DekTec

ATSC 3.0 Primer

- ☐ Video over broadband challenge
- ☐ What is ATSC 3.0?
- ☐ The technology
- ☐ The physical layer: Modulation
- ☐ SFN: Single Frequency Network
- ☐ Delivery Layer
- ☐ Video and Audio formats
- ☐ Watermarking and content redistribution
- ☐ Other services
- ☐ Application layer
- ☐ ATSC 3.0 in the home and on the GO
- ☐ Business model
- ☐ Replacement of current services
- ☐ New potential money generating services
- ☐ Delivery of video and audio to mobile and moving devices
- ☐ Non-real-time delivery
- ☐ Pinpoint local delivery and customization
- ☐ Timing of ATSC 3.0 deployment
- ☐ Opportunities and challenges ahead for broadcasters
- ☐ ATSC main standard references

DekTec
www.dektec.com (303) 318-4298

Introduction

In a short period of time, consumers have changed the way they view and consume media compared to when the first digital TV was deployed. ATSC 3.0 is a new set of standards being developed for the next generation of terrestrial broadcast which will address new consumption trends. The standards are being developed mostly in the US (ATSC being US based). However, Korea has announced that it will be deployed there first. Companies from all over the world are contributing to this effort and when complete, ATSC 3.0 has the potential to become a worldwide standard. There is a mandate in Korea to move to ATSC 3.0 starting Mid 2017, which is accelerating the ATSC 3.0 standards and products development to meet this timeline.

US broadcasters are interested in the potential ATSC 3.0 can bring to their business, but there is currently no mandate from the FCC nor a firm commitment from all of the US broadcasters that they will move toward ATSC 3.0. With the US spectrum auction, broadcasters need to decide which direction to take.

The ATSC 3.0 set of standards could interest other countries looking for a new generation of terrestrial broadcast. As a result, ATSC 3.0 has the potential to become an international standard, like DVB-T2 has become, and not just a North American and Korean standard.

ATSC 3.0 could offer a revolution in the broadcast industry – much more than an evolution of the current delivery system. ATSC 3.0 is based on standards used for broadband delivery mechanism and supports both broadcast over-the-air and broadband delivery.

The driving factors behind ATSC 3.0 include TV manufacturers; mostly LG and Samsung; and broadcasters. TV manufacturers are pushing for quality enhancements such as HDR, higher video resolution, higher frame rate, and new audio capabilities. Broadcasters are looking to create new revenue generating services. Both sets of goals are incorporated into the new ATSC 3.0 standards, but clearly there are differing goals from the different drivers to create a new set of standards.

Video over broadband challenge

Broadcasters have been under increasing pressure to compete against OTT (Over The Top) content, video content delivery over broadband or cell phone services, and have been steadily losing market share. More and more viewers turn to the Internet to watch content, especially on their mobile devices. Even for live events. However, currently, and probably for quite a while, Internet backbones cannot handle a majority of customers watching live content over the internet. The current model of delivering content unicast over the internet (1 to 1 connection) is not practical for very large-scale live content delivery (many streams to many people). Multicast transmission (few to many) is not really supported on the internet. ATSC 3.0, which will offer a broadband pipe carrying IP content to many via a few strategically positioned transmitters, could be the solution to complement the broadband offering. As the broadcast content will be IP or broadband download, we can imagine a cooperation with cell phone companies where the broadcasters could offload the LTE towers during large broadband demand for live content requests such as breaking news or sports events.

What is ATSC 3.0?

