CRESTRON

FUSION EM®
Design Guide

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Introduction

Fusion EM® is a complete energy management software solution for organizations of any size. From school districts to corporate offices and hotels, Fusion EM tracks the carbon footprint of an organization while providing the ability to easily analyze energy consumption and manage a facility. Fusion EM can also save energy by automatically turning off lights and reducing HVAC use in unoccupied spaces.

Key Features

- **Complete Control of an Entire Facility**: Fusion EM provides control of lighting, shades, heating, and cooling for every room or area in a facility. The rich graphical user interface organizes each room or area into a tree-like hierarchy that can be customized to reflect the physical or logical order of an organization. The user can change scheduled events, rules for meeting times, climate set points, lighting scenes, and shade levels for occupied and vacated states.

- **Energy Tracking**: Fusion EM tracks all the lighting loads and is capable of tracking real-time and historical energy consumption. The program provides the ability to view real-time and historical energy usage by day, week, month, or year. Compare numbers from the previous time period and project future consumption by viewing future time periods. Fusion EM takes advantage of real-time data collected by Crestron® GLPP, GLPAC, and GLS-EM-MCU or other energy metering devices. It can also estimate energy consumption based on the lighting fixture and current lighting level or scene.

- **Demand Response Control**: Demand response settings call upon predetermined rules that are followed during peak consumption to cut down energy usage by a facility. Fusion EM makes it easy to set these rules. Quick adjustments can be made to heating and cooling set points, timeout settings for unoccupied rooms, and brightness settings for lighting levels. When the demand response mode is activated, Fusion EM ensures that each room is overridden according to the demand response settings.

- **Meeting Automation**: Fusion EM allows for room preparation. Pre-meeting settings can be adjusted easily from the intuitive graphical user interface (GUI). Drop-down menus provide temperature set points and lighting presets—simply make a selection then choose how many minutes before the meeting the settings should take effect. If the meeting is cancelled, there is no need to notify the room. Once occupancy is undetected after the timeout period, the room automatically returns to the vacated state.

- **Reporting**: Fusion EM reports on historical energy consumption by source and by day, week, month, or year in a way that reveals the peak energy consumption of the space, room, and energy category level. Compare data to previous time periods and energy baselines. Crestron Fusion® reports enable intelligent data-driven decisions, leading to more effective planning and forecasting. Custom reports may be added upon request.

- **Global Control**: Fusion EM allows global adjustments to be made to every room in a facility. Change the occupied and vacant settings, pre-meeting rules, end of day events, and demand response for the floor, building, or even the entire campus. Alarms are sent to the facility manager to alert them of a failure condition, which enhances the way the network is managed.

To fully utilize Fusion EM, the software requires communication with various building and control systems. It is important to keep the following communication requirements in mind during the Fusion EM design process.

- The Crestron control systems (energy, lighting, and A/V), housed in the building, need to be connected to the building's LAN.

- The program that runs each system needs to include Fusion EM programming objects that facilitate communication with Fusion EM.

  NOTE: Fusion EM programming objects are different than Fusion RV® objects.

- The Building Management System (BMS) of the facility needs to communicate with Fusion EM. The BMS integrates with the HVAC system of the facility. Control and monitoring of other building systems, such as security access, may also be required. Integration with the BMS of a building can be accomplished in a variety of ways and depends on the command protocol used.

Refer to the Crestron website at www.crestron.com for Crestron Fusion EM and GLS-EM-MCU Power Metering Unit Construction Specifications Institute (CSI) documentation.

For a list of Crestron Fusion EM related terminology, refer to "Appendix A: Glossary" on page 28. For a list of frequently asked questions regarding Fusion EM software, refer to "Appendix B: Fusion EM FAQs" on page 29.

Audience

This design guide was written for system designers and specifiers and provides detailed information on the hardware, software, infrastructure, and programming that is required for the successful deployment of Fusion EM software. This design guide is to be utilized as a reference source.

Deployment Model

When integrating Fusion EM software in a facility, the sequence of events varies depending on whether the software is to be part of a new construction project or added to an existing system (retrofit).

New Construction Project

If installing Fusion EM as part of a new construction project, refer to the Crestron recommended sequence of events below:

1. Review the physical construction of the building.

2. Install and commission Crestron lighting systems. Fusion EM programming objects must be included in the lighting control programs.

3. Install the electrical monitoring and metering hardware (Crestron or other). In some cases monitoring is performed by Crestron lighting control hardware. Refer to "Lighting" on page 11 for more information.

4. Install the building LAN and WAN.

5. Install the Crestron A/V systems. Fusion EM programming objects must be included in the A/V control programs.

6. Bring the BMS system online and integrate with the Crestron control system.

7. Install the Fusion EM server computer and commission the software.

Retrofit Project

If installing Fusion EM as part of a retrofit project, refer to the Crestron recommended sequence of events below:

1. Add power monitoring hardware (Crestron or others) to the electrical system.

2. Estimate the energy use through programming changes.

3. Revise or rewrite programs for Crestron lighting control systems to include Fusion EM programming objects.

4. Revise or rewrite programs for Crestron A/V control systems to include Fusion EM programming objects.

5. Integrate Crestron devices with the BMS (if not already done).

6. Install the Fusion EM server computer and commission the software.

7. Add occupancy sensors to the existing systems (if practical).

It is best to take an incremental approach to the deployment of Fusion EM in a retrofit project. The end user may be skeptical about the advantages of energy monitoring and new automation techniques in an existing facility. A proof of concept test case can be helpful in this situation.

Most office facilities have a schedule for upgrading and refurbishing rooms in existing buildings. When a meeting room is scheduled for refurbishment, suggest the following actions to the customer.

1. Identify the electrical circuits that feed the new room along with those that feed the existing room of similar size. It is important to identify lighting circuits and electrical outlets, which power the room's display and equipment rack. The goal is to get an accurate reading on the total energy used in each room.

2. Install a GLS-EM-MCU (or two) to track the electrical usage in both rooms.

3. Install the updated A/V and lighting system in the new room. This updated system should be equipped with an occupancy sensor, lighting control (GLPP and GLPAC devices are useful in retrofits of this type), and A/V control. A scheduling panel installed outside of the room and HVAC control are additional features to consider.

4. Install the free version of Fusion EM (free for up to five rooms) and configure it to monitor both the old and new rooms. Integrate the room scheduling for the new room with the customer's scheduling system.

5. Use the Automation feature and other tools to optimize the room's performance.

6. Once the new room installation is complete, run the room for a few weeks and then compare the energy usage in the new room equipped with Fusion EM against the old room.

A comparison of the power usage in the new room versus the old room should show significant energy savings. Once the end user acknowledges the advantages of the new design, a strategy can be developed to bring other areas of the building online as they are refurbished.

Fusion EM System Overview

The example below shows how Fusion EM can provide control for an entire facility.

Fusion EM System Overview Example
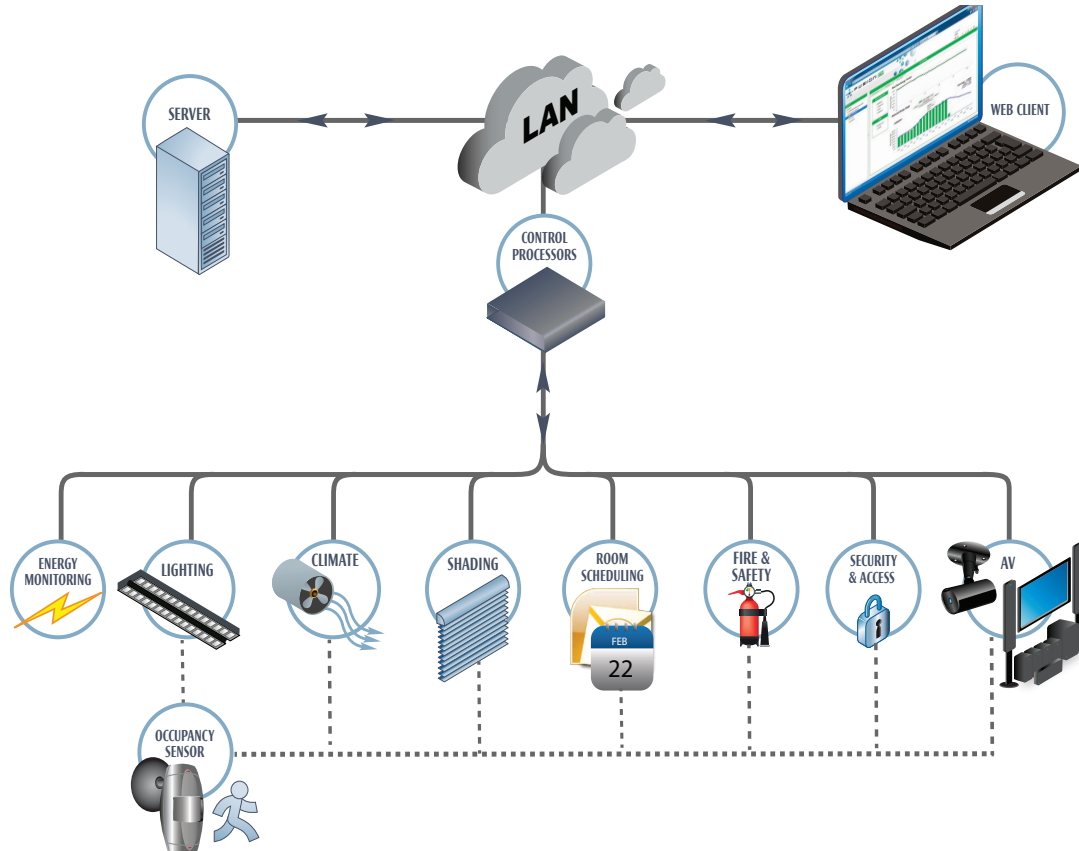
Energy Monitoring

The energy tracking ability of Fusion EM can be used to evaluate the effect that different automation rules, such as time clock schedule, HVAC settings, occupancy sensor settings, etc., have on overall energy use. Data can be evaluated so that building systems can be set up to be as energy efficient as possible. The end user should be involved during the design process to determine the goals for energy tracking. Discuss with the end user how electricity use is monitored so that data can be properly gathered for lighting and HVAC on individual building systems.

