CHAPTER 7

Operations Energy Management

Energy Consumption Awareness

Reducing energy consumption in buildings can be accomplished in a step-wise manner. Efforts such as improving window energy efficiency, insulation, adding occupancy sensors and lighting controls can provide an initial sustainable reduction, but these changes alone will not result in a sustainable reduction such as the 30 percent reduction mandated by executive order 13423 for public sector entities.

To achieve and be able to sustain this level of energy reduction takes a systematic approach. The solution needs to achieve the following requirements:

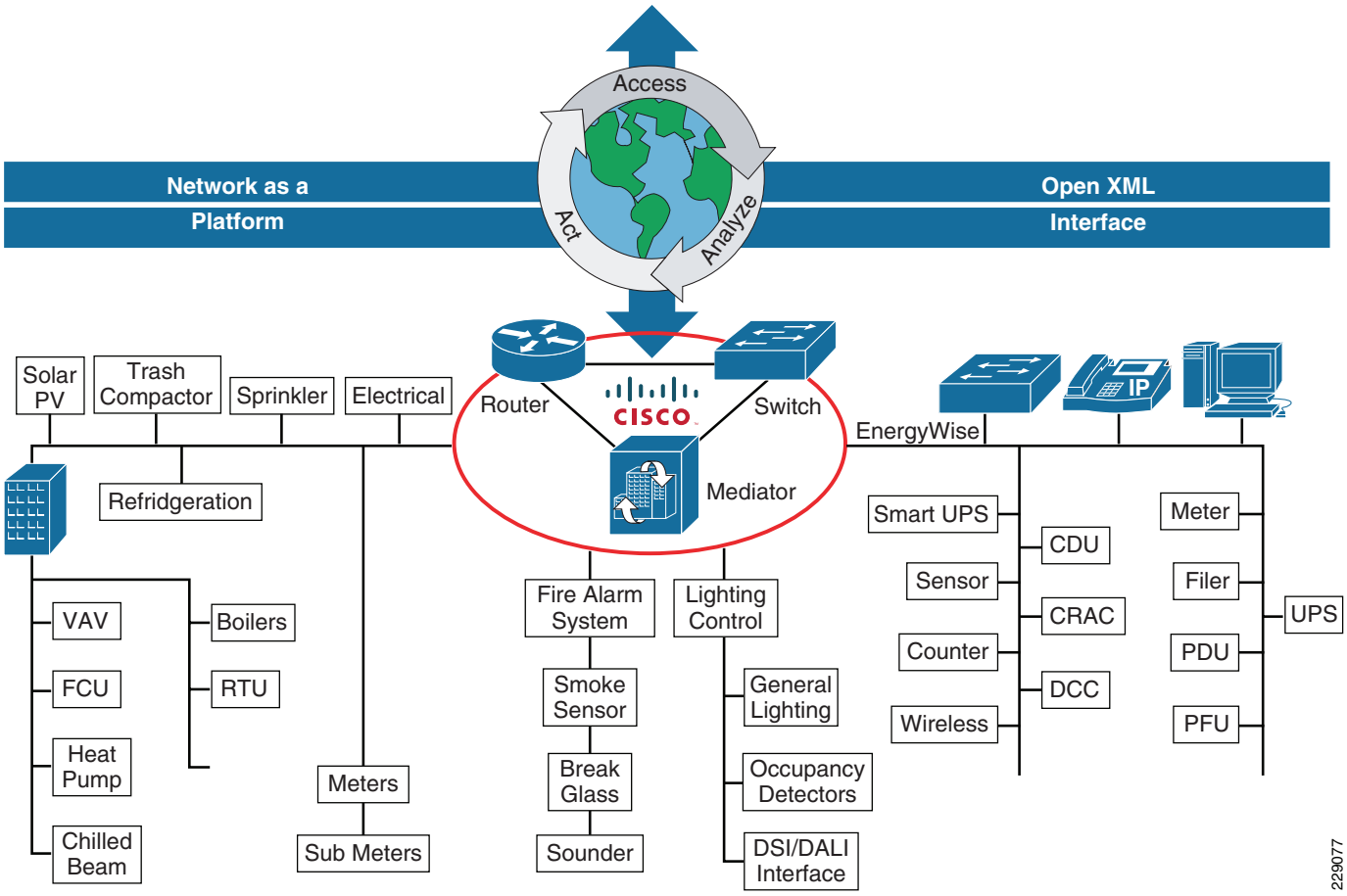
- Accessing data from all of the energy consuming systems in the building.
- Managing those systems based upon the data to reduce energy use.
- Correlating data between systems to find new ways to lower energy use.
- Ability to integrate new Energy Star systems to reduce energy use.
- Ability to integrate alternative energy systems, if applicable, to reduce energy use.
- Ability to provide the information to accommodate new regulations to reduce carbon.
- Ability to be managed to work with Utility Company Demand Response programs to reduce energy costs.

An energy management solution that provides the proper subset of these requirements might be able to lower energy usage by 30 percent. To achieve the 30 percent goal and be able to sustain it and continue to meet new regulations and standards, the Energy Management solution must meet all of these requirements.

Cisco's Network Building Mediator provides access to all of the energy consuming systems within a building. Many of these systems have unique data protocols and unique data formats, making access alone a major hurdle. The Mediator normalizes this data and places it into standard XML format so that it is accessible by a broad range of applications that can use that data to manage energy use.

The sustainability of an energy management system is based on its ability to access energy data from all of the energy consuming devices in a building. Another dimension of sustainability is through energy visibility to the building occupants. Changing building occupants behavior is critical method to ensuring that energy reduction is sustainable. A comprehensive energy management solution is one that keeps building occupants informed about their impact on energy use and carbon footprint. See Figure 7-1.

Figure 7-1 Energy Management System



Energy Management Information Collection

Building systems and energy management applications that are able to collect energy, management, and usage information provide the foundation necessary for a comprehensive solution. The critical differentiator that enables building systems to be transformed from simple device management to an advanced level of building automation is a TCP/IP network with the ability to connect these devices to it. The Cisco Mediator connects systems and devices to the network, and facilitates the automation and data collection from these devices to energy management applications.

