ATSC TELEVISION
IN TRANSITION

Sep 20, 2016

ATSC 1.0 Overview

The move from analog to digital…

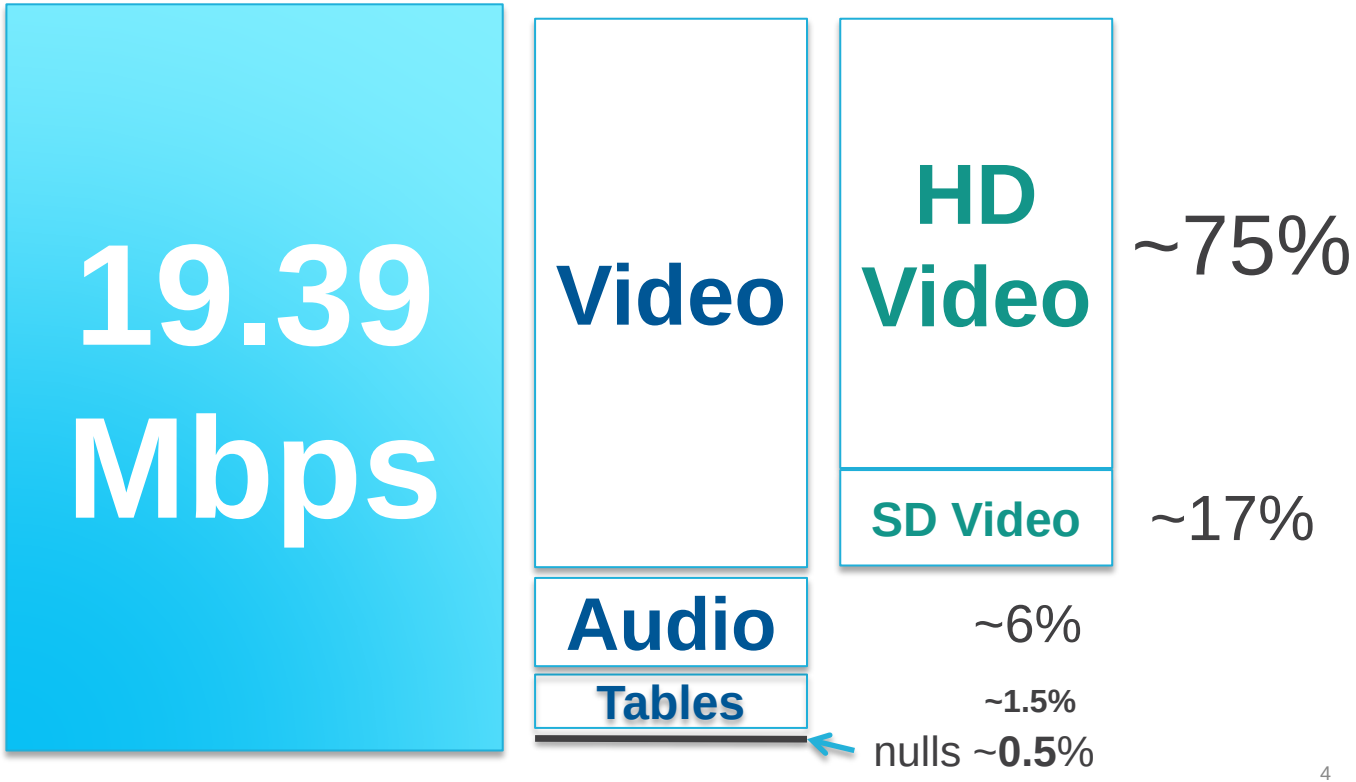
The ATSC 1 Digital Paradigm Shift

- ATSC broadcasters built systems based on the state of the art (at the time)
- Ushered in 4 new technologies…
  - **Real Time Media Compression**
    - Video (MPEG 2)
    - Audio (AC-3)
  - **Multiplexing** (MPEG 2 TS)
    - Metadata (PSIP)
  - **Digital STL** (ASI / SMPTE 310M)
  - **Digital Modulation** (8VSB)

