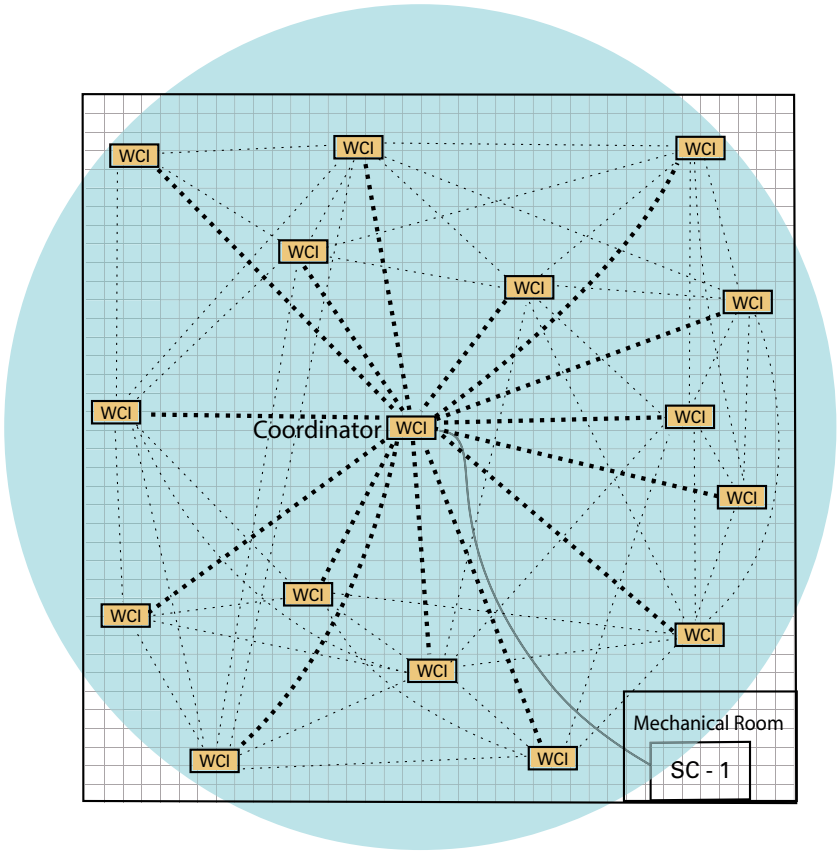
Installation, Operation, and Maintenance

Air-Fi® Network Design



⚠ SAFETY WARNING

Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

September 2024

BAS-SVX55J-EN

Introduction

Read this manual thoroughly before operating or servicing this unit.

Warnings, Cautions, and Notices

Safety advisories appear throughout this manual as required. Your personal safety and the proper operation of this machine depend upon the strict observance of these precautions.

The three types of advisories are defined as follows:

⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury. It could also be used to alert against unsafe practices.
NOTICE	Indicates a situation that could result in equipment or property-damage only accidents.

Important Environmental Concerns

Scientific research has shown that certain man-made chemicals can affect the earth's naturally occurring stratospheric ozone layer when released to the atmosphere. In particular, several of the identified chemicals that may affect the ozone layer are refrigerants that contain Chlorine, Fluorine and Carbon (CFCs) and those containing Hydrogen, Chlorine, Fluorine and Carbon (HCFCs). Not all refrigerants containing these compounds have the same potential impact to the environment. Trane advocates the responsible handling of all refrigerants.

Important Responsible Refrigerant Practices

Trane believes that responsible refrigerant practices are important to the environment, our customers, and the air conditioning industry. All technicians who handle refrigerants must be certified according to local rules. For the USA, the Federal Clean Air Act (Section 608) sets forth the requirements for handling, reclaiming, recovering and recycling of certain refrigerants and the equipment that is used in these service procedures. In addition, some states or municipalities may have additional requirements that must also be adhered to for responsible management of refrigerants. Know the applicable laws and follow them.

⚠ WARNING

Proper Field Wiring and Grounding Required!

Failure to follow code could result in death or serious injury.

All field wiring MUST be performed by qualified personnel. Improperly installed and grounded field wiring poses FIRE and ELECTROCUTION hazards. To avoid these hazards, you MUST follow requirements for field wiring installation and grounding as described in NEC and your local/state/national electrical codes.

⚠ WARNING

Personal Protective Equipment (PPE) Required!

Failure to wear proper PPE for the job being undertaken could result in death or serious injury. Technicians, in order to protect themselves from potential electrical, mechanical, and chemical hazards, MUST follow precautions in this manual and on the tags, stickers, and labels, as well as the instructions below:

- **Before installing/servicing this unit, technicians MUST put on all PPE required for the work being undertaken (Examples; cut resistant gloves/sleeves, butyl gloves, safety glasses, hard hat/bump cap, fall protection, electrical PPE and arc flash clothing). ALWAYS refer to appropriate Safety Data Sheets (SDS) and OSHA guidelines for proper PPE.**
- **When working with or around hazardous chemicals, ALWAYS refer to the appropriate SDS and OSHA/GHS (Global Harmonized System of Classification and Labelling of Chemicals) guidelines for information on allowable personal exposure levels, proper respiratory protection and handling instructions.**
- **If there is a risk of energized electrical contact, arc, or flash, technicians MUST put on all PPE in accordance with OSHA, NFPA 70E, or other country-specific requirements for arc flash protection, PRIOR to servicing the unit. NEVER PERFORM ANY SWITCHING, DISCONNECTING, OR VOLTAGE TESTING WITHOUT PROPER ELECTRICAL PPE AND ARC FLASH CLOTHING. ENSURE ELECTRICAL METERS AND EQUIPMENT ARE PROPERLY RATED FOR INTENDED VOLTAGE.**

⚠ WARNING

Follow EHS Policies!

Failure to follow instructions below could result in death or serious injury.

- **All Trane personnel must follow the company's Environmental, Health and Safety (EHS) policies when performing work such as hot work, electrical, fall protection, lockout/tagout, refrigerant handling, etc. Where local regulations are more stringent than these policies, those regulations supersede these policies.**
- **Non-Trane personnel should always follow local regulations.**

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Revision History

- Updated following sections in Overview chapter:
  - Air-Fi® Wireless Communications Interface (WCI)
  - Maximum Number of Air-Fi® Devices and Networks Allowed
  - Network Security
  - Related Literature
- Updated following sections in Network Design chapter:
  - Line of Sight Placement

  - Factors Affecting the Network Layout
  - Design Considerations for BCI-I, BCI2-I, BCI-R, BCI2-R and Symbio™ 700
  - Multiple Networks Managed by a Tracer® SC+
  - Use of Repeaters to Provide Redundancy
- Updated following sections in Addressing chapter:
  - Tracer® SC/SC+ Addressing
  - Controller Device IDs
- Updated Installation Best Practices chapter.
- Updated Site Survey Using Tracer® TU section in Conducting a Site Survey chapter.

Table of Contents

Overview

Trane Air-Fi® provides wireless communications for Trane® building automation systems that use the BACnet® communication protocol. Air-Fi simplifies building controls projects significantly by minimizing engineering, estimating, and project management tasks associated with communication link and space sensor wiring. Air-Fi also makes problem solving easier for new buildings, control upgrades, and building expansion projects.

Air-Fi devices are available factory installed. For improved installation quality, they are tested with our Tracer controllers that use the BACnet communication protocol. Self-repairing mesh technology and twice the signal range of other wireless solutions make Air-Fi Wireless a more reliable solution, reducing risk and maintenance costs.

A standard, open platform makes an Air-Fi Wireless system flexible; the system is ready for expansion when needed. The lifetime battery (based on normal operating conditions) saves time and money over the life of the system.

Wireless Devices

A Trane Air-Fi® Wireless system is enabled by the following three devices, which use Zigbee®[1] radios to form a wireless mesh network:

- The Air-Fi Wireless Communications Interface (WCI)
- The Air-Fi Wireless Communications Sensors (WCS)
- The TU Communications Adapter with integrated wireless radio

WCIs are wired to Tracer® controllers and to BACnet® Communications Interface (BCI) devices. WCIs that are wired to Tracer SC+ system controllers act as the “hub” or coordinator of each wireless network. WCIs that are wired to unit controllers or BCIs normally act as routers (routing messages toward the intended destination). WCIs that are not wired to controllers or BCIs can also act as routers to repeat messages, thereby extending the effective communications range as necessary. (Note that very few repeaters are expected to be required.)

Another viable application is the combination of Air-Fi Wireless zone sensors and BACnet MS/TP or BACnet/IP (hardwired or Wi-Fi) network communication. For those applications, one WCI (per network) is designated as the coordinator, without requiring a dedicated WCI at the Tracer SC+. Consider this hybrid (wired/wireless) approach when hardwired network communication is preferred or required.

Servicing and Maintenance

For servicing and maintenance, a Trane technician uses the Tracer TU service tool with the TU Communications Adapter in wireless mode. The technician can then discover, access, and service the device or any other device in the network.

Air-Fi® Wireless Communications Interface (WCI)

The Air-Fi Wireless Communications Interface (WCI) enables wireless communications between system controls, unit controls, and wireless sensors for Trane® control products that use the BACnet® protocol. The WCI replaces the need for communications wire in all system applications.

The WCI is available in three configurations:

- Universal Model (most common) - installs the same as a wired zone sensor in indoor applications and suitable for plenum use.
- Outdoor Model - housed in an enclosure suitable for outdoor environments. It is usually used on equipment above the roof deck.
- Flush Mount Model - used on fan coils, blower coils, and unit ventilators and suitable for plenum use.

1. *ZigBee is a registered trademark of the ZigBee Alliance.*

Air-Fi® Wireless Communications Sensor (WCS)

The Air-Fi Wireless Communications Sensor (WCS) is compatible with any Trane controller that uses a WCI. The WCS provides the same functions as many currently available Trane wired sensors. No further software or hardware is necessary for site evaluation, installation, or maintenance. Space temperature is standard on all models. (A service tool cannot be connected to a Trane wireless sensor.)

Six WCS models are available:

- CO_2 with occupancy WCS-SCO_2
- Digital display (WCS-SD) model
- Occupancy WCS-SO
- Base (WCS-SB) model has no exposed display or user interface
- Refrigeration and freezer monitoring sensor WCS-SB/R
- 2% relative humidity sensor module (WCS-SH), which can be field installed inside either the WCS-SD, WCS-SB. WCS-SO, WCS-SCO_2, WCS-SB/R

In most applications, one WCS sensor will be used per WCI acting as a router. However, up to 6 WCS sensors can be associated to a single equipment controller or BCI.

