Multiple Description Coding (MDC) and Scalable Coding (SC) for Multimedia

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Outline

- Challenges for multimedia transmission
- Multiple Description and Scalable Video Coding
  - Rationale
  - Issues
  - Synergies -> what are the by-products?
  - Support in current standards and adoption
- Challenges
- RoSE Project
  - What we do
  - Potential applications
- Conclusion
- Q&A
- References

Challenges

- Heterogeneous networks (different core, different edge, different end-points)
  - Rate adaptation in the network -> active networks
  - Congestion avoidance
  - Resource-constrained end-points
- Proliferation of wireless systems
  - Wireless multimedia transmission is challenging
    - Formidable channel conditions due to scattering, diffraction, multipath fading, etc.
    - Mobility
- A multitude of representations for streaming and on-demand multimedia

Video Coding Fundamentals

- The video (in most basic form) has a huge bitrate when uncompressed -> transmission, storage, processing overhead (e.g. approximately 216 Mbits for 1 second of uncompressed TV-quality video)

  ➡ utilize source coding and get rid off temporal and   spatial redundancy -> compress (MPEG-2: up to 15 Mbits/s)

- The major video coding standards released since the early 1990s (H.263, MPEG-1/2/4, H.264, …) based on the same generic design (or model) of a video CODEC :

  ▫ a motion estimation and compensation front end (sometimes described as DPCM)

  ▫ a transform stage

  ▫ an entropy encoder

 The model is often described as a **hybrid DPCM/DCT CODEC**.

Generic Model: Hybrid DPCM/DCT CODEC

DPCM/DCT video encoder [6]

DPCM/DCT video decoder [6]
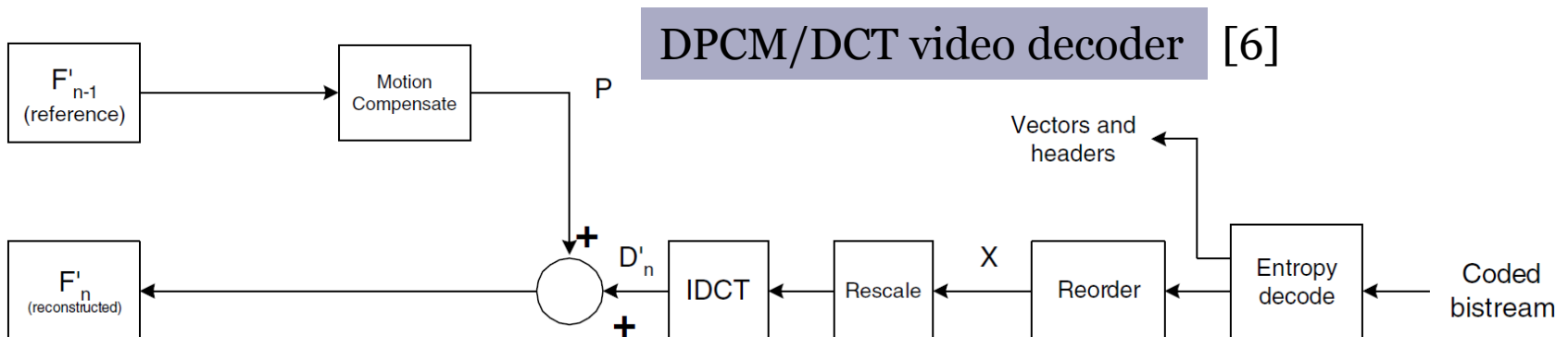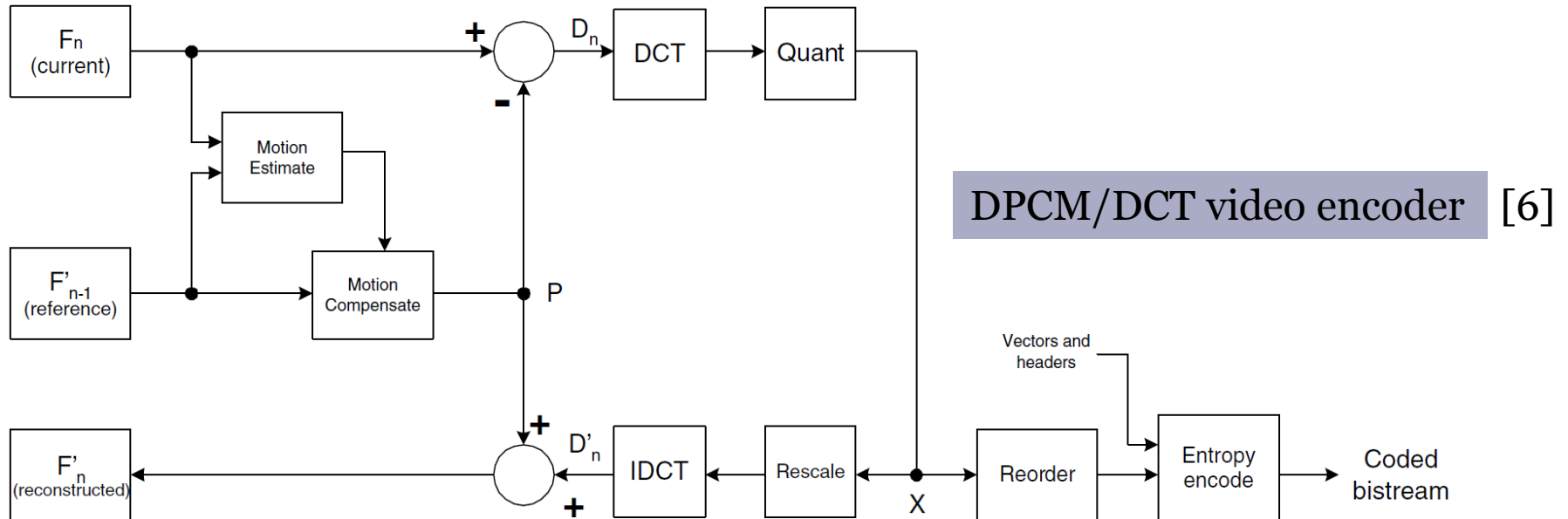
MDC and SC

