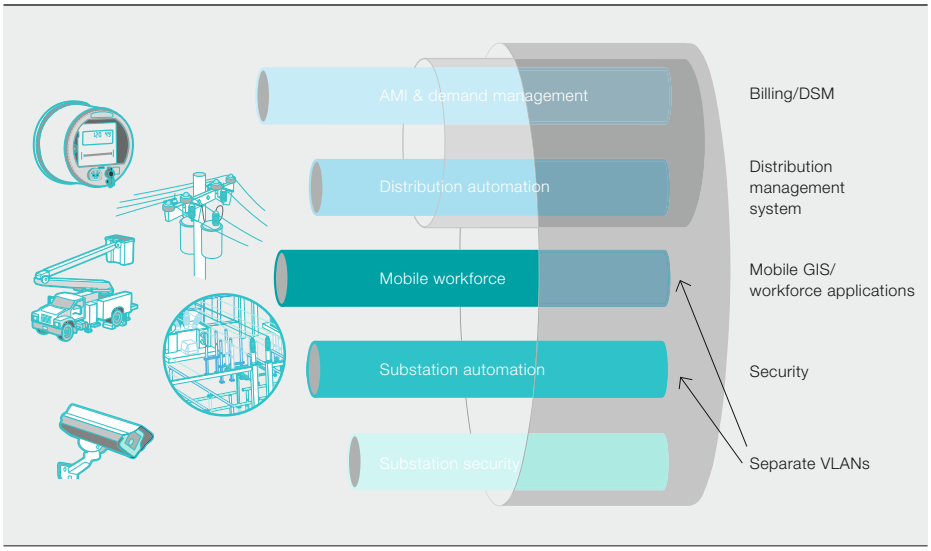
Robust radio

Meshed Wi-Fi wireless communication for industry

PETER BILL, MATHIAS KRANICH, NARASIMHA CHARI – Communication is an enabler of key applications in many sectors of industry – and wireless is often the most cost-effective and practical means of providing it. Recognizing this, ABB has extended its portfolio to include mesh 802.11 wireless technology with the acquisition of the Silicon-Valley-based company, Tropos. The Tropos mesh technology has a very robust technical foundation and is already being applied in major implementations in different industrial fields.

1 Tropos allows logical separation of the multiple applications running over the common infrastructure.



ABB's communication networks business now offers a market-leading, IP-based outdoor wireless broadband infrastructure that can be cost-effectively deployed for one or multiple applications. ABB's Tropos solution has many advantages over competing technologies [1] and is designed to deliver high broadband speed, resiliency, security and scalability. The mesh architecture is decentralized and highly flexible.

The strength of ABB's Tropos solution is founded on six cornerstones: mesh routing intelligence, radio frequency (RF) resource management, multilayer security, outdoor optimized router hardware, open standards and advanced control and analysis software.

Title picture
Many industrial applications depend on resilient, secure and scalable wireless broadband communications. How does ABB's Tropos mesh 802.11 wireless technology provide this?

Mesh routing intelligence

By combining patented RF resource management algorithms with standards-based radio technologies operating in unlicensed frequency bands, the Tropos architecture provides a highly reliable, scalable, fault-tolerant network infrastructure that is capable of quickly and seamlessly routing around interference and congestion bottlenecks.

Unlike network architectures that are dependent on a central controller, the Tropos mesh architecture, because of its distributed networking capabilities, can easily recover from the loss of any network component. Each router continually monitors its environment for potential ways to optimize the network, so if a problem occurs with either a gateway or node router, the mesh automatically adapts its topology to keep the network up and running. When the router is brought back online, the network quickly re-establishes an optimal configuration.

Tropos offers a market-leading, IP-based outdoor wireless broadband infrastructure that can be cost-effectively deployed for one or multiple applications.

The foundation of the Tropos mesh architecture is the Predictive Wireless Routing Protocol™ (PWRP), which is based on patented routing algorithms that maximize the performance and resilience of wireless mesh networks. PWRP is a dynamic, wireless-aware routing protocol that allows mesh routers to perform end-to-end measurements of path quality and use these measurements to make routing decisions that result in the highest end-to-end throughput.

