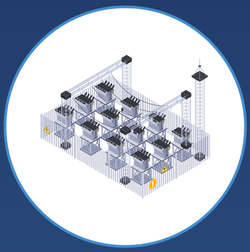
White Paper | Modernizing Utility SCADA

Navigating the Transition from Legacy Narrowband to LTE with MPLS Core Integration



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Executive Summary

Utilities are facing a pivotal moment in their communications infrastructure. For decades, narrowband SCADA systems — especially those using licensed MAS 900 MHz networks — have provided reliable monitoring and control. However, shifts in operational demand, evolving regulatory requirements, and the availability of advanced communications technology now challenge the long-term viability of these legacy systems.

This white paper explores the key drivers for change in utility SCADA communications, including increased data requirements, expectations for lower latency, growing cybersecurity concerns, and significant changes in regulatory standards such as NERC CIP. It outlines the strengths and limitations of traditional narrowband systems and evaluates technically sound pathways for modernization, emphasizing LTE and MPLS integration.

The document aims to equip utility professionals with a clear understanding of the technical, operational, and regulatory considerations involved in planning for the future of critical infrastructure communications.

MAS 900 MHz radios provided dependable, simple, and isolated telemetry for utility SCADA systems, but their non-routable serial protocols and limited scalability now fall short of modern demands.

While licensed spectrum systems offer modest improvements over MAS, their limited throughput, inefficiency, and high latency make them inadequate for modern grid operations and advanced applications.

1. Legacy MAS 900 MHz Networks: Context and Limitations

1.1 Historical Context

MAS (Multiple Address System) radios operating in the 900 MHz band have served as the backbone for utility SCADA systems for decades. Their point-to-multipoint architecture, operating with non-routable serial protocols, was once considered a best practice for utility telemetry. These networks were valued for their dependability and relative simplicity, offering a dedicated channel for mission-critical control and monitoring.

Originally, the logical isolation of MAS networks was seen as a protective factor from cyber threats, and the technology benefited from a stable vendor ecosystem and broad industry adoption.

1.2 Purchased Spectrum and Performance Constraints

In recent years, some utilities have explored licensed spectrum options beyond traditional MAS networks, such as the 700 MHz Guard Band, to achieve modest improvements in throughput. By leveraging modulation schemes like 64QAM, these systems can provide higher speeds compared to legacy MAS radios. However, significant limitations arise due to the lack of frequency reuse and the need to subdivide the spectrum into smaller channels to support multiple links.

In practice, these systems typically deliver data rates of approximately ~100 kbps per channel. While this is an improvement over MAS links, which operate at 4.8–19.2 kbps, it remains insufficient to meet the demands of modern grid operations. The limited capacity makes it challenging to support advanced applications such as synchrophasors, video monitoring, and high-volume IoT telemetry.

The absence of frequency reuse further exacerbates inefficiencies in spectrum utilization. Utilities are often forced to balance trade-offs between channel count, coverage, and capacity, resulting in networks that, while incrementally better than MAS, fall short of the capabilities of modern LTE/MPLS architectures. These advanced architectures offer multi-megabit throughput, scalable endpoint support, and robust QoS segmentation—features that spectrum-limited systems cannot match.

Additionally, throughput in the ~100 kbps range is inadequate to support modern IP networking. Utilities are frequently compelled to rely on traditional polling methods or emulate polling over low-speed Ethernet channels, further reducing network efficiency. Such constraints render it impractical to implement real-time IP communications and scalable networking architectures, which are critical for seamless integration and performance.

The high latency associated with ~100 kbps channels also poses a significant challenge. Field Area Network (FAN) protection applications typically require end-to-end latencies of ~50 milliseconds, which these systems cannot reliably achieve. As a result, spectrum-limited solutions are ill-suited for supporting advanced grid protection and real-time automation functions that are increasingly essential for modern utilities.

