December 4-5, 2012

Transcript of Proceedings

PROCEEDINGS

December 4, 2012

CHAIRMAN HERSMAN: Good morning. I am Debbie Hersman. I am Chairman of the National Transportation Safety Board. I'm joined by my colleagues this morning: Member Robert Sumwalt, Member Earl Weener, and Member Rosekind. Vice Chairman Chris Hart is unable to join us this morning.

We are here today to learn about the use of Geographic Information Systems, or GIS, in Transportation Safety. Here at the NTSB we see GIS helping us conduct better investigations across all modes of transportation. In addition, there are benefits from using GIS to help identify trends and areas of growing risk. For example, if we start to see a series of accidents and incidents, with GIS we can identify patterns, understand relationships, and use its capabilities to help develop countermeasures.

GIS is an exciting use of technology, both for what it can do and how it can work with other data sources, which we will hear more about today and tomorrow. I look forward to an extremely informative conference about how GIS can help in accident investigation, prevention, emergency response, and so much more.

Today we're going to be joined by a number of distinguished panelists across academia, industry, government, and the research community. We thank all of you all for joining us for this 2-day conference.

Now for some logistics. To begin with, we have a pretty tightly scripted agenda. We're going to have eight panels designed to cover a range of topics about GIS in Transportation Safety. The agenda is available in the lobby outside the board room and on the NTSB's website. The website also contains biographical information about the panelists, who have graciously availed themselves to participate this week.

Since this is a conference, it means that it is an organized meeting where individuals present materials and discussions are facilitated. I will lead each of the panels and we will be assisted by NTSB technical staff. Each panel will be opened with presentations by the panelists. The presentations will then be followed by a round of questions from our staff technical panel, and in some cases the Board Members may ask questions.

We have selected topics and panelists to address a range of GIS topics. Although we are not soliciting questions from the audience, we encourage your participation by e-mailing your questions to gis2012@NTSB.gov, and also through our public docket. Individuals and organizations who wish to submit written comments may do so until January 4th, 2013. Again, you can e-mail those comments and documents to gis2012@NTSB.gov.

Because we have a full agenda, we appreciate your cooperation in helping us to keep on schedule. We ask that panelists respect time limits and keep discussions focused on the subjects at hand. In addition to our midday break -- you are encouraged to get lunch at that point in time -- there will also be two breaks each day, in the morning and the afternoon. This is then an opportunity for all of us to chat with each other and network. We will keep to the posted schedule so that the agenda can be fully implemented, so follow that as your guide.

We have 12 exhibitors joining us today and tomorrow. You can visit them during the breaks and see several applications of GIS data and technologies up close. The exhibitors may also be able to answer your questions in detail during the break periods.

As for lunch, there's plenty of places to eat upstairs in L'Enfant Plaza food court. Go upstairs and when you enter the main underground walkway, head past the atrium and there will be several choices. I do want to warn you, though, the lines can be pretty long at lunch so make sure as soon as we break that you head in the direction that you want to go so you'll have time to get back before we begin the afternoon session.

In case of an emergency, please note the nearest emergency exit. You can use the rear doors that you used to enter the conference center, and there is one set of emergency doors on this side over here, and these you exit down the stairs and out.

If you've not already done so, please silence your electronic devices. The board room is not Wi-Fi equipped, but you can connect through the Internet if you have a Verizon cellular connection. Later this week, by Thursday morning, presentations provided by our speakers will be available on our website. Also, within a few days after the conference, a video archive of our webcast can be accessed through our web page.

Lastly, I'd like to thank our NTSB staff for their tremendous effort in organizing this conference. Vice Chairman Hart has told me about all of the work that you've done to put this together. He knows that we're going to have a great conference and he's sorry he can't be with us today.

We know that teamwork is critical to accomplishing the NTSB's mission and the team behind this conference epitomized the meaning of that word. They've identified and worked with a world-class group of experts and panelists who are going to provide us with an extremely comprehensive and varied agenda. It's been a pleasure working with this group from Office of Research and Engineering to put this conference together.

I will now turn the podium over to Dr. Ivan Cheung, who's been the lead on this conference. Dr. Cheung.

DR. CHEUNG: Thank you, Chairman Hersman and the Members of the Board.

I have two staff technical panelists assisting me in the panel. Dr. Joseph Kolly and Dr. Robert Dodd are both from the Office of Research and Engineering.

Dr. Reginald Souleyrette is a Commonwealth Professor of Civil Engineering at the University of Kentucky. Professor Souleyrette, would you please begin your presentation?

DR. SOULEYRETTE: Madam Chairman, Members of the Board, and ladies and gentlemen. I'd like to thank Chairman Hersman for the invitation to come today and speak, and Dr. Ivan Cheung for his kind assistance in helping me prepare these remarks.

This is the second highway safety conference that I've been to during which my daughter has been involved in a serious car crash. The good news is she's not been seriously injured, but I think I'm going to have to stop going to these things. Thankfully, and I am pleased to be here to discuss a topic of great national and obviously personal interest to myself.

Let's see if I can make this go. There we go.

By some accounts, geographic information systems turn 50 this year. There are some formal definitions of GIS we might use. We can think of GIS as the merger of cartography, statistical analysis and database technology. It's usually thought of as a system of hardware and software, people and procedures working together to capture, store, manipulate, analyze, manage and present all types of geographical data. More broadly, though, GIS can be thought of as geographic information science, or any spatially-enabled or location aware technology. For example, there are now three smartphone apps for collision avoidance. I wish the elderly gentleman that was behind my daughter had such technology in his car earlier.

GIS-T is GIS applications in transportation. These applications span across the modes. AASHTO, the American Association of State Highway and Transportation Officials, has held an annual GIS-T conference since 1988. More specific to this conference, there are also GIS-T safety applications. Many or even most of these have concerned highway safety.

As some in the broader audience may not be aware, the NTSB has identified its Most Wanted List. The Most Wanted List is the NTSB's advocacy priorities. It's designed to increase awareness of and support for the most critical changes that are needed to reduce transportation accidents and save lives. GIS can help in many of these. In particular, airport surface operations, infrastructure, pipeline safety, positive train control, or PTC, and collision avoidance seem to naturally benefit from applications of geospatial technology.

Mike Goodchild, Professor Emeritus from UCSB and member of the National Academy, notes GIS-T applications from the very early times of GIS. He characterizes GIS-T evolution in three stages: the map view, the navigational view, and the behavioral view. Dr. Cheung has asked me to provide a 30,000-foot view of GIS-T for safety, but since he did not specify the type of lens, though, I'd like to briefly introduce a view of GIS-T evolution through the perspective of one who has mainly worked with government transportation agencies on highway safety.

In 1989, we began using GIS to characterize the potential impacts of hazardous materials routing. The focus was on inventory and proximity, two obvious applications of GIS. During the 1990s, GIS had a significant impact on location accuracy of crash data. GIS enabled basic analysis by integrating crash and roadway elements. It facilitated multidisciplinary approaches to traffic safety, involving engineering, law enforcement, emergency response and the education community.

Around 2000, services based on GIS made use of more sophisticated analysis on the highway side. GIS fostered the applications of the emerging fields of spatial and Bayesian statistics to traffic safety.

Later, more user tools and analysis functions were added and distributed to engineering consultants, local law enforcement and state agencies. Expertise with GIS was not necessary to access larger and larger databases of crash and roadway data. Users close to decision makers could do their own analysis rather than depending on a centralized IT department to run queries for them.

In 2003, GIS was used to compile information from hundreds of local, mainly volunteer emergency responders to better coordinate planning and resources needs. Maps were considered less threatening ways to obtain information from volunteers that we did not want to over burden with paperwork.

Today, we are working with the AAA Foundation for Traffic Safety to improve and implement the U.S. Road Assessment Program using GIS for comprehensive highway safety planning. The intent of usRAP is to put risk at the heart of safety decision making and provide engineers, analysts and decision makers at all levels of government with tools to save lives in the most cost-effective way possible.

usRAP has been piloted in eight states and recently used to develop safer roads investment programs in some counties. usRAP is also a contributor to the "zero fatalities" component of AASHTO's UPlan, "a powerful yet easy to use web-based decision-support mapping and informational tool for completing complex planning and project development tasks." AAA and TRB sit on the advisory committee to UPlan.

I'm very proud to volunteer as a member of the Transportation Research Board. TRB is one of six major divisions of the National Research Council, a private, nonprofit institution that is the principal operating agency of the National Academies, which provides services to the government, the public, and the scientific and engineering communities. TRB's varied activities annually engage thousands of engineers, scientists, and other transportation researchers and practitioners from the public and private sectors and academia. These contribute their expertise in the public interest by participating on TRB committees, panels, and task forces.

TRB is supported by state transportation departments, federal agencies, including the component administrations of the U.S. Department of Transportation, and other organizations and individuals interested in the development of transportation. The mission of TRB is to provide leadership in transportation innovation and progress through research and information exchange, conducted within a setting that is objective, interdisciplinary, and multimodal.

TRB Technical Activities Division is organized into some 200 committees and task forces, these organized into sections and groups. As current chair of the Data and Information Systems Section, I would like to mention some of the many TRB committees involved in GIS or transportation safety.

A quick search of the Technical Activities Division webpage indicates 37 units related to safety or human factors. Within our own section of Data and Information Systems are 29 standing or special purpose committees comprised of more than 1,000 members and friends dedicated to information technologies and data. Thirteen committees list GIS in their missions or scopes.

Within such a large organization, it is easy to miss what is going on in other committees or groups. Each year during the annual meeting of TRB, a crosscutting group meets to discuss and coordinate among data and safety issues. Attendees include representatives of federal, state and local transportation organizations. This slide shows just some of the relationships between TRB data and safety committees. Common topics deal with data collection, analysis and management challenges and opportunities.

TRB is a terrific venue for continued work on GIS for transportation safety, and we are pleased to be part of this NTSB event. We welcome participation from the Board, in that there are plenty of challenges to work out:

Big data is the buzz word. How do we deal with it? Yet, even today there is lack of data (e.g., traffic on local roads, road inventory elements, and many data considered too sensitive for public release).

There are inter-operability issues, creating obstacles for efficient integration.

There is no multimodal national network.

In some areas, there is lack of an authoritative data source.

Data quality is important. Quality metrics include timely, accurate, complete, uniform, integrated, and accessible.

Despite the exceptional integrative nature of GIS, development and application is fragmented. At this conference we will try to create an opportunity to deal with this and ask TRB to play a significant role.

Fortunately, there is the Federal Geographic Data Committee, private-public collaboration and the open GIS consortium.

There are big new questions, and some big old ones that remain. The document on the right that you can't read comes from the 1989 AASHTO GIS-T conference proceedings. It refers to the challenges of education, organization, control, the federal role, standards, integration, and so forth. It still sounds familiar.

There are even some questions that most people would think are easy or have already been solved, such as maps with missing features and inconsistent representations, problems arising from the improvements of only parts of maps, continued discussion on how best to represent and access features in GIS, missing information which is key to good decision making, struggles with appropriate topologies for analysis -- Dr. Cheung, can you help me out? I seem to be bouncing back and forth between slides. Move on to the next slide and the next one, please, and the next one. Thank you.

And even the realization that how we describe our data may have more of an impact on decision making than on the choice of analytical technique. Let me say that again because the slide here indicates the number of intersection crashes. The size of each of the dots there is the number of intersection crashes, depending upon how you define an intersection crash. Clearly, you can see that how we define an intersection crash is going to have a big impact on the outcome of our analysis, no matter how fancy the statistical technique used.

Going back to big data. How can we understand and use big data when it comes in such an unstructured format? I mentioned that GIS turned 50 this year. I like to think of 50 more like the 32nd anniversary of my 18th, probably you -- like that too.

Do we have 50 years of progressive experience with GIS? What has fundamentally changed? In 1962 Roger Tomlinson wrote about big data without calling it that. He recognized even then that a situation -- this is a quote, "a situation can be reached where the amount of data precludes its use." Mr. Tomlinson's comments are more poignant today. Transportation futurists see a world with billions of embedded sensors. Even today, traffic systems' cameras and sensors produce data volumes that we cannot keep up with.

In TRB's Strategic Highway Research Program, GIS is being used to collect, process and serve immense volumes of naturalistic driver data. Lidar is becoming ubiquitous. Issues include not only expense and obvious benefits, but massive lidar datasets require much highly specialized labor to post-process and make useful to decision makers.

Now even low-cost sensors produce huge datasets. At Kentucky we built a 3D scanner with submillimeter precision costing less than $5,000. Using a technique called structured light, our initial application is safety and performance of at-grade railroad crossings.

We have a long history of rail research at UK. The photo, from 1916, shows campus dignitaries dedicating a monument to the first piece of track laid west of the Appalachians dating 1831. The track had no ties, as made of strap steel and screwed into limestone sills.

When building our sensor, we didn't initially shoot for submillimeter precision, only low cost and fast. There are over 217,000 railroad crossings in the United States, so we need fast. Smaller railroad companies also need low cost.

This is an example of the image resolution. It is possible with the scanner to identify cracks and other deviations in the rail.

These are not photos, rather reconstructed 3D images that can be stitched together to present a complete and detailed 3D model of track structure. I believe it makes a nice contrast to see our 2012 sensor on that piece of 1831 track. Note that the gauge is the same, 4 foot 8½.

In summary, we have technology that solves problems but sometimes creates new ones. We then need regulation or other technologies to mitigate the problems caused by the initial solutions. However, I am optimistic. The latest issue of *Berkeley Engineer* reports on a possible USB port for the brain, a virus that creates electricity, and a toilet that produces disinfectant and sterilized fertilizer; we should be able to meet the challenges of GIS for transportation safety.

To conclude, I'd like to suggest two questions to think about during this conference: How has the development and application of GIS technologies and analytics enabled the improvement of transportation safety? And, what are some of the most critical challenges and obstacles facing GIS professionals?

The USDOT is taking on a leadership role in coordinating various GIS and geospatial activities among different agencies. I'm looking forward to hearing from our next speaker, Mr. Stephen Lewis, about USDOT efforts and to the rest of this conference.

Thank you.

DR. CHEUNG: Thank you, Professor Souleyrette.

Mr. Steve Lewis is the Geospatial Information Officer at the U.S. Department of Transportation. Mr. Lewis, would you please proceed with your presentation?

MR. LEWIS: Good morning, everyone. I'd like to thank the Board for having me here today and I hope you enjoy my presentation.

These are the topics I'm going to cover this morning. First, I'll go over the USDOT organizational structure for those of you that aren't familiar with it, talk a little bit about the geospatial programs that exit there, and then go into the geospatial coordination that we are trying to do there. The bulk of my time I'm going to spend on Transportation for the Nation because I think that is of the most interest to the safety community because we are trying to build complete geospatial databases for transportation that can have a tremendous impact on safety. And finally, I'll cover moving ahead for progress in the 21st Century, or MAP-21, and there are plenty of implications in MAP-21 that could greatly help this effort.

USDOT is, like most federal agencies, split up into many parts. Here I listed the 13 operating administrations that exist under USDOT. I'm not going to bother to read the entire list to you, but if you take a look, you'll notice that most of these operating administrations are focused on a single mode of transportation.

Now almost all of the operating administrations do have a geospatial program. Some of them have many geospatial programs. A few of them are dedicated, such as mine at the Research and Innovative Technology Administration, but others are just job elements or other duties that are assigned to the employees there. And almost -- the sole exception is the Research and Innovative Technology Administration -- all of these GIS programs have a modal bias.

So for better or for worse, RITA, the Research and Innovative Technology Administration, does lead the geospatial coordination efforts at the USDOT. In 2008, I was appointed the geospatial information officer there. In my position I am not a decision maker, so part of OMB requirements, we also needed a senior agency official for geospatial information, or SAOGI. That currently is my boss, the director of the Bureau of Transportation Statistics, Patricia Hu.

We are also mandated by Congress to be the lead for the transportation theme of the National Spatial Data Infrastructure, or NSDI. And my group at the Bureau of Transportation Statics annually produces what we call the National Transportation Atlas Databases, or NTAD. And that is our representation of the transportation theme. It does have its gaps that we constantly are trying to fill, but that is our version of the transportation theme.

My staff and I represent the USDOT in the Federal Geographic Data Committee. We also respond to the OMB e-Government initiatives when the data calls for that. We also try to stay in the geospatial community as a whole, and we participated in the meetings of the National States Geographic Information Council and the National Geospatial Advisory Committee.

Now I'm going to move into Transportation for the Nation. I'm always embarrassed to say that the concept of Transportation for the Nation emerged from the National States Geographic Information Council and an issue brief that they published in 2008. They, before USDOT, recognized the need particularly for a complete representation of a road network. USDOT at this point had only been interested in federal aid highways. So we had good representations of those federal aid highways, but they only represent maybe 15% of all roads. OMB Circular A-16 does identify us as the lead agency for transportation, so we really do need to worry about all roads and this issue brief kicked us into gear.

And, in addition, emerging data requirements at USDOT, particularly safety-related, made us recognize the need for a complete road network. After all, not every accident is located on the federal aid system or occurs on the federal aid system. And we also think that the Transportation for the Nation initiative fits in well with the emerging concepts across the federal government, such as geospatial platform.

The concept is simple. The quotation there is directly from the 2008 issue brief, "creation and maintenance of high quality nationwide transportation data that is in the public domain." There has never been a complete road network in the public domain. Some may argue that the Census TIGER files contain the roads, but they are not suited ideally for transportation analysis and for transportation purposes.

I do want to state here that although the bulk of our effort so far has been focused on highways and roads, we do want to expand Transportation for the Nation to include all modes of transportation and the interconnections between those modes.

So, basically, we spent about a year and a half developing a strategic plan for how to build this complete road network. That year and a half took all of 2010 and parts of 2009 and 2011. And the most important thing we did is the first bullet there; we went out and talked to our stakeholders. There had been many efforts in the past to try to build a complete road network, but they were viewed as USDOT or Federal Highway Administration efforts and they were pretty much doomed for failure because of that. We went out and talked to everybody that had interest in using road data and we got consensus on how to proceed and we believe that this is viewed as a community effort and not just a USDOT effort.

The next, stakeholder outreach. Here is some of the interviews we did here locally without having to travel. Spent a bit of time in USDOT talking to the various agencies on the list there, but we also reached out to our federal partners and the special interest groups. We talked to, of course, the Census Bureau and United States Geological Survey. We touched based with the American Association of State Highway and Transportation officials, the Transportation Research Board, even the National Emergency Numbers Association. We asked them what they needed to see in a roads database and where that roads database should come from.

We also took advantage of various GIS conferences across the country and help workshops where we got audience participation to tell us how to proceed. Our first workshop was at the AASHTO's GIS for Transportation Symposium that Rich mentioned earlier. We also had workshops at the NHTSA conferences, at the ESRI International User Conference, at URISA's GIS-Pro, and we, of course, presented to the FGDC Coordination Group, the steering committee, and to the National Geospatial Advisory Council.

But what came out of all of this outreach? Well, it was a simple concept. You know, it was the road network should be a baseline geometry with what we coined the "special sauce" that falls on top. So basically we have a base geometry that represents all of the 4 million miles or so of roads, and the users are -- we're going to add functionality. They add their own special sauce, so to speak.

This is my favorite graphic. It's a pretty good representation of the position of Transportation for the Nation effort. That hamburger patty on the bottom is the baseline geometry that everybody will be using, and they're going to add their own toppings and make it their own.

So what was the recommendation after all of the outreach and the strategic planning effort? Well, we decided that the model for Transportation for the Nation was an existing program. The Highway Performance Monitoring System that exists within the Federal Highway Administration.

Now, for those of you that aren't familiar with HPMS, it's basically a large database of conditions and performance attributes for all federal aid roads. And it's been in existence since the '70s. Basically, for almost 30 years it was nothing but a flat file, an ASCII file. It was collected by the state either to use and submitted to the Federal Highway Administration every June so the annual update process is already there.

Starting in the 2009, 2010 time frame, the Federal Highway Administration started requiring that each state DOT submit a GIS network along with the HPMS attributes. Of course, based on what I said earlier, that GIS network only included, or only was required to include federal aid roads. After our outreach and our planning effort, we thought this was an ideal place to start. The annual update was there. The requirement for a network was there. All that needed to be done was expand the requirements so that we received all roads from each state DOT.

Now, there are, of course, obstacles associated with that model and, of course, the first is to change the reporting requirements. And I'll go more into that a little bit later because that has happened now. Also, by HPMS rules, pretty much every state is an island. They're not required to work with their neighbors for that kind of activity, although we think we can address that as well.

At the time, before MAP-21, there were no dedicated resources to try to make this happen, to try to get complete road networks from every state. Also, the GIS programs at each state DOT are at different levels of maturity so, of course, there are different levels of accuracy at each state. So we felt like that regardless of that we had to have a starting point and we felt like this could be the best starting point.

And although there was general agreement that state DOTs are an authoritative source, there's really an independent verification that there be a -- it is authority of all the -- they certainly think it is and Federal Highway Administration agrees.

At the end of the planning effort we conducted several case studies that I coined mini TFTNs, because it proved that this concept can work. In Ohio, the state is activating the individual counties in providing matching funds for the counties to build an interconnected network up to the state level. And all these case studies I'm mentioning here, resulting data is going into HPMS program already. So New York is an example of a private-public partnership, where they actually use NAVTEQ data and NAVTEQ has allowed them to distribute the geometry for these purposes.

Michigan was a case where the state DOT didn't have significant funding, so the state GIS coordinator took it on as a entire state project, not just a DOT project. And they worked together to build the road centerline network.

In Kentucky, it was all based around E9-1-1. They needed a centerline network to route emergency vehicles, so they used that type of funding to build a network, again, partnered with the other state agencies and it is used in HPMS.

In Virginia, there was a consortium of counties here in Northern Virginia that just got together on their own with a handshake agreement to build their E9-1-1 databases to ensure that connectivity occurred across the borders, and that gets fed into the statewide database.

In Washington, they used a full-fund study with multiple state, regional and federal government agencies to build a network across the Northwest Region there. And I-95 Corridor Coalition built a multistate database that included complete networks for every state that includes a portion of I-95.

So as you can see, this type of collaboration is happening already and there's no reason why we can't make it work for Transportation for the Nation.

We completed the strategic plan, a final draft, in Spring of 2011 and we presented the findings from the plan, including HPMS as the model. We presented it to the National Geospatial Advisory

Council on June 8, 2011. And the very next day, NGA endorsed the strategic planning process and the recommended that we proceed with a business plan to make this happen. I'm very proud of that endorsement and I think that this is an indication that this stakeholder outreach was the proper way to do this.

Will the business plan happen? Probably not at this point. My agency did not have the money to fund it. The Federal Highway Administration, although they have deep pockets, they felt like they really didn't need a business plan, which worries me a little bit because we need to keep the stakeholders involved to continue this be community effort and not just a Federal Highway Administration effort. But as I'm about to go into, MAP-21 is going to make this happen, so hopefully, we can make it work without the business plan.

Back in July the President signed into law, Moving Ahead for Progress in the 21st Century, or MAP-21. It funds the surface transportation programs for the next 2 years, 2013, 2014. And the big news for us into this -- year, it included almost 5 billion in funding for what is coined the Highway Safety Improvement Program. Under that Highway Safety Improvement Program there is a requirement to develop a base map of all roads, and that base map will be used to attach safety attributes. And HSIP funds can be used to develop the networks within the state DOTs. That's an eligible expenditure for these funds.

The Federal Highway Administration was pleased that the strategic planning for TFTN did point towards their HPMS program. They embraced it. They began working together. And when MAP-21 was passed, instead of trying to recreate the wheel, the Office of Safety in Federal Highway Administration got together with the Office of Policy, which houses the HPMS program, and they decided to follow the recommendations of the strategic plan and to build the base map from the Highway Performance Monitoring System.

A memo was issued to each state DOT changing the requirements from federal aid roads for the network to complete roads, and not only that, the requirement for a dual carriage-way representation where appropriate. So that means interstate highways, for example, will not be represented by one line, but by a line for each direction.

They also, in order to make life a little easier on the state DOTs, the Highway Safety Improvement funds are available for this, but traditionally what's known as state planning and research funds have always been available to build the GIS networks, but they required a match. So for every dollar that the feds put in, I believe the states had put in 50 cents. Well, in order to make this easier on the states, they dropped the match requirement for the state planning and research funds.

Starting in June of 2013, each state has to have to have a plan of action on how they're going to submit the road networks, including the dual-line representation. And based on that plan of action, the complete road networks will start coming in the Federal

Highway Administration in the summer of 2013. You might say to yourself that's still a year and a half away, but other than working at USDOT for the better part of 25 years, it's never come this close before. So I think this is a huge step forward.

So what's next? We're going to continue to try to keep the stakeholders involved and one way we're going to do that is through the Federal Geographic Data Committee's transportation subcommittee. And in addition to the stakeholder involvement, we want to expand USGN to include the other modes of transportation and the interconnections between those modes and work towards the multimodal transportation network that Reg noted is presently lacking.

So I have 2 minutes left. Thank you for your time.

DR. CHEUNG: Thank you, Mr. Lewis. You actually have 2½ minutes left.

Dr. Dodd, would you please start with your question?

DR. DODD: Sure. I have a few follow-up questions. Let me start with Professor Souleyrette. You mentioned the usRAP program as part of your presentation. The question I have -- there's three questions, actually: Is this a demonstration program? How are the data being used or how will they be used? And what's the long-term goal of that particular program?

DR. SOULEYRETTE: Thanks for your question. In its current state, usRAP is a demonstration program, at least at the national level. It has been implemented by a few counties and, as

I mentioned, in Utah will be part of the new plan overall asset management program using GIS.

The data are used in several different ways. usRAP has really four different protocols. There's risk mapping which takes into account exposure and severity of crashes to identify those route segments that are at highest risk in the state. We also, for those areas that don't have as good underlying data, which are most of your local roads, we have a protocol called the star rating, whereby the road is assessed for its ability to provide safety to the motorist. We realize that human factors are extremely important in causation of crashes, but, for example, if someone makes a mistake to choose to drink and drive, you know, that will often end up in a death penalty for someone. We believe that roads should be more forgiving and that that should not be the inevitable consequence of stupid decisions on people's parts. So we do have a way to rate the roads for their protective capability.

Probably the most important part of usRAP though is its ability to recommend safety mitigation strategies for state and local highway authorities. And so that's the safer roads investment program part.

We have eight states that have participated in the program so far. AAA has a vision that this would be a national program, strictly a voluntary program right now. States can participate if they choose to.

DR. DODD: Okay. Thank you.

I have an additional question, actually, perhaps suitable for both of you to respond to, if you care to. And that is, data is so central to the whole GIS system and for analysis -- one had spoken about this, this morning, whether or not it's a problem, is the issue of privacy. Are there certain types of data that are problematic from the point of view of being private, perhaps that's collected in the private sector and the data that's actually available in the public domain?

MR. LEWIS: Sure. Very little of the transportation data has those concerns right now. There are programs within DOT -- I'm thinking of the Federal Railroad Administration where they do use proprietary data, but that does not get distributed to the public. Also, everything at USDOT geospatially is public domain right now, with the exception of the national pipelines database, and that was deemed to be a for official use only. So I recognize that it can be a concern, but presently it's not.

DR. SOULEYRETTE: Institutional issues, legal issues and tort liability, these are things that the usRAP program, for example, is carefully considering. There are, I would like to add, in addition to privacy issues, that -- a whole legal concern about the release of data. Congress has set forth legal protections for states and local agencies that put out crash data, for example, such that those kinds of data cannot be used in court against the government agency. There are still states that are very risk averse. You know, I believe New York has something like $8 billion of tort litigation in the court systems at some point and it's pretty typical for a very large state like that. And so they're really not that interested in making the problem worse. So there's legal concerns.

The privacy of crash records varies state to state in interpretation. Not only are there some real concerns about privacy and legal issues, but there's a whole lot of perceived concerns and it's a lot easier to stop something from happening than to get something going.

DR. CHEUNG: Thank you. In fact, though, we actually have a couple of questions from the conference audience. And the first question is for Professor Souleyrette. And can we have slide 3 pulled up? The question is regarding this Android app about collision avoidance. The question is can he elaborate on the technology behind this particular app?

DR. SOULEYRETTE: Well, actually, this is a fairly simple app that just uses the camera in the phone, the smartphone, to get the image that you're looking at here through the front windshield and then using some real basic image analysis and calculations it tells you how long it will take you to get to the vehicle that's in front of you. Like this particular example is a 1.8 second app, which is close to the 2-second recommended following distance. And when the gap starts closing rapidly it'll send out a warning. It's not really GIS, but to inform the slide by saying there's a whole lot of location aware technologies out there that I don't think that we should just use a strict definition of GIS in our discussions.

DR. CHEUNG: Thank you. The second question, I suspect that is coming internally from NTSB, and this is for Mr. Lewis. The question is, you mentioned that you actually have to work with 12 different agencies within USDOT and they're all modal specific, and NTSB is also divided up into different offices. Can you comment on the difficulty and then also some approaches that integrate the different agencies in terms of coordinating that office?

MR. LEWIS: Yes. What makes it particularly difficult at USDOT that my position as GIO is appointed with no budget, no staff, and as I like to say, no carrot, no stick. So what I've tried to do is build a community of peers or a community of interest, as a former DOT administrator said, and make it known that it's in the best interest to work together in these tight budget times to build programs to make sure that we're not duplicating efforts. That being said, we're going to be forced to use a carrot or a stick here soon because GAO recently just last week or the week before released a report on geospatial coordination across the government. DOT was one of three agencies that were interviewed and none of the three fared very well.

Some things I wasn't happy with, we were dinged for not having written policies for doing things like creating metadata that we've done every year since 1995. But since we don't have a written policy we did not score well. But we are going to have to do better coordination, more official coordination, and towards that end, we are in the process of creating a geospatial advisory or policy council. It's going to be chaired by BTS Director Pat Hu. I'll be sitting on with her and we're going to have decision makers from each of those 13 operating administrations so that we can develop geospatial policy and make sure that it's followed in the department.

DR. CHEUNG: Thank you, Mr. Lewis.

And I guess I should ask my question now. At NTSB we're often faced with the issue of not getting a full piece and precise or good exposure data.

Professor Souleyrette, you mentioned that there is also a need of having a lot of data. Can you comment on whether the new geospatial technology such as employed intelligent traffic systems or intelligence transformation system may help with that cost?

DR. SOULEYRETTE: I would hope so. Exposure is a real problem, not only in the highway mode, in particular for rural areas, but in the other modes as well for pedestrians and bikes. One time when I was working with the Iowa DOT, we borrowed a sensor that you could put next to a path and it would detect the presence of pedestrians as they would go by. And it had a little bit of light on it. Well, some concerned pedestrian saw this box, reported it to the police and the bomb squad came out and blew it up. That's not something you would anticipate as a problem for getting exposure data.

But I think some of the technologies such as Bluetooth and other passive sensors can do a good job of getting exposure data on heavily traveled routes. For those less traveled routes where really exposure is still critical for making investment decisions, I think we probably have to go to some type of remote sensing type of technology, satellite sensors or something that can get us get ahead when it's just too expensive that formally involves a road count, every road often enough. Some of these roads, if you set a camera out there, you'll double the mileage, so --

DR. CHEUNG: Thank you. The follow-up question is do you envision that more and more coordination will be happening with navigation commercial business like TomTom and Garmin and placing that would be able to at least at the highway level be able to help us with that?

DR. SOULEYRETTE: Indeed. And I know that, for example, AAA is working with NAVTEQ to incorporate some of the data and to help each other in providing better information to the public and also getting some of the underlying data then needed to support the systems.

DR. CHEUNG: Great. Staying on focus on the exposure data, I would like to ask Mr. Lewis to comment on if there is any plan in the NTAD, the National Transportation Atlas Database, to incorporate more exposure data; it may not just highway, but also other modes?

MR. LEWIS: Currently there are no plans. We just had a meeting last week on the latest steps forward for NTAD and one thing that we have neglected in our congressional mandates to produce NTAD is flows of getting goods and people. So in the near future we will be working on incorporating the flows into the NTAD data.

DR. CHEUNG: Thank you.

DR. SOULEYRETTE: Dr. Cheung, if I could just follow that up briefly? I meant to mention that some of the geospatial technologies are also going to be very helpful in computing some of the traffic volumes and exposure levels that we can't really afford to go out there and collect. I think some definite progress has been made toward that using geospatial statistics.

DR. CHEUNG: Thank you. My next question is for Professor Souleyrette. I'm particularly interested in the sensor that KU built, the scan that is -- the railroad. And you mentioned the criterias of fast and low cost. Can you tell us a little bit about how fast can you stitch together all these 3D images and at what cost? And how far are we away from having widespread deployment of such technology to the rail industry?

DR. SOULEYRETTE: Well, you can win a national championship in basketball, but they still call you KU. I shouldn't talk about basketball this year. We're not having such a hot year.

But anyhow, to answer your question about the sensors, it's -- I'm a civil engineer. My angle on this is really from the grade crossing side of it. We can collect the data. Right now the prototype we have, it takes -- well, once you set up, you click a button, we'll get the image, but we have to take quite a few images to cover an entire rail crossing, say, about 100. And the very first time we did this, it took us about an hour to cover a railroad track crossing.

The goal by the end of the year is to get that down to about a 10-minute process. Once we get it on the rail instead of on the highway and roll through, it should be a matter of just being able to stop, take the pictures and move on.

The stitching right now takes some time. In the lab we're still working on some of the -- 3D stitching is not as easy as the 2D stitching. And that's really occurred here, the electrical engineers that I'm working with right now. The goal there, though, is to be able to have it stitched by the time we move out to get the next image.

And then the last part of your question again, if you don't mind?

DR. CHEUNG: Sure. How far do you think that we are away from having widespread deployment of such technology throughout industry?

DR. SOULEYRETTE: Okay. The Class 1 railroads already have technology so they can roll down the track at operating speeds using geometry cars, which also have the advantage of loading the track while they're making admissions. That's really our -- they already have sensors that can look for cracks in the rail and the cant of the rail and the superelevation and all that. That's already out there.

What's not out there is something for the highway departments to use in looking at the rail crossings from their perspective. And also what's not there is something for the short line railroads that can't afford to use fancy technology the Class 1's can use. So that's the next issue.

DR. CHEUNG: Great. Thank you.

I have a question from one of my colleagues here. Based on your experience in the fields of transportation safety and your participation on TRB, what are some of the most critical advances you think in the last decade or so that facilitated an integration of GIS technology in transportation safety?

DR. SOULEYRETTE: Is that a question for me?

DR. CHEUNG: Yes.

DR. SOULEYRETTE: Thank you. I don't know if young people could be considered a technology or not, but I think getting young people involved has been incredible. They're just so used to using these kinds of technologies, it's natural for them to want to use them in the analysis. Young engineers that are coming out, for example, they want to use GIS and GPS. I think big technical advances. Garmin got to do pervasive GPS, GPS in everything, mobile applications. The fact that it's becoming easier for more people to use.

DR. CHEUNG: Thank you.

Dr. Dodd, do you have a question?

DR. DODD: Yeah, I had a follow-up question for Mr. Lewis. You mentioned in your comments the coordination and challenges you face both at the federal level and I assume the state and local levels too when those opportunities arise. You also mentioned the lack of carrots and sticks to help move your mission along. What types of carrots would be useful, do you think, to help us locate, improve coordination among the various stakeholders?

MR. LEWIS: As always, I think funding. If there was a central pot of funding for geospatial activities and you had to present your project to a council and get funding by the council, approval, I think that's the best way to keep the policies in line.

DR. CHEUNG: I have another question for Mr. Lewis.

You mentioned that MAP-21 includes funding for highway safety improvement program that requires the development of base maps of all roads onto which safety attributes can be attached. Can you share with us what kind of safety attributes may be included or perhaps even some candidates' safety attributes? If not at the moment, how does FHWA plan on identifying these attributes and, in your opinion, would you foresee NTSB making some recommendation?

MR. LEWIS: The two easiest attributes that Federal Highway will be grabbing first are accidents, of course. They've already got a database, the Fatal Accident Reporting System, that's for fatal accidents. They want to expand that to include nonfatal accidents as well. And studying that geospatially is one way to determine cause of the accident and ways to prevent it. So that's going to be a low hanging fruit to begin with.

And additionally, I consider the safety of -- you might also call it asset management. They want to be able to locate the bridges and the tunnels and know where the deficient bridges are and how -- and figure out a way to prioritize how to make improvements to those deficient bridges. And, yes, I do think in the spirit of trying to keep this a community effort, I think there's definitely opportunities for NTSB to influence that in the entire community. And I mentioned earlier that my effort with Transportation for the Nation started with the National States Geographic Information Council. I think that's another good resource for NTSB. And I want to mention Kenny Miller is in the audience representing NSGIC today.

DR. CHEUNG: Thank you. Another question. You said that -- I'm making a list. You said that a plan of action is required by each state DOT by June 2013. We are about 6 months away. Are most states ready and what kinds of federal assistance and guidance are provided for these states?

MR. LEWIS: Believe it or not most states are ready. In fact, quite a few states -- I think last year as many as 20 of the states submitted complete road networks without being officially required to. Quite a few more states had the capability to submit complete road networks, but because Federal Highway only required federal aid roads, they chose to extract federal aid roads rather than to submit complete networks. So the plan of action I think is going to be more for the states that aren't as far along and Federal Highway Administration, in particular the HPMS group, is going to be there to help them, guide them, and the funding is there for them to move this forward.

DR. CHEUNG: Okay. Thank you.

There is another question from the audience here. Can you give us a sense of whether the U.S. as a country is training enough geospatial specialists with the proper skills to handle the expanding workload in the future? This question is for both of you.

DR. SOULEYRETTE: Well, kind of everywhere you turn in academia there's a GIS certificate program or GIS classes. I'm teaching a GIS class this coming spring. There seems like we've had enough classes. You do see an awful lot of advertisements for GIS positions from e-mail and from the Internet. I think if we weren't producing enough perhaps the salaries would be a little higher. I believe sometimes they're a little bit low for some starting GIS professionals. But I don't think that GIS professionals -- I mean, yeah, we need some people just in GIS, but

I think maybe more important is people that have basic classical training in planning or engineering with additional GIS skills, is much needed. And we need to provide a better way for practicing professionals to be able to make the time to get some of this continuing education. And so I see that's probably the biggest move yet.

MR. LEWIS: I agree that there are plenty of geospatial programs out there and I just think that there is a need for supplementing the programs, as Reg said. I've been shocked by the number of young GIS-ers that I've run across that have absolutely no programming skills. And I don't think you can succeed without the programming skills and Internet mapping application development skills. I think there's a little bit of a gap there.

DR. SOULEYRETTE: Steve, I just read an article about that, that there is a issue and it turns out, I think, that people are hiring GIS professionals thinking they're getting a programmer. They want to apply for a GIS analyst, but get a programmer, so there may be a bit of a disconnect there.

DR. CHEUNG: Thank you. I believe that Dr. Kolly has a question.

DR. KOLLY: Yes. I'm thinking about the traveling public and the example you gave of the app, the collision avoidance app was very interesting. What do you foresee being available for the traveling public to help them personally in their travels. For instance, we probably all have GPS to help weigh our travels and we can select things like quickest time, no tolls. You know, I'm just thinking of a point where we select safest route or anything like that. What's on the horizon?

DR. SOULEYRETTE: That's a tough one. That's almost like asking last week when I asked 120 incoming freshmen how many of them felt the aspects of the increase and one sheepest person in the background raised their hand. So it's one person who I got approved.

If you ask people if they would choose the safest route at the expense of time or some other metric that they usually use to a certain route, I'm not sure you would get a whole of takers, but there are people that are choosing to buy five-star safety rated cars all the time. I think we need to provide information to people so they can choose five-star rated roads. To me it doesn't make a whole lot of sense to buy a minivan to protect your kids with five stars of protection and when we could take a route that was 25% safer, for example, or less risky, that you wouldn't want that information as well. And that technology is very near. In fact, it's one of the goals of the usRAP program.

DR. CHEUNG: Thank you.

Chairman Hersman, the first panelists has completed our questions and back to you.

CHAIRMAN HERSMAN: Thank you very much, Dr. Cheung.

I just have one closing question for you all. Someone mentioned that GPS is in everything. How do you leverage what's available through new technology and information but also within the GIS community address privacy concerns?

DR. SOULEYRETTE: I believe Mr. Lewis will take that question.

MR. LEWIS: As I said before, we haven't really touched on privacy concerns much, but when it comes to data -- Census street map, where it's crowdsource community data, the big question there is not really that of privacy concerns but it's been a third source and do we want to build a network that might be used to route an emergency vehicle on a crowdsource database that hasn't been independently verified. So, again, I -- at the DOT level there's just not much data that is considered private now.

DR. SOULEYRETTE: Chairman Hersman, I think that's a great question. It goes back to the big data issue that I brought up, where we're looking at keeping everything. And it's volume, very high velocity data stream that's coming and what we're doing is we're picking off information that we need and -- we can protect the individual privacy and get the kind of collective information that we need. But I'm not sure that the trust is there on the part of at least those that are elected to represent the public interest. I'm not sure the public really cares that much. They're always placing their own private information everywhere on the Internet all the time. But I guess as elected officials, they must express concern -- be concerned about that.

CHAIRMAN HERSMAN: Thank you all very much, Dr. Souleyrette, Mr. Lewis. You all have been a great lead off for us. We're ready for the next panels to come and we'll get a little bit more modal specific, Mr. Lewis, and we'll continue to talk with you. We very much appreciate all of the support from DOT and the modal administrations and the coordination. And "Go Wildcats." I hope that Coach Cal can turn it around. So thank you all very much for your opening presentations.

We're going to take a 20-minute break. We will be back at 10:30.

(Off the record at 10:10 a.m.)

(On the record at 10:30 a.m.)

CHAIRMAN HERSMAN: We'll now begin with our second panel of the GIS forum. Dr. Cheung.

DR. CHEUNG: Thank you, Chairman.

In this panel I am being assisted by three staff technical panelists: Mr. Bill English from the Office of Aviation Safety, Dr. Eric Emery from the Office of Communications, and Dr. Loren Groff from the Office of Research and Engineering.

Dr. Nadine Alameh is the Director of Interoperability Programs of the Open Geospatial Consortium.

Dr. Alameh, please begin your presentation.

DR. ALAMEH: Thank you, Dr. Cheung.

It's my pleasure to be here this morning on this panel. I'm very, very happy because the four organizations represented on this panel: the Census Bureau, FAA, NASA, and USGS are all members of the Open Geospatial Consortium, so they're already strong supporters of geospatial standards and I think this going to make my talk very, very easy. So thank you.

So let's get down to business. I'm very happy, actually, to be following also the previous panel. I want to build on a point that Professor Souleyrette mentioned, that we're going from GIS, beyond GIS to geospatial, hence the geospatial standards here. And hopefully, that will set the tone for the rest of the day or even the event.

So why we're here, I think it's important to let you know at least my perspective so you can put it into context. It's really because location, location, location is important to us in general and it's important, it's critical in transportation. And specifically, it's important for transport efficiency, logistics, routing, trying to find where you are in, you know, remote places all over the world. And more recently -- again, this was mentioned in the prior panel -- just the explosion of the mobile applications out there that rely on location as one of the inputs to give you the information that you need and that's relevant to your location. And we're still pushing the limits with, you know, standards for the mobile platform, but also standards for augmented reality. I mean, we're really going all out there, again, with the support of the young people who probably only know this and don't know the actual GIS that, you know, we grew up with.

So as a consortium, so we are a membership organization, about 500 members right now, international. We want to location and geospatial information and standardize it, standardize how you access it, how you discover it, how you integrate it with other information, and how you model it. So our member organizations are -- you know, hopefully, you recognize many, many on this slide and, you know, many others. But you'll see the traditional GIS players from, you know, ESRI and the integrators, like Intergraph, but also you see, you know, the Google and the Microsoft, which is essentially emphasizing the point that location is now just everywhere. It's not just in GIS.

And for the government organizations, I've already made my point. You know, this is a very strong collaboration. In general, to make any standards, not just geospatial, you need the collaboration amongst industry, research, academia, and of course, government. And once again, my fellow panelists' organizations are up there, and you'll see their equivalents really all over the world in Europe, Australia, the Middle East, and Asia.

Location is very important, but it's not the only thing by no means. So location is really part of the package and if we really want to standardize the location and be able to consistently handle location, we need to be working with many communities. We call them alliance partners. So these are standards organizations. So if we're dealing with the World Wide Web, if we are dealing with notification, we'll go to WCC or Oasis or IETF. And often, because location is part of the package, you have to deal with domain-specific standards as well. So you'll see also domain-specific organizations out there like the World Meteorological Organization, for example, or buildingSMART. So it's really across the board and this is an important point that, you know, with standards you just can't do it alone. You have to collaborate and you have to collaborate often.

And I'm not going to go into the details of the standards, except there's a whole suite of them out there available, of course, on the website and we have a poster out there, you know, or ask me questions. You can Open Location Services out there. There's a suite of web services and a suite of encodings. I'm also happy the prior panel mentioned sensors and sensor web. This is another big topic.

So we're trying to share not just information from the traditional GIS system but also information that's coming directly from the sensors out there. And the sensors can be NASA satellites, for example; big sensors that you can task and get observations and satellite imagery. And they can be water quality, air quality, earthquake, you know, detectors and so on. So it's a big range of geographic information out there.

The problem is interoperability. There's a lot of data out there, and you can see, you know, several codes on this slide. We don't have a common language. We need to find and pull together information from different sources, existing sources and future sources. We want to deliver this data to different systems. We want to be able to share maps on the web, across devices, not just on the desktop, but also on your iPad, on your iPhone, and so on.

So standards, essentially, just can pull all this together. And I'm very glad that, you know, this is actually a topic on this panel and in this event in general so we can keep it at least in the back of our heads to minimize the headache of information sharing amongst all of us.

Developing standards in a consortium such as ours is driven by community needs. Some problems are cross-community, of course, but others come from specific domains. And you can see here infrastructure transportation is one of the domains as well. And, honestly, the cross-community information sharing comes up more frequently than one thinks and mostly, unfortunately, in disaster response situations when you really need the data and another community might have it.

I have many, many examples of geospatial standards existing and emerging that are applicable in the transportation. And Dr. Cheung would attest to that, as he worked with me on cutting down the number of slides. So we really, I think, have tackled successfully the problem of encoding information in the Geography Markup Language, GML, so this is an international standard. It's also an ISO standard for including information. And I think, you know, all the organizations here are using it quite successfully. Industry has adopted it and not just the geospatial industry, but also elsewhere.

We have the example of KML. So Google came to OGC a couple of years ago and made KML an international standard so that they don't appear to be the only force behind that, just widely essentially technology. The realize the importance of people, users, developers trusting who's maintaining a technology and if it's an international collaborative organization it makes a lot of sense. So if we're members especially of the consortium, any of us can now influence the next generation KML, which is a very big statement.

So instead of talking about all of that, I chose to focus on two examples: aviation and vessel tracking. Aviation safety, so a few years back the international, the global aviation community has agreed to adopt an international framework of standards, specifically for the goal of improving air travel safety and operational efficiency. The numbers are really scary between just the increase of the number of travelers, the increase of the price of fuel and, I mean, you name it. It's an interesting domain that's being constrained in multiple, multiple ways.

So the global aviation community led by FAA, led by EuroControl, the equivalent of FAA in Europe, essentially agreed on an international framework of standards and location is just so critical to all aspects of aviation that they have also adopted as part of that framework the suite of OGC standards as well.

So how critical is location to aviation? We've been working with FAA and EuroControl since 2006 on how we can use the

Geography Markup Language to encode all the information that's aeronautic information that's weather information. So you name it, it's the airport, it's the runways, it's the taxiways, it's the obstacles, it's the observations about humidity, icing; it's the special use airspaces; it's the digital NOTAMs that are being sent when a runway is closed. So all this information is being encoded using a standard.

This is very important because planes fly across the ocean and across countries so you need that interoperability. And more importantly here, we've been working with them on the suite of web services to ensure that the users -- actually, the right users get the right information at the right time so you don't get everything, you just get what you need. But this information is so critical because the pilot needs to know if the runway is closed not 5 minutes, you know, he needs to know as soon as possible to make decisions.

We've worked with FAA more specifically on incorporating those standards, those geospatial standards along with the aeronautical information standards into the FAA operation environment, their systemwide information management. So this is the FAA pilots here. This was about just using the restricted airspaces. So if a pilot is flying and the President is flying at the same time, you know, the pilot needs to reroute accordingly. The nice thing about those airspaces is that there's not just geospatial information, it's temporal information. Their spaces are out there, but they get activated and deactivated based on different criteria, based on the schedule and so on. And communicating that information to not just the pilots -- dispatchers, you know, the Deltas, Lufthansas, and United airlines of the world, is also critical and only feasible at this scale using standards.

Another example is in the maritime domain. So this is vessel tracking. So there are about a dozen satellites up there tacking literally every vessel on the water over the surface of the world and getting the information about each vessel several times a day. Again, we're talking a large scale. We're talking multiple providers, so again, standards is a common theme to be able to pull that information and be able to support some decision making questions here, such as, you know, tracking the vessels in the Arctic or tracking pirated vessels or fusing this information with other types of information, as you can see here. So plenty, actually, of examples, of operational examples at a global scale. So not just big data, but also just big scale.

And I think this was also mentioned in the prior panel, and I love it. We're really evolving. I mean, we've seen airplanes and vessels, but all of a sudden we're really all sensors right now. We're really moving very quickly to this Internet of things concept where we can collect information from any device and the devices talk to each other and they control each other. So many, many applications in there, and you can see from today's

Internet to tomorrow's Internet of things, you know, controlling your microwave from a distance or your AC or your heater or your computer, essentially, is all going to be through standards to make it feasible in the first place.

So my quick conclusion here is, once again, you know, it's great to focus on the geospatial aspects, so not just the GIS, the geospatial in transportation. And remembering that location is important, not in transportation, but across communities, across organizations and across countries.

We're really innovating as a community here, as you can see, and standards are critical for this information exchange and sharing and interoperability, and to be ready for those unforeseen events where you need the data when you don't expect it. So we continue to push the boundaries and we need the transportation input to continue innovating on the standards' front. You know, location is a general thing, but if there are any requirements that can come in and that are specific to the transportation domain, we would be very happy to actually hear those requirements and start working on them. We've done this very successfully with aviation, so all of our work in aviation was actually incorporated back into the general standards. So it came from requirements from a community, but the benefit is really to everyone. And we hope to achieve that in transportation as well.

Thanks again for the opportunity and I look forward to hearing my fellow panelists talk.

DR. CHEUNG: Thank you, Dr. Alameh.

Mr. Michael Ratcliffe is the Assistant Chief for Geocartographic Products and Criteria Geography Division at the U.S. Census Bureau.

Mr. Ratcliffe, please begin your presentation.

MR. RATCLIFFE: Thank you. It's a pleasure to be here. The Census Bureau is, of course, a statistical agency, but all of our data on population and economy relate to some location in the U.S., and even for our international data to locations around the world. So we are in essence also a geospatial agency.

What I want to do today, it's going to be difficult to give an overview -- or to talk about all of the geospatial and geodemographic data that the census bureau has, to talk about that in 15 minutes. So I'll offer brief overview of our spatial data and some of our geographic information and ways for accessing and visualizing spatial data.

We'll start with TIGER. TIGER is our geographic database. We built TIGER to support the 1990 census, and many people are perhaps more familiar with TIGER/Line Shapefiles, but TIGER is the Census Bureau's geographic database. When we built TIGER, a relative accuracy was important to us or was the primary focus, and that remained true up through the 2000 census into the early 2000s. TIGER contains roads, hydro, housing unit locations in our master address file, address ranges, boundaries for a variety of geographic areas. The Census Bureau collects boundaries for municipalities and all of the political geography in the U.S., as well as defining boundaries for statistical areas such as census tracts and urban areas.

The major change in TIGER, as we continued through the 2000 census and began planning for the 2010 census, it became clear that relative accuracy was no longer sufficient to carry out the work of the Census Bureau, specifically as we were planning to use GPS and handheld devices in field data collection operations, address canvassing where we walked every street in the country and collected housing unit locations, but also planning for other operations. So with that in mind, TIGER had be brought up to positional accuracy. So the major effort last decade was the MAF/TIGER Accuracy Improvement Program. The emphasis again on positional accuracy for the road network, less focus on the hydrology, railroads and boundaries from an accuracy or positional accuracy standpoint; although boundaries is one area that we wrestle with on how to keep those positionally accurate and legally accurate in relation to the road network. We recognize that railroads are important to the NTSB as well, but from the Census Bureau's standpoint, because people don't usually live along a railroad, we focused less attention there. And we are looking and very interested in finding a good, highly accurate road network database for the nation.

I want to give a couple of examples. As part of MTAIP we processed data for every county in the country at least once. So every part of the U.S. did go through the updating process, some areas more than once. But I do want to emphasize that some counties went through the MTAIP process early on in the decade when we were still working out some of the kinks and were not updated again leading up to 2010. So you will see some variation in the accuracy level for road networks, and you'll see some variation across the country.

But here's some examples just to give you a sense of TIGER before and TIGER after. This is a portion of Scotland County, North Carolina and you can see in yellow the roads that were in TIGER at the time or leading up to or before the MTAIP process, and then after MTAIP. So a good example of the improvements in positional accuracy that were made in the TIGER database and for most of the nation.

Let me move quickly now to talking about ways to access our spatial data. This slide isn't showing up quite as well. What this is, is a screenshot of our TIGER landing page. We have a variety of TIGER products now, not just TIGER/Line Shapefiles, but now geodatabases, KML files, WMS and a variety of ways to access our spatial data, cartographic generalized boundary files. And so what we've done to help users is provide some guidance on what type of file, what type of a format might best meet their needs.

And this is one thing that we hear as more and more people are using GIS data, using spatial data, more of our customers are requiring some guidance on what might be the best format, what might be the best way to access data.

TIGER/Line Shapefiles are the flagship product that we've produced for quite some time. In 2007, we shifted to -- we started producing TIGER/Line files in Shapefile format following the general direction of most of our data users. Rather than downloading a TIGER/Line file and then having to convert that to Shapefile format, we began producing it in Shapefile format. I've got one note on there noting Oracle. TIGER database is now in Oracle database format and that's helping us in maintaining the vast amount of information.