Device Compatibility and Support

The following zone sensors are compatible with the Air-Fi® Wireless Communications Interface (WCI) and can be used with Air-Fi wireless systems:

- Air-Fi Wireless Communications Sensors (WCS)
- Wired zone sensors

Note: *The new Air-Fi Wireless Communications Sensors (WCS) are compatible with old WCIs that have updated firmware.*

The following controllers and BACnet Communication Interfaces (BCI) are supported by Air-Fi Wireless Systems:

- Tracer® SC/SC+ system controller
- Tracer® UC210 programmable controller
- Tracer® UC400 programmable controller
- Tracer® UC600 programmable controller
- Symbio™ 210/210e
- Symbio™ 400/500
- Symbio™ 700
- Symbio™ 800
- BCI-I: BACnet Communications Interface for IntelliPak™ systems

  Note: *While BCI-I is compatible with WCS-SB and WCS-SD sensors, it does not support WCS-SO or WCS-SCO_2 or WCS-SB/R.*
- BCI-R: BACnet Communications Interface for ReliaTel™ systems

  Notes:
  - *It is not possible to create any points or references on BCI-Rs or BCI-Is.*
  - *The UC800 and BCI-C are currently not supported devices for wireless applications.*

Air-Fi Wireless sensors are compatible with Tracer SC/SC+, Tracer UC series of unit controllers, and Tracer Symbio series of unit controllers for both wireless (BACnet® over Zigbee®) and BACnet MS/TP (hardwired) and BACnet/IP (hardwired or Wi-Fi).

Maximum Number of Air-Fi® Devices and Networks Allowed

There are limits to the number of devices in an Air-Fi network. Following are some definitions and a table describing the limit of the number of devices in an Air-Fi wireless network. The best practice is to design the network well below these limits to provide room for future expansion as well as getting the most efficient wireless performance.

Notes:

- *The number of WCIs that can be installed at a site is determined by the applicable Tracer SC+ license, which specifies the total number of controllers.*
- *For instructions on installing a WCI on a Tracer SC+, see Air-Fi Wireless System Installation, Operation, and Maintenance (BAS-SVX40*-EN).*
- *Always consider leaving room on the network for additional WCIs or WCSs for future expansion.*
- *Generally, about 20 WCIs on a network is the optimum number to achieve an adequately dense mesh network for multiple communication paths as well as the fastest communication speed with minimum hops.*

Terms:

- **Router**— A WCI wired to a UC controller
- **Repeater**— A WCI that is stand alone. Its only job is to pass on information received from other WCI routers and sensors near it. It is set up with the same Group and Network number as the rest of the network, but it is not wired to a UC controller.
- **Coordinator**— A WCI coordinator establishes the Zigbee®[2] mesh network with surrounding WCI routers. Most of the time this will be the WCI that is wired to the Tracer SC+. However, there are instances where the network is formed without the Tracer SC+. In this case the Coordinator is wired to a UC controller. This is most common for applications with Air-Fi Wireless zone sensors and wired BACnet network communication, in which case the WCI coordinator at the Tracer SC+ is **not required**.
- **Devices**— WCI Routers, WCI Coordinators, WCI Repeaters, and WCS Sensors
- **WCS**— Wireless Communicating Sensor (WCS-SB, WCS-SD, WCS-SO, WCS-SB/R, and WCS-SCO_2)
- **SC**—Can be either Tracer SC or SC+

Table 1. Maximum Air-Fi networks and devices allowed

Max	Equipment	Usage Level	Notes
6	WCS	Per unit controller	A total of six (6) Air-Fi sensors can be associated to a unit controller in any combination (WCS-SB, WCS-SD, WCS-SO, WCS-SB/R, and WCS-SCO_2).
6	WCS	Per Air-Fi wireless network when associated directly to the Tracer SC+.	A total of six (6) Air-Fi wireless sensors can be directly associated to each WCI on the SC+ in any combination (WCS-SB, WCS-SD, WCS-SO, WCS-SB/R, and WCS-SCO_2). Sensors associated directly to the SC+ counts against the Devices maximum of 61.
8	Networks	Per Tracer SC+	App and/or Base
8	Coordinator WCI	Per Tracer SC+	1 Tracer SC+ coordinator WCI per network.
30	UC/Symbio™ controllers	Per network	30 is the maximum limit, 20 is recommended.
31	WCIs	Per network	1 Tracer SC coordinator WCI + up to 30 UC router WCIs + WCI Repeater(s).
48	WCS	Per Tracer SC+	Each SC+ Air-Fi Wireless network can have up to 6 sensors directly associated. An SC+ would have to have 8 wireless networks in order to have 48 sensors associated (6 sensors per network x 8 networks = 48). Sensors associated directly to the SC+ count against the Devices maximum of 61.

2. *ZigBee is a registered trademark of the ZigBee Alliance.*

Table 1. Maximum Air-Fi networks and devices allowed (continued)

Max	Equipment	Usage Level	Notes
61	Devices	Per network[a] [b]	1 Tracer SC coordinator WCI + up to 30 UC router WCIs + WCSs + WCI Repeater(s).
120	UC/Symbio controllers	Per Tracer SC+[c]	Applies to both App and Base SC+ controllers.
240	UC/Symbio controllers	Per App SC+ plus Base SC+ controllers	See note [d] below for examples.

[a] A WCI on a single UC/Symbio controller may have up to 6 WCS sensors associated. Count each WCS sensor as part of the device total.

[b] Example1: 30 UCs each with 1 WCS sensor associated (30 UCs +30 sensors + 1 coordinator = 61 devices). Example 2: 20 UCs each with 2 WCS sensors associated (20 UCs + 40 WCS + 1 coordinator = 61 devices). Example 3: 8 UCs each with 6 WCS sensors associated (8 UCs + 48 WCS + 1 coordinator = 57 devices.

[c] This would require a minimum of four (4) networks with 30 unit controllers on each network.

[d] Example 1: 120 UC controllers on App SC + 120 UC controllers on Base SC. Example 2: 120 UC controllers on App SC + 60 UC controllers on Base SC1 + 60 UC Controllers on Base SC2. Example 3: 60 UC controllers on App SC + 60 UC controllers on Base SC1 + 60 UC controllers on Base SC2 + 60 UC controllers on Base SC3. Example 4: 0 UC controllers on App SC + 120 UC controllers on Base SC1 + 120 UC controllers on Base SC2.

Automatic Network Formation and Sensor Association

A WCI that is connected to a Tracer SC+ is auto-assigned as the network coordinator. The coordinator WCI allows all WCIs and WCSs having matching GRP/NET addresses to automatically join the network. (For more details about the process of network establishment, see *Air-Fi® Wireless System Installation, Operation, and Maintenance* (BAS-SVX40*-EN).

If no Tracer SC+ is present, a centrally located WCI connected to a programmable or unit controller or a BCI must be designated as the coordinator. You can designate a WCI to be a coordinator either manually on the WCI or by using Tracer TU. See Establishing the Network Prior to Tracer SC+ Installation or Without Tracer SC+ Installation in the *Air-Fi® Wireless System IOM* (BAS-SVX40*-EN). For wireless zone sensors applied with BACnet MS/TP or BACnet/IP network communication, refer to the same manual for installation instructions.

After the network is formed, WCSs automatically associate with their designated controllers.

Notes:

- *When a WCS is first powered up, it **joins** the network using any WCI within range including the coordinator, and repeaters. The WCI becomes the **parent** for that WCS. As long as there is adequate signal level the WCS will stay with this parent WCI indefinitely. The parent WCI passes any WCS messages over the network to the associated unit controller.*
- *The network must be open for a WCS to join the network, but does not need to be open for the WCS to be manually assigned to a controller.*

Network Security

Air-Fi® Wireless is secured using Advanced Encryption Standard AES-128 (FIPS Pub 197) and HMAC (FIPS Pub 198). The Trane WCI operating as a Trust Center will create a randomly generated 128-bit network security key for each ZigBee®[3] network. This network security key is required to decrypt communications from the network. In order to join the secured Air-Fi network, the network must first be opened to allow devices to join. To open the network, a technician must plug into a controller on the network from inside a building. This adds another level of security. A device requesting to join the network is given a transport key which must be decrypted by the joining device before it can communicate on the Air-Fi network. The Air-Fi network will automatically close or prevent new devices from joining the network one hour after it was opened.

Related Literature

Refer to the following documents for additional information about Air-Fi® Wireless System installation, configuration, and troubleshooting:

- BAS-SVX40*-EN: *Air-Fi® Wireless System Installation, Operation, and Maintenance*: Describes how to address, install, modify, and troubleshoot an Air-Fi Wireless system.

[3] *ZigBee is a registered trademark of the ZigBee Alliance.*

- BAS-SVN038*-EN: *Air-Fi® Wireless Communications Interface (WCI) Installation Instructions*: A quick-start guide to addressing and installing a WCI.
- X39641265001*: *Air-Fi® Wireless Communications Sensor (WCS) Installation Instructions*: A quick-start guide to addressing and installing a WCS.
- X39641266001*: *Air-Fi® Wireless Communications Sensor (WCS) Configuration Instructions*: A quick-start guide to configuring a WCS.
- BAS-PRD021*-EN: *Air-Fi® Wireless System Product Data Sheet*.
- BAS-SVU029*-EN: *Air-Fi® Wireless Communications Sensor (WCS) Quick Reference Guide:* For owners.
- X39641157-01*: *Tracer TU Communications Adapter User Instructions:* Allows the Tracer TU service tool to connect to a remote unit controller through a zone sensor or wireless connection.
- BAS-SVX068*-EN: *Air-Fi® Wireless Planning and Implementation Best Practices Guide*
- X39641284001* *Air-Fi® Wireless Communication Sensor (WCS –SO/SCO_2) Installation and Configuration Instructions.*

Network Design

Designing an Air-Fi® wireless system with robust performance and reliability is relatively easy. However, the design of a wireless network has a direct impact on performance and reliability. For example, performance can be improved by locating the coordinator near the center of the network. Reliability can be enhanced by avoiding wireless signal obstructions.

Note: *Always check for pre-existing Air-Fi networks using Tracer TU and the Wireless Adapter. If a network already exists you won't be allowed to create another network using the same address.*

Wireless Network Device Location Best Practices

For most installations, barriers limit proper radio signal quality more than distance. To provide the best signal quality between wireless devices and to reduce the number of WCIs needed for an application, mount WCIs and WCSs in direct, unobstructed, line-of-sight paths. Where this is not possible, try to minimize the number of barriers between a WCI and a WCS or coordinator. In general, sheetrock (drywall) walls and ceiling tiles offer little range reduction to the transmission of the radio signal throughout the building. Do not design networks to span more than one floor.

General guidelines are as follows:

- Locate wireless devices so that they are easily accessible and their covers can be removed.
- Locate wireless devices in direct line of sight when possible.
- Avoid metal, concrete, and brick obstructions between wireless devices.
- Avoid placing devices inside metal enclosures.
- Locate wireless receivers and repeaters in elevated space.
- Locate wireless devices including the coordinator that are on the same network on the same building level. Do not span networks across multiple floors.

