Imagine. Build. Succeed.

The compelling Business Case for the Internet of Things

The Industrial IoT delivers the functionality that is taking the economy into a 21st Century Era

white paper

www.eurotech.com
welcome@eurotech.com

A white paper written by Roberto Siagri (CEO), Robert Andres (CMO) and Bob Emmerson

Resume

The Internet of Things (IoT) divides into B2B and B2C sectors. This is a B2B paper, however, the term Industrial IoT (IIoT) is widely used and it is the one that Eurotech employs.

The business case for implementing robust IIoT solutions is compelling and very soon it will be overwhelming. Right now it's compelling because solutions from Eurotech and other leading vendors are delivering tangible benefits, e.g. the proven ability to: boost operational efficiency, enhance customer service, open up new business opportunities, and increase agility.

Consider this quote from Ray Kurzweil: "In the 21st century we won't experience 100 years of progress, it will be more like 20,000 years of progress."

It will be overwhelming because this development leverages the technologies that are taking us into a new 21st century era, one that's based on the transition from a product to a services economy, on distributed intelligence and intelligent devices, as well as new business models, paradigms and concepts. These include: cloud computing; machine functionality that's virtualized in software; powerful multi-core processors; multiple operating systems; big data; advanced real-time and historical analytics; shorter and faster business cycles; intelligent networks and brand-new business processes.

The rate of technology change is accelerating and this is something that no business that wants to stay in business can afford to ignore. That does not mean taking a deep dive into these new technology pools, but a clear understanding of the benefits is required as well as the functionality that is needed to deliver them.

Contents

Executive summary

M2M apps should function just like ICT enterprise apps.

This paper targets C-level executives and IT management who are examining the IIoT and considering the implications of this important development for their organization. Unfortunately a lot of misleading media and promotional hype can obscure its importance and even cause confusion. This is an issue that we address.

A flexible architecture allows what were formally stand-alone M2M apps to be integrated in holistic IoT solutions.

We also indicate how the key IIoT benefits are realized as well as the creation and deployment of solutions that integrate both Information Technology (IT) and Operational Technology (OT) domains, thereby providing end-to-end, *holistic* IIoT solutions.

The resulting benefits come from an IIoT architecture that goes all the way from the sensors through to the enterprise environment. This has to be a seamless, flexible architecture that allows the functionality of the solution to grow and change simply by adding, amending or dropping individual applications.

The six key benefits:

Some 43% of Manufacturing Professionals don't understand or know about the IoT according to LNS Research, an unfortunate fact that this paper takes on board.

1) *Boost operational efficiency*. Realized via decisions based on real-time data from the field as well as minimizing costs and downtime via preventive maintenance.
2) *Improve products and services*. Discover new ways to serve customers and increase customer satisfaction.
3) *Open up new business opportunities.* Transform your business in line with new developments; create new revenue streams.
4) *Increase agility*. Fast time-to-market; move faster than the competition; enable small things to make a big impact.
5) *Build the ability to scale*. Scale up and down in line with demand.
6) *Create new business models*. Facilitate the transition from a product economy to the 21st century service economy.

There is no commonly accepted, precise definition of the IoT, which is unfortunate. It comes from the complexity and breadth of the concept as well as the difficulty of combining B2B and B2C since they are related but separate developments. This is one reason why the term has become entangled with that of M2M: they tend to be used interchangeably and all too often vendors are rebranding M2M solutions as IoT. Example: many of todays "IoT" solutions are just remote extensions of local networks. Without the requisite functionality they cannot deliver those six key benefits. Therefore it is hard to overstate the importance of understanding the difference.

Let's keep things simple but not too simple. Regular (traditional) M2M applications monitor parameters coming from one device that transfers data directly to a single application, i.e. *M2M* *solutions are point-to-point*. IoT allows multiple device types, monitoring a variety of assets, to interact with each other and with a diverse range of applications and stakeholders: *IoT solutions are multipoint*. IoT should therefore be seen as an evolutionary, complementary development. In a nutshell it does more, much more: IoT is a super-set of M2M.

IIoT solutions can accommodate diverse, distributed unattended devices that are geographically dispersed and connect the different data types coming from various intelligent assets in the field to enterprise systems and manage everything through the solution's life cycle. Moreover - this is a key, unambiguous differentiator - the architecture of IIoT solutions is intrinsically flexible: assets can be amended and new assets can be incorporated at any time. There is no need to make changes to the infrastructure. Solutions are therefore future proofed: able to adapt to changing economic and business requirements.

Virtualization might sound technical but the concept is simple. It's covered in the first chapter

A key requirement is the need to decouple (separate) data generation from data usage. In M2M solutions they are physically linked. In IIoT solutions decoupling is realized in a virtual architecture that replicates the architecture of enterprise environments. It's needed in order to allow data to be shared between apps, enable interaction and interoperability. This is something that ICT professionals take for granted.

Although IoT is a complex concept and solutions employ advanced technologies, usage should be intuitive; complexity should be encapsulated. We drive cars without being concerned about components like gearboxes: we talk and send text messages on smartphones without thinking about the intelligent networks that provide ubiquitous connectivity.

Eurotech's credentials

Experience, plus the use of open standards-based technologies, enables solutions to be designed from an IT perspective and to follow best practice.

Eurotech has been enabling end-to-end solutions that integrate with enterprise back-office systems for more than two decades, starting with ultra-robust solutions developed for the oil and gas industry as well as transportation. The company has therefore accumulated a vast amount of knowledge and experience.

The company's offer incorporates the functional elements needed to perform message transformation, message routing, protocol conversions, data normalization, service virtualization, tracking, accounting, administration plus life cycle management of the distributed devices. And an important feature is the use of device/protocol specific adaptors to retrofit legacy solutions.

