A Realtime No Reference Video Quality Analysis

Abstracts of the IfN/R&S Algorithm

Joint Development

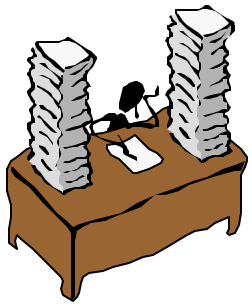
- Institute of Telecommunication Technologies (“IfN”) of Technical University Braunschweig, Germany headed by Prof. Ulrich Reimers
- Rohde & Schwarz Broadcast Division

Real time process

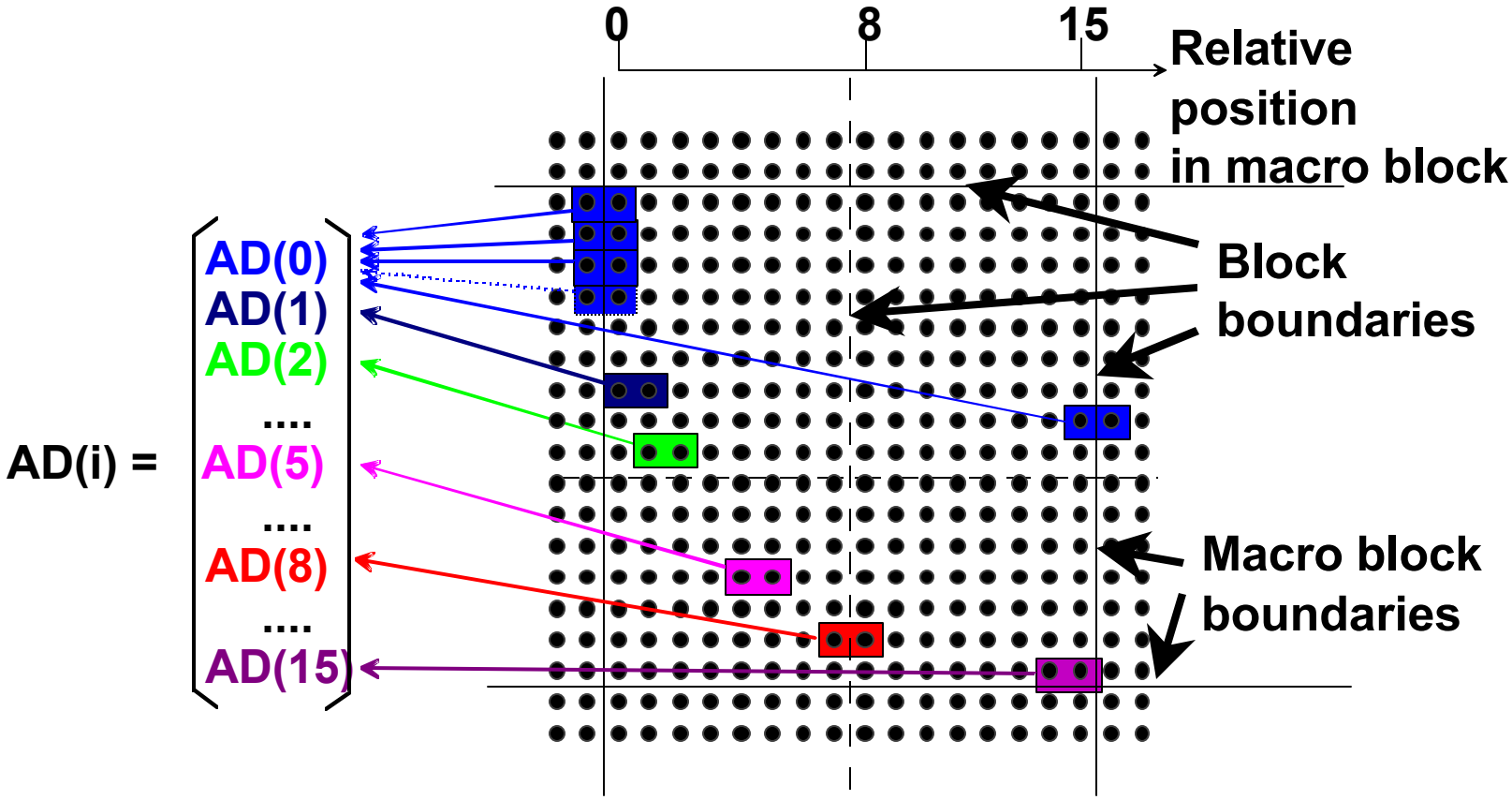
Without reference (NR) or with reduced reference (RR) signal

Analog distortions cannot be addressed

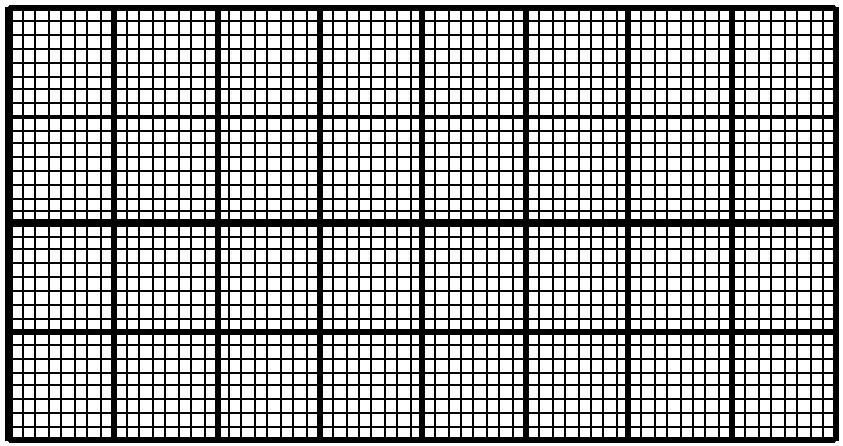
Basic Image Data Analysis (I)



Averaged amplitude differences of adjacent pixel pairs relative to their position in the macro block grid

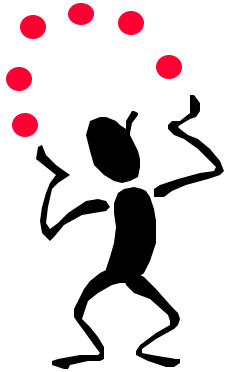


Basic Image Data Analysis (II)



normalized sum
of all ADx(i=0) .... ADx(i=15)
of all macro blocks
in all lines

total 3 * 16 values in x-direction
(Y, Cb, Cr)



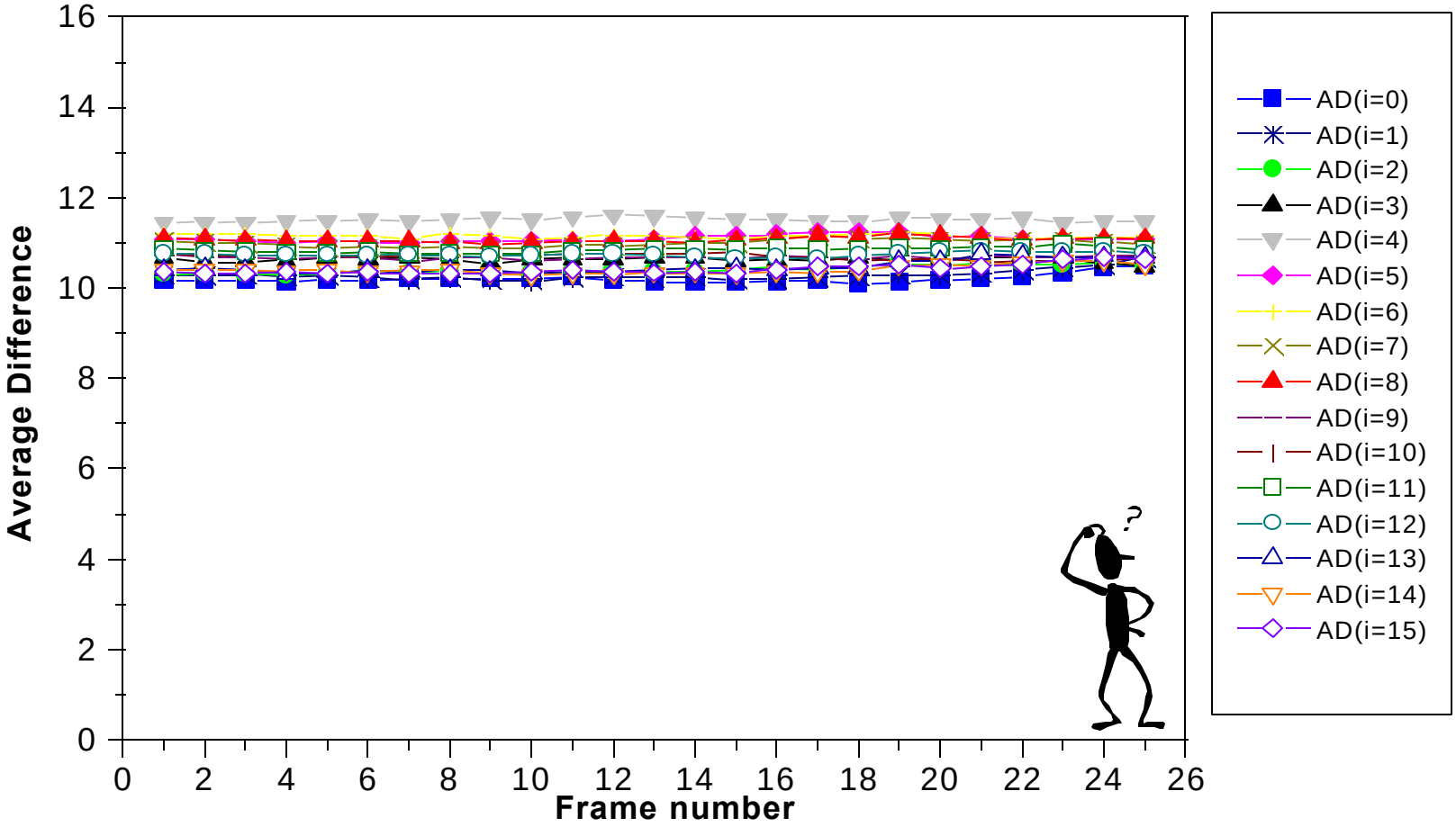
normalized sum
of all ADy(i=0) .... ADy(i=15)
of all macro blocks
in all columns

total 3 * 16 values in y-direction
(Y, Cb, Cr)

- In both directions
- Separately for Y and C's

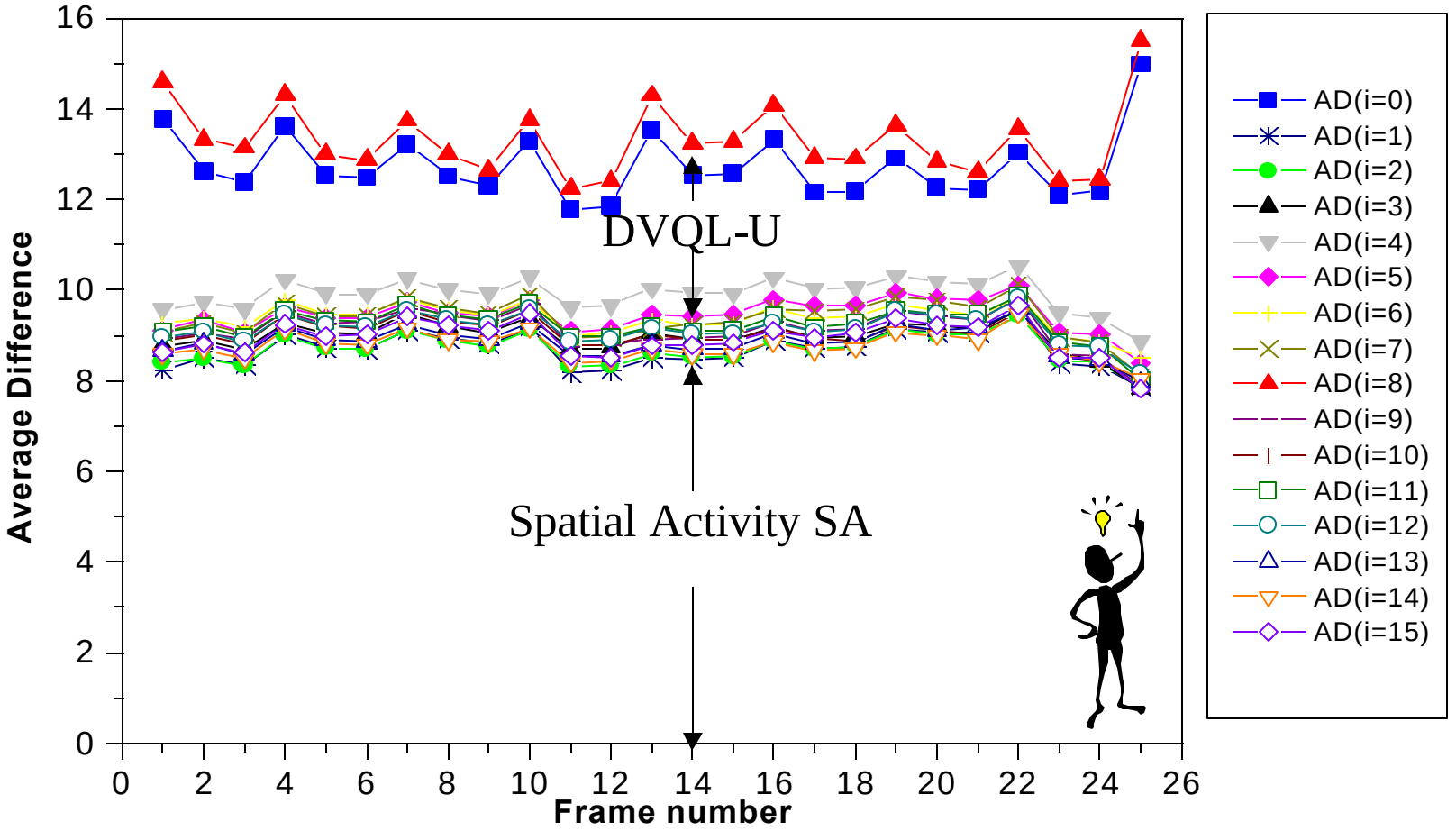
Analysis Results of non-coded Images

Example: Flowergarden - original sequence without compression



Analysis Results of coded Images

Example: “Flowergarden” - compressed sequence 2 Mbit/s

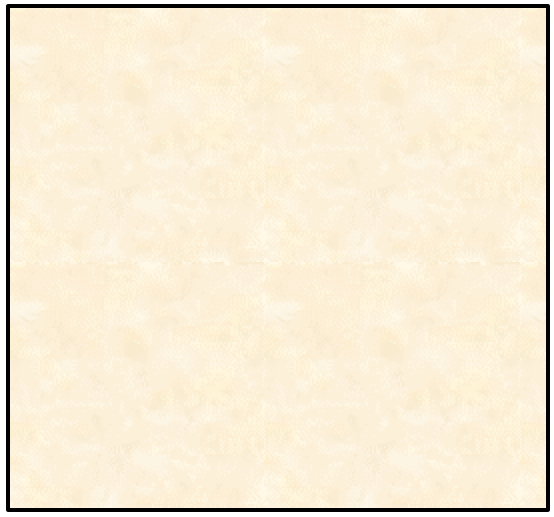


Subjective Weighting (part I)

