RITA Intelligent Transportation Systems Joint Program Office

Quick Wins Connected Vehicles Deployment Scenario

A grassroots approach to safer roads, greater mobility, and cleaner air

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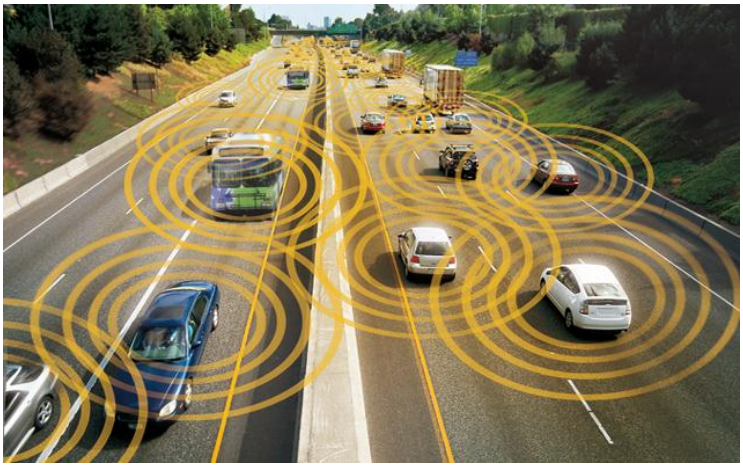

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The Quick Wins Connected Vehicles deployment scenario provides stakeholders – from planners, to operators, to manufacturers, to policymakers – with a defensible path towards the deployment of Connected Vehicles technologies over the next half-decade or so. The Quick Wins scenario describes a complementary set of timelines and deployments to those articulated in the research roadmaps published by the Intelligent Transportation Systems Joint Program Office (ITS JPO), and has been conceived as both fully supporting and extending the efficacy of those efforts.

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Executive Summary

The Quick Wins Connected Vehicles deployment scenario provides stakeholders – from planners, to operators, to manufacturers, to policymakers – with a path towards the deployment of Connected Vehicles technologies over the next half-decade or so. The Quick Wins scenario describes a complementary set of timelines and deployments to those articulated in the research roadmaps published by the Intelligent Transportation Systems Joint Program Office (ITS JPO), and has been conceived as both fully supporting and extending the efficacy of those efforts.

While the Connected Vehicles research programs are properly oriented towards the eventual deployment of Connected Vehicles on a national scale – with all of the attendant technology, governance, and policy concerns – Quick Wins imagines a series of locally-driven, near-term organic deployments in response to currently emerging technologies, principles of operation, and adoption readiness.

Quick Wins offer a range of benefits in support of national deployment. In particular, the localized and exploratory deployments offer substantive information about the intricacies and realities of operational deployment. Additionally, and no less importantly, Quick Wins creates an opportunity for market maturation, as suppliers, installers, planners, and procurements officials gain critical insight into the integration, deployment, operations, and maintenance of deployed Connected Vehicles technologies.

The Quick Wins scenario depends on, and constantly references, ongoing research activities at both the federal and state level, with particular focus on the *ITS Strategic Research Plan, 2010-2014* generally[1], and the primary research paths coordinated through the ITS JPO in particular. These research paths – or tracks – and the time tables associated with each reveal a range of opportunities for local agencies – ranging from state departments of transportation, to tolling, to transit and public safety – to begin benefiting in the near term from the promises and capabilities of Connected Vehicles technologies and practices.

Quick Wins suggests that meaningful and operationally useful deployments are possible within the next 3 to 5 years, and then rapidly expand as peers learn from one another and the resultant business cases prove out. The implications for the Connected Vehicles program are significant, in that not only will deploying agencies, equipment suppliers, servicers, and policymakers get real world experience and evidence of the inherent benefits of Connected Vehicles technologies, but the program is likely to generate significant credibility in the eyes of the public and the national policymaking community.

[1] *ITS Strategic Research Plan, 2010-2014*, Research and Innovative Technology Administration, U.S. Department of Transportation (Washington DC, 2010).

1.0 Introduction

1.1 Role of the Quick Wins Scenario

While the use of scenarios has a long history in the world of strategic planning and risk management,[2] they are usually developed in sets of three or four so that the audience is reminded that the scenarios don't represent what will happen, but what might happen based on current circumstances and anticipated developments. This is the approach we took in an early iteration of this work; the Quick Wins scenario is slightly different.

The Quick Wins scenario originates in the work of the four-scenario approach presented to the deployment community in June 2010, and more comprehensively discussed below in Section II. It is derived from the results of our interactions with the community around these original four scenarios, continued research, and a more near-term horizon tied closely to ongoing research and stakeholder interactions.

As with any scenario, Quick Wins represents a possible future for the deployment of Connected Vehicles, but one deeply resonant with the realities on the ground and the concerns of the deploying community. As such, Quick Wins is at once a planning tool, a structured guide for discussion within the deployment community (including industry and Government), and an application for managing the inherent risks associated with new technological systems in the context of existing policy, political, and social systems.

As a planning tool, the Quick Wins Scenario offers a defined set of application areas that are tied to near-term research and development calendars, and therefore can serve as a common baseline for thinking about local, organic deployments.[3] As a discussion guide, the scenario elevates the key concerns of the deployment community and suggests a way to mitigate the many – but not intractable – obstacles standing in the way of national deployment through earlier and more localized deployments.[4] And, as a risk management application, the scenario proposes a series of dependencies and actions across the deployment community that if successfully negotiated could

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[2] The most frequently cited examples are the pioneering work by Royal Dutch Shell beginning in the late 1970s and continuing through the present, and the Mont Fleur scenarios that where developed to examine the possible futures and planning priorities for the newly post-apartheid South Africa in 1991. Transportation has benefited from scenario work as well. See, for example, "What if: The Texas Transportation Scenario Project," *Horizon* (Texas Dept. of Transportation, 2008).

[3] This study relies on the most recent public version of the ITS JPO research roadmaps. Although these roadmaps are in flux, we do not anticipate any material changes in the dates proposed throughout this document.

[4] Here, and throughout, we talk of national deployment as a process and not a single event. National deployment may, in fact, be the proliferation of the sort of local deployments articulated herein.

lead to deployable Connected Vehicles applications in the near term, and that if not would almost certainly slow the eventual deployment on a national scale.

Additionally, the Quick Wins scenario is designed to demonstrate that there is a wide-range of options available to the deployment community in thinking about Connected Vehicles applications and the level of investment required. Throughout the scenario and its supporting material, we've endeavored to show that deploying agencies, industries, and Government can make choices at various times either to move ahead with deployment or to wait.

1.2 Audience

This document is intended for members of the Connected Vehicles deployment community. All members of the deployment community have a stake in the deployment of Connected Vehicles – whether in the long-term or short-term – and this document is intended to be useful in this relatively broad context. The immediate implications of the Quick Wins scenario will, however, be most tangible for state and local transportation agencies, transit and public safety agencies, commercial vehicle operators, Government, and particular segments of industry, which can see significant benefits from Connected Vehicles even in the absence of a broad mandate for deployment of in-vehicle devices.

1.3 Overview

The first section of this document – Looking Back – briefly examines prior work over the past 18 months by Pinyon Labs and Noblis on behalf of the ITS JPO. We recap the intent of that first round of deployment scenarios and the four perspectives on the future of Connected Vehicles that it produced[5]. As expected, those scenarios generated significant discussion within the deployment community, and this section also categorizes stakeholder responses and lays out how those contributions drove the second round of work leading ultimately to the Quick Wins deployment scenario.

