2017 Connected Lighting Systems Workshop

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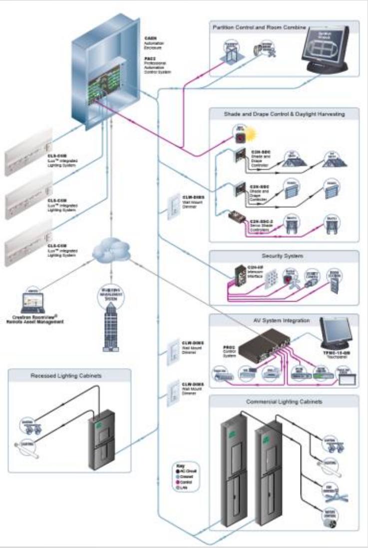
Session Topics

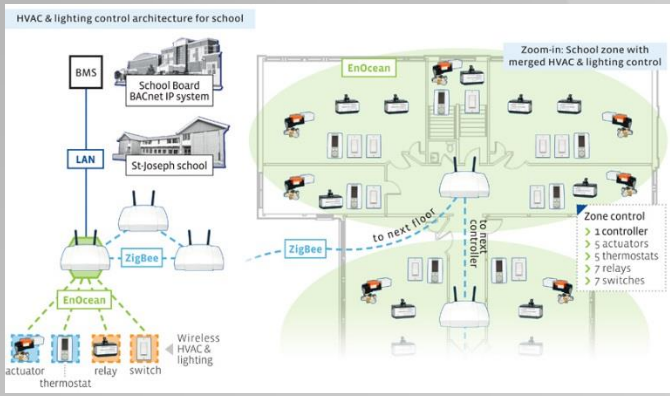
- Connected lighting systems and their integration in 'smart buildings'
  - Specification trends to drive integration in new construction
  - Connectivity support
    - Open communication standards vs. APIs
  - Practical support of standards
    - Documentation examples
  - Practical examples of connected lighting systems 'in the wild'
    - Occupancy-driven HVAC setback modes
    - Space reservation/booking systems
    - Occupant-level override and adjustment capabilities
    - Fire alarm system interaction
- Moderator-driven Q&A

Connection Architectures

- The host LCS (Lighting Control Systems) can use various methods to connect their field devices together, and to expose that data to 3rd party systems.



Wired systems utilize a dedicated communication network for the field devices – this network typically utilizes the manufacturer's proprietary communication protocol, and thus, is dedicated for this system only



Many systems are now offering wireless communication capabilities which can greatly reduce installation costs. The protocols utilized for the wireless networks can include open protocols like ZigBee, EnOcean and Bluetooth, among others.

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Specifying Integratable Solutions

- A Connected Lighting Control (CLS) system obviously needs to support some method of connecting the system to other devices in a building – the days of accepting closed and proprietary systems that operate in stand-alone silos are gone.
- Building owners are demanding connectivity in the systems that are being designed into their facilities to maximize their investment – to that end, these systems need to be able to speak in a common language, and the current standard protocol in commercial building applications is BACNet. LonWorks is another open protocol example, but has a smaller implementation percentage in this marketplace.
- BACNet is a communication protocol that was developed to allow for open and standard communication between building systems and became an ASHRAE/ANSI standard in 1995 and has been growing in its' acceptance ever since.

Specifying Integratable Solutions

- Unfortunately, simply specifying a requirement that a system support BACNet or any other 'open' communication protocol does not guarantee any level of application support and specifically, any desired method of actual integrated control functionality.
- BACNet is not the panacea that we all hoped for – connectivity is not the end-all, be-all in the integration world.
- Connecting the systems together is only the first step in a relatively long journey toward a usefully-integrated facility.
- For new-construction projects, consulting and specifying engineers can include fully-integrated control sequences in the project requirements, greatly enhancing the functionality of these integrated systems.
- For owner-direct and retrofit applications, owners will typically rely on the experience and capabilities of the system integrators.

