Bits by the Bay

Transitioning to ATSC 3.0:
A look at the challenges ahead

May 24, 2017
ATSC 3.0 is the next-generation broadcast system, coming 20+ years after A/53 DTV (1996)

ATSC 3.0 is designed to be: **Configurable, Scalable, Efficient, Interoperable and Adaptable**

The key highlights of this next generation broadcast television are:

- Significantly higher data capacity
- Native mobile handheld support
- Flexible use of spectrum – for fixed, indoor or mobile reception
- Hybrid delivery methods – broadband and broadcast
- Advanced A/V formats, compression and delivery tools
  - Including HEVC, Immersive Audio AC-4, UHD, WCG and more
- Interactivity and rich application layer
- And much more…
Transit of ATSC 3.0 compressed audio/video can be over DASH/ROUTE or MPU/MMTP.
- This is all IP, no MPEG transport stream
- ROUTE can transport everything over the broadcast IP path: audio/video, signaling, ESG, NRT files.
Bit Interleaving, Coding, and Modulation Performance

Wide Range of Operating Points for ATSC 3.0

Lower Capacity
More Robust

Higher Capacity
Less Robust

A/53
HEVC — What Is It?

- HEVC (High Efficiency Video Coding) is a joint ITU-ISO/MPEG standard
- The latest in long line of video compression standards

MPEG-1 1993 1995 MPEG-2 2003 MPEG-4 AVC 2013 HEVC
HEVC Advancements

Existing Tools: Small, but Important Improvements

- Intra Prediction
- Improved Motion Compensation
- Improved Motion Vector Prediction
- Adaptive in-loop deblocking filter
- More and larger block sizes and shapes for Motion Estimation, transforms

One New Tool

- Addresses a technical shortcoming of AVC/H.264
- In-loop Sample Adaptive Offset (SAO) filter
HEVC Block Sizes

- Tailor the encoding to the content
- Especially helps HD, Ultra HD
• Encoder sends correction ("offset") to pixel ("sample") values, decoder adds it
  – Two modes: edge and non-edge ("band")
  – Very computationally demanding on encoder
• Helps clean edge noise and contouring artifacts
• Compute intensive in the encoder, but relatively easy for the decoder
HEVC Performance

The Result

25-50% improvement in compression efficiency over H.264
The Transition to ATSC 3.0
Why?

- Better video and audio
  - UHD, HDR, WCG  Pictures with much more impact
  - Immersive audio, object based audio, more languages
- More Devices
  - Portable and Mobile
  - Tablets, phones
  - Larger TV's
- More programming
  - Higher efficiency encoding
  - Better Modulation
  - Spectrum efficiency and flexibility
- OTT Delivery
  - DVR
  - Play it now
- Targeted Advertising
But really why?

- Cord never’s are usually antenna never’s
- TV antennas are rare, often not available for apartments or other MDU’s
- Over the Top viewing is replacing broadcast viewing
- Younger people watch most TV on demand, not by appointment
- More and more viewing is done on portable devices
- Top sports events are more expensive than ever to carry but cater to the last tethered audience - who demand better and better experience
- Broadcast bits are now more costly than satellite bits
- There is more programming available for more channels
- The current standard is stuck in the past: 20+ year old CODEC, interlace, poor picture quality, inefficient modulation
• Viewers don’t have ATSC 3.0 TV’s
• ATSC 1.0/2.0 TV’s will not work
• Transitioning viewers without STB subsidies or additional bandwidth will be challenging
• Manufacturers need programming on air if they are to be motivated to include ATSC 3.0
• Without programming there will not be devices
• Will there be programming without devices?
• RF channels are in short supply – especially post repack
• The spectrum auction and repack has made channel sharing palatable and common
• We all have to continue to make $ in the mean time
3 Phases

Spotlight - Prime the Pump
- One or more stations in each market introduce ATSC 3.0 and provide content and new services for devices
- Stations share to open these channels

Transitionary - Two audiences - Build new services, trim away old
- The most difficult period: A large number of ATSC 1.0 households alongside a large number of ATSC 3.0 devices
- Further collapse of the ATSC 1.0 channels is required to supply new services and business models to an increasing number of ATSC 3.0 transmitters
- Extensive channel sharing is required to maintain both standards
- New MVPD carriage challenges
- Competition from Wireless, OTT will be intense

Lighthouse - Sustaining
- Reduced ATSC 3.0 service, lower resolution, higher compression, fewer channels
- Broadcasters share incentives with manufacturers to transition the population
- FCC challenges to find the end game for ATSC 1.0
What Channel Mix Can You Deploy in 6 MHz Using ATSC 3.0?

