

**BEFORE THE UNITED STATES
DEPARTMENT OF TRANSPORTATION**

Wireless Innovation for Transportation
Request for Information

**COMMENTS OF THE TELECOMMUNICATIONS INDUSTRY ASSOCIATION
REGARDING WIRELESS INNOVATION FOR TRANSPORTATION**

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TABLE OF CONTENTS

I.	INTRODUCTION.....	1
II.	DISCUSSION	
	ITS APPLICATIONS FOR RURAL AND SPARSELY POPULATED AREAS INCLUDING M2M	3
	ITS APPLICATIONS ON NATIONWIDE PUBLIC SAFETY BROADBAND NETWORK ON LTE	9
	ITS APPLICATIONS FOR ALTERNATIVE FUEL VEHICLES	12
	ITS APPLICATIONS FOR REDUCING THE USE OF NON-RENEWABLE FUELS	13
	OPEN, REAL-TIME, ANONYMOUS TRAFFIC AND TRAVEL CONDITION DATA	14
	M2M ITS APPLICATIONS	16
	ITS APPLICATIONS FOR REGULATED COMMERCIAL VEHICLES	17
	RELIABILITY AND RESILIENCY REQUIREMENTS.....	20
	MANDATORY OR GOVERNMENT-SPONSORED ITS APPLICATIONS	22
	INTEGRATED, MULTI-PLATFORM WIRELESS DEVICES (DSRC/4G)	26
	OTHER BROADBAND TECHNIQUES.....	28
	SECURITY REQUIREMENTS (E.G. AUTHENTICATING MESSAGES).....	29
III.	CONCLUSION	30

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I. INTRODUCTION

Intelligent Transport Systems (ITS) are an important part of the Administration's Wireless Innovation and Infrastructure Initiative and Wireless Innovation Fund (WIN). The WIN fund aims to catalyze innovation by funding research and development of emerging broadband wireless technologies and applications. The US DOT is undertaking an important part of that effort, to bring the nation's transportation infrastructure into the information age. Part of this transition has already started in small ways. The adoption of smart phones has given drivers increased access to real-time traffic information aided by the Global Positioning Satellite (GPS) system, in addition to allowing easier access to emergency services through the mobile phone network. As many of these changes are happening in uncoordinated ways, it has become clear that building an intelligent transport system is complex and will depend heavily on much more pervasive integration of information and communication technology (ICT) with existing transport infrastructure, vehicle fleets and the travelers themselves.

Designing, deploying and managing ITS services, with a multitude of applications, devices and connectivity, creates a series of challenges in terms of system complexity and cost of deployment and operation. Transport providers will benefit from a common service platform that is based on recognition and understanding of the challenge of matching communication

technology and vehicle product lifecycles, as well as one with great strength in management of applications and the consumer needs and usage patterns.

Existing wide area mobile communication systems provide various enablers to simplify and accelerate ITS deployment. Connectivity to commuters' vehicles and traffic infrastructure can be provided through existing systems, as can specific service enablers such as location, messaging, billing and service creation tools.

Wide area communication solutions have two key advantages: a large deployed base of existing networks and users with the accompanying economies of scale it brings in terms of speed of deployment, and the ecosystem of application and device developers that already exists to serve the mobile market. Mobile networks based on GSM (2G), WCDMA/HSPA (3G) and LTE (4G) are connecting vehicles, transport infrastructure and travelers. Demanding traffic safety services such as automatic crash notification (eCALL) and road hazard warnings can be rolled out very cost effectively using existing mobile networks.

ITS services that are consistent across all users in a transport system are dependent on effective service enablement and content management tools layered on top of connectivity.

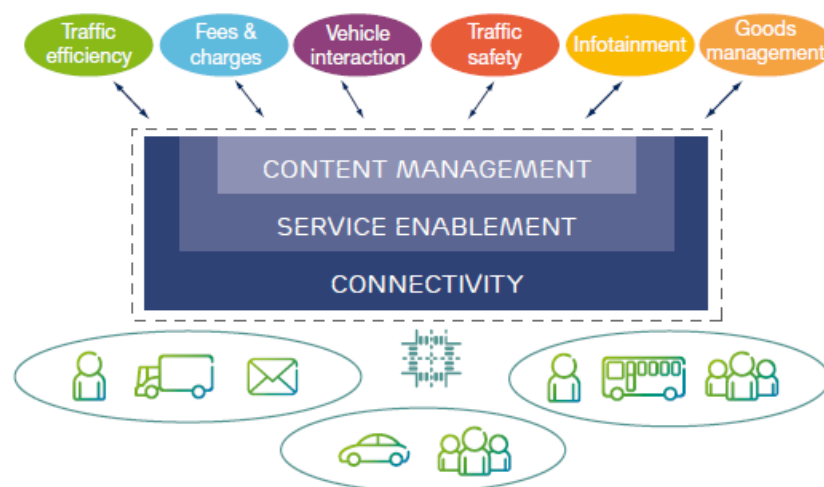


Figure 1. View of a structure for a connected transport platform

Figure 1 describes how ITS services such as traffic management, trip-related fees and charges, vehicle centric services, traffic safety, infotainment and goods management can share resources through content management, service enablement and connectivity, and thereby enable a more attractive business case per service.

