Network Strategy for Energy Management
Unified architecture to facilitate enterprise-wide energy management

A Frost & Sullivan White Paper in Partnership with Schneider Electric
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“The role of the network in enabling effective energy management in industrial and infrastructure environments is not always obvious.

Ethernet is the fastest growing segment in industrial networks. However, barriers to its uptake and its effective leverage remain significant. More importantly, the opportunity to use Ethernet to facilitate proactive energy management is often missed.

In this context, the contribution from a industrial automation solution partner, with Ethernet as the core of its architecture and energy as its focus, is critical.”

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The Paper was completed in July 2012.
Background

This whitepaper is one in a series written by analysts of the Industrial Automation Practice at Frost & Sullivan that included, amongst others, the following whitepapers:

- ‘Process Control for Active Energy Management in Industry’; which focuses on the untapped potential to leverage process control solutions for active energy management in industry.

- ‘Energy Management for Industry’; which highlights the importance of adopting an integrated system approach, leveraging open, collaborative energy management solutions and working with specialists who understand energy management technologies and practices.

This particular white paper, titled ‘Network Strategy for Energy Management’, analyzes energy management challenges in industry and highlights network strategies that can help facilitate effective energy management.
Industrial energy intensity (energy consumed in the industrial sector per dollar of economic output) in non-OECD countries is typically double that of OECD countries. With industrial energy consumption in non-OECD countries growing much faster than that in OECD countries, the challenge of lowering overall energy intensity is made that much more important.

In fact, energy usage is a growing challenge to all organisations irrespective of region. This challenge springs from a number of factors:

**Deregulation:** In many developing regions that are transitioning to market-driven economies, deregulation of the energy sector and the removal of rate caps will cause a significant rise in electricity prices.

**Increased energy demand and consequent supply augmentation:** In booming economies, the need to keep pace with surging demand will trigger massive investments in the energy sector. For example, the Gulf Co-operation Council (GCC) countries are

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1. **OECD** refers to the Organisation for Economic Co-operation and Development; comprising high-income, developed economies.
likely to spend around $2.2 trillion on alternative energy sources to generate electricity between the period 2011 and 2020³.

**Renewal of energy infrastructure:** In established markets, the renewal of generation, transmission and distribution infrastructure will require significant investments that will in all likelihood be recovered from consumers. Nationwide upgrades from traditional electric grids to smart grids in the United States are estimated to cost an accumulated $338-$476 billion over the next 20 years⁴; a huge amount for which utilities will continue to lobby for rate hikes.

**Closing the demand-supply gap through other means:** In the United States, projections of an 18 percent increase in energy demand and only a six percent increase in generation capacity, from 2010 to 2020⁵, highlight the need for better energy management through means other than building power plants.

In all of the above scenarios, energy management is being viewed as one of the key proactive solutions that can help governments and industry meet the energy challenge.

Obviously, energy management can be approached from a variety of angles (such as people-focused change, the use of more energy efficient equipment etc) and in reality a combination of solutions is typically required to achieve desired outcomes.

However, a critical fact is that energy cannot be managed effectively if it is not measured accurately. This requires collecting relevant data from all parts of the system, using a networking structure that facilitates this on a reliable basis.

**Challenges with leveraging old, traditional networks**

The immediate problem with this approach is that many industrial networks were developed with production optimization in mind; not with energy management in mind. This makes it more challenging for organisations with such infrastructure to address energy management mandates (both internal and external).

³ Frost & Sullivan research
⁴ Frost & Sullivan research
⁵ Frost & Sullivan research

“Energy cannot be managed effectively if it is not measured accurately. This requires collecting relevant data from all parts of the system, using a networking structure that facilitates this on a reliable basis.”

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For instance, the sheer volume of data required for effective process energy management is more than many old, traditional networks can handle. In fact, moving from monitoring the process to monitoring process AND energy in context increases the volume of data to be captured by a factor of at least three. This increase can be easily accounted for by the following factors:

- **More devices:** Energy management will require additional devices at control points (such as extra sensors and meters), thus increasing the volume of device point data.

- **More data:** It will not only be required to collect new types of data (e.g. power factor, power quality, reactive power etc), but also to have it properly time-stamped and secured to ensure data integrity.

- **Increased frequency of data collection:** To facilitate peak energy demand management, time demand management, demand response management and state changes based on process needs, data on the process and related energy consumption will need to be captured more frequently.

- **Higher speed of data capture and transmission:** The efficacy of energy management interventions depends to a great extent on the ability to respond quickly to process changes. This requires a high speed network that ensures there is no lag in data capture or transmission.

Industrial fieldbus and other device level protocols are also unable to deliver a seamless flow of actionable data from the plant floor to the business systems such as ERP. This prevents senior management from achieving operational visibility needed to manage effectively as well as to report (to internal and external stakeholders) adequately.

Again, many end-use sectors are diverse environments (for example, infrastructure across tunnels, airports, roads etc) which require a mix and match of data, video surveillance and access control. Adding energy management data to an already demanding load can prove challenging for most network protocols.

