Adaptive Video Streaming for Mobile Devices

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Outline

Motivation

- Mobile devices:
  - Smartphones, PDAs, Pocket Multimedia Players
  - 300 – 600 MHz
  - 64 – 128 MB RAM
  - Small screen resolutions

  $\Rightarrow$ Great heterogeneity of mobile devices
- Video streams
  - High data rates
  - Complex to decode
  - Fixed encoding parameters

Approach

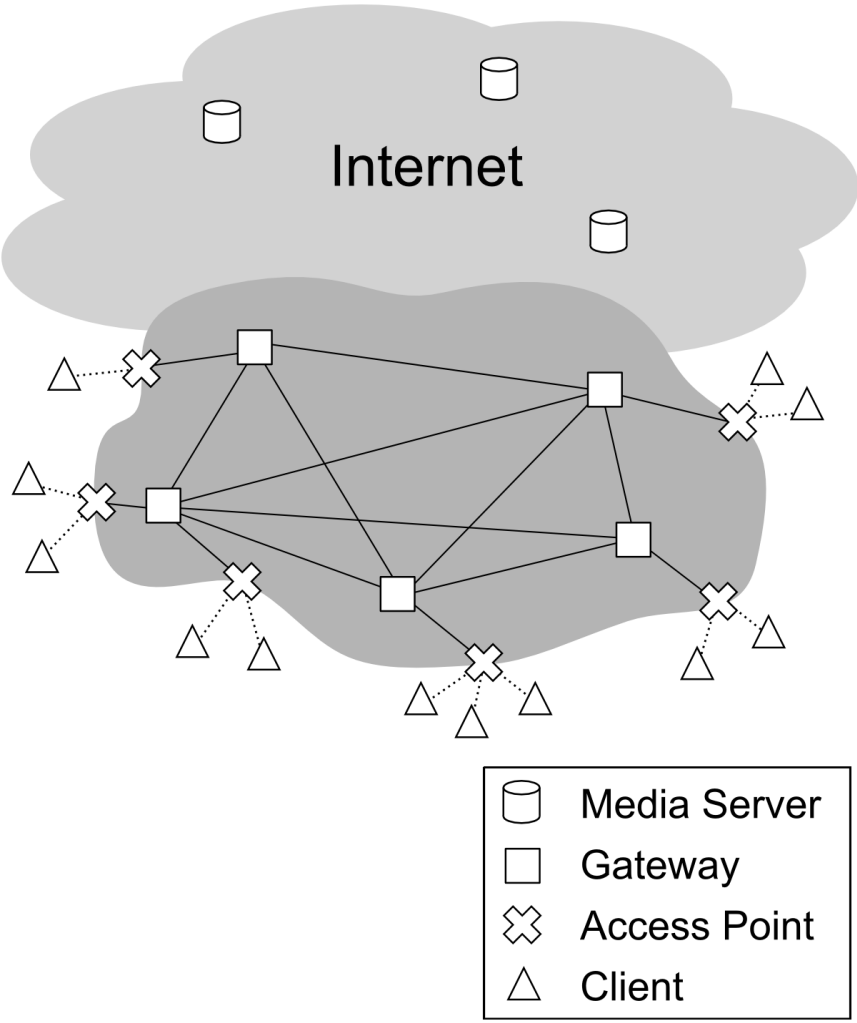
- Video adaptation
- Different versions of video streams to support different devices
- Traditional approach:

  Differently encoded versions of each stream on each server
- Dynamic approach:

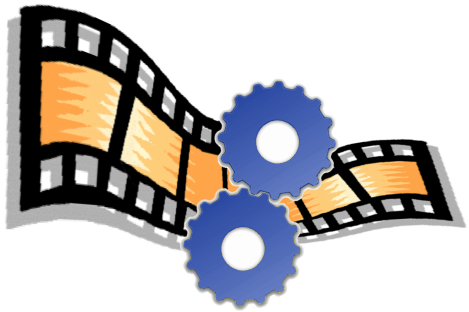
  Individual adaptation in the network

Scenario

- Signaling by RTSP
- Transport by RTP
- Discovery based on SLP
- Gateway Cooperation
- Session Transfer



Adaptation Dimensions



- Spatial resolution: reducing the resolution of each frame
- Temporal resolution: reducing the number of frames
- Detail resolution: increasing the quantization level
- Bit stream syntax: changing the syntax of the stream
- Semantic: changing the content of a video
- ...

