2022 ENGINEER SUMMIT

The Evolving Landscape of HVAC Building Automation

TRANE

TRANE TECHNOLOGIES

Agenda

Melissa Schumann

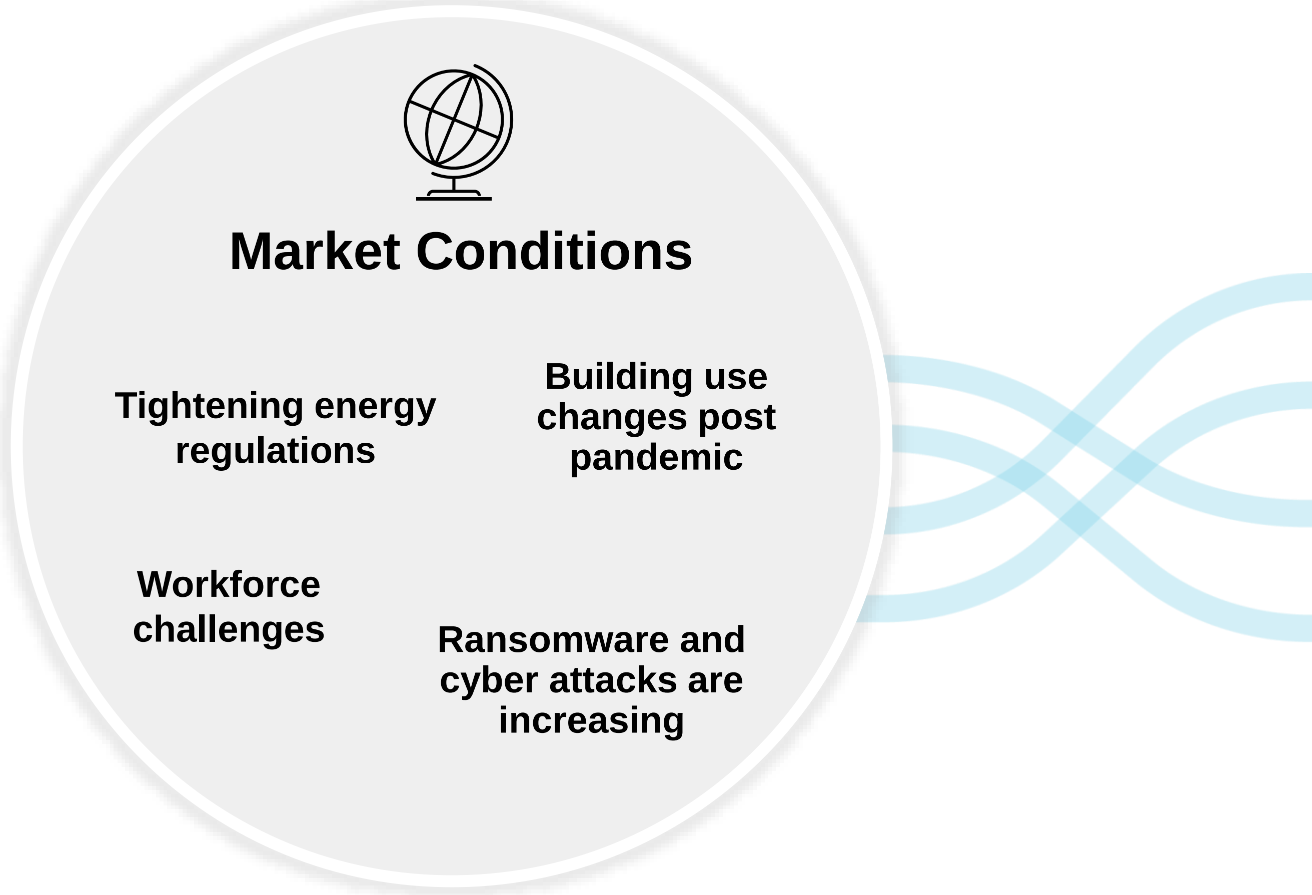
- ✓ BAS Communications: Evolving Options
- ✓ Practical Implications of Connected Systems

Munir Kaderbhai

- ✓ Flexibility in the Offering

BAS Communications: Evolving Options

Evolving Customer Needs



Market Conditions

Tightening energy regulations

Building use changes post pandemic

Workforce challenges

Ransomware and cyber attacks are increasing

Customer Needs

Greater need for data

- “Data is Cheap”
- “I can make better decisions today and react to future needs”

Greater need for flexibility

- Unit/Equipment control flexibility for evolving requirements
- Support for multiple controller vintages (equipment lifecycle)

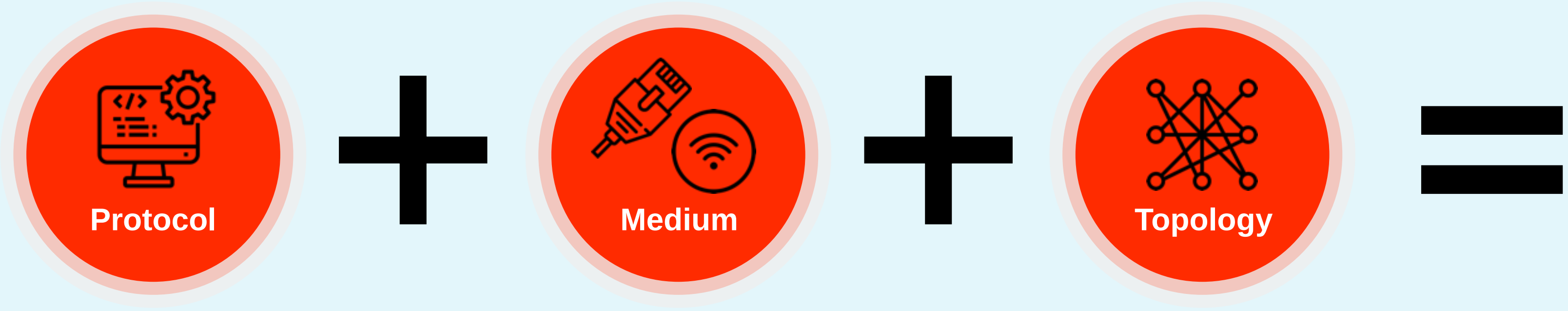
Operational Efficiencies

- Less people expected to solve more complex needs
- Technology to help transition from reactive to proactive

IT Engagement and Risk Management

- IT/OT Convergence required to address infrastructure and risk
- Education – awareness of maintenance requirements
- Translation – help in bridging IT/OT gap

Defining your customer's communications approach



Protocol + Medium + Topology = BAS Network Options

Consider a meeting with your coworkers

Protocol We must agree on a common language, such as English… (the protocol)

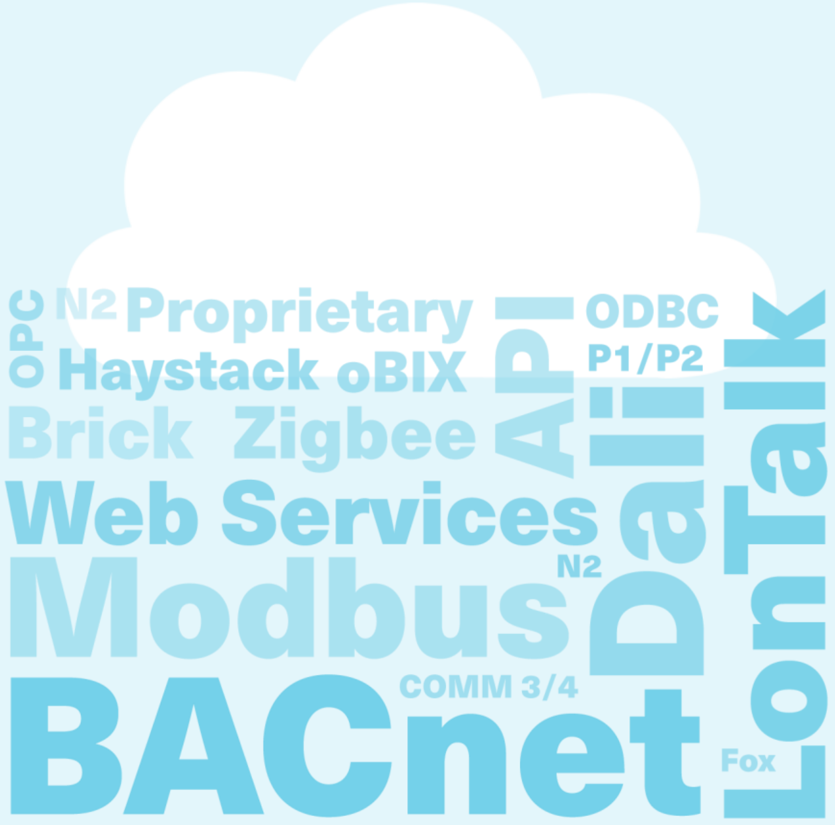
Medium And how we communicate with each other, such as face-to-face, email, or text… (the medium)

