Evolution in mobile video

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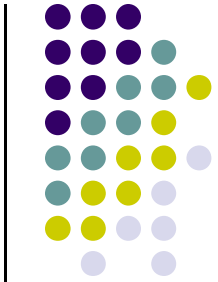
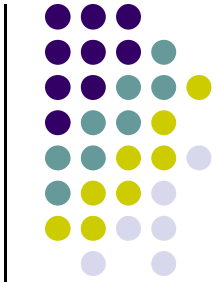
Views of technology's Masterminds



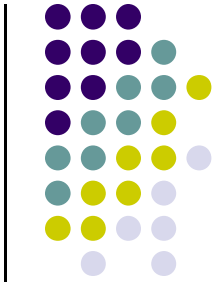
- At the end of year 2004 IEEE Spectrum thought the views of 40 Technology's Masterminds, whom are the leading thinkers from the Science and Engineering to gaze out over the technology landscape and tell the world what they see.

They were asked THREE questions



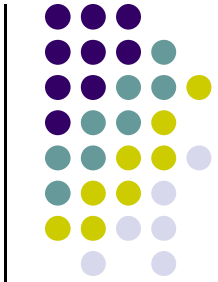
1. What has been the most important technology of the last 40 years?
2. What technology has evolved in a way that surprised you?
3. What technology will have the biggest impact in the coming decade?

Answers to the most important technology in the past:



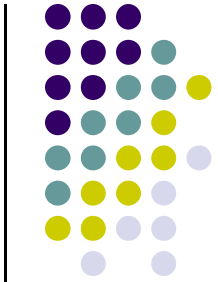
- Nearly all the answers to this question boiled down to 3 points:
  - The integrated circuits
  - The internet
  - Computers
- (some people covered their bases by naming two of these or even all three)

Answers to technological surprise:



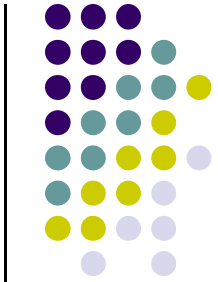
- Moor's Law: for being an engine as well as a predictor for changes:
  - Catalyzing astonishing progress in computing power and transmission speed;
    - Computer power:40 years ago supercomputers could do just basic arithmetics; NOW most PCs operate @ 5 GHz
    - Transmission speed: 40 years ago best international links were confined to 12 voice channels (48 kHz), NOW optical links of more than 60 Gbit/s are in use

Answers to: in the coming decade



- Our daily life being saturated with Information Technology
- Mobile services:
  - Will know who you are; where you are; what you need at any given time
  - Reads E-mail to you while you are driving
  - Scrolling text messages, while you are watching TV

It is a future that will depend on:

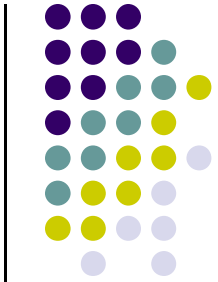


- Wireless Communications and technology
- Distributed sensing
- Embedded systems

- →Smart, Intercommunicating Everything

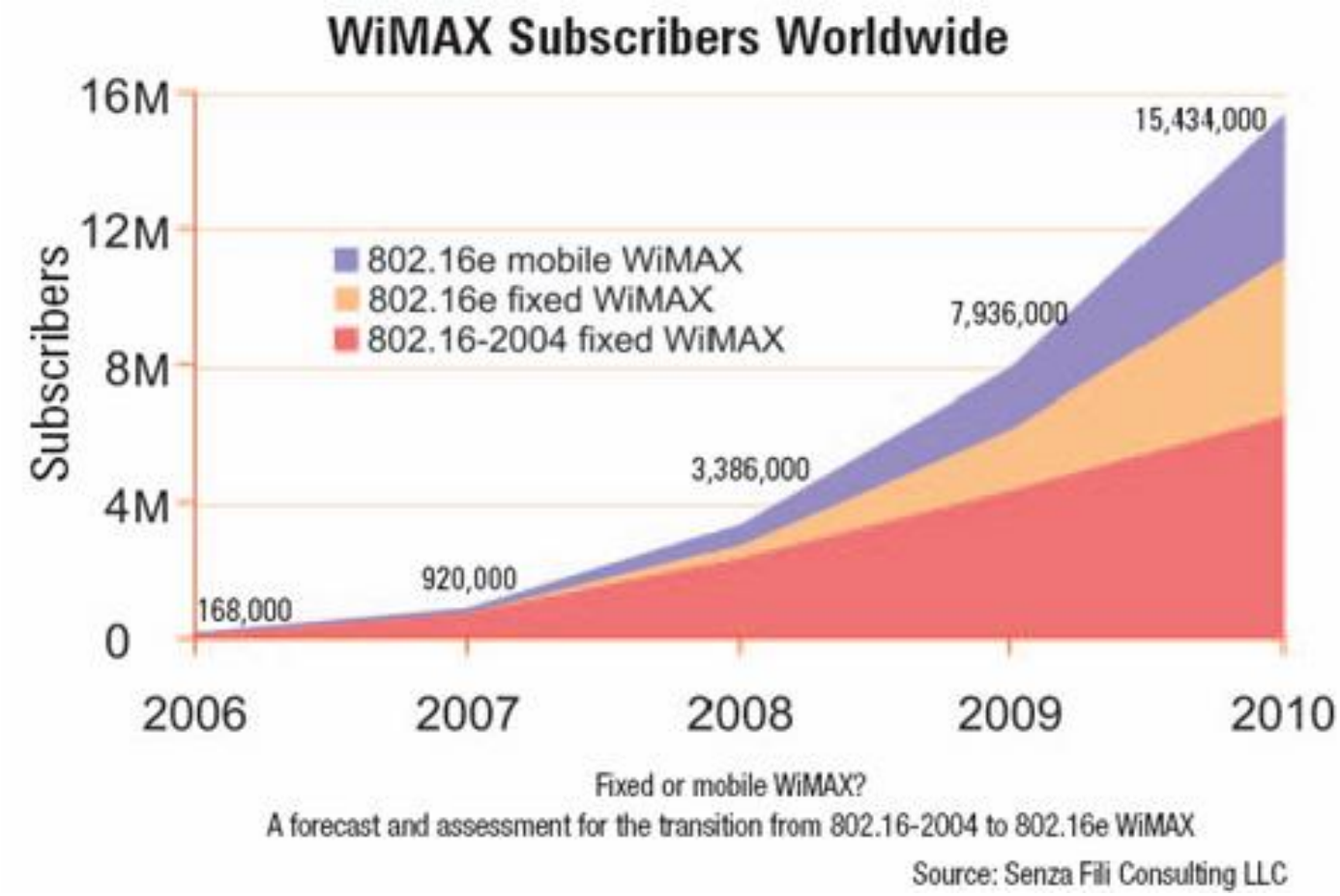
- Many believe No one can predict the Future, Just as a forecast from 1964 (40 years ago) may have failed to foresee the explosion of the Internet or longevity of Moor's Law

Current technological advances in MM industry



- Mobile phone subscribers passed 1.5 bn, in June 2004 and still growing
- WiFi, Wimax, PTT (push-to-talk), over Cellular to co-exist with 2G/3G
- All these technologies are going into the handset, which can then seemlessly switch between WiFi, UMTS(3G), GPRS or WiMax