The Mediator

The Cisco Mediator is a system composed of both hardware and software that gathers and manipulates data from numerous sources. These sources are typically intelligent machines or sensors, found in virtually any facility, which are otherwise unable to intercommunicate. The Cisco Mediator allows communication to occur between these devices, facilitates additional processing, and provides a uniform presentation of this information to users (through web-browsers) and third-party applications such as the following:

- Connects BAS systems such as HVAC, Lighting, Electrical, Energy Management and Security with Unified Communications and other IP Applications
- Software and hardware integration platform and web server
- Embedded Linux OS
- Python Framework
- Multiple physical ports
- Software support for common open and numerous proprietary BAS protocols
- CISCO Unified Communications
- AJAX-based web page and website created by onboard tools
- Use XML-RPC

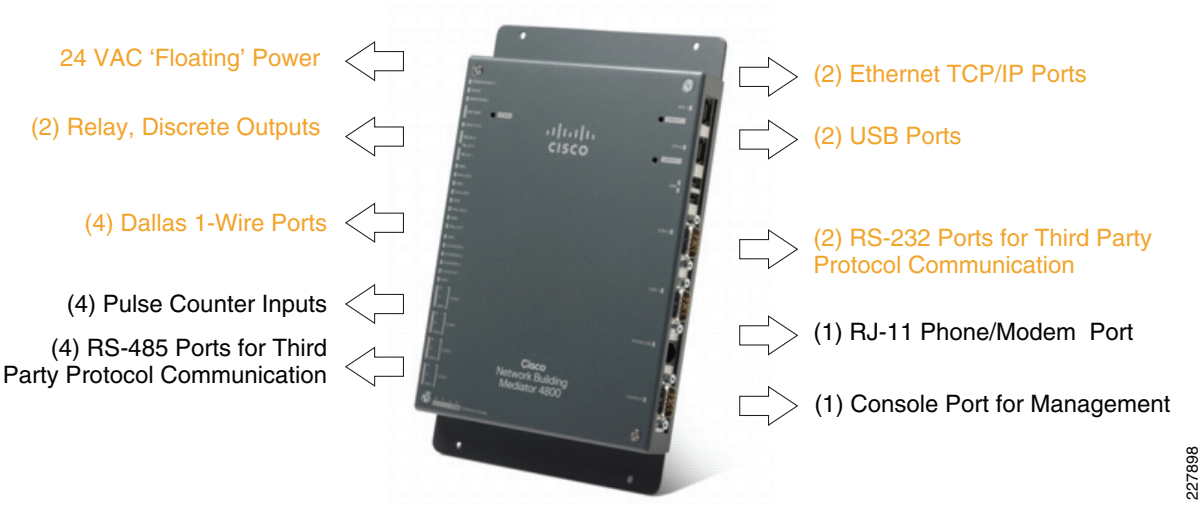
The physical connectivity functions and capabilities of the Mediator are extended by a suite of configuration and management software. The Mediator includes an extensive web-based management interface known as OMEGA. The OMEGA interface consists of operations tools and several separate applications as follows:

- Event Manager
- Security Manager
- Trend Manager
- Web Scheduler
- Web Express
- Website Builder

Two additional software applications are the Mediator configTOOL and Mediator perfectHOST. These are Windows software applications that enable graphical application programming and application monitoring. The Mediator applications communicate with the Mediator control system via two-way communication over a TCP/IP network. The Mediator collects data from multiple sources, including systems that use disparate protocols and are otherwise unable to intercommunicate, converting the data into a single, widely used format such as XML, and provides information to the end user in a uniform presentation. The Mediator enables building engineers to specify the type and quantity of information they want to receive, and omit anything they consider unessential. In addition, the Mediator is able to receive data through the perfectHost user application and convert it into commands and data that conforms to the protocols required by the facility's sensors, devices, and systems. The Mediator can run multiple services and protocols simultaneously and still have the capability to respond immediately to events generated in the network environment.

The Mediator Configuration Tool is an interactive, menu-driven software application that allows the user to specify the configuration parameters of the a mediator host system and all the connected systems including the control systems. See Figure 7-2.

Figure 7-2 Mediator Architecture



For more information on the Cisco Mediator, refer to the following URL:
http://www.cisco.com/en/US/products/ps10454/index.html

For the *Mediator End User Guide*, refer to the following URL:
http://www.cisco.com/en/US/products/ps10454/products_user_guide_list.html

Energy Management Application Partners

As collection of data for energy management operations within the Mediator itself is limited to only a few days, it is necessary to export and upload the data from individual Mediators to an external repository for the purpose of long term data collection, analysis, and trending of building systems. To collect information from many mediators covering hundreds of locations several methods are available, two of which are local databases in the enterprise and cloud-based services from Cisco partners.

Cloud-based services from Cisco partners provide added value and visibility based on their extensive experience across many different types of building systems and their respective idiosyncrasy's.

Out of the extensive list of solution partners, this validation evaluated products from Facilities Solutions Group (FSG), Noveda, and PreNova.

Facilities Solutions Group—Energy Scorecard for Operational Trend Reporting

FSG Energy's approach to the industry is to assemble "best of breed" open standard technologies, applications, and service providers. They have formed an alliance with Cisco for technology infrastructure and Sensus MI for automated HVAC Fault Detection and Diagnostics. These coupled with FSG's powerful delivery and infrastructure support allow companies to take advantage of the best combinations of technologies and applications, without being tied to one proprietary vendor.

Energy Scoreboard™

Managing energy and operations for multiple facilities requires connecting energy metering systems with building automation systems at the site/store level. By integrating these technologies a common platform is created upon the robust IT data backbone. Through centralized data aggregation and reporting, informed decisions can be made at the corporate level, keeping score on the greater energy management challenge. Energy Scoreboard™ (see Figure 7-3) is:

- An Internet-based energy management tool that is closely integrated with a control system allowing the enterprise to "call the energy plays" and immediately measure results.
- Shows how and when the enterprise uses energy through easy to view graphs, charts, tables, and reports.
- Provides the ability to compare energy use across multiple sites.
- Consists of a hardware device for data collection (the Cisco Mediator), an FTP server, database server, and web server (for web-based energy analysis).

