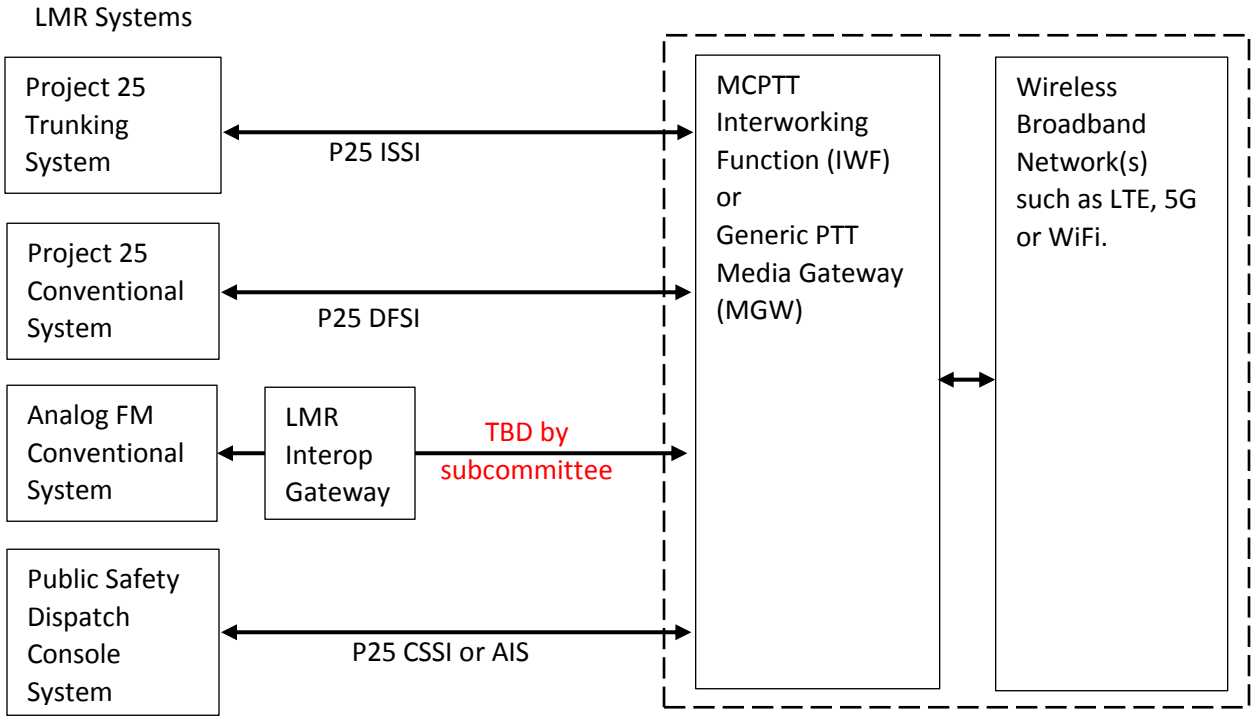
PSTA LMR/LTE Interoperability Technical Subcommittee Report

Background

The PSTA LMR/LTE Interoperability subcommittee is tasked with identifying integration protocol standards suitable for public safety users operating across LMR and Broadband Push-to-Talk (PTT) using any wireless broadband technology. One objective of the subcommittee is to establish an agile model delivering standards that will allow participating vendors to rapidly deliver compliant products to the public safety market. LMR to LTE Interoperability shall remain a key component for the successful transition from traditional LMR technologies to Broadband technologies.

This document describes interoperability of numerous existing LMR technologies to broadband PTT. This document shall treat the broadband PTT system as generic, supporting interoperability with any standards based or proprietary broadband PTT system, including those using 3GPP MCPTT. While standards exist for integration of Trunked and Conventional Project 25 systems, there are no IP-routable, open standards for integration of Analog FM LMR systems, which represent an estimated 30% of the deployed public safety LMR systems. There are numerous gateways available on the market for creating interoperability from LMR to LMR and from LMR to LTE, but these gateways rely on a non-standards based protocol and lack features required for public safety. **Identifying a suitable protocol and feature set for the integration of Analog FM LMR is the primary need being addressed in this effort by the PSTA LMR/LTE subcommittee**.

See the diagram below.



Goals of Radio Over Internet Protocol Selection

In light of the benefits of building upon **open standards**, a primary goal in the subcommittee's selection of protocols is to leverage existing LMR protocols that are or can be published by a Standards Development Organization (SDO)[1]. We also want an LMR protocol that is **capable** of supporting features identified in the National Public Safety Telecommunications Council's (NPSTC's) report on LMR/LTE integration[2]. And we want an LMR protocol that is **affordable**, both from a development perspective (relatively free from IPR licenses), and from a deployment perspective (the user agency's cost to license the interface), because it is important to make LMR/LTE integration solutions available even to public safety agencies on tight budgets.

