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PowerLine Telecommunications (PLT);
Transcoding of HD and UHD video over powerline network

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Foreword

This Technical Specification (TS) has been produced by ETSI Technical Committee Powerline Telecommunications (PLT).

The present document is for Gigabit Home Networking and includes Video Transcoding for UHD video for long range PLT networks and short range based PLT links.

Modal verbs terminology

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1 Scope

The present document focuses on Gigabit Home Networking for Very High Speed Internet video distribution using video transcoding for the distribution of HD and UHD video streams over SISO and MIMO PLT networks [i.1].

The present document defines the transcoding of HD and UHD video for improvement of the house coverage of powerline networks for existing or forthcoming new video services as streaming and VOD MIMO-PLT and filling the gap between MIMO-PLT channels capacity and new services as UHD and HD video for forthcoming UHDTV, namely transcoding of H264/AVC into HEVC/H265.

The SISO/MIMO Powerline networks channels have time varying capacities depending on noises, overage, range as HD and UHD encoded in H264/AVC video streams have additional bit rate compared to stream [3], [4] encoded in HEVC/H265, the usage of transcoding for video streaming over Powerline using SISO & MIMO PLT modems is explored by testing.

The present document includes the technical specification for video transcoding and transportation standards impact on Powerline Networks coverage and produce technical guidance to the Powerline telecommunication vendors to cope with very high rate services over Powerline communication for the UHD and HD video transcoding coding.

2 References

2.1 Normative 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.

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference.

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

[1] Recommendation ITU-T H.265 (12/2016): "High efficiency video coding".

[2] Recommendation ITU-T H.264 (04/2017): "Advanced video coding for generic audiovisual services".

[3] ETSI TS 101 154 (V2.2.1) (06-2015): "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".

[4] ETSI TS 101 154 (V2.3.1) (02-2017): "Digital Video Broadcasting (DVB); Specification for the use of Video and Audio Coding in Broadcasting Applications based on the MPEG-2 Transport Stream".

2.2 Informative 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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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 TR 101 562 (V1.1.1) (05-2011): "PowerLine Telecommunications (PLT); MIMO PLT Universal Coupler, Operating Instructions - Description".

[i.2] ETSI TR 103 234 (V1.1.1) (12-2014): "Power Line Telecommunications; Powerline recommendations for very high bitrate services".

[i.3] ETSI TR 103 343: "Power Line Telecommunications (PLT); Powerline HDMI® analysis for very short range link HD and UHD applications".

[i.4] DIRAC.

NOTE: Available at http://www.bbc.co.uk/opensource/projects/dirac/.

3 Abbreviations

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

AV	Audio Video
AVC	Advance Video Coding (H264)
BB	Broad Band
CE	Consumer Electronic
CEC	Consumer Electronic Command
DCT	Discrete Cosinus Transform
DSL	Digital Subscriber Line
Gbps	Giga bit per second
GOP	Group Of Picture
HD	High Definition
HDMI	High Definition Machine Interface
HEVC	High Efficiency Video Coding (H265)
HPNA	Home Phone line Networking Alliance
I-UWB	Impulsion based Ultra Wide Band
LDPC	Low Density Parity Check
LVDN	Low Voltage Distribution Network
MB-OFDM	Multi-Band - Orthogonal Frequency-Division Multiplexing
MIMO	Multiple Input Multiple Output
OFDM	Orthogonal Frequency Division Multiplexing (Multi-carrier transmission)
PE	Protective Earth
PHDMI	Powerline High Definition Machine Interface
PLC	PowerLine Communication
PLT	PowerLine Telecommunication
PSD	Power Spectral Density
PSNR	Peak Signal to Noise Ratio
Rx	Receiver port (Rx port)
SAD	Sum of Absolute Differences
SISO	Single Input Single Output
SSD	Sum of Square Differences
STB	Set-top-Box
STF	Specialist Task Force
TC	Technical Committee

TS	Technical Specifications
TV	Television
Tx	Transmitter port (Tx port)
UEP	Unequal Error Protection
UHD	Ultra High Definition
UHDTV	Ultra High Definition Television
UWB	Ultra Wide Band
UWB-I	Ultra Wide Band Impulse
VOD	Video On Demand
WLAN	Wireless Access Network

4 Video transcoding for Home PLT networks

4.1 Introduction

The present document includes recommendations given in Technical Reports resulting from STF investigations made during the over past 5 years (2012-2017) in ETSI TC PLT.

