Industrial IoT and CAN/CANopen

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Everybody seems to be talking about the Internet of Things these days, but what are the actual implications for industrial machine builders? What do you need to do to make your machines "IoT-ready"? Will heavy investments be needed or is there an easier way? Tag along as we try to straighten out these question marks.

There is no doubt that more and more devices will be connected in the future. Estimations point at 50 billion devices being connected to the Internet in 2020 and the pace at which this is happening is breathtaking. It took 25 years to get 5 billion people connected to the Internet (1975-2000), while it will only take 15 years to get 50 billion devices connected (2005-2020). [1]

IoT vs. IIoT

When talking about the Internet of Things, we need to separate industrial devices from consumer devices. Connecting a wristwatch to the Internet is one thing, but connecting an industrial robot in a car plant is completely different as it brings tough demands for robustness, quality, communication reliability etc.

Therefore, it is important to separate IoT from Industrial IoT (IIoT). Whereas the general IoT notion is that billions of connected devices will push data onto the Internet, the focus of Industrial IoT is capturing data and information from machines and manufacturing systems for a more contained intelligent information processing – mostly for intranets rather than the World Wide Web.

Smart manufacturing systems

The overall objective for Industrial IoT is to create smart manufacturing systems and machines that are characterized by higher flexibility, efficiency and productivity as a result of adaptability, resource optimizations and predictive maintenance.

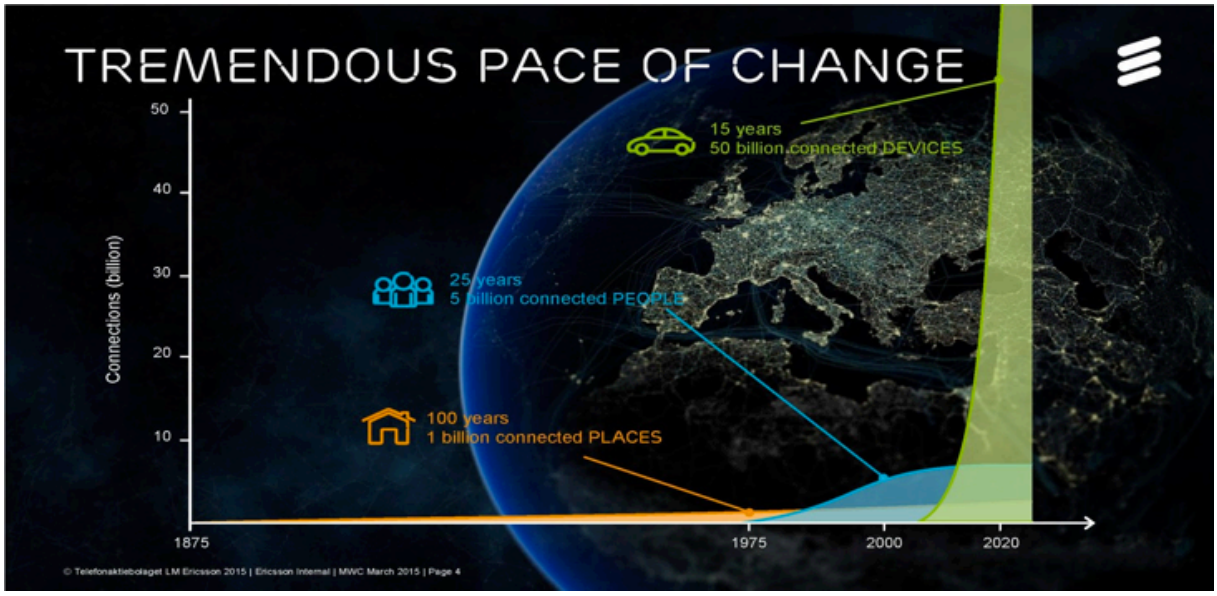

Figure 1: It took 25 years to get 5 billion people connected, but, will only take 15 years to get 50 billion devices connected.
Source: Networked society & cities of the future, Presentation from Maria Boura at Ericsson. http://www.slideshare.net/mabou/networked-society-cities-of-the-future-190315-a

This may sound like wishful thinking for a far-off future, but the fact is that the prerequisites for IIoT are already available.

Today's manufacturing systems and machines already sit on valuable information. The problem is that the machines in the Operational Technology world (OT) cannot communicate with the Information Technology world (IT).

