Status Report: ATSC 3.0

13 OCTOBER 2016

Agenda

- About the Advanced Television Systems Committee
- Overview of ATSC 3.0
- Specialist Group Activities
- Document Development Status
- Next Steps

ABOUT THE ADVANCED TELEVISION SYSTEMS COMMITTEE

About the ATSC

Standards development organization for digital television

- Founded in 1983 by CTA, IEEE, NAB, NCTA, and SMPTE
- Focused on terrestrial digital television broadcasting

ATSC is an open, due process organization

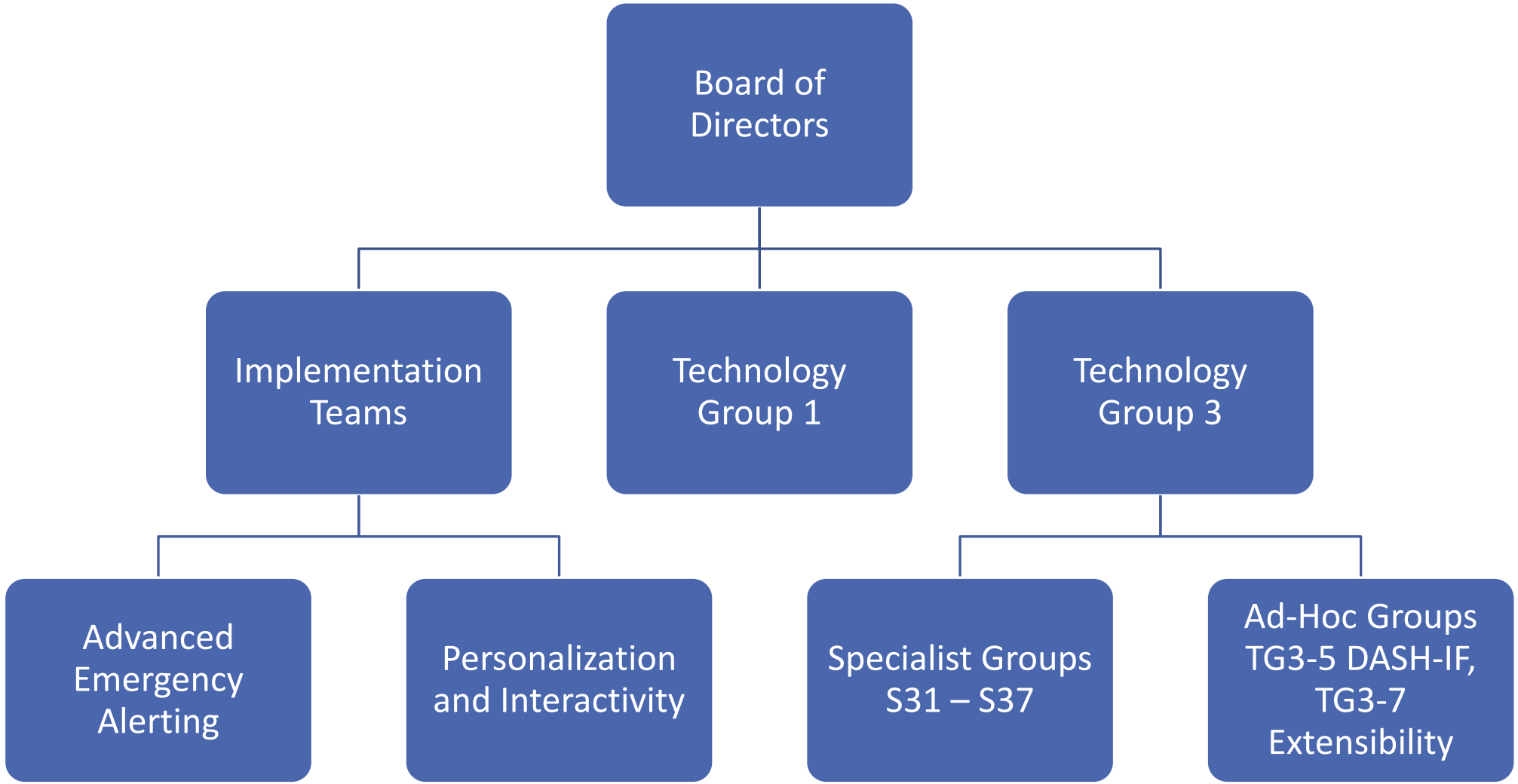
- Approximately 150 member organizations
  - Broadcasters, broadcast equipment vendors, cable and satellite systems, consumer electronics and semiconductor manufacturers, universities

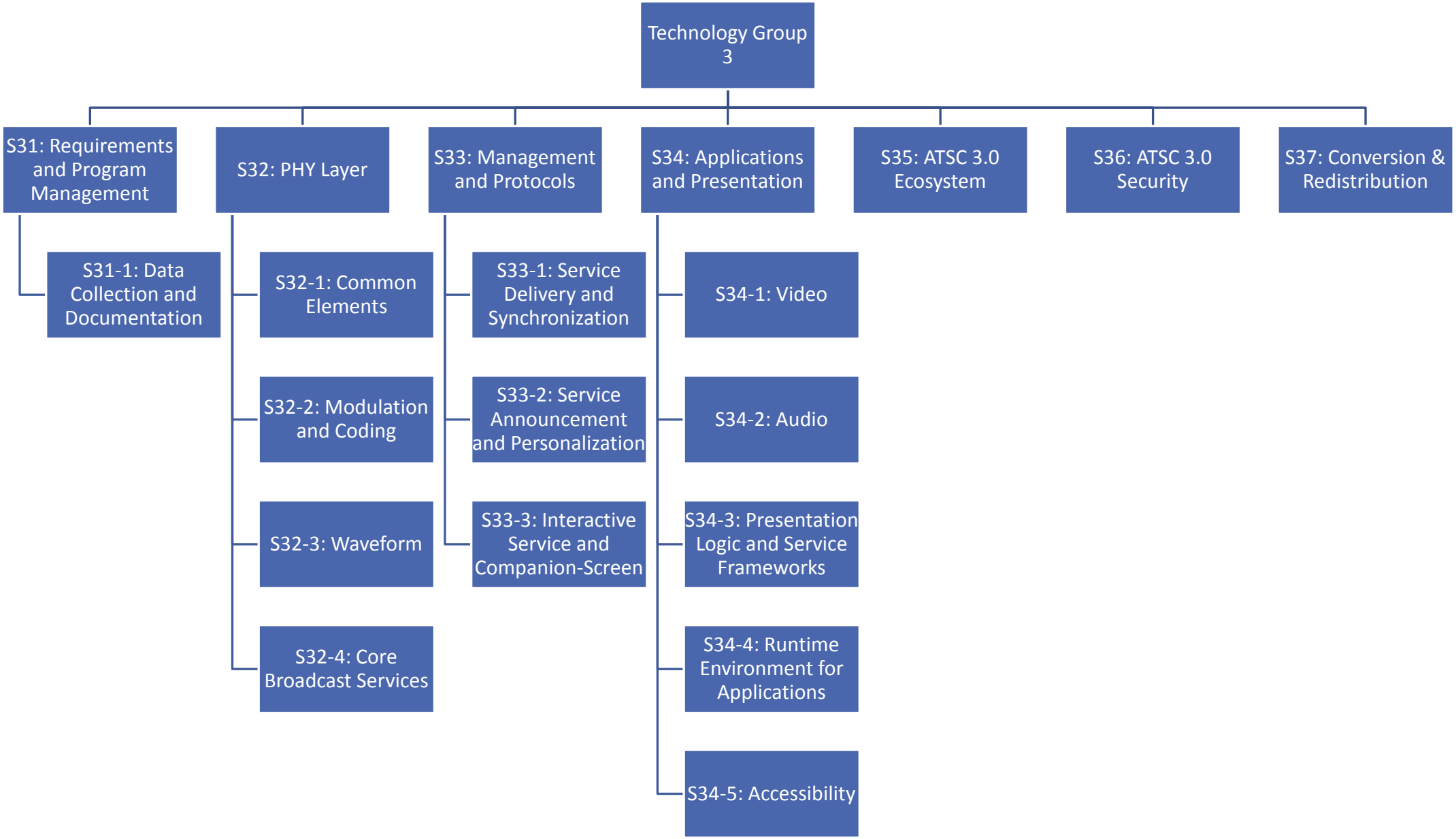
ATSC Mission Statement:

- To create and foster implementation of voluntary Standards and Recommended Practices to advance terrestrial digital television broadcasting, and to facilitate interoperability with other media.

ATSC Members

ATSC Organization




Technology Group 3
S31: Requirements and Program Management
S32: PHY Layer
S33: Management and Protocols
S34: Applications and Presentation
S35: ATSC 3.0 Ecosystem
S36: ATSC 3.0 Security
S37: Conversion & Redistribution
S31-1: Data Collection and Documentation
S32-1: Common Elements
S32-2: Modulation and Coding
S32-3: Waveform
S32-4: Core Broadcast Services
S33-1: Service Delivery and Synchronization
S33-2: Service Announcement and Personalization
S33-3: Interactive Service and Companion-Screen
S34-1: Video
S34-2: Audio
S34-3: Presentation Logic and Service Frameworks
S34-4: Runtime Environment for Applications
S34-5: Accessibility

OVERVIEW OF ATSC 3.0

The Goals of ATSC 3.0

To improve the television viewing experience

To add value to broadcasting's service platform

- Extending reach, adding new business models
- Providing higher audio and video quality, more accessibility
- Personalization and interactivity

To address changing consumer behavior and preferences

- TV content on all devices, both fixed and mobile

Benefits to the Consumer

- Maintain competitive top-tier picture and sound quality
- Reach new consumer devices with broadcast platforms
- Leverage the power of broadcasting and the Internet
- Provide for flexible and efficient use of the spectrum
- Tap new technology advances to deliver a complete new system
- Realize the potential for a standard widely adopted around the world

