# The ROLE of MOBILE OPERATORS and the JAVA™ PLATFORM in the **MACHINE-TO-MACHINE MARKET**

Bruce Baikie
Steve Gaede

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# Chapter 1
# Introduction

The ever-broadening geographic coverage of wireless data networks is stimulating the growth of a new generation of Machine-to-Machine (M2M) applications. M2M devices use integrated radios to exchange data with other machines over existing cellular networks. Once the domain of remote telemetry devices using expensive satellite or fixed-frequency radios, now virtually any device can be networked over mobile operators' GSM networks. In Spain, ice cream vending machines communicate with the vendor's logistics center so that machines can be re-stocked more efficiently. In Canada, M2M parking stations can lower parking rates during holiday shopping periods, prohibit parking during special events, track which slots are out of time, and relay that information to enforcement officials with wireless PDAs. The range of M2M applications is limited only by the imagination, from gas wellhead monitoring to home security.

The M2M market is growing rapidly as the price drops for both M2M devices and wireless data subscriptions. Alexander Resources predicts that the number of M2M connections will overtake the number of mobile phones in North America, Western Europe, and Japan by 2012 (press release, *alexanderresources.com*, January 27 2004) Wireless Data Research predicts a 27 percent growth rate through 2008 ("The Wrap" newsletter, *m2mpoint.com*, May/June 2004). ABI Research estimates an annual market growth of 40 percent through 2010 (press release, *abiresearch.com*, April 15 2004). This growth is good news for wireless carriers — FocalPoint Group predicts that carriers will reap $10 billion in data transmission fees by 2008 ("A Machine-to-Machine 'Internet of Things,'" *businessweek.com*, April 26, 2004). In Europe, Orange is already offering lower rates for M2M devices and offering software tools to attract M2M customers. Vodafone offers an affordable tariff that includes a basic monthly amount of data transmission and a per-kilobyte incremental charge.

Despite the predictions, some mobile operators are not yet enthusiastic about the market. They see M2M devices coming online by the tens or hundreds of subscriptions, not unlike new company accounts moving to their networks. But unlike mobile telephone accounts, M2M devices help re-pay the costs of expensive 3G networks by making exclusive use of the data portion. And unlike mobile telephone users, the churn rate of M2M customers is practically zero. If mobile operators view the M2M market as one that will help them make up for slowing demand for new mobile subscribers, they will begin to see its benefits.

Even greater benefits will accrue to those mobile operators that see beyond M2M as just another use of their network. When carriers get actively involved with their M2M customers and application developers, they will see opportunities to add value to their network — adding new revenue streams while differentiating their services from the competition. Mobile operators can provide gateway and whole-application hosting services in their datacenters. They can provide Application Programming Interfaces (APIs) so that their M2M customers can provision services and bring new devices online without human intervention. They can insert themselves into the revenue stream by making it easy for customers of M2M services to pay by credit card, stored-value card, or through their wireless bill. And mobile operators can offer identity services that integrate M2M with other online services through customer telephone accounts.

This white paper describes the growing M2M market, the wide range of applications coming online, and the role of different market players. It discusses M2M network infrastructure, and the role of the Java™ platform in making it easy for application developers to create and integrate M2M devices with back-end systems. Finally, it discusses ways in which mobile operators can increase revenues by pro-actively engaging with the market, making money from the revenue stream that M2M devices generate. Sun Microsystems has long been a preferred vendor to communication carriers, and its experience working with M2M application developers and the Java platform can help carriers grow their business through value-added services on their wireless networks.

# Chapter 2
# The Growing M2M Market

M2M Magazine (*www.m2mmag.com*) defines Machine-to-Machine as providing communication between people, devices, and systems, turning data into information that companies can act upon. By this definition, M2M is both an old and a new market. For years, remote monitoring of stream flows, reservoir levels, and well heads has been accomplished using radio and satellite communication. Today, some M2M devices are built to communicate over short-range Wi-Fi networks — for example, a security system can interconnect sensors around the home using a mesh network. The M2M segment most interesting to mobile operators is the use of cellular wireless technology to give practically any device a digital heartbeat, at a relatively low cost.

Once a device becomes part of the network, it can be integrated into a larger framework. Vending machines can report on units sold, helping to automate the supply chain and reduce inefficiencies. Traffic can be managed with M2M traffic sensors and M2M-powered informational signs that help route drivers around congestion. Parking stations can play a community role, for example selling downtown music festival tickets through their receipt printers.

## M2M Market Players

The M2M market is relatively complex because of the wide variety of applications being developed, the corresponding range of end-customers, and the large number of different technologies that M2M can leverage. Although the market is rapidly evolving, it is possible to identify a set of key players:

- *Network Equipment Providers.*Most of the key network equipment providers, including Sony Ericsson, Nokia, and Siemens have developed M2M modules that interface from a networked device to a General Packet Radio Service (GPRS) network. Essentially mobile phones without a keypad or display, some of these devices support the Java Platform, Micro Edition (Java ME) Information Module Profile (IMP), making it straightforward to integrate them into an end-to-end Java technology solution. Some of these devices offer the capability to interface to non-Internet Protocol (IP) networks, for example through Short Message Service (SMS) messages. Other vendors, like 8D Technologies, have developed flexible devices that can interface to Wi-Fi networks just as easily as to cellular wireless networks. 8D Technologies' ECO system supports a wide range of peripheral devices, and it also supports the Java platform.
- *Software Platform Providers.*These companies offer software infrastructure that give application developers a platform on which to build their software. Esmertec, for example, offers a run-time platform for M2M devices that uses load-time compilation to speed the execution of software written using Java technology. 8D Technologies offers a Java ME platform-compliant environment that includes a number of libraries to interface with specific peripherals attached to their M2M device and also to back-end systems in the datacenter. Some platform providers (like Esmertec) specialize in providing M2M platforms to application developers, while others (like 8D Technologies) are also application developers themselves.
- *Application Developers.*Application developers integrate all layers of the M2M environment including the hardware and its wireless interface, the software platform, device-resident software, and the datacenter-resident back-end applications that turn data from M2M devices into actionable information. Because of the number of different environments for which they must write software, developers often prefer the "Write Once, Run Any-

where™" nature of the Java platform. Developers can use the Java ME platform on M2M devices, and the Java Platform, Standard Edition (Java SE) or the Java Platform, Enterprise Edition (Java EE) on the back-end. Application developers are most likely the ones to work with mobile operators to qualify their devices for use on the carrier's networks, obtain coverage for a large number of devices, and establish communication paths from their devices to back-end servers.

- *Mobile Operators.* Mobile operators are the natural data network providers for M2M devices equipped with cellular radios. In Europe, Orange and Vodafone have made public announcements regarding their M2M tariffs. Across Canada, both Rogers Wireless Communications and Microcell Telecommunications have been supportive of the M2M market, and a recent acquisition of Microcell by Rogers promises to give M2M application developers coast-to-coast coverage for their devices.
- *Virtual Mobile Network Operators (VMNOs).* In many areas, obtaining geographically-broad cellular coverage from a single carrier is difficult, one factor contributing to the rise of VMNOs. These operators aggregate coverage from cellular networks and sometimes from paging networks to blanket a geographic area, giving application developers a one-stop shop for their data transmission needs. In the U.S., Aeris.net has extensive coverage, making it a popular carrier for applications including container monitoring, fleet management, security tracking, and remote monitoring of vending machines, copiers, and package drop boxes.
- *Internet Datacenters (IDCs).* M2M devices operate around the clock, every day of the year, requiring back-end applications to be highly available or risk losing potentially critical data from devices in the field. As a result, most application developers host their applications in IDCs that can support their availability requirements. Given that communication carriers often have high-quality datacenter facilities, hosting customer applications close to the wireless network interfaces is a natural revenue-generating option.
- *Customers.* The customer is the end user of the M2M application, and often not the mobile operator's direct customer. M2M customers include shipping companies, municipalities, and product vendors.

## Wide Range of Applications

Machine-to-machine communication enables a wide range of applications, in industries and enterprises including heavy industry, services, and retail. Virtually any company that could benefit from remote monitoring can fit its products (or the products that it handles) with M2M communication devices with a dramatic impact on operations.

- *Escalators and Elevators.* Companies maintaining escalators and elevators can use M2M devices to provide operational and maintenance status to a central monitoring system. T his is of great benefit to companies maintaining equipment in locations they do not own or cannot easily access. When a monitored system encounters a problem, help can be dispatched before the client company could even locate the maintenance company's phone number. With real-time monitoring of maintenance status, companies can help to minimize their downtime with M2M technology.
- *Heavy Equipment Monitoring.* Any company that uses or rents heavy equipment such as bulldozers and excavators can use M2M to help track and maintain its fleet. M2M monitors can track engine hours so that maintenance can be properly scheduled. Integrated with GPS technology, equipment can be monitored for lease violations, for example using the equipment on a weekend away from an approved construction site.
- *Exit Signs.* In Japan, a building's exit signs must be checked once per month to ensure that its batteries can properly power the sign to illuminate an exit in the event of a power failure. Not a problem for a small restaurant owner, but when hundreds of exit signs are deployed in a large hotel or business complex, monitoring and test-

ing can be time-consuming and error-prone. With M2M devices monitoring lamp status and battery state, up-to-date information is always available to a monitoring center, which can replace components before they fail, even exceeding governmental testing regulations.

- *Energy Management.* M2M technology can do more than make meter reading a thing of the past. M2M can help homes and businesses make intelligent choices regarding their energy use. With remote devices, utility companies can disable air conditioning units on a rotating basis, managing peak energy use and reducing the need for additional power stations. Energy companies managing natural gas or oil wells can monitor their status and pipeline flows with M2M devices. Without the need for a wired network, M2M devices can give precise status from anywhere that cellular coverage is available.
- *Home Security Systems.* Eaton Corporations's HomeHeartbeat system uses a mesh network of short-range M2M devices to monitor appliances, windows, and doors. These devices interact directly with a central monitoring system in the home, or they connect to the nearest sensing device which can pass status on to the central station.
- *Vending Machines.* With M2M devices giving sales information to a central management system, their owners can manage inventory, schedule product deliveries, and better track customer purchasing habits. M2M devices can monitor machine status, sending an alert if temperatures are out of range, or if a cash box needs to be emptied. With vendors able to communicate back to their machines, they can change product prices dynamically, for example lowering prices to move a particular product.
- *Traffic Monitoring.* M2M devices can be used to monitor traffic patterns, allowing traffic sensors to be placed virtually anywhere. Both portable and permanent message signs can help re-route traffic around congestion. Tied into a Web interface, residents can plan their trips beforehand to avoid known problem areas.