Topology And how to best arrange our offices, cubicles, and desks for efficient communication… (the topology)

Protocol

The Protocol

- ✓ **BACnet, Modbus®, LonTalk®, other proprietary languages**
- ✓ **Trane can speak most of these, but we believe in using an Open, Standard protocol: BACnet, the industry-standard established by ASHRAE**
  - Provides interoperability
  - Allows for multi-system communication
  - Flexibility in who can access, service and manage your data points (allowing you to be vendor agnostic)



Evolving Technologies – BACnet Secure Connect

- ✓ **ASHRAE® members recognized necessary changes due to the convergence of Information and Operational Technologies (IT and OT).**

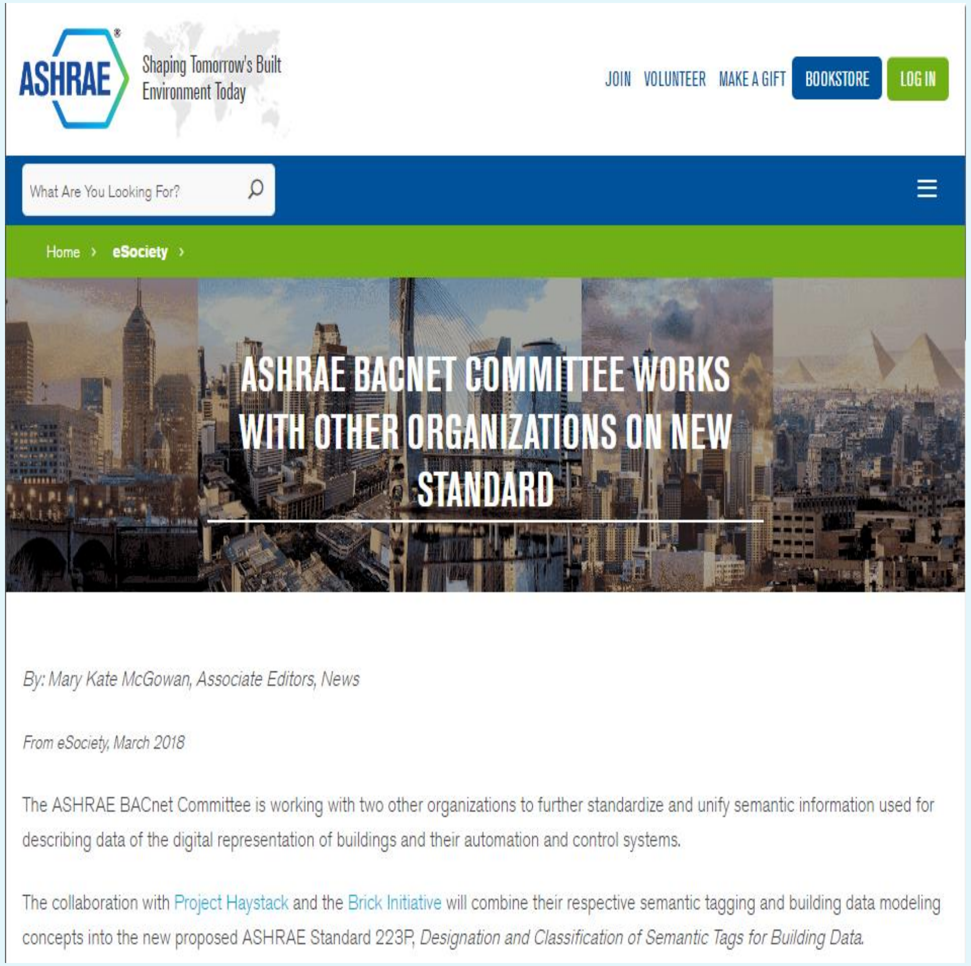
- ✓ **BACnet® Secure Connect (BACnet/SC) developed rapidly – many manufacturers (including Trane) are shipping compatible product today.**

- ✓ **BACnet/SC is “IT friendly” and “backward compatible”:**
  - No Static IP addresses or broadcasts (no BBMDs)
  - Data is encrypted between devices (TLS 1.3)
  - Routers can ensure co-existence with BACnet/IP, BACnet/MSTP, BACnet/Zigbee, etc.

Specify that all IP-based products support (or are software upgradable) to BACnet/IP & BACnet/SC to ensure a graceful transition.

Evolving Technologies – Web Services & APIs

- ✓ **Emerging customer needs difficult to handle exclusively with “traditional BAS protocols”.**
  - Building Automation Systems (BAS) are often isolated islands of information
- ✓ **Web Services present opportunity to connect these isolated islands with Enterprise Applications…**
  - Identity Providers, Remote Access, Artificial Intelligence/Machine Learning (AI/ML) in the cloud, etc.
- ✓ **…but this opportunity doesn’t come without challenges.**
  - Data mapping between systems is generally site-specific and labor intensive.


ASHRAE
Shaping Tomorrow's Built Environment Today
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ASHRAE BACNET COMMITTEE WORKS WITH OTHER ORGANIZATIONS ON NEW STANDARD

By: Mary Kate McGowan, Associate Editors, News

From eSociety, March 2018

The ASHRAE BACnet Committee is working with two other organizations to further standardize and unify semantic information used for describing data of the digital representation of buildings and their automation and control systems.

The collaboration with Project Haystack and the Brick Initiative will combine their respective semantic tagging and building data modeling concepts into the new proposed ASHRAE Standard 223P, *Designation and Classification of Semantic Tags for Building Data.*

The Medium

- ✓ **The Protocol needs a Medium on which to communicate – for BACnet, wired and wireless options exist**
- ✓ **When wired methods are preferred or required, select from the following:**
  - BACnet MS/TP is familiar to many and is isolated from the other building networks
  - BACnet/IP increases data throughput and may be isolated or integrated with other networks
- ✓ **Wireless methods can be much more cost effective compared to wired networks**
  - Air-Fi Wireless uses BACnet over Zigbee, two open communication standards
  - BACnet over Wi-Fi is emerging as another flexible open-source option in some applications
- ✓ **Continue to work with customers to explore the best solution, but know that Trane supports a broad range of possibilities**

WIRED

Twisted pair
MS/TP

Ethernet
Wired IP

WIRELESS

Wi-Fi®
Wireless IP

Zigbee® wireless mesh
Air-Fi

Evolving Technologies – IP and Wireless

IT preference for IP

Advantages

- Higher bandwidth for large amounts of data
- Wireless and Wired Options
- Enables data driven decision making & serviceability in buildings

Disadvantages

- More complexity and cost
- Security considerations

Proliferation of Wireless

Advantages

- Wireless is proven technology (Cellular, Wi-Fi®, Zigbee®)
- Flexible/lower cost installation
- Retrofit cost advantages for upgrades

Disadvantages

- Typically lower bandwidth than wired
- Many proprietary implementations

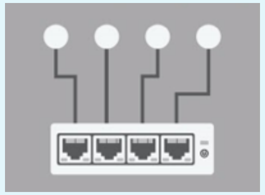
Topology

The Topology

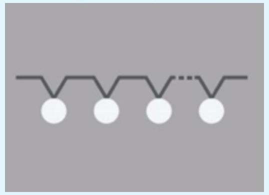
WIRED

WIRELESS

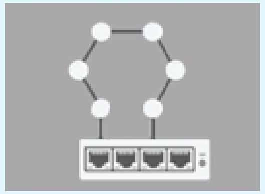
TOPOLOGY



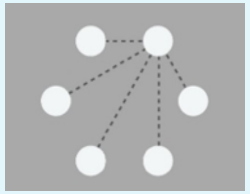
Home Run/Star



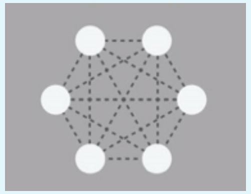
Daisy Chain



Ring



Point-to-Point



Self-Healing Mesh

Protocol	BACnet/IP	BACnet/ IP	BACnet MS/TP	BACnet/IP
Medium	Ethernet	Ethernet	Twisted Pair	Ethernet
Bandwidth	High	High	Medium	High
Failure Recovery	★★★	★	★	★★
IT Collaboration	High	Medium	Low	High
Networking Expertise	Medium	Medium	Low	High
Total Installed Cost	$$$$	$$$	$$	$$$$

