THE RISE OF INTELLIGENT DEVICES

PAUL DRYSCH

ABSTRACT

Cellular networks are best known for the cell phones that they serve, but they also support a far larger – yet often overlooked – user base: machines with embedded intelligence that permits them to exchange specific information with other machines. Referred to as telemetry or machine-to-machine (M2M) communications, these devices and services cater to vending machines, truck trailers and utility meters, to name just a few common applications. M2M has been and will remain a growth market because it gives enterprises, government agencies and others a powerful way to cut costs, streamline their operations and improve their competitive position through real-time data dissemination.

INTRODUCTION

The rise of telemetry has been underway for several years. For example, in 1999, electric utilities already had 164 telemetry deployments, with a total of 4.8 million units, and another 22,000 units across 24 trials, according to a study by the Automatic Meter Reading Association. The AMRA also found that across all types of utilities, the number of telemetry installations had grown 8 percent just between 1999 and 2000.

Although the utilities sector is just one example of how M2M is used, it provides a good overview of some of the reasons why telemetry deployments keep increasing:

Cost – Telemetry frequently is cheaper than hiring personnel or contractors to read meters manually on a regular basis. The technology also can eliminate unnecessary trips into the field. For example, with telemetry, an electric utility can remotely take a reading on the day that an apartment tenant moves out and then track usage to make sure that another tenant hasn't moved in without signing up for service. Without telemetry, a worker has to take the reading, shut off power and then return to restore power when a new tenant moves in.

Precision – The cost of manual readings is only part of the calculations used to assess the business case for telemetry. For example, by providing readings that are more frequent and more accurate than those done manually, M2M reduces adjunct costs, such as staffing call centers to handle questions related to estimated bills.

Figure 1 below shows the potential overall market for intelligent devices in M2M applications. Wireless data applications and devices represent a subset of the overall market.

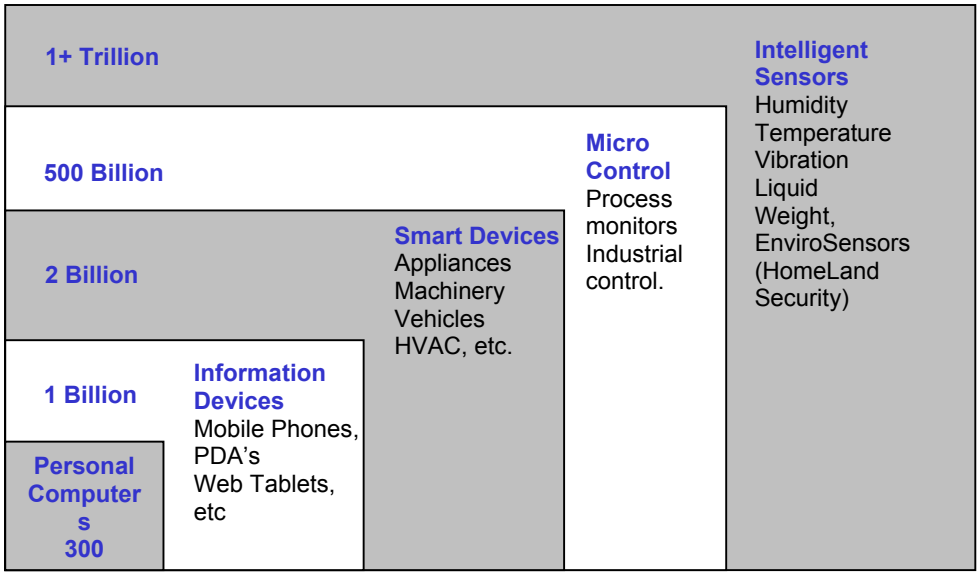

Figure 1. M2M Will Extend to an Enormous Device Population*

As compelling as telemetry is, it's important to note that not all telemetry solutions are created alike. In fact, the architecture and underlying technologies largely determine the solution's business impact and the system's ability to live up to telemetry's full potential. This paper looks at the key requirements for an effective, flexible M2M ecosystem of devices and network infrastructure.

