International Telecommunication Union

Standard encoding protocols for image and video coding

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ITU and Image Coding Standardization

- Standardization role
  - Primarily in ITU-T SG16 (Multimedia)
- Coordination & harmonization role
  - With ISO/IEC (JPEG, JBIG, MPEG)
    - JPEG = *Joint* Photographic Experts Group
    - JBIG = *Joint* Bi-level image Experts Group
    - "ISO/ITU Collaborative Team" – since 1986
  - With other standardization bodies (IETF, regional bodies, etc.)

Lossless vs. Lossy Coding

- Lossless coding – preserves exact input
  - Preserves details only visible to experts
    - X-rays, diagnostic imagery
  - Preserves details for automated analysis

- Lossy coding – much better compression
  - Can appear perfect to normal viewers
  - Only practical way to send/store video

Lossless Coding

- Quantization still limits input quality
  - Finite bits/sample, samples/picture, frame rate (for video)
  - But loss can be made arbitrarily small
  - Diagnostics require large sample depth
- Compression from *redundancy removal*
  - Simple example: Run-length encoding
  - Simple example: Huffman coding

Lossy Coding

- Not all details are preserved
  - More effective compression possible
  - Amount of loss can be controlled
- Compression from:
  - Redundancy removal (as with lossless)
  - Drop details not perceived by people
    - Reduce quality in carefully selected ways
    - Simple example: Color vs. Brightness
    - Simple example: Fast motion in video

Still Image vs. Video Coders

- Still image coder applications
  - Documents
  - Diagnostic imagery
  - Photographs
- Motion video applications
  - Live interactions with patients, experts
  - Observation, monitoring
  - Procedure training

Still Image Coders (exploit 1- or 2-D redundancy)

- JPEG (Rec. T.81, ISO/IEC 10918) – Royalty-Free "baseline"
  - Lossy & lossless; supports full-color images
  - 8 bits/pixel/channel (baseline- 256 grey levels)
  - Widely used on World Wide Web
- JPEG-LS (Rec. T.87, ISO/IEC 14495-1) – Royalty-free
  - Lossless (near-lossless also possible), fast
  - Up to 16 bits/pixel/channel (65536 grey levels)
- JPEG-2000 (Rec. T.800, ISO/IEC 15444) – RF "baseline" dec.
  - Lossy & lossless- Improved compression v. JPEG
    16 bits/pixel/channel (medical profile)
  - Wavelet technology – high encoder complexity

Cooperation with the Medical Standardization Community

- DICOM (Digital Imaging and Communications in Medicine) standards committee
  - All JPEG codecs used in DICOM standard
  - Strong liaison relationship with JPEG-2000
  - Special “Medical profile” of JPEG-2000
  - Requirements of DICOM incorporated from start
- Further cooperation invited!

More Still Image Coders

- Bi-level (black & white) encoders
  - T.4, T.6, T.82 (JBIG), T.88 (JBIG2)
  - Mainly used for documents, fax
- GIF
  - Proprietary, 256 colors/image, obsolete
- TIFF (Tagged Image File Format)
  - Proprietary – many complex modes
- PNG (ISO/IEC FDIS 15948 – in progress)
  - Lossless, up to 16 bits/channel

Video Coder Standards (exploit redundancy over time)

- H.120, 768-2000 kbps, small picture,1984-1988
- H.261, baseline video compression – 1990
- MPEG-1/Video (ISO/IEC 11172-2) - 1993
- H.262=MPEG2-Video, high rate video - 1995
- H.263, improved lower rates - 1996
  - Same core as original video part of MPEG-4
- H.263+, H.263++ ➔ H.263 (2000)
  - Extensions for flexibility, new features
- H.264/AVC, next generation video coding
  - For final approval on Friday (30 May 2003)

Video Coder Considerations

- Picture quality depends on *encoders*
- Bitrate and compression efficiency
  - Video bitrates from 40 to 20,000 kbps
- Resolution: Picture size, Frame Rate
  - SQCIF (128x96), QCIF (172x144), CIF (352x288), SD (704 or 720 x576), HD (up to 1920x1280)
  - 10 to 60 Hz common (25i PAL, 30i NTSC)
- Progressive vs. interlaced scan
- Error resilience

ITU-T Rec. H.261 Video Coder (1990)

- 1st practical & successful video coding standard
- Used today in video conferencing systems (on ISDN)
- Bit rates commonly 64 kbps to 2 Mbps
- CIF (352x288) and QCIF (176x144) picture sizes, progressive-scan

MPEG-1 Video (ISO/IEC 11172-2) - 1993

- The first video coding standard using half-pel motion compensation
- Typical bit rates 1-2 Mbps

ITU-T Rec. H.262/MPEG-2 Video Coder (1995)

