Advances in Video Compression and Coding Standards

Per Fröjdh, PhD
Head of Visual Technology Research
2009-04-02

ERICSSON
TAKING YOU FORWARD

Outline

- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

Outline

- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

About me

- Per Fröjdh
- Physicist from Chalmers
  - MSc Eng Phys (88), PhD Theor Phys (93)
  - Post Docs in Seattle (93-96) & Copenhagen (96-97)
  - Associate Professor at Stockholm University (98-00)
- Multimedia at Ericsson Research (2000-)
  - Codec development
    - H.264 (ITU/MPEG)
  - Standardization
    - MPEG Video standards, MP4, HoD Sweden
    - 3GPP Streaming, 3GP, MM Telephony
    - JPEG, W3C HoD
  - Head of Visual Technology Research
    - Video, Image, Graphics Coding
    - H.265, 3D Video
    - Video Quality

Outline

- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

JPEG encoding Chain

Color space conversion

8x8 blocks

DCT

Quantization

Zig-Zag scan and huffman coding

Reconstruction

The YUV image format

RGB

Color Space Conversion

2x compression

Y = luminance

C_b ="bluish" C_r = "redish"

JPEG encoding Chain

Color space conversion

8x8 blocks

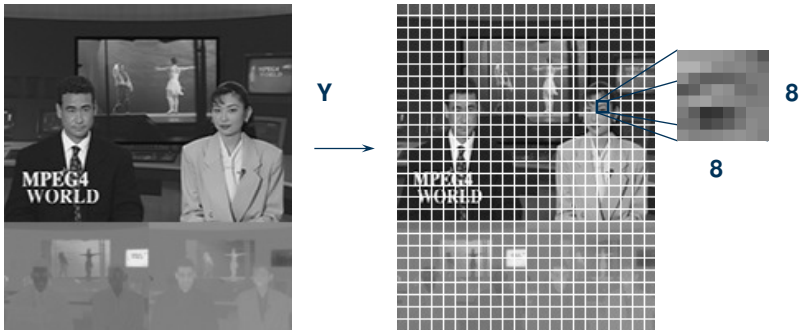
DCT

Quantization

Zig-Zag scan and huffman coding

Reconstruction

JPEG, 8x8 blocks



JPEG encoding Chain

Color space conversion

8x8 blocks

DCT

Quantization

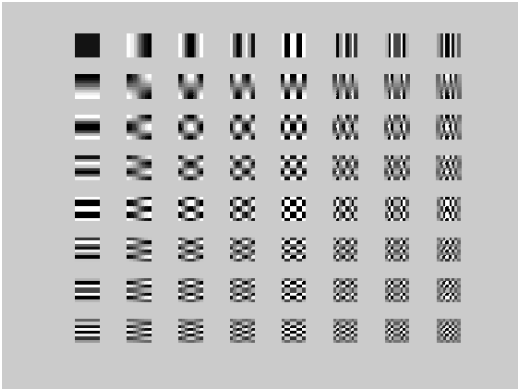
Zig-Zag scan and huffman coding

Reconstruction

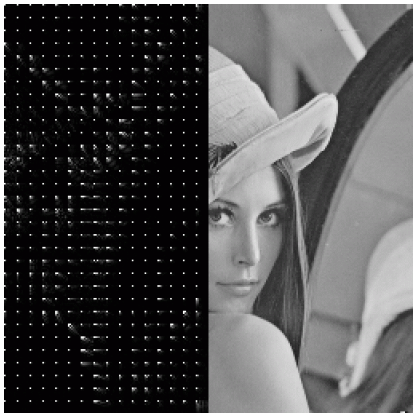
2D DCT Basis Functions

$$F(u,v) = \frac{C(u)C(v)}{4}\sum_{j=0}^{7}\sum_{k=0}^{7} f(j,k)\cos\left[\frac{(2j+1)u\pi}{16}\right]\cos\left[\frac{(2k+1)v\pi}{16}\right]$$

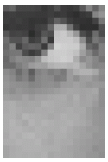
$$C(0) = 1/\sqrt{2},\ C(x) = 1,\ \text{for}\ x \neq 0,$$



Energy Concentration



DCT coeffs Pixels



Pixels

DCT coeffs

JPEG encoding Chain

Color space conversion

8x8 blocks

DCT

Quantization

Zig-Zag scan and huffman coding

Reconstruction

Quantization

$$F'(u,v) = \frac{F(u,v)}{Q(u,v)}$$

$$F(u,v) = \begin{bmatrix} 1260 & -1 & -12 & -5 & 2 & -2 & -3 & 1 \\ -23 & -17 & -6 & -3 & -3 & 0 & 0 & -1 \\ -11 & -9 & -2 & 2 & 0 & -1 & -1 & 0 \\ -7 & -2 & 0 & 1 & 1 & 0 & 0 & 0 \\ -1 & -1 & 1 & 2 & 0 & -1 & 1 & 1 \\ 2 & 0 & 2 & 0 & -1 & 1 & 1 & -1 \\ -1 & 0 & 0 & -1 & 0 & 2 & 1 & -1 \\ -3 & 2 & -4 & -2 & 2 & 1 & -1 & 0 \end{bmatrix}$$

DCT Coefficients

$$F'(u,v) = \begin{bmatrix} 79 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ -2 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Quantized Coefficients

JPEG encoding Chain

Color space conversion

8x8 blocks

DCT

Quantization

Zig-Zag scan and huffman coding

Reconstruction

Zig-Zag Scanning

$$F'(u,v) = \begin{bmatrix} 79 & 0 & -1 & 0 & 0 & 0 & 0 & 0 \\ -2 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & -1 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Quantised Coeffs

$$\begin{bmatrix} 0 & 1 & 5 & 6 & 14 & 15 & 27 & 28 \\ 2 & 4 & 7 & 13 & 16 & 26 & 29 & 42 \\ 3 & 8 & 12 & 17 & 25 & 30 & 41 & 43 \\ 9 & 11 & 18 & 24 & 31 & 40 & 44 & 53 \\ 10 & 19 & 23 & 32 & 39 & 45 & 52 & 54 \\ 20 & 22 & 33 & 38 & 46 & 51 & 55 & 60 \\ 21 & 34 & 37 & 47 & 50 & 56 & 59 & 61 \\ 35 & 36 & 48 & 49 & 57 & 58 & 62 & 63 \end{bmatrix}$$

Scanning Order

Resulting Information to code: 79 0 -2 -1 -1 -1 0 0 -1 EOB
The DC component (79) is differentially coded.
The coefficients are coded using a composite run-length encoding and typically results in 35 bits (8 for the DC).
The compression ratio is: 512/35 = 14.6

JPEG encoding Chain

Color space conversion → 8x8 blocks → DCT → Quantization → Zig-Zag scan and huffman coding → Reconstruction

Inverse Quantisaton & IDCT

$$\hat{F}(u,v) = F'(u,v) * Q(u,v)$$

$$f(j,k) = \begin{bmatrix} 139 & 144 & 149 & 153 & 155 & 155 & 155 & 155 \\ 144 & 151 & 153 & 156 & 159 & 156 & 156 & 156 \\ 150 & 155 & 160 & 163 & 158 & 156 & 156 & 156 \\ 159 & 161 & 162 & 160 & 160 & 159 & 159 & 159 \\ 159 & 160 & 161 & 162 & 162 & 155 & 155 & 155 \\ 161 & 161 & 161 & 161 & 160 & 157 & 157 & 157 \\ 162 & 162 & 161 & 163 & 162 & 157 & 157 & 157 \\ 162 & 162 & 161 & 161 & 163 & 158 & 158 & 158 \end{bmatrix}$$

Original Pixel Values

$$\bar{f}(j,k) = \begin{bmatrix} 144 & 146 & 149 & 152 & 154 & 156 & 156 & 156 \\ 148 & 150 & 152 & 154 & 156 & 156 & 156 & 156 \\ 155 & 156 & 157 & 158 & 158 & 157 & 156 & 155 \\ 160 & 161 & 161 & 162 & 161 & 159 & 157 & 155 \\ 163 & 163 & 164 & 163 & 162 & 160 & 158 & 156 \\ 163 & 163 & 164 & 164 & 162 & 160 & 158 & 157 \\ 160 & 161 & 162 & 162 & 162 & 161 & 159 & 158 \\ 158 & 159 & 161 & 161 & 162 & 162 & 161 & 158 \end{bmatrix}$$

Decoded Reconstructed Pixel Values

Reconstruction Error, PSNR

$$e(j,k) = f(j,k) - \hat{f}(j,k)$$

$$RMSE = \sqrt{\frac{1}{64}\sum_{j}\sum_{k} e^2(j,k)} = 2.26$$

$$PSNR = 20\log_{10}\left(\frac{255}{RMSE}\right) = 41.0\text{dB}$$

$$e(j,k) = \begin{bmatrix} -5 & -2 & 0 & 1 & 1 & -1 & -1 & -1 \\ -4 & 1 & 1 & 2 & 3 & 0 & 0 & 0 \\ -5 & -1 & 3 & 5 & 0 & -1 & 0 & 1 \\ -1 & 0 & 1 & -2 & -1 & 0 & 2 & 4 \\ -4 & -3 & -3 & -1 & 0 & -5 & -3 & -1 \\ -2 & -2 & -3 & -3 & -3 & -2 & -1 & 0 \\ 2 & 1 & -1 & 1 & 0 & -4 & -2 & -1 \\ 4 & 3 & 0 & 0 & 1 & -3 & -1 & 0 \end{bmatrix}$$

 Per Fröjdh 19 Advances In Video Compression 2009-04-02 ERICSSON

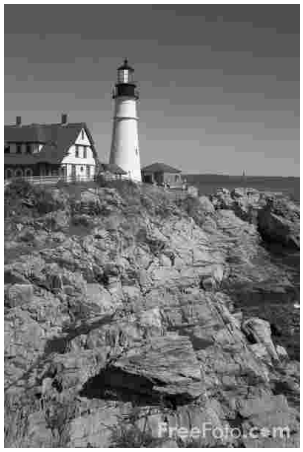
JPEG quality

ERICSSON
TAKING YOU FORWARD

JPEG at 0.25 bpp (32 times compression)

JPEG at 0.125 bpp (64 times compression)

JPEG coding artifacts



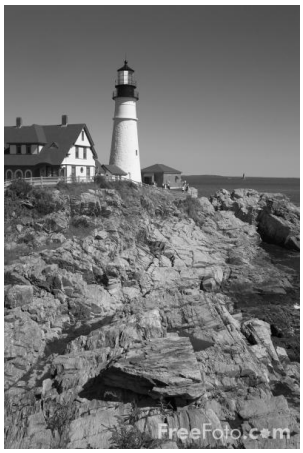
Coding errors are less visible in highly textured areas

Coding errors are more visible in plain areas such as skies

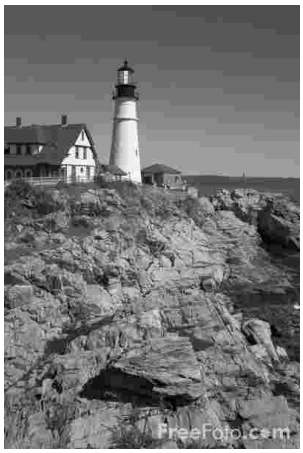
Visually annoying blockiness can be reduced by post-filtering the image.