Figure 7-3 Energy Scoreboard

For more information about FSG and their products, refer to the following URL:
http://www.fsgi.com/site/energy/products.php

Noveda—Energy Consumption Information to Building Occupants via Digital Media or Corporate Web

Noveda Technologies provides a web-based, dynamic, graphic visualization solution for real-time monitoring, diagnostics, metrics, and historical tracking of renewable energy, conventional energy, and building mechanical/environmental systems.

Their building projects include institutional, commercial, educational, governmental clients for which we provide a critical tool for dramatically improving energy efficiency; allowing substantial cost savings, reducing systems maintenance, decreasing a building's greenhouse gas emissions and carbon footprint while providing an exciting platform for communicating these efforts and achievements to customers, clients, employees, and the general public.

The Noveda systems not only measure energy use, but also analyze the information allowing building owners to better manage energy resources, improve energy and mechanical system performance, and lower energy and maintenance costs. It is understood that an immediate energy savings of 10 to 30 percent can be realized by taking simple measures. By monitoring and displaying building energy consumption on a real-time basis, opportunities for operational efficiency improvements arise as well as incentives for changes in occupant behavior in regards to energy use.

EnergyFlow Monitor™

For buildings that use conventional and/or alternative energy (electric, gas, steam, solar, wind), Noveda's real-time web-based EnergyFlow Monitor™ is the most powerful tool available to monitor a building's energy and natural resource use in order to lower energy costs and reduce the consumption of fossil fuels. It easily track the *before* and *after* effects of energy conservation efforts, such as high efficiency lighting and mechanical equipment retrofits. Receive notifications when peak demand thresholds are being reached so that billing rates can be controlled.

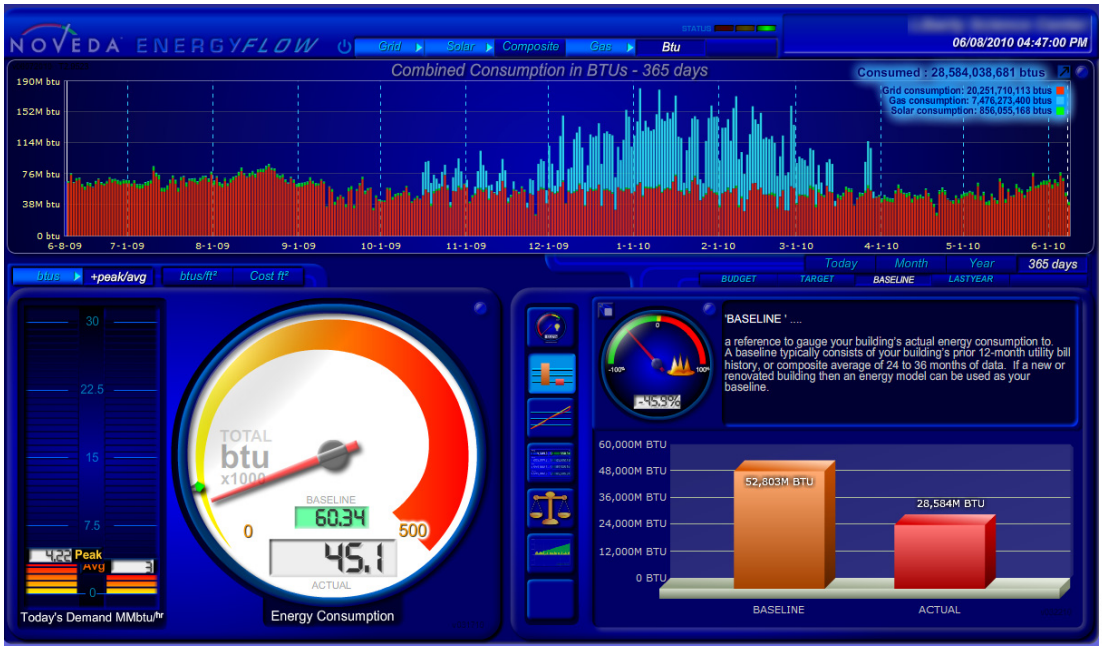
Studies[1] have consistently shown that the best way to save energy is to show people how much they are using. Noveda's real-time web-based EnergyFlow Monitor™ is the most powerful tool available to communicate building energy and natural resource use to effect change.

With engaging visuals and industry-leading monitoring frequency, EnergyFlow Monitor™ provides the context that is normally missing in energy consumption data. With meaningful graphics, analysis-based alerts, detailed reporting and complete data export flexibility, EnergyFlow Monitor™ gives answers, not just details.

Dynamic visualizations not only informative to building occupants, but engage them in helping achieve goals for energy and resource efficiency. Easily track the before and after effects of energy conservation efforts. EnergyFlow Monitor™ provides real-time energy in perspective, it tells occupants “How they are doing right now”, enabling timely action to be taken instead of waiting 30 to 45 days to see the impact on utility bills.

1. July 2009, European Commission's Directorate-General for Energy and Transport initiative, “*Energy Savings from Intelligent Metering and Behavioral Change (INTELLIGENT METERING)* http://www.managenergy.net/products/R1951.htm", 2009. http://www.noveda.com/resources/general/sales%20-%20energyflow-ehb093008.pdf

Figure 7-4 EnergyFlow Monitor



Prenova—Services Provider for Deployment, Support and Daily Operations

Prenova provides technology-based energy management services that help customers reduce utility costs and improve energy efficiency. The company works hand-in-hand with customers to develop an energy strategy that fits their unique business needs. Then they help customers implement this plan consistently across their entire organization. With a combination of services that includes Utility Management, Energy Procurement, and Remote Monitoring, Prenova drives customer savings of up to 10 to 15 percent of energy spend. From securing the best available rates in deregulated energy markets to optimizing the performance of building systems in real time, the company's solutions span the entire energy lifecycle.