LEVERAGING ANALOG CELLULAR

Cellular networks feature a control channel that the phone and network use for tasks such as setting up calls. However, only part of this control channel is used. The first generation of Aeris.net's MicroBurst telemetry solution used the excess control channel bandwidth to send and receive small packets of data to and from telemetry devices. Nevertheless, MicroBurst's telemetry traffic was completely transparent to the network and didn't affect the quality or amount of voice traffic.

In North America, analog was and still is the most widely available wireless technology in terms of geography, including remote rural areas. That made it ideal for telemetry applications such as vehicle and trailer tracking, where M2M devices travel a wide geographic area, both urban and rural. By partnering with all of the major analog cellular carriers in North America, the MicroBurst service was available to M2M users in nearly all of Canada and the United States. Wireless carriers were receptive to MicroBurst because supporting it didn't require significant capital outlays or system upgrades, yet the telemetry service provided significant incremental revenue.

To develop a network that would satisfy all the requirements of seamless coverage, real-time connection, low cost, and scalability, Aeris.net integrated:

A nationwide network of cellular carriers to provide a seamless air interface and switching infrastructure across North America

Signaling System Seven (SS7) carriers, Internet Service Providers (ISPs), and telecommunications companies to provide seamless national data transport

Equipment manufacturers to provide the low-cost MicroBurst radios that are mounted on devices such as utility meters

Third parties to provide network, software and hardware expertise

Application developers to provide the customer applications

Aeris.net linked these elements together using their proprietary control channel technologies, extensive, custom-designed software and the Aeris.net central hub facility to provide real-time messaging, with seamless North American mobility.

DIRECT LINKS WITH CARRIER NETWORKS

The Aeris.net central hub provides an internetworking connectivity and message management facility that is unlike anything else in the telecommunications industry. The hub facility is directly connected via SS7 links to each of the 600-plus switches in the aggregated nationwide network of cellular carriers. This direct connection provides Aeris.net with a unique "window" into the North American cellular network, and allows Aeris.net to manage MicroBurst devices both within and across participating networks throughout North America.

Wireless M2M applications often require multiple devices operating across different networks and in disparate locations. In many wireless M2M applications, such as vehicle and trailer tracking, devices are not only in different networks, they are also constantly moving between networks, going from carrier to carrier, and technology to technology.
Although carriers can monitor their own networks, they're not capable of monitoring a device once it switches to another carrier's network. There also is no sharing of information between the carriers to manage a device or to let the new carrier know where the device was before it entered the new network.

Each MicroBurst device is designed to operate automatically anywhere there's cellular coverage in North America, and to provide information back to the Aeris.net central processing hub. This information includes the current status of the device, its serving cellular switch and time of day. Because of the interconnection to each switch in the network, the Aeris.net central processing hub knows where each device is located, where each device has been and what the specific network requirements, regardless of the M2M device's physical location at that particular moment.

MICROBURST NETWORK OVERVIEW

The MicroBurst network consists of five basic components:

The cellular airlink and carrier

The SS7 network

The Internet (or dedicated links) for the data traffic

The Aeris.net central hub facility

The MicroBurst Device

MicroBurst's basic network architecture is illustrated below in Figure 2.

