Lighting Control Application Note

Campus

Overview

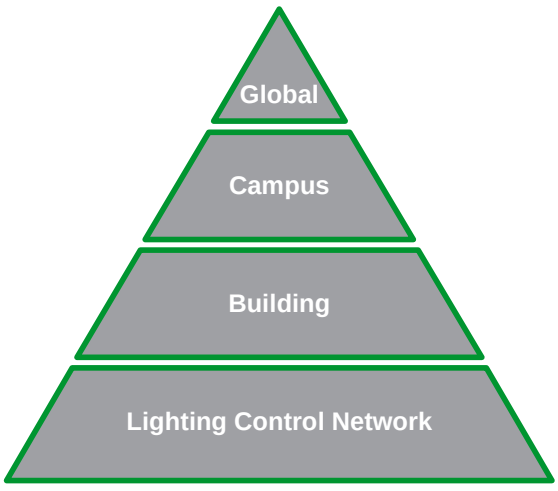
One of the challenges in maintaining a large Campus site is how to maintain each building individually while also being able to retrieve data across the entire site.

Lighting control, maintenance and management has been restricted to individual buildings for a long time. As we enter a new era of green building ratings and government legislation, organisations are trying to maintain and manage lighting more efficiently throughout all of their buildings. In many cases, campus buildings can be located in satellite locations around the country.

This document describes how several separate lighting control systems can be converged across a Campus site consisting of multiple buildings to provide the appropriate level of access and detail for the required tasks. We will show how this methodology also provides a scalable structure, allowing system additions and upgrades without the need to reconfigure the entire architecture. We will also show how everyday maintenance, testing and repair tasks can be carried out on a building by building basis, while giving the ability to carry out overall system management and monitoring tasks at a Campus wide level.

This is achieved by treating the overall system as a series of layers. Each layer provides a level of services and access appropriate for the staff working at that level. The layers are described as follows;

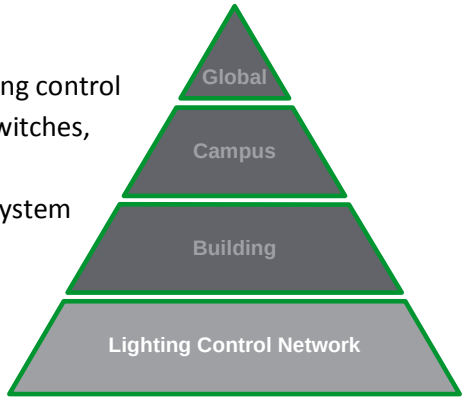
- **Global** – an overall view capable of bringing together more than one campus
- **Campus** – the collection of buildings on one large site (some may be off-site also)
- **Building** – the structure(s) containing the lighting control system
- **Lighting Control** – the bottom layer. This refers to the physical lighting control network (i.e. cable, switches, etc)



Each layer passes/receives information from the one above/below, creating a system that is able to withstand failures of varying severity without causing major disruption across the entire campus.

Layer boundaries are not always clear. Depending on the size and structure of the organisation, some examples might cross over to other layers. Even if this is the case, this method still stands as a good way to look at the overall topic.

Lighting Control Network



The lowest layer of this architecture is the **Lighting Control Network**. The lighting control network consists of the physical hardware installed in a building (i.e. cabling, switches, sensors, Touchscreens, etc). Typical users in this area are general staff and maintenance workers. Failure types are limited to device failures and general system errors. At this level problems are typically discovered passively;

- User reported - the Touchscreen no longer works
- Ad-hoc viewing of Touchscreens or system web pages (i.e. DALIcontrol line controller web page shows device failures)
- Schedule maintenance – annual checks carried out on equipment to ensure everything is in an acceptable condition

