# ATSC 3.0 overview

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# Subject to Change

Specialist Groups and ad hoc groups have made preliminary decisions to select technologies for incorporation in ATSC 3.0. Selections of all technologies are subject to approval of TG3 and ultimately the Voting Membership in accordance with ATSC due process.

# About the ATSC

- Standards development organization for digital television
  - Founded in 1983 by CEA, IEEE, NAB, NCTA, and SMPTE
  - Focused on terrestrial digital television broadcasting
  - ATSC is an open, due process organization
- Approximately 120 member organizations
  - Broadcasters, broadcast equipment vendors, cable and satellite systems, consumer electronics and semiconductor manufacturers, universities

# ATSC 3.0 Participation

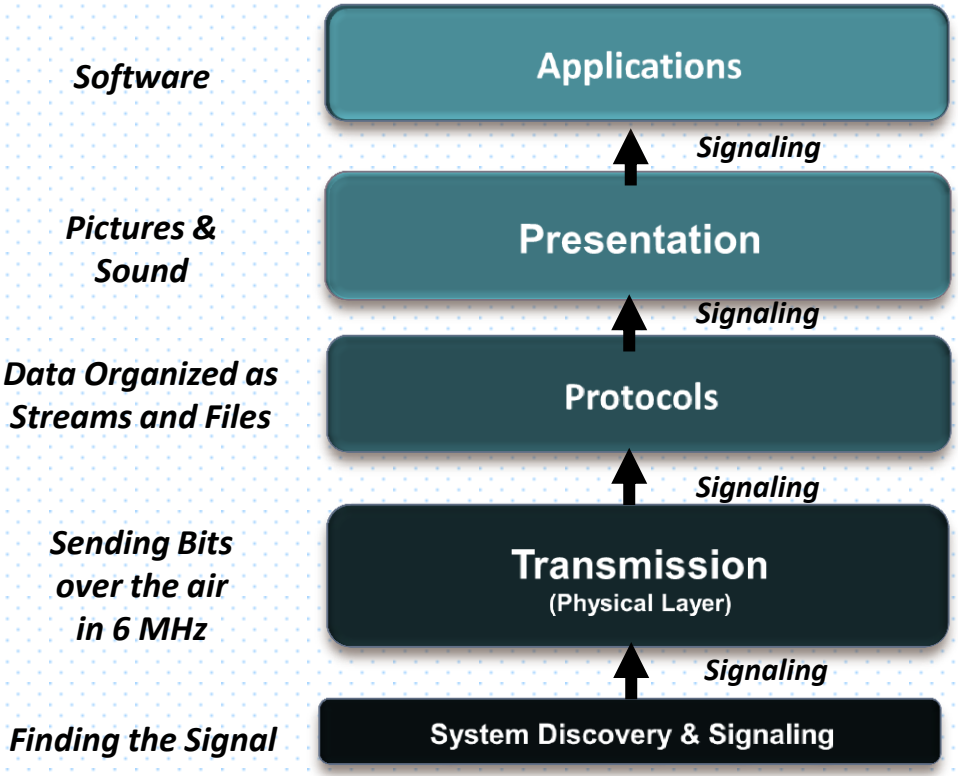
- 373 individuals on reflector/document system
  - Many others focused on 3.0 development efforts
- 110 organizations
  - Broadcasters
  - Consumer Electronics Manufacturers
  - Professional Equipment Manufacturers
  - R&D Laboratories
  - Universities

- International Participation
  - Canada
  - China
  - Europe (including DVB)
  - Japan (including NHK)
  - South Korea
  - United States

# ATSC 3.0 Elevator Pitch

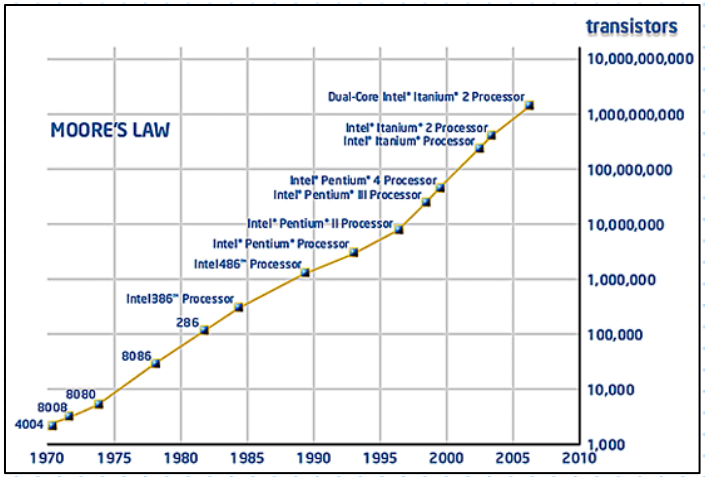
- ATSC 3.0 will add value to broadcasting's services
  - Extending reach, adding new business models
    - Content on all devices, fixed, mobile and handheld
  - Providing higher quality, audio and video
    - UHDTV & Immersive Audio
  - Improved accessibility
  - Personalization and interactivity
  - Leverage the power of broadcasting and broadband
  - More flexible and efficient use of the spectrum
- Target Completion (complete, released standards): 2017


# Overview - ATSC 3.0 System Layers



# Extensibility/Evolution

- ATSC 3.0 meant to last, but technology advances rapidly
- Methods to gracefully evolve must be in the core
  - Signal when a layer or components of a layer evolve
  - Signal minor version changes and updates
  - Signal major version changes and updates
- Goal is to avoid disruptive technology transitions
  - Enable graceful transitions



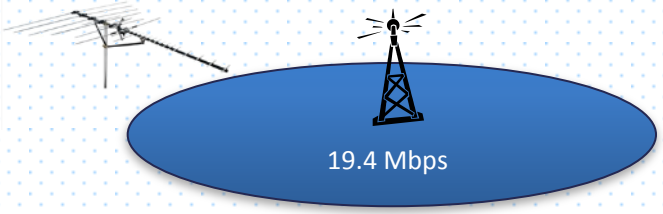

# What do we need (1)?

- A means to OTA broadcast “bits” to a multitude of receivers simultaneously
- Efficient use of spectrum
- Ability to control robustness
- Ability to select operating points to match broadcasters business needs
  - And to utilize multiple operating points simultaneously
- Ability to reach all devices
  - From large screen & rooftop antenna to handheld portable devices and anything in between
- Ability to utilize different network topologies

