USDOT Guidance for Connected Vehicle Deployments

Institutional and Business Issues and Financial Sustainability

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Kate Hartman (ITS JPO, CV Pilots Program Manager)

16. Abstract

This document provides guidance material in regards to Institutional and Business issues as well as Financial Sustainability for the CV Pilots Deployment Concept Development Phase. This material also provides part of the foundation for the Performance Evaluation under Task 5. This document emphasizes the importance of identifying risks and mitigation actions associated with a broad range of institutional and financial issues related to the Pilot deployments with the understanding that institutional issues can be more challenging than technical ones. This report also emphasizes the importance of documenting the business processes and institutional models as CV deployment moves from the baseline ("As Is") case to the Desired ("To Be") case and ultimately to deployment ("Implemented").Tools for capturing these changes include narratives and diagrams concerning an extension of the Capability Maturity Model, a macroscopic version of the relevant institutional framework, and a microscopic version of the business processes that reflect specific CV applications. Of considerable importance is cash flow associated with institutional and business models that potentially can achieve financial sustainability of successful CV deployments.

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1 Introduction

1.1 Purpose of the Report

This report provides assistance to Connected Vehicle (CV) Pilot sites to help ensure timely and successful completion of Concept Development Phase deliverables regarding institutional issues and how to achieve financial sustainability for a CV deployment. It describes how to develop insight regarding the institutional changes that are likely to occur as CV deployment occurs. New methods of documentation have been developed to capture these changes. These methods build on the tools of business process mapping, provide linkages to performance measurement, and provide high level models of institutional change, one by using a Capability Maturity Model (CMM) tailored to CV (CMM-CV) and the other, high-level institutional/business models

This document does not replace or alter the work statement defined in the Broad Agency Announcement (BAA); in some cases it provides additional detail regarding deliverables defined by the statement of work, and in others it provides recommendations regarding the approach to completing the tasks from the perspective of institutional and financial issues.

1.2 Organization of the Report

Following this introductory section, this report has the following sections:

- Section 2 presents concepts that may be useful to Pilot sites.
  - Concept A. Approaches to managing risks concerning institutional and financial issues. This includes identification of potential risks of this nature and preparation of a risk management matrix.
  - Concept B. A method to document the business processes associated with CV applications. A detailed or micro-perspective is offered. It is recommended that process maps be used to document the baseline case (As Is), the desired case (To Be), and the Implementation Case. The Actors in these process maps are people, not vehicles or equipment, and directly relate to the types of individuals to whom safety, mobility and environmental benefits accrue.
  - Concept C. High-level approaches to characterizing the business processes in terms who is responsible for the lifecycle of CV deployment – plan, design, contract, test, build, maintain and operate. Different business models, for example a Department of Transportation (DOT) centric approach, a public private partnership and a franchise are compared and contrasted.
  - Concept D. Proposed CV extension of the operations CMM and how to apply it to a Pilot site. The CMM-CV is strongly recommended as a tool to help document the baseline capability maturity and ultimately the level of capability maturity associated with the implemented system.
  - Concept E. Different approaches to achieving financial sustainability of CV deployments at different Pilot sites. This section discusses the types of financing that will generally accompany this typical institutional framework, namely the gas tax, transportation fees, tolls,

and local option transportation taxes. There is a brief discussion of other types of business models that can potentially achieve financial sustainability.

- Section 3 reviews the deliverable requirements of Task 10, Partnership Coordination and Finalization, from the Broad Agency Announcement. Requirements based on related tasks are also discussed.
- Section 4 sets out some of the most important challenges in addressing the institutional, business and financial issues.

There are also three appendices:

- Appendix A is a list of acronyms used throughout this document.
- Appendix B presents the matrix representing the Connected Vehicle extension of the Capability Maturity Model and how the Pilots should apply it.
- Appendix C describes how to document the institutional context using a diagramming process consisting of or similar to the Enterprise layer of the SET-IT tool for implementing the Connected Vehicle Reference Implementation Architecture (CVRIA)

2 Background

From an institutional standpoint it is anticipated that the Pilots will be typically organized in a DOT- centric manner. The public sector is expected to assume responsibility for the infrastructure aspects of the system and the private sector the installation of vehicle equipment, although the public sector could also have a key role in this regard. Proposals of the Pilots reveal the roles and responsibilities of each sector. The DOTs will continue their traditional responsibility for system management and operations as well as upgrades of roadside equipment such as traffic signal controllers.

According to the Footprint Analysis of the American Association of State Transportation Officials (AASHTO), CV deployments are most likely to spread incrementally across the country, which reinforces the idea that deployment will be largely DOT-centric. The incentives resulting in this institutional arrangement will remain largely unchanged. In other words, funding to financially sustain CV at the Pilot sites and elsewhere will mainly occur in the traditional manner, through Federal Aid funding, State and Local transportation related taxes, tolls, and so on.

However, the AASHTO Footprint Analysis also indicates that a relatively small amount of CV deployment will not occur incrementally but instead through such means as Public Private Partnerships (PPPs) and innovative business models and finance.

This guidance points to a variety of new tools that can be used to characterize the changes in the CV institutional environment during the shift from the baseline case to deployment. Each Pilot must prepare a performance measurement and evaluation support plan that includes measures and targets. Each Pilot will also need to support additional quantitative and qualitative measures for an independent evaluator to use. The qualitative ones are expected to include the change at each Pilot site in the institutional framework and business processes both at a macroscopic (high level institutional) and microscopic (CV application) level. Understanding how value and costs accrue to different road users and entities (partners and stakeholders) is important.

Finally, each Pilot must consider the manner in which the feasibility of achieving financial sustainability will be achieved through traditional and/or non-traditional means.

2.1 Key Concepts

Historically it has been typical of those involved in planning, designing, implementing, operating and maintaining Intelligent Transportation Systems (ITS) to focus on technical issues. It is often heard that there are no real technical barriers to deploying ITS (including CV), but the institutional challenges, including numerous non-technical issues, can be considerable. Some of these, such as privacy and security, are addressed in other guidance material. However, there are other significant institutional issues that must be considered including organizational effectiveness, business relationships and financial viability.

The concepts addressed in this report are based on the following fundamental considerations:

- There needs to be vigilance with respect to potential institutional and related risks that may be costly, cause schedule delay or have other important ramifications.
- The CV applications for each Pilot, based on a desired implementation concept, will be introduced into an existing or baseline environment. Each Pilot site will implement a set of applications. Specialists in business process change frequently and refer to these three cases as the existing or "As Is" case, the desired or "To Be" case and the actual or "Implemented" case.
- Documentation for each of these applications or package of applications ideally requires three things: a narrative, one or more graphics, and a changes in performance. Performance is expressed in both quantitative and qualitative terms.
- The changes created by the CV Pilots will alter the benefits and costs to users of the transport system, stewards of the network, and those in the private sector who buy and sell equipment and services in the market place.
- Many diagramming conventions exist for defining the institutional framework, business processes and effectiveness of the CV process. Suggested conventions are described in this report.
- While the focus of each Pilot is on a specific local deployment, the long term goal of the program is local sustainability that will help foster national deployment. The Pilots are expected to serve as models for other regions to emulate with regards to planning, design, building, testing, operations and maintenance. Many institutional and business models are potentially relevant to fostering CV deployment. These models may involve singly or in combination public provision or private provision, public-public partnerships, and public-private partnerships. While CV deployment at the Pilot sites is expected to be incremental, it is possible there is a role for creative business models and innovative finance.

2.1.1 Concept A – Inventory of Institutional Risks, Assessment and Mitigation

At the beginning of the Concept Development phase of the CV Pilot Deployment, it is desirable for each Pilot site to take a thorough inventory of potential institutional and related issues and identify any risks associated with each. Input to prepare the risk inventory should begin with an examination of each site's Pilot site proposal, early deliverables, relevant summary and expanded guidance documents, the literature on institutional issues concerning Intelligent Transportation Systems and related industries, and discussion among the partners and selected stakeholders involved in each Pilot.

For each risk, each Pilot site should indicate the title, the owner, the probability of occurrence, a measure of impact, a measure of severity (probability x impact), the risk response, and the risk mitigation strategy. This array of information could be set out in a table which should be periodically reviewed and revised. The top risks should be incorporated into the Risk Management Plan prepared under Task 1. The Tampa Hillsborough-County Expressway Authority pilot team included in their kickoff presentation an exemplary risk matrix. Table 2.1 presents a similar risk matrix focused on institutional issues. Each Pilot should think broadly and deeply about the institutional risks it faces and how to portray them in such a matrix.

It is worth noting that many technical systems either have significant underlying institutional requirements or they are enablers of effective institutional communication, coordination and cooperation. For example, on the face of it, the Security and Credential Management System addresses security and privacy, two traditional institutional issues. However, in addition there is a broad set of institutional players necessary to make this facet of the CV system work. Original Equipment Manufacturers (OEM) and aftermarket device installers are mainly responsible for implementing Vehicle-to-Vehicle communications (V2V) consistent with specifications

set out by standards organizations and operating in a manner consistent with expected FCC regulations. At the same time owners of roads – states, counties, cities, toll authorities -- are generally expected to install the infrastructure portion of Vehicle to Infrastructure communications (V2I) to support credentialing, although one can envision other communication providers – Wi-Fi, cellular, satellite -- satisfying this need in part.

