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Enabling Digital Business Transformation

The Industrial IoT enhances future competitiveness, facilitates changes to business models and transforms products into services for the data-driven economic order

white paper

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Resume

The Industrial IoT (IIoT) is the driving force behind a data-driven economy that is redefining industry boundaries, creating a wave of unprecedented innovation, improving competitiveness significantly and enabling brand-new business models. By extracting data from assets and products, companies are becoming more efficient through strategic rethinking of their value chains and business processes. In turn this allows businesses to transform product-centric offers into customer-centric, integrated services bundles that enable and accelerate entry into the up-coming outcome economy.

An economy based on outcomes is predicated on the delivery of measurable results that are important to the customer. It demands a deeper understanding of customer needs and the contexts in which products and services are used. Value based on outcomes also entails quantifying results in real time. These requirements used to be hard to realize, but advances in digital technologies and the development of a robust architecture that unlocks the power of the IIoT have made the outcome economy both possible and viable. However, before examining these developments — the data-driven economy and the outcome economy — here's a reminder of IoT's intrinsic functionality.

IoT solutions allow multiple device types, monitoring a variety of assets, to interact with each other as well as a diverse range of applications and stakeholders. They accommodate diverse, distributed, unattended devices that are often geographically dispersed and that connect the different data types coming from various intelligent assets in the field to enterprise systems. IoT architectures have to be intrinsically flexible so that assets can be amended, new capabilities added when required, and new assets incorporated at any time.

A key requirement is the need to decouple (separate) data generation from data usage. Decoupling is realized in a layered and highly modular architecture that virtualizes and abstracts the physical architecture of enterprise environments. It's needed in order to allow data to be shared between apps and enable interaction and interoperability efficiency.

Executive summary

Businesses are transforming at an unprecedented rate, largely fueled by chip technology, which continues to progress exponentially. To put this development in perspective, if we are at a relative performance level of around four, the next exponential step will take us to eight and then to sixteen.

Innovation is the new norm and this has resulted in environments that are increasingly vulnerable to disruption. For example, the IIoT has the potential to realize savings of 30–50% on global logistics and shipping costs and 30–70% of the costs of personal mobility and transportation by 2025. (Source: "*Technology vs Humanity*" by Gerd Leonhard). These are developments that no business that wants to stay in business can afford to ignore.

When designing IoT solutions that can enable outcome economy functionality businesses need to accommodate a number of external factors such reflecting the operational model and its role in the business value chain. The model should guide the design and technology selection, not the other way around. Moreover the context in which the solution will operate has to be taken onboard.

In addition, progress in chip technology is driving a related development — a software revolution. Regular hardware products and even networks can now be defined in software and implemented in silicon without sacrificing performance. This allows new functionality to be created and tested in the lab and to be deployed in real-time. It's a groundbreaking concept.

Software defined networking (SDN) is an early manifestation of a super-set development that is often referred to as Software Defined Everything, i.e. a combination of all relevant computing technologies. It embraces software defined computing, data centers and storage as well as SDN. This allows computing infrastructures to be virtualized and enables everything to be delivered as a service. In this virtual environment the management and control of both the Information Technology (IT) and Operational Technology (OT) domains are enabled by intelligent software.

Software-defined machines form part of this development and the term is often used in combination with the digital transformation of industry and automation. This does not mean that machines can be completely realized in software, but figure 1 clearly indicates that it has become the single most important component and the enabling role that software plays also applies to the machines employed in production processes. Moreover the application of intelligent software allows machines to be given new functionality, e.g. a service component and/or a mobile communications facility.