Protocol	BACnet/Wireless IP	BACnet/Zigbee
Medium	Wi-Fi	Air-Fi
Bandwidth	High	Medium
Failure Recovery	★★★	★★★
IT Collaboration	Medium	Low
Networking Expertise	High	Low
Total Installed Cost	$$	$

Project Considerations and Decision Makers

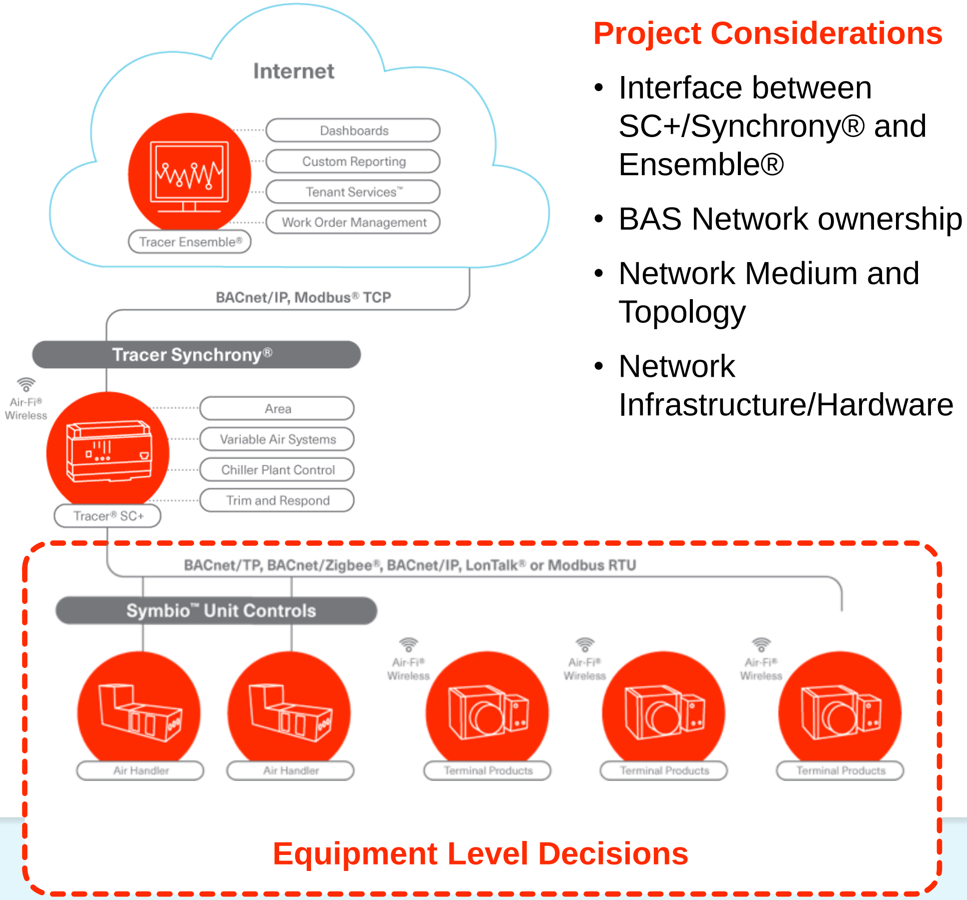
Customer/Stakeholder Concerns

Building Owner
cost, flexibility, energy use, comfort

Engineering/Contractor
ease of design/installation, serviceability

IT Manager
risk, IP connection, security

Building Operator
comfort, ease of use, remote access



Project Considerations

- Interface between SC+/Synchrony® and Ensemble®
- BAS Network ownership
- Network Medium and Topology
- Network Infrastructure/Hardware

Decision Makers

Protocol

Then: Owner + Engineer
Now: Owner + Engineer

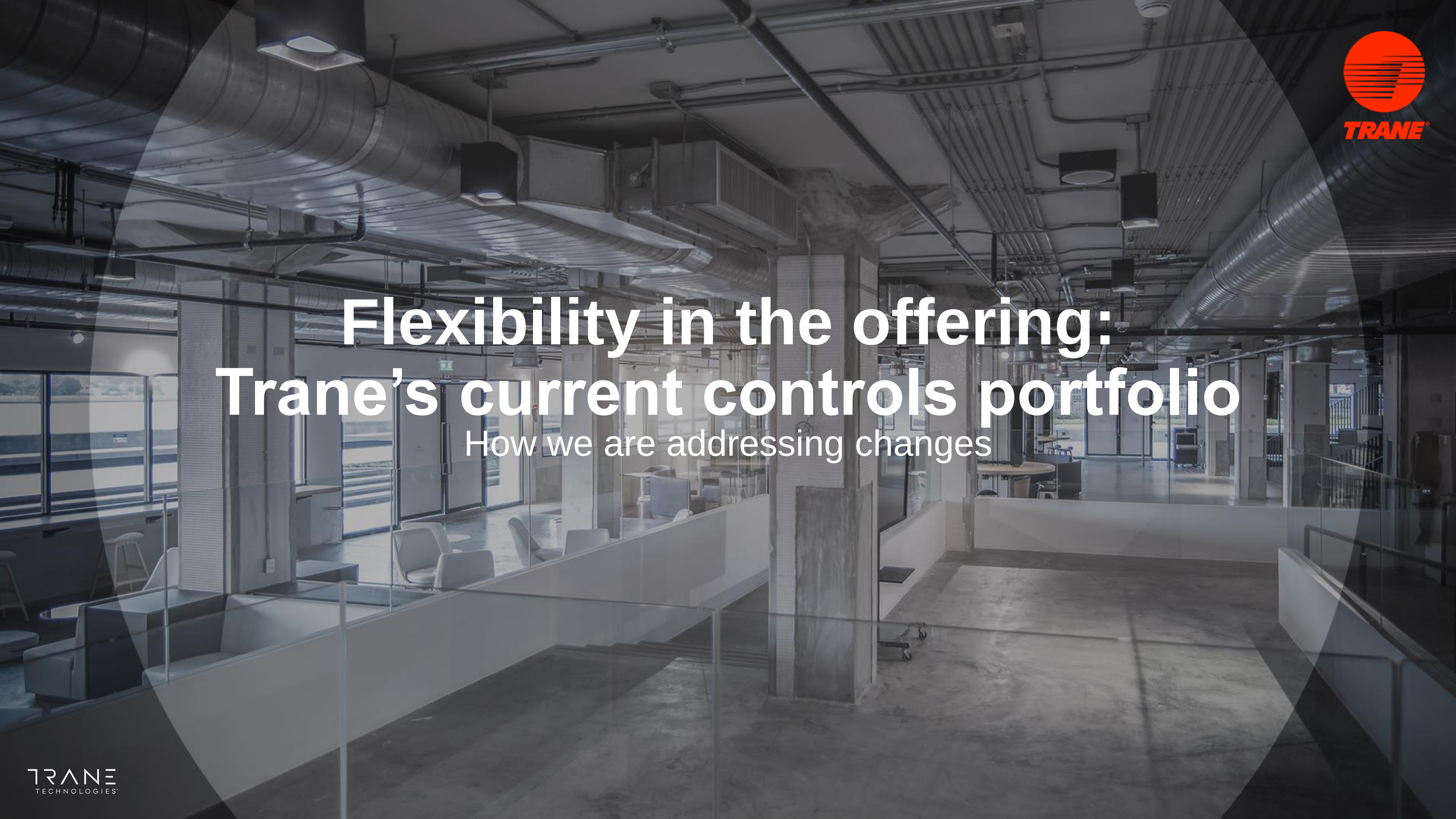
Medium

Then : Owner + Engineer
Now : Owner + Engineer + IT

Topology

Then : Contractor
Now : Contractor + IT

TRANE



Flexibility in the offering: Trane’s current controls portfolio

How we are addressing changes

TRANE TECHNOLOGIES

EXAMPLE

HVAC upgrades in an existing hospital

Scenario

- Medical campus with multiple buildings of different vintages (age)