Involves Parameter “Spatial Activity” (SA)

- Average of amplitude differences of all pixels
- Describes the amount of details within one single frame

SA low



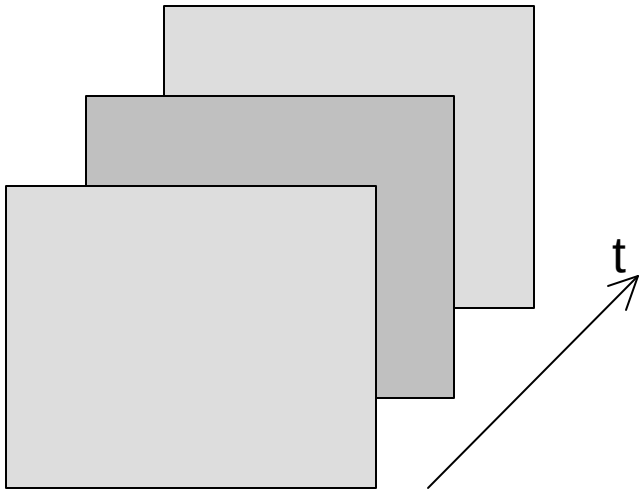
SA high

Subjective Weighting (part II)

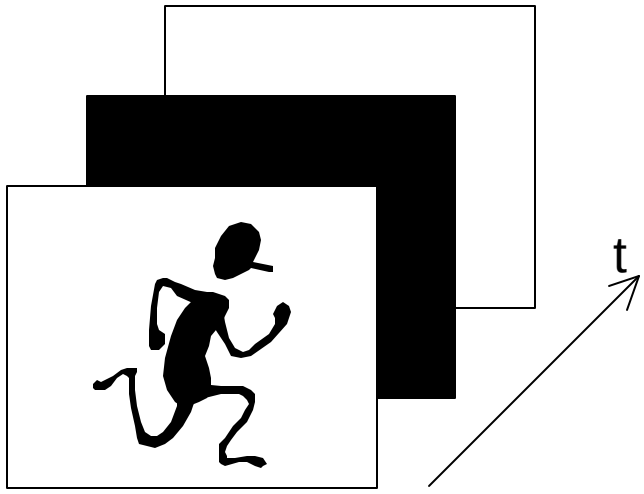
Involves Parameter “Temporal Activity” (TA)

- Average of all amplitude differences of the same pixels in subsequent frames
- Describes the "motion” within a sequence
- Determined by grouping pixels by eight and averaging their amplitudes in subsequent frames

TA small

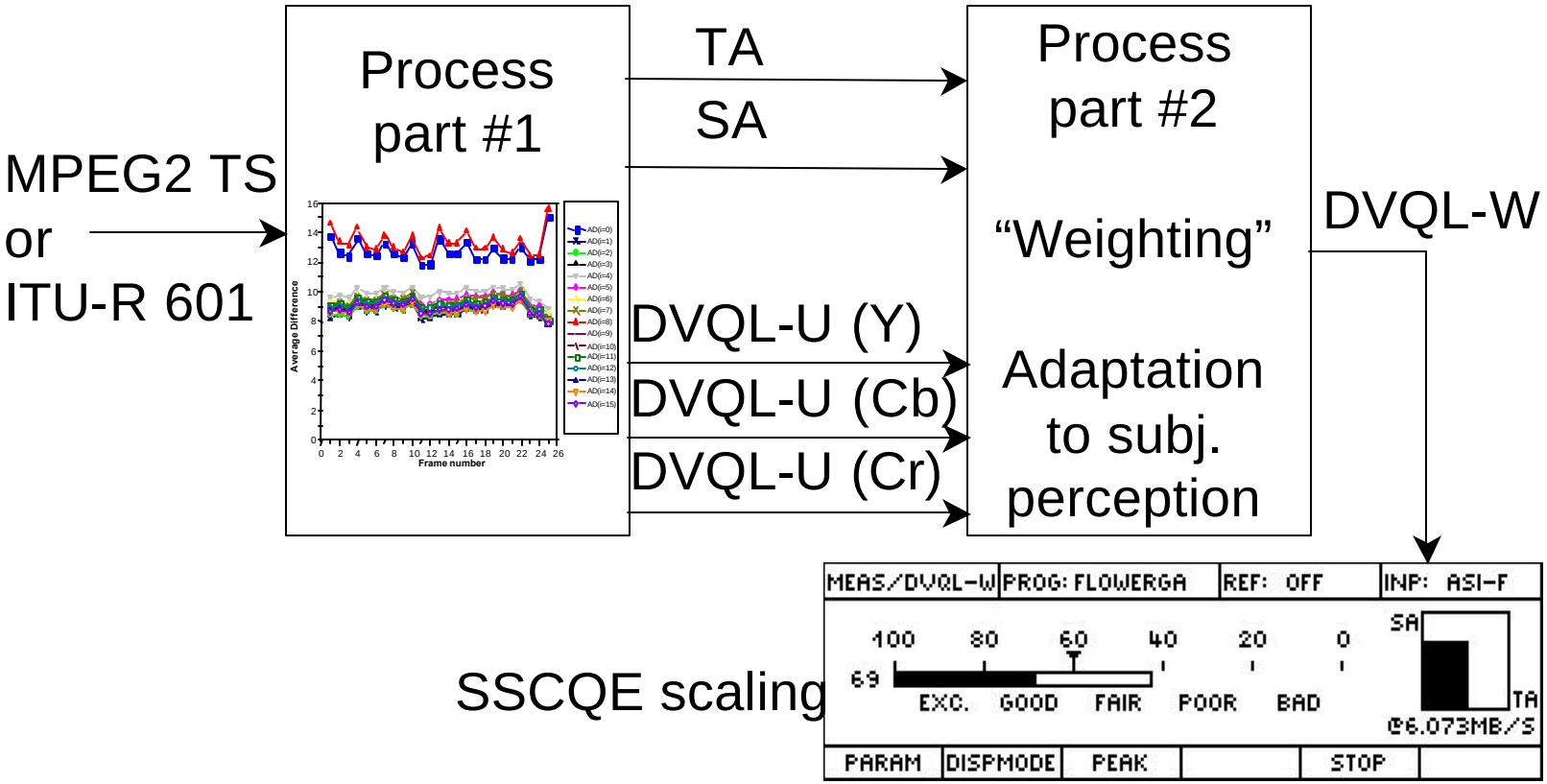


TA high (maximum)



The whole Quality Analysis Process

Masking of perception of quality degradations by high spatial (SA) & temporal (TA) activity values