New research from Gartner highlights the trend towards IT and OT convergence, driven by benefits of alignment and integration.

In addition, and it is a very important addition, Eurotech's credentials include the management of event and parameter data as well as facilitating the development of the applications that generate the data. This represents the integration of the IT and OT domains. OT (Operational Technology) comprises the devices, sensors and software necessary to control and monitor plant and equipment. Until recently OT and IT were developed and managed as separate domains.

Integration enables best practice IT technology such as security to reach devices that are out there in the field. It also allows data to be correctly presented and interfaced to the enterprise.

Chapter 1: The M2M business model

This is a short chapter that lays the groundwork for this paper. The focus is on the traditional M2M model, which employs a point-to-point architecture.

M2M Communications is predicated on the measurement and management of physical, quantifiable parameters such as moisture, pressure, speed, movement, etc. You can think of M2M as a broad set of data applications. The data is all around us: it's everywhere. M2M can reach out and grab it. What kind of data? It can be medical, environmental, vehicular, or location data: it doesn't matter. What does matter is the fact that M2M delivers tangible benefits to society, individuals and businesses.

The generic business model is very simple. Capture data, transmit the data, and then process the data, thereby turning it into real-time *actionable* information. A typical solution used to involve different vendors, which meant that the technology appeared to be complicated. However, there is nothing intrinsically complex about the process. Different vendors were needed because different technologies make up the various links in the value chain.

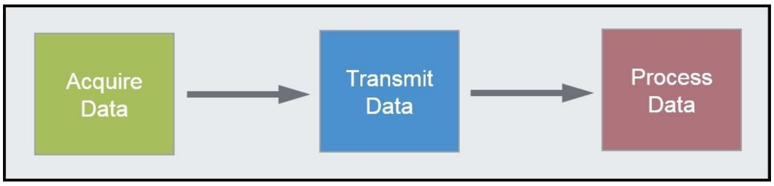

Figure 1. The value chain starts with sensors and ends with applications. Connectivity can be provided by cellular, wireline, satellite, or short-range wireless networks. Note that the link from acquisition to processing is either direct or it goes via a gateway.

The model has worked well and the business case has been proven in applications that address widely different vertical markets: automotive, buildings, smart energy, homes, healthcare, etc. etc. However, these apps run in proprietary, vertical solutions (rigid silos) that stand apart from standards-based, horizontal enterprise environments. Therefore this architecture has an intrinsic limitation. Designs are point solutions. Moreover they are not flexible; they cannot accommodate new information requirements in short timeframes.

Solving the problem of monitoring one type of thing in a dedicated environment is entirely different from creating the infrastructures, protocols and platforms that allow multiple device types, monitoring a variety of assets, to interact with each other as well as a diverse range of applications. When enabled, that is the functionality set needed to create scalable, reusable, managed IoT architectures that bridge today's historic islands of automation.

End-to-end solutions

M2M has been and continues to be a very successful industry in its own right and the technology has evolved, for example, enabling the seamless transfers of data to the cloud and integration of the real-time information into mainstream enterprise systems such as ERP and CRM. That represents a very significant development. Moreover the ability to create and implement M2M end-to-end solutions can be and is being leveraged in IIoT environments. In a nutshell, IIoT builds on robust M2M technologies.

However, these solutions are not a practical proposition in a multi-vendor ecosystem. If something goes wrong then finger pointing ensues. There has to be a solution provider, one company, and ideally they should be able to dissolve the links in the value chain and create a delivery model that is a holistic entity. This concept can best be realized if the solution provider "owns" the technology at both ends: data acquisition (M2M devices) and data processing (a platform that uses cloud technology to enable integration within private or public clouds and between those clouds and the enterprise).

Eurotech has this capability: the company has been enabling end-to-end solutions for more than two decades, originally for the demanding oil and gas and transportation industries. Numerous other innovative projects have been realized using robust M2M building blocks that connect intelligent devices and sensors in the field with business applications in the office. For example, automated vehicle monitoring based on people counting systems in trains and public transportation vehicles.

Two ways to analyze the data

M2M / IIoT solutions turn event and parameter data into sector-specific information, which transitions into a corporate asset when it is integrated into the enterprise environment. But big benefits accrue when analytics is employed: when live data delivers insightful intelligence on which important business decisions can be made.

The ability to transition from raw device data into decision-making processes based on customized dashboards that pinpoint operational and financial trends and issues is an exciting, innovative concept. Moreover, it's a logical development that addresses a generic issue: organizations lack real-time insight into the critical aspects of their business: aspects that are getting increasingly complex in today's highly competitive, global marketplace.

At first sight it might seem that we are talking about so-called Big Data: analyzing the vast amount of data that is being generated by today's solutions and which is set to rise dramatically. Big data does produce insightful information by making a statistical analysis of aggregated data assets in a central facility, i.e. the Cloud. However, no intelligence mechanisms are used. Instead, analytical software is used to find correlations between events that at first sight would not appear to be related and this process takes time. Big data analysis does not deliver near real-time information.

When data is processed locally, close to the source, less data needs to be communicated and in-memory computing platforms allow it to be analyzed in real time. The objective is to provide fast answers having a defined probability of being correct. Moreover by applying advanced database technology, for example, technology optimized to deal with time-series data we can process a lot of sensor data in a much more efficient way. In this particular case it reduces the effort to sort and aggregate the data before it's processed in order to perform tasks such as calculating averages over a specified time period. In turn this allows more data to be aggregated at the edge, which is very beneficial for applications like smart metering.

Eurotech supports both centralized and local computation and data analysis. In our firm belief IoT solutions have to be flexible enough to allow the use of computational power where it best supports the specific applications requirements.

