Media Adaptation for Ubiquitous Computing

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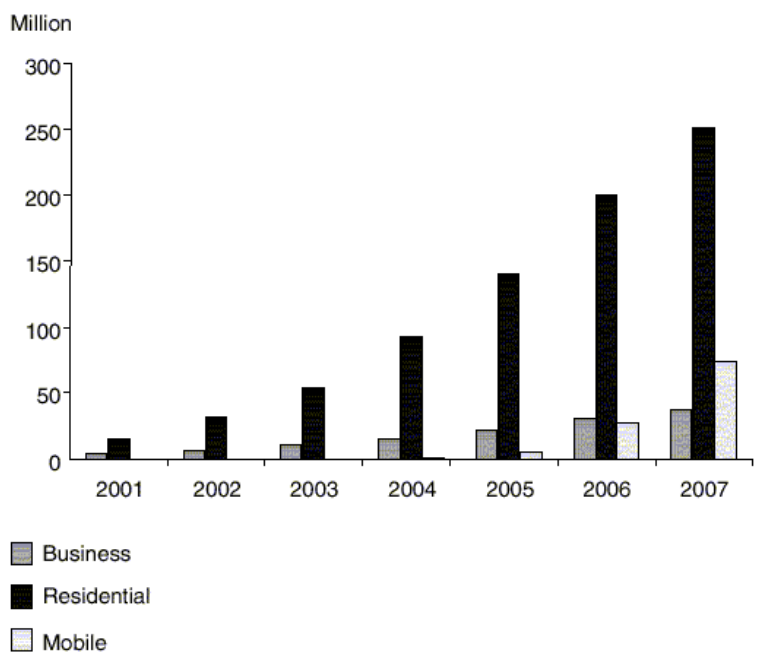
Overview

- Motivation
- Media Adaptation Mechanisms
- Media Adaptation Frameworks
- Ubiquitous Computing
- Ubiquitous Adaptation?

Motivation

- Multimedia streaming will be ***key issue*** in the future Internet

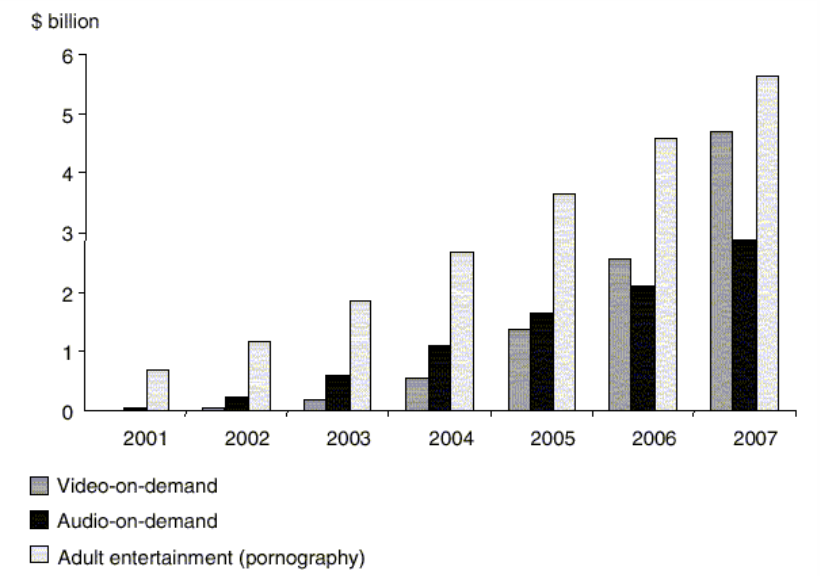


Number of Streaming End-points World-Wide

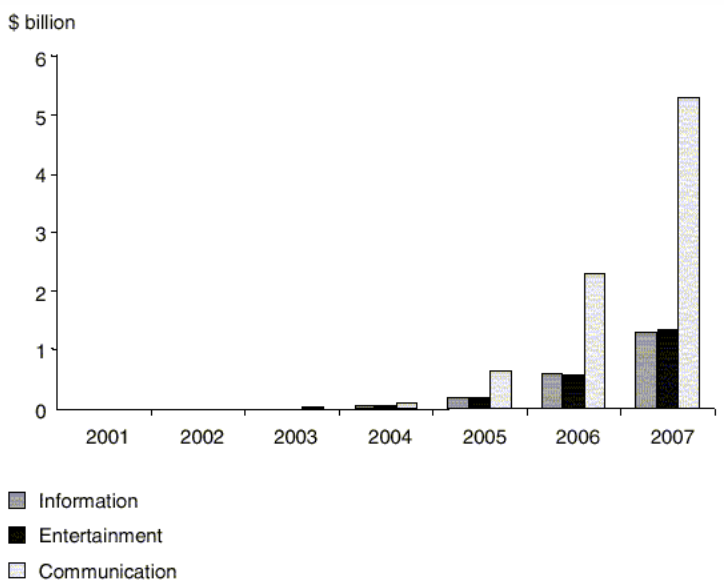
Source: Ovum, Streaming Media: Commercial Opportunities, Forecast, 2002