WCI Positioning

It makes no difference whether the WCI is positioned horizontally or vertically. It will work in any position. However it is good to know that the antenna is located within the top 1" of the WCI. The antenna radiates in all directions, generally in the shape of a sphere. The position of the WCI, either horizontal or vertical, does not change the radiation pattern. However, the surface where the WCI is mounted can change the radiation pattern. If mounted to a sheet metal box like on a VAV, the sheet metal will reflect much of the radiated signal, in effect blocking the signal from going to the other side of the VAV box. Once the radio signal leaves the antenna it bounces around off hard surfaces in all directions which tends to alleviate some of the blocking effects of the sheet metal box. Most of the time this blocking effect will not be a concern because the bouncing radio signals tend to fill in the entire area. However, in cases where too much signal level is blocked by a sheet metal box or object, and there is not enough signal bouncing back, it may be necessary to reposition the WCI or insure at least the top 1 inch of the WCI is cleared of any metal objects so the radio signal is free to radiate in the direction it needs to go.

Line of Sight Placement

When mounting WCIs, always be cognizant of where the coordinator and other WCIs are located. You do not need to physically see the coordinator or other WCIs from each WCI, but you should at least be aware of any obstruction between them. Remember that the radio signal will penetrate three drywall walls or one cinder block wall and still have about 200 feet of range, so these obstructions should not cause concern. An obstruction like large duct work, sheet metal boxes, large steel electrical panels, solid concrete walls, or elevator shafts may cause signal degradation. If you encounter these obstructions you can extend the IMC cable and mount the WCI in a better location to create an unobstructed signal path to the coordinator or other WCIs. Refer to Figure 6, p. 18 where multiple networks are used to avoid obstructions.

The IMC and power cable can be extended up to 656 feet using methods described in *Air-Fi® Wireless System Installation, Operation, and Maintenance* (BAS-SVX40*-EN).

Necessary Site Information

To begin designing a wireless mesh network, you need access to the following information:

- A detailed, scale floor plan of the application site, including walls, columns, and other interior features such as stairwells and elevator shafts. The floor plan should also include the proposed HVAC system layout.
- Architectural and mechanical specifications of application site with construction materials identified.

Typical Obstructions Affecting Network Signal Strength

Identify major and minor obstructions on a copy of the floor plan. Examples of major obstructions that reduce signal strength are:

- Elevator shafts
- Stairwells
- Mechanical/electrical rooms
- Metal-reinforced walls
- Large metal-reinforced columns
- Concrete walls and floors
- Brick walls
- Multiple cinder block walls
- Glass walls with metal coating and large mirrors
- Multiple rows of office equipment such as tall file cabinets, book shelves, computer racks, and metal partitions
- Plumbing or electrical risers
- Electrically noisy environments, such as hospital imaging rooms
- HVAC equipment chases
- Large diameter duct work above the ceiling with little open space

Note: *In industrial environments, be aware of large metal objects, such as trucks, sheet metal, or structural steel that may frequently pass through the space and could impact signal transmission.*

For estimating purposes, several minor obstructions can be considered a single major obstruction. Examples of minor obstructions are:

- Metal light fixtures
- Sheetrock walls with metal studs
- Single, hollow core, cinder block walls
- Multiple rows of cabinets or shelves or small columns
- Glass walls without a metal coating

When you encounter these obstructions, reduce the design range from 200 ft.

Factors Affecting the Network Layout

Consider the following factors when designing a network layout:

- Typical signal range

  The WCI has a typical signal range (radius) of 200 ft—potentially more for line-of-sight installations, less for obstructed installations.

  The exception is for WCIs mounted inside the return plenum of a rooftop unit (RTUs), which have a range limited to 100 ft. For more details, see “WCI Location Recommendations for RTU Installations ,” p. 21.
- Number of networks per Tracer SC+

  A Tracer SC+ can support up to 8 wireless networks.

- Number of WCIs and sensors per network

  Each Trane wireless network can include up to 30 member WCIs and 30 Air-Fi sensors. If fewer WCIs are used, you can include additional sensors in any combination that totals up to 60 devices. For example, if a network includes 20 WCIs, you can install up to 40 sensors in that network. Hence, we recommend designing networks with about 20 WCIs.

  Each member WCI is connected to a UC, a BCI, or acts as a repeater. In addition, each wireless network has one coordinator WCI.

  Notes:

  – *The coordinator WCI exists in addition to the 30 member WCIs in a network.*

  – *See the table in "Maximum Number of Air-Fi® Devices and Networks Allowed," p. 8 for more information on devices allowed.*

  – *You can use the Tracer TU Adapter to connect Tracer TU to a network that includes the maximum number of WCIs and sensors.*

  – *The number of WCIs that can be installed at a site is determined by the applicable Tracer SC+ license, which specifies the total number of controllers.*

- Maximum wiring length

  The maximum IMC length for each Tracer SC+ is 656 ft (200 m). (This is the maximum length for the entire link and must include both IMC connections to the PM014.)

Design Considerations for BCI-I, BCI2-I, BCI-R, BCI2-R, and Symbio™ 700

A best practice when designing Air-Fi networks used on BCI-I, BCI2-I, BCI-R, BCI2-R, and Symbio 700 controllers is to always provide a wired sensor in the unit's return section as a backup in case BACnet® communication is lost.

The Air-Fi temperature sensor information is mapped to the Symbio 700, ReliaTel™ or IPak controller like a BAS point. If the WCI coordinator fails and the network goes down, the unit thinks it has lost local space temp, so it shuts down in response.

Having a wired sensor in the return section for the unit to default to in case the wireless network fails, is inexpensive insurance against this type of unit shutdown.

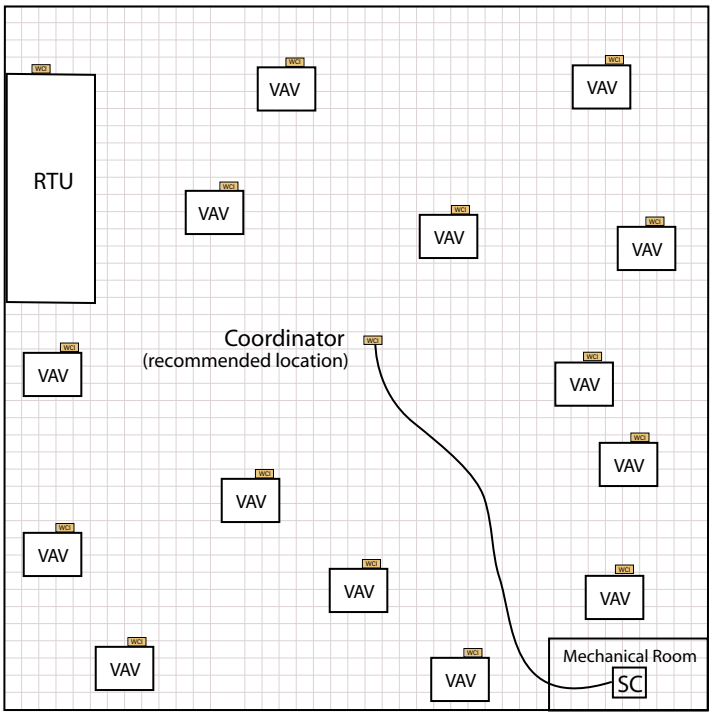
Unlike the UC and Symbio families of unit controllers, applications of Air-Fi Wireless zone sensors combined with BACnet MS/TP or BACnet/IP network communication cannot be applied with BACnet Communication Interfaces (BCIs). BCIs support only one form of communication at a time, either Air-Fi wireless or wired MS/TP, not both concurrently.

Locating Wireless Devices on the Network

To begin designing a wireless network, establish the location of the equipment that will be controlled by WCIs.

1. On a copy of a floor plan drawn to scale, identify potential WCI locations and mark them. WCI locations are typically determined by the location of the equipment that will be on the wireless network.
2. Choose a central location for the network coordinator and mark it on the floor plan.

Figure 1. Floor plan with WCI locations and coordinator identified



3. Draw a circle with a 200 ft. radius to scale to represent the typical radio range for a WCI.
4. Place the center of the circle on the coordinator as shown in the following figure. This will allow you to see which WCI signals have a direct route to the coordinator and which ones need to hop to one or more WCIs before reaching the coordinator.

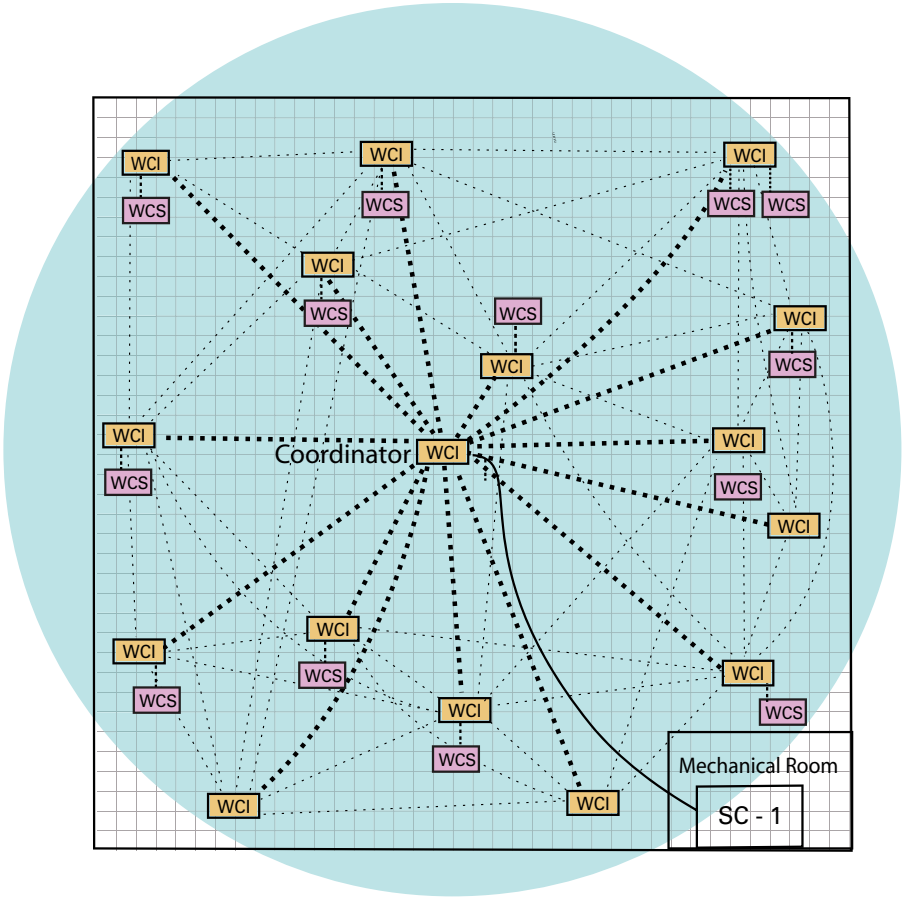
   Note: *Ideally, each device should need to hop no more than twice to reach the coordinator.*
5. Relocate the circle to other WCIs to examine how robust the network is for that node, that is, how many potential routes that node can rely on.

A Simple Network Structure

The blue sphere in the following figures (and figures throughout this document) indicates a typical WCI radio range of 200 ft. It is centered over the coordinator WCI in every figure. In the following figures, all WCIs are within the blue sphere. These figures illustrate a simple network in which all nodes are located within the 200 ft signal range of the single coordinator WCI. They require only one hop to reach the coordinator.

