Video Quality Assessment

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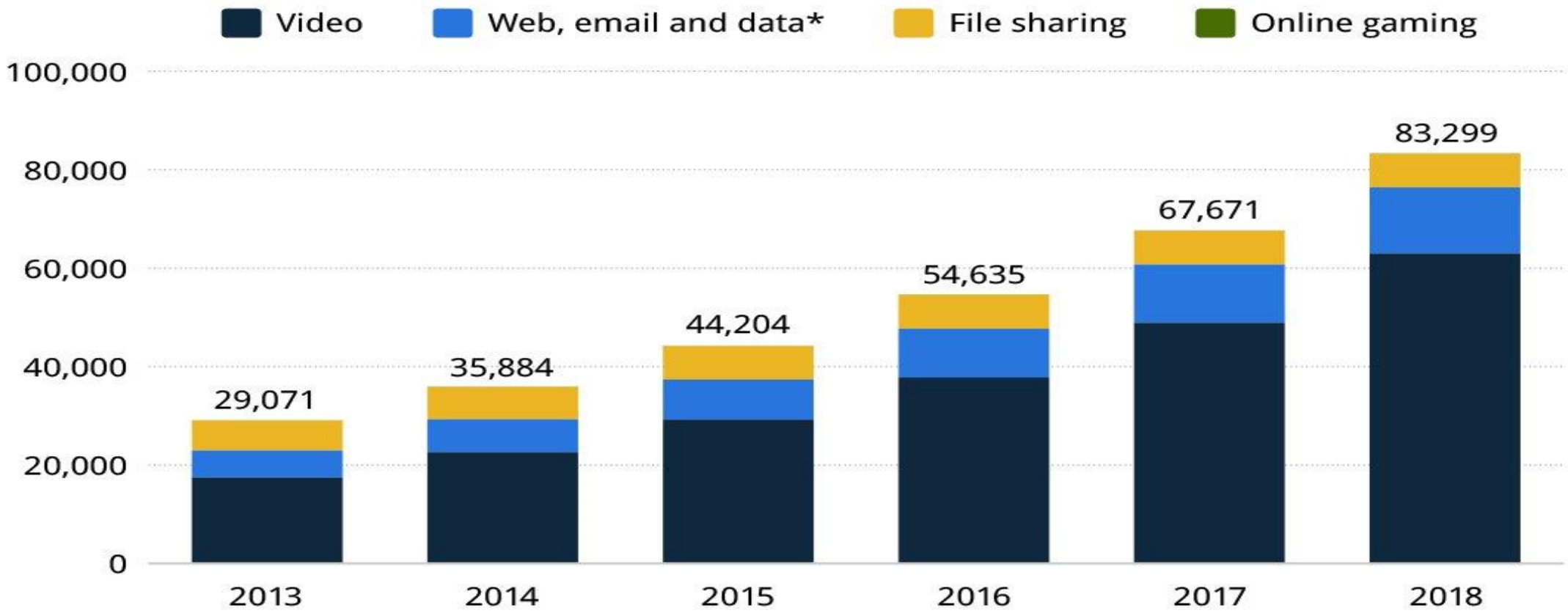
Tech Chart of the Day

Online Video To Account For 3/4 of Consumer Internet Traffic by 2018

Estimated monthly consumer internet traffic broken down by type of usage (in petabyte)



* Includes web, email, instant messaging and other non-filesharing data transfers via HTTP and FTP

BUSINESS INSIDER

Source: Cisco

statista

A Historical forecast

- *Professor Pearson* in 1990 said:
- Network has grown so much that without defining new Network Services, it cannot grow further
- Multimedia Services will consume almost all the network bandwidth (today video is more than 85% and multimedia more than 95% of network bandwidth)

Video Compression: The main driving force for sending video over Networks

- This is despite of very efficient video compression techniques. For example, in video broadcasting:
- HDTV has a raw data rate of more than 600 Mbit/s
- MPEG2 could reduce this value to 10-20 Mbit/s
  - This was done for 10 years of broadcasting (1993-2003)
- H.264/AVC is twice better than MPEG2
  - This was also done for more than 10 years (2003-Now)
- Now H265/HEVC is twice better than H.264/AVC
  - The standard was finalized in 2013
  - Will it replace H.264/AVC?
  - Will it go for another 10 years?
- New standards of VVC, AV1, etc are underway!

Why so much video traffic?

- New distribution platforms
- Visual monitoring of human life
- Growth of Internet Of Multimedia Things (IOMT)
- Growth of social networks
- Watching more than listening or reading
- Growth of user friendly access networks, such as 4G/5G
- Desire to watch video on users' choice
- Cheaper network service costs (Shared media)

Thus:

- Research on Multimedia includes:
  - Information (Signal) Processing
  - Networking
  - Communication

