# global networks for M2M

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M2M has a relatively short history, having been around since 2000 when it became apparent that communication between machines carrying out similar functions would be a good idea.

Since the concept of the technology, it has broadened into communication between dissimilar devices, the outstanding example being the medical field where monitoring various conditions of patients has become an expanding use and is extremely attractive to governments, doctors and patients as pressures on health services increase due to an ageing population.

Such systems appeal to both patient and doctor as normal lives can be led without time-consuming hospital waits and additional workloads for medical staff.

But outside medicine, M2M has expanding horizons. It has become a worldwide phenomenon with Europe and the US agreeing to support M2M devices and hopefully adopting global standards that will lead to universal acceptance. Improving efficiencies is one of the key goals as is preventing fraud through the use of smart meters that cannot be tampered with.

Control and monitoring of processes in hazardous areas such as oil refineries, chemical plants and nuclear power stations, as well as labour-intensive tasks such as parking and utility meters, are obvious fields for this technology — especially with shrinking workforces and declining skills. Elsewhere mining is mentioned and its uptake of M2M, and there can be few operations more hazardous than underground coal mining.

So where do we go from here? M2M has only just begun to make inroads into our way of life. In a short time it has brought about some dramatic changes in industry. The next 10 years could promise much.

Mike Smyth
Editor — *What's New in Electronics*

# A look to the future of global navigation satellite systems

**‘Global Navigation Satellite System,’ or ‘GNSS’ is a generic term used for a constellation of satellites with worldwide coverage that function to send positioning and timing signals to receivers located on Earth. It is this technology that allows us to perform simple applications from determining location and finding addresses to more sensitive asset tracking and military operations.**

The most mature system is the GPS, developed and maintained by the US. As the need for GNSS grew, different nations including Russia, Europe and China started developing their own systems. Currently, in addition to the popular GPS, other systems such as GLONASS, GALILEO and COMPASS are under construction and are expected to mature in the next decade. It is crucial for module providers and device manufacturers to recognise these changes and develop next generation products that will satisfy demands in different markets.

The first ever satellite navigation system created was 'Transit,' introduced in the 1960s by the US military. It was primarily used by the navy to provide accurate information for its submarines and ships. Since then, researchers have been developing and testing a more stable system with increased location accuracy for both civilian and military use. The relentless search for new technology finally gave birth to the GPS in 1993. As telecommunication technology matured, hand-in-hand, the number of GPS users reached an exploding number in the beginning of the 21st century. With this, other nations decided to develop their own GNSS and to obtain independency from the American system. The following is a brief introduction to the systems that are currently functional or under construction:

## GPS

Developed and operated by the US Department of Defense, the GPS (also known as NAVSTAR-GPS: NAVigation System with Timing And Ranging Global Positioning System) has been fully functional since 1993. Currently, there are 24 satellites out of the planned 32 in orbit at an altitude of 20, 180 km around the Earth. These satellites are organised on six orbital planes at an inclination of 55° to the equator, ensuring that at least four satellites are in radio communication with any point on Earth. Signals from individual satellites are encoded and distinguished using Code Division Multiple Access (CDMA) and broadcast on L1 and L2 bands.

## GLONASS

Currently, the only other fully functional GNSS, GLONASS, was developed and is maintained by the Russian government. It was created in 1976 and has undergone various transformations and restorations since. In late 2011, the system was restored to its complete capacity of 24 satellites, which are located on 3 orbital planes with an inclination of 48° from the equator. The Russian government has been promoting the civilian use of GLONASS, requiring the production of GLONASS-compatible vehicles by car manufacturers starting from early 2011. Like GPS, GLONASS transmits on L1 and L2 bands, however, it uses Frequency Division Multiple Access (FDMA) to distinguish between satellite signals.

## GALILEO

GALILEO is the GNSS currently being developed by the European Union. When complete, it will consist of 30 satellites located on three orbital paths around the Earth with an inclination of 56°. One of its main objectives is to provide a system that European nations can depend on, separate from GPS and GLONASS, which can be disabled for commercial users in times of international conflict. The system was set to become operational in 2012, but due to political and financial reasons, has been delayed until 2014. When functional, GALILEO will signal on L1, E5, and E6 bands, using CDMA techniques to differentiate satellite signals.

## COMPASS

The Compass Navigation Satellite System (or otherwise known as Beidou-2) is a second generation navigation system being developed by China. This second generation system is a completely new system, different from Beidou-1, which only had regional coverage. When complete, it will have a total of 35 satellites with signals based on the CDMA protocol, transmitting through E1, E2, E5B and E6 bands. The system’s tenth satellite was launched at the end of 2011 and is set to start services in Asia-Pacific in 2012.

