Next Generation DTV: ATSC 3.0

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The DTV Standard

- High-Definition
- Multicasting
- 5.1 Digital Surround Sound
- Electronic Program Guides
- Enhanced Closed Captioning
- Enabled government goal of reclaiming spectrum
- Backwards compatible enhancements

ATSC 3.0

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- ATSC 1.0, is 20 years old!
  - It incorporates technologies are about 25 old
- Industries prosper by leveraging new technology
  - Broadcasting is no different
- Broadcasting needs new capabilities and increased capacity
  - While spectrum is being reduced

ATSC 3.0

- Revolution
  - Complete new system
  - Non-backwards compatible
  - Will offer significant performance improvements and new services
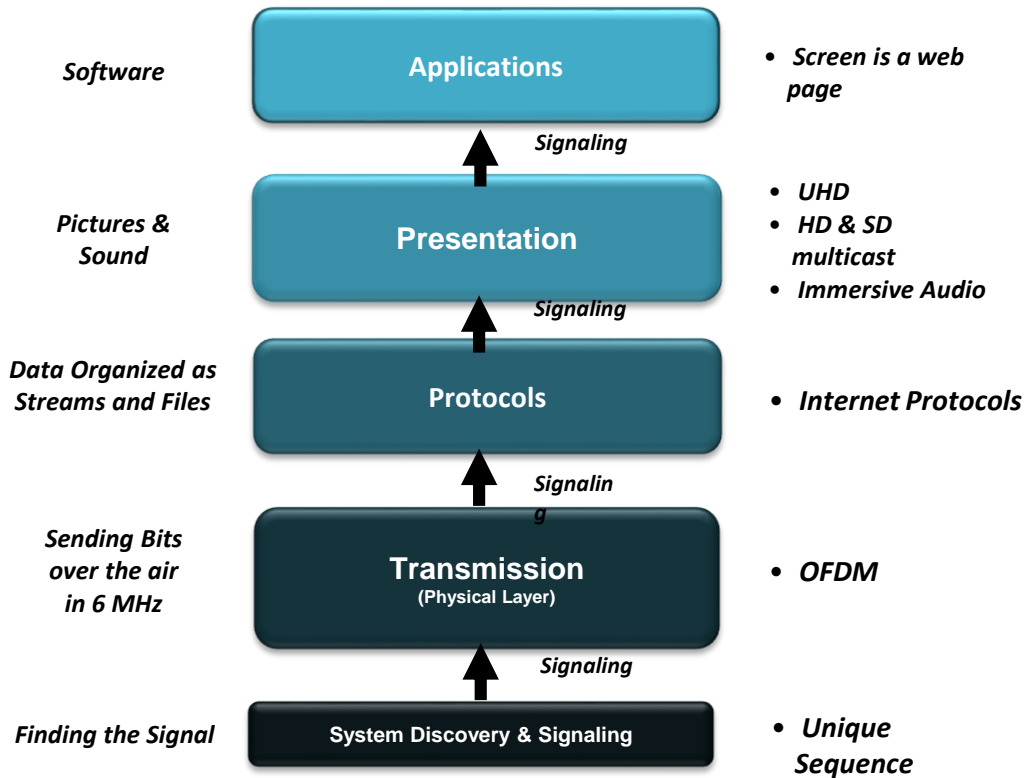
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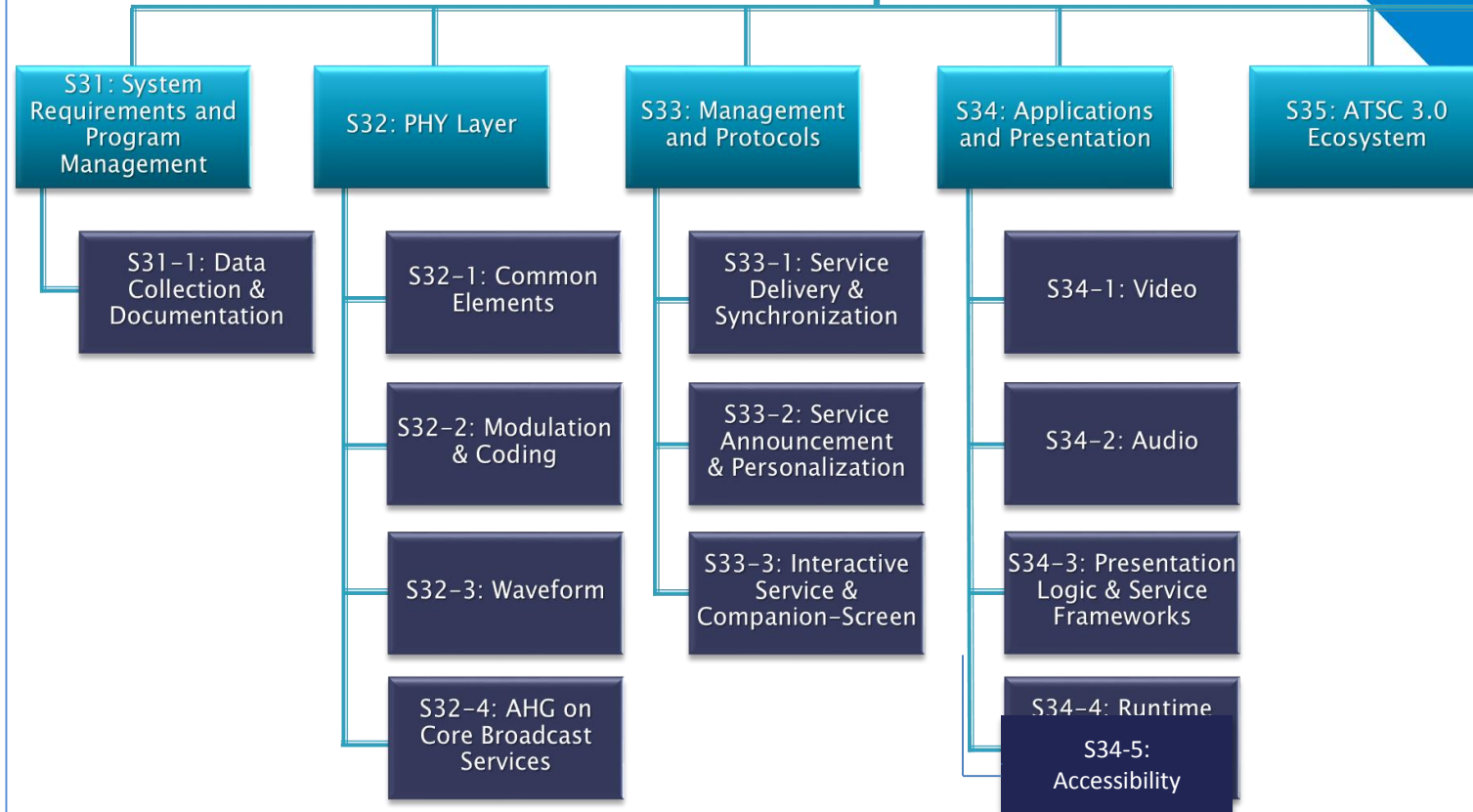
ATSC 3.0 Overview

