Newtec

White Paper

DVB-S2X DEMYSTIFIED

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This white paper provides an update of the technologies involved in the new DVB standard, called DVB-S2X.

DVB-S2 is the most accepted and widely spread standard in the satellite market. The standard has a deep market penetration in Sports and News Contribution, Professional Video Distribution solutions, IP trunking and Cellular backhauling, Broadband VSAT solutions up to Government and Defense networks over satellite.

In a fast moving satellite world new technologies (HTS, HEVC, UHDTV) emerge, data rates increase at an accelerated pace and end-users expect to get connectivity anywhere anytime. Within applications such as Contribution and IP Trunking the efficiency requirements are already testing the limits of the DVB-S2 standard. The risk for a massive take-over by proprietary technologies with better performance is realistic. A proprietary scenario would disperse the satellite industry, increase the cost of satellite communications as well as prevent interoperability and result in vendor lock-in.

The new DVB standard, called DVB-S2X (or extension to DVB-S2), with improved efficiency will give the satellite industry more breathing space to increase profitability and allow for business growth throughout all applications, from High Speed IP to Broadcast to VSAT.

The efficiency technologies contributed by Newtec to the new DVB standard boost the satellite link up to 20% in Direct-To-Home networks and 51% in other professional applications compared to DVB-S2. These gains already exceed the results by proprietary systems in the market today.

Introduction

Kick-started by Newtec in the course of 2012, key players in the satellite industry are calling for a new satellite transmission standard, specifically for professional satellite contribution links, which would extend the existing DVB-S2 standard.

The satellite world has changed a lot since DVB-S2 was first published in 2005. Higher speeds, more efficient satellite communication technology and wider transponders are required to support the exchange of large and increasing volumes in data, video and voice over satellite. Moreover end-users expect to receive connectivity anywhere anytime they travel, live or work. The biggest demand for the extensions to the DVB-S2 standard comes from video contribution and high-speed IP services, as these services are affected the most by the increased data rates.

In the long run more throughput will be required for Direct-to-Home applications as well with the rise of Ultra-High Definition TV (UHDTV) and the High Efficiency Video Coding (HEVC) video compression standard to support the request of higher quality images by the market.
Ultimately, for satellite businesses, the creation and adoption of these extensions will translate to higher efficiency, higher speed, more mobility and greater service robustness to increase business and therefore revenues.

The combination of technologies incorporated in the new standard results in a gain of up to 20% for DTH networks and 51% for other professional applications compared to DVB-S2.

Many vendors, operators and satellite specialists within the industry did agree with DVB and have worked towards the new standard.

Finally in February 2014 the new standard, called DVB-S2X will be launched officially towards the satellite communication market.

The Market is in (R)evolution

Satellite's Challenge against Fiber

Changes have never occurred so rapidly in the satellite industry as today. The increasing penetration of terrestrial communication alternatives has put satellite under pressure.

A common misconception is that fiber will entirely replace satellite sooner or later. Use cases, economic considerations and new technologies prove that satellite still has value for years to come. Terrestrial and satellite communications are more likely to cohabitate in network structures and will be selected depending on the application.

Breakthrough Technologies Change the Game

High Throughput Satellites (HTS) and efficiency technologies have changed the game. More bandwidth capacity will become available and prices per megabit will drop. Both HTS and efficiency technologies blow oxygen into satellite service provider's profitability and growth.

Efficiency technologies allow for more throughput in the same bandwidth or to save on OPEX. In technical terms, efficiency technologies push more bits through the same Hertz.

What can be done with these extra megabits? Examples throughout different applications demonstrate the benefits:

- In a VSAT environment more users can be added to the network resulting in extra revenue. Higher SLA's become possible increasing the user experience.
- Broadcasters can add more TV channels to their offering and increase the quality of the image.
- Extra revenues can be achieved by adding services in a multiservice context.

The impact of efficiency technologies and HTS is so big in the satellite market; that the standardization of these technologies cannot be delayed.

Impact of Standards

Why Standards?

