Connected Vehicle Certification Program

Task 2 - Overview of the Connected Vehicle Certification System

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INTRODUCTION

The objective of Task 2 is to provide a summary view of the work efforts and outcomes specific to certification for the Connected Vehicle program. The definition of what are the Connected Vehicle boundaries is still being defined and the direction from the USDOT for certification is that it be 'protocol-agnostic' and that the national certification program should be able to facilitate any protocol, any device and any application.

Given that foundation, the task was no longer to develop a certification program, but to create a certification *system* that can house multiple certification programs. OmniAir's initial steps in developing this system was to model currently successful and relevant product certification programs in hopes of gleaning the features and attributes that contribute to their sustainability and ultimately applying these best practices to needs of the Connected Vehicle and Cooperative System.

The following document is divided into two parts. The first part summarizes previous research with three currently successful certification programs and examines them through several perspectives; Structural Elements (Organizational Design, Technology Infrastructure, Financial Models), Addressing User Needs, and Program Attributes.

The second part of the document describes the organization, processes and technical requirements of the Connected Vehicle Certification System. This system is still evolving but was conceived with many of the features that contributed to the success of the modeled certification programs.

PART I – CERTIFICATION PROGRAM CHARACTERISTICS

CERTIFICATION PROGRAM – KEY ELEMENTS AND CHARACTERISTICS

In previous research, OmniAir conducted a scan of certification programs within the wireless communication sector with the intent of learning from these current industry certification models and applying there core characteristics to the Connected Vehicle Certification System. We reviewed the certification programs developed for WiMAX, CDMA and Bluetooth communication protocols. To reveal the common characteristics, we examined their structural elements, how they address user needs and the program attributes that contribute to their sustainability.

STRUCTURAL ELEMENTS

The certification programs surveyed exhibited similar characteristics in structural elements to increase program efficiency, sustainability and be responsive to market needs. Three elements of compare include organizational design, technology infrastructure and financial models.

Organizational Design

Typically, a certification program scheme owner is an industry driven organization such as a professional society or trade association. These types of non-profit organizations depend on industry representatives to provide the technical skills and resources necessary to manage a program designed to benefit the business segment. To effectively manage sector-wide programs a committee structure is established to allocate responsibilities. Although committee titles may differ between organizations the functions remain consistent:

Oversight Committee – There is typically an oversight committee that is responsible for establishing the strategic direction of the certification program and supervision of the tactical implementation. This group has cross-industry representation and a balanced view between the players within the sector's supply chain (user, vendor, and operators). Through a consensus process the group determines the scope of the certification program and approves changes to the program such as a new market endorsement or certification profile.

Policy Committee – Another committee type develops the policies and procedures required to implement the strategic initiatives of the Oversight Committee. This committee focuses on process flow defining how the vendor, testing facility and certification body will interact.

Technical Committee – This group focuses on the technical aspects of the test specifications and requirements of each endorsement of certification profile. This group may also be the one responsible for establishing the requirements and accrediting the independent testing facilities.

Technology Infrastructure

A commonality among the surveyed certification programs is the presence of a technology infrastructure to automate the information hand-offs between the roles within the certification cycle. Below is a description of how the roles would interact with the technology platform:

Device Vendor

- Submit application for certification
- If program has multiple testing requirements the vendor would be instructed as to the specific testing plan that they will be required to meet
- Ability to receive cost quotation and choose testing facility (if more than one is available)
- Receive testing results
- Receive certification

Testing Facility

- Receive application from device vendor
- Receive test plan that vendor is applying for
- Provide cost quotation
- Input testing results

Certification Body

- View applications that are in system
- Receive test data from testing facility
- Alert device vendor of certification decision

Financial Models

The financial model chosen must be one that meets the needs of the certification body (and constituents) and provides the correct balance of efficiency and sustainability of the system. Some of the scenarios presented in the models include:

- Certification scheme owner licensing fee – Required fee paid by the vendor to be allowed to carry the certification program's mark
- Certification body fee – Fee paid by vendor for verification and oversight services provided by certification body
- Testing fees – Fees paid by the vendor to the lab for testing
- Authorized lab fees – Fees paid by the lab to the certification body or the scheme owner to be allowed to test against the certification program

- Membership Fee – Fees paid by the vendor (also open to operator) to the certification body
- Devise Fee – Fee paid by the vendor to the certification body to certify their devises on a per device basis
- Test Plan Fee – Fee paid by the authorized testing facility (passed onto vendor) to the certification body to use the certification body's test plan

ADDRESSING USER NEEDS

The certification program must have the proper processes and structure to meet the needs of the various users that interact with the program. The typical users within a certification program consist of the vendor, the certification body, the testing facility and the end user of the product.