Conclusions

M2M / and the IoT are complementary developments but there are two significant differences. One is the architecture. M2M employs stand-alone solutions based on a vertical, fixed silo-type model. IoT employs multiple-solutions based on a horizontal, flexible integrated model. The other is the ability to add and drop IoT solutions from enterprise environments without making changes to the infrastructure. This is a key difference; details come in the next chapter.

Both M2M and IoT deliver tangible benefits to society, individuals and businesses but IoT does more. It holds the potential to have a profound impact on society, bringing efficiency and convenience into the lives of many, whilst subtly modifying their underlying behavior to reinforce the efficiencies being made.

Chapter 2: IoT, Similar model but significantly different

This is another short chapter. The initial focus is on an architecture that decouples data generation and data usage. Unless an IoT solution employs this paradigm it is simply an M2M solution that has been rebranded. The remainder of the chapter covers what is needed to enable the delivery of the IoT vision.

As shown in figure 2, data acquisition and data processing are decoupled by middleware, which you can think of as software glue. In computing environments middleware supports complex, distributed business software applications and similar functionality is required for the IIoT. In this environment it enables end-to-end solutions to be deployed in a virtual architecture, in which virtual circuit links appear to function as physical links between data sources and data destinations.

This is the way the Internet works: data reaches its destination using virtual connections that employ different physical routes. The postal system works the same way: a letter or parcel might travel by plane, by van and then be delivered by hand. The key point is that transportation is payload and communications agnostic. Therefore it is advisable to forget entrenched silo-type thinking when adopting a networking paradigm based on a virtual architecture, one that employs methods and paradigms beyond those employed in M2M solutions.

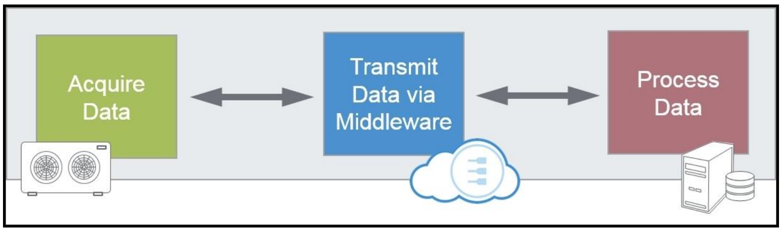

Figure 2. The functionality of IoT's virtual architecture is very similar to that of today's ICT networks. Note that data flow is bidirectional in this model.

Consider the installation of a people-counting sensor on a train; the operating company uses the data to monitor passenger patterns. At a later date the maintenance organization adds an application that employs the same data in order to move to a usage based scheduling system. This is followed by the catering company that delivers products to the train and by the stations to warn of approaching passenger loads and then by city or town authorities establishing transport strategies.

It started out as a single, simple app, counting passengers, but ends up as a mix of applications that includes those of third parties. That would not be possible in a solution based on the vertical, M2M silo model.

Social networks for machines

The IoT advances the many benefits provided by M2M and leverages its intrinsic functionality by adopting the decoupled ICT architecture of enterprise environments. They have been in place for decades and are also employed in social networks.

Consider the implications of employing event-driven IoT data that is similar to the way message-type data is communicated in Twitter. Hash tags define the topic and users don't need to know anything about device addresses or the communications architecture. They simply register their interest in receiving messages when the hash tag matches their criteria. Data on new topics can be added at any time, new hash tags are generated, but the underlying architecture doesn't change. There are no connectivity issues.

The use of a topic-based IoT architecture would allow new data flows (topics) to be added at any time. Applications would register an interest in a topic that contains the data elements it needs, and then they would receive the relevant information. New data flows would be automatically delivered to the subscribing applications. Scaling wouldn't be an issue.

Is it doable?

Yes. In fact Eurotech has done it. As indicated earlier, to make this concept work a middleware data aggregation layer is needed. The system adapts whenever new topics appear. If a company wants to monitor a new type of asset then the infrastructure, including any databases used for data archiving, needs to be able to simply store data from new topics without the need for user intervention or reconfiguration. And new data should be immediately available for mining by applications such as analytics or dashboards.

Sensors generate data that is acquired by devices, which process it for use within the new architecture. Multi-service, intelligent edge gateways provide this vital link layer - a common hardware platform onto which protocol agents and business logic can be downloaded in order to integrate existing assets.