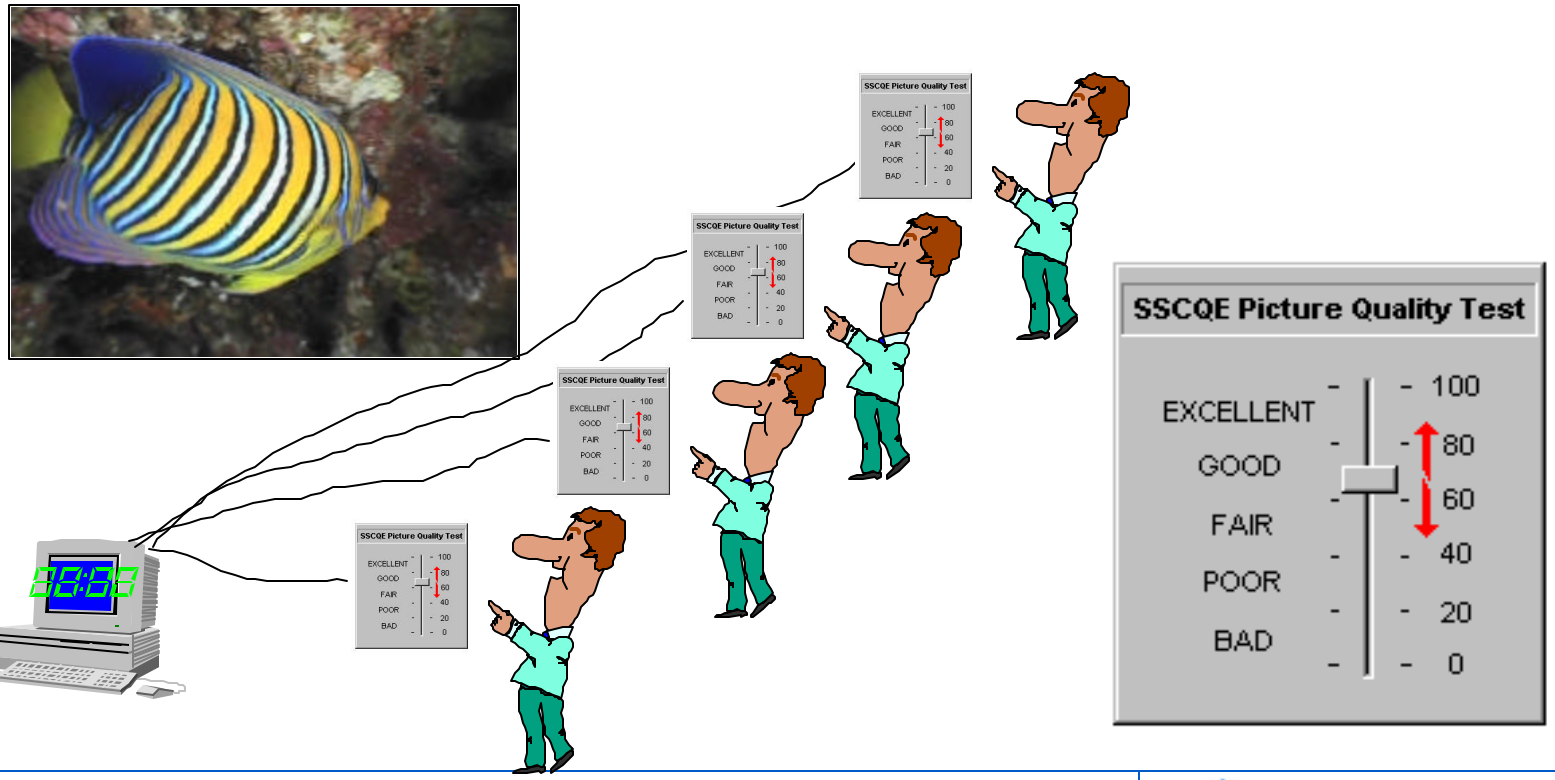


SSCQE acc. ITU-R B.T.500-7

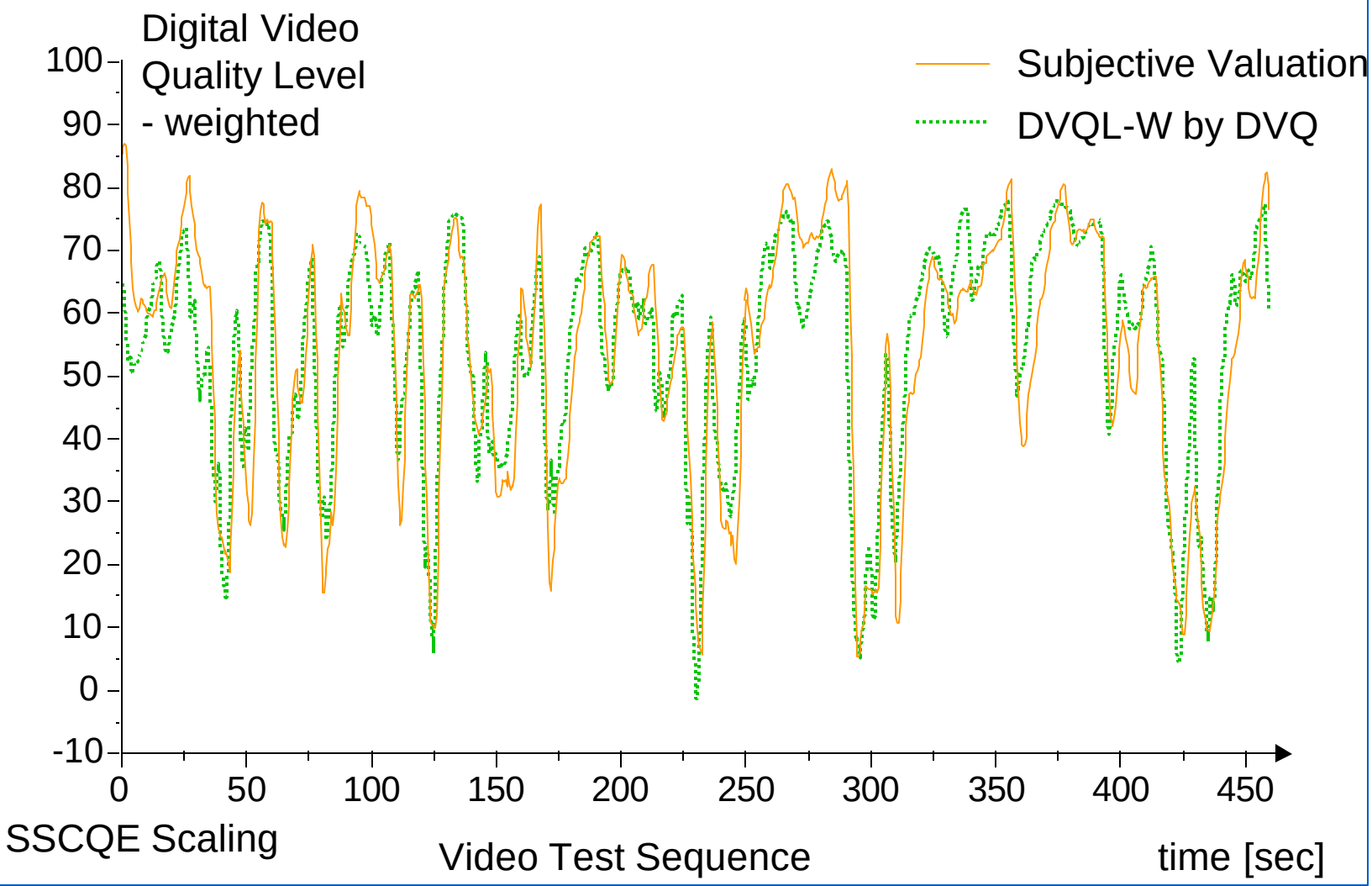
Test persons watching sequence (**S**ingle **S**timulus)

Continuous **Q**uality **E**valuation with slider movements while watching

Value sampling and averaging over viewers

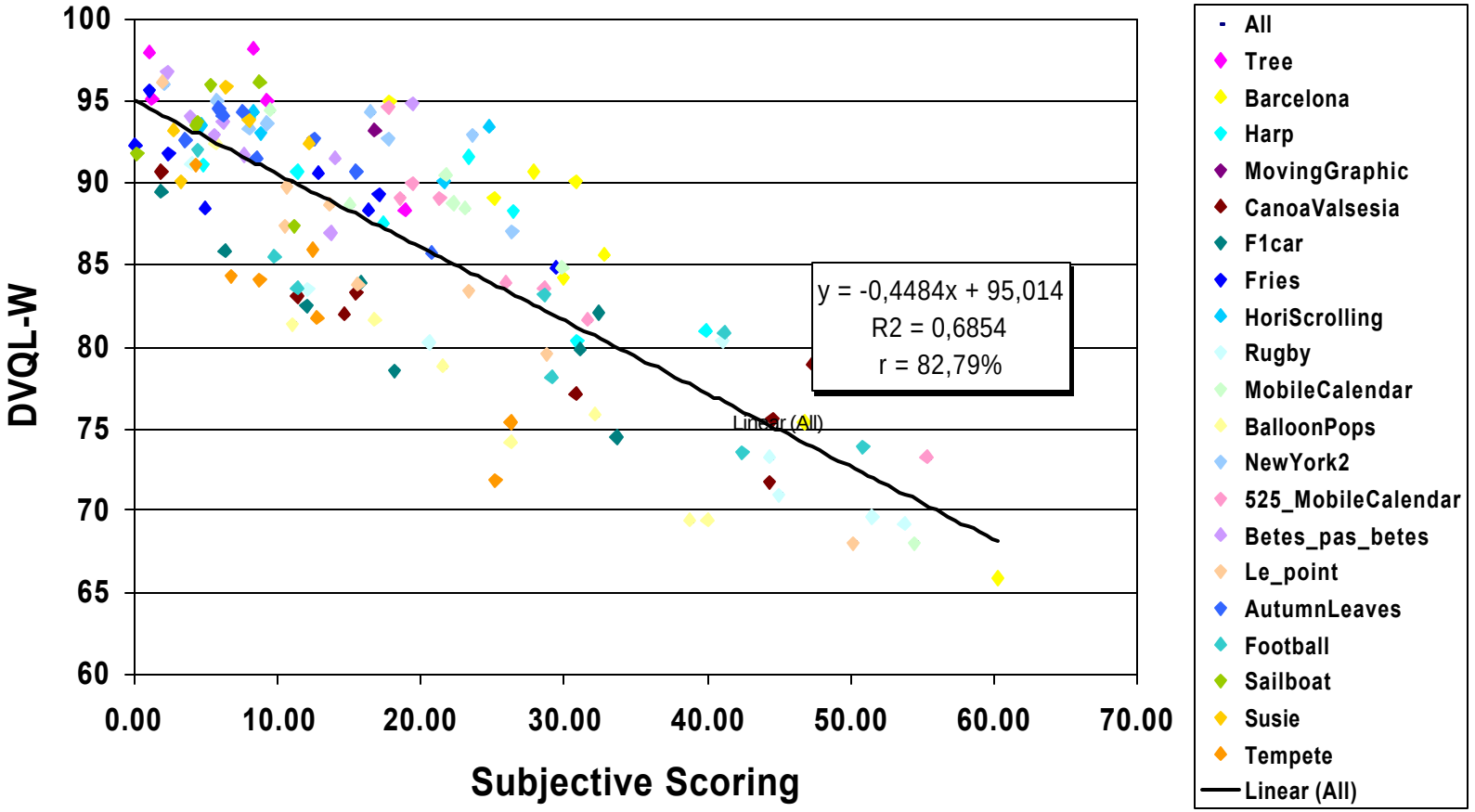


Comparison with Subjective Values (I)



Comparison with Subjective Values (II)

Correlation of 82.79% with Version 2.0 of the algorithm



Key Features of DVQ & DVQM

Quality analysis without reference

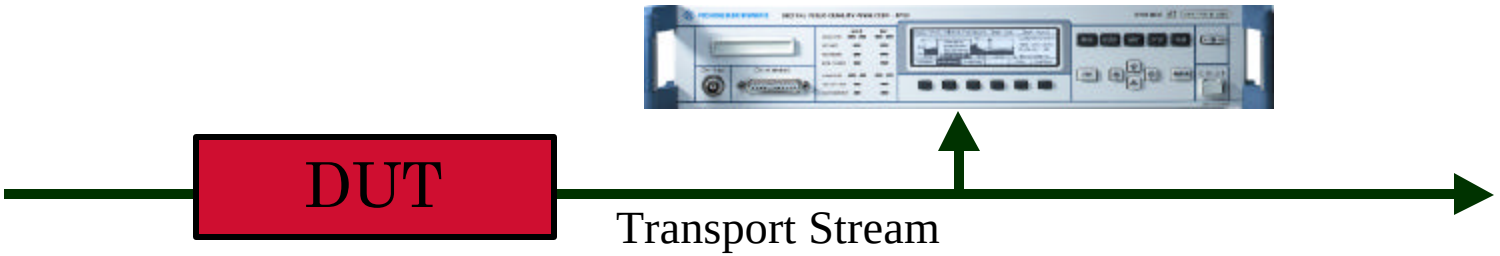
Real time operation

Integrated MPEG2 decoder (incl. 422 profile)

Referenced measurements possible

Detection of basic distortions

- Picture freeze and loss
- Sound loss (right / left separately)



Characteristics of the Basic Unit

Signal Inputs

- Transport stream inputs:
  - DVB-ASI & -SPI/LVDS
  - SMPTE310M optional [DV-B310]
- SDI serial plus AES/EBU [ITU-R B.T.601 or SMPTE259E]
- CA descrambling optional [DVQ-B10/11/12/15/16]

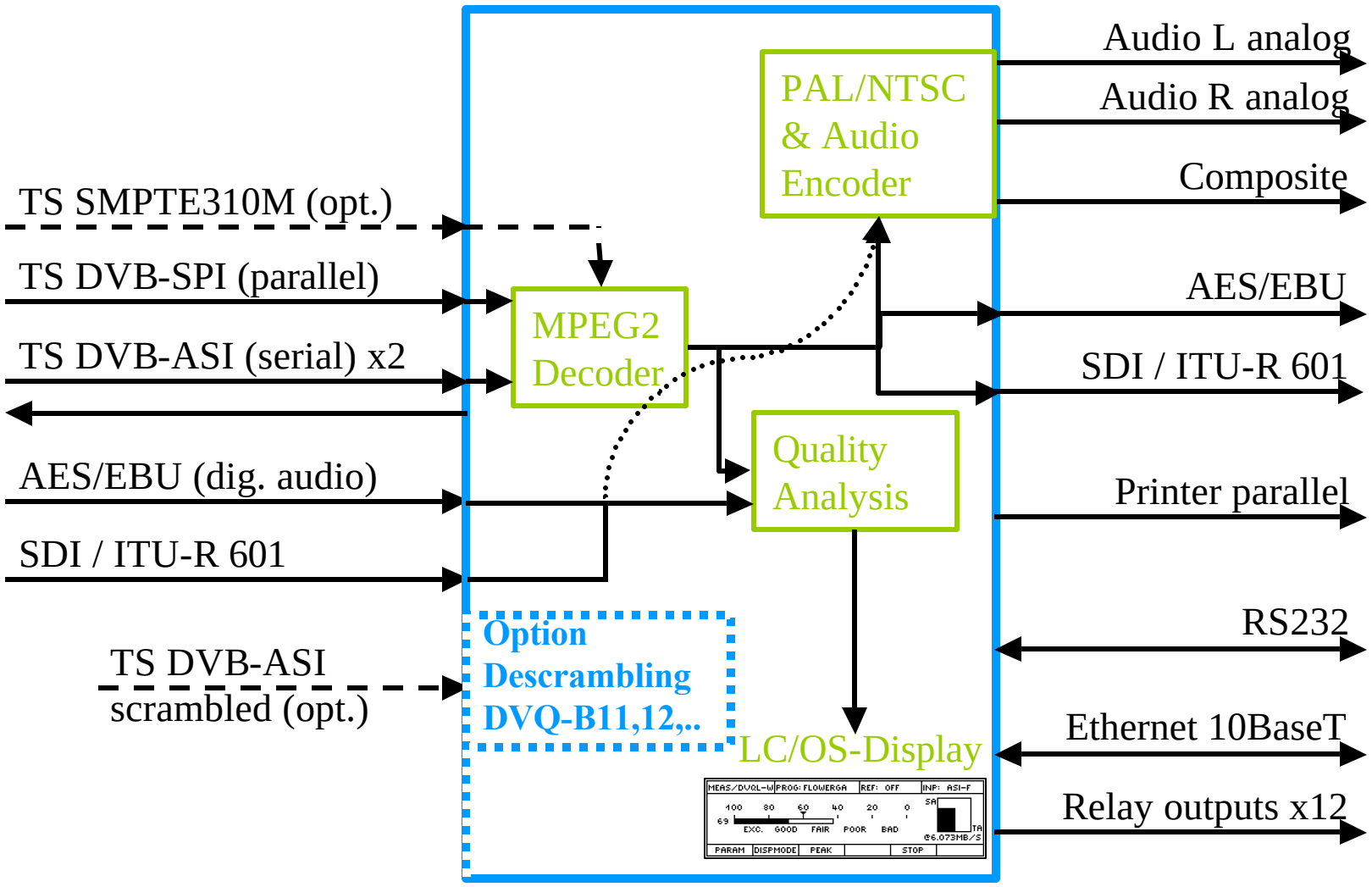
Control Interfaces

- Network [TCP/IP & SNMP]
- Serial [RS232]
- 12 Alarm closures
- Printer [Parallel]

Result Output

- LC display [bars/histogram/long time]
- OS display inside decoded video
- Integrated long-term statistics
- Detailed event & error report
- Relay outputs

