
ATSC

# Ultra-High Definition, Immersive Audio, Mobile Video, and Much More—A Status Report on ATSC 3.0

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# Agenda

**ATSC**

- Overview of ATSC, organization and purpose
- Scope of ATSC 3.0, why now?

**3.0**

- ATSC 3.0 attributes and benefits
- The standardization process

**Status**

- Where we are now
- Overall schedule

# OVERVIEW OF ATSC, ORGANIZATION AND PURPOSE

# ATSC Mission

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

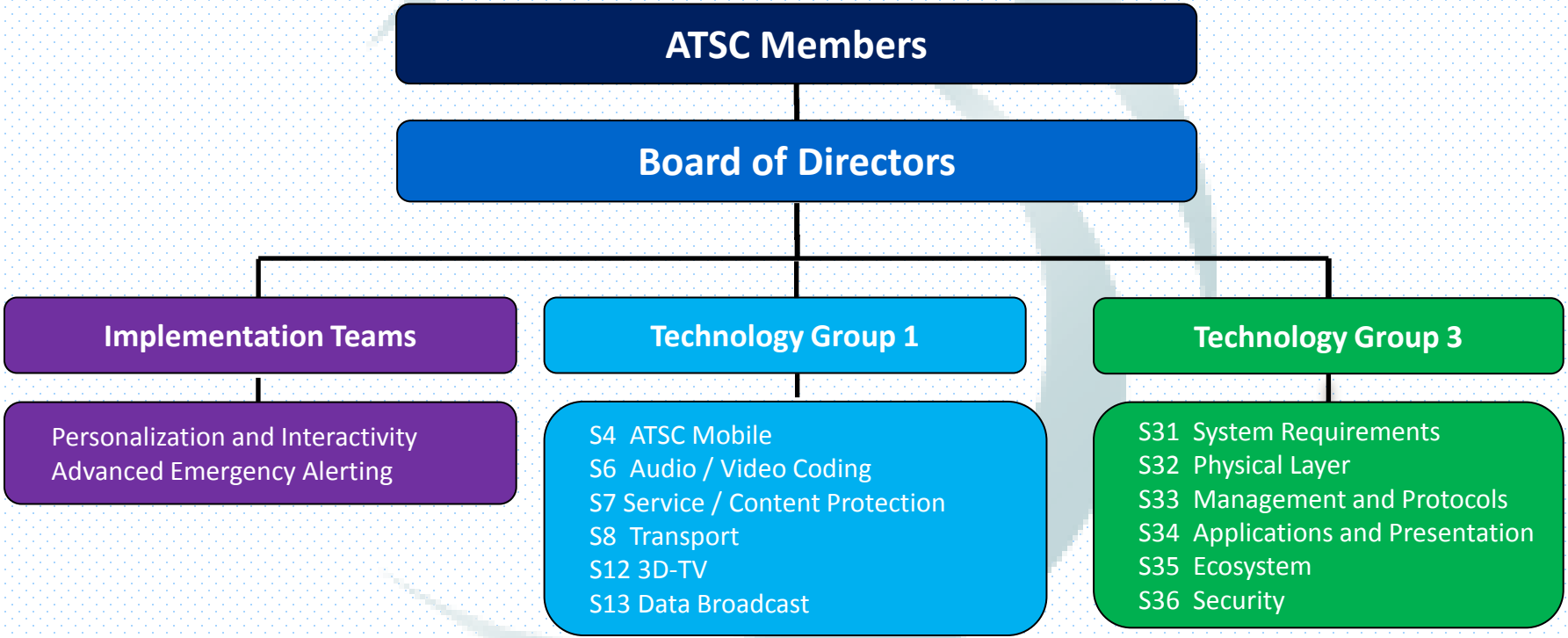
# About the ATSC

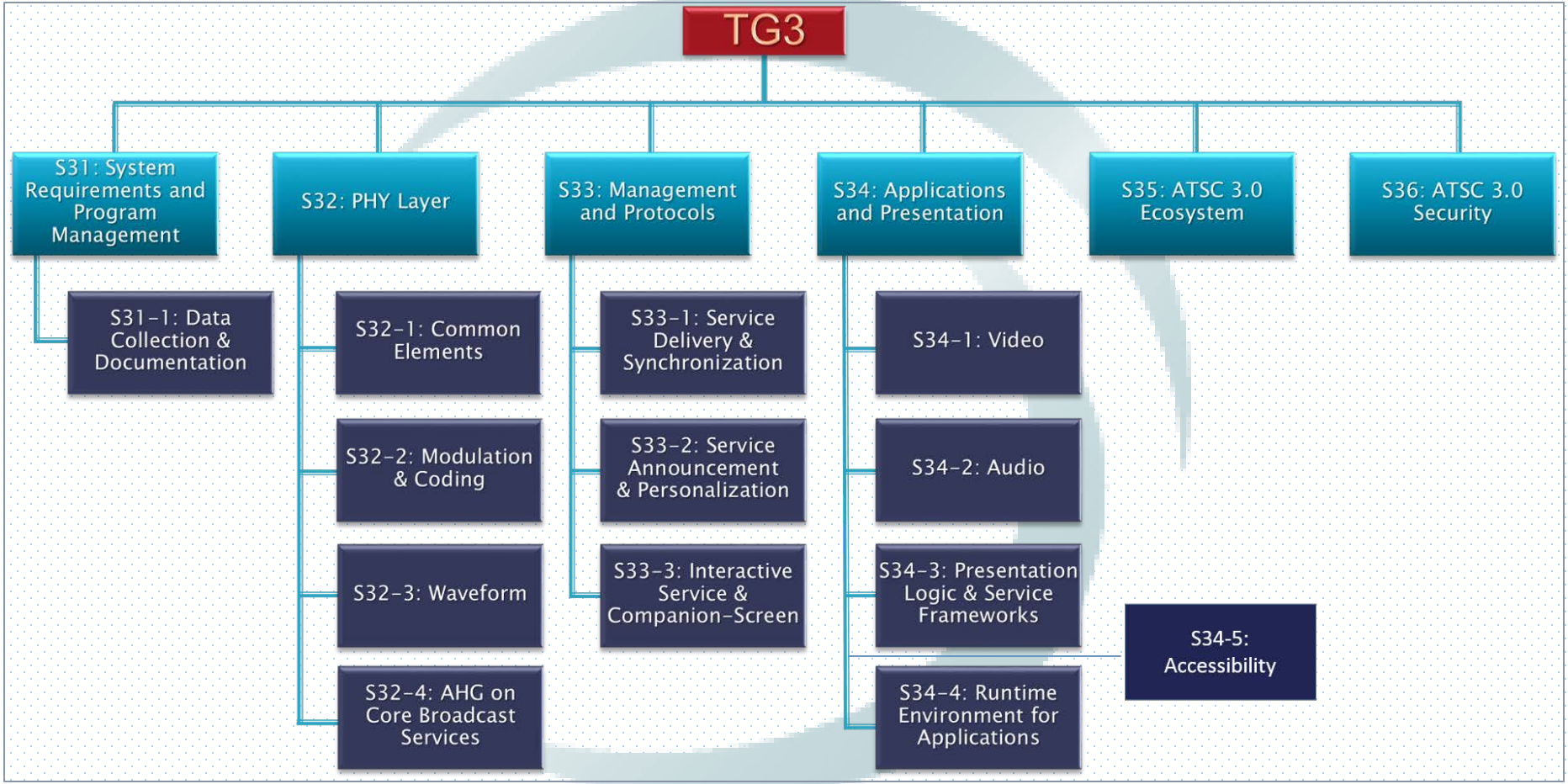
- Standards development organization for digital television
  - Founded in 1983 by CEA, IEEE, NAB, NCTA, and SMPTE
  - Focused on terrestrial digital television broadcasting
  - ATSC is an open, due process organization
- Approximately 150 member organizations
  - Broadcasters, broadcast equipment vendors, cable and satellite systems, consumer electronics and semiconductor manufacturers, universities

