5. Convergence of fixed networks – Convergence of TV and Internet (TV over IP or IPTV)

5.1. IPTV introduction

5.2. IPTV main protocols

5.3. IPTV over DSL

5.4. IPTV network aspects:

a. Bandwidth requirements

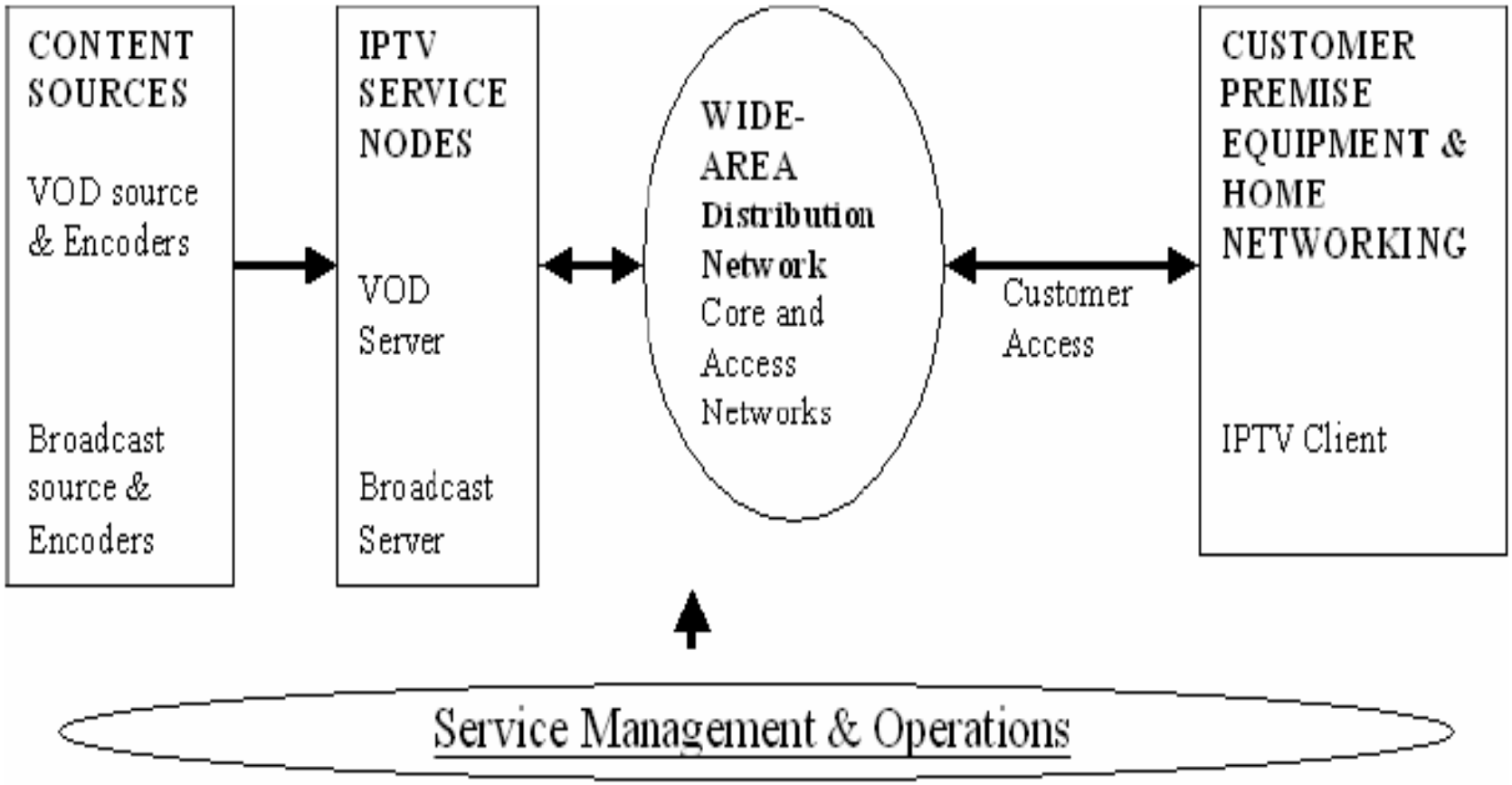
b. QoS issues for multimedia traffic

5.1. IPTV Introduction

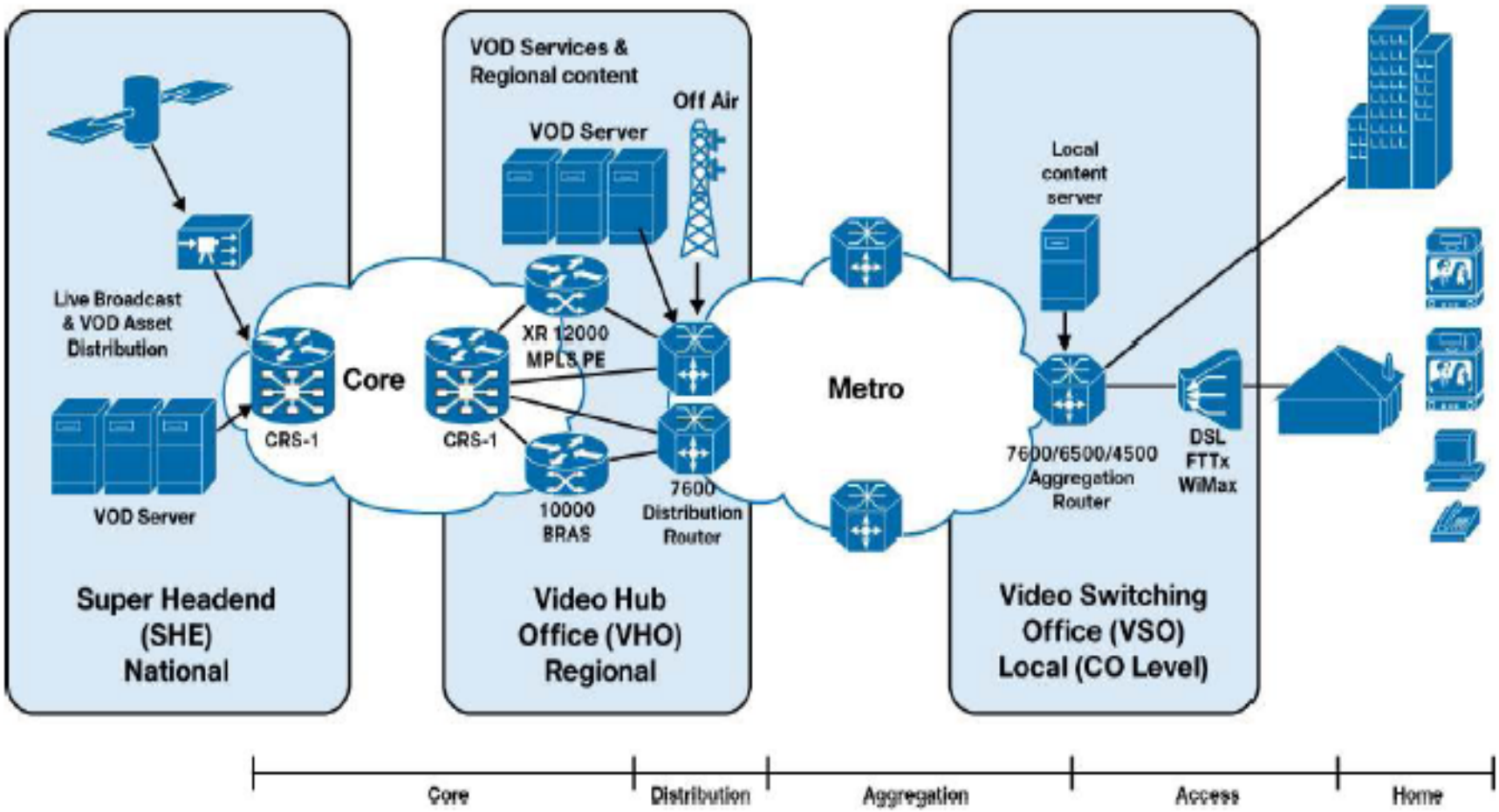
Definition

IPTV – Internet Protocol Television, is a system used to deliver digital television services to the consumers who are registered subscribers for this system. This delivery of digital television is made possible by using Internet Protocol over a broadband connection, usually in a managed network rather than the public Internet to preserve quality of service guarantees. Often, this service is provided together with Video facility on demand. In addition to this, there is a possibility to include Internet services such as web access and Voice over Internet Protocol (VoIP). In cases when internet service is also provided, it may be called Triple Play.

General IPTV architecture



IPTV architecture-2



IPTV vs. Internet Video

- IPTV is a video service supplied by a telecom service provider that owns the network infrastructure and controls content distribution over the broadband network for reliable delivery to the consumer (generally to the TV/IP STB).
- Internet Television is an open evolving framework where a huge number of small and medium-sized video producers contribute. This is due to the opening of different traditional channels which are retail and use for wide distribution.

