



Welcome to GASFA!

We are so glad to see everyone!





Integration of Building Automation Systems (BAS)

AGENDA

1. Introductions
2. What is an 'Integrator'? Why is this important to the Owner?
3. Protocols! What'll Ya Have?
4. BACnet compliant?
5. System Architecture Examples
6. Integration Examples w/ Screen Captures
7. Summary
8. Questions & Answers



Integration of Building Automation Systems (BAS)

INTRODUCTIONS

Gary Paoletta – Kennesaw State University
Senior Engineer



Jeff Boston – Control Concepts, LLC
Business Development Manager

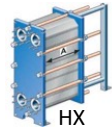
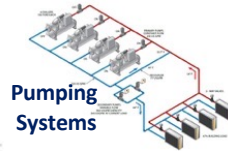


Integration of Building Automation Systems (BAS)

Facility Management? Controls? Isn't that just comfort control?



Integration of Building Automation Systems (BAS) Reality - many different Systems to Understand!



A3.2 M6.5 E1.0
P2.3
Design Documents



SECTION 23 0993
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

Integration of Building Automation Systems (BAS)

What exactly is an 'Integrator'?

Integrators utilize industry standards to include best in class technologies to design & implement integrated software and hardware solutions for Building Automation Systems.

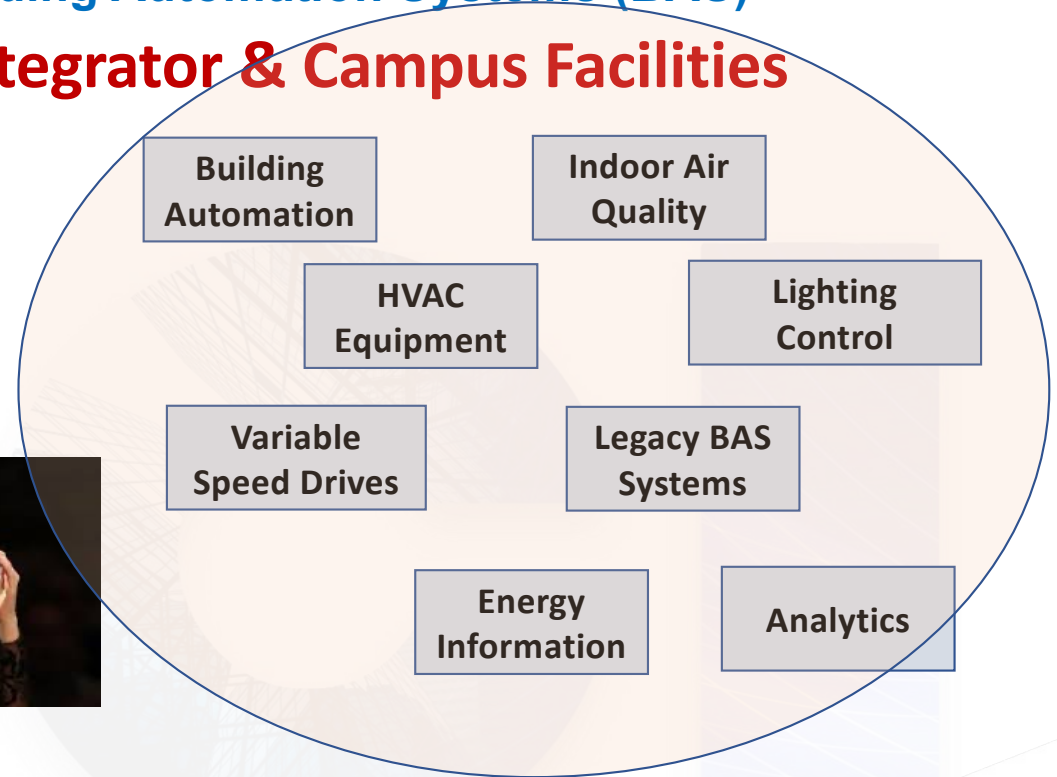


Integration of Building Automation Systems (BAS) Role of the Integrator & Campus Facilities

As the various HVAC and Building Systems include communications capabilities, the significance of an Integrator is of utmost importance.



The Integrator is like the conductor of an orchestra - bringing all of the different systems into harmony.



Integration of Building Automation Systems (BAS)

Important Considerations

- Innovative Technology & Solutions
- Utilize Open Systems
- Documentation/As Builts
- Training of Staff
- Experience matters
- Unwavering Commitment to Quality
- Customer Advocate
- Industry Reputation



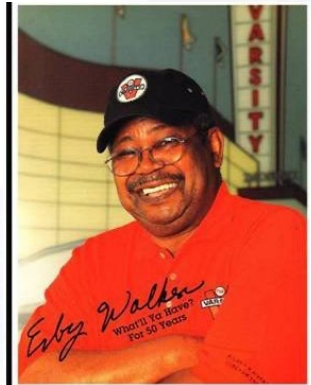


Integration of Building Automation Systems (BAS)

Understanding BAS Protocols

Everything we need to know about understanding Protocols, can be learned at the....

THE VARSITY



WHAT'LL YA HAVE?!

Erby Walker was one of the most well-known employees after working fifty-five years at the Varsity....Because of his loyalty, language, and southern hospitality, his presence created an aroma of familiarity and happiness....

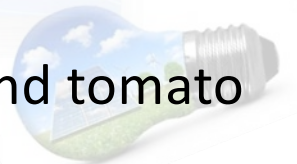




Integration of Building Automation Systems (BAS)

The Varsity 'Lingo' (from their website)

Naked Dog	= Plain Hot Dog on a Bun
Red Dog	= Naked Dog with Ketchup
Strings	= An order of French Fries
F.O.	= Frosted Varsity Orange Drink
P.C.	= Chocolate milk served with ice
Joe Ree	= Coffee with Cream
Glorified Steak	= Hamburger with mayo, lettuce and tomato



Integration of Building Automation Systems (BAS)

Let's Order!

WHAT'LL YA HAVE?

What we say...

*I would like 2 hot dogs with ketchup,
one hamburger with mayonnaise, lettuce and tomato,
an order of French fries and a frosted orange.
This is to go.*

What they say...

Gimme 2 Red Dogs, 1 Glorified, Strings, and a FO walking

Understanding what is being communicated is essential!



Integration of Building Automation Systems (BAS)

Interpretation...can be a challenge

A good integrator understands the different languages (protocols)



Sometimes even the same language can be hard to understand!

'Pahk the cah in Hahvahd Yahd'

The same is true with BAS Protocols, interpretation may be required.





Integration of Building Automation Systems (BAS) So many Protocols (Lingo) to Understand!

Comm4/5

BACnet

FLN

AC256

System 600

Veeder-Root

Infinet

'Proprietary'

CCN

LON



AAM PHP

OPC

Continuum

DALI

Modbus

Apogee

N2





Integration of Building Automation Systems (BAS)

Most Common Protocol = BACnet...or is it?

Unfortunate reality...multiple considerations for Integration solution

Not everyone adheres to the defined standards of 'BACnet'

1. Which media is used for the communications?
 - a) RS-485 (mstp)
 - b) Ethernet (BACnet over IP)
 - c) Other/Proprietary/Non Industry Standard
2. What is the baud rate/communication parameters?
 - a) Different systems could communicate slower or faster – depends on capabilities
3. If BACnet, does the manufacturer automatically default to **exposing** their points to other systems?
4. HVAC Equipment Manufacturer Factory provided controls - can they 100% adhere to the Design Parameters and Sequence of Operations per the Engineer's specifications?





Integration of Building Automation Systems (BAS)

BACnet Compliance – Unfortunate Reality

Equipment I/O Points Alarm Sources Trend Sources Network Points Equipment Checkout BACnet Points Rm 128 - V1-6A : Equipment

Control Program property differences detected. Upload properties from the controller, download properties to the controller, or click Details for more information.

