**2012 Report to Congress**
**on**
**Intelligent Transportation Systems**
**Program Advisory Committee Recommendations**

## 1. Overview

a. Pursuant to Section 5305(h) of the Safe, Accountable, Flexible Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU, P.L. 109-59), this report describes how the U.S. Department of Transportation (DOT or Department) has implemented recommendations made by the Intelligent Transportation Systems (ITS) Program Advisory Committee (ITS PAC) in 2011.

b. The SAFETEA-LU directs the Department to establish an Advisory Committee with no more than 20 members to provide advice to the Secretary of Transportation on the scope and direction of the Department's ITS Program by providing input into the development of the ITS aspects of the Department's strategic plan and by reviewing ITS research being considered for funding. The Department is also directed to submit an annual report to Congress in February of each year that includes:

(1) All recommendations made by the Committee during the preceding calendar year;
(2) An explanation of how the Secretary has implemented those recommendations; and
(3) The reasons for rejecting the recommendations not implemented.

c. In response to the SAFETEA-LU requirement, the Department established the ITS PAC in 2007. Since its inception, the ITS PAC has met eleven times. Early ITS PAC meetings focused on strategic planning activities and program reviews that were critical to development of the ITS Joint Program Office's (ITS JPO) Five-Year ITS Strategic Research Plan for FY 2010 – FY 2014. In 2008 and 2009, the Department solicited the ITS PAC's specific input on the ITS JPO future mission, goals, and focus areas. Also, as required by SAFETEA-LU Section 5305(h)(3)(B), the Department requested that the ITS PAC review proposed ITS research initiatives and provide the following input:

(1) Whether current research activities are likely to advance either ITS state-of-the-practice or state-of-the-art;
(2) Whether ITS technologies are likely to be deployed by users, and if not, to determine the barriers to deployment; and
(3) The appropriate roles for government and the private sector in investing in the research and technologies being considered.

d. In December 2009, the ITS PAC was reconstituted for a new two-year term with 20 members comprising 7 who had served on the previous Committee and 13 new members. The reconstituted ITS PAC's two meetings in 2010 focused on leveraging the diverse professional backgrounds and viewpoints of committee members to gain a better understanding of the relative importance of critical issues facing the ITS research

program. In August 2010, the ITS PAC submitted a memorandum to the ITS JPO that outlined several issues to form the basis of subsequent ITS PAC meeting agenda topics and help shape the planning and execution of the ITS research program.

2. **ITS PAC Activity in 2011**

   a. The ITS PAC met four times in 2011. The January and March meetings were held at the Oakland California Metropolitan Transportation Commission and in Detroit, Michigan, respectively, to provide the ITS PAC more in-depth information on ITS in transit operations and automobile manufacturer vehicle-to-vehicle (V2V) technology research. At the January meeting, the ITS PAC established three subcommittees to focus its evaluation of the ITS research program on three areas that the ITS PAC considered are the most critical aspects of the program: technology strategy, standards harmonization, and program evaluation and strategy. To support the ITS PAC's efforts, the ITS JPO presented briefings at the January and March meetings on six ITS research program issues that the ITS PAC had identified for discussion in its August 2010 memorandum to the ITS JPO. Unfortunately, a V2V demonstration scheduled for the Detroit meeting was cancelled due to inclement weather.

   b. The ITS PAC's May and June meetings focused on subcommittee deliberations and progress briefings on their assigned ITS research program evaluation topics. As needed, the subcommittees engaged outside experts and ITS JPO staff in the process of developing their recommendations. Following wide-ranging discussions and debate, the ITS PAC reached consensus on twenty-six recommendations to help improve the ITS research program in the critical areas of technology strategy, global standards harmonization, and program evaluation and strategy. The ITS PAC submitted its recommendations in a November 28, 2011 advice memorandum to the Department. The Department carefully considered the ITS PAC's advice and responded, describing the Department's implementation of the Committee's recommendations. The ITS PAC's recommendations and the Department's response are included in paragraph 3 below.

3. **ITS PAC Recommendations and U.S. DOT Response**

   a. **Technology Strategy.** The ITS PAC concluded that it is important to consider at least two levels of automotive safety systems it called "soft safety" and "hard safety." In general, soft safety systems can utilize higher latency communications for primarily driver information. Hard safety systems involve safety warnings and vehicle control that must be based on low latency, highly robust and secure communications, such as from a dedicated short range communications (DSRC) network.

   **Recommendation 1.** Develop concepts for, promote and facilitate open platforms and standards for software developers that can be accommodated in the Connected Vehicle infrastructure architecture, to promote the development and incorporation of "soft safety" applications using consumer electronics devices, developer applications for those devices, and communications interfaces with existing cellular infrastructure or other consumer networks to enable near term and wide deployment. Successful deployment of

a Connected Vehicle system depends on widespread adoption by the user community so that the costs of system expansion can be shared with high volume consumer applications. This is essential for promoting consumer buy-in and for motivating the private sector investments that will drive costs down so the necessary market penetration is achieved.

**Department's Response to Recommendation 1.** The Department concurs with this recommendation and is taking action toward its implementation. Proper layering within design of the Connected Vehicle system is a key enabler for open platforms to support all types of applications. One of the features of the recently completed system description update is the inclusion of the concept of layered communications – the content of the message used to facilitate an application is separated from the medium used to transport the message. Based on feedback from the ITS PAC and other stakeholders, the design of the security credential management system that will initially be used to support the Safety Pilot Model Deployment, a one-year field test of new vehicle safety systems, makes use of a layered approach so that other wireless communication media such as cellular could be used for "soft-safety" applications as appropriate. The Department believes that this recommendation serves as a guiding principle for maximizing the benefits and minimizing the costs associated with connected vehicle technology integration.