Energy Management—Top Priority for Many Organizations

Energy Procurement helps customers reduce energy spend by securing lower utility prices in deregulated markets and identifying the most appropriate rates and tariffs in regulated markets. Prenova's team of experts continuously monitors global events and market trends to assess the short- and long-term impact changing conditions will have on energy supply. They also track changes in state and federal regulations that may affect rates. Extensive experience and understanding of the energy industry help Prenova develop a unique sourcing strategy for each customer.

Utility Management Services

Prenova's Utility Management solution is designed for organizations that want to free up internal resources by outsourcing the process of receiving, processing, and remitting utility invoices. This service includes a two stage audit that helps customers avoid overpaying for energy. A pre-payment review spots the most common billing mistakes, while a thorough post-payment analysis identifies billing anomalies that may indicate an error has been made by the utility. Prenova personnel investigate and resolve all billing errors, securing refunds when necessary.

Remote Monitoring

Remote Monitoring optimizes the performance of critical building systems, including HVAC, lighting, and refrigeration equipment. Prenova technicians monitor the performance of these systems from the company's remote Operations Control Center and are on hand 24/7 to respond to inbound service requests and system alarms. Using the company's advanced Asset Optimization technology, they perform sophisticated diagnostics to ensure equipment is functioning properly, within predefined operating standards. Should a problem occur, Prenova staff can often resolve the issue remotely, helping the customer avoid an expensive field service call.

Exporting Mediator Data

In order to take advantage of the applications and services of energy management partners, data from the Mediator must be exported to these partners. The Cisco Mediator stores data collected from various sensors and managed devices locally within FLASH. The flash storage available within the mediator itself is limited, and based on the number and rate of data logging typically can only store a week’s worth of information. For long term storage and trend analysis of energy management and building systems this data should be exported to a central repository on a regular basis.

Mediator Data Exporting Steps

The Mediator can be configured to export data through the following four types of transports:

- HTTP post
- HTTPS post
- SFTP
- FTP
- SMTP

There are several supported export formats, and one specifically for FSG. This example shows the steps necessary to export data to an FSG account. Out of the four transport types, FSG can only accept FTP and SFTP export options from the Mediator at this time.

Note A best practice is to assign all physical inputs and soucres via aliases. These aliases are then used in logging and are more user friendly names. If for some reason a device needed to change to a different physical interface (e.g., COM5 to COM5), the alias just needs to be pointed to the new physical interface, eliminating the tedious task of finding all other references for that resource in logs and reports.

The following are the steps to create a new Export Log, typically one is created for each device at the location:

Step 1 Under the logger right click and select **ADD** and **Periodic Log**.

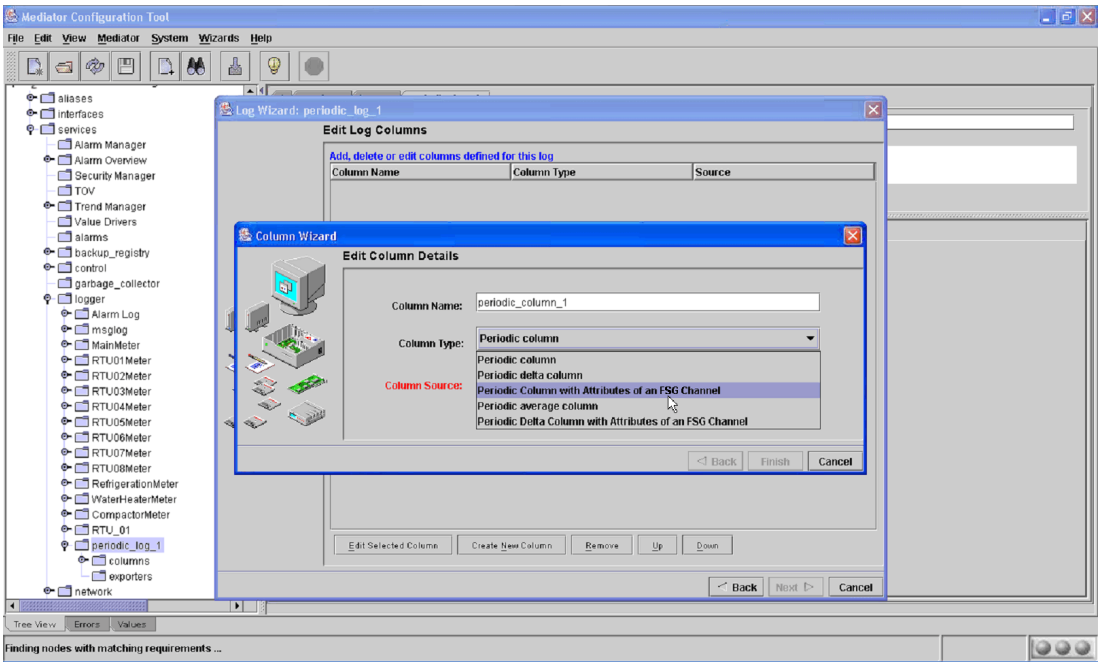
Step 2 Assign an appropriate name for the log related to that location.

Step 3 Select the **Wizard is Available** button.

Step 4 Select **Next** at the bottom, then **Create New Column**.

