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Enhanced TV services delivery

With fast channel change and video retransmission

Application note

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Abstract

Consumers of IPTV have increasingly high expectations for quality of experience (QoE). They simply will not accept slow channel change times or visual and audio distortions.

The challenge for service providers is to deliver HDTV and ultra-high-definition TV 4K high dynamic range (UHD TV 4K HDR) as well as simultaneous video streams to multiple rooms and devices — and to do all this using highly efficient MPEG-4 audio video compression (AVC/H.264) and high efficiency video coding (HEVC/H.265). The end goal is to provide consumers with an immersive experience while assuring superior QoE.

Nokia fast channel change (FCC) capabilities reduce channel change time from up to 4-8 seconds to less than a second — with minimal change in bandwidth requirements on the user connection. In addition, Nokia FCC introduces minimal live latency. Nokia video retransmission (RET) capabilities prevent the visual and audio distortions caused by packet loss.

This application note explains the technical and business benefits that Nokia FCC and RET deliver to service providers.

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Challenges of IPTV service evolution

Initially, IPTV service providers delivered only standard definition (SD) television to the home, which could be a broadcast channel or video on demand (VoD). Today, advanced service offerings include HDTV, ultra-high-definition TV 4K high dynamic range (UHD TV 4K HDR), and immersive experience techniques with multiple simultaneous video streams — both multi-room and multi-screen.

Consumer challenges

Consumer expectations are high: they expect the user experience of HDTV and UHD TV (SDR/HDR) to be flawless. They expect no visual distortions and instantaneous channel change. However, the new technologies required to deliver HDTV, UHDTV and multi-room or multi-device services can degrade users' quality of experience (QoE) because these technologies place larger demands on the video transport and delivery infrastructure. Problems can include visual and audio distortions as well as time-lagging channel change.

Impact on service providers

For service providers, poor quality of experience for consumers can result in increased calls to customer support centers plus the increased associated costs. Worse, you can lose customers as there are several competing alternatives, including over-the-top providers, such as Netflix and Amazon. So, it's imperative to meet customer expectations and provide a superior user experience.

Technical challenges

The technical challenges for service providers are video compression and packet loss.

Video compression

HDTV/UHD TV and simultaneous video streams to multiple rooms or devices share a requirement for more bandwidth on the connection to the home. To keep the aggregated bandwidth demands within the levels supported by xDSL connections, the efficient video compression techniques of MPEG-4 advanced video coding (AVC/H.264) and high-efficiency video coding (HEVC/H.265) are required.

To leverage the full compression capabilities of MPEG-4 and HEVC, the time between I-frame transmissions, which is used to refresh the entire video image, is increased compared to typical I-frame transmission times used with MPEG-2. The result is slower channel changes — often, much slower. Channel change time can increase from one second or less with MPEG-2 to four seconds or more with MPEG-4 and HEVC.

Packet loss

MPEG-4 and HEVC are also more sensitive to packet loss than the previous, less compressed MPEG-2 technologies. Packet losses translate into visual distortions, also called visual artifacts. With MPEG-4 and HEVC, packet loss is more noticeable than with MPEG-2. In addition, visual artifacts that occur have a longer duration.

Some digital subscriber lines cannot provide a good enough baseline service level to support an IPTV service. Providing a video packets retransmission solution on these lines makes it possible to deliver the IPTV service over xDSL, G.fast or FTTx with the expected quality, increasing the total addressable market while maximizing investment protection of existing network assets.

Another contributor to packet loss comes from the home network. An important concern for IPTV service providers is the distribution of the video streams from the residential gateway to the set-top box (STB) and/or smart TV.

Traditional CAT5/CAT6 cables for Ethernet connections have been used in the past. However, the added deployment effort, coupled with the unaesthetic appeal of running new cabling, makes some users reluctant to accept this solution. The problem is exacerbated with multi-room offerings where several of these cables must be laid in the home.

To address this challenge, service providers are resorting to alternative home networking techniques based on wireless connections (Wi-Fi™ or mesh Wi-Fi network) or connections over electric wires. Both of these media inherently have more packet loss than traditional CAT5/CAT6 wiring and also more visual distortion/artifacts.

Nokia solution

Nokia fast channel change (FCC) and video retransmission (RET) allow IPTV service providers to evolve their service offering while delivering a superior QoE for consumers. The consumers enjoy channel change times of only half a second along with no visual or audio distortions.

