RITA Intelligent Transportation Systems Joint Program Office

IntelliDrive[SM]

Safer. Smarter. Greener.

Achieving the Vision: From VII to IntelliDrive

POLICY WHITE PAPER

By the ITS Joint Program Office
Research and Innovative Technology Administration
U.S. Department of Transportation

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Purpose of the White Paper

This white Paper traces the strategic evolution of the U.S. Department of Transportation's (DOT's) plans for IntelliDrive^SM[1] research. As this White Paper was being written, in Spring 2010, DOT was embarking on the ITS Strategic Research Plan, 2010-2014 — IntelliDrive research comprises a major portion of the research program. DOT recognizes the need to provide stakeholders with an explanation of the major strategic issues that drove the development of its current plans for IntelliDrive research, and an explanation of how, and when, the research results will enable decisions regarding the future development of IntelliDrive capabilities.

The VII Vision

Launched in the mid 1990s, with roots stemming back to earlier DOT research in the 1960s, the U.S. DOT ITS Program adapts emerging technology innovations to the needs of the surface transportation community. The ITS Program initially focused on applying processes and technologies that had been developed by the defense community — such as surveillance technologies and systems engineering — to transportation systems.

In the early 2000s, it became apparent to the DOT ITS Program and its partners that the interaction between vehicles (Vehicle to Vehicle or V2V) and between vehicles and the roadway (Vehicle to Infrastructure or V2I) held tremendous potential to address the highway safety problem and other difficult transportation challenges. Building from earlier ITS research, DOT launched the Vehicle-Infrastructure-Integration (VII) Program in 2003. The VII vision was to use wireless communication with and between vehicles to achieve dramatic safety and mobility improvements.

The VII program was rebranded as IntelliDrive^SM in January 2009 — largely for communications purposes. The VII name was not readily understood outside of research circles and was easily confused with the Roman numeral for seven. However, the program has also undergone changes in concept from the original vision, due to initial research findings.

The VII Approach

Fundamentally, VII was an engineering research program. As the VII Program was originally conceived, V2V was recognized as a potentially powerful technology that could address many safety issues. While V2V promised dramatic safety gains, it was assumed at the time that achievement of maximum safety benefits would require all vehicles (cars, trucks and buses) to have radio devices installed to provide the necessary V2V communications capabilities. Unfortunately, it would take 15 to 20 years for the vehicle fleet to turn over so that a sufficient number of vehicles would be equipped with the V2V technology and start to yield tangible benefits.

Because of this fleet-turnover-timeline problem with V2V implementation, the VII Program planners concluded that an alternative approach was needed. In-vehicle devices talking with roadside infrastructure (V2I) was seen as a way to achieve safety benefits more quickly and

[1] IntelliDrive^SM is a service mark of the U.S. Department of Transportation.

address safety issues that V2V could not. The VII research program was based on the premise that infrastructure-based radios would achieve benefits – particularly safety benefits – sooner. The program was grounded in the need for a nationwide deployment of roadside infrastructure to support the communication with and between vehicles, while radios became prevalent in the new vehicle fleet.

In addition, in the VII approach, both V2V and V2I required a dedicated short-range communications (DSRC) radio tuned to the 5.9 GHz frequency in the vehicle and in the infrastructure. The Federal Communications Commission allocated, at the behest of the transportation community, 5.9GHz for transportation safety applications. This allocation gave the VII program the key technical requirement that would be needed for ultimate deployment. The spectrum was allocated for safety purposes, but it allowed unused bandwidth to be available for other applications, such as mobility or convenience. Preliminary indications were that safety messages would use only part of the communications bandwidth. As a result, non-safety applications, such as mobility and convenience applications, could also be accommodated through the same DSRC radio.

These assumptions — to start with V2I while V2V capabilities migrated gradually, and use of one DSRC radio at 5.9GHz for all applications — were a good starting point, but many questions remained. Would V2V and V2I work technically? Could these technologies be implemented practically?

Proof-of-Concept Test

First, DOT conducted a proof-of-concept (POC) test to address the basic technical feasibility questions. The POC, conducted in 2008 and 2009 in specially designed "test beds" located in Oakland County, Michigan and Palo Alto, California, was designed to validate the technical feasibility of key components of VII. For example, the first DSRC multi-channel radios were built for the test vehicles, and the first instrumented roadside equipment was placed at the test beds. The researchers conducted basic tests to assess the communication capabilities and characteristics of the DSRC radios and the 5.9GHz band. The POC testing proved that the basic technical concept would work. However, the POC test was never conceived as the answer to all technical questions. There were practical limitations regarding the scope of the tests. POC testing included less than 30 vehicles, and they represented only one vehicle type — light passenger vehicles. The testing focused on evaluation of message exchange between partially developed “stub” applications, using draft DSRC standards.

The POC testing accomplished much of the initial work necessary to determine that the concept was technically sound and feasible. But the question of whether it could be practically implemented remained.

The Chicken and Egg Dilemma

The VII approach had a classic "chicken and egg" problem. Why should vehicle manufacturers invest in developing and paying to install in-vehicle devices (DSRC radios) with no guarantee that there would be any infrastructure-based devices with which to communicate? Conversely, why should State and local agencies invest in the installation of infrastructure-based technology with no guarantee that there would be any in-vehicle devices for their infrastructure-based devices to talk to?

In particular, there were many uncertainties about infrastructure deployment. Early estimates indicated that approximately 300,000 roadside equipment (RSE) units were needed to support initial applications at a nationwide scale. An infrastructure installation of that magnitude had obvious problems. How quickly could those units be installed? Would infrastructure installation be faster than fleet turnover for V2V? Who would pay to install, operate and maintain RSE units? These 300,000 units needed to be installed alongside roads controlled by thousands of State and local jurisdictions. How could that many agencies all be convinced that installation of roadside radios at key locations was a worthwhile investment?

