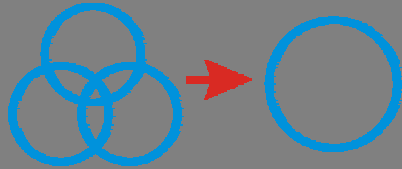


## Multimediale Visualisierungssysteme WS 2000/2001



### 3. Integration

Prof. Dr. Paul Müller

AG: Integrierte  
Kommunikationssysteme

ICSY

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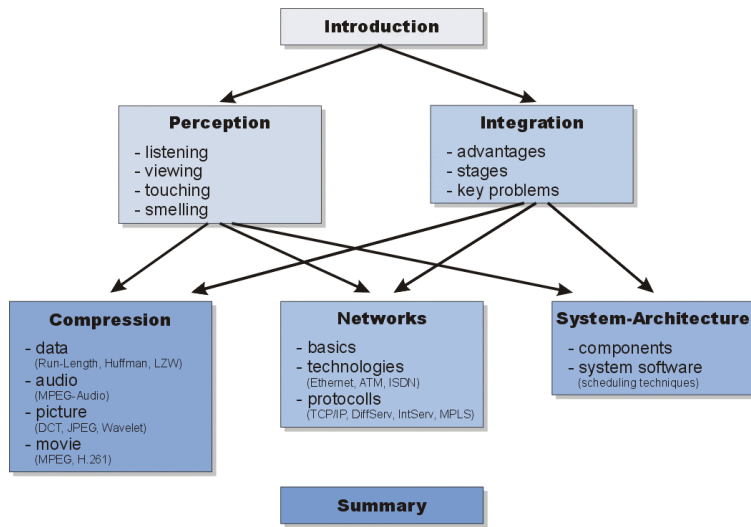
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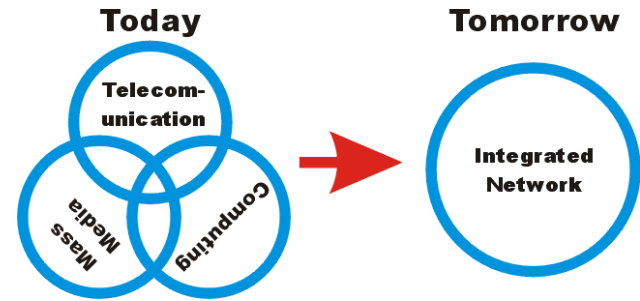
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## Sitemap



## 3. Integration

Combination of three areas:



Technological outlook:

- Networked computers as the information tools of the 21st century

## Integration Results

Potential advantages of integration:

- Reduction of costs for existing services
- Improvement of the quality of existing services
- Interaction between existing services
- Availability of new services

## Integration Advantages

Future Multimedia Systems:

One single:

- computation
  - communication
  - entertainment
- } Workstation



**Information-  
Communication-  
Entertainment-  
Workstation**

Replaces:

- personal computer
- telephone & answering machine
- FAX machine
- high-fidelity stereo set
- TV receiver
- video cassette recorder
- video game

## Media Advantage: Expressiveness

### Man-machine communication:

- From computer-oriented interfaces to human-oriented interfaces
- From a human perspective, interfaces are still insufficient:
  - Speaking is faster than writing.
  - Listening is easier than reading.
  - Showing is better than describing.

### Information spectrum:

- Any idea requires a certain amount of information to express it
- Each medium has limitations on the information it can convey
- When information is transported through inappropriate media, parts of it may get lost

### Extended bandwidth of perception:

- More complete media spectrum with audio and video
- More familiar “look-and-feel” of man-machine interfaces

## A Network Advantage: Reachability

### Network evolution:

- Today: Disjoint telephone, data and TV distribution networks
  - Advantage: Pervasiveness
  - Disadvantage: One medium only
- Almost today: Integrated Services Digital Networks (ISDNs)
  - Advantage: Already voice and data
  - Disadvantage: Only voice and data
- Tomorrow: Integrated Broadband Communication Networks (IBCNs)

### Chicken-and-egg problem:

- Consumers will not connect to the network before good services are available
- Providers do not offer services if there is no market