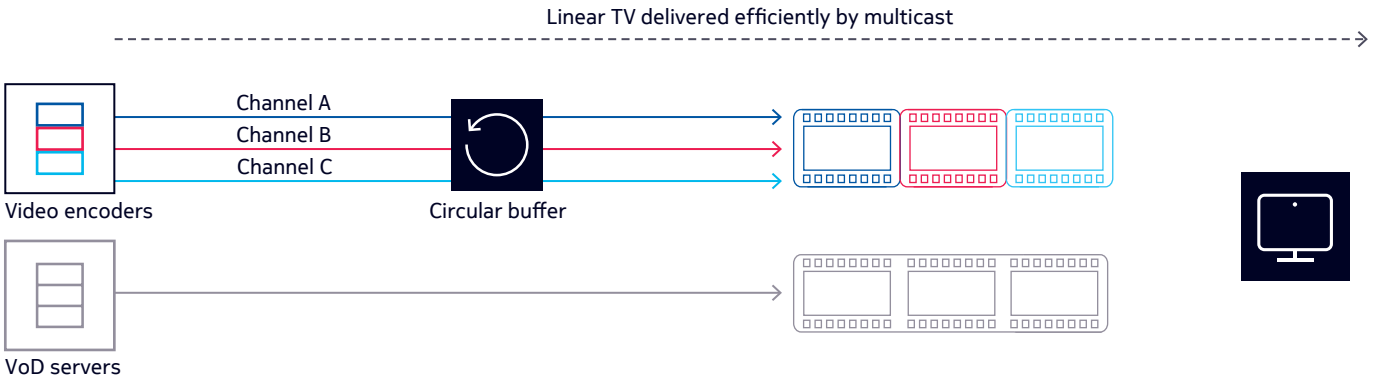
Nokia FCC and RET capabilities

Nokia FCC (see Figure 1) eliminates the inherent IPTV channel change lag problem, reducing channel change time from four seconds or more to half a second.

Nokia FCC uses circular buffers located between the video source and the STBs or smart TV app in a user's home. These buffers cache a few seconds of the linear TV video streams. When the user is changing the channel using a remote control, the FCC client running on the STB or smart TV app requests that the buffered content be sent at an accelerated rate starting from an I-frame so that video decoding can begin immediately.

Nokia packet loss recovery is based on RET. When the RET client running on the STB or smart TV app detects a missing packet, it requests that the packet be retransmitted. The RET request is addressed to the circular buffers that cache the broadcast video streams. The packet is retransmitted before it is needed for decoding. Retransmission follows the recommendations detailed in the ETSI DVB-IPTV TR 102 034 v 1.4 standard.[1]

