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Connecting Business with Machines in the Cloud-Based World of IoT

Eurotech® combines Intel-based hardware, Wind River Linux software, Oracle Java Virtual Machine, McAfee security technology, networking expertise, and a global cloud-based infrastructure to create a framework for Internet of Things developers.

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Executive Summary

Adding value is all about focusing on your core strengths while leveraging those of others. As the "Internet of Things" becomes more complicated and diverse, it's important to make a solid business case for attaching all of those "things"

to the Internet – or to your business systems. From the sensors and actuators at one end of the scale, to the business information systems at the other, there's a huge amount of technology in between. Technology that most companies aren't equipped to handle. Eurotech and Intel have already built out that infrastructure and made it available to system integrators and developers so that they can add value while leveraging the existing (and future) technology.

Key Business Objectives

Eurotech and Intel offer an open, scalable, and expandable infrastructure to developers and system integrators so that they can connect their systems to a global network cloud (either public or private) and to in-house information systems. They do this in a way that minimizes one-off development and instead leverages existing technology, standards, and protocols, while providing the ability to remotely manage the distributed devices and the applications running at the edge. The result should be cost-effective, standards-based, and broadly interoperable.

Business Challenges

The "Internet of Things" (IoT) is a new term for an old concept. Developers have been attaching embedded systems to public and private networks for decades, usually by engineering or customizing the hardware and software from scratch. That forced system integrators to develop networking, embedded and operational technology expertise whether they liked it or not. A firm specializing in medical equipment, for example, doesn't typically also employ experts on protocol stacks, low-level driver code, operating system kernels, or quality-of-service (QoS) algorithms. Distributed, industrial-grade networking expertise shouldn't be a mandatory requirement for all system developers.

Moreover, connecting a product to business applications is only the beginning. How can that connection be managed and monetized? How can it be integrated into the enterprise's existing back-office business information systems? Can it communicate with suppliers and vendors? How are updates, upgrades, revisions and changes in hardware handled? In short, developing a successful IoT product involves far more than just hardware/software engineering; it means integrating products into the business in an accessible, flexible, and financially sensible manner while creating investment protection against future changes and growth.

Solution Benefits

Knowing that many aspects of IoT are the same for everyone – and that few potential IoT developers have the time or inclination to develop all the infrastructure from scratch – Eurotech has spent the past several years crafting an end-to-end, or "edge to application" software framework and application enablement platform for IoT developers and systems integrators. From individual IoT devices at one end (say, a vending machine or an air-conditioning unit), to the manufacturer's information technology (IT) department and business-information systems (BIS) at the other end, Eurotech's collection of IoT building blocks takes care of all the Internet hops, skips, and jumps along the way.

The company's framework has two major components, called the Everyware* Software

Framework (ESF) and the Everyware Cloud. Between them they form an application enablement platform for the enterprise IT world while also providing the required data, device, and application management functions to distributed devices in the field. One of the guiding principles behind these two pillars was that every feature and function they provide should be modular and replaceable. That is, ESF is not one big monolithic software project that works for everyone. On the contrary, it's a set of pieces that can be added (or removed) as necessary. All the pieces work together. Just as important, they also work with outside, third-party software. That's because the Everyware Software Framework and Everyware Cloud are based on globally accepted standards, not Eurotech-specific "hooks." Developers are not locked in to any particular technology or any specific approach. Quite the opposite: they're free to innovate when and where they choose – which is usually somewhere completely unrelated to the device software framework and the cloud infrastructure.

Eurotech believes that IoT developers should add value in their chosen field as subject-matter experts and not spend time developing and debugging systems that are already well understood by others. Writing TCP/IP stacks doesn't add value. Original features specific to a market add value. Spend your time on engineering creative solutions, not recreating existing infrastructure.

Connecting Devices to Business:
The Everyware Cloud quickly connects any type of device, sensor, or asset to business applications. More than just a gateway to the cloud or a network stack for IoT, Everyware Cloud brings field data right to where it's needed. Everyware Cloud scales with the number of devices deployed, from a single prototype to thousands of installed units in the field. It's a developer's private bridge from IoT sensors at one end to in-house information systems at the other. Additionally, it extends the rich management functionality of the device to allow for remote management of device applications and bundles.

