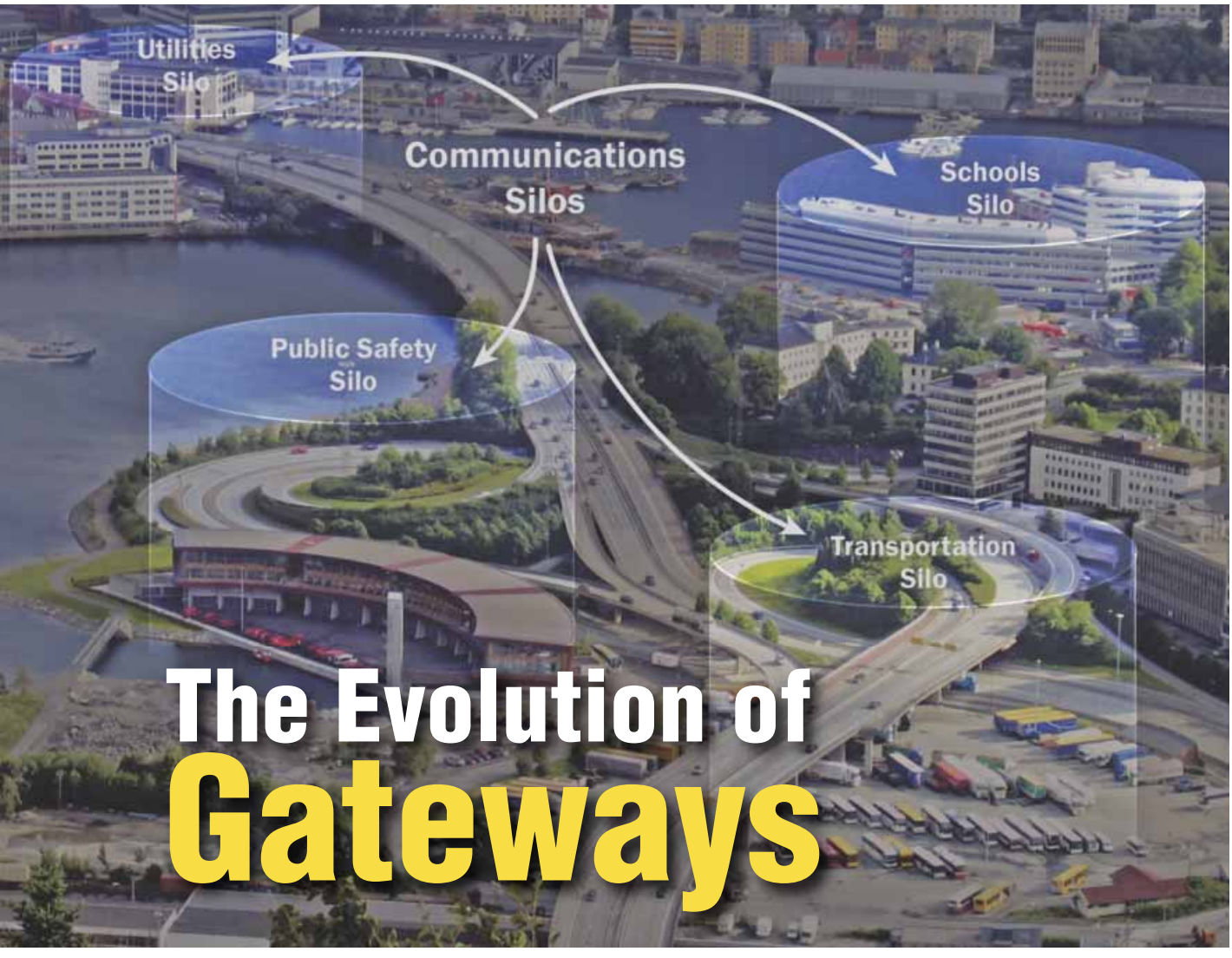

The Evolution of Gateways

From modest beginnings as analog gateways supporting talk path patching interoperability between LMR networks, enhanced gateways have evolved into umbrella networks that incorporate push-to-talk (PTT) voice, video and data (VVD) over terrestrial internet and commercial and public-safety wireless broadband networks. The current and evolving landscape of these solutions, how they are being employed by public safety to expand interoperable communications, and their prospect for the future are explored in this article.