# Transmission

More Bits To
More Places

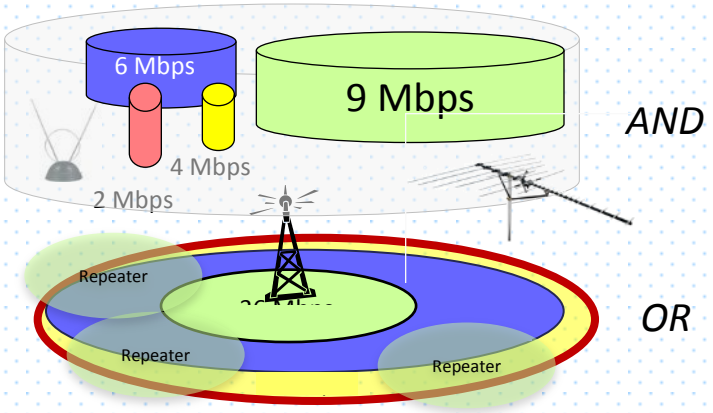
## ATSC 1.0




*8-VSB*

- One bit rate – 19.39 Mbps
- One coverage area – 15 db CNR (rooftop)
- Service flexibility – HDTV, multicast, data

## ATSC 3.0

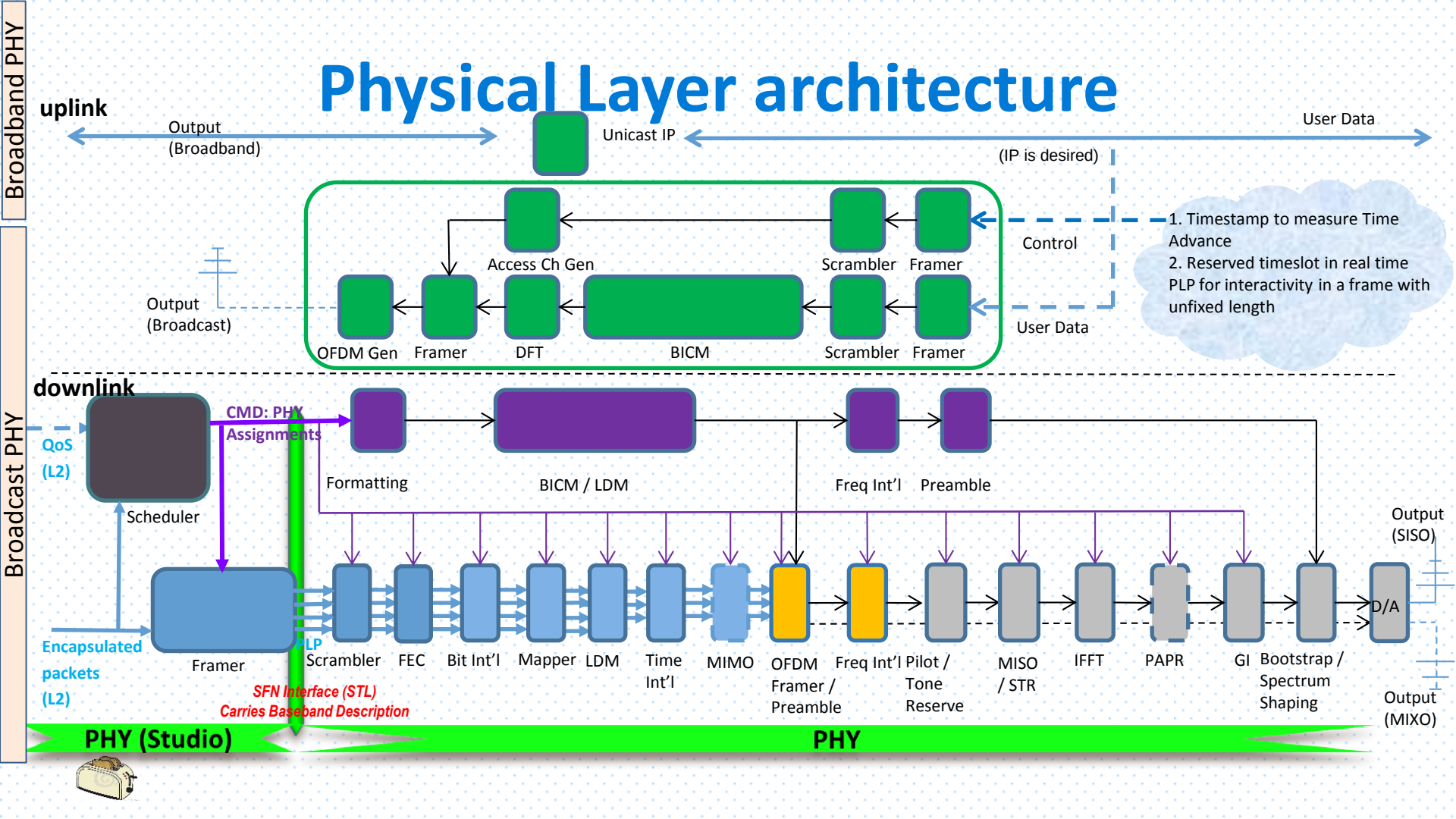



*AND*

*OR*

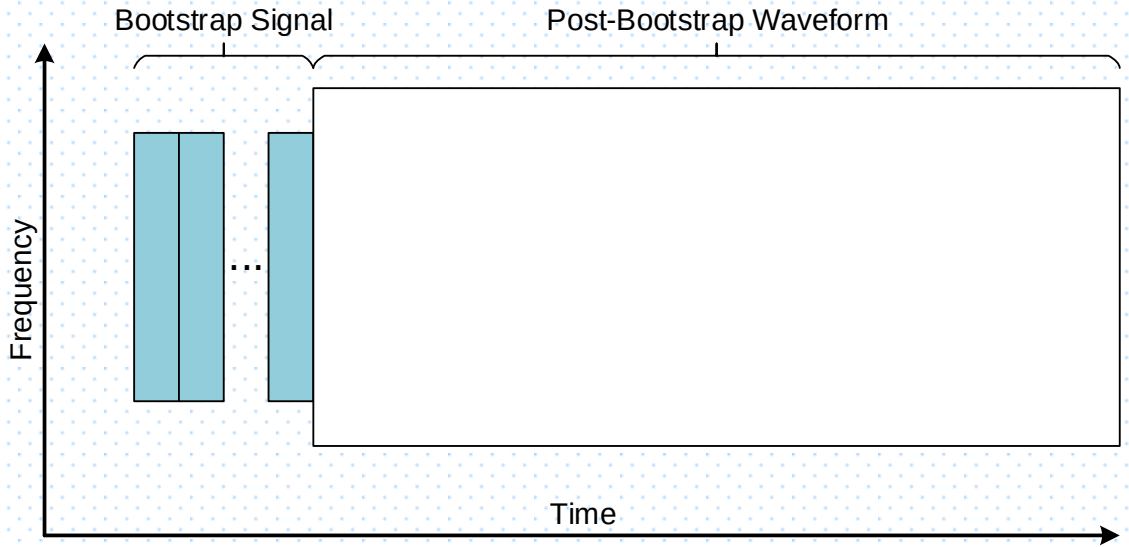
*OFDM with variable-rate LDPC*

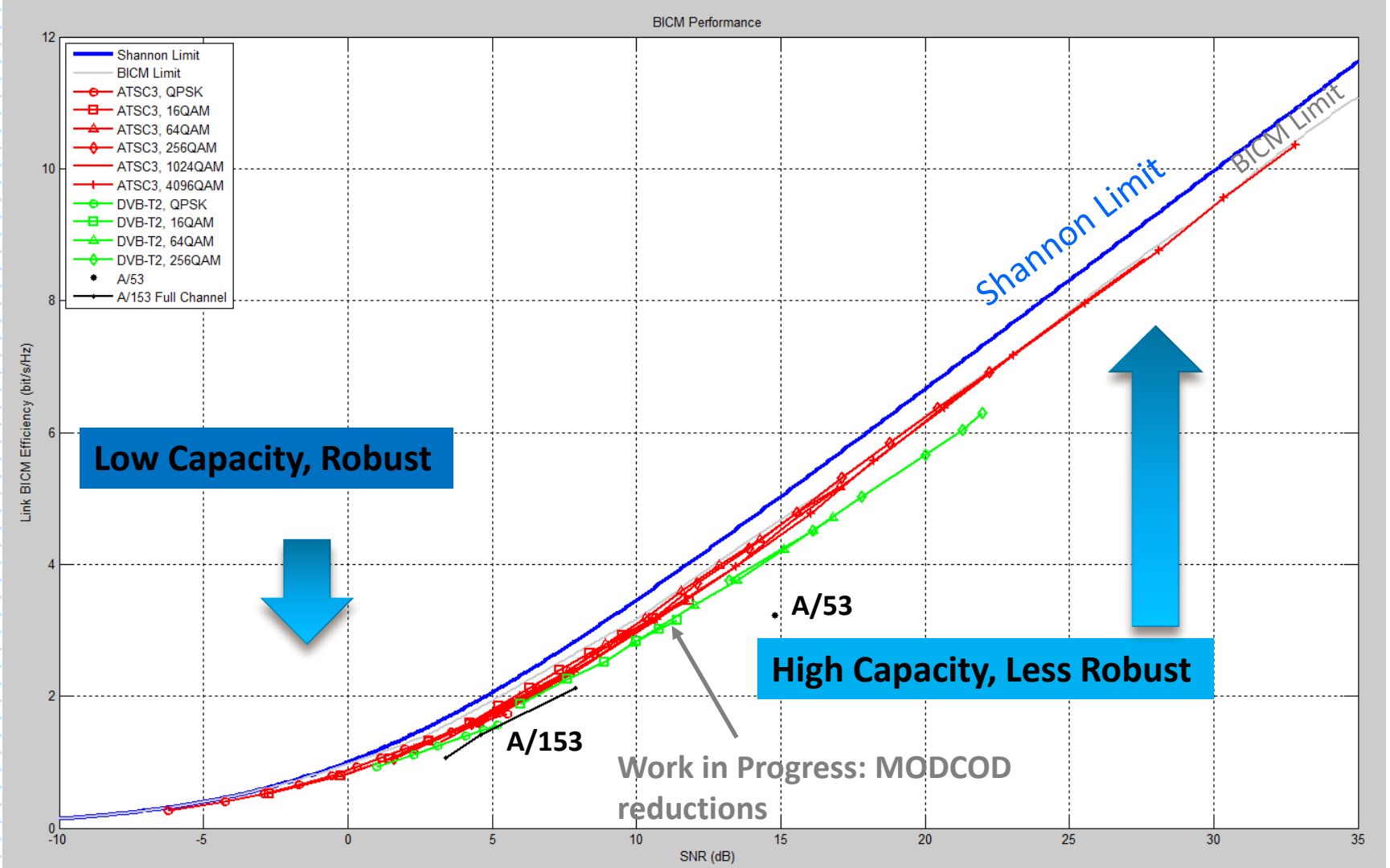
- More bits/Hz – spectrum efficiency near theoretical limit
- Flexible bit rate & coverage area choices
- Multiple simultaneous “bit pipes” – different choices for different broadcast services
  - Physical Layer Pipes (time)
  - Layer Division Multiplexing (power)
  - Channel Bonding
- Optional on-channel repeaters for robust indoor & mobile reception over entire DMA


Broadband PHY
Broadcast PHY
Physical Layer architecture
uplink
Output
(Broadband)
Unicast IP
User Data
(IP is desired)
Access Ch Gen
Scrambler
Framer
Control