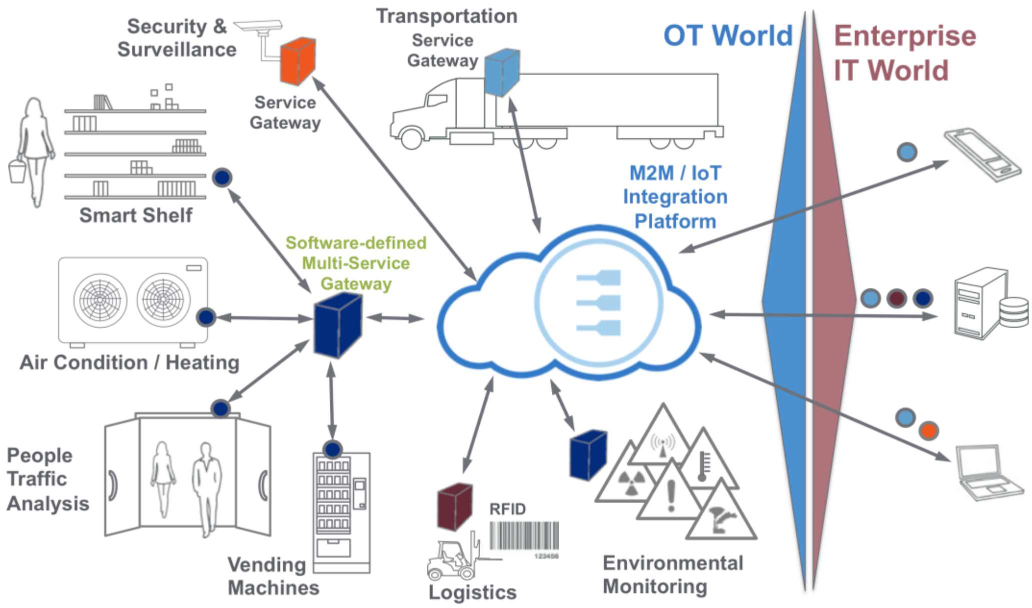

Figure 3. This schematic illustrates the intrinsic flexibility of Eurotech's IoT architecture. It can accommodate numerous vertical applications that all come together and are able to communicate with each other, thereby enabling functionality that meets the needs of the new economy.

A typical enterprise IIoT network will have numerous "things" that communicate with gateways, each of which can accommodate numerous individual inputs. They can also be used as an application development environment: it makes sense to create and deploy the app in the environment where it will be used.

Gateways tend to be perceived as a separate hardware box that allows retrofitting to legacy M2M solutions. However, all the requisite functionality - communications, application management, etc.- can be enabled in software on an embedded printed circuit board that is incorporated in an intelligent edge product.

Conclusions

The rationale for producing this paper was to help cut through the hype and confusion that obscures the importance of M2M and the IoT to the business community. M2M solutions have the proven ability to deliver tangible benefits to individuals, businesses and society. However, the applications run in proprietary, sector-centric solutions: so-called silos.

A new virtual architecture that employs the decoupled ICT architecture of enterprise environments is needed to remove this limitation and allow data to be shared between apps, enable interaction, interoperability and resource sharing. These are mandatory parameters and unless they are enabled in an IoT solution it cannot deliver the vision, which includes enabling an evolutionary transition from a product to a services economy.

Are data generation and data usage decoupled? Then it's IoT. If they are physically linked then it is M2M. No more confusion if you apply this acid test.

Chapter 3: The new IoT architecture

We have emphasized the need to employ middleware to decouple data acquisition and data processing. This chapter covers the use of an Enterprise Service Bus for Machines that enables virtual connectivity between different device data systems and different enterprise applications.

As visualized in figure 3, the M2M architecture only allows apps to be integrated in business environments on a one-to-one basis, i.e. one app interfaces with one business system. If the same data is needed for a second system then a second communications link has to be employed and so on. This architecture is not flexible and therefore less suitable for enterprise environments.

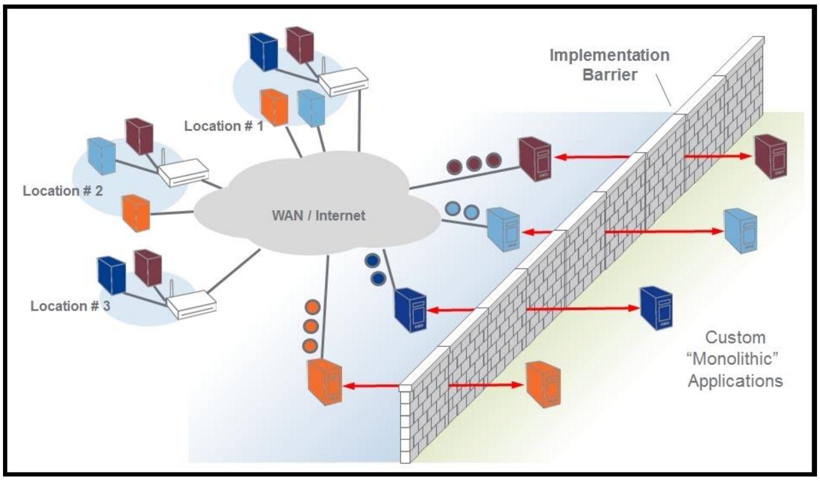

Figure 3. M2M's inflexible legacy architecture acts as an integration barrier since it only enables one-to-one data relationships between the services (devices). Customized monolithic applications are needed to access data.

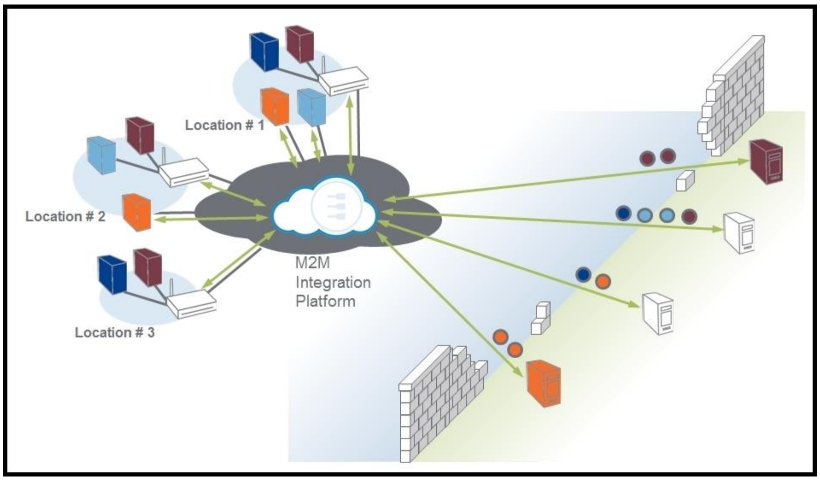

Figure 4. IoT architectures are very flexible. The producers and consumers of M2M device data are decoupled. They enable many-to-many data relationships between the business applications and the devices. There is no integration barrier.