For video there is both spatial and temporal masking

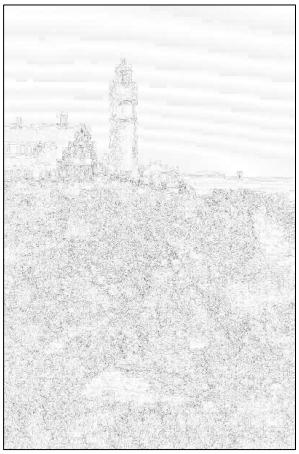
JPEG coding artifacts



Source



Coded



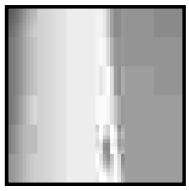
Coding error

JPEG coding artifacts

Source

Coded

- Loss of detail
- Blockiness
- Ringing

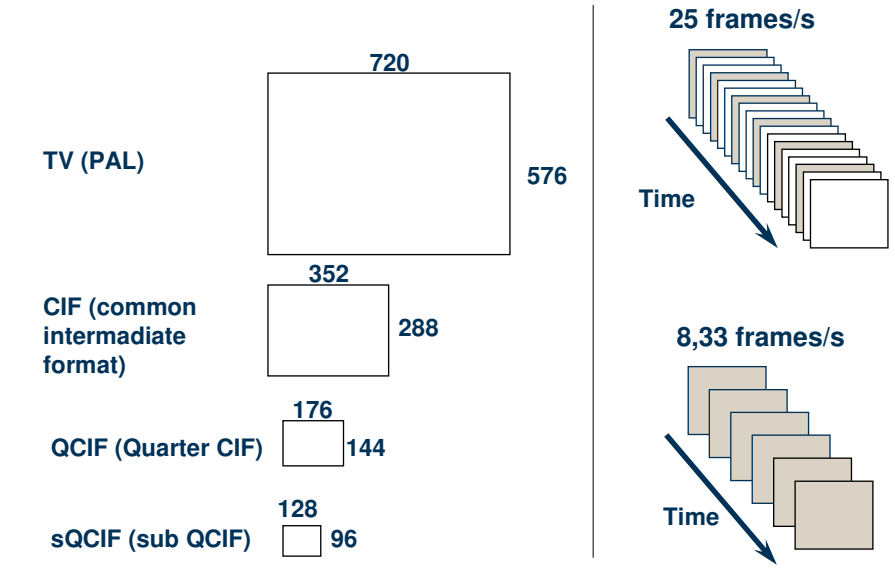


 Per Fröjdh 25 Advances In Video Compression 2009-04-02 ERICSSON

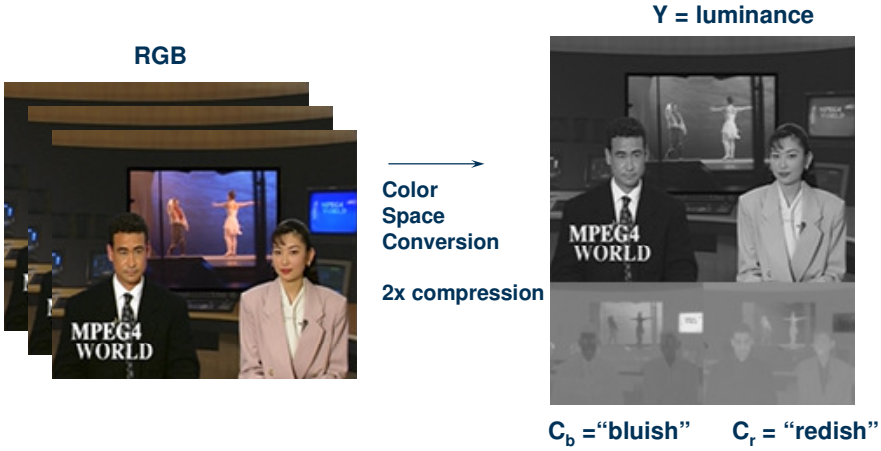
Video Coding Basics

ERICSSON
TAKING YOU FORWARD

Video = Moving pictures

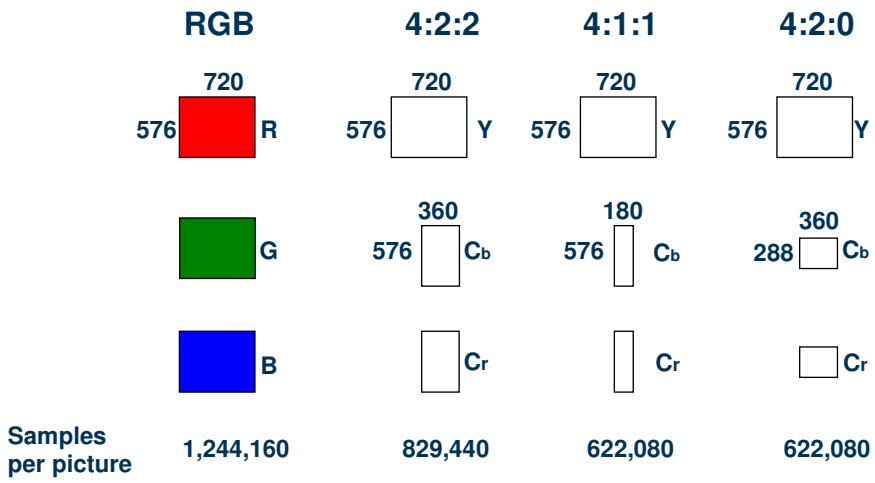


The YUV image format



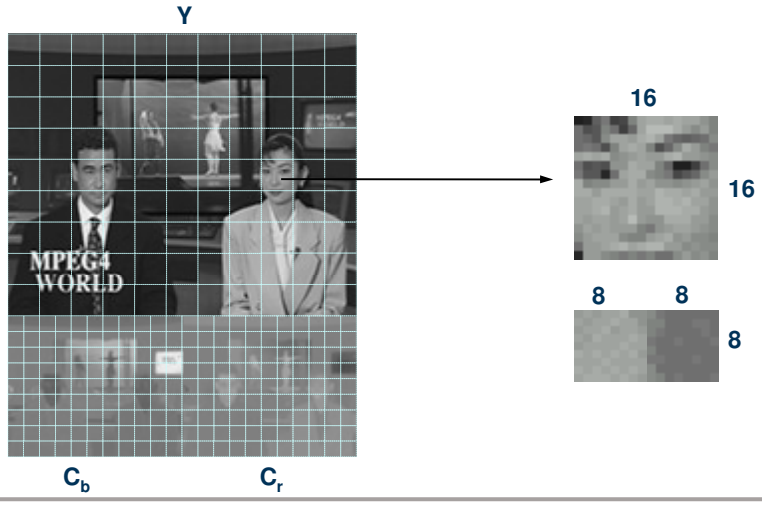
C_b ="bluish" C_r = "redish"

Subsampling



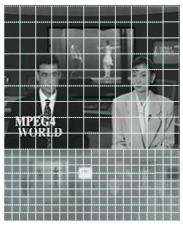
Macroblocks (MB)

A picture is commonly divided into macroblocks, 16x16 pixels
Each picture is then encoded as a sequence of macroblocks



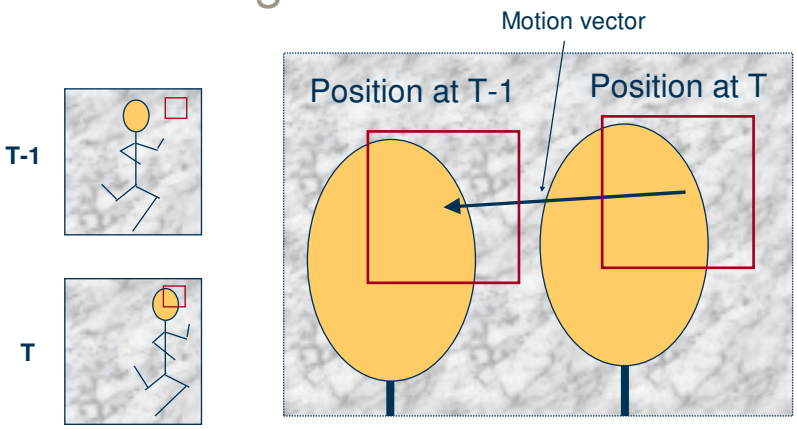
Intra and Inter

- Coding mode is decided on macroblock level
- A macroblock can be coded in two ways:
  - **Intra coding (I)** Still image,
  - **Inter coding (P)** Difference image
- I pictures
  - All MB are intra coded
    - Motion JPEG
    - DV
    - First Picture in Video
- P pictures
  - MBs are I, P or skipped
    - all major video standards