It is likely that the ITS service structure over time will become as sophisticated as the service layer in the telecoms world, which today enables design, deployment and management of a multitude of applications and services for 5 billion mobile phone users across the globe. As done in the telecoms world, ecosystem development is a key factor for success in ITS. Mobile communication is a critical foundation for effective usage and operation of ITS services in public transport, safety and emergency services, logistics management, road and rail operations and management of major transport hubs.

II. DISCUSSION

1. ITS APPLICATIONS FOR RURAL AND SPARSELY POPULATED AREAS INCLUDING M2M

1. The FCC's National Broadband Plan and the President's Wireless Innovation and Infrastructure Initiative jointly aim to provide broadband access to 98% of all Americans within five years. Providing coverage for citizens and businesses accessing the Internet may be very different than providing coverage for surface transportation applications. For example, there may be rural highway rail intersections, border crossings in lightly populated areas, or roads over mountain passes that experience severe weather that would benefit from ITS applications.

- a. What types of rural and sparsely populated locations and what applications would benefit from this type of broadband deployment?
- b. What research is needed for techniques such as Machine-to-Machine (M2M) communications that would be needed to implement these applications?
- c. What research is needed on alternative broadband approaches other than cellular that may be either more suitable or more cost-effective to deploy broadband mobile wireless in these areas?

When comparing private and business Internet access, the prime difference originates from different data traffic patterns with ITS vehicle-to-infrastructure or vehicle-to-infrastructure-to-vehicle communications requirements. And even within the ITS applications area, there are many application categories with quite different characteristics:

1) Broadband Intensive vs. Messaging Applications

Broadband intensive applications are typically multimedia voice and video applications. Such services are often delivered as session oriented services to maintain certain QoS requirements. Despite the relevance of providing services for primarily non-driving vehicle passengers their interruption-free delivery is second priority compared to safety relevant information services.

Many of the ITS data services, engaging a vehicle as sender or receiver of information, are data messaging services. Such services are typically characterized by a large (or even huge) number of smaller and self-contained messages to be delivered to road authorities, traffic management centers or to other vehicles in certain proximity. Some of these smaller messages can be critical, demand very short delivery latency and thus impose quite different communications system requirements compared to former broadband services, although being delivered over the same radio channel.

Correspondingly, **TIA recommends research to study and verify mechanisms for allowing clear separations between such different application categories in order to permit proper prioritization and friendly co-existence whilst sharing some common radio or systems resources.**

2) Event Driven Applications vs. Periodic Messaging Applications

“Event driven applications” are typically demanding data messages being delivered and received with very short latency and with high priority and reliability. Driver information services benefit from more relaxed requirement constraints. Common to both is the information value that each of such data messages is carrying. **Questions evolving from corresponding communalizations latency requirements will require research to understand to which extent standardized cellular networks (3G UMTS/HSPA and 4G LTE) can be used to fulfill such stringent requirements.**

In 2009, the German CoCar project (partners Ericsson, Vodafone, MAN trucks, Volkswagen and Daimler) demonstrated a live end-to-end integration of a Road-Hazard-Warning application (heavy breaking alert) plus an Emergency Vehicle Approaching notification, in the Vodafone live HSPA 3G cellular network. End-to-end latencies below 500ms were achieved.¹

Just recently the German CoCarX project (partners Ericsson, Vodafone, Ford, BMW and a national authority) managed to show a full end-to-end integration of a Heavy Breaking alert notification using an LTE network.² End-to-end latencies below 100ms were achieved.³ This gives confidence on the capabilities of modern cellular networks and their optimized use for a large range of ITS applications.

“Periodic messaging applications” may also have stringent latency requirements, but it might be acceptable if one or the other such messages do not reach all target vehicles all the

¹ See Car to Car Hazard Warnings Over Cellular Networks, available at <http://www.youtube.com/watch?v=xkSD4NTsFPc>.

² See CoCarX live demonstration, Düsseldorf, Germany, 25th of May 2011. EE Times: available at http://eetimes.eu/en/lte-suited-for-traffic-applications-research-project-concludes.html?cmp_id=7&news_id=222907544&vID=209

³ See CoCarX More Road Safety, IKT.NRW (via Google translate) available at <http://translate.google.de/translate?js=n&prev=t&hl=de&ie=UTF-8&layout=2&eotf=1&sl=de&tl=en&u=http%3A%2F%2Fikt.nrw.de%2Fhighlights%2Finformation%2Fikt%2F796cocarx-mehr-sicherheit-auf-den-straen%2F&act=url>

time, as long as a certain delivery level with a certain information quality level can be maintained. Early tests by Ericsson, Vodafone, BMW and Ford have shown that an intersection assistant application can send so called Cooperative Awareness Messages (CAM, ETSI-TS 102-637-2 Standard) with up to 10 Hz over a DSRC and a cellular network. Both technologies were integrated at a common vehicle platform and tested in a live end-to-end scenario.⁴

TIA recommends that extensive simulation studies should be performed to understand which application classes could co-exist with each other, how system resources might get impacted by each of these classes, and what additional system data processing and communication control mechanisms are required to consolidate ITS data messages to cope with limited system resources without compromising on the information quality delivered. Special attention needs to be put on understanding the system communication capacity implications, caused by ITS safety and security applications while assuming a high density and a high penetration rate of communication enabled vehicles with active co-operative services on board. Systems and radio limitations and implications, including DSRC networks, need to be understood before committing to large range deployments.

