Technical Note
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Self-Organizing Network: Best Practices Planning, Installation, and Commissioning Guide

INTRODUCTION

A wireless self-organizing network from Emerson Process Management is simple and easy to install and commission. There are a few best practices to ensure that the network performs properly.

This document lays out best practices and ensures the proper concepts are covered when planning the wireless network. There are two major categories of best practices: 1) Network Planning and 2) Network Installation and Data Integration.

HARDWARE CONSIDERATIONS

Wireless Devices

Emerson's Smart Wireless devices have process connections and mountings engineered according to the same practices and systems that govern wired instrumentation today, with the exception of loop wiring / conduit. The measurement devices are powered by an intrinsically safe power module.

- Rosemount 648 Wireless Temperature Transmitter
- Rosemount 3051S Series of Instrumentation
- Rosemount 702 Discrete Input Transmitter
- Smart Wireless THUM™ Communicator

Smart Wireless Gateway

The Smart Wireless Gateway (Model 1420) connects the self-organizing network to the information system and needs continuous line-powered 24V DC service at 0.5 Amps. An Uninterruptible Power Supply (UPS) is recommended for the gateway.

Lightning protection and earth grounds installed by certified electricians are recommended for gateways with either integral or remote antennas.

PART 1: NETWORK PLANNING

Scope the Project

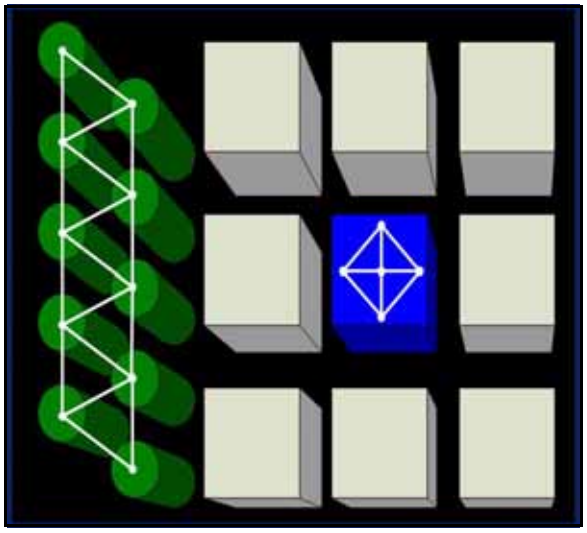
The first step is to answer the fundamental question, “where is my data?” What types of applications are targeted for monitoring and where do their data points exist?

If the process facility is very large, consisting of several or more process units, then scope the wireless project to remain within a single process unit. This allows the data from the self-organizing network to flow through the Smart Wireless Gateway into the information system, following the same organizational structure, physical structure and workflow of the process facility. This minimizes hardware and data ownership issues and gives a general direction to the data flow.

If the process facility is a small operation, then treat the wireless project as a single process unit . This works whether the entire process unit is entirely outdoors or entirely indoors. If a process unit is of complex design, for example an enclosed multiple floor manufacturing facility, then it may be optimal to scope a wireless network to each floor of the facility. For process facilities that are extremely compartmentalized by steel and concrete, it may be necessary to treat each large enclosure as a process unit.

Action: Scope a wireless project to a single process unit or cluster of process units and obtain a scaled drawing of the process area.

Plot Wireless Devices



Within the scoped area for the initial self-organizing wireless network, identify the measurement points that satisfy the application needs. Consider all applications that are in the same process unit, and consider future measurement points as well. Keep in mind that a single self-organizing network can support multiple application needs across maintenance, engineering, operations, environmental, health and safety, and instrumentation.

Self-organizing networks have a high tolerance for the exact location where wireless devices are mounted, since the technology self-navigates complex process environments. First plot wireless devices according to optimal process connection, and then connection to the self-organizing network.

If the wireless device is located in a hazardous area, the wireless device will need the appropriate approvals. Most Smart Wireless devices, with the exception of the gateway, are available with Class I, Division 1 approvals. A self-organizing network can be scoped to an area that includes both hazardous and non-hazardous areas since the wireless signals pose no danger of ignition. Again, consider the process connection first and identify the properly approved wireless device for operation in a hazardous area.

Action: Plot the location of all wireless devices on the scaled drawing of the process area.

Plot Device Network Connections

There are three potential causes of connectivity issues when designing a self-organizing network:

1. Wireless devices are out of range of each other.
2. Wireless connections are blocked by large obstructions.
3. Wireless devices are inside an enclosed area.

On the scaled drawing of the process area with device locations plotted, draw connecting lines between each wireless device and neighboring wireless devices that meet any of the following criteria:

1. The clear line of site distance between wireless devices with no obstructions is less than 750 feet (230 m).
2. The distance between wireless devices with moderate infrastructure is less than 250 feet (75 m). In moderate infrastructure there is no clear line of site between wireless devices and can typically by characterized as able to support vehicular traffic.
3. The distance between wireless devices with heavy infrastructure is less than 100 feet (30 m). In heavy infrastructure there is no clear line of site between wireless devices and can typically by characterized as unable to support vehicular traffic.

