In-Car Entertainment using Mobile Devices: A study on Automotive Manufactures in India

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ABSTRACT: With smart phones and mobile internet devices rapidly becoming the application platform of choice, consumers expect to be able to use their favorite applications and services anytime anywhere. Mobile devices such as smart phones have enabled consumers to gain access to a growing number of interactive and useful applications, anytime anywhere. However, once a user enters his/her vehicle the availability of such applications and their user experience degrades drastically either because of being restricted to using the few applications available on the In-Vehicle Infotainment (IVI) system or due to the challenges of interacting with a tiny mobile device screen attached to a car dock. In this paper, we present Terminal Mode – a technology which transforms mobile devices into automotive application platforms and seamlessly integrates them into vehicle infotainment systems. This technology not only enables consumers to access their favorite mobile services and applications in a safe manner while traveling in a vehicle but also provides top quality user experience consistent with high end IVI systems.

Keywords: Automotive User Interface Framework, Automotive Application Platform,
Connected Car and In-Vehicle Infotainment Framework.

1. INTRODUCTION

Consumers can access their mobile applications inside their vehicles in a seamless, intuitive yet safe manner. In this paper, we present Terminal Mode, a technology which enables smart phones and other mobile devices to seamlessly integrate into automotive infotainment environments and essentially become a dynamic and full-featured service and application platform and communications gateway for the automobile. Terminal Mode aims at enabling consumers to have services and applications at their fingertips on-the-move. Its goal is to serve as a catalyst for new services which interlink vehicle information with mobile device applications and fuel innovation in both mobile computing and automotive services domain.

1.1 IN-VEHICLE INFOTAINMENT SYSTEMS

In-Vehicle Infotainment (IVI) systems such as BMW's iDrive , Audi's MMI and Alpine's after-market solutions have been the primary application platform for interactive automotive applications till now. IVI systems are integrated into the car and provide an all-in-one solution which includes an application platform hooked up with driver-friendly displays and controls.

Advantages:

The advantage of IVI systems is that they are designed specifically for in-car use. The physical UI components such as the displays and controls are optimized specifically for use by the driver and/or passengers in a vehicle. Furthermore, the design of IVI systems ensures that they comply with laws and regulations governing driver distraction and driver/passenger safety.

Disadvantages:

IVI systems suffer from a number of disadvantages. Firstly, they can be quite expensive especially if they are factory fitted. Secondly, IVI system manufacturers have a much longer product development cycles as compared to consumer electronics manufacturers which implies that their systems are already out of- date in terms of hardware and software capabilities as compared to other consumer electronic devices, by the time they reach the market. On the other hand, consumers typically use their vehicles for an average of 8 to 12 years and this further increases the obsolescence of any integrated IVI unit over time.

1.2 Mobile Devices with Car Docks

With the advent of touch screen equipped mobile devices such as smart phones with finger-friendly UI, there has been a renewed surge in popularity of car docks which can be used for mounting one's mobile device on the windshield or the dashboard. The driver directly interacts with the mobile device, typically through its touch screen and uses the applications running on it.

Advantages:

Unlike IVI systems integrated into vehicles, the car dock is an extremely cost effective and user-installable solution. Moreover, a typical user upgrades his/her smart phone every 2-3 years hence it always remains more updated in terms of hardware and software capabilities as compared to IVI systems. As a consequence of this, users have access to all the latest and popular applications without expending any extra effort. Furthermore, the user has access to all his/her mobile applications, preferences and data inside the vehicle.

Disadvantages:

The main disadvantage of using smart phones mounted on car docks is that they are not optimized for use inside a vehicle. Mobile devices are extremely constrained in terms of display size and require the user's full attention in order to operate it. Moreover, the small size of the display and touch area make it difficult to operate from behind the wheel, when the device is attached to the windscreen or the dashboard at an arm's length. This can prove to be unsafe for the driver and passengers of the vehicle due to increasing amounts of driver distraction and the poor quality of user experience.

