

# Multimedia Networking

#1 Introduction  
Semester Ganjil 2012  
PTIIK – Universitas Brawijaya

# Networking Courses ... at a glance

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Discrete Mathematics

Advance Networking

Operating Systems

Network Analysis

Computer Networks

Multimedia Networking

Network Security

Network Programming

Distributed Systems

Server and System Administrations

# Today's Lecture

- This Course
  - Goals
  - Outline/Schedule
  - Grading Policy
- Introduction to Multimedia Networking

# References

- Kurose & Ross, “Computer Networking : Top down Approach”, 6<sup>th</sup> Ed., Pearson/Addison, 2012.
- Tanenbaum, “Computer Networks”, 5<sup>th</sup> Ed., Prentice, 2010.
- Hofmann & Beaumont, “Content Networking”, Morgan, 2005.
- Rosenberg, “A Primer of Multicast Routing”, Springer, 2012.
- O’Driscoll, “Next Generation IPTV Service and Technologies”, Wiley, 2008.

# Goals

- Who can take this class?
  - Almost anyone
- Learn the structure of networks and protocols used for transporting multimedia data
- Prerequisites:
  - Minimum: Have taken “Computer Networks” class
  - Helpful: if already taken “Advance Networking” class

# Outline of this Course

- #1 Introduction to Multimedia Netw.
- #2 Multimedia Netw. Apps
- #3 Requirements of Multimedia Netw.
- #4 Coding and Compression
- #5 Real-time Transport Protocols
- #6 Live Streaming: IP Multicast
- #7 Live Streaming: IP Multicast (cont'd)
- #8 Live Streaming: Overlay Multicast
- #9 CDN: Solutions
- #10 CDN: Case Studies
- #11 QoS on the Internet: Constraints
- #12 QoS on the Internet: Solutions
- #13 Discussion
- #14 Summary

# Grading Policy

- Classes
  - Two (2) Credits
- Exercises (assistant required)
  - One (1) Credit
- Evaluation
  - Homework 15%
  - Paper Reading and Presentation 30%
  - MidTerm Test 20%
  - Final Exam 35%

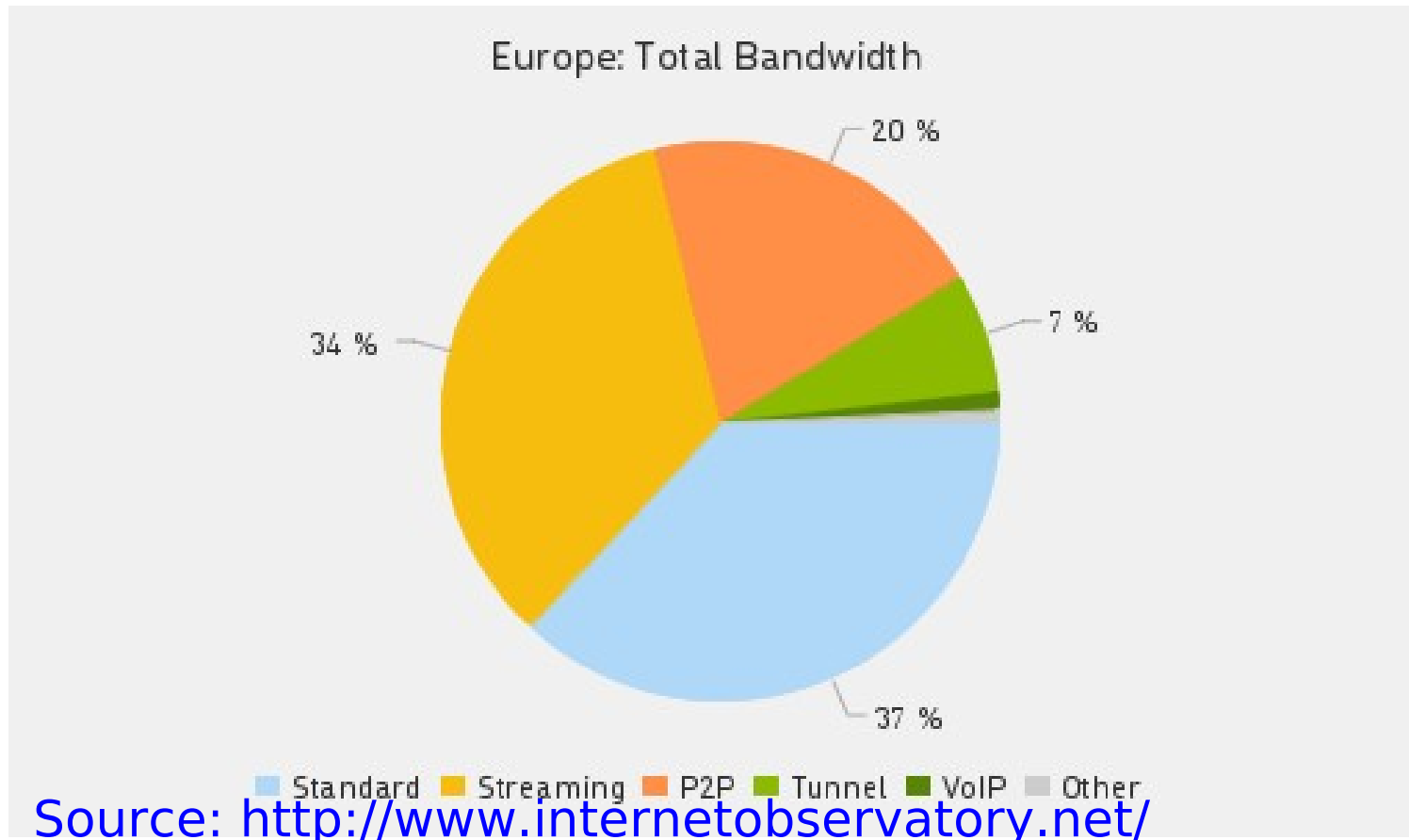
# #1 Introduction to Multimedia Networking



