

## Multi-Agency Radio Communications

LMR (or Land Mobile Radio) has traditionally been used by companies, government agencies, and branches of the military to provide wireless communications between mobile personnel in the field and centralized dispatching and control centers. As the costs associated with purchasing and deploying radio systems have come down it has become commonplace to see radios in use in general business environments such as retail, customer service, car rental, and construction.

This paper will discuss how the MARC server integrates with radio systems, showing how you can extend the reach of your LMR communications over IP infrastructure.

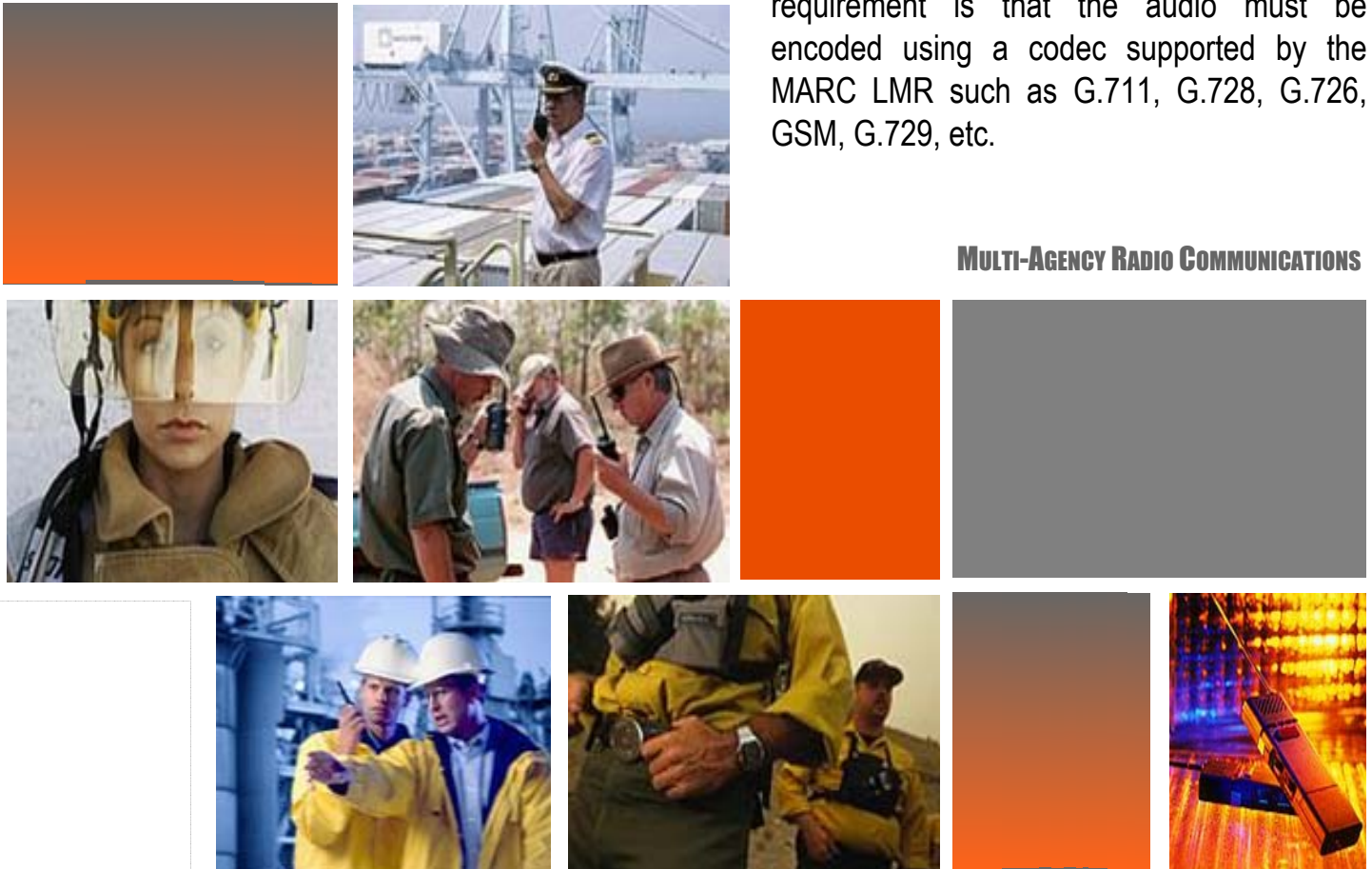


### How does The MARC Server integrate with LMR?

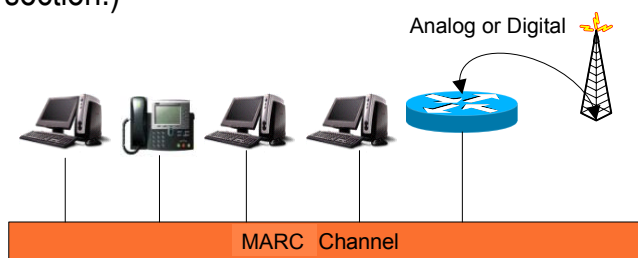
To the MARC Server powered by MARC LMR, a radio is simply another endpoint in the communications infrastructure that may (or may not) require specialized processing to make communication possible. Let's examine this statement in detail, starting with receiving audio from radios.

For MARC LMR to receive radio transmissions, those transmissions need to be converted into Voice-over-IP packets and placed onto the network using the industry standard Real-Time Protocol (RTP). A further requirement is that the audio must be encoded using a codec supported by the MARC LMR such as G.711, G.728, G.726, GSM, G.729, etc.

### MULTI-AGENCY RADIO COMMUNICATIONS



Sending audio to a radio is the inverse of the above process, requiring a conversion from Voice-over-IP packets into a format acceptable to the radio. The only additional requirement is that the audio transmission from MARC LMR may need to be accompanied by signaling required to “key” the radio. (We’ll discuss signaling in the next section.)



In most situations, the easiest way to connect the radio to the network, and to establish the bi-directional audio flow, is to use a device such as a simple router or VoIP gateway that connects to the radio through an analog interface such as E&M, FXS, or FXO. P25 Digital Radio interfacing are available by some radio manufactures as well and are supported with MAR LMR. Support for analog interfaces varies across radio manufacturers so it’s worthwhile to find out what’s best suited to your environment.

Once this step is accomplished, all transmissions from the radio are placed on the network and received and processed by other MARC LMR endpoints. Audio from these other endpoints is received by the connecting device and relayed to the radio.

