Network Planning and Service Deployment Considerations for ATSC-3.0 services

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Abstract

In this article we review several important network planning and service deployment considerations for the introduction of ATSC 3.0 digital television services. A concise overview is provided of the key ATSC 3.0 system features. The unique system features, such the wide range of Modulation and Code rate schemes (MODCOD), Layer Division Multiplex (LDM) and Channel Bonding, are reviewed on their practical implications in a network planning exercise. The article includes insights on the current retail prices of ATSC 3.0 receivers, as well as service deployment considerations for carrying out the ATSC 3.0 introduction in stages, easing the impact on consumers. Finally, some regulatory measures are addressed, which are directly relevant for ATSC 3.0 broadcasting network operators and service providers to consider.

Introduction

This article addresses some important network planning and service deployment considerations for broadcasting network operators and regulatory authorities, planning for the introduction of ATSC 3.0 digital television services. The article also includes considerations for countries migrating from analogue television services to the latest digital terrestrial television standard ATSC-3.0.

It is noted that such a migration scenario from analogue television to ATSC3.0 services is different from migrating services from ATSC 1.0 to ATSC 3.0, as currently in progress in South Korea and the United States. In addition, these two countries are challenged for spectrum, limiting the possibilities for simulcasting incumbent (ATSC 1.0) services.

The rest of this article is structured as follows:

1. Key ATSC 3.0 System Features
2. Network Planning Considerations for ATSC 3.0
3. Service Deployment Considerations for ATSC 3.0

Key ATSC 3.0 System Features

Table 1 below shows a list of the key system features of the ATSC 3.0 suit of standards.

System Features	Short Description	Practical considerations
Physical Layer	Coded Orthogonal Frequency Division Multiplexing (COFDM) or a multi-carrier system.	All OFDM based systems have the advantage of having ruggedness against multipath interference, or in other words are specifically suited for indoor-reception conditions.
	A wide range of Modulation and Code Rate (MODCOD) configurations, Layer Division Multiplex (LDM) and Channel Bonding.	Very flexible system to cater for a wide range of service deployment scenarios, carried by a single multiplex. For example, robust system variants for mobile/indoor reception conditions, whilst also catering for rooftop settings for delivering HD/UHD services.
Transport Layer	IP based transport layer	Transmitter sites can be fed by an IP broadband infrastructure. Hence more choice for designing the distribution network and potentially lower costs, as network equipment, such as routers, is widely available.
Content Protection	W3C Common Encryption protocol (CENC) for implementing interactive features requiring a return path	ATSC 3.0 is developed for smart-tv sets with IP broadband connections in mind. However, within the ATSC 3.0 suit of standards, the W3C protocol has additions to allow broadcast-only implementations.
Video Coding	HEVC (or H.265)	HEVC widely deployed in IP environments, in broadcast settings (smart-tv sets and set-top-boxes) has a more limited deployment. Hence relative high receiver prices. Licensing costs for HEVC may also have to be considered, increasing the receiver costs.
Interactive Services	HTML-5 based with a full integration of the IP broadband return channel	Development of interactive applications (for smart-tv sets, mobile and tablet devices) in an IP environment. Hence more choice of app developers and in the long run lower costs. Uptake of interactive service dependent on availability of IP broadband infrastructure.

Table 1: Key ATSC 3.0 System Features

In the next two Sections, we address in more detail what these ATSC 3.0 system features entail for the network planning and service deployment of ATSC 3.0 services.

Network Planning Considerations for ATSC 3.0

The features for the physical layer of the system standard, also referred to as the transmission standard, are key in carrying out the network planning for ATSC 3.0 services. As included in Table 1, the ATSC 3.0 physical layer is defined by four key system elements: COFDM, MODCOD (Modulation and code rate), Layer Division Multiplex (LDM) and Channel Bonding. In this article we address the latter three as these features sets ATSC 3.0 apart from other OFDM based transmissions systems like DVB-T2.

ATSC 3.0 has many options when selecting the MODCOD (Modulation and Code Rate). From very robust modulations carrying less capacity, to less robust modulations carrying more capacity. Unlike for example DVB-T2, ATSC3.0 allows the use of 1024 QAM and 4096 QAM, which can carry high data-rate 4K or Ultra-High Definition (UHD) content. These two modulation schemes may be useful for Multichannel Multipoint Distribution Service (MMDS) type transmissions to fixed receivers, as a substitution of the 'last-mile' of cable infrastructure (also referred to as

wireless cable). It is assessed that the practical implementation of these modulation schemes will be limited. Because for having a reliable transmission the distance between transmitter and receiver needs to be very short. Or in other words, for terrestrial transmission in the UHF band the practical implementation is limited since it requires high signal levels for an error-free reception.

