Michael L. Sena Consulting AB

Special Report

The Evolving Telematics Industry

Author:	Michael L. Sena
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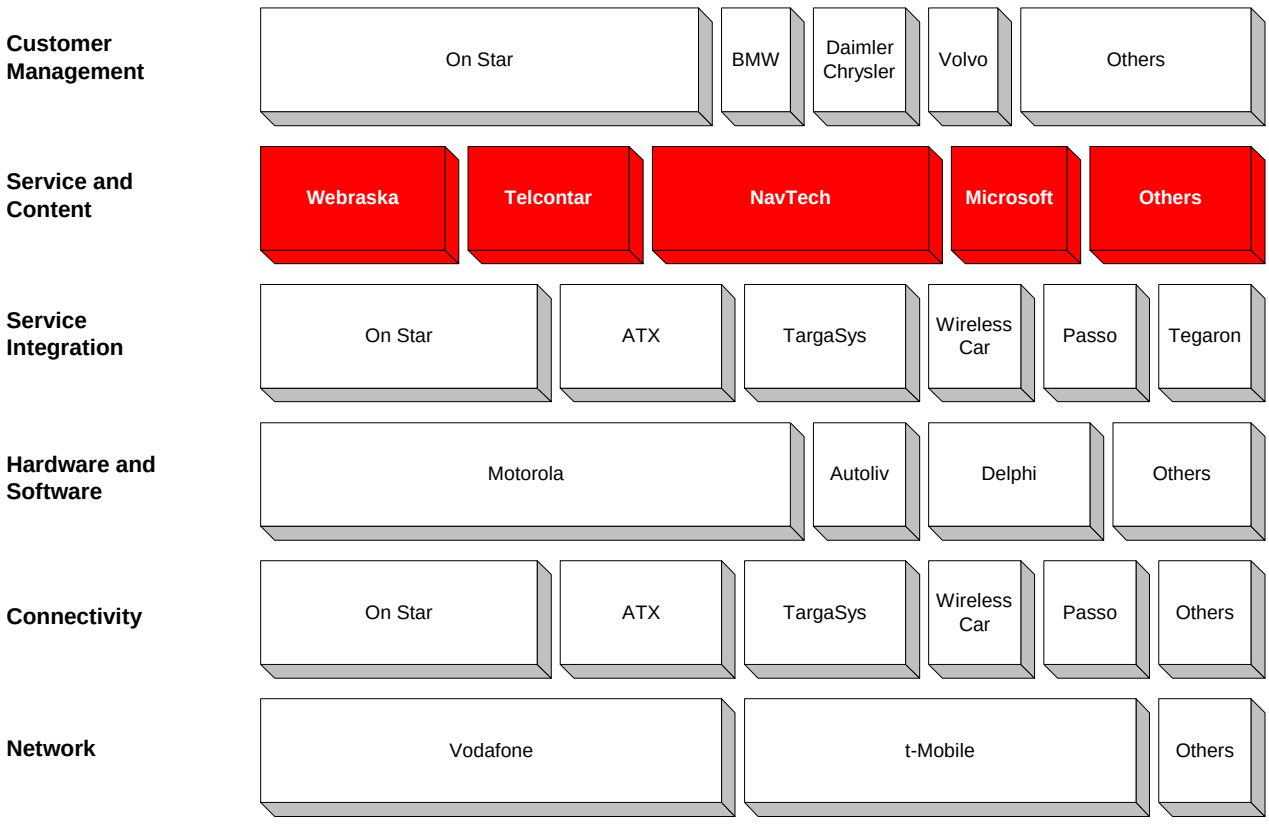
In-vehicle Location-based Services - The Vertical Industry Structure

In-vehicle Location-based Services - The Horizontal Industry Structure



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The Evolving Telematics Industry

Push-the-button safety, security and convenience services represent the early, first stage of telematics. As a primary customer offering, and a supplementary cash generator, they have not yet proven to be successful for any of the companies involved in their delivery: OEMs and device manufacturers; network operators; service and content providers; or telematics service providers, like WirelessCar, who deliver connectivity, customer management and service integration.

Compared to navigation systems, which have begun to deliver real profits to vehicle OEMs, system developers and map data suppliers, telematics systems and services are thus far a disappointment. This is because the telematics offering is not perceived by prospective customers as more compelling than other options, such as navigation systems, and the value proposition (i.e. what telematics systems are replacing with a better alternative) is not being clearly explained in the OEMs' marketing campaigns or at the point of sale. This was also the case when navigation systems were introduced. Dealers made higher margins on sun roofs and other options, and they knew they would have fewer complaints from customers after the sale. It was only when customers began to demand navigation systems—when they understood the value proposition better than the dealers—when the systems became more dependable and the databases covered larger areas, that the dealers began to promote them. Neither the dealers nor the customers—nor the OEMs for that matter—are currently able to clearly state the value proposition for telematics, and why the customers should pay for the systems or the fees for their use.

The Start of Telematics

Part of the reason for this is the way that telematics systems were initially conceived and then promoted inside the car companies. Telematics systems were mostly engineering-driven, not market driven. As opposed to navigation systems, in which marketing and product development departments played key roles in their conception and introduction in the mid-1980's, telematics boxes with positioning and communications technology were seen by some engineering departments as security system enhancements. Instead of a simple car alarm, telematics systems would be able to relay the exact position of the vehicle at the time of a break-in, and security services would be able to follow the car if it was stolen. This was the case with Volvo Cars, where the Security Systems department financed the initial efforts to build prototypes and develop the service provision network.

Ford was more concerned with sending out a distress signal from the vehicle in case of an accident or a car jacking. Other OEMs, like BMW, viewed the addition of a telecommunications device to their navigation system, which already had positioning capabilities, as a logical extension and the means to add new customer convenience services. A third set of initiatives, like those inside General Motors, started in the US as exercises in providing integrated, hands-free telephones, either to prepare for possible legislation restricting mobile phone use in vehicles, or to capture revenue as a virtual private network operator. The idea of requiring a separate business unit to develop and manage services was an afterthought in most cases.

When it became clear that telematics would require coordination of service and content providers along with the network operators, the task was given to the marketing groups, in particular the customer offer organisations who were responsible for warranty breakdown assistance. At most OEMs these groups took over from the engineering departments the job of bringing telematics systems to market. This was seen as a natural progression at the time since it was these departments that had budgets for services, such as warranty breakdown assistance. Companies like Volvo, Jaguar, Ford (Europe and US), Opel/Vauxhall and others who outsourced their warranty breakdown assistance attempted to work with the same partners (e.g. AA, ADAC, Mondial) to provide the necessary services. Those companies that had their own warranty breakdown services, like DaimlerChrysler in Europe and BMW in Germany, supported the creation of specialised telematics service providers and call centers, like Tegaron and Passo.

The problem with this approach has been the relationship between cost and perceived reward by the car companies. Warranty breakdown assistance charges are not directly included in the cost of the vehicle. They are a marketing cost. The services do not require any additional equipment in the vehicle or special handling by the dealer. Cooperating in the establishment of a telematics service network is time- and resource-intensive, and the marketing departments do not have the discretionary budgets to finance these investments, nor the organisational authority to direct the engineering departments to implement them. The money rests with the car platform teams, and it is they who have either financed the telematics developments for their cars, or decided, at their own discretion, to omit them from their programs. So, in Volvo's case, the S80, S60, V70 and XC70 all have telematics systems, but the XC90 does not. What is the prospective customer to think, that the other models are defective and require an additional emergency assistance device, or that the XC90 is missing a key technology compared with its segment competitors? If the car companies cannot provide a clear message on telematics systems to their customers, how are customers going to be able to understand these systems' true value.