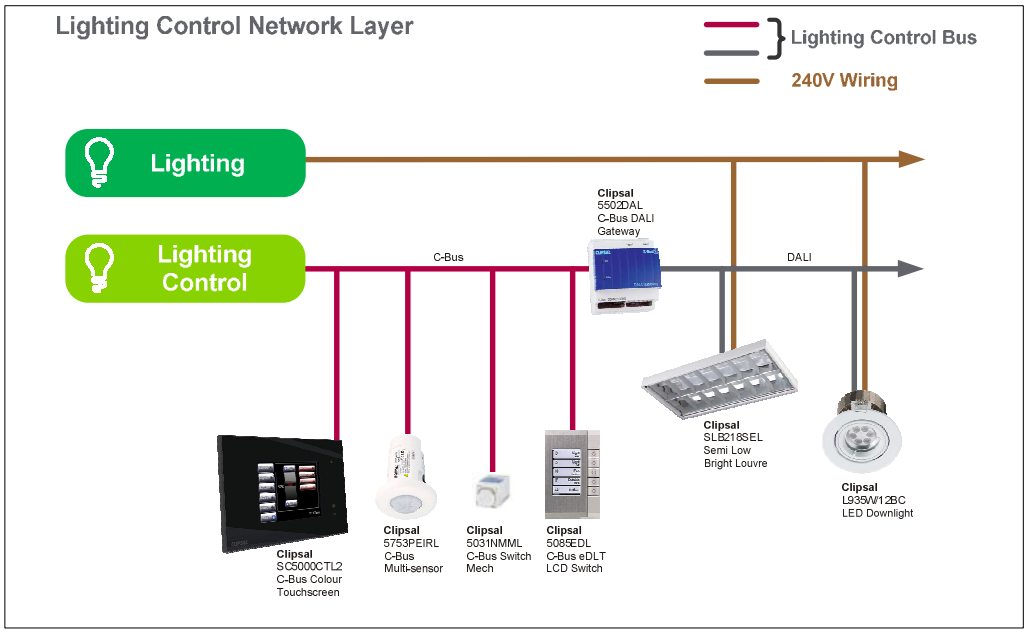


Figure 1; Typical layout of the Lighting Control Network Layer

There is no automatic reporting or notification of errors or status at this level. Issues are either discovered by the user through day to day use or by viewing Touchscreen notifications. Any faults need to be reported manually to maintenance staff via internal processes and resolved as deemed necessary.

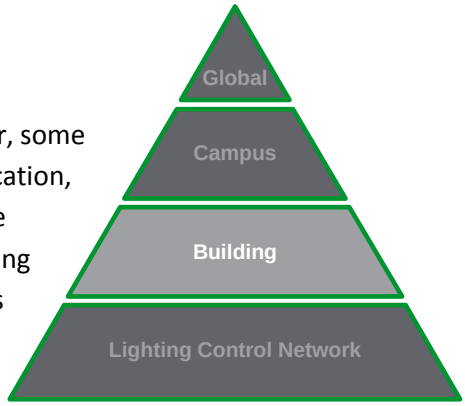
Tasks such as Scheduling and Logic functions are carried out locally by C-Bus PAC and/or Touchscreens (or DALIcontrol Line Controllers). This gives the local system a level of tolerance to failures at higher layers; even if all other layers above were to fail, the lighting control system would still function.

Figure 2; Sample Touchscreen layouts showing an example of Lighting Control status information

Typically due to the higher skill required maintaining a lighting control system, onsite maintenance staff are only trained on the basics allowing them to identify and isolate any potential issues. Anything more than this requires external contractors to be engaged.

At this low layer, the lighting control system behaves like any other standalone system; and that is the intention. As far as the user is concerned, their system is the one that matters. They aren't concerned with what is happening in the upper layers of this architecture.

Building



The next layer up is the **Building**. Sitting above the lighting control network layer, some more intelligent features can begin to be introduced such as email failure notification, remote access, etc. Depending on the size of the building, there may be multiple lighting control networks connected to this layer. Communication with the lighting control network is achieved using the messaging protocol for that system (C-Bus or DALIcontrol) via Serial RS-232 or Ethernet.