Figure 1. Multicast video stream caching for FCC and RET

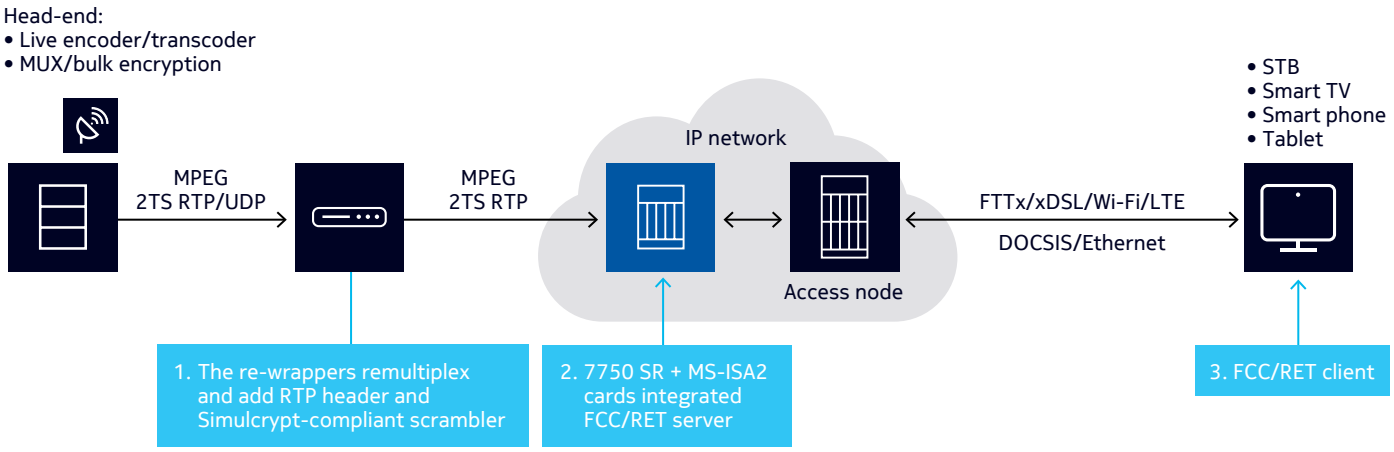


1 ETSI, TS 102 034, v1.4.1, Digital Video Broadcasting (DVB); Transport of MPEG-2 TS Based DVB Services over IP Based Networks, August 2009.http://www.etsi.org/deliver/etsi_ts/102000_102099/102034/01.04.01_60/ts_102034v010401p.pdf

Nokia FCC and RET (see Figure 2) are provided by:

- **The re-wrapper**: A function provided by:
  - The Video Broadcast Optimizer to support video stream analysis and conditioning for FCC and RET
  - The Simulcrypt-compliant scrambler, which can sustain multiple digital rights management/ conditional access scrambling (DRM/CAS) vendors simultaneously.
- **The FCC and RET server:** Resides on a card on the Nokia 7750 Service Router (SR). A circular buffer caches and forwards multicast video traffic. This caching and forwarding function is integrated in 7750 SRs on the MS-ISA2 card. The FCC and RET functions can be integrated into any existing Layer 3 network.
- **The FCC and RET client:** Requests FCC and RET services from the appliance or the VoD Real-time Transport Protocol (RTP) servers.

Figure 2. Nokia FCC and RET components



The re-wrapper is a key component. It receives the multicast stream from the video source, analyzes the MPEG flows and processes them. If required, the re-wrapper encrypts the payload using Advanced Encryption Standard (AES) or ATIS ciphers, and then forwards the FCC/RET-ready streams using RTP.

There are two benefits to having a specific element perform these tasks:

- The solution can be introduced into existing networks seamlessly by avoiding any changes to existing video head-ends.
- Deep packet analysis is performed only once for the whole network at a dedicated and centralized device; this removes the requirement for the downstream elements to perform any video processing, which enhances the scalability of the solution and minimizes the live latency.

The FCC and RET server integrates the circular buffer that caches a few seconds of each multicast video stream. The server responds to FCC and RET requests from user devices. The content in the buffer is then unicast to the requesting user device to accelerate the channel change and recover from packet losses.

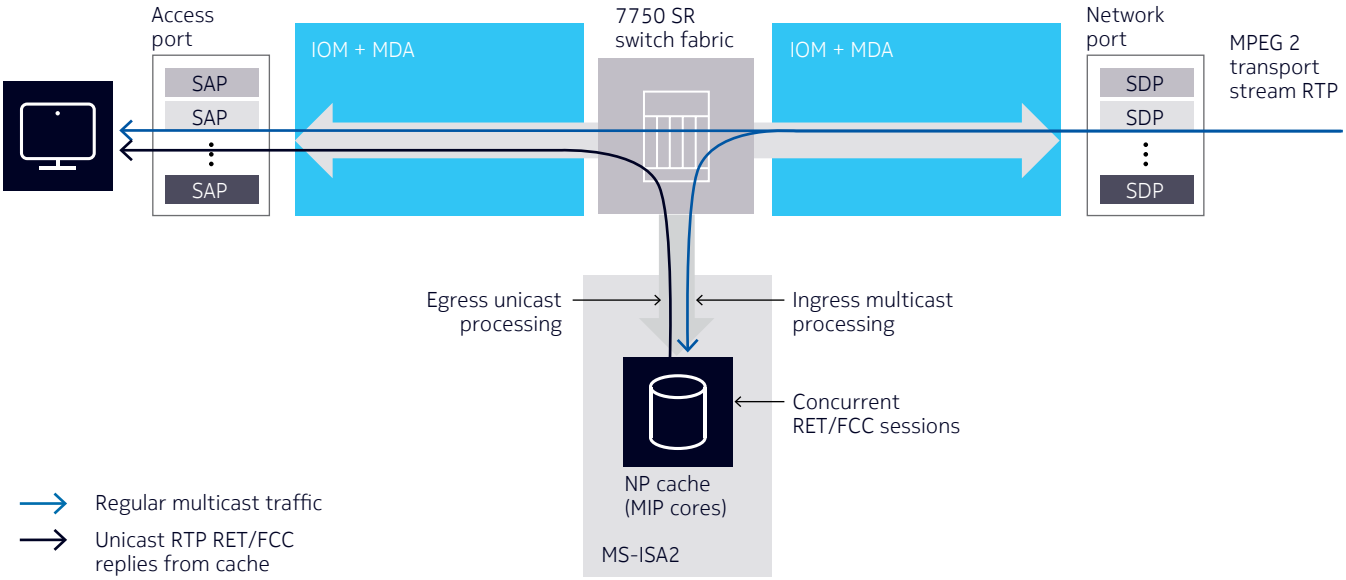
Packet retransmission occurs only when packets are lost and only on those connections where the loss occurred. In addition, only the lost packet is retransmitted. This approach to packet loss recovery requires a negligible increment in bandwidth above the regular video stream bit rate, which makes it an ideal solution for IPTV distribution over xDSL connections, Wi-Fi, meshed Wi-Fi or very noisy network environments where packet loss occurs.