- 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

Overview - ATSC 3.0 System Layers

Software — **Applications** — • *Screen is a web page*

Signaling

Pictures & Sound — **Presentation** — • *UHD* • *HD & SD multicast* • *Immersive Audio*

Signaling

Data Organized as Streams and Files — **Protocols** — • *Internet Protocols*

Signaling

Sending Bits over the air in 6 MHz — **Transmission** (Physical Layer) — • *OFDM*

Signaling

Finding the Signal — **System Discovery & Signaling** — • *Unique Sequence*

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ATSC 3.0: Physical Layer

- **Flexible,** robust transmission system
  - Greater capacity (more bits per Hz)
  - Ability to trade-off capacity for robustness
  - Robust System Discovery and signaling
  - Integrated mobile/handheld capabilities
  - Flexible bit rate and coverage area choices
  - Enable on-channel repeaters for robust indoor and mobile reception
  - Channel bonding enables spectrum sharing
  - Return channel option for emerging markets
  - Spectrum Efficiency
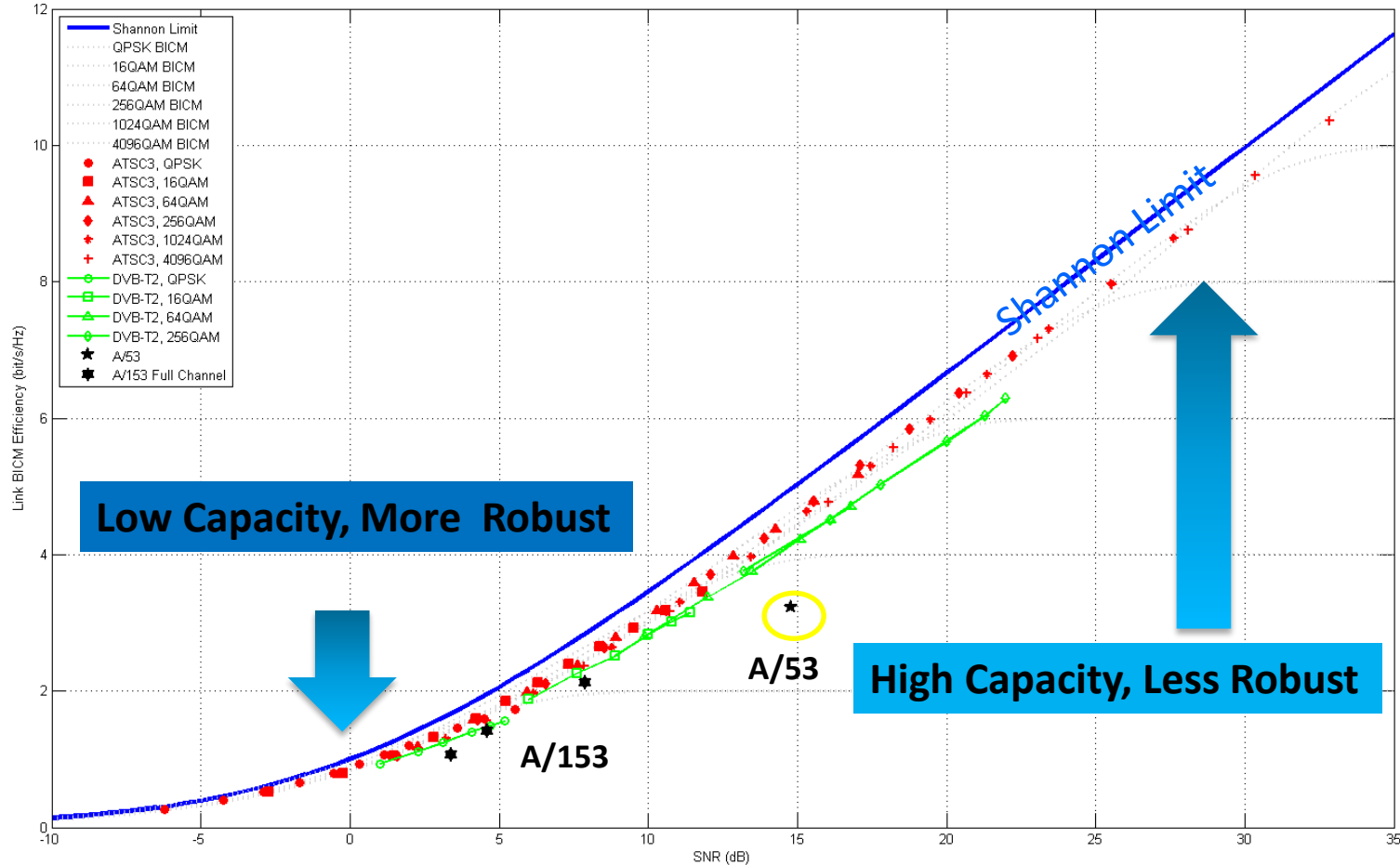
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Physical Layer Similarities

- Same FFT sizes of 8K, 16K and 32K
- Time Division multiplexing option
- Physical Layer Pipe concept is same, Multiple PLP is a likely use case
- Hierarchical preambles preceding frames
- Low Density Parity Check for Forward Error Correction is similar, but there are new codes with different code rates

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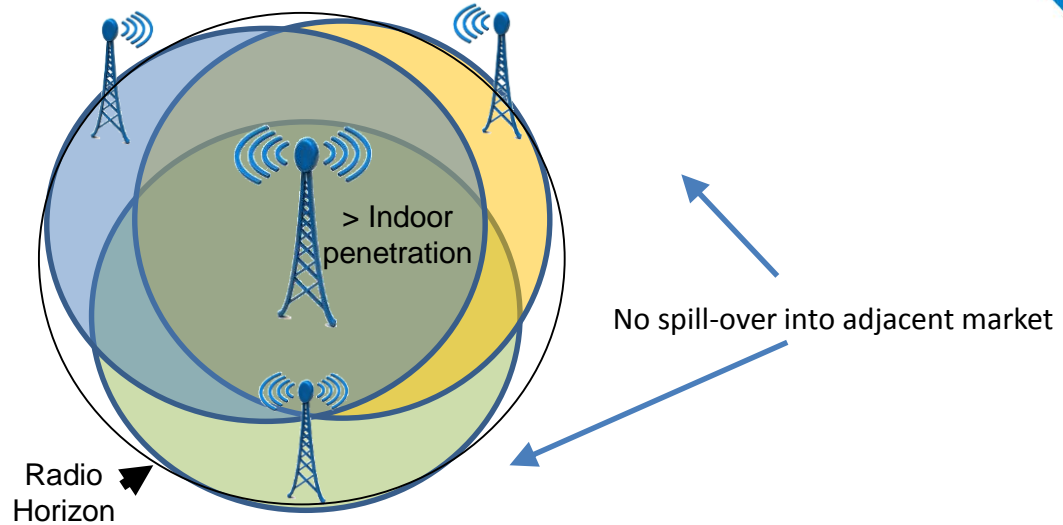
Physical Layer Enhancements

