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New user applications and broadband access – challenges for the network

Danny De Vleeschauwer, Jan Bouwen

Network Architecture Team

QoS, Traffic and Routing Technology Project

Network Strategy Group, Alcatel Bell, Antwerp, Belgium

Bahman Mobasser

Director for Data Technology Strategy Group

Alcatel HQ, Paris, France

Contents

- ◆ High-speed access as disruptive technology

- ◆ Traffic on the Internet today

- ◆ Requirements for high quality audio and video

- ◆ Video service types

- ◆ Architectures for content distribution

- ◆ Traffic issues in content distribution networks

- ◆ Conclusions

Emerging New Network Applications

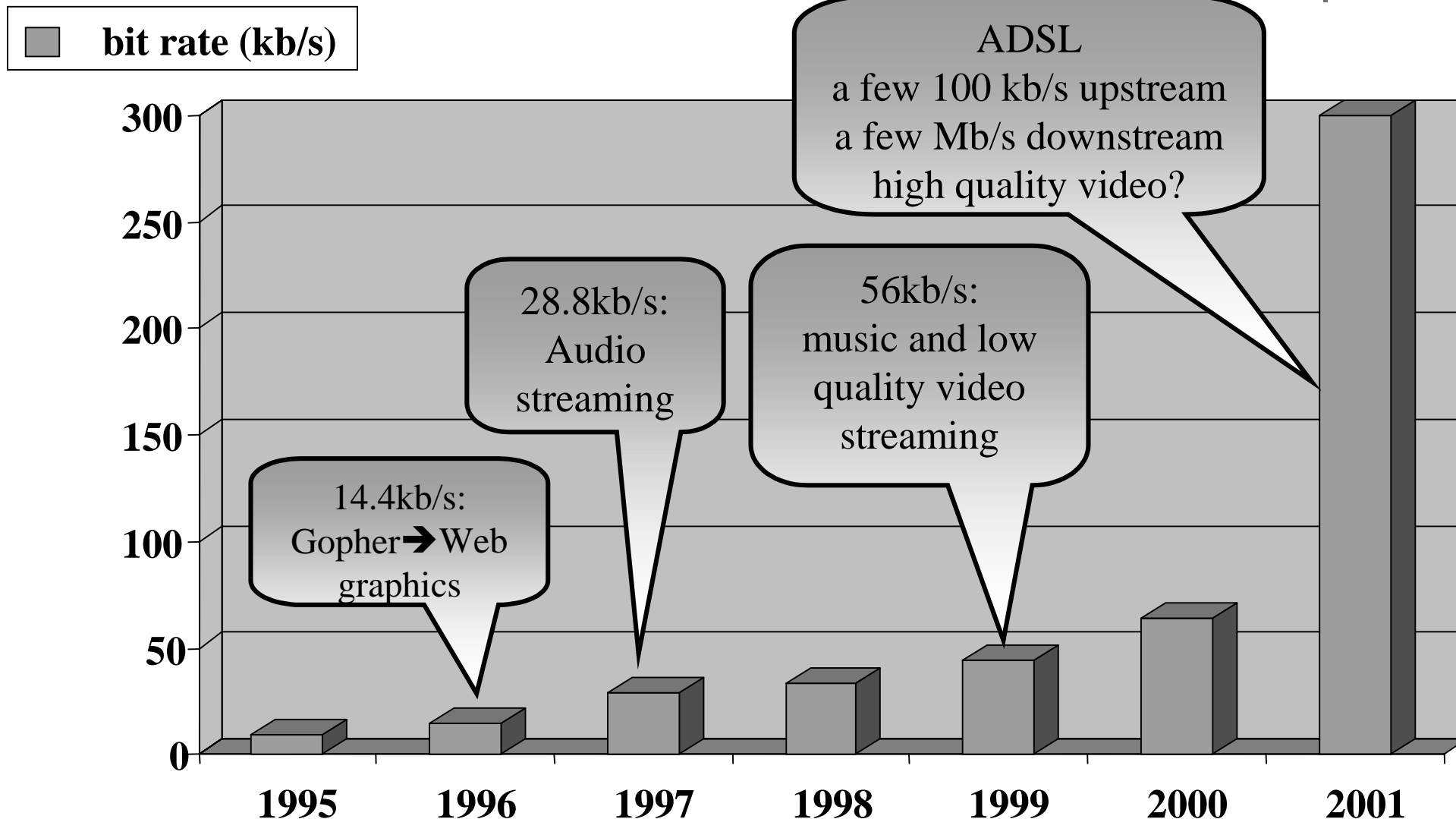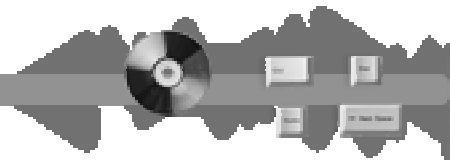high-speed (xDSL) access is a disruptive technology

Disruptive technology

◆ Incremental technological advances are introduced by equipment vendors and service providers to improve the way we do things …

◆ … but they often have the side effect of allowing us to start doing something we were not doing before

◆ Technological progress produces positive and creative discontinuities in user applications

◆ We want to plan ahead for the positive disruptions caused by high-speed access

◆ Network strategy must stay ahead and predict the changes
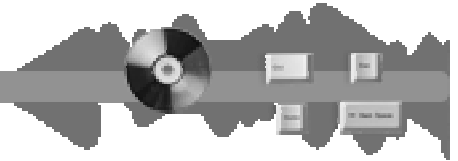
xDSL as disruptive technology

◆ One discontinuity has been known for a while: xDSL is Always On

  ◗ but so far there has been little application adaptation to this capability

◆ The innovation will probably come from the increased bandwidth initially and exploit Always On later

More bandwidth does not mean more of the same!

bit rate (kb/s)