Motivation

- Hugh ***potential revenues*** for streaming provider



Residential Market



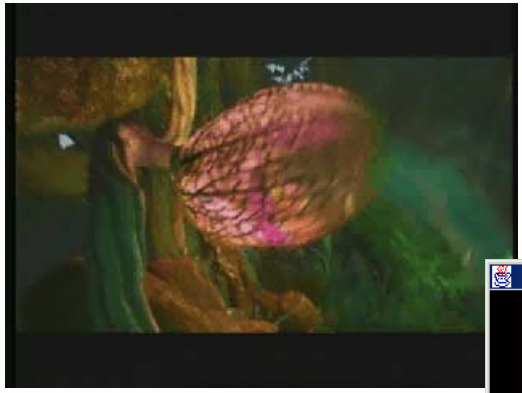
Mobile Market

Source: Ovum, Streaming Media: Commercial Opportunities, Forecast, 2002

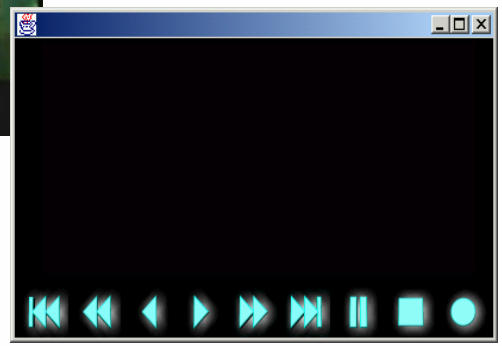
Motivation

- Typical Examples

IP-Telephony



Online Gaming



Internet Television
Video Distribution
Video-on-Demand
Distance Learning

Audio/Video-Conferencing

Motivation

- Heterogeneous ***Multimedia Applications/Services***
  - Varying requirements (interactive/non-interactive, realtime/non-realtime, unicast/multicast, low delay/high bandwidth, etc.)
- Heterogeneous ***Devices***
  - Varying screen sizes, CPUs, memory, power supplies, interfaces, etc.
- Heterogeneous ***Access Networks***
  - Varying characteristics for loss, bandwidth, reliability, etc
- Heterogeneous ***User Policies***

‚Normal User‘

likes to have an ‚on/off‘ button

‚Cyborg‘

wants to specify the importance of certain parameters

Motivation

- Additional challenges in ***Mobile Networks***

Challenge: Heterogeneity

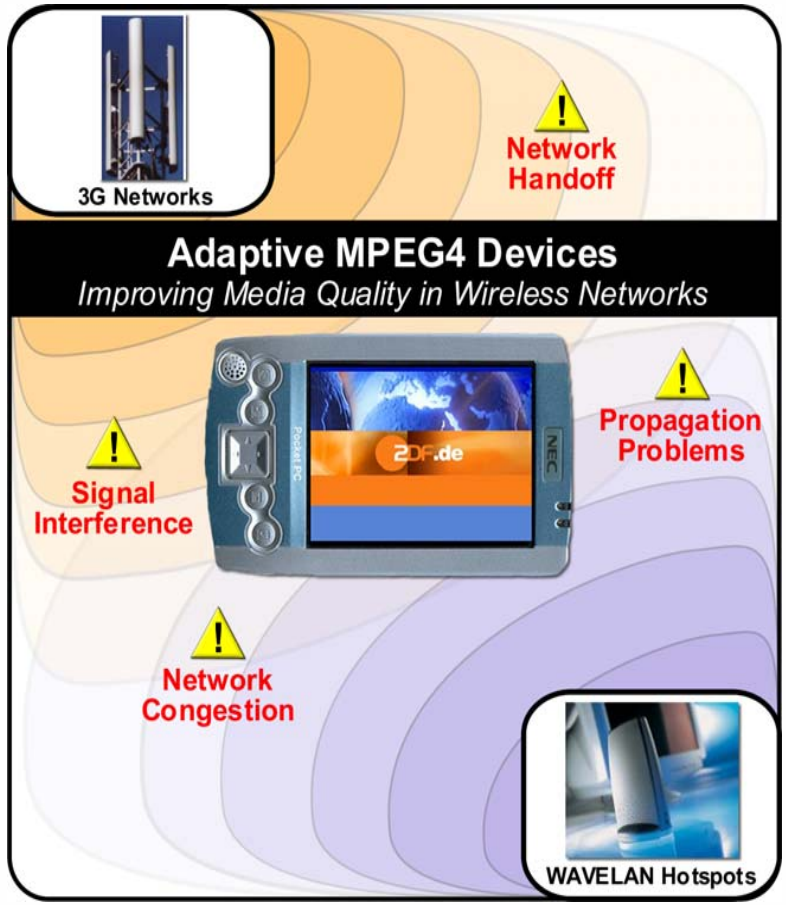
- Differing access technologies
- Differing network characteristics
- Differing device capabilities
- Java performance issues

Challenge: Network Congestion

- Shared network scenarios
- Unpredictable join / leave
- Fluctuating network load

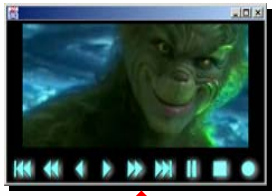
Challenge: Radio Access

- Signal interference
- Propagation problems
- Uneven network coverage
- Network handoff



Adaptation Mechanisms

- ***Where*** should media adaptation be performed?



Adaptive Applications

+ Specific requirements of the Applications are well-known

- Adaptivity mechanism has to be ‚re-invented' by each application
- No global view for fairness, no inter-operability

Middleware

Adaptive Middleware

+ Combines advantages of both
  Allows for fairness as well as application-specific treatment

Operating System

Adaptive Operating Systems

+ Global view allows for optimized utilization and fairness
- Application semantic is unknown

Network

Adaptive QoS (Networks)

Active power control on the physical layer
Error control and adaptive reservation at the data link layer
Dynamic re-routing at the network layer
Dynamic re-negotiation of connection parameters at transport layer (IntServ, DiffServ)