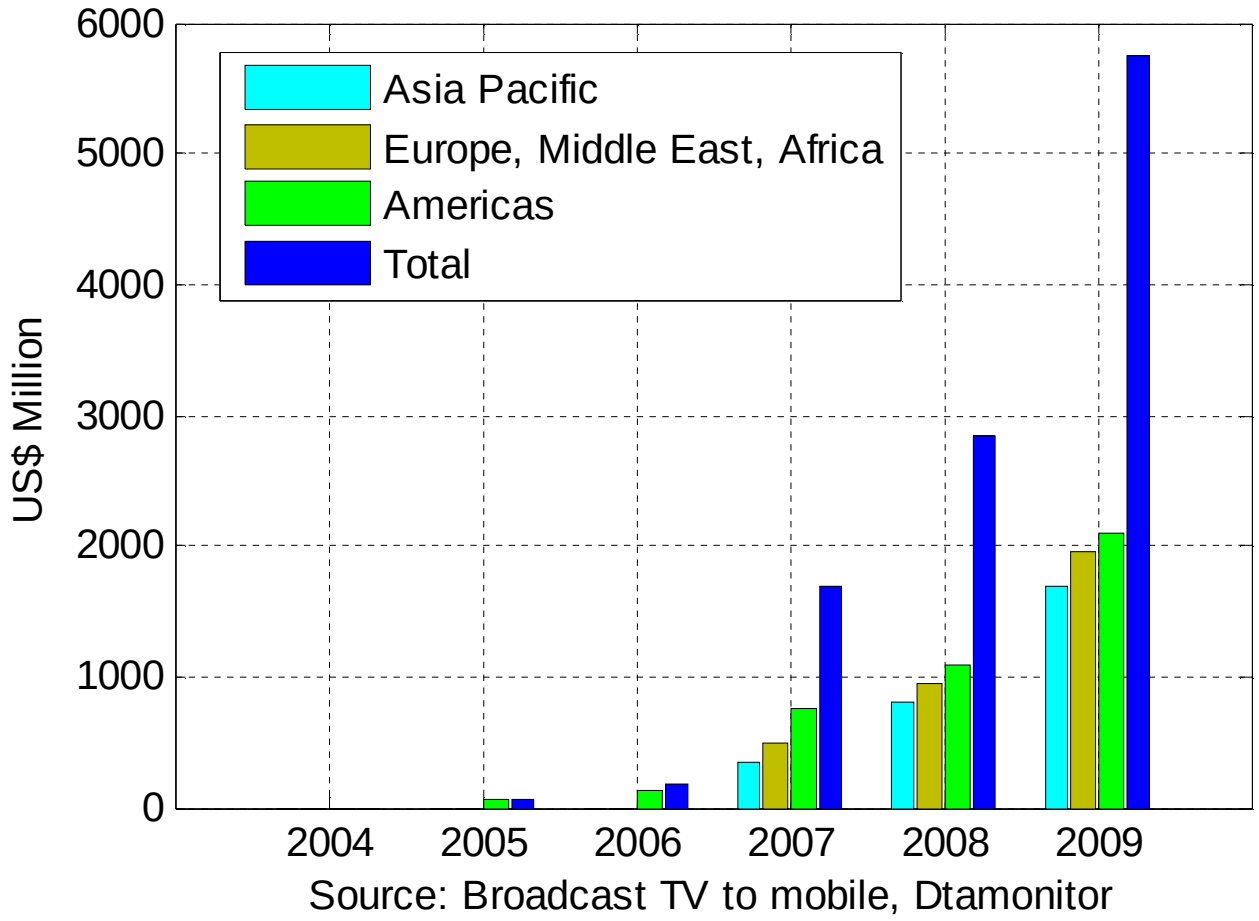
Forecast for Wimax



DVB-H: TV goes mobile

- DVB-T: Digital video broadcasting-Terrestrial, now is well on its way, and soon analogue TV will seize to exist.
- DVB-H: DVB-Handheld, where people on the move can watch TV programs, now is becoming practical.
- DVB-H system is based on existing DVB-T, but with additional FEC, to operate at lower C/N.

Mobile TV revenue forecast (December 2005)

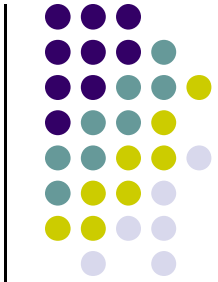


Some commercially available Mobile TV

DVB-H (Contd.)

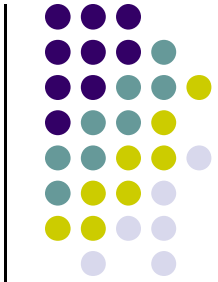
- DVB-H uses IP as the transport layer and on top of that there is MPE-FEC and Advanced Video Coding (AVC).
- DVB-H can offer more than 30 TV programs for small displays using 16-QAM/QPSK modulation.
- The transmitted power is modulation dependent (25.5 dB for 16-QAM and 18.5 dB for QPSK).
- *UHF band can be utilised for DVB-H services, but it may not be possible for all countries.*
- *There are two possible alternatives in which DVB-H services can be deployed.*
  - *Either using DVB-T infrastructure, but this will have low mobility performance.*
  - *Enhancements in DAB services (which is mainly developed for high mobility applications) to include DVB-H services using L-Band frequencies and UMTS for return path.*

New services



- Audio streaming (from Internet)
- Graphic files (e.g. maps,)
- Mail attachments
- Picture messaging for diagnosis
- Shared video
- Video streaming (short video clips, e.g. exiting events in football clips)
- Geographic positions are reported to both mobile terminals and network (traffic control)

CHALLENGES

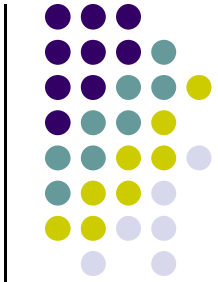


- To deliver good quality of service, two main challenges in the wireless communication systems have to be dealt with:
  - Bandwidth Limitation
    - Wireless bandwidth is very scares

    (in contrast to almost unlimited optical bandwidth)
  - Channel Noise
    - Wireless channels are very prone to errors

    (normal error rate 10^{-4}, compared to 10^{-12} for optical channels)

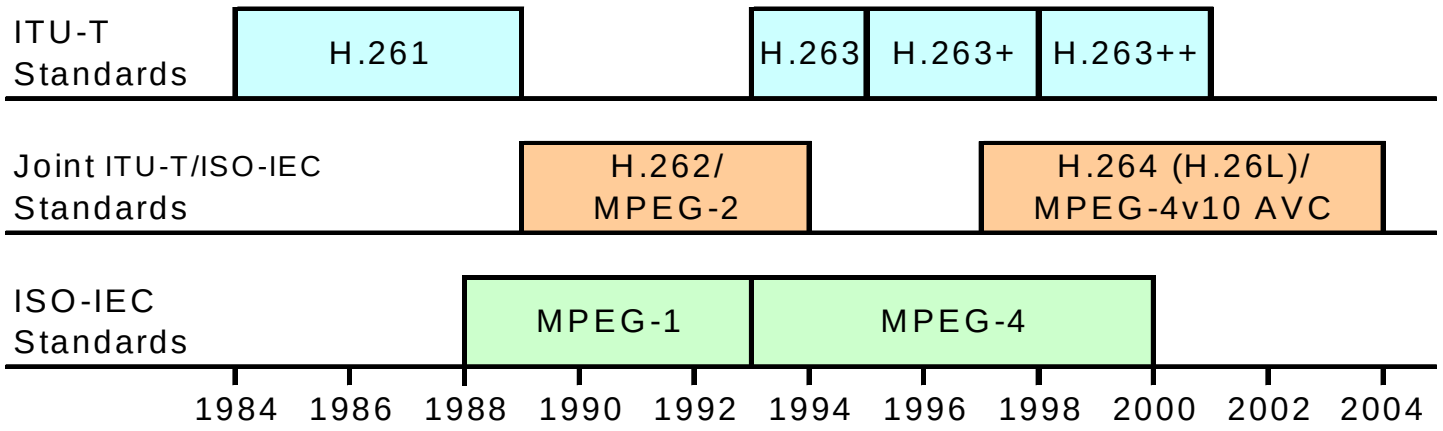
BANDWIDTH



- Video services are bandwidth and time thirsty
  - (larger bandwidth and longer duration)
- Video services should not occupy much larger bandwidth than the existing voice like services.
- Raw video services contain a huge amount of data:
  - Raw data rate of VHS quality video ≈37 Mb/s
- Therefore a sophisticated **Video Compression** tool is needed.

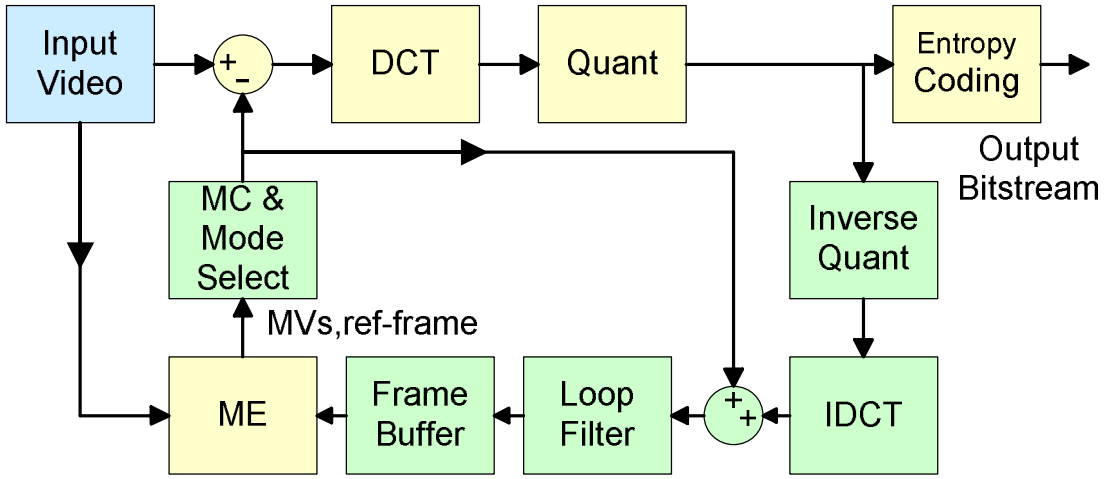
Video coding standards

- Over the past 20 years the Video Coding Experts Group (VCEG) of ITU-T and the Motion Picture Experts Group (MPEG) of ISO/IEC have standardized many video codecs for various applications.
- They have worked either independently or Jointly.