Block Diagram / In- & Outputs



Referenced Measurement

Quality analysis for two signals

- MPEG2-TS vs. SDI
- SDI vs. MPEG2-TS

Comparing evaluation of artefacts

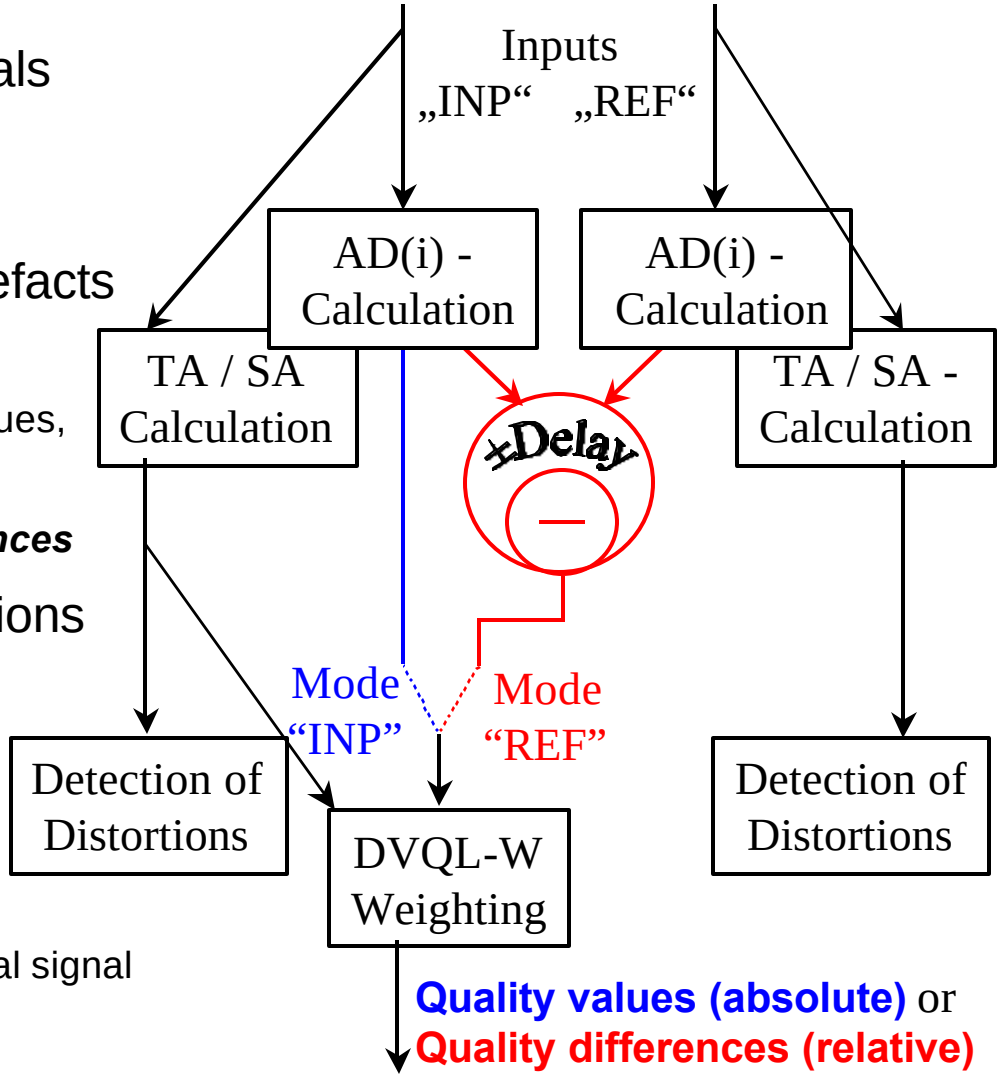
- ***No comparison of pictures !***
- Difference of single quality values, subjectively weighted
- ***Evaluation of quality differences***

Separate detection of distortions

- Picture freeze & loss
- Sound loss (right / left)

Propagation delay

- max. ± 5 s
- automatic detection from typical signal characteristics



Multiplex Scan Mode

Sequential check of all programs contained in one transport stream

- ***No Scanning of multiple TS !***

Variable duration per program

Program selection

- Automatic all
- Manual choice

Limits for TA / SA / DVQL-W

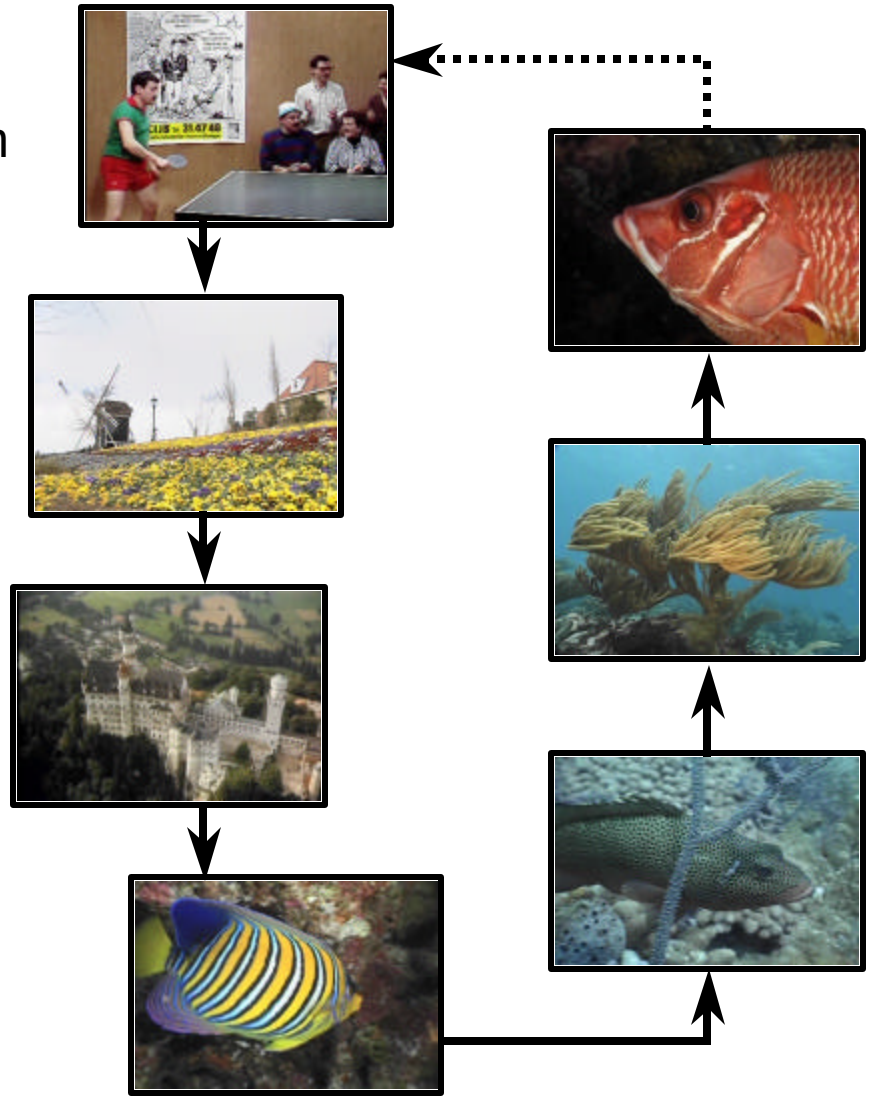
- ***Adjustable per program***

Indication of distortions

- ***Immediately or***
- ***After 1...5 detections in subsequent scan cycles***

Status display of results

- All programs in one clear view



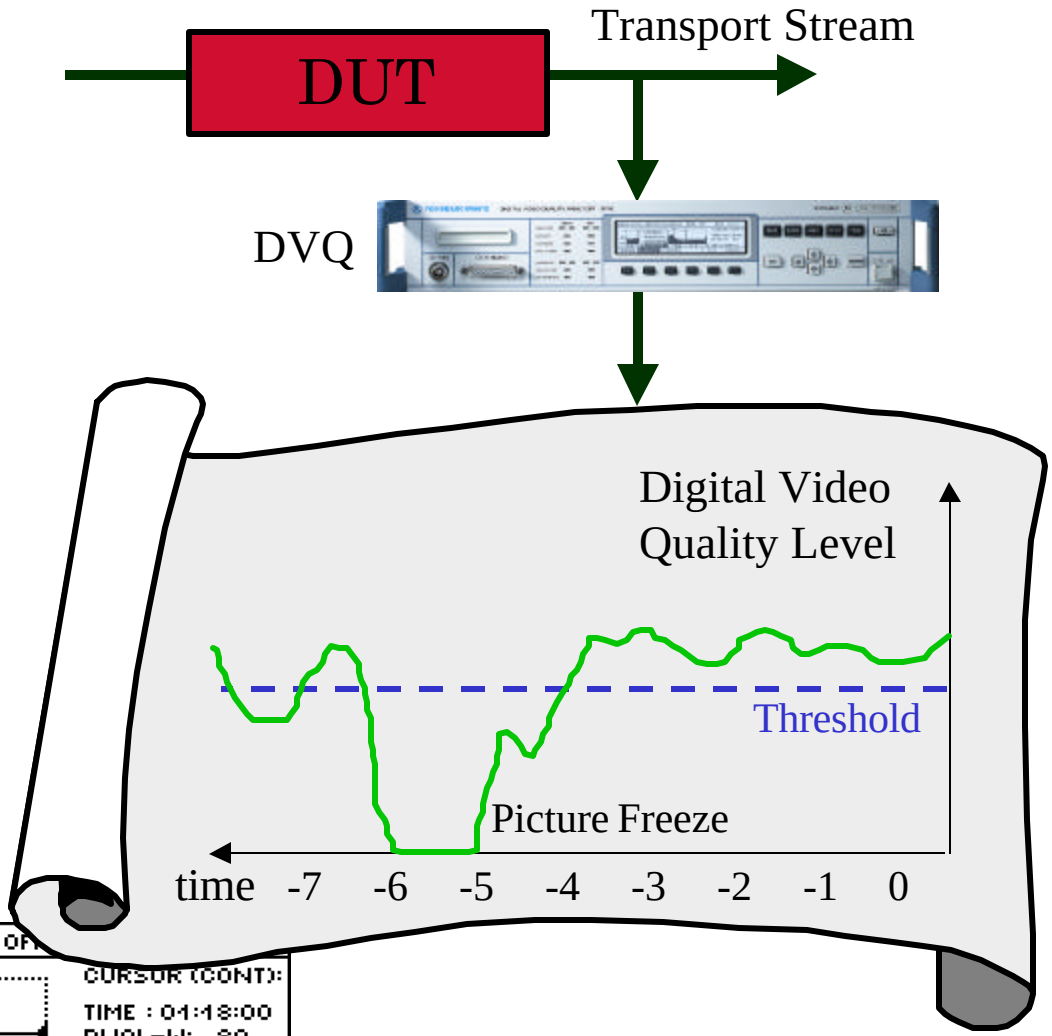
Monitoring

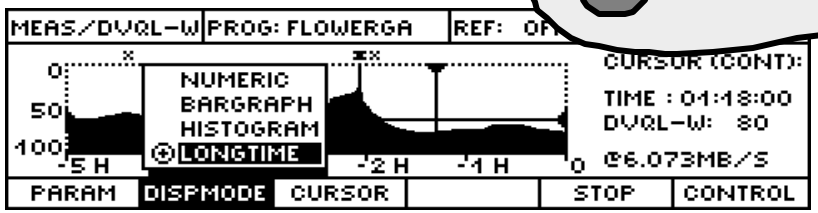
Details

- Freeze frames
- Picture outages
- Sound outages
- Video quality profile

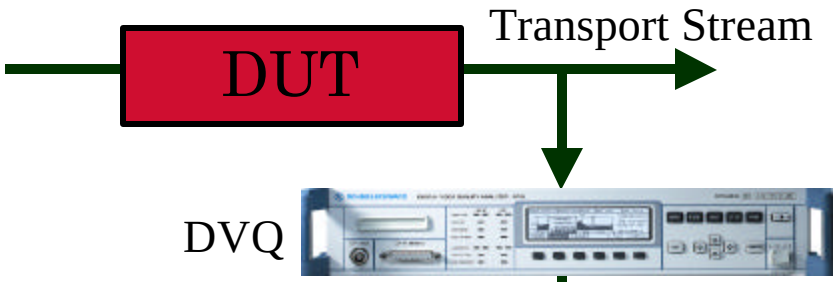
Benefits

- 24 hour real time
- Without operator
- Quality assurance
- Network optimization
- Fault identification





Quality Explorer Software DVQ-B1

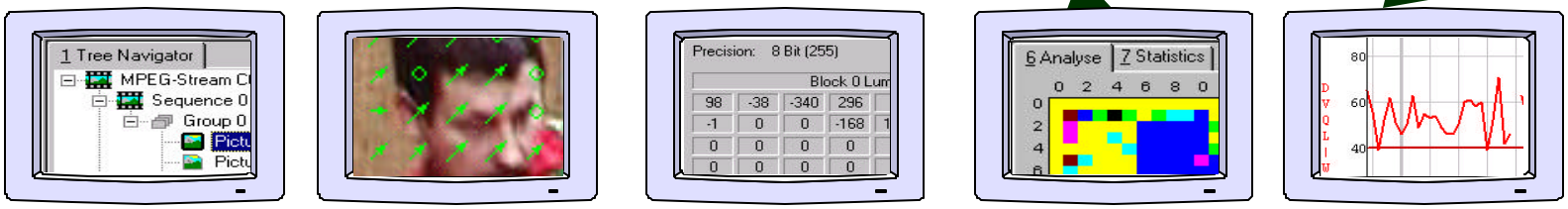


Functions

- Video ES analysis
- Offline or on-line

Benefits

- Detailed coding analysis
- Network valuation
- Equipment valuation



Video ES Organization | Motion Vectors | Quantification Factors/Tables | Macro block Data | Quality Statistics

Options for CA Descrambling

Main characteristics

- One descrambling board per DVQ
- Separate DVB-ASI interface 45 Mbit/s
- Smart card reader included
- Smart card not supplied
- Product designation DVQ-B10/11/12/15/16

CA systems supported

- Conax - Nagravision - Viaccess (one board)
- Irdeto
- Mediaguard
- NDS-Videoguard (BSkyB)
- BetaCrypt
- Philips Cryptoworks