Monitoring Strategy

The types of energy being tracked need to be identified. If the facility is tracking electrical usage, it is important to determine the details of the energy being monitored. If the facility is tracking the total energy use of the building, the main panel electrical feeds to the building are the only components to meter.

Main Panel Metering Example
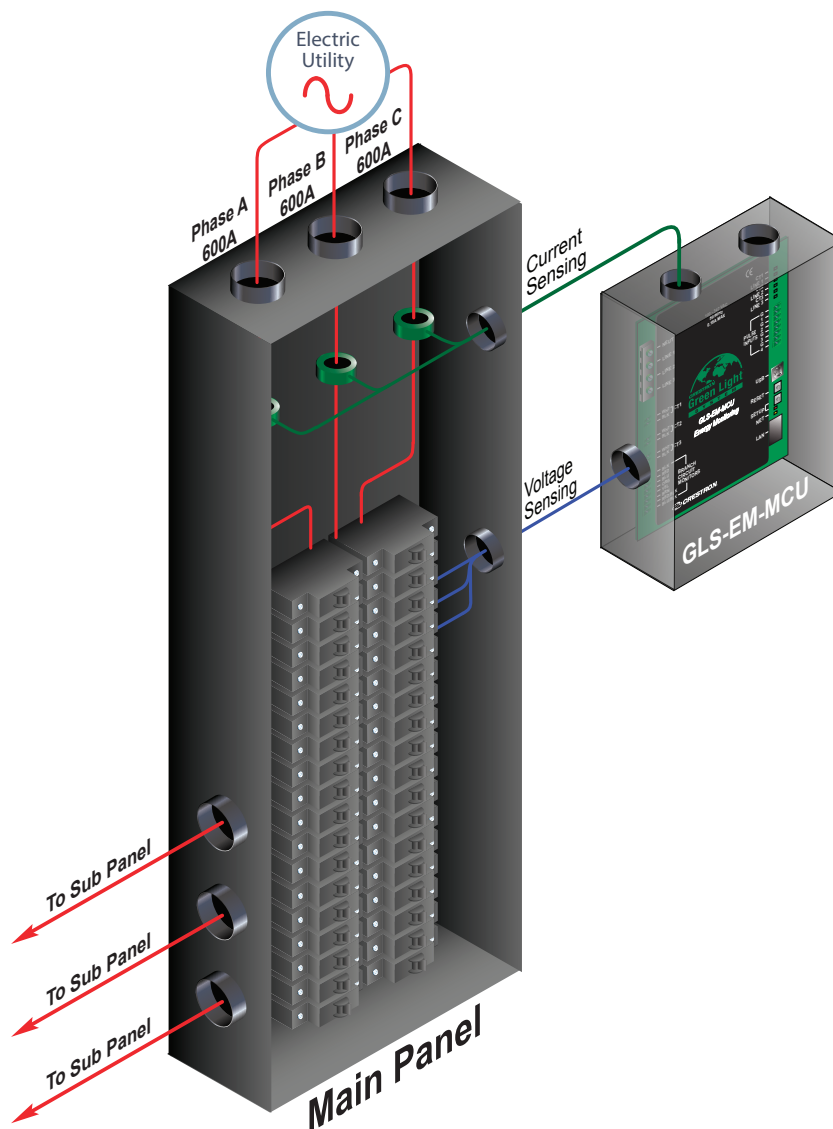
DIAGRAM NOTE: For greatest accuracy, the GLS-EM-MCU should be connected to each of the three phases directly by dedicated breakers in the panel.

The Crestron GLS-EM-MCU can be used to track total building power usage by monitoring the main electrical feeds from the utility. Many modern buildings receive electrical power from more than one source. Some facilities are equipped with renewable energy from solar or wind generators. If local generation is part of a facility's electrical source, it is suggested that it be monitored separately from the grid energy supply. Data on how much of a building's energy comes from the grid and how much comes from renewable sources can be gathered to demonstrate how green the building is.

Another energy tracking approach is to monitor the amount of electricity used by specific systems within the building. Some customers want to track the electrical energy used by systems such as lighting, HVAC, mechanical systems, and electrical outlets. This type of tracking assists the facility manager in understanding how different automation settings affect specific systems. For example, changes in the building's shade settings can be compared with HVAC electricity usage to determine if the shade settings generate energy savings.

It is useful to look at the energy consumed by lighting, electrical outlets (plug loads), and HVAC system components. For example, data on the extensive use of energy from electrical outlets may indicate that building residents are making use of space heaters. The facility manager may then decide to adjust public area HVAC settings to eliminate the need for such devices.

A look at the electrical panel schedule of the building helps determine how practical it is to monitor individual systems. If possible, the building's electrical engineer should be encouraged to group feeds to similar systems into the same electrical panel to make targeted monitoring easier. Electrical panels can be monitored by their main feeds and by specific breakers depending on the detail needed in the usage report. A renewable energy panel meter example is shown on the next page.