1. Timestamp to measure Time Advance
2. Reserved timeslot in real time PLP for interactivity in a frame with unfixed length
Output
(Broadcast)
OFDM Gen
Framer
DFT
BICM
Scrambler
Framer
User Data
downlink
QoS
(L2)
CMD: PHY Assignments
Scheduler
Formatting
BICM / LDM
Freq Int'l
Preamble
Output
(SISO)
Encapsulated
packets
(L2)
Framer
PLP
Scrambler
FEC
Bit Int'l
Mapper
LDM
Time Int'l
MIMO
OFDM Framer / Preamble
Freq Int'l
Pilot / Tone Reserve
MISO / STR
IFFT
PAPR
GI
Bootstrap / Spectrum Shaping
D/A
Output
(MIXO)
SFN Interface (STL)
Carries Baseband Description
PHY (Studio)
PHY

# Bootstrap Synchronization Symbols

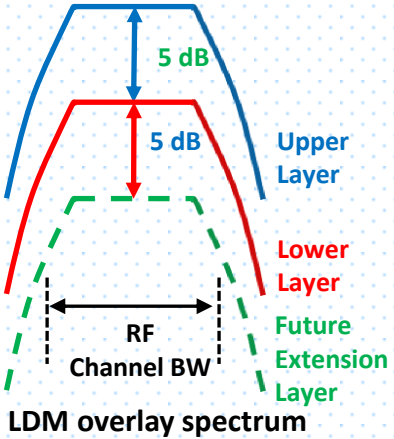
- Robust synchronization
  - Service discovery
  - Coarse time,freq ACQ
  - Initial CH estimation
  - 5MHz bandwidth
  - <-6dB SNR performance
    - with FER = 1E-2
- 22 signaling bits
  - Sampling frequency
  - Channel BW
  - EAS, Preamble selection
  - Time to next similar frame





