Motivation

Emerging mobile networks and devices present unique challenges for high quality multimedia delivery

Challenge: Heterogeneity

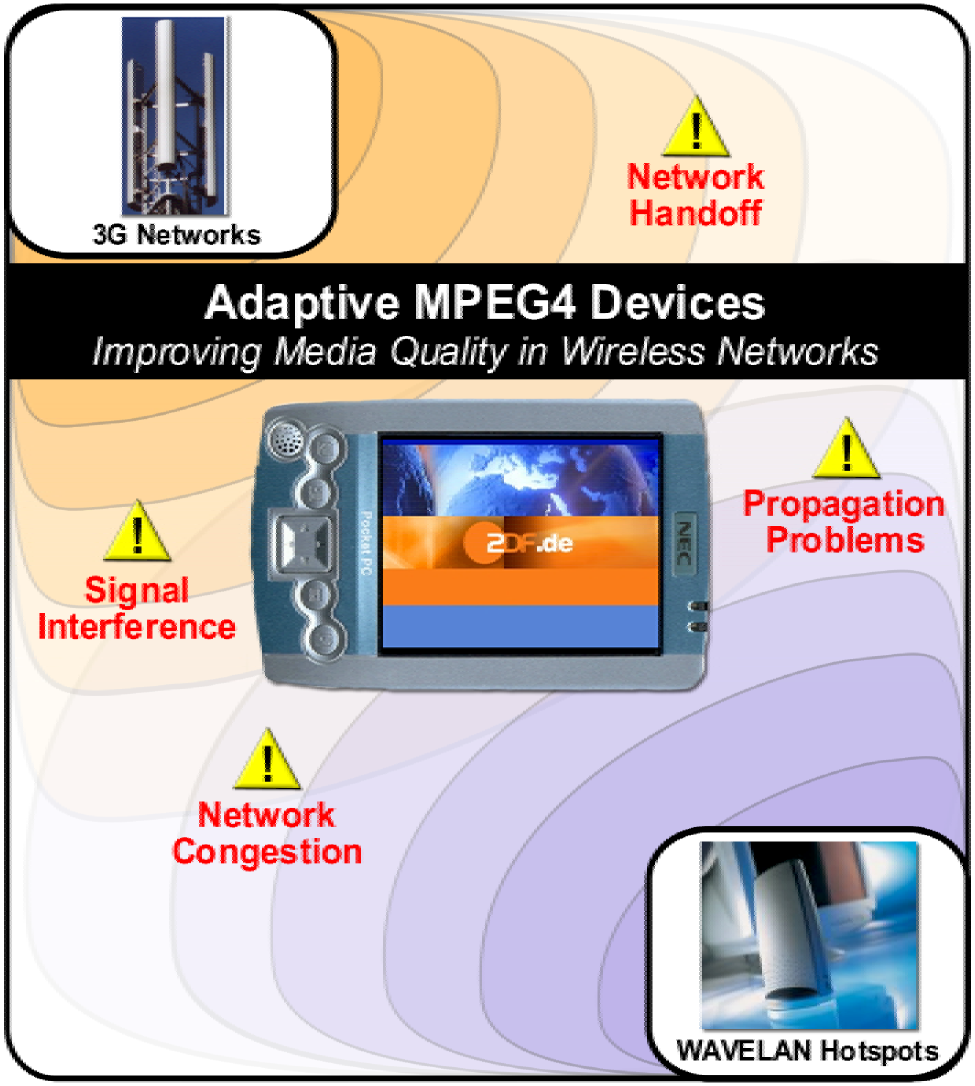
- Differing access technologies
- Differing network characteristics
- Differing device capabilities
- Java performance issues

Challenge: Network Congestion

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

Challenge: Radio Access

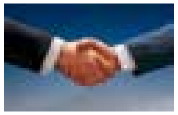
- Signal interference
- Propagation problems
- Uneven network coverage
- Network handoff



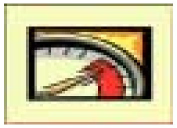
Solution

Seamless automatic media adaptation allows
sophisticated responses to mobile delivery challenges

