A·B QUALITY *Allen-Bradley*

Flexible Solutions for Your Supervisory Control and Data Acquisition Needs

A·B *Allen-Bradley* · *Rockwell Software*

Rockwell Automation

Important User Information

Read this document and the documents listed in the additional resources section about installation, configuration, and operation of this equipment before you install, configure, operate, or maintain this product. Users are required to familiarize themselves with installation and wiring instructions in addition to requirements of all applicable codes, laws, and standards.

Activities including installation, adjustments, putting into service, use, assembly, disassembly, and maintenance are required to be carried out by suitably trained personnel in accordance with applicable code of practice.

If this equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

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Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

⚠	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
⚠	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

Labels may also be on or inside the equipment to provide specific precautions.

⚡	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
🔥	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
💥	**ARC FLASH HAZARD:** Labels may be on or inside the equipment, for example, a motor control center, to alert people to potential Arc Flash. Arc Flash will cause severe injury or death. Wear proper Personal Protective Equipment (PPE). Follow ALL Regulatory requirements for safe work practices and for Personal Protective Equipment (PPE).

This manual contains new and updated information. Changes throughout this revision are marked by change bars, as shown to the right of this paragraph.

New and Updated Information

This table contains the changes made to this revision.

Topic	Page
Updated the device selection table.	72

Notes:

To download or view a .doc file version of this procurement specification, please visit: www.rockwellautomation.com/industries/procurement-specifications.

**Choosing Data
Communication Equipment**

Chapter 3

**Choosing a Device for a
Master Station**

Chapter 4

How to Use This Document

Use this document as a guide for choosing SCADA system components. This book assumes that you have a thorough understanding of the:

- control-system requirements of the application.
- locations of the sites that you will be controlling.

Table 1 Document Usage

If you are	Then
Unfamiliar with SCADA or are choosing an Allen-Bradley SCADA system for the first time	Follow sections in a sequential order, using the selection worksheet on page 20 as a reference
Familiar with Allen-Bradley products and want to see available master and remote stations	See Chapter 4 and Chapter 5
Interested in third-party products	See Appendix A
Unfamiliar with terminology	See the Glossary

Additional Resources

These documents contain additional information concerning related Allen-Bradley products.

Resource	Description
Micro800 Programmable Controllers Family Selection Guide, publication 2080-SG001	Provides information on selecting a Micro800 programmable controller.
Micro810 Programmable Controllers User Manual, publication 2080-UM001	Provides information on how to install and use your Micro810 controller.
Micro830 Programmable Controllers User Manual, publication 2080-UM002	Provides information on how to install and use your Micro830 controller.
MicroLogix 1100 Programmable Controllers User Manual, publication 1763-UM001	Provides an overview of the MicroLogix 1100 programmable controller and gives installation and wiring guidelines.
MicroLogix 1400 Programmable Controllers User Manual, publication 1766-UM001	Provides an overview of the MicroLogix 1400 programmable controller and gives installation and wiring guidelines.
MicroLogix 1100 Programmable Controllers Instruction Set Reference Manual, publication 1763-RM001	Provides an overview of the file types used by the controllers, provides the instruction set for the controllers, and contains application examples to show the instruction set in use.
MicroLogix 1400 Programmable Controllers Instruction Set Reference Manual, publication 1766-RM001	Provides an overview of the file types used by the controllers, provides the instruction set for the controllers, and contains application examples to show the instruction set in use.
MicroLogix Programmable Controllers Family Selection Guide, publication 1761-SG001	Provides information on selecting a MicroLogix programmable controller.
CompactLogix Selection Guide, publication 1769-SG001	Provides information on how to select your CompactLogix components.

Resource	Description
ControlLogix Controllers User Manual, publication 1756-UM001	Provides information on the ControlLogix controller including its features.
Logix5000 Controllers Common Procedures Manual, publication 1756-PM001	Provides links to other ControlLogix information.
ControlLogix Selection Guide, publication 1756-SG001	Provides information on how to select your ControlLogix controller.

You can view or download publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Allen-Bradley distributor or Rockwell Automation sales representative.

Chapter 1

Your SCADA System Solutions

What Is SCADA?

SCADA is an acronym for Supervisory Control and Data Acquisition. Use this book as a guide for choosing SCADA system components. If you are already familiar with SCADA, go to page 18.

SCADA systems let you monitor and control various remote functions and processes by using modem communication links between master and remote locations.

Figure 1 - SCADA System Overview
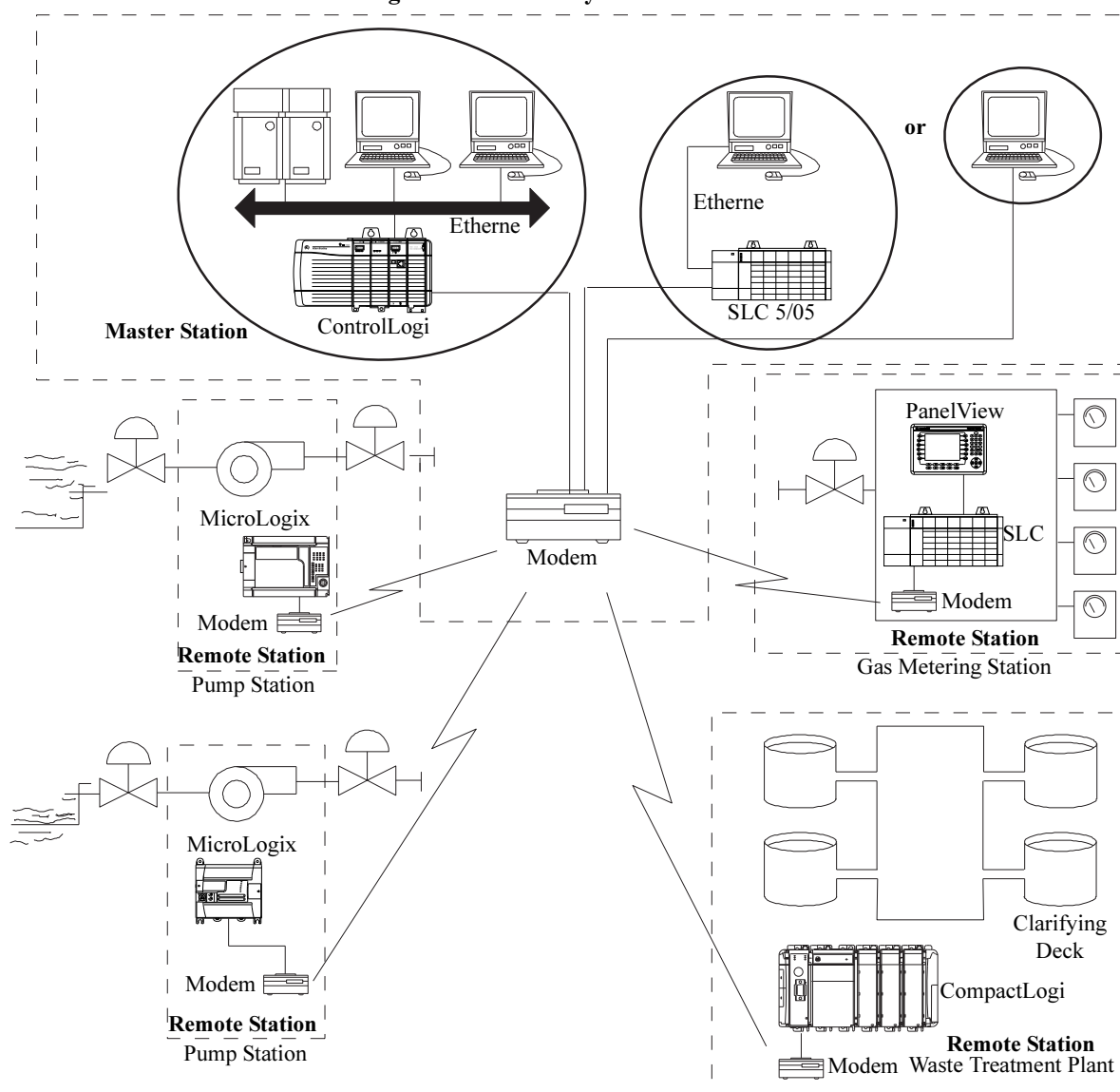
Variety of Applications

There are a variety of SCADA applications:

- Water and wastewater applications
- Oil and gas production

Water and Wastewater SCADA Application

These applications use lift stations and water booster stations.

Lift Stations

Collection systems rely on a series of lift stations and combined sewer overflow (CSO) stations communicating to a central location to prevent sewerage back-ups and protect the environment.

Water Booster Stations

Booster pump stations for fresh water systems operate by maintaining system pressure or matching water-flow demand.

Figure 2 - Water and Wastewater SCADA Applications
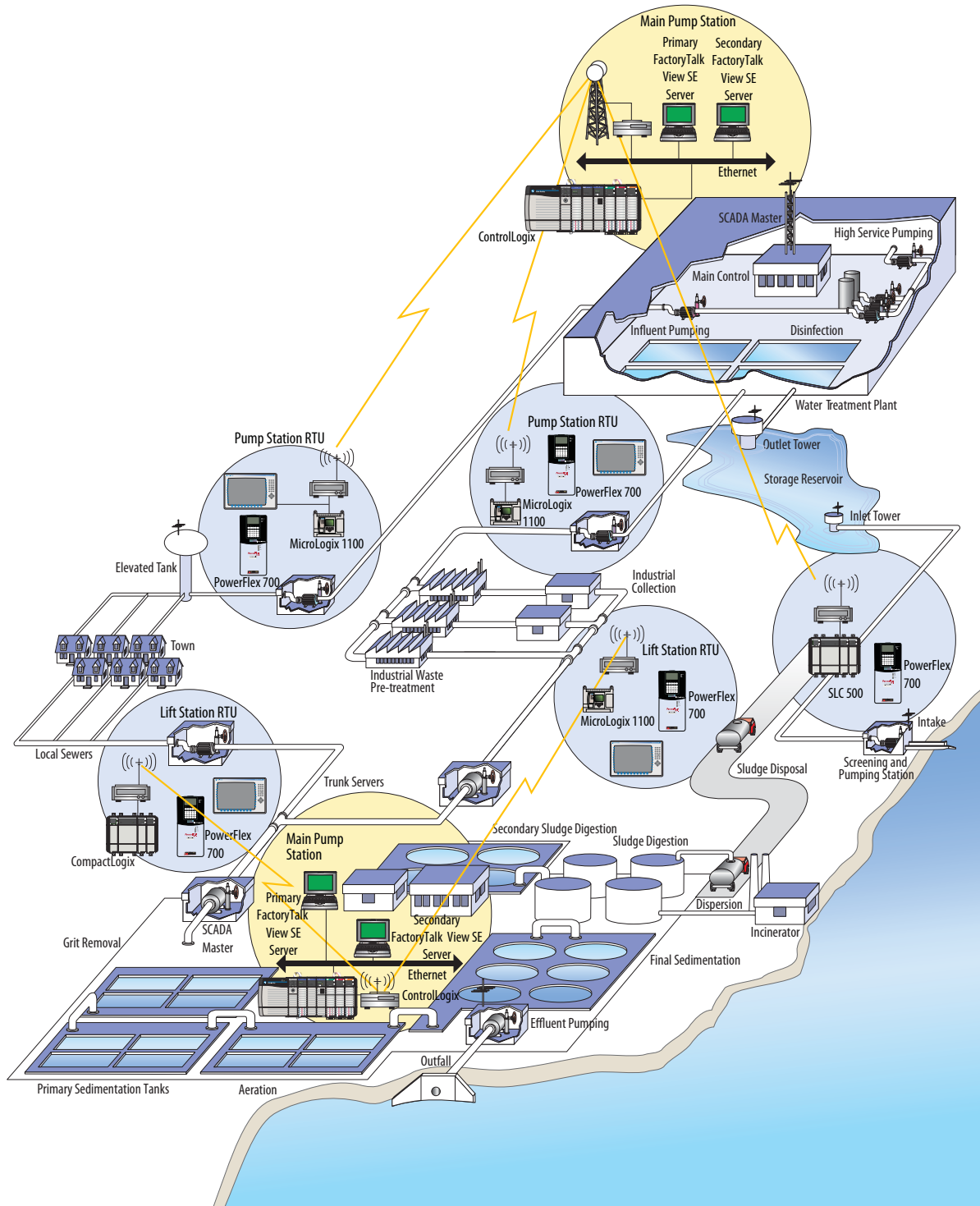
Oil and Gas Production SCADA Application

Oil and Gas Wells

There are two main types of wells: Natural Flow and Artificial Lift wells. Monitoring and remote control requirements depend on the type of well. For natural flow well, surface process variables like flowing/casing pressure and temperatures and the position of the flowing valve need to be monitored and gas wells include compensated flow calculations. Remote control is limited to the shutdown valve. For artificial lift wells, additional monitoring and control is required to be able to supervise motor or gas lift valves and be able to control those devices.

Compressor Stations

Compressor Stations are responsible in pipeline systems for maintaining the appropriate pressure levels needed to deliver gas at the destination locations. Multiple compressor stations are typically needed in a gas pipeline and the communication to a central location is key ensure coordination and safety of the operation.

Valve Stations

An important element in the safe operation of a gas or liquid pipeline is the block or segmenting valves. These valves are mainly responsible for shutting down segments of the pipeline to isolate leaks or ruptures. Local and remote control capabilities as well as data acquisition functions to be able to collect process information along the pipeline (Pressure, temperature, flow, and valve position) are the main requirements of this application.

Pump Stations

Operate by maintaining system pressure or matching flow demand. Multiple pump stations connected to the pipeline and communicating back to a central location are used to deliver crude oil or products to refineries and terminals.

Figure 3 - Oil and Gas Production SCADA Applications
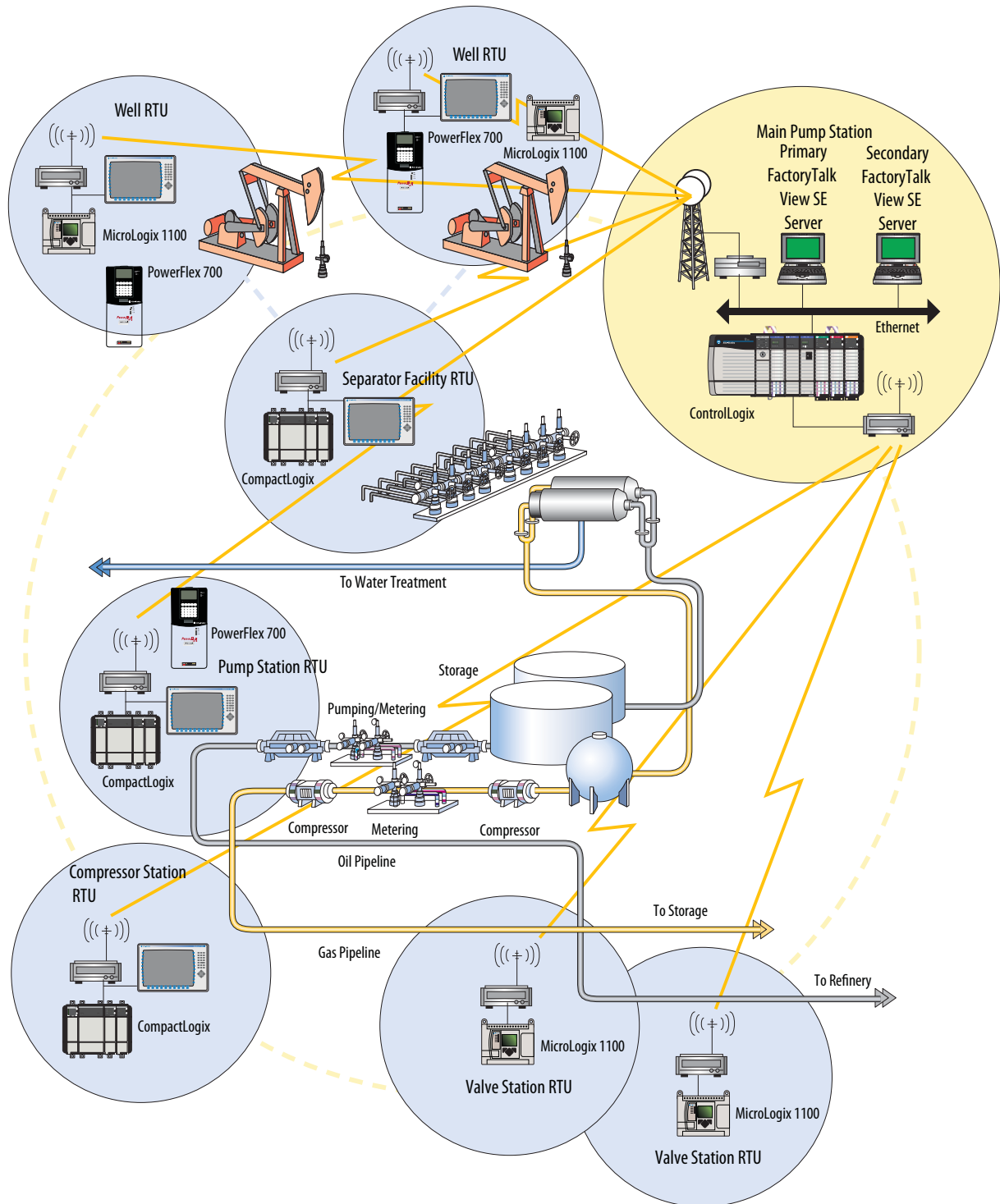
System Flexibility

Rockwell Automation has developed a close relationship with several companies who supply SCADA-related hardware and software. Through the Encompass Program, we reference hardware and software companies that provide additional products to meet your application needs. We review each company to make certain it provides the quality and service you deserve. For the latest information, refer to the Encompass Program Product Directory, at: http://www.rockwellautomation.com/encompass.

