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Powerline recommendations for very high bitrate services

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Powerline Telecommunications (PLT).

Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**may not**", "**need**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the ETSI Drafting Rules (Verbal forms for the expression of provisions).

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Introduction

Already back in 2012, the ETSI STF410 studied the feasibility to increase the transmission capacity of the PLT modems by using the existing ground wiring in houses, in addition to the Phase and Neutral wiring being used by the SISO-PLT modems. The PLT industry today takes benefit of this technology to launch MIMO-PLT modems on the market. These new generation MIMO-PLT modems offer a throughput above 1Gbits allowing Gigabit Home Networking for high internet services developments as UHD/4K video services distribution in a house.

The present document addresses the transportation of very high bitrate services like UHD/4K in phase over MIMO-PLT. The present analysis carried out by the ETSI STF468 is taking place at the crossroad of three major technologies for video distribution in a house using existing electrical grids:

- MIMO-PLT offering a throughput up to the double compared to SISO-PLT;
- HEVC/H.265 reducing the bit-rate by a factor of 2 compared to existing AVC/H.264; and
- emergence of UHD/4K increasing the number of pixels by four compared to the HD (High Definition) video.

Therefore the actual phase 1 of the present study, explore the benefits of each component of the emerging technologies. The STF establishes performances of video transportation over powerline by validation of the combination of MIMO-PLT and UHD/4K video based on visual criteria. For this purpose a visual quality criteria recognized by e.g. ITU and MPEG groups video experts is used in this study for evaluation of video after transmission on electrical grids as well as throughput and robustness of the PLT links is measured.

For UHD/4K and HD video sequences used in this work, definitions given by EBU [i.2], [i.3] and specifications published by DVB group in an ETSI standard [i.1] were referred to.

The present document, first, present the phase 1 of UHD specifications [i.1] from DVB is now published as a technical standard from ITU, EBU and DVB to avoid confusion with 4K from Digital Cinema as 4K is referring to quad HD resolutions encoded in AVC/H.265.

The specification includes an HEVC Profile for DVB broadcasting services that draws, from the options available with HEVC, those that will match the requirements for delivery of UHDTV Phase 1 and other formats [i.1].

The present document studies the video transportation of HD and UHD video sequences encoded in H.264/AVC and HEVC/H.265 over Powerline technologies based on SISO and MIMO in referring to measurements based on PSNR and SSIM as described by figure 1.