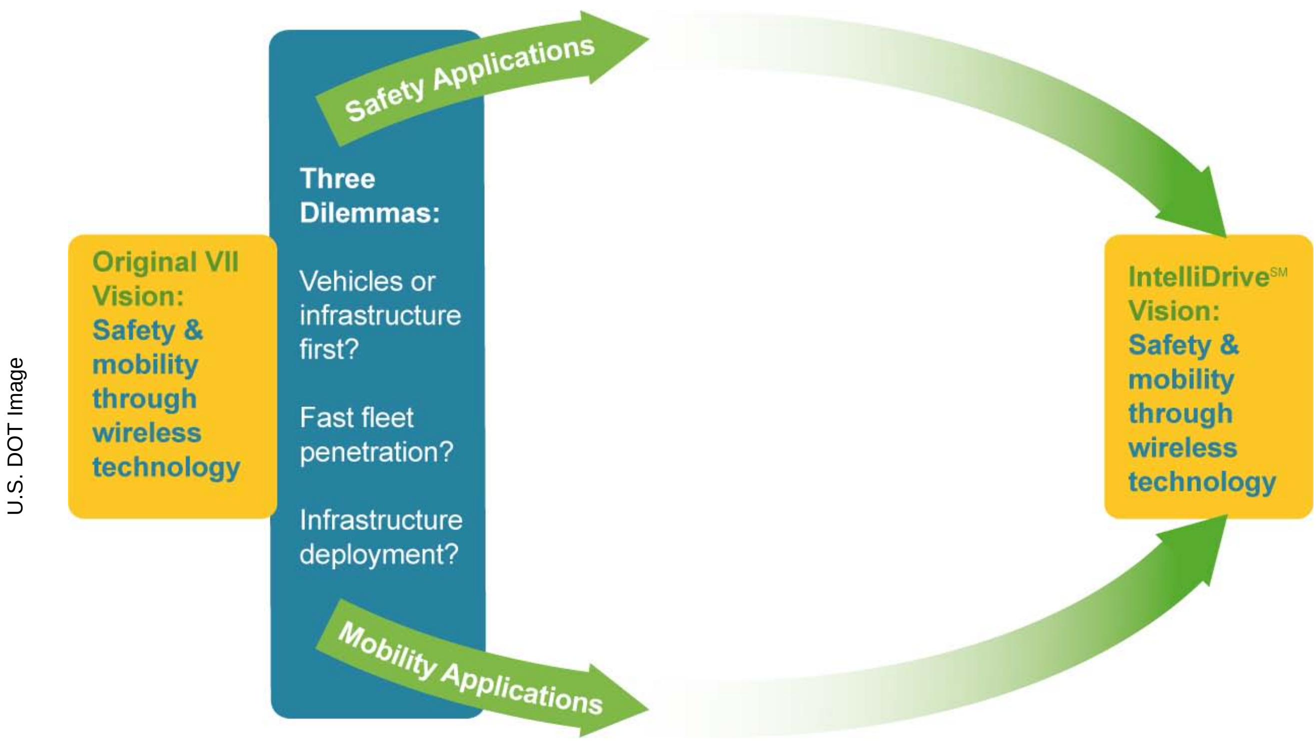


Figure 1: The Three Big Dilemmas to Achieving the VII and IntelliDrive Vision

VII and IntelliDrive share the same vision: safety and mobility through wireless technology. Three dilemmas exist to achieving that vision.

The VII infrastructure conundrum gave rise to three big dilemmas (Figure 1):

1. **Which is installed first**: vehicles or infrastructure?
2. How can the vehicle fleet be equipped with DSRC radios quickly enough to realize early benefits from the technology? In other words, how can **market penetration** be accelerated?
3. How can the financial and logistical challenges be overcome to achieve sufficient **infrastructure deployment**?

New Technologies

In the meantime, wireless technology exploded in the consumer marketplace, and consumer mobile communications devices, including smartphones and mobile internet devices, proliferated. These technologies had significant implications for the future of VII. To support high-speed transmission of text, voice and video data, telecommunications providers greatly expanded the bandwidths available for cellular phone technology, providing 3rd Generation (3G) networks. To make the wireless mobile devices more appealing to the customer, new applications were developed, including some capable of providing location-specific information — for example, applications that locate the closest store selling a hard-to-find item, or that forecast the weather for your location during the next 60 minutes. These applications use global positioning systems (GPS) or cellular positioning technology to pinpoint the device's location. As the wireless revolution exploded, other recent information technology innovations, including cloud computing and real-time search capabilities, showed potential for application to transportation.

As the VII Program progressed from the research laboratory stage into commercial testing and marketing, it became apparent that the DOT ITS Program needed to expand the scope of the VII Program to explore the potential applications of the newer wireless and computing technologies. To better reflect the expanded spectrum of the research, in 2009 DOT rebranded the VII Program to IntelliDrive. V2V and V2I communications remain critical components of the expanded program. While DSRC remains a primary focus for safety, the IntelliDrive research program also is exploring how other communications capabilities can be used to support non-safety applications — particularly for mobility applications.

The IntelliDrive Approach

The implementation dilemmas associated with the original VII approach and the new technologies emerging in the market indicated that it was time to adapt the research program based on new information. But, significantly, the original vision remained the same; it was only the approach to achieving the vision that needed to be revised to take advantage of new opportunities.

<u>Safety</u>

Results of a recent high-level NHTSA analysis of the potential of V2V and/or V2I to address crash types indicate that V2V has the potential to address a large proportion of crashes involving unimpaired drivers. Specifically, up to 82 percent of all crashes by unimpaired drivers could potentially be addressed by V2V technology. If V2V were in place, another 16 percent of crashes could potentially be address by V2I technology. In imminent crash situations, V2V is uniquely capable of addressing forward collisions and lane change/merge collisions. At very high market penetration levels V2V can also address intersection collisions. V2I has the potential to address road departure and intersections crashes at lower market penetration levels. The actual effectiveness of V2V and V2I in addressing these crash types still remains to be tested.