⁴ See Vodafone example available at <http://www.youtube.com/watch?v=9R1brCfsTZ4>.



Figure 2: Heavy Breaking warning via cellular LTE network (Picture by Vodafone Germany)

3) Individual, Proximity or Wider Relevant ITS Data Applications

In rural and sparsely populated areas the density of ITS communication enabled vehicles might remain low, even if co-operative vehicles applications have matured and a high penetration rate has been achieved. For the sake of conserving rare communications systems resources, a variety of means for delivering ITS data information to vehicles should be considered.

Depending on the context and the specific geographical area, a point-to-point unicast messaging mechanism could be sufficient. Messages only relevant to a certain geographical area should be limited to that specific region. Although a cellular system is able to deliver a specific information item across a country, within fractions of a second, one should investigate cellular geo-fencing, geo-messaging and geo-broadcast mechanisms. Such geo distributing mechanisms

should be made available to regional road authorities for local adaptations or to cross-country traffic management centers. Studies should be done on how such mechanisms could be used for system self-adaptations and auto-configuration purposes.

Vehicle-to-vehicle ad-hoc, vehicle-to-vehicle via cellular or vehicle-to-infrastructure-to-vehicle communication constitutes just a special case of an M2M applications scenario portfolio. Some of the applications covered might be classified as “for your kind information” type of services. Others, however, might be life saving applications with utmost urgency to deliver or receive a certain information item to targeted vehicles. Even different networks might be utilized simultaneously to shout out a warning message. Or it might happen that urgent information is being received by a vehicle, from the same or different sources, over different wireless communication channels, concurrently.

At the same time, there are definite benefits to develop methods by which heterogeneous multi-channel, multi-network and multi-technology ITS communication mechanisms may interoperate with one another. Car reference platform designs should then be developed and validated in multi-operator scenarios. **TIA recommends that standardization bodies and policymakers work to ensure global and interoperable deployments of fundamental data communications for ITS safety applications, vehicle and system platforms. Stakeholders need to further address how to deal with information inconsistency, information reliability and with the trade-off between data privacy and data availability needs for safety and road-traffic efficiency applications.**

2 ITS APPLICATIONS ON NATIONWIDE PUBLIC SAFETY BROADBAND NETWORK ON LTE

2. The overall Wireless Innovation and Infrastructure Initiative has provisions for accelerating the implementation of a nationwide interoperable broadband public safety network. This network would be based on LTE (Long Term Evolution) cellular technology, be built to public safety reliability specifications (public safety grade) and would be capable of transmitting voice, video, images, and multimedia communications. Both public transit (including transit police) and highway maintenance and incident response personnel are eligible to use public safety networks.

a. What ITS applications could be enabled on these networks that cannot be implemented on the existing public safety narrowband radio systems transportation agencies and organizations currently use?

In an emergency or in a disaster recovery situation it is important that authorities police and rescue teams get instant and comprehensive information about the current situation. Under such circumstances a picture or a video snapshot delivers much better details about the current situation, rather than a person describing what is going on via a voice-only narrow band communication channel.

Video links to technical experts, familiar with specific first response actions or specialists helping to break-down a situation, can save time and lives. Costs and time are being saved by sending information directly to required experts and requesting needed equipment or other tools specific to the situation.

b. If a nationwide public safety broadband network were implemented allowing state departments of transportation (DOTs), public transit properties, and first responders to use broadband interoperable communications equipment, what new ITS applications, operations, and procedures could be implemented for emergency response, coordination with first responders, and disaster response?

Applying the same LTE standard as a default communication platform for ITS services can provide interoperable communication solutions for the ITS community and foster development of various new applications that can interoperate with emergency response and

dispatch personnel. This can greatly enhance the safety and security of the vehicle users in addition to providing quality service that can save lives in case of an emergency or an accident. Additionally, using a standards-based approach for safety and security solutions in the ITS domain will enable quick market introduction of these solutions and applications with minimal interoperability issues as well as achieve economies of scale by virtue of the standards-based ecosystem.

While many use case scenarios can be drawn in this context, one immediate application that can greatly benefit emergency response is the in-vehicle emergency call service commonly known as eCall in Europe. eCall is a pan-European in-vehicle emergency call system which uses the European emergency number 112 in the event of an accident. The European Commission has currently under assessment a solution relying on GSM narrowband circuit based technology for communicating info about the crash.

Next generation eCall based on LTE broadband technology will include intelligent information that can expedite emergency response. In addition to the location of the incident, other details such as accident severity, type of collision, area of damage, number of passengers in the vehicle and their approximate weight can be made available leveraging the existing intelligence already built into the vehicles. Optionally, on-demand images or video footage could be included if available, for example in a school bus or a public transport vehicle. This would greatly enhance situational awareness for emergency personnel prior to arriving at the scene of the incident.

Broadband connectivity can also be used to provide mass emergency alerts, amber alerts and others in an intelligent manner based on the location of the vehicle. This would be in lieu of blanket civil warning broadcasts such as those made possible via car radios.

c. How might such a network be used to coordinate emergency operations such as evacuations with local, state, and Federal law enforcement and emergency response personnel?

Broadband Public Safety networks provide a paradigm shift in public safety end user services. Broadband public safety networks, integrated with ITS interoperability, can enable the availability of the right information to the right people in case of an emergency for rapid reaction and response.