One of the recent innovations following the 2010 census. This again is in response to what we were hearing from a large number of our customers. We produced TIGER/Line Shapefiles with prejoined demographic data. So we took the 2010 census demographic profiles and joined those to the TIGER/Line Shapefiles for the various layers of geography that were available in the profile products, and so that way users don't have to download the TIGER/Line Shapefiles separately, download the data out of American Fact Finder and then do that join within their own GIS. It's prejoined for you so it's ready to go as you download it.

The first product that had prejoined data was our block layer. We released that in June of 2011 with the population and housing counts already joined to the 11.1 million blocks in the nation.

Moving on with new products for viewing the geography and accessing geography, we've recently released TIGERweb in the last year. This is an online geography viewer. Think of it as a reference map online giving you access to all of our geospatial data, at least to view the geography. But it also has access to web mapping service and REST services and we are planning web feature services as well, for those who want to quickly go in and grab the geography, grab the geometry and bring that into their databases.

And throughout the Census Bureau we've been -- one of the things we've found as GIS has become more ubiquitous throughout the agency and tools have become easier to work with, we have a plethora of online mapping tools, enough now that it's difficult to find all of the different online mapping tools that are available and our new challenge now is to make it easier for data users to know what data are mapped, what mapping tools exist, what statistical programs, data collection programs they can access through those tools, and how to find them very easily. But here's just a couple of examples.

The Census Data Mapper should be released this week. This will have 2010 census data precanned so you'll be able to access data at the county level first and then we plan to add tract level data. The Census Data Mapper was designed for folks who are interested in mapping data in a format that is ready, where the cartography is good enough for putting into a presentation or into a report. You can see Hawaii is in the lower left; Alaska is framed in the upper left; Puerto Rico in the lower right, following Census Bureau cartographic standards. And so we wanted a tool that would allow people to map data quickly and then download it into PDF and throw it into a presentation or a report and produce a good-looking map.

The other tool that's on here is our Metro/Micro Area Data Viewer, and this was just released in conjunction with a printed report on metropolitan and micropolitan statistical area population change from 2000 to 2010.

Just two examples. I think we've probably got about a dozen different online mapping tools within the Bureau now. And again, as I said, the challenge is bring those together in a location where data users, first, can find them, and then understand which one they want to access to find the data that they're interested in.

And we've also been focusing on data visualization. If you frequent our website you may have seen the vis of the week. This is where we've been testing different data visualization techniques, ways to open up statistical data to wide variety of audiences. Some work, some don't. That's part of our plan to -- part of the idea behind the visualization of the week is to put a visualization of data on the web, start collecting user feedback and see what works. What helps people understand statistics in a meaningful way to carryout their work or answer their questions?

This is a particularly fun one. We've done for I-95 and then for a number of other interstate highways. You click on the map and the cursor or the dot follows I-95. In this case it follows it northward from Miami all the way up the coast and you get the population density gradients along the entire route of Interstate 95. And you can see probably what's fairly intuitive and what we would expect to see. You see a huge spike in density around the New York area; you see lower densities in the southern portions in South Carolina and Georgia. But you can see where the population concentrations are. Again, for those who know the urban geography of the U.S., it's probably not a surprise, but it's a great way to help visualize where the concentrations of population are in terms of driving along a highway.

I'll now turn to data access, other data access tools. American Fact Finder is our flagship data dissemination tool. If you've worked with it over the years, since 2000 and then perhaps again 2010, you may have experienced some challenges in using the American Fact Finder 2. We are constantly working with our data users and our customers to understand how people would prefer to access statistical data, what are the more intuitive approaches. But American Fact Finder for the time being is our primary tool for allowing access to the wide variety of demographic and economic statistical data that the Bureau collects.

But we've also branching out into additional ways to open up access to statistical data to our databases through a variety of APIs. So through a data web effort we've now designed APIs for developers who are working with various applications for handhelds, various devices, who don't want to have to go through American Fact Finder to download data for all of the, say, census tracts or block groups or whatever geography they're interested in. The API allows them a quick and easy way to reach into the Census Bureau's databases and extract the information that they need.

In essence, this is the same -- from the statistical side this is much the same as a web mapping service or a web feature service would operate. So we've got those two methods for accessing statistical and then geographic data.

And now I'm going to turn -- just to finish out the presentation, I'll turn to a few geographic areas. Because one of the things we do in order to present statistics in a way that makes sense and is meaningful for folks, we collect boundaries for a wide variety of geographic areas, municipalities, townships, counties, states, of course, and then we also define a variety of statistical areas for presenting statistical data.

The first one here, the Urbanized Areas and Urban Clusters. We've been defining urban areas since 1950. These are the cores of the OMB's core-based statistical areas: the Census Bureau's urbanized areas of 50,000 or more; urban clusters of 2500 up to 50,000. The urbanized areas are also used by the Federal Highway Administration for determining metropolitan planning organization status and also used in a variety of legislation for determining urban and rural definitions throughout the federal government.

Here's a closer-in look at the Washington urbanized area. The urban areas are defined based on population density. We do this every 10 years. We've been incorporating some additional land use/land cover information to help us identify nonresidential urban land uses that are part of the urban footprint. And again, these are defined by the Bureau for statistical purposes but used widely throughout the federal government for programs and determining program participation and funding levels, especially in the transportation community.

We also identify a variety of places. So OMB has issued a number of memos directing agencies to do place-based planning, place-based budgeting, place-based programs, but OMB has defined what a place is in any of those documents. Census Bureau collects boundaries for places. The 19,000 incorporated municipalities around the country, cities, towns, villages, boroughs, and also then census-designated places throughout the nation. And the census-designated places are unincorporated communities, for instance places like Silver Spring, Maryland; Tyson's Corner, Virginia; Columbia, Maryland. So we have boundaries for those and produce data for those places on a regular basis.

And lastly, Census Tracts. These are small statistical units, 1,200 people to 8,000 people. And you can think of in terms of similar to a neighborhood and a variety of data. And I'll skip on through to the last slide and look forward to questions.

DR. CHEUNG: Thank you, Mr. Ratcliffe.

Mr. George Gonzales is the Production System Team Manager at the Mike Monroney Aeronautical Center of the FAA.

Mr. Gonzales, would you please begin your presentation?

MR. GONZALES: Good morning. I'd like to thank the NTSB and Dr. Cheung for giving me the opportunity to present today.

I'm going to talk specifically about an application that we have been designing and developing and deploying, actually, within the last 5 years. It's called the Instrument Procedure Development System. The history behind the system is to replace a legacy system that's used today by the AeroNav Products organization to develop instrument flight procedures in the United States, and also we do some work overseas. We have a legacy system that's been in use since 1974. It's called the Instrument Approach Procedure Automation tool. It's obsolete, to say the least.

Moving forward with web services and GIS data and other services that we plan to pull data from, we're deploying this new system that uses the state of art GIS systems through the ESRI. It provides excellent map data and images and other data. So this tool is also going to be used by the DoD. So it is a joint venture with the FAA and DoD to use one tool. This greatly enhances the cost for maintenance of this tool. Previously both the DoD and the FAA used separate tools for Instrument Flight Procedure development. So we're moving forward to a joint venture that would provide one tool for both agencies.

The DoD operators will continue using their present tool, which is called Global Procedure Designer, to about 2015, 2016 time frame, when they will take full use of the IPDS tool. Currently we have a version of IPDS deployed that's being used by our developers. It currently just does space-based procedures, which is your GPS, your RNAV, RNP procedures. There is a module being delivered within the next 12 to 18 months that will provide ground-based procedure development. The DoD plans to use obstacle data for overseas development using NGA, the National Geospatial-Intelligence Agency, data. For stateside, the DoD also plans to use the FAA obstacle data from the Obstacle Repository System, ORS, and utilizing obstacle evaluation, airport, airspace and analysis, which is the OE AAA tool.

This is just a short presentation of what the tool can provide. This is a 2D view of a procedure. You can see the segments of the procedure, the intermediate, the final going into an airport. Different layers of data is provided using the GIS format. You can get obstacle data. You can get fixed data. You can airport data, runway, NavAids. You can click on and off. You can present them in different colors. It's a very exciting tool. The procedure specialists that are using this today are very, very excited about using it. As I said, this replaces a legacy system that's been in use for 37 years; it's very clunky. This new system uses the Aeronautical Information Exchange Model to push and pull web services and data. It's very high tech.

This is a closer view using a different map. As you can see in the background, just the same data that was presented. The obstacle and map data is presented on the left side. You'll see the tree there. Those are different areas of the map that you can click on and off. You can see road data. There's just about everything a procedure specialist would need. And this would also become, I believe, useful for NTSB when it comes to trying to evaluate a procedure that may or may not have been involved with a aircraft crash. This is data that can be pulled up.

We're also looking at providing flight path data on this system. That's also a future request that we've gotten from users. So there's still lots of development that's still on the board for this particular application.

It also provides a 3D view. So what you saw before was 2D. This is a 3D view. We can get terrain. We can get obstacles. Those cylinders that you see is an obstacle with its accuracy. That has to be taken into consideration when there is procedures being built because some obstacles don't have a very exact accuracy of the height or the position. So the system is smart enough to set up a cylinder so it takes in that consideration of inaccuracy when it comes time to build procedures.

And as 3D allows, it can be flipped over, flipped to the side. It can be viewed at very different angles for the procedure specialist. Right there you can see the final, the glide paths, some of the obstacles that are in the way, and it just provides all kinds of new ways of viewing the terrain, airport environment and those sorts of things, which we didn't have with our legacy system.

So as I said, currently deployed is the ground-based version -- or, a correction, the space-based version. We're looking to get the ground-based criteria installed on that version. It will have the ability to do diverse departures. It'll have a component to do obstacle evaluation assessments for those ground-based procedures. Again, those are coming out probably within the next 18 months, by early 2014.

A new version to upgrade what we have on the floor today, which is under a Windows XP format, will change it into Windows 7 with a 64 bit technology. And then future versions of the tool will include some more en route and departure capability and automated obstacle evaluation tool, which the system will do on its own once it has a integration with the OE AAA system. Standard Terminal Arrival Routes are going to be added to do those with the air traffic helicopter RNAV procedures.

And then a real exciting thing that we're getting ready for is a lot of the documentation for Instrument Flight Procedures is done by hand still today. We're looking at where we can make the system push back data to those forms and populate those forms digitally, where we won't see the fat-finger errors that are done when a human is typing in the data. So that's very exciting for us.

The way we work with this new tool, since it is a joint

DoD/FAA venture, we have what we call a Change Control Board. Both organizations meet on a regular basis and changes are proposed, and at board it's discussed, you know, the funding -- if it's a benefit for both the FAA and the DoD, it's discussed about how much funding each organization will provide. If it just provides capability for one or the other, they pick up the bulk of that. But the other software systems that IPDS will utilize will be what we have up there, and there's -- I apologize for the acronyms, but there's the FIX data, Departure databases. The SIAP is the Standard Instrument Approach Procedure database. And many others. The AIRNAV database, which is airport and navigations. All these tools are discussed. It's not just the IPDS, because IPDS is integrated with all these tools. So when there's a change, it usually involves changing some coding in some of these other applications, so that's why they're all included under this Change Control Board. So, as it says up there, enhancements, maintenance, and defects and bugs are discussed at these gatherings.

DR. CHEUNG: Thank you, Mr. Gonzales.

Mr. Jeffrey Danielson works as a geographer at the U.S. Geological Survey, Earth Resources Observation and Science Center.

Mr. Danielson, please begin your presentation.

MR. DANIELSON: Madam Chairman, Board, thank you for the invite.

Most users of geospatial data, in general, look to the

USGS as a source of information for things like hydrography, geographic names, imagery, as well as elevation. And the USGS is the A-16 mandate for mapping elevation for the nation.

And our flagship product for mapping elevation is the National Elevation Dataset, or called NED. Yeah, NED is a seamless database. It's a raster database at multi-resolutions of 1 arc-second, which is about 30 meters; 1/3 arc-second, which is about 10 meters; and 1/9 arc-second, which is about 3 meters.

The NED is a consistent database in terms of its vertical and horizontal systems: NAD 83 and also NAVD 88. The NED database is actually updated six times a year to bring in the most current data where possible. And most of the data is coming from a lidar-based source, which I'll be talking mostly in this presentation about lidar actually. And the NED is an official layer on The National Map.

And The National Map contains many different types of data. It contains elevation. It contains imagery, contours. It contains a lot of data from our member agencies, Transportation, Census. And so we get data from these agencies and put them into The National Map.

And, you know, before the NED data was ever developed, the USGS used to provide data in our 5-minute quadrangles. And there was numerous problems with these quadrangles in terms of artifacts, you know, missing data, slivers, and so on. And so about 15 years ago, we actually came up with this idea of making a seamless data called NED and all data was transformed into a consistent coordinate system, standardized in terms of datums and units, filtered and edge-matched, and brought together into a seamless dataset, where we also provide spatially referenced metadata so a user can tell exactly what source was used to make that piece of data.

Today most of the data going into the NED is based on lidar. So all the stuff you see here in this -- I guess this graphic here on your screen shows like a red, dark red color. That's all based on lidar. So 28% of the lower 48 states is based on lidar now. And as you can tell from this map, that most of the data is along the coast and that's where, you know, there's a lot of storm damage impact due to hurricanes and things like that. And also the implementation of lidar also depends where there's matching funds by the state agency. So Iowa, for example, is covered and so is Pennsylvania and so is Ohio.

The currency of NED varies dramatically. So this map here shows -- all the gold areas are basically from the old 1960s topographic map so, you know, '60s contours basically. All the stuff you see in red or that darker color is more current. That's more based on lidar. And the vertical accuracy of this dataset also varies dramatically. So if you overlay our spatially referenced metadata, you can tell exactly what the vertical accuracy is for that one source. But overall, as a CON-L dataset, CONIS-based dataset, it's at 1.44 meters root mean square error.

And the NED is also a bare earth source, so that means we're mapping the bare contour surface. We're not mapping the first return or the top of canopy.

You know, since NED is mostly based on lidar, I plan to spend the rest of my talk talking about lidar and the applications of lidar. You know, lidar is Light Detection and Ranging. It's made up of a scanner, GPS and IMU. So GPS controls the position, the scanner controls the range or distance, and the IMU controls the position of aircraft, which is the roll, pitch and yaw.

And the lidar typically can output 300,000 pulses per second and it can record many echoes per pulse, and resulting in billions of points X, Y and Z of the vertical structure. You know, a point cloud -- this is an example of a point cloud. A point cloud is not a raster. So lidar is not raster; lidar is points. So it's X, Y and Z, representative of the vertical structure of your terrain or of your landscape.

A lidar is composed of many platforms. So it's composed of fixed wing aircraft, helicopters for corridor mapping, tripod-based systems for mapping buildings, vehicles for doing more like ground-based lidar, for example, and even satellite-based data, which we use from our colleagues at NASA. You know, lidar takes various forms. It can look like trees, canopy, bare earth, top of a surface. You know, lidar really is a way to map the whole vertical profile of a landscape.

We've seen drastic improvements in the accuracy of our terrain data using lidar. It's amazing going from the old 10-meter DEMs based on contours to using lidar where you can actually map the feature much more precisely in terms of its position, as well as the actual morphology of that feature. You know, within the NED itself, we use lidar to update -- the coarser scale is at 1/3 and 1 arc-second. And you can tell exactly what source was used from -- and you can tell based on this graphic what source was based from lidar.

Lidar is used for many applications. There's over 200 applications these days that use lidar. It's used for biomass, coastal studies, transportation, which I'll be showing some examples of that, carbon, land cover modeling, earthquakes, volcanoes. It's really becoming a standard for a lot of geospatial applications these days.

You know, definitely in terms of change detection, it's a great source. And, you know, for those mapping vertical structures, you know, this could be used to look at changes in vertical obstructions and vertical structures. This shows the changes in trees loss over a forest fire area in Colorado. Urban modeling, obviously, mapping cities, features. This is New Orleans. You can see that that little round thing, that's the Louisiana Superdome, for example. And you're able to map these features and extract building footprints as well as looking at the infrastructure, the vertical nature of a city and you're able to capture the vertical profiles of these cities and look at them in a whole different way geographically and spatially than ever before by using this new type of data from a lidar system.

Also with lidar you can also do feature extraction. so, you know, this can feed into different other databases as well, but you're able to extract building footprints and you can take these footprints and you can assign attributes, like the vertical accuracy as well as the vertical height, and you're able to extrapolate different attributes from the remote sensing data. Since it is remote sensing, it contains what's called intensity, which is in your traditional form of remote sensing, it was reflectance, which is the -- basically, as a satellite bounces off the Earth's surface, it returns a digital number, which is reflectance.

Lidar is an active system so it basically supplies its own energy from the system itself, but it still measures a reflectance off of that surface. And in this case, this intensity, I mean, shows you -- you know, you see trees, for example, roof types, grass, water, you know, structures and different transportation features which show up as different types of intensity. And I guess what's cool about this is that you can merge the intensity with the points and you can do various things from an application standpoint.

And, obviously, mapping veg attributes is also a capability of lidar. Looking at biomass, you know, tree canopy, tree height, those are all areas in which lidar is being actively pursued right now within the Forest Service and other agencies within the U.S. government, as well as many commercial and private companies. Obviously, for corridor mapping, looking at utilities. Lidar is used for power lines and looking at towers. You know, towers are of concern for the FAA and other people looking at obstacles, for example, and lidar can be used, depending on the density of the lidar. So I have to caution that not all lidar is useful for corridor mapping or for power line mapping. It all depends on the point density of that lidar dataset. So if it's like 2 points per square meter, it probably isn't good enough for corridor mapping, but if it's 8 points per square meter, then it probably is. But definitely, to get large area mapping, lidar is a good tool, a good data type to use.

Once again, looking for power inspection. In fact, this dataset here was actually derived from a helicopter-based source. It contains millions of points. It's very dense and you can map every crook and cranny of that tower.

Just more recently, we've been doing stuff with Hurricane Sandy. So we all know Sandy happened on the East Coast and this shows the track of actually Hurricane Sandy as it came on shore in New Jersey. And this shows imagery taken of the New Jersey coast along Mantoloking, New Jersey, which is on the Barnegat Peninsula. And this was taken using the USGS EAARL-B system, which is our own lidar system that's waved formed; it's not discrete. And this was actually showing the imagery taken from -- the pre-2010 imagery from USDA on your left, and the NOAA imagery on your right. And you can see that new breach in the barrier island caused by Hurricane Sandy, as well as there's also tons of overwash created from that storm. And, I mean, if you zoom into your imagery, which is actually 1-meter spatial resolution, you can see tremendous detail and damage caused by the hurricane.

But we also, using the USGS EAARL-B system, we're showing changes in lidar. So on your left is lidar taken 1 week prior to the storm and on your right is lidar taken 1 week basically right after the storm, and you can see the breached map using lidar, as well as the graphic on the far right, the difference map shows the change between those two topographic datasets. So all the stuff in purple you see is where the most change has occurred. And as you see this purple going inside toward the bay side of the barrier, that's where sand is being migrated and moved by the storm over time. So when you look at change over time using lidar, it's very useful in terms from an application standpoint.

In terms of transportation, obviously, road networks and you can map features on that road system using lidar, and you can measure different features of that surface using the different types of returns from the lidar point cloud.

Finally, landing approach. You know, if you look at vertical obstructions, as you come in on that glide path you can see different structures as you approach. And lidar is one tool, not the only tool because it, you know, still I would say using traditional total station and GPS is still your most accurate way of measuring obstacles, but with lidar it does have the potential to be a tool to map obstructions, depending on the precision of your lidar and the point spacing and so on.

And with that, thank you.

DR. CHEUNG: Thank you, Mr. Danielson.

Mr. Mark Skoog works for the Integrated Test Team for the Automatic Collision Avoidance Technology at the NASA/Dryden Flight Research Center.

Mr. Skoog, please proceed with your presentation.

MR. SKOOG: Okay. Thank you. Madam Chairman, the Board Members, thank you for inviting me here. I'll be speaking as a user of specifically an application of digital terrain data that we're talking about here today, in this case elevation data to prevent aircraft from running into the ground.

I'm going to cover two topics: One, the system that uses the data, and then some specific features we found concerning the data that follow-on users need to be aware of when using digital terrain data.

This work covers a large span of time. We've been working on this for over 25 years, automatically providing collision avoidance for an aircraft to avoid hitting the ground and other aircraft. The ground collision avoidance profile began over 25 years ago. So I'll cover a number of topics, run through them rater quickly.

Specifically, I'm going to talk about some recent work here, both on the F-16 and then just very recently on a small unmanned aircraft. The primary differences between this technology development and others in aviation is that this is dealing with aircraft that have to fly near terrain. There are a number of commercial systems available out there today and they've been implemented and fielded now for over 10 years and they've provided tremendous safety benefit to commercial aviation. Other aircraft, though, haven't necessarily seen that same benefit.

Some of the things that make this technology different is the attention to requirements. Because this is an automated system that we're talking about, we have to first make sure that it's not going to create more of a hazard than it's solving; in other words, it's not going to run an aircraft into the ground as opposed to away from it.

The next thing is making sure that the system does not interfere with the pilot's normal operations. Aircraft are out there flying today relatively safely, very safely. Aviation has a very safe record. We have to make sure that we aren't going to impede their use of that aircraft out in the airspace. Then, finally, if we can accomplish the top two requirements, then we'll prevent collisions with this system.

Some of the other aspects about this is its functionality, both sensor agnostic, platform agnostic, and we achieve this through a modular software architecture.

The specific things that allow this automated system to work are precisions in digital terrain, the handling of that terrain, modeling the aircraft's performance, and making sure that everything integrated appropriately.

This is a cartoon of the software functional architecture that we use. In the lower left is the portion of the software that brings in the digital terrain product. Above that we are sensing where the aircraft is, GPS, and other state information, how fast it's flying, the atmospherics around it, winds and what have you.

That top left block feeds a model that then executes a simulated recovery in the software to be able to understand how the aircraft can execute an avoidance maneuver. And parallel to that we're bringing in the digital terrain on the lower left and then processing that. Digital terrain, there's a lot of data out there, as you heard Jeff just speak of previously. We have to downsize that to an appropriate amount of terrain that we can understand what the immediate situation is. We do that through a terrain handling module. We then compare this near terrain profile to the aircraft's evasion options to decide when and where the aircraft needs to avoid.

If the automated function is enabled, when an avoidance is needed, it's then issued and turns on an autopilot that automatically executes that recovery.

You see the brown bars both on the left and then a block on the right. We do integrity management of the data, taking a look at the data to see if it's of sufficient quality to be able to perform this kind of a function. If that integrity check is failed, we then place the system in standby and we don't let it actually take control of the aircraft until we feel that the health of the overall system is sufficient to regain control.

Specifically, some of the things that we've done in flight test. On the F-16 we've done over 100 flights just in the last few years and over 140 flight hours with thousands of recoveries. This system is going on to the production F-16, as we speak. They are completing the production flight tests of that and it should field starting next year and going into 2014.

This is a system that allows the pilots to perform every F-16 mission that they currently have to without any impedance of those missions, yet it provides full collision avoidance protection.

That system was then migrated over onto a small UAV to show how we could adapt it to a very different performing aircraft. You see that in the lower left. We did a number of flights and recoveries over the past year. What we found with that was, one, there had to be some changes indeed made to the system to further its ability to apply to any performance aircraft that you have out there. And out of that -- effort we believe now that although we're doing automated collision avoidance in these cases, that there's a level of precision that could be now brought over into a warning system for other aircraft.

Commercial aircraft, they already have the systems, as I said, and I'll talk a little bit about why we don't need to address them. They have a very good functioning system. But other vehicles do have an issue.

So this is -- I'm going to show you a particular run here. This is a run during the F-16 flight test that we did. It's going to be a case where the pilot was testing the potential for the system to impede a low altitude pass over a ridgeline and he did not notice how close he was getting to the ground and there was a ridgeline that he misjudged. This is the case where the system's going to take over at the last instant.

What you see in the right-hand is a box with an R next to it. That's the altitude above the ground. On the left is a scale. It has a little "C" next to a tick. That is the airspeed in knots. G's is above that to the right. Right now it's 1.0. What you'll hear is as this -- you'll hear quite a few radio calls going on. It's a typical flight test environment, but you'll hear a tone as it gets very close to the ridgeline. The lower right of the screen here will show the closest approach of the terrain. You'll hear a tone come on. That's automatic system taking control from the pilot. You'll hear a second tone within a second after that where it gives it back to him. So you can see how quickly that system comes on and off.

Okay. Could you start the video?

(Video played.)

MR. SKOOG: The pilot didn't even realize the system had come on. He thought he was performing that recovery. As it was, the system was about a half a second ahead of him and probably made the difference between him returning from that flight.

I'm going to show you now a run of the small unmanned aircraft in a similar situation. This is one we're actually doing a flight test --

(Video played.)

MR. SKOOG: You can see it getting bounced around by the -- flying into a box canyon here. And here you see what it's avoiding.

I'd like to talk a little bit about the digital terrain product that helps enable this technology. Specifically, requirements for aviation aren't necessarily the same as the rest of the users of digital terrain products. First and foremost, bare earth versus first return is a very important thing to understand. Most of the users of GIS products, terrain elevation products, are interested in bare earth.

However, aviation has a different need. In this case, you see a first return would end up being the canopy height in this case, a much more desirable product; however, that is not what the standard product is, as we found using this product.

Also, the level of accuracy, it depends very much on the kind of mission the aircraft's going to fly. In the case of commercial aircraft, they tend to operate close to the ground only near airports. Airports tend to be very flat and the surrounding terrain tends to be relatively flat. So, therefore, vertical accuracy really is of paramount interest to them. However, if you're going to operate near vertical terrain, vertical terrain content, you're going to need to understand the horizontal accuracy as well, which is not always the same. This tends to be the resolution of the product.

As you heard in the previous presentation, there are products available both at 30 meter, 10 meter, and even now down to sub-10 meter accuracy. That is a very desirable product for some of the applications we're talking about here. Commercial, they don't need that level of horizontal fidelity.

As you're doing with aircraft performance, the high performance aircraft, they can pull quite a few G's; however, they're flying at a speed that doesn't allow them to do lateral turns very well. General aviation aircraft aren't able to pull and turn quite -- achieve as high a climb rates as a high performance fighter can, so they need to focus on lateral escape, as you see in the lower right. All this has been embedded in the system that I just showed you.

When you're looking at digital terrain products, you also need to understand the relative accuracy. As we began this development effort for the F-16, there was one product that the military primarily used and there was a new product coming out, the Shuttle Radar Topography Mission, or SRTM, data, which is a near global dataset. So you have vertical terrain for most of the planet's surface.

The first we did, we had heard -- we had seen numerous errors in very specific locations so we wanted to go out and take a look specifically at where those errors might be. Here you see a comparison of the two products, one to the other, in a difference map. The dark blue representing low terrain where one product is lower than the other, red, or it's higher. You can see a lot of artifact in that.

Zooming in to a specific area, we developed tools that brought in the actual location of the digital terrain elevation point and where it was off. In this case you see push pins where they were off, where elevation differed between the two products by more than 500 feet. You see there has a geographic feature there.

To figure out which product was right, we did some manual surveying on our own, and this is the type of thing that we found. On the left you see the original product the DoD was using and the black dots is basically hiking data. On the right is the Shuttle Radar Topography Mission data. This information was used and has moved DoD to the shuttle data.

Another artifact that's in most products that we've seen out there is ridgeline clipping. And, of course, for aircraft one of the most likely features that they're going to run into is a ridgeline. In this case you see hiking data over a ridgeline.

This is very commonly seen over almost all the products. And it has to do with the fact that the elevation of the terrain is averaged over a given area, whatever resolution they're using. So in the lower left is a simple little plot showing whatever the terrain slope is up to that ridgeline and about how much ridgeline clipping you can anticipate.

Okay. Also, there can be very geographic-specific errors involved as well. The lower left is a 3D representation of the digital terrain product over the Edwards strafing range. And the areas in red you see there are actually absolutely flat areas out on the range; however, you can see the vertical content there is quite noisy. In this case because the area had been scrubbed of all shrubs, this particular product had more difficulty in that area of giving a good solid signal, so you get more background noise in the product.

Finally, resolution. Here's an example of what the F-16 was flying prior to the institution of this automatic collision avoidance system, 6 arc-second data. Here you see 3 arc-second data, allowing the pilot to fly down this little gully here.

With more data brings more storage requirements. So we developed a data compression utility for the DoD to be able to bring the global product into a smaller file size. You see the original data on the left, our compression technique on the right. And this is very easily tailored to any given aircraft's flying requirements and it can be very geographically referenced as well where you have to fly low or you don't.

Finally, what's next? We are advocating a yet-to-be-funded effort where would bring this technology over to general aviation. What this system would be, would be an improved collision avoidance system, taking the 300 gigabytes of global terrain data, intelligently manipulating it down into 180 megabyte file, processing it through 108k algorithm to issue 2 bits to the pilot to direct him when and where to avoid.

We bring this all to a cell phone app as well, so it would be, if not freely distributable, nearly freely distributable. We actually have a prototype of it running in that small unmanned aircraft that you saw.

Thank you very much.

DR. CHEUNG: Thank you, Mr. Skoog.

We would like to begin our questions with Mr. Bill English.

MR. ENGLISH: Thank you, Dr. Cheung. Thanks to everyone on the panel, all fascinating presentations.

My question is for Dr. Alameh. You mentioned the worldwide partnership with OGC and some of the aviation products. How do you envision a transition to harmonize various levels of users, airline, general aviation, military, and different navigation service providers and regulatory authorities as these technologies are phased in?

DR. ALAMEH: Thank you for the question. I think it's a very timely question indeed. As we are struggling, essentially, of moving beyond, you know, the technology and the standardization, those are actually the easy parts of the equation. Interestingly enough, in the aviation industry and even in the weather community, they have been able to get together and agree on this Aeronautical Information Exchange Model. We're slowly agreeing on the next generation of the Weather Information Exchange Model and now working on the Flight Information Exchange Model.

So I think sooner or later we'll get the standards part and the technology part and then it becomes an issue of, not just the adoption -- I think there's a high interest in adopting these standards and technologies and information exchange. It's the challenge, as you mentioned, of phasing them into the operational systems, especially the aviation industry. It's a very well established industry and it's a very conservative industry. So actually injecting those new technologies into it is going to take time.

Just the safety concerns alone, I mean, just getting those -- you know, can develop an application on the iPad today. Just getting it on an airplane, it's just such a process to get it certified for safety, you know, for communication and so on. You cannot just replace the avionic systems on the plane just overnight. You know, these planes have a long, long shelf life. So I think it's just -- it's great that the community agrees with the leadership from the government organizations, like FAA, like

EuroControl, like Air Services Australia.

In some cases it's easier for the developing countries to actually catch up faster than us because they don't have the legacy systems that we do. But, I mean, we're doing, I think, already really well. Just collaborating here between NGA and FAA and NASA on the U.S. side with the support of NOAA to begin, you know, just getting the product, at least, the information out there and the standard standards.

We've heard it from several of our members, you know, the set of standards they set. Indirectly quoting them, but you really, really, really want the industry to switch, you have to shut down the existing systems, which is really, really hard. But believe it or not, it's actually going to happen in Europe. They are transforming everything into these new XML-based information exchange models and web services and to so-called SWIM environments. That, yes, they will turn off the switch and if you're not ready tomorrow, you're not part of this new, you know, information age. I hope this helps.

MR. ENGLISH: Thank you.

Dr. Emery.

DR. EMERY: Thank you. Thank you again to the presenters today. My question is for Dr. Alameh and it's broad enough where afterwards if other panel members wanted to talk more specifically about your specialty areas.

We heard a few references already to big data. As spatial models, data models, structures and systems are designed and modified to address larger and larger datasets, what are some of the immediate quality control, quality assurance challenges that we face?

DR. ALAMEH: That's another interesting question and I can envision already our chief technology officer, whenever he has a -- you know, someone asks a big data question, he says, I've been dealing with big data since 1970. It's such a relative, essentially, term. You know, when we first started, we didn't have the band width, we didn't have the processing power; it was big data. I've always dealt with big data.

But I think, you know, we're really faced with big data because we've, you know, already covered the performance and the band width and all of that. We're dealing a lot, actually, and it keeps popping up. It's a, you know, quote/unquote, "boring topic," but as they say, you know, quality. And I think in the previous panel there was also the issue authoritative data source. So, yes, you get all this data but how do you have the authoritative data source?

So we've been working from a standards' perspective with the ISO organization on some data quality standards. There's a lot of talk about the prevalence of data. So you really know not just from a processing perspective what happened to your data but really where it came from and when it came from as you make those decisions. So it's a timely topic and I think it's being explored.

The challenge is actually to incorporate it with all the other sets of standards and all the different domains because quality means different things to different people. Like the aviation domain, you know, they're working on their own quality because their measures are different from, you know, say -- you know, other domains. So maybe I'll leave it to the other panelists.

MR. SKOOG: I wouldn't mind adding to that actually. As we went through the development of the systems using digital terrain data, I found it actually interesting within the aviation community a tremendous reluctance to dive into the data. They wanted to accept it as certified data and leave it at that. Whereas, understanding its heritage, what has gone on with that data, how it was collected, proved of great benefit to us in getting more performance out of the system that we eventually were able to put together than we otherwise would have. So I think within aviation there does need to be more attention be applied to understanding the providence of these products that are being produced.

MR. RATCLIFFE: I'll just add to that as well. I think as data users, especially users of big data, we need to ask what are the quality assurance methods that an organization or group is using in collecting and then processing their data. Are they providing CV? Coefficients of variation on statistical data are margins of error to help the data user understand how accurate the data are at different geographic scales. Are they producing metadata that help you understand where the data came from, the attributes about it, how it's defined? There's a lot of -- I won't name any particular organizations, but there's one that's producing an awful lot of data that most of us use every day and they won't tell you the quality assurance methods behind it and they won't provide the metadata for their data, especially their geographic information. And that's a concern for those of us who like to use that as a source, but can't be certain of the quality or the source of the information.

MR. DANIELSON: Yeah, I think from the USGS perspective, you know, we produce a lot of data and definitely the metadata is sometimes lacking behind the data, but we're striving to bring that to match up with the data in terms of currency. And I can speak more from the side of terrain, that we've provided spatially-referenced metadata now for the last 12 years that basically documents the sources going into the model itself and the accuracy of those sources.

But, you know, I agree with the panel in terms of, you know, metadata probably is one -- is definitely one of the most challenging aspects to geospatial data.

DR. EMERY: Thank you very much. I'll turn it over to Dr. Groff.

DR. GROFF: I have a question, I think, is actually just a -- almost a follow-on to that and I guess I'll direct it to Mr. Ratcliffe first since you mentioned it, but it's regarding accuracy and precision and how to present that information to users, particularly since one of the real values as we've seen with GIS is merging various datasets, if you could provide any thoughts on how they're quantified? You mentioned statistical methods to quantify error. Are there ways -- or thought being given to how to present that to an end user that may not understand that and their intention is to follow exactly what they're being told?

MR. RATCLIFFE: Great question. Yes, there are methods but we don't know which ones work best and with what types of users. So cartographers have been mapping CVs and mapping margins of error for quite some time, mapping uncertainty through all sorts of different methods of overlaying patterns on top of the choropleth data. But what you end up doing in that approach is adding more you could call it noise on the map, more things that the map reader has to interpret. And we don't really know how well that works with most of the data users.

The Census Bureau and NSF have funded a study through our NSF-Census Research Network out of the University of Colorado at Boulder and University of Tennessee, Knoxville, that's brought together a number of people to apply different techniques for mapping uncertainty, put them into user testing and see which techniques actually work best, how well do people understand the statistical uncertainty that's coming from those different methods and then use that in making decisions about the data that they're viewing.

That's just started though, so we don't have any results from that but we're waiting anxiously for those to -- because those will then factor into how we do our maps and present our statistical data to understand how do people approach the information and then make use of it in an intelligent way.

DR. CHEUNG: Thank you.

I actually have a question from the public, and this is for Mr. Ratcliffe. And the question about whether the transportation safety community, in your opinion, is properly using census data?

MR. RATCLIFFE: I don't know the answer to that because I don't know how the transportation safety community is using our data to begin with. I'd love to have more conversation about that and then be able to understand just exactly what they're doing with our data -- I think that the answer to that has to come from what are people doing with our data and at what scales of geographic information. So we're producing statistical data, population and housing counts down to the census block level, which are very small geographic units, giving a great -- a fine resolution on the data, but we're also producing statistical data at larger geographic units.

So if you're, say, charting a course for -- if you're looking at the moving of hazardous waste through an urban area and you're making decisions only at, say, the urbanized area scale, well, you're going to get one view of the information -- the view of the information will differ compared to looking at it at, say, a census tract level or at a census block group level or a census block level, if you're trying to look at where the concentrations of population are in relation to a rail network or in relation to a highway network. So we really need to know how people are using it, if they're using the right geographic units for the analysis that they're attempting to do.

DR. CHEUNG: So my personal follow-up question is that -- it seems like historically the transportation safety community isn't really in long dialogue with the Census Bureau.

MR. RATCLIFFE: That's correct. I'm a population geographer working amongst a large group of more spatial data types of geographers. And what I typically find is that when Census Bureau geographers are invited to these sorts of geospatial meetings, it's more the feature networks that folks are interested in and not the statistical data and the geographic resolution on the data, and even how those geographic units are defined in relation to the questions that people are asking. So -- but I'd love to have more of a conversation about that from the geodemographic side of things.

DR. CHEUNG: Thank you.

Mr. English.

MR. ENGLISH: A quick follow-up for Mr. Gonzales on a different subject, I guess going back to data quality maybe. I guess I'll date myself. I remember when IAPA was put in that Excel spreadsheet. We thought that was real Star Trek. And now we see this. With these new tools that you're able to use in procedures design, can you elaborate a little bit on any quality control findings you've had? Have you found the ability to better process the obstruction evals, things like tree height? Mr. Skoog mentioned that a little bit as well with collision avoidance. Have you had any findings there?

MR. GONZALES: Well, what's very good about this new system is that it's going to be integrated with a lot of different sources for data for procedure development, where IAPA really only pulled from one database. So we are getting data from multiple levels. Most people in the government are aware that we're moving forward, the FAA is, with data stewardship and data custodians. Where we want to pull data directly from the source: airport data from airport GIS; NAVAID data from system operations; obstacle data from ORS. In the past we have had to input that data manually into that one database that IAPA used to pull from.

So, yes, we are getting better data. We are getting data much faster, pulling from multiple sources. We do have a concern about the quality at times because we are getting -- I would use an example of a obstacle. We have lat/longs that differ; sometimes not very much, but sometimes they do. We'll get data from OE AAA on a proposed obstacle. When that does get put into the federal system, ORS may have a different source for that. The AIRNAV database might have a different source. So sometimes we do get conflicting data for the same object. But I would say it has improved tremendously from what we used to have before and what we are using today.

And there is still a lot of development that still has to go on with the new IPDS system, and more data sources that we are going to try to pull from. So there is going to be a huge improvement in efficiency and accuracy of the data that we are going to be using for procedure development.

MR. ENGLISH: Thank you.

Dr. Emery.

DR. EMERY: Thank you. Are there any federal initiatives at present to require independent accuracy checks?

MR. DANIELSON: From the terrain side, you know, as we acquire lidar data, yeah, we've actually written specifications within the USGS. It's called the lidar spec for the USGS. And it was for our terrain mapping program, but it's been adopted by many countries now as a base specification for lidar. And with that, you know, as a vendor acquires lidar over a various area, they are required to do external checks and quality checks as part of that contract. But with that, there actually needs to be more of that. I mean, it's lacking.

MR. RATCLIFFE: As part of the Census Bureau's work last decade, we collected or we had control points collected in each county, roughly 110 control points per county and we used those to assess the quality of spatial data files that we were receiving from local governments and will continue to use those points going through this decade as we maintain the TIGER database and then add features to it. So it's not an independent check, you know, sitting outside the Bureau, but it is us checking the local government file against a set of control points to verify accuracy.

MR. DANIELSON: I guess I should add one more thing. With our national terrain data we also use all the NGS points to quantify the vertical accuracy and to assess the accuracy of the national terrain data using whatever the National Geodetic Survey has.

DR. EMERY: Thank you very much. I'll turn it over to Dr. Groff.

DR. GROFF: I have a question I'll direct to Dr. Alameh. You made a comment regarding requiring standards -- and I'd actually open it up to anyone else on the panel that has any response. Maybe talk to the upside and downside of requiring a standard rather than the community developing a standard. And if -- I'm certain you're probably faced with those kind of conversations, whether they can be imposed or whether the community themselves develop those standards.

DR. ALAMEH: It's actually both. So I'll take, again, just the example of the FAA, for instance. So this started with the community essentially getting together and figuring out how they're going to develop these information model. And the logical way was to use an existing standard at the time, and they're now working on a Change Control Board and so on. And as a natural step they have worked with the community to test those standards in rapid prototyping environments to test that pilot. And they've done them in small operational environments here and there to point that I think like 6 months ago, for example, FAA in a request for information, they've actually required in the language for the next generation weather-enabled system, the NextGen, they have required the use of OGC standards. So that's why it's both.

It's coming not top down; it's coming as a necessity essentially in today's world for interoperability and then testing it definitely within the domain, so not taking anyone's word for it, essentially. Making sure it works, creating your profile, your extension, whatever you need for your domain, and then the next step is requiring it in acquisitions or stating it in policies and so on.

DR. CHEUNG: Thank you.

Chairman Hersman, at this point we have no additional questions.

CHAIRMAN HERSMAN: Member Rosekind.

MEMBER ROSEKIND: Just one quick one. Dr. Alameh, can you say whether your consortium also has a focus on user application? There's been a lot of talk about standards interoperability. You know, where's the innovation going to come when, you know, somebody interested in one application talks to somebody else and issues related, data processing, visual representation, et cetera, where does that user community come together for those innovations? Is that the consortium or are there other places that focus on that?

DR. ALAMEH: So the consortium is -- definitely not just the consortium. I mean, innovation is coming from all over the place, especially with location being just pervasive these days. But from our perspective we kind of encourage this rapid prototyping or just bring the idea that we haven't thought of yet through this rapid prototyping environment that we have. It's a virtual environment so it really doesn't exist. It's really just the community's members getting together, you know, for 3, 6 months to work with one, two, three -- nowadays, actually, we're working with nine government agencies from all over the world on things like cross-community interoperability, or more interestingly maybe geospatial for the mobile. So not let me import what I have on the desktop for the mobile and see if it works, but actually let's start with a clean plate and see what the community out there is doing with packaging geospatial information. So -- and it's an eye-opening exercise essentially. It's a way to bring innovation to all of us and then back to where it came from, so --

MEMBER ROSEKIND: Thank you.

CHAIRMAN HERSMAN: Thank you to all the panelists. I think one of the things that it draws into sharp focus is how much what you all do is a part of the work that's done every day in transportation. I note that looking at just our news clips from this morning, there's discussion about the FAA installing new technology, NextGen technology in western Colorado to help search and rescue responders trying to find aircraft that are down in the mountains, making sure that they have better technology to do that. I note that there is also a reference to insurers using GPS technology to reward drivers for not speeding. And, finally, Mr. Danielson, there's an article in our clips that says USGS data suggests riverbed erosion is putting pipelines at risk due to some of the flooding that took place in the Missouri River.

And so, I think we all appreciate what you all do and how much it helps us as a society to be safer and for us at the NTSB to do our jobs. So thank you so much for your contributions to our forum and for the work that you do every day that helps support what we're doing. Much of the data and the integration of that data underpins the decisions and the priorities that we have. Thank you all so much for being here.

And thank you all in the audience for your attention and for sending questions in to Dr. Cheung. We're going to continue to try to answer those. We will take a break and our third panel is on aviation safety. It convenes at 1:20 this afternoon. Give yourself some time to get back and get through security. We are adjourned until 1:20

(Whereupon, at 12:00 p.m., a lunch recess was taken.)

AFTERNOON SESSION

CHAIRMAN HERSMAN: Welcome back. We'll now begin with our third panel, the aviation panel.

Dr. Cheung, will you please introduce our presenters?

DR. CHEUNG: Thank you, Chairman.

In this panel I am assisted by Mr. Bill English of the Office of Aviation Safety, and Dr. Loren Groff of the Office of Research and Engineering.

Dr. Michael McNerney is the Assistant Manager of the Airport Engineering Division of the FAA Office of Airport Safety and Standards.

Dr. McNerney, please begin your presentation.

DR. McNERNEY: Thank you, Dr. Cheung. And Madam Chairwoman and Members of the NTSB Panel, thank you very much for inviting me and giving me an opportunity to present to the public our small part of the Airports-GIS Program and it's impact on aviation and aviation safety.

CHAIRMAN HERSMAN: Mr. McNerney if you could pull the mic just a little bit closer, that would be great.

DR. McNERNEY: Sure. Thank you. Can everybody hear me now?

Okay. Again, my background is -- I've only been with the FAA for 2 years, but then I was hired specifically to work on the Airports-GIS Program. From my previous background, I did my dissertation on "The Use Of GIS for Airport Engineering and Management" about 16 years ago. And so I've been an aviation consultant and also at the University of Texas for 10 years as well, so -- and Air Force pilot. So I have a wide background in aviation and been pretty much involved in Airports-GIS and GIS for aviation for over 20 years.

And -- I'll get the next slide here. The reason for this slide is that a lot of people don't know that there are several types of airports, particularly as related to airport funding. In the United States this comes out of the report to Congress, NPIAS airports. There are over 19,000 landing areas. Some of those are airports and heliports and seaplane bases, but about 5,000 of those are open to the public.

But there are about 3300 that receive federal funding. They're in the National Plan of Integrated Airport Systems. Those are the ones that we provide funding to. And because we provide funding through the congressionally related Airport Improvement Program, we can require them to use our standards.

And the other airports that are in the National Airspace System that are not -- either privately owned or publicly owned, but not getting funds from the FAA, we very little control over those individual airports. We primarily are developing a data collection program in GIS and our carrot is funding and standards, and for the other airports it's safety reporting.

So we embarked on this program starting in about 2008 and we had reasons for developing the justification for Airports-GIS. One was improving efficiencies and a big one was reducing costs. We actually did a cost-benefit analysis to show that. But another benefit is improved safety. So by having this better data and real-time data, correct and traceable data. And also it provides support to the NextGen program.

So what is the Aiports-GIS Program? Again, there are about 547 airports that are certified airports. Those airports we control a lot more because we require certification that you meet these standards in order to have scheduled air service. And the other 2,000 airports, again, they're receiving our funds, so when you're doing projects, you have to follow our standards to get our funding.

The other 13,000 airports, we have very little control over. Sometimes we have self inspections, sometimes the states do inspections and licensing, but we do not.

That first group of airports that are NPIAS, we are embarking on a program to do full-scale geospatial data collection at engineering level accuracies. The second group of those is related for charting and recordkeeping purposes and we are doing limited geospatial use on those airports. We're requiring the airports to report geospatially or will be in the next 2 years.

The Airport-GIS system has several standards that we use primarily for geodetic control. We have very strict geodetic control that we use developed by the National Geodetic Survey, and they review the geodetic control. We require those airports to set up a primary control and a secondary control in the airports. And then in the aerial photos, we require them to submit a plan. We review their plan. Sometimes we make them redo the plan, and then they submit aerial photography and we review that as well. And of that, we're having about a 30% rejection in having them redo that to get it to our standards and have all the data in it.

That data now currently goes to the ATO side of the house in the FAA and that is used for charting and other purposes, primarily for flight procedures as well.

So we are looking at this data -- right now we are developing what we call the electronic ALP module, Airport Layout Plan, and that's used for all of our planning applications. In order to get a construction project approved, you have to have planned it out to make sure that it's the best thing for your airport, gone through that process, and we review that. Currently those are all paper, but we are going digital in this next year.

And then we're developing engineering applications so we can measure on an airport layout plan distances between runways, runways to parallel taxiways, taxiways to adjacent buildings, and actually measure those data from the data that we've collected.

We're in a transition program right now. Right now in 2012, airports are submitting some data electronically. Anything safety critical related to a runway or taxiway, they are submitting it in GIS. But we also still have legacy data from all those airports. In the future, in order to transition, we're going to collect some data electronically and still have some that are still in the old method, depending on the size of the airport. Again, we're using the biggest airports first and working down to the smaller airports. But by 2016 we expect to get a full digital, all electronic airport layout plans and all of our digital data.

The Airport Layout Plan is a module that we developed using the data that we've collected. We have over 100 features that we collect at an airport and you're allowed to view those features and you can build the actual airport layout plan drawing set from Airports-GIS. And many different layers and it allows to do measurements and tools with it to measure distances. A lot of the GIS tools are available in it as well.

Now, once we've collected this data we expect to be interoperable with other agencies. We developed our standards in conjunction with other existing standards. We are keeping them up to date. We expect in the next year to be compatible with the FAA's ADM program, the Aeronautical Data Management program. We're a part of that and we're developing our data to meet those things which will result in a common geospatial model and a common temporal model, which will require some changes to our data. But it should make it much more interoperable and much more useful.

So those are some of the other agencies that we expect to have our data interoperable with.

And again, NextGen, one of our industry people have said that Airports-GIS is an unsung enabler of the NextGen program. But we're going to have the most accurate and most current and up-to-date data that will go to the NextGen program. The one advantage that we have over other programs who collect data at a one-time snapshot is that we are providing funding for new construction projects and therefore we can require that construction project update its data as it goes along. That keeps our data up to date on a routine basis and keeps it refreshed and up to date.

Some of the incremental benefits of Airports-GIS. We have a lot of benefits and primarily we see labor productivity by being able to coordinate that airport layout plan. Right now a paper ALP can take up to a year, but generally about 4 to 6 months to get one of those submitted to the FAA reviewed by all the different lines of business within the FAA: Air Traffic, Airspace, and NAVAIDS, everybody look at it and see that it is a good plan going forward. Also we think by having the data -- reliable data and available to everybody, we'll be able to reduce the time that a project is completed by having less coordination problems doing that.

We also will have better information for the planning and actually be able to do preliminary engineering on our data. One of our outputs is 1-foot elevation contours in the airport area. Our consultants who used the data think that's one of our best projects and they really like having that available.

And we also looked at eliminating redundant mapping, going out and surveying things multiple times because nobody has provenance on the data that was collected last time. We keep all the provenance. We keep all the data. We have it reviewed by NGS and so we have the authoritative data on that. And we did a cost-benefit analysis and we were very happy with the results of that.

Now, the safety benefits -- again, it wasn't designed initially as a safety system, but it does have a lot of benefits that result in safety. One of the other things that we have is that this, by being the authoritative source, preclude other lines of business as they've done in the past and say, oh, well, nobody else has this data, we're going to go out and create it again as a one-time snapshot and no way to keep it up to date. So we have had cases where other programs within the FAA have done that and we're now working together in the FAA to avoid that.

Requiring a single data entry point will enable people to have the most current data. And a situation when I was an airport consultant, I was doing the master plan for Houston Intercontinental. We were putting in a new -- siting a new runway and the FAA was telling us that runway is too far away from the tower, you can't site it there. And we said, yes, it's within limits. And then so they said, show us your data. And when we showed them the data, they said, oh, that's where the tower is. They still were using an old ALP that didn't have the correct tower location. So it's important to have everybody looking at the same data and doing that.

Having safety critical data, runways and taxiways having a very rigorous verification and validation program, we are doing that and what we're doing, again, is we review aerial photography plans and then the data is flown and then it's reviewed by NGS or a third party that we have available. And once it's reviewed, then they do feature extraction of it. So the buildings and the pavement edges, all that is extracted from that data that has already have a provenance of being accurate as best we can.

Previously, when I've worked with other airports on their master plan, a building would be located in the general area, but it might be within 50 feet of where it really is. Now we have data that shows exactly where that building is. And we can measure from the taxiway to the building and see what the clearances are.

And, again, I said we are having rejections of the data either for incompleteness or by having this very systematic process. And it takes us almost 18 months to go through this process to do a complete dataset for an airport. But we find it's worth it and we're going to have excellent data at the end of that point.

Also, again, having the ability to put the design data into Airports-GIS, say, okay, this runway is going to be extended sometime in the future. We put dates on that and then we can analyze when, in fact, and plan for those approaches to be ready when that runway is ready for construction. And we've had a rather poor history in the past of having runways completed and not having instrument approaches ready. But by having this coordination process and having the Airport Flight Procedures office being able to use geospatial data to analyze that and actually should reduce the time. Currently the wait list for an airport to get a new approach is around 2 years and we hope by going everything geospatially we can reduce that significantly in time.

Let me go to the next slide here.

We have a program under Airport Data and Information Management that was started under the NaviLine program in the ATO office and they invited us to participate. But we're going to transition to collecting all of that other safety data directly into GIS. So there will be one entry source. Right now there's about four entry sources, plus you can call up or send a PDF and data can get transcribed into the National Airspace System on those airports.

It'll be all landing areas. Most of it will be non-survey data. And the airport itself will submit it to a web portal and a digital signature will be attached to when they put it in. That'll be the authoritative source. We'll have the airport district office be able to review that data and send it forward. That'll be available in a geospatial format for analysis as well.

Safety benefits of the new data program, a direct web input and transfer will avoid transcription errors, especially in coordinates. I've got an example on the next slide of an error that we found. And if you plot it geospatially, the data itself, it's a way by looking at the data to see if things look out of -- you know, the coordinates don't look right. And then you have the digital signature and then review from the airport's district office.

Currently, we're receiving about 500 new landing facilities per year and also abandoning about 500 landing facilities per year in the database. So it's something to keep up with.

Non-quantifiable benefits. When we did our benefit-cost analysis we did only those items that we could dollar cost because we were justifying that we had a cost-beneficial program. But really there are other benefits that we didn't try to quantify, but we did say they're available, one of those being improved safety.

We are working -- I've only been with the FAA 2 years and when I first got here the Office of Aeronautical Information Management and the Office of Airports, it was not a very good relationship between the two, what I found when I got here. But since then, we have become very close partners and we are working together and the data that they have in the NAS is now going to be migrated into Airports-GIS and so we'll have different data, originating data, but we'll have one single data source that people can come to look for data.

