Ethernet-enabled energy optimisation is rolling out

As energy-aware devices begin to roll into the marketplace, manufacturers are poised to reduce energy costs by 20-30% using intelligent, Ethernet-based networking as an enabling technology. With open interface standards such as PROFIenergy, Sercos Energy and the CIP Energy Object definitely on users' radar, energy optimisation is set to become a major system architecture topic. Al Presher talks to Carl Henning of North American PI, and Bosch Rexroth's Scott Hibbard

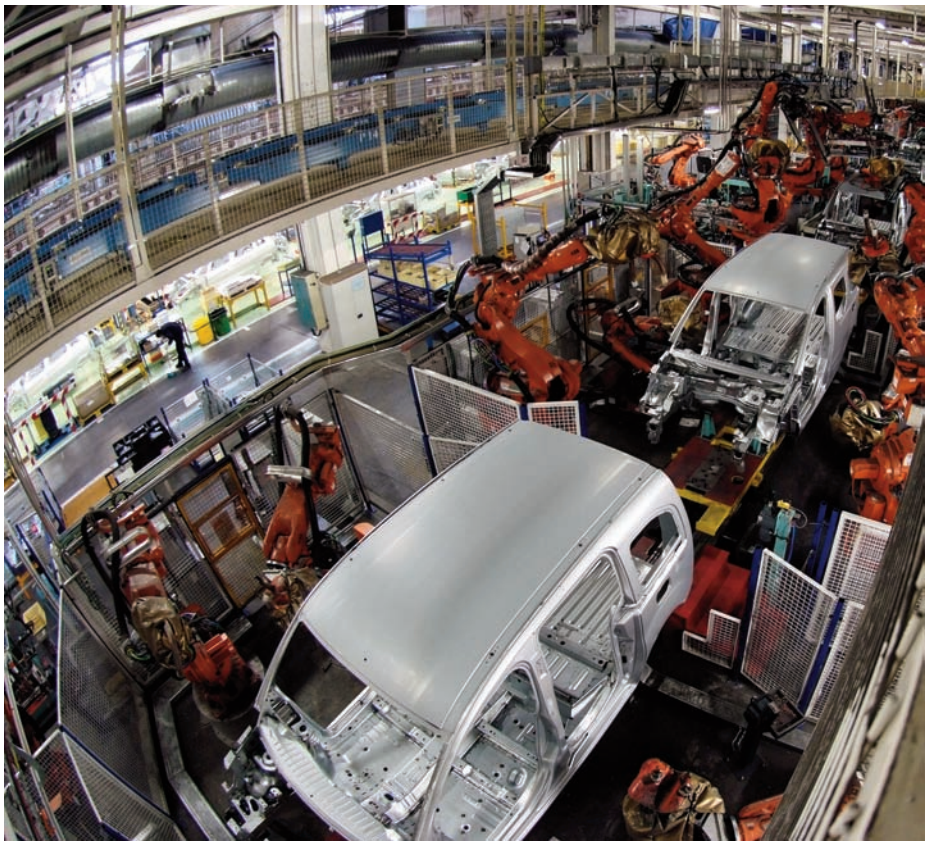


PHOTO: PSA CITROEN

THE STAGE IS SET for Ethernet-based energy management to become routine policy for end-users and machinery builders implementing automation projects. The first objectives of the new energy measurement protocols will be to place systems into standby mode during production pauses to reduce energy usage.

Even though the base technology has been ready for a year or so, moving to application deployment has taken time to develop. But now with the first wave of open interface, energy-aware devices coming to market, the uptake will increase as companies explore how to integrate energy priorities into real-time automation machinery control loops.

Open interface standards

'Before the release of Sercos Energy, we had already been putting energy functions in our products, but now we are converting over to the open interface standard for our drives, CNCs, and motion controls,' said Scott Hibbard, Vice President of Technology, Factory Automation for Bosch Rexroth.