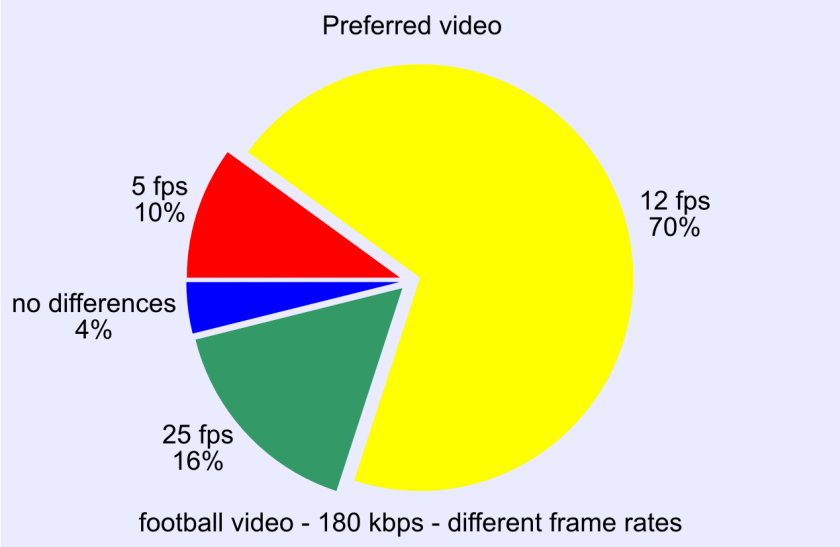
User Interviews

- Measurement of perceived quality by subjective tests
- 4 different video sequences:
  - Soccer scene
  - Animation video
  - Movie trailer
  - News sequence
- Encoded at different frame rates (25, 12, 5 fps)
- Presented to potential users on a PDA