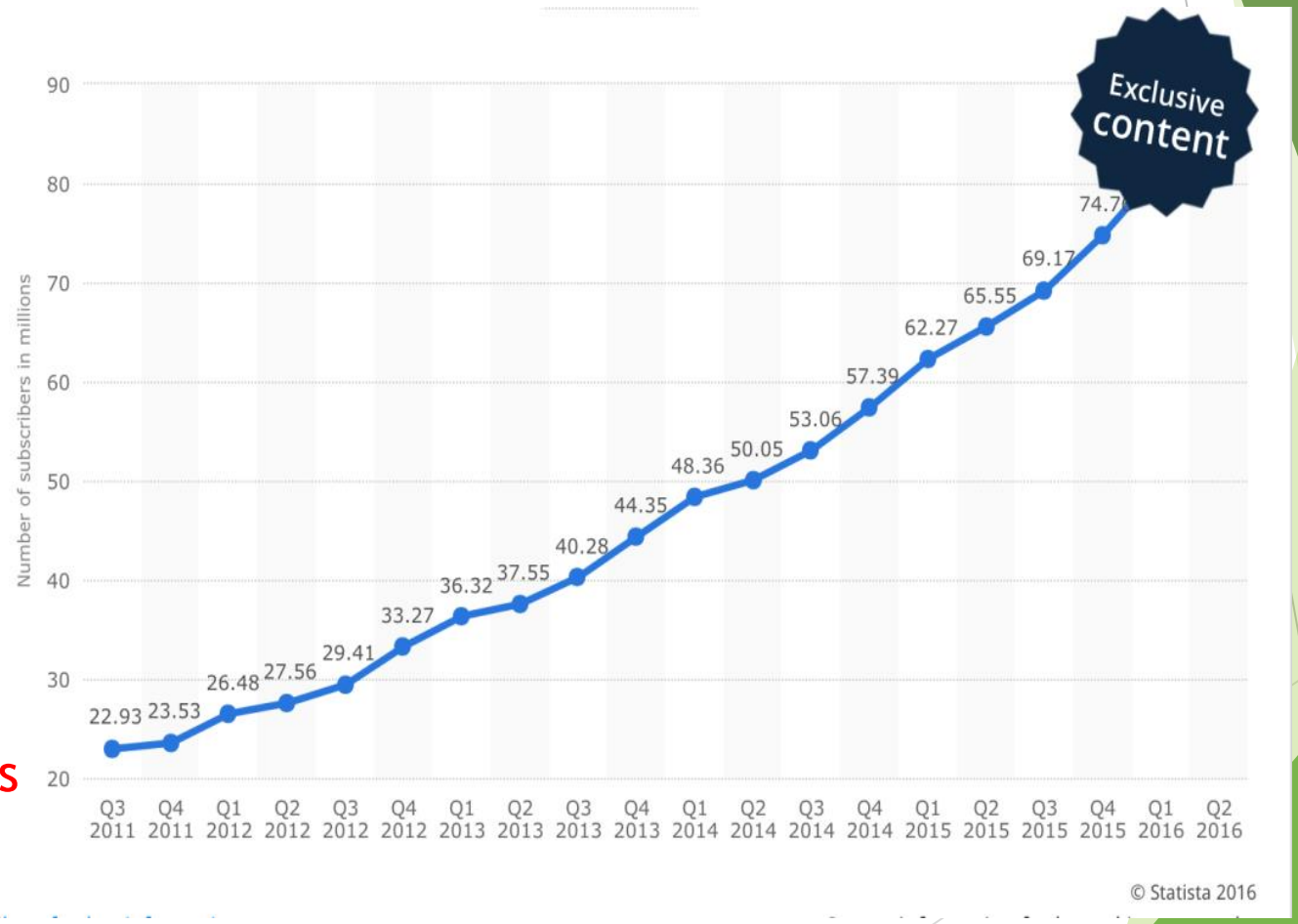
Video over internet

- Video over internet is provided via three methods:
  - IPTV: streaming video over managed networks
    - Preferred by network operators, suitable for live video
    - Good for multicasting
  - OTT: streaming video over unmanaged internet
    - Preferred by service providers,
    - Good for on demand services
  - HBB: Hybrid Broadcast of Broadband services
    - Preferred by broadcasters,
    - Sending live video over off air and on demand services via internet (IPTV or OTT)
- Video over unreliable channel needs monitoring

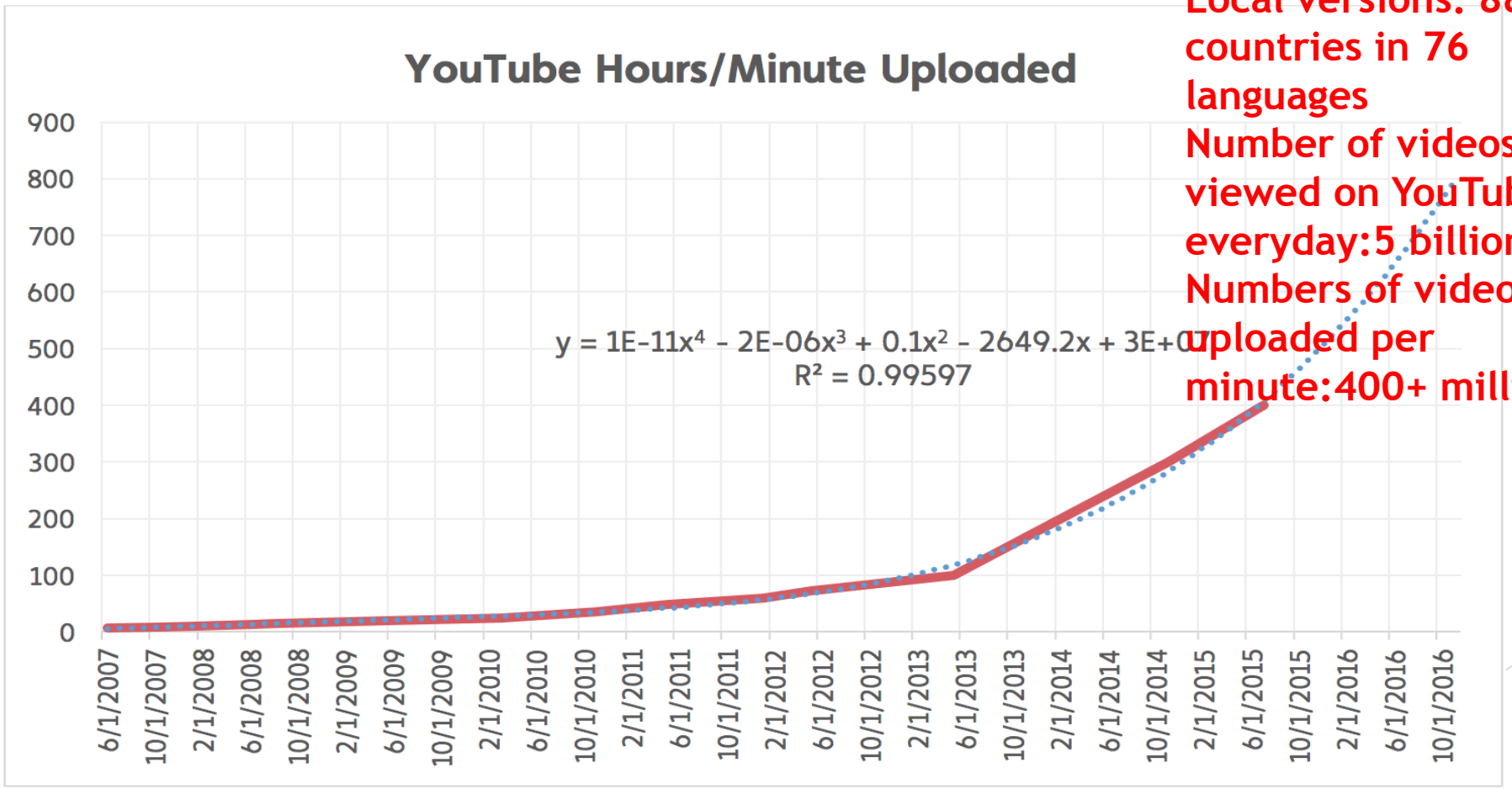
Netflix: Champion of on demand (OTT)

Year of digital distribution launch: 1999
Total number of Netflix subscribers: 83million subscribers
Number of Netflix international subscribers: 34 million