'The standardised version for controllers will be in prototype units early in 2013 for customers to try out on their machines,' said Hibbard. 'The new controls will use the Sercos Energy information in conjunction with function blocks in the PLC programs as part of Rexroth's 4EE Energy Efficiency program for Manufacturing Equipment.'

The idea is for an IEC-61131 Energy Efficiency function block to pull in data from Sercos Energy-capable devices, and present that information to the programmer who in turn, can create functions to monitor energy usage and/or tune down devices. By performing calculations on the overall equipment switching cycle, the programmer can determine under what circumstances energy functions should place a piece of equipment into power-down mode.

While these capabilities are not out in the field, the development process is far advanced. Hibbard says it has been a complex process to pull all of the variables into a control structure that allows engineers and programmers to work efficiently on specific applications. With a large amount of data available, the question has become one of using it all in an effective, coherent solution. Achieving this has required the cooperation of end-users.

'The problem is that you can provide a lot of data but, if it isn't easy to program the system, people won't do it,' said Hibbard. 'The goal is to find clear methods of presenting the information to the programmer, but now we have a function block that does the job.'

Implementing energy monitoring in an application is relatively simple because it takes an aggregate of the energy consumed by all of the devices, and measurements set against time slots recorded from the Sercos clock. A graph that shows a CNC block number, for example, and system energy consumption at a specific time may be easily constructed from this. The graph will show if the system is running, in cycle or out of cycle. Using this technique provides a method to collect detailed energy usage information on parts of the process and individual parts of the line. Users are also able to analyse the data for resource management purposes.

Managing energy during pauses

'Saving 20-30% of energy just by entering standby mode during production pauses shows potential savings of hundreds of thousands of dollars in larger automotive plants,' says Carl Henning, deputy director for PI North America. 'In some parts of the world, companies are also penalised for their carbon footprint. So implementing PROFIenergy, in addition to saving money, also becomes a huge deal if carbon credits are a factor for manufacturers.' Some companies, notably Wal-Mart, are also demanding that their suppliers reduce their carbon footprints.

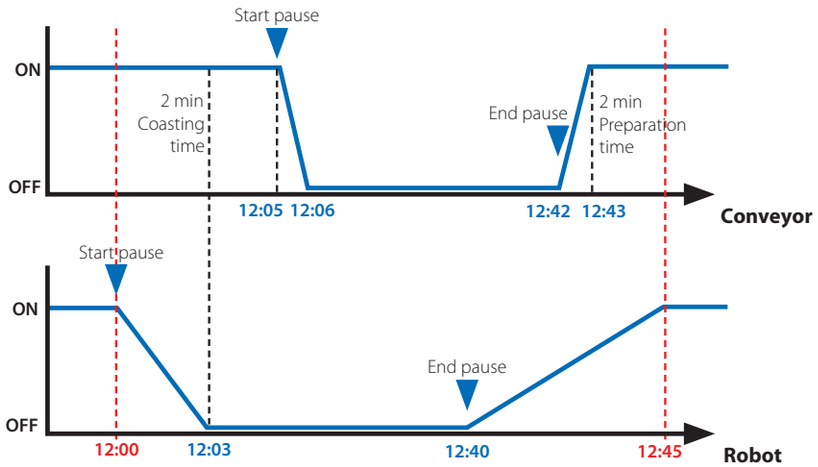
PI International has conducted an extensive, highly instrumented study of different automotive plants, examining what happens during a production pause. The conclusion from that study is that up to 30% savings are achievable and, from the automotive industry standpoint, it looks like a promising opportunity to reduce costs.

'What we are now concentrating on is where PROFIenergy is applicable,' said Henning. 'We recently did a study in the logistics market on applications that typically include a series of conveyors, cranes and systems to determine potential energy savings by placing devices into standby mode when they are not needed.'

Henning reported that the automotive companies, who have been the primary impetus behind this development, are only just starting to complete the first installations with the new model changeovers – there is, as yet, limited feedback in real customer data.