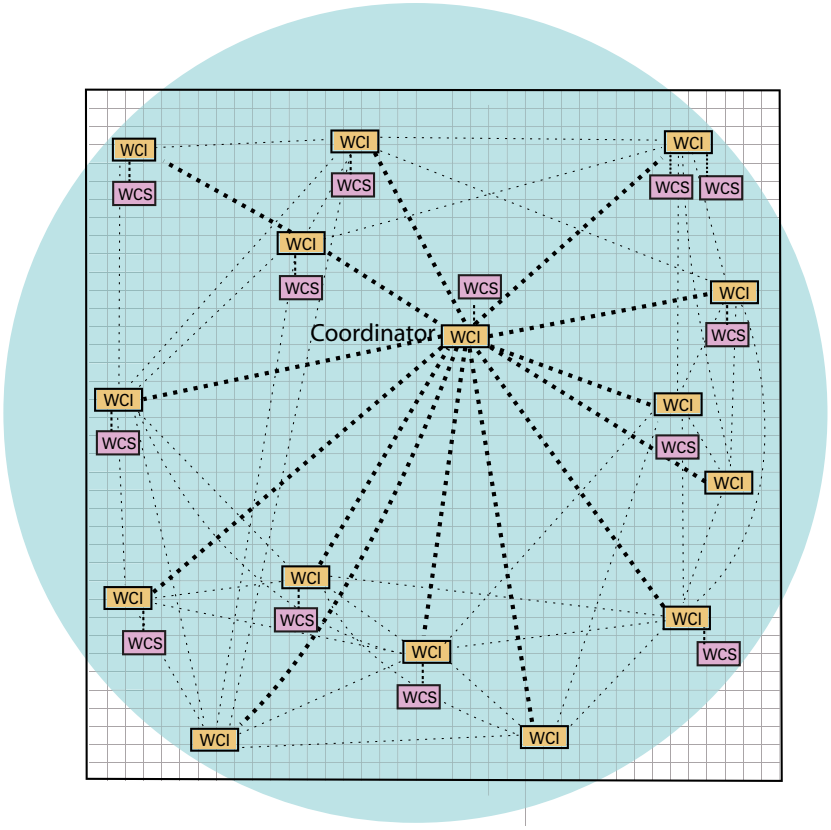
In addition these figures, and all of the network figures in this manual, illustrate the most direct route between the WCIs and the coordinator WCI by the use of heavy dashed lines. Other potential routes are shown with light dashed lines.

Figure 2. A network with a Tracer SC



Note: *The WCS will never route messages in the network, so it cannot be used as a repeater. This is by design, so that battery life is maintained.*

Figure 3. A network without a Tracer SC

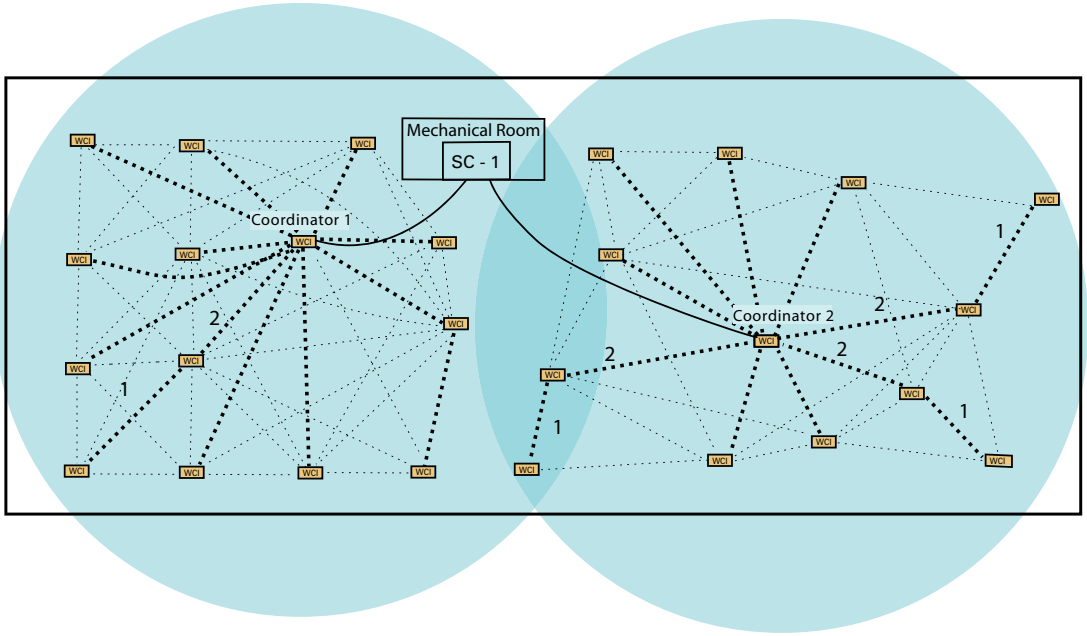


Note: *In networks that do not include a Tracer SC+, the WCI coordinator must be associated to a centrally located unit controller. A repeater can also be used as a temporary coordinator but this practice is discouraged. Generally the repeater is not going to be centrally located, which will create communication issues with distant WCIs. Also, when using a repeater as the coordinator you limit yourself to a wireless connection only. When the coordinator is a unit controller, you have a USB connection option as well as wireless. This is the common approach when combining Air-Fi® Wireless zone sensors with hardwired BACnet® network communication, both BACnet MS/TP and BACnet/IP.*

A Complex Network Structure Using Multiple Overlapping Networks

This example shows the same space and devices as the previous example. In this example the space is covered using two centrally located coordinators to create overlapping networks that cover the entire space, instead of relying on node-hopping like in the previous example. This is the recommended way to design networks.

Figure 4. Use of two centrally located coordinators

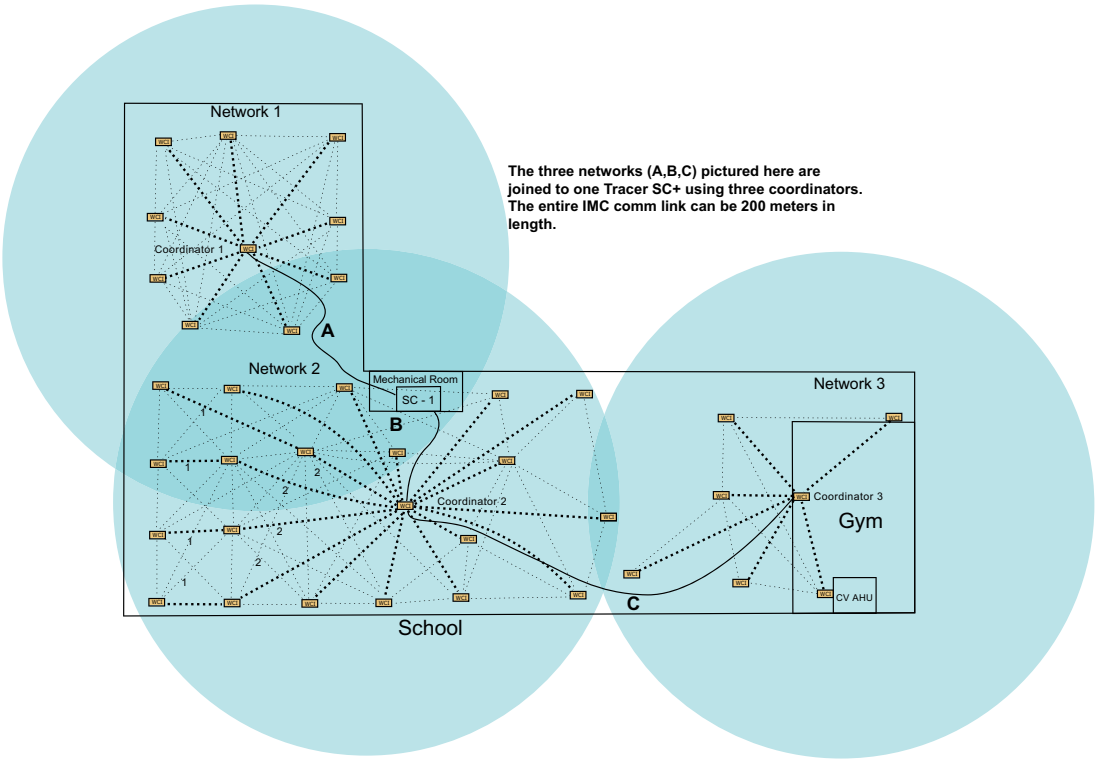


Multiple Networks Managed by a Tracer® SC+

Common reasons for using multiple networks in a space is to provide 100% overlapping coverage of the space, and to design around obstructions that limit radio signal range like elevator shafts and concrete walls.

The following figure illustrates a space with 35 devices. This space must be covered using three networks because of the extended distances due to physical layout of the building.

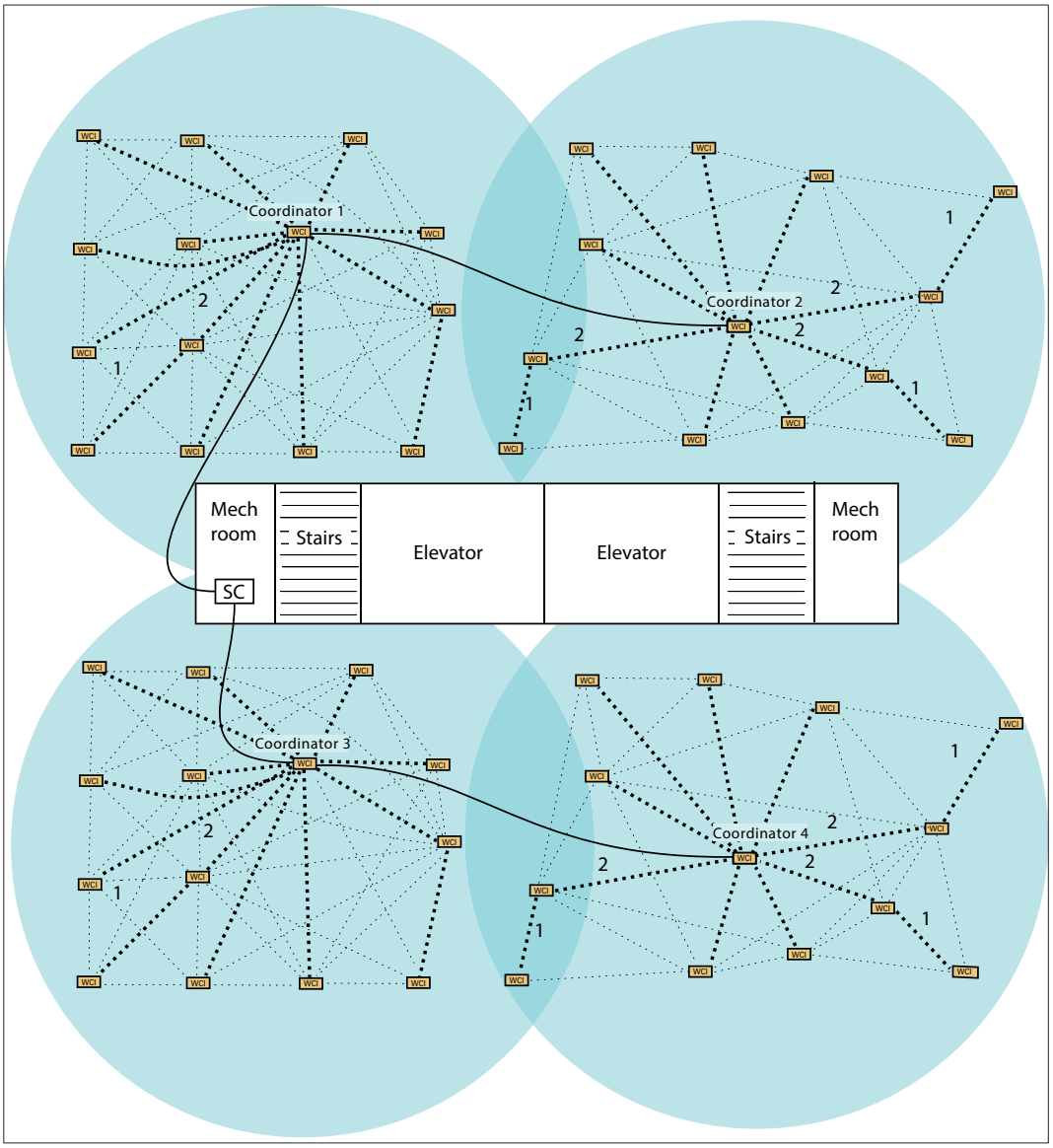
Figure 5. Floor covered by three networks