Requirements for the New System

Flexible, robust transmission system

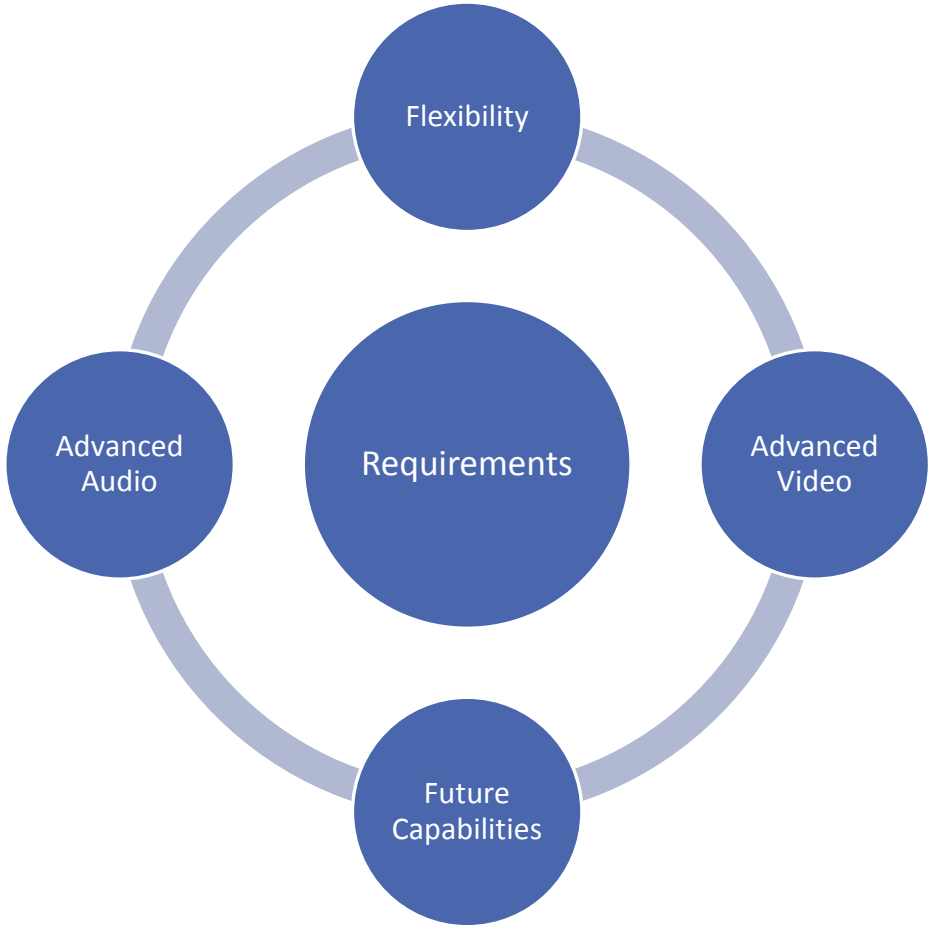
- Greater capacity (more bits per channel)
- Ability to trade-off capacity for robustness
- Integrated mobile capabilities

Advanced audio / video coding systems

- Ultra-high-definition video
- Immersive and personalized audio

Future capabilities

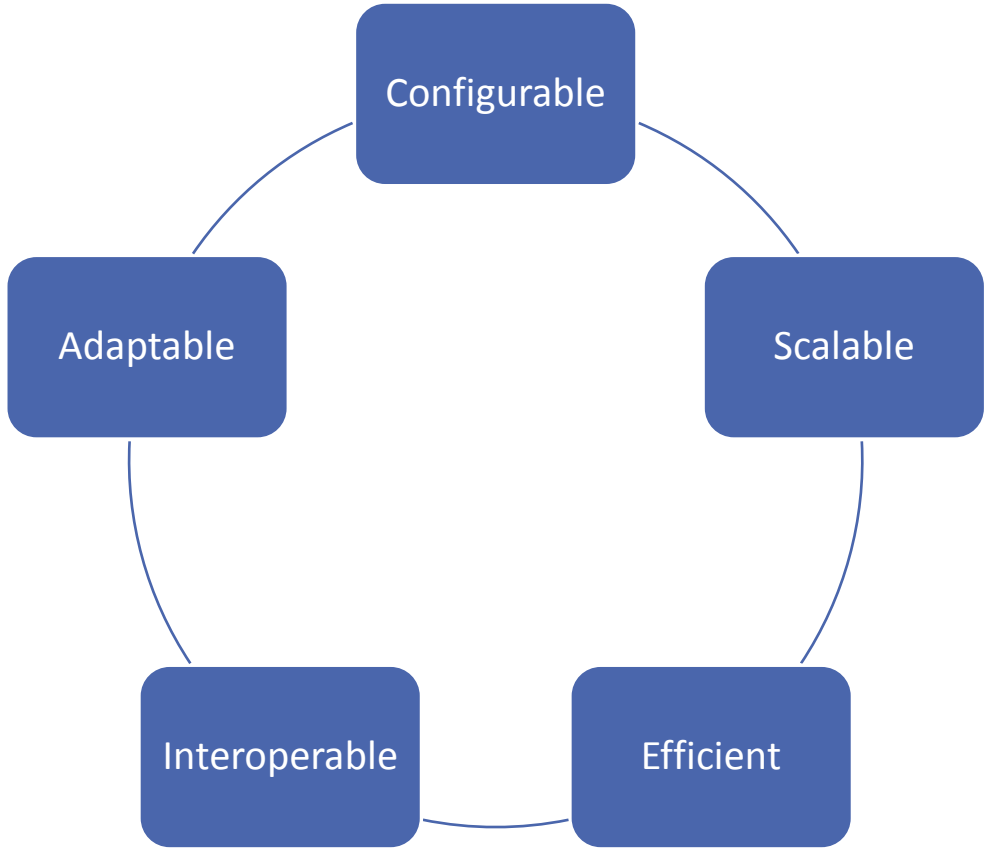
- Extensibility and scalability



The Elevator Pitch

Next generation broadcast television

- Significantly higher data capacity
- Flexible spectrum use
- Higher physical layer robustness
- Future extensibility
- Mobile / handheld support
- Hybrid broadcast + broadband delivery
- Advanced A / V compression
- Immersive audio, UHD video
- Interactivity and personalization
- Potential for new business models
- Provide a path to the future of broadcasting



SPECIALIST GROUP ACTIVITIES

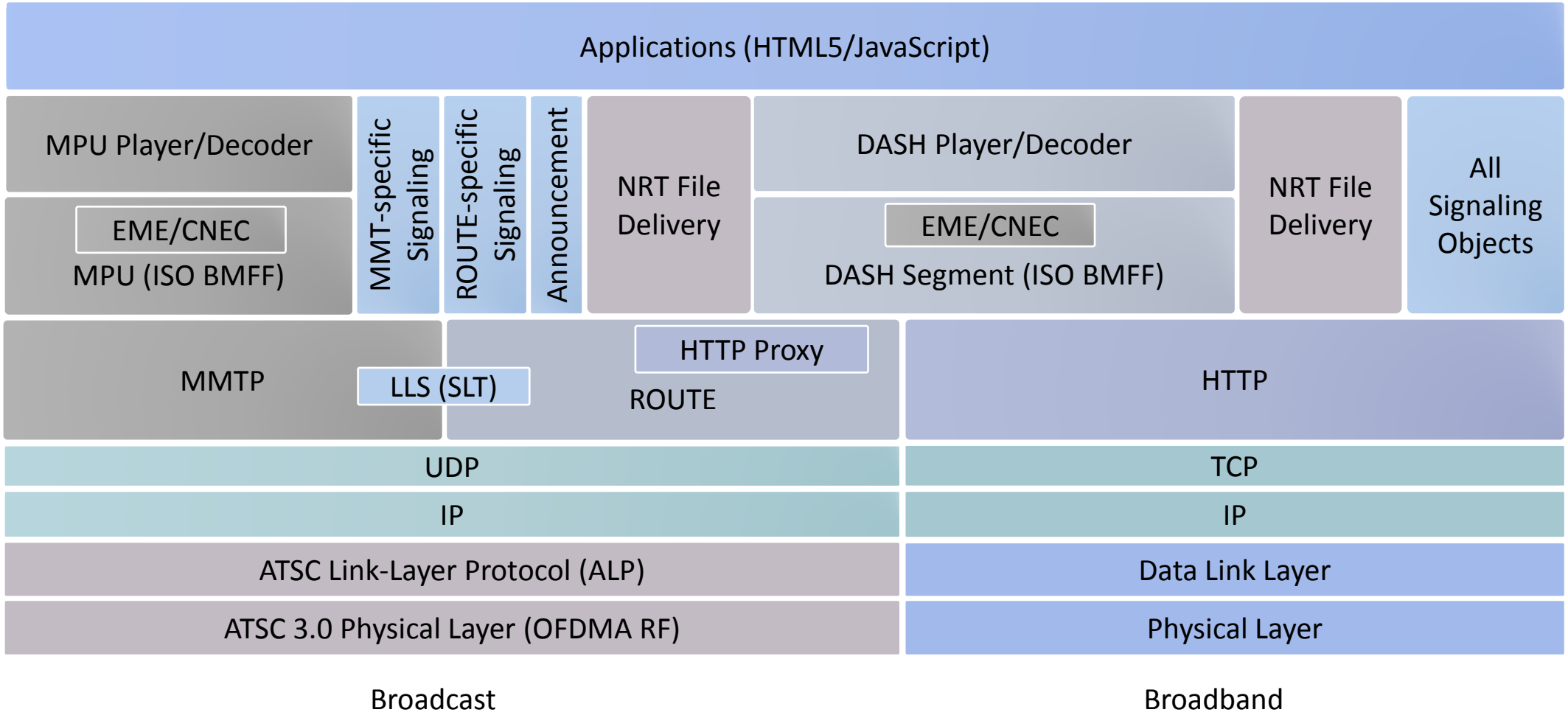
System Layers and Specialist Groups

S37, Conversion / Redistribution	• Conversion and redistribution of ATSC 3.0 signals for MVPDs
S36, Security	• Service and content protection
S34, Applications / Presentation	• Software, pictures, and sound
S33, Management / Protocols	• Organizing bits into files, streams, and packets
S32, Physical	• Sending bits over the RF channel
S31, System Requirements	• Use Cases, Requirements, and overall program management

ATSC 3.0 Basic Use Cases

Flexible use of spectrum	Robustness	Mobile services	UHD video	Hybrid services
Multi-view / multi-screen	3D content (video)	Enhanced and immersive audio	Advanced accessibility	Advanced emergency alerting
	Personalization / interactivity	Advanced advertising / monetization	Common world standard	