So in the future, in AIM, their digital NOTAM maps will be submitted in Airports-GIS, the SMGCS charts. And we also want to put our data from Airports-GIS into the OA AAA for airspace analysis. I thought I had some more slides in there, but I guess they've been deleted, but okay.

My conclusions were that we have a better than a 2 to 1 benefit on our cost-benefit analysis that we did. So and the safety benefits not measured, not costed out, are also going to be significant by having that accurate correct data available to everybody who needs it. And the geospatial data of Airports-GIS will be a supporter of NextGen implementation.

And those end my remarks. Thank you very much for your time.

DR. CHEUNG: Thank you, Dr. McNerney.

Mr. Dejan Damjanovic is the Director of Air and Marine Solution of GeoEye.

Mr. Damjanovic, please begin your presentation.

MR. DAMJANOVIC: Thank you. Madam Chairperson, distinguished members of the audience, thank you for your attention this afternoon.

The world is moving to something called FANS. FANS is known as the Future Air Navigation System. And the Future Air Navigation System fundamentally solves the problem that we have in our current navigation system, which is, number one, it's voice-based and we simply cannot speak enough to talk to all the people whose aircraft need to be moved in and out of the system; and, secondarily, we have run out of space and since we cannot invent more space, the only possible solution is to move to an air traffic management initiative that reduces the space from aircraft to aircraft. That is something that we refer to as containment and containment is the critical discussion that I'll be talking about today as it pertains to obstacles.

The FANS concept was invented by ICAO a number of years ago. And, again, the primary notion is message-based air traffic management with smaller containment to get, purely and simply, more airplanes per hour in and out of everyone's airspace and airports in order to improve travel, improve efficiency, and of course enhance safety at the same time. The physical implementation of a FANS is what we know as NextGen for the FAA and, in Europe, Single European Skies, or SESAR. Components of these will be implemented by about 2015, so it's critical that we're able to interoperate successfully between, of course, the U.S. and Europe over the North Atlantic, but eventually throughout the whole world.

This is a global challenge and I wanted to thank Dr. Alameh for introducing the AIXM concept of a data standard. A data standard initially developed by the Europeans and further enhanced and expanded by many, many other contributors around the world, but it provides for an aeronautical information foundation that allows us to always come up with the same aeronautical answer to a question with, as was discussed in some of the earlier presentations, the exact same levels of quality and the same levels of accuracy.

Most importantly, I'd like to bring out a concept. When we speak about accuracy we actually have two important notions: that which is absolutely accuracy, where are in the world; and that which is relative accuracy, which is to say the relative accuracy of one part of the runway to another, the relative accuracy of an obstacle to a runway, and another runway within the same airport. So relative accuracy is as important as absolute accuracy, both of which need to coexist in the same frame of reference.

There are some 14,500 airports around the world with hard surface runways and at least 1 instrument approach. We need to ensure that we're all using the same frame of reference in terms of aeronautical information. And AIXM helps us do that by ensuring that we're always communicating and, most importantly, getting the same answer to the same question no matter where the airplane comes from.

Much of the defining publications for navigation in the FANS world stem from two different publications: something called "ICAOnics 15", which defines how aeronautical information is collected; and the "ICAO Performance-Based Navigation Manual," which defines how we can navigate in the FANS environment using the reduced containment principles that I alluded to earlier.

One of the predominant requirements in order to reduce the containment is that we must have a concise and clear idea of where is the terrain and the obstacles which affect flight because fundamentally we will be bringing aircraft closer and closer to those terrain and obstacles in order to increase the numbers in a given number of square miles or cubic miles of airspace. Currently the ICAO construct is based on something called Areas 1, 2, 3 and 4. The FAA constructs are built on something that was essentially a legacy of the WAAS program, known as VGATS and a number of others. They are both centered and organized around a runway but they give fundamentally different answers when we ask the question what are obstacles around my airport?

The ICAO FANS concept has given us a global or let's say universal notion of accuracies for terrain and obstacles. And as I mentioned earlier in my presentation, these provide us with standards for absolute accuracy, relative accuracy, precision, and levels of quality assurance associated with those numbers. So it does provide a single global notion of quality and assurance, which is going to be a huge benefit when planes from countries all over the world are all trying to take off and land at our nation's airports.

When we talk about the notion of defining obstacles, we're typically talking about manmade obstacles, which are obviously created through human intervention, and then we also, of course, concern ourselves, as the earlier gentleman spoke before lunch about, terrain which is a potential hazard to or from an airport. So these are the ICAO international standards for how we collect terrain and obstacle data around airports.

Now I've actually taken a particular airport in the Midwest and I've superimposed the obstacle identification surfaces using the FAA criteria, which is the light blue line, alongside with the ICAO criteria, which is the purple line. And you'll notice although they both align perfectly on the runway down the middle, the actual outlines of the areas are significantly different. So this is an example of what's the obstacle off the end of Runway 15-Left? Well, it depends.

What this also outlines is in terms of geospatial solutions this is also what I talked about before about the concept of relative accuracy, one of the challenges that we have in aeronautical data is that I may have runway information that was provided to me by the airport authority, I may have obstacle information that was provided to me by the county authority, I may have other obstacle information that was provided to me by the utility company. All of those pieces of information were provided at different points in time so we do not know if all of those pieces of information existed at the same point in time and, secondarily, we do not know if they were all necessarily collected with the same frame of geospatial reference. They may have been collected at NAD 29. They could have been collected NAD 83. They may have been collected WGS 84. So there is a challenge of both temporality and datum that could have affected the quality and resolution of that data. If we're going to be flying more airplanes in the same cubic miles of airspace, we need to have a much better handle on how well that information is acquired and maintained.

When you're going to go through a process to collect obstacles and terrain, there are a number of critical steps that need to be followed. First and foremost we need to understand the actual collection requirements that we're going to be working with. In other words, if I'm developing terrain and obstacle data for an instrument procedure, what is the containment or the amount of airspace on either side of that instrument procedure that is required to successfully develop that procedure. Then need to understand what is the criteria? Is it a TERPs criteria? Is it a PANS-OPS criteria? Is it the new Area-2?

Then you have to choose your collection method. How am I going to collect this information so that I may successfully acquire all of the terrain and obstacles that I need?

You then need to determine your validation sources. What existing sources of information do I have that may be used to validate? For example, in the United States we do have obstacle sources that are maintained by the FAA. We also have things like tower databases that are managed by the FCC. Although there are lines of communications between the FAA and the FCC, the reality is they are two separate databases with two separate sets of information.

And then, of course, we get back to the original discussion about bare earth. In the earlier discussion this morning, it was mentioned that for terrain avoidance, first surface was critical because we wanted to make sure we understood what we had proximity of hitting. In the obstacle business we go back to the fact that we have to have bare earth because we need to be able to determine what was the base of an obstacle, what is the height of the obstacle, when that obstacle is identified on bare earth. So that is a critical requirement.

Then we collect the features. We determine the relative position of those features to the runways and to each other. And then, of course, once we've acquired all that data, we look to developing an obstacle maintenance plan.

What are the collection methods? There are four generally recognized methods of data collection which are widely understood in the aviation universe. The traditional methods is aerial photography, which is currently endorsed by the FAA in their advisory circular. There is the ability of using SAR or IFSAR technology, which the space shuttle mission was predominantly based upon and there are airborne sensors that can use SAR data. This is not currently supported in FAA documentation. There is lidar, which has been discussed earlier, is a popular newer form of data which is being supported by FAA. And last, but not least, we have satellite-based collection. And again, satellite-based collection, as is the case with SAR, is not currently supported by FAA guidance.

However, it is important to note that in the same U.S. government that we speak of, the Department of Defense community has widely and broadly used satellite data as a means of collecting information, both aeronautical and otherwise. And, in fact, to one of the questions that was asked earlier about the ability to quantify and measure and assure the ongoing quality of the sensors, in fact, satellite data for much of the last decade has had quantitative assessments done by NOAA and members of the military to ensure the consistent accuracy and quality of the data.

So we have a variety of choices in how we collect data and we have a variety of data accuracies and data qualities associated with that.

Let's look at a real world example of some of the interesting issues that come up with real world collection. This was a program that we were doing recently San Diego, California. One of the first things that this brings up to the obvious observer, if you look at the black line outside the outer perimeter of this, that is the limits of the ICAO Area-2 criteria. In fact, you will immediately notice that almost half of the required area is over the country of Mexico. So now this brings the question, how can you appropriately collect information, whereas in the case of, let's say in the United States, significant numbers of airports have their airspace both in the U.S. and Mexico or in the U.S. and Canada?

This is an interesting problem. Imagine this problem in Europe where virtually every single country's airspace automatically overlaps into some other country or in many cases several other countries.

We look first at obstacles in the simplest of terms, point obstacles. And this would typically be towers or high trees and things like that. We always want to make sure that when we're identifying these obstacles we position them properly on the bare earth. We also want to make sure that we identify groupings of obstacles as intelligently as possible. But just to give the audience a notion of what some of the densities are, we're coming up with literally thousands of points around a single runway. A single runway at San Diego, 2700 points per runway, an astonishingly large number.

We also collect obstacles in line form, and as was previously mentioned, line obstacles are typically power lines or tall fences or things associated with that. And again, in an area such as San Diego, between power lines and fences, we came up with close to 500 of these just for a single runway. Very significant number and, again, one where there's all sorts of special considerations that must be taken with respect to things like identifying the towers that support the power lines, identifying the line features between the power lines. This is an area where, again, the particular collection that you're using, whether it's aerial or satellite or lidar or IFSAR, each of those has unique properties and characteristics. When they are collecting things like power lines it's important for the people responsible for the survey to understand the limitations of the technology that they're using and enhance and embrace those limitations in the best way possible to produce the most accurate result.

Polygonal obstacles, which are of course typically manmade buildings. These are the most significant challenge. It's really important to identify all the different kinds of structures. San Diego is a particular torture case because virtually the entire city of San Diego downtown is an obstacle of one kind or another. And as you can see from that, we identified over 3,000 individual buildings or manmade structures off the end of that one runway. Ballpark numbers, it's not uncommon in populated areas of the United States to identify between 5- and 10,000 obstacles around a single runway.

We have to identify all of those because, again, it comes back to the containment question. If the NextGen initiative is going to allow us to fly more and more aircraft in a smaller space, we have to have a better understanding of where all those obstacles are, the first point. And then the second point, even more so, as I think some of the earlier slides this morning, not only are we concerned with aircraft fixed wing procedures, we're also concerned about helicopter procedures, and increasingly when we talk about helicopter procedures, they're going to have their own takeoff and landing and instrument approach procedures and it's even more important for helicopters to be aware of all of these obstacles, which may not be an issue to a fixed wing but would certainly be an issue to, you know, a rotary wing aircraft.

And when you now accept the fact that why are people doing helicopter operations? Typically it's first responders, Medevac, National Guard. They're doing this because they need to be in harms way. It's going to be even more critical in the NextGen future that we have an incredibly detailed and, you know, complete grasp of all the point features, the line features, and the polygon features that constitute the obstacles around given airports so that we can better implement the procedures that NextGen requires us to do.

So, in summary, some conclusions. Things to keep in mind when you're acquiring this kind of data, you must understand all of the collection technologies that are available and don't make assumptions about technologies that you may not have worked with. It's good to look at all of the technologies, make an assessment of which of the technologies is best for the particular task you have at hand. Understand that AIXM is a critical part of the success of these technologies because AIXM is the sort of single global "lingua franca" that the aeronautical community requires. Indeed, my colleague Dr. McNerney mentioned the digital NOTAM system. The digital NOTAM system is predicated on the concept that all of the aeronautical data of the U.S., certainly all of the airport GIS information, will be available in the AIXM format so that in fact we can use digital NOTAMs to turn off and turn on features associated with airports or features associated with obstacles around airports in a digital manner. In order to do that, the data must be created from a consistent frame of reference with a chosen sensor and, most importantly, maintained in AIXM so that in fact we can use the benefits of the digital NOTAM technology to temporally change the condition of these informations.

You also, of course, need to understand how you want to validate or cross-reference the collected data with published sources. And that could be county sources, that could be FAA sources, that could be FCC, that could be other databases, power line databases from utility companies. And then last, but not least, you must establish a clear and concise baseline of the information so that you know that out of a particular point in time, December 5th, 2012, these obstacles and this terrain is associated with this runway and then you must have a prudent and well thought through plan for how do I maintain that data for the remainder of the aviation life span. Because you do need to collect it and maintain it forever.

Thank you.

DR. CHEUNG: Thank you, Mr. Damjanovic.

Mr. Christopher Knouss is a Principal Geospatial Computing Specialist at MITRE Corporation.

Mr. Knouss, please proceed with your presentation.

MR. KNOUSS: Madam Chairperson, Members of the Board, Dr. Ivan Cheung, and fellow panelists and audience, thank you very much for having me here. From my unique perspective I'm going to hope to try and walk you through some of the opportunities and challenges with actually doing some of the spatial and safety analysis.

Being from MITRE, we are federally funded research and development center established for the public interest. So from our perspective, as we're working through some of these, we get tossed a lot of unique challenges for taking a look at some of these established issues regarding safety, but in other parts of the aviation analysis area.

When I typically sit down with someone who wants to go ahead and start a spatial analysis effort, one of the first things we are challenged to talk about is that aviation analysis is actually inherently spatial. And although that, you know, this may become obvious to those here in the audience, when dealing with air traffic controllers, other persons associated with the aviation domain, they think in different topological frameworks in their mind. To them, they're dots on the map and they try to keep those dots separate. But for our perspective, we're also interested in taking a look at not only how these dots work between each other, but also with entities on the ground and the actual real world topological relationships.

Oftentimes this involves typical types of geospatial analysis where we try to wrangle in some of the unique nature of the aviation domain. Unlike with typical transportation anaylsis, cars typically stick onto the roads, with airports, with aviation, this may not hold true. Although they may be flying produres, there are different issues regarding GA aircraft, military, UAV, hang gliders, and other forms of aviation use. So as we typically are sitting down to look at this, one of the first things we'll do is take a look at what are the aspects of the aviation and traffic that are occurring. So we will typically use some of the traditional geospatial analysis approach.

We'll also take a look at the unique nature of the aviation and traffic. This includes flows of traffic, whether or not the flows are active or not. And this has particular type of definition in which aircraft will either follow a particular type of route or they will actually follow a different route that may not be established on a procedure. And so we will derive these metrics and we'll actually play back and show some of this information.

Part of this also is the cartographic use. When we're sitting down and briefing out, we will have to often provide airspace traditional maps, sitting down with public hearings. So it's part of the conversation specifically for the reroutes or for different types of analysis or how airspace is either changing. The aspects that people sit down in those public hearings will be not NIMBY, but NOMBY -- not over my backyard. And so with the recent New York and Philadelphia redesign, that often is the case that we will help out with. And one of the things that I've discovered along the way is during these conversations a lot of the individuals that are associated with the airspace or associated with the procedures or associated with the traffic, have never actually seen it on a map. They don't understand the relationships between some of the different airspace, surrounding airspace, special activity airspace. So getting them to first appreciate and see what some of this information is, is often a first step.

We will also take a look at some of the safety aspects. So Class B type of airspace, look to determine if there are any excursions. We're looking at flights. We're looking at airspace. But we're also interested in looking at the runways. For the picture up on the left side, middle row, that is showing an issue where an aircraft was coming in with a high amount of energy and went out across the end of the runway. So we are trying to take a look at not only showing these incidents and looking at them at a per incident level, but we're also interested in the systematic problems. Does this one issue indicate that there's a problem at the airport, that there's a problem with the procedure; is there a problem much more broader to the airspace, or is this much more of an indication of a systemic issue?

Some of the other aspects that we'll take a look at, non-traditional, is radar or radio coverage analysis. And so one of the other challenges is because the aviation domain has been around for so many years and had been well established, there's been a lot of development tools, analysis prep, that has been done that predate a lot of the commercial and actual proprietary geospatial techniques that people are typically used to using. So a lot of work that we will do is to wrap a number of these software capabilities around a GIS to be able to utilize the GIS's data administration and management aspects but leveraging what has already been done for the analytical side.

So that is what you're seeing on the left-hand side in which we're taking radar analysis and we are running our radar tool to determine where there are potential issues for holes in the radar and what's known as a cone of silence in the middle of the radar. These are typical things that often as people are doing some of the procedures design or talking about outages, that it's a particular emphasis that may not always be known until you actually visually see it.

Also, of a challenge is to understand that the aviation analysis that we are faced with is not necessarily a 2D, 3D, but a 4D issue. And, again, that is something that I am sure it's much more of a commonsense approach, but when we're using a lot of the commercial, some of the proprietary tools, they're not necessarily designed for the true processing of large amounts of that four dimension issue.

So part of the discussion also is, at a research center everybody had their favorite tool. Everybody has their favorite way of doing their data management. We have many very smart, very industrious individuals that all seem to want to do geospatial work. So when we're facing an analysis project or to combine modeling and analysis, we have to sit down and look at the tools not only that are being used in the field operationally, but also tools that are typically used inside of our own corporation and out in industry.

So when we're looking at it from a data management perspective, we will have to understand if it is a traditional relational database; is it much more of a non-Sequel type of data management; is it regular file? And we will wrap a lot of that in data services to ensure that some of the end users', systems or individuals, can have access, as well as to discover that data.

One of the unique pieces that we also have been facing and that I've been trying to work through is the idea of the content management. And I look at this challenge not necessarily from data, but from a knowledge management perspective. If I am going to take the effort to do an analysis, spend a large amount of time data prep, creating a lot of derivative products, I then want later on down the road, 2, 3 years, for someone to be able to discover and use my same data to either have to review my analysis or to also extend what I have done. What is sadly the case is that if an individual has left or if there has been a change over of a hardware or computer, there are potential problems because you may not be able to have the same data. So you have to go through that process all over again. And that is a continual challenge and one that it is not unique to ours. But as we're looking at NextGen and some of these other initiatives, where some of the data products are advancing, trying to look at past analysis, how do we bridge the gap between what's happening in NextGen and some of these wonderful data products that have been described, as well as legacy ones to do a more systematic and systemic look at what is happening in our National Airspace System.

So again, this is further compounded by the problem of looking at commercial, open source and proprietary information. So as we're looking at use and going through and evaluating what is the best possible choice, we have to potentially use multiple sources, either from commercial or governmental source.

So the other aspect is the approach. One of the things that we are faced with is looking at simulation, and simulation both in the real -- in the fast simulation as well as the real-time simulation. We are taking a look at doing a lot of human-in-the-loop analysis for safety issues, whether it be for runway procedure, airspace design. And one of my goals is to make sure that as we are using those different data sources, GIS services, that those that are taking the time to develop these baseline and alternative analyses are then further making sure that others that are doing modeling to determine some of the system advantages, the cost-benefits towards some of these procedures, that they're going to use the same information.

The problem is that, again, looking towards how the data management is working is we are faced with also using some of the operational data coming from the real systems. So we don't get a chance to use some of the open sources, some of the open services. So we have to then use that information and we'll have to convert it. And what is happening is that the simulation folks are using that data but then they're having to convert it again into the modeling environment and that others that want to additional data monitoring are doing conversion after conversion after conversion of the same data, which introduces resolution error; it introduces biases and inaccuracies of the data. So what you're originally starting out with for, say, an airspace may be very different from what has been converted down the line at the end result for a mining.

One of the other challenges is authoritative source. We would very much like to use authoritative sources for two reasons. The first is that we can point to it, it's easy for our provenance, for our metadata. And for the second, we can ensure that if others are going to do similar analyses, that we can point them to that source. The issue becomes is that as we're looking at these sources, between weather, whether it be from the aircraft or FOQA data, whether it be for the traffic itself, or for infrastructure, is that there are many different possibilities for where we can grab that information. For just traffic alone, we have to consider what is the scope of our analyses because each type of traffic that we potentially may be able to get in have different benefits.

There is a huge challenge for us when we're looking at consideration, not for local issues, but more systemic problems, is that we are faced with multiple facilities that we would get information from, from different locations, from different sensors with different accuracies, with different sensitivities, and with different data holders that we then have to work with to ensure that as we're doing the analysis that if there are any sensitivities that we ensure that those are maintained.

And so as, again, just in the traffic situation, when we're looking at this we have to consider the flight story as we're doing our analysis. This flight story begins at the gate, at the airport, if we're looking at weather, or for traffic initiatives, ground stop programs, and as it departs into the en route, down back to the other airport, to the destination airport, as well as weather along the way, collision potentials, all of these become part of this flight story. And this flight story is important because the problem is, is that it is not able to be stitched together currently by just authoritative sources. This is compounded by the problem of when we're looking at from a temporal and geospatial -- or, I'm sorry, temporal and an extant that when we're getting into looking at combining some of these, we have to pull from multiple sources of our traffic information.

Sorry, this is taking a moment to play.

And so one of the things that we've been attempting to try and do is to thread the tracts. And so we're taking different information from different sources -- from SDX at the airport, from the National Offload Program, as it's departing, from ETMS in the en route, and we're attempting to try and pull the best available data from those different sources to stitch together a synthetic tract that we can then use to be able to derive and infuse with additional GIS data to create a best possible data source.

This threaded track allows to be able analyze these larger systemic problems that we would not necessarily be able to do ahead of time. High energy is a perfect example. As an aircraft is coming into an approach, the different -- the source of the actual flight may chop off. So how do you then be able to analyze seamlessly between an ETMS or en route into a offload program data source and be able to make sure that that information is accurate throughout?

So as we're looking at this, this problem is not necessarily for traffic alone. We face this with airspace, with navigational problems, with radar and radio, some of our terrain. And this is not necessarily to say there isn't a best solution, but we are challenged to define across several years what is the optimal solution. So if we are going to investigate a certain type of analysis that may have happened, say, 2 years ago, we need to easily be able to pull all of the information from that cycle update from 2 years ago. So we are in a collection phase for all of this information to ensure that our analysis moving forward is going to be possible. And that is a significant challenge when, again, we're looking at the evolution into NextGen and some of these other initiatives, how do we bridge that gap? Very similar to what the Census faces as their changing definitions are for each decennial census.

So the other challenge that we face is that when we're doing analysis a traditional GIS model oftentimes won't do. In the past, we'll have to take a look at, if we're going to do a traffic analysis, we have to -- we can't process all the traffic for, say, an entire year. We would like to, but we couldn't do it before. So what are you faced with? You have to identify a 90th percentile day, a good weather day, something that is representative statistically for a good day that we can then analyze. The problem is, is that's very specialized and very scoped. You will oftentimes miss a lot of the very important peculiar events that may actually indicate some of the systemic problems. So we are looking to try and leverage and we have been moving towards much more of a traditional big data analysis where we're moving away from the commercial typical GIS applications for large processing and we will do that in, say, a -- or a non-Sequel type of distribution where we may have several hundred computers processing on a single days' worth of traffic. And then we will take a look at and use a traditional GIS to be able to analyze those derivative products.

One of the interesting things is that we've been also moving towards cloud computing. Now, cloud computing, everybody is talking about. And the problem with cloud computing is that it is very, very good at processing very large amounts of data when you need it. For our threaded track, we would like to process multiple years' worth of data that on our infrastructure takes multiple months to be able to crunch through that information. In a cloud computing environment we could scale that up as fast as we want to be able to process that data very quickly. The problem with that is, is that we have to work through a lot of the data sensitivities. We have to identify those that own the data, to be able to work out individually how -- if they approve for our use in this new environment. And so that is a very time consuming effort to have to do that. And so oftentimes one of the biggest challenges is not only identifying that, yes, go ahead and use that data, but instead it is "I don't know who owns that data, let's find out." And so without knowing who is the owner of a particular information source, it's very difficult to go ahead and then get approval to work in this environment.

So, again, in sort of conclusion, all of this has allowed us to really be able to do some of our safety analysis that we couldn't actually do before, as well as to look at a from a broader perspective, things such as traffic -- I'm sorry, overshoots. We're looking at some of the runway overruns. We're looking at traffic collision. We're looking at high energy events. We look at runway issues, missed approaches and excursions.

And so, a lot of this analysis that we're looking at, again, couldn't have been done at the scope that we're looking at if we had not been able to combine some of these authoritative sources and also to be able to leverage some of the big data analytical capabilities to really look at systemic problems. And so one of the challenges that we also are facing from some of this, looking at some of the sources, is that for airport information for other information is not only to identify the best source, but a source that is pervasive for all the areas of interest that we're looking at. Specific for airports, airports are a big challenge for us, not only for the cost associated with it, but to identify the best possible source.

So with that, I conclude my presentation, and thank you very much.

DR. CHEUNG: Thank you, Mr. Knouss.

Mr. Rich Fosnot is the Senior Manager for Aviation Safety at Jeppesen.

Mr. Fosnot, please begin your presentation.

MR. FOSNOT: Thank you. I'm very pleased to be here. Madam Chairman, thank you for the invitation to participate in this event, and thank you, Dr. Cheung, for your encouragement and the incredible amount of energy that you put into this conference.

Now, I am not a GIS expert. I'm a safety person. So the approach that I'm taking in my presentation is how GIS is used in improving safety in the aviation environment. And the two things that I'll be talking about is the Airport Moving Map and terrain and obstacle databases.

Runway incursions continue to be a threat in the airport environment. The graph you see here shows actually an increase in the amount of incursions in the FAA National Airspace System.

However, I need to qualify this in that there are different categories of runway incursions, Category A being the most severe, where a near collision almost occurs, and Category B. The combination of Category A and B incursions is less than 10. So the remainder of these incursions that you see on this graph were Category C and D, which is an incursion, and an incursion being the incorrect presence of an aircraft, a piece of a equipment or a person on an airport landing service. So a Category C and D incursion in most cases poses little to no threat to the public.

The data I'm presenting here is from the IATA Accident Classification Taskforce Safety Report. I'm a member of this group and it's a very unique group in that we meet every January to review the accidents in the airline industry worldwide and classify these in terms of taxonomy of threat and error management. It's somewhat of a difficult task in that the accidents in the preceding calendar year, the official accident investigation and report in most cases has not been completed. But in order for us to provide a meaningful and timely safety report to the IATA membership and to the aviation community in general, we are faced with the task of assigning a probable cause to these accidents before it's official. And by doing this, the people that are on this taskforce are the major airframers, being Boeing, Airbus, Bombardier, and Embraer, some of the major airlines, including Air France, Lufthansa; cargo operators such as Cargolux; and OEMs such as Jeppessen and Honeywell. And the folks that are on this taskforce in most cases have been very involved in the ongoing investigation of the accident and this group of people have a very unique and composite knowledge of these accidents and we feel that our accuracy in determining what happened is pretty good. In fact, we'll go back to previous years after the state accident report has been complete and issued and verify that the conclusions that we made before that report was available were correct.

Now, that said, this is world-wide airline operations and it certainly does not represent aviation in its entirety, that being military aviation, general and business aviation are not included here. So that said, in 2010, the IATA group identified 20 runway excursion accidents; 10% of these accidents were fatal. That is, 2 of these accidents include multiple fatalities. In 2011, last year, again we identified 17 runway excursion accidents with 0 fatalities.

For runway incursions, in 2010 we did not encounter any accidents involving a runway incursion that was fatal. And the same case for 2011.

Now, the Airport Moving Map was introduced as a tool to enable our air crews to positively identify their location on the airport surface. This application was introduced on the Boeing Class 3 EFB, electronic flight bag, in 2003. Now, this application includes a known ship position to show the flight crew their current position on the airport surface. Now, the elements within the Airport Moving Map in the Airport Moving Map database include the runways, the runway identifiers, the taxiways, taxiway identifiers, terminals, gate numbers and gate locations, also restrictions on the airport surface. And a unique feature of this Airport Moving Map is the ability for the flight crew to trace with a touch screen their assigned taxi route. And you can see it in this example indicated in green. If they make a mistake, there's a button they can push that will erase and they can retrace their taxi route.

Also shown on the Airport Moving Map is the location of hotspots that have been designated by the aeronautical authority. And the hotspot being a location on the airport surface. It could be the intersection of two runways. It could be the taxiway and runway intersection or two taxiways, where historically there have been problems with events that either exhibited confusion on the part of the flight crews or where there have been accidents or near accidents. And the purpose of the hotspot is to indicate to the flight crew that, hey, pay attention here.

Now, the Airport Moving Map is supported by a database, which is unique in ARINC 618 format. The Airport Moving Map is a true electronic chart in that it is data driven. As the aircraft moves across along the airport surface, the alignment of the map can be aligned with the direction of the aircraft and the map regenerates as the aircraft moves along. Now, Jeppesen currently has a bit over 800 airports that are in this database and there are other data providers too that provide Airport Moving Map databases in this ARINC 618 format.

Now, the Airport Moving Map was originally introduced, as I said, on the Class 3 EFB, which in a Boeing 777 is down to your left or lower right, depending on which seat you're sitting in, right by the nose wheel tiller. In today's newer generation aircraft, such as the Airbus A380 and the Boeing 787, these Airport Moving Maps are able to be displayed on front panel multifunction displays, which is less heads time effort by the flight crew in going from the map to the outside environment.

One of our operators has reported that utilizing the Airport Moving Map in their aircraft operations at a very busy aircraft had resulted in an average savings of 30 seconds per taxi, which is an incredible amount of money. But we're here to talk about safety and the less time the flight crew is figuring out where they are, the safer they're going to be.

Now, I talked about there not being any incursion accidents in that subset of accidents looked at by IATA, but there were excursion accidents and they continue to be prevalent in worldwide airline operations. Now, the Airport Moving Map as utilized in the Airbus A380, Airbus has introduced a very unique application called "Brake to Vacate." And it allows the flight crew to interact with the Airbus version of the Airport Moving Map to select the landing runway and also to select the turnoff that they are assigned or desire to make. Now, the software in the Brake to Vacate application will, upon landing, engage in autobrakes, give enough braking energy to the system so that the aircraft is slowed just at the right moment to make the desired turnoff.

Now, there's a lot of values here in saving time and money, but also there is protection from runway overrun warnings, where if the runway selected and the turnoff or end of the runway and the current state of the aircraft as it's configured on the approach, if there is insufficient room to brake the aircraft safely, the system will issue a warning for the overrun.

Now, there's a lot of improvements, new features that we can incorporate in the Airport Moving Map, one of which is to include additional data, such as published taxi routes, low visibility routes, holding positions, tailored airline information, preferred routes, ramp freeze, company-specific deicing areas. And these are being addressed in a new version of the RTCA document for the content of the Airport Moving Map.

Some of the plans that we're looking at is to incorporate all of these different pieces of airport information that's in different locations on different charts to incorporate them all within the EFB Airport Moving Map.

The previous slide showed a airframe-specific airport diagram and I wanted to show this to you in a little bit larger scale. The chart shown here is for LAX and we create this for Airbus A380 and for the Boeing 747-8, in that these aircraft are so large that there are many specific restrictions on the airport for these airplanes. So this chart is created for these operators to have that information immediately available.

Accurate airport diagrams is another project we're working on to make a Airport Moving Map available to general aviation and to corporate operators that do not have a Class 2 or Class 3 EFB with the Airport Moving Map application. And we hope to get approval from the FAA this January to be able to include the ownship position on the traditional airport map as displayed on an electronic charting service, but distinctly different from an Airport Moving Map in that this is a precomposed chart, not data driven chart. But this would make this feature available to all.

Now, the accuracy of the information available from the airport authorities in some cases is not as accurate as is required. Maybe not so much in the United States, but in other countries we will find errors in the location of taxiways in their intersections up to 200 and 250 meters. So the use of georeference satellite information allows us to locate these taxiway intersections accurately.

In the future we hope to introduce the Airport Moving Map to mobile devices such as the iPad.

I'm running out of time here. Controlled flight into terrain events continues to be a severe problem in our industry. The IATA group identified seven accidents, 86% fatal CFIT, controlled flight into terrain, and 2011, 10 accidents with 90% of those accidents were fatal. The terrain and obstacle databases that we provide, that industry provides to drive terrain and awareness warning systems has been a incredible safety enhancement to the industry in reducing CFIT accidents.

The other uses of digital terrain, in addition of TAWS is on aeronautical charts, moving map displays, synthetic vision, flight planning systems, flight procedure design, and airspace and airport modeling software. We also, as I mentioned, apply the terrain to the chart. In our assistance to reduced situational awareness, and this is the definition I use, the perception of the elements in environment of time and space, the understanding of their meeting, and the projection of their status in the future. So it's a lot more than just, where am I?

And with that, I conclude. Thank you.

DR. CHEUNG: Thank you, Mr. Fosnot. And we really appreciate everybody keeping on time.

Mr. English, would you please begin your questions?

MR. ENGLISH: Thank you. Thanks to everyone on the panel for some excellent presentations.

My question for right now, probably for Dr. McNerney or Mr. Fosnot, if we can go back to what Rich just mentioned actually about the Airport Moving Map. Recently we've investigated a number of incidents that were ground movement collisions. Fortunately, none that were catastrophic, but certainly expensive. And I was interested in the aircraft model-specific airport diagrams and movement, but especially a lot of these ground movement collisions have occurred at that seam between the airport movement area and nonmovement area. Can you speak to any data difficulties that you have there or any products or improvements you have between movement and nonmovement area and some of these ground collision hazards?

MR. McNERNEY: Well, in our airport GIS program we are collecting all that information. We will have that very accurately and available. It's just taking a while before we can get that all collected. But as far as the operation of that, there is a problem in the fact that you have control of the movement area, whereas you don't necessarily have control of the nonmovement area as defined in the gate and terminal area where it's overseen by ramp operations rather than by air traffic controller. So there is the disconnect there. It's an issue in Office of Airports we are looking at. But the fact that, you know, we do not have that control because we allow the airlines to operate in there. So that's part of the issue. But as far as data collection, that's not a problem. We will have the data, but whether it -- it probably will not go into the aircraft moving map beyond a certain amount. But I'll let you talk about some of the industry efforts that are doing that, the RTCA, if you want to.

MR. DAMJANOVIC: I'm one of the original co-authors of something called the RTCA DO272, which is the Airport Moving Map standard document. And one of the choices that the committee made well over a decade ago was explicitly to limit the Airport Moving

Map such as is intended for use by cockpit and air traffic management was to only map movement areas. So by definition if an aircraft is not supported for moving in that particular place, it is not required to be mapped and typically would not be mapped because it is excluded from the terms of reference of the RTCA specification. Dr. McNerney is very correct, the Airports-GIS initiative contrarily has the full intention of mapping all of the air side and ground side, or movement and nonmovement areas, to provide a complete geospatial picture of an airport.

So over the long haul, I think that the kind of collisions that you're aware of -- that you're describing, are intended to be reduced or eliminated by the depth and breadth of the Airports-GIS program, not by the DO272 initiative which is narrower and focused on aircraft movement only, not nonmovement.

MR. FOSNOT: Let me give an example here, and it's one that you at the NTSB are quite familiar with. And this was a collision at Newark some time ago involving a Lufthansa 747 and another Boeing aircraft which was under tow, kind of an unusual situation. Now, Lufthansa does not -- I don't know if they had a EFB on board, but one of the issues that was raised in your report was the taxiway identifiers were incorrect on one of the charts. That information was correct in the Airport Moving Map databases that we produce and that we know of. So I'm going to say we're doing a pretty good job.

MR. ENGLISH: Thanks. Hopefully that keeps up.

Dr. Groff.

DR. GROFF: A slightly different question. I'll start, direct it to Dr. McNerney because you spoke directly to this, but I'd also be interested in maybe the commercial perspective as well, and that is the, let's say, the burden of producing data of sufficient quality. You mentioned that, I believe, the value you gave was 30% are sent back because they're not of sufficient quality. And then you also spoke to some cost-benefit analysis. Could you speak maybe very, very generally or, you know, to the level that you can about the cost associated with, let's say, an airport, the burden that's placed on them both in financial cost, but also just in time; how long does it take to create these data?

MR. McNERNEY: Yes, I'd be happy to be speak to that. The Airports-GIS program went under a very thorough review and cost-benefit analysis on all of the costs that we would take over the life of the program or at least a 20-year look at the program to collect all this data, and what is the cost of collecting it versus staying with just our paper and not putting it into geospatial databases. And there is a significant cost and upkeep in keeping that up to date. But we looked at the benefits just to the airports and the FAA and we found a better than 2 to 1 cost-benefit analysis. Now -- and that was using very high costs and a big program, all 3300 airports and over a 20-year period of time. Now, we think we're going to reduce those costs when new technology that the commercial people are working on that'll try to make things like satellite be available for us, reduce the cost for the smaller airports in the future. But for the big airports we are doing a very concerted effort.

Now, the cost of that effort, again, is funded through AIP grants to the airport and the AIP program which pays my salary, of course, is based on the ticket tax on the flights, so continue to keep flying. But that program administered through us is what the FAA is doing. And that's where primarily the benefit. Now, unfortunately the charting issue is not part of the office of airports. We have to give it over to the other side, in that we can't give data; they give the data. So, but it's getting into the cockpits because it's becoming the authoritative source. So but the benefit is that we also are paying to make the changes in the airport; therefore, we can make changes in the data.

The other question was the 30% reject rate. That's because we were looking at the data that is being verified. We want our data to be, you know, go to court accurate. We want it to be as best we can do with the data available and we want a third party to go look at what the contractor is submitting, because it's being submitted by the airport and its contractor. So we are very critical in our review. And we're finding not so much technical errors as incompleteness and issues to do that. So, you know, we're sending them back and we're making corrections and we're getting it right, and then putting that data in geospatial. So that's -- part of the benefits of our data is having that accuracy in review.

Did I answer all parts of your question?

DR. GROFF: Yeah, actually, could you give a ballpark figure of -- let's say for one airport?

MR. McNERNEY: For one airport? It could be -- again, you know, for instance, one airport, a big airport maybe doing a master plan, and it may be a $2 million master plan, but they may be getting a grant to put the data into Airports-GIS as well. And it varies in size to do that. But the cost is -- ballparks are -- I think we had in our pilot projects something like 240,000 or 300,000 per runway. And it depends on the size of the airports, of course. But over the life of the program, if we don't reduce our data for the small airports, it's going to cost about $500 million of AIP funds to collect all this data over 20 years. But the benefits are going to be at least two times that in productivity. So we really would like to get everybody to collect this data tomorrow, but it's just not going to happen that fast.

DR. GROFF: Thank you.

Dr. Cheung.

DR. CHEUNG: Thank you. I actually have two questions from the public. The first one is for Mr. McNerney. When will the Airports-GIS database be fully populated with both public and private airport data?

MR. McNERNEY: Well, there's going to be two different rollouts on that, of course. To get the full geospatial airport layout plans is going to take many years. Right now it's forecast about 2015. I should be retired by then, so I'm not really sure if that's an exact date or not. But the -- actually, even longer than that, 2025. So that's better. Yes, I'll definitely be retired by then. But 2015 or 2016 we expect to have maybe 800 airports have their data entered and reviewed. They may not be complete ALPs yet, but that's about the same time that major changes are occurring in the FAA so that we can have data available to that.

Now, in Airports-GIS, the small airports, helicopter pads, that data is available in GIS as point source right now. But again, there is a lot of potential errors and issues with this old data that was collected at the time. So we are in the next -- starting in January for a 15-month effort, we're starting to make that geospatial, rather than as it is now. And we hope that will improve the quality and data and make that -- that should be available to the public sometime after that.

DR. CHEUNG: Thank you.

The second question is actually from an NTSB staff. You stated that one -- this is for Mr. Knouss. You stated that one common problem in aviation analysis is choosing among different sources of data. Is the unavailability of data also a problem? Are there particular types of aviation data that would useful but are extremely or especially difficult to obtain?

MR. KNOUSS: Thank you very much for the question. For the question of availability; absolutely. That is a potential issue dependent on the type of analysis. When we're looking at, say, airport related study, depending on the time frame of the actual analysis, the available data may or may not be there that we're hoping for. When we're looking at more of an en route and into the terminal environment, the temporal aspect again arises. Part of the issue that we tend to look at is things such as we know that the data does exist, but oftentimes it becomes a challenge of actually obtaining the information. So one of the -- one example may be for sectors of airspace. If we're looking for efficiencies of the sectors of airspace, whether or not those sectors are combined or decombined, depending on the date, to allow us to understand the overall analysis.

One of the other big potential issues is audio. The loss of the audio is probably one of the bigger challenges that we face when you're looking at trying to identify down to a specific incident for either validation purposes. So I would say that those are probably the biggest challenges.

DR. CHEUNG: Thank you.

Mr. English.

MR. ENGLISH: Yes, let me find my note here. A little bit of a change of gears. We talked some about some of the large airports. Some of your technology -- and this is really to anybody who can answer it -- looks like it would be very useful for some ad hoc terrain avoidance. I'm looking at things such as perhaps emergency response. One of you mentioned rotorcraft in an emergency response using ad hoc landing fields. Could whoever would like to take it elaborate a little bit on the potential in the future for such a development?

MR. DAMJANOVIC: I would probably break that down into two separate discussions. One would be for rotorcraft and the specific capabilities of rotorcraft. There's no question that there are known algorithms predominantly developed by folks like NASA to, you know, sort of autoland or emergency land helicopters. There's sort of known profiles and known operational paths. And as a consequence, you know, using some of the much better terrain data that the USGS has created and some of the better awareness of obstacles that we're going to be having with NextGen, it's certainly capable -- it's certainly possible to engineer avionics where you could tell a piece of avionics in, you know, what we would call synthetic vision display to say "present position, find me a landing corridor." There's no question that that technology probably exists today. Whether or not the actual symbol generator on the EFIS has the electronic capability of rendering that in the near real time necessary, that's maybe a second issue, but I think the algorithms certainly do exist.

The second part of that, however, is if what you're describing is a UAV that now must make an emergency landing because it's lost datalink with the operator, I would say that's an open question. I think that could be something that we have to look at building into perhaps a UAV's operational profile. And I understand the FAA is already limiting, in some of our earlier discussions, that profile. But certainly the technology exists. The data gathering exists. And the understanding of what the profile per aircraft type needs to be. Probably the one area where that could be of greatest benefit would be in single engine or general aviation aircraft where you probably have a much less skilled pilot, potentially in an instrument, you know, sort of condition situation. You'd want to be able to use that in some of these, you know, either portable or fixed displays to help them make it to the ground safely.

MR. ENGLISH: Yeah, exactly, in emergency or diversionary. No other comments than -- it sounds like it could be an exciting development.

Dr. Groff, anything else?

DR. GROFF: Maybe just one -- you talked a little bit bringing together commercial and government data. Maybe from both sides I'd be interested in the -- maybe the problems, if you have any problems that you've encountered merging from both proprietary and commercial data with government data. Maybe the government perspective and then also the commercial perspective.

MR. McNERNEY: Well, from the FAA perspective, we've written our specifications to be very, very tight and they are primarily to look at it from on the ground. We're looking at it as an engineering perspective. We want to construct buildings. That's what we're doing. We're saving money in the planning and construction of buildings. And they're looking at it from getting in the cockpit to the pilot's perspective. And so they're not requiring quite the same levels of accuracy and I'll let Dejan talk a little bit about how he's admitted that some of the data that we do may be labeled as fine, whereas they have other data that's labeled as medium or coarse. And in having that, we have a plan now with the Aeronautical Information Management Office is to combine a database that has whatever is available, either the medium or the fine, and have those separated but available in the same data source. And I'll let him talk about trying to merge that.

MR. DAMJANOVIC: Bear in mind that we're using two very different operational requirements. The operational requirement of civil engineering to manage the facilities of an airport is one that requires the kind of submeter accuracy that Dr. McNerney is referring to. The needs of NextGen and SESAR to safely move aircraft in and out of airports is something that requires perhaps a somewhat lower level accuracy that's still in the sort of 2, 3, 4, 5 meter range, but what's critical is that all the aircraft and the all the moving parts all have the same quality, both the absolute geopositioning accuracy and the relative geopositioning accuracy so that all the surface movements or flight movements can be conducted within a safe but smaller sphere of containment. Two different missions: real-time flight operations or real-time surface operations, as opposed to engineering operations for the purposes of execution and management of the airport. I think the right answer is both pieces of -- let's say both levels of quality information can interoperate as long as the frame of reference, the datum, the quality, the absolute accuracy, the relative accuracy, and all those things are clearly understood, then I think they can successfully coexistent within a common data warehouse.

DR. CHEUNG: Thank you.

Chairman Hersman, the staff technical panel has no more questions.

CHAIRMAN HERSMAN: Thank you.

Member Weener.

MEMBER WEENER: Thank you. I've had the pleasure of having moving map displays using JeppView on an MX20 now for about 8 years. And it kind of astounds me that it's taking so long to get it into the 121 operations. But I've also encountered the 200-foot or 200-yard inaccuracy for the taxiways and so forth, and you kind of learn to live with them. But you do end up having a great deal of dependence on the accuracy of the known -- you know, the ownship position. And one of the things that -- you know, we talk about the importance of GIS data accuracy, but we need to have position accuracy in order to know where we are in that realm, in that coordinate system.

One of the major avionics manufacturers has provided me with a bit of data showing the number of times that GPS signals in their particular operation, helicopter operation in the Northeast using enhanced ground prox where they can go back and look at their own units to see where they have noncomputed data or invalid data, and it turns out to be quite often at low altitudes. So how do we ensure the integrity of this system, one that can be readily jammed by a fairly inexpensive device and is, in fact, frequently done that way? And as a side comment, I've had dual GPSs on a vessel both fail as I go past the Naval Weapons Research Lab or when I go through Norfolk. So how do we assure the integrity of what we've come to depend heavily on for integrity? A comment from any of you?

MR. DAMJANOVIC: Again, our friends at NASA have spent many years studying the problem, particularly in the context of synthetic vision, and they've developed, of course, the process known as RAIM, which is essentially automatic assurance of GPS position solutions, particularly as it pertains in the United States to the WAAS augmentation system that we have. So it's certainly not hard for any avionics solution to tell you whether you have a raw GPS, a raw GPS of poor quality or a good GPS or a WAAS GPS, and for that to be visually displayed to the pilot what the quality level of the RAIM solution is, and that would essentially give the pilot some sort of an obvious visual clue to say right here, right now you need to be focusing a lot more in looking out the window because the GPS solution that you have is a pretty poor one.

NASA has pioneered a lot of the work to do that. I don't know how much of that work has made it from, you know, the R&D labs at Langley and some of the other NASA facilities, into the avionics that are currently, you know, being delivered to either GA aircraft, BA aircraft, or air airline. But certainly the RAIM assurance of the overall GPS position solution is something that is known to the internals.

MEMBER WEENER: But correct me if I'm wrong, RAIM refers to the constellation of the satellites.

MR. DAMJANOVIC: Um-hum.

MEMBER WEENER: It has nothing to do with local jamming?

MR. DAMJANOVIC: That is true. But ultimately whatever the EFIS, portable EFIS or fixed EFIS, ultimately it is deriving some kind of a common filtered geopositional solution with or without WAAS augmentation, so it should still be able to effectively deliver to the pilot some notion of I have good lock, I have bad lock, I have WAS lock. Even those three levels alone, that would at least give the pilot some degree of notion. You know, just the fact of having WAS or not having WAS right there and then, that increases significantly your cone of uncertainty.

MEMBER WEENER: But, in fact, most of those out of service or invalid data were of short enough duration that the system didn't recognize them; in other words, it free wheeled --

MR. DAMJANOVIC: Um-hum.

MEMBER WEENER: -- fly wheeled past. But there still then is a period where there is no good signal and it's just dead reckoning based on its last position. And that doesn't show up apparently in the integrity monitoring.

MR. DAMJANOVIC: Well, then I would probably suggest that when we consider again the smaller containment that's going to be supported in NextGen and CZAR, it may be necessary to specify a degree of GPS awareness that is essential for EFIS that are going to be operating in NextGen and CZAR but they, in fact, have an appropriate technical solution that, you know, reduces to some known frequency the updating of their GPS and the updating of the GPS quality in order to avoid that situation.

I understand what you're describing. It sounds like, obviously, the current technology that's in the avionics infrastructure right not may not be there and maybe that needs to be updated to get to the close tolerances that we're going to be living with in NextGen and CZAR in terms of aircraft proximity.

MEMBER WEENER: Or it may require us to do some inertial smoothing along with it to get the kind of integrity that we think we -- I believe that we think we already have, but I'm not sure that we do.

MR. DAMJANOVIC: Well, if you've got solid state air data and you've got, obviously, VOR, DME supplements -- you know, the airliners have multiple position solutions of air data, you know, laser ring gyros and all those things, common filter together. Smaller aircraft that don't have air data, they're not going to have that degree of sophistication so they can't extrapolate their position very far. That may be something that has to be reexamined for, again, for NextGen and CZAR operations.

MEMBER WEENER: Yeah. Thank you.

CHAIRMAN HERSMAN: Thank you all very much. This was a great panel. It allowed us to get into a little bit more detail on some of the aviation issues that I know that our staff is concerned about and we are very interested in. So thank you for sharing your expertise and your knowledge with us. We look forward to continuing to stay in touch with you all as we move forward in the work that we're doing.

We now stand adjourned. We will be taking a break for -- it's about 15 minutes now. We will be coming back in at 3:20.

(Off the record at 3:00 p.m.)

(On the record at 3:20 p.m.)

MEMBER SUMWALT: We are going to introduce the next panel, our final panel for the day. Thank you.

MR. CHEUNG: Thank you, Member Sumwalt.

I have Dr. Kris Poland of the Office of Research and Engineering and Dr. Rafael Marshall of the Office of Highway Safety assisting me this afternoon.

Dr. Thor is a Research Civil Engineer at the Federal Highway Administration of the USDOT.

Dr. Thor, would you please begin your presentation?

DR. THOR: Thank you. Thank you to the Board and thank you, Dr. Cheung, for inviting me and giving me the opportunity to talk about GIS at Federal Highways and particularly in the area of safety.

I work in the Office of Safety R&D at Federal Highway Administration. It's part of the U.S. Department of Transportation. And I'll admit that I am also, as conceded earlier, someone said that they are not GIS specialist -- I am not a GIS specialist, but I am a lover of data and the analysis that data allows us to perform, particularly in the area of traffic safety. And clearly, GIS has a strong role in moving analysis forward, particularly in the safety area, and in that sense I'm very much for promoting GIS to advance transportation safety, highway safety in particular. So that's kind of what I'm going to talk about in my presentation here.

So just to talk a little bit about GIS at Federal Highways. Federal Highways is divided up into a number of different offices that are obviously all related by the highway system itself but typically have very different interests in mind. And you can see a list of some of those on the screen there and it's -- while they may have different concerns day to day, a lot of the issues are linked, particularly with the data that's required in order for us to do our jobs.

You can think of something like exposure data or AADT data and, you know, Operations may use that information to do analysis regarding signal timing, where Safety may use the exact same data to look at crash exposure. Or you could look at road uses by vehicle type and see that the Highway Performance Monitoring System would be interested in who are using our roadways and what types of vehicles are using our roadways, while asset management may be interested in the types of vehicles that are using their roadways and how they affect the deterioration of our roadways and how do we maintain our roads.

So, clearly, there's a lot of tie-in between these different disciplines. Of course, I'm here to talk about safety. That's the area that I work in. And, you know, some of the specific data that we're interested in would be crash data, number one. Of course, that's our -- that's what we're primarily focused on. But also information about the roadway itself and how it affects the occurrence of crashes. That includes roadway configuration, roadway design, exposure data, AADT data, also geospatial information such as proximity to trip generators that include things like schools or bars or shopping centers and so forth and how that relates to safety.

One of the things that Federal Highways has been promoting and even developed on their own to a certain extent is analysis tools that are based on GIS platforms. To a certain extent these analysis systems are somewhat basic in some of the potentials that they offer, but it's definitely an area that we want to promote the states to move forward with, as far as what the capabilities are with using GIS to perform safety analysis for crash data.

So I'll go through basically these two tools here on the screen, the GIS Safety Analysis Tool and the PBCAT, or the Pedestrian and Bicycle Crash Analysis Tool, and how those can be used to analyze crash information.

Here is a screenshot of the GIS Safety Analysis Tool. And what this is, is essentially just -- it's based on a ESRI platform. It's an analysis tool that allows you to important your crash data on to a base map of some kind and, of course, add other layers on as they're available to you. And what you can see is the different crashes there with the different yellow and red dots and so forth along the road network there. And on the top left of the screen there you can see, if you click on an individual crash, you can import a particular crash report that corresponds to that crash. At the same time, in the bottom right corner, you can see video logs. If you have you video logs available in your jurisdiction, you can access a video log of the particular crash location and help you visualize the circumstances and the road configuration and features that were present at the time of the crash and so forth.

So this is to help you look individually at the types -- or individually at the crashes themselves and the characteristics of that particular crash. But, of course, what we're also interested in is the crashes as a collection and where we have high crash locations and so forth, not just the individual crashes. And so we want to be able to perform effective analysis of the high crash locations and the problem areas, essentially.

One of the more basic functions that we have available in this tool is an intersection analysis or a spot analysis. Basically all it is, is you can choose an intersection on your roadway network. You can identify a radius around that location and identify how many crashes occurred in that location. One, it will tell you how many crashes you obviously have at that location, but it also gives you the opportunity to compare whether or not there are specific characteristics associated with those crashes that may be relevant to those crashes occurring in the first place. You can also compare it to other similar intersections within your roadway network and see whether or not those same characteristics pop up or whether or not one has higher crash incidents as compared to the other, and so forth.

Another type of analysis that's available is a strip analysis. This is just simply identifying a roadway of interest. You can define the length of that roadway that you're interested in. You can also define whether or not you want to include crashes within a certain distance from intersections that connect to that roadway and so forth and perform similar analysis looking at high crash locations and so forth.

A little more advanced is a sliding scale analysis, where you can actually -- it's more of an iterative process where you can identify segments within a roadway that have higher crash locations so the segments can be of varying length depending on the crash rate and how far they're spread out along a road. And there's a number of input parameters that are available. And it iterates through and identifies automatically these high crash zones along the roadways themselves.

