Applying SEL-3031 Hop-Sync™ Technology to Distribution Automation Schemes With Collocated Radios

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INTRODUCTION

Distribution automation (DA) systems have been in use for over a decade. Very few DA systems employ sophisticated communications systems in addition to providing high-speed control. Interest in DA with loop scheme architecture is increasing as communications with high-speed fault detection and the isolation of permanent faults are required. The key factor that determines the performance of this type of DA system is the communications infrastructure. The DA system collects information on the state of the distribution system and provides control functions to open and close remote switches and reclosers. The communications infrastructure is the backbone of the DA scheme.

Many electric utilities are installing recloser systems with loop-fed power in order to improve the System Average Interruption Frequency Index (SAIDI) index. This has proved to be one of the best investments for quickly increasing your SAIDI index.

PROBLEM

In typical loop-fed network configurations, two distribution circuits are separated by a normally open tie point. When a fault occurs and is cleared by one of the reclosers on either side of the normally open tie point, additional line sections may be de-energized by the operation of the clearing recloser. These additional line sections remain out of service until field personnel or system operators can perform sectionalizing via manual operation or supervisory control and data acquisition (SCADA). The outage time of the de-energized nonfaulted line sections is determined by the availability of field personnel or the ability of system operators to diagnose the event and take the proper steps to correctly sectionalize the system.

SEL SOLUTION

The SEL-3031 Serial Radio Transceiver, used with SEL recloser controls and automation equipment, can be applied to develop an automatic sectionalizing scheme using MIRRORED BITS® communications channels between adjacent reclosers. The SEL-3031 provides a wireless deterministic link with high-speed control data along with SCADA and engineering access. There are multiple ways to configure a loop scheme system. This application note describes the classic loop scheme example with two sources connected to sectionalizers, midpoints, and an open tie point (as shown in Figure 1).