Renewable Energy Panel Meter Example
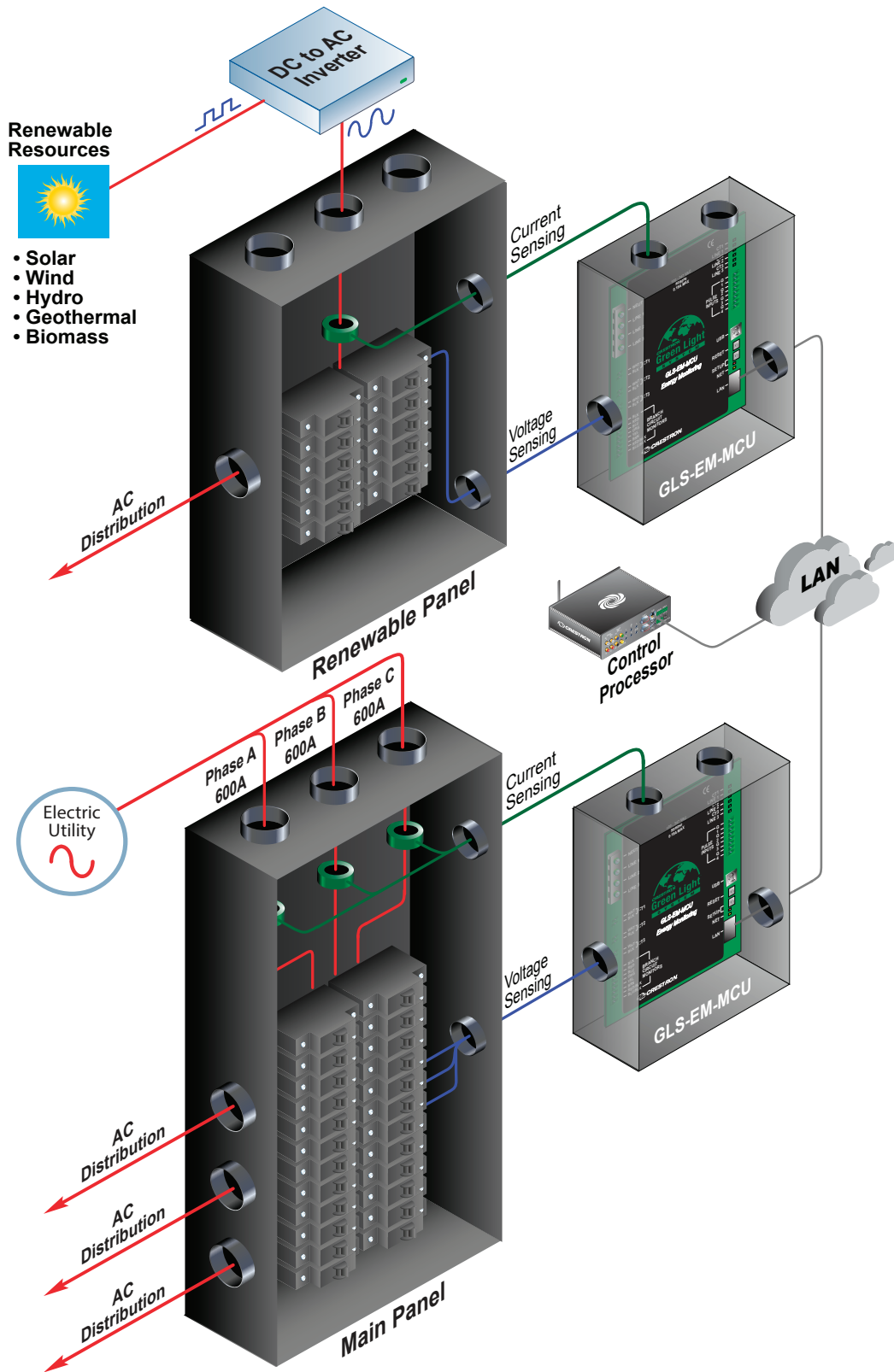
Sub-Metering by System Example 1
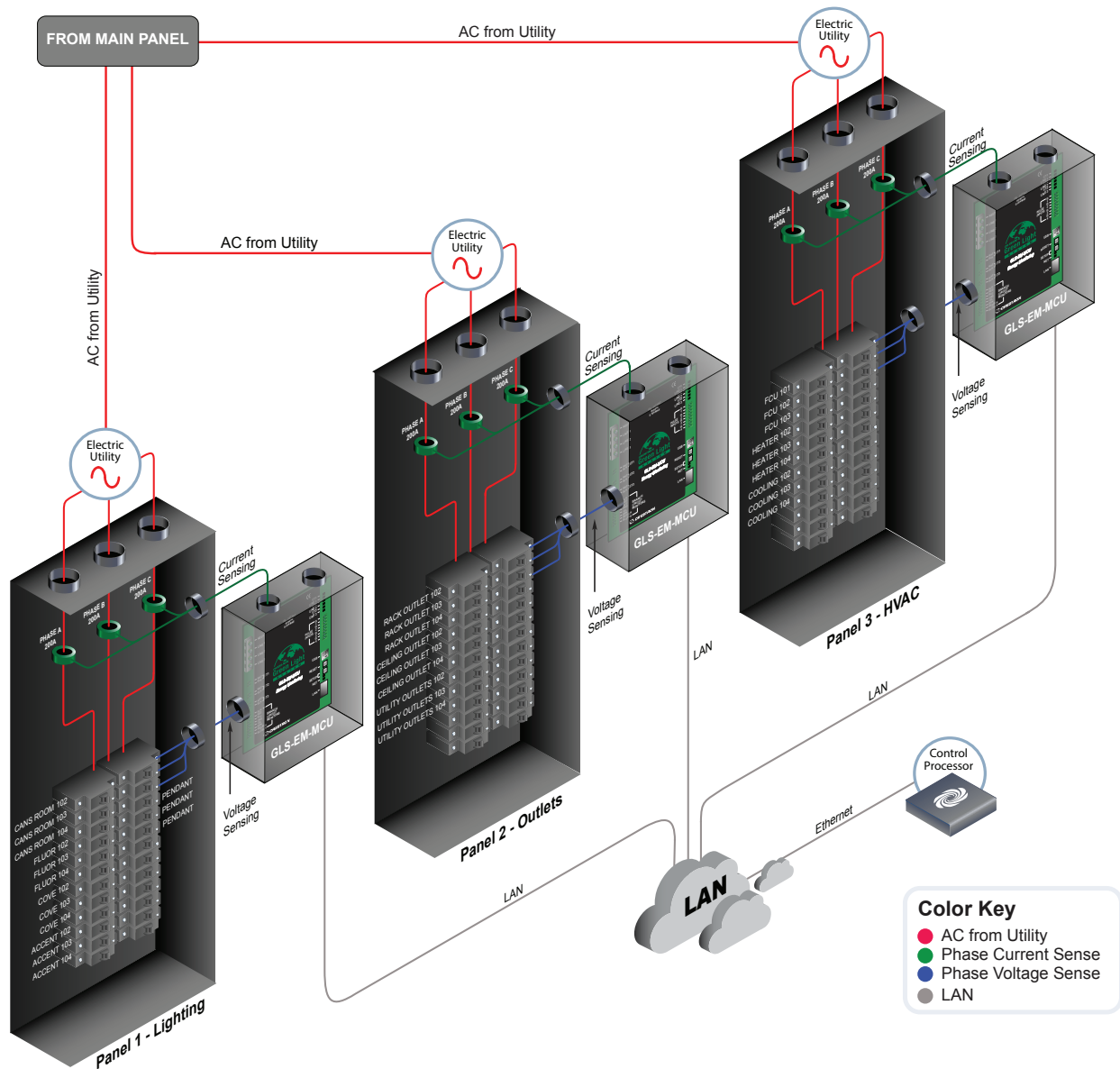
DIAGRAM NOTE: When electrical loads for particular building systems such as lighting, electrical outlets, and HVAC components are grouped together in the same electrical panels, sub-metering is easy. The main feeds are metered to each panel.

Sub-Metering by System Example 2
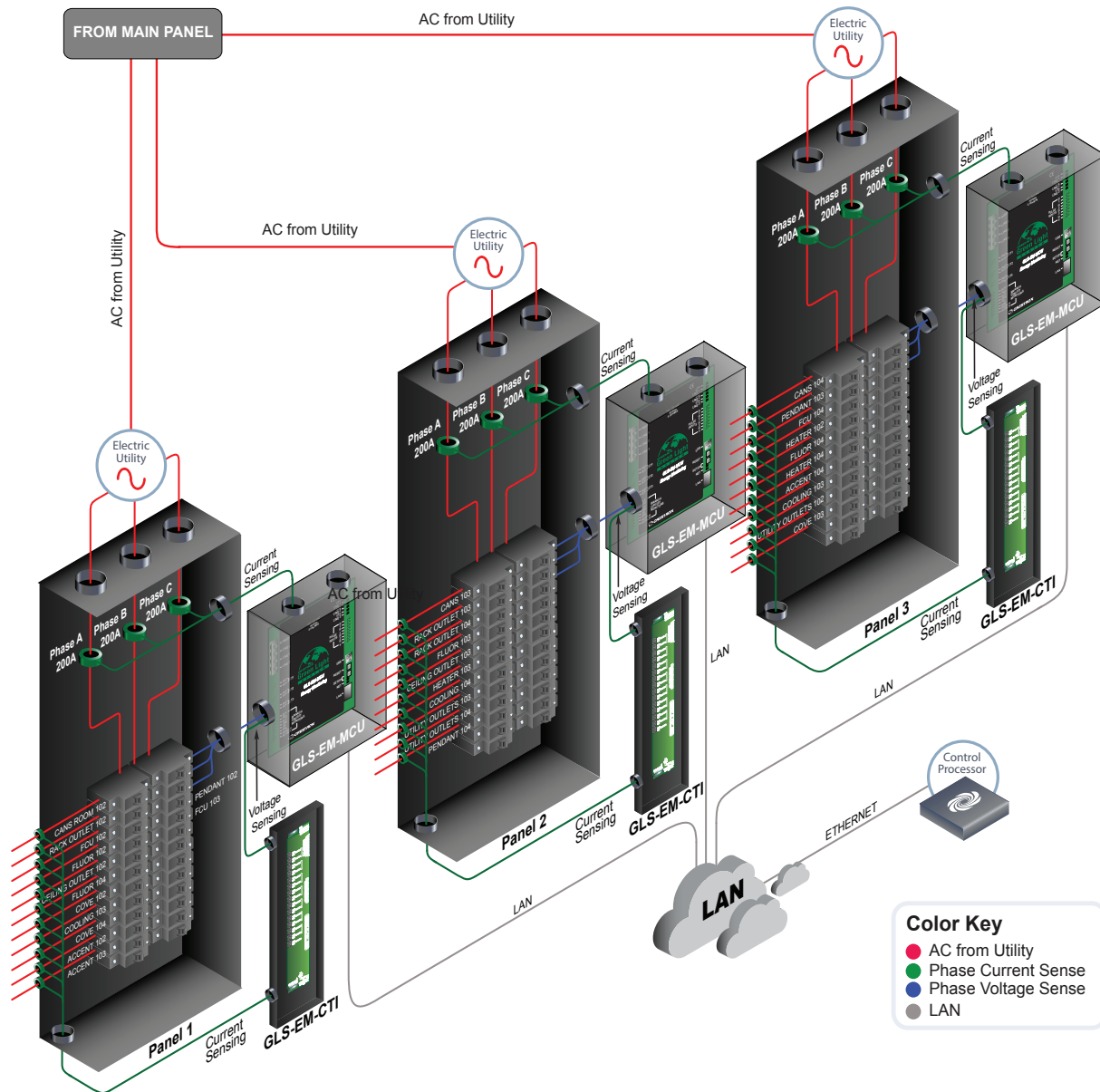
DIAGRAM NOTE: When electrical loads for the building system are randomly assigned in breaker panels, it becomes necessary to monitor individual circuits. This requires current transformer interface (CTI) boards for the GLS-EM-MCU along with multiple smaller current transformers (CTs) to meter individual circuits.