Table 2.1: Example of Risk Assessment Matrix

TITLE	OWNER	PROBABILITY (L=1;H=5)	IMPACT (L=1;H=5)	SEVERITY	RESPONSE	MITIGATION
Lack of legal authority to share revenues from Public Private Partnerships involving sale of value added information based on public data	City	1	3	3	Find other source of revenue or proceed with partnership and sales if there is no explicit legal prohibition	Obtain broadly worded or explicit legal authority
Lack of legal authority for nomadic devices to be used for crash avoidance	State	3	5	15	Determine if authority exists	If not, obtain legal authority or encourage private third party to develop 2-way smart phone communications and app for warnings
Security and Credential Management System has minor perceived vulnerability	ITS JPO	1	5	5	Continue improving safeguards	Strengthen code; provide necessary training to all parties involved; develop and follow rigorous test procedures
Institutional Review Board does not give approval for Pilot to proceed	State	2	5	10	Be as responsive as possible to IRB's concerns	Keep strengthening the case for justifying the Pilot Deployment until the IRB approves
The TIP includes no funding for CV	State	1	2	2	Address need in Long Range Plan; line up funds	Take steady, concerted action to address this need – consider traditional sources of funds, transportation option taxes, creative business models, and innovative finance
Project Manager (PM) takes another job	City	1	2	2	Backfill with qualified PM	Ensure qualified backup is fully engaged in all phases of Pilot deployment
Pilot Logo not checked for trademark infringement	City	1	3	3	Check to ensure use of logo does not infringe on any trademarks	Make sure legal department is apprised of issues concerning intellectual property rights

One area where systematic risks can arise may be discovered through the branch of economics knowns as industrial organization. This sub-discipline of economics is concerned with how various types of entities interact in the economy including such issues as competition, antitrust, pricing, ability to achieve economies of scale, public and private roles, market behavior and the extent that participants purposefully or implicitly engage in behavior addressed in game theory. This is no abstract set of concerns. For example, the November 2, 2015 issue of Forbes Magazine notes that Ford Motor Company is facing numerous challenges in an emerging world of talking, self-driving, and shared vehicles with competitive threats not only from traditional vehicle manufactures in the U.S. and abroad but also the likes of Google and Tesla in Silicon Valley. This is not the end of it. Ford is experimenting in London where their cars are carrying bicycles and it costs $18 per day to enter the central city cordon. Ford is putting folding bikes in the backs and trunks of cars and is studying the behavior of drivers to understand when and why drivers switch modes and leave their vehicle and ride their bike the rest of the way to their destination. As a result, Ford is thinking in terms of providing mobility services in a world where cars talk to each other, there are many automated vehicles, transportation is shared, and multi-modalism is a key part of the solution. Over the next 20 years, the evolving industrial organization is going to affect the number of CVs, their market penetration, and the incremental benefits that accrue from their deployment.

Another area that warrants some thought are ethical issues. At the kick-off meeting for the CV Pilots, equity was raised as an important concern, both horizontal equity and vertical equity. There is a basic concern that echoes an oft-expressed emotion that toll roads are only available to those who have the ability to pay, derisively called by some as “Lexis Lanes.” Vertical equity is defined as charging a greater price or imposing higher tax on people who have greater ability to pay. CV applications that can both provide driver warnings and take emergency control of a vehicle will likely initially appear only in more expensive vehicles. Those with lower income/wealth generally will not benefit in early years. Horizontal equity means that people in the same position are treated the same, for example two different people who earn $75,000 are taxed the same. Another example of horizontal equity would be assuring that people in each state are able to purchase and operate cars that have both CV transponders and a minimum set of automatic controls to avoid crashes. Failure to address fundamental equity issues could result in a significant setback to CV deployment if there is market or political backlash.

There are also likely to be important ethical issues concerning Artificial Intelligence in emerging automated vehicles and driver assistance functions. A recent article in the Washington Post raised the question of whether the occupant of an automated vehicle faced with striking two pedestrians or taking an evasive action resulting in the death of that occupant should put the safety of the person in the self-driving vehicle first. These types of ethical dilemmas are likely to enter popular, political, religious, and engineering discourse.

What about the issue of ageism? Some may argue there is little inherent about CV applications that enhance the mobility of elderly. Rather, AV are much better suited for this role. Indeed, with 60 million baby boomers falling within the ages of 64 to 84 by the year 2030, society may conclude demand-responsive services of driverless vehicles will be a social imperative. CV applications may increase the safety, mobility, and environmental benefits of these vehicles, everything else being equal, but automated driving technology is the real enabler of revolutionary mobility for the elderly who otherwise would have to give up driving. Will members of the American Association of Retired People (AARP) embrace CV technology or self-driving cars? This clearly is a false choice. It is anticipated that connectivity will enable full automation, and self-driving cars will be connected-automated vehicles. However, there is a risk that the press, radio talk show hosts and listeners, TV pundits and viewers could seize on this issue which, at a minimum, will require a thoughtful response.

Some risks are local or unique and not technical or systemic. Trenching to install optical fiber and to provide connections for RSUs poses a risk in an area with a rich Native American Heritage and the prevalence of Native American burial grounds. The density of population and traffic in Manhattan at certain times and

locations may pose safety problems and tort liability that connected vehicle solutions may not be able to fully or adequately mitigate. In other words, the introduction of connected vehicle technology will change the nature of interactions among vehicles and people on foot and on bikes so that new physical and institutional precautions are required.

Each Pilot should consider whether each of the following and other topics, including those mentioned above, could result in a reduction or failure of CV performance, unacceptable schedule delay, or high, unanticipated costs. It is desirable to distinguish between risks that could slow or thwart national deployment and those which are local or unique.

National Issues

- Federal law
- Federal regulations
- Categorical limitations on use of federal funds
- Spectrum for Dedicated Short Range Communications (DSRC)
- International coordination and cooperation (e.g. ports, border crossings, standards, CV data sharing)
- Interoperability
- Security and privacy of CV applications
- A major public relations incident that draws national attention
- Coordination, including agreements and Memoranda of Understanding (MOU), within and among the following:
    - Federal agencies
    - Different levels of government
    - Industry and government associations
    - Regional and interstate organizations
- Multistate or national telecommunications providers and services
- Applicability of the National Environmental Policy Act
- Frameworks for addressing sets of CV applications (e.g. intersections, freight, safety, mobility, environmental, support)
- Relevant research on CV deployment from across the country – academia, government, private sector)
- Chicken and egg structural issues (DSRC in vehicles or infrastructure first?)
- Little or no leverage to other locations from Pilot sites (private resources and capabilities, Right-of-Way (ROW) access agreements, training, documentation)
- Inability to share locally developed software solutions across the country
- Inability to share CV data, useful analytics, etc. across the country

Local or Unique Institutional Issues

- Legal authority and requirements
- Regulations
- Restrictions on the use of funds
- Tort Liability

- Regional joint powers authority and cooperative arrangements
- Interagency agreements and Memoranda of Understandings
- Public-public partnerships
- Public-private partnerships
- Contractual agreements including performance based contracts
- The Long Range Planning Process of States and Metropolitan Planning Organizations (MPOs)
- The resource allocation process of State and Metropolitan Transportation Improvement Programs (TIPs).
- State or local regulations or other framework for addressing environmental, social, cultural and economic issues
- Insufficient trained staff to address each phase of the CV lifecycle (design, test, build, maintain, operate)
- Unique safety, privacy, security issues
- Insufficient leveraging of assets or strengths (e.g. ROW, data, skilled staff)
- Taxpayer vs. consumer willingness to pay for CV applications and related issues such as product differentiation and consumer surplus (e.g. pertains to CV, autonomous vehicles, shared vehicles, multimodal solutions)
- Intellectual property rights (trademarks, patents -- including business methods --, copyrights)
- Union issues
- Sustainable revenues from public sources of funds and funding processes for CV (federal, state, local, authority (tolls, transit))
- Other revenues for sustaining CV – Institutional and business models involving the internet, PPPs, innovative finance and other approaches relevant to ITS
- Accommodating those with disabilities or others with special needs such as the elderly
- Institutional Review Board
- Low CV Capability Maturity Level

2.1.2 Concept B – Documenting Application Business Processes and Supporting Performance Evaluation

This section concerns business processes useful for three things: (1) using business process mapping to document CV applications or groups of applications at each site, (2) Identifying where value accrues in a business process, and (3) providing a linkage to the performance evaluation of the Pilot site as well as to the independent evaluation.

The CV Pilot Deployments are partly predicated on the idea that applications at each site will be models that others across the country can reproduce to the extent relevant. One might think of the three Pilot sites as lily pads on a vast pond, the United States. Over time the lily pads will propagate and with the right roots almost appear spontaneously elsewhere in the country. For each site to be models for others to emulate, the deployment process needs to be well documented. An effective form of documentation is to capture the evolution of the business processes for all the applications at a site with good graphics and narratives.

To provide appropriate documentation of the business process of each CV Pilot deployment site useful to places throughout the United States, may require three process maps for each application or group of applications:

- As Is – The existing or baseline business process before a change occurs
- To Be – The business process describing the desired or planned application deployment. The "To Be" case is likely to require revision as a result of the test phase.
- Implementation case -- The business process representing the application or group of applications actually implemented. The change from the "As Is" case to the "Implementation Case" will be the subject of both the Pilot sites' performance evaluation and the independent evaluation.

