PROGETTAZIONE E PRODUZIONE MULTIMEDIALE

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Univ. degli Studi di Firenze

- **Programma ANNO ACCADEMICO 2002-2003**

- **PART I Media e formati**
  - **Del Bimbo**

- **PART II Standards per immagini, video, audio :** JPEG, JPEG2000, MPEG 1-2-4-7……
  - **Bertini- D'Amico**

- **Part III Linguaggi di presentazione e interscambio:** HTML, XML
  - **Mencarelli- Bertini**

- **Part IV Multimedia interfaces:** Web design: Usability/Accessibility, Natural interfaces
  - **Del Bimbo- Valli**

- **Part V Applications**
  - **Del Bimbo**

Orario Lezioni

- Lunedì 11.15 - 13.15 Aula 205 Vle Morgagni
- Martedì 8.15 - 11.15 Aula 205 Vle Morgagni
- Mercoledì 8.15 - 11.15 Aula 205 Vle Morgagni

Ricevimento

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PART I Media e formati

- Multimedia
  - Multi = many
  - Media = an intervening substance through which something is transmitted or carried on. A means of mass communication such as a newspaper, magazine, or television (American Heritage Electronic Dictionary 1991)

Media classification

- Anyway, wrt computer processing:
  - Medium – a means of distribution and presentation of information: text, graphics, speech, music……
- Media can be classified wrt different criteria. We can classify media according to:
  - Perception,
  - Representation,
  - Presentation,
  - Storage,
  - Transmission,
  - Information exchange

Perception medium

- Perception media help the humans to sense their environment; perception mostly occurs through seeing or hearing the information.
  - For the perception through seeing the visual media such as *text, image* and *video* are used.
  - For the perception of information through hearing, auditory media such as *music, noise* and *speech* are relevant.

Representation medium

- Representation media are characterized by internal computer representations of information.Various formats are used to represent media information in a computer:
  - A text character is coded in ASCII or EBCDIC
  - Graphics are coded according to CEPT or CAPTAIN videotext standard or to the GKS graphics standard
  - An audio stream can be represented using PCM
  - An image can be coded in JPEG, JPEG 2000, TIFF… format
  - A combined audio/video sequence can be coded in different TV standards (PAL, SECAM, NTSC) and stored in the computer using the MPEG format

Presentation medium

- Presentation media refer to the tools and devices for the input and output of information.
  - The *paper*, the *screen* ……. are used by the computer to deliver information;
  - *keyboard, mouse, camera, mcrophone, dataglove,*….. are the input media.

Storage medium

- Storage media refer to a data carrier that enables storage of information.
- Microfilm, floppy disk, CD-ROM, DVD-ROM are examples of storage media

Transmission medium

- The transmssion medium characterizes different information carriers that enable continuous data transmission.
- Information is transmitted over networks that use wire and cable (coaxial, fiber) as well as free air space transmission (for wireless traffic).

Information exchange medium

- The information exchange medium includes all information carriers for transmission: i.e. all storage and transmission media.
- Information can flow through intermediate storage media, through direct transmission using computer networks or through combined use of storage and transmission media (e.g. the electronic mailing system)

Media representation dimensions

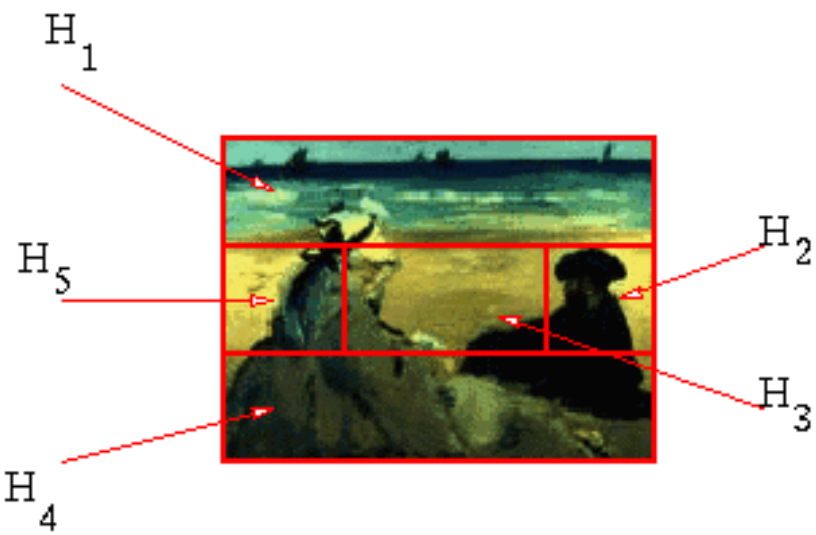
- Media can be divided into two types, in their representation space wrt time:
  - time independent (discrete),
  - time-dependent (continuous).

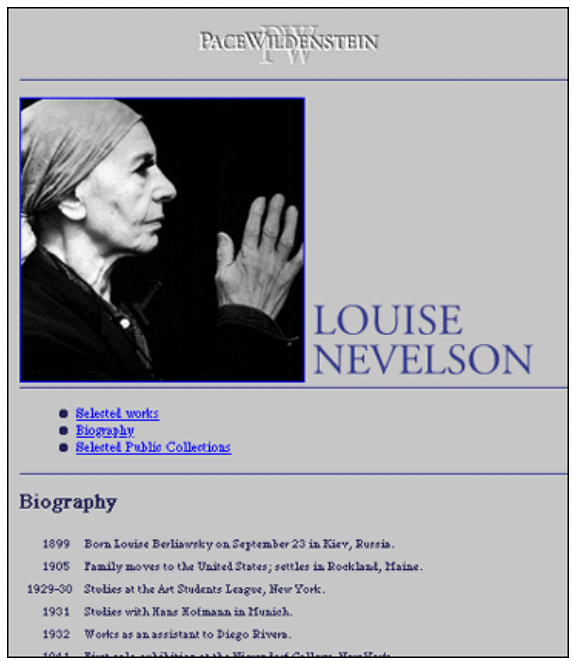
- This classification has nothing to do with the internal representation but rather relate to the impression of the viewer or the listener

Discrete media

- Time-independent (discrete):
  - Some media, such as text and graphics are time-independent. Information in these media consist of a sequence of individual elements or of a continuum without a time component (eg text, graphics).
  - Processing of discrete media should happen as fast as possible but this processing is not time-critical because the validity and correctness of the data does not depend on any time condition.

- Discrete media are composed of different media that are spatially arranged.

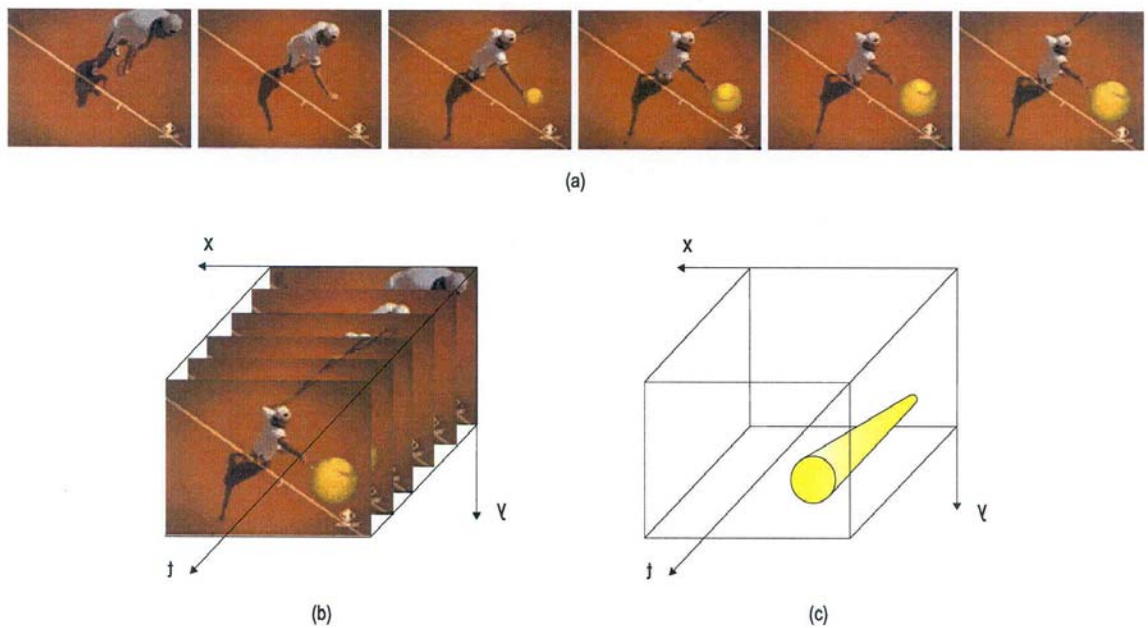




Continuous media

- Time-dependent (continuous):
  - In other media (such as full motion video, sound, signal from different sensors…) the values change over time. Information is expressed not only in its individual value but also by the time of occurrence. The semantics depends on the level of relative change of the discrete values or of the continuum.
  - Processing these media is time critical because the validity and correctness of the data depends on a time condition (f.e. a transmitted audio sample delivered too late is invalid if the subsequent samples have already been played back).
  - Time dependent representation values which occur aperiodically (e.g. control commands in a real time system) are not considered continuous media..

- Continuous media consist of a time dependent sequence of individual information units called Logical Data Unit.



Multimedia systems

- Not every combination of media justifies the use of the term multimedia. One should talk about multimedia only when both continuous and discrete media are utilized. According to this, the defining characteristics of multimedia systems is the incorporation of continous media such as voice, video and animation.

- A text processing program with incorporated images is therefore not a multimedia application.

- An important aspect of different media is their level of independence.
  - The media independence prerequisite provides the possibility of combining media in arbitrary forms. The system should be capable of computer controlled media processing and programmable by a system programmer. (f.e. simple input/output of different media doesnot cope with this definition)
  - Computer controlled data of independent media can be integrated to accomplish certain functions using timing, spatial and semantic syncronization. (f.e a text processing program that supports text, table calculation and video clips is highly integrtaed if changing the content of a table row also causes corresponding video scene changes).

- Research and development efforts in multimedia fall into two groups:
  - stand-alone multimedia wks and associated software systems such as music composition, computer aided learning and interactive video.
  - multimedia computing with distributed systems: multimedia information systems, collaboration and conferencing systems, on-demand multimedia services, distance learning…..

Stand alone multimedia

- Stand alone multimedia systems are such that multimedia information is created, processed, presented and stored in the workstation.