And so I'm going to kind of provide an example of a corridor analysis, which essentially utilizes the sliding scale analysis, to show you what kind of analysis can be done with this type of technology and show -- this is the type of information we're trying to provide to the states and show them that these are the types of analysis they can be performing as well if they have these systems available to them.

So this is a proof of concept type of analysis that was done just to support this tool, and it's truck crashes that occurred within Wade in North Carolina. So what you see here on the map is Wade County, and the red roads that you see are actually what are known as the STAA roads, the Surface Transportation Assistance Act roads. And essentially what these are, are roads that are permitted for truck traffic within the county. And the regulations within this particular county say that heavy trucks are allowed to drive along these roadways, and they may travel to their locations off this network as long as it's within 3 miles of drivable distance from the network itself. So ideally, they would be planning their trips so that they would get as close as they can on these STAA routes and then minimize the amount of driving that they do off of these routes.

But what we wanted to see was how many crashes -- or what is the crash rates and the high crash zones that occur off this network and on this network. So we're going to look, particularly in this first analysis, just at the red roads and the orange roads. The oranges are primary roads that are not on the truck network itself.

Here is the sliding scale parameters that are inputted. Essentially you're looking at 1.6 kilometer, 1 mile starting length and you iterate every tenth of a mile. And then you're also, in order to identify what a high crash zone is, we're using average crash rates by roadway type. So each roadway type has its own crash rate, and that's how we're going to determine the critical value to determine whether or not that segment actually has a high crash rate. And that's determined by crashes per million vehicle miles.

So what we see is that we actually identified 18 total high crash zones within Wade County based on these criteria. And to kind of -- and those are highlighted in green there. And a blow-up here, in the southern end of Wade County to show you some things that are kind of interesting in particular. First of all, we look at this segment here, which -- I know you can't read the numbers very well, but I'll tell you what it says. That's Route 55, which runs along the southern edge of Wade County. And Route 55 is not part of the truck traffic permitted roadway network, but yet we see that there are four high crash zones along this roadway, which is obviously concerning because we're hoping that majority of the truck traffic would be on the truck permitted roadway network.

But what's also interesting is when you -- what you can see from a spatial perspective that you might not get from another perspective, is that you see that Highway 55 is actually a shortcut between many major roadways that you can see on there. It connects U.S. 401, U.S. 1, and just outside of Wade County, also I-40. And so the assumption is, of course, that the truckers are leaving the permitted roadway network in order to save time and gas, and in order to find a shortcut. Additionally, we found that there are three locations in the southern end that are outside of the 3-mile boundary completely and that these are also equally concerning because, you know, the truckers should not be driving on these roads according to the regulations that are in place in Wade County.

So what we really take away from these is that these high traffic zones are -- these high crash rates occur for probably a couple different reasons. One is there's probably higher traffic, truck traffic on these roads. The higher exposure, obviously, is going to lead to more crashes.

Additionally, because these routes are not on the permitted truck traffic routes, they're likely not designed for truck traffic as well. The configuration of these roadways, whether it's lane width, shoulder width, so forth, do not permit this type of traffic, which is why they were not designated as permitted truck routes in the first place and that's why there's possibly a higher occurrence of crashes.

There's also -- you know, there's things you can do to mitigate this. One would be to step up enforcement of these zones and to check to see why are people driving on these roads and to, you know, to pull them over and ask them why are you driving on these roads, how can we find you a better route, and so forth. Or also another way is to redefine the truck network and adjust the way that the roadways are designed and retroactively fit them so that they are safer for truck traffic, with the assumption that they're going to be driving on these routes anyway so let's make it safe for them to do so.

Performing a similar analysis -- looking at just the yellow routes here, which are local roadways off of the truck network, but within 3 miles drivable distance, we see high crash locations on these routes as well. But what we found with this analysis is that these tend to be very clustered. You see these eight different clusters of local road crashes with trucks, and what this gives us the opportunity to do, because it's in a spatial format that you might not get in another format, is to identify these clusters and then you can look within those clusters and look to see what it is about those locations that are causing these high truck crashes. Again, is it because of the way the roadways are configured? Is it because of the locations that they're traveling to? Maybe these are high commercial zones or retail zones that they need to deliver products and goods to, and so forth. And so you can overlay zoning layers in order to see what the zoning is in these areas and so forth.

And some of the things you could follow up with, with this type of information, is to identify safe routes in these areas that the truckers can driver or reconfigure the roadways again and so forth. So having it in a spatial format like this allows you to identify these high crash clusters that you can use in order to modify either the behaviors of the truck drivers or the roadway itself.

I'm going to touch on a couple of other tools that we have available too. In the top left corner there is a screenshot of what's -- it's our Safe Routes to School Program, which is available, which actually is a program where you can choose an address and a school and choose the safest route from one location to the next, and this includes things such as traffic volumes along the roadways, the availability of sidewalks within the neighborhood and so forth, and help actually find the safest way to get to school.

Top right we also have heat maps for pedestrian crashes, where again you can look at the high crash zones and identify the characteristics of those areas. Is it a lot of foot traffic in those areas? Are there unsignalized crosswalks, and so forth? And then down at the bottom we have bicycle routes that are identified based on the safety performance of those routes as well. So it's again extending the same ideas, but to pedestrians and bicyclists.

So those are some of the tools that have been developed. But also in the last 10 years Federal Highways has been really interested in moving beyond just tools and looking very much at the data and the analysis that's being done for safety in general, not just in a GIS format. The most notable deliverable of this effort has been the *Highway Safety Manual*. The *Highway Safety Manual* is a -- it's a document that is usable by practitioners in the field to use advanced statistical techniques and historical crash data to make evidence-based decisions about countermeasure development, countermeasure implementation, and so forth, and the safety performance of the roadways within a jurisdiction.

There have been a couple of different tools to support this, such as SafetyAnalyst and IHSDM, which are available that support specific sections of the *Highway Safety Manual*. But the general idea is to use empirical-based methods and other statistical methods in order to use historical crash data from the roadway network and the current roadway that you're interested in, in order to compare whether or not the location you're interested in is actually performing as well as it should, and if not, if you implemented now countermeasures, what is the expected change, the expected change in crash rate that you should see so you can make decisions based on how well it's currently performing and how well you can expect it to perform in the future if you make these countermeasure changes.

Of course, these are all well and good, but none of these analysis are -- we can never perform these analyses if we don't have the appropriate data in order to do it and the accurate data we need to do it. So another program that Federal Highways has implemented and is currently working on is the Roadway Safety Data Partnership.

Federal Highways has the unique challenge of working with 50 different states on their safety data, their analysis, and so forth. And so what we'd like to do is really get an idea of where the states are at with their data collection, their use, and see how we can help. And so we've done this through the Roadway Safety Data Partnership, which is each state has gone through a capability assessment where we've analyzed their safety data and their collection of safety data to see what they're collecting, what their strengths and weaknesses are and how we can help them get to a better place if they're behind in some of those areas; as well as some peer exchanges that are currently ongoing where we're working with each state and having an open forum for them to discuss their challenges and try to identify how we can get them to a place where they can really make some good decisions with their data.

We also have a couple other efforts. The first one -- well, MMUCC and MIRE, which I didn't choose those names, but that's what they're called. The MMUCC program is a joint program with NHTSA, where we look at the crash criteria and identifying definitions and the fundamental elements to be included in police crash reports and try to have a unified approach to crash criteria. And, similarly, Federal Highways has the MIRE program, which is the same idea, but for roadway elements and trying to help the states identify what the fundamental roadway elements are, what they should be collecting, how they should be defined. And those are specifically designed to support those programs that I was talking about earlier, SafetyAnalyst and IHSDM, so that they can automatically take the information that they collect and implement it into these programs and start making these sound safety decisions.

Beyond that, we want to take both these GIS tools that we've developed and the idea of improved safety analysis and safety data and start implementing it all into a GIS system. And some states are already doing this, but it varies significantly. Some states are well beyond some of the things that we're proposing. Some states are just beginning to look at GIS as an option for performing their safety analysis.

And so, but I think as Federal Highways, it's important for us to understand where the states are at and how we can help them get to where they need to be when it comes to using GIS to perform safety analysis. So we have an ongoing project where we're going to talk to the states about where they're going, what their priorities are, what the challenge gaps are, and how can Federal Highways help. So it's a project that just kicked off this year and essentially those are the objectives is to work with the states and identify what those issues and concerns are and how we can help.

Some of the current challenges that the states typically encounter are existing analytical tools. It's do they develop an in-house tool or do they use an off-the-shelf tool in order to support these types of analysis and data storage systems and so forth? What are the analytical and statistical techniques? Do they have the appropriate personnel in place in order to do these analyses, and so forth? Technical obstacles are how do you warehouse all of this data and the availability for base maps. If you're bringing different systems together, you have different geo-referencing systems and so forth, and incompatibility of data definitions.

And then one of the biggest challenges is administrative obstacles. A lot of times they don't have someone to promote GIS within the organization. Funding, clearly, in this day and age is always a challenge. Identifying GIS as a priority, doing cost-benefit analysis of investing in GIS is a challenge, and promoting that to leadership within the organization.

So what is needed is for us to look at these research topics and identify the current state of practice. You know, look at the emerging practices and tools and what will be available in the future; what are the research gaps in particular? How can Federal Highways, on the research side, how we can help fill those gaps so in the future it's more of a seamless transition to these systems? What program support can we provide? What kind of guidance can we provide as far as transitioning to these different types of systems? You have legacy systems that you might have to move away from. How do you make those changes and so forth? And how do we have guidance for administrative challenges; when it comes to funding how do you promote the investment in GIS data and so forth? So we have a big hill to climb, but Federal Highways sees it as a priority so we're going to continue to keep moving in that direction.

So that's my presentation. Thank you very much.

DR. CHEUNG: Thank you, Dr. Thor.

Dr. Matthew Barth is a Professor of Electrical Engineering and University of California, Riverside.

Professor Barth, please proceed with your presentation.

DR. BARTH: Great. Thank you.

I want to thank the National Transportation Safety Board for inviting me here to speak today, and again, I want to also thank Dr. Cheung for pulling all this together.

I'm going to change gears slightly here and talk about some recent research we've done in what we call Innovative Approaches for Roadway Mapping and Vehicle Positioning. This is work that myself and colleagues have done at the University of California at Riverside. And it's based on a couple projects that have been sponsored by the Federal Highway Administration, one, of course, being an exploratory advanced research project in position, and then the other one dealing with mapping; how do you get the data in order to support the positioning.

So what's the motivation for doing this? A lot of the research that I do is in intelligent transportation systems, mainly to support traffic operations. And it's gotten to the point now where there's a whole slew of ITS applications that can benefit from what we call lane-level positioning and lane-level mapping. So we heard earlier this morning about improving accuracy of maps in terms of understanding the roadway centerlines. What we're concerned about now is actually looking at the lanes, knowing where the lane centerlines are, where they stop, where they end. We want to look at intersections and know, you know, where are the turn pockets, where do they start, how long can a queue accumulate. So what we're doing is really we need to get down to submeter level positioning accuracy in order to enable a lot of these ITS applications.

Naturally, we want to do this in a way where it's highly automated. You know, we can take a lot of aerial photography and other sources and put it together, but we want to develop a method that can be more or less automated where we drive a vehicle down the road, collect the data, create the maps, and then use it for the lane-level positioning.

The second bullet up there talks about some of the applications. Some of the obvious ones are things like lane departure warning, curve overspeed, when you arrive to a signal knowing which lane you're in order to pay attention to perhaps data that comes from the traffic signal controller, things like merge -- when you merge onto a freeway, and then certainly intersection management applications are going to be the big applications that take advantage of this lane-level accuracy.

It's important to point out that there already are different sensors and things out there that deal with lane-level positioning from a relative perspective. I mean, obviously, lane level -- or, I'm sorry, lane departure warning can occur now just by observing what the car's doing with respect to the lane markings. That's more of a relative understanding. But I think there's a large number of these applications too that are going to need to know the absolute coordinates to understand the latitude-longitude of these different roadway features. And this is beneficial for a number of things. Obviously, safety is one of the key ones, but other things are just mobility and even environmental applications will benefit from this type of lane-level accuracy.

So, you know, when we talk about lane level, we often talk about the accuracy component and what we do we really need. And so if we have accuracy down to a meter or less, that's usually what's necessary for understanding where you are within the lane. But the other key parts up there, the other characteristics that are equally important are things such as continuity and the availability. So continuity, what we mean is can we have this information on a consistent high rate? And the other one is availability; does this work in all possible driving environments?

And we've heard various terms, but when vehicles drive in downtown urban canyon areas, often the GPS signals are blocked, and so that's a situation where if we just simply depend on GPS in terms of positioning a vehicle, there's going to be some environments where that's not possible. So what we want to do is use an approach that is a inertial measurement system that's aided by different other sensors.

We heard a talk earlier this morning that talked about the lidar coupled with an IMU and GPS in an airplane. That's a case where you have open sky and you can get pretty reliable GPS information. But, again, if you're driving in city streets where there's a lot of buildings, a lot of other vegetation and whatnot that can potentially signals, we have to look at other potential methods of aiding an inertial sensor to get the continuity and availability that we want to get.

So we're going to go through and talk about some of the experiments we've done using other feature sensors such as radar, lidar, cameras and things like that. And it also hinges on the fact that we're going to be able to map some other landmarks, the other parts of the infrastructure to help aid in the solution. And, again, on the bottom there are some of the other applications that benefit from this.

This is a little bit hard to see, but the idea here was to look at all possible methods of aiding the inertial systems so that you can more or less calibrate and reset these inertial systems as you drive along. The first ones there at the top are the GPS solutions. You can have, you know, your standard GPS or a differentially corrected GPS, and then even use the more expensive receivers to get the carrier phase differential GPS, with different levels of accuracy there.

That middle section there deals with other terrestrial signals, terrestrial radio and navigation. Again, those are typically time of flight measurements and looking at the phase of those signals to possibly aid your position information. But what we're going to focus on here is the bottom part, those that are based on features, right, and that's using computer vision, radar, and lidar. So we'll talk a little bit more about that as we move along here.

This is a diagram of the overall process. It's the mapping that occurs there in that left-hand column. The middle section there deals with the databasing and the GIS aspects of it. And then the right side column is focused in on the application in the positioning side of things. So the recent work we've done has been on how do we use these feature-based positioning systems in order to show that we can do this at the lane level? This is again just listing out a few of the different applications that we want to be able to work with.

So let's talk now about the mapping side of things. So what we're showing here is a vehicle that has been equipped with a sensor platform. This is some work that we did this last summer at Turner Fairbanks Highway Research Center in McLean, Virginia. And you can see on the right side, sensor platform and it shows the different components. And, again, the basis of this is to have an inertial measurement unit that's aided by GPS when you do have the GPS signals available. It has the lidar sensor there underneath that. This is a lidar system that has 64 planes that basically scans as it spins around at 20 Hertz. So that provides a tremendous amount of data.

We heard the USGS person this morning quite a bit about lidar. It's equally valuable when you're doing a surface level type of vehicle positioning and mapping. And then also a camera there is also something that provides a good amount of data.

The table on the bottom is a little bit complex. It goes to show you essentially how much data you're getting. This is essentially, you know, somewhere around 275 megabytes of data per second. So, you know, driving down the road at, say, 30 miles an hour, you're basically getting a terabyte of data for every 30 miles or so that you map.

This is the overall mapping process, starting at the top where you have the different sensors, the lidar, the inertial navigation, the global navigation, and the computer vision. And so what you do essentially is you collect all the data, the raw data, and then the subsequent parts of the diagram show the different types of processing that takes place. The final outcome, of course, is developing a feature database that can be used subsequently for positioning applications.

If we -- let's see, it's not really advancing at this point. It looks like we're stuck on this diagram. I'll keep talking and hopefully we can keep it going there.

So, again, the part in the yellow there is just turning on all the sensors, collecting that large amount of data and storing it. There is a certain amount of on-board processing that we do, and that's that first box in the gray, that really does the sensor trajectory optimization. It's taking the IMU data along with the GPS data and smoothing the trajectory. So this is basically filling in the gaps, smoothing it, to where we have a trajectory that's essentially going to be the accurate, absolute position of where the vehicle is as it drives down the road.

The second box there in the gray looks at the feature extraction. That's where you rely more on the lidar and the vision sensors. We want to be able to pick out features that are stable in the environment that we can use subsequently for positioning.

An example of that would be traffic signs. So traffic signs are put along the road to aid drivers, but they're also very valuable as essentially landmarks to help aid in the positioning system. So if we have our lidar unit and we look specifically for flat planes of certain size, we can pick out things like stop signs, speed limit signs, pedestrian crossings, things like that.

So when we do this mapping, we're looking for those features. We find the candidate objects within the lidar imagery -- and, again, this is a point cloud set of data -- and then we can verify that with a computer vision sensor to say, yes, this is a 25-mile-an-hour sign or a stop sign or what have you.

So in the mapping process what we're trying to do is we're combining the accurate position of the vehicle and then it's calibrated to, you know, looking out with our sensors, the lidar and the computer vision, that we can then combine those together and say, okay, I know now where that 25-mile-an-hour sign is that can be used later for a landmark as we're driving down, as an aid to the positioning.

So this is a demo of what we did at Turner Fairbanks Highway Research Center, where there was a number of signs along the road. We were able to drive down the roads and do that type of mapping in real time as we drove along. Hopefully, we can get some of those videos going later on.

Okay. So just jumping ahead. Again, this is the trajectory smoothing that we perform. This is the feature extraction. The features that we're basically looking at -- I talked a little bit already about the road signs. We're also looking down on the road and looking at the lane markings. Again, the talk this morning about the lidar, because lidar is not just providing a range data about the features and the environment; it also provides an intensity. And it's intensity that you can actually see very clearly the lane markings along the road. So those are extracted and used in that subsequent processing there.

Let me keep going on this. This is an overview of the Turner Fairbanks Highway Research Center. It shows you the position of those signs. And, again, a lot of those signs were in place. We put in a few additional signs just to prove that the technique works. And then we went back and independently validated that.

This is again a little bit hard to see. There's circles and X's there. Basically the X's are survey -- they were professionally surveyed, you know, down to a few centimeters. And then as we drove down the road we were able to estimate the positions of the signs with the X's being on top -- I'm sorry, the circles being on top of the X's. This boils down to roughly in the range of around 6 centimeters. So just simply driving down the road, we can look at these roadway features along the side down to about 6 centimeters of accuracy.

If we can click on that, that shows you the real time -- it's a movie that shows the real time discovery of the signs and identification of the signs. This is, you know, again, just -- it's looking with the lidar along the side for flat planes that represent signs. The computer vision knows where it needs to look. It recognizes what type of sign it is, whether it's a speed limit, a stop, or whatnot, as we drive through.

Okay. We'll keep moving. The other features besides the road signs is curve extraction. We actually create splines that represent the curvature of the roadway as we're driving along. So this is a point cloud from the lidar signal. This is something where you can look at it from a top view. You can come in, zoom in and take it at different angles. You can see how rich the information is just from that lidar. Again, this is point cloud data.

So, essentially, we know for every point in that point cloud now what the absolute latitude. Longitude, and elevation is by combing the GPS IMU along with the lidar data. So with that rich data set, then we can extract the curves of a roadway fairly accurately.

That's just a little bit more detail on that. And then this is the final step, essentially combining the feature data along with the trajectory data to get those absolute coordinates that I was speaking about.

The data are extracted. They are then stored as roadway features, lane-based features. And then we can use those lane-based features in subsequent application processing. We can also bring them into a standard GIS environment for other type of processing. This is, you know, just ArcGIS that uses that point cloud dataset that's overlaid on top of some aerial imagery. But, again, it provides us with the data that we need in order to create these different map features.

And then, finally, applications. The key point here is that we don't need the same expensive equipment in order to do the positioning. Mapping, yeah, you need the expensive lidar and this and that, but the idea here is that if we want to do lane-level positioning for a lot of cars, we don't want to make it a very expensive process. And so you don't need the lidar, you don't need an expensive camera to do this. You still need an inexpensive inertial navigation in a GPS and then just a regular standard rectilinear camera that can be used for your position aiding.

And it' looks like we're stuck again. Okay. So there's a few other movies if we can still play them. They're essentially showing a couple of these applications. One is showing a overhead view of a vehicle driving through. The left is -- I know we can't see it, but left side is going to show what the camera is actually showing outside the car. The other, right side of the imagery shows where the vehicle thinks it is with respect to a map that's been geo-rectified.

I think we'll, hopefully, get that up here. Okay. Great. Okay, so if you can just click on that movie, that'll help us get moving here. Again, so left side is actual imagery; right side is where are vehicle thinks it is with respect to a geo-rectified image that we're driving over. And so there's a couple things to look for here. It's a little bit hard to see, but it shows you your heading as you're driving along. And we put these two videos together mainly to show how they line up. So when this car pulls through and parks into a parking space, you can see that it's down to the lane level in terms of knowing where it is when it does this parking. A little bit hard to see there on the left, but, again, we're driving along and able to do this.

The next couple slides show lane departure warning. Let's not play this video, but essentially it says that if you're heading goes outside those two lines there, you do get a warning message.

Curve overspeed is essentially saying, okay, if you're coming in at a higher speed than what the curve can typically allow a vehicle to drive, it gives you a warning.

And then this last one, which I do want to play, shows two things. One is where it uses these outside landmarks, the signs, to aid in the positioning solution. Again, a little bit hard to see but there's basically elipses; a blue, green and red elipse that shows the uncertainty of the positioning solution as you're driving along. The one on top is not using the sign-based aiding or the landmark-based aiding. The one on the bottom is. And so you can see how that uncertainty changes. As it drives along, it observes the different landmarks and it's able to increase its accuracy as it moves along. Those elipses are essentially 5, 10 and 15 standard deviations of the positioning solution.

Okay. So, in conclusion, you know, this has been a successful project. There's a number of other things that we want to do as future work, but I think one thing, you know, to solve the continuity and the availability issues that we really can't just simply rely on GPS by itself or GPS with an IMU. It really requires additional sensors that can help aid the IMU in order to make this work in all possible environments.

The other aspects of this is that for the mapping side of things we want to take advantage of things that already exist, infrastructure that already exists. We don't want to create new infrastructure to make the positioning system work. If we can take advantage of existing landmarks, like signs and other things, then it's all that more successful.

From a mapping perspective, this is more of a proof of concept project. Really the next steps are taking it and do a more extensive map development for the lane-level mapping features. And it's sort of the question of whether this is done, again, as a university research project or as a government project or even, you know, a commercial project where someone like NAVTEQ or Tom-Tom or other map companies can take these techniques and create better lane-level maps for these type of applications.

So with that, I'll conclude. Thank you.

DR. CHEUNG: Thank you, Professor Barth. And we apologize for the technical difficulty.

Mr. John Bingham is the GIS program manager at the University of California, Berkeley, Safe Transportation Research and Education Center.

Mr. Bingham, please begin your presentation.

MR. BINGHAM: Thank you, Dr. Cheung.

For my presentation I'm going to -- (noise). That was not part of the presentation, but now I can start with a bang. So for my presentation I'm going to outline the potential causes of georeferencing errors when applied police reported crash data.

And just a brief note about SafeTREC, which is a mouthful when you say it all out. But it's a research center at UC Berkeley. We're affiliated with the School of Public Health, as well as the Institute for Transportation Studies. And it's really a multidisciplinary approach to reducing fatalities and injuries through education, technical assistance, and research and information dissemination.

My role there is involved with GIS most of the time and I work a lot with collision data in California and applying that to different geospatial analyses as well as incorporating into web development crash mapping tools we have.

So for today's presentation, I just kind of want to walk through the steps of what happens from that initial crash report being completed in the field until it gets compiled into a central database, and how you can go about providing a latitude-longitude coordinate or georeferencing that data. If there's any problems along the way, any data that's entered wrong, you are going to have difficulties in the end georeferencing the data.

And here's just kind of the phases I broke down. And for this presentation I'll be talking about California and the workflow there, but I think this is very applicable to most states, each of these different phases. And in California, the central authority is the California Highway Patrol. And you'll see as I go through the steps their involvement in this, and then looking at these different types of aspects of georeferencing.

So I've created this flow chart. Hopefully, you can read that, but I'm going to go through each of these sections of the flow chart and just kind of describe when errors occur how that'll impact the georeferencing later on. And the end result is when this database is published, and in California it's called the Statewide Integrated Traffic Record System, or SWITRS, how you can go about georeferencing those records and then utilizing that later for geospatial analysis.

The first section is when the police report is entered at the collision site. The report's prepared and the officer needs to mark the nearest intersection and the distance from that intersection. If possible, and more in recent years they're able to include a GPS coordinate as well.

Now, this is the most crucial phase of the process because if you have wrong data from the start, you're not going to be able to map that out later on. So, of course, you have typical errors -- spelling errors, streets that don't exist, intersections that are actually parallel streets, and then you have, for instance, landmarks that are used instead of streets and those can't be georeferenced later on. And, of course, even if you have a GPS coordinate, it doesn't necessarily mean it's going to be accurate. So I listed here that accurate on-site data entry is really the most crucial requirement.

After the police report is compiled in California you have to submit copies to the CHP, hard copies, and then they go about entering it into a central database. Now, of course, just the concept of submitting these paper reports to CHP and having them manually review these and enter these into their system results in another potential place that errors could occur when you're transcribing these. So it's really the second opportunity, the biggest opportunity to invalidate the location before georeferencing occurs.

Now, if the crash occurred on a state highway, there's a separate process that's completed, and the CHP sends that to the DOT and the DOT is required to establish a postmile value on the crash. Now, a postmile value is essentially a reference location along the state highway. All the events that occur in state highways in California have a postmile value, a mile marker value in other states, and CHP sends the records to Caltrans in order for a Caltrans analyst to review the crash report and add this postmile value. Everything the DOT does revolves around these postmile markers: the pavement maintenance, construction zones, all their infrastructure data revolves around having this postmile value.

And so, when the Caltrans analyst reviews the crash record they have custom software they use to essentially input a postmile, a county, the route number, and the direction that it occurred. And this information is really invaluable when you need the georeference later on, but of course this is a third aspect where if the postmile is incorrectly translated you'll have georeferencing errors at the end.

And just listing out some of the postmile errors, you know, you can have a postmile value that's outside of the established range for the highway, or nonexistent highways, incorrect counties for that postmile, and then you're going to have postmiles that fall within a valid range but, of course, they could be wrong, and those aren't easily detectable.

And these are valuable because once that data comes back to the final SWITRS collision database, SafeTREC as kind of a third party in this takes that data and we want to geocode it. And collisions that occur on state highways are difficult to geocode by a standard intersection. If you have two major freeways that intersect, you can't really run a geocoding process and just say put a point at that intersection because there's all kinds of multiple instances where they could intersect. And so for the state highways, that postmile value is very important and what you would use is a linear referencing system to geocode it.

Now, just briefly, a linear referencing system is essentially a way to store locations and measure other locations based on the relative position of those known features. So an example here, if you had postmiles for ramp markers, entrances or exits, you would know those and then when you have collisions that occur, you could essentially say, okay, this collision occurs between these two, and the software knows to place that collision appropriately.

But if you have a linear referencing system it can be difficult to avoid any types of calibration errors, especially when you're dealing with -- and in California the measuring system was established in 1970, approximately, for the highways and over time there's different realignments, different ways of measuring, and so there's a lot to incorporate, and then looking systemwide at the state you have a lot of different routes.

And these are just types of errors that if you're developing a linear referencing system, if you have your postmile reference points, the ramps and entrances and exits or intersections, then you're going to have problems later on when you're georeferencing based on that system. Some other ones, if you don't have markers near the end of the route, you're going to have crashes that cluster there, and I'll show an example of that later on.

Now, for the collisions that occur on local roads, you would have a more traditional geocoding process, to geocode it to the nearest intersection. But, of course, even if you have a perfect data entry from the get-go, you may have errors. In most of the geocoding errors to the intersections occur because of different problems with the original data entry. But even if the data's perfect, you could have a street network that's out of date, the names mismatch on the roads, and that doesn't even get into the positional quality of the street network, how well does it match up to the actual reality of where the road lies.

And a second component is that, in California, if you want to get the most accurate georeferencing, when a crash occurs it's marked a distance and direction from an intersection if it did not occur directly at the intersection. So, for example, 200 feet north of the intersection, to do that, we developed -- and you basically need to use some custom programming code in order to move that collision from the intersection. And that's another component that the code won't be perfect and you have a potential for the georeferencing to fail.

Finally, and this -- the fatal collisions, this probably should be attached up to the top where CHP inputs in a central database. If a fatal collision occurs, this is separate from the state database and this report is sent to a FARS analyst. That's the Fatality Analysis Reporting System. And so all the collisions that involve a fatality are reviewed by the analyst and they need to be geocoded themselves.

Now, the FARS database since 2005 has begun including the latitude-longitude coordinates of collisions. And this is done through a manual process with custom software, where the analyst must review the crash report and then enter into the software the location. So this is another room for human err in this process.

If they, you know, can't locate crash, there will be crashes that are incorrectly geocoded.

Another issue with FARS is that you're required to enter a latitude-longitude coordinate for a completeness of the data, but in some cases it can be quite difficult from a crash report to actually establish where the location was. You may have, for example, a landmark that was used and it's really sometimes a guess, I think, to have to put down the location of the crash.

And another factor with FARS is it can be difficult to actually identify the accuracy of the coordinate location. There's not secondary street information and not all the data that you would find available in the original state database. So if you wanted to go back and verify and look at the coordinate location, you wouldn't be able to unless you were able to match it to a state record. So it's kind of a black box, I feel like, with the coordinates that are there.

So just going through this, the idea that it's really extensive process to georeference collision data, and if there's any err along the way, you're going to have problems at the end result from the scene of the crash, to the initial report, to the final database, to the applications of that data, you will have problems if any of the other phases have errors.

Why is this important? Well, I like this sentence, even though maybe it's common sense. But, you know, accurate georeferencing is necessary for accurate geospatial analysis.

There's a lot of different research that's been done on studies that say, well, what was the result of the study when using correct georeferencing versus incorrect, and it has a very high impact. And particularly in traffic safety, in work that we do at SafeTREC, I wanted to give some examples of utilizing this collision data and why it's important to have georeference collision data and accurate georeferencing.

So one example is this Transportation Injury Mapping System, TIMS. That was developed in order to provide the public georeference data access. You know, SWITRS data is publicly available in California, but without that coordinate location it can be difficult to utilize it and easily map it. More and more data, especially from the highway patrol, does include a GPS coordinate, but a large majority of the data still doesn't and this georeferencing process enables it to be used in a site like this.

And the idea is this site will allow you to map collision data in your area, to view it, to query it, to download a subset of it, and essentially let anyone with any skill set access the data and move on to other types of analyses tasks. Of course, if you have incorrect georeferencing here, you're going to have a problem with their results later on.

Now, this may be a little bit difficult to see, but just talking about the idea of hotspot identification, you have collisions along a highway corridor. And shown here on the Y axis is the collision rate, collisions per mile. On the X is the postmile value along the corridor or the freeway. And this is just an example I mentioned where a postmile marker on your linear referencing system at the end of a route was not included. Well, you're going to have issues when you're developing these hotspots and you're going to have potentially errors that occur, and the purple there showing kind of a hotspot that developed where you miss the other slightly hotspot next to it.

And, of course, this is a GIS conference. I had to have at least one visualization in my presentation so it could stand up to the rest of the show. But this is a 3D visualization of the chart I just showed. I actually flipped it around, unfortunately. But you can see the top is the actual risk, and this is several years of collision data and we calculated this risk. And you can see the highest risk was actually on the bridge over the water. And in the incorrect georeferencing you'll see that the cluster occurs there before it hits the water.

So this may be easy to see, in one example on one route, but when you're looking systemwide, you have a lot of data to analyze, you really want to reduce these types of errors and they may not always go noticed. So it's very important to have accurate data for any of these corridor analyses.

A third example of utilizing the data is that we developed in conjunction with the Caltrans Local Assistance Division a tool to analyze the benefit-cost of potential countermeasures. Now, this was implemented in the last call for

Highway Safety Improvement Program funds. And essentially users are required to utilize this tool and establish a benefit-cost of potential countermeasures that they wanted to apply for funding to implement.

And the idea is they could come to the site, quickly map the data they're interested in, and select that data and import it into this tool, and by doing that could scroll through different types of established options for countermeasures and then input their construction cost and you have a benefit-cost ratio. Now, the end result of this is, of course, to have the higher benefit-cost ratio to strengthen your application for the funding. And really, if you have incorrect georeferencing it causes issues with this. If you're going to include crashes that didn't actually occur in that spot, you're going to get invalid benefit-cost ratios.

So, of course, California and most states recognize the value of this, I think. And they've established, you know, Traffic Records Coordinating Committees and a traffic records assessment was done by NHTSA in 2011 to essentially look through the data systems in California and establish what needed to be improved. Some of the initiatives are basically, you know, standardizing the statewide entry forms and then automating these processes. Reducing the number of paper submissions and copying, that's really a big issue in that the more electronic transfer you can have, the better off you'll be. And then there's also ways to improve the data entry tools that police officers can use, for example, allowing kind of smart technology to validate the location before it's even entered into the system and preventing any errors from occurring in the location of the crash, and making the georeferencing much smoother later on.

I just wanted to mention the funding for TIMS came through the Office of Traffic Safety in California through NHTSA. And thank you, that's my presentation.

DR. CHEUNG: Thank you, Mr. Bingham.

Captain Woodland Wilson is from Baltimore County Police Department. Today he is actually joined by his colleague, Sergeant Joseph Donahue, Analyst Emily Vargas, as well Lieutenant Tillman, and they are the contributors essentially to the DDACTS project.

And, Captain Wilson, would you please start with your presentation?

CAPT. WILSON: I'd first like to thank the Board for allowing us to come down today to present our DDACTS model.

Is that better?

CHAIRMAN HERSMAN: Even closer would be better.

CAPT. WILSON: Okay. I'm currently assigned to the Operational Support Section, and part of my responsibilities that are under my command is the Traffic Management Section, which handles the DDACTS program. And I'd really to thank my staff because I've only recently been assigned to this command they're actually the ones responsible for putting together the presentation.

What is DDACTS? DDACTS is an operational model that uses the integration of location-based crime and traffic data to establish effective and efficient means for deploying law enforcement and other resources. So, in essence, basically what we're doing in Baltimore County, we're mapping out our crashes and our crimes and doing targeted enforcement and other efforts in those areas to address those long-term problems that we're having.

Why DDACTS? Well, what we discovered was that a lot of our crime -- or, excuse me, our crashes were occurring in our hotspot areas throughout the county. In around 2006, our crime analysis folks started doing research into our hotspots. And what they discovered was that many of our crashes were occurring right in our hotspots. So the idea was to start making sure that we are deploying our resources in those areas so that we can target both of those problems, both the crashes and the crime. And around 2007-2008, we launched the Crash-Crime Initiative.

And, again, the idea was to basically try to tackle two problems with the same resource. You know, that one patrol officer out there, instead of just worrying about crime suppression, that officer was also worried about taking care of the crash and crime that was going on.

Now, while we were in the process of implementing our project, NHTSA was also working a proof concept for DDACTS model and we were able to team up with NHTSA to come together to be one of the first demonstration sites that they had throughout the country.

Now, this is the first map that we have of what we looked in Baltimore County. And as you can see, the highlighted areas on this map are actually the primary arteries that run in and out of Baltimore County and Baltimore City. And they were the identified areas that we were showing that we were having the majority of our crashes and crimes.

Now, Baltimore County is a little different than most jurisdictions. We surround Baltimore City. Both Baltimore City and Baltimore County are both two distinct jurisdictions. We do work together commonly, but each of us have our own police department and our own local government.

Now, what we really needed to know was also that the fact that a lot of our crime was going up and down these corridors so it was an easy sell to our command staff that we were going to start focusing these areas.

Why DDACTS? Well, again, as I stated earlier, crime and crashes often occur in close proximity to each other. An increased demand for our services with limited resources. We definitely, with the economic downturn, in law enforcement are really tasked with doing a lot more for a lot less. And we have conflicting and competing demands for service. Most of the time all we're told is all about crime suppression, crime suppression, and a lot of times what happens is, is that traffic safety tends to take a back seat.

We don't do it knowingly. It kind of just happens because we focus so much on crime numbers. Well, the nice thing about DDACTS is we focus on both of those issues, both crime and crash, because we know that more people are killed and maimed and injured in traffic accidents than they are in violent crime throughout this country.

Next, the majority of our crime that was committed in Baltimore County is there's a use of a motor vehicle. So with our traffic stops and investigative stops, we were able to, again, attack two problems at once.

The next thing is we wanted to renew our emphasis on motor vehicle safety. And with the right collection of data, we also determined -- because we're using a historical perspective of our data. We're taking about a 2 to 3-year set of data when we're looking at our targeted areas, to kind of use it to kind of determine where we think our crimes may be occurring and also where our crashes are occurring so, again, then we can deploy our resources to kind of also be in a preventive mode.

Next slide. What I'll review real quick for you is the DDACTS seven guiding principles. The first one is when you're developing your target areas you want to make sure you talk to both your partners and your stakeholders participation. And that's both internal and external, to find out as much information you can before you start setting up your targeted areas.

Then you want to do is determine what data you're going to collect and whether that data will give you timely information so you can start deploying your resources. Again, like I stated previously, we use about a 2 to 3-year set of data so we can get our averages on what we want to look at.

Then next we do our data analysis to see whether this data is accurate and what, in fact, is the data we really do need to make sure we deploy our resources correctly.

And then our strategic operations. We use the three E approaches of, of course, enforcement, education and engineering. In any issue of law enforcement, as much as we may like to, we cannot use enforcement to get us out of the problem. We have to use the other three components. And we also need to think out of the box and look to other agencies to address our problems. Not only the engineering side of it, but code enforcement, things like that, to address our problems.

Then, as with the lessons of 9/11, we need to share the information, not only with our internal folks, which is really important because we need to get buy-in from them. You know, when you're having the patrol officers or the deputies out there on the street and they're hitting these targeted areas for you, they kind of need to know why. Officers tend to have two things they like. They either like doing traffic enforcement or they like doing crime. In this program they get to do a little bit of both. So they kind of get to have a little buy-in. And you also need to share the information with your partners and your stakeholders to let them know how you're doing it.

Then while you're implementing your targeted areas, you need to monitor them, make sure you're following the plan that you set out. And also evaluate what you're doing, and then adjust when you need to adjust. If your problem's addressed and it's fixed, don't be afraid to move on. If the problem is still continuing or getting worse, be prepared to make a change to either deploy more resources or look at a different dataset that you want to look at.

And then, of course, outcomes, which is really important. You know, sometimes in law enforcement we get so caught up in our outputs that we don't look at the quality of them. You know, sending an officer out on a road to write 100 citations when you do not have a traffic safety problem or a crime problem, when you're only sending them out there to write 100 citations so that they can get a good performance review, that's probably the wrong way to look at things. We need to look at the quality of those citations. Are we hitting those targeted areas they want to? You know, suppressing the crime and also making sure we're helping with traffic safety.

And then, lastly, what we found out, mainly my staff who commonly go around the country in doing some of these workshops for DDACTS is if agencies that are implementing DDACTS do not adhere to these guiding principles they tend to have a problem with their program being successful. So you really got to make sure you stay with these principles.

Data collection. Well, the first thing in Baltimore County what we do is, of course, we collect crash data, crime data, calls for service, and community complaints. The community complaints sometimes it's hard to get, but you need to reach for the district commanders. There's 10 district commanders in Baltimore County. We're a fairly large county. Getting their input with these community complaints is very helpful to give you a good idea exactly what you got going on in these targeted areas.

Here's our data flow collection that we do. One of the issues that we are running into, and the gentleman next to me also talked about it. In the state of Maryland we used the paper MAARS form, which is the accident form that all jurisdictions in Maryland fill out. For us to get accurate crash data there's an 18-month delay. So we had to go to our CAD data, our computer aided dispatch data. Now, the problem we have with that is a lot of times our CAD data, when the officer is dispatched to a location for an accident, sometimes the accident didn't occur at that location or it does not tell us the severity of the accident. It could be a property damage accident that's dispatched as a personal injury, or vice versa. Or it could be a fatal accident. So there are things that we have to constantly jump over to make sure we're getting accurate data.

As far as difficulty with geocoding in crash locations, commonly roads are misspelled, road names are missing, multiple designations for interstate highways. On one side of Baltimore

County, Route 40, which runs all the way through Baltimore County and Baltimore City, on one side of the county is Pulaski Highway, on the other side it's Security Boulevard. So that tends to cause us problem in some of our data collection. And then we have a hit rate of about 83% on our MAARS form.

Now, I have to admit Maryland State Police is addressing the MAARS report. They're working towards getting electronic format and they're also trying to work on getting GPS coding into it. You know, it's -- I think it's going to come within the next couple years. And also with us as an agency, we're moving towards the Field-Based Reporting System, which is a very onerous process to get going and within the next year or so we should have that up and running. So that may also help us a little bit.

This is one of our first maps that we put out there for a hotspot map. This is 2 years' worth of hotspot data, and this is commercial burglaries. And these hotspots were developed with the use of the Crime Stat 3 model using the neighbor hierarchical ellipsis software.

Next is our composite hotspot areas. The red polygons, they are the composite hotspots for all the selected targeted crimes. And in Baltimore County the main crimes we kind of focus on, and we talk about it at our weekly crime stat meetings, are burglaries, robberies, auto thefts, and theft from autos. We also included in here our personal injury crashes. And the reason we used the personal injury crashes is it's just a larger dataset. If we use fatals, we don't have as many fatals, of course, but also the majority of our fatals occur out in the rural parts of Baltimore County, so they don't -- it doesn't work well as far as looking at it from a crime perspective.

Now, the blue ovals are the hotspots for the personal injury crashes. And as you can see, they're both intertwined between each other.

The next one is a composite hotspot area map. This combines crime and crashes hotspots that are further developed with the Cardinal Density Heat Map to show the highest portions in the area. This also helps to distinguish between the various levels of the problems that we're having.

This is how we develop our target areas. And it's kind of hard to see. This slide represents two different commanders making decisions, and you have to really solicit your district commanders on how you -- when you want to identify the targets. Because they're the ones that actually deploy their resources into the area. Selecting their targets, both commanders, like I said, totally different perspective on how to do it.

Since the red reporting areas are the smallest geographical reference in our CAD system aside from individual addresses, for data collection purposes reporting areas must either be entirely in or entirely out of a hotspot. The commander to the left, and the commander to the left would be our Towson Precinct, which is noted by 06. Like I said, it's hard to see up there. And the other one is 08, which would be our Parkville Precinct.

The commander to the left chose to have a single targeted area. The commander to the right chose to have three smaller hotspots. This is the flexibility of DDACTS. It allows the commanders to decide how they want to deploy their resources to affect these issues.

This map which is -- looks like, really, spaghetti all over the place, this is geographically the target area of Baltimore County that we're looking at. It comprises about 31.1 square miles of Baltimore County's 610 square miles. It's for calendar year 2011. It's our DDACTS combined areas. And they combine for about -- our target areas combine for about 169,000 calls for service of a total 576- calls for service that we have in Baltimore County.

As you can see, the area that we have targeted is only about 5.1% of the county. But this 5.1% of the county is almost 30% of our calls for service. So as you can see, with DDACTS you can actually target your biggest problem areas and direct your resources to address the majority of your calls for service. So really you get a better bang for your buck with this DDACTS philosophy than you would for normal ways you're doing enforcement.

Some evaluation considerations while you're implementing your program: Establish a criteria ahead of time; identify pre- and post-periods, when you want to start and when you want to end; use average individual data points, you know, because you have to worry about the highs and the lows, particularly with crime. If you have an individual who is a career burglar. He gets into a neighborhood, or she gets in a neighborhood, they may do 100 burglaries. Well, that year, your burglary numbers are going to be off the charts. If you look at a 2 to 3-year perspective, it gives you a better average to give you a historical perspective.

Methods of measuring change.

Control areas. They're not mandatory but it's something you may want to look at.

Statistical tests and significance.

Displacement and diffusion. We haven't really seen displacement in Baltimore County. I know that you commonly hear about, you know, you're just pushing crime to someplace else. We really have not seen that. And as far as diffusion or the halo effect, it's something we'd like to look into in the future but we haven't had a chance to look at it right now.

And with DDACTS you have to remember, DDACTS is not a short-term fix. It's really a long-term approach to your long-term problems. The areas that we're talking about that you're seeing on the maps, these are areas we've been traditionally having problems with for years. It's not something that just developed over a year or two. It's something in long-term problems that we're having.

Long-term effects of DDACTS. Going back to 2009, the three targeted areas have remained the same since 2009. But as you can see on the chart -- well, it's a little bit hard to read -- the rest of the county we've had significant changes and with that our workload as far as traffic stops has only increased by about 1.1%, but our activity or our traffic stops have increased 55% in our targeted areas, and you can see it's made a definite impact. So, again, it's doing more with less.

And, lastly, before I end, DDACTS has been around now for a couple years. We've implemented many a workshops, about 300 agencies, state, local, and federal, have been involved in it. There's lots of information about DDACTS on the Internet. My predecessor, Captain -- or it's actually now Chief Howard Hoff from Roanoke Police Department kind of spearheaded for our agency, is definitely an expert on the topic. And you can implement DDACTS in pretty much any size agency. It does not have to be an agency the size of Baltimore County where we have over 1900 sworn officers. It could be as small as about 14 officers depending on where you want to go.

And that would conclude my presentation and thank you.

DR. CHEUNG: Thank you, Captain Wilson.

Dr. Poland, would you please start with your question.

DR. POLAND: Thank you very much for all the presentations. They were excellent presentations.

I'm going to start with a question for Dr. Barth, but if others want to weigh on it, they're certainly welcome to. My first question is: Are emergency medical services involved in the GIS systems planning and applications, because certainly some of the aspects that you talked about, about vehicle-based systems such as collision avoidance or even some of the systems that are available on the cars themselves, like airbag systems or a seatbelt system, would provide critical information to emergency personnel. And that would be along the lines of like automatic collision notification systems.

DR. BARTH: Yeah, I think certainly those can be part of it. I don't know if there's a lane-level aspect to that though. I think knowing that an accident occurred and the airbag deployed, you know, knowing where that occurred on the road is sufficient. I'm not sure, I don't think we've thought too much if there's lane-level information that would also pertain and make that even more useful.

Dr. Marshall.

DR. MARSHALL: I also want to thank the panel for their informative presentations. My question is for Dr. Thor. You mentioned there's been several challenges that need to be tackled by the Roadway Safety Data Partnership, and I was wondering if Federal Highway has set milestones for the states to adequately address each of these issues?

DR. THOR: There haven't been specific milestones -- general milestones set broadly for all the states. Instead they've worked with the states individually and identified -- it's a point scale that they've used for different areas within their collection and data usage that's ranked from 1 to 5. And so if they fall within a certain spectrum within these different areas, and so then with that, they've identified what they can do to improve their standing within each of those areas, whether it's the specific data elements that they collect or how they're analyzing that data or, you know, the different areas and so forth.

DR. MARSHALL: And what sort of resources have been made available to the states to improve their data and GIS programs?

DR. THOR: Traditionally it's been using programs such as the HSIF funds, Highway Safety Improvement Funds, and so forth. And some of that is changing, as was discussed this morning, with MAP-21 and what they're going to be able to use, what funds they're going to be able to use in order to improve their data. I can't speak too well on exactly what the specifics are on how they can spend that money, but I know that there's been some loosening of the requirements on how they can spend HSIF funds in order to improve data and invest in data, specifically for base map development and GIS implementation.

DR. MARSHALL: Thank you, Dr. Thor.

Dr. Cheung.

DR. CHEUNG: Thank you. I have a staff question here. This is for Mr. Bingham. And you talk about there are different way that geocoding error can occur. You talk about that with the state level data, the SWITR data, and you also talk a problem associated with FARS. And it seems to be, you know, fairly different in terms of the error. How can you reconcile those sort of differences?

MR. BINGHAM: So the question is how you can reconcile the error differences between FARS and SWITRS?

DR. CHEUNG: Right.

MR. BINGHAM: Well, for one thing, as I mentioned, you can't actually confirm the location from FARS without the secondary street information. In SWITRS you have the intersection and the distance and direction from the intersection and so anyone could take that data and look at it on a base map and Google and see if that's in the correct location. In FARS you just have the coordinate and you may not be able to -- you can't associate that unless you have the SWITRS data. For example, we had the SWITRS data and we could view the records of where they should actually be. But as far as the error types, you know, the geocoding process that we used is not the process that someone else may use for SWITRS, so we're going to show different errors in our process than someone else would. FARS there's only one process and there's only one, you know, one authority to implement the latitude-longitude coordinates on FARS.

DR. CHEUNG: Thank you.

The second question is for Captain Wilson and the team. And you talk about the DDACTS programs is being implemented in many different authorities and police force and things like that. Can you comment on how much coordinations are actually occurring between different forces?

CAPT. WILSON: It's really varying by local agencies.

Many of the agencies -- what we're seeing a lot of times is with the smaller agencies, they are working with their surrounding jurisdictions, and I think that just grows out of necessity because of their significant lack of resources and it's something they're used to doing anyway. And then when we start to see the larger agencies, they're more or less encapsulating it within themselves, again, because that's what they're used to doing. They have the facilities and the infrastructure to be able to support the entire program by themselves, where they don't have to share those resources.

I know in some specific cases we've had, in New Jersey we had several agencies who, they were small enough they could not afford a crime analysis in and of themselves. So several agencies went together and basically hired a crime analyst to do all the agencies at once. And they shared that -- they did that cost sharing that way. And that provided them the ability to really get that definitive data analysis to make their program work.

DR. CHEUNG: Thank you.

Dr. Poland.

DR. POLAND: Captain Wilson, I'll follow up on that question and ask what types of resources are needed for a county or a region to initiate a DDACTS program?

CAPT. WILSON: First of all, they have to have a crime analysis -- or in our case, we have a crime analysis section. That's imperative to get that data to ensure you're deploying your resources. Have enough flexibility and manpower so that you can adequately adjust those crime areas. They're the two primary things you have to have before you even attempt to implement the program.

DR. CHEUNG: Thank you.

Chairman, the technical panels have no further questions.

CHAIRMAN HERSMAN: Member Rosekind.

MEMBER ROSEKIND: One short question for each half of the table. So first with Dr. Thor, Dr. Barth, and then Mr. Bingham. Just one word, I'm curious if each of you would identify what you think the biggest research gap is right now? I mean, we talked about everything from error sources to technology needs, state coordination and other kinds of databases. So give me one word on what you think the biggest research gap is that would get you the most.

DR. THOR: I think from our perspective -- I wouldn't necessarily call it a research gap as much as it is the availability of accurate base maps to build off of, I think is a big hindrance for the states in being able to do the analysis and collect the data.

MEMBER ROSEKIND: Great. Dr. Barth?

DR. BARTH: Yeah, I'll take it one step further. I would say we can collect a lot of data, but it's really the analysis. So I think we have bits and pieces of analysis that we can do, but a system of analysis is still -- is what's needed.

MEMBER ROSEKIND: Great. Mr. Bingham?

MR. BINGHAM: Well, I would say actually traffic volume, pedestrian volume, bicyclist volume, the exposure amount is key. The number of crashes in itself only tells so much. You really need to know how many cars are out there and how many people are out there and how many bicyclists are out there.

MEMBER ROSEKIND: So all three of you have those going on, right? All those things.

So, Captain Wilson, I see you got your team there. What I'm really curious is, this was a great panel because I really like the flow of the day from our technical discussions down to the user. And I'm curious, as a user, what's on your list? You know, if you got to talk to the feds, the states, you know, the researchers about what would really make your program even more effective, what would that be?

CAPT. WILSON: I think for us it's real-time data, both the crime-wise and the crash. Getting it up to where -- to the point where the actual officer on the street can pull up that data and know -- you know, get an idea what's going on in that neighborhood immediately. That would probably be the next thing I'd like to see us do in law enforcement.

MEMBER ROSEKIND: Great. Thank you.

CHAIRMAN HERSMAN: Dr. Cheung, do you have additional questions?

DR. CHEUNG: We have no further questions.

CHAIRMAN HERSMAN: Okay, great.

Thank you to all of you. I know it's been a long day for you all in the audience and we do apologize of the AV troubles that some of the panelists had earlier. We'll work to endeavor to address those for tomorrow.

Thank you very much for your presentations. I think we certainly see some of the benefits that can come from this technology, both reactive and predictive, and so we'll look to understand how we can better use those in our investigations and incorporate them into our recommendations.

We stand adjourned for the day. We will reconvene at 9:00 tomorrow.

(Whereupon, at 4:57 p.m., the proceedings in the above-described matter were adjourned, to reconvene, Wednesday, December 5, 2012, at 9:00 a.m.)

December 5, 2012

CHAIRMAN HERSMAN: Good morning. Welcome back. We'll now begin the second day of our GIS Conference.

Dr. Cheung, will you please introduce our panelists?

DR. CHEUNG: Thank you, Chairman, and Members of the Board. I have two staff technical panelists assisting me in this panel: Dr. Eric Emery of the Office of Communications, and Dr. Loren Groff of the Office of Research and Engineering.

Ms. Lisa Park is a Research Analyst at the American Transportation Research Institute. Ms. Park, please begin your presentation.

MS. PARK: Good morning and I'd like to say thank you to Madam Chairman and the NTSB and everyone in the audience. It is definitely a great opportunity and a pleasure to speak with you this morning.

I am a research analyst for the American Transportation Research Institute. We go by ATRI. We have a primary mission to conduct transportation research that has an emphasis on the trucking industry's central role in a safe, efficient and viable transportation system, and these are some of the topics associated with the industry that we typically do research on.

We have a board of directors that's comprised of industry leaders, both carriers and suppliers, and we also have a Research Advisory Committee. This is comprised of government officials, academics, independent scientists and, of course, members of the trucking industry and suppliers to the trucking industry. And this Research Advisory Council is charged with setting our research agenda annually.

So in 2010, the RAC decided that this research would be a top priority for our institute. Knowing that truck rollovers are often severe and extremely costly, they thought that this research initiative would be very important.

