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The Connected Machine[©]

In the consumer Internet of Things, the phone company now lets you turn your home's lights on and off from your mobile device, change the thermostat, and lock or unlock your doors -- connecting what previously were manual devices that could only be operated locally.

Simply stated, IoT identifies and represents unique intelligent devices over the Internet.

But we *already* identify and represent unique devices in industrial automation. It may

or may not be over the Internet and it may not be every device on a machine, but in general, industrial automation is ahead of consumer technology adoption -- for once -- in what is really just distributed intelligence based on standards.

This paper seeks to separate the hype from the practical and identify existing industrial IoT functionalities.

Many new terms are entering the automation lexicon as big money begins chasing big data.

GE calls it Industrial Internet. For Germany, it is Industry 4.0. Others include the fourth industrial revolution, M2M for machine to machine, and D2D for device to device. Intel, Cisco, IBM, GE and AT&T founded an Industrial Internet consortium in March 2014.

Whatever the buzz, the goal for industrial IoT is straightforward. It is to achieve The Connected Machine[©], taking plant floor visibility to the next level. ■



Connecting your home over the Internet to your smart phone may be revolutionary, but for industrial processes, IoT has been going on for over a decade. Here, a vision system is connected via industrial Ethernet to an Internet enabled controller.

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How industrial automation systems will change to achieve IoT goals



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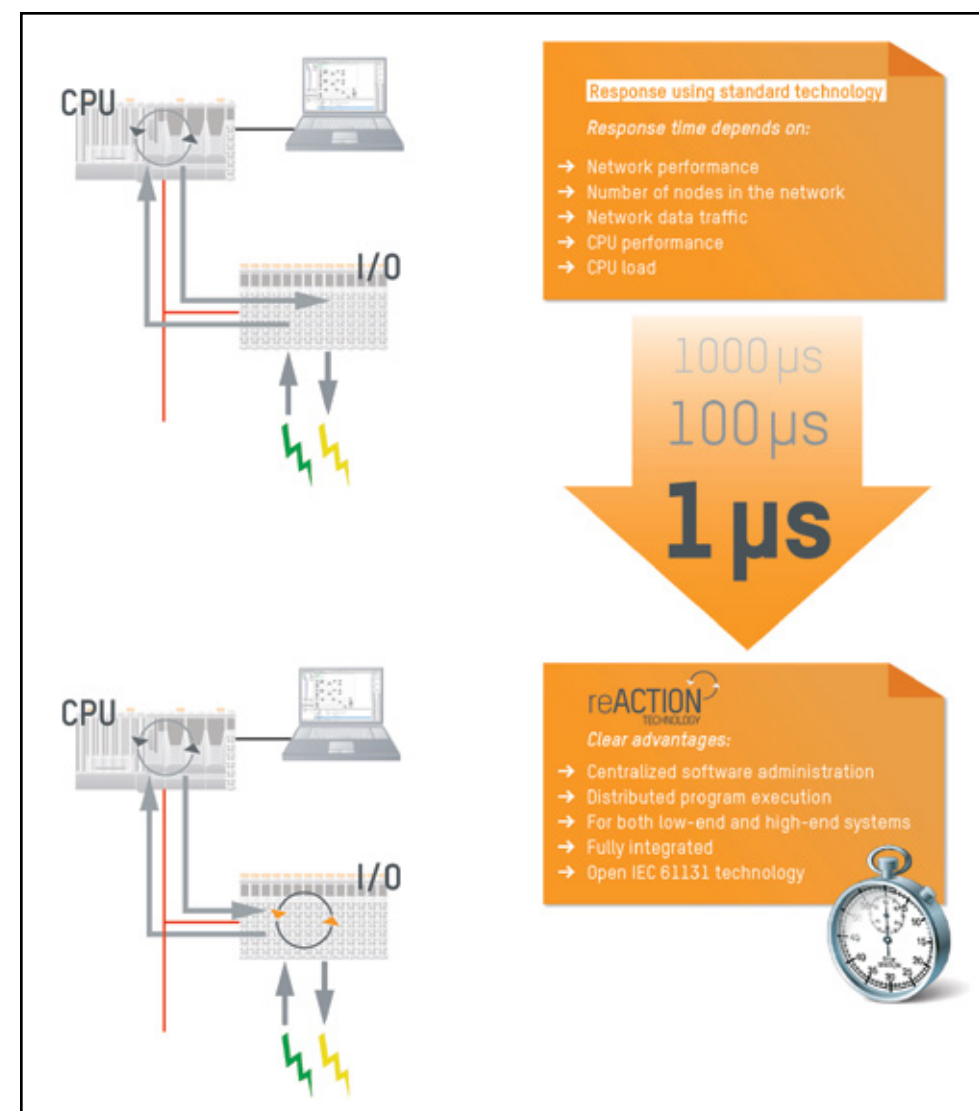
How industrial automation systems will change to achieve IoT goals