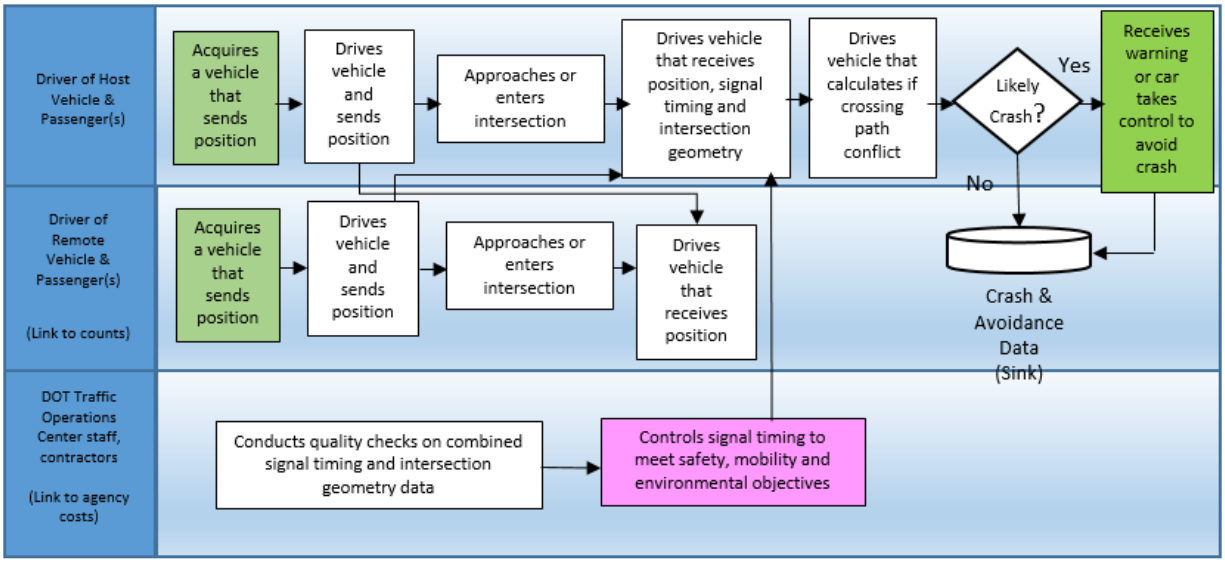
Widely used business process diagramming conventions portray the steps of each important actor or type of actor and how the steps are connected. While this type of diagramming convention is very useful, it was determined that it lacks features to capture how value accrues with the change in the business processes from the "As Is" case to "Implementation." More to the point, it is easy to focus on technology and lose sight that what really matters is how CV applications result in benefits to people that use the roads and how organizations responsible for managing and operating the road network help create those benefits along with vehicle manufacturers. It is desirable to keep the bottom line in view, i.e. the net benefits that accrue to road users and the public sector (and the profits to the private sector). Keeping an eye on the customers and the enablers that make realization of benefits possible is helpful in developing strategies to ensure financial sustainability.

Thus a somewhat new diagramming convention was developed for the CV Pilot Deployment. It is described briefly here:

- The modeling process represents CV users as people, organizations, or an organizational unit – not vehicles, equipment or a communication unit.
- Users are drivers/operators of vehicles with or without passengers, carry or not carry freight, and be with or without on-board equipment. Users can be pedestrians or bicyclists with or without nomadic devices.
- The graphical representation of key steps identifies where the most value accrues by type of user or where an actor most contributes to the value received by a user.
- There are actual or potential linkages to an accounting framework (e.g. spreadsheet) that can be integrated with the performance evaluation and can calculate total benefits and costs over some time horizon.

Figure 2.1 is an example of a business process diagram that identifies where benefits accrue and has suggested linkages to a spreadsheet for calculating the benefits and costs of the application. The guidance summary for the Task 5 Performance Evaluation suggests how to calculate the probabilities of outcomes that underlie the benefits of CV applications. Those probabilities are expected to be key entries in such a spreadsheet.

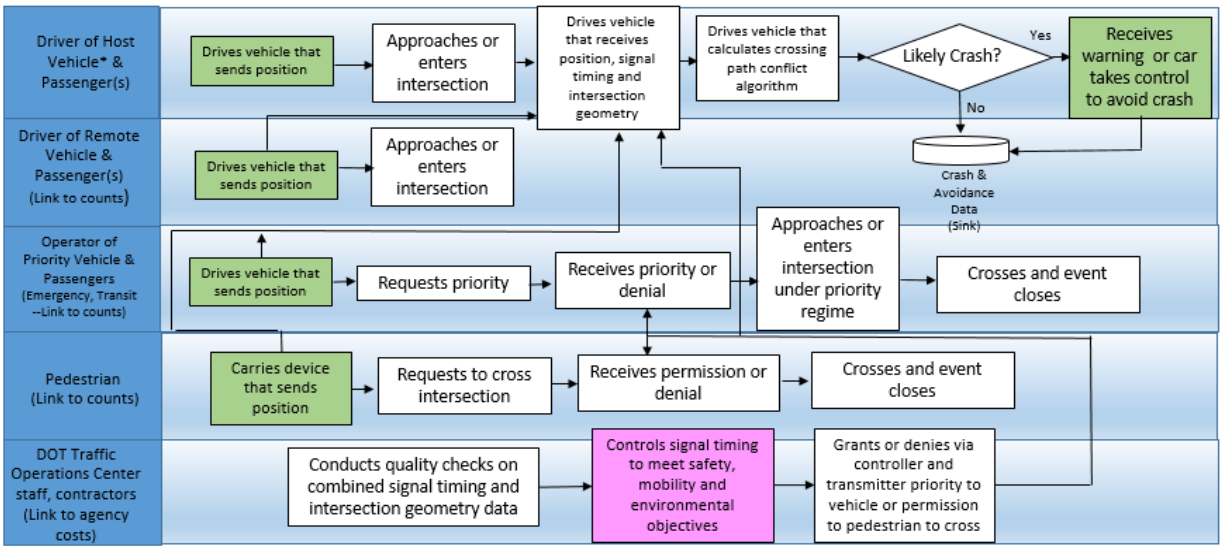
Figure 2.1: Example of Application-Level Business Process Diagram Intersection Movement Assist (Source: Noblis, 2015)



Note that Figure 2.1 is similar to a standard business process diagram, with swim lanes for each actor, and draws from a relevant use case. This diagram shows an Intersection Movement Assist application involving the drivers of host and remote vehicles and their passengers. The diagram also draws attention to the DOT Traffic Operations Center staff and contractors. One feature of this diagram is that some text boxes are colored in green where value (safety, mobility, environmental benefits) accrues. Light purple is used to indicate where the DOT plays a significant role in creating those benefits. Thus the diagram has some characteristics of a value chain. Another feature is the linkage of an actor (say driver and passengers) to directional traffic counts for the host and remote vehicles. This count can be linked to a spreadsheet or the calculations done separately. When these counts are forecasted and combined with vehicle occupancy rates and relevant economic imputations, one has the basis for estimating how total benefits accumulate at this intersection over time.

It is expected that each Pilot will pursue numerous CV applications, in some cases a large number. To keep the documentation manageable, it may be desirable to focus only on the most important or representative ones. In some cases one can prepare a composite diagram that addresses more than one application. While Figure 2.1 focuses principally on drivers and passengers of host and remote vehicles at an intersection, it is possible to prepare a composite diagram that also shows other road users, i.e. drivers and passengers of priority vehicles (emergency and transit), pedestrians, and bicyclists, as in Figure 2.2.

Figure 2.2: Composite Business Process Diagram -- Intersection Movement Assist with Priority Vehicles, Pedestrians and Bicyclists (Source: Noblis, 2015)



*Vehicle may be a bicycle that is being driven under the same rules of the road governing a motor vehicle; the bicyclist has a nomadic device that provides the same functionality as a vehicle's On Board Equipment (OBE) ; if the rider gets off the bike, s/he becomes a pedestrian.

2.1.3 Concept C – High-Level Institutional Models

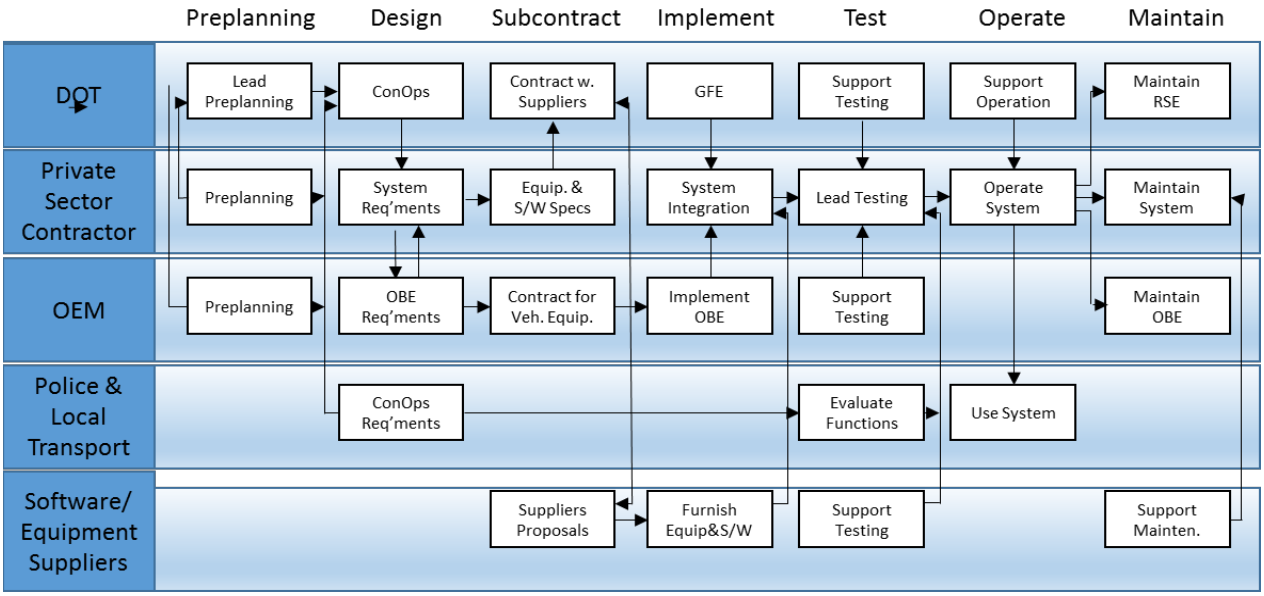
The Broad Agency Announcement (BAA) that established the Pilot sites, indicates that the focus of the Connected Vehicle (CV) Pilot program is to deploy "collections of applications that address specific local needs, while laying a foundation for additional local/regional deployment, and to provide transferable lessons learned for other prospective deployers across the nation." Thus the emphasis of the CV program is on the implementing groups of applications including an evaluation of their effectiveness. However, the BAA also indicates that "the CV Pilots program seeks institutional and financial models that enable long-term sustainment of successful elements of the Pilot deployments without dedicated federal funding." Because of the critical importance of the long-term sustainment of the CV program, consideration of institutional and financial models must be a key consideration of the Pilot program.