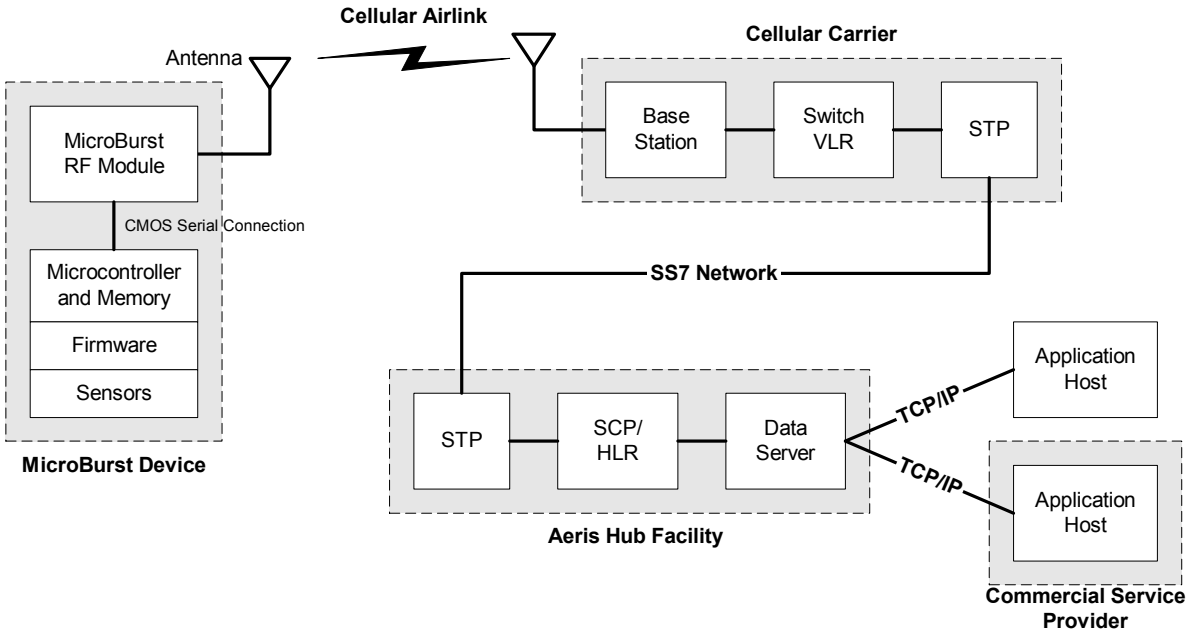

Figure 2. MicroBurst Network Architecture

The cellular airlink and cellular carrier system provides wireless connectivity from the Aeris.net central hub facility out to the MicroBurst devices. MicroBurst uses standard cellular control channels, as well as ANSI-41 and GSM Mobile Application Part (MAP) signaling mechanisms, to relay short messages to and from MicroBurst devices.

The SS7 network is used to authenticate devices and transport ANSI-41 and GSM MAP network messages – including the MicroBurst data packets – between the Aeris.net central hub facility and the cellular carrier switches. The hub has direct SS7 connections into over 600 switches owned by 30 different carriers across North America. Aeris.net is the only network provider with

SS7 connectivity throughout the North America Internet (or dedicated TCP/IP links) for data traffic.

The Internet and dedicated TCP/IP data links provide transport for the data traffic between the hub facility and application host facilities, from which the MicroBurst devices are remotely monitored and controlled.

The Aeris.net central hub facility provides the central processing functions for the MicroBurst service. The hub consists of fully redundant and fault-tolerant carrier-class telecommunications infrastructure equipment, and features extensive proprietary software to control the system operations and provide the billing capabilities of the system. The Aeris.net central hub facility routes messages between end-point devices and application host facilities anywhere in North America in near real time – typically a few seconds end-to-end. Aeris.net's MicroBurst system uses TCP/IP as its underlying data transmission protocol to the application host systems.

The main components of the Aeris.net central hub facility include:

Home Location Register (HLR)

Short Message Service Center (SMSC)

Mobile Switching Center (MSC)

Signaling System Seven (SS7)

Signal Transfer Point (STP)

The MicroBurst device is an application-specific, programmable telemetry unit that consists of:

A cellular radio

A micro-controller with memory

MicroBurst-specific firmware

A serial connection between the radio and the micro-controller

I/O between the micro-controller and integrated or external application-specific data sources such as one or more sensors or a GPS receiver

Each MicroBurst device is designed to gather and encode the application data for trans-mission to the application host computer, and decode and execute instructions received from the application host computer. The precise internal configuration of each MicroBurst device will differ depending on the specific application requirements.

DIGITAL AND DUAL-MODE SERVICES

Many wireless networks are in the midst of evolving from analog to digital technologies, such as CDMA and GSM. Digital technologies make more efficient use of spectrum, and they're capable of supporting a far wider range of data services, which makes them ideal for telemetry applications.

