SAE International™

Realizing Customization and Personalization through Vehicle Connectivity

2010-01-2314
Published
10/19/2010

Niall T. Berkery
ATX Group

Abstract

Connectivity, software and services are the key elements that will define the next-generation vehicle experience. Drivers are being provided new innovative solutions that seamlessly integrate their online digital lifestyle into their vehicle environment, enabling automakers increased opportunity for brand differentiation, while giving drivers the ability to personalize their vehicles down to an individual level.

This will be accomplished through “virtual accessorization” - where drivers will personalize their connected vehicle experience by choosing applications and services that best suit their individual needs. After selecting applications from an online automotive apps exchange, the apps are sent wirelessly to the car or the driver's smartphone for immediate use. The in-vehicle apps can also be configured based on who is driving, so that preferences and personal functionality moves with each driver. The next-generation vehicle experience will be supported by an ecosystem of approved development partners. By leveraging innovation from this broader community, more appealing solutions can be brought to market faster and at a reduced development cost.

Today we manage many aspects of our lives online. Soon we will manage our vehicle from home in a similar manner. The “desktop to dashboard” concept will allow drivers to create driving plans at home, manage the vehicle's health, and configure settings and preferences. With all of the intricate settings made at home, drivers' time in the car can be spent enjoying the driving experience.

Access to off-board content and services can offer greater options, as the most current and personally relevant information will be central to this next-generation experience. For example, rather than searching for a favorite song on a radio station, it will be possible to enjoy personalized radio that caters to each individual's musical tastes. In addition, the driver's mobile device will also become an important component of the connected vehicle, with mobile handset apps being used as an extension of the vehicle.

1.0. Background

The market for embedded two-way connectivity in vehicles - also commonly known as telematics -- continues to grow at a healthy pace. The penetration rate of embedded telematics in North America was about 20 percent of new vehicle sales in 2009, with over 6M active subscribers across the industry. Embedded telematics is forecasted to increase to about 40 percent of new sales by 2015 and growing to a subscriber base of 20M.

Thanks to the heavy investment in high-profile marketing in mainstream media by OnStar and Ford Sync and others, consumer awareness of telematics and vehicle connectivity in general is now very high. In many cases telematics is now a high consideration for purchasers of new vehicles.

Deployment of telematics in new vehicles is increasing with more car makers offering telematics on a higher percentage of vehicles and even adopting telematics across mass market models. As more OEMs introduce solutions in the market place, diverse implementations of telematics are emerging and new features and services are evolving at a faster pace. In addition to Safety/Security and auto centric services that are prevalent today, new connected navigation and connected entertainment experiences are being added to vehicles to make them more appealing to wider range of demographics.

Car makers are under increasing pressure to offer more flexible solutions that keep pace with the rapid changes in consumer electronics and the mobile phone industry. The rate of innovation in the higher end of the mobile phone market has been most remarkable. Since Apple launched the iTunes

App Store in summer 2008, customers have demonstrated a voracious appetitive for downloading applications to their smartphones.

It is widely believed that customers have a high interest in being able to personalize and customize their in-vehicle experience in a manner similar to their smartphone. Offering an attractive and broad portfolio of relevant content and services, that is refreshed faster and more frequently - even post-launch will be the new paradigm. To successfully deliver such a large body of software products on an on-going basis, the innovative efforts of a variety of 3rd party service and content providers, as well as application developers will need to be leveraged.

The concept of "virtual accessorization" where the vehicle can be easily accessorized and personalized with software applications and services that can be downloaded for safe use in the vehicle will be a powerful tool for differentiation. Giving drivers the ability to personalize their vehicle experience to their individual taste, will greatly increase a vehicle's appeal in the market. The challenge for car makers is how to do this in safe, secure, and distraction-free way, while preserving the vehicle's brand theme.

The following sections will address the major technological enabling elements that will be required to realize the connected vehicle that can be fully customized and personalized.

2.0. Wireless Connectivity

Today the in-vehicle infotainment experience is largely defined by content that is physically brought into the car or received from terrestrial or satellite based broadcasts. And the navigation systems being installed at the factory are powered by map databases that are shipped with the vehicle.