Products Designed for SCADA Applications

Key features built into Allen-Bradley products help provide a one-stop SCADA solution.

Scalability

Choose from many sizes of programmable controllers to meet master station and remote station control needs.

- Select one or more ControlLogix processors in a chassis with one or more Ethernet, ControlNet, and/or DeviceNet communication modules to fit your most demanding master station and remote station requirements in single or redundant configurations.

- Select a CompactLogix L3*x* or L4*x* controller to fit your small to medium master station and/or remote station applications that require Store & Forward and/or true Report-by-Exception capabilities.

- Select a MicroLogix 1400 or CompactLogix L2*x* controller to fit your small to medium master and/or remote station applications that require Store & Forward and/or true Report-by-Exception capabilities.

- Select a MicroLogix 1100 or Micro800 to fit your small remote station applications.

- Select a DataSite RTU to fit your extreme temperature or low-power remote-station applications.

Integral Communication

Built-in communication support means less equipment to buy.

- Choose versions of ControlLogix, CompactLogix, MicroLogix, or Micro800 controllers that have built-in or plug-in serial ports.

- Select a CompactLogix L*xx*E, MicroLogix 1100/1400, or Micro850 controller for built-in Ethernet connectivity that uses standard TCP/IP protocol.

FactoryTalk View Site Edition Software

Fulfill your SCADA computer software needs using Rockwell Software FactoryTalk View SE software.

- Using FactoryTalk View SE software, additional workstations can be clients to the FactoryTalk View SE Servers across a local-area or wide-area Ethernet network. FactoryTalk View SE software also supports redundant configurations for maximum system availability.

- Add RSLogix programming software, and the workstation can become the system programming terminal for both local and remote stations.

- Add Encompass Partner value-add software such as Specter Instruments WIN-911 Alarm Notification software.

Control System Experience

Our many years of control system experience and broad product line can provide you with a total system solution. Choose from our many:
- push-buttons and switches.
- programmable controllers.
- I/O modules.
- operator interfaces.
- development software packages.
- industrialized computers.
- specialized PLC-based hardware and software that support process control, motion control, and AC/DC drives.

Support

We offer a world-wide technical support network to answer your questions.

- Rockwell Automation Technical Support provides help via telephone or at your control sites.

- Allen-Bradley local distributors provide quick turnaround on your orders and local support.

- Allen-Bradley and Rockwell Software product training courses are available. Contact your local Rockwell Automation sales office or Allen-Bradley distributor for information.

Securing SCADA and Control Systems

A robust security strategy is both broad and deep in the enhanced protection it facilitates in control system safety and operational integrity. The scope of a truly expansive industrial security solution includes the control system and its constituent products, but also the people, policies, and procedures necessary to maintain a specific level of security. Expert consulting services can often help assure a more thorough and complete evaluation of security posture. Rockwell Automation Network and Security Services group has the expertise and know-how to help address industrial security concerns in a balanced way.

For more information about Rockwell Automation Industrial Security position and capabilities, including Network and Security Services, visit http://www.rockwellautomation.com/security.

Select System Components

Each section in this publication (and in the worksheet on) describes a specific component and presents selection criteria to help you make appropriate choices for your application.

Follow this procedure to select SCADA system components.
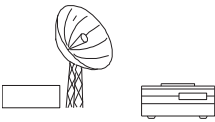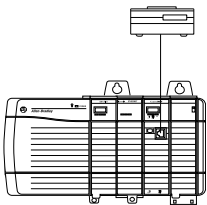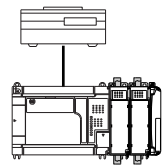
1. Choose a telemetry network (if not specified).
2. Choose data communication equipment (DCE).
3. Choose a master station and (if necessary) an operator interface.
4. Choose remote stations for the local control sites.
5. For modular processors, choose appropriate input/output modules to monitor and control the application.

Figure 4 - SCADA System Components
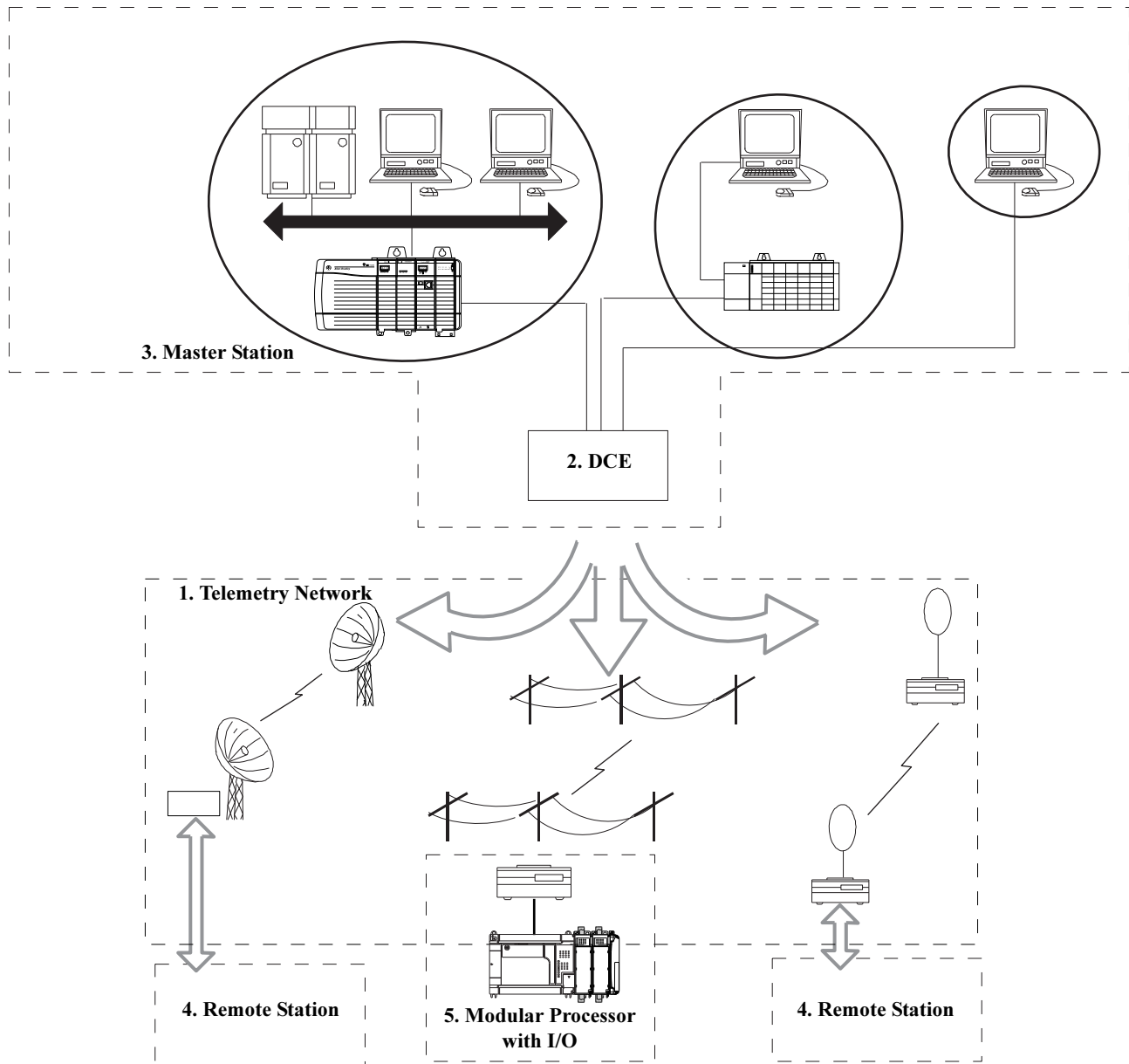
Selection Worksheet

Use this worksheet as a quick guide to specifying a system.

Step	For this component	Choose	See page	Record your selection
1	Telemetry network	Topology: • Point-to-point • Point-to-multipoint • Multipoint-to-multipoint	22	
		Transmission mode: • Half-duplex • Full-duplex	24	
		Link media	24	
		Protocol	33	
2	Data communication equipment	Choose DCEs based on the following: • Link media • Transmission requirements • Diagnostic requirements • Master and remote station needs • Application	41	
3	Master station	Choose a master station based on the following: • Functionality required (I/O to scan, amount of data to be collected, operator interface needed) • Quantity of remote stations • Protocol being used • Other application requirements Make sure you have the following: • A serial and/or Ethernet interface • The proper equipment for the protocol you are using • Power for the station Select other components you may need: • I/O modules and chassis • Local area network components • Enclosures	61	
	Operator interface submaster station	Depending on the size of your application, you may need operator interfaces or submaster stations.	66	
4	Remote stations	Choose a remote station based on the following: • Functionality required • Quantity of I/O points being controlled • Power availability • Space • Location of the remote station • Other application requirements	71	
5		Choose control system components: • I/O modules and chassis • Enclosures • Operator interfaces		

Choosing a Telemetry Network

Overview

A telemetry network provides the communication pathway in a SCADA system. Topologies, transmission modes, link media, and protocols make up a telemetry network.
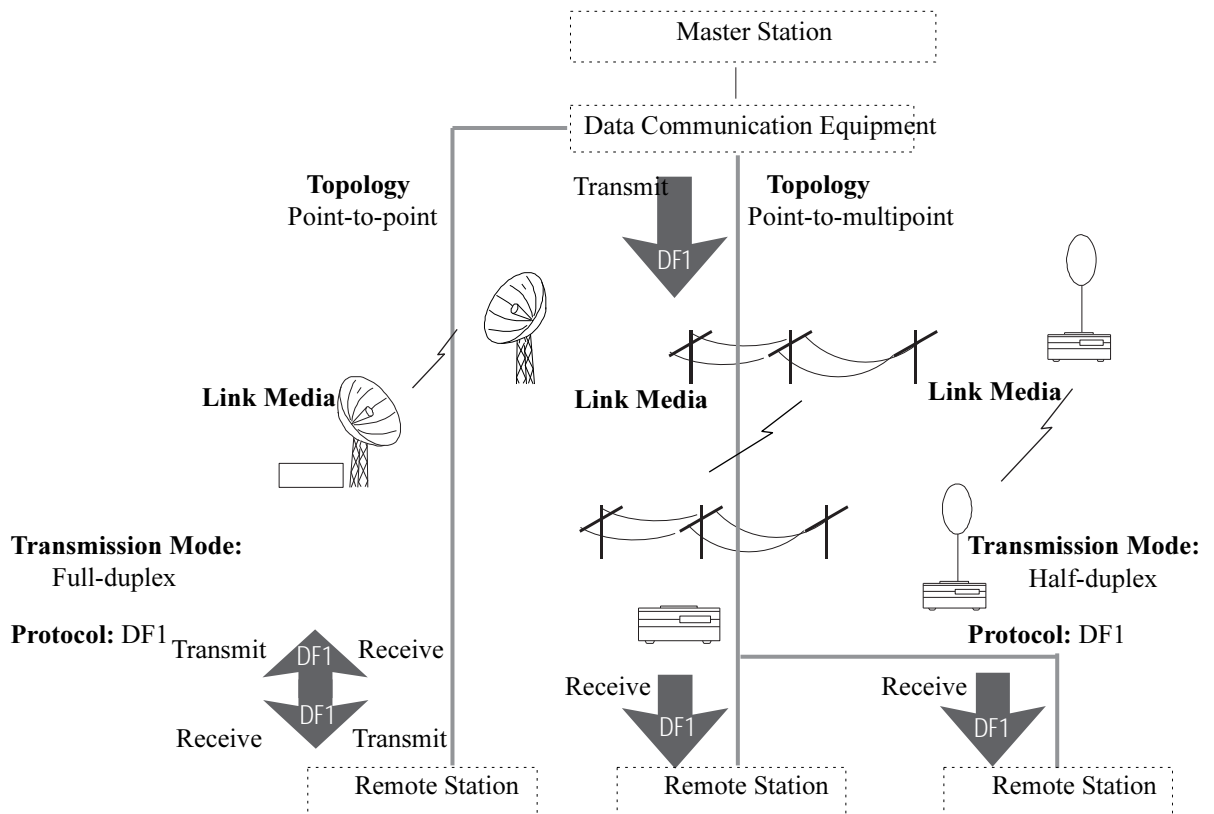
An application can have more than one telemetry network. In some critical applications, you may want to design a back-up system or recovery procedure for your main network. Analyze your requirements and select telemetry networks accordingly.

Design the network by selecting each component.

Topic	Page
Choosing a Topology	22
Choosing a Transmission Mode	24
Choosing a Link Media	24
Choosing a Protocol	33

Choosing a Topology

Topology is the geometric arrangement of nodes and links that make up a network. For a SCADA system, choose among point-to-point, point-to-multipoint, and multipoint-to-multipoint topologies.

Point-to-point

Point-to-point is a communication link between only two stations, where either station can initiate communication with the other, or one station can inquire and control the other.
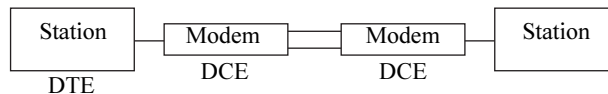
Stations can be connected using:

- cables or permanent public media like leased telephone lines or digital data services.
- temporary connections, such as dial-up lines or microwave, radio, or satellite transmissions.

Point-to-point is generally a 2-wire connection, with the transmission media using two wires for signal transmission/reception. Since a public-switched telephone network (PSTN) provides a 2-wire connection, the topology used for a dial-up line is 2-wire point-to-point.

> **TIP**   Choose this topology if you need a peer-to-peer communication connection, such as a back-up communication link between remote stations at a site and the master station at the control site.

Point-to-multipoint (multidrop)

Point-to-multipoint is a communication link among three or more stations with one station being a communication arbitrator (master) that controls when the other stations (remote stations) can communicate.
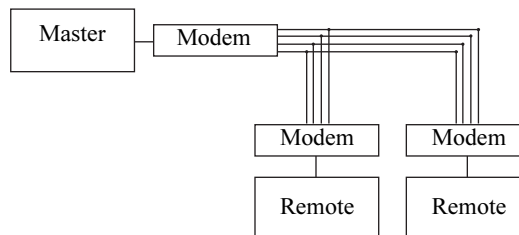
The stations can be connected using:

- permanent public media like leased lines or digital data services.
- atmospheric connections, such as microwave, radio, or satellite transmissions.

Point-to-multipoint connections are generally four-wire connections, with the transmission media using four wires for signal transmission/reception: one pair to transmit and one pair to receive. Private leased lines and digital data services provide four-wire, point-to-multipoint connections.

> **TIP**   Point-to-multipoint is the main topology for SCADA applications.

Multipoint-to-multipoint
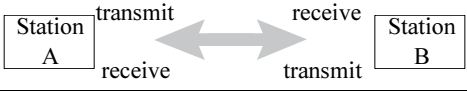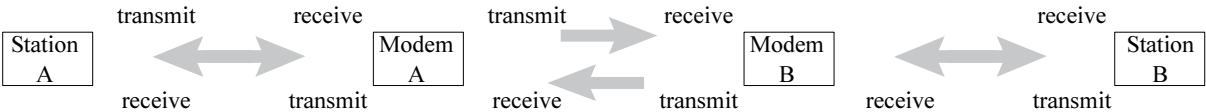
Multipoint-to-multipoint is a radio modem communication link among three or more stations where there is no communication arbitrator (master) and any station can initiate communication with any other station.

This is the topology used by spread-spectrum Ethernet radio modems. It provides a peer-to-peer network among stations.
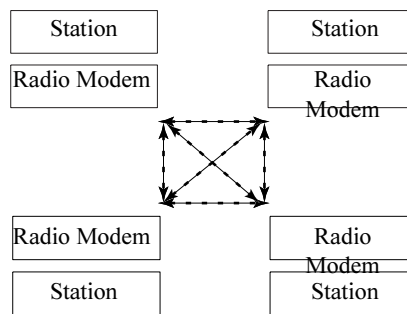
Choosing a Transmission Mode

The transmission mode defines the way information is sent and received between and/or among devices on a network. For SCADA systems, your network topology generally determines your data transmission mode.

If you have chosen this topology	Then your transmission mode is	Which means
Point-to-multipoint	Half-duplex	Information is sent in one direction at a time over the link. Station A → transmit → receive → Station B Station A ← receive ← transmit ← Station B
Point-to-point	Full-duplex	Information is simultaneously sent and received over the link. Station A transmit ↔ receive Station B Station A receive ↔ transmit Station B
Multipoint-to-multipoint	Full-duplex (between station and modem) Half-duplex (between modems)	Information is simultaneously sent and received over the station to modem link, whereas information is sent in only one direction at a time over the modem to modem link.

Station A — transmit/receive ↔ — Modem A — transmit → receive → Modem B — receive ↔ — Station B
Station A — receive/transmit — Modem A — receive ← transmit — Modem B — receive/transmit — Station B

Choosing a Link Media

When choosing link media, consider the following:

- Data transmission needs of the application
- Remote site and control center locations
- Distance between sites
- Available link media services
- Project budget

Several types of link media are available, including public transmission media, atmospheric media, and dedicated line media.