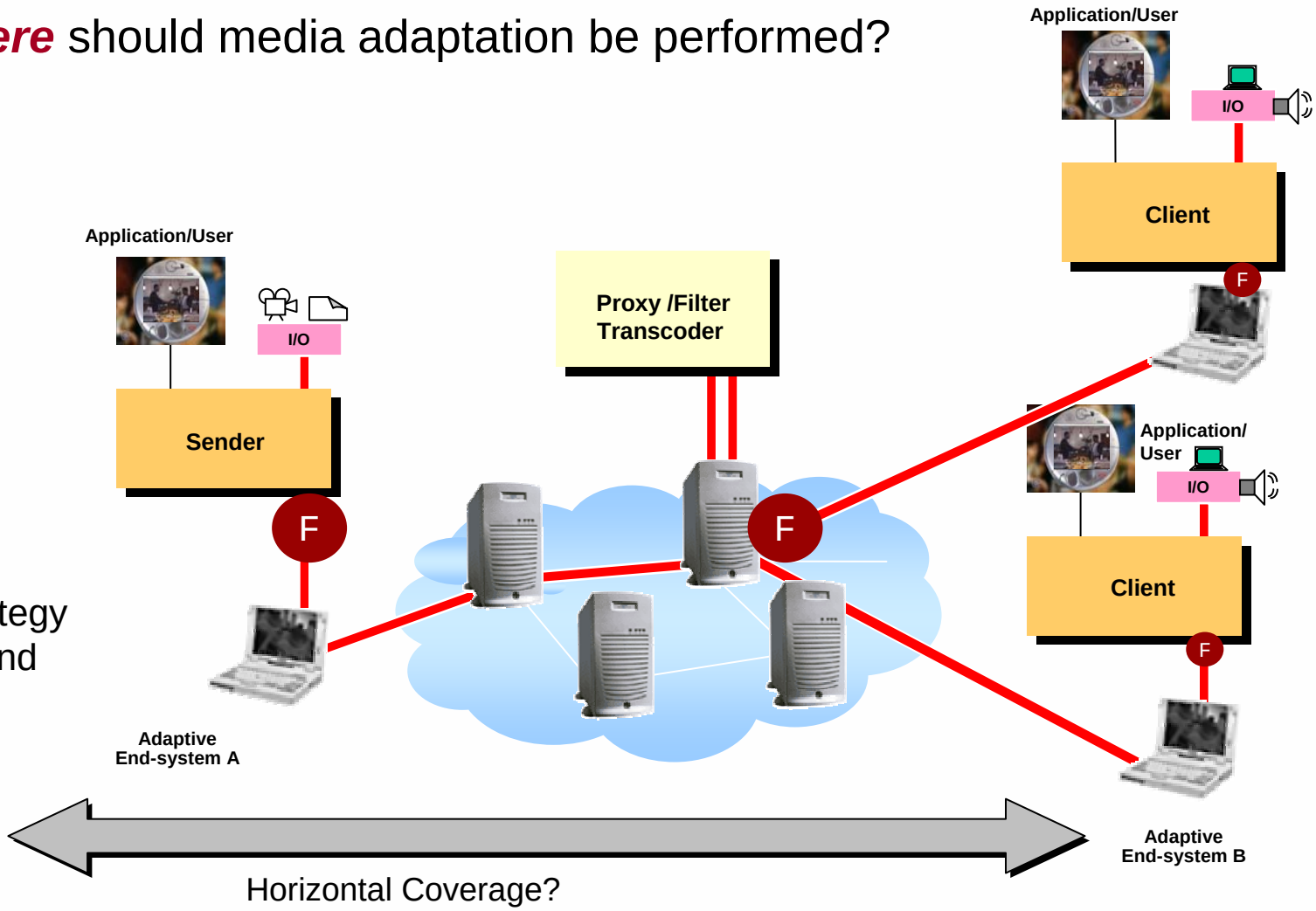
Vertical Coverage?