Figure 3. Broadband public safety communications

To meet the public safety requirements, TIA members are developing network features to provide enhanced features for public safety application while maintaining interoperability with commercial networks. Some of the features particularly geared towards public safety include:

- Dynamic prioritization and pre-emption for public safety and government users
- Real-time multimedia intelligence
- Unified services across public safety networks
- Enhanced public carrier interoperability

The Public Safety LTE network features can be leveraged for mission critical ITS application to support roaming and interoperability with public safety networks.

3. ITS APPLICATIONS FOR ALTERNATIVE FUEL VEHICLES

3. The growing use of alternative fuel vehicles brings new challenges. What innovative broadband wireless applications would support the use of alternative fuel vehicles? For example, traveler information is traditionally based on shortest route or fastest route. For alternative fuel vehicles, it may be more important to consider additional parameters such as real time routing based on High-Occupancy Vehicle (HOV) lanes open to alternative fuel vehicles, exemption of alternative fuel vehicles from tolls, authorizing access of alternative fuel vehicles into restricted-access, environmentally-sensitive areas (e.g., “nonattainment areas” as defined by U.S. Environmental Protection agency, National Parks, National Monuments, etc.), special corridors (such as the “Hydrogen Highway” in California), the range of the vehicle, vertical terrain, and the location of potential stations supporting the alternative fuel source. What unique challenges are faced by alternative fuel vehicles, and what mobile broadband-based applications might best address them?

A user of an electric vehicle wants maximum flexibility. Electric vehicles can be charged at special fast charging stations or charged “slow” at a smart charging pole or any electrical outlet. Many research projects all over the world are ongoing.

Research reports show that when electric vehicle penetration reaches 5-10 % it will be necessary and beneficial to introduce demand management, whereby the energy provider and electrical grid provider can start and stop charging of individual cars within the requirements stated by the car owner. For example, when a driver comes home from work at 6:00 pm, they may always want to have 20 mile range. They may want the car fully charged Monday to Friday at 7:30. At other times the energy and grid provider can manage the demand depending on availability of energy and local transmission capacity and actual car status. Communication and control can be over the cellular network, which has some advantages over wireline communications at smart charging poles in terms of cost and time to build out.

Also, the driver of an electric vehicle must be able to override the settings at any time. The driver must be able to start heating or cooling of the compartment when the vehicle is attached to the grid and to preserve battery power according to his/her wishes.

The electric vehicle is most often charged at home and at work, but it may be connected anywhere in the grid, and a system must support this type of new roaming electricity consumer. An intelligent infrastructure for charging of electrical vehicles is needed. Electric vehicles should be connected, via cellular networks to the driver's mobile phone and to the internet to reach and be reached from all relevant energy and grid providers. This will require a number of functions in the "telecom cloud," for example: authentication, aggregation of charging information, scheduling of charging, clearing and billing etc. The system must be designed in such a way that functionality is maintained in the best possible way even when the electric vehicle is out of mobile phone coverage.

4 ITS APPS FOR REDUCING THE USE OF NON-RENEWABLE FUELS

4. In addition to addressing the unique challenges facing alternative fuel vehicles, how can the WIN for Transportation program help address issues related to reducing the use of non-renewable fuels and to reducing greenhouse gas emissions from transportation vehicles? What specific research and development areas might be undertaken with these reductions in mind? For example, how could innovative wireless broadband technology be used to monitor unnecessary idling of commercial vehicles, such as idling that does not occur at an intersection, stop sign, or at a bus stop and does not occur for power-take-off?

Eco-navigation is beneficial to all kinds of vehicles. A map database with both fixed and dynamic content must be established. Fixed data can be stored on board while dynamic data is off board and accessed via the cellular network. Anonymous location and speed data from mobile phones and connected cars can be used to calculate traffic flow and provide input to routing. A map with elevation and curve radius can be used for routing and optimum speed recommendations. Dynamic data examples include information on congestion, traffic flow, wind speed and direction etc.

5 OPEN, REAL-TIME, ANONYMOUS TRAFFIC AND TRAVEL CONDITION DATA

5. How would the provision of open, real-time, anonymous traffic and travel condition data via wireless broadband significantly increase opportunities for entrepreneurs to develop innovative transportation applications, as the provision of public, standardized transit schedule data has done in cities across the U.S.?

Modern cellular communication networks – and particularly LTE networks in the 700-800 MHz range – provide means for real-time global data communication. Combined with the capabilities of sensor data fusion in modern vehicles we are now seeing an unrepresented opportunity for the establishment of nationwide ITS road and traffic data networks, capturing and providing real-time traffic and road weather conditions.

Prime receivers of (anonymous) road and traffic data, seaming from all kinds of individual and commercial vehicles, are the various road management and operation centers. These centers or their automatic processing system could in turn deliver, in real-time, context aware information, tailored to the needs of individual drivers or driver groups in specific geographical areas. This would be available all over the country, assuming cellular network coverage exists and that the cellular network operations, including a nationwide public safety broadband network operator, would constitute a dedicated ITS data exchange overlay network.

TIA proposes research, prototype and live testing of an open and distributed ITS data exchange network. This open (for extensions) and distributed (for the sake of scalability and resilience) data exchange network shall constitute a well protected networked cluster of ITS Service Providers (including road authorities and governmental service providers) and data communication network providers (including several private cellular communication networks, DSRC networks and a nationwide public safety

broadband network). Figure 4 gives a conceptual indication of such technical “network associations”.