The FCC/RET solution supports:

- MPEG 2
- MPEG 4
- H.264 (AVC) encoded video streams
- H.265 (HEVC) encoded video streams
- Video profiles for picture in picture, SD, HD and UHD 4K SDR/HDR.

Figure 3 shows the internal details of the traffic flow in the Nokia 7750 SR-7, SR-12 or SR-12E equipped with an MS-ISA2 card.

Figure 3. Inside the 7750 SR, the MS-ISA2 data path



The FCC and RET client is a portable software layer for IPTV STBs, smart TVs and mobile devices (smart phones and tablets). The client sends FCC and RET requests to the appliances and VoD RTP servers. For FCC, the client requests that the content in the buffer be unicast.

The client is not specific to any IPTV middleware or DRM solution. It can be integrated with the wide range of IPTV middleware platforms available on the market, with IPTV middleware solutions developed by service providers internally, or with open-source middleware such as RDK.

Nokia FCC and RET differentiators and benefits

Differentiators

- Middleware- and DRM/CAS-independent
- Distributed functions
- Built-in Simulcrypt-compliant scrambler in the video headend re-wrapper
- Video denting
- Smart audio reordering
- Carrier-grade security and quality of service (QoS)
- High availability of the FCC and RET server
- Seamless introduction for existing video head-ends
- A highly optimized FCC and RET client

Each of these differentiators is discussed in the following sections.

Middleware- and DRM/CAS -independent

Nokia FCC and RET are middleware- and DRM/CAS-independent and comply with ETSI and IETF® standards. FCC and RET work with any head-end and with any IPTV middleware that complies with digital video broadcasting (DVB) standards where integration with the middleware is not mandatory. (Please contact your Nokia sales representative for product support details).

Moreover, Nokia is a leader in key standardization initiatives. Nokia is also a co-author of an IEEE submission to IETF that proposes to use the RTP/RTCP framework for FCC.

Distributed functions

The distribution of functions in Nokia FCC and RET maximizes scalability. The FCC and RET functions are distributed between the re-wrapper and the FCC and RET servers.

Nokia FCC and RET are very flexible and can be deployed in a centralized or decentralized setup. Depending on scalability requirements of the IPTV service, elements of the solution can be deployed in the most optimal location(s) in a service provider network. This way, the provider can have its preferred combination of optimal service quality, scalability and cost.

The service provider can start deployment with one centralized setup in the network. Gradually, and in line with the uptake of IPTV services, more servers can be added to the edges of the network.

Built-in Simulcrypt-compliant scrambler in the video head-end re-wrapper

A built-in DVB/ETSI Simulcrypt-compliant scrambler is able to sustain multiple DRM vendors and support a wide range of DVB/ETSI Simulcrypt-compliant Key servers, Entitlement Control Message Generators (ECMGs) and Entitlement Management Message Generators (EMMGs).

AES 128 ECB-L/ECB-CE/ECB-T/cipher block chaining (CBC) and ATIS cipher/encryption are performed on re-wrapper egress streams. All of these capabilities reduce the complexing of the video head-end failover and improve cost-effectiveness.