In the second and central section – the Connected Vehicles Quick Wins Deployment Scenario – we articulate the underlying assumptions and characteristics of the Quick Wins scenario, their relationship to existing research roadmaps, and identify early-stage candidates for deployment, as well as the most likely early-stage Connected Vehicles application areas and the necessary policy and research components required for successful deployment.

The final section – Winning Deployments – identifies the various ongoing research and community interactions around specific and general issues of Connected Vehicles deployment and how those activities and their timelines contribute to the deployments imagined under Quick Wins. In addition to these research initiatives, there are a number of secondary deployment factors as well – such as peer deployments and partnership opportunities – that we address. The section includes anticipated timelines for application readiness and offers a range of potential Quick Wins deployments and supporting business models.

[5] *Connected Vehicles Deployment Scenarios* (June 2010) has not yet been released by the USDOT, but is available by request from the ITS JPO.

While this document does not prescribe a deployment scenario, approach, or specific timeline or set of timelines, it does illustrate a potential and responsive pathway to deploying the technologies and supporting processes to make the Nation's roadways safer, more efficient, and more environmentally friendly. The Quick Wins scenario is just that: a way for the deployment community and Government to enable those quick wins early on as the first stage in a longer and more comprehensive national deployment.

2.0 Looking Back

The Quick Wins scenario is derived from previous work, extensive interactions – collectively and singularly – with relevant stakeholders, ongoing research, and evolving perspectives on the operational aspects of Connected Vehicles deployment. This section examines the background to Quick Wins and illuminates the underlying process used to generate the new scenario.

2.1 First Generation Pinyon/Noblis Scenarios

In March 2009, Pinyon Labs and Noblis began an eight-month collaboration on behalf of the ITS JPO exploring a range of alternative Connected Vehicles deployments. We examined current and past research and results, undertook a directed and lateral examination of emerging trends in transportation technology, as well as demographics, social movements, current and projected economic circumstances, as well as extensive personal interviews with a significant cross-section of the prospective deployment community.

From this research and analysis we developed a set of four forward-looking scenarios designed not to dictate the actual process of deployment, but to imagine the world created under a variety of deployment scenarios. These scenarios – titled *Full Throttle*, *Safety Net*, *Proving Ground*, and *Facilitator* – were explicitly developed by Pinyon Labs and Noblis from the perspective of Government's role – and particularly policy role – in a variety of deployment environments. In summary:

- ***Full Throttle*** imagined a world where Government funded, in large part, the deployment of in-vehicle devices and roadside infrastructure;
- ***Safety Net*** saw a significant diminution in the role of infrastructure, and Government's focus was on in-vehicle devices designed to create a network of vehicle nodes communicating with one another;
- ***Proving Ground*** offered a world where Government continued its focus on active safety research[6], while much of industry focused on currently deployable applications in a wait-and-see mode; and finally,
- ***Facilitator*** saw Government's role as an evangelist and broker, with little ongoing research around active safety relying instead on the private sector to realize Connected Vehicles's benefits.

[6] Active safety refers to applications designed to warn a driver of an eminent crash as opposed to safety applications that warn drivers of more general hazards that do not necessarily pose an immediate danger to the vehicle. Active safety applications have more strenuous communication requirements than other applications, including requirements for extremely fast and secure communications transactions.

In each case, the Pinyon/Noblis team explored the policy decisions that would face Government under each scenario, and then extrapolated from those decisions to a possible Connected Vehicles future.

2.2 Community Interactions and Refinement

The four deployment scenarios were presented to the deployment community in June 2010, and we facilitated a workshop session around each. While there was very little consensus on any single scenario, there were areas of general consensus[7] overall. As a group, participants dismissed Full Throttle as improbable and found Facilitator and Proving Ground undesirable. The elements included in the Safety Net scenario received general support, but most participants were unhappy with the absence of near term mobility applications and infrastructure deployment.

In addition to a strong desire for a Safety Net-like deployment to incorporate infrastructural components – not just for security – but as an enabler for other activity safety measures making use of the so-called "basic safety message" (BSM), and/or a "here I am" message, there was also a significant desire to see real evidence of forward motion in deployment. This was a recurring theme both during the workshop and in subsequent conversations with stakeholders, and the Quick Wins deployment scenario is an outgrowth of those concerns.

In particular, while the scenario that follows is distinct from the Safety Net scenario of June 2010, it assumes a parallel development that incorporates the primary elements of Safety Net with the addition of infrastructural elements that support both the vehicle-oriented safety components of Safety Net and the goal of Quick Wins.

2.3 Process Leading to the Quick Wins Deployment Scenario

Following the June 2010 workshop, at the direction of ITS JPO, Pinyon Labs and Noblis began work on a new round of scenarios with instructions to:

- ensure that the stakeholder reactions and recommendations coming from the meetings and workshops were appropriately incorporated
- reorient the underlying perspective from that of Government (and federal policy) to the deployment community more generally
- closely align the resulting scenario work with ongoing and proposed Government research priorities as expressed in the ITS JPO Connected Vehicles research tracks.[8]

Over the next few months we returned to a select group of community members to explore a series of assumptions arising from feedback received during the workshops as well as the implications of developing a deployment scenario from existing strategic and research requirements.[9]

[7] It is worth noting that the Connected Vehicle deployment community is diverse and represents significant differences in priorities, business models, and experience with the Connected Vehicle Program and its predecessors.

[8] The majority of the research tracks and associated timetables are available at http://www.its.dot.gov/connected_vehicle/connected_vehicle.htm

In addition to these conversations, we also incorporated thinking previously documented on deployment issues such as payments[10] and deployment tactics[11] to provide context and additional texture to our new analysis. The Quick Wins scenario benefits not only from the stakeholder feedback received in June 2010, but from a number of years of organizations and Government working together on intelligent transportation and safety issues. In the next section we will explore the scenario and its characteristics before moving on in the final section to specific deployment opportunities.

[9] There is a significant difference in the character of the June 2010 scenarios and the Quick Wins scenario. The four June 2010 scenarios were developed to imagine a world after differing deployment policy choices; Quick Wins is designed to reflect existing policy, direction, and research objectives.
[10] OmniAir, *Vehicle Infrastructure Integration, Tolling and Payment Applications Concept of Operations*. (August, 2007); and not-yet-published work on Connected Vehicles based payments.
[11] OmniAir, *Proceedings of the VII Tactical Deployment Workshop* (May 2008).

3.0 Quick Wins Deployment Scenario

Drawing from the efforts outlined in the previous section, the Pinyon/Noblis team developed Quick Wins – a scenario that supports the underlying and ongoing Government Connected Vehicles research initiatives, recognizes and embraces the on-the-ground reality of local test deployments and widespread interest in Connected Vehicles technologies, and articulates a path towards near-term and widespread but localized deployments.

This section characterizes the scenario, focusing on supporting research, the parallel role of the scenario over the longer-term process of national deployment, and a portfolio of applications that, based on current research and market interest, show great promise for securing benefits of Connected Vehicles deployments within the next 3-5 years. A series of short vignettes illustrating Quick Wins deployments finishes this section.

3.1 Deployment characterization

The starting point for characterizing Quick Wins is recognizing that deployment – whether that imagined by this deployment scenario or the broader national deployment – is a process and not as an event. This recognition has a number of important implications, although two particularly stand out:

1. Under Quick Wins there is no Government mandated or Industry established set of so-called "Day 1 Applications".[12] Various deploying entities will choose Connected Vehicles applications based on both availability and presumed efficacy in meeting their own particular safety or mobility challenges.

2. Closely tied to this, is varying timetables and deployment models, again depending on the particular and individual needs of deploying agencies.

