ATSC 3.0, Convergence, and Spectrum Efficiency

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Advanced Television Systems Committee

- Standards development organization for digital terrestrial broadcasting
  - Founded in 1983 by CTA, IEEE, NAB, NCTA, and SMPTE
  - Focused on digital terrestrial broadcasting including television

- ATSC is an open, due process organization
  - Approximately 140 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.
## A World of Experts behind ATSC 3.0

### 370+ active contributors
- Many others work “behind the scenes” on 3.0 development efforts

### 140 organizations
- Broadcasters
- Consumer Technology Manufacturers
- Professional Equipment Manufacturers
- R&D Laboratories
- Universities

### International Participation
- Canada
- China
- Europe
- Japan
- South Korea
- United States
ATSC 3.0 Summary – Broadcasting in the Internet Age

- Physical Layer – flexible, configurable, world’s most efficient one-to-many DTT system
- Transport – IP-based protocol via MMPT and ROUTE/DASH
- Video – UHD, HDR, WCG, HFR, scalable video coding via HEVC H.265
- Audio – immersive audio, personalization via Dolby AC-4, MPEG-H Audio
- Apps – web-based interactivity via HTML5, CSS, JavaScript and Websocket APIs
- Accessibility – new capabilities for visually and hearing-impaired audience
- Advanced Emergency Messaging – new rich media capabilities and receiver “wake-up”
- Datacasting – ability to deliver data to IoT, e.g., cars, agriculture, signage, smart cities, etc.
- Convergence Ready – designed to easily interoperate with other IP data delivery networks
Innovative Technologies Implemented in ATSC 3.0

- Low Density Parity Check (LDPC) code, up to 64k-bit code length;
- Non-Uniform Constellation (NUC) Modulation with up to 4096NUC-QAM modulation;
- Layered-Division-Multiplexing (LDM) that can efficiently combine robust mobile and high data rate fixed services in one TV channel;
- Robust Bootstrap (synchronization/signaling sequence) that combines time and frequency domain signalling technologies (PN + Zadoff-Chu sequence);
- System Sampling frequency $F(s) = N \times 384,000$ Hz, same as 5G for easy convergence (384,000 Hz is 1/10 the 3G WCDMA chip rate).
- IP-based transport system, same as many global data network standards for easy convergence.
ATSC 3.0 is a Platform

Unlike previous DTT standards, ATSC 3.0 is a Platform that evolves
ATSC 3.0 must continually develop so that broadcasting can serve the changing market demands
ATSC members maintain and develop the ATSC 3.0 Platform
ATSC Committee Structure

Planning Teams
- recommendations

Technology Groups
- draft standards

Implementation Teams
- build solutions
Active ATSC Committees

Planning Team 4 – Future Broadcast Ecosystem Technologies
Planning Team 5 – Automotive Applications
Planning Team 6 – Global Recognition of ATSC 3.0
Planning Team 8 – Core Network Technologies for Broadcast

Technology Group 3 – ATSC 3.0
 ◦ 7 Specialist Groups, 2 Ad Hoc Groups are active under the TG3 umbrella

Conformance Implementation Team
India Implementation Team
DEPLOYMENTS
SOUTH KOREA DEPLOYMENTS

South Korea literally paved the road to ATSC 3.0, adopting its Next Gen TV standard in 2016 and launching 4K Ultra High Definition ATSC 3.0 broadcasts in May 2017. Momentum continues to build since the landmark UHD broadcasts of the Winter Olympics, and ATSC 3.0 services now reach over 70% of the population.

In addition to UHD, broadcasters in South Korea continue developing new services on the country’s ATSC 3.0 service roadmap.

“On the Air” with ATSC 3.0
DEPLOYMENTS

Broadcasters have announced that they are working together to bring ATSC 3.0 first to 62 markets across the country, which collectively would mean next-generation TV reception by more than 75% of all viewers. Those 62 “First Markets” are indicated on this map. Each “first market” (in dark blue) will transition to readying broadcasts (in light blue) and then on-the-air with ATSC 3.0 (in orange.)

UNITED STATES DEPLOYMENTS
Two Generations of Digital Terrestrial Broadcast Standards

- **ARIB**: ISDB-T
- **ATSC**: ATSC 1.0 (2.0), ATSC 3.0
- **DVB**: DVB-T, DVB-T2
- **NRTA**: 1st Gen

**Powered by ATSC 3.0**
Multimedia Broadcast Multicast Services (MBMS) is a point-to-multipoint (P2MP) communication system designed for 3G cellular network (Release 6, Q4 2004); Evolved MBMS (eMBMS, also called LTE-Broadcast) was an upgrade for 4G/LTE (Release 9 & 12, Q4 2008 & March 2015); Further Evolved MBMS (feMBMS, also called enTV) is a further enhanced system (Release 14, mid-2017). Specify options for broadcasting to 4G/LTE terminals; 3GPP did not address “5G broadcast” in Release 16. (i.e., feMBMS is not based on 5G NR; it is a 4G-based system)
Converged Networks and Spectral Efficiency

Different networks and different frequency bands excel at different use cases. The ability to dynamically steer, switch or share data sessions across different data networks allows optimal usage of spectrum.

A key use case for convergence is to intelligently and dynamically choose one-to-one (P2P) networks vs. one-to-many (P2MP) networks according to the current need.