Optimal Strategy covers all layers

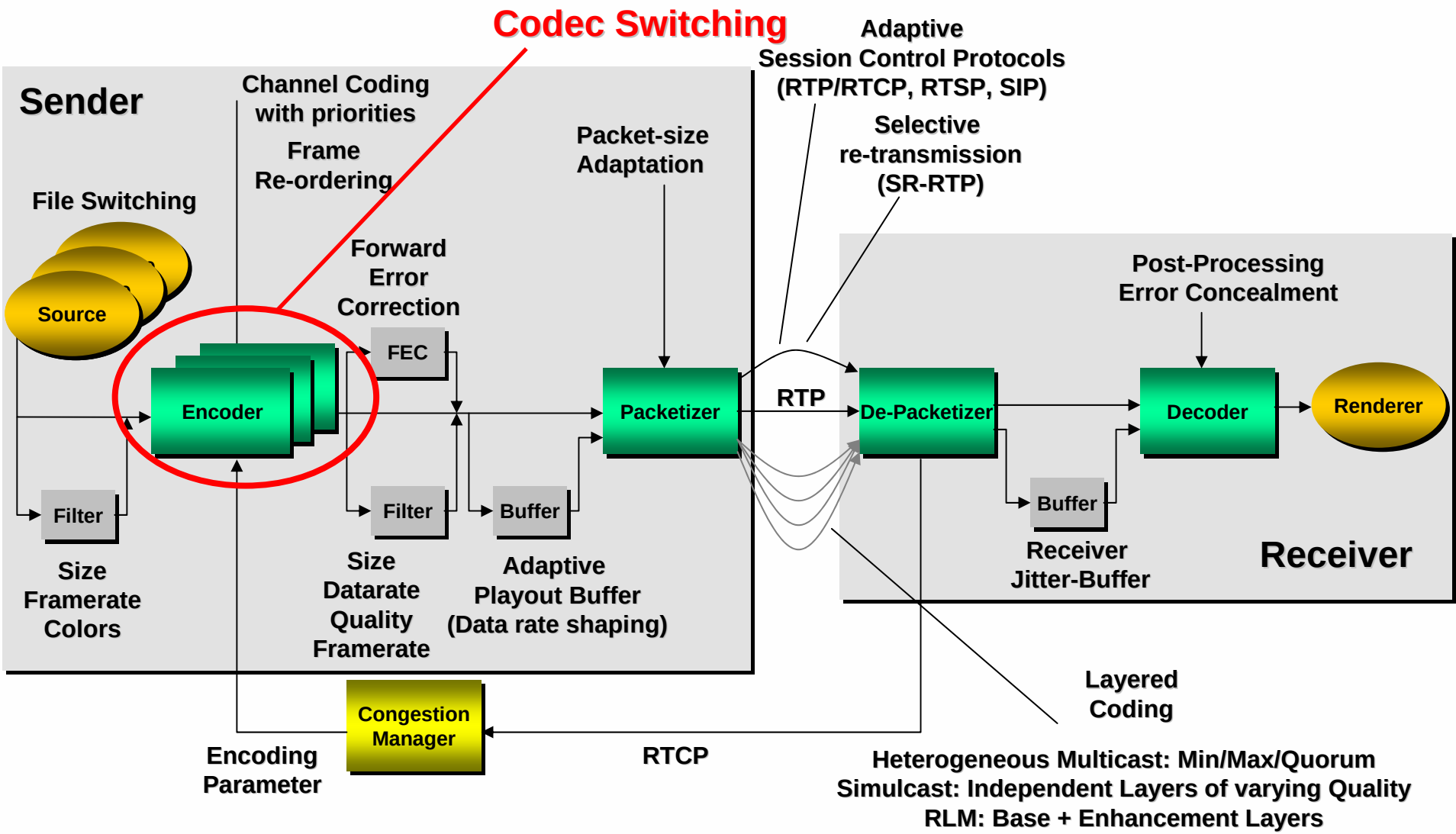
Adaptation Mechanisms

- ***Where*** should media adaptation be performed?

Optimal Strategy is end-to-end



Adaptation Mechanisms



Adaptation Mechanisms

- References and Surveys (a very small collection ...)

C. Perkins, O. Hodson, V. Hardman
A survey of packet loss recovery techniques for streaming audio.
IEEE Network Magazine, pp. 40-47, Sep./Oct. 1998.

W. Feng, J. Rexford
A comparison of Bandwidth Smoothing Techniques for the Transmission of Prerecorded Compressed Video.
IEEE Infocom, pp. 58-66, April 1997

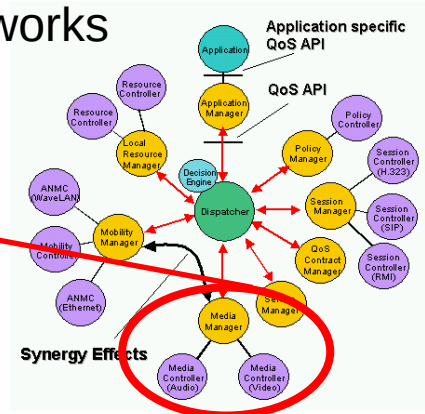
N. Laoutaris, I. Stavrakakis
Intrastream synchronization for continuous media streams: A survey of playout schedulers.
IEEE Network Magazine, 2001

D. Wu, Y. Hou, W. Zhu, Y. Zhang, J. Peha
Streaming Video over the Internet: Approaches and Directions..
IEEE Transactions on Circuits and Systems for Video Technology, vol. 11, no.1, 2001

B. Vandalore, W. Feng, R. Jain, S. Fahmy
A survey of application layer techniques for adaptive streaming of multimedia.
Journal for Real Time Systems, Special Issue on Adaptive Multimedia, April 1999.

Adaptation Frameworks

- ***MASA Qos Framework***
  - Co-operation between NEC, Siemens and University of Ulm (2001-2003)
  - Adaptive middleware between applications and networks
  - Dedicated adaptive ***Media Manager***



MediaStorm
Java Multimedia Technology

- **C. Niedermeier, C. Fan, D. Carlson, A. Schrader, A. Kassler, A. Schorr**
  MASA - A scalable QoS Architecture
  7th IASTED International Conference on INTERNET AND MULTIMEDIA SYSTEMS AND APPLICATIONS, Honolulu, Hawaii, USA, August 13-15, 2003
- **H. Hartenstein, A. Schrader, A. Kassler, M. Krautgärtner, C. Niedermeier**
  High Quality Mobile Communication
  Proceedings of the KIVS'2001 Conference (Kommunikation in Verteilten Systemen), German Informatic Society (GI), Hamburg, Germany, February 2001
- **See also IEEE SoftCOM'2000, IEEE ASW'2001**
- **http://masa.ccrle.nec.de**

Adaptation Frameworks

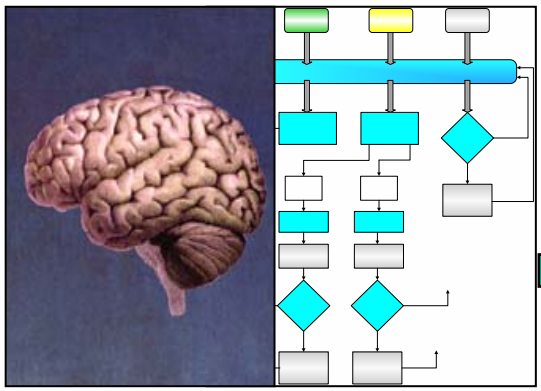
- ***MASA Media Manager***
  - Analysis comprehensive monitoring values
  - Performs locally and globally optimized adaptation strategies
  - Decides for parametrization of attached Media Controllers and QoS reservations
  - A number of algorithms have been developed