Everyware Software Framework:
Deploying an innovative IoT product shouldn't depend on engineering network interfaces, understanding wireless protocols, or debugging operating system drivers. The Everyware Software Framework (ESF) provides all the building blocks required to get Device X up and running on the Everyware Cloud. ESF includes the Wind River Linux operating system, Oracle Java programming tools, support for multiple wired and wireless protocols (ZigBee, Wi-Fi, GPRS, etc.), gateway services, an administration GUI, and much more. Everything about ESF is based on open, global standards, not proprietary technology.

M2M/IoT Standard Protocols:
The deployment of large numbers of geographically dispersed systems in the field require communication protocols that ensure efficient use of bandwidth, real-time transactions, and the ability to cope with unreliable networks. MQTT (Message Queue Telemetry Transport) publish/subscribe technology addresses these and other aspects of highly distributed, network connected embedded devices.

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Security built in:
Security is one of the important aspects of any M2M/IoT solution and has to be looked at in a holistic way. Holistic, in this case, means that the overall security architecture is as important as the quality of the approach in each of its parts. In these solutions, there are the devices and their software. There is the communication channel that leverages the Internet as the "WAN backbone". There is the cloud or data center portion of the solution and the connection to the enterprise IT world.

Eurotech's solution contains security technology, authentication methods and best practices for each of these parts in the M2M/IoT solutions as described in this document. Examples of some of the security solution building blocks range from TLS encrypted communication channels that are limited to a single TCP/IP port on the remote device to remote boot and Embedded Security from Wind River and McAfee / Intel Security, notably, McAfee Embedded Control.

McAfee Embedded Control includes system integrity and change control for embedded

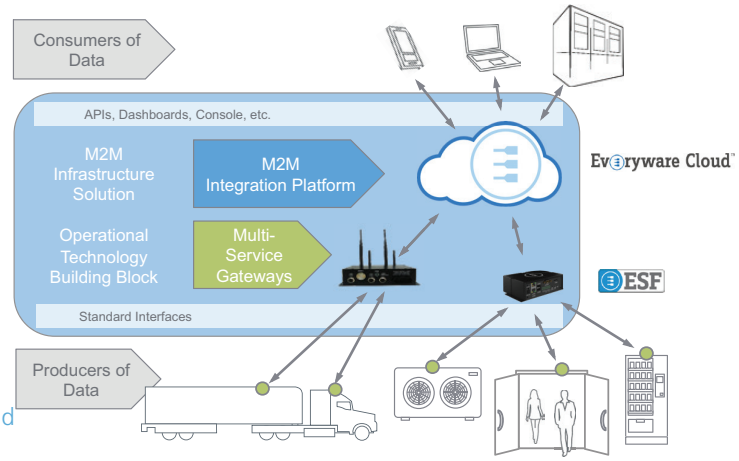

Figure 1. Cloud-connected devices.

devices. This software blocks unauthorized applications from running on your embedded systems (whitelisting). It is also configurable to allow for trusted software update sources to be identified. The McAfee Change Control mechanism offers file integrity monitoring, which includes the ability to restrict system changes and visibility into change events on the embedded device, real-time.

In addition, having external security experts perform continuous evaluation and testing on a regular basis is an important step in validating the security of the platform.

Java Programming Made Easy:
ESF is based on open-sourced Java code, the choice of more than 9 million programmers around the world. Java excels in quick development time and rapid deployment. Java's large (and growing) talent pool means it's easy to find experienced Java programmers, which isn't always the case with other programming languages or development environments. Additional benefits come from Java's portability across operating systems and devices. This allows developers to write and test their software on a PC and then push it out to devices with a single click. It also provides future-proofing, because Java is both forward and backward compatible. Code written today can be ported easily to the devices of the future.

Productive Hardware and Service Abstraction:
Much of the value of ESF and the Everyware Cloud lies in its abstraction layers. Together, they enable developers to focus on their value-add, not on the arcane details of cloud-based hardware and software. That allows subject-matter experts to do what they do best: develop original applications, not debug low-level code. That makes the entire development team more productive and more valuable, while accelerating time to market.

Intel-based Hardware:
From network gateways to development systems to industry-specific solutions, Eurotech's hardware underpinnings rely on Intel's world-class microprocessor technology. No other processor family offers as broad a range of performance, power, and price points as Intel® architecture. For more than 40 years, Intel archietecture processors have set the standard for performance, while always maintaining software compatibility with legacy systems. This allows developers to focus on new development and new features, not fixing interoperability issues with older systems.