GM was an exception from the outset to this division of responsibility. GM created OnStar as a separate company to provide telematics services to all of its brands. Some believe that OnStar was created in order to offer a brand-neutral service, while others believe that it was

intentionally separated from the brands for liability reasons. That is, if OnStar was sued, the brand names would not be tarnished. GM started to offer OnStar to Cadillac customers in 1996, and has since made OnStar a standard offering in most of its brands' models, with the hands-free telephone, emergency and breakdown assistance components standard parts of the service. GM provides the OnStar equipment as a standard factory fit (i.e. free) in the majority of its brands' models, and the standard services are free for the first year. The telephone works with pre-paid telephone minutes, so the customer can either use it or ignore it. Premium services, like route planning and traffic information, or personal assistance services, can be added by the customer to the service offering at any time.

OnStar has advertised heavily in the US, in print and on TV. It has close to three million users who have used one of the standard services at least once during their free service period, who have signed up for premium services, or who have agreed to start paying for the standard services after the free service period expired. These users are either going to turn into long-term subscribers because they value the services OnStar offers, or they will let their subscriptions lapse. GM will either continue to install OnStar telematics units in its vehicles as standard, make them an option, or discontinue its support of OnStar. On Star maintains that it is meeting its budget and growth targets, and it now provides services to other OEMs. GM has stated that OnStar gives it a competitive edge in the sale of its cars. Whatever happens to OnStar, GM now has an operational telephone module in all of its vehicles.

The other part of the problem for telematics systems is that they were the subject of oversimplification of the technical difficulties, and overselling by the financial markets. First, the overselling issue. External forces (i.e. non-automotive) took over the telematics concept in the late stages of the dot.com era. Telematics was projected by financial analysts to be the next big expansion area for the automotive OEMs, like the financial services business they had entered a few decades earlier and which now account for a large percentage of their profits. Telematics, it was said, would generate double-digit growth for an industry that had grown accustomed to single-digits or less. Ford Motor Company, under its former CEO Jacques Nasser, was the principal promoter of automotive companies re-engineering themselves into information technology companies. Telematics, they claimed, was their future. Unfortunately, they confused their businesses with those of the network operators and the service and content providers. They underestimated the cost of creating the necessary infrastructure to support the full range of mobile services that they were promising.

Ford, along with its joint-venture partner Qualcomm, invested $125 million in Wingcast before Bill Ford, Nasser's successor, closed it down two years after it started, and before a single system or service could be delivered. Ford has also closed down its consumer telematics operations in Europe, after three unsuccessful tries at introducing telematics systems in Europe. Volkswagen, Renault and PSA closed their fledgling operations. Fiat's TargaSys operation is

under heavy financial restrictions. Mercedes and BMW are rethinking their service network. The entire telematics industry is marked by much lower levels of exuberance, and much more modest development budgets. In the post-dot.com environment, the telematics industry has begun searching for applications that could unite the OEM's engineering and marketing organisations. It has started to promote applications that focus on the benefits of communications systems in the vehicles, such as remote diagnostics and Customer Relationship Management (CRM). But even these types of applications, as useful as they sound, are not enough to support telematics as a standard fit in all cars.

On the technical oversimplification issue, the OEMs' engineering departments, their system suppliers and the telecom operators bear the responsibility for making and breaking promises. Integrating a telephone module in a vehicle environment, and guaranteeing that it will work under all conditions, was much more difficult than any of these groups initially believed. The Volvo On Call system was delayed in Europe for over four years (it was initially planned for delivery in the US in December 1996, then in fourteen countries in Europe in June 1998; it was finally released in December 2001 in Sweden and in the US in September 2002) because of problems related primarily to the telephone module. Ford and GM in Europe were plagued by similar problems.

There is a Future for Telematics

In spite of all that I have just written, and in spite of all the gloomy news about telematics in the trade and financial press, telematics is not dead. What has occurred to-date with telematics, roughly from mid-1995 when the first systems were introduced, and even earlier while they were being developed, is only a prelude to what is to come. All of the actors in the supply chain (i.e. all those who are still in the business and are determined to remain in it) have been learning what it really takes to build a communications device into a vehicle, to make it work in all circumstances and under all conditions, and to manage the complete life cycle process for the combination of a telecommunications device installed in a vehicle and the owner/driver of that vehicle.

What comes next is currently in the planning or pre-implementation stages at most vehicle OEMs. It is advanced driver assistance systems (ADAS). These systems are primarily intended to improve the overall safety and performance of vehicles for the driver, the vehicle's occupants, the vehicle in relation to other vehicles on the road, and pedestrians. There are extremely ambitious goals being set in Europe and North America to reduce the number of annual vehicle-related deaths from their currently high level of approximately 40,000 in each region to one-half this number by 2010. Passive methods, such as seat belts and air bags, and better vehicle design to improve their crashworthiness, have resulted in a levelling off in relative terms of serious and fatal injuries, but they have reached their limits of effectiveness. Active methods, such as braking and steering assistance, curve warning, obstruction warning, intelligent speed

adaptation/advice, lane-keeping advice/assistance, and many other applications are seen as the only way, short of severely limiting vehicle usage—which is also under serious discussion—to reach the death and injury reduction goals.

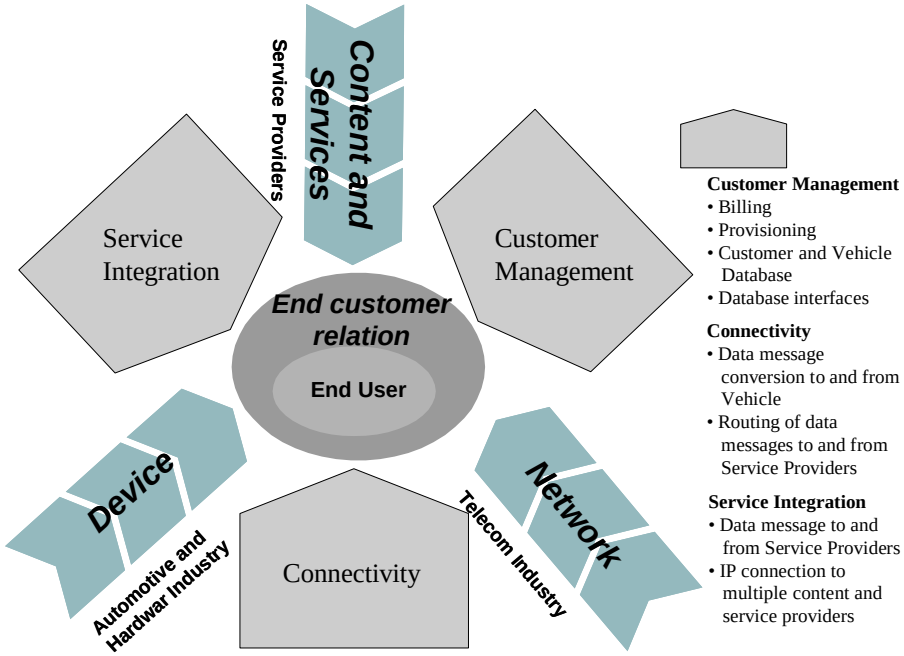
Some ADAS functions can be performed with vision and movement systems (see Appendix A), but many of them will rely on a combination of sensors and a digital map database that will allow predictive modelling of the road and its surroundings. These databases must be more accurate and up-to-date, and contain more detailed information than the databases used in the current on-board navigation systems. This will require new methods of collecting road-related data and new methods for transferring this data in real time to and from all vehicles. These methods will be based on communications devices in the vehicle capable of both transmitting and receiving location-based data. In other words, telematics.