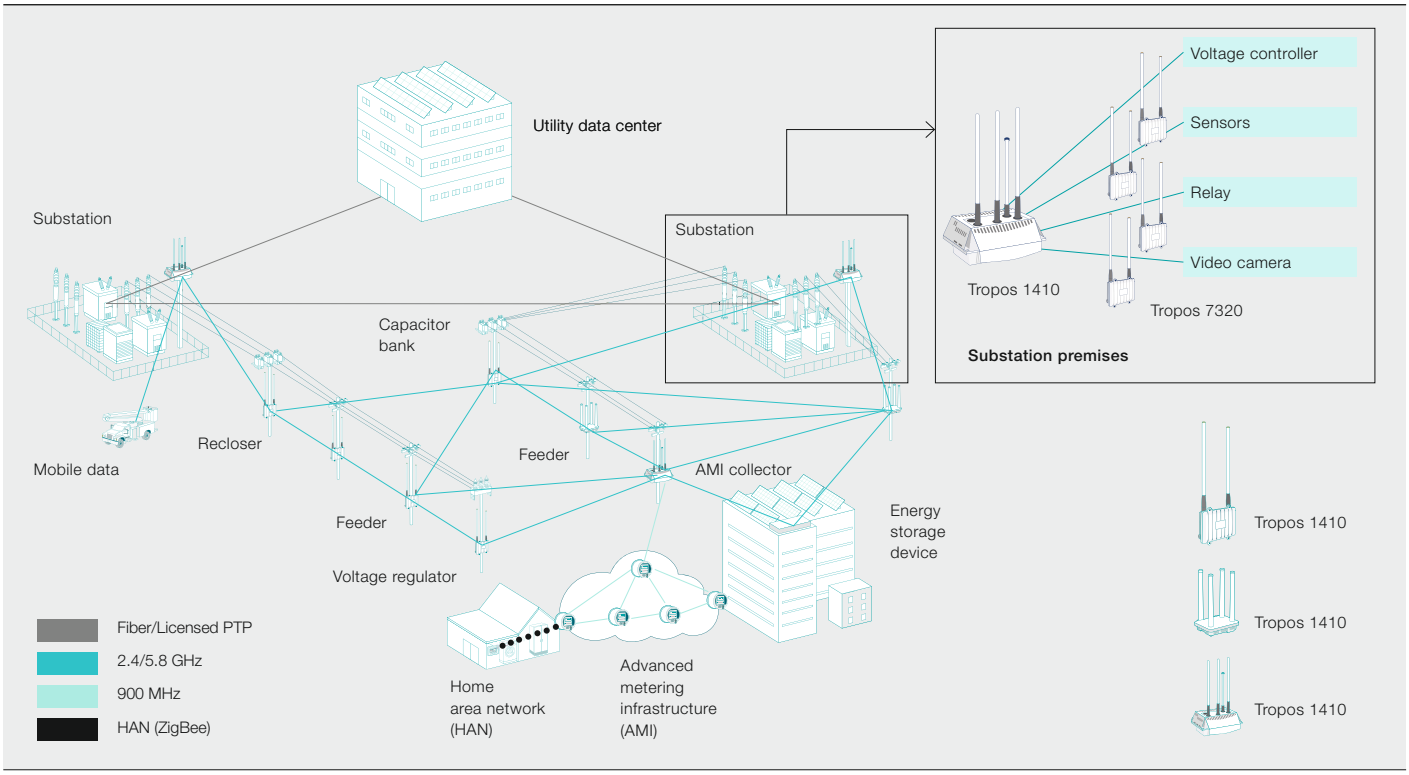
Flexible dual-radio routers

The IEEE 802.11 standard set provides support for two frequency bands of operation and Tropos is unique in enabling both radios of a dual-radio router to be used for either mesh connections or client access, thereby significantly increasing the reliability and the capacity of multiband networks. Dual-mode routers increase mesh capacity by opportunistically exploiting less congested 4.9/5.8 GHz links whenever possible. In areas where 4.9/5.8 GHz use is restricted due to lack of line-of-sight, the routers automatically fall back to using 2.4 GHz radios, which provide a reliable long-range connection.

Seamless mobility

The fixed infrastructure Tropos mesh networks can be quickly extended with mobile routers from the same product line, for use by emergency services, for example. Each mobile node extends connectivity to client devices in the vehicle vicinity, creating a tactical response zone in almost any location.

2 Tropos configuration



The distributed Tropos mesh architecture is capable of quickly and seamlessly routing around interference and congestion bottlenecks.

RF resource management

PWRP uses patented algorithms to continuously and dynamically optimize the use of the available spectrum:

- PowerCurve™: This distributed algorithm dynamically increases or decreases transmission power levels and continuously adapts the link data rates to maintain the reliability of each wireless link and also maximize the number of concurrent links. This stops, for example, "loud" routers from drowning out nearby "conversations."
- Airtime Congestion Control™ (ACC): ACC is designed to provide consistent performance for a large number of users, especially under heavily loaded network conditions, thus overcoming a well-known shortcoming of 802.11 MAC.
- Adaptive noise immunity (ANI): ANI adjusts chip-level packet detection parameters in real time to minimize false detection events and maximize receiver sensitivity.

Multilayer security

Security-wise, wireless networks are more vulnerable than traditional wired infrastructures, so Tropos' comprehensive security approach is based on:

- Open-standard security mechanisms that have undergone extensive scrutiny by the security community, such as IPSec, IEEE 802.1x, IEEE 802.11i, AES encryption, SSL/TLS, FIPS 140-2, etc.
- Robust security at every layer, from the physical hardware (eg, tamper-resistant, ruggedized hardware) right up to application-level traffic protocols (eg, HTTPS-based security).
- A security approach that allows granular, operator-specified policies to ensure the logical separation of the multiple applications running on the common infrastructure → 1.
- Software that adapts to the evolving threat landscape and that encompasses the latest security standards and requirements.