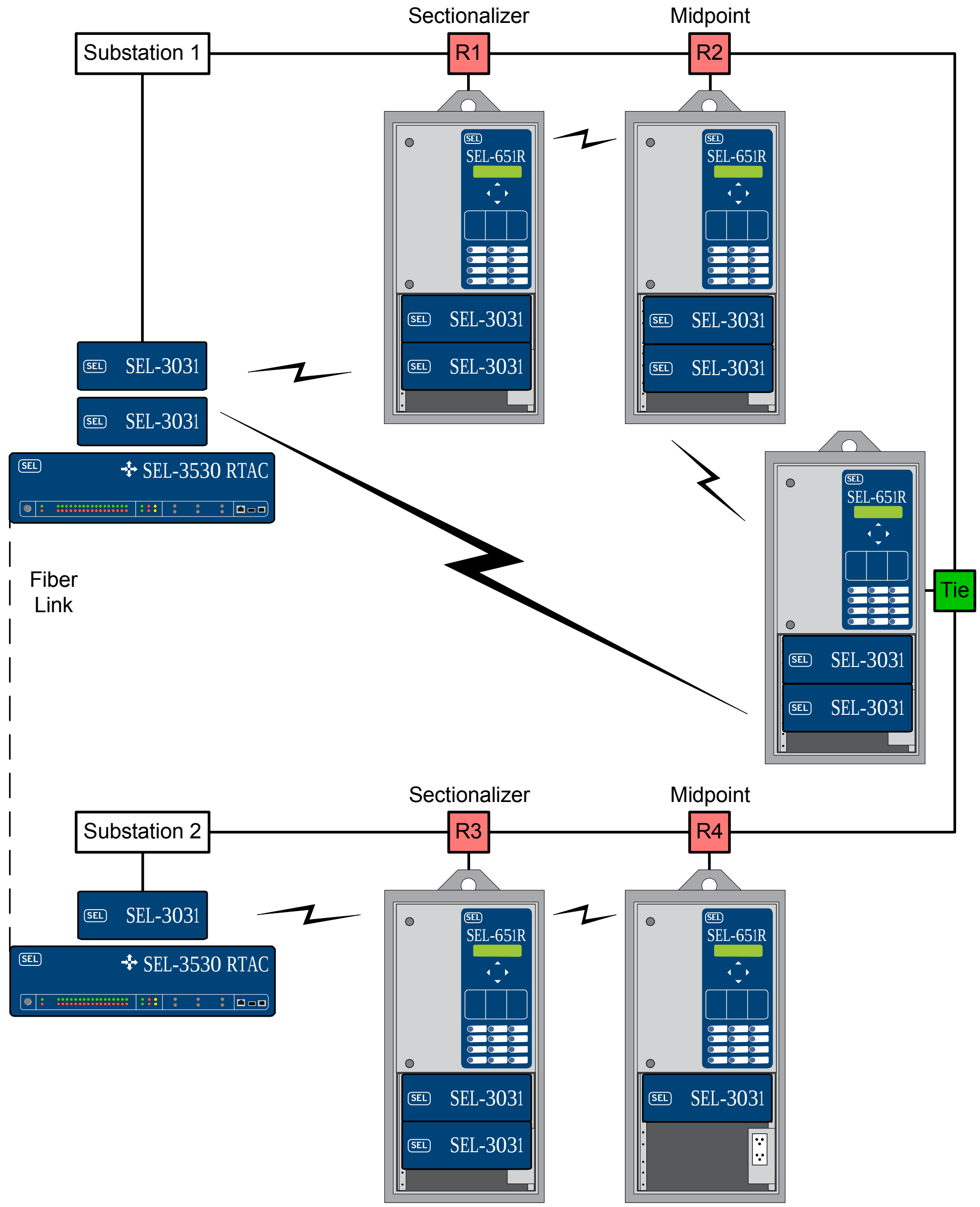

Figure 1 Loop Scheme for Complete Metering and Control

Using Collocated Radios

Generally, when there are multiple radios at the same site (collocated), the transmission from one radio can easily overpower the weaker signals (from up to 20 miles away) that a nearby radio is trying to receive.

SEL Hop-Sync™ technology allows collocated radios to operate such that they all hop, transmit, and receive at the same times, so no local radios will be transmitting while an adjacent radio is receiving signals. This allows dependable data communications for back-to-back radios used as repeaters and for multiple point-to-point (P2P) links from the same station.

A dedicated serial port used on a P2P wireless link provides a deterministic communications channel. SEL Hop-Sync technology allows the installation of multiple radios at the same location, providing each end point with multiple dedicated serial ports for control, SCADA, and engineering access.

Piping Serial Protocols in a Loop Scheme

Figure 2 and Figure 3 demonstrate how wireless P2P links are connected to each recloser and how each of the three serial ports is routed through the network.

