Request for Information:
Encapsulation of Composite Audio (MPXA) within the Distribution and Communications Protocol (DCP)

November 9, 2022

This request for information (RFI) is being released by the IBOC Standards Development Working Group (ISDWG) of the Digital Radio Broadcasting (DRB) Subcommittee of the NRSC. **Please direct responses to David Layer, VP, Advanced Engineering, NAB, at dlayer@nab.org by December 15, 2022.**

The system described in this RFI is under consideration by the NRSC for possible standardization. The NRSC is seeking input and comments from manufacturers, industry leaders and partner organization on the following topics:

1. Comment on the feasibility on implementing analog FM only links across typical studio transmitter links using DCP uncompressed MPX. Is it necessary to define reduced bit resolution modes (12,14,16-bit) to conserve bandwidth?

2. Comment on the feasibility of optionally adding or linking to an existing E2X transport stream for the HD Radio transmission that is time aligned. Is it conceptually feasible that MPXA equipment can optionally be upgraded to carry the E2X DCP application frame, as well? What challenges exist in aligning application frames for MPX and E2X in practical implementations?

3. DCP is defined one layer up from the physical channel implementation. What physical channel implementations should be considered for standardization? UDP, TCP/IP (client/server), serial, file based. To what degree does it need to be specified (ports, bit rates, …)?

4. What implementations of the PFT layer exist today? Are there any published papers discussing the reliability of the FEC within the DCP PFT layer across errored links.

5. Any other relevant observations, questions or suggestions pertaining to this RFI.

Responses are not confidential; however, they will not be circulated outside of the NRSC without permission of the respondent. Note that issuance of this RFI does not obligate the NRSC to take any action.

Background

All major digital radio standards utilize the DCP protocol to provide application frames to exciter modulators:

1. Digital Radio Mondiale (DRM); Multiplex Distribution Interface (MDI) (ETSI TS 102 820)
2. Digital Audio Broadcasting (DAB); Encapsulation of DAB Interfaces (EDI) (ETSI TS 102 693) for both ETI and STI-D.
3. HD Radio; Exporter 2 Exgine (E2X) (HD Radio™ Data Network Requirements)

The NRSC is considering defining profiles for composite MPX audio (MPXA) over DCP with application frames targeting analog FM modulator time slices that line up and can be linked with a simulcast delivered via another DCP stream with concurrent time slices.

The application for MPXA is for analog FM only broadcast, hybrid FM+IBOC broadcast, DRM simulcast, or service following implementations across DAB, DRM, and analog FM. The linking concept is generally applicable to any standard provided the concurrent application frame time slices can be achieved. An overview of the proposed concept is discussed below.

System overview

The composite audio (MPXA) interface carries the composite audio including left, right, 19 kHz pilot, and subcarrier modulation (for example, RDS) as typically employed in FM broadcasting. Some digital audio standards simulcast an analog and a digital audio signal often produced by a common modulator/exciter as is the case for the main channel audio in hybrid IBOC as defined by NRSC-5.

While the simulcast is based on a common audio feed, today the processing and distribution paths for the analog and digital signals are not related or linked. Different and time-varying delays can be introduced across the two paths resulting in a misaligned FM and HD1 simulcast.

It is the goal of this specification to provide a mechanism to provide the necessary application frames synchronously to a modulator without introducing a slip in differential time alignment for hybrid IBOC, as well as other standards. Strict locking of application frames at the modulator level ensures no differential time slip can occur from encoder to modulator.

System architecture

The application data is carried from the encoder to the modulator through a number of layers as shown in Figure 1. It follows the basic system architecture defined by DCP (TS 102 821 [2]) with the extension of being able to link the AF of two separate audio encoders such that a single modulator can re-combine both application frames into a single broadcast signal as in an analog and digital simulcast.

In a future revision of the DCP specification it may be considered to move this linking capability to it in order to generically handle AF linking. Linking at the AF level makes MPXA itself agnostic to the digital radio standard used in a simulcast can equally be employed for HD Radio, DRM and other standards.