CANopen is perfect for IIoT

The fact is that communication standards like CANopen are very well-suited for IIoT – no matter where you connect on the network you can access all information. The problem is that the information needs to be converted in order to be understandable for the IT world and made available for further processing in ERP systems such as SAP, Microsoft Dynamics or Oracle E-Business Suite.

But this doesn't change the fact the information is actually already there on the OT level – the machines have information on how they are performing when it comes to reliability and efficiency.

So let's have a look at how you can get this information from OT to IT – in other words how to make machines IIoT-ready.

Ways to get IIoT-ready

There are three main ways to enable the IT and OT worlds to communicate: Firstly, enable the devices on the operational level to "talk" the IT language using HTTP commands, OPC UA (OPC Unified Architecture) etc. Secondly, use gateways that translate the different protocols and data format so that the different worlds can communicate. And thirdly, use a gateway that connect the machine directly to the Internet.

Let's look into these three options a bit more closely.

1. **Make OT-equipment speak IT**
   Developing an IT-communication interface for and individual machine in order to communicate with the IT-side is complicated and time-consuming. Also, it is only available for new devices under development. The already installed base needs to find ways to do retro-fitting.

   It will, on the other hand, give you exactly the communication solution you require. There are stacks, chips and modules available if you want to do-it-yourself, both for integrated solutions into the machine and for stand-alone gateways.

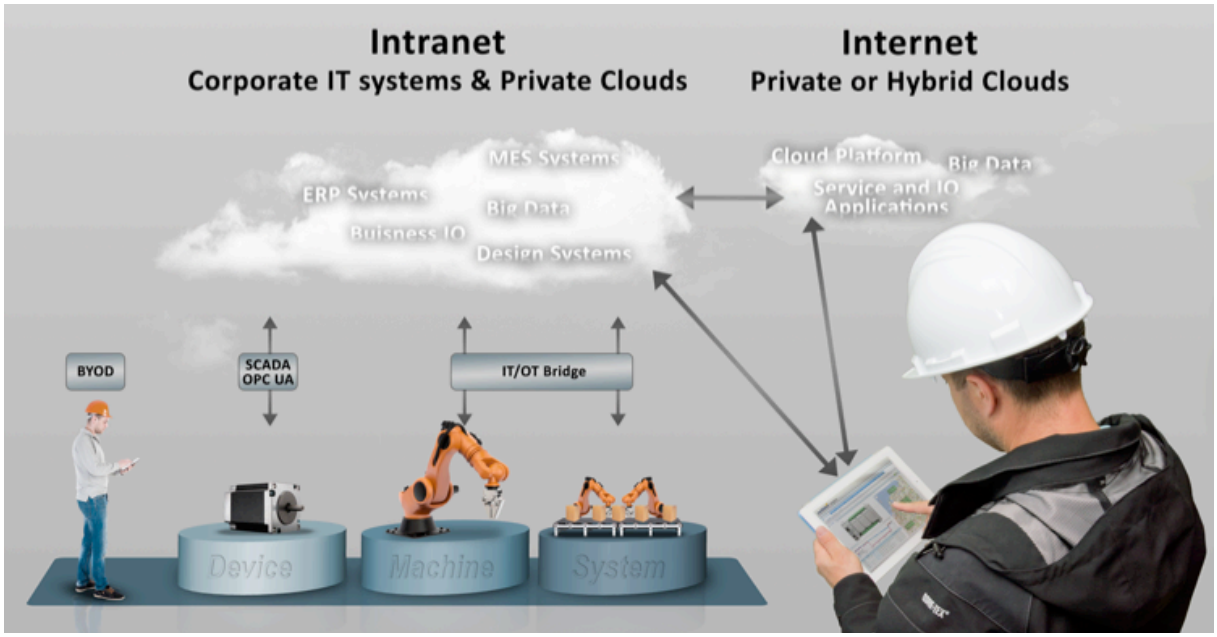

Figure 2: IIoT means that information form the OT world (devices, machines and systems on operational level) becomes available to the IT world enabling unprecedented access to information for analysis and control.