More devices will be connected and more machine components will be monitored. It is a matter of scale. We are already using mainstream interfaces, such as tablets and smart phones, to communicate with control systems. That's not news any more.

The big change will be increased demand for deterministic network bandwidth, processing power and distributed intelligence, all at a more affordable price point than legacy PLC or PAC platforms. This is the same model that was responsible for the proliferation of servo motion – a steady increase in capability with a corresponding reduction in hardware costs. In mainstream electronics, it's called Moore's Law.

The result will be an order of magnitude more communication with machinery – what we are calling The Connected Machine[®]. ■

By distributing more intelligence down to the I/O slice, response times as incredible as one microsecond are now commercially available. Practical application? Shrinking the time/distance a product needs to travel from sensor to reject station, and therefore cycle time and machine footprint.



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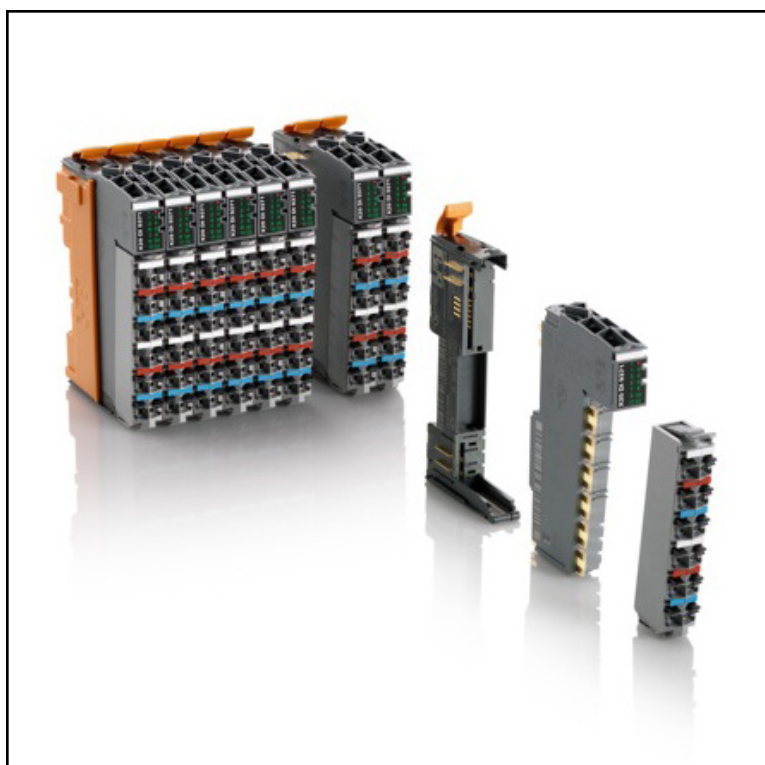
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Automation products that enable IoT today:
I/O with unique addressing



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Automation products that enable IoT today: I/O with unique addressing



A good example is B&R's I/O system. Each I/O slice or distributed I/O module is identified by a unique serial number that is recognized by the control system. If two I/O slices are removed and inadvertently swapped into the wrong slots, faults will be indicated at the HMI. Likewise, if someone swaps a failed, out of warranty component into a newer I/O system that is still under warranty, the machine builder can identify the occurrence. These conditions can be diagnosed remotely via Internet connection. ■

Uniquely identifiable automation components can prevent all kinds of errors and their associated costs, such as placing the wrong I/O slice in a rack.

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**Automation products that enable IoT today:
Secure remote diagnostics over VNC**



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Automation products that enable IoT today: Secure remote diagnostics over VNC

System Diagnostic Manager provides powerful diagnostic functions and allows the user to access information about B&R system hardware and software from anywhere in the world via Internet. The SDM's ready-made diagnostic applets can be easily integrated directly into applications.