- Bootstrap signal has -10dB C/N robust performance for synchronization and tracking of system types
- Non Uniform Constellations provide more than 1dB performance gain
- Higher modulation order options (up to 4096 QAM)
- Layered Division Multiplexing addresses robust service area
- Wider range of SNR operating points (-6dB to over 30dB)
- 4 PLPs per service assignment for graceful operation (robust audio, scalable video coding options)
- Channel bonding enables spectrum sharing

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BICM Performance

Network Flexibility

> Indoor penetration

No spill-over into adjacent market

Radio Horizon

Management & Protocols

- Management and Protocols Layer
  - Service delivery and synchronization
  - Service announcement and personalization
  - Interactive services and companion screens
  - Redistribution support / watermarks
- **IP transport** (only) will be used for broadcast delivery of both streaming and file content
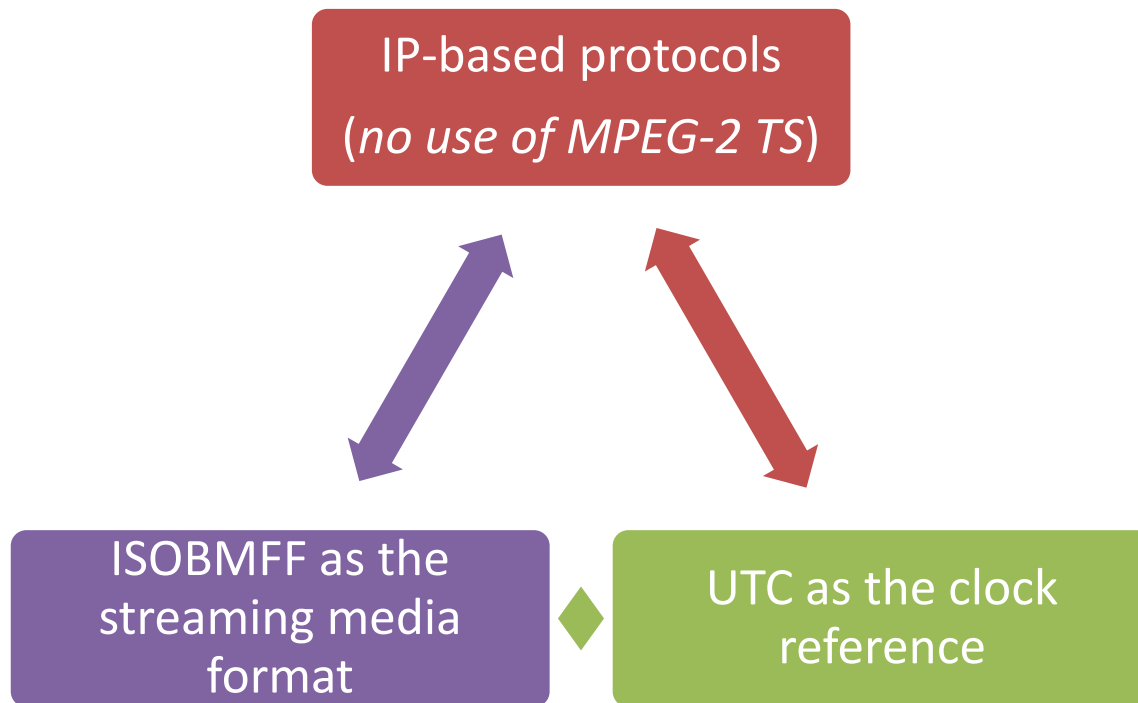 - Broadcasting is part of the internet!

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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

Key features of
ATSC 3.0 Management & Protocols

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IP-based protocols
(*no use of MPEG-2 TS*)

ISOBMFF as the
streaming media
format

UTC as the clock
reference

Applications and Presentation

- The application and presentation layer is focused on what the consumer experiences
  - Video
  - Audio
  - Closed Captions
  - Interactivity, personalization, alternative component selection, etc.

