CASE
STUDY

Rigorous Testing Conducted by ABB Reveals that Trilliant's SecureMesh Wide Area Network (WAN) Excels in Distribution Automation Applications

ABB offers a broad portfolio of switchgear, transformers, reactive power compensation, sensors and other solutions as part of a comprehensive Distribution Management System that enhances the operation of medium- and low-voltage power networks. Because its substation and distribution automation solutions must operate with existing communications networks deployed by electric utilities, ABB thoroughly tests the performance of wireless networking solutions commonly used in Smart Grid applications.

These tests, combined with a rigorous assessment against a set of established criteria, revealed that Trilliant's SecureMesh WAN afforded these five significant advantages over other wireless network solutions:

- *Ease of commissioning in both urban and rural environments*
- *Exceptional performance with both a high throughput and a low latency*
- *Transparent support for all protocols at Layer 2 and above in their native mode, including many legacy ones that are proprietary*
- *Ability to partition the network to support multiple applications with acceptable levels of quality and security for each*
- *High reliability that derives from the use of a resilient mesh topology*

The Demands of Distribution Management

ABB's Distribution Management System (DMS) applications for distribution and substation automation (DA/SA) are quite comprehensive: protection and control; fault detection, isolation and restoration (FDIR); load/demand management; Volt/VAr optimization (VVO); conservation voltage reduction (CVR); distributed generation (DG); automatic and semi-automatic switching operations; real-time event analysis and notification; asset monitoring and management; and system control and lifecycle management. All of these applications require two-way communications via protocols like IEC 61850, DNP3 and Modbus with numerous monitoring and control systems deployed at the substations and along distribution/feeder lines, including smart sensors, breakers, reclosers, sectionalizers, transformers, capacitor banks, and other intelligent electronic device (IEDs).

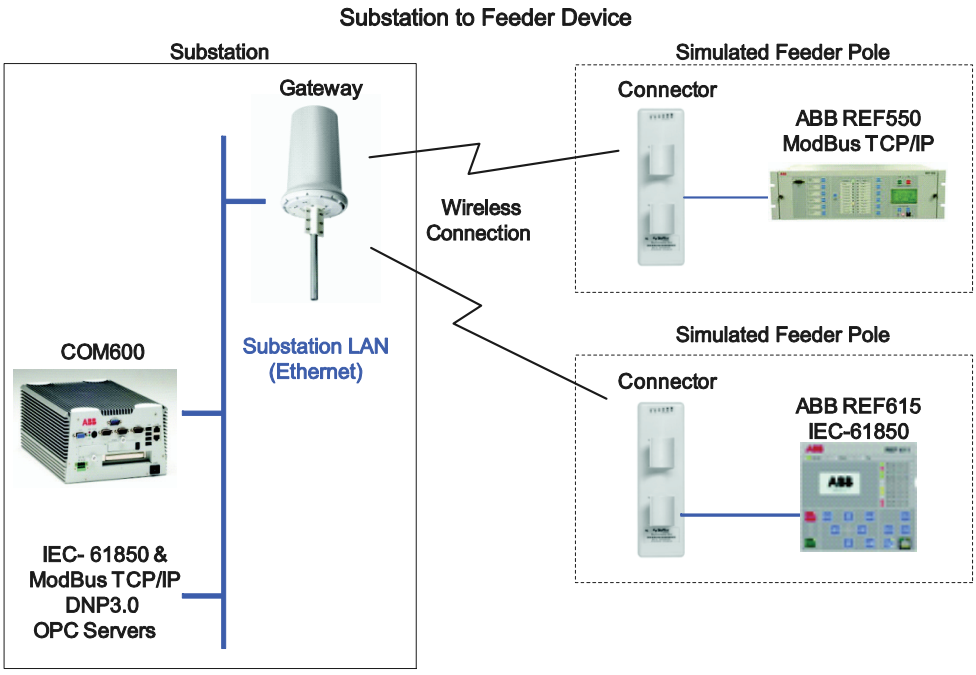
Interoperability with support for standards is critically important to ABB's business model. According to Doug Voda, Vice President at ABB, "We regularly have opportunities to provide turnkey solutions that include the communications network. But we often need to work with whatever network a utility has already deployed in the wide area or neighborhood area for Smart Meters or some other Smart Grid application." This means that ABB needs to support virtually any networking solution. But ABB also needs to understand the capabilities—and limitations—of those networking solutions. So the company conducts some fairly rigorous performance testing at its Research Center in Lake Mary, Florida.

ABB Tests Reveal Trilliant's WAN Excels in DA Applications

Putting SecureMesh WAN to the Test

For this test ABB focused on two major configurations: substation-to-feeder device connections and field device–to-field device (or peer-to-peer) connections.