Media Category	Type
Public transmission media	• Public-switched telephone network (PSTN); Internationally: general switched telephone network (GSTN) • Private leased line (PLL) • Digital data service (DDS) • Internet via ISP
Atmospheric media	• Microwave radio • VHF/UHF radio • Geosynchronous satellite • Cellular network
Dedicated line	• Dedicated wire • Power line

The following sections outline the advantages, disadvantages, and requirements of each link medium.

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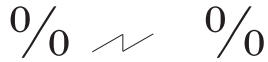
Public-switched Telephone Network (PSTN) or General Switched Telephone Network (GSTN)

The dial-up network is furnished by a telephone company. This telephone line is the one that we use daily and that carries voice and data transmissions.

Advantages/Capabilities

- Public-switched telephone networks are cost-effective for:
  - short, occasional data collection from remote sites that have access to a PSTN.
  - sites calling in to a central location.

- Often point-to-point applications have a dial-up connection as a backup to the main media link.

- The phone company charges a monthly fee based on usage – the number of local connections made and/or the time and distance of each long distance connection.

- The network supports communication rates of up to 57,600 bps.

- The network is a 2-wire connection that supports half-duplex modems and 2-wire, full-duplex modems. The topology is point-to-point.

Disadvantages

- Transmission is costly for long, frequent data collection from remote sites.

- The lines can contain impairments that can cause modems to have error rates of less than 1 error per 1,000,000 bits.

- The media cannot be used in areas that do not have access to the network, such as an offshore oil or gas well.

- Time is required to dial and establish each connection.

- Additional logic is required to automatically initiate a connection.

Equipment Required

Use standard Bell or Consultive Committee for International Telephone and Telegraph (CCITT) modems. Contact the telephone company for information about connecting to the network.

Phone Company
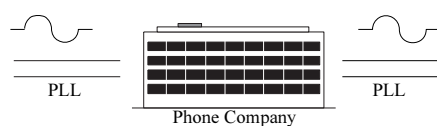
Private Leased Line (PLL)

PLL is a dedicated telephone line that is a permanent connection between two or more locations and that is used for analog data transmission. The line is available 24 hours a day. In order for the line to be used for voice communication, a voice option must be installed.

Advantages/Capabilities

- The media is cost-effective for applications that require large amounts of data to be collected frequently from remote sites and/or applications that require remote sites to have a constant connection to the master station.

- Regardless of how much you use the line, the phone company charges you a flat, monthly fee based on the following:

  - Distance between sites
  - Area of the country
  - Type of line conditioning
    Leased lines have different levels of conditioning, or grades - the higher the grade, the greater the modem data rate that can be supported by the link, and the more the phone company charges for it.

- The standard, unconditioned line, supports speeds of up to 56 Kbps.

- Private leased lines provide a 4-wire connection. You can purchase modems that operate the circuit in either half- or full-duplex mode. You can also order a 4-wire multi-drop line.

Disadvantages

- The media cannot be used in areas that do not have access to the network, such as an offshore oil or gas well.

- The lines can contain impairments that can cause modems to have error rates of less than 1 error per 1,000,000 bits.

Equipment Required

Use standard Bell or CCITT modems. Contact the telephone company for information about connecting to the network.

DDS   DDS
Phone Company
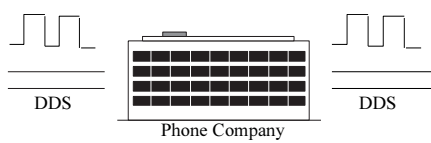
Digital Data Services (DDS)

DDS is a special wide-bandwidth private leased line that uses digital techniques to transfer data at higher speeds and at a lower error rate than private leased lines. The line is available 24 hours a day.

Advantages/Capabilities

- DDS is a digital network that offers higher transmission rates and minimal, if any, line impairments.

- The media is useful when an application requires very large amounts of data to be transferred between sites with a low data error rate.

- Regardless of use, the phone company charges you a flat, monthly fee based on the following:

  - Distance between sites
  - Area of the country
  - Speed of the integrated service unit (digital 'modem')

- A constant connection exists.

- Asynchronous communication rates are 2.4 K, 4.8 K, 9.6 K, 19.2 K, 38.4 K, and 57.6 Kbps.

- The network provides a four-wire connection and can be configured in a multi-drop topology.

Disadvantage

The media is costly for applications not needing to transmit large amounts of data quickly and at a low data error rate.

Equipment Required

Use standard integrated service unit, ISU (also called a data service unit [DSU] or channel service unit [CSU]). The ISU data rate must match that of the digital data service line, which operates at a fixed rate.

Internet via Internet Service Provider (ISP)

Advantages/Capabilities

- High-speed broadband Ethernet network connections readily available in metropolitan areas
- Low monthly fixed cost for continuous data connections
- Minimal capital costs
- Remote access possible to/from anywhere on the Internet

Disadvantages

- Dependent on a public network (may not be available when needed most)
- Requires network security precautions to prevent unauthorized access

Equipment Required

- Ethernet router/modem (typically provided by ISP)
- Ethernet security hardware (for example, firewall or VPN)
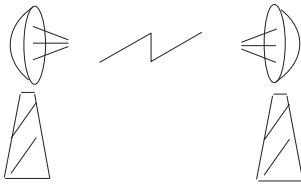
Microwave Radio

Microwave radio is a high-frequency (GHz), terrestrial radio transmission and reception media that uses parabolic dishes as antennas. The dishes are usually mounted on towers or on top of tall buildings, since this is a line-of-sight topology.

Advantages/Capabilities

- The media links geographically-remote areas that are not accessible by phone lines.
- A constant connection exists.
- Transmissions can occur over very long distances over rough terrain.
- You incur no monthly service fee because you own the equipment. The only expenses are operation and maintenance costs.
- Low transmission delay times exist.
- The larger bandwidth allows you to multiplex many channels over one antenna.
- Lease circuits from another company who owns their own private microwave circuit.

Disadvantages

- Transmission is limited to a line-of-sight, for example, you cannot transmit through mountains. The signal can experience distortion and interference. Also, atmospheric conditions such as rain, snow, or fog can affect the signal.

- Most microwave link frequencies are allocated and regulated by the Federal Communications Commission (FCC). In urban areas, fewer data-transmission frequencies are available.

- You can incur large initial expense for equipment.

Equipment Required
- Transmitters
- Receivers
- Parabolic dish antennas
- Repeaters are needed to transmit long distances over hills or mountains
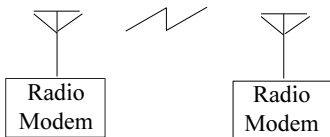
VHF/UHF Radio

VHF/UHF radio is a high-frequency electromagnetic, wave transmission. Radio transmitters generate the signal and a special antenna receives it.

Advantages/Capabilities

- The media links geographically-remote areas that are not accessible by phone lines.

- A constant connection exists.

- Transmissions can occur over rough terrain and over distances of less than 30 miles.

- You incur no monthly service fee because you own the equipment. The only expenses are operation and maintenance costs.

- Minimal transmission delay times exist.

Disadvantages

- Repeaters are needed to extend transmissions over distances greater than 15 miles.

- Most radio link frequencies are allocated and regulated by the FCC. In urban areas, fewer data-transmission frequencies are available.

- The signal from 900 MHz and higher transmitters can experience distortion and interference, and can be affected by poor weather conditions.

- The narrow bandwidth carries only one channel.

- You incur an initial expense for equipment; less expensive than microwave or satellite.

Equipment Required
- Transmitters
- Receivers
- Antennas
- Repeaters are needed to transmit greater distances and over hills and mountains
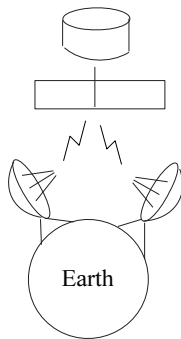
Geosynchronous Satellite

Geosynchronous satellites use a high-frequency (GHz) radio transmission to route transmissions between sites. The satellite's orbit is synchronous with the earth's orbit (geosynchronous); therefore, the satellite remains in the same position with respect to the earth. Satellites receive signals from and send signals to parabolic dish antennas.

Advantages/Capabilities

- The transmissions can link sites almost anywhere on Earth.

- A constant connection exists.

- You incur a monthly service fee.

- You can lease circuits from a telephone company

- Rates can be competitive with leased lines, depending on the total distance, remote station locations, and amount of data being transmitted.

- The media offers high reliability and data integrity.

- You do not need to 'group' remote sites because the communication media usually is accessible.

Disadvantages

- You can encounter longer transmission delays, measured in seconds rather than milliseconds as for other media.

- You incur a large initial cost for the satellite dish and supporting equipment.

Equipment Required
- Access to satellite
- Satellite transmitters
- Earth-bound receiving parabolic-dish antennas

Cellular Network

Advantages/Capabilities
- High-speed broadband Ethernet connections readily available in metropolitan areas, as well as in many rural areas where no other communication options exist other than satellite
- Lower fixed and monthly costs vs. satellite
- Minimal capital costs
- Remote access possible to/from anywhere on the Internet

Disadvantages
- Dependent on a public network (may not be available when needed most)
- Requires network security precautions to prevent unauthorized access

Equipment Required
- Cellular Ethernet router/modem
- Ethernet security hardware (for example, firewall or VPN)

Dedicated Wire

With dedicated wire modems, you can transmit and received data over a pair of copper conductors for extended distances.

Advantages/Capabilities
- May be able to use existing installed wires
- Simplified design lowers costs

Disadvantages
- Relatively low speed
- Bit error rate dependent on quality of media

Equipment Required
- Dedicated wire modems
- Suitable wire media
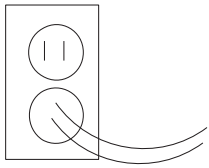
Power Line

With special data communication equipment, you can transmit and receive data over 120V AC or 460V AC power conductors within a factory.

Advantages/Capabilities
- No need for extra cabling.
- Simplified design lowers cost.
- You do not need an FCC license.

Disadvantages
- Transmission cannot occur through transformers without bridges. See the vendor for the bridges.
- With some vendors, speed may be distance limited.

Equipment Required
- Power line or other power delivery media
- RS-232 interface

Choosing a Protocol

A protocol governs the format of data transmission between two or more stations, including handshaking, error detection, and error recovery. When choosing a protocol, select one that best fits your application's:

- Connection topology
- Transmission mode
- Other application requirements, such as connections to existing equipment

If your transmission mode is	Then choose this type of protocol
Bidirectional but one direction at a time	DF1 half-duplex or DNP3
Simultaneously bidirectional	DF1 full-duplex or DNP3
Peer-to-peer	DF1 radio modem or EtherNet/IP

If all the control products used in your application are Allen-Bradley products, use the DF1 serial protocol or an EtherNet/IP network because they provide benefits, such as the following:

- Remote data table monitoring and online programming using standard Rockwell Software programming software

- Remote station-to-remote station messaging

- A more cost-effective solution since the protocol is built into Allen-Bradley products

DF1 protocol is an asynchronous, byte-based protocol. DF1 protocol options are described below.

DF1 Half-duplex Protocol

Using DF1 half-duplex protocol provides these advantages:

- You do not have to program the master station to read blocks of data from each remote station to determine if the remote station has new data. Get data from remote stations just by polling them. Remote stations can collect data on their own and have the message blocks waiting to send when the master station polls them.

- You can perform remote station-to-remote station messaging through the master station without any special ladder logic in the master and without increased processing time.

- You can program remote stations over the telemetry network without interrupting the master station's normal control and data acquisition functions.

- You can program the master to broadcast write a block of data to all remote stations simultaneously for synchronization purposes.

DF1 Radio Modem Protocol

Using DF1 radio modem protocol in radio modem configurations provides one or more of these advantages, depending upon the radio modem used:

- Any station can initiate to any other station at any time for true Report-by-Exception capability.

- Any station can be configured to be a Store & Forward node between nodes that are not within radio reception range of one another.

- Any station can be programmed over the radio network.

- Any station can broadcast write a block of data to all remote stations simultaneously for synchronization purposes.

DF1 Full-duplex Protocol

Using DF1 full-duplex protocol provides these advantages:

- Either station can initiate to the other station at any time for true Report-by-Exception capability.

- Simultaneous transmissions over full-duplex channel for maximum throughput.

Ethernet/Industrial Protocol (EtherNet/IP)

Use EtherNet/IP over any Internet Protocol-based telemetry network, such as Ethernet radio modems, cellular data modems, or the Internet.

This open protocol (maintained by ODVA at www.odva.org) provides the following advantages:
- Any station can initiate to any other station at any time for true Report-by-Exception capability.
- Any station can be programmed over the network.

DNP3

DNP3 Slave is a serial and Ethernet SCADA/RTU protocol built into the DataSite RTU and MicroLogix 1400 controller. DNP3 Master OPC drivers for FactoryTalk View SE software are available from Encompass Partners Kepware Technologies and MatrikonOPC, and DNP3 Master/Slave interface modules for various Allen-Bradley controllers are available from Encompass Partner Prosoft Technology.

Distributed Network Protocol version 3.0 (DNP3) was developed by Westronics, an electric utility RTU manufacturer in the early '90s, specifically for SCADA/RTU communication. They turned the specifications over to the newly formed DNP Users Group in the mid '90s and since then this open protocol has been implemented in hundreds of devices. While originally primarily used in the Electric Utility Industry, it has more recently been embraced for Oil and Gas and Water/Wastewater SCADA/RTU applications as well because it is efficient, reliable, robust, and secure.

- Efficiency

  DNP3 is an event-driven protocol. You can configure the slaves to only report changes, like bit changes or analog inputs outside of a configured deadband. These changes can be reported back to the master either in response to the master's poll or as unsolicited responses generated by the controller. There are mechanisms built in to send multiple events together and to prevent unsolicited response 'event storms'. The master can periodically send an 'integrity' poll, which triggers the controller to send the current value of all points in its DNP3 database, packed into as few packets as possible. Also, over Ethernet, DNP3 gives you the flexibility of using either TCP or UDP as its transport protocol. UDP has much lower packet overhead and therefore is much more efficient than TCP, making it ideal for a cellular or low bandwidth Ethernet radio SCADA system.

- Reliability

  DNP3 is a SCADA protocol designed 'from the ground up' to work over inherently unreliable connections. As such, DNP3 has data logging built-in. When events are generated, they get logged into a queue, even if it's just for a few seconds. If the master can't get a poll through for hours, or if the unsolicited responses can't get through to the master, the events simply continue to get added to the queue until communication is restored. The MicroLogix 1400 can store over 6000 events in its queue.

- Robustness

  With DNP3, all configured data changes are captured and reported as events, so nothing is missed regardless of the frequency or duration of changes. Also, all events are time-stamped at the RTU level, and all RTU clocks are synchronized over the DNP3 network. Once the event data has been received by the master, the data change is reported to the HMI or historian application using the RTU millisecond timestamp. If the master receives multiple changes for the same point, all of those changes will be recorded with their original timestamps.

- Security

  DNP3 offers a Secure Authentication option. This is a sophisticated mechanism that the RTUs can use to verify that the communication packets actually came from their master and vice versa. This prevents hackers from using spoofing or replay to disrupt RTU operations and can be used in conjunction with other security measures such as encryption.

Other Protocols

You may need to choose a different protocol if you are:

- Using links, such as satellite or packet radio, that may require software handshaking to communicate
- Expanding an existing system (you are adding Allen-Bradley remote stations) or specifying a retrofit, which is not using DF1 protocol
- Emulating someone else's product with an Allen-Bradley programmable controller

All MicroLogix controllers (except MicroLogix 1000), Micro800 controllers (except Micro810 12-pt), and DataSite RTUs have Modbus RTU Master and Slave built-in. DataSite RTUs and MicroLogix 1400 controllers also have Modbus TCP and DNP3 slave protocols built-in. FactoryTalk View SE software can communicate with Modbus RTU, Modbus TCP, and DNP3 through standard OPC.

Once a non-Allen-Bradley protocol is used, Allen-Bradley protocol advantages, such as remote station to remote station messaging and online programming, may no longer apply.

However, if you need to use other protocols, our third-party protocol suppliers provide gateway solutions between Allen-Bradley devices and devices that communicate by using non-DF1 protocols.

See the following tables for a list of protocols available from third-party suppliers. You can find their addresses and web sites listed in <u>Appendix A</u>. For the most up-to-date list of available protocols, see the supplier's web page.