So far so good, but enterprise environments can add and drop ICT systems without making changes to the infrastructure. This is where Enterprise Service Bus for Machines comes into the picture.

There is no need to take a deep technology dive into this concept, but it is worth noting that the Enterprise Service Bus (ESB) architecture is employed not only on enterprise ICT networks, but also the World Wide Web. It's a proven concept, a communications bus that allows different enterprise applications to communicate with each other over the bus. As illustrated in figure 5, an ESB *for Machines* allows IoT applications to communicate with enterprise applications in the same way. You can think of this ESB as providing a seamless enterprise extension to an IoT domain.

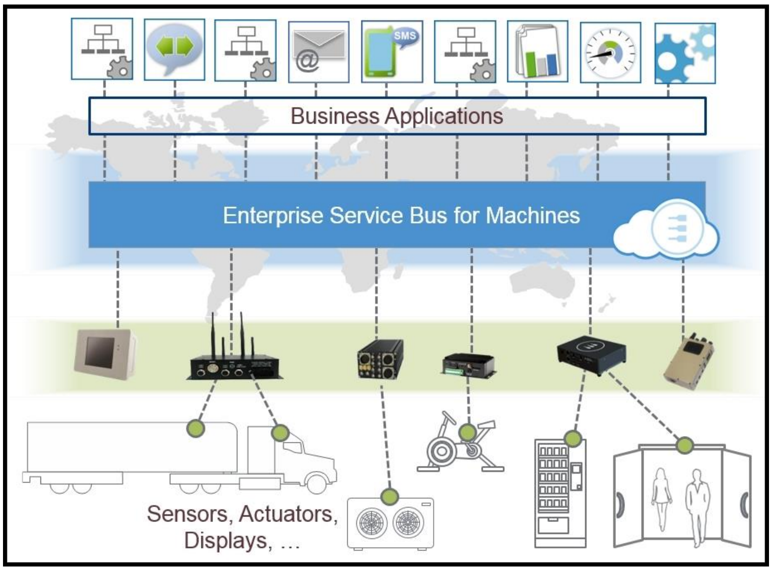

Figure 5. An ESB for Machines allows any relevant enterprise application to interact with any M2M data source.

Enterprise Service Bus
An enterprise service bus is a software model used for designing and implementing the interaction and communication between mutually interacting software applications in a service-oriented architecture. It provides agility and flexibility with regard to communication and interaction between applications. Its primary use is in enterprise application integration, hence its usage for IIoT apps.

Eurotech built ESB for Machines on an established product designed for implementing communication between mutually interacting software applications in a service-oriented architecture (SOA). This architecture is based on software components that provide application functionality as services to other applications. Being in software means that the architecture is very flexible.

End-to-end solutions

In Chapter 1 an M2M value chain was visualized as three components: acquisition, transmission and processing. The IoT value chain was the same, but data transmission went via middleware. Figure 6 represents an end-to-end IIoT solution in which the middleware is located in Eurotech's Everywhere Cloud, i.e. the device cloud infrastructure. This component also functions as an iPaaS (Integration Platform as a service).

iPaaS provides users with a combination of cloud services, collectively called integration platform services, to develop, execute, and manage integration flows.

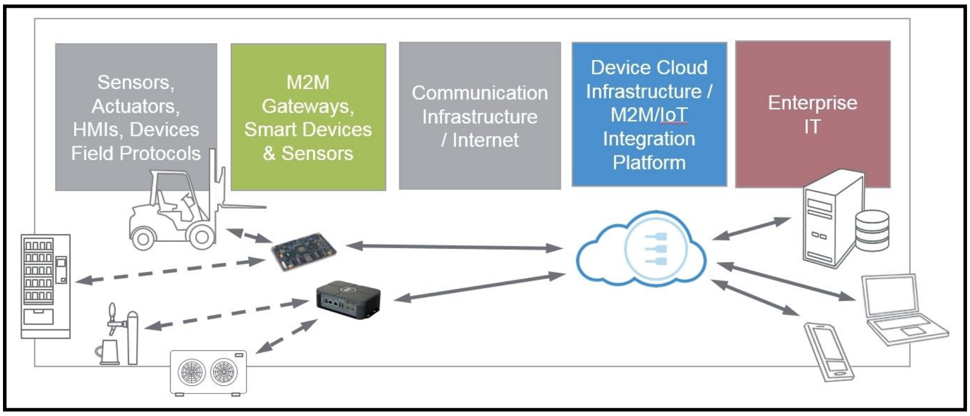

Figure 6. Everywhere Cloud is a software integration middleware platform that also acts as an Enterprise Service Bus for Machines. It is part of the Device Cloud Infrastructure.

Reminder: acquisition starts with sensors that monitor and manage parameter data as well as meters and actuators that provide event data. B2B IoT solutions would typically comprise numerous sensors: tens of thousands or hundreds of thousands. They could be on site, on different sites involving different devices, or devices that are out there in the field. We have the requisite technology to enable easy deployment and management. This allows cost-effective solutions having advanced functionality to scale up for enterprise-class networks and also to scale down, for small- and medium-sized businesses. At the end of the paper there is an example of a scaled down application that captures and transmits data related to hits on helmets, as used in contact sports like ice hockey and American football.

Depending on the distance, different communications technologies are used to connect to one or more intelligent gateways. For example, long- and short-range RF for local area connectivity and cellular for wide area communications with the Cloud. The primary task of these gateways is to aggregate the data, but they are often used to perform pre-process tasks, for example, only transmit exception data in order to reduce the volume of data that is transmitted and perform data normalization, e.g. process raw sensor data into a standard data format.