Outdoor optimized router

The Tropos router hardware has a battery backup and is ruggedized for operation in the most challenging operating environments. The radios are designed for optimal outdoor performance: They can transmit up to the maximum allowed transmission power level and they offer the industry's best receiver sensitivity.

Open standards

The Tropos solution set/technology aims to provide maximum interoperability and investment protection through support of all relevant open standards at every

3 Tropos router at EOG Resources exploration site

PWRP is a dynamic, wireless-aware routing protocol that allows mesh routers to perform end-to-end measurements of path quality and use these measurements to make routing decisions that result in the highest throughput.

layer of the protocol stack including IEEE 802.3 Ethernet, IEEE 802.11 Wi-Fi, IEEE 802.1x access control, TCP/IP, etc.

Advanced control and analysis

Tropos Control is a software application that provides comprehensive network management to streamline the deployment, optimization, maintenance and control of large-scale networks.

Mesh applications

There is a huge number of possible applications for ABB's mesh 802.11 solutions.

Smart grid applications

An advanced metering infrastructure (AMI) is just one of many applications that are required to fulfill the vision of the smart grid. However, demand management and response, distribution automation and control, outage management, and mobile workforce applications are also needed to make the vision a reality → 1. Deploying and managing separate networks for each application is not cost-effective. A single, standards-based, high-performance network, such as Tropos, that aggregates communications for multiple applications is not only simpler to manage, but also yields an attractive return on investment → 2.

In the coming years, additional applications for smart grids related to distribution automation, distributed generation, electric vehicles and video security will create a new appetite for high-bandwidth and low-latency communications that only a scalable broadband network like Tropos can provide.

Burbank Water and Power (BWP) in the United States is using Tropos for AMI, demand response and distribution automation. With a smart grid, BWP seeks to flatten demand peaks (to avoid having to build new generating plants) and accommodate the growth in electric vehicle numbers. The utility also plans to segment data traffic across different user groups and applications and share the network with other city departments.

Open-pit mining applications

Safe and efficient operation of open-pit mines requires precise coordination of some of the world's largest and most expensive machines in settings characterized by punishing heat or cold as well as extreme shock and vibration. Maximizing productivity in operations and maintenance can yield substantial improvements in profitability and safety.

The Tropos solution includes a suite of algorithms for efficient RF spectrum management and optimal spatial frequency reuse.

Wireless communications can significantly enhance the efficiency, productivity, safety and security of open-pit mines. A wireless network enables truck and heavy equipment telemetry data, operational and surveillance video feeds, safety and security system information, highwall scans and field data that drive mine management software all to be transmitted to a central location where the data is monitored, analyzed and acted on in real time.

The PotashCorp-Aurora phosphate mine in Aurora, North Carolina, has deployed a Tropos network with fixed and mobile nodes that provides equipment telemetry, real-time vehicle monitoring (speed, temperature, tire pressure, etc.), manufacturing process data and voice over IP (VoIP) communications.

Oil and gas applications

Measurement, logging and adjustment duties at remote rigs and wellheads are often performed by well tenders who travel long distances to site. However, wireless communication enables remote monitoring, in real time. This makes better use of skilled resources, speeds problem resolution and reduces travel time. In addition, a wireless network can provide cost-effective voice and high-speed data services to field facilities even in areas that lack cellular coverage.

EOG Resources, an oil and gas company operating in North America, owns very remote sites where cellular coverage is absent. The Tropos networks they have implemented provide their workforce with connectivity between these sites and the operational control center. This leads to improved operational performance as well as increased workforce security → 3.

Container port applications

Busy container ports, with large, constantly moving metal objects, present a particularly challenging wireless network environment. In one of the largest Mexican ports, for example, Tropos is successfully being used for tracking and real-time location of shipping containers both outdoors and in warehouses.

Smart city applications

In smart cities, multiple city agencies can benefit from a Tropos wireless communications network. For example, Oklahoma City's network of Tropos fixed and mobile wireless routers, covering 1,600 km^2, is used by more than 180 city applications, including:

- Mobile broadband in police vehicles, allowing 1,500 officers to spend 100,000 more hours per year in the field.
- Several hundred IP video cameras for monitoring and surveillance.
- The building inspection agency, allowing inspectors to be more productive in the field and reduce application turnaround time.
- Traffic signal controllers in the downtown area.

Simple and safe

ABB's patented algorithms and software in the Tropos product line, along with its industrial-grade hardware, put the company ahead of competitive alternatives in terms of reliability, performance and ease of maintenance, while providing easy access for thousands of different Wi-Fi standards-compatible endpoint devices.

Many applications require a wireless broadband solution with high resilience, security and scalability. ABB provides these features, allowing customers to build and operate high-performance communications networks enabling their applications to operate in multiple industries.

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Reference

[1] P. Bill, M. Kranich, N. Chari, "Fine mesh: Mesh 802.11 wireless network connectivity," *ABB Review 1/2013,* pp. 42–44.