Managing Change and Differentiation; A Fundamental Architectural Consideration for the VII.

Overview

Vehicle to Infrastructure Integration (VII) is a groundbreaking concept that holds tremendous potential for safety, and for road and motor vehicle management. The idea of being able to communicate with every car and to deliver information and services to the car from the infrastructure and from the car to the infrastructure provides a potentially unbounded array of opportunities.

However, this is a huge undertaking, and one that must be accomplished in the context of a rapid evolution of technical capabilities. This makes decisions about architecture crucially important, for if the architecture is unable to support change, or if change requires massive revision of the infrastructure or the base vehicle population, the concept will become quickly obsolete.

It is therefore critically important that the VII architecture, a system that will, if successful, be as pervasive and long lived as the nation's highway system, be supportive of change and evolution, both in terms of implementation technology and in terms of the applications it must support.

Sources and Impacts of Change

The auto industry is in the midst of important and significant evolution. The rapid growth of electronic processing and communications capability, and the emergence of software oriented implementations of nearly all vehicle systems is creating major changes in the underlying vehicle architectures and is also creating many new safety, control and convenience functions. The pace of change in the types and configurations of vehicle systems means that vehicles on the road today are different from vehicles built five years ago. The acceleration of these changes will mean that vehicles built ten to fifteen years from now will be significantly different from today. These new systems and features will provide new safety opportunities, and they will also create new types of safety risks, and additional/different administrative demands.

The steady growth of technology also has important implications for the infrastructure. Ten years ago, the cost of radio data systems was prohibitive; today almost every computing device sold contains such hardware. Fifteen years ago a laser diode cost $1,000; today they are sold in $15 presentation pointers. These radical changes in price points make possible the implementation of new applications that were infeasible only a few years before; and this trend is only likely to accelerate. This combination of changing vehicles and changing technology means that safety and administrative features of the VII will need to evolve significantly over time. The concern then is how do you quickly grow a large installed base, both in the infrastructure and in the vehicle population, but also allow for evolution of technology and applications.

The OSGi Provisioning Architecture

The most obvious approach to the issue of longevity is to create a VII architecture that can effect and manage change in the vehicle terminals. This would mean that the in-vehicle terminals could gain new functionality over time, or even from region to region, simply by remotely installing new software, much the way people install software in PC's today. This approach however requires some means for remotely managing the software configurations of millions of vehicles. Without remote management, each vehicle would require regular technical support, in much the same way PCs do today. This provisioning concept has been discussed in the context of VII as a means for remotely managing roadside units (RSUs), but it is in fact much more important as a means for managing the functionality of what will surely become tens of millions of VII equipped vehicles on the road.

The best candidate for large scale remote software management is the Open Services Gateway Initiative (OSGi). OSGi has developed a specification for a system that uses a back-end server to manage the installation and removal of software components in terminals. This has been primarily directed at cable TV boxes, but they have also included a significant set of services for motor vehicles. The system is designed to include a variety of configuration checks to assure that new software loaded into the terminal will work properly with other software already installed, and to assure that out of date software is removed. This approach is illustrated in Figure 1.

The Promise

Using the OSGi provisioning approach, each vehicle on the road could benefit from new VII applications as long as it was capable of communicating with the infrastructure, and as long as the vehicle itself supports the required functionality. What's attractive about this approach is that it is easy to see how we might have different versions of the same application, supporting different levels of vehicle functionality over time. Rather than a vehicle being scrapped with the same 10 year old functionality it was sold with, it could acquire new capabilities over its useful life. The result is a VII system that is robust and in which every car can support VII applications to the best of its ability.

This also creates an interesting opportunity to allow state and local authorities to provide regional applications to support functionality that may only be relevant in a local area. For example, a state might provide an application to perform ongoing emissions assessment and thereby issue emissions testing requests only to those vehicles that appear to be out of spec. Such an approach could save millions in high testing states like California; A local municipality might implement a DSRC based parking meter system that would charge vehicles on some sliding scale, thereby eliminating a costly and time consuming parking enforcement infrastructure. In each of these examples, the software required to support the application could be provided to the vehicle as it entered the region. Such an approach makes it possible for local authorities to use the VII system locally to meet local needs, while supporting the nationwide safety applications. This would appear to create a stronger motivation for local deployment investments that would support the nationwide system.

Summary

The dynamic provisioning concept solves the problem that technology can change faster than the VII can be rolled out. Using this approach, vehicles would be sold initially with one set of capabilities, and over their lifetime they would acquire new capabilities through software provided by the VII infrastructure. This means that all vehicles on the road would benefit from advancements in technology and improvements in the infrastructure. Such an approach strengthens the VII concept and insures it against technical and regional evolution in applications and implementation, and thereby broadens the appeal of the system and makes it easier to justify.

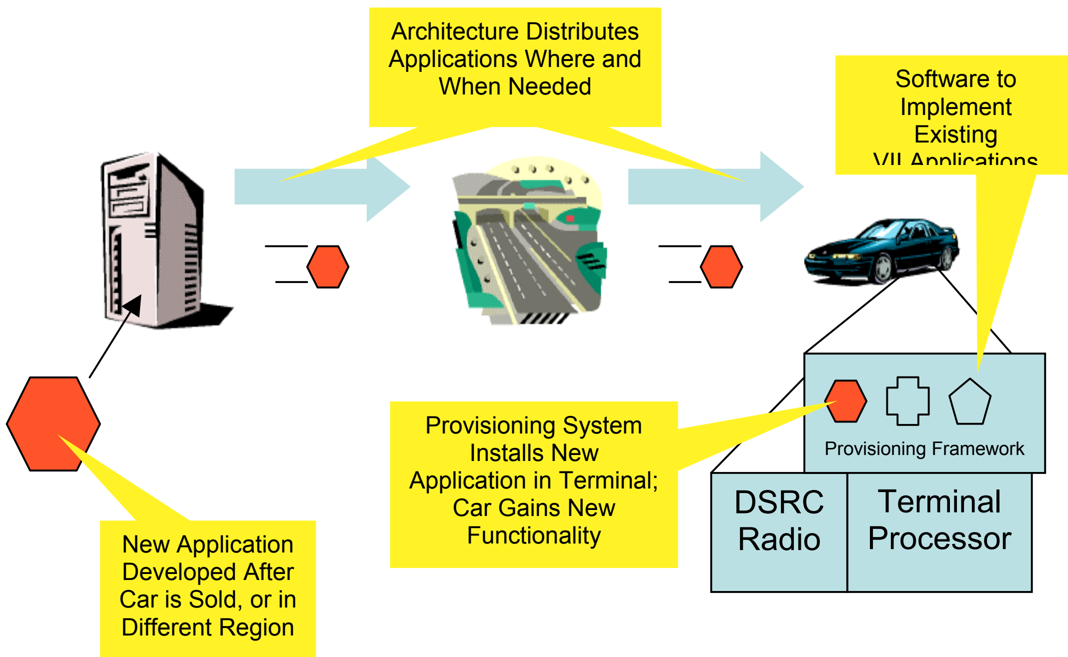

Figure 1. Provisioning Architecture applied to VII

Additional Information

This paper was prepared by Cogenia Partners, LLC, and the Connected Vehicle Trade Association. It is part of an ongoing series of papers developed to illustrate and examine various aspects of vehicle communications. Please contact the Connected Vehicle Trade Association at info@connectedvehicle.org for additional information.