Intra coding – similar to JPEG

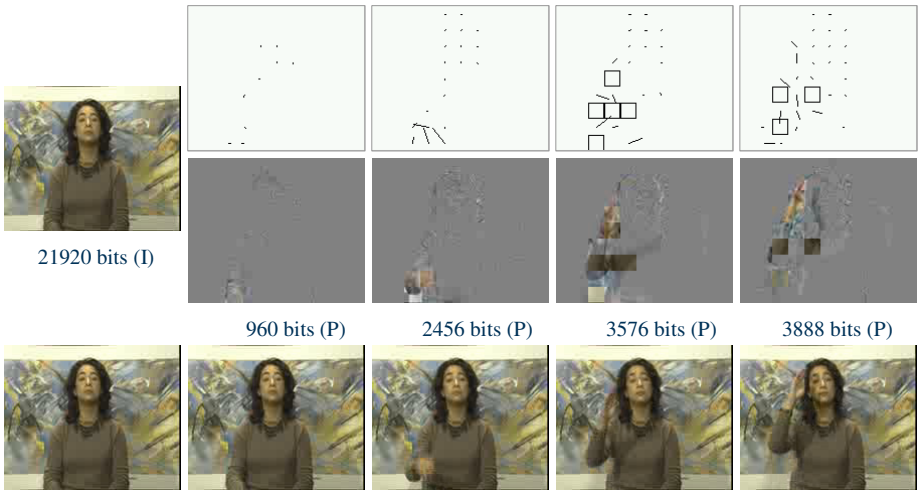
Inter coding



For each 16x16 macroblock, the encoder tries to find a 16x16 block in the previous image that matches the current block.

Each macroblock is coded by a motion vector and a difference block.

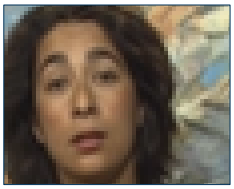
Video coding example (I and P)



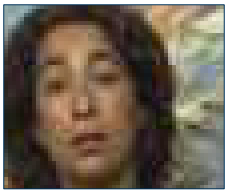
Coding artifacts

- Blocking (8x8 pixels)
- Color bleeding
- Loss of sharpness
- Ringing

QCIF, 20 times compression



Detail of Original



Detail of compressed image

Outline

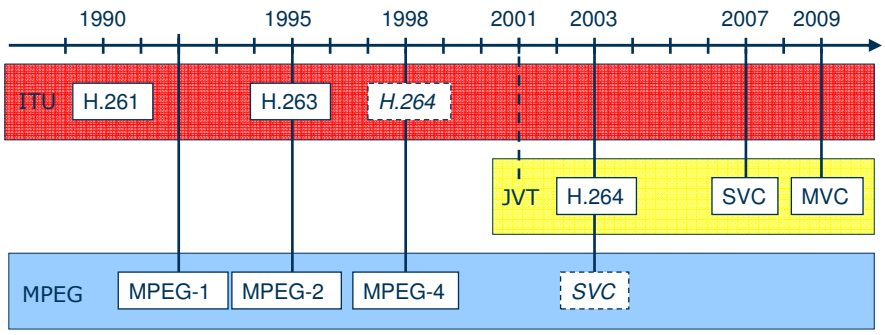
- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

Who Standardizes Codecs?

- International Telecommunication Union (ITU)
  - Emphasis on conferencing & mobile video
  - H.261, H.263, H.264/AVC, (H.265)
- Moving Picture Experts Group (MPEG)
  - MPEG-1 (VCD, Audio Layer 3 = MP3)
  - MPEG-2 (Video DVD, DVB)
  - MPEG-4 (MP4, DivX, AAC, ...)
  - MPEG-4 AVC/H.264 (HDTV, BluRay)
  - (HVC, 3DTV)
- Joint Photographic Experts Group (JPEG)
  - JPEG, JPEG 2000, JPEG XR, (AIC)
- 3rd Generation Partnership Programme (3GPP)
  - Speech & audio codecs for 3G
  - AMR, AMR-WB, AMR-WB+, (EVS)
- AVS
  - AVS1, (AVS2)

Audio Video coding Standard Workgroup of China

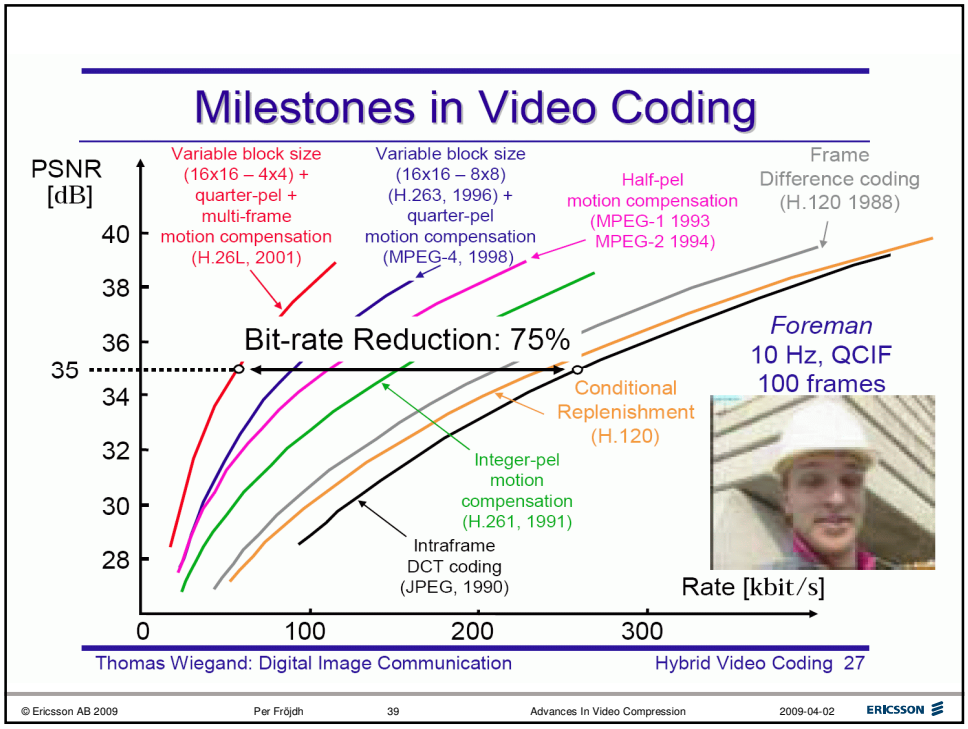
Video Codec Evolution

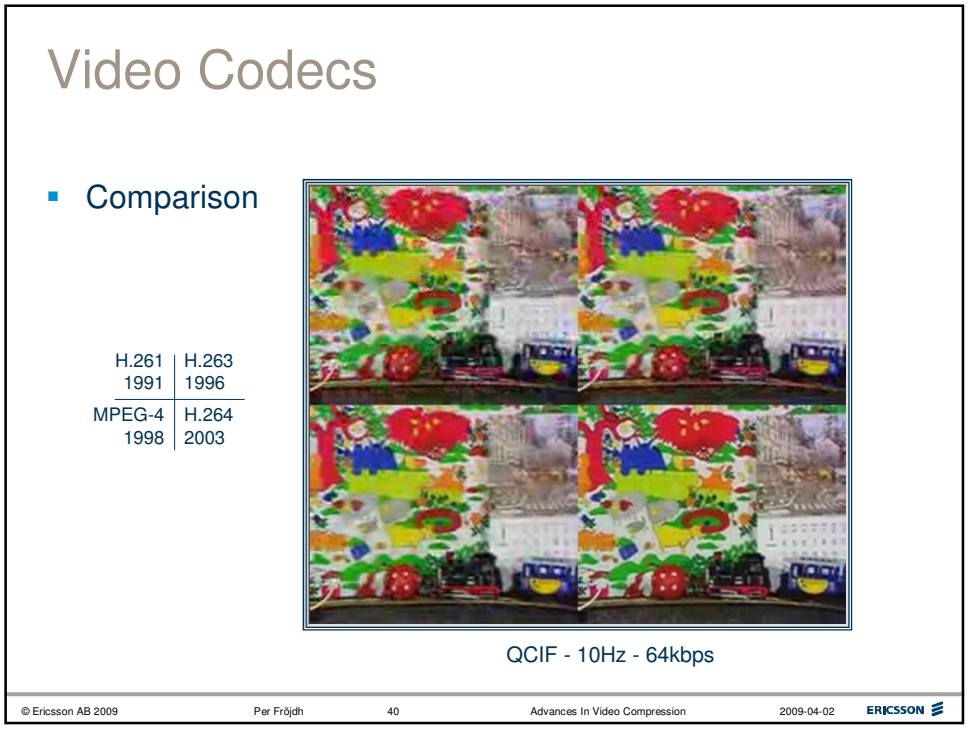


- *XYZ* Call for Proposal
- XYZ Published

} H.264 took 5 years, SVC 4 years

- JVT = Joint Video Team (of ITU and MPEG)


Milestones in Video Coding
PSNR [dB]
40
38
36
35
34
32
30
28
0
100
200
300
Rate [kbit/s]
Variable block size (16x16 – 4x4) + quarter-pel + multi-frame motion compensation (H.26L, 2001)
Variable block size (16x16 – 8x8) (H.263, 1996) + quarter-pel motion compensation (MPEG-4, 1998)
Half-pel motion compensation (MPEG-1 1993 MPEG-2 1994)
Frame Difference coding (H.120 1988)
Bit-rate Reduction: 75%
Foreman
10 Hz, QCIF
100 frames
Conditional Replenishment (H.120)
Integer-pel motion compensation (H.261, 1991)
Intraframe DCT coding (JPEG, 1990)
Thomas Wiegand: Digital Image Communication
Hybrid Video Coding 27
© Ericsson AB 2009
Per Fröjdh
39
Advances In Video Compression
2009-04-02
ERICSSON