# Outline of Introduction

- Trend of Global Internet Traffic
- What is Multimedia
- What is Multimedia Networking

# Today's Internet Video Traffic



<http://www.cisco.com/go/vni>

# Overview

## ***What is Multimedia?***

- Characteristics of multimedia
- Various media types

## ***What is Multimedia networking?***

- User requirements of multimedia applications on the network
- Technologies associated with multimedia networking
- Overall structure of multimedia networking

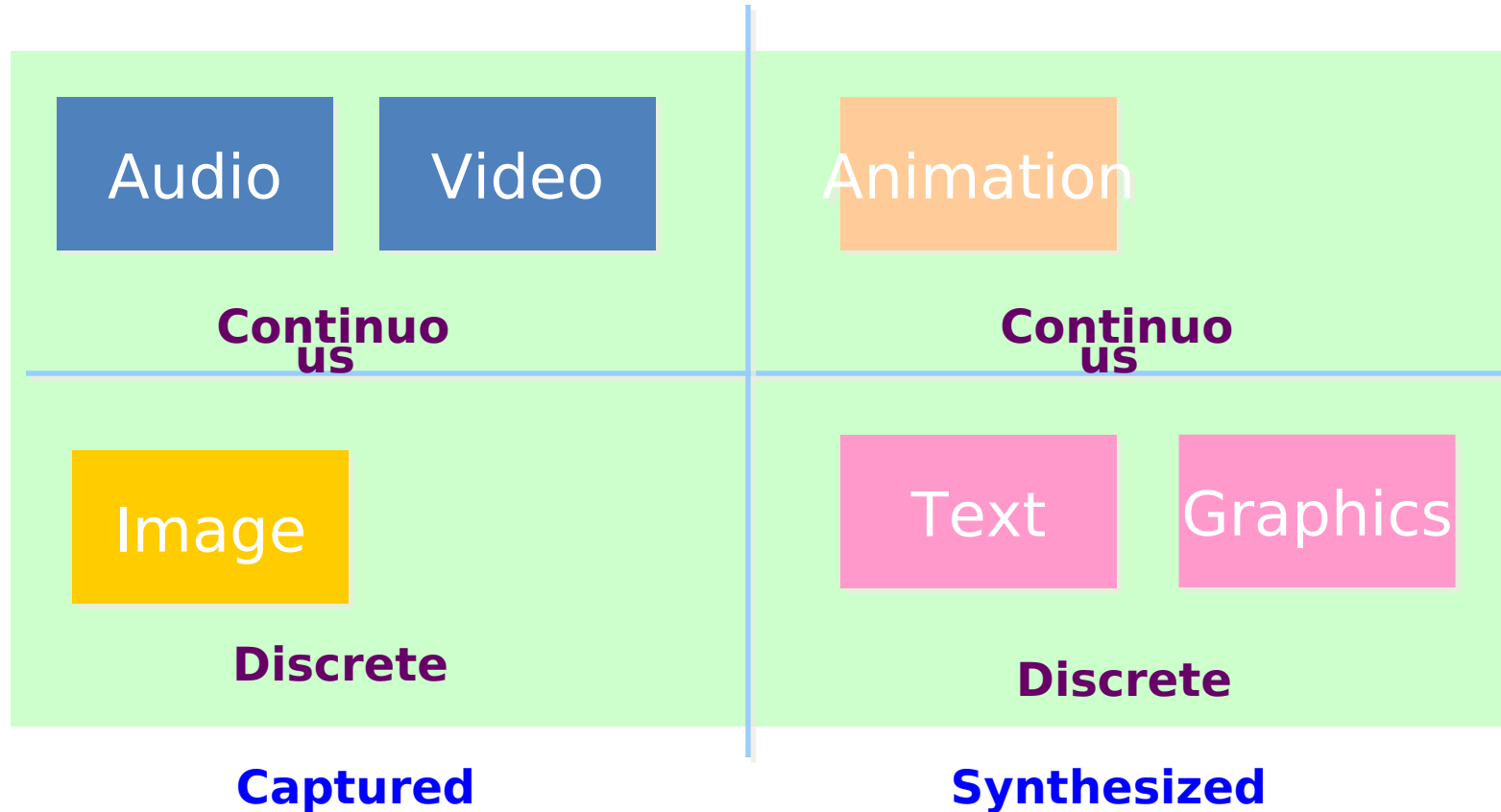
# What is multimedia?

- Definition of multimedia
  - is an integration of text, graphics, still image and moving images (video), animation, audio, and any other medium where every type of information can be represented, stored, transmitted and processed digitally
  - is media and content that uses a combination of different content forms. ...  
[wikipedia.com](http://wikipedia.com)
- Characteristics of multimedia
  - Digital – key concept
  - Integration of multiple media types, usually includes video or/and audio
  - May be interactive or non-interactive

# Various Media Types

- Text, graphics, image, video, animation, audio, etc.
- Classifications of various media types
  - Captured vs. synthesized media
    - Captured media (natural) : information captured from the real world (still image, video, audio)
    - Synthesized media (artificial) : information synthesized by the computer (text, graphics, animation)
  - Discrete vs. continuous media
    - Discrete media: spaced-based, media involve the space dimension only (**Text, Image, Graphics**)
    - Continuous media: time-based, media involves both the space and the time dimension (**Video, Audio, Animation**)