Another approach is to look at energy usage on a per-room basis. This strategy is especially suitable in retrofit applications. To track electrical use in a particular room, the circuits can be monitored via a GLS-EM-MCU or with one of the Crestron Power Monitoring (PM) lighting control systems such as the GLPP-PM. The Crestron PM component can report power usage to the room's control processor. The data from the control processor is then passed over to Fusion EM for monitoring.

Monitoring Methods

Data on energy usage can be gathered by a variety of methods. Many projects require a combination of methods to cover the full monitoring needs. Crestron recommends determining the method based on the overall building's electrical design. The best (or most accurate) electrical monitoring method is to measure both the current and voltage. A metering method that assumes voltage is being consumed at a constant 120 volts introduces some error in tracking energy because voltage actually varies considerably. A meter that monitors both voltage and wattage produces a much more accurate reading of electrical usage.

Another method of electrical monitoring is tracking wattage, which assumes a constant 120 volts and is often less expensive than the other methods. This method of tracking is built in to the PM versions of several Crestron dimming devices like the GLPAC-DIMFLV4, GLPAC-DIMFLV8, GLPP-PM, and DALI® PM ballasts.

Crestron offers an energy monitor called a GLS-EM-MCU that tracks both voltage and wattage and provides a more accurate reading. A GLS-EM-MCU is connected to an electrical panel and monitors its main feeds. It can also monitor individual breakers. This device reports data to a Crestron Control Processor (CCP) via Ethernet. Refer to the previous pages for energy monitoring examples.

A number of manufacturers offer electrical panels that perform their own monitoring. This data can usually be accessed from a standard building automation protocol like BACnet® IP Support or Modbus®. Crestron offers several methods to communicate with these types of systems:

- Direct BACnet IP communication to Crestron 3-Series Control System®
- GLA-BMS for Modbus, LonWorks®, and Metasys® (via Ethernet communication to a Crestron-controlled processor)

Data from these devices can be mapped into Fusion EM and used to track energy usage.

BACnet IP Integration

Crestron 3-Series® control processors can communicate directly with the BACnet IP protocol. Data from building systems, such as power monitors that offer BACnet IP communication, can be routed through a CCP. Fusion EM can access this information from the processor.

BACnet IP Integration Example
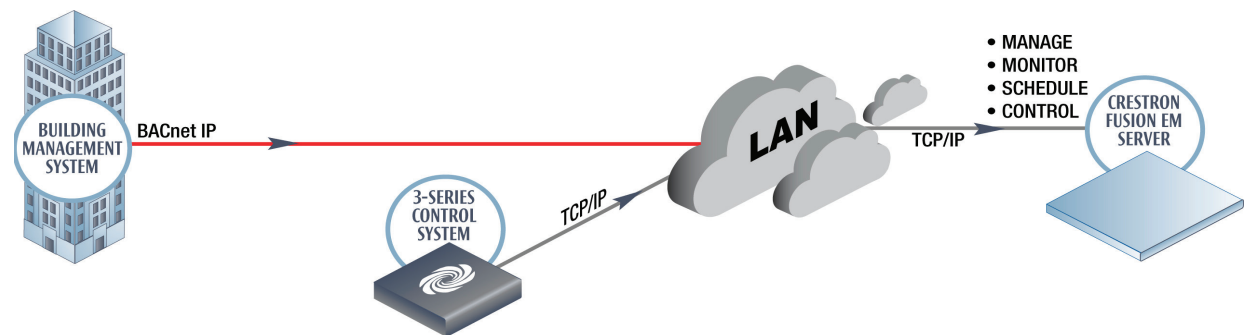
Estimated Energy Usage

Fusion EM is equipped with its own electrical usage estimator for tracking electricity. When Fusion EM is set up, data on wattage, type, and quantity of fixtures for each lighting circuit can be loaded into the program. Based on known wattage, lighting levels, and time, Fusion EM can create estimates on the amount of electricity used by lighting in each room. This method is not as precise as using the GLS-EM-MCU but can still assist in tracking usage trends. Depending on the end user's needs and budget, multiple methods can be combined to provide a complete picture of the building's energy use.

Modbus, LonWorks, and Metasys Integration

Devices that communicate via BACnet MSTP (serial), Modbus (IP or serial), Lonworks, or Metasys require a GLA-BMS translator unit. This device is used to translate communication from building management protocols into digital and analog joins to be read by a CCP (2- or 3-Series). Information from the control processor is relayed to Fusion EM.

Modbus, LonWorks, and Metasys Integration Example

Lighting

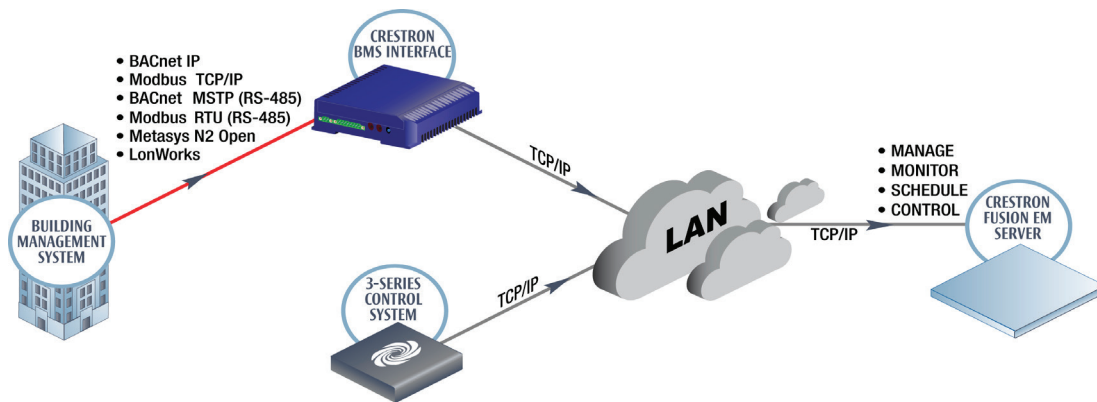Lighting is a critical component of any facility. Proper illumination is important in a school or work environment and creates a sense of security for the building's occupants. However, lighting uses a great deal of energy. A properly designed lighting system with photocells and occupancy sensors should not need adjustments from building management. However, if necessary, easy-to-use software that sits on top of a building's lighting system allows facility managers to adjust rules for comfort and efficiency. When rules are not set properly, lighting is often left on in empty and unused rooms and building occupants can be left in the dark when working during off peak hours.

Use Fusion EM to improve lighting efficiency in the following ways:

- Utilize the time clock adjustments to enter lighting and motion sensor rules.

- Use energy monitoring data and reports from building occupants to specify settings that allow for maximum comfort and efficiency.

- Use room automation rules to allow data from room schedules to be added to occupancy data to make sure that empty rooms are not illuminated unnecessarily. Set lighting cues to anticipate room use by a few minutes so that people are not walking into a dark meeting room.

- Set rules to allow the occupancy sensor to make sure that a room is actually occupied according to a schedule. If a room shows that it is empty after a reasonable period of time after the scheduled beginning of a meeting, the meeting is cancelled and the room reverts to its unoccupied settings.

Crestron offers a variety of lighting control products. The choice of control products depends on the type of project (new construction or retrofit) as well as the preferences of the building's lighting designer.

The Crestron line of architectural lighting products is most appropriate for new-building construction or for full-scale renovations. This product line provides centralized control of all major types of dimmed and switched fixtures. When designing a lighting system, a centralized approach provides the best and most cost-effective way to manage energy.

In retrofit or renovation jobs, Crestron's room solution products usually are the appropriate fit. Whether a project calls for the reconstruction of a room or the replacement of existing in-wall light switches with remote controlled units, Crestron can provide the appropriate hardware. Fusion EM can be implemented in stages as the rooms within a building are renovated. Lighting control can be added to a facility on a room-by-room basis.

Occupancy Sensors

Occupancy Sensor Integration Example
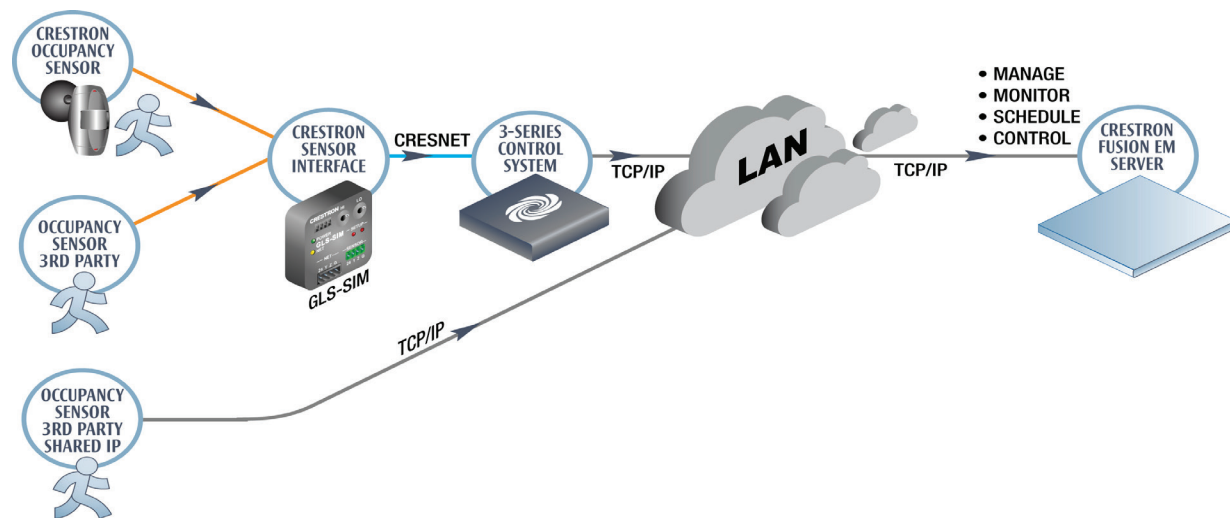
Occupancy sensors are essential if the full energy-saving capabilities of Fusion EM are to be utilized. The best way to be sure that lighting and other energy-consuming devices are turned off when rooms are not occupied is to use occupancy sensors.