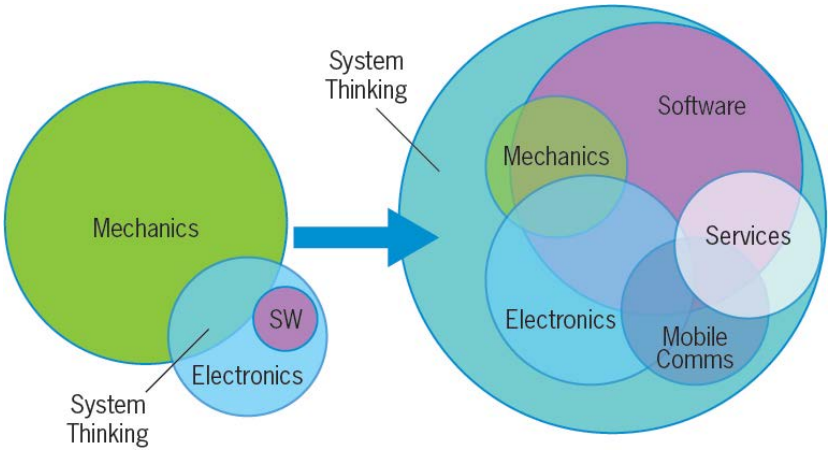

Figure 1. visualizes the enlarged role that systems thinking, software and electronics play in software-defined machines. This is in sharp contrast to the reduced role of mechanics, i.e. physical functions.

In a nutshell, businesses are facing a formidable set of challenges, but it is hard to overstate the potential of digital transformative solutions that will change the basis of competition, redraw industry boundaries and enable a new wave of innovative business models.

How will it be achieved? There is no simple one-size-fits-all solution. But the industry is moving towards open, scalable systems that will allow businesses to harness the power of diverse, connected partnership ecosystems, thereby enabling successful IIoT implementations.

Red Hat, for example, is one of Eurotech's ecosystem partners. The companies' competencies and products complement each other, with Eurotech being strong on the OT side and Red Hat on the IT side. Red Hat's products and services are secure, open, and trusted by more than 90% of the Fortune Global 500. In this case of IoT the respective technologies enabled the creation of an end-to-end, open source,

enterprise-ready IoT stack, developed and maintained as part of Eclipse IoT. Eclipse IoT provides the technology needed to build IoT devices, gateways, and cloud platforms and the IoT stack has been incorporated in Eurotech's offer.

The company's ecosystem partners recognize the need to push intelligence to the edge of the network and to deliver solutions that provide complex, real-time event processing, business rules, data transformation, and interoperability. Enabling seamless interoperability between the individual building blocks is realized by a well-defined, robust open architecture. In turn this leads to the creation of an agile environment that can be used to identify opportunities, to gain and service customers and respond to market changes and competitive threats.

Seamless integration of IT and OT

To truly embrace business transformation organizations need to collect actionable data from their assets, processes, and products and then connect the OT (Operational Technology) domain where data are generated to the IT (Information Technology) domain where data are consumed. OT involves industrial and factory automation, supply chain management and asset monitoring. IT embraces business process automation, office automation, mobile & web applications, and all the other elements required for the digital enterprise.

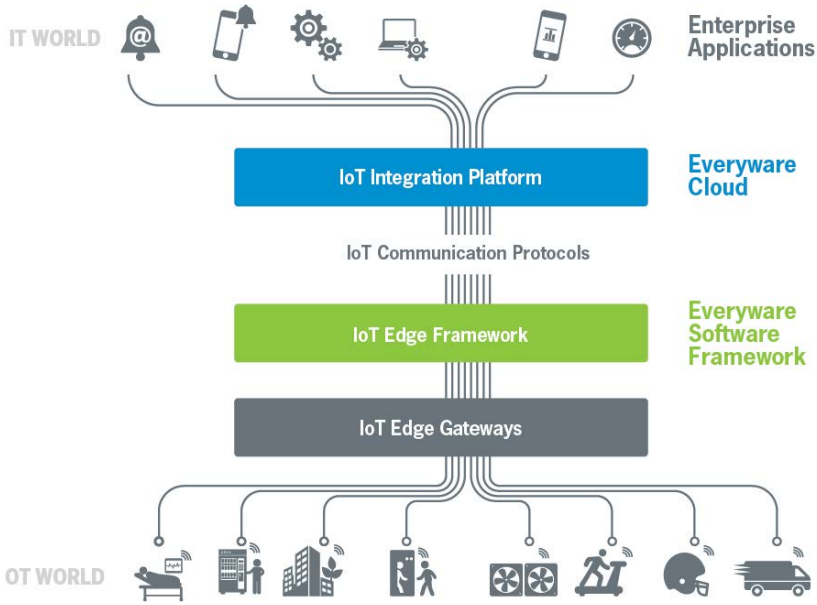

Figure 2. Devices in the OT domain communicate with one or more intelligent gateways, which in turn transmit data to an integration platform in the cloud, where data is processed into real-time information used by IoT services. This information is subsequently transmitted to mainstream enterprise services and it can be integrated with the historic information that they generate. The Internet becomes not only the IoT backbone but also an enabler of the secure, managed services of mobile carriers.