IPTV Services

- Broadcast TV (BTV) services which consist in the simultaneous reception by the users of a traditional TV channel, Free-to-air or Pay TV. BTV services are usually implemented using IP multicast protocols.
- Video On Demand (VOD) services, which consist in viewing multimedia contents made available by the Service Provider, upon request. VOD services are usually implemented using IP unicast protocols.

How does IPTV work?

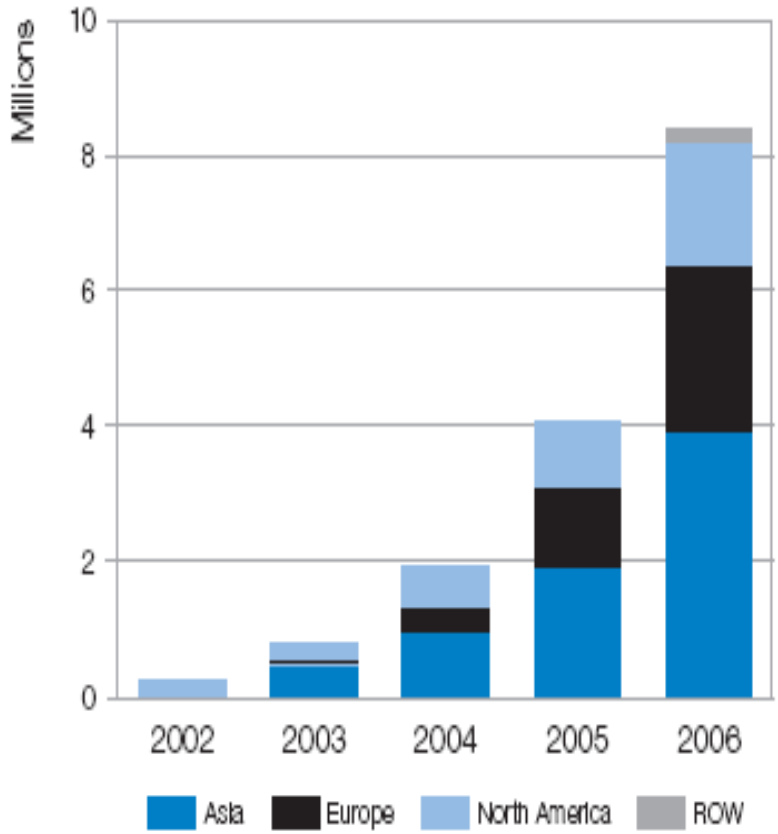
IPTV uses a two-way broadcast signal sent through the provider's backbone network (PSTN) and servers.

The viewer must have a broadband connection and a **set-top box (STB)** programmed with software that can handle viewer requests to access to many available media sources.

IPTV uses multicasting with Internet Group Management Protocol (IGMP) for live television broadcasts and Real Time Streaming Protocol for on-demand programs. Compatible video compression standards include H.264, MPEG-2 and MPEG-4.

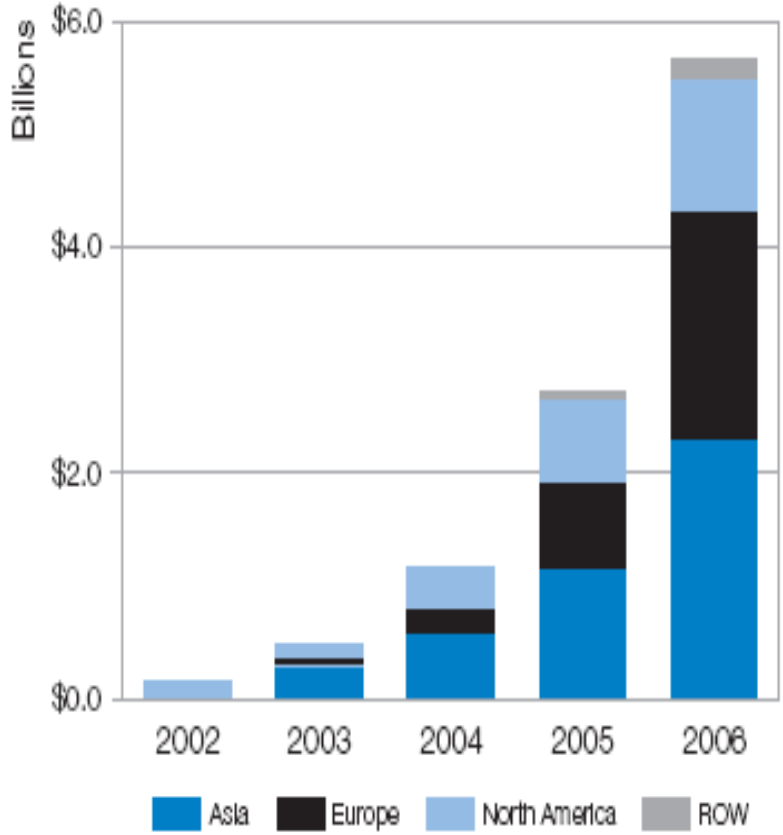
IPTV services market (Source: MRG, Inc., 2003)

Global IPTV subscriber forecast



Source: MRG, Inc., 2003

Global IPTV revenue forecast



Source: MRG, Inc., 2003

5.2. IPTV main protocols

A. H.264/MPEG-4 AVC Coding

H.264 or MPEG-4 AVC (Advanced Video Coding) Features

- H.264/MPEG-4 AVC cuts the bandwidth required to deliver full-screen

DVD-quality digital video to consumers up to 700 kbps that is

suitable within the capabilities of a 1.5 Mbps DSL loop.