The car of the future will be connected and in-vehicle data access will be expected by customers. A vehicle with a high speed two-way wireless connection can take full advantage of the best the internet can offer. Connectivity will be a defining element in the future infotainment experience, with most of the content, services and applications coming from 'the cloud'.

2.1. Connectivity Options for Vehicles

There are two main approaches to connecting a vehicle to the outside world; one that uses an embedded wireless module and one that uses the customer's mobile phone.

2.1.1. Embedded Wireless Module

The classical telematic programs are embedded and highly integrated into in-vehicle sub-systems. This is a proven approach that was first introduced in North America on Lincoln vehicles in 1996 (RESCU System with services powered by ATX) and the technology has been improved continuously since.

In these "embedded" implementations a telematics control unit (TCU) is integrated into the vehicle design and connected to the vehicle's communication bus system. The TCU contains a GPS receiver and a two-way cellular wireless module that creates the connection with an off-board server to perform and receive telematic services.

The major benefit of an embedded wireless approach is the highly reliable communication - which is important for mission critical services like Automatic Crash Notifications services and other emergency services. As the TCU is always in the vehicle it enables remote interaction with the car - even when the driver is away from their vehicle. Examples of such remote services include remote door unlock/lock and stolen vehicle tracking.

The downside of embedding a wireless module is that it must be planned and designed in conjunction with the vehicle a number of years prior to production launch. Also, costs for the TCU itself and wireless voice and data charges need to be accounted for in the overall business model.

2.1.2. Customer's Mobile Phone

The customer's mobile phone can be used as for connectivity. If the customer's phone is paired with the vehicle's electronics systems, the phone can be used a voice and data conduit to off-board services.

The main advantages of this approach are the lower costs incurred for the in-vehicle hardware module and wireless connectivity charges. If the customer's phone has an existing data plan, it can be leveraged to provide broadband communication to internet-based services.

The demerit of using the customer's phone is that services cannot be provided if a paired and charged phone is unavailable in the vehicle. Remote services, like remote engine start will not be possible and the mobile handset approach is not always reliable for emergency response services.

While telematics and connected services in some vehicles may be enabled solely through the customer's phone, many experts believe the optimum approach to vehicle connectivity in the coming years will be a hybrid approach that combines the best of both embedded and handset based implementations (see Figure 1). The smarter telematics systems will route services through the appropriate communications path depending on the type of service and the circumstances.