- RETRIEVAL BY CONTENT

- The VideoNews project addresses content based retrieval and browsing of news reports
  - Shot segmentation of the news stream
  - Shot classification as anchorperson and report shots
  - Textual information automatically extracted from captions and speech in the anchorperson shot
  - Search by content based on keywords

Anchorperson shot detection

- **Shot life-time**

- **Quantity of motion**

$$QM = \sum_{(0,0)}^{(X,Y)} QP(x, y)$$

$$QP(x, y) = \|R_i - R_{i+1}\| + \|G_i - G_{i+1}\| + \|B_i - B_{i+1}\|$$

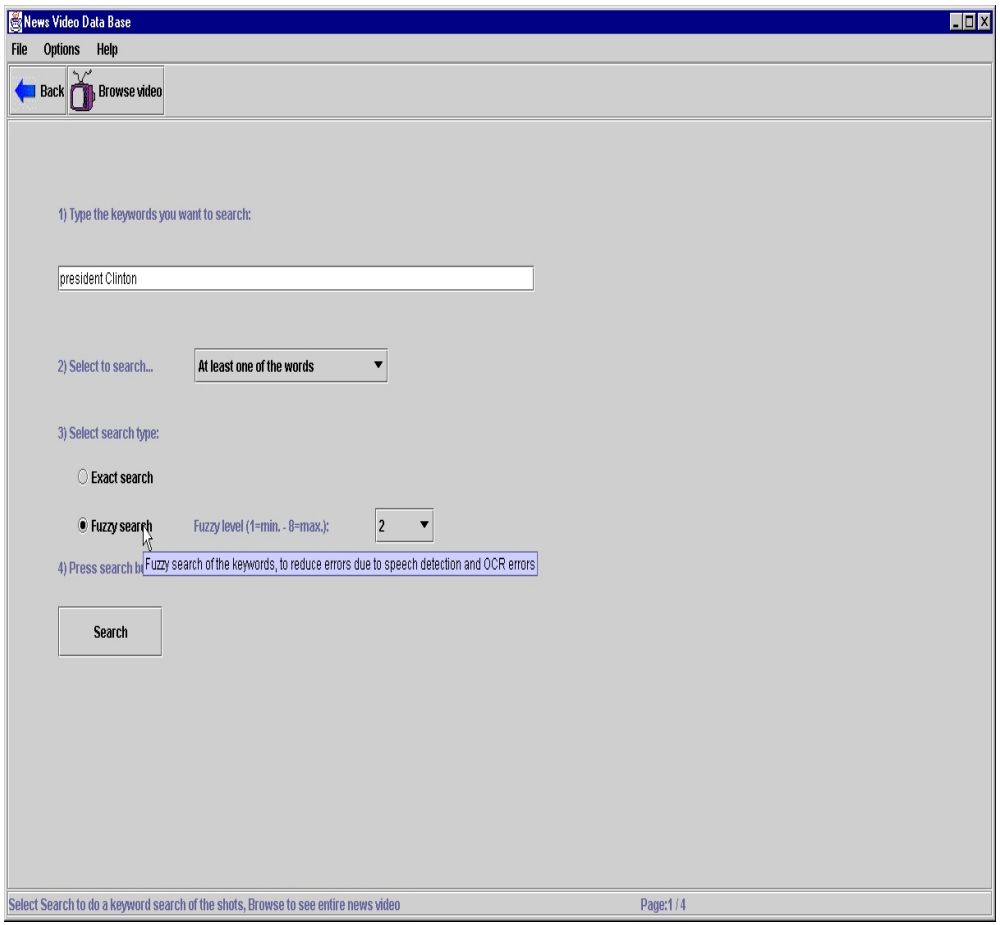
Text detection

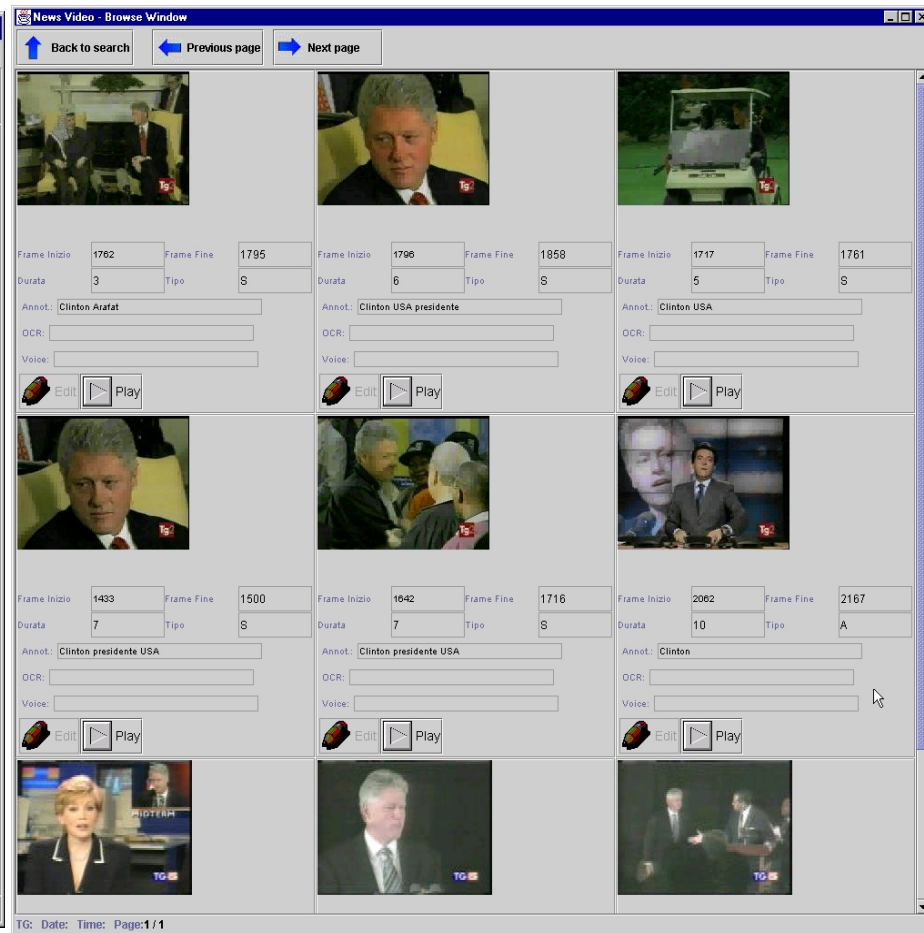
Original images with fading effect on text captions

Speech translation into text

Speech in the anchorman shot is translated into text (IBM Via Voice)

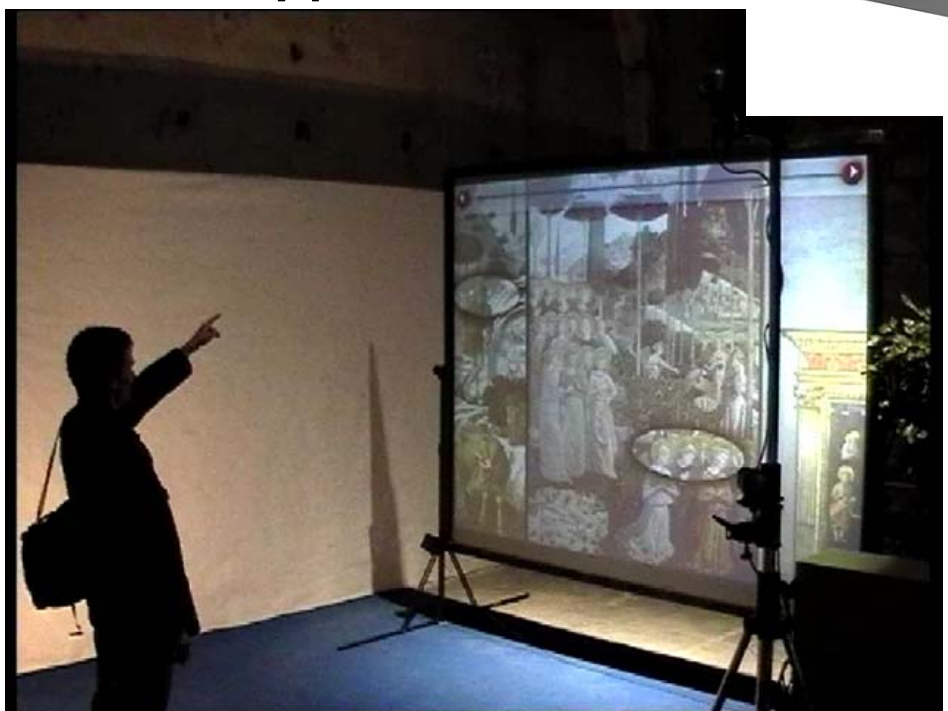
Query for "President Clinton" video clips





- ADVANCED MAN-MACHINE INTERACTION

The PointAt project addresses natural interaction with a hypermedia application

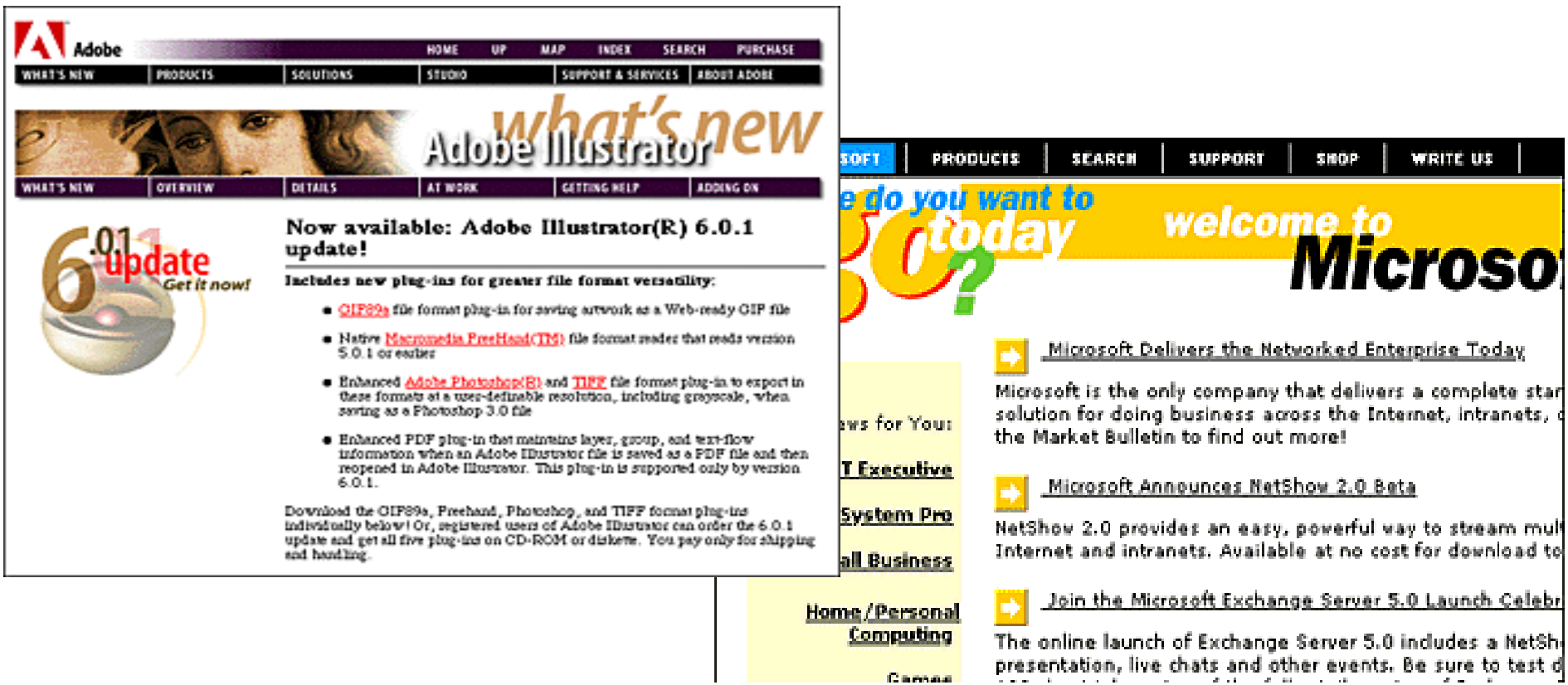


Distributed multimedia

- Communication capable multimedia systems are such that multimedia information cannot only be created, processed, presented and stored, but also distributed above the single computer boundary.