In the satellite industry there will always be a field of tension between open standards and proprietary technologies. Although in the short term proprietary technologies might be the best option to acquire quick revenues, in the long run the availability of open standards will benefit the entire satellite industry for the following reasons:

- Open standards **create an eco-system** that spurs companies to develop new solutions based on common building blocks
- Open standards **reduce the barrier** for entry for companies to develop new solutions for satellite communications
- Open standards create an **economy of scale** that allows a reduction in the cost of equipment and increases the profitability of the industry
- Open standards **avoid vendor lock-in** and allow multiple vendors to enter the network, lowering the overall risk of high pricing, companies going bankrupt or non-availability of spare parts
- Open standards increase the **quality of products** as the technical implementation is supported by multiple organizations.
- Open Standards allow for **interoperability** between different government, NGOs and commercial organizations increasing the effectiveness of operations in the field.

The impact of standardization increases the quality of life in both developed and developing countries. Standards for satellite communications allows people to connect all over the world to the information highway to give them better access to education, to (welfare) services, to economical, political and social involvement.

Which Markets Will Quickly Adapt to DVB-S2X?

The satellite industry has come to a consensus that a successor to the DVB-S2 standard is required to accommodate for increased profitability, interoperability and growth in the professional satellite communications market.

Newtec has taken the lead and teamed up with other DVB-members in order to define and develop the update on the DVB-S2 standards. The current DVB-S2 standard has served the industry well, but it is now close to 10 years old.

The satellite industry will benefit from an extended standard in line with today's technological advances. Through the new standard (DVB-S2X) better efficiencies and throughputs over satellite will be obtained.

Up until now the DVB-S2 standard has been the solution for a wide scope of applications over satellite including distribution applications such as Direct-to-Home (DTH). For distribution activities broadcasters are likely to continue to use the existing DVB-S2 standard for some time. But with the new higher resolution technologies like ultra high definition TV (UDHTV) and High Efficiency Video Coding (HEVC) video compression about to hit the market, and the drive for more content, in the longer term the new S2 Extensions will be adopted for DTH networks as well.

We are likely to see an immediate take-up in applications that require high throughput over satellite for professional use and in applications that suffer for bandwidth or need better margins to remain profitable.

The applications that will adapt quickly to the DVB-S2X are:

- IP Trunking & IP/Telecom Backbones
- Broadcast Contribution and Exchange
- IP Backhauling & Professional IP Access
- Government High Speed Communications & Disaster Recovery
- Multiservice networks over satellite

The Innovations behind DVB-S2X

The successor to the DVB-S2 standard is a combination of innovative technologies that improve overall efficiency over satellite links.

The technologies involved in DVB-S2X are:

- Low roll off, smaller carrier spacing and advanced filter technologies
- MODCOD and FEC upgrades (more granularity, adding 64, 128 and 256APSK, improving FECs & MODCODs and differentiating linear & non-linear MODCODs)
- Wideband implementation.
- Very Low SNR MODCODs to support mobile (land, sea, air) applications
- Bonding of TV streams
- Additional standard scrambling sequences

These technologies and their intrinsic benefits will be described in more detail in the sections below.

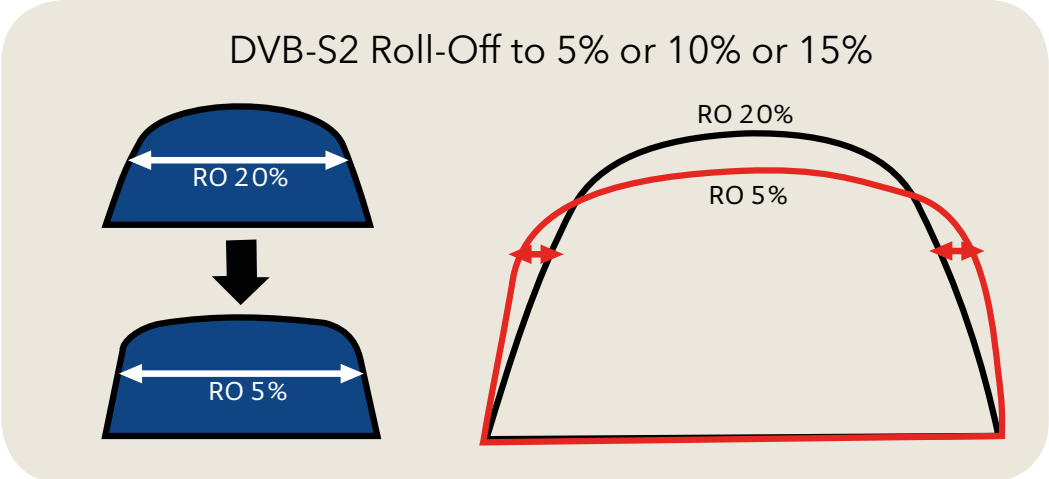
Smaller Roll-Offs and Advanced Filtering Technologies

The new DVB-S2X includes a combination of smaller roll-offs (5%, 10%, 15%) and introduces advanced filtering technologies to allow optimal carrier spacing. Compared to DVB-S2 the combination brings efficiency gains up to 15%.