MicroBurst is expanding to work with the two most widely used digital cellular technologies in North America: CDMA and GSM, including their 3G versions, such as 1xRTT, EV-DO and UMTS. As carriers expand their digital networks, Digital MicroBurst will grow with them and be available everywhere there's digital cellular.

To accommodate the transition from analog to digital networks, Aeris.net has developed Digital MicroBurst devices that offer dual-mode, dual-band functionality. Commercial Service Providers (CSPs) will be able to select CDMA/AMPS or GSM/AMPS devices, each of which is equipped to scan all possible channels: digital, analog, 800MHz, 1900MHz, A side or B side and up to six carriers in any major market.

As a result, a Digital MicroBurst device can scan the spectrum of the aggregated carriers in one market and pick the best of the 20 or 30 channels available in that specific area at that time to ensure optimal service. The result is a multi-band aggregation of carriers that provides robustness and seamless coverage. In addition, because MicroBurst is based on network standards rather than radio frequency (RF) standards, it operates with equal efficiency regardless of the airlink technology.

A HUB FOR THE FUTURE

Besides developing dual-mode MicroBurst devices, Aeris.net has enhanced its central hub facility in order device has registered in a specific market. There is no information about when the registration was made, or where the device was registered before. For the carriers, it is only necessary to know if a device is registered in their market.

The Aeris.net HLR keeps track of time stamps and a history of every place a device has registered with the network, regardless of carrier or market. By keeping a running history of where and when each network registration occurs, the hub is able to closely monitor each device on the network, and find problems within a commercial wireless network that otherwise couldn't be discovered without specialized – and expensive – testing.

The ability to gather and manage a greater variety of information, combined with direct switch access, provides the hub with invaluable diagnostic and network management capabilities: The hub can monitor device and network behavior across the entire North American MicroBurst network. In the process, the Aeris.net HLR established a new benchmark for inter-network device and information management.

Those diagnostic and network management capabilities benefit carriers by helping them diagnose and pinpoint network problems. The device-location information can assist network providers to fine tune their networks to ensure optimal performance of the overall network, not just for wireless data devices. Performance data from the MicroBurst devices provides a critical tool for carriers to improve network efficiency without having to deploy extensive diagnostic teams.

In addition to expanded diagnostic and network management capabilities, Aeris.net's HLR architecture allows software upgrades to be performed without having to take the network offline, and for broader functionalities to be available to commercial service providersto accommodate subscriber growth, improve performance and add services. The most important recent upgrade is the new, custom-designed Home Location Register (HLR), fully optimized for data traffic.

For example, unlike conventional HLRs, the Aeris.net HLR can manage far more data for every device registration. Current cellular network standards require only minimal information to be stored at the carrier HLR, such as a basic acknowledgement that a.

WHAT'S NEXT FOR M2M

As the needs of M2M users evolve, the telemetry services that support them must evolve, too. Besides supporting digital and 3G wireless technologies such as 1XRTT, Aeris.net has developed AerFrame, a comprehensive infrastructure and service offering that builds on MicroBurst's existing processing, database, provisioning and network management foundation. AerFrame will support all these next-generation M2M applications.

Figure 3 illustrates a conceptual architecture of the Universal Aeris Network.