Finally, in many large control systems, the cost of customizing new technology to fit the existing system can be prohibitive.
Ethernet

Originally developed to link office networks together in the 1970s, Ethernet is ubiquitous in commercial and domestic end-use sectors globally. Being an established technology with a demonstrable track record in these environments, its eventual leverage in industrial environments was only a matter of time. However, not all Ethernet-enabled industrial automation devices speak the same Ethernet dialect. This is where EtherNet/IP as an industrial networking standard brought significant value.

By deploying equipment and data transfer mechanisms based on accepted standards (such as IEC and IEEE⁷) and by using standard TCP/IP for the network layer, organisations have been able to more easily implement commercial data communication standards in the industrial environment.

Thus, by using Ethernet/IP — created exclusively for the industrial environment — organisations have realized many significant benefits:

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⁶ EtherNet/IP, introduced in 2001, is currently the most developed industrial Ethernet network available. According to ODVA estimates, EtherNet/IP had 4.5 million shipped nodes by the end of 2011.

⁷ International Electrotechnical Commission (IEC) and Institute of Electrical and Electronics Engineers (IEEE)
High capacity and scalability for integrated control: Companies are seeking to replace or enhance homegrown legacy systems that require substantial time and cost to maintain. In addition, they are looking to break down silos and achieve centralized visibility and control. Also, diverse and changing end-user requirements demand significant flexibility and scalability of the network. Ethernet, being an open and standard network, can provide a consistent technology across disparate applications requiring high capacity. This it can do vertically – from device level upwards – and horizontally to deliver plantwide / sitewide scalability.

EtherNet/IP shares ODVA\textsuperscript{8} common industrial protocol (CIP); enabling end users to integrate different systems together without the need for gateways or proxies that increase complexity due to extra configuration and programming. This also permits increased flexibility, assures compatibility, and offers ease of device integration into new and legacy systems while giving manufacturers the power to converge their communications architecture for improved operational efficiency.

The increasing speed of Ethernet also ensures fast data flows. Gaining a few microseconds, on activities that occur thousands of times each day, adds up to significant improvements over time.

\begin{center}
\textbf{Ethernet Speed* Evolution}
\end{center}

\begin{itemize}
  \item 1980: 3-Mbps
  \item 1990: 10-Mbps
  \item 1995: 1-Gbps
  \item 1999: 10-Gbps
  \item 2006: 40-Gbps and 100-Gbps
  \item 2010: 200-Gbps
\end{itemize}

Source: Industry estimates and Frost & Sullivan analysis

*Speeds in the commercial data communication environment; not industrial environment

\textsuperscript{8} ODVA is a global consortium of leading automation vendors promoting open, interoperable information and communication technologies in industrial automation.
Determinism: Using design and configuration options specific to the application, EtherNet/IP can ensure deterministic operation. This means organisations can maintain consistency and predictability, whilst all along retaining flexibility of process design.

Reduced risk: Ethernet is standard technology that does not force organisations into expensive custom purchases. The fact that this essentially ‘plug-and-play’ technology receives widespread vendor support in the automation community reduces the risk to organisations using it and helps protect their investment over the long term. Also, while many protocols can result in significant additional costs to organisations seeking to add new functionality to large systems, Ethernet does this more cost effectively. By accommodating any number of point-to-point nodes, it allows users to expand the system without compromising flexibility or functionality. Once you install an Ethernet switch, you can connect myriad devices to it and can connect multiple switches to one another to create ever-larger networks. This is a significant benefit to users of large systems such as those typically found in the water & wastewater, mining, minerals and metals and infrastructure sectors. Ethernet cables are extremely simple to connect, and they are much easier to troubleshoot than many other options. That is important, because wiring can be a time-consuming aspect of an installation. Standard industrial off-the-shelf network infrastructure devices, physical media, connectors, and switches can be used.

Facilitating business-centricity: Traditionally, industrial environments maintained separate networks for plant floor operations and the business environment. However, industry demand for transparency across operations has gathered momentum and Ethernet ensures that this demand is addressed by providing high-speed connectivity between plant floor and the board room. This enables companies to link plant floor data with their business goals and enables them to take real-time business related decisions.

Remote monitoring and control: Thanks to Ethernet technology, engineers are now able to get more advanced diagnostic data on controllers, sensors, and other devices, remotely, using standard web browsers. These capabilities increase asset utilization (by reducing downtime) and workforce productivity levels for the organisation.

Specifications for improved energy management: In April 2012, ODVA published expanded capabilities for the optimization of energy usage on EtherNet/IP and other CIP Networks. This, along with specification enhancements announced in November 2011,

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9 Determinism of the network is the ability to achieve a consistent and predictable response time between two end devices.
ensures that Ethernet/IP specifications now include comprehensive functionality for energy visibility and management.

According to Katherine Voss, Executive Director, ODVA, “The energy functionality in CIP and EtherNet/IP allows users both to measure energy consumption as well as consume energy more efficiently. The definition of standards for energy reporting and power management will allow vendors to provide a scalable and comprehensive energy solution for their customers and reduce overall time for implementation for vendors, OEMs, systems integrators and end-users alike.”