Improvement 1: Smaller Roll-Offs

A first innovation inside the new standard implements a smaller Roll-Off (RO) percentage than currently used in the DVB-S2 standard. In the DVB-S2 standard the 20% and 25% Roll-Off percentages are common and are an integral part of the modulated carrier (i.e. symbol rate plus Roll-Off).
Reducing Roll-Offs to 5%, 10% and 15% results in a direct gain in bandwidth. Looking at the spectral image when implementing smaller Roll-Offs the slope of the carrier becomes steeper compared to DVB-S2 but still fits nicely in the allocated bandwidth.

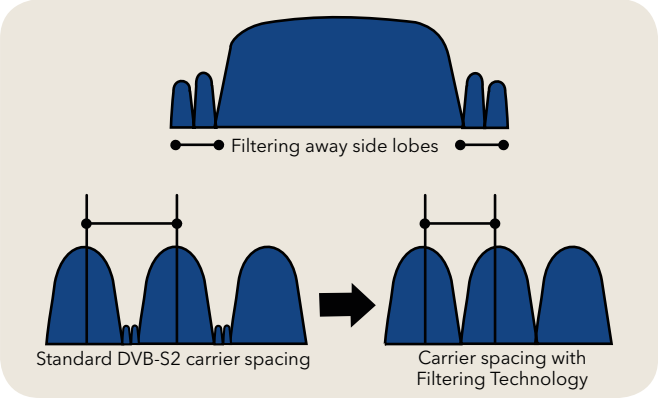
The efficiency gain by implementing smaller roll-offs can go up to 15%. When implementing smaller roll-offs every network and/or link needs to be checked individually as immediately switching towards 5% roll-off does not always bring the best efficiency. In some cases 10% roll-off will give better results.



Low Roll-Off: 5/10/15%

Improvement 2: Advanced Filtering Technologies for Improved Carrier Spacing

The second innovation deals with noise levels (side lobes) on both sides of the carrier. These side lobes prevent putting satellite carriers close to each other.
Applying advanced filter solutions has an immediate effect on bandwidth savings as the spacing between carriers can be put as close as 1.05 times their symbol rates (or even closer in some specific use cases).

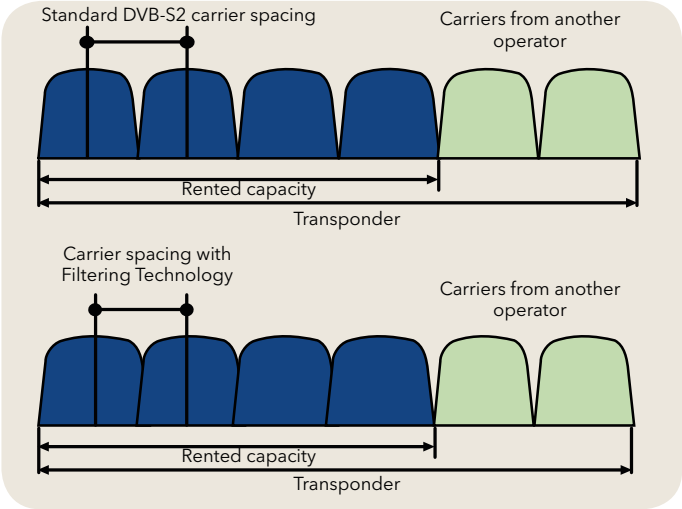


Optimal Carrier Spacing

It is important to note that even with 35%, 25% and 20% Roll-offs better filtering results are obtained. The improvement has the best effect when the ground station High Power Amplifier (HPA) is driven close to saturation. The spectral regrowth at a frequency offset (= symbol rate) will be lower with the better filtering. Meaning, at saturation the result will have a much cleaner signal spectrum.