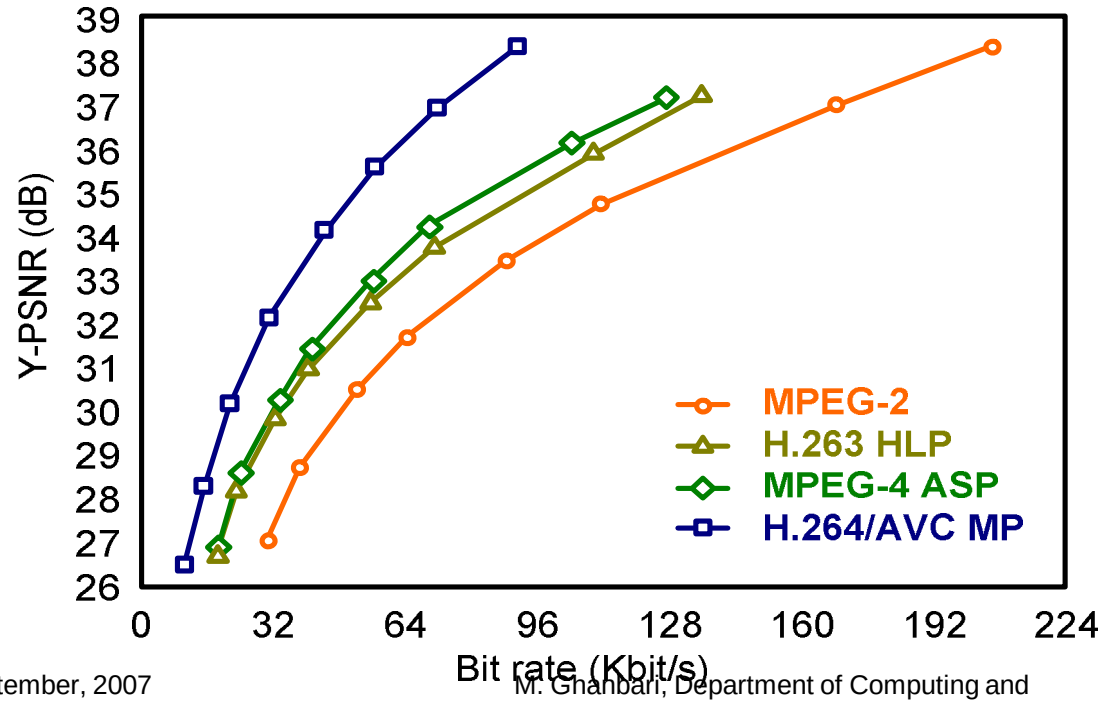
Overview of H.264/AVC

- H.264/AVC is the latest video codec standard of the Joint Video Team (JVT) of ITU-T VCEG and ISO/IEC MPEG.
- It follows the generic standard codec, i.e. DCT, MC, Entropy Coding, etc.



Compression efficiency

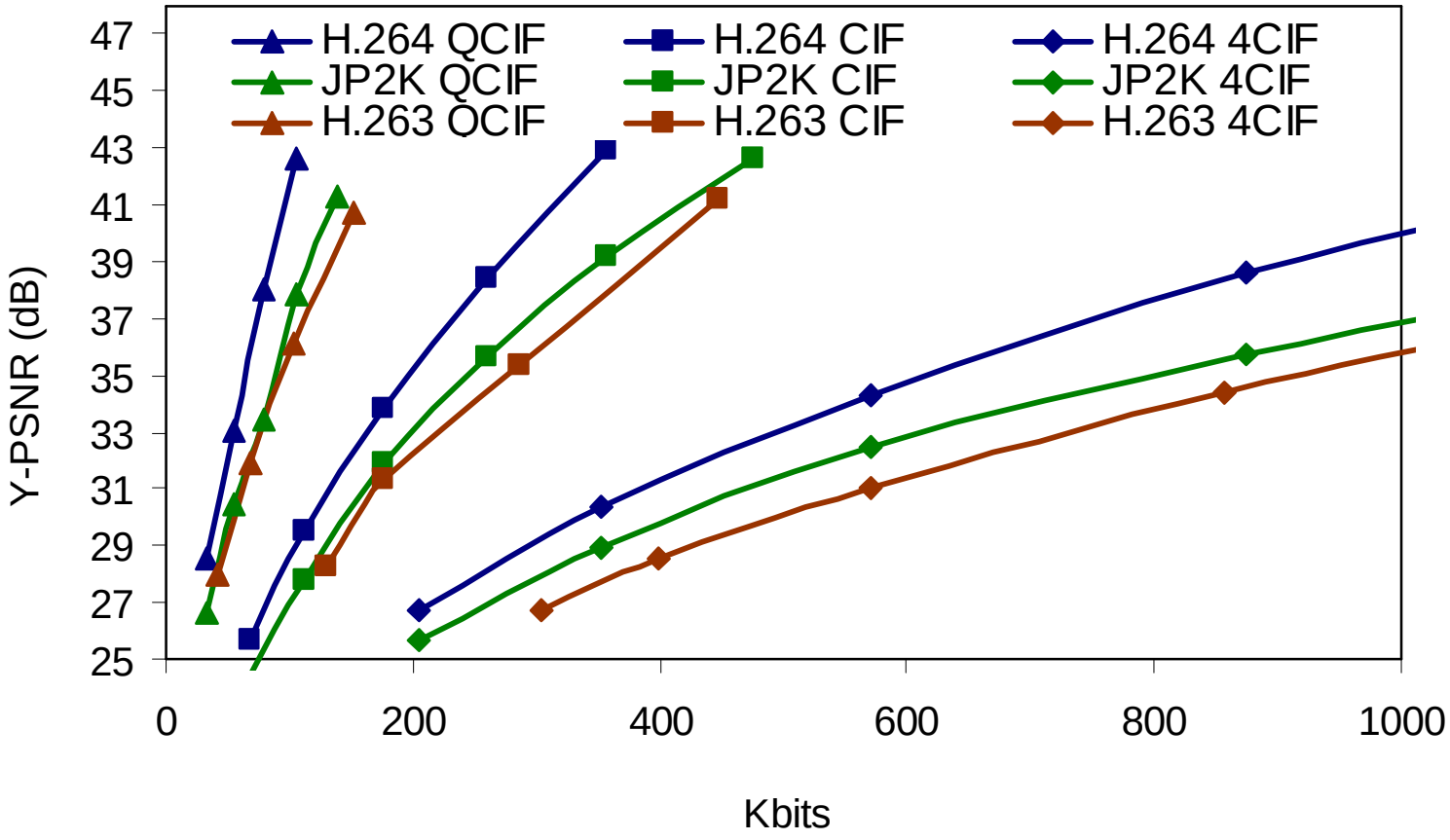
- H.264/AVC has achieved a significant improvement in compression efficiency over the previous standard video codecs.