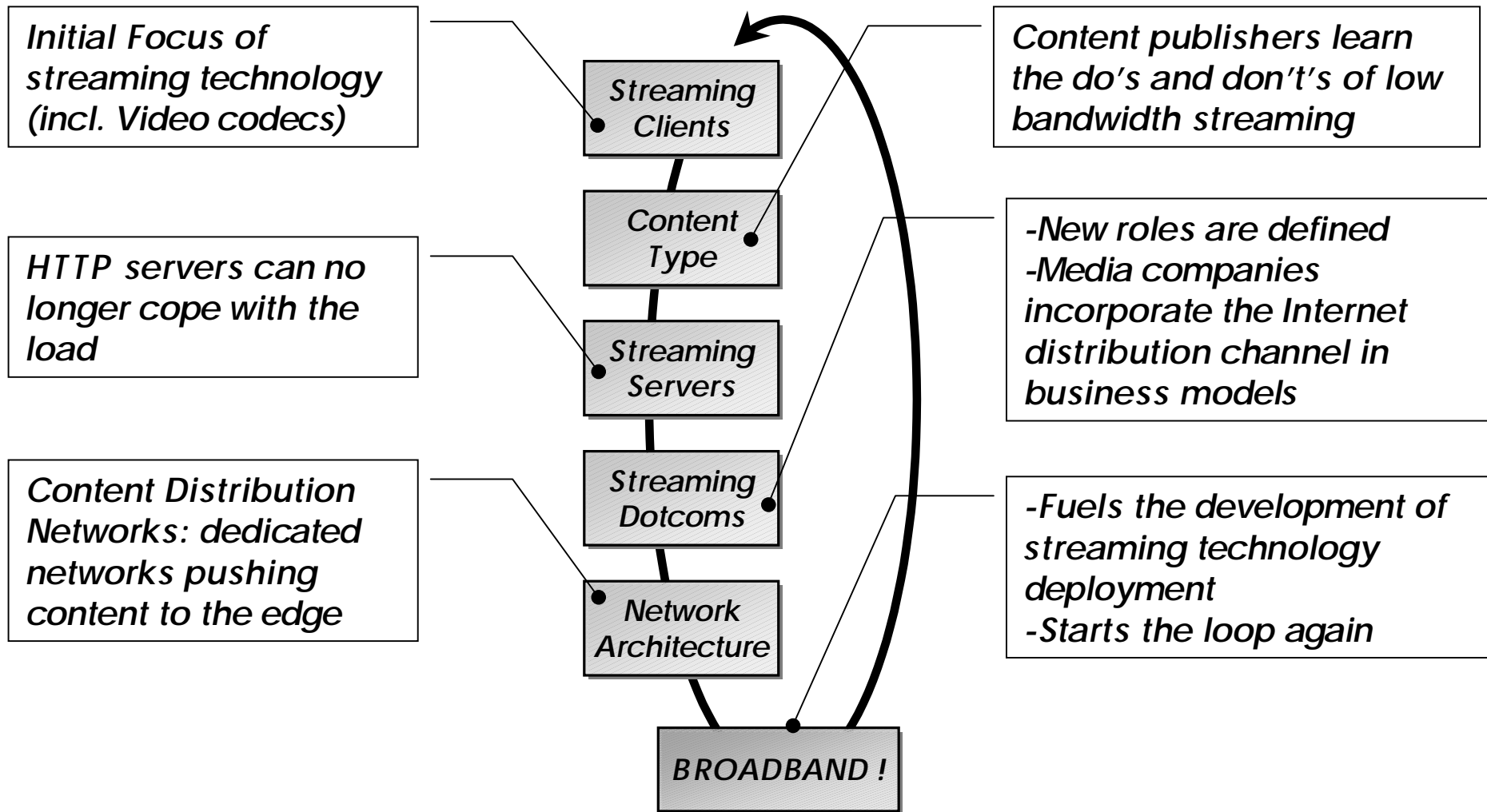ADSL
a few 100 kb/s upstream
a few Mb/s downstream
high quality video?

28.8kb/s:
Audio
streaming

56kb/s:
music and low
quality video
streaming

14.4kb/s:
Gopher➔Web
graphics

300
250
200
150
100
50
0

1995   1996   1997   1998   1999   2000   2001

Influence of "broadband" on streaming technology

◆ Streaming technology affects Internet components:

Initial Focus of streaming technology (incl. Video codecs)

Streaming Clients

Content publishers learn the do's and don't's of low bandwidth streaming

HTTP servers can no longer cope with the load

Content Type

Streaming Servers

-New roles are defined
-Media companies incorporate the Internet distribution channel in business models

Content Distribution Networks: dedicated networks pushing content to the edge

Streaming Dotcoms

-Fuels the development of streaming technology deployment
-Starts the loop again

Network Architecture

BROADBAND !

◆ The PC, as the multi-application platform, has been adopted by all categories of users: home, SOHO, SME and Corporate

◆ With the PC being in the middle of networking and applications, applications are being networked, e.g.:

  ◗ online games

  ◗ picture and home movie exchange

  ◗ pull communication: personal web sites.

The PC is no longer king of the Internet
New network appliances

- Putting more and more applications on the PC and making it simpler is a losing game
  - going beyond the community of fault-tolerant technophiles will require robust systems
- An important page is being turned – we're moving towards application specific devices, used in homes, SOHOs and enterprises
  - network-aware PDAs
  - network-aware cameras and camcorders
  - network-aware music devices
  - network-aware televisions
  - multiple network-aware telephones
  - network-aware positioning devices