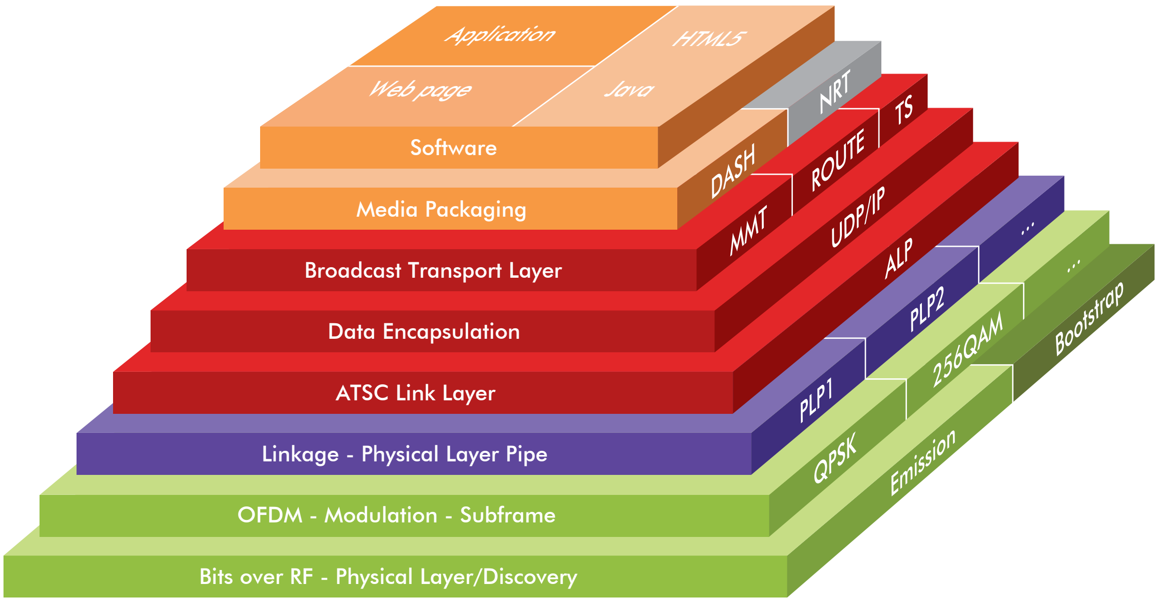
ATSC 3.0 is a set of standards and practices developed for the next-generation terrestrial broadcast.

ATSC 3.0 is named 3.0 after ATSC (1.0) which is the current North American terrestrial standard (8VSB modulation). ATSC 2.0, which was an evolution of ATSC 1.0 retrofitting mobile application, was never deployed in large scale.

ATSC 3.0 is not compatible with current ATSC 1.0 (8VSB), so broadcasters will need to plan for this element when deploying the new standards.

ATSC 3.0 incorporates not only a new set of modulation, transmission parameters and capabilities but also offers a brand new ecosystem based on IP multicast and broadband content distribution. ATSC 3.0 systems contain three functional layers, namely, the Physical Layer, Delivery Layer, and a Service Management Layer. (See below)

In short, and simplified to the extreme, ATSC 3.0 allows broadcasters to broadcast IP packets via their RF channels to their broadcast area in a flexible, efficient way. The organization, content, and distribution of these IP packets, are defined by many new standards developed under the ATSC umbrella suited for today's and tomorrow's distribution applications. Those IP packets can contain, real-time video, non-real-time video, standard IP data, and applications.



Different layers of ATSC 3.0

The technology

The physical layer: Modulation

The new modulation scheme for ATSC 3.0 systems is based on OFDM (Orthogonal Frequency Division Multiplexing) modulation. It pushes the efficiency of the spectrum to the Shannon limit allowing more throughput through the same bandwidth.

From a high-level point of view, the modulation scheme of ATSC 3.0 uses the same principle as DVB-T2 used in many European and Asian countries but offers further options and refinements.

The ATSC 3.0 system for Korea and the US will be using 6 MHz per RF channel, but other countries could be using 7 or 8 MHz.

OFDM modulation divides data among thousands of carriers (8K, 16K or 32K); versus the legacy ATSC standard that uses 8-VSB (Eight-level Vestigial Sideband), which puts all the data on a single carrier. This new system transmits compressed digital audio, video, and other data in "physical layer pipes" (PLPs), using OFDM modulation with concatenated channel coding and interleaving. PLPs are logical channels carrying one or more services, with a modulation scheme and robustness particular to that individual pipe. This will be key for new service offerings such as mobile services.