So we have conducted the research in three phases. I'll be presenting mostly from Phase 1. This is where we looked at specific sites where truck rollovers are most prevalent. And the second phase, we are designing an in-cab warning system that can alert drivers in real time as they approach these identified locations to allow them to adjust their driving behavior. And in the third phase we'll work with DOTs to try to mitigate whatever effects may be present at these locations and causing these truck rollovers.

So the first thing that we had to do was define our data elements that we wanted to collect and then collect the data. We started with fatal rollover truck crashes from FARS and then also worked with AASHTO to reach out to the states to try to find who was the gatekeeper of this data for each state and how we could get it from them.

Then we also worked on data simulation and mapping. So we had the fatal records in FARS and we had the nonfatal records from our state contacts, and in these records we had where the rollover was a crash event for the truck. The truck was typically a Class 7 or 8, the gross vehicle weight rating of 26,001 lbs or greater, and it had to have a specific X/Y latitude/longitude attribute in the data, and that's what we used to do the mapping portion of this research.

So what we focused on with the plotting of the data was cluster identification. So we used ArcGIS to put all of this data on base maps and then use an integrate tool to find where the data was clustering. And here you can see how we used a .25 mile cluster tolerance and it gave us representative points where we could find the centroid of a cluster of truck rollover events.

So from doing this research we were able to make an interactive map and state reports for every state. We tried to collect data from 9 years, from 2001 to 2009, but not every state was able to provide us data for all of those years. In total, we had a little over 51,000 rollover crash records that we were able to collect from the states. A little less than 48,000 were nonfatal, and then a little over 2,600 were fatal records.

And then in the state participation we were able to get 39 states integrated into our national truck rollover database. Eight of the states did participate, but, as you heard from several of the panelists yesterday, state data is often not standardized in what they collect, how they collect it, how they provide it to you, so we were not able to integrate data from eight of the states. Ten states ended up not participating. Sometimes that was because we were unable to find the correct person who was able to work with us and provide the data for us, and there was one state who declined, citing legal concerns for participating in the research.

So here you can see our map of which states are in the database, which ones participated and are not integrated, and which ones were nonparticipants, and these small blue dots represent the locations that we were able to identify as high frequency rollover locations.

So we created the 31 state reports and we are also working now with FMCSA to reach out to the states that we were not able to integrate their data or find an appropriate contact so that we can try to expand this database to all 50 states. We have developed an online interactive map where government officials, industry executives and, most importantly, drivers can go look at the sites that we've identified in their state, and they can zoom in as you would on Google Earth and see what the road geometry is like in that area and kind of see why that area might be a problem.

So here's an example of the state report that we produced for Georgia. It gives you a spatial indication of where these locations are in the state. Of course, here most of them cluster around Atlanta. Of course, there's a lot of truck exposure in that area and also a lot of interaction with passenger vehicles, which may play a role in some of these sites.

You can see by year the number of fatal and nonfatal and total number of rollovers, and you can see the number of rollovers that were found at each identified site. Here at the number 1 spot at 285 and I-75 on the south side of the perimeter there were 35 large truck rollovers in a period of time between 2001 and 2009. Here's the image of the interactive map which we host on our website that everybody can go and look at these locations, zoom in on them, and you can also link to the state report.

So we found that there is a feasibility of gathering these disparate data from the states and there are ways that you can try to assimilate them into one database. We also think that this is a good methodology for finding those locations where rollovers are occurring because of interactions between multiple roads or interactions with passenger vehicles instead of identifying a site where this may occur on just a single road.

We also used GIS at the institute with our FPM program. This is sponsored by the Federal Highway Administration. We have several hundred thousand individual trucks that we are able to receive GPS readings from, and we call these truck pings, and we get billions of these unique pings every year and process these, and then we can use this unique data source to do some safety analysis.

And I will tell you about a few of the analyses that we've done with this data. Here we utilized this empirical data to analyze road closures and freight diversion. Due to a truck's size and weight, communicating detours are very important for safety. You want to keep trucks on the roads that are designed to carry trucks, and this is important to do both locally and regionally whenever you have a freight diversion.

So here we looked at a flooding incident during May of 2011 on I-40, which is a critical trucking corridor, and we used the FPM data and a GIS system, which is very valuable with this type of data. As you can see, we have the unique truck ID, latitude and longitude, time and date stamps, speed, heading. All of these attributes become much easier to analyze in a GIS system.

Here's an image of what these truck pings look like whenever they're plotted in a GIS, and here you can see how those truck pings disappear from that portion of the road during the closure. Here is the official westbound and eastbound detour. And then whenever we started analyzing the unique truck position pings you can see by the color-coding on the lines that the trucks mostly followed the official detours. The red shows the decline in truck counts and the green shows the increase in truck counts.

But we also saw a 4% decline in the number of unique trucks in the area, so this told us that there might have been some regional freight diversion along with the local diversion. And we also see a decrease in the mean spot speed showing that the entire region suffers a decrease in system performance during this closure.

So after we looked at it specifically at the closure we also did a methodology to look at it under a more regional analysis, and this image here shows regionally the change in unique truck counts from 1 week prior to the first full day of the closure. And here you can see regionally how trucks westbound from Nashville going to Dallas used the I-65 South to I-20 West corridors instead of I-40, and from Dallas to Memphis they were using I-50 East to I-55 North.

And so looking at another issue related to freight and truck driving and how we can use this FPM data source, truck drivers are only allowed to drive for 11 hours at a time before they have to take their break and there are a lot of factors that can influence the distance that they can travel during that time, so knowing that the truck driver has to stop, we decided to look at truck parking areas. So, for example, if a truck is leaving Los Angeles, the time of day and the average congestion levels can cause an 80-mile difference between the shortest and longest distance traveled in those 11 hours.

And then in the next slide we see how this variability in travel distance determines which parking facilities must be used to take the mandatory time off. So using the same example, a truck leaving Los Angeles in mild congestion will likely find parking at facility C or D here, but a truck that encountered heavy congestion will not make it across the New Mexico border where there's more parking before the 11-hour time is up.

So in this image we can see that large gaps in the system can lead to inefficiencies and shortages in the amount of truck parking spaces available. So, in this example, heading south from

Harrisburg the truck will be forced to stop 86 miles before the 11-hour maximum, and that shortfall might increase to 129 miles if the drivers fears all of the 10 spaces at parking space A are taken. On this stretch of road the AADTT is 10,000 vehicles, so we know that that might be a likely scenario for that truck driver.

And then in our next example you can see that while there is truck parking near the end of the 11 hours of service, in the best case scenario there is so few spots at that location that the driver may have to stop 90 miles east of facility C where there's more truck parking or they can risk going beyond the 11-hour rule to reach facility A in El Paso and they'll have 12 more spaces there if facility B is full.

And that's my presentation and I have copies of the rollover report if anybody is interested in those later.

DR. CHEUNG: Thank you, Ms. Park.

Ms. Michelle Barnes is a Senior Research Engineer at the UMTRI, University of Michigan's Transportation Research Institute. Ms. Barnes, please begin your presentation.

MS. BARNES: Chairman Hersman, Dr. Cheung, NTSB staff and audience, thank you so much. I'm very glad to have received your invitation.

CHAIRMAN HERSMAN: Ms. Barnes, could you pull the microphone a little bit closer? Thank you.

MS. BARNES: The title of my presentation is Employing Spatial Data and GIS Tools to Support Transportation Safety

Research. As I said, I'm from the University of Michigan Transportation Research Institute. Our vision is safe, sustainable transportation for a global society. Our mission, research advancing safe and sustainable transportation. We are an interdisciplinary transportation safety institute. We receive about $23 million annually from a variety of sponsors, and we have about 120 full-time staff and students.

Again, many thanks to the NTSB, and my presentation's really broken up into about three parts. The first part is an overview of UMTRI research supported by GIS. The second is a short list of UMTRI-generated spatial data, as opposed to data that has been provided to us to use to support our research. And experiences and suggestions for employing a diverse set of data to support transportation research.

This is, like I said, a little short list of UMTRI spatial data that we have generated and it's primarily from our naturalistic diving endeavors. The first one listed there is the Safety Pilot Model Deployment Project, which many of you may have heard about. It's vehicle-to-vehicle and vehicle-to-roadside connection. Currently that project has completed about 2400 instrumented vehicles, on its way to about 2800.

The second one listed is the Road Departure Crash Warning Project and that was a field operational test. And the third one is the Integrated Vehicle-Based Safety System. That was a field operational test. And the difference between those two projects was road departure was all light platform or passenger vehicles. The second one was a combination of platforms, truck and car.

Now here is the list of data that many agencies have kindly provided to UMTRI to use to help with data fusion and integration and analysis. And so you'll see that we have national data that was provided by Federal Highway for the HPMS system, and we have a variety of states that have given us their HPMS data. We have all public road intersections and roads. We have several local agencies' sign and signal locations, building footprints, parcel data. We have the MDOT, Michigan Department of Transportation, system sufficiency data, high resolution aerial photography, and lidar data for many Michigan counties and also Michigan statewide crash data.

So what I have here -- I wanted to kind of give an overview of the different kinds of projects that you use GIS because there are different areas that we engage in research. The first one is the development of analysis methods using a multivariate analysis method. It's a big long title, but it boils down to saying we're going to take naturalistic driving data, we're going to fuse it with road data and determine whether we can find crash surrogates or whether we can prove that crash surrogates exist in the naturalistic driving data, and that is a driver behavior based research project. That was supported by SHRP II and TRB.

The next one is very similar in its aspects to the DDACTS presentation from yesterday. This is ticketing aggressive cars and trucks. It was a project we did for the Office of Highway Safety Planning to support their submission to the Federal Carrier Safety Administration, and what this project is is law enforcement/driver behavior.

We developed a subset of crash data that was indicative of aggressive driving, and we plotted the data and completed some data fusion to identify clusters of this driver behavior that was related to crashes and we can came up with two sites that were controls and two sites that are being considered for concentrated law enforcement. And there's a group within UMTRI called CMSST, Center for Management of Safety and Sustainable Transportation, and that group provided us with the crash data for that project.

Another project is Teen Driving Behaviors. This is a public health oriented project and this is through the Injury Prevention Center at U of M funded by the CDC. This project has not started yet, but the idea is to take a variety of spatial data identifiers and possible explanatory variables that exist in and around teen driving and see if they can be found as having a statistically valid impact on the occurrence of crash. And the idea is that if we can do that, then there might be a way to revise the Graduated Drivers Licensing System for when and where teens can drive.

Here's the model deployment project again that I just mentioned. Again, this is vehicle-to-vehicle, vehicle-to-roadside.

The model deployment route is in Ann Arbor, Michigan, and we anticipate that this is going to be a very rich source of spatial data to analyze when the project's completed.

This last project I have on this slide here is Look Ahead Driver Feedback and Powertrain. This is from Eaton. It was also funded by the Department of Energy. And what it has to do is eco-driving and examining driver -- how the driver's actually driving, along with the terrain and fuel usage and issues with the vehicle in order to reduce, you know, fuel usage and improve routes on timing.

So this is kind of a pictorial shot of the typical data sources that we use and that we integrate at UMTRI: bare earth returns, and those have been a process from lidar data to digital elevation models, national/local road centerline data, attribute data, crash data, building footprints, transit routes, Census, time zone, lidar. And then the last picture that you see there is aerial photography with an illustration showing our -- this would be the road departure crash warning or IVBS vehicles where alerts were recorded as part of the data acquisition of those projects.

So I wanted to talk just briefly in detail about the SO1 Project. This is the one that dealt with using naturalistic driving data to identify surrogates for crash. So the objective was to provide a validated quantitative link between the measures of naturalistic driving behavior, road departure crashes and road segment attributes, and then to identify, if possible, common roadway elements that are associated with crash data and driver behavior as captured in the RDC naturalistic driving data.

So our research questions were: Do naturalistic driving data contain measurable episodes of disturbed control? Do objective measures of disturbed control from naturalistic driving data integrated with on- and off-roadway geometrics and environmental factors satisfy the criteria to act as crash surrogates for actual crashes?

So here, again, are our layers that we used for this project, and the arrow is trying to illustrate that, you know, we kind of picked up a bundle of stuff from each layer and tried to make sure and apply the statistical methods to support our research questions.

So here's the analytical model, and the analytical model shows what measures we used in order to build the multivariate analysis, and we had measures of disturbed control from the naturalistic driving data as being identified as time to edge crossing, lateral drift, lane deviation and yaw rate error. And highway measures were basically the characteristic of the road, meaning, you know, how many lanes, shoulder width, functional class, anything that would characterize the road. And then there's the crash measures which were the weather, lighting, road condition, direction and time. And our conclusion was that the analysis provided ample indication that episodes of disturbed control exist in naturalistic driving data and can be related to crashes via highway variables. The fusion or integration of the spatial datasets made it possible to develop valid surrogate measures for behavioral outcomes.

This is another view of the deployment site. You know, you say, well, here's -- we've deployed a project, but I wanted to give you a map that gave you an idea of where the deployment site is in Michigan. It's largely including and among -- including, excuse me, and within the freeway ring of Ann Arbor, Michigan. UMTRI envisions a model deployment project and its spatial data as a critical step in improving transportation safety.

Here's just a brief slide on what potential we might see or we might envision for spatial data when it comes out of the model deployment project. So there's an antenna there in the middle of that intersection, and what that antenna is doing is it's sending out its signal and its signal has a particular range and distance, but it's not going to go through a building and it will not wrap around a corner.

So what this is showing is that the surface of the earth and building footprints were used to model those features which may block or degrade the antenna signal. So when we're in the process of analyzing data and we have signal pack drops that might be between vehicles or between the antenna and a vehicle, we could go back and analyze why that signal pack dropped, and could it be because it was trying to go through a building. And to construct that GIS analysis, I'm showing on the left side the different layers that you need to integrate and, you know, essentially glue together so that you can put the attributes of the antenna in place to show its limits.

This is the eco-driving project I mentioned earlier with Eton and UMTRI and the Department of Energy. We integrated roadway characteristics relative to rain and grade in addition to route as part of the input for the driver and the management feedback on the fuel usage and route.

These are a couple of the older projects from our sort of early days at GIS at UMTRI. The lower one I remember fondly because that was where we were actually taking paper crash records and we were hand-geolocating the crash so that we could put it in a model. So, you know, it was the old days. We don't necessarily have to do that as much anymore, but that was one of the first projects and that was for large trucks that were hauling hazardous materials. We worked with Sandia National Labs on that.

And then in the upper right was a project that we put together and that had to do with looking at bus crashes at bus stops and what the analysis of those crashes might mean in determining where you should put a bus stop, because you have different districts and different rules that have to do with putting in where bus stops are located, but we wanted to review that relative to crash data.

This is the Road Departure Crash Warning Project that I mentioned earlier. This was the one that was only the light vehicle and it had 11 passenger vehicles. It had 78 unsupervised drivers and we captured 83,000 miles of road, and 400 channels of data was captured at 10 Hertz or faster. And this was the safety system that was embedded in the vehicle for testing, was the road departure crash warning or the curve overspeed, sometimes referred to as that.

This is the Integrated Vehicle Based Safety Systems project. This is the one that we completed just shortly before getting the model deployment project. This is the one with the two platforms. So we had 10 large trucks. It was part of a fleet from Conway, and the safety devices that were being tested on that were forward crash, lane drift and lane change, and there was 600,000 miles collected from the large truck platform.

And then the passenger fleet was 16 vehicles. 200,000 miles of data was collected and there were 500 data channels. And there were four warning systems that were embedded into the vehicle for testing, lateral drift, forward crash warning, curve speed warning, and lane change merge.

So this is just a brief slide on -- just a comment on experience and kind of what I've seen from my eyes in doing this for UMTRI. And that is, that before you start integrating data from other sources it's really important that you have a clear understanding of the different -- not just the different types of data in their structure, but to go back to say why did they collect this data and can you use it, because just because it's spatial data doesn't mean it's really good for you to use. You need to understand why that agency decided to collect that data. And they did it for their purposes, and if this happens to be a cross-link between how they collected something and you can use it that's a good day. But it's really important to try to have an understanding of why they collected that data and whether it's appropriate to use.

And also understand the variance and resolution. You know, I get a lot of people who say, well, you've got the GPS data. And I'll say, well, what is the resolution of the GPS data? And many times I don't get an answer. So as much homework as you can do before you start integrating these sources and their different resolutions and different reasons why they were collected, the better off your end product will be.

And, also, we do a fair amount of validation of map matching. Map matching in itself is a very big area and there's a lot of people working on it and they have different kinds of purposes and guidelines on why mapping should be done, but it's a challenge.

So, with that, UMTRI is highly regarded as a field-based geo-spatial data collection analysis and integration house. UMTRI projects have involved a variety of platforms, and GIS plays a key role in improving the safety of the nation's transportation system through the collection mining, analysis and spatial data emerging from model deployment. Thank you very much.

DR. CHEUNG: Thank you, Ms. Barnes.

Mr. Marco Merens is a Safety Data Analysis Officer at the ICAO's Integrated Safety Management Section. Mr. Merens, please proceed with your presentation.

MR. MERENS: Thank you very much. The Chair, the Members of the Board, thank you for giving me the opportunity to present today to you ICAO's safety analysis activities around GIS.

So we have talked a lot about roads here, so I'll propose you to take a little bit of height, so we will -- ICAO is global aviation safety, so the granularity we're using is a state. So you will see world maps mostly. So I propose you take a little bit of height and a little bit of abstraction is probably needed for this exercise.

In ICAO what you want to build is safety intelligence, global safety intelligence. So what you mean by that is actually you want to create actionable information to use by our decision makers who want to define aviation safety strategies, meaning where to go, where are the risks, and where should we put our priorities, globally speaking. So we want to identify targeted areas of current and emerging risks to effectively work on our mitigation strategies.

So Safety Intelligence is actually now a program we are running. You can say that we have two systems which support us in that. So one is iSTARS, which I'm actually personally responsible for. And it's an online platform, a secure platform, where we're producing integrated safety analysis results using -- use of all the data mainly around, but also feeding in accident, traffic and fleet information like average fleet age and things like that. On the other side we have also a GIS portal where we are showing a lot of maps, but mostly related to air navigation. So it's roots, it's traffic, it's airspace design.

So we really try to make use more and more of GIS in iSTARS or the future of iSTARS. It's not very easy to manipulate. We might be creating much more easier charts which are more -- well, it's more fluid, more dynamic, and tables. A map, it's much more difficult to manipulate, so -- but I will show you two examples where GIS definitely helped us in improving our safety intelligence.

But, first, I have to give you a little bit of an idea of the accident risk model we are using. So we have -- accident rate, so we are calculating accident rates. Now it's the number of accidents by departures for the world. It's actually just sort of empirical measure of risk. And so we're using that for the world to calculate the global accident rate. But we also calculate the accident rates for regions, so -- but then we also used regions, as we saw that how the regions were defined was actually not important; a rate was a rate. But actually we saw that some regions -- it was actually unfair for us to create a region like that. And I will give you an example and that's actually a known problem in geography. It's called modifiable areal unit problem.

And so GIS helps to understand that.

Another thing was that from a conceptual point of view we think accidents are random events and that they follow a certain distribution and, of course, some distribution actually, of course, nicely fit there, and so it's proportional to it. Departures, but there is a parameter inside which is accidents by departure. And that one is a theoretical number, and we say that sometimes it's in the -- it's a combination of hazards and defenses. So that's something in risk that safety management using a lot. It's hazards or threats and defenses of control. So in somewhere you have hazards, but you're controlling them.

So if there are places in the world where there are hazards, but they are well under control, well, that's fine. But if there are hazards and they are not under control, well, that's then a risk. So if we're weighting them and comparing them with each other, and GIS actually helps us quite a lot in that, we are able to identify even visually where is our priority in some sense. So that's a second example I will show you.

So this is a world map of traffic overlaid with accidents. So the red points you see are accidents in the last 5 years, not necessarily fatal ones; accidents and where they happen in the states, different countries, and the coloring of the countries is the traffic or number of departures. You can see it's from a very light blue it's less than 7,000 departures per year. It goes to really dark blue, which for the United States, for example, it's 10 million. So you see the variety around the world. So there are states in western Africa where they are all light blue. You see they have all less than 7,000 departures per year. And actually ICAO has always grouped these states by ICAO regions and West Africa is an ICAO region.

Once we have plotted the traffic, we have seen that we could not have created a worse region in the world and more unfair one like that because it actually contains the lowest traffic in Africa. We have grouped them together and they have actually not many accidents. You see that those are actually very small. But if you calculate the rate, it gives us a rate which is two, three, four times higher than the global accident rate. Okay?

One of the reasons is this modified areal unit problem, so we tried to quantify that. So we calculated actually what a single accident -- a single accident, more or less, per year, what difference does that make for that region. So we have compared two regions, two regional cuttings actually. One is the ICAO regions. We have seven, which were on the map before. And we also use U.N. regions. So it's more like continents, you know, Africa together, Asia, Europe.

So if we're using ICAO regions, well, for western Africa a single accident every year, more or less, it's making a difference of five in the accident rate. Knowing that the global accident rate is around four accidents per million, a single accident in that region really doubles or triples their rate, so we cannot really use that to measure that state safety.

So we have actually stopped doing that and we are moving away and we have -- now all of our statistics are U.N. region based because you can see that it's much more the same; it's much more equal. Every accident in this region has an equivalent impact. So when you put that on a map that's how we were able to tackle this modifiable areal unit problem.

Another thing where we use GIS is to evaluate risks. So there are actually three things we do. First, we have to -- we are putting hazards on the map, but for that we have to give them a measure. So traffic, for example, is really our first hazard. The more traffic you have, the more you are -- the more lives are at risk and the more general you have accidents regardless of now your accident rate. But that's easy to quantify. But a hazard like terrain, I mean, I can quantify it by the highest point, but that's maybe not what I mean by terrain, it's maybe more of the slopes and things like that. It's much more difficult. Or weather, you know, how well we're quantifying weather. It's all those hazards.

So we can overlay them with a defense or mitigation. For example, for us it's if a state applies ICAO standards we think that it is to protect against hazards. So on the level of implementation of these standards, actually it's giving us a measure of the defense which is in place there. And our other program is actually quite good and goes into very much detail, so we're using that to evaluate the defenses.

And putting those together and finding places where there are strong hazards together with weak defenses, well, that's for the risk. If you have weak defenses it doesn't mean necessarily that there is risk. If there is no hazards, well, you can have weak defenses and it probably not make a real difference in risk. So we try to use GIS to do that.

So I give you two examples of that. One is what we call in air navigation, we call -- calling it loss of separation. Loss of separation is before a mid-air collision arrives. In air traffic control you have to keep the aircraft separated from each other. Loss of separation means that they are getting too close, so we want to evaluate that risk.

And this is -- we have -- this map actually shows flight information region, so it's airspace, and the colors is the number of flights per year in that airspace. So you have from dark red, which is around 5, 6, 7 million, to really dark green, which is then again around 70- or 50,000 flights. So that is our hazards in that case, number of flights per airspace.

The areal unit we have chosen is the airspace. Okay? And the defense which we could overlay is, well, how well is separation minimal, how well is separation minimal apply in that space. And we have quite an idea on that because our use of auditors that go into these countries and they ask questions like, okay, show me your regulations, show me where are you radars, do you have this or that to ensure separation, and we capture that information. So we are able to overlay that. I cannot really show you that today because all this other data is actually confidential information. It's only for states. But conceptually that's where I'm actually -- to show you where we are going.

So we have hazards on one side and we are overlaying them with defenses, and where those things don't match we can say, okay, there is more risk. So we are actually generating this map. It was actually not very easy because we were using scheduled flights. There are 30 million flights over the world. We have 40,000 city pairs, so origin/destination, and we have calculated the flight passes of all those flights and see through which airspace they are going. So to generate that map it took us quite a long time.

But we have gone a little bit further. This what you see is actually -- we have shaded out the airspaces and we only are showing the borders of the airspaces, because that's another risk which we would say it's linked to handover coordination between states. A flight typically -- if you take a flight from New York to Paris, it goes from the American airspace to the Canadian one and then it goes from the Canadian one into the U.K. one, and then from the U.K. into the Brussels airspace and then goes to the French. So it crosses borders.

Every time a flight crosses a border there is sort of a handover which has to be done between air traffic controllers. And if that's not done, well, the aircraft just appears on the radar, on the new airspace. And if that was not coordinated before, well, there may be loss of separation problems there. And so we have calculated how many aircraft are crossing each border. So you see the red lines. They are around -- again it's around 5, 6 million per year which aircrafts are crossing that border. And then you have the very light green one that's actually less than 1,000.

So, for example, you see that the United States and Canada, this border is red. If there was no coordination between the United States and Canada that would be a really huge risk. Okay? Suppose that there's no real coordination between the United States and Mexico or one of the other countries or airspaces in the south. Well, it would still be sort of a problem, but comparing that, you cannot compare that to the problem which would exist between the United States and Canada.

So this, again, gives us a view of where would our priorities be. And our use of the program also includes questions where we're asking the states are you really coordinating flights and can you show me and how are you doing that, do you have procedures in place with your neighboring states? But we very well know that there are some countries in the world which are in a war with their neighboring countries or they don't even recognize their airspace, so we very well know that they don't do that. And if the traffic between those countries is high, well, that's a potential risk.

So when our executives travel to those regions, that's what they will highlight. Okay. They will talk about the subject and that's the subject they will talk about. They will probably not talk about controlled flight into terrain if there's no terrain. You basically need mountains to fly into them. If you don't have any, well, the defenses you have to put in place are probably less important.

Again, for generating this map it took us quite a long time because we had to really see again through which borders we are going and we're using global flight information and it's a real challenge.

So how we are going about that for the future is really we want to -- we definitely want to expand the iSTARS or safety analysis to include more of the spatial analysis tools, and iSTARS is actually including -- we have almost real-time use of data, all the data, and connecting that to a map is actually quite difficult, so we want to try to do that.

And then I'm speaking -- I would really like to have analytical terrain and weather related information. So it's not having a map where you can look at; it's having a measure of how bad the weather is. I mean, that's a complete domain. But I would need a number, how bad the weather is in someplace. Is it an average of days per year or something like that? But if I have a number I will be able to do what I've shown you. I can feed it into my risk model and I can then check, okay, is that state -- does that state have a metrological service, does it produce this information, et cetera, and couple that with how the weather is and maybe coming up with a simulated world which we would be able to use for doing our analysis.

Thank you very much.

DR. CHEUNG: Thank you, Mr. Merens.

Mr. Marc Berryman is representing the National Emergency Number Association today. Mr. Berryman, please begin your presentation.

MR. BERRYMAN: Great. I'd like to thank the Board and Ivan for inviting me to this important forum. My name is Marc Berryman. I'm representing NENA, which is the National Emergency Number Association.

The National Emergency Number Association is basically a nonprofit organization comprised of volunteers for the most part dealing with emergency communications, 9-1-1 centers around the country, developing policy, technology, standards and operations for the members -- not only for the members, but for everyone to be able to use. There are freely available standards and information on the NENA website. There's about 7,000 members within NENA and there's 48 chapters across the U.S., and now it's actually international.

The idea behind the National Emergency Number Association, or NENA, is to provide leadership and guidance on 911 principles, operations, technical information and standardization. The idea behind that is to be able to share data back and forth among different PSAPs, which are public safety answering points.

I'll show you a graphic right here in a few minutes, but for the most part when you make a 9-1-1 call it goes to a local 9-1-1 center, which we call it a PSAP in the industry.

PSAPs -- once you've been in one PSAP you've been in one PSAP. They're all different. They're all the same, but they're all different in many different ways. So we're trying to standardize everything across the country so we can start sharing information back and forth freely amongst everyone to get a better idea of what's going on.

The first 9-1-1 call -- I had to throw this in there. The first 9-1-1 call was back in February 16th of 1968 in Haleyville, Alabama. Then in about 1980 Orange County, Florida and St. Louis first started doing what they called emergency 9-1-1 or E9-1-1. E9-1-1 is where the actual location of the call comes in with the call itself. That worked really well when you had a hard-wired phone into the jack -- into the wall over there, but then wireless technology came around and we didn't know -- initially we didn't know where the wireless calls were coming from. And basically the system that they developed back in the 1980s is still in existence today, unfortunately, but we're working on moving into an IP-based next generation type system.

This is just a graphic of the approximately 6,000 primary public safety answering points across the country. You can see there's -- you can imagine where the clusters are. Like I say, when you make a 9-1-1 call it goes to a local 9-1-1 call center.

It's typically the local law enforcement agency.

So what brought GIS into 9-1-1? Well, when we started doing wireless technology people started getting cell phones, more people started getting cell phones. Initially the real estate people and lawyers had them, but no one else did. We needed to be able to locate those callers. The only way we could locate those callers initially was the callers had to know where they were, which was a huge issue. I remember typically you'd say, what is your location? They'd say, I'm on I-10. Well, great, you're somewhere between Florida and California. It didn't really help much.

But today almost 80% of the calls coming into the 9-1-1 call centers are wireless calls, so using GIS technology to help locate those calls is instrumental. Basically today when a 9-1-1 call is made from a cell phone we get the location of the cell tower and a sector, the direction that call comes in from. Then about 30 seconds later we can actually do a rebid and get the actual longitude-latitude or XY coordinates from that. We can put that on a map, GIS map. Then we can determine where the caller is calling from and then the closest available emergency responder to respond to that particular call.

But GIS is instrumental within 9-1-1 because once GIS got into the public safety answering points, it was just an explosion because they said this is wonderful technology. We can do all sorts of stuff with this GIS, everything from analytics, predictive analytics to determine what time we need more people on staff and what have you. It's a godsend for the emergency responders because now we have a location of an instant. We can tie it to a map, tie that to a locational map. Then we start tying together additional information about that location.

In this example we just have some floor plans, pre-attack plans or fire plans, if you will, for certain structures. Is there anything else in that area that could be of importance? You know, aerial imagery. Is there any hazardous materials in that area? If there is hazardous materials, what is it; what do I have to worry about? All this information is now available just by tying all this information to a location in the GIS data.

As I said originally, we didn't have this information coming in from the wireless cell phones, but back in April 8th of 2000 Norm Mineta made this statement. I think everybody can read it, so I don't have to read it to you, but basically it says we have the technology, we have the willpower, we have the right people around to be able to do this, to make this happen, to be able to determine where that cell phone call is located for 9-1-1 purposes.

It's interesting that the FCC right down the street here came out with an edict 6 months later that basically said if you have a cell phone, you have to have technology on that cell phone where you can actually locate that cell phone. So that was in 2002.

Today, you can see the dark green is where they actually have Phase II, what's called Phase II location technology, in place. That's where we can actually rebid the call and get an actual XY, longitude-latitude, coordinate of the caller that's fairly accurate. It's within a football field. People say pinpoint, but then you have to say well, are you pinpointing it on a local map or on a global map, so --

The dark green, like I said, is where we can get the actual information coming in today. The red is where there is no -- where it's not available. You see there are some parts out there in Nevada where it's not available, but luckily few people live out there.

But NENA, like I said, is also a standards developmental organization and over the years we've worked very closely with many different stakeholders. I just have a few examples here of some stuff -- some work we did with the Department of Transportation. This is the first one we worked with. In 2001 we did the Milepost Information Document, so being able to locate where you are calling from by a milepost, whether that milepost is a railroad milepost or a highway milepost. It was again invaluable to be able to figure out where the closest first responders were to that particular area.

Right after September 11th we had -- we came out with a NENA standard for NORAD/FAA Notification of Airborne Events. These standards are basically defining standard operating procedures that all PSAPs must have available to the call taker, so if they do get a call coming in they can have a little flipchart there that has the standard operating procedures written down: this is what you do, this is who you call, this is who you need to talk to.

This one is the railroad interaction operation document. Again, this was an operation information document that defined how the public safety answering points needed to define standard operating procedures for their organization on how to deal with an instance involving railroads.

And the last one we've done was, of course, the Pipeline Emergency Operations Standard. Again, this was -- not only did it put in place a standard operating procedure, but also to try to standardize the information across the country on how to deal with pipelines, pipeline incidents, pipeline accidents. I noticed just earlier this year they actually came down -- it says all the pipeline providers must know the local public safety answering point 10-digit, 24/7 emergency number. Because if I'm in Houston, Texas watching my pipeline and there's an accident in Alabama, it doesn't do much good to call 9-1-1 because I'm going to get Houston 9-1-1. I don't know the number for the Alabama 9-1-1. So they put in place where the pipeline operators now have to have this information available to them.

This is just going back to 2008. We have a 9-1-1 system. It's basically 30-year-old technology, 30-plus-year-old technology now, and it can't really meet the needs of the types of telecommunication devices everyday Americans are using today. We can't get text into 9-1-1, we can't get video into 9-1-1, we can't get images into 9-1-1 because 9-1-1 is based on 30-year-old analog technology.

We have to deal with public education. The public thinks we know exactly where they are when they call 9-1-1 because they've been told by countless news organizations that we can pinpoint accuracy. Well, again, is that pinpoint on a globe or on a local map?

We did a couple of surveys with school children between the seventh and twelfth grade. We did a cross-sectional survey of about 50,000 school-age children. We found out that 80% of them thought they could send a text to 9-1-1. You can't. There's two areas in the country you can, but you don't know where -- you can't really tell when you're in that area or not.

Today almost 95% of the mobile phones have a camera, so wouldn't it be great to be able to take a picture of the accident and be able to send it to 9-1-1 and say -- the 9-1-1 operator looks at that and says, oh, we need to send jaws of life and a tow truck and a wrecker and a couple of ambulances because this is the type wreck we have.

Right now today almost 85% of all the calls coming into the local public safety answering point are downgraded to go into this analog technology, and that's the idea behind this Next Generation 9-1-1 I'm going to talk about just shortly here. But today we have all kinds of new source information. We have the smartphones. We have vehicle telematics. We have OnStar, Cross-Country, ATX, Agero. Lots of different people have wonderful analytic vehicle technology. We're using automatic crash identification in a lot of places.

Environmental sensors are everywhere. Environmental sensors are radiological, biological, chemical. It's amazing sometimes what goes off at the Houston Ship Channel. Video surveillance cameras are widespread. Intelligent transportation systems are very well known by this group, but being able to get that information not only to 9-1-1, but being able to get the information out to the first responders, the actual information where they can actually use by the people on the scene. So it's one thing to get the information into the public safety answering point; it's another thing to get it out to the first responders that could really use it.

This is just an example of some information that is available in some places today. In this case a call came in from this particular location and additional information pops up about the caller. In this case we have a family of four. They have the location of the house, different little tabs you can press there to see different information. In this case there's a child in there that has allergies and he's hearing impaired, so it might be important to know if there's a -- if you're having to send an ambulance to that location. But, like I say, getting information out to the first responders is the whole idea behind Next Generation 9-1-1, or NG 9-1-1.

So we had a research development grant from RITA back in 2005 to start pushing this idea forward to have an IT-based upgrade, if you will, to 9-1-1. Of course, the major goal is to save lives, health, property, and be able to better provide information, like I said, to the first responders.

In 2009, they came out with the proof of concept plan and I'm happy to say that we've written many standards since then and this is actually progressing forward. The whole idea behind Next Generation 9-1-1 is to have an open system, a nonproprietary system, that's available to all public safety answering points as well as the emergency service providers. And the emergency service providers aren't just the people in the middle there, the police, fire and EMS you typically think about, but you can see on this graphic it expands out to hospitals, public health, poison control, public works, utilities department. There's a whole wide area of what you could consider emergency service providers.

So the ideal, for me, behind Next Generation 9-1-1 is to have a better common operating picture, have more information -- extra more information available to the incident commanders, to the people out in the field, to give them a better idea of the operating picture, situational awareness. The bottom line, here it says improve public safety. Also the bottom line is it improves officer safety out there.

The nice thing about Next Generation 9-1-1 or the bad thing, however you want to look at it, is for Next Generation 9-1-1 you have to have the GIS data to make it work. You have to have good GIS data -- good standardized, normalized GIS data, I should say, to make it work. And the idea behind Next Generation 9-1-1 for NENA is that this GIS data needs to be locally maintained. The local people have a vested interest in that data. They know when the roads are being closed, when the roads are being opened. They know what's going on out there on a day-to-day basis. So being able to have that information up to date, locally maintained, pushed up to the state, pushed up to the national level is much better we think, a grassroots approach rather a top-down approach.

And this is just an example of -- several people brought this up yesterday and I just had this slide in there. This is a -- the state of Ohio has a location-based response system where they've actually married the Ohio DOT information along with the 9-1-1 information along with the -- information along with federal and state agencies. They've actually got one base map that covers everything. The base map has the road centerlines and address points in there. These address points are field verified, site specific.

What's amazing is -- the attributes on this are amazing. There's 3- or 400 attributes on every road segment in there. You think oh, my God, I don't want to deal with 3- or 400 attributes. Well, they've set it where I as a 9-1-1 organization only have to worry about my 230 attributes on this road centerline that I need to worry about. The Department of Transportation, they only have to worry about their attributes, the same way with the tax appraiser, the same with everybody else, only have to worry about their attributes. They merge them altogether to have a statewide site specific, very accurate database. And that's it. Thank you.

DR. CHEUNG: Thank you, Mr. Berryman.

Dr. Emery, would you please begin your questions?

DR. EMERY: Thank you, Dr. Cheung. My first question -- first of all, thank you to all the presenters for your presentations today. They were excellent. My first question is for Mr. Berryman. What would you say are the key challenges or limitations regarding the application of GIS technology and, more importantly, analytics to the emergency response world?

MR. BERRYMAN: Well, today across the country there's -- everybody thinks their GIS data is really good until you start looking at it from a public safety perspective. Then you quickly see that it's not good enough for public safety. It's oftentimes good enough for planning purposes or something else. I think there's a lot of education that needs to be done. It all boils down to, you know, the cooperation, coordination, collaboration and communication with your neighbors to make sure that your stuff matches up with their stuff when you cross the state line or the county line, whatever it may be. So I think a lot of it is just educating.

DR. EMERY: All right. I just have a follow-up question to that. In the effort to do so, is there an emphasis on metadata, is there an emphasis on data interoperability, so that once it's collected and maintained locally you have a mechanism by which you can share it?

MR. BERRYMAN: Absolutely. Without metadata you don't know what the data -- you don't know how the data was gathered, what it was actually gathered for or what its intended uses are, so we're very strong on forcing people, if you will, you almost have to force them to have that metadata in there. I'm sorry, would you ask the second part of that question again?

DR. EMERY: And the mechanism for sharing the data.

MR. BERRYMAN: Oh, I'm sorry, yes. The whole idea -- NENA's has come out with a standardization for, you know, certain data fields that has to be in there for 9-1-1. They have to be standardized. They have to be normalized. So if I start sharing my data across the county, across the state or across the nation, we can share data back and forth and know exactly what fields go where, what -- that this is, you know, Smith Drive as opposed to Smith Court; the same standardization as far as the attribute information.

The whole idea of the bottom up approach is everybody has to do this in order for us to be able to pull this information together on a state level and on a national level, because if you do it one way and he does it one way and I do it another way, it's not going to work. But to help do that we've actually gone to an XML base. We have XML tags. So if he calls his data attributes something different than I do, it doesn't matter as long as the XML tags in there, it'll make it interoperable.

DR. EMERY: And one last question. The coordinate system today, is it integrated with national grid or is it a localized system?

MR. BERRYMAN: We've actually gone with world geographic -- WGS84, which is the international standard. National grid is also in there as well. Oftentimes it's a local coordinate system, but when we start pushing it up to -- pulling it together on a regional scale or a state scale, we need to have one common geographic system to do that.

DR. EMERY: Thank you very much. Dr. Groff?

DR. GROFF: Thank you. My first question would be -- I'll direct it to Ms. Park, but I'd also like to hear your response, Ms. Barnes. One of the questions that came out yesterday was -- early on was providing a model of like -- currently we have consumer GPS devices in vehicles and you can choose a routing based on time or distance, and how far we are from the equivalent of providing you the safest route.

Well, both of you spoke to that and it sounds like you have elements of that already available. Maybe if you could speak to in-vehicle alerting of safety issues, maybe ones that are somewhat static or long-term? Like the rollover conditions I think are related to in many cases just the design of the roadway, but you also both spoke to things that may develop very rapidly. I'd be interested in both of your responses to how close we are and maybe what it would take to get there.

MS. PARK: Yes. As you said, the rollovers are static. We are also doing research at ATRI to be able to provide a real-time weather notification in the same kind of in-cab alerting system that would tell a truck driver that the route that he has chosen is going to go through a severe weather event, so that he has time to change his route before he gets stuck in that event.

We are also doing research right now where we have been surveying truck drivers and trucking company executives to see if they're using truck-specific GIS systems in their trucks and also what preferences they have for those systems, which features work best for them, and then we can, in turn, give this information to the manufacturers so that they know how to better their GIS systems. Because we do know that anecdotally, it's been in the media a lot, where trucks have had bridge strikes and other issues where they've gone down roads that they thought they could travel on and they can't and can't turn around and these cause accidents. So that's definitely something we're aware of at the institute and trying to work with the industry to improve that.

MS. BARNES: Thank you for your question. At the institute we are about doing research for what are considered in planning or in development in-vehicle safety systems. So what we're doing is testing the robustness, the consumer acceptance, and the field measurement of these systems.

So when it comes to the GPS, we do our best to get between 3 and 10 meters depending on the project and whether it's been differentially corrected. So for our purposes it's kind of similar in that we're looking for the place on the road where the alert went off, and then we're going to try to tie that alert to, well, did the alert go off on the part of the road we expected it to or did a behavior incite that alert? So it's not -- it's similar to what was just discussed, that there are these static locations, but dynamic issues that bring you to that location. So we don't look at the GPS as sort of an end product. It's a tool to go forward and analyze the robustness and field worthiness of safety systems that are being developed.

DR. GROFF: Thank you.

Dr. Cheung?

DR. CHEUNG: Thank you, Ms. Barnes, and I do have one question from a staff member. You talked a lot about the various data that UMTRI collected. How much of that is being passed down to, for example, Michigan DOT or law enforcement, and if at all possible can you just give like one specific example?

MS. BARNES: Well, the Michigan State Police and MDOT are two of our biggest suppliers of data that help us out, and then what we do is we take their data and data that we have available and some of the tools and actually we hand back reports and products that they request of us.

So just recently the Office of Highway Safety Planning asked me to put together a series of maps for their DDACTS meeting and they gave me a set of criteria on what crashes they wanted seen by police district and police location for certain areas they were focusing on for that DDACTS meeting. I hope that answers the question. We usually turn it back in the form of a product or analysis.

DR. CHEUNG: Yes. Just to remind everybody, DDACTS is the police crime and traffic coordination efforts. Thank you.

And, Chairman, we have no more questions.

CHAIRMAN HERSMAN: I have a question for you. I think one of the things that I'm hearing that's a continuous theme throughout the presentations is there's lots of different databases, and I think, Ms. Park, you talked about the states that you could get access to or couldn't get access to or people weren't prepared.

MS. PARK: Yes.

CHAIRMAN HERSMAN: How much of this is really an infrastructure question where we need to establish something that's a common accessible shared database? I mean, what are the issues with the proprietary information, are people -- is this a moneymaking venture? How do we deal with this issue when it seems like every panelist really needs the same good data? What do we need to do to figure out how to move forward on that?

MS. PARK: I believe it isn't an infrastructure issue. While we can get data from the states, as I discussed, it's an effort to assimilate it into one database that we can use. And then also there are issues in the analysis that you can do with that data once you've assimilated it. It's very hard, for example, to compare these rollover locations based on crash risks because we don't have exposure data for all of the roadways which may participate in that rollover cluster, so that's one of the problems. If we had that exposure data for all of those roadways, then we would be able to do more of the crash risk analysis between the locations and between states.

For the product that I mentioned, an in-cab warning system -- we're a not-for-profit organization. That will not be a commercial product that we will be selling, but I do know that there has been lots of interest from the industry for getting our base data, of course, because they have dollar signs in mind. However, that's something that we're not distributing. Just the clusters and those locations is what you can see, not the original raw crash data underneath.

MS. BARNES: Thank you. I agree with Lisa; however, I'd like to just expand on that. And that is that currently Federal Highway and HPMS does not represent all public roads. It is a subset of public roads. So if you're a large truck, then you're going to be pretty much running on a VB HPMS subsystem. But, as we know, many of the crashes happen on rural and local roads and many of those roads are not in HPMS. But Federal Highway and HPMS have just recently asked the states that -- I believe it is by 2014, to make sure all public roads are listed in the HPMS dataset. And then if we can get exposure data, which is primarily volume, to be included as part of all that road set, then you have had a huge -- you've done a huge step in -- or completed a huge step in having the whole nation's public road system with exposure data available for analysis and use, which you don't have right now.

You'd have to -- I had a question from a faculty member last week that said where's all the volume data for all the roads in the country? I said it's not in one spot. He goes, oh, you'd probably have to go state to state. I said, no, you'd have to go state to state, county to county, city to city, village to village. So we need more data for more of the system with exposure data, and for the research community that would be wonderful.

CHAIRMAN HERSMAN: And I think maybe, Mr. Berryman, on the infrastructure issue. It's not talking about this information like it's concrete, but I think it's the information highway that we need to think about, and when I looked at the information that you needed on the response side it really is trying to make sure that that information is able to be built out and accessed. Do you want to comment on that?

MR. BERRYMAN: Absolutely. It's all a matter of building in or outbuilding into the data and then also getting the data to the level it needs to be, the very fine grained level, so it's not only useful for public safety, but for everybody else that's been presenting the last several days, because we're all having the same issues, the data's not good enough for what we need to do. I think, again, that gets back to -- it gets back to education, but it also gets back to being able to -- we might need a carrot. I'm not sure.

CHAIRMAN HERSMAN: Well, another question that I had was about security and privacy, but maybe you all can share your thoughts very briefly, as we're intended to adjourn, if someone feels very strongly about that. I did read an article this morning about some assessment of some highway technology sensors that were susceptible to hacking, and so I think there are definitely some questions that I have about security and also privacy. I think, Mr. Berryman, you showed us some really interesting information, but understanding how that is used and who has access to it is probably very important to the people who are providing it.

MR. BERRYMAN: Absolutely. For the most part that information's only available to the responding agency, and it's kind of a look at it once and pretty much forget about it. It's there, but it's not -- addresses and relatives are widely available, it's well known, but as far as who lives in this house and what are their susceptibilities and stuff like that or where the chemical, biological and radiological centers along the roadways, that's not public consumption, you're right.

CHAIRMAN HERSMAN: Well, as a NTSB employee who just came back from a hot hazardous materials site in New Jersey where we had a train derailment and a vinyl chloride release that's still in effect, I think there are definitely some questions about evacuation areas and understanding where schools are and where people who might need special consideration, if they're disabled, for transportation to get out of those hot zones. I think there's a lot that we can do with better information both proactively and in a reactive position as well.

MR. BERRYMAN: Absolutely. And knowing where those -- knowing that chloride vinyl -- where the release was and knowing the population, especially the susceptible population, the daycares, the schools, the elderly homes -- I couldn't think of the right word -- just do a quick prelim analysis which software does it very quickly nowadays, it used to take hours and hours, but now it's almost instantaneous, and have an alert -- early warning and notification alerting system to get those people out of the way, either that or shelter in place. You're absolutely right.

CHAIRMAN HERSMAN: Great. Thank you all so much, yet again another outstanding panel. You've given us a lot to think about and we very much appreciate the excellent presentations. And, Ms. Park, I was particularly struck by some of the photos that you showed, the diagrams that you showed, about the truck stops and the hours of service, and I think that we all talk about theoretically what we want to see, but at the end of the day it's the practical issues that inhibit people from being able to follow the rules or work as effectively as they are expected to, and so we need to understand some of those underlying things. The data is a tremendous tool to unlock that for us.

Thank you all for your presentations and thank you so much for coming from ICAO. We appreciate our relationship on the international side and we'll look very closely at those red lines that I saw between the U.S. and Canada.

We stand adjourned. We will reconvene at 10:35.

(Off the record at 10:15 a.m.)

(On the record at 10:35 a.m.)

CHAIRMAN HERSMAN: Welcome back. We will now continue with our second panel on our second day. Dr. Cheung, will you please introduce our panelists?

DR. CHEUNG: Thank you, Chairman Hersman.

In this panel I am being assisted by two staff technical panelists: Mr. Eric Stolzenberg from the Office of Marine Safety and Mr. Chris Babcock, Office of Research and Engineering.

Ms. Julia Powell is the Electronic Navigational Chart Technical Director at NOAA Coast Survey Office. Ms. Powell, please begin your presentation.

MS. POWELL: I'd like to thank Madam Chairman and the Members of the NTSB for this opportunity to speak. My presentation sort of covers a little bit of everything that the Office of Coast Survey does in terms of utilizing GIS to improve navigation safety.

So the first one is, who is Coast Survey? Most people don't know that we were the first science agency of the U.S. We are responsible for surveying 3.4 million square nautical miles, which represents the U.S. territorial limits. We create and update nautical products on a weekly basis.

We also speed the reopening of ports after hurricanes and other disasters. So in order to get marine commerce getting back into the ports, we go in and have navigation response teams that go in and quickly survey for obstructions in the channels, to ensure that there is still the appropriate water depth below keel so the ships can reenter the ports, and we work closely with the port captains in order to do so.

We also do development of hydrodynamic models for coastal management. So Coast Survey sort of runs the gamut of a variety of different things. And we also provide global hydrographic leadership.

So our scope of coverage, which I mentioned, is the 3.4 million square nautical miles. As you can see, it's a lot of territory, and we haven't even surveyed half of it adequately, so there's large amounts of territory that still haven't been surveyed. It costs a lot of money to run survey vessels, but we have, I believe, four full-time vessels that are continuously surveying. I think we have two that usually work up in Alaska because that's our one area that's mainly very sparsely surveyed. We're also starting to move into the Arctic because the Arctic is becoming a very hot territory.

And, you know, we also get support from the Army Corps of Engineers for the channels, as they're responsible for the channel depths. And basically we have 95,000 miles of coastline and 25,000 miles of navigable channels of which we're responsible for depicting the accurate portrayal of the depth so the ships can move in and out of port.

So basically we produce navigational information for a diverse group of users. We have over 1,000 traditional paper charts which are usually what's used to navigate. If you want to -- if you navigate, use a traditional paper chart; if you want to use a raster chart, it's only used as a navigational aid. We also produce the equivalent for our paper charts.

We also have another product, and if you have an ECDIS system, which is for larger vessels, and you have -- you comply to the IMO requirements for ECDIS, you're allowed to use ENCs for primary navigation if you're engaged in international voyages, and we have approximately 958 ENCs. We are still working to do one-for-one coverage for our traditional paper charts, but we have declared that we are adequately covered for primary navigation within the U.S. for ENCs.

We also have about 1,000 print-on-demand charts which are sold by OceanGrafix. These charts are traditional paper charts, but they are corrected on a weekly basis. So your traditional paper chart, you have to hand correct it for your Notice to Mariners. The print-on-demand charts, it's sort of a convenience.

The user pays, but they're already pre-corrected. And of these products, the raster charts, the ENCs, and the PODs are updated on a weekly basis for critical corrections. The papers charts, the mariner would have to correct those.

And in order, you know, for who we are to meet our legislative and regulatory mandates we have the Coast and Geodetic Survey Act of 1947, which basically authorized Coast Survey to support maritime commerce with nautical charts and products. And then we also have Title 33 of the Code of Federal Regulations, which mandates that NOAA charts, the *Coast Pilot,* and tidal and current information be carried on all self-propelled vessels bigger than 1600 gross tons, including passenger vessels.

And then we also comply to the International Maritime Organization's *Safety of Life at Sea*, Chapter V, which states that "nautical chart or nautical publication is a special purpose map or book or specifically compiled database," which is the ENC, "that is issued officially or on the authority of a government-authorized hydrographic office." And because of the Coast and Geodetic Survey Act of 1947 that authorizes NOAA to issue the electronic navigational charts and the paper charts for the United States.

So basically the whole maritime organization -- there's also two international bodies that sort of govern both the standard side for data and for systems and for maritime regulations. There's the International Hydrographic Organization, which is comprised of 80 member states, and we support the safety of navigation through standardization. And they're responsible for S-57, which is the electronic navigational chart data standard. I didn't put it up there. They're also responsible for S-52, which is how the electronic navigational chart displays on the ECDIS system. They also are moving into more of a GIS ISO-based standard and have developed S-100, which is the universal hydrographic model.

And then we're also moving to a new standard to replace S-57, probably within the next 5 to 10-year horizon, is S-101, which is the new electronic navigational chart specification. And then you also have the International Maritime Organization, which is comprised of 160 coastal states and they have the responsibility for the safety and security of shipping, and they have developed the Electronic Chart Display and Information Performance Standard, which is ECDIS, which is the over-arching system that the data that the IHO is responsible for standardization feeds into.

So basically ECDIS is a computer-based navigation system. It's integrated AIS and radar, and in order to use it for primary navigation you have to have an ENC. It does improve the safety and efficiency of marine operations because depending on your navigation scenario, alarms and warnings are triggered based on the ship's draft and surrounding chart elements. And, also, SOLAS Chapter V was amended in 2012 that ships of a certain size must carry an ECDIS.

So basically this is sort of the components of an ECDIS.

You know, your ECDIS is basically a box, and in order to have an ECDIS for official navigation you have to sort of have two ECDIS's that are power independent so if your ship's power goes down the ECDIS will still operate. It also has sensors that feed into it. You have your AIS; you have your depth sounder, your radar, your satellite navigation, your gyrocompass. And the part that NOAA's sort of responsible for in this is that we feed the ENC that goes into the ECDIS to display properly for your navigational picture.

And this is sort of a snapshot of where we are in terms of where SOLAS mandation [sic] is. So, as you can see, that new passenger ships have already started to have ECDIS installed and existing cargo ships over 10,000 gross tons must have ECDIS installed on by July 2018. So the thing is, ECDIS is a reality, it's here and ships will be navigating with it, and so the importance is the data that feeds into it.

So basically this is a very old scenario that we like to use in our office, is that sort of hypothetically in the Exxon Valdez, what if it had an ECDIS? Although they did purposely cross the traffic separation scheme to avoid ice, every time they would have crossed that scheme an alarm would have sounded to alert the navigator on board or the ship's captain that something was happening and they were deviating off course. So at every point an alarm would have sounded, and by the time they hit the reef, because it was so much shoaler than their ship's draft, there would have been an alarm sounded.