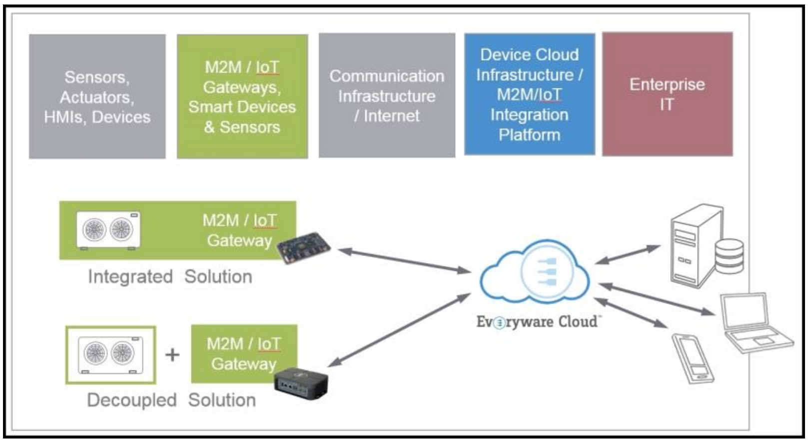

Figure 7 completes the picture. It also illustrates how the architecture can be used for both regular M2M Integration Solutions and IoT Decoupled Solutions.

This is a comprehensive solution that provides the functional elements needed to perform message transformation, message routing, protocol conversions, data normalization, service virtualization, tracking, accounting, administration plus life-cycle management of the distributed devices. This means that EveryWare Cloud delivers additional functionality to the enterprise environment. It allows the OT infrastructure to be seen from the IT perspective as an extension of the enterprise environment and it also allows interaction with the infrastructure in IT centric ways.

Now it gets interesting

EveryWare Cloud enables integration within the cloud and between the cloud and enterprise, which involves the bidirectional seamless transfer of information between devices and business processes. It lets users develop integration flows that connect applications residing in a private or public cloud and then deploy them without installing or managing any hardware or middleware.

An important feature is the use of device/protocol-specific adaptors to retrofit existing solutions. They are created using modular software building blocks on the device side. On the enterprise IT side, there are generic adapters for device data management as well as device management, and different standard ways of retrieving device data.
The business logic on the device side is done using Java, which corresponds not only with Enterprise IT approaches and best practice, but also solves the "resource scalability" problem associated with the IoT.

It's interesting to recall that mainstream applications / business processes were originally created as silo-type solutions that ran on dedicated servers, but in recent years they have been distributed across multiple servers in centralized data centers. This development involved a decomposition process whereby the applications were divided into components that were linked using Service Oriented Architecture (SOA) and Web 2.0 tools. This was done in order to obtain more efficient use of computing resources and to facilitate the development of new applications. In this model applications are decoupled from dedicated hardware: they become virtual apps but are used the same way. The IIoT employs a very similar model: it's another indication of the way that the architecture and functionality meshes with that of the enterprise.

Connectivity

Despite considerable success, as evidenced by the plethora of innovative solutions for consumers, companies and society, there is a fundamental fact that the industry ignores. Today's cellular networks were designed for voice and high-volume data traffic: most M2M traffic has a payload of under 30 bytes and only needs a throughput of 100 bps. A related fact is IP's relatively high 500 to 600 bytes overhead, which is an order of magnitude higher than M2M payloads.

These two facts are not issues: cellular networks were and still are a key connectivity medium, but the telecoms industry has recognized the need to improve performance. A narrow-band 4G service, known as NB-IoT, will provide low power, cost-effective, wide area network performance having data rates measured in a couple of hundreds of kbps, which is more than adequate for most IoT applications where the transfer of large amounts of data is not necessary.

Because of the massive amount of additional traffic that will be generated by the IoT there is a clear need for an efficient protocol. A lightweight protocol known as MQTT (Message Queue Telemetry Transport) meets this need, however MQTT is also a heavyweight connectivity technology. IM-type messages can be used and files exchanged, which means that transportation is payload agnostic. It's ideal for use in constrained environments, for example, when the cellular network starts to fade or when satellite networks need to be used to provide connectivity.

Recall the earlier reference to Twitter, which employs message-type data and topics that are defined by hash tags. MQTT employs a client/server model, where every sensor is a client that connects to a server. Every message is published to an address, known as a topic. Clients may subscribe to multiple topics. Every client that has subscribed to a topic receives every message published to that topic.

Earlier the paper indicated that a topic-based IoT architecture would allow new data flows (topics) to be added at any time. Applications would register an interest in a topic that contains the data elements it needs, and subsequently receive the relevant data. New data flows would be automatically delivered to the subscribing applications.

MQTT is the enabling communications protocol. It is already used in a wide variety of embedded systems. Hospitals use the protocol to communicate with pacemakers and other medical devices. And it's used by oil and gas companies to monitor thousands of miles of oil pipelines.

Take home messages

1) M2M employs stand-alone solutions based on a vertical, silo-type model
2) IoT employs multiple solutions based on a horizontal, integrated model
3) New methods and paradigms are needed
4) Decouple data acquisition and data usage
5) Databases should automatically adapt to new data topics and content
6) Infrastructure should be communications technology agnostic and enable multi-point solutions
7) Build systems on published, open protocols
8) Address user, device and application access, together with other security issues like encryption
9) Abstract device hardware. Enable applications to be reused across a wide range of devices and industries
10) Implement gateway devices, both as interfaces to existing equipment, but also to act as aggregation and control points.

Chapter 4: Delivering and maintaining the vision

This is an important chapter. It summarizes the functionality of five key developments; it underlines the importance of adopting ICT technology; and it demonstrates that IoT is creating a software and services centric economy. It concludes with six real-world cases that illustrate both the power of next-generation services and the ease with which they can be deployed and used.