- Same as MPEG-2 video (ISO/IEC 13818-2)
- Commonly used for TV-quality video applications
- First practical standard for interlaced video
- DVD, digital cable/broadcast/satellite TV, etc.
- Bit rates commonly 4-20 Mbps

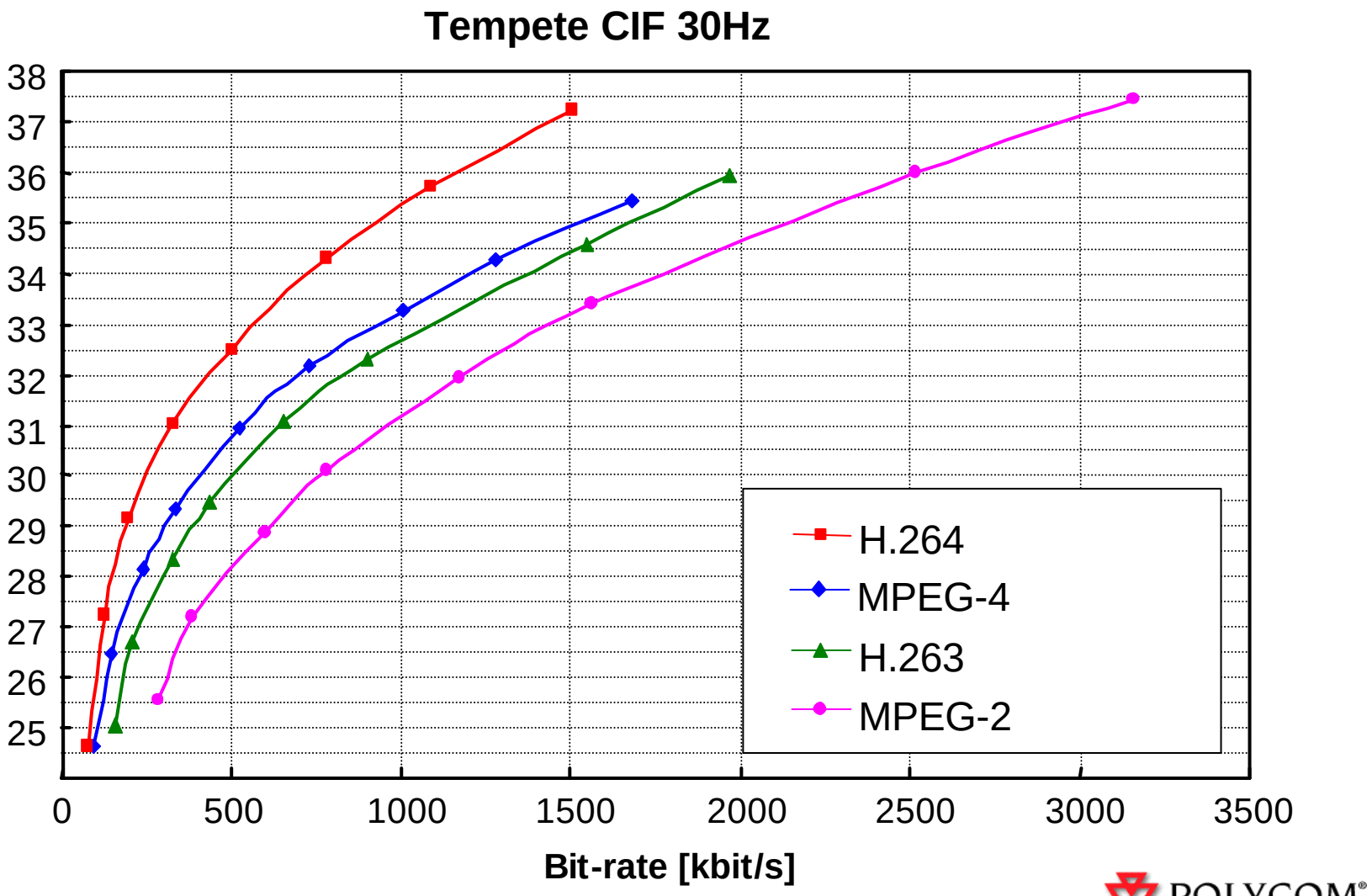
ITU-T Rec. H.263 Video Coder (1995)

- Significantly improved compression
- 1st error and packet loss resilient standard
- Widely used today
  - IP, wireless, and ISDN video conferencing terminals (H.320, H.323, H.324, 3GPP, etc.)
- "Baseline" core is the basis of MPEG-4 Video
- Rich set of features for many applications
- Optional interlaced scan mode
- Very wide range of bit rates and possible applications

ITU-T Rec. H.264 / MPEG-4 Part 10 AVC (ISO/IEC 14496-10)

- Breakthru performance increase – 2x or more
- Started as "H.26L" in ITU-T
  - Officially in 1995, in practice in 1997-1998
  - SG16 Q.6 (Video Coding Experts Group, VCEG)
- Joint Video Team (JVT) formed with MPEG
  - Started late 2001 after request from MPEG
- Much simpler Profile/Level feature & capabilities signaling
- Baseline Profile (progressive scan only) is offered royalty-free

Compression Performance



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Slide: T. Wiegand

Thank you!