ATSC 3.0 provides improvements over existing OFDM-based standards by offering a wider range of constellations ranging from QPSK to 4096QAM. OFDM modulation is commonly known to be more immune to multipath, but more importantly, can support SFN (Single Frequency Network).

An important new modulation feature includes Bootstrap or also called “Discovery and Signaling”. This simple signal carries data identifying the version of the data frame following it. This allows for a receiver to do a quick scan of services and quickly identify if the service is TV, LTE or other services. It also allows for future upgrades of the ATSC 3.0 system into a completely different modulation scheme.

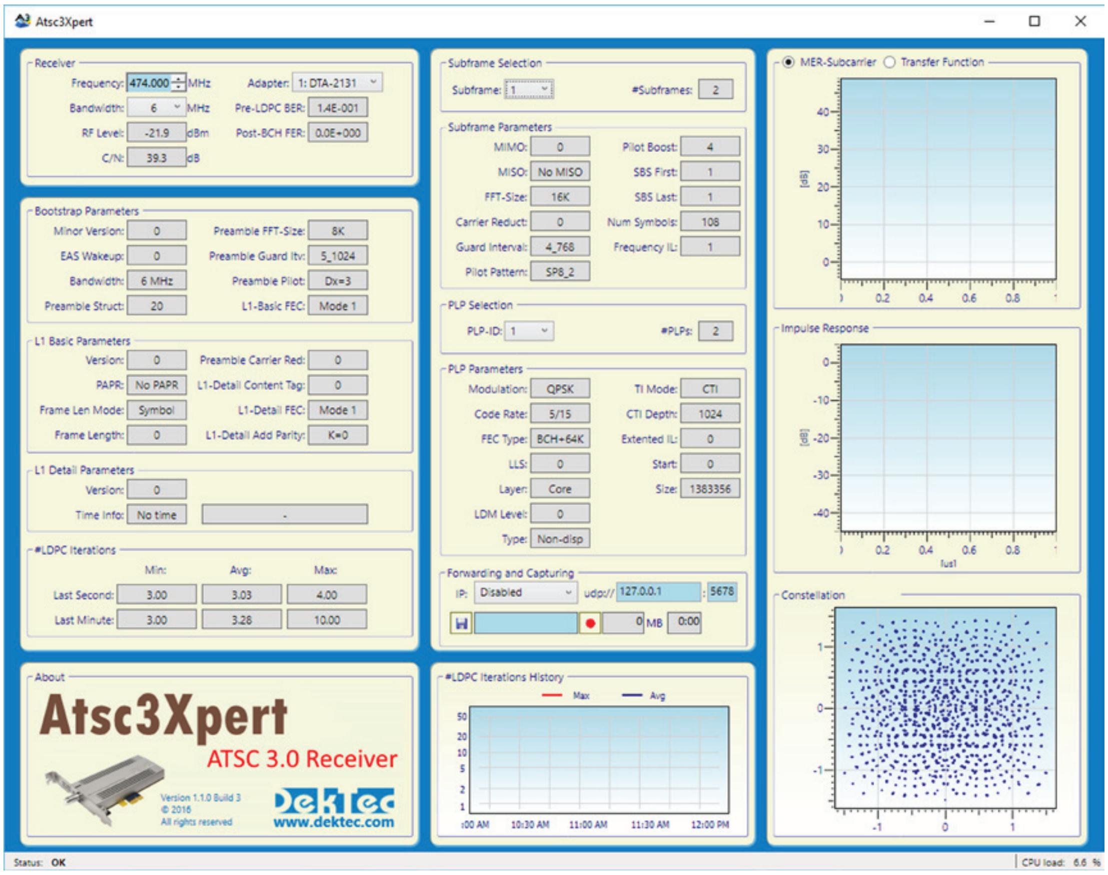
ATSC 3.0 offers other new options designed to optimize the RF transmission for spectrum efficiency such as sub frames or spectrum overlay technology LDM.

