*A Deloitte Research Wireless Study*

# MOBILIZING THE MACHINE

*The coming embedded mobile revolution*

**Deloitte Research**

# INTRODUCTION

Embedding cellular mobile communications technology into machines—what we call "mobilizing the machine"—has the potential to be the first major communications breakthrough of the twenty-first century. Mobile-enabled machines can transmit and receive information instantaneously from almost anywhere. This capability improves efficiency, reduces costs and improves response times. It also opens the door to new revenue opportunities and new ways of both working and relaxing.

This Deloitte Research Viewpoint explains the potential impact that embedded mobile can have, identifies the different parties that need to be involved and outlines what their potential benefits are. We explain how this market, rather than being an extension of the mobile voice market, is a market in its own right and needs to be treated as such. We discuss ways that embedded mobile applications can be deployed, from simple provision of connectivity, to a basis for business process redesign, to supporting new business models. The combination of mobile communications and machines will be challenging, and we explain the many issues the industry must resolve if it is to exploit the market's potential. Throughout the Viewpoint we provide a mix of live, trial and hypothetical examples of embedded mobile applications.

This Viewpoint draws heavily from our own experience in developing mobile data solutions for enterprises, primary research conducted with leading players in the embedded mobile market, and in-depth research into the latest trends and drivers of mobilizing the machine.

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*By 2003, a third of the world's 6 billion people will have a mobile phone; the market for connecting humans to each other via the cellular network will quickly become saturated. As this happens, the biggest opportunity will become connecting man with the silicon life forms on the planet: vending machines, aircrafts, cars, personal computers and home appliances. Some will be connected via fixed links, others will be connected over cellular networks. By 2005, most appliances will be supplied with integrated mobile connectors. The market potential is huge: already today our planet is inhabited by some 50 billion machines.*

*Wolfgang Grulke, Chairman of FutureWorld*[1]

# MANAGEMENT SUMMARY

As humans, our need to communicate is critical. Innovations that have filled that need, such as the telegraph, the telephone, the Internet, and the cellular phone, have dramatically changed the way we live and work. Businesses that have successfully developed and sold those innovations have enjoyed much success. Now, our lives are inextricably linked with machines. In fact, recent studies show that machines currently outnumber humans by at least four-to-one. This implies an incredible potential market exists to enable and expand communication between people and machines, and between machines themselves.

Embedding cellular mobile communications technology into machines—what we call "mobilizing the machine"—has the potential to be the first major communications breakthrough of the twenty-first century. For those companies that are prepared to effectively implement and market this technology, the potential rewards are enormous.

"Mobilizing the machine" means enabling a machine to transmit and receive information through a cellular connection whenever and wherever the need arises—limited only by the coverage area of the cellular network. We consider embedded mobile as a subset of telematics, which relates to the use of any wireless technology—not just cellular mobile—to exchange data. Any machine, static or moving, located indoors or out, for both leisure and business use, could have cellular mobile communications embedded. Likely candidates include:

- **Transportation vehicles:** Passenger cars, freight trucks, fork lifts, cargo containers.
- **Monitoring devices (portable or fixed):** Healthcare monitors, security cameras, utility meters.
- **Point-of-sale devices:** Vending machines, credit card authorization terminals.
- **Consumer electronics:** Digital cameras, media players, games consoles.
- **Computing devices:** Laptop computers, Personal Digital Assistants (PDAs).

Embedded mobile communications helps machines operate more efficiently, resulting in lower costs and faster response times. It also extends their capabilities, opening the door to new business opportunities and, for end-users, new ways of both living and working. Sample applications include:

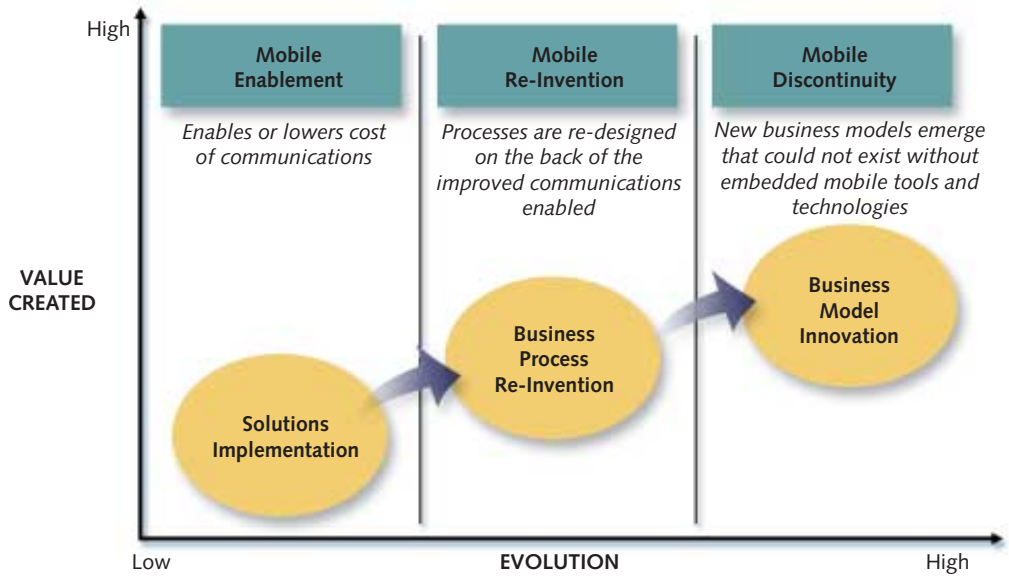
- **Transportation vehicles:** Cars that automatically call for help in emergencies, can be diagnosed and adjusted while on the road, and can provide drivers with real-time information about traffic, roadside services, etc.
- **Monitoring devices:** Portable health monitors for infants, the elderly, and the chronically ill, located at the patient's home, that allow doctors to constantly monitor patient status and respond quickly to problems without restricting the patient to a hospital bed.
- **Point-of-sale devices:** Vending machines that send an alert when in need of restocking or repair, request exactly what they need, and can have their pricing modified remotely. More advanced units could even offer on-demand digital content and real-time advertising downloaded through the cellular mobile network.
- **Consumer electronics:** Digital cameras can send pictures to friends and family shortly after they have been taken.
- **Computing devices:** PDAs can send and receive information, such as instant messages, e-mail, web pages and games.

The ultimate impact of an embedded mobile application depends upon the ambition and creativity in its design. In its simplest form, mobilizing the machine provides a basic communication link where none previously existed, or provides a lower cost alternative to conventional solutions (e.g. a fixed phone line). This basic approach—***mobile enablement***—can be powerful; but it is only the beginning. A more advanced approach—***mobile re-invention***—uses a machine's mobile communication capabilities to transform business processes, literally changing the way work is done. The most powerful approach—***mobile discontinuity***—uses embedded mobile in a way that drastically alters the business landscape, creating opportunities for business model innovation and new sources of revenue. The potential return on investment, and quantity of value generated, increases with each level, but so does the risk and complexity.

Mobilizing the machine will differ significantly from any previous communications innovation. While the technology involved is similar to that used in cellular phones, the industry model, market channels, and range of potential products is completely different. To thrive in this emerging market, businesses must understand and embrace these differences.

The industry model for embedded mobile solutions will bear little resemblance to the voice market's vertically-integrated model. A wider, more complex value chain will be needed to develop, market and maintain embedded mobile solutions. This will require all industry players to make a significant break from their current operating model.

FIGURE 1. A METHODOLOGY FOR MOBILIZING THE MACHINE




SOURCE: DELOITTE RESEARCH

The core players in the embedded mobile industry will be: network operators, cellular device vendors, original equipment manufacturers (OEMs), and specialist service providers:

## Network Operators

The network operator's primary role will be providing the cellular network infrastructure that makes mobile communication possible. Operators may also provide ancillary services such as third party billing, third party technical support, application hosting, and security. As embedded mobile is likely to generate a lot of additional data traffic, it will be an important potential source of revenue and growth. Mobile applications could also improve operators' margins—particularly if significant data traffic can be steered toward off-peak periods. To achieve this, operators will need to design new rate structures for embedded mobile applications that will be distinct from voice rates. Another difference that will challenge network operators is that with embedded mobile they will probably not own the customer relationship as they do with voice.

*There will be more invisibly connected (mobile communication without human intervention) machines and physical objects than visible humans from 2005 onward.*

Source: Forrester

## Cellular Device Vendors

For cellular device vendors, mobilizing the machine represents a new market, much larger than the person-centric voice market they have historically targeted. Machines currently outnumber humans by more than four-to-one, and that disparity will continue to grow. Embedded mobile devices will use the same underlying technology as cellular phones, but will be different in many other ways. They will be designed and sold as components that must integrate into other machines, rather than as standalone products. They will need to meet specialized requirements that vary greatly from one application to another, and must be able to withstand rough treatment and harsh environments. They will also be sold through a different sales channel than cellular phones.

## Original Equipment Manufacturers

Original Equipment Manufacturers (OEMs) will be able to enhance their products by embedding mobile capabilities, making those products more compelling in the marketplace. Communication capabilities and mobile applications add to a product's feature set and extend the way it can be used by both business and consumers. This extended functionality increases the product's appeal and widens its potential market. OEMs could also generate incremental revenue by offering value-added services made possible by mobilizing the machine.

## Specialist Service Providers

Specialist service providers will have a specialized understanding of a specific vertical or horizontal application, and will help integrate diverse components and services into a complete solution. They will also act as an intermediary between all other players. Specialist service providers will be a diverse group, of varying origin, ranging in size from small, independent companies to units of multinational system integrators.

The industry as a whole must address several key challenges before the potential of embedded mobile can be exploited. The most formidable of these is for all players to fully appreciate that mobilizing the machine is very different from the mobile voice business, in key aspects such as channels to market, pricing, customer ownership, partnerships. Another key challenge is collaboration. Embedded mobile applications will be too complex and specialized for any one company to deliver on its own. Industry players—even those not used to collaborating—will need to work together to deliver complete offerings. The requirement for close collaboration also implies a commitment to standardization. The embedded mobile industry will need to develop new sales channels capable of selling highly specialized solutions. Finally, the industry must carefully scrutinize potential applications, using a formal business case approach, to ensure those applications are truly worthwhile and economically viable. Marginally useful applications will damage the industry's reputation and limit growth.

*By 2007, there will be between 100 million and 160 million machine-to-machine connections worldwide that use wireless mobile phone networks (0.6 probability).*

Source: Gartner

Some of the industry's major challenges will need to be addressed by individual players. Network operators must develop a network infrastructure and rate plans appropriate to support embedded mobile. Specialist service providers must offer consumers bundled applications that justify the initial hardware investment. Device vendors must simultaneously standardize their devices for easy integration into other machines, while still allowing the devices to be customized for specialized applications.