Standards vs. API Connectivity

- Some LCS vendors that do not support an open standard protocol offer a software API (Application Programming Interface) to allow connectivity to their systems. While this might simplify the interface process for the vendor, it is less-desirable from an integration standpoint for a few reasons:
  - Not all Integration platforms support the creation of a custom software application that will allow for this interaction
  - The use of an API adds additional complexity to the integration process, which adds expense in the form of higher-cost programmer labor (there are more BACNet-experienced integrators than there are software programmers) and increased project interaction between the two vendors
  - The API leaves two potentially-fragile points of failure in the system – the source API logic, which is subject to modifications during system upgrades, as well as the receiving code in the integration platform
- From an integration perspective, standard protocols are preferred

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Real world integration example

- Real-world CLS integration use case
  - Leverage lighting control system (LCS) occupancy sensors to set HVAC zone controls into an 'Unoccupied' or 'Standby' state when the occupancy detectors sense complete zone vacancy
  - Utilize LCS power sensing capability (when available) to calculate and report on lighting zone energy consumption
  - Calculate, trend and report on zone-based daily occupancy percentage values
  - Alarm on fixture or bulb failure status and log fixture burntime, when available
- Use Case Requirements
  - Identify HVAC control zones
    - Provide HVAC zone naming and coverage info to LCS contractor, have them provide a LCS output point that aligns with the HVAC zones (rarely occurs)
  - Review LCS zones and create logical 'neighborhoods' that aggregate all of the LCS sensors that make up a zone of HVAC control
  - Link LCS points to integration logic, test and implement

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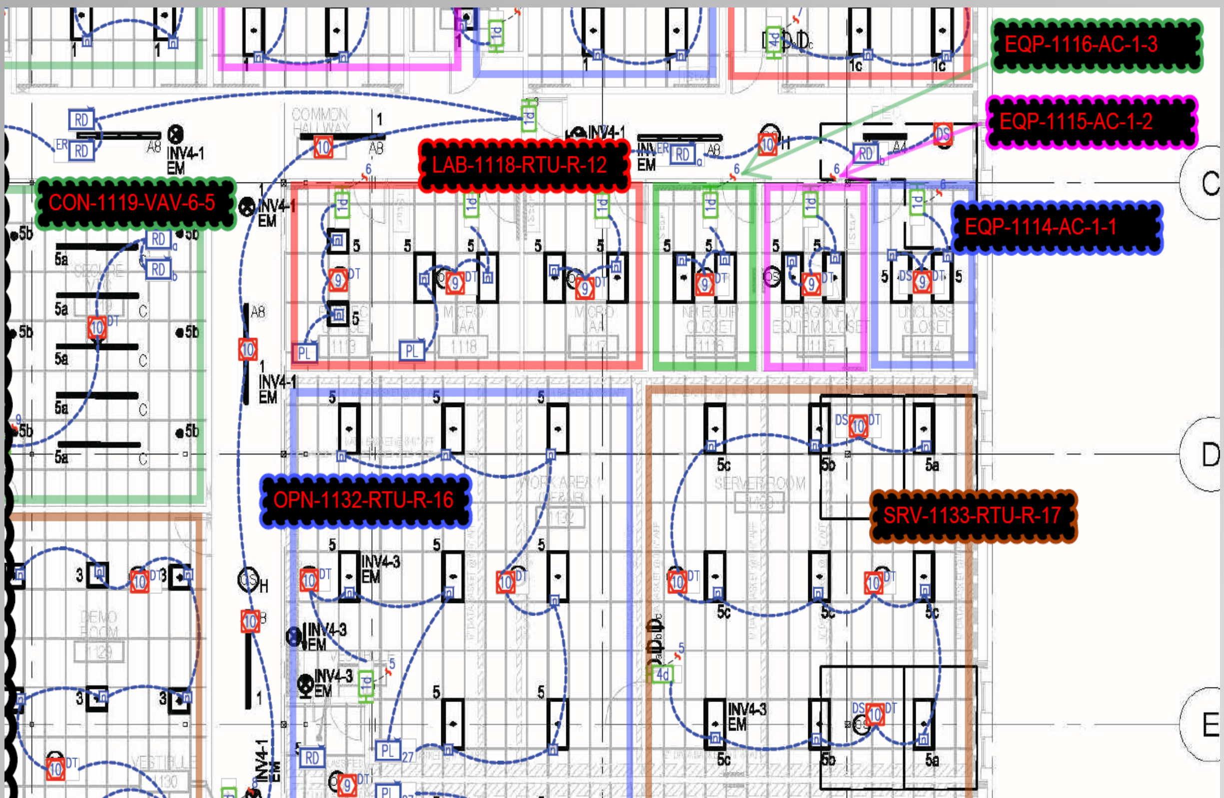
Sifting Through the Information

