Field Area Communication Networks for Digital Oil and Gas Fields
The digital oil and gas field
The challenge

- More wells
- More area
- More monitoring and control

The old SCADA radio model has been pushed past its capability
- 900 MHz congestion
- Slow data rates
- Multiple, non-integrated networks
- Lack of comprehensive management

Resulting in a communications traffic jam
The digital oil and gas field

The solution

- Multi-use, intelligent, broadband network
- Eliminating the communications traffic jam

Modern wireless mesh networks
Digital oil and gas field communications
Wireless networks enable key oil and gas applications

- SCADA
- Meter Reading
- Access Control
- Mobile Workforce
- Wellhead Monitoring and Logging
- VoIP
- Video Surveillance
- Safety Systems
- One Network, Many Applications
Oil and gas communications network
Multi-tier architecture

**Tier 1: Core IP Network**
- Point-to-Point (PTP) Microwave, Point-to-Multipoint (PTMP), Fiber, Leased Lines
- DHCP
- AAA
- Firewall
- DNS
- IDS
- VPN
- IPS
- Chairwoman

**Tier 2: Field Area Network (FAN)**
- Broadband Mesh
- NMS
- Internet

**Tier 3: Narrowband Network**
- 900 MHz Support for Legacy Devices
- SCADA Endpoints
- VolP Phones
- Laptops, Tablets and Smartphones
- Safety and Security Systems
- Wellhead Metering and Logging
- VoIP
- Email
- Other

**Exploration & Production Applications**
- Measurement & Control
- Safety and Security
- SCADA

**Enterprise Information Services**
- GIS
- VoIP
- Email

**Network Services and Security**
- Remote Monitoring and Technical Support
Well head monitoring

Data Center(s)

Tier 1: Core IP Network Layer
Fiber, Point-to-Point (PTP) Microwave

Network Services and Security
- VPN
- Firewall
- DNS
- AAA
- DHCP
- IDS

Well head monitoring software
Oil field mobile access

- Access using standard Wi-Fi client (laptop, tablet, handheld, smart phone, etc.)
- Users typically stationary or walking
- Nomadic use case (stop, connect, move)
- 4G network throughput (up to 20 Mbps)
- Range up to 1,200 feet with line-of-sight

**Tier 1: Core IP Network Layer**
Fiber, Leased Lines, and Point-to-Point (PTP) Microwave

**Tier 2 Node Router**

**Tier 2 Gateway Router**

**Data Center(s)**
Network Operations Center (NOC)

Network Services and Security
- VPN
- Firewall
- DNS
- AAA
- DHCP
- IDS

Stationary Vehicle with Laptop

User walking with Tablet

Range up to 1,200 feet with line-of-sight

Access using any standard Wi-Fi client device
Oil field mobile broadband

- Vehicular speeds (>75 mph)
- 4G network throughput (up to 20 Mbps)
- Extend connectivity and coverage using mobile routers (e.g. disaster response)
- Switch to cellular data service when out of service territory coverage

Tier 1: Core IP Network Layer
Fiber, Leased Lines, and Point-to-Point (PTP) Microwave

Data Center(s)

Network Operations Center (NOC)

- VPN
- Firewall
- DNS
- AAA
- DHCP
- IDS

Network Services and Security

Tier 2
Gateway Router

Range ½ mile to several miles (with LoS)

Mobile Mesh Router in each truck

Tier 1
(Core)

Tier 2
Node Router

Tier 2
Mobile Router

Tier 2
Node Router
Oil tanks video surveillance and access control

Tier 1: Core IP Network Layer
- Fiber, Leased Lines, and Point-to-Point (PTP) Microwave

Connect Video Surveillance Cameras to Tier 1 or Tier 2 and Disseminate Video to Mobile Broadband Users

Data Center(s)
- Video Surveillance Application
- Network Services and Security
  - VPN
  - Firewall
  - DNS
  - AAA
  - DHCP
  - IDS

Tier 2: Node Router
- Tier 2 Gateway Router
- Storage tank security
  - Safety monitoring
Wireless mesh conceptual diagram
Field site communications

- 2.4 GHz Wireless Mesh Link
- Satellite Link

Internet connection to Houston, Sugarland, etc.

Frac-CAT (CCC)

Main Application Server, Network Management Server, Fixed Mesh Router

Mobile Mesh Router in each truck

VSAT

2.4 GHz Wireless Mesh Link

Satellite Link
Field automation communication challenges
Communicate with thousands of endpoints in large geographic areas

- Reliability of connections
- Network capacity headroom to enable future applications
- Low latency to support automation applications
- Support multiple applications with QoS, security and traffic segmentation
- Scalable to large number of devices covering large geographic areas
- Cost-effective
- Easy interoperability with edge devices, avoid stranded assets
VLANs and QoS for multi-application support

- Traffic classification and prioritization
- Differentiated services over common wireless infrastructure
- Security and QoS policies per-VLAN
- Supports extension of IT policy and framework

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Multi-layer security

Application
- HTTPS, SNMPv3, XML/SSL

Transport
- SSL/TLS

Network
- IPSec, Firewall, IP ACLs

Link
- 802.1x access control, 802.11i authentication, AES encryption, MAC ACLs and whitelists/blacklists, DoS detection and mitigation

Physical
- Hardened outdoor enclosure, tamper-detection, encrypted file system, hardware authentication, protection of critical security parameters
Traditional proprietary communications solutions can’t extend security to field endpoints.