BICM Performance
Shannon Limit
BICM Limit
ATSC3, QPSK
ATSC3, 16QAM
ATSC3, 64QAM
ATSC3, 256QAM
ATSC3, 1024QAM
ATSC3, 4096QAM
DVB-T2, QPSK
DVB-T2, 16QAM
DVB-T2, 64QAM
DVB-T2, 256QAM
A/53
A/153 Full Channel
Link BICM Efficiency (bit/s/Hz)
SNR (dB)
Low Capacity, Robust
High Capacity, Less Robust
A/53
A/153
Work in Progress: MODCOD reductions

# Layered Division Multiplexing (LDM)

- LDM is a new transmission scheme that uses **spectrum overlay technology** to super-impose multiple physical layer data streams with different power levels, error correction codes and modulations for different services and reception environments;
- For each LDM layer, **100% of the RF bandwidth and 100% of the time** are used to transmit the multi-layered signals for spectrum efficiency and flexible use of the spectrum;
- **Signal cancellation** can be used to retrieve the robust upper layer signal first, cancel it from the received signal, and then start the decoding of lower layer signal;



LDM overlay spectrum

- The **upper layer (UL)** is ultra-robust and well suited for HD portable, indoor, mobile reception. The **high data rate lower layer (LL)** transmission system is well suited for multiple-HD and 4k-UHD high data rate fixed reception.
- **Future Extension Layer (FEL)** can be added later with full backward compatibility.

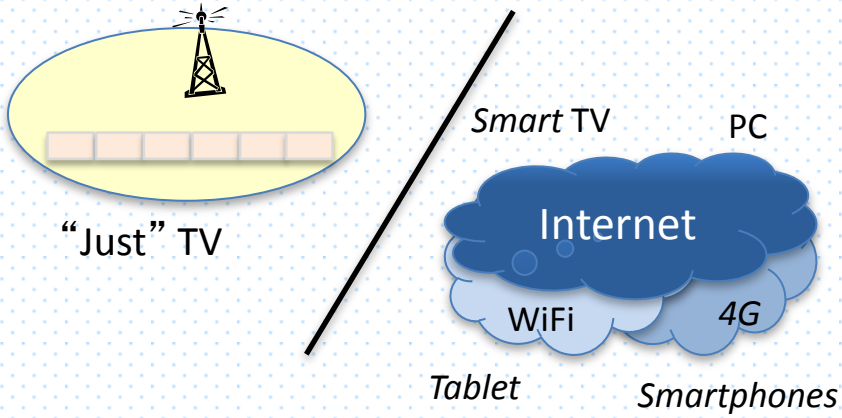
# What do we need (2)?

- A means to transport the components to the receiver
  - Both in broadcast and over broadband
- A means to segment and reassemble into/out of the physical layer
- A means to organize the bits associated with components of a service
- A means to associate components of services
- A means to tightly synchronize component presentation
  - No matter how the components are delivered
- A means to provide a guide for the viewer
- A means to personalize services
- A means for a receiver to understand what it is playing via an intermediary system

# Protocols

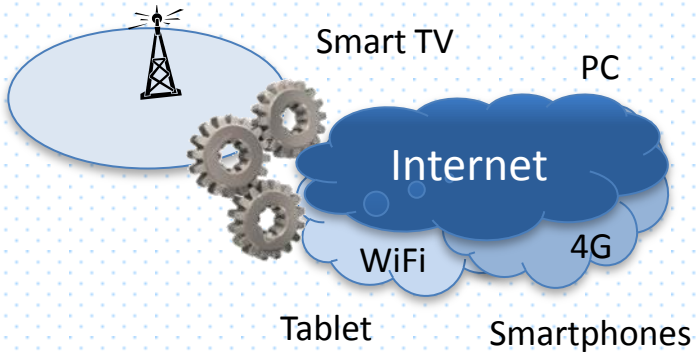
**Broadcasting Becomes Part of the Internet**

## ATSC 1.0




- MPEG-2 Transport Stream provides service flexibility for multicasting
- But Broadcasting isn't part of the internet … and its massive global investment