# ATSC Members


…and many more

# Overall Organization

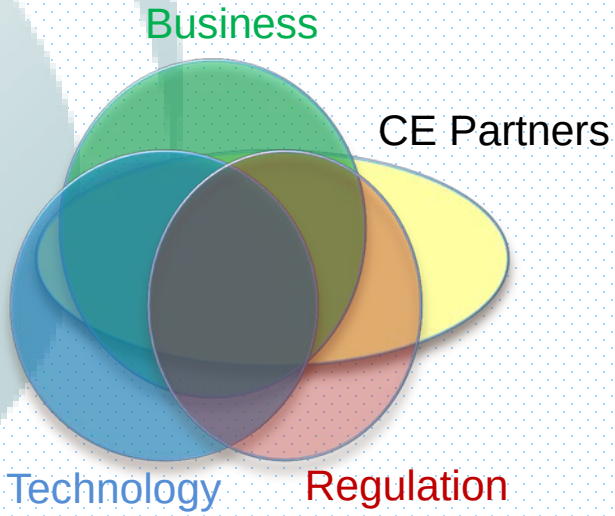



TG3
S31: System Requirements and Program Management
S32: PHY Layer
S33: Management and Protocols
S34: Applications and Presentation
S35: ATSC 3.0 Ecosystem
S36: ATSC 3.0 Security
S31-1: Data Collection & Documentation
S32-1: Common Elements
S32-2: Modulation & Coding
S32-3: Waveform
S32-4: AHG on Core Broadcast Services
S33-1: Service Delivery & Synchronization
S33-2: Service Announcement & Personalization
S33-3: Interactive Service & Companion-Screen
S34-1: Video
S34-2: Audio
S34-3: Presentation Logic & Service Frameworks
S34-4: Runtime Environment for Applications
S34-5: Accessibility

# SCOPE OF ATSC 3.0
# WHY NOW?

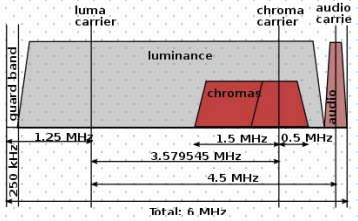
# Broadcast Industry Model

- The traditional broadcast paradigm is based upon use of a common open standard
  - Industry standard is set and approved by the regulatory authority
    - Broadcast equipment manufacturers build hardware compliant with the standard
    - Broadcasters transmit signals that are compliant with the standard
    - CE manufacturers build receivers capable of decoding the emitted signals
  - Consumer TVs receive all broadcast stations in their area



# NTSC Broadcast System

- Very successful technical standard
  - More than 60 year lifetime
- NTSC uses a 6 MHz RF channel
  - Channel # = brand
  - Single program delivered to consumers
    - One video stream – first monochrome, then compatible color
    - One audio stream – first mono, then stereo, and later SAP added
    - Closed captioning



# Perspective on ATSC 1.0

- ATSC 1.0 (A/53) delivers
  - High-definition video
  - Multicasting capabilities
  - 5.1 digital surround sound
  - Electronic program guides
  - Enhanced closed captioning services
  - Extensibility
  - Mobile digital TV (added in 2009)
- Grand Alliance system was a revolution in 1993

# Today: Rapid Advances, Ongoing Disruptions



# Competitive Landscape

- Cable modems offer greater than 150 Mbps to consumers
- WiFi 802.11ac operates at 1300 Mbps
  - 1999: 802.11b, 11 Mbps
  - 2009: 802.11n, 600 Mbps
  - 2013: 802.11ac, 1300 Mbps
- 4G networks capable of 12 Mbps
- Smart connected TVs and LCD / LED / OLED displays
- 4K UHD available, programming provided by
  - Netflix, Blu-ray Disc, Amazon Prime, others

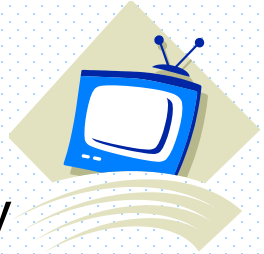
# Requirements for a New System

- 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 scalabilty

# ATSC 3.0 ATTRIBUTES AND BENEFITS

# What is the Goal of ATSC 3.0?

- To improve the television viewing experience
- To add value to broadcasting's service platform
  - Extending reach, adding possible 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