Enabling seamless connectivity between IT and OT domains is a mandatory requirement. Seamless fusion is realized by an edge framework (middleware) and an integration platform, normally located in the cloud or data center. This combination is used to decouple data generation from data usage.

In computing environments middleware supports complex, distributed business software applications and similar functionality is required for IoT. In IoT environments middleware enables end-to-end solutions to be deployed in a virtual architecture. Communication between data sources and data destinations functions in the same way as a regular physical architecture, but the communication links are virtual, not

physical. These virtual links are secure and they abstract (hide) the complexity that is associated with physical communications.

The OT benefits that come from seamless integration with IT derive from the use of a more efficient, better scalable, well managed and secured infrastructure onto which numerous OT applications are layered. They include predictive maintenance as well as remote asset monitoring and management. The IT benefits include secure real-time communication with the enterprise's assets while retaining the requisite efficiency for creating, scaling, maintaining and securing the infrastructure. The result is an increase in operational performance, protection of profit margins, customer retention and the creation of new business models. Open, well-defined IoT architectures and their specific properties are the business transformation key. They unlock the potential of IoT ecosystems and transform any business into a smart business.

The primary focus of figure 3 is on the IT domain, i.e. the typical enterprise environment of an industrial manufacturing company. It indicates how the various applications, processes and services, shown in red, interact with the core IT infrastructure. Integration with the 'World of OT" is enabled by the integration of Everyware Cloud, shown in blue. This combination allows any IT component to interact securely with any IoT asset.

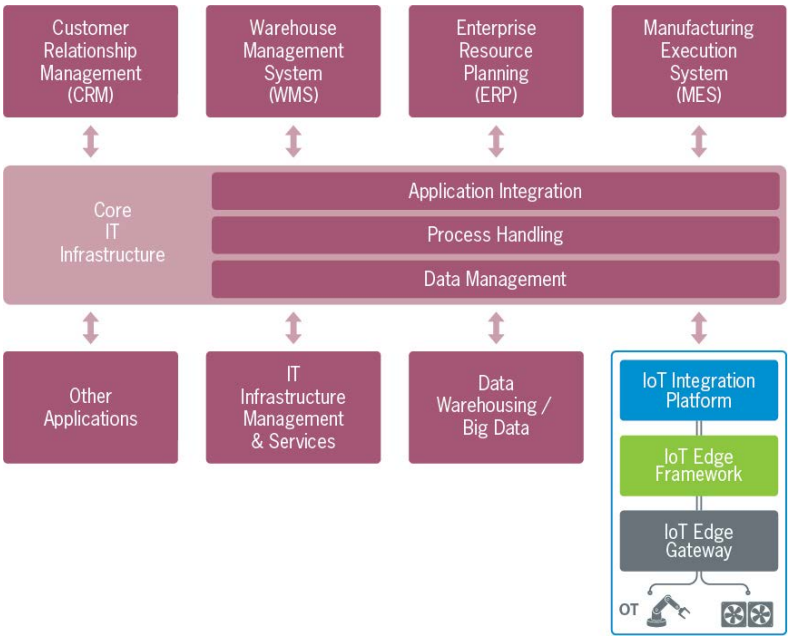

Figure 3. Enterprise environments comprise different mainstream systems that communicate and interoperate over a robust, standards-based IT infrastructure. Enabling seamless integration with this domain is enabled by the integration platform in the company's Everyware Cloud.

iPaaS (integration Platform as a Service) is a well know enterprise IT term. Gartner defines iPaaS as a suite of cloud services enabling development, execution and governance of integration flows connecting any combination of on-premise and cloud-based processes, services, applications and data within individual or across multiple organizations. The core functionality of Eurotech IoT Integration Platform, Everyware Cloud, is very similar but there is a significant difference.

The information flow in iPaaS involves bridging *between* enterprise applications in the IT domain. Everyware Cloud functions as a bridge *between* the OT domain of distributed devices in the field and the IT domain of enterprise applications. It connects all the OT domain's specific requirements and needs in an IT-centric way to the enterprise's IT infrastructure. It provides all the requisite data, device/asset,

security and remote device application management elements and enables the enterprise applications to interact with these elements.