- Real-world examples – Lighting Control Design Drawings



Each of the HVAC zones are outlined, given a unique tagging name that defines the space use type, room number and HVAC equipment that serves it.

This information is typically given to the LCS contractor so that they can aggregate their lighting control zones if/when they have more than one zone that serves an HVAC space.

Unfortunately, this type of cooperation rarely happens. Usually, the Integrators have to determine the information manually.

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Sifting Through the Information

- BACNet point discovery

Bacnet Discover Points

Discovered

Object Name	Object ID	Property ID	Index	Value
0095BCC7 - nIO-EZ-PH - nIO EZ PH Rm 1129 - Dimming Input Level	analogInput: 106602	presentValue		0.00
0095BCC7 - nIO-EZ-PH - nIO EZ PH Rm 1129 - Dimming Output Level P1	analogValue: 106611	presentValue		0.00
0095BCC7 - nIO-EZ-PH - nIO EZ PH Rm 1129 - Online	binaryInput: 106600	presentValue		Active
0095BCC7 - nIO-EZ-PH - nIO EZ PH Rm 1129 - Relay State P1	binaryValue: 106631	presentValue		Inactive
0096B3B7 - nIO-EZ-PH - nIO EZ PH Rm 1041 - Dimming Input Level	analogInput: 142202	presentValue		0.00
0096B3B7 - nIO-EZ-PH - nIO EZ PH Rm 1041 - Dimming Output Level P1	analogValue: 142211	presentValue		100.00
0096B3B7 - nIO-EZ-PH - nIO EZ PH Rm 1041 - Online	binaryInput: 142200	presentValue		Active
0096B3B7 - nIO-EZ-PH - nIO EZ PH Rm 1041 - Relay State P1	binaryValue: 142231	presentValue		Active
00989CE2 - nIO-EZ-PH - nIO EZ PH Rm 1144 - Dimming Input Level	analogInput: 170602	presentValue		0.00
00989CE2 - nIO-EZ-PH - nIO EZ PH Rm 1144 - Dimming Output Level P1	analogValue: 170611	presentValue		100.00
00989CE2 - nIO-EZ-PH - nIO EZ PH Rm 1144 - Online	binaryInput: 170600	presentValue		Active
00989CE2 - nIO-EZ-PH - nIO EZ PH Rm 1144 - Relay State P1	binaryValue: 170631	presentValue		Active
009CB45F - nIO-EZ-PH - nIO EZ PH Rm 1142 - Dimming Input Level	analogInput: 135602	presentValue		0.00
009CB45F - nIO-EZ-PH - nIO EZ PH Rm 1142 - Dimming Output Level P1	analogValue: 135611	presentValue		0.00
009CB45F - nIO-EZ-PH - nIO EZ PH Rm 1142 - Online	binaryInput: 135600	presentValue		Active
009CB45F - nIO-EZ-PH - nIO EZ PH Rm 1142 - Relay State P1	binaryValue: 135631	presentValue		Inactive
009CB522 - nIO-EZ-PH - nIO EZ PH Rm 1148 A - Dimming Input Level	analogInput: 146302	presentValue		0.00
009CB522 - nIO-EZ-PH - nIO EZ PH Rm 1148 A - Dimming Output Level P1	analogValue: 146311	presentValue		100.00
009CB522 - nIO-EZ-PH - nIO EZ PH Rm 1148 A - Online	binaryInput: 146300	presentValue		Active
009CB522 - nIO-EZ-PH - nIO EZ PH Rm 1148 A - Relay State P1	binaryValue: 146331	presentValue		Active
009D1590 - nIO-EZ-PH - nIO EZ PH Rm 1031 - Dimming Input Level	analogInput: 159702	presentValue		0.00
009D1590 - nIO-EZ-PH - nIO EZ PH Rm 1031 - Dimming Output Level P1	analogValue: 159711	presentValue		0.00
009D1590 - nIO-EZ-PH - nIO EZ PH Rm 1031 - Online	binaryInput: 159700	presentValue		Active
009D1590 - nIO-EZ-PH - nIO EZ PH Rm 1031 - Relay State P1	binaryValue: 159731	presentValue		Inactive
009D16F6 - nIO-EZ-PH - nIO EZ PH Rm 1031 - Dimming Input Level	analogInput: 159602	presentValue		0.00