- …All without the restriction of backward compatibility

# The Next Revolution in Broadcasting

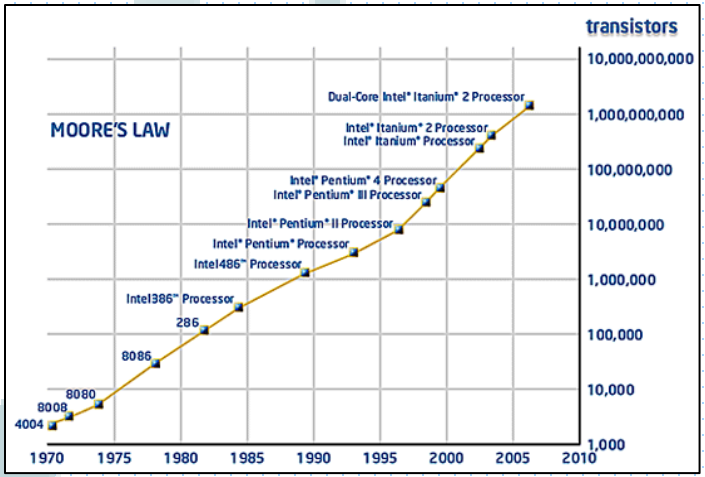
- How is an advance possible?
  - Advances in video compression: MPEG-2 … MPEG-4/AVC … MPEG HEVC
  - Advances in audio compression: AC-3 (A/52) … AAC … object-based audio
  - Advances in digital transmission and error-correcting codes
- Tapping these new advances permits a complete new system, however…
  - Because it is not backwards-compatible, the system must offer *significant performance improvements and new services*

# Benefits for Consumers

- Maintain competitive top-tier picture and sound quality
- Reach new consumer devices with broadcast platforms
- Leverage the power of broadcasting and the Internet
- More flexible and efficient use of the spectrum
- Potential for a world standard
  - FOBTV initiative

# Extensibility/Evolution

- ATSC 3.0 will be built to last, but technology advances rapidly
- Methods to gracefully evolve must be in the core, namely:
  - 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



# The Elevator Pitch

**ATSC 3.0**

- Configurable
- Scalable
- Efficient
- Interoperable
- Adaptable

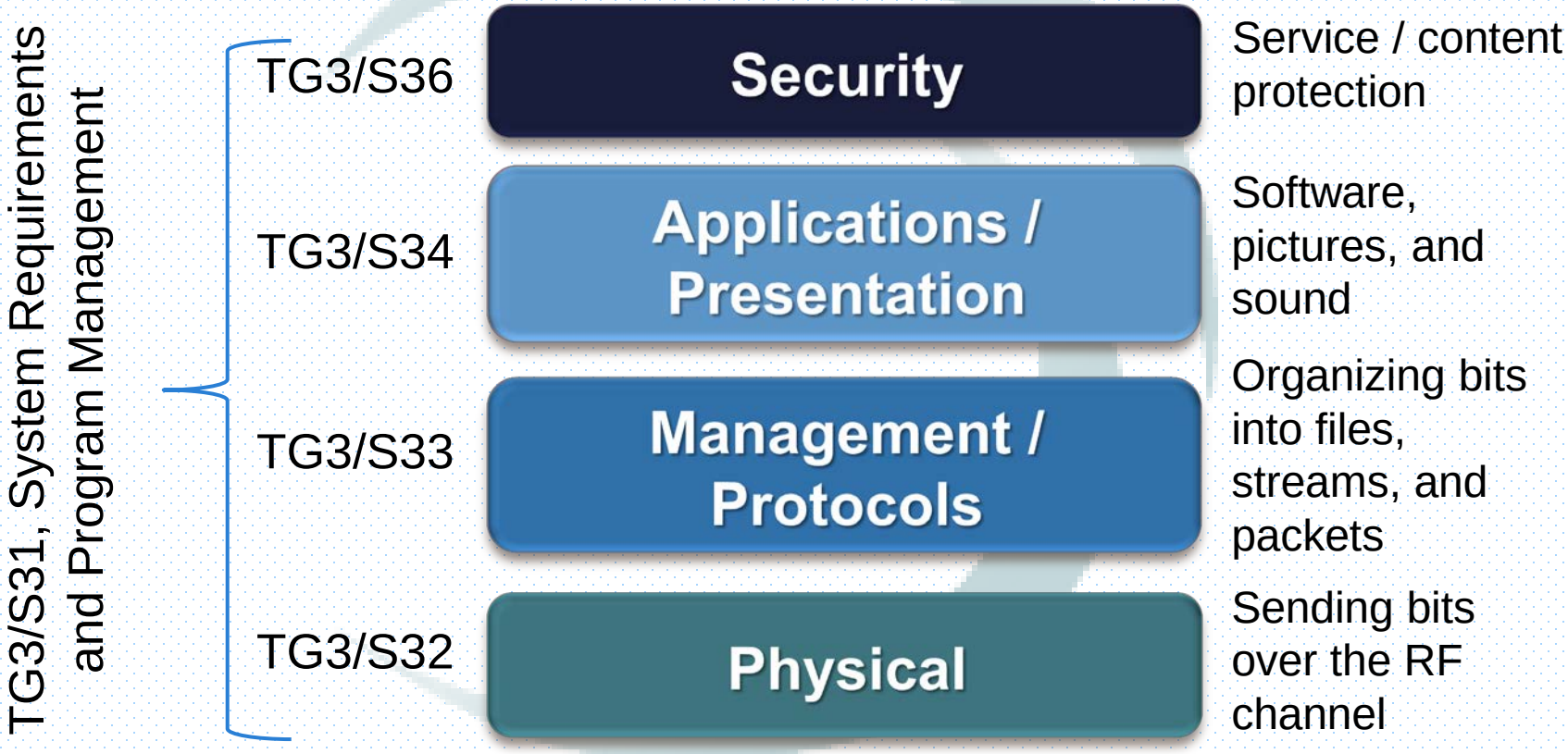
- Next generation broadcast television
  - Significantly higher data capacity
  - Flexible spectrum use
  - Higher physical layer robustness
  - Future extensibility
  - Mobile / handheld support
  - Hybrid broadcast + broadband delivery
  - Advanced A / V compression
    - Immersive audio
    - UHD support