Multi Channel Quality Analyzer DVQM

Official introduction NAB 2001

Broadcast Engineering Pick-Hit Award 2001

8 RU 19” wide - 12 slots

Modules available

- Quality board (DVQ like)
- CA descrambling options

Remote operation

- TCP/IP & SNMP protocols

Actual customer reference

- SES-Astra, Luxembourg

Europe’s largest satellite operator

Main Features of DVQM

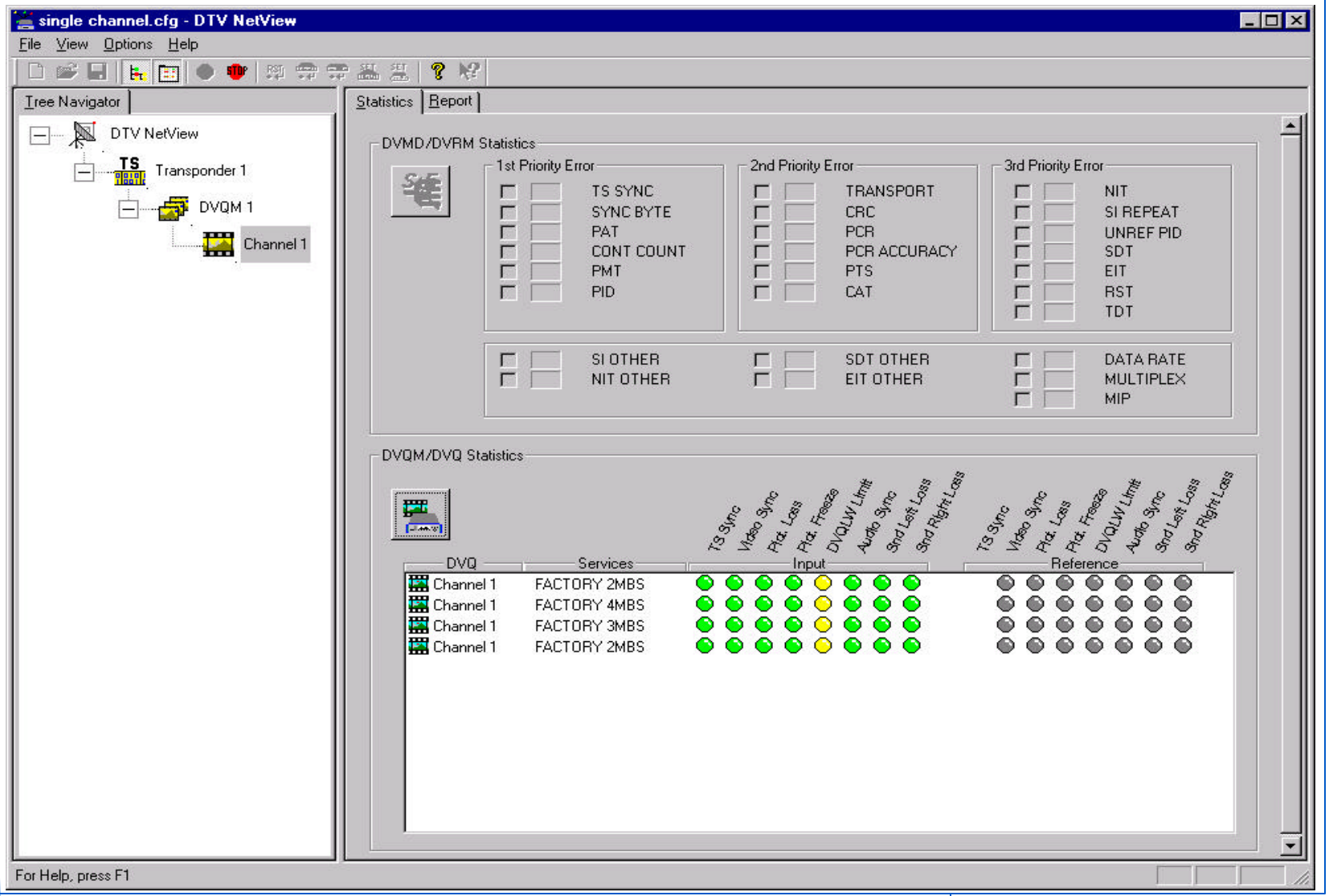
Up to 12 totally independent processing cards

Same characteristics as DVQ

- Real time quality analysis
- No reference signal
- Freeze frame, video & audio outage detection
- Internal error report
- TS input, SDI 601 input
- MPEG2 decoder included, composite outputs
- Scan mode available
- TCP/IP & SNMP connectivity

Monitoring software “NetView”

DTV NetView - Statistics



DTV NetView - Error Report

single channel.cfg - DTV NetView

File View Options Help

Tree Navigator

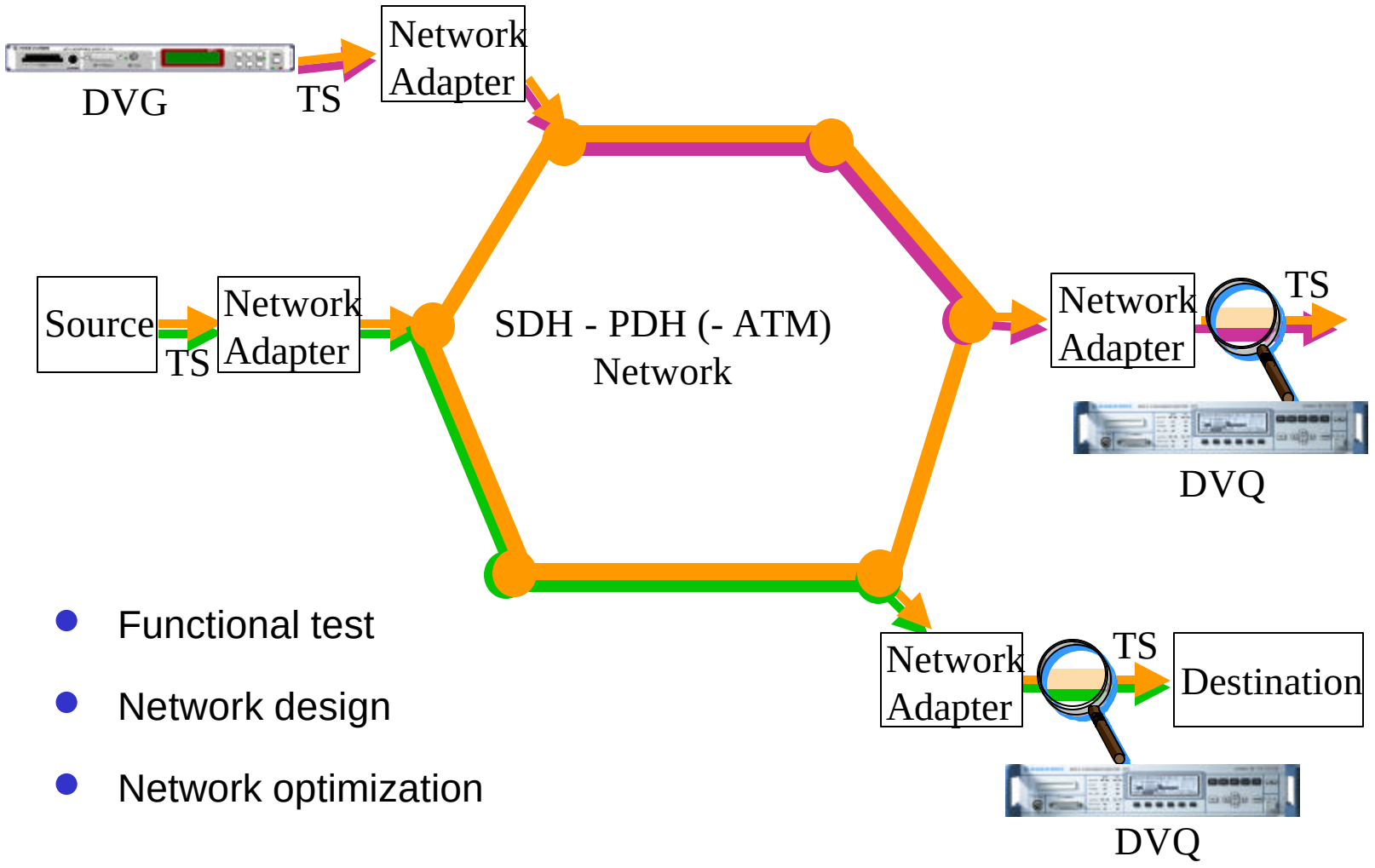
- DTV NetView
  - TS Transponder 1
    - DVQM 1
      - Channel 1

Statistics Report

No	Date	Time	Device	Code	Event	Details	PID	Program	Ref
0	13.06.2001	07.25.53	Channel 1		CLEAR			NA	0
1	13.06.2001	07.26.37	Channel 1		DVQL LIMIT	44/0.800 sec	300	FACTORY 3MBS	0
2	13.06.2001	07.26.43	Channel 1		DVQL LIMIT	48/0.400 sec	300	FACTORY 3MBS	0
3	13.06.2001	07.26.46	Channel 1		DVQL LIMIT	42/0.400 sec	400	FACTORY 2MBS	0
4	13.06.2001	07.26.47	Channel 1		DVQL LIMIT	39/1.200 sec	400	FACTORY 2MBS	0
5	13.06.2001	07.26.48	Channel 1		DVQL LIMIT	41/2.400 sec	400	FACTORY 2MBS	0
6	13.06.2001	07.26.50	Channel 1		DVQL LIMIT	25/1.200 sec	400	FACTORY 2MBS	0
7	13.06.2001	07.26.51	Channel 1		DVQL LIMIT	24/2.000 sec	400	FACTORY 2MBS	0
8	13.06.2001	07.26.52	Channel 1		DVQL LIMIT	49/2.400 sec	400	FACTORY 2MBS	0
9	13.06.2001	07.26.53	Channel 1		DVQL LIMIT	38/1.200 sec	400	FACTORY 2MBS	0
10	13.06.2001	07.26.54	Channel 1		DVQL LIMIT	41/2.400 sec	400	FACTORY 2MBS	0
11	13.06.2001	07.27.16	Channel 1		DVQL LIMIT	41/0.400 sec	300	FACTORY 3MBS	0
12	13.06.2001	07.27.26	Channel 1		DVQL LIMIT	41/0.800 sec	400	FACTORY 2MBS	0
13	13.06.2001	07.27.27	Channel 1		DVQL LIMIT	47/1.200 sec	400	FACTORY 2MBS	0
14	13.06.2001	07.27.28	Channel 1		DVQL LIMIT	23/0.800 sec	400	FACTORY 2MBS	0
15	13.06.2001	07.27.29	Channel 1		DVQL LIMIT	24/1.600 sec	400	FACTORY 2MBS	0
16	13.06.2001	07.27.30	Channel 1		DVQL LIMIT	45/2.000 sec	400	FACTORY 2MBS	0
17	13.06.2001	07.27.31	Channel 1		DVQL LIMIT	47/0.800 sec	400	FACTORY 2MBS	0
18	13.06.2001	07.27.32	Channel 1		DVQL LIMIT	38/2.000 sec	400	FACTORY 2MBS	0
19	13.06.2001	07.27.33	Channel 1		DVQL LIMIT	41/2.800 sec	400	FACTORY 2MBS	0
20	13.06.2001	07.27.34	Channel 1		DVQL LIMIT	39/3.200 sec	400	FACTORY 2MBS	0
21	13.06.2001	07.28.06	Channel 1		DVQL LIMIT	28/0.400 sec	400	FACTORY 2MBS	0
22	13.06.2001	07.28.07	Channel 1		DVQL LIMIT	19/1.200 sec	400	FACTORY 2MBS	0
23	13.06.2001	07.28.08	Channel 1		DVQL LIMIT	24/2.000 sec	400	FACTORY 2MBS	0
24	13.06.2001	07.28.09	Channel 1		DVQL LIMIT	49/0.400 sec	400	FACTORY 2MBS	0
25	13.06.2001	07.28.10	Channel 1		DVQL LIMIT	38/1.600 sec	400	FACTORY 2MBS	0
26	13.06.2001	07.28.11	Channel 1		DVQL LIMIT	41/2.400 sec	400	FACTORY 2MBS	0
27	13.06.2001	07.28.12	Channel 1		DVQL LIMIT	47/2.800 sec	400	FACTORY 2MBS	0
28	13.06.2001	07.28.13	Channel 1		DVQL LIMIT	22/0.800 sec	400	FACTORY 2MBS	0
29	13.06.2001	07.28.14	Channel 1		DVQL LIMIT	24/2.000 sec	400	FACTORY 2MBS	0
30	13.06.2001	07.28.46	Channel 1		DVQL LIMIT	38/0.400 sec	400	FACTORY 2MBS	0
31	13.06.2001	07.28.47	Channel 1		DVQL LIMIT	43/1.200 sec	400	FACTORY 2MBS	0
32	13.06.2001	07.28.48	Channel 1		DVQL LIMIT	36/2.400 sec	400	FACTORY 2MBS	0
33	13.06.2001	07.28.49	Channel 1		DVQL LIMIT	42/3.200 sec	400	FACTORY 2MBS	0
34	13.06.2001	07.28.50	Channel 1		DVQL LIMIT	41/4.000 sec	400	FACTORY 2MBS	0
35	13.06.2001	07.28.51	Channel 1		DVQL LIMIT	44/0.400 sec	400	FACTORY 2MBS	0
36	13.06.2001	07.28.52	Channel 1		DVQL LIMIT	21/1.600 sec	400	FACTORY 2MBS	0
37	13.06.2001	07.28.53	Channel 1		DVQL LIMIT	43/2.000 sec	400	FACTORY 2MBS	0
38	13.06.2001	07.28.54	Channel 1		DVQL LIMIT	48/0.800 sec	400	FACTORY 2MBS	0
39	13.06.2001	07.29.27	Channel 1		DVQL LIMIT	36/0.800 sec	400	FACTORY 2MBS	0
40	13.06.2001	07.29.28	Channel 1		DVQL LIMIT	40/2.000 sec	400	FACTORY 2MBS	0
41	13.06.2001	07.29.30	Channel 1		DVQL LIMIT	20/1.200 sec	400	FACTORY 2MBS	0