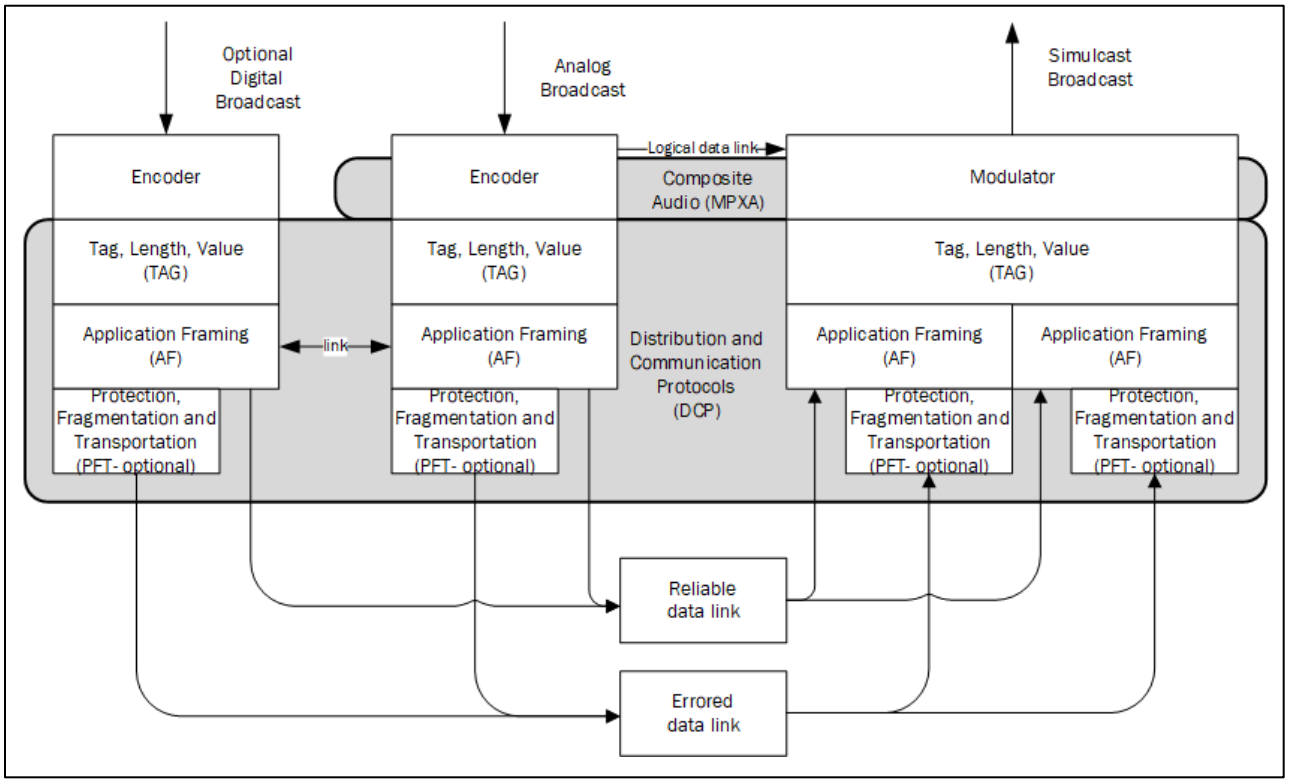

Figure 1: DCP protocol stack linking 2 encoders to a single modulator.

DCP modulation frame linking

Figure 2 shows an example MPXA AF that is optionally combined with another DCP AF with identical time slicing. To minimize deep packet inspection, MPXA is linked to the DCP SEQ number of a partner DCP transmission on an adjacent or same channel. It is a strict requirement that MPXA matches the on-air modulation time slice of the partner transmission.

A LINK tag is introduced that can optionally point to a digital simulcast of another DCP AF. The LINK tag only identifies the SEQ of the other frame containing the corresponding modulation content. Note that DCP does not define any rules around the SEQ other than it being sequential from one packet to the next but not every packet on the channel may contain modulation data.

In the case of HD Radio E2X, modulation data is interleaved with a clock packet containing timing information, each incrementing the SEQ. No assumption should be made of the SEQ of the partner protocol other than the frame designated with this specific SEQ corresponds to this specific MPXA frame.

The LINK tag identifies the other protocol by name, either MDI for DRM or EDI for DAB via a 4-character name field. Alternatively, the field can be set to “PT=X” where X can assume the single character payload type field of the partner DCP frame.