**Recommendation 2.** Promote, encourage, and use open systems that seek to maximize broad-based active developer communities.

**Department's Response to Recommendation 2.** The Department concurs with this recommendation and is taking action toward its implementation. As noted by the ITS PAC, it is important to engage a broad range of developers to enable a robust industry and creative development. At this point in the research program, the Department has taken care to ensure that all device procurement activities related to the Safety Pilot Model Deployment have been held as full-and-open competitions. We have attracted a number of companies that range from small start-ups to old-line automotive and infrastructure electronics companies. Their devices are being designed so that they could eventually accommodate third-party applications. This is one step toward the broader goal of engaging an active developer community. The Department will continue to be cognizant of this recommendation from the ITS PAC as research progresses.

**Recommendation 3.** Respond to the specific need for non-proprietary and/or license-free security, authentication, and Application Programming Interface (API) standards, which include data among vehicles and data transmitted between vehicles and infrastructure, as well as transit schedule-related data.

**Department's Response to Recommendation 3.** The Department concurs in principle with this recommendation and is taking action toward its implementation. For example, the Department is engaged in policy research products that outline the viable alternatives for security, authentication, and API standards. As part of this work, per the ITS PAC's recommendation, the use of non-proprietary approaches will be investigated. A second activity is the Safety Pilot Model Deployment, where several security and credential

management schemes are being deployed and evaluated for suitability as a model for long-term deployment.  Again, the Department understands the ITS PAC's recommendation for non-proprietary interfaces.  The final resolution of this issue may hinge on the party that becomes the final deploying entity.

For transit data, the goal is for non-proprietary data, and DOT is currently examining this as part of the Dynamic Mobility Applications program.  Applications will be developed using non-proprietary data and open sourcing.

**Recommendation 4.**  Rely as much as possible on communications architectures that promote flexibility and extensibility and can be used across multiple sectors, not just within the transportation sector.

**Department's Response to Recommendation 4.**  The Department concurs with this recommendation and is taking action toward its implementation (see Department's Response to Recommendation 1).  This topic was discussed in the ITS PAC's meetings; therefore, the Department had previous insight into this recommendation.  The thoughts of the ITS PAC, as well as input from others in the ITS community, prompted the Department to update the system architecture for connected vehicles.  The recently completed system architecture update emphasized the proper layering of communication to allow the separation of the message payload from the medium that transports it.  This allows a variety of communication media to be used as fits the needs of the applications, which promotes flexibility and the broadest possible user base.

**Recommendation 5.**  Using the principle of driver opt-in, consider ways to make vehicle data available to developers who can then innovate applications serving individuals as well as applications generating information from the data across wider populations of drivers and vehicles.

**Department's Response to Recommendation 5.**  The Department concurs with this recommendation in part and is taking action toward its implementation.  The ITS JPO plans to make data from federally-funded *research* programs available for research purposes in an open data environment accessible through a Research Data Exchange providing supporting mobility, weather, and sustainability data environments to application developers and researchers.  We will then use the lessons learned to support recommendations related to a deployed connected vehicle environment.  However, in a deployed system, availability of the data is likely to be the prerogative of the owner of the data.  In many instances, DOT may have limited leverage to compel privately-owned data to be made available to developers.  The Department agrees that driver opt-in solutions may offer an opportunity to the broad developer community for greater innovation based on the availability of new data sources.  However, the Department may have little direct authority in this space, depending upon the final deployment scenario that is ultimately determined to be viable.

**Recommendation 6.**  Emphasize utilization of common, high-volume commercial sector components wherever possible to leverage cost curve advantages so that new solutions do

not necessitate high-cost, low-volume components.  Where customization is required, attempt to utilize open, common hardware standards and customize with software for flexibility and lowered costs.  In addressing aggressive "hard safety" goals, the current Connected Vehicle system concept has certain technological limitations which should be thoroughly analyzed and evaluated.  While active V2V and vehicle-to-infrastructure (V2I) programs (collectively, V2V and V2I concepts are referred to as "V2X") need to be pursued in a timely manner, the Federal Government should continue to reassess its assumptions and be completely objective about the technology and its limitations.  These limitations are noted in the following three recommendations.

**Department's Response to Recommendation 6.**  The Department concurs as outlined in the responses below.

**Recommendation 7.**  Connected Vehicle performance will be highly dependent on vehicle positioning performance.  Ensure that lane-level positioning is feasible in most conditions, across all vehicle types, and at acceptable cost.  For V2V communications, relative lane-level positioning is key, while for V2I, absolute lane-level positioning is critical.

**Department's Response to Recommendation 7.**  The Department concurs with this recommendation and is taking action toward its implementation.  Further, the Department concurs with the ITS PAC's assessment that positioning is a critical element for successful V2V and V2I performance.  Therefore, technical analysis is under way to ensure that this issue is fully addressed and resolved.  Specifically, the Crash Avoidance Metrics Partnership (CAMP) and the DOT are jointly conducting extensive research into characterizing the positioning performance of the various GPS devices and positioning services that make use of them.  Furthermore, in the Safety Pilot Model Deployment, both V2V and V2I applications will be deployed in the test environment and extensive data will be collected which can be used to accurately assess the performance of the devices in terms of absolute and relative positioning performance.  Based on the results of the data collection, performance standards may be employed to ensure that V2V and V2I positioning solutions are consistent and accurate across all manufacturers.