Upload Download Details

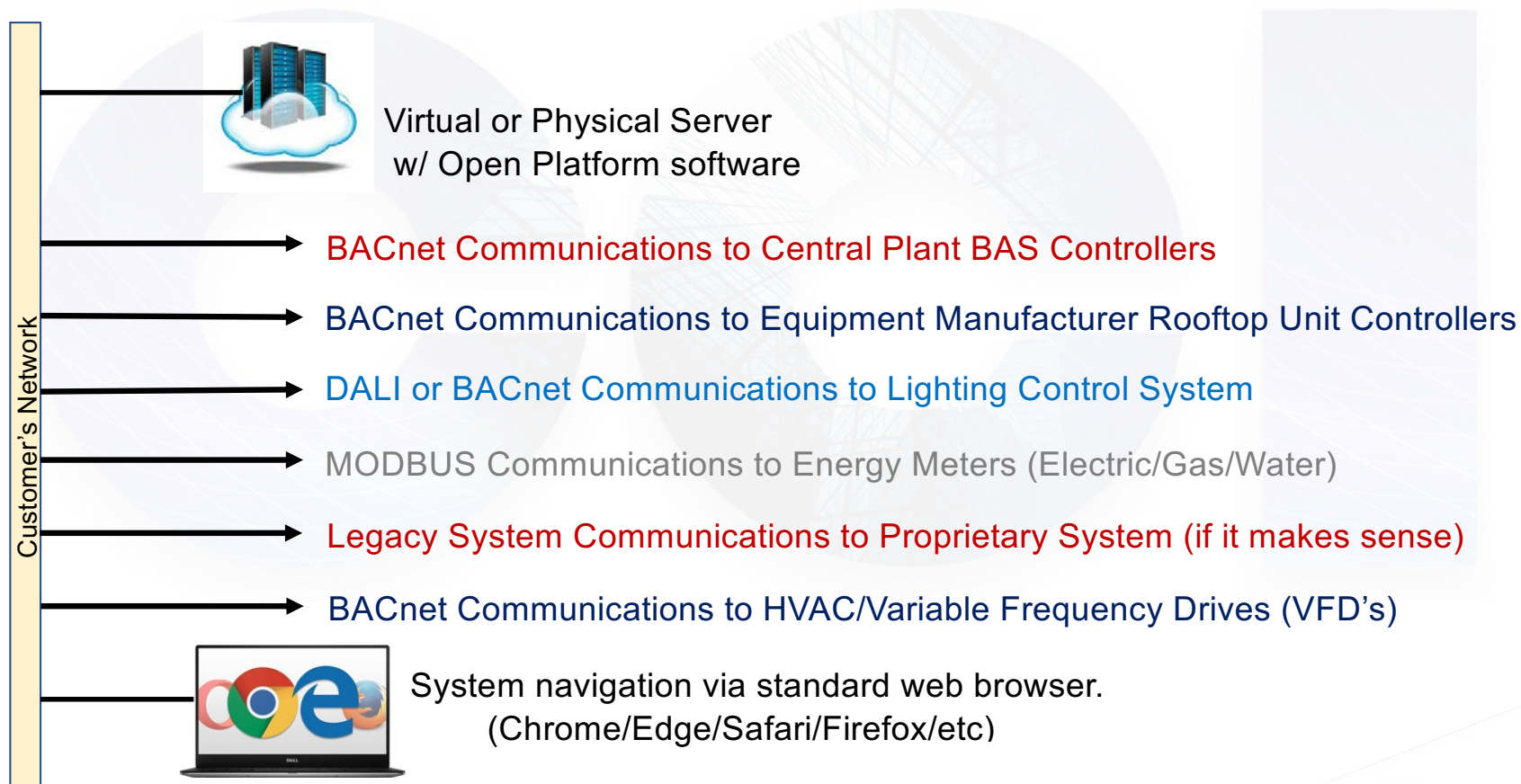
Name	Reference name	Type	Value	Object Name	Object Id	Network Visible
Flow Control						
Flow Input	air_flow	(BAF)				<input checked="" type="checkbox"/>
Flow Input	flow_input	(BAI)	65 cfm	flow_input	Analog Input 0, #1	<input checked="" type="checkbox"/>
Zone Temp Sensor						
Zone Temp	zone_temp	(BRS)				<input checked="" type="checkbox"/>
Zone Temp	zone_temp	(BAI)	72.5 °F	zone_temp	Analog Input 0, #2	<input checked="" type="checkbox"/>
Override Time Remaining	override_time_remaining	(BAV)		override_time_remaining	Analog Value 2, #1	<input checked="" type="checkbox"/>
Setpoint						
Effective Heating Setpoint	effective_heat_setpoint	(BAV)		effective_ht_stpt	Analog Value 2, #5	<input checked="" type="checkbox"/>
Effective Cooling Setpoint	effective_cool_setpoint	(BAV)	78 °F	effective_cl_stpt	Analog Value 2, #4	<input checked="" type="checkbox"/>
Cooling Setpoint Adjust	cooling_setpoint_adj	(BAV)	2 °F	cl_stpt_adj	Analog Value 2, #2	<input type="checkbox"/>
Heating Setpoint Adjust	heating_setpoint_adj	(BAV)	2 °F	ht_stpt_adj	Analog Value 2, #3	<input type="checkbox"/>
Cooling Setpoint	cooling_setpoint	(BAV)	80 °F	unocc_cl_stpt	Analog Value 2, #3003	<input checked="" type="checkbox"/>
Heating Setpoint	heating_setpoint	(BAV)	60 °F	unocc_ht_stpt	Analog Value 2, #3004	<input checked="" type="checkbox"/>
Cooling Setpoint	occupied cool setpoint	(BAV)	76 °F	occ_cl_stpt	Analog Value 2, #3001	<input checked="" type="checkbox"/>
Heating Setpoint	occupied heat setpoint	(BAV)	70 °F	occ_ht_stpt	Analog Value 2, #3002	<input checked="" type="checkbox"/>
CO2 Sensor	co2_sensor	(BAI)	0.00	co2_sensor	Analog Input 0, #3	<input type="checkbox"/>
RH Sensor	srh_sensor	(BAI)	0.00	srh_sensor	Analog Input 0, #4	<input type="checkbox"/>
SAT Sensor	sat_sensor	(BAI)	56.6 °F	sat_sensor	Analog Input 0, #5	<input type="checkbox"/>
Zone Temp	zone_temp t55	(BAI)	-60.0 °F	zone_temp_t55	Analog Input 0, #6	<input type="checkbox"/>
Occupancy Contact State	occ_switch	(BBI)		occ_switch	Binary Input 3, #1001	<input checked="" type="checkbox"/>
Sensor Invalid	rnet_invalid	(BBI)	Off	rnet_invalid	Binary Input 3, #1	<input type="checkbox"/>
Hot Water Valve	hw_valve	(BAO)	0 %	hw_valve	Analog Output 1, #1	<input checked="" type="checkbox"/>
Fan S/S or EH 3	fan	(BBO)	Off	fan	Binary Output 4, #1	<input type="checkbox"/>
Heating Stage 1	htg_stg1	(BBO)	Off	htg_stg1	Binary Output 4, #2	<input type="checkbox"/>

*** Note * - Integration does not fix a system issue! If something is not functioning in a stand-alone mode (prior to integration), it definitely won't work after.**



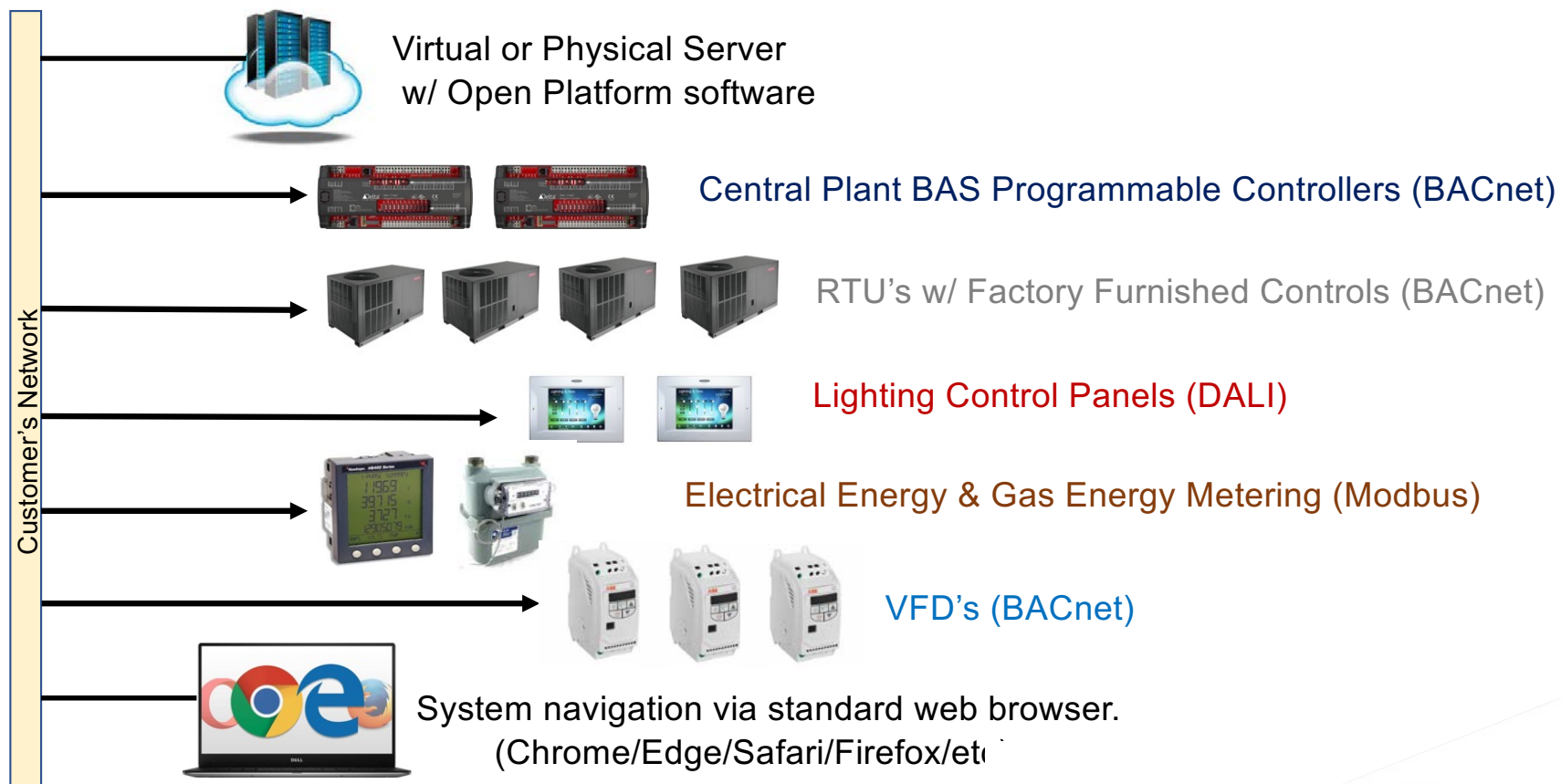
Integration of Building Automation Systems (BAS)