Depending on code rate, constellation mode, FEC scheme like LDCP of the ATSC 3.0 modulator a 6 MHz bandwidth can allow 1 Mbits/s in an extremely robust mode to over 57 Mbits/s in a high signal to noise environment (typical will be around 28Mbits/s compared to 19.39Mbits/s for ATSC 1.0).

Future capabilities such as channel bonding (combining multiple 6MHz channels into a wider band broadcast signal) could offer more bandwidth and more capabilities to broadcasters.

ATSC 3.0 (OFDM) waveform has a higher peak-to-average ratio than ATSC 1.0 (8VSB). Broadcasters may need to update their transmitter to keep their footprint. However, the SFN may offer new and better coverage in some areas. It will be important to evaluate the RF capabilities of the new ATSC3.0 system and make technical choices in line with the new business models. Note that depending on the service and how “rugged” each RF Pipe layer is constructed each PLP may have different footprints with a more rugged signal, like mobile signals, having a further reach.

The modulators will be fed by a gateway, which controls the modulator setting and provides the correct payloads for each PLP. As a result, it is possible to reconfigure the RF signal (multi PLP, settings, FEC code rate) during different times of the day for different applications. This could open up some interesting opportunities during non-peak hours where part or all of the spectrum could be used for non-broadcast applications.



Example of a ATSC 3.0 RF reception parameters

SFN: Single Frequency Network

SFN is an important part of ATSC 3.0. The idea behind SFN is that multiple synchronized transmitters emit the same signal at the same time on the same frequency. At the receiver location, depending on the signal strength of each signal, multipath, etc., the receiving device can combine different RF received signals to allow a stronger tuned signal and increase the chance of solid reception. The hope is that ATSC 3.0 modulation will offer indoor reception with no need for big antennas or attic antennas.

On the emission side, all local transmitters must be GPS locked and synchronized perfectly to achieve SFN which, of course, increases the complexity of the RF emission.

Delivery Layer

At the root of ATSC 3.0 is IP multicast delivery. From the encoder, through the STL (Studio Transmission Link), all the way to the modulator, to the home the underlying transport mechanism will be IP. This is the first system that embraces IP end to end natively. The payload of the IP packet can be any digital content, real-time, VOD (Video On Demand) and non A/V content. In the case of live video content, the encapsulated choice is DASH (Dynamic Adaptive Streaming over HTTP) which is already used in mobile phones.

Video and Audio formats

With ATSC 3.0 it is possible to provide multiple independent payloads on the same RF channel including, real-time A/V, VOD, non-video data. Of course, real-time audio and video distribution will still probably be a key element of ATSC 3.0 as this is the main business of broadcasters.

For ATSC 3.0, HEVC codec has been selected for the video. The Video format will range from HD to 4KP60 and even potentially 8K video.

In Korea, broadcasters are focusing on 4KP60 delivery. In the US it will probably be 1080P60 video.

The video will probably be enhanced with HDR (High Dynamic Range) and higher color gamut.