The first configuration for SecureMesh WAN, from substation to feeder device, is depicted in the diagram below, consisting of a SecureMesh Gateway and a SecureMesh Connector. The SecureMesh Gateway was connected to an ABB COM600 station automation device via an Ethernet switch. The SecureMesh Connector simulated three distinct connections, and interfaced with three ABB devices, also via an Ethernet switch: an REF550 feeder terminal running Modbus TCP/IP and two REF615 feeder protection relays running IEC 61850.



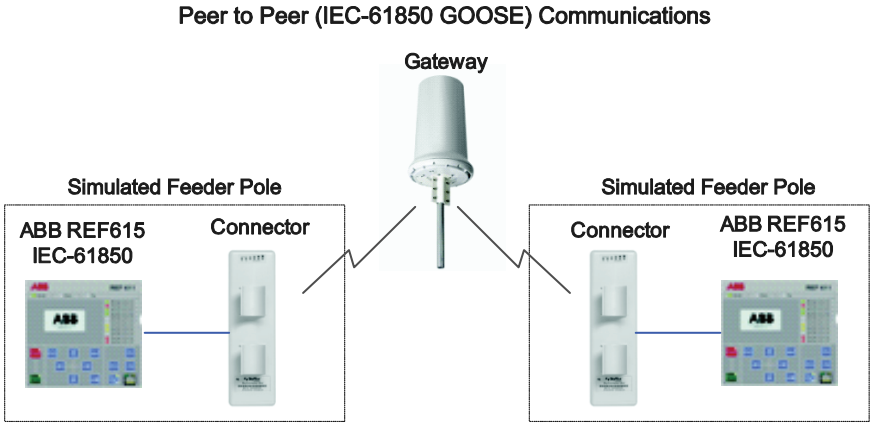
SUBSTATION TO FEEDER TEST CONFIGURATION

The observed results for the substation to feeder test, which involved DNP3, Modbus TCP/IP and IEC 61850 protocols, were as follows:

- Communications between the COM600 and relay devices were established without any alarms or timeouts.
- On initialization, over 2500 messages per device were transmitted to the COM600 without error at data rates of approximately 7 Megabits per second (Mbps).
- Operation commands to the devices were completed within 1 second and display feedback returned within 1 additional second. During this time, static readings were continuously updated without error or timeout.

The peer-to-peer test configuration, depicted in the diagram below, consisted of two SecureMesh Connector systems (each connected via Ethernet to an ABB REF615 running IEC 61850), which then communicated with each other through the SecureMesh Gateway.

ABB Tests Reveal Trilliant's WAN Excels in DA Applications



PEER TO PEER TEST CONFIGURATION

The observed results for the peer-to-peer test, which exchanged IEC 61850 Generic Object-Oriented Substation Event (GOOSE) messages, were as follows:

- Communications between the relay devices were established without any alarms or timeouts.
- GOOSE messages were transmitted between feeder devices at data rates of approximately 7 Mbps without errors and within expected time frame.

The IEC 61850 standard for *Communication Networks and Systems in Substations* from the International Electrotechnical Commission is particularly important to ABB for two reasons. One is the role the company played in developing and implementing IEC 61850 protocol as the first global communications standard for substation equipment. Among its many contributions to the advancement of the Smart Grid, ABB is particularly proud of this one as a significant breakthrough in substation and distribution automation technology. The second reason is that IEC 61850 is far more capable and secure than other communications protocols, which makes it a better fit for demanding real-time applications—and an ideal means of testing the limits of networking solutions. GOOSE messaging is particularly well suited for testing purposes because it requires that messages be transmitted and received within 4 milliseconds.

Assessing the Full Potential of SecureMesh WAN

Based on the very successful results of these two formal performance tests, ABB conducted further evaluations of the SecureMesh WAN solution—both in the lab and through other means—to better assess its full potential and possible limitations. ABB was particularly interested to determine how well SecureMesh WAN would support applications in addition to substation and distribution automation, such as the advanced metering infrastructure (AMI) and field workforce communications.

The criteria employed for this rigorous evaluation are identified in the 2010 edition of its corporate technical journal, the *ABB review*, where the following factors are recommended for consideration when selecting communications networks:

- Availability of communication media, such as existing copper or fiber-optic connections
- Availability of wire ducts, or sites for radio transmission towers
- Communication performance, such as data rate (bandwidth) and transmission latency for a given number of communication nodes
- Communication reliability and availability
- Security requirements, i.e. confidentiality, integrity, authentication
- Interoperability and application of standards
- Upfront investment
- Recurring costs, e.g. operational costs such as monthly data transmission fees
- Future-proof technology with respect to changes in technology

ABB Tests Reveal Trilliant's WAN Excels in DA Applications

SecureMesh WAN satisfied this set of requirements quite well. Indeed, the results of this rigorous evaluation yielded five distinct and major advantages SecureMesh WAN has over other wireless networking solutions pertaining to commissioning, performance, protocol support, application partitioning and reliability.