All service functions necessary for a machine or system are integrated in the System Diagnostics Manager. It can be launched from any PC without any installation whatsoever. The only requirement is a conventional Web browser and Virtual Network Computing (VNC) freeware. Increasingly, cloud VPN services are being commercialized that meet IT's increasingly rigid security requirements.

The appearance of the System Diagnostics Manager can also be individually customized by the manufacturer to match the look and feel of the machine or system application. ■

The keys to industrial IoT are a proliferation of secure, off-the-shelf communications tools that require no proprietary hardware or software on the users' devices.



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**Automation products that enable IoT today:
Controllers with web servers and OPC UA**



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Automation products that enable IoT today: Controllers with web servers and OPC UA

Controllers have long had their own IP addresses and onboard web servers to provide access to manage software updates, data acquisition and maintenance functions. All the IoT really changes is the level to which unique Internet addresses are assigned, and this will occur only where it makes sense.

The controller serves as the gateway for all the devices over a deterministic industrial Ethernet network. It's not unlike the printers, scanners and other devices on a home network – they

don't have direct access to the Internet, they go through your personal computers with their firewalls and virus protection.

B&R supports OPC UA clients and servers directly on the controller, allowing vertical communication to SCADA, MES and ERP systems as well vendor-independent communication from PLC to PLC. With new PLCopen-compliant OPC client function blocks, this communication can be easily implemented in the application software regardless of the hardware being used. ■



Industrial IoT utilizes controllers with built-in web servers and the latest development -- OPC UA, standardized in accordance with IEC 62541 for vendor-independent data exchange.

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Automation products that enable IoT today:
The role of industrial Ethernet



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Automation products that enable IoT today: The role of industrial Ethernet

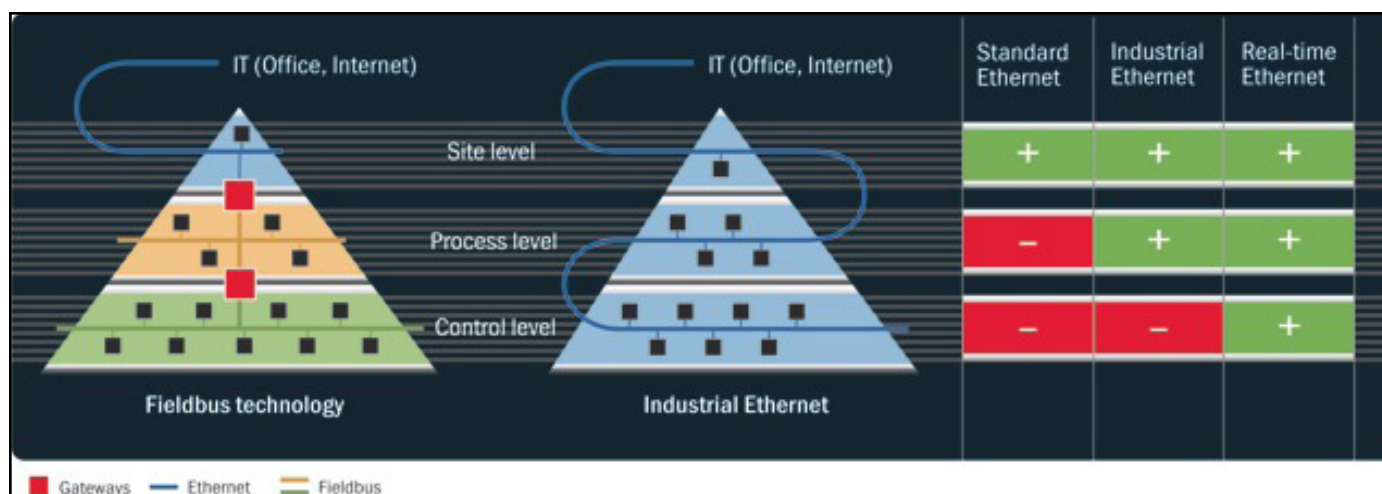
In the case of the industrial Ethernet network championed by B&R, the open source POWERLINK standard, third party device makers have patent-free, license-free access to a deterministic network protocol based on standard Ethernet.

POWERLINK also allows M2M and D2D peer communications as well as master-slave machine control and communications with management

systems. An example of D2D is the ability of servo drives on a POWERLINK network to synchronize with each other at high speed, rather than waiting for synchronization commands from the controller, which would take longer to travel across the entire network.