- The enhanced compression and perceptual quality of H.264 are obtained by:

motion estimation

intra estimation

entropy coding

H.264/MPEG-4 AVC: The IPTV enabling technology standard

The following table summarizes the development of different H.26x/MPEG standards and their intended applications.

Standard/Recommendation	Developer Organization	Applications
H.261, H.263, H.263+, H.263++	ITU-T	Video telephony, Video conferencing
MPEG-1, MPEG-4 SP/ASP	ISO/IEC JTC1	DVD, Video-on-demand, digital video broadcast via cable/satellite/DSL, video streaming for Internet and wireless
H.262/MPEG-2, H.264/MPEG-4 AVC	Joint Video Team (JVT) formed by ITU-T and ISO/IEC JTC1	Video-on-demand, digital video via cable/satellite/DSL, video streaming for Internet and wireless, IPTV

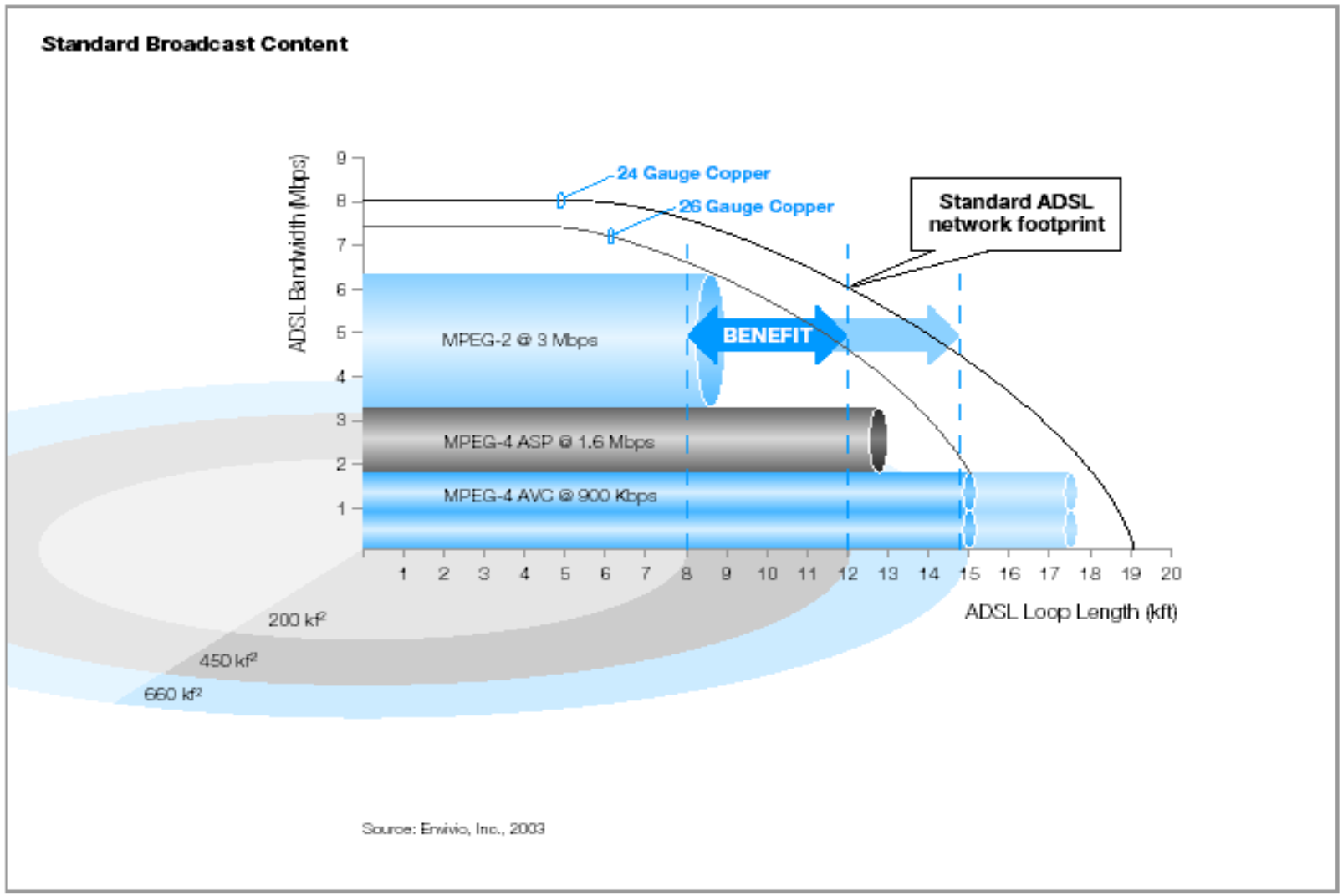
H.264 new opportunities

H.264 opens the door to new opportunities and reduces operating and deployment costs when compared to MPEG-2.

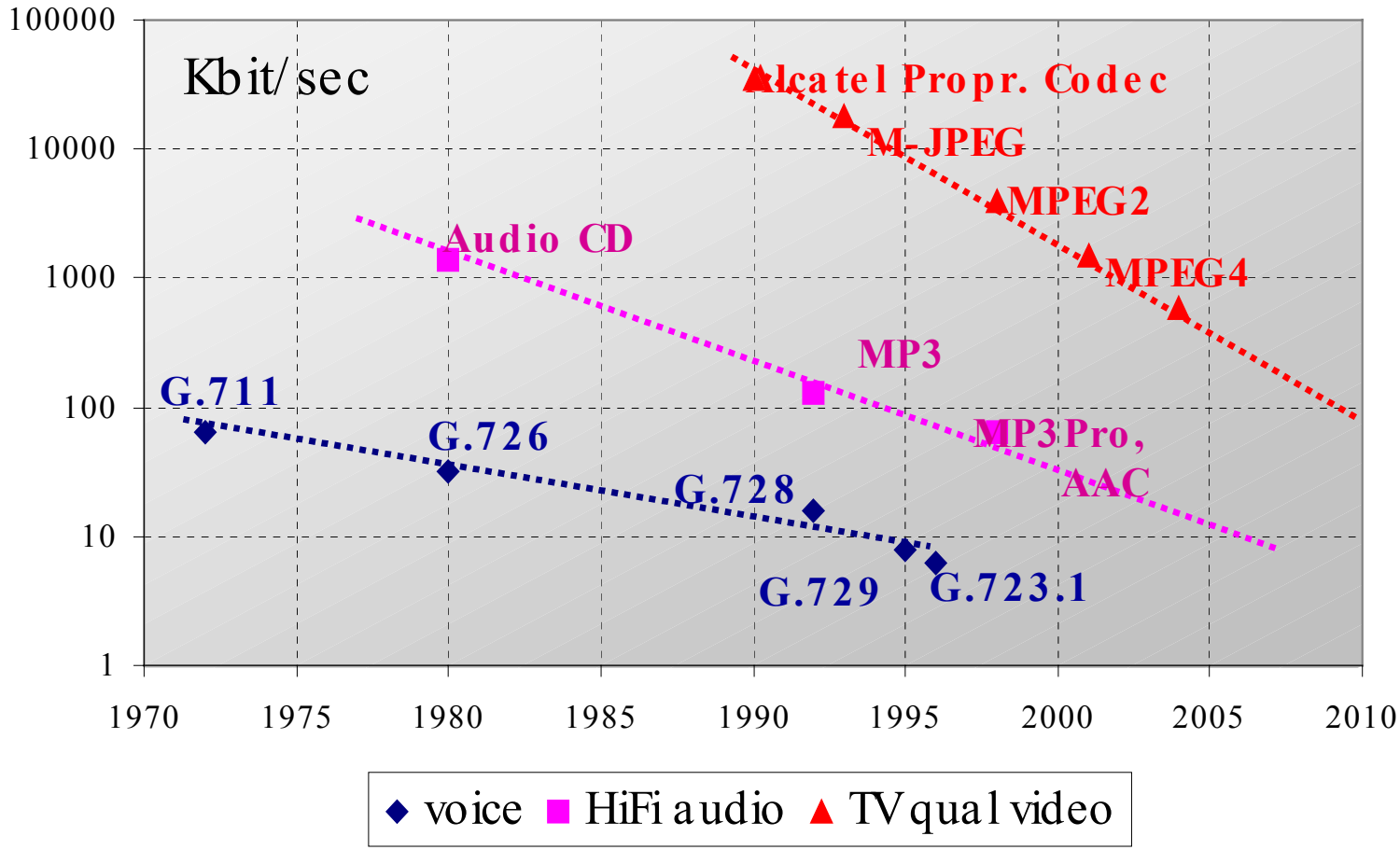
There are several reasons:

- H.264/MPEG-4 AVC addresses the needs for greater compression, leading to lower data rates, while maintaining broadcast quality for video-on-demand (VOD) and high-definition television (HDTV) needs.
- This advance has followed the evolution of video compression technique toward higher quality and lower bandwidth.
- H.264 compresses video more efficiently, cutting transmission costs over satellite or terrestrial links.

H.264/MPEG-4 AVC enables reaching greater distances over DSL with more content

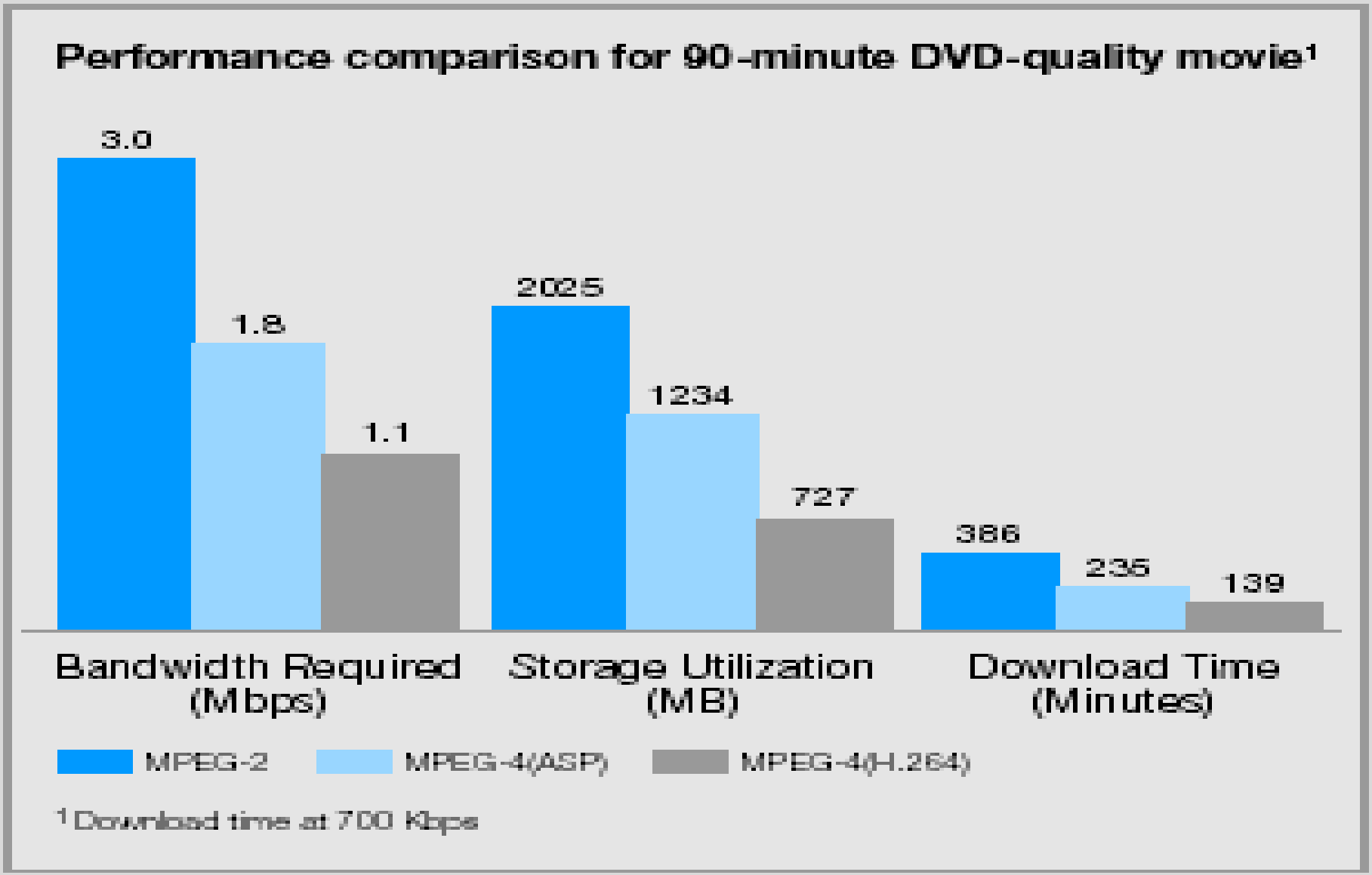


Codecs



Source: Alcatel

H.264/MPEG-4 AVC benefits bandwidth demand, storage requirement, and download times



B. IGMP

- The **Internet Group Management Protocol (IGMP)** is the Internet protocol, part of the Network Layer. IGMP is formally described in the Internet Engineering Task Force (IETF) Request for Comments (RFC) 2236.

- **IGMP** provides a way for an Internet computer to report its multicast group membership to adjacent routers. Multicasting allows one computer on the Internet to send content to multiple other computers that have identified themselves as interested in receiving the originating computer's content.