The Crestron approach is to connect occupancy sensors to Crestron control equipment to allow conditional logic to be applied for the sensors' use. The conditions that determine what equipment is on or off are varied and include time of day, holiday or normal schedule, day of week, and room schedule.

Normally, lighting is not left on in unoccupied areas, but for reasons of security and comfort, there may be public areas in a building that should remain illuminated even if not in use. For example, corridor lighting in a hotel meeting room area may be left on during normal business hours but set to occupancy sensor mode overnight or when meetings are not scheduled.

Data from occupancy sensors can be leveraged with scheduling software to help regulate a room's automation. Crestron offers a variety of occupancy sensors that can easily connect to control systems. In a room that does not have a control system, an occupancy sensor can be connected to the room's scheduling touch screen. GLS-OIR sensors use infrared light to track motion. GLS-ODT sensors combine ultrasonic with passive infrared to track motion. This dual technology approach cuts down on false readings. Crestron offers a variety of occupancy sensors. A few examples are shown below.

GLS-OIR-C-CN   GLS-OIR-C-1500   GLS-ODT-C-2000

Use Crestron for lighting as well as A/V control to allow multiple systems to share the same occupancy sensors. Data from sensors that are connected to a lighting control processor can easily be shared with A/V control processors and with Fusion EM software.

Because occupancy sensors are closely associated with lighting systems that are generally installed before other building systems, Crestron recommends that occupancy sensors be included in the base lighting design for a room or building. To reduce false readings, careful placement of the sensor should be taken into consideration. Sensors should not be placed near a door where a passerby may falsely set it off. Sensors should be placed in a space that is intermittently occupied (unoccupied for two or more hours per day) and where the lights are typically left on when the space is not occupied. Some examples of appropriate applications are offices, classrooms, copy rooms, bathrooms, storage areas, conference rooms, and break rooms.
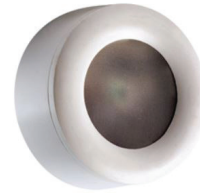
Photocell Sensors

Photocells are sensors that detect the presence or absence of light. Most photocells used in commercial lighting systems read the amount of light or illumination level in a space.

Crestron offers a variety of interior and exterior photocells such as the Crestron GLS-LOL and GLS-LCL photocell sensors.

GLS-LOL   GLS-LCL

In a daylight harvesting application, target illumination levels are determined for areas in the building. Photocells are used to determine light levels where natural light from windows or skylights is present. The photocell reads the amount of natural light and adds artificial light (via dimmers or switches) until the target illumination is reached.

A photocell can also remove artificial light (by dimming-down or shutting loads off) if the target illumination is exceeded. Daylight harvesting settings are adjusted using the individual lighting control processors and operate independently from Fusion EM.

The quantity, location, and type of photocells needed for an application varies. The building's position, orientation, and shadows created by adjacent buildings or landscape features should also be considered. Once a thorough review of the building and its surroundings has been completed, it can be determined if photocells are needed on the exterior and interior of a building.

Climate

HVAC typically uses the largest amount of energy in a facility. Thousands of dollars are wasted daily on heating and cooling empty spaces. While some HVAC systems include occupancy sensors, only Fusion EM is equipped to interface with room schedules and other systems. Fusion EM controls HVAC systems and lighting in the same way.

There are several ways that HVAC systems can be integrated with Crestron control systems. Crestron offers a large selection of thermostats (wired and wireless) that can be utilized. These devices work on 24 volt relays and are designed to work with the type of HVAC systems most often found in homes and hotel rooms. Some low-tech Variable Air Volume (VAV) and Fan Coil Units (FCU) that are used in commercial spaces are compatible with this type of thermostat, but many commercial systems require a different approach.

Many commercial HVAC systems can communicate using standard building automation protocols such as BACnet IP. Once communication has been set up between the HVAC system and the Crestron system, the Crestron system reads and changes set points. It is important for a building's mechanical engineer to understand that the Crestron system does not replace the BMS system; it simply reads set points and changes them according to preset conditions. Crestron can also interface with BACnet serial, Modbus, and Metasys protocols.

Once control of the HVAC systems is established, Fusion EM can manipulate them in the same manner as other building systems. HVAC systems can be scheduled like other devices and can share data from Crestron occupancy sensors to trigger empty room setbacks.

The automation controls of Fusion EM are especially useful for HVAC settings. Systems that rely only on occupancy sensors generally do not begin heating or cooling a room until it is occupied. Fusion EM allows facility managers to set rules to allow for heat up or cool down time before a scheduled meeting. If these rules are set properly, meeting rooms are always comfortable when attendees arrive. If it is determined that a particular room needs more time for heat up or cool down, it can be easily adjusted.

Shading

Crestron Shading Solutions utilize quiet, precision-controlled Quiet Motor Technology™ also known as QMT™. The Crestron QMT motor is housed inside the roller shade assembly and controls movement and adjusts the shade to the desired preset positions. Shade deployment and positioning can have a profound effect on the energy used to heat or cool a space. In cold weather months, shades may be left open to allow sunlight to warm building spaces. In warmer months, shades may be kept closed to minimize the sun's heating effects and keep the room cooler. Shading systems can be programmed to account for the building's location and the position of the sun.

Crestron provides three different types of fabrics that can help minimize glare and harmful UV rays. These fabrics provide outward visibility, privacy, or even completely block out all sunlight from entering a room. By adding shade control to Fusion EM, an additional level of shade automation is provided. Shade position adjustments can be part of the facility's timed events.

Crestron also offers solutions for controlling third party shade motors for projects where the shades are already installed. Some of these solutions include RS-232 control of shade motors, contact-closure triggers, high and low voltage bidirectional motor controllers, and BACnet interface to a shading control system.

Room Scheduling

Most large enterprises use room scheduling software to help manage their rooms. Fusion EM allows popular scheduling software packages such as Microsoft® Exchange Server with Microsoft Outlook®, Google Calendar™, Lotus Notes®, and CollegeNET® R25® to be integrated with the building's critical systems such as lighting, HVAC, and A/V.

Scheduling integration in Fusion EM adds value in several ways:

- Scheduling data can be combined with information from occupancy sensors to minimize the electricity wasted in empty rooms. Fusion EM allows the user to create occupied and scheduled rules for room systems. For example, HVAC can be set up to either heat up or cool down an empty room for a designated period of time prior to a scheduled meeting.

- Rules can be set up for lighting and A/V system presets based on scheduled meetings. Rules can also be set up to cancel a meeting if a room is not occupied after a meeting was scheduled to begin. Once the meeting has been cancelled, it is removed from the schedule. If a room is determined to be empty, the software reverts to the presets established for empty rooms (lights and A/V system off and HVAC setback).

- Scheduling panels such as the TPMC-4SM can be mounted outside of each meeting room. The scheduling panel shows lights that indicate whether a meeting is currently scheduled for the room. The room's schedule for the day or week can also be displayed. This panel can also be used to schedule ad hoc meetings in a room. The data on ad hoc meetings scheduled from a panel is refreshed to the scheduling software and the meeting is displayed to all users.

Fire and Safety

Fire and safety systems are independent of other building systems and need to function when other systems fail. Building codes do not allow other systems to take control of fire and safety systems. However, fire and safety systems can send alarms to other systems either via RS-232 communications or simple contact-closure signals. Fusion EM can monitor alarms so that building administrators are notified. If the fire and safety system is connected to a CCP, these alarms can be monitored by Fusion EM.

Through control system programming, system commands can also be associated with alarms. A typical scenario would be to mute all building projector and room audio during an alarm so that building occupants are able to clearly hear the alarm and any emergency announcements. Lighting systems can also be triggered to provide full illumination to all critical exit areas.

Security and Access

Security systems are not always integrated with a Crestron control system. Some real advantages can be gained by integrating the facility's security and access system with a CCP. Integration generally requires communication (via RS-232 or Ethernet) between a CCP and the security system or using RFID readers. Once communication is established, data from the system can be used to trigger control system actions (such as lighting a pathway at night). The control system can also be programmed to allow authorized individuals access to a building using a touch screen, iPad®, iPhone®, or Android™ device.

