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Portable and Embedded Wireless Devices as Conduit for Telematics Applications

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ABSTRACT

As wireless devices and cellular networks continue to evolve, opportunities are created for enhancing the overall user experience with telematics related services. This paper discusses the pros and cons of portable phone systems and embedded phone systems as conduits for telematics applications. Methods to enhance embedded in-vehicle telematics systems to include operation with handheld wireless devices on both Wide Area Networks (WAN) and Wireless Local Area Networks (WLAN) will also be presented. Services will be discussed that allow vehicles and wireless devices to interact with each other and with remote servers. Implementation options will be explored along with an analysis of the key players in the telematics supply chain (i.e., OEMs, Suppliers, Carriers, Call Centers, Consumers) who ultimately benefit from each approach.

INTRODUCTION

Automotive telematics is the blending of wireless telecommunications, information technologies, and vehicle-based human-machine and machine-machine interfaces. Historically, automotive telematics functionality has consisted of safety and security applications such as air-bag deployment notification, remote engine diagnostics, roadside assistance, remote door lock/unlock and theft tracking. Other applications such as concierge services, hands-free cellular voice communications, navigation and traffic information have attempted to enrich the user's overall driving experience.

As the telematics market continues to grow, applications and services that seamlessly connect the automobile to the rest of the world will become increasingly important (Figure 1). Technological advancements and regulatory trends for in-vehicle cellular communications are helping to drive consumer interest in telematics products. Next to the workplace and home, consumers spend more time in their cars than anywhere else [1]. The challenge is to provide the right portfolio of applications and services that satisfy emerging regulatory trends, meet the needs

of the consumer and fulfill the business models of the key players in the telematics supply chain.

Telematics... *Seamlessly Connecting the Automobile to the Rest of Your World*

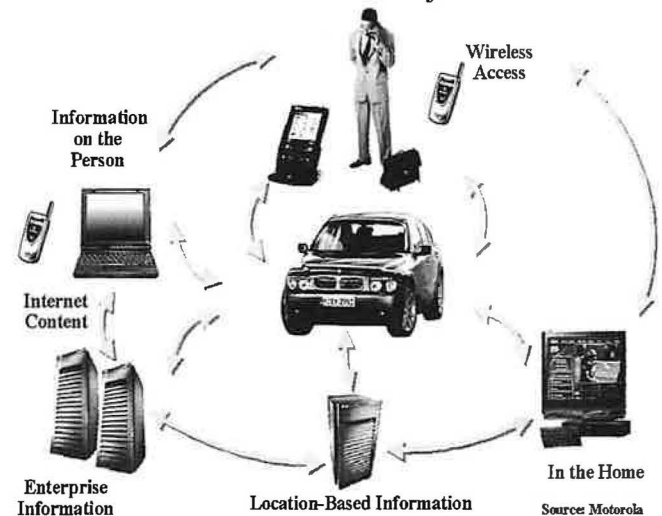


Figure 1: Seamless Telematics Connectivity

A recent Strategy Analytics survey (Figure 2) plotted key potential telematics applications and services in terms of value to the user versus potential frequency of use. This survey shows that Emergency Roadside Assistance (ERA), security, and cellular voice communications present the most significant opportunity for in-vehicle service providers because they are of highest value to users – across consumer segments [2]. Understanding these consumer interests and usage models is one key element in designing enhanced telematics systems.

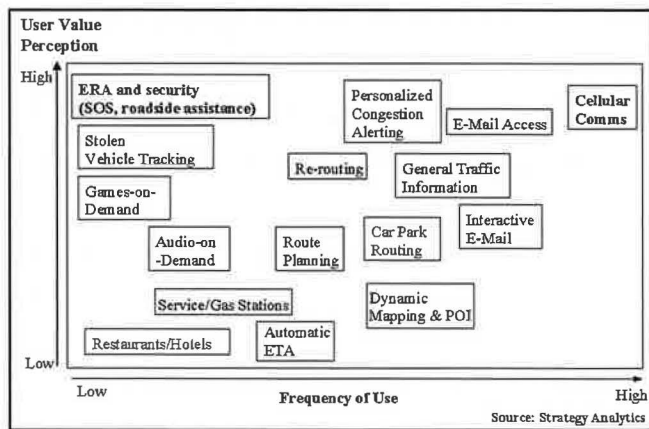


Figure 2: Strategy Analytics Consumer Survey

Wireless embedded phone systems, portable phone systems, and combined systems are the conduits for telematics applications and services. We will discuss in detail the advantages and disadvantages of these systems along with emerging technologies that will significantly influence the telematics industry. Overall, we believe there is no one single solution that satisfies the entire telematics market. Instead, a suite of products, services, and applications tailored for each automobile manufacturer and consumer segment will ultimately be the most beneficial solutions for the telematics market.

TRADITIONAL TELEMATICS ARCHITECTURES

Today's automotive telematics architectures are tailored for each automobile manufacturer. Figure 3 shows a combined embedded and portable phone system and the interaction with a service provider. In this design, an embedded transceiver is used to communicate wirelessly with the service center delivery gateway. This gateway provides both voice and data communications to the vehicle.

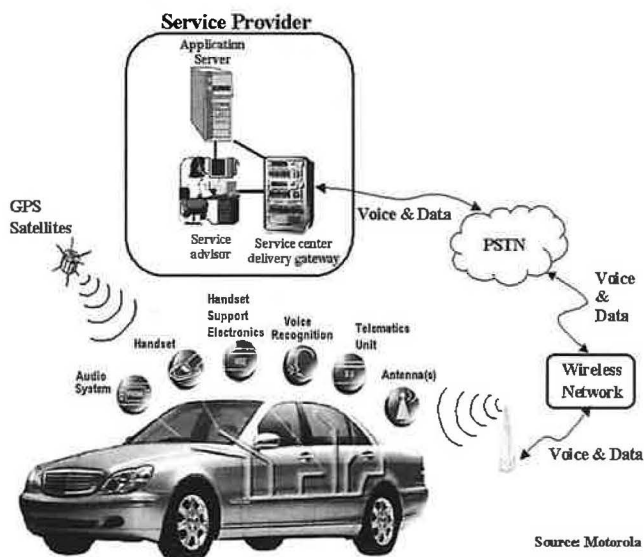


Figure 3: Telematics System

When the in-vehicle telematics system is activated, the Telematics Unit (TU) places a call to the service center where trained advisors respond with any number of services, from emergency assistance to providing concierge services. Advanced software allows the telematics unit to communicate with the on-board computer or engine control unit and provide enhanced services such as remote engine diagnostics, stolen-vehicle tracking and automatic airbag notification.