Number of hours Netflix users watched in 2015
: 42.5 billion streaming hours
Revenue: 6.78 billion USD (2015)



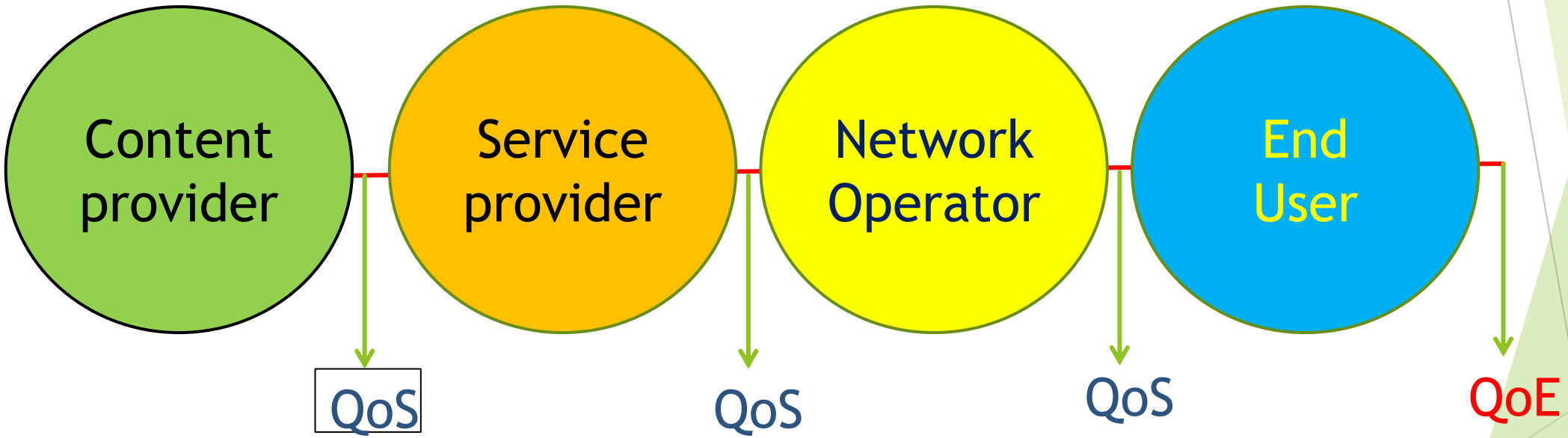
Youtube: another successful OTT video



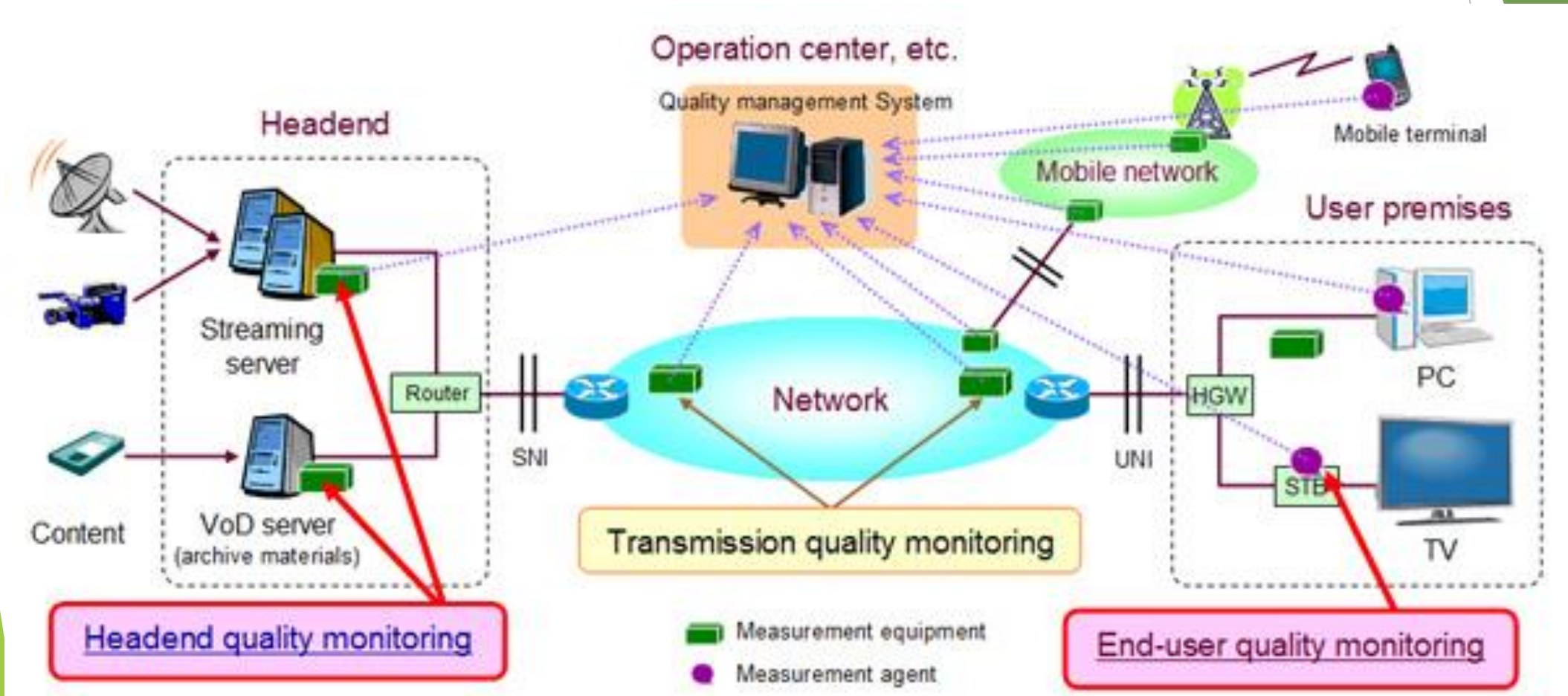
Number of users: over 1billion
Local versions: 88 countries in 76 languages
Number of videos viewed on YouTube everyday:5 billion
Numbers of videos uploaded per minute:400+ million

