In-Vehicle Smartphone Integration

Whether you are a telco operator, a mobile phone manufacturer (OEM - Original Equipment Manufacturer), a consumer electronics firm, an insurance company or even a software vendor, you are most probably familiar with the "automotive vertical" term. However, it has a slightly different meaning for each of the mentioned industries.

For a telecom operator, automotive will be immediately mapped into a considerable segment of the M2M platform, therefore you will consider a modern vehicle (car, truck, boat, airplane) as yet another "thing" (based on the IOT – Internet of Things concept) to be connected to your network. A phone OEM will immediately visualize the "context" of phone usage related to driving. The phone OEM's ecosystem will at the same time see some potential for their apps and services – isn't it natural that your own navigation service should definitely work on board the vehicle, offering the most user-friendly experience, providing the right level of security, and avoiding driver distraction? Obviously, some companies, like insurance, sometimes even have the core of their business set around automotive, and it is clear that they also evaluate what modern automotive technologies have to offer, and how they can utilize them to improve and add to their business. Going further, In-Vehicle Smartphone opens up new innovative idea for business (like the pay as you drive concept for insurance). Software vendors are needed to build the right bridges between the vehicles and rest of the connected world, as well as create apps and services for use on board the car. There are simple solutions for simpler business models – like for instance Telematics and Fleet Management - and for much more advanced schemes like Loyalty Management systems, which integrate the full context of the customer and their vehicle, involving many partners.

Connected Car

One thing we know for sure in today's fast-paced world, is that we need to be both mobile and on-line (for most of the time), and there is absolutely no exception when it comes to being on board of a car or even when being the driver. What matters is how we handle our interaction with the phone as well as other electronic gadgets on board of the car including IVI (In-Vehicle Infotainment – Information and Entertainment) systems. If we consider that, driving at 60 km/h, we move almost 17 meters each second, then keeping our attention focused on the phone for just three seconds means that for 50 meters we are not focused on driving and are prone to potential hazards. It's something that we shouldn't do, but in real life we do it quite often.

As a study by the National Highway Traffic Safety Administration (NHTSA) and the Virginia Tech Transportation Institute (VTTI) shows, 80% of crashes and 65% of near-crashes involve some form of driver distraction – mostly within three seconds before the crash!

As indicated in the study, the principal actions that distract drivers and lead to vehicle crashes are:

- Cell phone use
- Reaching for a moving object inside the vehicle
- Looking at an object or event outside the vehicle
- Reading
- Applying makeup

It is a general principle that the automotive industry pays special attention to safety and security. Many regulations around these domains make life very tough for one who wishes to enter the industry. Luckily, there is a magic word, "comfort", that helps a bit. Instead of talking about and working on the safety function-s, we move towards comfort and break some of the barriers. That's obviously a nice way of doing things, but it shouldn't change the general consideration of distraction. Going to automotive means you'll hear and use this word, despite the fact that some young people consider driving to be a distraction factor for their Facebook and general social media habits.

There is no doubt that cars are becoming connected, and that car manufacturers have their own schedule that drives them in this direction. There are many reasons behind this – some resulting from market expectations, some simply forced by new legal obligations (for example the EU attempt to implement eCall across the whole European territory by 2015).

The first Connected Cars have been driving on our roads already for some time, but it will still take a couple of years before we see all cars connected. The automotive industry is much slower than consumer electronics, and their product lifecycles are a couple of times slower. A car that is three years old is still considered almost new, whereas the same old phone should already be recycled, its gold, palladium and other ingredients becoming elements of its successor on the production line. That's why it's not so obvious that the state of being connected for a modern car doesn't necessarily need to be a result of native and embedded solutions, but that an equally probable scenario will assume the use of modern phone as the bridging technology. Besides the technological benefit, most modern connectivity technology and related aspects offer simple ways to charge for connectivity. Does it mean that the concept of built-in SIM cards in cars can't be realized? No. It means only that, for some categories of traffic and the services behind them, it is simply easier to use the phone as a bridge, while for other categories the car-embedded SIM will provide connectivity (such as telematics and basic services with less demand on bandwidth).