As best practice during the design phase, each wireless device should be connected to three other wireless devices, even though the wireless connection distances may vary by direction. Having three connections during the design phase ensures each device has two alternate connections after installation. If a wireless device does not have three connections during the design phase, then add additional measurement points or utilize a range extender to fortify connectivity. Currently, a range extender is either a Rosemount 648 Wireless Temperature Transmitter or a Rosemount 702 Discrete Input Transmitter.

There should not be any connectivity lines between wireless devices in the following situations:

1. The path between wireless devices crosses a large obstruction, such as a large building or an entire process unit.
2. A device is in an enclosed area, such as an equipment room, that isolates the device from the other wireless devices. In most situations a wireless device will communicate through a single metal or concrete wall, but distance outside of the wall will be greatly reduced.

For wireless devices housed inside an enclosed area, there are several connectivity options. The first is to place the transmitter outside of the enclosure and run the remote process connections inside. The second is to place another wireless device very near the structure, or utilize a range extender. The wireless signal will penetrate some of the structure, but the resulting signal will be weak and require a wireless device nearby to relay the data. Data reliability may be affected if additional wireless devices, or range extenders, are not used - especially for any isolated wireless devices.

When utilizing the criteria above to plot connectivity between wireless devices, the self-organizing network that forms will be highly reliable. In most cases, adding additional wireless devices, or range extenders, will not be necessary. Ensuring reliability and robustness in wireless device connections is discussed more in depth in Commissioning Considerations on page 5.

If connectivity issues are to be resolved with a range extender, it should be located above major obstructions, such as light posts and 2nd or 3rd level catwalks.

Action: Plot the wireless device connections according to the above guidelines.

Self-Organizing Network Integration

After plotting the wireless device locations and connections, it is time to position the Smart Wireless Gateway, integrate with the self-organizing network, and incorporate the gateway into the information system to create data flow.

Host Integration

The Smart Wireless Gateway cannot be plotted on the scaled drawing of the process area until it is known what data applications on the information system will leverage the data flow from the self-organizing network.

Since self-organizing networks are optimal for complementing wired systems, data can enter through the control system or applications which exist on an Ethernet network. This is important to remember for applications where legacy serial systems have no room for analog expansion and in situations where operators do not want to see non-critical data points. Thus, it is important to select the gateway connection solution that best fits the process unit.

If the data application requires a serial connection utilizing Modbus®, a serial connection between the Smart Wireless Gateway and the information system must be planned. Serial connections will be mostly limited by legacy systems with no room for analog expansion and by small selection of connection points. Consult the system administrator who operates the serial systems for advice and availability on connection points. Key information required by the administrator will be the number of Modbus registers required for integration. A good estimate for the number of registers is three times the number of data points, so that the process variable and device status indicators can be remotely monitored.

If the data applications like Data Historians, DeltaV™, AMS® Suite: Intelligent Device Manager, and remote access to the gateway require data in the format of Modbus TCP, OPC, and HTML, then either a wireless or wired Ethernet connection is necessary. Ethernet connectivity provides advanced integration including data flow, as well as remote access to the gateway for diagnostics and configuration. Wireless or wired Ethernet will provide the optimal connectivity, security, and integration.

The Ethernet communication protocols also provide the means for advanced security implementation. These security features allow the user to control access to the gateway as well as manage the gateway like a network device in a secure Ethernet network. With serial systems, the user is limited to physical isolation of the components and is unable to encrypt data or manage access due to Modbus limitations.

Ethernet communications will have fewer restrictions than serial systems, but may require the involvement of your IT department. For these installations, the gateway can comply with the data connection requirements. The IT services can identify the connection point and integrate the gateway through Ethernet firewalls, and provide remote access to the gateway.

Smart Wireless Gateway Location, Mounting, Antenna selection

The Smart Wireless Gateway location should provide wireless connections to 25% of the wireless network and a connection to the information system. Choose a location that is convenient for the physical connection to the information system and judge gateway connectivity with the self-organizing network by applying the procedure outlined in Plot Wireless Devices on page 2. Optimally, the gateway will be centrally located within the self-organizing network. For very small self-organizing networks, less than five devices, the gateway should connect to all devices for optimal reliability and connectivity for future network expansion.

If the Smart Wireless Gateway cannot provide adequate connectivity with the wireless network and a physical connection to the information system, then there are several possible solutions. If possible, extend the physical connection of the information system to a location where the gateway can connect to 25% of the self-organizing network using either wireless Ethernet, fiber-optic Ethernet, wired Ethernet or serial cables. Another option is to add wireless devices, or range extenders, to bridge the distance between the gateway and the self-organizing network. A third option is to start with a self-organizing network that is centered around a physical connection to the information system.