The telematics unit is the central component of the telematics system and is installed inside the vehicle. A typical system consists of a micro-controller, wireless cellular transceiver(s), Global Positioning System (GPS) receiver, vehicle bus interfaces, hands-free audio system, portable handset interface, crash sensory input and various discrete I/O.

The vehicle bus interfaces are automobile manufacturer specific and allow the in-vehicle telematics unit to communicate with other devices connected to these vehicle buses. Other devices routinely connected to the vehicle buses are head units, body electronic control modules, chassis electronics, and power train electronics. Discrete I/O and dedicated crash sensor inputs are routinely deployed for safety and security applications. Received phone audio is routed to the vehicle's sound system by a line level output. Optionally, on some vehicles a backup speaker is installed to provide audio in the event the vehicle's sound system becomes disabled. One or more microphones provide uplink audio.

In the U.S., the embedded transceiver is typically an automotive hardened device used for communicating with Wide Area Cellular Networks (e.g., AMPS). Communication means can be bi-directional for both voice and data applications. The embedded transceiver can be used for personal calling, remote vehicle applications (e.g., unlocking doors, sounding horn, flashing lights), and communications with remote service providers such as OnStar® and ATX®.

The GPS receiver provides location and time information to the vehicle for various applications such as vehicle location, vehicle tracking, time synchronization and future E911 Phase 2 positioning information. In some vehicles, dead reckoning sensors can be used in conjunction with the GPS receiver to provide positioning data when out of GPS coverage.

The portable interface is used to connect the user's portable phone to the vehicle for hands-free communications. This portable interface connection can be wired or wireless. With a wired connection, the vehicle is usually limited to one particular brand of handset. Once the system is active, the phone audio is routed through the vehicle's existing sound system, overriding the radio and initiating hands-free communication. With new Wireless Local Area Network (WLAN) technologies such as Bluetooth™ and 802.11, a new class of portable devices is emerging that allows

multiple brands of handsets and devices to easily communicate with a vehicle equipped with a complementary WLAN transceiver. High-end systems also provide connections for battery charging, an external cellular antenna and a compensator. A compensator is a device that "compensates" for in-vehicle cable loss in both the uplink and downlink direction.

TODAYS CONDUITS FOR TELEMATICS APPLICATIONS & SERVICES

The conduit for today's telematics applications and services is cellular (WAN) communications. Cellular provides broad geographic coverage needed for the four classes of applications and services shown in Table 1.

Table 1: Current Telematics Applications and Services

Safety & Security
Air bag deployment notification
Emergency services
Stolen-vehicle tracking
Remote door lock/unlock
Remote diagnostics
Roadside assistance
Sound Horn
Flash Lights
Hands-free personal calling (Voice Recognition)
Convenience
Concierge (reservations, convenience)
Information
PIM (appointments, calendar, address book,
Email, news, sports, stocks, weather, traffic)
Tourist & recreational information
Navigation
Directions (voice delivered)
Traffic reports (voice, text-to-voice)

Source: Motorola

Safety and security applications require voice and data communications. Voice is used to communicate verbally with the service advisor (Figure 3). Data is used to transfer information about vehicle location, identification, and diagnostics. Some applications such as air bag deployment notification and concierge services send a small amount of data to the application server, followed by a transition to a voice call. Theft tracking requires a periodic transmission of a small amount of data from the vehicle to the application server. Distributed Navigation relies on a small data transmission from the vehicle with a modest amount of returned data. Hands-free personal calling only requires the voice telephony capability of the cellular phone.

With all of these existing applications and services, the amount of data transferred is small and can be easily handled by the use of voice-band modems operating over AMPS Cellular Systems.

PROS AND CONS OF TODAY'S PORTABLE AND EMBEDDED PHONE SYSTEMS

In-vehicle telematics system configurations vary across automobile manufacturers. Typically, there are three main types of designs: Embedded Phone System; Portable Phone System, and; a combined Embedded and Portable Phone System.

Embedded Phone System

An embedded phone system is a requirement for OEMs heavily focused on safety and security applications and who offer services such as automatic air bag notification, theft tracking and vehicle alarm notification. A portable phone and associated interfaces is not included in this system. The advantage of this design is reduced cost (as compared to a combined embedded and portable phone system) while providing an automotive hardened design that can be used for safety and security applications. Personal hands-free calling using the embedded transceiver is also possible with this design. This type of system addresses the ERA and security segments as well as the cellular communications segments shown in Figure 2. OnStar equipped vehicles such as Acura, Audi, Buick, Cadillac, Chevrolet, GMC, Hummer, Pontiac, Saab and Saturn typically fall into this category.

One disadvantage of this design is the inability for a user to attach a portable phone to the system for hands-free operation and phone number management. Typically, users also own portable phones. This results in two dialable numbers for the consumer, one phone number for the vehicle, and one phone number for the portable phone. This can make it confusing and difficult for users to manage the two phone numbers.

One work-around is for users to set up call forwarding on the portable device to forward calls to the embedded phone. However, this may leave the user with multiple voicemail boxes to manage. Cellular network upgrades to centrally manage multiple phone numbers via a single voice mailbox would be beneficial for users.

The costs of embedded systems have also limited the deployment of telematics into the mass market. Adding embedded telematics technologies into vehicles requires additional vehicle wiring, antennas, telematics unit, and integration costs. However, over the next few years the authors anticipate embedded telematics equipment costs to decline, as designs are further integrated and standardized.

Finally, embedded systems have also been historically harder to "upgrade" to newer cellular technologies over time. Embedded systems today are semi-custom

designs highly integrated into the vehicles. To upgrade older cars to the latest technologies could require changes to the cellular antenna and telematics unit. In many cases, these upgrades would be cost prohibitive. Focusing on standardized vehicle wiring, connectors, mechanical packaging, multi-band antennas, and accessible locations to critical telematics components can enhance the upgradeability of future designs.