Improvement 3: Supporting Different Network Configurations

The Roll-Off and filtering innovations within the new standard can be applied in satellite links with single carriers (mainly Roll-Off effect), multiple carriers (Filtering and Roll-Off effects) or carriers sharing the same transponder with other providers. In the latter case DVB-S2X carriers



Shared Transponder Support

can easily co-exist with adjacent carriers from other operators within the same transponder. The improved roll-offs and filtering technologies are only applied on the allocated carriers. Neighboring carriers will not be affected and do not notice any form of interference.

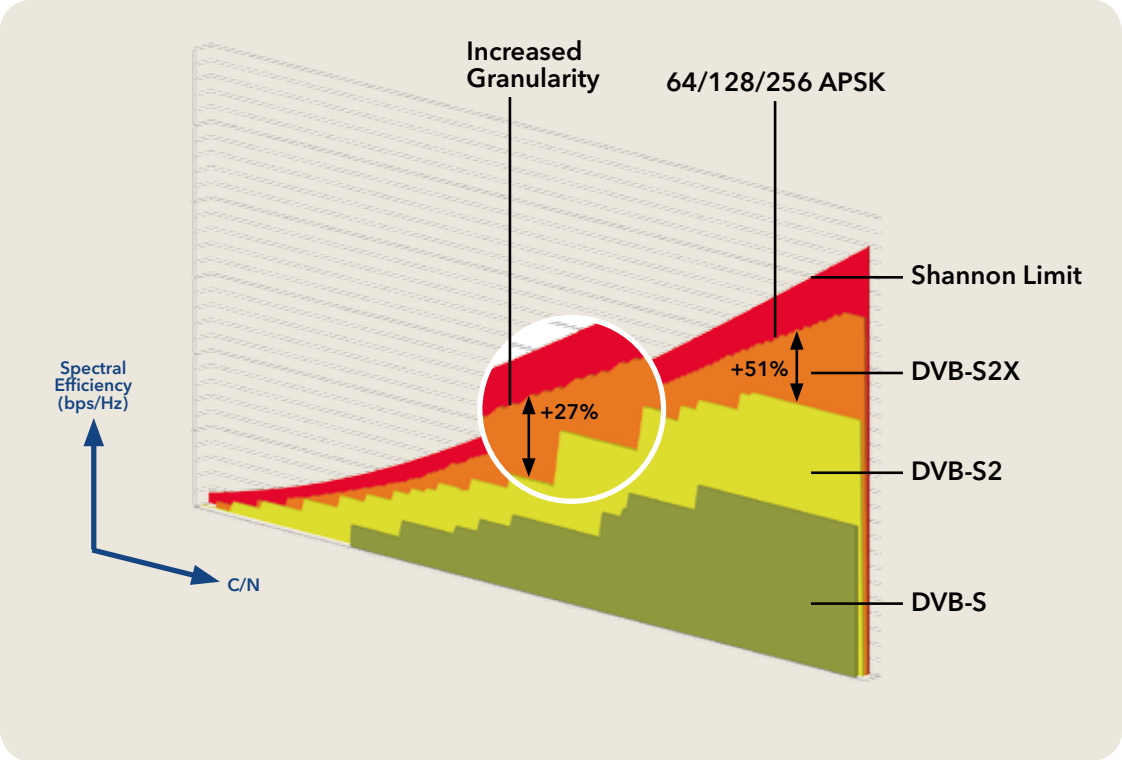
S2 Extensions MODCOD and FEC Upgrades

Improvement 4: Increased Granularity in MODCODs

As a next step the DVB-S2X standard increase the modulation and coding (MODCOD) schemes and Forward Error Correction (FEC) choices compared to DVB-S2.
By introducing an increased granularity the highest resolution for optimal modulation in all circumstances can be provided. The current DVB-S2 quantization steps are quite far apart. By adding granularity in the upcoming standard the service provider can further optimize the satellite link depending on the application. In combination with Adaptive Coding and Modulation (ACM), where the highest MODCOD is selected automatically, full efficiency can be gained. The amount of MODCODs has grown from 28 in DVB-S2 up to 112 in DVB-S2X bringing efficiency as close to the theoretical Shannon limit as possible.

