International Telecommunication Union

Clinical Study on MPEG-2 Compression Based on the Rec. ITU-R BT. 500-9

Isao Nakajima, M.D., Ph.D.

Associate Professor

Tokai University Institute of Medical Sciences

Invited Researcher

Communication Research Laboratory, Japan

Workshop on Standardization in E-health
Geneva, 23-25 May 2003

ITU-T

Agenda

1, Useful ITU Recommendation !

Recommendation ITU-R BT. 500-9

< suitable data speed of MPEG-2 compression >

2, Application

Ambulatory applications

Real time telemedicine

< data speed x traffic numbers = bandwidth >

ITU-T

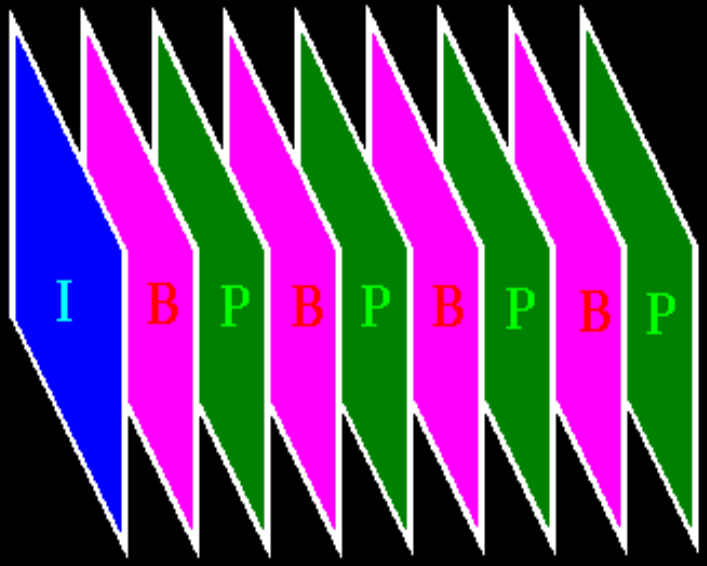
User report on ITU Recommendation Clinical Study on MPEG-2 Compression Based on the Rec. ITU-R BT. 500-9

Purpose

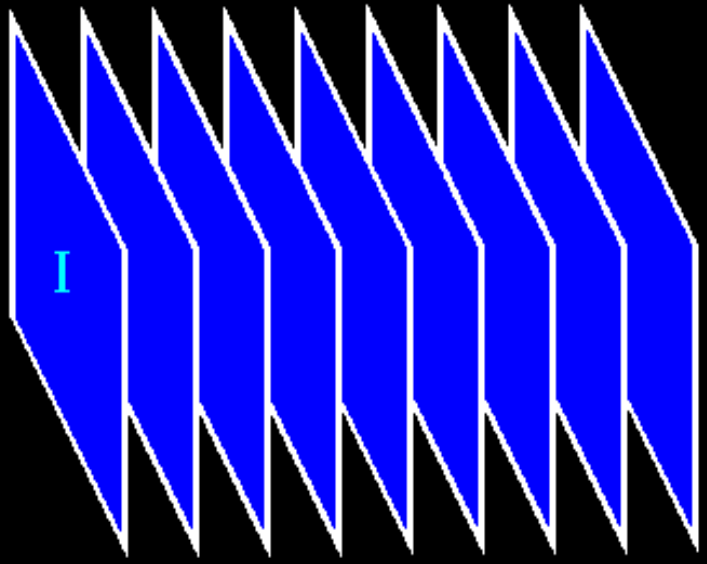
This research is intended to identify the optimum transmission rate of clinical-use MPEG motion pictures by the Double-Stimulus Continuous Quality Scale method based on the Recommendation ITU-R BT. 500-9.

ITU-T

Frame Structure of MPEG & H.261



time ⟹



MPEG-1

MPEG-2

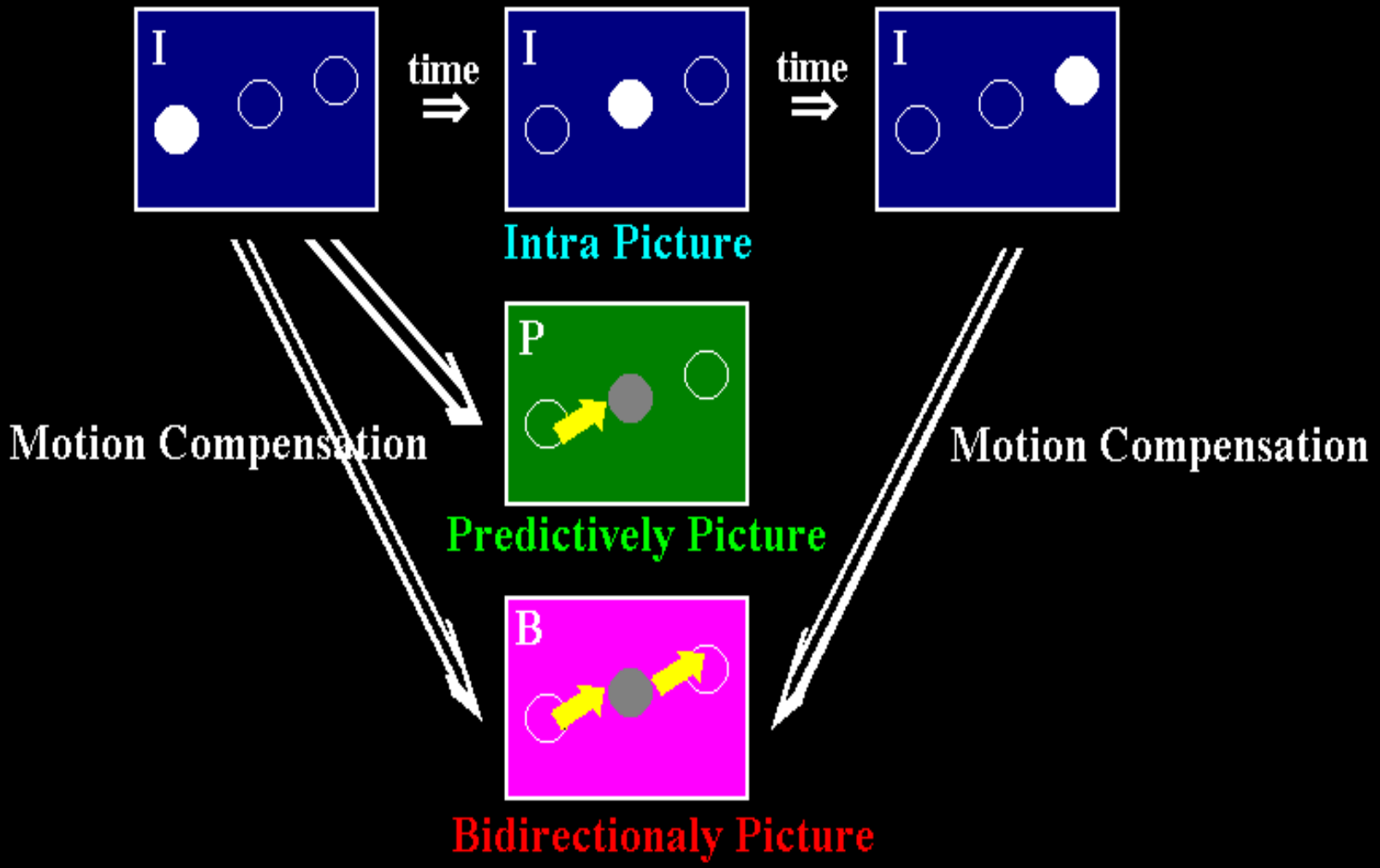
I : Intra Picture
P: Predictively Picture
B: Bidirectionaly Picture

Motion JPEG

H.261(Video conference)

ITU-T

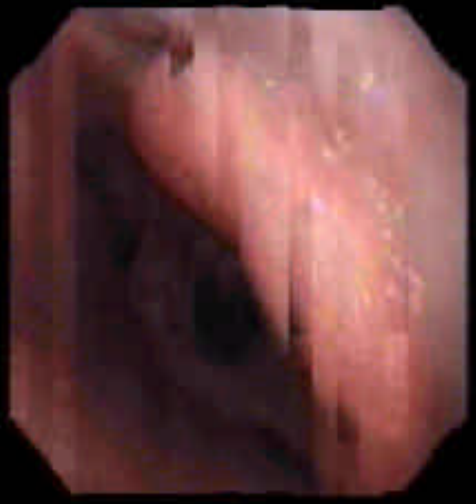
Motion Compensation



ITU-T

Quality degradation of MPEG images

The following are examples of types of degradation in image quality caused by MPEG compression.