Portable Phone Systems

Today many people use portable phones in their vehicles. OEM portable phone systems focus on providing in-vehicle hands-free cellular communications. Recently, areas of the United States and other parts of the world have issued legislation which only allow portable cellular phones to be used with hands-free operation. OEMs can respond to these new legislative trends by providing wired or wireless hands-free solutions.

The advantage of portable-only phone systems is that they are low cost solutions for providing in-vehicle hands-free solutions. They also allow communications "mobility" where users can take the portable phone with them when they leave the vehicle. Newer in-vehicle technologies, such as Bluetooth, allow consumers to pick from a range of cellular products operating on numerous wireless carriers. It is these "universal" phone connections to the vehicle that consumers and OEMs prefer for maximum flexibility and upgradeability. For example, Chrysler recently announced a Bluetooth-enabled in-vehicle communications system with factory-installed availability in early 2003 [3].

The disadvantage with these portable phone systems is that they are a poor conduit for safety and security applications. Since no transceiver is embedded in the vehicle, services such as automatic air bag deployment notification would not work if the driver forgot his phone or failed to connect the phone into the vehicle.

Combined Embedded and Portable Phone Systems

Automotive telematics systems on some upscale vehicles contain both embedded and portable phone communications systems (e.g., Mercedes-Benz S-Class). The advantage is phone number portability and the ability to offer a wider range of services and applications. Safety and security applications can use the embedded transceiver, whereas the portable phone system allows the user to integrate the portable phone into the vehicle for hands-free personal calling. These systems also provide the groundwork for advanced applications that allow the user to link vehicle operation to and from their portable phone. The disadvantages with these combined systems are higher costs and increased system complexity. In addition, on some systems the user is faced with two service bills, one for the embedded phone system, and one for the portable phone system.

Table 2: Pro and con comparison of telematics capabilities for embedded, portable, and combined phone systems

Function	Embedded	Portable	Combined
SAFETY & SECURITY			
Air Bag deployment	+	-	+
Emergency Services (voice)			
Stolen Vehicle Tracking	+	-	+
Remote door lock/unlock	+	-	+
Remote diagnostics	+	-	+
Roadside assistance			
Sound Horn	+	-	+
Flash Lights	+	-	+
Handsfree Operation			
Automotive Grade	+	-	+
CONVENIENCE			
Communications Portability	-	+	+
Voice Recognition			
Concierge (voice access)			
Phone # management	-	+	+
Upgradeability	-	+	-
INFORMATION			
PIM			
Email, news, sports, stocks,			
Tourists & recreational info			
NAVIGATION			
Directions (voice delivered)			
Directions (data delivered)		-	
Traffic reports (voice, TTS)	+		+
COSTS			
Equipment	-	+	-

Key: "+" = Pro, "-" = Con, "" = Neutral Source: Motorola

Tiered Approach

As can be seen from Table 2, no single solution meets the needs of all of the telematics applications and services. Taking into account the pros and cons of these different systems, tiered solutions have been developed to address the different telematics market segments. For entry-level telematics systems emphasizing maximum communications portability, portable-based handsfree systems are an appropriate solution. Product groups emphasizing additional safety and security applications while providing handsfree personal calling can utilize an embedded telematics system. Finally, product groups emphasizing Safety & Security and communications portability can choose a combined telematics system.

EMERGING TECHNOLOGIES, TRENDS, AND REGULATORY INITIATIVES

The wireless industry is undergoing rapid changes that will strongly affect future embedded and portable phone systems. In particular, three areas are rapidly evolving that are important to the automotive telematics market: Wide Area Communications Systems, WLAN & PAN Communications Systems, and Regulatory Initiatives.

WIDE AREA COMMUNICATION SYSTEMS

The embedded transceiver in the vehicle provides voice and data communications between the in-vehicle telematics systems and the wide area cellular infrastructure. Today in the United States this in-vehicle wireless link is AMPS based at 800 MHz in order to maximize geographic coverage. As these cellular networks migrate to new digital standards (Figure 4), AMPS capacity will be reduced over a period of time to make way for additional capacity on the digital channels. In addition, new digital standards will offer enhanced services, capacity, data rates and cost efficiencies. This will cause a fundamental shift from embedded transceivers utilizing only AMPS to multi-mode transceivers (e.g., CDMA with AMPS or GSM with AMPS). AMPS functionality will be desired until digital coverage is comparable to today's analog coverage.

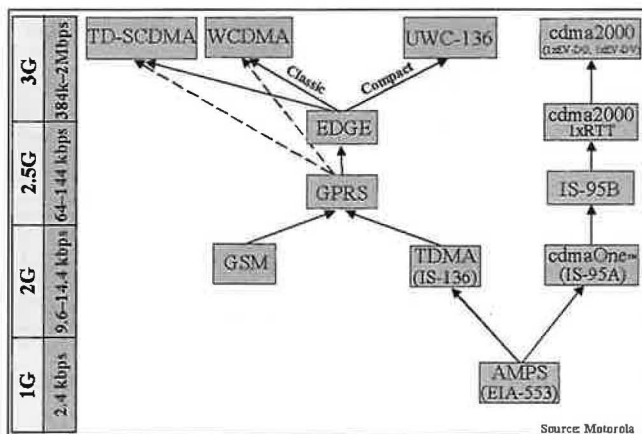


Figure 4: Wireless Standards Migration

This shift to digital technology will allow for new high-speed packet data transports into the vehicle. Packet data is of particular interest since it reduces the connection time compared to analog-based modems and allows the vehicle to be "always connected." Higher data rates will enable new applications and services such as server-based navigation, additional diagnostic capabilities, entertainment, email, web browsing and vehicle configuration and control. Digital technology will also provide a more cost-effective means to transfer large amounts of data for telematics applications.

Carriers also prefer packet data to circuit switched data since packet data makes better use of network capacity, distributes the load more efficiently and is more cost effective. Digital transceivers also use advanced technologies that lower the overall standby power consumption. This allows the possibility for embedded in-vehicle transceivers that are "always on." The disadvantages with these dual mode transceivers are that they are typically more expensive and complex compared to analog-only transceivers.

