Ultra High Definition Television: Current Scenario and Challenges

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Digital Video: Where are we now?

The 2012 International Consumer Electronics Show was a key event for the TV industry with the launch of the first 4K Ultra High Definition TV ("UHDTV") display.

With four (4) times the spatial resolution of High Definition TV (HDTV), UHDTV provides a sharper, more detailed picture. While the emphasis with UHDTV has been on the larger spatial resolution, UHDTV introduces a number of other enhancements – including higher frame rates, greater color gamut and increased dynamic range – which together create a more immersive TV viewing experience and realism.

But the widespread adoption of UHDTV requires more than just the availability of UHDTV services. It requires the wholesale upgrade of the entire broadcast eco-system:

1. Content creators filming and producing UHD content
2. Channel operators purchasing and aggregating UHD content into UHD channels
3. Distributors, i.e. satellite and fiber, delivering UHD channels to TV platforms
4. TV platforms broadcasting or delivering UHD channels to the end consumer
5. Consumers viewing UHD content

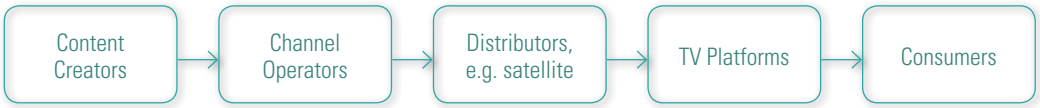

Figure 1. *The digital video value chain*

Whilst the satellite sector has is already prepared for UHDTV, other participants in the value chain have more work to do.

Satellite Systems: Primed for UHDTV Delivery

TV channels have been distributed via satellite for many decades. Satellites provide a highly reliable delivery platform with their wide coverage allowing a single satellite to deliver a linear channel direct to hundreds or thousands of television head-ends across a region. As such, today C-Band satellites form the backbone of the video distribution system.

With four (4) times the resolution of HD, UHD requires at least four (4) times the data rate to carry its content. For satellites to be able to cost effectively deliver UHDTV content, more efficient compression and encoding is needed.

High Efficiency Video Coding ("HEVC") is a new video compression standard which meets this criteria. Introduced in 2013, HEVC is the successor to H.264/MPEG-4 AVC (Advanced Video Coding). It was jointly developed by the ISO/IEC Moving Picture Experts Group (MPEG) and ITU-T Video Coding Experts Group (VCEG) as ISO/IEC 23008-2 MPEG-H Part 2 and ITU-T H.265.

With HEVC encoding it is possible to distribute a good quality UHD feed over satellite transmission with bit rates of between 20 – 25 Mbps, without compromising the picture quality. This is a 75 % improvement over MPEG-4 encoding. Additional features of HEVC include:

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- Supports multiple colour spaces such as but not limited to: generic film, NTSC, PAL, Rec. 601, Rec. 709, and Rec. 2020
- Uses larger block structures of up to 64x64 samples
- Offers better sub-partitioning of the picture
- Other enhancements in areas such as motion compensation, de-blocking filters, range extensions, and others.

In addition to improving the coding, it is also important to increase the efficiency of satellite transmission governing the modulation and bitrate of the satellite's bandwidth.

Increasing demands for more efficient use of bandwidth led to the development of DVB-S2X. DVB-S2X is a new digital satellite television broadcast protocol standardized by Digital Video Broadcasting Project (DVB) in March 2014 as an optional extension of the DVB-S2 standard. The key features of DVB-S2X are:

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- Lower roll off (5%, 10%, 15%)
- Increased granularity for modulation coding by introducing new FEC (Forward Error Correction)
- Higher modulation (64APSK)
- Minimized implementation loss
- Wideband implementation (up to 72MBaud)

These new features help increase the link's spectral efficiency and improve the signal-to-noise ratio at the receiving end. The new DVB-S2X standard can achieve up to 20% improvement in data rate for a single carrier transmission on a conventional 36 MHz C-band transponder.

Broadcast vendors have produced equipment that support HEVC and DVB-S2X. This equipment has already been implemented by leading satellite operators, making satellite a technically viable delivery solution for UHD channels.