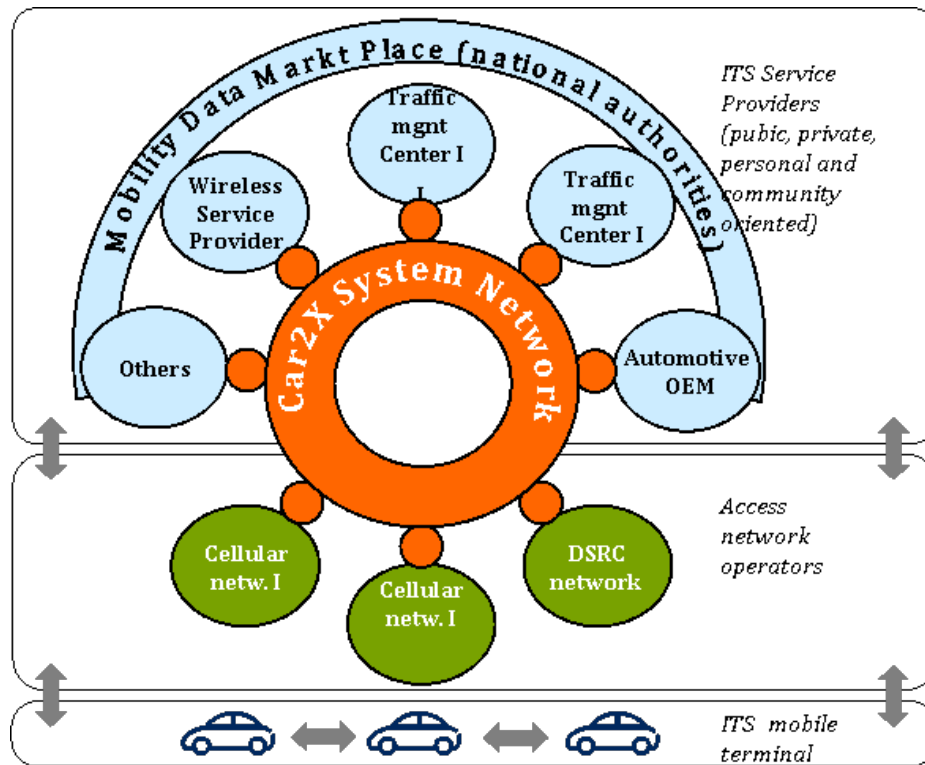


Figure 4. A distributed System Network Association for ITS safety and efficiency applications

6 M2M ITS APPLICATIONS

6. Next generation broadband systems are expected to have efficient means of implementing Machine-to-Machine (M2M) communications. One example is using embedded modules (small self-contained units with integrated sensor and communications functions) in vehicles to provide information on road, weather, or environmental conditions to traffic management centers or other centralized entities, in a manner transparent to the driver. In this regard, applications using M2M would meet the US DOT objectives concerning distracted driving.

- a. What emerging ITS applications would benefit from M2M?
- b. What applications could be prototyped or tested in a “living laboratory”?

Modern vehicles are already equipped with a large number of sensors and driver assistant features and functionality. Supported by proper in-vehicle data fusion such vehicles can derive high quality information about road surface conditions or road weather conditions. Driver assistant functions, like Electronic Stability Program (ESP), can provide alert triggers to further capture vehicle sensor data. Depending on the in-vehicle system assessment a warning message may be composed and sent anonymously to a road authority or to approaching vehicles in proximity in order to flag potentially dangerous driving or traffic conditions.

TIA recommends that techniques for data fusions and for deriving situation assessment notifications should be developed, prototyped and tested. Automatic messaging methods, ad-hoc DSRC and cellular wide range connection and geo-message reflection, should be developed and be delivered to vehicles in that region and to the corresponding road and traffic management organizations.

Rather than building expensive ice detection sensors in road surfaces all over, such equipped vehicles could detect emerging ice on roads or road flooding situations in early stages - country wide - and call-in, by an automatic communication procedure, for salting vehicles or snow plow support.

7 ITS APPLICATIONS FOR REGULATED COMMERCIAL VEHICLES

7. What new commercial vehicle, fleet, rail, or transit safety applications or new methods for operations, based on the availability of broadband wireless that could substantially reduce the cost and improve the quality of regulated commercial vehicle applications? How might such applications be implemented? Which ones might be possible candidates for integration and testing in the near term? Considerations might include:

- a. Wireless “fast lanes” supporting real-time safety inspections, reporting, and information access, including at border crossings and in rural areas. Real-time multi-agency access to information at rural and mobile inspection points nationwide could dramatically transform the way freight and motor-coach safety is implemented. The types of information could include carrier and or operator inspection and enforcement data as well as critical safety and lading information (documents issued by a carrier to a shipper, acknowledging that specified goods have been received).
- b. Development and implementation of a standardized, secure freight hazardous materials electronic manifest system.
- c. Continuous automated safety monitoring with periodic reporting via broadband wireless, without the use of roadside inspection stations.
- d. Cross-agency access to standardized vehicle and operator data for enhanced data sharing and improved mission effectiveness.