Solution Overview

The IoT is enabling billions of Internet-connected devices, ranging from small wearable sensors to large shipping containers, vehicles, and building infrastructure. Although they all can share the same "cloud," they have little else in common, and their developers have radically different business models and technical needs. Eurotech's Everyware Cloud and ESF framework accommodate this variety through its modular and standards-based architecture.

Key Components

Figure 1 shows a very simplified diagram with an assortment of cloud-connected devices, large and small. Put simply, Eurotech's solution encompasses everything from the sensor

hubs and network gateways (including their underlying hardware, their wired/wireless network interfaces, intrinsic interoperability capability, their remote management features, built-in security measures, data aggregation, and more) all the way up to the integration with the developer's business information systems. While there is obviously a lot of hardware, software, and technical know-how encapsulated in this "edge to application" solution, every individual step is customizable by the developer.

A somewhat more expanded version appears in Figure 2. Here, a number of different IoT devices (including both moving vehicles and stationary assets) are connected to the cloud and share data between multiple applications. Trucking systems obviously need wireless technology, and one that can accommodate long ranges, national (or international) coverage, and occasional network drop-outs as the vehicle passes through tunnels, urban canyons, or areas of sparse coverage. Engineering around these details would easily occupy the talents of an entire team of developers, even before they start work on the "real" development of their product.

Conversely, fixed assets might connect to the cloud via wired interfaces, or wireless interfaces with short range and low energy. Some devices may require high data rates and constant transmission, while others may "squawk" data only intermittently, such as when they've collected sufficient data or need servicing.

Regardless of the details, the technical challenges are daunting. And as the number and type of devices increase, so does the complexity of connecting them – especially if they need to communicate amongst themselves. A simple point-to-point connection from device to cloud rapidly becomes a rat's nest of incompatible interfaces, standards, protocols, and device types. And what about security? Merely getting these disparate systems to work together and communicate is daunting enough. What happens when malicious hackers start looking for weaknesses and vulnerabilities that the developers didn't even know were there?

In contrast to this complexity, Eurotech's Everyware Cloud, shown in Figure 3, rationalizes the connections into a single, abstract communication platform. Rather than dealing with disparate interfaces, developers can concentrate on their value-add, whether it be application-specific data filtering, business intelligence, device-to-device communication, or simple data logging. Eurotech's multi-service gateways allow any type of device, fixed or mobile, to connect to the Everyware Cloud.

Just as important as the cloud infrastructure are the devices themselves. IoT devices are no good if they can't connect to the cloud, but most specialty IoT developers don't have any real cloud expertise. Many don't even have extensive networking proficiency or experience with complex operating system integration. If your specialty is sports equipment, for example, it's unlikely you'll also be expert in protocol stacks and Linux device drivers.

As Figure 4 shows, the Everyware Software Framework (ESF) provides all the pieces a development team needs to get up and running without spending valuable time on basic (and not-so-basic) hardware/software integration.

Eurotech itself uses ESF in its own products, in this case a ReliaGATE 15-10 multi-service

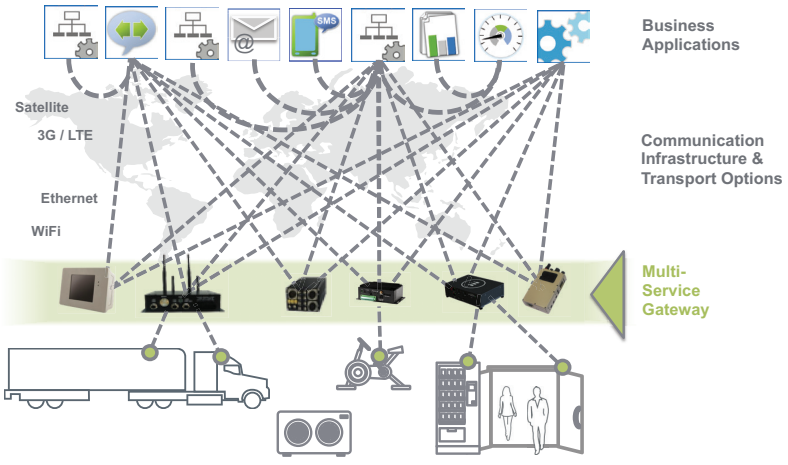

Figure 2. Complexity rises as the number of connected devices and applications grows.