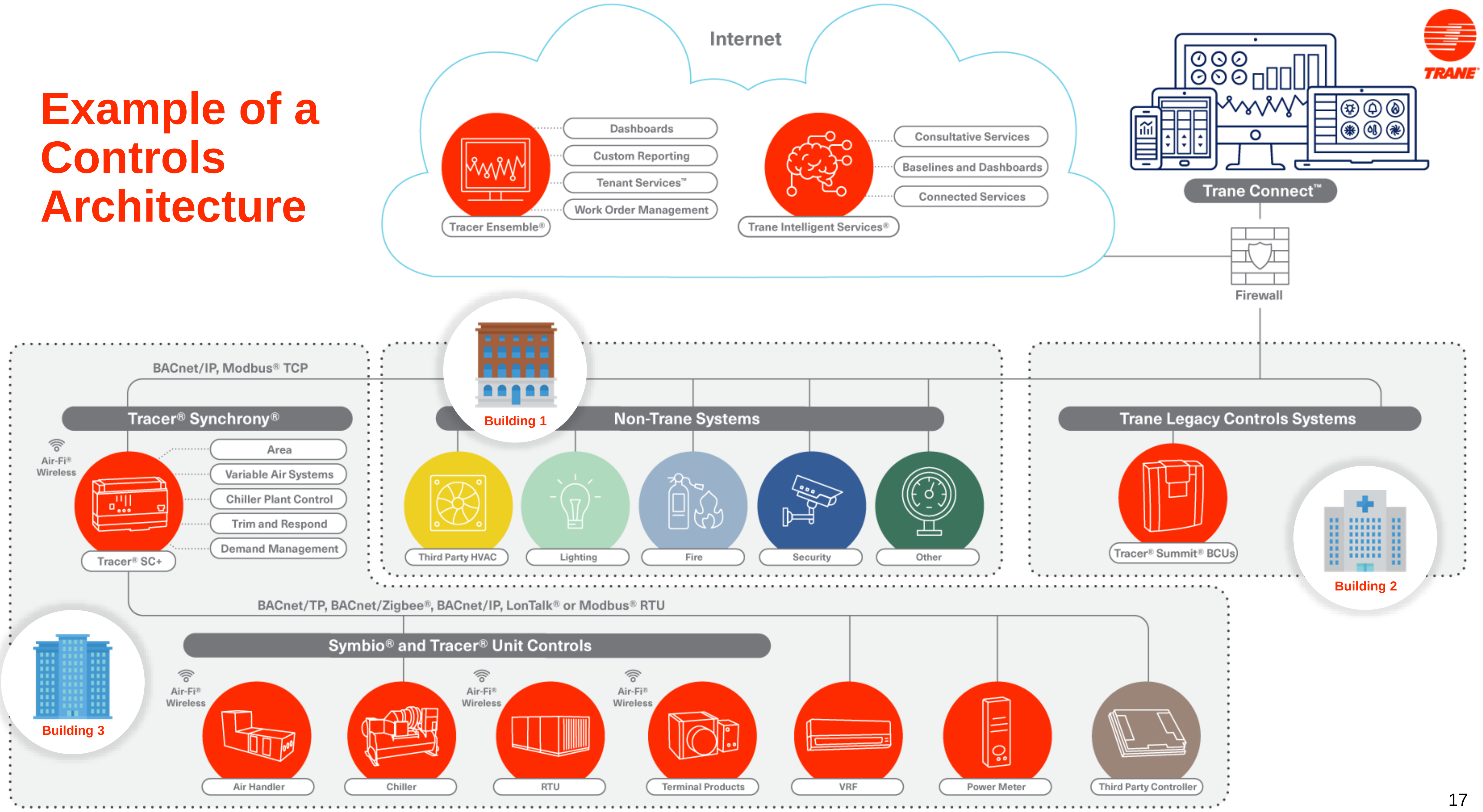
Goals

- Keep buildings operational and maintain functional equipment where possible (avoid rip and replace)
- Integrate the existing systems into a “single pane of glass”

Challenges and Considerations

- Non-BACnet proprietary communication
- Potential interference from communicating hospital equipment
- Lots of zones with individual patient rooms and shifting spaces
- Combination of new construction and retrofit

Example of a Controls Architecture



Trane Controls Offering

Connected Equipment Controllers

CONNECTIVITY SOLUTION

Symbio® Unit Controllers

Smart, networked HVAC systems are built on a foundational network of connected controls for unitary and terminal equipment. The Symbio portfolio of controls provides the latest technology advancements from Trane Controls.

KEY BENEFITS:

- Advanced flexibility with multiple protocol options
  - BACnet/IP, BACnet MS/TP, Modbus, Air-Fi Wireless
- Enhanced serviceability with purpose-built mobile app
- Seamless Tracer® integration
- Secure remote connectivity

Connected Building Automation

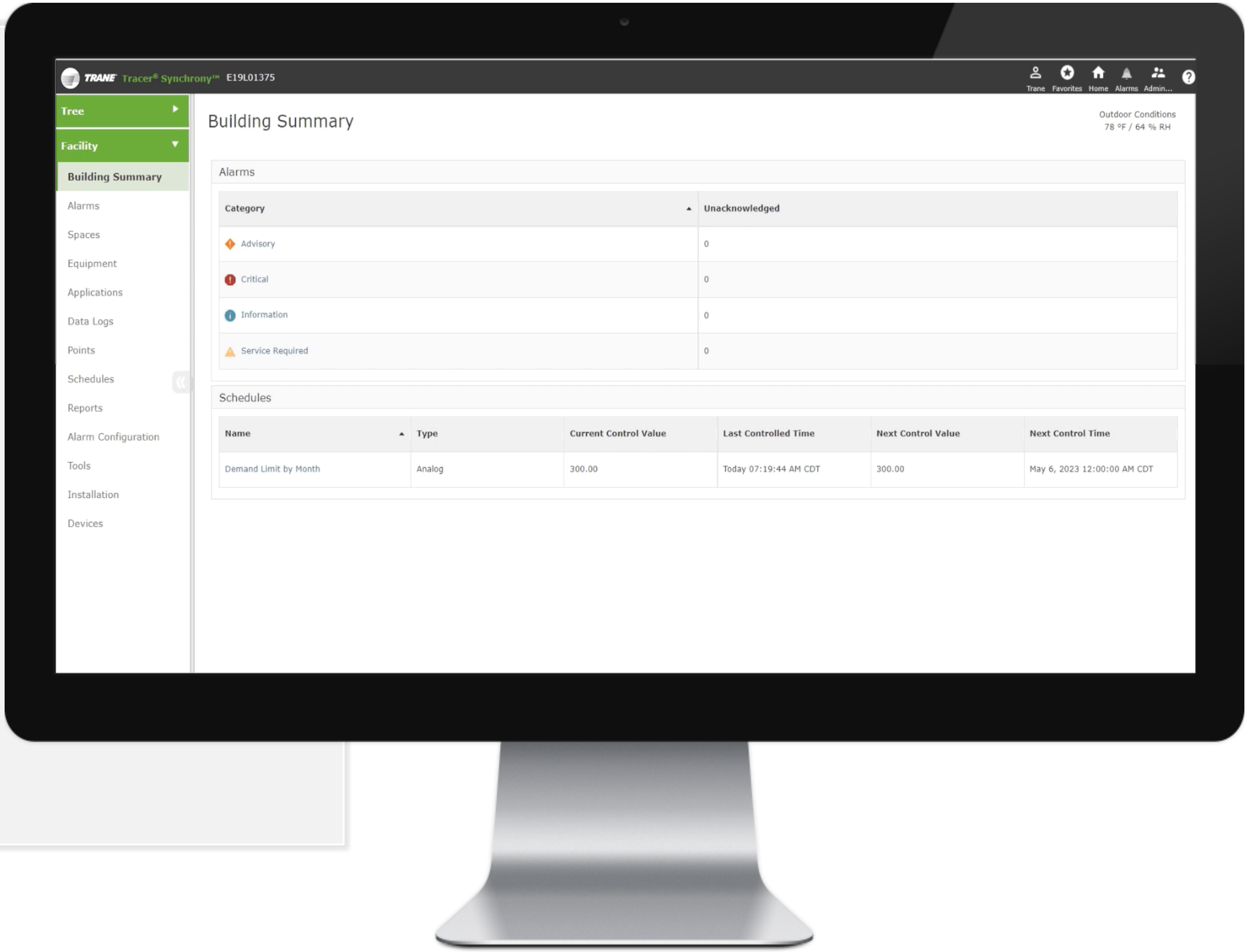
CONNECTIVITY SOLUTION

Tracer® SC+

Tracer SC+ is a powerful building automation system (BAS) that integrates systems to simplify command and provide better control over comfort and efficiency.