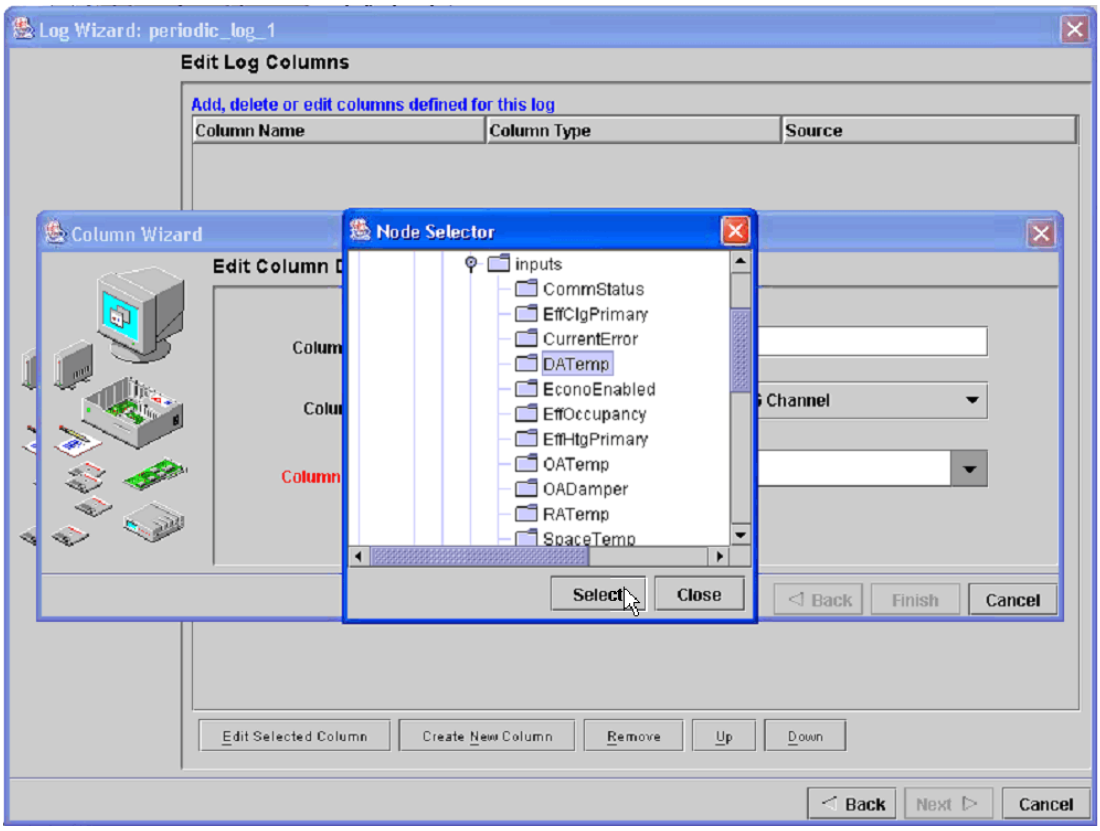
Step 5 In the New Column wizard dialog, change the column type to *Periodic Column with Attributes of an FSG Channel* (see Figure 7-5).

Figure 7-5 - FSG Exporter —New Column Details



Step 6 Add the appropriate column source for this column via the Node Selector pop-up (see Figure 7-6).

Figure 7-6 FSG Exporter - New Column Node select



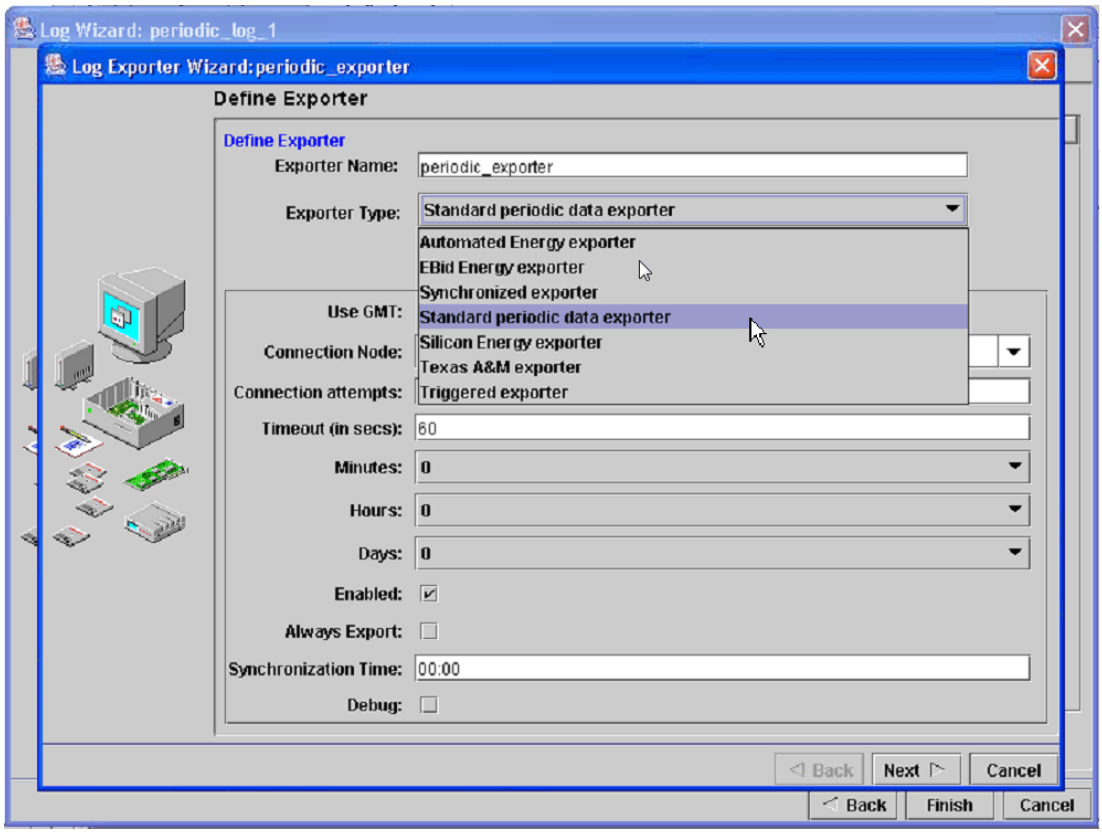
Step 7 Click **finish** and then repeat Steps 4 to 7 to add additional columns.

Step 8 Once all the desired columns have been added, click **Next**.

Step 9 On the Define Log Exporters page, select **New**.

Step 10 in the Log Exporter Wizard interface, make sure the Exporter Type is **Standard periodic data exporter** is selected (see Figure 7-7).

Figure 7-7 FSG Exporter - Log Exporter Type



Step 11 Click **Next**.

Step 12 On the Define Formatter page, change the Formatter Type to **FSG XML formatter**.

Step 13 Click **Next**.

Step 14 Set the Transporter type to **Standard FTP** or **SFTP** as desired.