1.3 Current Challenges and Technical Constraints

The landscape for utility operations has changed substantially, revealing several limitations of legacy MAS infrastructures:

- **Bandwidth:** MAS networks support low throughput (typically 4.8–19.2 kbps per channel), which limits their ability to carry the volume and variety of modern SCADA data, including advanced analytics, video, or IoT telemetry.
- **Latency:** Polling-based systems produce delays measured in seconds, making real-time automation and rapid response applications impractical.
- **Scalability:** The endpoint capacity of MAS networks is limited—often just dozens of remote terminal units (RTUs) per master station—constraining utilities that seek to expand monitoring across distributed energy resources or a modern grid.
- **Cybersecurity:** Legacy protocols generally lack strong authentication or encryption, leaving data transmissions vulnerable.
- **Lifecycle Management:** Vendor support for MAS radios is in decline, with replacement hardware increasingly scarce and institutional expertise fading.

2. Regulatory Trends: NERC CIP and Changing Security Expectations

2.1 Evolving Compliance Landscape

The regulatory environment for utility communications has undergone a significant shift. For many years, non-routable, serial-based systems could claim exemptions or reduced requirements under NERC Critical Infrastructure Protection (CIP) standards. The assumption that logical isolation was sufficient for security has eroded in the face of new threat vectors and regulatory interpretations.

Current NERC CIP requirements now clarify that all control system communications—regardless of transport technology or logical isolation—must meet robust security standards. This includes requirements for encryption, authentication, centralized logging, intrusion detection, and continuous monitoring.

2.1 Evolving Compliance Landscape

Modern compliance demands pose several challenges for legacy MAS-based SCADA:

- **Complex Retrofitting:** Upgrading MAS radios to meet current authentication and encryption requirements is frequently complex, with technical and cost barriers.
- **Monitoring Limitations:** MAS systems are not designed for the logging and monitoring functions required by NERC CIP and similar frameworks.
- **Risk Exposure:** Utilities that continue to rely on legacy architectures may face audit findings, compliance penalties, and elevated risk in the event of a cybersecurity incident.

Legacy MAS networks face critical limitations in bandwidth, latency, scalability, cybersecurity, and lifecycle support, making them inadequate for modern SCADA demands and grid expansion.

NERC CIP standards now mandate robust security measures for all control system communications, eliminating exemptions for non-routable, serial-based systems.

LTE delivers high bandwidth, low latency, and robust security, enabling advanced applications like video monitoring and meeting regulatory requirements with SIM-based authentication and encryption.

MPLS ensures reliable performance, traffic prioritization, and enhanced security through QoS controls, traffic segmentation, and resilient, redundant network paths.

3. Modernization Strategies: LTE and MPLS Integration

Amid these operational and regulatory drivers, the industry now recognizes the utility of high-speed, scalable, and secure network architectures. Two technologies have emerged as leading candidates for modern SCADA transport:

3.1 LTE (Long Term Evolution) for Wide-Area Connectivity

LTE brings substantial improvements in available bandwidth, latency, and security:

- **Deployment Models:** Utilities can leverage either private LTE networks (in licensed bands such as Anterix Band 8/106 or CBRS Band 48) or public carrier networks, selecting an approach that best fits their needs for coverage, control, and cost.
- **Performance:** LTE supports multimegabit throughput per endpoint, which allows for a broader range of applications, including video and asset monitoring.
- **Security:** Built-in SIM-based authentication and AES encrypted transport satisfy many regulatory security requirements.

3.2 MPLS (Multi-Protocol Label Switching) for Core Network and Traffic Management

MPLS offers utilities the ability to provide deterministic performance, enhance security, and optimize the use of network resources:

- **Traffic Engineering:** MPLS supports Quality of Service (QoS) controls that enable prioritization of mission-critical SCADA traffic.
- **Segmentation:** Virtual Routing and Forwarding (VRF) capabilities allow for logical isolation of different types of traffic within a shared infrastructure.
- **Resilience:** Redundant nodes and path diversity support high levels of availability and protection against failures.