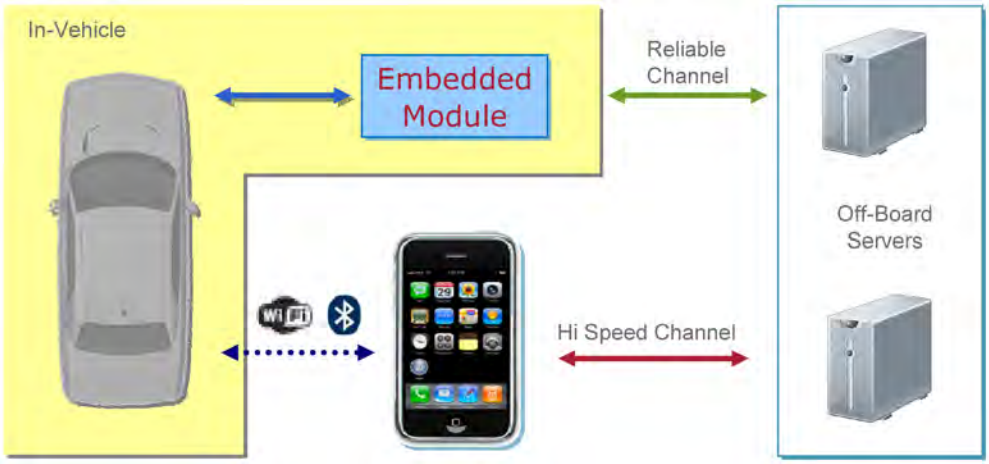

Figure 1. Hybrid Approach to Vehicle Connectivity

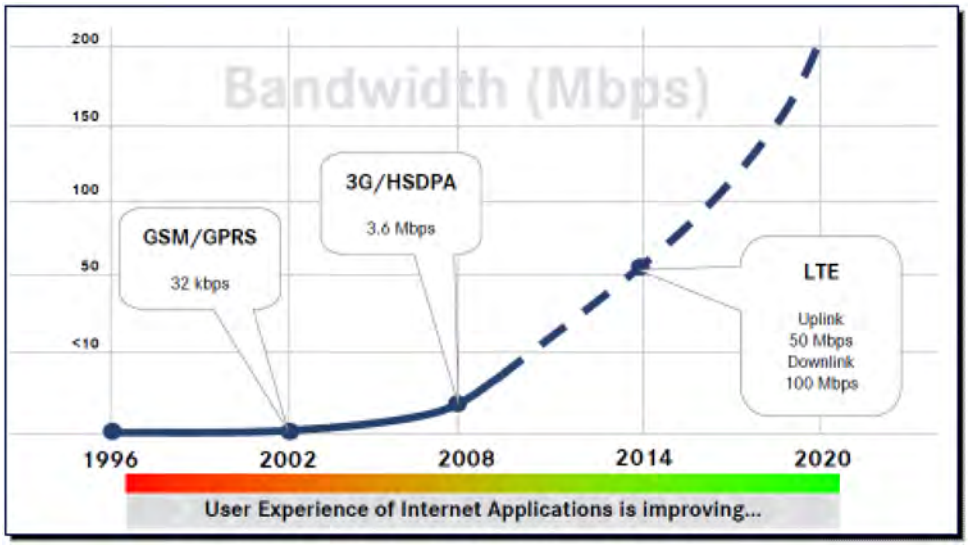

Figure 2. Wireless Technology Evolution

2.2. Wireless Speed

The speed of the wireless connection through which the vehicle interacts with the outside world has a direct impact on the type of services that can be delivered to the vehicle.

Most of the embedded wireless implementations on the road today are some variation of 2G second-generation wireless cellular telephone technology, for example 2.5G. Although technical implementations vary from amongst the top wireless network operators, data rates for 2.5G (ex. GRPS) range between 50 kbit/s and 110 kbit/s.

Today the major wireless carriers in the US have built out 3G networks that cover high percentages (>90%) of the population. These faster networks with speeds of over 10 times their predecessor can handle both voice and data communication simultaneously, which opens up potential for new service implementations.

Wireless carriers are beginning to roll-out next-generation 4G networks that will succeed the 3G and 2G families of standards. These 4G networks will have nominal data rates of 100 Mbit/s, even in moving vehicles. Some analysts predict that over 90% of wireless subscribers will be able to access 4G services by 2013.

2.3. Services Enabled by Connectivity

Faster wireless networks make new types of connected vehicle services possible. Figure 3 shows representative services that are enabled by each wireless generation.

Telematics in vehicles on the road today typically utilize lower bandwidth wireless connectivity based on 2G variants.

2G Enables	3G Enables	4G Enables
Short Messaging Service (SMS)	Voice Recognition (via data ch)	IPTV
Emergency Services	Internet radio streaming	Video Chat
Remote Diagnostics	Off-Board Map Navigation	Hard Drive Synchronization
Turn-by-Turn Navigation	LBS Social Networking	On-Line Interactive Gaming
Remote Vehicle Services	Advanced Traffic Applications	3D Map Navigation

