Shifting to ATSC 3 – NextGen TV’s Advantages and Transition
An Overview of Television’s Next Big Leap

Skip Pizzi
Owner/Principal
Skip Pizzi Media Consultant LLC
ATSC TG3 Vice Chair

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ATSC 3.0 – A New Physical Layer

• From 8-VSB to COFDM
• RF Channel Capacity Increase of ~30% (19 Mbps → ~25Mbps)
• State-of-the-Art Error Correction (LDPC) and Interleaving
• Wide Range of FFT Sizes and Modulation/Coding Settings
• TDM or LDM
• “Bootstrap” concept for Flexibility/Extensibility
• SFNs, MIMO & Channel Bonding Options
# Bootstrap (A/321)

**Extensibility / Flexibility**
- Possible to evolve system/physical layer
  - Announces technology used in each frame
- Layers signal technologies to layer above
- Allows graceful evolution over time

Bootstrap emission is the starting point for ATSC 3.0
- Robust synchronization
- Service discovery
- Coarse time, frequency acquisition
- 5 MHz bandwidth
- Receivable at <-6 dB SNR (with FER = 1E-2)

<table>
<thead>
<tr>
<th>Time</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Bootstrap Signal</td>
<td>Preamble</td>
</tr>
<tr>
<td>L1 Basic Signaling</td>
<td>Sub-Frame Payload</td>
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<tr>
<td>L1 Detail Signaling</td>
<td>Sub-Frame Payload</td>
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<tr>
<td>...</td>
<td>Sub-Frame Payload</td>
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- 24 signaling bits
  - Sampling frequency
  - Channel bandwidth
  - EAS wake-up
  - Preamble selection
- Preamble frame control
  - Basic / detail
Bootstrap Also Allows Flexibility, Longevity & Public Service

Bootstrap allows mixture of different PHY formats in a single broadcast

Extensibility via versioning & mixture of PHYs
- Can support a mixture of today’s PHY tech along with tomorrow’s in a way that allows a receiver to utilize what it understands

Wake-up of receiving devices in standby mode in case of emergency
- Mechanisms to reduce annoyance factor & battery conservation (for mobile devices)
ATSC 3.0 Physical Layer Performance (A/322)

ATSC 3.0 has considerable flexibility in operating points:

- Low capacity, high robustness
- High capacity, low robustness
- Multiple Physical Layer Pipes (PLPs) at different operating points simultaneously on a single TV channel
Multi-PLP Use Case: Scalable Video Resolution

SHVC (Video Spatial Scalability)
- Base layer (BL) optimized for mobile reception
- Enhancement layer (EL) optimized for UHD resolution

Considerable efficiency advantage vs. simulcast is possible
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.
Single-frequency Networking (SFN)
SFNs Provide Better Coverage & Deep Indoor Penetration

Multiple transmitters in a SFN can be used to extend coverage and add capacity by raising the SNR.

OFDM guard interval alleviates potential inter-symbol interference arising from multiple transmitters.
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 is used for broadcast delivery of both streaming and file content
- ATSC 1.0 uses MPEG-2 Transport
- ATSC 3.0 is exclusively IP transport

The use of IP Transport is a game-changer for broadcasters
- Enabling hybrid broadcast/broadband delivery is a powerful, wholly new model
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 for synchronization and buffer management
  - All elements of the system “know what time it is”
Physical Layer

ATSC Link

ATSC Link-Layer Protocol (ALP)

Data Link Layer

ATSC 3.0 Physical Layer (OFDMA RF)

Physical Layer

Broadcast

Broadband

MPU Player/Decoder

EME/CENC

MPU (ISO BMFF)

MMTP

LLS (SLT)

HTTP Proxy

ROUTE

HTTP

TCP

IP

UDP

ATSC Link-Layer Protocol (ALP)

NRT File Delivery

Announcement

DASH Segment (ISO BMFF)