WLAN & PAN COMMUNICATION SYSTEMS

Over the last several years, industry initiatives have aimed at providing short-range wireless connectivity solutions for mobile devices. The goal was to wirelessly connect devices such as cellular phones, personal digital assistants (PDAs), laptop computers, printers and headsets to each other and to other access points. Emerging from these industry efforts have been two concepts: PAN and WLAN.

A wireless Personal Area Network (PAN) is a short-range communications scheme that utilizes technology that allows compatible devices to detect each other and communicate with each other without user intervention. Bluetooth is an example of a PAN technology. Originally designed as a replacement for connecting cables, Bluetooth enables devices such as PDAs, cellular phones, and laptops to communicate wirelessly over short distances. Bluetooth provides several classes of operation, the most common being Class 1 with a range of about 100 meters, and Class 3 with a range of 10 meters. Bluetooth devices operate in the 2.4 GHz ISM band, allowing license-free operation [4]. Bluetooth is also considered a WLAN for some applications.

A Wireless Local Area Network (WLAN) is another short-range communication technology. WLAN devices are emerging as a substitute or extension of existing wired Local Area Networks (LAN). A recent trend in data communications has been the shift from wired solutions such as 10BaseT and 100BaseT to wireless solutions such as 802.11b (also known as Wi-Fi). 802.11b provides up to 11 Mbps data rate to fixed devices with a range of up to 100 meters. 802.11b devices also operate in the 2.4 GHz ISM band. Another technology beginning to appear is 802.11a, which provides up to 54 Mbps within a typically 50-meter distance [5].

These wireless networks provide a new class of alternate conduits into the vehicle. With their higher data rates, they are likely to be utilized for transferring much higher volumes of data than is considered for today's telematics systems. These higher data rates create the opportunity for new applications and services.

REGULATORY INITIATIVES

Two trends in the United States will have a significant impact on the telematics marketplace in the next few years. These trends are legislation to limit the use of wireless phones in motor vehicles while driving and the US E911 regulations.

Hands-free Legislation

There is growing legislation in the United States and other parts of the world to limit the use of cellular phones while operating a motor vehicle. A NHTSA survey completed in January 2001 found that 54 percent of motor vehicle drivers in the United States usually have a cell phone in their vehicles or carry cell phones when

they drive. Almost 80 percent of these drivers leave their cell phone turned on while driving, and 73 percent report having talked on the phones while driving [6].

This legislation will be a key driver in creating a wide range of in-vehicle "hands-free" telematics systems. OEMs recognizing these trends continue to invest in telematics and new technologies that address consumer safety.

US E911 Regulations

In 1996, the FCC adopted new E911 rules as an initiative to improve the reliability of wireless 911 services and enhance features generally available for wire-line calls such as location or call back number. The E911 initiative was broken into two phases. Phase 1 requires that a dialable number accompany each 911 call and that cell site location (which gives a rough indication of caller's location) be transmitted to the Public Safety Access Points (PSAP). Phase 2 adds increased accuracy requirements for caller location (called Automatic Location Identification or ALI) [7]. It is this E911 Phase 2 mandate that has the potential to significantly impact the telematics industry.

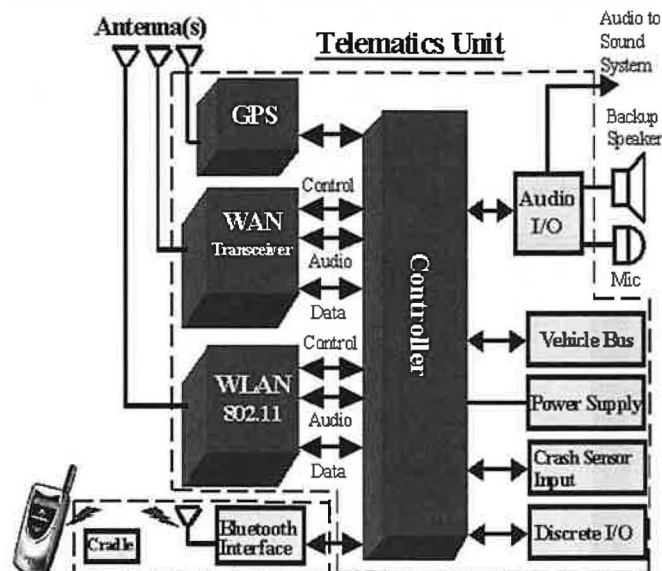
Over the next few years, the E911 Phase 2 legislation will be driving location-enabling technologies into portable phones. This will help enable new person-centric location based applications and services for cellular phones that can complement automotive-based telematics. Today's in-vehicle applications such as safety and security, navigation and concierge services could be extended to portable phones. Thus, when a person leaves his vehicle the same type of in-vehicle services provided by telematics services providers could be extended to portable devices. This concept helps to create a seamless user experience for users to enjoy telematics services both within and outside of the vehicle. The marketing challenge is how to best blend these in-vehicle telematics features with "telematics" like applications running on wireless portable devices.

Similarly, hands-free and E911-like regulation trends are likely to be seen in Europe and other countries in the next few years. Together these new legislative and regulatory initiatives will lead to in-vehicle telematics solutions and new telematics applications on cellular phones.

ENHANCED IN-VEHICLE TELEMATICS CONDUITS

With these new emerging technologies and trends, opportunities are created for enhancing the conduits into the vehicles. The existing telematics applications were built on a foundation of a cellular phone providing a voice call, with the inclusion of transferring a modest amount of data. As described previously, the data consisted mainly of vehicle location, identity, and status information.

Today's embedded telematics systems can be enhanced to include WLAN communications. Figure 5 shows an enhancement to today's in-vehicle telematics unit. In this implementation, a Wireless Local Area Network (WLAN), such as 802.11b, is added to the telematics unit. The WLAN circuitry can be either embedded or plugged into the telematics unit via a standard form factor such as a PC card. An antenna is then routed from the WLAN to a suitable location in the vehicle. A Bluetooth node can also be used to wirelessly connect a portable cellular device to the vehicle for hands-free communications.