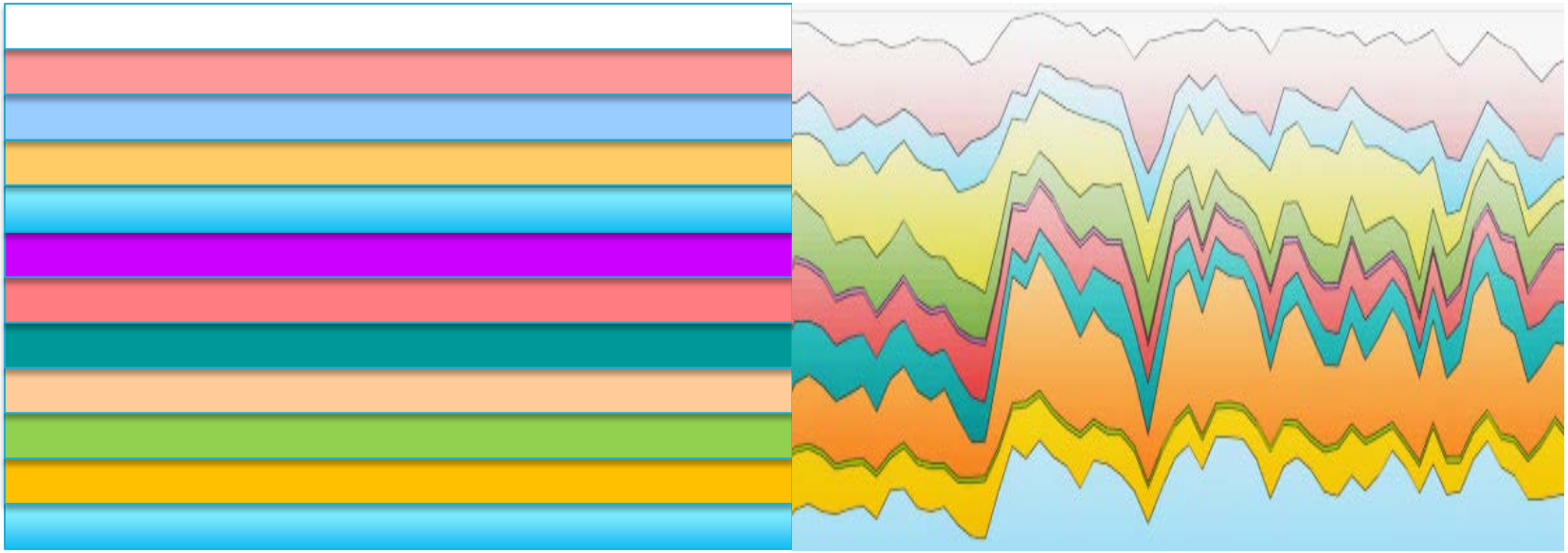
Compression and Multiplexing

harmonic

The ATSC Transport Stream



Constant vs. Variable Bitrate



CBR — Variable VQ (lower average)

VBR — Constant VQ (higher average)

CBR = Less Efficiency when running multiple channels

Look-ahead is used to allocate bits in the best quantity and exactly timed.

ATSC 1.0 Historical

HD and 5.1 was the attraction but struggled w/ 1080i HD at 18Mb/s in the early days

Statmux allowed systems to combine multiple channels with maximum efficiency for .2's