Monitoring and Evaluation of streamed video quality

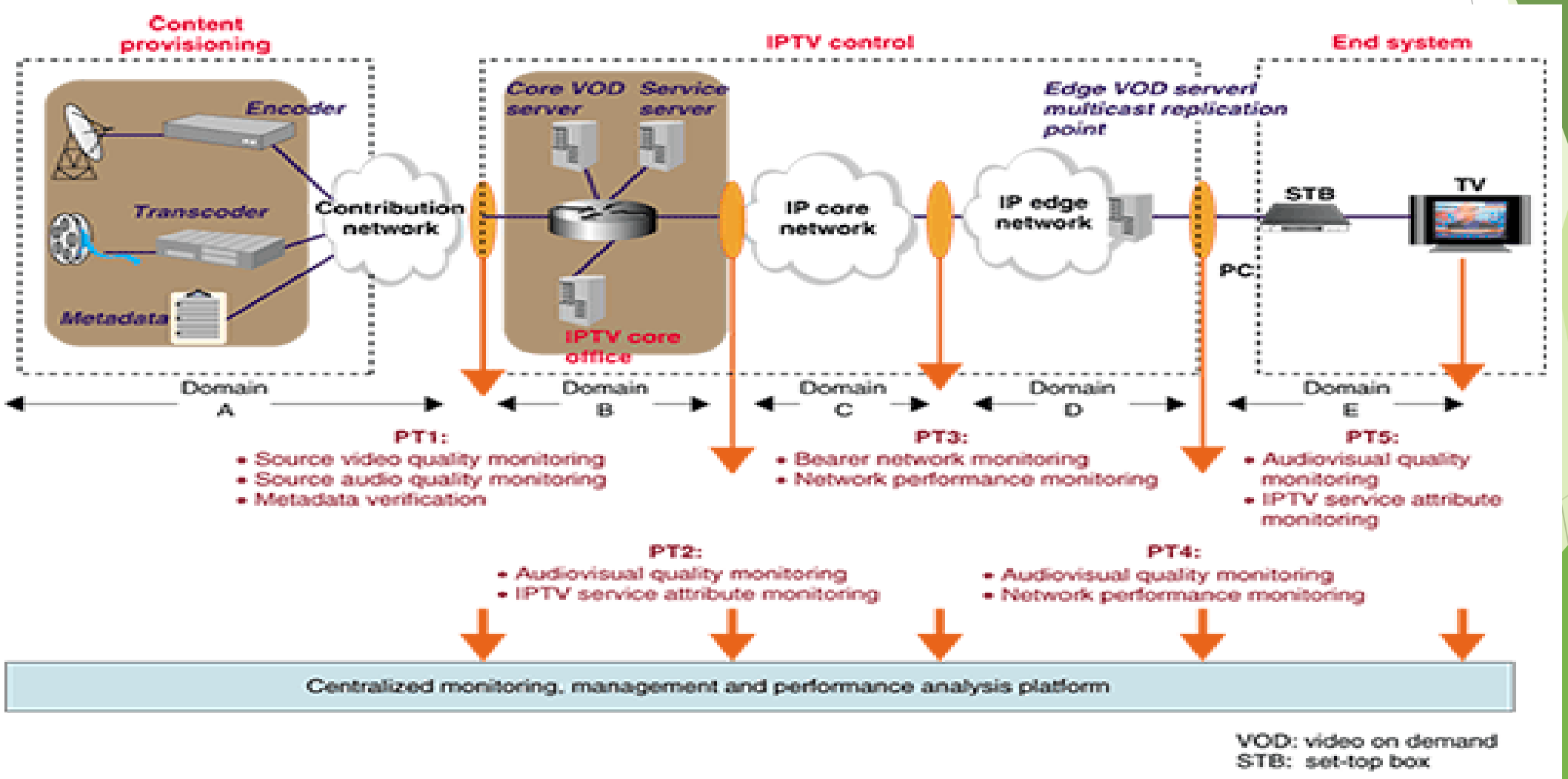
- Unlike traditional broadcasting, several key players need to evaluate the video quality



Quality monitoring



IPTV QoS/QoE


Content provisioning
IPTV control
End system
Encoder
Transcoder
Metadata
Contribution network
Core VOD server
Service server
IPTV core office
Edge VOD server/ multicast replication point
IP core network
IP edge network
STB
TV
PC
Domain A
Domain B
Domain C
Domain D
Domain E
PT1:
• Source video quality monitoring
• Source audio quality monitoring
• Metadata verification
PT3:
• Bearer network monitoring
• Network performance monitoring
PT5:
• Audiovisual quality monitoring
• IPTV service attribute monitoring
PT2:
• Audiovisual quality monitoring
• IPTV service attribute monitoring
PT4:
• Audiovisual quality monitoring
• Network performance monitoring
Centralized monitoring, management and performance analysis platform
VOD: video on demand
STB: set-top box