From the question of 'if' we should move to the question of 'how'. In the beginning, IVI systems were designed as separate ecosystems with their own brick-sized phones; then the era of Bluetooth1 connectivity arrived, and from there we have drifted into application-centric and cloud based solutions. Bluetooth is just an example of integration technolo-

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IDEAS IN BRIEF:

- For some categories of traffic and the services behind them, it is easier to use the phone as a bridge, while for other categories the car-embedded SIM will provide connectivity
- Keeping applications embedded in the smartphone and integrating them into a vehicle creates many opportunities, provided they are well-designed and built by organizations aware of the specific requirements of the car context
- Most of the existing mobile applications where not designed for usage in a vehicle, which is why CCC's MirrorLink™ technology enables application developers to implement parts of the UI in the Head Unit, or to provide optimized UI designed for use while driving

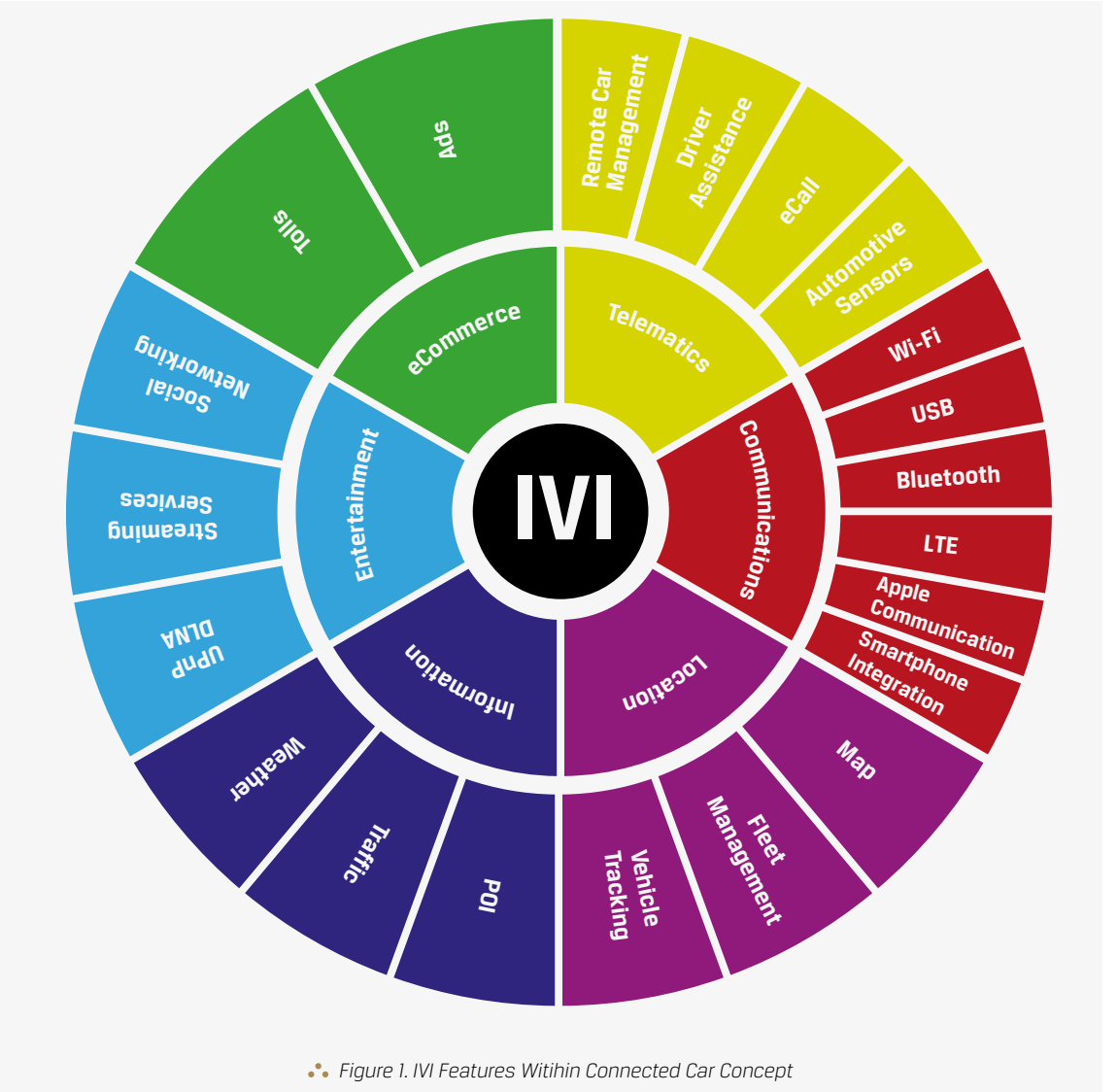

Figure 1. IVI Features Witihin Connected Car Concept

gy, while others, like USB, WiFi, NFC, and proprietary interfaces are equally important.