Multicasting applications:

- updating the address books of mobile computer users in the field
- sending out company newsletters to a distribution list
- "broadcasting" high-bandwidth programs of streaming video to an audience

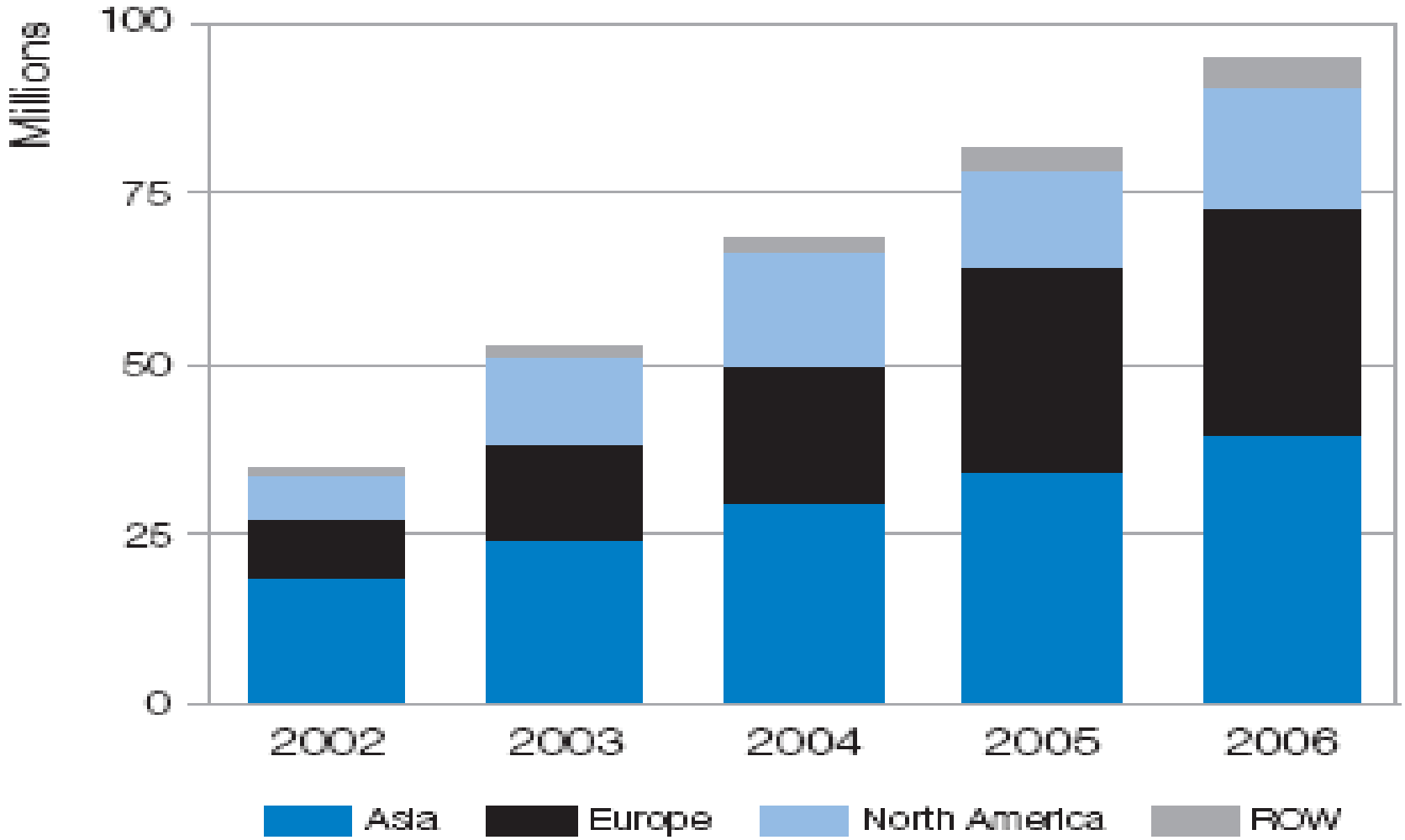
5.3. IPTV over DSL

Using new H.264/MPEG-4 AVC delivery platforms and standard PCs or STBs, Telcos can offer exciting IP video services to their home and business customers using their existing copper infrastructure.

With DSL technology, the Telcos hold a significant advantage by delivering IPTV to more of the masses than cable operators.

DSL is still the leading broadband technology that users subscribe to around the world.

Global DSL connections forecast



Source: MRG, Inc., 2003

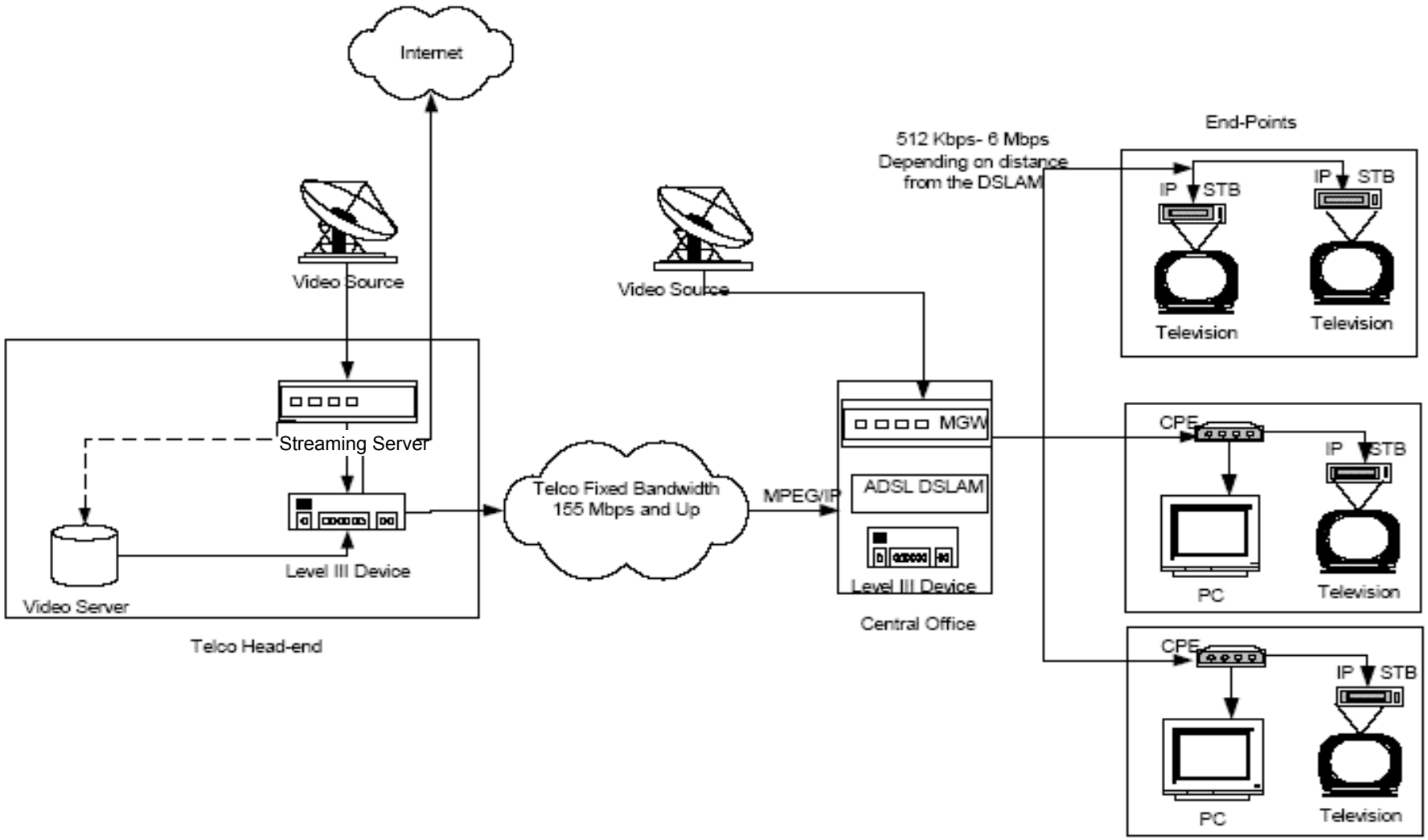
Delivering video services over DSL

H.264/MPEG-4 AVC can use transport technologies compatible with MPEG-2, simplifying an upgrade from MPEG-2 to H.264/AVC to help protect the investments in MPEG-2 some companies have already made, while enabling transport over TCP/IP and wireless.