Traffic on current IP networks
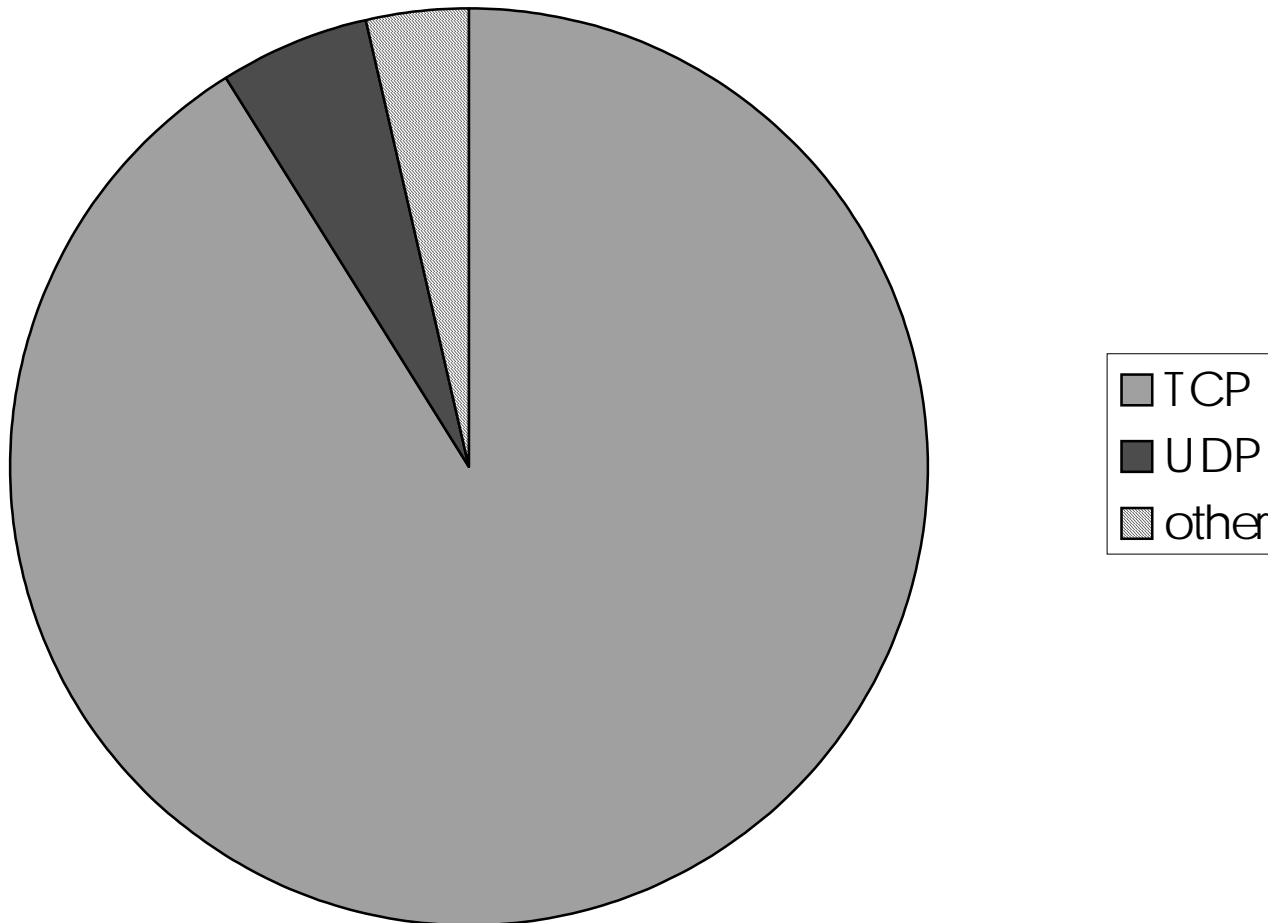
Which traffic is on the network nowadays?

◆ Elastic applications (most of the time TCP-controlled)

  ◗ if resources are available, they will try to consume them
  ◗ if resources are temporarily unavailable, they will wait without being severely affected
  ◗ examples: www, email, ftp, news, ...

◆ Streaming applications (most of the time over UDP/RTP)

  ◗ once the first packet is played, there is a "deadline" for all others
  ◗ for "interactive" applications this deadline is tight
  ◗ a minimum amount of resources is required
    • only if this minimum amount is available, the application works well
  ◗ examples: VoIP, streaming video, ...

Applications and protocol stacks

• Voice over IP • Video over IP • DNS • Real-time games • SNMP	• HTTP (www) • telnet • FTP (file transfer) • SMTP (mail) • POP3, IMAP • NNTP (news) • IRC (chat)
UDP	TCP
IP	
Ethernet, ATM, PPP, ...	

Current traffic mix

Traffic Mix February 2000 (percentage of bytes)

Legend:
- TCP
- UDP
- other

Current traffic mix (cont'd)

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Detailed Traffic Mix February 2000 (percentage of bytes)