Implementation considerations quickly emerged as key hurdles for the original VII approach based on massive infrastructure installation up front. This fact prompted the USDOT to explore alternative approaches to achieving the safety vision.

Dilemma #1: Which is Installed First: Vehicles or Infrastructure?

The information from the NHTSA report provides a compelling reason to aggressively pursue V2V technology and applications while continuing to pursue V2I. In fact, the potential is so great, that NHTSA has embraced V2V as a priority for its rulemaking research plan, and has identified this technology for possible future regulation or other action to encourage its implementation. Action by NHTSA would dramatically change the pathways to implementation and would "crack" the chicken and egg problem by firmly establishing vehicles as the path to early implementation (Figure 2).

U.S. DOT Image

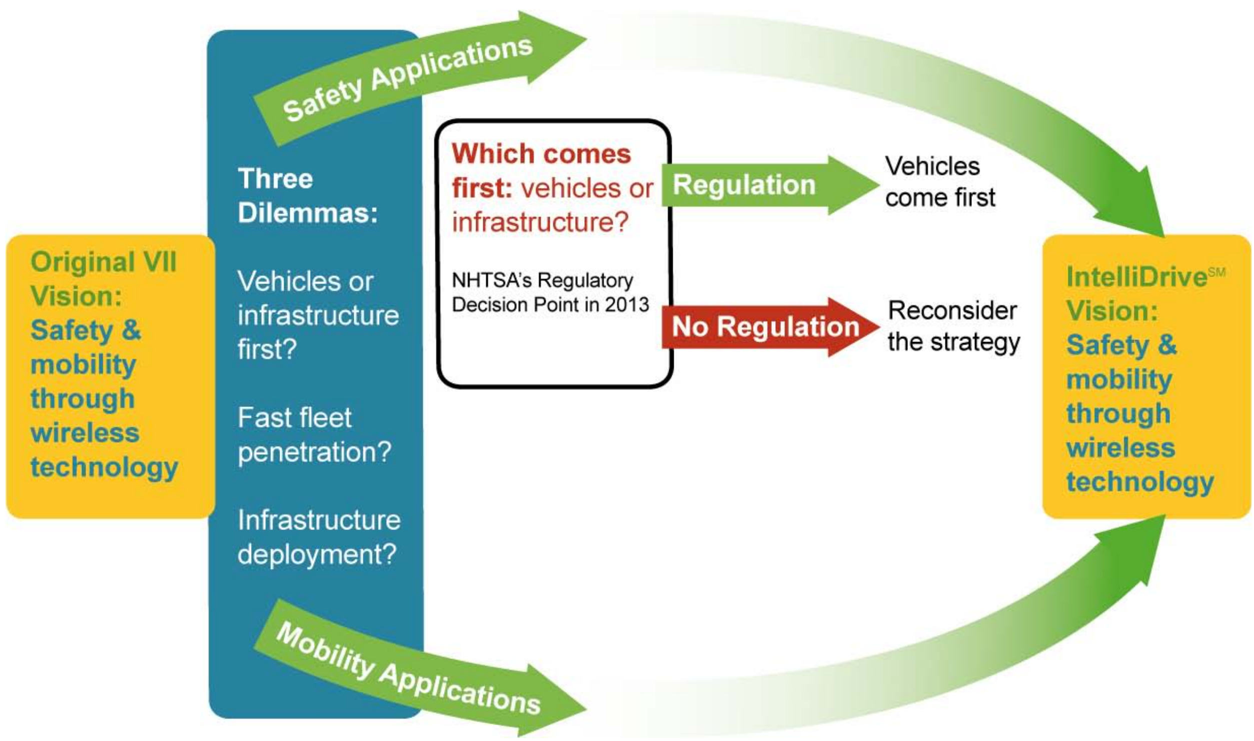


Figure 2: The Vehicles or Infrastructure First Dilemma

Answering the dilemma of which comes first – vehicles or infrastructure – could hinge on a NTHSA regulatory decision in 2013 about whether to require technology on new vehicles.

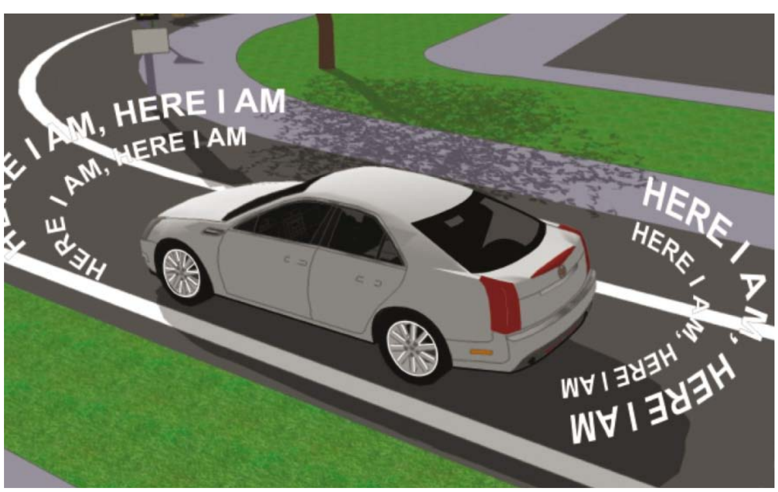
However, regulation or other government action in private markets is not something that NHTSA or any other Federal agency takes lightly. Much research, data collection and analysis is needed to support a regulatory decision. The V2V research program outlined in the ITS Strategic Research Plan is structured to develop applications, test their effectiveness and validate the results to support a regulatory decision in 2013. If the research results indicate that IntelliDrive^{SM} is beneficial, practicable and can be tested objectively, then NHTSA will proceed with rulemaking for light and heavy vehicles. If the results are sufficiently positive but do not justify a rulemaking, then the agency may advise drivers to purchase vehicles with this technology through its consumer information program.