Source: Motorola

Figure 5: WLAN Telematics Enhancements

With the advent of higher data rates available through 2.5G and 3G cellular systems and WLAN connectivity to the vehicle, it is expected that advanced applications for telematics will be primarily concerned with transferring data to and from the vehicle. As shown in Figure 4, 2.5G systems will provide mobile data rates up to 64kbps, with 3G increasing the data rates up to 384kbps. General Packet Radio Service (GPRS) is a 2.5G system built on GSM cellular technology. These systems are delivering data today at a price of 0.6¢ to 2¢ per kbyte [8].

The types of telematics applications and services that can be offered are dependent on the in-vehicle components and the type of on-board communications technology (e.g., WAN or WLAN). The WAN communications link is used for applications and services that require extended geographic coverage. The WLAN link can be Bluetooth, 802.11a/b, or DSRC and provides a short range for applications and services that require high-speed connectivity. It is important to note that for some applications to work properly the on-board WAN or WLAN must be "on" continuously to accept incoming commands or requests. This imposes a maximum average standby current drain requirement that is vehicle and manufacturer dependent.

Recently, Starbucks™ announced availability of 802.11b at some of their establishments for customers who

choose to be online while enjoying their morning cup of coffee. The plan included expansion to include 70 percent of Starbucks' 4000 stores located in North America [9]. Airlines have started adding 802.11b coverage to their clubs and gate areas. Companies such as Boingo, Wayport, and others plan to provide areas of Wireless LAN coverage, referred to as "hot spots." For example, Boingo currently provides service in over 500 hot spot locations in airports, hotels and other public locations [10]. Hot spots provide wireless Internet access for users' devices, for example, allowing a laptop to connect back to a corporate mail server to access email when away from the office. Starbucks rate plans ranged from \$0.07 to \$0.30 per minute of connect time depending on the monthly rate plan [9]. Boingo provides access plans ranging from \$2.50 to \$7.95 per day with no limit on the amount of data that is transferred [10].

Similarly, it is envisioned that hot spots could provide Internet access for telematics units. Cahners In-Stat Group estimates that wireless Web access will soon be ubiquitous [12]. For example, while parked outside her favorite lunch establishment, a user's telematics unit could download the morning stock reports, complete with associated bulletins and reports. This information could then be viewed while the vehicle is stationary or read to the driver by a Text-to-Speech application.

CHOOSING A TRANSPORT

In choosing the transport that is best suited for a given transfer, one must first define 'best.' A number of factors must be considered. Here is an example listing:

1. Cost sensitivity of transfer
2. Real-time, or timeliness of the information
3. Size of the data to be transferred
4. Time to transfer the data
5. Vehicle speed at time of transfer
6. Geographic coverage requirements

For example, consider downloading the morning's email. Assuming for the moment the user has 10 emails, with the typical one page email with no attachments consisting of two kbytes of data. This is about 20 kbytes of data. Transferring this over an AMPS channel using a Bell 212A voice-band modem operating at 1200 bps would take approximately 180 seconds not including messaging overhead. With overhead, this is likely four minutes or more. At a charge of \$0.28 per minute, this costs the user approximately \$1.12 [13].

Having the same messages delivered via GPRS at a cost of 0.6¢ per kbyte costs the user \$0.12, a mere fraction of the cost of the same transfer using today's system.

Another example is the transfer of diagnostic information from the vehicle to the instrumentation in the service bay at the dealership. Here a WLAN connection is the logical choice, as the target for the transfer is located near the vehicle at the time that the data transfer is required.

Onboard electronics modules could receive new software delivered through the WLAN with the Telematics unit acting as a gateway between the WLAN and the automobile buses.

A user's home network equipped with WLAN would permit "free access" to the user's home network and the Internet while the car is parked at home. One such example is to communicate with the user's in-home network while the car is parked in the garage. MP3 music and even video can be downloaded to the vehicle.

Another example would be to download a video while parked at Blockbuster™. If Blockbuster provided WLAN connectivity, a video could be downloaded to the vehicle while the user is browsing inside.

Rental car return will be made much quicker and easier when the rental car is equipped with a telematics unit and WLAN connectivity. While the user parks the car, the rental agency check-in computer communicates with the on-board telematics unit, retrieving the vehicle identification information, mileage, fuel usage, etc., and prints the receipt while the driver unloads his luggage from the vehicle.

Table 3 lists some of the anticipated Telematics applications and the authors' suggestions as to choice of transport for the particular application.

Table 3: Comparison of wireless transports for telematics services and applications

	WAN	WLAN
Safety & Security		
Air bag deployment notification	✓	
Emergency services	✓	
Stolen-vehicle tracking	✓	
Remote door/unlock	✓	✓
Remote diagnostics	✓	
Roadside assistance	✓	
Sound Horn	✓	✓
Flash Lights	✓	✓
Vehicle alarm notification	✓	
Vehicle location change alert	✓	
Vehicle start notification	✓	
Hands-free personal calling (Voice Recognition)	✓	✓
Vehicle "Black Box" data	✓	✓
Convenience		
Concierge (reservations, convenience)	✓	
Vehicle Start	✓	✓
Lock/unlock doors (proximity detection)		✓
Heater/defroster/air on/off	✓	✓
Personalization (radio, seat, mirrors)		✓
Electronic toll collection		✓
Electronic parking collection		✓
Electronic fuel payments		✓
Electronic food payments (e.g., drive thru)		✓
Electronic car wash payments		✓
Information (Upload & Download)		
PIM (appointments, calendar, address book)	✓	✓
Email, news, sports, stocks, weather, traffic	✓	✓
Tourist & recreational information	✓	✓
Vehicle upgrades (reflashing modules software)	✓	✓
Vehicle status (mileage, fuel remaining, emissions)	✓	✓
Navigation		
Directions (voice delivered)	✓	
Directions (maps, turn-by-turn) data download	✓	✓
Server based navigation	✓	
Traffic reports (voice, text-to-voice)	✓	
Dynamic Road Guidance (with real-time traffic info)	✓	
Location-based advertising	✓	✓
Vehicle-to-vehicle location sharing	✓	
Entertainment		
MP3 music downloads (pay-per-use)	✓	✓