OT and Enterprise IT

IoT is normally depicted as an end-to-end solution going from devices in the field through to enterprise environments. That is the OT-centric view. But an IT-centric view goes in the opposite direction: enterprise to field and that underlines a development that is reshaping business and technical requirements. In a nutshell, IoT is becoming an enabling component of a much bigger picture, one that is needed to facilitate business transformation.

Enterprise computing operates in a robust, powerful, IT-centric domain that employs established industry standards. In order to enable seamless integration a similar OT infrastructure is needed. It should enable fast delivery of data from the field and be flexible: businesses need to be prepared for changes that simply can't be anticipated right now. The architecture should also enable access to data from devices across applications, build relationships between data sources, and take action in one area based on data from another. And last but by no means least, be agile, enable the creation of customized, changing and evolving solutions.

The following schematic is a high-level view of the requisite IT-OT architecture. It shows assets (devices) in the field communicating with an intelligent multi-service, which in turn communicates with an integration platform that interfaces with the enterprise environment. The platform, Everyware Cloud in an Eurotech architecture, is the place where the OT and IT domains exchange data.

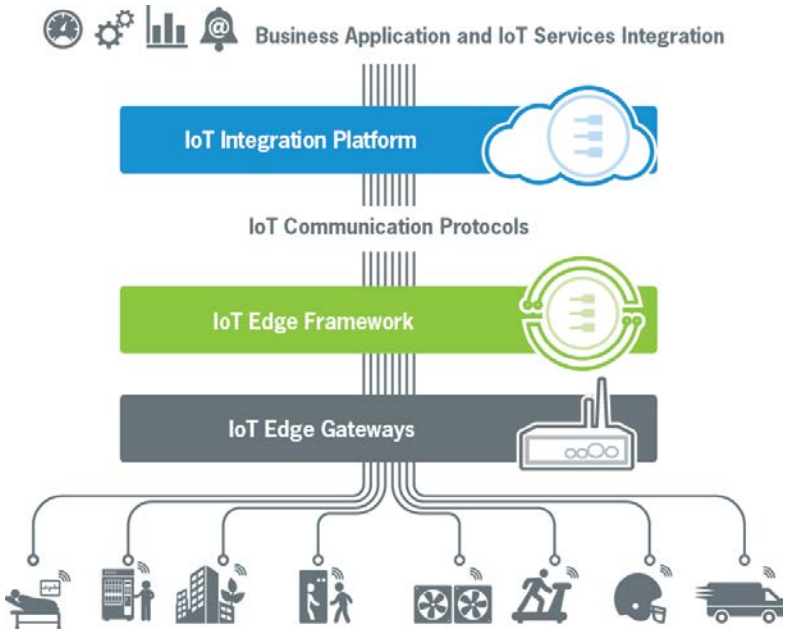

Figure 4. Enterprise-class IoT architectures are similar to a five story building and there is nothing complex about the concept.

By connecting data producers (sensors and actuators) with data consumers (business applications), the integration platform enables any-to-any communications, i.e. OT devices can communicate with all the applications at the IT level and the other way round in real-time. Besides this data management aspect, the solution is also required for security, remote asset and embedded application management.

Encapsulating complexity

Enabling the seamless flow of information between the OT and IT domains represents a complex set of tasks. It's enabled by an integration platform that figure 5 visualizes as an "IoT Gearbox". This somewhat unusual term is used because specialized knowhow and experience are required to build gearboxes. Therefore, pre-manufactured gearboxes that encapsulate the complexity of this component are employed by vehicle manufacturers.

Everyware Cloud platform provides this “Gearbox for the IoT” facility. It encapsulates the complexity of integrating the two domains. It’s specifically designed in order to 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. Everyware Cloud can therefore be seen as a cost-effective, efficient, off-the-shelf component that enables short time-to-market deployments.