- Web-based multimedia systems support multimedia applications over the Internet. Distributed multimedia systems require continuous data transfer over relatively long periods of time, media syncronization, very large storage and special indexing and retrieval.

- WEB SITES INFORMATION DOWNLOAD

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Realizing the Full Potential of the Web...

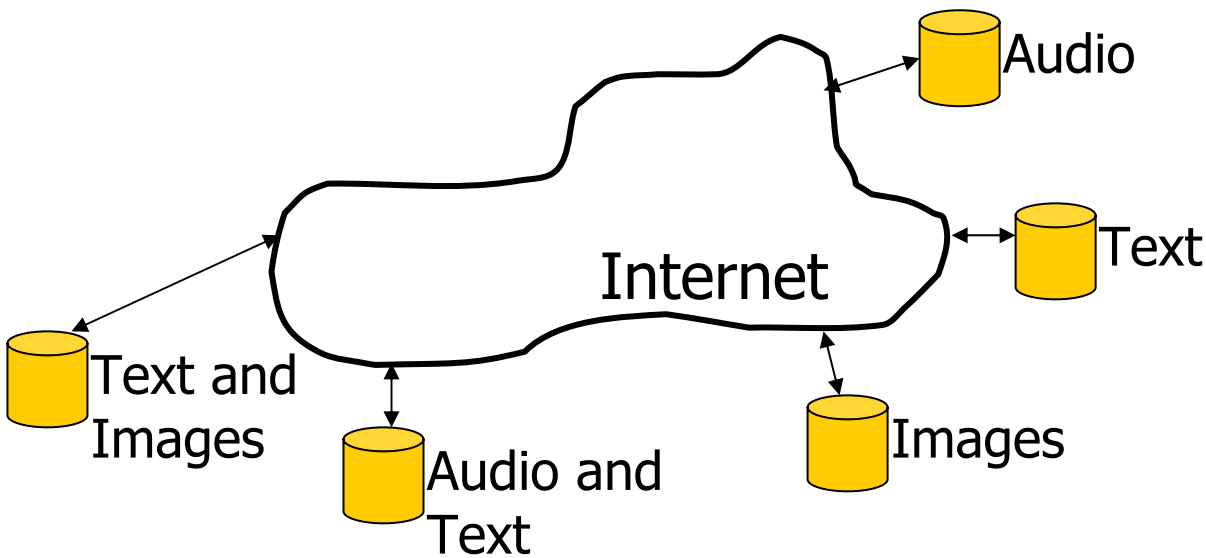
Announcing First Public Release of Amaya

> "The Amaya client, like the Jigsaw server, is a tool for experimenting to find out what is possible and demonstrate what can be done. Experiments, tests and demonstrations of developments in HTML, CSS, HTTP are examples of the way Amaya has already been used to great effect. Amaya provides focus for the community to come to consensus on implementable, practical standards."
> *-- Tim Berners-Lee, W3C Director*

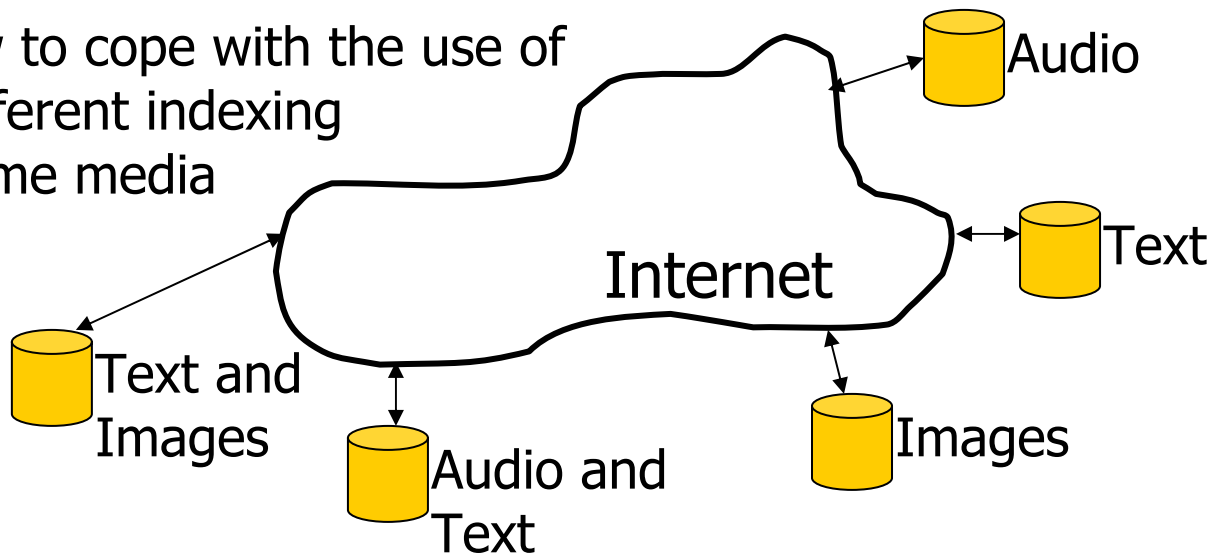
- *Tired of Waiting?* HTTP 1.1, CSS1 and PNG Can Make the Web As Much As 2-8 Times Faster

- DISTRIBUTED CONTENT BASED RETRIEVAL

- The EC MIND project addresses issues related to the access to thousands of heterogeneous and distributed multimedia Digital Libraries.

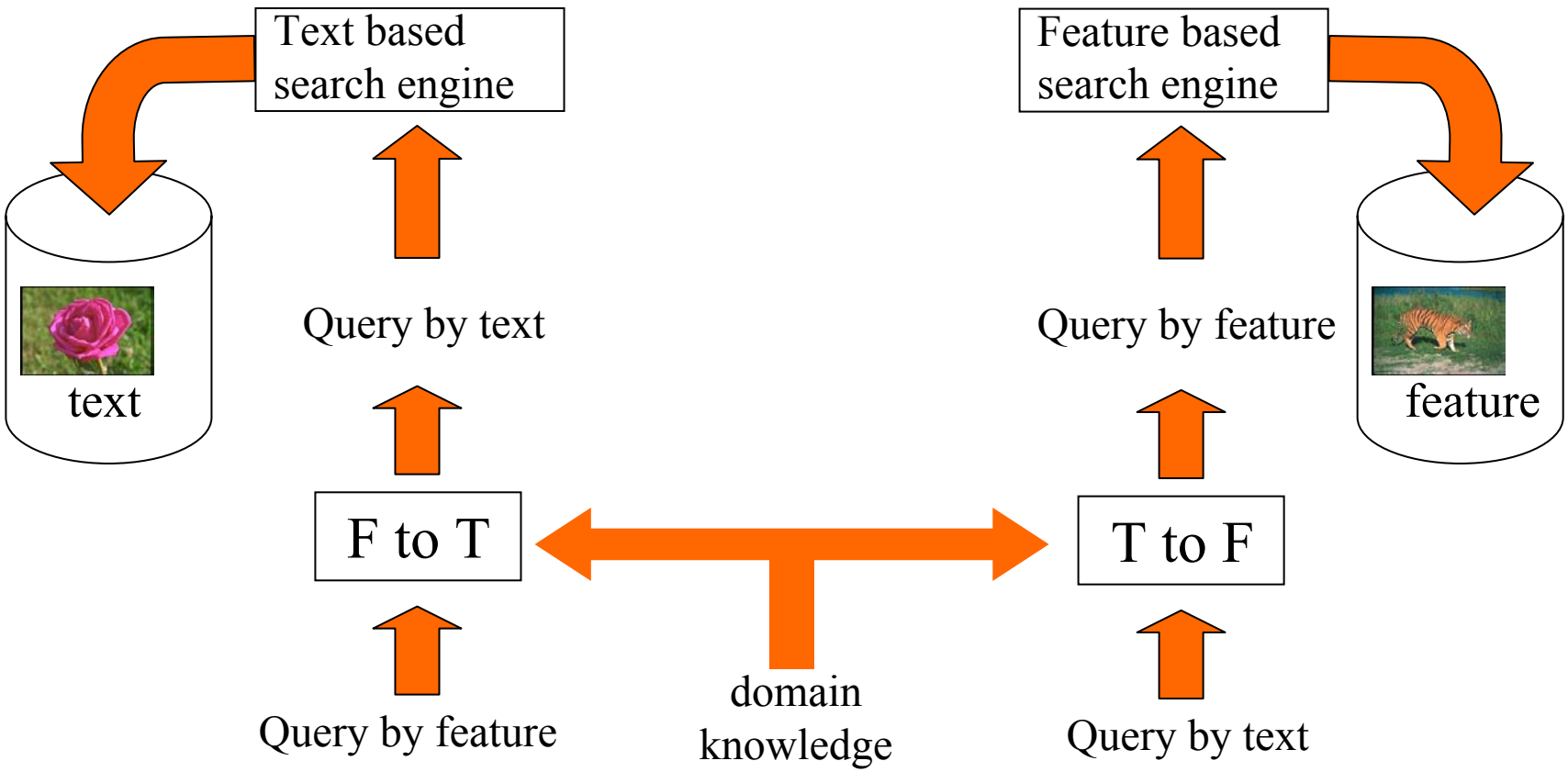


- *Resource description*: how to represent the content of an entire archive
- *Resource selection*: given a query, how to select the archives that are best candidate to contain relevant documents
- *Data fusion*: how to combine multimedia information returned from diverse resources
- *Heterogeneity*: how to cope with the use of different media, different indexing methods for the same media or different database schemas.

