SOLUTION DATA SHEET

ATSC 3.0 LDM

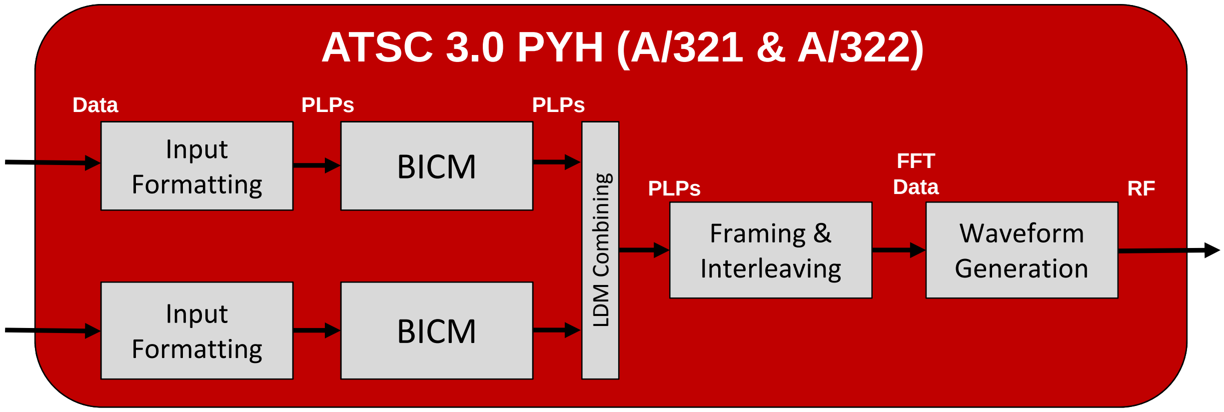
Layer Division Multiplexing

Hitachi-Comark provides high performance and award winning television transmitters that are backed by more than 45 years of leadership in broadcast technologies.

What is LDM?

LDM is a technology that overlays multiple data streams in a common RF channel. It is part of ATSC's "PHY" layer of the ATSC 3.0 suite of specification documents (A/322; section 6.4).

LDM implementation has both differences and commonalities between the Core and Enhanced layers. The main difference is the BICM (Bit-Interleaved Coded Modulation) processing block between the layers. BICM includes inner code length, code rate, and constellation mapping (i.e. QPSK, 64QAM). The common elements including Framing & Interleaving and Waveform Generation processing blocks. These include the RF channel, bootstrap, preamble, PAPR, and pilot insertion.



LDM Block Diagram – 2 Layer System

LDM allows simultaneous transmission of multiple PLP's at different power levels, modulation densities, and code rates. LDM must have at least two distinct layers; Core (or upper layer) and Enhanced (or lower layer).

Injection Level	Split of RF Power Between Layers	Injection Level	Split of RF Power Between Layers
-3dB	UL 67% / LL 34%	-5dB	UL 76% / LL 24%
-4dB	UL 72% / LL 28%	-6dB	UL 80% / LL 20%