In general, all satellite systems work the same way. It involves a complete system that consists of three parts: a network of satellites in space, a control station on Earth that manages the satellites and devices with receivers set to detect and accept signals from the satellites.

So, how does it work? Each satellite constantly sends out signals in the form of radio waves to the Earth. Each signal carries with it all the information about the satellite it came from and a time-stamp record of when it left the satellite. Receivers located on Earth pick up these signals and use their information to calculate location. For the receiver to calculate a 2D position (latitude and longitude) it must be locked to a minimum of three satellites. Four satellites or more are required for calculating 3D positions (latitude, longitude and altitude).

The ability of GNSS technology to calculate location information becomes extremely valuable when applied to the business process. It allows organisations to have greater control over business transactions, improving both productivity and efficiency while decreasing costs. Three recognisable GNSS applications - location based services, tracking and turn-by-turn navigation - are explored in the remainder of the section.

A location-based service, or LBS, is a mobile application that provides information services to users based on their geographical location. These services can range from finding popular landmarks such as service stations and banks, to locating specific people or places. In order for LBS to

work, mobile devices with positioning capabilities must be hooked onto a communications network, in addition to the presence of service and data content providers.

The adoption of LBS by businesses has the following benefits:

1. Location services - LBS is helpful in situations where employees are unfamiliar with the region they are in and are trying to search for a particular service.
2. Informed decision making - The application filters vast amounts of material available on the internet into relevant information for the user's current context. Users can see important information, enabling them to make informed decisions on the spot; for example, locating and choosing the nearest service station.
3. Access to new information - By making relevant information available to users, LBS not only supports timely presentation of data, it highlights information that users may not normally be aware of, such as traffic congestion and bad weather.
4. Reduce manual operation - LBS can automatically obtain location information and related data, reducing the need for manual data entry when users need to gain access to a certain service.

One of the original uses of GNSS technology in the field was to provide real-time tracking, which allowed vehicles to periodically report their location over a wide area network. Typically, these systems include a map-based interface where the backend or dispatch office can view vehicle location and condition. Some systems also provide more advanced features such as Geofencing, which enables the backend to be alerted when the vehicle disobeys predetermined routes. With real-time tracking, not only is the transportation process made transparent, but vehicle security is also enhanced.

Investing in a tracking system is beneficial because it helps to:

1. Reduce fuel costs - A GNSS-enabled tracking system helps businesses monitor fuel consumption by identifying vehicles with excess fuel consumption caused by speeding and idling.
2. Improve customer service - By locating the exact location of company vehicles, businesses can estimate more precisely when a driver will arrive at a user's location. The backend or dispatch office is able to dispatch vehicles near a customer's location rather than vehicles located further away which, in turn, saves time, fuel costs and improves service efficiency.
3. Reduce overtime - By identifying inefficient routes and unscheduled and unauthorised stops, business can reduce the number of reported hours on time sheets, as well reduced work hours due to enhanced productivity.
4. Increase employee accountability - Businesses can eliminate the possibility of employees using company vehicles to conduct personal errands. When drivers know that their driving behaviour, routes taken and time spent is being monitored, they are more likely to be accountable for their actions.
5. Increase driver safety - A GNSS-enabled tracking system allows the backend to monitor speeding, which allows unsafe driving behaviours to be identified before an accident occurs.

One of the most popular applications of GNSS technology is the ability to receive 'turn-by-turn' driving directions in real time. In-vehicle navigation systems use GNSS to calculate the user's current position and then use navigation algorithms to compute the best route for the user's planned destination. The system provides driving directions, which take the form of voice instructions and visual screen display.

Advantages of GNSS enabled navigation include:

1. Reduced costs - Unnecessary mileage, caused by inaccurate driving directions, can be reduced, saving both time and money for the organisation.
2. Improved performance - The ability to navigate in unfamiliar locations decreases the possibility of getting lost or following inefficient routes. This, in turn, translates into improved on-time performance for businesses.
3. Enhanced efficiency - GNSS navigation allows businesses to reduce travel between stops or activities, which can enable more stops per driver, per day.

The integration of GNSS technology into everyday business operations can no doubt bring about tremendous benefits. Not only does it increase visibility of the supply chain, but it also assists in the decision making process, allowing businesses to reduce associated costs. Hence, devices with GNSS receivers have become popular in the industry, especially where fleet and asset management is concerned.