DASH Player/Decoder

EME/CENC

NRT File Delivery

All Signaling Objects

Applications (HTML5/JavaScript)

Announcement

ROUTE-specific Signaling

MMT-specific Signaling

Applications (HTML5/JavaScript)

MPU (ISO BMFF)

MMTP

LLS (SLT)

HTTP Proxy

ROUTE
Bringing Broadcast to Parity with Other Digital Delivery Systems

Broadcasting no longer an independent silo
- Use of IP allows taking 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
- Addressable advertising
ATSC 3.0 Presentation Layer – A Brand New Palette

- Improved video and audio quality and coding efficiency
- Multiple audio, video and caption tracks for one program possible
- Targeted content
- Lots of choices for the consumer and broadcaster
- Web-like Interactivity
- Advanced emergency alerting
- New accessibility features
- Integrated OTA and OTT delivery
Key Video Features

- Up to 4K UHD (2160p) spatial resolutions
- High Dynamic Range (HDR)
- Wide Color Gamut (WCG)
- High Frame Rate (HFR)
- Enhanced 2K HD (1080p)
  - Add HDR and WCG to HD
- Significant efficiency improvement with HEVC (~4x over ATSC 1.0)
Key Audio Features

• Immersive audio
• Sound with improved height and distance perspective
• Works on different devices and speaker set-ups
Key Audio Features

- Personalization
- Ability to efficiently customize an audio experience with channels/objects:
  - Enables more language choices
  - Offer alternate commentary (home/visitor team, director’s commentary, etc.)
- Improved dialog enhancement technologies
- Significant efficiency improvements with AC-4 and MPEG-H
Key Accessibility Features

Deliver video description audio service emergency alert crawl audio tracks
  ◦ While also sending additional alternative audio tracks
  ◦ Alternate audio tracks can share the immersive music & effects track that the main audio listeners enjoy
  ◦ Multiple languages are possible

Deliver multiple closed caption tracks
Multiple languages are possible
Improved Dialog Intelligibility control
Advanced Emergency Information

- Leverages the power of ATSC 3.0 to supplement existing EAS alerts
- On-screen icons/prompts/summaries
- Detailed and targeted info
- Rich media content (video, evacuation maps, etc.)
- User selection of preferences (e.g., language)
- Possibility to wake up devices for urgent alerts
Interactivity

Based on HTML 5, W3C technologies
- Similar to the web (“Broadcast App”)

Web development teams can understand the system
- Skills of your existing digital platform staff apply to this system
- Easy to adapt web applications for use on TVs

Adds TV-centric functions to the web-based foundation:
- Change the channel
- Check parental control setting
- Access the device’s PVR
Security

Encryption system for broadcast content enables new business models:
- Protect high value content
- Offer Subscription or “Freemium” services
- Offer Pay-per-View programming

Viewer registrations for services creates a 1-to-1 relationship between broadcaster and viewer

- TLS for protecting broadband-delivered content
  - Standard web security technology
ATSC 3.0 Service Models

Components delivered via OTA broadcast

Components delivered via broadband

Components can be dynamically selected and combined at the receiver
**NextGen TV Transition in U.S.**

No new spectrum provided for simulcast during transition period

Reciprocal 1.0/3.0 Channel Sharing (“Lighthouse” model)

FCC rules have been changed to accommodate
- Coverages of simulcast partners must match ~95%...
- Or broadcaster must provide STB converters for households unserved by 1.0 simulcasts
- More rules changes in progress

Translators decoupled from originating stations regarding ATSC 1.0 / 3.0 service, and no simulcast requirements
- Translators in ATSC 3.0 era may be mostly SFNs (or “on-channel repeaters” using loopback cancellation)

Different transition rules for LPTV: No ATSC 1.0 simulcasts required
Large “Lighthouses” (~5 Stations) Face a Bottleneck

Ideal transition strategy is to get to one remaining ATSC 1.0 station (“nightlight”) in the group ASAP