It is no surprise that all of the Connected Vehicle Pilot Sites have been organized and funded following a traditional DOT-Centric institutional model in which the program requirements have been defined by the US Department of Transportation using a BAA to which various consortia of states, local agencies and contractors have responded. Funding is provided by the DOT through the states, who reimburse the contractors based on the work performed. The DOT funding is supplemented with various types of cost sharing contributed by the participants. Project performance is specified and monitored by the United States Department of Transportation (USDOT). This is an effective mechanism to ensure that the program is compatible with the vision and objectives of the Federal Government. It is also an approach that will facilitate program delivery, in that the participants are all working with a well-defined, time tested set of rules and procedures.

Figure 2.3 has been prepared as a high level description of the flow of processes and responsibilities associated with the DOT-Centric institutional model. In practice, this model has many variations. Therefore, it would be useful for the Pilot teams to produce a diagram similar to that of Figure 2.3 that reflects their specific

relationships and practices. The diagram produced by the Pilot teams, in essence provides the "As-Is" definition of their institutional relationships. Similar diagrams are recommended for the definition of new institutional models that might be defined in response to the objectives of the BAA, in the event that alternative models are considered for the long term sustainability of the program.

Figure 2.3: An Example of the DOT-Centric Framework (Source: Noblis, 2015)



While the DOT-Centric framework serves as a reliable approach for the implementation of a new system, it may not be the ideal approach for the installation, expansion, operations and maintenance and enhancement of a sustainable, regional program. In general, the DOT-Centric approach tends to be most applicable to a federal or state-funded project that produce a specific deliverable or set of deliverables over a pre-defined time-frame. Changes to the deliverables in terms of technology or functionality require contract modifications. Obviously there have been exceptions to this generalized description of the process, but these exceptions are made within strictly defined processes.

For this reason, an incremental approach is suggested in which other institutional models are considered that might be better suited for an ongoing activity which requires alternative forms of financing, including opportunities for outside investors, and provides increased flexibility to accommodate advances in technology and future system expansions. Participants in the Pilot Program could potentially use an incremental approach in which the existing DOT-Centric Framework evolves into a new institutional model while the relationships among the participants are redefined and operating agreements are negotiated near the conclusion of the existing project.

Two models that offer the potential to overcome the limitations of the DOT-Centric approach are public private partnership and franchise approaches. The first is well known to the transportation community while the second is more commonly used by the utility industry including power, water, telecommunications, cable television, etc. These alternatives are briefly described in this section including a description of the manner in which they might be applied to the CV program. As noted below, the two are not mutually exclusive.

Public-Private Partnerships: A PPP is a contractual arrangement between one or more public agencies (federal, state or local) and one or more a private sector entities. Through this arrangement, the skills and assets of each sector are shared in delivering a service or facility for the use of the general public.

As applied to connected vehicles, a private entity or combination of such entities (a systems integrator, a telecommunications company, a fleet operator, etc.) would establish a contractual arrangement with a public agency(s) to install and operate connected vehicle infrastructure within the geographic boundaries of the participating public agency(s). Both the public and private sectors would contribute funding for the system implementation, operations and maintenance.

The incentives for the public sector are obvious; the private sector's financial contributions to the program could offset the costs associated with the implementation of a CV capability in their jurisdiction(s). The public sector might also contribute local funding which might also include some of the Federal funding to which it is entitled. The incentives for the private sector are possible benefits realized by their ongoing businesses through reduced operating costs and/or improved safety. They might also realize intangible benefits not directly related to the operation of the CV system such as enhanced reputation. The PPP would be led by a governing board including representatives from all participants. A supporting organization may be created to support the governing board. The need for such an organization depends on the capabilities of the participants.

The PPP that most closely resembles the one described above is **H**eavy Vehicles **E**lectronic **L**icense **P**late (HELP), Inc. HELP is a non-profit (501(c)(3)) public/private partnership that was established to promote heavy vehicle safety and efficiency. HELP includes 31 member states. More than 465,000 trucks for been processed for clearance and prescreening. The PrePass system, installed and operated by HELP, which provides pre-clearance and automated toll collection services, comprises the largest vehicle-to-infrastructure (V2I) system in the nation. The organization has invested more than $400 million in PrePass and other safety related technologies.

The majority of HELP's income is derived from fees paid by its commercial partners based on their usage of the system. This revenue is used for the operations and maintenance of the PrePass network. HELP's board of directors is made up of an equal number of representatives from public agencies and the private sector (trucking companies and trucking associations). Day-to-day operations are managed by a director and paid staff of fewer than 10 employees. HELP celebrated its 20th anniversary in 2013. Its longevity and widespread acceptance is a testimony to its success.

Thus many of the ingredients important to the success of the CV program are embodied in HELP including equal public/private representation, self-sustaining revenue flow, and multi-state standardization. It is clearly a model worthy of further consideration.

Franchises: A franchise may be defined as a privilege of a public nature conferred on a private entity by a government. One example that fits this definition would be a franchise to operate a transit system within a given geographic area. A second useful definition of a franchise is granting a private entity access to public right-of-way for the purpose of earning a profit while meeting a public interest obligation. This latter example would apply to conventional utilities such as power, water, or telecommunications. It differs from the first definition in that the services offered by some conventional utilities are not necessarily considered to be of a public nature. A combination of these two definitions is most applicable from the perspective of the CV program because such a franchise would require access to public right-of-way as well as access to publicly owned infrastructure such as traffic signal equipment, and in addition, the services offered are of a public nature.

A CV franchise is one in which an organization is granted permission for use of the public right-of-way, access to publicly owned infrastructure (such as traffic signal equipment), and access to the CV equipped vehicle fleet, for the purpose of operating CV applications. It is anticipated that a single franchise would be awarded for these applications, since the existence of more than one competing franchises for the same geographic area would not be feasible.

A franchise might be awarded to an investor owned organization, non-profit organization, or a consortium. Power companies are examples of single franchises which may be investor owned corporations or in some cases publicly owned corporations. In both cases, exclusive franchises are awarded and rates are controlled by either a public utilities commission for the investor-owned utility, or a local government agency in the case of a publicly owned corporation.

Franchises may also be granted to PPPs. Here again, HELP is an example of an organization that has been granted a franchise for heavy vehicle clearance and prescreening. As previously indicated the HELP PPP includes 31 states in which it is also franchised to operate. Since HELP is a PPP, its rates are self-regulated by its board of directors which include representatives of both the public sector which has the traditional regulatory powers over the franchise, as well as the trucking industry which is the source of revenue for the organization.

Thus franchises should be considered as a viable alternative to the conventional DOT-Centric model of CV design and operation. The granting of exclusive rights for the installation and operation of a system provides a mechanism for attracting outside investment, as well as the organizational flexibility to incorporate new technology as needed. If a franchise approach is being considered, the possibility of establishing a PPP as a potential franchisee should be recognized as a feasible alternative.

2.1.4 Concept D – Capability Maturity Model

Capability refers to the ability to perform a set of tasks in a consistent and reliable manner, whether they are related to software development, system acquisition, product manufacturing, or transportation operations. Maturity that increases implies growth of capabilities and processes. A model has the dual meanings of an ideal as well as a structured form of analysis. Taken together, these three terms imply that the Capability Maturity Model (CMM) is a framework that can be used by organizations for the continued improvement of their performance toward an ideal end state.

The CMM model and its supporting processes were developed by Carnegie Mellon University's Software Engineering Institute under research funding provided by the US Department of Defense (DOD). Based on that initial success, CMM has been successfully adapted and applied to numerous other areas, many of which are unrelated to software development.

The CMM was first used by the transportation community for an assessment of the traffic incident management processes of the Maryland Transportation Authority. It was subsequently adopted as the basis for a project of the Second Strategic Highway Research Program (SHRP 2) on institutional architectures for management of non-recurring congestion by transportation agencies. The goal of the research was to identify ways in which Transportation Systems Management and Operations (TSM&O) within state DOTs could be evaluated and areas of potential improvement identified and undertaken. The operations-oriented CMM has been applied to the Transportation System Management and Operations (TSM&O) activities of agencies throughout the United States. To date 40 CMM workshops have been conducted.
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The Connected Vehicle Pilot site deployments are potential beneficiaries of the CMM approach. To succeed, these deployments must consider many factors in addition to the technological considerations that are often the focus of these types of programs. The application of CMM assessments as the Pilots progress will provide

both an evaluation of their current (As-Is) level of effectiveness, as well as a definition of the desirable (To-Be) levels of effectiveness that could become goals for the end state of the Pilots. Application of the CMM will ensure that the results of the Pilot deployments will be a legitimate demonstration of the full potential and sustainability of Connected Vehicles with adequate levels of organization, planning, performance measurement, coordination, systems engineering, and funding.

The CMM assessment as adapted to transportation processes, is deceptively simple. It consists of a matrix (see Table 2.2) whose rows contain the dimensions of the activity being analyzed, and whose columns define the level of maturity associated with that dimension. The rows in Table 2.2 are labelled with the dimensions that have been identified for the Connected Vehicle Pilots. The individual cells of the matrix contain qualitative descriptions of the performance occurring for a given dimension to achieve each level of maturity. The level of maturity of each dimension is selected collaboratively by a group of individuals that are directly involved with the process being assessed. It is the responsibility of the group to select the cell that best matches the current level of maturity for the organization(s) being assessed.

Table 2.2: Schematic of CMM Matrix

<table>
<tr><th rowspan="2">Dimensions</th><th colspan="4">Maturity Level</th></tr>
<tr><th>Level 1 – Performed</th><th>Level 2 – Managed</th><th>Level 3 – Integrated</th><th>Level 4 - Optimized</th></tr>
<tr><td>Business Processes</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Systems and Technology-Design</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Systems and Technology-Operations and Maintenance</td><td></td><td colspan="2" rowspan="3">The cells contain the criteria for evaluating the maturity level of each dimension</td><td></td></tr>
<tr><td>Performance Measurement</td><td></td><td></td></tr>
<tr><td>Culture</td><td></td><td></td></tr>
<tr><td>Organization and Workforce</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Collaboration</td><td></td><td></td><td></td><td></td></tr>
</table>

As shown in Table 2.2 four levels of maturity are defined for each dimension and are as follows:

- Level 1: Performed – Activities and relationships are typically informal, and conducted based on prior experience with similar work. Guidance documentation is sparse or non-existent and formal procedures have not been defined.
- Level 2: Managed – Some procedures have been developed, and needed staff capabilities are recognized with limited training provided. Documentation of activities remains limited and may be informal. Organization-wide collaboration and sustainable resources do not exist.
- Level 3: Integrated – The procedures associated with each dimension are defined and standardized. Applications are prioritized based on anticipated benefits and performance is managed and tracked. All personnel involved with the process have a common understanding of its objectives. All processes are documented and understood by the participants.