Example – Integrated Automation System Architecture



Integration of Building Automation Systems (BAS)

Example – Integrated Automation System Architecture





Integration of Building Automation Systems (BAS)

BAS Integration Examples





Integration of Building Automation Systems (BAS)

Example #1 – Town Point Office Building, Kennesaw, Ga

Quick Facts

4 Story Office Building

Built 1999 (22 years old)

Transitioned from Commercial Use to Front Office/Admin for KSU

Mechanical System Overview

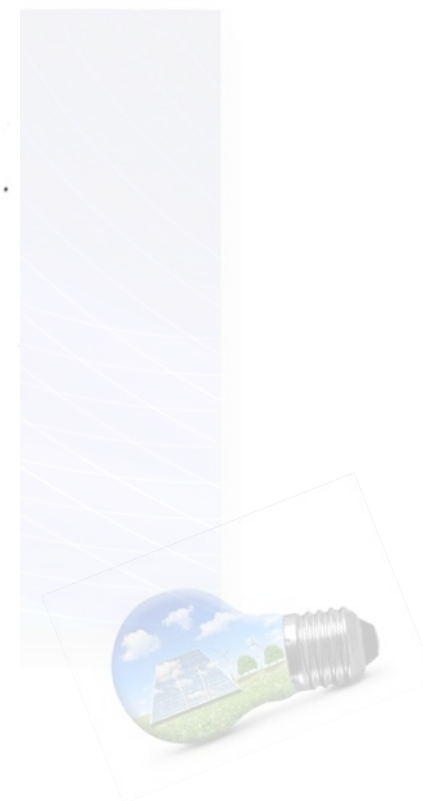
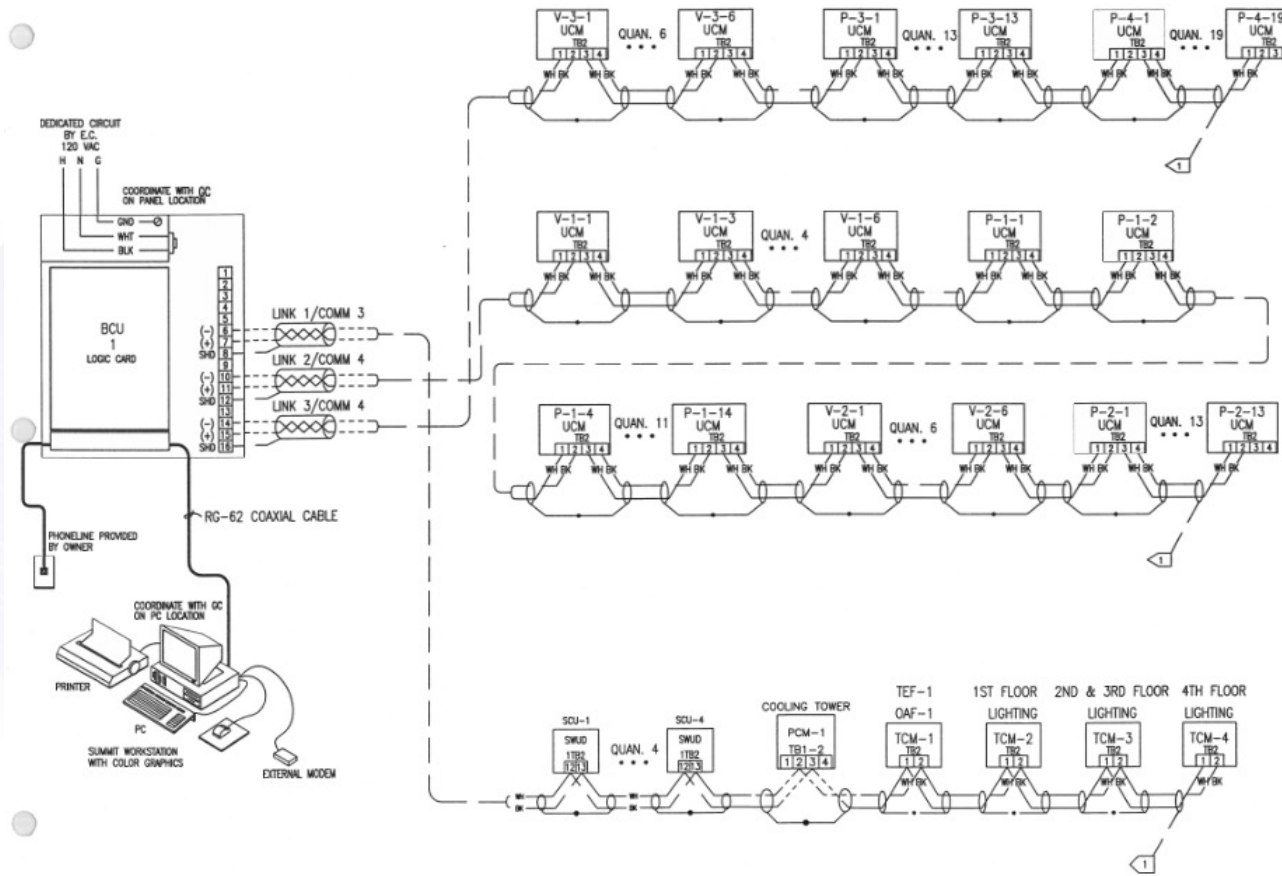
- AHU per Floor (SWUD)
- Terminal Units (VAV's PIU's)
- Cooling Tower/Pumps/etc.
- Existing Control System w/ proprietary protocol





Integration of Building Automation Systems (BAS)

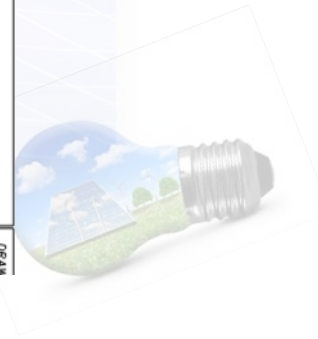
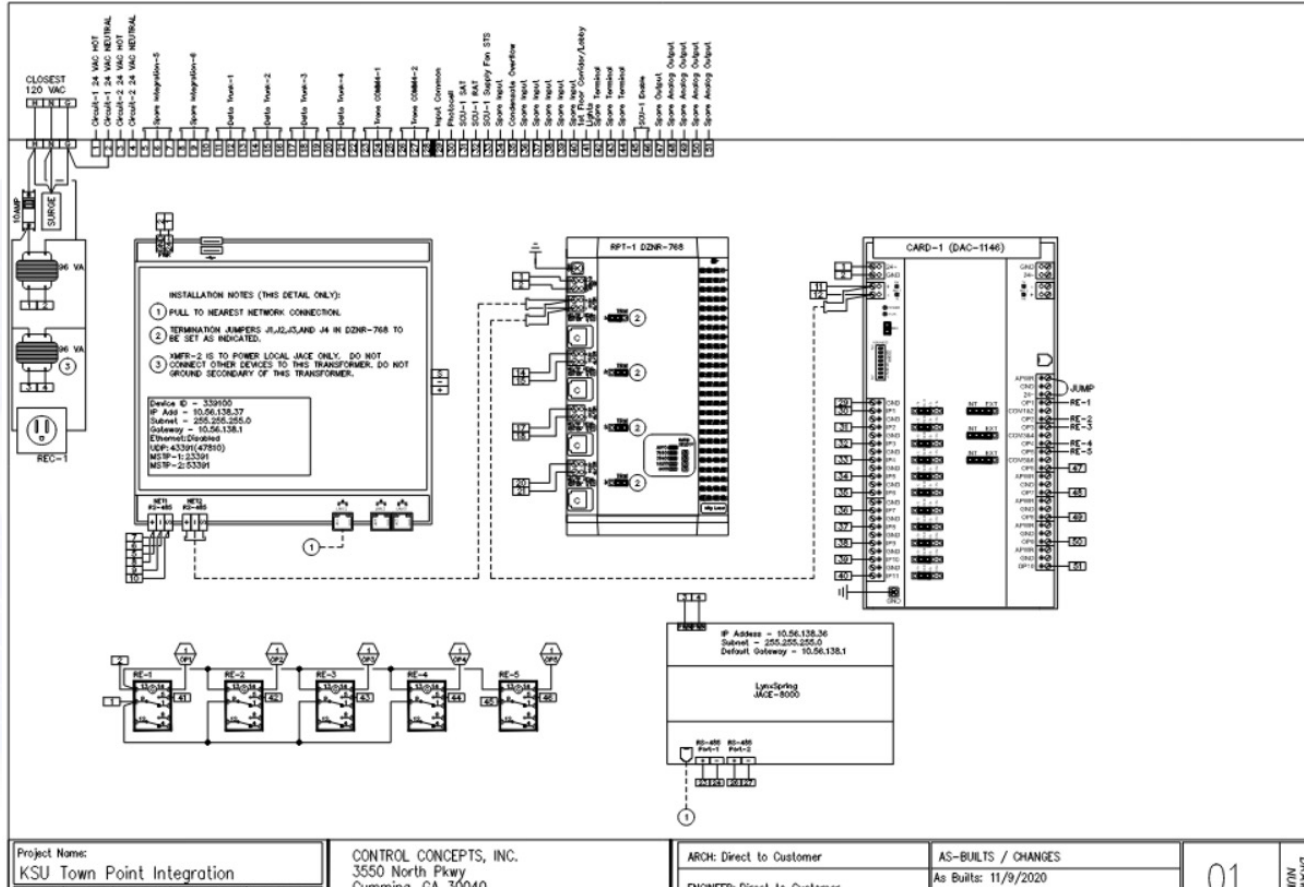
Example #1 – Town Point Original Controls Drawing