This generic approach allows the MARC Server to integrate with practically any radio system available and allows agencies to add interconnectivity to the MARC Server in the shortest possible timeframe.



## Signaling

While receiving audio from a radio is a relatively simple process, transmitting audio to a radio is a tricky procedure. Generally speaking, a radio needs to be instructed to transmit the audio that it is receiving and this is where specialized signaling is required to “key” the radio – i.e. essentially “pressing the talk button”.

Most radio systems available today support keying using special tones embedded in the audio stream. When a radio receives these tones it “keys up” the transmission (“press the button”) and transmits the audio onto the airwaves.

The MARC Server takes advantage of this functionality by embedding the tones into the audio stream in one of two ways – end-to-end signaling or through proxied tone injection.

End-to-end signaling involves the radio client generating the tones in real-time on the transmitting device (a client PC for example using MARC LMR) and combining those tones with the audio being transmitted. These tones are carried across the network to the audio interface of the router that serves as the ingress point between the network and the radio and are propagated across the audio interface described earlier.

In order for this functionality to work however, you need to carry the audio across the network using a codec that has sufficient range to represent the entire tone sequence. Such codecs (G.711 for example) require large amounts of bandwidth (up to 80 kbps) and can quickly consume precious network resources when multiple streams are being generated. A further issue to bear in mind is that a radio is rather unforgiving on lost tones and the loss of just a small portion of a tone sequence is enough to “unkey” the radio transmission.

Lastly, carrying a high-bandwidth audio stream over wide-area connections may not even be possible in many environments (such as a WAN consisting of 56 kbps links between sites).

To address these issues, MARC clients can take advantage of remote tone injection features of the MARC Server.

Using the MARC Server to inject the tones on behalf of clients is a straightforward process. Simply install the MARC Server and instruct clients to use that server to inject the tones on their behalf. (This is all done using the MARC Server’s web-based interface.)

The MARC Server enables MARC LMR clients to use any codec they wish to transmit their audio. This audio, upon being received by the MARC Server, is combined with the necessary tones and retransmitted using a codec capable of supporting the entire range of the tone pattern.