Automatic Media Adaptation



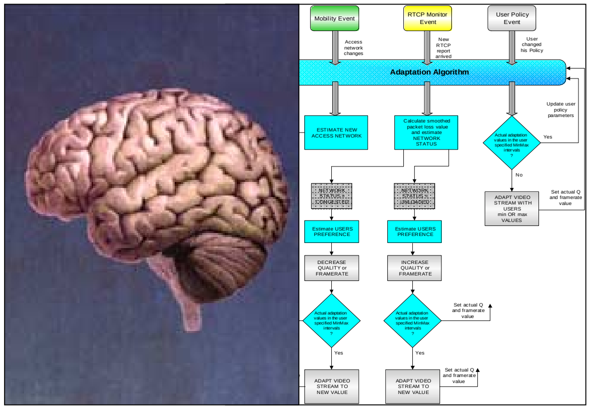
User QoS Policy



Monitoring Results

Movement Detection

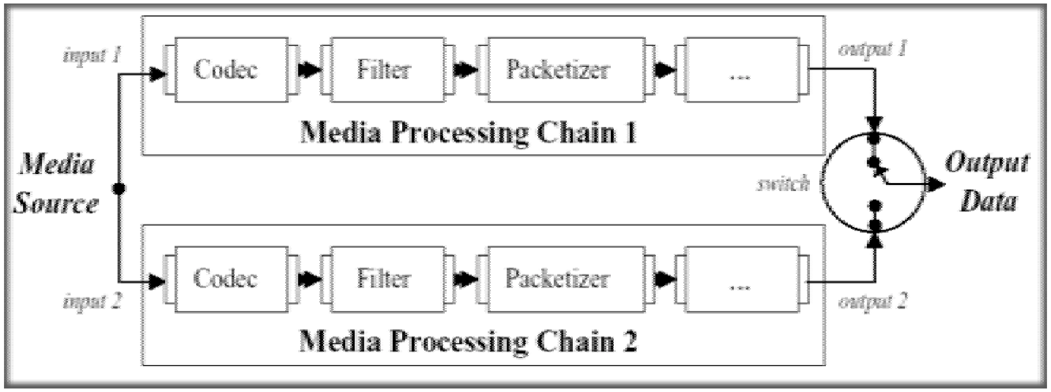
Resource Availability


Mobility Event
RTCP Monitor Event
User Policy Event
Access network changes
New RTCP report arrived
User changed his Policy
Adaptation Algorithm
ESTIMATE NEW ACCESS NETWORK
Calculate smoothed packet loss value and estimate NETWORK STATUS
Actual adaptation values in the user specified MinMax intervals ?
Update user policy parameters
Yes
No
NETWORK STATUS = CONGESTED
NETWORK STATUS = UNLOADED
ADAPT VIDEO STREAM WITH USERS min OR max VALUES
Set actual Q and framerate value
Estimate USERS PREFERENCE
Estimate USERS PREFERENCE
DECREASE QUALITY or FRAMERATE
INCREASE QUALITY or FRAMERATE
Actual adaptation values in the user specified MinMax intervals ?
Actual adaptation values in the user specified MinMax intervals ?
Set actual Q and framerate value
Yes
Yes
ADAPT VIDEO STREAM TO NEW VALUE
ADAPT VIDEO STREAM TO NEW VALUE
Set actual Q and framerate value

MediaStorm
Java Multimedia Technology

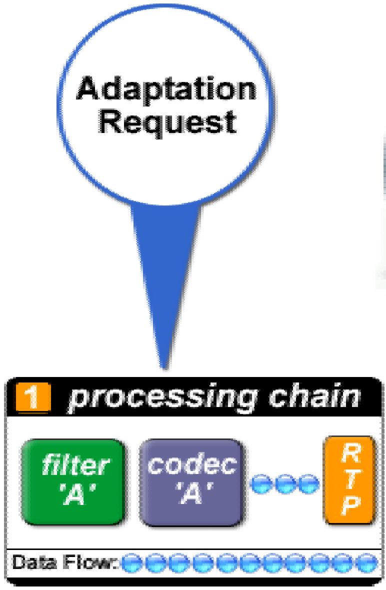
- **QoS Parameters**
- **Codec Selections**
- **Filter Selections**