Both of these implications reflect the way technology, particularly technology that alters the relationship between significant components of a system, is adopted on-the-ground. In addition, of course, these also recognize that there are varying levels and types of financial constraints between deploying organizations and that without significant sources of outside funding, deployments and deployment choices will have to be incorporated into different budgeting and planning scenarios.

Another key element in characterizing Quick Wins is the recognition that the two decades of work that precede this scenario have established a significant foundation for those interested in deploying Connected Vehicles technologies. While the terminology and specifics of early work may not align with current research and direction for Connected Vehicles, they offer a series of use models, attempts to grapple with operational issues, and perhaps most importantly, unambiguous evidence that these

[12] In contrast, see USDOT, Vehicle Infrastructure Integration (VII) *VII USDOT Day-1 Use Case Descriptions*, May 2006.

technologies and the benefits that are expected to accrue are important to both Government and industry, and are worth deploying.[13]

These twenty years of work have resulted in a research program that contains a mixture of near-term and long-term goals and presumed results. This mixture of the almost-ready and still-needs-more-work creates an opportunity in the deployment community to think about varying timelines and varying capabilities. Quick Wins exploits the almost-ready capability to bring those benefits forward as soon as technologically possible, and as soon as deploying agencies and organizations are ready.

While Quick Wins is tied to Government research plans and priorities, Pinyon/Noblis recognizes that safety, mobility, and environmental stewardship are accomplishable through a variety of mechanisms and technologies. Quick Wins, therefore, is technology agnostic with cellular, Wi-Fi, RFID, and other wireless technologies coexisting with DSRC. However, because DSRC holds out significant promise, particularly in its efficacy for active safety and other applications where very low latency is required, the Quick Wins' timetables reflect Government research interests around DSRC.

3.2 Parallel deployment structure

Another way to characterize the Quick Wins deployment scenario is in terms of the proposed deployment path. Quick Wins is not designed to replace or supplant existing plans around a national deployment. Instead, Quick Wins envisions Connected Vehicles deployment on parallel paths – both national and local; both safety and mobility; both research and practical.

The first of these paths is national and directed. This is the default deployment path as reflected – although not explicitly articulated – in Government research tracks and publications. The Quick Wins scenario takes it as a given that this deployment path will continue largely as anticipated by current research activities. It has four central components, and is:

1. Safety-focused: Although mobility and environmental stewardship are key components of a national deployment of Connected Vehicles applications, the program is focused primarily on a reduction in the 33,808[14] fatalities on the Nation's roadways, and the ability of Connected Vehicles technologies – particularly those based on DSRC – to significantly reduce that number.

2. Nationally-oriented: The deployment that sits as the endpoint of Government Connected Vehicles research is nationally-oriented and encompasses a number of industry sectors and potentially includes a regulatory action of some sort to ensure wide scale deployment.

3. Integrated and interoperable: Because of the national character of this deployment path, as well as the eventual wide adoption of active safety Connected Vehicles technologies, the deployment must be integrated and interoperable. Standards, as well as common practices, certification, and testing will ensure that applications and management of those applications

[13] In reference to this latter point, see, VII Consortium, "Final Report: Vehicle Infrastructure Integration Proof of Concept, Executive Summary – Vehicle," (May 19, 2009).
[14] National Highway Traffic Safety Administration, "Highlights of 2009 Motor Vehicle Crashes," (August, 2010), DOT HS 811 363.

can operate successfully across state borders.

4. Process-driven: National deployment depends firstly on a long-term and comprehensive research and development process, followed by a regulatory process designed to ensure widespread deployment and common approaches. These processes must necessarily extend over multiple years and incorporate a broad range of perspectives and approaches in order to satisfy both procedural and technical requirements. These processes or their timetables cannot – in any meaningful sense – be radically altered and still produce the same set of results.

The second of these deployment paths is local and organic. Quick Wins builds on a national, directed deployment path with the addition of this second deployment path. It too has four central components that are essentially supplementary to the national and directed deployment path. But, they effectively define a different sort of deployment that is:

1. Dependent: While it is possible to imagine a sub-set of benefits – particularly mobility and environmental benefits – of Connected Vehicles emerging entirely independently of ongoing Connected Vehicles research,[15] Quick Wins assumes an essential dependence on the broader research program. Specifically, early deployments under Quick Wins incorporate and build on the findings and benefits from that research. As a result, these deployments ultimately provide the foundations for a fuller and more comprehensive deployment later in the decade. Additionally, Quick Wins deployers are heavily dependent on peer deployments and partnership arrangements in order to fully realize the benefits from Connected Vehicles capabilities.

2. Mobility and advisory-focused[16] initially: Because of this dependency, Quick Wins deployments will necessarily be those that are closest to deployment, both in terms of technological-readiness but also in terms of process, practice, and governance. However, as research proves out, and peers begin to experiment with active safety type applications, it is to be expected that those too will migrate to Quick Wins deployments.

3. Locally-oriented: Quick Wins deployments will be locally-oriented because they will reflect the local orientation of those organizations that choose to undertake deployment of Connected Vehicles applications. Unlike national deployment where an expectation of linkages could

[15] Indeed, there are a number of mobility- and environmentally-oriented applications available on the market, as well as proprietary safety-systems, and more forthcoming. For example, Volvo's Commute Greener project allows users to drive in a more environmentally-sensitive way; Honda's newest hybrid has a speedometer that gives visual feedback to promote environmentally conscious driving; Lexus has brake-assist available as well as a pre-collision system; Ford has recently released adaptive front lighting; Waze's crowdsourced GPS and mapping application is gaining ground among commuters; and a number of transit agencies have either made their data available for third parties to use to promote better mobility choices, or have developed applications on their own. Many of the proposed Connected Vehicle applications, and their supporting infrastructure, could offer alternative – and more integrated – functionality to these existing applications already on the market.

[16] Advisories refer to general advisories of a potential hazard in vicinity of a vehicle, and exclude eminent crash situations. These require less strenuous communication requirements than those safety applications intended to warn a driver of an eminent crash.

reasonably be expected, Quick Wins deployments are likely to happen – at least initially – in isolation and will be expected to solve particular, local problems that may or may not be shared by neighbors.

4. Limited to high-value and constrained deployments: Deploying agencies and organization will – and do – have to make hard choices about what sorts of deployments make sense in the near-term world of Quick Wins. Of the low-hanging fruit that might be available or become available over the next few years of research and development, deploying organizations will almost certainly be limited in what they can choose to do, and will therefore seek out deployment options that deliver significant value for the least amount of money spent.

These two paths are reinforcing. Progress in one strengthens the other, and *vice versa*. The clearest way to imagine their relationship is to look at what it means for particular applications under Quick Wins.

3.3 Quick Wins application areas

The key, underlying insight for imagining deployment along the lines suggested by Quick Wins is that existing research timelines offer more than just a path to national deployment; they offer the opportunity for complementary, local, nearer-term, and organic deployments *independent of a national deployment*. In particular, using the existing research plans as a baseline, we have identified four specific application areas where it is probable that the deployment community will have sufficient and compelling evidence to drive local deployment planning and financing decisions.

These four application areas – data capture and management, fleet management, traffic signal management, and CVO compliance, control, and enforcement – all have *aspects* that can be accomplished through current mechanisms but that could be significantly improved through the use of Connected Vehicles technologies. In this section, each application area is defined. In Section 4 – Winning Deployments – these application areas will be mapped explicitly to existing research efforts and timelines, and integrated into the larger ecosystem of supporting actions, applications, and business models.