ATSC 3.0 Protocol Stack



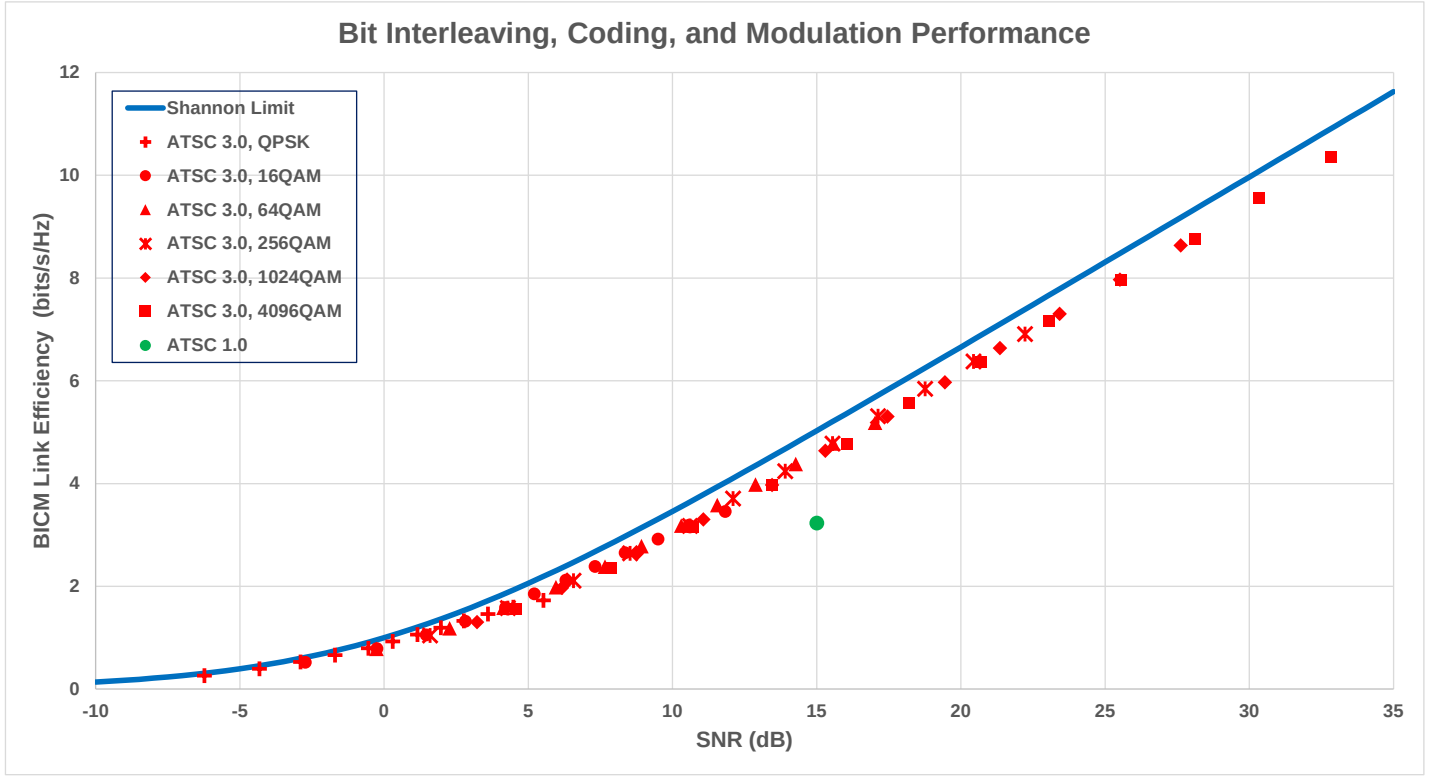
ATSC 3.0 Physical Layer

The ATSC 3.0 Physical Layer encompasses

- Common system elements
- Bootstrap signaling
- Modulation and coding
- Waveforms
- Core broadcast services

ATSC 3.0 will have considerable flexibility in operating points

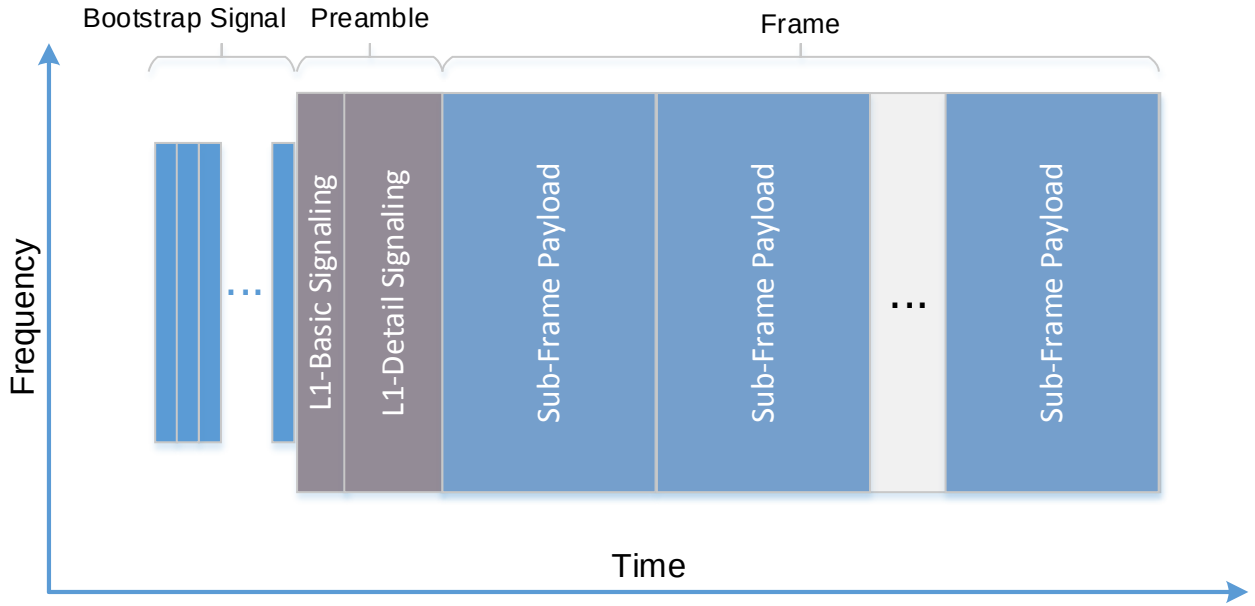
- Low capacity, highly robust
- High capacity, less robust



Signaling Physical Layer Parameters

Bootstrap emission is the starting point for ATSC 3.0

- Robust synchronization
  - Service discovery
  - Coarse time, frequency acquisition
  - 5 MHz bandwidth
  - <–6 dB SNR performance (with FER = 1E-2)
- 24 signaling bits
  - Sampling frequency
  - Channel bandwidth
  - EAS wake-up
  - Preamble selection
- Preamble frame control
  - Basic / Detail



Physical Layer Pipes

PLPs carry data in various configurations

- Robustness vs. data capacity tradeoffs
  - Based on selections of modulation and coding
  - Based on selections among interleaving choices

PLPs can be arranged in patterns of frequency and time resources

- Patterns can vary between sub-frames

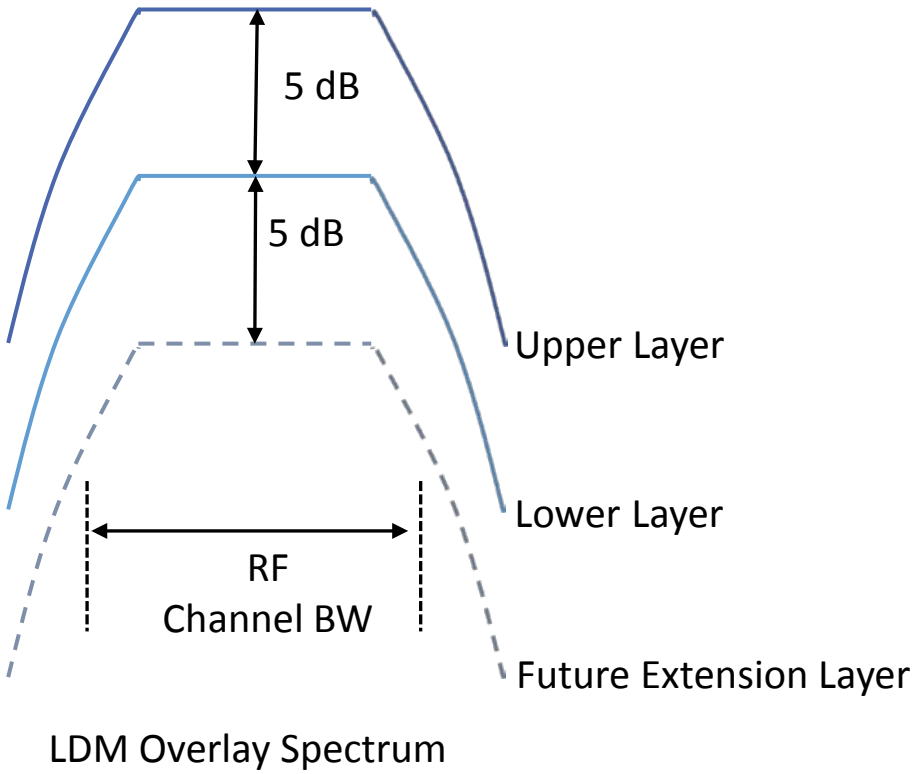
Up to 64 active PLPs “simultaneously” on a single RF channel

Up to 4 PLPs in a single service – limited by receiver resources

Layered Division Multiplexing

LDM is a new transmission scheme that uses spectrum overlay technology to superimpose 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.