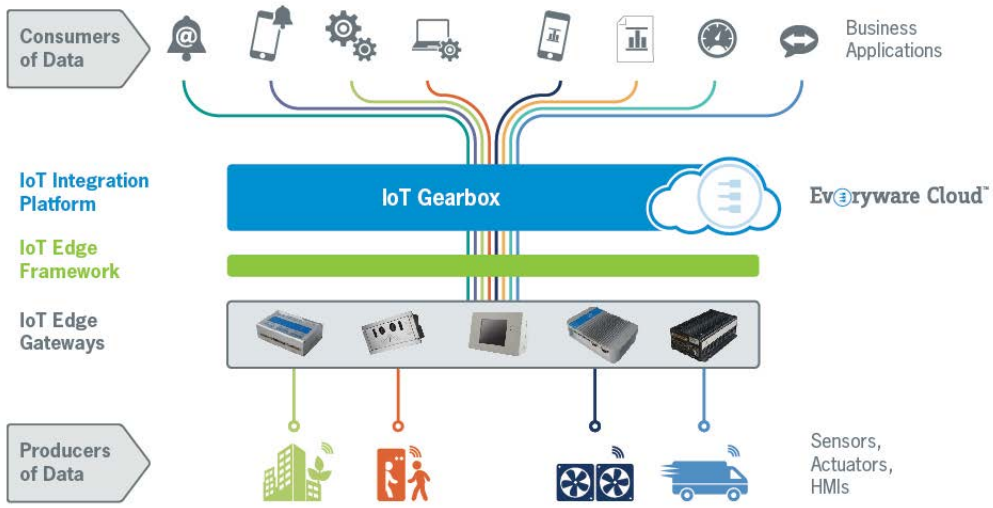

Figure 5. In addition to connecting data producers (sensors and actuators) with data consumers (business applications), the integration platform must enable any-to-any communications, i.e. OT devices should be able to communicate with all relevant IT apps.

Integrated IT & OT enterprise environments combine efficient operation with scalability and agility. For example, intelligent gateways located at the edge allow data analysis to be performed in a local facility, thereby generating real-time, insightful business intelligence that allows decisions to be made “in the moment”. And when applied to manufacturing operations, this information enables the creation of preventative maintenance programs that detect potential performance issues and allow them to be addressed before they occur.

Real-time decision-making is critical to business success. IoT architectures supply both the raw device data and sophisticated real-time local analytics that shape and guide intelligent business decisions. Without the requisite architecture and state-of-the-art analytics, and the right practices to take advantage of this development, companies will be stuck with the basic applications: monitoring, reporting, and simple rules-based operations. In other words, they will not be able to transition to the data-driven economy and at a later stage take part in the up-coming outcome economy.

A future-proof architecture

As indicated earlier businesses need to be prepared for changes that simply can't be anticipated. At first sight, that would appear to be a very tall order, given the rate at which the economic climate is changing. The on-going developments in chipset and sensor technology suggest that continuing to imagine our future in a linear way will probably lead to seriously flawed assumptions about the scale, speed, and potential impacts of change. That future isn't imminent, but businesses do need to consider the kind of architecture that can accommodate change along the way and that can be implemented today.

It is clear that the architecture has to be an ecosystem play, one based on standards like MQTT and open-source technologies like Linux and the enterprise-ready software building blocks the Eclipse IoT Working Group is providing. Open and industry standards are key: they enable IoT infrastructures to be future-proofed and they can be deployed without creating vendor lock-ins. This ecosystem approach also enables development to be conducted in an abstract, open, well-understood programming language and development environment. In turn this minimizes time-to-market by

leveraging existing developments and code. In addition the ecosystem approach provides software validation and ensures interoperability at all levels, including the fast implementation of new protocols and standards.

That is why companies like Eurotech and Red Hat are investing in and contributing to open source projects and initiatives. The resulting IoT building blocks then become the core of solutions that are commercially supported and that can be optimized for customer-specific solutions. Eclipse Kura™ and Eclipse Kapua™, which are key building blocks, are two examples of successful projects conducted by the Eclipse IoT Working Group. Eclipse Kura provides a development environment for Java programmers that simplifies the creation of embedded applications. Eclipse Kapua is the open source IoT integration platform.

Figure 6. indicates how the two Eclipse building blocks are deployed. ESF (Everyware Software Framework), which is embedded in the gateway, is Eurotech's commercial, enterprise-ready edition of Eclipse Kura. Everyware Cloud employs a commercial version of Eclipse Kapua, which is the Open Source IoT integration platform.

Eclipse Kura provides a platform that operates at the boundary between private device networks and the Internet or cellular network. A key function is the provision of a secure execution environment and the functionality needed to develop, deploy, manage and secure the software (OS, middleware, applications) in the smart IoT devices that operate at the edge of the enterprise's network. In addition to aggregating from the field devices the multi-service gateway enables real-time data analytics, business intelligence and AI functions to be performed at the local level, i.e. the network edge.