MPEG-2 performance improved over time, and still improves, albeit more slowly

Coding and filter techniques developed for AVC & HEVC also benefit MPEG-2

Statmuxing, along with filter tools & coding techniques support higher channel densities

harmonic

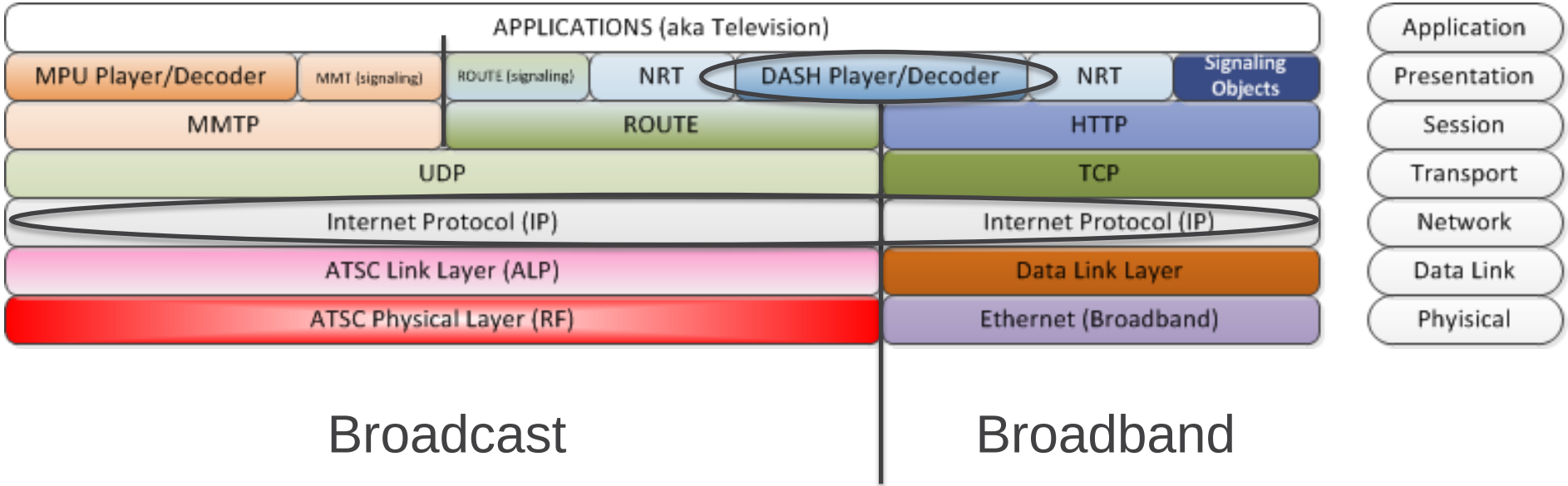
ATSC 3.0

Overview

The Next Paradigm Shift

- The ATSC 3.0 system is the next level of state of the art…
- Looking at the same 4 layers as ATSC 1:
  - New Compression codec's
    - Video (HEVC)
    - Audio (AC-4)
  - Packaging / Streaming (DASH / MMT)
    - Metadata (ROUTE, MMTP)
  - IP Digital STL
  - Digital Modulation (A3P)

The ATSC 3.0 Protocol Stack



ALC: Asynchronous Layered Coding
DASH: Dynamic Adaptive Streaming over HTTP
LCT: Layered Coding Transport
MMTP: MPEG Media Transport Protocol

MPU: media processing unit
NRT: non-real time
UDP: User Datagram Protocol

The ATSC 3.0 Documents (ATSC.ORG)

harmonic

A/321	**SYSTEM DISCOVERY AND SIGNALLING (final)**
A/322	PHYSICAL LAYER PROTOCOL
A/330	LINK LAYER PROTOCOL
A/331	SIGNALING, DELIVERY, SYNCHRONIZATION & ERROR PROTECTION
A/332	SERVICE ANNOUNCEMENT
A/333	SERVICE USAGE REPORTING
A/334	AUDIO WATERMARK EMISSION
A/335	VIDEO WATERMARK EMISSION
A/336	CONTENT RECOVERY IN REDISTRIBUTION SCENARIOS
A/338	COMPANION DEVICE
A/341	VIDEO (H.265)
A/342	AUDIO (AC-4 {US})
A/343	CAPTIONS AND SUBTITLES