**Recommendation 8.**  Near-zero communications latency and packet loss is essential to V2V safety performance.  Ensure that this is feasible under extreme communications loads and at acceptable cost.

**Department's Response to Recommendation 8.**  The Department partially concurs.  First, near-zero packet loss is very difficult to achieve, and current research has shown that some amount of V2V packet loss is acceptable while still meeting the minimum V2V performance levels.  Furthermore, packet loss alone is not an adequate metric.  Packet loss requirements must be coupled with requirements on inter-packet gap.  We are not prepared, at this point, to quantify these values and the final specification may vary according to the various application types.  The results of scalability testing, other performance testing, and the Safety Pilot Model Deployment will provide a basis for future recommendations on required packet performance and latency.  However, the

intent of the ITS PAC's recommendation is understood and the Department agrees that reliable performance of the communications systems is essential for safety-of-life applications. The Department will continue to assess this issue in future Connected Vehicle research.

**Recommendation 9.** Current DSRC 5.9 GHz communications have limitations in line-of-sight, range, and signal blockage and corruption. Ensure that this signal will be robust in all realistic intersection environments. The potential gap between Federal Government platform initiatives and private sector deployments - the problem of "if we build it, will they come?" - needs to be monitored and addressed. The success of a Connected Vehicle Safety System will also require active participation at all levels of government; it is important to devise ways to speed State, regional and local adoption of technologies that meet safety goals.

**Department's Response to Recommendation 9.** The Department concurs with this recommendation and is taking action towards better characterization of performance and increased robustness of the technology. The line-of-sight limitations of DSRC are currently being tested and results have been positive. Those tests have demonstrated strong capability for the signals to take advantage of features in the environment to cause signals to go around vehicles and around blind intersections. This capability has been demonstrated at each of the Safety Pilot Model Deployment driver clinics as well as at demonstrations in Washington, DC and public demonstrations at the ITS World Congress in Orlando, Florida. We continue to conduct performance testing at each of the driver clinic locations around the country and in a variety of environmental conditions; e.g., urban canyons, rural, etc. Roadside equipment is also being redesigned to include multiple radio sets that provide equally capable radio lines-of-sight at intersections. We will also be collecting data as part of the Safety Pilot Model Deployment to ensure that the technology meets necessary performance requirements at both intersection and open road environments.

Additionally, another objective of the Safety Pilot Model Deployment is to begin involving State, regional, and local governments in limited model deployments to better understand the issues associated with actual deployment of connected vehicle safety technology. Lessons learned from the Safety Pilot Model Deployment will be applied both to the DOT research program as well as to the State and local governments involved with ITS deployment and operation as part of the continuous ITS technology transfer function.

**Recommendation 10.** Use leverage and incentives to maximize and strategically support a complex nationwide deployment for an extended period of years. While V2V capabilities may be mandated for the auto industry, potential actions affecting other sectors and industries (including the infrastructure sector) also need to be considered.

**Department's Response to Recommendation 10.** The Department concurs with this recommendation and appreciates the emphasis that the ITS PAC places on this issue. While V2V capabilities are critical for advancing safety, they alone do not encompass the

entire vision of connected vehicle technology. This vision also includes the capability for vehicles to interact with traffic signals and "back-end" systems to support a multitude of safety, mobility and environmental applications. The ITS policy research being conducted by the ITS JPO is looking at how the broader network needs for connected vehicles could be implemented and supported. Additionally, the Department continues to engage the stakeholder community throughout all of its research activities related to the connected vehicle program. Specifically, DOT works with American Association of State Highway and Transportation Officials (AASHTO) members to understand the perspectives of State and local agencies. The Department expects to have more clarity on how to provide for other sectors and industries as the research illuminates opportunities and tradeoffs.

**Recommendation 11.** Communications with vehicles and with individuals will require applications at the device level (including in-vehicle) and the services infrastructure to deliver the required services and applications. Whatever part of that infrastructure is defined or implemented by the Federal Government should be delivered to State and local governments to reduce their required investment. This could be done via model deployments that are executed in such a manner that they can truly be replicated by other regions and organizations. In order for such model deployments to become permanent, operational solutions, it is essential to allocate the maintenance and operational expenses of the system after the termination of the model deployment.

**Department's Response to Recommendation 11.** The Department partially concurs. At this time, the infrastructure requirements to support a connected vehicle environment are not clear nor is it clear who will be the most logical party to provide infrastructure should it be needed. Multiple final system implementation models for connected vehicle infrastructure exist, and various public, private and hybrid approaches are being explored through the current policy research. Should the best approach involve State and locally deployed infrastructure, then field testing and model deployments would certainly be a viable approach to familiarizing State and local agencies with the technology and facilitating local deployment. However, part of the consideration must include full deployment and the associated operations and maintenance costs. The level of effort is not yet clear and would require serious discussion with any party that provides the final system. The Department is aware that the ITS JPO research program funding is not intended, nor adequate for funding long term operations and maintenance costs of deployed systems.

**Recommendation 12.** Decide on where open standards are required and ensure that they are put in place so that system solutions work in all locations and the operation of vehicles and experience of individuals is the same wherever they travel.