## ATSC 3.0

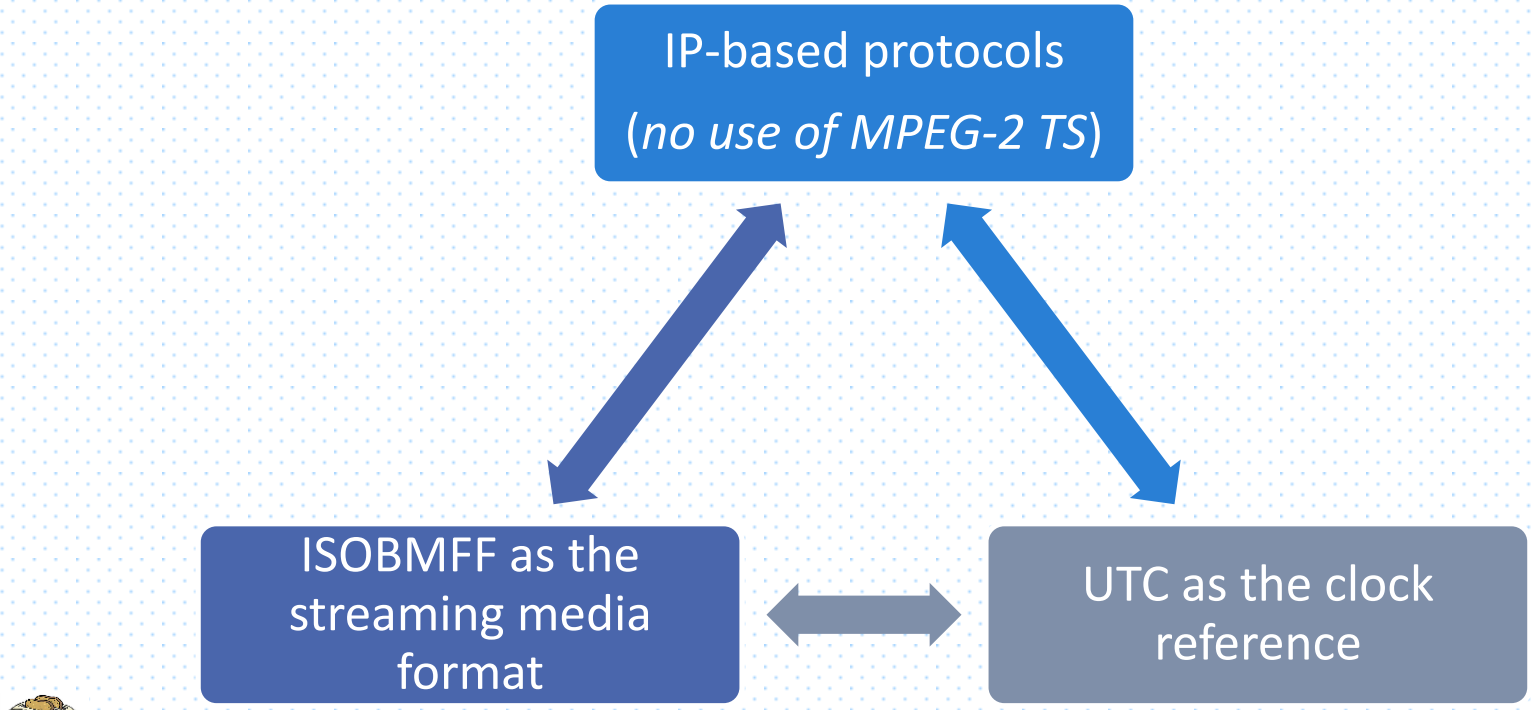



- Internet Protocol based - enable broadcasting to become PART OF the wireless internet
- Encryption, Conditional Access / DRM enables monetization
- File delivery enables VOD and Dynamic Ad Insertion

# Component Synchronization

- Synchronization of components must work, no matter what the delivery mechanism
  - Broadcast, Broadband or Hybrid (Broadcast & Broadband)
  - “Streamed”, “Fetched” or Pre-delivered
- Universal Time (potentially UTC) rather than recreation of encoder clock
  - Working through how to carry time in system & what precision needed where
  - Likely to utilize SMPTE PTP in some fashion

# Key features of ATSC 3.0 Management & Protocols



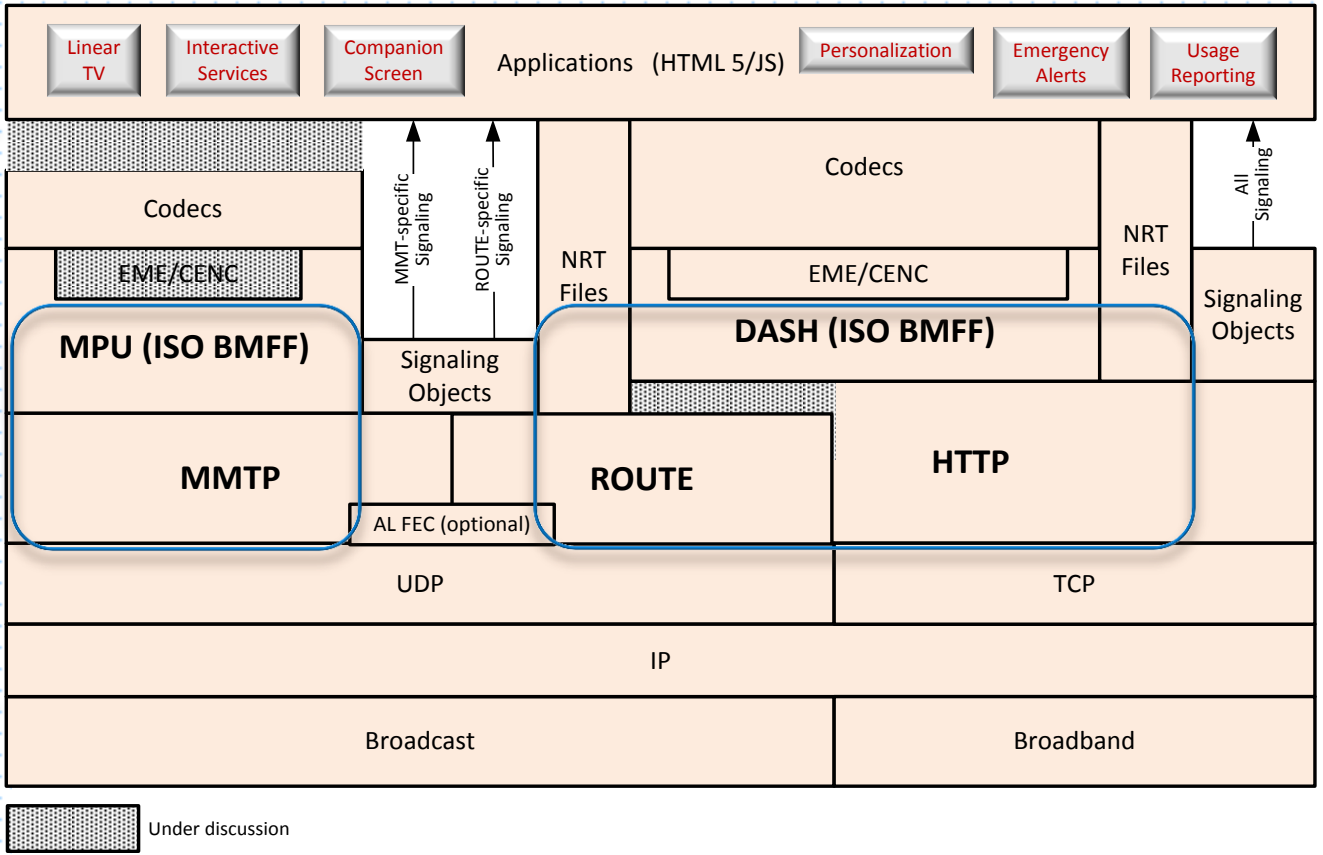
# Conceptual Protocol Model

Linear and App-based Services

Encoding, formatting and Service Management

Delivery (OSI Model)

7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data Link
1. Physical



# Benefits of IP transport

- Broadcasting no longer an independent silo
  - Take advantage of evolution speed of Internet
- Broadcast & Broadband as peer delivery mechanisms
  - Enables new types of hybrid services
  - Ability to seamlessly incorporate niche content
- Enable new business models
  - Localized Insertion
    - Ads or other content
    - Allows revenue model for broadcasters that has been available to cable or IPTV operators

# What do we need (3)?

- A means to provide “pretty” moving pictures
  - UHDTV: 4K (initially), High Dynamic Range, Extended Color Gamut, High Frame Rate
  - On a multitude of devices – from large screens on the wall to small hand-held devices
  - Coded as efficiently as possible
- A means to provide high quality audio
  - Immersive in 3 dimensions
  - Personalizable – control of dialog, selection of audio tracks
  - Rendered at receiver to match device capabilities/speaker configurations
  - Loudness and Dynamic Range control capabilities
- A means to support accessibility – including captioning
- A means to support applications and interactivity
  - Application environment

