

The challenges of car connectivity

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Many cars already connect to iPods, cellphones and other personal electronic devices. In the not-so-distant future, cars will also connect to the Internet, other cars and roadside systems. For automakers and automotive suppliers, this trend toward ubiquitous connectivity presents many opportunities, but also many challenges.

Take, for example, connectivity to personalelectronics. Consumers today want to use their MP3 players and smart phones even while they drive. They also expect to be constantly connected, using their portable devices to “Tweet,” “Facebook” or geotag throughout the day. It is only a matter of time before consumers demand that the car becomes an extension of this plugged-in lifestyle. For automakers, the opportunity is clear: If they can help the consumer stay connected in a safe, reliable and legal fashion, they can differentiate their brand and build customer loyalty.

The problem is the automobile must always play catch-up. In the personal electronics industry, it takes six to 18 months to bring a product to market. But in the auto industry, where a new product must be planned into the vehicle’s manufacturing process and undergo far greater testing and validation, the process often takes 3 or more years. As a further complication, an in-vehicle system that connects to personal electronics must stay relevant for at least 10 years. But how can it do that if the MP3 players of today become the 8-tracks of tomorrow?

To address some of these problems, automotive engineers can implement systems with modular, upgradeable software architectures. In other cases, they can keep content and applications up to date by moving functional-

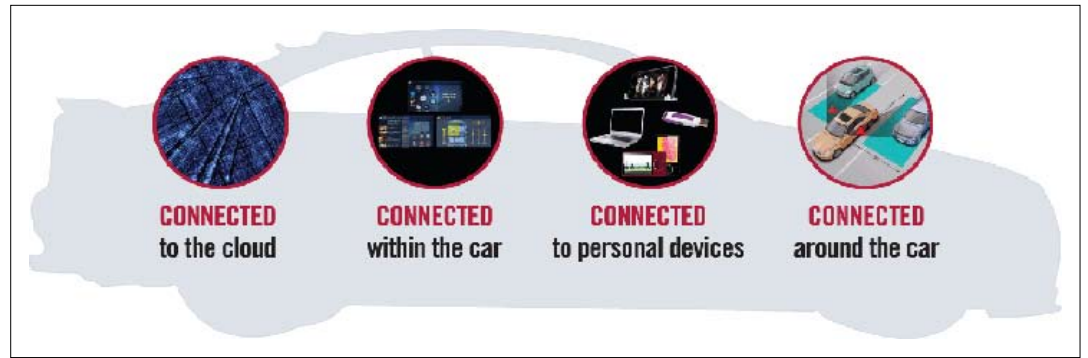


Figure 1: Personal lifestyles, economic pressures and the need for market differentiation are driving automakers to implement multiple forms of connectivity.

ity from embedded modules to the Internet. For example, navigation databases, music metadata sources and speech recognition back-ends can all run on a perpetually refreshed server, rather than be distributed through costly DVD updates or bay module reprogramming. A remote server provides a host of capabilities—such as streaming media, application downloading and real-time traffic reports integrated into navigation services—that are difficult or impossible to implement using only on-board resources.

The economy is also driving the car towards greater connectivity. Pressure to reduce engineering costs and time to market has grown more intense than ever. Meanwhile, burgeoning complexity is driving up the cost of software development as a percentage of the car’s total cost. As a result, automakers must create new ways to reduce BOM costs and streamline the software development process. Increased connectivity can shorten time-to-market and the embedded engineer’s burden, by shifting some of the complexity back into the cloud. In fact, by leveraging Internet services, an automotive OEM can even create new revenue streams.

Connectivity categories

A car can be “connected” in several ways. Below are the categories:

Connected to the cloud—In this

case, an in-vehicle system derives some or most of its functionality from Pandora, Netflix, Amazon, Hulu, Google, Twitter or other Internet-based services. To achieve this goal, the system requires a network access device (NAD) and a wireless network with near-ubiquitous coverage. Depending on the application, network requirements range from 2.5G cellular to wireless broadband technologies such as 4G or LTE.

Connected to portable devices—This category includes connectivity to iPods, Zunes, PlaysForSure/Media Transfer Protocol devices, USB storage devices, personal navigation devices and Bluetooth headphones. It also includes connectivity to a phone (typically through Bluetooth), which can serve as a NAD for Internet access. The phone connection could stream media and provide GPS location data, phone book contacts and calendar management.

Connected within the vehicle—This approach leverages the connection between the center-stack console, rear-seat entertainment unit, digital instrument cluster and other in-car modules. For example, the modules can shuttle streaming multimedia around the vehicle. Such high-bandwidth traffic exceeds the capacity of the CAN bus and requires at least a high-speed MOST network or perhaps Ethernet audio-video bridging.

Connected to the environment—This form of connectivity includes vehicle-to-vehicle or vehicle-to-roadway communications for collision avoidance and traffic management. Lane departure warnings, driver drowsiness alerts and other driver-assist technologies also fall into this category, as do parking assist and adaptive cruise control.

New challenges

Every automaker must deal with various combinations of these connectivity types, and each combination poses a new set of challenges. The challenges include:

Device testing—Performing compatibility testing on a constant stream of new consumer devices is a major chore, as is updating an in-car system to work with those new devices. To keep pace, automakers can outsource to companies that specialize in compatibility testing. They also need an over-the-air facility to readily deploy the software updates.