# THE STANDARDIZATION PROCESS

# Basic ATSC 3.0 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

# System Layers and TG3 Specialist Groups



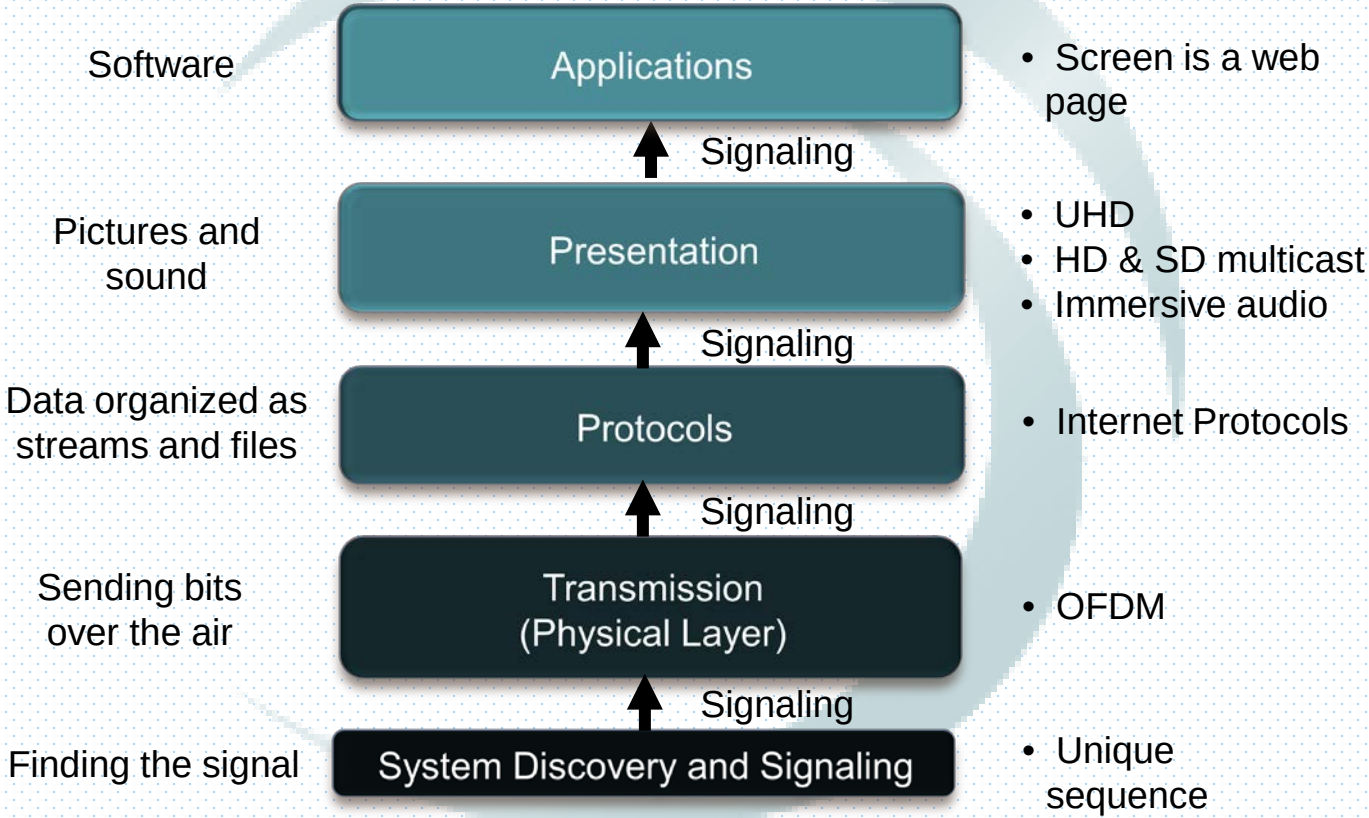
# Program Management

- System Requirements and Program Management are critical to any large project
- Specialist Group TG3/S31, Skip Pizzi (NAB) chair
  - Developed the Requirements and Usage Scenarios for ATSC 3.0
    - Work completed; updated Requirements ongoing
  - Address questions from Specialist Groups on Requirements
  - Prioritize work
  - Keep the big picture in mind
    - Track progress between and across all groups (cross-layer items)
    - Verify fulfillment of Requirements

# 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.

# ATSC 3.0 System Layers

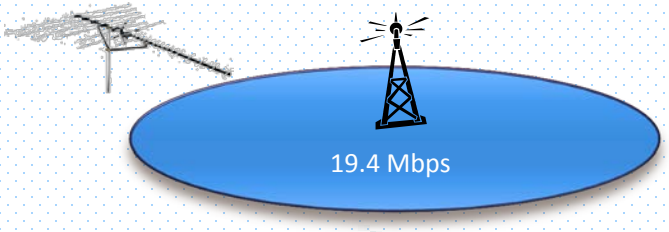


# PHY/Overview

- The ATSC 3.0 Physical Layer encompasses
  - Common system elements
  - Bootstrap signaling
  - Modulation and coding
  - Waveforms
  - Core broadcast services
- Specialist Group TG3/S32, Luke Fay (Sony), chair

# PHY/Comparison

- ATSC 1.0 physical layer
  - One bit rate – 19.39 Mbps
  - One coverage area – 15 db CNR (rooftop)
  - Service flexibility – HDTV, multicast, data