**Barriers to leveraging Ethernet**

For organisations already invested in one network, but looking to change to Ethernet for improved performance, the main barriers to making the switch are:

**Unwillingness to step beyond the comfort zone of legacy networks:** Resistance to change is a common barrier to migration to a more advanced network.

**Inadequate research and strategy applied to the design phase of new architecture:** Ethernet opens up a lot more possibilities and choices when designing a communications architecture. To design an effective system, the user must research the options to make informed choices. Some users find this a challenge or elect to take a more limited network to avoid the need to do this even if it means giving up the desired functionality.

**Lack of awareness around the performance levels of Industrial Ethernet:** In many instances organisations are unaware of the fact that today’s Industrial Ethernet has overcome the performance issues found in early implementations of Ethernet technology in process control applications.

**Concerns around security of the network:** Security concerns are a real issue for industrial customers; especially for those dealing with critical infrastructure. However, these concerns can be fully mitigated by using the correct design approach which includes properly segmented systems and available security products as part of a full security strategy that is needed in today’s systems (where access to data is just as mandatory as fulfilling the basic process control requirement).

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Mitigating Security Risks

Open technologies such as Ethernet are attractive on many levels. However, they, by their very nature of openness, present security issues that need to be addressed effectively. This is an area requiring attention especially between the SCADA and control levels. Given the increasing sophistication of hackers, users of standard technologies are understandably concerned. Also, in many large industrial networks, the availability of remote access, though necessary, increases the vulnerability of the network.

The problem is one of approach and implementation, rather than a network protocol-specific issue. At a macro-level, it calls for government directives requiring organisations overseeing critical infrastructure to ensure robust network security practices are used. At the organisation level, the need is to shift from reactive check-it/fix-it approaches to more proactive strategies that start right from vendor selection, through to work practices and regular upgrades.

In the context of ensuring security over the Ethernet, the progressive steps to mitigating security risks are:

- Firewalls in the architecture
- Ensuring backdoors are closed and gaps plugged through timely upgrades to the system
- Designing in secure features (for example, moving toward ISA level compliance)

Schneider Electric’s Approach

In deploying Ethernet, it is important that organisations partner with a solution provider who views Ethernet as central to industrial control architecture.

ODVA principal member, Schneider Electric's approach, of leveraging Ethernet as the backbone of PlantStruxure™ (the company's collaborative automation architecture), reflects this strategy to network management.

This approach, first introduced over 10 years ago and continually enhanced since, allows seamless data flow across different modules of process infrastructure directly from the low-level field devices to business-level decision-making systems.
By using and supporting unmodified standard Ethernet, Schneider Electric ensures true interoperability, ease of upgrade, simplified training and the availability of several troubleshooting tools.

More importantly, Schneider Electric provides the service suite that is geared to enabling effective energy management. This includes a comprehensive energy audit, root cause analysis, the fine tuning of underlying network architecture, designing an energy management information system, delivering energy optimization systems at an enterprise-level, as well as continuous improvement consulting services. This way, network strategy and energy management strategy are no longer unrelated pursuits, but part of a unified plan.

In fact, through its PlantStruxure™ architecture, Schneider Electric provides organisations a blueprint for energy management that is open, transparent, collaborative and standards-based, with high-availability systems at every level.

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Conclusion

A single, open, standards-based network, such as Ethernet, covering all elements of the production environment means consistency in tools and approach. This translates into reduced costs and time related to configuration, programming, commissioning, maintenance and upgrade; thus resulting in improved efficiencies.

A centralized network also helps in improved plant functioning, which then brings greater flexibility in workforce deployment.

More importantly, Ethernet enables organisations to view and analyse large volumes of production and energy data in context and send through digestible data on key energy metrics to senior management; thus helping create a more agile, robust and proactive energy management approach throughout the organisation.

By integrating Ethernet at the core of the system and delivering a service suite that is focused on energy optimization, Schneider Electric enables organisations to move beyond production optimization to reliably collect, manage and leverage process and energy data to drive effective energy management.
Realized Benefits of deploying Schneider Electric's PlantStruxure™ using Ethernet
For Ethanol producer, Total Agroindustria Canavieira, Brazil

THE NEED
To facilitate high quality plant output, Total required an automated, scalable, and integrated system, with high availability and strong diagnostic capabilities.

THE SOLUTION
Application based on Schneider Electric’s PlantStruxure™ architecture.
Solution built on Ethernet, for optimal data availability.
Daisy chain network topology adopted for configuration.
Training and technical support from Schneider Electric.

THE BENEFITS
Savings of nearly $43,000 in hardware and engineering costs. Engineering time reduced by 15%.
35% less staff needed to operate the plant.
The ability to remotely monitor and control plant operations using Ethernet saves valuable time in diagnosing any issues that may arise.
Technical support and maintenance staff need not be onsite at all times in order to address any issues.
Redundancy in the boiler process resulted in a 15% reduction in equipment failure rate.
Schneider Electric’s ability to offer in-house expertise for training and start-up support saved the customer nearly $35,000.

Source: Schneider Electric

For more information, please visit www.schneider-electric.com