## A Computer Advantage: Individuality

### Interaction:

- TV uses broadcast (couch-potato mode):
  - Users can select program, but nothing else
  - Prevents applications outside a mass market
- Computer at the receiving side can influence:
  - When to watch
  - What to watch
- Advantages:
  - Adjustable degree of interaction
  - Single-consumer applications

### Personalization:

- Computer can filter and select information
- “Personalized newspaper”

## Advantages of Processing

### Computer processing functions can be used to:

- Select information
- Modify information
- Interpret information

### Media transformation:

- Generate movie from textual description
- Play music from a score

### Media understanding:

- Audio commands
- Video analysis

## Advantages Summary

### Media Advantage: Expressiveness

- Man-machine communication
- Information spectrum
- Extended bandwidth of perception

### A Network Advantage: Reachability

- Network evolution
- Chicken-and-egg problem

### A Computer Advantage: Individuality

- Interaction
- Personalization
- Processing

## 3.1 Steps toward Integration

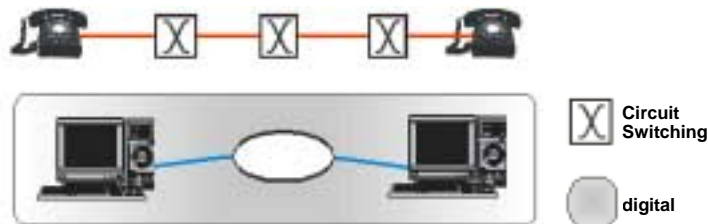
Stages of evolution:  
towards integrated digital systems

- Traditional approaches
- Computer controls audio/video components
- Digital, but not integrated communication
- Integrated communication, but separate local AV components
- Digital systems with analog interfaces
- Digital systems with all digital interfaces

## Stage I: Traditional Approach

Separation of analog and digital data:

- Continuous vs. discrete media
- Analog vs. digital
- Telecommunications vs. computers



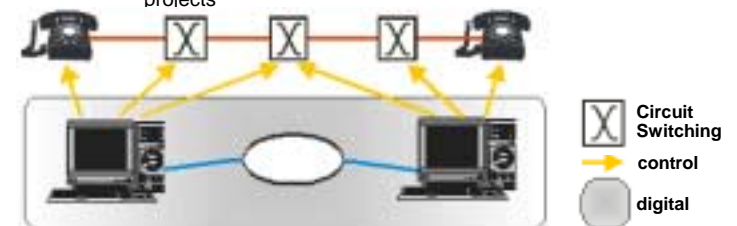
## Stage II: Computer Controls External Devices

Make use of:

- AV components
- Computers control analog devices:
  - SCSI, RS-232C, other interfaces

Examples:

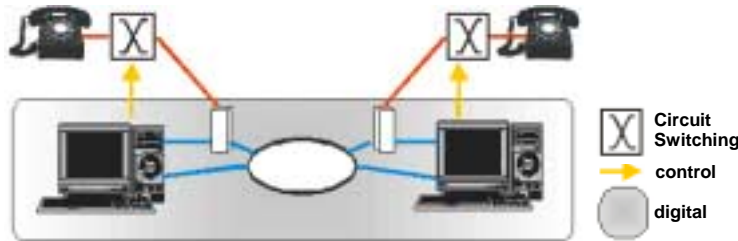
- Integrated Media Architecture Laboratory (IMAL), Bell Research
- Video Services in Muse and Pygmalion of the MIT Athena projects



## Stage III: Digital Communications

Digital, but not integrated communication:

- Digitalization of continuous media
- Separate net access
- Example:
  - PBXs connected via ATM networks (PBX = Private Branch Exchange)

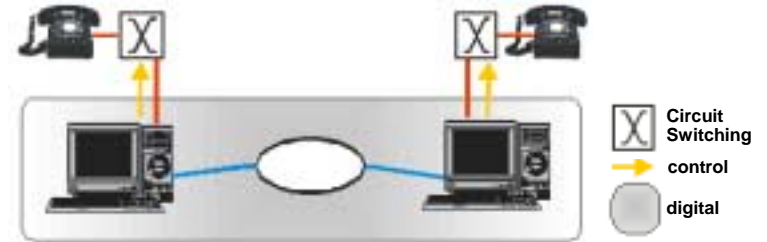


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## Stage IV: Integrated Digital Communications