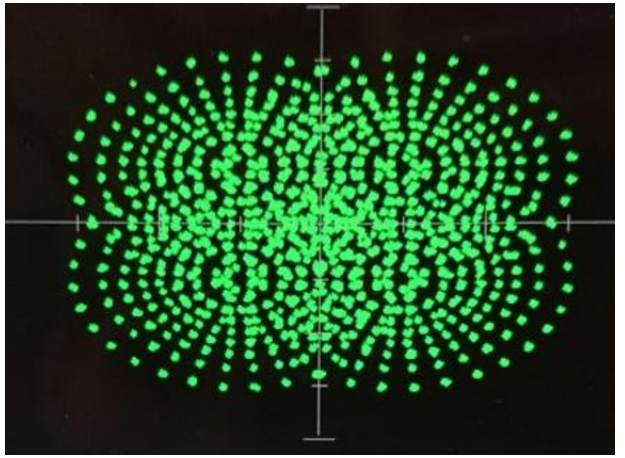
LDM Overlay Spectrum

Layered Division Multiplexing

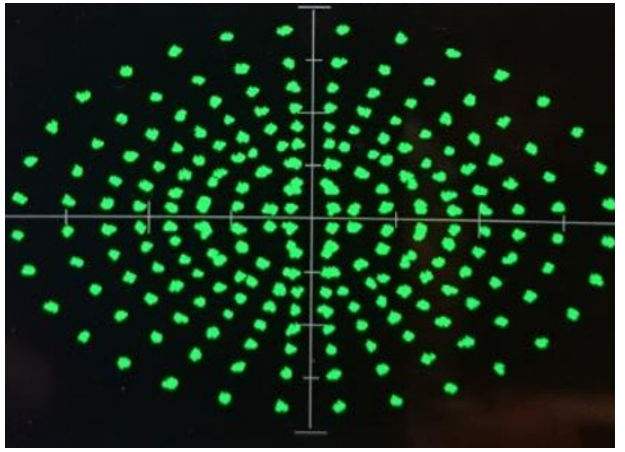
Signal cancellation can be used to retrieve the robust upper layer signal first, cancel it from the received signal, and then start the decoding of lower layer signal.

- 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.



Combined constellation (core + enhanced)



Enhanced constellation

A/322, Physical Layer Protocol Functions

Payload scrambling

Low density parity check forward error correction

Bit interleaving

Non-uniform constellations

Single / multiple physical layer pipes

Time / frequency / layered cell-multiplexing combinations

Layered division multiplexing

Multiple input / multiple output

Single frequency network

Time interleaving

Orthogonal frequency division multiplexing modulation

Frequency interleaving

Pilot / tone reservations

Channel bonding

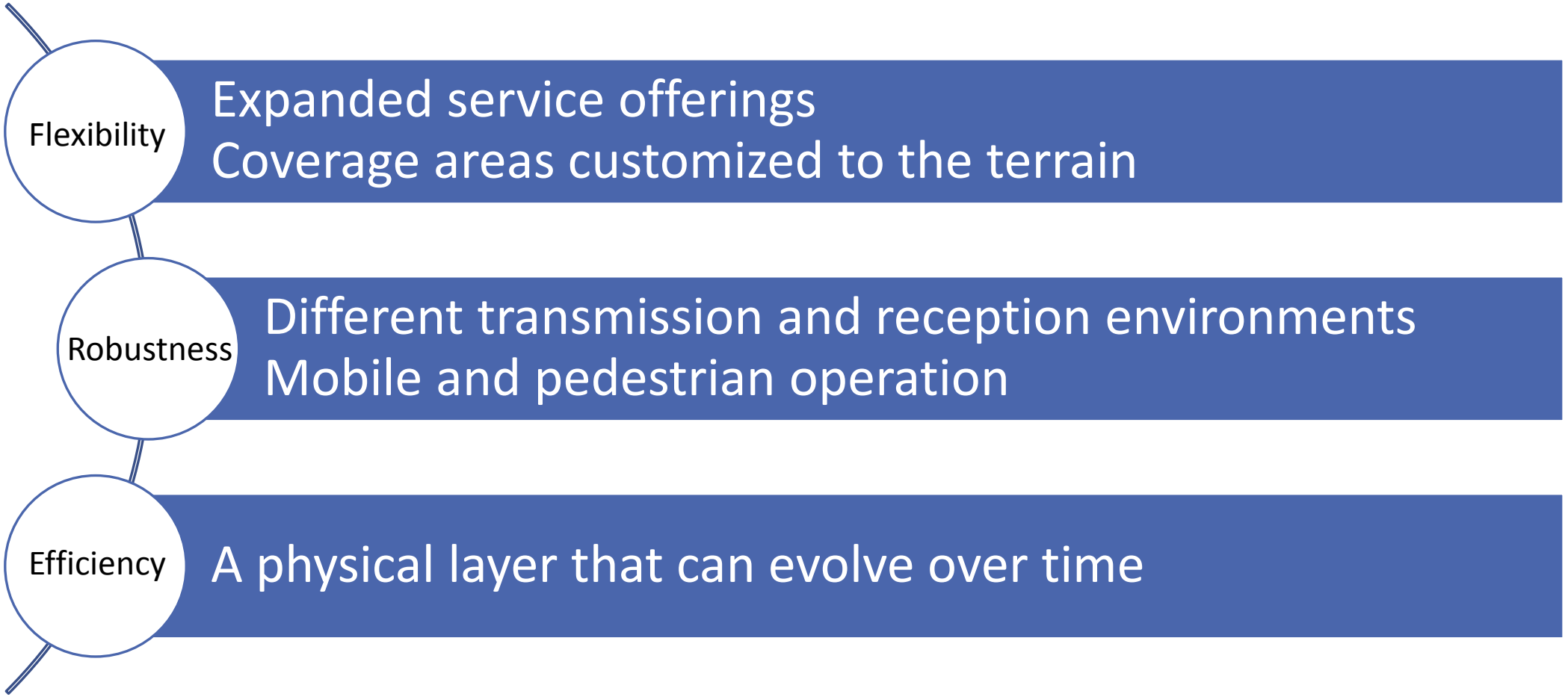
Peak-to-average power ratio reduction

Large guard interval range

A/321 bootstrap signal discovery

Hierarchical robust preamble signaling

Meeting the Needs of Broadcasters



ATSC 3.0 Management Layer

The ATSC 3.0 Management and Protocols Layer encompasses

- Service delivery and synchronization
- Service announcement and personalization
- Interactive services and companion screens
- Redistribution support / watermarks

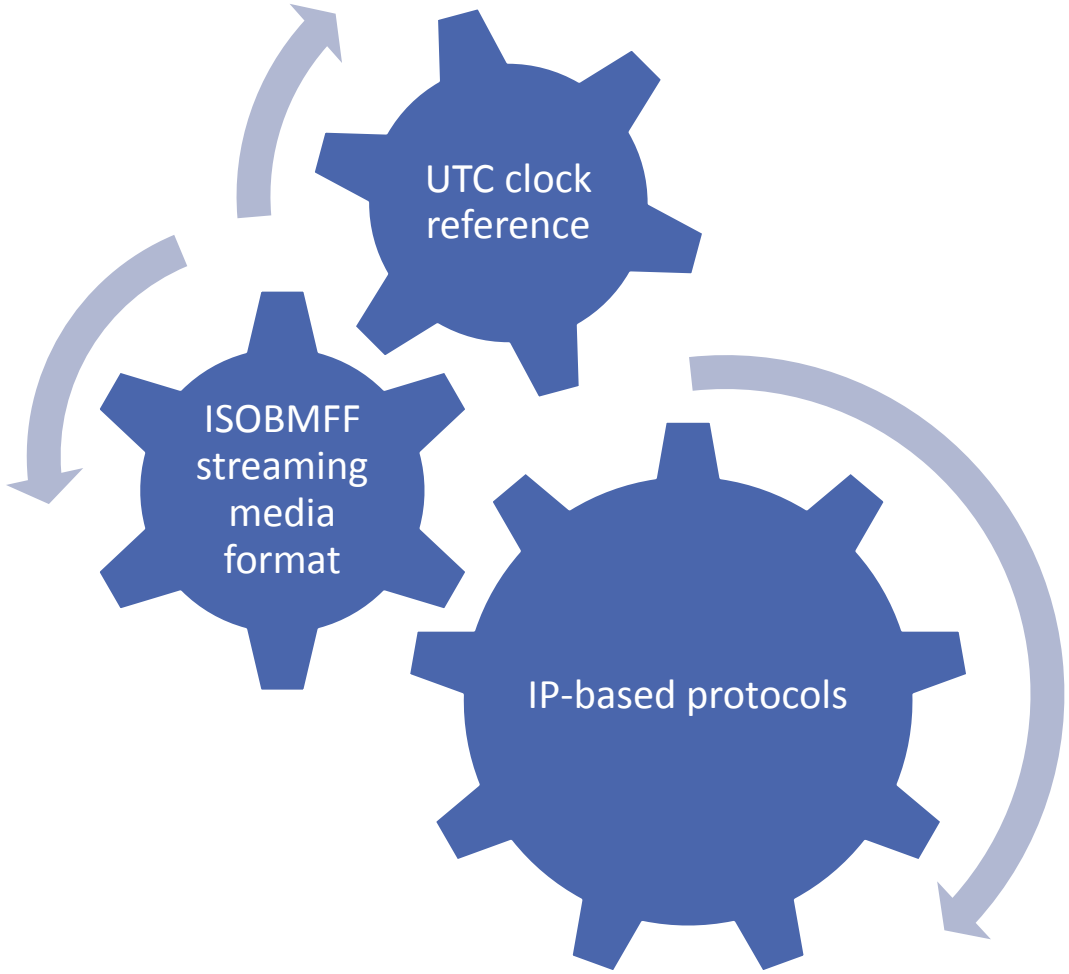
IP transport will be used for broadcast delivery of both streaming and file content

- ATSC 1.0 uses MPEG-2 Transport; ATSC Mobile uses IP

Management Layer Key Elements

Common elements include

- Use of IP Transport for broadcast delivery
- Use of ISOBMFF as a content format for streaming delivery
- Use of UTC (or some other form of "absolute" time) for synchronization and buffer management



Benefits of IP Transport

Broadcasting no longer an independent silo

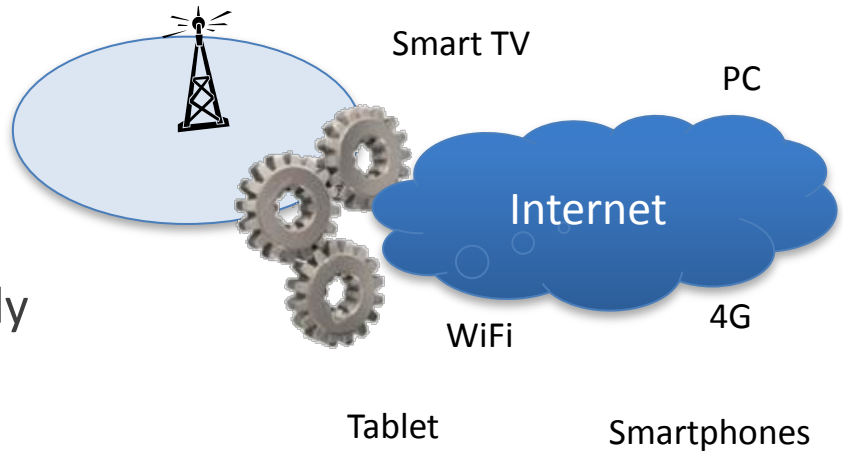
- IP takes advantage of evolution speed of the Internet