1.3 Vertical Integration of Mobile Devices with IVI Systems

There have been several efforts towards vertical integration of mobile devices with IVI systems. The most commonly seen integration is the utilization of Bluetooth Hands Free Profile which enables drivers to make phone calls through the IVI system. Other more recent efforts involve sharing of data from the mobile device with the car's IVI system. In this way, the driver avoids interacting with the smart phone directly while driving but still has access to its data. One example of this is the Google Maps integration with Ford SYNC . In the Google Maps case, a smart phone user has the option to send map directions from their phone's navigation software to the navigation application hosted on the Ford SYNC IVI system located in the car. BMW has also collaborated with Research in Motion to integrate e-mail and media content from Blackberry devices into their iDrive IVI system . Another example of such efforts is the development and release of the SYNC API by Ford which enables smart phone applications to interact with the user through the human-machine interface (HMI) of the SYNC IVI system .

2. THE TERMINAL MODE CONCEPT

The Terminal Mode concept combines the versatility and powerful application platform capabilities and development ecosystems of today's mobile devices with the driver and passenger optimized UI hardware available in vehicle IVI systems. The result is a concept somewhere between using the applications natively on the mobile phone and using applications running in the vehicle IVI system.

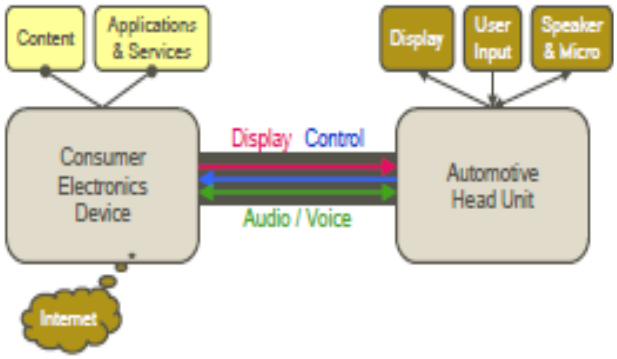

Figure 1. Terminal Mode Concept

Figure 1 depicts the Terminal Mode concept. In Terminal Mode, the mobile device (such as a smart phone) becomes the application platform for the automotive environment whereas the VI system is responsible for user input and output. Figure 2 shows an example of what the Terminal Mode concept looks like when deployed in a vehicle. The mobile device hosts and executes all the applications and services accessible to the user and also acts as a communications gateway to the cloud. The vehicle IVI system on the other hand, provides the UI hardware and physical input/output capabilities through which the driver/passengers interact with applications running on the mobile device. These may include one or more displays, input mechanisms such as touch, buttons and multi-functional knobs, audio playback and voice input systems. The mobile device and the IVI system communicate with each other over one or more wireless or wired network interfaces. From a user experience perspective, Terminal Mode offers "the best of the both worlds" where the large variety of mobile device applications is complemented and enhanced by the vehicle IVI system's UI hardware thereby, providing a convenient and safe means for using these applications.

Figure 2. Terminal Mode inside a Vehicle

Figure 3. Smart Phone Music Player via Terminal Mode

The advantage of the Terminal Mode approach is that the user experience and interaction for the same application now becomes automatically tailored to the specific environment the user is residing in at any given time. When the user is outside the car, he/she directly interacts with the navigation software using the phone's input/output mechanisms. Whereas when the user is driving, he/she interacts with the same navigation software using the IVI display and driver-friendly controls and is able to get the same quality of user experience as that of in-car navigation software running natively on the IVI system without the accompanying cost and other disadvantages. Figure 3 shows an example of a smart phone-based music player running on an IVI system using Terminal Mode.

2.1 BENEFITS OF TERMINAL MODE

Terminal Mode provides a number of benefits to the consumers, automotive manufacturers and mobile device manufacturers.

2.1.1 Benefits for Consumers

They get access to all their mobile applications and data both locally and in the cloud through their vehicle's IVI system. They can use mobile applications is a safe and legal manner without having to directly interact with the small screens and controls of their mobile devices. Terminal Mode will work on different vehicles from a wide range of manufacturers and will even work in rental vehicles. Consumers will have access to all of their personal services, applications and content coupled with a consistently familiar user experience regardless of the vehicle they are using at any given time. The IVI system in the vehicle automatically gets updated every time the mobile device is updated and upgraded.