- Level 4: Optimized – The process is recognized as a sustainable, region wide activity. Both organizational and system performance is continuously tracked and analyzed to identify potential enhancements. All organizations involved in the process are committed to continuing improvement.

The complete matrix that forms the basis for the CMM assessment of the Pilot sites and recommends for its use appears in Appendix B. This matrix is a modified version of the one that has been used for the TSM&O assessments. The assessment for CV is intended for use by the collective set of organizations at a Pilot site responsible for the implementation, operations and maintenance of a CV system. It is applicable to all types of organizational frameworks whether they are DOT-led project, public-private partnership, or a franchise.

In addition to the significant modifications that have been made to the individual cells of the TSM&O matrix, the Technology and Systems dimension of the original CMM for TSM&O has been divided into the two dimensions: (a) Technology and Systems – Design, and (b) Technology and Systems – Operations and Maintenance. This change has been made because the organizational relationships and even the participants are likely to change as the Pilots evolve from system design and implementation to operations and maintenance.

The seven dimensions as shown in Table 2.2, the schematic of the CMM matrix, and the full matrix in Appendix B include:

- Business Processes – This dimension includes all activities associated with the planning, programming and budgeting of the program. Both short-range and long-range planning are included. Emphasis is placed on the planning activities associated with the sustainability of the program.
- Systems and Technology-Design – The use of the systems engineering process is emphasized in this dimension. Also included is the manner in which the systems architecture is defined, recognition of appropriate standards, and the quality of documentation. The procurement practices utilized by both the private and public sectors for the acquisition of equipment and services is also included.
- Systems and Technology-Operations and Maintenance – The manner in which the system is operated and maintained is considered to be a critical aspect of the systems and technology. The complexity of the Connected Vehicle program is higher than that of a traditional ITS project because of the need to ensure that both infrastructure and vehicle systems are operated effectively and are adequately maintained.
- Performance Measurement – This dimension incudes the definition of performance measures, the efficiency with which the required data is collected and processed, the evaluation and presentation of this data both in real-time and off-line, the analysis and use of the performance data. This dimension is particularly critical for evaluating the success of the Pilot program including demonstration of the benefits and costs of the program.
- Culture – The immediate success of the Connected Vehicle program, as well as acquisition of support for its continuation, requires a supportive agency culture that offers an understanding and appreciation of its potential benefits. While many of the functions of the system can be outsourced, the program is likely to place an unanticipated burden on the public sector's staff and facilities. Similarly the private sector could experience unusual demands for cooperation and collaboration with various public agencies, unusually high demands for comprehensive and detailed documentation, and open source products capable of interoperability with other systems. The success with which these needs are met is a reflection of the culture of the participating public and private sector organizations.
- Organization and Workforce – This dimension provides an assessment of the degree to which the participating organizations are structured both internally and externally to meet the needs of the Connected Vehicle Pilots. It is also an assessment of the staffs' capability and capacity in terms of its suitability to the needs of the program.
- Collaboration – The Pilot programs may be unique in the sense that there are an unusual number of participating organizations whose cooperation is essential to their success. This dimension documents the existence of working agreements in the form of contracts and memoranda of understanding that define these relationships, and the degree to which the terms of these agreements are being met.

The adaptation of the TSM&O assessment process for the use of the Connected Vehicle Pilot sites represents an evolutionary step from the proven evaluations of TSM&O effectiveness. Its application by the Pilot sites will facilitate the interpretation of the results of the Pilot program by isolating the management process from the technical details of the applications being tested at these sites. This will ensure that the results of the Pilot Sites can be evaluated with full knowledge of the capabilities of the implementing organization. It will also provide a roadmap for evolutionary improvements that will facilitate the path toward the long term sustainability of the Connected Vehicle program.

2.1.5 Concept E – Financial Sustainability and Cash Flow

The long-term sustainability of the CV program is dependent on a revenue stream to support its expansion, enhancement, operations and maintenance. Governments are under great pressure to fund competing demands for transportation dollars, including ITS, because of erosion of the gas tax receipts due to inflation, rapidly growing market share of vehicles powered by alternative fuels, a declining propensity to drive among certain demographic groups, and other reasons. Consequently government agencies are increasingly turning to alternative revenue sources and different business models that may involve public private partnerships and creative forms of finance. As the Pilot sites examine the ease or difficulty of generating revenues to continue the successful application after the CV Pilot Deployment program ends, the sites may wish to consider various combinations of traditional and non-traditional institutional and business models as well as finance. This section provides a list of some alternatives.

Public Funding Sources

- Traditional public sector sources of revenue for transportation systems including Federal aid, state and local gas taxes, transportation fees and developer impact fees. The use of these existing revenue sources is likely to divert funding from other transportation uses, and could generate resistance from the beneficiaries of these uses.
- Toll authorities might be encouraged to contribute toll revenue toward connected vehicles based on the improvements in toll road operation and safety connected vehicles offer
- Bonds might be used to finance the implementation of the system provided that a revenue stream can be identified to support their retirement.
- If the CV Program is organized as a franchise, it can be considered a public utility. As a result, a utility fee (as opposed to a tax) can be levied against property owners whose occupants use the transportation system. The levy is in proportion to the estimated number of trips generated by the type of property receiving the levy. This approach has been used by some smaller communities and upheld by the courts.
- A variety of local option transportation taxes have been used to fund roadway construction and maintenance. These might be considered for the connected vehicle system. A sample of local option taxes include: parking taxes and fees, employer taxes, property taxes, vehicle registration fees, rental car taxes and set asides of a percent of sales taxes.

Private Funding Sources – Possibly with Public Participation

- The sale or lease of the right to conduct a business using resources of the Pilot participants (e.g. data, intellectual property). A franchise agreement granting access to public Right-of-Way to a private entity was previously discussed.

- A share of revenues from business products and services that derive from the Pilot applications, such as a training course and modules or commercial vehicle data distributed to motor carriers and commercial vehicle owners.
- Pooled funded projects of public and/or private firms that generate private sector revenues and profits derived from specific features of CV applications. A software solution useful for other locations throughout the country is an example.
- Shared products or services achieved through simultaneous or sequential sharing of vehicles, infrastructure, products, or services through renting or purchase
- A business franchise, a common way for a business owner to earn money and replicate a business format in many locations by requiring a franchisee to make an initial minimum investment, use a trademark or logo, and furnish the product or service in conformance with the franchisor's policies and marketing plan.
- The internet freemium model in which a website offers some type of content for free, perhaps ad supported, but simultaneously offers premium content for a subscription or to paying members, possibly also ad-supported.
- The internet affiliate model. A website includes the presence of numerous affiliated businesses selling products or services. The website earns revenue if someone clicks through to one of the affiliate sites and makes a purchase or makes a significant step toward a purchase.
- Competitive joint ventures where parties share ownership but compete in the provision of services (e.g. private entities may pool data originally from CV Pilot sites but compete to provide value added information to buyers)
- Funding from companies who feel that their support of the system enhances their corporate image in the same way that would a local sports stadium.
- Sharing cost savings of insurance companies resulting from fewer claims due to the safety benefits of the connected vehicle system.
- Funds earned from commercial partners through reduced system installation and maintenance cost of shared facilities (such as shared fiber optic cables)
- Crowdfunding projects. For example, money was raised to support TXDOT's cleaning of signage that had been vandalized. Crowdfunding was also used by the Anchorage MPO to support a truck study. Commercial crowdfunding ventures have in some cases raised millions of dollars.
- Advertising offers an additional source of revenue though often frowned upon by public agencies. For example, a CV users group concerning on-board vehicle units could form and there could be an accompanying monthly newsletter with advertising.

The income from different sources may have to be combined to meet the requirements for financial sustainability of the CV deployment. In the event that a franchise, Public-Private Partnership or other significant business concern is being considered, the challenge is to identify an ongoing revenue stream that will attract outside major investors either through the normal financial markets or through a newer mechanism such as crowdfunding. The essence of this challenge is to have a sound, thoughtful, persuasive and realistic business plan that includes the standard elements and financial statements such as cash flow and profit and loss. Even though local and national deployment is most likely to proceed incrementally, these business options should be continuously considered while the Pilots are underway so that long term financial sustainability can be assured. Such business approaches may also accelerate national deployment.

A few other points. There are numerous types of finance and business models that the USDOT Office of Innovative Program Delivery has supported. These include various types of loans and credit assistance, funding vehicles that provide revenue in anticipation of grants, and innovative sources of revenue such as value capture. Some of these options may be of particular interest where tolls are a major source of revenues as part of or in the vicinity of the Pilot site.

Related to the whole area of business models and financing are incentives. These typically involve outlays to change behavior of road users. Examples of incentives are (1) monetary payments to vehicle owners to install transponders in their vehicles in order to increase the likelihood of observing CV outcomes that improve safety, mobility, and the environment (2) payments to enter or leave major traffic generators at off peak times (Stanford University provides incentives of this nature), and (3) reservation systems in which some form of reward is provided to enter and use a facility within a time period that drivers reserve. Pilots that wish to make outlays to provide incentives would need to earn a compensating source of revenue or perhaps reallocate their budget so they are not further challenged in satisfying the requirements of financial sustainability.

The first reference below refers to the original Broad Agency Announcement for the CV Pilots Program. The following references provide more information on institutional, business and financial issues, processes, and models, and documentation.