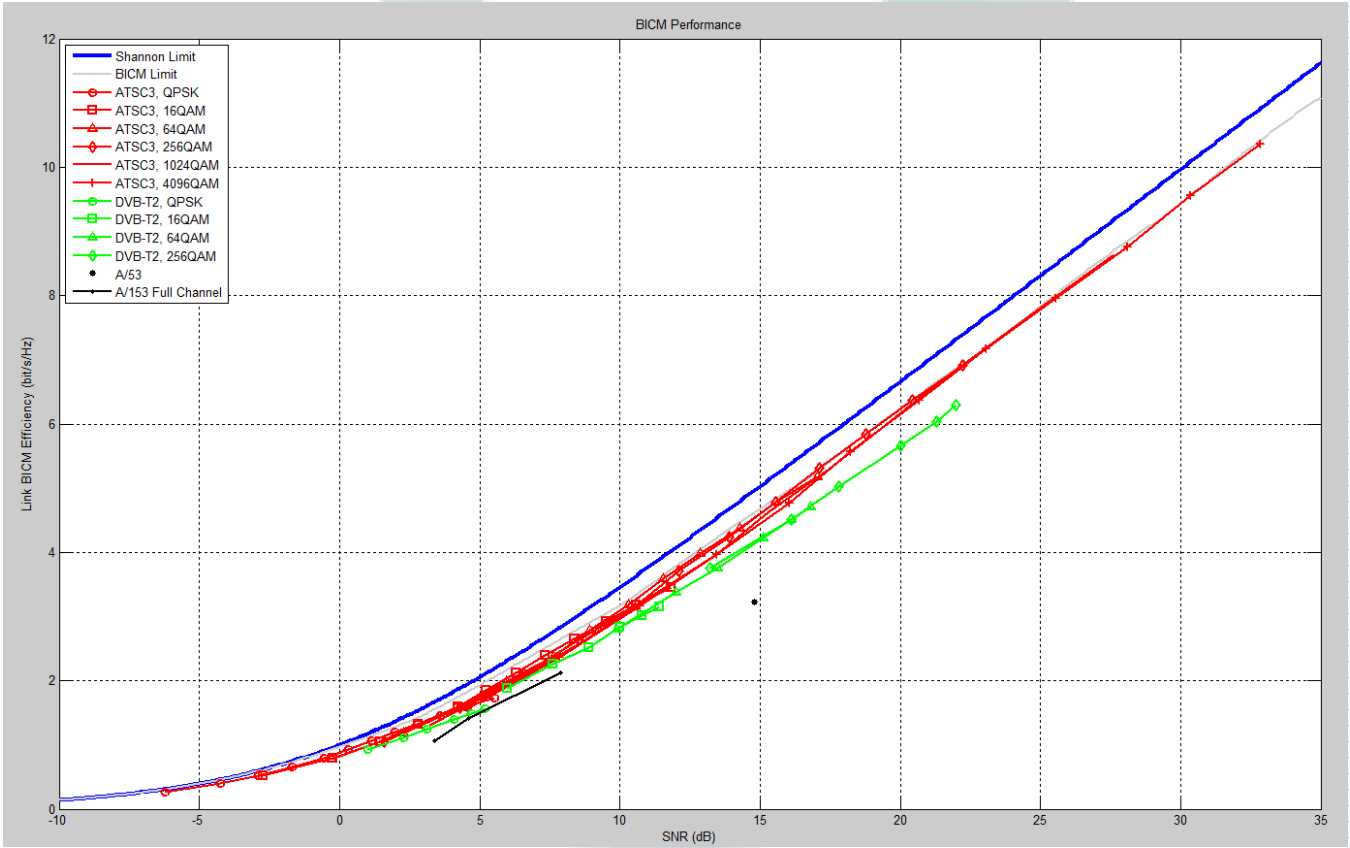

8-VSB with fixed (188,210) RS FEC

- ATSC 3.0 physical layer
  - More bits / Hz – near theoretical limit
  - Flexible bit rate and coverage area choices
  - Enable on-channel repeaters for robust indoor and mobile reception
  - Multiple simultaneous “physical layer pipes”

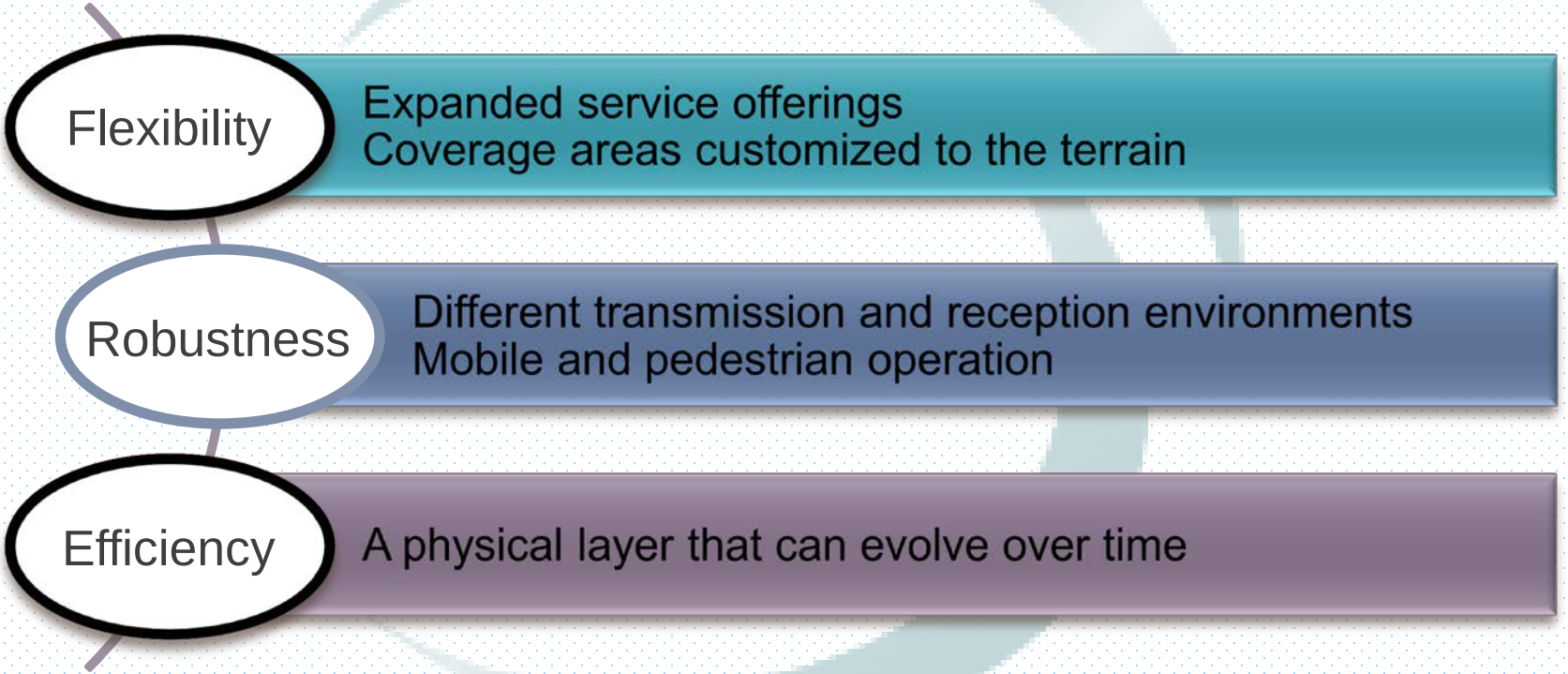
# PHY/Re-Thinking the Physical Layer

- ATSC 1.0 broadcasters have operated with a single constrained physical layer throughput of 19.39 Mbps since 1995
  - ATSC Mobile (added later) provided a separate robust emission that worked off the 19.39 Mbps stream
- ATSC 3.0 will have considerable flexibility in operating points
  - A large number of broadcast options will be available that are very close to the Shannon limit
    - Low capacity, highly robust
    - High capacity, less robust