2. **Utilizing an IT-OT gateway**
   Using a ready-made gateway that serve as an interface between the wide-area network (for example, an intranet) and the industrial data, is an easier solution. IT/OT-gateways could be fixed devices connected to a backbone network or embedded within other devices, for example in an Internet router (ADSL or GSM/3G/4G routers or similar) for remote systems.

   Smartphones or other mobile devices can also serve as temporary gateways, for instance, when the IIoT device is carried together with the phone as with a body-worn sensor or when a phone is used for authentication of an IIoT device using an Internet service.

3. **Utilizing a gateway that connects your machine directly to the Internet**
   You can also choose to attach a gateway to your machine which communicates directly to the cloud. By logging into a webpage, you can see all parameters of your machine and control it remotely. The most modern cloud-connection gateways even allow you to do configurations such as PLC programming via a secure tunnel.

An interesting aspect of this, is that it allows machine manufacturers to become service providers. They can offer remote maintenance, configuration and support which opens up lots of new business opportunities.

So what other effects can we see when IIoT is being put in place? Let's have a look at some effects and some real-life examples:

IIoT will bring an increased need for wireless

An IIoT-enabling gateway can be connected to the office network via an Ethernet cable but as more and more devices need to be connected, it is likely that there will be an increased demand for wireless communication. This will both reduce wiring costs and make system integration easier.

If you require a connection directly to the Internet via a cellular connection, there are ready-made remote management solutions consisting of both gateways and online services. But if you need a more short-range wireless solution for communication within a plant, you need to consider which communication standard to use. The most common standards are WiFi and Bluetooth. Shortly put, Bluetooth gives you a more reliable wireless connection, while Wireless LAN gives you higher performance and more data throughput. [2]

So which road should you choose? A good recommendation is to use a solution which supports several communication standards, allowing you to test your way to the best solution.

Figure 3: So which road should you choose? A good recommendation is to use a solution which supports several communication standards, allowing you to test your way to the best solution.

Bring your own device (BYOD)

In the IIoT-enabled plant of the future, it is important to get access to plant data as well as configuring and maintain the systems locally and remotely. A cost-efficient solution for these functions is to bring your own device (BYOD) or use a smart phone or a tablet connected either locally via a short-range wireless link (Bluetooth Low Energy, Classic Bluetooth or Wireless LAN) or the cellular network. The access could either be established over a wireless gateway or over the internet depending on the requirements.

By creating tailor-made apps, BYOD opens up easy-to-use and secure handling that could easily be tailored for each individual application, each functional role (manager, plant operator, maintenance engineer etc.) and need. Of course, the same app can be designed to perform other specific task, for example acting as an HMI panel for a machine.

Security

Security becomes a big issue as more and more devices are connected to the Internet and the risks associated with this.

Security usually has different meanings for the IT and OT worlds. In IT, security often equals data security – keeping data safe and away from unauthorized access. In the OT world, security usually equals keeping machines from breaking down or being manipulated. Both aspects of security needs to be addressed for IIoT solutions.

When using wireless, we need to take care of possible events-dropping to secure that no non-authorized persons are able to access the data. Providing the Industrial data to the IT-systems requires encryption systems with extensible Authentication Protocols.

Solid, proven and trusted communication solutions will be of utmost importance when connecting machines to the Internet. Pushing data “upwards,” from the OT side to the IT side, is generally no problem, but when it comes to accessing the OT-equipment from the Internet, it goes without saying that the security must be rigorous. Here, it becomes very important to choose a supplier with long experience of security and quality assurance.

IIoT is already here – real-world examples of connecting CAN and CANopen device to the Internet

Although IIoT is often described as a trend for the future – the technology for enabling IIoT is already here. HMS Industrial Networks have been working with connecting devices to IT systems for more than a decade. Below are a three examples of IIoT – Two cases from HMS customers and one potential case for technology under development.

Case 1: Anybus communicator makes straddle carriers talk to the IT-world [3]

In The port of Zeebrugge in Belgium, there are 22 so called “straddle carriers” which are used to transport cargo containers around the terminal. The name “Straddle Carrier” comes from the fact that they “straddle” their load making them able to stack up to four containers on top of each other. The operators sit at the top of the machine with a view all around the carrier.