## M2M Parking Systems in Montreal

8D Technologies of Quebec, Canada, started out as an M2M technology developer. The company built its 8D ECO embedded M2M device for managing point-of-sale systems. 8D Technologies supported the M2M device with its Cloud9 Java platform for programming the device and accessing peripherals. In order to show the capabilities of its products, 8D became one of the most interesting application developers in the M2M marketplace.

In 2002, the City of Montreal began looking for alternatives to replacing its traditional parking meters with a more advanced technology. The city wanted to install wireless terminals that could work entirely on solar energy, function in Montreal's punishing winter climate, and provide a set of innovative new features, including:

- Central access to payment and parking utilization information, as well as monitoring each terminal's performance and security, for example providing notification when cash boxes are full
- Support for multiple payment methods, including cash and real-time credit card clearing
- "Pay and display" mode where drivers pay for their parking slot and place a receipt on their dashboards
- A "pay and go" model where drivers can input their parking slot number at the terminal, pay for the desired amount of time, and leave without the need to place a receipt on their dashboard
- A wireless Personal Digital Assistant (PDA) to provide the status of each slot to parking enforcement officers. Slots without paid time are marked in red, and if the corresponding parking slots are occupied, a violation has occurred.

Cale, a leading supplier of parking equipment, worked with 8D Technologies to integrate the 8D ECO M2M device, solar panels and batteries. 8D Technologies built the end-to-end Java technology solution including the Cloud9 environment, point-of sale software operating in the parking stations, and the back-end parking management application running on the Java SE platform in a datacenter. The resulting system is 8D Technologies' Automated Parking Management System (AMPS) (Figure 1).


*Figure 1. Three key components of 8D Technologies' parking solution includes the solar-powered parking station (left), the embedded ECO M2M device (middle), and the wireless PDA used by parking enforcement officials (right).*

### Potential to Evolve

With a platform that is driven by software, it can grow to support even more capabilities. Indeed, the application's potential future uses are even more exciting than its current features:

- Given the ability to accept multiple forms of payment and print receipts, the parking station can print tickets to civic events, such as a downtown music festival.
- Additional forms of payment can be developed, for example an RFID-based stored-payment card, or payment via cell phone SMS message.
- Parking rates can be adjusted by time of day or day of the week, and parking can be prohibited during special events such as street fairs or parades.
- Other wireless applications can be developed to allow the general public to benefit from the centralized nature of the parking system. For example, a driver could query a mobile phone-based application to find the nearest open parking space. Implemented with Java technology, such an application could integrate with the existing Java platform-based software virtually seamlessly.

Capabilities such as those built into the 8D Technologies ECO device allow it to be deployed for general point-of-sale applications — making it easy for retailers of all kinds to securely accept multiple forms of payment anywhere that a cellular network reaches. Where a large number of terminals are deployed into a small space, such as in a department store, the ECO device can be equipped with a Wi-Fi interface.

# Chapter 3
# M2M and the Java Platform

All of the major wireless Network Equipment Providers (NEPs) have developed M2M modules that interface between external devices and the wireless network. Essentially mobile phones without a keypads or displays, these devices interface to external devices, and can send messages onto the wireless network. These devices often include sufficient processing capability to run the remote side of the M2M application.

Other companies, like 8D Technologies, have developed proprietary M2M devices for specialized markets. 8D's ECO device provides a set of interfaces for typical Point-of-Sale (POS) devices such as keypads, LCD displays, and receipt printers. With the ECO's ability to support many different POS devices, developers can more quickly build an application without having to engineer a custom hardware solution. The ECO's wireless communication is supported through a modular connection that can support different wireless interfaces, including GPRS and Wi-Fi.

## M2M Architecture

M2M modules are only one component in a larger M2M architecture, for example the 8D AMPS application architecture illustrated in Figure 2. This architecture illustrates three tiers: M2M devices themselves, a wireless gateway, and back-end servers:

- *M2M Devices.* M2M devices, in this case parking stations, are deployed into the field. Wireless devices communicate to the wireless gateway through an application-specific messaging protocol. Depending on the M2M application, devices can communicate on the wireless network using socket connections or HTTP. Some applications use XML-formatted messages sent over HTTP.
- *Wireless Gateway.* The wireless gateway translates messages from the wireless network into an Internet Protocol (IP) message understood by the back-end application, if necessary. It also manages communication with the wireless devices, allowing only authorized communication. In the 8D AMPS application, the gateway is part of the Cloud9 platform. In Europe, Orange, a subsidiary of France Telecom, supports its M2M customers with gateway services that translate XML-encoded messages from the wireless network into Simple Object Access Protocol (SOAP) messages on the IP network.
- *Back-End Servers.* The M2M application itself is deployed on one or more back-end servers that are hosted in Internet datacenters. The application software interacts with the gateway to send and receive messages from the wireless devices, and it also provides an interface for the customer to manage the application. In the case of the 8D AMPS application, the Parking Manager and Payment Server functions are hosted on two separate servers, and the Console manages the parking application through a Java technology-based or a Web-based interface. In addition, an interface for wireless PDAs support enforcement officers in the field.