The Role of Telematics Service Providers

There will be telematics systems in most cars in the future to support ADAS functions, most probably starting in the 2006 year models. In the meantime, GM, BMW, DaimlerChrysler, Audi, Volvo and a few other OEM's will expand their current telematics programs, both geographically and with services offered, and make them standard fits in some models. They will do this because they know they need the telecommunications systems to operate in all regions, not just their home markets, or their largest markets. What role will telematics service providers like WirelessCar have in the eventual value chain? To answer this question we need to look at how the overall location-based services business is evolving, and which companies are taking a leading role in this evolution. (We also must look at the development of communications technologies and services, from the current GSM/SMS (2G) services to GPRS (2.5G) and UMTS (3G) services, but this is beyond the scope of this Special Report.)

Telematics is a subset of location-based services (LBS). LBS deliver information and assistance to individuals who use position-enabled devices to communicate their location via a wireless network to service and content providers. Put LBS in the vehicle and you have telematics. LBS is itself a subset of mobile services, that is, all types of services delivered to mobile devices. There are many types of services that can be provided to mobile devices, and most of them are not location-dependent. Examples are entertainment, games, personal information management, financial services, m-commerce and Internet access. (See Appendix B.)

The Location-based Services Value Chain



The location-based services industry has its own value chain. Its three major components are:

- Services and Content delivery;
- Hardware and Software; and,
- The Network.

Each of these components can be mixed and matched according to various business models to create interdependent architectures. In between the three major components are the links that make possible the service delivery to the on-board device or other wireless devices via the network. Connectivity is needed to match the device with various network standards. It is needed to ensure that the data messages are delivered to the appropriate service providers. Service integration provides for the conversion of device protocols to formats that can be understood by service providers. Customer management provides billing and invoicing services, vehicle and customer data management, provisioning services, and customer care services.

There are four categories of companies attempting to build businesses around these services, and there are three basic business models that are evolving for the delivery of mobile services, location-based services and telematics. The company categories are:

- Network operators;
- Vehicle OEM's;
- Companies that have LBS services as part of their core business, such as automobile clubs and security service companies; and,
- The major hardware/software developers and IT consultancies.

The Companies

Network operators, particularly those that have acquired 3G licenses, are building the capability to deliver all types of mobile services, including general LBS and telematics. They are doing this primarily in order to increase traffic to their networks. For example, NTT DoCoMo, a Japanese wireless network operator that has popularised Internet connectivity on wireless devices with its i-Mode service and is one of the first companies to deliver content on 3G networks, combines device, network and specialised links to service and content providers to internalise all profit possibilities. It bears no cost for the services and content, but takes a 10% fee for providing the connectivity links. It does not manufacture its own devices, but brands and sells devices which it specifies.

European network operators began to offer LBS around 2000, primarily using the Wireless Application Protocol (WAP). One LBS platform developer, Webraska, was the chosen ASP for most of these early systems. The network operators are now building their own LBS systems. They have a major advantage over the other two categories of companies because they can, in theory, control the entire value chain. At best, other companies can control everything but the network, but there are few companies who have attempted to do so.

The vehicle OEM's primary objective is to increase the desirability of its core products (i.e. vehicles) and establish closer and more long-term connections to their customers to increase the rate of repeat sales. While they have talked about new revenue generation channels, as I stated earlier, there is little evidence that the business models they have adapted offer significant income generating opportunities for the OEM's compared to their core business. The vehicle OEM's who have thus far introduced telematics systems offer a complete and branded service to their customers. The OEM's buy network access, purchase and install the devices, and contract for services and content. Some OEM's have built subsidiaries or contracted with internal organisations who provide the services and content. GM's OnStar and DaimlerChrysler's Tegaron are examples of such organisations (although DC sold its 50% stake in Tegaron). The OEM's can therefore control up to two of the major components, but they cannot control the network. Even if they hide the network operator's brand behind their own, they cannot charge a premium over standard calling and messaging rates to make any real profit on telephone-related services. They are basically a pass-through for the network operators.

Automobile clubs, emergency services (both public and private) and security services companies are already in the business of providing services and content that are in large part related to location. These types of companies have a strong interest in incorporating LBS into their operations, and most are already doing so. The European automobile clubs have established links with the dominant club in the US, American Automobile Association, and with clubs in other parts of the world to form a global telematics alliance. The goal is to offer an OEM with a single supplier of roadside assistance and telematics

services in all global markets. The emergency services have finally begun to react to the potential for interfacing directly to in-vehicle systems, rather than being contacted by telematics service providers. A European project has been established called e-Merge which has as its goal to develop the necessary infrastructure and message protocol to allow both data and voice to be sent directly to the emergency services.

With the exception of ATX in the US and Falck in Sweden, security firms have been relatively inactive in the area of telematics. This is surprising given the success of ATX. ATX is the one company in the telematics services business that has managed to attract, hold and satisfy its customers. It was the first telematics service provider. Then it was called Westinghouse Security Systems, and it cooperated with Motorola and Ford to develop Ford's RESCU system for the Lincoln brand. Since then the company has been through three ownership changes, but it has continued to strengthen its offering. It has acquired new customers, including DaimlerChrysler's Mercedes, BMW and Infinity. Both DaimlerChrysler and BMW have asked ATX to expand into Europe to replace respectively Tegaron and Passo as their TSP's.

What does ATX have that has led to these successes compared with other companies, including Tegaron, Passo and WirelessCar, all of whom have struggled to expand their client base?

- Security focus with an existing call center and highly trained managers and operators
- Strong IT systems support, with redundant operations and systems to ensure continuous operations
- Deep understanding of the importance of location-based services and content
- An existing profitable business in commercial and private security services that it uses as a base on which to build additional services
- Willingness to adapt to each client's specific system requirements

ATX is now in a position to expand its services offering into both off-board and ADAS data delivery, the two key future areas for telematics. They have been identified by the major map data content provider in the US, Navigation Technologies, as the platform of choice for DaimlerChrysler's and BMW's new developments in both areas.

Computer hardware and software integrators, especially IBM, HP, Fujitsu and the large IT consultancies, have identified vehicle-related LBS as their domain. They are all working closely with the vehicle OEM's IT departments as Tier1 suppliers of IT services for design, manufacturing, logistics and administrative systems. They are well-positioned to specify, build and operate telematics platforms that will deliver all types of services.

The Business Models

Mobile services in general, and LBS in particular, is a young industry. Like most young industries involving complex technologies, it is characterised by very tight integration of its components. For telematics these components are: GPS positioning; data and voice communication; interconnection with vehicle systems; user interface; call center functions; and, customer management. There were no standards for any of these functions or their interfaces when the first telematics systems were developed, and there are still no standards for them today. An attempt to create a data protocol standard called GATS (Global Automotive Telematics Standard) for linking the in-vehicle telematics unit to call center services has met with limited success.

In order to achieve acceptable performance by their LBS product, including both system and services, companies offering these products have tried to create vertically integrated business models in which they control the entire LBS value chain. Extensive research by Clayton M. Christensen and others at Harvard Business School show why this occurs.[1] In the early stages of an industry, large, vertically integrated companies control the complete value chain and dominate their industries. "This is because," according to the researchers, "the products are immature, not yet good enough for the mainstream market. Competitive pressures force engineers to focus on wringing the best possible performance out of each succeeding product generation by developing and combining proprietary components in ever more efficient ways. To make the highest-performing products possible, companies typically need to adopt interdependent, proprietary architectures."

The authors offer as examples "IBM dominating the computer industry in the early 1980's with 70% of the mainframe market and 95% of its profits; Ford and General Motors, as the most integrated automakers, dominating their industry during the early days before car manufacturing became component assembly; RCA, Xerox, AT&T, Alcoa, Standard Oil and U.S. Steel dominated their industries. Their products were based on the sorts of proprietary, interdependent value chains that were necessary when pushing the frontier of what is possible."