Table 2 - Protocols Available from Third-party Suppliers

Protocol		Allen-Bradley form factor	Installation
Master	**Slave**		
• Allen-Bradley DF1 half-duplex • AMOCAMS 500 • BIF (BRITE) • Caterpillar Gas and Diesel Engine • Caterpillar Digital Voltage Regulator • Controlotron • Danload 6000 • Data Aire • Dynalco TM5000 and TEC9000 • GE SNP • HSQ • Leeds & Northrup Conitel C2020 • Liebert • Modbus ASCII and RTU • Omron Host Link • Power Measurements Ltd. ACM3720 • Quantum • Reliance Single and Multiple Processor • SquareD Sy/Max • Sullair Supervisor II and IE • Sutron • Tejas 3 and 5 • Teledyne Control Applications • Toshiba PLC • TRW S70	• Allen-Bradley DF1 half-duplex • BIF (BRITE) • CDC Type II • Colonial Pipeline DLE • Conitel 2020 • ENRON • Johnson Controls Metasys N2 • Modbus ASCII and RTU • SCI CSNET • Square D Sy/Max • Tejas 3 and 5 • Teledyne CA • Tennessee Gas	• 1746 I/O chassis slot • DIN rail mount	Install the MARC module into a 1746 I/O chassis and connect via an RS-232 cable to the SLC (powered off of chassis backplane). DIN rail mount Omnii-Comm connects via RS-232 or Ethernet network to processor (powered off of external 24V dc).
• Allen-Bradley DF1 half-duplex • DNP 3.0 • Emerson FX Drive • Fisher ROC • Honeywell 7800 Burner Control • IEC 60870-5-101/103 • Limitorque Valves • MDA Scientific CM4 • MDA Scientific System 16 • MetOne PCX • Modbus ASCII and RTU • MTS Level Plus • SEAbus • York Chiller XTACK	• DNP 3.0 • Fisher ROC • Foxboro/Systronics Minimote RTU • IEC 60870-5-101/103 • Harris 5000/6000 • Landis & Gyr 8979F • Metasys N2 • Modbus ASCII and RTU • Systronics (VSAT supported) • Teledyne CA	• 1746 I/O chassis slot • 1756 I/O chassis slot • 1794 Flex I/O • DIN rail mount	Install the ProSoft module into the chassis (where communication with the processor takes place across the chassis backplane) or install a DIN rail mount ProLinx Gateway, which connects via an RS-232 cable to the processor.

Communication Drivers

Rockwell Software also sells communication drivers from KEPware.

KEPServer Enterprise software, a set of communication drivers, which enable OPC connectivity to many third-party devices. Use KEPServer Enterprise software with FactoryTalk View SE software on Windows XP and Windows 2000 systems. KEPServer Enterprise software is catalog number 9301-OPCSRVENE.

The following drivers are available with KEPServer Enterprise software.

Table 3 - Available Drivers with KEPServer Enterprise software

Analog Devices	GE SNP	Omron FINS Ethernet	Thermo Westronics Serial
Aromat	GE SNPX	Omron FINS Serial	TIWAY Host Adapter
Aromat Ethernet	Honeywell UDC	Omron Host Link	Toshiba
Automation Direct EBC	IA Super SEL	Omron Process Suite	Toshiba Ethernet
Automation Direct ECOM	IDEC	Optimation Optilogic	Toyopuc Ethernet PC3/PC2
BUSWARE Ethernet	IOTech Pointscan 100	Partlow ASCII	Toyopuc Serial
Contrex	K Sequence	Phillips P8/PC20	Uni-Telway
Contrex M Series	Micro-DCI	Siemens S5	User Configurable Driver
Cutler-Hammer	Mitsubishi A Series	Siemens S5 (3964R)	Wago Ethernet
DDE Client Driver	Mitsubishi Ethernet	Siemens S7 MPI	Yaskawa Memobus Plus
DIRECT-NET	Mitsubishi FX	Siemens S7-200	Yokogawa Darwin
EtherTRAK	Mitsubishi FX Net	Siemens TCP/IP Ethernet	Yokogawa Darwin Serial
Fuji Flex	Modbus ASCII Serial	Simatic 505 Serial	Yokogawa DX
GE CCM	Modbus Ethernet	Simatic 505 Ethernet	Yokogawa DX Serial
GE Ethernet	Modbus Plus	Simulator	Yokogawa DXP
GE Ethernet Global Data	Modbus Serial	SquareD	
GE Focas 1 Ethernet	Modbus Unsolicited Serial	Thermo Westronics Ethernet	

Additional KEPServer OPC drivers, such as DNP3, are available directly from Kepware Technologies.

Securing the Telemetry Network

Whenever the telemetry network incorporates links over public networks, consideration must be given to securing the data in the link so that it can't be interpreted, altered or spoofed. An effective way of securing Ethernet data that travels over public networks is to use Virtual Private Network (VPN) technology. VPNs encrypt the Ethernet data before it is transmitted and only the intended receiver knows how to decrypt it. Encompass Partners Secure Crossing and Spectrum Controls supply industrialized VPN devices.

These are some of the tools for securing your SCADA and control system. See for more information.

What To Do Next

Record your telemetry network choices on the selection worksheet (). You should have defined the:

- topologies.
- transmission modes.
- link media.
- protocols.

Go to the next chapter to choose your data communication equipment.

Notes:

Choosing Data Communication Equipment

Overview

Data Communication Equipment (DCE) is the link between a transmission medium and master and remote stations (data terminal equipment or DTE). Data communication equipment includes phone and radio modems as well as microwave and satellite transmission equipment.
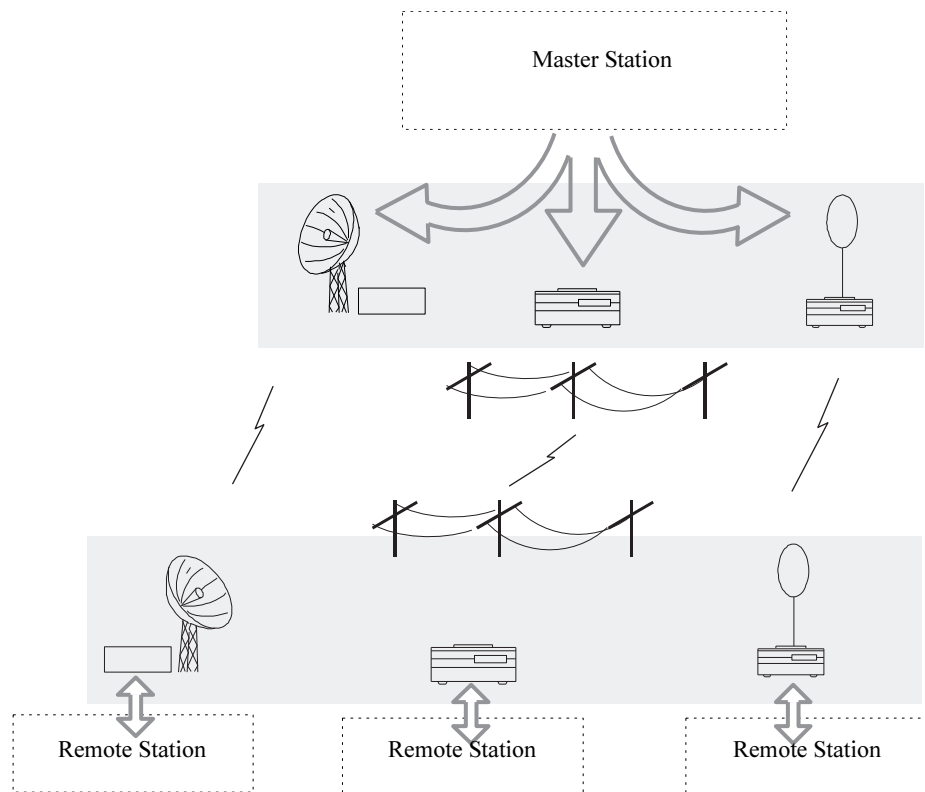
Choose the data communication equipment appropriate for the communication media you have chosen.

Topic	Page

Choosing a Telephone Modem

Modems convert digital information from a programmable controller or computer to an analog signal that is compatible with the communication media being used. The signal is then transported to the receiving modem, which converts the analog signal back into a digital one.

In the illustration below, digital data from each DTE is converted to an analog signal for transmission over the communication media.
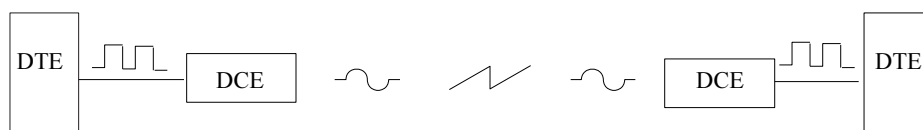
Two modem technology standards exist to make certain that modems developed by different manufactures are compatible.

Type	Description
Bell	The Bell standard was the predominant standard in the United States until the break-up of AT&T in the USA.
Consultive Committee for International Telephone and Telegraph (CCITT)	The CCITT standard is the international standard that is now becoming the standard for the USA. Most modems now conform to one or more of the CCITT standards, such as V.32, V.32bis, and V.22.

In most cases, the two modem types are not compatible. Keep this in mind when choosing modems for stations that are being added to or are retrofits for an existing installation. Compatibility charts exist. Consult a modem supplier for more information.

Use the selections that you recorded from the previous section, 'Choosing a Telemetry Network', to answer these questions:

- What type of links are you using to transmit data (for example, PSTN, private leased line, or radio)?

- What transmission modes are you using (half-duplex, full-duplex)?

- What are your network topologies (point-to-point, point-to-multipoint)?

- Are you using 2-wire or 4-wire lines?

Once you know the type of modem, use these criteria to help you choose appropriate models:

- Required data communication rate.

- Requirements of the DTE devices to which you are connecting.

  – Do you need asynchronous or synchronous operation?

    > **TIP**   If you are using all Allen-Bradley DTE devices, choose an asynchronous modem.

  – What interfaces do you need (RS-232, MIL 188, EIA-449, IEEE 488, CCITT V.24)?
  – What other features are required to support your DTEs?

- Required standards (for example, UL, CSA, and FCC).

- Space requirements. Do you need a rack-mounted or stand-alone modem?

- Input-power requirements.

- Ambient temperature specifications.

- Modem design and operation.

- Modem response time.

Once you have a good idea of the modem type you need, choose a modem based on the many available features and options, which vary by manufacturer.

Topic	Page

Analog Dial-up Modem

The following table lists the modem features that are required by certain Allen-Bradley DTE devices. Since you may not know the exact programmable controller or computer your application requires, you may need to refer to this table after you have chosen your DTEs to finalize your modem selection.

If you are using this DTE	The DTE needs support for	Make certain the modem you choose has this feature
ControlLogix processors	ASCII strings to configure and control the dial-up modem	AT-command-set support
CompactLogix		
MicroLogix (except 1000)		
SLC 5/03, 5/04, and 5/05 processors		
RSLinx software		
MicroLogix 1000 controllers	Answer capability only	Auto answer support

Consult the vendor for information about their product offerings.

Supplier	Maximum Transmission Rate	Modem Model
DATA-LINC Group	33600/28800	DLM4000/DLM4500
Miille Applied Research Co. Inc.	2400	166-100 (1746 chassis mount)
	2400, 14400, 28800, and 33600	366-100 (DIN rain mount)
Rockwell Automation	28800	9300-RADKIT
	28800	9300-RADES[1]

(1) Ethernet dial-up modem
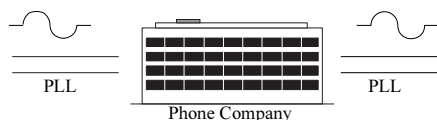
Analog Leased-line Modems

Depending on the speed of the modem you choose, you may need a better conditioned line. A leased-line modem's cost is composed of two principal items:

- Monthly leased-line charges, which are directly proportional to the conditioning or communication rate capability of the leased line
- Modem price, which is directly proportional to the modem's communication rate capability

Therefore, the most efficient system matches the maximum communication rate of the modem to that of the leased line to which the modems are attached.

For Point-to point, Full-duplex Applications

Choose an asynchronous, full-duplex 2-wire or 4-wire leased-line modem pair.

For Point-to-multipoint, Half-duplex Applications

Choose a modem which supports asynchronous, point-to-multipoint operation over a 4-wire or 2-wire leased line. Typically these modems have a 'master' setting for the modem connected to the master station and a 'slave' setting for the modems that connect to remote stations.

For the master station, choose a modem that has the capability of holding the modem carrier high so that no time is lost waiting for the modem carrier to turn on and stabilize whenever the 'master' modem has data to transmit.

For the remote stations, choose a modem that can switch the carrier on and off, whether transmitting or receiving, based on RTS/CTS signal handshaking with the other remote stations. You need to use a switched modem carrier since the stations share the same leased-line channel and would jam each other's data transmission attempts if two or more remote station modems set their carriers high at the same time. Using a half-duplex mode virtually guarantees that no two remote stations will attempt to transmit data at the same time.

Whether an application uses 2-wire or 4-wire leased lines, choose remote modems that support switched modem carriers.

Modem Suppliers

See the following table for a listing of recommended analog leased-line modem suppliers and respective modem models. Consult the vendor for information about their product offerings.

Supplier	Transmission Rate	Topology	Modem Model
DATA-LINC Group	1200	Point-to-point[1]	LLM1100[4]
		Point-to-multipoint[1]	
	33,600	Point-to-point[2]	DLM4500
Miille Applied Research	1200	Point-to-multipoint[3] Point-to-point[3]	166-101 (1746 rack mount)
		Point-to-multipoint[3] Point-to-point[3][1]	366-101 (DIN rail mount)

(1) 2-wire maximum transmission rate is 300 baud.
(2) 2-wire leased line only.
(3) 2-wire or 4-wire leased line.
(4) 1746 rack mount available.

DDS   Phone Company   DDS
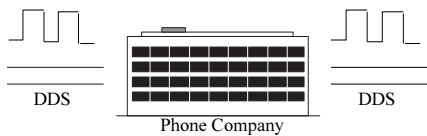
Digital Leased-line ISUs

Integrated Service Units (ISUs) are the modem equivalents for the digital data service lines. You can use the DDS network for point-to-point and point-to-multipoint systems. Two components make up an ISU, as shown below:

- The data service unit (DSU) connects to the RS-232 link.
- The channel service unit (CSU) transmits the digital signal onto the communication line.

Integrated service units are the DCEs for the digital data service lines.
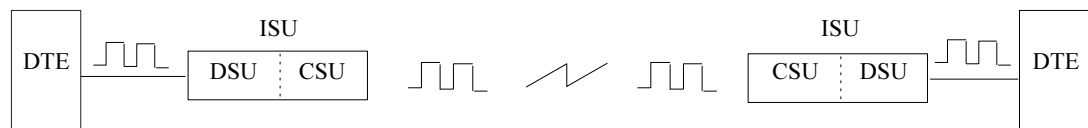
The data rate for the ISU must match that of the DDS line. Some ISUs can operate at multiple rates, but the rate of a DDS line is fixed.

Typical asynchronous DDS line speeds are 9600, 19.2 K, 38.4 K, and 57.6 K bits per second.

Consult the vendor for information about their product offerings.

Telephone Modem and ISU Installation Guidelines

Telephone modems and ISUs require a telephone-company approved connector. Consult your modem/ISU vendor for installation requirements.

Choosing a Radio Transmission System
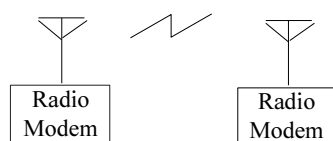
You can use radio modems for point-to-point, point-to-multipoint, or multipoint-to-multipoint applications.

The primary consideration for radio modems is the radio frequency band in which they operate. You can choose among the radio types in this table.

Radio Type	Frequency
VHF	66…79 MHz 150…174 MHz
UHF	450…470 MHz
Higher frequency UHF	850…960 MHz
Microwave	1 GHz and above

Also, consider the following criteria when selecting radios:

- Serial or Ethernet communication
- Range/distance of area to be covered
- Required communication rate
- Licensed fixed frequency or unlicensed spread-spectrum radio
- Space requirements
  - Do you need a chassis-mounted or standalone modem?
- If serial communication, requirements of the DTE devices to which you are connecting
  - Do you need asynchronous or synchronous operation?

    TIP   If you are using all Allen-Bradley DTE devices, choose an asynchronous modem interface.

  - What interfaces do you need (RS-232, MIL 188, EIA-449, IEEE 488, CCITT V.24)?
  - What other features are required to support your DTEs?
- Required remote diagnostic features

  Radio modems can either be crystal-based or microprocessor based. Microprocessor-based modems can be more easily serviced and programmed from a central control site. Diagnostics can be performed at the control site, allowing technicians to diagnose problems without having to travel to the remote site.

- Power availability at the remote sites
- Required licensing

- Required standards (for example, UL, CSA, or FCC)
- Whether the radio modem is composed of an integrated unit or a radio and a modem as separate units
- Radio modem design and operation
- Data security
- Required response time
- Ability to buffer serial data and avoid data collisions between radio modems to allow Report-by-Exception
- Ability to route DF1 data packets and to store and forward

Licensing

There are two major types of radio networks; licensed narrow-band fixed-frequency radio and unlicensed spread-spectrum radio.

Licensed Fixed-frequency Radio

Licensed narrow-band fixed-frequency radio operate in the UHF/VHF bands.

The FCC requires that you obtain a license before you operate a radio modem at a particular location and frequency within these radio frequency bands.

Unlicensed Spread-spectrum Radio

Alternatively, the FCC allows you to use relatively low transmit power, spread-spectrum radio modems without a license.

Spread-spectrum radio systems operate in the 900MHz and the 2.4/4.8 industrial, scientific, and medical (ISM) bands.

There are two implementations of spread-spectrum currently in use:

> Direct-sequence spread-spectrum (DSSS) radio takes the same data that would be transmitted on a single narrowband fixed frequency and transmits it over an available wideband of frequencies at a reduced power level.

> Frequency-hopping spread-spectrum (FHSS) radio also takes the same data that would be transmitted on a single narrowband fixed frequency, but in this case transmits it over a sequence of narrowband frequencies over the available wideband. That is, it 'hops' from one narrowband frequency to the next.

Licensed Fixed-frequency vs Unlicensed Spread-spectrum Considerations

Consider the following when choosing either a licensed fixed-frequency or an unlicensed spread-spectrum system:

- The licensed fixed-frequency option requires a license - this can be an issue in urban areas where available frequencies are already allocated.