- Lack of access control mechanisms
- Lack of firewalls for endpoint and network protection
- Lack of user and device identification and authentication

![Diagram showing IPSec VPN connections between sites with proprietary security mechanisms indicated as the weakest link.]
Network security
Extending the enterprise security model to the edge

- End-to-end secure IPsec VPN tunnels
- 802.1x for authentication and access control
- Traffic segmentation using VLANs
- Firewalls for endpoint security
Mesh networks operation

The routers automatically discover one another, intelligently choosing optimal paths back to the wired connection.
Mesh networks operation

Newly added routers participate in auto-discovery,
Mesh network operation

Newly added routers participate in auto-discovery, recalculating the optimal paths to the wired connection.
Mesh network operation

Capacity can be dynamically upgraded by adding backhaul connections as needed

- Wired backhaul
- Optimal routing paths
- Alternate back-up routes
Mesh network operation

Capacity can be dynamically upgraded by adding backhaul connections as needed.
Mesh network operation

If a backhaul link fails...

- Wired backhaul
- Optimal routing paths
- Alternate back-up routes
Mesh network operation

If a backhaul link fails the network automatically adapts by re-assigning paths in real-time to maintain connectivity.
Mesh network operation

Similarly, if interference causes a path to fail…

- Wired backhaul
- Optimal routing paths
- Alternate back-up routes
Mesh network operation

Similarly, if interference causes a path to fail the network re-configures to route around the obstruction.
Mesh network operation

Mesh software leverages redundant paths, channels, frequencies, and backhaul locations to create the most robust network possible.

- Mesh links dynamically choose 5 GHz or 2.4 GHz band
- Channel within band automatically chosen on a per link basis

2.4 GHz Link
5.X GHz Link

- Wired backhaul
- Optimal routing paths
- Backup links
Oil and gas field deployment concept
Customer: Peyto Exploration and Development Corporation – Sundance area, Alberta

Customer need
- High capacity, reliable communications between field office and ABB Totalflow RTUs at well sites
- Cost effective CAPEX and OPEX

ABB response
- Tropos mesh routers and software powered by solar for well sites
- Tropos to gradually replace 900 MHz communications to each well pad
- Mobile Tropos mesh routers in field worker trucks

Customer benefits
- Increased well pad polling frequency by factor of six reducing downtime
- Significantly increased mobile worker efficiency
- High availability and affordable network
Customer need
- Enhanced network resiliency and performance at a lower cost

Solution
- Installed wireless mesh routers at well sites and across oil field

Customer benefits
- Lower deployment and operating costs
- 10x bandwidth at ½ cost
- 99.999% availability
- IP application support
  - Drill rig communications and diagnostics
  - Emergency shutdown and recovery
  - Mobile workforce applications
  - VoIP (SIP) phone support

“Replacing 900 MHz radios with a Tropos mesh enabled our SCADA systems to work reliably.”

Wes Nelson
Sr. Field Systems Manager
EOG Resources
Customer: Newfield – Uinta Basin

Customer need
- Affordable, reliable communications between field office and well sites
- Gradually replace 900 MHz network

ABB response
- Supplied 20 Tropos mesh routers and software powered by solar for well sites
- Tropos to gradually replace 900 MHz communications to each well pad
- Mobile Tropos mesh routers in field worker trucks
- Trained Newfield personnel to install and configure network

Customer benefits
- Enabled critical well planning and deployment application
- Reliable operation in extreme weather conditions
- High availability and affordable network

“We expect to reduce costs associated with wireless by $10K per month because the new Tropos network is available, dependable, fast, and affordable.”

Chris Korte
Network Engineer
Newfield
United States – Newfield, Asherton, Texas

Customer need
- Communications between two Central Tank Battery (CTB) facilities and two field offices to support automated control system. SCADA, Wi-Fi

ABB response
- Two Tropos mesh routers installed on a pole at each site – one for PLC and SCADA, one for Wi-Fi access
- Tropos mesh routers used for PTP connectivity between the two offices

Customer benefits
- Reliable high performance network for remote monitoring and control of CTB systems
- Simple and fast installation and operations
- Lower operating costs
Customer need
- Centralized monitoring of 75 access control stations (keycards) at entry gates
- Centralized monitoring of >100 IP video security cameras
- Access to live video feeds from security vehicle

ABB response
- Tropos mesh routers deliver the high capacity and reliability plus low latency needed for video
- Single Tropos network supports fixed and mobile routers
- Mobile Tropos mesh routers in field worker trucks
- Ease of network scalability over time – capacity and coverage

Customer benefits
- Single network enables real-time centralized monitoring of all access control and security cameras increasing facility security and safety
- Mobile security officers have site-wide visibility to live video feeds from all around site
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