IEIMobile's in-vehicle computers use a GNSS receiver module that supports GPS and GALILEO systems. However, with the maturation of the GLONASS system and the regulations drawn out by the Russian government, the demand for GLONASS-support devices has greatly increased, especially for aftermarket automotive products. In response to Russia's growing demand, the company is currently working with GNSS receiver module provider Ublox to develop devices that will support the system. Ublox's latest LEA 6H module will be integrated into the company's devices and offered to the Russian market in early 2012.

As the market has received affirmation from early adopters, GNSS technologies are geared for a prosperous growth over the next few decades. However, with the maturity of such technologies and the development of separate systems by different nations, the market will, no doubt, go through a period of change. Compared to the previous era, dominated by the American GPS, different markets must now search for solutions that will support their respective navigation systems. It is critical for module providers and device manufacturers to realise this impact on the development of next generation products.

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# M2M is coming of age

*Mike Smyth, Editor What's New in Electronics*

**M2M technology has reached into many aspects of our lives and is continuing to expand into areas that a few years ago would have been thought regions of science fiction.**

Several factors have contributed to its wide acceptance. Two of them, electronics and the widespread use of wireless networks and the declining workforce in manufacturing and shortage of labour in other areas, have forced M2M technology into an early maturity.

On the electronics side, components in general and programmable devices in particular have fallen dramatically in price as their capabilities and complexity have gone up. Couple this with greater miniaturisation and the lower power demands of today's components and there is a technology that is within the grasp of all but the smallest organisations.

And there is the bonus that M2M systems don't want holidays, never go sick, don't ask for pay rises but keep working 24 hours a day with little human intervention that in itself reduces the likelihood of man-made human error.

Wireless systems such as Bluetooth and Wi-Fi are already familiar to many of us. M2M is an extension of this technology that promises to revolutionise manufacturing, medicine and process control among others.

The technology allows networked machines to exchange information and perform actions without human intervention. This has enabled applications to expand across a wide range of fixed and/or mobile devices, including transport, water and energy smart meters, HVAC, smart homes, military, environmental monitoring, home medical devices and robotic equipment.

Physical conditions that can be monitored include temperature, fluid leaks, energy spikes, location, consumption, heart rate, stress levels, oxygen levels, light, movement, altitude, speed and many more.

Wireless carriers have partnered with service delivery platform providers to make their networks more accessible to M2M applications. Globally connected solutions can be created using wireless communications technologies such as GSM, CDMA and satellite connections. Some of these connections occur over a relatively short range, some over many kilometres.

When looking at the advantages and disadvantages of wireless M2M applications, it is important to consider how the design factors of the data link can play a most important role in terms of real-time guarantees, energy efficiency, scalability, throughput, latency and reliability. Such varied design implications have dramatically increased the complexity of finding the ideal balanced and cost-effective solution across the wide range of diverse applications.

In the past, the effective polling, monitoring, storing and fusing of vast amounts of data coming from hundreds and sometimes thousands of network devices have been challenging. Now, with smarter devices, software and more reliable networks, new M2M applications are possible and reliable. The widespread availability and decreasing cost of wireless communication is making M2M applications more cost-effective to implement. Two examples that illustrate the practical use of M2M technology are healthcare and mining.

## Healthcare applications

According to the Australian Bureau of Statistics, one in three Australians is over the age of 50. By 2050 it is estimated that at least 44% of the population, or over 14 million people, will be aged 50-plus.

One of the problems caused by an ageing population is that it places big strains on the existing health systems as these people are more prone to illness and injuries. Smart technologies can help provide a solution that will eventually reduce doctors' visits and hospital admissions.

The Australian Academy of Technological Sciences and Engineering (ATSE) estimates that home-based, self-management interventions can improve patient outcomes, halve hospital admissions and reduce doctor visits by 40%.

Certain patients can use radio-based monitors that can be used to measure their temperature, heart rate and blood oxygen level while the patient remains in their home during treatment. This information is then fed back to the medical station/hospital for monitoring.

Bioelectronics melds biology and electronics to design and build the likes of ECG machines and 3D CT scanning equipment. Linking gerontology with smart technologies can make a substantial contribution to meeting the economic and social challenges posed by changing demographics.

Dr Alistair McEwan from the University of Sydney's School of Electrical and Information Engineering is an expert in bioelectronics and says the bioelectronics degree at the university will train engineers to help drive down the skyrocketing health costs associated with growing numbers of elderly patients.

In an article featured on the ***What's New in Electronics*** website, he said he believes wired and wireless technology can help diagnose, monitor and manage patients, with instruments connected via telephone, web-based services and databases.

It is crucial for M2M systems used in healthcare applications to be accurate and up to the minute. Patient information must always be available for every piece of equipment, from digital thermometers to life-support machines, and networked and associated with a patient ID.