Network Operators – The network operators are the users that will specify and integrate the devices into their infrastructure. Their needs from a certification program are going to be driven by factors that will help them incorporate devices efficiently and effectively as to not degrade the functionality of the infrastructure. Key aspects include:

- Interoperability – The network operators need to know that the devices they purchase for their network will all work seamlessly. Certification that establishes device interoperability across vendors provides assurance that their network will continue to operate regardless of the device manufacturer
- Product Reliability – The operators have a financial risk that needs to be managed by a certification program that assures product reliability.
- Features/Functionality Communication – A certification program communicates the tested and approved features and functionality of a device. If a certification program has various endorsements or classifications the operator needs to be aware of which products carry which endorsements to ensure network compatibility

Device Manufacturer (Vendor) – The manufacturers are the organizations that provide the inputs for the certification process as required by the end user.   They need a system that will enable them to meet the requirements of their customer in a manner that adds as little cost as possible to the overall value chain.

- Limits Liability – A device vendor that manufactures a product that meets product performance and device interoperability standards of a certification program is given a level of product liability protection
- Marketing & Sales – Conforming to the standards of a certification program can aid a vendor in the marketing/sales of their product. It communicates the approved features/functionality of the product to the customer and provides a level of competitive advantage over those products that cannot meet the requirements. It provides market entrance into those markets that require certification

Testing Facility – An integral component to a certification program is the testing entity. Their needs are linked to the overall efficiency of the certification system.

- Consistency of testing methods – As the implementer of the certification program a key user need for the testing facility is the consistency of the testing methods and procedures.

End User - The end user is the consumer that is ultimately using or interacting with the devices that are part of the operator's network.

- User Confidence – The 'network affect' is a critical component to the success of communication technologies. The technology will be increasingly successful as more people adopt and grow the network, expanding the value for each member of the network.

PROGRAM ATTRIBUTES

The Connected Vehicle program is anticipated to be the intersection of current and future communication protocols to create an interoperable network of mobile device, vehicle and infrastructure. We chose to model the certification programs of WiMax, CDMA, and Bluetooth because they are among the current protocols that are likely to be within the Connected Vehicle boundaries and can teach lessons on fundamental program attributes. What we learned from these successful programs was that **Adaptability** and **Accessibility** must be structured into the program to account for changes in market conditions and retention of program efficiencies.

Adaptability

The features and functionalities of devices (both hardware and applications) within the certification program will eventually expand beyond the current scope of the certification program. The program must have the ability to add or subtract technical requirements without disrupting the overall certification scheme (certification profiles, endorsements, etc.).

Each program supports a technology and a market that depends on flexible deployment of the protocol. The anticipated growth is based on a phased approach and new instillations must be interoperable with existing network components and devices for a basic level of common requirements. CDMA in particular enables a specific market to add requirements beyond the core CDMA testing and still have the testing done within the same certification framework.   This adaptability allows for individual markets to drive unique requirements and yet ensure core level interoperability.

Accessibility

A common goal for all of the programs is to minimize the cost of certification across the supply chain while maximizing the benefits of certification. If the process is too cumbersome and inefficient the incremental cost of certification will outweigh the benefit and be a barrier to deployment. To overcome this potential obstacle, all of the groups have looked to technology as a bridge between all parties of the certification value chain.

The technology hub connects all of the roles and provides access to the information in a way that is most useful to each of the parties. The processes and technical infrastructure must be such that organizations, with different needs, can interface with the system and perform the tasks they require. The technology infrastructure at the center of the program enables a vendor, a testing lab or a network operator to interact with the system in the way they need. Along with the requirement for accessibility comes the need to protect the data coming in and out of the system. The technology infrastructure will incorporate proper credentialing to ensure the confidentiality of data.

PART II – CONNECTED VEHICLE CERTIFICATION SYSTEM

CONNECTED VEHICLE CERTIFICATION SYSTEM

DESCRIPTION

The purpose of the Connected Vehicle Certification System (CVCS) is to support the Connected Vehicle vision to "bring connectivity to the U.S. surface transportation system through the application of powerful advanced wireless technologies – which can enable transformative change." The CVCS will accomplish this by ensuring interoperability among the various devices, communication protocols and applications that are within the Connected Vehicle ecosystem.