The challenges involved in exploiting embedded mobile are significant; but the potential benefits are even greater. For enterprises that use embedded mobile, there is the potential for greater efficiency, improved business processes, and innovative new business models. The net results: lower costs, faster response times, better service, and most importantly—higher revenue. For network operators, mobilizing the machine represents a way to greatly extend the subscriber base and drive up data traffic. For cellular device vendors, machines are a vast new target market. For OEMs, embedding mobile in their products allows differentiation, has the potential to expand their customer base, and could even enable new product lines.

As the embedded mobile market evolves, potential applications will proliferate, and the opportunity for profit will be substantial. Those organizations that understand early on that this is a new market, not an extension of mobile voice; and that are prepared to embrace its unique challenges and opportunities, will be best positioned to reap its rewards.

# MOBILIZING THE MACHINE

The power of mobile telephony to connect individuals has already been clearly demonstrated; the potential from connecting machines is clearly significant but thus far little exploited. Embedding cellular mobile communications technology into machines—what we call "mobilizing the machine"—has the potential to be the first major communications breakthrough of the twenty-first century.

"Mobilizing the machine" means enabling a machine to transmit and receive information through a cellular connection whenever and wherever the need arises—limited only by the coverage area of the cellular network. Any machine, static or moving, located indoors or out, for both leisure and business use, could have cellular mobile communications embedded. Likely candidates include:

- **Transportation vehicles:** Passenger cars, freight trucks, fork lifts, cargo containers.
- **Monitoring devices:** Healthcare monitors, security cameras, utility meters.
- **Point-of-sale devices:** Vending machines, credit card authorization terminals.
- **Consumer electronics:** Digital cameras, media players.
- **Computing devices:** Laptop computers, Personal Digital Assistants (PDAs).

Embedded mobile communications will work on any type of cellular network: the second-generation (2G) networks that predominate today, the third-generation (3G) networks that are under development, and the intermediate (2.5G) networks that many network operators are currently deploying. However, embedded mobile applications will work better on 2.5G and 3G networks as these are more optimized for data transport. All cellular mobile standards are applicable: GSM (Global System for Mobile Communication), CDMA (Code Division Multiple Access), TDMA (Time Division Multiple Access), and PHS (Personal Handy-phone System).

> *Only 4 percent of all drink and vending machines are currently mobile-enabled, but this will grow to 38 percent by 2006, and will generate three billion dollars in revenues for operators.*
>
> Source: Arc Group, "Wireless Vending"

This Viewpoint focuses on the use of cellular mobile technology, which is expected to be the predominant means for mobilizing the machine. However, other wireless technologies such as Bluetooth (an inexpensive, short-range wireless technology) and GPS (the Global Positioning System) may be used to supplement cellular's capabilities for certain applications. A detailed discussion of embedded mobile technologies can be found in the appendix.

Embedded mobile applications can involve up to three types of communication: machine-to-person, person-to-machine and machine-to-machine. Each type of communication has its uses, and many solutions will incorporate all three.

Machine-to-person communication involves a machine sending a message to a human being over a cellular mobile network. These most often take the form of an alert or exception report that requires action. Examples are shown in Figure 2.

Person-to-machine communication involves a human being sending data to a machine over a cellular mobile network. This data could be used for a variety of tasks, including re-programming, requesting status, or executing a repair. Examples are shown in Figure 3.

FIGURE 2. EXAMPLES OF MACHINE-TO-PERSON COMMUNICATIONS

| | |
|---|---|
| **Remote Patient Monitoring** | A cardiac monitor alerting a physician if the patient's condition suddenly deteriorated, enabling an emergency response. |
| **Vending Machines** | A mobile-enabled vending machine requesting attention from a technician in the case of a technical fault, reducing down time. |
| **Driver Services** | A traffic information system alerting a driver in the event of an accident on his known route, allowing an alternate course to be taken. |
| **Car Rental** | A mobile-enabled rental car alerting the rental company if it was driven outside of its permitted boundary, allowing the staff to take immediate corrective action. |

SOURCE: DELOITTE RESEARCH

FIGURE 3. EXAMPLES OF PERSON-TO-MACHINE COMMUNICATIONS

| | |
|---|---|
| **Traffic Management** | Remotely reconfiguring the timing for a traffic signal, allowing traffic patterns to be quickly altered (perhaps in response to a traffic accident). |
| **Vending Machines** | Changing prices on a vending machine without requiring a site visit. |
| **Vehicle Services** | Remotely unlocking a car door; or turning on the air conditioning or heating in a car a few minutes prior to the owner arriving. |
| **Maintenance** | Conducting remote diagnostics and maintenance on a machine, saving the technician a visit to the site. |

SOURCE: DELOITTE RESEARCH

Machine-to-machine communication involves sending data between two or more machines over a cellular mobile network—without human intervention. Machine-to-machine communication is used in wide range of applications, from simple information exchange to remote maintenance. Examples are shown in Figure 4.

FIGURE 4. EXAMPLES OF MACHINE- TO-MACHINE COMMUNICATIONS

| | |
|---|---|
| **Cargo Monitoring** | A high-value cargo vehicle communicating its location at regular intervals to a monitoring station. No human intervention is required unless an exception occurs, such as the vehicle deviating from the agreed route. |
| **Vending Machines** | A vending machine communicating its stock levels to a central computer at the end of the day. |
| **Healthcare** | Healthcare monitoring equipment, such as a cardiac monitor or dialysis machine, communicating a patient's status to a medical database at the end of a day. |
| **Remote Access** | Overnight, automated downloading of files (e.g. e-mail) to a laptop computer or PDA. |
| **Vehicle Services** | Automated updating of a vehicle's navigational system to incorporate up-to-date information, such as road construction and weather forecasts. |

SOURCE: DELOITTE RESEARCH

# DEPLOYING EMBEDDED MOBILE

## Overview

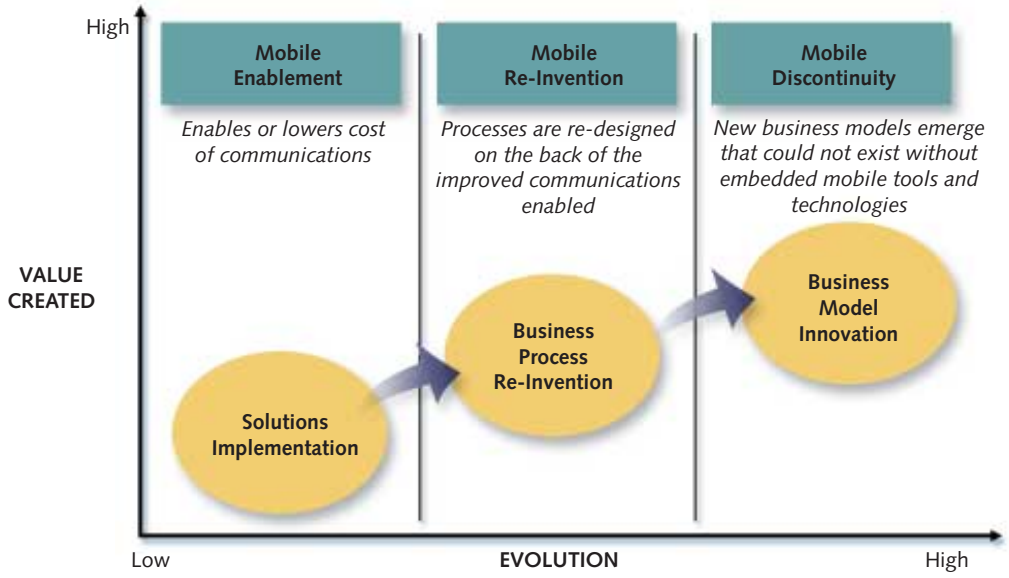
The core proposition of voice communications over cellular networks was the ability to communicate immediately. Suddenly, you didn't have to wait until you were at a fixed phone line. You could make calls wherever you were. And you could reach other cellular phone users immediately, wherever they happened to be. Mobile telephony thus allowed both business and social information to flow between people more quickly.

The fundamental benefit of mobile-enabling machines extends our base requirement for better communication to the billions of machines that are playing an increasing role in the global economy.

Mobile-enabled machines have the potential to help companies grow revenue and reduce costs. By enabling or improving communications, embedded mobile will allow information that we require from machines to reach people more quickly; similarly, it will be quicker for people to convey data to machines. In many circumstances, mobile-enabled machines will allow human intervention to be bypassed altogether. This enhanced communication will enable faster decisions, accelerated responses, and more appropriate actions.

Companies that have implemented embedded mobile solutions have already enjoyed significant benefits. A US based company[2] operating a network of 3,000 ice making

FIGURE 5. A METHODOLOGY FOR MOBILIZING THE MACHINE




SOURCE: DELOITTE RESEARCH

and packing machines, enjoyed numerous benefits by embedding mobile, including reduced machine down-time (50% lower), fewer on-site calls (over 75% less), increased production (10% per machine). A UK company[3] with a network of 100 vending machines experienced an increase in operational productivity of over 30%, resulting from more efficient delivery route planning, improved stock management and lower vehicle fuel bills.

## A Methodology for Mobilizing the Machine

The ultimate impact of the embedded mobile application will depend on the ambition and creativity in its design. We have identified three distinct approaches to mobilizing the machine (see Figure 5).

In its simplest form, mobilizing the machine provides a basic communications link where none previously existed, or provides a lower cost alternative to conventional solutions (e.g. a fixed phone line). In itself, this approach—what we refer to as ***mobile enablement***—can be powerful; but it's only the beginning. A more advanced approach—***mobile re-invention***—uses a machine's mobile communication capabilities to transform business processes, literally changing the way work is done. The most powerful approach—***mobile discontinuity***—uses embedded mobile in a way that drastically alters the business landscape, creating opportunities for business model innovation and new sources of revenue. The potential return on investment, and quantity of value generated, increases with each level, but so does the risk and complexity.

### Mobile enablement

The majority of applications will fall into the mobile enablement category, particularly in the initial stages of the market. Such applications require little investment; but their potential returns are limited.

There are two main types of benefit from mobile enablement. In the first case, embedded mobile establishes a basic communication link where none previously existed. In the second case, embedded mobile provides a lower-cost alternative to a conventional communication link (e.g. a fixed phone line). Good candidates for mobile enablement include:

- Machines that are **used when mobile**, such as vehicles and portable electronic equipment. For example, embedding mobile into a credit card authorization terminal would allow on-line transaction authorization in moving locations such as trains and buses. This would give travellers more payment options without increasing the risk of fraud.
- Machines that are **frequently moved between locations**, such as projectors, computer equipment and industrial diggers. Mobile enabling such devices—especially those that are extremely valuable and easily lost or stolen—would allow location tracking and improved security.
- Machines that are **frequently moved within a location**, such as cash registers in a retail store. Embedding mobile would make it easier to reconfigure the floor layout and move cash registers around, without needing to worry about the presence of a phone jack.
- Machines that are **located remotely but strategically**, such as roadside information panels on a major highway. These devices can be difficult to access with fixed lines, but are generally within the coverage area of a cellular network.
- Machines located in areas where there is difficulty in obtaining fixed connections. Even in developed countries, it can take several weeks to complete the installation of a fixed connection, but only minutes to install a mobile connection.[4]

### Mobile re-invention

With *mobile re-invention*, embedded mobile technology is used to dramatically improve information flows and transform business processes. Processes that previously involved periodic checks or reports can be virtually eliminated. Processes that relied on prediction and guesswork can be replaced by solutions that provide immediate responses to real-life events. Tasks that required face-to-face visits can be addressed remotely.