The devices and the network need to be 'intelligent' and 'real time' so the M2M systems must embed device intelligence and software support within a reliable network. Eliminating the need for human intervention for network and device support and keeping the patient out of hospital have the potential to save huge costs for the community.

## Mining applications

Mining at the traditional 'coalface' is where many of the worst accidents happen and mining remains one of the most dangerous occupations. Automating mining using robotic equipment networked to remote monitoring centres and moving people out of danger zones could provide huge benefits to the improvement in human health, safety and productivity in the industry.

For over 16 years, Rio Tinto has been working on what it calls 'the mine of the future'. Just this year, the company rolled out a fleet of 150 automated trucks at its Pilbara iron ore operations in what it claims is the world's first major deployment of an autonomous truck fleet.

The trucks are controlled from its Operations Centre in Perth, 1500 km away. Following predefined courses, the trucks use GPS to navigate from loading units to dump locations.

The trucks were trialled at Rio Tinto's West Angelas iron ore mine near Newman and can take themselves to refuelling stations when they need a refill. The trial used five autonomous trucks fitted with radars, lasers, communication antennas and high-precision GPS and travelled 570,000 km in over 897 days of operation.

The vehicles are fed data about the location, speed and direction of all manned and unmanned vehicles in the pit and can adjust speed based on that information. The trucks travel along defined GPS courses that identify haul roads, intersections and mine locations, such as loading areas, stockpiles and crushers.

According to reports, the company is also working with machine manufacturers to create next-generation tunnelling machines to replace traditional human-driven drilling and blasting equipment.

The automated systems would mean less waste as efficiency improvements would result in reduced need for energy and consumables, but the labour shortage is also cited as a reason for the move. Greater safety and lower costs would also follow the shift from human to machine labour.

These two examples are just the tip of the iceberg. Networked technology will undoubtedly spread into many other areas in the next few years, limited only by imagination and cost. ■

# Parking meter monitoring using wireless global network

A solution was required for a recent application to ensure high-demand parking meters, in multiple locations across the globe, are constantly monitored, updated and able to process transactions instantly. Wirelessly enabled parking meters, powered by Integrated Technology Solutions' (ITS) state-of-the-art hardware and software solution, were installed and operated using the optimised KORE Global M2M Network.

ITS's Metro Parking Meter Series is built for both on- and off-street parking, giving councils and municipalities, universities, hospitals and private car park operators a cost-effective way to manage their parking operations.

Metro Series include Pay & Display, Pay by Plate and Pay by Space models, with the ability to integrate third-party systems such as in-ground bay sensors and licence plate recognition cameras.

Continuously connected meters provide large cost savings, due to a reduced need for manpower for maintenance and collection of revenue; as well as providing real-time updates for any faulty machine. ITS contracted KORE Wireless to provide wireless connectivity over the GSM network for its newly developed parking meters.

ITS needed secure and reliable connectivity globally to demonstrate to customers the full potential of its powerful new solution, enabling:

- real-time transaction processing;
- over-the-air programming;
- alarms and warnings; and
- feedback to EziCom ITS's proprietary web-based monitoring and reporting solution.

All of the models in the Metro Series range communicate in real time to a central management system through the KORE Wireless Global GSM Network and provide customers with options for payment by coin, online credit card, mobile phone text messaging and banknote acceptance.

In a recent application, ITS's Metro Parking Meter Series using the KORE cellular solution replaced the old, manual meters and instantly began receiving the following benefits:

- instant cost saving by eliminating expensive physical monitoring costs;
- immediate meter deployment;
- decreased transaction time and allowance for multiple-payment solutions;
- enabled use of ITS's leading-edge software to remotely manage and monitor from its control station; and
- static IP and a private connection to the KORE network allows for instantaneous monitoring and secure transactions.

Using KORE's Global presence, ITS is able to seamlessly provide, manage and deploy solutions for multiple countries, including Australia, New Zealand, Canada, North America and Europe, all from its office in Auckland, New Zealand.

## About Integrated Technology Solutions

ITS provides technology solutions to a number of markets including banking, retail, parking, fuel, self-service and cash handling. Its diversified product portfolio is derived from either: solutions selected from overseas or solutions developed by its own Auckland-based research and development team. This ability to choose from a range of leading international suppliers or to develop new solutions places ITS in a unique position, as it enables it to work with clients to deliver flexible solutions which are not constrained but rather add value and meet the unique needs of the client. ITS delivers: product sourcing, software development, hardware design, hardware manufacturing, systems integration, consultancy - process engineering, project management, installation services, maintenance services and help desk services (24/7).