Mathematical limit to 1.0 simulcast carriage prevents this
  ◦ Getting beyond one or two full-power 3.0 stations is a problem
    ◦ Must drop multicast channels (or use MPEG-4 AVC)
    ◦ Must reduce HD to SD
    ◦ Must hope for flash-cut rule change

Better solution is more, smaller groupings (“Dance Partners”)
Example Service Map Today
All Stations Operating in ATSC 1.0

Station A
- Primary Svc-HD
- Aux Svc 1-SD
- Aux Svc 2-SD
- RF Ch 27

Station B
- Primary Svc-HD
- Aux Svc 1-HD
- Aux Svc 2-SD
- RF Ch 31

Station C
- Primary Svc-HD
- Aux Svc 1-SD
- RF Ch 9
Example Transition Service Map – Full Power (2022 – 2027?)

Station A (ATSC 1.0)
- Primary Svc-HD
- Aux Svc 1-SD
- Aux Svc 2-SD
- Station B/Pri-HD
- Station B/Aux2-SD

Station B (ATSC 3.0)
- Primary Svc-HD
- Aux Svc 1-HD
- Aux Svc 2-SD
- Station A/Pri-HD
- Station A/Aux1-SD
- Station A/Aux2-SD
- Station C/Pri-HD
- Station C/Aux1-SD

Station C (ATSC 1.0)
- Primary Svc-HD
- Aux Svc 1-SD
- Station B/Aux1-SDL

Leaves ~30% bandwidth available for other uses
Service Map Post-transition
All Stations Operating in ATSC 3.0

Station A
Primary Svc-HD
Aux Svc 1-SD
Aux Svc 2-SD
RF Ch 27
+ ~60% excess capacity

Station B
Primary Svc-UHD
Aux Svc 1-HD
Aux Svc 2-SD
RF Ch 31
+ ~50% excess capacity

Station C
Primary Svc-HD
Aux Svc 1-SD
RF Ch 9
+ ~70% excess capacity

NEXTGEN TV
Powered by ATSC 3.0
Example Service Map Today – Low Power
All Stations Operating in ATSC 1.0

- Station A: Primary Svc-HD, Aux Svc 1-SD, Aux Svc 2-SD, RF Ch 27
- Station B: Primary Svc-HD, Aux Svc 1-HD, Aux Svc 2-SD, RF Ch 31 (LP)
- Station C: Primary Svc-HD, Aux Svc 1-SD, RF Ch 9

Powered by ATSC 3.0
Example Transition Service Map – Low Power
Flash-cut LP to 3.0 – No 1.0 Simulcast Requirement

Leaves ~60% bandwidth available for other uses
Service Map Post-transition – Low Power

All Stations Operating in ATSC 3.0

Station A
Primary Svc-HD
Aux Svc 1-SD
Aux Svc 2-SD
RF Ch
27
+ ~60% excess capacity

Station B
LP
RF Ch
31
< ~500% “excess” capacity

New Services

Station C
Primary Svc-HD
Aux Svc 1-SD
RF Ch
9
+ ~70% excess capacity

All Stations Operating in ATSC 3.0
+ ~500% “excess” capacity
+ ~60% excess capacity
+ ~70% excess capacity
Possible Uses of Excess ATSC 3.0 Capacity
During and after transition

Additional TV services
- News, Entertainment, Educational

Spectrum Sharing
- Other local stations

Datacasting
- Data services to non-broadband homes/students and incarcerated populations
- Content delivery to Digital Signage/Kiosks
- Advanced Emergency Information
- Precision Location Services
- Automotive Software Updates
- Internet of Things

Interactivity
- Application development (including program enhancements and new advertising techniques)
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  - https://nabpilot.org/beitc-proceedings/

NextGen TV Training (MSW)
- https://www.nextgentvtraining.com/
Questions?

skip@skippizzi.com

www.atsc.org