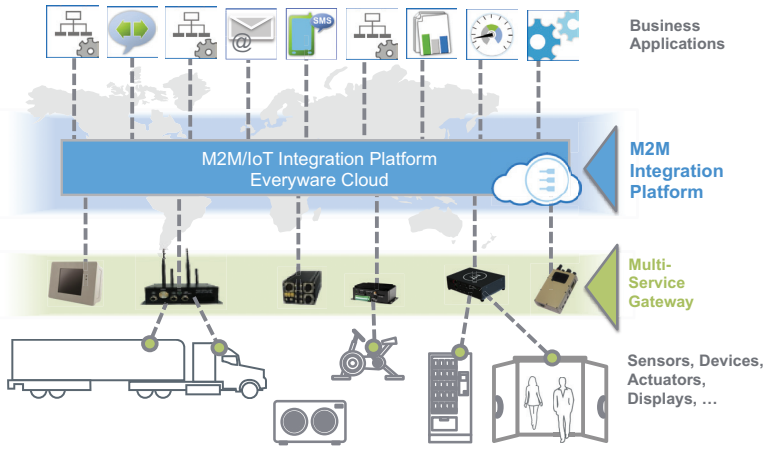

Figure 3. Eurotech's Everyware Cloud rationalizes the connections into a single, abstract communication platform.

gateway designed to allow different devices to connect to the cloud. It starts with an Intel® Quark™ processor, part of the large Intel architecture processor family that includes Intel® Atom™, Intel® Pentium®, Intel® Core™, and Intel® Xeon® processors.

On top of the hardware layer, Eurotech builds on the Intel® IOT Gateway Software Stack featuring Wind River Linux operating system, widely regarded as the most popular operating system for IoT devices and itself an open standard. Then comes the McAfee Embedded Control security and finally the Java virtual machine (JVM) from Oracle, creators of Java technology.

Java is a key component in ESF because it allows programmers to be productive sooner. In an earlier era, most embedded systems developers relied on C or C++ programming to write low-level code, drivers, and applications. This approach required considerable expertise with C/C++ programming plus detailed knowledge of the underlying hardware – on top of detailed knowledge of the application to be developed. Finding and hiring programmers with all three skills proved daunting and costly.

In contrast, ESF abstracts away the details of the underlying hardware and software layers so that programmers don't need to be hardware experts or C/C++ experts. Instead, they need only be subject-matter experts with some proficiency in Java. This opens up a vastly greater talent pool, speeding product development while reducing development costs. Nothing about ESF or the Everyware Cloud requires deep technical knowledge of hardware, OS kernels, driver code, network stacks, or C/C++ programming. Basic Java skills and a knowledge of the application are all you need.

Solution Capabilities

Eurotech's modular hardware and software offerings cover everything that system developers would need to deploy sensors and actuators (at one end of the IoT spectrum), to integrating with business back-end systems (at the other end), including a complex array of interconnection technologies in between. Several alternatives are offered each step of the way with, for example, multiple wireless gateways, different industrial computers, and various networking protocols, Developers are free to choose the solution they prefer from a number of industry standards and open-standard choices. The Linux/Java/GUI software stack then makes it easier to develop and deploy application-specific solutions with a minimum of low-level technical knowledge.

Example Use Models

1: Sports Medicine

Professional sports often involve rough contact and serious impacts to the players' heads, which is why the players on ice hockey teams or American football teams wear helmets. But how do you to judge when a blow is severe enough to sideline the player? And what are the effects of sustained impacts over time? These are serious issues that need real-world data, not guesswork.