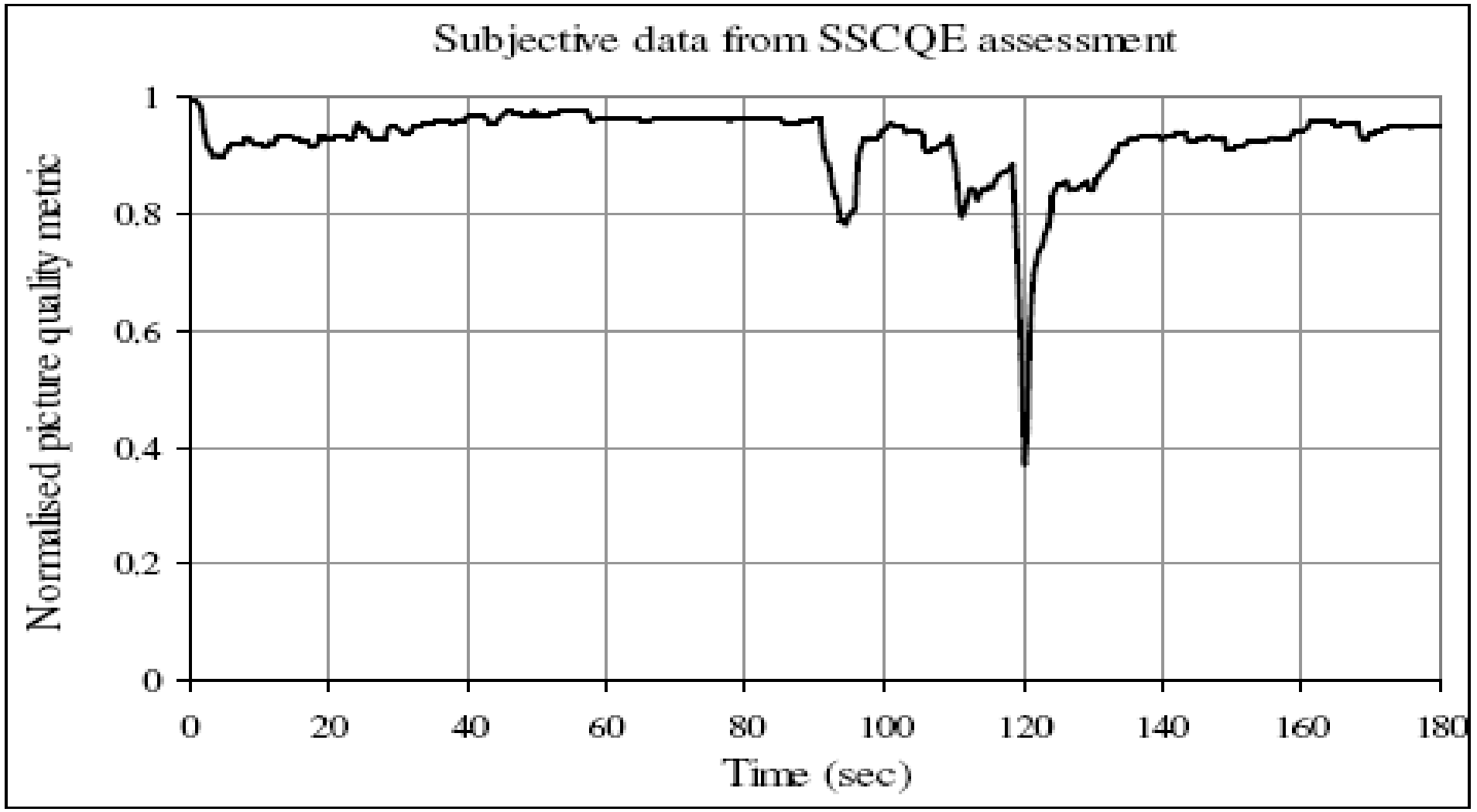
Subjective measures

Subjective assessment

- In subjective evaluation, a panel of human observers are given the task to rate the quality of image or video sequence.
- There are normally 25 subjects, but the minimum is 15
- Subjects should have normal HVS (age 18-30)
- They should NOT be familiar with Image degradations (but now it is changed!)
- The average values of the score is called: Mean Opinion Score (MOS)
- MOS is normally defined in the range of 1-5
- 8-10 sec segments of test video sequences with DSCQS

A typical test set-up for the SSCQE method.

Quality trace obtained using the SSCQE technique



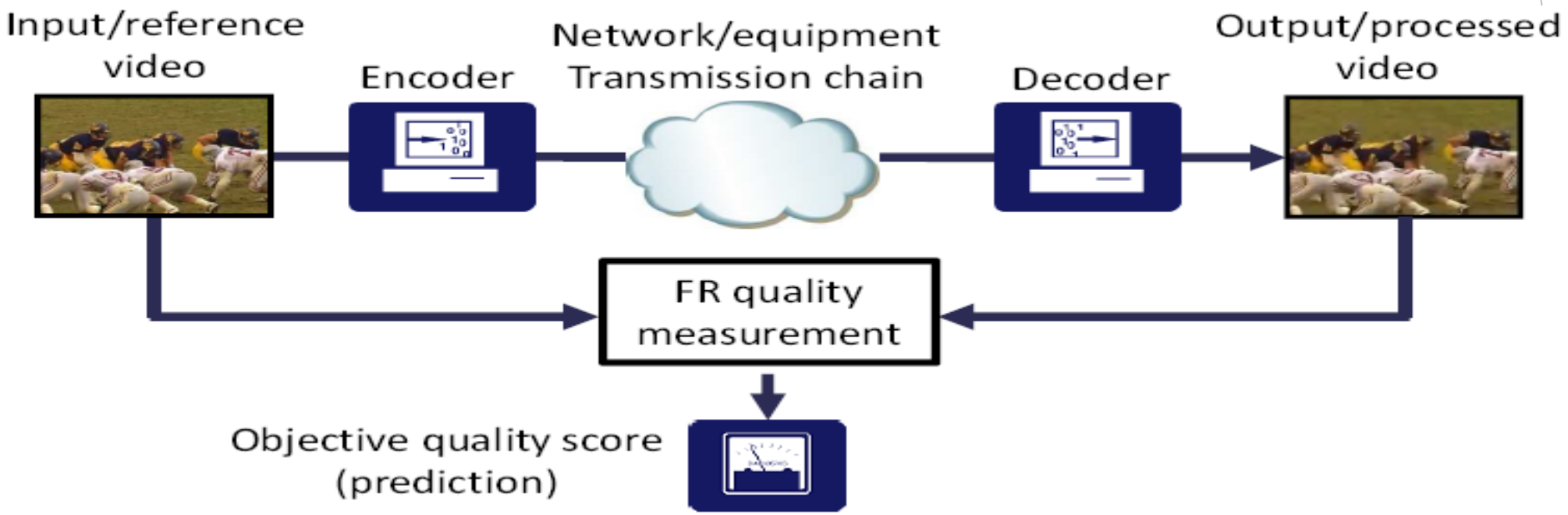
Objective measures

VQEG

- The Video Quality Experts Group (VQEG) have defined three methods as an objective Video Quality meter:
  - Full Reference method (FR)
  - Reduced Reference method (RR)
  - No Reference method (NR)