Using Multiple Networks to Avoid Obstructions

Always design networks keeping the building infrastructure in mind. Elevator shafts, stairwells and solid concrete walls do not allow radio signal to pass through. Separate networks will need to be set up around these obstructions. In the following figure, we show elevator shafts and stair wells located in the center of the building. The recommended strategy in this case is to split the floor into as many networks as it takes to provide 100% coverage around this obstruction. In this example, four networks are needed to provide 100% coverage to all areas without forcing any signals to go through the obstructions.

Figure 6. Separate networks around obstructions



Use of Repeaters to Provide Redundancy

You can use repeaters to provide a Unit Controller an alternate communication path back to the coordinator when only a single path exists. However, we recommend the use of repeaters be kept to a minimum and only used when there are no other options. Air-Fi® sensors may use a repeater to join the network or to extend the range as long as the repeater WCI has at least v2.0 firmware.

The following figure illustrates a WCI with a single route to the coordinator which requires three hops. This creates a situation where the WCI has a single point of failure.

Figure 7. Single point of failure and an alternative route

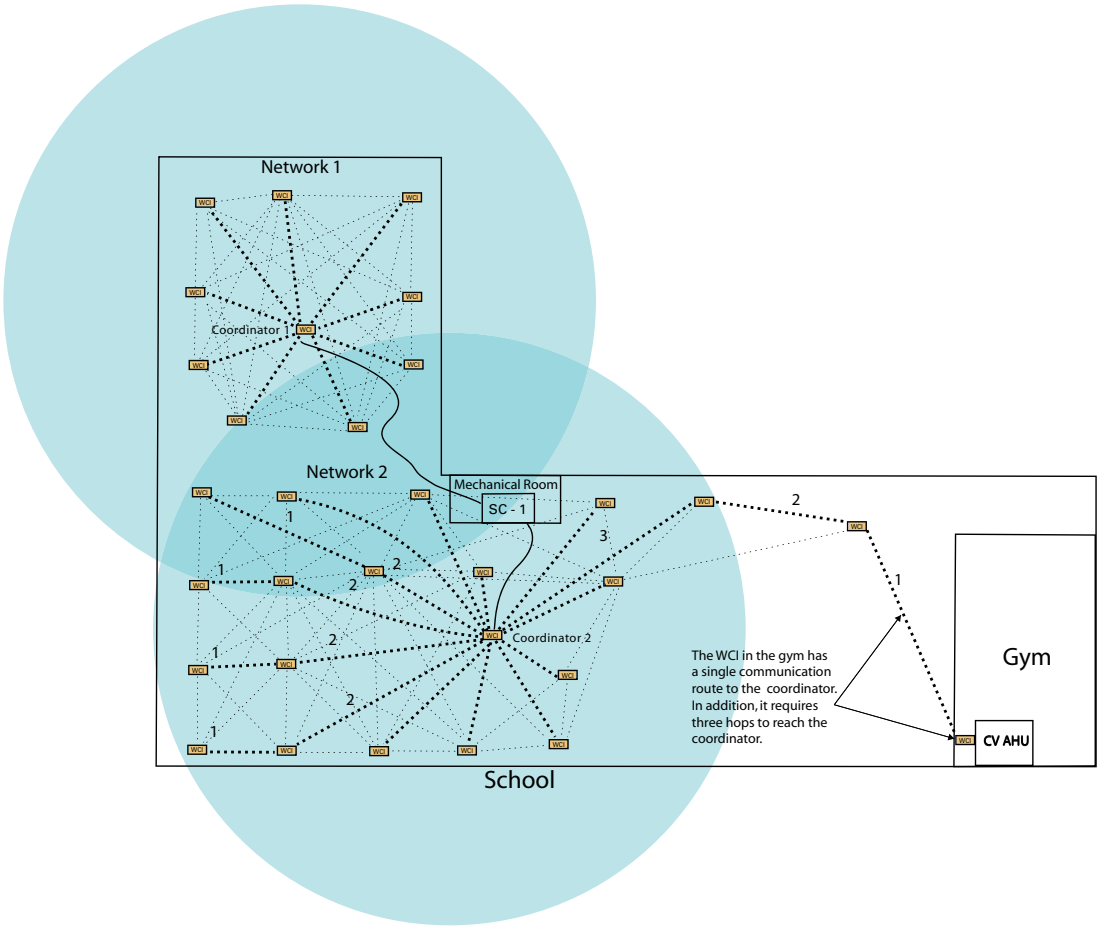
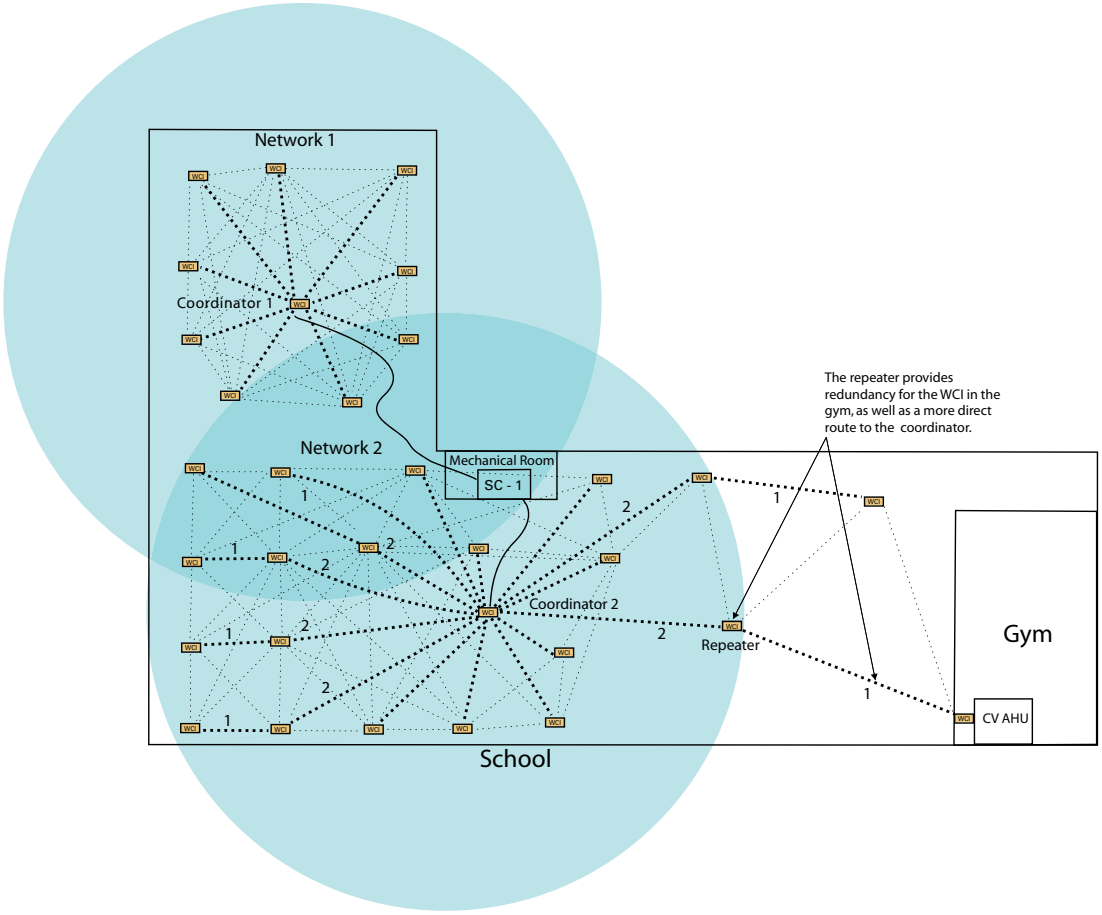
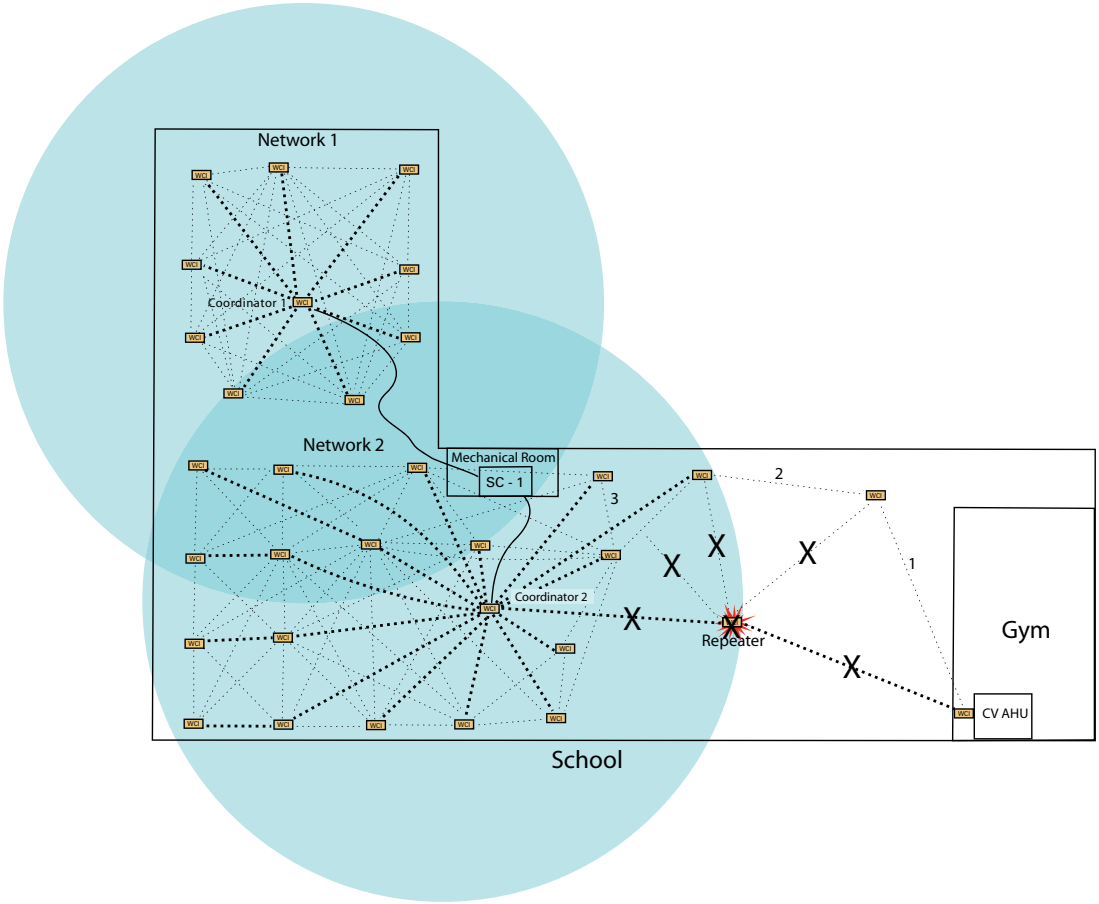