  However, in recent years the FCC has subdivided the existing licensed frequency bands to make more available. Also, many former users of these licensed frequency bands have switched to newer technologies such as cellular, freeing up more bands for new potential licensees.

  The unlicensed spread-spectrum option does not require a license, but this does mean that there is the potential for other users to encroach on the frequencies being used. However, this is rarely an issue due to the lower power levels and technologies used with spread-spectrum radio.

- Licensed fixed-frequency systems are allowed to transmit at higher power levels than spread-spectrum systems (5 watts vs 1 watt) and thus have greater range capability, are less prone to attenuation from atmospheric and environmental conditions, and have less need for line of sight configurations.

- Licensed fixed-frequency systems transmit at lower frequencies than spread-spectrum systems and thus have greater range capability, are less prone to attenuation from atmospheric and environmental conditions, and have less need for line of sight configurations.

- Licensed fixed-frequency systems typically support lower bandwidth throughputs than spread-spectrum systems (due to smaller channel widths). However, this is often not an issue for industrial applications using small packet sized serial protocols.

- Licensed fixed-frequency systems can be more susceptible to noise or interference as they utilize a single frequency.

Spread-spectrum Direct-sequence vs Frequency-hopping Considerations

- Spread-spectrum direct-sequence systems typically support higher data throughputs because of the data transmission being spread over a wider band. They can be susceptible to noise that occurs over the wideband being used.

- Frequency-hopping systems support a lower data throughput but have greater noise immunity because the frequency at which the transmission takes place is constantly changing.

Radio Modem Types

There are two types of radio modems: Ethernet modems and Serial modems.

Ethernet Radio Modems

Ethernet radio modems have a standard IEEE 802.3 (10Base-T or 100BaseT) interface that can connect directly to the Ethernet port on the computer or PLC, or to the Ethernet network via a bridge or router.

Serial Radio Modems

Serial modems may be sold as:

- integrated units.

  - Key-up time between the radio and modem is integrated fully. The unit does not require programmable controller intervention.
  - When the modem and transmitter/receiver are separate, compatibility becomes an issue.

- two separate units.

  - a digital data modem that has an RS-232 connector
  - a radio transmitter/receiver that has an antenna connector

Often, since the modem is not able to directly control when the radio transmits a carrier, the data communication device must also have a way to key-up the radio transmitter just prior to transmitting data to the modem.

Also, consider the time-to-transmit power requirements of the combination, since the external modem is not able to determine when the radio is at full power. The modem requires a time delay prior to data transmission.

Like leased-line modems, the cost of radio modems is directly proportional to the communication rate or communication throughput that they can support.

Select your modem based on the type of application: point-to-point full-duplex, point-to-multipoint half-duplex, or multipoint-to-multipoint full-duplex.

For Point-to-point Full-duplex Applications

Choose full-duplex radios. This application requires a separate transmitter and receiver in each radio modem.

For Point-to-multipoint (or Broadcast) Half-duplex Applications

Choose full-duplex master radio, half-duplex master radio, or half-duplex remote radios.

For best performance use a 'master' radio modem capable of full-duplex operation, since a full-duplex radio modem has a transmitter that is separate from the receiver. This provides shorter RTS-to-CTS delays with each master station data transmission.

To be cost-efficient, use radio modems that have a transceiver for the remote stations. Having a transceiver limits modems to only half-duplex operation, since they can only send or receive data at one time. Therefore, with each remote station transmission, the RTS-to-CTS delay is longer, since the transceiver takes time to switch from receiver operation to transmitter operation. This time delay allows the transmitter time to fully power up.

Also, think about setting up your master station in a redundant configuration. If the master station's radio modem goes down, the whole communication system is down. Whereas, when a remote station radio modem goes down, only communication to a single remote station is lost.

For Multipoint-to-multipoint, Full-duplex Applications

Choose 'intelligent' radios. Although 'intelligent' radio modems receive and transmit across the airwaves in a half-duplex fashion, they are able to transfer data with the attached controller in full-duplex fashion when the controller is configured to communicate using DF1 radio modem protocol. This allows any station to trigger a message instruction in ladder logic and immediately transmit it to the attached radio modem. The radio modem buffers the message and transmits it once it has an idle channel available.

Modem Suppliers

The following table lists radio modem suppliers and the modems they sell. Consult the vendor for information about their product offerings.

Encompass Partner	Modem Model#	RF Transmission Rate	Frequency	Type	Published Line-of-Sight Range
CalAmp (Dataradio)	Integra-TR 242-4018	19.2 kbps	132 to 174 MHz	Serial	30 miles
	T-96SR 242-4016	19.2 kbps	132 to 174 MHz	Serial	30 miles
	Viper 140-5018	19.2 kbps	136 to 174 MHz	Serial/Ethernet	?
	Integra-TR 242-4048	19.2 kbps	380 to 512 MHz	Serial	30 miles
	T-96SR 242-4046	19.2 kbps	380 to 512 MHz	Serial	30 miles
	Viper 140-5048	19.2 kbps	406 to 512 MHz	Serial/Ethernet	?
	HiPR-900 242-5099	512 kbps	902 to 928 MHz(1)	Serial/Ethernet	?
	Integra-TR 242-4098	19.2 kbps	928 to 960 MHz	Serial	30 miles
	Viper 140-5098	32 kbps	928 to 960 MHz	Serial/Ethernet	?
Data-Linc Group	SRM6000(2)	144-188 kbps	902 to 928 MHz(1)	Serial	25 miles
	SRM6200E-SLC(2)	144-188 kbps	902 to 928 MHz(1)	Ethernet	25 miles
	SRM6210E(3)	144-188 kbps	902 to 928 MHz(1)	Ethernet	25 miles
	SRM6220E-S(4)	144-188 kbps	902 to 928 MHz(1)	Serial/Ethernet	25 miles
	SRM7210E(3)	612 or 867 kbps	902 to 928 MHz(1)	Ethernet	20 miles
	PLR5000	38.4 kbps	902 to 928 MHz(1)	Serial	4 miles
	FLC910E	6-54 Mbps	902 to 928 MHz(1)	Ethernet	10 miles
	SRM6100(2)	144-188 kbps	2.4 to 2.484 GHz(1)	Serial	15 miles
	SRM6300E-SLC(2)	144-188 kbps	2.4 to 2.484 GHz(1)	Ethernet	10 miles
	SRM6310E(3)	144-188 kbps	2.4 to 2.484 GHz(1)	Ethernet	10 miles
	SRM6320E-S(4)	144-188 kbps	2.4 to 2.484 GHz(1)	Serial/Ethernet	10 miles
	FLC810E+	1-11 Mbps	2.4 to 2.484 GHz(1)	Ethernet 802.11b	6 miles
	FLC820G	1-54 Mbps	2.4 to 2.484 GHz(1)	Ethernet 802.11b/g	10 miles
ESTeem	192M	19.2 kbps	150 to 174 MHz	Serial	15 miles
	192MHP	19.2 kbps	150 to 174 MHz	Serial	40…70 miles
	192F	19.2 kbps	400 to 420 MHz	Serial	15 miles
	192C	19.2 kbps	450 to 470 MHz	Serial	15 miles
	192CHP	19.2 kbps	450 to 470 MHz	Serial	40…70 miles
	195Es	200 kbps	902 to 928 MHz(1)	Serial/Ethernet	10 miles
	195Ed	1-54 Mbps	902 to 928 MHz(1)	Serial/Ethernet	10 miles
	195Eg	1-54 Mbps	2.4 to 2.484 GHz(1)	Ethernet 802.11b/g	5…7 miles
	195Ep	1-54 Mbps	4.9 GHz.	Serial/Ethernet	5…7 miles

Encompass Partner	Modem Model#	RF Transmission Rate	Frequency	Type	Published Line-of-Sight Range
FreeWave Technologies	LRS-455	19.2 kbps	435 to 470 MHz.	Serial	60 miles
	LRS-760	38.4 kbps	757 to 788 MHz.	Serial	30 miles
	FGR2-CE-U	115.2 or 153.6 kbps	902 to 928 MHz(1)	Serial	60 miles
	HTPlus	867 kbps	902 to 928 MHz(1)	Ethernet	15 miles
	FGRplus RE	154 kbps	902 to 928 MHz(1)	Ethernet	60 miles
	LRS-140	19.2 kbps	1.427 to 1.432 GHz.	Serial	30 miles
	IM-800X009	115.2 kbps	2.4 to 2.484 GHz(1)	Serial	20 miles
ProSoft Technology	RLX-FHE	250 kbps	2.4 to 2.484 GHz(1)	Ethernet	15 miles
	RLX-FHES	250 kbps	2.4 to 2.484 GHz(1)	Serial/Ethernet	15 miles
	RLX-FHS	250 kbps	2.4 to 2.484 GHz(1)	Serial	15 miles
	RLX-IFH9E	1.1 Mbps or 345 kbps	902 to 928 MHz(1)	Ethernet	30 miles
	RLX-IFH24E	1.1 Mbps or 345 kbps	2.4 to 2.484 GHz(1)	Ethernet	15 miles
	RLX-IFH9S	230, 172, 115 or 19.2 kbps	902 to 928 MHz(1)	Serial	30 miles
	RLX-IFH24S	230, 172, 115 or 19.2 kbps	2.4 to 2.484 GHz(1)	Serial	15 miles
	RLXIB-IHA	6-54 Mbps	5.725 to 5.850 GHz	Ethernet 802.11a	5 miles
	RLXIB-IHG	1-54 Mbps	2.4 to 2.484 GHz(1)	Ethernet 802.11b/g	10 miles
	RLXIB-IHW	1-54 Mbps	5.725 to 5.850 GHz	Ethernet 802.11a/b/g	3 miles
	RLXIB-IHW-66	1-54 Mbps	5.725 to 5.850 GHz	Ethernet 802.11a/b/g	3 miles
	RLXIB-IESC	1-54 Mbps	5.725 to 5.850 GHz	Serial/Ethernet 802.11a/b/g	3 miles
	RLX-IH	1-11 Mbps	2.4 to 2.484 GHz(1)	Ethernet 802.11b	20 miles

Ethernet vs. Serial Radio Modem Considerations

- Ethernet offers the advantage of widespread acceptance and connectivity and easier implementation.
- Ethernet ports are available on a wide variety of commercial and industrial devices such as personal computers and programmable logic controllers. Serial ports are becoming less common on both, particularly on commercial devices, and may not be available without the use of an external adapter.
- Serial may be required in applications where Ethernet is not available for the devices already installed or to be added to the network.
- Ethernet allows connection to the Internet (for example, remote access and email/text notifications).
- Ethernet supports multiple applications on the same network (for example, web servers, video cameras, and data collection from multi-vendor/protocol devices).

- Ethernet supports higher transmission speeds. However, consider that this may be offset by the fact that Ethernet is usually less efficient in transmitting industrial data than serial protocols. This is because industrial data typically consists of smaller packets (for example, control information) than commercial data (for example, file downloads). The overhead of an Ethernet packet is usually much greater than that of a typical serial packet.

- Ethernet radio modems typically operate in higher, spread-spectrum/ unlicensed frequency bands (900Mhz, 2.4/5.8 GHz) that are limited in allowable output power and thus have less range than traditional licensed fixed frequency serial radio modems.

Radio Modem Installation Guidelines

For a radio system, you need these components.

Component	Comments
Antennas	The height and quality depend upon the application and project budget.
Cabinets	Consider the environmental conditions or the location of the remote sites to select an appropriate cabinet.
Repeaters (optional)	If the radios are not located in a line of sight with each other (for example, due to terrain), you may need repeaters to carry the signal from the initiating station to the destination station.

When becoming involved with radio system design, consult radio system vendors. A site survey should always be performed to determine the following:

- Radio transmit power requirements
- Quantity of radios
- Whether or not repeaters are needed
- Antenna type and heights

Choosing a Satellite Transmission System
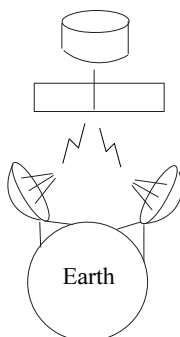
A Very Small Aperture Terminal (VSAT) network provides a mechanism for multiple remote sites to communicate with a central site (a hub) on a shared access basis. You can choose between single-hop and double-hop systems.

Single-Hop

Data is transmitted across leased lines to the master Earth station, which beams the data to the satellite. The satellite beams the data to the remote sites (or master site).

The charges may be high if you purchase your own inbound and outbound channels, and usually, you do not use the channels' entire bandwidth. Also, you must pay for the leased line that transports the data to the master hub.

You can choose a single-hop system that shares the inbound and outbound channels with others to offset costs.

Double-hop

A VSAT site is directly connected to your master or remote station. This VSAT beams the data to the satellite, which beams the data to either the remote site or master site.

With a double-hop system, you are not dependent upon the availability of terrestrial leased lines.

These components make up a satellite transmission system:
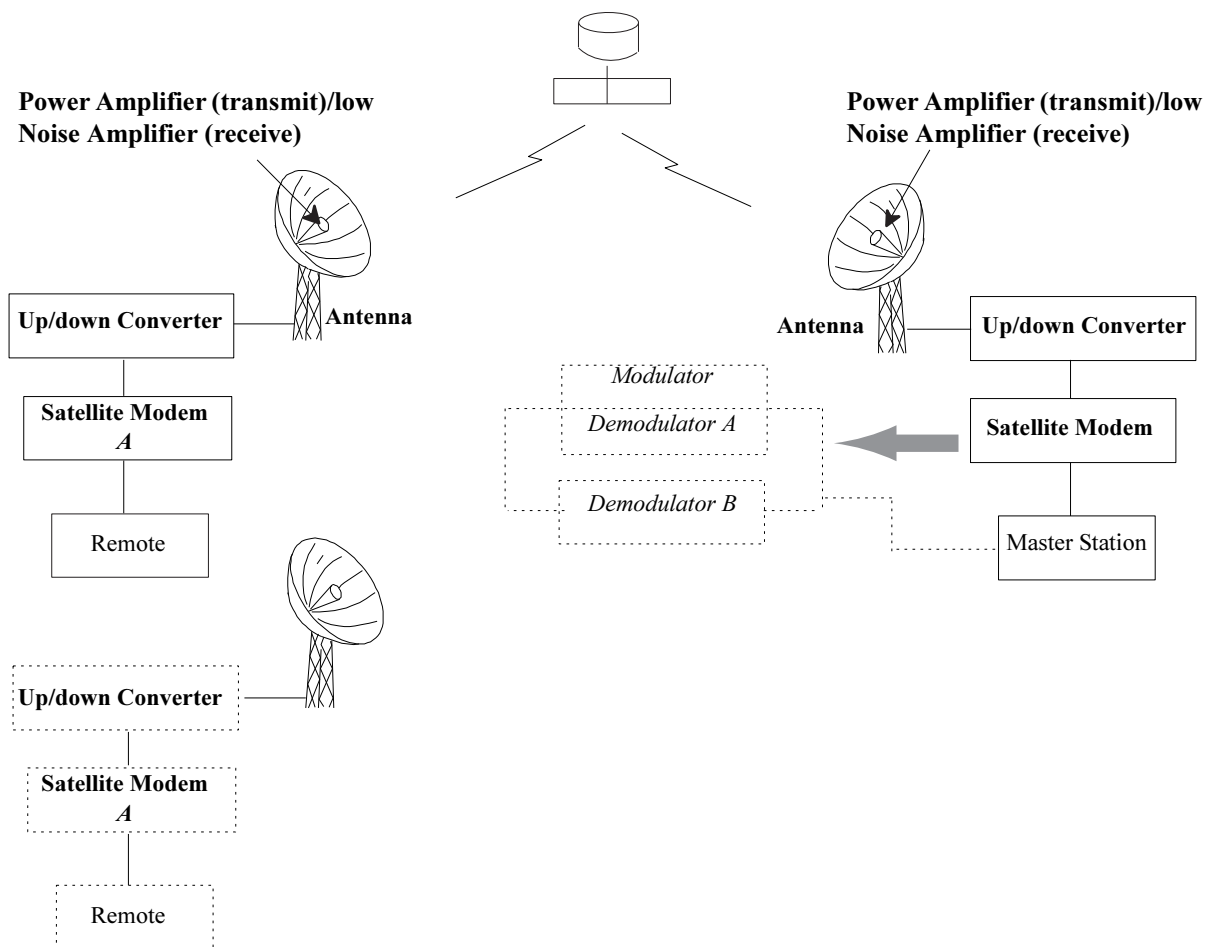
Choosing Dedicated Wire/ Power Line Modems
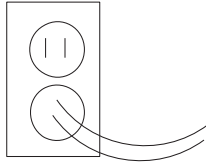
You can easily integrate dedicated wire/power line modems into your application. You need a suitable dedicated wire pair or power line and an RS-232 interface.

The following table lists the recommended dedicated wire/power line modem supplier and modem models. Consult the vendor for installation requirements and detailed information about their product offerings.

Supplier	Transmission Rate	Topology	Modem Model
DATA-LINC Group	9600 bps	Point-to-point Point-to-multipoint	MDL500[1]
	1200 bps	Point-to-point Point-to-multipoint	LLM1100
	19200 bps	Point-to-point	DLM4000

(1) suitable for power line installations.