**Department's Response to Recommendation 12.** The Department concurs with what we believe to be the underlying intent of this recommendation. The Department agrees that an appropriate suite of V2X applications should be made available to permit seamless nationwide interoperability. Standards are an essential part of ensuring consistent operation between vehicles. However, the Department does not advocate

"open standards" in the sense of the sometimes-used definition where anyone may add to or alter content of a standard. Rather, the Department advocates open standards development processes that allow full participation of all interested stakeholders in the development of standards that are then made available on equal and reasonable terms to everyone. For the most part, we support standards development being led by appropriately qualified standards development organizations (SDO) via their own processes using open working groups and a rigorous but appropriately tailored systems engineering process. In our experience, this has produced the best results for ITS standards, although the Department supports alternative development processes when advantageous to do so. Further, when beneficial and feasible, we of course will continue to seek to harmonize standards internationally. Currently, it is not the Department's intent to specify how warning systems will be displayed inside a vehicle. The Department supports the vehicle manufacturers' opportunity to differentiate their system solutions to meet all necessary performance requirements – including those related to driver distraction.

**Recommendation 13.** Monitor private sector developments in vehicle communications and safety technologies to ensure that planned government systems will be compatible.

**Department's Response to Recommendation 13.** The Department concurs with this recommendation and is taking action toward its implementation. In 2008, the Department, through the ITS JPO, established a technology scanning program to monitor private sector technology developments related to communications and other topics with potential implications for the connected vehicle environment. Recent technology scan studies have included: Electric Vehicle and the Smart Grid; Vehicle Based Active Ranging Sensors – RADAR, LIDAR and Ultrasonic Sensors; Location Aware Technologies and Vehicle Applications – High Resolution Navigation, Computer Vision and Active Ranging Sensors; Stream Computing and Real-Time Transportation Applications; Global innovations in computing with a focus on design of secure systems and risk management. Based on the ITS PAC's recommendation and the great value the Department and its partners and stakeholders have found in these assessments, the ITS JPO plans to continue the technology scanning effort to ensure ITS technologies are compatible and interoperable with other commercial technologies.

**Recommendation 14.** Ensure that the unique needs of full electric and hybrid electric vehicles are included in the Federal Government developments. Support and incentivizing of this rapidly emerging segment, which enjoys a large investment in technology, could assist rapid deployment of Connected Vehicle technology.

**Department's Response to Recommendation 14.** The Department concurs with this recommendation and is initiating action toward its implementation. Based on the ITS PAC's recommendation, the Department, through the ITS JPO, has allocated funds in the fiscal year 2012 budget to explore the potential to leverage electric vehicle research and development into the connected vehicle research. This funding will enable the Department to better understand the unique needs of full electric and hybrid electric vehicles. The connected vehicle research team has had initial discussions with

Department of Energy colleagues.  The ITS JPO plans to continue this dialogue as we execute the exploratory research into electric vehicle technology.

**Recommendation 15.**  Ensure that vehicle drivers have control over their data and that adequate privacy safeguards are in place to prevent data breaches and to maximize participants' ability to exercise control over their information.

**Department's Response to Recommendation 15.**  The Department concurs that privacy and data protection policies are essential components of any connected vehicle system, and is actively addressing privacy and security safeguards through the connected vehicle research.  The Federal Fair Information Practices Principles (FIPPs) established under NIST SP 800-53 Draft, Appendix J (http://csrc.nist.gov/publications/drafts/800-53-rev4/sp800-53-rev4-ipd.pdf) will provide the framework for analysis of privacy protection in any test or end-state system involving the Federal Government.  However, the Department concurs in part with the statement that vehicle drivers must have control over their data.  Should the Department conclude that some safety applications be made mandatory, the data needed to support those applications would be mandatory and not optional.  On the other hand, future opt-in services would allow vehicle drivers to choose data to be shared as required by the services that they seek.

**Recommendation 16.**  Encourage facilitation of multimodal transport by investigating ways to publish transport schedule and price data so that it is searchable in real-time.

**Department's Response to Recommendation 16.**  The Department concurs with this recommendation in part and is taking action toward its implementation in a research environment.  The Department plans to make *research* data available for research purposes in an open data environment accessible through a Research Data Exchange providing supporting mobility, weather, and sustainability data environments to application developers and researchers.  Mobility applications and data supporting multimodal transit, freeway, and arterial transportation are being explored that can provide transit schedule and pricing data both static and in real-time.

From the perspective of the transit community, the Department concurs with the intent of the recommendation.  The ITS JPO is working with the Federal Transit Administration (FTA) and the transit community to address some of these issues.  However, with respect to transit data, specific data challenges exist.  Since transit agencies own their data, the data they make available may vary from one agency to another.  The Department has limited authority to require data sharing.  Nonetheless, the Department has supported the concept of open data sharing through standards.  The ITS JPO, in partnership with FTA, has made available standards (TCIP) and Google has established a common feed standard so that when transit agencies want to coordinate services they can share information in a common way.  The Department will continue to encourage and facilitate real-time multimodal data sharing for all high-value transportation data sets to leverage greater uses and benefit to the traveling public.

b. **Global Standards Harmonization**

**Recommendation 17.** The ITS JPO should make, and periodically reinforce, a clear public statement that globally harmonized ITS standards are critical to the efficient and rapid deployment of ITS technologies. Similar statements from the Administrator of the Department's Research and Innovative Technology Administration (RITA), the Secretary of Transportation, and the Secretary of Commerce would add important emphasis. The statement should also make clear that the quality of standards and the degree to which they are harmonized is more important than arbitrary dates imposed for completing them. While ITS JPO has in the past made such statements as part of its outreach programs, clear single-purpose statements, and reinforcement from higher levels within DOT, would be of substantial value.