For Help, press F1

Application 1 - Network Monitoring

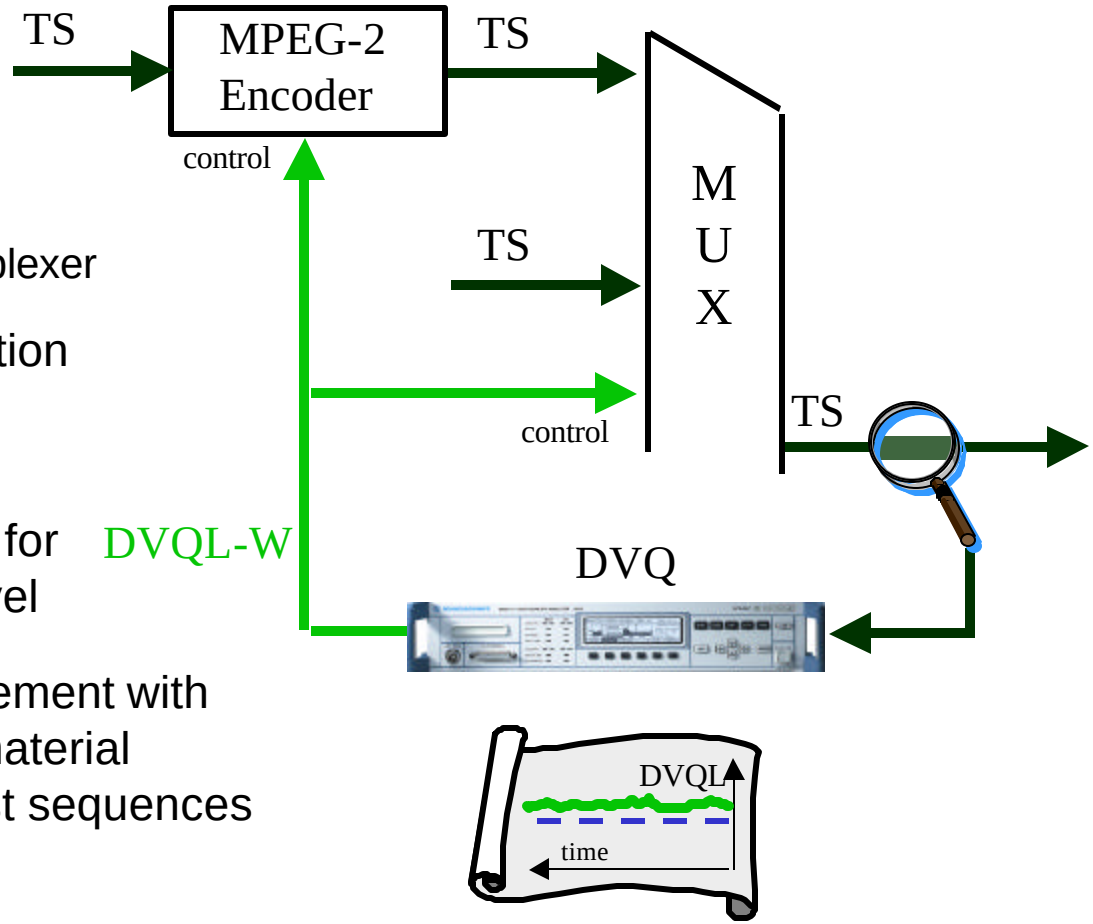


- Functional test
- Network design
- Network optimization

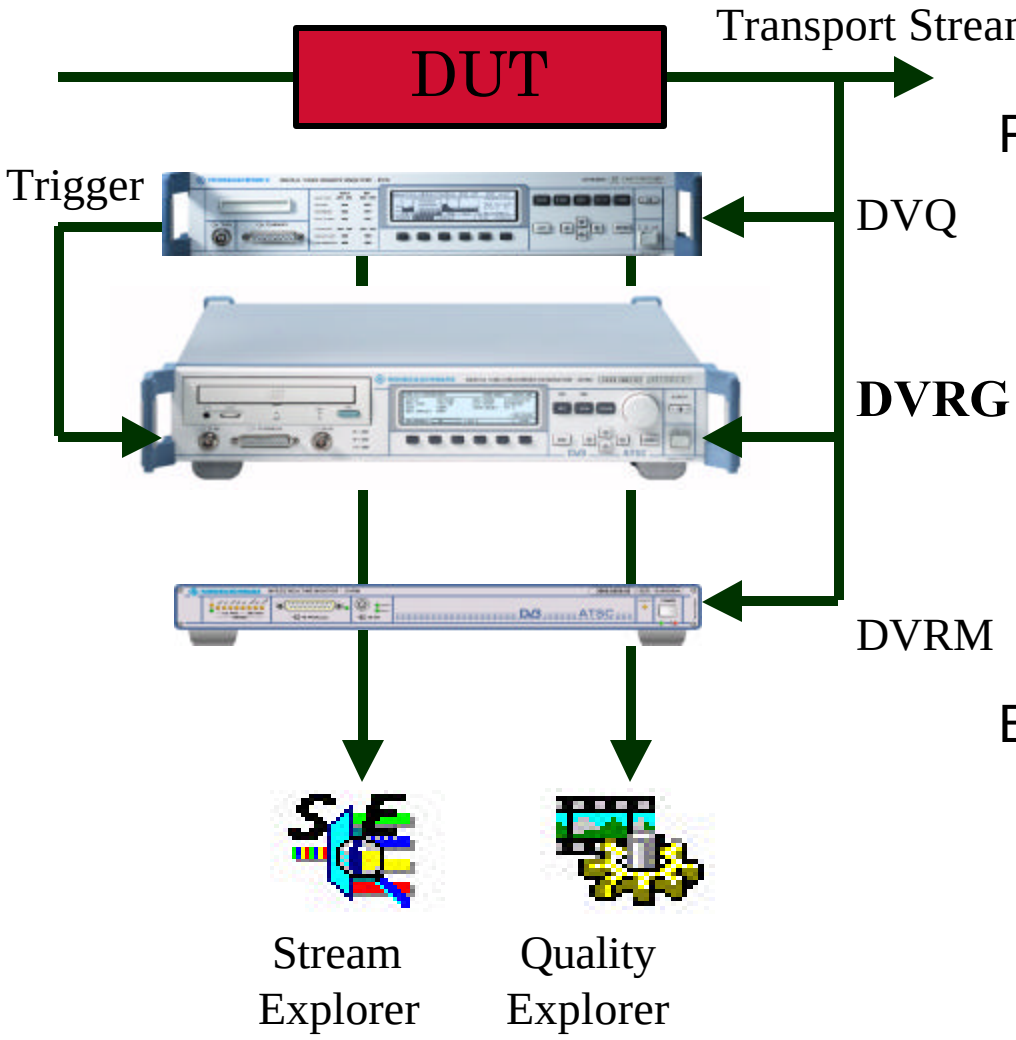
Application 2 - Process Control

Transmission bandwidth / data rate optimization

- For
  - Encoder
  - Statistical Multiplexer
- Data rate minimization
- Quality assurance
- ➔ Minimum data rate for constant quality level
- ➔ Long-term measurement with real live program material instead of short test sequences



Application 3 - Detailed Fault Analysis



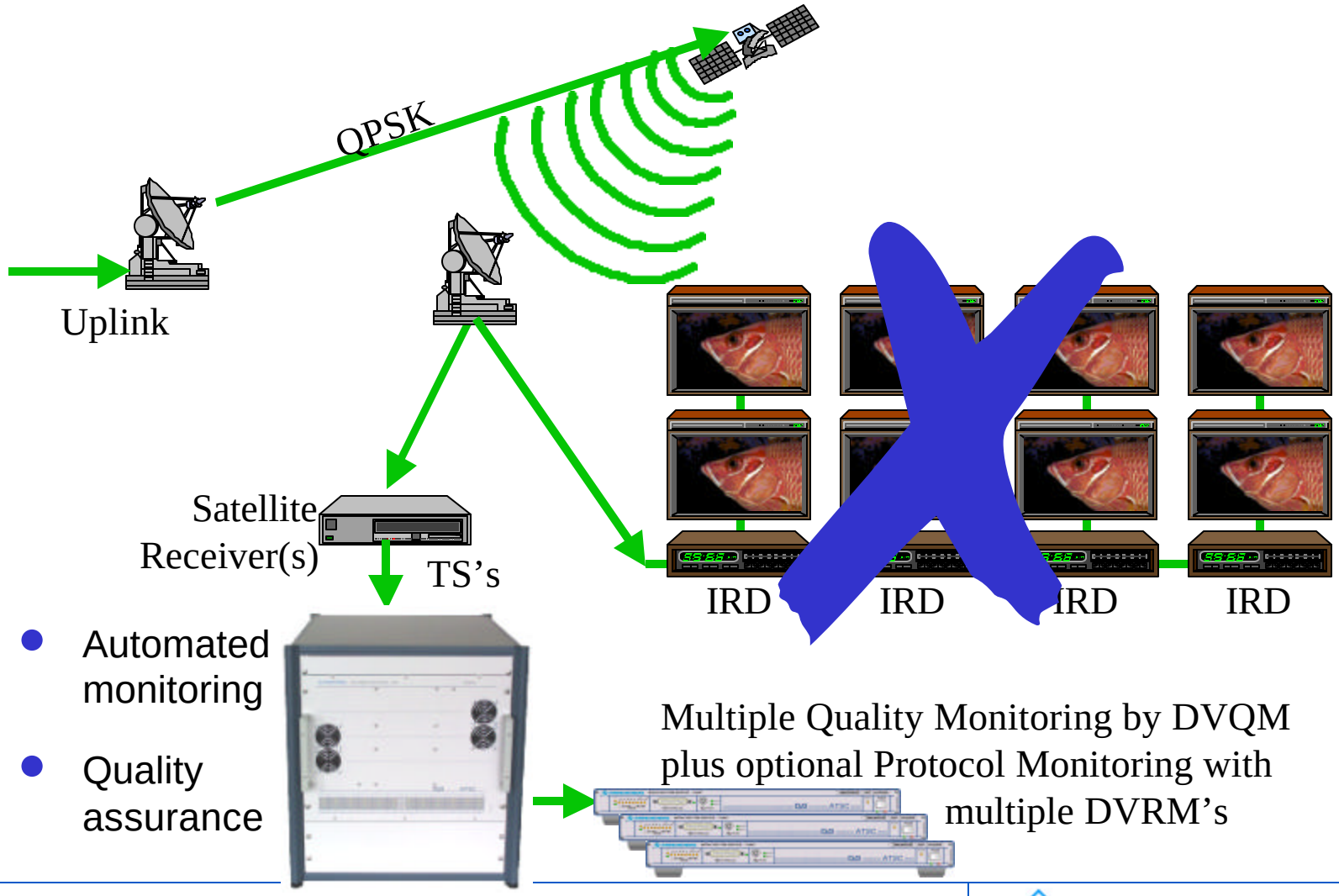
Function

- Picture quality decreases
- DVRG receives trigger
- DVRG records the faulty signal before and after the trigger
- Further offline in depth analysis

Benefits

- Fault tracing
- Fault verification
- Network optimization

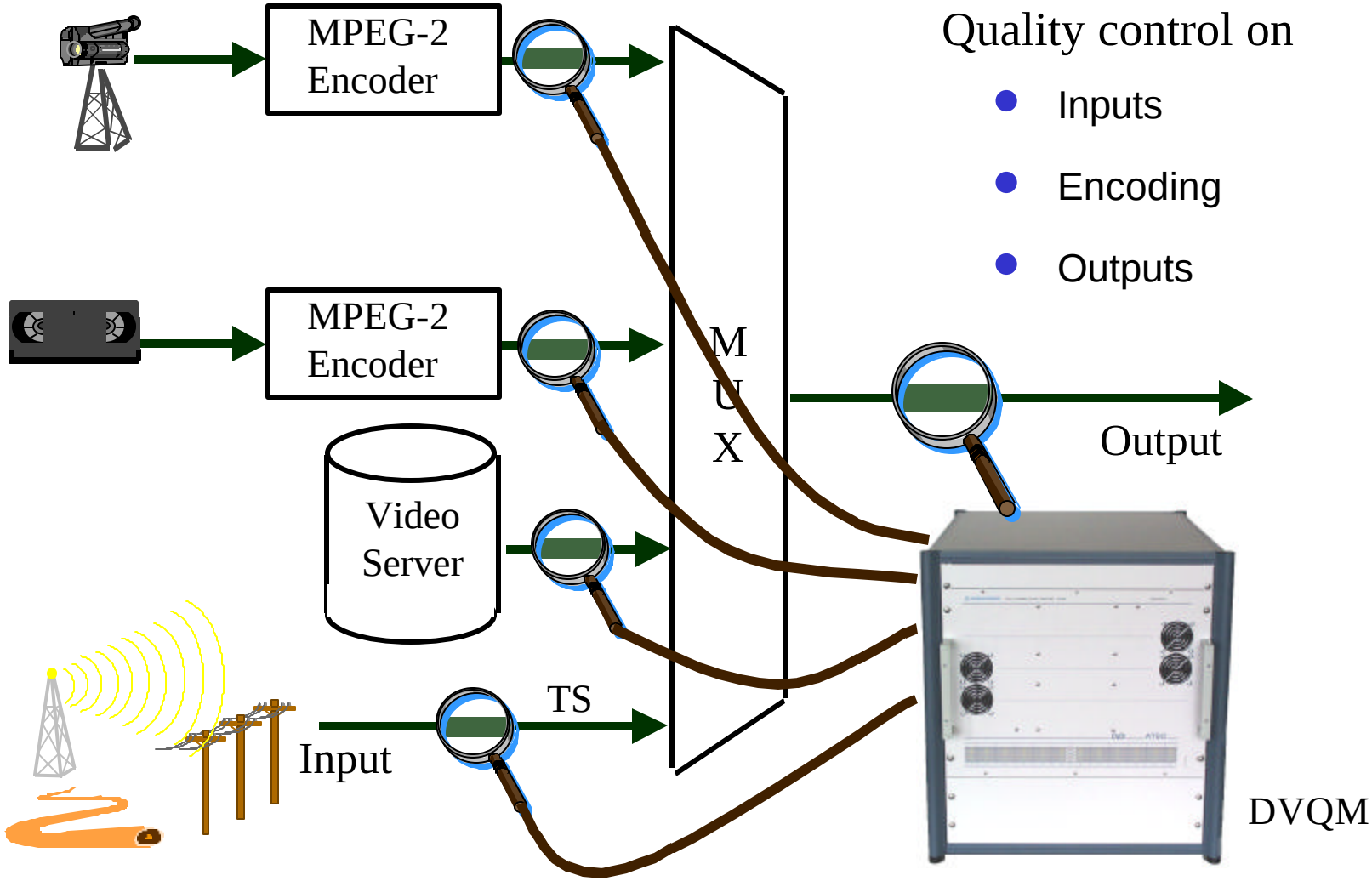
Application 4 - Satellite Monitoring



- Automated monitoring
- Quality assurance

Multiple Quality Monitoring by DVQM plus optional Protocol Monitoring with multiple DVRM's