## About KORE

KORE Wireless is one of the world's largest wireless network providers specialising exclusively on the rapidly expanding global machine-to-machine (M2M) communications market. Providing unified control and management for cellular and satellite network service delivery in more than 180 countries worldwide, KORE empowers its application, hardware and wireless operator partners to efficiently deliver M2M solutions for connected devices across the globe. KORE offers a range of technologies — including GSM, HSPA, CDMA and EV-DO, as well as satellite services — that ensure the greatest possible reliability and coverage. KORE delivers: 100% true global coverage, M2M expertise and a strong service delivery track record, dual VPN connections with auto fail-over should one go down, two, fully geo-redundant data centres powered by Cisco with automatic fail-over and self-healing capabilities and multiple, redundant connections to the largest global carriers. ■

# Remote asset control is changing our lives

**M2M communications is the networking of intelligent, communications-enabled remote assets. It allows key information to be exchanged automatically without human intervention and covers a broad range of technologies and applications which connect the physical world - whether machines or monitored physical conditions - to a back-end IT infrastructure.**

These remote assets, which can be fixed or mobile, include cars and truck fleets, utility meters, copiers and printers, kiosks and wireless displays, ventilation and air-conditioning sensors, home medical devices, fitness monitors and CCTV cameras.

The physical conditions they monitor can include temperature, location, consumption, heart rate, stress levels, light, movement, altitude and speed.

M2M communications can be used to gain immediate feedback on how a particular remote asset is being used, which features are most popular and what problems such as errors or breakdowns typically arise.

This information is useful for shortening the lead time to an improved or updated version, thereby providing a competitive edge.

M2M communications are made possible using intelligent sensors or microprocessors that are embedded in the remote asset.

These sensors include a SIM card - albeit slightly different to the one you have in your mobile device - that is able to receive and transmit data wirelessly to a central server where it can be analysed and acted on.

Wireless communications technologies used to enable this connectivity include GSM, GPRS, EDMA, 3G, LTE, or Wi-Fi and WiMAX. Some of these connections occur over a relatively short range, some over a distance of many kilometres.

The widespread availability and decreasing cost of wireless communications, economies of scale and improvements in bandwidth have redefined what's now cost-effective to connect.

As a result, multinational businesses can consider M2M not just for their most important production assets, but for almost every remote asset they own or service for customers.

When that networking is conducted globally, it can translate into improved efficiency and reduced operating and maintenance costs.

In addition to commercial pressures to differentiate, new stringent legislation is requiring companies in many sectors to be accountable for product tracking and management.

Over the next few years, M2M could be a key enabler in helping to restore confidence after the world economic crisis, providing the next leap forward in global productivity in much the same way as the mobile phone did in the latter part of the last century.

It's hard to imagine a time when M2M wasn't a vital part of the transport and logistics industry. At the end of 2009 there were more than 3.2 million passenger cars in Europe with an onboard telematics device.

M2M is now being used to add new in-car functionality such as 'infotainment' and navigation services and to enable the vehicle to self-diagnose and warn the driver of potential difficulties before a journey is undertaken.

In the event of an accident, the vehicle's M2M system can notify emergency services of its location and establish communications directly with the occupants.

Following a breakdown or accident, roadside assistance can be informed immediately with details of the problem and the vehicle's precise location.

Other applications include: usage-based vehicle insurance (also known as pay-as-you-drive); vehicle tracking to aid the recovery of stolen vehicles and increase driver safety; measurement of driving behaviours including the G-forces resulting from hard breaking and fast starts and speeding; as well as value-added services such as car concierge and location positioning.

When used in conjunction with satellite-based GPS and location-based services, M2M can provide real-time information such as vehicle location, driver speeds, kilometres driven, fuel consumption and employee work time.

The technology is also being used to manage and dispatch fleets and resources and enable supply chain companies to deliver cost-efficient goods. Delivery at the door can also be confirmed and paid for using M2M.

As part of the efforts to build a sustainable energy system, the traditional mechanical utility meter can now be replaced by a smart meter that can improve efficiency and reliability in energy distribution and better optimisation allocating resources.

Energy regulations and smart-grid funding are likely to push the number of smart meters installed worldwide to more than 100 million during the next few years.

Smart metering incorporates a wide range of applications in the fields of remote meter reading, user relationship management, demand management and value-added services such as home automation.

The deployment of automatic meter reading applications will help users gain better visibility over their energy usage and spending. Similar technology is needed to ensure the motor vehicle and transport markets do their part by moving smoothly from fossil fuels to hybrid and electric cars.

