Report of the FCC Technological Advisory Council Working Group on Implications of Next Generation TV Broadcasting Technology

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EXECUTIVE SUMMARY

The Technology Advisory Council ("TAC") of the Federal Communications Commission ("Commission") convened the Working Group on Implications of Next Generation TV Broadcasting Technology ("Working Group")[1] to consider the implications of the development and deployment of the next-generation television broadcast standard known as ATSC 3.0. This standard has the potential to deliver numerous benefits to consumers and broadcasters, and broadcasters are expected to begin transmitting ATSC 3.0 signals on a voluntary basis as soon as 2018.

The Working Group is charged with addressing a number of specific questions related to how this new standard might fit into the overall communications landscape. In this Report, the Working Group addresses these questions and the broad question of how ATSC 3.0 fits in a rich, dynamic communications ecosystem.

We conclude that different broadcasters are likely to utilize ATSC 3.0 in different ways, on different time horizons. Some broadcasters may pursue a "mobile first" strategy in the short term to transmit ATSC 3.0 video content to consumers on their mobile devices. Other broadcasters, however, may be unwilling to devote the downlink capacity for mobile delivery in the short term, choosing instead to focus on delivery of richer audio and visual content. Likewise, some broadcasters may move quickly to establish single frequency networks ("SFNs") while other broadcasters choose to continue to broadcast from a single high-power station through the simulcast transition period.

These different use scenarios will result in different interactions between ATSC 3.0 and other communications services in the broader communications ecosystem. While initial studies suggest that ATSC 3.0 does not present greater interference risks than ATSC 1.0, the incorporation of ATSC 3.0 receivers into mobile devices could present cost, and other implementation issues. Similarly, if multiple broadcasters were to move to SFNs, siting and interference issues could arise. Likewise, the flexibility that ATSC 3.0 affords to broadcasters could create implementation difficulties for MVPDs, ultimately negatively affecting consumers if unresolved.

This Report explores these issues and offers thoughts on actionable recommendations for the Commission and industry participants to consider.

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1. SCOPE AND STRUCTURE

Broadcasters are developing ATSC 3.0, the next-generation broadcast standard, with the intent of merging the capabilities of over-the-air broadcasting with the broadband viewing and information delivery methods of the Internet, using the 6 MHz channels presently allocated for digital television. Broadcasters are expected to begin to transmit ATSC 3.0 signals on a voluntary basis as soon as 2018.

The Technology Advisory Council ("TAC") of the Federal Communications Commission ("Commission") convened this Working Group to consider the implications of this next generation standard. The new standard differs from traditional television broadcasting in several important ways. It has the capacity not only to carry what can be characterized as traditional content (in an enhanced ultra high-definition format), but also to offer new services. The task of the TAC working group is to consider how this new standard might fit into the overall communications landscape, looking ahead at how implementation may impact the future of communications generally.[2]

The first part of the Report provides a backgrounder on ATSC 3.0. Then, the Report addresses specific questions directed to the Working Group:

- To what extent will this new service compete or integrate with services that are offered by commercial wireless services?
- To what extent might the implementation of ATSC 3.0 raise issues such as expanded deployment of distributed transmission systems that could face issues such as tower siting?
- What are the ways that ATSC 3.0 is likely to be deployed that could intersect with other communications facilities and devices such as the use of gateways that could rely on Wi-Fi to distribute multiple video signals throughout a dwelling?
- If a gateway and Wi-Fi were used, how would they interplay with wireless routers used for other services in the same dwelling?
- What other synergies or interfaces might exist between broadcast data services and commercial wireless services?

The Report provides conclusions and thoughts on actionable recommendations to address the areas of concern discussed in this Report.

[2] The working group is aware of the FCC's ATSC 3.0 rulemaking proceeding, but the issues and topics raised in that proceeding are outside the scope of the working group's charter.

2. BACKGROUND

The Advanced Television Systems Committee ("ATSC") is an international television standards development organization, and is responsible for developing voluntary standards that govern digital television transmission over terrestrial broadcast channels. The ATSC 1.0 standard was developed in the early to mid 1990s and is the basis for DTV broadcasting today in the U.S. The process of developing ATSC 3.0 began in 2010. The ATSC 3.0 standard actually comprises numerous standards for different component parts, and they are in various stages of development and finalization. Broadcasters are expected to begin voluntarily transmitting ATSC 3.0 signals as soon as 2018.