ATSC 3.0 Over The Air Options

- **Single Carrier**
  - Single PLP (Physical Layer Pipe) – i.e. one level of robustness
  - Multiple PLP – Allows various size pipes
    - Where each PLP is offers a different trade off between robustness and payload
- **Multiple Carrier**
  - Multiple PLP are bonded across two or more carriers to make an aggregate pipe for multi tuner operation
  - The carriers don't need to be concurrent in spectrum
    - VHF may offer indoor advantages
    - UHF may offer portable advantages
    - When combined with different modulations both portable and fixed reception can be optimized

ATSC 3.0 Physical Layer (A3P)

harmonic

- Supported bit rate ranges in a 6MHz channel are …
  - Minimum **0.83 Mb/s** using QPSK, coderate 2/15, 8K FFT, 300usec GI
  - Maximum **56 Mb/s** using 4096 QAM, coderate 13/15, 32K FFT, 28usec GI
- A ~28Mbps service in 6 MHz is considered a “comparable” use case to a 8VSB
- Receivers must support at least 4 PLP’s
- Multiple PLP’s allow mixing different combinations of bits vs. robustness

Single RF PLP example

Service	PLP#	% Channel	PLP Capacity	AGWN SNR	Rayleigh SNR	Doppler
UHD	PLP1	45%	17.3Mb/s	22.2 dB	26.6dB	49 mph
SD	PLP2	25%	5.5Mb/s	12.9dB	15.8dB	49 mph
Mobile	PLP3	20%	0.58Mb/s	-1.3dB	-0.1dB	180 mph
NRT	PLP4	10%	0.17Mb/s	-3.7dB	-3.0dB	180 mph
Total		100%	23.6Mb/s			

*Thanks to Comark for this example

Enhancements to Linear TV

- **Service Types** – Enhanced linear services include alternative components and interactive application enhancements, pre-load application-based VoD services, audio-only services, push style data-only services
- **Hybrid Delivery** – Delivery of programs, program elements and triggers via broadcast to announce additional products or services available to those with broadband connectivity
  - Main program delivered via broadcast and alternate components or interstitials delivered via broadband
  - Trigger delivered in broadcast and preloaded content delivered via broadband
  - Temporary “hand-off” from broadcast to broadband and back for brief fades in reception
- **Real-Time and Non-Real-Time Delivery** – Content can be streamed in real-time (i.e., linear or streaming on-demand content) via both broadcast and broadband. Content can also be delivered in non-real-time and cached locally via both broadcast and broadband.

New Ecosystems

- **Security –** Security-enabled business models such as subscription services, “freemium” services
  (i.e., user registers and then the content is provided free), subscription for additional components and pay-per-view programs

- **Interactivity** – The interactive application environment for ATSC 3.0 will enable interoperability with apps that producers and broadcasters author

ATSC 3.0 Broadband

- Broadcast services must announce the products available in the streaming services (geo fencing)
- Streaming services can provide… (but not stand alone)
  - Diverse, Unlimited, Extra/Bonus and bidirectional
  - Alternate content, Alternate endings, Continued interviews
  - Off load VoD materials,
    - previous season
    - older episodes
    - Ad split

harmonic

Moving From ATSC 1.0 to 3.0

FCC Progress

- The Consumer Technology Association (CTA), and The National Association of Broadcasters (NAB) filed a Joint Petition for Rulemaking (“Petition”) asking the Commission to “amend its rules to allow broadcasters to ……the new ATSC 3.0 (‘Next Generation TV’) broadcast standard, **while they continue to deliver current-generation DTV broadcast service to their communities**.