# PHY/Shannon


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)
0
2
4
6
8
10
12
-10
-5
0
5
10
15
20
25
30
35

# PHY/Needs of Broadcasters

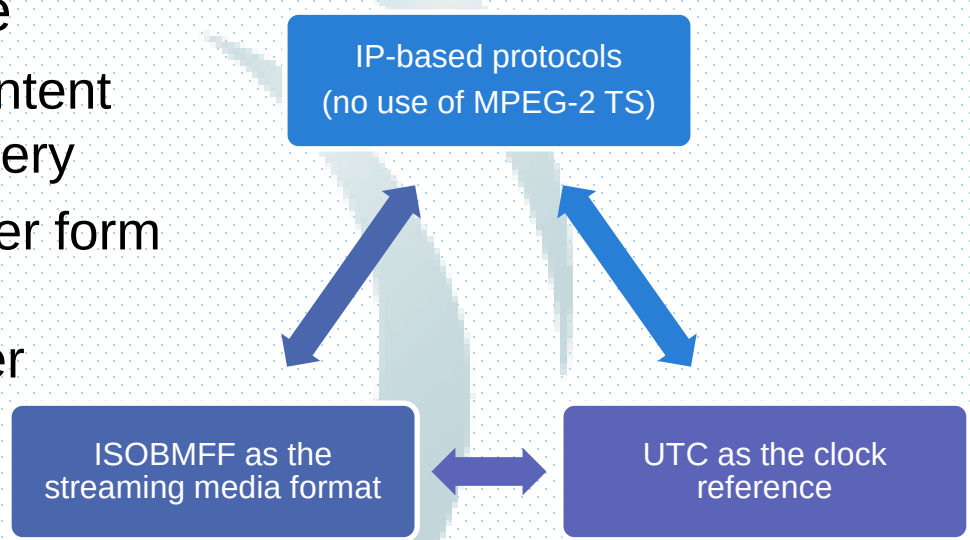


# MGT/Overview

- 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
- Specialist Group TG3/S33, Youngkwon Lim (Samsung) chair
- 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

# MGT/Key Elements

- Common elements include
  - 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
  - Use HTTP(s) over TCP (not UDP) for unmanaged broadband networks

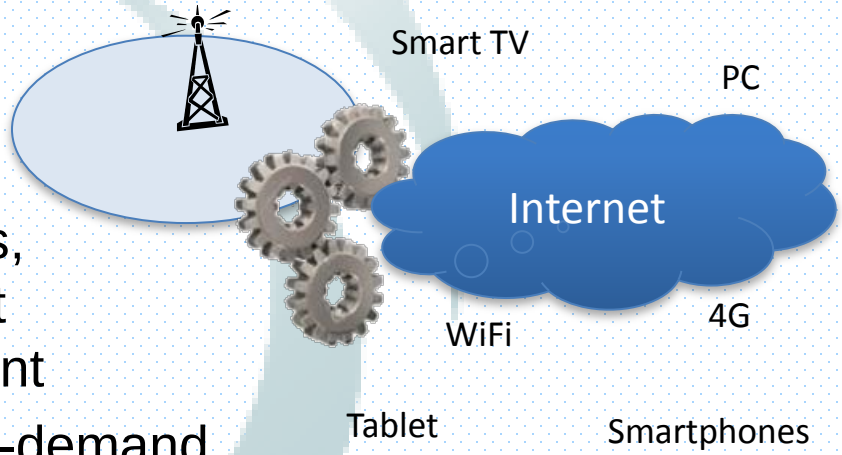


# MGT/Benefits of IP Transport

- 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
    - Ads or other content
    - Allows revenue model for broadcasters that has been available to only cable or IPTV operators

# MGT/Part of the Internet

- An Internet Protocol based system
  - Enables broadcasting to become part of the wireless internet
  - Encryption, conditional access, and digital rights management enables monetization of content
  - File delivery enables video-on-demand and dynamic ad insertion




- Makes broadcasting part of the Internet … and its massive global investment

# APP/Overview

- The ATSC 3.0 Applications and Presentations Layer encompasses
  - Video coding
  - Audio coding
  - Presentation logic and service frameworks
  - Runtime environment
  - Accessibility
- Specialist Group TG3/S34, Madeleine Noland (LG), chair

# APP/Video/Overview

- The ATSC 3.0 video system will support
  - Enhanced HD and UHD
  - Hybrid broadcast / broadband program delivery
  - High efficiency compression
  - Multiple, selectable video components
  - Alternate camera angles
  - Multi-view (e.g., picture-in-picture)
  - Multi-screen and companion device support
    - Not just “second screen”

# APP/Video/Technologies

- The ATSC 3.0 video system will take advantage of recent advances in coding technologies
- General agreement on
  - Codec, based on HEVC
  - Progressive only for UHD resolution
- 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