Another goal is to have solutions that are **compatible** with the greatest number of deployed public safety LMR systems, so as to maximize the availability of LMR/LTE integration. The table below shows the approximate distributions of public safety LMR systems by percentage of individual users based on available market information. The subcommittee's goal is to have solutions to address the first three types of LMR systems, which we hope will make LMR/LTE interoperability available to 95% of the public safety user base.

- Project 25 Trunking – 50% of PS users
- Project 25 Conventional – 15% of PS users
- Analog FM Conventional – 30% of PS users
- Other (Project 16, NXDN, MotoTRBO, DMR) – 5% of PS users

Protocols Considered & Examined Criteria

The subcommittee considered all known LMR open standards relevant to Public Safety in North America[3]. What emerged were the Project 25 (P25) wireline standards developed by the Telecommunications Industry Association (TIA – and ANSI approved SDO); the Inter Subsystem Interface (ISSI) designed to interconnect P25 trunking systems, the Console Subsystem Interface (CSSI) designed to interconnect Console systems with P25 trunking systems, and the Fixed Station Interface (FSI[4]) designed to interconnect Console systems with P25 and Analog FM fixed stations. We also examined a standard developed by DHS called the Bridging System Interface (BSI) designed as a low cost, basic interoperability protocol. Lastly, we considered existing non-standard LMR protocols, generically called Radio Over IP (RoIP).

These LMR protocols were examined according to a number of criteria, including the four primary criteria described above. See the table in the appendix for details.

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[1] The Spectrum Act, Section 6206.b(2) states "the [FirstNet] Authority shall (B) promote competition… by requiring that equipment for use on the network be (i) built to open, non-proprietary, commercially available standards." Also, the PSTA is not a SDO, and wishes to identify relevant standards rather than create them.

[2] See the NPSTC Public Safety LMR LTE Interoperability Report.

[3] Other LMR standards exist globally, such as TETRA and DMR, but these have very little if any installed base for public safety in North America.

[4] The P25 FSI (TIA standard 102.BAHA-B) defines both an Analog (AFSI) and Digital (DFSI) variant, both of which are capable of conveying either Analog FM or P25 CAI traffic. Only the DFSI is IP routable.

Selected Protocol

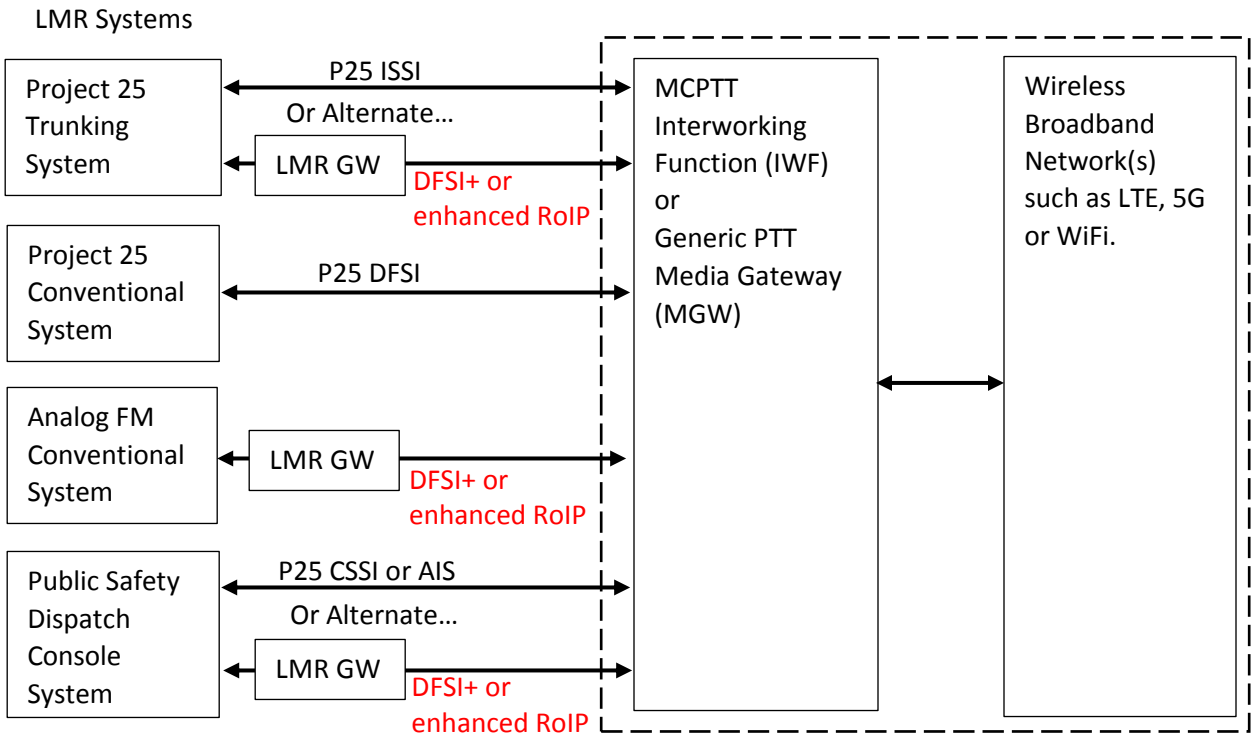
In examining the open standard LMR protocols, the subcommittee identified the following existing and alternate LMR protocols for integrating various types of LMR systems.