The Connected Vehicle environment as proposed by the USDOT is a future state of technology integration. As such, there is no current certification system. While the communications industry has established certain certification programs such as Wi-Fi, WiMax, CDMA, Bluetooth, and others, there is no singular certification program that identifies requirements enabling the various protocols to integrate in one larger environment. The CVCS is a 'greenfield' project to create a certification nexus with and across communication protocols, mobile devices, stationary devices and applications.

The Connected Vehicle Certification System was created with the pillars of Adaptability and Accessibility in mind. These embedded qualities are critical to the system's functionality as it needs to accept and process an application or device that is operating on any current or future communication protocol.

The following sections describe the organizational structure, technology infrastructure and process attributes.

ORGANIZATIONAL STRUCTURE

CVCS FORUM

The Connected Vehicle Certification System Forum is a cross-industry organization representing the key stakeholders of the Connected Vehicle Environment. This group is the "scheme owner" of the Connected Vehicle Certification System (CVCS) and ultimately responsible for the development and implementation of the system's policies and procedures

Function

A certification program that is cross- industry (automotive, infrastructure, device manufacturer) and cross-protocol (Wi-Fi, BlueTooth, 5.9 GHz, WiMax, etc.) requires an oversight organization that includes both sector and technology representatives. The Forum brings all interested and impacted parties together in one membership organization to develop and approve the testing requirements necessary in the Connected Vehicle environment.

Membership

The membership of the CVCS Forum is open to all interested and affected parties of the Connected Vehicle environment. The core membership categories are:

Regulatory – This includes federal, state and local regulatory authorities such as NHTSA, Federal Highway and state DoT

Producer – This includes the manufacturers and developers of the applications and hardware that create the Connected Vehicle network, the categories include:

>   Device Vendor – The vendors that manufacturers the radio devices that comprise the hardware portion of the connected vehicle network

>   Application Vendor – The vendor that develops the applications that run over the devices

User – The users are those organizations that use the applications and devices that are certified within the CVCS

Technology Interest Groups – The external interest groups that represent the communication protocols that are included in the Connected Vehicle environment

Testing Laboratories – The testing facilities that become accredited to perform the CVCS test suites and conduct the testing

CVCS Forum
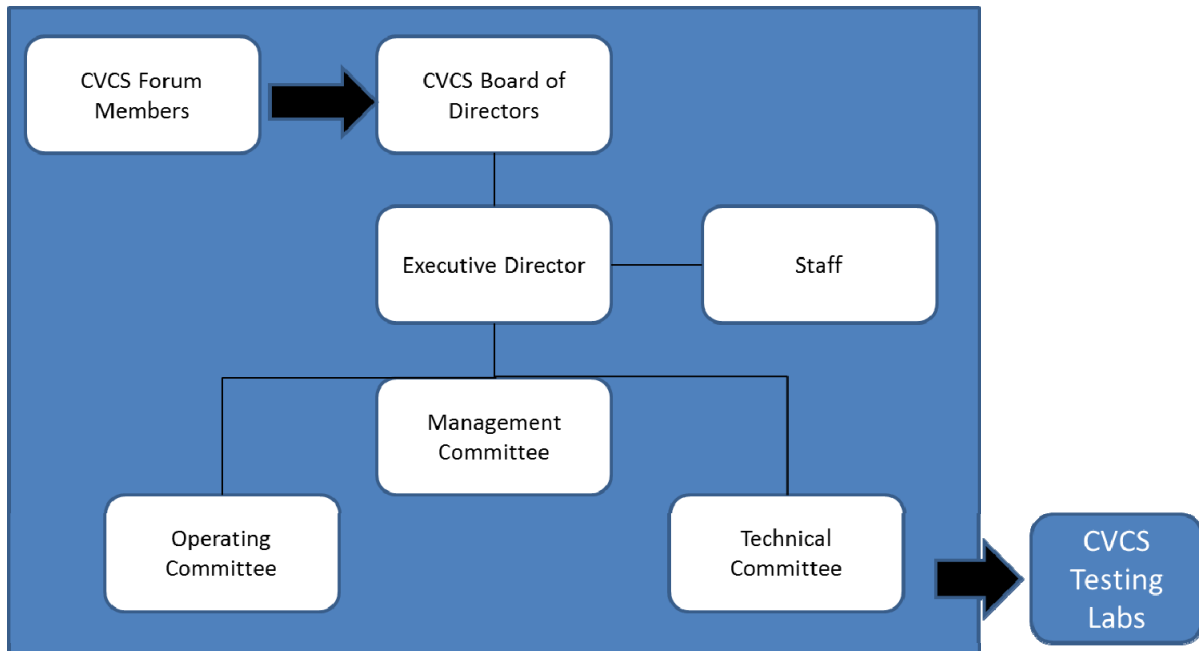
CVCS BOARD OF DIRECTORS

Function

The Board will develop and approve the organizational policies, bylaws and establish the strategic direction of the Forum. The board has direct supervision of the Forum's Executive Director and oversight of the board committees which include:

- Executive Committee
- Steering Committee
- Funding Committee
- Membership Committee

Membership

The minimum number of Board members is seven with a maximum to be established by the initial sitting board.

Function

The Management Committee (MC) is responsible for approval and implementation of the outputs of the Operating Committee (OC) and Technical Committee (TC). The MC is the link between the strategic direction of the Board and the tactical policies of the TC and OC. The members assure that work of the TC and OC is in alignment with the Board's strategic direction.

Their responsibilities include:

- Approve new profiles developed by Technical Committee
- Approve new endorsements developed by Technical Committee
- Approve new Test plan developed by Technical Committee
- Authorizes test laboratories based on recommendations by Technical Committee
- Approves organizational policies and procedures developed by Operating Committee
- Second level of appeals for both technical and procedure related grievances based on CVCS procedure

Membership

The committee is chaired by Forum's Executive Director and is comprised by an established number of member representatives. The member representative will be appointed by the Board with the number of seats to be determined as a percentage of total membership.

OPERATING COMMITTEE

Function

The Operating Committee's core responsibilities revolve around the procedures, forms and guidance document development that establish the operating framework of the CVCS. They are also responsible for maintaining a relationship with the management organizations of external certification programs (CCF, WiMax Forum, Wi-F Alliance, etc.) and standard development organizations (SAE, IEEE etc.) to coordinate industry efforts. Examples of the Operating Committee's outputs include:

- CVCS Process Guide
- CVCS Portal User Guide

- All forms that live within the CVCS Portal
- Quality manual and all associated and referenced procedures

Membership

The committee membership is appointed by the Board from the Forum's general membership with a chairman elected from the committee membership. The Executive Director will have direct oversight responsibility of the Operating Committee

TECHNICAL COMMITTEE

Function

The technical committee's core responsibilities revolve around the technical aspects of the certification programs within the CVCS. The intent of the CVCS is to have multiple certification programs operate under one umbrella system, requiring significant resources to develop test plans or work with outside organizations to coordinate the development of technical requirements. The TC is also the first level of appeal for product/testing related grievances. Examples of the outputs of the TC include:

- Creation of new test plan or coordinated work with outside committee to develop test plan
- Technical requirements for new Profile, Endorsement or Scale
- Reviews accreditation assessment results for new or current Authorized Testing Laboratories (ATL)
- Reviews applicable test data (from ATL or vendor of self-declaration)

Membership

The committee membership is appointed by the Board from the Forum's general membership with a chairman elected from the committee membership. The Executive Director will have direct oversight responsibility of the Technical Committee.

The adaptability of the CVCS depends on how the various certification programs fit within the framework of the overall system. The following diagram depicts the CVCS and associated programs and the various Profiles and Endorsements that make the adaptability possible.

Network Profile
-Network operations requirements

Device/Protocol Profile
- 5.9GHz DSRC device
- HIA device
-After Market Safety device (ASD)
-Integrated Vehicle Safety Device (ISD)
-Heavy Vehicle Safety Device
-Traffic Sensor Device
-Other wireless communication safety devices
-Other wireless communication non-safety devices

Service /Application Profile
Infrastructure Profile
Endorsements

Safety
-Lane Incursion Application
-Intersection
Mobility
-Traffic Monitoring Application
- Mobility App. Test Plan 2
Environmental
-Fuel Efficiency Application
-Environmental App. Test Plan 2

To meet the Connected Vehicle objectives of certifying any application, device or protocol that operates within the Connected Vehicle environment a flexible framework has to be created that has various levels of certification that are delineated by Profile, Endorsement and Class. The application's purpose will dictate the certification level based on the criticality of the information delivered such as "life threatening situation". Each device and appropriate applications need to be "Classified" which determines the certification "need" level. All device classes need to "conform" to its requirements and have interoperability among its peers.