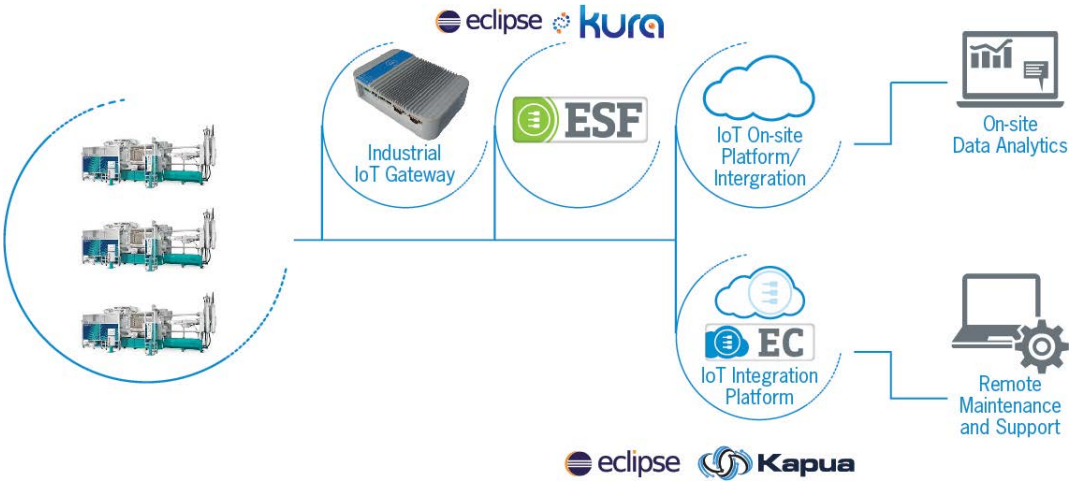

Figure 7. shows how Eurotech gateways can provide multiple connections, in this case two, to different IoT platforms and different technology worlds. An on-site integration platform provides on-site data analytics while a cloud-centric platform enables remote maintenance and support.

Looking ahead

As indicated earlier, flexibility is a key feature of Eurotech's IoT architecture, as is the ability to integrate at all levels. The need for integration between platforms, enterprise software architectures and cloud services is clear, less obvious is the emerging need in large deployments for simultaneous connectivity to different cloud services and/or different enterprise architectures, as shown earlier in figure 6.

Customers' clouds will be different to that employed by the solution provider. Interconnecting systems at a cloud or data center level is one option, but it will not provide an optimum solution for many IoT projects. An additional issue is the need for the IoT solution that is running on local machines to integrate with the customer's own IoT solution, which will typically involve monitoring the quality and quantity of the manufactured product and tracking delivery to their customers.

Those solutions might be on premise or cloud-based and they will typically employ one or more offers from leading IT software players. For example, they might be leveraging the technology of companies such as Microsoft, Oracle, IBM, Red Hat, SAP, Amazon and others. Moreover, their offers will include IoT Cloud solutions that feed IoT data coming from the field into their world of big data, analytics and business applications.

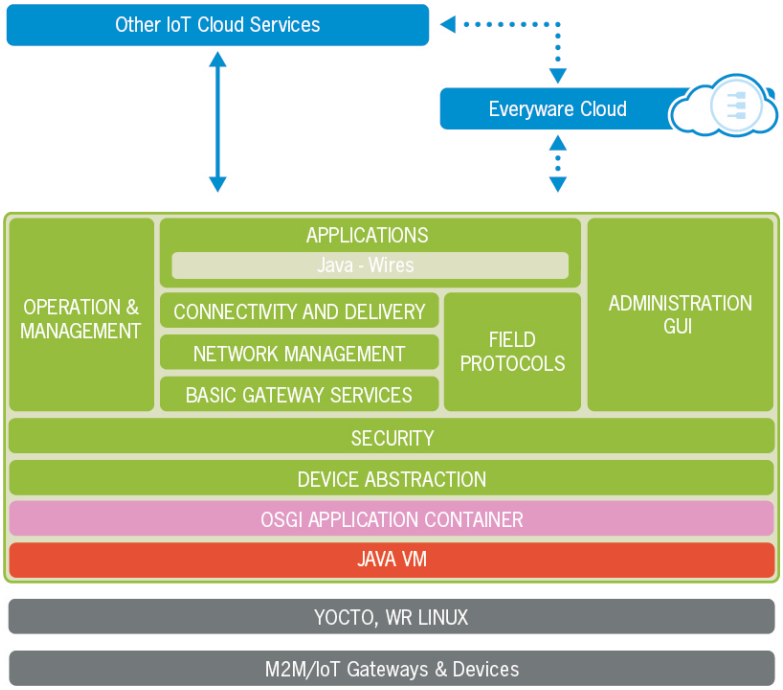

Figure 8. indicates Eurotech's addition of a multi-client capability to the regular multi-service features of the intelligent open-systems gateway.