Seamless Chain Switching



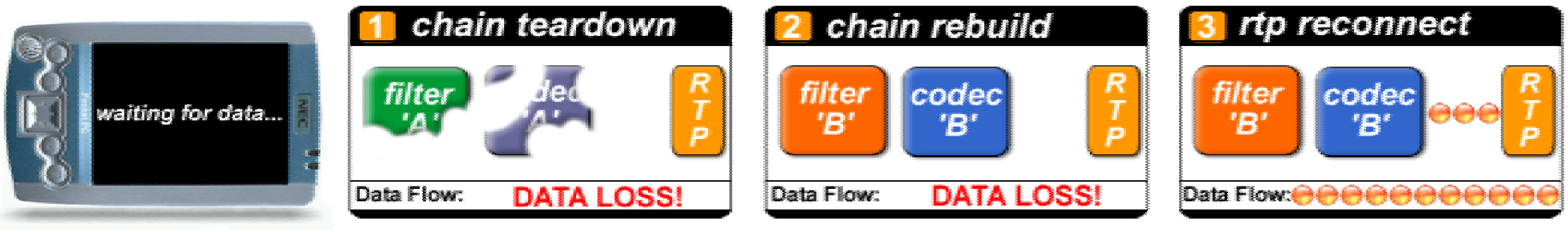
- **Media Processing Chains consist of Codecs, Filter, Packetizer etc.**
- **Switching between Chains usually imposes additional degradations**
- **Our approach: Seamless switching**

Seamless vs. Traditional Adaptation



Original Media Chain

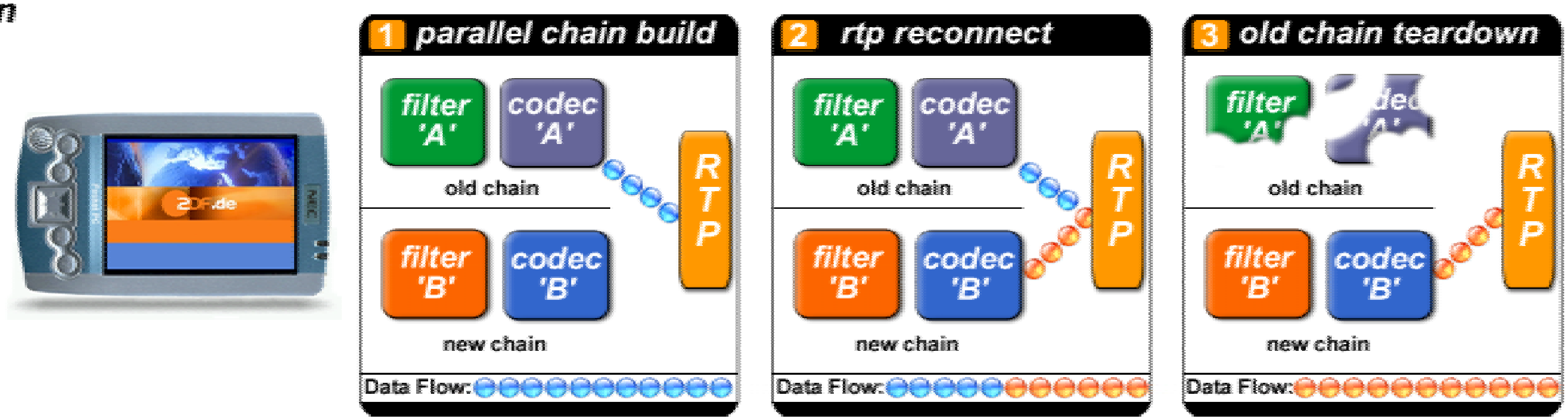
Traditional Adaptation Approach



Problems:

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

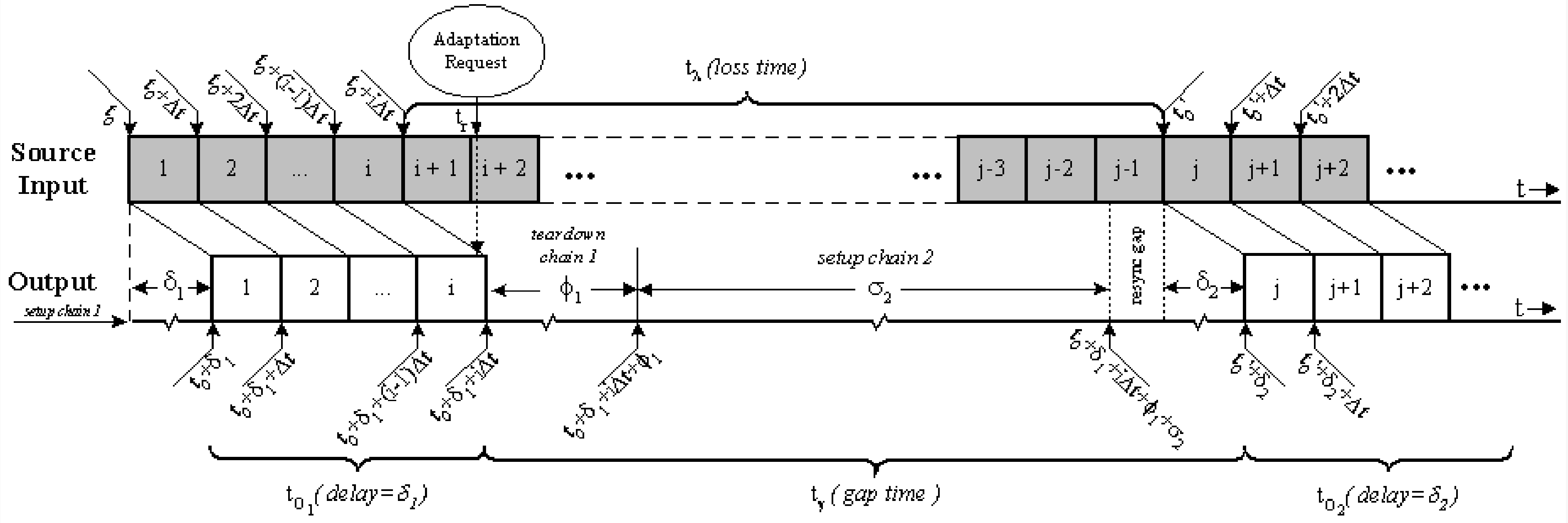
Seamless Adaptation Approach



Advantages:

- **No loss during chain reconstruction**
- **Reduced adaptation time**

Traditional Adaptation



Conventional media adaptation through sequential chain rebuilding

Loss Time $$t_\lambda = \lceil \frac{\delta_1 + \phi_1 + \sigma_2}{\Delta_t} \rceil \cdot \Delta_t$$

Lost Frames $$\lambda = \lceil \frac{\delta_1 + \phi_1 + \sigma_2}{\Delta_t} \rceil$$