Improvement 5: Higher Modulation Schemes up to 256APSK

Adding higher modulation schemes such as 256APSK proves to be useful considering the professional applications that work with improved link budgets provided by, for example, bigger antennas (more powerful satellites that become available). Newtec sees the 32APSK boundary being reached frequently with its auto-adaptive FlexACM® technology during clear weather conditions. In these situations having higher modulation schemes as 64, 128 and 256APSK is highly beneficial.
When combining the increased granularity (MODCODs and FECs) and higher order modulation immediate efficiency gains up to 51% can be achieved compared to DVB-S2 (see figure below).



DVB-S2X compared to DVB-S2 (64/128/256APSK & increased granularity)

Improvement 6: Very Low SNR for Mobile Applications

DVB has added 9 extra MODCODs to the DVB-S2X standard in the QPSK and BPSK range in order for satellite networks to deal with heavy atmospheric fading and to enable the usage of smaller antennas for applications on-the-move (land, sea, air). These Very Low Signal-to-Noise Ratio (VL SNR) MODCODs will increase the robustness and availability of the satellite link.

Some BSPK MODCODs in the new standard use spread spectrum technology. The term 'spread spectrum' refers to the deliberate expansion of the signal bandwidth by several orders of magnitude (factor 2 in DVB-S2X). The power is equally spread over a wider occupied bandwidth resulting in a lower carrier's spectral density (dBW/Hz). By reducing the spectral density levels smaller antennas can be used (for mobile applications on land sea and air) while overcoming adjacent satellite interference. Moreover the link security and availability can be increased.

In addition the header of the VL SNR MODCODs has been modified (with an extended Physical Layer Header) with better error-correcting capabilities for operations with signal-to-noise ratio values as low as -10dB.

Improvement 7: Different Classes for linear and non-linear MODCODs

Different to DVB-S2, the MODCODs in DVB-S2X have two different classes for linear and non-linear MODCODs. Since the DVB-S2 MODCODs are focused on DTH, the constellations are well suited for distribution applications with quasi-saturated transponders. For high-speed data and contribution applications other constellations can be considered where the performance gain is larger than 0.2dB. Although the MODCODs might use the same code/name, the linear and non-linear MODCODs are not interchangeable. Additionally the MODCODs and FECs themselves have been improved compared to the DVB-S2 standard to achieve even better efficiency levels.

Wideband

Improvement 8: Wideband Support

The DVB-S2X standard supports technology for typical wideband transponders that become/are available today hosting high-speed data links.
The wideband implementation in DVB-S2X typically addresses satellite transponders with bandwidths from 72 MHz (typically C-band) up to several hundred MHz (Ka-band, HTS). In principle it would be possible to allocate several narrower channels inside the wideband transponders, but this would require the operation of the satellite transponder with reduced downlink power and therefore at sub-optimal efficiency. The DVB-S2X demodulator will receive the complete wideband signal up to for example 72 Mbaud resulting in a very high data rate. The introduction of the wideband technology adds extra 20% efficiency gain.

Improvements for the Direct to Home Transmissions

Improvement 9: Channel Bonding

The channel bonding feature inside the DVB-S2X standard finds its main implementation in the Direct-to-Home application and is a direct response to the increase in rates with the introduction of Ultra High Definition Television (UHDTV) transmission over satellite. The size of a UHDTV channel requires four times the transmission capacity of a High Definition Television (HDTV) channel. With the introduction of improved encoding technologies such as HEVC (High Efficiency Video Coding - H.265) the compression efficiency can be doubled compared to AVC (Advanced Video Coding - H.264). Below some typical rates for HDTV and UHDTV in DTH.

- HDTV with AVC coding = 10 Mbps
- UHDTV with AVC coding = 40 Mbps
- UHDTV with HEVC coding = 20 Mbps

In a traditional 36 MHz transponder it was possible to transmit 6 HDTV channels or 60 Mbps. The amount of channels could even be increased to 7 when taking a 20% statistical multiplexing gain into account. For UHDTV however only 3 channels can be provided over the same 36 MHz transponder. The gain from statistical multiplexing has been reduced to 12% and as such no extra program can be added in this context.

DVB-S2X introduces channel bonding specifically to increase the statistical multiplexing for UHDTV transmissions. With this feature a single big transport stream is sent over several different transponders at the same time. The capacity of these transponders is merged and will provide extra gain (extra 12% for 3 bonded channels). The accumulated gain will allow in the end to accommodate an extra UHDV channel in the big Transport Stream by using the spare capacity of the individual transponders.