The previous chapter showed that a virtual architecture is needed to enable the IoT vision. Delivery comes through the convergence and intersection of recent developments in six key areas: (1) sensors; (2) intelligent devices; (3) intelligent gateways; (4) wireless networks; (5) virtualization and (6) data analytics. Leveraging the technologies in those areas – together with the right architecture – releases the full potential of M2M/IoT technology. It results in a new form of intelligence having powerful, new capabilities that optimize process productivity and the efficiency of corporate decision-making. Equally, and possibly more important, is the ability to future-proof solutions that employ this powerful combination.

Add it up and it becomes clear that this new, enhanced IoT environment will take us into a new era, one that will deliver some amazing, innovative applications and services.

The second chapter considered employing event-driven data that is similar to the way message-type data is communicated in Twitter. In business it represents a significant, game-changing development, but it's something that's taken for granted in social networking.

Now think about the implications of this amazing smartphone app and ignore the target audience (unless you're a young reader).

You hear a song somewhere when you're out and about. The smartphone app recognizes the performer and the song; asks if you want to download it; you buy it; then the app tells you about an upcoming concert in your area; asks you if you want to buy a ticket and you do. It's a seamless, transparent process conducted on a handheld device: something that is taken for granted by the target audience. More significant is the fact that it is not seen as a solution: it didn't address an issue. The deliverable is a *service* and services are the future of IIoT.

Employing similar functionality in an IoT environment would be amazing - initially - and later on it too would be taken for granted. Dream on? No, Eurotech has done it and real-world examples are outlined at the end of this chapter.

21st century developments

These are the key developments that will usher in the new, IoT era. However, they only represent the start. Recall this quote from Ray Kurzweil: “*In the 21st century we won’t experience 100 years of progress, it will be more like 20,00 years of progress.*”

1) Sensors. Sensors and actuators are the first component in the value chain. In this sector costs continue to come down while performance increases. Sensors are getting smaller and new technologies enable them to monitor more than one parameter, e.g. air pressure, humidity and ambient air temperature. In addition wireless sensors enable usage in difficult and dangerous environments.

2) Intelligent devices. Processing costs have declined dramatically in recent years and so-called multi-core chips allow intelligence and advanced computing power to be embedded in devices. Apps, software and operating systems can function autonomously and/or connect to other machines in a synchronized manner. GE (General Electric) calls them “Brilliant Machines”.
This development impacts on the traditional value chain: acquire data, transmit data and then process data. Data can now be acquired and processed efficiently, in the device, and only the results need to be transmitted. It also allows devices to be self-aware, able to adapt to new or changing circumstances via the ability to be reprogrammed to meet changes in business requirements. This is one example of the way that 21st century developments allow solutions to be future-proofed.

3) Intelligent gateways are used to aggregate data coming from the sensors and to send data (instructions) to actuators. They can manage numerous endpoints and transmit their input data to the preferred data management platform. That is the baseline function. However, sensors have become small, battery-powered devices that can operate in the field for up to seven years, and communicate with the gateway at distances over 10 miles. That is a significant development but there’s more.

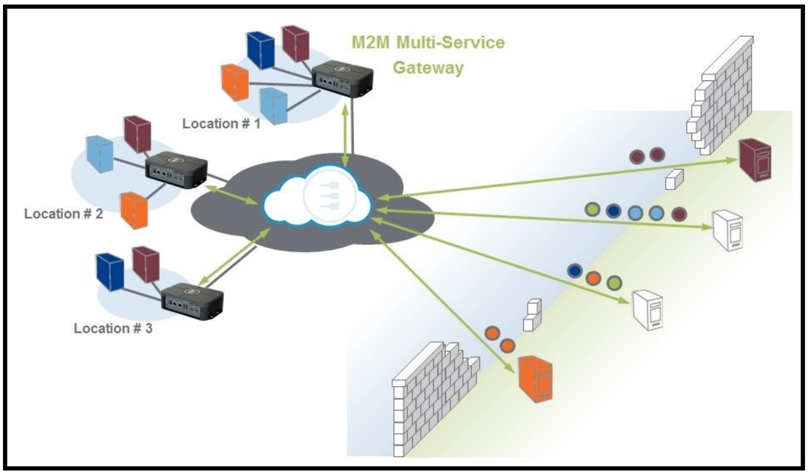

Figure 8. Multi-service gateways facilitate the transformation of bits of data at the edge of the network into actionable information and knowledge in the users’ hands.

Eurotech's offer in this space includes an intelligent, multi-service gateway and edge controller designed with flexible connectivity options. It includes the company's device-resident application development framework, used to program devices quickly, enable remote device management and allow device software development in Java.

4) Wireless technologies. There are numerous wireless technologies; listing them all would be confusing, but for the new IIoT architecture outlined earlier we can make a clear division into two categories. One, those that are employed to connect to the Internet and enterprises; and two, those that connect devices in the field.
Seen from the perspective of the intelligent multi-service gateway, the first category comprises North facing, wide area technologies, and in the second category South facing, local area technologies are employed. This indicates the pivotal role of the multi-service gateway in the IIoT architecture.
The particular technology that is employed will depend on the requirements of the individual solution, but it is clear that cellular would normally be employed for wide area communications. Satellite will typically be used as a complementary technology for global transportation solutions and long-range Wi-Fi is also being employed in wide area networks.
Local area technologies are used to connect devices and sensors that are relatively close to the gateway. This is the first leg of data's journey "up north". In this category we find Wi-Fi, Bluetooth, ZigBee and LoRa, which is a Low Power Wide Area Network technology. LoRa is a relatively new technology. Here too, the choice will depend on the individual solution and in some cases old technologies that were employed in legacy M2M may need to be incorporated.