As set forth below, ATSC 3.0 was designed to be configurable, scalable, efficient, interoperable, and adaptable. Relative to the ATSC 1.0 standard, ATSC 3.0 offers significantly higher data capacity, flexible spectrum use, higher physical layer robustness, future extensibility, mobile opportunities, hybrid delivery via broadcast and broadband, advanced A/V compression, immersive audio and ultra-high-definition ("UHD") video, interactivity and personalization, and new business models for broadcasters. Specifically, broadcasters expect to be able to extend their reach and reliability within their defined service areas, offer improved accessibility to their content, establish personalized and interactive services, compete in the emerging mobile marketplace, and make more efficient and flexible use of their spectrum.

ATSC 3.0 involves a protocol "stack," and incorporates both broadcast and broadband transmission. Notably, all content transport is based on Internet Protocol, instead of the MPEG-2 transport mechanism included in ATSC 1.0. Broadcasting thus will no longer be an independent silo; instead ATSC 3.0 will utilize broadcast and broadband as peer delivery mechanisms, enabling new types of hybrid services and localized insertion of advertisements or other content. Broadcasters hope to realize revenue from new business models that currently are available to other service providers (*e.g.*, dynamic ad insertion). The broadband protocol in ATSC 3.0 also takes advantage of the constantly evolving speed of broadband service.

ATSC 3.0 will allow broadcasters to deliver content via broadcast (over the air) and broadband (over the Internet). If these inputs can be combined synchronously and seamlessly, it theoretically could support multiple use cases. For example, a broadcaster could transmit main audio and video components via broadcast and could deliver an alternate audio (*e.g.*, second language audio) via broadband. For another, a broadcaster could deliver main program content via broadcast and could transmit alternate interstitials for targeted ad insertion via broadband. Yet a third example would be to transmit main program services via broadcast and in-depth educational material by broadband. As discussed at greater length below, some of these use cases may present complications for retransmission by multichannel video programming distributors ("MVPDs").

The physical layer of ATSC 3.0 involves numerous features that broadcasters anticipate will deliver benefits to consumers, including a signaling process, referred to as the "bootstrap." An ATSC 3.0 transmission is initiated through a process of system discovery through the transmission of a bootstrap, which defines a container that is a variable size time-slice of the RF waveform. The physical layer protocol of ATSC 3.0 then defines the signal waveform through orthogonal frequency-division multiplexing ("OFDM") modulation—which currently is utilized

in the delivery of mobile broadband, but is not a feature of ATSC 1.0 transmissions. The use of OFDM in the physical layer, in conjunction with advanced error correction coding, should improve spectral efficiency, facilitating many of ATSC 3.0's expected benefits. ATSC 3.0 also provides broadcasters with flexibility in operating points, allowing for transmissions that are lower data capacity and highly robust as well as transmissions that are high data capacity but less robust.

ATSC 3.0 physical layer pipes are capable of carrying data in various configurations, balancing robustness and data capacity. Broadcasters can select transmission parameters based on selections of modulation and coding, and based on selections among interleaving choices. The physical layer pipes can be arranged in patterns of frequency and time resources, and can vary between sub-frames. It is possible for broadcasters to use up to 64 active physical layer pipes simultaneously on a single radiofrequency channel, or up to 4 physical layer pipes in a single service—given limitations placed on receiver resources. As will be discussed below, the varying options available to broadcasters, and their varying market-by-market and broadcaster-by-broadcaster incentives, may present difficulties for MVPDs.

The use and the resulting greater spectral efficiency of OFDM in ATSC 3.0 also will support broadcasters moving toward the deployment of single frequency networks ("SFNs"). A broadcaster using multiple transmitters in an SFN can extend its coverage reliability and add capacity by increasing its signal-to-noise ratio throughout the defined service area. The possibility that the deployment of SFNs could result in siting or interference issues is discussed below.

ATSC 3.0 has the capacity to deliver richer video content. It supports up to 4K UHD (2160p) spatial resolutions; high dynamic range ("HDR"); wide color gamut (WCG); high frame rates; enhanced 2K HD (1080p), including with HDR and WCG; and significantly improved, high efficiency video coding. ATSC 3.0 also has the capacity to offer richer and personalized audio content. For example, ATSC 3.0 will support immersive sound, with improved height and distance perspective (*i.e.*, conveying spatiality and directionality). ATSC 3.0 also will enable viewers to control and choose audio content.

Accessibility services are a key element of ATSC 3.0. Features built into ATSC 3.0 include Closed Captions (CC), Video Description Service (VDS), and dialog intelligibility features. In addition, an information service can be provided for the visually impaired that is a translation of emergency information visual text crawls into an appropriately labeled audio component.