Improvement 10: Additional Standard Scrambling Sequences

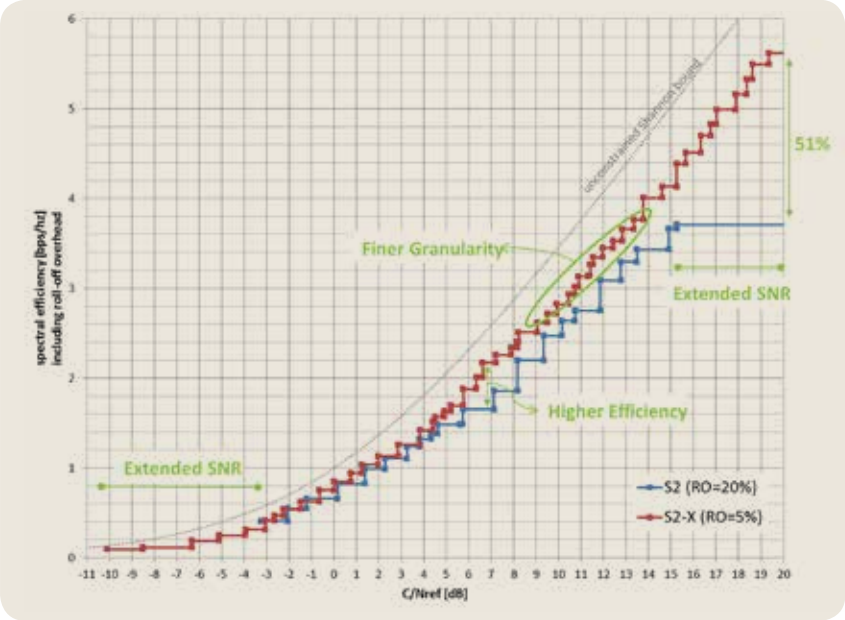
With the increase of data traffic, rich media and TV channels over satellite resulting in a steady growth of DTH services, HTS and multi-spot beam satellite payloads the topic of co-channel interference (CCI) could no longer be ignored when the new DVB-S2X standard was being developed. The new standard today has a mechanism to mitigate CCI by providing a better differentiation between neighboring services.

The differentiation between these services is based on the addition of physical layer (PL) scrambling sequences within DVB-S2X. Whereas DVB-S2 only had one default code (PL scrambling sequence number 0) another six codes have been defined for the new standard. On the reception of a scrambled signal a typical DVB-S2X receiver will firstly try the default code and only afterwards cycle though the the new codes to de-scramble the signal.

DVB-S2X Technology Results

When comparing the current DVB-S2 standard against the full implementation of S2 Extensions (activating smaller Roll-Offs, advanced filtering and 256APSK) staggering efficiency gains up to 51% can be achieved for professional applications over satellite. By implementing Wideband an extra 20% gain can be added to the equation. For DTH networks up to 20% efficiency increase can be obtained. These gains already exceed the results by proprietary systems in the market today.

In the figure below, DVB-S2 with 20% roll-off is compared with DVB-S2X and 5% roll-off. The main efficiencies are located in the higher MODCODs. Herein resides the reason why the DVB-S2X standard first targets data rate hungry applications such as Broadcast contribution and exchange, TSoIP Contribution & Primary Distribution, IP backbones and IP Trunking related configurations (IP Access, IP Backhaul, Government high speed communications).



DVB-S2X with RO 5% compared to DVB-S2 with RO 20%

Newtec Implementation of the New Standard

Newtec has a big hand in the new DVB-S2X standard as the majority of developments inside the new standard are based on Newtec technology. The smaller Roll-Offs and advanced filtering technologies were already introduced by Newtec as early as September 2011 as a first step towards the new DVB-S2X standard through Newtec's Clean Channel Technology®.

Clean Channel Technology is available on Newtec's professional equipment. Both as a software field upgrade for installed based equipment as well as new Newtec equipment.

In the meantime Newtec has invested a lot in its innovative technology to add to the new S2 Extensions standard. Today, Newtec's contribution to the new standard comes in two flavors. On one hand the pre-standard technology candidates called S2 Extensions (with Clean Channel Technology, 64APSK, increased granularity and 72 Mbaud wideband) to support existing installations and satellite networks that prefer to remain 'closed'. On the other hand the official brand new DVB-S2X standard as defined by the DVB organization. Both flavors are already implemented on the Newtec professional equipment.