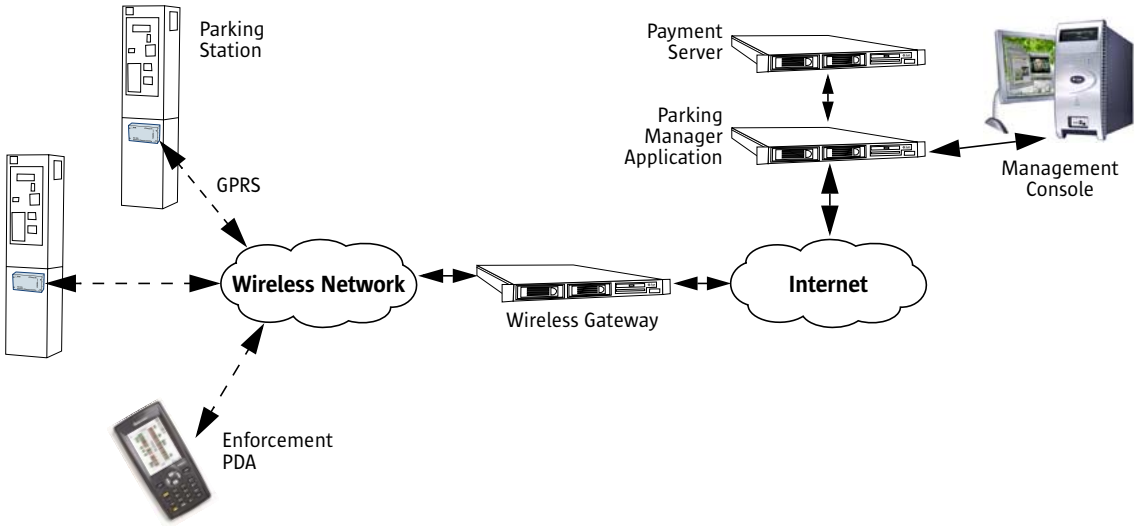


*Figure 2. Typical M2M application architecture with M2M devices, gateway, and application servers.*

Some M2M devices integrate into custom applications like 8D AMPS. Other M2M devices provide data to enterprise management systems like HP Open View. Using enterprise management software allows application developers to leverage existing, off-the-shelf software to provide an intuitive, visual interface, allowing customers to visually monitor device status, handle alerts, and automatically page appropriate personnel to respond. Other M2M devices might integrate with Enterprise Resource Planning (ERP) systems to automatically order replacement stock for vending machines, or track containers in shipment.

## The Role of the Java Platform

The Java platform is an ideal foundation for multi-tier distributed applications running on multiple hardware platforms. The “Write Once, Run Anywhere” nature of Java technology software allows developers to use one programming language for each network layer, insulating them from the details of on which processor their software is to run. This gives developers flexibility to deploy objects across M2M devices and applications, and change where those objects reside when and if the need arises. Processor-independent software also gives developers more leverage with their NEPs — if one NEP’s M2M modules aren’t satisfactory for the application at hand, developers can move to a different device supporting the Java platform without having to be concerned with the processor instruction set. Developers also have leverage with the software they write: when they use the Java programming environment to develop all of their applications, they are free to use software developed for one application in their next application. The object-oriented model of the Java platform facilitates code re-use.

Many network equipment providers and third-party software platform vendors support the Java ME platform on M2M modules because the platform supports key functions like downloading objects, which enable upgrading M2M software in the field. Downloaded objects may be signed and encrypted, helping to ensure that only authorized parties can update running systems. The Java platform is built for distributed environments. The Java EE platform supports library supporting standards-based communication including HTTP, SOAP, and Java™ Remote Method Invocation (Java RMI). The Java programming language and its memory-management model makes it difficult to

access non-existent objects or address invalid memory locations, virtually eliminating a whole class of problems that tend to make other programming languages less reliable.

## The Java Platform in M2M Environments

The Java platform is more than just a good idea for application developers and network equipment providers — a series of Java technology specifications have been designed to support the specific needs of developers building software for small devices with limited memory footprints. With the Java EE platform supporting the back-end portion of M2M applications, application developers can build end-to-end Java technology-based M2M applications that are flexible, scalable, reliable, and secure. What end-to-end Java technology-based solutions mean to mobile operators is the ability to support and add value to M2M applications through standards-based interfaces.

The use of Java technology to support an M2M application is illustrated in Figure 3, and includes M2M devices, wireless gateway, and back-end application.