UDP

TCP

TCP

UDP

Legend:
- web
- news
- ftp
- mail
- napster
- unidentified TCP
- realaudio
- games
- dns
- unidentified UDP
- other
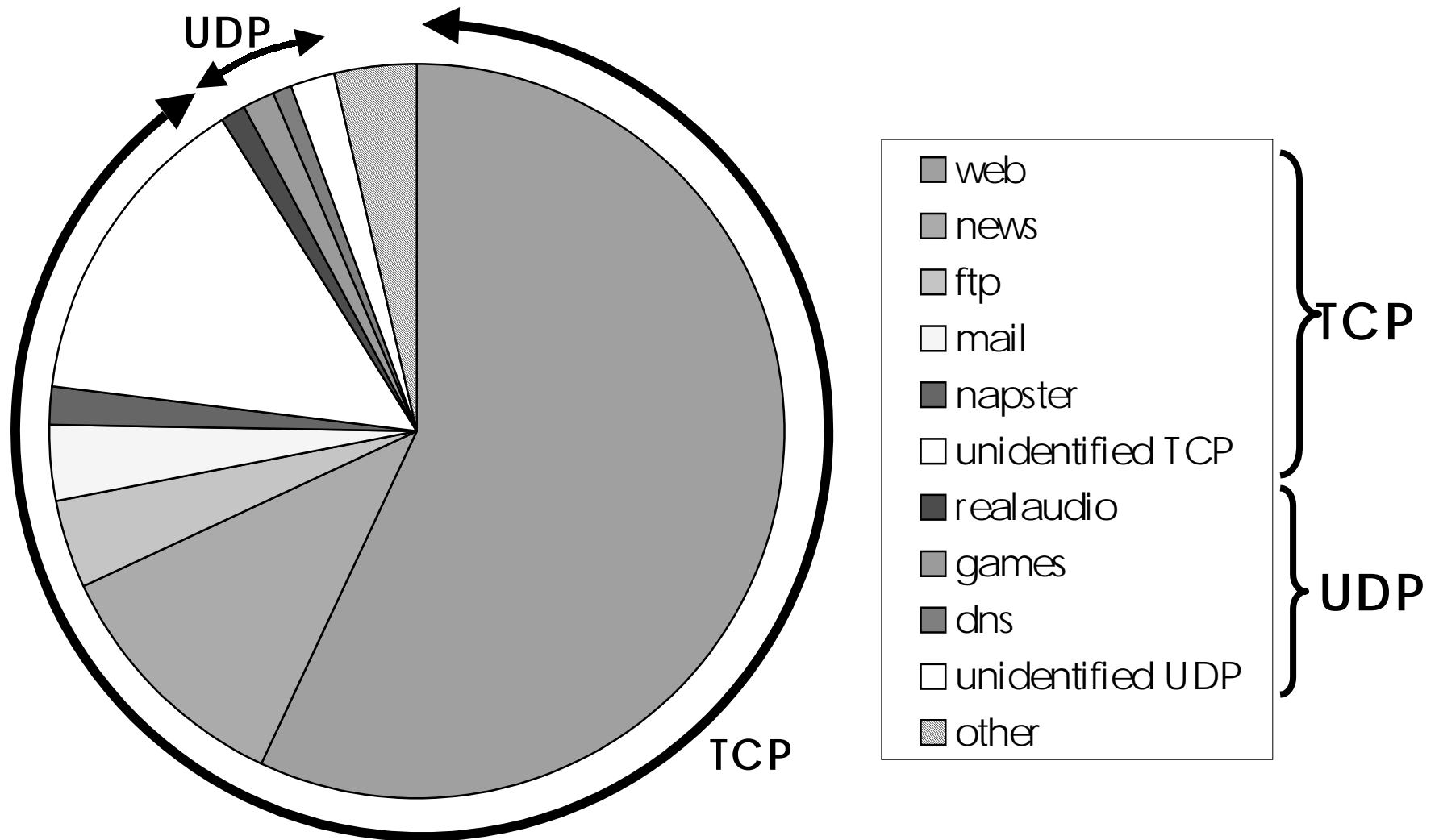
- Most traffic is still TCP-controlled
  - mainly web-related traffic
- There was not yet a lot of UDP traffic on the Internet (in February 2000)
- UDP traffic is growing
  - due to gaming traffic (1%) and
  - due to a limited, but growing, amount (1%) of streaming traffic (audio and video)
- Napster traffic has grown to about 1%

The Streaming Multimedia Scene

from narrowband to broadband:
from hype to critical analysis

Streaming media some history

- ◆ Real Networks streaming client software

  - ◗ 1995: Introduction of RealAudio Software

  - ◗ 1997: First release of RealVideo

  - ◗ Today: >20 million RealPlayer clients installed

- ◆ Streaming media web sites (source: Multimedia Research Group)

  - ◗ 1998: 36,000

  - ◗ 1999: 108,000
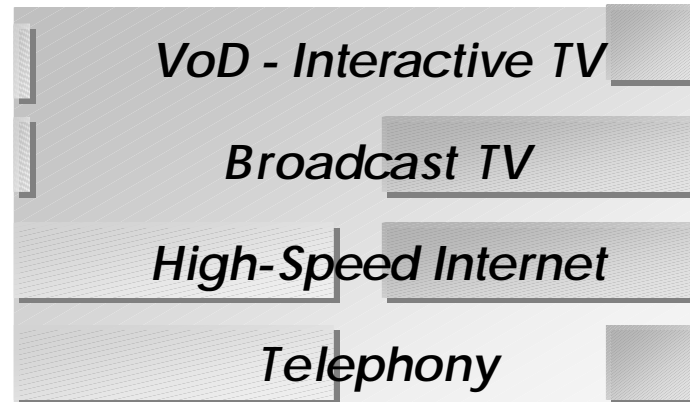
  - ◗ 2000: 250,000

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◆ Lots of dotcoms focus on Internet video

"MP3 today - video tomorrow"

◆ Telco - Cable operator competition

Broadband Service Set

We want Video !

T E L C O

| VoD - Interactive TV |
| Broadcast TV |
| High-Speed Internet |
| Telephony |

C A B L E

O P E R .

2001
back on the ground

◆ Fall 2000: dotcom bubble bursts - content sites disappear

  ◗ DEN, FasTV, Pseudo, iCast, POP, ...

  ◗ ad revenues cannot support broadband sites

  ◗ content owners are cautious - copyright issues remain a challenge

◆ Telecom Providers still want video services, but ...

  ◗ critical analysis of business models

  ◗ efficient use of network resources

  ◗ ONE video service will not be the killer application

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Requirements

Which bit rates are needed for streaming applications?

Current quality is low

◆ Offered streaming content is of low quality due to bit rate restrictions

- ◗ audio
  - music stations, radio news
  - 8 kb/s - 64 kb/s
- ◗ video
  - news shows (CNN.com, abcNews.com), movie trailers (screening room)
  - 1 to 10 frames per sec
  - small image size (e.g. 144x180)
  - 16 kb/s to 128 kb/s