How to transition

- It is unlikely that the FCC will allocate additional spectrum for a transition
- Consumers aren't going to replace all their TV's overnight
- A single channel can't broadcast ATSC 1 and ATSC 3 simultaneously
- The analog to digital transition took 10 years (and isn't actually complete)
- ATSC 1 to ATSC 3 is likely to take as long

➢Channel sharing is probably the only logical way to complete a transition

Channel Sharing

- The concept of channel sharing started with the FCC’s desire to recover spectrum
- It now exists as a legal mechanism as well as a technology
- MPEG 2 encoding improvements have made higher density multiplexes practical
- ATSC 3 will support much higher density than ATSC 1

- A practical solution will require advanced channel sharing to be efficient

Advanced Channel Sharing

- Advanced channel sharing treats the DMA spectrum as a shared asset, with many or all stations participating
- It assumes programming can be assigned to any RF multiplex as needed to optimize overall quality
- Stations would have to find business arrangements that allow reasonable trade offs between economics, video quality, and the ability to carry sports and other high complexity content

ATSC 3 channel density

- ATSC 3 will use the new HEVC codec
- This codec is currently 3 to 4 times as efficient as MPEG 2
- ATSC 3 provides a wide range of available bit rates
- Similar coverage will allow 25 to 28 Mb/s
- Robust coverage for mobile will be less
- Business concerns will drive new services based on Mobile, HDR and UHD, all of which consume more bits or bandwidth

Estimates, projections and guess work

- High end content will likely migrate to 1080p HDR:
  - Many facilities can support this work flow today (3G HDSDI)
  - 1080p HDR looks MUCH better than UHD 8 bit and consumes about 30% of the bits
- Mobile and 2nd channel SD will migrate to 480p
- Much of the rest will be 720p
- Required bit rates for similar quality:
  - 1080p HDR will need about 60% of the MPEG 2 1080i rates
  - 480p 8 bit will need about 50% of the MPEG 2 SD rates

Example of an initial sharing plan

- DMA has 24 SD, 7 720p, 6 1080i across 12 RF channels
- ATSC-1 total 9 RF channels
  - 2 transmitters with 10 SD
  - 2 transmitters with 2 x 720p + 2 SD
  - 1 transmitter with 3 x 720p
  - 3 transmitter with 2 x 1080i

- ATSC-3 3 RF channels:
  - 1 transmitter with 24 SD mostly 480p
  - 2 transmitters with 2 x 1080p HDR + 5 720p
  - 1 Transmitter for new business
- This leaves an open carrier for enhanced ATSC 3.0 services, or for additional growth of the ATSC 1.0 channel lineup
- Over time some ATSC 1 programming will be dropped to allow more ATSC 3, driven by viewership

harmonic

Final Thoughts

Industry Trends

- Consensus is developing around 1080p60 HDR as the primary large screen format
  - This trend is obvious among both OTA and Cable Networks
  - UHD offers little real world advantage over 1080p but needs ~4 times the bits
  - HDR offers revolutionary quality improvement with ~20% more bits
- CTA is pushing UHD, but just wants stunning pictures to sell new TV's
- Look for household ATSC3 tuners ahead of integrated TV's
- Cable companies are moving to IP, ATSC 3.0 will translate well
- MPEG2 is the new Analog – BUT progress is required to power the transition to HEVC…….

Thoughts

- Portable and Mobile represent the greatest potential for new revenue
- The Internet link is critical!
  - True Geo Location
  - True cross links between OTT and OTA
  - Hedge against Telco blocking of OTA features
  - Extremely robust PLP's for announcement will allow OTT reception where OTA doesn't work
- Consumers don't want to know or care how TV gets into their device

Harmonic's role (this is the Ad….)

- Harmonic has the worlds largest dedicated encoding R&D group
- New Technologies like EyeQ will revolutionize video delivery
- ATSC 3.0 is BOTH OTA and OTT!
  The best solutions will come from companies that live and breathe both
- Very advanced statistical multiplexing isn't easy
- We have encoders that do both ATSC 1.0 and 3.0
  - BUT – an ATSC 1.0 encoder you buy today will be on the air for 7 to 10 years
  - You will still need another encoder for ATSC 3.0….
- We have several solutions, one size doesn't fit all
- Software vs. ASIC doesn't matter
- Encoders are like phones or computers, there is always something better in the pipe

Questions?

Thank You

Thank You

www.harmonicinc.com

#VideoInnovation