Broadcast and broadband as peer delivery mechanisms

- Enables new types of hybrid services
- Ability to seamlessly incorporate niche content

Enable new business models

- Localized insertion of ads or other content
- New revenue model for broadcasters that has previously been available to only cable or IPTV operators



ATSC 3.0 Applications Layer

The ATSC 3.0 Applications and Presentations Layer encompasses

- Video coding
- Audio coding
- Presentation logic and service frameworks
- Runtime environment
- Accessibility

ATSC 3.0 offers “hybrid” delivery

- Broadcast (over-the-air) and broadband (over the Internet)
- Use cases include:
  - Main A / V components delivered via broadcast, alternate components (e.g., alternate language) delivered via broadband
  - Main program delivered via broadcast, alternate interstitials delivered via broadband (e.g., targeted ad insertion)
  - Temporary “hand-off” from broadcast to broadband and back for brief fades in reception

Key Video Features

The ATSC 3.0 video system will support

- UHD (4K) delivery is a key goal of ATSC 3.0
- Enhanced HD
- Wide color gamut, high dynamic range, scalable coding
- Targeting small screens (HD) and large screens (UHD)
- Multiple, selectable video components
- 3D support

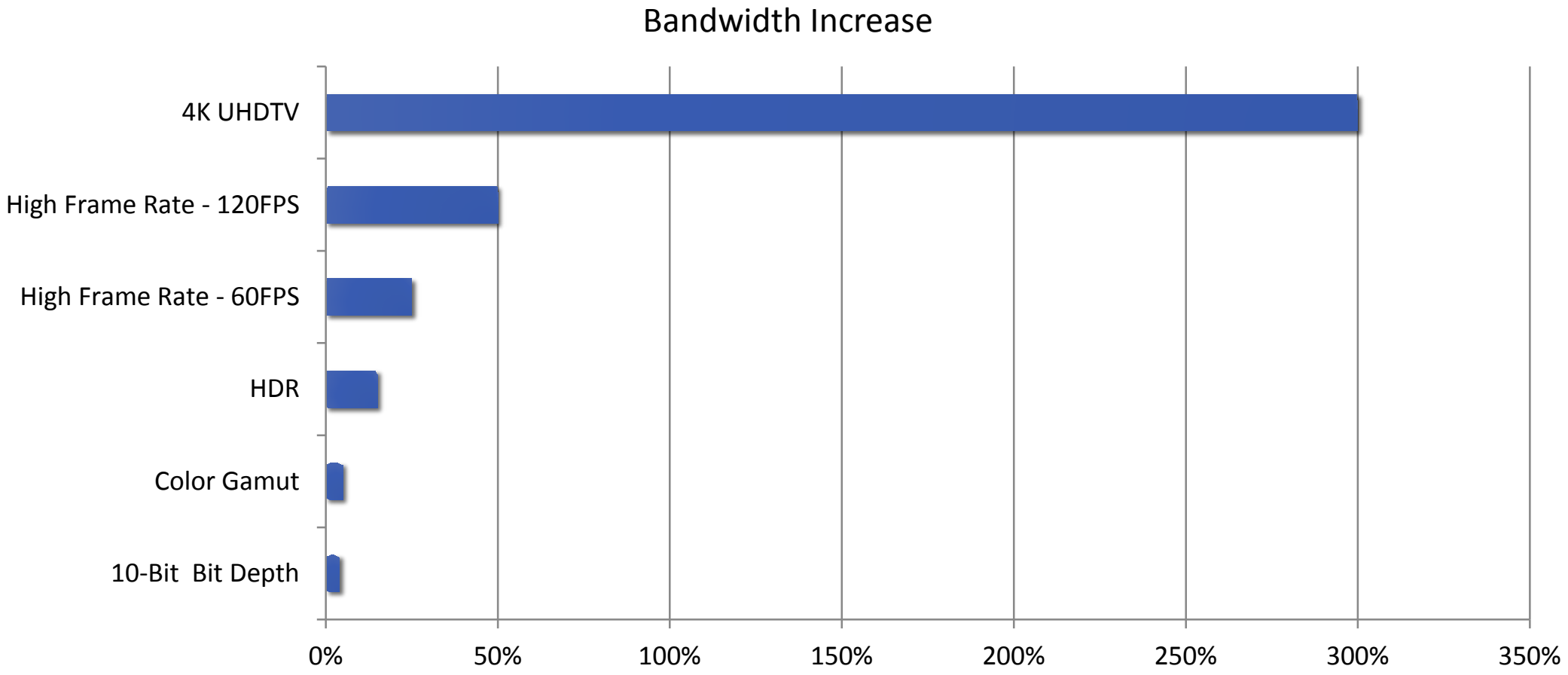
State-of-the-art video compression

- HEVC Main 10 Profile specified
  - 35 – 50% performance gains vs AVC/H.264

Several HDR proposals submitted and under evaluation

- Video quality (compression efficiency)
- Backward compatibility with SDR (100nit, ITU Rec.709)
- Production workflow considerations

HDR/WCG: Good Bang for the Buck



Reference bit rate is 709 color space, 1080, 30P, 8 bit. Chart courtesy of NBC/Universal and Cablelabs.

Key Audio Features

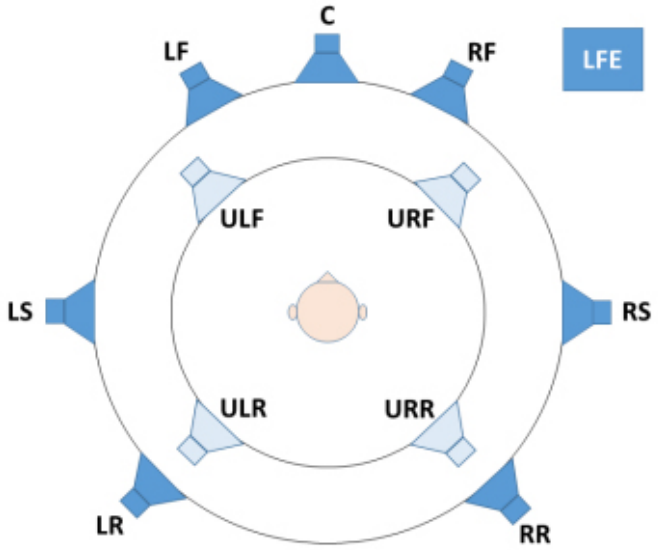
The ATSC 3.0 audio system will feature

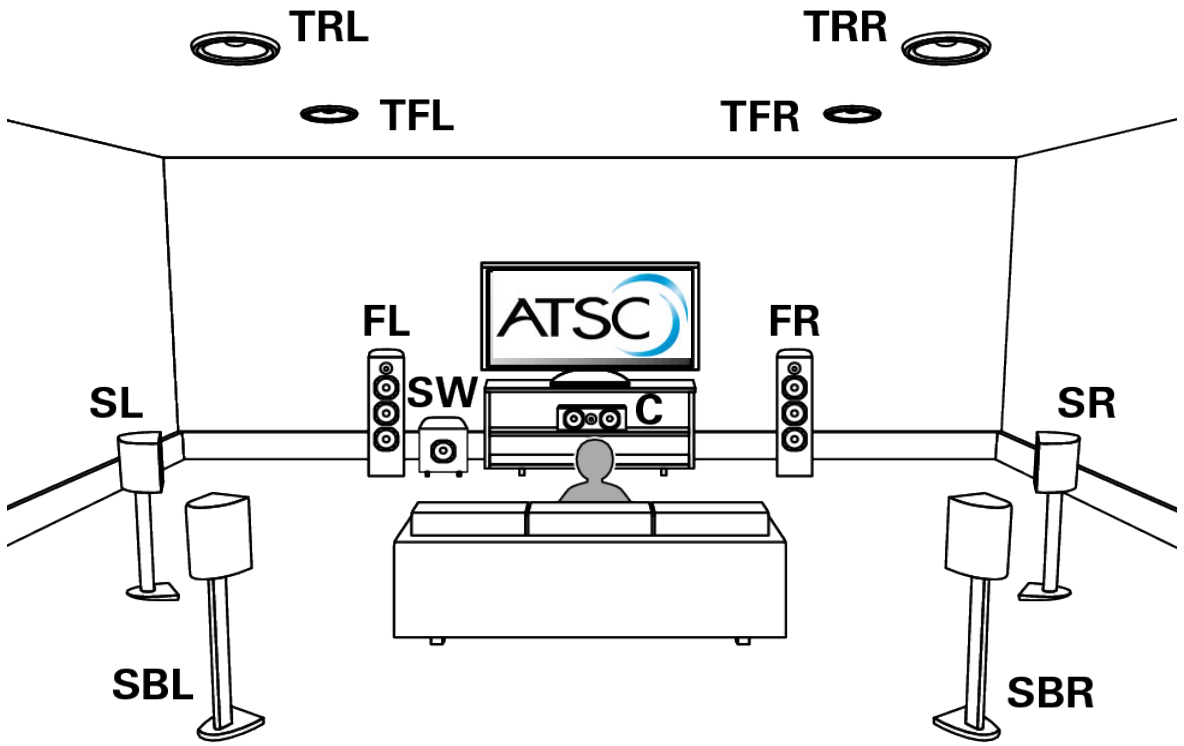
- An enhanced, immersive experience
  - Sound with improved azimuth, elevation, and distance perspective
  - Use of channels and objects or “elements” and metadata
    - Metadata allows rendering at the decoder, customized to the user’s sound system
    - The decoder places the sound in the most accurate position that the user’s sound system can support
- Targeted to various devices (fixed, mobile) and set-ups
- Personalization
- Support for audio-only content as well as A / V content
- Hybrid broadcast / broadband delivery will be supported
- Normalization of content loudness and contouring of dynamic range
  - Based on the specific capabilities of a user’s fixed or mobile device, and the unique sound environment