Additionally, ATSC 3.0 provides very robust system variants with a low bit rate using QPSK modulation. These variants may provide robust reception to mobile receivers possibly using LDM. An effective LDPC (Low Density Parity Check) error-correcting code has been used. It offers code rates with fine granularity from2/15 to 13/15. This makes it possible to adopt the capacity and robustness more precise to fit a specific (mobile/indoor) use case.

LDM is a new feature in ATSC 3.0, which makes it possible to combine for example HD programs for rooftop reception and robust mobile reception in a single UHF channel, in an efficient way. This approach is more spectrally efficient compared to the use of for example different MODCODs in different Physical Layer Pipes (PLPs), like in DVB-T2. The drawback is that a more careful planning is needed in particular when using Single Frequency Networks (SFNs).

Channel Bonding in ATSC 3.0 distributes the content across two RF channels, aimed at carrying high data rates. The implication is however that receivers with two RF- tuners are required, increasing the receiver costs. As of today, this technique is not used by broadcasters nor are any receivers currently available supporting channel bonding.

When migrating from analogue television to ATSC 3.0 due consideration should be given to the re-use of existing rooftop antennas, as these antennas may be technical obsolete or not present any longer. Hence planning for indoor reception, or even mobile reception, is likely to be a prerequisite, at least in some parts of the service areas.

Although planning for indoor reception is very well possible with ATSC 3.0, it is important to realise that accepting to plan for indoor reception, requiring a more robust signal, comes with the price of a reduced capacity for loading the ATSC 3.0 multiplex with HD/UHD services.

In countries with limited fixed broadband infrastructure, the ATSC 3.0 interactive broadband channel (see the last item in Table 1) is likely to be delivered by mobile means and hence the ATSC 3.0 indoor network planning will have to consider the mobile coverage.

Finally, for limiting the costs and the duration of the simulcast period (i.e., incumbent analogue services are also delivered by the digital terrestrial television network), a detailed prediction of the existing analogue television service coverage is critical. The digital terrestrial television deployment is likely to take place in stages and the first stage should, as a minimum, cover the analogue television reception areas. Hence the ATSC 3.0 network planning should replicate these analogue television reception areas. A network planning tool should cater for a careful analysis of the digital television service covering the analogue television service areas. In the network planning software, such as the PROGIRA® plan software it is possible to investigate and evaluate several different roll-out scenarios, network structures, as well as evaluate possible interference before implementation.

Service Deployment Considerations for ATSC 3.0

A key challenge for deploying ATSC 3.0 services is the uptake of receiver equipment. As the adoption of ATSC 3.0 services is still at its infancy, the ATSC 3.0 receiver costs are currently

relatively high, especially as compared to other well established digital terrestrial television transmission standards. Also, ATSC 3.0 enabled receivers, such as smart-tv set and Set-Top-Boxes (STBs) or digital converter boxes, are currently only available in limited numbers. Prices are still relatively high but are likely to drop during the coming years as more services become available, and more receivers sold.

It is noted that the currently available ATSC 3.0 receivers include an ATSC 1.0 receiver, as having such a feature is a requirement for serving the US and South Korean markets. For example, the FCC has set a comprehensive set of regulatory requirements for simulcasting ATSC 3.0 services with incumbent ATSC 1.0 services.

Table 2 and Table 3 include a concise overview of the cheapest available receivers for respectively ATSC 3.0 and ATSC 1.0.

Category		Model	Manufacturer	Retail Price (USD)
Smart-tv sets (*)				
55”	4K	LG G1 Class with Gallery Design 4K Smart OLED evo TV w/AI ThinQ®	LG	$1,699.99
65”	4K	LG G1 Class with Gallery Design 4K Smart OLED TV w/AI ThinQ®	LG	$2,399.99
50”	4K	50" Class QN90A Samsung Neo QLED 4K Smart-tv (2021), $1249,99 up to	Samsung	$1,249.99
65”	4K	65" Class QN90A Samsung Neo QLED 4K Smart-tv	Samsung	$2,099.99
55”		X900H 4K HDR Full Array LED with Smart Android TV	Sony	$999.99
65”	4K	X900H 4K HDR Full Array LED with Smart Android TV	Sony	$1,399.99
Digital converter boxes (**)				
Converter box	4K	HD Home Run Flex 4K ATSC 3.0 NextGen TV. 4 tuners (2 ATSC 1.0 and 2 ATSC 3.0)	Silicon Dust	$200.00
Mobile receivers				
Currently not commercially available only for trial and testing purposes (***)				

Notes:
(*) Commercially available ATSC 3.0 compatible tv sets comprise approximately 60 models of 3 manufactures.
(**) ATSC 3.0 converter boxes, include other features like multiple tuners or hard disks.
(***) One Media 3.0 (a Sinclair company) produces on limited scale for trials (sets are branded as Mark One).