KEY BENEFITS:

- Advanced flexibility with multiple protocol options
    - BACnet/SC, BACnet/IP, BACnet MS/TP, Modbus, Air-Fi Wireless
- Pre-Engineered Tracer System Applications
- Secure remote connectivity
- Embedded Tracer® Synchrony® UI



Building Summary

Outdoor Conditions
78 °F / 64 % RH

Alarms

Category	Unacknowledged
Advisory	0
Critical	0
Information	0
Service Required	0

Schedules

Name	Type	Current Control Value	Last Controlled Time	Next Control Value	Next Control Time
Demand Limit by Month	Analog	300.00	Today 07:19:44 AM CDT	300.00	May 6, 2023 12:00:00 AM CDT

Enterprise Building Management

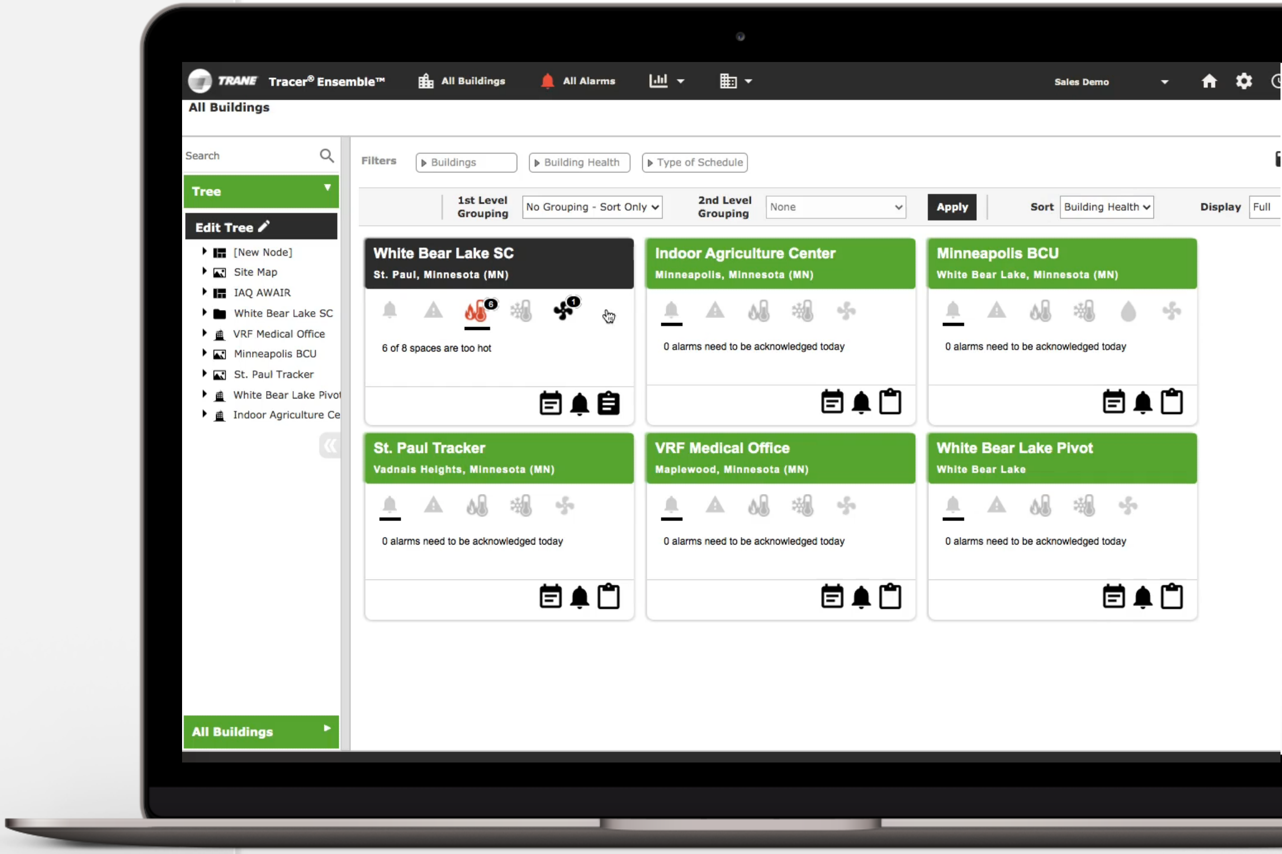
CONNECTIVITY SOLUTION

Tracer® Ensemble

Tracer Ensemble is a web-enabled enterprise-wide building management system (BMS).

KEY BENEFITS:

- A remote enterprise view of your entire organization
- Greater productivity for daily operation and troubleshooting
- Enhanced energy management with dashboards
- More profitable tenant solutions for scheduling and work order management
- Optimized use of buildings and maintenance staff
- Security via SAML 2.0 Single Sign and BACnet Secure Connect



1st Level Grouping: No Grouping - Sort Only

2nd Level Grouping: None

Sort: Building Health

Display: Full

White Bear Lake SC
St. Paul, Minnesota (MN)
6 of 8 spaces are too hot

Indoor Agriculture Center
Minneapolis, Minnesota (MN)
0 alarms need to be acknowledged today

Minneapolis BCU
White Bear Lake, Minnesota (MN)
0 alarms need to be acknowledged today

St. Paul Tracker
Vadnais Heights, Minnesota (MN)
0 alarms need to be acknowledged today

VRF Medical Office
Maplewood, Minnesota (MN)
0 alarms need to be acknowledged today

White Bear Lake Pivot
White Bear Lake
0 alarms need to be acknowledged today

Secure Remote Connectivity & Serviceability

CONNECTIVITY SOLUTION

Trane® Connect™

Trane Connect is a secure, cloud-based customer portal to access your building systems for remote monitoring, building management and routine maintenance.

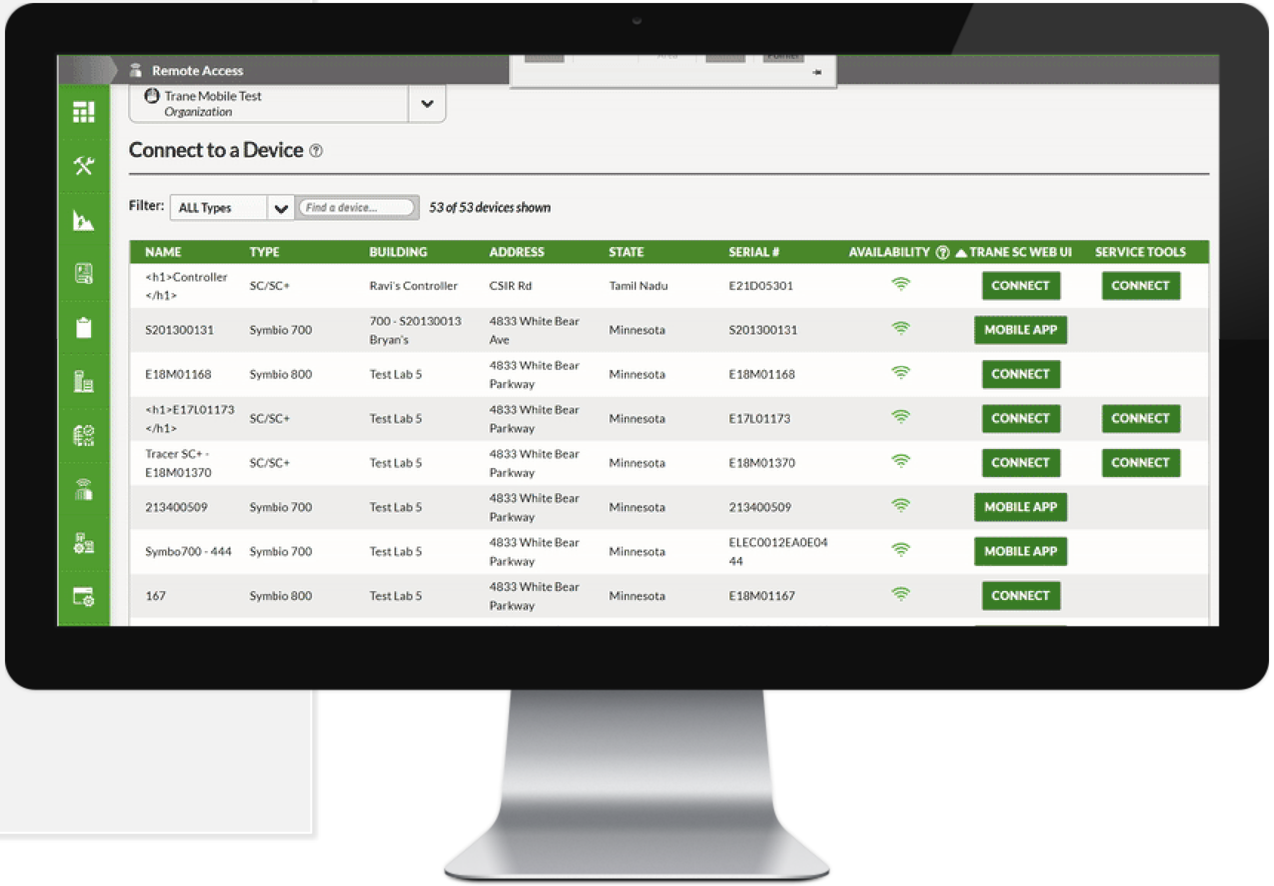
KEY BENEFITS:

- Platform for authentication and user management for secure remote access to:

  BAS System Level
  - Ensemble
  - SC+/Synchrony

  Equipment Level
  - Symbio 700/800
  - Future Symbio offerings

- Web user interface for status, troubleshooting
- Service tool pass through for issue resolution



Trane Mobile Test
Organization

Connect to a Device ?

Filter: ALL Types *Find a device...* *53 of 53 devices shown*

NAME	TYPE	BUILDING	ADDRESS	STATE	SERIAL #	AVAILABILITY ?	▲ TRANE SC WEB UI	SERVICE TOOLS
<h1>Controller </h1>	SC/SC+	Ravi's Controller	CSIR Rd	Tamil Nadu	E21D05301	📶	CONNECT	CONNECT
S201300131	Symbio 700	700 - S20130013 Bryan's	4833 White Bear Ave	Minnesota	S201300131	📶	MOBILE APP	
E18M01168	Symbio 800	Test Lab 5	4833 White Bear Parkway	Minnesota	E18M01168	📶	CONNECT	
<h1>E17L01173 </h1>	SC/SC+	Test Lab 5	4833 White Bear Parkway	Minnesota	E17L01173	📶	CONNECT	CONNECT
Tracer SC+ - E18M01370	SC/SC+	Test Lab 5	4833 White Bear Parkway	Minnesota	E18M01370	📶	CONNECT	CONNECT
213400509	Symbio 700	Test Lab 5	4833 White Bear Parkway	Minnesota	213400509	📶	MOBILE APP	
Symbo700 - 444	Symbio 700	Test Lab 5	4833 White Bear Parkway	Minnesota	ELEC0012EA0E04 44	📶	MOBILE APP	
167	Symbio 800	Test Lab 5	4833 White Bear Parkway	Minnesota	E18M01167	📶	CONNECT	

Advanced Analytics and Energy Offerings

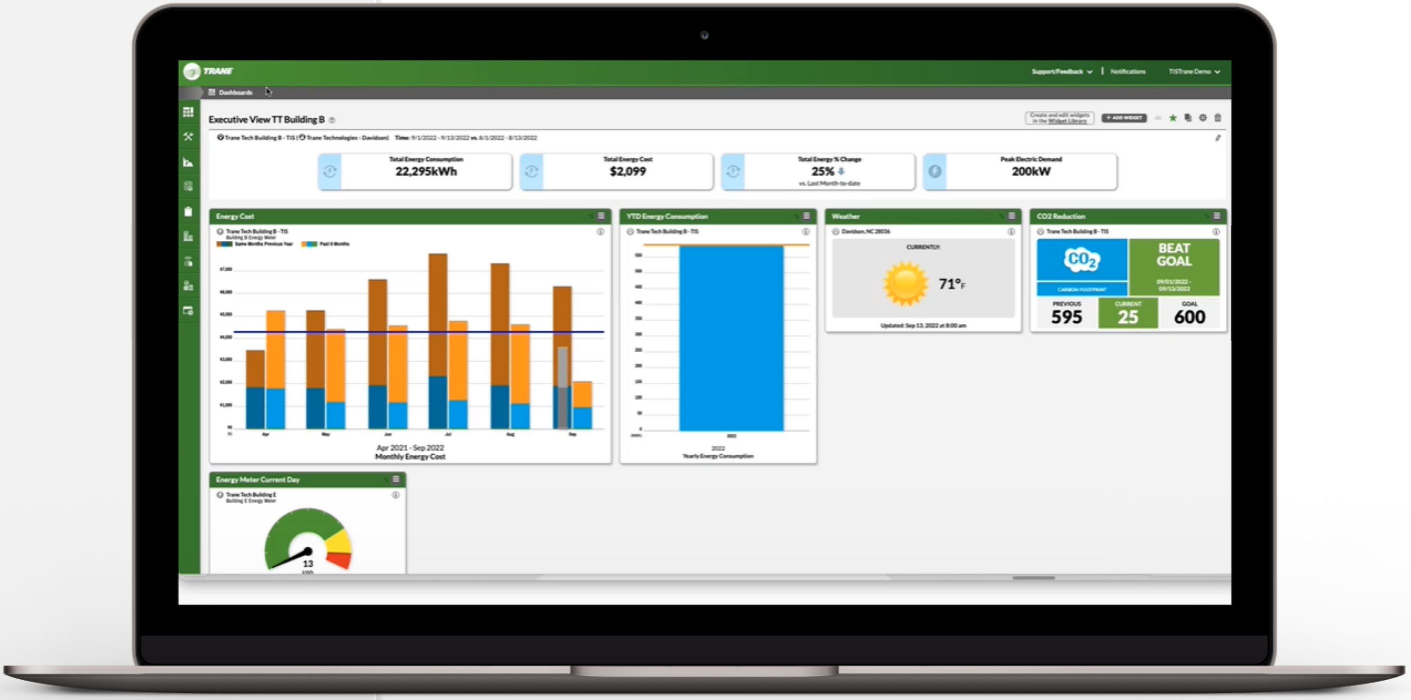
CONNECTIVITY SOLUTION

Digital Services

Building data can tell us a lot about performance, energy use and optimization. The suite of digital services from Trane provides you with the access to information, visualization and support you need to make data-driven decisions.

KEY BENEFITS:

- Service levels to suit your needs
  - Intelligent Services
  - Connected Building
  - Connected Mechanical
- Built on industry-leading systems expertise
- On-demand energy and building performance analytics
- Prioritized actions based on your system and goals



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Now What? Practical implications of evolving Technology

Cybersecurity and HVAC machine data

The Issue

- Privacy and Security (Data Breaches & Legislation)
- Building owners focused on keeping their internet-facing systems secure
- IT risk managers care about what kind of data is in the system and who has access
  - Personal Health Information (PHI)
  - Personally Identifiable Information (PII)
  - Payment Card Information (PCI)

What to Specify

- Documented standards for IT staff to support pre-qualification requirements
- Minimize the effort of integrators and end users to configure the security of the system.
  - Require documentation of the procedures for installers and end users on how best to secure the system.

Why You Care

- When servers are specified via BMS projects they can be orphaned by IT
  - On Prem Software needs to be managed by IT staff
- Unmanaged servers are liabilities and targets of ransomware due to outdated software
- Cloud hosted solutions (SaaS) have software maintenance built in

Resources

- Building Automation Systems (BAS) and Cybersecurity (trane.com)
- Cybersecurity for Building Automation Systems | Trane

On Prem or Cloud

TRANE

The Issue

- Manage BMS software with Owner's IT resources or outsource to a third-party provider (Software as a Service- SaaS)

What to Specify

The enterprise building management system shall consist of a cloud-based service that includes server maintenance, site backups, and software upgrades for the term of three years as part of this contract. The service fees shall include licensing fees for operating systems and databases. The system shall have the ability to be transferred to an on-premises solution maintaining all data upon expiration of the contract should the contract not be renewed.