2.1.2 Benefits for Automotive Manufacturers

Terminal Mode provides added value to IVI systems by making them more upgradable and relevant in the long run. This provides a powerful incentive to potential customers to buy IVI units with their vehicle without worrying about them rapidly becoming out-of-date in terms of hardware and software capabilities. Terminal Mode components use hardware and software technologies which are accepted industry standards. This is important for automotive manufacturers, since they want to ensure that they do not have to perform frequent expensive redesigns of their IVI systems. Through Terminal Mode, IVI systems automatically get access to powerful mobile developer eco-systems with a large third-party developer pool. This enables IVI systems to always have access to the latest updated and popular applications without requiring the manufacturer to perform application development or upgrades. Automotive manufacturers can utilize any Terminal Mode equipped mobile device as a vehicle telemetry platform for gathering vehicle usage and wear/tear data for statistical and preventive maintenance purposes, without requiring the installation of separate communications modules.

2.1.3 Benefits for Mobile Device Manufacturers

Terminal Mode opens up an entirely new application space for mobile devices which has not yet been fully exploited. Mobile device manufacturers can provide automotive specific applications and services to the consumer thereby driving higher demand for both their devices and services. Mobile device manufacturers can provide App Store and other cloud resources as leased services to automotive manufacturers. They can also provide services which enable automotive manufacturers to gather/analyze vehicle data.

2.1.4 Benefits for Third-Party Developers

Terminal Mode opens up the automotive application domain as a new source of revenue for third party developers and delivers it as an extension of the pre-existing mobile development and deployment ecosystem. Mobile application developers are now not only able to target the automotive application space but also do not have to learn new development platforms or technologies in order to do so. Automotive developers can now leverage both mobile and cloud computing capabilities to incorporate seamless and high quality user experiences into their applications. Terminal Mode enables a "*Write Once, Deploy Everywhere*" approach. It empowers developers to write automotive applications which will work across multiple vehicle models and manufacturers out-of-the-box.

3. CONCLUSIONS AND FUTURE WORK

In this paper, we presented Terminal Mode, a technology which transforms mobile devices into automotive application platforms and seamlessly integrates them into in-vehicle infotainment systems. This paper only provides a comprehensive overview of the technology. As part of current and future work, the following aspects of Terminal Mode are being developed: Addition of video streaming mechanisms to the Remote UI components of Terminal Mode. Addition of discovery and delivery of vehicle based

services to the Terminal Mode standard including access to on-board diagnostic data and other vehicle sensor data through the IVI system. Currently this is done out-of-band through the standard OBD-II interface available on most vehicles.

REFERENCES

1. *Alpine A/V Head Units*. http://www.alpineusa.com/product/category/av-head-units-head-units.
2. *Audi MMI Technology*. http://microsites.audiusa.com/brandsite/us/tech/mmi.html.
3. Cooper, D., et al. 2008. *RFC 5280, Internet X.509 Public Key Infrastructure Certificate*. IETF.
4. *Ford SYNC*. http://www.fordvehicles.com/technology/sync.
5. Niedermaier, B., et al. 2009. *The New BMW iDrive - Applied Processes and Methods to Assure High Usability*. In Proceedings of the 2nd International Conference on Digital Human Modeling (San Diego, CA, 2009).
6. Richardson, T., et al. 1998. *Virtual Network Computing*. IEEE Internet Computing, 2(1):33–38.
7. Schulzrinne H., et al. 2003. *RFC 3550, RTP: A Transport Protocol for Real-Time Applications*. IETF.
8. *Terminal Mode Specifications v1.0* 2010. http://www.nokia.com/terminalmode.
9. *Trusted Computing Group*. http://www.trustedcomputinggroup.org.
10. *UPnP Device Architecture v1.1* 2008. http://www.upnp.org.