# Presentation

**Better Pictures & Sound and/or More Services**

## ATSC 1.0

Standard Dynamic Range and Color

100-nit color grading, Rec. 709 color, 8 bits/pixel

- Allows HDTV & SD multicast
  - HDTV – MPEG-2 (12 – 18 Mbps)
  - SDTV – MPEG-2 (3 – 5 Mbps)
  - 5.1 Dolby Digital surround sound

## ATSC 3.0

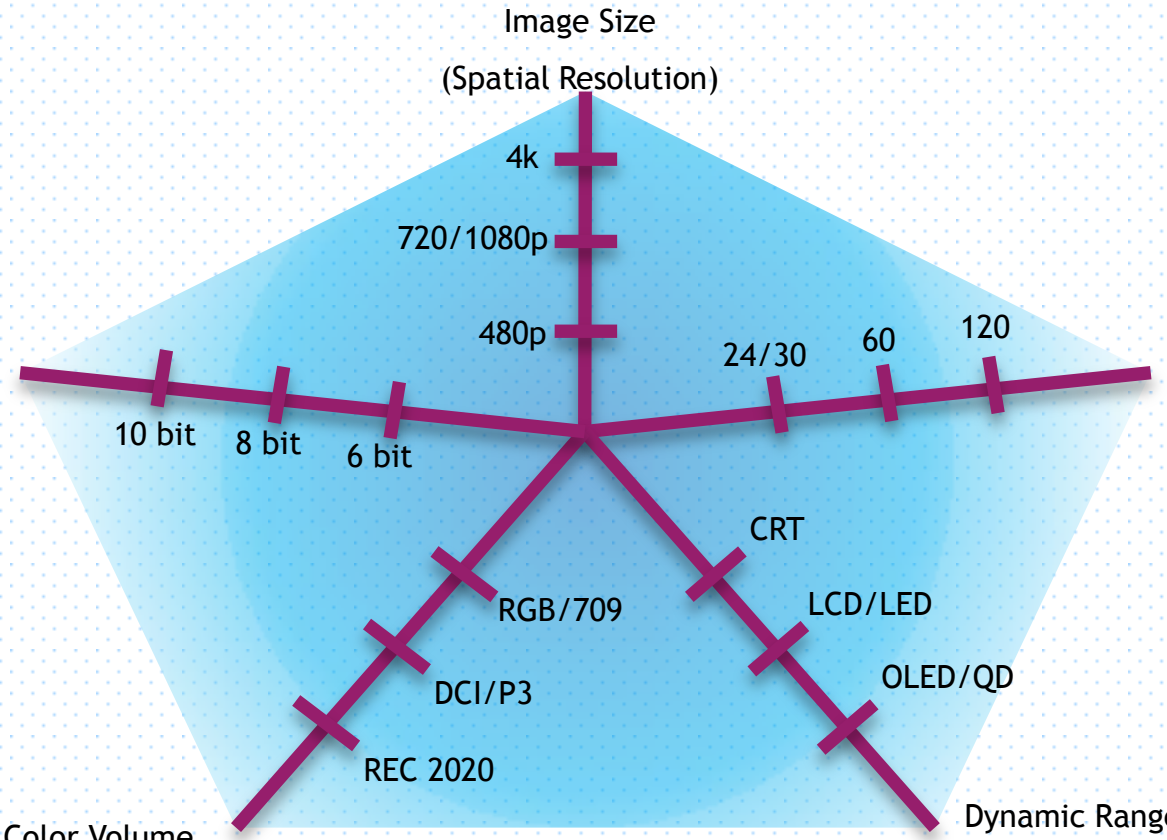
High Dynamic Range and Wide Color Gamut

1000-nit color grading, Rec. 2020 color, 10 bits/pixel

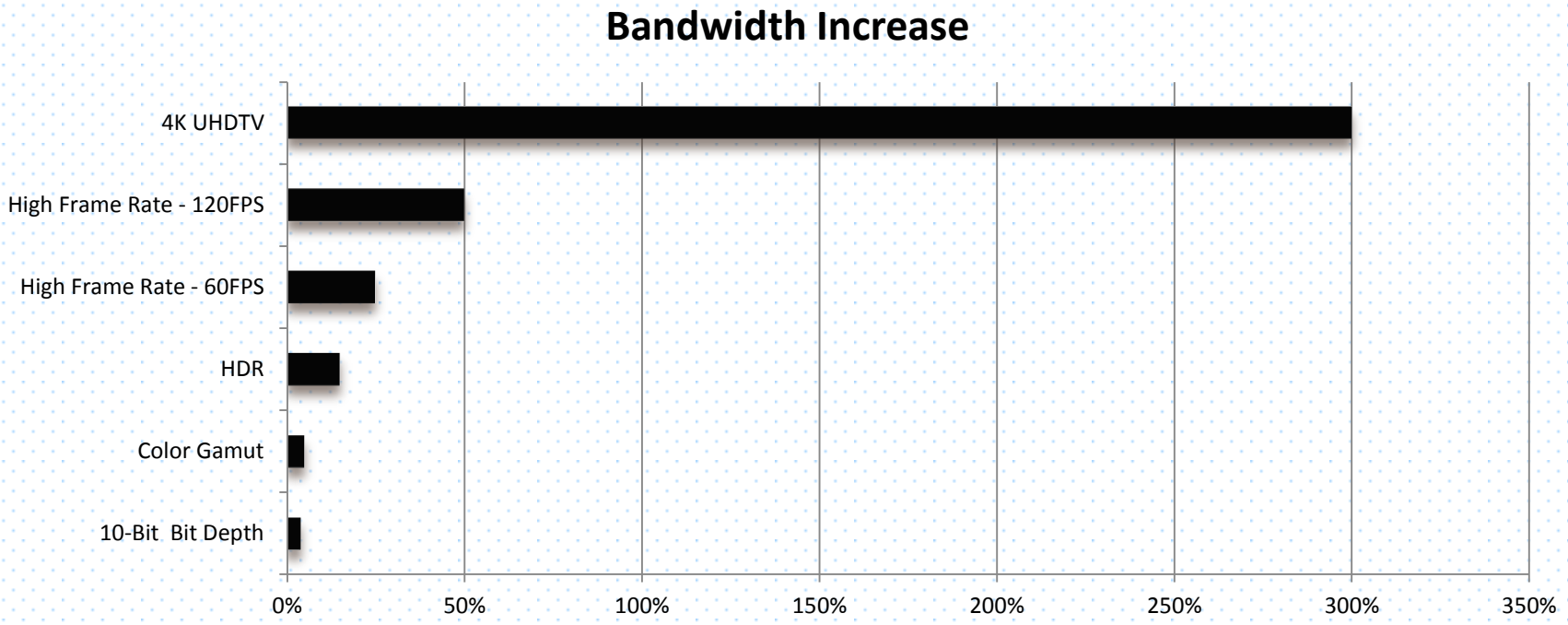
- Allows UHD and/or HD multicast
  - Super-4k – HEVC (18 – 30 Mbps)
  - Super-HD – HEVC (8 – 12 Mbps)
  - HD – HEVC (3 – 8 Mbps)
  - SD – HEVC (1 – 2 Mbps)
  - Immersive Audio