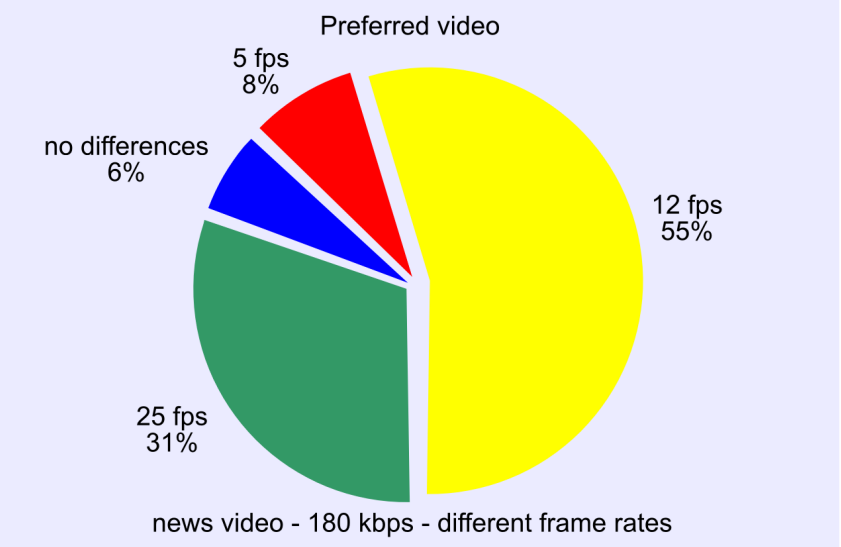

SAT.1
MasterCard


Vor den Parteitagen
CDU
CSU
SPD
tagesschau 13.11.2005

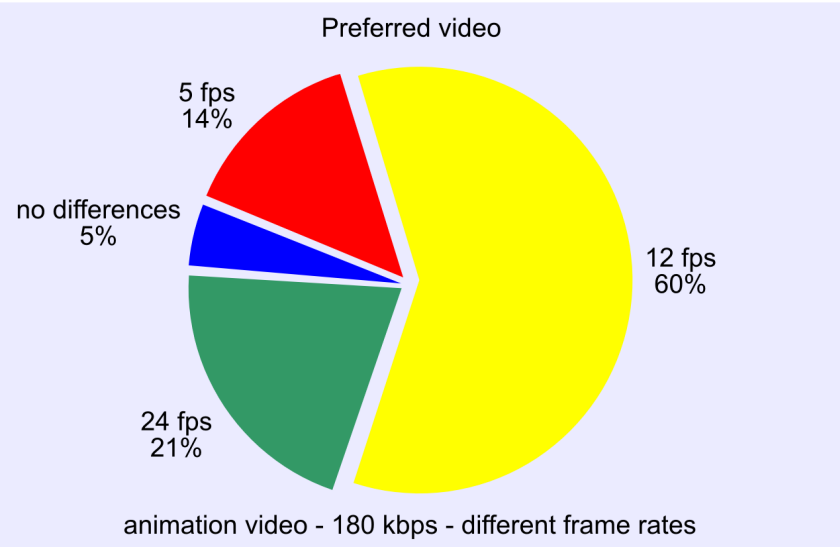

963



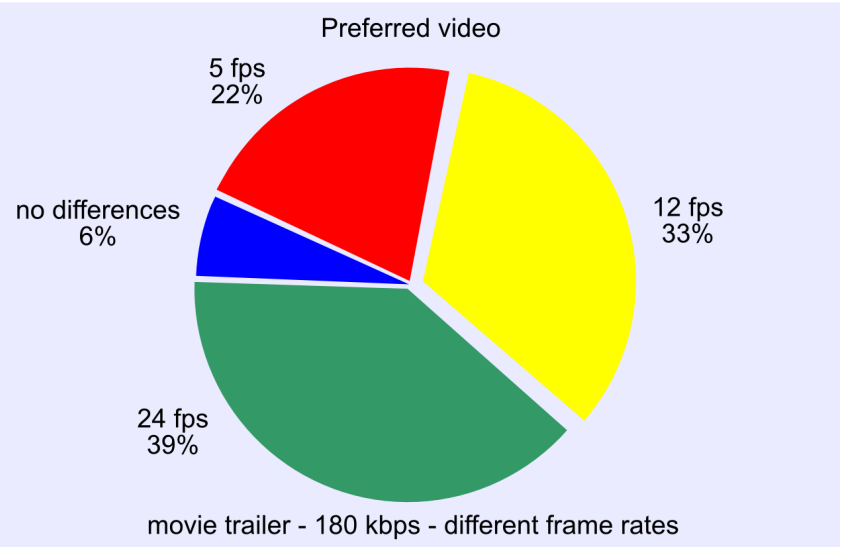
football video - 180 kbps - different frame rates



news video - 180 kbps - different frame rates



animation video - 180 kbps - different frame rates



movie trailer - 180 kbps - different frame rates

Client Capabilities

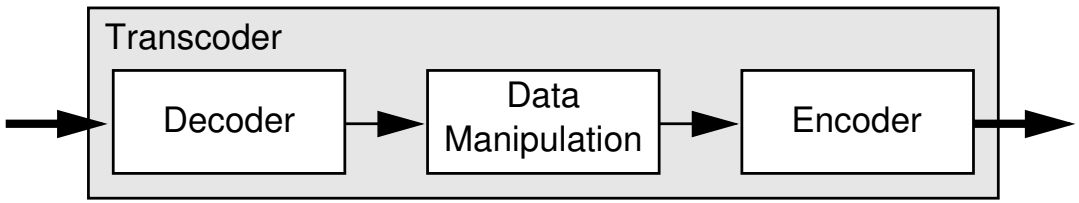
- Determination of the adaptation method at the gateway
- Requirements of the client
  - Device capabilities
  - User's preferences
- CC/PP to describe a client profile
  (Composite Capabilities/Preferences Profile)
  - Processor
  - Network connection
  - Screen resolution
  - Video encoding format
  - User's preferences
- 4 Components: Hardware, Software, User, Priorities