Some network operators, like **3** (the commercial name for what has been called Hutchison3G), Vodafone, Deutsche Telekom and Orange, are pursuing a completely vertically integrated approach. They are acquiring the technology and data to build their location-based services business in-house. They are creating proprietary processes for their value chain and taking advantage of the modular, dis-integrated links in the mapping industry value chain to build their own vertically integrated systems. They can choose the best data suppliers, content aggregators, mapping and routing processing

[1] Harvard Business Review; November 2001 issue; Clayton M. Christensen, Michael Raynor and Matt Verlinden titled *Skate to Where the Money Will Be*. Christensen is also the author of The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail in which he describes his theory of disruptive technology.

systems, geocoders and map display engines. They are doing this because they believe the location-based services industry is not yet at a stage where the individual links in the value chain can be specified, verified and delivered in a predictable enough manner to satisfy customer needs. In Christensen's terms, these links are not yet "good enough" for the mainstream market.

Within a few years after the start of the telematics industry, the major automotive OEM's had established their vertically integrated organisations. They had selected their hardware device suppliers and the data protocol that they would use to connect to the call center. They had contracted for call center services or built the platforms themselves. They had designed their customer management processes and decided who would build them.

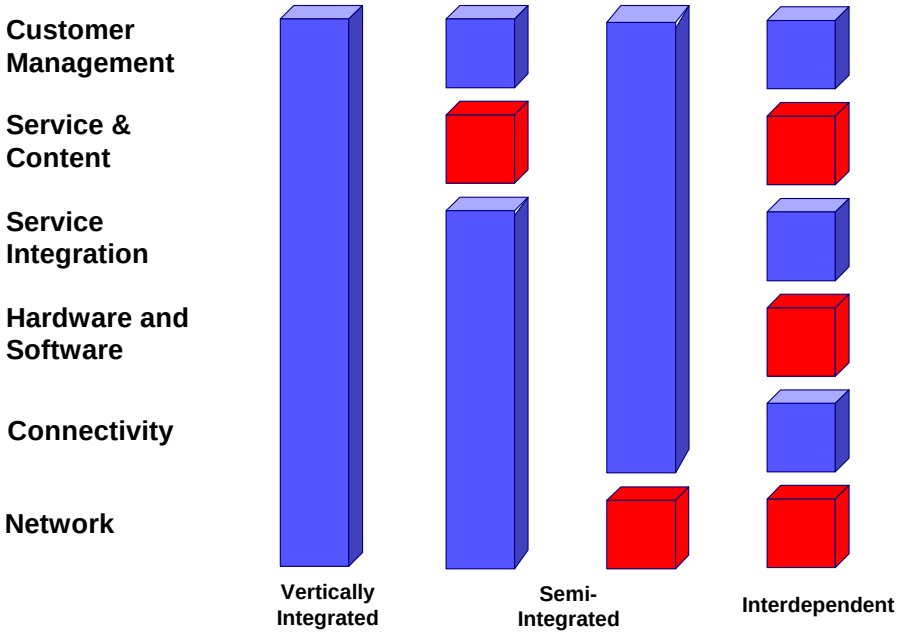
The second model is semi-integrated. NTT DoCoMo's model separates service and content delivery from the other parts of the value chain. This means that they have decided not to build their own location-based services system, nor any other type of service delivery system. They allow their customers to choose service providers from a list of pre-qualified companies. The service providers agree to conform to NTT DoCoMo's standards and compete with each other for NTT DoCoMo's customers on the basis of price, speed, convenience, customisation and quality.

GM's OnStar in the US is also pursuing a semi-integrated model, taking in-house all components except the one that it cannot control, the network. They specify the device which interfaces only to the OnStar call center. The OnStar call center staff deliver all information services and content using systems purpose-built for OnStar. These operators provide the interfaces to the breakdown and emergency services. Telecommunications components are not owned by OnStar, but they are managed through OnStar with no visibility of the operators to the customer.

The Disadvantages of Vertical Integration

A major disadvantage of the first two models is that the customer is tied to a specific device and a specific network. The vertically integrated models tie the customer even further to specific content and services. The customer is dependent on the company to constantly upgrade content and services, the network and the device. This is the case for customers who attach themselves to any type of vertically integrated company. They do so because the alternatives are not perceived to be good enough. Customers give up choice for performance.

Current Location-based Services Value Chain Business Models



The third model is an interdependent one in which one or more specialised integration providers fills the gaps between the device, the network and the service and content provider. This model allows multiple service providers to communicate with multiple devices over multiple networks. Since there are as yet no standards for these interfaces, each one is defined separately for each combination of device, network and service. A service provider, such as an automobile club, would specify its own internally consistent interface to an external device and to a network. The integration provider would translate that interface for use with multiple networks and devices. ATX, Tegaron and Passo have all combined these three services with call center and LBS content services. They allow for device and network independence, but not services and content independence.

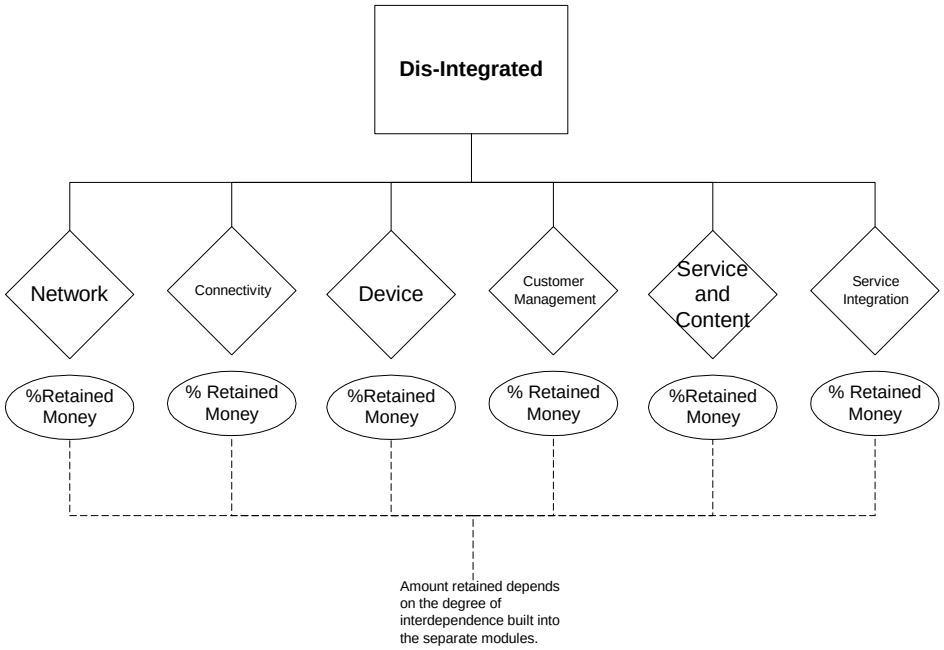
WirelessCar Allows Interdependence

An example of a company providing purely connectivity, service integration and customer management in the vehicle LBS industry is WirelessCar. WirelessCar started operations as part of the Volvo Cars telematics organisation. Volvo specifies the devices, selects the customer service center provider, and chooses the network operator. WirelessCar ties all of the pieces together for Volvo. The major difference between the Volvo Cars solution and the other automotive OEM solutions is that WirelessCar provides a technical solution that allows Volvo to interchange or enhance the individual components separately without the need to modify all of the components simultaneously as the tightly integrated telematics companies must do. Volvo can mix and match any one of the three major LBS components anyway it wishes. Volvo's is an inter-dependent model, rather than vertically integrated.