"High" quality audio and video

- TV quality video (currently) requires about 4 Mb/s (MPEG2)
  - over a "good" ADSL link it is possible to stream one video channel in downstream direction
  - 1 movies lasting about 1.5 hour (say 5000 sec) takes about 2.5GB of disk space
- CD quality stereo audio (currently) requires 128 kb/s (MP3)
  - over an ADSL link it is possible to stream CD quality audio in up- and downstream direction
  - 1 song lasting about 3 min (180 sec) takes about 3MB of disk space
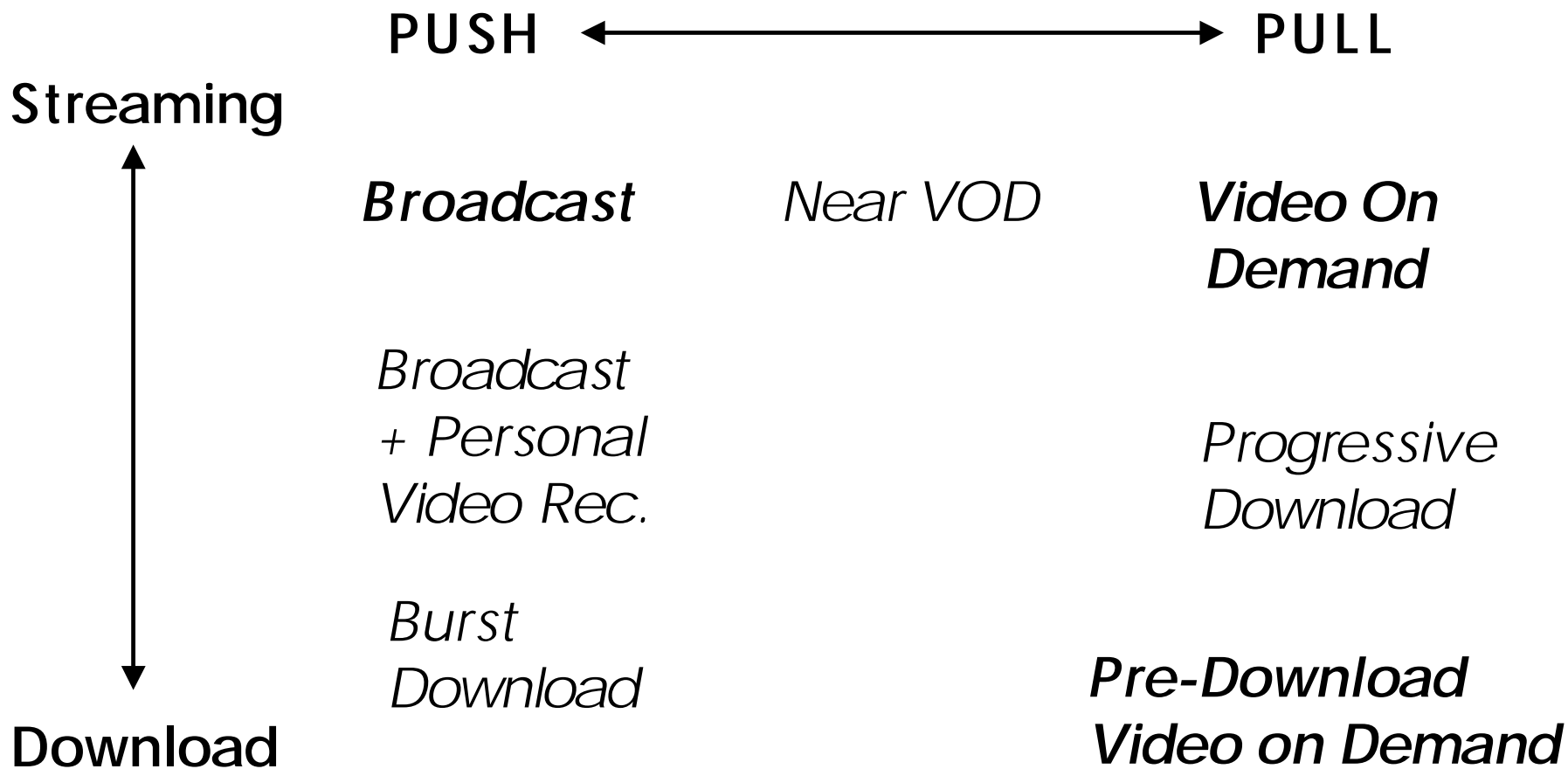   - $\Rightarrow$ napster, gnutella happen!
- Codec technology is still evolving

Video Service Types

Classification of video service types

PUSH ← → PULL

Streaming

↑

Broadcast   *Near VOD*   *Video On Demand*

Broadcast + Personal Video Rec.

Progressive Download

Burst Download

Pre-Download Video on Demand

↓

Download

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High Quality Video on Demand

◆ Terminal	TV (high-end)
◆ Video Quality	DVD - digital TV
◆ Audio Quality	CD
◆ Service	-VCR-like control
	-EPG, T-commerce
◆ Content	-movies
	-documentaries - special events

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Pre-Download Video on Demand

◆ Terminal	TV + Set-Top Box with storage
◆ Video Quality	DVD - digital TV
◆ Audio Quality	CD
◆ Service	EPG, subtitling, ...
◆ Content	-movies, documentaries, ...
	-recent TV broadcast content