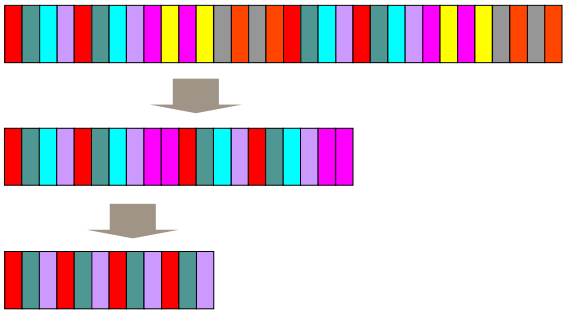

Video Codecs
Comparison
H.261 1991
H.263 1996
MPEG-4 1998
H.264 2003
QCIF - 10Hz - 64kbps
© Ericsson AB 2009
Per Fröjdh
40
Advances In Video Compression
2009-04-02
ERICSSON

Scalable Video

ERICSSON
TAKING YOU FORWARD

SVC - Scalable Video Coding

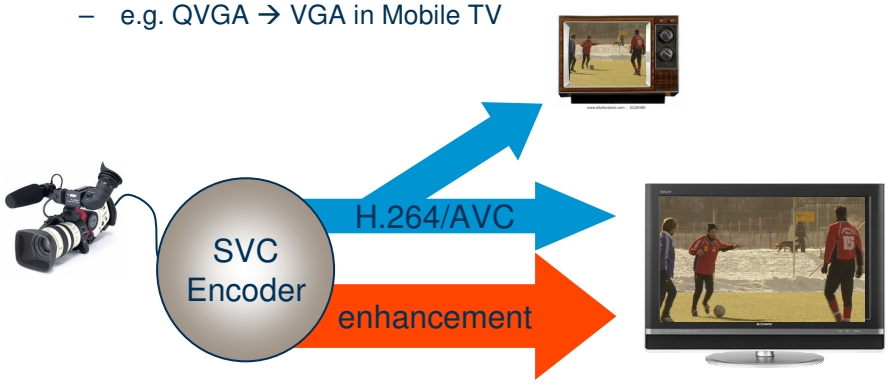
- Provide a compact representation of multiple resolutions of a video signal in a single compressed bit stream



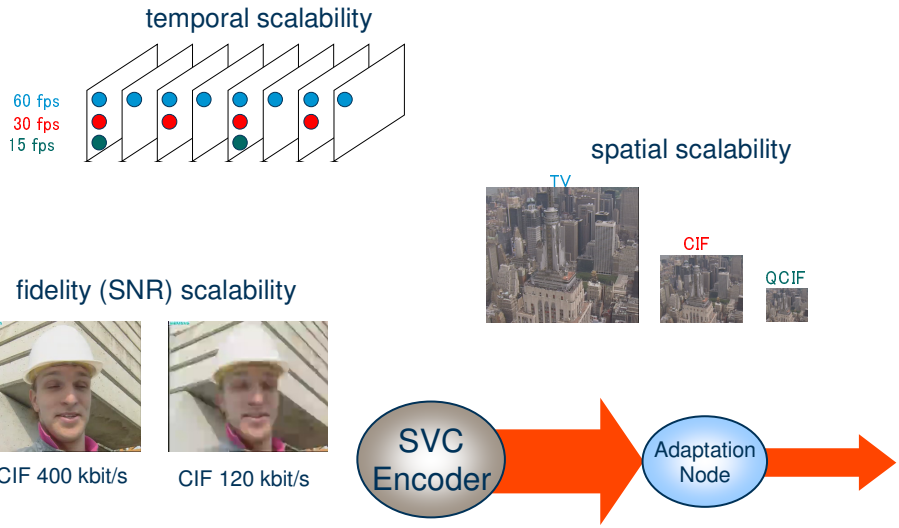
Shall be more efficient than simulcast!

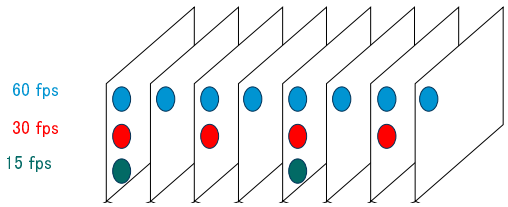
SVC - Format Adaptation

- Enables backward compatible introduction of higher quality services (lower bit rate than simulcast)
  - e.g. SD → HD in terrestrial broadcast
  - e.g. QVGA → VGA in Mobile TV