The Connected Car is an excellent business machine that, besides bringing lot of comfort for the driver and passengers, also provides the right foundations for new services and applications for private as well commercial use. The above-mentioned Fleet Management or Loyalty Management uses are just examples. A new method of charging insurance fees is yet another great idea. We should expect a huge number of integrated services that will take this new context of the car into consideration. There is also an excellent advertising opportunity – selection of a specific offer will also bring us by embedded navigation to the point of sale. There is also huge potential for AV based solutions; as suggested by numerous studies, 70% of music content perception occurs in the car.

Smartphone Integration

But how should the actual communication between a vehicle and a phone be possible made? How to avoid driver distraction? How to ensure that the chosen solution will remain viable through the lifespan of the vehicle?

The decision-making framework, among other business and marketing topics, would consist of, firstly, the location of the application. It could be stored in the head unit (in other words in the IVI system), in the smartphone or in the cloud. Secondly, is the question of how to control driver distraction – which HMI should be used, which apps should be allowed, how to proceed with legislation and certification? The third question would be about integration strategy; at present, options include at least iPod out, MirrorLink™, Remote skin, Simple UI, Ford and Microsoft's Sync, or generic HTML5 approach.

The amount of different technologies and options simply results from the fact that the concept is new and emerging. Companies are now promoting solutions that are relevant to their strategies, business metrics and other facts that stimulate them to force one option over other. The good thing is that some of the technologies may coexist on board of a car, but the risk here is that it could generate some confusion for

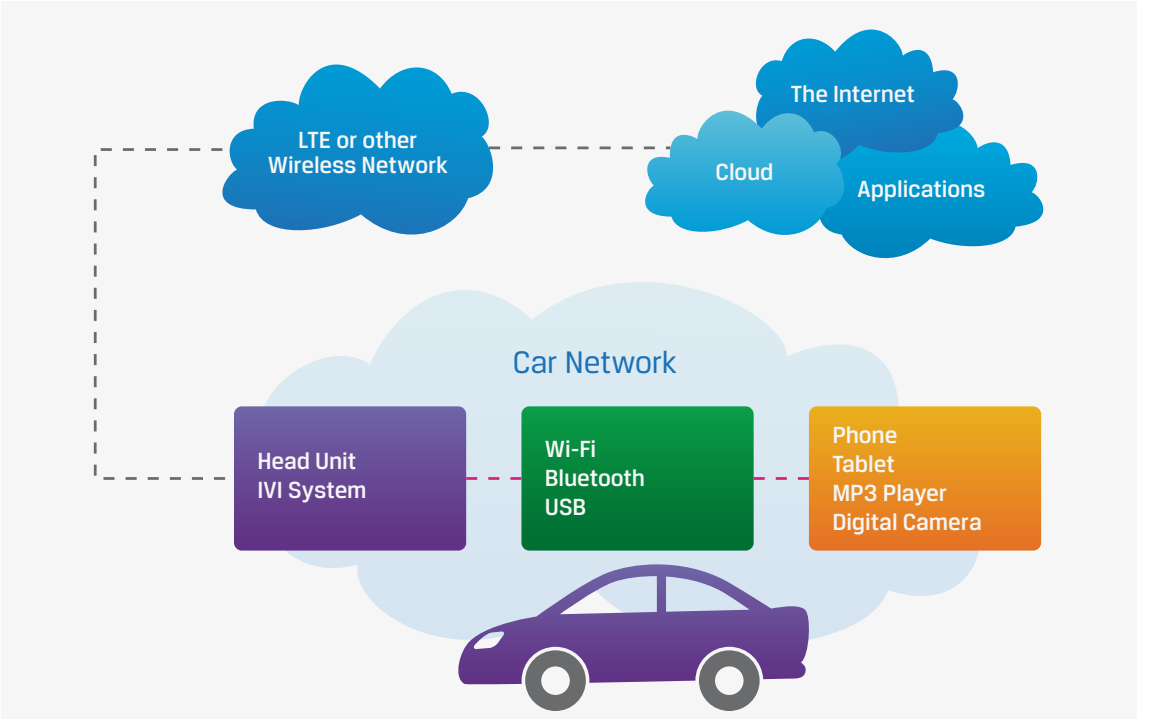

Figure 2. A Connected Car is a Car That is Equipped With Internet Access and Wireless Local Area Network

consumers, which is absolutely not in line with the idea of avoiding distractions. It's also natural to assume that, at some stage, there will be just two or three winning mainstream integration technologies, since the rest will remain as potentially specialized and niche technologies.