Smart grid technology enables utilities to connect wirelessly to their grid assets, such as circuit breakers, transformers and other substation equipment. This allows them to develop interactive utility networks that are more intelligent, resilient, reliable and self-balancing.

Recent health reports project the global telemedicine industry to be worth US$18 billion by 2015 boosted by new M2M functions in radiology, cardiology, dermatology, psychiatry, dentistry, paediatrics and pathology.

Currently, there are nearly a billion people around the world with at least one chronic disease and the number is rising. By 2020 diabetes is expected to double and deaths caused by heart disease and stroke will increase to more than 20 million a year.

M2M is becoming an integral part of patient care, helping to cut costs as well as save lives. Sensors in the bathroom, by the bed or near the door can collect information without compromising the individual's privacy.

Remote monitoring devices can be used to allow physicians to remotely monitor information about patients with heart conditions and diabetes.

Patient sensors act as extra eyes and ears for doctors treating chronic illness such as cardiac disease, high blood pressure, diabetes and obesity.

Continuous two-way data feeds over the M2M network provide detailed monitoring information that allows doctors to spot early warnings of medical deterioration and apply treatment earlier than physical diagnosis allows.

Patients can learn to monitor their own vital signs and better administer their own treatment regime, and elderly relatives can be monitored remotely by their families to make sure they are safe and healthy.

Healthcare providers can immediately see whether patients have complied with their physicians' instructions and treatment regimes.

Statistically, about half all hospital beds are occupied by patients who have chronic illnesses that could equally well be monitored using M2M technologies if they were at home.

So, not only does telemedicine promise better quality patient treatment, it also reduces costs and refocuses resources on face-to-face treatment and allotting bed space to patients with life-threatening conditions or intensive treatment needs.

The industry sector has always needed to closely monitor and control plant and field equipment and processes to ensure production is maximised while all machinery operates within safety limits.

The introduction of remote monitoring and adjustment capabilities from M2M has seen companies increase their productivity and profitability while expanding their services into new areas.

It has empowered expansion and increases in efficiency and productivity by recognising performance issues just before or as they happen, thereby minimising downtime.

Remote machines and robots controlled by M2M can undertake routine repairs and maintenance, while emergency repair crews can arrive at a site fully briefed to resolve an issue quickly, with the right tools.

Over time, industrial business can learn more about the causes of equipment malfunction and downtime and build detailed performance analysis models from M2M data feeds.

Most importantly, M2M offers the industrial sector the opportunity to transform from a hardware-based business model to one that is more user-service orientated.

Retail was one of the first sectors to see significant breakthroughs for wireless M2M. Radio frequency identification tags have been used for many years to provide retailers with real-time visibility into their inventory and allow individual items to be monitored and tracked to the doorstep of the final delivery.

In service-driven industries, M2M will make the difference in revenue generation by providing immediate information on the required items to be replaced. M2M goes beyond this, enabling new business models and market approaches such as pay-per-print.

With no fixed infrastructure required, wireless terminals are one of the fastest growing segments of the payment industry and are being used for applications including point-of-sale terminals.

Meanwhile, retail outlets are becoming savvier in their use of M2M to boost sales through up-to-the-minute in-store shopping discounts based on personalised consumer needs powered by M2M.

M2M can be used to push news or eye-catching advertisements to remote kiosks, electronic display boards and mobile screens displaying information such as location, time of day and passing traffic.

As environmental considerations become more pressing, retailers are also looking to M2M to help them monitor how they consume the energy that powers their business.

The market for security products and services has grown rapidly recently, with the government leading strategic warfare overseas to limit potential terrorist impacts at home.

Individuals have become more aware of their own responsibilities towards security and have renewed efforts to stem a rise in vandalism, theft and violence.

The use of wireless communications to automate remote security solutions provides a more efficient and cost-effective means of monitoring intrusion of CCTV images, allowing remote surveillance and access to control systems, motion detectors, lighting and access points.

The control station can remotely authorise access to controlled areas with the ability to open and close locks, doors and gates via the wireless network. It can generate alerts for security breaches that trigger appropriate actions such as locking doors or calling for assistance.

Personal navigation devices, fitness monitors, e-readers, track-and-trace animal collars and networked digital photo frames are just some of the innovative consumer products and services that are changing people's lifestyles.

M2M solutions provide quick and easy payment methods for couriers and remote tradespeople, while also providing cost-effective, secure and easy-to-install payment solutions at trade shows, exhibitions and sporting events.

Supermarkets, service stations, convenience stores and retail outlets can also use M2M to reduce ongoing running costs of electronic point-of-sale terminals due to the low-cost tariffs available.