Choosing a Cellular Transmission System

Cellular modems are increasingly being used in SCADA applications to increase productivity and uptimes. One of the key benefits of the cellular modem over WLAN modems is that cellular modems are able to offer more network coverage mobility. Being able to collect and distribute data without the limitation of wireless hotspots or having a dedicated wired network using cellular network is powerful. Typically a cellular modem is used when the network coverage requirement is large and when use of satellites or other technology is not cost effective. Cellular networks are predominantly offered as major technologies namely, GSM (Global System for Mobile Communications) and CDMA (Code Division Multiple Access). The GSM technology is more popular across different countries while the CDMA is more popular in the U.S.

Cellular Network Architecture

The diagram below shows a typical cellular network layout.
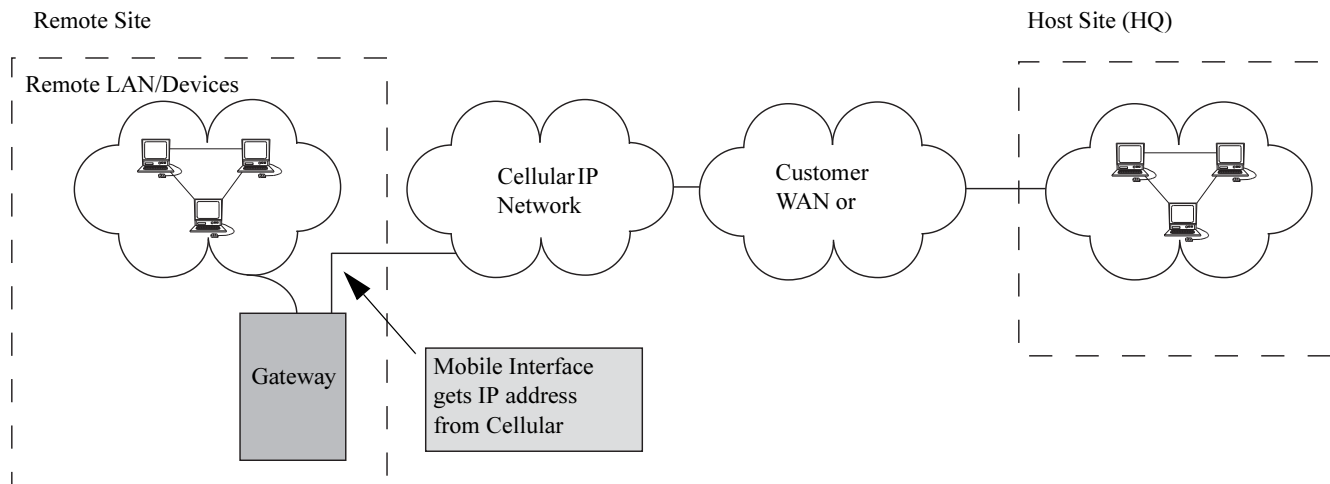
Two major components of the cellular network are the remote site and the host or central site. The remote site has application devices locally networked and communicate to the host site by using the cellular network through a gateway. These devices could be a PLC or other equipment like an embedded computer. The host site runs an application server that could be a web server that is responsible for running the application.

Depending on the application of the cellular network, a cellular network may be organized as Mobile Originated mode, Mobile Terminated mode, or Both Mobile Originated and Terminated mode.

In the Mobile Originated mode, the remote device or node initiates a connection. This connection is terminated at the host, usually at the host web server. In the Mobile Terminated mode, a host will request or poll for information from the remote device. In this case, the host device initiates the connection and the connection is terminated at the remote site. In the Both Mobile Originated and Terminated mode, the host and the remote site are able to initiate connections. Usually, the host will poll for information from the remote site, but the remote site is also proactively able to send out event and alarm information to the host site.

To use the cellular modem technology effectively, a user has to have the following components:

- Data plan subscription
- Cellular modem

The user needs to make sure that the cellular modem purchased for the network is compatible with a good cellular service provider's plan. As mentioned above, there are two very popular cellular technology types namely GSM and CDMA. Verizon Wireless, Alltel, and Sprint use CDMA. T-Mobile and AT&T use the GSM cellular format. Often, CDMA may be referred to as or associated with W-CDMA, EV-DO, and EV-DV, while GSM/GPRS may be associated with EDGE or EGPRS.

Below are some considerations to be made before finalizing a cellular modem and plan purchase:

- Ensure that the manufacturer of the cellular modem device offers technical support and other regular update services.
- If you are expecting certain areas to have low connectivity issues, purchase a signal booster or repeaters to enhance data reception.
- Understand the different cellular providers' plan options in the target areas.
- Choose a carrier that offers the maximum reception coverage in the target areas. Most carriers have interactive websites with geographic maps that you can use to determine coverage in your area.

Some cellular modem providers have dedicated contacts with the cellular providers who can facilitate and make cellular account set up easier.

Table 4 - Comparison of Cellular Modems from Rockwell Automation Encompass Partners

Partner Name	Product Name / Catalog Number	Description
Digi International	Digi Connect WAN IA (Verizon) / DC-WAN-G511	• Uses Verizon CDMA. • Din rail mountable. • Class 1, Div 2
Digi International	Digi Connect WAN IA GSM/ DC-WAN-F501	• Uses GSM EDGE. • Din Rail mountable. • Class 1, Div 2 approved.
CalAmp	LandCell 882	• Applies GSM and CDMA technology. • Updates are quick and easy with over-the-air configuration and browser-based management. • Interfaces with Ethernet, USB or serial devices. • Supports HSPA and EVDO data rates over public networks.
CalAmp	LandCell819	• GPRS cellular data modem gets you connected with a quad-band integrated platform through a serial connection. • With plug-and-play installation. • Packet data transmission speeds up to 86 kbps.
CalAmp	Vanguard 3G	• Broadband router • CDMA or GSM connectivity • Uses EVDO technology • Has an optional WIFI access point
Hiprom Technologies	GSM/CELL Module 1756HP-CELL	• GSM cellular network for Logix messaging. • SMS/GPRS/3G for alarm notification and remote monitoring. • Platform - 1756 ControlLogix I/O
Prosoft Technology	Cellular Ethernet/Serial Modem RLXIC Family	• Broadband M2M. • SCADA connectivity over GSM HSUPA cellular networks.

Managing Cost of a Cellular Network Data Charges

The design of a cellular network has to be done with care factoring in connectivity and bandwidth requirements. This will enable a designer to meet any cost targets involved. An important factor that affects the cost is the Network overhead. There are primarily two modes of communication when using an IP network - TCP and UDP.

TCP stands for Transmission Control Protocol. It is a transport protocol and offers a guaranteed delivery service. The reason TCP is able to offer guaranteed service is because it has a mechanism in the network layer itself to detect loss of data packets and retransmit the lost packets.

UDP stands for User Datagram Protocol. This is also a transport protocol which does not offer reliable service for data delivery. This protocol leaves the responsibility of data receipt up to the application layer in the protocol stack.

While it may seem that using the TCP mechanism should be the obvious choice, this is not always true. TCP gives room to a lot of network overhead as it initiates packet retransmissions and Acknowledgement packets whenever it detect a loss in data receipt. Several applications employ their own data delivery integrity validation procedures and do not require the network to validate data delivery for it. In this case, the use of UDP may be encouraged as UDP has much less network overhead compared to TCP. Hence, a choice of transport protocol to use to needs to be made based on the application. A good choice of protocol can prove to be cost beneficial.

Determining Monthly Cost for Data Usage

Monthly Circuit Switch data cost consists of a fixed data rate charge for a certain amount of data per month, with additional data typically costing about US$0.05/Megabyte. Roaming data charges are applicable if the equipment is used outside the coverage area.

Monthly Packet data cost is charged to the nearest Kilobyte transferred. Cellular providers have different plans (which could range from a set minimum to an 'unlimited' maximum); each consisting of a minimum block of Kilobytes. If the monthly Kilobytes transferred figure is exceeded, the balance is billed as extra charges. Site costs typically range from US$30...70 per month (including the Kilobyte transfer).

Below is an example from a Rockwell Automation Encompass Partner, Prosoft who is cellular modem provider.

Prosoft offers their modems bundled with data service plans from AT&T and Verizon. Once a user selects a preferred carrier, Prosoft provides pricing and other order related information. The list price for a Prosoft cellular modem device with a two year service contract is approximately US$575. The Data Service charge for the period of two years is an additional US$900 with a US$100 activation fee.

Prosoft also provides a plan where you can buy an already activated modem. This plan costs about US$575 for the modem with a $100 Monthly 'Try Before You Buy' Prosoft Data service plan. The customer is also charged a two year data service plan with a two year activation plan. But, if the customer decides to return the modem, Prosoft accepts the device back without a restocking fee and will not invoice the Data Service plan and Activation charge. The trial period permitted is 60 days.

Other providers have similar products and services as well that can be used when setting up a cellular network.

Advantages and Disadvantages over other Modem Technologies

Listed are the advantages and disadvantages of choosing a cellular transmission system over other modem technologies.

Advantages

- Ability to use existing secure cellular infrastructure thereby significantly reducing cost of cabling and antenna towers.
- Increases mobility of users.
- The network coverage area can be made significantly larger when using cellular networks as networks can be setup in areas where wiring may not be possible.

Disadvantages

- Dependency on a third party supplier for service and support of communication infrastructure.
- Since you pay based on the amount of data transmitted, it becomes important to minimize (or at least monitor) the amount and frequency of data transmission to avoid large overage charges.
- There could be situations in which cellular network coverage is not available in international geographic locations as it is in the North American regions. In those cases, a user needs to rely completely on the coverage provided by the local cellular service provider.

What To Do Next

Choose your data communication equipment. You may need more specific information about the control devices to which you are connecting. Therefore, after choosing your master and remote stations, refer to this section as needed to finalize your transmission system.

Go to the next chapter to choose master stations.

Notes:

Choosing a Device for a Master Station

Overview

The master station in a SCADA system does the following:

- Gets field data by periodically reading and/or receiving data directly from the remote stations or through a submaster

- Provides coordinated monitoring and control over the entire system through its operator interface

Several master station types are possible.

Figure 5 - Available Master Station Types

Computer-based Master

FactoryTalk View SE Software with DNP3 OPC Driver

Serial or Ethernet

In small SCADA systems, a single personal computer can serve as both the master station and central computer.

Remote Stations

Remote Stations

PLC-based Master

Ethernet

Use a programmable controller as a master station if an application requires one or more master stations separate from the operator interface, such as when you need to control local inputs and outputs.

Serial or Ethernet

Remote Stations

Very large applications can also require submaster stations, which:

- gather data from the remote stations within a region.
- support local operator interface for the region.
- support logging of alarms and events.
- communicate remote station data and support control commands.
- interface with a larger, host master station.

In the illustration below, a submaster station controls remote sites within a region.

Figure 6 - Submaster Station Controlling Remote Sites
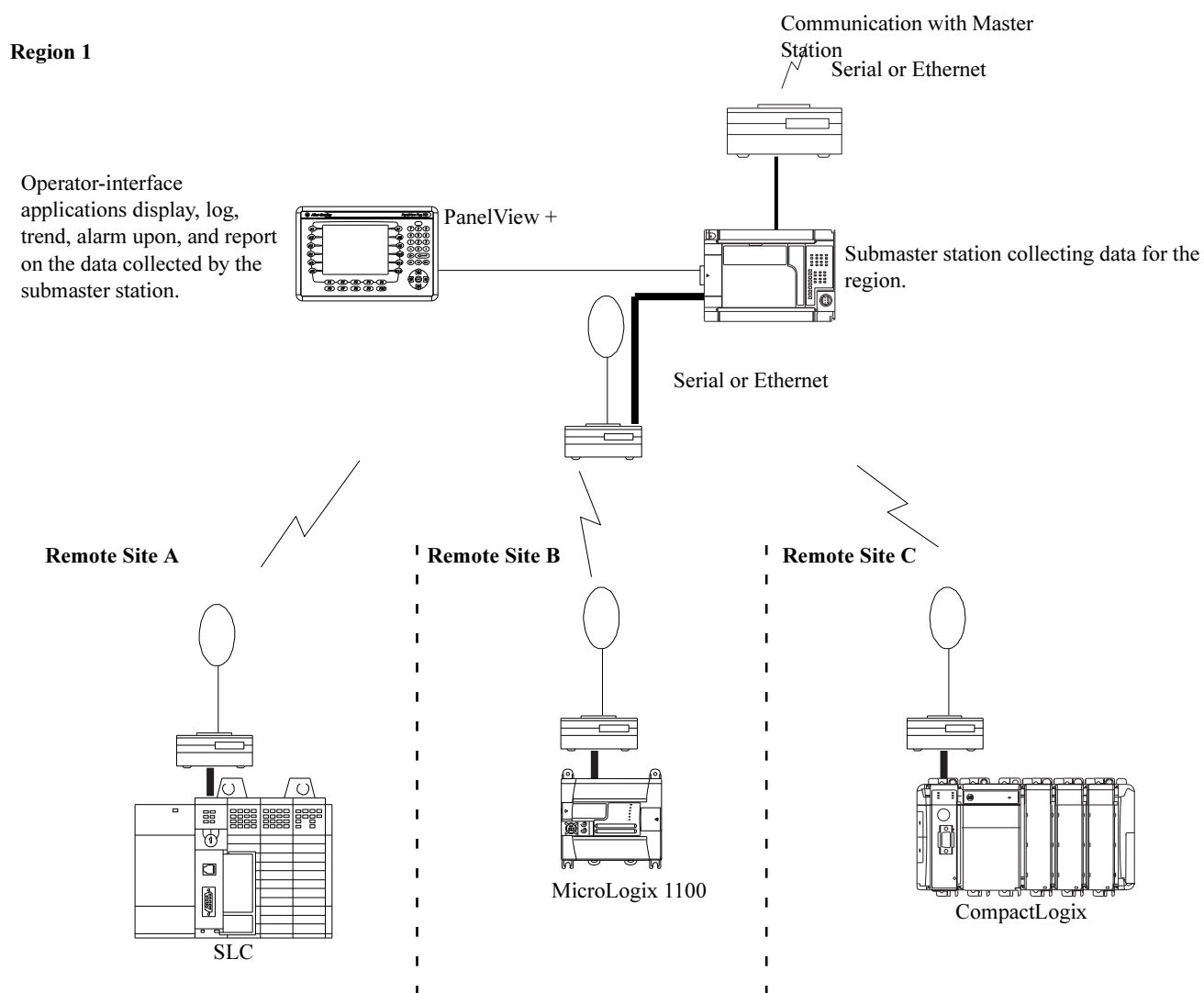
Choosing a Computer-based Master Station

For many small SCADA configurations, a personal computer running Rockwell Software FactoryTalk View SE software and DNP3 OPC Driver can meet the requirements for both the operator interface and the master station. FactoryTalk View SE software provides not only an operator interface but also master station functionality, both at the same time. This configuration provides for the most integrated and cost-effective master station for smaller applications.

Using FactoryTalk View SE Software as a Master Station
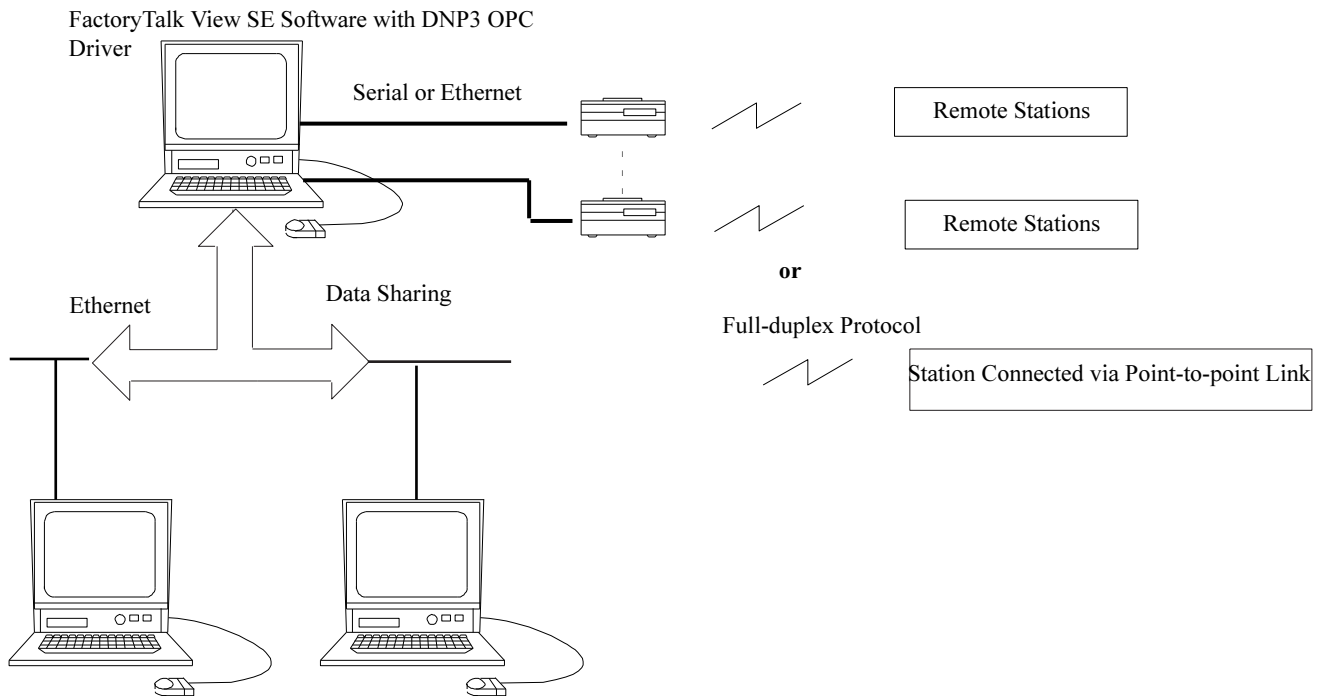
A single FactoryTalk View SE workstation can simultaneously be:

- the host computer, running operator-interface software.
- the master station, performing the remote station data-gathering functions.
- the remote station programming terminal.