Modalities of Scalability

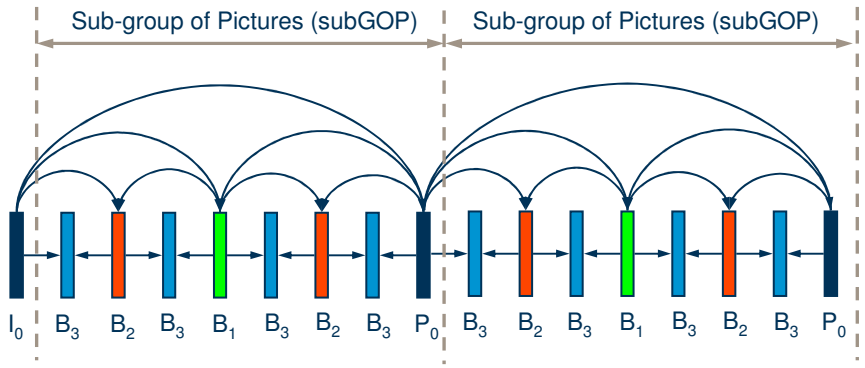




SVC Temporal Scalability

ERICSSON
TAKING YOU FORWARD

Hierarchical B Picture Prediction

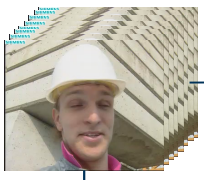


higher bitrate lower bitrate

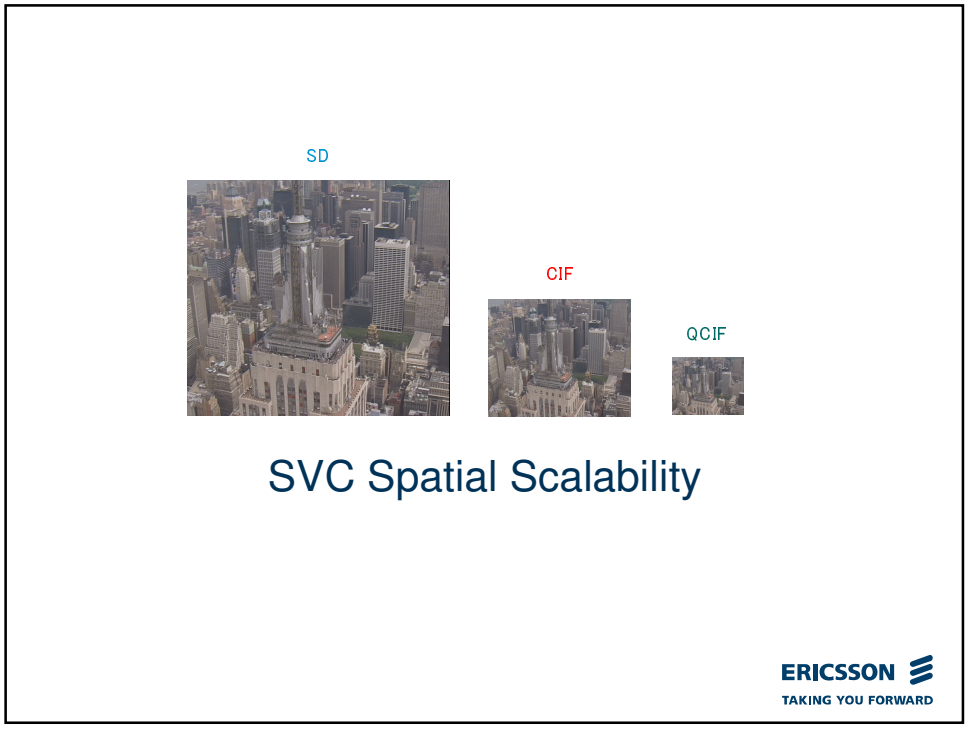
SVC SNR Scalability

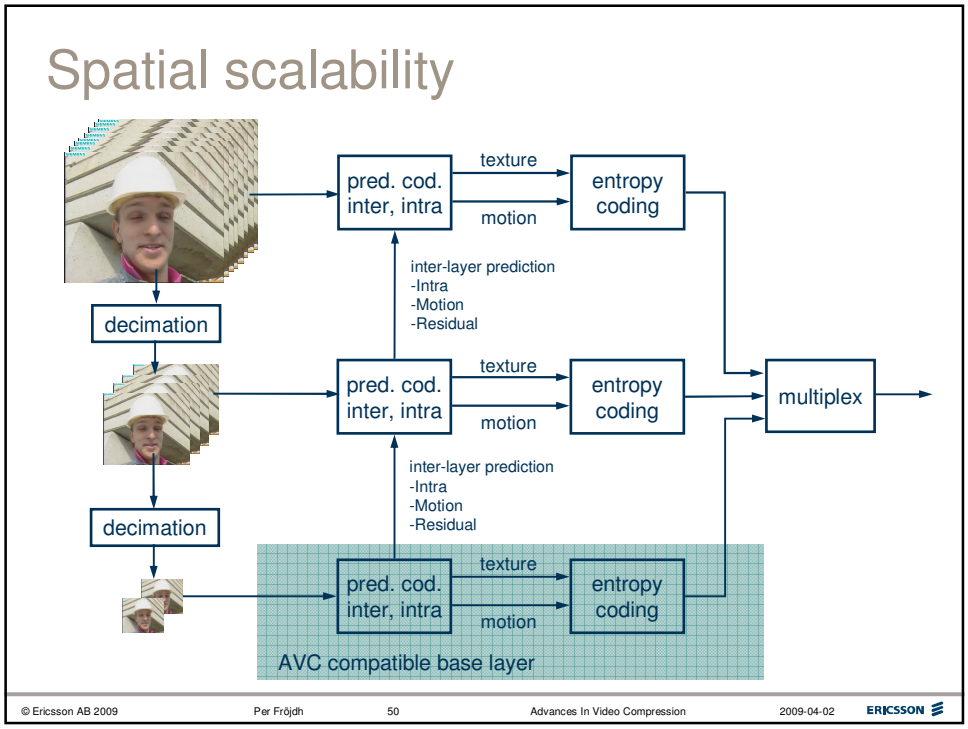
ERICSSON
TAKING YOU FORWARD

SNR scalability

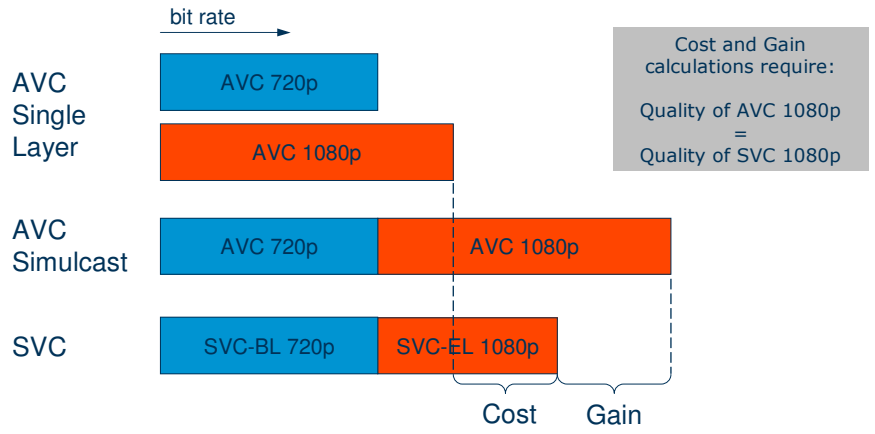


 Per Fröjdh 48 Advances In Video Compression 2009-04-02 ERICSSON


SD
CIF
QCIF
SVC Spatial Scalability
ERICSSON
TAKING YOU FORWARD


Spatial scalability
pred. cod. inter, intra
texture
motion
entropy coding
inter-layer prediction
-Intra
-Motion
-Residual
decimation
multiplex
AVC compatible base layer
© Ericsson AB 2009
Per Fröjdh
50
Advances In Video Compression
2009-04-02
ERICSSON

Single Layer, Simulcast, Cost, Gain



How much cost does SVC induce compared to AVC single layer?

How much gain does SVC achieve compared to AVC simulcast?

SVC tests conclude

- Scalable Video Coding is hard
  - Attempts in MPEG-2 and MPEG-4 never adopted
  - SVC better
- For practical test points
  - SVC costs against AVC single layer are in same percentage range as SVC savings against simulcast
- SVC drawbacks
  - Not optimized for interlace
    - Not suitable for SD to HD TV
  - Complexity, in particular joint coding of layers
- Possible use case
  - 720p (HD) to 1080p (Full HD)

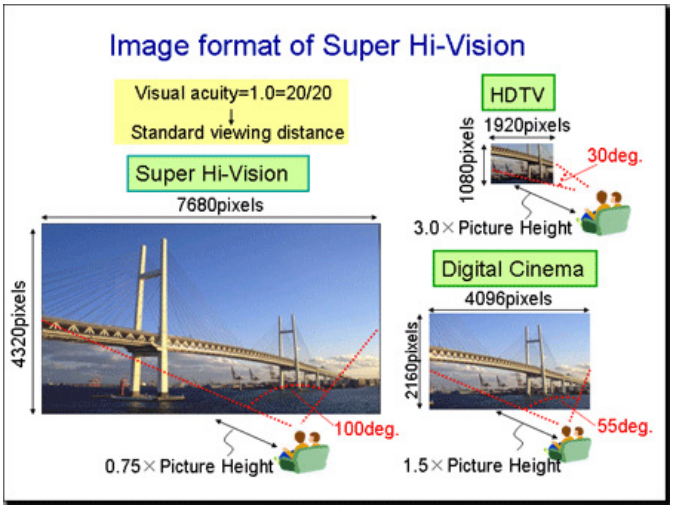
Exploration – Next Generation Video

ERICSSON
TAKING YOU FORWARD

Video Trends

- Personal viewing
  - Large display
  - Short viewing distance
- High Resolutions
  - Ultra HD
  - 4Kx2K, 8Kx4K
- Architecture
  - Multi-core
  - Scalable
- Issues
  - Complexity (battery)
  - Compression ratio
  - Licensing costs

Ultra-High Definition 4Kx2K



(NHK Science & Technical Research Laboratories)

New video coding standard?

- H.264 / AVC
  - Six years old
  - Optimized for mobile video (low resolutions)
  - Complexity can be reduced
- ITU
  - Explorations towards **H.265**
    - New tools
  - Gain over state-of-the art H.264
    - 25% average
    - 50% certain sequences
    - Higher for HD and Ultra HD
  - Requirements
    - Clean-sheet design
    - 50% bitrate reduction compared to H.264
    - Up to 8Kx4K
  - Call for Proposals
    - July 2009 (?)

New video coding standard?

- MPEG
  - Work towards High-performance Video Coding (HVC)
    - Similar tools as in ITU
  - Gains over AVC
    - HD 1080p ~ 37%
  - Requirements
    - 4Kx2K/1080p/VGA
    - 60fps, 14 bits,
  - Call for Proposals
    - July 2009 (?)
- Industry wants to merge H.265 and HVC
  - Joint Video Team (?)
  - New standard 2013 (?)
- AVS2
  - Ultra HD (4Kx2K), 3D multiview, ...

Outline

- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

Exciting Applications

Three Dimensional TV

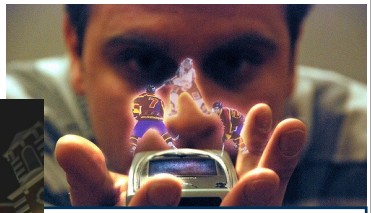
Which goal post side you want to seat ?

Free Viewpoint TV

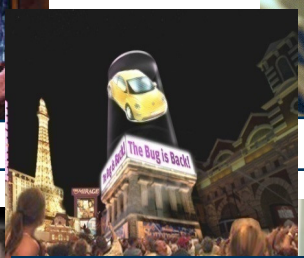
(KTH, Pravin Kumar Rana)

Exciting Applications

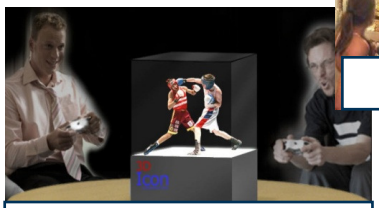
Home Entertainment



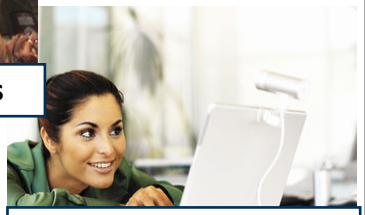
Mobile Applications



Advertisements



Interactive Gaming



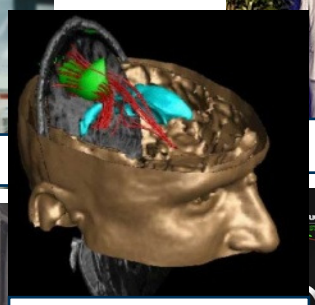
Internet TV/VoIP/IPTV

(KTH, Pravin Kumar Rana)

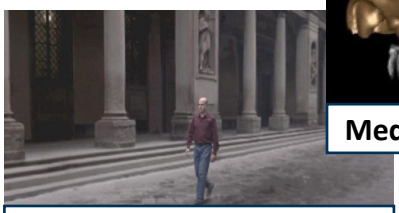
Exciting Applications

Security

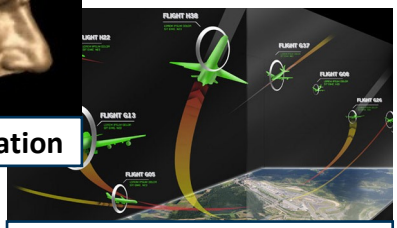
Telepresence



Medical Application



Virtual Real Time Tourism



Air Traffic Control

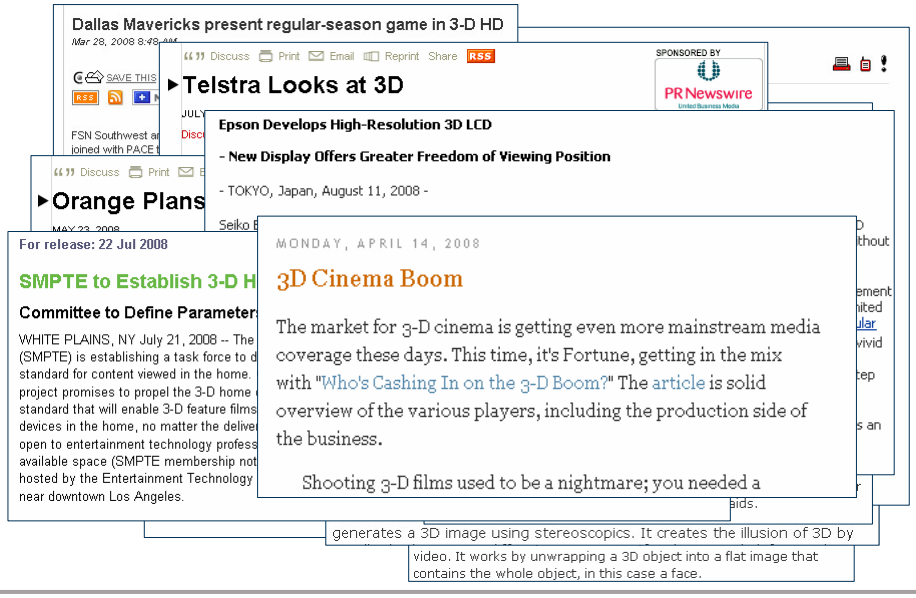
(KTH, Pravin Kumar Rana)