This also allows service providers to deliver content to devices for which MPEG-2 cannot be used, such as PDA and digital cell phones.

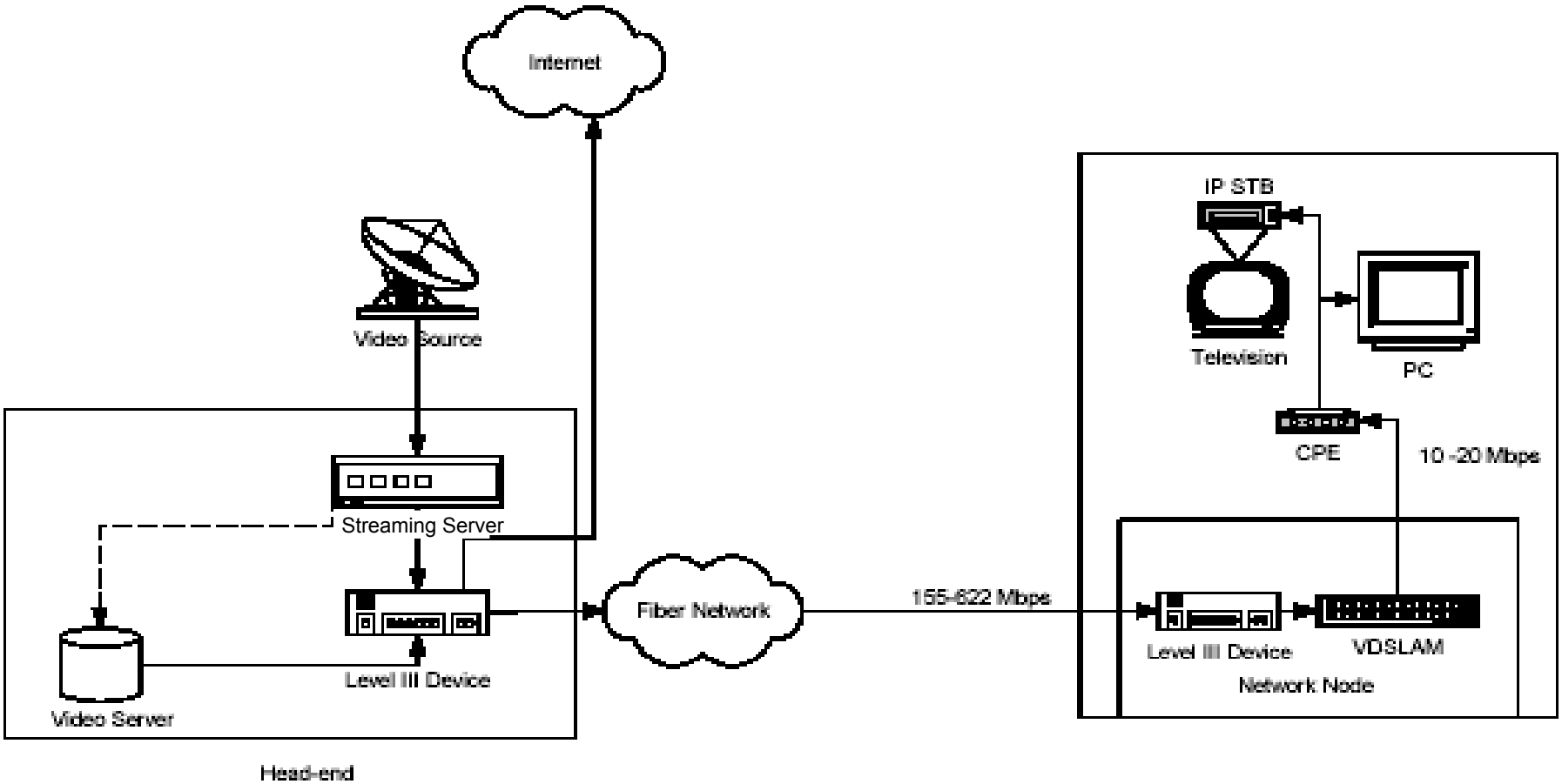
TV over IP using ADSL

ADSL can support last-mile bandwidths between 512 Kbps and 6 Mbps. The actual bandwidth available depends on the distance between the end-point and the ADSL DSLAM. Depending on the last mile bandwidth available, users can receive 2 channels of video. In this case, two IP STBs will reside at the end point (one STB for each channel).