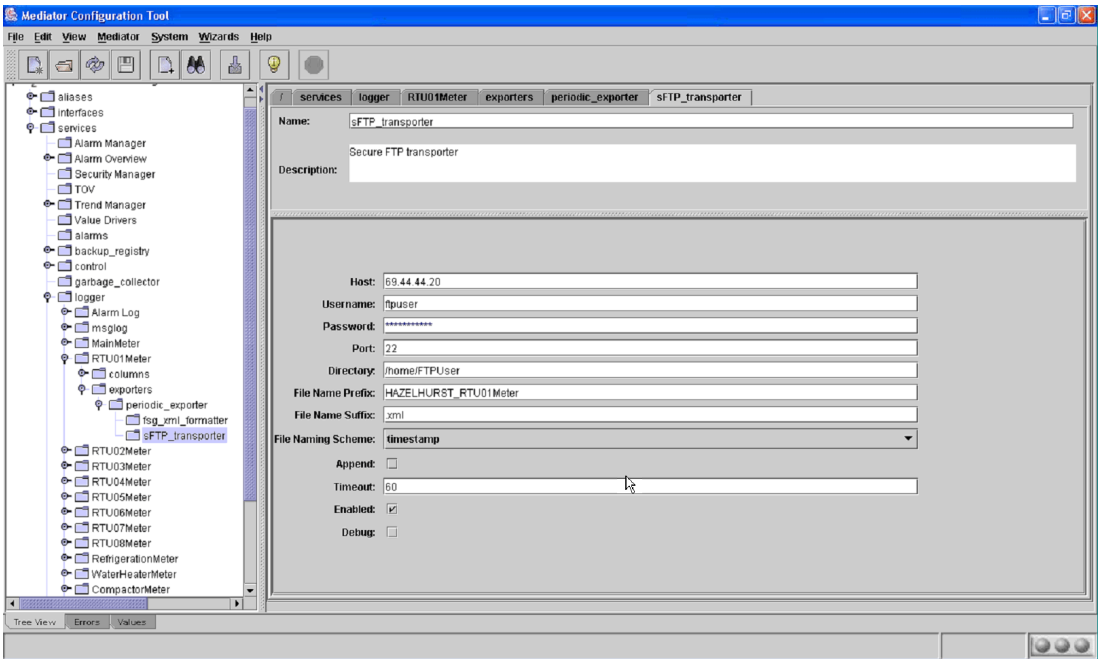
Step 15 Enter the appropriate hostname, username, and password for the FSG service account.

Step 16 Set the port as appropriate for the protocol used (21 for FTP, 22 for SFTP).

Step 17 the directory will be */home/FTPUser*.

Step 18 The file name prefix should be unique and be based on a hierarchal schema such as [*CustomerEnterpriseName*]_[*LocationID/Name*]_[*MediatorID/Name*]_[*DeviceID/Name*] (see Figure 7-8).

Figure 7-8 FSG Exporter - XML File Name

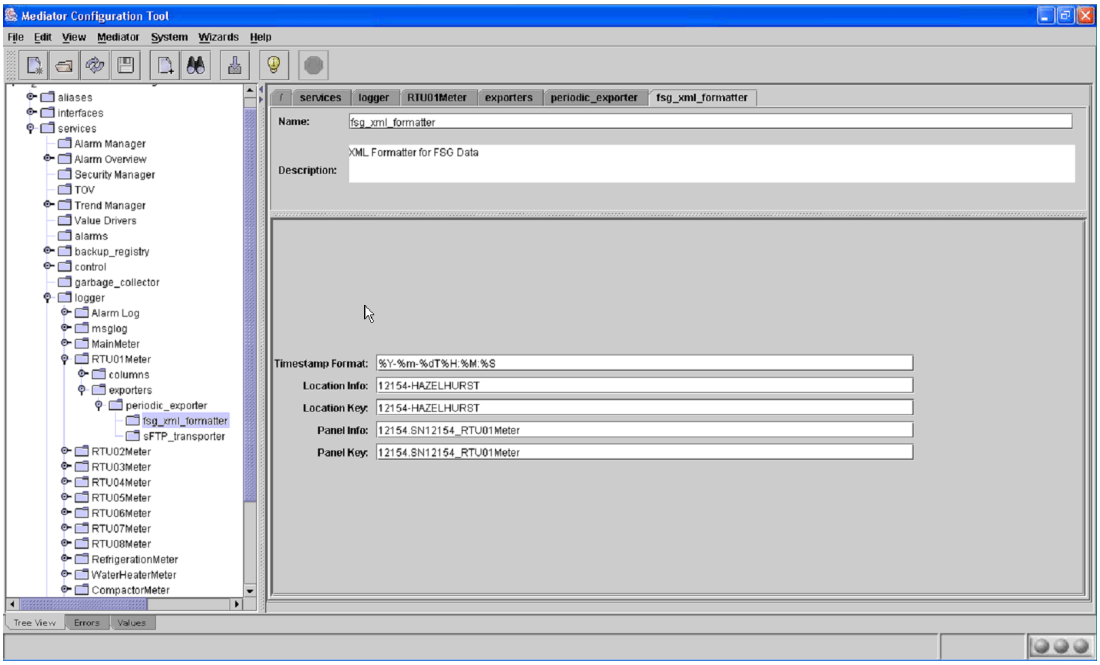


Step 19 Under the **periodic_exporter**, select the **fsg_xml_formatter** folder.

Step 20 Set the **Location Info** and **Location Key** data fields. These items must be unique to FSG and are often set to a unique store number and name relevant to the enterprise: [*StoreNumber-StoreName]*_[*MediatorID/Name*].

Step 21 Set the **Panel Info** and **Panel Key** data fields. These items must be unique to the location and are often set to the common device name alias [*StoreNumber*]_[*MediatorID/Name]*_[*DeviceID/Name]* (see Figure 7-9).

Figure 7-9 FSG Exporter - XML Location Info



Step 22 Change the timer, if a different export rate is desired.

This completes the steps necessary for creating an XML data export to FSG.

Data that is sent to FSG is normally collected by the database system at 15-minute intervals and assimilated for use. Once assimilated it is used to update reports and status pages used by building managers, compared against trend indicators and historical system function.