Collecting that data may simply be a matter of outfitting players' helmets with sensors. But that's only the start. Streaming that data from multiple sensors per helmet throughout the

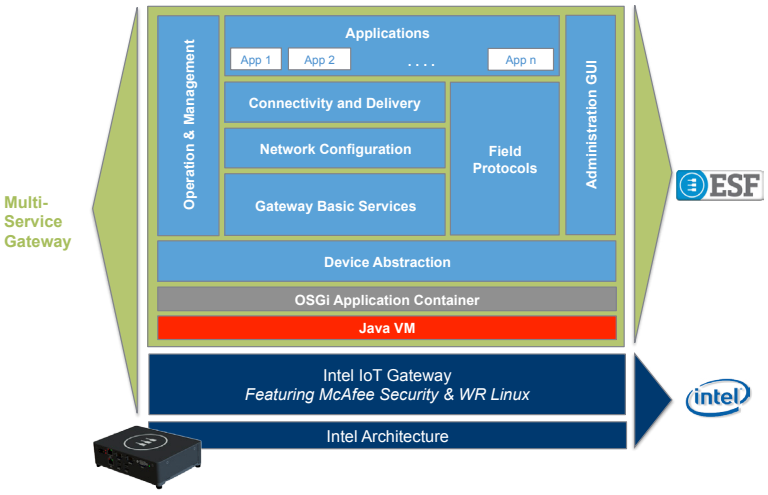

Figure 4. Everyware Software Framework (ESF) provides all the pieces a development team needs.

course of a game will generate plenty of data, but no useful or actionable information. The data needs to be filtered and analyzed, not just logged. And the medical experts with the right experience are probably not also experienced C++ programmers.

Using ESF and the Everyware Cloud, the raw data streaming off the field can be contained on the field, where it's filtered and condensed before being uploaded to a central analysis system, which may be located half a world away. Only the relevant information, not the mountain of raw numbers, is transported for analysis. The subject-matter experts can focus on their area of expertise, all the way from the sports field to the central office.

2: Pedestrian Traffic Tracking and Management

A large metropolitan area wants to maximize the attractiveness of its convention and visitor facilities. Large conferences and events are lucrative, and reflect well on the host city. But problems with public transit, parking, foot traffic, and missed directions can mar the experience for thousands of attendees. How can these problems be solved – or even identified?

The solution starts with an array of sensors throughout the venue and the surrounding city streets. Cameras can monitor crowd movements and the flow of foot traffic. Sensors can track arrival times for trains and buses. Traffic lights, crosswalks, entry gates, and exit doors can all be monitored to look for congestion or bottlenecks. In fact, so much data can be collected that it's difficult to know how to make sense of it all.

Civic planners aren't typically well equipped to deploy and collect so much data-collection gear. On the other hand, data-analysis experts aren't usually experienced in managing pedestrian traffic flow. Bringing these disparate disciplines together requires a layered approach to hardware, software, sensors, and information systems. ESF separates the "nuts and bolts" of collecting the data from an array of mutually incompatible sensors from the "intelligence" of analyzing and then acting on that information. The developers constructing such an elaborate system can focus on their value-add rather than the mechanical details of making it all work together.

Technology

Eurotech's embedded solutions rely on a wide assortment of hardware and software components that have been designed to work together.

Single Board Computers

The company offers SBCs and modules in a number of common form factors, including PC/104, COM Express, CompactPCI, VMEbus, and high-performance blades. More than a dozen different boards, in different form factors, rely on Intel architecture processors.

Stationary Systems

For fixed computing systems that don't have to be moved, Eurotech offers an assortment of "panel PCs" with an entire Windows-compatible computer embedded into a flat-screen LCD monitor with screen sizes of 12", 15", and

17". Industrial computers with weather- and contaminant-resistant enclosures are also offered.

Mobile Systems
For vehicle-based systems, Eurotech has engineered a number of rugged, portable systems for fanless operation, fleet management, networking, and more. Eurotech's ReliaGATE family of products can be used in both fixed and mobile environments.

Everyware Software Framework (ESF)
ESF layers on top of the Intel IoT Gateway, offering a further layer of abstraction from the hardware of a gateway solution to allow for faster application development and additional complex event processing at the edge, closer to the device, to manage bandwidth usage and ensure transmission of truly useful data to the cloud environment for further business analytics, processing and interface to back-office systems.

Intel® IoT Gateway
The Intel IoT Gateway offers companies key building blocks to enable connectivity to legacy systems as well as the latest connectivity technology when building new systems. It integrates technologies and protocols for networking, embedded control/application white listing, security, and easy manageability on which application-specific software can run.