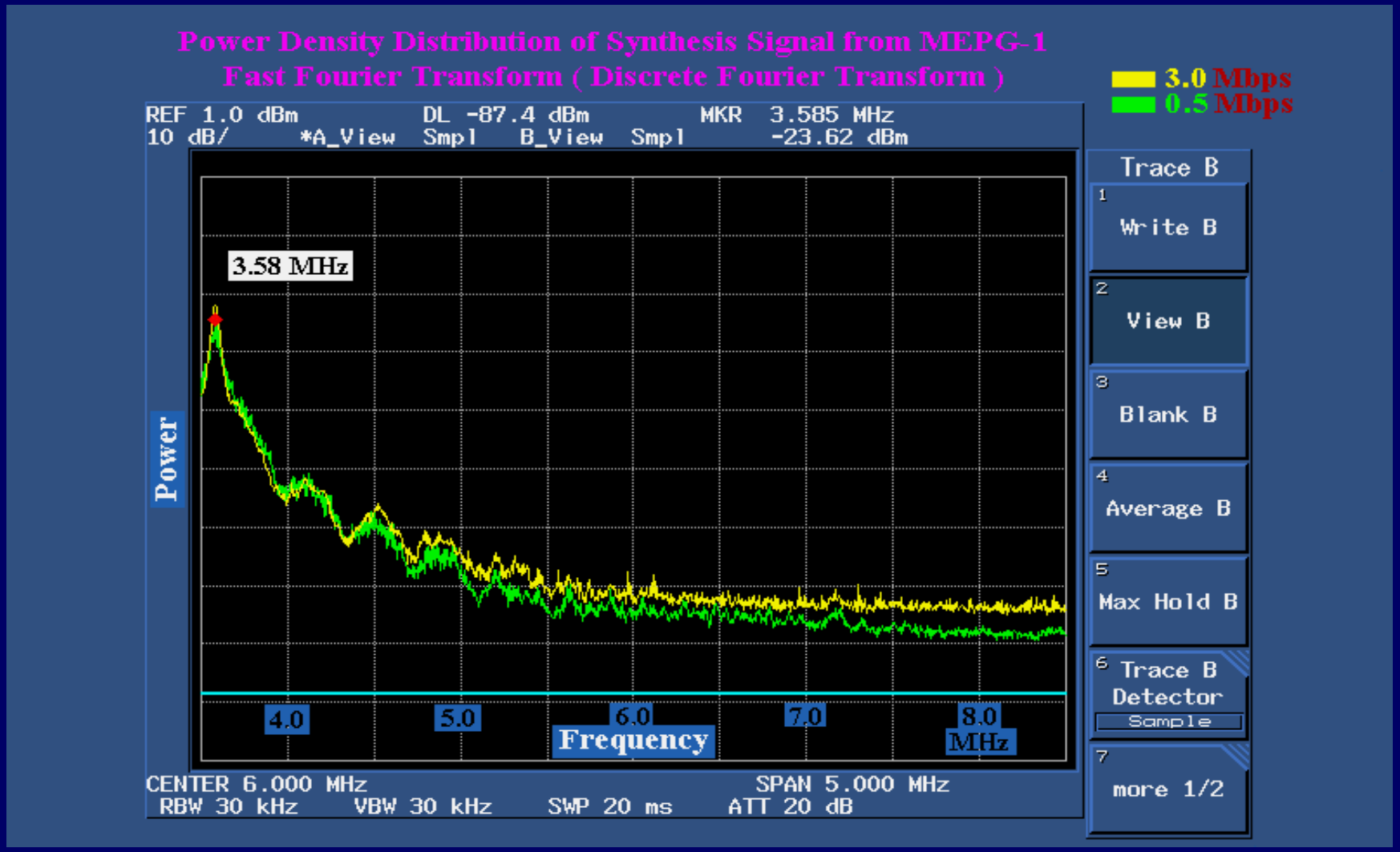


Block noise

1. Block noise
2. Mosquito noise
3. Color smearing

Color smearing

MPEG-1 power density tested with DFT
3.0 Mbps v.s. 0.5 Mbps



ITU-T

Display Protocol (ITU-R BT.500-9)

1. Gather 10 examiners who are not familiar with image compression.
2. Explain to the examiners the test contents, presentation sequence, and how to fill out the evaluation form.
3. Using an image that is not used in the test, demonstrate quality degradation, features of degradation, and degree of degradation.
4. Request that the examiners point out clinical problems associated with image degradation.

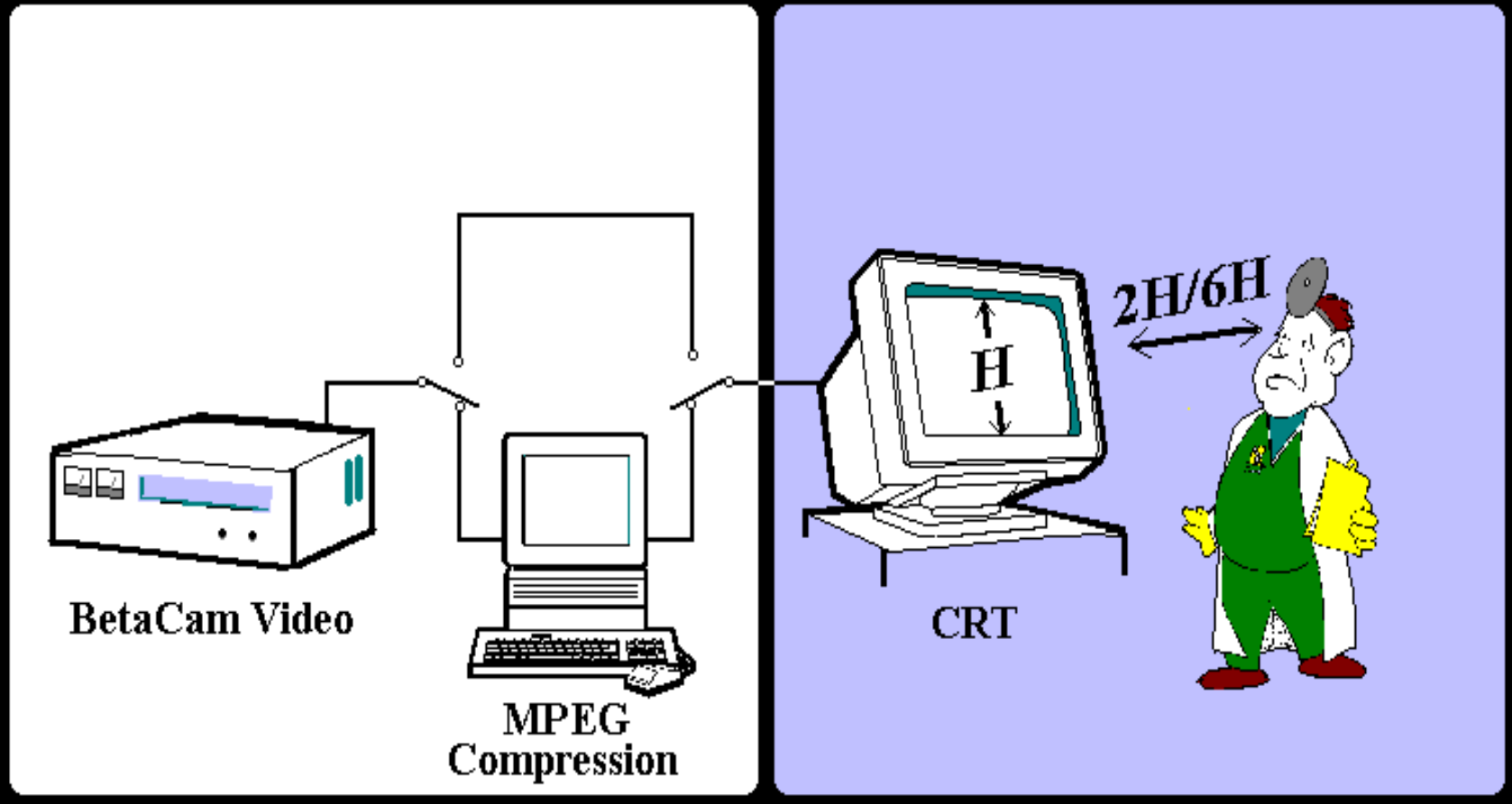
ITU-T

Display Protocol (ITU-R BT.500-9)

5. Display the original image followed by a compressed image, twice each in this order, and have the examiners fill out the evaluation form immediately after the completion of each presentation.
6. The order of the displayed images is not changed until all examiners have completed the test.
7. The first five images are dummy pictures (examiners are not informed of this), and the evaluations of those images are not included in the test results.
8. The test time must not exceed 30 minutes per examiner.

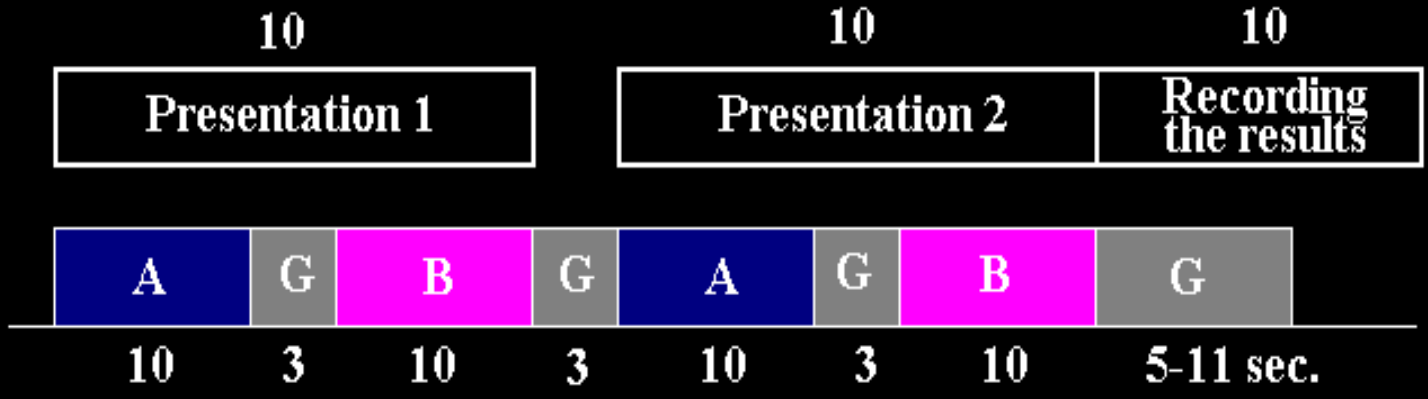
ITU-T

Evaluation System



ITU-T

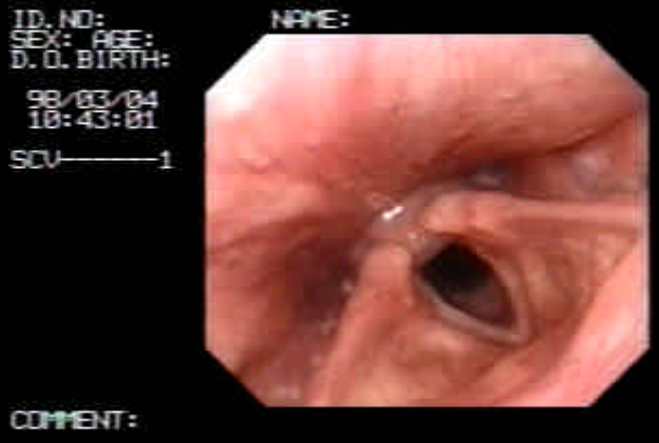
Double Stimulus Continuous Quality Scale Method
Presentation Structure of Materials