2.2 References:

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- Institutional Architectures to Improve Systems Operations and Management, SHRP 2 Report S2-L06-RR-1, (http://www.nap.edu/catalog/14512/shrp-2-report-s2-l06-rr-1-institutional-architectures-to)
- Guide to Improving Capability for Systems Operations and Management, SHRP 2 Report S2-L06-RR-2, http://www.nap.edu/openbook.php?record_id=14513&page=R1
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- Overcoming Barriers to ITS, Final Report (http://ntl.bts.gov/lib/jpodocs/repts_te/5804.pdf)
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- Philip Tarnoff, The Road Ahead ... Why Are We Driving 21st-Century Cars on 20th-Century Roads with 19th-Century Thinking?, Strategic Book Group, 2011
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- Patrick DeCorla-Souza, Innovative Public-Private Partnership Models for Road Pricing/BRT Initiatives, Journal of Public Transportation, Vol. 8, No. 1, 2005, pp-57-78
- FHWA Office of Innovative Program Delivery, Site Directory, (http://www.fhwa.dot.gov/ipd/site_directory/)

3 Deliverables

A number of deliverables concerning institutional and business issues and models relate to tasks that are primarily technical in nature. However, these more technical tasks cannot be divorced from the larger institutional framework that defines the organizational environment for the CV Pilots as well as the specific business processes that correspond to each Pilot's CV applications.

Below are the important deliverables, including requirements taken directly from the BAA.

3.1 Tasks 1, 2, 6 and 7 – Program Management Plan, ConOps, System Requirements, and Application Deployment Plan (Corresponding Institutional Framework and Business Models)

Task 1 of the BAA calls for development of a Program Management Plan that includes a Communications Plan as follows:

{The] Communications Plan shall describe internal team communications and governance methods…A stakeholder Registry shall be developed.

Task 2 of the BAA says a Concept of Operations (ConOps) shall be prepared that addresses the current operational practice ("As Is" case) and the proposed operational practices ("To Be" case). The ConOps must detail specific use cases for the proposed Pilot Deployment concept. In addition, the ConOps is required to include a context diagram that provides a high-level physical description of the proposed system. The BAA states that the context diagram is intended only to provide context for the ConOps in the elicitation of needs and to surface ambiguities or uncertainties relevant to ConOps development.

The point about the context diagram is important. There is a technical orientation to most of the work directed under the BAA. But in reality the silence regarding many institutional and business issues creates significant ambiguity and uncertainty. This vagueness cannot be resolved without being explicit in numerous ways, including providing a complementary context diagram that shows the partners, stakeholders and other entities that collectively represent the non-technical elements of CV deployment at a Pilot site. It is important that the Pilots attend to the institutional framework, business processes, and related issues as they prepare the Program Management Plan, the Use Cases, and the ConOps under Tasks 1 and 2. This is equally true in developing a System Requirements Specification (SyRS) under Task 6 and the Application Deployment Plan under Task 7, which needs to address the additional functionality and performance elements to be integrated into the overall Pilot deployment. According to the BAA the SyRS, shall identify what the Pilot Deployment must accomplish, identify the subsystems, and define the functional and interface requirements among the subsystems. There are really no more important interfaces than those among the technical and human, institutional, and business/financial subsystems. The environmental and other subsystems (e.g. historical)

should not be ignored either because of regulatory requirements (See Task 12. Comprehensive Pilot Deployment Plan).

After a thorough Stakeholder Registry is developed, each Pilot site should prepare an institutional equivalent of the context diagram. This can be done using various diagramming software, possibly including the Enterprise layer of the CVRIA/SET-IT tool. An example diagram that largely follows the SET-IT convention for the Enterprise layer appears in Appendix C. Before too long in the Concept Development Phase, it is desirable that the CV Pilot contractor document the current or baseline business models ("As Is" case) and once the Use Cases, ConOps and SyRS have been sufficiently detailed, the proposed or "To Be" case. The "As Is" and "To Be" cases may be developed at the same time for more efficient use of staff. Also, an "Implemented" version of the high-level institutional framework and the business processes for CV applications should be developed during the Operate/Maintain Phase that covers CV operation and maintenance. Documenting the magnitude of change of the "implemented" case relative to the baseline is a role expected to fall to the independent evaluator. To maintain a sense of proportion when there are large numbers of CV applications, it may be possible to focus on the most important or representative ones. However, one should not take short cuts if it means shortchanging a thorough evaluation

Each of the three cases should include:

- Descriptions and roles and responsibilities of all participants
- Business process flow charts for both the high level institutional framework and the CV applications as shown in Figure 2.1 and Figure 2.3, perhaps focusing on the most important or representative. The more microscopic views of the CV applications can be prepared as use cases or operational scenarios.
- Documentation of the current and proposed costs and financing.
- An overall assessment of the effectiveness of the institutional framework and specific business processes employed.

Task 1 requires the preparation of a Program Management Plan that includes both a Risk Management Plan and a Quality Management Plan. While the use of a CMM analysis is not explicitly required, this process offers the potential of contributing to the quality of the project and risk reduction. For these reasons, the application of the CMM process to the CV Pilots is recommended. An assessment of the "As Is" case using the CMM at the outset and a "To Be" case once the Use Cases, ConOps and SyRS are completed should be conducted. Also, an "Implemented" assessment using the CMM, should be developed during the Operate/Maintain Phase that reflects CV operation and maintenance. Again, an independent evaluator will assess the institutional change from the baseline to the "Implemented" case.

Each time an assessment of CV capability maturity occurs, the following steps should be conducted:

- Organize the CMM assessment meeting with representatives from all organizations included in the project. The meeting should include all disciplines in the project and senior as well as mid-level managers.
- Introduce, or review as appropriate, the CMM concept to meeting participants.
- Discuss each of the CMM attributes and allow the meeting participants to select the appropriate level of capability maturity.
- Develop an action plan for increasing the level of any attributes scored at levels one or two.
- Assign responsibilities and schedule for the action plan.

More details on the CV extension of the CMM and how to use it appear in Appendix B.

3.2 Task 5 – Performance Measurement and Evaluation Support Plan (Benefit-Cost Analysis, Financial Sustainability and Cash Flow)

Task 5 of the BAA calls on each Pilot site to prepare a Performance Management Plan that identifies use cases with the most potential impact and identifies data flows by using field data, performance measures, and an action log. Task 5 further calls on each Pilot to deploy a performance monitoring system and support an independent evaluation including benefit-cost analysis, user acceptance/satisfaction, and lessons learned. The change in capability maturity should also be addressed.

Business process flow diagrams for CV applications described in Section 2.1.2 have been expressly designed to reflect key steps of use cases undertaken by various actors (drawn partly from standards documents in many cases while maintaining a customer or stakeholder focus), identify how benefits accrue to users (could include passengers, pedestrians and bicyclists), show how agencies such as a DOT contribute to those benefits, and provide a linkage or a pointer to a tool such as a spreadsheet for conducting benefit-cost analysis. Thus there are interfaces or touch points between the business processes for CV applications described in Section 2.1.2 and the Guidance on Performance Evaluation. An independent evaluation is expected to produce conditional probabilities of different types of benefits for different CV applications. These probabilities need to be applied to relevant volumes of different types of road users in the near-present and the future.

While Task 5 does not explicitly request the translation of measured performance into financial outcomes suitable for sustaining the Pilots in the long term, nevertheless financial sustainability needs to be addressed. Therefore in addition to traditional mobility, safety and environmental benefits one should at least begin to think about how to generate net revenues for continuation of the CV deployment after the Operate/Maintain Phase. The more rigorous the business planning, the better.

3.3 Task 9 – Participant Training and Stakeholder Education Plan

This training and education plan needs to address the relevant institutional frameworks, business processes and models, linkages to performance evaluation, and how to achieve financial sustainability.

3.4 Task 10 – Partnership Coordination and Finalization (Financial Sustainability and Cash Flow)

The bottom line is that CV operations are expected to endure beyond the end of the Pilot deployment. As stated in the Background section at the beginning of the BAA,

[P]ilot deployments are expected to become a part of a permanent connected vehicle capability that is fully integrated into routine operational practice in the Pilot site – and create a foundation for expanded and enhanced deployments. The CV Pilots program seeks institutional and financial models that enable long term sustainment of successful elements of Pilot deployments without dedicated federal funding.

To this end, under Task 10, the Pilots are required to document agreements, contracts and subcontracts among partners that cover:

- Agreed-upon and main elements of the ConOps,
- Performance measures and targets
- Operational changes
- Governance framework and processes, and
- Financial agreements.

Key to achieving the goal of financial sustainability will be sound analysis, perhaps best in the form of a business plan that makes a compelling case for the revenues that can be earned and documents the costs. Credible net revenues must be achieved that will support ongoing maintenance and operations of the CV applications and any further required investments. The references provide information on what constitutes a sound business plan that may be relevant if a Pilot site decides not to rely on a traditional DOT-Centric approach and sources of funding.

3.5 Task 12 – Comprehensive Pilot Deployment Plan

The Comprehensive Deployment Plan needs to be as solid regarding institutional, business, financial, and related benefit-cost issues as it must be regarding technical matters. This plan should address institutional and business risks, identify the institutional framework and business processes and models that will underpin the applications, help set the stage for the evaluation, and identify how each Pilot site plans to achieve financial sustainability. It would also be informative to indicate how Pilot deployments will contribute to national CV deployment.

3.6 Task 13 – Deployment Readiness Summary

The Deployment Readiness Summary is intended to assure that each Pilot site is ready to begin the Design/Build Test Phase. Final deliverables for all prior tasks are to be completed, including the parts that concern institutional and business models, financial sustainability, and the linkage to performance evaluation. A clear scope for the Pilot deployment must be defined, and this will need to include the roles and responsibilities of participants in any institutional, business, or funding arrangement.

A Teaming Framework must be in place with signed agreements, including:

- Any needed governance agreements associated with coordinated systems management.
- Any needed financial agreements signed among all parties engaged in remunerative transfers.

4 Key Challenges

There are numerous challenges associated with the evolution of the Pilots into a well-understood and sustainable connected vehicle deployment. The following challenges represent the greatest potential obstacles to achieving this goal.