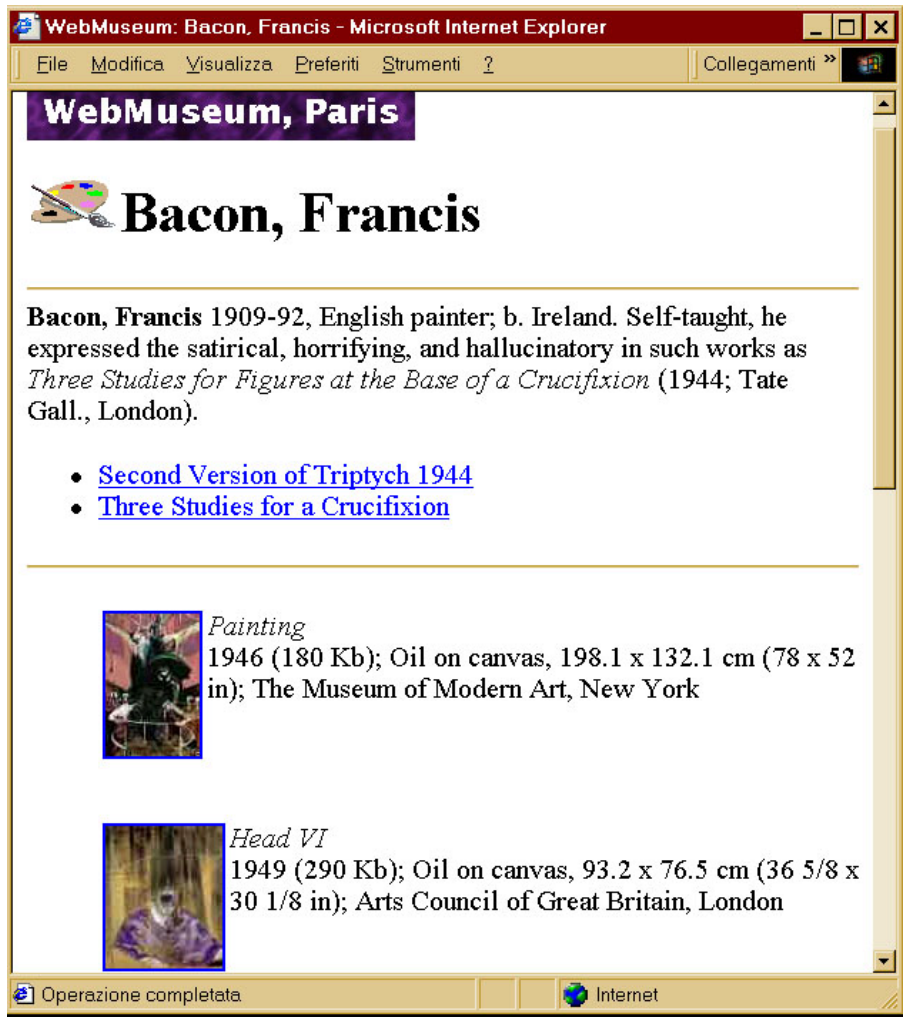


Heterogeneity

Query	Resource Descriptor: flower, car, aiplane, ...	Resource Descriptor:  
flowers	Retrieval based on text	
		Retrieval based on visual features

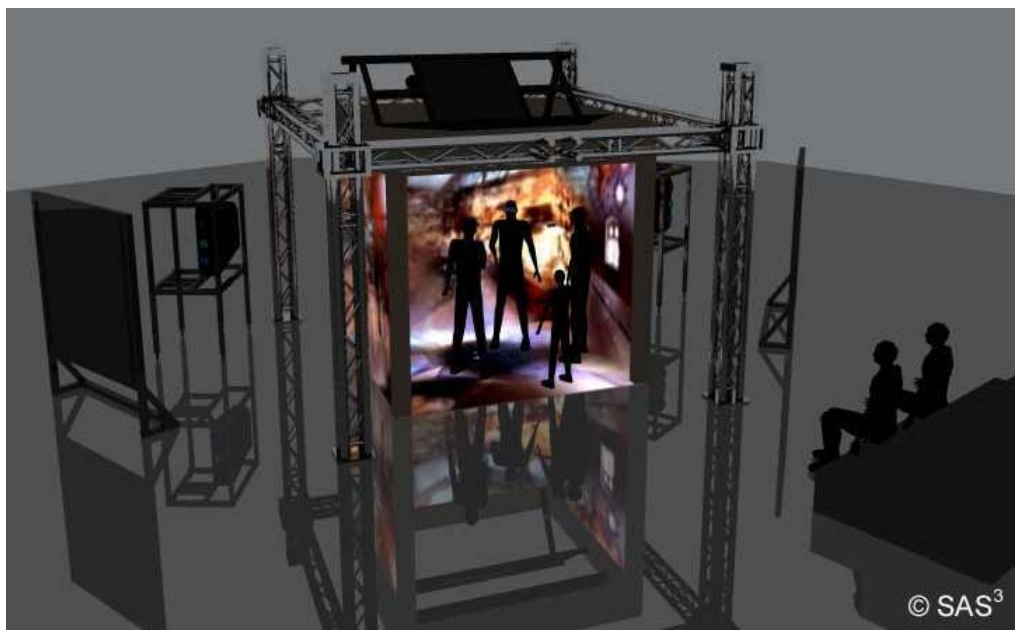

Text based search engine
Feature based search engine
text
feature
Query by text
Query by feature
F to T
T to F
Query by feature
domain knowledge
Query by text

- MIND testbed: the WebMuseum that includes a collection of over 1000 images of paintings with textual descriptions



DISTRIBUTED VIRTUAL REALITY

In a virtual environment the user is inside the environment surrounded by stereoscopic retro projections thus the user is fully immersed in a 3D environment. Users interact in real-time with their whole body and link the environment (via Internet) to other virtual environments. The movement and perspectives of the environment change according to the user's position and navigation.



Requirements of Multimedia

- Processing power.
  - To implement software codecs
  - Multimedai file systems and file format
- High bandwidth and efficient I/O
- OS support:
  - New data types,
  - realtime schedule,
  - fast interrupt processing
- Storage system: high capacity fast access
- Networking: new protocols
- Software tools

Research lines

Hw:

- Fast processors
- High speed networks
- Large capacity storage devices……..

Sw:

- Interactive graphics systems
- Human computer interfaces
- Real-time operating systems
- Object oriented programming
- Information storage and retrieval
- New video and audio compression algorithms
- New data structures
- Hypertext and hypermedia
- Web design……

Key topics of multimedia

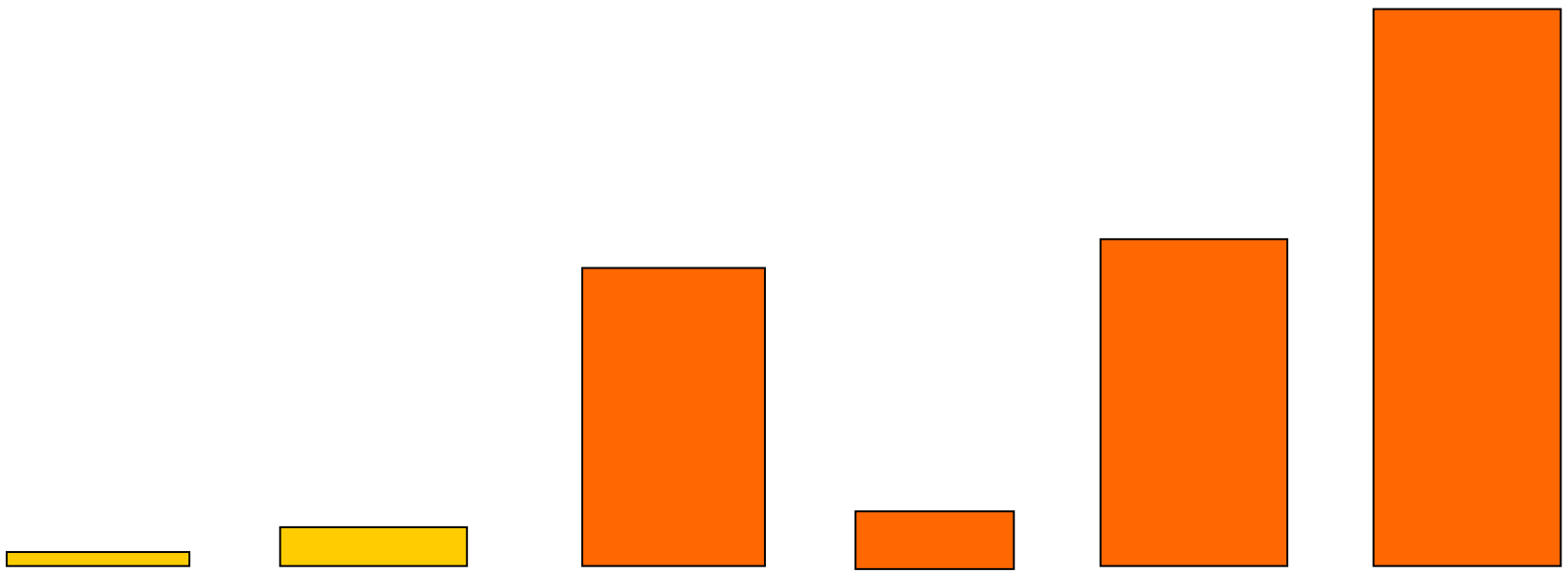
- Key topics of multimedia are:
  - Multimedia compression
  - Multimedia networking
  - Multimedia syncronization
  - Multimedia authoring

Multimedia compression

- Storage requirements: A single frame of color video with 620x560 pixel frames at 24 bits per second would take up about 1MB. At real-time rate of 30 frames/s that equals 30MB for 1 sec of video.