CERTIFICATION PROFILES

The CVCS is divided into profile types to categorize differing certification needs. We project an initial three types of profiles; Network, Device/Protocol, Service/Application.

Network – Defines network parameters
Device/Protocol – Defines device/protocol level requirements
Service/Application – Defines application level requirements
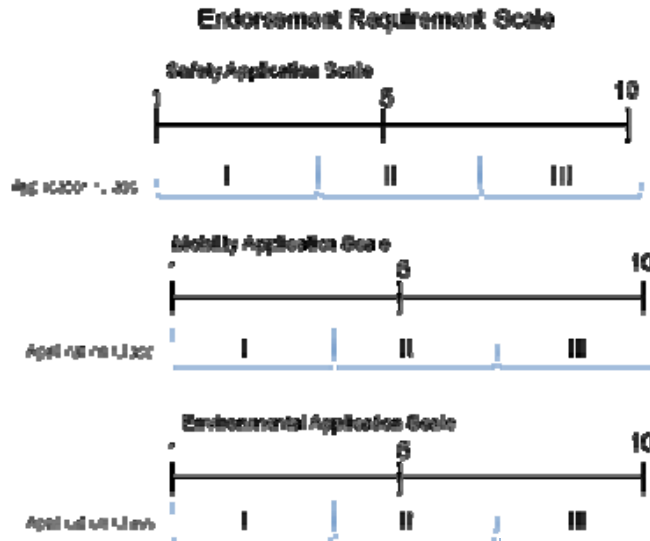
CERTIFICATION ENDORSEMENTS

Within the profiles there are Endorsements that further specify the requirements of testing. Within each Endorsement there may be multiple certification programs that reflect the needs of a specific network, device/protocol or application.

Although separated through Profiles it is recognized that there must be a connection point between protocols and applications within the test plans because of the functional relationship. In the envisioned fully-open architecture of Connected Vehicle, applications should not be limited to specific wireless communication mediums or protocols; and there may be several mediums or protocols available (e.g. DSRC, cellular, Wi-Fi, etc.) to provide vehicle connectivity in support of the various Connected Vehicle applications. A possible mechanism (as an example), is for applications to declare their communications requirements (throughput, latency, etc.) to a middleware "Communications Manager" (CM) that would select the best available communication medium and protocol to satisfy the application's need under the current conditions. The CM enabler would route message traffic between the applications and their respective chosen wireless communications handlers, and may even change mediums/protocols dynamically as either the needs of the application(s) and/or the available connectivity changes, or to balance communications loading. This CM middleware layer also provides a clear demarcation between communications devices and applications for the purposes of design, implementation and test/certification. Communication devices could be certified independently to meet specific, quantitative requirements for protocol/standards compliance, throughput, latency, range, interoperability, etc. independent of any application which may eventually utilize the device. Similarly, applications could be validated to meet functional requirements assuming that wireless interface data requirements are being satisfied.

The separation of certification Profiles and Endorsements enables the CVCS to institute various sets of policies and procedures. For example, one test plan could require third party certification and another test plan could allow self-declaration of conformance. Although

separate, these different certification plans can be linked together through an overarching set of requirements that must be followed for all Connected Vehicle applications. These overall program requirements are linked to the application test plans through an Endorsement Requirement Scale.


ENDORSEMENT SCALES

The CVCS Technical Committee creates these scales for each Endorsement which specifies criteria that must be present for all applications within an Endorsement category. Because not all applications within an Endorsement category may require the same level of rigor, each Endorsement Scale has multiple classes. The Technical Committee establishes quantitative parameters around each class. During the certification submittal process the vendor provides information that will place their application within one of the classes. This will determine which CVCS requirements they must conform to along with the specific requirements of the test plan. For example, a safety application that has "safety of life" implications would qualify as a Class III Safety application. In order to complete certification they must conform to all requirements as specified in the test plan as well as a Fail-Safe requirement determine by the Endorsement and Class structure.
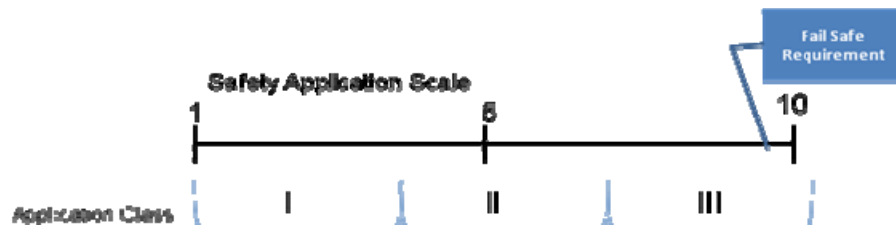
PLATFORM