Eurotech addressed this need by adding a multi-*client* capability to the regular multi-service feature of the open-systems gateways. Everyware Cloud is the company's regular cloud client, but this new capability allows additional cloud clients to run simultaneously. Support for concurrent access is needed otherwise contention issues would arise between different clients.

Conclusions

Extracting data from assets and products is the foundation on which the Industrial Internet of Things is being built. This development is the driving force behind a data-driven economy that is reshaping the business landscape, and when the exponentially increased volumes of IoT data are harnessed the benefits will be enormous.

In order to leverage the potential of the IoT, which is progressing at a faster rate than many could have imagined, and realize those all-important benefits business need to employ a future-proof IoT architecture that is secure and easy to manage. It must be open and be intrinsically flexible so that assets can be amended, new capabilities added when required, and new assets incorporated at any time. In a nutshell, businesses need to be prepared for changes that simply can't be anticipated right now. That is the only way to enable a low TCO (Total Cost of Ownership).

Eurotech's architecture meets those demanding criteria. Via ecosystem partnerships with leading companies such as Red Hat the company has created an end-to-end, open source, *enterprise-ready* IoT stack, developed and maintained as part of Eclipse IoT. Moreover it is intrinsically flexible, as evidenced by the recent addition of multi-client capability to the regular multi-service feature of intelligent open-systems gateways.

Appendix: The Outcome Economy

"*The Outcome Economy looks well beyond the simple concept of connectivity to delve into the specific ways in which new value is being created, and how that will alter the most basic economics of how we live, work, and play. It offers a concrete understanding of how the Internet of Things is transforming business models by taking the quantum leap from companies that make promises about products, to companies that promise outcomes; a collaborative and interconnected world in which success hinges on how well you can integrate your organization as part of a complex ecosystem that will align itself around outcomes and innovation.*" The quote comes from Thomas Koulopoulos, Chairman, Delphi Group.

That may sound like blue-sky thinking, but quantum leaps have been made and spectacular results obtained. For example, instead of buying jet engines, airlines pay for the time engines are available: it's called 'time-on-wing'. Capital expenditure is reduced because they don't own the engines. Tight service-level agreements mean fewer disruptions and more satisfied travelers. Less well known is the Spanish national railway company Renfe's money-back guarantee that reimburses passengers for the full ticket price if a train is late by more than 15 minutes. This high service commitment was enabled by outsourced maintenance operations that monitor and analyze data from hundreds of sensors on trains and track. After going into operation, only one train in 2,300 didn't meet the guaranteed uptime.

These two examples indicate how the outcome economy represents a radical change in the way that products and services are marketed. To survive and succeed in this new era companies will need to employ better data and analytic tools in order to measure performance, calculate costs and manage the risks associated with

guaranteed business outcomes. They also represent a "*product-as-a-service*" model in which the manufacturer retains ownership of the product and takes full responsibility for the operating and service costs. The outcome economy can therefore be seen as an evolutionary development, one that demands a deeper understanding of customer needs and the contexts in which products and services are used.

The outcome economy is predicated on the ability of IoT solutions to deliver the required business outcome. In the case of shop floor production lines and heavy-duty mobile machinery the outcome is optimal performance, which equates to maximum uptime and minimal maintenance costs. Preventative maintenance programs enable this deliverable. They are enabling manufacturers to realize saving of 12% on scheduled repairs, reduce maintenance costs by 30%, and minimize breakdowns by an impressive 70%. (Source WEF data from Industrial Internet Report, Feb-2015).

Predictive maintenance programs, that detect and pinpoint potential issues before they occur, are a more recent development. Early identification helps companies deploy limited resources more cost effectively, maximize equipment uptime and enhance quality and supply chain processes, thereby ultimately improving customer satisfaction.