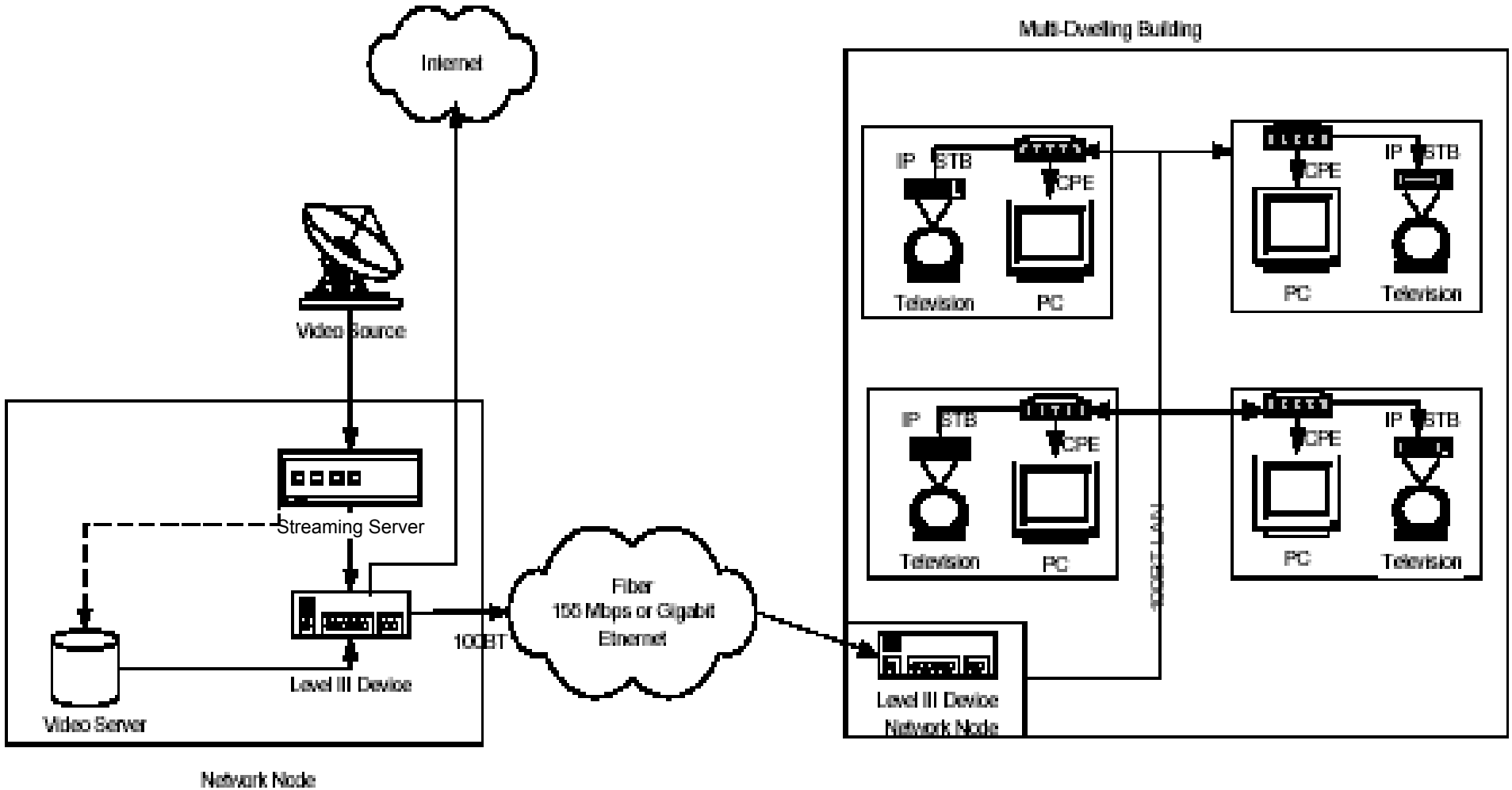
TV over IP using VDSL

VDSL configuration rests on fiber connectivity over the backbone at bit rates of 155 Mbps and up. Transmission from the last mile network node to the end point is at bit rates of between 10 and 40 Mbps. The high bandwidths supported by VDSL enable consumers to receive multiple channels for playback on multiple TV sets. With VDSL, the backbone infrastructure is based on fiber to the curb/basement while the last mile solution uses VDSL over the telephone copper line.



TV over IP using FTTH (Fibre to the Home)

FTTH configuration rests on fibre connectivity from the head-end to the end-point. In this configuration video is transmitted over a fibre backbone at more than 155 Mbps. Last mile configuration consists of a 100BaseT network. Such wide bandwidths allow users to receive multiple channels, which are played back by IP/STB.



IPTV main building blocks

Streaming Server

Streaming server resides at the head- end. It can encode and stream live streams in real-time and pre-encoded streams that are stored on the video server. Streaming server transmits the streams to the switch or router which transfers them over the backbone to the central/remote offices, and from there to the end user location.

IPTV main building blocks (Cntd.)

Video Server

Video servers fulfill several purposes. For store and forward transmissions, video servers store digitally encoded content and stream it through level III devices via operators' networking infrastructure. Video servers receive newly encoded digital content that is uploaded from the streaming server.

Video servers also enable time shifted TV applications. Viewers at home can then watch any program at a time convenient to them.

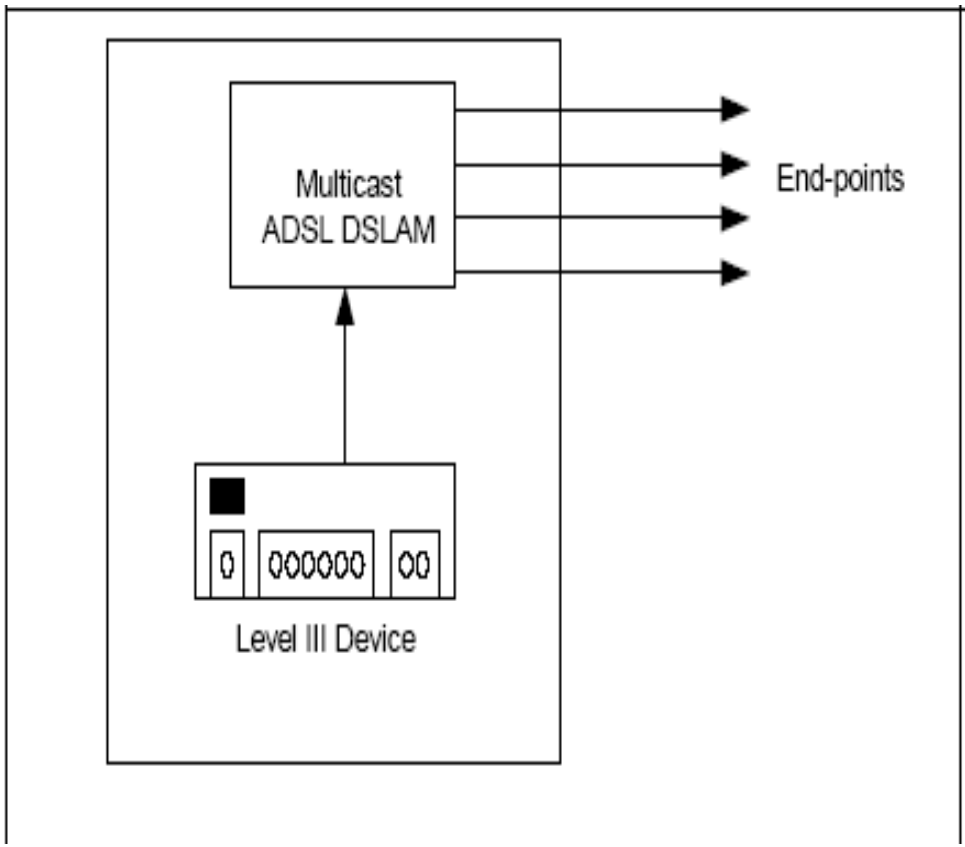
IPTV main building blocks (Cntd.)