- Rationale: Code the content in different/hierarchical representations - > different modalities : spatial, temporal, or SNR
  - MDC -> independent bit streams
  - SC -> base+enhancement layers
- Source-coding solution for robustness and scalability
  - Rate adaptation in the network -> active networks
  - Congestion avoidance
  - Resource-constrained end-points
- Early video compression standards such as ITU-T H.261 and ISO/IEC MPEG-1 did not provide any scalability mechanisms.
- Issues
  - Decoder complexity increases
  - Coding efficiency decreases
- Transmission with heterogeneous clients and multicast to diverse clients
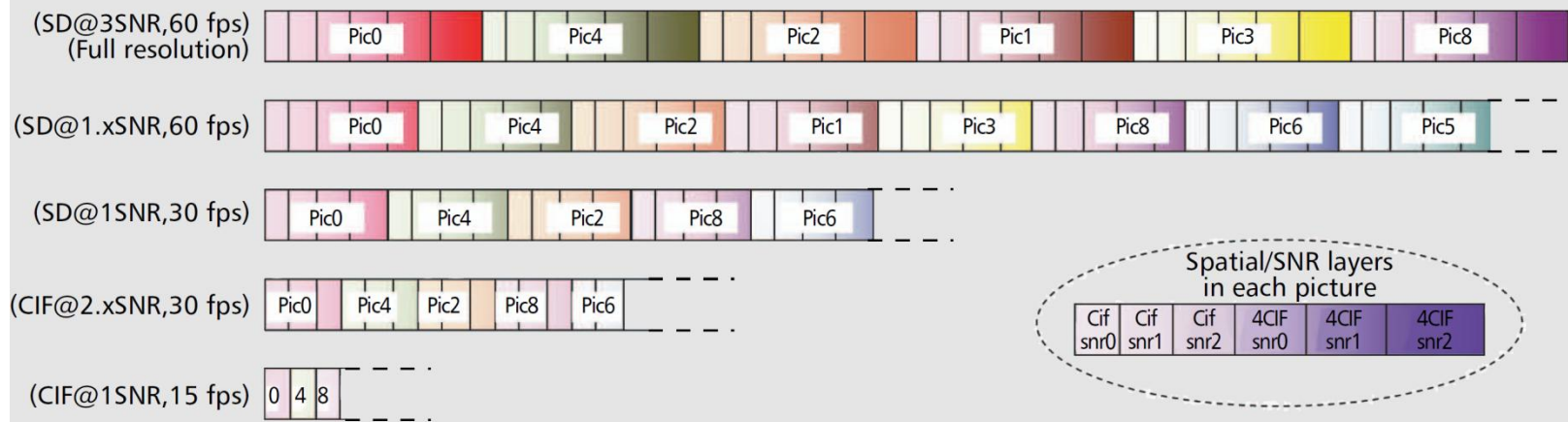
Typical MDC and SC encoder architecture
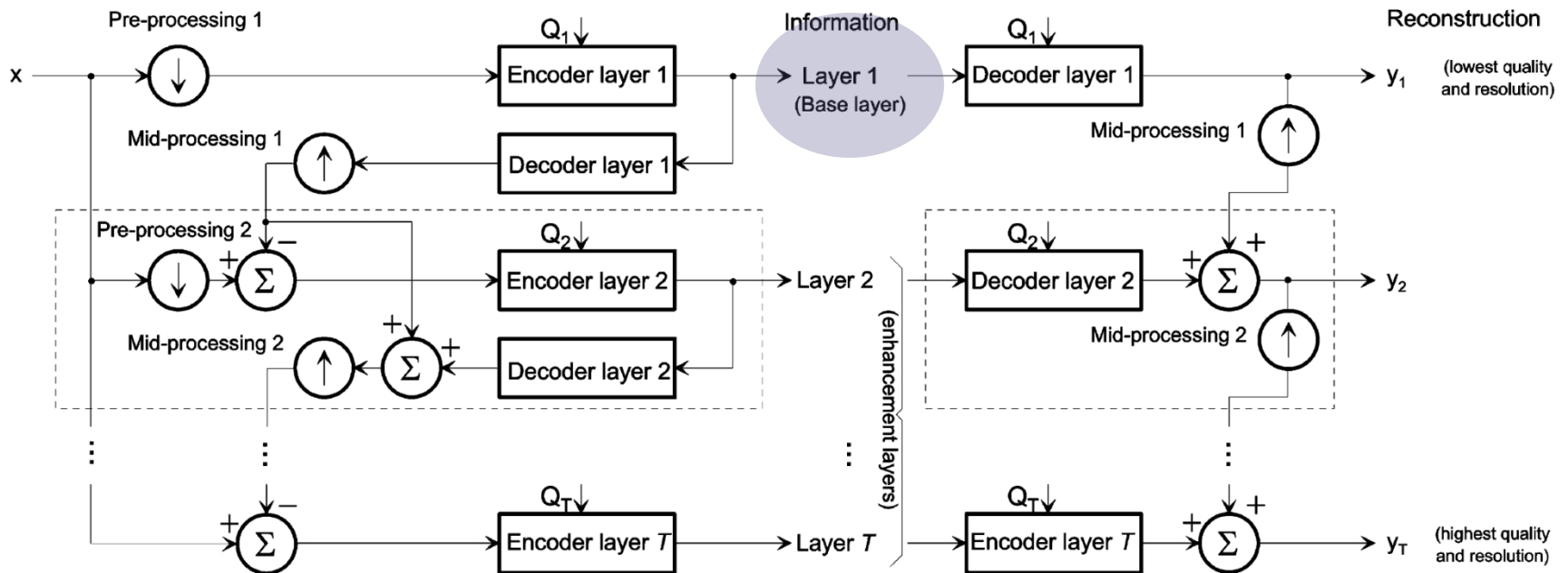
Principle of scalable coding using T layers [5]