So basically that's the key thing about an ECDIS, is you have all these attributes in your data that feed into the different systems that are coming into the ships. That alarms sounds, you know, if you're getting close to an obstruction, if you're crossing over -- you know, if you're crossing into water that's shoaler than what your ship's draft is, if you're crossing traffic separation schemes, and then integrated with the AIS you can see other ships' positions. So that's sort of a hypothetical.

And there's been other things like the recent accident in Italy of the Costa Concordia. It's too soon to say, you know, what -- because we're not sure what data was being used on it, but I was at a -- you know, so if they had the appropriate ENCs, alarms definitely would have sounded because if you look at where the ship was they definitely should not have been there.

So and here we are, NOAA ENC coverage. In 1997, we put out our first ENC, and by 2012 we have complete coverage. So you can see all those squares are different data at different scales. And in terms of worldwide ENC coverage, most of the world is adequately covered with data. There are some parts that have sparse coverage. However, other hydrographic offices do a lot of capacity building to assist those countries in either building and maintaining ENCs until those countries are able to support their own ENC production. So countries like the coast of Africa that have limited hydrographic capabilities, other countries step in and do capacity building efforts.

And then, also, in terms of our ENC distribution we have two methods. Back in 1997 when we were producing our first ENC there was a decision that we would make them freely available to the public. It was a byproduct of data that the taxpayer has already funded, so there was no need to try and, you know, cost it out, and trying to put a dollar value on actually producing the data was very complicated, so I think we just said it will be free.

But you can also, if you choose to, pay for our data through a certified ENC distributor. What these distributors do, they actually offer point-to-point services, so they actually distribute more than just U.S. data. They distribute more of a worldwide dataset. So if you're engaging in an international voyage from Oslo to New York City, you're going to need several countries' ENCs to navigate safely, so they offer that point-to-point distribution. So they're going to give you Norway, Belgium, France, Germany, you know, all the way to the U.S., everything you need to engage safely in your voyage. And all of our ENCs are updated to the latest Notice to Mariners on a weekly basis.

So in order to produce ENCs we actually have to produce all our products in order to comply with navigation requirements and also to provide a safe product for the mariner. And we get a lot of source data into our office. I think we get about 8,000 different documents a year that we have to assess and apply to our various products.

And pre-2012 we sort of maintained what we call a dual-production system, so we had multiple copies of products. We had our raster production system and we had our ENC production system, and the source was sometimes evaluated twice, sometimes evaluated once, and we would sort of use one product to backdrop against the other. But we found that it wasn't very efficient and it wasn't good data management.

So we sort of started this whole large-scale project and this project has been going on a long time, but we're moving into a true GIS production system. So basically our goal is to take our source data and apply it into what we call the NIS, which is our Nautical Information System. We're applying our data one time and then our updates are being sent to all our products in a shorter amount of time.

Right now, because of resources, some products, even though they're updated weekly, there is a bit of a time lag because you have to do, you know, your raster product and then you follow on with your ENC product, or you do your ENC product and follow on with your raster product. So our goal is to try and have synchronization within our updates in a short amount of time period and then we can publish our multiple products.

And so the reason why we wanted to go to a GIS-based approach is we wanted to increase the efficiency of our production system. It's a one-time source load evaluation and application of the data. We can support a variety of formats. Our workforce then becomes trained on multiple products versus a product specialization. Currently we have cartographers who all they want to do is sort of the "what you see is what you get" raster environment and they don't want to move to ENC, and then you have ENC cartographers who don't want to move to raster because they like the encoding of the data. And so we're trying to move it more towards a data centric environment. And then the key thing is that while it improves the efficiency of our operations, it improves the product for the mariner, and that's the key goal, is that now you have multiple products from a single database that provides improved product consistency, product synchronization, and you get a more up-to-date product.

One of the problems that we don't have is sometimes we put out a new edition of a large-scale ENC and a large-scale raster, but you don't necessarily publish all the information. We publish the critical information. So if there's an obstruction, that's gone out, and the obstruction will always make it out because it's critical. But there's things like shoreline changes or pier changes that might make it out to your largest scale navigation product, but for the smaller scales it might be a couple of years. So when you're in a GIS database approach the data is certified in the database and you can put it out to the products easily and more efficiently, and then we also end up with sort of an integrated end-to-end solution and then we can also leverage our data for other applications.

So this is sort of a snapshot that we do in terms of product finishing to get from our database into a paper product because it's a little bit different. So here we have a snapshot of our vector data, and then you run some processes and it starts looking like a traditional chart. You have to start masking out some of the lines, and then you add your grids and you add your display and your representation of soundings and then you do get what looks like a traditional paper chart, but it's derived from vector data instead of your traditional paper-based product.

And then the other thing that our office works on is that we are continuously working with the IHO to improve the existing electronic navigational chart standards. It's currently based on the IHO S-57 standard and while it's a good standard, it could be better. It's not a flexible standard, so if you have something new that comes in -- if the IMO comes up with a new requirement that we have to chart, it takes years for us to add it into the standard.

So, one example, the IMO came up with archipelagic ceilings and it took the IHO probably about 7 years to amend the standard for hydrographic offices that had to depict an archipelagic ceiling into their ENC. Whereas the IHO then realized because S-57, due to its nature and not being very flexible, introduced sort of the S-100 universal hydrographic model, and what it does is it leverages the isogeographic information standards but more in tune to hydrographic modeling versus sort of land-based modeling.

That's one of the big differences between GIS standards, is they're more tuned to being on the land whereas depicting depths is a little bit more complicated. You know, they don't know how to handle those negative values. But what it does, it introduces a flexible catalog structure so we can make changes. So if the IMO comes up with a new requirement or if somebody else comes up with -- or if there's something wrong with it, we can actually update the catalog, send it out to the ships, the ships can update their catalog easily, and then the data producers can update. So you cut that time of 5 to 7 years of making a change into a 1-year time period.

And so then the next step is S-101, which is what represents sort of the major step forward in product specifications for ENCs, and that's where I'm talking about we have this dynamic content. We have sort of these exchangeable and machine-readable catalogs. Right now the portrayal side of things is not very machine-readable, so you have all the ECDIS manufacturers hard-coding everything in, so, you know, it makes for hard changes.

And then you get for real-time title information, which is what mariners want, you get interoperability with other product specifications like sailing directions and high resolution bathymetry. So in the future, an S-100 enabled ECDIS will have -- become more of a true GIS versus just a navigation system, although we do say that the front of ship ECDIS should really only contain the navigational information and this true S-100-enabled ECDIS is really for voyage planning and back bridge operation, because if you put all this information in front of the navigator they're going to actually lose the navigation picture.

Thank you very much for your time.

DR. CHEUNG: Thank you, Ms. Powell.

Mr. Pete Noy is representing the Coast Guard's Geospatial Management Office and today he is being assisted by Lieutenant Rodney Martinez. Mr. Noy, can you start your presentation?

MR. NOY: Yes. On behalf of Lieutenant Martinez and myself, thank you for the opportunity to present.

Coast Guard GIS has been in operation for about 7 years now. It started as a small project to support a very specialized group of users, and then the visualization of data started to spread across the department when users started seeing how the technology could be applied for maritime domain awareness and to understand what was going on in the environment. This gives you pretty much the mission set the Coast Guard supports and GIS has its hooks into each one of those environments.

The current challenges we face right now as an agency, one, ease of use -- you know, users want something that's either one button or extremely intuitive as opposed to being more complex; adapting to the new technology; data accuracy, which is a strong issue across a lot of the programs; identification of both authoritative and trusted data sources; and working within DHS and DOD IT requirements that are put on us.

The Enterprise GIS right now is a data warehouse for the

Coast Guard. It's a one-stop shop where a lot of data goes for storage and then accessed by a number of GIS's throughout the department. It alleviates the need for local storage and it's accessible to all users within the unclass environment.

Part of the bases are national data coverage. We use what's known as HSIP. That's the Homeland Security infrastructure Protection dataset that was developed after 9/11 and it's a conglomeration of various datasets that support the homeland defense/homeland security mission. For the Coast Guard, we kind of approach it as a pyramid of capability where at the bottom of the pyramid that's your basic use requirements -- I want to see your point, I want to see data -- up to the very tip of the point where you have not as many users, but they have very high-end geospatial analytic requirements.

Our Enterprise GIS is built off of a COTS solution. It's called ArcGIS Explorer for Desktop. We had that tested by our TISCOM. We have that deployed on our standard image, but what the software allows us to do is to add functionality. We were able to extend Coast Guard specific requirements to be met by the application. For example, out-of-the-box functionality gives you a view of either a 2D or 3D representation.

A lot of our area of responsibility crosses the International Date Line, so we needed to be able to view that data without having the data run into issues with that type of display. We're also consuming authoritative sources. We're consuming the

DHS Microsoft Bing Catalog. It's a protected source of data that gives us access to base maps and to some high-resolution imagery for pretty much most of our AOR.

I do take advantage or we as an agency take advantage of my colleague's great work in the RNC datasets. We have that available as a seamless edge mashed solution for consumption by a number of users. We are in the process of converting our RNC web services to an ENC service so it gives us a more streamlined look. In the past users would have to basically take data and load a DVD, find out that they were not in the right area, reload a DVD, try to find that information. We've taken that and basically created a seamless edge mashed service, so as they pan and zoom the data is provided and it's updated on a quarterly basis. And key on this is it's not for navigation, it's for visualization.
We also take advantage of the Army Corps IENC to cover the inland rivers since that's one area that they have responsibility on.

The Coast Guard has developed a number of capabilities that leverage the out-of-the-box functionality and extends its capability to the desktop user. One is we have a layer catalog that allows users to search by type of data or search the metadata and the data will be presented, so they don't have to know the path, they just know what type of data it is.

We also have the ability to generate reports. We can draw a geographic shape. It goes to the systems of record and pulls that data out. You know, it could be for a specific sector or within a date range or within a type of activity. We also added the ability to connect to external data sources. What we found working with our users is that our catalog has a lot of data, but users at the desk have tons more data in spreadsheets, in Access, in Word documents, things that are not in the Enterprise solution, so we built a wizard that steps the user through how to make that connection to that data.

In addition, we connect to other systems that needed a geospatial capability. This is an application called CART. It's the Common Assessment Reporting Tool. And the purpose of that is to -- during an event, either a natural disaster or a manmade event, to identify issues in a port and then get that port open in a timely fashion, so we're able to track what are called essential elements of information and look at the status of if it's available, partially available or not available and then just display that in the Sector Command Center so they can see in real-time as the port is reopened.

We also have direct access feeds to Coast Guard's National or Nationwide Automatic Identification System. We take the AIS feeds and we mash it to other Coast Guard authoritative data sources like MISLE and, you know, do a web scrape to get imagery of the vessel so that we're able to look at the vessel and then draw through, look at data pertaining to that vessel.

That also includes a lot of the inland rivers that has a lot of information and, you know, it gives the operator the ability to pull up a vessel and look at the picture and say this is not the one I want. It also allows us to tie into what's our case management system called MISLE. It's the Marine Information for Safety and Law Enforcement. So I can look at a vessel, click on it and then determine when it was last boarded, were there any safety violations, is there any, you know, captain of the port actions on that vessel, look at the manifest, draw through that data.

We've also implemented a satellite-based AIS to provide coverage outside the terrestrial-based AIS capability, so we have worldwide capability on satellite AIS. It's not near real-time. It's updated at about a 90-minute cycle between position reports.

The power of AIS is not -- well, one part is in the current tactical view, but what's important to the investigator is looking at the historic actions of that vessel. This is a slide of the Cosco Busan allision event in San Francisco. We were able to go back and play a history of it coming out of the port and alliding with the Golden Gate Bridge. That gives the operator the ability to see what time window he needs to work with, and then from a legal perspective he can go make that request for the authoritative legal data from the NAIS system that has that same data stored in a forensically secure legal archive.

We're also able to go and play back a vessel voyage. We can pick two vessels, watch them interact. We can look at a day of a port and play all the histories of the vessel. This is an example of what we call an area transet or transit. A lot of times our command centers will get a report of an oil sheen and, you know, they know on their last patrol there was no oil seen, so they draw a geographic boundary and AIS will basically print out a report of all the vessels that transitted that area in that time window, and then it allows the investigators to kind of go, you know, interview, take oil samples, do whatever they have to do with the identified vessels that transitted that area.

Another part of the GIS requirement from our users is the ability to consume externally held data. In the past unless it was in GIS you didn't see it. It wasn't consumed unless we had to go through and build that functionality. Using a COTT solution it gives us the ability to consume data that follows an OGC compliance standard, so if it's in a GORSS, KML, web mapping service we basically just point to that service and then consume it in real time. This is an example of the NORTHCOM sage feed displaying helo tracks for Coast Guard air assets being consumed from NORTHCOM directly.

And, again, this is another example of a feed where we're basically listing all the facilities that the Coast Guard is tracking and then we basically tie to a NOAA storm track that kind of shows the storm event that's coming in and that gives our captain of the ports and the sector commands the ability to basically get prepared for the event.

At the top of the pyramid, again, is the desktop solution. We do have one solution that is built off of that. It's very customized. It's called SAROPS. That's the Search and Rescue Optimal Planning System, built on Arc Editor Version 93. We're going through a major rewrite now. It needed to be built off of that because it has some high-end modeling and also it uses Monte Carlo simulation to basically take the position of either the vessel or the person, and then it pulls in environmental data and then runs a drift model to calculate where that person or boat should be and lets us design the search patterns to send our assets out.

This is an example of the EDS. It's our Environmental Data Services that basically captures and holds environmental tide and wind data. So if we get a report of a vessel that's been missing, you know, and it was supposed to be in port two days ago we can go back in time and play where its last known position was and then build the model out to show where it should have drifted given winds and tides, and it gives us a pretty simple heat map that shows based on the patterns of weather here's the likelihood of where that vessel or that person would have drifted, and then we just basically design the most logical search pattern based on the asset, if it's a vessel or if it's a helo or an aircraft, and then send that out.

The data then can also be shared with another system called AMVER. It's a voluntary system where we transmit information to vessels that are within the SAR area to basically be on the lookout. It's kind of adding eyes on scene to the commercial partners who partner with us, that we give them what's called a SURPIC and they're able to kind of report back if they see anything or, in some instances, actually perform the rescue themselves.

We are in the midst of a major migration from what's a desktop client to a web-enabled environment. This is a shot that shows kind of the current environment that we are working in, very stove-piped or what I like to call tubes of excellence. You know, each system does a really good job, but, you know, what we have to constantly do is what our captain has called the swivel chair interface, I need to pull up something in one system, look at the next system and then try to cognitively mesh the data together. We need to get out of that pattern because it's just taking too much time, too much effort, to kind of get that common picture.

So what we are proposing is a system that we're calling CG-1 View. Basically the back ends will maintain their centers of excellence on SAR modeling or environmental modeling, you know, in AIS vessel tracking, but they will funnel the data to a common front end viewer so that the buttons mean the same thing to a person in the command center to a person in the Waterways Control Office to a person at a small boat station. You know, it reduces the training overhead and we know that all the data that can be presented is being presented in one display.

This is just a shot that shows pretty much the various efforts that we're looking at. We realize that there's going to be an architectural and governance framework that needs to be established to make sure that, you know, as new requirements come in, as new data sources come in, they get vetted and moved into the CG-1 view. The middle diagram basically shows the current systems that are slated for roll into the CG-1 view environment, Enterprise GIS, SAROPS, and then in the future other existing systems like Watchkeeper and what have you.

And then the bottom shows those systems that don't have a geospatial display, but we still want to have their data geospatially enabled for consumption by the display. A lot of these systems are capturing latitude/longitude, which is the Holy Grail of location for Coast Guard, so as long as they have a latitude and longitude and can document how it was captured via, you know, some stringent metadata standards we'll be able to consume that and then push that out to the standard viewer.

We've already stood up a -- it's kind of a prototype, but it's in a production environment now. We took the same functionality that was in a number of different systems and are starting to push it into the Silverlight environment. The prior environment, you had to have a desktop client installed. This one you just have to have access to the Internet, CG-1, Coast Guard's Internet environment, and then you have access to the full suite.

This shows the table of contents that we ported over. We are able to consume that type of data, same type of imagery, pretty easy drop-down menus for a user to change, you know, I want to see the imagery, I want to see nautical charts, I want to see whatever. The resolution being handled from an external service kind of takes us out of the business of having to manage that large dataset, and it's a DHS-wide asset and we all basically are looking at the same set of information. The data is all co-registered together, so we have, you know, the Bing base maps. We're able to display existing facility data from MISLE, and then if it provides us that link I can click on that link and drill back to the official system of record to get further information. And this is just the RNCs that we've displayed using that technology.

This is an example of another mash-up capability where we took VMS data, which is maintained by NOAA. It's for fisheries. And then we mash that to our MISLE data so we can prioritize which fishing vessels haven't been boarded to conduct our fisheries boardings in a more logical way. We're dealing with captains that said, you know, you boarded me last month, now you're boarding me again. This gives our underway cutters the ability to kind of, you know, see what's been boarded and then prioritize appropriately.

We're also taking infrastructure that the Coast Guard has deployed. This is called ISIS. It's our Infrastructure Status Information Service that reports the status of our DGPS Rescue 21 NAIS towers in a pretty standard red, yellow, green dot. You know, if it's red, there's a problem. If it's green, it's operational, and it will assess -- you know, turn eyes to get that asset operational again.

We also do leverage the DHS ELA for the ArcGIS desktop suite. There is a very small dedicated group within the Coast Guard that need the higher-end cartographic and modeling capabilities that don't make sense for us to build in an Enterprise solution, so we let them leverage the desktop solution. They can still consume authoritative sources, but then they can kind of take that and push the data a little bit more to do some more high-end analysis.

For example, this is looking at water temperature and chlorophyll distribution to show where the fish are biting so that the captain of a cutter can basically say okay, we know fisheries are going to be in this location, let's look at that area. And this is just looking at the -- you know, identifying what those constraints are and allowing us to target those areas. It also gives us the ability to work with our local partners, take their data, consume it, mash it with Coast Guard data for our Maritime Security Committee's efforts and communications. You know, I'm a geographer by trade, so, you know, you can say the document -- you know, if it's on a map you've got me there, and that pretty much sums everything up.

DR. CHEUNG: Thank you, Mr. Noy. Dr. James Dobbins is a Research Associate Professor of Civil and Environmental Engineering at Vanderbilt University. Professor Dobbins, would you please begin your presentation?

DR. DOBBINS: Hello, Madam Chairman, members of the Board and technical panelists and Dr. Cheung. Thank you for the opportunity to present my research in this forum. I'd also like to thank my research sponsors. This work was funded by the Intermodal Freight Transportation Institute at the University of Memphis with matching support from the Ingram Barge Company.

For the purposes of my research, marine casualties were limited to allisions, collisions and groundings. Allisions, for those of you that might not be familiar with that term, represent instances where a moving object hits a fixed object. It's kind of a maritime unique term.

The research was performed in two phases. The first phase was to identify the most hazardous sections of the U.S. inland waterway network. By doing that, we'd be able to assess the quality and limitations of the relevant datasets. Secondly, and this work was just completed this summer. We wanted to determine the effect of weather, which includes river gauge, wind speed and visibility on inland casualties.

The technologies we used, the GIS did our cluster analysis and the spatial joins, things like figuring out the nearest weather station to a casualty, which river and mile marker each casualty was located at. We also used database management systems. We used Oracle to manage and relay our historical casualty data with the data warehouse of weather observations. And, finally, we used data visualization and analytics tools to discover trends in our data, to perform ad hoc drill down into the detailed data, the detailed raw data, as well as to animate the events over time.

Internet GIS, several people have mentioned it, which I think is great. Internet GIS has come a long way from when we first started working with it in the late '90s, but it's where you're providing GIS functionality through an Internet browser. Several advantages, centralized. You don't have data floating around on different desktops in different states. It's easy to use. You don't need GIS training.

The screenshot to the right actually shows the Silverlight viewer. We're looking at -- it may be a bit of an eye test for people in the back, but we're looking at the Illinois River and allisions, and it's showing the clusters of allisions on that waterway, so when you continue to zoom down you'll eventually be able to see the individual allisions. You can turn on and off layers. You can filter, query the data, extract the data. You can edit the data. It's a very powerful tool these days.

The third function, I've got an example of this on the next slide, is report management. So what I've got here -- I know this is a marine forum, but I put together a rail accident database. This came straight from FRA. We're looking at the city of Chicago with rail lines and the yards. Each one of those points, if you click on it, you get the standard information you'd expect from an accident, you know, when it happened, what kind of accident it was, but you have that link, and when you click that it brings you to the accident report, so you can scroll down and see the narrative of what happened, all kinds of details.

The point here is, you know, it doesn't have to be just the accident report. It could be images captured from the investigation. It could be investigation notes. It could be video, interviews, anything. This is the way a lot of GIS people thing, is geographically, and, you know, I think this is an effective way to kind of manage your accident reports. And so when future accidents happen you can kind of go back and see if anything similar, you know, has happened in the past.

The data we use came from the Coast Guard. The Coast Guard since 1981 has used three different reporting systems. We took those three datasets, merged them into a common data structure of relevant attributes, date and time, the type of casualty, property damage and the latitude and longitude. There are other attributes that we retained, but we did not use them for these two phases of the research. These include the vessels that were involved, the types of vessels, the number of fatalities, injuries, and other contributing factors. I'd like to point out some of these, especially in the older datasets' contributing factors, you know, weren't -- there were several null values and things like that, and that's one of the reasons we left those out.

This slide here shows a visualization of the marine casualties by year and by type of casualty. You know, besides the grounding spikes, you know, that occur in drought years, the uptake in allisions after 1992 is very noticeable. In 1992, that was the year of the Sunset Limited where a barge allided with a rail bridge pier causing the derailment of an Amtrak train and several deaths. So after that the reporting requirements changed and that kind of explains that uptake.

This next slide is -- it's the same -- we're looking at the same dataset. It's another visualization. We're looking at property damage by year and by accident type. You'll probably notice -- I don't expect anyone to see this. I can barely see the 2002 from where I'm sitting. But you'll see that spike in 2002 of allisions, so with these analytics tools, if we click on that blue bar to isolate it, we can see that, you know, the number of allisions, that there were over a $105 million worth of property damage in 2002. We click on the data icon and we can bring up every allision that occurred or that was reported in 2002. After we sort by the property damage field we can see it was a $77 million property damage allision which happened to be the I-40 bridge collapse over the Arkansas River. And there's a number of ways to slice and dice through this data. It's almost unlimited.

The methodology that we used, the data contained more than 51,000 allisions, collisions and groundings. The screenshot on the upper right kind of shows where these map -- where we initially mapped the entire dataset. We then identified national waterway network links. That's a product of -- it's actually the NTAD from BTS that was mentioned in one of yesterday's panels. We identified the inland waterway network links and found all the casualties within three miles of those links. The inland casualties accounted for about 54%, and so for each casualty we figured out what the nearest mile marker and river was, and it was pretty simple to come up with the counts, you know, of the type of casualty and where those are occurring.

The screenshot on the lower right is around the New Orleans area and the precision, especially of the older data, wasn't what we'd like for the coordinates, so to kind of capture some of this error in the coordinates we applied a one mil square grid, and in each grid, if you click on those, it will tell you the number of allisions, number of collisions, groundings. You can drill down into the data that way.

I've got another example here. This is showing the Illinois River at mile marker 151. This is a vector representation. The red dots are the allisions, which are most numerous in this area. You can see some of those appear to occur on land. Those are, you know, maybe in previous datasets when the coordinates were manually typed in. The green dots are groundings and the yellow dots are collisions.

So when you apply the one-mile square grid and apply color scheme based on the number of allisions your attention is immediately drawn to mile marker 151. When we zoom in there and take out -- and we switch in an aerial photo you can see exactly where those allisions are occurring on the bridge and see that in close detail. That's pretty high resolution.

We can swap out that base layer and turn on the inland electronic navigation charts. So now we're seeing what the towboat pilot is going to see while they're navigating this span of river. When they click on that bridge they'll get that image that comes up that tells the span, the horizontal and vertical clearances and so forth. Some of the other sections of the inland waterways, they'll have an actual picture of the bridge. So we think it's important to be able to kind of see what the pilot sees.

Some of the issues that we saw with the data, I've kind of mentioned some of the coordinate typos in the older datasets, the casualty data. We wanted to get down to the bridge pier or a lock wall level to see which ones expressed or presented an extraordinary hazard. The MISLE dataset, the geographic quality is a lot better, as you can see from that bridge image.

Also, the property value or the property damage, there was a number of null values in there. We didn't know if those were, you know, unknown or zero damage, so that kind of, you know, affected the quality of our results. Secondly, the lack of detailed trip data or exposure data. This is maintained by the U.S. Coast Guard. We obviously wanted trip data to be able to calculate allisions per million vessel trips, groundings per million trips and so forth.

The Coast Guard aggregates all their trips and drafts data to protect confidentiality of the carriers on the inland waterways, so instead of reporting the number of trips maybe on a ten mile section they might report them for the entire river, and for that reason we weren't able to really come up with a true, you know, rate calculation type hotspot.

You're probably wondering what these hotspots are by now. We came up -- for each casualty type we came up with ten -- the top ten locations. We validated these with river industry personnel. They were largely confirmed and largely well known within the industry.

Just generally, the Illinois River bridges, there's a large number of allisions that occur on that waterway. There's some pretty narrow openings. We were even told some -- you know, in some places it's almost common operating procedure to do a little bump off the bridge as you're navigating up the river.
A high number of collisions occurred down on the lower Mississippi River near the southwest pass, the entrance to the Gulf of Mexico, and Memphis and St. Louis were high grounding locations.

If you asked me the most hazardous or where the most frequent casualties occur I'd have to say the intersection of the Intercoastal Waterway west with the Houston ship channel in Galveston, and you've got a lot of things going on. You've got blue water interacting with brown water traffic. You've got a ship channel that's constantly being dredged, and you've also got a bridge just west of Galveston that has a number of allisions. And that's what that screenshot to the right shows, some of the --

again, some of the clustering because there's so many casualties that have occurred there, but you can kind of see the vessel approaches, the anchorages and so forth.

So for the second phase of the research we were looking at the effect of weather. Again, some of the older Coast Guard casualty datasets did have weather attributes. However, they weren't consistently populated. So we went to NOAA and we've used their integrated surface hourly dataset product and we downloaded -- there's more than 29,000 stations worldwide and we were looking -- for each one of these stations we went with hourly observations back to 1981.

And what we're trying to tease out here or trying to figure out from this data is we want to add wind speed and visibility to our casualty dataset. The way we did was we knew the date of our casualty. We knew the nearest weather station. So we take that date and time from the casualty. We take the weather station ID and then we dive into the data warehouse to figure out at that hour exactly what the wind speed and visibility was.

Similarly, we did the same methodology for the river gauge data. However, this dataset is very different. We had to combine gauge readings from the USGS and from the Corps of Engineers. You can see on the map the green represents the Corps gauges and the purple are the USGS gauges. What's very noticeable is the lack of a large number of gauges on the Ohio River. There are gauges there, but they just don't have the historical archive that we needed.

Another shortcoming was the flood level categories. They're available for some gauges, and by this I mean normal operating level, severe flood, extreme flood. We really wanted to use those kind of categories, but they're not available across the board, so we did notice that the gauge readings were normally distributed and we ended up using percentiles instead of flood categories.

So the results of this, the wind speed data, I think, deserves another pass because we found some order of magnitude and some unit conversion problems, so we kind of just passed on the wind speed. This was surprising to me, the restricted visibility doesn't appear to be a factor in inland casualties. I was expecting this to be a big factor.

Some theories that we've been discussing are that the industry's very conscientious about pulling over and tying up to a bank, wait until the visibility lifts or until the visibility improves. Secondly, the technology these days is better, the electronic navigation charts. And, thirdly, this is kind of the common sense observation that kind of escape me when I was first doing this, was you seldom have much more than a mile of visibility on the rivers just due to the geometry, the bends, you know, and so forth.

Some of the temporal kind of visualizations which we came up with were that groundings occur primarily between 11 p.m. and 5 in the morning. Allisions occur primarily during business hours, and this is just kind of the result of all these casualties just kind of slicing over the time of day.

Allision and groundings, we've known for a while that they're correlated with the seasons, so in the spring during the thaw and melt-off when you have a lot more water running you have a lot more allisions, and then when the water levels drop the groundings go up.

There is a very strong relationship between allisions and river gauge levels, and the way to read that table on the bottom is for allisions -- in the far right column, 23% of all our allisions occurred at or beyond the 90th percentile river gauge level. So you're looking at 42% of the allisions occurring at the top 20th percentile, so that was a pretty strong relationship. There weren't near as many collisions as there were allisions and groundings in the database. And, of course, groundings at the lowest levels, we expected that to happen. When the water goes out it's much easier to hit bottom.

So some of the future research that we've talked about is using the results of this to kind of closely examine maybe a corridor and specific hotspots to see what's contributing to those casualties. The use of AIS data, which has been mentioned during this panel, we've done a lot of work with that, just kind of archiving and how you can reconstruct trips and so forth, but you can also combine that with some of the lockage data that's put out by the Corps of Engineers and generate more precise trip data, so you might be able to get more information about how many barges are associated with each vessel and so forth.

Using AIS to detect near miss events is a little bit more of a challenge in the inland water industry because you don't -- they don't typically populate the size of the tow and the size of the tow -- that number of barges is what I'm referring to. That will change based on the trip. I think there might be a way to model it, you know, and kind of figure where the tow was, you know, so you don't have to look for when the -- you know, the AIS transponder's on the pilot house. You don't have to look where the pilots may have high-fived, you know, passing through the river.

Finally, in other future research would be -- and this is actually a currently research which we talked about yesterday, is to correlate the AIS data with the black box data or the voyage data recorders. They record engine RPM and rudder angle to detect difficult maneuvering areas. If you have a large enough fleet where you can take each vessel's AIS track and then relate that to the engine log data you might be able to detect the areas where maybe they went from 500 rpms ahead to 200 rpms or maybe 500 rpms at stern to kind of detect those inextremist situations.

And, finally, the conclusions. I think -- we believe and I think we've shown that the combination of GIS database management systems and data visualization tools is very powerful. It's difficult to do this kind of work and get these kind of results if you don't, you know, use more than one of those. GIS has traditionally been a little bit weaker at handling large datasets, so, again, the big data topic comes up, and using, you know, database management systems like Oracle or Sequel Server, those type of things, are necessary.

And, also, GIS performs the spatial linkage that's critical to make that linkage between seemingly unrelated datasets, so it's possible to reconstruct events, you know, using this external data. You can also add to the attributes of your dataset. And, as was mentioned, you do need to understand, you know, the data that you're using and its limitations.

And, finally, we think Internet GIS -- we're thinking about this point from the NTSB's perspective, is that the Internet GIS can be very effective as a casualty data maintenance and repository platform. So thank you for your time.

DR. CHEUNG: Thank you, Professor Dobbins. Mr. Richard Ford is the Technical Officer for the U.K. Marine Accident Investigation Branch. Mr. Ford, please begin your presentation.

MR. FORD: Chairman and the Board, I'd like to thank you for inviting me to present today. As Dr. Cheung said, I'm from the Marine Accident Investigation Branch. We are the U.K. government organization which is responsible for covering and investigating all types of marine accidents in the U.K. which is all U.K. ships in territory waters. A lot of people think that we're the bad guys. We're not. We're there to improve safety and we can never apportion blame. We're looking to help mariners in accidents.

Just to give you an idea of SCOW (ph.) we have four groups of three inspectors. All the inspectors are ex-mariners. They are either ex-captains or chief engineers or naval architects and they backup today's teams. There's two technical officers, me and a technical manager, so we go out and recover the technical evidence. As part of the technical team, my role is to recover, preserve, analyze and present that data to the investigators. And recovering can be anything from locating a sunken ship to recovering USB drive from a black box, a voyage data recorder.

It's intrinsically crucial that we keep that forensically sound because we have the primacy over this evidence over any other investigating authority at the moment, so we get the primary evidence and we have to maintain that, so we use things like this hard drive -- tool in the top right-hand corner to ensure that the primary evidence is forensically sound and we can pass that downstream to other investigators.

The analysis side is the bit that takes the longest. That's where we're digging into the real nitty-gritty of the data trying to see what's there, what we're -- we're trying to find the bits of information that are pertinent to the accident and converting that into a way that we can understand and present.

The presentation is where we spent a lot of time building our -- tools, and that image there is of the Marine Accident Data Analysis Suite or MADAS. I'm coming to that in a minute. But it enables us to present information in a familiar way to a mariner.

The sources of data that we're looking at I think have all been covered by the panels so far. AIS is brilliant from our point of view because we can go and get this data before we go out and interview people in the field. We can recreate routes and see which vessels were involved and get a good idea of what's going on and show this to the crew and witnesses in the interview process. It's a massively important tool for us.

And we've got two main sources. We have the Coast Guard -- Marine and Coast Guard Agency, which we work closely with to get the very fine grain in ten seconds accuracy of the AIS, but we also use a website called Marine Traffic which is widely available and has stations all over the world where the Marine Coast Guard Agency are in the U.K. water. And marine traffic, we've got stuff for China and it's a very useful tool to us and we've built scripts that can pull data out of that and analyze separately.

Those images on the right there, the top one is a -- voyage data recorder capsule. That's part of the system of a voyage data recorder or a black box. These area designed to withstand massive pressures and temperatures, so if we do lose a vessel this will be what we're going to look for to get the data back.

Ms. Powell covered ECDIS in some detail, but we love these things. They're great. They have voyage replay facilities in them, so if we go onboard we get another source of data other than the voyage data recorder to see what the navigator was seeing at the time of the accident and what scale he was seeing charts, what information was being displayed to him and what alarms were being sounded, and that's something that the voyage data recorder doesn't currently have in it. We're currently working with the IMO to get this information recorded into the voyage data recorder because it's a massive source of information.

And the other scale of the industry, you're talking about small fishing vessels. You see these GPS units. These have tracks, waypoints and routes that we can then recreate where their whereabouts was, so you've got the two ends of the scale there.

So some of the tools we use, we've got two GIS platforms, desktop platforms. We're not interested in Enterprise solutions at the moment, but Global Mapper is a very cheap and very user friendly facility that we've provided to all our inspectors, so we can create GIS packages which have all charts and AIS and GPS positioning on it and we can send that out to anybody in the field and they can on their desktop what's happened to all the evidence we gathered so far, so it's a very real-time analysis.

RGIS 9.2 is what we've built our marine accident data suite on, analysis suite on, but we also use it for in-depth analysis on top of that, so we're looking at the -- and things like that which is what ArcGIS is great at doing.

That's the analysis side, but getting the data out, the nitty-gritty I was talking about, we've got tools like FTK which is very useful for analyzing massive email databases, so if you've got a PC on the bridge of a ship that's talking about emailing back to office and getting permission to do things, it's very hard to find those data cracking passwords. FTK is great for doing that for us. It's a one-stop shop for all email problems.

If we have data being overwritten by VDR or other electronic evidence we quite often are looking at data carvings and that image with what looks like code is Hexadecimal so we can data carve individual files out of hard drives and recreate those files to replay at another time. And what we found is this is a freeway. It was designed for recovering images. It does this incredibly well. It's called Photo Wreck and we've used it a number of times because it things that no other software does. It's looking at hard drives and file systems that aren't mountable within Windows or Unix. It's very configurable and we particularly like that.

So some of the issues we face, there's a number out there. So the VDR not functioning, expectedly is quite common unfortunately, so if we've got no audio being recorded, no configuration file explaining the in-depth detail of the digital and analog feeds coming into this VDR is explained, so if we don't know what a sentence is recorded we need to have a configuration for it to explain to us. And this has resulted in us going out and doing sea trials to determine what controls are outputting to be recorded into the voyage data recorder.

The ship being out of AIS range is an interesting one because outside of base stations on the coast is one thing, but then you've got witness vessels that are around picking up the AIS and recording them to their own VDR, so it's an interesting one, how do you get that information out of another witness vessel.

Data missing is, unfortunately, becoming a bigger problem as well. This year we found our first case of crew turning VDRs off after an event or trying to manipulate data to hide accidents from us, and there's not much we can do that at the moment. These VDRs do have a switch. You can turn them off. We've had people throwing hard drives over the side of the ship. It's an issue that we're trying to deal with.

Okay. So this is a more practical demonstration of how we use desktop GIS. This is the simplest case. Basically we've got a fishing vessel that's grounded on some rocks in Scotland. Unfortunately, some of us weren't willing to go onboard the vessel to recover any electronic evidence for us and do a health and safety assessment, and we weren't going to go onboard their either because it was a dangerous environment, so instantly there's no AIS on this vessel, so we've got nothing. We contacted our colleagues at the Fishery and Protection Agency and they had VMS data, which I think the Coast Guard talked about earlier.

So you can see those three red dots. There's one on the port, one out in the channel and one on the island. So we know where they were, where they ended up and basically where they were trying to get there, so we were able to recreate their track talking with the skipper of the vessel and he agreed with this, and then we managed to see what was he trying to do, and that's the dotted line going beneath the island. This is -- it tells a story. If you're trying to put lots of numbers into a report it's very hard to understand, but as soon as put a naval chart up there mariners love that. They can see what's going on instantly.

This example is a bit more in-depth. This is a grounding that happened in the northeast of England. We are looking at AIS tracks here. So the accident happened coming into the port, so you see the tracks are all coming in very narrow. The sailing directions for this port, so you have to make the turn three miles out so it gives you enough time to stand to orders and change into maneuvering mode to have enough time to manage all this.

But we looked at the trends for this vessel entering and they always come in very narrow, very tight to the entrance to the port. The scale there is one nautical mile, so they're always within a mile. Three miles is off the chart. So I pulled out a massive selection of AIS. I think it was two months' worth of tracks for this vessel. I used the MAT-6 to show you the date of the track so it's not just one massive information coming in.

I used the definition period to remove anything that was going out or past the port, so we had a lot of tracks which were going just straight past and the ones that were coming out which weren't of interest to us. And we're using the -- functionality to simplify the complex. It makes it easier for the mariner to understand what's going on here. This is the power of GIS. We really like this kind of representation of what happened in the real world.

Okay. The marine accident data analysis Suite is a tool we've built in conjunction with funding from the NTSB. It's quite unique in the way that it represents data. So say we had a collision between two vessels and we would have to -- the comparative analysis of that would be quite complex because you'd have the -- two voyage data recorders and we're playing them at the same time and the same screens. It's almost impossible. You can't listen to both channels. You can't watch both radar screens. So we've got an issue that we had to solve, and we wrote a white paper for the IMA to ensure that all voyage data recorders are able to output their rule format.

And a lot of these things are recording in a complex compression so they can get the amount of data stored into their capsules and find the recording mediums. That isn't easy for us to interpret, so we had to ensure that they had an output that was commonly understood like text files, MP3s and jpegs for understanding the radar. So we take that output and we plug that into our Marine Accident Data Analysis Suite with Ship Shapes which is to scale. There's no VDR -- I mean it does this kind of backdrop with naval charts and scale vessels.

So in this example here we're in Aberdeen. There's no animation. There's no simulation. We're looking at real points of ships moving from the GPS position. So this example is very poor of a GPS signal and the ship will jump through the temporal movements, so as time goes on it doesn't move and then it will jump a bit. And that's important to the investigation because if you're smoothing out that line you might be missing the crucial point of why did it go this way, what happened here, and it's using your own brain to understand what's going on there, and you can bring in as many ships as you like, as many backgrounds as you like. It's incredibly user definable. We can set it up in a number of ways.

This is quite an old scenario and what I'll do here is show you a more up-to-date version. It's probably quite hard for you guys to see at the back there, but on the left-hand side we've got two rudder controls, and every now and again you'll get a voyage data recorder that isn't showing the correct values for rudders and variable pitch propellers, and a lot of digital analog information isn't being displayed in the way we want to see it.

So these controls, the actual bars moving up and down and pins moving on the screen, are definable by us. We can set the scales that they are working to and that's crucial because we know what we want to see and we know the way that we need to display that.

In the middle on the left-hand side you'll see a yellow box with a red line in it. That's a trend graph, so if we're looking at a year's worth of data that some of these voyage data recorders can restore we can zoom into an event. We can see large crucial changes in heading or maybe speed, and we can zoom in on that and play that point in time and see what the vessel was doing in relation to other things around it.

On the top next to the rudders we have an ECDIS display, so we've taken a download from the ECDIS and we can play that in real-time so we can see what the navigator was seeing in relation to what we're seeing on our naval charts. They might have a different ENC or a different Arc system, so they're seeing a different background. So we've got the real-time play in ECDIS and the real-time play of the ship moving on our chart. And our chart looks a bit gray. That's because it's a radar overlay there.

You can just about make out the yellow target and another target to the left of it. This is the point of collision of two vessels coming into the Belfast Harbor. But having that radar display adds more context to the image. You can turn that off and the transparency is available to turn up and down.

So this is the latest version of MADAS and we're -- a lot of accident investigators all over the world are using this. It's a common language now. We've got the Canadians. We've got the Australians, the Germans, the Dutch. Lots of people are doing this and we have a very good user grid where we can get together and discuss the best ways of using it and it's an exciting topic of what's the best way of displaying information. Everybody's got a different take on what we can do with this, and so it's a very powerful tool.

Okay. This is a video of MADAS because we've looked at stills so far. This shows -- if you'd like to start the video? Thanks. This shows two vessels coming into Hacia, which is on the northwest of England. It's a quite small port. The yellow vessel didn't come in at the same time as the red vessel. This is adjusted. I've applied a temporal shift to the yellow vessel to make it appear that she came in at the same time because the maneuver that the red vessel does is very limited because there's a 35-knot wind coming from the west and she's lost one bow thruster. She usually had two bow thrusters which aids her maneuverability. The loss of that bow thruster was crucial to the accident.

At this point now she's colliding with the key and causing severe damage to her aft end. And you see the white berths to the right. There's two vessels there. One of them is the yellow vessel. That's where she ends up. And she T-bones them causing massive damage to the bows of both of them as well. So you can see what she should have done with the yellow vessel, seeing how she could have entered and made that maneuver in the deep water and come in, and you can see what actually happened. This is the comparative analysis I was talking about, and that would have been impossible using the voyage data recorders' type specific replay.

So each vessel, when I went onboard, they both had very different voyage data recorders and it was very different to get the accident information out of them, but to bring them together like this is unimaginably important. It gives you a lot more interesting information than looking at them independently.

Okay. I think that's my presentation.

DR. CHEUNG: Thank you, Mr. Ford. Mr. Stolzenberg, would you please start your question?

MR. STOLZENBERG: Good morning. Thank you all. This question will be for Dr. Dobbins, I believe, and maybe Mr. Noy could opine as well. During your presentation you analyzed allisions, the groundings and restricted visibilities, but you also mentioned there's areas for future research where spatial linkages might reveal trends to improve safety. My question would be is there currently a means to provide these attributes going forward that you might be looking for and, if not, how might they be received later either through investigations, Coast Guard or industry?

DR. DOBBINS: I assume you're talking about like being able to add those attributes maybe during the investigation or something like that rather than putting them on later like I did, is that right?

MR. STOLZENBERG: Correct. I think to the baseline map would be the term. The attributes, you could analyze them or trend them or find relations between say wind speed or horsepower of the vessels, number of crew members, any number of overlaid attributes.

DR. DOBBINS: Okay. One thing -- you know, I had to use kind of static shots today of the analytic software and it's as simple as dragging these attributes over. As far as getting those in real-time and being able to see them, there are -- the AIS message standard will account for, you know, current vectors and we've done some of that work where we put an acoustic Doppler sensor below a lock wall and we basically wrote some code to get that message broadcast to pilots that were approaching the lock and dam, and, of course, outdraft is a big issue on the inland waterways. So that's -- is that answering your question as far as, you know, getting that real-time information out there and modeling it in one environment?

MR. STOLZENBERG: Thinking more along the lines of the attributes that you might be able to trend later based off vessel length, number of barges, things that might be important I guess at the investigation level after the incident.

DR. DOBBINS: Right. I see where you're going now. You'll, again, have to do kind of a data fusion, you know, using different datasets, so something like from the Corps of Engineers that has the number of barges they had. The vessel database that we have, there's a number of them out there. There are some proprietary databases, too. We've used the publicly available one. It needs a lot of cleaning. You know, there's vessels in there that -- they're in there multiple times due to little typos with the names and so forth.

MR. NOY: From the Coast Guard's perspective, a lot of the data already we've identified exists in, you know, our systems or record, MISLE, NAIS, so it's a matter of providing that drill-through to those other systems. We are working currently with Army Corps in an initiative called FINDE, the Federal Initiative for Navigation Data Enhancement, and between, you know, Corps, Coast Guard, you know, the maritime community we're trying to identify common data standards, how we can interchange data normalization because the Corps may track some element one way, the Coast Guard has to track it differently, so we're trying to identify what those commonalities are and then make those links and then do those interconnections.

MR. STOLZENBERG: Thanks.

LT. MARTINEZ: Actually just to add a little to that -- I had to contribute somehow. You know, that really speaks to some of the conversations that we had in the earlier panel. You know, FENDA, it's a great forum for us to talk about data standards and moving forward with, you know, sharing data and information exchange, but it's a real challenge. It's really challenging, just its sheer complexity. I mean we're talking about maritime casualties here and that's one very small slice of the Coast Guard's interest.

And when we talk about data sharing and, you know, our efforts with Army Corps of Engineers, what we're talking about is, you know, significant -- I mean something really has to happen with regards to data exchange. Who creates those standards? Basically with KML and some of the different GIS standards that are coming out now, those -- the commercial -- it's the commercial world that's really been forcing those standards. And, you know, data sharing in general is a real challenge. It all has to boil down to Memorandums of Agreement and there's a lot of time and effort that has to go into place or has to take place before that can actually happen. That's where we have a significant challenge.

MR. BABCOCK: Good morning. Thanks for your presentations. I had a couple of questions, my first for Dr. Dobbins who has done some very interesting research. The question specifically goes to some of your future research which, I guess, as you mentioned, some of your current research now in regard to correlating some of these existing datasets with vessel real-time and specific information such as the engine RPM and the rudder angles. Most vessels in U.S. waters and certainly in inland waterways are not equipped with VDRs like we think of when we think of SOLAS class vessels. What kind of data sources are you using to provide that information?

DR. DOBBINS: Okay. I may have jumped the gun by talking about that research too soon. This is something we've been discussing like in the last couple of weeks, and it's -- I think it's a great idea because, you know, when you just map the casualties, you know, you may not be getting the whole picture. You're probably not getting the whole picture.

We know from talking to the pilots that areas like the bridge at Vicksburg, you know, at Cairo where the Ohio meets the Mississippi, that there's some really difficult areas to navigate, so we believe with some of the newer engines that we might be able to get a data log of at least, you know, the engine orders, and I think the rudder commands may also be available in a similar fashion.

MR. BABCOCK: Thank you. I have another question, I guess, perhaps for Mr. Ford. I know Ms. Powell alluded to the emergence of ECDIS as a navigational and situational awareness tool where you have a huge amount of information, obstructions and various other nav aids and navigational features, but also displaying AIS data from other vessels in the area. I know some of this data that's displayed is based on some of the static information that's input by the vessel's officers themselves such as GPS antenna locations and the breadth and the length of the ship, so, for instance, some of these could be in our -- some of them are easy to spot. For example, in a narrow waterway you'd see a vessel at 700 feet coming along at you at 6 knots, but driving over the land. Some may not be so obvious. So how can a mariner identify some of these issues and begin to manage them?

MR. FORD: How can a mariner identify issues like that? That's a good question. They would have to be looking out the window at approach, don't rely on looking at your AIS and ECDIS. There's too many systems on that bridge that are tying people in. ECDIS was there to improve navigation. It's not meant to take more time. It's meant to be quicker and faster than paper charts. You may be looking out the window more to improve situational awareness would stop that. If you're in inland waterway and it's around a bend, it's common sense if it's driving on the land.

DR. CHEUNG: Thank you. I actually have a bunch of questions coming in through our email. The first one, I think, is more or less a follow-up to Mr. Babcock's question and specifically for Ms. Powell. You expressed concerns about overwhelming navigation users with information overload. Couldn't a system such as the ECDIS allow people to choose options and turns things on and off?

MS. POWELL: Actually ECDIS currently is configured to turn things on and off. There's three different display categories. There's the base display, standard display and all. Base display is a very basic display, and that's actually not certified for navigation. And then there's the standard display which has the minimum what you need to navigate safely utilizing an ECDIS, and then all has everything.

And when I'm talking about additional data I'm talking about, you know, sailing information like large amounts of text information from the coast pilot which is traditionally a book. And now we're also talking about where NOAA has started a project with the National -- we have the National Weather Service to look at ocean forecasts and an overlay of the ocean forecast that comes out on a daily basis to overlay that onto your ECDIS.

So I think even right now all the information that's contained in an ENC, if you put it on all display you could have a pretty bad information overlay, and a lot of that has to do with the way the standards interoperate in terms of displaying things. Like I know if you look at an ENC and you turn on all the test, well, the text, if you're in a narrow channel, starts overriding each other and it overwrites the channel so you can't actually see the channel characteristics, so you have to turn text off.

So the ECDIS does provide functionally right now to turn things on and off, but what I'm talking about is when you start adding more and more data for that complete navigational picture which is more future speak.

DR. CHEUNG: Thank you. The second question from the public is for Mr. Noy and Lieutenant Martinez. Is the Coast Guard using GIS data capture to improve navigational safety? If so, then how is the end user such as the mariner actually involved?

LT. MARTINEZ: Well, we recognize data capture and use, especially with the public, is -- it's a significant challenge. It's going back to what I said before and what's been mentioned previously. The Coast Guard GIS program is seven years old, and the GIS capability has increased by ten times in seven years, and we're just recognizing that everything that we do is geospatially referenced.

So I would say regarding that particular question that we're working really hard on identifying how to manage and share data locally, so with respect to marinas, locations of specific nautical points on charts, hazards, all those different points and datasets come from various sources. Some of them are regulated. Some of them are from people are good Samaritans.

And right now, you know, we're trying to grasp how we manage and deploy that kind of data and bring it to the public, and then as well, you know, protect our own data and share it amongst our partners, so it's a very complicated challenge.

DR. CHEUNG: Thank you. Another question from the public and this one is for Dr. -- Professor Dobbins. It's actually very similar to my own personal question. Can you explain how the data that you talk about, the MISLE data and things like that, can be used to improve marine and navigational safety, and I can give you an example. You talk about the Arkansas -- milepost 15. What comes of it, you know, now that you've identified -- you know, that seems to have all kinds of allisions. What countermeasure is being put in place?

DR. DOBBINS: That's a great question and, you know, it's the whole point of the research. At first it was just a personal interest of mine to find these hotspots, but now that we've done the work what do you do next, and I think a logical way is to -- you know, kind of going past these casualties and looking at the near miss events and difficult maneuvering areas and maybe notify the pilots that they're approaching an area of, you know, high allisions.

Again, it was mentioned during the presentation that the pilots are aware of these. When we ticked off each one of the locations they're like yes, that's -- you know, these are all spots that they know about, but, you know, maybe having a little bit of a notification or something like that. We don't want to clutter up the display, of course, as we've mentioned, but some kind of notification that, you know, maybe could be even put out in real-time.

And if the data is recorded and, you know, distributed in a very quick fashion, I mean you could see something as like hey, there were four groundings on this spot last week. You know, it could get down to that level.

DR. CHEUNG: Thank you. Okay. I have a question for Ms. Powell. Yesterday USGS EROS talked about the use of terrain data analysis and put together the products and things like that. Is there any coordination that you see that actually would improve the navigational product? Particularly you were earlier referring to instead of critical changes from the mariner charts, but also coastal erosion due to storm and things like that. Do you see that the USGS product would be helpful?

MS. POWELL: I think that -- for the mariner, I think we -- the USGS for terrain, we use that for basically charting, you know, if there is a peak or not and what the height of the peak is, but that's more for a visual positioning. For shoreline, we actually do not get the information from the USGS. We actually have the National Geodetic Survey as part of NOAA, which is responsible for the official shoreline for the United States.

However, for coastal management, I think that when you put in a GIS and a database type system and you can put the navigational charts and then the USGS data and you get this amalgamation of different datasets that's where the strength comes in for coastal managers, but for our specific, we do get information from the USGS, but we don't directly import it all into our datasets because it's so specific and so geared to one thing. And we are fine with our data being used for other things, but what our office does is basically geared for navigational charts and navigational products.

DR. CHEUNG: Thank you. Chairman, we have no more questions.

CHAIRMAN HERSMAN: Thank you very much to the Technical Panel and to our marine experts. I think we all, as you all were making presentations, looked at some of the maps and some of the images and said we need to do some of that in our reports, and so thank you very much for what you've shared with us and I think given us a lot to think about. I think we investigate accidents as single events, and I think what we saw today, Mr. Dobbins in your presentation because we've been down on those shipping channels down in Texas, I think giving us a little bit more context of not just the single events that we investigate, but the near events, the events that we haven't participated in will help us give more context to what we do, so thank you for sharing that with us, very informative.

We will now take a break for lunch. We will reconvene at 1:30 p.m. Thank you.

(Whereupon, at 12:10 p.m., a lunch recess was taken.)

AFTERNOON SESSION

CHAIRMAN HERSMAN: If everyone could take their seats we're about to begin. Welcome back. We will now conclude our deliberations for the afternoon. We will proceed into the last two panels, panels number 7, Rail, Pipeline and Hazardous Material Safety. Dr. Cheung, will you please introduce our presenters?

DR. CHEUNG: Thank you, Chairman Hersman. In this panel I am assisted by Mr. John Vorderbrueggen of the Office of Rail, Pipeline and HazMat Safety and Dr. Robert Dodd of the Office of Research and Engineering. Ms. Raquel Hunt is a GIS Program Manager at the Federal Railroad Administration. Ms. Hunt, would you please start your presentation?

MS. HUNT: Thank you, Madam Chairman and the Board.