The upgrade process has primarily been a software change in two parts. Where operators use existing I/O, a firmware update adds the PROFIenergy capability. In the case of a controller, vendors typically introduce a PROFIenergy function block which is used to take advantage of the additional features. With new installations, since PROFIenergy is being integrated into the newer I/O and controller products, the updates are not required and device updates are easily done on the job.

As for energy measurement techniques, more customers are starting to implement these functions, and third-party software packages using PROFIenergy are being designed specifically for energy management. 'From an engineering point of view, the PROFIenergy application profile provides a series of commands including the ability to START PAUSE and END PAUSE,' said Henning. 'The key for systems engineers is to determine what devices and systems can be placed into standby mode, how long a device should stay there and how it relates to the other machines in the production line.'



An example PROFIenergy system consists of a controller, a conveyor belt and a robot. *Based on the production process, the conveyor belt may only be switched off two minutes after the robot, and must be ready to operate two minutes before the robot. PROFIenergy is used to determine the time behaviour of the conveyor and robot with switch-on and switch-off times set at one minute each. The device must be switched to energy saving mode at least two minutes before it may be switched on again to establish the production pause.*

The challenge is to coordinate the starting and stopping of various functions effectively, and details such as determining how long it takes for a system to go from being off to being on again. The process is not trivial but, like implementing safety and security systems, it's one more thing that the engineer has to account for.

This seems to be a user-driven Ethernet-based technology, although automation suppliers are definitely looking for products with PROFIenergy compliance. They think that it will be a selling point for their machines, but want a simple way to achieve it.

'Adding PROFIenergy to a new application is not a difficult task, and the implementation can really become commonplace,' Henning said. 'Retrofitting an existing system requires changes to the application code and also the logistics of updating the I/O firmware in the field. For new applications from a technical point of view, the biggest task is developing strategies for pausing devices and planning out how the systems respond to different conditions. Implementing the strategy is actually straightforward but the planning phase is the most demanding because of the need to understand the different aspects of system operation.'

PROFIenergy specific use cases

From the beginning, the goal has been to address four use cases. The first three all relate to what happens during a production pause, whether it is short, long or even an unplanned pause. The impetus came from a study by Mercedes Benz which suggested that, even when they were not making cars, they were using 60% of the energy required for production during downtime. The company set itself a goal of reducing energy consumption by 20%.

The fourth use case relates to data movement over Profinet. It has to be given a standardised form. With PROFIenergy, the goal is to take the information related to energy measurement, and to establish a fixed profile to enable its predictable use – for instance in estimating peak demand. With billing periods now measured in 15 minute periods, responsive demand shaving saves money. That might include putting a system into standby mode, or reducing power consumption within the system.

While the Ethernet-based energy capabilities are taking time to find their way into factories, nearly all of the new products from Siemens, as expected, now are PROFIenergy compliant. Other vendors, even smaller ones, are also introducing PROFIenergy-based products.

Energy analysis tools

Bosch Rexroth has an additional tool for use with its CNC products, the ega Energy Analyzer, which provides an energy monitor and creates the ability to view energy usage down to sub-millisecond increments. It can record a complete cycle and builds a file that engineers may use to view the aggregate energy usage of individual devices.

Before standards such as Sercos Energy, Hibbard said it was relatively easy for a vendor to pull energy information from its own devices but hard or impossible to gather information from third-party devices. There have been function blocks that can be dedicated to a pump, for example, where a user can turn the pump on and off, and put values into the function blocks to record energy usage. The pump draws a specific amount of energy to turn the pump on, get up to speed, run constantly and stop. That process, in the past, has been manual work for the programmer and the information was not always accurate.

'The next step is for the device supplier to put together a profile of energy usage or use sensors to provide this information,' said Hibbard. 'If the device on the network reports that it is Sercos Energy compliant, it can provide information on the energy required to start, run or stop. With this information, an energy management system becomes much easier to incorporate into the application program.'