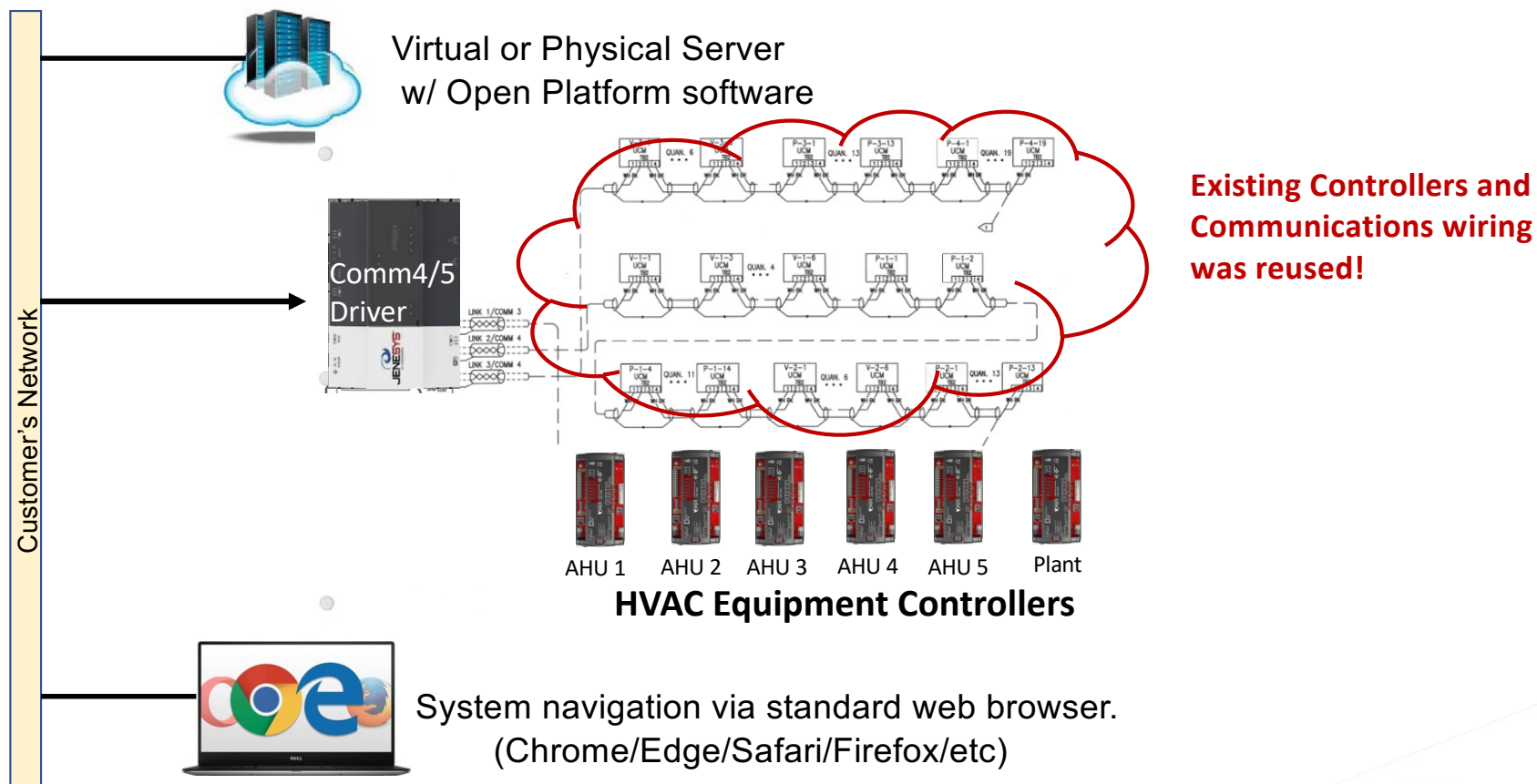
Integration of Building Automation Systems (BAS)

Example #1 – Town Point Integration Control Drawing



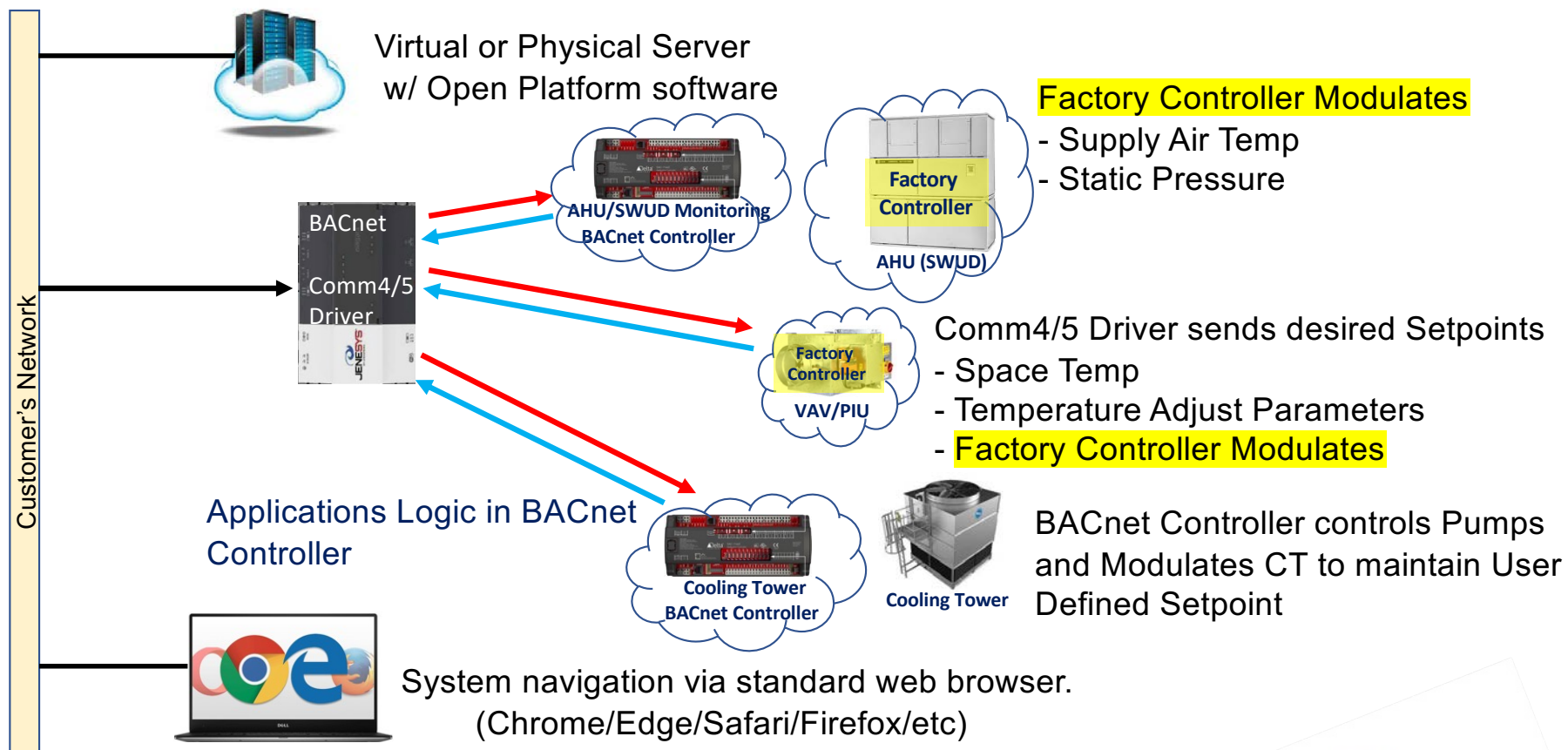
Integration of Building Automation Systems (BAS)

Example #1 – System Architecture



Integration of Building Automation Systems (BAS)

Example #1 – Architecting the Solution



KENNESAW STATE
UNIVERSITY



Integration of Building Automation Systems (BAS)

Navigation Graphic Examples



Integration of Building Automation Systems (BAS)