SVC: A Typical Example
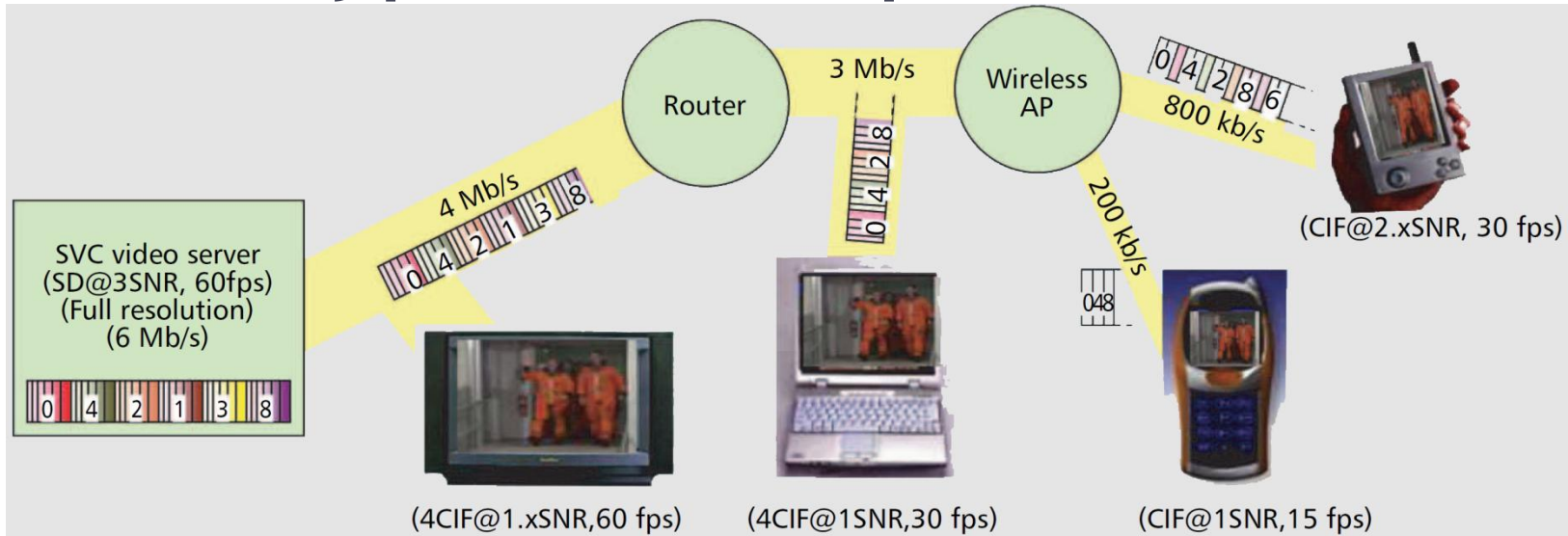
a) application scenario [2]