Figure 3. Sample Services for Each Wireless Standard

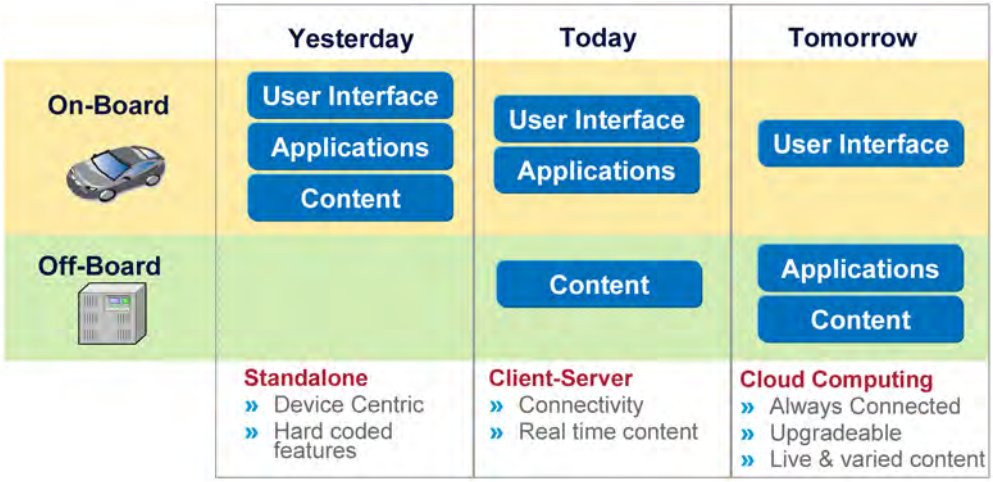

Figure 4. Functionality and Intelligence Moving to the Cloud

Despite the slower data rates, some internet-based applications and content are effectively deployed, such as local search, Traffic information, destination download and turn-by-turn navigation.

In-vehicle adoption of 3G technology in embedded Telematics systems is starting to emerge in production vehicles. Higher speed 3G networks enable more personalized service offerings that are very relevant to the driving experience; most notably streaming audio music services and off-board navigation.

The blazing speeds that 4G brings is really suited to video streaming, video chat, mobile TV, off-board navigation with a variety of additional content including aerial photos and 3D city profiles.

3.0. Flexible Infotainment Architectures

Traditionally infotainment systems are very hardware centric, with mechanical buttons, fixed format displays with hard coded functions - all of which constrain upgradeability and personalization.

Future infotainment systems will be powered by Operating Systems-based platforms that are flexible and can be upgraded with new features over time. The major platforms contenders today are Microsoft Auto, Android, QNX and GENIVI. When making a platform choice, OEMs need to consider robustness, security from outside intrusion and support by the widest range of application developers.

These upgradeable platforms can realize a cloud computing model, where the in-car device becomes a thin client with graphic and media rendering capabilities and applications and content reside primarily off-board.

Storing software and provisioning services in the cloud enables easier upgrade of features and software distribution. These future architectures facilitate a faster pace of application and services innovation while reducing development costs. Additionally it will be easier to integrate new features and evolve the offering over time - even to vehicles that are in the field. This approach will enable car makers to stay closer the pace of innovation of the mobile phone and consumer electronics industries.

Figure 5. Sample of Emerging Auto Relevant Smartphone Apps

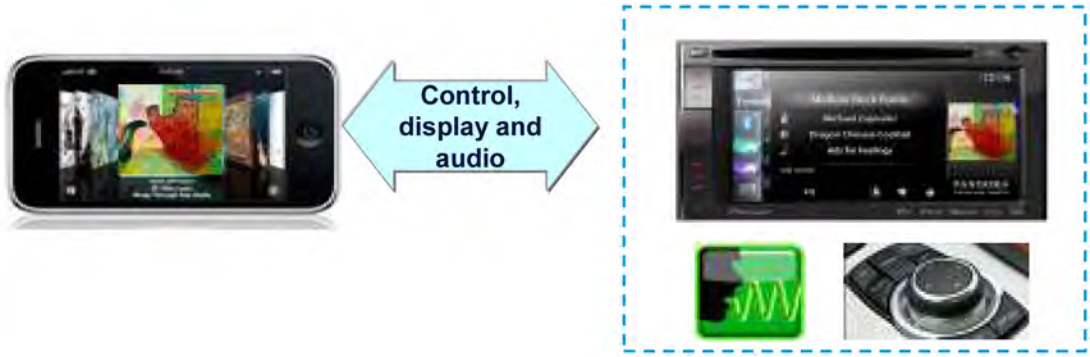

Figure 6. Remote HMI Concept

4.0. The Impact of the Smartphone

The smartphone is an attractive device for enabling connected vehicle services as innovation can take place at a rapid rate. The capability of the smartphone hardware is increasing, app download mechanisms are in place and the voice and fast data can be used for communicating to and from the vehicle.