Application 5 - Playout Center



Quality control on

- Inputs
- Encoding
- Outputs

Sample Measurements

Site: Berlin, Germany

Play out centre Winterfeldstraße

Identical parallel structure

- Constant MUX
- Statistical MUX

3 or 4 live programs ⟹

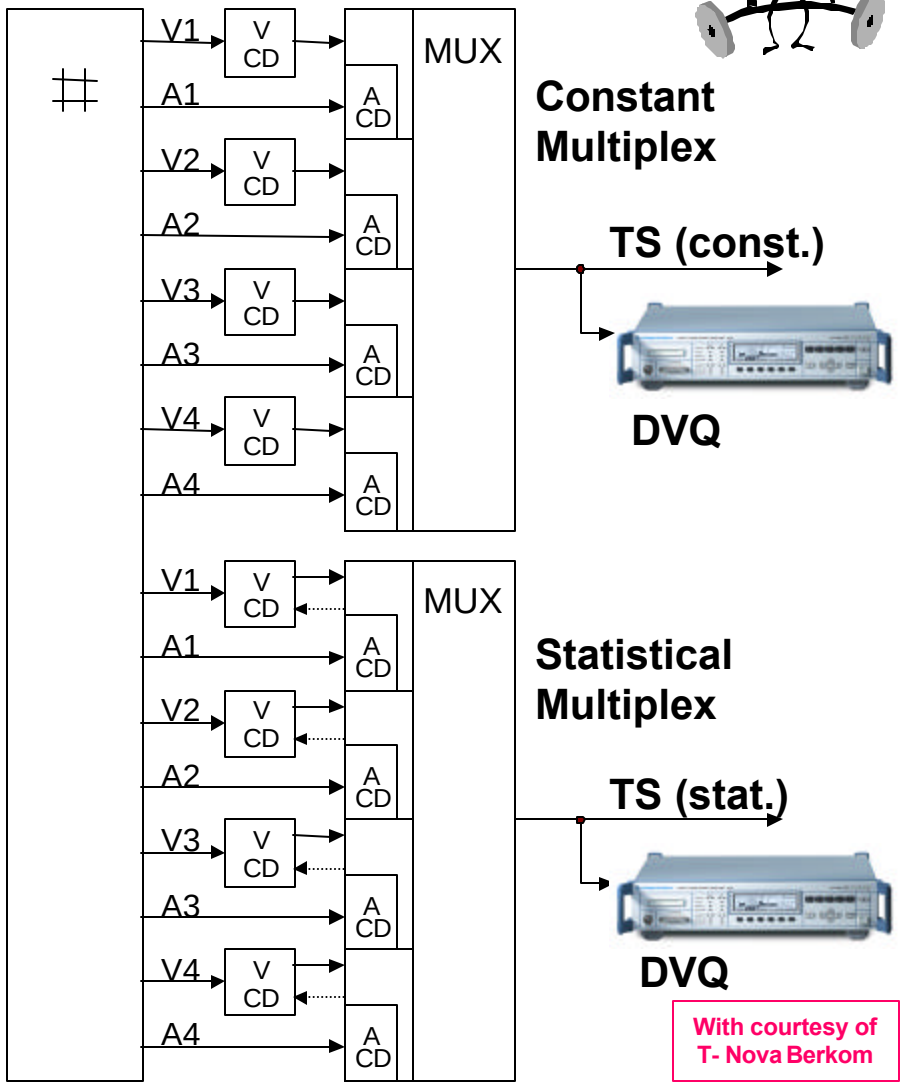
Configurations

- 3 x 3.5 Mbit/s (Video 3.2 Mbit/s)
- 4 x 3.5 Mbit/s (Video 3.2 Mbit/s)
- 3 x 4.7 Mbit/s (Video 4.4 Mbit/s)

Average data rate with stat. MUX identical to constant data rate

Encoder and multiplexer from same supplier

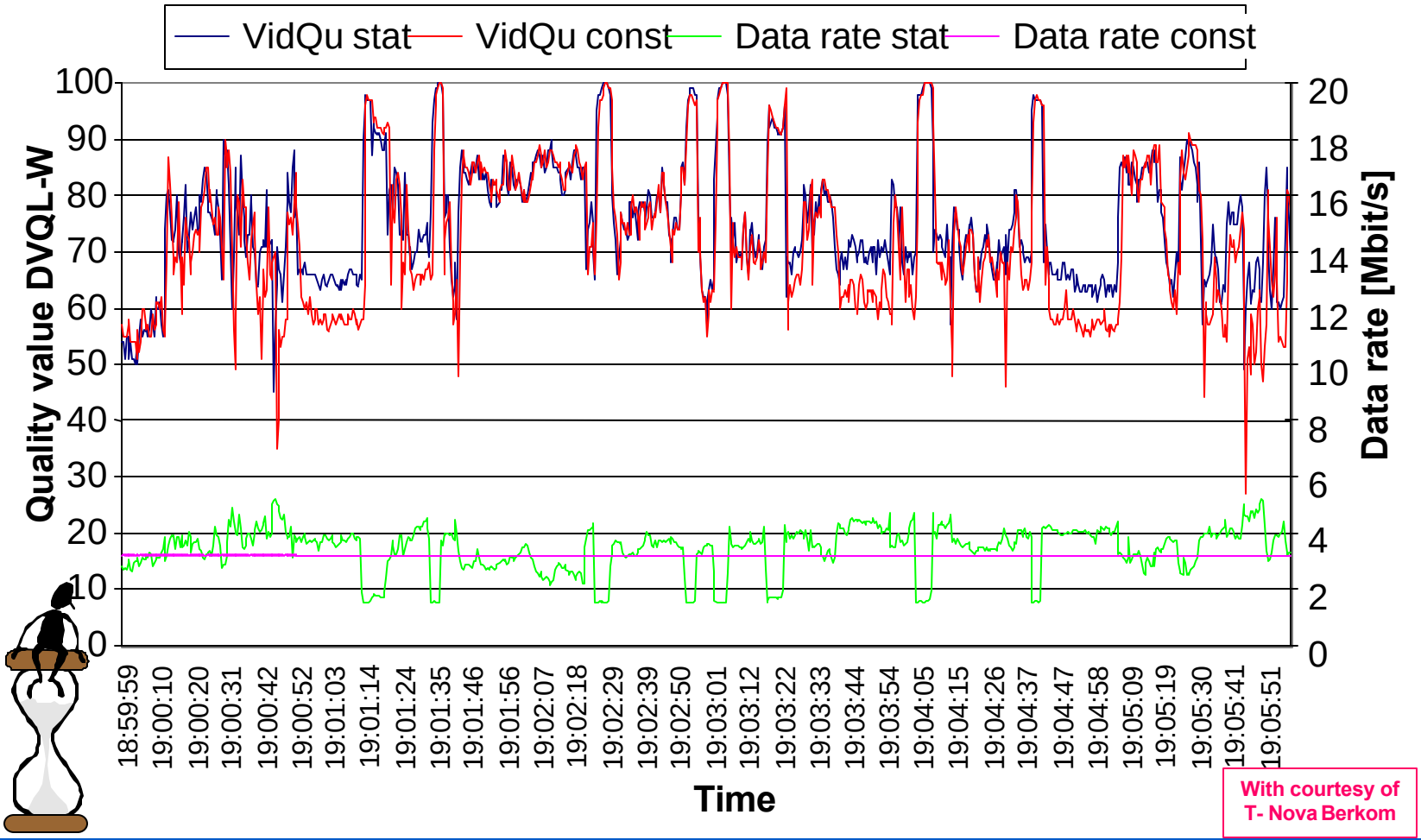
Performed by T-Nova Berkom, Deutsche Telekom