1. **Data capture and management**, as imagined under Connected Vehicles, is the gathering of real-time and multi-modal traffic information to enhance roadway safety and overall operational efficiency. It sits at the heart of a range of specific applications ranging from traffic advisory, to real-time routing, to parking availability notifications, to travel mode assist. Certainly some of this data – and the means to capture it and make use of it – is available already, and is already being deployed along similar lines. By focusing on integration, refinement, and provision, Connected Vehicles offers a better solution – and eventual ubiquity.

2. **Fleet management** is the use of real-time data and reporting to enhance the efficiency, safety, and reliability of transit, taxi, public safety, and trucking fleets. Representative applications might include vehicle diagnostics, routing, and time of arrival notification.[17] As with data capture and management, fleets are currently being managed using a variety of technologies to accomplish

[17] We treat CVO clearance and similar activities separately in number 4.

safety and operational goals. Connected Vehicles offers both integration and interoperability.

3. **Traffic signal management** is the use of real-time and near real-time data to operate signalized intersections more responsively and efficiently. Better management of signalized intersections is one of the most frequently cited benefits of Connected Vehicles deployment. It has been the subject of substantial testing and test deployments using Connected Vehicles-oriented technologies, spectrum, and messaging, in particular DSRC and signal phase and timing (SPaT). These activities make traffic signal management an obvious choice for Quick Wins deployments, and these might include applications like transit signal priority, or on a limited-basis even cooperative intersection collision avoidance systems (CICAS). Connected Vehicles would offer both efficiencies and new opportunities.

4. **CVO compliance, control, and enforcement** is already the locus for significant technology investment and research, running the gamut from more efficient border crossings[18] to enhanced screening and road condition notification[19]. Quick Wins Connected Vehicles applications can more closely tie together vehicles and roadway information and provide enhanced compliance capabilities, and enforcement at highway-speed. These efficiencies – as well as the opportunity to consolidate on-board and multiple antennae and transponders – makes CVO compliance, control, and enforcement a satisfactory Quick Wins application area. Additionally, highly trained vehicle operators offer a better – and safer – user base for early-stage deployments.

Other applications are, of course, possible and more will become available as research, development, and testing progresses.

3.4 Quick Wins Deployment Candidates

A tertiary way to characterize Quick Wins deployments is by looking at those who are likely to participate in early, local deployments of Connected Vehicles technologies. In many cases, the pathways to Quick Wins are already being defined by a number of private and public-sector deployments of Connected Vehicles technologies, or technologies that could very well be incorporated into a Connected Vehicles system. Of particular note here are robust private sector efforts to gather and make sense of probe data, and local transportation agency efforts to incorporate that data into tools to enhance traveler information efforts.

Unlike a national deployment where there will presumably be a strong set of positive *and* negative incentives, Quick Wins relies entirely on positive incentives, and therefore on deployment candidates who are able to not only recognize the benefits, but also evaluate the risks, and still decide to move

[18] See the Intelligent and Efficient Border Crossings project governed by the ITS JPO, FMCSA, and FHWA. http://www.its.dot.gov/strat_plan/strategic_plan2010 _2014/#two-d-4.
[19] See the Smart Roadside program for more information on the demonstration, evaluation, and deployment of interoperable technologies throughout the Nation's freight transportation system. http://www.fmcsa.dot.gov/facts-research/art-technology-smart-roadside-for-commercial.htm

forward. For many state and local agencies, the deciding factor will be budget, and so it is likely that Quick Wins deployments will only be undertaken by those who feel certain of return value.[20]

Based on the probable Quick Wins application areas discussed above, there are four likely Quick Wins deployment candidate groups. These four groups – state and local departments of transportation (DOTs), transit agencies, emergency services/public safety, and commercial vehicle operations (CVO) – have different requirements, but each has an underlying incentive to increase safety, enhance mobility, and, increasingly, demonstrate environmental stewardship.

1. **State and local DOTs** are concerned individually with safety on roadways under their jurisdiction as well as improving mobility for their constituents. As operators of the Nation's roadways, Connected Vehicles technologies under both Quick Wins and a national deployment will benefit them extensively. At the same time, a large portion of the costs of deploying necessary infrastructure and maintaining and upgrading it will also fall on the state and local DOTs. Quick Wins deployments place state and local DOTs in a strong position *vis-à-vis* a national deployment.

2. **Transit** is a likely Quick Wins deployment candidate not only because of a desire nationwide for better, and frequently proactive, information and information delivery for customers, but also because transit vehicles tend to be around the same place at about the same time every day. A known route can considerably reduce infrastructure deployment costs while creating a denser information picture of the roadway. Transit agencies, like all deployment groups, require successfully structured partnership arrangements for successful deployments.

3. **Emergency services** maintain and operate fleets that lack the predictability of transit, but often function from hubs with a well-defined perimeter of operation. In addition, there are clear safety benefits available to public safety operators, as well as mobility benefits such as traffic signal pre-emption. Like transit, public safety represents a fleet of professional operators, already used to a variety of interfaces.

4. **CVO** is perhaps the best example of experienced operators accustomed to a variety of communication, mobility, and safety applications as key components of their daily business. That, combined with an industry-wide focus on efficiency and better data management, suggests that CVO would be a likely candidate for Quick Wins deployments.

Because of the range of technologies involved in deployment, and the proper focus of public agencies, public-sector deployment groups will not be able to deploy without considerable assistance from industry, whether through provision of hardware, software, expertise, or all three. Unlike many traditional ITS deployments where the contractor relationship has predominated, possible market penetration – particularly at the level of individual vehicle operators – offers a very different playing field for both industry and public-sector agencies. Quick Wins anticipates that deploying agencies or organizations will have little difficulty in finding industry partners once the latter are assured: a) of a

[20] There are a number of considerations that go into any investment decision, and business models will remain unclear for a few years even after deployments are underway. This is discussed in greater detail in Section 4.

revenue stream, b) that the proposed project will be compatible with a national deployment, and c) that risks are shared appropriately. Section 4.5 below explores the question of business models more fully.

3.5 Representative vignettes

The remainder of this section offers a collection of representative deployment vignettes that take as their starting point the initial deployable application areas and the prospective candidate groups. The intention in offering these vignettes is to illustrate deployable Connected Vehicles elements as part of a locally oriented and directed deployment. These vignettes don't address timelines or explicit connections to ongoing research (those are treated in the next – and final – section), but are rather designed to encourage thought around imaginable circumstances.

These vignettes are written from the perspective of three distinct deployment stakeholders – transit, emergency services, and state DOTs – and are representative rather than exhaustive. In each case, specific Connected Vehicles applications are in bold.

Transit

Over the last few years, City Core Transit (CCoT) had established a pretty good record for being on time. Generally its customers could expect only a few minutes delay, and even regular riders didn't find themselves too frequently inconvenienced. However, over the last eight months or so, as more people had been getting back to work, city traffic had gotten more and more unpredictable and dense. Travel times began to suffer and the customers CCoT had won over recently were beginning to consider finding some other way around town.

CCoT managers as well as city planners and local business groups were concerned. Remembering a series of presentations at recent conferences, and conversations with colleagues, a small group of managers hatched a plan. Partnering with the regional transportation association, CCoT installed Connected Vehicles DSRC radios on their buses, and working with the state DOT, installed RSEs on signals along the major transit routes.

After a week of intense negotiations, the regional authority and CCoT agreed on a **signal prioritization** plan that would use signals coming from the DSRC radio onboard the buses to permit those running eight minutes behind schedule and more than half full to speed up through signalized intersections.