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4. Comparative Analysis: Legacy MAS vs. Modern LTE/MPLS Architectures

Characteristic	MAS 900 MHz	700 MHz Guard Band	LTE/MPLS Architecture
Bandwidth	4.8–19.2 kbps per channel	~100 kbps shared across base station devices	Multi-Mbps per endpoint
Latency	Seconds	Seconds	Sub-100 ms
Endpoint Scale	Dozens per baes station	Hundreds (limited by channelization)	Thousands per network
Authentication / Security	Minimal	Limited, retrofitted security	SIM-based, AES encryption, segmented traffic
Reliability	Single point of failure	Improved but constrained by spectrum	Redundant and diverse paths
Lifecycle	Vendor sunsetting	Niche deployments, limited vendor support	Broad ecosystem, ongoing evolution
Applications Supported	Basic telemetry	Limited IP, polling only	SCADA, AMI, DER, IoT, video, analytics
Regulatory Compliance	Complex retrofitting	Still challenged for NERC CIP	Native NERC CIP alignment

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5. Migration Pathways and Practical Considerations

Transitioning from legacy narrowband to LTE/MPLS does not require a disruptive "rip and replace" approach. Utilities can adopt a phased migration, balancing operational priorities and regulatory demands with investment protection:

- **Deployment Models:** Initial deployment can focus on LTE-enabled routers or gateways at remote sites, while maintaining legacy RTUs in place and aggregating new network traffic into an MPLS core.
- **Backward Compatibility:** Modern solutions can coexist with existing systems during a controlled transition, minimizing operational risk.
- **Advanced Applications:** The foundational shift enables future adoption of analytics, predictive maintenance, enhanced situational awareness, and improved fault response and restoration.

Each stage of migration should be informed by detailed technical planning, spectrum analysis, physical and cybersecurity assessment, and organizational readiness, including staff training and change management.

6. Industry Experience: Observable Outcomes

Early adopters of LTE/MPLS hybrid architectures within the utility sector have reported:

- Reduced commissioning times for substations and distributed resources due to standardized protocols and increased bandwidth.
- Improved centralized visibility into OT/IT environments, enabling proactive management.
- Lower ongoing operations and maintenance costs associated with retiring legacy radios and streamlining communications management.
- Enhanced resilience in response to storms, fiber disruptions, and cybersecurity events.
- The ability to support advanced grid applications, including distributed energy management and high-fidelity asset monitoring.

The transition from MAS 900 MHz and similar narrowband systems to LTE and MPLS-based architectures represents a pivotal moment for utilities managing mission-critical communications. This shift is driven by new operational demands, an evolving threat landscape, and increased regulatory scrutiny. To navigate these challenges, utilities must align their infrastructure with modern technical and regulatory realities.

Here's why LTE/MPLS integration is the foundation for next-generation grid communications:

- **Regulatory compliance readiness:** Meet evolving standards and ensure operational integrity.
- **Scalable, high-speed communications:** Support growing data demands and enable future innovations.
- **Improved cybersecurity:** Strengthen defenses against modern threats with advanced, secure architectures.
- **Resiliency and long-term ROI:** Build a network designed for reliability and sustained value over time.

This is not just an upgrade—it's a strategic transformation. A successful migration requires careful planning, collaboration across disciplines, and a focus on both technological advancements and human impact. By taking a principles-based and educational approach, utilities can confidently transition to a communications network that supports both near-term compliance and long-term modernization.

***MCA specializes in designing and deploying LTE/MPLS solutions tailored for utility-grade SCADA.* Contact us today to learn how we can help modernize your network while preserving your existing investments.**

A phased transition to LTE/MPLS allows utilities to integrate modern solutions alongside legacy systems, enabling advanced applications while minimizing risk and protecting investments.

Utilities adopting LTE/MPLS report faster commissioning, improved visibility, reduced costs, enhanced resilience, and support for advanced grid applications.

About MCA

MCA is one of the largest and most trusted technology integrators in the United States, offering world-class voice, data, and security solutions that enhance the quality, safety, and productivity of customers, operations, and lives.

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Our team of certified professionals across the United States delivers a full suite of reliable technologies with a service-first approach. The MCA advantage is our extensive service portfolio to support the solution life-cycle from start to finish.

About The Author

John Geiger is Senior Strategic Account Executive at MCA and a recognized expert in **MPLS, LTE, MAS radio, and IoT networking solutions**. He has held senior leadership positions at Machfu, Microwave Data Systems (MDS), and GE Energy, and is credited with multiple patents in communications technology. With decades of experience serving the Utility and Oil & Gas industries, John specializes in helping organizations modernize mission-critical networks with resilient, next-generation solutions.

MCA Headquarters

135 N Church St #310
Spartanburg, SC 29306

800.596.8205

info@callmc.com

www.callmc.com

MCA