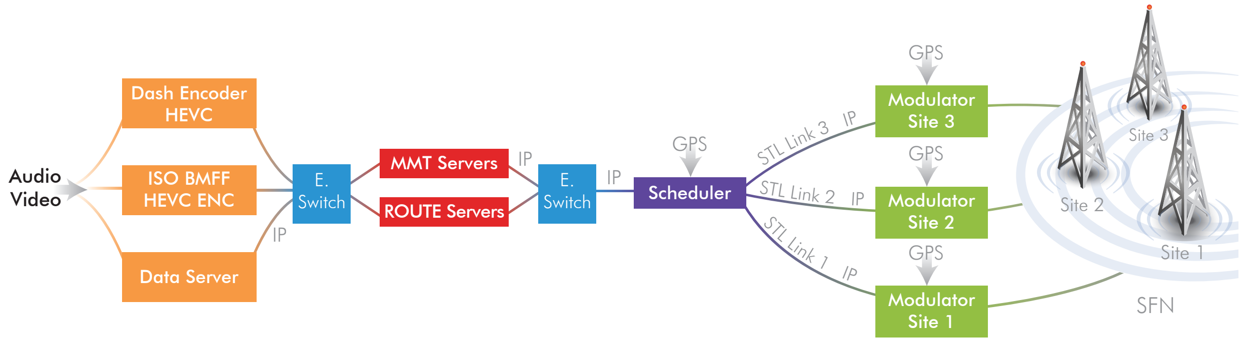
HDR offers deeper black levels and enhanced colors. There is a lot of work going on at SMPTE and ATSC to define proper HDR signaling and standards. HDR will likely consume extra bandwidth when delivered to the consumer and will involve a complicated workflow.

HEVC encoding, when fully optimized, is hoping to provide 30-50% bandwidth improvement over H.264 which offers 30-50% improvement over MPEG-2.

In the case of 1080P60 it requires about 30-50% more bandwidth than traditional HD to encode. We, therefore, expect that the net gain of bandwidth will be about 50% from HD encoded MPEG-2 video which is broadcasted now in ATSC 1.0 allowing more services for ATSC 3.0 such as mobile TV.

On the audio front, 2 major audio codecs have been selected: Dolby AC-4 and MPEG-H. MPEG-H will most likely be deployed in Korea and Dolby AC-4 in the US.

The audio encoding scheme will be more efficient bandwidth wise and will offer many options such as Mono, Stereo, 5.1, 7.1, and immersive audio. Immersive audio increases the audio experience by processing sounds as audio objects instead of audio channels. An audio object moving through the sound field can include different languages or alternative audio (like commentators or different point of view comments). Immersive audio also has the capability to support many more speakers (like 20+) in a single room. Immersive audio allows for a richer audio experience. It will also provide the end user with control of the level of dialog vs. surround for example.



ATSC 3.0 content flow

Watermarking and content redistribution

Since ATSC 3.0 is IP based, it will be, by design, easy to redistribute the content when receiving it. Due to copyright and business agreements, some of the content may be protected or encrypted offering DRM (Digital Rights Management) capabilities. However, in the past many encryption schemes have been broken, and it may happen again in ATSC 3.0. Another way to "protect" the content is to use watermarking technology which doesn't necessary prevent illegal content distribution but allows the content owner to trace the origin of the content and where the content security has been compromised. ATSC 3.0 provisions audio and video watermarking, by inserting watermarking info into the ancillary data in the transmitted pixels of a video signal. It is intended to provide a data path for the ancillary data payload that can readily survive changes in video compression data rate, transcoding to other video compression codecs, and delivery over legacy consumer HDMI interfaces. Emission, by a broadcaster, of the video watermark is optional.

Other services

With ATSC 3.0 and the new modulation schemes, it is possible to broadcast as a second channel a mobile service. This mobile service could be HD video HEVC encoded at a lower bitrate with a modulation mode designed for small moving antenna reception.

Program Guide: ATSC 3.0 offers better capabilities for program guide including previews, clips, or 3rd party applications. It can also offer a link to broadband content that can be consumed by TV sets without the need to switch to a tablet for example. It is believed that the 1st US transmission of ATSC 3.0 will include a main TV channel at 1080P60 and a mobile TV service 720P60 for example.

EAS: The Emergency Alert System is also going to be enhanced with ATSC 3.0 by offering new capabilities to the receiving devices, including native mobile phone support. The bootstrap offers a mechanism to "wake up" ATSC 3.0 devices in case of an emergency. This includes TV but also mobile devices in the case LTE towers would be down. Due to the Geo-location targeting capabilities of ATSC 3.0, EAS can be better targeted to when and where the emergency is occurring and as a result be more effective. The EAS message can consist of text, video, picture etc… as it will be delivered over IP.