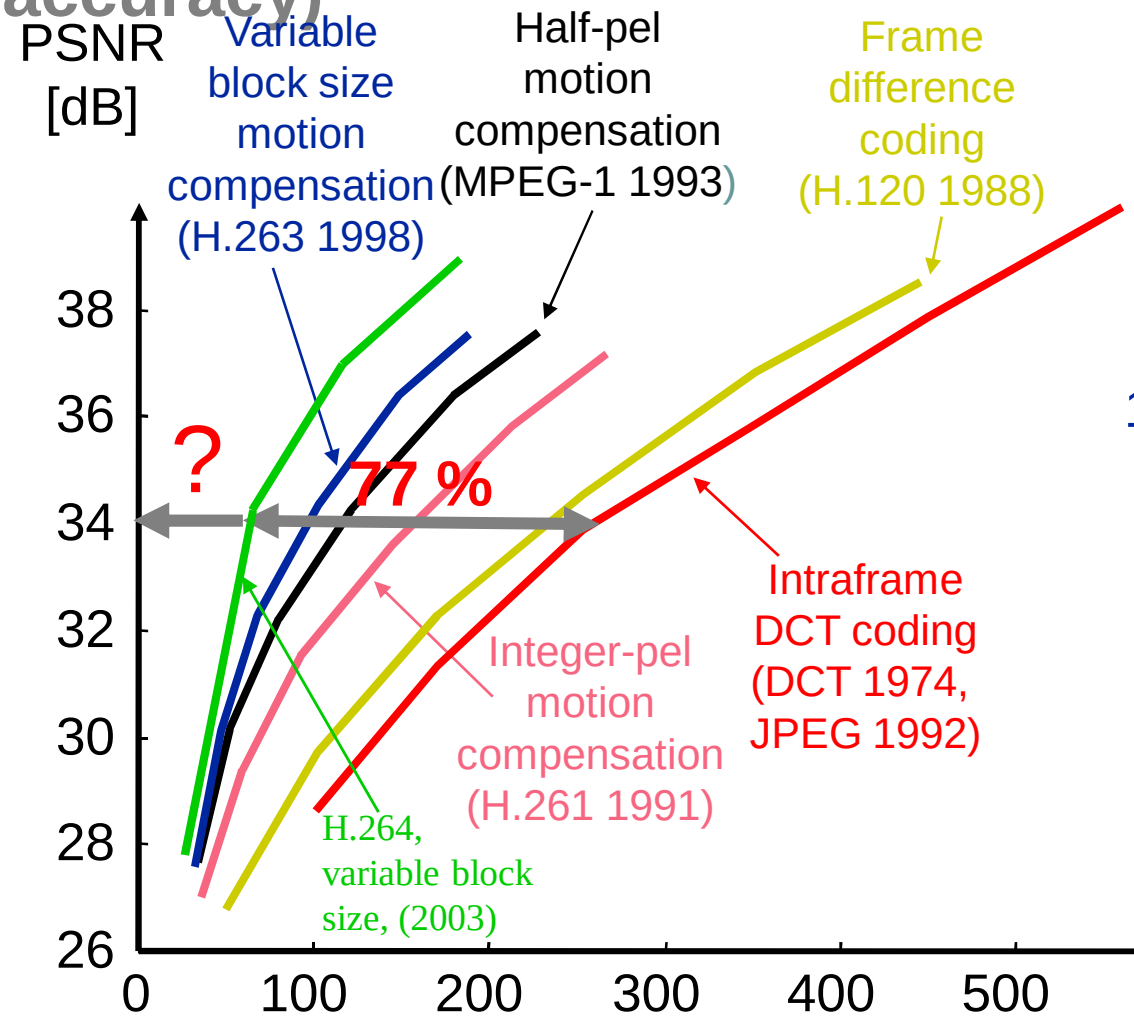
Foreman Test sequence, coded with four standard video codecs [Wiegand et al].

Inrta JVC/JPEG2000

(the intra frame prediction is even more powerful than the wavelet based image coding, used in JPEG2000)

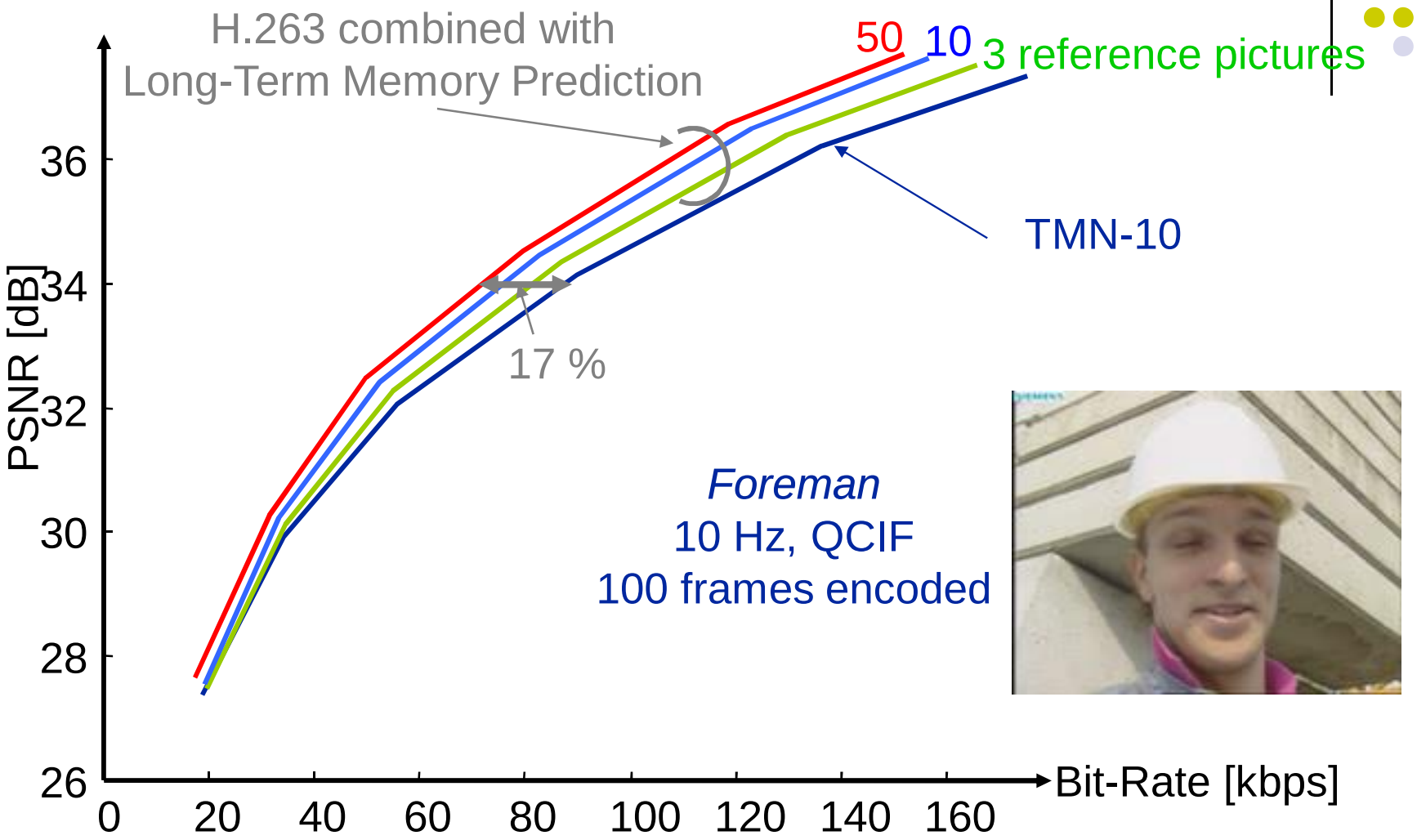


Effect of ME/MC (integer to sub-pixel accuracy)