Dolby AC-4

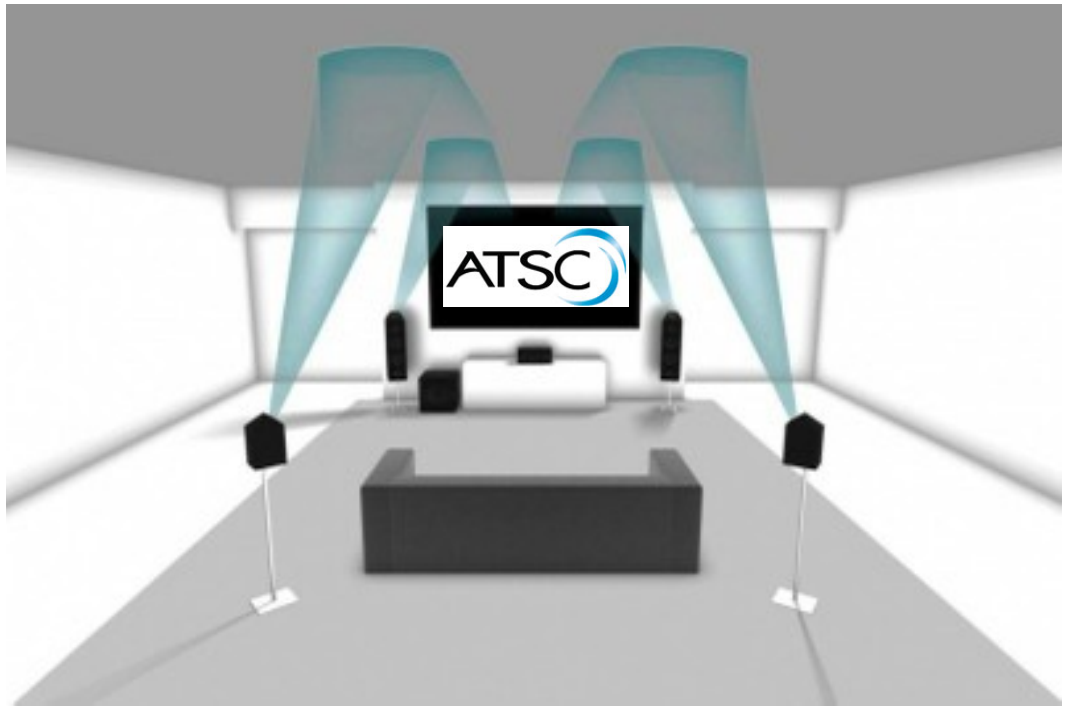
MPEG-H AUDIO ALLIANCE
The Next-Generation System for Interactive and Immersive Sound

7.1.4 Immersive Audio





7.1.4 Immersive Audio



Key Applications Environment Features

Goal is to deliver a personal and dynamic experience

- HTML5 / Internet overlay graphics
- Hybrid delivery — merging broadcast and internet
- Dynamic ad insertion
- Personalized graphics
- Interactivity capabilities
- Synchronized second-screen applications
- Immersive audio — user control of tracks and mix
- Audience measurement capabilities

Content can be streamed in real time (i.e., linear or streaming on demand content) via both broadcast and broadband

Content can be delivered in non-real time and cached locally via both broadcast and broadband

Key Interactive Services

ATSC is specifying an interactive application environment for ATSC 3.0

- The standard will enable interoperability between the receiver runtime environment and the apps that producers and broadcasters author

Based on W3C technologies

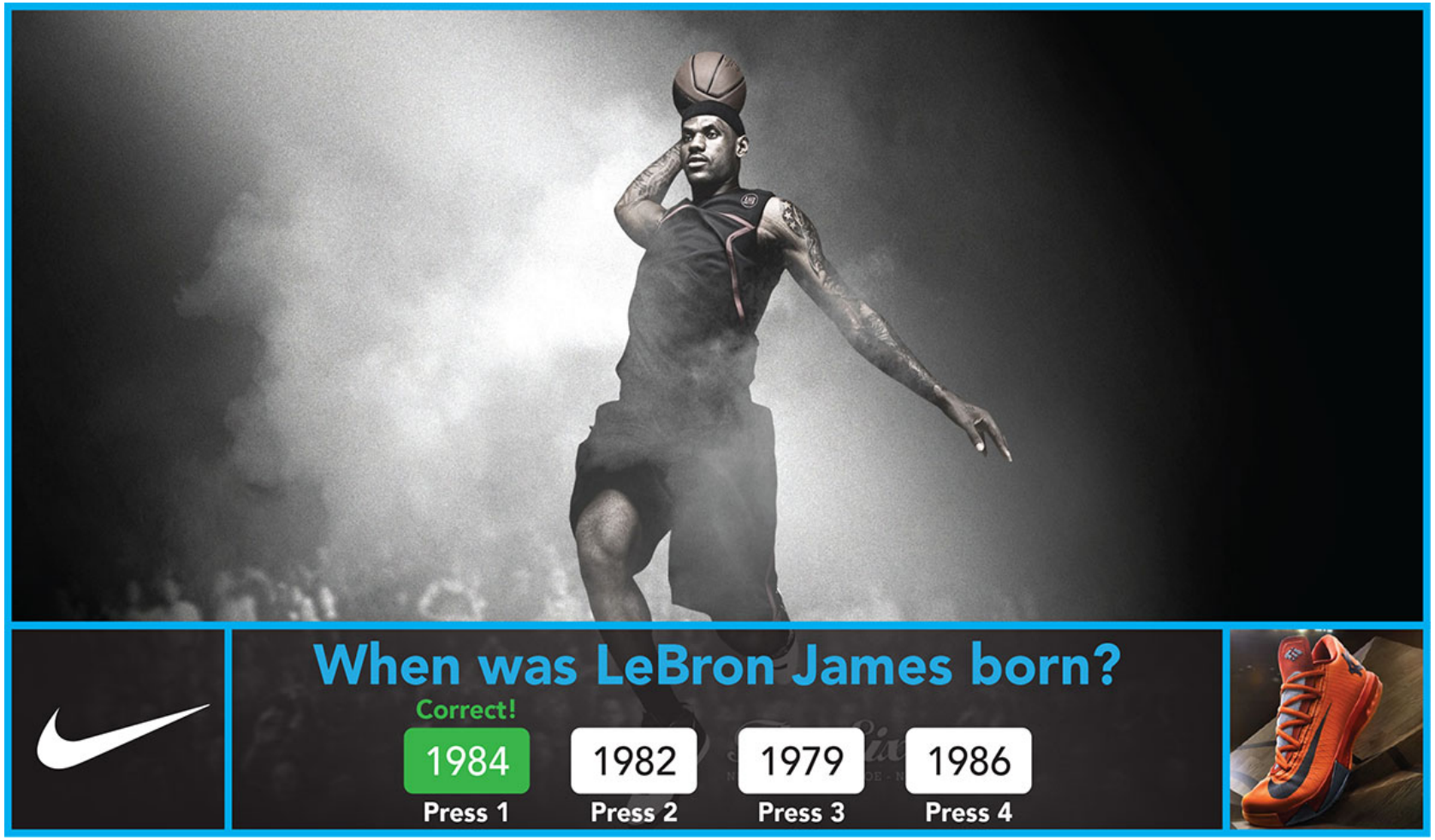
- Goal is to align with the web as much as possible
- Ideally, application authors will be able to easily adapt web apps for TV and vice versa

ATSC 3.0 will add TV-centric functions to the W3C technologies

- Change the channel
- Check parental control setting
- Access the device's PVR
- Response to a timed event in the program