Examples of mobile re-invention include:

- Equipment that sends an alert when it needs maintenance, rather than requiring a technician to make periodic check-ups. This would save on unnecessary visits, and reduce the delay for repairs.
- Mobile-enabled meter readers that allow utility companies to monitor and set controls on individual home and business consumption, rather than relying on blanket brownouts and unenforceable watering guidelines.

- Mobile-enabled automobiles that could be alerted and pre-qualified in the event of a product recall on defective parts. This would help car manufacturers resolve the problem faster—enhancing consumer safety and reducing liability risk—while simultaneously avoiding the major expense associated with a full recall.
- Programmable electronic devices that can be maintained and repaired remotely.

### Mobile discontinuity

The most powerful application of embedded mobile is where it can enable new business models. An example would be using positioning information from vehicles to feed traffic information services.

The quality of a traffic information service depends on the quantity and quality of data sources. The most accurate traffic information services today are typically based on data obtained from traffic beacons located at the side of major roads. A major investment is required to set up such a system.

Yet the positioning systems that are increasingly being deployed in cars, combined with embedded mobile technology, could provide a far more powerful information gathering service. Vehicles would transmit their speed and position periodically via a built-in mobile modem. If the car's speed dropped, indicating a traffic jam, data would be sent more frequently. The more congested the area, the greater the flow of information. Thus during summer months, traffic information for coastal areas would automatically improve due to the higher concentration of vehicles. A service based on this approach would only be possible with embedded mobile.

## CASE EXAMPLE: POTENTIAL IMPACTS OF EMBEDDING MOBILE IN VENDING MACHINES

Any company developing an embedded mobile application should consider the three stages as an evolutionary process, starting with *mobile enablement*, progressing to *mobile reinvention*, and evolving finally to *mobile discontinuity*. The investment required for each stage is greater, but so is the potential value generated. Consider the example of a soft drink vending machine. Figure 6 shows how embedding mobile can both generate revenue and cut costs.

*Mobile enablement* of a vending machine provides a basic communications link to the management company administering the device. The additional investment required would generally be limited to the cost of implementing the mobile capability.

In many cases, communicating through a fixed line would also be an option. However, embedded mobile would generally be a better choice for the following reasons:

- Vending machines are often moved around.
- The vending machine company may not own the property where the machine is located, greatly complicating the installation of a phone line.
- It may cost more money, and would certainly take more time, to install a fixed line.

Mobile enablement would allow the vending machine to send the management company information on stock levels and operational state. This data could be used to allow a quicker response to breakdowns, and to improve stock availability. The fix process for vending machines today is primitive. Typically, a breakdown causes a small red light in the front of a machine to be lit, indicating that the machine needs service. It may be some time before anyone notices the problem and places a call to a technician. In the meantime, revenue is being lost. A mobile-enabled vending machine would send an immediate alert to a technician, significantly reducing down-time and lost revenue.

The present stocking procedure for vending machines is similarly crude. Low stock levels can generally only be determined by opening the door and looking

inside. A mobile link could provide a timely alert of low stock, prompting replenishment and reducing the chance of lost sales. Mobile enablement could also make it possible to set prices remotely, once again removing the need for an on-site visit.

*Mobile re-invention* would take the improvements to a higher level by transforming many of the processes used to manage vending machines. This would require a higher level of investment. In addition to the cost of the embedded mobile technology, additional funds would need to be allocated for business process redesign and for data analysis software.

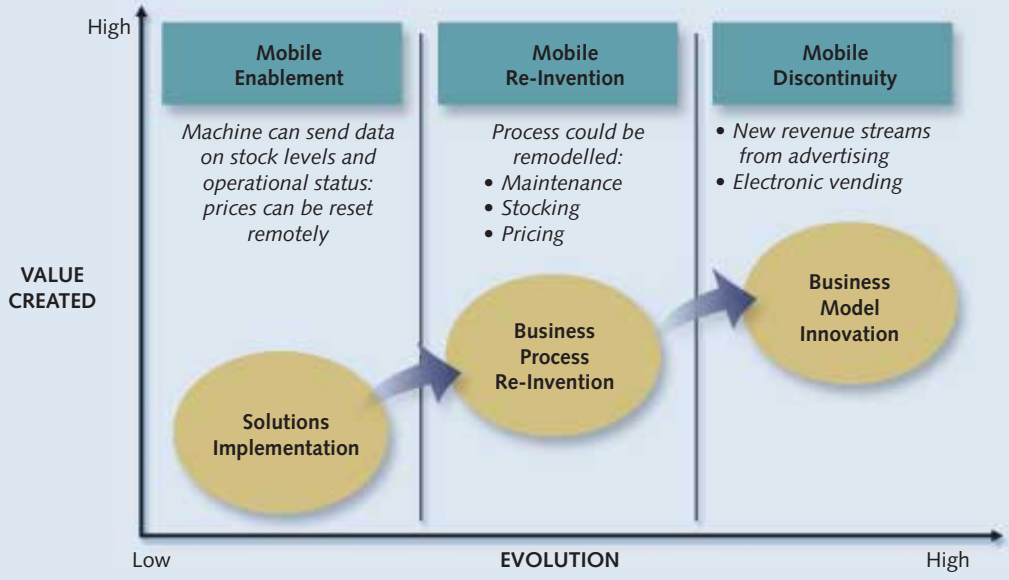
Redesigned processes could include:

- **Maintenance:** In the event of a machine breaking down, the communications link would not only advise of the problem, it could also provide details. This would enable the technician to bring the necessary parts, increasing the probability of a first-time fix. If the problem were software based, it could even be fixed remotely.
- **Stocking:** A mobile-enabled vending machine could communicate its exact inventory prior to the delivery, meaning less stock would have to be carried and potentially allowing a greater number of vending machines to be filled on a round. Daily stock information could also be used to monitor the impact of new product introductions.
- **Pricing:** The mobile link could provide a steady stream of pricing data, allowing the company to optimize prices and maximize profitability. The link could also enable dynamic pricing, with adjustments based on environmental and seasonal factors. Prices could drop during cold spells, and be increased during summer months. The embedded mobile capability might also be used to enable new payment methods, such as payment via a mobile phone.

*Mobile discontinuity* would take the improvements to the highest level by generating new revenue streams. The additional investment required would include upgrading the vending machines to support additional services, and associated marketing costs.

Vending machines today are used to sell physical product. Applying a mobile discontinuity approach to vending machines might see them also being used as a channel for digital marketing and products. As vending machines are often located in public places, they can be very effective for advertising. Two approaches are possible. Text-based advertising could be updated continuously. Rich media advertising, such as video, could be downloaded overnight. Both cases would provide an additional source of revenue. Vending machines could also be used to sell electronic content, such as music, screen-savers and ring-tones. Content could be downloaded during quiet periods, then transferred to personal digital assistants (PDAs) or phones over a short range communications technology such as Bluetooth or Wireless LAN.

FIGURE 6. EMBEDDED MOBILE CASE EXAMPLE–VENDING MACHINES




SOURCE: DELOITTE RESEARCH

## Mobilizing the machine in vertical sectors

Every vertical sector that uses machines can benefit from embedded mobile. Each sector should evaluate its information flows, and identify where embedding mobile could improve this. Figure 7 provides examples of current and hypothetical embedded mobile applications that apply to various vertical sectors. The impact of these applications range from just providing a mobile connection (mobile enablement), to driving business process improvements (mobile re-invention), to creating new business models (mobile discontinuity).

FIGURE 7. MOBILE-ENABLED APPLICATIONS FOR SELECTED VERTICAL SECTORS

| SECTOR | APPLICATIONS |
|---|---|
| **Advertising** | • Remotely updating digital advertising displays, located in various places from parking meters to billboards. For example, a billboard for a supermarket could advertise its latest offers, updated hourly, on a scrolling display. |
| **Agriculture** | • Communicating soil, temperature, and humidity data to a central monitoring unit to provide early notice of adverse conditions. Early notice of conditions, such as frost for sensitive crops (e.g. grapes or tobacco), could allow a harvest to be saved. |
| **Automotive** | • Alerting emergency services automatically in the event of an accident (e.g. when the vehicle's air-bag is deployed).<br>• Providing drivers with in-vehicle information on traffic, maps, news, local restaurants, etc. |
| **Healthcare and Pharmaceutical** | • Remotely monitoring patients—especially infants, the chronically ill, and the elderly—allowing them to spend less time in the hospital. This would improve patient comfort and reduce costs.<br>• Remotely gathering drug trial data, leading to faster and more frequent feedback than with hospital-based data gathering. |
| **Financial Services** | • Authorizing credit card transactions in locations without fixed connections, e.g. trains and temporary exhibition centers.[5] This could reduce the quantity of fraudulent transactions. |
| **Media** | • Wirelessly transmitting press photographs (low to medium resolution) where immediacy is more important than image quality. This could be based around digital cameras with embedded mobile capability. |
| **Retail** | • Maintaining and programming vending machines. Machines could alert stock clerks to low stock levels and technicians to mechanical breakdowns. Prices could be updated remotely. |
| **Transport** | • Tracking the location of cargo and hired vehicles.<br>• Remotely controlling vehicle functions (e.g. disabling the engine of hijacked cargo vehicles or rental cars). |
| **Utility** | • Automated meter reading in areas of light population.[6] Deployment would work best in multi-service offerings, where the utility provides a range of services (e.g. security) in addition to gas, water, and electricity.<br>• Transmitting weather information wirelessly from remote monitors. This could be cheaper than providing a wireline connection. |

SOURCE: DELOITTE RESEARCH

# THE INDUSTRY MODEL FOR EMBEDDED MOBILE

## Introduction

The industry model for embedded mobile solutions will differ fundamentally from that for voice solutions. It will not be the vertically-integrated model that characterizes today's mobile voice market. A wider, relatively complex value chain will be required to develop, market, and maintain the solution. Each of the players will need to make a significant break from their current operational model to address this market.