Already in the market, applications are emerging that are relevant to the automobile and drivers (see Figure 5)

As more customers upgrade to smartphones (ABI Research expects 90% of phones sold in US will be smartphones in 2014), OEMs that do not leverage the services available through smartphones will be at a competitive disadvantage.

4.1. Remote HMI

With concerns about use of mobile phones while driving on the rise, it will be necessary to balance the increased usage of phone and their applications by drivers with appropriate HMIs that prioritize safety and a distraction-free experience. The vehicles HMI assets -- touch screen, steering wheel controls and voice commands etc - should be utilized to ensure the vehicle can be operated safely when consuming all services -- even those on the customer's smartphone.

"Remote HMI" is a compelling concept that allows an application that is hosted on a smartphone to be controlled remotely controlled by the vehicle's HMI (see Figure 6).

In a Remote HMI configuration, smartphone applications can be seamlessly integrated into the in-vehicle infotainment experience in a manner where the OEM maintains full control over how and what applications are made available when the vehicle is motion.

5.0. Approaches to Automotive Applications

While there is general consensus that the app store model is coming to automotive marketplace, there are several approaches that are being explored.

• Embedded apps: These are apps that are built into the infotainment system. They have tighter integration into the vehicle environment and more secure and robust.

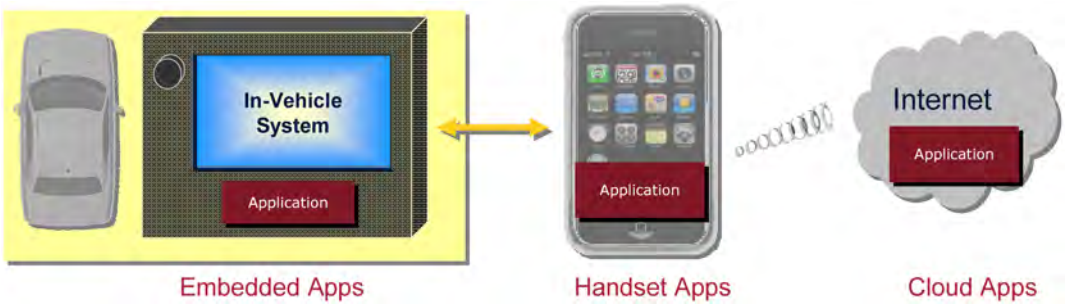

Figure 7. Types of Applications in Vehicles

• Handset apps: These are apps that are downloaded to the smartphone and then and then manipulated from in-vehicle Human Machine Interface (HMI). The mechanism for downloading apps to the phone already exists and these apps pose these of a security risk to the infotainment system. But these apps need to be created for each different smartphone platform.

• Cloud apps: These are browser based apps that reside off-board and can be given access to non-critical vehicle data (ex. fuel level or head lights on). This approach can have the greatest reach as large numbers of developers are familiar with web services design techniques.

It is likely that several approaches to apps will coexist for the foreseeable future, as different types of apps are suited to different functionality. When true ubiquitous connectivity is a reality we believe the logical focus of applications, features and services will be cloud based.

5.1. Challenges for Automotive App Success

While customers desire a fully personalized experience, their expectations for their vehicle are different from their smartphone. Car makers will face a number of key challenges in delivering a successful automotive app model, namely;

• Security: OEMs will need to provide access to vehicle data and sensors to trusted 3rd parties while ensuring that on-board systems and customer information are maintained.

• Branding: Deliver apps that are appropriate for the OEM's brand experience and render it with the OEM's look and feel.

• Liability: Provide a robust certification of 3rd party app functionality that is comparable to the process for traditional infotainment functionality.

• Safety: Ensure the usability of the application, using the in-vehicle HMI controls and that the driver is not distracted on the road.