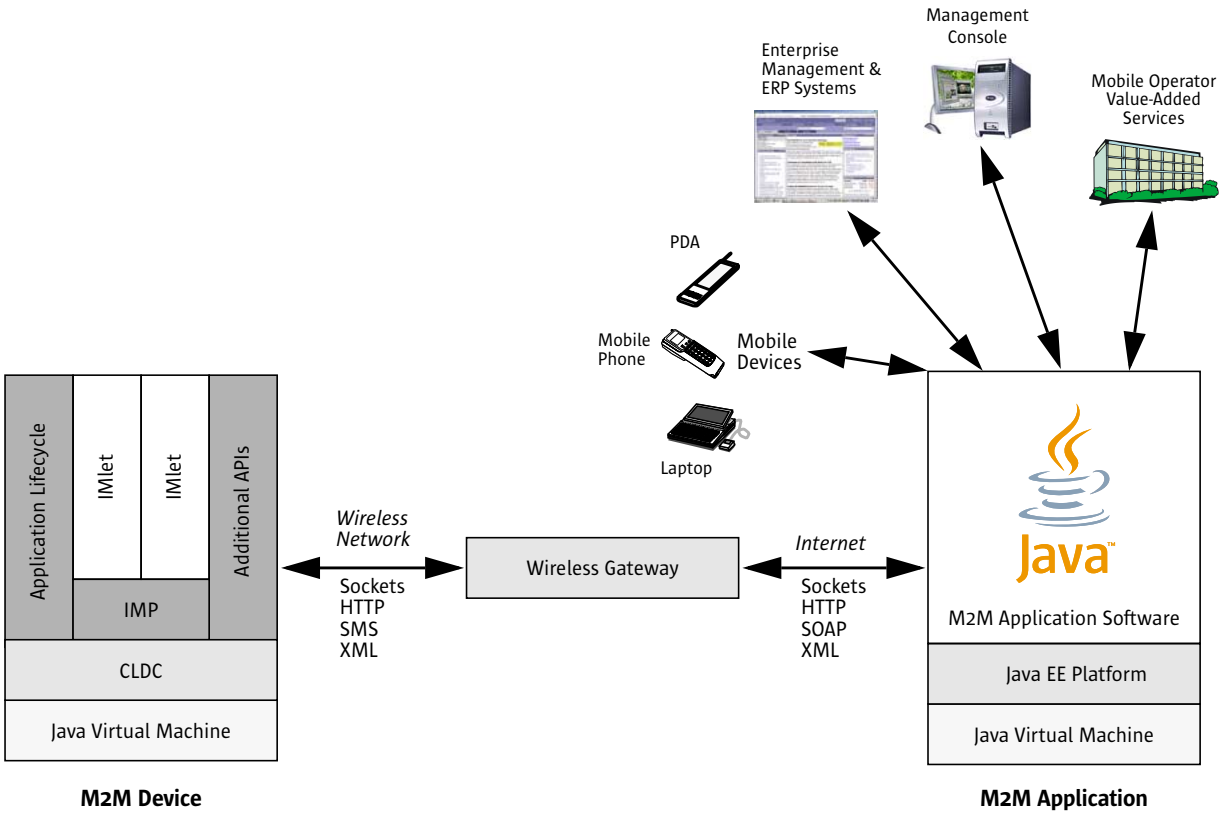


*Figure 3. An end-to-end Java technology-based M2M application includes the M2M device, wireless gateway, and back-end application supporting one or more clients and interfaces to external systems.*

### M2M Devices

M2M devices built to support the Java Platform, Micro Edition have at their lowest level a Java Virtual Machine and software that supports the Java ME Connected Limited Device Configuration (CLDC) specifi-

cation is designed to support Java software running on devices having 16 to 32-bit processors, limited memory footprint, low power requirements including battery operation, and connectivity to some type of network. The CLDC specification supports the Information Module Profile (IMP) that supports applications known in this context as IMlets.

IMP is a subset of the Mobile Information Device Profile (MIDP) used for mobile phones. Unlike MIDP, IMP does not support a keyboard or display. Indeed, just like M2M modules are like mobile phones without displays or keyboards, the IMP profile is like MIDP without interfaces to drive displays and keyboards. IMP 1.0 includes a fully multi-threaded execution environment, an application lifecycle just like MIDP, serial communications, and HTTP network communication.

Additional interfaces are often provided by NEPs supporting the IMP profile, for example APIs for controlling I/O interfaces. Additional Java technology APIs are often included as well, for example the Java Wireless Messaging API for SMS communication.

**Esmertec's Jbed IMP**

Esmertec, an M2M software platform provider based in Switzerland, supports just such a standards-based environment with its Jbed IMP product. Esmertec provides a complete portfolio of high-quality engineering services including consulting, integration, porting, testing, certification, training, support and maintenance, delivering complete solutions and ongoing support to its customers.

Esmertec works with application developers to port their complete Java platform to custom M2M devices, allowing them to write their software to a standards-based platform, helping to reduce cost and speed development. Esmertec's Jbed IMP addresses the limited processing capabilities of M2M CPUs by augmenting the Java Virtual Machine with load-time compilation. Esmertec's Jbed FastBCC compilation engine is a single-pass, load-time compiler that allows IMlets to be compiled and later run at the native processor speed. The compilation engine's memory footprint is a mere 50 KB, making it ideal for memory-constrained M2M devices. The compilation process is transparent to developers, and they can develop and load IMlets without regard to the fact that their software is actually compiled on the device.

### Wireless Gateway

The wireless gateway passes authorized traffic between the wireless network supported by the mobile operator and the Internet, where the back-end M2M application resides. The two networks have significantly different characteristics, often requiring mediation:

- Mobile operators carefully control what traffic enters or leaves their network, helping to protect the wireless network from hackers and from levels of traffic that can overwhelm their networks' limited bandwidth. They control how messages are transmitted, helping to secure the network from outside observers. And of course they charge their subscribers for bandwidth used. M2M devices typically pass messages to back-end systems, either through IP-based GPRS or through SMS.
- The Internet is comparatively insecure, full of authorized and malicious traffic, and it is exclusively IP-based. Where mobile operators support multiple messaging mechanisms (like SMS), they need to translate those messages into IP-based protocols.

M2M application developers may or may not have control over the wireless gateway that translates their traffic from the wireless network to the Internet. For example, Orange's M2M Connect service provides supports M2M devices through GPRS and SMS. Following Orange's specifications, M2M devices can send messages to the wireless gateway and Orange translates them into the Web services Simple Object Access Protocol (SOAP). This minimizes the amount of software that must be loaded onto an M2M device (i.e., simple messaging, not SOAP), and it allows back-end M2M applications running on Java SE or Java EE platforms to utilize the full power of the Web services environment supported by the Java platform.