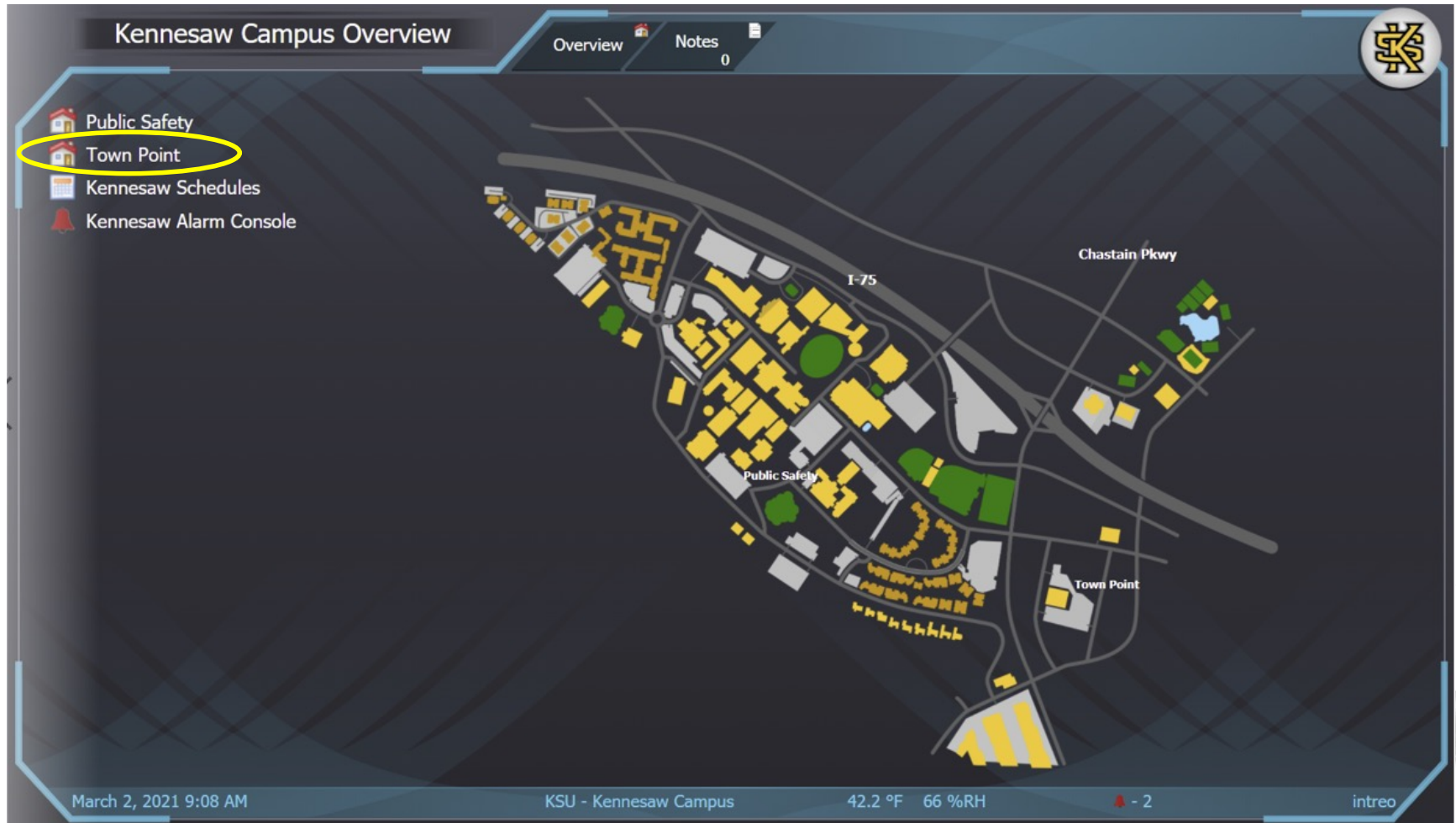
The screenshot displays a software interface for Kennesaw State University's Building Automation System (BAS). At the top, the title "Kennesaw State University" is shown on the left, and navigation options "Overview" and "Notes 0" are on the right. A Kennesaw State University logo is in the top right corner. A legend on the left side lists the following items: "Kennesaw Campus" (house icon), "Marietta Campus" (house icon), "Alarm Console" (bell icon), "iNTREO Network Devices" (server rack icon), and "Control As-Builts" (document icon). The main area features two maps: "Marietta" on the left and "Kennesaw" on the right. The "Kennesaw" map has a yellow oval around its label. In the bottom right corner, there is a graphic of a glowing lightbulb with a globe inside, symbolizing ideas or technology.

Integration of Building Automation Systems (BAS)

KENNESAW STATE UNIVERSITY



 Control Concepts





Integration of Building Automation Systems (BAS)

Town Point Overview

Overview
Notes
0

Town Point Plant
 Kennesaw Schedules
 Kennesaw Alarm Console

Unit	Supply Temp	Supply Stpt	Return Temp	Plant Call
CW Plant	47.8 °F	46.0 °F	48.8 °F	On

4th Floor

3rd Floor

2nd Floor

1st Floor

Unit	Supply Temp	Return Temp	Occupancy	Unit Enable	SFan Status
SCU-1	57.6 °F	69.4 °F	Occupied	On	On
SCU-2	57.7 °F	71.6 °F	Occupied	On	On
SCU-3	56.4 °F	71.9 °F	Occupied	On	On
SCU-4	59.8 °F	69.1 °F	Occupied	On	On

Condensate Drain Overflow: ● Normal

*Condensate lines for all the SCU's drain to the 1st floor mechanical room

March 2, 2021 9:04 AM
KSU - Kennesaw Campus
42.2 °F 66 %RH
▲ - 2
intreo



Integration of Building Automation Systems (BAS)





Integration of Building Automation Systems (BAS)

SCU-3

Graphic Overrides Trends Alarms Notes

3rd Floor

**The SCU's are only enabled by the BAS, and sensors are for monitoring only.
**Not all components are monitored. Graphic may not represent their actual state.*

Occupancy: **Occupied**
Unit Enable: **On**
SCU Lockout: **Auto**

RAT: **72.5 °F**

Return Air

Economizer Coil

Fan Status: **On**

SAT: **58.7 °F**

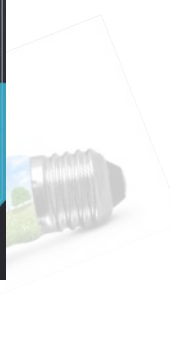
Supply Air

Outside Air From Mech Room

CW Supply Temp: **76.9 °F**
CW Return Temp: **81.3 °F**
CW Pump Running: **On**

**Sensors are located in the plant.*

August 13, 2021 2:33 PM KSU - Kennesaw Campus 89.6 °F 40 %RH - 0 intreo





Integration of Building Automation Systems (BAS)



Integration of Building Automation Systems (BAS)

KENNESAW STATE UNIVERSITY



Control Concepts

PIU-3-1

Graphic **Settings** Overrides 0 Trends Alarms 0 Notes 0

3815

Fan Call: **Off**
Fan Lockout: **Normal**

SCU-3
SAT: **56.3 °F**

Damper Position: **10 %**
Airflow: **141 cfm**

Click To Recalibrate.
SCU should be off for proper calibration

Supply Air

Heat Call: **Off**
Heat Lockout: **Normal**

Thumbwheel: **Enabled**
Wheel SP: **84.2 °F**

Effective Cool	Effective Heat
76.0 °F	74.0 °F

74.4 °F

0 % 0 %

*Demand is an estimate only. Controller does not provide demand.

Occupied
TRANE

Mode: **Deadband**

March 2, 2021 9:09 AM KSU - Kennesaw Campus 42.2 °F 65 %RH - 2 intreo

Integration of Building Automation Systems (BAS)

KENNESAW STATE UNIVERSITY



Control Concepts

PIU-3-1

3815

Graphic Settings Overrides Trends Alarms 0 Notes 0

Space Temperature Settings

Occupied Cooling Setpoint: **74.0 °F** *Occupied setpoints are only available if the thumbwheel is disabled.

Occupied Heating Setpoint: **70.0 °F**

Unoccupied Cooling Setpoint: **85.0 °F**

Unoccupied Heating Setpoint: **60.0 °F**

Cooling Low Limit Setpoint: **72.0 °F**

Cooling High Limit Setpoint: **76.0 °F**

Heating Low Limit Setpoint: **68.0 °F**

Heating High Limit Setpoint: **74.0 °F** *Limit setpoints are only available if the thumbwheel is enabled.

Airflow Settings

Maximum Cool Flow Setpoint: **1210 cfm**

Minimum Cool Flow Setpoint: **121 cfm**

Minimum Heat Flow Setpoint: **0 cfm**

Thermostat Settings

Occupancy Bypass Override Time: **120 min**

Setpoint Thumb Wheel: **Enabled**

The local heat setpoint will equal the local cool setpoint minus: **3.0 °F**

March 2, 2021 9:09 AM KSU - Kennesaw Campus 42.2 °F 65 %RH - 2 intreo



Integration of Building Automation Systems (BAS)



Integration of Building Automation Systems (BAS)



The screenshot displays a BAS interface for a unit labeled PIU-3-6. The interface includes a navigation bar with options: Graphic, Settings, Overrides (0), Trends, Alarms (1), and Notes (0). A blue bar at the top left shows the number 3755. The main display area features a 3D cutaway of a fan unit with a 'Supply Air' outlet. To the right is a Trane thermostat showing a temperature of 0.0 °F and a mode of 'Deadband'. A yellow text box is overlaid on the fan unit with the following text:

***Reminder* - Integration does not fix a system issue.**
> Could be a damaged communications cable
> Could be the power is off/blown fuse
> 22 yr old Controller could have failed
> Best to investigate, then consider options