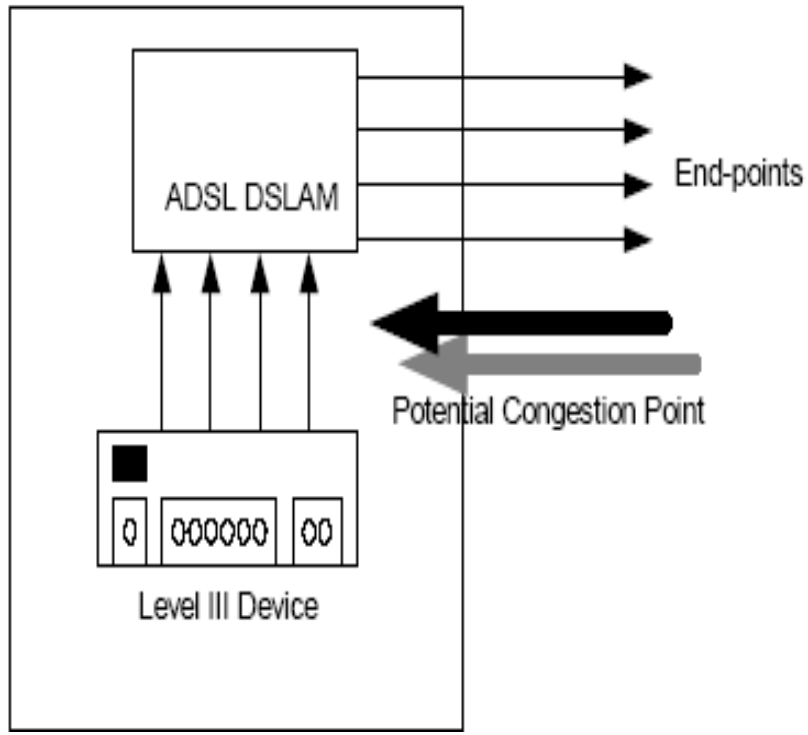
Level III Device

A switch or router that supports multicast transmission. The router or switch resides at the head-end, interfacing with the network. Another router or switch receives data at the central office and transmits either to DSLAMS located there, or into end-user network.

IPTV main building blocks (Cntd.)

DSLAM





IPTV main building blocks (Cntd.)

CPE (Customer Premises Equipment)

The equipment located at the end-point that receives the TV/IP stream. Usually the term CPE refers to the DSL modem. The DSL modem receives the stream from the DSLAM or Level III device and transfers it directly to the PC for display on the desktop or to the IP STB.

IPTV main building blocks (Cntd.)

Set-top Box (STB)

Gateway between TV set/PC and NT (PSTN line, satellite or cable)

Signal processing – receiving, decoding/decompressing
STB also accepts commands from the user and transmits these commands back to the network, often through a back channel

Functions - TV signal receiver, modem, game console, Web browser, e-mail capabilities, video-conferencing, cable telephony

Set-top Box (STB) – Cntd.

- Components - Electronic Program Guide (EPG), CD ROM, DVD player etc.

- Hardware
- Data network interface
- Decoder
- Buffer
- Synchronization hardware

Set-top Box (STB) - Cntd

Types of STB

(1) Broadcast TV Set-top Boxes - (*Thin Boxes*)

More elementary level set-top box with no return channel (back-end).

(2) Enhanced TV Set-top Boxes - (*Smart TV set-top box, Thick Boxes*)

Such STB have a return channel, usually through a phone line.

(3) Advanced Set-top Boxes

Like a PC have processors, memory and optional large hard-drives.

(4) All-in-one Set-top Boxes - (*Integrated set top box, Super Box)*

A fully integrated set-top box.

5.4. IPTV Network Aspects

A. Bandwidth Dimensioning

IPTV and VoD services require high bandwidth capacities and predictable performance, placing additional requirements on the network. Depending on the compression and coding technology the following transmission rates should be considered:

- H.264 (MPEG-4 part 10) coded SD VoD video streams or IPTV stream per one TV channel: up to 2 Mbit/s
- HD signals will need 8-12Mbit/s coded with H.264
- MPEG-2 coded SD VoD video streams or IPTV stream per one TV channel: 3,5 – 5 Mbit/s

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Influence of Broadcast TV (IPTV) services on bandwidth

Example: 30 IPTV channels are broadcasted and each channel is encoded by H.264 codec providing a gross bit rate of 2 Mbit/s (incl. Ethernet overhead), 60 Mbit/s bandwidth is required for the IPTV service. This amount of traffic does not affect the throughput of the IP core network dramatically. However, in the access network, bandwidth can be reduced by supporting IGMP (Internet Group Multicast Protocol)

Influence of Video on Demand services on bandwidth

Example: VoD service planned for 10,000 IPTV subscribers must be capable of handling VoD requests for 10% of IPTV subscriber's. 10% is a realistic average number that is commonly used for budgetary calculations. Thus, 1,000 simultaneously transmitted movies encoded in H.264 format at 2 Mbit/s bit rate will produce 2 Gbit/s traffic. The IP core network must be capable of handling the additional traffic load.

B. QoS issues for multimedia traffic

- **Voice traffic** is smooth, drop-sensitive, and delay-sensitive, and is typically UDP-based. Bandwidth per call depends on the particular codes adopted, sampling rate, and Layer 2 media employed. Voice quality is directly affected by all three QoS quality factors (loss, delay, and delay variation).

- **Data traffic** is much more varied. It can be smooth or bursty, benign or greedy, or drop- and delay-insensitive, and involves Transmission Control Protocol (TCP) for send/receive acknowledgment and retransmit. Traffic patterns vary by application, and data classes must support several different priorities or application categories.

- **Video traffic** is bursty, bandwidth-greedy, drop-sensitive, and delay-sensitive. IP-based videoconferencing has some of the same sensitivities as voice traffic.

Traffic classes

In general, enterprises should restrict themselves to about five main traffic classes, such as:

- **Mission-critical and real-time** - Interactive applications with high business priority;
- **Transactional/interactive** - Client-server applications, messaging applications
- **Bulk** - Large file transfers, e-mail, network backups, database synchronization and replication, and video content distribution
- **Best-effort** - Default class for all unassigned traffic; typically at least 25 percent of bandwidth is reserved for best-effort traffic
- **Scavenger** (optional)—Peer-to-peer media sharing applications, gaming traffic, and entertainment traffic

QoS requirements for video applications

QoS requirements for interactive video traffic:

Packet loss should be no more than 1 percent.

One-way latency should be no more than 150 ms.

Jitter should be no more than 30 ms.

The minimum priority bandwidth guarantee is the size of the video session plus 20 percent. (For example, a 384 kbps video conferencing session requires 460 kbps of guaranteed priority bandwidth.)

QoS requirements for streaming video traffic:

Loss should be no more than 2 percent.
Latency should be no more than 4-5 seconds (depending on video application's buffering capabilities).
There are no significant jitter requirements.
Guaranteed bandwidth requirements depend on the encoding format and rate of the video stream.

Scavenger Class

The *Scavenger* class is intended to provide “less-than Best-Effort” services, to certain applications.

Applications are typically entertainment-oriented and include:

- Peer-to-peer media-sharing applications (KaZaa, Morpheus, Groekster, Napster, iMesh, etc.)
- Gaming applications (Doom, Quake, Unreal Tournament, etc.), and any entertainment video applications.

Varied sensitivities of different types of traffic

Traffic type	Sensitivities			
	Bandwidth	Loss	Delay	Jitter
Voice	Very low	Medium	High	High
E-commerce	Low	High	High	Low
Transactions	Low	High	High	Low
E-mail	Low	High	Low	Low
Telnet	Low	High	Medium	Low
Casual browsing	Low	Medium	Medium	Low
Serious browsing	Medium	High	High	Low
File transfers	High	Medium	Low	Low
Video conferencing	High	Medium	High	High
Multicasting	High	High	High	High