And, whereas in the past multiple networks and masters had been required, network hierarchies

have also been compressed. Separate device and motion networks are no longer needed to overcome performance and cost constraints. Controllers, both hardware and software, have been dramatically integrated. Vision processing can take place in the camera now, allowing for deterministic communication to the machine controller that has PC functionality inside. ■



POWERLINK provides the determinism of a real-time fieldbus over patent-free, license-free, open source Ethernet that supports TCP/IP, FTP, OPC and related standards.

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Automation products that enable IoT today:
openSAFETY over industrial Ethernet



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Automation products that enable IoT today: openSAFETY over industrial Ethernet

An example of M2M as well as open source, portable network technology is openSAFETY. It has been proven to run on the application layer of all the popular industrial Ethernet networks.

openSAFETY is also ideal for changing the way that production lines perform safety functions to increase productivity. Instead of dropping out power, new functionalities such as safe motion and safe robotics allow the power to remain on and under control to limit the speed, direction, torque and working envelope of moving parts to prevent possible injury.

Communicating safety commands across the network to other machines, the entire line can be slowed while the affected portion of the line is made operational again. This prevents production from being completely stopped, is easier on equipment, and reduces energy consumption and scrap rates. ■

In the world of industrial IoT, networked safety over deterministic Ethernet becomes a cost effective way to increase the operational efficiency and sustainability of machinery.



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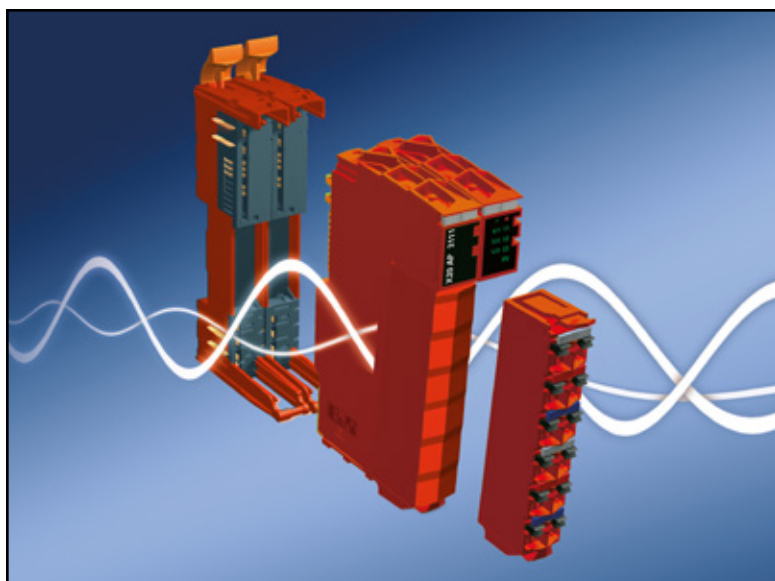
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Automation products that enable IoT today:
Advanced monitoring for The Connected Machine



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Automation products that enable IoT today: Advanced monitoring for The Connected Machine



Energy monitoring (above) and condition monitoring (right) of individual machines and modules are big benefits of industrial IoT.

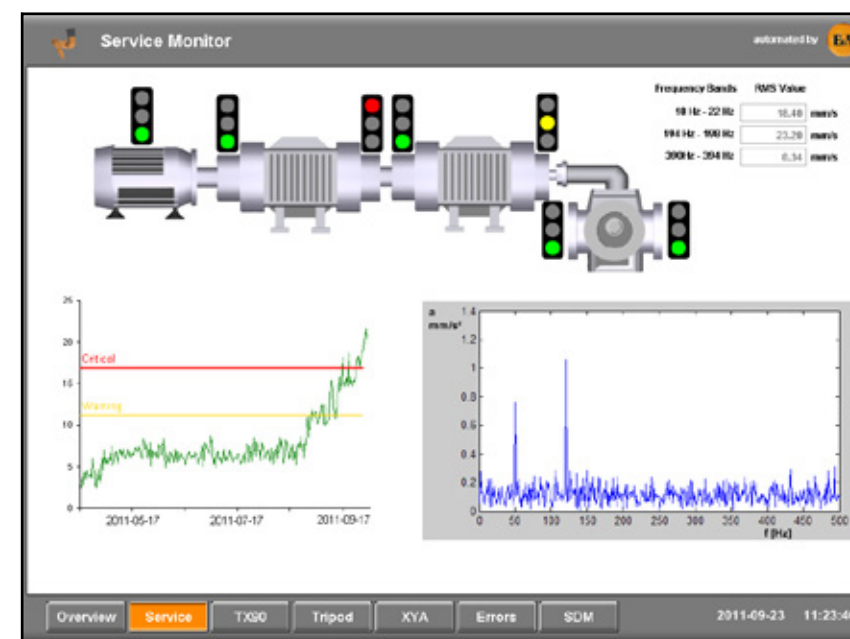
Energy monitoring, condition monitoring, networked safety and remote diagnostics are examples of intelligent devices already connected to the control system over industrial Ethernet and Internet protocols. These are devices ranging from vibration monitors on critical bearings to active vibration dampening, to light curtains to temperature sensors on shrink tunnels.