ATSC 3.0 is designed to augment and upgrade the capabilities of broadcasters to provide information and alerts during emergency situations. ATSC 3.0 can deliver rich-media, geo-targeted public alerts. The system also facilitates waking up devices in order to deliver alerts even when devices have been powered down.

ATSC 3.0 broadcasts will continue to provide free, over-the-air delivery of television content, but also have the ability to protect and/or limit access to high value content through conditional access systems and encryption techniques. Subscription, "freemium," pay-per-view and other business models are thus made possible for desired subsets of content.

3. WORKING GROUP QUESTIONS

The Working Group was charged to address the following questions:

- To what extent will this new service compete or integrate with services that are offered by commercial wireless services?

- To what extent might the implementation of ATSC 3.0 raise issues such as expanded deployment of distributed transmission systems that could face issues such as tower siting?

- What are the ways that ATSC 3.0 is likely to be deployed that could intersect with other communications facilities and devices such as the use of gateways that could rely on Wi-Fi to distribute multiple video signals throughout a dwelling?

- If a gateway and Wi-Fi were used, how would they interplay with wireless routers used for other services in the same dwelling?

- What other synergies or interfaces might exist between broadcast data services and commercial wireless services?

These questions relate to the broader issue of how this new standard might fit into the overall communications landscape. This Report addresses each question in turn, before turning to a broader set of recommendations as broadcasters move forward with deploying ATSC 3.0 on a voluntary basis.

a. To What Extent Will This New Service Compete or Integrate with Services That Are Offered by Commercial Wireless Providers?

ATSC 3.0 has the capacity to allow consumers to receive video content both over-the-air (distributed by broadcasters via ATSC 3.0) and over-the-top (distributed via cellular networks) to their mobile devices. The trend toward mobile consumption of video content is already apparent, and is expected to increase as mobile network operators deploy denser networks with greater capacity for video distribution. One of the most frequently cited benefits of ATSC 3.0 is its capacity to allow broadcasters to enter the mobile video market.

The Working Group expects that some broadcasters will prioritize improved picture quality in the short-term (the "large screen" phase of ATSC 3.0 rollout) with mobile delivery more likely in the medium- to long-term (the "small screen" phase of ATSC 3.0 rollout) while other broadcasters may pursue a "mobile first" strategy at the outset.

Some broadcasters will see advantages in a "mobile first" strategy, and may seek to take advantage of the greater spectral efficiency of ATSC 3.0 to begin delivery as soon as possible to mobile devices, including phones, tablets, wearables, and other Internet-of-Things ("IoT") devices. Indeed, the capability to transmit ATSC 3.0 signals to devices in transit, at particular points, is seen by broadcasters as a primary benefit of the new standard.

For other broadcasters, however, mobile delivery likely will demand too much capacity, due to the modulation schemes, Forward Error Correction and signaling overhead requirements, requiring trade-offs with anticipated video enhancements. In the near term (i.e., the "large screen" phase of ATSC 3.0 rollout*)*, many broadcasters are likely to prioritize improved picture quality. For these broadcasters, mobile delivery may be more likely to be pursued in the medium- to long-term (i.e., the "small screen" phase of ATSC 3.0 rollout).

The Working Group expects that broadcasters, especially those seeking to pursue a mobile first strategy, will invest heavily to address issues arising from the design and incorporation of ATSC 3.0 receivers into mobile devices.

Widespread ATSC 3.0 delivery to mobile devices will create challenges related to the design and incorporation of ATSC 3.0 receivers into such devices, which could create issues related to antenna integration, processor capacity, and device battery life. For example, new receiver chains for ATSC 3.0 reception will include many components, such as new antennas, filters, amplifiers, oscillators, and ATSC 3.0 demodulators/receivers. The integration of these component parts could impose direct costs, as well as potentially indirect costs, by requiring the use of larger devices, by adversely affecting the performance of the device for delivering and receiving LTE/5G mobile broadband and voice services, or by displacing other functionality such as 4x4 MIMO. That is so because mobile devices already are extremely complex and composed of a large number of interconnected circuits. Most mobile devices involve multiple antennas and receivers, which decode and demodulate various signals (including LTE, Bluetooth, GPS, Wi-Fi, etc.). The addition of new components will be necessary, despite the fact that both mobile broadband and ATSC 3.0 utilize OFDM modulation, because otherwise the two signals do not share many common characteristics. Handset manufacturers may resist incorporating the added components needed for 3.0 as they are redesigning for 5G.

The Working Group anticipates that the guard band adopted in the 600 MHz band plan should prevent ATSC 3.0-to-mobile interference, although early deployment of 600 MHz spectrum (i.e., prior to the completion of the channel repacking process) in some markets could be an additional complication in need of management.