When we have to manually extract the system information, we rely on the BACNet 'discovery' functionality. This allows us to query the systems and they reply back with the data points as their system provides them.

In this case, we can see the values are not very 'human-friendly', which means we need to parse through the information, extract those points that we need and then add them to the Integration platform.

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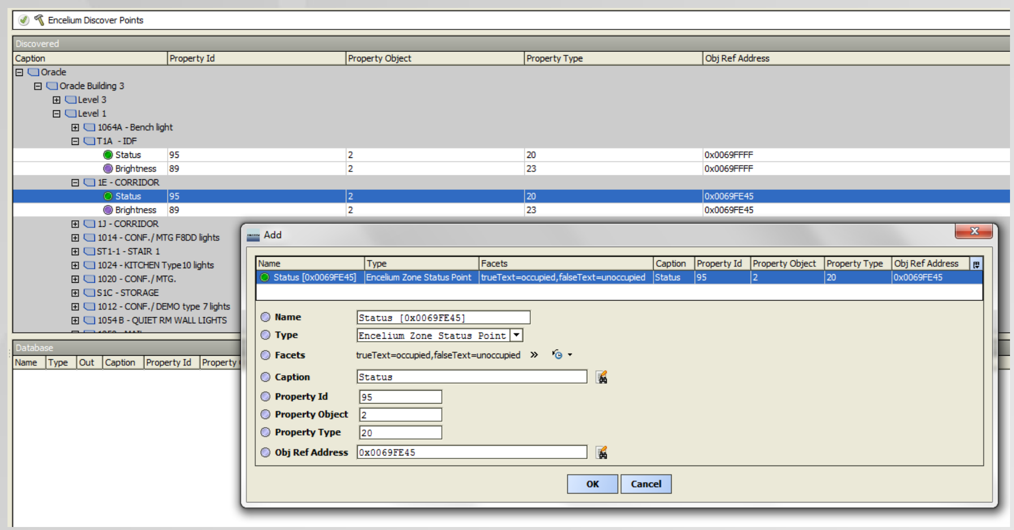
Sifting Through the Information