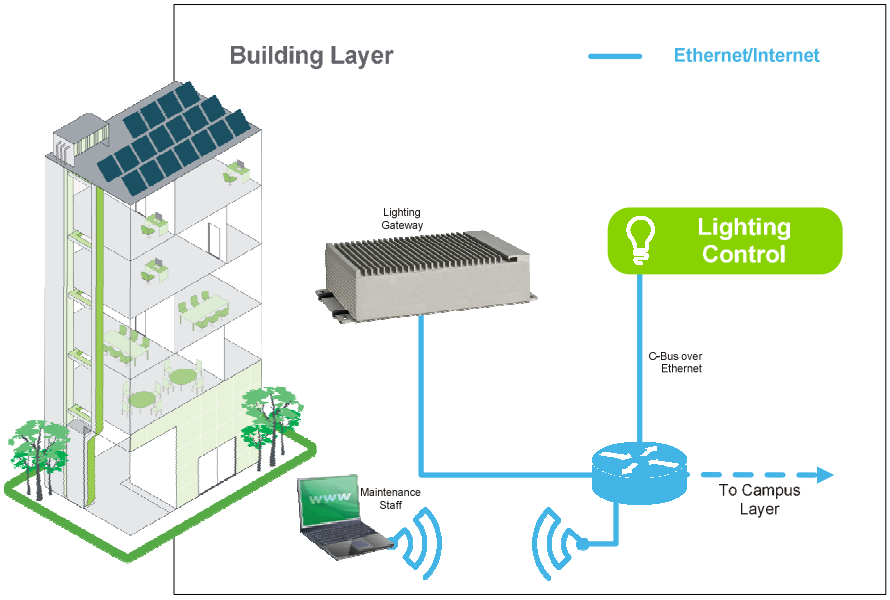


Figure 3; Typical layout of the Building Layer

Through the use of a Lighting Gateway that monitors all lighting control activity, we can now keep a 24 hour check on the lighting control system. The Lighting Gateway can be configured to email errors to the local maintenance or external contractors. Sending an email provides a traceable time and date of the event. This allows for accurate Service Level Agreement (SLA) tracking and puts accountability to the responsible maintenance staff.

Via the Lighting Gateway, remote access can be provided to the maintenance staff/contractors allowing them to log in any time of the day/night and investigate reported issues without having to attend site. By giving access to each building only, it removes the ability for someone to access critical information on the entire campus and gives management the ability to control who has access to where. This is important when there might be multiple external contractors working on the same campus. Removing the ability for them to interfere with other buildings (accidentally or otherwise) prevents any risk of unexpected changes.

At this level Contractors are able to configure, replace and make other changes to the connected lighting control systems. Depending on the connected system, they may also be able to initiate testing of the Emergency and Exit lighting systems.

The Lighting Gateway also serves as a local data storage point for the connected lighting control systems. This ensures that there is no single point if data storage. The layer above retrieves data when required. If data protection is deemed to be a critical requirement, backup systems can also be introduced.

The Building and Lighting Control Network layers are limited to the Building only. In other words, in everyday operations, the lighting control system behaves like any other standalone system. If there is a catastrophic failure in either of these bottom layers, there will be no negative functional impact on the rest of the campus. In addition, a failure in either of the top levels will have no impact to the Building layer.

To provide some level of redundancy and failure tolerance, Schedule Plus would be configured to listen to a heartbeat sent by the PAC or Touchscreen. If this heartbeat is not detected for a preset period of time, Schedule Plus is configured to provide backup functions such as default lighting schedules, etc.

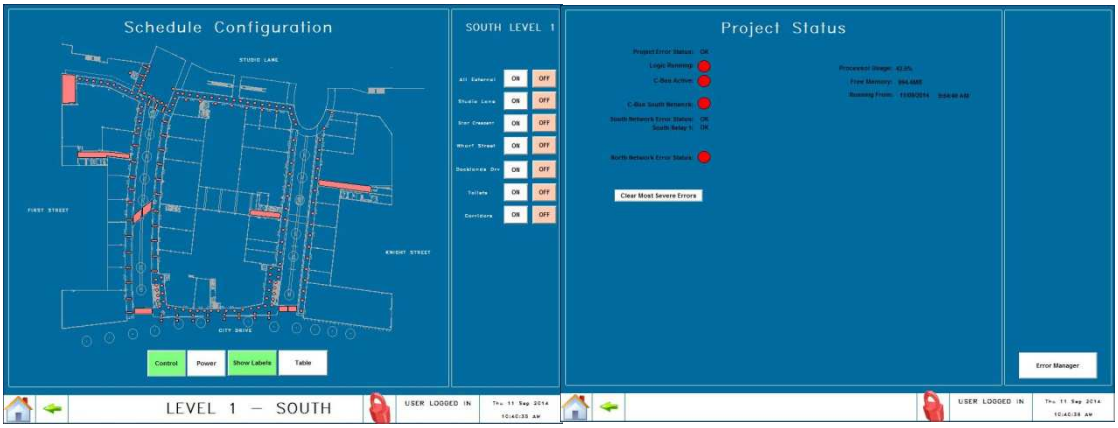
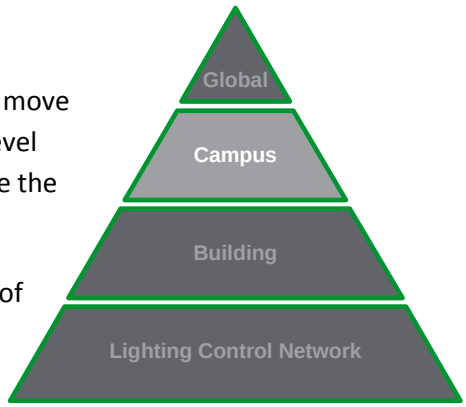


Figure 4; Sample Schedule Plus layouts showing an example of Lighting Control status information available at the Building Layer

Campus



The **Campus** layer covers all buildings across the campus. At this level we start to move away from a functional focus to a reporting and trending one. Hardware at this level connects to the SQL database stored in each Building Lighting Gateway to retrieve the required data.