Case Study of a Large Retail Merchandise Chain

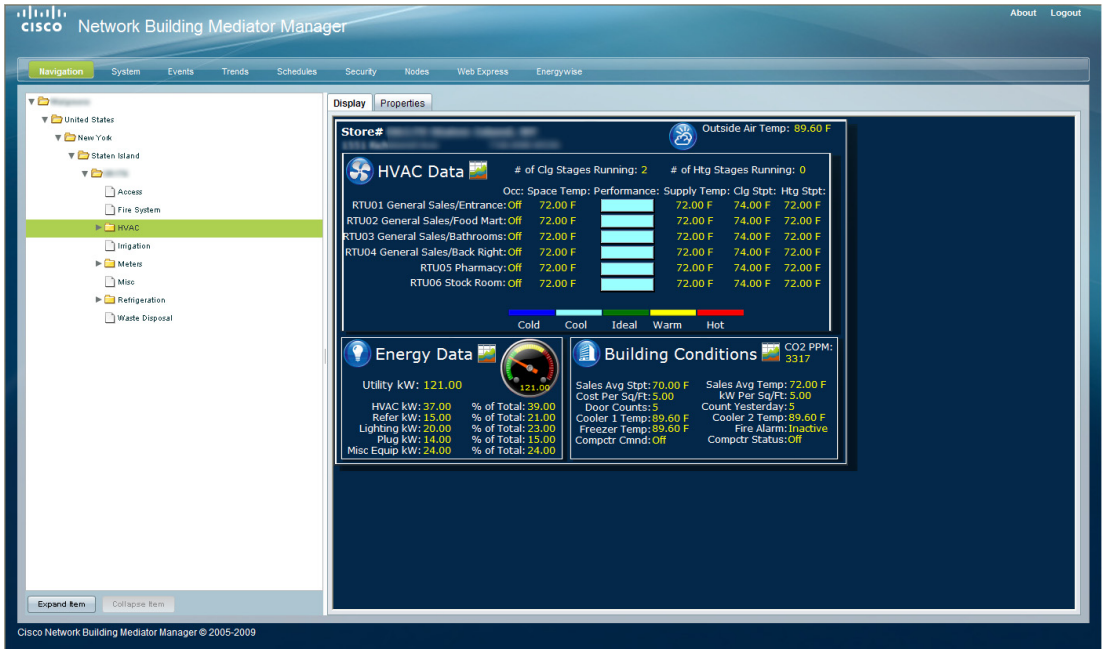
Revamped Stores

A large retail merchandise chain has set its expectations to save money through energy management. Green building techniques at this retail merchandise chain involve roughly 100 different environmental projects running concurrently. The large retail merchandise chain first partnered with General Electric (GE) back in 1968 where they began developing energy-efficient lighting for stores. Fluorescent ceiling lights alone saved $5.7 million a year in energy costs. Solar energy now provides 20 percent of the electricity needs in 52 stores of the large retail merchandise chain and two distribution centers, and LEDs illuminate store refrigerators. In May, the first store of the large retail merchandise chain with a green roof opened in Chicago. The roof is planted with heat and water-absorbing plants, reducing both heating costs and water runoff. Meanwhile, other environmentally friendly policies (reduced water consumption, more recycling of construction waste, designated parking for energy-efficient cars, and bike racks for customers and workers) all contributed to this large retail merchandise chain's selection to participate in

a pilot program run by the U.S. Green Building Council to help develop environmental standards for retail construction. the large retail merchandise chain used in this case study is the only drugstore chain among 70 retailers in the program.

In its ongoing efforts to conserve energy, the large retail merchandise chain partnered with Cisco Systems and Facilities Solutions Group to automate its store building systems in a more comprehensive and coordinated fashion to monitor and control building systems globally. See Figure 7-10.

Figure 7-10 WG-1 - HVAC Cisco Mediator



Cisco and FSG Pilot

The large retail merchandise chain pilot implemented systems to monitor and measure various systems throughout the store. Systems were connected to the Cisco Mediator as follows:

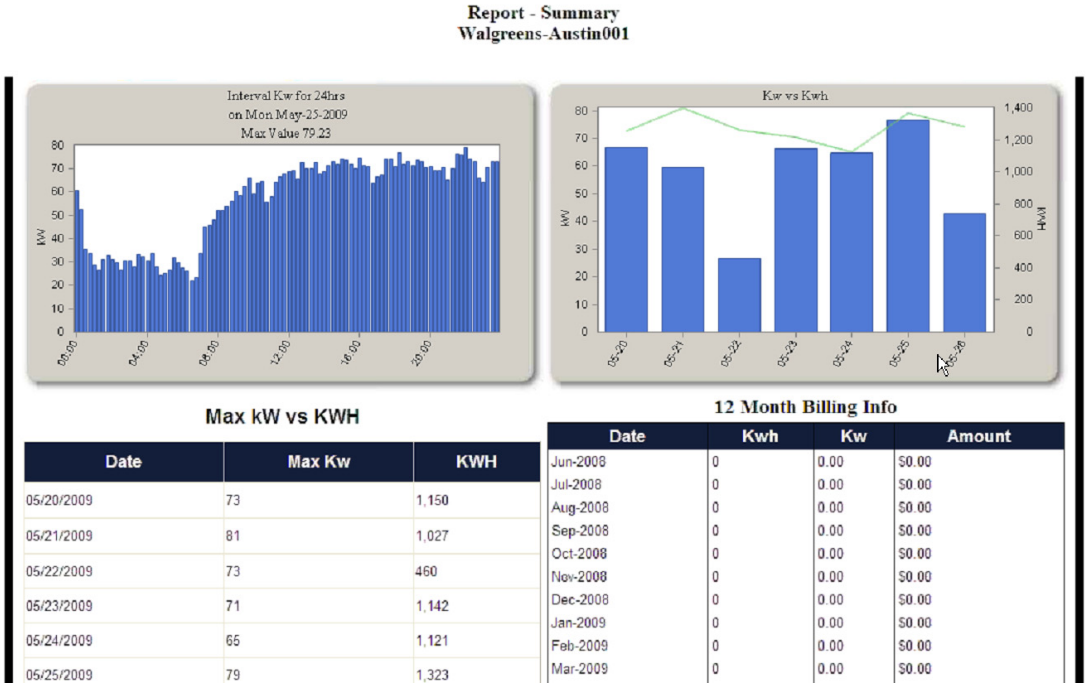
- HVAC rooftop unit (RTU) control systems and temperature sensors connected via BACnet
- Main incoming power lines via a SATEC BFM136 meter
- Refrigerators and freezers via DALLAS sensors
- Fire, sprinkler, and trash compactor systems via relays
- Lighting systems via a KMC BACnet controller