Once the Smart Wireless Gateway's location is decided, select the exact mounting location and antenna type. The gateway is designed for exposure to process elements, including hazardous areas. The gateway may be installed in one of the following options:

1. Mount the Gateway with Integral Antenna

   The gateway with integral antenna should be mounted in a location for optimal connectivity to the self-organizing network. If all wireless devices are near the ground, then the gateway should be mounted approximately 15-25 feet (4-8 m) above the ground. If mounted on the side of a building or infrastructure, the gateway should be 3 feet (1 m) from the side of the building or infrastructure. If placed above a building, then the gateway should be at least 6 feet (2 m) above the roof of the building.

   Be sure to properly ground the housing and install lightning protection for the Smart Wireless Gateway to ensure proper functioning of the wireless systems.

2. Mount the Gateway with Remote Antenna

   All gateways with remote antenna options come with 50 feet (15 m) of remote antenna cable to comply with global spectrum regulations. Shorter remote antenna cables would not comply with spectrum regulations and longer cables would reduce the range of the wireless signal from the gateway, so 50 feet of remote antenna cable must always be used. If mounted on the side of a building or infrastructure, the remote antenna should be 3 feet (1 m) from the side of the building or infrastructure and 15-25 feet (4-8 m) above the ground. If placed above a building, then the remote antenna should be at least 6 feet (2 m) above the roof of the building and 15-25 feet (4-8 m) above the ground. Mount the gateway within 50 feet (15 m) of the remote antenna. If there is excess remote antenna cable, coil and securely mount. Do not use the 50 feet (15 m) of remote antenna cable to place the remote antenna 50 feet (15 m) above the ground.

   Be sure to properly ground the housing and install lightning protection for the Smart Wireless Gateway to ensure proper functioning of the wireless systems.

PART 2: WIRELESS NETWORK INSTALLATION AND DATA INTEGRATION

Installation Considerations

Installation Order

It is optimal to always install the Smart Wireless Gateway first and the wireless devices second. In this way, wireless devices can be commissioned as they are installed and integration between the gateway and information system occurs in parallel.

Installation Resources

The same organizational resources that install and maintain wired instrumentation can provide services for wireless instrumentation. Users performing the installation should read the Quick Installation Guide (QIG) that pertains to each Smart Wireless device for any special instructions or considerations. The QIG contains the most up-to-date information regarding device installation.

The user will only need the tools used for wired instrument installation to perform a wireless device installation. Rosemount Smart Wireless devices come already configured and calibrated from the factory. A HART® Communicator, such as an Emerson's 375 Field Communicator, can perform wireless device configuration in the field if necessary. The HART Communicator will need to have the most recent device descriptors (DD) installed – refer to 375 documentation for instructions on updating DDs or call your local Emerson contact for additional assistance.

Commissioning Considerations

Commissioning Order

Always commission the Smart Wireless Gateway first, followed by the closest wireless devices. This allows the user to verify wireless device connectivity to the gateway, as well as allow the self-organizing network to form and support wireless devices as it grows. The self-organizing network serves as a giant antenna for any additional wireless devices during the initial commissioning process and future network expansions.

Commissioning Wireless Devices

Smart Wireless devices are factory configured to your specifications using the Configuration Data Sheet found in the Product Data Sheets for each wireless device. Configuration changes can be done with a 375 Field Communicator, AMS Device Manager, or any HART Communicator. In addition to sensor configuration, each wireless device requires a Network ID, Join Key and Transmit Rate to securely join a self-organizing network. Refer to the wireless device Quick Installation Guides or manuals for detailed instructions.

The transmit rate is how often the wireless device samples the process and transmits new measurement and device diagnostics through the self-organizing network to the gateway. The smaller the transmit rate, the more frequently measurements will be made, but with a faster consumption of the power module. If the process being monitored does not need fast transmit rates, then do not configure the wireless device for transmit rates faster than necessary for optimal power module life. As a guide, processes should be monitored at a rate of 4-5 times faster than the rate of change in the process. Thus, for processes with a rate of change that is noticeable every five minutes, there is no need for wireless devices to transmit faster than every 60 seconds. For processes that are currently not monitored with any instrumentation, there is no need to transmit faster than once every five minutes. The transmit rate of a wireless device does not affect the ability to relay measurements for dependent wireless devices, even if the dependent wireless device has a faster transmit rate.

Commissioning Wireless Network

Once all wireless devices are online and data can be viewed through the Smart Wireless gateway, the user can see the connections between all wireless devices. If a wireless device does not have multiple neighbors, it may be necessary to add an additional wireless device to fortify the network.

Application Integration

Configure the Smart Wireless gateway to transmit the data in the appropriate formats for the data applications on the information system. The gateway easily facilitates serial and Ethernet configurations, Modbus registers, OPC tags, and AMS integration. Refer to the gateway manual for detailed instructions.

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