While CCoT found their record improving, Millet Stevenson – a traffic engineer working in central operations – worked out an algorithm that leveraged transit vehicle reporting through both radio and DSRC/RSE links. His data provided accurate **location reporting** of transit vehicles in real-time. Additionally, he found that using that data, it was possible to look at overall traffic flow measured through inductive loops and private sector traffic data and predict arrival times at various stops that were considerably more refined and accurate than previous methods.

CCoT had already seen enhanced gas mileage and reduced idling since the implementation of the city core signal prioritization effort, but the commission was still asking that they do more to document environmental benefits to support the Connected Vehicles investments. The problem – as soon became apparent – was that there wasn't much data being collected to demonstrate environmental benefits in terms of either efficiency or technology.

CCoT saw this deficiency as an opportunity to extend the Connected Vehicle footprint within the agency. CCoT buses, with their DSRC radios connected to the bus systems, began **transmitting real-time emissions data** to RSEs along their routes. The agency archived the data and used it to document the environmental benefits – particularly in emissions reductions – accrued from the use of signal prioritization. The result? Additional support for the next year's budget request for a broader deployment of RSEs for signal prioritization throughout the city.

Emergency Services

Johnson City Fire Department (JCFD) had always maintained a fairly high ranking in the state for response times to 911 calls. Recently, though, as more people had moved into the city, and development had begun in some of the old industrial areas, response times were getting unacceptably long for Chief Samuel Thompson.

He'd watched as the local transit agency (CCoT) had used Connected Vehicles technology to improve timing and customer service, and Thompson assigned a team to evaluate what might be done along the same lines for the Department. The results were encouraging, and over the course of the next eight months, working with Johnson City and CCoT, JCFD adopted Connected Vehicles technology that would allow public safety vehicles to interact with the instrumented signals that existed throughout on most of the major roadways. Along with lights and siren, responders were now able to also **preempt traffic signals**, measurably enhancing response times.

With such a success, Thompson was able to consider another growing problem: first responders of the JCFD had long made use of dash mounted GPS units for finding their way to out-of-the-way places. And, while the units worked fine in most cases, congestion and the location of other units could severely impact response times and even the ability of the unit to reach its destination.

Chief Thompson decided that his officers needed additional assistance from Connected Vehicles applications, and he piggybacked on and real-time traffic information made available from the stated Department of Transportation (StDOT). Using vehicle location, dispatchers in the operations center are able to feed not only congestion information and the location of other responding units to the vehicle operators, but also monitor the progress of vehicles responding to incidents

State DOTs

Congestion was the thing State DOT (StDOT) head Tony Churchill was asked about at every annual budget meeting. He always answered that StDOT invested in the best practices and technologies: loop detectors, dynamic message signs, and ramp meters on key roadway sections, as well as dissemination of travel advisory information through its 511 system and web site. Despite all of that, it was still extraordinarily difficult to manage entire corridors, and Tony was always looking for something to make it easier.

When Tony had started to look into Connected Vehicles technology what struck him most powerfully was the capabilities he'd likely gain from the use of better real-time information about road conditions. With local agencies like CCoT and JCFD finding ways to incorporate Connected Vehicles technology, he saw that he could improve operations on arterials and interstates. The next year's budget made a strong case for both DSRC radios and RSEs.

Within another year or so, Tony began looking at new ways to collect traffic data and disseminate information to the traveling public. His department already made use of roadside signage, 511

services, the StDOT Traffic Alert website, as well as a special mobile phone app they'd had built to share information about road conditions and potential hazards. But it continued to be difficult to get the right information to users in time for it to be truly useful.

The RSEs StDOT put in place relied on Connected Vehicle technology equipped state fleet vehicles and a smattering of commercial vehicles to convey information about traffic speed, and particularly anomalies in traffic speeds when compared to historic data. That, combined with CAD data from JCPD, created a fairly robust data environment – one Tony felt he could further take advantage of. Towards that end, StDOT incorporated additional Connected Vehicle technology to update roadside signage in real time in response to this data, and the new carry-on Connected Vehicle devices and smart phone apps delivered **hazard warnings** where there is no signage (i.e., places along the road without dynamic message signs).

To round out StDOT's investments in Connected Vehicles technologies, Tony turned towards commercial traffic. With existing applications like CVISN, Tony felt that they had a pretty good handle on freight. But other states were beginning to implement Connected Vehicles applications that gathered data StDOT didn't – most importantly safety and maintenance records. Finally, with the increased motor freight traffic during the winter months, Tony decided took the advice of a group of engineers and added **compliance and inspection** capabilities to the state's already burgeoning RSE deployment.

Although not mandatory for commercial vehicles entering the state, StDOT assured those that were Connected Vehicles technology-equipped that they would experience a significantly improved experience, and many carriers – already experimenting with Connected Vehicles technologies and the coherence they offered – agreed. In the end, as other states adopted the Connected Vehicles-based compliance systems, and as CVO Connected Vehicles applications proliferated, the open, non-proprietary standards meant significantly less capital outlay and an assurance of cross-jurisdictional interoperability, and thus reduced cost for everyone.

While this section provided the basic characterization of Quick Wins as well as a number of deployment vignettes, the next section explores the time line and specific application deployment possibilities for Quick Wins.

4.0 Winning Deployments

4.1 Assumptions

Quick Wins is a dependent scenario, meaning that it has not been conceived as a standalone or replacement scenario for Connected Vehicles deployment, but rather as a supplement. The scenario's efficacy relies on that and the following set of assumptions:

1) Imperatives (what's driving deployment?)
   a) Over the next 3-7 years, the primary objective for state and local deployments is mobility enhancement. Furthermore, mobility applications continue to grow in importance as congestion continues to increase (at least in urban areas).
   b) While secondary to mobility, safety concerns play a significant role in state and local deployment even over the next 3-7 years, with particular deployment consideration given to applications that enhance public safety and transit benefits (e.g. emergency vehicles and bus lines).
2) Governance
   a) Despite local, organic deployments, interoperability of a national system remains a foundational principle.
   b) Connected Vehicles device and data standards are finalized and a certification process and set of requirements are decided upon.
   c) Ultimately, organizations procuring Connected Vehicles technologies will seek those applications and hardware that conform to these standards and meet certification requirements.
   d) The effects and results from local deployments are widely shared with a national audience through conferences, networks, and training.
3) Technology/capability availability
   a) Due to the versatility of DSRC and long-term possibilities as a platform for enhanced capabilities (e.g., cooperative safety), and all other things being equal, state and local deployments favor DSRC-based capabilities when feasible and affordable even if deployment timelines are longer than with alternative technologies.
   b) V2V DSRC technologies – of whatever form factor – cannot be counted on in a meaningful number of light vehicles until at least 2016.
   c) Private sector firms take advantage of whatever technologies/capabilities are available and will emphasize near-term capability availability over a focus on a particular technology (e.g., DSRC).
   d) In cases where DSRC-based technologies are available, as well as access to them and their data, private sector firms find innovative (and, in many cases, not previously articulated) applications of state and local deployments.
   e) Connected Vehicles technologies – particularly those such as DSRC that don't have a significant private sector market presence – continue to show promise and are proven-out during testing and prototype efforts.

   f) Significant non-technological milestones are reached over the next five years. In particular standards and security concerns are adequately addressed as projected in the ITS JPO research roadmaps.
4) Budget availability
   a) Concerns regarding increasing congestion are a significant factor in state and local transportation planning. As a result, state and local agencies are willing (and, importantly, able) to allocate funds to Connected Vehicles deployment assuming clear benefits (in terms of either safety or congestion relief) can be compellingly articulated.[21]
   b) Current Government research efforts continue at a sustainable rate of funding through the periods articulated in the existing research roadmaps.
5) Business/benefits case
   a) Early-stage deployments prove-out benefits and are recognized for doing so within the deployment community.
   b) Industry will continue to innovate and offer safety and mobility solutions to the market; some of these innovations will be adopted into the Connected Vehicles system as it continues to evolve.
   c) There is sufficient and compelling evidence to support rule-making efforts over the mid-decade.