It is not difficult to understand why WirelessCar has not yet been able to break into the other OEM's vertical chains. Their links are designed to work with one another. WirelessCar would have to completely

replace a link, such as Tegaron for Mercedes or Audi, Passo for BMW. There has not been a compelling enough reason thus far for the OEM's to make such a switch. The links in their vertical chains have worked as they were designed to work, even though the design objectives have been limited (e.g. single country implementations.) However, during 2001 the telematics industry began a period of re-evaluation and re-design. The first systems had been delivered and tested. The OEM's have seen what works and what does not work. As new model cars entered the planning stages, an opportunity arose to re-think the vertical model for both systems and businesses . Ford, Renault and PSA halted their independent telematics efforts and decided to join forces in a new venture called Signant. Mercedes, BMW and GM have all announced plans to develop international offerings, with DaimlerChrysler divesting its fifty percent ownership in Tegaron, BMW actively seeking new providers in Europe and other markets, and GM once again releasing a request for proposals for a new pan-European telematics platform.

If the LBS industry follows other industries, the vertically integrated model will initially be the most successful. Those companies who adopt it will hold on to the largest profits. By default, the network operators have the clear advantage. NTT DoCoMo, 3, Orange, T-Mobile and most of the other network operators who have developed LBS platforms are still in the earliest stages of their product and service offering. It will be several years before they will be able to see whether their business models are sustainable. If they are, it is possible that the telematics industry will continue to be locked into vertical integration for some time to come, and that it will be dominated by the network providers.



Interdependence and Horizontality Preferred

Christensen and his Harvard colleagues provide an explanation for what is currently happening in the telematics industry. "What happens over time is that the performance of these products goes beyond what the mainstream customers can use. To stay competitive companies must bring more flexible products to market faster and customise their products to meet the needs of customers in ever smaller market niches. To compete in these new dimensions, companies must design modular products in which the interfaces between components and subsystems are clearly specified. Ultimately, these interfaces coalesce into industry standards. Once modular architecture and the requisite industry standards have been defined, integration is no longer crucial to a company's success. In fact, it becomes a competitive disadvantage in terms of speed, flexibility, and price, and the industry tends to dis-integrate as a consequence." By dis-integrate, Christensen means breaking apart into constituent pieces.

This modular, 'dis-integrated' approach is desired and needed. The OEM's need to be able to combine devices, services and content, and telecommunications in ways that suit the specific markets and their customers. This will also allow investments to be shared by each of the major component developers and spread over a wider set of users, as opposed to the OEM financing each specific implementation.

Although there are a number of standards initiatives covering most areas of telematics and LBS, the chances are remote that industry standard interfaces will be agreed during the next several years. However, the interdependent telematics model applied by Volvo Cars is gradually being recognised as the most desirable alternative. It achieves a similar effect as having standards by allowing the component developers to operate independently of one another.

In the dis-integrated telematics industry, profits will fall to the companies that have the greatest control over the interdependent links in the dis-integrated value chain. The power to make money will shift, according to Christensen, "away from companies that create the end-use product toward the back end of the value chain to those companies that supply subsystems with internal architectures that are still technologically interdependent." The vertically integrated companies will either sell off their components—if they are technologically superior—or they will dismantle them. These companies should now be building their internal systems as products so that they can be sold off at a profit, or provide the base for an internal business that offers services to the external market, including competitors.

Companies – WirelessCar

WirelessCar is unique among its telematics service provider competitors in that it does not offer at least one of the three principal services: Content/Call Center; Device; or, Network. ATX, OnStar, Passo, and the automobile clubs have call center operations, and they have developed their own location-based services (LBS) platforms with map display, vehicle positioning, tracking, location finding and routing applications. Network service providers such as Vodafone and Deutsche Telekom, who have thus far been only indirectly involved in telematics service provision through their subsidiaries Passo and Tegaron, will be more active in the future and be able to offer content, call services, network access and even devices. The same is true of 3G network providers Orange and 3 (Hutchison3G), who are creating strong mobile services offerings and have announced their intentions to compete in the in-vehicle LBS market.

Thus far, only Volvo Cars has recognised WirelessCar's uniqueness as a competitive advantage, and have understood that it allows them to mix and match the best content, network and device suppliers in each geographic market. The rest of the industry is built on tight integration of proprietary components within vertically integrated companies. If the telematics industry follows the course of other industries involving complex technologies, such as the computer and automotive industries, eventually the vertically integrated business model will give way to a horizontal structure. Companies will compete within each link of the telematics value chain, rather than single companies attempting to assemble all links under their control and competing for the end customer. The power to make money will shift away from companies delivering the end use product to companies that supply subsystems. The main unanswered question is how long this transition period from vertical to horizontal business models will take.

In order for WirelessCar to continue in operation during this transition period it needs to deliver products and services that can be used by the vertically integrated companies, including its potential competitors. The telematics workstation client and workstation back-end server now under development by WirelessCar is a key product set that could generate short-term revenue and position the company for the future. This client/server combination combines LBS functions with all the necessary telematics call center operator functions. It has four major markets:

- Emergency Services – public emergency call centers in each European country. These organisations are in the early stages of attempts to standardise and interface directly from vehicles to their call centers, rather than being contacted by an intermediary. The WirelessCar workstation provides them with a ready to use vehicle application.

- Breakdown Services – there are a number of small-to-medium competitors to the large automobile clubs who would benefit from a Web-based mapping and call center operator workstation with a local server. The workstation and server would not need to be used initially as telematics workstations, but a company would always have the possibility to do so if the business materialised.

- Network Operators – some are purchasing software from companies like Webraska and Telcontar and building LBS systems and call center workstations. WirelessCar's workstation would offer them less costly and complete solution for their call center activities, and it could be interfaced to their own LBS server if they wished to do so.

- Telematics Service Providers – ARC Transistance has already requested a proposal from WirelessCar to supply a telematics workstation. Signant will require a solution, as will ATX if they build a European operation

Additional products that could be developed by WirelessCar include:

- Plug-in modules for protocol conversion
- Plug-in modules for billing
- Plug-in modules for DTMF integration
- Plug-in modules for CTI integration

These products would most likely be sold to customers who have already licensed the workstation and server. However, they can also be sold as modules to device manufacturers, network operators and service and content providers to be integrated in their own solutions.

Partnerships should be limited to companies who can provide WirelessCar with important complementary technology, or who have critical content or services that can be delivered by WirelessCar technology. HP, IBM and the large IT consultancies are competitors to WirelessCar. They are, or would like to be, building the tightly integrated platforms for the verticals, and will attempt to provide their own special-purpose workstations.

Potential partnership candidates are:

- Map data content providers – Navigation Technologies. Provide a platform for delivering up-to-date map data content to in-vehicle systems for navigation and advanced driver assistance systems.
- On-board software, system and handset developers – Siemens VDO, Navigon, Acunia, Motorola. Provide plug-in modules for protocol conversion, call routing, DTMF and CTI integration.

WirelessCar is a merger or acquisition candidate for companies that either are, or who have the ambition to become, an LBS telematics service provider, and who have not yet made heavy investments in their own solutions. WirelessCar's TCP/IP-based platform with plug-in modules, database structure, billing system interfaces, and Web

interfaces offers companies a strong head start in delivering services to the market.

- ATX is a prime merger or acquirer candidate for WirelessCar if they decide to expand operations into Europe. They have a functioning system in the US, but, like OnStar, they will have difficulty using their platform in a multi-country, GSM-based environment.

- Signant is an obvious acquirer of WirelessCar. They have the task of building a telematics service platform that will be very similar to the one already developed by WirelessCar. WirelessCar would bring one important customer in Volvo Cars, and offer them ready-to-use technology.
- PTV is an LBS services provider with its primary customer base in Germany. Its main focus has been on commercial fleet operations, and has a going concern offering software solutions, transport planning and logistics, and map data. Telematics would be a new business area, but they are already attempting to enter this market through the delivery of off-board navigation.
- Toyota is a 'wild card' in Europe. So far, they have moved cautiously and have not announced any plans to deliver telematics services in their European models. They offer OnStar in the US Lexus models. They will either work with one of the three automotive 'spheres' (OnStar, a German consortium, Signant); expand its cooperation with ITIS and help it become a TSP; or build something on their own, possibly with other Japanese companies.
- ITIS is a company that has major ambitions to grow beyond its UK base. They are primarily a traffic information collection and RDS-TMC information supplier. They currently have cooperation agreements with the UK Automobile Association and NavTech.