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ATSC 3.0: Video

- UHDTV is a key goal of ATSC 3.0
  - 4k is the current focus, with 8k possible in the future
    - Resolution of 3840 × 2160
    - Frame rate of 60 Hz; 120 Hz is under consideration
- High dynamic range
- Wide color gamut (Rec. 2020)
- 10 bits/pixel
- HDTV delivery to mobile and handheld devices such as tablets
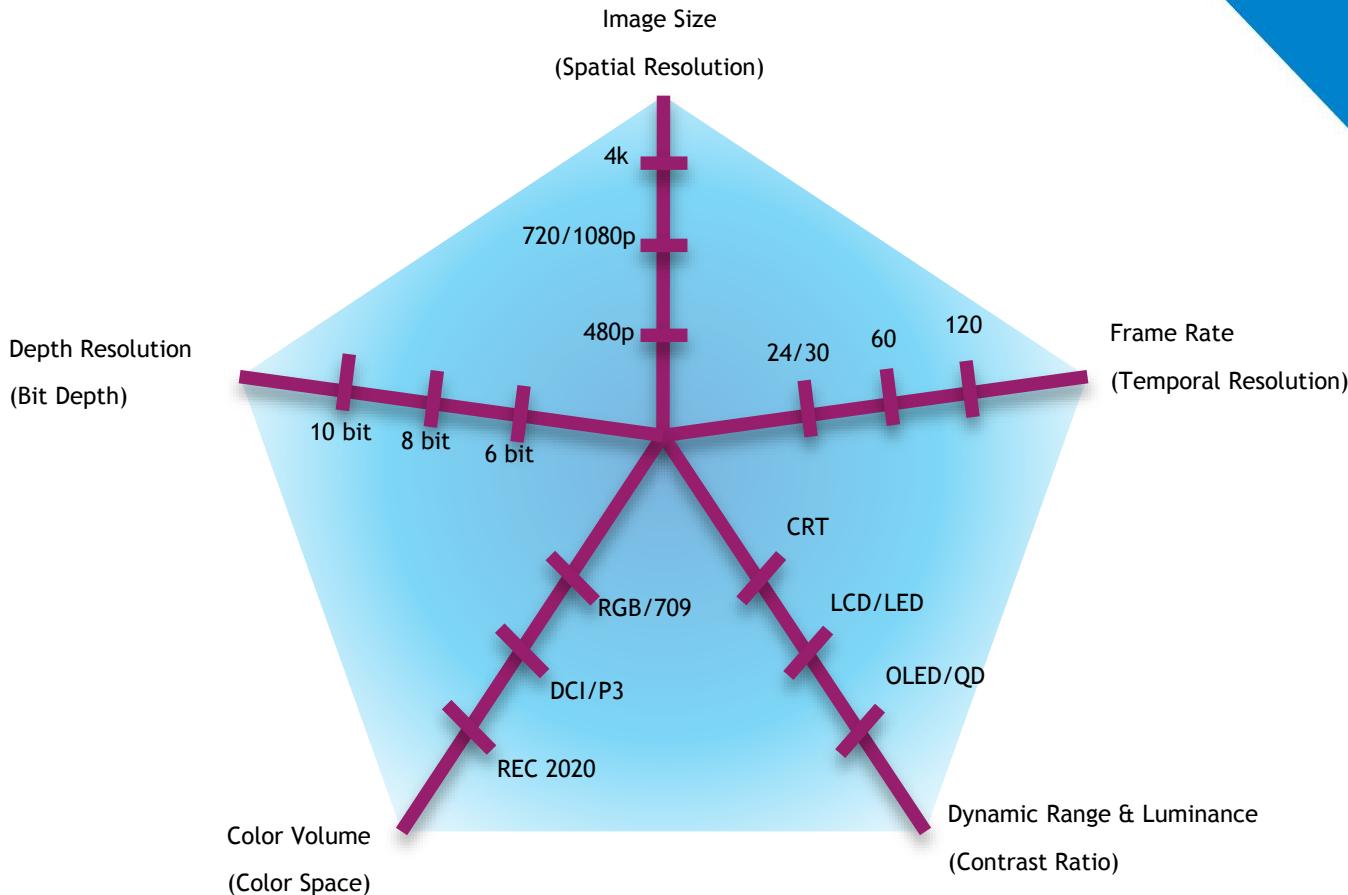
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ATSC 3.0: Video

- The ATSC 3.0 video system will take advantage of recent advances in coding technologies