Ease of Commissioning

The self-forming, self-configuring nature of a SecureMesh WAN makes it easy to commission and operate in both urban and rural environments. Each node added automatically joins the mesh network topology, making it easy to expand coverage and add substations. Installing a node is as simple as mounting it, connecting the Ethernet cable and providing power, with the last two steps consolidated into one for nodes supporting Power-over-Ethernet. The new node and its neighbors automatically discover one another and reconfigure themselves for optimal operation along the best primary and alternate routes. This means that deploying a SecureMesh WAN requires absolutely no special engineering and no radio frequency (RF) expertise.

Exceptional Performance

SecureMesh WAN excels in performance with both a high throughput and a low latency. Over-the-air data rates of up to 54 Megabits-per-second (Mbps) provide ample capacity headroom to support advanced substation applications like video surveillance and aggregated AMI backhaul. The use of directional antennas and synchronized transmissions ensure that this high level of throughput does not degrade over multiple hops, as it does with most other mesh networking solutions. Synchronizing the traffic flows also ensures a round-trip latency of as low as 8 milliseconds to provide dependable support for real-time grid reliability applications.

Transparent Protocol Support

SecureMesh WAN supports any and all protocols at Layer 2 and above, whether standard or proprietary, in a fully transparent fashion. This enables native mode support for popular protocols used in the Smart Grid applications, including IEC 61850, DNP3 and Modbus, as well as Ethernet connectivity to Ethernet-attached devices and entire Ethernet LANs in substations. SecureMesh WAN even supports serial connectivity to SCADA devices through serial-to-Ethernet adapters. Proprietary protocols, including those used in legacy applications, are also supported in their native modes through transparent bridging.

Superior Multi-Application Partitioning

SecureMesh WAN handles multiple applications by partitioning or segmenting the physical network into separate virtual networks with acceptable levels of security and performance for each. Security is ensured on each virtual network through the creation of boundaries to isolate that application's traffic, and to prevent exposures and attacks. In this way, substation communications occur entirely separately from meter-reading traffic, for example, and both are protected from external threats. Performance is assured separately for each virtual network through prioritization and other means that guarantee specific levels of throughput and/or latency, making the solution suitable for mission-critical applications like grid reliability.

High Reliability

"High reliability is especially important to ABB in substation and distribution automation applications, because these are mission-critical to electric utilities. And Trilliant's SecureMesh WAN enjoys a distinct advantage in this regard over other wireless network solutions," Voda observed. This advantage derives from the ability to deploy SecureMesh WAN in a highly resilient mesh topology. A mesh employs multiple routes or paths to create a fully redundant communications infrastructure that is both fault-tolerant and self-healing. The virtually instantaneous and automatic failover provides a dynamic private network capable of handling exception-based communications extraordinarily well.

WiMAX networks, by contrast, cannot be deployed in a resilient mesh topology, resulting in the base stations creating single points of failure. SecureMesh WAN is like WiMAX with its ability to deliver all of the same benefits, including efficient throughput, deterministic latency and extended range. But SecureMesh WAN

ABB Tests Reveal Trilliant's WAN Excels in DA Applications

also permits deployment in a full mesh topology capable of eliminating (when properly configured) all single points of failure. This gives SecureMesh WAN the many benefits of WiMAX without its inherent risk.

SecureMesh WAN has one other advantage that will appeal to ABB's utility customers: The ability to extend from the headend via the wide area network (WAN) through the neighborhood area network (NAN) and into the home area network (HAN). In proposals where no WAN or NAN already exists, this could give ABB a significant competitive edge.

About ABB

ABB (www.abb.com) is a worldwide leader in power and automation technologies that enable its electric utility and industrial customers to improve performance while lowering their environmental impact. The ABB Group of companies is headquartered in Zurich, Switzerland, operates in nearly 100 countries and employs some 117,000 people. Technology plays a key role at ABB, which has seven research centers, 6,000 scientists and 70 university collaborations around the world. The company estimates its R&D investment for power transmission and distribution has exceeded $10 billion over the past decade. The ABB Corporate Research Center in the United States is in Raleigh, North Carolina, where its researchers work with scientists at several prominent universities, including Carnegie Mellon, MIT and Stanford. ABB has also established a Smart Grid Center of Excellence at North Carolina State University in Raleigh.

Trilliant

1100 Island Drive Redwood City, CA 94065
T 650-204-5050 F 650-508-8096
www.trilliantinc.com