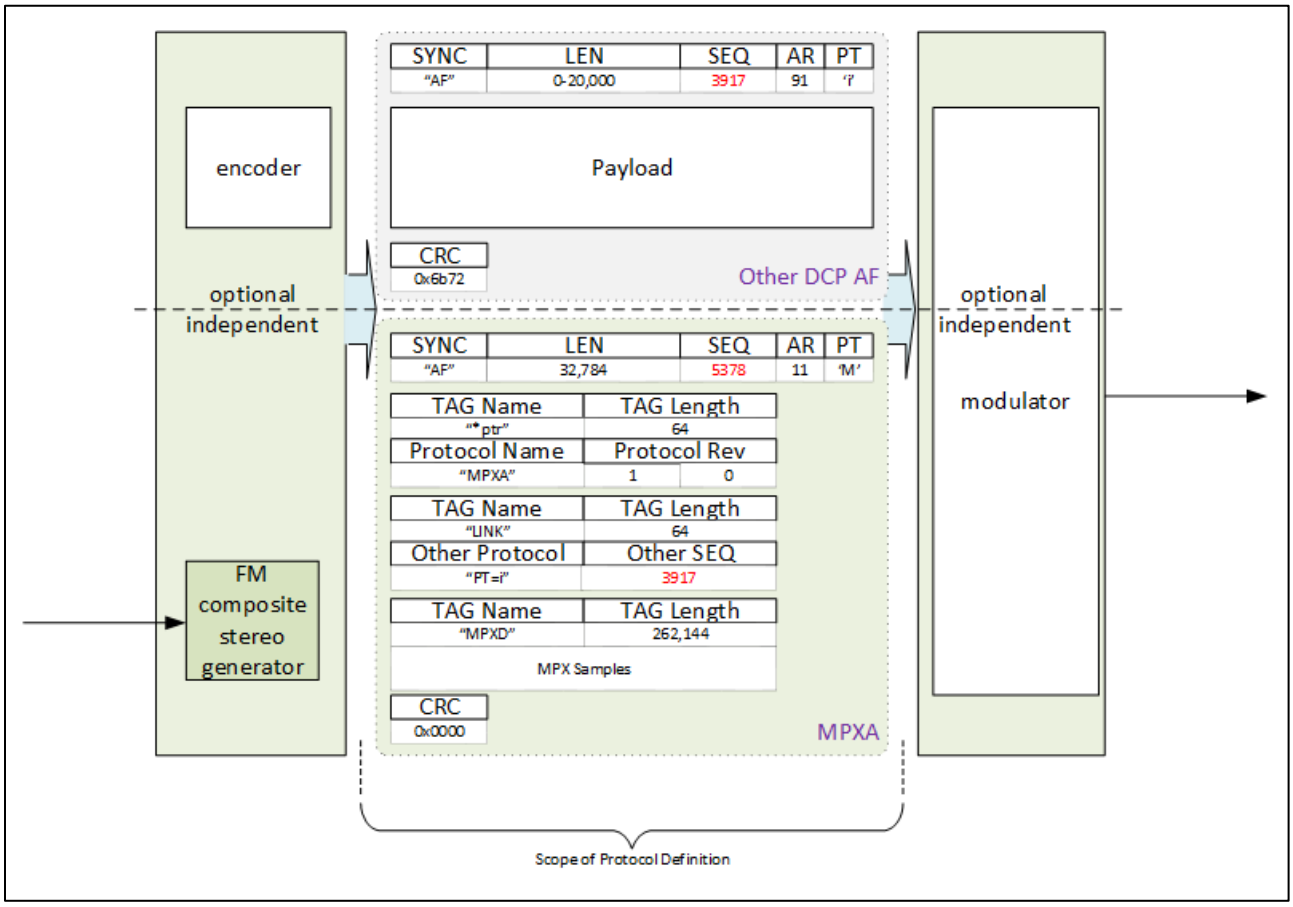

Figure 2: System overview linking MPXA to other DCP AF protocols.

The other protocol field aids the modulator in selecting a partner modulation but does not uniquely identify the partner protocol in all circumstances. It is anticipated the modulator requires configuration to unambiguously select the partner framing, for example the modulator may open two separate IP ports one for each DCP stream.

If both partner DCP frames are transmitted across the same reliable and ordered channel, such as a TCP/IP channel, the LINK tag may be omitted under the assumption that consecutive DCP AF are linked where the MPXA will be considered the leading frame.

Since the modulation frame of the analog MPX transmission must match its optional digital counterpart, several profiles are defined as shown in Table 1.

Table 1: MPXA profiles linked to digital radio standards.

Profile	Profile Name	Base Audio Rate (Hz)	Samples in Frame	MPX Samples	MPX Rate (Hz)	Modulation Time Slice (s)
MPX for HD Radio E2X	MPX1	44100	4096	16384	176400	4096/44100≈0.09288
MPX for DRM-FM	MPX2	48000	4800	19200	192000	0.100
MPX for DAB	MPX3	48000	1152	4608	192000	0.024

Within each profile, MPXA may configure a variable sample bit depth with the default being 16-bit signed integer format. Future profiles may add MPX compression algorithms to reduce bandwidth requirements.

HD Radio E2X profile

Figure 3 applies linking of MPXA to the HD Radio E2X protocol (HD Radio™ Data Network Requirements). The E2X DCP frame is identified by the Payload Type 'i' and cannot be assumed to follow the DCP Tag layer identified by a payload type 'T'. Since the payload of E2X is not disclosed, a system implementation requires a proprietary (non-open) exporter and proprietary exgine modulator implementation to create a waveform compliant with the NRSC-5 specification of a hybrid FM+IBOC signal.