Hardware redundancy—Multiple car configurations and multiple vehicle lines can result in redundant hardware, thus increasing cost. For example, a Bluetooth module deployed across an entire vehicle line can also be deployed in an optional add-in box that supports multiple vehicle lines, resulting in some vehicle configurations that have a duplicate Bluetooth module. Similar situations can occur

with USB ports, SD card interfaces and hard disks. Multiple instances of a software resource, such as a database, can also occur within the car, driving up total processor usage, flash and RAM size, and software royalties.

To reduce such duplication, automakers need to take a holistic view of the vehicle's software and hardware architecture. They can also reduce duplication by using technologies such as QNX transparent distributed processing, which allows systems to transparently leverage one another's hardware resources in a peer-to-peer fashion.

Category blurring—The boundaries between hands-free, telematics, infotainment and navigation systems are fluid, and can promote a lot of confusion in the internal ownership and development of these products. However, by using a standard software base as an application platform, automakers and automotive suppliers can reuse development across multiple departments and multiple projects. To achieve this goal, they must ensure that the software base is portable across a range of high-cost and low-cost hardware.

Maintaining safety—How can automakers add new features to the vehicle without also adding to driver distraction? Proper human machine interface (HMI) design is key. For instance, audio prompts (text to speech) and speech recognition can keep the driver's eyes on the road. Graphical touchscreens with intuitively designed

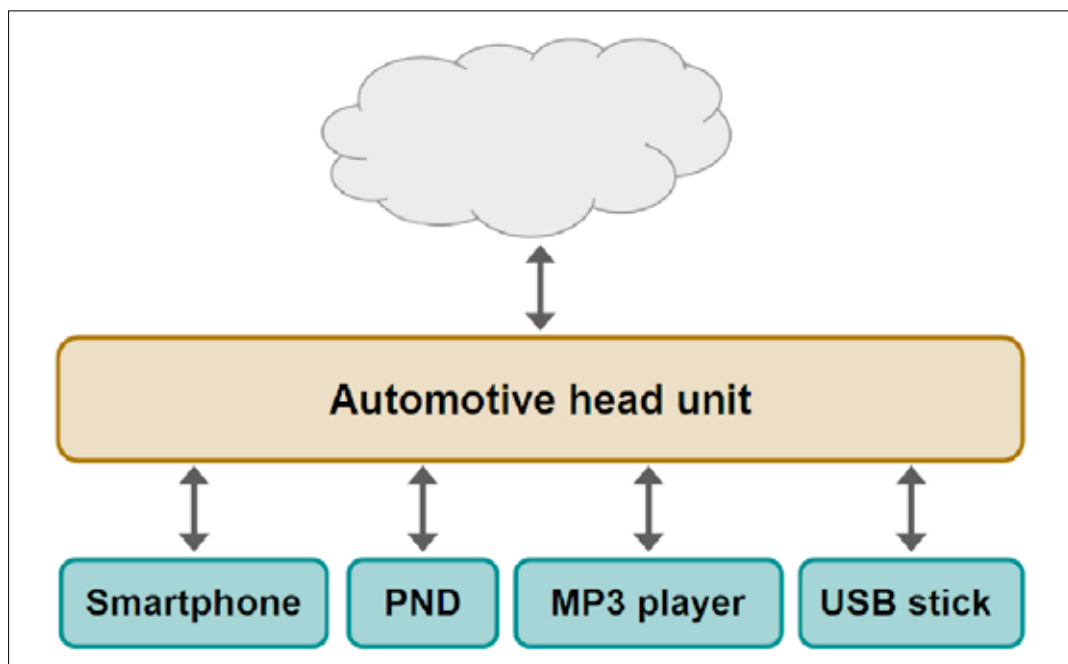


Figure 2: By combining connectivity to the cloud with connectivity to portable devices, a car infotainment system can display cleaned metadata and allow car owners to download and purchase of music.

controls and layout also help.

Revalidation of software updates—Most software systems require validation on the final software load. However, allowing customers to download new applications can create a huge number of possible software states that can't be tested. Just two downloaded applications create four possible configurations, quadrupling the test and validation load. To address this problem, automakers can use a partitioning system to isolate the new components in a sand box, thereby preventing downloaded components from affecting the rest of the system. For instance, the system designer can create a time partition for downloaded applications that prevents those ap-

plications from consuming more than 10 percent of the CPU.

Reducing development time—Wherever feasible, OEMs should use a software platform that contains as many pre-integrated building blocks as possible.

Differentiating the brand—Automakers and automotive suppliers need to focus on areas where the user will notice the greatest impact. Developing middleware blocks (multimedia, graphics, databases etc.) in-house when they can be purchased off the shelf doesn't make fiscal sense, particularly when the engineering effort could be directed at value-added activities, such as differentiating the HMI.

Software cost—The temptation to go with open source is great, but automakers and automotive suppliers must be wary of false economies. Costs incurred by legal teams, licensing requirements, additional engineering resources, required non-open source components, front-end nonrefundable engineering, pay-for-use fees, mandated hardware selection and higher-cost hardware (needed if the software wasn't designed for embedded use) can easily negate advantages gained by using "free" software. Careful analysis of the total cost of ownership is a must.

The companies that can solve the majority of these problems quickly and cost-effectively will be well-placed to reap the benefits of ubiquitous connectivity.