Source: Motorola

NEW TELEMATICS APPLICATIONS & SERVICES

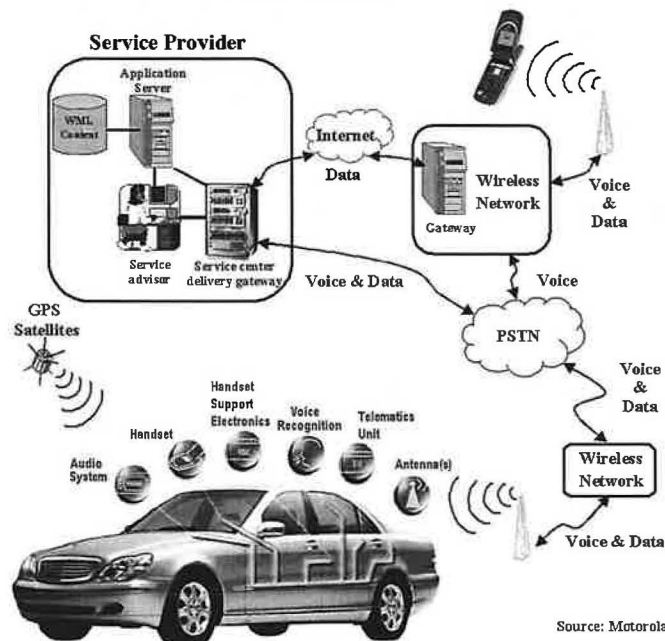
With these new enhanced telematics conduits, opportunities are created for new telematics applications and services. Research has shown that consumers are very interested in safety and security applications along with safe, hands-free cellular communications [2].

As one example, a new class of applications and services can be made available to automotive telematics users that extend the traditional in-vehicle telematics functionality to include out-of-vehicle operation with WAN and WLAN communications devices (e.g., cellular phones, PDAs, homes, kiosks, gas stations, car dealerships, etc.). The idea is to use the embedded in-vehicle telematics system and expand its functionality to allow remote operation and communications with

complementary devices (e.g., cellular phones and PDAs).

TELEMATICS SPECIFIC PORTABLE DEVICES

Figure 6 shows an enhancement to the telematics system to include voice and data interactions with external wireless portable devices.



Source: Motorola

Figure 6: Enhanced Telematics System

In this implementation, a Wireless Application Protocol (WAP) interface is provided from the wireless portable device to the service provider over a wide area network. WAP is an application that runs on wireless portable products. It was developed to allow Internet access from portable products with limited resources like small displays, numeric-only keypads and low data bandwidth. WAP also supports various levels of security using Wireless Transport Layer Security (WTLS) protocols.

A key advantage of using WAP is that it allows manufacturers, network operators, service centers and content providers to offer new services on many compatible products (e.g., cellular handsets and wireless PDAs). Other key advantages for automotive telematics are upgradeability and time to market. Since portable devices only need to support the WAP application, content and services can be easily upgraded over time on the hosting applications server. WAP can also be custom tailored to individual groups of users by specifying unique IP gateway addresses. This would allow an OEM or carrier to host unique applications and services.

Figure 7 shows a wireless mobile handset using WAP for accessing automotive telematics functionality. In this implementation, the service provider is hosting an application that allows the user to interface with the service provider for both voice and data communications.



Source: Motorola

Figure 7: Telematics Specific Handset

The user can contact the service provider via a voice call by selecting the first menu option on the handset as shown in Figure 7. The number to be dialed is specified by the application server at the service provider. Thus, the user does not have to remember the number to contact the service provider. This methodology also allows the service provider to easily change the phone number.

This service can be used as a Customer Relationship Management (CRM) enhancement tool. The menu system could easily be expanded to include customer assistance call menus to other telematics players such as an OEM, wireless carrier, or other telematics service providers in the telematics supply chain. Other voice call menu possibilities could be made available for concierge services, roadside assistance, medical assistance and stolen vehicle reporting.

Figure 7 lists other data applications that can be provided to the user such as door unlock, sounding the horn, vehicle alarm notification, and web browsing. Other examples include the ability to lock the vehicles doors, flash the lights, turn on the heated seats, start the car (regulations permitting), configure user settings (e.g., seat position, radio channel settings, mirror position, etc.), transfer data, transfer vehicle information (e.g., mileage, location, error codes, fuel levels, tire pressure, etc.), traffic information and server based navigation.

The conduits or interfaces to the vehicles for these features can be over a WAN or WLAN. On vehicles

equipped with both WAN and WLAN technologies, portable devices with complementary technology could be configured to choose how to interact with the vehicle in the most efficient manner. For example, if a person is trying to find her car in a parking lot the phone could first try to sound the horn on the Bluetooth link. If the car is out of range, then the phone could be configured to automatically switch to the cellular (WAN) link and sound the horn.

TELEMATICS SUPPLY CHAIN ANALYSIS

Traditionally, consumer demand for automotive telematics equipment and services has been based on in-vehicle applications. The basic idea is that drivers spend long hours in their vehicles so why not capitalize on this fact with a wide range of applications and services. Expanding the revenue opportunities to now include out-of-vehicle telematics operations with portable and WLAN communications devices is a logical migration for the telematics industry.

Figure 8 shows a Telematics Supply Chain as it relates to the inclusion of portable and embedded wireless communications devices and transports. One of the most important factors to the success of these applications and services is how the overall supply chain decides to work together to provide real consumer value. A telematics specific handset, as an example, could be a crossover-product that provides benefit to both the automotive and carrier markets. If, however, there are battles over customer ownership and/or business models, then this concept could falter. These telematics supply chain opportunities will now be discussed in detail.