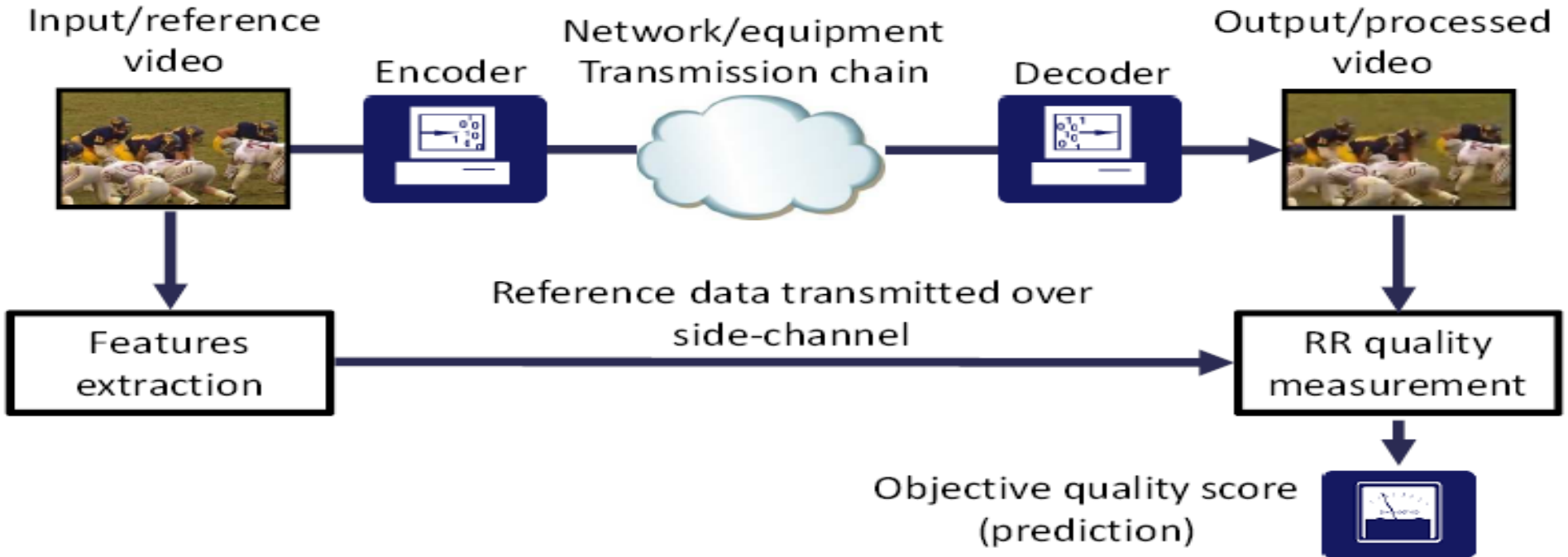
Full reference meter

- A full-reference (FR) quality measurement makes a comparison between a (known) reference video signal at the input of the system and the processed video signal at the output of the system



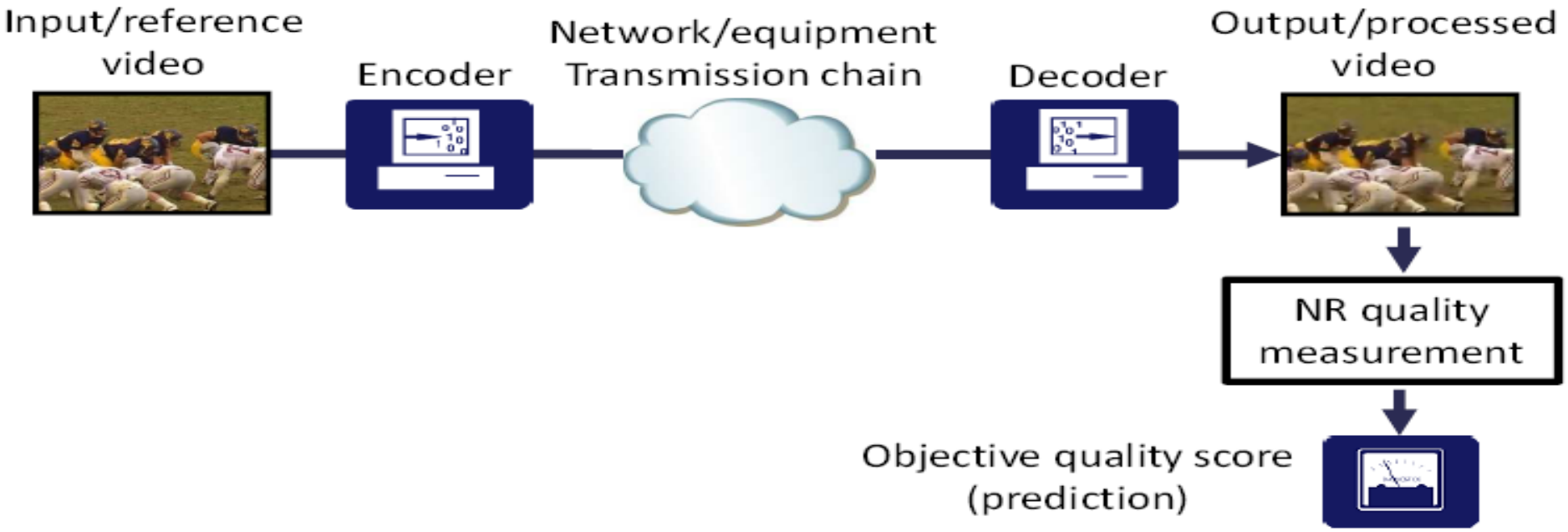
Reduced-reference Method

- In a reduced-reference (RR) quality measurement, specific parameters (features) are extracted from both the (known) reference and processed signals.
- Reference data relating to these parameters are sent using a side-channel to the measurement system (e.g. Watermarking).
- The measurement system extracts similar features to those in the reference data to make a comparison and produce a quality measurement.



No-reference Method

- A no-reference (NR) quality measurement analyses only the processed video without the need to access the (full or partial) reference information.



Relative performance

- Some of the weaknesses (in terms of sensitivity to various aspects inherent in image/video) of Objective measures

Type	***FR***	***RR***	***NR***
Application	***Studio VQM***	***Network VQM***	***Network VQM***
Spatial & temporal offset	Very sensitive	Less sensitive	insensitive
False statistics	insensitive	sensitive	insensitive
Coding Method	Less sensitive	Can be adjusted	Very sensitive
Type of degradation	Less sensitive	Can be adjusted	Very sensitive