Silos and Interoperability

With the introduction of LMR systems, mission-critical PTT (MCPTT) communications was delivered to all subscribers within the coverage footprint of an LMR network. However, subscribers to a given LMR network had limited means of communicating with neighboring networks. Therefore, establishing LMR networks created communications islands, or silos, isolating first responders from their neighbors.

The original voice interoperability solution has evolved to include push to talk (PTT) and radio over IP (RoIP) for broadband.

By Douglas Greenwood and Omna Solomon

One early effort to address these limitations led to the engineering of national interoperability channels that public-safety subscriber radios could be programmed to access. Separate mutual-aid channels were established for each of the primary public-safety radio bands (UHF, VHF, and 700 and 800 MHz). This approach provided a talk path to ensure that all UHF radios could communicate with other UHF radios containing the appropriate mutual-aid channels; however, UHF radios could not communicate with VHF radios. Something more had to be done to promote interoperability among different systems, frequency bands, radio architectures, and

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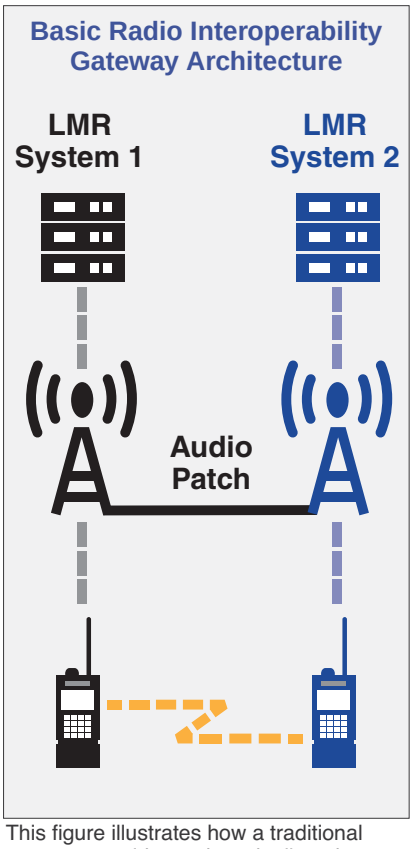


This figure illustrates how a traditional gateway provides a shared talk path between two trunked networks.

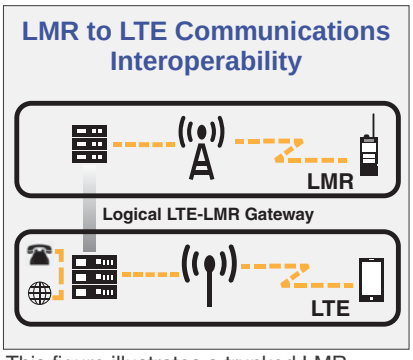
proprietary and non-Project 25 (P25) technologies.

Radio gateways were developed to address these issues. With a gateway, a talk path can be established between disparate radio technologies and frequency bands, expanding radio interoperability for end users. These gateways facilitate inter- and intra-jurisdiction interoperability between agencies operating disparate radio systems and are typically deployed to support short-term tactical incidents.

LMR Gateway Patches

Radio gateways have become essential tools in the strategy to expand and advance interoperable radio communications; however, they have inherent limitations. Talk paths can indeed be shared through a gateway by patching together a repeater channel or talk groups from different systems that need to communicate together. However, this piecemeal approach leads to somewhat larger communications silos — the combined systems are still not interoperable with their neighboring radio systems.

Additionally, gateway patches are not practical solutions for long-term interoperability across disparate systems and are typically deployed temporarily. For example, if two entities patch together radio communications channels, each entity will hear all the traffic from the other system's users over their respective repeaters. Significant unrelated traffic can potentially render the shared talk path in both jurisdictions useless. These solutions additionally take up multiple channel resources from other communications services while patched. We have all experienced the operational patch that lives long after the incident response, when it is no longer required.



This figure illustrates a trunked LMR system connected to an LTE system.