By giving Facilities Management staff the ability to gather data over long periods of time (and monitor live events if required) it allows them to see a high-level view of how each building is used. Building this picture of usage allows them to;

- Look for unexpected pattern of behaviour in the future
- Target high usage buildings for energy saving programs
- Make decisions to ensure automatic functions match actual usage (i.e. why are the lights scheduled to turn OFF at 9PM when the last class finishes at 7PM?)

Industry standard IT protocols such as SNMP (Simple Network Management Protocol) are used at the level to receive Lighting Gateway health status (CPU loading, temperature, etc). This type of information is then used to identify potential hardware issues before they become critical failures.

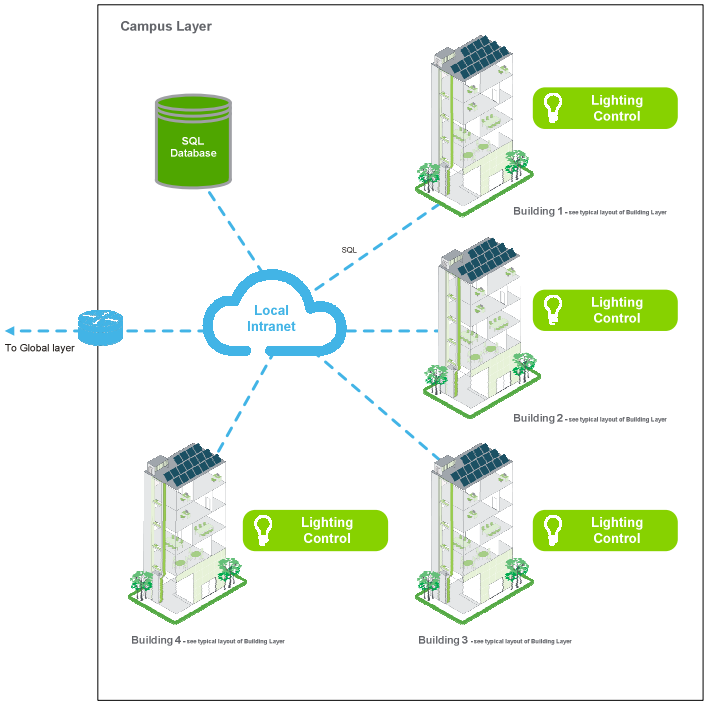
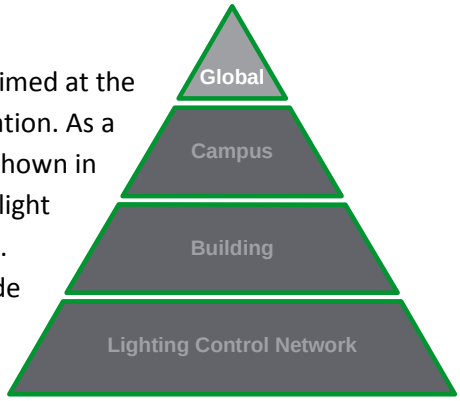


Figure 5; Typical layout of the Campus Layer

If required, alerts can be set up either by email or SMS to notify staff on a range of issues from potential problems to critical failures (i.e. Building offline).

Due to this layered Lighting Control architecture, a failure at the Campus layer will have no impact to the everyday user at the lower levels.

Global



The **Global** layer has the ability to see all Campuses within an organisation. It is aimed at the decision makers (Financial Managers, Energy purchasers, etc) within the organisation. As a result, the type of information presented doesn't need to be as detailed as that shown in the lower layers. The staff in these positions don't necessarily want to know if a light is left ON; they want to see generalised information regarding the overall system. The data is presented in a visual manner using graphics and dashboards to provide real time analysis of sites.