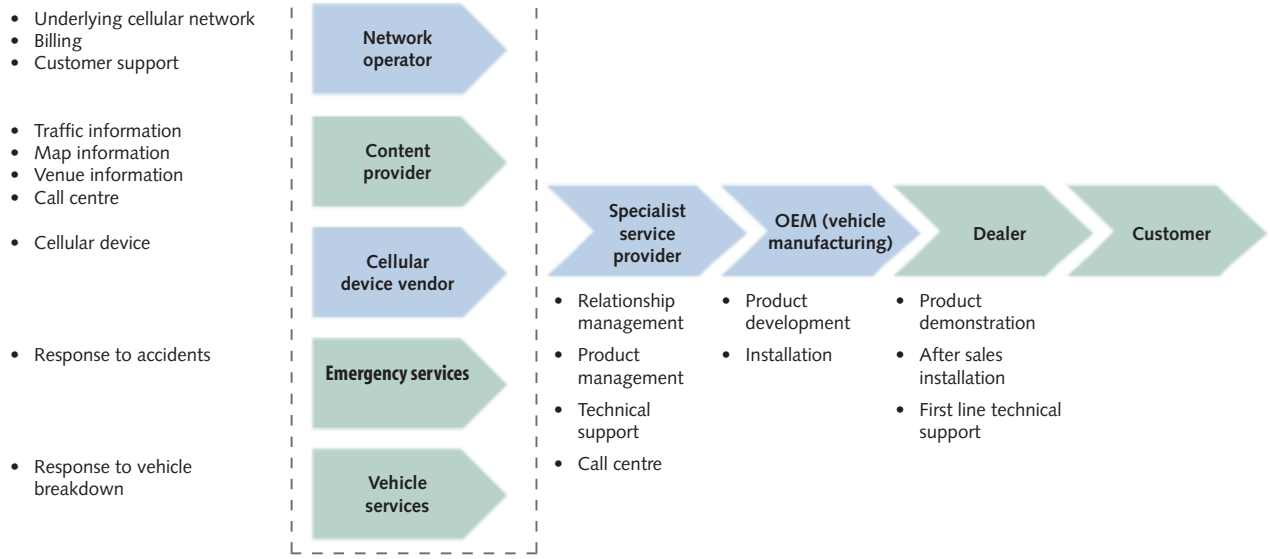
The following are the core players that will collectively underpin the embedded mobile market:

- **Network operators** will provide the underlying cellular network infrastructure.
- **Cellular device vendors** will provide the communication devices that enable connection with the cellular network.
- **Original Equipment Manufacturers (OEMs)** will make the machines in which mobile capability is embedded.
- **Specialist service providers** will act as an intermediary between all players to develop applications and solutions, and will likely be a channel to market.

Other vendors provide niche services that are specific to a particular application. These niche services cover a broad range including specialized content, repair services, and call center support–to name just a few.

Figure 8 shows a typical value chain for an embedded mobile application. Although the example focuses on in-vehicle services and roadside assistance, the number of players and the complex collaborations shown are typical of what is needed to deliver an embedded mobile solution. The key players that are common to every embedded mobile application are shown in yellow. One thing to note is that many of these key players will need to take on a different role than what they're accustomed to. The remaining sections of this chapter describe in detail the roles, opportunities, and challenges for each of the key players.

FIGURE 8. THE INDUSTRY MODEL FOR EMBEDDED MOBILE SOLUTIONS: CASE EXAMPLE OF VEHICLE SERVICES




SOURCE: DELOITTE RESEARCH

# Network Operators

## The role of the network operator

The network operator will play a variety of roles in the provision of embedded mobile applications. Its core contribution common to all mobile applications will be to provide the underlying cellular communication infrastructure. In addition, the operator may provide associated services such as: third party billing, third party technical support, application hosting and security. With voice services, which have a high degree of vertical integration, the operator often owns the customer relationship. That will generally not be the case with embedded mobile.

## Infrastructure provision

The network operator's core role is to provide the network infrastructure used for mobile communication. Operators whose infrastructure best meets the unique requirements of embedded mobile applications will become the favored providers, and will be able to charge a premium. Selection criteria vary from one application to another, but generally include:

- quality of service levels available;
- traffic prioritization;
- bandwidth;
- coverage;
- capacity;
- reliability;
- existing roaming agreements.

For example, quality of service and traffic prioritization are major considerations for a medical application. Operators that can assign levels of urgency to files, and can guarantee delivery within an agreed time period, have a better chance of being selected as the underlying network provider for those critical types of applications.

## Additional network related services

Network operators may also provide additional network-related services that add to their potential revenue stream. These additional services include:

- *Third Party Billing*–re-branded billing services on behalf of other vendors (see Figure 9 for an example of an operator providing this service).
- *Third Party Technical support*–outsourced technical support services.
- *Hosting*–application hosting on behalf of their clients.
- *Security*–privacy protection and data security, particularly for financial and business-to-business applications.

## The opportunities for network operators

Mobilizing the machine is a very important business trend for network operators. Embedded mobile has the potential to generate significant amounts of additional data traffic and revenue. Furthermore, if packaged astutely, embedded mobile applications could help drive up an operator's margins.

FIGURE 9. FORD AND VODAFONE – JOINTLY DELIVERING ENHANCED DRIVER SERVICES

Ford and Vodafone in Europe have collaborated to launch an in-vehicle service, branded fordtelematics. This is available in Ford's Focus and Mondeo models. The service is based around a dashboard mounted unit with four buttons, each of which provides access to four services, namely: "emergency" (requests assistance in the event of an accident); "operator" (provides driver assistance from a live agent such as driving directions, local hotel recommendations); "traffic" (localized information); "communication" (voice activated dialing). The unit includes cellular mobile capability with voice and SMS support, and GPS for positioning. The service was jointly developed by Ford and Vodafone, but also includes products and services from third parties. Motorola supplies the cellular mobile capability; traffic information and vehicle recovery services are provided by the Automobile Association. Vodafone, whose subscriber identity modules (SIMs) are embedded into the telematics module, also provides billing and customer service. Ford provides marketing and customer management, and its dealers work directly with the customer.

Generating data traffic from embedded mobile applications is directly in line with most operators' objective of raising the contribution of data to their overall revenues. Several of the largest network operators aim to generate over 20 percent[7] of overall revenues from data by 2004. At present, for most operators, the sole driver for data is person-to-person messaging (i.e. Short Messaging Service, commonly referred to as SMS).

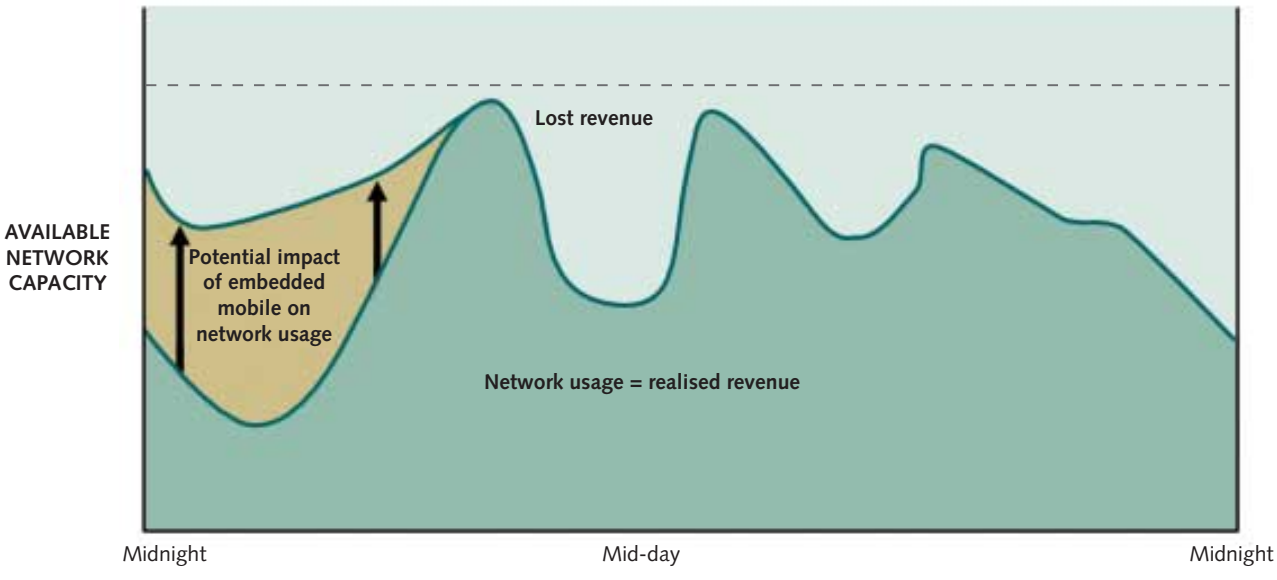
Success in mobilizing the machine implies both additional traffic and an extension to the customer base. And since much of the additional business will come from the huge number of machines that have yet to be mobile-enabled, mobilizing the machine could allow network operators to attractively position their industry as "high-growth" rather than "mature."

*"There will be tens of millions of wirelessly connected machines in 2003".*

Source: Julian Phillips, Head of Customer Solutions, Orange, quote in ci-online

FIGURE 10. EMBEDDED MOBILE'S POTENTIAL IMPACT ON CELLULAR NETWORK UTILIZATION

- This leaves large trenches of unsed capacity
- Embedded mobile applications can be designed to utilise currently unused network capacity, adding directly to an operator's bottom line




SOURCE: DELOITTE RESEARCH

Embedded mobile could also be a key driver of operator profitability, particularly if some of the data traffic can be steered toward the network's off-peak periods. Network infrastructure is a sunk cost, and operators have predictable periods when they know the network will be under-utilized. A typical operator's network is less than 10 percent occupied between 1am and 7am on weekdays, as shown in Figure 10. Given the 24/7 characteristic of some embedded mobile applications, if operators could drive traffic usage toward the under-utilized periods, the additional business could be handled with essentially no marginal cost.

In addition to increases in data traffic, embedded mobile offers operators the opportunity to sell associated services such as security, application hosting, and premium service levels.

### The challenges for network operators

Network operators will encounter three major challenges as they make the transition from mobile voice to embedded mobile. First, many will need to upgrade their voice networks to efficiently handle embedded mobile applications. Second, they will need to develop new rate structures that address the unique aspects of mobile data. Finally, they will need to relinquish their traditional role as the primary sales channel and owner of the customer relationship. Collaboration—though possibly unfamiliar to them—will be the only way to succeed in the embedded mobile market.

For a detailed discussion of these and other challenges, please refer to the section: Key challenges to mobilizing the machine.

## Cellular Device Vendors

### The role of cellular device vendors

The role of cellular device vendors in the embedded mobile market will be to supply the devices that enable communication over a cellular network. This is similar to their present role in the voice market. However, most of today's mobile communication devices (i.e. cellular phones) are standalone, ready-to-use products targeted at the end-user. Embedded mobile modules are components that will be sold to OEMs and resellers for integration into other products.

