

A Research Study on the Technology Developments of the Ultra High Definition Televisions

Abstract

Recent advances of the UHDTV (Ultra High Definition Television) developments are evolving from 4KTV toward 8KTV in terms of the improved resolutions. The 4K UHDTV sets are getting popular on the market nowadays and 8K TVs are around the block. Technologies that support the compression and transmission of the UHDTV programs are getting matured. Facing the upcoming 5G era, the UHDTV technologies will be harmonized in various application areas such as HBB-Next (Next Generation of the Hybrid Mode TV) and Content Everywhere (Cross-media Content Production) in addition to the IoT and 3D/AR/VR proposed in the 5G Specifications.

In this study, we've analyzed and compared three major DTTV (Digital Terrestrial TV) systems around the world, which are the DVB-T2 by EBU in the Europe, the ATSC 3.0 by FCC in the US and South Korea, as well as the next generation ISDB-T2 which is currently developed by NHK in Japan. A draft version of "the UHDTV Technology Specifications for the Terrestrial TV Stations" is proposed for the regulator to consider as the next generation UHDTV regulations. In this draft UHDTV Specs, we've included all three standards before the regulation policy is confirmed.

Currently, there are several DTTV specification systems deployed around the world, which are the DVB systems in the Europe, the ATSC systems in the US and the South Korea, the ISDB systems in Japan, and the DTMB systems in China. The three most adopted systems are the DVB, the ATSC, and the ISDB specifications, and they've all started developing the UHDTV technologies in recent years. The earlier two UHDTV systems, i.e., the DVB-T2 and the ATSC 3.0, are focusing on the 4KTV developments. The Japan ISDB-T2 system, though is coming out late, is taking further steps to push the technologies into the 8KTV program transmissions. The NHK and the MIC of Japan are planning to deliver the 2020 Olympic Games in 8KTV mode.

According to the digital TV broadcasting structure, such a DTTV system can be modeled as two layers, i.e., a Source Coding layer and a Channel Coding layer. The Source Coding layer is dealing with different content formats, such as Audio, Video,

and various data formats; it is responsible of doing the content coding, compression, as well as multiplexing, for preparing the ready streaming contents. The Channel Coding layer, on the other hand, is dealing with different signal transmission environments, such as Terrestrial, Satellite, Cable, and Internet; it is responsible for minimizing the effects of the noise and the errors generated during the transmission pass, and trying to recover back the correct data. Several technologies are employed in this layer; they are, the convolution integral for power and noise dispersions, the FEC (Forward Error Correction) coding, and different digital modulation schemes for various transmission environments.

Different from the first generation DTTV specifications, the content formats are defined quite the same way across all these UHDTV standards. The major differences come from the Channel Coding definitions, especially, in the Terrestrial transmission environments. Moreover, the Terrestrial TV stations are required to have special licenses to be transmitted over the air utilizing public Terrestrial spectrum, special requirements are defined in the DTTV Channel Coding specifications and related regulations.

Regarding the Channel Coding standards, the DVB systems have the most complete coverages, including the Terrestrial TV using DVB-T and DVB-T2, Cable TV by DVB-C and DVB-C2, Satellite TV by DVB-S and DVB-S2, as well as the DVB-IPTV for the IPTV. On the other hand, the US ATSC systems are quite simple which are only focusing the Terrestrial broadcasting. And, hence, it has the original ATSC 1.0 for HDTV and the newly defined ATSC 3.0 for 4KTV. The intermediate ATSC 2.0 was only defined for the additional Hybrid Mode TV services. The Japanese ISDB standards are the latest ones among the three major systems. It includes the ISDB-T for Terrestrial TV, the ISDB-C for Cable TV, and ISDB-S for Satellite TV.

Most of the original DTTV systems were designed for the HDTV delivering. An exception is the Japanese ISDB-T, which utilizes the “segmentation” concept to combine multiple content formats into one DTTV transmission system; including HDTV, Data, and Handheld Mobile Contents called “One-Seg”. In the next generation ISDB-T2 developments, both the number of segments and the density of the constellation map in the modulation scheme are greatly increased such that hierarchical transmission layers are possible. These technologies can add additional dimensions to the content formats to serve their targeted areas.

As for the advances of the latest compression technologies, HDTV is compressed by the MPEG-2/H.264/AVC(MPEG-4 Part 10, Advanced Video Coding), 4KTV is using the H.265/HEVC(MPEG-H Part 2, High Efficiency Video Coding), while

8KTV is expecting the emerging H.266/FVC(Future Video Codec). Since there are requirements on the cross-platform content display, the Source Coding definitions should be so defined that they can be exchanged easily across Terrestrial TV, Cable TV, Satellite TV, and IPTV platforms. By all means, all the content formats should be decoded and displayed easily on any UHDTV sets sold on the market nowadays.

To conclude, the global UHDTV starts from the European DVB-T2 developments. In addition to the Terrestrial TV, DVB-T2 can also be extended to cover other related DVB systems in the Cable, Satellite, and IPTV networks. The DVB-T2 systems are pretty much matured but certain technologies may have some improving spaces. As the second 4KTV on the market, the US ATSC 3.0 is testing and finalizing its standards. The most complete ATSC 3.0 trial was performed in the 2018 Pyeongchang Olympics in South Korea. The technical as well as the commercial trial data are still not widely available. The Japanese ISDB-T2 system, although comes late, its technologies are quite advanced and moved directly toward 8KTV system. Due to commercial policy conflicts between the technology developer NHK and the regulator MIC, the name “ISDB-T2” as well as its technologies and specifications are not yet registered with the Japanese standard body ARIB. Although Japan has decided to broadcast the 2020 Tokyo Olympic Games in 8KTV format, it may only be available on the Satellites and over the Internet. The ISDB-T2 cannot make the show in the 2020 Olympics this time.

The 4KTV sets are getting popular on the markets nowadays. We suggest that an UHDTV technology trial to be performed in the 2019 and followed by a commercial trial later the same year. So we can expect the launch of 4KTV services soon in 2020 or a year after. Hopefully, we can meet the UHDTV promotion opportunity in the 2020 Olympics, and push forward the related TV industries and the manufactures.

Key Words: Ultra High Definition Television, UHDTV, 4K/8K TV, Draft Regulations for the “4K UHDTV Specifications and Verification Requirements”.