Interactivity – Quiz

Linear Ad



Brand Logo

Dynamic Image

Interactivity – Information Bar

News Program

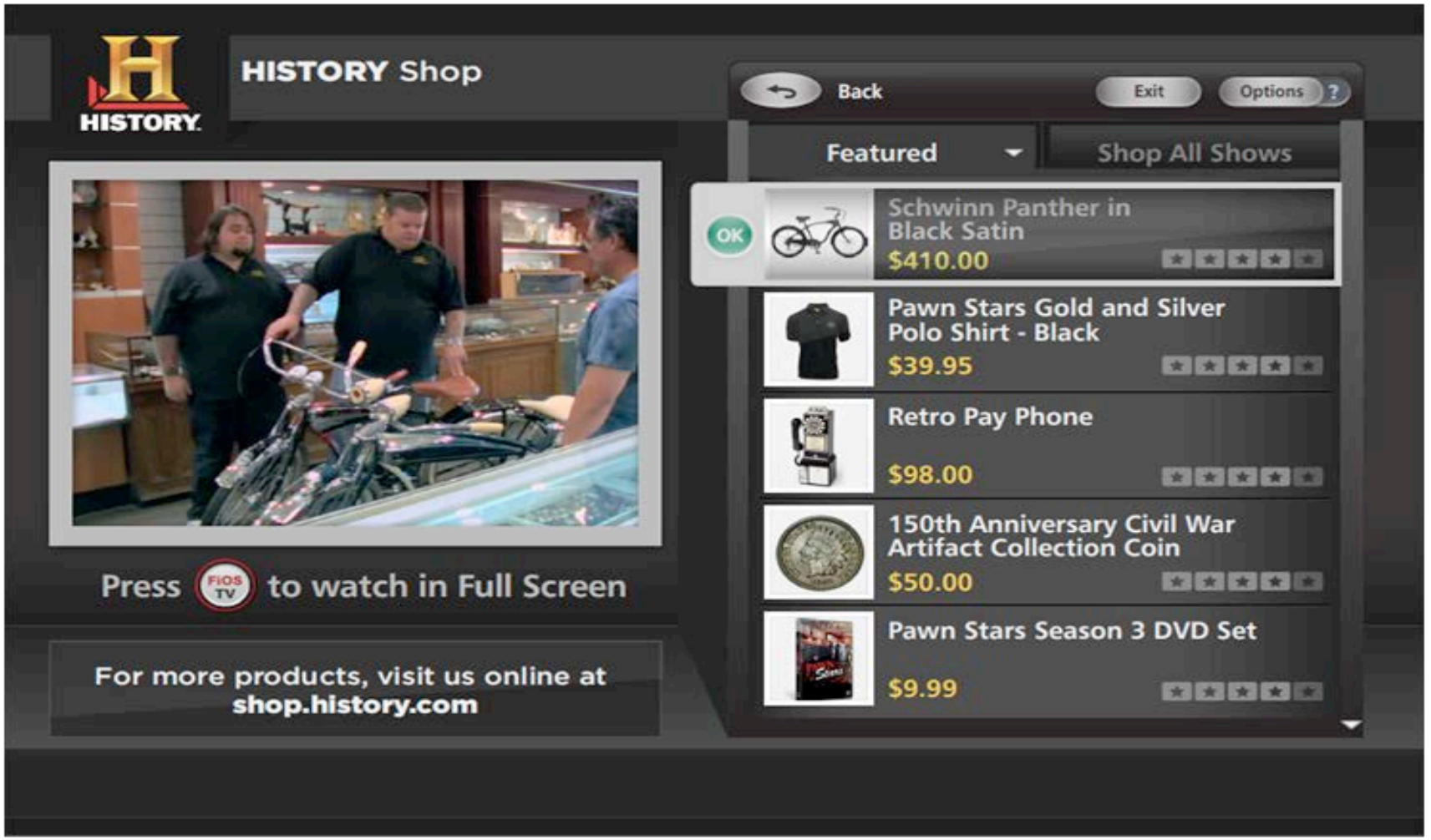
Program Image

UI Module

Send Buttons

Interactivity – Shopping

Linear Program



Sale Items

Key Accessibility Features

New public service capabilities

- 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

ATSC 3.0 feature set supports

- Visually Impaired (VI)
  - Video Description
- Hearing Impaired (HI)
  - Closed Caption
  - Closed Signing
  - Dialog Intelligibility
- Emergency alerts and messaging
  - Emergency crawls and audio tracks

Advanced Emergency Alerting

Next step in robust delivery of emergency information to the public

- Provide a more robust and reliable public warning and safety information communications system
  - Independent of cellular network congestion
- Leverage broadcaster's major role as a public information provider with disaster-resistant facilities
- Offload data and video traffic during times of emergency to preserve LTE for what it does best – point-to-point voice communications

Opportunity for broadcasters

- Enhance the station's brand for weather, essential information, and public service in times of emergency
- Provide a pipeline for extensive information beyond simple text, for disaster preparation and recovery, in addition to acute warnings

AEA Features

ATSC 3.0 and AEA designed to reach many types of receivers

- Fixed, portable, mobile, handheld
- ATSC 3.0 specifies an optional robust-level AEA wake-up signal for all types of receivers in “sleep” mode

The emission standard enables receivers to present the following

- Primary text alert message displayed as banner or crawl overlay
- Audio announcement of primary alert message

Alert messages are capable of targeting receivers in specific geographic locations

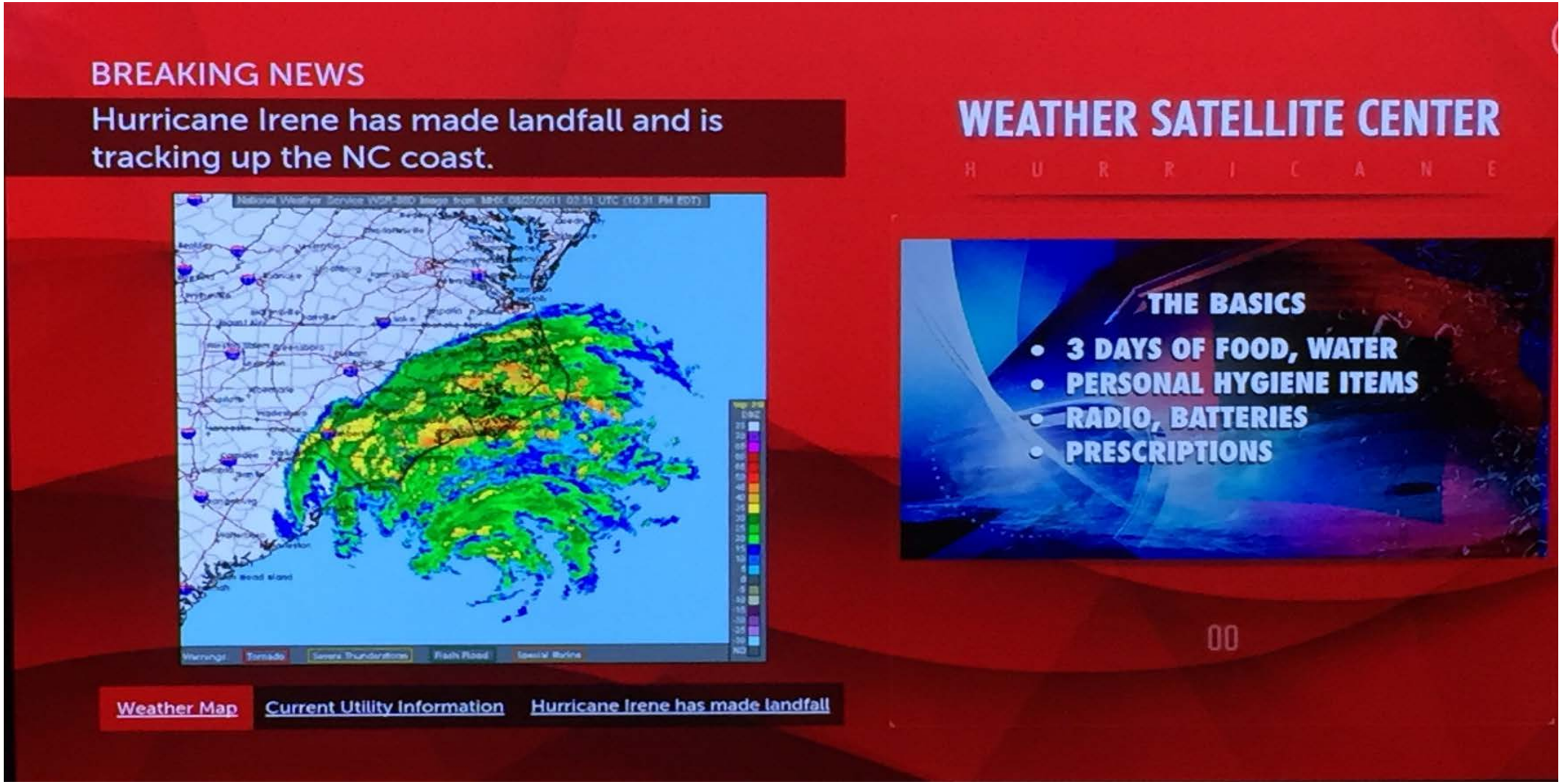
- Works with receivers that “know where they are”

AEA supports optional delivery of multiple types of rich media content in support of enhanced alerting

- File- and stream-based rich media, including:
  - Weather radar, evacuation routes, live news and weather reporting, instructions for what to do

AEA Rich Media Content

AEA Integrated Content



ATSC 3.0 Security

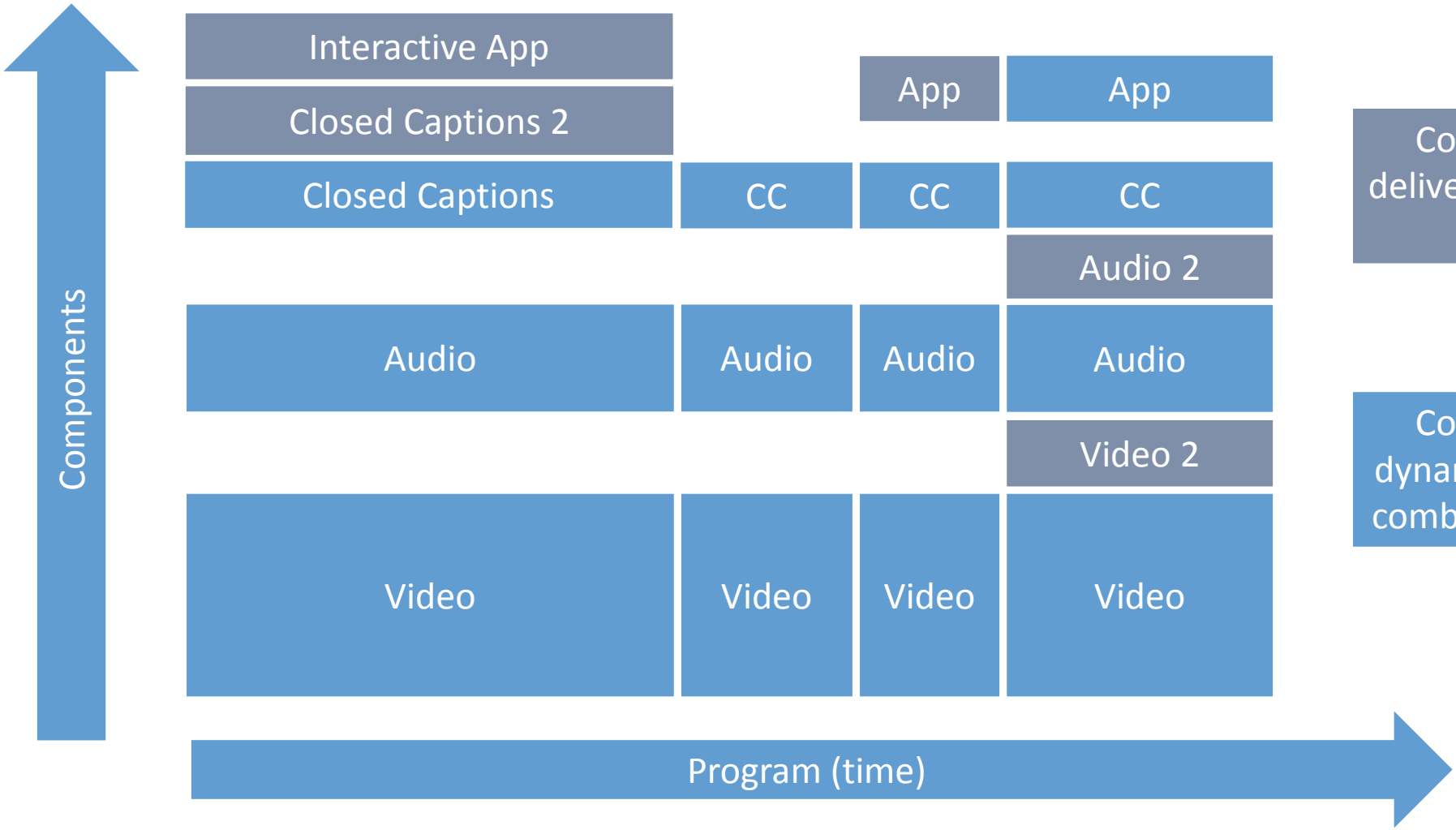
Security enables new business models for ATSC 3.0