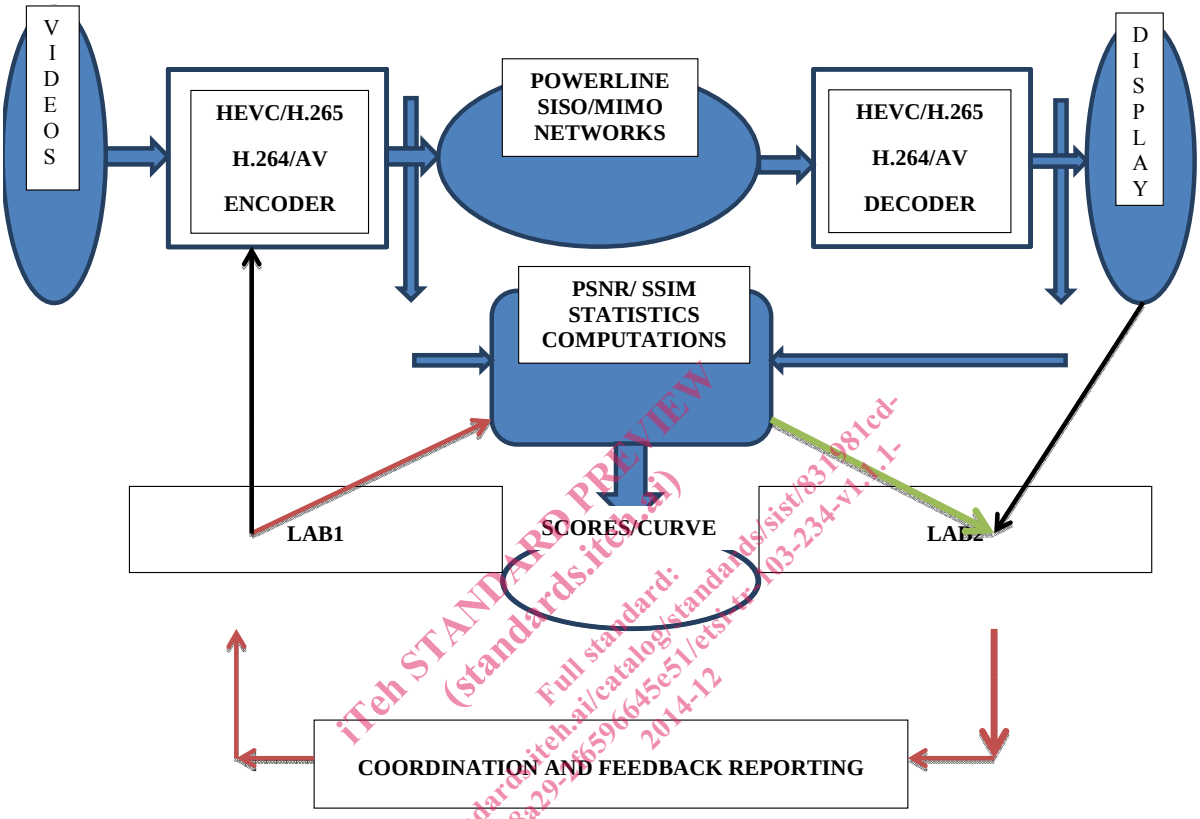

Figure 1: General Principles of tests and video quality measurements

1 Scope

The scope of the present document is to investigate the increased capacity of MIMO-PLT for Gigabit Home Networking based on forthcoming UHD/4K SVOD and streaming services distribution from Residential Home Gateway (VDSL2/G.Fast) to Set-Top-Box & Network-Top-Box, Media Servers for Tablets & Smart Phones.

The present phase 1 of the work is focusing on validation of the performances of MIMO versus SISO PLT channels in laboratory tests and in real houses using video sequences.

These video sequences consist of reference sequences of HD and UHD/UHD (used by experts from ITU, EBU and MPEG experts) and from real world sequences encoded by H.265/AVC and H.265/HEVC codecs are used for comparison of performances SISO-PLT versus MIMO-PLT.

2 References

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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2.1 Normative references

The following referenced documents are necessary for the application of the present document.

Not applicable.

2.2 Informative references

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] ETSI TS 101 154: "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".

[i.2] EBU: "Beyond HD update" (H.HOFFMAN).

[i.3] MPEG: "HEVC: Targeting streaming and mobile applications and higher resolution".

[i.4] Recommendation ITU-R BT.2020: "Parameter values for ultra-high definition television systems for production and international programme exchange".

[i.5] IEEE Consumer Electronics Magazine July 2012: "The new gold standard for video compression".

[i.6] RWTH Aachen University, March 2014, J.R. Ohm: "Overview of High Efficiency Video Coding (HEVC)".

[i.7] DVB: "CM- UHDTV and DVB TM-AVC is looking into HEVC".

[i.8] CEA: "4K" Working Group, define 4K technology, discuss 4K content options, and educate consumers about the newest era in high-definition television (HDTV). Nomenclature: "Ultra HD".

[i.9] EBU: "Ultra High Definition Television in Europe".

[i.10] Recommendation ITU-R BT.709: " Parameter values for the HDTV standards for production and international programme exchange".

[i.11] ITU-T SG16-Q6: "Mutlimedia".

[i.12] ISO/IEC JTC 1/SC 29/WG 11: "Coding of moving pictures and audio".