A: Original
B: MPEG-1
G: Mid grey

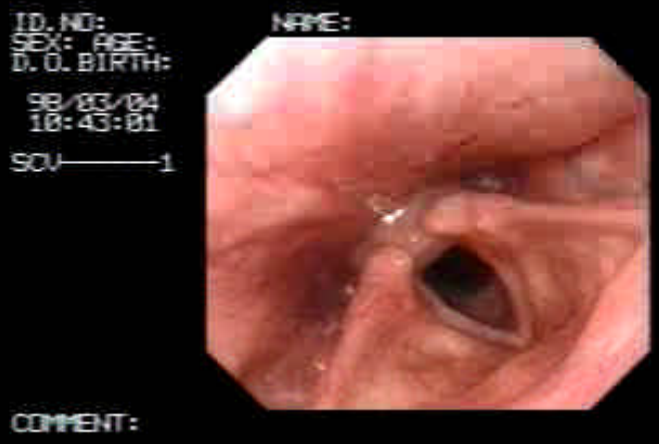
ITU-T

Mid gray scale



Original

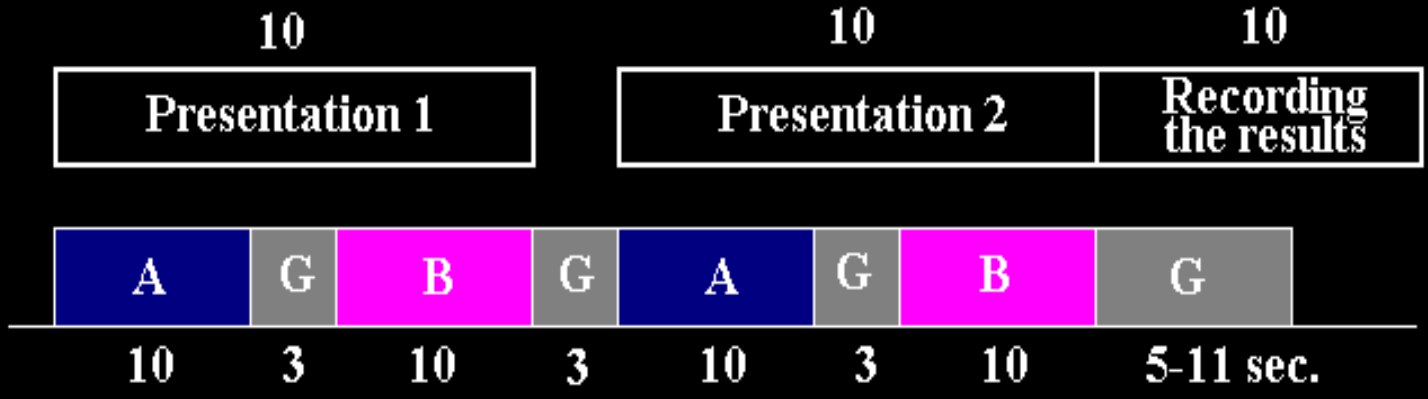
Mid gray scale



Compressed

ITU-T

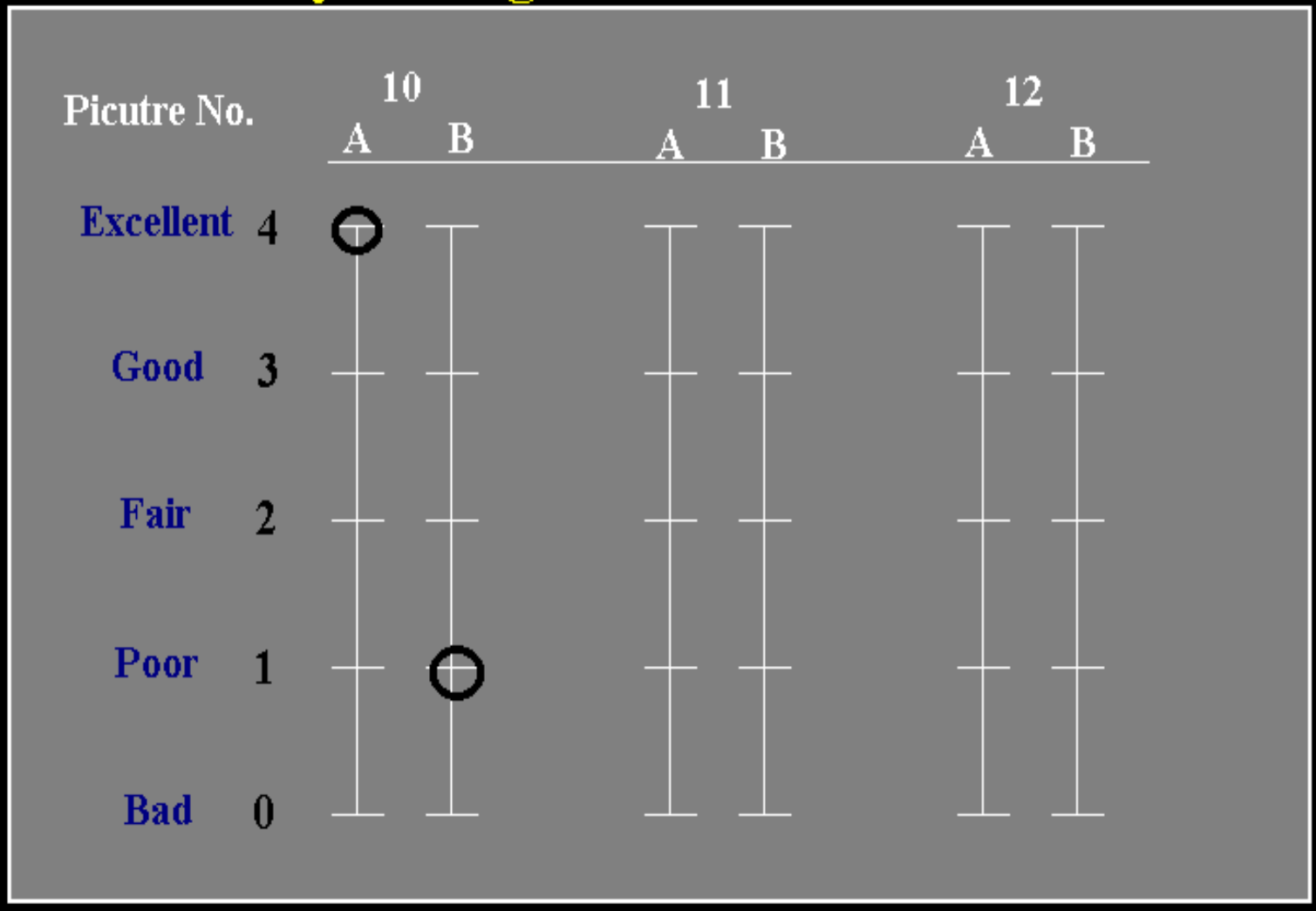
Double Stimulus Continuous Quality Scale Method
Presentation Structure of Materials



A: Original
B: MPEG-1
G: Mid grey

ITU-T

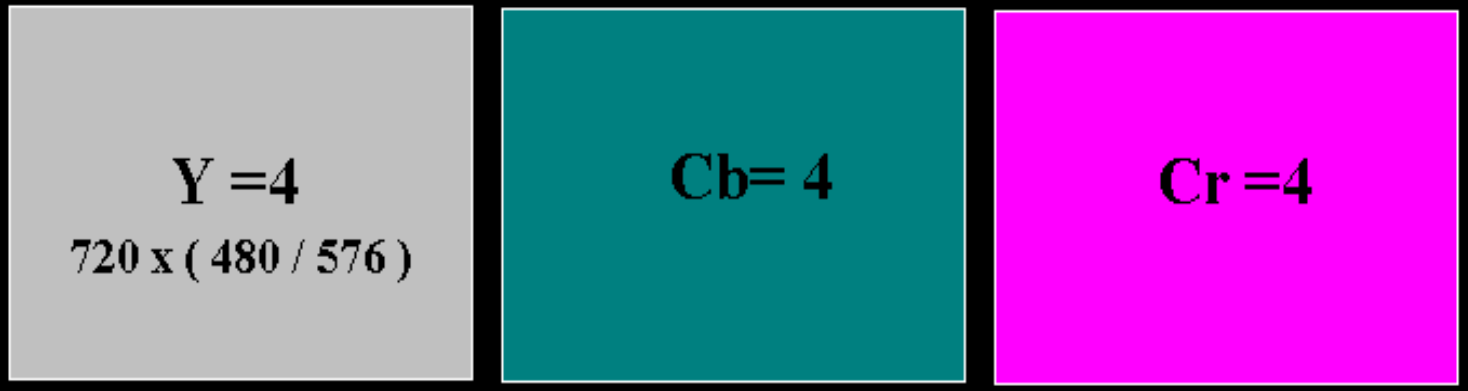
Quality-Rating Form of the DSCQS

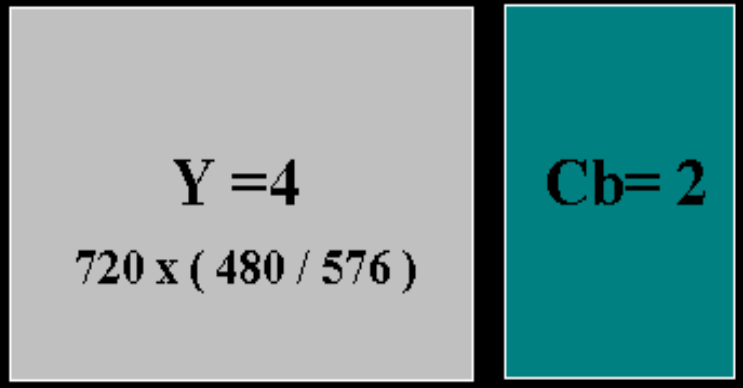


N. Narita: "Subject-evaluation Method for Quality of Code Images"
IEEE Trans. Broadcast., BC-40, 1, pp. 7-13 (Mar. 1994)

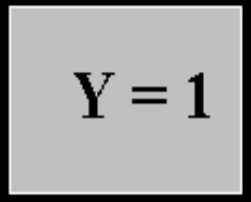
ITU-T

Digital Video Format





ITU-R BT.601
Format MPEG-2



Cb= 0.5

Cr =0.5

SIF: H.261, MPEG-1

360 x (240/288)

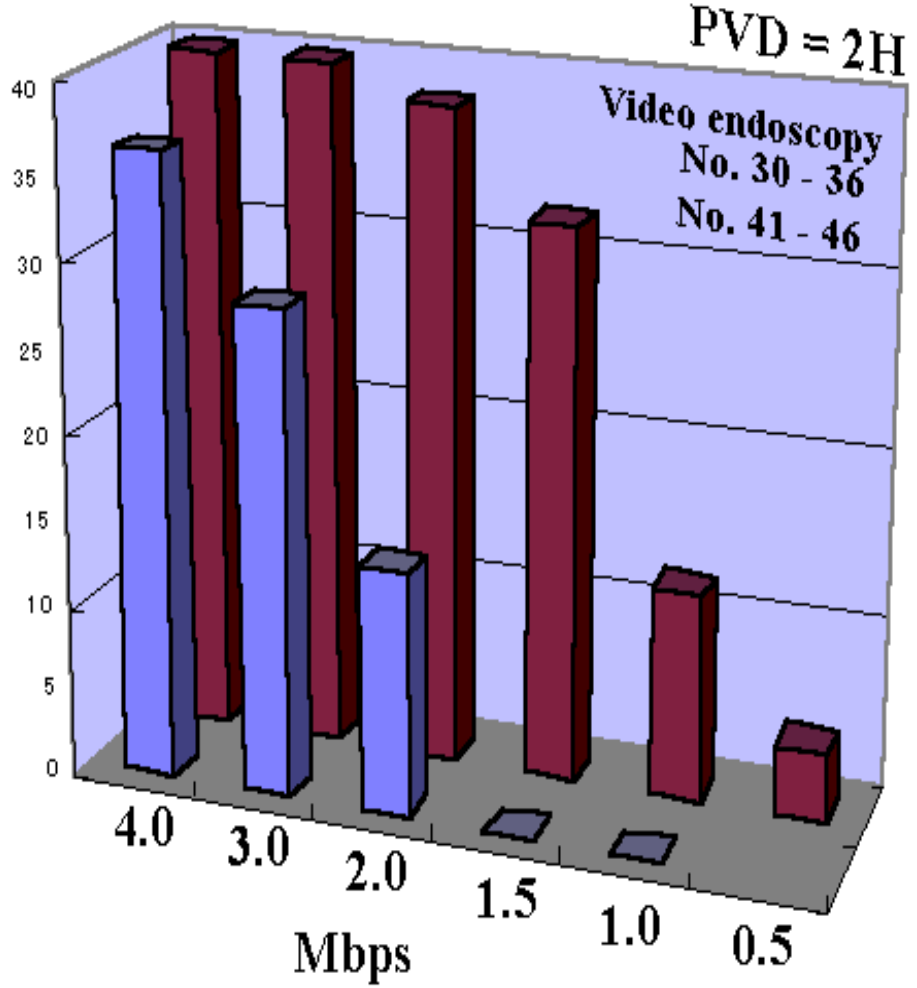
SIF(Source Input Format)