Integrated communication, separate Local AV Components:

- Only some continuous media data stream routed through the computer
- Use of available AV technology
- Example:
  - Etherphone developed by XEROX PARC with integrated communication but, e. g. separate storage

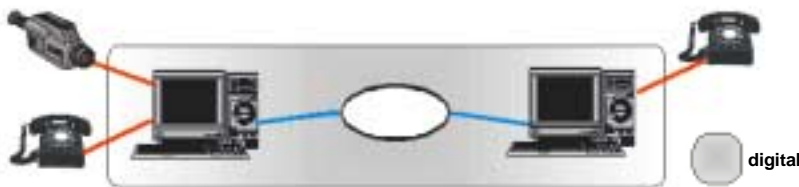


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## Stage V: All Digital But Analog Interfaces

Digital systems with analogue interfaces:

- All data routed through the computer
- Examples:
  - AT&T in Naperville: Fast packet-switching net attached to workstation:
    - Expansion of UNIX towards "connectors", "active devices"
  - DASH in Berkeley



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## Stage VI: All Digital System

Digital systems with all digital interfaces:

- Assumes corresponding terminal equipment
- Advantage to previous architecture:
  - Error free reproductions



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## 3.2 Technical Key Problems

- 1 Real-Time Dependencies
- 2 Communication Systems
- 3 Operating Systems
- 4 Processing
- 5 Synchronization
- 6 Stream Handling
- 7 New Data Types

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## Real-Time Dependencies

### Constant-rate delivery:

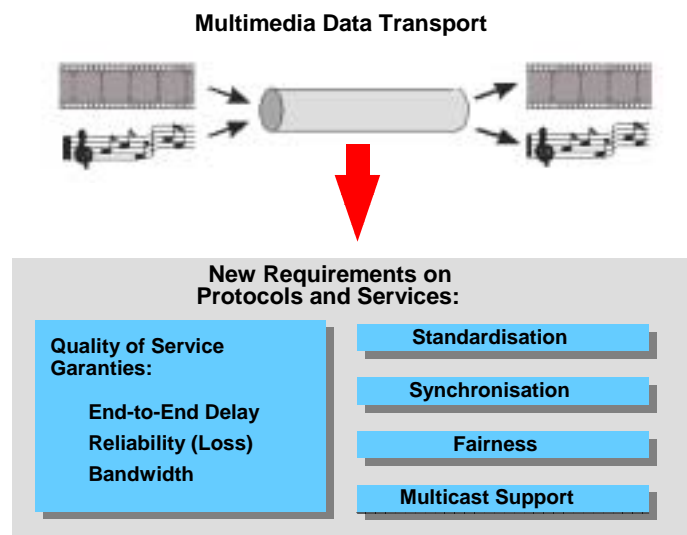
- Smooth playout at receiver's end
- Needs to take human perception into account
- Requires:
  - Real-time management and timing techniques
  - Buffering

### Synchronization:

- Among continuous media
- Between continuous and discrete media
- Requires:
  - Instrumentation of synchronization
  - Description of synchronization

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## Communication Systems – Requirements



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## Communication Systems – Today

### Support for real-time communication is missing:

- No QoS provision for multimedia applications
- No resource management existing
  - No reservation protocols
  - No resource reservation
  - No resource scheduling

### Multicast mechanisms are not provided:

- Existing facilities are often hidden

### Degree of reliability is not scalable:

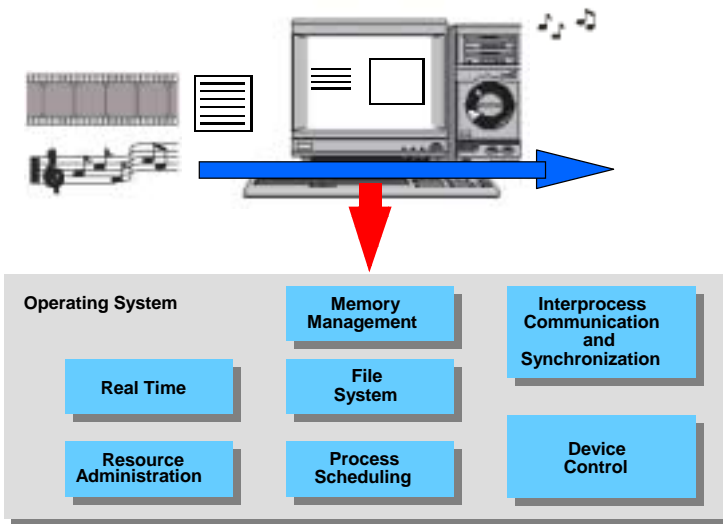
- reliability is unknown or 100%
- Loss of some data can be tolerated by multimedia applications