M2M enables an asset, such as a lift or vending machine, to immediately advise its service centre if there is a fault. The service centre can then interrogate the product remotely to determine the fault and ensure that technicians are equipped with the correct parts before making a visit to the site.

The drivers for M2M will vary depending on the specific business and its needs, but generally include:

- As digital cellular coverage has expanded, there has been a corresponding shift away from satellite connectivity towards terrestrial cellular connectivity.
- Cost saving remains one of the primary drivers for businesses to adopt M2M. The recovery of one misplaced diesel generator, for example, can cover the installation and running costs of a tracking deployment.
- While cost saving is still very important and valuable to businesses, this represents only one aspect of the potential of M2M. The most powerful driver for M2M is that it can enable new business models.

Increasingly, M2M solutions are being used to enhance business operations, improve functionality and environmental stewardship, and connect the business with its end users.

At this point M2M moves from simply being part of business processes to a key part of the overall business operation and user experience.

Take, for example, a manufacturer of commercial air-conditioning systems. It sells its products through distributors and building integrators, and may receive equipment fault information only second hand.

It would be unable to track usage and performance data, with no view of who is using its equipment or where it is installed.

By integrating an intelligent monitoring and control M2M system into its air-conditioning assets, the manufacturer gains direct ongoing access to field intelligence about its units.

If this solution were extended to provide a front end accessible to end users, such as a website, the manufacturer could then gain direct access to the user and have the opportunity to enhance its products.

Various governments and regulatory bodies around the world are enacting regulations that mandate functionality of the type enabled by cellular M2M.

For example, Sweden has decreed that all its utilities must read their electricity meters at least once a month. Swedish utilities are using cellular connectivity as part of the advanced metering infrastructure solution, and other Scandinavian countries are expected to follow suit.

M2M can be used to help restructure and improve business relationships; for example, by replacing regular servicing with on-demand servicing.

Rather than removing equipment from service for scheduled monthly maintenance, built-in diagnostics can schedule minor servicing to be done on an ad hoc basis and major servicing only when it's necessary. It can also record a full audit trail of defects, usage, maintenance activities and any external inputs.

Many industries are now using specialised M2M-enabled badges or more generic 'man-down' solutions to ensure that employees away from the office are adequately protected.

We need smart metering because climate change, population growth and the availability of primary fuels mean that how we satisfy our energy needs is changing and that delivering sustainable, affordable, secure energy requires action.

Some companies are leading the way in tackling energy wastage by using M2M technology to monitor their property assets. Information collected from light and heat sensors throughout buildings can be processed and monitored. Instructions can be transmitted back to individual devices to recalibrate their settings, thereby reducing energy consumption and costs.

M2M can be used to strengthen and differentiate service offerings and add greater value to the end user. Sensors built in to a vehicle, for example, can be used to add new functionality such as 'infotainment' and navigation services, and to enable the vehicle to self-diagnose and warn the driver of potential difficulties before a long journey is undertaken.

When built into an end-to-end logistics system, more advanced M2M solutions can be extended to provide additional benefits such as producing information for customs officers or providing confirmation that a shipment has satisfied environmental constraints and has not been tampered with en route.

Some solutions offer the ability to continuously monitor and ensure compliance of remote assets regardless of location.

By automatically collecting business distance information, for example, a company can produce employee kilometre claims and tax deduction confirmation without waiting for the employee to submit an expense form.

For those businesses involved in transport and logistics, this easily extends to confirming compliance with drive time regulations, CO2 emissions, working hours and corporate responsibility for occupational training.

An enterprise commissioning an M2M solution will face unique challenges compared with traditional IT projects.

While IT projects range widely in terms of the lifetime of the project from systems planning to retirement, M2M systems generally have lifetimes of 10 years or more. The build phase alone can take a year or longer.

Once up and running, these systems need maintenance and upgrading so as to be able to incorporate the new technologies that may come along in the interim.

Global M2M deployment is not a trivial task, especially for companies whose core businesses are in non-technical areas. Business terms, device certification requirements and technical configurations can change from one country to the next.

Sourcing communications through a single global supplier can dramatically reduce the cost and complexity of global M2M deployment.

Having a single global M2M solution provider will help facilitate multinational deployments, ease negotiations and technology selection, and simplify ongoing management. By negotiating centrally, deployment cycles can be reduced and seamless cross-border coverage achieved.

The cost of cellular M2M solutions can be an inhibitor for some applications.

However, the cost of connecting remote assets has fallen, which means that M2M can be considered not just for the most important production assets but for almost every other physical asset an organisation owns or services it provides.