CHAIRMAN HERSMAN: Is that on? There we go.

MS. HUNT: Okay. Thank you. Thank you for having me here today. I feel very honored. Thank you, Ivan, for setting up this agenda.

I'm going to be talking about putting rail safety data on the map. I'm with the Federal Railroad Administration, also known as FRA.

CHAIRMAN HERSMAN: Ms. Hunt, if you can just point the microphone a little closer to your mouth that would be great.

MS. HUNT: Is that better?

CHAIRMAN HERSMAN: Even closer.

MS. HUNT: Is that better?

CHAIRMAN HERSMAN: That's better.

MS. HUNT: Okay. I'm just going to give a quick overview of the rail industry and FRA and how they interwork together. A little background kind of helps to understand why we collect GIS, the GIS program and some of the data and applications within FRA.

This is a map that just shows the mainline tracks within the United States. Currently there's around 139,000 miles of mainline tracks within the U.S. This is passenger rail overlaid on top of the mainline track. This is the Amtrak. This is about 21,000 miles of passenger rail within the U.S.

So the rail industry was deregulated in 1980 by the Staggers Act, and what that really did is open up for competition for the rail industry, and this is just a schematic that shows how the rail industry has merged over the years for the real major Class 1 railroads to date.

And how the railroads are defined, they're really classified into three classes, the Class 1's, 2's and 3's, and it's really based on the revenue that they bring in each other is how they're classified. So there's 7 Class 1 railroads, there's about 10 Class 2 railroads, and over 500 Class 3 railroads. And those Class 3 railroads are called short lines, and I think Reg touched on that yesterday. Those are the mom and pops, the very small, small companies out there.

These are just maps that show the Class 1 railroads, and really there's two main ones on the west coast, Union Pacific and Burlington Northern Santa Fe, two on the east coast, Norfolk Southern and CSXT. There's two significant Canadian companies, Canadian Pacific and Canadian National, and one in the Midwest that works in New Mexico which Kansas City Southern.

Now the FRA was founded in 1966 and we do regulate rail or regulate the safety on rail. We also have assistant programs and a very large R&D shop that look at safety and national transportation policy issues. And, of course, we're one of the agencies within the Department of Transportation.

Now the GIS program, if they know it or not, everyone at FRA touches GIS somehow or another. Maybe the administrator needs a map. Chief council is working on a rule that has to touch on latitude and longitude.

IT is a big component in supporting GIS. Currently the GIS program is in the policy and development shop, and the reason why safety has such a large circle is not only are they our main end user and we provide so many tools to them, but they have so much data that they collect that we geo-enable, and it's really important to keep the GIS centralized within the agency. We do have small pockets of GIS users here and there within the agency and giving tools to our inspectors, but centralizing and having one GIS is very, very important.

So I'm going to go into some of the data. I break these out into two categories, the primary layers and the secondary layers. And the primary layers is developed to maintain within FRA besides the freight stations. The network milepost great crossing Amtrak stations is developed and maintained within FRA. The freight stations is actually developed by Rail, Inc., but it's an essential part, key component, to the overall primary datasets.

The secondary layers are just examples of how we can take safety data or other layers and create new layers based on these primary layers. So, for example, accidents, quiet zones, bridges, these are information that we can create by taking safety data, and I like to use the word "manipulate" it or actually geo-enable it based on the primary layers.

So a little background on the FRA network. I just wanted to -- there's a lot of users of the FRA network and just having a little background of it. The FRA maintained two networks before 2005 to the work of Gary Baker in the -- Center. In 2005 he basically took the 1 to 2 million network and completed the attributes onto the 1 to 100K, so before 2005 FRA maintained two networks, the 1 to 2 million which came from the digital line graphs from USGS, and the 1 to 100K which came from the Tiger Lines from Census, and so after 2005 we retired the 1 to 2 million network and had the 1 to 100K.

And what I mean by being routable is that you can take data and origin destination matrix and flow data on top of the FRA network. So this is an example of the Waybill Sample, and this data is proprietary and it's actually owned by the Service

Transportation Board, but we use it in the Office of Policy to see how different commodities are being shipped on the rail lines, how different companies are shipping their commodities, so this is a very useful tool that we use within the Office of Policy.

So some of the spatial improvements that we have done to the FRA network, another program we have is called our Automated Track Inspection Program or ATIP Data, and what it does is we have several cars out there trying to look for exceptions. We don't really call them defects until we have an inspector go out and actually define that yes, it is a defect, so we call them exceptions. And to detect exceptions it has to take a reading over foot, latitude and longitude. And to the Office of Safety this is a byproduct. They really can't use it unless there's other information tied to it. When I found out we had this data I thought this was a huge goldmine for the GIS program.

So what we've done is we've taken the last six years of data, the foot-by-foot data, and used it to realign the FRA network. So in the map on the top left you can see there's the foot-by-foot data and over-aligning of the FRA network. You can see it's somewhat spatially off. You can see in the map below we've done the realignment and anything that was not in the FRA network, as you can tell as the turnout in the southern portion of the track, we actually built that into the network.

We have already processed Alabama, Massachusetts, Connecticut and Rhode Island. We're in the process of doing

Florida. Next on the queue is going to be Illinois, South Dakota, Wyoming, Kansas, Oklahoma and Texas. Texas and Illinois is going to be probably the most time intensive two states within the whole United States to do because there's so much rail there. After that we're going to do the states in blue and then we'll do the rest of the states. This is only going to be the track that the ATIP has traversed, so this is why we're going to take that data and spatially enhance and correct the FRA network.

Now to go into a couple other key points of the data which I thought we should actually identify some of the data disclaimers, limitations, improvements, and one of them is the milepost, and here, as you can see, I believe this is out of Kansas City, and this is BNSF, and you can see it's almost like a spider web. It starts at 0, goes 1, 2, 3, 4, 5, all the way out. Unless you have the railroad's uniquely linear referencing system, you're not going to be able to uniquely define or locate using just mileposts and the actual rail company information, and since there is over 500 companies out there, it's really hard to detect where these locations are at.

Now the mileposts are publicly available. We don't put it out for download. We do give it out when people understand the data discrepancies in some of the issues and we always say, especially for the 9-1-1 communities, if you're going to use this data you must check with the railroads and verify that this is the location and get their linear referencing system to uniquely identify that location.

Another key point is the grade crossings, and I'm not going to read through it, but I'm going to just highlight some of the key points. We do have a division devoted to grade crossings, and what they're doing is trying to reduce the number of any type of incidents that occur at grade crossings.

We do have a grade crossing inventory record. It keeps a record of every single grade crossing out there. Now if it's a public grade crossing, it is a requirement for the state DOT to populate that database. If it's a private crossing, it's the requirement of the railroad to populate that database.

Now working with this data I could take a latitude and longitude, apply it on the map, and I knew the data could be off. There is some crossings in the middle of the Atlantic Ocean. You knew that this information was not accurate. So, thankfully, in 2008 the Rail and Safety Improvement Act, what they did is they required any type of updates to those records, if it's updating the physical characteristics, the railroad information, the phone number, they are required to get a spatial reading of that grade crossing, and we have seen a huge improvement at the latitude and longitude in the actual inventory.

One thing I also wanted to point out is the work we've done with NENA. I know many of you talked about this earlier a little bit, but we did work on the policy for developing what happens when a rail accident occurs, and two of the key things that came out of that, one is the education of 9-1-1 operators about rail accidents. If you're going to have to shut down that line when a rail accident occurs, they think they have to call their local rail company to shut it down. They don't have the understanding or realize that dispatch center could be four or five, six states away.

Another key component is the grade crossing. If an accident occurs, let's say hypothetically a car gets hit by a train, the train does not stop at that grade crossing. It might take them a half-a-mile to a mile down the track for the train to actually stop. So if you're going to route 9-1-1 or emergency vehicles, fire trucks, ambulances, they're most likely going to have to go through the grade crossing and go down that right-of-way to actually get to the people that need help.

Now I touched on this a little bit earlier about the ATIP car, and these are just the actual cars. We have what we call the 216, 217 and 218 or 219 and 220, and this just shows where they've been in the 2011. Now, as I mentioned, when they actually collect exceptions -- and as I mentioned before, we actually have track inspectors in the field to go out and verify that they're actually defects.

Now I'm going to go into some of the applications or what -- I broke this into data driven. I'll kind of explain that a little bit and web services. Now these are some of the data and web applications that are available in the public domain. Some of the information I'm going to show is not in the public domain and some of it is.

Everything in the public domain as far as our rail data, it's available on the National Transportation Atlas Database. I know we've discussed that a few times in the last two days. And we have a main application and a pop-up viewer in the public domain that actually displays the grade crossings in our rail lines.

Now the FRA -- our safety regions are broken up into eight regions, and within eight regions we have five different disciplines or five different types of inspectors. We have HazMat inspectors, motor power equipment, operating practices, signal and track. Our track inspectors, a lot of them are out there collecting latitude and longitude of the defects of their reports and the actual defects. As of right now the other disciplines are not collecting latitude and longitude, but there are placeholders in that report and we would like them all to be collecting latitude and longitude on all of their reports in the future.

So this is an example of another what I call data driven, is the accidents. When an accident occurs, the railroad is required to submit a report to FRA. We call it our Form 54. And in this report -- I believe the gentleman before showed the accident location, and it's nice to see that this data's being used in a link to the actual report. We build those links into the actual database. We also do that within the grade crossings, so the accident point location is developed in this process.

And when we worked with the Office of Safety in 2007 and we looked at the accidents, we said well, this is why we can't use mileposts, because you can see in this example there's this accident that happened at milepost 68 owned by UP. Well, there's two milepost 68s, and we need something else in that actual accident report, and what we do is we identify station information. As I mentioned before, station is very critical, and we created a location and a little referencing system to uniquely identify which accident or which milepost that accident actually occurred at.

Now this process is becoming obsolete because -- thankfully, because of the Act, the Rail and Safety Improvement Act, the accidents are being coded with latitude and longitude and we just started getting that data in, so as soon as all the accidents become geo-located that process will soon be extinct.

So I'm going to go into some of our applications. This is our main application and we are using ESRI technology. This technology is using their ADF and it's actually going to be phased out with their newest release of the technology. We're in the process of taking this main application and building out Silverlight viewers, and I have a couple of examples of some of the applications that we have deployed.

We also have what we call a pop-up viewer where you can put in the unique USDOT grade crossing number and hit generate map and it will pop-up a map zoomed into that grade crossing, and you can get information. Click on the grade crossing, pull up the report similar to the accidents.

This a Silverlight viewer application. We took all of the trespassers in the last year and not only identified the injured, but the fatality and created a heat map to show where there's a high incident of -- spatially where these are occurring. And where I think where the Grade Crossing Division is going to go with this is start to look at human factors when you go into trespassers. Is it near college campuses? Is it near metropolitan areas? They're going to look at different human factors and things like that to try to help reduce trespasser incidents.

We are also creating a mobile application. We did a prototype last -- well, I would say last May, June, July, and we are going to deploy a mobile app dedicated to grade crossings where the individual can not only identify the grade crossing -- route to a grade crossing that would really be used for our safety inspectors, but it will be publicly available. It will be first deployed by IOS and we're going to look at all different platforms. This will be released this spring, and this is also going to fulfill an OMB requirement on the USDOT being mobile ready.

And, lastly, I'm going to go through -- this is an internal application, what we call the GIS Track Inspection Dashboard. As I mentioned before, the track inspectors are out there collecting latitude and longitude on the reports and defects, and what we did is we did a mash up of that information with the accidents and the ATIP data. You can filter out by different types, time. Here's just a basic overview and the inspector can go in, and really we built these requirements based on the track inspectors, what they wanted to do. We wanted a tool to support them. We're not trying to identify where you've been or where you haven't been, we just really want to use the tool to see where they can do their follow-up inspections and where are the locations that they need to follow up at. So you can through. This is just using the Silverlight technology. You can in the different tabs the ATIP data, accidents, defects and reports.

And then just to close up in conclusion, I just really want to emphasize that one of the key parts of this is our partnership with the Office of Safety and to having a centralized GIS. When you start to stovepipe or have your centers of excellence you're really going to miss the bigger picture. And I think I've seen this throughout several presentations the last two days, is having one streamlined GIS is very essential for not only the current GIS, but the future in leveraging the GIS technology. That's it.

DR. CHEUNG: Thank you, Ms. Hunt. Mr. Ed Wells is the GIS Manager for the Washington Metropolitan Area Transit Authority. Mr. Wells, would you please start your presentation?

MR. WELLS: Madam Chairman, members of the Board, members of the staff, thank you for your interest in geographic information system technology and for the chance to participate in this conference.

I want to give an operational view of what it takes to build an Enterprise GIS for a large transit agency and then give some examples of how it can be used to support safety culture within the agency. I want to talk a bit about the challenges and some of the foundations needed for success, then show some possibilities for using GIS in support of safety culture and safety investigations, and, finally, conclude with some principles for implementing a GIS in a large agency. And I'd like to state here that I will be talking about general capabilities of GIS, not about any specific WMATA plans or capacities.

So GIS integrates geography and relational databases. It's a powerful combination. It's easy to focus on the display, on the pretty maps, on the analysis, but that's not the heart of the matter. The real heart is database management, geographic database management. That's the payoff for us.

When you take the relational integrity of a relational database and add to it the spatial relations that geography brings you add a whole layer and a whole new set of tools for ensuring data integrity spatially as well as within records. And because spatial analysis is unique to GIS and because so many other systems create and consume spatial data without benefit of robust GIS tools, GIS is a powerful force for integrating data across systems and breaking down data silos that plague so many large agencies. As Rachel said, the one big picture as opposed to the many little views.

The first challenge that you face is the scope and scale of a transit operation. At WMATA, for example, we provide rail, bus and paratransit service to parts of Maryland and Virginia and all of D.C., about 1,500 square miles. This requires that we establish and maintain stops and routes and fleets of vehicles. We also maintain a number of complex infrastructure systems to support that, track, electric power, signals, HVAC, drainage networks, all the engineering that goes behind the transit services, and a number of what I would call support services that support the delivery of transit services, safety, police, planning, real estate, environmental management. All of those require a common view because we're serving the public as one agency.

The second -- I'll say that transit poses some very unique challenges for GIS. The first is location. How do you say where something is? Well, you can give coordinates, and we do that a lot. We rely on geographic coordinates. You can give addresses. They also specify locations. But consider our rail system. It's not addressable and half of it is underground, so it's GPS denied. Therefore, we also have to use linear reference systems. The most common familiar system would be the mileposts along highways. And we have to then use all three and interchange all three in seamlessly providing data for all of our operations.

In addition, time matters for transit, at least when you're waiting for the bus it matters a lot, and if you give me a route and a time I can give you or should be able to give you back a location, so time and location are interdependent in the transit world.

Precision also matters. Our key infrastructure is located by engineering drawings and we want to keep that precision in providing an Enterprise GIS to support engineering maintenance, so that's an order of magnitude more precise than a typical municipal GIS.

Another challenge is the complexity of network data structures. If you move a stop -- a transit system is basically stops connected into routes. If you move a stop, then you move that route and how people get from here to there changes and it ramifies throughout the entire network, so everything is connected directly to everything else when you finally get down to it.

This involves us in the entire span of IT, not just the servers and the networks and the storage, also data modeling, data compilation and, finally, business process analysis as we work out with the business departments how they're going to maintain the data in the course of their operations with support from IT.

So with all of this going on as one integrate whole serving the entire enterprise, GIS becomes a powerful -- it should be the sole source for spatial data and it should feed other systems, and then it should get feedback from systems as states change, as infrastructure is swapped in and out, as vehicles move, so there has to be an integration across systems, and GIS can drive this. That is the real payoff from an Enterprise GIS, is consistent data across the enterprise.

So how do we build this? Well, we need two foundations that I'll talk about right now. First is to analyze the business and data needs across the agency and establish a coherent framework for relating data across operations. In the transit world it boils down really to asset management, transit operations and then support operations.

Asset management, you've got assets, infrastructure assets, scattered throughout the system, and you keep records on each of them, you keep inventory, you have to track where they are and you have to track when they need to be maintained and the work orders and what land they're on or not. That's one set of operations.

The operating network of stops and routes is a very different realm and it's a much more complex data structure and much more concise data structure. That has to be built in a way that is consistent with the infrastructure that powers the transit services.

Finally, the support operations are specialized. Each have specialized requirements. I include safety management in this along with police and planning, environmental management, real estate. Their goal is to -- the goal is not to serve each separately, but to provide consistent information for all so that support is embedded in operations and operations then becomes aware of the specialized needs.

The second foundation is the IT infrastructure itself. You need Enterprise software. You need data models and data maintenance procedures and the data itself. You can't do anything with pretty software only. You need servers, storage, networks. You need production staging and development environments so you can bring in changes and do editing without disrupting day-to-day operations. You need to supply this to desktop and web and other applications within the enterprise. You have to be able to scale up the system as demand grows. You have to prepare to provide information to the public as well as internally and provide for security and disaster recovery as you do this. So within the strategic framework in the IT infrastructure you can begin to organize and maintain data, and then when the foundation is in place you can build applications that support analysis and planning.

So let me start with an example of that that shows how it can support safety within the agency, and I'll start with a very simple one. This is a Roadway Access Guide. It's given to our track inspectors. They walk the track. They are told along the way here is where the special conditions are that you have to -- where you have to be vigilant, restricted views or there's no clearance alongside the track to step away if a train comes through, be aware of those and be in communication. You look at the center white column, you see the linear reference positions given in increments of hundred feet from an origin point.

Here's that same table as a map overlaid on imagery, color-coded. That's a different way and in many ways a more informative way to visualize what you're going to encounter during the day. Here's the same map and there's the emergency phones laid on top of it. This, again, is more informative. It helps people to visualize and be aware of their surroundings. So that's one aspect of asset maintenance, is inspections.

Let's talk about the asset inventory. So here is -- you have your list of assets. The lists are necessary, but let's look at where they are and how -- what's next to what and how they might interact.

So you can make a map and map them where they are, the different classes of assets. You can then -- if you interact the GIS with the Work Order Management System and send a query out of GIS to say get me the ID's that are in this area and read back which ones are up for inspection or which ones need maintenance. Now you've selected and you can see what's going on in that particular area, so you now are reaping the benefit of system interaction.

Then you can click on those assets and look at contextual views. You can activate web services like Google Street View or Bing Maps and see what the context of that particular stretch of track is. You can look at hyperlinks to scans of the original engineering drawings and see the history or site-specific safety plans and look at the documents that might inform operations there.

And when you need to monitor what's going on, you can then -- if you have your cameras and you've built polygons of the camera view shed, you can decide which camera you need to activate in order to see a particular asset because you know where the assets are located and what the view sheds are.

So those are a few examples -- couple of examples for how GIS supports asset management. Now let's look at operations, situational awareness of operations.

You begin with the stops and the routes that are shown here. You then add in vehicles that are monitored. Their positions are monitored, updated maybe every 90 seconds from GPS readings on the buses and other technology for the trains. You can then add in alerts that are being processed that particular moment. The yellow triangles show that somebody's delayed somewhere for some reason. You can click on the pop-up and see what's going on.

And then you can bring in other information from the support operations. This is crime mapping, but you can bring in other things such as emergency management or special events or special deployments, for example. So that's situational awareness of operations and those are the basic building blocks for building that.

A particular challenge for transit is building interiors. Now think about our rail stations, very complex, some of the most important civic spaces in the region, absolutely critical for any kind of emergency management or safety operations, and how do you say where you are in a rail station?

So here is the floor plan, hard to read. You can do it if you're an architect. If you geo-reference the floor plan, put the coordinates on the building corners, lay it up against the imagery, you begin to see a little bit more. It's more informative. With lidar you can compute the exterior of the building and, because you're getting coordinates rather than photographic images, you can then pan around and do a fly-around of the building on the outside and you can run those same sensors through the interior of the building. This is one view and that's a recomputed view, same story.

So you can also bring in 3-D imagery or 360 degree imagery like you see in Street View and that will give you a different way of inventorying or knowing what's inside. So this is invaluable for those who want to look for environmental points, points of environmental monitoring, for those who want to inventory what's in the building in the way of infrastructure. For safety personnel, if they have to respond to an emergency, they know what's there. They know what it looks like exactly before they go in.

So if you think about it our rail stations in downtown D.C. connected by tunnels really are one structure interconnected, and the levels matter. The vertical position matters as much as the horizontal. So it's a real challenge for GIS to handle this and we're having to invent some things as we confront this challenge in Metro.

Once you have the simple building blocks in place you can then get to the more complex applications that support planning and analysis, incident analytics, safety dashboards, impact zone and plume dispersion overlays to model or respond to an incident, GEO data feeds to external fusion centers, station or rail evacuation planning, preset map configurations delivered by web service around the agency for emergency planning scenarios, tabletop exercises or, in the event of an actual incident, incident response.

So these are powerful tools, but they're powerful only if they are backed by an IT infrastructure and the data and the data maintenance procedures that ensure that you get the right information to the right people at the right time in day-to-day operations, so these applications then would -- they feed operational data into, in this case, safety applications.

So how do you build a GIS, an Enterprise GIS, in an agency where everything's moving all the time? A few principles for guidance, build from the simple to the complex, do one thing, get it solid, then go to the next thing, brick by brick, bite by bite you can build from the simple to the complex. Write once, use many. Make one system the source for recording original information for a given topic or asset and let it feed the other systems, so you integrate, you don't replicate. You break down the silos.

You will have to build a close relationship between IT and the business departments. The operation departments have to maintain the data, but they need to do so with IT support. Use legacy data. Yes, it might be out of date. Yes, it might not be perfect. Yes, it's from a silo. Take that, bang it against the other datasets. They're all so similar, and find the discrepancies, figure out the errors. Then perfect the data and continue to build.

All in all, set strategy first. Then obtain the infrastructure that you need. Then begin building the data and the maintenance processes to keep that data current, and that's an iterative process that has to happen simultaneously and interactively.

Once that foundation's in place we can think of applications. Then when the applications are in place the support departments are really embedded in the operating departments and we can begin to feed back. Not only are we improving, for example, sample management by getting good data to safety management departments, but because their operation is feeding into safety and they're getting feedback the operations personnel then begin to build a safety culture into the operations directly, and really prevention is the best cure.

Thank you. I look forward to your questions.

DR. CHEUNG: Thank you, Mr. Wells. Mr. Eric Williams is the Coordinator of Damage Prevention and Public Awareness at Access Midstream Partners. Mr. Williams, please start your presentation.

MR. WILLIAMS: Thank you, Dr. Cheung and to the Board for the invitation to this meeting. I'd also like to commend the work of the other panelists that we've seen in the last two days. As a father and a husband, it's nice to see academia and the government sector working so hard on these very important issues.

So to start with I thought I would give a brief overview of who we are, what our industry is, and then our role in government regulations and then get into the GIS section of what I want to talk about today.

So who is Access Midstream? We are a midstream operations company, so we build and operate pipeline across the United States. We were founded in 2002 as a part of Chesapeake Energy. We are now a standalone organization. In my seven years with the company we've grown from 24 employees to over 1,200 and from about 500 miles of pipeline to over 6,500 miles of pipeline, so it's been an extreme growth curve and GIS was a major part of us being able to manage the growth and continue to operate our assets safely.

Where we fit in the industry as a midstream organization, we're the transportation portion of the energy sector. Upstream you think of traditionally as the geologists, the land men, the folks doing the production, the EMP companies. Downstream are the local distribution companies getting our products to the customers at the end of the line, and we kind of fit in the middle. We play that piece of the delivery system to get those -- that energy from the wellhead to the burner tip. And just to give you a little bit better overview, we operate pipelines, compressor stations, processing plants, really getting the product ready for consumption at the end.

A little bit about how we are regulated, not the entire pipeline industry is regulated, but, you know, as a misnomer, unregulated doesn't necessarily mean unsafe. It just means that the industry does a lot of self-governance. Where we are regulated we're required to provide records and keep repository information in regards to certain activities and tasks that we perform on our assets.

The determination of what is jurisdictional versus non-jurisdictional assets is slightly different between natural gas or liquid pipelines. Normally with natural gas you're looking at potential impact radiuses, looking at what type of an impact an incident could have on population whereas liquid -- the higher concern is generally environmentally based for the liquid assets.

Our jurisdiction of where we fall under, the rules we play by, of course, are set forth by DOT and PHMSA, but being intrastate we don't operate pipelines across state lines at access, so, therefore, we are actually inspected and audited at the state level, normally by the Public Service Commission, the utilities commissions and the local state agencies responsible for pipeline safety in a given state.

Let's talk a little bit about our GIS system. I began my life as a GIS person at Access. I assisted in building and managing a GIS system basically from two Shake files up to an SDE corporate database of over 150 different data errors or individual datasets, so it's been exponential growth along with the growth of the organization.

I now work in Pipeline Safety and Compliance and one of our main concerns is damage prevention. That's a huge impact to our assets. There's 2-1/2 million miles of oil and gas pipeline in the United States as well as multiple other facility types that are buried, everything from fiber-optic to sewer, water, electric, and all those can have a substantial impact on the population as a whole.

You see here a map of Oklahoma demonstrating kind of the coverage of the varied assets. It would be hard to put a shell on the ground anywhere without finding some sort of facility underneath your feet, and remembering Oklahoma's far more sparsely populated than a lot of the areas along the east coast and the west coast.

So a little bit about the one call process and how it works, we manage every piece of this through GIS. The CDCs or Call Distribution Codes -- I'm here with a lot of government folks, so I had to throw out my own acronym here. The CDCS are used to establish who operates and owns what in which area, and so that's how we establish with the one call centers in each state, we're Access Midstream, here's where we have our pipelines, if someone intends to excavate or perform any sort of construction activity in this area here's how you reach us. Normally this is done through some sort of FTP communication or email system back to us, so on a monthly basis we're submitting new centerline files, new asset data, so they always have a continuous understanding or footprint of where we operate.

Once that ticket's called in and -- they generate a ticket and send it to our operations. There's a lot of work that has to be done there because each state does have its individual on call centers. Some states have multiple, Texas, New York, Idaho. I don't know why Idaho has four, but they do.

So each ticket comes in differently, so we have to have a system internally that can handle those tickets and normalize them across, so we use GIS heavy in this regard to where it allows us to integrate our data no matter what state we're in, so we can look across the board, whether we're in Texas, Oklahoma, New York, New Mexico. It all looks the same, smells the same. The data is flattened out for us to look at more clearly and efficiently.

What else GIS allows us to do is to count the white noise. Obviously, it's going to be an issue if a ticket or excavation happens that we're not notified of in our area, but just as important is for us to be able to recognize those excavation activities or those third party incidents that may be near our line, but not impacting our facility.

So GIS provides us a great means for being able to weed out and only look at those incidents that we need to be concerned with, especially when you look at areas like the Barnett Shale at Fort Worth or the Haynesville Shale in Shreveport, highly urbanized areas with very advanced oil and gas development, a lot of pipelines in the area. So, you know, looking alone at our Fort Worth operations, Johnson and Tarrant County, Texas, as well as Dallas County, you know, we're looking at somewhere to 50- to 60,000 tickets a year that we have to manage with a team of nine locators, so it's a daunting task and really there's no way that would be possible without the use of GIS.

Some of the gaps that the system lends itself to, poor GEO coding, poor road networks, poor addressing concerns. Normally at the ticket center level if someone -- long, if there's two Elm Streets and they put North instead of South, those type issues can cause issues for us, so, therefore, we also try to clearly mark our right-of-ways, put signage out so if someone does roll up on that location to do some digging they'll be able to quickly tell that it's one of our facilities. So that's some of the mitigative activities that we do.

As far as investigation, anytime we have some sort of third party line strike or any sort of damage to our pipeline there's a system called DIRT, which is the National Information Reporting Tool. It's a very powerful reporting system developed by the Common Ground Alliance of which we're a member of which encourages any owner or operate, whether it be pipelines, telecom, electric, water, to gather their incident data the same way and try to normalize the way these investigations are handled so that at a national level the CGA can compile the information and provide it back to industry to help teach us what we're doing better. We've taken that to another level as well to where internally we're doing a similar processing, creating DIRT reports internally, so we can take lessons learned from any incidents that we may have and apply it back to our operations.

And so one of the big things that we've learned in implementing the DIRT program is that one of our major concern areas was second party damage, the contractors we're paying to do work on our behalf striking our own pipelines. So by getting that information we're able to turn around and better educate the contractors that we contract with, change the way that we do our training and change the way that we communicate with these contractors to help improve our safety.

Most of the incidents that we saw were due to tolerance zone infractions, which means using a backhoe, a trencher or some other mechanical excavation equipment within two feet of an asset. This is -- that's a practice that is not welcomed in the industry and it's something we've done a lot of education outreach for. And the DIRT system allowed us to put some proof behind our concerns. We were able to go to the contractor and say see, this is -- 80% of our damage is from tolerance zones, so this is why we focus so hard on these issues.

Some of the ways that we analyze and look at our pipelines internally, we're a little bit unique from other forms of transportation. You can see a highway, you can see a railroad, you can see a bus, you can see a plane, you can't see a pipeline, so we really have to capitalize anytime we get a chance to view our asset at a detailed level.

If there's any sort of excavation where it will be unearthed, we spend that time to analyze the pipe, and we also implement what are called inline inspections, internal inspections, smart pigs. They have a lot of different terms. These smart pigs are basically large pieces of equipment that are put through the line in order to assess the quality of the asset.

So, as you see from the screen here, it's a screen capture of a pig run that we have done. This is actually crossing Interstate 35 between Oklahoma City and Dallas. And just to let everybody know, those are not holes in the pipeline, those are welds, so those are very normal. I don't want anybody getting real concerned about this pipeline. But it provides us information about internal corrosion, external corrosion, third party dents, gouges, any areas where the pipeline may have subsides or sank or was exposed. It will also give us depth to cover, a lot of good information that we would otherwise not be able to obtain.

You know, one of the issues with these machines is that they're very expensive. They're quite costly to rent. We don't own them. They really serve one purpose. We only hear from them -

- about once every four or five years we'll get some good information out of them.

So in between that those are -- what that's gathering is really lagging indicators, so we have to be proactive as well to try to find leading indicators and try to figure out okay, proactively what can we do to help prevent possible issues on our pipelines, so that's where risk and integrity -- a risk program comes into play.

So this is an analytical approach, a scientific approach, at analyzing risk on our assets. This is done at a company level in the industry. There is no comparison between organizations. I couldn't take my assets and compare it against, say, TransCanada. Everybody assesses their assets differently, has different algorithms that they look like -- that they look at. The strategy is that you're comparing your greatest risk locations inside your own organization, so it's really you're trying to find your bottom 10 or 15, 20% and trying to improve on those so over time you're improving the integrity of your assets by focusing on those low hanging fruit.

So, you know, some of the things that the risk algorithm will look at is past incidents of third party damage, external corrosion, internal corrosion. Perhaps it's an area that's seen elevated one call ticket response. Maybe it's an area due to wetlands or protected areas we're not allowed to mow the right-of-way. We're not allowed to put up signs. That would create undue risks to the pipeline.

And they're also looking at probability, what type of facility it is, how old is it, what's the pressure that it's operating at, what type of commodity is in the line, and through this we can assess our system and understand where do we have the largest amount of exposure.

And then we have standard operating practices that will allow us to say you have this amount of risk on this pipeline. Therefore, to mitigate that risk you must do X, Y and Z. So this really allows us to look at our asset portfolio as a whole and decide where can we best spend our capital to better protect our assets and protect the communities in which we operate.

And just briefly I want to touch on public awareness which kind of ties all this back together. Third party damage and anything that may be impacted by or created by a third party as well as the response to any possible incidents is handled by our Public Awareness Program. This is where we're going out -- and I'll skip that there. This is where we're going out and speaking to the stakeholders, anybody who may cause an incident due to digging, farming activities, homeowners. And we're also talking to local public officials about how to properly plan a community around a pipeline, don't put a Walmart Supercenter over the top of a pipeline, talking to emergency officials, if there were to be an incident here's how you would respond, here's the areas that you would want to focus on. So this is really our step in making sure that people know how to live, work and operate around our lines safely as well as how to respond if there were to be an incident that occurred. So in that regard, emergency response is a big piece of this puzzle.

So right now in the industry where we're at is you have NPMS, which is a great system for looking at transmission pipelines. The issue or the gap there is that NPMS is a very small piece of our industry. It's transmission pipelines only. It doesn't capture the large breadth of distribution gathering, midstream type assets.

And so kind of our goal as an organization, what we're trying to move towards, is as an industry can we create some sort of a GIS system that can be put in the hands of these emergency response professionals so that they understand where we're at, what type of assets we're operating in their area. Right now it's kind of a collection of paper maps. We might be able to get them a Shake file. They might be able to handle it. They might not.

So from the emergency response industry there's not a solid target for us to shoot at and as an industry we don't have a solidified voice in order to provide that data. So as an industry we do a good job of leveraging GIS because it's really the only way for us to track our assets, being underground assets.

We use that information to create repositories to asset -- management preventative maintenance, but the next step is really how do we get all this good data that we have and this good information that we're producing in our organization and push it to those emergency response professionals or those elected public officials or those folks that may have an impact in protecting our community and protecting these assets?

We've made some effort in working with different emergency response organizations to understand what their needs are and what benefit they could have from a system of this type, but really taking that next step of how can we create this at a national level or, you know, even more specifically, a regional level to make sure if there were an incident that we're looking at a common operating picture and our operators are speaking the same language as the emergency responders.

So, with that, I'll wrap it up and pass it back to Dr. Cheung.

DR. CHEUNG: Thank you, Mr. Williams. Ms. Amy Nelson is the GIS Manager for the USDOT Pipeline and Hazardous Material Safety Administration. Ms. Nelson, please start your presentation.

MS. NELSON: Hi. I'm Amy Nelson and first I want to thank you, Dr. Cheung, Chairwoman Hersman and everyone else for having us -- for inviting me here today. I think it's a terrific lineup that we have of these presentations.

I work for the U.S. Department of Transportation in the Pipelines Division called PHMSA, and today I'm going to present about the National Pipeline Mapping System or NPMS which was actually mentioned in Eric's presentation.

I have a few objectives, first to explain what the NPMS is and what kinds of GIS applications we have using this data that we collect through the NPMS program, to explain why our program is somewhat unique, why our data issues are different than what most GIS groups face, to talk about how the GIS interfaces with PHMSA's other data management systems and the tabular data within those, and to talk about how we use the NPMS to help with integrity management related issues, in other words, to prevent pipeline accidents from occurring.

The National Pipeline Mapping System dataset is made up of gas transmission in hazardous liquid pipelines. The operators are required to make annual data submissions to us showing us their pipeline location and a small set of attributes such as the commodity carried, the pipeline diameter, the system name, and there's a few other pieces of data, but basically we don't have all the attributes that say Access Midstream would have attached to the NPMS. There's a few very basic things designed to let PHMSA know what kind of pipeline it is and also designed to let the general public know what they might find close to their property.

The NPMS is a huge dataset and that engenders certain problems for processing the data for our web applications. We've got over half-a-million miles of pipeline data which is submitted by just over a thousand pipeline operators, so every year we're getting new submissions from these operators either saying here's what changed in our data over the past 12 months or else saying we have no changes, and by the by, we have a very small staff processing these, just a few full-time people, so we've had to make custom tools in order to expedite the processing, and I'll touch on what those are later in the presentation.

We've got two basic web-based GIS applications and here's our website. The first is the Public Viewer, so that allows citizens to view pipelines in one county per session, so you can go in, look to see where your house is and see the pipelines that are around it. You are restricted in the ability to zoom into that data and you're restricted in certain attributes which are hidden such as diameter and data accuracy, in other words, you know, is the data within a hundred feet, is it within 500 feet, and 500 feet is our current accuracy standard.

So we did levy these restrictions in conjunction with meetings with the Department of Homeland Security since pipelines are considered critical, but also sensitive infrastructure. Although it's true that there are commercial datasets of pipeline data available, the NPMS is the most complete and the most current data source for pipelines. And since those are areas which could be targeted by terrorist activity we need to keep that data secure, and so with the Public Viewer we were looking for kind of a happy medium between the public's right to know about pipelines in their property, perhaps near property they're interested in buying in their neighborhood, and keeping that data as secure as possible.

The other application called PIMMA is at the same website, but it's only available to government officials, so a federal official could see the entire U.S. and a county official could see pipelines in their county. They can also receive this raw geospatial data is they request it from us.

The role of NPMS has kind of evolved over the 11 years that the system has been up. First, it was created to help PHMSA manage its regulatory assets, in other words, to help inspectors in the field. Inspectors can say okay, you know, first I want to make sure that I'm inspecting this entire pipeline, then I want to make sure that what the operator says they're running is what the other paperwork says that they're actually running through the pipeline, and also to find the unusually sensitive areas along the pipelines. This might be, for example, an ecologically sensitive area where there's a protected species nearby. It might be near a large urban area where, you know, you would have higher consequences if a pipeline did release than in a rural area, so a large part of the NPMS was designed in order to analyze pipelines close to these unusually sensitive areas.

And one of the main roles of the NPMS now is in disaster response, so if there is a pipeline release reported we can look -- first of all, identify the pipeline it occurred in because often these just come from the general public who says, you know, there's an explosion, what do we do, and so we've got to get the lat/long of where that happened, get the area, however it's described, find that pipeline, but also find other pipelines nearby so that we can alert those operators and make sure that, you know, their pipelines are safety and it's not going to be a domino effect.

And this helps PHMSA meet our mission goals of environmental stewardship, preparedness and response, and we also help meet our mission goal of safety in having accurate information about where these pipelines are, so it's essential that we know where the assets are that we manage, and that we can make sure that our policies are being applied to all of these pipelines and no pipelines, for example, are slipping under the inspection radar because they're not properly mapped.

But the role of the NPMS has really evolved in the decade or so that it's been around, and PHMSA has found that geographic analysis is a very useful tool in things like decision support. If we're looking for a certain type of pipeline, we can find out where it's clustered. If we're looking at accidents that happened and we plot those accidents, perhaps we can see a pattern in where those have occurred and then we can allocate more resources into finding out why a specific type of pipeline has a higher frequency of accidents or more outreach in that area.

We also have been using the NPMS as the primary tool for our pipeline risk ranking. We have a new risk algorithm and we've been using several characteristics of the NPMS data to evaluate pipelines risk and, therefore, prioritize them for inspection. We have several community groups who are interested in where pipelines are when they plan their community, when they approve new development. Of course, you want to not make it close to an existing pipeline corridor if that's possible.

Our data is a little bit unique, I find, and we've had to create custom tools to manage it. First of all, I'm going to talk about the data accuracy. So the pipeline accuracy is plus or minus 500 feet. That dates back to the 2002 Data Information Collection which was written up as a statutory requirement and which gives us the authority to collect this information from operators.

We're finding that, of course, now it's much easier to get even submeter (ph.) accuracy than it was back in the turn of the century when these were first written, and at the time they were designed to encourage pipeline operators to submit their data, so -- since it was optional before the rulemaking in 2002, so we didn't want to make the standards too strict, at least that's how the thinking went, and now we find that the technology has advanced and we really need to tighten up this accuracy requirement.

Another challenge is synchronizing the NPMS submissions so the data of them and the currency, I guess I would say, of them with the annual reports. What we've done now is to say both the NPMS and the annual report should show the pipelines as of 12/31 of the previous year, and so we have the gas operators submitting in March of the next year. So in March 2013 we'll be getting in submissions as of 12/31/2012, and for liquid operators it's June of the next year.

That's been kind of a double-edged sword in that it's very useful to be able to compare statistics between the end reports and the NPMS submissions. We kind of need those two pieces to work together so we can say these are describing the same assets, the operator hasn't bought or sold anything between these two data submissions, but it also kind of hampers us because the data is always going to be out of date. I have inspectors in the field saying well, this pipeline went into service, you know, in April of this year, why isn't it showing up yet, and I have to say well, it's because it's not going to be in our system until next year because we do have the synchronization.

We are attempting to integrate tabular datasets with the NPMS data. We have already integrated several of them such as inspection reports, so the inspection reports are tied to a length of pipeline. When an inspector goes out, if it's a large pipeline operator or a large system, they might only inspect part of the pipeline operator's holdings, usually between 200 and 400 miles of pipe. So we tagged the segment begin and end of that inspection period as it were and we've tied that back to the tabular data about all the findings in the inspection report, but that was a challenge. That was a project that had to be done manually, and I believe there are 1,200 or 1,400 inspection units, so it was all meeting one-on-one with these inspectors and defining where these boundaries are.

Perhaps our biggest challenge is when we decided to implement change detection or pipeline history. So for each pipeline segment we wanted to know what -- I'm sorry, each pipeline operator we wanted to know what has changed in their submission between last year and this year. And what we're trying to do here is if you imagine all the pipelines in the U.S. at one network, we're just trying to tag each piece of the network with who owns it now.

Pipelines are bought and sold at a very rapid rate, so we want to know that this pipeline that Operator A operates this year was operated by Operator B last year so that we can look -- we can tie these inspection reports together. We can look at the history of problems along this pipeline and we can differentiate the operator performance from the pipeline performance. This is a very valuable tool for PHMSA to have, but also creates many headaches in terms of data processing, and I'll get into that a little more in the presentation.

So I've kind of touched on how we're meeting some of these challenges, but one of the first ways is that we're drafting a rulemaking to collect additional pipeline data, so that will be additional attributes of these -- you know, it's still in the draft stage. It hasn't been released as a Notice of Proposed Rulemaking yet, but when it is you'll see that there are many additional attributes or, you know, facilities along the pipeline that we're interested in collecting and we really need to improve or data accuracy and bring it into the 21st century here.

It seems that there's a common thread among these presenters here of linear referencing, so we all have linear features and we're interested in relative distances along a linear feature, and in order to facilitate that we converted the NPMS to linear referencing. That was about two years ago. And we just have our own internal linear reference system.

Each pipeline operator has their own system, too, and they often refer to a pipeline at a specific station, so yes, it would be useful if we could use that operator's specific referencing, but, instead, what we chose to do is look at it as the entire U.S. as a whole user-owned NPMS linear referencing system, and it's possible that at specific key points we might note the operator's referencing so that our regional offices can talk to the operator in their language about what part of the pipeline we're talking about here.

And, most of all, we've created custom tools in order to facilitate this data integration between our tabular datasets and the data that can be integrated geospatially and perform this change detection, what's happening with the pipeline from year to year which allows us to build a pipeline history.

In terms -- I'm going to talk a little more about the rulemaking here and talk about upgrading the data accuracy, and a few attributes which will be in the rulemaking are things like pumping compressor stations, so that's where you put the commodity into the pipeline.

And, for one thing, it's a vulnerable point along the pipeline because it's above ground and it's an area that could potentially, you know, be attacked by someone who wanted to do such a thing, but it's also an important marker along the pipeline. And a lot of our records reference, you know, an accident near a pump station or an inspection unit or inspection boundary that starts at a pump station. So we were trying to map all of these inspection units so that we could integrate them with the tabular inspection reports and we had none of these pump stations which were constantly mentioned in the inspection span.

So, for one thing, that will help us ensure the safety of these assets, and for another thing it will actually help us integrate the data a lot more easily.

And if there's any pipeline operators in the audience, I just want to say that the new data collection is going to most likely be a phased approach and we're certainly evaluating the cost and benefits -- cost to the operators, benefits to PHMSA, when we're writing this rulemaking.

I've talked kind of extensively about how we integrated the inspection unit data. There's another dataset called special permits which is a waiver for a pipeline to operate at a higher pressure than you would normally grant them, and we just have a small handful of those, although they do -- some of them have coordinates where they start and stop, but a lot of them might just reference a system name, which being reported to our regional office might be different than the system name that's put in the

NPMS submission by the operator's GIS tech. So we're going to map those manually and keep that data as an event along the pipeline, so here's where the special permit segment starts and you get the waiver to operate and here's where it stops.

By the same way, the accidents and incidents are, of course, point data and those will become events on the pipeline segments. Currently we just get a lat/long for the accidents and incidents, and sometimes they fall on a pipeline, but usually or almost always they won't fall exactly on the pipeline because the line has no real width in the GIS system, so we've got to snap it to the closest pipeline and, of course, make sure that it's the same operator that we're snapping it to.

And if we're looking at historical accidents, we have this problem which is going to be solved by change tracking where the operator who had the accident might be different than the operator who's operating it now, so we've, you know, got to make sure that when we have these historical accidents we're putting them to the right operator's name.

I've talked again about how the tabular data is currently tied to the operator, so if you want to know who operated a specific pipeline over the last two, three or five years, all you can do really is depend upon institutional knowledge, to go to the inspectors and say do you remember who operated this, you know, before it was ConocoPhillips?

And you can also look through the paperwork and try to discern who operated it based on the counties that the pipeline ran through, based upon a discussion of the perhaps breakout tanks or other facilities associated with the pipeline, but it's very, very difficult, so, again, this is another problem we have, that change tracking is going to help solve. And, again, relating the accidents and incident to the pipeline, not to the operator, let's us go through time and see which pipelines have been problematic.

We've built these custom applications to help us with the change detection process. So here -- I'm not sure how well these colors are showing up. You can see there's a green overlaid on a blue pipeline, and then there's another blue pipeline in the bottom right-hand corner.

And if you look on the left-hand side of the screen you can see that it's basically the operator's submission this year and last year, and for this operator you can see there's some segments that are in this year's that were not in last year's submission, so our first step is to compare it to last year's submission and see what has changed.

And then our custom tools run a special report for us. What this means is basically just kind of -- I guess I would call it use cases, so it's saying this segment is new this year and we think that it's new construction, and we have the operator try to designate what was new construction for us because we're just comparing the pipelines in the known universe or network of the U.S. pipelines, so if they throw in a new pipeline that was constructed and don't tell us it's new construction the system is going to look for a pipeline near it and to try to match it to that pipeline, so we want to avoid pipelines getting mismatched.

Additionally, another complexity to our data is because it's not just one operator's data. We have many, many pipelines running along the same right-of-way, and you can have situations where the pipelines are no more than 20 feet apart. And in that case, if you've got three pipelines here, three pipelines slightly offset, perhaps the operator re-GPS'd their pipelines over the past year, there's a risk of the wrong pipelines getting matched and the system not realizing that it was just a GPS shift and everything's kind of shifted over to the east a bit. So we have all these custom and complex tools to help us kind of be detectives and match pipelines from one year to the next.

And that concludes my presentation. Thank you.

DR. CHEUNG: Thank you, Ms. Nelson. Mr. Vorderbrueggen, would you please start with your questions?

MR. VORDERBRUEGGEN: Thank you, Dr. Cheung. My first question is to Amy Nelson. Amy, in Eric's presentation he commented that the dig tolerance zone is as critical as only two feet and, of course, we've seen that in accident investigations where two feet makes a big difference. And you commented that right now the National Pipeline Mapping System is within an accuracy of approximately 500 feet or maybe somewhat better than that, and you also mentioned that there is some rulemaking activities ongoing in the PHMSA organization.

Can you elaborate a little bit on that? Is it going to -- are you going to adopt or are you targeting an adoption of the current accuracy of GPS systems in the general public or are you going to try to get them much tighter than that? And then, if you could, some kind of a timeline.

MS. NELSON: Sure. I'm happy to. Thank you for your question. First I would say that we need the best accuracy possible in order to do our job, so although GPS systems can get, you know, submeter accuracy, sometimes within a foot accuracy, and that's pretty standard now, we do need the rationale to support collecting that data, so is there a difference to PHMSA if we pinpoint the pipeline within 3 feet versus if we pinpoint it within 20 feet?

So right now we're evaluating, you know, what the different cases could be that 20 feet isn't good enough, that we would need, say, 3 or 5 foot accuracy. So we're anticipating the accuracy to be -- I'll just say well under 50 feet. At this point, you know, I can't -- since it's not a truly public meeting I can't speak in very specific points about what's going on at PHMSA discussing the accuracy, but I will say that, you know, we're looking at under 50 feet, you know, even under 25 feet.

And we need to determine exactly what our business needs are for this data because it is a large burden on operators, which is certainly something that PHMSA is wanting to stand up and demand that we need this data because it's very important for us in order to do our job, but we're still evaluating the cost to operators, the cost to re-GPS all of these pipelines in the rural areas, the cost to very small pipeline operators who don't have a comprehensive GIS or the tools to do it.

In terms of a timeline for the rulemaking, it's likely that the NPRM will come out mid-next year, so right now the internal draft is just about finished.

MR. WILLIAMS: Yeah, and also to speak to that also, as she said, there's a diminishing return for sure on doing an after-build or some sort of post-construction GPS or survey of an asset. The two feet is more for -- more of a guidance for excavation. In the one call system, as I mentioned, we provide asset data to them and that is buffered, a 500 foot buffer, and then our operation staff will then respond and go on location and determine actually how far it is from the location using advance sign locating equipment, as-built survey drawings, different -- other mechanisms to attempt that. So we don't necessarily clear a ticket or say you're all cleared just from looking at a GIS system and saying oh, you're not within two feet, we don't need to come out. We're going to go on location, locate the line, put flags or paint down, and then work with the excavator to understand you get within this tolerance zone you're using shovels or some other method to get to our pipeline.

MR. VORDERBRUEGGEN: Thank you. Eric, I have a question for you, and you mentioned the dig tickets, so that kind of ties right in. PHMSA does not regulate the one call system and the big system. It is state regulated and, as you mentioned, some states have multiple organizations that operate them and some organizations operate for multiple states.

What we've seen is that in some cases they provide opportunities for using latitude/longitude to identify a pipe dig location, but it doesn't appear to be mandatory at this point in time. Is there an action in the organizations and in industry to really improve on that and get the technicians that are going out in the field to rely more heavily on the latitude and longitude coordinates when they do the dig ticket and the ultimate surveys?

MR. WILLIAMS: Yeah, and to speak to that, the one call centers aren't necessarily regulated by PHMSA, but PHMSA has approached the subject of improving the operations at one call centers through funding and different means. One of the major concerns right now is enforcement, the states being able to enforce the dig laws in the various states.

I'm sorry. And what was your -- what was the follow-up question?

MR. VORDERBRUEGGEN: Really, the follow-up is is there a push to really focus on using latitude -- accurate latitude/longitude for the technician going out in the field?

MR. WILLIAMS: Absolutely, and the push to use that more advanced technology because, as I said, geo-coding isn't exact, as all the GIS folks in the room understand, and to really push them towards that, the use of lat/longs and GPS's. And really that technology, you know, we're in the industry of GIS, we understand the technology, but it can be a bit daunting to someone who doesn't work in GIS or GPS regularly. Using any sort of GPS system could be very intimidating.

So what a lot of states are going and a lot of industries are assisting with is pushing the use of online ticket generation where you look at a map and you draw the box yourself on a Google Earth or Google Map type interface, or even using new development in smart phones in order to have an app where you go to a location and then you submit your ticket while you're standing where you're going to be doing your dig to help facilitate some of that inhibition perhaps to use the technology from the excavators or contractors doing the work.

So, yes, from an industry perspective we're pushing very hard to make it more accessible, not just for the professional contractors because I think they're the first onboard to really understand how to use those more advanced systems, but the homeowners and the general public who don't necessarily do excavation every day. You know, they pick up the phone and make the call and give an address. We're really trying to push that sector into using more of the online stuff. Texas 8-1-1, for example, has pooled their marketing on call 8-1-1 and now it's click it, you know, click 8-1-1 is kind of their new push, so trying to get folks away from the traditional methods of phone and getting to more advanced methods of submission is definitely a goal of the industry.

MR. VORDERBRUEGGEN: Thank you very much. Dr. Dodd?

DR. DODD: Okay. Thank you very much. I want to thank all of you for your presentations. I found each of the presentations informative and interesting, so thanks very much.

My first question is to Ms. Hunt, and I was interested in the Automatic Track Inspection Program, and you cited in your discussion in your presentation that you found the data of use. I'm curious how you're using the data, how accurate it is, and then the last question is when do you think, if you know, the whole system will be ultimately inspected and whether or not all that data might be available to you in your work?

MS. HUNT: Thank you for the question. The ATIP program -- excuse me, I'm getting over a little bit of a cold. The ATIP program, the use of the data is basically -- it's owned by Safety. I'm just actually a user of it, and when I create the GIS of it, I guess I would be a co-owner of it.

So the ATIP program itself is actually owned by the Office of Safety and they designate the track to be passenger rail, HazMat rail, rail that has large volumes of traffic, so for the ATIP program to cover all of the track in the United States, I don't know if that's ever going to happen. I know they're looking at lines that are a high priority and they would like to traverse all of the lines, but I don't think they have enough cars or enough staff or resources to do that.

Whenever I get the data, I get it at a quarterly base right now, and I think if I had another presentation I could go into centralizing databases, having like a middle tier where we can have -- get safety data dynamically. I think that's going to be the wave of the future. Right now it's a manual process which is -- for instance, the accident that occurred in New Jersey would be excellent if we could actually have real-time data feeds, when was that track last inspected, when did ATIP go over it, what did they find. That's the information -- that's the wave that we need to be looking at and utilizing and using GIS with that safety data.

DR. DODD: Okay. Thank you very much. My second question is for Mr. Wells. In your presentation you referenced the fact that you're using a number of different techniques for your geo-referencing of the assets within the system, both GPS, above ground linear referencing, I assume underground. I'm curious how well those different techniques integrate and, more importantly, how does that information get transmitted to first responders if needed?

MR. WELLS: Thank you. The integration of the locations is really a software question. It's a matter of technique and the tool to handle that. Basically the cheap way is to convert everything to lat/long one way or the other, but to read in its native format and then do the conversion.

As for transmitting to first responders, we don't do that directly from within IT. That is done by the rail officials, and if you're an emergency responder you may or may not want electronic maps, so they provide what they can and they provide what is appropriate for the incident.

DR. DODD: Okay. Thank you. Dr. Cheung?

DR. CHEUNG: Thank you. I have a question from the staff through the email system and I'm trying to read this. Two reasons NTSB pipeline accident investigations have highlighted gaps -- oh, this is -- sorry, this is for Mr. Williams. Two reasons NTSB pipeline accident investigations have highlighted gaps in emergency responder knowledge of the pipelines running through their jurisdiction.