- The speed of real-time storage device would need to be 30 MB/s. CD ROM technology provides a transfer rate varying with "generation"
  - **1x 150 KB/s = 1.2 Mb/s**
  - **2x 300 KB/2 = 2.4 Mb/s**
  - **8x 1200 KB/s = 9.6 Mb/s**
  - **24x 3600 KB/s = 28.8 Mb/s**
  - **40x 6000 KB/s = 48 Mb/s**

- A typical multimedia application might store more than 30 minutes of video, 2000 images and 40 minutes of stereo sound on each side of a laser disc. This requires 64.5 GB in total:
  - 50 GB for video
  - 15 GB for images
  - 0.4 GB for Audio
- This requires compression algorithms



1MB	6.4MB	500 MB	100MB	550 MB	1GB
500 pages text	100 fax line images	100 color images uncompr	10’ animation Cr 15:1	10’ dig video Cr 30:1	1h dig Video Cr 200:1

- Compression techniques can be classified into:
  - Lossless
  - Lossy (applied more often in image and video compression)

Compression techniques

- La scelta della tecnica di compressione da impiegare dipende dal contesto applicativo e da una serie di parametri legati al tempo di compressione al fattore di compressione ed alla fedelta' dell'informazione ripristinata. In generale:
  - documenti testuali: compressione lossless
  - dati per analisi numerica: compressione lossless
  - Programmi: compressione lossless
  - immagini destinate a tipografia: compressione lossless
  - immagini destinate al WEB: compressione lossy
  - Video: compressione lossy
  - Audio: compressione lossy
- L'impiego di tecniche lossy e' in molti casi obbligatorio e rappresenta l'unica possibile soluzione qualora si vogliano dei fattori di compressione molto elevati.

Lossless Compression

- **RUN-LENGTH ENCODING**

  Con questa tecnica si sostituisce una sequenza di simboli uguali con un solo simbolo accompagnato dal numero di volte che questo compare consecutivamente:

  ppppppppppp ppppppppppp ppppppppppp diventa $11p $11p $11p

- E' necessario definire l'impiego di un carattere speciale (in questo caso $). L'intero file puo' essere codificato con la sequenza:

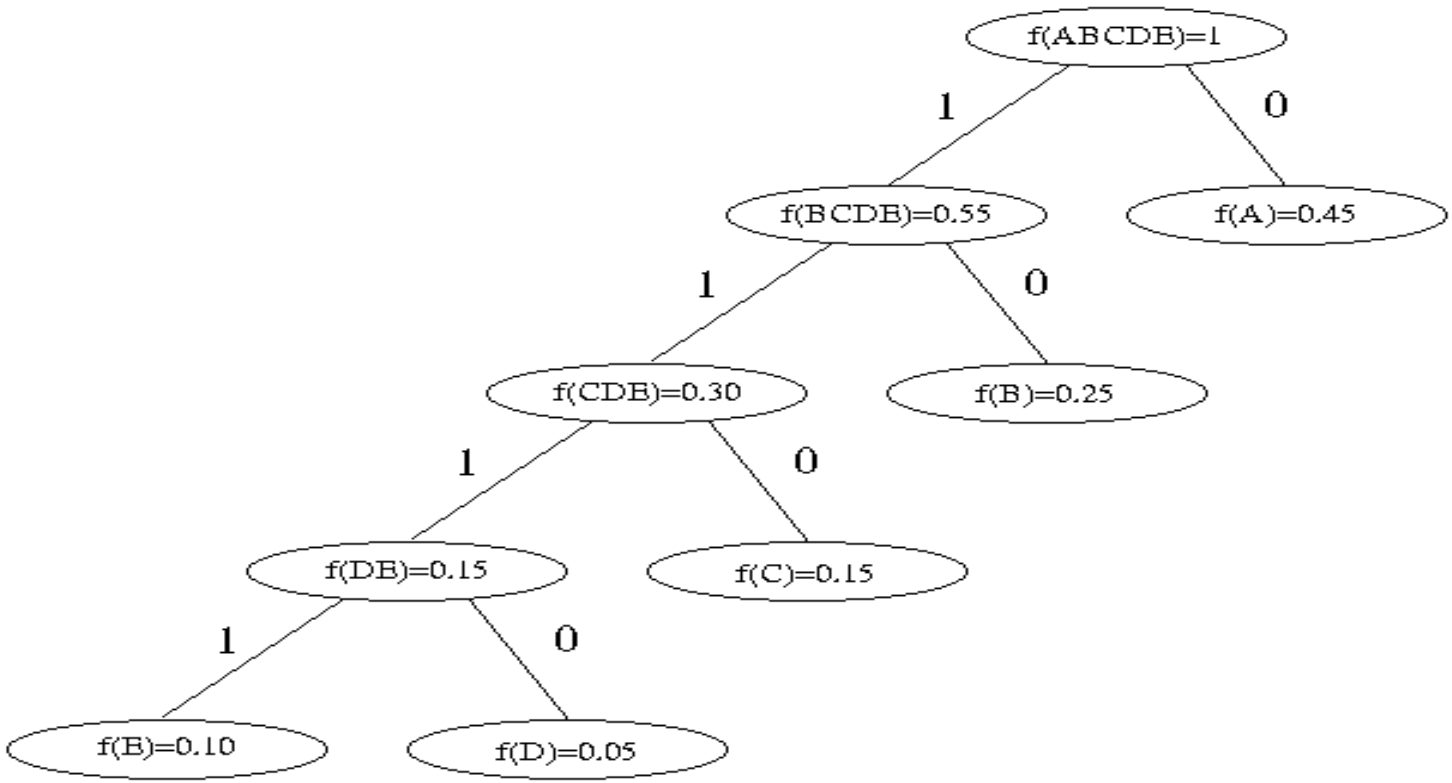
  $11r $11r $11r
  $11p $11p $11p
  $11c $11c $11c

  Totale caratteri: 6+6+6 = 18
  Totale numeri: 3+3+3=9
  Dimensione file: 27Byte = 216bit

- Questa tecnica puo' essere impiegata anche per la codifica di immagini, traendo vantaggio dall'occorrenza di pixel consecutivi di ugual colore.

- **HUFFMAN ENCODING** Invece di rappresentare ogni carattere con un Byte, e' possibile associare ad ogni carattere un codice. Ai caratteri piu' frequenti viene associato un codice di pochi bit, mentre la lunghezza del codice cresce al diminuire della frequenza del carattere.
- Il codice da associare ad ogni carattere puo' essere determinato costruendo una struttura ad albero binario sulla base delle frequenze dei singoli caratteri.

- Si consideri il caso di un documento in cui compaiono 5 caratteri A, B, C, D, E. La frequenza dei singoli caratteri e': f(A)=0.45, f(B)=0.25, f(C)=0.15, f(D)=0,05, f(E)=0.10.
  Il corrisponde
- Pertanto i 5 c
  - A: 0
  - B: 10
  - C: 110
  - D: 1110
  - E: 1111



Lossy Compression

- Lossy techniques can be further subdivided into:
  - Prediction based: predict subsequent values by observing previous values (ADPCM)
  - Frequency oriented: apply the DCT related to fast Fourier Transform
  - Importance oriented: use other characteristics of images such as color lookup tables and data filtering (DVI)
  - Hybrid

Standards for compression

- Various groups have established standards for digital multimedia compression:

- JPEG: compression ratio 15:1
  - Full color still frame applications
- MPEG: compression ratio 200:1
  - Video based telecom.
- H261 px64: 100:1 to 2000:1
  - video-based tlc

……

Compressed images/video and audio

Applications	bandwidth	standard	Size (pix by line)	Frame/s
Interactive MM image storing CD	N/A	JPEG	352x288	1
Analog videophone	5-10 Kbps	none	170x128	2-5
Video telephony	56-128 Kbps	px64	176x144	5-10
Video conferencing	> 384 Kbps	px64	352x288	15-30
Interactive MM motion video	1-2 MB/s	MPEG-1	Upto 352x288	15-30
Digital NTSC	3-10 MB/s	MPEG-2	720x480	30
HDTV	>15 MB/s	FCC	1200x800	60

- **Immagine 146 x 184 con 75 colori. Dimensione file:**
  - **Teorica con 8 bpp: 26864 byte**
  - **Teorica con 24 bpp: 80592 byte**
  - **PPM (24 bpp) : 80674 byte**
  - **GIF (8 bpp): 3585 byte (FC=22.48)**
  - **JPG (24 bpp): 4805 byte (FC=16.77)**
  - **PPM.ZIP (24 bpp): 3698 byte (FC=21.79)**

Immagine 244 x 334 con 31322 colori. Dimensione file:

Teorica con 8 bpp: 81496 byte
Teorica con 24 bpp: 244488 byte
PPM (24 bpp) : 244620 byte
GIF (8 bpp): 49613 byte (FC=4.92)
JPG (24 bpp): 16352 byte (FC=14.95)
PPM.ZIP (24 bpp): 190977 byte (FC=1.28)

Multimedia networking

- Many applications such as video mail, video conferencing and collaborative work systems require networked multimedia.
- Multimedia objects are stored at a server and played back at the clients' sites. Such applications might require multimedia broadcasting of multimedia data to various remote locations

Networks for Multimedia

- Multimedia transfer has different requirements from traditional data transfer:

	Data transfer	Multimedia transfer
Data rate	low	high
Traffic pattern	bursty	stream-oriented Hbusty
Reliability req	no loss	some loss (no retransmission)
Latency req	none	low (20 ms)
Comm. Mode	point to point	multipoint
Temporal relation	none	syncronized no Jitter

- Traditional local area networks are partially suited for multimedia:
  - Fast Ethernet 100Mb/s access time not bounded, latency and jitter unpredictable
  - FDDI 100 Mbp/s in syncronous mode low latency and low jitter, bounded access delay and predictable average bandwidth for syncronous traffic (used for backbone)

- B-ISDN key network for multimedia applications
  - Basic: 2B + D channels
    - B channel 64Kbps (128Kbps composite)
    - D channel 16 Kbps
  - Primary: 23B/30B + D

- Conferences can use part of this for wideband speech, saving the rest for control, meeting data and compressed video.

- B-ISDN networks are in either syncronous transfer mode (STM) or asyncronous transfer mode (ATM).
  - STM provides fixed bandwidth channels
  - ATM greater flexibility in bandwidth allocation by assigning fixed lenght packets (cells) to virtual connection.