The number of interfaces linking the components (not to mention the M2M collection network itself) make it vulnerable to security breaches. Hence it is important to ensure that the data have been transmitted safely and securely and no data have been lost.

Tools and techniques used to monitor and troubleshoot network performance are just as necessary here as with all telecoms networks.

Data security is a major issue for applications that involve sensitive information such as healthcare records, financial transactions and types of commercially sensitive data.

Encryption, secure password authentication and low-cost, easily deployed, firewall/antivirus products can be deployed to prevent security breaches or hacking into remote devices.

The challenges involved in exploiting M2M are significant but the potential benefits are even greater. For the enterprise there is the potential for greater efficiency, improved business processes and innovative new business models.

The net result is lower costs, faster response times, better service and, most importantly, higher revenue.

M2M communications present a challenge for multinational business. There are many different solution providers and even more branded solutions to choose from.

From the business model to the supply chain and ongoing support for devices thousands of kilometres away, simply purchasing a data plan is not enough. You need the tools, technology and best practices to ensure profitability for your connected device initiatives.

Solutions are determined by the target application and the industry as well as the technologies used along the way. Designing the solution involves optimising all of these components and the way in which they interact.

Some solutions are very specific, such as applications in telemedicine. Others such as the smart grid are long range and large scale and must interconnect with existing, non-M2M-specific systems.

Developers of M2M projects face a two-fold challenge: to address the technical issues for each part of the chain, and to ensure the whole functions properly.

Partnering with a solution provider that has proved M2M global deployment expertise will help to eliminate the challenges and complexity and ensure that any solution implemented can scale globally.

Global M2M solutions are highly specialised, so choosing the right partner, one that fully understands the different components involved and that is financially stable, is critical to successful deployment.

Whichever partner you choose, as a minimum they must be able to:

- Satisfy the enterprise of its financial and corporate stability;
- Demonstrate that it has highly extensive M2M knowledge, skilled people with good experience and a proven methodology;
- Provide a full range of M2M services and capabilities, including proof of concept or testing of M2M applications in a test or live network;
- Provide consistent services, support and account management on a local, regional and global scale;
- Have direct influence and control over the network design

and functionality;

- Demonstrate how it will be able to remove cost and complexity from the enterprise's operations;
- Guarantee quality of service.

To gain maximum return, a global, business-wide identification of potential M2M candidates and solutions should be undertaken.

This review should aim to identify system synergies across the enterprise; for example, it might be appropriate to integrate the results of a monitoring system with an engineer job despatch system.

When making the case for a global M2M deployment, it is essential to identify a realistic scope for any proposed solution and the investment needed, together with a clear understanding of the returns that the investment will generate.

In this company's experience, an ROI showing payback within a short term, for example 12 months, is more likely to justify and create successful adoption.

As well as the cost benefit and ROI calculations, it is important to consider the end user of the service. This means thinking about how user-facing applications will be sold, and how they will work, be maintained, charge for and so on.

Having identified that M2M is viable, it is vital to ensure that the solution has the flexibility and scalability to evolve to meet the changing needs of the business and maintain a consistent end-user experience.

The embedded hardware must work and continue to work, even in harsh environments with excessive heat, vibration or dirt.

It is vital to fully understand how the devices behave on the network under many different scenarios. This information can be used to improve connectivity performance and optimise the total data consumption of the device.

The SIM card in the sensor must support the mobile network and spectrum ban employed in the area the remote asset is located. It must also be fully functioning and working before final shipping. The network infrastructure used for communication must be secure, responsive, reliable and impervious to natural disasters and tampering.

The wireless technology chosen must be appropriate for the application in terms of speed, bandwidth, cost and quality of service. There must be no coverage, roaming or interoperability challenges.

Controlling how, when and where remote devices access the network will help to contain costs, particularly for applications where roaming is involved.

Enterprise data tariffs can provide price predictability and simplify the management and complexity of a global deployment.

It is vital to review, test and finetune devices in the field. If possible, benchmark M2M deployment elements against other organisations, industry best practice and industry trends.

It is worth ensuring that a target-based service level agreement is in place covering ongoing performance levels.

In 2009, Vodafone launched its global M2M service platform designed for multinational corporations looking to deploy and manage large, wireless M2M projects.

Today, the company provides users a single point of contact to manage the complex area of M2M connectivity, from early concept development to support for national and multinational deployments.

The company's M2M global service platform provides corporate users with managed connectivity for M2M smart service deployments and contains a set of management tools to control all aspects of M2M communications in real time.

The company has also put in place a global M2M team to develop services designed to match specific industry needs alongside flexible commercial models. ■

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