4.1 Mitigating institutional risks

At the outset, and continuing through each phase of CV deployment, each Pilot should inventory the institutional risks and identify mitigating actions. Some of these risks may prove challenging in terms of potential cost, schedule disruption, and negative public relations. Legal issues could arise that range from tort liability to infringement on intellectual property rights. The Institutional Review Board process to address the use of human subjects in the Pilots could take much longer than expected. Business models a Pilot site would like to pursue may require agreements among different organizations not easy to achieve. In each case a Pilot site will need to take concerted action to avoid or minimize such problems.

4.2 Achieving Financial Sustainability Including Translation of Benefits into Financial Gains and Getting Commitments of Resources

The long-term viability of the CV program depends on funding from a variety of sources. Persuading both governmental and non-governmental organizations as well as the general public to make long-term commitments of funding requires persuasive logic and data related to the financial benefits of the program. Financial needs and the manner of acquiring funds will depend upon whether further CV deployment is incremental, the most likely case, or involves a much larger thrust with large impact, for example involving a major PPP. In the former case the Pilot site most likely will turn primarily to government for funds. In the latter case it will be imperative that the PPP be a viable business operating under a sound business plan.

4.3 Be User and Stakeholder Oriented as Opposed to Focused on Technology

The CV Pilots must be considered more than demonstrations of technological feasibility. They must be focused on the needs of the stakeholders, especially those who use the roads. The long-term success of the program depends on this customer orientation. This focus requires an understanding of the needs of a broad spectrum of transportation users including vehicle operators, freight operators, pedestrians and bicyclists.

4.4 Identifying and Evaluating Institutional and Business Models

Many different models might be used to implement CV. These models offer varying capabilities in terms of implementation cost, timeframe, and most importantly- their ability to generate sustainable financing.

Because of the many different possible institutional and business models, the numerous candidate applications, the varying capabilities of participating organizations, and the range of management structures at the Pilot sites, it is easy to lose focus on the most straightforward approaches to implementation and financial sustainability. Nonetheless, to overcome barriers that may emerge regarding the DOT-centric and incremental approach to deployment, may require a different path involving creative business models and non-traditional finance.

5 Technical Support Summary

A series of USDOT-sponsored webinars were developed to assist early deployers of connected vehicle technologies with Concept Development activities. The webinar described below provides support for the development of a Partnership Coordination and Finalization Plan.

1. ***Preparing an Institutional/Business Model and Financial Sustainability for Connected Vehicle Deployments***

   This webinar presents the USDOT perspective on the development of a Partnership Coordination and Finalization Plan, a key step in the concept development phase for deployment planning. Brian Cronin of the ITS Joint Program Office will describe the concept and the requirements of a Partnership Coordination and Finalization Plan to ensure that partnership coordination and finalization occur properly. The existing, desired, and implemented institutional framework and business approaches need to be addressed along with the technical tasks, the performance evaluation, and ways to achieve financial sustainability.

To access the presentation slides and audio recording for this webinar, please visit the technical assistance page of the CV Pilots website: http://www.its.dot.gov/pilots/technical_assistance_events.htm.

Appendix A: List of Acronyms

Table A.1: List of Acronyms

Acronym	Meaning
AARP	American Association of Retired People
AASHTO	American Association of State Highway and Transportation Officials
ATMS/ATIS	Advanced Transportation Management System / Advanced Traffic Information System
B/C	Benefit/Cost
BAA	Broad Agency Announcement
BRT	Bus Rapid Transit
CMM	Capability Maturity Model
CMM-CV	Capability Maturity Model for Connected Vehicles
CVRIA	Connected Vehicle Reference Implementation Architecture
DOD	Department of Defense
DOT	Department of Transportation
DSRC	Dedicated Short Range Communications
FCC	Federal Communications Commission
FHWA	Federal Highway Administration
IRB	Institutional Review Board
ITS	Intelligent Transportation Systems
JPO	Joint Program Office
LRTP	Long Range Transportation Plan
MOU	Memoranda of Understanding
MPO	Metropolitan Planning Organization
OEM	Original Equipment Manufacturer
PPP	Public Private Partnerships
SET-IT	System Engineering Tool for Intelligent Transportation
SHRP	Strategic Highway Research Program
TIP	Transportation Improvement Program
TSM&O	Transportation Systems Management and Operations
USDOT	U.S. Department of Transportation
V2I	Vehicle-to-Infrastructure
V2V	Vehicle-to-Vehicle

Appendix B: The CV Extension of the CMM and It's Use

This appendix recommends procedures for a Pilot site to apply the CV extension of the CMM. The matrix for this version of the CMM appears at the end of this appendix. Ideally, each of the Pilot sites should conduct the CMM process independently. It is recommended that the process include the same steps that have been successfully employed with the TSM&O assessments:

1. The first step is the preparatory stage. It is conducted by the workshop facilitators with the cooperation of the organization for which the assessment is to be performed. It includes the identification and collection of documentation that provides relevant background information for the assessment. This material typically incudes items such as organization charts, plans, concepts of operation, contract documents and other non-proprietary material. This material is used to facilitate the discussions of step 2 and to ensure that the meeting of step 3 covers all relevant aspects of the program.

2. The second step is the selection of workshop participants. Participants are selected based on the following criteria:
    a. The group should ideally be limited to fewer than 25 participants. If the group is too large, discussion and brainstorming become unwieldy.
    b. The group should include representatives of every phase and function of the process being assessed including planning, design, implementation, testing, maintenance and operations. Procurement and legal representatives should also be included if these functions are important elements of the process.
    c. If practical, senior management should be absent from the meeting because their presence tends to inhibit frank discussions of the group regarding shortcomings of the process.

3. The third step is meetings with the senior leadership of the Connected Vehicle Pilots. This would include project managers of the partners participating in the Pilot; typically the lead government agency and the prime contractor. The purpose of the meeting is both to gain their perspective on the key issues likely to surface during the assessment and to ensure their support with the implementation of the improvement plan resulting from the process.

4. The fourth step is the facilitated workshop. The workshop typically requires six to eight hours for its completion. It includes the following steps:
    a. A brief orientation describing the objectives of the workshop and the manner in which they will be achieved. This introduction also includes assurances to the participants that the discussions occurring during the workshop will remain anonymous.
    b. The heart of the workshop is a discussion of each of the CMM dimensions and the current (as-is) level of maturity associated with that dimension. In some cases multiple maturity levels are identified for a given dimension which represent differing levels of maturity for different organizations participating in the program.
    c. When the evaluation of maturity levels has been completed, an action plan is prepared that defines the steps to be taken to raise the maturity level for the dimensions that have received

the lowest scores. The dimensions with lower maturity levels receive priority during the formulation of an action plan in recognition of the fact that the remaining dimensions cannot advance unless the lower level dimensions are improved. In other words, the overall maturity of an organization can only be as high as its weakest dimensions.

5. The fifth step in this process is to combine the steps identified to raise the levels of the weaker dimensions into an action plan. This plan includes identification of responsible individuals or organizations, funding (if needed) and schedules. In many respects this is the most critical step of the CMM process, because without an action plan there is no guarantee that the process will be completed. The action plan also includes a description of the time and schedule of the next meeting (typically one year) at which time the assessment will be repeated and progress or lack of progress will be noted. The annual follow-up meetings include possible adjustments to the original action plan in the event that there is inadequate progress, and the development of a second year action plan to ensure that the organization's progress is continued.

Assessment Guidelines

The CMM assessment is a proven process for evaluating the maturity of a project, a program, or an entire organization. It has been successfully employed within the TSM&O community on 40 occasions, and is currently being used by many state DOTs to improve the process by which they deliver transportation operations.

Several rules must be recognized during the CMM assessment and follow-up:

- The lowest scoring dimensions must be improved in order for the organization's maturity to be increased. Since the dimensions are interrelated, organizations cannot improve without addressing their weakest areas of performance.
- It is not possible for an organization to skip a maturity level. In other words, if a particular dimension is identified as maturity level 1, it is not feasible to develop plans to move it to level 3. It must first spend a year at level 2 before proceeding to a higher level.
- CMM assessments must be performed in an atmosphere that encourages frank discussion. Participants must be assured that their discussions will remain confidential, and that all suggestions will be seriously considered.
- The resulting plans for improvement MUST be accompanied by identification of responsible parties, schedule deadlines, and required funding resources (if needed).

Table B.1: The CV Extension of the Capability Maturity Model

CAPABILITY LEVEL DEFINITIONS FOR THE CV PILOTS				
DIMENSIONS	**LEVEL 1 PERFORMED**	**LEVEL 2 MANAGED**	**LEVEL 3 INTEGRATED**	**LEVEL 4 OPTIMIZING**
Planning and Programming	Each jurisdiction and organization participating in a CV program acts according to its own priorities and capabilities	Consensus system-wide approach developed regarding CV goals, deficiencies, Benefit-Cost (B/C) methodology, networks, strategies, customer expectations and common priorities. Agreed-upon approach developed for institutional and financial sustainability of CVs. Planning performed for limited operational scope (i.e. arterial, congested network, etc.) The CV program is reflected in the plans of all participating agencies	CV program integrated into participants' overall multimodal transportation and business plans of all participating agencies with an accompanying staged program. B/C justification of applications. Shared commitment to financial sustainability of CV, steps to achieve it, and program tracked and adjusted as needed. Three to five year plan developed for future System expansion and operation (e.g. corridor, Central Business District).	Activation of common, integrated operational and business plans with the establishment of a program for ongoing operation, including development of coordinated CV planning and programming activity. Planning performed for regional operation (i.e. metropolitan area, county, statewide, etc.). Actions defined and business models implemented for expansion of existing Pilot and transition to support long term national deployment and evolution of an autonomous vehicle fleet.