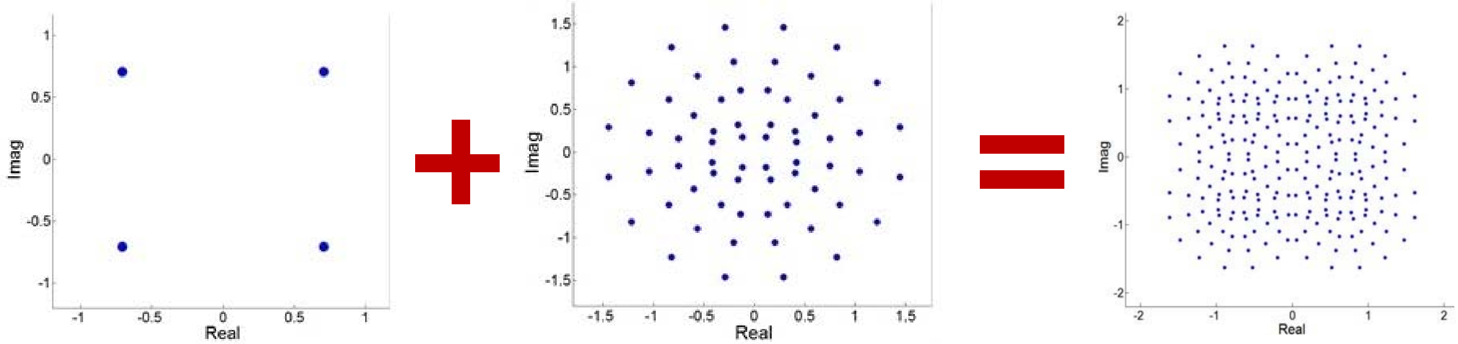
LDM Injection Levels

In order to have two signals in the same RF channel, the Enhanced (UL) is injected at a power level below the Core (LL) layer. This implies that the Core and Enhanced layers share the total RF power. The power delta between the layers is referred to as the injection level, which is configurable from 0 to -14dB. The table to the left summarizes the percentage of RF power split between the upper and lower layers at a few sample RF injection levels.

KEY FEATURES

- LDM is part of the current ATSC 3.0 standard (A/322)
- LDM improves system efficiency each layer uses 100% of the RF channel bandwidth
- LDM uses different ModCod for each layer to improve robustness
- LDM can provide 3-6dB SNR gain for mobile services as compared to TDM implementations
- LDM allows for mobile-only receive devices for tiered service
- New layers can be added to an existing LDM system without affecting backwards compatibility

LDM Constellation Generation



Example of the Core Layer QPSK Constellation | Example of the Enhanced Layer NU64QAM Constellation | LDM Signal Combined Constellation (QPSK Core & NU64QAM Enhanced)

Core vs. Enhanced Layers

As previously noted, LDM uses two or more layers for service differentiation. The Core or upper layer needs to be very robust and easily demodulated by deep indoor and/or mobile receivers. As such the Core layer is depicted with QPSK constellation above.

The Enhanced or lower layer is used for high data rate transmission services such as HD and UHD programming. Higher order digital modulation constellations are generally used such as 16, 64, 256 QAM, etc. It should be noted that additional layers can be added in the future to support new services. Adding new layers makes LDM scalable and backwards compatible for future extensions.

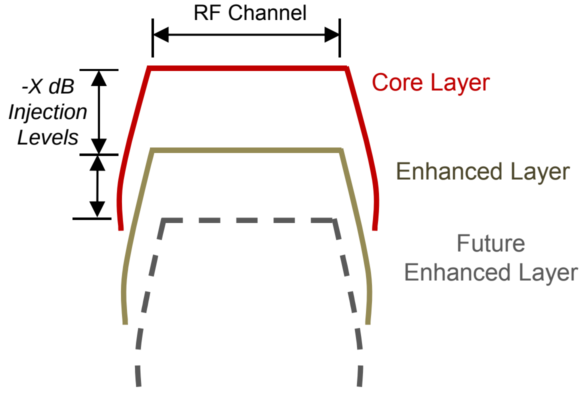
Advantages of LDM:

- ✓ Improved spectral efficiency, 100% use of the RF channel by all LDM layers
- ✓ 3 to 6dB gain in SNR performance of the mobile service compared to a single layer TDM implementation
- ✓ Future LDM layer additions do not affect backwards compatibility of fielded receiver equipment

Disadvantages of LDM:

- ✓ Higher complexity of both the Tx & Rx hardware
- ✓ Higher memory requirements of the Rx terminal

LDM Concept



Recovering Layers

LDM uses signal cancellation to extract and decode the various lower layers. At the receiver terminal, the Core layer is first recovered. Then signal cancellation is used to cancel the Core layer so that the Enhanced layer can be recovered.

SAMPLE LDM SYSTEM:

Service Description:	LDM Configuration:	Common PHY:	Throughput	AGWN SNR	Rayleigh SRN	Doppler
► Core Layer (Mobile & Indoor)	QPSK, 4/15 CR	16k FFT, 148µS GI, 64,800 LDPC	2.8Mbps	-0.4dB	-0.7dB	~150 mph
► Enhanced Layer (Fixed Reception)	64QAM, 10/15 CR -4dB injection level		21Mbps	18.3dB	21.3dB	~95 mph

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