In contrast, 8D Technologies has control over the gateway in the 8D AMPS application. The Cloud9 Operating Environment supports 8D's short message protocol known as Cloud9 Application Protocol (CAP), which can support communication ranging from short messages to serialized Java technology objects. The gateway supports secure communication between the wireless network and the back-end servers using Secure Socket Layer (SSL) encryption.

A wireless gateway is not always necessary. The Secure Socket Layer (SSL) is included with the MIDP 2.0 specification, allowing secure HTTP traffic to pass directly from the M2M device to the back-end application. This obviates the need for a wireless gateway for applications that can use an IP-based GPRS network exclusively.

### Back-End Applications

The server-based, back-end software is where most of the work is done to support an M2M application. Where M2M devices in 8D Technologies' 8D AMPS applications interact with customers, the back-end application keeps track of time remaining in a customer's space, interacts with the enforcement officer's wireless PDA, makes credit-card charges through a payment server, and provides a Web-based management facility for managing the entire network of parking stations.

A vending machine operator might have its own application software to support payment through SMS messages or RFID stored-value card swipes, and might integrate with third-party enterprise management ERP systems as well. Temperature and door open/closed status might be provided to an enterprise management system so that a single console can monitor the status of all vending machines, causing alerts and pages when temperatures are out of range or an unauthorized entry is detected. Product sales data can be fed to ERP systems that direct drivers which products to stock on their daily runs, and which automatically order replenishment stock from vendors as needed.

Mobile operators have the opportunity to add value to M2M applications, and they can provide functions through standard Java APIs for services like billing customer wireless accounts and provisioning accounts for new M2M devices being deployed. The value that mobile operators can provide is the subject of the next chapter.

# Chapter 4
# Value-Added M2M Services for Mobile Operators

Some mobile operators are merely reacting to growth in the M2M market, accommodating the growing number of applications by certifying M2M devices for use on their networks, and provisioning them onto their wireless networks as applications are deployed. They sell access to their networks, charge for kilobytes transferred, and garner the incremental additional income that M2M provides. Unfortunately, just as Internet access has become a commodity, operators that view themselves as just network providers may miss out on the additional growth that the M2M markets can bring their companies.

Forward-looking mobile operators are on the lookout for ways to differentiate their services, to make their networks easier to use, their customers' applications easier to deploy, and M2M easier to integrate with wireless telephony. These mobile operators find ways to partner with M2M application developers so that they provide more than just network access. Their efforts will result in their networks being preferred over the competition, and their cooperation will result in more innovative applications and payment models in the M2M marketplace. This chapter outlines some of the ways in which forward-looking mobile operators can provide value-added services for M2M applications.

## Datacenter Operations

Mobile operators are keepers of the gateway between the wired and the wireless networks, maintaining gateways to transfer IP traffic between the networks and translating wireless messaging protocols — like SMS — to Internet protocols as necessary.

Many mobile operators maintain Internet datacenters, and their proximity to the wireless gateway makes them a natural choice for M2M application developers when it comes to hosting back-end services. Mobile operators have several ways in which they can add value for application developers hosting in their datacenter locations:

- Traffic from M2M devices and back-end applications can be routed over private networks, securing communication between the two entities. Alternatively, the wireless gateway can encapsulate application traffic in a virtual private network or SSL connection and deliver data to the server of the customer's choice.
- Mobile operators can provide co-location services, and they can also offer hosted services with dedicated servers. They can add value by providing infrastructure software that is ready for application developers to leverage. Sun Java™ Enterprise System, for example, provides the core services needed to support a company's operations and to support its business-critical applications. It is an integrated software system, with messaging, calendaring, directory, identity, portal, clustering, Web, and application server components.
- Many M2M applications start small and grow over time. For example, the 8D AMPS application began with deployment in one city and a target of 500 parking stations with M2M devices. Applications such as these are not yet large enough to support a 24-by-7 network management staff, but a mobile operator can provide network monitoring and management functions for the servers supporting M2M applications — and be ready to grow as their customers grow.

## Gateway Services

For mobile operators supporting multiple wireless communication models, including GPRS, SMS, and Multimedia Messaging Service (MMS), services at the gateway can translate non IP-based messages into standards-based IP communication with back-end servers. Today, with encrypted communication not supported in the native MIDP 1.0 profile, encrypting IP traffic from devices on GPRS networks is a useful value-added service. In the future, with the MIDP 2.0 profile supporting encrypted communication, it will be possible for M2M devices to connect directly to back-end servers through secure, encrypted channels.

## Innovative Payment Services

The scope of some M2M applications is purely business-to-business, for example pipeline flow monitoring or truck fleet tracking applications. Other M2M applications provide services to the general public for which a payment is required, for example parking services and vending machines. These transactions are typically small, ideally-suited to alternative payment systems. Today, these services are typically limited to accepting cash or credit cards, however customers could benefit from payment systems integrated with their mobile phone accounts— something that only mobile operators can accomplish. Examples include:

- *Short Code.* This technique allows customers to dial a short code, a registered five-digit number, on their mobile phone. The short code is received by the mobile operator, the request validated by the vendor, the charge made through the mobile operator, and the product dispensed at the machine or through an authorization code returned via SMS message. Consider the benefit of clearing small transactions like time on a parking meter, or ice cream from a vending machine, through mobile operators. Customers don't need to have correct change, or the right paper currency in order to purchase a wide range of products, lowering the barrier to sales.
- *SMS Messaging.* Another variation is for customers to send an SMS message to a number posted on the machine, with an authorization code returned via SMS message. In this case, either the vendor must have the ability to put a corresponding charge onto the vendor's mobile phone bill, or the vendor's mobile operator charges its customer (or those from another carrier) a specific fee for the SMS message. More sophisticated SMS-based approaches allow customers to specify the product they wish to purchase in the content of the SMS message. For example, 45 minutes for parking slot 110, '1' for cola, '2' for lemon-lime soda. An advantage to this approach is that wireless clearinghouses are already set up to manage carrier-to-carrier billing.
- *Mobile Applications.* An easier way for customers to purchase products via mobile phone is through a Java technology application downloaded to the handset. Using the MIDP profile, application developers can create handset-independent MIDlets that can guide customers through the purchase process using a graphical user interface rather than having to describe potentially complex SMS messaging requirements on a vending machine. An advantage of using the Java platform is that the MIDlet can use TCP/IP networking to contact a back-end server, a more reliable technique than using SMS messaging.
- *RFID Cards.* •Application developers can allow services to be purchased through RFID stored-value cards. The M2M device would allow the card to be read, the product purchased, and the purchase cleared through the application's billing system. The problem with RFID cards, however, is customers must have a separate card for each vendor with which they wish to do business. If, however, a payment system were integrated into a mobile phone, and payments cleared through the subscriber's wireless bill, acceptance would be higher, making sales to mobile phone users even easier. In Japan and Germany, some phones are already being equipped with radio-frequency payment devices for just this purpose.

These innovative payment services are ones for which mobile operators are ideally suited. By establishing funds-clearing relationships with M2M application developers, operators are in a position to increase revenue by charging a small fee for each transaction. The easier that it is for developers to integrate into an operator's transaction-clearing system, and the more M2M applications that a mobile operator hosts on its wireless networks, the more that its revenue is likely to grow.

## Billing and Provisioning through OSS/J

Fortunately for mobile operators wishing to offer transaction support for M2M applications, and for developers that have created end-to-end solutions based on the Java platform, APIs already exist to facilitate them working together. Recognizing the need to integrate various functions within a communication carrier's complex operational and billing systems, Sun has helped to found the OSS Through Java™ (OSS/J) Initiative. The OSS/J initiative is chartered to develop APIs that accelerate the development of innovative OSS/BSS solutions where all applications function together. The initiative's APIs are standardized under the latest Java Community Process℠ (JCP℠) program. JCP deliverables for each application area consist of a specification, a reference implementation, and a technology compatibility kit — all of which, including the source code, are available to the industry free of charge. The initiative's APIs can help operators jump-start the deployment of end-to-end services on next-generation wireless networks and leverage the convergence of telecommunications and IP-based solutions such as M2M. Current OSS/J APIs are designed to facilitate service activation, quality-of-service performance management, trouble-ticket handling, and billing.

OSS/J interfaces for service activation and billing can help mobile operators get up and running quickly to support M2M applications. Billing APIs can be leveraged to allow M2M application developers to submit billing records to mobile operators, and service activation APIs can be leveraged so that M2M applications can bring new devices online programmatically, with no need for error-prone human intervention.

## Integrating Identity with M2M Applications

When innovative billing techniques are integrated with mobile operators through SMS messages, the customer identity is known by virtue of the telephone number included with the message. Unfortunately this is not the case with IP-based techniques including billing through handset-resident applications and WAP browser-based interfaces. When Internet protocols are used to access an M2M application, the customer appears as just another IP device, not associated with a mobile number or other identity mechanism. This means that application developers must implement their own identity management, usually involving customers having log in to an M2M application in order to use its services.

Mobile operators, however, do have definitive information on which subscribers have active sessions, and they are positively identified through their mobile phone serial number or SIP card. When this information can be shared with M2M applications, the subscriber's identity including mobile account number can be linked with the M2M application. Single sign-on between mobile operators and M2M applications makes logins unnecessary, easing the customer experience and potentially increasing revenues for both M2M applications and the mobile operator.

Sun Java™ System Access Manager provides just such a capability — and opportunity — for mobile operators and their M2M application affiliates. Sun Java System Access manager can implement a central identity-management

system integrated with the operator's OSS infrastructure. Acting as a central repository of identity information for its subscribers, operators can use it to manage access to applications hosted within its organization and also among business partners including M2M applications. Sun Java System Access Manager supports federated identity management and cross-domain single sign-on that can be used to create circles of trust that include the operator and its trusted affiliates. Best of all, Sun has experience integrating identity management into a variety of different communication carrier environments.

Sun Java System Access Manager includes the following features of importance to mobile operators:

- *Single sign-on* that improves user experience by enabling subscribers to use their identity established at network login time to access multiple resources, applications, platforms, and Internet domains. SSO forms the foundation on which mobile operators can support circles of trust and affiliate marketing programs.
- *Federated identity support* through Liberty Alliance Phase 2 and Security Assertion Markup Language (SAML) 1.1 specification compliance. These protocols enable authentication and authorization across federated business networks, providing increased revenue opportunities by supporting trusted partnerships — while helping to reduce costs with increased integration efficiency.
- *Session management* that maintains session state for subscribers that can be accessed by any of the applications for which SSO and federated identity are supported, including M2M applications.
- *Delegated authority* can be used to set up hierarchies that, for example, can be used to allow a family subscriber to set up sub-accounts — with unique application preferences and spending limits — for each family member.
- *Java EE architecture and comprehensive APIs* are used to build an open standards-based system that helps carriers implement high levels of integration and customization. The use of the Java EE specification allows developers — such as those creating innovative business applications — to extend their existing Java technology skills, helping to reduce cost and time to market.
- *Enterprise-class scalability and reliability* helps Access Manager grow with the speed of a mobile operator's business, while providing availability levels appropriate for telecommunication carriers. Sun Java System Access Manager can be deployed in ways that help eliminate single points of failure, for example through the use of multiple load-balanced policy servers, policy agents, and directory instances that provide high availability and failover capabilities.
- *Real-time audit* provides up-to-the-minute auditing of all authentication attempts, authorizations, and changes, delivering improved security with instant auditing of critical access-related information.