Figure 8. Network with repeater installed



In Figure 9, p. 21, the repeater has failed. The redundancy that it provided for the WCI in the gym, along with the more direct route to the coordinator 2, no longer exist. However, the three-hop route that existed before the repeater was installed enables communication to continue.

Figure 9. Repeater failure recovered by a WCI that provides a back-up link



WCI Location Recommendations for RTU Installations

Trane has special recommendations for coordinator and repeater placement on sites without VAV boxes. The recommended mounting location for RTU installations is in the RTU return section. This location provides the best overall sensor and communication link quality, and makes access to the WCI easier than below the roof deck for improved serviceability.

In RTU/VAV systems, there is adequate network density, which minimizes the need for repeaters. However, the increased distance between devices on single zone rooftops means that repeaters will be required in many of these installations. Unlike VAV boxes, which may be within line of site, RTUs have greater obstructions between devices, such as steel roof decks and return ducts. Consequently, the design range between these devices is shorter. Based on tests, Trane recommends a design range of 100 feet.

For large space installations without terminal equipment to act as repeaters, we recommend dropping the WCI below the roof deck. This also applies to ducted RTUs, where the WCI should be relocated inside the building.

Table 2. RTU application

RTU Application	Recommended WCI Location	Notes
RTU/VAV	Factory or field install in RTU return section directly above roof opening.	• Design radius reduced from 200 feet to 100 feet. • Lowest cost, serviceable, and proven reliability due to proximity of VAV boxes.
RTU only	Install WCI below roof deck within 200 feet of network coordinator WCI.	• Maintains 200 feet design radius and provides reliable communication, but increases cost . • Ensure WCI is in a serviceable location. • Use wired sensors if located below top floor.
RTU on grade/ducted (RTU/VAV or RTU only)	Install WCI inside building within 200 feet of network coordinator WCI.	• Maintains 200 feet design radius and provides reliable communication, but increases cost . • Use wired sensors above first floor .

Addressing

This section describes the addressing procedures for Air-Fi® devices.

WCI Addressing

WCI addressing determines which devices can communicate on a specific Air-Fi® network. WCIs can be installed within communication range of each other but will not have the ability to communicate with each other if they do not have the same network address.

A WCI has two rotary address switches. Address settings are defined in Table 3, p. 23.

- **GRP:** This address setting determines the Tracer SC+ group membership of the WCI. For consistency, we strongly recommend the GRP address setting be set the same for all WCIs connected to a specific Tracer SC+.
- **NET:** This address setting determines the network membership of the WCI and corresponds to a Tracer SC+ Air-Fi network. The NET address setting must be the same for all WCIs that are members of a specific network.

Table 3, p. 23 describes the WCI address settings.

Table 3. Address settings

Function/Purpose	GRP	NET
Trane BACnet communications	0–8	1–8[a]
Return to default configuration (Clears WCI of controller information.)	0	0
GRP 9 is reserved for future use when integrating with other BACnet over Zigbee® compliant devices. Do not use.	9	N/A
Future use	N/A	9

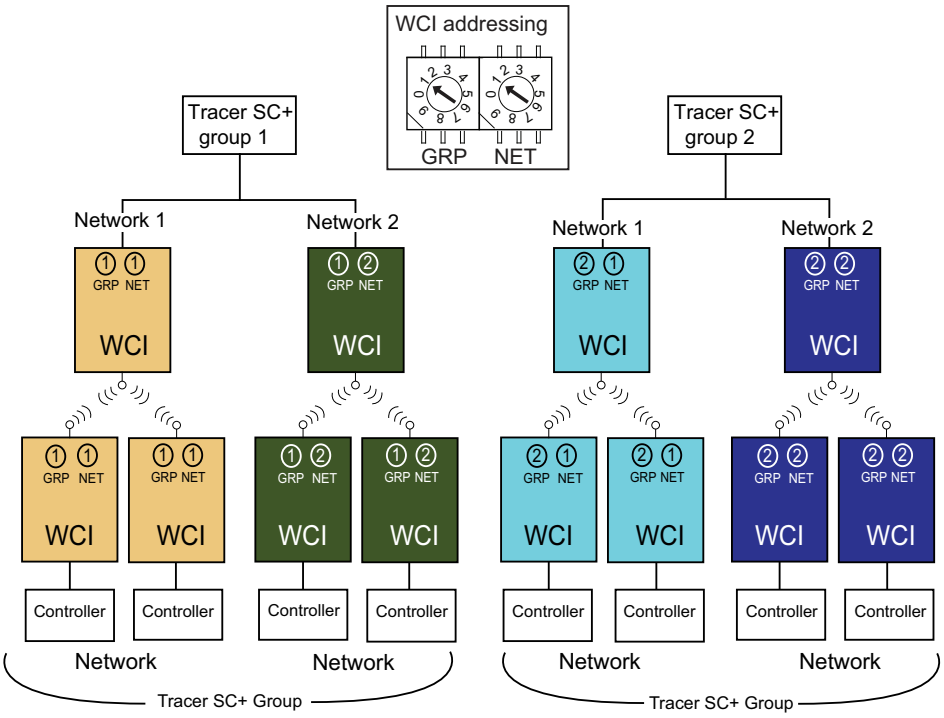
[a] Must match the Air-Fi Wireless network number. (See Tracer® SC/SC+ Addressing, p. 26).

Figure 10, p. 24 provides an example of an application with two Tracer SC+ controllers. In this example, each Tracer SC+ communicates with two networks. The GRP and NET settings are specified as follows:

We suggest the group (GRP) address be unique for each Tracer SC+ to help keep the network addressing scheme straightforward.

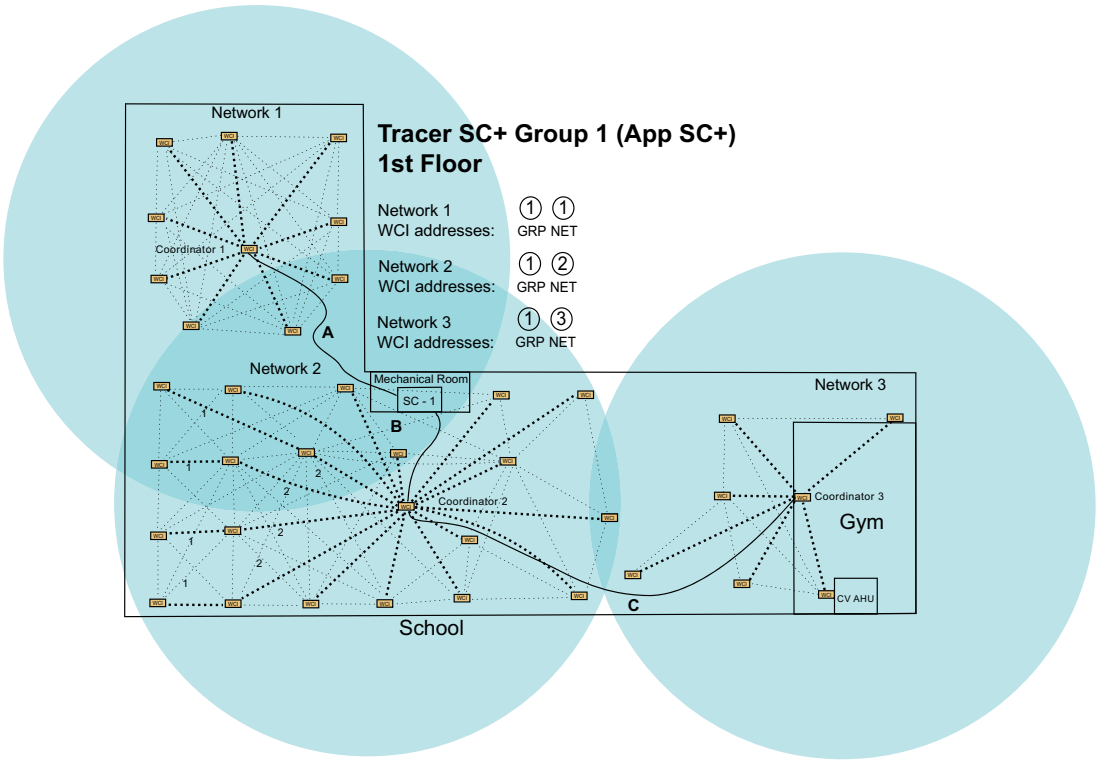
For example, the Tracer SC+ group 1 address is 1, and the Tracer SC+ group 2 address is 2. But, the group address can also be the same for multiple SC+ controllers or a Tracer SC can use different group addresses for each of its networks if desired.