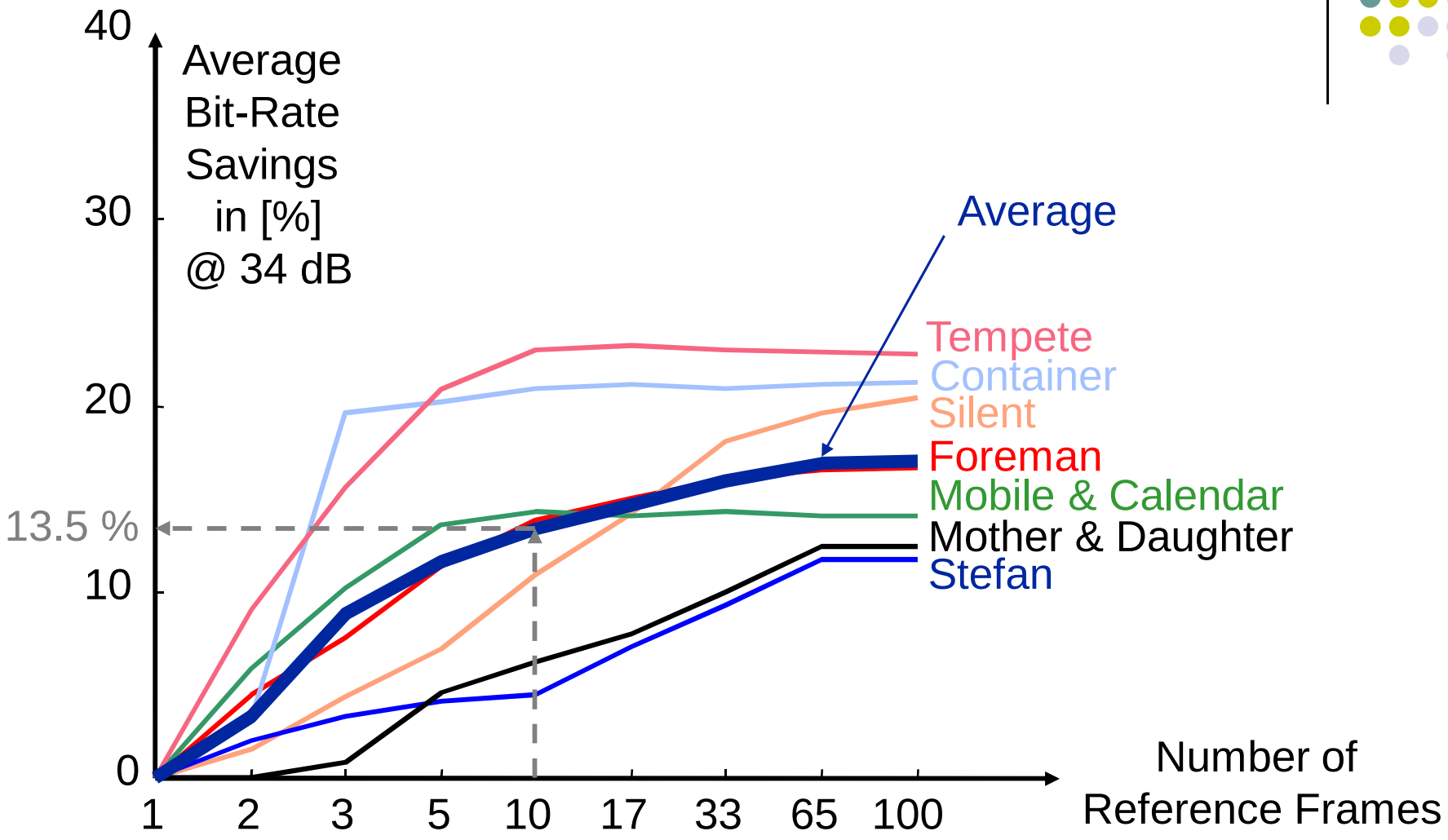
Foreman
10 Hz, QCIF
100 frames encoded

H.263++ (Annex U) Long-term memory Prediction



Foreman
10 Hz, QCIF
100 frames encoded

Effect of scene content in Multiple-frame Prediction in H.264



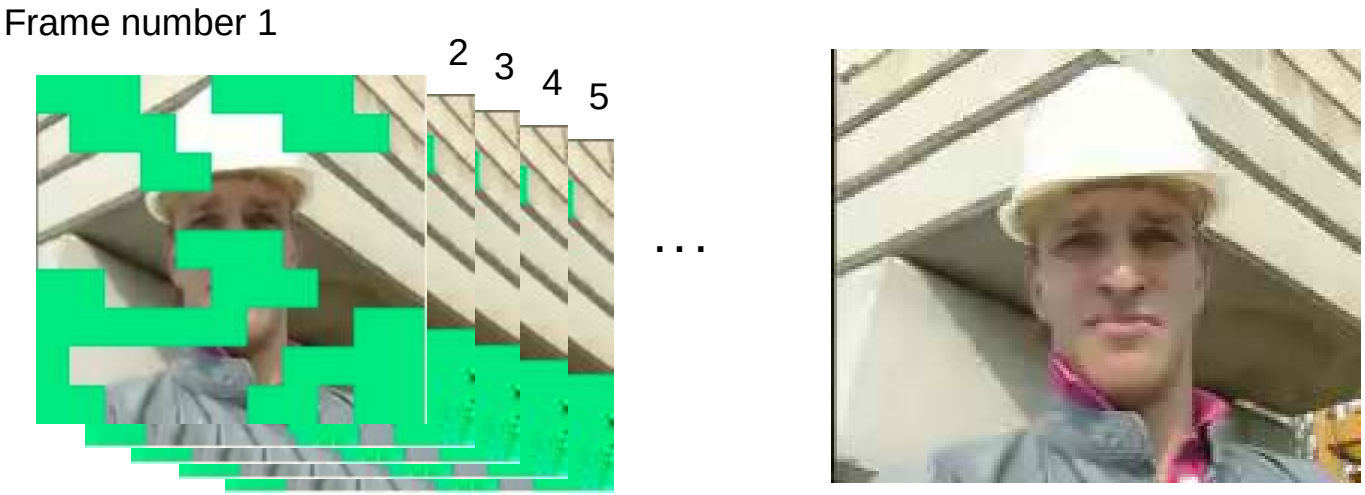
Compression Performance

H.264 versus H.263 which has a similar performance to Frame-based MPEG-4

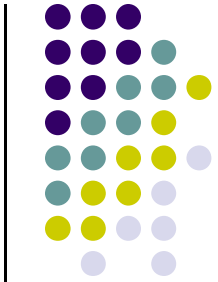
H.263, 30 K-Bits/Sec H.264, 30 K-Bits/Sec

Sensitivity to Errors

- Compressed video is very sensitive to errors.
  - A single error, will spread both spatially and temporally damaging all the successive frames.
  - The higher the Compression, the more sensitive is the compressed video to errors.

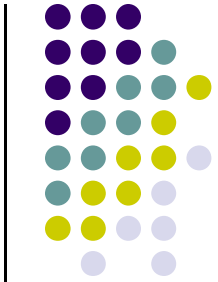


CHALLENGES
Noise

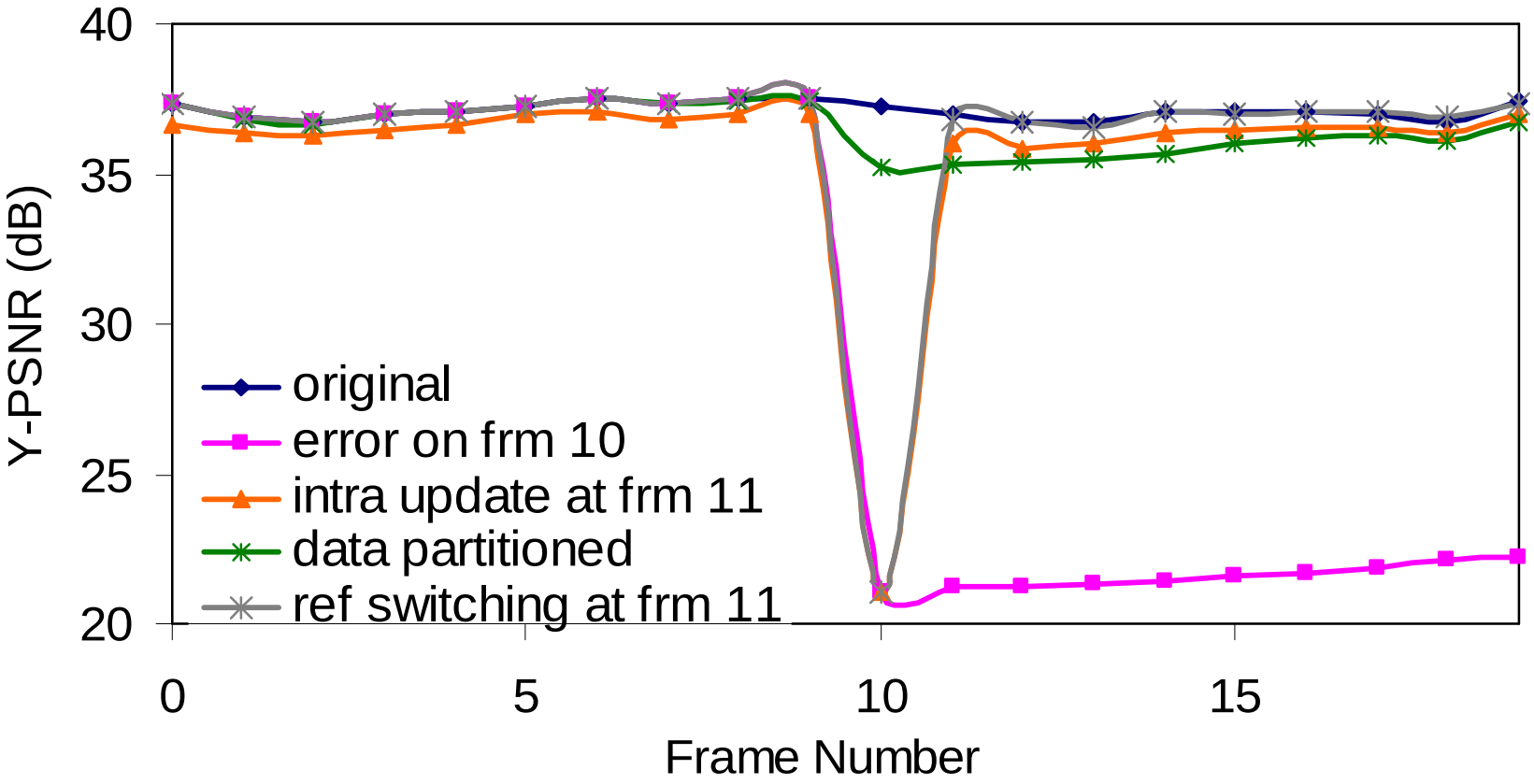


- There are several methods to decrease the impact of noise/errors on the compressed video:
  - Error resilient Source Coding
  - Channel Coding
  - Error Concealment
  - etc

Layered coding



- Intra-Refresh and Multiple-Reference are effective, but need a back channel.
- In non-feedback video transmission, layered coding with transport prioritization is a very effective error resilience scheme.
- To improve the transmission efficiency, higher error protections are applied to the more important units of the coded data.