		Content Providers	Service Providers	Wireless Carriers	Manufacturers	OEMs	
Services	- Airtime	-	✓	✓	-	-	End Users
	- Billing	-	✓	✓	-	-	
	- Activations	-	✓	✓	-	-	
	- Concierge	-	✓	○	-	-	
	- Content	✓	✓	✓	-	-	
	- Applications	✓	✓	✓	○	-	
	- Diagnostics	✓	○	○	-	✓	
Equipment (Hardware)	- Handsets	-	-	✓	✓	✓	End Users
	- Embedded	-	-	○	✓	✓	
	- Software	○	○	○	✓	-	
Wireless Transports	- Client	○	✓	○	✓	-	End Users
	- Server	✓	✓	○	✓	-	
	- WAN	✓	✓	✓	✓	○	
Wireless Transports	- WLAN	✓	✓	○	✓	○	End Users
	- Bluetooth™	-	-	✓	✓	✓	

Key: ✓ = Strategic Investment
○ = Opportunity
- = Minimal Investment

Source: Motorola

Figure 8: Telematics Supply Chain

Content Providers

Content providers are the natural owners of applications such as traffic reports, navigation, Points of Interest (POI), weather, news and stock quotes to name a few. Their revenue is derived from supplying content to service providers, wireless carriers and to the end users.

Today, telematics content providers deliver information to the vehicle via the embedded in-vehicle communications node. Expanding the vehicle's communications devices to include WLAN connectivity is a growth opportunity for content providers. This additional conduit provides another means for transferring POI information, advertisements, location-based information, m-commerce applications such as wireless gas payment, MP3 downloads, and toll booth applications. Delivery of telematics type content to portable wireless devices is another opportunity for content providers to expand their market to include wireless carriers.

Telematics Service Providers

To date, service providers have primarily focused on applications and services that use the vehicle's embedded WAN communications technology. These applications have primarily focused on convenience features, information, safety, and security. As an example, ATX Technologies, Inc. recently announced the "Dealer Connect" feature. This service provides drivers with a simple method to connect to their automobile dealership using the embedded WAN communications module for service or information pertaining to their telematics-enabled vehicle [14]. Other service providers have focused on reselling WAN airtime using the embedded in-vehicle communications system. Thus, service providers place a high value on the embedded communications system for both voice and data applications.

The authors believe that a logical step in the telematics evolution is to extend service and subscriptions to include telematics specific portable devices. This could be accomplished in one of two ways. First, to cover incremental costs associated with this service an additional nominal fee could be charged. Alternatively, service providers could simply add this capability as part of their standard product offering in an effort to increase sales and raise renewal rates. Increased operational efficiencies associated with the service (e.g., door unlock) may offset the increased costs.

As an example, OnStar has had more than 10 million interactions with subscribers in the United States and provinces of Canada. On a monthly basis, OnStar receives over 15,000 door unlock requests [15]. To handle these requests, trained operators are on call 24 hours a day, seven days a week. As telematics systems gain popularity, the number of user interactions and door unlock request will continue to rise. Reducing this "human" intervention and the overhead associated with delivering some telematics services is a key area for consideration.

Wireless Carriers

Wireless carriers can be involved in many different areas of the telematics market. Alliances with OEMs help drive the embedded in-vehicle communications technology

(i.e., AMPS, GSM, or CDMA). Carriers recognize that some of their best customers frequently use cellular communications while operating a vehicle. Thus, controlling the in-vehicle embedded communications technology helps solidify wireless in-vehicle communications on their network.

Wireless carriers can also derive airtime revenue from portable phone systems operating in the vehicle. A Strategy Analytics survey found that "US cellular users who spend more than 90 minutes per day in the car/vehicle have an average revenue per user (ARPU) spending level of US \$69 per month compared with an average monthly ARPU level of \$45 across all US cellular users surveyed. Similarly, heavy commuters in the US have an average minutes of use (MOU) level of 97 minutes per week compared with a MOU of 60 minutes per week across all US cellular users surveyed" [16]. Thus, carriers want to attract and retain users who frequently use cellular service while operating a vehicle since these are high ARPU customers.

However, with portable phone systems the carrier does not have as much influence or control over which carrier's phone the user brings into the vehicle. Thus, the benefit to the carrier for portable-only phone system is not as high as controlling the embedded in-vehicle communications technology.

New applications and services on wireless WAN portable devices can also provide additional data revenue opportunities for the wireless carriers. As an example, in order for subscribers to take advantage of some telematics data applications they must subscribe to the Internet services at an additional fee. Today this fee ranges from \$2.99 per month for basic access up to \$12.49 per month for 2 Megabytes of data [8]. At the end of 2001, OnStar was approaching two million subscribers [15]. As an example, if 25% of two million subscribers signed up for this enhanced data service it could generate upwards of a million dollars per month in additional revenue for the carrier.

Opportunities are also possible for wireless carriers with telematics applications and services that use WLAN transports. However, the business cases and target applications for telematics users are still being developed. One of the best opportunities appears to be with those carriers who could extend beyond wireless networks and target residential Internet services. Consumers with WLAN internet access points in their homes could transfer high bandwidth data to their vehicles without incurring airtime charges on the WAN networks. A carrier who could provide both WAN and WLAN access point into the vehicle could then optimize the content delivery to the vehicle in the most efficient and timely manner.

Telematics Equipment Manufacturers

The revenue opportunity for manufacturers primarily lies in embedded and portable equipment sales and software

sales. Manufacturers can benefit from both WAN and WLAN applications and services. Thus, telematics manufacturers are very interested in making the telematics industry as a whole successful in order to increase volumes. If sufficient volumes cannot be achieved, manufacturers will find it increasingly difficult to recover development costs.

Manufacturers can also become involved with applications or enabling applications to further increase equipment sales. Enabling telematics applications on portable devices creates the opportunity for expanding the size of the telematics product market. In the U.S., total light vehicle sales are expected to be roughly 15.9 - 16.5 million units in 2002 [17], whereas, U.S. & Canada cellular handset sales for 2002 are estimated at 74 million units [18]. Thus, extending telematics functionality into portable devices creates a much larger opportunity for additional equipment sales.

Automotive OEMs

OEMs will continue to look for ways to differentiate themselves in the market place. Telematics products can be seen as one approach for product differentiation. How the OEMs make money in telematics is still an ongoing debate. The authors believe that OEMs will continue to supply and generate revenue from the in-vehicle enablers for telematics. This includes the embedded communications modules, the hands-free cellular phone interface and telematics specific handset sales. Regulatory trends should drive consumer demand for superior in-vehicle hands-free systems. The OEMs will also continue to focus on key telematics services like safety and security.