- Not all system data is created equally

0x018A46D8 {RSSI}	analogInput:137999	presentValue	-82.00	[A5-04-01] Temperature and Humidity Sensor, SignalStrength
0x01A2542C [0] (1) Current Dim Level	analogInput:138001	presentValue	92.00	[D2-40-00] LED Controller Status, Current Dim Level
0x01A2542C {RSSI}	analogInput:138999	presentValue	-82.00	[D2-40-00] LED Controller Status, SignalStrength
0x019B41C0 [0] (3) Supply voltage / super cap. (linear); 251-255 reserved for error code	analogInput:139003	presentValue	2.60	[A5-07-01] Occupancy Sensor, Supply voltage / super cap. (linear); 251-255 reserved for error code
0x019B41C0 {RSSI}	analogInput:139999	presentValue	-67.00	[A5-07-01] Occupancy Sensor, SignalStrength
0x0192FBBC [0] (2) Illumination 0-1,020 (linear)	analogInput:140002	presentValue	40.00	[A5-06-02] Light Sensor, Illumination 0-1,020 (linear)
0x0192FBBC [0] (3) Illumination 0-510 (linear)	analogInput:140003	presentValue	0.00	[A5-06-02] Light Sensor, Illumination 0-510 (linear)
0x0192FBBC [0] (4) Supply voltage (linear)	analogInput:140004	presentValue	3.50	[A5-06-02] Light Sensor, Supply voltage (linear)
0x0192FBBC {RSSI}	analogInput:140999	presentValue	-54.00	[A5-06-02] Light Sensor, SignalStrength
0x01A24772 [0] (1) Current Dim Level	analogInput:141001	presentValue	0.00	[D2-40-00] LED Controller Status, Current Dim Level
0x01A24772 {RSSI}	analogInput:141999	presentValue	-70.00	[D2-40-00] LED Controller Status, SignalStrength
0x0198C7AC [0] (3) Supply voltage / super cap. (linear); 251-255 reserved for error code	analogInput:143003	presentValue	4.30	[A5-07-01] Occupancy Sensor, Supply voltage / super cap. (linear); 251-255 reserved for error code
0x0198C7AC {RSSI}	analogInput:143999	presentValue	-72.00	[A5-07-01] Occupancy Sensor, SignalStrength
0x019619DD [0] (1) Current Dim Level	analogInput:144001	presentValue	174.00	[D2-40-00] LED Controller Status, Current Dim Level
0x019619DD {RSSI}	analogInput:144999	presentValue	-70.00	[D2-40-00] LED Controller Status, SignalStrength
0x01A23676 [0] (1) Current Dim Level	analogInput:145001	presentValue	130.00	[D2-40-00] LED Controller Status, Current Dim Level
0x01A23676 {RSSI}	analogInput:145999	presentValue	-67.00	[D2-40-00] LED Controller Status, SignalStrength

Different systems present their data differently, and they are all different.

Some systems use a native Niagara driver that allows their system information to be presented in the Tridium Niagara framework level. For those Integration systems that utilize Niagara, this can expedite the integration process.