Architectures for Video Services Distribution & Delivery

Today's basic webcasting model

Streaming
Client

Internet

End-to-end unicast
streaming sessions

User control
and feedback
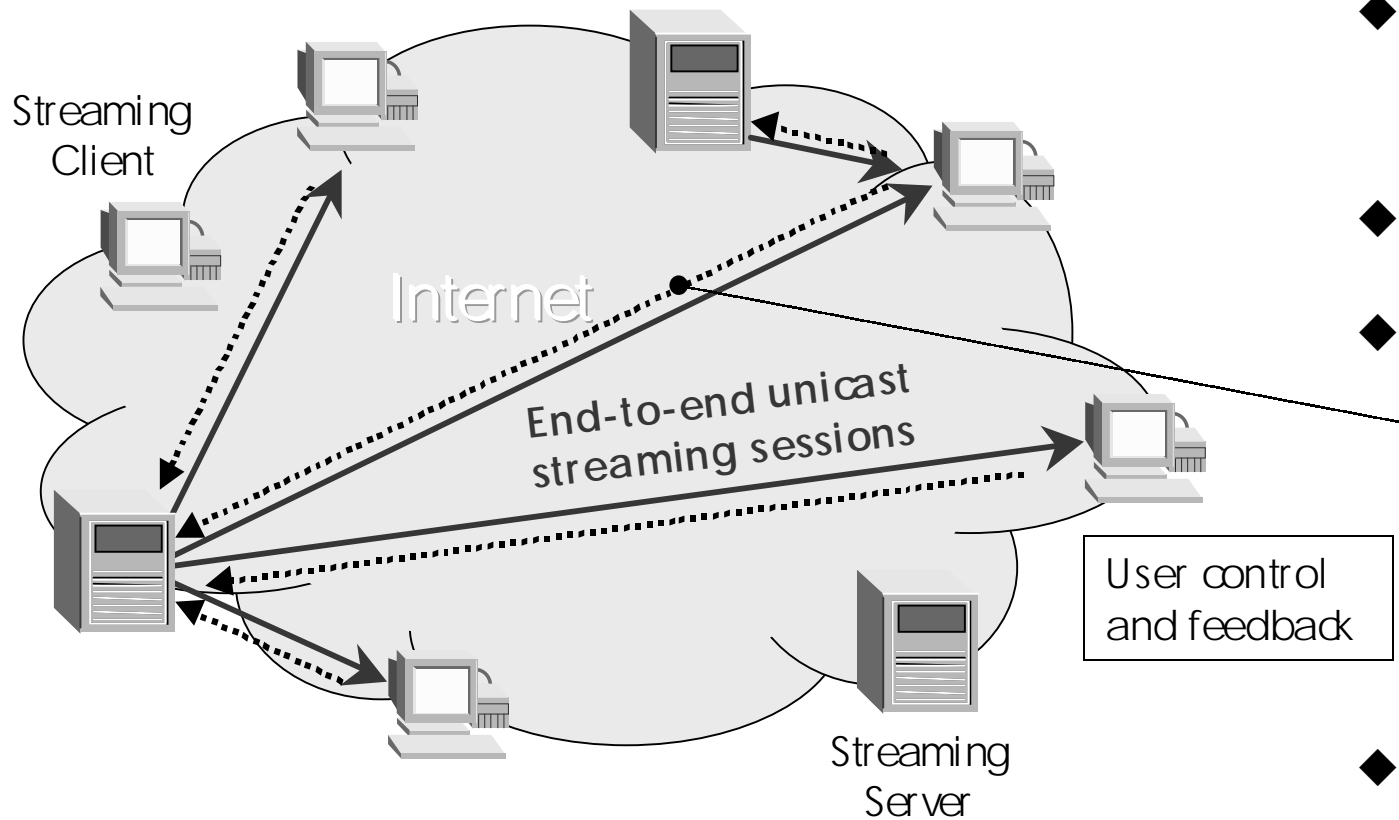
Streaming
Server

- ◆ Simple client-server architecture
- ◆ Global scale
- ◆ User communicate
  - ▶ with content provider, or
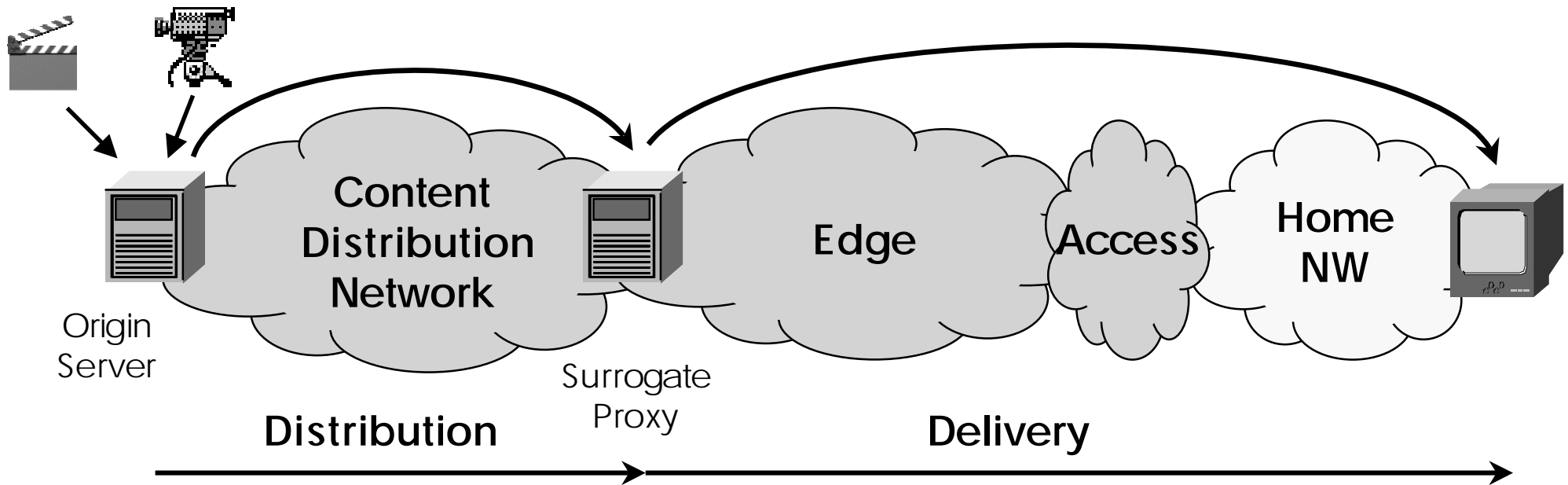 - ▶ with other users
- ◆ Integrated with web browsing

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◆ The current Internet can not support broadband streaming