Large data sessions intended for a large number of devices can be most efficiently carried by a PTMP network:

- Map updates to cars
- Popular media content
- If storage is available on the receive device, a PTMP network can be used for time-shifted consumption.
International Trends on Convergence

CRC Canada
- Initiated and on-going research Broadcast-Broadband convergence project in 2015

U.S.
- Proposal to ATSC on Convergence of 5G and Broadcast Core Networks (OneMedia)
- Cable TV and 5G core network convergence by Cable Labs

Europe
- EU 5G PPP X-Cast project 2017-2019
- Demonstrated SDR feMBMS in 2019

India
- National Standard Body studied OTA broadcast for LTE traffic off-loading. ATSC 3.0 and LDM favored. Plan to propose to 3GPP.

China
- National Broadcaster granted a 5G carrier license June 2019, using 700 MHz and mid-band to deploy 5G, while keeping broadcast TV services

Korea
- Demonstrated ATSC 3.0 & 4G/LTE-A field trial.
- ATSC-5G convergence project underway.
- Continue collaboration with CRC Canada.
3GPP Envisions Convergence

1. 5G will be an ecosystem that includes many different standards, operating on different spectrum bands, providing different services;
2. 3GPP has defined methods for Steering, Switching and Splitting data sessions across heterogeneous networks
ATSC Envisions Convergence

1. ATSC 3.0 is 5G ready and could be part of the 5G ecosystem as part of the wireless connected world;
2. ATSC 3.0 and 5G share many common components (IP transport, HTML5/JavaScript, Audio/Video, etc.);
3. ATSC 3.0 can deliver Audio/Video/Data to mobile and fixed terminals in large geographical areas, i.e., one-to-many communications to large amount of terminals simultaneously (P2MP Wide Area Network).
Physical Layer Capacity

- Low Capacity, Robust
- High Capacity, Less Robust

Shannon Limit

BICM Performance

Line BICM Efficiency (bits/Hz)

SNR (dB)

A/53

A/153

A/153 Full Channel

QPSK, BICM
16QAM BICM
64QAM BICM
256QAM BICM
1024QAM BICM
4096QAM BICM
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
Comparison of ATSC 3.0 and 3GPP Broadcast Mode

BICM Spectral Efficiency as a function of CNR for BLER=0.1% (SISO AWGN Channel)

ATSC3.0 Performance is closest to Shannon Limit

Source: TSDSI 5000 v1.0.0 Technical White Paper Broadcast Offload
Scenario: Traffic Offload in India

Sinclair Broadcast Group, Saankhya Labs and TSDSI (India’s Telecom SDO) are exploring Traffic Offload for India:

- India has 1.2 billion cell phones
- People routinely watch linear television content on their phones
- The Indian cellular network is facing major congestion issues; cell phone ownership and data usage is continually rising

Concept:

- “Smart” network core monitors the number of devices receiving the same data at the same time on LTE/5G network
- When the number of devices exceeds a threshold, data delivery is moved off LTE/5G and onto ATSC 3.0 DTT network
- No simulcast – bandwidth savings is the goal

Indian operators are working with the 3GPP broadcast mode (eMBMS), while also exploring ATSC 3.0:

- Cellular operators in India may prefer to utilize the DTT spectrum in order to preserve their spectrum for unicast services
- ATSC 3.0 tuner/demodulation would have to be added to the phones
- Regulations would have to permit this usage on the DTT spectrum
Planning Team 8 – Core Network Technologies Background

Background:

A core network that enables broadcast towers to be efficiently connected to form one or more service networks may be important or even necessary to fulfill myriad use cases, such as datacasting to the Internet of Things, Broadcast Traffic Offload, datacasting to moving vehicles, and others.

A broadcast core network may further enable convergence and interoperability with other heterogeneous networks.
Planning Team 8 – Core Network Technologies Scope

Scope:

PT8 will study the core network concept and consider how it may apply to ATSC 3.0 digital terrestrial broadcasting, including identifying specific use cases and commercial benefits of broadcast core network technology. The group will also investigate the applicability of other industry standards, analyze “gaps” and identify what new technical work might be undertaken by ATSC in this area, considering the guidance for new work as stated in the Bylaws. PT8 will report the results of this work to the Board.
Preliminary ATSC 3.0 Core Network Design Concepts

ATSC core network should be designed for standalone operation.

ATSC core network should be designed for converged operation with other data delivery networks, e.g., 5G.

ATSC core network should be designed for cases where an uplink is not available, as well as for cases when an uplink is always or sometimes available.
5G Core and ATSC intersection
Telco Meeting Broadcasting

Source: ATSC 3.0 Broadcast 5G Unicast Heterogeneous Network Converged Services Starting Release 16, Transactions on Broadcasting BTS-19-205
Summary

DTT broadcasters are operating in a global ecosystem of converging networks

Data session steering, switching, and sharing across heterogeneous networks can improve spectrum usage efficiency
  ◦ Use the most appropriate network(s) for each given data session in a dynamic fashion

ATSC 3.0 specifies the most efficient physical layer for one-to-many data delivery in the world today
  ◦ Designed for TV and non-TV uses
  ◦ Designed for fixed and mobile uses
  ◦ Designed for one-to-many downlink
  ◦ Designed for convergence with other data delivery networks, e.g., Internet, LTE/5G

A core network for broadcast enables broadcasters to efficiently participate in a global converged network ecosystem

ATSC Planning Team 8 is studying broadcast core network design

ATSC 3.0 is a platform that can be developed as market demands change, and technology groups await the outcome of PT-8’s findings
Thank You!

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