The CVCS Portal is an electronic certification system that provides connectivity and access to all of the stakeholders of the certification process. This centralized repository of all certification program data enables each user type to interact with the data in the manner that is meaningful to their role. Each user type will have a unique interface with the platform to upload, download or view the data that is required for their role.
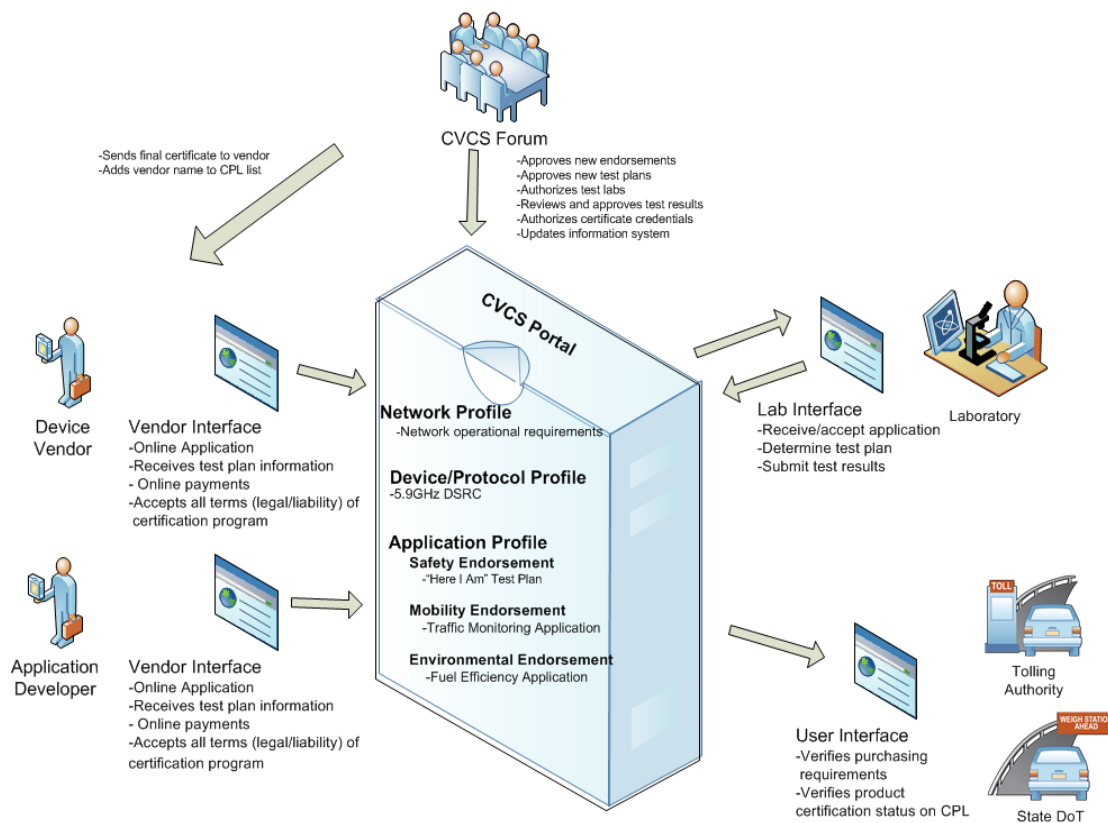
The roles interacting with the CVCS Portal include:

Connected Vehicle Device Manufacturer – Manufacturer of an OBE or RSE to be certified by ICS. Manufacturer must interact with ICS to gain certification.

Connected Vehicle Application Developer – Developer of application that falls within ICS application parameters. Developer must interact with the CVCS system to gain certification