If NHTSA chooses to issue a regulation requiring installation of V2V communications equipment in all new vehicles, then the "Which comes first?" question will be answered definitively. If NHTSA chooses not to regulate, then other implementation approaches to achievement of the safety goal will need to be considered.

Dilemma #2: How Can Market Penetration be Accelerated?

While the potential of V2V technology was recognized in the VII Program, benefits would be delivered only when a sufficient number of equipped vehicles were on roadways to interact. Early in the VII program, it was difficult to envision a feasible way out of this dilemma. But now, a plethora of consumer electronics devices are available in vehicles. The exponential growth of the use of these devices by travelers may open up a new avenue to accelerate DSRC into the vehicle fleet.

The concept is to embed DSRC communications in aftermarket devices, such as navigation systems, so that they emit a simple "Here I Am" message (Figure 3). The “Here I Am” message would be a subset of the full V2V message. Portable navigation systems are prevalent, and many smaller consumer devices also have navigation applications. "Here I Am" messages are continually emitted when these devices are turned on, and do not require any driver interface. Safety could be significantly increased by notifying other vehicles of the location of a vehicle that contains a "Hear I Am" device.



U.S. DOT Image

Figure 3 – Vehicle Emitting a “Here I Am Message”

Aftermarket devices have access to power, communication (typically cell) and location via GPS. This basic data, plus a little more, constitutes the "Here I Am" message. The V2V message includes all of this information, plus more robust data that is available directly from vehicle systems. The differences in message content will determine the type of applications that can be supported. "Here I Am" messages will probably have limitations in their capabilities; they will likely not have access to data from internal vehicle electronic systems. On the other hand, there is much that could potentially be accomplished with these simple messages. In addition, the presence of "Here I Am"- equipped devices would provide increased early benefit to fully equipped V2V vehicles, which could sense the location of an emitting device.

The V2V research program includes testing and validation of aftermarket DSRC devices and their potential benefit for owners of both vehicles and devices. If the research shows that these devices are effective, the market penetration dilemma may be diminished. If not, then other options need to be pursued (Figure 4).

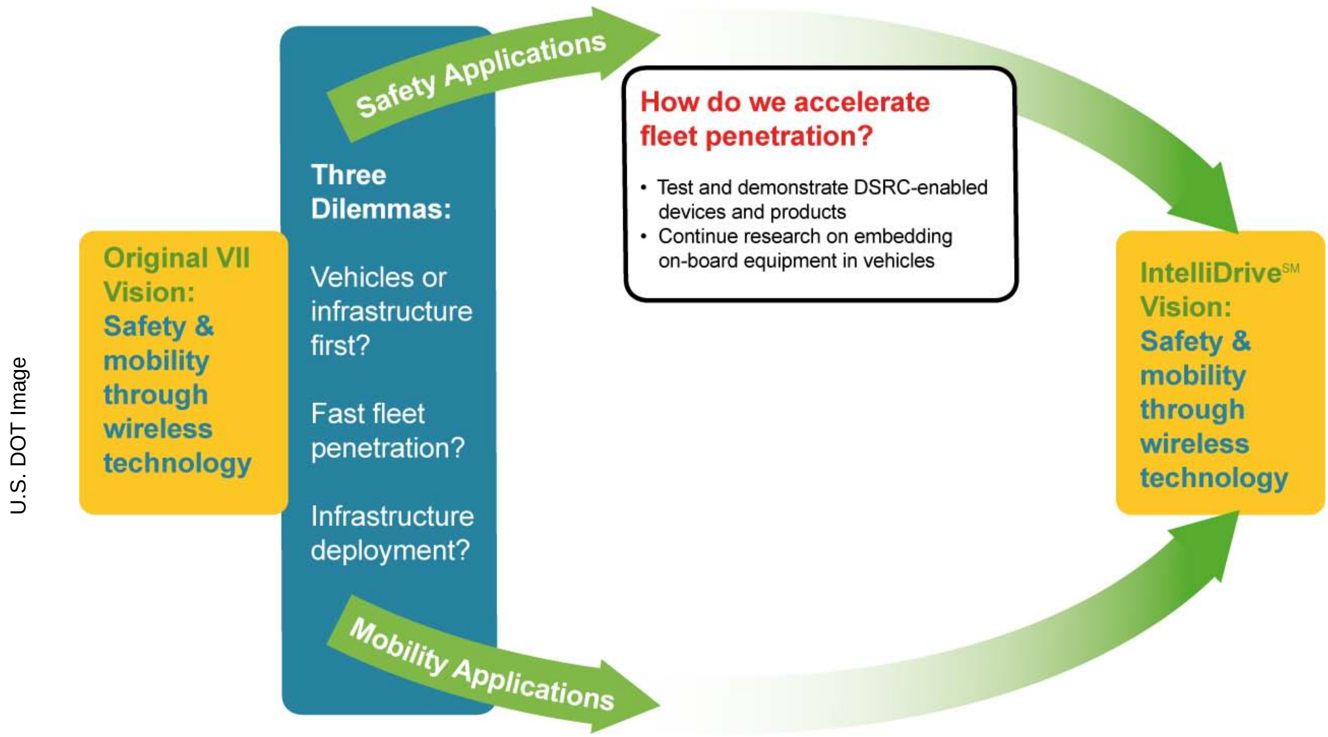


Figure 4: The Fleet Penetration Dilemma

DOT supports a two pronged approach to the dilemma of accelerating market penetration: test the potential of DSRC-enabled aftermarket devices and continue to advance research on technology embedded in vehicles.

Dilemma #3: How Can Financial and Logistical Challenges Be Overcome to Achieve Sufficient Infrastructure Deployment?

Again, new research results provide new opportunities. As V2V research progresses, one of the key questions under investigation is the need for infrastructure to support V2V applications.