In order to play a visible, leading role, the ITS JPO should provide adequate funding to appropriate organizations to involve more U.S. experts, develop harmonized standards and apply pressure where appropriate. The appropriate office/department within the U.S. Government should be identified to assume leadership of this important issue. It is also critical that this issue be given adequate senior level political support within DOT, the Department of Commerce and the White House. The other regions are invested at the political level and the U.S. Government should be as well.

**Department's Response to Recommendation 17.** The Department concurs that high level reinforcement for internationally harmonized standards by key U.S. political leadership is valuable and desirable. The Department has continued to publicly reinforce our commitment to internationally harmonized high-quality standards and has cooperated with the Department of Commerce via the National Institute of Standards and Technology (NIST) to disseminate our messages. Recently, the Secretary of Transportation spoke at the ITS World Congress in Orlando and reiterated his support of the V2V research and met with the international consortium of automobile manufacturers involved in the research. Going forward, the ITS JPO will seek additional opportunities to elevate outreach efforts and advocacy for harmonization of international standards by senior political leadership including the Secretarial level. Regarding the recommendation that the appropriate office within the Federal government be identified to assume leadership of this issue, the Department uses the ITS JPO to coordinate ITS standards engagement across several agencies within the Department. Specifically, standards continue to be discussed and coordinated among RITA, National Highway Traffic Safety Administration (NHTSA), Federal Highway Administration (FHWA), Federal Motor Carrier Safety Administration (FMCSA), FTA, and the Office of the Secretary (OST) to ensure high-level visibility and appropriate stakeholder involvement from all modes. With the ITS JPO serving in a leadership and coordination role with other DOT modal administrations, the Department can also connect and cooperate with other governmental and industry stakeholders. The ITS JPO regularly reports to the Secretary on the progress of international standards harmonization, as RITA is responsible for the implementation of the Secretary's Performance Plan item regarding international standards harmonization.

**Recommendation 18.** The ITS JPO should seek to play a more visible leading role in encouraging the development of globally harmonized standards by adequately funding organizations dedicated to and programs designed to result in harmonized ITS standards, and applying strong political pressure to standards organizations and other stakeholders where appropriate. Sufficient funding needs to be made available to effectively deploy U.S. interests in harmonized standards. In the case of federally-funded organizations, the ITS JPO should fully exercise contractual/grant authority to encourage harmonization. The ITS JPO should make a commitment to ensure adequate funding in future years, reinforcing its commitment to harmonization. The ITS JPO should ensure sufficient U.S. government staff are involved and encourage vehicle manufacturer participation in appropriate international standardization forums.

In order to further support the need for harmonization, the ITS JPO should fund a detailed analysis that demonstrates the implications of non-harmonized standards and the obstacles to achieve harmonized standards. The outcome of such an analysis would be useful for all members of the standardization community worldwide. However, it is noted that if such analysis is not done quickly, its value will be diminished by the pace of standardization activities in many regions. The ITS PAC recognizes that it will be challenging to find a means to credibly conduct such a study recognizing the competitive nature of industry and likely challenges in obtaining sufficient data of a type that is not normally publicly available.

**Department's Response to Recommendation 18.** There are several points in this recommendation with varying levels of Departmental concurrence. The Department agrees that robust involvement from industry experts and SDOs is needed to support standards harmonization. Having heard ITS PAC discussion on this topic over the last year, the Department has strengthened existing programs to provide appropriate funding for expert, industry, and SDO participation in activities to support harmonization. In recent months, these capabilities have been further strengthened by award of a cooperative agreement task to the Vehicle Infrastructure Integration Consortium (VIIC) for automobile industry support on harmonization efforts. Further, contracts have been awarded to SAE International, AASHTO and the Institute of Transportation Engineers (ITE) for future standards development work. These contracts specifically require international harmonization support. In all of these activities, the Department exercises intensive management oversight of the agreements with the SDOs to ensure the development of standards in a timely manner that will facilitate the deployment of ITS technologies. The Department exercises highly effective management without resorting to any forms of political pressure.

The ITS PAC recommends strong Federal funding support. To that end, the Department has allocated additional funding from the ITS budget to support international standards harmonization efforts. The Department believes that with the new contracts in place and increased funding allotments for development of globally harmonized standards, industry support will further increase. Current budgetary plans propose to continue this strong support, which appropriately reflects the high priority of this program. In the future, we plan to fund additional efforts via SDO contracts and other means to execute further

specific work items in support of the harmonization program. Additionally, in October 2011, based on collaborative work between the DOT and the European Commission (EC), the EC sent letters to the two leading European standards development organizations encouraging their commitment to participating in international standards harmonization activities. The Department is in the process of finalizing a letter to the International Organization for Standardization (ISO) reiterating our support of harmonization.

The Department concurs that Federal staff participation is essential. The ITS JPO has attempted to be as comprehensive as possible within staffing constraints and increasing international travel restrictions. The Department acknowledges that staff participation has not been as strong as desirable due to these constraints. Nonetheless, we believe Federal staff involvement continues to increase in effectiveness as relationships are established and strengthened. In order to provide additional staff support, as recommended by the ITS PAC, the Department intends to establish a multimodal Federal support team to ensure appropriate Federal leadership, especially as new work items are identified.

The Department agrees in principle that a timely and detailed analysis of the impact on non-harmonized standards would be both valuable and worthwhile. The Department also agrees with the ITS PAC's view that it will be challenging to obtain credible information to support such an analysis. The Department will assess the degree of difficulty involved in this undertaking and make a final determination regarding the feasibility of accomplishing this recommendation in the first quarter of calendar year 2012.