*estimated bit rates*

# Video: Multiple Degrees Of Freedom

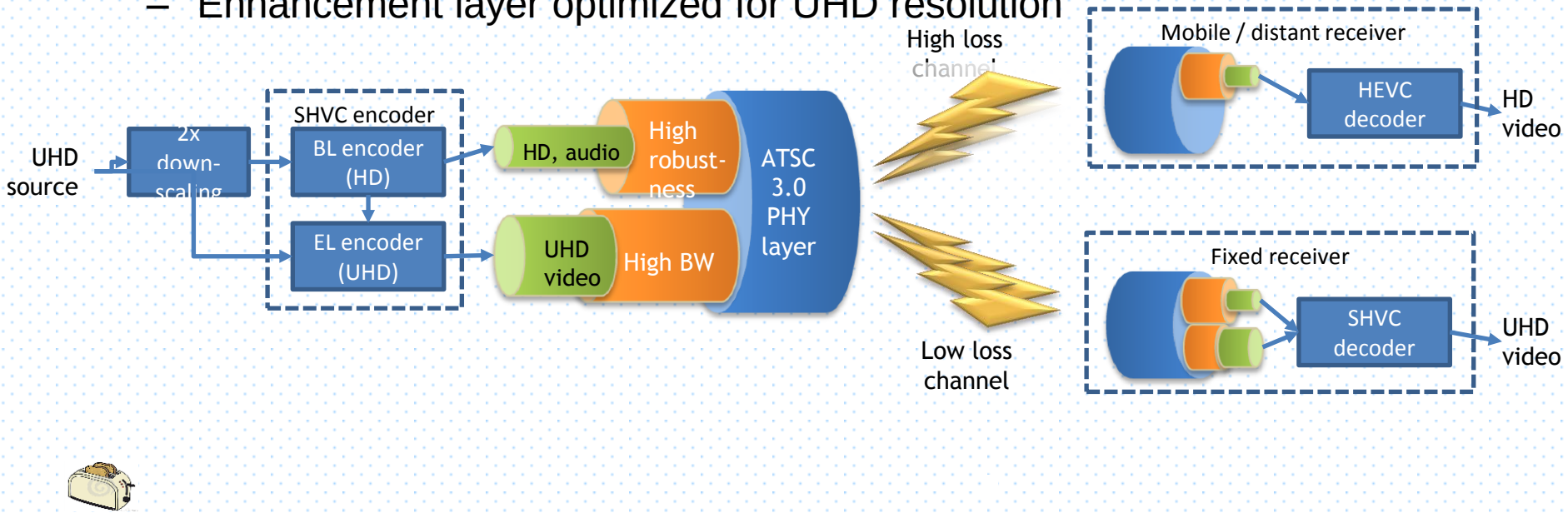


# Relative Bandwidth Demands Of 4K, HDR, WCG, HFR




# SHVC: Layered Video Coding

- HEVC with scalable extensions (aka SHVC)
  - 2x spatial scalability between base layer (BL) and enhancement layer (EL)
  - Base layer optimized for mobile reception
  - Enhancement layer optimized for UHD resolution



# Applications

Internet Experience
Personalized & Dynamic

## ATSC 1.0


- Pictures, Graphics and Sound are “burned in”
- Same experience for entire audience

## ATSC 3.0

HTML 5

HbbTV


- HTML5/Internet overlay graphics
- Hybrid delivery - merge broadcast & internet
- Dynamic Ad Insertion
- Personalized Graphics
- Interactivity
- Synchronized second-screen applications
- Immersive Audio - user control of tracks and mix
- Audience Measurement capabilities

# Audio: Personalization

- Ability to *efficiently* customize an audio experience with channels/objects:
  - Choose language

  - Choose commentary

  - Address impairments with description and improved intelligibility
  - Normalize loudness of all content