- Advanced modulation yields 24 to 26 Mb/s with similar SNR requirements to ATSC 1.0
- HEVC encoding improves efficiency
- 6 to 9 HD’s on a single carrier
- A single transmitter can function as a Spotlight station

- But far fewer 1080p60 or UHD
- Also far fewer robust SD for mobile
What About Bitrates?

- Compressed video bitrates (CBR) in Mbps
- Statistical Multiplexing improves the bitrates when there are multiple programs

<table>
<thead>
<tr>
<th></th>
<th>SD</th>
<th>HD (720p60)</th>
<th>HD (1080i30)</th>
<th>HD (1080p60)</th>
<th>UHD (2160p60)</th>
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</thead>
<tbody>
<tr>
<td>MPEG-2</td>
<td>2</td>
<td>8</td>
<td>10</td>
<td>N/A</td>
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<tr>
<td>HEVC</td>
<td>0.9</td>
<td>3</td>
<td>4</td>
<td>5.5</td>
<td>17</td>
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<tr>
<td>Savings relative to MPEG2</td>
<td>55%</td>
<td>63%</td>
<td>60%</td>
<td>(~ 73%)</td>
<td>(~ 79%)</td>
</tr>
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with HDR & WCG

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ATSC 3.0 fixed reception (in 6MHz with comparable SNR to ATSC 1.0) yields about

24-28 Mbps
## Deployment Scenario Examples

<table>
<thead>
<tr>
<th>Use case</th>
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<th>Channel Loading (BCN On)</th>
<th>PLP Capacity (Mbps)</th>
<th>Channel Occupancy (%)</th>
<th>AWGN SNR (dB)</th>
<th>Service Assignments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fixed Spotlight</td>
<td>PLP1: 32K FFT; 148 usec GI, 64QAM, 64800 LDPC, 11/15 FEC, 250 msec Frame</td>
<td>24.42</td>
<td>100</td>
<td>14.28</td>
<td>2 x 720p, 4 x 1080i</td>
</tr>
</tbody>
</table>

*Note: The table includes detailed service assignments*
The selection of modulation and picture formats is critical to success in every phase of the transition:
- New services types are necessary to attract consumer participation
- Revenue generation requires new service types and targeted advertising if the transition is to be profitable

SD efficiency is critical to support mobile:
- Highly robust PLP’s do not provide high bitrate/bandwidth
- A robust PLP with HEVC SD’s will likely not carry more channels than an ATSC 1.0 SD multiplex
- SD HEVC does not gain as much efficiency as HD or UHD over MPEG2

UHD does not yield a lot of channels either, 1 + 1HD perhaps 2 UHD

1080p60 with HDR is a sweet spot > 3 to 4 in 24 - 26 Mb/s
Other thoughts

• Early on, conventional programming makes mobile / portable viable
• Consumers need a new experience! The same programming with the same pictures will not grow a new audience!
  – Where are we going to get 1080p, HDR & UHD content?
  – What about playout of new formats?
• Availability of sports in UHD, 1080p & UHD is needed to drive the large screen
• ATSC 3.0 OTT delivery may be the optimal path for UHD + HDR
  – This experience may be needed to drive the consumer side, but may be better driven by more robust delivery OTA at a lower format, with an option to view UHD OTT
• Channel sharing may be necessary even in the end
  – VHF isn’t a good fit with mobile
  – UHF with robust modulation is needed for mobile, but limited in capacity
  – VHF with midrange robustness is a good fit for 1080p primary channels
Eventually this programming could be delivered in UHD via OTT
• Questions and discussion
Thank You