The manufacturers that will develop mobile modules for embedding in other machines will come from two main groups. The first group is comprised of existing major mobile phone manufacturers such as Nokia, Motorola, Siemens, and Sony Ericsson. The second group is comprised of specialty manufacturers that have historically developed niche wireless products, such as cellular mobile PC Cards, or cellular mobile devices for PDAs. Companies in this category include Novatel Wireless and Sierra Wireless.

### The opportunities for cellular device vendors

Mobile device vendors—which to date have generated most of their business from the manufacture of mobile phones—have for a long time enjoyed a constantly growing market. 2001 was the first year that global volumes of mobile device shipments actually fell. Predictions for 2002 have since been revised down. The reality is that the available market for mobile phones is nearing saturation. And so far the industry has been unable to motivate owners of existing phones to upgrade their devices in sufficient quantities to support continued sales growth.

Mobilizing the machine represents a new and much larger market. Around the world, machines currently outnumber humans by four-to-one, and the disparity continues to increase. All kinds of machine could be mobile-enabled. Examples include:

- **Personal Productivity Tools:** Personal digital assistants (PDAs), handheld electronic tablets, laptop computers.
- **Consumer Electronics:** Digital cameras, media players, handheld gaming devices.
- **Vehicles:** Industrial vehicles such as fork-lift trucks, passenger vehicles, freight vehicles.
- **Monitoring equipment:** Healthcare monitors such as dialysis machines, security devices at construction sites.
- **Traffic management:** Traffic signals, information boards.

While unit prices for embedded mobile devices might ultimately fall below that for person-oriented mobile phones–and there is less room for fashion as a motivation to upgrade–the unit volume potential is far higher.

### The challenges for cellular device vendors

Although embedded mobile devices use the same underlying technology as cellular phones, they present a different set of design challenges. As components that are integrated into other machines, they must be standardized to fit within a variety of products, while at the same time supporting sufficient customization to meet the requirements of highly specialized applications. They must also be able to withstand rougher treatment and harsher conditions than the typical mobile phone.

In addition, embedded mobile products will have different sales channels than voice products. Cellular device vendors will need new sales teams focused on OEMs and specialist service providers.

For a detailed discussion of these and other challenges, please refer to the section: Key challenges to mobilizing the machine.

## Original Equipment Manufacturers (OEMs)

### The role of Original Equipment Manufacturers (OEMs)

The role of original equipment manufacturers will be to embed mobile communications into their machines where appropriate, and to provide a channel to market. A wide range of OEM products could be mobile embedded—everything from PDAs to motor vehicles. In order to succeed, OEMs will need to collaborate pro-actively with the other industry players.

### The opportunities for Original Equipment Manufacturers (OEMs)

Embedded mobile capabilities make an OEM's products more compelling in the marketplace. Communication capabilities and mobile applications add to the feature set and extend the way a product can be used. This extended functionality increases the product's appeal and widens its potential market.

Standard products could be customized to individual tastes and requirements using information exchanged over a mobile channel. For example, a car's performance characteristics could be adjusted remotely by the manufacturer based on the customer's driving behavior. If a car is driven hard, the manufacturer might download a sports profile into the car, including changes such as firmer suspension, stronger braking ratios and more responsive engine settings.

Embedded mobile could improve customer relationship management. The mobile channel could provide a useful feedback loop to the manufacturer. Beta testers of a new product could send feedback via this channel. Vehicle owners–who traditionally only have a relationship with the dealer–would then have a means to communicate directly with the manufacturer.

*There will be 56 million mobile-enabled cars by 2005.*

Source: Arc Group, "Automotive and Freight Telematics"

OEMs could also use embedded mobile to improve service quality. Manufacturers of high value machinery, for instance, could embed mobile communications that enable remote diagnosis and maintenance. This would reduce the machinery's down time.

Mobilizing the machine could change the way a product can be used, thus increasing its potential target market. For example, medical equipment with embedded mobile could leave its traditional province of the hospital and move into the home, with the integrated communications capability allowing physicians to monitor the patient remotely.

Finally, OEMs could boost their revenue by offering value-added services that take advantage of the mobile communication link.

### The challenges for Original Equipment Manufacturers (OEMs)

OEMs need to determine if embedding mobile communications into their products makes sense. The assessment is a two-step process:

The first test is whether mobile can indeed work within a given product. Assessments on issues such as technical interference and performance need to be made. For example, a hand-held games vendor would need to test the impact that embedding mobile would have on battery life. A medical equipment vendor would need to ensure that readings would not be affected by cellular transmissions.

The second test is whether a viable application can be built around cellular capability. For some applications, mobile would have a significant impact. In other cases, little value would be added. Embedding mobile into a vehicle offers little benefit if this additional functionality would rarely be used (e.g. only when an airbag deployed). It represents a far better sales proposition if it would provide everyday benefit (e.g. updating navigation systems). Embedded

# CASE STUDY: ON-STAR PASSENGER VEHICLE TELEMATICS

One of the best known embedded mobile applications is GM's OnStar service. OnStar originally launched in 1996, debuting on the premium Cadillac product line. The service had over 1.5 million subscribers at the end of 2001, and is currently available on most models from the various GM brands: Buick, Cadillac, Chevrolet, GMC, Oldsmobile, Pontiac, and Saturn. OnStar has also recently become available on some non-GM cars, including models from Acura and Saab. It seems the product has evolved beyond its GM roots, and can now compete in the marketplace on the strength of its own merits.

GM fits OnStar as standard on selected (typically premium) models and is available as a factory fitted option on others. Typically, subscription for the first year is included in the price of the car, with renewals costing between US$200 and US$400 per year. Renewal rates are above 50 percent,[8] with the company aiming to improve that measure to 60 percent.[9]

On Star services are a mixture of voice and data services. The voice services are based around access to advisors, while the data services represent a more innovative use of automation.

Customers access OnStar's facilities via a three-button user interface on the car dashboard. Services are generally requested by the driver, although a few are automatic. An example of a driver-requested function is remote unlocking of the car if the driver is locked out. An example of an automatic service is notification of emergency services when an airbag deploys.

OnStar offers three service packages ("Safe and Sound", "Directions and Connections", "Luxury and Leisure") offering a mixture safety, information and concierge services. The services within each bundle are shown in Figure 11.

FIGURE 11. ONSTAR SERVICE BUNDLES

| | | PACKAGES | | |
|---|---|---|---|---|
| SERVICE | DESCRIPTION | Safe and Sound | Directions and connections | Luxury and Leisure |
| **Air Bag Deployment Notification** | OnStar is alerted if your air bags deploy and contacts you to offer assistance. | ● | ● | ● |
| **Personal Calling** | Voice-activated nationwide wireless calling service. | ○ | ○ | ○ |
| **Virtual Advisor** | Voice-activated access to web-based information. | ○ | ○ | ○ |
| **Emergency** | Emergency services is contacted with exact location. | ● | ● | ● |
| **Stolen Vehicle Tracking** | Advisors can locate a stolen vehicle by satellite and contact the police. | ● | ● | ● |
| **Remote Door Unlock** | We can send a signal to your car's computer to unlock your doors. | ● | ● | ● |
| **Remote Diagnostics** | We can run a diagnostic test of your engine-while you drive. | ● | ● | ● |
| **Roadside Assistance** | Provides roadside assistance by providing location information to services. | ● | ● | ● |
| **Accident Assistance** | Walks through 'best practices' to-do list. Can inform insurance company, police and emergency services. | ● | ● | ● |
| **OnStar MED-NET** | Forwards medical history and allergies to emergency medical services personnel. | ○ | ○ | ● |
| **Online Concierge** | Searchable database of travel, shopping, entertainment etc. maintained by local concierges. | ● | ● | ● |
| **Route support** | Operator assisted guidance to destinations. | | ● | ● |
| **Information/convenience** | Information about local conveniences such as gas stations or ATMs. | | ● | ● |
| **Ride Assist** | Calls a relative/friend or a taxi if the vehicle cannot be driven or the driver cannot drive. | | ● | ● |
| **Personal Concierge** | Personal concierge services at home or on the road. | | | ● |

○ = Additional charges apply

SOURCE: WWW.GM.COM, WWW.ONSTAR.COM

mobile applications that offer little value to the customer will damage the market's reputation.

OEMs will in some cases represent the channel to market. This is most likely to occur where mobile is providing additional value to an existing product, and where product usage is not complex.

As with all players in the value chain, collaboration will be key. OEMs must have firm and frequent communication with device vendors on product specifications and product design processes. OEMs will also need to work with network operators for performance testing. For more complex applications, OEMs will need to work with specialist service providers.

For a detailed discussion of these and other challenges, please refer to the section: Key challenges to mobilizing the machine.

## Specialist Service Providers

### The role of specialist service providers

The role of specialist service providers will be to combine an understanding of a specific vertical sector or horizontal application with a knowledge of the capabilities and constraints of cellular mobile networks and available embedded mobile devices. These providers will act as an intermediary between all of the other players required for a particular application, and will assemble the various components into a total solution.

Specialist service providers will be a diverse group, of varying origin, ranging in size from small companies to major units of multinational system integrators. The specialist service provider might be a business unit within a larger company, or an independent enterprise. Specialist service providers are most likely to be affiliated with:

- System integrators.
- Mobile service providers.
- Horizontal/vertical specialists.
- OEMs.

System integrators are likely to take on an expanded role. This group's skills in project management and alliance-based product development could be needed in order to develop mobile applications. More complex implementations will require specialist integrators to deploy the solution, and possibly to act as one of the channels to market.

Where an OEM is the specialist service provider, its role could include acting as project sponsor and manager. It would be responsible for defining applications that would be offered and for selecting the third parties required to deliver the overall solution.

Mobile service providers migrating into the embedded mobile space are most likely to serve as a sales channel. In this role, their key to success will be their ability to train, educate and support customers.

Specialist service providers in existence today include:

- TRI-MEX,[10] which provides high-end road-cargo security that includes embedded mobile capability as a key component.
- OnStar, a subsidiary of General Motors (GM), which has developed an embedded mobile solution for cars produced by GM and by other manufacturers.
- Vianet,[11] which enables "smart vending management" through vending machines with embedded mobile capability.

### The opportunities for specialist service providers

#### System integrators

Acting as specialist service provider will allow system integrators to generate incremental revenue and to diversify their scope of services. Given the complexity of embedded mobile solutions, system integrators are likely to play a major part. Appropriate roles would include project management, procurement, design, implementation and support.

#### Mobile Service Providers

The complexity of embedded mobile may justify the return of the mobile service provider. This niche segment, which originally emerged to advise a then bewildered public on the vagaries of cellular voice services, has seen its role gradually marginalised. Embedded mobile communication and other mobile data services re-introduce complexity into the mobile market–creating an opportunity for the mobile service providers. The current mass-market channels for mobile voice services are not adequate for embedded mobile solutions. Mobile service providers that specialize in mobilizing the machine could help educate the market, design solutions, implement systems, train users and provide technical support.