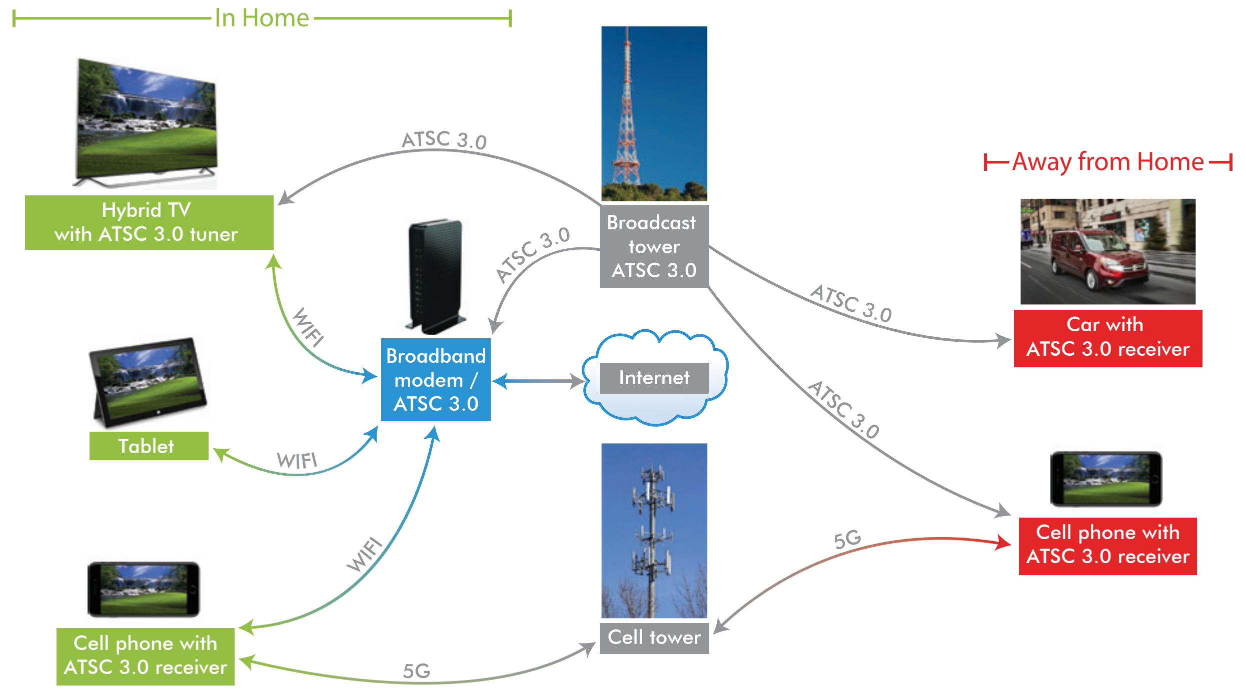
Captioning: There is a provision in ATSC 3.0 to broadcast services to the hearing impaired and blind community by offering services such as sign language and descriptive audio. Those channels can easily be carried in ATSC 3.0 as a side service and can be enabled on the receiving device.

Application layer

ATSC 3.0 defines the application layer for the content delivery and is based on HTML 5. This is what is used for mobile application development so we can expect many existing software applications linked to broadcast to run on ATSC 3.0 receiving devices natively.