5) Virtualization. At first sight virtualization might seem to be an improbable development. If so, it comes from an entrenched, hardware-centric way of thinking about how communications devices, systems and networks work. Most tasks can be performed in software, but they will always run faster in dedicated hardware. However, as a result of developments such as multi-core processors they can now run blindingly fast on commodity servers. The performance difference between a hardware and software solution is minimal, but the economic benefits are substantial.
Virtualization has enjoyed considerable success in enterprise IT, i.e. private and public clouds, in fact it is a key technology and now it is being applied to the IIoT. Virtualization and multi-core processor technologies are being embedded in machines.

6) Long term and real-time data analytics. The ability to transition from raw device data into decision-making processes based on customized dashboards allows operational and financial trends and issues to be pinpointed in real time. Eurotech's solutions provide this facility via a combination of real-time data analytics in the gateways and long-term data analytics in the cloud. It's a logical development that addresses a generic issue: organizations lack insight into the critical aspects of their business-aspects that are getting increasingly complex in today's highly competitive marketplace.
The findings can lead to more effective marketing, new revenue opportunities, better customer service, improved operational efficiency, competitive advantages over rival organizations and other business benefits.

At times it seems that we are drowning in data. One estimate indicates that around 90% of the data in today's world was created in the last two years and the rate at which it is being generated is rising.

The ability to process data locally in high-speed memory opens the way for more sophisticated market analysis, what-if analysis, data mining, and predictive analytics. And of course the results can be visualized, which is the way we remember information. In addition fast,
easy-to-run analytics frees up end users' imaginations, enabling them to pose questions they wouldn't even have thought of asking before.

Data analytics is a factor that will, to a large extent, determine the future growth rate in the industry. Without adequate analytics, and the right practices to take advantage of this development, companies rolling out regular solutions will be stuck with the basic applications: monitoring, reporting, and simple rules-based actions.
Real-time decision-making is critical to business success. And IoT architectures can supply both the raw material and sophisticated real-time local analytics that shape and guide those intelligent business decisions.

The proof of the M2M / IoT pudding

Real-world examples are the best way of validating the IoT business case and these short-take examples also reflect the breadth and depth of the vision.

For a sports medicine application, the customer required a gateway and cloud solution to capture and transmit data related to helmet hits (head contact in high-impact sports like hockey and football). Systems that monitor impact thresholds alert authorized individuals via a text message (SMS) or email. Historical data is kept for later analysis.

In order to monitor, analyse, visualize and manage people flows in one of the largest IT conferences in the world (Oracle JavaONE / OpenWorld 2013) Hitachi Consulting together with Oracle and Eurotech deployed a people counting solution in several locations in downtown San Francisco. A year later the company installed a similar system at the same location, EclipseCON 2014, but this time sensors were added in order to provide environmental monitoring data (air quality, electro-magnetic emissions). This case illustrates the intrinsic flexibility of IIoT solutions, i.e. the ability to add additional systems without disruption and to employ data analytics to correlate the information.

An elderly living project involved 30 residents of a care home in the city of Bolzano, Italy. The objective was to show how they could continue to live safely and for longer in their own homes. Monitoring was carried out via sensors, identifying and measuring a range of important indicators relating to the safety and comfort of the residents, including levels of CO2, carbon monoxide, humidity, light, temperature, smoke and methane. Round the clock, 24-hour monitoring was provided by staff from a local specialist care provider.

A company that ran a chain of fitness clubs was looking for ways to deliver more value to their customers and operate their infrastructure and equipment in a more efficient way. The goal was to integrate data from the fitness equipment, not only for preventive maintenance (repair proactively, less down-time, improve customer satisfaction), but also to collect data that allowed them to offer new individual services to the customers (personal fitness data) and to analyse usage rates (compare to other locations) and add equipment where demand is high).

The Washington Metropolitan Transit Authority wanted a maintenance solution for their public transit infrastructure. The application required a rugged on board computer to capture wheel revolutions per vehicle and to connect wirelessly to an IBM asset management system. When the wheels have a certain amount of wear, the authority performs preventive maintenance to improve safety for their passengers.

In this case the customer, an Italian municipality, was looking for a way to improve the customer experience with regards to finding free parking slots in the city's car parks. In order to get a constant "real-time" view on where, how many parking slots are available in the cities open space car parks, an intelligent video camera solution was requested. Everyware Client enables easy integration with other applications.

Conclusions

This paper covered a lot of ground, but the focus was on three key topics:

1) A new virtual architecture is needed in order to enable B2B IoT to deliver the functionality that will enable an evolutionary transition from a product economy to a services economy. This architecture must employ the decoupled ICT architecture of enterprise environments in order to allow data to be shared between apps, enable interaction, interoperability and resource sharing. These are mandatory parameters.

2) IIoT has the proven ability to: boost operational efficiency; improve products and services; open up new business opportunities; increase agility; and enable solutions to scale. These benefits are being delivered today; they will be enhanced tomorrow and more will follow.

3) Benefits, innovative applications and services will come through the convergence and intersection of recent developments in sensors and gateways; intelligent devices; wireless networks; cloud technology; virtualization and big data analytics. A powerful new benefit will be the ability to future-proof solutions that employ this sweet-spot combination of 21st century technology.

The results will be revolutionary: the IIoT environment will usher in a new era, one that will give us some amazing, innovative applications and services. But, and it is an important but, the transition will be evolutionary. The architecture that Eurotech proposes can be used for both regular M2M Integration Solutions and IoT Decoupled Solutions.

For further information on Eurotech products and solutions, please visit **www.eurotech.com** or send an email to **sales@eurotech.com**