In the past, PLT systems used only one transmission path between two outlets. It is the differential mode channel between the phase (or live) and neutral contact of the mains. These systems are called SISO (Single Input Single Output) modems. In contrast, MIMO PLT [i.1] systems make use of the third wire, PE (Protective Earth), which provides several transmission combinations for feeding and receiving signals into and from the LVDN (Low Voltage Distribution Network).

This investigation on MIMO PLT channels and noises enlarge the throughputs of PLT networks allowing Gigabit networks using MIMO PLT modems and is a major accomplishment for PLT technology.

TC PLT investigated the benefits of emerging technologies: the new generation of MIMO (Multiple Input-Multiple Output) powerline telecommunication modems and new video codec HEVC/H265 [1].

The resulting of measurements exhibit the extension of a PLT network for video services when using HEVC as video codec compared to H264/AVC [2], therefore the present document recommend the integration of a video transcoder in a broadband gateway and the present document specify a real time video transcoding algorithm from H264 /AVC to H265/HEVC for bit-rate reduction.

This investigation on video transcoding combined with MIMO PLT networks allows UHD video streaming [3] on wireline and wireless networks.

For very high speed uncompressed video distribution on short range PLT links is also based on video transcoding using wavelets.

This investigation is focussing on uncompressed video links as HDMI® ports for short range high speed links exploring the gap between the PLT transmission and the video compression using JPEG2000 tandem schemes and joint source and channel coding innovative processing schemes.

In 2010, ETSI Specialist Task Force (STF) collected all kind of MIMO channel properties in several European countries. The measurement campaign and experimental results are documented in the technical report [i.1].

As in the STF 410 on PLT MIMO and following the objective of increasing the bit rate of PLT modems on Short Range PLT links for PHDMI the UWB (Ultra Wide Band) using MB-OFDM and I-UWB have been investigated.

The present document address home wireline networks such as PLT, Coax and HPNA and also hybrid networks with WLAN for lossless or visually lossless compression transmission.

4.2 Powerline Home Networking

Modern residential homes contain an increasing number of consumer electronic (CE) devices for communications and entertainment, which should be interconnected among themselves and to the outside service providers that deliver entertainment content, telecom services and Internet access.

Today, broadband residential services are delivered to homes by coaxial cable, twisted pair, or optical fibre. Regardless of the access transmission media, the signal is terminated in the modem (DSL, cable, or Optical Networking Unit), and a home owner or network installer can distribute the signal inside the home to connect various CE devices.

There are two kinds for home network technologies usually deployed in a house:

- Wired - communicates through data cables (most commonly Ethernet-based).
- Wireless - communicates through radio waves.

Wired Home Networks: A type local area networking technology which is based on a special type of cable which is used to transfer data from one place to another in the form of analogue and digital signals, these cables are called as coaxial cables.

In-home PLT is a technology which delivers telecom services to every corner of a household through already existing electrical wiring. In recent years, PLC has emerged as a potential candidate for domestic high bit rate services.

The current in-home PLC technology, based on Single-Input Single-Output (SISO) configuration, under achieves the capacity offered by the physical PLC channel. The in-home PLC channel offers multiple signal feed ports as, usually, it comprises of three wires: Phase, Neutral and Protective Earth.

4.3 Video transcoding for Home PLT networks

The transcoding is the process that converts from one compressed bitstream (called the source or incoming bitstream) to another compressed bitstream (called the target or transcoded bitstream).

The present document give specifications for two types of video transcoding for PLT networks [i.2] and [i.3]:

a) The transcoding of HD and UHD video streams from H264 /AVC to H265/HEVC for bit rate reduction as measured in the tests performed in STF 468 and avoiding the cascading operations.

b) The transcoding of the uncompressed HD and UHD video decoded in H264 or H265 into visually lossless JPEG2000 and DIRAC codec [i.4] for short range PLT links as Powerline HDMI® using UWB transmission.