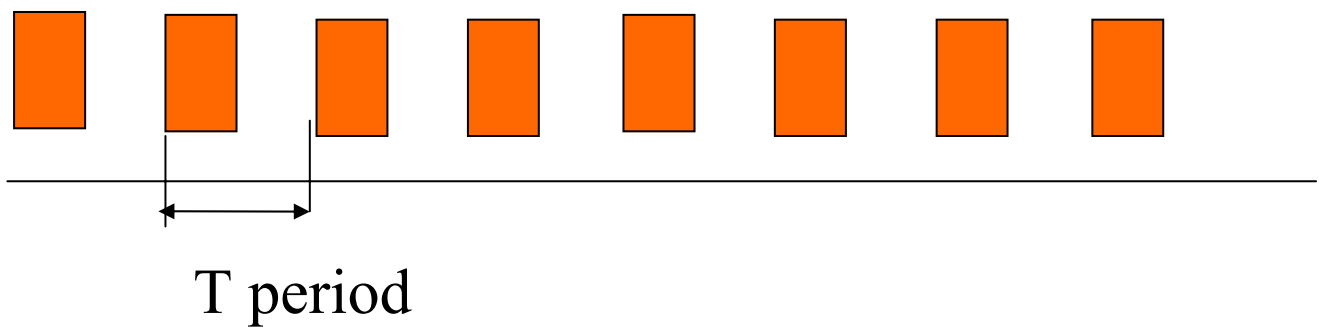
- B-ISDN Syncronous transmission mode
  - Defines a max end-to-end delay for each packet of data stream (*max endtoend delay guaranteed*).
  - The upper bound will never be violated
  - A packet can reach the receiver at any arbitrary earlier time  need of intermediate storage
  - EX: transfer of video data 140Mb/s max delay 1 sec. Packets can arrive at the receiver 1 sec too early and have to be stored intermediately: need of 17.5 MB temporary storage

- B-ISDN Asyncronous transmission mode
  - Provides for communication with no timely restriction
  - Packets can reach the receiver as fast as possible
  - If an asyncronous mode is chosen for transmission of continuous media additional techniques must be applied to provide time restrictions

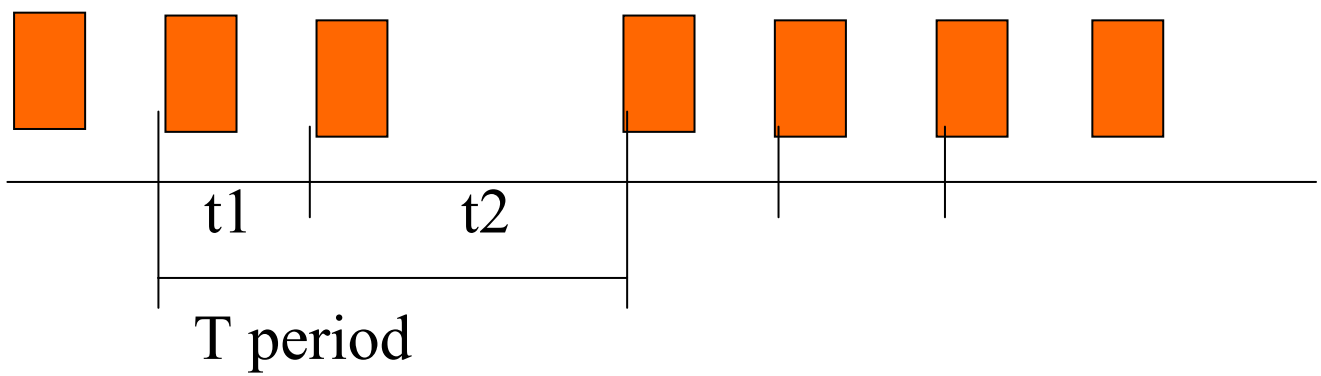
- Isocronous
  - Defines both a max end-to-end delay and a minimum end-to-end delay for each packet
  - The delay jitter for each packet is bounded
  - Reduced need of intermediate storage

Data streams characteristics

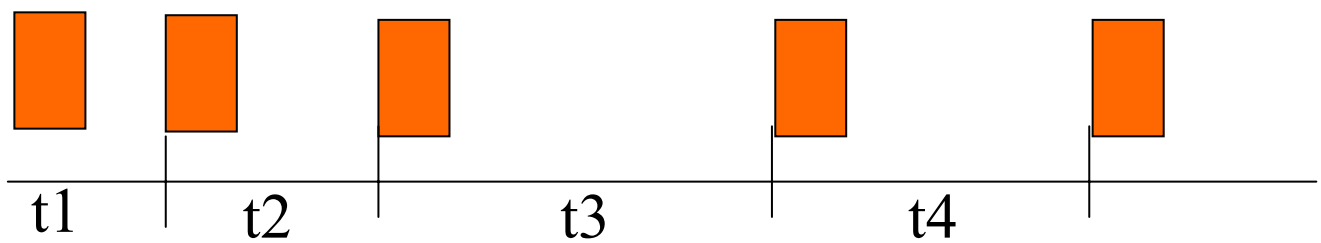
- The first characteristics is related to the *time interval* between consecutive packets.
  - *Periodic streams*: If the time interval between two consecutive packets is constant, a data stream is strongly periodic



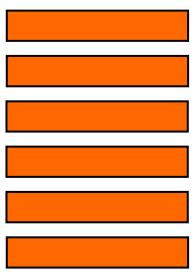
- *Weakly Periodic streams*: The duration of the time interval between two consecutive packets can be described through a periodical function with finite period but the time interval between two consecutive packets is not constant. The data stream is called weakly periodic



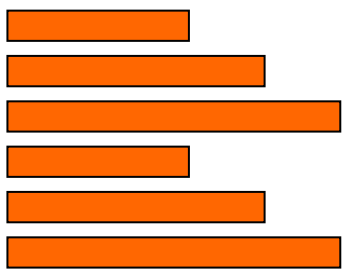
- *Aperiodic streams*: All other possibilities of transmission wrt time interval are known as aperiodic data streams. If this information is transmitted periodically, extremely high redundancy is present.



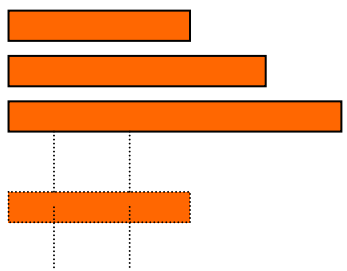
- A second characteristic of data streams is the variation of the *amount (size)* of consecutive packets:



Regular
Eg: uncompressed video stream

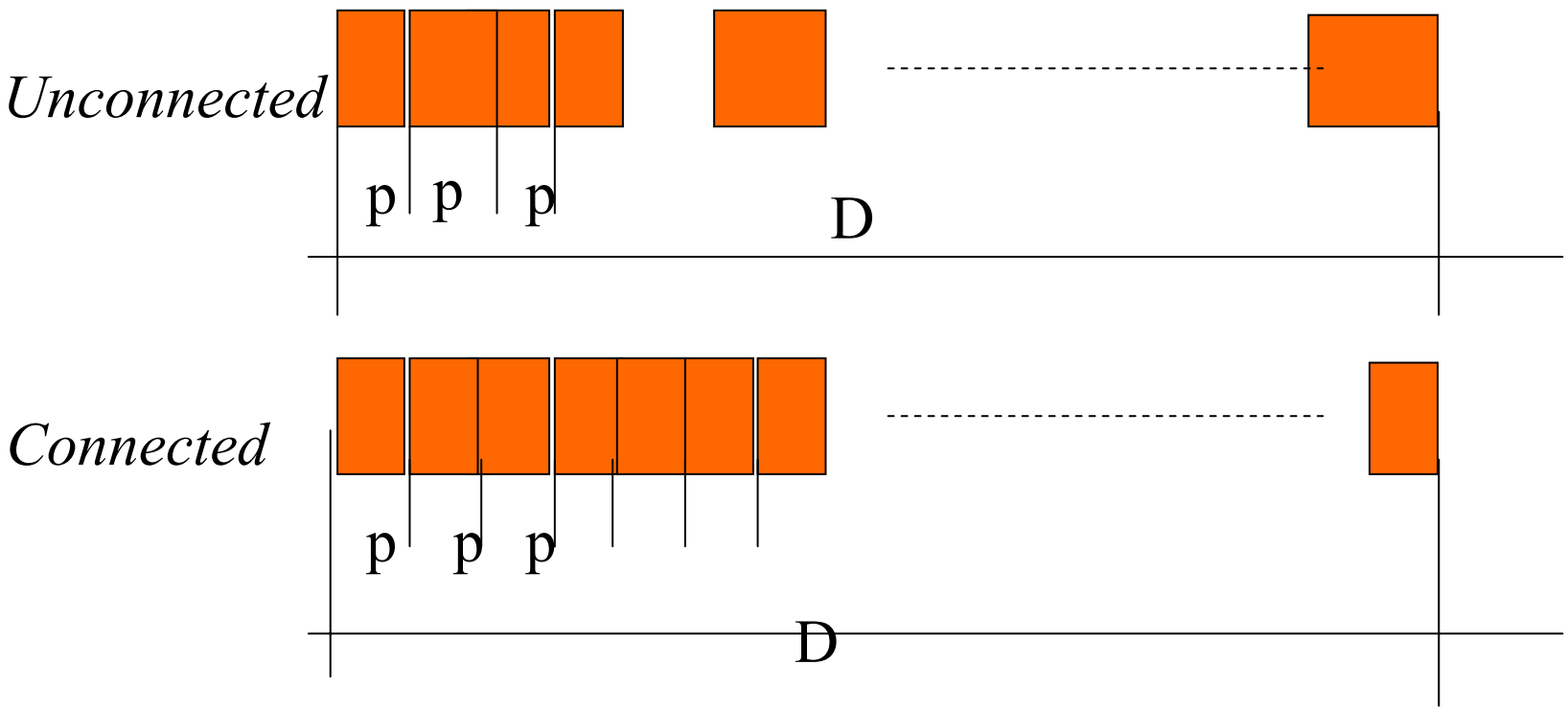


Weakly regular
Eg compressed video stream



Irregular
Eg size of packets determined by the content

- The third characteristics is *continuity*, or the connection between consecutive packets (whether they are transmitted directly one after another or there is a gap between the packets).