# Chapter 5
# Leveraging Technologies from Sun

Mobile operators that are willing to become active participants in the new M2M market are more likely to grow with the market than those operators that see themselves only as bandwidth providers. Operators that partner with M2M application developers have significant value to add. They can make it easier to deploy applications, to use their networks, and to bring new devices online. They can add value through hosting services, application monitoring, supporting cooperative billing capabilities, and providing identity services with single sign-on. As the M2M market grows, operators supporting their customers' income streams can grow with the flow of income through their billing systems.

State-of-the-art M2M applications use Java technology from end-to-end, and forward-looking mobile operators provide standards-based services that interface seamlessly with their customers. Using Java technology, M2M devices are controlled by IMlets that are built to use the IMP profile on the Java ME platform. With limited networking capabilities in M2M modules, mobile operators or their M2M developers can translate custom wireless protocols into Web services protocols such as SOAP at the interface between the wireless and the wired networks. On the back end, M2M applications are built on the Java EE platform, and have full support of Web services protocols and APIs that can interface to value-added services provided by carriers — from OSS/J APIs for provisioning and billing to identity management protocols that integrate with Sun products like Sun Java System Access Manager.

The best partner that mobile operators can choose as they work to better support M2M applications is Sun Microsystems. Long a preferred vendor to telecommunications companies, Sun is behind many of the technologies that mobile operators need in order to maintain their leading-edge market position. The inventor of the Java programming language, Sun continues to move the state-of-the-art forward, making substantial contributions to open standards initiatives like OSS/J. Sun's software technologies embodied in the Sun Java Enterprise System provide high-performance, highly-reliable, scalable, carrier-grade services that mobile operators need. Products like Sun Java System Directory Server, Sun Java System Access Manager, and Sun Java System Application server are hard at work for communication carriers worldwide. Sun's new x64 server product line gives mobile operators extraordinary performance and flexibility. Built using Single-Core and Dual-Core AMD Opteron™ processors, Sun Fire™ x64 servers can support all three of the major enterprise operating systems, including the Solaris™ Operating System, Linux, and Microsoft Windows. Mobile operators can purchase and deploy one set of dual- and quad-processor servers and use them for one purpose today, and re-deploy them using a different operating system the moment that their needs change. Of course Sun UltraSPARC® processor-powered Netra™ servers have long been the choice of communication carriers needing NEBS Level 3-certified servers that can run using AC or DC power, and stand up to the environmental rigors of central-office environments.

From support for end-to-end Java technology M2M solutions, to the server hardware and software platforms that mobile operators need to stay ahead of the competition, Sun is the clear choice.

# Chapter 6
# References

Sun Microsystems posts complete information on its hardware and software products and service offerings in the form of data sheets, specifications, and white papers at its Web site, *http://www.sun.com*.

- For more information on 8D Technologies, its ECO M2M device, Cloud9 software platform, and 8D AMPS parking application, please visit *www.8d.com*.
- For more information about Esmertec's Jbed IMP product supporting load-time compilation in Java technology-based M2M devices, please visit *www.esmertec.com*.

Chapter 7

# About the Authors

## Bruce Baikie

Bruce Baikie is responsible for developing Sun's global telecom strategies and strategic alliances with an emphasis on wireless services and platform infrastructure. His position leverages extensive knowledge in wireless architectures, mobile service delivery environments and next-generation wireless and broadband services. Bruce delivers field sales and marketing collateral to promote partner solutions developed by Network Equipment Manufacturers (NEPs), ISVs, IHVs, and consulting organizations. A key member of the Sun's telecom team, his responsibilities also include partner contracts and negotiations, solution architectural designs, managing iForce[SM] partner implementations and direct global field sales support. Mr. Baikie holds a B.S. in Mechanical Engineering from Michigan Technological University and a B.A. in International Business from the University of Wisconsin.

## Steve Gaede

Steve Gaede is a freelance technical writer and technology consultant. In his work with PointSource Communications, he develops numerous documents each year for Sun Microsystems. His history includes work with Amdahl Corp., Bell Laboratories, Cray Laboratories, NBI, Inc., and Software Design & Analysis Inc. Steve performs technology assessments, builds proof-of-concept prototypes, conducts performance evaluation projects, and develops IT best practices through his consulting company, Lone Eagle Systems Inc. He is active in the Boulder Colorado professional community, and has been a coordinator of the Front Range UNIX Users Group since 1984. Mr. Gaede received his B.S.E. in Computer Engineering from the University of Michigan and his M.S. in Computer Science from the University of California, Berkeley.

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**Sun Microsystems, Inc.** 4150 Network Circle, Santa Clara, CA 95054 USA **Phone** 1-650-960-1300 or 1-800-555-9SUN **Web** sun.com