With courtesy of T- Nova Berkom

Comparison of Statistical vs. Constant MUX

Program: ORB, 7.12.99, 19:00 - 19:06 h
Stat.. and const. MUX, 4x3,5 Mbit/s



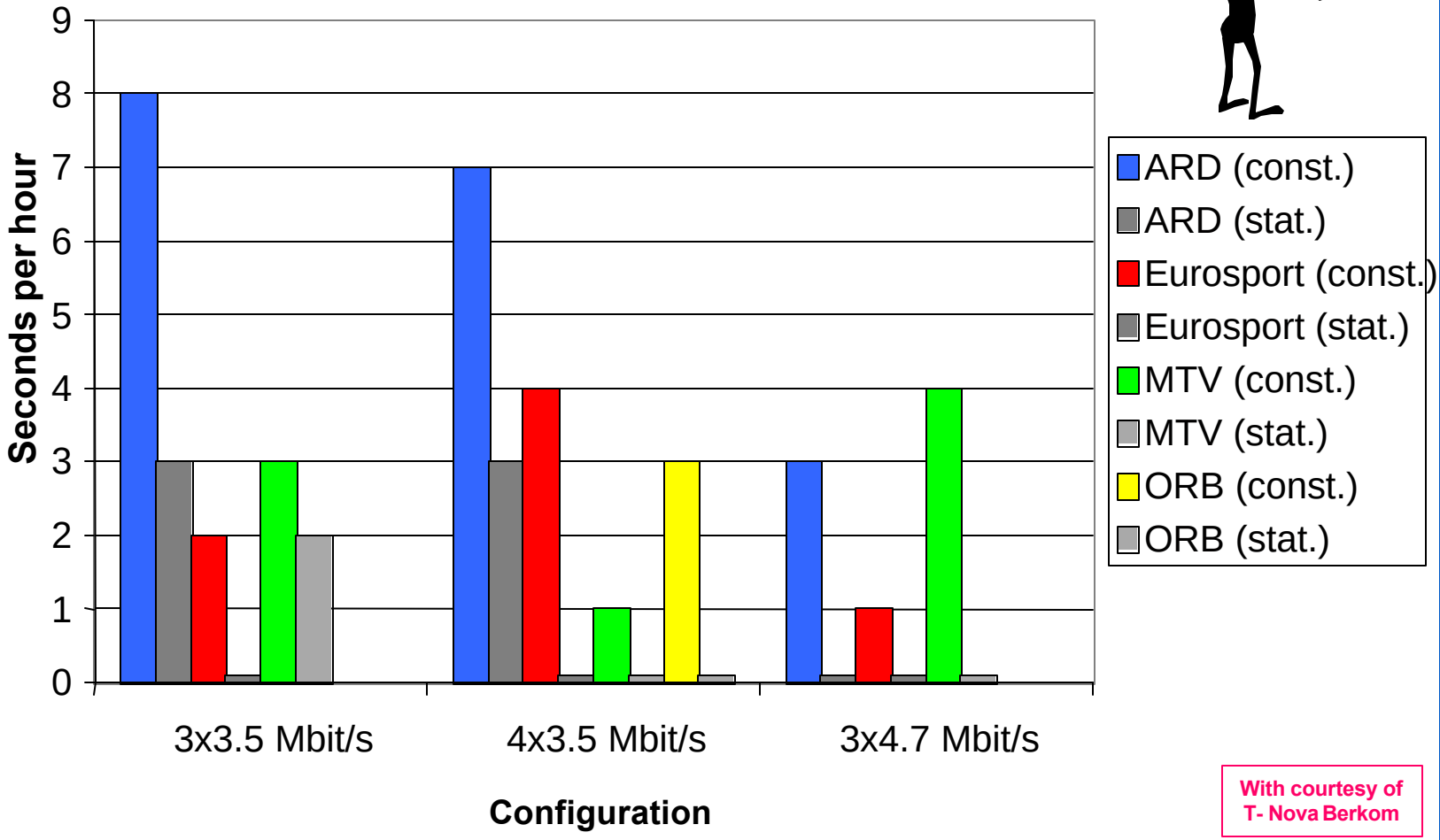
With courtesy of T- Nova Berkom

Average Picture Quality

With courtesy of T- Nova Berkom

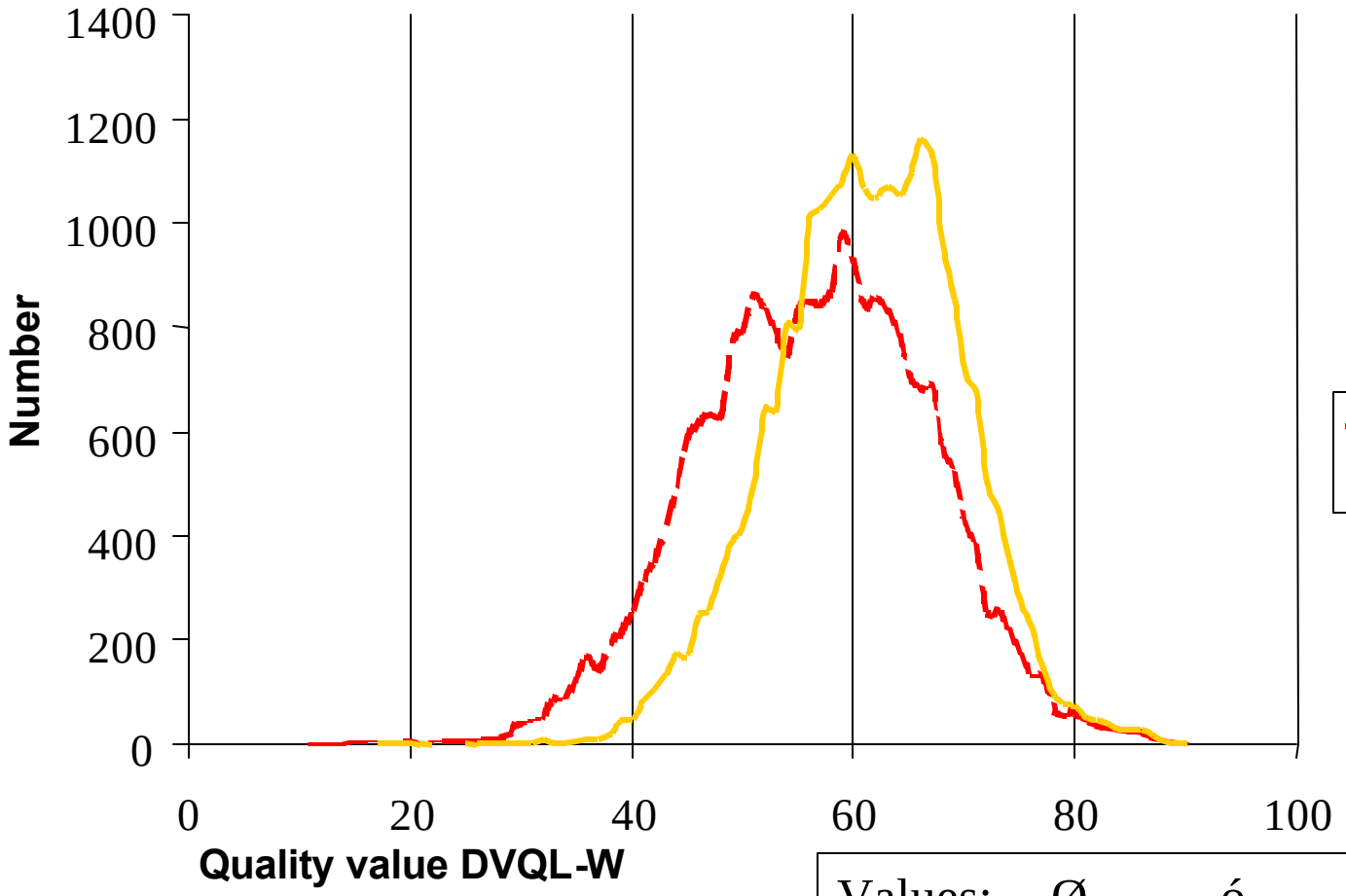
Hitting a low Quality Limit

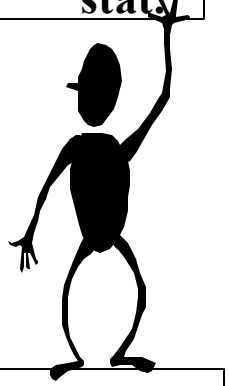
Frequency of hitting the quality limit “DVQL-W=20” with constant and statistical MUX



With courtesy of T- Nova Berkom

Quality Distribution with 4 x 3.5 Mbit/s

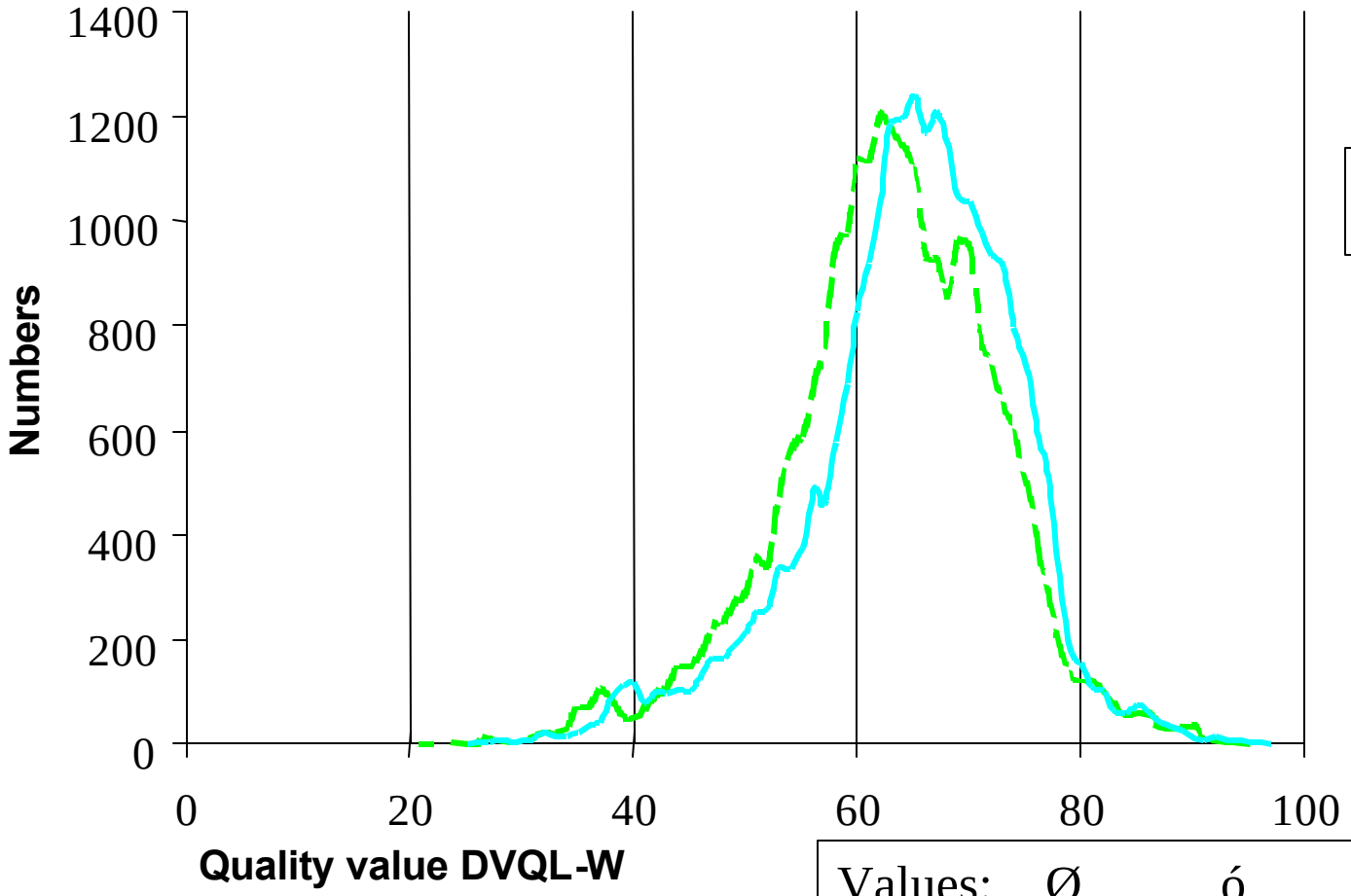




Values:	Ø	ó	n
const.	56.4	10.37	24448
stat.	61.2	8.39	24440

With courtesy of T- Nova Berkom

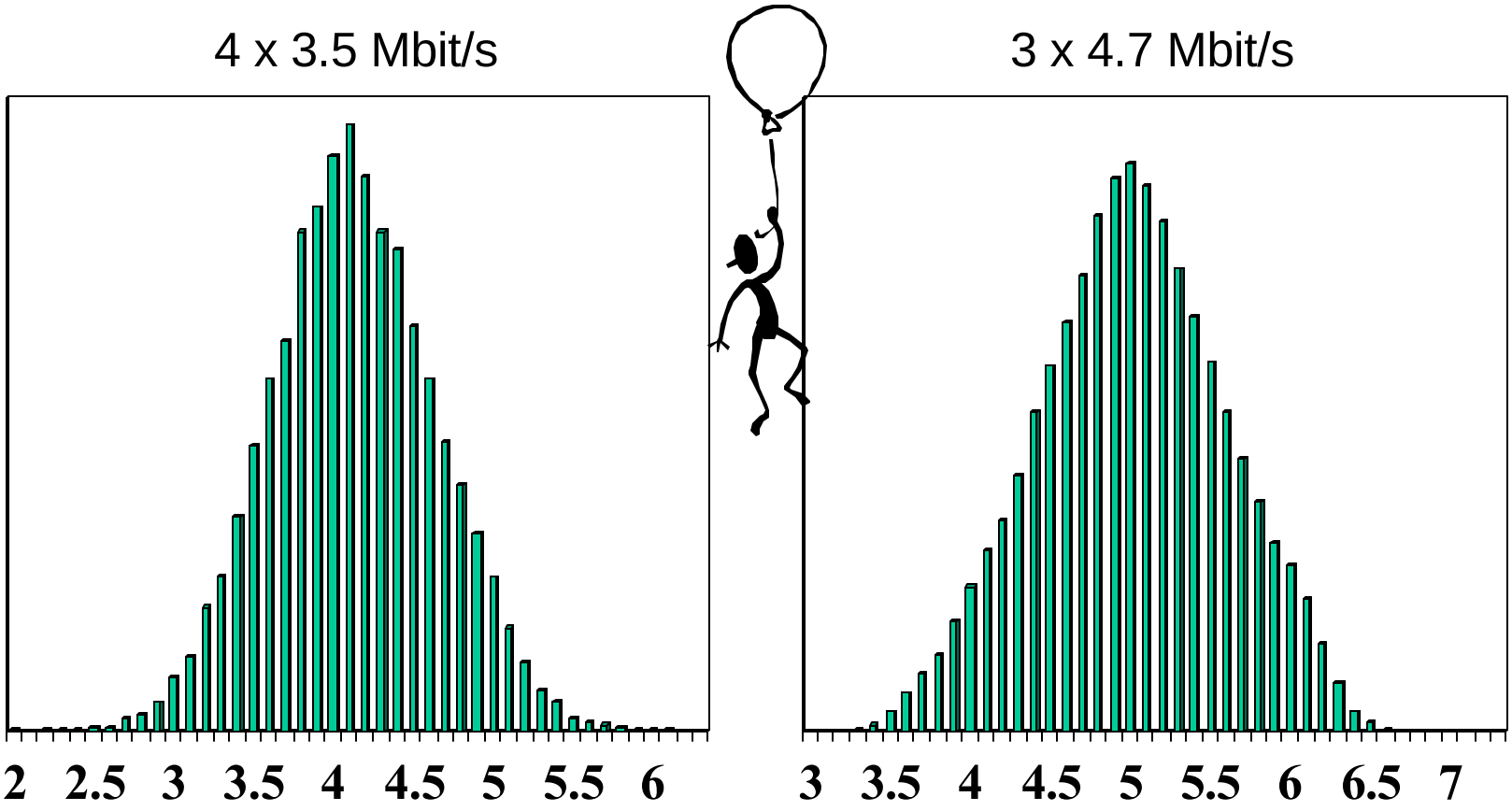
Quality Distribution with 3 x 4.7 Mbit/s



Values:	Ø	ó	n
const.	62,8	9,55	24454
stat.	64,8	9,38	24430

With courtesy of T- Nova Berkom

Distribution of Data Rates in Stat. MUX



Ø	4,1	5,0
ó	0,52	0,59
n	24439	24429

With courtesy of T- Nova Berkom

Conclusions for DVQ & DVQM

Video quality measurements

Due to **subjective** perception

Objective & reproducible

Real time process

No reference signal required

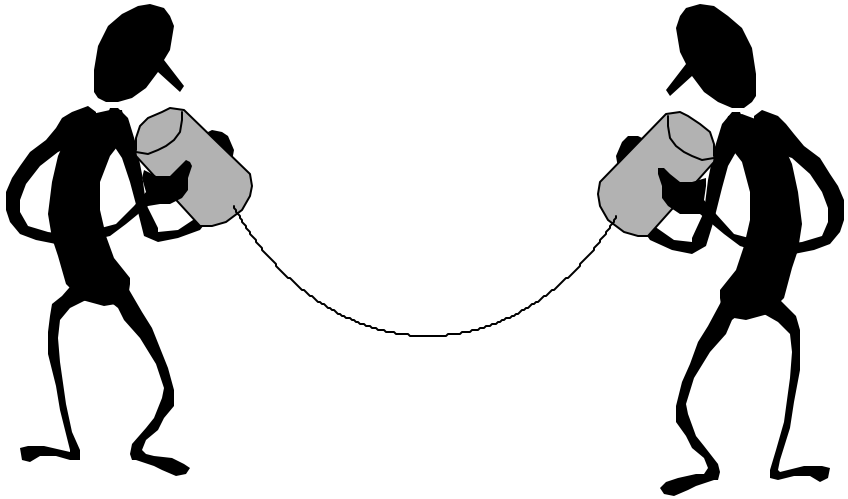
Typical video material

MPEG2 decoder included

Optional CA descrambling

EMMY award 2000

Contact Info



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