## Horizontal /vertical specialists

Horizontal and vertical specialists are experts in a particular horizontal or vertical market. For instance, a horizontal specialist might be an expert in sales force automation, or supply chain management. A vertical specialist might be an expert in the transportation industry, or in health care. These specialists could diversify their scope of activity through enabling embedded mobile solutions. They would use their knowledge and experience to identify where embedded mobile could add value, and would act as an intermediary between network operators, cellular device vendors and end-user enterprises.

## OEMs

OEMs might become specialist service providers for two reasons: it could be the only way to take an embedded mobile solution based on their product to market; or it might be a logical way to diversify their business.

Some OEMs might incubate these activities and then spin them off. Likely reasons for this include: giving the business unit more freedom; viewing the business as a non-core activity; or recognizing that the business can only be cost-effective if it is allowed to seek customers outside of the parent company. Another reason could be that the product life cycles for embedded mobile devices and for the OEMs' other products are simply too different. That might be why several car makers started out developing in-car mobile solutions for their own brands, then subsequently offered the package to other vendors.[12]

*A travelling executive may make a dozen calls per day, but her car may have 100 tiny GPRS sessions.*

Source: Forrester

# CASE STUDY: USE OF EMBEDDED MOBILES IN FREIGHT SECURITY

Embedded mobile can play a part in the protection of high value cargoes transported by truck. These cargoes—whose value can be in the millions of dollars—are increasingly under threat from organized crime. In Europe alone, 10 billion are lost annually and there are an average of three major hijacks every working day. Chubb, a security firm, has estimated that 10 percent of the price of consumer technology—one of the biggest targets for such robberies—covers the cost of losses in the supply chain. Embedded mobile can be used to improve the security available to such cargoes.

TRI-MEX—a specialist European provider of technology-enabled security solutions, has introduced the use of embedded mobile technology for the protection of high value freight. TRI-MEX installs a custom designed mobile communication unit that incorporates three wireless technologies: Short Messaging Service (SMS) over Global System for Mobile Communication (GSM), satellite, and ultra-high frequency (UHF). Multiple technologies are used as no single technology is yet reliable enough at all times, in all geographies. These communications means are used to send the vehicles location (generated via GPS) and other status information. Any deviation from the expected route or any unexpected condition changes such as unauthorized door opening, movement inside the trailer or a tampering - trigger an alarm at TRI-MEX's 24/7 multi-lingual control center in Norway. Status is verified by a number of means including contacting the Client, a voice call to the driver or review of traffic information. If there is no reasonable explanation for the alarm, the police are contacted directly. Uniquely TRI-MEX has permission to do this in any country across Europe.

The use of embedded mobile technology is an alternative to more labor intensive approaches. One approach is to have an escort vehicle follow the cargo, but this is expensive, especially when both have the ability to reduce insurance premiums.

TRI-MEX have now taken this embedded mobile technology even further by integrating RFID with its existing technology so that individual items, pallets, cages can be monitored, whilst moving through the supply chain. This is particularly important to companies that lose cargo on a small but incremental, part-consignment basis, rather than losing whole consignments. This service also provides condition monitoring of individual items moving through the supply chain.

TRI-MEX have also recently released an open-platform service named EUROWATCH which provides any transporter using any form of embedded mobile technology with the ability to contact police across Europe in the event of criminal incidents.

# KEY CHALLENGES TO MOBILIZING THE MACHINE

## Introduction

The embedded mobile market has considerable appeal, with major benefits for both customers and suppliers. However, there are key challenges that the market needs to address before the gains can be realized which we discuss in this section. Figure 12 summarizes the key challenges and the market player(s) which each is applicable to.

Some of these challenges are directed at particular key players; others are directed at the entire industry. What matters most is that all of these challenges are adequately resolved. Until that happens, the embedded mobile market will not be able to achieve its full potential. In this chapter, we will examine each of these challenges in more detail.

## Recognize that Mobilizing the Machine Is Different than Mobile Voice

The entire industry—both suppliers and customers—should respect mobilizing the machine as a standalone sector. It is not a simple extension of the mobile voice offering.

Network operators must understand that while mobilizing the machine is based on the same cellular network as that used for voice services, in most other respects the offering differs. Characteristics such as time of usage, frequency of usage, file size, and customer base will all be different. Consequently, rate structures, sales channels, service levels, and technical support must all be re-designed with embedded mobile in mind.

FIGURE 12. KEY CHALLENGES TO MOBILIZING THE MACHINE

| | NETWORK OPERATORS | CELLULAR DEVICE VENDORS | OEMs | SPECIALIST SERVICE PROVIDERS |
|---|---|---|---|---|
| Recognize that mobilizing the machine is different than mobile voice | ● | ● | | |
| Collaborate to develop and deliver solutions | ● | ● | ● | ● |
| Operate through new sales channels | ● | ● | | |
| Use a rigorous business case approach | ● | ● | ● | ● |
| Improve network quality for data use | ● | | | |
| Define a new rate structure | ● | | | |
| Offer consumers bundles of services | ● | | | ● |
| Design applications specifically for embedded mobile | ● | | | ● |
| Design specialized devices to meet unique requirements | | ● | | |

SOURCE: DELOITTE RESEARCH

Cellular device vendors must throw away many of the rules they have developed for selling voice-centric phones. With embedded mobile:

- The network operator might no longer be the primary sales channel.
- The end-user might well be a machine, not a human, and the device might need to fit and inter-operate with a totally different kind of machine.
- OEMs might derive more revenue from add-on services than product sales, which for some OEMs would be a completely new operating model.
- Enterprises considering embedded mobile solutions should consider them analogous—in terms of investment and complexity—to extending their technology infrastructure. It's nothing like the simple process of outfitting employees with mobile phones.

## Collaborate to Develop and Deliver Solutions

Embedded mobile applications will be too complex and specialized for most companies to develop and deliver on their own. Instead, different players will need to collaborate to provide a total solution. Collaboration is vital to the success of the embedded mobile market.

Prospective partners face many challenges. Most have not worked together before. Some players, such as network operators, will need to take on a different scope of activity. The vast majority of operators are focused on voice services, not data services. Mobile voice is a vertically integrated application requiring few partnerships. Operators are hence used to owning the value chain.

Embedded mobile will require operators to focus on providing the underlying infrastructure, and in many cases sharing or ceding customer ownership to a partner. The reality is that most operators lack the specialized knowledge required to deliver an end-to-end embedded mobile solution. For example few operators would be capable of building an embedded mobile solution from scratch.

The move to a collaborative model will initially be slow and painful, but is essential to the success of the embedded mobile market.

## Operate Through New Sales Channels

In the mobile voice market, network operators traditionally serve as the primary sales channel. In the embedded mobile market, that will generally not be the case. Network operators will need to relinquish "ownership of the customer" to the specialist service providers, which have deep knowledge and expertise around particular horizontal or vertical applications.

OEMs will in some cases represent the channel to market. This is most likely to occur where embedded mobile is providing additional value to an existing product, and where product usage is not complex.

Cellular device vendors in the embedded mobile space will need to create dedicated sales teams to build relationships with these new sales channels.

## Improve Network Quality for Data Use

Cellular mobile networks are currently optimized for voice communications. The embedded mobile market will get a boost when operators configure their networks for machine-based mobile applications.

Mobile networks have improved significantly in quality since their introduction in the 1980s. In many developed countries, population coverage is now close to 100 percent, while geographic coverage is typically over 80 percent. Capacity has also been increased in areas of high demand. The result of these improvements is that network quality is generally sufficient for voice calls.

However, there are three key areas in which service must be improved for the embedded mobile market to attain its potential. These are:

- Quality of Service Levels.
- Network Coverage.
- Secure Transmission.

### Quality of Service Levels

At present, few operators offer quality of service levels for their data services. This effectively restricts the use of embedded mobile in critical applications. Consider the example of a mobile-enabled heart monitor where timely and reliable message delivery can mean the difference between life and death. If the network cannot guarantee immediate delivery of urgent messages, the value of such an application is severely compromised.

Quality of service is possible, but technically hard to implement retrospectively, on second-generation (2G) networks. Unfortunately, those represent the vast majority of networks in operation today. The good news is that 2.5G networks, the interim network technology being used to bridge between current 2G networks and third-generation (3G) networks, can support prioritization. It is possible to assign higher levels of urgency to certain packets, making it much more likely that urgent data will arrive quickly.

Network operators should ensure that they design the network to support quality of service when rolling out 2.5G networks. As of the second quarter of 2002, more than 100 operators had launched 2.5G networks, yet there are few networks that incorporate quality of service guarantees.

### Network coverage

The market for embedded mobile applications will grow in direct relationship to the available cellular network coverage. There are three areas where coverage is currently weak: in very remote areas, inside buildings, and underground. This constrains the reach of certain embedded mobile applications.

### Secure transmission[13]

Data security is a major issue for applications that involve sensitive information. Examples include health care records, financial transactions, and other types of commercially-sensitive data. For these types of applications, additional security provisions—including secure transmission of data—will be required.

## Define a New Rate Structure

### Standardized Pricing

Network operators–as a group–must work together to develop more consistent pricing for their data services. At the moment, pricing varies considerably for both SMS (Short Messaging Service) over GSM (Global System for Mobile Communication) and for data services running over 2.5G networks. The cost of an SMS message varies between 1 cent (for some countries in Asia Pacific) and nearly 40 cents (while roaming in some Western European countries). The cost of sending a megabit of data varies from about $1 in some European countries to an initial cost of over $50 in the United States. For applications where roaming is involved (e.g. transportation applications), inconsistent pricing makes variable costs highly unpredictable. Wide cost variations also make it difficult to develop a consistent business case across national boundaries. Operators need to work to standardize rates. Both overly cheap and overly expensive rates will harm the industry.

## Specific Embedded Mobile Pricing Packages

The majority of network operators presently lack rate packages designed for embedded mobile solutions. Operators should develop packages appropriate to embedded mobile applications, bearing in mind volume, quality of service, and time of day.

- **Volume Based Rates:** Operators should offer high volume rates for embedded mobile applications, not just the consumer-oriented rates most offer today. Operators should bear in mind the volume that each customer is likely to generate, which for some applications will be quite high. For example a freight security application could require a status report to be sent once every hour. A mobile-enabled vending machine allowing payment via mobile phone would generate a message with every purchase. By comparison, mobile phone users in Europe average only one message per day. Lower average prices for data communications will improve the business case for embedded mobile applications.
- **Quality of Service:** Operators should factor various grades of service level quality into their rate packages. Many embedded mobile applications will require variable service levels. In some cases, communication will be urgent. In other cases, the message will have a longer validity period. Urgent messages should be priced at a premium, with less urgent data priced lower.
- **Time of Day:** Operators should understand the ability of embedded mobile applications to take advantage of under-utilized network capacity and set rates to spread the network loading. Certain machine-to-machine communication (e.g. new pricing information for a vending machine) could take place any time of day. Operators should design rates to encourage use of the network during off-peak times. This might also encourage the use of larger files.