Client Profile

```
<?xml version="1.0"?>
<rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
     xmlns:ccpp="http://www.w3.org/2002/11/08-ccpp-schema#"
     xmlns:ex="http://www.beispiel.de/schema#">
<rdf:Description rdf:about="http://example.de/schema#Profile">
<ccpp:component>
    <ex:Hardware rdf:about="http://example.de/schema#Hardware">
        <ex:DisplayWidth>320</ex:DisplayWidth>
        <ex:DisplayHeight>240</ex:DisplayHeight>
    </ex:Hardware>
</ccpp:component>
</rdf:Description>
</rdf:RDF>
```

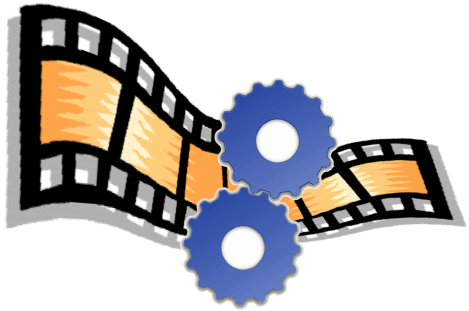
Decoder - Encoder

- Encoding parameters are defined at encoding time
- Cascaded Pixel Domain Transcoder (CPDT):



  - very flexible, but computational intensive
- Improvements:
  - Minimizing the needed decoding steps
  - Reusing information from the original data