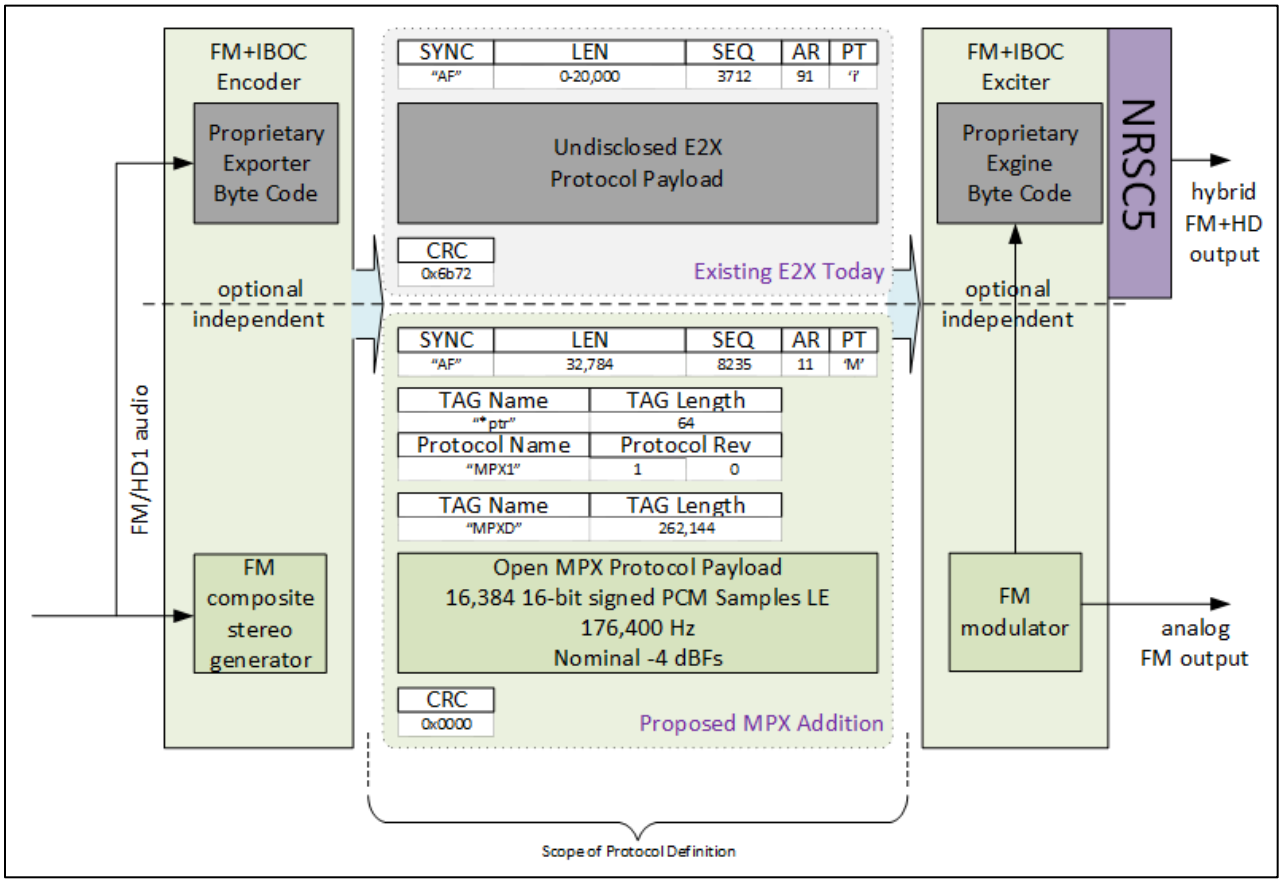

Figure 3: MPXA applied to HD Radio.

In this specific example the MPXA is carried across the same reliable and ordered channel as the E2X, thus the linking information can be omitted. Also, the MPXA CRC generation is disabled in this example.

Linking can be used when the exporter and MPX generator operate on independent channels, which can be applied to independent FM generator and exporter implementations. It is possible for an MPX generator to pass audio to be encoded on the simulcast audio service to the

exporter of the HD Radio system and link it to a resulting E2X DCP frame. Other implementations following this protocol specification are also possible.

Channel sub-profiles

The HD Radio E2X protocol only supports uni-directional UDP channels (HD Radio data network requirements) but defines an optionally supported bi-directional TCP/IP channel carrying the same logical information as the UDP E2X implementation. In this definition, the TCP server resides at the exciter and the client at the exporter.

For cloud delivery of MPX and E2X a sub-profile is introduced based on a TCP/IP channel with the client located at the exciter modulator and the server at the exporter and MPX encoder to follow a more Internet centric client server model. In this profile, the server will produce both the E2X and MPX across the same channel as shown in Figure 3, thus the LINK tag can be omitted. The SEQ of the E2X may or may not be the same as the SEQ of the MPX.