WirelessCar's ownership by AB Volvo, and its close cooperation with its principal customer, Volvo Cars, offers both opportunities and hindrances for WirelessCar's short-term future. There should be opportunities for working as a telematics service provider to Volvo Trucks and the other companies within AB Volvo. There should also be opportunities for expanding its relationship to other brands in Volvo's Premier Automotive Group and to Ford and its partners in Signant. However, companies outside the AB Volvo and Volvo Cars spheres have already shown a reluctance to work with WirelessCar because it is perceives WirelessCar as a competitor, or, at a minimum, as a captured supplier to their competitor.

By modularising its product offering, WirelessCar stands a greater chance of surviving in the short term, and becoming a key technology supplier to the LBS industry, particularly for telematics, in the long term.

[redacted]

Appendix A

Advanced Driver Assistance Systems (ADAS)

Advanced Driver Assistance Systems (ADAS) are a new set of applications that will improve driver comfort and safety by enhancing vehicle performance. These applications differ from the current in-vehicle driver information and assistance systems (I-DIAS), such as route guidance and traffic notification, in that they provide input directly to the vehicle's systems as well as to the driver. In certain cases the driver is unaware that an application is in operation and sees only the result, such as when the vehicle's headlights are directed through a turn or when the fuel mixture is changed on downhill slopes to reduce fuel consumption. In other cases, such as lane drift notification or speed limit warnings, the driver is prompted to steer the vehicle back into the proper lane or reduce the vehicle's speed to the legal limit.

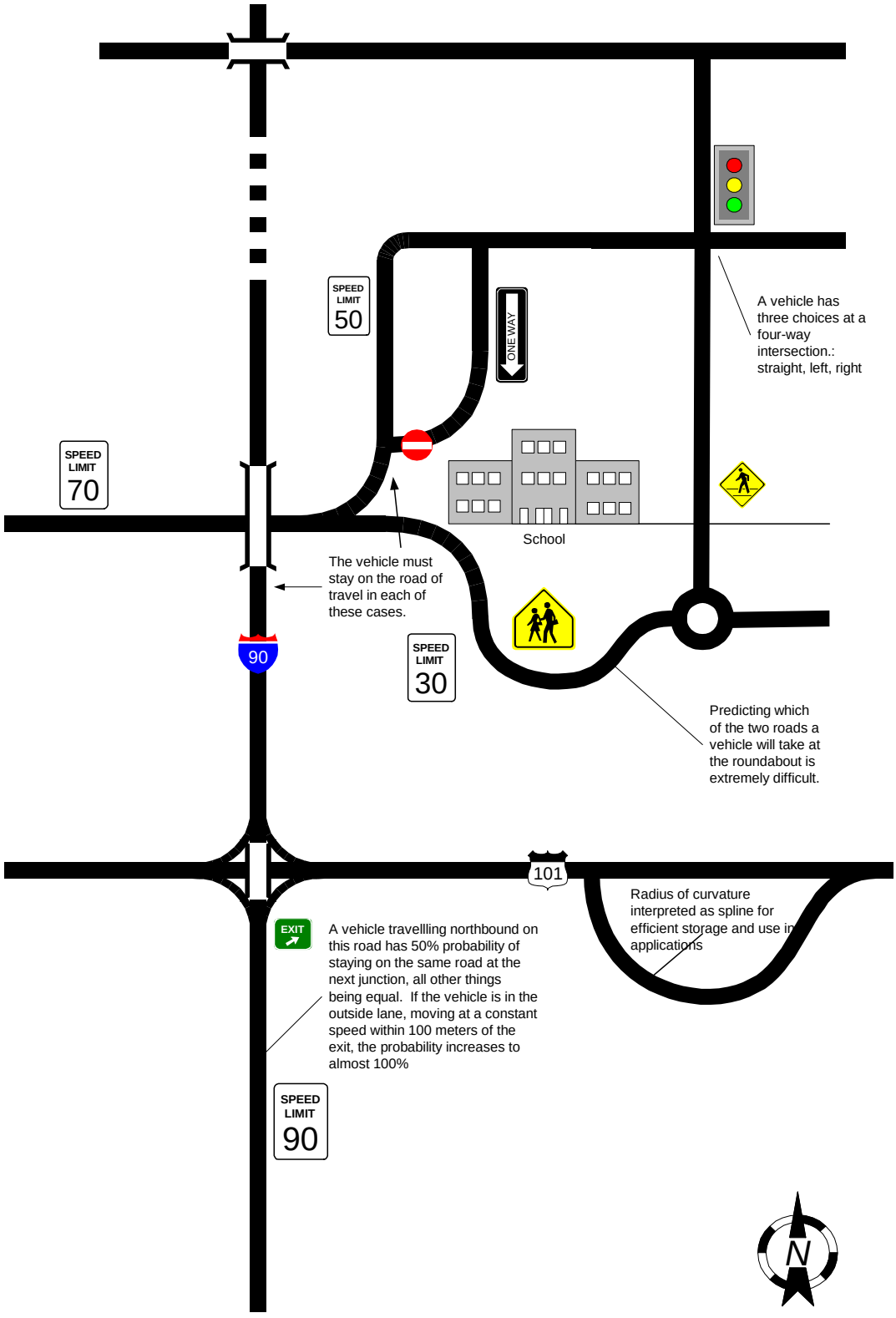
There are two types of ADAS applications which can be used independently or can co-exist in a vehicle:

- Those that depend on enhanced vision systems or other sensors that monitor the driving environment, the driver, the vehicle's performance and the relationship among them; and,

- Those that depend on predictive models of the driving environment that can "see" beyond the range of vision systems and sensors.

The first type might use standard or night vision video cameras, radar, gyroscopes or any of a number of different sensors. The second type require a detailed model of the driving environment—a digital map—and tools for matching the position of the vehicle with its location on this model. The path taken by the vehicle either can be prescribed by the driver performing a route planning function before starting the trip, or it can be inferred by software. Inference software would perform a constant match between the vehicle's position on a road, the possible paths that could be taken given intersecting roads ahead of the vehicle. It would incorporate path changing indications, such as lane shifts, turn signal usage and braking, and then calculate the probability that the vehicle will stay on that road or take another path.

The probabilistic approach might work like this: The car is on a road of a particular physical class with a known average speed for a time of day, time of year, type of weather conditions. The vehicle knows the time of day and year, it reports the speed and weather conditions (windscreen wipers on=wet). The vehicle then calculates the possible paths that can be taken from the current position given the vehicle's speed, lane of travel, status of turn signals, and assigns a probability to each. Any change in driver intentions (turn signal, braking, lane changing) and the probability is updated.



When a driver follows a pre-defined path that has been calculated by a route planning function, the probability that the vehicle is on that path increases significantly, but it is not one hundred percent. The driver can always stray from the route, knowingly or unknowingly, so there must still be an inference engine

operating to check that the vehicle is continuing on the route or preparing to take an alternate path.

Predictive systems can do more than the vision-enhanced systems. They expand the driver's and vehicle's vision horizon around turns in the road, over crests of hills, inside tunnels and beyond what is visible. However, they add another level of complexity—and cost—to ADAS implementations. They require a digital map database with a very high degree of positional accuracy, much higher than the plus/minus ten-fifteen meters that is currently available for navigation system applications. They require a richer attribute set than what is needed for turn-by-turn directions. In addition to the database, interfaces are required from the applications software to the various vehicle sensor devices.