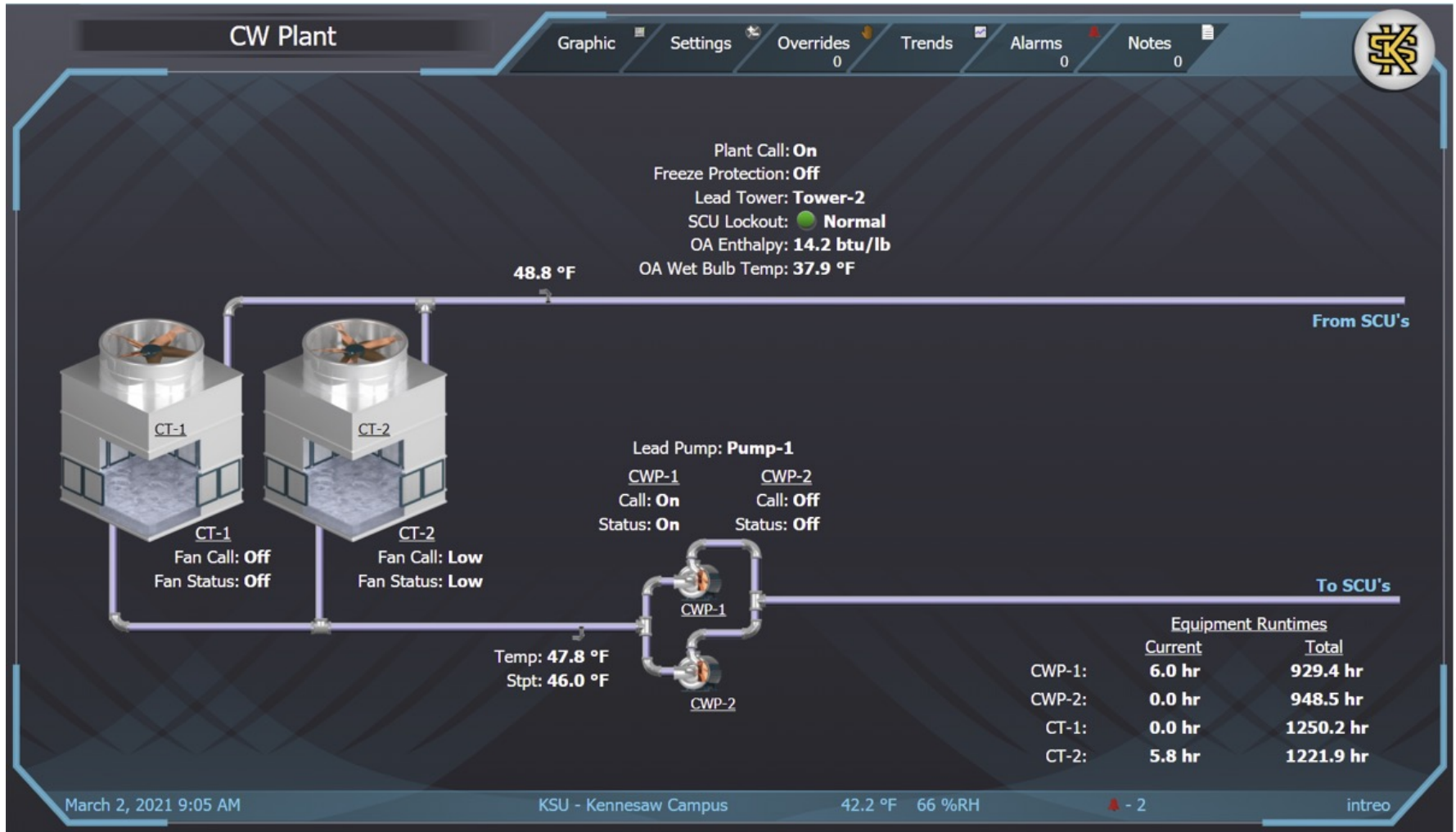
Other data points on the interface include:

- Fan Call: **Off**
- Fan Lockout: **Normal**
- SCU-3 SAT: **58.7 °F**
- Damper Position: **0 %**
- Airflow: **0 cfm**
- Heat Call: **Off**
- Heat Lockout: **Normal**
- Thermostat Thumbwheel: **Disabled**
- Thermostat Wheel SP: **0.0 °F**
- Thermostat Effective Cool: **0.0 °F**
- Thermostat Effective Heat: **0.0 °F**
- Thermostat Demand: **0 %**
- Thermostat Mode: **nan %**

A note at the bottom left of the fan unit says: "Click To Recalibrate. SCU should be off for proper calibration". The bottom status bar shows: August 13, 2021 2:32 PM, KSU - Kennesaw Campus, 89.2 °F 41 %RH, and a red alarm icon with "- 0". The 'intro' logo is in the bottom right corner.



Integration of Building Automation Systems (BAS)





Integration of Building Automation Systems (BAS)

Example #2 – Public Safety Building, Kennesaw, Ga

Quick Facts

1 Story Building

Originally built 1967 (54 years old)

Renovated 2020 – New HVAC

Mechanical System Overview

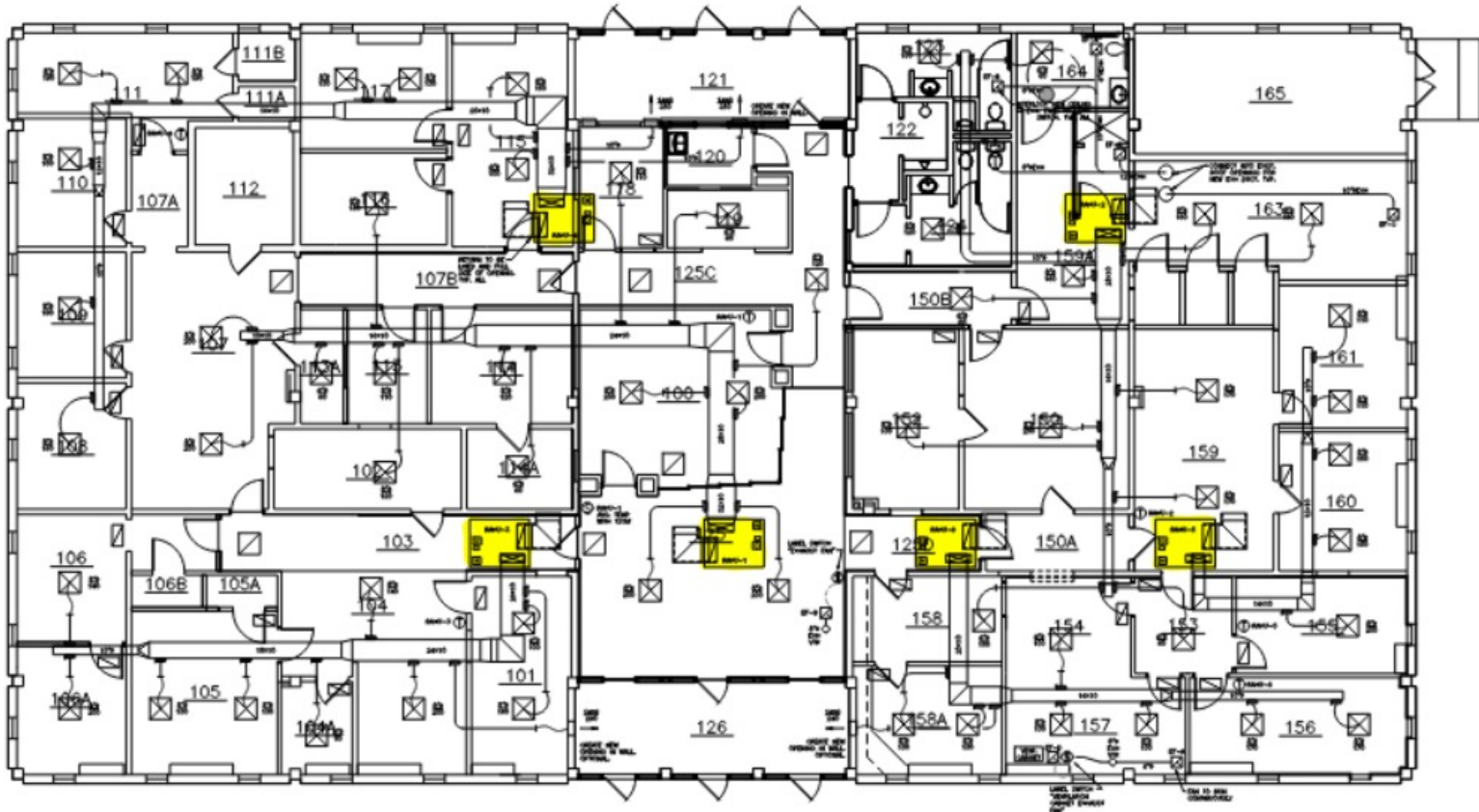
- 6 Roof Top Units with Factory Provided BACnet Controls
- BACnet controllers for Central Plant Equipment