ITU-T

Test Results

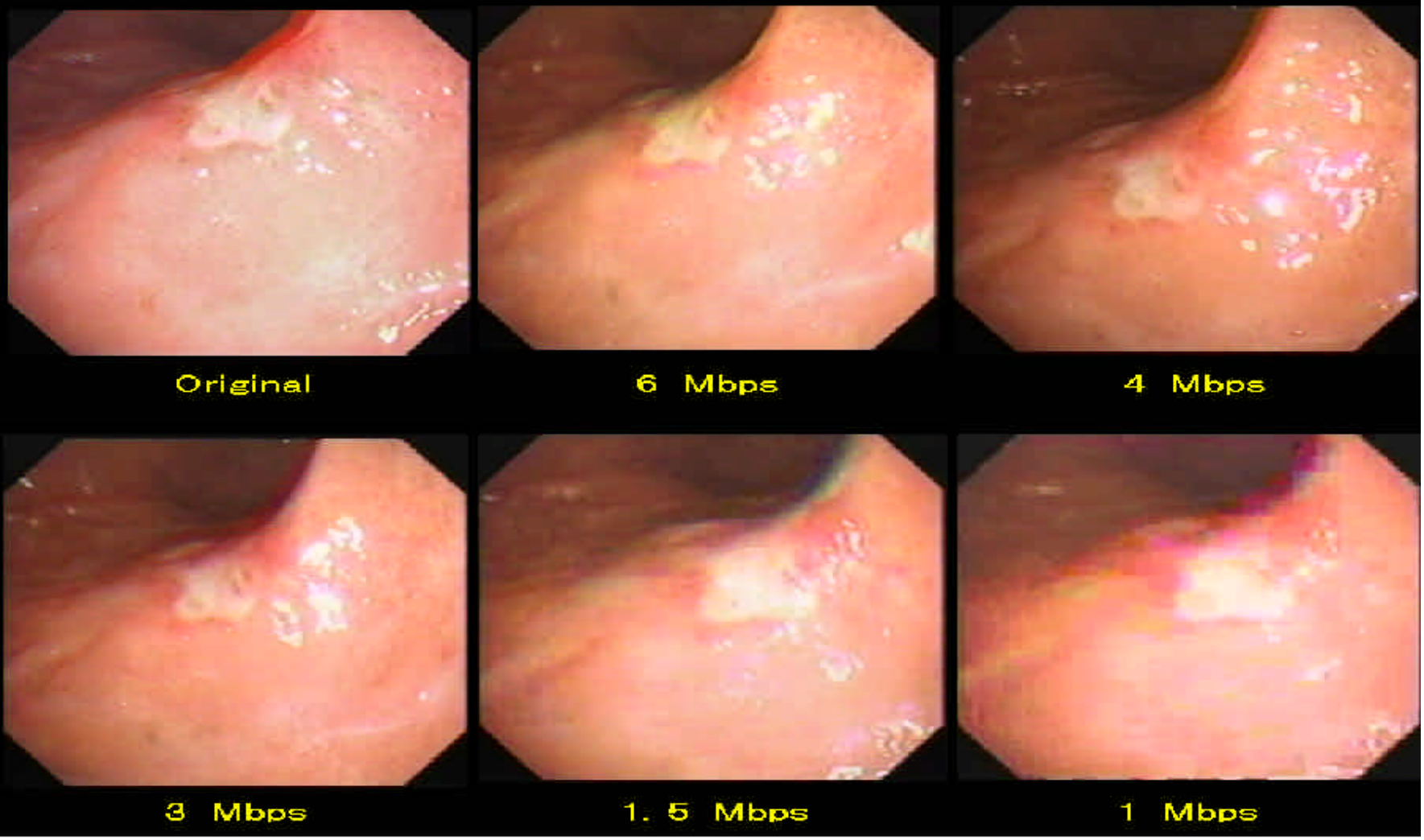
Comparison MPEG-2 and MPEG-1

4:2:2(720x480) SIF(360x240)



ITU-T

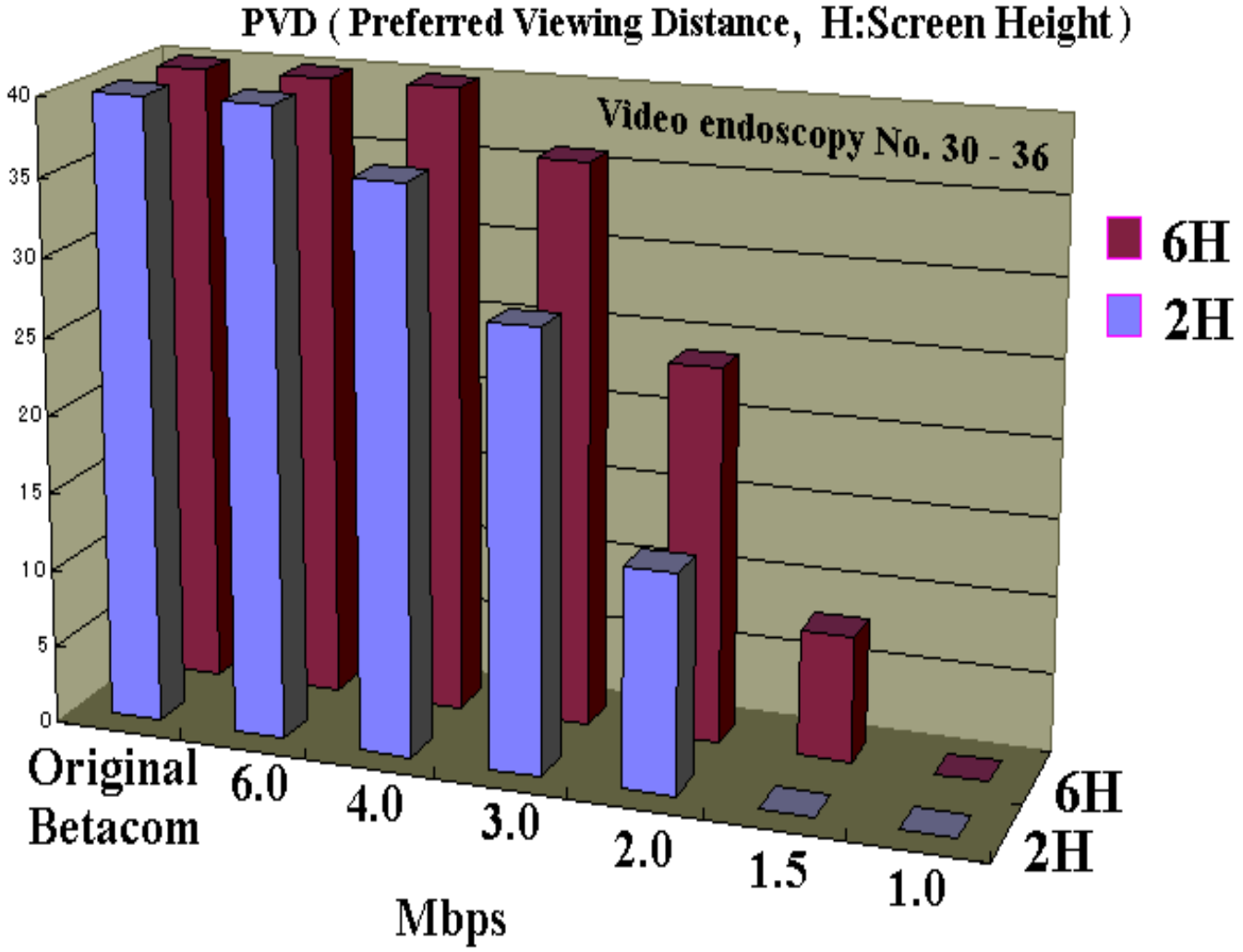
Comparison as with frozen picture



ITU-T

Test Results

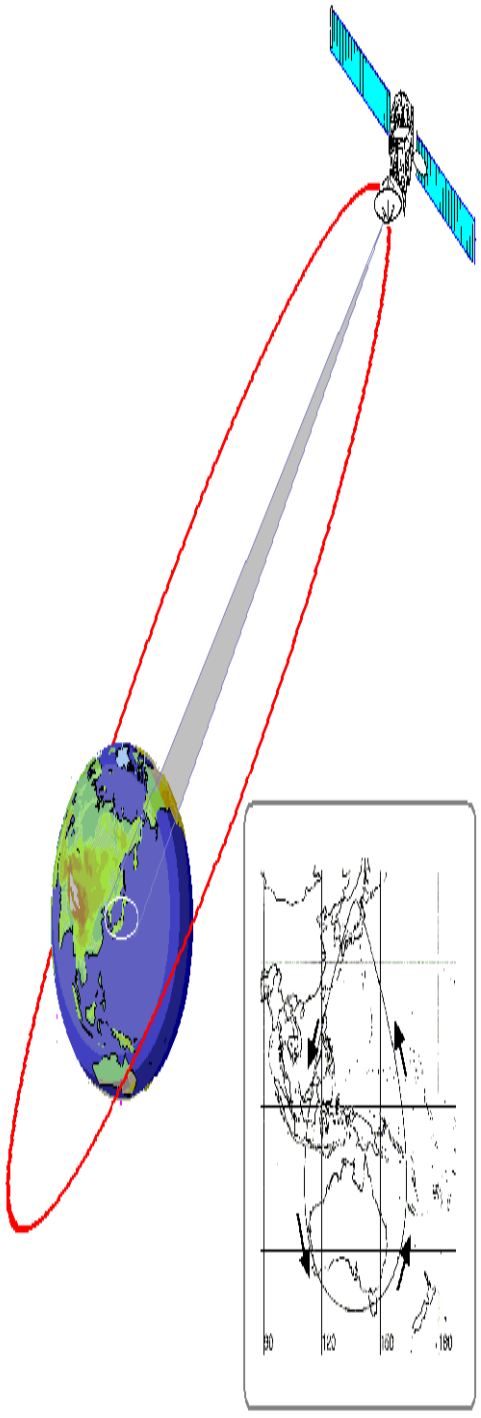
Comparison 2H and 6H



ITU-T

Conclusions

1. The Double-Stimulus Continuous Quality Scale method based on the Recommendation ITU-R BT. 500-9. is the better methods to find small distortion on MPEG compression.
2. PVD 2H shall be used in routine clinical use, and PVD 6H for educational purposes and the detection of lesions.
3. Video endoscopy and CCD image compressed with MPEG-2 shall be required at least 3.0 Mbps.
4. The SIF image compressed with MPEG-1 shall be required 1.5 Mbps.