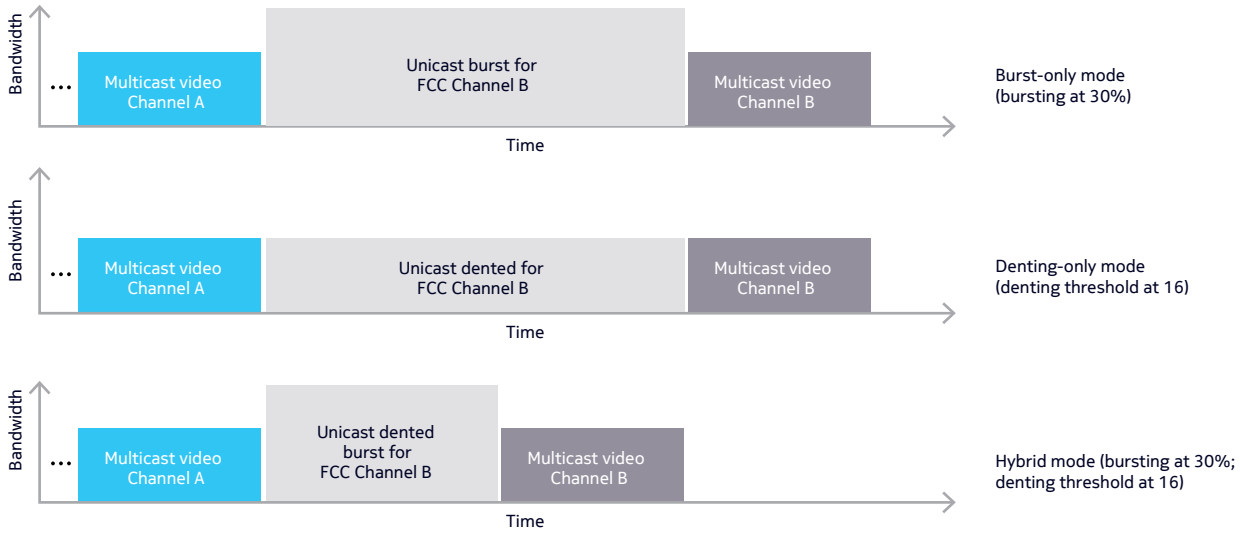
Video denting

Nokia innovations in video networking can optimize the bandwidth used on the access link by implementing a technique called “video denting.” Denting ensures that a digital subscriber line is not suffering from additional load during the FCC process compared to when it is carrying a regular IPTV stream.

Video denting can be very important when digital subscriber lines are close to full bandwidth capacity because denting can greatly reduce or entirely remove the need for unicast bursting, which is normally required for FCC.

Figure 4 shows the available video denting modes.

Figure 4. Available video denting modes



Smart audio reordering

Audio packets in an MPEG transport stream are usually sent later than the related video packet; this is because the video requires buffering but audio does not. During an FCC unicast session, Nokia FCC moves the audio packets forward with the video packets. This feature allows for FCC with perfect audio synchronization. Competitive FCC implementations typically don’t do this. The result is out-of-sync audio or no audio at all during the first seconds after a channel change until multicast is joined.

Carrier-grade security and QoS

Because the FCC and RET server is integrated in the Nokia 7750 SR, it inherits the carrier-grade security and QoS features of the 7750 SR-7, SR-12 or SR-12E node. Security features include the capability to configure the overall subscriber bandwidth for FCC and RET, the maximum rate for RET, the maximum number of combined FCC and RET requests per subscriber, and protection against DDoS attacks. QoS policies can be applied on the MS-ISA2 for both ingress and egress through Differentiated Services Code Point (DSCP) marking by the 7750 SR.

High availability of FCC and RET server

High availability of the FCC and RET server is provided through inter-chassis and intra-chassis redundancy and scaling.

- **Inter-chassis**: The FCC and RET client can be configured with two IP addresses (primary and secondary FCC/RET server) or a single anycast IP address so if the primary server does not answer, the request is sent to the secondary server. This allows scenarios where a central FCC and RET server can be the backup for multiple FCC/RET servers.
- **Intra-chassis:** Multiple MS-ISA2 cards can be used in a Nokia 7750 SR. The FCC and RET requests are internally load balanced over the available MS-ISA2 cards and have high availability through redundant CPMs.

Seamless introduction for existing video head-ends

Seamless introduction for existing video head-ends enables Nokia FCC and RET to support multiple existing content providers, encoder vendors or conditional-access vendors.

Highly optimized FCC and RET client

The highly optimized FCC and RET client features minimal CPU usage (2~7 percent CPU usage is typical) and no degradation of usability or user navigation.