**Recommendation 19.** The ITS JPO should fund an analysis of the costs and benefits of harmonized and non-harmonized ITS standards. At present, the European Union (EU) and Japanese participants to their respective regional Harmonization Working Groups (WG) with the U.S. are populated by a mix of government and industry personnel. This allows them to address harmonization issues at all levels. In contrast, official U.S. WG members are all U.S. government employees in order to assure compliance with legal requirements. Representatives from both the EU and Japan have stated that they would strongly prefer a mix of government and industry personnel and that without this mix the discussions are often inhibited in face-to-face meetings. Recent ITS JPO action to open WG meetings to additional participants is an appropriate course of action. In addition, until recently, meetings of the WG were both infrequent and short. The expansion of participation and increase in length to 1.5 days of the most recent WG meeting in Vienna in June 2011 is a welcome change. On this present course, the Harmonization Plan (HAP) will be completed well after the harmonization timeline has expired. The pace of Plan development, and, therefore, the frequency and duration of development meetings must be accelerated.

**Department's Response to Recommendation 19.** The Department concurs that understanding the underlying costs and benefits of harmonized and non-harmonized ITS standards would be valuable information. The current costs of V2X technology implementation are only a forecast with substantial uncertainty. Further, vehicle

manufacturers' incorporation of V2X technologies will be accomplished primarily through the purchase of products from suppliers. In this highly competitive industry, credible information on these costs is not easily available. That said, the ITS JPO will investigate whether such a study may be feasible in the near future.

Regarding the recommendations on frequency and participation in standards harmonization WG meetings, the Department generally concurs with the likely long-term benefits of the recommended actions. As a result of the ITS PAC's discussion, the ITS JPO has already broadened U.S. participation in WG meetings substantially by including U.S. representatives from SAE, ISO, and the VIIC. The ITS JPO will continue to explore methods to ensure robust involvement from U.S.-based stakeholders. The ITS JPO also reached agreement with the EU to increase both the frequency and duration of WG meetings. We intend to maintain this frequency and level of participation going forward. It should be noted, however, that the ability to (1) schedule and conduct meetings and (2) execute HAP work items more quickly are dependent upon our international partners' willingness and ability to act along with the DOT and U.S. industry partners. The Department believes that Federal Government staff and non-government involvement is essential in the strategic establishment of harmonization work groups and chartering their activities. The Department plans to continue to enhance stakeholder participation in the development and execution of both a comprehensive standardization plan for connected vehicle technologies and in the related harmonization plans that can now be initiated after completion of the Core System Architecture in late 2011. The Department intends to continue to provide travel support funding for voluntary industry experts participating in standards harmonization efforts. Further, the Department plans to continue engaging with industry experts via more traditional means, including SDOs, technical support contracts and cooperative agreements. This commitment to support U.S.-based experts will be substantial and will enable consistent and committed participation by the U.S. in harmonization efforts

**Recommendation 20.** The ITS JPO should ensure that the U.S. – EU Harmonization Task Force and any future U.S. – Japan Harmonization Task Force (and any other existing regional collaborations working on harmonized standards) are properly supported by both the U.S. Government and industry personnel who are actively engaged in standards work. Further, these groups should meet face-to-face more frequently and for longer periods than had been the case until recently in order to create a workable Harmonization Plan early enough that it supports the aggressive timeline proposed for the creation of harmonized standards. Further still, the U.S. should work to collapse the various regional Harmonization Task Forces into one global Harmonization Task Force. Presently, a variety of international and regional standards organizations are developing ITS standards that will impact the ability to efficiently and effectively implement V2X. Absent strong leadership and commitment, these standards will be developed regionally and will result in inefficiencies and costly duplication of efforts, delaying deployment of V2X. The U.S. Government should play a key role in supporting the identification and prioritization of key standards and support harmonization of those standards. The U.S. Government should continue to work with Europe and Japan as well as seek to engage with other major and emerging markets in this effort. While support for key "core" V2X

standards is critical to the success of the V2X program, support for the broader range of ITS standards is also critical considering the breadth of V2X and the need to send a clear message to standards organizations that they need to work together to develop a full range of harmonized ITS standards.

**Department's Response to Recommendation 20.**  The Department concurs with this recommendation and is acting in accordance with the collective desires of the countries involved.  The U.S. and EU have included Japanese participation in our cooperative work to the extent desired by the Japanese, and we have jointly and clearly stated our willingness to expand cooperation into tri- or multilateral agreements, as well as our willingness to welcome other interested partners.  For example, DOT is currently acting upon an expression of interest received from the South Korean government.  The ITS JPO continues to seek expanded leadership roles in international harmonization of ITS standards and continues to support U.S. governmental, standards community and industry participation, including meeting participation to the extent feasible.  As indicated in the response to recommendation 19, the DOT is looking into mechanisms to enhance industry expert participation as technical areas are identified for harmonization.  In our communications with the EU and Japan in particular, all parties struggle to balance the demands for individual research activities and the resources needed for international travel.  We share a commitment to multilateral work and we share the challenges that work at a global scale entails.