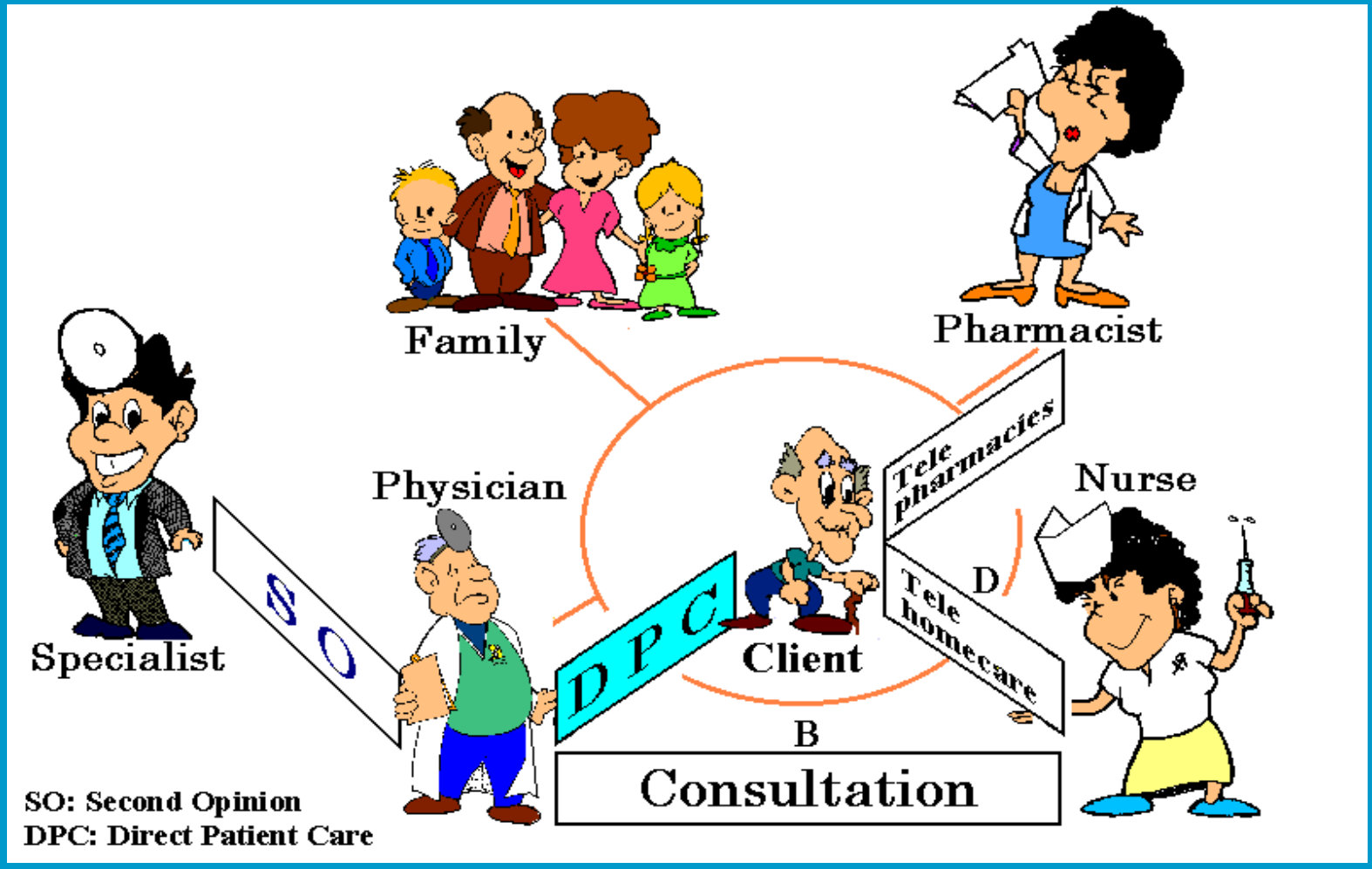


Video Transmission
What we are aiming to !

1. Problem of 3G(IMT2000) !
   - Frequency selective fading
   - Blocking
2. How we can track a satellite from a high speed vehicle.
3. IP-based multimedia for ambulatory applications.
4. We can reduce medical cost!!

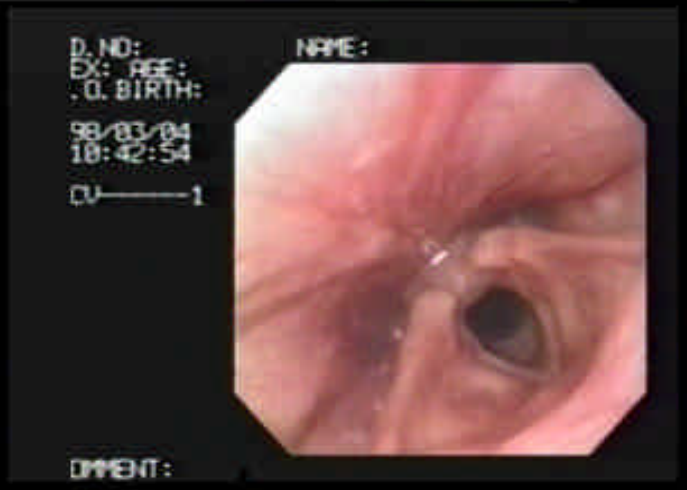
ITU-T

What is DPC via telecommunications ?



ITU-T

Target images



Video Endoscopy(Air way)

Light reflex

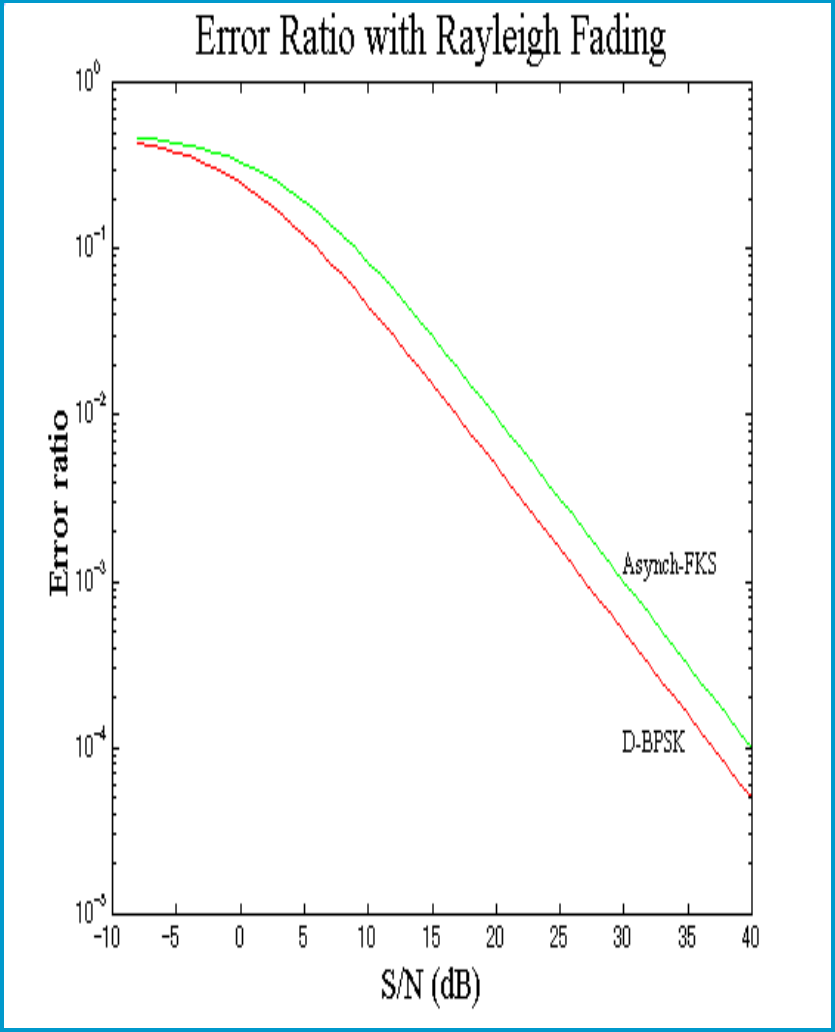
Video Endoscopy(Stomach)