V2V applications are inherently about communication between vehicles. Does that require **any** infrastructure? Initial indications from the research indicate that some infrastructure is needed to support data security. Communications security is essential for critical safety applications — but what type of communications is needed, and what is the density of infrastructure required? These questions are still subject to study and refinement. Preliminary results are beginning to emerge that seem to indicate that communications for data security will **not** require DSRC; other communication technologies might be used. Further research is ongoing, but if this proves out, then it may be possible to achieve a large portion of the safety vision without requiring new DSRC infrastructure (Figure 5). It is too early to know with certainty, but the results of this research may lead to new opportunities, without some of the difficulties that greater infrastructure needs would imply.

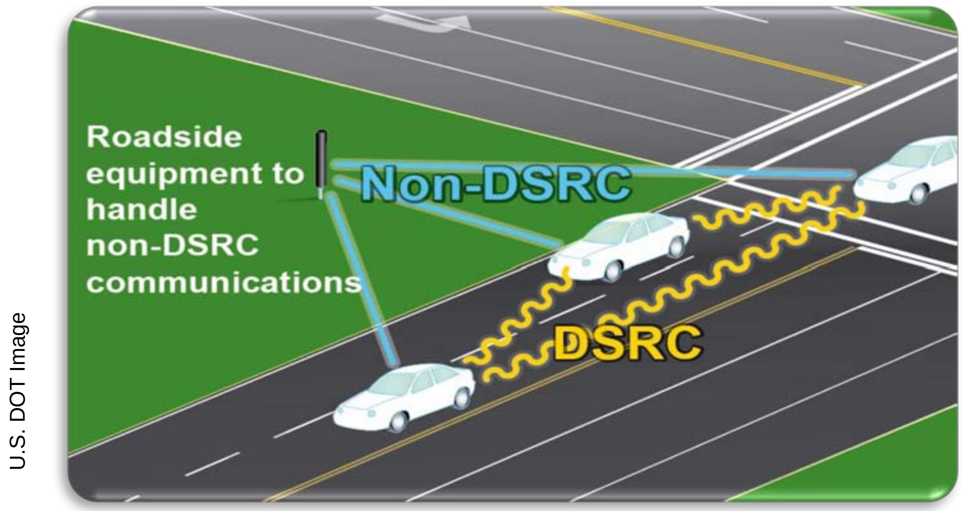


Figure 5: Vehicle to Infrastructure Communication May Not Require DSRC for Basic Functionality (Security)

What would that mean for V2I applications? Clearly V2I technologies have the potential to address crash types that cannot be addressed otherwise. As mentioned earlier, V2I is uniquely suited to address intersection and road departure crashes around sharp curves. If research shows that pervasive infrastructure is **not** needed for V2V, then V2I applications potentially could be pursued for high-crash locations, such as signalized intersections and sharp curves. In this scenario, with infrastructure deployment limited to "spot safety" applications, far fewer than 300,000 roadside equipment units using DSRC would be needed (Figure 6).

U.S. DOT Image

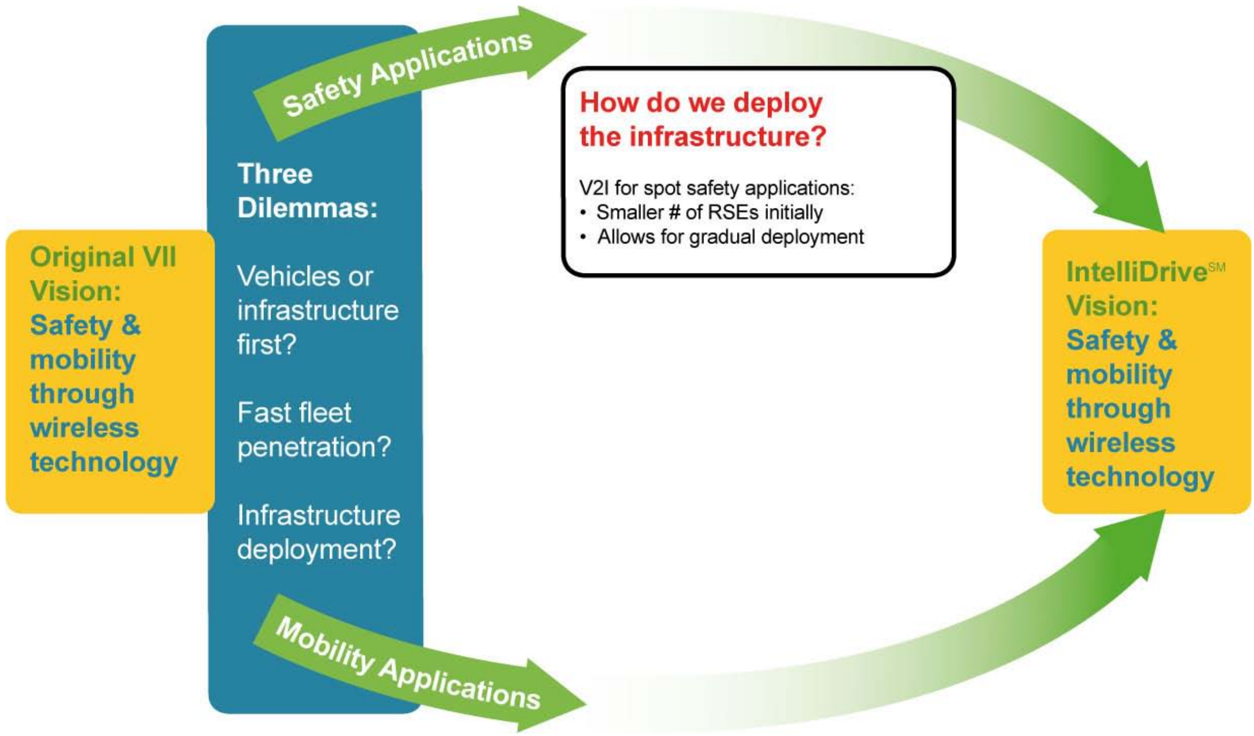


Figure 6: The Infrastructure Deployment Dilemma

The infrastructure deployment challenge is lessened if DSRC is not needed for basic functionality (security) of the system, but can be applied for spot safety applications – enable gradual deployment over time.