Audio Visual Systems

Crestron Fusion adds another level of automation to A/V systems. A/V systems usually contain their own control processor and user interfaces. When A/V systems are connected to Fusion EM, they can be controlled, monitored, and scheduled from Fusion EM. Meeting rules and other scheduling features can be used to make sure that A/V systems are not left on when they are not needed.

A/V systems are usually monitored by a facility's A/V or IT department using Fusion RV software. However, building administrators need to keep track of A/V systems along with lighting and HVAC. By adding critical aspects of A/V systems to Fusion EM, building administrators can make sure that the A/V systems are up and running for their end users.

Server Requirements

Crestron Fusion software requires a server. The server (CEN-FUSION) can be purchased from Crestron and loaded with Fusion EM, Fusion RV, or both Fusion RV and EM and other necessary software. However, many users prefer to provide their own computer and load Fusion EM themselves. The minimum client, server, database, and control system requirements are listed below:

Minimum Client Requirements

- **Platform and Operating System**: Mac® running OS X®; or PC running Windows® XP SP2, Windows Vista®, or Windows 7 or later with 10/100 network interface card (NIC)
- **Memory (RAM)**: 512 MB RAM (2 GB recommended)
- **Network Interface**: 10/100 Ethernet
- **Screen Resolution**: 1024x768 or higher

Minimum Server Requirements

- **Operating System**: Windows Server® 2008 R2 (32- or 64-bit) or Windows Server 2012 (64-bit)
- **Processors**: 2 Dual-Core Intel® Xeon® 2.8 GHz
- **Memory (RAM)**: 8 GB
- **Disk Drive**: 250 GB or as recommended by Microsoft for the chosen operating system
- **Network Interface**: Gigabit Ethernet
- **Display Resolution**: 1024x768 or higher

Minimum Datatbase Server Requirements

- **Operating System**: Windows Server 2008 R2
- **SQL Server Version**: SQL Server 2008 R2
- **Processor**: 1 Quad-Core 3 GHz
- **Memory (RAM)**: 16 GB

Control System

- Crestron 3-Series or 2-Series control system(s) with Ethernet interface

Network Best Practices

Although the best practice calls for a dedicated machine, it is typical to run the Fusion EM application on either a dedicated machine or in a virtual environment. The initial specification for a virtual machine should be set as follows:

- 4 GB RAM
- 100 GB Hard Disk
- 2 Core

Fusion EM can have up to 750 connections per server. The connections may represent a room, load, zone, panel, circuit, energy supply, etc. as determined by the programming. The architecture is scalable, so if there is a need for more than 750 connections, additional servers can be added. Additional servers also provide load balancing and failover.

Distributed Servers

Customers are no longer limited to only one server to manage the entire database. Multiple servers can be deployed at the same location or in different locations connected to one database supporting one installation.

Installing additional Crestron Fusion servers locally provides the benefit of maintaining short network connections to processors, which reduces network traffic and volume. Optional local logging can be used to help manage network traffic.

Load Balancing

Load balancing provides a means for a server to know the amount of connections to manage and only applies to installations with more than one server. One server in an installation manages 100% of the connections. Two servers in an installation can each manage 50% or anywhere from 30% to 70% if one server is significantly more powerful than the other. Each server can be weighted according to horsepower. Servers belong to server groups and all servers in one group divide the rooms among themselves according to server weight. In addition, servers can be reallocated among groups as necessary and be dynamically rebalanced when a new server is added.

Failover Support Between Servers

Servers in a group can act as failover support for each other. Servers must have some unused room capacity in order to provide failover support for other servers. If one server is offline, Fusion EM still runs with the remaining servers. Rooms will temporarily go offline while being reallocated to other servers in the group. Servers in different groups cannot failover for each other. Fusion EM still runs as long as one server remains online.

Server Environment

The location of the server must be taken into consideration if purchasing a CEN-FUSION series server. The server should be installed in a proper server environment, which includes making sure the room is temperature and humidity controlled with particle filtration. The rack should be properly grounded and the server should be powered through an Uninterruptable Power Supply (UPS).

Sensors

The occupancy sensors should always be connected to a processor if there is a choice between a scheduling panel such as a TPMC-4SM and a processor. The occupancy sensor status can be passed to the scheduling panel via Fusion EM. For rooms with a scheduling panel and an occupancy sensor, connect the sensor to the TPMC-4SM. Fusion EM can track the status of the occupancy sensor through the panel.

When programming Fusion EM applications, it is important to include lighting scenes in the code. The maximum flexibility is achieved by using a scene for each load. However, as long as the load is part of a scene, the user can modify scenes to adjust load levels in the future as part of scheduled events.

Accessing the Web Client

It is best to access the web client from a second workstation running a compatible browser (Internet Explorer®, Firefox®, or Safari®). The workstation also requires a Flash® Plug-in (version 10.1.0 or higher) in order to load the Fusion EM Flash client. It may be possible to browse to the Fusion EM client from the server, but the server may not provide the desired results due to high levels of security and browser restrictions which are typical of server deployments.

Network Considerations

Fusion EM requires an Ethernet network to enable communications between the Fusion EM server and the CCPs. Fusion EM communicates with the Crestron control system end points using a proprietary protocol.

Crestron uses a Transmission Control Protocol (TCP) to connect Fusion EM and the control system as well as for connections to the processor's web server and Telnet service. Only IP traffic is used.

If the Crestron control system is set up for Dynamic Host Configuration Protocol (DHCP), it sends out the necessary broadcasts in order to obtain a valid IP address. Also, the CCP occasionally sends out an Address Resolution Protocol (ARP) request. All other communications are via unicast. The Fusion EM software does not send broadcast packets.

The amount of traffic generated by, or routed between, Fusion EM and the CCP depends on the uploaded customized program and the amount of connections. Refer to "Network Bandwidth" on page 20 for more details. One of the features of the CCP is that it has a built-in web server. The web server is used for serving up pages that communicate directly with the processor. These pages contain HTML as well as Java™, ActiveX®, or Flash objects. Both the built-in web server and the Telnet server can be disabled as necessary.

The customer-provided network must be configured to allow IP traffic (on configurable communication ports) to flow freely between the Fusion EM server and Crestron control systems on the network. It is the responsibility of the network provider to ensure network reliability and security.

System Installation and Commissioning

When the network is supplied by others, the customer must ensure that the network is operational before the Field Service Engineer (FSE) arrives on site for installation and commissioning. The system installation cannot be completed without reliable connectivity between the Crestron components.

Site and Network Access

The FSE and supporting personnel must have access to all network equipment required to ensure communication between Crestron control components on the network. The FSE must be able to connect to any portion of the network utilized by the Crestron system and employ Ethernet network analysis tools for the purpose of system verification and troubleshooting. If access to the network equipment and network analysis tools is not permitted, the customer must ensure that qualified network support personnel are on site and available to support the FSE during the commissioning process.

Local Logging

Local logging means that a log database can be installed wherever a server is deployed. This allows logging to occur over a short network connection, which reduces network traffic and volume. Data collected in a local log database can be migrated to the main database through a scheduled background SQL replication task.

Network Documentation

All Crestron equipment connected to the network should have a static IP address. This is because of the many uses of the Crestron control system and the many diverse clients that connect to the processor over IP.

All systems should also be on the same subnet. Multiple subnets can be used if the appropriate routers and gateways are configured to ensure connectivity between all Crestron equipment on the network.

DHCP is supported, and if used, it is recommended that reservations are set on the DHCP server so the devices are assigned the same IP Address.

NOTE If the Crestron equipment connected to the network is required to have customer-specified static IP addresses, subnet masks, and gateway addresses, this configuration information must be supplied to the installer prior to when the FSE arrives on site to install and commission the system.

Network Support

The network that communicates with Crestron equipment is utilized as a control and data network. Control networks require more predictable and consistent response times. Increased traffic from corporate Intranet data can greatly affect these response times. Network reliability impacts the collection of data from Fusion EM. Fusion EM data is used to generate reports and to assess the system's health. Network reliability also impacts control functions such as automation and timed events.

Crestron recommends working with the end user's network team to provide a dedicated VLAN for Crestron lighting, A/V processors, and the Crestron Fusion server. A VLAN ensures that corporate broadcast, voice, video, and multicast traffic are separate from the control and data traffic on the Crestron Fusion network.

Crestron recommends that the customer employ qualified network support personnel to maintain the reliability and health of the network after commissioning. The network support personnel should have industry recognized certifications to configure and support the installed network.

In a new construction project, it may be necessary to install a dedicated network to support the CCP and the Fusion EM server. There should be a plan in place to interconnect the dedicated network with the end user's corporate network, integrate with the company's data backup systems and corporate mail server and allow end users access to scheduling functions such as the Room Booking Wizard. The interconnection assists in the management of the server and control systems. Isolated networks are helpful when separating the corporate and building traffic from the control traffic, but are sometimes inaccessible. The end user should be able to connect to the Fusion EM client from anywhere in the building and from remote locations that need network access.