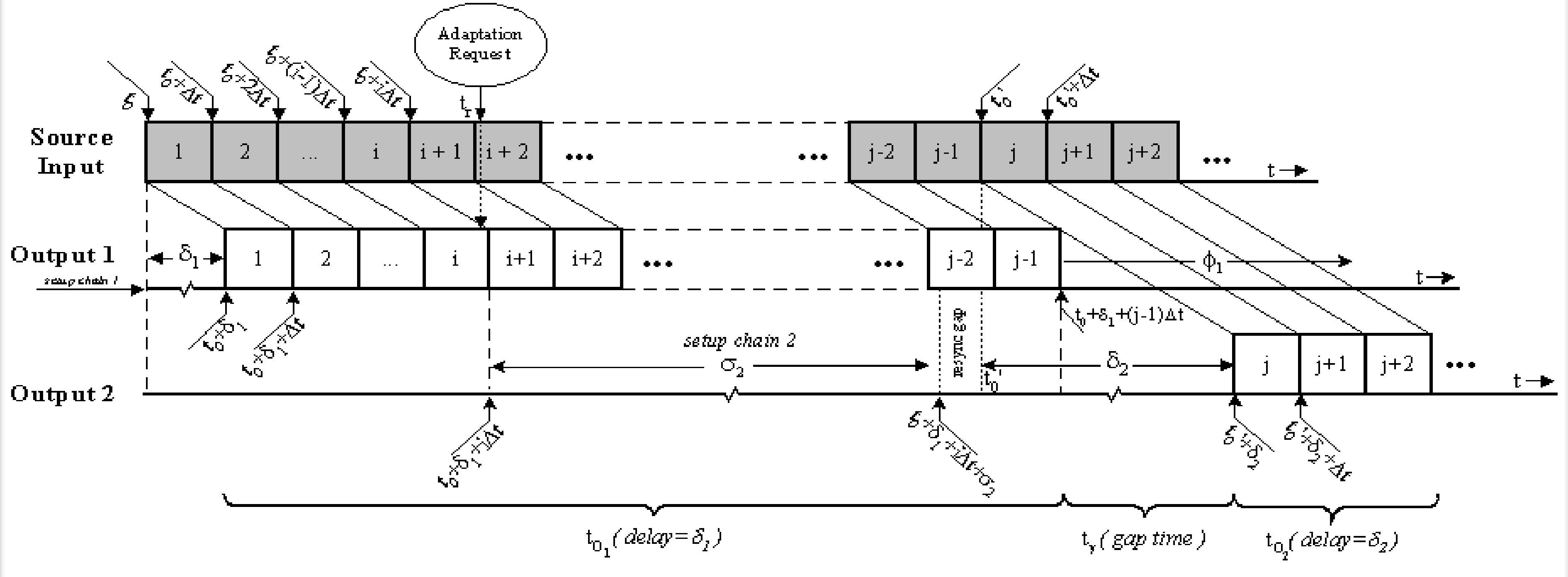
Gap Time $$t_\gamma \quad = \quad t_\lambda \ + (\delta_2 - \delta_1)$$