Application - Virtual Collaboration

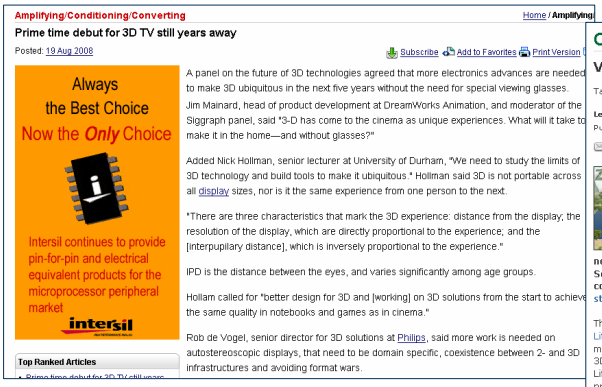
- Telepresence
- 3D communication
- Call centers
- Avoid CO_2 emissions

CISCO 3D collaboration trial system

Some recent news …



… but there is skepticism, too

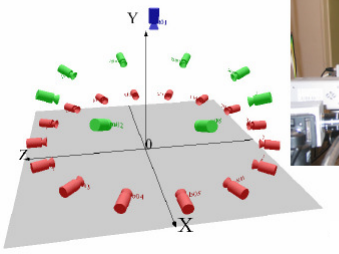


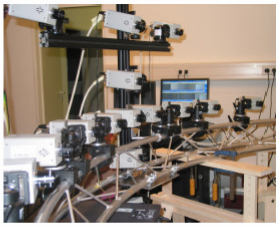
3D will start in cinemas and on mobile phones

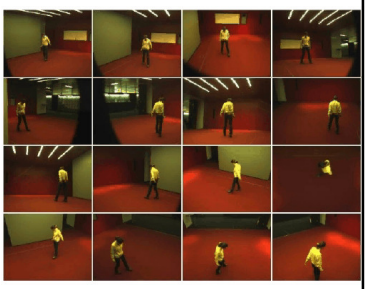
standards are needed

3D Capture

- Stereoscopic capture: available
- Free viewpoint capture: camera arrays
  - Transformation into suitable representation
  - Interpolation of intermediate views
  - Commercial solutions available, but not mature







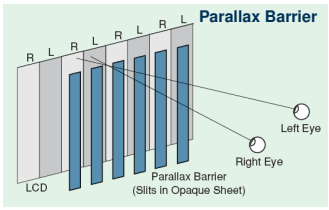
3D Displays – Stereoscopic

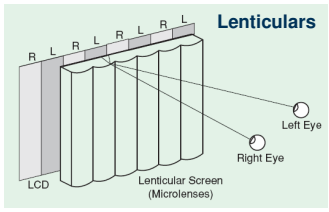
- Techniques
  - Anaglyphic (red/green)
  - Polarized glasses
  - Shutter glasses
- Advantages
  - Can use any color display
  - Many simultaneous viewers
- Disadvantages
  - Cross talk
  - Need glasses
  - No motion parallax

(KTH, Pravin Kumar

3D Displays – Autostereoscopic

- Techniques
  - Parallax barrier displays
  - Lenticulars displays
- Advantages
  - No glasses
- Disadvantages
  - Cross talk
  - Horizontal resolution loss
  - No motion parallax

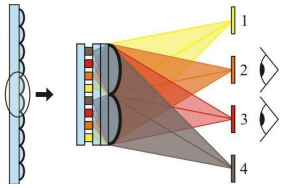




(KTH, Pravin Kumar

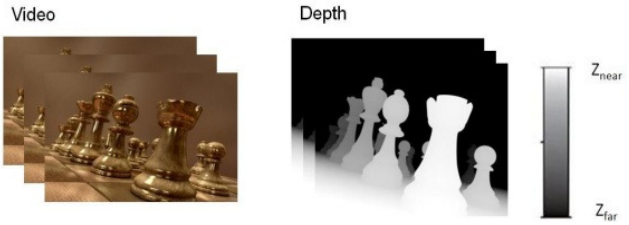
3D Displays – Freeviewpoint

- Active multiview displays
  - Head tracking
  - Single viewer
  - Full motion parallax
- Passive multiview displays
  - No headtracking
  - Only horizontal parallax



3D Coding – Depth based

- Depth map converts 2D into 3D
- Single View video + depth
  - Occlusion problem
- Multiview Video + depth
- True depth capture/estimation - challenge



(Müller et al., 2007)

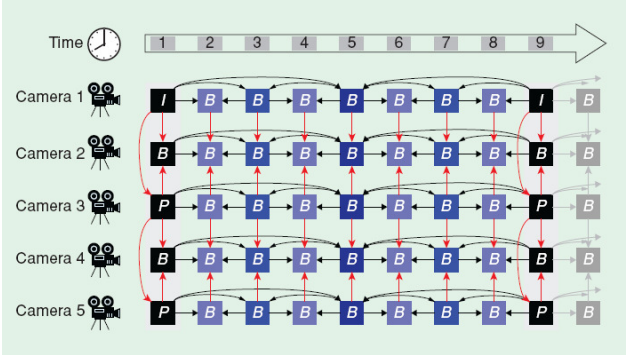
3D Coding - MVC

- Multiview video coding
  - Exploiting similarities among the multiview video images

(Markus Flierl and Bernd Girod, 2007)

3D Coding - MVC

- Multiview video coding
  - Exploiting similarities among the multiview video images



(Markus Flierl and Bernd Girod, 2007)

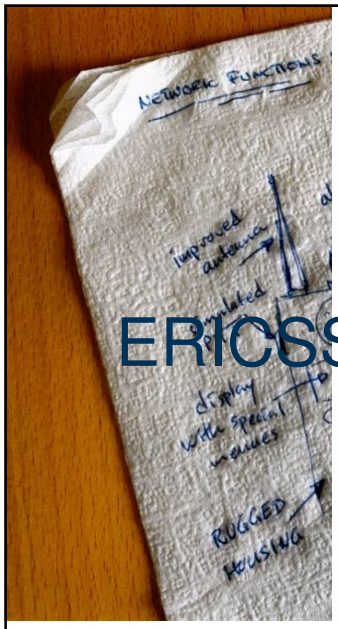
3D Video Status

- Techiques have different short-comings
  - Stereo is ”easy”
    - but no motion parallax
    - glasses or single/fixed position(s)
  - Multiview point ”realistic 3D”
    - but low resolution
    - bad compression efficiency
  - 3D Mesh models
    - State-of-the-art for computer graphics
    - but difficult to build for natural video
- Depth maps
  - Need image ”behind”, otherwise occlusion problems
  - Depth estimation is a challenge
- Combinations achieve compromises
  - Multiview plus Depth (MVD)
  - Layered Depth Video (LDV)