To create a cost-effective solution, equip a workstation with the following:

- FactoryTalk View SE HMI software
- DNP3 OPC server software
- RSLogix programming software

Using FactoryTalk View SE Software as a Plant HMI
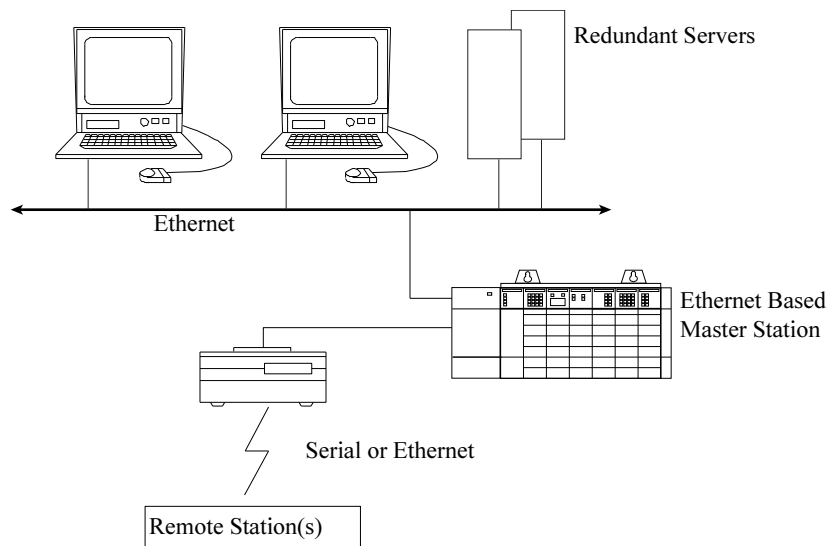
Minimum requirements:

- Personal computer with Windows XP or later operating system
- Ethernet communication card
- Cables
- FactoryTalk View SE software
- RSLinx communication server software
- For the PLC-based master station requirements, see Choosing a Programmable Controller-based Master Station

Choosing a Programmable Controller-based Master Station

Choose a programmable controller-based master station if any of these requirements exists:

- The master station must be able to control local I/O.
- Your application requires master station redundancy.
- More robust and flexible PLC hardware platform for polling remotes.

Use this chart to help you choose a programmable controller master station.

Controller	MicroLogix		SLC	CompactLogix				Control-Logix
Specification	1100	1400	5/05	L23E	L4x	L32E	L35E	
Number of RS-232 comms channels	1	1	1	1	1	1	1	1
Integral DF1 full-duplex	?	?	?	?	?	?	?	?
Integral DF1 half-duplex master	?[2]	?[3]	?	?	?	?	?	?
Integral DF1 radio modem	?[2]	?[3]	?[5]	?	?	?	?	?
Integral/backplane modbus RTU master[1]	?[3]	?[4]	?[6]	?[8]	?[8]	?[8]	?[8]	?[9]
Integral/backplane Ethernet	?	?	?	?		?	?	?[10]
Maximum remote stations	254	508	254	254	254	254	254	254
Controller redundancy available			?[7]					?[11]
Programming languages	RL	RL	RL	RL,ST,SFC,FB				

(1) Standalone DF1 full-duplex to Modbus interfaces are available from ProSoft Technology and Miille Applied Research Company.

(2) Series C, FRN 7 or later.

(3) Series C, FRN 8 or later.

(4) Series C, FRN 9 or later.

(5) Series C, FRN 6 or later.

(6) Series C, FRN 11 or later.

(7) Via 1747-BSN.

(8) Via 1769-SM2.

(9) 1756 form factor Modbus communication module available from ProSoft Technology.

(10) Via 1756-EN*x*T

(11) Via 1756-RM.

Choose the programmable controller based on processor memory requirements. The following table provides a selection guideline for programmable controller-based master stations. The guidelines are based on a maximum of 4 K of programming memory for the polling master application logic and 200 words of data table memory per remote station. Other application requirements might dictate specifying a larger processor.
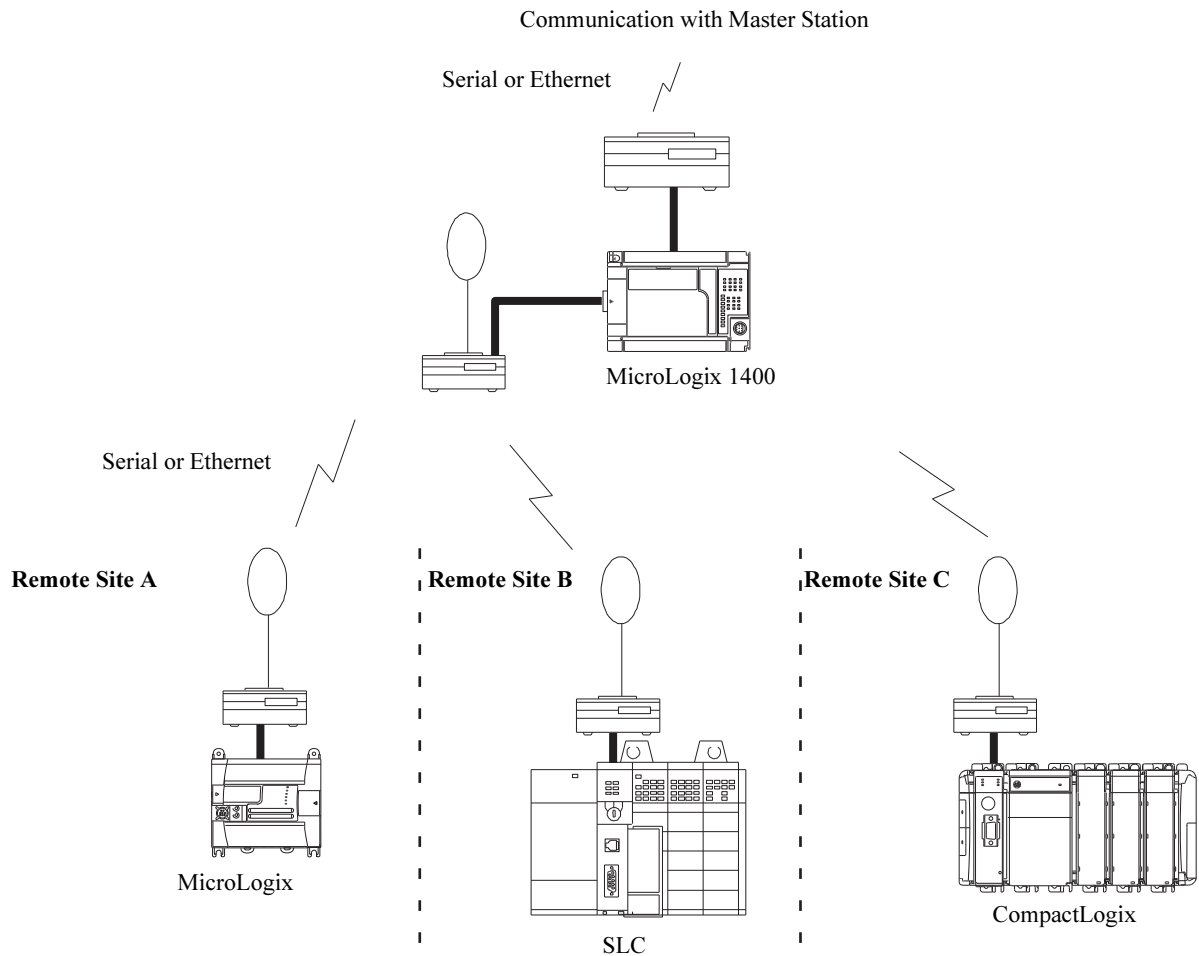
If you have this number of remote stations	Choose this processor or larger	
1...10	•MicroLogix 1100	•CompactLogix L23E
11...50	•SLC 5/05 1747-L551 •CompactLogix L32E	•MicroLogix 1400
51...130	•SLC 5/05 1747-L552	•CompactLogix L35E
131...210	•CompactLogix L43 •ControlLogix	•SLC 5/05 1747-L553
211...254	•CompactLogix L45	•ControlLogix
> 254	Multiple ControlLogix	

If an application requires multiple half-duplex master stations, you can use multiple ControlLogix processors in a single 1756 I/O chassis, with each processor supporting up to 254 remote stations. Using the built-in backplane to serial port routing capability of the ControlLogix processor, any processor has messaging capability to any remote station, no matter to which processor serial port it is actually connected.

Choosing a Data-concentrating Submaster Station

If your application requires one or more data-concentrating serial submaster stations, each submaster station must support both DF1 half-duplex master and DF1 half-duplex slave communication through two serial ports. In this application, the submaster can communicate directly with its master or its remote stations, but any data exchange between its master and its remote stations can only occur through the submaster's data table. The master programming terminal can remotely program the submaster, but not the submaster's remote stations. Alternatively, Ethernet can be used for communication to or from the submaster.

The MicroLogix 1400 controller can be configured as a serial submaster with DF1 half-duplex slave on channel 0 and DF1 half-duplex master on channel 2, or with DF1 radio modem configured on both channels. It has an Ethernet port for communication as well.

Figure 7 - Controllers Configured as a Submaster

Communication with Master Station

Serial or Ethernet

MicroLogix 1400

Serial or Ethernet

Remote Site A

MicroLogix

Remote Site B

SLC

Remote Site C

CompactLogix

Choosing a Data-routing Submaster Station

If your application requires one or more data-routing submaster stations, the master station and the submaster stations can either be ControlLogix or CompactLogix processor-based.

For serial communication submasters, each ControlLogix submaster station has two ControlLogix processors, one with its serial port configured for DF1 half-duplex master station communication and the other with its serial port configured for DF1 half-duplex remote station communication, or either one configured for DF1 radio modem.

The CompactLogix L31 has two serial ports that can be set up for DF1 half-duplex master and slave, or DF1 radio modem, with routing capability between them. Alternatively, Ethernet can be used for communication to or from the submaster.

In this application, not only can the submaster communicate directly with its master or remote stations, but the master can initiate messages to the remote stations by routing through the submaster, with no additional programming or data table memory used in the submaster.

A programming terminal or HMI computer connected to the master station via Ethernet network can also route through the master and submaster to program or exchange data with the remote stations.
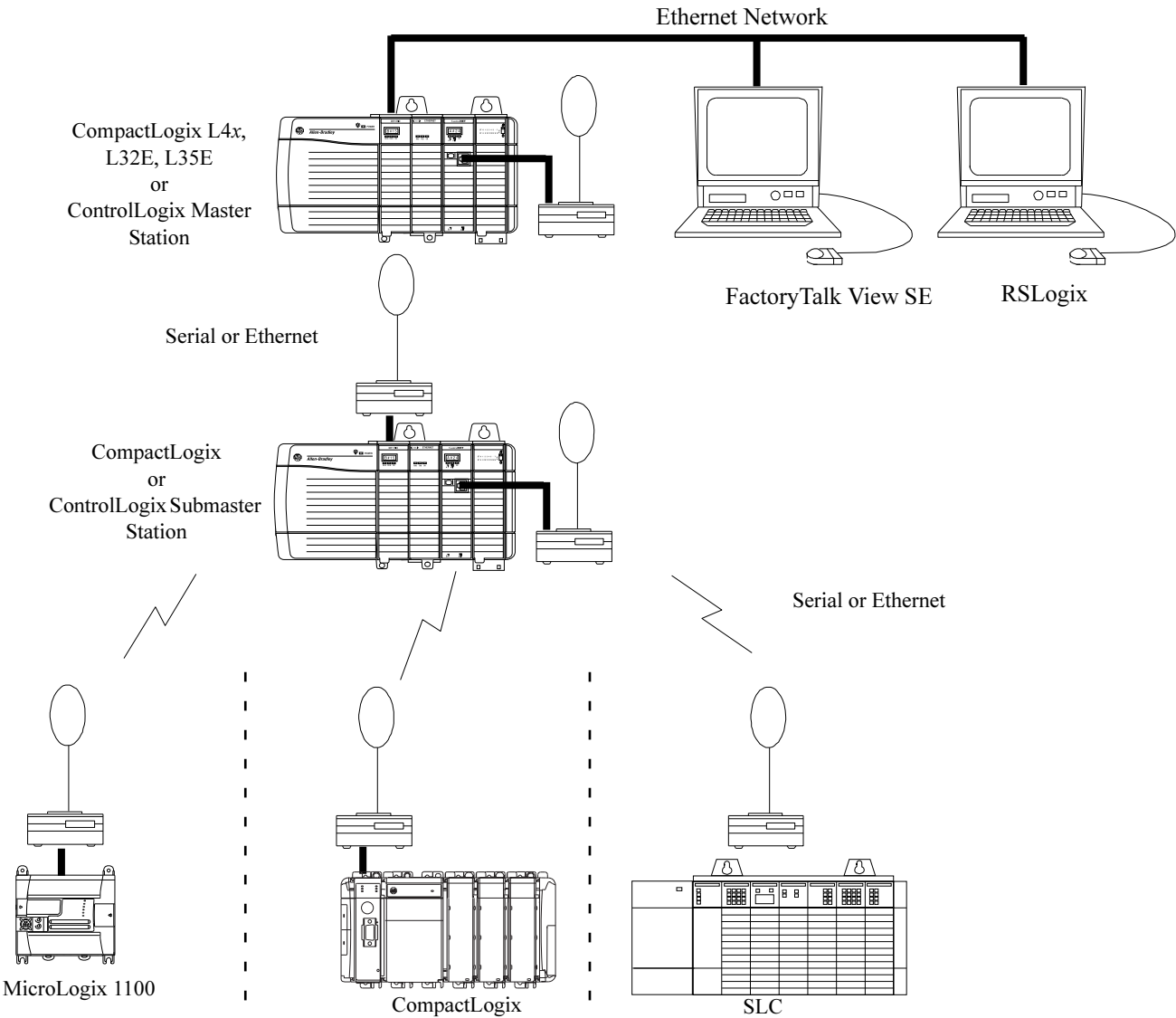
Type	MicroLogix	CompactLogix	ControlLogix
Data Concentrating	?		
Data Routing		?	?

Needed Equipment

Allen-Bradley offers a wide variety of chassis, power supplies, and I/O modules to help you automate your application.

Installation Guidelines

You must provide an appropriate environment and proper grounding for programmable controller systems. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for more information.

What To Do Next

You should:

- choose your master and submaster stations and operator interfaces according to your application requirements. Record these choices on the selection worksheet (page 20).
- finalize any telemetry equipment decisions.
- consult the related publications listed on page 9 to begin designing any needed control systems.

Go to the next chapter to choose your remote stations.

Notes:

Choosing a Device for a Remote Station

Overview

A remote station in a SCADA application does the following:

- Controls inputs and outputs of field devices, such as valves, metering equipment, and drives
- Monitors conditions of the field devices and logs alarms
- Reports status to the master station and carries out the commands it receives from the master station
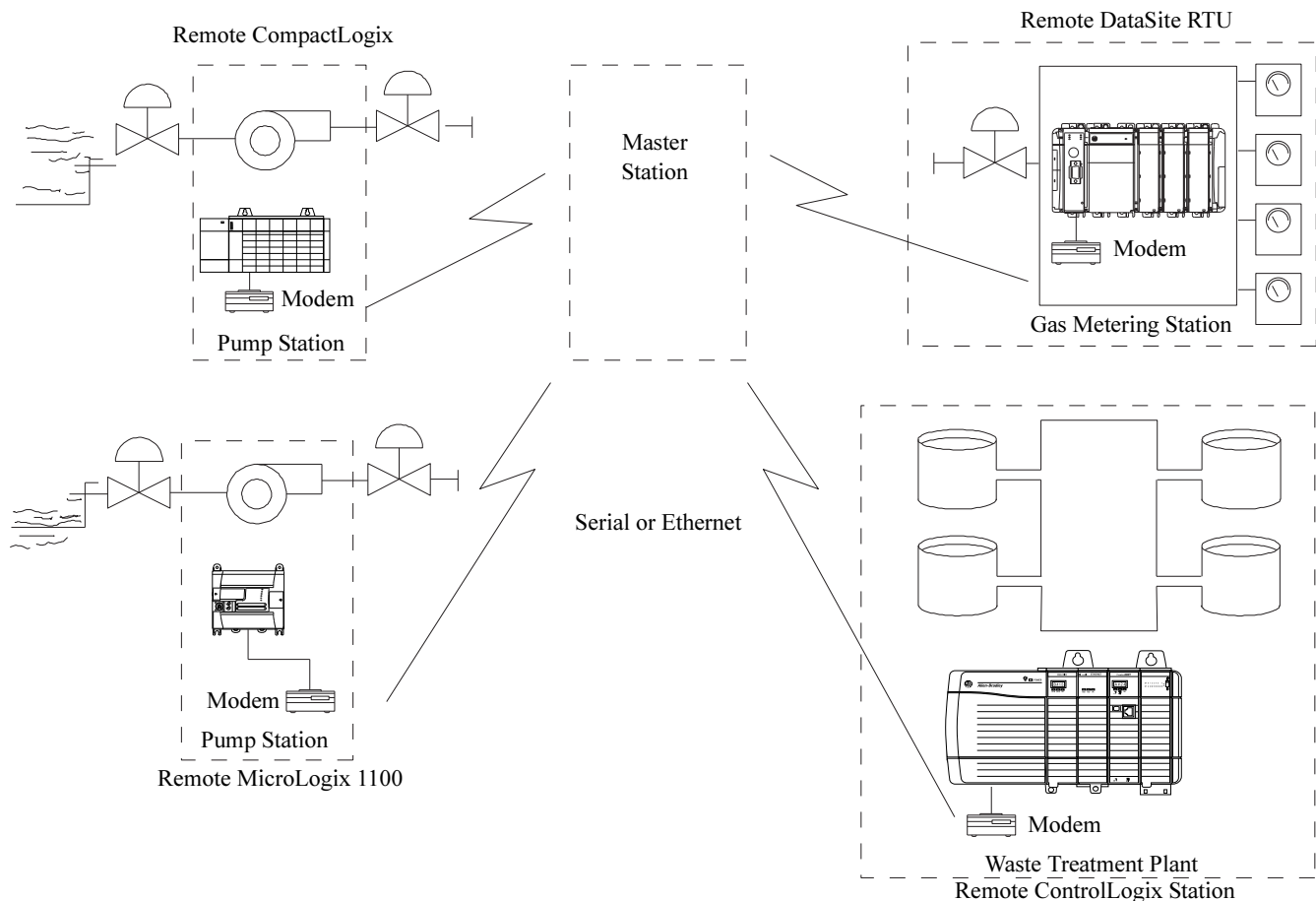
Choose a Device

Choose from a variety of remote stations that fit your application and cost requirements. The most cost-effective remote station for applications that use limited analog and/or discrete I/O are the Micro800 and MicroLogix families of programmable controllers. Otherwise, choose an SLC 500 or CompactLogix system for your remote station, unless specific redundancy, I/O, environmental, or communication requirements are only met by a ControlLogix or DataSite RTU system.