# Classification of Media Type



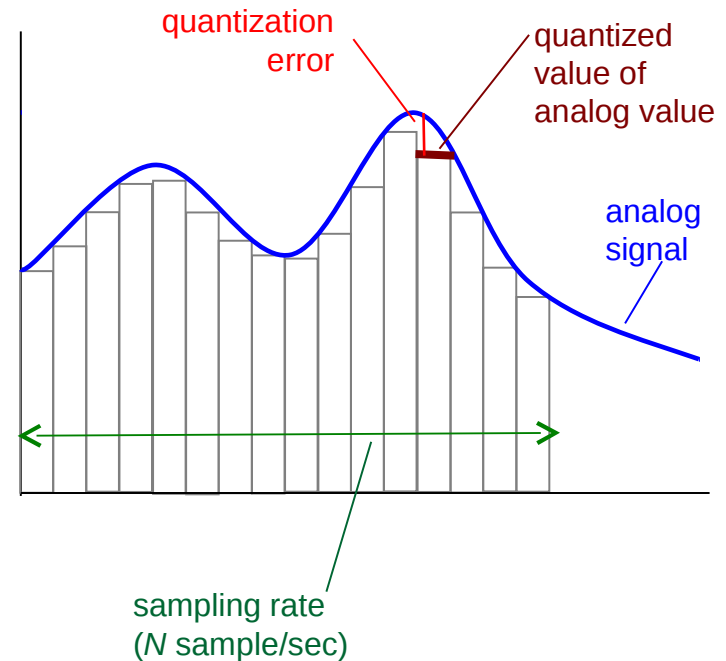
# Multimedia: ~~audio~~



- telephone: 8,000 samples/sec
- CD music: 44,100 samples/sec



- e.g.,  $2^8=256$  possible quantized values
- each quantized value represented by bits, e.g., 8 bits

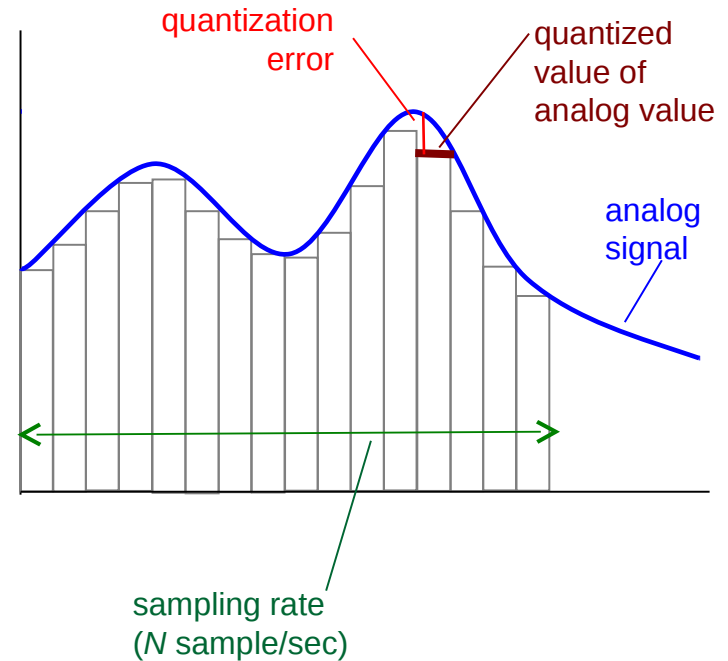


# Multimedia: ~~audio~~



- some quality reduction

## example rates

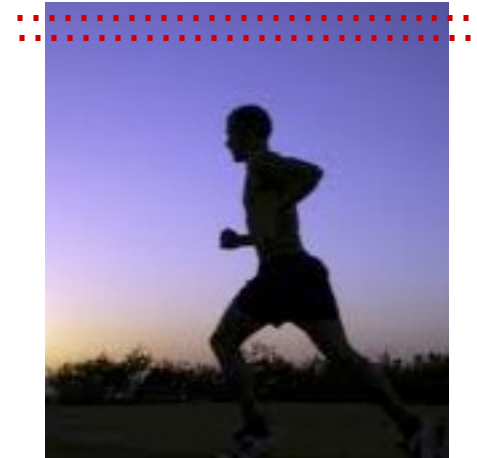




# Multimedia: ~~video~~

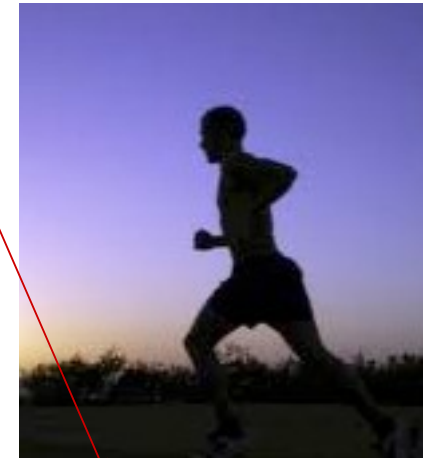
- video: sequence of images displayed at constant rate
  - e.g. 24 images/sec
- digital image: array of pixels
  - each pixel represented by bits
- coding: use redundancy *within* and *between* images to decrease # bits used to encode image
  - spatial (within image)