Explorations in MPEG

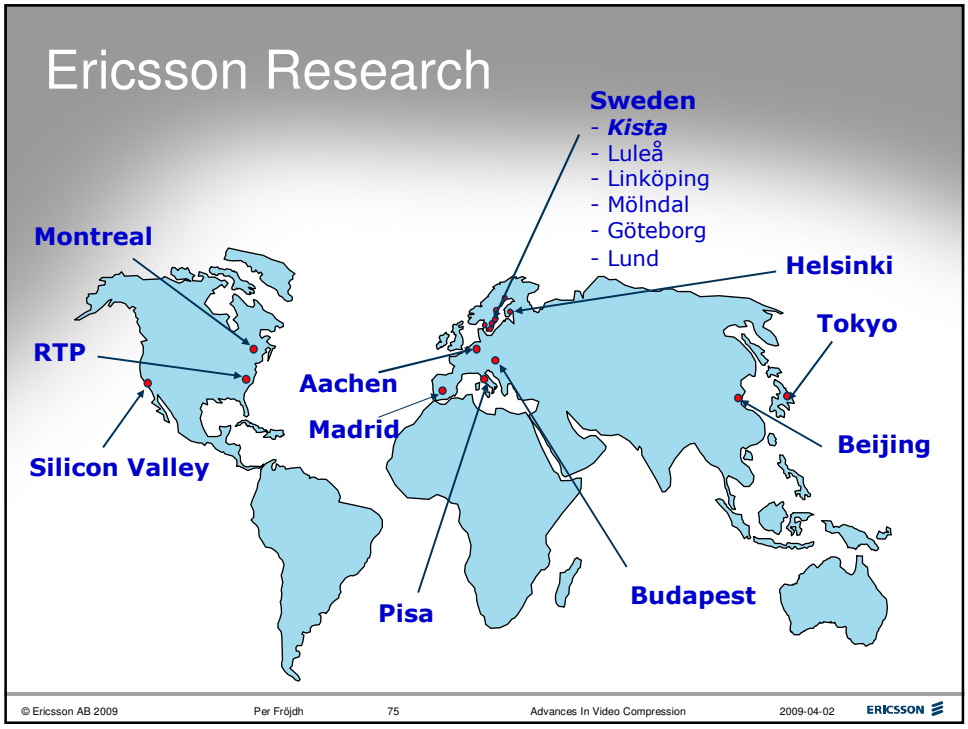
Outline

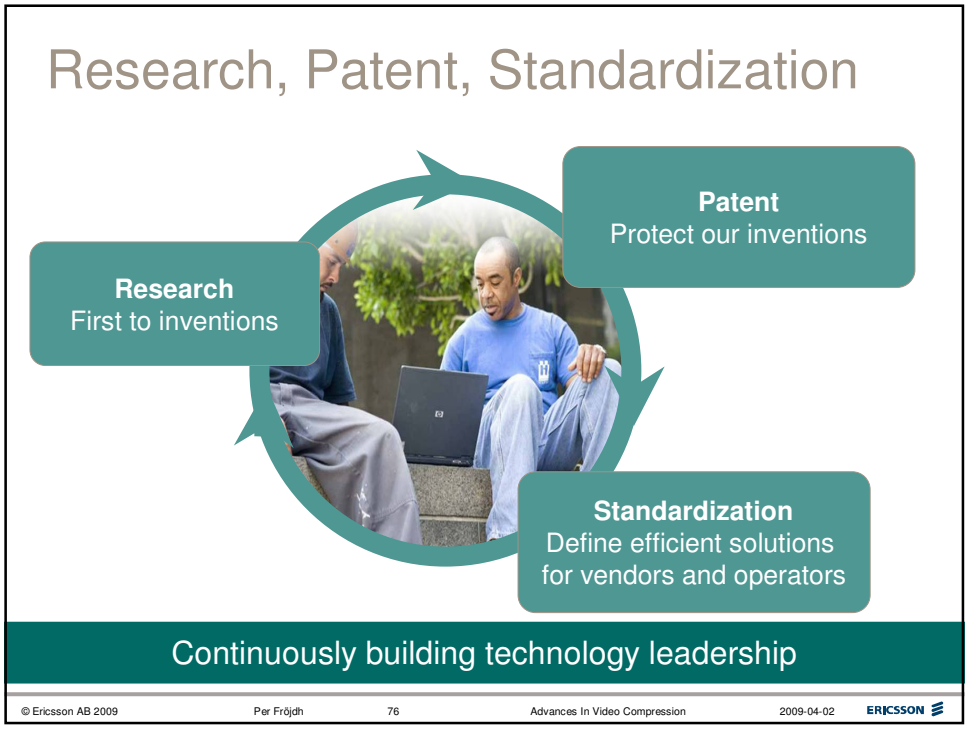
- About me
- Basic Image and Video Coding
- Standardization
  - Codec Evolution
  - Scalable Video
  - Exploration – Next Generation Video
- 3D Video
  - Applications
  - Capture and Displays
  - Coding and Explorations
- Ericsson Research
  - Multimedia Technologies