**Recommendation 21.**  The ITS JPO should work together with industry and others to develop a list of key V2X standards that should be prioritized for harmonization. Included in the V2X standards list should be a harmonized method to qualify any V2X system's performance and interoperability.  Some work in this area has been done regionally, but the regional data has not been aggregated and synchronized to create a global list.  This final prioritized list should then be shared with governments in Europe and Japan and a consolidated multilateral prioritized list negotiated.  The progress of these standards can then be tracked through the various standards organizations and pressure applied to ensure that they are being developed in a harmonized fashion.  Since V2X will encompass a broad range of standards, the ITS JPO should work together with industry and others to promote expanded standardization of ITS standards so that a clear message is sent to standards organizations about the critical importance of harmonization. Consideration should be taken for patents that are embedded in the developed standards (for example, the IEEE 1609.2 standard and Certicom) and the associated licensing waivers and agreements.

**Department's Response to Recommendation 21.**  The Department concurs with this recommendation and is acting accordingly.  The Department developed an initial list of candidate standards for harmonization and provided that list to the EU representatives through the WG.  The Department is awaiting EU input on this list.  Further, now that the U.S. V2X Core System Architecture has been completed, the ITS JPO will proceed with developing a reference implementation design of a candidate deployment architecture in order to derive a comprehensive list of candidate interfaces for standardization; this interface list will then be analyzed for harmonization potential with respect to EU and

other V2X architectures.  The ITS JPO continues to cooperate with stakeholders to promote expanded harmonization of ITS standards.  The Department is in the process of developing a letter to ISO to encourage the development of harmonized standards.  Our recent contracts with SAE, AASHTO, and ITE include language requiring the SDOs to work on standards harmonization where applicable.  Additionally, the Department has initiated a Legal Policy sub-team to research and assess the issue of embedded patents associated with V2X technologies and recommend appropriate steps regarding any needed licensing actions.

c. **Program Evaluation and Strategy**

**Recommendation 22.**  In addition to making progress toward national deployment objectives, the ITS JPO should provide an effective program and incentives to support system development, investment, and deployment by others such as State and local entities and private sector technology developers.  The ITS JPO should identify and quantify its investment in major program elements that are designed to support deployment such as prototype development, technical feasibility, demonstration pilots, evaluations, standards development, facilitation forums, etc.  The ITS JPO should measure how the ITS investment in each of the major program elements has resulted in deployment by others; e.g., deployment tracking.

**Department's Response to Recommendation 22.**  The Department partially concurs with this recommendation.  Over the last two decades, ITS activities within the Department have grown and matured so that today the Department's ITS involvement encompasses several modal administrations, as well as the research program managed by the ITS JPO.  The complete picture of ITS within DOT must be viewed from a Departmental level, of which the ITS JPO is only one part.  For example, FMCSA manages the Commercial Vehicle Information Systems and Networks (CVISN) program, FHWA has an active ITS program in support of transportation planning and operations, FTA supports ITS activities specific to transit properties, and NHTSA supports the Next Generation 911 office.  The efforts of these modal administrations are more specifically focused on deployment within their individual mission areas.  The ITS JPO works closely with these modal administrations and, in some cases, provides additional research funding support to supplement funding they have access to within their modal budgets.  When combined, these Department-wide activities form a complete picture of ITS, from research and testing through the final deployment stages.

More specifically to the ITS JPO, per current legislation, the purpose of the ITS JPO program is to "research, develop and operationally test" ITS, as well as to provide "technical assistance" in application of ITS.  Consequently, the ITS JPO program focuses on research and makes use of model deployments, field operational tests, and technical demonstrations.  There are many examples of the use of field deployments over the history of the program, the most recent of which include field tests of the Integrated Corridor Management (ICM) program, Mobility Services for all Americans (MSAA), CVISN, the Congestion Initiative, and the Rural Safety Initiative.  Field tests and technical demonstrations such as these and others provide an opportunity for evaluation

under real-world conditions and give opportunity for stakeholder (both public sector and private sector) involvement.  The most recent example is the Safety Pilot Model Deployment, which will be a real-world test of connected vehicle V2V and V2I technology.

With that background, the Department is not clear what the ITS PAC intends by the recommendation to provide "incentives."  For example, the Department does not have authority to change match requirements for ITS deployment projects; however, ITS projects are eligible for Federal-aid funds.  Secondly, the choice of which projects to fund is the prerogative of State and local planning agencies.  Further, we believe that the ITS PAC did *not* intend that ITS research dollars be used to fund ITS deployment, as the amount of ITS research funds is insufficient to make an impact on nationwide ITS deployment.  On the other hand, ITS research funds are actively used to seed technology development and new industries that support technology applications in transportation.

Finally, the Department is pleased to note the ever-growing pace of ITS deployment.  The most recent ITS deployment tracking survey, completed in 2010, indicates multimodal growth in ITS deployment (survey results at http://www.itsdeployment.its.dot.gov).  Estimates from our most recent ITS deployment tracking indicates that the largest 75 metropolitan areas cumulatively invest $500 million per year on ITS.  The current level of ITS investment among the largest metropolitan areas is estimated to be $18 billion.  ITS deployment, however, is not equal across all segments of the transportation industry.  Toll agencies have reached near saturation in ITS toll technology.  Large transit properties have made strong use of traveler information for transit schedules.  Nonetheless, the Department is in full agreement that ITS deployment benefits from continued emphasis to ensure growth and expansion.  The Department, through modal administrations and the ITS JPO, will continue to promote and facilitate deployment in coordination with State and local agencies responsible for deployment planning, operations, and maintenance.

**Recommendation 23.**  The ITS JPO should facilitate and accelerate institutional transformation among the DOT modal administrations and through Federal interactions with State/local governments and the private sector.  The ITS JPO should communicate transferable lessons across geographic areas where it is of fundamental value (or necessary) to achieve progress towards deploying transportation technologies.