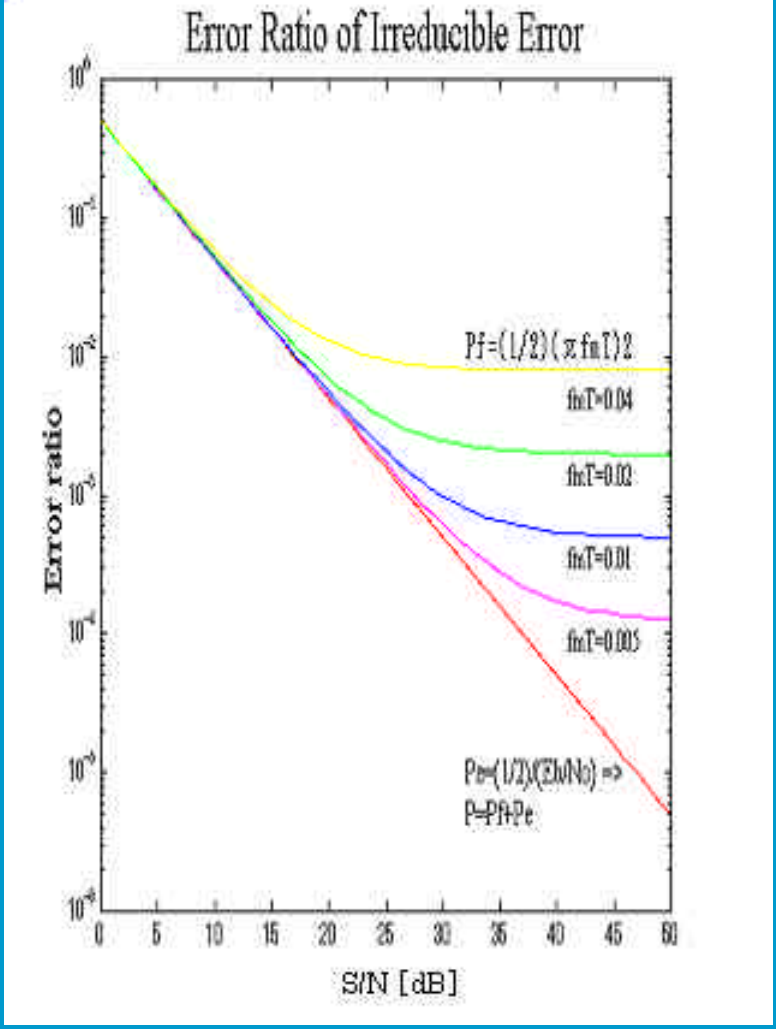
Abd. Echo

Frequency selective fading due to multipath

Flooring Phenomenon

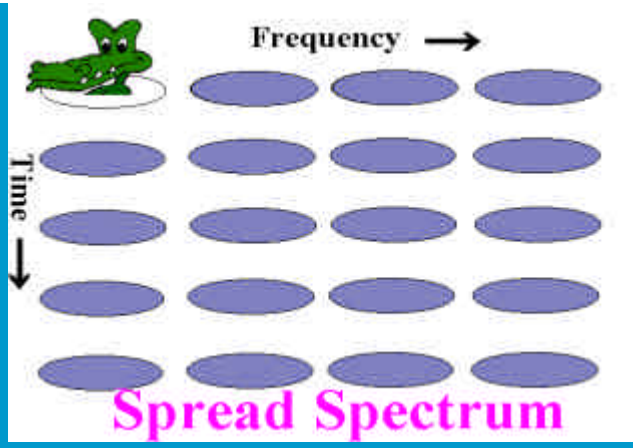
Error ratio can't improve with high speed vehicle under the environment of multipath





IMT-2000(3G)

2Mbps data up-link from moving vehicle is impossible with IMT-2000 (3G).
Only 144Kbps expected, but no hardware !!



Macro cell

Train

max15km
high mobility
<144Kbps
macro Node B
FDD

Micro cell

some 100m
medium mobility
<384Kbps
micro Node B
FDD or TDD

Pico cell

some 10m
low mobility
<2Mbps
pico Node B,**TDD**

Home

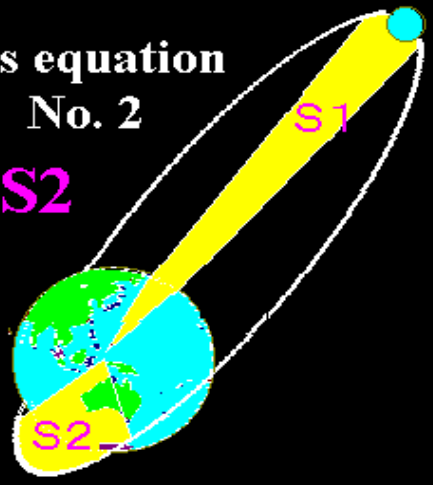
Building

ITU-T

Blocking (Shadowing)

Kepler's equation
No. 2

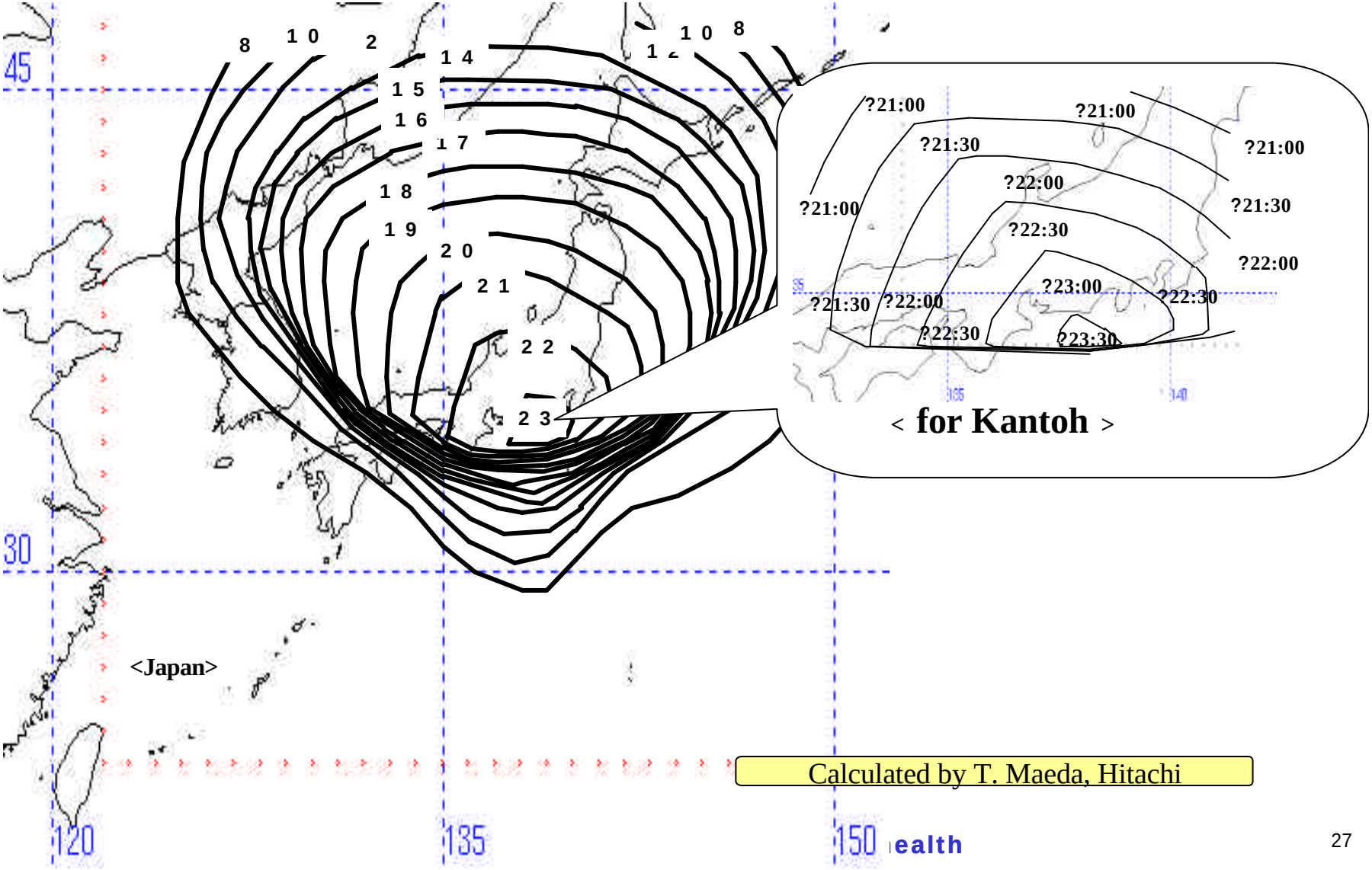
S1 = S2



Geostationary Orbit

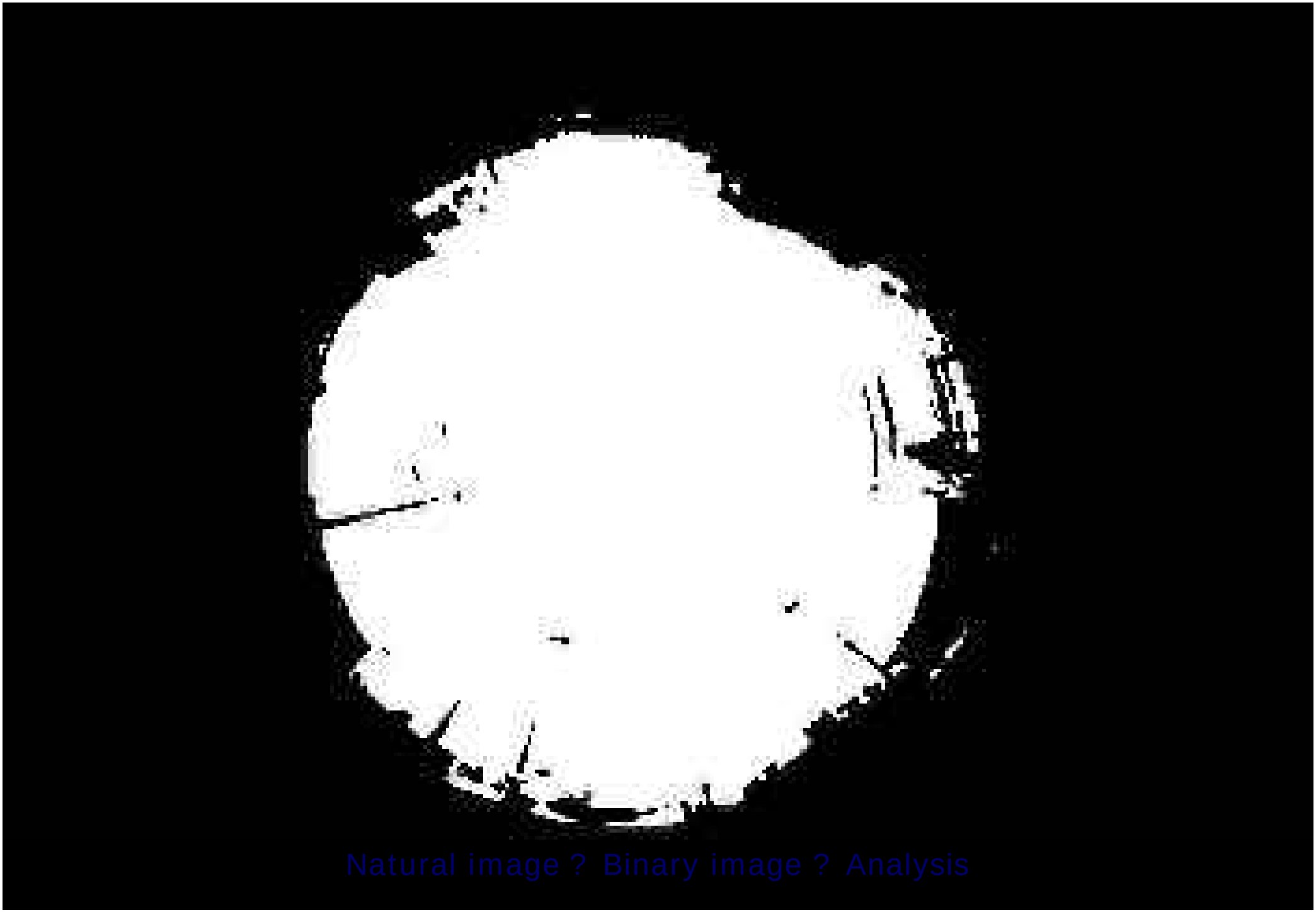
period 1436 mim. ≒ 24 hrs.