These challenges will push OEMs to build upon their in-house software expertise. Additionally, car makers that seek the skills of their trusted suppliers to establish validation processes, design custom HMIs and develop the core set of applications that are more tightly coupled with vehicle functionality should have higher likelihood for overcoming these challenges.

6.0. API Approaches in Automotive

In a world where variety of choice is highly desired, innovation from a variety of technology providers trumps a product that is designed exclusively by a single entity. Car makers are now faced with the conundrum of how to foster innovation from a collection of companies with whom they may have worked with in the past - all of this while balancing the challenges covered in the previous section.

The old paradigm of defining all requirements in rigid specifications will no longer lead to products that excite the marketplace. The new mindset will be to give creative developers access to vehicle sensors, data and HMI controls - in the form of Application Programming Interfaces (API). These efforts will be initially will be vetted out with trusted partners and then will be rolled out as security is tightened.

While an automotive industry standard API would be ideal for the software developer community, the barriers to realizing a standard are formidable. A standard API framework would need to incorporate all of the various infotainment platforms that are emerging, be compatible with multiple HMI implementations for each car maker and allows seamless interaction with apps on all types of smartphones. Additionally, gaining agreement on exposing a standard set of vehicle data would demand collaboration on topic that is very sensitive to car makers.

The prevailing thought is that OEMs will pursue disparate approaches to exposing automotive APIs. Figure 8 summarizes the emerging methodologies.

• Vehicle Integration API: Here the OEM is a pursuing an approach that is unique to the OEM's platform and vehicle interface. While control remains with the OEM in this approach, the onus is on the app developer to customize their apps to operate with each OEM's framework.

Approach	Description	Examples
Vehicle Integration API	OEM exposes interfaces that can be used by third party developers to develop OEM platform specific apps that can interact with the vehicle	SYNC App Link
Smartphone Integration API	Mobile OEMs build SDKs to enable seamless interaction between smartphone apps and in-vehicle Infotainment Units.	iPod Out NOKIA Terminal Mode
Head Unit Platform API	Infotainment supplier develops a platform that allows applications to be downloaded, installed on the vehicle and can access vehicle interfaces	tina

Figure 8. Emerging API Methodologies in Automotive

• Smartphone Integration API: Applications developers create hooks in the apps so that it can be controlled remotely by the vehicle infotainment system. No standard framework exists across all smartphone platforms, so apps need to be created for each smartphone type.

• Head Unit API: The OEM must choose a platform from the various options to ensure apps are compatible across all vehicles in the line-up. Application developers create native applications that can be downloaded to the infotainment platform. This implementation is best suited to an infotainment system with a rich Graphical User Interface (GUI).

These differing approaches can lead to great inefficiency. Developers will spend more time adapting and validating applications across multiple platforms and frameworks rather than actual development.

7.0. Conclusions

OEMs need to embrace consumer appetite for connectivity, applications and the personalized in-vehicle experience that they fulfill.

In doing so, car makers need to balance the challenge of offering flexibility to the software development community that fosters broader innovation, while establishing processes where security, safety and brand essence are assured.

Delivering the app store model in the automotive world will require major change to the infotainment value chain that exists today. Success in this new world will entail car makers building up their internal software resources and leveraging existing supplier partners in addition to creating new relationships from the application developer community.

The car makers that are most proactive and diligent in addressing the complexities, and that can deliver the framework that truly allows drivers to personalize their vehicle down to an individual level, will be positioned to keep pace with innovation in adjacent spaces, and have highest product appeal in the automotive marketplace.

References

Loeb, S., Falchuk, B., Panagos, E "The Fabric of Mobile Services" Wiley, 2009

Contact Information

8550 Freeport Parkway
Irving, TX 75063-2547
Tel: 972-753-5467
Fax: 972-753-6275
nberkery@atxg.com

The Engineering Meetings Board has approved this paper for publication. It has successfully completed SAE's peer review process under the supervision of the session organizer. This process requires a minimum of three (3) reviews by industry experts.

ISSN 0148-7191

doi:10.4271/2010-01-2314

SAE Customer Service:
Tel: 877-606-7323 (inside USA and Canada)
Tel: 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE Web Address: http://www.sae.org
Printed in USA