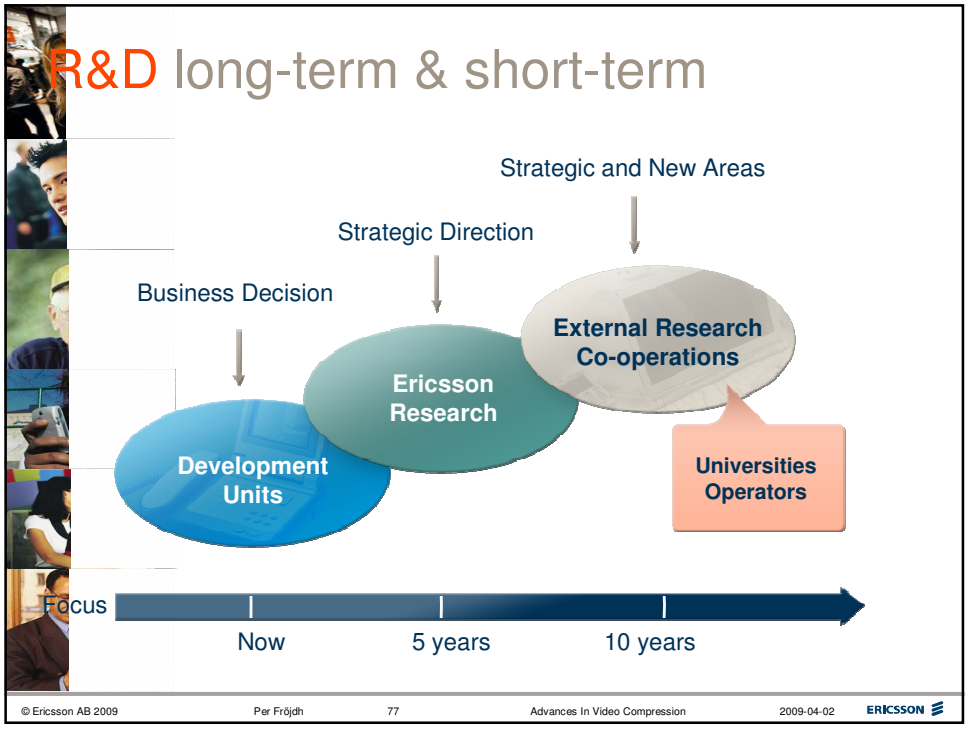


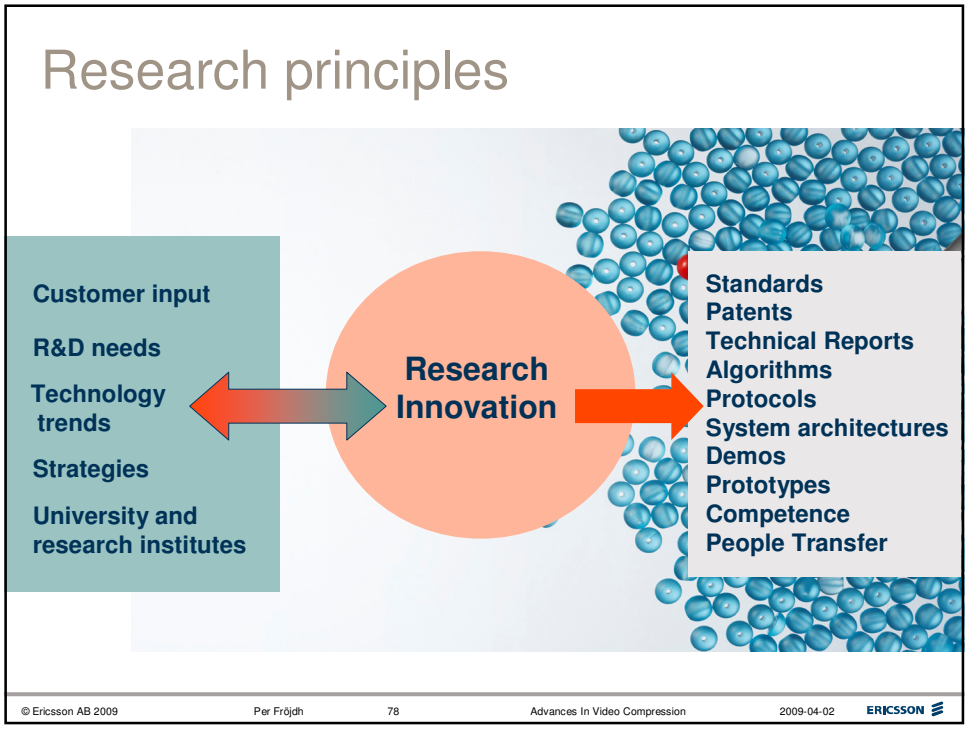
ERICSSON RESEARCH

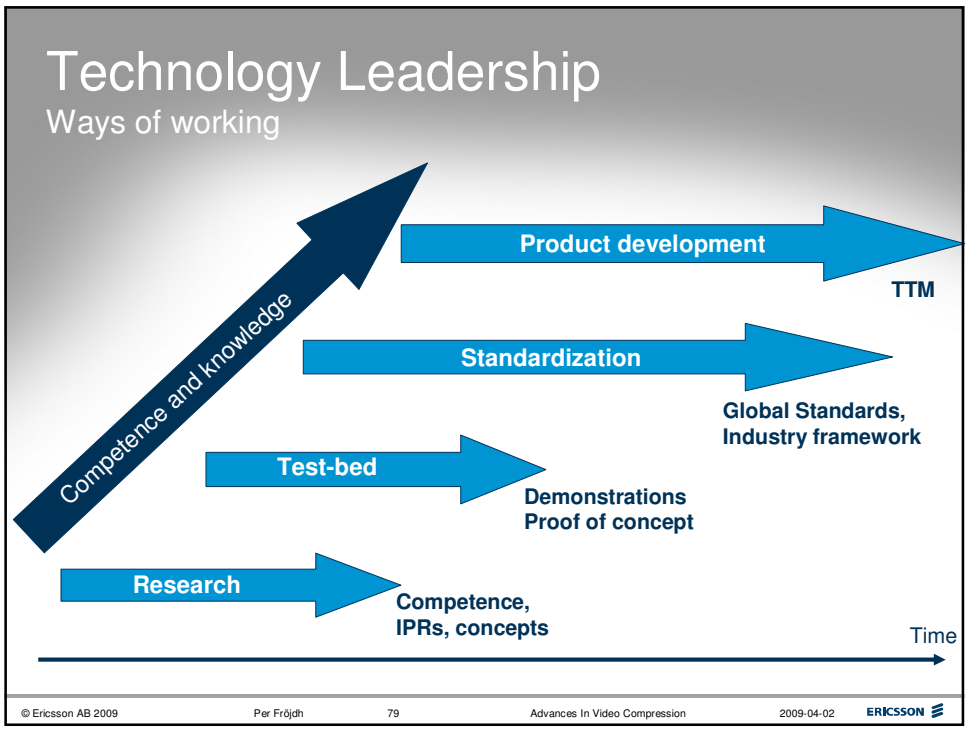
ERICSSON
TAKING YOU FORWARD

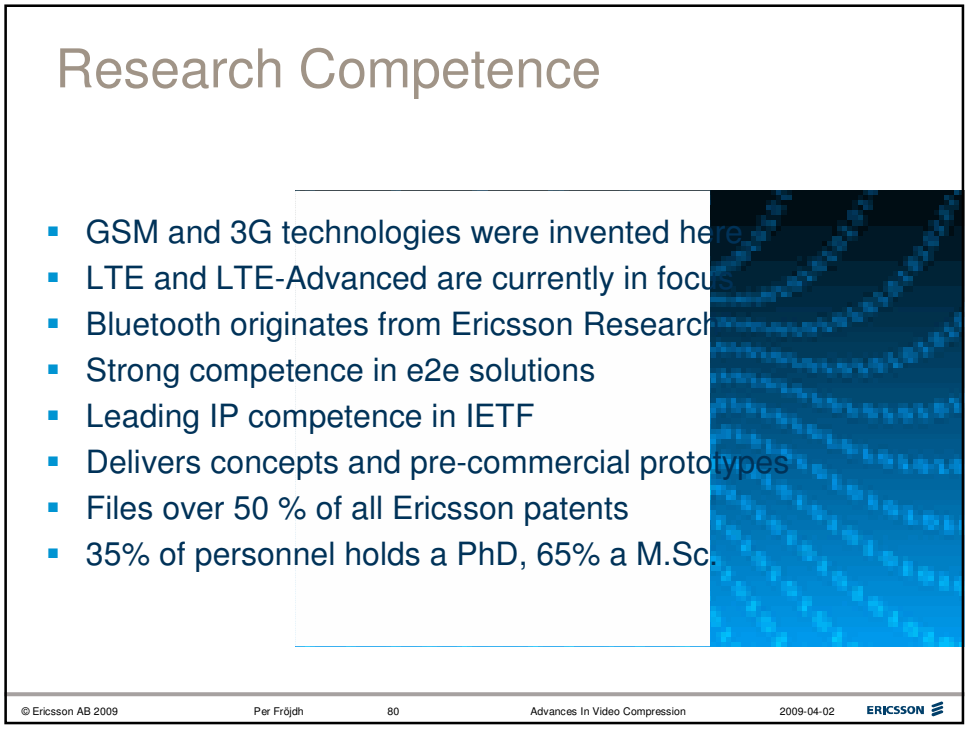

Ericsson Research
Sweden
- Kista
- Luleå
- Linköping
- Mölndal
- Göteborg
- Lund
Montreal
Helsinki
Tokyo
RTP
Aachen
Madrid
Beijing
Silicon Valley
Budapest
Pisa
© Ericsson AB 2009
Per Fröjdh
75
Advances In Video Compression
2009-04-02
ERICSSON

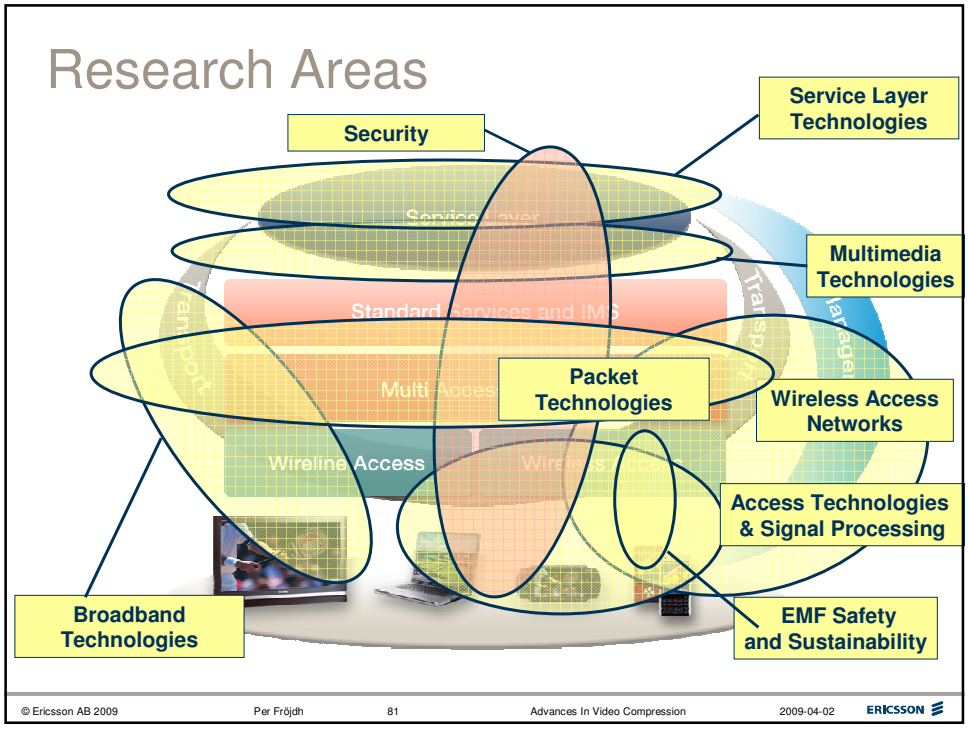

Research, Patent, Standardization
Patent
Protect our inventions
Research
First to inventions
Standardization
Define efficient solutions
for vendors and operators
Continuously building technology leadership
© Ericsson AB 2009
Per Fröjdh
76
Advances In Video Compression
2009-04-02
ERICSSON

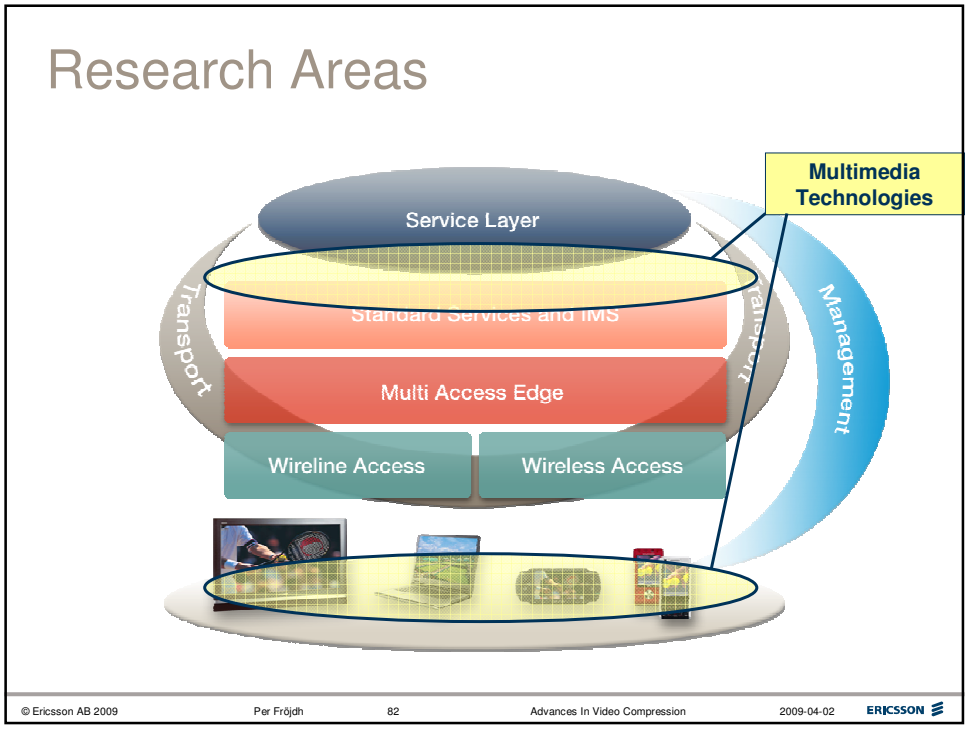

R&D long-term & short-term
Strategic and New Areas
Strategic Direction
Business Decision
External Research Co-operations
Ericsson Research
Development Units
Universities Operators
Focus
Now
5 years
10 years
© Ericsson AB 2009
Per Fröjdh
77
Advances In Video Compression
2009-04-02
ERICSSON


Research principles
Customer input
R&D needs
Technology trends
Strategies
University and research institutes
Research Innovation
Standards
Patents
Technical Reports
Algorithms
Protocols
System architectures
Demos
Prototypes
Competence
People Transfer
© Ericsson AB 2009
Per Fröjdh
78
Advances In Video Compression
2009-04-02
ERICSSON


Technology Leadership
Ways of working
Competence and knowledge
Product development
TTM
Standardization
Global Standards,
Industry framework
Test-bed
Demonstrations
Proof of concept
Research
Competence,
IPRs, concepts
Time
© Ericsson AB 2009
Per Fröjdh
79
Advances In Video Compression
2009-04-02
ERICSSON


Research Competence
GSM and 3G technologies were invented here
LTE and LTE-Advanced are currently in focus
Bluetooth originates from Ericsson Research
Strong competence in e2e solutions
Leading IP competence in IETF
Delivers concepts and pre-commercial prototypes
Files over 50 % of all Ericsson patents
35% of personnel holds a PhD, 65% a M.Sc.
© Ericsson AB 2009
Per Fröjdh
80
Advances In Video Compression
2009-04-02
ERICSSON


Research Areas
Security
Service Layer Technologies
Multimedia Technologies
Packet Technologies
Wireless Access Networks
Access Technologies & Signal Processing
EMF Safety and Sustainability
Broadband Technologies
Wireline Access
© Ericsson AB 2009
Per Fröjdh
81
Advances In Video Compression
2009-04-02
ERICSSON


Research Areas
Multimedia Technologies
Service Layer
Standard Services and IMS
Multi Access Edge
Wireline Access
Wireless Access
Transport
Management
© Ericsson AB 2009
Per Fröjdh
82
Advances In Video Compression
2009-04-02
ERICSSON

Multimedia Technologies

Main Technology Areas

- Media Codecs
  - Video standardization (MPEG, ITU-T)
  - Speech and Audio standardization (ITU-T, 3GPP)
  - 3D graphics textures (Khronos Open GL-ES)
- Media Processing
  - 3D Graphics, 3D Video
  - 3D Audio, Echo cancellation
- Image analysis
  - Face recognition, Bar/QR codes
- Transport / Storage
  - Streaming / Mobile TV (IETF RTSP, 3GPP PSS)
  - Video Telephony (CS & IP) (3GPP)
  - 3GP / MP4 file format
- Media Quality
  - Subjective quality assessment
  - Objective models
  - Service assurance

Multimedia Technologies

Career opportunities

- 75 researchers
  - Kista (45), Luleå (19), Lund (5), Aachen (6)
- Main entries
  - Master Thesis may lead to employment offer
    - Projects annonced at www.ericsson.com
    - ~10 openings per year (Kista)
  - PhDs in relevant areas
    - We sponsor speech/video coding research at KTH
  - Students with excellent grades
- We are interested in very good people
  - (no open positions right now)
- Contact per.frojdh@ericsson.com


ERICSSON
TAKING YOU FORWARD