Gateways can be designed to eliminate the interoperability barriers between neighboring systems; however, depending on the implementation strategy and the scope of the interoperable communications requirements, they may not be practical. In theory, audio gateways can interconnect and sum up a large number of different channels or systems. At a certain point, though, shared communications can become unintelligible to the participating entities. In reality, patching must be done among a limited number of partners and typically on a temporary basis to achieve optimal performance.

To address these issues, the LMR industry has evolved toward building large multijurisdiction or statewide solutions that employ the basic concepts of audio patching but do so using more elegant and efficient technologies.

IP and Wireless Broadband

The data communications industry developed IP-based signal transmission and switching to efficiently communicate all forms of information including VVD, making it the perfect platform to promote broadband interoperability. The adoption of 3G and 4G technologies by commercial carriers provides higher throughput IP communications to mobile devices. PTT services can also be purchased on various commercial networks, and many first responders carry Long Term Evolution (LTE)-capable smartphones.

The prevalence of smartphone-based PTT voice services and the continued use of LMR systems for mission-critical radio introduce silos similar to that of the disparate legacy radio systems. Connecting or sharing PTT talk paths over public and private wireless networks is essential to LTE-to-LMR interoperability as the technology platforms continue their respective evolutions. Supporting this approach through open and standards-based interoperability gateways enables a PTT application on a broadband subscriber's smartphone to communicate with LMR subscribers on their local LMR network.

Several non-public-safety communities, including

LMR audio would employ audio patching or vendor-specific solutions for voice interoperability, while a vendor-agnostic XoIP switching fabric will create an inclusive architecture capable of bridging all multimedia content.

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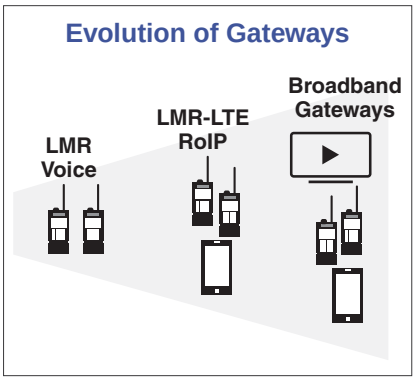


schools, utilities, transportation and medical facilities, play critical functions in the overall emergency response and mitigation structure. Information sharing within and among different emergency support functions (ESFs) not only includes voice but also a varied ecosystem of rich multimedia content. With respect to voice, a smartphone PTT application could be integrated into the local LMR gateway that supports commercial cellular interoperable communications. Delivery of this LTE-to-LMR PTT capability may use LMR vendor-specific (proprietary) solutions or vendor-agnostic third-party solutions, and these solutions make it possible, in theory, to bridge all non-public-safety PTT communications silos with public safety during an incident.

With the introduction of the First Responder Network Authority (FirstNet), the public-safety community will have access to a dedicated mission-critical LTE wireless broadband network that provides public-safety-grade services. When FirstNet MCPTT talk paths are shared with public-safety-grade LMR networks, the combined system will be capable of providing public-safety-grade services. FirstNet may also develop and host an open standards-based framework or marketplace that enables digital LMR system operators nationwide to better integrate their LMR systems with FirstNet to enable local-area LMR-to-LTE interoperability. An open standard gateway would also enable better integration with commercial PTT solutions and VVD between and among public-safety entities and the critical ESF community.

RoIP Gateways

Two different radio over IP (RoIP) gateways are available for LTE/LMR interoperable PTT voice services including LMR vendor-specific solutions and those provided by third-party LMR vendor-agnostic solutions. A comprehensive survey of existing gateway solutions is not the goal of this article, but each of these types of gateways are available. It is easy to identify LMR gateway products such as JPS Interoperability Solutions' ACU-1000, the SyTech RIOS, the Communications-Applied Technology ICRI gateway and various others. For vendor-specific RoIP, Motorola Solutions offers WAVE, while Harris provides BeOn. Vendor-agnostic RoIP solutions include Mutualink, ESChat and others. AT&T, a finalist to be the FirstNet industry partner, offers its commercial customers Kodiak's PTT solution. All of the solutions leverage a combination of open standards and proprietary enhancements to deliver viable solutions.