CAPABILITY LEVEL DEFINITIONS FOR THE CV PILOTS				
DIMENSIONS	**LEVEL 1 PERFORMED**	**LEVEL 2 MANAGED**	**LEVEL 3 INTEGRATED**	**LEVEL 4 OPTIMIZING**
Technology and Systems - Design	Ad hoc approaches to CV system implementation without consideration of systems engineering and appropriate procurement processes	Regional ConOps incorporating CV functionality and architectures developed and documented with costs included; appropriate procurement process employed for high-tech procurements Appropriate levels of cyber-security incorporated in system design. The CV Program includes adequate infrastructure to ensure timely issuance of security certificates to participants System design incorporates maintenance monitoring capabilities that permit rapid identification of system degradations or failures.	CV systems & technology standardized and integrated on a regional basis (including arterial focus) with other related processes. Emphasis placed on seamless operation across jurisdictional boundaries to ensure consistent availability of critical functions. Procurement process and procurement staffing defined that account for unique requirements of system for standardization of equipment, technological advancements and future expansion	CV architectures and technology strategically upgraded to improve performance; systems integration/interoperability maintained and evolves continually. Agreements in place that leverage regional/state CV deployment to support and enhance national deployment including equipment and facilities

CAPABILITY LEVEL DEFINITIONS FOR THE CV PILOTS				
DIMENSIONS	**LEVEL 1 PERFORMED**	**LEVEL 2 MANAGED**	**LEVEL 3 INTEGRATED**	**LEVEL 4 OPTIMIZING**
Technology and Systems – Operations and Maintenance	CV system operations staff present during normal business hours. Maintenance performed on an as-needed (fire-fighting) basis for both vehicles and field equipment with off-site personnel called to respond	CV system operations staff present 12 hours per day, seven days per week (12x7). Vehicle maintenance performed by technicians in vicinity of CV applications. Field equipment maintained by local agency staff. Maintenance personnel conduct periodic high level checks of field equipment. System reviewed at least monthly to ensure that needed or supplier-recommended upgrades are installed.	Safety-critical CV applications and subsystems operated 24x7. Other systems operated 12x7.CV system operations staff on duty 24x7. Maintenance actions, costs, inputs, and outputs for both field equipment, and vehicles captured in a maintenance management system Maintenance infrastructure established through combination of OEM dealerships for vehicles and on-site specialists for field equipment. CV system availability continuously tracked. System reviews performed semi-annually to identify needed and/or desirable technology upgrades.	CV system operated 24x7. Vehicle maintenance performed through service centers and dealerships. Field equipment maintained by a permanent on-site staff. All CV subsystems subjected to comprehensive and effective preventive maintenance program to ensure continuous improvement in system availability.
Performance Management	Some CV output data measured and reported by some participants	CV performance data used directly for after-action debriefings and improvements; data easily available and displayed on a dashboard. Some data collected includes measures related to system benefits (e.g. safety, mobility), operations and economic sustainability. CV-related outcomes such as market penetration, continuously tracked.	Performance measures related to CV system effectiveness (including outcomes, outputs and inputs) reported internally for utilization and externally for accountability and program justification. Outcome measures related to safety, mobility, and the environmental are monetized for benefit/cost analysis. Financial sustainability measures utilized to support business decisions related to future CV Pilot activities	Measures collected serve as the basis for overall transportation system resource allocation, particularly trade-offs related to CV system(s) and other transportation budget needs.

CAPABILITY LEVEL DEFINITIONS FOR THE CV PILOTS				
DIMENSIONS	**LEVEL 1 PERFORMED**	**LEVEL 2 MANAGED**	**LEVEL 3 INTEGRATED**	**LEVEL 4 OPTIMIZING**
Culture	Participants' involvement with CV program depend on continued support of individual champions within each organization. Little overall organizational familiarity with CV	Senior management of organizations participating in CV program leads the education of their organization's staff And fosters their appreciation of CV benefits. The concept and goals of the CV program are understood throughout all participating organizations	Participants' stated mission includes ITS and explicit acknowledgment of the role of CV and its benefits. Senior management leads the outreach to external policy makers and the general public related to the CV business case.	Customer mobility service commitment and accountability that embraces operations -- explicitly including CV -- accepted as formal, top-level core program of all participants
Organization/ Staffing	CV staff added on to units within existing structure and staffing -- dependent on technical champions	CV-specific organizational concept developed within/among participants with core knowledge and training needs identified; collaboration takes place	CV job specs, certification and training for core positions defined. Within each participating organization, CV responsibilities consolidated into an operational unit with a manager and defined budget Sufficient people trained to manage, operate and maintain the CV system through both in-house work and contracting out	CV senior level managers appointed with direct report to appropriate top level management of their respective organizations Staffing is capable of evolving to meet the demands of a changing mix of technologies and modes.

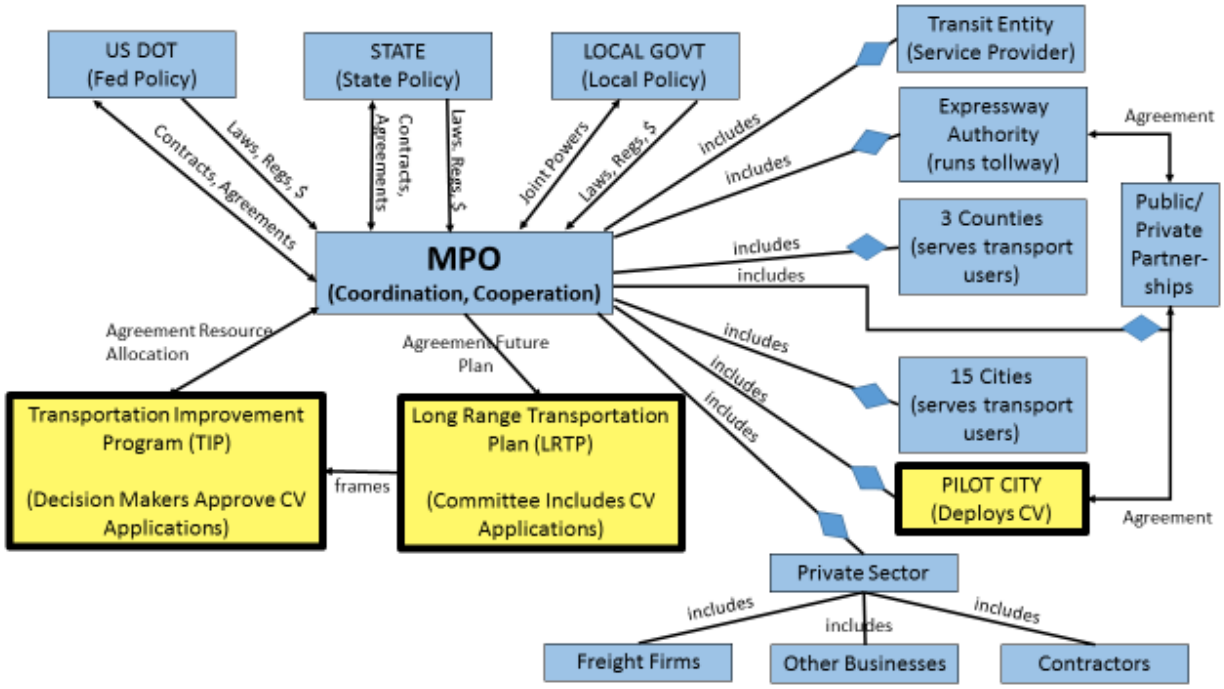
CAPABILITY LEVEL DEFINITIONS FOR THE CV PILOTS				
DIMENSIONS	**LEVEL 1 PERFORMED**	**LEVEL 2 MANAGED**	**LEVEL 3 INTEGRATED**	**LEVEL 4 OPTIMIZING**
CV Resources	CV Pilot dependent on Federal resources with minor contributions from other participants	Strong commitments of resources to CV program (including cash contributions) by all participants	Long-term/annual internal budget commitments and resource sharing for CV made by all participants and driven by lifecycle benefit/cost justification. Identification of income sources to supplement resource commitment of participants. Sufficient people trained to manage, operate and maintain the CV system through both in-house work and contracting out	CV as formal, visible, sustainable line item in each participant's budget, including projections of offsetting income sources (capital/operating/maintenance). State budget line item for operations with strong justification expressed partly in terms of CV staffing and dollar requirements, benefits and costs
Collaboration Among CV Program Participants	No formal definition of relationships among CV Pilot project participants.	Objectives, strategies and performance measures aligned among organized key players. Key players all have an equal say in the decision process for CV system operations and management. Formal project-oriented partnering agreements exist	Rationalization/ sharing/ formalization of responsibilities among key players thru long term agreements relevant to appropriate business models Periodically (at least annually) review the roster of collaborating organizations to ensure that all agencies within the expanding geographic and functional scope of the system have been included.	Long-term relationships, including funding responsibilities and business models, and future CV system operation, expansion and replication explicitly defined, by formal agreements.

Appendix C: Using the Enterprise Layer of SET-IT or Equivalent to Document the Institutional Context

As we have seen, there are a variety instruments that can provide different views of the institutional framework for documenting the evolution of the CV Pilot deployments. Another potentially useful framework is the Connected Vehicle Reference Infrastructure Architecture (CVRIA) and its accompanying Systems Engineering Tool for Intelligent Transportation (SET-IT). The CVRIA has an Enterprise view that allows one to describe the roles of each organization involved in a CV deployment and the types of coordination that occurs. It is recommended that each Pilot site use SET-IT or some equivalent diagramming software to document the institutional context for their applications. This would serve as powerful way to document and communicate what the key players at a Pilot site do and the important interrelationships.

Figure C.1 shows an example of part of an Enterprise view, prepared using PowerPoint, potentially relevant to a CV Pilot Site. The example pertains to the role of a hypothetical CV Pilot site, represented by a City, in the formulation of a regional Long Range Transportation Plan (LRTP) and the regional Transportation Improvement Program (TIP) that includes funding to financially sustain the CV deployment at the Pilot site after the deployment phase. The diagram highlights each entity involved, states their role and shows relevant relationships to other entities. For some organizations it shows those included (for example, all the members of the MPO).

Figure C.1: Hypothetical example documenting role of CV Pilot incorporating CV in the Long Range Plan and Allocating Funds for CV in the TIP* (Source: Noblis, 2015)



*Prepared using PowerPoint but with similar diagramming features to SET-IT.

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free “Help Line” 866-367-7487
www.its.dot.gov

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