These capabilities are available today, and implementation will expand as the bottom and top line benefits are recognized by machinery specifiers.

Condition monitoring is one such capability, in which the frequencies of drivetrain components, such as bearings, ball screws, splines and shafts, are monitored for deviation. The result

is true predictive maintenance functionality based on actual conditions, rather than relying on measuring hours or cycles to theoretically determine a useful lifetime that may be cut short by

an anomaly such as failure to perform routine lubrication, unseen mechanical damage to internal components, corrosion, contamination, vibration or temperature extremes. ■



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How low should intelligence go?



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How low should intelligence go?

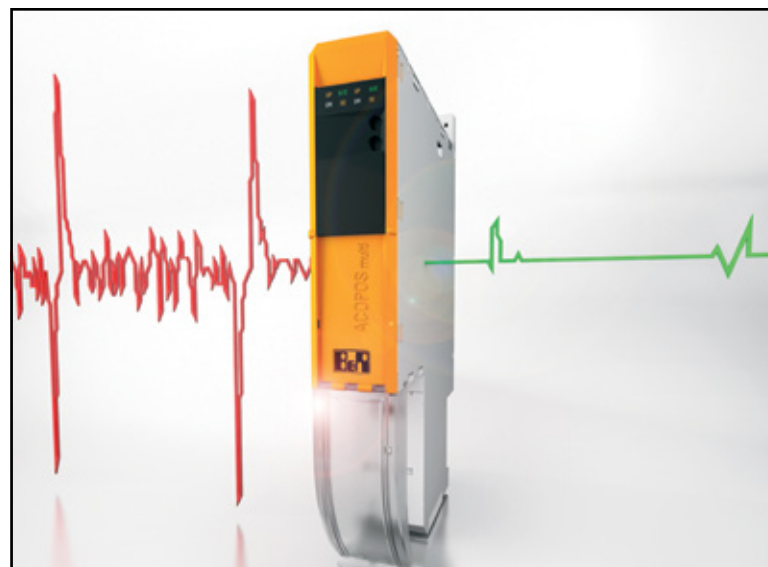
Will every device on a machine someday become an Internet node that can be accessed by its manufacturer, reseller or contracted service provider? It's entirely possible, driven by Moore's Law of constantly expanding processing power at ever lower cost.

And because B&R has based its control architecture on Moore's Law, taking advantage of every advance in mainstream computing technology, the architecture will remain inherently 'IoT ready' -- even though expectations for IoT functionalities will be a moving target.

Moore's Law has made such devices as accelerometers inexpensive enough to justify their cost today, whether in a smart phone's camera or an industrial device. And it continues to drive intelligence lower, into pushbuttons even. ■



Today, even the lowly pushbutton can afford to be an intelligent device connected to industrial Ethernet.



With functionalities such as automatic software version management and performance compensation, distributed intelligence down to low level devices quickly pays for itself.

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The criticality of global standards