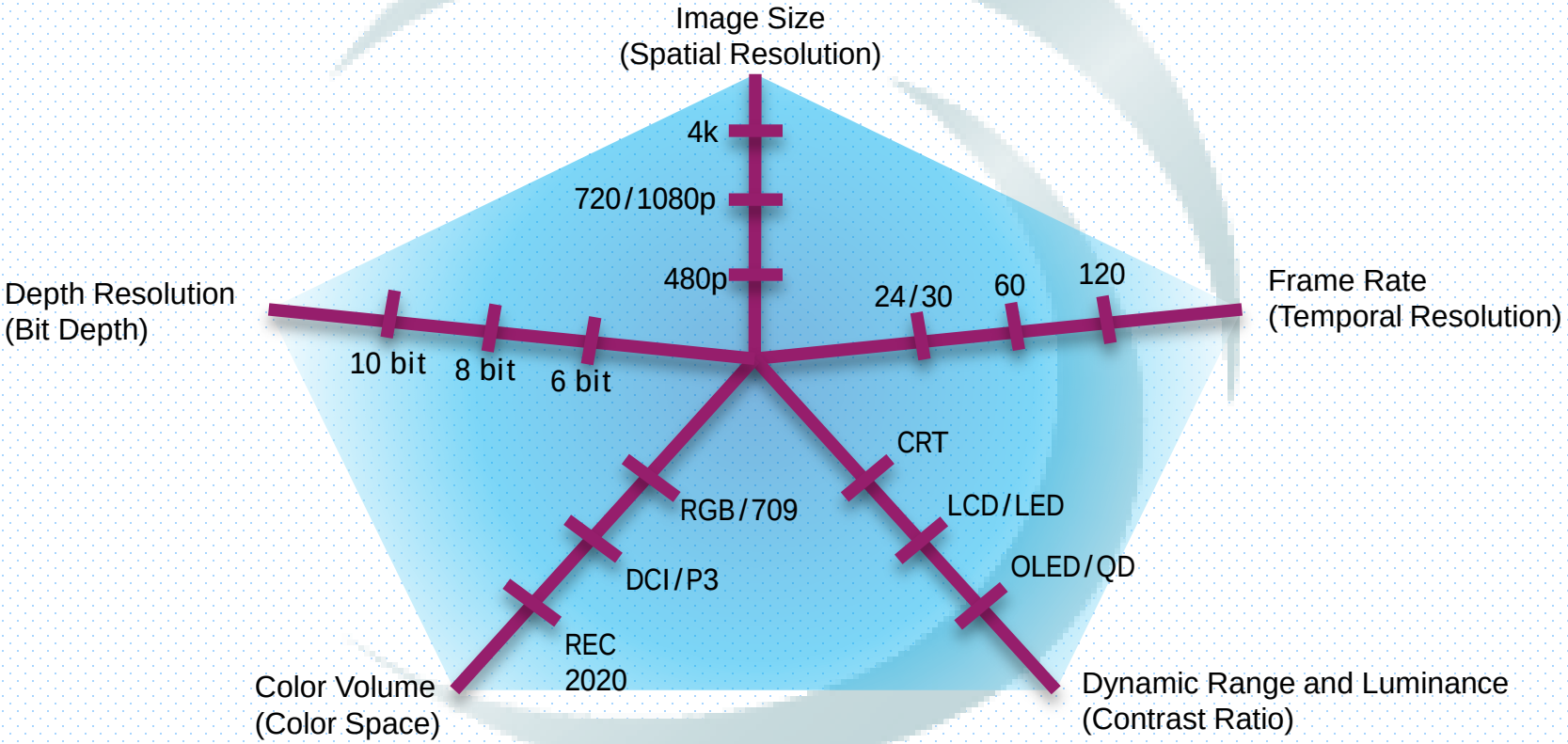
# APP/Video/Enhancements

- Likely video system enhancements include
  - UHD delivery to the home
  - 1080p formats
  - High dynamic range
  - Higher frame rate (anticipated)
  - Wide color gamut
- Additional HD resolutions are being considered; e.g., 2560 x 1440
- HD delivery to portable devices such as tablets

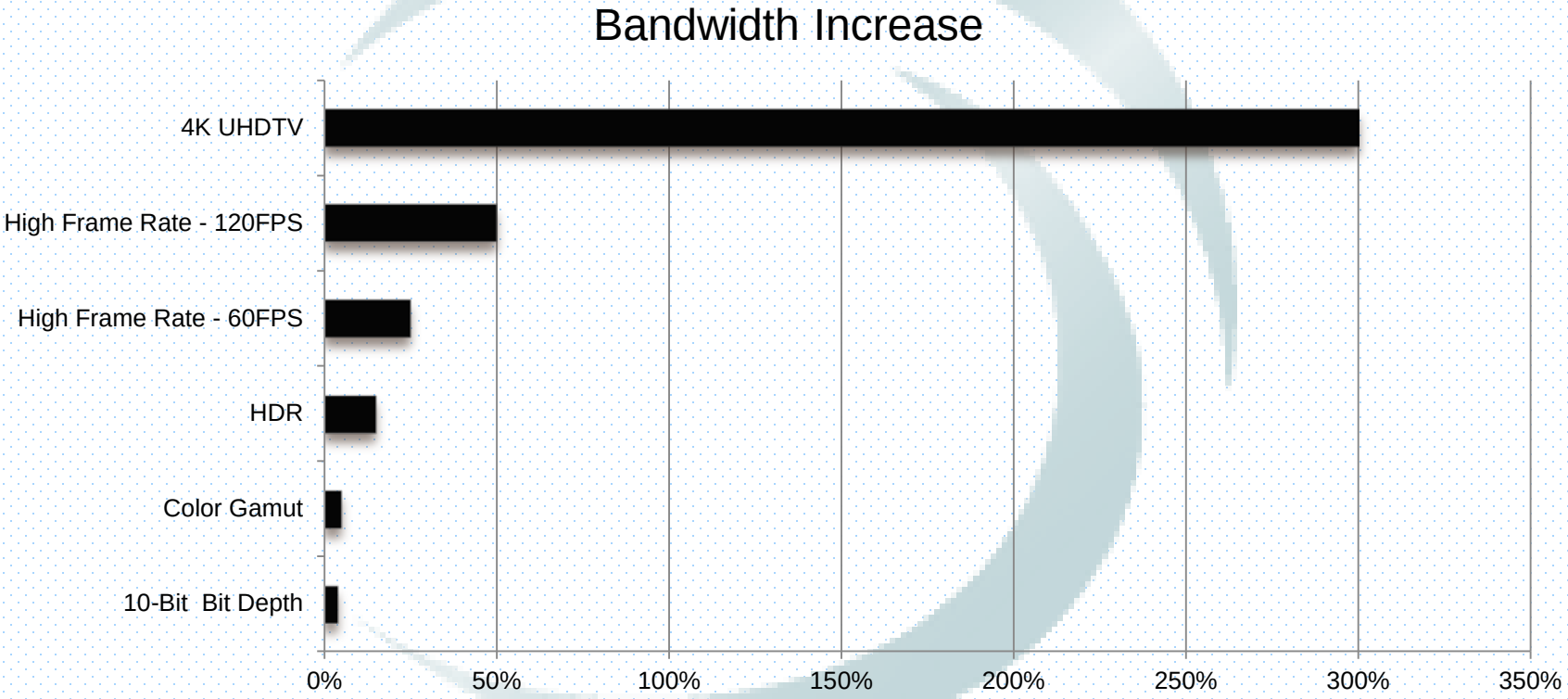
# APP/Video/UHD Video

- UHD 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
- Work in progress

# APP/Video/Multiple Degrees of Freedom



# APP/Video/Relative Bandwidth Demands



# APP/Audio/Overview

- The ATSC 3.0 audio system will feature
  - Personalization
  - An enhanced, immersive experience
- Targeted to various devices (fixed, mobile) and set-ups
  - 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 are planned
    - Based on the specific capabilities of a user's fixed or mobile device, and the unique sound environment