The following research scenario describes ITS applications for regulated commercial vehicles. In this scenario, commercial vehicles/fleets (road as and rail) will be fitted with LTE based modules. These per-trip configurable modules securely store multiple data and are the execution platform for multiple non-repudiable functionalities needed for regulated commercial vehicles. For example, the modules can include information such as the profile of the fleet vehicles, owners/operators, and their credentials as well as documents related to the cargo carried by the vehicle. Such data can be stored in encrypted and non-repudiably signed manner on the module. These modules also support securely partitionable space for application s provided/required by the agencies or custom or 3rd party apps for vehicle operators/owners allowing them to remotely operate, observe, and manage vehicle and its cargo.

The modules provide a platform for required sensing of the status of the vehicle and its cargo. Such information can be used for efficient inspection, enforcement, and operation of regulated commercial vehicles.

Modules in vehicles work in collaboration with applications and capabilities on supervision nodes at desired locations or intervals on roads and rail tracks. Certified and authorized applications on these nodes securely retrieve data and messages in real-time to and from the module. Such applications on the nodes conduct real-time processing of the data or message such as to apply enforcement and safety checks against the data/information carried by those messages. In case of violation of the policies or a safety issue with the vehicle/fleet or its cargo, applications on nodes send real-time alerts to appropriate authorities with identification of the vehicle to help coordinate an appropriate response. These applications also periodically send inspection logs to the agencies or to the cross agency information bureau. Supervision nodes are part of the infrastructure provided by and hence do not require any additional investments for deployments and their operations.

The message format for the exchange between the vehicle themselves and between the vehicles and the supervision nodes, such as documents as well as data regarding the cargo, is collected and transmitted in standardized format. Such standards will leverage existing standards and, if needed, develop new ones in collaboration between government and commercial entities.

The proposed system of modules and supervision nodes provides a configurable and adaptable platform for the creation and deployment of certified as well as 3rd party applications that can help improve safety and improve both the inspection and operational cost of commercial vehicles and fleets.

There are various public/private partnership and business models possible for the above proposed scenario. For example, such a system can be operated by commercial wireless infrastructure operators and provided a for fee services to commercial vehicle/fleet operators to be cost effectively compliant to rules and regulations. Government can also provide tax incentive models for wireless operators and vehicle/fleet operators as this will help improve safety and cost of inspection and supervision. Such business models need to be explored as part of the research activities.

8 RELIABILITY AND RESILIENCY REQUIREMENTS

8. How might a future commercial broadband service address connected vehicle applications (http://www.its.dot.gov/connected_vehicle/connected_vehicle_apps.htm), and what action could the US DOT take to ensure that industry addresses these requirements? For example:

- a. What is required from a commercial broadband service in terms of reliability and resilience to ensure it would be available during emergencies and disasters to support transportation services?
- b. What technologies such as mesh or ad-hoc networking or innovative use of relays, femtocells (which are small base stations attached to a fixed broadband connection), or Wi-Fi access points could be used to demonstrate an increase in network resilience for transportation applications?
- c. What such applications, technologies and techniques might be prototyped and tested in a “living laboratory” over the next five years?

The 4G cellular system based on LTE will be a common technology platform that is naturally poised to be adopted by the automotive industry. Indeed, many automobile manufacturers are building cellular modems into vehicles today so that new informational and entertainment solutions (collectively termed infotainment) may be made available to drivers and passengers in vehicles. At the same time, there are also plans to build a dedicated wireless network based on alternative radio technologies for those applications that today seem to evade the capabilities of commercial cellular networks, such as those needed for Vehicle-to-Vehicle communications and low latency operation in local environments. We believe that a majority of ITS applications can be supported by existing commercial networks that will implement LTE, and that LTE capabilities can also be enhanced to cover many application areas where it may seem that new air interfaces need to be deployed.

Recently the 3GPP has embarked on a concerted effort to study the specification of M2M specific modes into LTE. While much of the motivation for studying Machine-Type-Communications (MTC) devices in 3GPP is currently driven by low cost and low complexity, the standards process can and probably will look at ITS needs.

Research work needs to be conducted on the use of relays to densify the network so that roadside base stations that can more effectively handle ITS applications will naturally be available as the network grows to handle traffic expansion from other areas. TIA would like the US DOT to sponsor research on how specific ITS applications may be handled by LTE with the tools available. In addition we would like the research to provide avenues for the standards process to further evolve LTE so that a common nationwide infrastructure that will already be used by many automobiles in the future can also be utilized for all ITS applications.

Research should be carried out on the ability to use cellular radios in environments that do not have the aid of infrastructure in areas with poor cellular coverage. It is possible to specify Device-to-Device (D2D) and ad hoc networking modes that allow mesh networking of wireless devices, including those that use LTE. It is worth noting that the presence of infrastructure nodes will greatly enhance the ability of vehicles to be in direct communication, so the use of D2D modes that are aided by infrastructure will make LTE much more effective than to use completely ad hoc methods.

In vehicle networks may benefit from techniques that enhance the ability of those networks to coexist with other similar networks. Research should be conducted on the performance for many in-vehicle networks to coexist with each other in dense road traffic and in high traffic loads (to account for Internet audio and video use), with the objective of developing methods that will improve the ability of people to transition in-car infotainment to Internet technologies.

9 MANDATORY OR GOVERNMENT-SPONSORED ITS APPS

9. Security standards may need to incorporate techniques to provide anonymity and defeat tracking attempts against individual drivers when using connected vehicle applications or global positioning systems (GPS). Commercial broadband networks are designed to provide location information for emergency response (E911 and NG911) and are increasingly implementing applications using location-based services that specifically track user and/or vehicle locations. These features might limit the suitability of commercial broadband networks for some applications, especially those that may be potentially mandatory and/or government-sponsored.