Transcoding

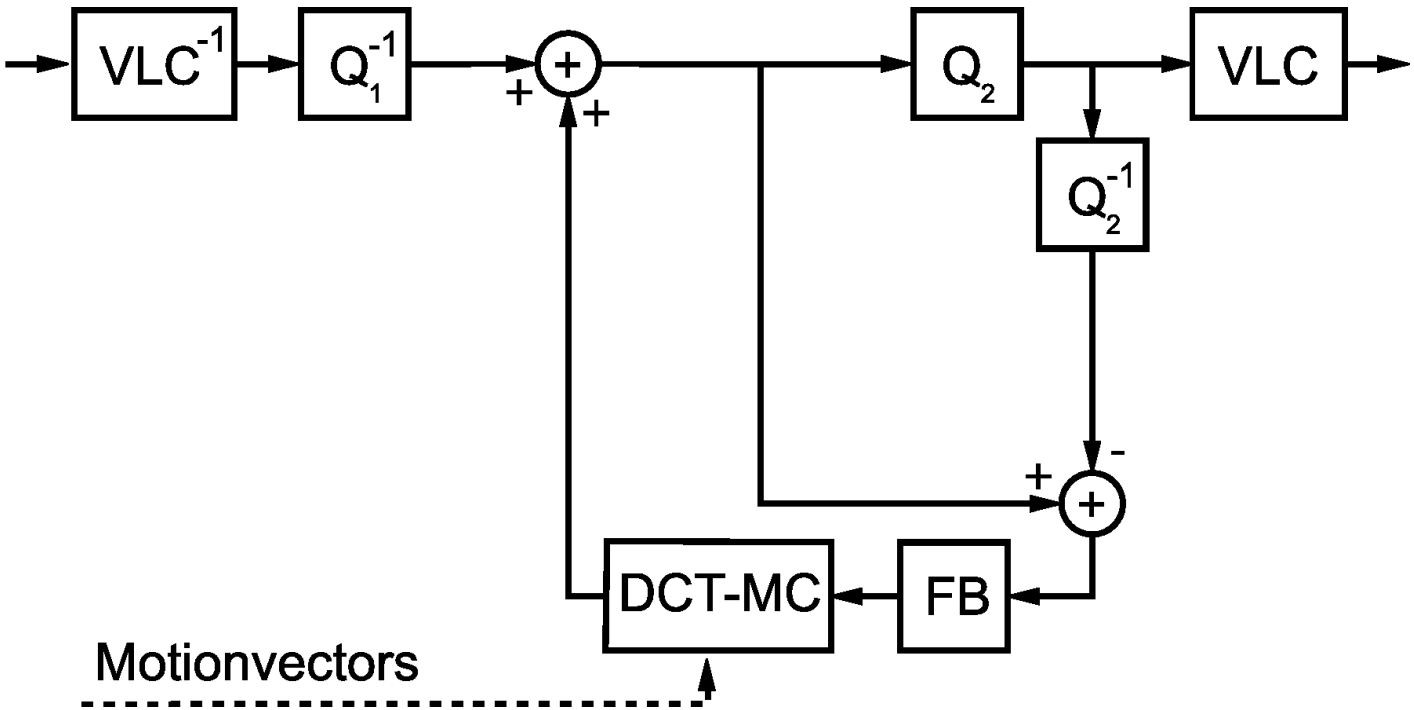


- Transcoding = manipulation in the compressed domain
- Linearity of the DCT:

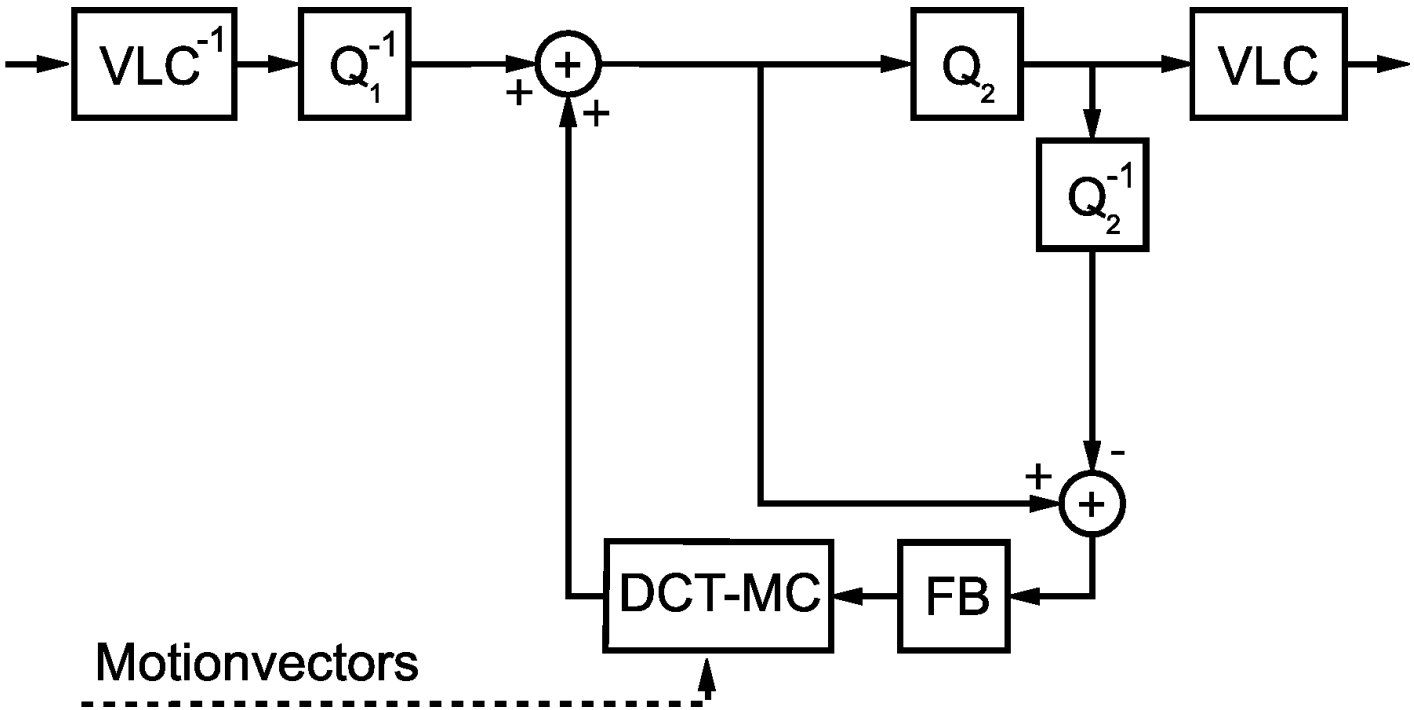
$$DCT(B) = DCT(X \cdot A \cdot Y) = DCT(X) \cdot DCT(A) \cdot DCT(Y)$$