Figure 10. Addressing example: two groups with two networks



The following two figures illustrate WCI addressing for the same type of installation shown in the previous network diagram, but from a floor plan perspective. In this case we are showing the use of two Application SCs; one per floor. **Never design networks to cover more than one floor. Each floor should have its own network or networks.**

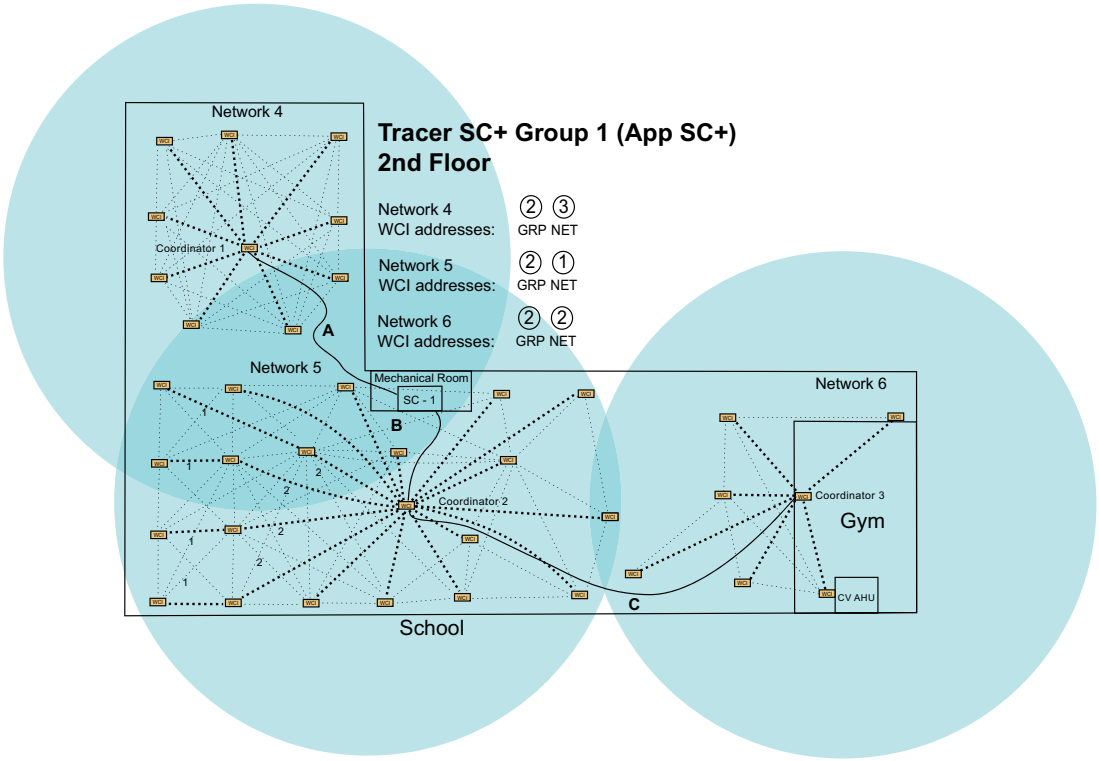
Figure 11. Example of first floor network addressing in a two-story building



We are showing that both floors are using the same three NET rotary numbers 1, 2, 3 for both floors. Since these networks are separated by a floor there is little chance that the networks will interfere with each other. As an added precaution against any possible interference, you can stagger the NET numbers so that the same NET number is not positioned directly above or below each other providing as much distance from each other as possible. Using different NET rotary numbers on each floor would also be an acceptable method to reduce any possible interference between networks. For instance, on floor 2 use NET 4, 5, 6, rather than 1, 2, 3.

Note: *Our testing has shown using the same NET rotary number in adjacent networks will work without a noticeable drop in performance, even if the networks are on the same floor. However, this should only be done when it is found that a specific NET rotary number is the only one that works in the building.*

Figure 12. Example of second floor network addressing in a two-story building



Tracer® SC/SC+ Addressing

All Tracer SC/SC+ controllers that are connected by BACnet/IP must have a unique rotary address. Network numbers are derived from the Tracer SC/SC+ rotary address as shown in the following table. A Tracer SC can have two MS/TP networks and eight wireless Air-Fi networks. A Tracer SC+ can have three MS/TP networks and eight wireless Air-Fi networks.

Table 4. SC BACnet links with corresponding network numbers

Link	BACnet Network number
MS/TP link1	(SC Rotary * 10) + 1
MS/TP link2	(SC Rotary * 10) + 2
Air-Fi Wireless Network 1[(a)]	(SC Rotary * 10) + 3
Air-Fi Wireless Network 2	(SC Rotary * 10) + 4
Air-Fi Wireless Network 3	(SC Rotary * 10) + 5
Air-Fi Wireless Network 4	(SC Rotary * 10) + 6
Air-Fi Wireless Network 5	(SC Rotary * 10) + 7
Air-Fi Wireless Network 6	(SC Rotary * 10) + 8
Air-Fi Wireless Network 7	(SC Rotary * 10) + 9
Air-Fi Wireless Network 8	(SC Rotary + 1 * 10) + 0

(a) The wireless network number matches the NET rotary setting on the WCI.

Note: *This scheme limits the Tracer SC to a maximum of 10 distinct BACnet MS/TP networks. Since the BACnet/IP network is common to all Tracer SCs, it is not considered one of these 10. The BACnet/IP network defaults to using network number 1. This scheme also limits the maximum number of wireless networks on a Tracer SC to eight.*

Table 5. SC+ BACnet links with corresponding BACnet Network numbers

Link	BACnet Network Number Calculation	Result: (SC+ rotary 001) BACnet Network Number
MS/TP link 1	(SC+ Rotary *10) + 1	11
MS/TP link 2	(SC+ Rotary *10) + 2	12
MS/TP link 3	(SC+ Rotary *10) + 3	13
Air-Fi Wireless Network 1[(a)]	(SC+ Rotary *10) + 4	14
Air-Fi Wireless Network 2	(SC+ Rotary *10) + 5	15
Air-Fi Wireless Network 3	(SC+ Rotary *10) + 6	16
Air-Fi Wireless Network 4	(SC+ Rotary *10) + 7	17
Air-Fi Wireless Network 5	(SC+ Rotary *10) + 8	18
Air-Fi Wireless Network 6	(SC+ Rotary *10) + 9	19
Air-Fi Wireless Network 7	(SC+ Rotary+1 *10) + 0	20
Air-Fi Wireless Network 8	(SC+ Rotary *10) + 0	10

(a) The Air-Fi Wireless Network number matches the NET rotary setting on the WCI.

Controller Device IDs

Controllers, both UC and Symbio™, are assigned a device ID by the Tracer® SC/SC+ during installation. The algorithm that calculates the desired unit controller device ID starts with the Tracer SC rotary address.

Controller device IDs are user configurable using Tracer® TU. However, currently, during installation, Tracer SC/SC+ will overwrite device IDs that have been configured with Tracer TU.

The algorithm that calculates device IDs is different for MS/TP and for wireless networks. This is the same algorithm for SC and SC+, UC and Symbio.

- **MS/TP**

  LINK1: DeviceId = SC-Rotary x 10000 + 1000 + Controller Rotary

  LINK2: DeviceId = SC-Rotary x 10000 + 2000 + Controller Rotary

  LINK3: DeviceId = SC+ Rotary x 10000 + 3000 + Controller Rotary (SC+ only)

- **Air-Fi® Wireless**

  DeviceId = BACnet Network-Number x 1000 + Controller Rotary

  To prevent an overflow of the unit controller device ID, the Network-Number of wireless networks is limited to 4193, which is more restrictive than the BACnet limit of 65535.

  Note: *This limit is of concern only if you manually configure the network number. You will not be able to install devices if you exceed 4193. The default values will not exceed this value, because the Tracer SC rotary address is limited to 419.*

The following table shows an example of BACnet network numbers and controller rotary ranges for a Tracer SC with a rotary setting of 001.

Table 6. SC Sample controller rotary ranges

Tracer SC Comm Link	BACnet Network Number	Controller Rotary Range[a]	WCI Net Rotary Number
MS/TP Link 1	11[b]	1 - 127	
MS/TP Link 2	12	1 - 127	
Air-Fi Wireless Network 1	13	1 - 999	1
Air-Fi Wireless Network 2	14	1 - 999	2
Air-Fi Wireless Network 3	15	1 - 999	3
Air-Fi Wireless Network 4	16	1 - 999	4
Air-Fi Wireless Network 5	17	1 - 999	5
Air-Fi Wireless Network 6	18	1 - 999	6
Air-Fi Wireless Network 7	19	1 - 999	7
Air-Fi Wireless Network 8	20	1 - 999	8

[a] Do not use 997, 998, or 999 as a rotary address for Symbio controllers, as these three rotary addresses are reserved for restoring the controller database on a power cycle.

[b] The Tracer SC rotary setting = 001.

Table 7. Sample device IDs assigned by SC+

Tracer SC+ Comm Link	BACnet Network Number from Table 5, p. 26	Controller Rotary Range[a]	Device ID assigned by SC+ = (BACnet Network Number x 1000 + Controller Rotary)
MS/TP link 1	11	001-127	11001 to 11127
MS/TP link 2	12	001-127	12001 to 12127
MS/TP link 3 (if used)	13	001-127	13001 to 13127
Air-Fi Wireless Network 1[b]	14	001-999	14001 to 14999
Air-Fi Wireless Network 2	15	001-999	15001 to 15999
Air-Fi Wireless Network 3	16	001-999	16001 to 16999
Air-Fi Wireless Network 4	17	001-999	17001 to 17999
Air-Fi Wireless Network 5	18	001-999	18001 to 18999
Air-Fi Wireless Network 6	19	001-999	19001 to 19999
Air-Fi Wireless Network 7	20	001-999	20001 to 20999[c]
Air-Fi Wireless Network 8	10	001-999	10001 to 10999

[a] Do not use 997, 998, or 999 as a rotary address for Symbio controllers, as these three rotary addresses are reserved for restoring the controller database on a power cycle.

[b] The Air-Fi Wireless Network number matches the NET rotary setting on the WCI.

[c] It is possible to have duplicate device IDs assigned if there are multiple SC+ with rotary's set to consecutive numbers. The duplicate device IDs will occur on Network 7 on the first SC+ and Network 8 on the second SC+. To avoid duplicate device IDs on large jobs with multiple SC + it is advised to set the rotary address of the SC+ non-consecutive. Example: First SC+ rotary set to 101. The next SC+ rotary set to 103. Or, you can use unique rotary addresses on all controllers across all Air-Fi networks to avoid the possible duplication.