- Newtec MDM6100 Broadcast Satellite Modem
- Newtec M6100 Broadcast Satellite Modulator
- Newtec MDM6000 Satellite Modem
- Newtec HUB6000 Satellite Hub

On top of the DVB-S2X the MDM6000 modem can be used in combination with technologies such as Adaptive Coding & Modulation (ACM), Pre-distortion, bandwidth cancellation, network optimization software and cross-layer-optimization to bring the efficiency of the satellite link to the highest level at maximum service availability.

How to Increase Efficiency and Availability of a Satellite Link on Top of DVB-S2X

When adding technologies such as Adaptive Coding & Modulation (ACM), bandwidth cancellation, pre-distortion, network optimization software and cross-layer optimization to the DVB-S2X innovations, the final bits can be squeezed through the available bandwidth, bringing the satellite link to full optimization.

Adaptive Coding & Modulation

Adaptive Coding & Modulation (ACM) auto-adaptively sets modulation parameters to the optimal point to overcome fading or interference conditions and allows for the best possible throughput.
Newtec's implementation of ACM, called FlexACM® combines the adaptive modulation with noise and distortion estimation technology (NoDE) and predictive technology on upcoming variation (ThIMM) to get as close to the zero margin limit as possible allowing the full use of the satellite link at maximum service availability.

Pre-distortion Technology

Pre-distortion technologies are typically designed to compensate for the effects of imperfections in the filters and amplifiers of the satellite.
Newtec's implementation of pre-distortion technology, Automated Equalink®, improves the performance of the end-to-end satellite communication channel by a typical 2 dB and allows the use of higher modulation schemes such as 16/32APSK or 64/128/256APSK on carriers occupying a full transponder.

Newtec's Equalink® brings up to 10% bandwidth efficiency gain even in saturated non-linear transponders (which is the use case for very high speed links). Moreover a better Quality-of-Service (QoS) can be achieved.

Bandwidth Cancellation

Bandwidth Cancellation Technology combines the forward and return transmissions in the same satellite bandwidth opening up extra capacity (up to 33%) for the service provider. This extra capacity gives room for considerable OPEX savings or deployment expansions by adding services within the same available bandwidth.

Cross-Layer Optimization™

Cross-Layer-Optimization™ is the technology that allows the satellite modulation equipment to be in continuous interaction with Acceleration, Compression, Bandwidth Management and IP Shaping technology. As soon as a satellite link condition changes the link will be auto-optimized following Quality-of-Service and Priority Settings without the loss of data or link.

Conclusion

The satellite industry has come to a consensus that a successor to the DVB-S2 standard is required to accommodate for increased profitability, interoperability and growth in the professional satellite communications market. Newtec has taken the lead and teamed up with other DVB-members in order to define and develop the update on the DVB-S2 standard.

Applications such as Sports and News Contribution, IP trunking and Cellular backhauling up to Broadband VSAT solutions will immediately benefit from the gains achieved by the new standard. As soon as Ultra High Definition TV hits town and more content is required by the market, the Professional Video Distribution and Direct-to-Home applications will quickly follow.

Newtec's contribution to the new standard DVB-S2X consists of a number of efficiency technologies, such as

- smaller Roll-Offs,
- advanced filter technologies
- increased granularity in MODCODs,
- higher Modulation (64/128/256APSK)
- Wideband
- Very Low SNR MODCODs to support mobile (land, sea, air) applications
- Bonding of TV streams
- Additional standard scrambling sequences

By combining these technologies an efficiency optimization up to 51% can be obtained in a professional satellite link. Wideband adds an extra 20% gain to the equation. For DTH networks the average gain will be around 20%.

The Newtec 6000 series Satellite modems and hubs integrate the DVB-S2X technologies combined with Newtec efficiency technologies (FlexACM®, Equalink®, Bandwidth Cancellation and Cross-Layer-Optimization™) and guarantees the best performance with barrier-breaking throughputs at optimal service availability.

More Information:

For more information read:
MDM6000 leaflet
MDM6100 leaflet
HUB6000 leaflet
S2-Extentions E-book

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