Widespread ATSC 3.0 delivery also creates at least some risks of service interference, but the Working Group anticipates that these issues can be managed. ATSC 3.0 to other DTV signal interference is expected to be minimal, unless broadcasters move to SFNs more quickly than expected and potential instances arise for adjacent channel interference between broadcast signals. Studies suggest that ATSC 3.0 and ATSC 1.0 are sufficiently similar to enable the management of interference between ATSC 3.0 and 1.0 signals through the Commission's existing planning factors, which define service and interference to a DTV signal.

The Commission requested information in the context of its ATSC 3.0 rulemaking proceeding into whether preliminary test measurement results entered in the record accurately reflected DTV receiver performance in the presence of an interfering ATSC 3.0 signal—*i.e.*, that supported or refuted these initial studies; the Commission received no additional reports or measurements to either support or refute the claim that ATSC 3.0 signals could be treated the same as DTV signals when considering interference from ATSC 3.0 to DTV signals.

b. To What Extent Might Implementation of ATSC 3.0 Raise Issues Related to Tower Siting?

The Working Group expects that many broadcasters will not seek to broadcast from multiple towers in the short- to medium-term—and even those who do are unlikely to build new towers. Here too, however, incentives may vary from broadcaster to broadcaster.

As discussed below, ATSC 3.0 is not directly compatible with ATSC 1.0 consumer and MVPD infrastructure. The Commission thus has adopted a simulcast transition period. At least through this simulcast transition period, the Working Group expects that many broadcasters will continue to use traditional single towers to broadcast ATSC 3.0 signals. These broadcasters will have a greater incentive to move toward single frequency networks ("SFNs") when there is a critical mass for mobile delivery of ATSC 3.0, which, as noted above, may be more likely in the medium-to-long term.

Some broadcasters may move to SFNs on a faster time frame, as part of their "mobile first" strategy. This may create some risks of signal interference within markets, and adjacent channel interference may be more of a challenge, depending on market conditions.

Even those broadcasters who move to SFNs on a faster basis are not expected to build new towers to support their SFNs. Instead, they are more likely to utilize existing towers from other wireless service operators. Thus, the Working Group concludes that tower-siting issues are unlikely to arise from the widespread deployment of ATSC 3.0.

c. How Might ATSC 3.0 Intersect with Other Communications Facilities?

ATSC 3.0 is not backward-compatible with existing broadcast and MVPD infrastructure—a fact which could create friction for consumers and MVPDs during the transition. The development of low-cost hardware (receivers, gateways, sticks), on the one hand, and industry best practices, on the other, could help mitigate these potential issues.

ATSC 3.0 signals will not be directly backward-compatible with existing TV sets and receivers, which have only ATSC 1.0 (and analog) tuners. Thus, to receive ATSC 3.0 broadcast transmissions over-the-air, consumers will need new hardware—either entirely new ATSC 3.0 gateways or television sets or additions and fixes for existing receivers, such as RF-to-HDMI stick adapters. While there are no ATSC 3.0 tuners or converter boxes currently available to consumers, the Working Group anticipates that low-cost converters may develop in the market.[3] To avoid disruption to over-the-air consumers, the Commission will require, for a temporary transition period, local simulcasting of a broadcaster's primary ATSC 3.0 stream in an ATSC 1.0 format. The Commission has committed to monitor the pace of voluntary deployment of ATSC 3.0 nationally and market-to-market, including the penetration of ATSC 3.0-ready TV sets and converter equipment, to determine when to sunset the simulcast requirement.

The fact that ATSC 3.0 is not directly compatible with existing infrastructure also presents a set of issues related to retransmission by multichannel video programming distributors

[3] However, consumers will need to purchase more costly full-featured devices to enjoy ATSC 3.0's new functionalities.

("MVPDs"). MVPD networks have been engineered to receive and retransmit ATSC 1.0 signals, and the FCC's simulcast requirement will ensure that MVPDs and their customers continue to have access to ATSC 1.0 signals, and the programming aired on the ATSC 1.0 simulcast channel must be "substantially similar" to that of the primary video programming stream on the ATSC 3.0 channel for at least the next five years . As broadcasters deploy ATSC 3.0, they will seek to enter into business arrangements with MVPDs for the latter to retransmit ATSC 3.0 signals to subscribers. However, retransmission of such signals would require MVPDs to acquire and deploy new and/or additional equipment, such as new set-top devices in subscribers' homes, as well as receivers, transcoders, demodulators, demultiplexers, and antennas at headends.