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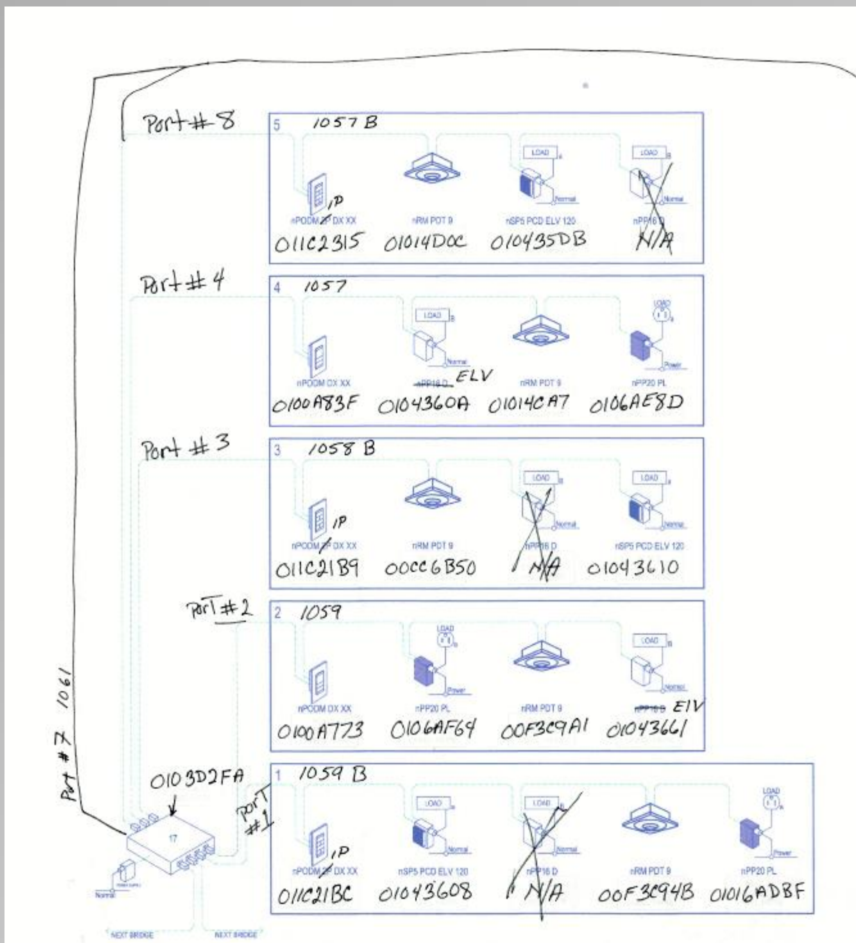
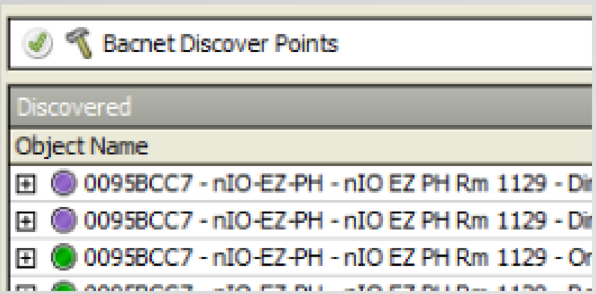
Sifting Through the Information

- Vendor-provided data is not always very useful



Sometimes, we have to rely on information provided by the system vendor to locate the control devices installed and their location in the facility.

In this actual sample of a recent lighting control system As-Built documentation, the vendor was kind enough to align the devices installed in each zone with the MAC address of the device in their system.



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Intelligent Integration Example

- **Lighting System Integration** – Primary Monitoring, Control, Alarming and Trending
  - Smart Building Integrated Sequences of Operation – Reservation & Occupancy Based Lighting
    - Bay Level Rules Apply –
    - Conference Room Level Rules Apply– Special Blinking Sequences at end of reservation
  - Stand alone Lighting Control, Alarming and Trending:
    - Lighting Zone Floor Plans & Individual Lighting Zones
  - Shade Controls – Monitoring and Control of Shade positions

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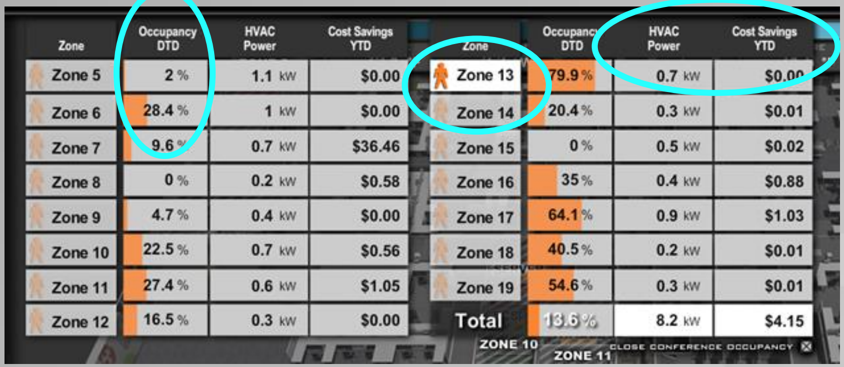
Intelligent Integration Example

- Reporting Levels and KPI’s: Floor Level Energy Conservation Measures
- Key Inputs: Electricity, HVAC, Lighting, Plug Load, Weather, Occupancy, Operational Schedule
- Features: Sustainable **Occupancy** Driven HVAC/Lighting/Plugload Automation and Reporting Analysis