# APP/Audio/Personalization

- 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

# APP/Audio/Immersive

- 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
  - Differing speaker set-ups, and headphones
    - Including sub-optimal set-ups

# APP/Audio/Object Audio

- "Object Audio" is a major step forward for sound technologies
  - Use of objects or "elements" and steering metadata
    - Metadata allows rendering at the decoder, customized to the user's sound system
    - The decoder / renderer places the sound in the most accurate position that the user's device or sound system supports
  - Multiple receiver types are supported
    - Fixed, large screen
    - Tablets and other portable devices
    - Loudspeakers and headphones

# APP/Personalization and Applications

- 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

# APP/Advanced Emergency Alerting

- New public service capabilities
- 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
- Builds on the work done on M-EAS

# APP/Accessibility

- 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

# WHERE WE ARE NOW

# Candidate Standards

- 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
- Two documents have been elevated to CS
- Ballots pending to elevate four other documents to CS

# A/321, System Discovery and Signaling

- This document describes the system discovery and signaling architecture for the ATSC 3.0 physical layer
  - The bootstrap provides a universal entry point into a broadcast waveform
    - Employs a fixed configuration (sampling rate, signal bandwidth, subcarrier spacing, time-domain structure) known to all receiver devices
    - Carries information to enable processing and decoding the wireless service associated with a detected bootstrap
- This new capability ensures that broadcast spectrum can be adapted to carry new services and/or waveforms

# A/322, Physical Layer Standard

- Describes the RF/transmission of the ATSC 3.0 physical layer
  - Enables flexible configurations of physical layer resources to target a variety of operating modes
  - Signals the applied technologies in ATSC 3.0
  - Allows for future technology adaptation
    - Significant flexibility comes with a signaling structure that allows the physical layer to change technologies and evolve over time, while maintaining support of other ATSC 3.0 systems
- Allows broadcasters to choose from a wide variety of physical layer parameters to address different broadcaster needs

# CS Ballots Pending

- TG3 has authorized ballots on four documents for elevation to Candidate Standard status
  - A/332, “Service Announcement”
  - A/334, “Audio Watermark Emission”
  - A/335, “Video Watermark Emission”
  - A/338, “Companion Device”
- Assuming approval, publication is expected in late November
- All ATSC Candidate Standards available on the Web site
  - http://atsc.org/standards/candidate-standards/

# Possible Document Structure


ATSC 3.0 will be documented in a suite of standards.

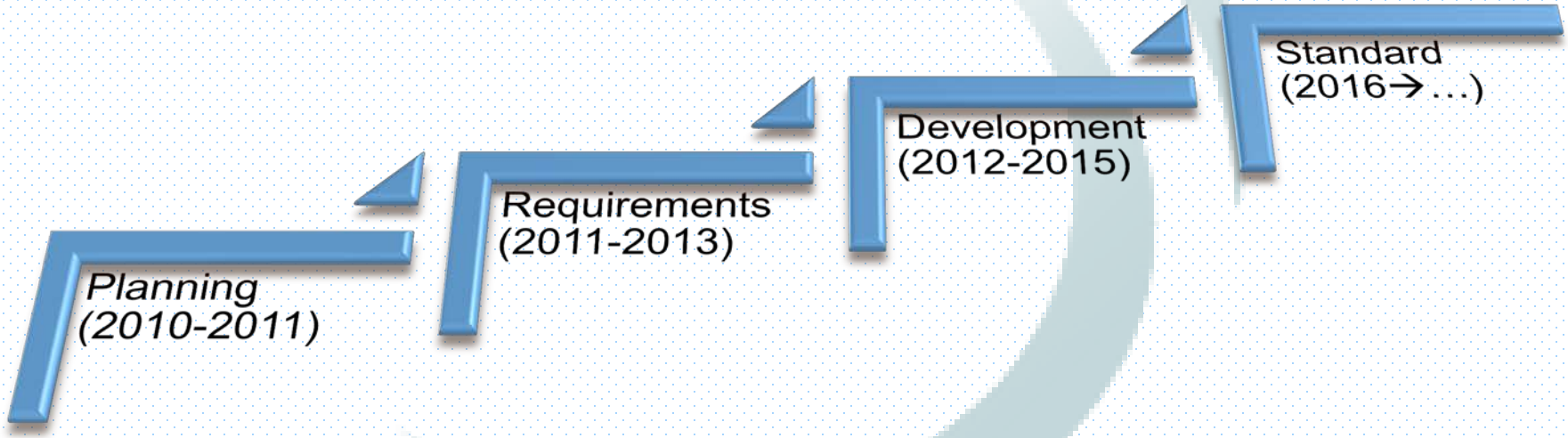
The top level "parent" standard (A/300) will describe the overall system and state what must be included to create an ATSC 3.0 system.

A/300 will point to a suite of around 20 standards for all of the core building blocks that make up ATSC 3.0.

- Sys. Disc. & Signaling: A/321
- PHY Layer D/L Standard: A/322
- PHY Layer U/L Standard: A/323
- Input Formatting into PHY Frames
- Input Formatting (e.g., ALP, TLV, etc.)
- Delivery & Signaling
- Service Announcement
- Service Reporting
- Audio Watermarking Standard
- Video Watermarking Standard
- Watermark Payload (A&V)
- Audio Standard
- Video Standard
- Caption Standard
- App Signaling & Trigger
- Runtime Standard
- Personalization Standard
- Companion Device Standard
- Security Standard

# PROGRESS AND SCHEDULE

# 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 2015
- Final approval of each document is expected in 2016 with completion of all in the first / second quarter of 2017

# Critical Next Steps

- Complete the standard!
  - Standard will consist of a number of documents for the various layers
  - Working Drafts now under development
  - More Candidate Standards expected to be published in Q4
    - Industry feedback solicited
    - Implementation experience gained
  - Updated documents move forward to Proposed Standard … then …Standard

# 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

# Contributors to this Presentation

- Mark Richer, ATSC President
- Glenn Reitmeier, NBC Universal, Chair of the ATSC Board of Directors
- Dr. Rich Chernock, Triveni Digital, TG3 Chair

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# THANKS. QUESTIONS?