**Department's Response to Recommendation 23.**  The Department concurs in part with this recommendation.  The ITS JPO uses a number of tools to communicate transferable lessons to potential ITS adopters across geographic areas.  The ITS Knowledge Resource databases, available online, free to the public, provide a unique collection of reports, studies, technical documents, and instructional guides for planning, procuring, and deploying ITS.  Four databases are available that are focused on ITS costs, benefits, lessons learned, and deployment statistics.  Additionally, specific technology transfer components are embedded within the major research initiatives, such as ICM, MSAA and the Congestion Initiative.  The ITS Professional Capacity Building (PCB) Program contributes to the transfer of ITS technology through in-person and online training

courses, web seminars, peer exchanges, and workshops primarily directed at the State and local transportation agencies. The variety of content and formats allow ITS professionals to meet their learning needs in the most customized and accessible way. The ITS JPO continues to work closely with the DOT modal administrations and actively seek areas to effectively partner in knowledge and technology transfer efforts. For example, the ITS PCB Program has partnered with FHWA and FTA to conduct training courses as well as the delivery of technical webinars and other knowledge transfer activities. However, as mentioned above, the ITS JPO is only one part of the ITS presence within the DOT. The Department views ITS as an inherently multimodal activity, and as such, technology transfer must be, and is, included in the mission areas of all modal administrations actively involved with ITS, in addition to the ITS JPO. The Department acknowledges the ITS PAC's recommendations pertaining to institutional transformation of DOT modal administrations. The Department believes that much institutional transformation has occurred. This is exemplified by expanded FHWA involvement in transportation operations and active NHTSA management of critical V2V program elements, as well as the relocation of the ITS JPO into RITA. All of these progressive changes speak to the cooperative efforts between the ITS JPO and modal leadership that reflect the strong commitment across DOT to foster deployment of ITS technologies. However, consistent with the ITS PAC's recommendation, the Department will continue to explore new ways to leverage lessons learned across geographic regions and across modal administrations to advance ITS adoption.

**Recommendation 24.** The ITS JPO should develop and execute strategies to support investments in modal technologies that are adaptable to other modes. The ITS JPO should evaluate these strategies to determine the degree to which technology investments that are made primarily for a single transportation mode will be beneficial to other modes.

**Department's Response to Recommendation 24.** The Department concurs with this recommendation and has made a significant effort to ensure that the ITS research program reflects a multimodal perspective. The ITS Program is structured to be multimodal, and involves nearly all of the surface transportation administrations within the Department. By bringing the modes together to coordinate research, the Department, through the ITS JPO, fosters the sharing of knowledge about technologies that can be applied across modes in two ways:

One way is through applying technology developed for a specific mode; e.g., automated vehicle location on transit vehicles, to deployment in other modes.

A second approach is to support activities that promote multimodal solutions. Examples include ICM and Adaptive Transportation Demand Management (ADTM) that foster the use of modal technologies to solve multimodal issues for the entire transportation system. Through ICM, the Department provides guidance to assist agencies in managing the transportation network as a system. Agencies learn how to manage their regional and cross-jurisdictional corridors as an integrated asset in order to improve travel time reliability and predictability, help manage congestion and empower travelers through

better information and more choices.  ADTM builds on this work using technologies and innovative operational approaches for improving traffic flows and transportation efficiency within the existing infrastructure.

**Recommendation 25.**  The ITS JPO should work toward an ITS program that contributes to a sustainable transportation system that supports economic development, environmental protection, and social equity.  The ITS JPO should propose the key metrics for each of these sustainability objectives and the data collection required as technology deployment occurs.  Measures should include the degree to which an integrated strategy of ITS investments at the regional/metropolitan planning organization level, as determined by the federally-required metropolitan planning process, results in achievement of a more sustainable transportation system.

**Department's Response to Recommendation 25.**  The Department concurs and is in the very early stages of considering sustainability metrics for ITS research.  In order to reduce the learning curve, the Department is seeking to learn from others by developing these metrics in coordination with the EC and Japan as part of the formal agreement to share research results.  Once developed, it is our intent for these metrics to be included in future ITS deployment tracking surveys.  We note the ITS PAC's recommendation that these measures be incorporated into the metropolitan planning process.  FHWA's Offices of Operations and Planning lead the Department's work on incorporating ITS into transportation planning processes.  Representatives from these offices are part of current discussions on this subject.  Further discussions are planned with these Offices to ensure the ITS PAC's recommendations are fully considered in the Department's work going forward.

**Recommendation 26.**  The ITS JPO should recommend program-level performance metrics, including metrics for the recommendations of the other two subcommittees, for review by the ITS PAC and implement them as an integral part of an ongoing independent evaluation to measure specific outcomes against expectations.

**Department's Response to Recommendation 26.**  The Department concurs with the intent of this recommendation.  The ITS JPO is currently working with the Volpe National Transportation Systems Center and the various programs to investigate project, portfolio-level, and program metrics intended to evaluate the overall performance of the ITS Program.  Individual project milestones are important measures of success for internal investment decision-making as well as external communication to stakeholders.  In addition, the ITS Program is developing processes to enable Program-level evaluation based on a portfolio-level approach.  The recommendations made by the ITS PAC are helpful and provide information for consideration in this effort.  Reviews of other Federal Government portfolio research programs provided some views on how to approach this effort, but there is no one specific approach that directly applies to ITS.  However, best practices obtained from across the Federal Government; specific information from the benefits, costs, and lessons learned databases; and information from the ITS PAC will be used to develop an approach tailored to the unique aspects of the ITS JPO.