The basic requirements in transcoding are:

- the information in the source bitstream should be exploited as much as possible;
- the quality of the transcoded video should be as high as possible, or as close as possible as if the original video was encoded in the target format; and
- the transcoder complexity (delay, processing power and memory requirements) should be kept at minimum, targeting real-time implementation.

5 MIMO-PLT

In powerline communications, the use of MIMO-PLT offer to Home Networking, several improvements over legacy SISO powerline transceivers:

a) Increasing the coverage in a home or building.

b) The ability of MIMO signals to cross over to other phases in the electrical wiring increases coverage and performance for many areas of the building.

c) Improving the throughput as MIMO is based on a highly optimized signal processing spatially multiplexed signals over each port.

MIMO-PLT specifications are based on characteristics of multiple-input multiple-output (MIMO) PLT networking transceivers capable of operating over premises powerline wiring.

MIMO-PLT transceivers are able to transmit and/or receive over three powerline conductors (e.g. Phase, neutral, and ground) using more than one Tx and/or Rx port, thus providing a significant increase of data rate, noise immunity improvements, and enhancing the connectivity of the home network in increased coverage.

Subsequent channel capacity calculations have suggested that the in-home PLC channel capacity can be increased through MIMO technique based on experimental networks the other on real networks.

6 Specifications of video Transcoding for PLT

6.1 Introduction

The contemporary inhome single phase electrical power delivery network consists of three wires. Therefore, multiple signal feeding ports are available in most inhome PLC channels.

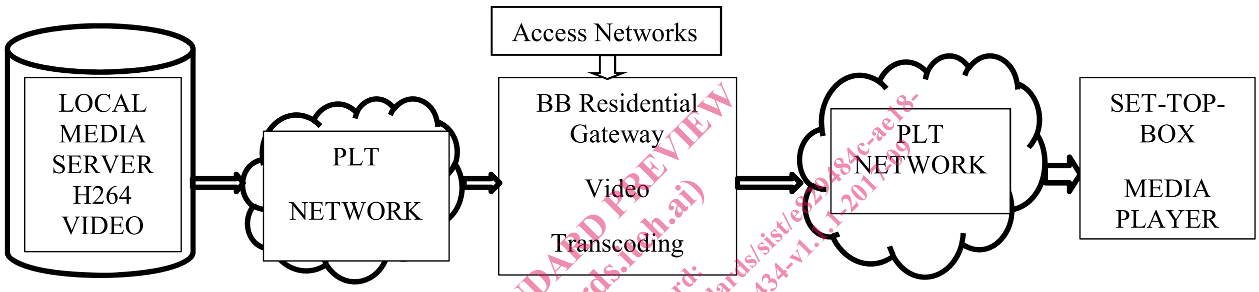

Figure 1: Broadband Residential Gateway with Video Transcoding

6.2 Use cases for transcoding

Many equipment and infrastructure are in the past years adapted to support the encoding of video streams in Recommendation ITU-T H.264 [2], while compliant actual equipment in Recommendation ITU-T H.265 [1] format are on market.

Transcoding is one of the most promising technologies, which provides video adaptation in terms of bit-rate reduction, resolution reduction and format conversion to meet various requirements.

The wide use of the AVC standard today and the expected adoption of HEVC raises a new demand for AVC to HEVC transcoding.

In practical, a video transcoder should make tradeoff between complexity and coding performance while making full use of the input bit-stream [3], [4] to generate a new one at a reduced bitrate.

According to Recommendation ITU-T H.265 [1] standard, the current HEVC model still belongs to block-based hybrid video coding framework, except that the block size is extended to up to 64x64 compared with that of AVC (16x16). Basically, AVC and HEVC share a similar prediction, transform, quantization, and entropy coding architecture.

However, since rate-distortion cost of multiple modes still needs to be evaluated, a mass of sum of absolute difference/sum of square difference (SAD/SSD) computation as well as fractional pixel interpolation has to be involved in the motion re-estimation or motion refinement process.

6.3 Transcoding for local network

This clause provides technical specifications of PLT transceivers for HD & UHD video transcoding on multiple-input and multiple-output (MIMO) Gigabit home networking.

In order to extend the coverage of PLT networks at home, the video transcoder, shall include the following clauses.