As the straddle carriers move around the terminal, it can be hard for the central administration to know the status of each unit. What is the fuel consumption, the oil level, the battery voltage, how many containers is it carrying, and maybe most importantly, where is it in the terminal? To enable the office to keep track of these things, APM wanted to install a wireless

system which would enable communication between the straddle carriers and the IT system in the central office. The problem was that the carriers use a CAN-based bus internally which could not communicate with the Modbus-TCP-based monitoring system that was to send the data to the office.

The Belgian system Integrator PICS quickly deemed that the Anybus Communicator CAN would be a perfect fit to handle the conversion between the CAN-based network in the 22 straddle carriers and the Modbus-TCP network. The Anybus Communicator CAN works as a translator between the CAN-bus in the straddle carrier and the Modbus TCP of the communication system, converting each telegram through built-in hardware and software.

Case 2: Online control of compressors with Netbiter [4]

Frick India Limited is the largest manufacturer of industrial refrigeration and air-conditioning equipment in India. Frick equipment is used in dairy cooling, ice factories, fisheries, marine applications, petrochemicals, food & beverages, breweries etc.

In a recent project, Frick compressors were installed in a potato cold storage in Hapur, located in the Uttar-Pradesh region in Northern India. The temperature variations in Uttar-Pradesh can be extreme and in the summer, temperatures can go as high as 50 °C. Consequently, efficient cooling is of utmost importance if you want to store foodstuff.

In the potato storage, there is a glycol chilling system with two screw compressors from Frick.

Connected to the compressors is a Netbiter gateway which is able to detect operating values from the compressors such as temperatures, energy consumption, running hours etc.

The Netbiter gateway sends this data to a cloud-based server called Netbiter Argos. The data is sent via Ethernet, but Netbiter gateways can also send data wirelessly via GSM/GPRS/3G. Frick and their customers can log in to Netbiter Argos at www.netbiter.net where they can view all parameters in an online dashboard. They can also view trends over time and download statistics on equipment behavior.

A very useful feature of the Netbiter system is the functionality called “Remote Access.” This means that Frick can connect to their PLCs remotely and do configuration using the usual configuration software. It is just like being connected on site. This means that changes, upgrades and debugging can be done from any location, saving a lot of service and maintenance costs.

Case 3: Predictive machine analytics using streaming CANopen data

The cost of a machine breakdown is significant and a factory owner will either pay for it directly, in the form of production losses – or indirectly in the form of insurance fees. Typically this cost is today reduced by scheduled service and maintenance.

A way to achieve a competitive edge and reduce machine malfunctions is for machine builders to move from traditional product-oriented business models and provide services where they guarantee a certain uptime for a monthly or yearly fee.

This is often called “predictive maintenance” meaning that technology is applied to detect issues before they cause machines to malfunction.

Predictive maintenance relies on three key components

1. Availability of data
2. Ability to quickly store large amounts of data
3. Software tools to do the analysis

The two last points, storage and software is developing rapidly and modern in-memory databases (such as SAP Hana) and software concepts (such as GE's Predix) are now at a point where predictive maintenance can become a reality.
The first point – availability of data – can be addressed in several ways. One way is to extract data from the machine controller (PLC) via for example an OPC connection. Another way is to mount additional sensors on the machine to directly measure the information needed for the analysis.
However, most of the data needed for the analysis is already available in digital format in the fieldbus (CANopen). By measuring parameter variance and drift, capturing alarms and system response times, it is possible to get a very good picture of machine health.

It is already today possible to extract this data directly from the CANopen network, using tools such as IXXAT CAN@Net2 or similar products.
The key benefit of using the data from the fieldbus level is that the data is updated hundreds of times every second. This is exactly what the analytics software needs in order to do advanced statistical analysis on for example parameter drift and variance.
Another major benefit is that this can be implemented without major re-configuration of the machine control architecture.
HMS sees intelligent extraction of data from existing fieldbuses as a key component for enabling predictive maintenance and we are already working with customers on the first real-life applications of this.

Conclusion: IIoT is already here!
It is time to get IIoT-ready.

There is no doubt that the World needs to utilize raw material and energy in an optimal way and machine manufacturers need to increase competitiveness in order to stay in business.

The information on Operational Technology level is already available, but we need to combine data from different systems and provide the data to the IT systems in an IT language in order to handle the important data in an understandable and efficient way. Solutions for efficient IT-OT bridging are already available, and even better, they are inexpensive and easy-to-install. So as a machine manufacturer, it is about time to get IIoT-ready.

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