Some developers of predictive ADAS applications have suggested that they be built on top of current in-vehicle navigation systems, using the digital map data delivered with these systems. This makes practical sense for a number of reasons:

- Most vehicle OEM's have an in-vehicle system supplier, and the work has already been done to integrate the navigation system and its components into the vehicle package.

- The integration of the navigation systems with the vehicle's position sensors (gyroscope, GPS, distance measuring) has already been done.

- The route planning function that is needed for some predictive applications is already part of the navigation system, and the man-machine interface to this function is available to the ADAS applications.

- There is an agreed standard (GDF) for transferring digital map content to the individual in-vehicle physical storage formats.

- The navigation systems are being componentised to operate as applications (e.g. positioning, route planning, route directions, map display, point of interest query, address location). ADAS can become one of these applications.

There are two problems with using navigation systems as the foundation for ADAS:

1. Each navigation system vendor employs its own proprietary physical storage format for the data that is used by the system's application programs (i.e. positioning, route planning, route directions, address and POI location, map display). Converting ADAS data to each system's proprietary format will increase the difficult of eventually delivering data to the vehicle from off-board, dynamically updated servers, and severely restrict the possibilities of using best-of-breed sources for such data. All data will have to be funnelled through the system vendors.

2. ADAS applications could end up having a higher take-up rate than navigation systems, suggesting that they become a standard feature on all or most of an OEM's models, rather than an option. It is also possible that ADAS features will be ruled as mandatory by government legislation. If ADAS applications require the navigation system, the OEM's would either have to increase the cost of their

vehicle to cover the cost of the navigation systems, or see their margins reduced.

A second alternative is to separate ADAS applications and the database from the navigation systems. This would allow the ADAS database to be optimised and standardised specifically for ADAS for on-board and off-board delivery. It would also allow ADAS to be included in vehicles as a standard feature if market conditions warrant it or if government regulations require it. Developing parallel and potentially redundant systems is not an alternative that is favoured by either system suppliers or vehicle OEM's for cost, vehicle packaging and purchasing efficiency reasons.

A third, and most likely the most desirable alternative, is for the vehicle OEM's, system suppliers and database producers to agree on a standard API from the ADAS applications to the database so that ADAS can be componentised and combined with only the necessary navigation system functions in a strictly ADAS installation. For example, a simple ADAS implementation might not include and route planning or map display. System suppliers have indicated that a standardised API is definitely possible to implement if the OEM's can agree on the database features that they require, and the types of attributes they will need.

Predictive ADAS applications are in the research and development phase. In order to bring these applications to the market, two critical pieces must be in place:

- Digital maps with sufficiently detailed and precise content must be available; and,
- Agreement must be reached on a standard way of delivering the content to the applications, either from on-board data, from data delivered to the vehicle from an off-board server, or using both methods.

Navigation system vendors designed their systems with varying degrees of input and involvement by the OEM's. The navigation systems and their components (GPS device and antenna, display, control buttons) had to fit inside the vehicle package, connect to speed indicator, gear shift, etc. However, there was little other than the human-machine interface that needed to be specified by the OEM. It will be different with ADAS. Since the ADAS applications will work with mission-critical vehicle systems, they will be specified in detail by the vehicle OEM's. Functions performed by these applications will ultimately determine the new types of data required in the digital maps, or any changes that might be necessary to the data that these digital maps presently contain.

Appendix B

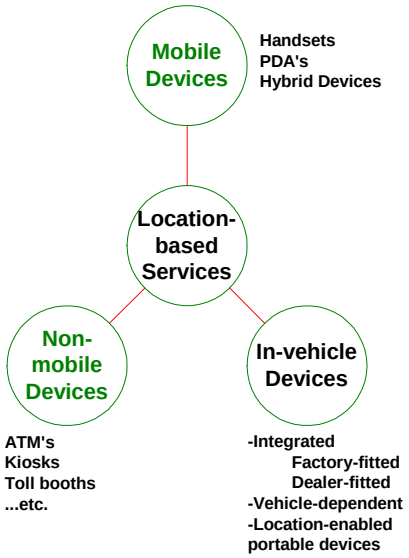
Mobile Services, that is, services delivered to wireless devices, include location-based services as one of the most important. Location-based services are currently estimated to be ranked fifth in popularity among the constellation of seven primary mobile services (Source: ARC Group: Future Mobile Handsets; 2001 ed.) The same report projects that by 2006 these services will be ranked first, with approximately 24% of mobile users accessing them.

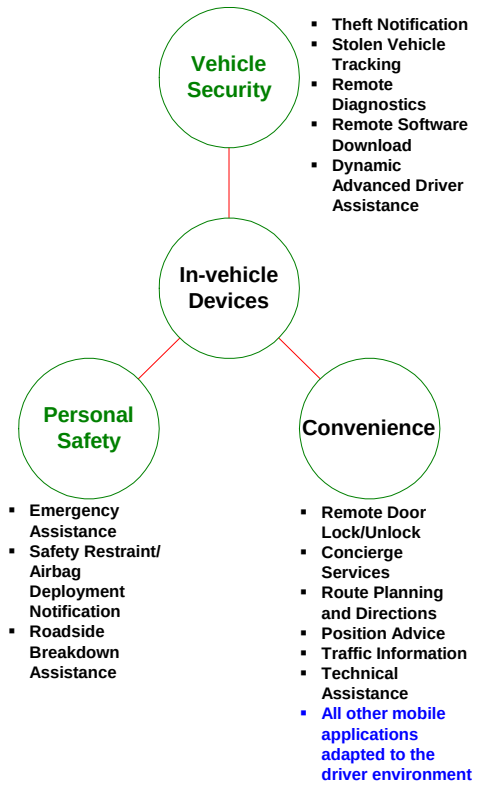
Location-based services are delivered to three types of devices:

- Mobile Devices, such as handsets, PDA's and hybrid appliances.
- Non-mobile devices such as ATM's, information kiosks, toll booths and other stationary devices that are more conveniently connected via wireless technologies than fixed lines
- In-vehicle devices

There are three types of in-vehicle devices:

- Devices integrated with the vehicle's systems and are an integral part of the vehicle's design
- Devices that are portable and can be installed in any vehicle, but which are dependent on connections to the vehicle's systems for their operation
- Portable devices that can be taken in and out of the vehicle and require no connection to the vehicle's systems





There are three principal groupings of services for in-vehicle devices:

- Personal Safety - these include services related to potential life-threatening situations, such as accidents or vehicle breakdowns. These services are the single most important reason that drivers in the US choose to install systems in their new vehicles.

- Vehicle Security - these are services that are primarily for the care and protection of the vehicle, but also provide the owner with added peace of mind.

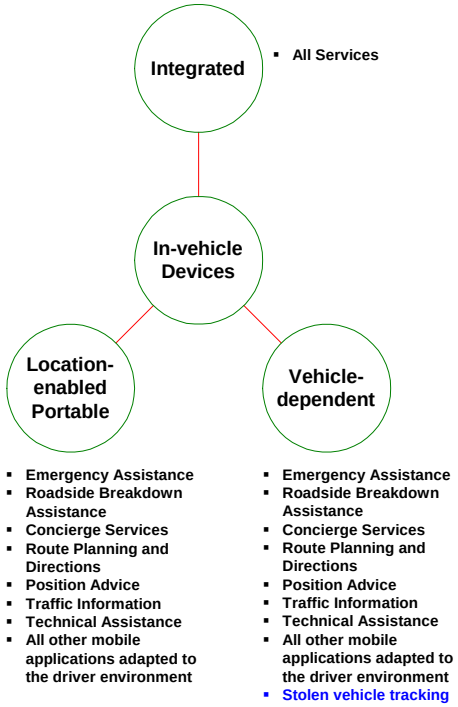
- Convenience - these are services that enhance the driving experience, save the driver time, or provide information when it is most useful. Route planning and directions and traffic information are the services most valued in European markets.