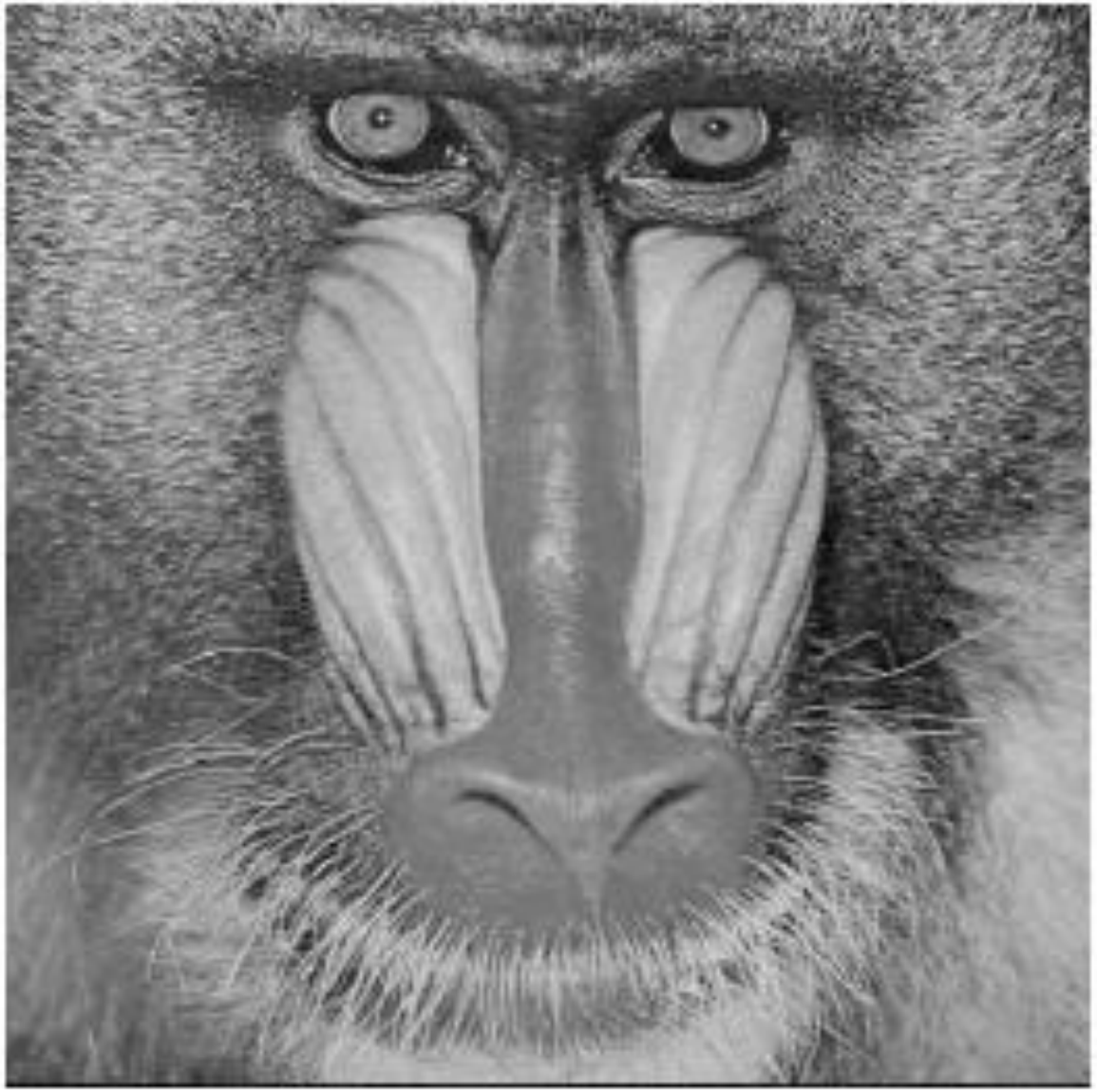
Type of degradations

Distortions due to compression

- Raw HD TV bit rate is in the order of 600-1200 Mbit/s.
- It is compressed to 4-8 Mbit/s, depending on applications
- Compression is achieved by removing small details of pictures, leading to picture bluriness
- In sever condition, several mid-to-high frequency coefficients are removed, leading to picture blockiness.

Blockiness due to compression

Spatial masking



But due to spatial masking, blockiness may nit be noticeable

Bluriness due to Compression

Both pictures have the same degree of blurriness, but one looks better than the other

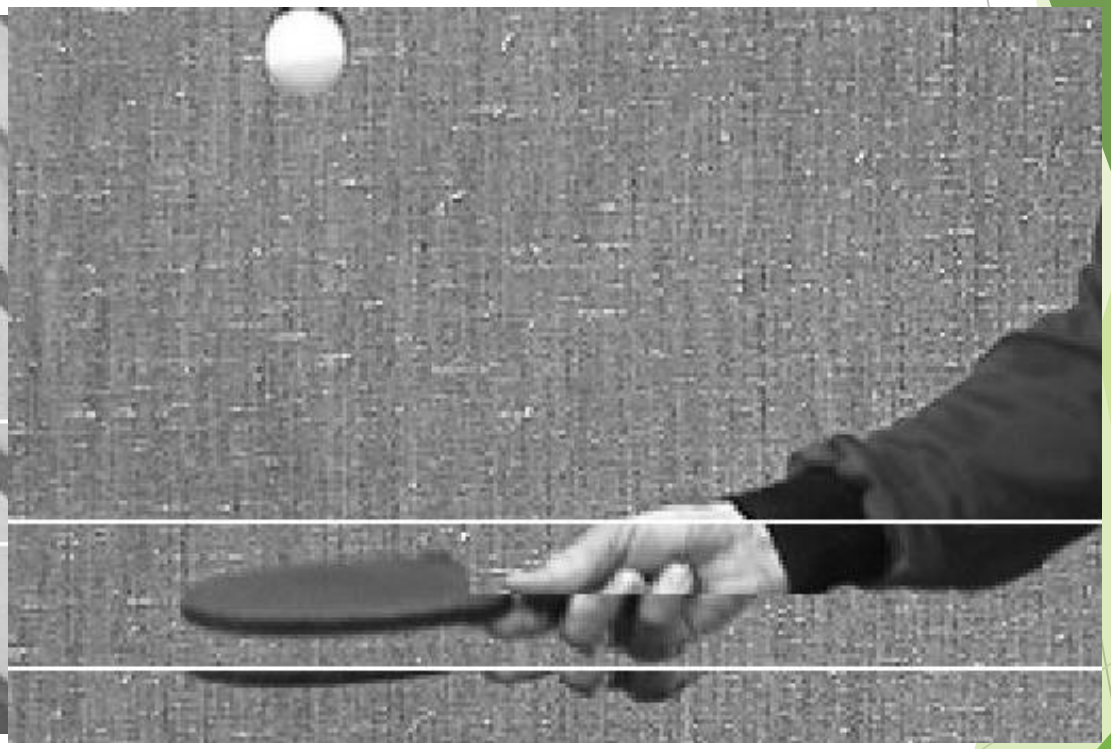
Distortions due to channel errors/packet losses

- Compressed video data in packet networks (e.g. Internet) due to congestion may be lost.
- They may also be damaged due to channel errors.
- In sever error condition, decoder gives up decoding, and erroneous data are regarded as lost information.

Loss concealment

- Lost data, can be concealed by:
  - Interframe error concealment (interpolate from previous frame). This can lead to picture blockniess.
  - They can also be concealed with intraframe concealment (interpolate from the same frame), leading to picture bluriness
- Isolated erroneous can also be concealed with Intrerframe or intraframe error concealments.