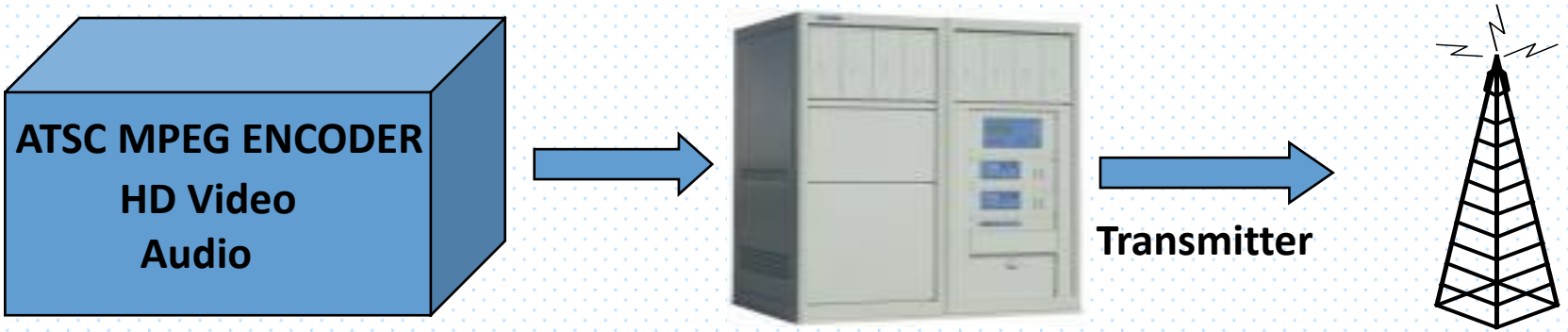

  - Contour dynamic range to the unique user, device and environment






# Personalization: Dialog Enhancement

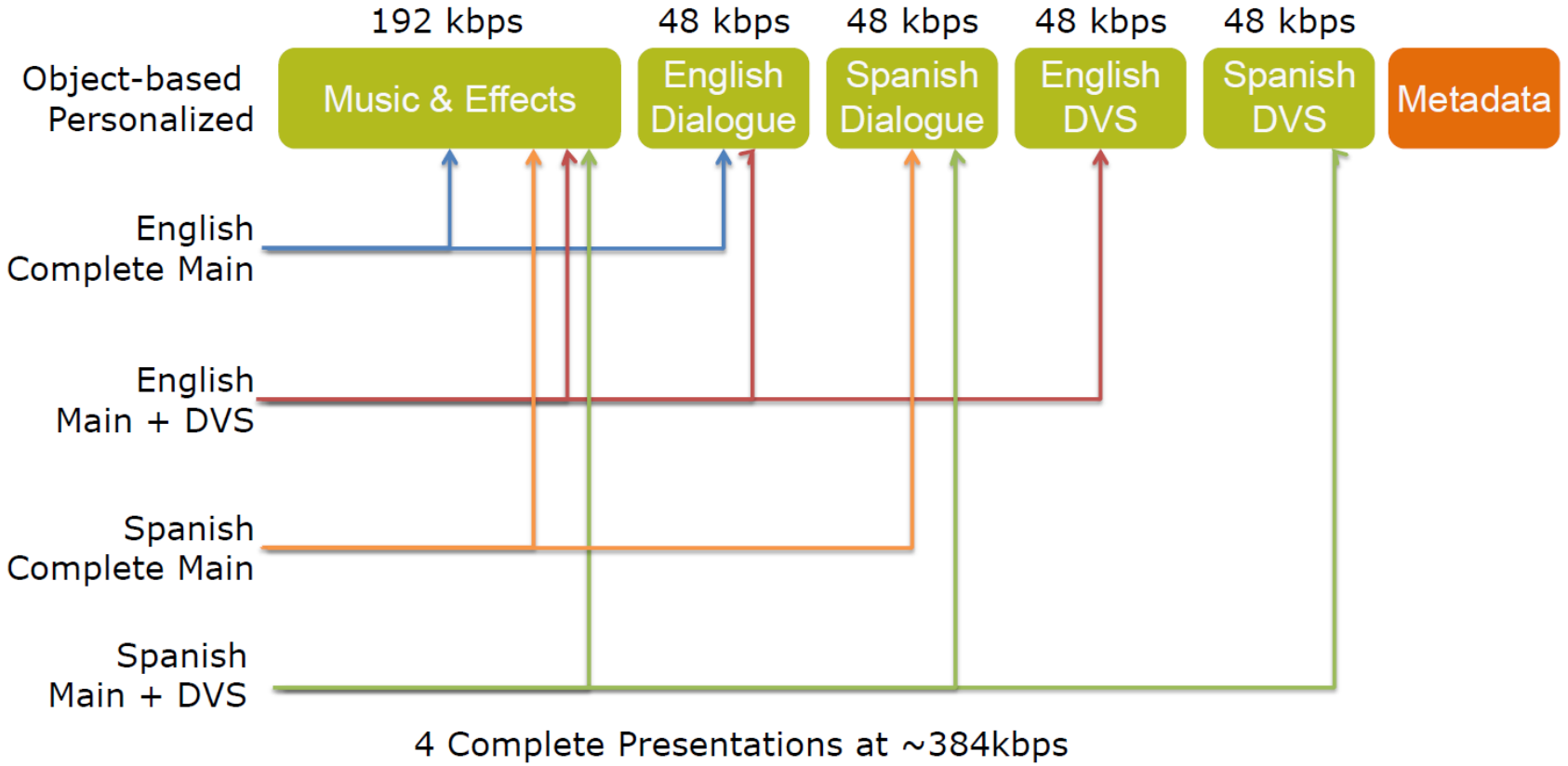
# Transmitting Audio: ATSC-1




- 1 Complete Main (Stereo or 5.1) **384 kb/s**
- 1 Ancillary Soundtrack (Alternate Language or VDS) ~**192 kb/s** (usually mono)

**576 kb/s**

# Transmitting Audio: ATSC-3




**384 kb/s!**

Dolby Laboratories

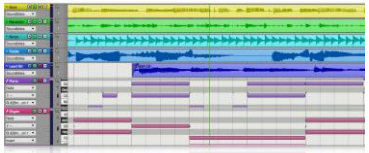
# Immersive, Enhanced Surround Sound

- Improved spatial resolution in sound source localization
  - Sound with improved azimuth, elevation and distance perspective
  - Use of objects or “elements” and steering metadata (similar to fader automation)
  - Metadata allows rendering at the decoder, customized to the user’s sound system
  - The decoder places the sound in the most accurate position the user’s sound system supports


ATSC 3.0 Supports Multiple Platforms!

# Rendering:

## Creative Intent: Multiple Elements

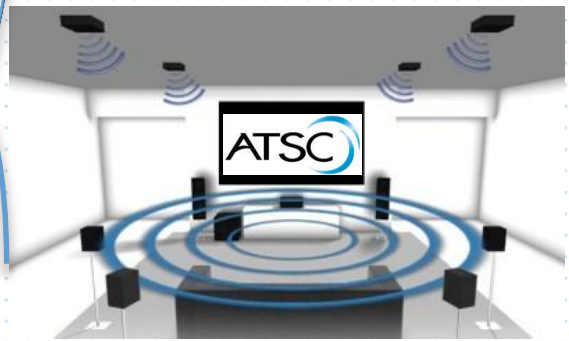



METADATA

## Decoder's Renderer



## Consumer's Capabilities



# What do we need (5)?

- A means to support subscription and pay-per-view services
- A means to support security for broadband services
- A means to support 2 way trust between primary and second screens
- A means to support certificates and their revocation
- A means to support security for interactive applications

# New Public Service Capabilities

- Emergency Alerting
  - Extremely robust EAS “wake up” signaling
  - Advanced EAS messaging capabilities
  - Ability to efficiently send rich media (maps, video clips …)
  - Ability to reach indoor, battery-powered receivers
- Robust Audio and Closed-Caption transmission even when picture fails
- Improved audio intelligibility for hearing impaired
  - New capabilities for improved dialog/narrative intelligibility (track – specific volume control)
  - Continued support for Video Description Services

# Overall Schedule

2012 2013 2014 2015 2016

System Requirements

CFP Proposals Evaluate Select

Working Drafts

Candidate Standards

Proposed Standards

Standards

Industry

Technology Demos

Testing

Product Design

Commercial Launch

# In Summary


- Will not be backward compatible to the legacy system
- UHDTV & Immersive Audio
- Personalization
- Robust delivery to multiple platforms
- Supports viability and new business models of broadcasters
- Flexible to accommodate future improvements and developments

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www.atsc.org

# THANK YOU!

BTS IEEE Broadcast Technology Society

triveni DIGITAL