*spatial coding example:*



*frame  $i$*

*temporal coding example:*



*frame  $i+1$*

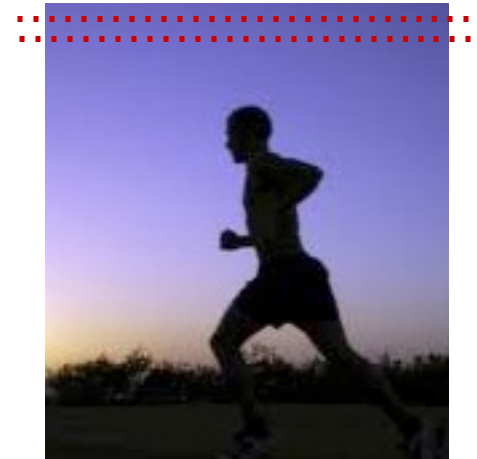
# Multimedia: ~~video~~

- ❖ **CBR: (constant bit rate):** video encoding rate fixed
- ❖ **VBR: (variable bit rate):** video

- ❖ **examples:**

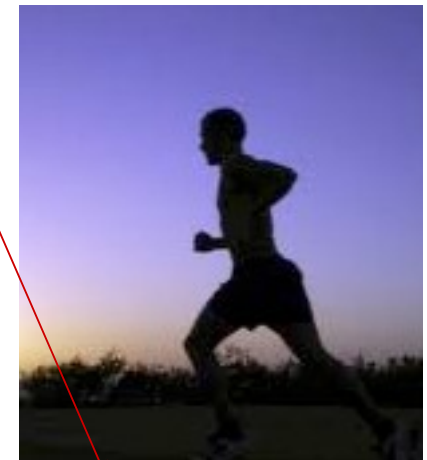
- MPEG 1 (CD-ROM) 1.5 Mbps
- MPEG2 (DVD) 3-6 Mbps
- MPEG4 (often used in Internet, < 1 Mbps)

*spatial coding example:*



frame  $i$

*temporal coding example:*



frame  $i+1$

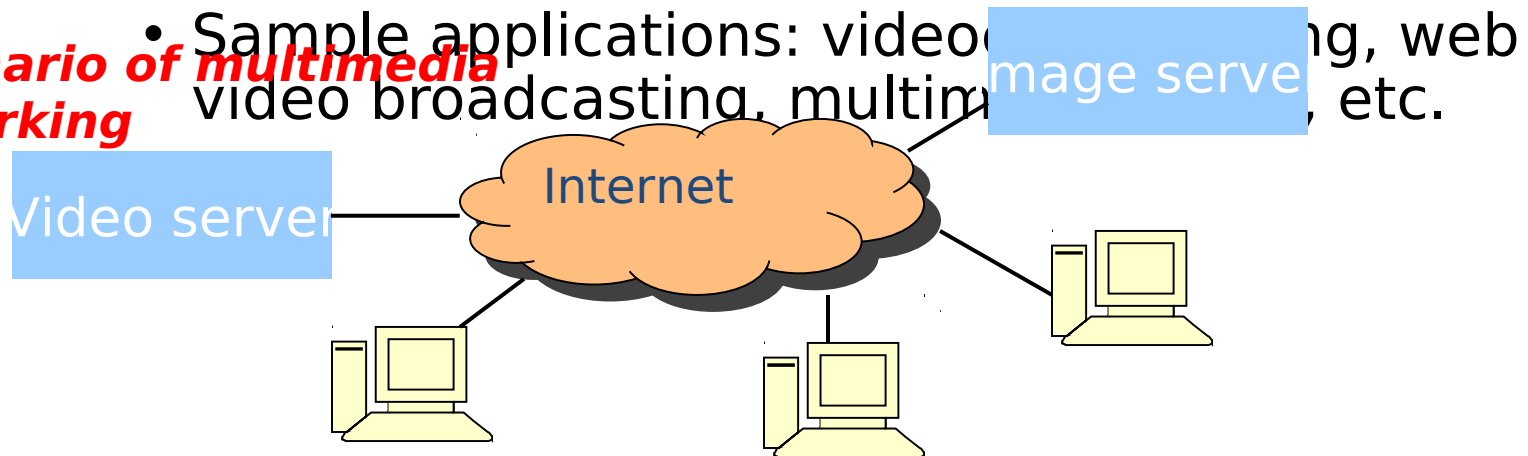
# Multimedia networking: 3 application types