b) bitstream extraction [2]

Robust Streaming Environment (RoSE) Project (1)

- What we do: We are investigating and developing simple and compatible MDC (SC) scheme(s) for multimedia transmission
  - Specifically, currently working on transcoding using ffmpeg for RoSES (RoSE server)
- More oriented towards practical aspects and challenges
- Target software deliverables:
  - Streaming server
  - Client for performance evaluation and tests
  - Porting of client-side on a linux-based handheld such as OpenMoko or Maemo platform
  - A testbed network setup for performance evaluation (server+router+wireless endpoint?) - > non-software :-)
- Performance evaluation of investigated schemes

RoSE Project (2- cont.) – System Architecture

This process may be real transmission on a test network, hardware-based emulator or software-based channel model

Client-side functionalities

Multimedia container (content)

RoSES

AV Server

POSTMUX

Video stream

Audio stream

D_0

A_0

REMUX

D_1

D_2

D_N

A_0

RTP connections

Tx (Channel)

D_1'

D_2'

D_N'

A_0'

D_0' Video

Audio

A_0'

PLAYER (e.g. VLC)

Play MD streams

Transcodes (postprocesses) a multimedia stream into multiple (N) descriptions using various methods

Serves (streams) the contents over RTP and manages the connections

Reconstructs the multiple descriptions and merges them (postprocesses) to generate D_0

$\Delta(D_0,D_0')$

PERFEVA

- Compares the single description and multidescription multimedia and generates performance metrics (PSNR, etc.) for evaluation
- Provides other statistics such as packet loss, jitter, etc.

RoSE Project (3- cont.)

- The key issues:
  - Standards compliant
  - simple and easily adoptable
  - open source
  - based on open source and trustworthy software components -> FFMPEG, QT, ACE (Adaptive Communications Environment), ...
- Potential Aplications and research directions:
  - Error resilience for WMSN
  - P2P transmission scalability based on MD and packetization
  - Broadcasting systems for NGN (DVB-SH)

Conclusion

- MDC+SC is promising but not caught up with practical systems yet (details of these techniques were omitted in this presentation)
- Crucial for adaptive and robust multimedia transmission in heterogeneous networks
- RoSE project aims to investigate and evaluate potential schemes in different settings using actual implementations and simulations
- No concrete results yet :-(But stay tuned :-)

Q&A

For offline questions:

- E-mail: gurgurka@boun.edu.tr
- This presentation is available at
  http://www.cmpe.boun.edu.tr/~gur/

References

[1] V. K. Goyal, "Multiple description coding: Compression meets the network," *IEEE Signal Processing Magazine, vol. 18, no. 5, pp. 74–93,* September 2001.

[2] H.-C. Huang, W.-H. P. ng, T. Chiang, and H.-M. Hang, "Advances in the scalable amendment of H.264/AVC," *Communications Magazine, IEEE, vol. 45, no. 1, pp. 68–76, Jan. 2007.*

[3] A. Vitali and M. Fumagalli. (2005) Standard-compatible multiple-description coding (MDC) and layered coding (LC) of audio/video streams. Internet draft. [Online]. Available: http://tools.ietf.org/tools/rfcmarkup/rfcmarkup.cgi?draft=draft-vitali-ietf-avt-mdc-lc-00.txt

[4] H. Schwarz, D. Marpe, and T. Wiegand, "Overview of the scalable video coding extension of the H.264/AVC standard," *Circuits and Systems for Video Technology, IEEE Transactions on, vol. 17, no. 9, pp. 1103–1120, Sept. 2007.*

[5] J.-R. Ohm, "Advances in scalable video coding," *Proceedings of the IEEE, vol. 93, no. 1, pp. 42–56, Jan. 2005.*

[6] Iain E. G. Richardson, *H.264 and MPEG-4 Video Compression: Video Coding for Next Generation Multimedia*, Wiley, 1st Edition, 2003. (ISBN: 0470848375)