ATSC 3.0 in the home and on the go

With ATSC 3.0 the traditional model of delivering content via the coaxial cable directly to the TV is not obsolete but no longer a necessity. Since the ATSC 3.0 content is natively IP, we can conceive that the new ATSC 3.0 receivers will consist of an antenna feeding its content to some kind of house gateway. The house gateway can then connect to the house Wi-Fi or wired network and distribute that content throughout the house, including tablets, cell phones, and of course smart TV. From a user point of view, this would unify content coming from the internet and over the air allowing broadcasters and TV manufacturers to create some applications and content that can be sourced from either broadband or broadcast. The switch from broadcast to broadband would be transparent, and during peak time, when the broadband and cell networks are overloaded, this gateway could offload some of the main video and audio distribution (like national news) from the broadband to the broadcast channel without the user being aware of it. It is clear, as demonstrated at CES 2017 by LG, that the new ATSC 3.0 TVs will work in a hybrid environment pulling media from many different sources. By being native IP and directly connected to the house wireless network, the broadcast content can connect more easily to cell phones and tablets than ever before.



Delivery of content to the home and mobile devices

Business model

ATSC 3.0 is unlikely to be a mandate, at least in the U.S.. ATSC 3.0 offers a lot of innovative tools which can enable the broadcasters to update their traditional business and also open new opportunities. ATSC 3.0 gives broadcasters a way to move from a traditional few linear TV services environment into a hybrid environment where TV broadcast and broadband not only interact but complement each other. Broadband (the internet) has moved into the broadcast space (e.g. Netflix), ATSC 3.0 allows the broadcaster to get into the broadband world. The intention of ATSC 3.0 is not to replace 8VSB by only providing the same linear TV services; current 8VSB is ideally suited for that, it is to offer a new innovative technical solution and business opportunities to the broadcasters.

Replacement of current services

The primary current function of the local broadcaster is to offer linear video and audio services, including local news, programming, and advertisement to the served market. This mandate will not go away with ATSC 3.0 as most broadcasters will continue offering linear services. The service will likely be 1080P60 using HEVC encoding with AC-4 video in the U.S., and probably 4KP60 using HEVC encoding with MPEG-H audio in

Korea. Thanks to the bandwidth improvement that ATSC 3.0 modulation and HEVC coding offer, there will be room for new services. We can imagine that these services will be duplicated on mobile devices at a lower bitrate and resolution and in a more rugged RF package along with other new services.

New potential money generating services

If we consider that with ATSC 3.0 the broadcaster could end up with a downlink pipe over RF (one to many) of over 25 Mbits/s to each device or home, we can imagine some new applications and revenue generation. The broadcasters could rent bandwidth for pushing data such as software upgrades, VOD content, targeted advertisements, and software applications to its viewers.

Delivery of video and audio to mobile and moving devices

With the more rugged RF delivery (PLP with high S/N ratio), it is possible to offer high bandwidth content to mobile or moving devices. This could involve traditional broadcast to people in cars, trains, and buses but could also allow, for example, delivery of content to digital signage at malls, store kiosks, displays in taxis, commuter trains and bus advertisement panels.

Self-driving cars are coming soon. When the driver doesn't drive, it is likely that entertainment and TV will play a big role in the car traveling experience. Mobile and moving delivery of content will be critical to the success of ATSC 3.0.

Non-real-time delivery

During non-peak hours, the broadcaster could rent some bandwidth to manufacturers to upgrade the increasing number of devices connected to the internet. We could imagine pushing updates to connected appliances, game consoles, and cell phones in the home. News and sports updates could be pushed over the ATSC 3.0 broadcast and provide VOD-style highlights to the different devices in the home. On the business side, a manufacturer could push updates to all of its dealers or a fleet of deployed cars or devices for example. These delivery modes would provide new revenue streams to broadcasters.

Pinpoint local delivery and customization

With ATSC 3.0, it is possible to localize the content and either target the audience based on its demography, the viewer's past choices, or based on location.

This targeted delivery could be crucial in times of emergency but could also generate targeted advertisement dollars by allowing customization of the message based on who is watching and what they are interested in.

Timing of ATSC 3.0 deployment

Korea has set a very aggressive schedule for deployment of ATSC 3.0. It may slip a little bit, but they are hoping that by the end of 2017, 70% of Korean homes will be able to receive ATSC 3.0 broadcast.