Network Bandwidth

The number of rooms per processor and per server vary greatly between users and is based on the amount of data sent across a network. An organization with a greater number of rooms and a heavier calendar load needs more equipment than a smaller, less busy organization. A Roomview® Bandwidth Calculator is available on the Crestron website as an online browser-based calculator or as a downloadable Excel® file.

Accessing the Excel Spreadsheet

After accessing the bandwidth calculator, click the Excel icon. The bandwidth calculator is displayed within the spreadsheet. Follow the instructions on the screen.

Bandwidth Calculator (Excel Spreadsheet)

CRESTRON.

RoomView™ Bandwidth Calculator

Use this spreadsheet to calculate the total bandwidth usage of Crestron RoomView.
The fields marked in yellow are changeable.

Number of rooms connected to RoomView:	250

Event	Bytes	Frequency
Connection Request	24	1 time total
Initial Update	72	1 time total
Heartbeat	12	12 per minute
Display Reporting	12	1 per hour

Based on programming - average number of events

Event	Bytes	Frequency
On/Off Event	12	30 per hour
Numerical Value Update	12	20 per hour
Textual Value Update	256	15 per hour

Traffic for initial connection to room from RoomView:	96 Bytes
Minimal traffic per hour, per room regardless of usage	8,652 Bytes
Additional traffic per hour, per room, based on usage	4,440 Bytes

Total Bandwidth per hour, per room	13,092 Bytes

Bandwidth per hour for 250 Rooms	3,273,000 Bytes
Bandwidth per second for 250 rooms	909 Bytes

Accessing the Online Version

To calculate bandwidth, enter the number of rooms into the online form. Click the **Calculate Bandwidth** button. The bandwidth results appear at the bottom of the page.

Bandwidth Calculator (Online Version)

Network Equipment Requirements

Physical and administrative access to network equipment should be limited to authorized personnel only.

Network Configuration

Crestron Fusion uses the following ports to connect to other applications and devices:

- Port 80 for Fusion EM Flash based web client
- Ports 80/443 for Microsoft Exchange server Webdav
- Port 843 for Flash security
- Ports 41794/41796 for TCP 2-way connections to the control systems (Plain/SSL)
- Ports 41795/41797 for TCP 2-way console connection to the control system (Plain/SSL)
- Port 1433 for SQL Server
- Port 65206 for EWS push notification (can be changed)

Crestron recommends opening the remote desktop port on 3389. This allows remote access to the system for service and troubleshooting purposes. All port and protocol configurations must be enabled after a power cycle to prevent system downtime.

Fusion EM Interface

From the Fusion EM interface, automation settings, energy usage, and an overview of the facility can be accessed. Refer to the Fusion EM online help for more information on how to use the Fusion EM application.

Summary View

The **Summary View** screen provides a quick overview of the entire facility. The view can be customized to allow for a logical distribution of rooms on the page. The user can view the status of main room attributes such as lights being on or off and alarm settings. From this screen, the user can drill down to take control of specific rooms and analyze more granular information on each room.

Systems designers should spend time with their end users discussing the types of room attributes to be monitored. The system programmers need to be instructed on the room attributes that are tracked by Fusion EM. Programming objects need to be included in the room system's program so that they are tracked and controlled.

Summary View Screen

Name	Location	Online Status	Lights	Shades	Occupied	Current Temperature	Alarm
Trading Floor	2nd Floor - Trading	✓	ScenesAllOff				
Shed 221	Facilities Level						
Room 2231 Dual Display	6th Floor - Hoteling Spaces	✓				0 °F	
Room 2124	6th Floor - Hoteling Spaces	✓					
Room 2123	6th Floor - Hoteling Spaces	✓			●		
Room 2122	6th Floor - Hoteling Spaces	✓			●		
Room 2120	6th Floor - Hoteling Spaces	✓			●		
Room 2118	6th Floor - Hoteling Spaces	✓					
Room 2115	6th Floor - Hoteling Spaces	✓			●		
Room 2114	6th Floor - Hoteling Spaces	✓					

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Automation

The **Automation** screen defines how rooms behave during the normal course of the day. From the **Automation** screen, the user can access the **Meetings and Occupancy**, **Time Clock**, and **Demand Response** screens.

Meetings and Occupancy

The **Meetings and Occupancy** screen defines how room systems behave according to room schedules and occupancy sensing. Unnecessary energy usage can be minimized while maintaining environmental comfort in the building. In order to fully utilize these controls, the Crestron system requires that scheduling software is installed. Proper settings can affect the overall energy usage in a building.

From the **Meetings and Occupancy** screen, the user can access and define the following rules:

- **Pre-meeting Rules**: From this screen, standard room behavior can be set to take place at a given interval before a scheduled meeting. Depending on building location (region), design, and HVAC system, it is often important to heat up or cool down a room before a meeting takes place.

  A time period can be set to control the temperature in the room before a scheduled meeting. If it is determined that room temperatures are not comfortable, the temperature and time period can be easily adjusted. This feature also allows the user to define additional items such as lighting cue, A/V equipment, warm-up, etc.

- **Occupied/Scheduled Rules**: From this screen, standard lighting, HVAC, shade position, and additional actions based on room schedule and occupancy setting can be assigned. Typically, this would be used to set back HVAC and turn off lighting and A/V equipment when a room is empty.

- **Vacant/Not Scheduled Rules**: From this screen, HVAC, lighting, shade and drapery positions, and action rules can be set for when a room is either vacant or not scheduled.

Meetings and Occupancy Screen

Time Clock

The **Time Clock** screen schedules repetitive tasks such as opening a building or preparing a conference room for an upcoming meeting. A time clock function is included in the specifications for most public-area lighting designs.

Time Clock Screen

In a building equipped with Fusion EM, the administrator can set up the scheduling for the entire facility. Fusion EM provides a convenient way to schedule stand-alone lighting and shading events, set up 7-day calendars, and specify special holiday settings.

The latest release of Fusion EM includes an enhanced calendaring interface that enables facilities managers to preset building system operations for weekends, holidays, and special events. With the enhanced time clock, the building calendar can be managed separately from the rules that operate the building. The administrator can now define a set of rules and exceptions to the rules. The dates for rules and exceptions can be organized into a calendar that is maintained separately from the rules definitions. Dates can be calculated using complex patterns for recurring events such as annual luncheons, monthly status meetings, etc. Fusion EM also provides preconfigured US Federal holiday calendars.

Time clock commands that are set up in Fusion EM are exported to the various CCPs, which execute the commands. This allows currently scheduled events to occur even if Fusion EM is taken off-line. Another advantage of the time clock feature is the ability to make scheduling changes and track how these changes affect overall energy use in the facility. Subtle changes in timed events can have a huge effect on energy usage over time.

Demand Response

The **Demand Response** screen defines the rules for behavior for a demand response scenario or condition. A demand response event is an event triggered in the control program from an external source, such as an RSS feed from a utility company to the control processor. The user can access settings that control lighting and HVAC while a demand response event is active. During the course of a demand response event, the facility must reduce its electrical demand.

Power companies often offer substantial discounts on electrical rates to customers who agree to set up demand response presets for their facilities. The method for a demand response call varies depending on the local utility. Consult the local utility company regarding this matter.

In system programming, a demand response preset can be set for each lighting load and caps usage. Heating and cooling offsets can be set to save energy on HVAC. A user can also define an additional action to be triggered by demand response.

Fusion EM defines the demand response rules, but the application does not trigger the demand response mode. Entering and exiting the demand response mode must be built into the control program.

Demand Response Screen

Energy Usage

The **Energy Usage** screen allows the user to track energy usage for the entire building or for individual rooms. The Fusion EM software does not contain the hardware that monitors energy usage. Some form of metering or monitoring hardware is usually connected to Fusion EM to provide it with energy usage data.

Data on energy usage can be gathered by a variety of methods. The best way to determine the method is to base it on the overall electrical design of the building. Many projects require a combination of methods to cover the full monitoring needs.

Fusion EM is equipped with its own electrical usage estimation function. Data on wattage, type, and quantity of fixtures for each lighting circuit can be loaded into the program when the control program is set up. Based on known wattage, lighting levels, and time estimates, Fusion EM can track the amount of electricity used by the lighting in each room.