What has happened over recent years is that each car manufacturer as well as each phone vendor has set a very systematic approach to this domain, and now it's time to move towards actual applications and services rather than spending time on the integration technology. New solutions should obviously be planned with the consideration of modular architecture, enabling easy migration from one integration technology towards the other, at the lowest possible costs, and with the least influence on User Experience.

Embedding Applications Inside the Head Unit

The obvious solution is to create a proprietary operating system for the Head Unit. But then the car manufacturer needs to develop new applications in-house, and adapt existing ones into its own system. In many cases it's not directly in the interest of the car manufacturer to either write an app or adapt the existing one. The distribution mechanism is also a potential problem. The mobile industry has managed to establish vital ecosystems gathered around each leading mobile OS, as the final step in the evolution of app distribution. No such ecosystem currently exists, and considering that even market leaders are having a problem creating one, the creation of a new ecosystem might be of serious concern to some of the car manufacturer leaders. Another issue that could prevent the creation of independent operating systems and software might be connected with maintaining hardware capable of running the newest applications for next few years; don't forget the different pace of R&D in the automotive and consumer electronics industries.

Despite these problems and challenges, the most common solution for IVI in the Asian market right now, is keeping applications embedded in the Head Unit. This is achieved by reusing the Android mobile operating system. There are some drawbacks to this option; the first is that this system is too immature for this usage – the system components were designed to handle smartphone or tablet usage, rather than Head Units (but this might potentially change over time). Secondly, the driver distraction is not handled in any way. In this solution there is no clear integration, the IVI is just reusing an application that already exists on the market.

GENIVI2, a non-profit industry alliance, was founded to address some of these issues. It is committed to create an IVI open-source development platform. OEMs such as BMW, PSA, Renault, Nissan, GM and Jaguar Land Rover are working together to establish such an eco-system. Comarch is also a part of this alliance as middleware and service supplier. GENIVI may gain some momentum by the effect of scale and very reasonable principles. The problem with GENIVI is simply that time is running out. Mobile ecosystems are so well established and already familiar to consumers, that a new category of apps named automotive may reach high potential and focus much faster than a new GENIVI-based ecosystem. Obviously, GENIVI-based IVI are needed in order to enable modern IVI systems to be built.

Applications Embedded in the Smartphone

As mentioned before, hands free communication and music playback from a regular smartphone is impossible, but if we create the right interfaces, then such concepts are already possible, and even preferable, via modern links between aphone and a car IVI system.

Many customers would like to bring their smartphone applications to the car – to the dashboard screen, to the car speakers, to get the GSM signal from the external car antenna, and to use the car microphone that has been specifically designed and tuned for a specific interior.

Keeping applications embedded in the smartphone and integrating them into the vehicle creates many opportunities, provided they are well-designed and built by organizations that are aware of the specific requirements of the car context. The crucial element of a successful application is well- designed HMI and overall User Experience – keeping the right balance of the car's constraints, and experiences gathered directly from modern mobile platforms.

Another question that the solution creator should consider is the actual data linkage, such as wireless or cable. The possibility of bidirectional control between the smartphone and vehicle is also an interesting factor. It's not only a means of controlling the phone by car HMI, but also of changing the car's settings, such as turning on the engine or air conditioning directly from the screen of our smartphone, also including remote access. Scenarios like remote engine activation on a cold winter morning are nothing unusual.

MirrorLink™[3] (Terminal Mode)

The Car Connectivity Consortium created MirrorLink™ to ensure that phones, applications and cars will integrate. The technology is based on VNC4 (Virtual Network Computing) and as such is replicating the smartphone screen inside the main unit display and allows it to be controlled. In other words, applications are shown on the car's display, and the user has the option to control it via touch and using existing car controls. Car sensor data is available through MirrorLink™, thus enabling all kinds of new applications to be developed for the automotive market.