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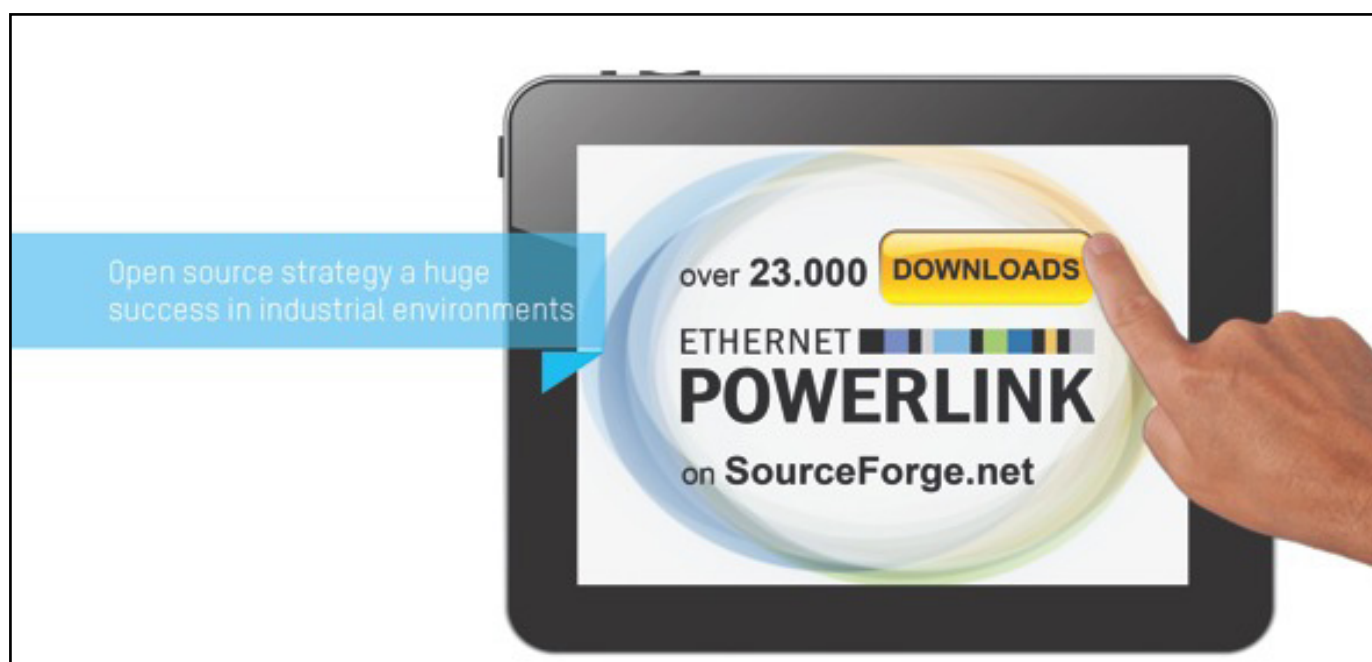
The criticality of global standards

Standards development isn't an exciting endeavor, but it is absolutely essential. In great part, it is the lack of true global standards that has contributed to the slower innovation in industrial automation compared to the IT and consumer electronics world.

It has been said that standards are like toothbrushes. 'Everybody needs one, but nobody wants to use yours.' In reality, resistance to true standards generally comes from status quo technology providers seeking to protect existing market share. Their growth has already slowed, and rather than invest in R&D they find it more profitable to try and slow down progress.

The established technology players that will continue to grow are those that follow the Silicon Valley adage 'eat your children,' meaning that you must cannibalize your existing technology with disruptive levels of innovation — or else hungrier competitors will.

For this reason, B&R continues to embrace both technological advances and all applicable standards. B&R makes its own network technologies 'open source' and therefore accessible without restrictive patents, intellectual property contracts and licensing fees. And it actively participates in the development of new standards required to expand the use of advanced technologies in automation. ■



Global standards for industrial Ethernet -- like openSAFETY and open source POWERLINK -- let progressive automation providers compete with legacy suppliers, so automation users can benefit from innovation.

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The Connected Machine® is reality...
you'll find them on YouTube



The Connected Machine[®] is reality... you'll find them on YouTube

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Want to see a Connected Machine[®] in action? You'll find several videos on the [B&R YouTube channel](#). You'll find plastics processing, inspection, CNC, packaging, printing machinery and more there, plus the enabling technologies.

The more that distributed intelligent devices can communicate with centralized control systems, the better production operations can be managed. Whether the functionalities are diagnostic, predictive maintenance, changeover or sustainability, connectivity to decision makers is essential. Security

issues are being addressed. Competitive advantage will continue to drive automation technology. And automation will leverage mainstream technologies.

Control networks based on true international standards are the foundation to assure that machinery installed today will support industrial IoT functionalities as they continue to evolve.

This is B&R Automation's IoT strategy – open and advanced – to provide its customers with sustainable competitive advantage.



The Connected Machine[®] will continue to evolve. Here, Team Foundation Server makes it easy for engineers anywhere in the world to collaborate on machine design and programming through automated version management in B&R's Automation Studio integrated software development environment.

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