$\Rightarrow$ Every linear pixel transformation can be computed in the frequency domain.

Transcoding Example: Requantisation



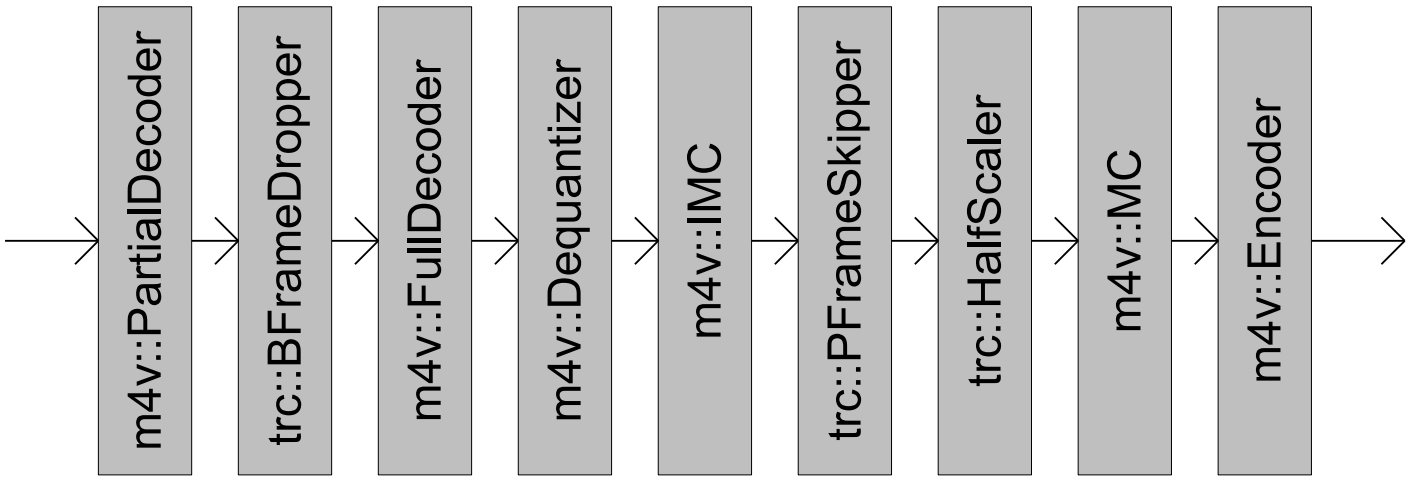
Transcoding Example: Requantisation



⇒ Not usable for spatial resolution adaptation

Multidimensional Transcoding

- Different specialized transcoding architectures exist
- A combined architecture is missing
- Multidimensional transcoding by using a transcoder chain
- Spatial, temporal and detail resolution reduction:



Summary

- Mobile devices:
  - Limited Resources
  - Great heterogeneity

$\Rightarrow$ Video Adaptation is mandatory

- Adaptation on multimedia gateways
- Determination of transcoding method on the gateway
- Based on the client's capabilities
- Multidimensional transcoding
- Fine-grain Adaptation

Questions?

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Implementation