THE BUSINESS CASE FOR ENHANCED TELEMATICS APPLICATIONS AND SERVICES USING PORTABLE AND EMBEDDED WIRELESS DEVICES

The potential size of the telematics marketplace is generally agreed to be very large, both for devices and the associated services. Historically, safety and security type applications have dominated the product offerings. Now, as technology advances, it is becoming easier to offer applications and services that extend telematics functionality to seamlessly connect the automobile with the rest of the world. Here are four reasons why telematics players should consider adding enhanced portable and embedded wireless applications and services to their business plans:

1. REGULATIONS WILL HELP DRIVE THE MARKET

Safety, security, and cellular communications are at the center of consumer demand. As regulations continue to grow that limit in-vehicle cell phone use, drivers will be forced to give up holding their cellular phone in a vehicle and must find alternative solutions that allow hands-free communications. This will create the market opportunity for embedded and portable phone systems in the

vehicles. OEMs, service providers and equipment manufacturers can capitalize on these trends with a range of products and services that fulfill consumer demand. Phone systems that allow hands-free operation will be essential for wireless carrier's business plans in order to retain revenue from in-vehicle phone usage.

2. TELEMATICS PLAYERS ARE LOOKING FOR WAYS TO DIFFERENTIATE THEMSELVES

Telematics equipment manufacturers, automotive OEMs, carriers, service providers, and content providers are looking for new applications and services to differentiate themselves from their competitors. Extending telematics functionality to include portable wireless devices and other communications nodes are key differentiators in the market place.

Handset manufacturers are looking at new ways to entice users into replacing their existing handsets as wireless subscriber penetration rates reach saturation. Offering handsets with telematics functionality is an opportunity for increasing handset sales.

OEMs can extend the in-vehicle communications technologies to allow increased functionality and consumer value with applications that improve the vehicle ownership experience. Enabling the vehicle for m-commerce, remote door lock/unlock, heater on/off, diagnostics, horn sounding and vehicle alarm notification are examples of applications that OEMs can use to differentiate themselves in the marketplace. Carriers, service providers and content providers can extend the telematics environment to portable devices and remote nodes as mechanisms to gain additional subscribers and reduce churn.

3. OPERATIONAL EFFICIENCIES

Service providers can achieve operational efficiencies with telematics applications and service on wireless portable devices. By leveraging the mobility and extensibility of telematics specific wireless devices, many lower-tier telematics services can be delivered without having to involve a human operator. As an example, applications and services that allow a user to remotely unlock their vehicle doors, without human interaction, in a safe and secure manner offer service providers the opportunity to increase operational efficiencies and reduce overall costs.

OEMs can also benefit from increased efficiencies with applications and services that utilize the in-vehicle communications equipment. WAN and WLAN technologies can be used to enhance the car dealership service experience with expedited documentation and information transfers (e.g., mileage, vehicle VIN, tire pressure, fluid levels, oil change indication, error codes).

Consumers using the in-vehicle WAN or WLAN can benefit from these same applications and services to electronically keep track of vehicle maintenance records,

mileage, fluid levels, tire pressure, and overall vehicle health through their personal vehicle website.

4. APPLICATIONS & SERVICES WILL DRIVE CONSUMER DEMAND

There is tremendous growth potential for new telematics applications and services. The embedded in-vehicle WAN communications technologies are migrating to digital while still including analog AMPS service to retain maximum geographic coverage. Packet data will be available on these new digital communications platforms to allow the convenience of being "always on." WLAN technology is becoming more widespread and migrating to cell phones and other products.

Recent consumer surveys suggest that telematics end customers will not be motivated to pay high enough prices to cover the costs of providing today's level of service [19]. For automotive telematics to be successful, new compelling applications and services are needed that will drive consumer demand. The authors believe the best short-term opportunity lies in applications and services that provide users with seamless mobility and tie together the core embedded safety and security product with cellular phone functionality at affordable prices. In a few years as technology progresses, there will be tremendous opportunities to extend telematics applications and services to WLAN systems and link the vehicle to other services such as fleet applications, m-commerce, automated toll booths and dealership service aids.

CONCLUSION

Wireless embedded phone systems, portable phone systems, and combined systems are the conduits for telematics applications and services. No single solution satisfies the entire telematics market. Instead, a suite of products, services, and applications tailored for each automobile manufacturer and consumer segment will ultimately be the most beneficial solutions for the telematics market.

For entry-level telematics systems emphasizing maximum communications portability, portable-based handsfree systems are an appropriate solution. Product groups emphasizing additional safety and security applications while providing handsfree personal calling can utilize an embedded telematics system. Product groups emphasizing Safety & Security and communications portability can choose a combined telematics system.

Opportunities exist for enhanced applications and services on both WAN and WLAN communications transports. Consumers will continue to desire cost competitive products that provide safety and security, as well as products that provide hands-free cellular phone use. Extending the telematics envelope to include out-of-vehicle telematics operations with portable and WLAN communications devices will help drive consumer

demand and create efficiencies in the telematics industry that will ultimately benefit the entire telematics supply chain.

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DEFINITIONS, ACRONYMS, ABBREVIATIONS

ALI: Automatic Location Identification

AMPS: Advanced Mobile Phone System

ARPU: Average Revenue per User

CDMA: Code Division Multiple Access

CRM: Customer Relationship Management

DSRC: Dedicated Short-Range Communications

ERA: Emergency Roadside Assistance

FCC: Federal Communications Commission

GPRS: General Packet Radio Service

GPS: Global Positioning System

GSM: Global System for Mobile communications

ISM: Industrial, Scientific, and Medical (Band)

IP: Internet Protocol

LAN: Local Area Network

MOU: Minutes of Use

OEM: Original Equipment Manufacturer

PAN: Personal Area Network

PC Card: Previously referred to as PCMCIA Card

PDA: Personal Digital Assistant

PIM: Personal Information Manager

POI: Point of Interest

PSAP: Public Safety Access Points

PSTN: Public Switched Telephone Network

SIM: Subscriber Identity Module

TTS: Text-To-Speech

TU: Telematics Unit

WAN: Wide Area Network – used in the paper mainly to refer to WAN utilizing cellular telephony

WAP: Wireless Access Protocol

WLAN: Wireless Local Area Network (e.g., Bluetooth™ or 802.11).

WTLS: Wireless Transport Layer Security

TRADEMARKS

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