### Scaling not supported in communication system:

- Each application must 'invent the wheel'

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## Operating Systems



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## Processing Requirements

### Goal:

- Processing of continuous media with high data rate

### Periodic and aperiodic processing:

- Deadlines for continuous-media processing
  - No hard deadlines as in traditional real-time systems
- No starvation of aperiodic requests
- No priority inversion

### Existing workstation operating systems:

- Mostly no support for real-time processing
- Some offer 'real-time' priority schemes
- Based on fairness aspects
- No provision of resource management for real-time requests

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## Synchronization

### Relation between:

- Information coded in various media
- Independent objects
- Here relationship in time domain

### Classifications:

- Intra-stream and inter-stream synchronization
- Live and synthetic/retrieval synchronization

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## Synchronization Mechanisms

### Intra-stream synchronization:

- Processing logical data units according to their time constraints
- Resource management
- Real-time scheduling

### Inter-stream synchronization:

- E.g., synchronization between audio and video part of a movie
- Interleaved coding
- Master / Slave Algorithms
  - Clocks (Logical Time System)
  - Master Stream

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## Stream Handling

### Application structure changes:

- Applications should not operate on data directly because of
  - Data size
  - Time dependency
- Some applications do not need any modification of data
  - e.g., video data transferred from server to client
- Applications form user interface
- Application determines how data should be modified and controls flow
  - e.g., software video decompression and synchronization
  - Flexible structure to combine processing modules

### Real-time and Stream management subsystem

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## New Data Types

### Audio and video in programming:

- New abstractions in the old framework:
  - Operating system
  - Communication system
  - Window system
  - Application
- Information retrieval and archiving problems intensified:
  - Hypermedia information
  - Content-based search
- New interaction methods:
  - Acoustic input/output
  - Virtual reality

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## 3.3 Integration Examples

### Multimedia applications:

- Consumer sector:
  - Multimedia games
  - Web & Internet applications
  - Interactive television
- Professional & business area:
  - Desktop conferencing
  - CSCW applications
  - Teaching & tutoring applications
  - Multimedia information and content management systems

### Application Types:

- Human-to-human interactive applications
  - Desktop conferencing
  - Synchronous CSCW applications
- Man-machine interactive applications
  - Kiosk systems
  - Multimedia information systems
- Non-interactive applications
  - Multimedia mail
  - Asynchronous CSCW applications

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## Requirements

### Applications types:

- Human-to-human interactive applications:
  - Delay sensitivity
  - Synchronisation drifts (skew)
    - Lip synchronisation (continuous media synchronisation)
    - Pointer synchronisation (continuous/ discrete media synchronisation)
  - Video & audio quality
- Man-machine interactive applications:
  - Synchronisation
    - Lip synchronisation (continuous media synchronisation)
    - Pointer synchronisation (continuous/ discrete media synchronisation)
    - Cross media/ multiple format synchronisation
  - Media quality
  - Media validity
- Non-interactive applications:
  - Synchronisation
    - Continuous/ discrete media synchronisation
    - Cross media/ multiple format synchronisation

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## Synchronisation

### Strong synchronisation:

- Multiplexing:
  - One data channel
  - Media and synchronisation information are jointly delivered



- Appropriate for:
  - Lip synchronisation

### Weak synchronisation:

- Timecode/ clock synchronisation:
  - Media linked via time references
- Appropriate for:
  - Pointer synchronisation (continuous/ discrete media synchronisation)
  - Cross media/ multiple format synchronisation

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## Questions

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## Interesting Links

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