Business benefits

Nokia FCC and RET offer service providers the following benefits:

- Improved video quality
- Reduced FCC time
- Lower power consumption
- Lower CAPEX and OPEX
- Increased addressable market

Each of these benefits is discussed in the following sections.

Improved video quality

Nokia FCC and RET ensure a high-quality video experience. A high-performance RET mechanism repairs video issues introduced during transmission across the network. By significantly improving the reliability (lowering the bit error rate), this solution allows the IPTV settings to be optimized so they obtain better video quality over the same bandwidth. This high-quality delivery improves the user experience and reduces churn.

Reduced FCC time

The FCC function enhances the QoE of IPTV services and can be a major differentiator from services offered by cable (without FCC) and satellite operators because their FCC performance may be slower — and sometimes unacceptably slow — compared to analog TV applications.

The servers for the FCC mechanism also support the RET server function. One MS-ISM card performs both FCC and RET. As a result, service providers need to configure and manage only one MS-ISM instead of two different products. In addition to improved FCC performance, service providers enjoy simpler, easier management.

Lower power consumption

Power consumption is reduced dramatically by splitting re-wrapper and FCC/RET servers over different equipment and using a low-power-consumption network processor in re-wrappers and FCC/RET servers. One FCC/RET server can replace up to 100 or more PC servers, which reduces power consumption significantly.

Lower CAPEX and OPEX

Integration in existing customer network elements (Nokia 7750 SRs) dramatically lowers CAPEX and OPEX, thereby reducing the Return on Investment (ROI) period.

Increased addressable market

Nokia FCC and RET have the potential to increase the number of local loops suitable for IPTV service. Some digital subscriber lines may not be providing a good enough service level to support an IPTV service by themselves. By adding Nokia RET, the IPTV service may now be deliverable over these lines with the expected quality, thereby increasing the addressable market.

Conclusion

Nokia FCC and RET provide a solution for FCC and RET of lost packets that follows the recommendations of the ETSI and IETF DVB IPTV standards. It can be integrated with the wide range of IPTV middleware and DRM solutions available in the market, including those developed in-house by service providers.

The distribution of functions between the re-wrapper and the FCC and RET server maximizes the scalability of the solution while allowing its seamless introduction into existing networks without changes to video head-ends.

If video denting is used, no significant increment in bandwidth on DSL connections above the regular video stream bit rate is necessary to support FCC.

Nokia FCC and RET provide an effective solution to deliver HDTV, UHD TV 4K HDR and SDR, and simultaneous video streams to multiple rooms or devices by assuring QoE for users with increasingly high expectations.

References

1. Nokia 7750 Service Router
2. ETSI, TS 102 034, v1.4.1, Digital Video Broadcasting (DVB); Transport of MPEG-2 TS Based DVB Services over IP Based Networks, August 2009.

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Abbreviations

ATIS	Alliance for Telecommunications Industry Solutions
AVC	audio video compression
CAPEX	capital expenditures
CAS	conditional access system
CPM	computer processing module
DDoS	distributed denial of service
DOCSIS	Data Over Cable Service Interface Specification
DRM	digital rights management
DSCP	Differentiated Services Code Point
DSL	Digital Subscriber Line
DVB	digital video broadcasting
ECB	Electronic Code Book
ECMG	Entitlement Control Message Generator
EMMG	Entitlement Management Message Generator
ETSI	European Telecommunications Standards Institute
FCC	fast channel change
FTTx	fiber-to-the-anything
HDTV	high-definition television
HDR	high dynamic range
HEVC	High Efficiency Video Coding
IEEE	Institute of Electrical and Electronics Engineers
IETF	Internet Engineering Task Force
IOM	input/output multiplexer
IPTV	Internet Protocol television
LTE	long term evolution
MDA	Media Dependent Adapter
MIP	Mobile IP (Protocol)
MS-ISA	Multiservice-Integrated Service Adapter
MS-ISM	Multiservice-Integrated Service Module

MUX	multiplexer
OPEX	operating expenditures
RET	retransmission
RTCP	Real-time Transport Control Protocol
RTP	Real-time Transport Protocol
SAP	service access platform
SDP	service delivery platform
SDR	standard dynamic range
STB	set-top box
UDP	User Datagram Protocol
UHD	ultra-high definition
VoD	video on demand

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