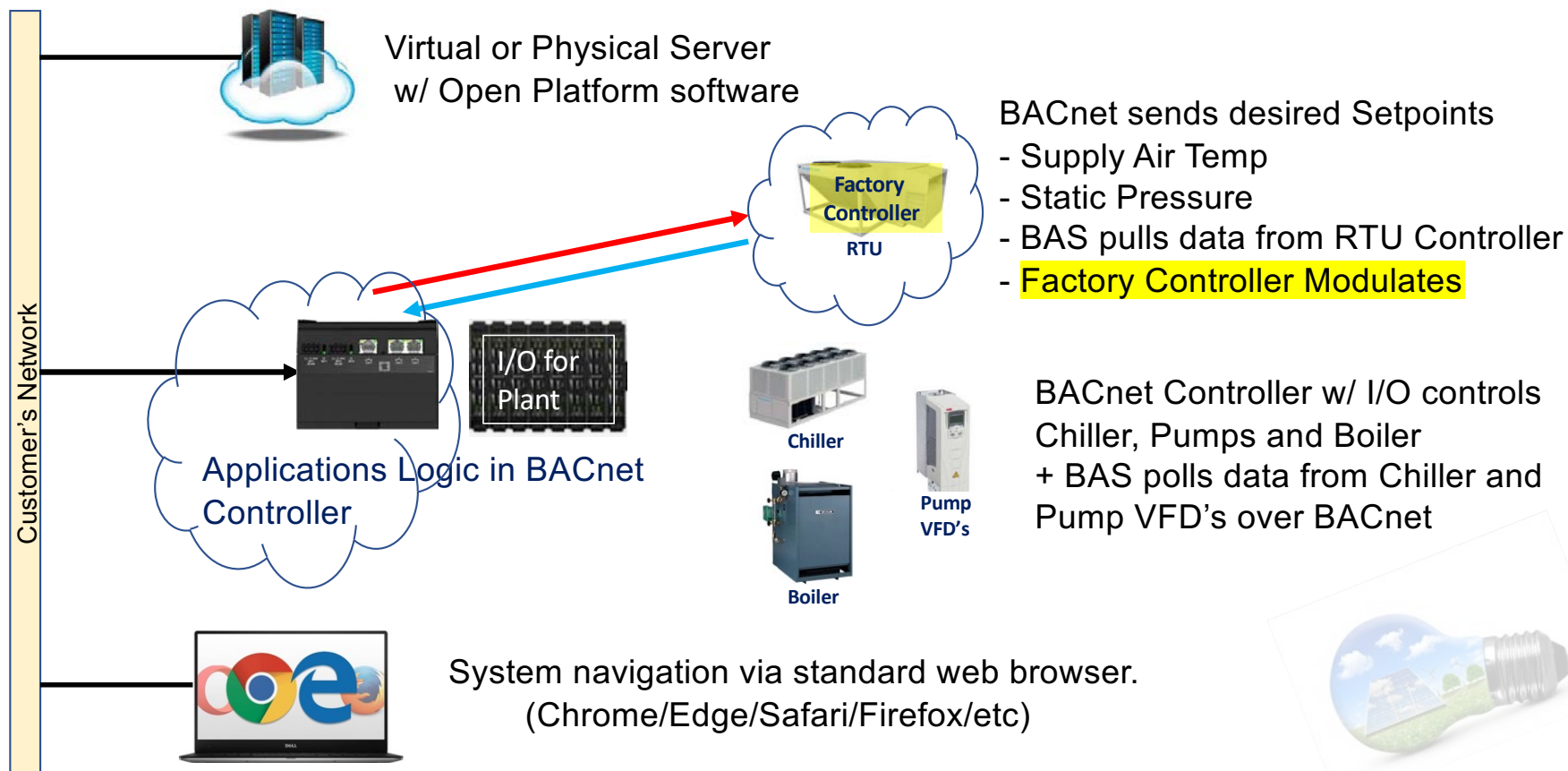


Integration of Building Automation Systems (BAS)

Example #2 – Public Safety Building, Kennesaw, Ga



Integration of Building Automation Systems (BAS) Example #2 – Architecting the Solution





Integration of Building Automation Systems (BAS)

Navigation Graphic Examples




Integration of Building Automation Systems (BAS)



Kennesaw State University

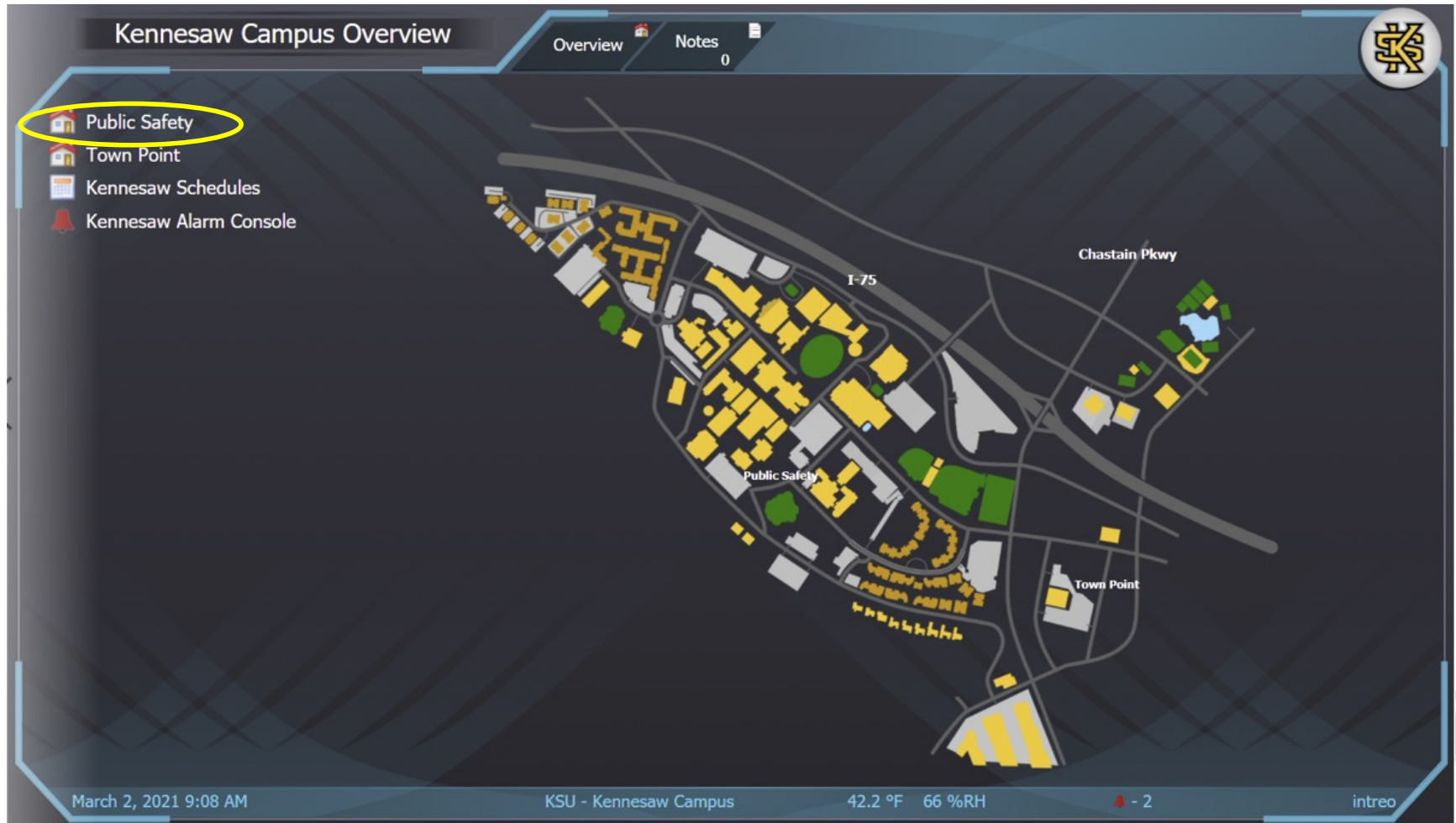
Overview  Notes 
0

-  Kennesaw Campus
-  Marietta Campus
-  Alarm Console
-  iNTREO Network Devices
-  Control As-Builts

Marietta

Kennesaw

Integration of Building Automation Systems (BAS)





Integration of Building Automation Systems (BAS)

Public Safety Overview

Overview Notes 0

- Public Safety Summary
- Chilled Water Plant
- Hot Water Plant
- Kennesaw Schedules
- Kennesaw Alarm Console

Unit	Supply Temp	Return Temp	Plant Call	Flow Switch
CHW Plant	43.3 °F	47.8 °F	On	Flow
HW Plant	127.6 °F	126.8 °F	On	Flow

Legend

- Unit
- Room Sensor
- High Pressure Supply Duct
- Exhaust/Return Duct
- Supply Duct from Unit
- Supply Diffuser
- Exhaust/Return Register