This schedule is driven by a mandate from the government and the upcoming 2018 winter Olympics in Korea.

In the U.S., the situation is different. Broadcasters are in the middle of a lengthy reverse spectrum auction which will result in a move in spectrum allocation and a shrinking of the available broadcast spectrum. There is no mandate to move to ATSC 3.0, and there is unlikely to be one, so the move to ATSC 3.0 will be a voluntary, business-based, decision.

After the auction, some broadcasters will have sold their spectrum and may exit the broadcast market. However, it is likely that the remaining broadcasters will study a move to ATSC 3.0 as it will allow them to become more competitive in the broadband environment.

It is possible that the timing of the move of the spectrum repack, which should be funded by the U.S. government from the spectrum auction revenues, could coincide with the readiness of ATSC 3.0 and allow the use of some of that money to help launch some new ATSC 3.0 services.

As ATSC 3.0 is not compatible with current digital broadcast and TV, it is obvious that ATSC 1.0 cannot be replaced in one day, leaving the majority without TV signals. There is no plan to subsidize ATSC 3.0 receivers to homes as it was the case when the U.S. moved from analog to 8VSB. Broadcasters will need to generate new ATSC 3.0 services and RF signals and maintain the current 8VSB services for a long time.

So, in theory, each broadcaster would have to deploy and maintain two transmitters; one for ATSC 1.0 and another for ATSC 3.0. Considering that the spectrum available will have been reduced and that budgets are tight, some new strategies may need to be put in place.

A potential idea for supporting new ATSC 3.0 services would be to collocate multiple local broadcast channels on the same tower and transmitter and maybe even on the same multiplexer. This would allow sharing the cost of deployment and maintenance. With the repack of the spectrum, we could also imagine that the same strategy could happen for the current 8VSB "legacy" services.

Between the repack and the still ongoing development of ATSC 3.0 standards, it is clear that outside of pilot projects and research, ATSC 3.0 will not take off in a commercial way in the U.S. before early 2018 at the earliest.

Opportunities and challenges ahead for broadcasters

It is clear that we are at a turning point and a decision point for the terrestrial broadcast industry. It is time to embrace the new technologies and create and develop a new business model or get out of the business. ATSC 3.0 is a very powerful, open, future-proof set of standards that offers the traditional broadcaster some new opportunities. As with any new and powerful system, it can be very complicated, and the number of options and capabilities can be overwhelming.

Lots of technical issues such as RF reception maps, content creation, and workflow need to be ironed out and resolved. ATSC 3.0 will raise many rights management issues, and content protection will be a challenge that must be addressed. At CES 2017, only one manufacturer of TVs was advertising ATSC 3.0 support. I expect that by CES 2018, many manufacturers will offer TVs, gateways, and other smart devices supporting the ATSC 3.0 standards.

Broadcasters will also need to adapt their content workflow and reach out to new partners to take advantage of new possibilities that ATSC 3.0 can offer. Setting up those relationships will take time on the broadcast side.

There are a lot of companies involved in ATSC 3.0 development, all testing and excited about the new ATSC 3.0 standards development. It has the potential to revolutionize the broadcast market as we know it and at DekTec we will continue monitoring and developing products to support this exciting new era.

ATSC main standard references

A/321:2016, "System Discovery and Signaling"

A/322:2016, "Physical Layer Protocol"

A/330:2016, Link-Layer Protocol

A/342 Part 1:2017, "Audio Common Elements"

A/343:2016, "ATSC Standard: Captions and Subtitles"

http://atsc.org/atsc-30-standard/a3352016-video-watermark-emission/

http://atsc.org/atsc-30-standard/a342-part-12017-audio-common-elements/

www.atsc.org

Click here or contact us for technical information.

Author: Stephane Billat
General manager, DekTec America, Inc.
stephane@dektec.com