Table 2: ATSC 3.0 retail receiver prices (November 2021)

Receiver Category		Model	Manufacturer	Retail Price (USD)	Notes
Converter box	1080p	Digital to analogue Converter Box	UBISHENG	$26.99	ATSC 1.0 only
Converter box	1080p	Digital to analogue Converter Box	ZJBOX	$27.59	ATSC 1.0 only

Table 3: ATSC 1.0 digital converter retail prices (November 2021)

From Table 2 it can be observed that the cheapest available ATSC 1.0/3.0 enabled smart-tv sets are high-end expensive models. Comparing Table 2 and Table 3, shows the current large price difference between ATSC 3.0 and ATSC 1.0 digital converter boxes. It is also noted that the available ATSC 3.0 digital converter boxes should be checked for their video/audio output (HDMI). This is important as the installed base of television sets may have another video/audio input (for example SCART).

As to overcome the initial ATSC 3.0 price hurdle, a multi-service digital television service deployment could be considered in which both ATSC 1.0 and ATSC 3.0 services are deployed. Under such multi-service deployment approach, the incumbent analogue services are simultaneously broadcasted in ATSC 1.0 and ATSC 3.0 format. Because ATSC 1.0 converter boxes are retailed around USD 25 on the US market, such a multi-service approach may pose a better financial proposition for the digital migration affected analogue television viewers. In a later digital migration stage, these ATSC 1.0 viewers can be easily migrated to ATSC 3.0. For example, when they replace their TV sets for an ATSC 3.0 smart-tv set. ATSC transmitter manufacturers also facilitate an ATSC 1.0 to ATSC 3.0 migration, for example by offering an easy-to-replace (or software upgradable) exciter of the transmitter.

However, the approach requires an additional transmitter and a temporary frequency on each transmitter site. ATSC 1.0 transmitters may be sourced from the second-hand market in the US and South Korea, depending also on decommissioning and transport costs. It is noted that due to current global chipset shortages, long delivery times can be expected for ATSC 3.0 transmitters. Aiming for a rapid migration to digital terrestrial television, an ATSC 1.0 launch may even be necessary. Clearly the availability of ATSC 1.0 transmitters should be investigated, as well as having enough transmitter equipment/antenna space on transmitter sites and spectrum availability in the UHF band.

Also, due consideration should be given to the fact that the ATSC 1.0 system is a single carrier system based on amplitude modulation (8-VSB). Such systems are not best suited for indoor coverage, which may be a requirement if rooftop receiver antennas are not widely used. Hence, a careful network planning exercise will be needed to investigate the possibilities for a proper reception of ATSC 1.0 services.

A deployment of digital terrestrial television services will require regulating the loading of the available multiplexes with the various services such as Standard Definition (SD), High Definition (HD) and Ultra-High Definition (UHD) services. Such regulations would also include a set of must-have or must-carry services, such as the incumbent television services. As addressed previously, the ATSC 3.0 offers many MODCOD options and the multiplex loading regulations should incorporate these system flexibilities, as to facilitate service development.

In setting these multiplex loading rules, the NRA should consider the impact on the multiplex operators or broadcast network operator. For example, under the assumption that transmitter

sites will be shared (as to have the same coverage area for each multiplex, offering a unified service offering for the television viewers), for future UHD service extensions the multiplex operators should not just install a single transmitter with filter section. They should also cater for a combiner system with various additional ports. For example, a port for an ATSC 1.0 transmitter (if applicable) and any extra ports for additional transmitters for delivering future (more) UHD services.

● Convergence ● Consulting ● Company

The Convergence Consulting Company (CoCoCo) is a consulting firm based in the Netherlands. CoCoCo was established in 2008 and is specialised in providing consulting services and capacity building for Telecommunications and Media Regulators, as well as for public and private companies operating in the converged ICT markets.

CoCoCo carries out its assignments across the world with multi-disciplined consulting teams and in close cooperation with local client staff. CoCoCo has a cooperative approach, focused on the challenges at hand and pragmatic in the delivery of solutions.

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Our software products are:

- PROGIRA® manager – Spectrum management system which automates the everyday tasks of radio frequency administration and regulators
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- PROGIRA® reach – For visualising network coverage
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We have offices in Sweden, Lithuania, Russia and Brazil. These offices are complemented by a large number of distributor world-wide.

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Some of our clients include regulatory authorities or governmental agencies, such as Comision Nacional de Telecomunicaciones (CONATEL) of Venezuela, Communications Regulatory Authority of the Republic of Lithuania, Office of The National Broadcasting and Telecommunications Commission of Thailand, Telecommunications Authority Suriname, and Ethiopian Broadcasting.

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