Authorized Testing Lab – The labs authorized to perform testing against the various certification profiles. The labs interact with the CVCS system to accept an application for certification and submit test results
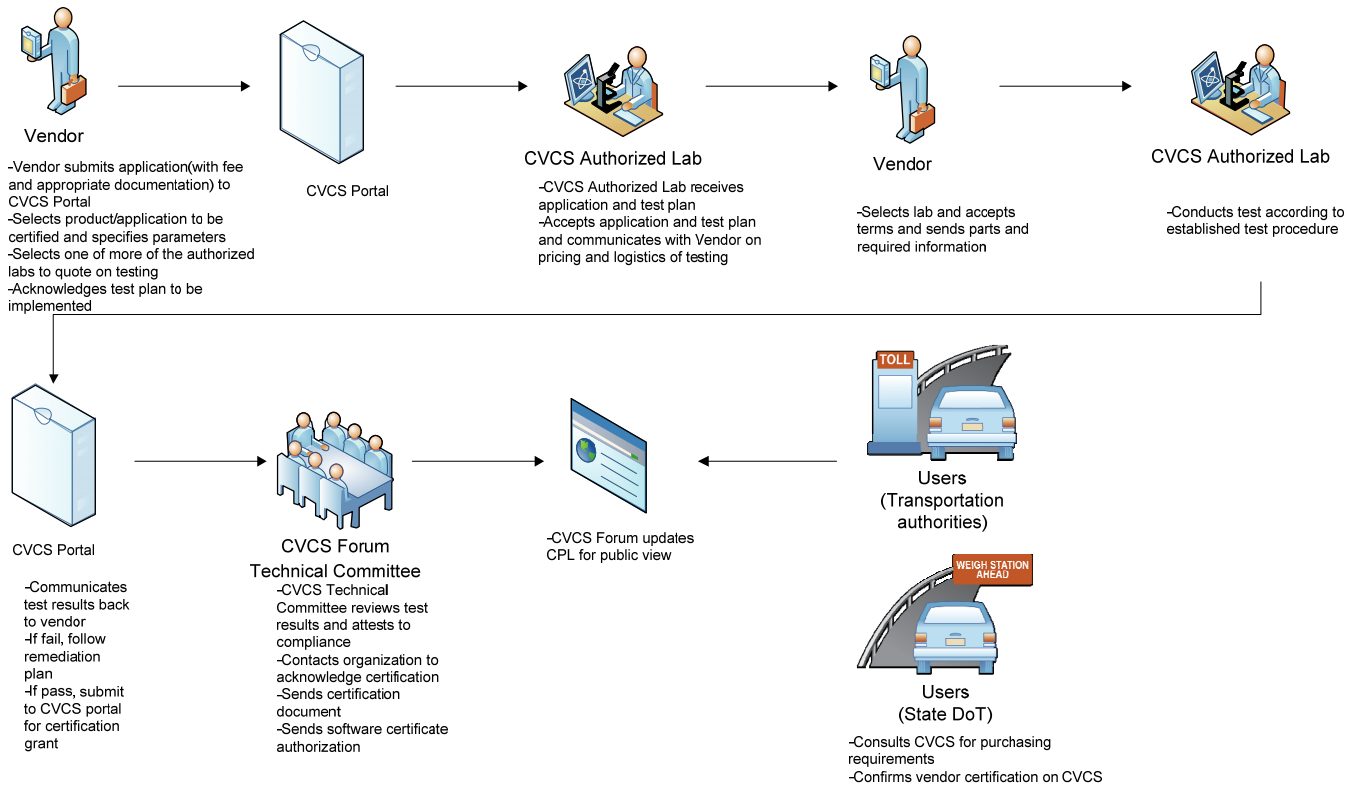
Infrastructure Operator – The operator is responsible for setting system requirements and making purchasing decisions for components of their infrastructure. They interact with the CVCS to verify product certification status. They must also have an understanding of the technical requirements throughout the profiles and various endorsements and the impact on interoperability.

Certification System Administrator – As the administrator of the certification system, the committees of the CVCS Forum (Technical Committee, Operations Committee) will have distinct roles and interfaces with the CVCS Portal.

- Technical Committee
    - Views/approves accreditation data on the ATLs
    - Views/endorses or rejects laboratory supplied test data and forward results to Management Committee for disposition
    - Responds to appeal action
    - Updates test plan criteria in database
- Operations Committee
    - Update all form, user guides and procedures that live within the CVCS Portal
- Management Committee
    - Disposition results forwarded by Technical Committee to either award certification or recommend testing remediation plan
    - Update QPL and issues the certificate generation request to Certificate Authority. Certificate allows the device, service or application to use the system.