- **MPEG HEVC**
  - Scalable video coding is being carefully studied
    - Attractive for possible efficiency gains
    - System complexity may be an issue
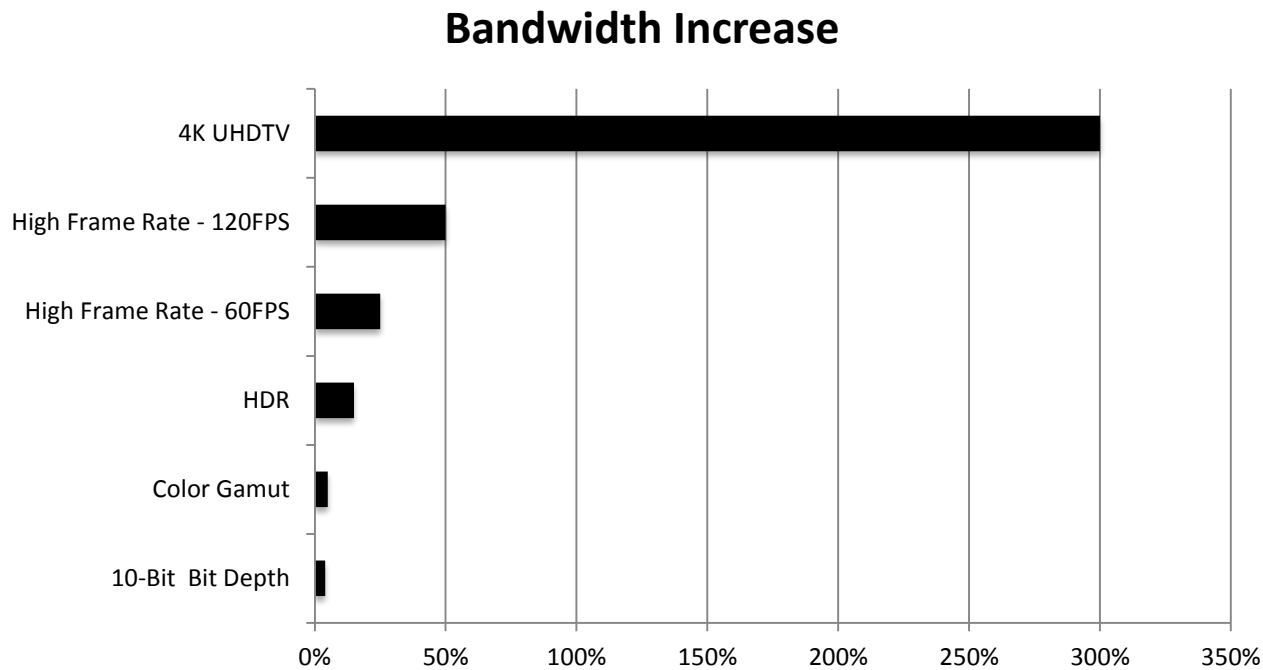   - A promising system for delivery to multiple platforms

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

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Bandwidth Increase

Category	Bandwidth Increase
4K UHDTV	~300%
High Frame Rate - 120FPS	~50%
High Frame Rate - 60FPS	~25%
HDR	~15%
Color Gamut	~5%
10-Bit Bit Depth	~5%

0%   50%   100%   150%   200%   250%   300%   350%

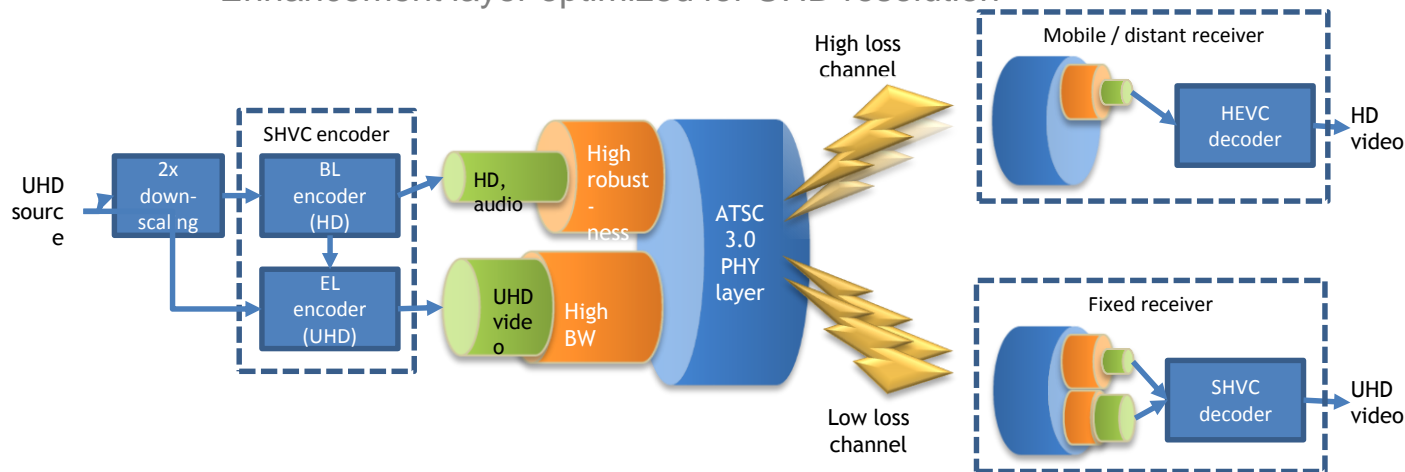# SHVC: Layered Video Coding

- 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

ATSC 3.0: Audio

- Immersive audio features will provide
  - High spatial resolution in sound source localization
    - Azimuth, elevation, distance
  - Increased sound envelopment for an enhanced "suspension of disbelief"
- ATSC 3.0 audio targeted to various devices
  - Fixed, mobile & handheld
  - Differing speaker set-ups, and headphones
    - Including sub-optimal set-ups