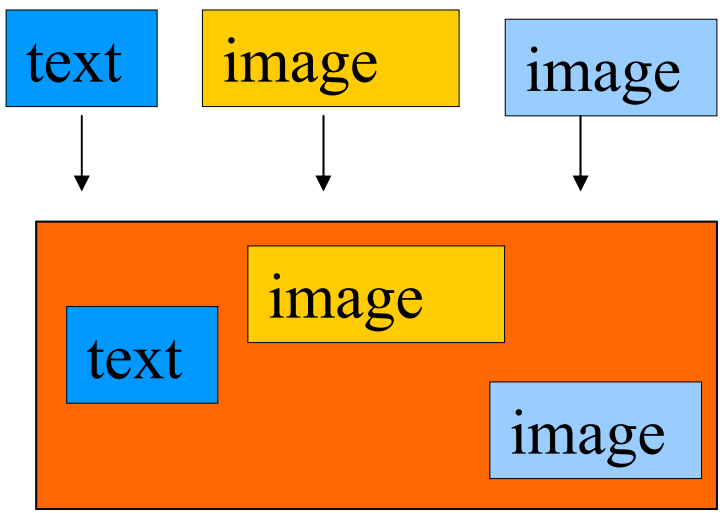


- Continuity can be seen as the utilization of a given resource such as a network.
  - A connected data stream allows maximal data throughput and reaches optimal utilization (ex a Bchannel of ISDN with transmission of 64Kbps audio data)
  - The transmission of a connected data stream through a channel with a higher capacity leads to gaps between individual packets (ex the transmission of a data stream coded with JPEG with 0.5 Mbps throughput on average on a FDDI network will lead to gaps)

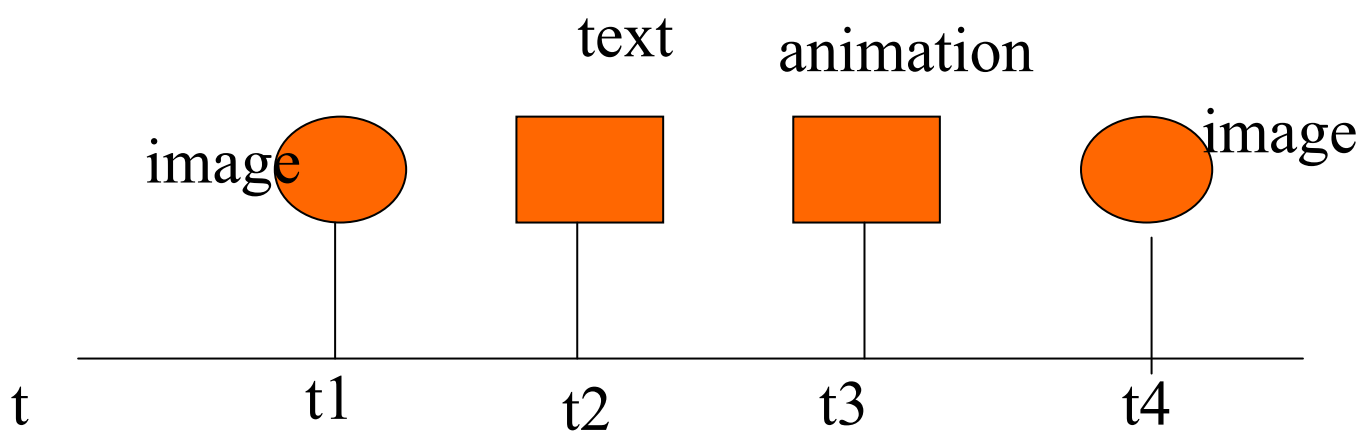
Multimedia syncronization

- Multimedia systems include various sources of various media either spatially or temporally to create composite multimedia documents.

- Spatial composition links various multimedia objects into a single entity dealing with object size , rotation and placement witin the entity

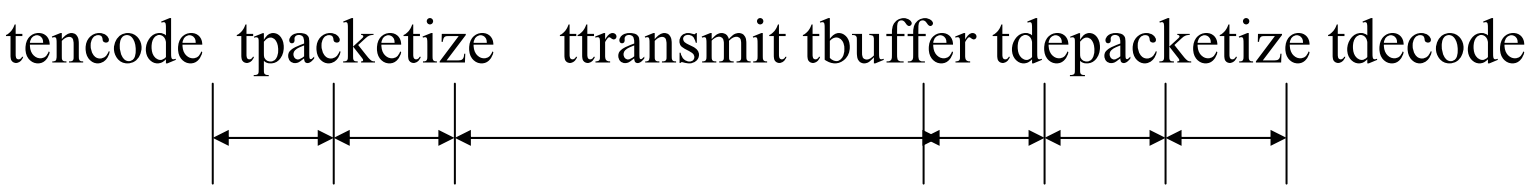


- Temporal composition creates a multimedia presentation by arranging multimedia objects according to temporal relationships



- The task of syncronization, whether implemened in the network or in the receiver is to eliminate all the variations and delays incurred during the transmission of multiple media streams and to maintain the syncronization among the media streams

- The end to end delay of a distributed multimedia system consists of all the delays created at the source site, network and the receiver site



- We can divide temporal composition or syncronization, into continuous or point syncronization.
  - *Continuous syncronization* requires constnat syncronization of lenghty events (*ex. Video telephony, where audio and video are created at a remote site, transmitted over the net and syncronized continously at the receiver for playback)*.
  - In *point syncronization*, a single point of one media block coincides with a single point of another media block. (ex a slide show with blocks of audio allotted to a single slide)

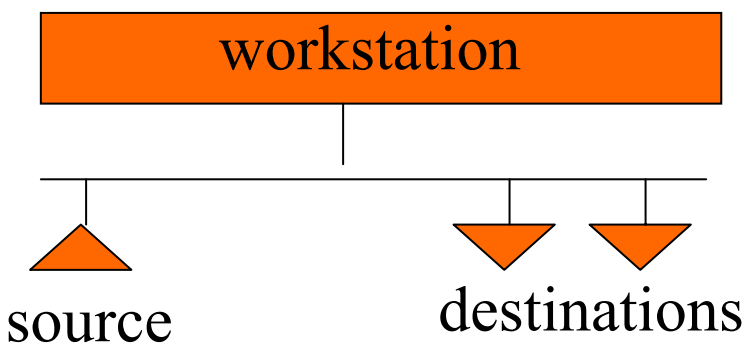
- Two futher classes of syncronization are serial and parallel syncronization.
  - Serial syncronization determines the rate at which events must occur within a single data stream (intramedia syncronization)
  - Parallel syncronization determines the relative schedule of separate syncronization streams (intermedia syncronization)

Intermedia syncronization

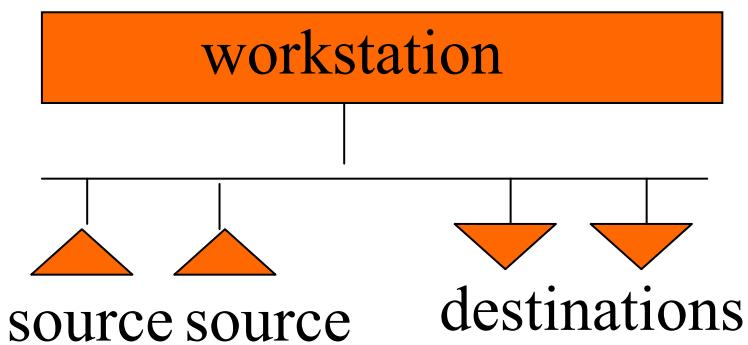
- Responsibility of maintaining intermedia syncronization falls into both the sources and the destination of data. Most techniques rely more on the destination.

- Classification builds on four data location models:
  - Local single source
  - Local multiple sources
  - Distributed single source
  - Distributed multiple sources

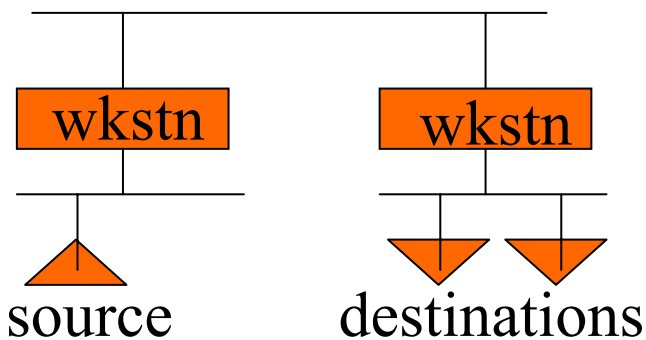
- Local single source: a single source such as a CD-ROM distribute the media stream to the playback devices.As long as the playback devices maintain their playback speed, no syncronization is required



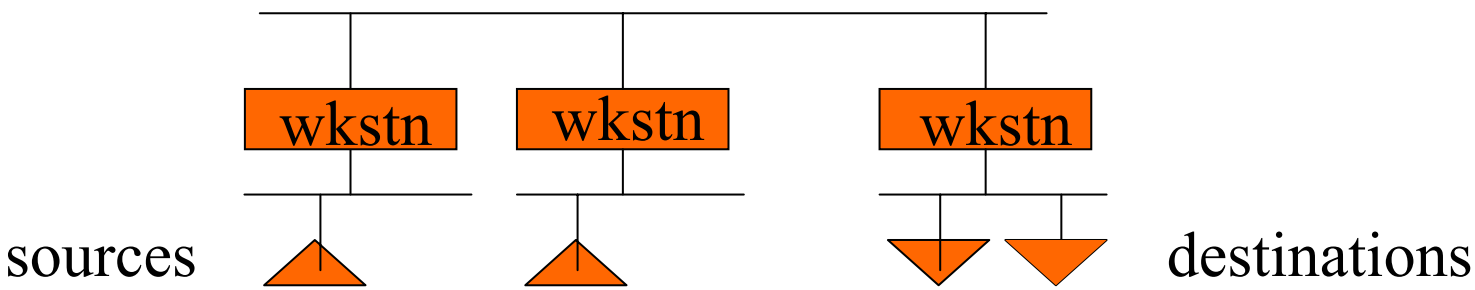
- Local multiple sources: more than one source distributes media streams to the playback devices: an example is a slide show played with music or an audio tape. Syncronization is required within the workstation



- Distributed single source: one source such as a videotape distributes media streams across a network to one or more nodes/playback devices (ex a cable tv). The technique requires no syncronization other than maintaining the speeds of the playback devices



- Distributed multiple sources: this is the most complex case, where more than one source distributes media streams to multiple playback devices on multiple nodes. This group further breaks down into:
  - multiple sources from one node distributed to another node (ex a video call);
  - multiple sources from two or more nodes distributed to two or more nodes (ex HDTV);
  - multiple sources from two or more nodes distributed to two or more nodes (ex group teleconference)