Further research is required to explore V2I application development, testing, and validation of effectiveness, and is included in the *ITS Strategic Research Plan, 2010-2014*. Stakeholders are particularly interested in the potential to equip traffic signals with DSRC communications to emit a frequent message about signal status — which is termed "SPaT" (signal phase and timing) — the equivalent of a traffic signal "Here I Am" message (Figure 7).

Intuitively, SPaT data appears to provide the basis for several applications that would support safety and mobility. Additionally, it may provide early benefits for infrastructure-based technologies and spur their implementation. As more traffic signals with DSRC communications capability are deployed, this data can be captured for mobility applications as a supplement to other wireless and conventional transportation data.

Figure 7: Vehicle to Infrastructure Communication with Traffic Signals Using DSRC May be Valuable for some Safety and Mobility Applications

Mobility

In the early stages of VII, it was understood that mobility applications that used vehicle-based communications did not need the same communications requirements as safety applications. In fact, only the most rigorous safety applications needed DSRC at 5.9GHz. Mobility applications had been a part of the original VII Program only because the spectrum could support BOTH safety and mobility simultaneously. If the DSRC radio was required for safety applications, the reasoning went, it could also be used for mobility. This was a rational approach for the initial program; however, technology innovations provided new opportunities.

Driven by the consumer marketplace, entrepreneurs have been using signals from cell phones to capture location data that could be converted into useful information for transportation applications. Other innovators are leveraging wireless equipment in vehicle fleets to capture traffic data. This data, already available, approximates the mobility data that could potentially be captured through V2I.

It now appears that the original **mobility** goals can be substantially realized using data from non-DSRC sources, while accommodating future DSRC data. Data from wireless sources is already being combined with data being collected by public sector agencies. Today these public sector data are collected by conventional equipment, such as loop detectors, traffic cameras, ramp meters and traffic signals. The challenge for the future is to increase the amount of data available and integrated for multiple uses. For instance, it remains a challenge to integrate data from multiple agencies to provide information across various modes or various jurisdictions within a connected region. Enhancing the quantity and quality of available data and the ability to combine data is likely to fuel new applications that could lead to revolutionary mobility improvements. Considerable research is required to understand user data requirements; to explore data quality issues related to new data sources; to understand how to integrate newer data with conventional data; and, finally, to develop applications for public sector use (Figure 8).

U.S. DOT Image

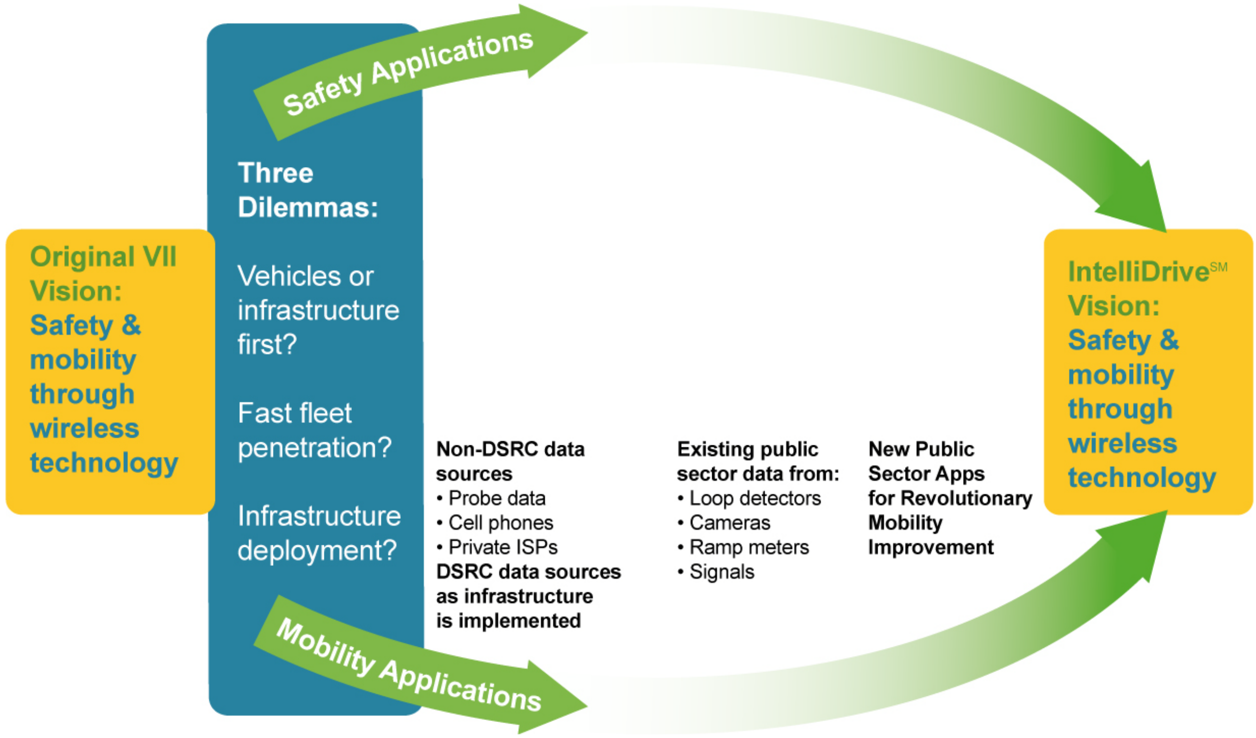


Figure 8: Achieving the IntelliDrive Vision for Mobility Applications

Achieving the IntelliDrive vision for mobility depends on the ability to combine data from multiple existing and new sources and use it in revolutionary new ways.

The *ITS Strategic Research Plan, 2010-2014* includes two new programs to address these research questions: the Real-Time Data Capture and Management research program, and the Dynamic Mobility Applications research program.