There are multiple other MVPD-related challenges associated with broadcasters' transition from ATSC 1.0 to 3.0, including:

- Fiber delivery of signal from broadcasters to cable headends;[4]
- Content pass-through issues (e.g., emergency alerts, encrypted streams, return path integration);
- Video and audio format issues (e.g., resolution, data rate, dynamic range, audio format, number of audio tracks).

The Working Group believes that the development of industry best practices will help address technical issues with MVPD transmission of ATSC 3.0 signals after the transition.

There has been some movement toward the development of industry Recommended Practices (RP) related to MVPD retransmission of ATSC 3.0, being undertaken by ATSC. The initial focus is on development of an RP for conversion of 3.0 services to 1.0. A second RP will focus on how to deliver 3.0 services to MVPDs for direct redistribution. Completion of these RPs is expected in 2018.

d. <u>If a Gateway and Wi-Fi Were Used, How Would They Interplay with Wireless Routers Used for Other Services in the Same Dwelling?</u>

The Working Group does not anticipate interference or service problems arising from Wi-Fi compatible ATSC 3.0 gateways.

It is unlikely that broadcasters will push for, or that manufacturers independently will design, ATSC 3.0 gateways designed to create independent Wi-Fi local area networks in the home. Instead, it is more likely that ATSC 3.0 gateways will connect to existing Wi-Fi networks, and there is no reason to anticipate that such connections will result in any in-home interference issues.

It is conceivable that manufacturers might develop ATSC 3.0 gateways capable of establishing a network for distribution of ATSC 3.0 signals in the home for those homes that do

[4] The transition also raises carriage issues, such as must-carry, retransmission consent, and tiering, but these matters are outside the scope of the Working Group's charter.

not already have a Wi-Fi network, but this is not expected to be common—and here too, there is no reason to expect any interference problems.

In either scenario, the distribution of a broadcast signal via Wi-Fi is unlikely to be more problematic than other forms of video distribution via home Wi-Fi that are commonplace today—for example, OTT streaming services such as Netflix, Hulu, and Amazon.

e. What Other Synergies or Interfaces Might Exist Between Broadcast Data Services and Commercial Wireless Services?

The ATSC 3.0 system supports aggregation, combination, synchronization and presentation at the receiver of content from different delivery networks (e.g., terrestrial broadcast and mobile broadband). The use of broadcast and broadband together have synergistic possibilities. For example, an ATSC 3.0 broadcast service may invoke a mix of real-time and non-real-time delivery of content via broadcast and broadband paths to optimize the efficiency of the hybrid delivery infrastructure and balance the data bandwidth demand on each network. Conversely, in a hybrid broadcast/broadband environment, broadband services may achieve maximum spectrum efficiency by invoking the use of the broadcast channel when real-time delivery of large data sets to mass audiences is required. However, these theoretical spectrum synergies and partnering opportunities of broadband and broadcast services would require practical business agreements and inter-service cooperation.

Another example of synergy between services takes note that a disadvantage of broadcast architecture is its inherent one-way transmission nature and the resulting limitations on implementation of interactivity applications. Commercial wireless services could provide a return path for broadcast user interactivity or independent interactive applications initiated in an ATSC 3.0 broadcast service that may supplement broadcast content or make broadcast content and services more flexible and useful.

4. CONCLUSIONS

The ATSC 3.0 standard is highly flexible and has the potential to offer many benefits for consumers and the broadcasting industry. However, different broadcasters have different strategies and plans on different time horizons for implementation of various ATSC 3.0 features. Important aspects of system implementation necessary to realize various ATSC 3.0 services to the public remain undefined but will likely be developed and agreed by industry participants in the marketplace.

Market dynamics will also determine the technical and other issues that may arise from the intersection of ATSC 3.0 with other communications facilities. Many of these issues may be relatively easy to manage, but others may produce friction with other video distributors and consumers.

5. ACTIONABLE RECOMMENDATIONS

In general, the Working Group has no specific actionable recommendations for the FCC with respect to the introduction of ATSC 3.0 broadcast services. It is likely, however, that issues will arise, although it is difficult to specifically identify and quantify these issues prior to development in the marketplace. Due to the many marketplace variables and the dynamic nature of the communications ecosystem, the Working Group recommends that the Commission should closely monitor the rollout of ATSC 3.0 service during the simulcast period (and after) and periodically examine whether resolution of any issues that arise would benefit from or require Commission involvement. Further, any FCC actions taken on these issues should be reviewed periodically and revisited as the market develops.

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