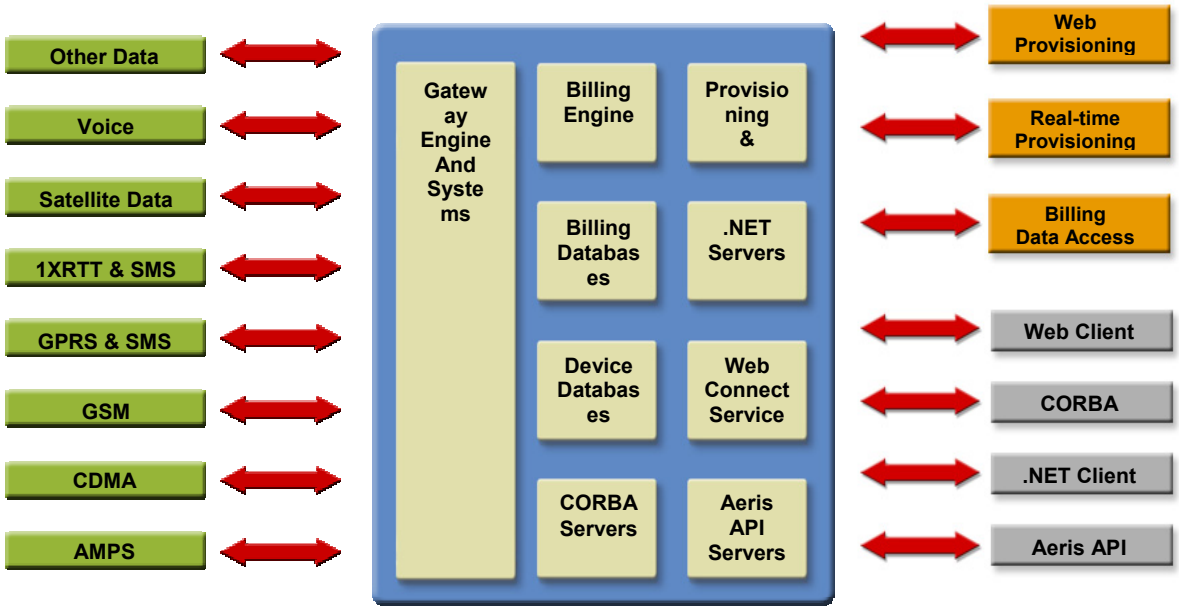

Figure 3. Aeris Microburst Network

The AerFrame architecture features:

- Multiple wireless data transport networks, including analog and digital MicroBurst, SMS, packet radio, satellite, voice and other data networks optimized for M2M services
- Data-delivery interfaces, including Aeris.net's API, .NET, CORBA, and Web client systems
- Real-time provisioning and billing data access, including new Web-based device information access
- A configurable network gateway engine, which allows for the transparent interoperability of different network and transport technologies
- Specific-purpose databases and servers

LEVERAGING SMS AND PACKET DATA

Today's SMS and packet radio services haven't been optimized for M2M applications. Their principal target applications are in the "enterprise and entertainment" space, designed for

consumer and business applications such as e-mail and multimedia. However, because they're based on accepted, international standards, and have readily available hardware, they represent an attractive opportunity for future M2M applications.

SMS and Packet Radio services provide an additional set of tools for the MicroBurst M2M data service provider without having to add additional equipment: Digital MicroBurst devices automatically accommodate SMS and Packet Radio for larger data payloads and for over-the-air upgrades to devices in the field. This ability directly impacts the M2M user's bottom line: Instead of sending workers to upgrade devices in the field, changes such as new firmware can be sent over the wireless network to the telemetry device. This method is much faster, yet less expensive, than hands-on upgrades.

Aeris.net's managed data delivery capability provides an entirely new approach to utilizing SMS for M2M applications. Conventional SMS is a store and forward, "fire and forget" system in which messages are subject to variable latency and uncertainty of delivery. Aeris's SMS (DirectSM) makes use of the short message airlink to send 140+ byte data messages to and from MicroBurst devices in the field, but uses Aeris.net's SS7 links to the carriers to route SM message directly through the Aeris hub facility, avoiding the text messaging infrastructure. This gives MicroBurst SM the same robust, real-time characteristics of MicroBurst itself.

TRANSACTION-BASED SERVICES

Many organizations are investigating the viability of transaction-based pricing for services. Aeris.net is uniquely positioned to offer transaction-based pricing for SMS and packet radio services. Because no additional MicroBurst infrastructure is required to provide or support either SMS or Packet Radio services, MicroBurst subscribers always have them available, but only pay for them when they are used. Aeris.net's ability to provide transaction-based enhanced data services to complement MicroBurst service dramatically increases the scope of possible applications. Aeris.net can offer subscribers the convenience of a nationwide, real-time, managed service only when needed.

Like Digital MicroBurst, DirectSM and MicroBurst Packet Radio, Aeris services will be deployed as standards compliant network overlays, aggregating multiple carriers' infrastructures and providing performance attributes optimized for the unique requirements of M2M.