When using MirrorLink™, not all applications need to be present in the Head Unit. OEMs have full power to implement their own policies about which applications should be available to the driver and when. For example, when stationary in a traffic jam you would be notified about all events, but while overtaking some notifications would be delayed. The same control is possible for the size and position of elements of the duplicated display, as is control over where the information is presented.

Most of the existing mobile applications where not designed for usage in a vehicle, that's why MirrorLink™ enables application developers to implement parts of the UI (User Inter-

Figure 3. Smartphone intagration concept

face) in the Head Unit, or to provide optimized UI designed for use while driving.

Last but not least, MirrorLink™ – despite the common perception – is not a simple UI replication technology. The technology is fully intended to integrate the phone and inherited ecosystem with the car environment, with full support given by car OEM's. Because of these objectives, there is a high probability that this technology will become mainstream.

RealVNC[5]

Last year, RealVNC, in conjunction with Jaguar Land Rover and Blackberry 6 presented a system called "Connect and View™". The main idea behind this solution is similar to MirrorLink™, in that it transfers the screen from the smartphone to Head Unit, and the controls to, for example, the steering wheel switches or buttons on the smartphone headset. The connection can run efficiently over most types of networks, such as GPRS, WiFi, Bluetooth or USB. The advantage of this solution is that it supports most mobile and in-vehicle embedded operating systems.

Remote Skin, Simple UI [7]and iPod Out Architecture

Remote Skin is an idea with real life implementation in Ford Sync AppLink8 and BMW Connected Car,9 where there is communication between the Head Unit and the smartphone. The application resides in the smartphone but the HMI runs in the Head Unit. For each application there is a need to tailor a driver-friendly UI, and each needs to be allowed to connect to the Head Unit.

With Simple UI protocol designed by QNX Software Systems and Research In Motion with Harman Becker, the Head Unit controls the application. The application needs to transfer icons, text and labels to be displayed in the Head Unit. So the applications need to create minimalistic HMI to provide a simple user interface.

As for iPod Out Architecture, the Head Unit becomes a terminal for the Apple device. The Head Unit display is running as a second screen. The commands from the car's controls are sent to the device using the iPod accessory protocol. The biggest disadvantage of this solution is that it supports only Apple devices.

Safety (Driver Distraction)

As already noted, the technology used for this integration should enable safe phone usage.

There are existing operator-enabled solutions like T-Mobile DriveSmart™ 10 and Sprint Drive First11 that automatically activate when a phone is in motion and prevent texts, calls and other unsafe distractions. This kind of behavior could be achieved independently if only phones could be integrated easily with cars. These examples also show that elements of well-designed applications and systems for the automotive segment may reside not only in the actual end devices and the car itself, but also have the potential to be deployed on the infrastructure side.

The eCall specification may also require very high-level cooperation between automotive and telco, so as to transfer the car accident related data smoothly and with the appropriate priority, reliability and security.

Summary

There is no doubt that all vehicles in the future will be connected. This small revolution has already started. Its first steps are soft, but it will soon be a regular topic on many conference agendas – not only those specific for Telematics and IVI systems. The future is in integrated, synchronized systems providing personalized user interfaces across all everyday life devices, for example computers, tablets, smartphones and cars. Synchronized data is kept in the cloud and applications' UI is written in standardized format such as HTML5, which is easy to customize for each device.

Some companies have already invested their efforts to implement just such a vision; we need only mention Intel with its Compute Continuum platform in this context. Telcos are also in the phase of building enablers and capabilities – with the development of M2M platforms progressing well in Europe – so it looks like it's already time to also invest in development and the deployment of actual applications and services. Some barriers, like driver distractions, market fragmentations, a broad ecosystem of players, and emerging integration technologies that are still in the development phase, are obvious, but if we look at any other vertical (for instance health) we can list similar obstacles. The future is connected, and the car is part of that connected world.

1 http://www.bluetooth.com
2 http://www.genivi.org
3 http://www.mirrorlink.com/
4 http://en.wikipedia.org/wiki/Virtual_Network_Computing
5 http://www.realvnc.com/
6 http://www.jaguar.com/gl/en/range_qr/c-x16/innovation
7 http://www.qnx.com/download/download/21914/qnx_auto_smart_phone.pdf
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11 https://drivefirst.sprint.com/welcome.htm