Blockiness due to loss concealment



Bluriness due to loss concealment

Modelling A long video sequence

- Video is made up of several video frames (e.g. 25 frames/sec)
- Measurements/Modelling are carried on individual frames
- Individual model scores/frame need to be amalgamated to represent model variation with video content
- Human visual system reaction to content should be taken into account

Loss/Gain harmonic analysis

- Having FFT of both reference and processed pictures:
  - The Loss of energy of harmonic components of processed image, means Bluriness
  - The Gain in energy of the harmonics components of the processed image, means Blockiness

Blockiness/Bluriness

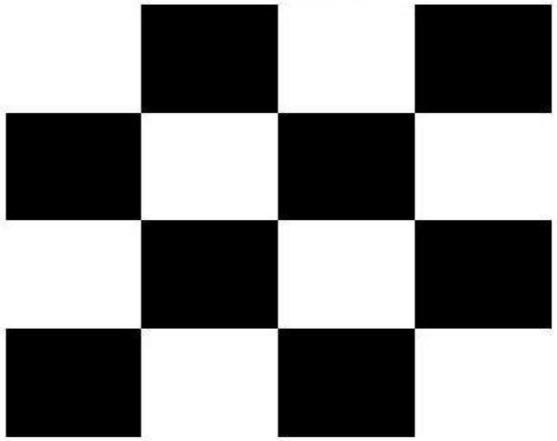


Fig 3(a)

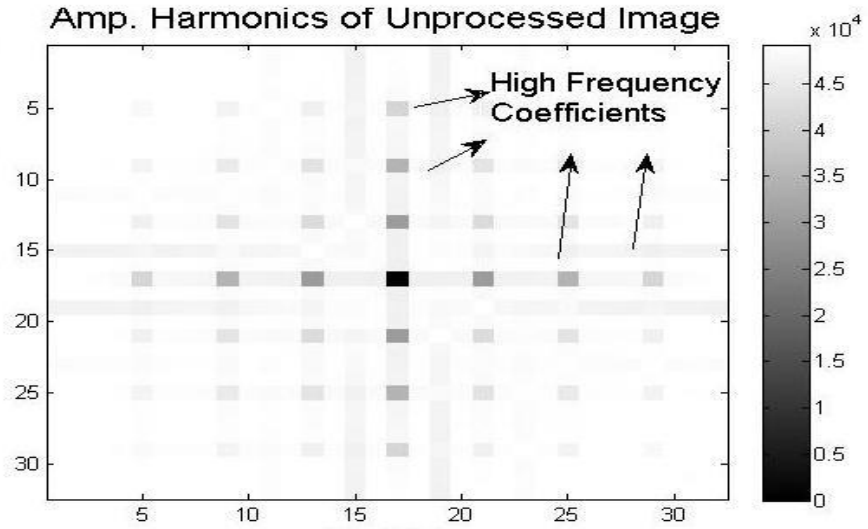


Fig 3(b)

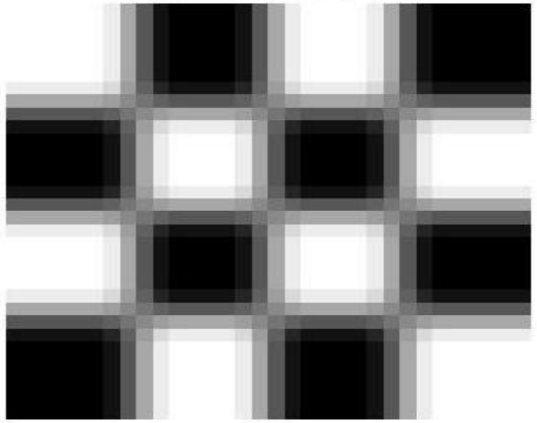


Fig 3(c)

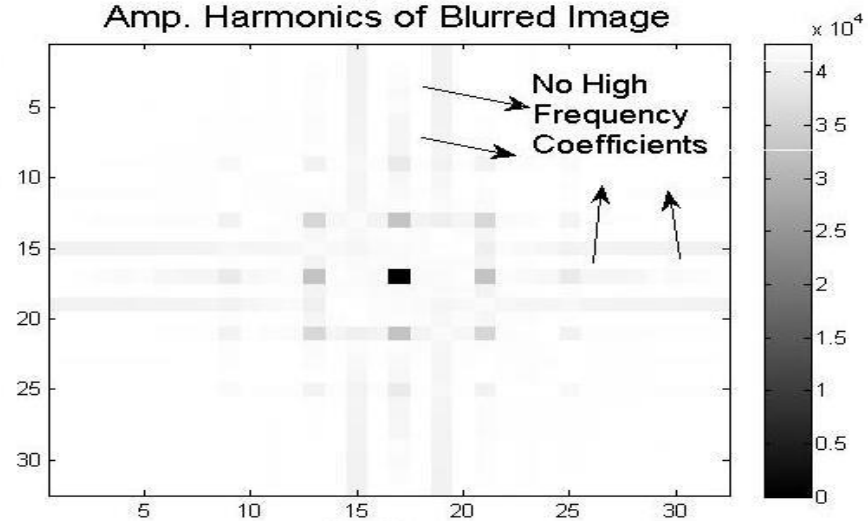


Fig 3(d)

Fig. 3(a) Reference image (b) Amplitude harmonics of reference image (c) Blurred image (d) Amplitude harmonics of blurred image

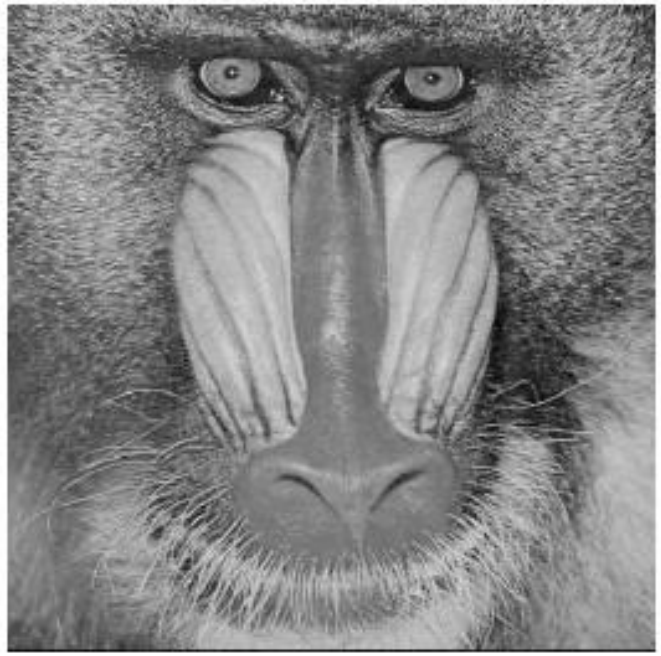
Subjective quality vs VQM &PSNR

(Blurred pictures) : All have the same degree of distortions (PSNR=25 dB)

Bad: LG=0.292 Moderate: LG=0.40 Good: LG=0.557

Subjective quality vs VQM &PSNR

(Blocky pictures): All have the same degree of distortions



Bad: LG=0.246 Moderate: LG=0.341 Good: LG=0.711

Experiment Set-up

- Test material:
  - Long sequence (3 minutes)
    - coded at different bit-rates at 1 minute intervals

Subjective and objective score for long sequence