Higher level enegy control can make predictions, perhaps plan a pause ahead of time while the application is unclamping the part and moving for example. It may make sense to idle a specific device on the machine to save energy; the goal is for energy data to become a real-time part of the control loop, controlling use of individual devices and optimising energy utilisation.

'Just by collecting energy data, it is possible to optimise the duty cycle of a particular process,' said Hibbard. 'For example, it reveals when it isn't necessary to accelerate an axis at a maximum rate if it can be ramped up more slowly to save on energy during the acceleration while still meeting production requirements.'

But it's also important within a cycle for the control to make intelligent decisions on idling back specific devices to reduce energy usage. Those kind of decisions made in a closed loop can begin to save a lot of energy with very little effort.

'Energy efficiency is something new for the system engineer,' said Hibbard. 'There should be a minimal amount of ramp-up and education for an end-user or machine builder to start using this technology. Once engineers begin to do this as a matter of course, they will be absolutely startled by the amount of energy savings they can produce – and how much energy has been wasted in the past.'

In the past, a physical PLC output may have been used to turn a pump on. If that device is network-capable and has an RJ45 Ethernet connector on it instead of a terminal strip, it can be plugged into the network. Traditionally, however, it is often controlled as a discrete on/off device. Now engineers need to see it as an intelligent device that can bring back information, and control it through a function block rather than a discrete I/O. Implementing better energy management is a learning curve, using logic within the function block to configure the system and optimise energy usage.

'The goal is to do as much of that process as automatically as possible, so the programmer has as little to do as possible,' said Hibbard. 'But it still takes programming effort to get past the initial learning curve and make the system work effectively.'

Al Presher *is a freelance journalist and US industry commentator*

FOR MORE INFORMATION CIRCLE **42**

IPv6 at less than 50µA per node

SEMICONDUCTOR company Linear Technology says that its WirelessHART & Internet Protocol wireless sensor networks can operate with a current draw of less than 50µA/node. The company promotes them as the industry's 'lowest power IEEE 802.15.4E compliant wireless sensor networking products.' The modules enable tiny sensor nodes – "motes" – to be designed with a battery life of over 10 years, while companion network manager components enable the development of secure wireless sensor networks.

The technology encapsulates an intelligent mesh network with algorithms and power saving technologies that enable deterministic power management and optimisation, auto-forming and self-healing mesh, zero collision low power packet exchange, and scalability to dense, deep networks.

Two communication standards are supported: the proprietary SmartMesh IP version is compliant with the 6LoWPAN standard, providing native IPv6 addressability to every node. The SmartMesh WirelessHART IEC62591 compliant products double the battery life over the prior release says the company.

The product family consists of several products. The LTC5800 integrates all radio circuitry components, including an onboard power amplifier and an ARM Cortex M3 32-bit microprocessor, requiring only power, ground and an antenna for wireless connectivity. The LTP5901/LTP5902 mote modules include a surface-mount printed circuit board (PCB) with FCC, CE and IC modular radio certifications. It also has an onboard chip antenna, while the LTP5902 module includes an MMCX antenna connector.

IPv6 in use

The device technology is now being geared to the 6LoWPAN standard. Prof Steven Glaser, with University of California, Berkeley, is responsible for the SierraNet program (http://systems.berkeley.edu/wsn/), enabling measurement of temperature, humidity,etc, in remote environments using mesh-enabled sensors. He stated, 'Our goal is to provide accurate, remote environmental monitoring to track the status of California's water supply. With a SmartMesh IP IPv6 routing node able to run at under 50µA average power consumption, SmartMesh IP represents a new paradigm for sensor networking, combining the ease of web programming.'

All SmartMesh networks are centrally managed, which provides comprehensive security and network management capabilities. SmartMesh IP managers can support up to 100 nodes per network, and multiple instances of SmartMesh subnetworks can be deployed side-by-side to create very large networks.

FOR MORE INFORMATION CIRCLE **41**