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ATSC 3.0: Audio

- ATSC 3.0 audio will provide for selectable, mixable audio components
  - Control of dialog
    - Hearing-impaired can raise dialog level
  - Alternate audio tracks
    - Multiple language tracks
    - Special commentary, and music and effects tracks
  - "Being there mode"
    - Allows viewers to select elements of the program mix and adjust to their preferences

ATSC 3.0: Audio

- A Call for Proposals for ATSC 3.0 audio technologies was issued in December 2014
  - Two systems now under consideration
    - Dolby
    - MPEG-H Alliance (Fraunhofer, Technicolor & Qualcomm)
- Test content has been collected and selected
- Proposed systems are are being evaluated

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ATSC 3.0: Interactive

- Robust App Runtime Environment with HTML5 support

- Based on HbbTV 2.0 with restrictions and extensions
  - HbbTV 2.0 was published earlier this year
  - 20+ extensions being documented, several based on ATSC: A/105 (aka "ATSC 2.0"), now in Candidate Standard phase
  - Changes being documented due to ATSC 3.0 IP delivery solution (HbbTV is based on MPEG-2 TS)

Interactive – a few sample uses

- Targeted ad insertion
- On demand interface
- Multiple videos, eg PiP
- T-commerce
- Voting/polling
- Games
- News and sports feeds
- Notifications/reminders

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ATSC 3.0: Accessibility

- Initial focus is Closed Captioning
- General agreement Closed Captions is its own essence
  - Decouple CC from video in ATSC 3.0

ATSC 3.0: Watermark

- Programs delivered to a TV via multichannel video program distributors (MVPDs) typically do not contain all components of the original terrestrial broadcast
  - Cable, satellite, HDMI
- Certain ATSC 3.0 functionality designed to be discovered and interpreted by the TV could be lost
  - For example, interactive applications associated with the main program
- Watermarking based Automatic Content Recognition (ACR) is a promising solution being pursued
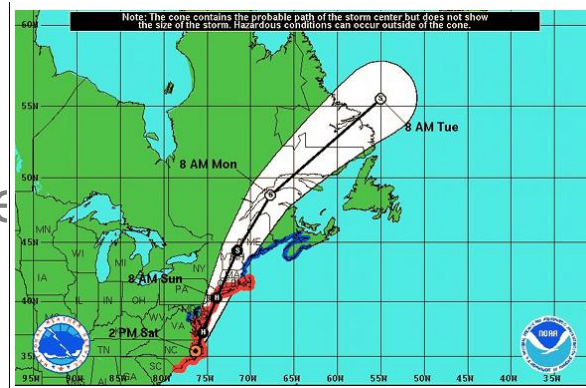
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ATSC 3.0: Watermark

- Evaluation is complete
  - Video watermark
  - Audio watermark
  - Fingerprinting specification currently under development (A/105, "Interactive Services Standard") likely to be included
- ATSC is staying abreast of related work in other SDOs
  - SMPTE, OpenID

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Advanced Emergency Alerts

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- Builds on AWARN system (aka M-EAS, ATSC: A/153 part 10)
- Receivable on ALL devices: Mobile and Fixed Home
- CAP & IP compatibility
- Ability to deliver rich media content
- Targeted alerting and content delivery
  - Geo-locational and User Types
  - No all-market interruption of TV service
- Ability to wake up targeted receivers
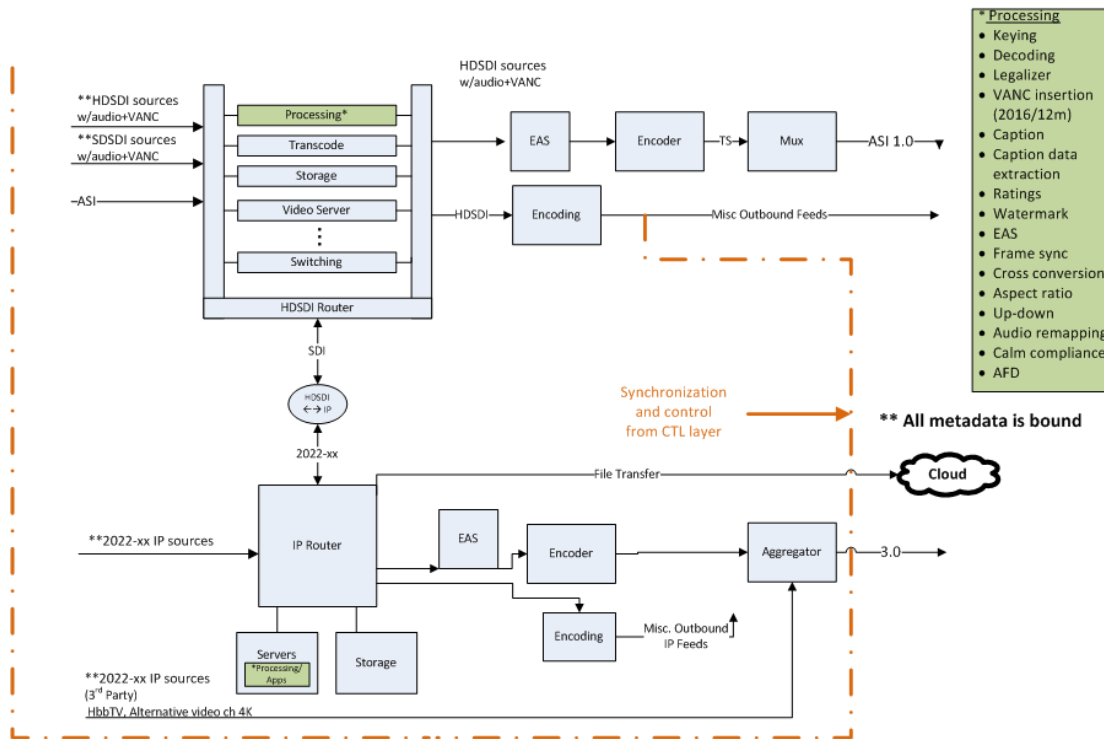- Robust delivery