Because Quick Wins is not designed as an alternative to national deployment, but rather as a complement to it (albeit one with enormous potential for both Quick Wins deployers and the national program), the deployment scenario relies on the existing Government research plans. We recognize that a significant number of Quick Wins' deployments could lead to a number of further-out changes to these research plans, but that is beyond the scope of this project.

4.2 Critical enablers

Each of these application areas relies on one or more of five building blocks, or enabling events. These enablers, like particular application areas, rely on current research and activity plans supporting the national deployment of Connected Vehicles. With any one of these enabling events some application areas may be viable and some not, but without any of them, deployments of any sort are highly unlikely.

1. Standards

Connected Vehicles is envisioned as a fully interoperable system of systems. In particular, Connected Vehicles devices should be interoperable independent of manufacturer, manufacturing location, or location of use.

The ITS Standards Program will enable the required interoperability by delivering a suite of standards supporting both infrastructure capabilities and Connected Vehicles applications. The ITS Standards Program has already developed almost 100 standards and supporting whitepapers. While most of these standards and whitepapers apply broadly to the ITS infrastructure, initial versions of the core Connected Vehicles standards (IEEE 802.11p, IEEE 1609.x, and SAE J2735) have also been released. While the IEEE 1609.x and SAE J2735 standards are currently undergoing revision, the ITS

[21] ITS JPO maintains a collection of ITS cost cases at http://www.itsdeployment.its.dot.gov/ segmented by application group.

Standards Program anticipates completing the revisions, along with completion of and updates to ITS infrastructure standards that are currently underway, by 2014.

2. Policies and procedures for operation

Policies and procedures will need to be established for Connected Vehicles deployments – but most applications do not require nationwide uniformity on policy and procedures. State and local agencies that pursue quick wins deployments will craft policies and procedures appropriate to their particular situation, including ensuring that deployments comply with all existing privacy regulations.

In fact, this early experience with Connected Vehicles technologies constitutes a major benefit of the Quick Wins deployment scenario. As early adopters gain experience with the technology, they will identify best practices with respect to policies and procedures that can then be leveraged during national rollout of comprehensive Connected Vehicles capabilities.

3. Security

Connected Vehicles users will expect applications to incorporate sufficient security to ensure good performance while avoiding the potential dangers associated with non-secure systems – including the possibility that hacking might lead to dissemination of incorrect and possibly dangerous information.

While early deployments will have to address security concerns, there is a growing (although certainly not yet comprehensive) body of research around Connected Vehicles security and work continues. Given that early, Quick Wins deployments will focus primarily on mobility services in which the possibility of failures resulting in life-threatening behaviors are likely to be negligible, these early deployments should be able to take advantage of existing capabilities to achieve the required level of security.

4. Infrastructure deployment

Quick Wins assumes that most early deployments will involve infrastructure deployment in some form. In most cases, it is assumed that this infrastructure will support DSRC communications between the infrastructure and vehicles. In some application areas – such as using vehicles as probes to capture better information on road and congestion conditions – early deployments may take advantage of non-DSRC infrastructure (such as cellular networks) for communicating information to vehicles. In this case state and local agencies wouldn't actually be installing any infrastructure initially, but partnering with existing data providers.

5. Mobile devices

In addition to infrastructure, mobile devices (both installed or mounted in-vehicle devices as well as handheld/carry-in devices) are, of course, central to most early-stage deployment considerations for Connected Vehicles applications. And while device manufacturers and application developers will have to pay attention to driver attention issues, Quick Wins assumes that there exists a set of early applications that provide sufficient benefits to both the deploying agencies as well as partners in such areas as transit, emergency response, and commercial vehicles to incent deployment. As such, these early deployments, driven by state and local transportation agencies, will rely on state and local fleets and/or commercial fleets for initial deployment of mobile devices.[22]

[22] The nature of the installed devices, particularly in the earlier stages of deployments is difficult to characterize accurately, but there is likely to be a combination of aftermarket, retrofit, and carry-in. Initially, these devices are not likely to have direct access to a vehicle's bus.

While state and local agencies won't necessarily target private vehicles in early deployment activities, Quick Wins assumes that entrepreneurial aftermarket device manufacturers will identify opportunities to create products that take advantage of emerging Connected Vehicles capabilities. Examples of such services might include access to SPaT information or advisory information. As such, these Quick Wins deployments represent a real opportunity to test market interest in Connected Vehicles devices and potentially build a foundation for longer-term, national deployment activities.

4.3 Secondary success factors

In addition to these application areas and enablers, there are a number of factors that will influence whether or not Quick Wins deployments successful in and of themselves, and as contributions to a national deployment. These success factors *are not necessarily* in the domain of Government and their efficacy in some cases depends on a collaborative approach by relevant members of the deployment community.

1. ***Pilot or test deployments*** are critical to establishing credibility for the deployment of Connected Vehicles applications, and are of particular but not exclusive importance in those cases where DSRC applications are involved. There is a substantial historical and ongoing portfolio of pilot and test deployments and these should serve – in principle – as a model for the Quick Wins scenario.
2. ***Peer deployments*** are of particular importance for public agencies and must demonstrate that Connected Vehicles applications can address common areas of concern (i.e. liability management or signal preemption) and do so in a manner that is compatible with existing ways of doing business. Where pilot or test deployments have demonstrated technical viability, peer deployments offer evidence of operational and fiscal efficacy to those considering deployment.
3. ***Effective opportunities to work together*** are essential between state and local agencies and industry. These opportunities – which might include standard contractor relationships, public private partnerships, or even shared-risk arrangements – will require mutual assurances of longevity (i.e. that investments made today will not be rendered valueless because substantial components of the Connected Vehicles program change). Additionally, absent obvious business plans, both industry and state and local governments will have to seek creative opportunities for defining and extracting value. Altruism is insufficient. Quick Wins offers a number of such opportunities from direct sales of products and services to franchise models to advertising.
4. **User acceptability** will become increasingly critical as Connected Vehicles applications move from the early stage management orientation to driver-oriented. It is not simply a matter of human factors engineering (HFE), but rather a larger communication effort around expectations and value. This is less of an issue among professional or government drivers.
5. **Sustainability**, or the predictable longevity of the Connected Vehicles program and its foundational elements (standards, policies, and procedures) is essential for investment decisions with both agency and industry stakeholders.
6. **Deployment-oriented champions, communications, and networks** will ultimately determine the effectiveness of both Quick Wins deployments as well as a national deployment. Early deploying agencies and organizations must be able to share results, expectations, best practices, and other information critical to assure others that deployment is sensible and viable.

4.4 Application areas and timelines

In general, Quick Wins assumes early deployers will identify a specific set of applications on which to base the initial rollout. We've identified the following application areas as those that are likely to be available for deployment over the next three to five years based on existing research timetables.

1. Data capture and management

While not, strictly speaking, a user-focused application area, data capture and management is a core capability of Connected Vehicles. The ability to capture data from vehicles on status and movement, road conditions, and environmental conditions enables a range of additional applications. At the first level, such applications include basic traveler information services and transportation system monitoring. These capabilities, in turn, support such follow-on applications as dynamic re-routing of all types of vehicles, transportation operations and maintenance, and, in fact, most of the applications in the areas identified below.