The Intel Gateway Solution for IoT (Figure 4) includes building blocks which enable:

- Connectivity up to the cloud and enterprises
- Connectivity down to sensors and existing controllers embedded in the system
- Pre-process filtering of selected data for delivery
- Local decision making, enabling easy connectivity to legacy systems
- A hardware root of trust, data encryption, and software lockdown for security
- Local computing for in-device analytics

Everyware Cloud
Eurotech's Everyware Cloud is an IoT-integration Platform as a Service (iPaaS) that supports any type of sensor data with APIs to feed data into any back-office system. This flexibility gives users access to data from diverse sources to be analyzed by business systems and mined for actionable information. With this actionable information, businesses drive their processes and services to make well-informed decisions and operate most effectively.

Figure 5. One of Eurotech's Intel® IoT Gateway.

IoT Tenets

The Eurotech solution stack is designed to provide security and interoperability from edge to cloud in keeping with the five key tenets defined by Intel:

World-class security as the foundation
- The solution implements McAfee's robust hardware- and software-level protection that secures data between the remote device, the enterprise applications, and end user mobile devices.

Automated discovery and provisioning of edge devices to ease deployment
- Eurotech and its partners ensure select wireless sensors and actuators are Plug and Play.

Data normalization through protocol abstraction to improve interoperability
- Eurotech's software performs protocol translation (e.g., ZigBee, Bluetooth, Ethernet, Wi-Fi, and a host of other protocols) without end user intervention.

Broad analytics infrastructure from edge to cloud to realize customer value
- Eurotech software running on gateway systems and either cloud- or premise-based servers provide a platform for valued-added services tailored to niche applications.

Infrastructure to monetize hardware, software, and data management from edge to enterprise applications
- Eurotech offers an end-to-end, IoT-enablement solution capable of providing the support to subject matter experts creating industry-specific solutions.

Summary

The Internet of Things (IoT) is creating a proliferation of distributed sensor and data-

collection systems, but also placing a heavy burden on the cloud infrastructure and the end consumers of that data. Designing and deploying a distributed IoT system is often not compatible with the skills, expertise, and experience required to manage and analyze such a system. Eurotech's Everyware Cloud and Everyware Software Framework (ESF) provide an industry-neutral platform for building complex global IoT networks while leaving the value-added services to the subject-matter experts.

Resources

Intel® Internet of Things Solutions Alliance
Members of the Intel® Internet of Things Solutions Alliance provide the hardware, software, firmware, tools, and system integration that developers need to take a leading role in the IoT.

Intel® IoT Gateway Development Kits
Intel IoT Gateway development kits enable solution providers to quickly develop, prototype, and deploy intelligent gateways. Available for purchase from several vendors, the kits also maintain interoperability between new intelligent infrastructure and legacy systems, including sensors and data center servers.

Eurotech ESF Registration
All developers can register to access the Everyware Software Framework and discover the tools that simplify application development on IOT gateways, enabling enhanced processing capabilities at the edge of the network and allowing for greatest efficiency in bandwidth use for communications into the cloud infrastructure. http://esf.eurotech.com

Eurotech Everyware Cloud Trial
IT teams and business operations staff can try the Everyware Cloud platform for 90 days, to become familiar with the capabilities of the M2M integration platform, its user interface and its APIs. See how the Everyware Cloud can help your business improve efficiency and develop new IOT-based revenue-generating services. http://www.eurotech.com/en/portal/cloudtrial.

ABOUT INTEL® :

Intel (NASDAQ: INTC) is a world leader in computing innovation. The company designs and builds the essential technologies that serve as the foundation for the world's computing devices. Additional information about Intel is available at www.intel.com/pressroom and blogs.intel.com.

ABOUT EUROTECH®:

Eurotech is a listed global company (ETH.MI) that designs, delivers and deploys full Internet of Things solutions, including services, software and hardware to leading systems integrators and enterprises large and small. With Eurotech solutions in place, clients have access to the latest open source and standardized software stacks, flexible and rugged multi-service gateways and sophisticated sensors to bring Big Data, analytics and insights into business operations. Working with world-class ecosystem partners, Eurotech delivers on the promise of the Internet of Things either from end to end, or with best in class building blocks, including device and data management, connectivity and communication platform, high performance computers, intelligent edge devices and sophisticated sensors following business models that fit today's business world. Learn more about Eurotech at www.eurotech.com.