Elevation > 80 deg.
Duration [hour]



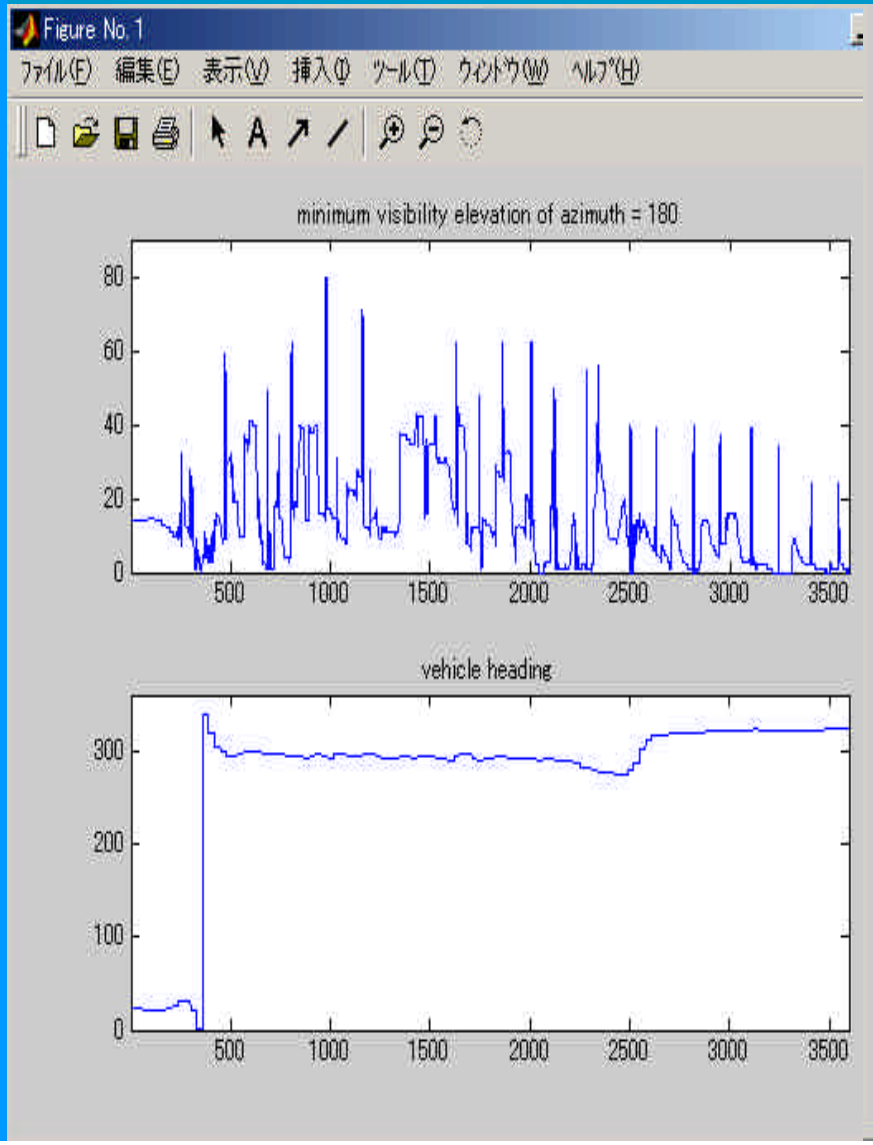
Calculated by T. Maeda, Hitachi

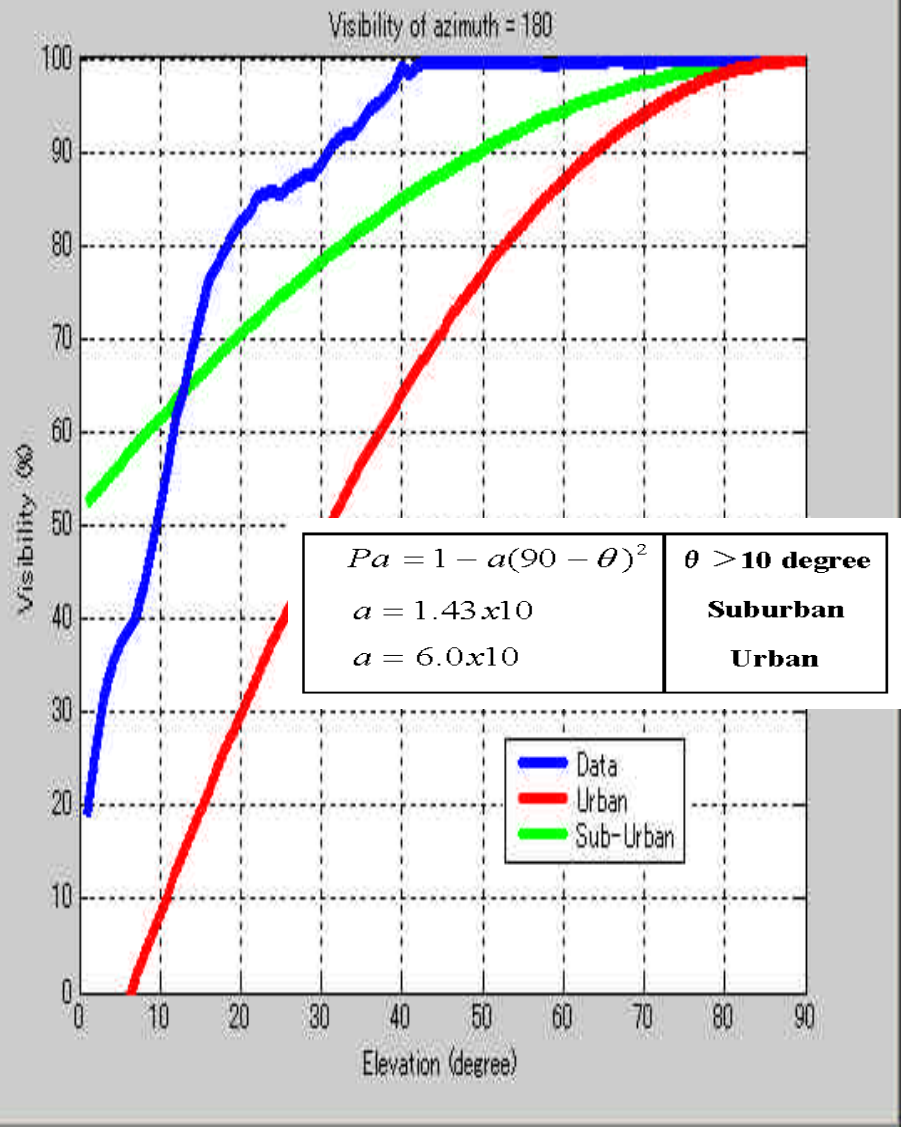
Visibility study (natural image)


Natural image ? Binary image ? Analysis

Result of visibility study

diversity distance shall be 2.3m



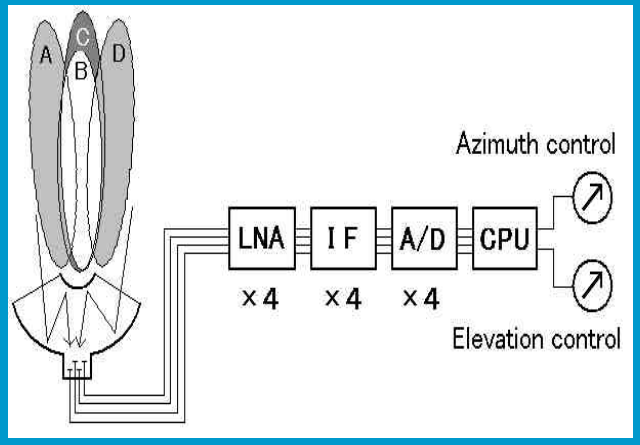


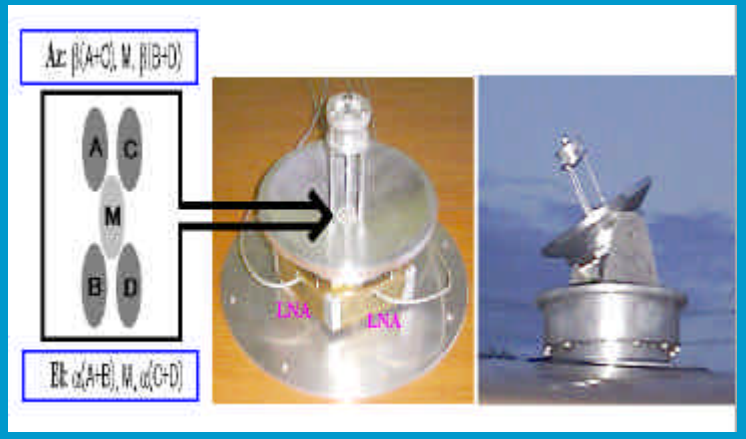
ITU-T

Super Ambulance

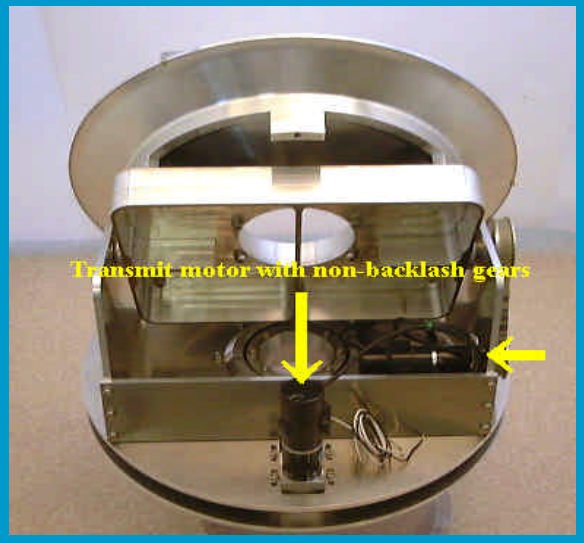
with diversity satellite antenna(distance 2.3m)