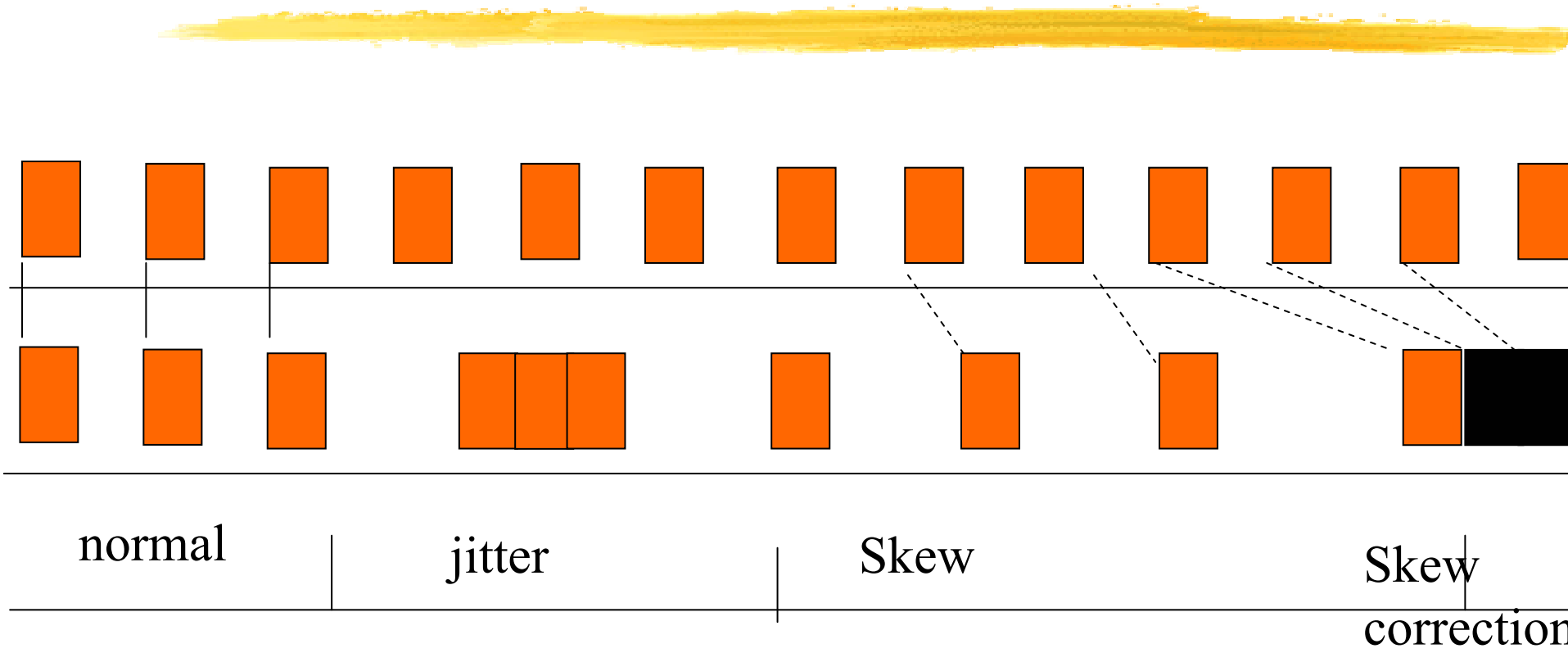


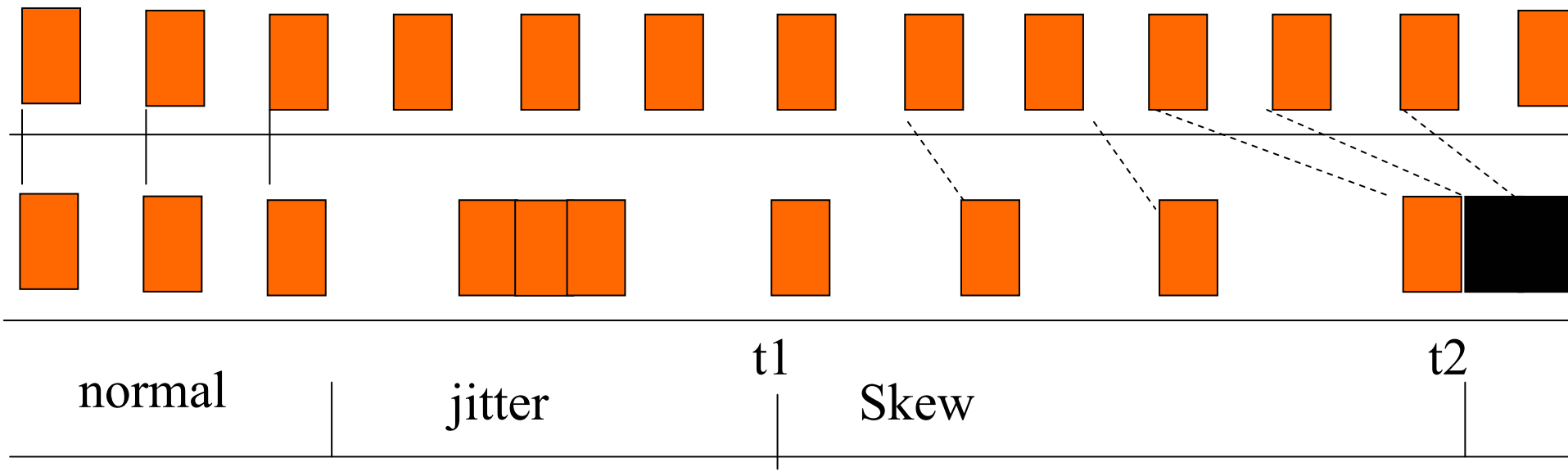
- For local single source and local multiple source local syncronization within the workstation suffices
- The two cases with distributed sources require complex syncronization to eliminate the various causes of asyncrony.

Quality of service

- Implementing a syncronization algorithm requires specifying the QOS for multimedia communication:
- QOS: set of parameters including:
  - Speed ratio
  - Utilization
  - Average delay
  - Jitter
  - Bit error rate
  - Packet error rate

- Speed ratio
  - Actual presentation rate / nominal presentation rate
- Utilization ratio
  - Actual presentation rate / available delivery rate
- Skew
  - Average difference in presentation times between two syncronized objects over n sync points
- Jitter
  - Instantaneous difference between two syncronized streams


normal
jitter
Skew
Skew
correction



Speed ratio: t0-t1 = 6/6 t1-t2 = 4/6

Utlization ratio: duplication of frames create DR greater than 1

Skew duplication of a frame creates retard t1-t2 = 4/6

- QOS requirements example:

	video telephony	JPEG video transmission
Speed ratio	1	1
Utilization	1	1
Average delay	0.25s	0.2s
Max Jitter	10ms	5ms
Max bit error rate	0.01	0.1
Max packet err. Rate	0.001	0.01

Single and multiple stream syncronization

- To syncronize an event first we must analyze the end to end delay or latency. Then schedule a retrieval time that allows enough time before the deadline to allow for latency.
  - For example, if the total latency time of retrieving a 1 hour video is 3’, and the customer ordered the video for 7pm, set the retrieval time for 6.57 pm at the latest

- We can extend single event syncronization to single data stream syncronization and further to the general case of multiple data stream syncronization.

- Syncronization consists of calculating the control time based on multiple dealines, playout times and latencies. In this case T represents the buffering at the receiving site to smooth out variations in latencies,

Multimedia Authoring

- *Authoring* -- the process of creating multimedia applications

- *Authoring metaphor*, also known as *authoring paradigm*, is the methodology for authoring multimedia applications. The following are some of the common ones:

Authoring metaphors

Main authoring metaphors are:

- **Scripting Language Metaphor**
  - use a special language to enable interactivities (button, mouse, etc), and to allow conditionals, jumps, loops, functions/macros e.g., OpenScript in Toolbook by Asymetrix
- **Slide Show Metaphor**
  - by default a linear presentation e.g., PowerPoint, ImageQ
- **Hierarchical Metaphor**
  - organized into a tree structure; seen often in menu-driven applications

- **Iconic/Flow-control Metaphor**
  - graphical icons and flow chart to help authoring e.g., Authorware by Macromedia
- **Card/Scripting Metaphor**
  - index-card structure, good for hypertext/hypermedia e.g., SuperCard, HyperCard by Apple
- **Cast/Score/Scripting Metaphor**
  - with cast members, music scores, and scripting language; many synchronous horizontal "tracks" simultaneously shown in vertical columns; e.g., Director by Macromedia (it uses Lingo as its scripting language)

Design issues

- Selecting attractive content for the user population
- Selecting appropriate content for the users task
- Planning the thematic thread through a presentation
- designing the reading viewing sequence to make the thread clear

  Emphasizing the key elements of the message

Cognitive processes

- Cognitive psychology has relevant research-multimedia: educational psychology Cognitive processes have to time slice between receiving information/ processing it / remembering it
- Attention gets distracted by input on different channels, especially dynamic media (visual dominance)
- We only remember fraction of content from dynamic media (speech, video)
- Comprehension in text/speech is linear-follows input, but not so in image

- Thematic Congruence: different parts of the message should be easy to integrate & comprehend
- Manageable Information: loading-users have time to assimilate the necessary information sequential or concurrent presentation
- Avoid attention conflicts: make sure the user can assimilate information without being distracted.

Message formatting and delivery

- "In multimedia, there are five ways to format and deliver your message.
  - You can *write* it,
  - *illustrate* it,
  - *wiggle* it,
  - *hear* it,
  - *interact* with it."

- Scripting (*writing*):

- Rules for good writing:
  - Understand your audience and correctly address them.
  - Keep your writing as simple as possible. -- e.g., write out the full message(s) first, then shorten it.
  - Make sure technologies used complement each other.

- Graphics (*illustrating*)
  - Make use of pictures to effectively deliver your messages.
  - Create your own (draw, (color) scanner, PhotoCD, ...), or keep "copy files" of art works. Color Themes must be consistent with the contents
    - pastels
    - earthtones
    - metallic colors
    - primary colors
    - neon colors

- Animation (*wiggling*)

- Types of Animation
  - Character Animation -- humanize an object e.g., a toothbrush, a car, a coke bottle, etc. Factors in choosing a character:
    - Emotion -- Is it happy, sad, funny, sloppy, ...?
    - Movement -- Is it fast, slow, bumpy, ...?
    - Visual style -- Is its color/texture consistent with the rest?
    - Copyright -- "Don't use Mickey before checking with Disney."
    - Adequacy -- e.g., Does it provide various poses (can't make a broomstick sit!)

- Moving Text
  - e.g., put up one character at a time like a typewriter; "pulsing" -- the word grows/shrinks (or changes color) a few times.....
- Video: live video or digitized video
  - +: more powerful than still images
    +: often easier to obtain than graphics animation
    -: takes a lot of disk space
    -: sometimes needs special hardware

- Audio (*hearing*)
  - Types of Audio in Multimedia Applications:
    - Music -- set the mood of the presentation, enhance the emotion, illustrate points
    - Sound effects -- to make specific points, e.g., squeaky doors, explosions, wind, ...
    - Narration -- most direct message, often effective

- **Interactivity (*interacting*)**

- **people remember 70% of what they interact with. Some common types of Interactive Multimedia Applications:**
  - Hypermedia
  - Web sites
  - Content-based retrieval
  - Simulations / Performance-dependent Simulations e.g., Games -- SimCity, Flight Simulators
  - Virtual/augmented reality environments
  - Advanced natural man machine interaction voice/gesture based

Visual Design

- Themes and Styles
- a multimedia presentation should have a consistent theme/style, it should not be disjointed and cluttered with multiple themes. The choice of theme/style depends on the styles and emotions of your audience.

- Some Possible Themes:
  - Cartoon theme
    - +: interesting / entertaining
      -: must be consistent with the character's personality
  - Traditional theme -- straightforward marketing pieces
    - +: simple, often informative
      -: not as interesting
    -

- High tech theme -- contemporary computer art work (morphing, texture mapping, metal texture, explosions, ...)
  - +: attractive, easy to animate
- Technical theme -- include blueprints, 3D models of the product, ... e.g., start with a drawing, then transformed into a rendered image.
  - +: shows adequate technical information
    +: gives impression of solid design and construction