Numerous terms describe voice services over FirstNet's LTE network, including VoIP, mission-critical voice (MCV) and voice over LTE (VoLTE). They are somewhat ambiguous and may refer to phone service provided over an IP data network. For this article, we will use the term RoIP because it is generally understood to refer to PTT services over LTE and LMR. A further distinction can be made between non-mission-critical and mission-critical PTT services.

Broadband Gateways

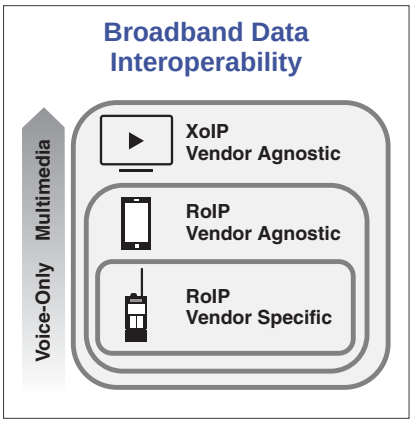
As information required for mission-critical services increasingly encompasses a broad range of multimedia VVD, gateways will continue to expand to other platforms. RoIP switching cores are based on IP technology capable of switching information in any form; the same concept can be extended to streaming video and other situational awareness data sharing across different emergency service functions.

Many mechanisms are already in place for sharing some video from publicly funded closed-circuit TV (CCTV). A utility or school, with video from fixed cameras it chooses to share, can set up a video server that provides login access to camera video streams. While this is one source of video sharing, video can also be shared by individuals within a utility or school directly from their smartphones. In the near future, citizens will also be able to directly stream video to support public safety's mission. Working with video from these different sources during an incident will require switching, and we identify this form of information switching over IP as XoIP. Broadband gateways in this context are implemented virtually through the XoIP switching fabric and are managed by some form of video management system (VMS).

Technology Specific or Agnostic

With the evolution of multimedia information and wireless broadband, vendor-specific and agnostic solutions that cover all media and metadata types will surface — both will inevitably employ open standards to share data across different platforms. However, VMS providers, similar to LMR vendors, will implement enhanced features to increase functionality and better align the standards to the operational needs of public safety. For instance, simple and user-friendly applications to provision and manage different user groups will require additional development beyond the underlying multimedia sharing servers and systems. The number of multimedia content providers will continue to increase; therefore, it will likely fall on third-party VMS vendors to provide logical solutions to capture and relay a citizen's Twitter Periscope feed to a battalion officer's mobile CAD application, for example.

LMR audio would employ audio patching or vendor-specific solutions for voice interoperability, while a vendor-agnostic XoIP switching fabric will create an inclusive architecture capable of bridging all multimedia content. An open standards-based vendor-agnostic solution will increase interoperability across different platforms and content. As FirstNet deploys the nationwide LTE network and



This figure provides a simple illustration of broadband data interoperability solution architecture.

the anticipated Third Generation Partnership Project (3GPP) standards-based MCPTT services, any of these approaches may be used to integrate LTE MCPTT with LMR PTT, which would additionally support multimedia content sharing and interoperability over a standards-based framework.

The value of multimedia content in enhancing the situational awareness of first responders and other emergency services personnel, including from schools, utilities, transportation and medical, will undoubtedly increase with public safety's penchant for data. Public-safety agencies will employ a growing ecosystem of VVD management tools to preserve and protect citizens and property and to extend multimedia communications to anchor community entities. Effective use of these tools will, however, require careful consideration of the legal, policy, technology and procedural issues. There are many steps in successfully translating a strategic vision for response into an at-your-fingertips tactical response.

Hundreds of best practice and standard operational procedure (SOP) documents were developed across the nation to guide the proper use of legacy audio gateways. Sharing, retention and management of rich multimedia content within and across agencies will be a significantly more complex feat. The launch of FirstNet may further expand the possibilities by enabling direct connectivity of broadband data with a private mission-critical broadband network and commercial PTT services. It will be incumbent on all stakeholders to devise comprehensive policies and procedures governing the effective and timely use of the ever-evolving data-sharing gateway technologies. ■

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