User QoS Policy


Monitoring Results


Movement Detection


Resource Availability



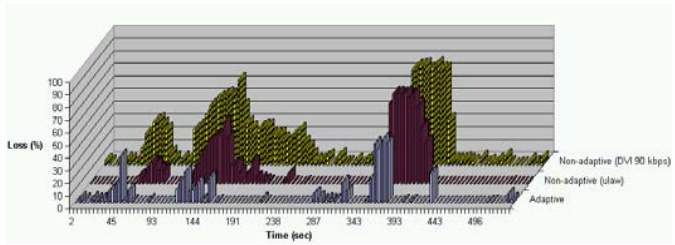
MediaStorm
Java Multimedia Technology

- **QoS Parameters**
- **Codec Selections**
- **Filter Selections**
- **Etc.**

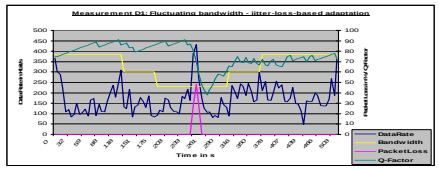
Examples

- ***Some Implemented MASA Media modules***
  - ***WaveVideo Filtering***
    - **Christian Kücherer**: Master thesis
    - (University of Applied Sciences Mannheim, 2001)

  - ***Audio Adaptation***
    - **Hyung-Woo Kim**: Master thesis
    - (University of Stuttgart, 2001)



  - ***MPEG-4 Filtering***
    - Philipp Bostan: Master thesis
    - (University of Applied Sciences Mannheim, 2002)



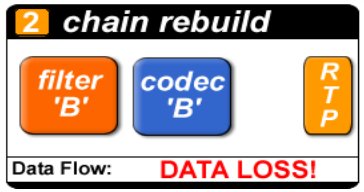
Christian Kücherer, Andreas Kassler, Andreas Schrader, Oliver Haase
End Device and Network Adaptation of WaveVideo Streams
Proceedings of the Conference on Advances in Infrastructure for Electronic Business, Science, and Education on the Internet (SSGRR) L'Aquila, Italy, August 6-12, 2001

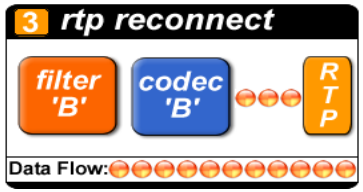
Andreas Kassler, Christian Kücherer and Andreas Schrader
Efficient Wavelet Video Filtering
2nd International Workshop on Quality of future Internet Services, (QofIS) Coimbra, Portugal, Sep. 24-26, 2001

Examples

Traditional Adaptation Approach

Original Media Chain

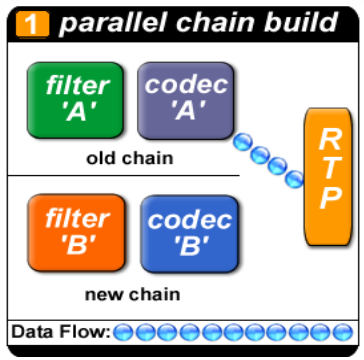


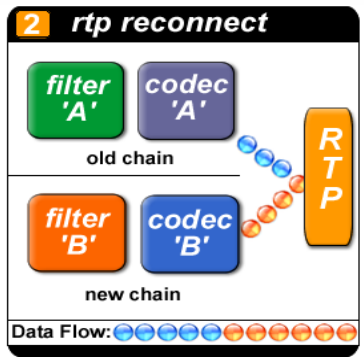


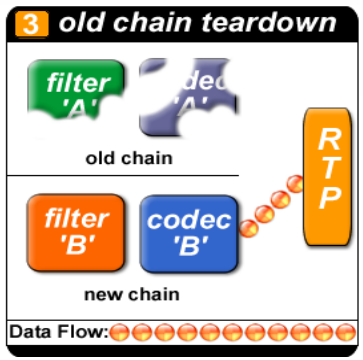
Problems:

- Data loss during chain teardown & rebuilding
- Long adaptation time interrupts stream

Seamless Adaptation Approach







Advantages:

- No loss during chain reconstruction
- Reduced adaptation time

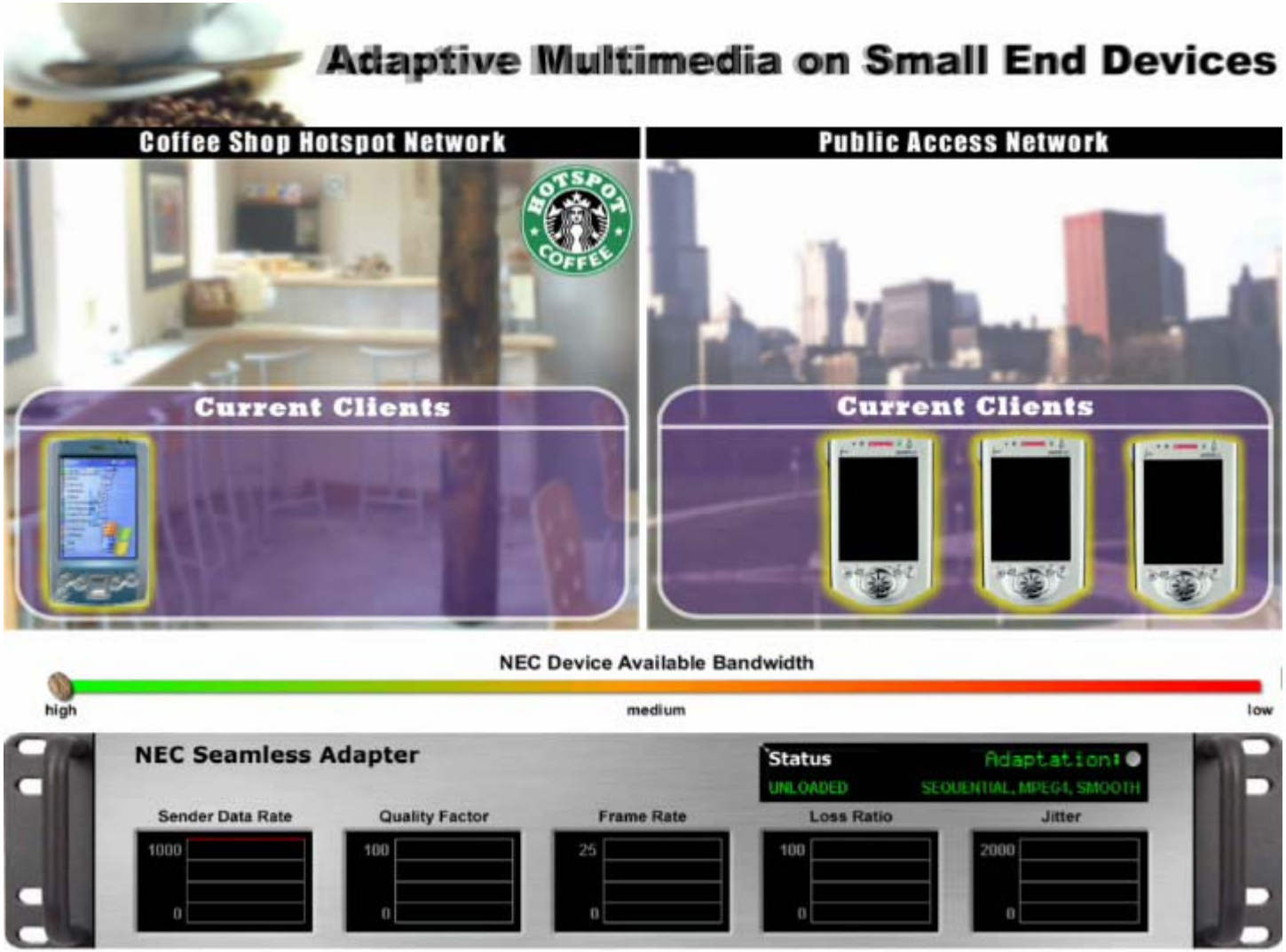
Examples

- ***Seamless Codec Switching***
  - Realized in Java (JMF/RTP/RTCP)
  - Pluggable Adaptation Modules
    (Frame Filter, Quality, Datarate, Codec Switch)
  - MPEG-4 Packetizer / Depacketizer / Frame Filter (DivX4.12)
  - Results:
    - ***Gap time below 1 ms*** (measurement accuracy)
    - ***Zero packet loss*** (proved with packet sniffer)
    - ***Codec and media type independent***

Darren Carlson and Andreas Schrader
Seamless Media Adaptation with simultaneous Media Processing Chains
Proceedings of the ACM Conference on Multimedia
Juan-les-Pins, France, December 1-6, 2002

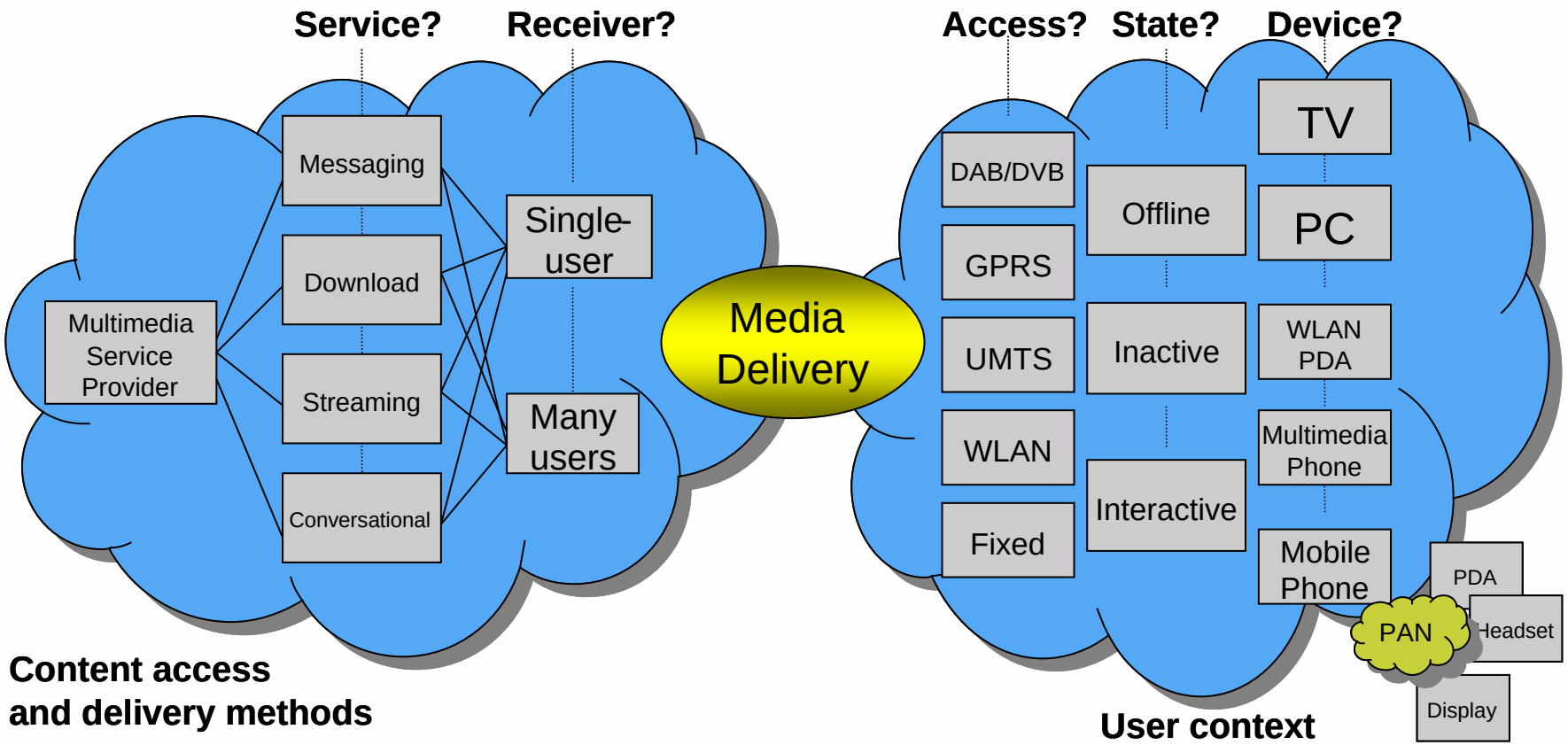
(International patent pending)