Remaining Challenges in UHDTV Implementation

Whilst satellites are already prepared for the distribution of HDTV content, other elements of the value chain are not as well prepared. Roadblocks need to be overcome and investments need to be made to facilitate the mass adoption of UHDTV by consumers.

When it comes to content creation and its subsequent aggregation into channels by channel operators, there is a distinct lack of UHD content. Many content creators have only recently begun to produce content in UHD. The saleability of UHD content to channel operators is one issue. Other issues are the price, availability, and trained use of UHD production equipment for recording, storing, editing and transmitting UHD content. Even though most broadcast production equipment such as cameras and playout servers have been upgraded to support UHD as of mid-2015, the full ecosystem of UHD production equipment still needs to be available and made affordable for more UHD content to be distributed. A new UHD channel will require a library of hundreds of hours of UHD content and the accumulation of this takes time. This lack of content is a major reason for the delay in the launching of UHD commercial services.

Another challenge is the hesitance of channel operators and TV platforms to invest further in UHD until the other party confirms their readiness. From the channel operators' perspective, they will aggregate and provide UHD channels when the TV platforms are ready to broadcast UHD channels. However before TV platforms upgrade their equipment to support UHD, they want more UHD channels to be available from channel operators. Both parties are waiting for the other to make the first UHD move.

TV platforms will also need to invest in UHD set-top boxes that are compatible with HEVC and DVB-S2X, and convince consumers to replace existing units with these new UHD set-top boxes. They will also have to decide on how to monetize future UHD services.

And finally, in the consumer market, although a recent study showed that roughly 60% of the flat screen TVs sold in Asia are 4K-ready, this does not indicate if consumers are ready to pay extra for UHD content. Early UHDTV models might not meet current UHD specifications, and while the world's first UHD disc player has just been introduced it is yet to be available for purchase.

UHDTV is Here to Stay

Despite various challenges and uncertainties that will require continued innovation, more content and crucial decisions, UHD sentiment remains high with it generally being accepted that UHD is the next stage in digital video's continuing evolution.

Consumer awareness of UHD will grow with more UHD trials which will coincide with major world events, such as the 2016 Olympics or World Cup 2018. The digital video value chain is also seeing progress across all stages. Content creators are ramping up UHD production for channel aggregation. Proven UHD distribution services are already available from leading satellite operators. Pay-TV operators are beginning to introduce UHD channels. Consumers have expressed UHD readiness with UHD TV sales increasing. And with the introduction of the world's first UHD channel in September 2015, UHDTV has arrived and is here to stay.

UHD Innovation and World's First UHD Channel Distributed via Satellite

The have been a number of trials over the last two years by broadcast operators to verify the performance of UHD transmission over satellite using DVB-S2 and DVB-S2X.

The first UHD transmission over satellite in Asia was carried out by MEASAT in 2013 with support from technology partners and TV manufacturers, using DVB-S2 transmission and H.264/MPEG-4 AVC compression. The trial proved that satellite is capable of supporting UHD video delivery for contribution or distribution.

More advanced trials and live demonstrations with DVB-S2X and HEVC followed. This culminated on 1st September 2015 with the launch of the world's first Ultra High Definition channel, whose distribution in Asia was provided by MEASAT. Beamed from 91.5°E, the region's leading video hot slot, the channel allows users in the Asia-Pacific, Middle East, Australia and Eastern Africa to enjoy a totally new TV viewing experience.

John Loke is MEASAT's Vice President, Network Engineering & Operations. He is responsible for managing MEASAT's Commercial Engineering division encompassing Customer Engineering, Network Management Centre, Product Development, and Value-Asses Service (Ground and IT) departments. John originally joined MEASAT in 2007 as Head of Customer Engineering and has more than 18 years of experience in the satellite industry. Prior to joining MEASAT, John was part of the pioneer team that started the ST-1 operation in Singapore Telecommunications Ltd (SingTel) in 1996. In SingTel, John managed the operating team of the ST-1 Telemetry, Tracking and Control (TT&C) system, and he is also a qualified Flight Dynamics Specialist. John holds a B. Eng (Electrical & Electronic Engineering) from Nanyang Technological University of Singapore.