  ◗ "trickling media" instead of streaming media

◆ No multicast support

  ◗ thousands of concurrent unicast sessions generate high server and network load

◆ Bandwidth scarcity

  ◗ media quality is limited to bottleneck bandwidth between streaming client and server
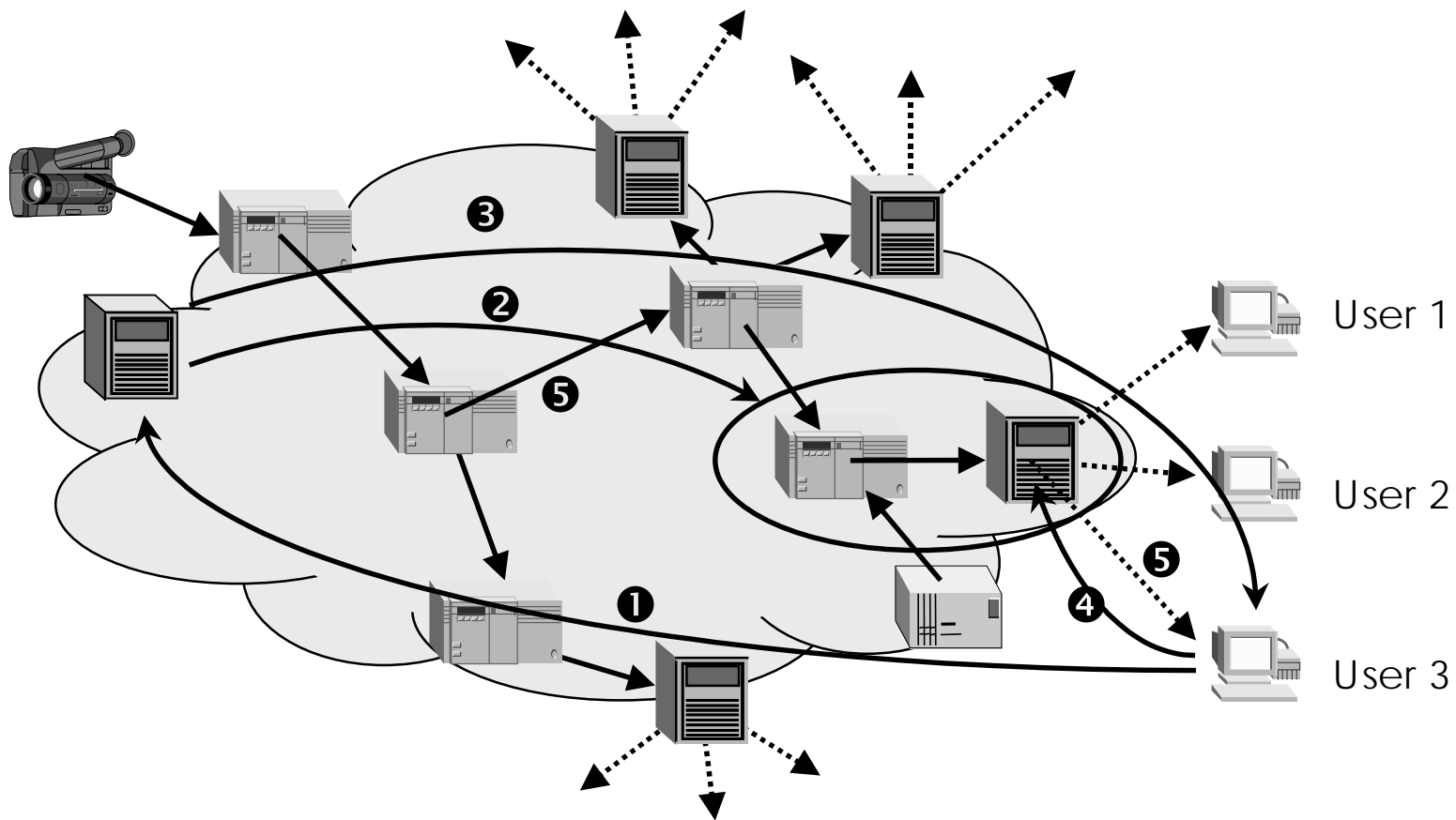
Video services architecture