Examples


Adaptive Multimedia on Small End Devices
Coffee Shop Hotspot Network
Public Access Network
HOTSPOT COFFEE
Current Clients
Current Clients
NEC Device Available Bandwidth
high
medium
low
NEC Seamless Adapter
Status
UNLOADED
Adaptation:
SEQUENTIAL, MPEG4, SMOOTH
Sender Data Rate
Quality Factor
Frame Rate
Loss Ratio
Jitter
1000
0
100
0
25
0
100
0
2000
0

Adaptation Frameworks

- ***Where*** should media adaptation be performed?



Adaptation Frameworks

- ***Adaptive Overlay Content Delivery Network***
  - ***Hiding the complexity*** of the underlying heterogeneous transport networks to operators and content providers
  - Providing ***new and enhanced services***
  - Supporting ***communication as well as consumption-oriented services***
  - Supporting ***multi-provider, multi-domain scenarios*** using different business models
  - Managing ***routing*** (coarse-graine modification), ***adaptation*** (fine-graine modification) and ***caching*** of multimedia in an integrated manner
  - Providing configuration means for providers and recipients
  - Interaction with underlying QoS and mobility management system

Adaptation Frameworks

- ***Adaptive Multimedia Routing Strategies***
  - Selecting optimal path(s) through the ‚wireless world' regarding resources and preferences from users and operators
  - Disjoint path delivery for individual media streams
  - Optimal selection of delivery means (broadcast, multicast, unicast)
- ***Multimedia Adaptation Strategies***
  - Optimizing the transmission parameters during a running session
  - Optimization of the mix of available adaptation means
  - Support of adaptive network nodes and adaptive end-systems

Andreas Schieder, Uwe Horn and Andreas Schrader
Media Delivery in Future Wireless Networks
9th Wireless World Research Forum (WWRF) Workshop
Zurich, Switzerland, July 1-2, 2003.

Ambient Networks, European Project FP6 (WWI)

Still there?

Ubiquitous Computing

- Invented by Marc Weiser in 1988 (Xerox Parc)

Marc Weiser (1952-1999)

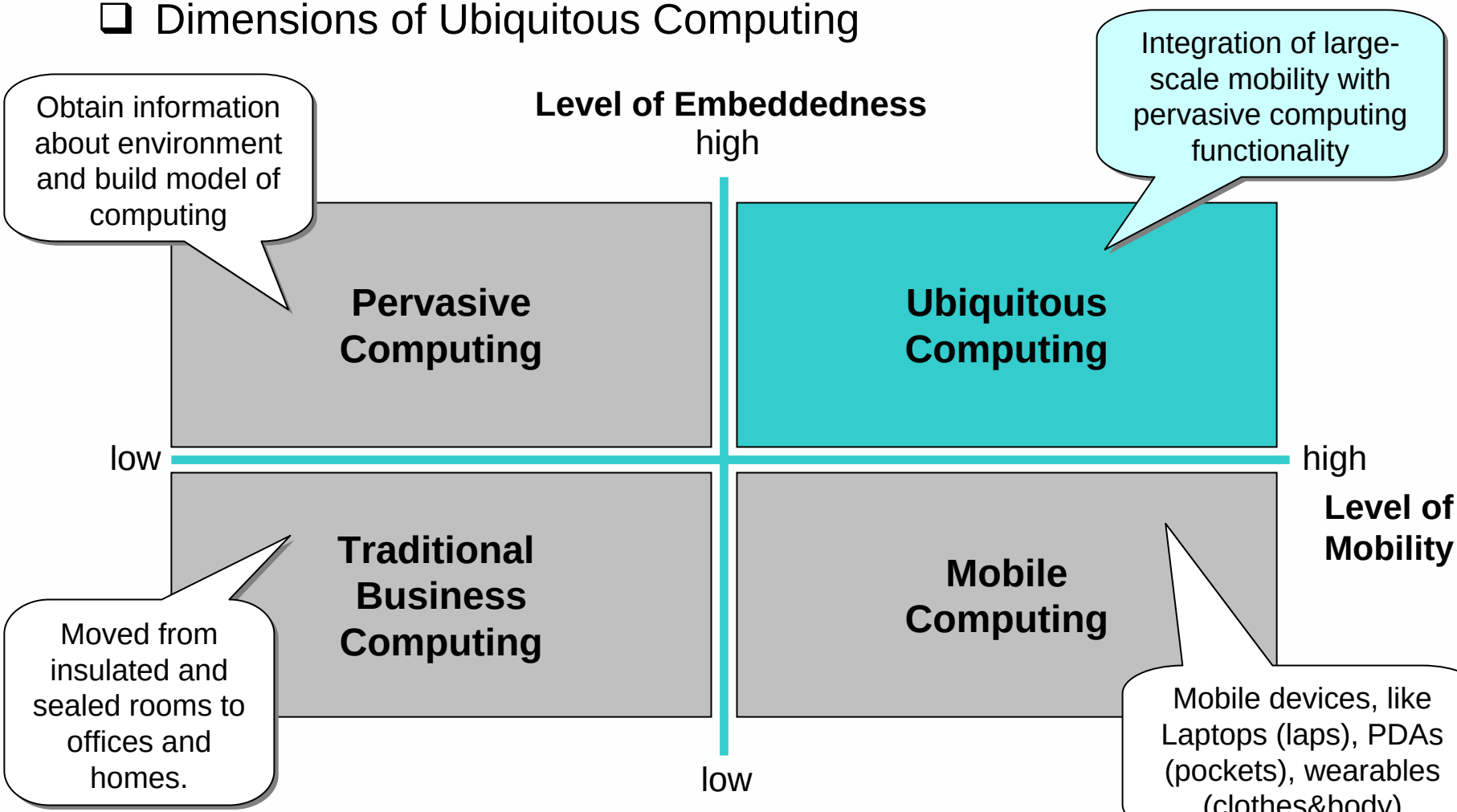
„Ubiquitous Computing enhances computer use by making computers available throughout the physical environment, while making them effectively invisible for the human user.“