## Offer Consumers Bundles of Services

Specialist service providers must ensure that embedded mobile solutions aimed at customers are packaged appropriately, which will often mean including a range of applications as part of a bundle.

While enterprises may be able to justify an embedded mobile investment based on one application, consumers are more likely to require a bundle of services. The entry cost of embedded mobile for the consumer will, in most cases, be too high if it only enables a single application.

As an example, consider in-vehicle services. The fixed cost of providing a basic communication system implies a price of several hundred dollars. This would cover the cost of the embedded mobile unit itself, installation, and supporting services. If the only application supported is emergency assistance–such as an automated alert when an airbag is deployed–customers are unlikely to take this option, as the perceived value is too low. However, the more additional services that could be enabled over the embedded mobile module, the greater the perceived benefit to the customer. OnStar, the GM developed in-vehicle service, is steadily expanding the portfolio of services it offers.

*There are one billion cameras in use. Eighteen million digital cameras were sold in 2001. Deloitte Research believes that a growing proportion of digital cameras will have an embedded mobile capability, allowing users to send images anywhere there is cellular coverage.*

Source: BBC News Online

## Design Applications Specifically for Embedded Mobile

Embedded mobile applications are best designed explicitly for a cellular mobile environment. Any other approach—such as porting fixed applications over to a mobile environment—is more risky.

The cellular mobile network has different characteristics than a fixed network. The cellular network's strengths and weaknesses must be taken into account when designing applications. While the availability of cellular networks is improving, their performance remains poor relative to that of fixed networks. This implies that embedded mobile applications should incorporate a capability to work off-line. Essential data should be downloaded to the device whenever possible. Also, cellular mobile will always lag behind fixed networks with respect to bandwidth. Even as of mid-2002, the best cellular networks were only just starting to offer speeds in excess of 100 Kbit/s. This implies that embedded mobile applications should be thin, i.e. focused on text-based information. Large files and non-critical data should be transferred during non-peak periods.

## Design Specialized but Standardized Devices to Meet Unique Requirements

Cellular device vendors must develop products that are sufficiently standardized to work within another machine, while still maintaining the ability to be customized to function within a variety of environments.

Embedded mobile modules need to fit within other manufacturers' products, not just at one point in time, but over the entire life cycle of the host product. Mobile phones have a shorter life cycle than most other machines, so this can be a real problem. Manufacturers will need to consciously design their modules so they can fit and inter-operate within the host machine over a period of years, while still allowing scope for upgrades.

Embedded mobile applications can be highly specialized and often require a high degree of customization. For example, a mobile device in an industrial digger must be able to withstand dirt, moisture, shocks, high vibration levels, and extreme temperatures. It must also be able to operate in an environment filled with electronic interference from other machinery–without creating harmful interference of its own.

Today's mass-market mobile phone vendors might not be able to deliver this degree of specialization economically. Instead, they may choose to develop a base platform that other specialist companies can customize to meet the specific needs of a particular application.

# THE TECHNOLOGY FOR MOBILIZING THE MACHINE

This chapter provides an overview of the underlying technology elements that enable embedded mobile services, including:

- The embedded hardware: the device that gives a machine mobile communication capability.
- The cellular network: the wireless medium over which machines exchange data.
- Complementary technologies: non-cellular wireless technologies that extend embedded mobile's capabilities.

## The Embedded Hardware

An embedded mobile device is essentially a stripped-down version of a mobile phone, with the ability to send and receive data over a cellular mobile data network. A variety of mobile devices are available today from several manufacturers. The main difference between the devices is the network standard supported. There are currently three different cellular network standards: GSM (Global System for Mobile Communication), which is used predominantly in Europe and Asia-Pacific, and to a lesser extent in the Americas; CDMA (Code Division Multiple Access), which is used in the Americas and parts of Asia-Pacific; and TDMA (Time Division Multiple Access), which is used in North America. The majority of embedded mobile devices available today are based on second-generation (2G) cellular technology–although there is increasing availability of devices based on the more advanced packet-switched 2.5G technologies such as GPRS (General Packet Radio Service) and CDMA 1x.

All major cellular manufacturers, including Nokia, Sony Ericsson, Siemens and Motorola, have developed embedded mobile products. A number of smaller manufacturers, such as Sierra Wireless and Novatel, have also developed embedded mobile products. Figure 13 provides a table of some of the embedded mobile products currently available.

An embedded mobile communication device may be integrated within a larger component, such as the telematics unit within a vehicle. Ford's telematics unit is fitted into a vehicle's dashboard and incorporates a range of functions, including a cellular mobile modem. Mobile communication devices are also available as an add-on, such as a PC card for a portable computer.

## The Network

Embedded mobile communication devices can communicate over a variety of networks, including:

- 2G networks, using an open circuit switched connection.
- Short Messaging Services (SMS).
- 2.5G networks, such as GPRS and CDMA 1X.

As third-generation (3G) networks become available, embedded mobile applications will be able to use them as well.

All second-generation networks—present in most countries today—support some form of data communication. This is handled by first opening a circuit-switched connection, then exchanging data. This approach is best suited to protracted communications, or for the exchange of large

FIGURE 13. AVAILABLE EMBEDDED MOBILE PRODUCTS

| VENDOR | PRODUCT | DESCRIPTION |
|---|---|---|
| **Nokia** | Nokia 20 GSM Connectivity Terminal<br>Nokia 30 GSM Connectivity Terminal<br>Nokia 31 GSM Connectivity Terminal | *The Nokia 20, 30 and 31 GSM Connectivity Terminals are machine-to-machine communications devices that provide wireless connectivity and remote management possibilities for customer applications. They offer high-speed data, voice, fax and short message services over GSM and GPRS networks.* |
| **Nokia** | Nokia M2M gateway | *The Nokia M2M (machine to machine) Gateway is middleware for used together with Nokia machine to machine terminals. The gateway establishes an end-to-end communications platform – the Nokia M2M Platform – for embedded mobile data applications. It bridges the GSM network and the Internet by providing a connection for two-way communication between the company intranet and remote devices. Nokia M2M Platform includes data transmission protocols for all GSM bearers available facilitating rapid mobile application development.* |
| **Sony Ericsson** | GM47 / GM48 | *These embedded GSM modules are designed for applications that send wireless information via a standard GSM network. They support data and voice communications.* |
| **Sony Ericsson** | CM42 | *Embedded modules for use in CDMA2000 1xRTT and AMPS networks.* |
| **Sony Ericsson** | GPRS PC Card Modem GC75 | *A PC Card modem dedicated to data communications supporting GPRS, CSD and HSCSD.* |
| **Siemens** | A20, AC35 | *Embedded speech, data, fax and SMS modules for automotive applications, supporting GSM and GPRS technologies.* |
| **Siemens** | M20, MC35 | *Embedded speech, data fax and SMS modules for industrial applications such as telemetry. The M20 works over GSM only, the MC35 supports GSM and GPRS. The TC35 is an integrated unit comprising a MC35 or M20 and a SIM card reader.* |
| **Siemens** | MC45 | *A tri-band GSM module for speech, data, fax and SMS.* |
| **Sierra Wireless** | SB555 | *An embedded CDMA 20001X module that supports packet data rates of up to 153 Kbit/s.* |
| **Sierra Wireless** | SB300 / SB320 | *The SB300 is a wireless data CDPD modem. The SB320 incorporates CSC and wireline modes—including data, fax and voice operations.* |
| **Sierra Wireless** | SB508 / SB519 | *CDMA modems: the SB508 supports 800MHz. AMPS and SB59 offers 1900 Mhz.* |

SOURCE: DELOITTE RESEARCH, VENDORS

files. It is not suited to short communications due to cost and set-up time. It can take close to a minute to establish a connection, and multiple attempts may be required.

SMS (Short Messaging Service) is available on all GSM networks, and increasingly over other cellular standards. SMS supports short communications (up to 160 characters per message). Messages are sent immediately. The cost of an SMS message is typically under 10 cents, and in some countries the cost is far lower. Messages are usually received immediately, but network congestion can delay receipt. In some circumstances, messages may be lost.[14] Therefore, SMS cannot be relied on for time-critical applications.

The emergence of 2.5G networks is an important development for the embedded mobile market. We expect many embedded mobile applications to migrate to this technology in the medium term. The key changes that 2.5G introduces are:

- packet-switching (enabling an "always on" connection).
- the ability to prioritize packets.
- higher data speeds.

Packet switching allows machines to both send and receive data. This is a critical capability that is difficult to effect with existing 2G networks. 2G networks offer only two approaches for receiving data, and neither approach is particularly satisfying. One approach is SMS, which has limited capacity and is limited to text. The other approach is leaving a circuit-switched connection permanently open, which is prohibitively expensive.

Packet switching makes it economically feasible to send small files. Applications that must frequently transmit small amounts of data are generally not viable on circuit-switched mobile networks because each time data is sent, a new connection must be established. This can take up to a minute, regardless of file size. And since charges are based on time spent on the network, not for data transmitted, the cost of sending small files is simply too great. With packet switching, charges are based on data transmitted. Also, because a permanent virtual connection is maintained, files can be sent without the need to re-establish a connection.

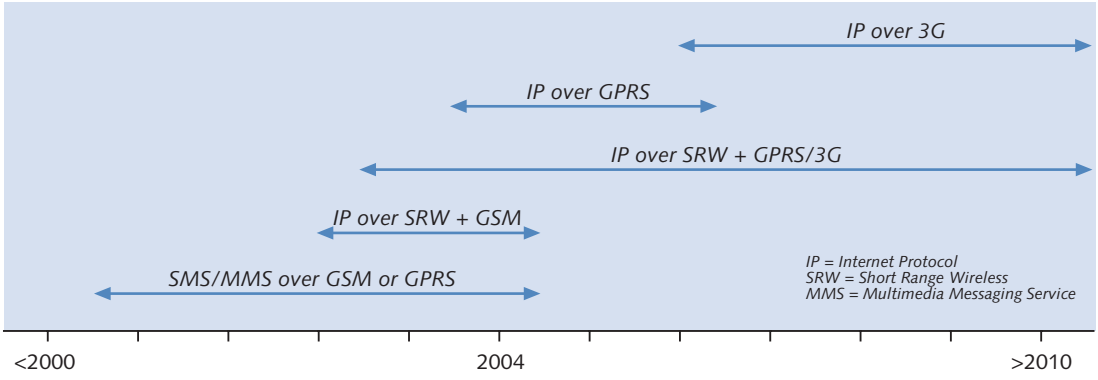
The ability to prioritize packets enables quality of service levels to be offered. This important feature is not possible with 2G networks. 2.5G will allow operators to develop and charge for different service levels. Machines could be programmed to send urgent data immediately (e.g. an alert from a vehicle involved in an accident), while files that are large or not time-critical (e.g. updates to mapping information for a vehicle's navigational system) could be sent at night to save money.