When planning for transportation infrastructure, such as new roads, changing from a normal cross road intersection to a roundabout, choosing which railroad intersections should be protected or optimizing local traffic (bus routes and subway schedules) deep knowledge of mobility patterns is needed. Measuring traffic on existing road segments could provide some information about the current volume of travelers, but since the planned infrastructure will inevitably change the travel habits of people, the utility of this kind of information is limited. Many countries are performing national household travel surveys (NHTS) to cover for this limitations, but manual surveys also have drawbacks in terms of cost and accuracy.

It is possible to enrich this information by aggregating knowledge about places where people are being stationary and routes between such places, for the benefit of creating a rich knowledge base supporting decision making. This information can be presented in different ways for different purposes. Focusing on a particular place, for example, the information can be presented as: the most common origins for trips ending at the place; the most common paths for arriving at the place (broken down by means of transportation); the most common destinations for trips starting at the place; and so on. An alternative way to present the information would be to identify the most common trips within a given area, and the places where most people gather when they remain stationary.

While it is common practice to collect data from various sources such as road tolls, ramp metering, etc., information collected by the carriers potentially could be of use, also in combination with phones equipped with global positioning systems (GPS).

An important aspect of the end result is that it is normally desired that it should be impossible to track data back to an individual that participated in the data collection, but at the same time it should be possible to gain the expected detailed results out of the study. Hence, the security aspect preserving the end user privacy in such analyzes is critical.

Users' privacy can be preserved in a number of different ways, but common for all methods are not to reveal the raw data. Then it is of great importance that the patterns presented in the final result cannot be matched to an individual. Hence, the methods used need to consider the number of users in each group and when mapped to a geographical space, analysis should also consider the distance from the original source with the goal of protecting user privacy while also gaining the data necessary for a valuable result.

a. What types of ITS applications, especially those that may be potentially mandatory or government-sponsored, might make use of commercial broadband networks?

Where applicable, the public safety LTE network can take advantage of the established mobile operator networks infrastructure to provide broadband coverage. This combination provides an excellent mechanism to harness economies of scale of commercial networks to provide safety and security related applications to coexist with Infotainment and other ITS applications. The basic network architecture that facilitates interoperable network is shown in the following figure:

BASIC ARCHITECTURE

PUBLIC SAFETY LTE SOLUTION WITH SERVICE PROVIDER INTEROPERABILITY

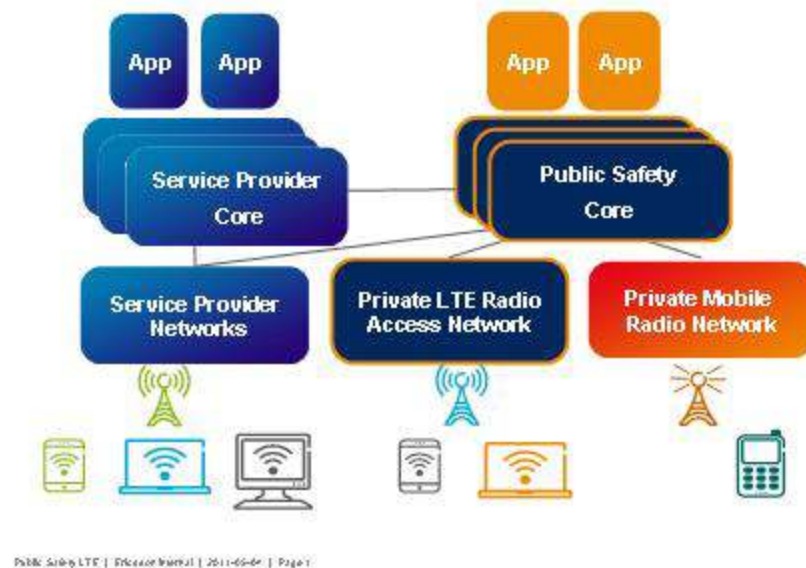


Figure 5. Public safety LTE solution with service provider interoperability

Examples of ITS centric safety and security applications may include:

- Next Generation In-vehicle Emergency Call service.
- Location based Civil warning and emergency alerts
- Lawful Auto Vehicle Disabling application (example: high speed car chase, car jacking etc)
- Instant traffic ticket citation (example: red light)
- Instant toll charging information with and without toll tags
- Traffic flow, average speed, time of day highway usage patterns, statistic collection via anonymous monitoring of vehicles on a highway.
- Fleet management of Government vehicles inclusive of rental vehicles for safety and security of employees
- Tracing and tracking of stolen vehicles

b. What policy initiatives and possible technical features will need to be implemented to assure users that their privacy is protected regardless of which communications network (or networks) is used?

TIA recognizes the importance of protecting privacy and confidentiality of the users, their data and their communication network usage patterns. This would be even more paramount when extended area networks are involved in their confidential communications. The end users

must have sufficient assurance that their data is not being unlawfully monitored or accessed by a third party.

TIA members have unique experience in developing solutions that protect user identity and data for national security and public safety organizations and enterprises under strict norms. Solutions can be extended towards users when mandatory communication is established for safety, security and regulatory reasons.