- Subscription services
- Monthly fee for access to the service
- “Freemium” (i.e., user registers and then content is free)

Subscription options for alternate components

- Custom views; e.g., pay for “dashboard cam” video in an auto racing event
- Pay-per-view programs

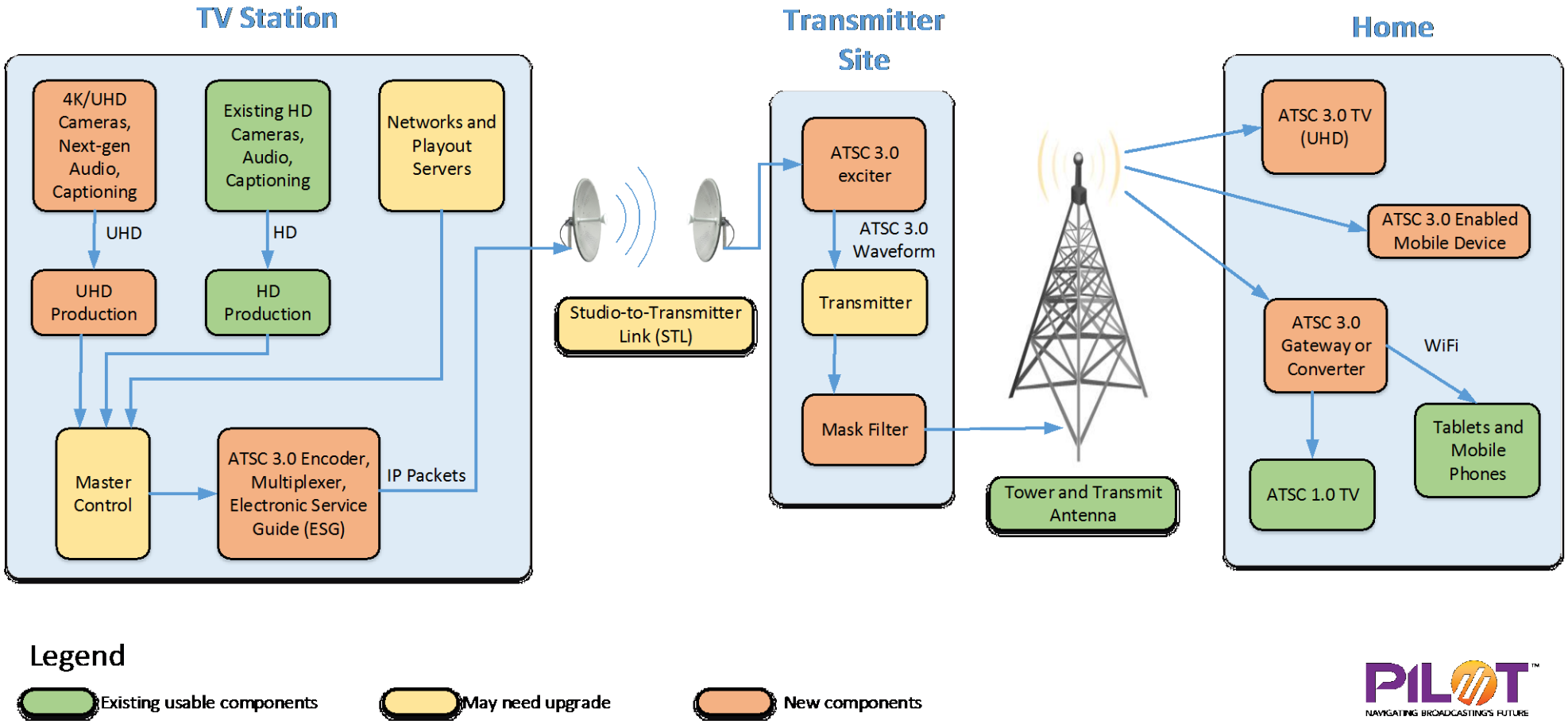
ATSC 3.0 Service Models



Components can be delivered via broadcast or broadband

Components can be dynamically selected and combined at the receiver.

Deploying the ATSC 3.0 Broadcast System



DOCUMENT DEVELOPMENT STATUS

Subject to Change

Specialist Groups and ad hoc groups have made preliminary decisions to select technologies for incorporation in ATSC 3.0.

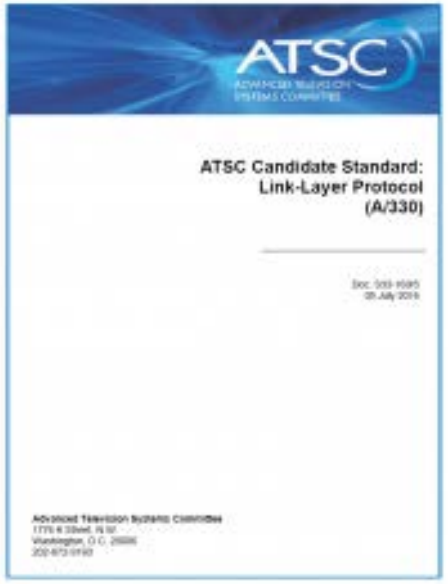
Selections of all technologies are subject to approval of TG3 and ultimately the Voting Membership in accordance with ATSC due process.

Candidate Standard

A Candidate Standard (CS) is a document that has received significant review within a specialist group and is ready for review by a larger group of potential implementers.

CS is an explicit call to those outside of the related specialist group for implementation and technical feedback

This is the phase at which the specialist group is responsible for formally acquiring that experience, or at least defining the expectations of implementation



Document Status - 1

A/300	• ATSC 3.0 System – Working Draft (WD)
A/321	• System Discovery and Signaling – Approved / Published
A/322	• Physical Layer Protocol – Approved / Published
A/323	• Physical Layer Uplink/Downlink – WD
A/324	• Scheduler, STL, and SFN – Candidate Standard (CS)
A/325	• Lab Performance Test Plan RP – Proposed RP

Document Status - 2

A/330	• Link Layer Protocol – Approved / Published
A/331	• Signaling, Delivery, Synchronization, Error Protection – CS
A/332	• Service Announcement – CS
A/333	• Service Usage Reporting – CS
A/334	• Audio Watermark Emission – Approved / Published
A/335	• Video Watermark Emission – Approved / Published

Document Status - 3

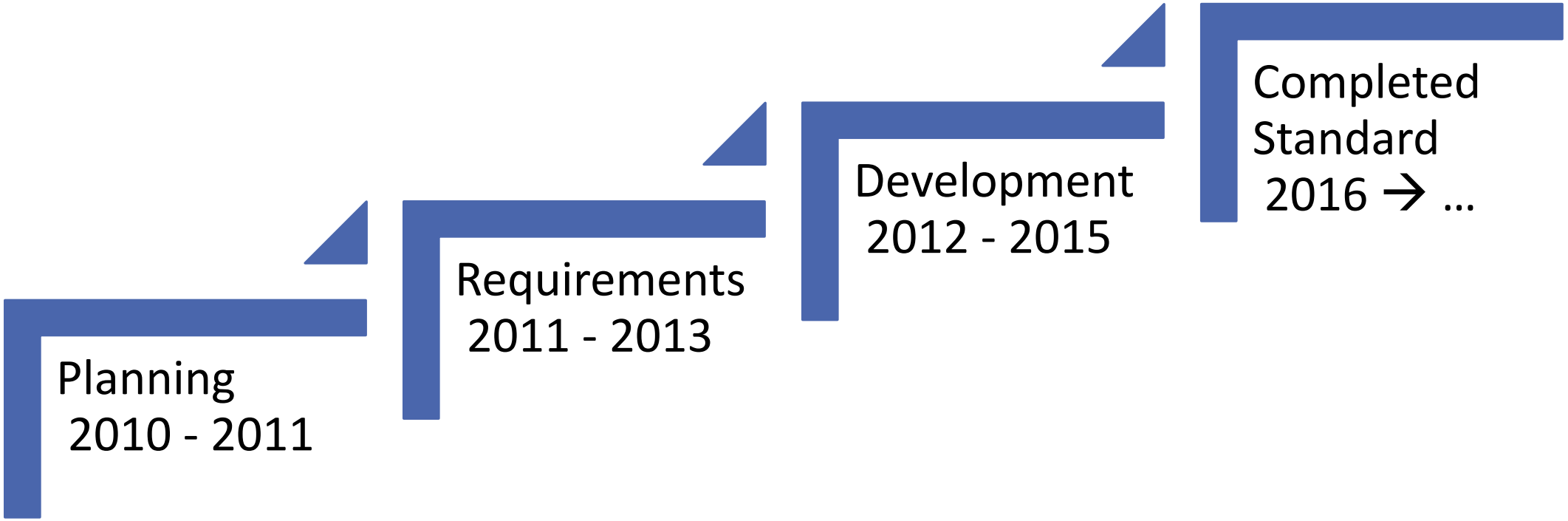
A/336	• Content Recovery in Redistribution Scenarios – CS
A/337	• Application Signaling – WD
A/338	• Companion Device – CS
A/341	• Video – CS
A/342	• Audio Parts 1, 2, 3 – CS
A/343	• Captions and Subtitles – CS

Document Status - 4

A/344	• Application Runtime Environment – WD
A/360	• Security – WD
A/370	• Conversion and Redistribution of ATSC 3.0 Signals
	• Various additional RPs expected

NEXT STEPS

The Path to ATSC 3.0



Schedule

ATSC 3.0 is a suite of standards

- One or more standards per layer
- Each standard moves through the process independently
- Most will move to Candidate Standard in 2016

Final approval of most documents is expected in 2016, with completion of all in the first / second quarter of 2017

FCC considering change in rules to authorize use of ATSC 3.0

ATSC 3.0 selected by South Korea

In Summary…

- Will not be backward compatible to the legacy system
- Acknowledges changes of user environments and needs
- Understands broadcast spectrum regulation issues
- Supports viability and new business models of broadcasters
- Flexible to accommodate future improvements and developments

Questions?

JWHITAKER@ATSC.ORG
WWW.ATSC.ORG