PROCESS

The following diagram portrays the process flow of the CVCS:

Vendor
-Vendor submits application(with fee and appropriate documentation) to CVCS Portal
-Selects product/application to be certified and specifies parameters
-Selects one of more of the authorized labs to quote on testing
-Acknowledges test plan to be implemented

CVCS Portal

CVCS Authorized Lab
-CVCS Authorized Lab receives application and test plan
-Accepts application and test plan and communicates with Vendor on pricing and logistics of testing

Vendor
-Selects lab and accepts terms and sends parts and required information

CVCS Authorized Lab
-Conducts test according to established test procedure

CVCS Portal
-Communicates test results back to vendor
-If fail, follow remediation plan
-If pass, submit to CVCS portal for certification grant

CVCS Forum Technical Committee
-CVCS Technical Committee reviews test results and attests to compliance
-Contacts organization to acknowledge certification
-Sends certification document
-Sends software certificate authorization

-CVCS Forum updates CPL for public view

Users (Transportation authorities)

Users (State DoT)
-Consults CVCS for purchasing requirements
-Confirms vendor certification on CVCS

Following is an operational scenario describing the sequences between the program users and the CVCS portal.

Vendor

- Vendor (device manufacturer of application developer) makes the decision that pursuing CVCS certification is in the best interest of their product
- Vendor logs into the CVCS Portal
- Creates vendor profile
- Selects desired certification Profile and Endorsement
- Enters product data
- Confirms test plan associated with selected profiles and CVCS requirements

- Selects laboratory for testing from list of authorized testing facilities
- Sends product to laboratory for testing and pays appropriate fees
- After testing, reviews results with laboratory. If failed, follow prescribed remediation plan, if passed acknowledge and have lab send to CVCS Forum for granting of certification

Authorized Testing Lab

- Receives and maintains authorization status with CVCS Forum
- Receives applicant's request for quote
- Review application and test plan requested and provides quote back to applicant through the CVCS Portal
- After quote acceptance by vendor , communicate logistics of testing to applicant
- Perform the testing as dictated by the testing plan
- Reviews test report with vendor and send to CVCS Forum if acknowledge by vendor
- Submit testing report back into the CVCS Portal

Technical Committee of the CVCS Forum

- Receives alert that new testing data is in system
- Reviews test report, applicant data (self-declaration if applicable)
- Makes recommendation to the Management Committee to award certification or remediation testing

Management Committee of the CVCS Forum

- Alerts vendor of certification decision and sends certification documentation and provides authorization for software certificate generation if applicable
- Updates Certified Product List (CPL)

Users (Infrastructure operator/ Vehicle manufacturer)

- When making purchasing decision for infrastructure devices the users would consult the CVCS Portal to determine certification requirements
- Consult CVCS Portal to confirm products certification status

CERTIFICATION STATUS IN THE USDOT CONNECTED VEHICLE PROGRAM

USDOT is initiating a larger scale "Connected Vehicle Safety Pilot" to test different aspects of Connected Vehicle components. A major component is the wireless communication device residing on the vehicle and on the road infrastructure. There are several types of 5.9GHz DSRC devices that will be tested: 1) Here I Am (HIA), 2) Aftermarket Safety Device (ASD), 3) Integrated Safety Device and 4) Roadside Units (RSU). These device types must be capable of two-way communication and demonstrate conformance to the requirements, including interoperability and non-interference.

USDOT has authorized OmniAir to develop and conduct the aspect of the certification pilot that qualifies the "Here I Am (HIA)" 5.9 GHz devices which will be used/deployed in the Safety Pilot. The Pilot plans for 3,000 devices, most of which will be HIA devices (80% to 90%). As such, HIA devices will be the most populated component in terms of proving WSM (Wave Short Message) transmissions. This certification pilot will evaluate the certification process, test procedures, test tools and its documentation to conduct screening and qualification testing with HIA product from multiple vendors. USDOT has procured the HIA product samples from five vendors and OmniAir will evaluate them, allowing the Safety Pilot Conductor (a contractor to be determined) to select from a variety of vendors groups of HIA devices deployed for Safety Pilot needs. This certification pilot allows the process to be tested and evaluated before addressing more complex components / elements of certification such as integrated 5.9 GHz DSRC devices and connected vehicle applications.

USDOT expects that a third party contractor/facility will test OmniAir's certification process and tools by running "Aftermarket Safety" device candidates, which have more functionality, through 'OmniAir's' program. This 'use' of the OmniAir process would fine-tune the process and yield additional experience with conducting certifications, as well as testing the adaptability of the process, i.e. how well it handles different product types.

Note: It appears the other device types such as RSU, integrated OBU and heavy vehicle OBU devices are being self-declared compliant through the manufacturer or testing efforts of other development groups such as CAMP (the Automotive Manufacturers Consortium). This means that in effect, we have distinct qualifying processes, which in OmniAir's opinion, poses a risk to interoperability in the field. OmniAir staff has made USDOT aware of this risk.