(A) Loss at Frame 10
(B) Loss at Frame 10, updated at Frame 15
(C) DP: Loss at frame 10, and not corrected

A B C

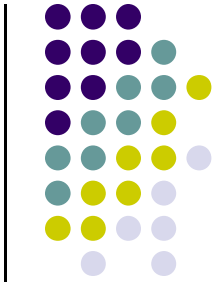
CHALLENGES

Noise: If nothing more can be done, then try to hide (conceal) errors

- Examples of some Error Concealment Methods;

A Corrupted Sequence	Concealed using simple copy	Concealed using an advanced method

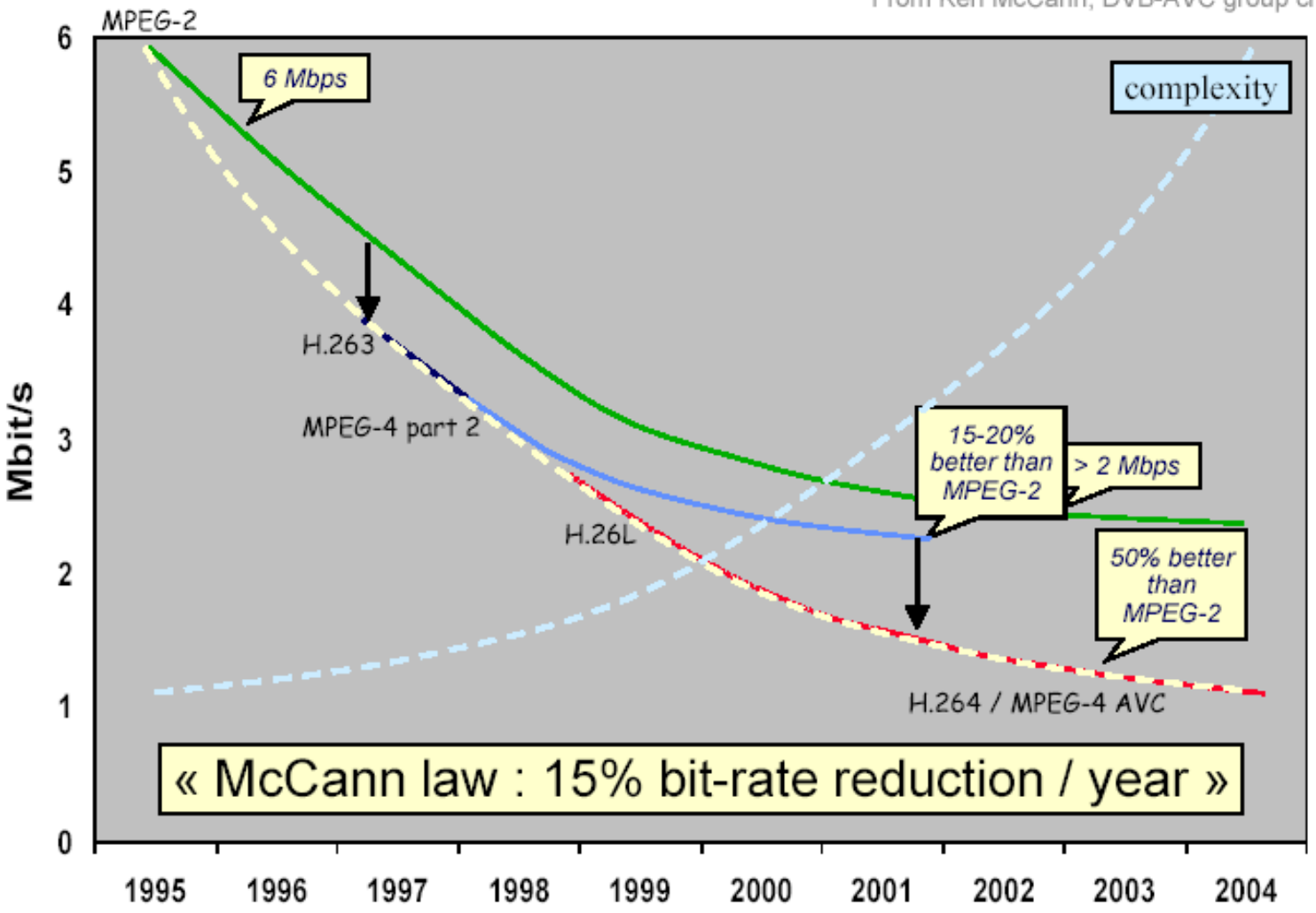
Future



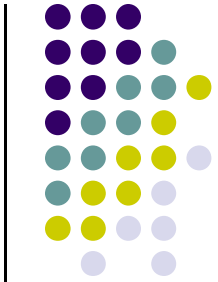
- What is the trend in compression efficiency
- How can it be improved?

Trends and Tendencies

From Ken McCann, DVB-AVC group chairm



Evolution of video codecs



- Coding gain improves steadily over the time
- A codec has a lifetime of almost 8-10 years
- Backward compatibility prolongs the lifetime further
- Introduction of a new codec is a significant step to its predecessor, with a *leap gain*
- An old but refined codec can be better than a new unrefined codec
- Thus prediction of future codecs depends on two factors of rate of improvement and leap gain, **Russian Steps**

Russian steps of codec quality

A new generation of codec is introduced every 5-8 years

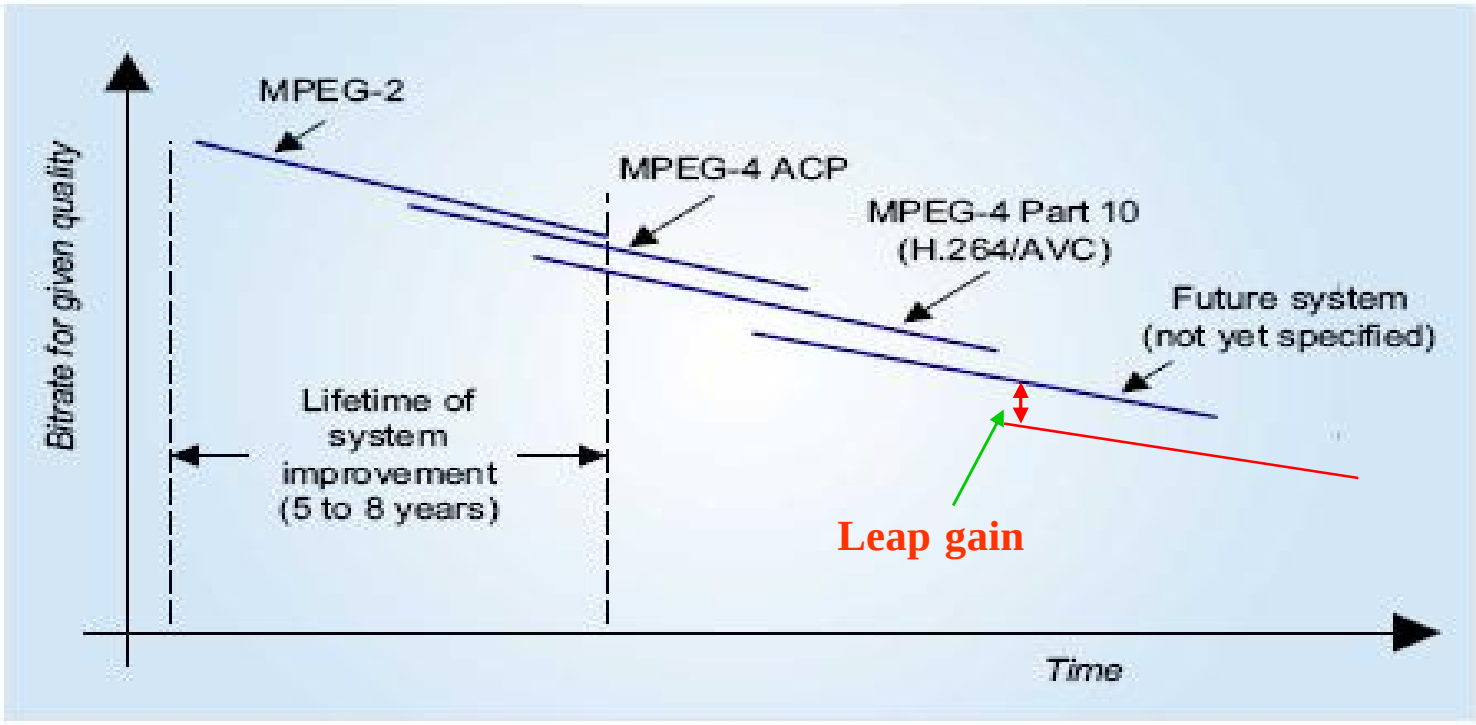
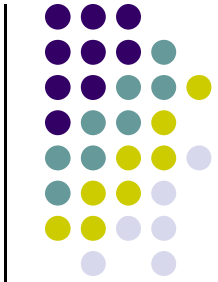


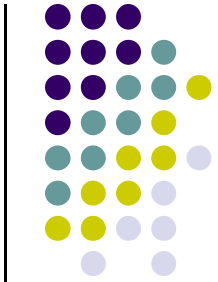
Figure 4
The evolution of open standard video compression systems

Future codecs



- It is likely that every life cycle a new method of coding to be introduced, with a Leap gain of around 10-20%
- There is a steady improvement in compression efficiency, with a rate of 5-8% per year
- Higher quality expectation, backward compatibility and scalability requirements slow down the rate of compression efficiency.