Zone	Occupancy DTD	HVAC Power	Cost Savings YTD	Zone	Occupancy DTD	HVAC Power	Cost Savings YTD
Zone 5	2 %	1.1 kW	$0.00	Zone 13	79.9 %	0.7 kW	$0.00
Zone 6	28.4 %	1 kW	$0.00	Zone 14	20.4 %	0.3 kW	$0.01
Zone 7	9.6 %	0.7 kW	$36.46	Zone 15	0 %	0.5 kW	$0.02
Zone 8	0 %	0.2 kW	$0.58	Zone 16	35 %	0.4 kW	$0.88
Zone 9	4.7 %	0.4 kW	$0.00	Zone 17	64.1 %	0.9 kW	$1.03
Zone 10	22.5 %	0.7 kW	$0.56	Zone 18	40.5 %	0.2 kW	$0.01
Zone 11	27.4 %	0.6 kW	$1.05	Zone 19	54.6 %	0.3 kW	$0.01
Zone 12	16.5 %	0.3 kW	$0.00	Total	13.6 %	8.2 kW	$4.15

Typical use case in an integrated system application can provide Zone-based occupancy states, occupancy daily (or other) percentages, power consumption, cost savings, burntime, etc.

In addition to zone-based data summaries, a connected and intelligent system can provide us with the ability to interact with space scheduling and reservation systems, as we show here for a customer who wanted to display the conference rooms in a separate data table.

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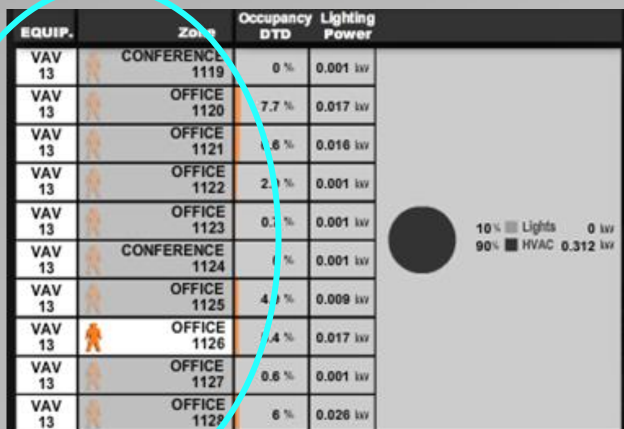
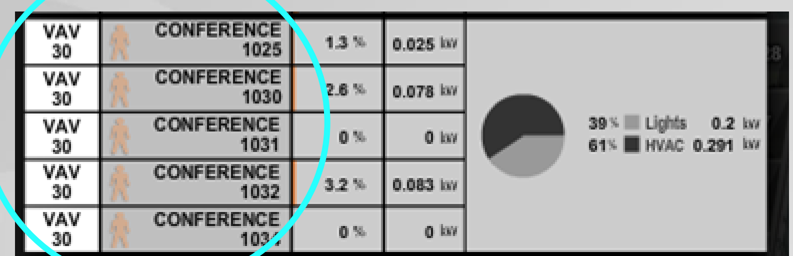
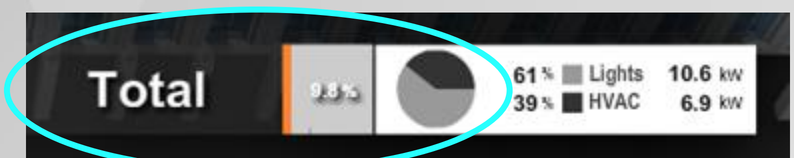
Intelligent Integration Example

- Individual lighting zones that are served by a single HVAC zone are grouped together for visibility – if any lighting sensor input detects Occupancy, the HVAC zone is left in 'Occupied' mode
- If all lighting sensors in a zone show vacancy, the HVAC zone is set to 'Unoccupied' mode
- The floor summaries are calculated and are trended for analysis, reporting, etc.