- *streaming, stored* audio, video
  - *streaming*: can begin playout before downloading entire file
  - *stored (at server)*: can transmit faster than audio/video will be rendered (implies storing/buffering at client)
  - e.g., YouTube, Netflix, Hulu
- *conversational* voice/video over IP
  - interactive nature of human-to-human conversation limits delay tolerance
  - e.g., Skype
- *streaming live* audio, video
  - e.g., live sporting event (futbol)

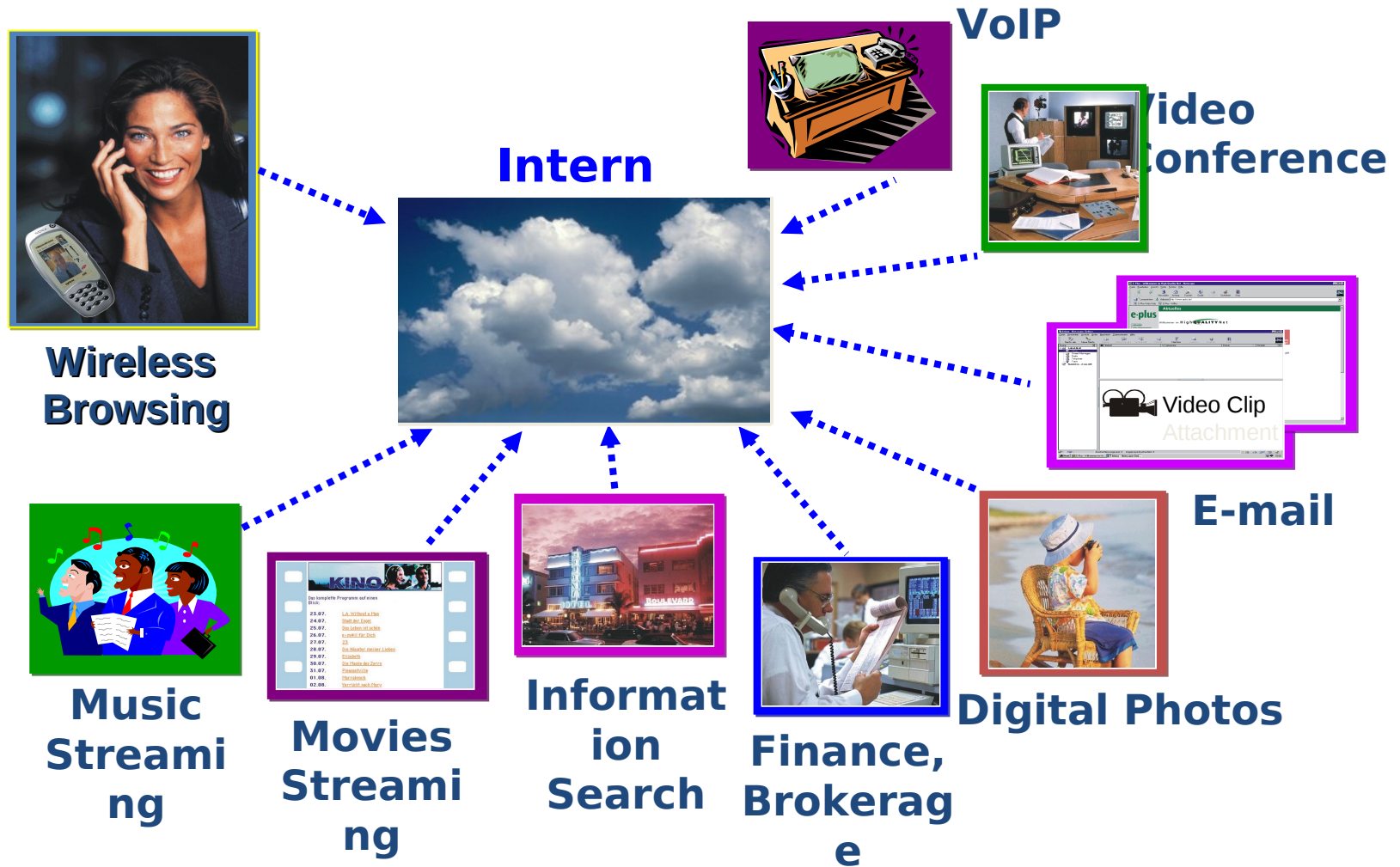
# Networked Multimedia

- Local vs. networked multimedia
  - Local: storage and presentation of multimedia information in standalone computers
    - Sample applications: DVD
  - Networked: involve transmission and distribution of multimedia information on the network
    - Sample applications: video on demand, web video broadcasting, multimedia streaming, etc.

**A scenario of multimedia networking**



# Multimedia over Internet



# Consideration of Networked Multimedia

- Fundamental Characteristics of multimedia information
  - **Large** data **volume**
  - Typically **delay sensitive**
  - But **loss tolerant**
    - infrequent losses cause minor glitches

# Consideration of Networked Multimedia

- Properties of current Internet (*packet switched networks*)
  - Suitable for unexpected burst of data
    - no need to establishing an explicit connection
  - Limitation of bandwidth
    - Bandwidth is shared statistically so data can be sent at any time
    - Causing Queuing delay, especially when congested
  - *Best effort* network
    - IP network is not reliable
    - cannot guarantee quality of multimedia applications
  - Heterogeneity
    - Different user requirements
    - Different user network conditions

# Requirements for Networked Multimedia

Medium	Application	Degree of symmetry	Typical data rates	Key performance parameters and target values			