ATSC 3.0: Ecosystems

- Produce Block Diagrams
  - Characterizing ATSC 3.0 Ecosystem by Layers
  - Models Sufficient to Cover Wide Range of Cases
  - Not Explicitly Representative of Any Specific Cases
- Produce Report Explaining ATSC 3.0 Ecosystem
- Aid Development of ATSC 3.0 Standards
- Aid Implementation of ATSC 3.0
- Educate Eventual Implementers

Ecosystem Example: Video – 1-5 Yrs

CEA R4WG18

- Receivers for Next Generation Broadcast Television
  - Develops recommended practices and technical reports on ATSC 3.0 receiver characteristics
  - Receiver Profiles

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
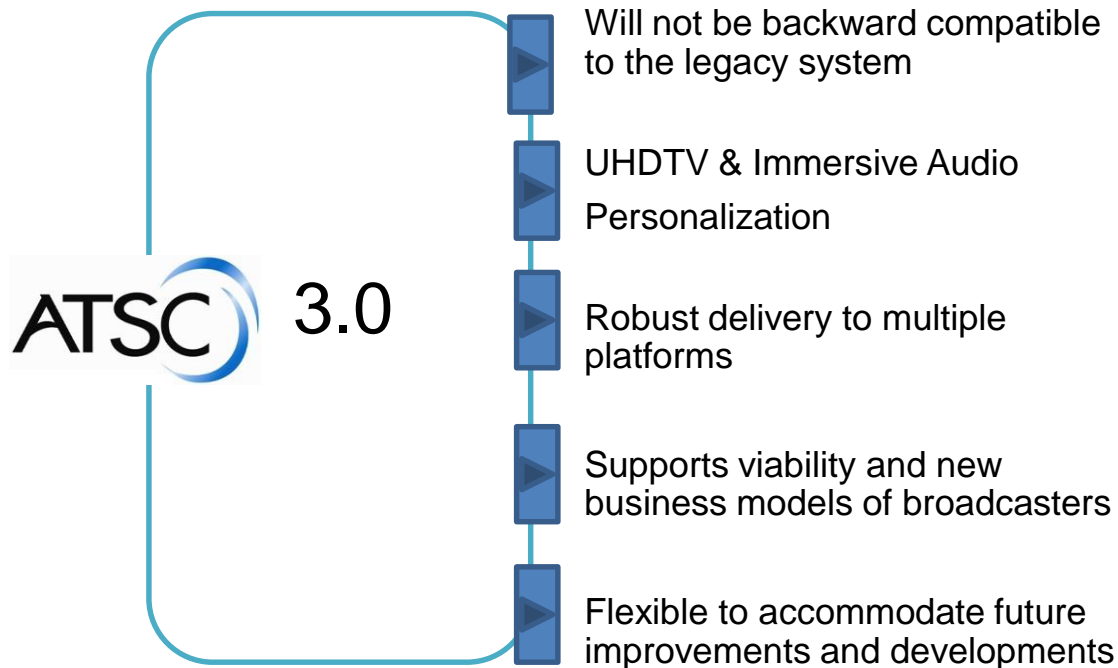   - United States

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Schedule

- ATSC 3.0 is a suite of standards
    - One or two standards per layer
    - Each Standard moves through the process independently
    - Most will move to Candidate Standard in 2015
    - Final approval of each document expected in 2016 with completion of all in the first/second quarter of 2017

In Summary

ATSC 3.0

- 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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THANK YOU!