Controller Specification	MicroLogix				SLC		CompactLogix					ControlLogix	DataSite RTU	Micro800	
	1100	1200	1400	1500 LRP	5/03	5/05	L23	L23E	L31	L32E	L35E			830	850 [11]
Integral DNP3 Serial			x										x		
Integral DNP3 Ethernet			x										x		
Number of RS-232 comms channels	1	2	2	2	1	1	2	1	2	1	1	1	2	1…6 [8]	
Integral DF1 full-duplex	x	x	x	x	x	x	x	x	x	x	x	x		x [11]	
Integral DF1 half-duplex slave	x	x	x	x	x	x	x	x	x	x	x	x			
Integral DF1 radio modem	x	x [1]	x	x [2]	x [3]	x [3]	x	x	x	x	x	x			
Integral/ backplane modbus RTU slave	x	x	x	x	x [4]	x [4]						x [5]	x	x	
Integral ASCII	x	x	x	x	x	x	x	x	x	x	x	x		x	
Integral/ backplane Ethernet	x		x			x		x		x	x	x [6]	x	x [11]	
Real time clock	x	x	x	x	x	x	x	x	x	x	x	x	x	x [9]	
Data logging	x		x	x									x	x [11]	
Online editing	x		x		x	x	x	x	x	x	x	x	x	x	
Programming languages	RL	RL	RL	RL	RL	RL	RL, ST, SFC, FB							RL, ST, FB	
Integral I/O points, max	18	40	38	28	0	0	38	38	0	0	0	0	22	48	
Local I/O modules, max	4	6	7	16	30	30	2	2	16	16	30	16	0	5 [10]	5 [10] +4 [11]
Local DI points, max	138	120	244	528	960	960	80	80	512	512	960	512	8	28	156 [11]
Local DO points, max	134	112	236	524	960	960	80	80	512	512	960	512	4	20	84 [11]

Controller Specification	MicroLogix				SLC		CompactLogix					ControlLogix	DataSite RTU	Micro800	
	1100	1200	1400	1500 LRP	5/03	5/05	L23	L23E	L31	L32E	L35E			830	850 (11)
Local AI points, max	34	24	60	256	480	480	36	36	256	256	480	128	8	20	36[11]
Local AO points, max	16	12	30	128	240	240	18	18	128	128	240	128	2	10	26[11]
Available User 24V DC (mA), max	250	400	250	400	1000	1000	0	0	750	750	750	0	0	N/A	
12V DC power supplies and I/O available	x				x	x							x	x	
Temperature range °C (°F)	-20...65 °C (-4...149 °F)	0...55 °C (32...131 °F)	-20...60 °C (-4...140 °F)	0...55 °C (32...131 °F)	0...60 °C (32...140 °F)							-25...70 °C (-13...158 °F)[7]	-40...70 °C (-40...158 °F)	-20...65 °C (-4...149 °F)	

(1) Series C, FRN 7 or later.

(2) Series C, FRN 8 or later.

(3) Series C, FRN 6 or later.

(4) 1746 form factor Modbus communication modules available from ProSoft Technology and Miille Applied Research Company.

(5) 1756 form factor Modbus communication modules available from ProSoft Technology.

(6) Via 1756-ENBT.

(7) ControlLogix-XT only.

(8) Optional serial ports via 2080-SERIALISOL plug-in.

(9) Via 2080-MEMBACK-RTC plug-in.

(10) Via I/O plug-in modules.

(11) Available in 2012.

Needed Equipment

Allen-Bradley offers a wide variety of chassis, power supplies, and I/O modules to help you automate your application.

See the publications listed on for more information.

Installation Guidelines

You must provide an appropriate environment and proper grounding for programmable controller systems. See the Industrial Automation Wiring and Grounding Guidelines, publication 1770-4.1, for more information.

What To Do Next

You should choose a remote station for each remote site in your application. Finalize any telemetry requirements.

Record these choices on the worksheet ().

- Finalize any telemetry equipment decisions.
- Consult the related publications on to begin designing any needed control systems.

Third-party Supplier Contact Information

Introduction

This section lists contact information for the third-party products mentioned in this document. For more information about either the vendors or products, do any of the following:

- Contact the vendor directly
- Visit the Encompass website at www.rockwellautomation.com/encompass

Contact your local Rockwell Automation office or distributor.

Contact List

Please use this as a reference. This list is not all-inclusive.

Company	Product Offering	Contact Information	Website
Cal Amp Data Com	Licensed and spread-spectrum radio modems and cellular modems.	299 Johnson Ave. Waseca, MN 56093 Phone: 1.507.833.8819 Toll Free: 1.800.992.7774	http://www.calamp.com
Cisco Systems, Inc.	Wireless Ethernet modems.	170 West Tasman Dr. San Jose, CA 95134 Phone: 1.408.526.4000	http://www.cisco.com
DATA-LINC Group	Dial-up, leased-line, spread-spectrum radio, dedicated wire, and power line modems.	3535 Factoria Blvd SE, #100 Bellevue, WA 98006 Phone: 1.425.882.2206	http://www.data-linc.com
Digi International	Cellular modems.	11001 Bren Road E Minnetonka, MN 55343 Phone: 1.952.912.3444	http://www.digi.com
ESTeem Wireless Modems	ESTeem licensed and spread-spectrum radio modems.	415 N. Quay St. Kennewick, WA 99336 Phone: 1.509.735.9092	http://www.esteem.com
Free Wave Technologies	Licensed and spread-spectrum radio modems.	1880 S. Flatiron Court Boulder, CO 80301 Phone: 1.303.444.3862	http://www.freewave.com
KEPware Technologies	OPC server connectivity to third-party hardware.	400 Congress St. Portland, ME 04101 Phone: 1.207.775.1660	http://www.kepware.com
Matrikon OPC	OPC server connectivity to third-party hardware.	10405 Jasper Ave. Edmonton, Alberta T5J 3N4 Canada Phone: 1.780.945.4099	http://matrikonopc.com
Miille Applied Research Co., Inc. (MARC)	Protocol converters, 1771 and 1746 chassis and DIN-rail-mounted modems for dial-up and leased line.	1730 S. Richey St. Pasadena, TX 77502 Phone: 1.713. 472.6272	http://www.miille.com
ProSoft Technology, Inc.	Protocol interfaces for SCADA, plant floor and foreign-device interface applications. Modbus modules for SLC 500, PLC-5, and ControlLogix. Spread-spectrum radio modems. Cellular Modems.	5201 Truxtur Ave. Bakersfield, CA 93309 Phone: 1.661.716.5100	http://www.prosoft-technology.com
Specter Instruments	FactoryTalk View SE software remote alarm notification over module devices.	4020 South Industrial Drive Suite 120 Austin, TX 78744 Phone: 1.512.326.1011 Toll Free: 1.800.331.8740	http:www.specterinstruments.com

The following terms and abbreviations are used throughout this manual. For definitions of terms not listed here, refer to the Allen-Bradley Industrial Automation Glossary, publication [AG-7.1](AG-7.1).

ACK — See Acknowledgment.

Acknowledgment — An ASCII control character that indicates the transmission and acceptance of data.

Asynchronous Transmission — A method of serial transmission where characters may be transmitted at unequal time intervals. Asynchronous transmission requires that each character contains start/stop elements so the receiver can detect the start and end of each character.

BCC — Block-Check Character. The 2's complement of the 8-bit sum (modulo-256 arithmetic sum) of all data bytes in a transmission block. It provides a means of checking the accuracy of each message transmission.

Bridge — An interface between links in a communication network that routes messages from one link to another when a station on one link addresses a message to a station on another link.

CRC — Cyclic Redundancy Check. An error detection scheme in which all of the characters in a message are treated as a string of bits representing a binary number. This number is divided by a predetermined binary number (a polynomial) and the remainder is appended to the message as a CRC character. A similar operation occurs at the receiving end to prove transmission integrity.

CTS — Clear-To-Send. A signal from the DCE that tells the transmitting device (DTE) to start transmitting data.

ControlLogix I/O — The integral I/O platform for the ControlLogix Series of programmable automation controllers providing the system with the latest I/O technology supporting customers control and information needs

ControlLogix System — Applies the new producer/consumer networking model to the I/O architecture. This means that the I/O modules produce information (both state and diagnostic data) when needed, eliminating the need for processors to continually poll I/O.

DCD — Data Carrier Detect. A signal indicating that the carrier is being received from a remote DCE.

DCE — Data Communication Equipment **1**) Equipment that provides the functions required to establish, maintain, or terminate a connection.
2) The signal conversion and coding required for communication between data terminal equipment and data circuits. Examples include modems, line drivers, coaxial cable, and satellite links. DCE may or may not be an integral part of a computer.

DF1 — The Allen-Bradley asynchronous serial protocol.

Digital Data Service (DDS) A special wide-bandwidth Private Leased Line (PLL) that uses digital techniques to transfer data at higher speeds and with lower error rates than voice-band, analog PLLs.

DSR Data-Set-Ready. A signal that indicates the modem is connected, powered up, and ready for data transmission.

DTE Data Terminal Equipment. Equipment that is attached to a network to send or receive data, or both. Programmable controllers, workstations, and interface modules are examples of DTEs.

DTR Data-Terminal-Ready. A signal that indicates the transmission device (terminal) is connected, powered up, and ready to transmit.

EOT End Of Transmission. An ASCII control character that indicates the end of a data transmission.

FCC Federal Communication Commission (United States).

Full-duplex Circuit A physical circuit that allows simultaneous, bidirectional transmission of data; also called a 'four-wire' circuit.

Full-duplex Modem A modem that is capable of simultaneous, bidirectional transmissions.

Full-duplex Protocol **1**) A mode of operation for a point-to-point link with two physical circuits, in which messages or transmission blocks can be sent in both directions at the same time.
2) Contrasted with two-way alternate.

General Switched Telephone Network International version of a public-switched telephone network.

Half-duplex Circuit A physical circuit that allows transmission of data in either direction but not at the same time.

Half-duplex Modem A modem that sends and receives messages on carriers of the same frequency. Therefore, simultaneous, bidirectional transmissions are not possible.

Half-duplex Protocol **1**) A mode of operation for a point-to-point or multipoint baseband link with two physical circuits, in which messages or transmission blocks can be sent in one direction or the other but not both at the same time.
2) Contrasted with two-way simultaneous. The master station-to-remote station communication uses a half-duplex protocol.

Handshake A series of signals between a computer (DTE) and a peripheral device (DCE; for example, a modem) that establishes the parameters required for passing data.

Integrated Service Unit (ISU) Data communication equipment for a digital data network, which serves as the data transmitting and receiving device. An ISU is a combination of a digital service unit (DSU) and a channel service unit (CSU).

Link A data channel established between two or more stations.

Logix Controller As part of the ControlLogix System, the Logix controller is a high functionality device capable of addressing the same requirements as the mid-sized PLC-5 controllers, but with significant functionality for addressing more complex sequential and process applications. Key benefits include multi-processors within a chassis, multi-tasking, interrupt-driven controllers, highly integrated motion control, use of RSLogix 5000 software, improved performance, symbolic addressing, and controller local/global data scoping

Master Station A device (programmable controller with I/O modules or a workstation) that sends data to and collects data from devices connected on a point-to-multipoint, half-duplex network.

Modem A device that modulates digital information from a programmable controller or computer to an analog signal that is transported over phone lines, radio waves, and satellite transmissions, and demodulates the analog data back into digital data at the receiving site.

Modem Handshaking A signaling protocol used for transferring information between devices in a synchronized manner at a rate acceptable to both devices. It may be accomplished by hardware or software.

Multidrop Link **1**) A link that has more than two stations.
2) Contrasted with point-to-point link.

NAK Negative Acknowledgment. An ASCII control character transmitted by a receiver as a negative response to the sender.

Node A station on a network.

Octal Numbering System A numbering system that uses only the digits 0...7; also called base-8.

Packet The transmission unit exchanged at the network layer.

Packet Radio Modem An intelligent radio modem that organizes the data it receives from the transmitting station into packets. The modem places a header and a trailer around the data before it transmits the data to the destination device. The header can also contain routing information. Packet radio modems also perform their own data error checking and will re-transmit the data if an error is encountered.

PAD Packet Assembler/Disassembler. Equipment used to assemble and disassemble data packets for transmission on a packet-switching network such as a satellite system.

Parallel Port An electrical connection on a computer capable of transmitting or receiving two or more bits of data at one time. The communication port to which such devices as parallel printers can be attached.

Point-to-multipoint A network where connections exist between one master station and multiple remote stations.

Point-to-point A network where a connection is made between two and only two terminal installations.

Poll When the master station sends a message to a remote station that allows the remote station an opportunity to return a response to the master or another remote station. In this manual, when the master polls a remote station, it is not initiating a read request.

Polling Cycle The order and frequency in which network nodes in a poll list are polled.

Poll List A list of nodes or stations on a network to be polled on a regular and repeated basis.

Protocol A set of conventions governing the format and timing of data transmission between communication devices, including handshaking, error detection, and error recovery.

Private Leased Line Network (PLL) A dedicated voice-band telephone line between two or more locations primarily used for data transmission.

Public-switched Telephone Network (PSTN) The standard dial-up telephone network originally used for voice communication.

RS-232 An EIA electrical connection standard, most often used as a standard interface for serial binary communication between data terminal equipment and data communication equipment.

RTS Request To Send. A request from the DTE module to the modem to prepare to transmit. In response, the modem typically sends out a data carrier signal and turns on CTS.

RTU Remote Terminal Unit. See remote station.

RXD Received Data. A serialized data input to a receiving device.

Remote Station A device (programmable controller with I/O modules) that is located in a remote site away from the master station and that controls I/O points at the remote site. A remote station accepts commands from and can send data (if capable) to a master station via a telemetry network.

SCADA Supervisory Control and Data Acquisition

Slave   See remote station.

Slave Protocol   See Half-duplex Protocol.

Serial Port   An electrical connection on a computer that handles data bits one after another. The communication port (COM1 or COM2) to which devices such as a modem, a mouse, or a serial printer can be attached.

Spurious Character   A false or unexpected character received when none is expected.

Standard Radio Modem   An assembly that contains both a radio and a modem, which transmits data without any special handling. Data error checking is the responsibility of the receiving station (DTE).

Station   Any programmable controller, computer, or data terminal connected to, and communicating by means of, a data channel. A device on a network.

Station Addressing   The syntax allowing packets to be routed correctly between master and remote stations.

Synchronous Transmission   A type of serial transmission that maintains a constant time interval between successive events.

Telemetry   Transmission and collection of data obtained by sensing real-time conditions.

Topology   The way a network is physically structured. Example: a ring, bus, or star configuration.

Transceiver   An electronic device that operates as both a radio transmitter and receiver.

TXD   Transmitted Data. An output from the module that carries serialized data.

Notes:

Rockwell Automation Support

Rockwell Automation provides technical information on the Web to assist you in using its products. At http://www.rockwellautomation.com/support you can find technical and application notes, sample code, and links to software service packs. You can also visit our Support Center at https://rockwellautomation.custhelp.com/ for software updates, support chats and forums, technical information, FAQs, and to sign up for product notification updates.

In addition, we offer multiple support programs for installation, configuration, and troubleshooting. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/services/online-phone.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/rockwellautomation/support/overview.page, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to help ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

United States	Contact your distributor. You must provide a Customer Support case number (call the phone number above to obtain one) to your distributor to complete the return process.
Outside United States	Please contact your local Rockwell Automation representative for the return procedure.

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