Dashboards are configured to show such information as;

- Campus/Building system uptime
- Campus/Building total usage
- Campus/Building over/under target
- Campus/Building online/offline

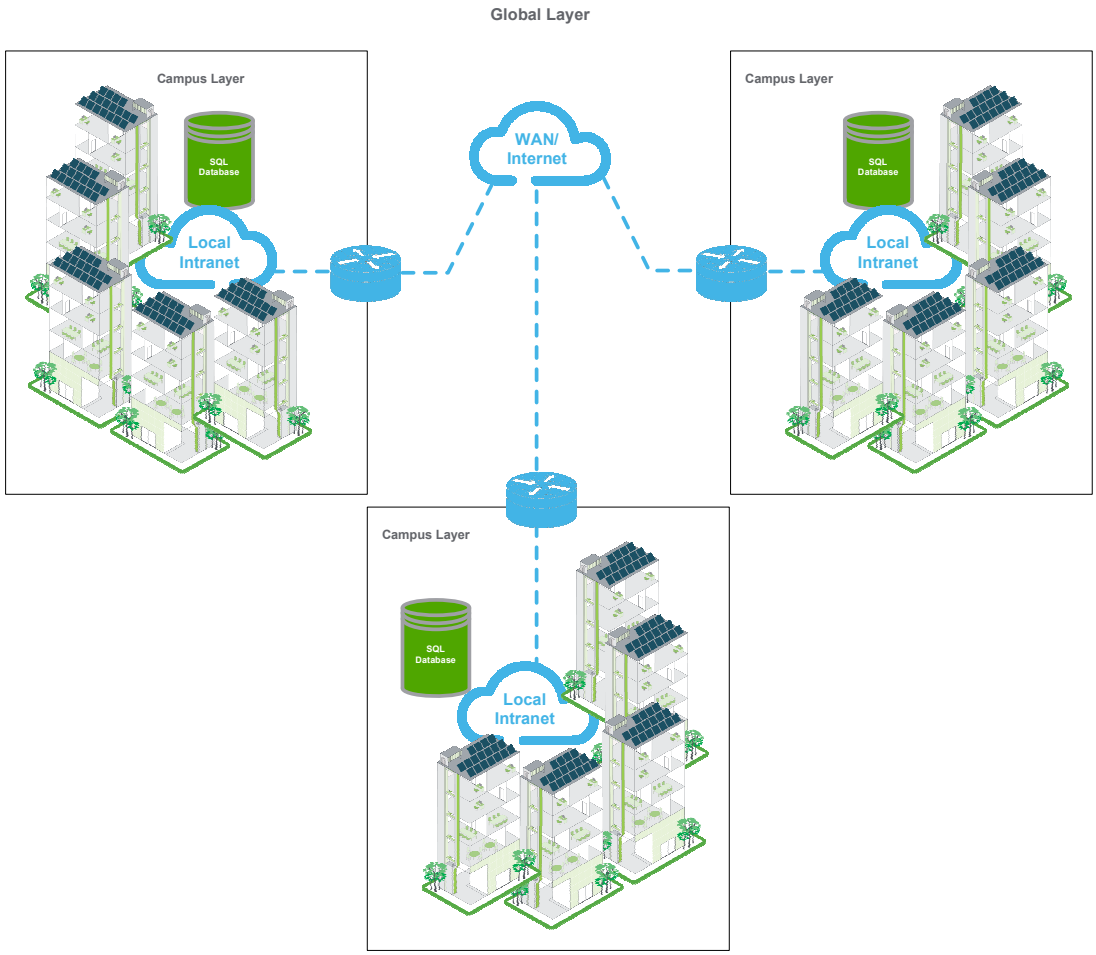


Figure 6; Typical layout of the Global Layer

By having this sort of information within easy reach, staff at this level have the data they need to be able to make everyday decisions without the need to request specialised reports every time (although these can be created if required).

Typically a SCADA system will be required to handle the large amounts of data and monitoring points needed for this level of supervision. All data would be pulled from the Campus layer via a common protocol such as Web Services. Web Services is fast becoming the industry standard for this type of interface. The advantage is its ease of transmission between networks and compatibility with many types of systems.