Why You Care

- When servers are specified via BMS projects they can be orphaned by IT
  - On Prem Software needs to be managed by IT staff
- Unmanaged servers are liabilities and targets of ransomware due to outdated software
- Cloud hosted solutions (SaaS) have software maintenance built in

Resources

- Tracer® Ensemble® Cloud IT & Cyber Security Summary
- Tracer® Ensemble® On-Premise IT & Cyber Security Summary
- Trane® Design Assist™ (tranedesignassist.com)

Secure Remote Access

The Issue

- Fewer skilled building operators available to manage more buildings
- Remote desktop services like LogMeIn are no longer IT accepted solutions

What to Specify

- Design and specify systems that provide and maintain secure remote access to the facilities Building Automation System (BAS) or other building systems.
- Balance between essential access and critical IT requirements
  - Ensure secure remote access to the BAS is available anywhere, anytime, using any compatible client device (PC/tablet/phone).
  - Ensure access is restricted to current, essential users.
  - Ensure BAS does not require ANY inbound ports on a firewall to be "exposed" or "forwarded".

Why You Care

- Owners desire serviceable systems that leverage technology
  - for quick response from servicers
  - lower maintenance costs for issue that can be handled without at truck roll
- Owners want to be able to manage buildings remotely
  - Access to systems is required anytime and from anywhere is require

Resources

- Connectivity & Cloud Services (trane.com)
- Trane Connect

Maintenance Required

The Issue

- Software must be updated frequently to provide current protection against new and evolving cyber threats.
- Outdated hardware can pose a security risk
- Failing to keep software up to date increases risk.
- Proactive maintenance is a major key to risk mitigation.

Why You Care

- Consider specifying new hardware lieu of integration to existing systems to decrease security and obsolescence risks
- Specify a plan for regular software updates
- Specify regular testing the system for internet exposure as part of ongoing scheduled system maintenance.
- Service providers may be contracted to assist with cybersecurity upkeep.

What to Specify

To ensure that the owner will have the most current operating system provided by the manufacturer, the BAS manufacturer shall include licensing and labor costs to facilitate software/firmware updates throughout the warranty period at no charge to the owner. These updates shall include upgrades for functional enhancements associated with the following: operator workstation software, project specific software, graphics, database, firmware updates, and all security related service packs.

Resources

- Building Automation Upgrades (trane.com)
- Building Automation Systems (BAS) and Cybersecurity (trane.com)
- Tracer® Ensemble® Cloud IT & Cyber Security Summary
- Tracer® Ensemble® On-Premise IT & Cyber Security Summary

Takeaways

Protocol

Open standard protocols help to best position you for future data needs

Medium

What you choose has implications for cost, complexity and engagement with IT

Topology

You can combine different network options to best suit a space or customer need

Trane has solutions that meet customer needs

- ✓ Secure remote access
- ✓ Communication flexibility
- ✓ Connected building solutions
- ✓ Enhanced serviceability
- ✓ Cloud or On Prem Offerings
- ✓ Proactive cybersecurity measures

Thank you!
Questions?

Please provide your feedback on this workshop by completing an anonymous 3-minute survey.

Appendix

Organizational standards for Security Controls

- **SOC2** is a report capturing how a company safeguards customer data and how well those internal controls are operating. Issued by independent third-party auditors cover the principles of Security, Availability, Confidentiality, and Privacy.
- **ISO/IEC 27001** is a standard to manage information security such as financial information, intellectual property, employee details or information entrusted by third parties.
- **SIG**, The Standardized Information Gathering (SIG) questionnaire is used to perform an initial assessment of vendors, gathering information to determine how security risks are managed across 18 different risk domains.

Vertical Market Specific Certification Examples

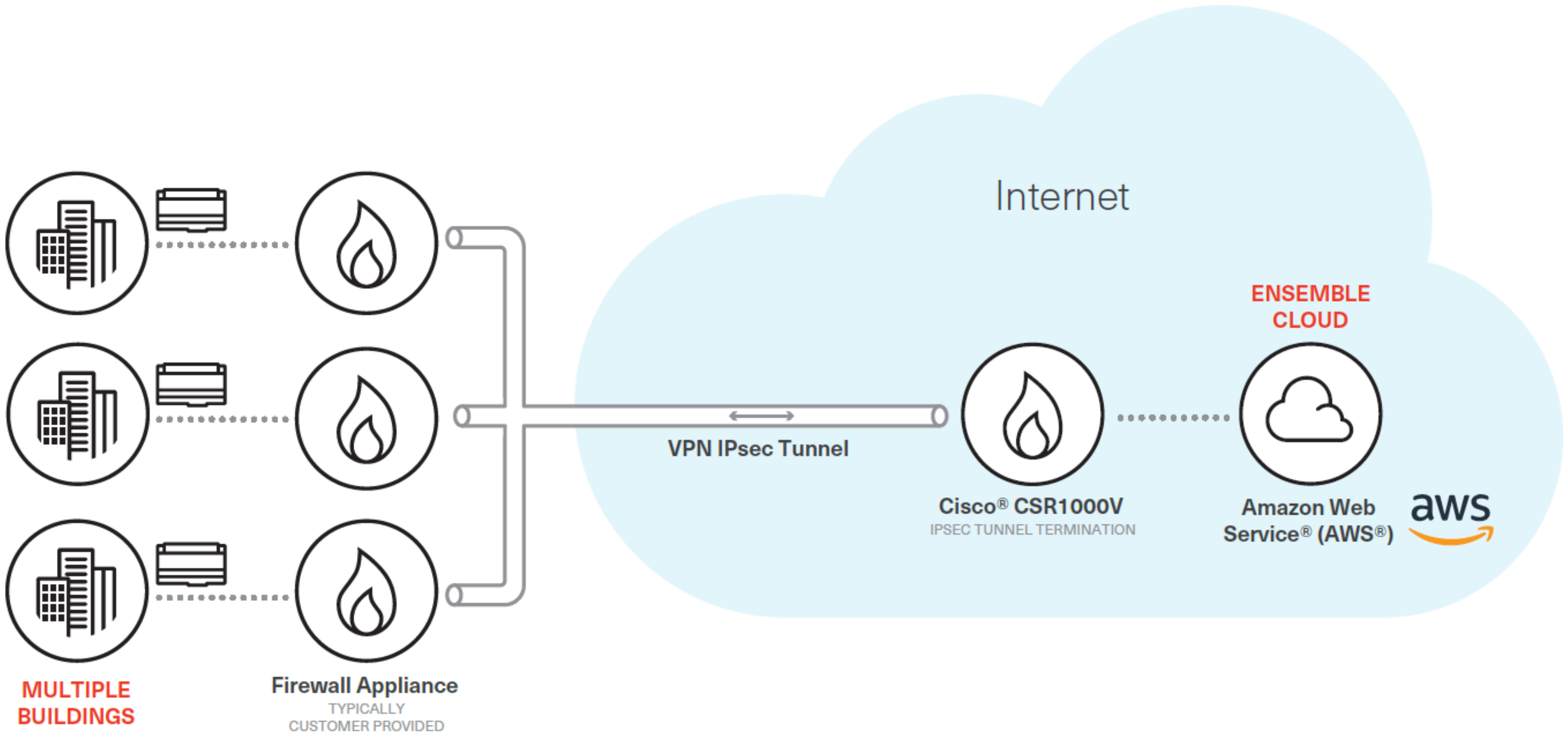
- HITRUST – Healthcare
- FEDRAMP – federal projects

Customer Specific Questionnaires

- Spreadsheet
- Web portal
- 3rd party vendor assessment

Tracer® Ensemble® Cloud architecture Data Flow

The Ensemble Cloud server and BAS controllers are connected via BACnet/IP and HTTPS inside an IPsec tunnel terminated at the remote network firewall (Cisco® CSR-1000V).