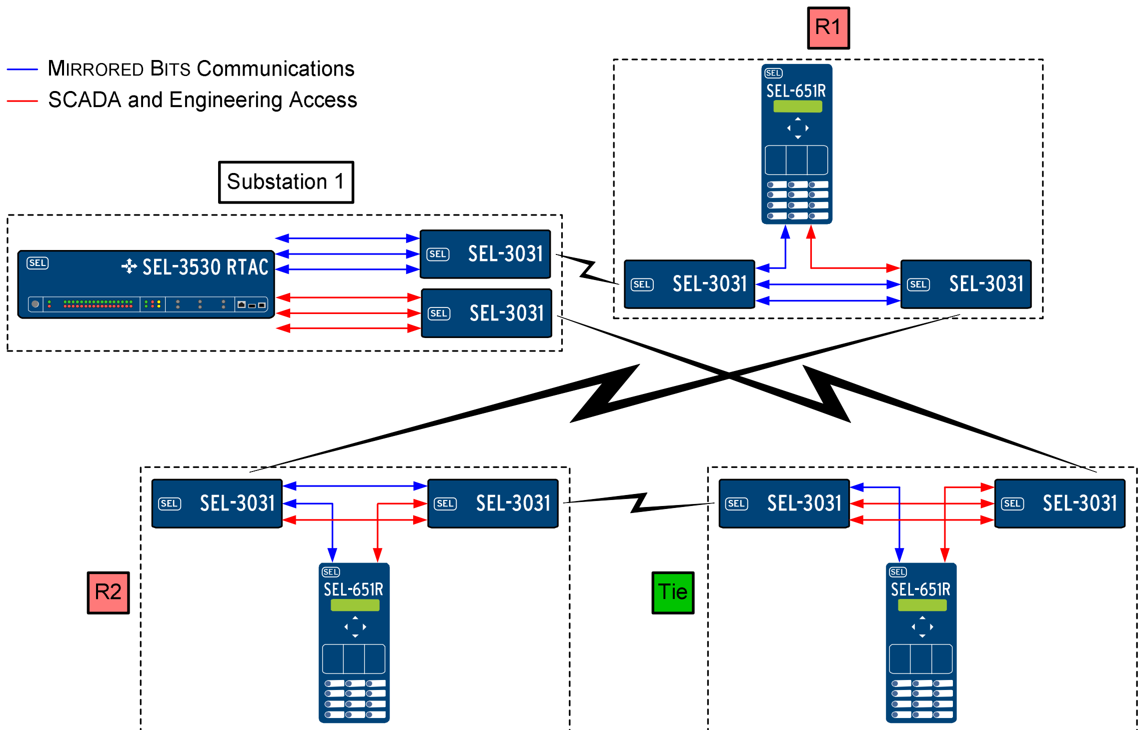

Figure 2 Substation 1 Communications Routing

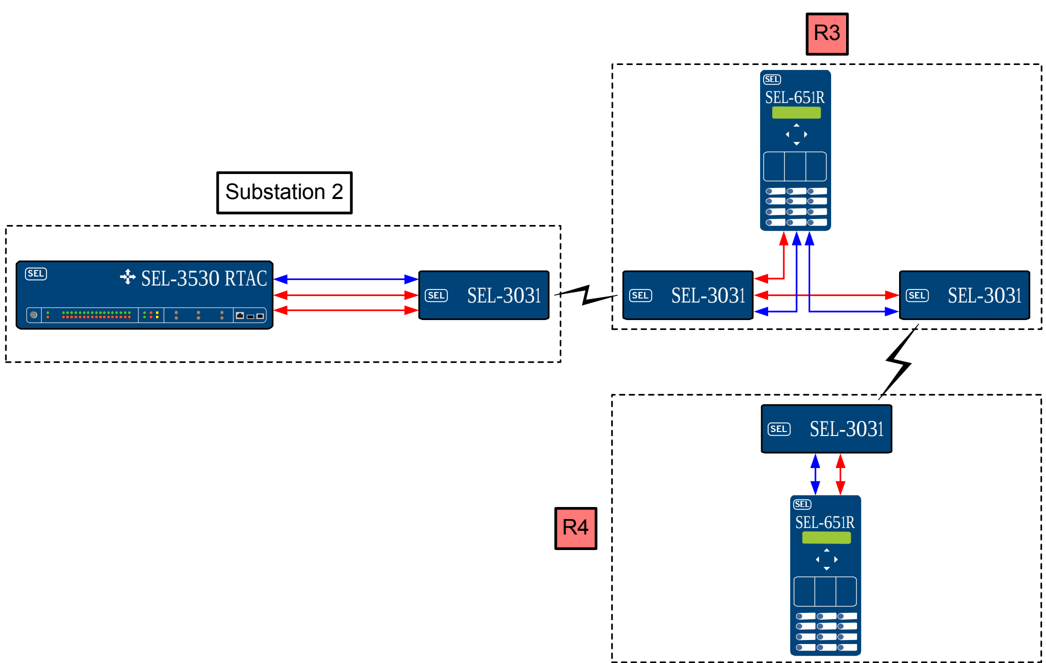

Figure 3 Substation 2 Communications Routing

In Figure 2, MIRRORED BITS communications messages are transported through the radio as shown with the blue arrows at Substation 1, R1, R2, and the tie. Between the radio at Substation 1 and the radio at R1, one of the MIRRORED BITS communications serial ports is connected to the local recloser control. The other two MIRRORED BITS communications ports are routed through the radio from R1 to R2. Again at R2, one of the MIRRORED BITS communications serial ports is connected at the recloser and the one remaining MIRRORED BITS communications serial port is sent on to the tie.

To allow SCADA and engineering access, a second radio is added at Substation 1 that is routed directly to the tie point. One of the three SCADA ports is connected to the local tie recloser. The other two SCADA serial ports are sent from the tie to R2. Again, one of the serial SCADA ports is connected locally and the remaining SCADA port is routed to R1. This sequence is routed in the opposite direction from the MIRRORED BITS communications serial channels.

Figure 3 represents how the serial channels and radios are routed through Substation 2 to R3 and then R4. Because there are only two recloser controls in this scheme, a second radio from Substation 2 to R4 is not required. MIRRORED BITS communications are routed through the network following the blue arrows, and SCADA is routed through the red arrows. The other difference in Figure 3 when compared with Figure 2 is that there is only one MIRRORED BITS communications channel from Substation 2. At R3, there are two MIRRORED BITS communications ports, creating a connection to R4 through one channel and back to Substation 2 with the other channel.

SERIAL RADIO BENEFITS COMPARED WITH ETHERNET RADIOS

The largest expense of any radio system is the installation cost. The radio is one of the lower costs of the system. Adding a few more collocated radios allows dedicated P2P serial links and creates a large increase in the level of performance and availability. These dedicated serial links with MIRRORED BITS communications provide a very low-latency, deterministic channel operating at 6 milliseconds per link or less.

If the serial link was replaced with an Ethernet radio network, the primary advantage would be fewer radios to accomplish the multiple protocol support. The Ethernet radio does not provide a deterministic link or dedicated bandwidth for high-priority control data. If this was a point-to-multipoint (P2MP) Ethernet system, there would be additional nondeterministic delays. Some delays are due to Ethernet packets requiring much more bandwidth than serial packets to send the same data. This requires a higher throughput radio, which would, in turn, reduce the maximum distance between radios and reduce the availability when compared with serial radios. Other delays in a P2MP Ethernet radio system include delays when an access point is communicating with multiple remote points. In this scenario, if multiple remote radios are trying to communicate a control signal to the rest of the system, then the system will have contention that slows down the network even further until the access point decides which remote radio communicates first. This can, in turn, reduce the overall throughput by 30 to 40 percent, which causes additional delays.

P2P serial links provide the best deterministic link to operate within predictable and easily verified operation times. In addition, P2P links have the advantage of using high-gain Yagi antennas. High-gain antennas allow a much stronger signal at a longer distance with much less interference.

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