Higher data speeds will allow machines to exchange large files, not just brief text messages. While the vast majority of communication over mobile-enabled machines will be based around small chunks of data, 2.5G networks make the exchange of larger files, such as software updates or images, a viable option. For example, a freight cargo security application could evolve from just providing notice of a break-in to providing images from security cameras.

Deploying 2.5G has proven to be a challenge. GPRS technology's teething problems in particular have been well documented in the mainstream and technical press. However, participants in a recent Deloitte Research study seem to believe the major issues have been resolved.

Third-generation networks, which are already being launched in a few countries, will provide embedded mobile applications with even higher bandwidth. Figure 14 provides our view of the likely progression in adoption of underlying network technologies.

FIGURE 14. THE TECHNOLOGY TIMELINE FOR EMBEDDED MOBILES




SOURCE: DELOITTE RESEARCH

## Complementary Technology

This report focuses on mobile communication using cellular technology. However cellular mobile is not the only technology that can be used to mobilize the machine. Other mobile and wireless technologies can both be combined with cellular mobile, or be used autonomously, to deliver an application. These technologies include:

### Global Positioning System (GPS)

The Global Positioning System (GPS) provides location information based on signals beamed from a network of satellites. The GPS system provides data only—it is not a transport network. Vehicle tracking applications already use GPS in conjunction with cellular mobile. Vehicles with GPS sensors are able to determine their exact location anywhere in the world. That information can then be transmitted, via cellular network, back to a central computer that keeps track of vehicles in the fleet. For a detailed example of the complementary use of GPS and embedded mobile, see the TRI-MEX case.

### Wireless LAN[15]

A wireless LAN provides a localized network connection for voice and data transfer, using radio waves instead of network cables. The coverage area is determined by the positioning of specialized base stations, and is generally limited to a small area such as an airport, hotel, or office building. Although the coverage area of a wireless LAN is much smaller than that of a cellular network, wireless LANs offer much higher data speeds.

Wireless LAN technology can be used in conjunction with embedded mobile to capitalize on the benefits of both. Consider the example of a portable computer with both wireless LAN and embedded mobile capabilities. In areas with wireless LAN coverage, that technology is used due to its higher data rates. Outside of the wireless LAN coverage area, embedded mobile provides continued wireless connectivity–albeit at a much slower rate. Embedded mobile devices that combine wireless LAN and cellular mobile capability are already on the market.

### Bluetooth[16]

Bluetooth is a short-range radio technology supporting voice and data communication. Bluetooth's typical range is about 10 meters, or 30 feet. It is designed to be a low-cost, ubiquitous technology featured in a wide range of devices, from PCs to overhead projectors to refrigerators.

Bluetooth may be used in conjunction with cellular mobile to enable applications. Bluetooth would provide the short-range link, with cellular mobile handling long-range communication. Consider a maintenance application within a supermarket that has rows of refrigeration units that support remote maintenance. One approach could be to have each unit mobile-enabled. However, a more cost-effective approach would be to have Bluetooth in each unit, with all units wirelessly connected to a nearby hub containing both mobile cellular and Bluetooth. The hub would handle all communication with the remote maintenance facility—using the cellular network. This configuration is shown in Figure 15.

### Proximity RF Tags

Proximity RF (Radio Frequency) tags are low-cost devices that communicate small amounts of information such as location, temperature, and humidity. Tags range in cost from $0.20 to $3, but their price is expected to drop to $0.05 within three to five years.

Tags can be used to gather information, and to relay this over a very short distance to an embedded mobile module. This data can then be sent over the cellular network. For instance, temperature tags could be placed on pallets containing heat-sensitive cargo. A mobile module would wirelessly monitor readings from the tags, and send an alert over the cellular network if the temperature reported by any tag went above a specified level.

# CONCLUSIONS AND RECOMMENDATIONS

Mobilizing the machine has the potential to deliver significant benefits, both for the many parties that would together supply the market, and for their customers. Just as cellular phones revolutionized the way people communicate, embedded mobile communication is poised to transform the capabilities of our machines.

However, realizing the benefits of embedded mobile will be significantly harder than it was for mobile voice. The latter was fairly straightforward: a vertically-integrated cellular industry providing relatively standard handsets that enabled an application that people already understood (i.e. talking to each other).

Establishing a market for embedded mobile will pose much greater challenges. Developing embedded mobile applications will require co-operation between parties that have not previously collaborated. Mobile devices will need to be specialized to each application. Cellular networks will need to be configured for machine-centric applications. Rate structures will need to be redesigned. New sales channels will need to be developed. A new type of industry player—the specialist service provider—will need to emerge to develop, market, and support highly specialized solutions and bundles of applications. And finally, the industry as a whole will need to carefully scrutinize potential applications, using a rigorous business case approach, to ensure those applications are worthwhile and economically viable.

The challenges involved in exploiting embedded mobile are significant; but the potential benefits are even greater. For enterprises that use embedded mobile, there is the potential for greater efficiency, improved business processes, and innovative new business models. The net results: lower costs, faster response times, better service, and most importantly—higher revenue. For network operators, mobilizing the machine represents a way to greatly extend the subscriber base and drive up data traffic. For cellular device vendors, machines are a vast new target market. For OEMs, embedding mobile in their products allows differentiation, has the potential to expand their customer base, and could even enable new product lines.

*There are an estimated 25 billion machines in the world.*

Source: ci-online

As the embedded mobile market evolves, potential applications will proliferate, and the opportunity for profit will be substantial. Those organizations that understand early on that this is a new market, not an extension of mobile voice; and that are prepared to embrace its unique challenges and opportunities, will be best positioned to reap its rewards.

## End Notes

[1] For more information on FutureWorld please see: http://www.futureworld.co.za.

[2] For more information, please see http://www.isochron.com/collateral/Packaged_Ice_Case_Study.pdf.

[3] For more information, please see http://www.vianet.co.uk/english/casestudy4.asp

[4] Mixe Communications Solutions (MCS), a solutions provider based in the Netherlands, comments that installation of a traditional wired box can take several weeks to complete. For more information on MCS, see www.mcs-nl.com.

[5] Vodafone UK has developed a Mobile EPOS (Electronic Point of Sale) solution for credit card authorization over a cellular network. Vodafone claims the system provides the "same simplicity, speed and security you'd expect from a standard POS (Point of Sale) terminal". A remote connection is made to the bank via Vodafone's GSM network and verification, authorization and payment processing are provided at the point of sale.

[6] Enermet, an energy data management company based in the Nordic region notes that the region's sparse population makes it inefficient to have door to door reading. Remote metering is the favoured approach, with connection via cellular mobile estimated at half the cost of a wire-line connection. For more information see www.Enermet.com.

[7] Vodafone Group's target is for 20 per cent of total revenues to be derived from mobile data services by end 2004; MM02 group is aiming for a 25 per cent mobile data contribution by end 2004. As of Q2 02, revenues from mobile data represented 14.0 per cent and 14.6 per cent of the total for Vodafone and 02 group respectively. Sources: "Vodafone adds 2.7m to customer base", Financial Times, 30 July 2002 and "Big Brother text messages lift MM02" , Financial Times, July 19, 2002.

[8] Forrester Research, OnStar's Windfall: More and Better GM Customers, 26 November, 2001.

[9] The Wall Street Journal, "GM Plans to Merge its e-Business Unit Back Into Corporate," November 16, 2001.

[10] For more information on Tri-Mex, see:http://www.tri-mex.com/indexNew.html.

[11] For more information on Vianet, see http://www.vianet.co.uk.

[12] GM's Onstar service is now available for the Acura range from Honda. This reflects Onstar's philosophy to offer its platform to other OEMs such as Lexus (from Toyota), Volkswagen-Audi and Subaru. Wingcast, the Ford-Qualcomm joint venture signed a deal with Nissan shortly before the company was disbanded in June 2002.

[13] For more information on security over cellular mobile networks, please see "Transforming Shields into Swords: How Your Mobile Data Security Strategy Can Become a Competitive Advantage", published by Deloitte Research. Copies of this report can be downloaded from www.dc.com.

[14] According to a survey undertaken in February 2002 by Airslide, a routing specialist company, 40% of respondents did not believe that all SMS messages reached the intended recipient.

[15] For more information on Wireless LAN, please see "Top 5 Mobile and Wireless Technologies for Business, 2002", published by Deloitte Research, pages 31 to 35. Copies of this report can be downloaded from www.dc.com.

[16] For more information on Bluetooth, please see "Top 5 Mobile and Wireless Technologies for Business, 2002", published by Deloitte Research, pages 5 to 10. Copies of this Viewpoint can be downloaded from www.dc.com.

## About the Author

PAUL LEE
Deloitte Research
Tel: +44 0 20 7303 0197
e-mail: paullee@dc.com
Paul Lee is a director at Deloitte Research, based in London. His research focuses on mobile and wireless issues for service providers and enterprises. Paul is a regular guest lecturer at London Business School and a frequent contributor to business press. Paul was previously a director at Gartner Consulting.

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## Research Notes

The term *mobile data*, as used in this report, refers to the transmission of data over cellular mobile networks only. Complementary wireless technologies such as Wireless LAN, Bluetooth and infra-red are important, but were excluded from the research scope in order to maintain a sharp focus on cellular mobile solutions.

The interviews were undertaken under our management by a third party specialized in quantitative technology interviews with senior executives. The sample size for the U.S. was 50 respondents, drawn from multinational global 1,000 companies across a range of industry sectors. Our target respondent was the CIO or CTO, or the person responsible for mobile data implementation. The study included companies in the U.S., Germany, UK and Japan, with 50 respondents in each market. All interviews were undertaken on the phone, except for Japan where we met with respondents in person. For further information on the survey approach, please contact the authors of this survey.

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### COMMUNICATIONS INDUSTRY PRACTICE

#### GLOBAL

**J BRADFORD BRANCH**
Tel: +44 207 303 7475
e-mail: bbranch@dc.com

**IGAL BRIGHTMAN**
Tel: +972 3 608 5500
e-mail: ibrightman@deloitte.co.il

#### AMERICAS

**JOHN LEVIS**
Tel: +1 469 417 3185
e-mail: jlevis@dc.com

**PHILIP ASMUNDSON**
Tel: +1 203 7007 3349
e-mail: pasmundson@deloitte.com

#### ASIA-PACIFIC

**ARTHUR OWEN**
Tel: +852 3416 2709
e-mail: artowen@dc.com

**YOSHITAKA ASAEDA**
Tel : +81 3 3457 1841
e-mail: yoshitaka.asaeda@tokyo.tohmatsu.co.jp

#### EUROPE

**FABIO TROIANI**
Tel: +39 02 655 661
e-mail : ftroiani@dc.com

**GRAHAM RICHARDSON**
Tel: +44 20 7303 3498
e-mail: grrichardson@deloitte.touche.co.uk


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