Data capture and management capabilities are, in fact, quickly maturing, although they currently lack the sort of comprehensiveness and integration that Connected Vehicles would offer. A number of agencies release real-time traffic and transit information to the public, and a handful of service providers analyze and repackage that data into traffic maps and "next bus" alerts. However, data collection is still limited outside major metropolitan areas, and some service providers consider the data they handle to be proprietary. Furthermore, many data sources cover only a single mode, while Connected Vehicles envisions the fusion of data from multiple modes.

Data capture and management is a specific program area of the ITS JPO. The program is intended to address the above limitations by:

- Working with transit agencies and commercial vehicle operators to provide a publicly available, real-time, multi-modal database of transit information.
- Conducting demonstrations that show the value of ubiquitous, real-time, multi-modal information.
- Transferring data capture and management technologies to other researchers and users.
- Supporting data capture elements of other ITS activities.

As such, the ITS JPO has created a timeline over which it anticipates developing data capture and management capabilities. Based on this timeline, the Quick Wins scenario assumes early deployers will be able to take advantage of emerging data capture and management capabilities as follows.

- 2011, Q3:
  - Prototype data environment developed and data environment guidelines established
  - Applications for research, development, and testing selected
- 2013, Q3:
  - Refined data environment delivered (under contract)
- 2015, Q1:
  - Completion of data environment demonstration

With delivery of a refined and demonstrated data environment in the 2015 time frame, most state and local transportation agencies will likely begin deployment planning activities starting in 2015. Quick Wins anticipates that early deployers, however, will begin deployment activities as early as late 2011

as ITS JPO research activities clarify the general expectations for data environments and identify specific applications for further development. In particular, new traffic data applications could be deployed in the next three to five years as results from the Data Capture and Management program begin to bear fruit, and likely:

- Produces test data environments that are used by researchers and entrepreneurs to develop new applications and products
- Assists new or existing consortiums such as FHWA Cross-Town Improvement Project (C-TIP) in developing new traffic and transit data applications and provide the resulting data to the public and other service developers
- Works with existing traffic and transit data providers such as Google, Inrix, Navteq, or NextBus to expand the timeliness and geographic coverage of their services with the understanding that the publically developed Connected Vehicles-enhanced source data is publicly available.

2. Fleet management

Fleet management systems track and report the status of vehicles in the field. Used by commercial companies and public transit agencies alike, fleet management systems can improve the efficiency, safety, and reliability of a fleet's operations.[23] Existing applications include enforcing proper use of vehicles, recommending more efficient driving strategies, reporting vehicle locations to customers, and monitoring vehicle health.

Fleet management systems are implemented with telematics – the integration of telecommunications, data gathering, and data processing technologies. Today, fleet telematics commonly combine GPS navigation systems, in-vehicle diagnostic electronics (such as engine health and tire pressure monitors), and satellite or cellular communications. In the near future, these systems could be augmented with additional Connected Vehicles data sources and DSRC communications.

Fleet management will benefit from nearly all elements of the Connected Vehicles program such as:

- Data Capture and Management: As fleet operators share data, overall understanding of traffic conditions will improve substantially. Multi-modal datasets can help fleet operators improve services that use road, ship, air, rail, or water.
- Connected Vehicles Safety: Information generated as part of the operation of Connected Vehicles safety applications can be used by fleet managers as the basis for a curriculum for driver training.
- Connected Vehicles Mobility: The DSRC infrastructure associated with mobility applications such as those relying on Signal Phase and Timing (SPaT) give fleet operators another communication option that could supplement or replace cellular or satellite-based telematics.
- Advanced Traffic Management: Free flowing traffic is just as important, if not more important, to fleets as it is to individual travelers. Advanced traffic management systems could suggest alternative routes to improve service reliability during bad weather or construction.

[23] While there are a number of overlapping deployment opportunities and applications between commercial fleets and transit fleets, there are differing timelines and economic considerations. In particular, long-haul fleets aren't likely to benefit as immediately from local deployments.

Since fleet management applications pull from research across the Connected Vehicles program, early deployers will be able to take advantage of current activity aimed at defining the initial applications for further development. In addition, the Quick Wins scenario anticipates that fleet operators will be involved with data capture and management activities or tapped to participate in ITS-CVO prototype and field operational tests that will occur through 2013. These tests and other potential pilot deployments provide fleet operators the chance to evaluate the benefits of DSRC-based telematics and ITS datasets. If operators are satisfied with the costs and benefits, Connected Vehicles resources can be integrated into existing fleet management architectures, allowing early deployers to roll out service offerings in the next three to five years.

3. Traffic signal management and related applications.
Connected Vehicles offers a number of opportunities for deployment of traffic signal management applications over the coming three to five years. Specific applications that offer near-term opportunities for deployment include:

- Signal prioritization and preemption, offering improving travel for emergency and transit vehicles, in particular.
- Signal coordination and optimization to reduce congestion and improve vehicle flow on signalized arterials.
- Advisory Message Delivery Service (AMDS), or in-vehicle signage, offering opportunities to alert drivers to incidents and roadway hazards.

As an additional benefit, deployment of the infrastructure required to support traffic signal management applications will provide significant new opportunities to collect probe data from vehicles in support of other application areas.

Furthermore, much work has already been done to develop and test the infrastructure required for traffic signal management. The proof of concept testing carried out under a cooperative agreement between the USDOT and the Vehicle Infrastructure Integration Consortium (VIIC)[24], for example, demonstrated many of the required vehicle-to-infrastructure communication capabilities while also identifying specific areas requiring further development and testing.

In addition, several states have installed systems and developed supporting applications for testing purposes. New York State, for example, has already installed eight DSRC roadside equipment devices (RSEs) with traffic signals along NY 25 and developed intersection management applications (including intersection safety using Signal Phase and Timing (SPaT) and signal prioritization for transit) for demonstration purposes.

The ITS JPO is currently conducting a number of research activities that will ultimately support deployment of intersection management and related applications. These include the following:

- The Vehicle-to-Infrastructure Safety Applications research program is working to develop a traffic signal interface and supporting application base to communicate SPaT information to vehicles to support delivering safety advisories and warnings. Specific milestones include:
    - Completion of SPaT prototype: Q1, 2012.

[24] *Final Report: Vehicle Infrastructure Integration Proof of Concept, Executive Summary – Vehicle,* This report is available from the ITS JPO by request.

    - Completed SPaT interface definition and policy guidance: Q4, 2013.
- The Dynamic Mobility Applications Program, working with state DOTs, is conducting a pooled fund study with the Center for Transportation Studies at the University of Virginia.
    - Under one of its tasks, the study has already developed new traffic control signal algorithms that take advantage of Connected Vehicles information to improve intersection coordination. The study is conducting ongoing work to evaluate the algorithms and analyze deployment opportunities. The analysis of the algorithms is expected to be complete in Q1, 2011.
    - A second task is investigating the potential benefits of broadcasted SPaT data under Connected Vehicles. The study will deliver recommendations in Q1, 2011.

With delivery of these results and the experience gained through existing test deployment activities, Quick Wins anticipates that additional early deployers will begin deployment activities as early as 2012. These early deployers will take advantage of ITS JPO and state research activities with respect to SPaT prototype definition and development of intersection management algorithms.

4. CVO compliance, control, and enforcement

The use of ITS in commercial vehicle operations (CVO) has been rapidly expanding since the Commercial Vehicle Information Safety Network (CVISN) began in 1994. The CVISN program is aimed at streamlining and automating the management of highway freight by implementing:

- National databases of safety information automatically populated by inspection station reports.
- Automated credentials administrations implemented with a standard electronic data interface.
- Electronic credentialing systems that improve the quality and speed of truck inspections.