The objective of the Real-Time Data Capture and Management research program is to enable the development of environments that support the collection, management, integration, and application of real-time transportation data. Some of the data types that can be captured and managed include: situational safety; environmental conditions; congestion data; and cost information (derived from both traditional sources — traffic management centers, Automated Vehicle Location systems; and non-traditional sources — mobile devices, IntelliDrive applications). Data also can be collected from toll facilities, parking facilities, and transit stations. The results of the Real-Time Data Capture and Management research program will reveal opportunities for achieving greater efficiencies within our transportation systems.

Dynamic Mobility Applications is a closely related research program. This program will seek to answer the question, "What do we do with all this data if we have it?" Key objectives include development of multi-modal applications targeted to public sector managers, leveraging the abundance of new data that is possible from wireless technology. DOT will work with stakeholders to identify a few high-value applications and test them in real-world environments to assess their effectiveness. The intent is to focus on applications that are of specific value to public agencies across all modes. Consumer applications will be left to private companies.

IntelliDrive also will create the capability for location-specific messages to be relayed back to individual vehicles — for instance, traffic, weather, school zone, speed limit, or road closure information. This would make other forms of message delivery, such as variable message signs, 511 systems, highway advisory radio, etc. less critical in the future — saving local agencies money. Ensuring safe, non-distracting, message delivery methods is a critical part of the *ITS Strategic Research Plan, 2010-2014*.

Other Vexing Issues

In addition to the challenges described above, other vexing issues must be addressed. The POC test accomplished a great deal by developing and testing the technical foundation needed to support IntelliDrive. However, many technical issues will need to be addressed to achieve a system that can be effectively implemented and is financially feasible. Discussed below are some of the particularly difficult remaining technical issues. Research to address these issues is under way. The *ITS Strategic Research Plan, 2010-2014* describes how the results of the technical research will be used to systematically resolve the issues into implementable solutions.

- Data security: For IntelliDrive to be successful, data being transmitted wirelessly needs to be secure. Many questions remain around data security: What level of security is needed? What are the communications requirements? How much of what type of infrastructure is needed for secure data transmission? What are the tradeoffs between data security requirements and privacy principles?
- Positioning: Positioning, or the precision and accuracy of locating a wireless device, is another challenging issue. V2V technologies require relative positioning ("Where is the other vehicle relative to me?"), whereas V2I communications require absolute positioning ("Where is the vehicle? On which road? In which lane? Where in the lane?"). Initial research indicates that relative positioning using equipment from a single GPS manufacturer may be reasonable; however, relative positioning using equipment from different GPS manufacturers may be more problematic. For V2V to work, relative positioning must be uniform and fully addressed to support safety applications.
- Scalability: Another uncertainty of the IntelliDrive approach is whether these technologies, assuming they perform well in limited pilot and field operational tests, will be able to accommodate all 250+ million vehicles in the United States. The VII POC test involved only a small number of vehicles with prototype equipment. More extensive tests are needed to identify any issues for the communication network at full scale.

In addition to these and other technical issues, policy issues also remain. Many of these issues must be addressed iteratively, as technical research results inform policy options. Among the most complex policy issues are these:

- Balancing technical data security requirements with privacy principles: The handling of security "certificates," the frequency of certificate renewal, the use of multiple certificates, and the handling of fraudulent messages all require careful consideration and balancing of security requirements with privacy concerns. The VII Privacy Principles have served as a basis for technical design. As the design, particularly for security, is further developed, the implications for privacy will need to be fully considered.

- Certification and enforcement: The IntelliDrive concept depends on interoperability of components developed by various manufacturers based on open standards. Purchasers must be able to trust that equipment does indeed work within the system as intended. A transparent process must be in place to instill this trust – whether it is based on self certification by manufacturers or some level of testing and oversight by outside entities. This issue is especially significant for active safety applications that are intended to safeguard against a crash. There may also be some authority or operating entity involved in issuing security certificates to system users. An approach for these oversight and authority issues needs to be developed.
- Funding: At present, there are many unanswered questions about the ultimate structure that an IntelliDrive system would take, and whether it would be built and operated by the public or private sectors or through a partnership. Multiple developers and operators is another possibility. Regardless, there will be a cost for building and operating the system. Funding requirements and potential sources will need to be identified and assessed to determine feasibility.

These are just a few of the particularly difficult policy issues. Narrowing policy and technical options will require an iterative process that will include discussion and balancing of benefits, costs and societal acceptance.

Weather and Environmental Applications

As previously discussed, it appears that many mobility applications can be realized through the combination of current transportation data from traditional sources, and new data from wireless sources that are available today and in the future. For safety applications, research is centered around V2V and V2I technical and policy issues, and application validation, to support a potential regulatory decision by NHTSA. The research program is also exploring the potential of other vehicle-based data to support new road weather and environmental applications.

For both road weather and environmental applications, vehicle systems may be a powerful source of new data. In the case of road weather, for example, vehicle-based data can supplement conventional weather data, primarily collected in the atmosphere, to provide more relevant and pervasive information about roadway surface conditions. For instance, activation of automatic stability control systems on multiple vehicles in a common location could indicate slippery pavement that needs treatment. Similarly, vehicle-based data may provide new information sources that could enable new transportation management techniques that are sensitive to environmental impact. For example, data generated from IntelliDrive systems may provide system operators with detailed , real-time information on the location, speed, and operating conditions of vehicles using their system. This data could enable transportation agencies to manage system operations more efficiently — for example, by adjusting traffic signal timing to accommodate the predominant directional flow of traffic, which can save fuel and reduce environmental impact.

As noted above, the ability to send information to the vehicle from the Traffic Management Center (TMC) and other sources also will support road weather and environmental applications, enabling drivers to make safer and more environmentally responsible travel choices.

The data and technical needs must be fully considered in the research and development of the ultimate IntelliDrive system. For both road weather and environmental applications, the *ITS Strategic Research Plan, 2010-2014* provides for research to understand the communication needs (DSRC or not), any infrastructure needs (what type, frequency), and to develop and test applications. As these questions are answered through research, the requirements must be woven into considerations for the overall network.