- Goal: Making the computer invisible to enhance the real world (opposite of virtual reality!)

Philips HomeLab:
Mirror with integrated Displays

Ubiquitous Computing

- Dimensions of Ubiquitous Computing



Ubiquitous Computing

❑ Wearable Computers

Digital Jewelry (IBM)
Source: http://www.ibm.com

Steve Mann: Cyborg

Electronic Display in Jacket (Pioneer)
Source: http://www.i4u.com/article407.html

PDA size | Book size | Web Browser size | Full Screen Size

Normal Size | Unfolded once | Unfolded twice | Unfolded completely

The foldable display (Cornegie Mellon)
Source: http://www.ices.cmu.edu/design/FoldableDisplay.html

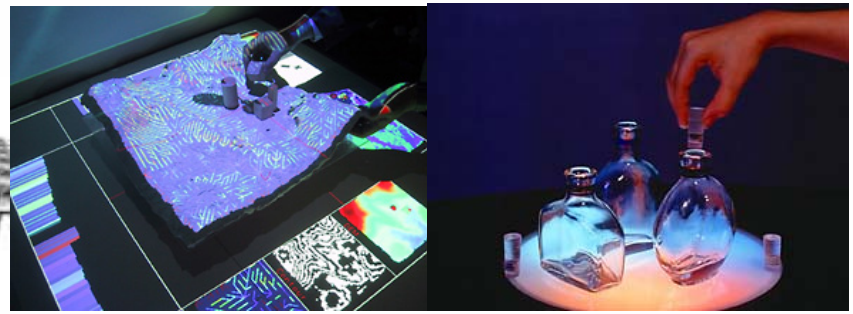
Ubiquitous Computing

- ***Human-Computer-Interfaces***

Augmented Reality (Eyetap)

Source: http://eyetap.org/research/medr/rwm.html

D, Bandyopadhyay, R. Raska, H. Fuchs:
Dynamic Shader Lamps: Painting on Real Objects
(ISAR'01), New York, NY, October 29-30, 2001.



Tangible Media (MIT)

Source: http://tangible.media.mit.edu/

Ubiquitous Computing

The nightmare of the film industry?

- Ubiquitous multimedia in ***Minority Report***

Personalized Public Commercials

3D Shop Assistant

Electronic Ink Newspaper

Buildings and Walls as Displays

Copyright: Steven Spielberg (20th Century Fox/Dreamworks), 2002

Ubiquitous Adaptation?

- New Challenges in Ubiquitous Environments
  - Pervasive devices will be used for different tasks, by different users, in different environments, locations and contexts.
  - Pervasive Devices
    - ***Very limited*** in capabilities
    - In extreme cases, ***sensor nodes*** are covering the environment
      (smart carpet, intelligent brick, smart cups)
      Can we use them as proxies or caches?
      How to delegate/distribute?

  - Context Information
    - Location awareness of content, user and stream provision entities
    - ***Session mobility*** with ***context transfer***
    - Proximity awareness through user recognition systems
    - Supporting fluctuating ***sparse and dense user concentrations***

Ubiquitous Adaptation?

- New Challenges in Ubiquitous Environments
  - Human-Computer Interfaces
    - Support of ***disabled and handicaped persons*** (e.g. color blindness)
    - New transcoding mechanisms for ***tangible media interfaces***
    - Ambient content adaptation to environment features (e.g. style)
    - Intelligent adaptation algorithms considering ***subjective and objective*** aural and visual quality ***perception***
  - General
    - Automatic decisions for best presentation device (or means)
    - ***Privacy and security*** aspects (e.g. media streaming in public displays)
    - Generalized placement strategies for proxy server
    - Power Management
    - Optimizing the mix of available adaptation means (e.g. file switching, codec switching, codec parameter changing, pre- and post-codec filtering, FEC, layered transmission, selective re-transmission, adaptive playout buffers, jitter compensation buffers, etc.)
    - Multiple media tracks (e.g. different camera positions)
    - Etc.?

ISNM

- International School of New Media
- Affiliated Institute of the University of Lübeck
- Master of Science Program (Digital Media)
- 18 months program (ECTS), focus areas:
  - E-Business
  - Work Design
  - Digital Media Development
  - Mobile Communication and Computing
- http://www.isnm.de

Partner Institutions:

:: McLUHAN INSTITUTE
Toronto Kanada

:: ZKM :: CENTER FOR ART AND MEDIA TECHNOLOGY
Karlsruhe, Germany

:: UNIVERSITY OF CALIFORNIA
Santa Barbara, USA

:: UNIVERSITY OF COLORADO
Boulder, USA

:: UNIVERSITY OF QUEENSLAND
Brisbane, Australia

Any Questions?