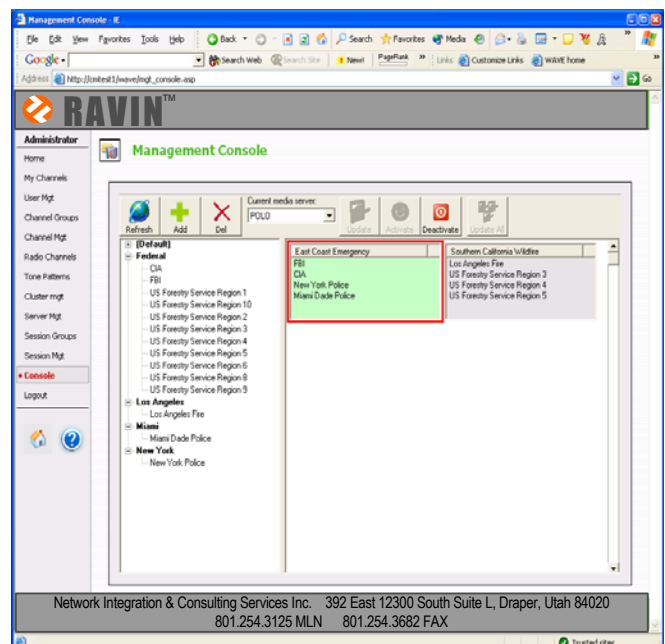
A secondary benefit of using the MARC Server for tone injection is that multiple MARC clients can transmit to a radio simultaneously –



the server ensures that only a single tone pattern is generated for all speakers, maintaining that tone until all speakers have ceased talking.

### Other Signaling Architectures

While we have discussed tone-based signaling, the MARC Server also supports other signaling options such as hardware devices installed on the MARC Server connected through E&M cabling to the radio. These interfaces are specific to individual radio manufacturers and/or models and adding support for them in MARC LMR is an ongoing process.





## Radio Interoperability

The MARC Server can be used for interoperability between radio systems – essentially creating a “talk group” of radios across a geographically dispersed area. For example: Suppose an officer of the Los Angeles City Police Department needs to communicate with officials of the Los Angeles Fire Department, the FBI, and the DOT.

By using the MARC Server, a central dispatcher can tie these radio systems together over the IP network by simply dragging and dropping the radio channels (one for each organization) into a talk group hosted by the MARC Server. Once the talk group is established (usually within less than 1 second), anyone on any of the participating radio channels (and therefore radio systems) can communicate with all other parties in the talk group.

It's also important to remember that they can use MARC LMR right from their desktop PCs or IP telephones!

## Conclusion

We hope this paper has given you a better understanding of how the MARC Server powered by MARC LMR works with radio systems and the communications possibilities it offers your organization.

To learn more about MARC I & MARC II Interoperability Servers and how they can help your business contact a NICS Sales Representative or visit us on the web at

<http://www.nicserv.com>

### MARC I & MARC II Summary: Description

- Multi-Agency Radio Communications

Land Mobile Radio multi-channel Interoperability System

### Architecture

- IP Multicast/Unicast peer-to-peer with optional servers

### Client Types

- Microsoft Windows™ PCs
- Cisco 7960 & 7940 IP phones
- Land Mobile Radio (LMR) systems

### Quick Features

- Browser-based system administration
- Standalone or browser-based PC Client.
- Simultaneous multi-channel, multi-speaker, and multi-codec support
- Dynamic VAD (Voice Activity Detection) on clients and servers
- Dynamic TAD (Transmission Activity Detection) on servers
- Client- or server-level channel recording
- Transmission to multiple LMR channels simultaneously
- Uses industry-standard TCP / RTP transmission protocol
- Transmissions optionally encrypted using built-in or customer provided algorithms.
- Open architecture SDK allows organizations to develop custom solutions.

### PC Client Technical Details:

#### Operating Systems Supported

- Microsoft Windows 98 or better

#### Simultaneous-Use Codecs

- G.711 (μlaw and ALaw)
- G.726
- G.728
- G.729
- G.723.1
- GSM 6.10
- Speex (2.15 kbps - 24.6 kbps)

#### Sampling Rates

- 8 kHz for all codecs
- Up to 44.1 kHz using Speex

#### Audio Devices Supported

- All Windows-compliant devices

#### Network Cards Supported

- All Windows-compliant NICs