Most states have deployed or started deploying Core CVISN capabilities. States are also expanding their CVISN deployments with systems such as virtual weigh stations that are five times faster and more than 10 times cheaper than traditional static inspection stations.

To use CVISN services, many highway freight operators currently employ transponders at 915 MHz for electronic clearance and toll payment. However, 5.9 GHz DSRC offers significant advantages over current transponders. The higher data rates and longer range of 5.9 GHz DSRC equipment can enable a range of Connected Vehicles safety and mobility applications for commercial operators including:

- Wireless roadside inspections.
- Universal truck identification.
- Virtual weigh stations.
- Truck parking applications.
- Blind Spot Detection.
- Do Not Pass Warnings.
- Smart Parking Availability Announcements.
- Road Weather and Operating Conditions Information.

Some state DOT programs have already begun studying how to migrate CVISN capabilities to 5.9 GHz DSRC while also implementing DSRC-enabled Connected Vehicles safety and mobility applications. For example, New York State's Commercial Vehicle Infrastructure Integration (CVII) program uses DSRC equipment to demonstrate a variety of safety and mobility applications in

commercial vehicles on a highway corridor. In addition, ITS-CVO applications are being developed for commercial operators in city environments. C-TIP is developing advanced route scheduling and collaborative traffic monitoring for CVO using ITS concepts.

The Federal Motor Carrier Safety Administration (FMCSA) and FHWA are continuing to research these services as part of their jointly sponsored Smart Roadside research program and the expanded CVISN program. These programs should provide results for use by early deployers in Quick Wins deployments as follows:

- 2012, Q3-Q4: Complete Smart Roadside prototype.
- 2012, Q3: Complete Smart Park prototype.
- 2013: Field Operational Tests.

In addition, the V2V Safety Applications program will identify and test commercial vehicle Connected Vehicles safety systems in 2011 and 2012. With the current availability of ITS-CVO applications through CVISN and the rapidly maturing DSRC CVO-targeted road-side and on-board DSRC equipment (as noted above), the Quick Wins scenario anticipates that many non-active safety Connected Vehicles CVO applications could begin to roll out following these tests, perhaps even sooner that anticipated.

4.5 Investment and business models

There continues to be significant interest in identifying Connected Vehicles deployment business models, particularly those for private actors. However, without the reality of an impending deployment, business models will continue to be primarily theoretical. Quick Wins, by offering short-term opportunities for deployments of viable Connected Vehicles technologies, sets the table for the emergence of potentially workable business models.

Different communities have different requirements for investment, but there are some common top-level considerations. These are:

1. A clear understanding of the Connected Vehicles system as it is and as it's imagined including technology, policy, and governance.

2. An understanding of deployment costs and anticipated return on investment (ROI).

3. Predictability, that is, is there surety that a national interoperable system will exist at some point in the future.

Among the primary Quick Wins deployers – state DOTs, transit and public service fleets (e.g. surface maintenance, emergency services), CVO fleets, and aftermarket and retrofit manufacturers – there are a number of potential business plans, deployment methodologies, alliance opportunities, and incentives. The following table captures high-level investment benefits for these groups, as well as

important considerations in contemplating the development and articulation of Connected Vehicles and Quick Wins business models.[25]

Deployer	High-level benefits	Investment considerations
State DOT	A. Integrated management capacity B. More complete data picture C. Enhanced roadway safety	1. Minimization of custom/proprietary technology 2. Reduced capital costs 3. Return on investment projections, particularly compared to current-day expenditures
Transit and public/emergency service fleets	A. Reduced operating costs B. More complete data picture C. Reduced capital costs D. Better customer service	1. Evidence of return on investment and answering the question 'does it work?' (peer deployments particularly important) 2. Level of capability offered to customers, and will they recognize the value 3. Overall impact on maintenance and operations 4. Interoperability with existing data and transportation management systems 5. Partnership viability with state or local DOTs
CVO	A. Reduced capital and operational costs B. Enhanced operational efficiencies	1. Capability of Connected Vehicles to integrate successfully with on-board systems. 2. Possibility for reducing hardware redundancies and associated operator training 3. Evidence of return on investment 4. Evidence of supporting infrastructure 5. State enforcement policies
Aftermarket and retrofit mfg	A. Early-mover status B. Deployment experience C. Technology definition	1. Existence of a viable emerging device market 2. Presence of necessary/appropriate infrastructure to support desired applications

4.6 Connected Vehicles Community and Quick Wins Deployment

Connected Vehicles already benefits from an active community of interested companies and state, local, and federal agencies. By and large, this community is interested in the technologies that will

[25] We assume that for all deployers, the overall safety of the system – in addition to other considerations – will be critical to making a deployment decision.

constitute a Connected Vehicles system as well as the direction Government might take in mainstreaming those technologies and capabilities over the next half-decade or so. Quick Wins envisions something broader.

Just as the technologies, applications, and infrastructure deployments of Quick Wins complement a national deployment of Connected Vehicles, the community and collaborative efforts that underlying these local and state deployments will do the same. The ultimate success of Quick Wins relies on the ability of early deployers to communicate successes, best practices, and results to all interested parties. Without clearly communicated deployments, the value of individual local deployments is diminished for both the deployers (who lose the capacity to benefit from real time peer feedback) and for the community at large (who loses the knowledge generated during the deployment and subsequent operation).

Quick Wins imagines three sorts of collaboration and communication opportunities arising out of the drive for near term local deployments of Connected Vehicles technologies. These three opportunities – research to practice hub, showcases, and public communications – are purely self-sufficient but when combined offer an active and resilient basis from which Quick Wins deployments and eventually a national deployment might grow.

1. A **Research to Practice Hub** extends the ongoing research-oriented collaboration model and focuses attention on moving Connected Vehicles from a research program to a deployable system. Quick Wins requires a library of best practices, emerging practices, failed deployments, deployment results, ROI finding, deployment paths, possible partnership opportunities, common presentations, communication tools, training manuals, how to guides (e.g. cabinet retrofit), and the like.[26]

   The Research to Practice Hub answers both questions – Does it work? How does it work?

2. ***Showcases*** have a history within Connected Vehicles, and are remembered fondly by many throughout the state and local community. Local deployments will require local buy-in and understanding if they are to be considered, funded, and completed. Showcases, whether they are of the old VII-era road show type, or delivered digitally, or both give those with a stake – engineers, politicians, drivers, public safety officials, and others – an opportunity to see Connected Vehicles technologies at work, and understand their value in meeting the various needs and interests of the community.

   Showcases also bridge the gap between the research and operational perspective found in research to practice activities and the public communications that is essential for longer-term political interest. In seeing the technology as bits and pieces and then how it all comes together to make roadways safer, more efficient, and greener stakeholders are able to imagine their own set of implications.

3. **Consistent and unambiguous communication with the public** hasn't been a necessary part of Connected Vehicles research, or the collaborative associations that have been participating in and supporting this research. But as the research progresses beyond design

[26] ITS JPO is currently finalizing a Connected Vehicles Knowledge Management Portal that will provide much of this functionality.

and into testing and actual Quick Wins deployments, the role of the public will become increasingly important.

The Connected Vehicles community – both that which exists now, and that which will exist as deployment begin – has a new role. Beyond theory, and embracing real practices, real benefits, and the real world, this community sits at the ultimate heart of Connected Vehicles. Technology, long the focus, assumes its proper role under Quick Wins: a supporting tool in creating safer roads, easier travels, and cleaner air.