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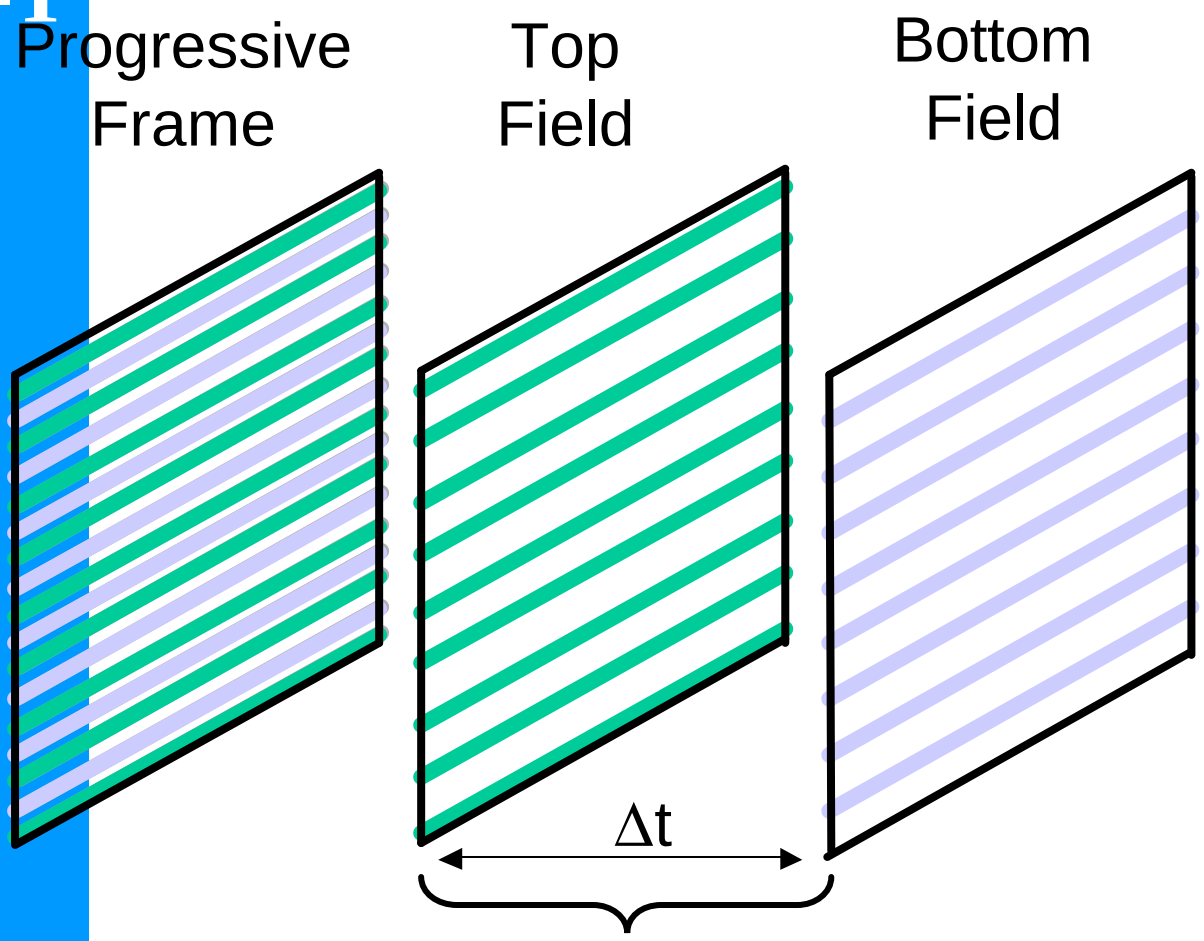
    - Counsellor, ITU-T Study Group 16
  - Istvan Sebestyen, Siemens AG
    - Liaison representative to/from SG16, JTC1 SC29
- Questions?

BACKUP SLIDES

Input Video Signal



Interlaced Frame (Top Field First)

- Progressive and interlaced frames can be coded as one unit
- Progressive vs. interlace frame is signaled but has no impact on decoding
- Each field can be coded separately
- Dangling fields
- Macroblock-based frame field adaptive coding

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