Reducing Driver Distraction

Minimizing driver distraction is a major factor in the design of all IntelliDrive applications, whether the application is for safety, mobility, weather or the environment. It is important to remember that well designed IntelliDrive applications can reduce driver distraction by alerting drivers to hazards that they may not see, or to which they have failed to respond. The *ITS Strategic Research Plan, 2010-2014* includes a research program to study driver distraction issues specific to IntelliDrive. In addition to sponsoring research targeted at an increased understanding of driver behavior and enhanced driver assistance technologies, this program will develop interface guidelines. Based on user-centered design, the guidelines will steer development of new IntelliDrive products and applications to leverage new technology by reducing driver distraction.

Achieving the Vision

Much has changed with the metamorphosis of DOT's VII Program into IntelliDrive. But what has not changed is the vision that these programs seek to achieve: dramatic improvements in safety and the potential for revolutionary improvements in mobility. A third major goal was added most recently — decreasing transportation's impact on the environment.

While the vision remains the same, new opportunities have emerged to address the three major shortcomings of the VII approach. IntelliDrive embraces a multi-pathway approach that uses DSRC capabilities for safety; and explores aftermarket DSRC devices for their ability to more quickly provide benefits through faster penetration into the vehicle fleet. IntelliDrive also takes advantage of data collected by non-DSRC devices for mobility applications.

The broader IntelliDrive approach is designed to address the three dilemmas of the "chicken and egg" impasse between vehicle and infrastructure deployment; market penetration in vehicles; and the institutional and policy issues associated with infrastructure deployment. Many additional technical and policy issues remain to be addressed, but work is under way (Figure 9).

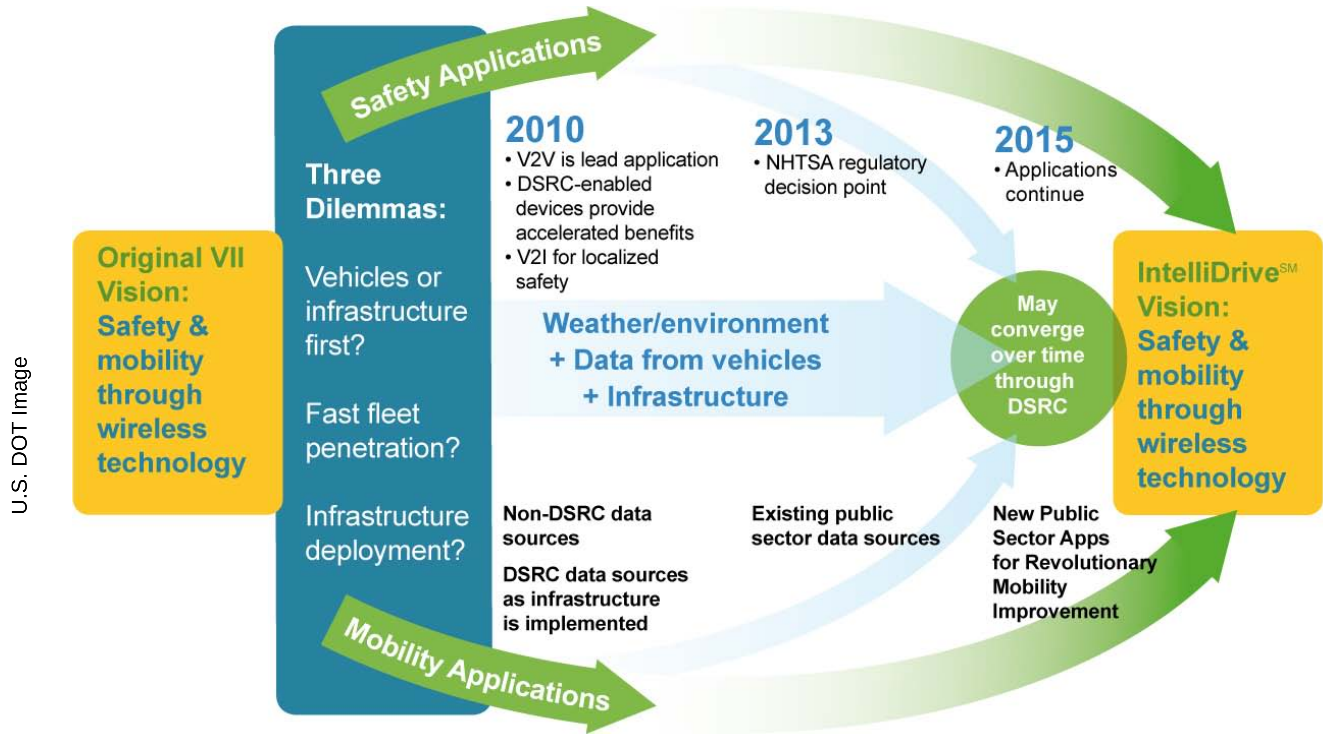


Figure 9: Achieving the IntelliDrive Vision — the Full Concept

Safety, mobility, weather and environmental applications take different paths to achieving the IntelliDrive vision, but may ultimately converge in the use of DSRC over time.

The *ITS Strategic Research Plan, 2010-2014* is designed to take advantage of the new opportunities provided by advancing technology, and to do so in a way that specifically addresses the remaining research questions that need to be answered to ensure implementation of the full suite of applications that comprise IntelliDrive.

IntelliDrive is new next evolution of VII. It opens the research scope to new opportunities, while continuing to pursue the original goal of materializing the safety, mobility and environmental benefits that captivate our imaginations and motivate our work.

For more information about the *ITS Strategic Research Plan, 2010-2014*, please visit: http://www.its.dot.gov/strat_plan/index.htm

For more information about IntelliDrive, please visit: http://www.its.dot.gov/intellidrive/index.htm

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