WCS Addressing

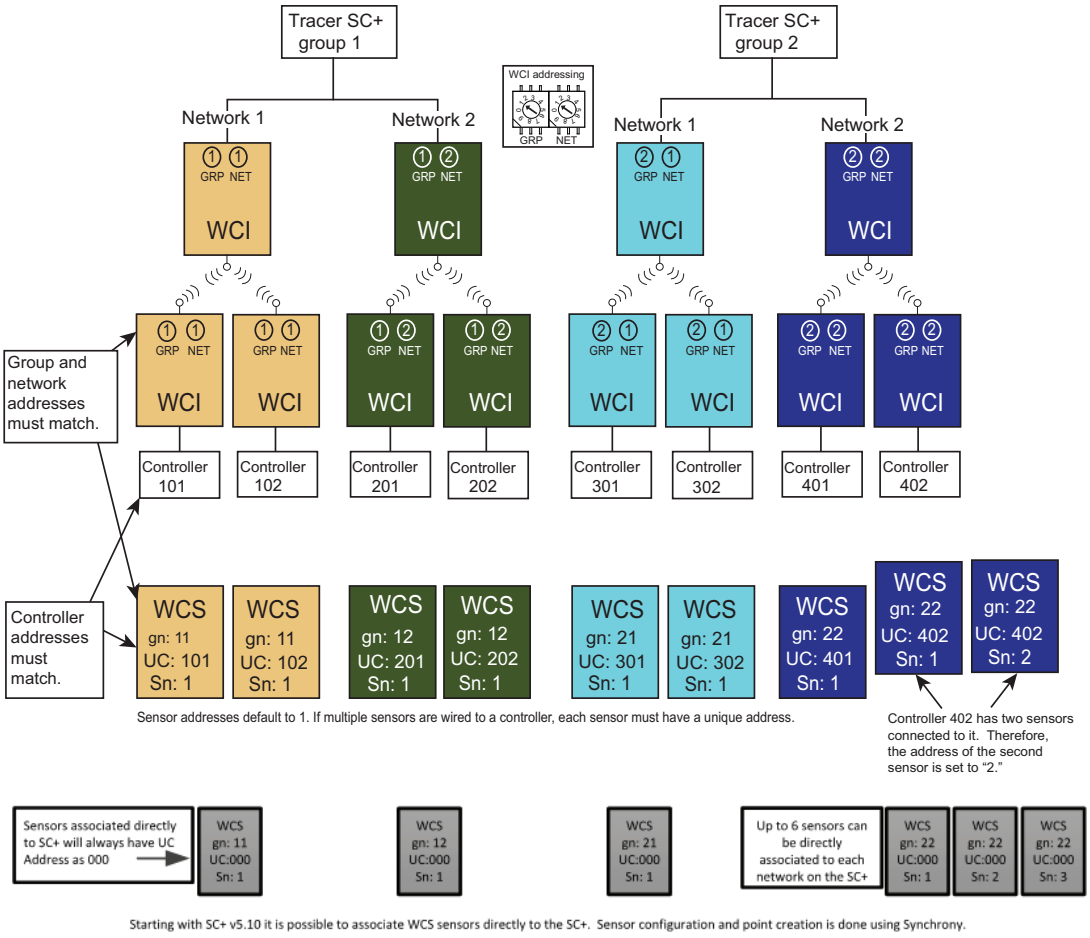
To enable the WCI to receive the signal of a WCS, addresses must be set on the WCS using its keypad. Prior to setting addresses on the WCS, you need to know the group address (1 digit), the network address (1 digit), the unit controller address (3 digits), and the sensor number, which can be 1 to 6 (1 digit).

If multiple WCSs (maximum of 6) are associated with the same WCI, each WCS must have a unique sensor number. WCS sensor numbers must be consecutive.

Note: *The total number of associated sensors affects the total number of WCIs that can communicate on the network. Refer to "Number of Air-Fi® Devices per Network" .*

Figure 13, p. 29 shows the same Air-Fi example as in “Addressing example: two groups with two networks” in “WCI Addressing ,” p. 23 but with the WCSs added. After addresses are set, the WCS will immediately attempt to join the network and associate with the unit controller.

Figure 13. Air-Fi network diagram with WCSs added



Installation Best Practices

- Do not attempt to complete an installation without using Tracer® TU and a Wireless Adapter to check network health. Select **Network Health** on the Wireless drop-down menu. Check for three green bars of Link Quality and less than three hops on each unit.
- Use Channel Quality Scan found in Tracer TU to scan the area before the installation to avoid busy channels. After installation, save screenshots of the scan for future reference and for commissioning data.
- A site survey to test signal strength may be necessary for installations that include hops through very dense materials (thick concrete) or reflective surfaces (solid metal). Refer to “Conducting a Site Survey ,” p. 31.
- On multiple floor buildings, do not design networks to span more than one floor. The Air-Fi radio signal may not penetrate the floor material reliably resulting in poor signal quality. Each floor should have its own networks.

Conducting a Site Survey

For most installations, a site survey is not necessary. However, if there is significant doubt about the ability of a signal to penetrate difficult materials, such as solid steel surfaces or thick reinforced concrete, or to reach unusually long distances (for example, more than 200 ft) while penetrating walls or floors, a site survey is recommended.

Note: *A site survey is a conservative test that is dependent on a single link. The mesh networks in actual installations may choose a more optimized path that results in superior signal quality and system reliability.*

To conduct a site survey, you will need Tracer TU with the TU Wireless Adapter, WCI, and a wall transformer.

Site Survey Using Tracer® TU

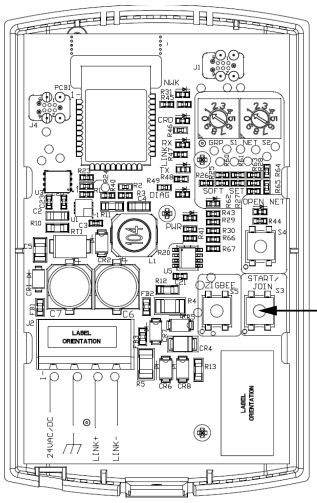
To use Tracer TU as the site survey tool, the following parts are required:

- Laptop with Tracer TU Software (version 9.3 or later is recommended)
- 24 V wall transformer, P/N 35803005
- WCI, P/N X13790901030
- TU Adapter, P/N X13651532010

To assemble, wire the 24 V wall transformer to WCI inputs: 24 Vac/Vdc and Ground.

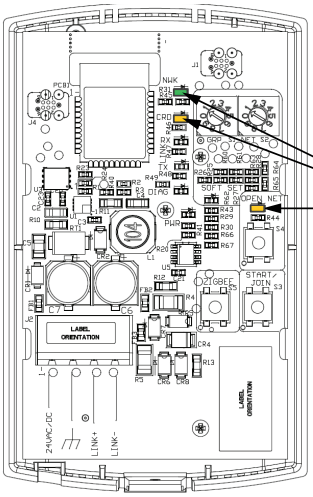
To conduct the survey:

1. Set the WCI group (GRP) and network (NET) numbers to addresses that are currently not being used in the building (example shown uses 1 and 2).
2. Use the 24 V wall transformer to power the WCI closest to one end of the questionable hop.
3. Press the **START** button on the WCI for 5 seconds (or until the coordinator light is turned on) to initiate the network. Place the WCI in a location where you believe the coordinator will be located.



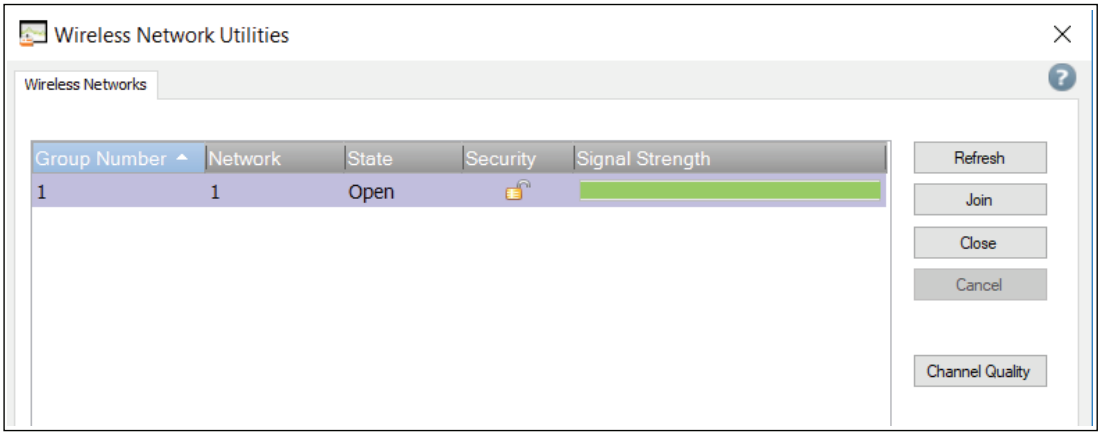
WCI

Coordinator WCI

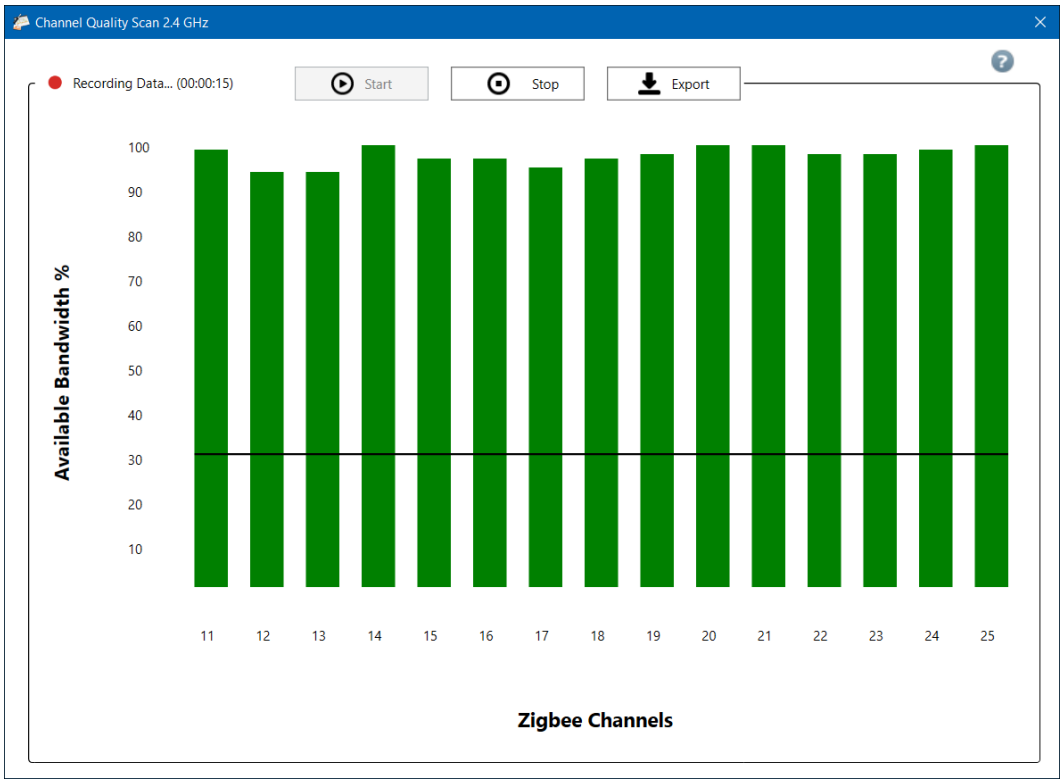


4. Refer the following steps:
    a. Connect wireless TUA to laptop wlith a USB cable.
    b. Move the laptop and TUA to the questionable area.
    c. Open TU and connect using TU Adaptor - Wireless.
    All Air-Fi wireless network within range will be displayed under the Wireless Network Utilities page including the signal strength of your test WCI.
    d. Note the signal strength of your test WCI.
    e. Take several scans spread out over time and average the signal strengths for the final result.

    If the signal strength is shown as a green bar, the signal quality is sufficient. If signal strength is not shown as a green bar, relocate the WCIs to avoid the obstruction, or consider adding more than one network to the space.



5. When you have finished the site survey, disband the network by pressing and holding the **Start button** on the WCI for 10 seconds.
6. Scan the area using Tracer TU Quality Scan Tool and the wireless adapter to check for busy channels before installation.



Notes

Trane - by Trane Technologies (NYSE: TT), a global innovator - creates comfortable, energy efficient indoor environments for commercial and residential applications. For more information, please visit trane.com or tranetechnologies.com.

BAS-SVX55J-EN 15 Sep 2024
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