Estimate of future coding gain

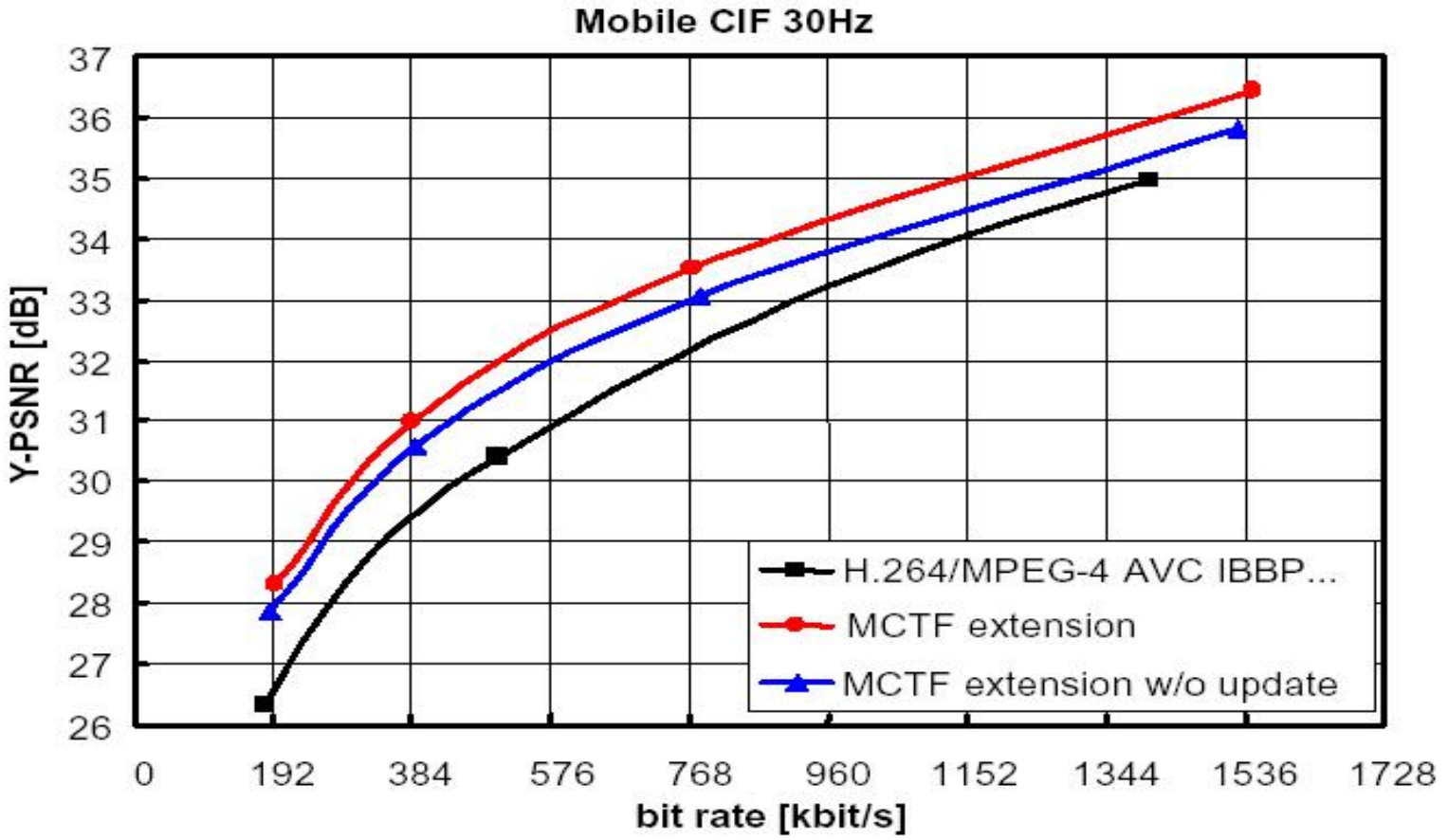


- During 1995-2005 (10 years), the coding gain from MPEG-2 to H.264 was almost 50%.
- This trend is likely to continue for the next 10 and 20 years.
- These can be achieved via leap gain and rate of improvement.
- However, future “better quality expectation” counteracts this trend.

Leap gain

- Some new coding methods can improve compression efficiency. These include, for example:
  - Motion compensation temporal filtering (MCTF)
  - Motion compensation with spatial transforms
  - Use of metadata in compression

Motion compensation temporal filtering

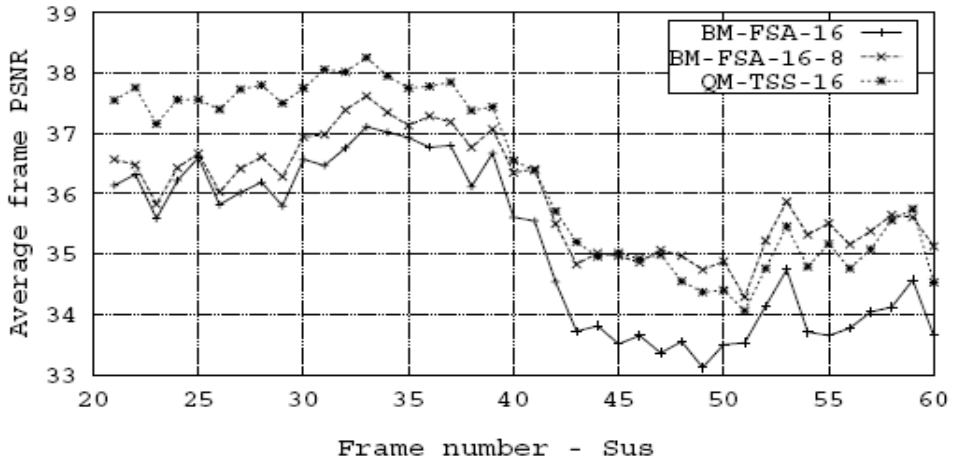


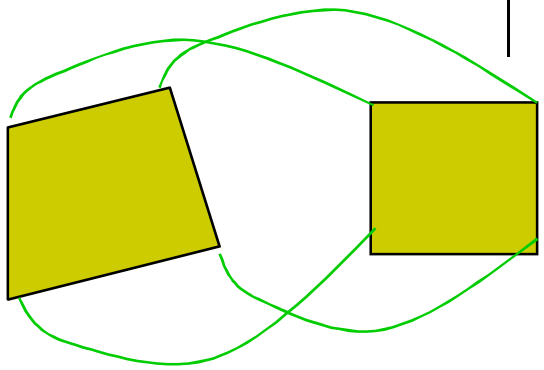
Fraunhofer Institut Nachrichtentechnik Heinrich-Hertz-Institut

T. Wiegand: Scalable Video Model 3.0

Quadrilateral ME/MC

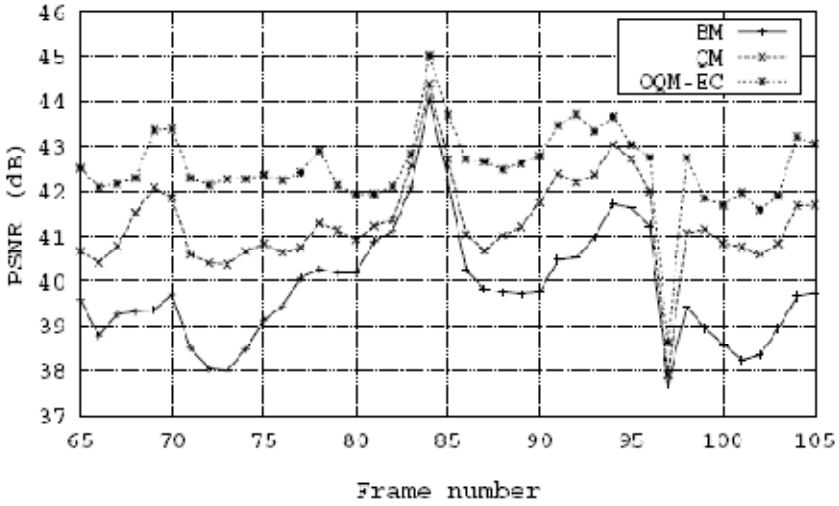
- To incorporate both translational and non-translational motions.