◆ Trying to solve the Internet's problems: a two-step approach

Origin Server

Content Distribution Network

Surrogate Proxy

Edge

Access

Home NW

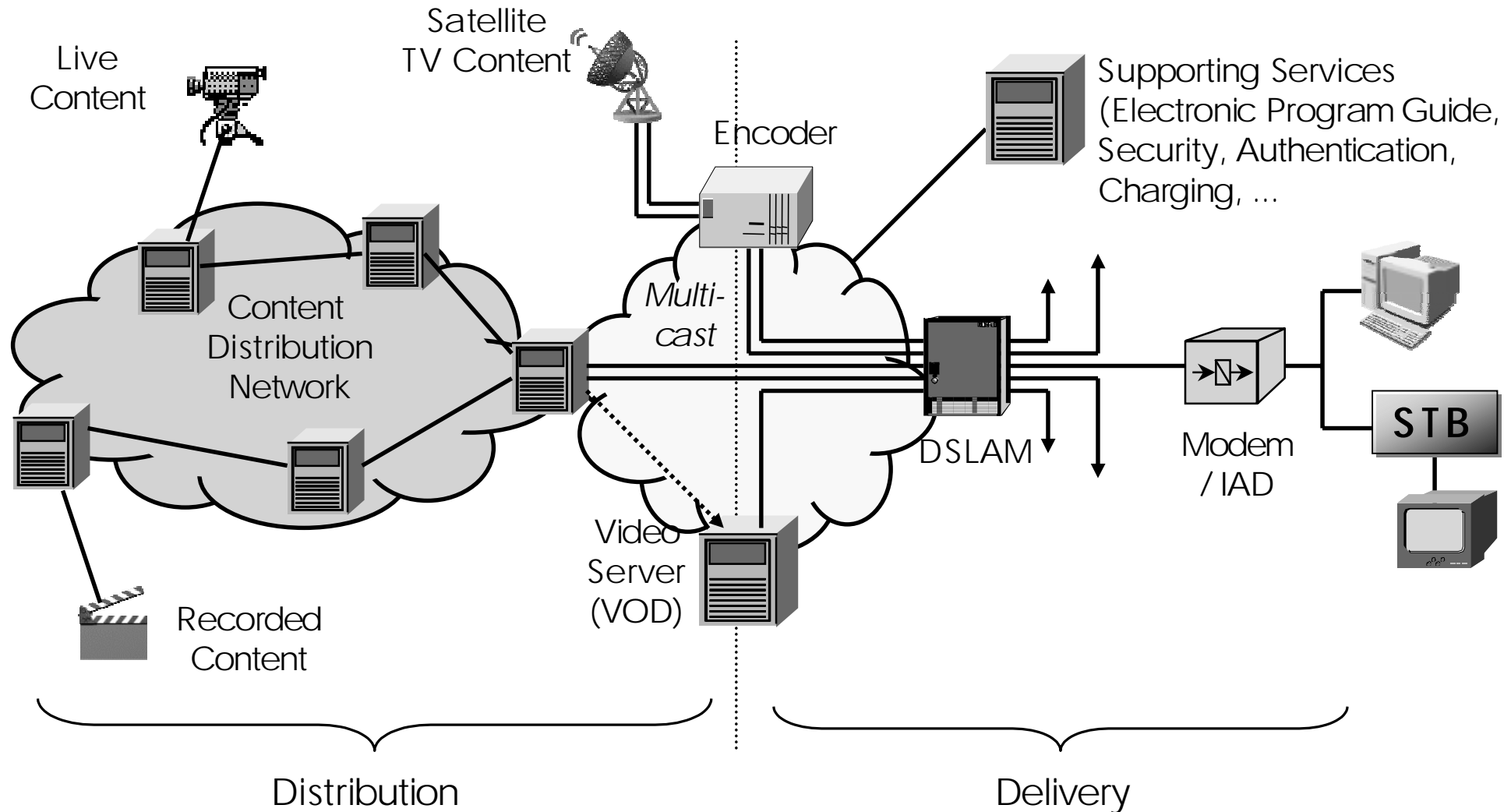**Distribution**

Delivery

Content distribution networks

◆ Dedicated (virtual) network that pre-positions content on the edge of the network, in surrogate servers

◆ Redirection mechanisms guide the client to the optimal surrogate server to answer the request

◆ Originally used for heavy components in webpages (jpegs)

◆ Specialized companies offer content distribution services (Akamai, iBeam, Cidera, Digital Island, …)

◆ Used for web casting (live) and video on demand

User 1

User 2

User 3

Video Delivery (xDSL based)

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Live Content

Satellite TV Content

Encoder

Supporting Services (Electronic Program Guide, Security, Authentication, Charging, ...)

Content Distribution Network

Multi-cast

Recorded Content

Video Server (VOD)

DSLAM

Modem / IAD

STB

Distribution

Delivery

◆ **A video operation: a lot more than media transport !**

▶ Electronic program guides (EPG)

Personalised program guides and streaming portals direct the user to content in line with his personal taste

▶ Video search engines

▶ User authentication and authorization

▶ On-line payment mechanisms

▶ Digital Rights Management (copyright protection)

Traffic Issues

◆ Traffic characteristics of video

  ◗ TV quality video needs a lot of resources

  • video streams are big streams (a few Mb/s)

  • video files to download are big files (a few GB)

  • how far can the evolving codec technology bring these requirements down?

  ◗ burstiness of video depends on tolerable delay

  • zapping response of streaming applications

  • streaming versus download

◆ Is layered coding useful?

◆ Are adaptive applications useful?

  ◗ TCP-friendly streaming sources

◆ Content distribution from the content provider to the edge
- ◗ streaming "live content" to the edge
  - how many bursty sources can be multiplexed in the core network?
  - acceptance control for UDP traffic of amount of UDP traffic grows
- ◗ copying "recorded content" to the edge
  - when to distribute the content?
  - to how many points?

◆ Streaming the content from the edge to the user
- ◗ how close to the user should the multicasting point be positioned?
- ◗ how many video streams can an xDSL link carry simultaneously?

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Conclusions

- ◆ xDSL has the potential of being a disruptive technology
  - ◗ due to its very high capacity
  - ◗ due to its "always on" feature
- ◆ Internet traffic is mostly TCP-controlled nowadays
  - ◗ there is shift towards UDP traffic
  - ◗ there is nowadays a limited amount of streaming traffic (of low quality)
- ◆ Technology is ready for streaming video at high quality
- ◆ Content distribution networks, i.e. core network to distribute the content from the provider to the edge combined with multicasting network from the edge to the user, pose
  - ◗ new architectural issues
  - ◗ new traffic management issues

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Backup slides

Crystal gazing:

What will the users do with their high-speed access?

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- ◆ Video services must use the Internet experience model
  - ◗ easy integration of applications
  - ◗ inherent interactivity
  - ◗ global reach
- ◆ The killer application will not be a single video service, but the bundle of broadband multimedia services
  - ◗ on-demand, broadcast, download
  - ◗ conferencing applications
- ◆ PC is no longer king of the Internet
  - ◗ Internet appliances used in home networks and on the road
- ◆ Digital Rights Management will remain a hot topic
- ◆ Content distribution is an example of application layer networking

Fetch bigger files

- ◆ The web content today is mostly static

- ◆ The increased capacity of ADSL, and the flat tariff, will initially encourage users to do a lot more of what they used to do with dial-up networks, i.e., download more/bigger files

- ◆ Big files means mostly video clips

- ◆ The amount of server based video content, and its variety, is very limited

- ◆ There is no real business model which would encourage this type of application to spread

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◆ Peer-to-Peer music exchange has already created a solid example of how and why this can work.

◆ Hardware at reasonable price now exists for home users to create, transform and capture video content.

◆ Unlike server-based commercial and archived content, p2p video exchange represent an unlimited potential content.

◆ The network traffic created can be huge – but avoids the problems of clustering characteristics of server file exchange.

User – Network:
a changing relationship

◆ Music exchange over the net has shown both the possibilities and dangers of exchanging existing commercial content.

◆ The problem of content ownership for music and commercial films is going to continue.

◆ We are still in the early days of user-network relationship. Users see themselves as primarily consumers of content.

◆ Ultimately the users are going to move towards a more active and creative relationship, in which they both consume and creat content.

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◆ Combine a relatively large bandwidth and «Always On» and what have you got?
Permanent windows to the outside world.

◆ Fifty years ago Isaac Asimov wrote that in future people will keep in touch with their friends and family by having large, high definition virtual windows into each other's homes.

◆ Always-On High-Speed access is making this possible.

◆ Increased bandwidth makes it worthwhile to create a new application

◆ Large scale adoption of the new application creates a market and business support for improving codecs

◆ The improved codecs can now be used on the lower bandwidth access interfaces

◆ Example: Net Music

  ◗ The 56K modems opened the door for AM Quality music

  ◗ Large scale adoption of net-music created competition between the two Player Software providers

  ◗ The codecs continuously improved to the point that now AM Quality music is possible at half the original rate