The technical features of these types of solutions may include:

- Operator independent anchoring of trust
- Central policy control
- Scalable and efficient
- Group key management
- Secure forking – late binding of keys to users
- Remote-end user identity assurance

10 INTEGRATED, MULTI-PLATFORM WIRELESS DEVICES (DSRC/4G)

10. What actions should the USDOT take, either from a technical or policy perspective, to encourage development of integrated, multi-platform wireless devices (e.g. Dedicated Short Range Communications (DSRC) /4G) for vehicles, mobile devices, and roadside equipment?

The goal of the US DOT should be to develop technologies that incur the least possible cost to the consumer at greatest economic benefit. There are two main imperatives that the US DOT should focus on – improving vehicle safety and emergency services, and creating a sea change in the efficiency with which increasing amounts of traffic can be moved through an aging system of highways and roads. While the use of new technologies may seem necessary at first glance, the US DOT should try to see how requirements for future ITS applications can be handled within the scope of systems which will naturally be deployed in the vicinity of our transport infrastructure. In this, we do not mean to sweep aside the shortcomings of available systems in respect to what one may desire out of wireless technologies to be used for ITS. Many cellular phones today are multi-mode, multi-platform devices with their ability to use vastly differing interfaces such as WiFi, LTE/HSPA/WCDMA/GSM, GPS, and Bluetooth within an integrated platform that can operate over a variety of frequency bands. At the same time, it should be realized that this versatility does come at a cost that is not insignificant and any additional interfaces that are specified will add to the cost and complexity of the terminal. While one may argue that certain ITS applications are worth an increased cost to a user, it may also be argued that a safe driving environment should be available to all vehicles on the road. Additionally, it may be argued that widespread dissemination of certain types of information such as traffic alerts has further benefits such as lower fuel consumption and smoother flow of traffic, lower levels of driver fatigue, and lower pollution that will boost overall productivity and cause general economic expansion.

The US DOT can play a very important role in guiding the development of technologies that do not stifle competition between service providers that want to enable value added services. At the same time, the US DOT can also encourage the development of wireless networks that provide improved driving experience within the scope of existing technologies and at low cost to the end-user.

One cannot emphasize enough the importance of carrying out detailed simulation studies of propagation and radio network performance to evaluate technologies. The automotive industry is used to evaluating systems based on prototyping, but a new wireless ITS technology cannot be adequately studied through proofs of concept alone. It is possible to understand the behavior of a wireless system quite effectively by empirical studies of propagation and channel modeling followed by simulation studies that evaluate the network performance under a variety of loading conditions and traffic densities. Specific research studies need to be conducted comparing propagation environments and channel models in various cellular frequency bands and in new bands being proposed for ITS such as the 5.9 GHz band⁵ Such studies must be used along with specific deployment plans in city canyons, dense urban and suburban deployments and in sparsely populated areas with large inter-site distances and tall antennas. Simulation studies should consider detailed models of expected vehicular traffic, service models, and data traffic requirements. The role of alternative spectrum technologies that provide for wide area deployment of in-vehicle wireless systems can be considered as well. The definition of uniform evaluation criteria is crucial to the ability to compare the various available wireless technologies.

⁵ See T. Saito, "Advances in Future Vehicular Communication," ITS World Congress, Pusan, 2010.

11 OTHER BROADBAND TECHNIQUES

11. What other broadband technologies or applications would provide substantial public benefits and testing or deployment of which would be accelerated by WIN funding?

[No Comments]

12 SECURITY REQUIREMENTS (E.G. AUTHENTICATING MESSAGES)

12. Security standards for vehicle-to- vehicle and vehicle-to-infrastructure communications may require techniques for authenticating messages, including verifying the authority to send various classes of messages and the source of the messages. They may also include techniques to encrypt messages if needed.

a. What transportation applications might require such security features when implemented on commercial networks, and what attributes might the applications require (for example, authentication, data integrity, nonrepudiation, etc.)?

c. Could widespread broadband wireless capability be leveraged to address the security requirements transportation and/or other non-transportation applications?

Various security capabilities are required for vehicle-to-vehicle and vehicle-to-infrastructure communication. The communicating devices, the vehicles they are attached to, and nodes in the infrastructure need to have non-repudiable identities. Such identities can be provided by the LTE infrastructure operator(s).The messages communicated by these entities needs to be encrypted and non-repudially authenticated. Safety, route planning, emergency response system, hazardous material and commercial cargo inspection applications will need such security to prevent cyber attacks of various forms on the infrastructure.

Additionally, messages sent by the applications executing in wireless infrastructure need to be secure and authenticated. These applications also need to access vehicle-to-vehicle and vehicle-to-infrastructure generated messages to provide value added services such as safety, inspection/enforcement, and efficient operations and managements. Web-based open standards such as OpenID and OAuth should be used in conjunction with public/private key based infrastructure to meet such needs through an end-to-end security framework. Such an approach will help Web-based rapid application developers and wireless broadband infrastructure operator(s) to leverage and build upon their strengths to provide an end-to-end standards-based security framework encompassing identity services, non-repudiable encrypted messaging

services, and authorization services. Such a framework can also be used by non-transportation applications.

III. CONCLUSION

TIA appreciates the opportunity to provide input and looks forward to working with the Department of Transportation and other stakeholders on these issues in the future.

Respectfully signed and submitted on June 13, 2011.

TELECOMMUNICATIONS INDUSTRY ASSOCIATION

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