LMR System Type	Existing Open-Standard Interface	Alternate Interface	Notes
P25 Trunking (50%)	P25 ISSI/CSSI	DFSI w/ extensions	ISSI/CSSI is technically ideal, but very expensive. DFSI can support P25 trunking with extensions.
P25 Conventional (15%)	P25 DFSI	N/A	P25 Conventional systems have inherent DFSI capability
Analog FM Conventional (30%)	P25 AFSI	DFSI and/or RoIP w/ extensions	AFSI is not IP routable. DFSI and RoIP with extensions can add PTT-ID & emergency capability
Other (5%)	Varies	DFSI and/or RoIP w/ extensions?	Only DMR and TETRA have open standard interfaces. DFSI and RoIP with extensions might also support any type of LMR.

At this time, the PSTA LMR/LTE Interoperability subcommittee has identified **the P25 DFSI as suited to meet the four primary goals**. It is inherently part of P25 conventional systems (no gateways would be needed), can be modified with simple extensions to add significant capabilities to Analog FM systems (including PTT-ID and Emergency calls), can be used as an affordable alternative to the ISSI/CSSI for P25 trunking systems, and could possibly be leveraged to integrate some or all of the remaining 5% of the market that uses other LMR technology.

We are also **considering an enhanced RoIP protocol** as potentially suitable to meet most of the goals. While RoIP is not presently an open standard, it potentially could become an open standard.

In light of the DFSI's capabilities, the diagram below shows its other potential uses ("DFSI+" is used to indicated the DFSI with enhanced extensions added. "Enhanced RoIP" is used to indicate an enhanced RoIP protocol).



Here is a brief list of some of other advantages of using the P25 DFSI as an LMR gateway protocol.

- No IPR license is required for gateways (the DVSI IMBE/AMBE vocoder, if required, is used at end-points, not at gateways).
- Built-in provision for G.711 un-coded audio, ideal for Analog FM systems.
- Supports transport of PTT-ID and Emergency for core interoperability with in-band overlays (such as MDC-1200) commonly used on Analog FM systems.
- Supports transport of voted receiver and zoned transmitter selection.
- Supports transport of both P25 conventional and P25 trunking messages for talk group IDs, NAK, supplemental data messages, etc.
- Supports P25 encryption, and can be keyed to the interfaced P25 system.
- Compared to the ISSI, CSSI, DFSI is a much easier protocol to implement.
- Formal conformance tests exist, with the likelihood of eventual oversight by DHS.

Note, however, that the subcommittee does not propose elimination of the P25 ISSI/CSSI, which still have their place as the ideal integration standard where the system owners can afford those licenses.

An enhanced RoIP protocol has not yet been fully explored, but could share most of the positive attributes of the DFSI above.

Protocol Shortcomings

However, the P25 FSI is not entirely suitable for all of the desired capabilities. The subcommittee identified the shortcomings below. Fortunately, the P25 standards, including the DFSI, have built-in provisions for “manufacturer extensions” that allow extending the protocol’s capabilities, and this key feature provides a means to address many of the shortcomings, while remaining true to the standard.

1. Doesn’t support both analog (G.711) audio and PTT-ID.

2. Needs documentation for decode/encode of in-band PTT-ID/Emergency schemes.
3. Lacks “Floor Control” (positive confirmation of talk path grant), useful for Trunking environments.
4. Doesn’t convey LMR location data.
5. Interoperability tests have not yet been written for the DFSI.

Potentially an enhanced RoIP protocol could be developed which might address all of the above limitations. The challenge will be to have a new protocol recognized and published as an open standard by an SDO, which could be a two to five-year process. The subcommittee is considering the DFSI for the short term by virtue of it being an existing, extensible standard, and potentially RoIP for the long term with the hope to be entirely suitable for the intended application.