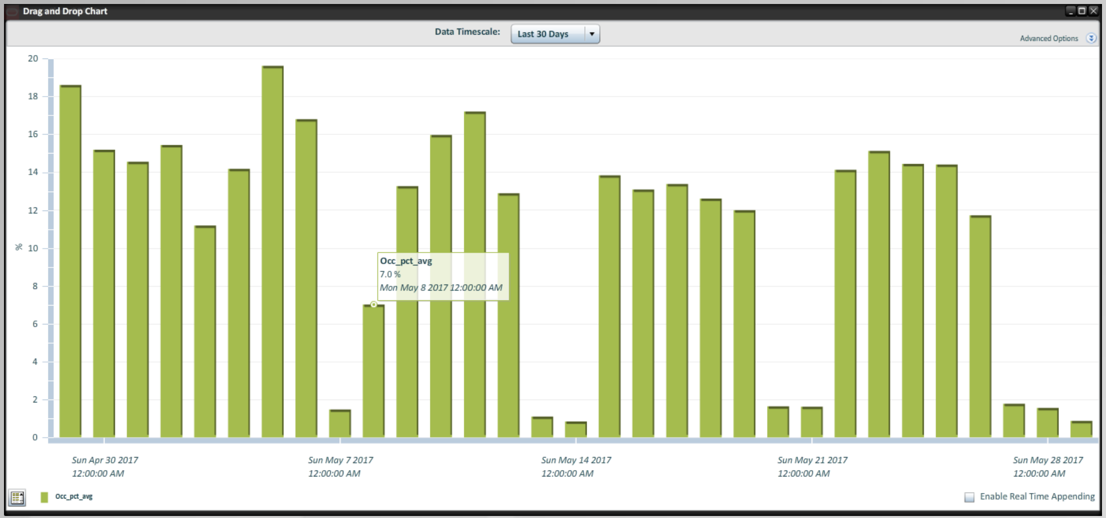


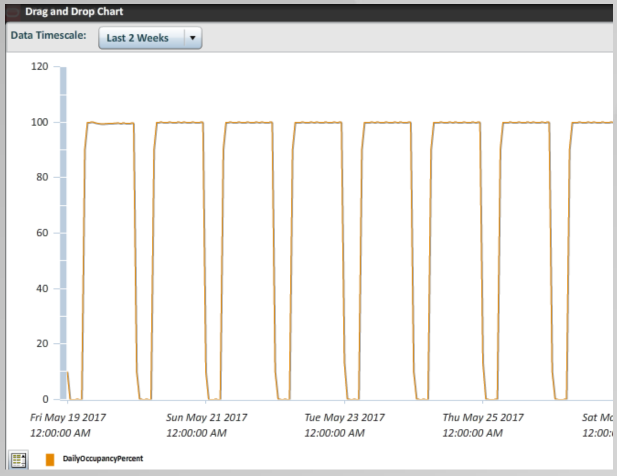


Intelligent Integration Example

- Once all of the sensors are integrated, their data can be used for analysis, reporting and analytical purposes, similar to any other data source

System data points like the daily occupancy percentage for a fixture, zone, floor or building can be trended for usage analysis





Performance analytics can be used to identify zone data points that indicate a failure to operate correctly – this example of a conference room occupancy sensor that never changes state during daily occupied periods warrants further investigation to determine the root cause of the failure

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What's Next

- What would help facilitate the integration of a CLS into more facilities?
- If we push for more facilities to include functional integration, the process will be simplified, the costs will decrease and performance expectations will rise (Do you remember when power windows were a luxury options in our cars? Keyless entry system?)
- A standardized data model would simplify the data integration process – the 'IoT Ready' Alliance is striving to create a physical standard for intelligent sensors used in lighting control systems, but doesn't appear to attempt to standardize on the data provided from those sensors.
- Naming standards should be utilized – Project Haystack has a lighting systems group established already and could be leveraged to provide additional data points, as they are defined, in an open-source forum

Q&A

- Questions and Answers?

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