3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
AV	Audio and Video
AVC	Advanced Video Coding (H.265)
AWGN	Additive White Gaussian Noise
BPSK	Binary Phase Shift Keying
CEA	Consumer Electronic Association
CSMA/CA	Carrier Sense Multiple Access with Collision Avoidance
DCT	Discrete Cosine Transform
DSSIM	structural dissimilarity derived from SSIM
DVB	Digital Video Broadcasting
EBU	European Broadcasting Union
EMC	Electromagnetic Compatibility
FEC	Forward Error Correction
GB	Giga Byte
GOP	Group Of Pictures
HD	High Definition
HD	High Definition (720p, 1080i/p)
HDR	High Dynamic Range
HEVC	High Efficient Video Coding (H.265)
HFR	High Frame Rate
HM	HEVC test Model
HPAV	HomePlug AV
IBBB	Sequence of a Intra frame (I) followed by Interpolated frames (B)
IP	Internet Protocol
IPPP	Sequence of a Intra frame (I) followed by Predicted frames (P)
IPTV	Internet Protocol TeleVision
ITU	International Telecommunication Union
JM	Joint Model
KTA	Key Technical Area
LISN	Line Impedance Stabilizing Network
MAC	Media Access Control
MB	Mega Byte
MIMO	Multiple Input Multiple Output
MKV	Matroska Video container
MPEG	Motion Picture Expert Group
MSE	Mean Square Error
MTU	Maximum Transfer Unit
NAL	Network Adaptation Layer
OFDM	Orthogonal Frequency Division Multiplex
OSI	Open System Interconnection
PC	Personal Computer
PHY	PHYsical
PLC	Powerline Communication
PLT	Power Line Telecommunications
PSNR	Peak Signal to Noise Ratio
QAM	Quadrature Amplitude Modulation
QoE	Quality of Experience
RTP	Real Time Protocol
RTSP	Real Time Streaming Protocol

SC	Sub Committee
SISO	Single Input Single Output
SNR	Signal to Noise Ratio
SSIM	Structural SIMilarity
SSIM	Structural Similarity Index Measurement
TCC	Turbo Convolutional Code
TCP	Transmission Control Protocol
UDP	User Defined Protocol
UHD	Ultra High Definition
UHD	Ultra High Definition (UHD1 for UHD and UHD2 for 8K)
UHDTV	Ultra High Definition TeleVision
VCEG	Video Coding Experts Group
VLC	VLC media Player
WG	Working Group
YUV	A colour space format

4 HD and UHD video specifications

With more than eight million pixels of resolution UHD (Ultra High Definition) video, also called 4K or Quad HD in the past, is the next generation of video technology and contents to distribute in the whole home using PLT modems, connecting Home Gateway to Set-top-Box and Media Servers.

Figure 2: Number of Pixels of UHDTV [i.4] versus HDTV

In 2012, the usage of 4K introduce consumers confusion on devices on the market as TV sets and contents as UHD is not only more pixels but better pixels as defined by EBU experts.

During the year 2013, the industry has developed a common understanding with respect to a two-stage introduction of Ultra HD based on EBU, DVB and CEA standards.

Phase 1 is intended to provide a short-term market entry (2014/2015) based on the current available Ultra HD displays and limited compared to Full HD (1 920 x 1 080) mainly due to a four times the number of pixels (3 840 x 2 160).

The DVB specification for UHD Phase 1 was published in July 2014 adopted by the DVB Steering Board. DVB-UHDTV contains a HEVC profile for DVB Broadcasting Services and renewed ETSI TS 101 154 [i.1].

In addition to the four times the resolution of the system allows frame rates up to 50/60 Hz and also sets bit at a bit depth of 10. For 2160p content level of 5.1 HEVC Main is 10 profile provided HD services with up to 1080p are supported by Level 4.1.

As UHD video specifications are still evolving in standardization processes by ITU, EBU DVB, CEA, the same definitions and parameters as described by DVB were used:

The main elements of UHD are:

- HEVC Main 10 profile encoding