Integrated devices have the advantage over vehicle-dependent devices in being able to delivery the full range of services, including vehicle security, personal safety and convenience.

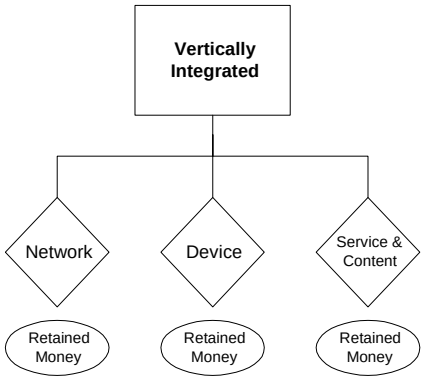
Integrated systems can access the OEM's internal data bus to receive information from the vehicle's sensors, to send commands to internally-controlled systems, and to share devices that are used for other applications devices.

Vehicle-dependent devices require installation to connect to the vehicle's battery and loudspeakers, but must include built-in GPS, GSM, microphone and display. Connection to internal systems is not currently possible. Most of the vehicle security and airbag deployment notification services are also not possible.

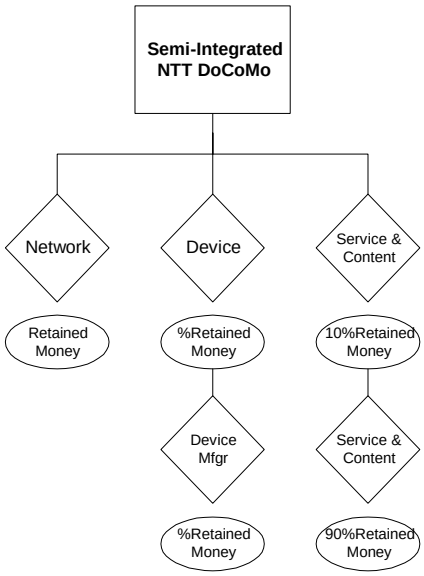
Portable devices that are location-enabled (i.e. Have some form of positioning capability) can provide limited in-vehicle services, similar to those provided outside the vehicle environment.



Appendix C

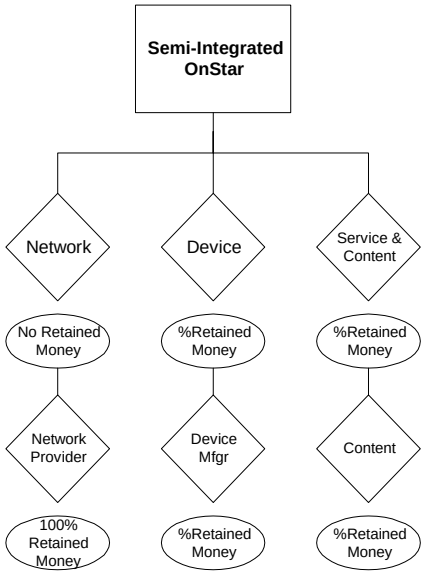


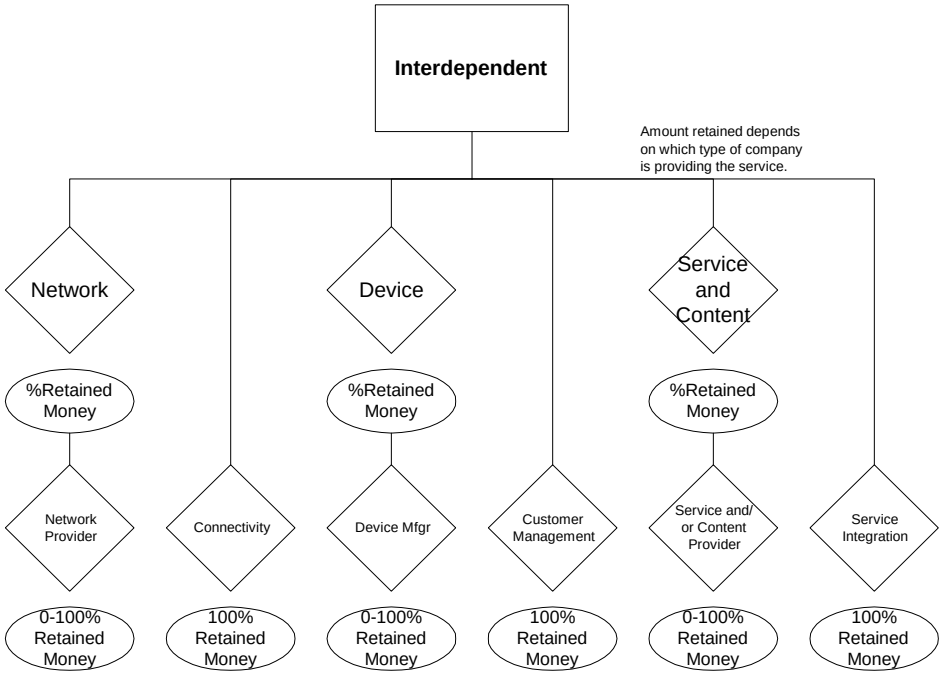
The objective of vertical integration it to retain as much profit as possible inside the company by outsourcing as little as possible, and converting whatever is outsourced to an internal component by re-branding it. The network operators who are creating location-based services have the best opportunity to retain profits in all three areas: network, device and content. To do this they must also build their own connectivity, service integration and customer management systems. As long as there are no standards for network connectivity, device interoperability and customer interchangeability, these companies can retain their dominance. They can brand the device and re-brand content and services and sell their own network time.



NTT DoCoMo and GM's OnStar division in the US are examples of semi-integrated companies. NTT DoCoMo can retain all of the money for its network, although it must pay a portion of its customer usage fees to the fixed line company, NTT. Matsushita Communications Industrial (MCI) and NEC are two of the principal suppliers of handsets to NTT DoCoMo. They are paid for their hardware, but it is NTT DoCoMo who brands and sells the devices. NTT DoCoMo's policy on services and content might appear unusual given that they could certainly have created their own location-based and other service and content infrastructure like their rival J-Phone. They retain only a 10% fee for enabling the connectivity between the consumer and the service and content supplier, but this strategy has created a wealth of willing suppliers.

OnStar is not currently billing for airtime. It pays the network operators directly out of the subscription fees it receives from its customers. The in-vehicle telematics device is built to OnStar specifications by different suppliers, Delphi, formerly part of GM and now an independent automotive Tier 1 supplier, and Motorola. The systems are branded OnStar and OnStar retains a portion of the profit from their sale. They also retain a portion of the intellectual property rights in these systems. OnStar has built its own location-based service center with automated and operator-based services. It has licensed mapping technology from MapQuest, licenses and integrates data from among others, Navtech.





The Interdependent model is a move in the direction of dis-integration. The Volvo On Call telematics service, now operational in Sweden and soon to be introduced in the US, is a prime example of the interdependent model. Volvo has contracted separately with the network provider (Vodofone Europolitan); the device manufacturer (Tier 1 automotive supplier Autoliv); and the service and content supplier (roadside assistance, emergency assistance and security services company Falck). These companies on their own cannot delivery a telematics services. Volvo has contracted with a fourth company, WirelessCar, to provide the needed connectivity, customer management and service integration. It is clear that in this model the money flows from the company selling the service to all the companies providing the actual services or systems. Depending on the billing approach, the company selling the service can retain a portion of the money received for network services, the device and the services and content. Volvo, in contrast with other automotive OEM's offering telematics, has a flexible subscription, service and transaction charging system that allows it to retain a portion of the three primary components. WirelessCar, because it is providing interdependent services, is able to retain all of the money charged for its services.

Notes