σ_2 **: New Chain Set-up time**

ϕ_1 **: Old Chain Tear-down time**

δ_1 , δ_2**: Intrinsic Chain Delays**

Seamless Adaptation



Seamless media adaptation through parallel chain rebuilding

Loss Time $t_\lambda = 0$

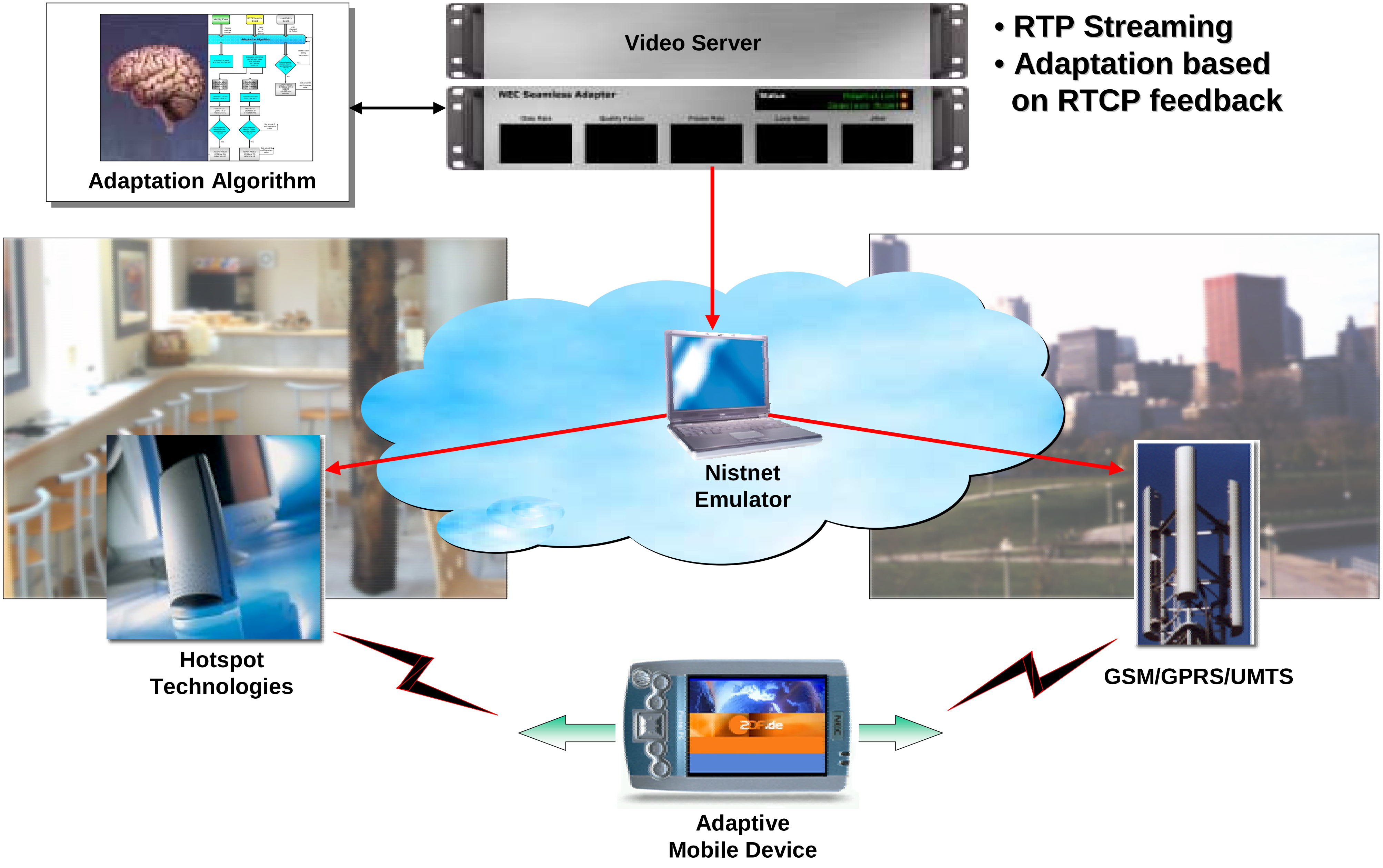
Lost Frames $\lambda = 0$

No loss at all!

Gap Time $t_\gamma \;=\; \delta_2 - \delta_1$

Just codec-intrinsic delay!
Overall adaptation time also reduced!

Demo Scenario



- RTP Streaming
- Adaptation based on RTCP feedback

Prototype Implementation

MediaStorm

Java Multimedia Technology

- Java based adaptive multimedia API
- Based on Java Media Framework (JMF)
- Pluggable Adaptation Modules (Frame Filter, Quality, Datarate, Codec Switch)
- Reference implementation of Seamless Codec Switcher as a plug-in module
- Enhanced high-speed switching datasource to enable on-the-fly format switching to JMF RTP mechanisms.
- MPEG-4 Packetizer / Depacketizer / Frame Filter (DivX4.12)
- Optimized Resource Management (multi-threading, event-driven)
- JMF Native Encoder extensions to allow DivX on-the-fly parameter changes
- Transcoding Support
- NistNet Emulator remote control (Java/C++)

Preliminary Results

Sequential Mode

- CaptureDataSource reading audio from microphone

Loss Time [ms]	DVI	GSM	G.711	G.723	MP3
DVI	174.4	586.8	667.0	583.0	140.0
GSM	178.2	586.6	600.6	589.0	140.4
G.711	188.2	598.8	678.8	556.6	142.2
G.723	182.4	550.4	671.0	588.8	148.8
MP3	234.2	585.0	654.8	603.0	148.2

Average of 10 adaptation cycles
(Athlon Thunderbird 750MHz, 256MByte
Memory, Windows 2000)

- Results with FileDataSources are even worse (worst case 3 seconds!)

Seamless Mode

- Loss Time is 0ms
- Chain Switching Time below 1ms (measurement accuracy)

Proposed Approach improves Codec Changes significantly

- Zero Loss at Sender (verified with Packet Sniffer)
- Reduced Overall Adaptation Time
- Codec Independent
- Media Type Independent