Energy Usage Screen
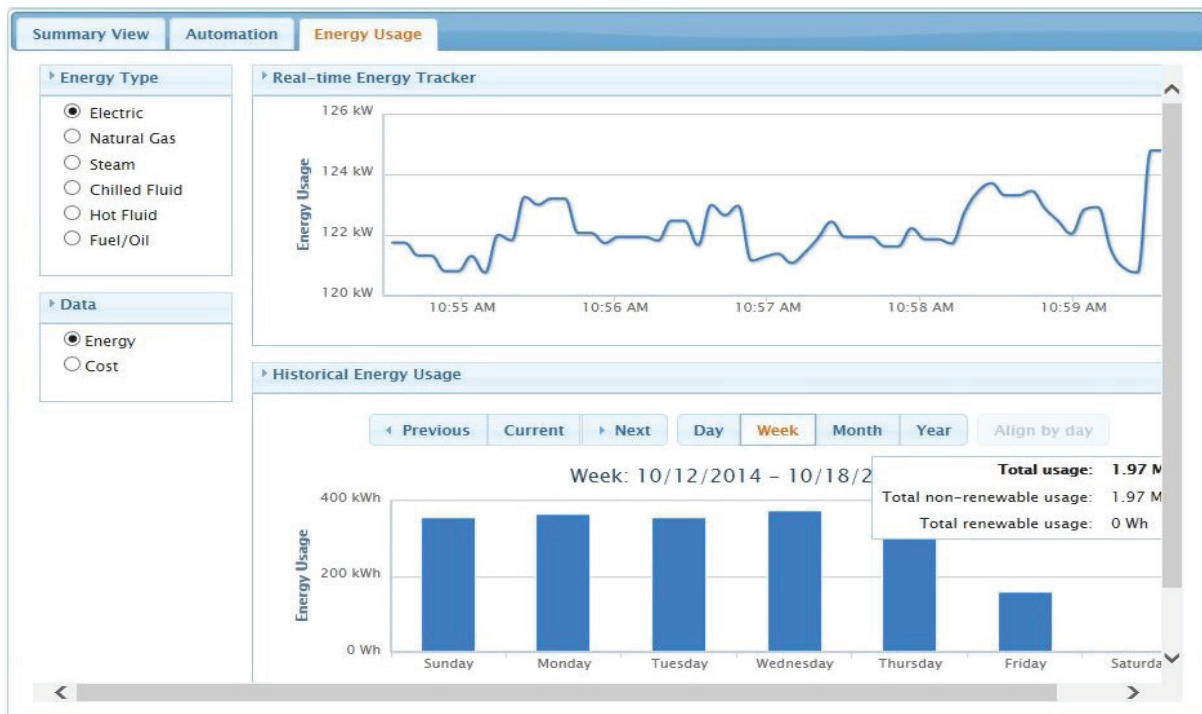
Energy Monitoring with Fusion EM

Crestron Energy Monitoring Devices

Crestron offers a number of devices that can monitor the use of electricity. The following is a list of the most important devices:

- The Crestron Green Light® Power Meter Control Unit (GLS-EM-MCU) is an energy monitoring unit designed to measure both voltage and wattage to provide an accurate reading of energy usage. The GLS-EM-MCU is designed to measure the main feeds to an electrical panel (1-, 2-, or 3-phase). It can also be equipped with smaller CTs to track individual circuits.

  The GLS-EM-MCU is also equipped with four pulse inputs. Many utilities use pulse meters to track the use of natural gas or water. If utility meters are equipped with pulse outputs, they can be connected to the GLS-EM-MCU. The unit can then be calibrated to measure usage and utilities can be tracked along with electricity use. In addition, the GLS-EM-MCU connects to the local area network and reports data to a CCP. Data on use (historical and current) is then relayed to Fusion EM by the control processor.

- The Crestron Greenlight Power Pack Systems (GLPP) is a family of lighting controllers that offers power monitoring versions (designated by the suffix PM). This is a flexible family of products that can control one or more channels of lighting. These systems report power usage to Crestron 2- or 3-Series control processors. This is a very versatile family of products that is useful in retrofit applications.

- The Digital Addressable Lighting Interface (DALI) lighting ballasts (GLB-DALI-T-1, GLB-DALI-T-2, and GLB-DALI-T-3) are also available in Power Monitoring versions (PM). These ballasts measure their own energy usage and report it to Crestron 2- or 3-Series control processors.

Fusion EM Compatible Devices

Crestron provides an extensive selection of keypads, touch screens, occupancy sensors, photocells, shade controllers, lighting devices, and numerous other peripheral options, which provide design flexibility for integration with Fusion EM. Refer to the Crestron website at www.crestron.com for Crestron Fusion EM compatible devices.

Appendix A: Glossary

Daylight Harvesting: The dimming of electric lighting sources when natural daylight is available.

Dynamic Host Configuration Protocol (DHCP): A computer networking protocol used by hosts (DHCP clients) to retrieve IP address assignments and other configuration information.

Load Shedding: An intentional reduction of power consumption to avoid total power disruption due to overloading the circuits or a reduction of power consumption to avoid crossing an agreed on threshold of power usage.

Monitor: An acquisition and presentation of the status or operating condition of microprocessors or electrical devices in the network of the monitoring device or program.

Scene: A predetermined position of shades and light levels.

Secure Sockets Layer (SSL): A communications encryption protocol for managing the security of message transmissions over the internet or a local area network.

Unicast: The delivery of messages or information to a single network destination identified by a unique address.

Appendix B: Fusion EM FAQs

1. How does energy usage information get into the Crestron Fusion database?

   All energy usage data in Fusion EM comes from a control processor. The control processor can access this data in a number of ways:

   - Data can be accessed from the Crestron GLS-EM energy monitor. This device communicates with the control processor over Ethernet. The GLS-EM-MCU is capable of recording the following:

     √ Consumption of 3-phase mains

     √ Consumption of individual branch circuits

     √ Up to 4 pulse inputs, typically provided by flow meters

   - Energy use can be calculated based on a signal from a current transformer or a similar device that can measure real-time current. Some Crestron products, such as models of GLPAC and GLPP, have sensors built-in and can relay real-time current use to the control processors. Third party current CTs can be used, which deliver a 0-10 volt signal. The control processor takes the current usage information and multiplies it by the expected voltage to arrive at an estimated power usage. While not as accurate as using a true energy meter such as the GLS-EM-MCU, this can be a cost-effective way to arrive at a good approximation.

     NOTE: This technique is not recommended for loads with power factors less than 1.

   - Energy usage can be calculated based on the expected load wattage. This is appropriate for loads with the following criteria:

     √ A power factor close to 1.

     √ When the load is either switched on or off or is controlled directly by a Crestron device such as a dimmer (this is not accurate as either of the first two methods but can provide useful estimates).

   - The use of third party monitoring devices is supported, if that device is able to provide direct communications with a CCP. Typically, these devices communicate via Modbus or BACnet, so the use of a GLA-BMS may be required.

2. What sort of energy information does Fusion EM handle?

   Crestron Fusion energy tracking is built around the monitoring of electricity use. Electricity can be monitored for the entire building and for individual building systems, loads, and rooms. It is important to discuss the end user's expectations and goals for energy monitoring so that proper monitoring strategies can be employed.

3. Can Fusion EM collect water usage data?

   There are plans to add this to a future release. Currently Fusion EM only supports data related to electrical energy consumption.

4. What reports can be generated?

   The initial release of Fusion EM did not include a report generation engine but it will be added to a future release. The data is stored in a standard Microsoft SQL Server database, and custom reports can be generated upon request on a case-by-case basis.

5. How many rooms and loads are supported by a single control processor?

   Design considerations vary depending on the system design. Please contact Crestron Sales Support Services at 1-888-CRESTRON with any questions.

6. Which control processors are supported?

Any CCP with an Ethernet port is capable of communicating with Fusion EM. Please note that devices that have out-of-box programs, such as the GLPAC and IPAC, are not initially supported by Fusion EM. These devices will eventually have their out-of-box programs updated to support Fusion EM and can be custom programmed using SIMPL Windows.

The GLPP, iLux®, and GLS-EM-MCU devices need to talk to a control processor and are not capable of direct communications with Fusion EM. A control processor is required to act as a go-between.

7. Are only Crestron products supported by Fusion EM?

Any device that can communicate with a control processor can report to Fusion EM. The Fusion EM interface only supports certain classes of devices as follows:

- Lighting loads (switched and dimmed)
- Switched loads
- Occupancy sensors and photocells
- Shades and drapery
- HVAC zones
- Energy meters

Other device types may be added in future releases.

8. How does Fusion EM communicate with a BMS?

All communications with a BMS must happen via a CCP. The control processor handles communication of data and command traffic between the Crestron system and the BMS. Crestron offers several options depending on the communication protocol used by the BMS system. Crestron 3-Series processors offer native BACnet IP communication. If a choice is offered for BMS communication, BACnet IP is the preferred method.

Crestron can also communicate with other standard building communications protocols such as BACnet MSTP, Modbus (IP or serial), or Metasys via the GLA-BMS protocol translator. The GLA-BMS communicates with the BMS system via native protocol(s) and with the CCP via Ethernet. GLA-BMS must be factory-configured for the appropriate communication protocol and system data points.

9. How do I integrate Fusion EM with Fusion RV?

Fusion RV and EM share a common platform; therefore, a single control processor can support both RV and EM. The programmer has to add the appropriate EM symbols to the program. Programmers can also choose to have separate control processors for RV and EM functionality. Both Fusion RV and Fusion EM run on the same server or virtual machine.

10. What happens to my system when the Crestron Fusion server goes down?

Multiple servers can be used in failover mode to take the load from a failed server. However, if only a single server is installed, room automation events including pre-meeting rules, time clock, and demand response continue to execute. Additional actions that have been added to a scene as part of the automation event do not execute as they require Fusion EM to be online. Energy data is logged locally and then transferred to Fusion EM once communication is restored.

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