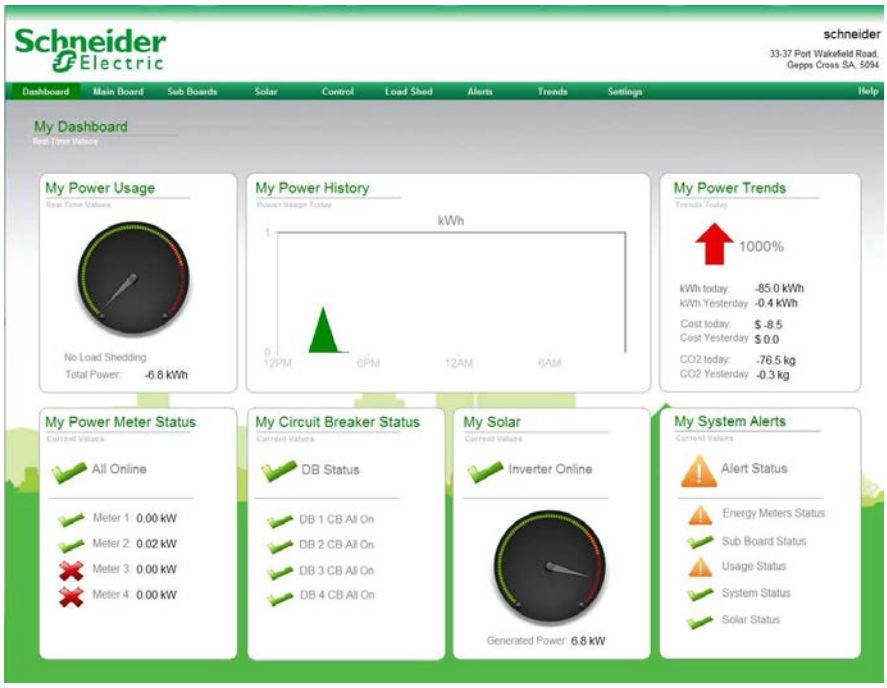


Figure 7; Sample Dashboard used at the Global layer

Summary - Many Systems, One Campus

Many Systems

This concept allows each building to be designed as a typical standalone lighting control system. The Lighting Control Gateway in each building provides local monitoring, data storage and alarm generation. This method has various advantages;

- Distributed data collection and intelligence
- There is no single lighting control server – i.e. no single point of failure
- If the site Ethernet backbone fails
    - System functionality will remain unaffected
    - Data and monitoring will continue locally
- Segregation of systems
    - Provides increased security
    - Allows maintenance staff to grant contractors individual access to each site without fear of unexpected control of other areas
    - Allows separate contractors to maintain different buildings without the risk of them interfering with each other's configuration
    - Allows for systems to be distributed across separate IT networks
    - Simplified management of the overall system

Different Lighting Control Systems can be accommodated if required. While for maintenance and reporting purposes it will always be easier to use the same Lighting Control System, it is expected that this will not always be the case. Differing building upgrade schedules mean that some buildings will use different systems, models, software versions, etc. By providing an architecture that assumes a separate system is in each building, any compatibility issues are handled by the Lighting Control Gateway.

Integration to third party systems (i.e. BMS, AV, and HVAC) is handled by the Lighting Control Network or Building layers. This allows for multiple third party vendors to connect separately without the need to a single large high level interface server. Once again this removes any single point of failure concerns. It also minimise delays experienced in communicating with a central control server for simple lighting commands and status updates.

For general maintenance tasks, such as lamp replacement and Emergency & Exit testing, each building can be considered as a separate system. Typically these types of tasks would not be carried out on such a large scale at the same time, so this is not of concern.

One Campus

Through the use of various integration methods (e.g. Web Services, SQL), all required information is passed up to the higher layers. This central/main headend is used for monitoring, logging, trending and general reporting purposes.

The Lighting Management Server can be used as a single point of monitoring for the separate lighting control systems. Through the use of various software types

Common integration methods available include;

- Web Services
- SQL
- OPC
- BACnet

Web Services is emerging as the preferred option for high level integration in building systems. The reason for this is the ease at which the data can be transferred through IT networks (both local and intercampus) simple way data is presented. Making it easy for all types of system to interpret and act upon available information. There will always be a use for other methods such as OPC and BACnet; however for the types of information used in the lighting control system, Web Services serves the purpose well.

Apart from lighting information, the Lighting Control Gateways can be configured to provide system health states to the Lighting Management Server at the Campus Layer via industry standard IT protocols such as SNMP. Using these standards will give the Server the ability to monitor Gateway and failures. Any potential issues can be emailed or SMSed to maintenance staff for immediate consideration.

Multiple Campuses can be pulled together at the Global layer to provide a very high level view of each Campus. At this layer the information is vastly generalised through the use of dashboards and visual alerts (i.e. Good/Bad, Pass/Fail).

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