Savings Calculations for the Enterprise Energy Management System

The following items were used to calculate savings achieved in the pilot:

- FSG Energy Scoreboard usage data as shown in Figure 7-11
- Weather trend daily CDD and HDD data (from Austin Bergstrom Weather station)
- Calculation from Dr Haorong Li University of Nebraska

Figure 7-11 FSG Scoreboard Energy Collection Information



Date	Max Kw	KWH
05/20/2009	73	1,150
05/21/2009	81	1,027
05/22/2009	73	460
05/23/2009	71	1,142
05/24/2009	65	1,121
05/25/2009	79	1,323

Date	Kwh	Kw	Amount
Jun-2008	0	0.00	$0.00
Jul-2008	0	0.00	$0.00
Aug-2008	0	0.00	$0.00
Sep-2008	0	0.00	$0.00
Oct-2008	0	0.00	$0.00
Nov-2008	0	0.00	$0.00
Dec-2008	0	0.00	$0.00
Jan-2009	0	0.00	$0.00
Feb-2009	0	0.00	$0.00
Mar-2009	0	0.00	$0.00

Austin Texas—Large Retail Merchandise Chain Case Study Analysis for February

The HVAC systems were the initial focus of the analysis. They are often the largest energy loads of any building, providing the area of greatest return of effort. Each of the large retail merchandise chain stores uses six separate rooftop units (RTU) to maintain temperature through out the store. Each unit is typically controlled via a locally-zoned thermostat, independent of the other systems in the building. As the analysis in Figure 7-12 shows, these systems would often operate in opposing modes and not make use of economizer capabilities.

Figure 7-12 Analysis for February

					Economizer Potential		Simultaneous (Hours)	
		Off	Heating	Cooling	% of Cooling	Savings	Heat	Cool
RTU1	Cashier	53%	3%	44%	25%	56.78	0.3	43.9
RTU2	Sales	85%	13%	2%	16%	1.58	16.1	1.3
RTU3	Cosmetics	90%	0%	10%	27%	26.42	-	13.3
RTU4	Pharmacy	85%	6%	9%	24%	11.32	10.0	9.5
RTU5	Stock	73%	26%	1%	9%	0.15	34.3	0.1
RTU6	Photo Lab	98%	0%	2%	20%	1.40	-	0.9
		81%	8%	11%		97.65	19%	16%
							Savings	105.0

229087

The information gathered through comprehensive building system monitoring identified the following key problems:

- One or more RTUs were running on average 11 percent of the time
- The Cashier-zone RTU ran significantly more than the other RTUs mainly in cooling mode.

- The Stock-zone RTU ran much more in heating mode than any of the other RTUs.
- On average, the RTUs were in cooling mode 20 percent of the time where they could have been using outside air and had the compressors off, saving close to $100 for the month.
- Between 15 and 20 percent of the time, while the RTUs were running, there was another RTU operating in a different mode.
- In the main floor area covered by RTUs 1,2, and 3, RTU1 and RTU3 were often in cooling mode to balance RTU2 that was often in heating mode. RTU5 was also often running in heating mode when other RTUs were in cooling mode.

Tip Additional savings could also be realized through more advanced supervisory control implementation.

By integrating these HVAC systems into a comprehensive energy management system through the Cisco Mediator, coordinated control can be accomplished and significant savings achieved.

Total Annual Savings Projected and Measured

The following show the initial dollar cost savings achieved in the pilot:

- Total energy costs last year: $39,615.00
- Total kWh used last year: 455960 ($/kWh at .087)
- Savings for economizers and heat and cool coincidental loading: *$4,893.00/year*
- Savings for cooling loads:15 percent blended value of 306560 kWh during cooling season (March through October)
- Total HVAC savings: 45984 kWh saved; $4,000.60 saved (kWh at $.087)
- Combined annual savings: $8,893.60 ($4,000.60 + $4,893)
- Margin of error of saving overlap of staging and HVAC control is 20percent—Conservative 20 percent reduction
- Total savings is $7,114.88 (.8*$8893.60), a 17.96 percent savings annually.

Overall, the large retail merchandise chain in this case study reduced energy consumption by more than 30 percent in the Austin Texas Pilot store through monitoring and automated systems intelligence. To further validate sustainability, the large retail merchandise chain is extending its energy management solution from the pilot to a 500-store deployment.

Other retailers with Mediator deployments include the following:

- Circle K—Remote energy management deployment 300 stores
- Simon Mall—Automated meter reading of thousands of check meters for energy usages.

Other enterprise with Mediator deployments include the following:

- Google Campus —Energy control and demand response across entire campus. 25 percent reduction achieved.
- NetApp Campus—Automated demand response system from PG&E, system successfully shed 1MW in 10 minutes.
- Wipro Campus (India)—Converged systems management over IP

Summary

Reducing energy consumption in buildings can only be accomplished in a step-wise manner. The sustainability of an energy management system is based on the ability to integrate data from all of the systems in a building and intelligently control these devices together in a coordinated fashion. Cisco's Network Building Mediator provides access to all of the energy consuming systems within a building, normalizing this data and making it accessible to a broad range of applications and partners. Coordinated decisions and system programming changes can then be aggregated to efficiently operate the building as a whole. Building occupant behavior is also crucial to ensuring that energy reduction is sustainable. A comprehensive energy management solution is one that keeps building occupants informed about their impact on energy use and carbon footprint, while improving efficiencies in building operations and use.