Next Steps

The proposed future work of the PSTA LMR/LTE Interoperability subcommittee will be to draft DFSI extensions to address shortcomings 1 through 3 above to enable integration with Analog FM LMR systems, and to fully examine the capabilities of an enhanced RoIP protocol which we hope to complete in the first sprint. We plan to draft DFSI extensions to address the remaining shortcomings, and perhaps publish a draft standard of an enhanced RoIP protocol in the subsequent sprints.

APPENDIX – LMR Protocol Comparison Matrix

CRITERIA	P25 ISSI/CSSI	P25 FSI	DHS BSI	enhanced RoIP
Open Published Standard	Yes. TIA 102.BACA-B	Yes. TIA 102.BAHA-A	Yes	Future
Industry Defacto Standard	N/A	N/A	N/A	Future
Proprietary, but Mfg will make publicly available	N/A	N/A	N/A	N/A
Cross Vendor Interoperability	Yes	Yes	TBD	Planned
IPR License Fee and/or Conditional Use Agreement	Yes (DVSI vocoder[5])	Optional (DVSI vocoder[5,6])	No	N/A
End-To-End Affordability	Cost prohibitive (from Tier 1 mfgs)	Affordable	Affordable	Affordable
Implementation Difficulty	High	Medium	Low	Low (future)
Extensible Protocol	Yes[7]	Yes[7]	No	Yes (future)
Native support for Conv Fixed Stations	No	Yes (FS)	No	Yes (future)
Native support for Trunk RFSS	Yes, ISSI	No	No	N/A
Native support for Consoles	Yes, CSSI	Yes (host)	No	N/A
Widely adopted for LMR	Yes, ISSI/RFSS	Yes, P25 FS	No	Future
Widely adopted for Dispatch	Yes, CSSI/CSS	Yes, FS Host side	No	Future
Defines Analog Fixed Station Interface	No	Yes	No	N/A
Compatible with In-Band PTT-ID Overlays	No	Yes	No	Yes
Passes G.711 audio (ideal for Analog FM LMR)	No	Yes	Yes	Yes
Passes native vocoder for Digital LMR audio	Yes[8]	Yes[8]	Possible	Possible

[5] For most existing P25 & digital LMR vendors, the one-time DVSI AMBE+ vocoder license fee has already been amortized.

[6] The P25 DFSI can use either AMBE+ vocoded audio, or G.711 unvocoded audio.

[7] The P25 interfaces have provisions for manufacturer-specific extensions (additional messages).

[8] The DVSI AMBE+ vocoder is used for P25, DMR and its variants (MotoTRBO, NXDN), but not for TETRA.

CRITERIA	P25 ISSI/CSSI	P25 FSI	DHS BSI	enhanced RoIP
Voice Encryption supported	Yes	Yes	Possible[9]	Possible
Encryption P25 KMF Interface supported	Yes	Yes	No	No
Supports Packet Data (e.g. location services)	No?	Yes[10]	No	Yes
Supports PTT-ID	Yes	Yes	DTMF only	Yes
Supports Normal Group Calls	Yes	Yes	Yes	Yes
Supports Emergency Group Calls	Yes	Yes	No	Yes
Supports Emergency Alert/Alarm	Yes	Yes	No	Yes
Supports Floor Control[11]	Yes	No	No	TBD
Supports Supplemental Data Features (e.g. Call Alert)	Yes	Yes	No	TBD
Supports Voted Receivers, Zoned Transmitters	No	Yes	No	No
Feature Parity with P25 Conventional	Yes	YES	No	TBD
Feature Parity with P25 Trunking	YES	Yes	No	No
Feature Parity with DMR	Yes	Yes	No	No
Feature Parity with NXDN/Nexedge	Yes	Yes	No	No
Feature Parity with MotoTRBO	Yes	Yes	No	No
Feature Parity with P16 Systems	Yes	Yes	No	No
Compliance Tests Exist	Yes (Interop & conformance)	Yes (conformance)	No	No
Compliance Documentation Process Exists	Yes[12]	Future[12]	No	No

[9] The DHS BSI can optionally support encryption, but it may be limited to generic IP encryption schemes rather than P25 encryption.

[10] The P25 DFSI V2 can pass data, including P25 Conventional Tier 1 Location Services data.

[11] Floor control is positive confirmation that the originating transmission has received a talk path at the destination

[12] The DHS P25 Compliance Assessment Program (CAP). CAP has plans to incorporate P25 DFSI testing.