- Rooms
- Temps
- Units
- Ductwork

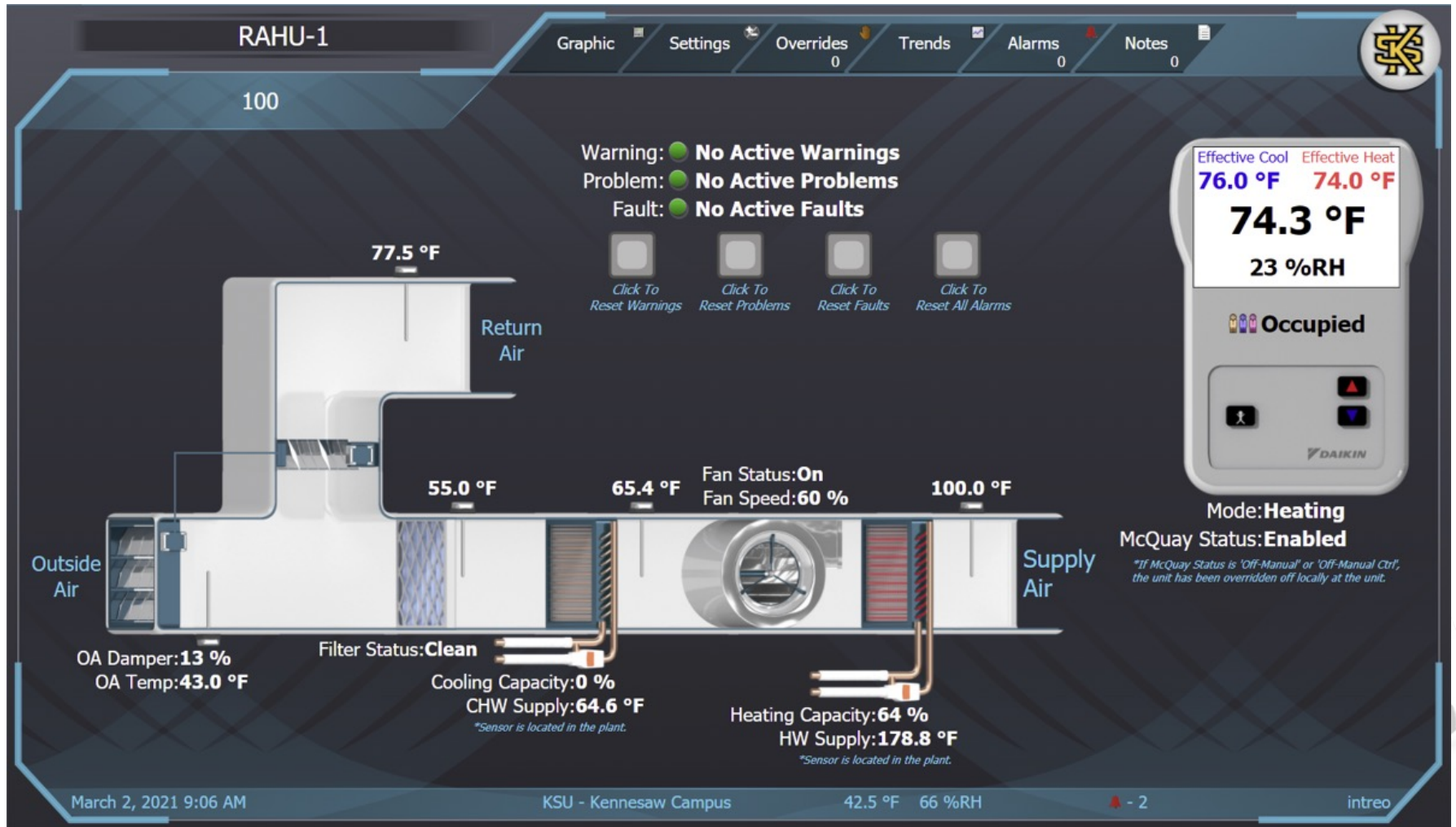
HVAC Shutdown: ● Normal

August 13, 2021 2:29 PM
KSU - Kennesaw Campus
89.2 °F 42 %RH
▲ - 0

intreo

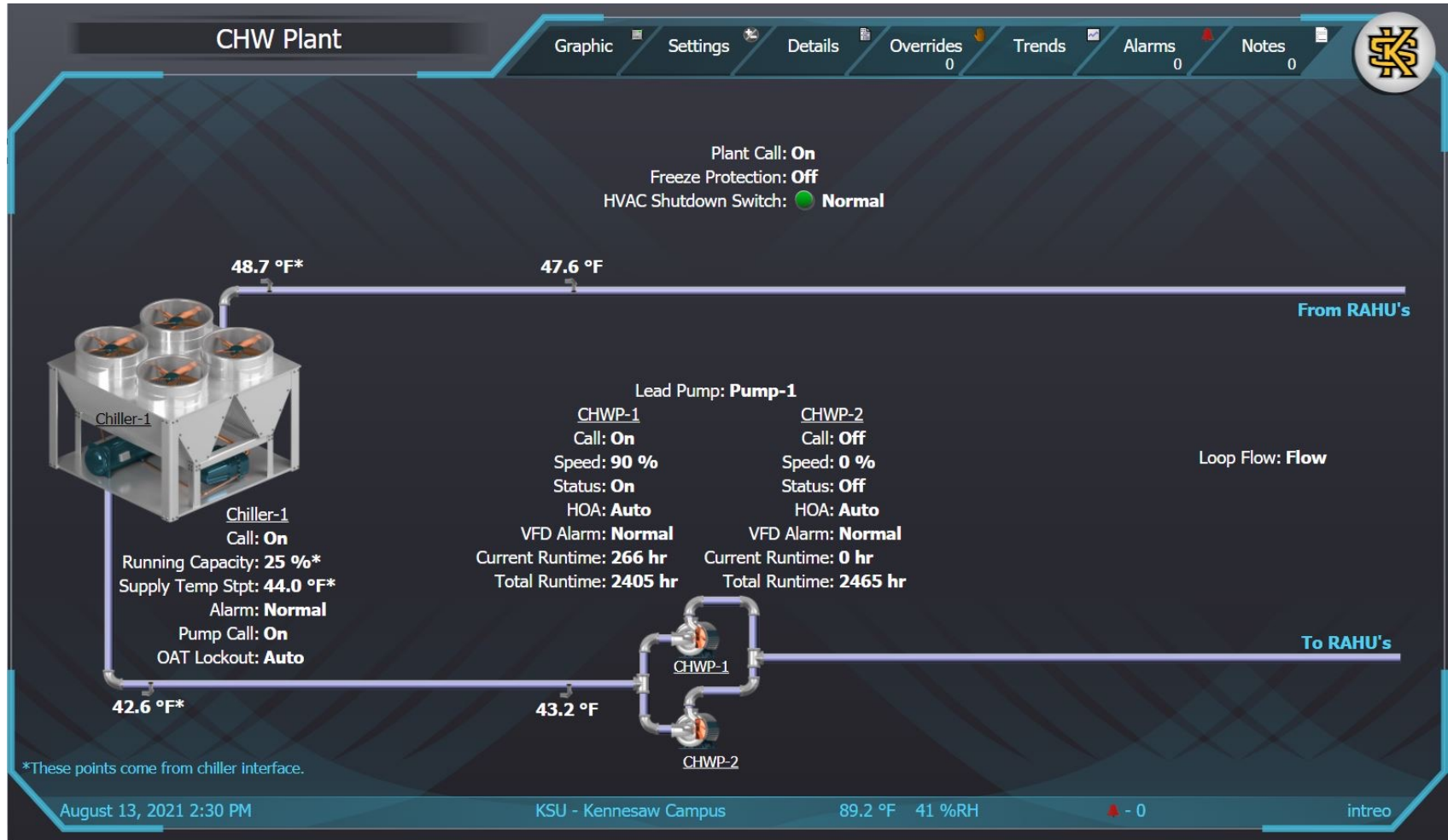


Integration of Building Automation Systems (BAS)





Integration of Building Automation Systems (BAS)





Integration of Building Automation Systems (BAS)

CHW Plant

Graphic
Settings
Details
Overrides
Trends
Alarms 0
Notes 0

General Chiller Info

Chiller Status: Run	Supply Temp: 42.9 °F
Alarm: Normal	Return Temp: 49.0 °F
Running Capacity: 25 %	Supply Temp Spt: 44.0 °F
Load Limit: 100 %	Evap. Flow Status: Flow
OA Temp: 87.7 °F	Chiller Control: Local
Low OA Temp Lockout: Normal	Evap. Pump Status: On
Cond-1 Pressure: 349.5 psi	Cond-2 Pressure: 273.7 psi
Cond-1 Saturated Temp: 106.8 °F	Cond-2 Saturated Temp: 89.8 °F

⚠ Attempt To Reset Alarms

CHWP-1 VFD

Output Frequency: 54 Hz
Output Speed: 1589 rpm
DC Bus Voltage: 271.8 V
Output Voltage: 160.0 V
Current: 3.36 A
Torque: 45 %
Power: 0.5 kW
*Drive Temp: 38 %
Total Power Consumption: 1792.3 kW-hr
HOA: Auto
Runtime: 2120 hrs
Run Status: Run
Active Fault-1: None
Active Fault-2: None
Active Fault-3: None
Active Warning-1: None
Active Warning-2: None
Active Warning-3: None

⚠ Attempt To Reset Faults

CHWP-2 VFD

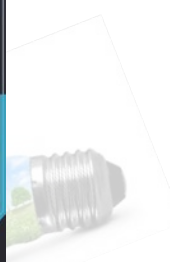
Output Frequency: 0 Hz
Output Speed: 0 rpm
DC Bus Voltage: 278.0 V
Output Voltage: 0.0 V
Current: 0.00 A
Torque: 0 %
Power: 0.0 kW
*Drive Temp: 28 %
Total Power Consumption: 2256.7 kW-hr
HOA: Auto
Runtime: 2596 hrs
Run Status: Stop
Active Fault-1: None
Active Fault-2: None
Active Fault-3: None
Active Warning-1: None
Active Warning-2: None
Active Warning-3: None

⚠ Attempt To Reset Faults

*Drive temp is given as a percentage where 0%=32°F and 100%=Fault Limit.

(Example of information obtained via BACnet Communications to Chiller & VFD's)

August 13, 2021 2:28 PM
KSU - Kennesaw Campus
89.5 °F 41 %RH
▲ - 0
intreo





Integration of Building Automation Systems (BAS) Summary

1. Use Open Software Technology. Building owners should not be limited to a specific vendor or manufacturer.
2. Partner with an experienced Integrator. One that can effectively integrate disparate systems/devices and support all the open standard network protocols used in buildings today.
3. Utilize open protocols like BACnet. Insist that the provided BACnet is *really* '100% BACnet'. Specify that industry standards are used for the communications (e.g. BACnet mstp or BACnet over IP), do not allow any proprietary communication wiring methods.
4. Emphasize that **ALL** BACnet points are made available to other systems, not just a select few. Disqualify vendors who do not comply.
5. For BACnet interfaces, assert that the manufacturer of the equipment must adhere to the Design Documents/Sequence of Operations per the Engineer's specifications. Do not allow deflection to others (e.g. 'we assumed the controls integrator would be responsible for ...')
6. Experience & Sustainability. Choose an integrator that has the experience & resources to deliver a project of any magnitude and that has a succession plan for sustainability of the business.

Reminder - Integration does not fix a system issue! *If something is not functioning prior to integration, it definitely won't work after.*



Integration of Building Automation Systems (BAS)

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THANK YOU!

Any Questions?



Control Concepts