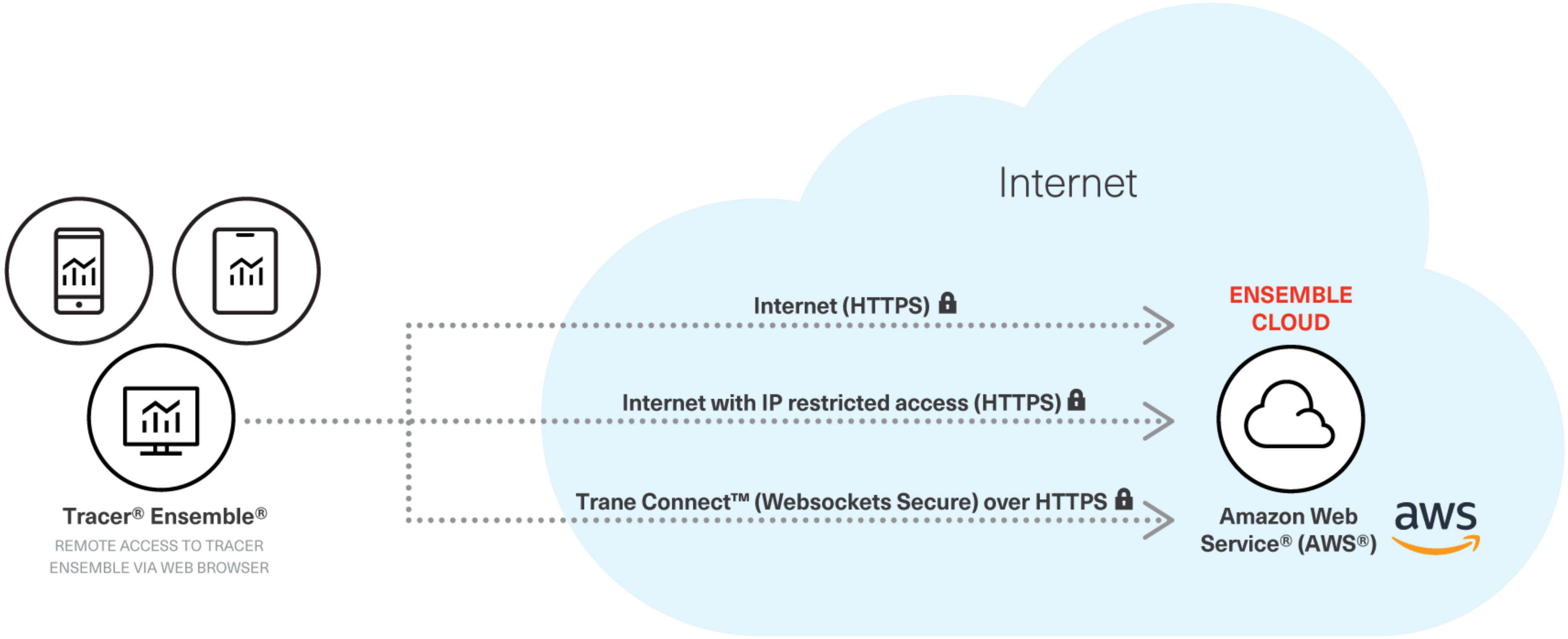
Tracer Ensemble Cloud Network Security

- The Ensemble Cloud server and BAS controllers are connected via BACnet/IP and HTTPS inside an IPsec tunnel terminated at the remote network firewall (Cisco® CSR-1000V).
- BACnet/IP is a data communication protocol for building automation and control networks that use specified UDP ports. The port designation is configurable; the default port is UDP/47808. As BACnet/IP has no native encryption, all BACnet/IP traffic is tunneled to the Ensemble Cloud using a secure IPsec tunnel. BACnet/IP does not support Network Address Translation (NAT).

Responsibilities	
Trane's Cloud fulfillment team	**Customer's IT staff**
• System maintenance, backups, and upgrades with a current subscription. • Major updates and firmware patches are installed remotely	• Provide a firewall capable of IPsec tunnel • Configuration of IPsec tunnel in conjunction with Trane

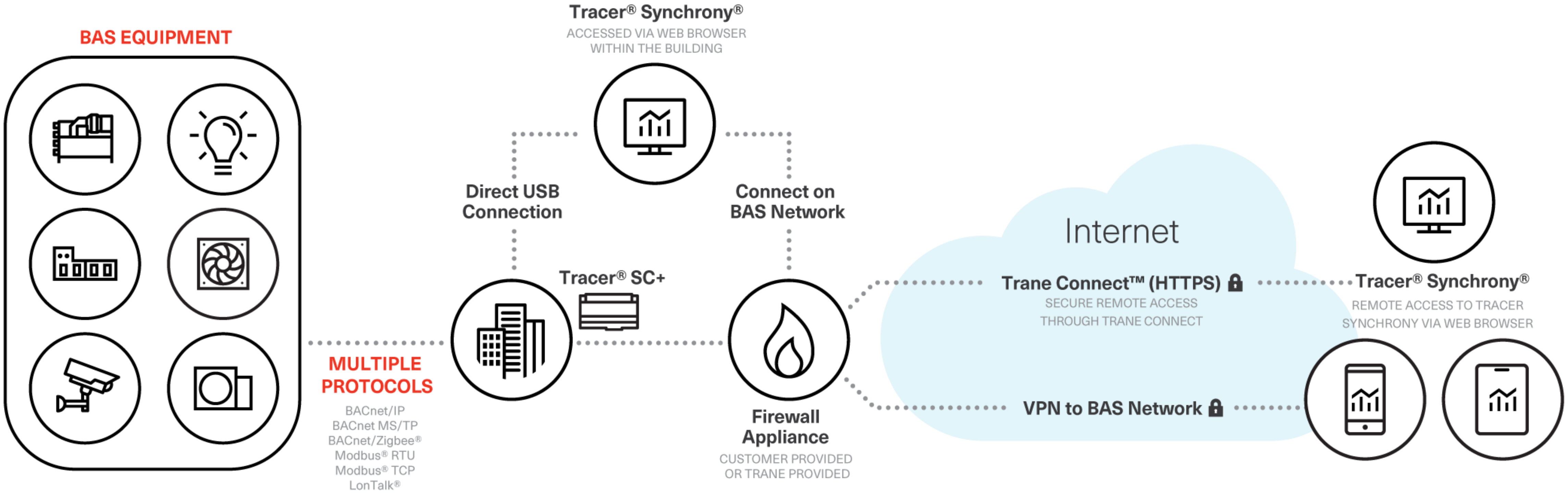
User Access to Ensemble (Front End)

For access from outside your facility, it is recommended to use Trane Connect™ Remote Access over HTTPS. Trane Connect is an initial outbound-only connection via port 443 that uses WebSocket protocol to connect to the Ensemble server.


Internet
Internet (HTTPS) 🔒
Internet with IP restricted access (HTTPS) 🔒
Trane Connect™ (Websockets Secure) over HTTPS 🔒
ENSEMBLE CLOUD
Amazon Web Service® (AWS®)
aws
Tracer® Ensemble®
REMOTE ACCESS TO TRACER ENSEMBLE VIA WEB BROWSER

Tracer SC+ architecture

Tracer Synchrony can be accessed using most modern web browsers. For access from outside your facility, it is recommended to use Trane Connect™ Remote Access over HTTPS. Trane Connect is an initial outbound-only secure connection that uses WebSocket protocol to connect to the SC+ controller. Although not recommended, users may also access Tracer Synchrony after creating a VPN connection to the BAS network.



Tracer SC+ Network Security details

- Tracer SC+ should be installed behind the customer’s firewall.
- Connectivity between Tracer SC+ and BAS controllers is via one of the following protocols: BACnet/IP (UDP port), BACnet MS/TP (Shield Twisted Pair), BACnet/Zigbee® (referred to as Trane Air-Fi®, utilizing Zigbee wireless mesh network), Modbus® TCP (IP), Modbus RTU (Shield Twisted Pair), and TCP/IP.
- BACnet/IP is a the most common communication protocol for building automation and control networks, and it uses specified UDP ports. The default port is UDP/47808.
- Network connectivity options, and port designation are configurable via Tracer Synchrony.
- Tracer SC+ supports outbound DNS functionality – with this capability it is easy to configure the system to send alarm and event messages by e-mail to multiple users of the system.
- Tracer SC+ controller firmware and software are signed and encrypted.
- Tracer SC+ controller backups can be stored on the device, on an installed micro-SD card, an external USB device, or uploaded to Trane Connect cloud. The controller backups are encrypted.

Tracer SC+ Data security

Tracer SC+ utilization of data is limited to ***HVAC Machine Data*** only.

HVAC Machine Data is data generated and collected from the product or furnished service without manual entry.

HVAC Machine Data is data relating to the physical measurements and operating conditions of a HVAC system, such as but not limited to, temperatures, humidity, pressure, HVAC equipment status.

HVAC Machine Data does not include Personal Data and, for the purposes of this document, the names of users of Trane’s controls products or hosted applications shall not be Personal Data, if any such user chooses to use his/her name(s) in the created accounts within the controls product (e.g.,firstname.lastname@address.com).