Earlier today Mr. Berryman of NENA discussed the use of GIS to better locate and access what services should be dispatched during an emergency. Please expand on the challenges in getting emergency core centers outfitted to the level on par with the 8-1-1 program with respect to pipeline location mapping. Discuss any industry efforts to partner with NENA to overcome these challenges. Looks like a dissertation question.

MR. WILLIAMS: Great. Thanks for throwing me that. Yeah, absolutely there's gaps in the communication and probably the first thing to say is that it's easy to communicate to 8-1-1 because all we have to tell them is where our stuff is. We don't have to provide any sort of attribute information, no response information, no local contact information. It's basically here's our pipeline, you send it to this email address, we'll handle it from here.

When you're looking at an emergency situation it becomes a little bit more complex because they need to know what was their operating pressure, who's the operator -- well, who's the local contact as well as the corporate contact for emergency response, what type of commodity is being carried in the pipeline and how deep is it, what type of facility it is, do we have the capabilities and the emergency responder community in that area to respond to that sort of commodity or that sort of release, so there becomes a lot more -- you know, a lot more information that needs to be communicated.

There are efforts in the industry. We're actually a part -- a major part of quite a few of them. Currently what was provided to the emergency responders is these annual meetings, annual training meetings, where we provide every county in the U.S. There's an invite sent to every emergency responder, whether it's the PSAPs, the fire stations, the law enforcement agencies, the medical response teams, the emergency managers. They're invited to these trainings to come out, meet face-to-face with the operators in their county, get paper maps, digital maps, information as well as local contacts, so we provide that. We also do mailers on an annual basis, sending hard copy mailers.

But, as you know, during a response it's not always easy to grab a thumb drive or a paper you received a year ago in a training class and try to roll up on an incident and respond to it. And a lot of that, too, is that we don't get good responses in a lot of areas. Especially the non-volunteer fire departments normally won't participate as heavily in these training classes. We get good response from the volunteers because it's free training. It's stuff that they don't have to budget for. They can come out, we foot the bill, and they get free training whereas from a paid department usually they're already over-trained, they're staff thin, they don't have the opportunity to send a lot of folks to all these different trainings that they have to accomplish. So in that regard it's us trying to reach an industry that's not required to come listen to us how to respond to our incident or for our industry, and so that's a challenge that we have to get through.

So the approach that we've taken is is there any way for us to put this data in their hands sans their attendance to our training events or our organizational events? So we're partnering with different folks from the Council on Firefighter training in Oklahoma and Oklahoma State University Fire Service Training Organization, Dalcoma Fire Marshals, SAC, which is the Safety Alliance of Cushing. Cushing's a major hub in the United States for pipelines. We're working with these different industries as well as response agencies to try to develop what can we provide as a GIS information base of our assets, and it's really difficult because there's a lot of different mediums that that's delivered in to the emergency response agencies. You know, they each have their own Silverlight. They each have their own GIS deployment. They each have there -- you know, you name it, they've deployed something differently, so the challenge is to create a medium agnostic dataset that can be delivered in whatever medium they're using to approach.

And so programs like the NPMS or the more national efforts are what we're really interested in trying to help facilitate improvements to make sure that that's a system that can be accessed during an emergency or during pre-planning, that these emergency response agencies would have data readily available in order to respond.

DR. CHEUNG: Thank you. We also have a question from the audience, and seeing how Ms. Nelson, you talked about change detection and perhaps you can address this. Others may feel like helping.

The question is that there seems to be -- that there were a lot of discussions about a nationwide dataset, so, for example, roadways or any kind of transportation network with unified standards and quality control and what not, but there is not much of a talk about the temporal components of GIS data, and is there any suggestions or advice based on the NPMS experience that can be applied to automotive transportation? For example, geometry of a roadway may change over time and looking at accident data over a ten year period might not necessarily reflect the geometric characteristics of a roadway.

MS. NELSON: Thank you for the question. I hope I'm getting the gist of it with my answer. Audience member, let me know if I'm not.

First of all, let me specify that this year, so calendar year 2012, was our first year of change detection as it truly exists. Last year was the baseline year. So we chose not to go back into the past because we don't have the data structured in a way we could do that and, you know, plot all the changes into the pipeline network over the past, you know -- some pipelines have been there since the 1920s, so that's an awfully long time, but this year shows us the first set of changes from last year.

Talking about the temporal element, yes, we're in the defining stages of building a viewer that will allow you to query pipelines temporally, so to say show me what the pipeline network looked like between this time and this time or show me which pipelines carried ethanol between this month and that month or accidents that happened in this period, et cetera.

Speaking about the challenges and relating them to the railways which might change position slightly, yes, that is one of our biggest challenges. Specifically for us, it's when operators either re-GPS pipelines so they're slightly offset from last year's submission and our tools have to figure out is that the same pipeline or should I match it to a different pipeline which is nearby as well. And when it does that the tool looks at other characteristics like the system name and the commodity carried in order to make the best match, and if it's anything less than very close certainty it has the analyst inspect it manually and determine whether it is, indeed, the same pipeline. So I think that that is similar to what the audience is talking about regarding the railroads.

I would say our second biggest challenge is when pipelines are rerouted. So you might have a pipeline that's rerouted around a new, you know, hospital or something of that nature, so the pipe, you know, is abandoned or inactivated in place and then a new loop is built around the new structure, and operators, I believe, often won't tell us if that's actually new construction because to them it's the same pipeline, it just got rerouted.

So I think that all these cases -- there are solutions to all these cases and these, you know, little blips when the data changes, but it's maybe not viewed as a true change. It's not truly a new pipeline. And I think it's just a case of balancing the tolerance of your tool in terms of looking for lines that match the existing one versus the time you spend manually inspecting all these changes whereas a tool might make it more efficient.

DR. CHEUNG: Thank you. I have one question for Mr. Williams. From your professional experience can you comment on how much geospatial technology is being used in the pipeline operators, and your company is doing it and obviously it seems to be doing a very elaborate process. Is it really common?

MR. WILLIAMS: Yeah, GIS is used extensively in the pipeline industry and specifically at access. You know, as I said, our assets are visible, so we have to have some method of recording our assets and doing asset management.

But we leverage GIS from everything like I presented today with pipeline safety in regards to pipeline integrity, risk analysis, third party damage analysis, but we also use it for everything ranging from, you know, financial system planning. We look at pressures, design characteristics of the lines, when we need to put in a compressor station, what size the compressors need to be. We look at it from a sales perspective or a marketing perspective, which nearby transmission lines gives us the best price at market, so where can we lay to the most easily?

In regards to constructability can we lay through an area? We track our right-of-way or our land owners in the area, so we know it's going to be easier to lay an extra mile to avoid this certain ranch owner as opposed to trying to go buy right-of-way from him. We use it for -- taxation, so we're able to develop our tax schedules off of our GIS system. We use it for preventative maintenance. We track exposures, valve inspections, right-of-way inspections. We do helicopter base lead detection.

GIS is really central to everything that we do. It's our asset base. It's our central repository for every type of information that you can -- I mean we put out -- you know, we put our field office locations in there and the square footage of the field offices, so everything we manage, both core business as well as supplemental or tertiary business process, are managed through GIS.

DR. CHEUNG: Thank you. Chairman, we have no further questions.

CHAIRMAN HERSMAN: Thank you, Technical Panel. Member Sumwalt?

MEMBER SUMWALT: Thank you. Ms. Hunt, as you are aware, positive train control is something of great interest to the NTSB and in order to have PTC system you need to have very precise measurements of your rail. You need to know exactly where the grade crossings are, where the signals are, where the switches are, the inventory of the rails so that you can demarcate the maintenance of way areas. So the measurements that will be taken for PTC, will those be done by the FRA or will those be done by the individual owners of the track?

MS. HUNT: I knew I would get a question about positive train control. I explicitly told Ivan I really can't comment on positive train control because it so sensitive in nature, but I will say that a lot of those measurements, they're -- it's required on the railroads. I believe they have until, I think, 2014 or '15 to go out and GPS down to a very high level accuracy of everything within their -- that has to be adhered to positive train control.

I can definitely give you to the right person, but, again, it is such highly sensitive in nature I really cannot comment a lot about that. I can direct you to the right person at FRA, but that responsibility does fall on the railroad.

MEMBER SUMWALT: And that -- you answered the question right there in that last sentence. The responsibility for measuring the rails comes from -- is the responsibility of the railroads, the owners of the track.

MS. HUNT: Yes.

MEMBER SUMWALT: That's really what I wanted to know --

MS. HUNT: Yes.

MEMBER SUMWALT: -- because you were showing all those nice cars that you go out and measure things. I wasn't sure if FRA was actually conducting the inventories or if that was done by the owners of the track.

MS. HUNT: It's the responsibility of the rail companies.

MEMBER SUMWALT: Right. Thank you so much.

CHAIRMAN HERSMAN: Member Rosekind?

MEMBER ROSEKIND: Mr. Williams, a comment and then a question. We've had -- as you heard in the previous question, two pipeline accidents have come before the Board in the PG&E explosion in San Bruno and then the Enbridge release in Marshall, Michigan, and one of the things that was a theme throughout all of those had to do with the response, and so my comment is you just -- well, first, the negative was we had real problems in the PG&E the operations center didn't even have a requirement really to call 9-1-1. We had the first responders from San Bruno not knowing where the pipes were, not knowing what was carried.

So what was very positive about what you just said is basically programs and efforts to try and address that because we've had a lot of other venues here where in their hearing I asked where's the model for this, where's the industry model for what works? They sent out mailers and in the hearing it came out that, you know, thousands sent out, barely -- less than a hundred came back, and so just because we're sending stuff or there's a requirement to do it doesn't mean it's working.

So GIS seems like it's like this critical foundation for that because you've got to know where it is. Second is what's being carried, so you know the response. So what you were describing sounds really positive, so I want to put you on the spot. Can you talk a little more about, just briefly, timeline for some of those activities and how you make sure that the work that you're doing actually ends up getting translated and transferred to the industry so that it's not, you know, your company benefiting, but really, you know -- when we see accidents, like, oh, no, we're using that model because we know it works, it was tested.

MR. WILLIAMS: Right. So the major concern right now is that we provide the mailers, we provide the county training, but, as I said, there's no responsibility on the other side to come to the table and listen. So our approach has been -- you know, there's been a number of organizations and companies, stand-up GIS systems, where someone can log in, see nearby pipelines -- pull out an iPhone, see nearby pipelines, but, you know, if I go to a fire chief and I say well, here's our website for access, but if you want, you know, ABC Company, XYZ Company, go to those seven other websites and pull all this data together.

One of the maritime presentations was the swivel GIS. You know, you turn on your chair to see each map that you need to see. So the idea is to bring it centrally to where it's in a central location. And not only that, but go to the emergency agency and start from the grassroots movement saying what do you need, what helps you most?

We can throw up solutions all day. We could have something next week for you to go in there and log in and use, but if you're never going to log in and use it what's the use? You know, like you said with the response from the mailers, it's actually even lower than you imagine. It's less than 1% response on the mailers, .2% or so, and normally those are just the fire stations who happen -- maybe the fire chief works at a pipeline company and realizes how important it is to send it back.

So in that regard, you know, some of the projects we're working on like that, I mentioned COFT in Oklahoma, the Council on Firefighter Training, as well as the state fire marshals has been really an integral part of what we're doing as well as the city of Oklahoma City, Oklahoma County, the Sheriff's Department, in trying to tell us what capabilities do you need, what can we provide to you that you're going to use on a day-to-day basis, not just when there's a pipeline emergency, what will you get in there and look at if you're responding to wildland fire, if you're needing to cut a firebreak, if you're needing to see a response plan from a building down the road, what are you going to use more than just when you're thinking about pipeline?

It needs to be something that's in your everyday usage, and so we've formed a committee through the Safety Alliance of Cushing to work with those 11 or 12 operators to kind of start small, create something that's a pilot and try to expand from that.

You know, we're trying to attempt from eating the whole elephant in a day. Let's start with a bite, get something that's manageable and pilotable and create a perfect concept that we can start with at a local level, and then try to create that spark through training or education to make it grow and become something that grows from their side, that they own and they develop and it's for their use and we just become a part of that project.

So it's tough in regard that we're trying to create something that benefits our industry by working through another industry, so there's a lot of challenges there, but, you know, we've made a lot of progress and we're still trying to move forward.

MEMBER ROSEKIND: I just wanted to -- part of the comment was we've heard a lot about this. Yours is a positive action, really maybe the only positive action we've heard, to address this issue and it's a big nut to crack, so I hope, you know, if you start seeing that progress that you find a way to get the entire industry onboard with taking these kinds of actions because, again, this is a GIS conference, that seems foundational to a lot of the critical issues that need to be addressed here, so thank you.

MR. WILLIAMS: Thank you.

CHAIRMAN HERSMAN: Thank you to our four panelists from the public and the private sector. You've given us a lot of good information and I think foundational again to some of our understanding of what our expectations are, information that is made public, information that is private, trying to understand that.

Thank you for your presentations and for answering questions, and for also -- I know we've asked you some tough things. We understand the position you're in and we will follow up on those with your respective agencies, too. Thank you all for your testimony. We're adjourned until 3:30.

(Off the record at 3:10 p.m.)

(On the record at 3:30 p.m.)

CHAIRMAN HERSMAN: Welcome back. We will now wrap up with our final panel of the 2-day conference. Dr. Cheung, will you please introduce our presenters?

DR. CHEUNG: Thank you, Chairman Hersman.

I have Dr. Joseph Kolly and Dr. Robert Dodd of the Office of Research and Engineering assisting me in this panel.

Dr. David Cowen is the Chairman of the National Geospatial Advisory Committee and a distinguished Professor Emeritus at the University of South Carolina. Dr. Cowen, would you start your presentation?

DR. COWEN: Good afternoon, Chairman Hersman, fellow Gamecock Director Sumwalt, other Board Members, and Ivan and his staff and the staff that has been supportive of him. Thanks so much for inviting me to summarize the activities of the last 2 days and to provide some alternative next steps, you know, what should you do next.

First of all, it's been an amazing 2 days. I don't know that, you know, those of us who have been in the field for decades appreciate the type of effort that went into getting together the activities here. You see how pervasive this technology is. When the person from the gas utility says he couldn't do his job with without GIS, then you say this is critical stuff.

I think when the Chairman said just before lunch, we've got to stop thinking about individual events and thinking about things in a larger context and larger -- that summarized it all. You guys got it. So, you know, our job is sort of to summarize those activities.

Somebody just reported they've been watching some of the videos of this. So I think, first of all, this is the first step in the activities here at NTSB. You're going to put together a record that, you know, we would all direct our students to and other people to come see. Because what you've got is every mode of transportation, you've found out the current state of the art, the best practices and some of the issues facing it. So, you know, I think it's going to be a terrific snapshot of where we are.

This is my 45th year in the GIS business; it's my life's work. I've worked closely with the National Academy of Sciences. For many years I served as the Chair of the Mapping Sciences Committee. I've spent the last 5 years with the National Geospatial Advisory Committee. So in other words, I spent about 25 years coming to Washington to try to figure out what they're doing wrong and trying to provide some advice about how to straighten it out. I would say that I'm very optimistic about that right now.

So one of the concerns that I have as the wrap up guy is that I submitted my slides last Tuesday. But I do have -- I've taken many notes about that, and what I'm going to attempt to do in terms of my next steps is provide you a path forward. One of the things that I did want to make -- I have been to every session and I've taken a few notes. So, in addition to those slides and before I start those, these are some of my takeaway messages.

Clearly the technology is pervasive and transparent. It's almost like you don't even have to know it's there, but it is there and you're comforted by the fact that it is there. I think that was the comments that were just made now. It's comforting to know the level of detail that we have about some of these critical infrastructures.

I looked at your Most Wanted List. It looks like GIS to me, you know. Almost every aspect of whether it's motorcycles or -- I actually wrote them down -- aviation, pilot, traffic control, alcohol, teenagers, all of those things, if you put those in a spatial context then you can get to some solutions about those things.

In a sense GIS is forensic, right, it allows you to investigate something and to come away with some critical information about that. That also says that the data quality is critical. You know, if you're off by 20 or 50 yards, or some of this discussion this morning about thousands of feet off, you know, the conditions are different in that spot than the other spot so, you know, you have to put those things and have to push things forward in that.

One of the things that we saw today is a discussion today about what Ohio is doing, and the stuff with NENA this morning. Ohio is a model that says that a state can put together transportation network data to meet multiple purposes. That's a critical issue, okay, that the needs for the Census Bureau, for the public safety people, for the Department of Transportation can be met from a common dataset. And they've run a good model for there, so that's a good place to go and investigate further.

Software and the kind of functionalities that the NTSB require are now available to you through web services. That's part of a takeaway message. You know, it's a great time for you guys to get serious about it. You can access it and get through to it. I'm going to tell you a little bit about some services, data services, software services that provide very little in terms of your input into them and your ability to use those things.

I would say very importantly that the NTSB has a loud and critical voice, okay. If you guys came to the committee that I chair and said we need the federal government to step up and to solve some of these coordination issues, then we would listen. You guys have an awful lot of clout. Nothing is foremost in the public's opinion than public safety, right? We expect government, right, to protect us. Okay, and so you guys are critical in that thing.

Okay. So now let's move ahead with some of these slides, and some of these I'm going to jump through at times because we've heard about it, right? Like Ed just covered everything you need to know about implementing GIS, didn't he? Let's see here, where do I point this? Oh, there we are, okay.

Here's my outline. The role of GIS and Data Technologies in Transportation Safety. Some institutional issues, the Federal Geographic Data Committee, the National Geospatial Advisory Committee; some of the concerns about who should manage and how it should be managed, a transportation theme; some of our own activities and some of the things that my committee has been attempting to do; potential linkages to NTSB; the data accessibility, some standards, some interoperability, we heard a lot about that yesterday; and then some long-term aspects and some steps forward.

So, first of all, in terms of GIS data and technologies. Okay, I looked at one of your reports, okay, and I found these maps, right. Here's a map for an accident report in a non-GIS environment, right. These are static maps that don't give you a whole lot of detail about things, okay.

Now, let's look at that -- where do I point it? Okay, for -- if you look at the context of GIS and maps that form the basis of GIS, we look at public safety as GIS events, right. Events happen at points, events happen along a linear feature most notably and most commonly. So this sort of comprehensive way of looking at GIS environment. Next.

So in a GIS context, and we've seen an awful lot of that in the last couple of days, we see accident reporting. So some of the Bureau of Transportation statistics, GIS data, we can map those things and we can give some spatial context to them. We can put those things in real time. Next.

Okay. And GIS has evolved and we see, you know, there's the vendor out here. And if you heard every one of the agencies that we talked about is using GIS technology, so this isn't some emerging field. It's a very mature field. Next.

So, that whole ability to look at things, as the Chairman said, in context and not as an individual item. And a lot of what we have now is the ability to bring kind of virtual reality, right. It's possible to sit anywhere and to look at the context, just some examples of that. Next.

Okay. And we see that one of the beautiful things is that with current technology things can be placed on the web and be available to everyone at one time. We heard discussions about that, oh, you know, where's that flash drive, where's that paper map? Well, we want to move to this context in which everything is available to us when we need it as a server-based application. Next.

Okay. I was also struck by -- you know, not a whole lot of discussion about infrastructure maintenance in the last couple of days. I was struck by *The Economist* a couple years ago. They put the price tag at $1.6 trillion, you know, for looking at our systems, right, of improving the infrastructure in the United States. And so here we see the cracks in the pavement. And the relationship between those, just think about this as a potential accident scene, right. Next.

And we took a lot of that data in our state and we looked at deteriorating bridges, all right, again special context instead of tabular data. Next.

Okay. So let's look at some of these institutional issues and see whether there is some solutions to some of the problems that we talked about. So I'm going to talk about the Federal Geographic Data Committee, the transportation theme, and then some of the things that we've been doing. Next.

So, there is a thing called the Federal Geographic Data Committee. NTSB is not a member of that, but I think you should be a member. I think you should go to those meetings and I think that you should make yourselves heard very loudly.

The effort of the FGCD -- and we go back to 1994, okay. In 1994, President Clinton, under Executive Order 12906, created something called the National Spatial Data Infrastructure and established a group called the Federal Geographic Data Committee to oversee the coordination of geospatial activities. So that's, you know, that's 1994, right, almost 20 years ago. Okay. And the committee has been involved in trying to figure out a coordinated development use in sharing of geospatial data.

The important thing here is building partnerships: federal, state, local, tribal communities. We heard NENA people speaking this morning about the need for the local governments to be the authoritative source of data, right. The federal government isn't going to go out collect address information. The federal government doesn't have parcel-level data. The federal government doesn't know where all the local roads are. So building partnerships is critical to the FGDC. Next.

Okay. Now, so the FGDC is structured like this. And if you look in the upper left you see this National Geospatial Advisory Committee. Allen actually was a charter member of what we call NGAC, 5 years ago. Established as a Federal Advisory

Committee with very strict structure and policies associated with it.

The NGAC is a group of 28 people. Half of them are private sector. Many of them are state and local government people and just a couple of federal government people. And what we do is respond to requests for guidance.

Every year, and we've just concluded -- we had a meeting on Monday where we concluded responding to some questions for guidance that the Department of Interior provided to us back in January. So one of the things -- one of the ways that you can interact with that is to raise issues -- some of them you heard the last couple days about lack of coordination, and request that NGAC look at that. So we're sort of an objective set of individuals who have no vested interest other than to serve our country and to improve some of these coordination issues. So the FGDC is organized around some data themes, and one of those important ones is transportation. Next.

So, transportation we see is what we call a framework data layer. That means it's of interest to everyone, okay, along with cadastral, which is property ownership records, governmental units, hydrography, elevation, orthoimagery and geodetic control. We heard about every one of those, didn't we? The importance of geodetic control for measuring the coast lines, the role of imagery, the importance of elevation and certainly the transportation theme. Next.

Okay. So under what we call OMB Circular A-16, the Department of Transportation is listed as the steward for the transportation data. Now, we heard Steve Lewis and the Department of Transportation speak yesterday morning. So let me pick up from what he was saying.

Approximately 4 years ago I was invited to go to the Transportation Statistics Board and to discuss the role of NGAC and the FGDC. And so what I did was I looked at the job that the Department of Transportation was doing with respect to being a steward of the transportation layer of the country. Well, I looked, there was no standard, there was no work plan, there was no progress being made at all. Steve Lewis was there as a representative of the Bureau of Transportation Statistics, and he talked about intermodal freight movement.

Well, the good news is that they listened, okay. And Steve has become the spokesperson for coordination of transportation within the Department of Transportation. He spoke yesterday about building partnerships, right. So he came to NGAC, okay, with a plan for building transportation data and coming forth with a serious effort on that for building what we'll call Transportation for the Nation. So I would say there's been a huge amount of progress in that area. Next.

So, there are -- as in all bureaucracies there's an awful lot of changing of statistical reports and different types of standards and other aspects. Okay, this is the latest. Okay, you'll see that there are various -- so the transportation theme, the Department of Transportation now, Rachel Hunt, has been appointed as what we call a SAOGI, or the senior advisor. Next.

It's important to realize that transportation is not just a set of linear features, but there's a series of databases that are associated. So, this is all new thinking and new ways of looking at this. Some of those are the Bureau of Transportation Statistics, but some of those are also Census, and I want to get to that point. Next.

So, I'll move ahead quickly. A very important event happened last week. GAO came out with a report last Monday, okay. Geospatial information, okay, OMB and agencies need to make coordination a priority to reduce duplication. Okay, that report has been kind of festering for about a year.

In 2003, I was invited to testify to a congressional committee. The House -- I forgot the name of the House committee. But basically we said the same thing in 2003, there's a lack of coordination, there's duplication of effort, you're not making the best use of getting local government data together. GAO came out with this report and, you know, it's making the headlines in our field. Next.

Here's the critical issue. That report that came out last week, and Steve mentioned this yesterday morning, recommendations to DOT that there is no strategy, there is no policy, you don't have a set of procedures in place, okay. Very critical and shouting out specifically to the Department of Transportation. I think DOT has taken that very seriously now though, okay, and we heard Steve address that yesterday. So I see some good things taking place there. Next.

So, critical -- right now the big terms is what I call portfolio management. So instead of having one agency, Department of Transportation, be the sole proprietor and steward for transportation, they should be the point of contact for a group of people that would help manage that and have an interest in it. And so we hope that they will develop partnership programs along those lines, but it lays it out very specifically. Next.

There is a standard, the standard for thoroughfares, landmarks and postal addresses, okay. And, Ed, are you still here?

So Ed was one of the co-authors of this, an overview of the draft street standard, address standard. So, there is a standard that does exist. It's been developed in cooperation with the people at NENA, with the people at URISA, the local government. So, we do have a published standard. It was published about a year ago, okay. And there's information about address quality. You saw several reports on that in the last 2 days of how we geocode an address. So those things are percolating up to the top.

A couple of things that we have done at NGAC, okay, we believe that the federal government, and in particular the Department of Interior, had not taken their responsibilities seriously enough. So we said they must assume a central role in the policy, the budgetary and procurement process related to geospatial programs; that the FGDC needs greater authority and a more comprehensive funding strategy, and that's exactly what was echoed by GAO last week. Okay.

We believe that a geospatial strategy for the country would stimulate economic growth. Just take the infrastructure stuff, shovel-ready infrastructure programs. It would help control cost, save taxpayer dollars, and it would support public safety and better decision making, okay.

Specific recommendations that we have, okay, very specifically, multiple agency, intergovernmental data initiatives. Okay, 3D elevation program. The pilots flying in Alaska are doomed in many cases. The data is terrible in terms of trying to find a landing strip there because the data, the elevation data is bad.

Transportation for the Nation, we need to solve that. Land imaging or the land sat program; the land parcel database. The Consumer Financial Protection Agency, the new agency that was just established, wants to create a national mortgage database. Assume that we had that in 2008 when everything was going to hell, but we haven't. We have no federal parcel databases. Don't get me started. National address database, Imagery for the Nation, and some kind of height modernization programs, all these things are important.

We, this week on Monday, we published -- we approved a paper, which will be published in about a week, of the need for a national address database, a publically accessible resource, okay, for the entire country. We think that will save life, reduce cost, so we're going to be huge advocates of this. Those are some of the needs for addresses.

Specific linkages there. You guys need to place accidents and safety into a spatial context. You're not going to be a primary data gatherer; you're not going to build framework data, but you have to work with the people who are producing that data so that your attributes can be associated with that, okay. Very specifically, you know, I hope you've learned in the last couple of days, we can give you ways of doing forensics and analysis, but you guys are going to come back with issues about speed limits, crossing hazards, guardrails, signage, bridge maintenance, all of those things that are ways that we can improve, you know, and anticipate and improve the situation.

A couple of issues here in terms of interoperability. The Obama administration has pushed very hard that we have a common platform, okay. And I would say that the Department of Interior has stepped forward on this, okay. We have the prototypes of a geospatial platform in place now. Ivan and his people should work closely with this so you can go in and get things as services, common data, common services, common applications through web-based interfaces instead of buying desktop GIS and staffing up, okay. This is the way we're going, and I think this provides you a great way to enter the field.

In terms of the highway database -- let me jump ahead here because I'm kind of running out of time. We heard yesterday about MAP-21. This is a landmark, okay. This is the first time the Department of Transportation has been charged with collecting every public road in the United States, that's paved and unpaved roads, okay. It's provided financial support to the states to do that. Okay, that's a big deal, right.

So let's look at a couple of things. There are differences between what the Census Bureau talked about yesterday and their TIGER/Line files, which has been the only digital representation of roads that we've had for the last 20 years, and that jumpstarted the whole industry, right. I mean, when you look at your navigation system, okay, or Google Map or anything else, it all stemmed from Census Bureau's pioneering work, okay, to create a street centerline file for the country. But there are differences in the ways that would treat interstate highways and ramps, okay.

Let me show you a very specific example. I did some work in Loudon County in suburban Washington here, in Virginia, and what we saw was the local street centerline file, and that's sort of in white here -- let's say we have a roundabout. Most street centerline files established by local government and those that were needed for transportation have to support navigation, right. So if you come to a roundabout, you've got to see that that roundabout is there and that you can't just go through that intersection. The Census Bureau TIGER data would make a T intersection of that, okay, because they don't really care; nobody lives in that center, okay. So, we have a little bit of a misconnect there.

But let me tell you that geo -- you know, I've been doing GIS, as I say, 45 years and we've got some pretty fancy tools, okay. So here's a great example. So we've got street centerlines here and let's assume that we wanted to attach the address, right, we want to attach an address to a point on the street centerline. That's what you want when you navigate, right? You want your navigation system to say you have arrived and you've arrived at the right location. So in this particular case we've taken parcel-level data in the centroid, which does have the street address, and we've snapped it to the street centerline.

My point here is that even though there may be differences in the type of attributes, and we saw this huge list that Ohio had, there's differences in terms of the attributes that different users want on those street centerlines, we have tools that we can make that right. If you get the geometry right, then we can build the attributes. Okay.

So, let me close with a couple of interesting examples here. You see, this is the crash on I-10 last week, okay. That didn't have to happen; it didn't have to happen, right? We already have, and we heard presentations about that here, right, crews on, you know, autopilot slot themselves into awkward parking spaces, brake -- you know, automatic braking. And we have a whole variety of different examples. We heard some from University of Michigan today. We heard from Riverside yesterday. There are about 20 cars that can drive themselves. And that all is involved with an intelligent sensing system, okay, where we have an instrumented, augmented environment, and we have vehicles that can respond to that, you know, in an intelligent way. And it's been proved that we can do that, right? The Google people probably have been foremost in proving that we can do that.

Now, you know, I like people who kind of think out of the box a little bit. So *The Economist* in October said, let's just think about it for a moment if we really had driverless cars, okay. Well, we'd boost car sales, right, because we'd have a whole bunch of feature rich stuff. We'd increase the capacity of existing roads, right, because we could drive nose to tail, right? We'd have new designs -- why would we need steering wheels? Why would we need pedals? Okay. We would have all kinds of entertainment for the driver. Kind of interesting, right? He doesn't have to watch the road. We could have busses that travel in convoys. You don't need to stop at night, let the car drive you to the next destination in the morning. So we'd need fewer hotel rooms, we'd have a loss of jobs, we'd have taxis, car rentals could all be merged into a different kind of environment. We could live further from work, right? Anyway, I thought those were interesting.

So, let me conclude this. A robust GIS program would enable NTSB to improve the way it monitors, manages its safety programs. NTSB should work closely with other federal partners. NTSB should take advantage of the platforms that now exist. And NTSB should help guide the stakeholders, okay. You guys should be looking forward to some concerns about the next generation of vehicles. I'll conclude there.

DR. CHEUNG: Thank you Professor Cowen.

Mr. Allen Carroll is the program manager for arcGIS online content at ESRI, and also a former chief cartographer of the National Geographic Society. Mr. Carroll, please start your presentation.

MR. CARROLL: Thank you very much, Dr. Cheung, and Members of the board and NTSB staff. It's a real honor to be invited to speak here and also to have the perhaps slightly dubious distinction of being the last panelist on the program, so I'll try to be brief and merciful.

At any rate, I'm going to talk about something slightly different but actually very much related to what a lot of things that Dave was talking about, which is this notion of emancipating data and using GIS to serve the public. I think a lot of the discussion has to do with GIS serving the organizations that have built the GIS and the data therein.

And forgive me for this slide but just a little bit about my background, which is just slightly germane, which is that I come to GIS from a slightly different viewpoint. After 27 years at National Geographic, and as you can see being exposed to maps at a very early age -- that's me in the middle. I joined ESRI a little bit over 2 years ago to head a story maps team. And a lot of my life coming from an editorial and design background has been about telling stories with maps. So right now I've got a very specific charge to head a small team and we're cranking out more or less on a weekly basis these story maps.

Why are we doing them and what is a story map? Well, we're combining maps with other rich content: text, photos, videos, et cetera, to tell various stores. And what we're trying to do is combine the traditional allure of maps with the latest in technology, including, of course, GIS, but also mobile and web apps, in order to inform, education, entertain and inspire people in a whole bunch of different ways about the world. And this isn't to tout our efforts, but just to serve as examples that you can peruse at your leisure. We've got a modest website at storymaps.esri.com. And so, as I said, pretty much every week we publish a new story and you can just browse it at will.

Why are we even making story maps? We want to -- you know, it's just a nice platform, nice sort of ego boost for me to just say, hey, this is an interesting topic, let's take it on. That's the least important of what we're doing. But we're working hard to develop new ways to tell stories with maps, so new user experiences using these wonderful media that we have at our fingertips these days. And we want to show how GIS is very dramatically emerging from the back office. And, of course, its function in the back office remain very important, but it's now suddenly, and in a much more comprehensive way, available to a much larger audience.

And then I feel very strongly about this, this notion of liberating enslaved data. So again, a little bit more on that notion that the GIS data has been very valuable to the organizations that have created it and manage it, but just like any enslaved person who is serving that organization, that person is not fully functional as a citizen until he or she is liberated. And I feel that way very strongly -- not about all data, of course. There is some data that's proprietary for business or national security reasons. But to a large extent data can do a whole lot more when it's liberated and made available to larger audiences.

And by the way, that doesn't mean just set free. In other words, you don't just say, okay, here's my data in the form of GIS data or Shapefile or just even a web map. It has to be kind of trained and enabled as a citizen. So in other words, it has to be interpreted and presented in a useful context, and that's kind of what we're about.

And then, finally, and to me perhaps most exciting, is to enable lots of other people to create and publish their own story map. So it's fun for us to create our story maps, but a big part of what we're doing is, as we create a story map, we then say, okay, we created this little app, this little user experience; is it useful in a broader context? And sometimes it isn't, but a large percentage of what we do is useful. And so we work behind the scenes to then kind of package that up, make our code a little more kind of watertight and present it -- and make it available to the public so that they can build their own story maps. And we have on our site, a growing gallery of examples of how people have used some of our templates and put their own data in it and created sometimes some really interesting and unexpected versions of what we've done.

Meanwhile, we at ESRI and I think in the academic community too, talk about the various uses of GIS. And what we're especially interested in, of course, is this last one, of constituent engagement. So that means taking that data and making it available to managers, to Congress, to other agencies, to citizens, in terms of how NTSB might think about constituent engagement.

Meanwhile, putting it in the context of the mission of the NTSB, of course, it's that last issue, safety recommendations, where this makes the most sense. So, if we're -- I think -- I don't want to presume knowing much about how NTSB works, but if accidents didn't have some kind of context, you might just be able to have a one sentence report saying this accident was a random event; it just happened. Well, of course, accidents don't just happen. They happen in a very rich and complex and interesting set of circumstances, many of them -- most of them, perhaps, having a key special component. So that, I think, GIS interpreted again in the form of a story made understandable to the public is a key part of a safety recommendation. So in other words, in all of these contexts it really is about telling stories.

And so how do you make a story map? Well, you first start with stuff that's not technology-based at all. You have to have an idea of what your story is. And, of course, in this context it has to do with saying these are the factors that might have caused this accident and these are factors that might contribute to preventing future accidents. And then, of course, you have to think about the audience that you're telling it to; is it a technical audience or a non-technical one.

Then come the nuts and bolts. One is compiling and publishing intelligent web maps -- more on these to come. And then publishing those into an app or application that creates -- that packages that map or data up into a really interesting and user friendly user experience.

So a little more on web maps, and Dave had alluded to this, that another really key component of this emancipation of data and GIS emerging from the back office is that now GIS is dramatically, increasingly enabled via the web. So that we can now create, all of us without training can find very rich and interesting datasets from many, many different sources, be able to mash them up in a form of a web map or an intelligent map that essentially is a set of instructions saying, okay, go to this server and draw me out this set of data and combine it with imagery from this server over here. So those web maps themselves are very powerful. And then we put them, as I mentioned, into apps that can be used by everyone everywhere.

So we try to make our apps -- to write them in code that works across all platforms. What we haven't completely done yet, but are working on, is also making sure that those apps are adaptive so that you can view them both on a big screen in your office or home, but also on your tablet or on your smart phone.

So just to reiterate slightly, so what we take is a series of raw materials, we assemble them into web maps on our GIS online, and then we essentially pour those into apps that we've developed to serve audiences via these various platforms. And by the way, this is not a linear process; it's a very iterative process to refine these stories.

And we have a growing selection of these apps or templates that we make available to anybody and everybody that the source code is downloadable free of charge. And people can have at them and hack them and modify them to their heart's content. And we plan to make this process even easier. Right now it means to some extent, a small extent in many cases, going into the source code and making changes to commands and things, which I personally am not very good at all. So we're in the process of making it even easier, providing builder apps that essentially give you a wizard-style means of assembling these stories.

And it's hard for me these days to give any kind of presentation without a live web link. So I'm going to show very quickly a series of examples of the kinds of story maps that we've done just so you know -- get a sense of what we're doing.

So one basic concept I should mention is the GIS, of course, is very powerful software that can do all sorts of things, but when we're telling a story, we strip off almost all the functionality. So we're saying, okay, we need to serve an audience with a very specific need so we want to do just one or two or three very basic things.

So one thing we did last year for the centennial of the sinking of the Titanic was simply go to Wikipedia and get a list of the passengers of the titanic. And as with any tabular information that has a spatial component, once you put it on a map you discover really interesting things. So one thing we discovered was that the fatality rate for first class versus steerage passengers was much larger. So this is first class, two-thirds survived; steerage passengers, only about a quarter survived. But then you go also into the patterns and you see steerage -- the first class passengers were mainly from cities in western Europe and the U.S. and Canada. Steerage passengers were from really interesting places, a lot of small rural villages in Ireland and Scandinavia and even the Levant and the Middle East and beyond.

And then our little app enabled people to then drill down, click on a town and find out who from that town was aboard the Titanic. And in this case, in this small town in the United

Kingdom was all something like 10 or 12 members of a single family, all of whom died on -- perished in the sinking. And then for each passenger you're also able to see where that passenger originated, where they boarded the Titanic, and their intended destination.

So, a very different example is that we learned of a study that NOAA did assessing the potential damage of the biggest historical earth -- I'm sorry, hurricanes, if they were to strike today. And so we compiled a kind of top 10 list of the most devastating or potentially the most devastating hurricanes. And, of course, the one we all think about -- well, now we tend to all think about Sandy, but when we published this story in September we were thinking about Katrina. But, in fact, the most damaging potentially one was this unnamed earthquake [sic] that went right across -- mowed right across the center of Miami. So if that hurricane were to strike today it would have been very, very devastating.

So, yet another example was a partnership with IUCN, which is a big international conservation organization. And they, of course, are keepers of the red list of rare and endangered species. And I've always felt -- this is a typical example of really rich, really important data that's been sequestered or enslaved within this organization. So we created this little viewer where they could highlight representative species.

So you can use this little slider to change the endangerment level and you see a different species located on a map, and then a click on to one of those icons calls up a more detailed description of that species and the reasons it's threatened and its range map along with links to more technical information for those who might want it.

So, I haven't been -- I haven't had the time or been able yet to create a story map specific to NTSB, although I would love to do that, by the way. But I did -- we did take a look at some data. So here's an example just thinking how we might take some data that's relevant to NTSB and turn it into a story map.

So here is data on bird strikes. And there is, of course, the actual number of bird strikes or bird strikes per passenger departing from or arriving at an airport. And it was the latter that, of course, that was more interesting and certain things, certain destinations stuck out, one of which was Santa Barbara, California. So for each of these, by the way, you can view by month when the bird strikes happen. So you might, you know, you might be able to find from that, that migratory birds are a cause of the problem or it might be more consistent year round.

But one of the -- you know, one hypothesis might be that airports close to wetlands might have a greater threat level from bird strikes. And there were examples, by the way, of both. There were high bird strike airports that weren't close to wetlands. But this is a perfect example of how something like a geospatial platform through which data from many federal agencies is available would enable a story. So in this case, it's that bird strike data, together with National Wetlands Inventory data, that shows that in fact the Santa Barbara airport, as those of us have flown in and out of Santa Barbara know very well, is right next to a wetland, which also right there in its coastal location means that your flights are often delayed due to fog, not just birds flying around.

Here's an example, in Harrisburg, Pennsylvania, it's proximity not so much to wetlands but right there next to a river where you might find gulls and geese and herons flying around.

So that's just one example to drive home, and I'd like to repeat, this notion that getting this kind of information out to our broadest possible constituencies in these new ways is a wonderful opportunity for us all, and I think specifically for NTSB. Thank you very much.

DR. CHEUNG: Thank you, Mr. Carroll.

Dr. Kolly, question?

DR. KOLLY: Yes. Wonderful presentations both of you, thank you very much.

Mr. Cowen, just as kind of a wrap up question, considering the greatest impact on transportation safety, can you offer one GIS technology or capability that's available today that's not being used to its fullest extent? And also, what would you recommend to change that?

DR. COWEN: That's a good question, because I actually learned an awful lot in the last 2 days, and I'm impressed and very pleased to see the pervasiveness of the tools at the Department of Transportation.

I guess what we heard this morning, you know, about identification of lane switching. You know, I mean, I think that there are -- people who say that we can actually implement much safer automobiles for an expense of something like 3- or $4,000, right, that can do automatic braking, can prevent lane switching, you know. Is it possible to move that instrumentation of the transportation network in such a way that we would have sensors that would be available to anyone who had that technology?

I don't think we talked a whole lot about pavement management systems in the last couple of days. You know, I think there's a lot more that could be done there with harvesting that data. We saw a little bit of that with the rail system. But I think that, you know, what is the relationship between the type of pavement and accident rates?

I know that our state does a heck of a job with respect to that pavement management. Even the, you know, a lot of things -- a lot of people are moving toward 3-dimensional transportation networks. I've heard estimates of, you know if you put a truck on cruise control but the truck doesn't realize that it's going downhill and is approaching another hill the waste of fuel is something like 20%, whereas if you could anticipate that there's a hill ahead of you. So we have a lot of 2D networks that would be greatly enhanced by adding the third dimension.

DR. DODD: Like Dr. Kolly, I'd like to thank you for two excellent presentations. I also appreciate your enthusiasm. After 2 days I've learned quite a bit too, and I came away with, I think, a conclusion that we're doing pretty well on the analytical side of the house with the software tools and development and what's going on in that regard. And this is actually for both of you. What I'm a little less clear on and what I'm a little concerned about is, collection of data, good quality data is an expensive and labor intensive process; it's not easily done. And it seemed to me that there is unevenness in that process and coordination between the various stakeholders is not necessarily where we'd like it to be.

Can you talk a little bit about what you see the future might be as far as making that process more efficient, making the coordination perhaps -- the GAO report certainly is addressing that, but to me it seems to be a great challenge to get where we would like to be with GIS potential.

DR. COWEN: Well, let me address it with a very specific kind of example. This MAP-21 initiative, I think it's a game changer, okay. Because, you know, there were very specific deadlines, and I think by this summer each state is supposed to tell DOT how it plans to meet that need, you know, and then start actually gathering the data, and there's money involved with doing that. Well, what I have found over the years in terms -- and I guess that's why I would say I was very pleased to see how well GIS has penetrated the Department of Transportation and the different examples that we have seen. Because traditionally highway departments have stood alone. They've been autonomous, right. They have gasoline tax, they have their own funding basis, you know, they've got their own rules. And they've got their own GIS-T. They have their own interest group that does that. They haven't always played very nicely with those people who are interested in demographic and natural resource applications or public safety applications.

Well, it's going to be interesting -- we have a meeting on Monday. I'm interested in our how state DOT is going to address this issue, because all they have to do is come to our state GIS coordinator who has 46 counties -- every county we've got street centerline files, address points and parcels already done, okay. So, you know, it's a matter -- and we're going to love it because people are going to start playing nicely with one another, right, because that's the cost effective way to do it. So, I think that's a great example. So I think this is a game changer. But I'm really concerned with making sure that Census and DOT and the public safety people sit at the table and try to iron out these issues with how can we do this in a consistent set of geometry, right, and then adding the attributes that are necessary.

MR. CARROLL: I'd like to quickly make a very different point, which is that in some ways data collection is a continuing challenge, both in terms of a huge and ever increasing volume of data and the number of players involved. But in another sense, data collection is so much easier than it use to be. And, in fact, we are all potential data collectors. We've all got these devices. And, of course, there are serious and continuing privacy concerns, but of course I've got on my iPhone a traffic app where I can report with a click on the screen a traffic accident or say whether, you know, the stretch of road that's showing green should be red. And that we've got literally millions of potential sensors out there in real time, that provides an enormous opportunity for ever richer data, if we can just some of the, I think, completely solvable challenges of how to go about collecting and gathering and integrating that data while dealing with issues like privacy and security, et cetera.

DR. DODD: Okay, thank you.

DR. CHEUNG: Thank you. I have a question of my own, but I think there's also an e-mail question that is more or less in the same thread of thought. This is particularly for Mr. Carroll. You talk about, you know, using the story map and I think it is very important for a safety agency like ours to communicate safety message and recommendation and whatnot to the public or decision maker. What kind of team should we put together to more effectively put together either that is a map or a geovisualization, you know, type of thing?

MR. CARROLL: Yeah, that's a good question, and I'm still learning the degree to which there really can be quite a divide between the kind of analytical and technical capabilities that many

GIS analysts have and the story-telling capabilities that those GIS people may not have. And that -- you know, I've used -- I tend to consider GIS the hard part, the data the hard part and the story telling is, oh, well, if you just put it together. Well, guess what, story telling -- because I've been doing it for a long time, that's the easy part to me.

So, I think that's the key, it's getting those people in the back office doing the analytical work connected to existing or future people in the, you know, in the public affairs office who are good at framing the question of what is the story and what elements do we need to tell it and really key questions like what do we take off of the map that we don't need or what can we leave out in order to focus on the story.

So, I think it's that, you know, it's the GIS expertise, of course, it's the communications expertise, and then a third, of course, might be this app development expertise. And we're trying to kind of fill that gap with our own apps but there are always, always needs and opportunities for new ones. So a web development capability, web and mobile development capability might be the third part of that formula.

DR. CHEUNG: Thank you, Mr. Carroll.

Chairman Hersman, we have no additional questions.

CHAIRMAN HERSMAN: Member Sumwalt?

MEMBER SUMWALT: Thank you. This really has been a fascinating couple of days, and Dr. Cheung, thank you for your advocacy of this. I suspect that you're the one that planted the idea. And, Dr. Kolly, I thank you for your leadership. I think that's a hallmark of a good leader is recognizing talent that works in that person's department and enabling that person to flourish. So thank you for allowing this to happen; it really has been fascinating.

I think the first time I heard the term GIS was when we had the PG&E San Bruno accident and we were talking about the GIS measuring the attributes of the pipeline. And now we've had this forum and certainly I've learned a lot more.

I also note that, Dr. Cowen, you've been in this business for only 45 years and you were a late comer, I guess. It's been around for 50 years. But, you know, you've been doing this for as long as the NTSB has been around. We were established in 1967, so -- and that's the year you got into it.

So, really what I get out of this is that we're taking data and turning it into useful information. And it's amazing how when we saw some of the presentations, like the FRA showed a tabular format of the attributes of the track, and then we showed a GIS presentation of that and just how much more clear that was to somebody having to look at it without having to spend a lot of time interpreting that.

And, Dr. Cowen, thank you for outlining a road map, if you will, for moving forward, I think that's what we need is what can we do with the last 2 days? What can we do at the NTSB do with it, and I appreciate your laying that out.

I thought the presentations this morning were particularly -- they were all interesting, but this morning I was fascinated by the fact that you can, you know, on our iPhones we can look and pull up somebody's picture of their house and see where it is. But to realize that we can drill down, through a good GIS program, we can drill down and see the floor plan of a house. We can even pull up a picture of somebody that may have special medical needs. We could probably even have in a file the medications that that person may be taking or something like that.

And, Dr. Cowen, you and I both live in a fine state but just back in October there was a huge data breach where 4 million Social Security numbers were stolen from the Department of Revenue. I'm not one of these people that spends a lot of time worrying about security. Back when I was at the University of South Carolina, as you will recall, we used to post our grades outside the door using Social Security numbers, but now when somebody finds that out we're all up in arms. But it does bring up an interesting something that the question has been raised, the privacy issue, the security --

CHAIRMAN HERSMAN: And sometimes you didn't want people knowing what your grades were, was that right?

MEMBER SUMWALT: Exactly. I didn't care if anybody knew my Social Security number; it was the grade I was worried about. But anyway, so I know we're really out of time, but you know, what measures are taking place to make sure that this is -- these data are secure? Are they in different databases and then fused or how does this -- how would this ideally work?

DR. COWEN: I remember those now that you reminded me, posting grades by Social Security number, that was not long ago.

MEMBER SUMWALT: I was going to say, it wasn't that long ago.

DR. COWEN: It wasn't that long ago.

MEMBER SUMWALT: Thank you for saying that.

DR. COWEN: We happened to meet for breakfast this morning and I was telling you about an example in our state where the county published a list of 13 pages in the newspaper, 2 columns in 13 pages of delinquent property taxes, okay, every parcel in the county that was delinquent, okay. And so -- the nice thing was, there was a website, the URL; you go there and all of a sudden all that tabular data is a map. And you can push -- click on any one of those parcels and what you bring up is the owner, the address, the amount of delinquent taxes, and how long they've been delinquent.

Now, there's a lot to be learned from that, okay. If you choose to own property then you have to live by the rights and responsibilities of society, okay. If you wish to be below or out of the radar screen don't own property, right. There's a lesson there, okay.

What I would say is, the issue of geolocation privacy is a huge issue, okay, because right there, using that data, you are attaching an owner to an address. Most of the databases that we're talking about here would strip that away. All we're interested in is what are the XY location -- XY coordinates of an address, independent of who lives there or owns that property, right. But clearly, with data mining activities, such as the one here on property ownership, you know, you can acquire an awful lot of information about that.

The question of geolocation privacy I will refer to the committee that I currently chair, NGAC. We had a panel on that in September -- I think Ivan, you were there -- and that we kind of kicked that one off, okay. Let's just say that within the federal community there's a huge awareness of this issue and I know that we're going to follow up on it. So this Federal Geographic Data Committee and the NGAC folks, you know, we hope to develop white papers and to lay out the alternatives for protecting that.

But again, the response this morning was a proper one; the need to know is the need to know is the critical issue, right. The first responders needed to know some of those conditions about what they were facing and the residents of that house where they were would benefit from the first responders knowing that information as well.

MEMBER SUMWALT: Well, thank you. And I do recognize there would be tremendous benefit for that information to be known. I worry about the people that don't need to know that do find out about it. But anyway, as long as people are worrying about that and trying to figure out and make sure it's not misused I think that's the main thing. Thank you very much, it's been great.

CHAIRMAN HERSMAN: Member Rosekind.

MEMBER ROSEKIND: So I mentioned earlier to both of you, all the pressure to close; great close. So the next pressure is we've got to be done. So, very short response. Dr. Cowen, Dr. Kolly already asked a question, you know, we issue recommendations and you were kind of in the weeds about sensors in the pavement, et cetera. Big picture, if the NTSB were to focus somewhere, where transportation safety would be most enhanced by sort of our laser focus on a particular GIS issue, what would that be?

DR. COWEN: Wow.

MEMBER ROSEKIND: You can send me an e-mail later.

DR. COWEN: Yeah, how about that. Yeah.

MEMBER ROSEKIND: Well, you've talked about, you know, the coordination of the groups. We've heard database. We've heard so many different things. We're in a particular area of recommendations. I'm giving you a little more time to think here.

DR. COWEN: Right, right.

MEMBER ROSEKIND: You know, and so I get the level of detail -- you're in the weeds with him. I'm thinking, big picture, if we were to, you know, after this conference, out of focus, what would that area be, you think, that we could have the most impact?

DR. COWEN: I think pushing all of the stakeholders, you know, the kinds of portfolio management, get the Department of Transportation to step forward, okay, meet their responsibilities. Get stakeholders together and make sure that for everyone of these networks that we talked about today, okay, that we have the most accurate and timely manner of collecting and maintaining that data, okay. And doing it in such a manner that we're making sure that the local partners, those people who are closest to the data, have an easy way of sending it and letting the federal government ingest that data.

MEMBER ROSEKIND: Great.

DR. COWEN: I think there are obstacles. There's Title 13 and other kind of questions that we have about that, but --

MEMBER ROSEKIND: Great. No, that's excellent.

And, Mr. Carroll, you've already answered my question, which Dr. Cheung asked, and it was basically going to be, who do we call at your organization to do the first NTSB story map? I'm sitting here with a great half dozen in my own head, but I think I already heard you make a commitment for the first one, so I'd just like to confirm that on the record again, if you would, but --

MR. CARROLL: The commitment is hereby confirmed. Now, I have a business card right here.

MEMBER ROSEKIND: We'll exchange at the photo. Thank you very much.

CHAIRMAN HERSMAN: On behalf of all of the Board Members and all of our staff I'd like to recognize I see that we don't have quite as big of a crowd as we did when we started yesterday, but I thank all of you all for sticking around. And I thank all of our panelists. They took so much time out of their own busy schedules to provide us with great presentations and answer our questions. I think we've heard so much about what is possible. I think that at the end of the day we've realized that really anything is possible when we're looking at this GIS.

I think that was brought home to me in a very personal way. I have three sons. We visited the science museum in Richmond. And they have an SOS that it's a Science on a Sphere. I'm sure that you all have seen these, and they're basically pulling together information from 250 databases, and they use an iPad app. And they stand around and they allow the children to ask them any question, you know, about the world. Where do most hurricanes happen? And they pull it up. And they pull up the world. Where do the tsunamis happen? How do the whales migrate? You know, all of these amazing things that all these different databases from around the world have pulled together. And you know what? The kids don't think that there isn't a question that can't be answered. They ask any question that they want expecting that they will get an answer and that they can trust and believe that that answer is true. That's what we need to do. We need to realize we can ask any question and the data can pull that out. The only limit is on us understanding what the questions are and what the limitations of the data are.

We at the NTSB will be taking what we've learned over these last 2 days, and we have another tool in our toolkit. We look forward to using it. We look forward to working with this community to ask the right questions and to get the best answers to improve transportation safety. We stand adjourned.

(Whereupon, at 4:37 p.m., the proceedings in the above-described matter were adjourned.