				One-way Delay	Delay variation	Information loss	Other
Audio	Conversational voice	Two-way	4-13 kb/s	< 150 ms preferred* < 400 ms limit*	< 1 ms	< 3% packet loss ratio (PLR)	
Audio	Voice messaging	Primarily one-way	4-13 kb/s	< 1 s for playback < 2 s for record	< 1 ms	< 3% PLR	
Audio	High quality streaming audio	Primarily one-way	32-128 kb/s	< 10 s	< 1 ms	< 1% PLR	
Video	Videophone	Two-way	32-384 kb/s	< 150 ms preferred < 400 ms limit		< 1% PLR	Lip-synch < 80 ms
Video	One-way	One-way	32-384 kb/s	< 10 s		< 1% PLR	

\* Assumes adequate echo control



# Challenges of multimedia networking

- Conflict between *media size* and *bandwidth limit* of the network
- Conflict between the *user requirement* of multimedia application and the *best-effort network*
- *How* to meet different requirements of different users?

# Technologies of Multimedia Networking

- **Media Compression** - reduce the data volume

**Address the 1st challenge**

– **Image compression**

– **Video compression**

– **Audio compression**

- **Multimedia Transmission**

**Address the 2<sup>nd</sup> and 3<sup>rd</sup> challenges**

– Protocols for real-time transmission

– Rate / congestion control

– Error control

# Multimedia Networking Systems

- Live media transmission system
  - Capture, compress, and transmit the media on the fly
- Send stored media across the network
  - Media is pre-compressed and stored at the server. This system delivers the stored media to one or multiple receivers.
- Differences between the two systems
  - For live media delivery:
    - Real-time media capture, need hardware support
    - Real-time compression- speed is important
    - Compression procedure can be adjusted based on network conditions
  - For stored media delivery
    - Offline compression - better compression result is important
    - Compression can not be adjusted during transmission

# Generic Media Streaming System