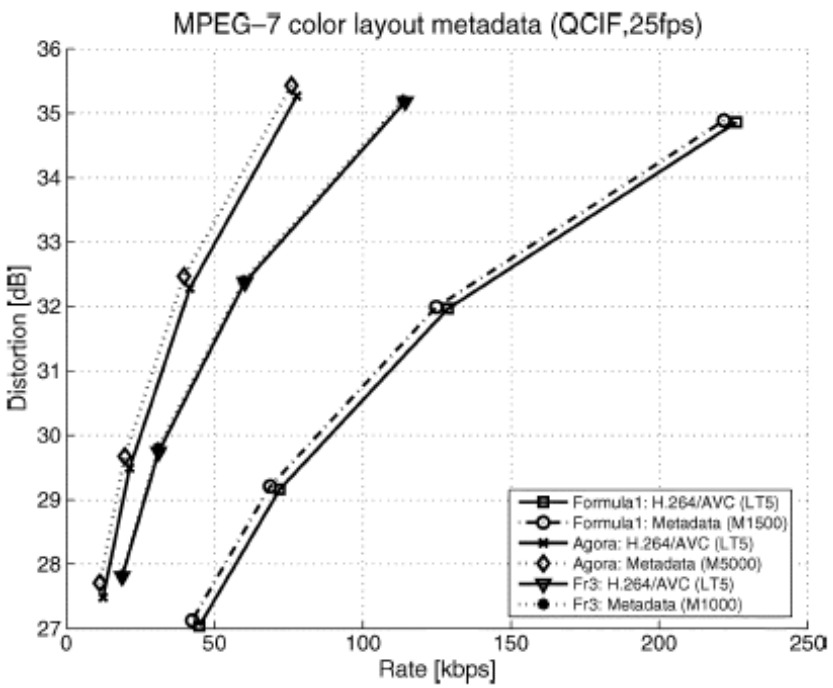


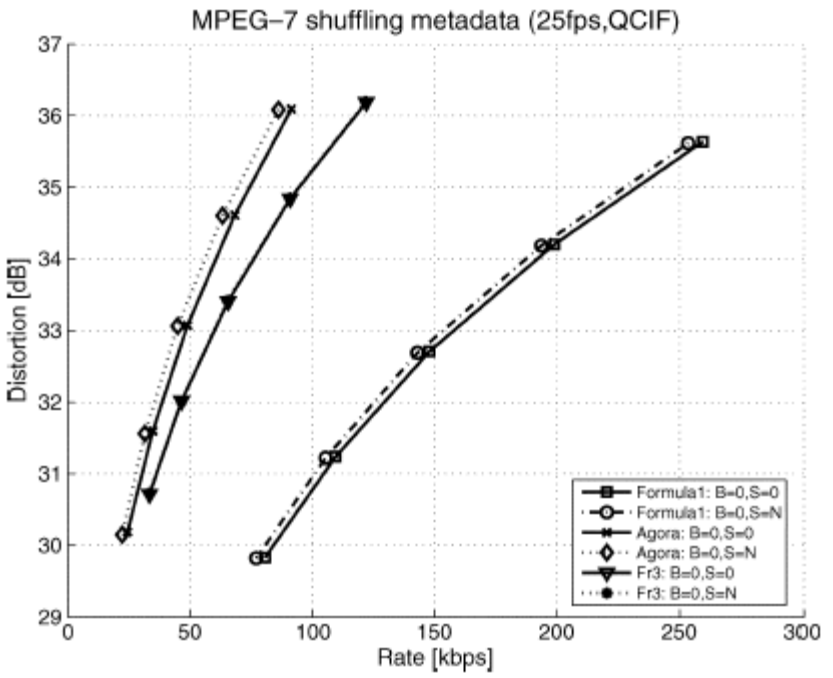
Very complex:

For each match, there are transformations and interpolations



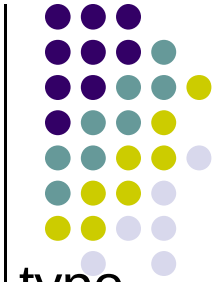
Metadata





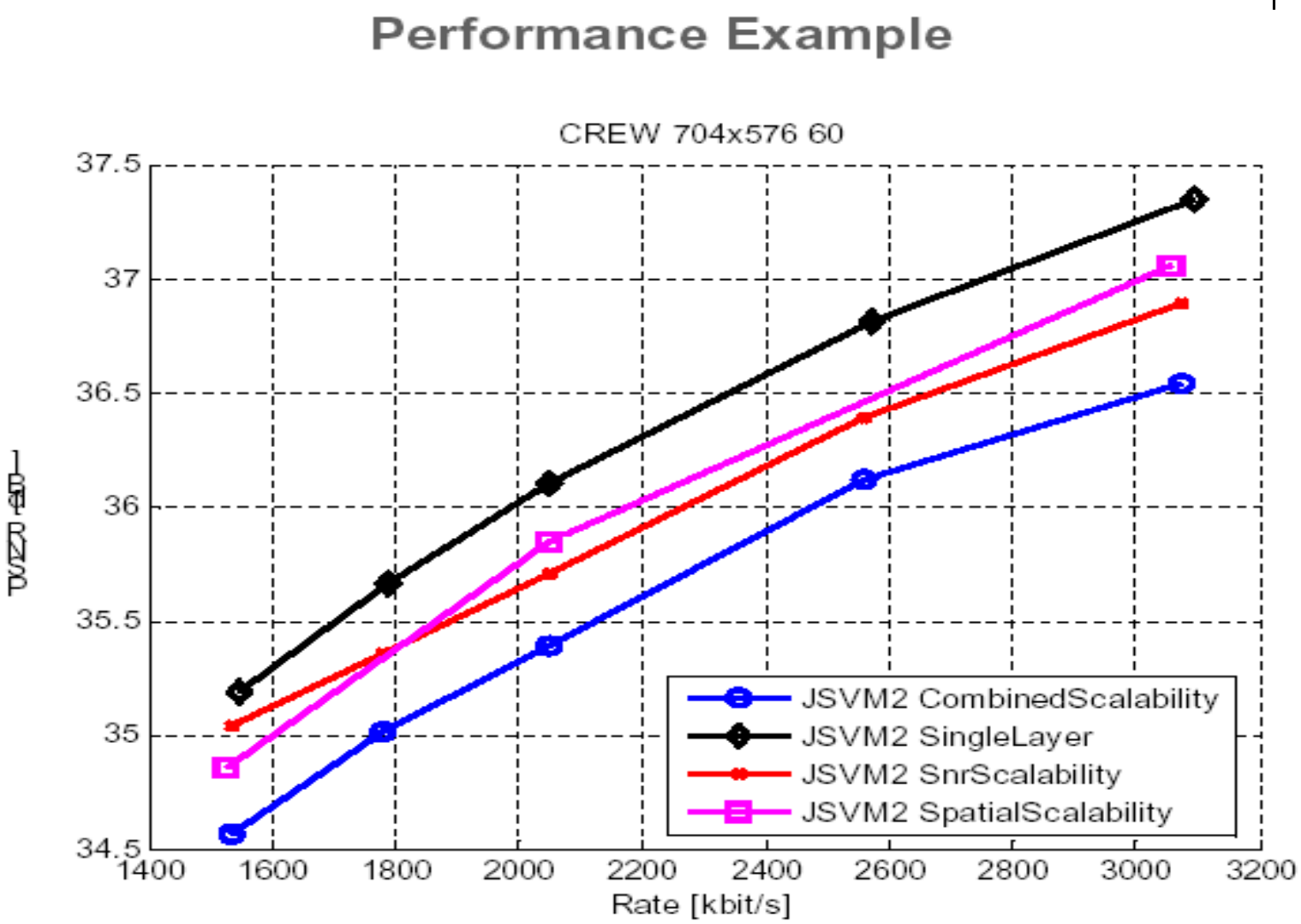
Two indexing metadata based coding techniques that exploit indexing metadata information in order to improve the efficiency of current hybrid codecs.
The first technique uses the MPEG-7 colour layout descriptor 3-12% bit-rate savings over H.264/AVC base line coder
The 2nd technique is based on the MPEG-7 Segment DS, with 3-8% savings.

Scalability

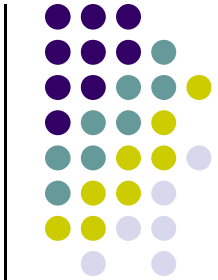


- The scalability feature in new standard is likely to provide all type of scalability in a single bitstream without too much loss of coding efficiency.
- This is in contrast to previous layered based scalable modes in H.263 and MPEG-4, where every additional enhancement layer reduces the coding efficiency by approximately 20%.
- Thus previous standards were used only with limited scalability feature whereas the new standard has very fine scalable characteristics.
- Due to increased heterogeneity of networks and display devices (from Mobile to HDTV), the fine scalability is the future solution to provide video services to the customers, any time, any where and on any device.

Reduction in coding gain due to scalability



conclusions



- Wireless MM services are evolving
- Video codecs performance improves steadily
  - Higher quality expectation
  - The rate of improvement is about 5-8 % year (doubling every decade)
- For improved quality of service we also need
  - Multilayer coding
  - Congestion control
  - Loss concealment