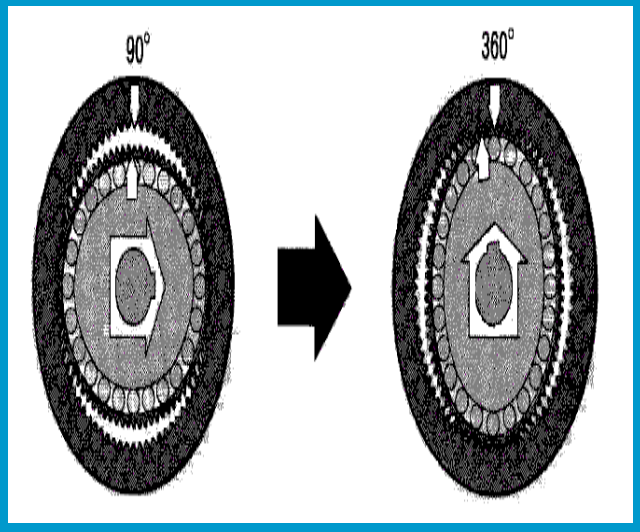
How to track a communication satellite from high speed vehicle

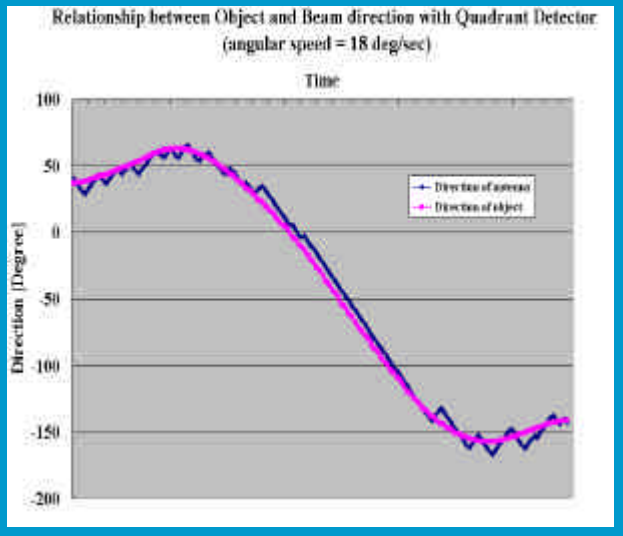




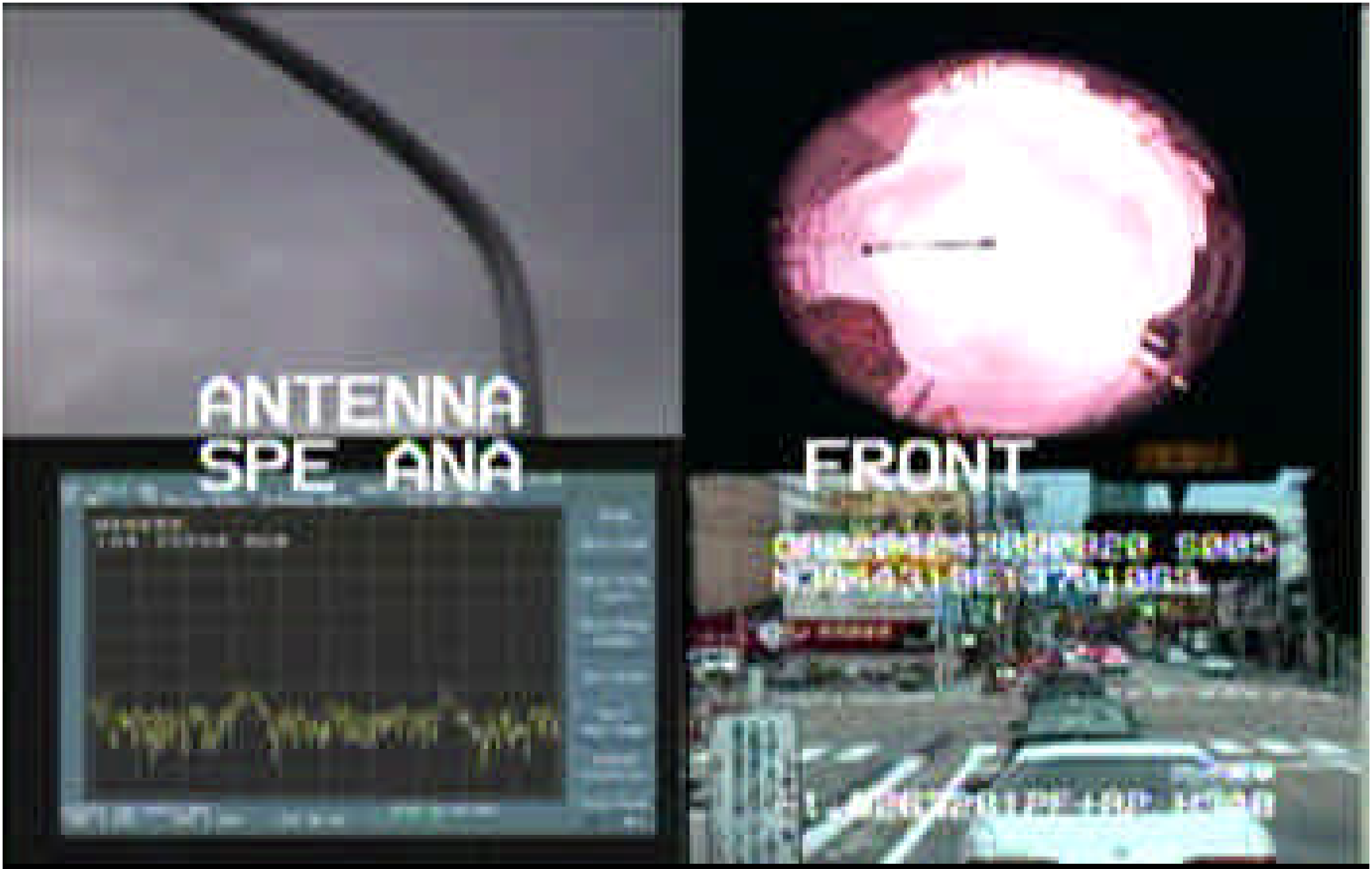
Quadrant detector





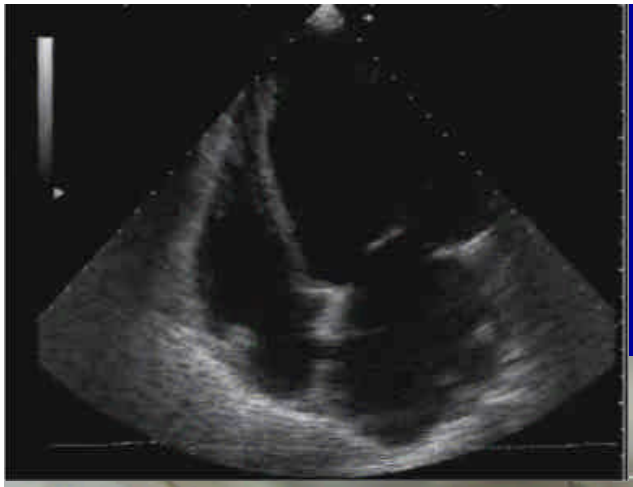


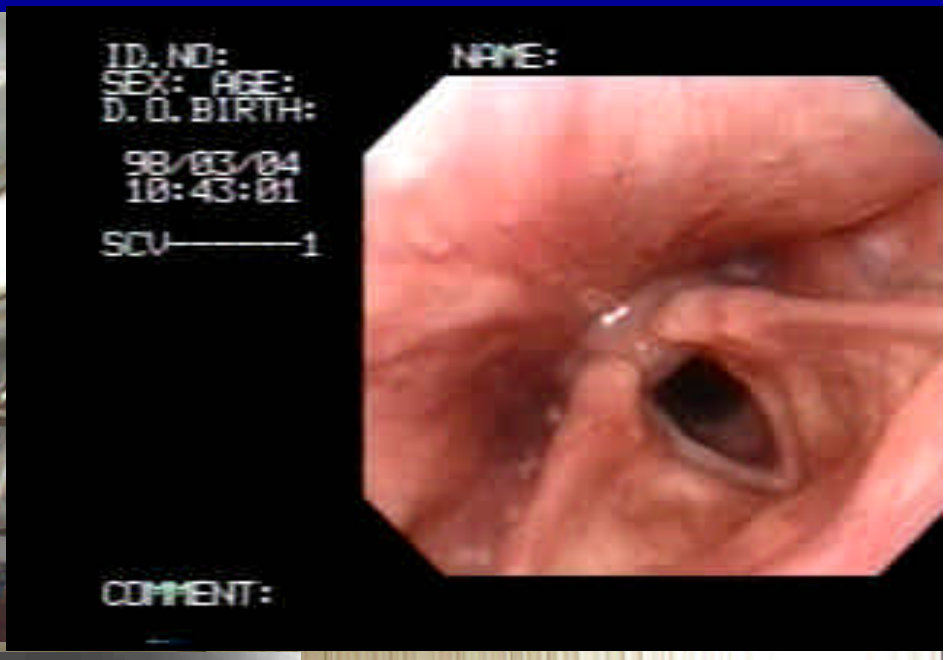
Non-backlash

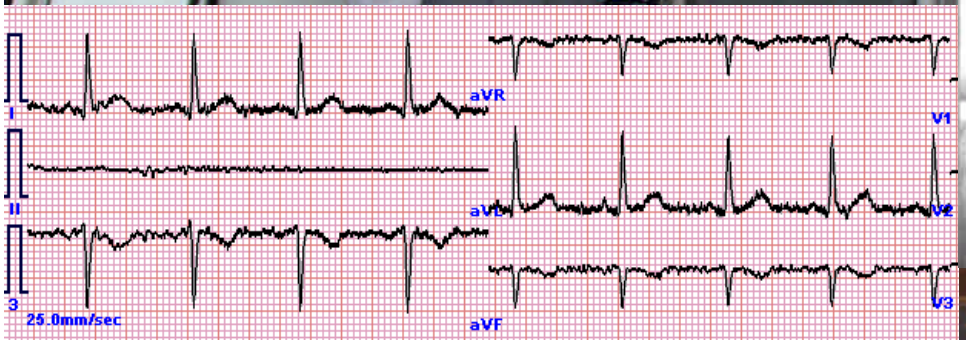


N-star(GEO) tracking with Quadrant Detector

Real-time Telemedicine
MPEG-2,-4 , 6 (3+3)Mbps







ITU-T

Reduce Medical Cost !

Medical Cost

In case of Acute Myocardial Infarction in Japan,

Thrombolytic agents are effective within 60 minutes after the attack. To make fine diagnosis of AMI, we have to send 12-lead ECG and Echography from moving vehicle at real time.

If 50% of patients will benefit => reduce medical cost

=> over U.S. $ 2 Billion/10 years

Satellite System Cost

Total cost of the Quasi-Zenith satellite system

(3 space crafts, 4800 ground terminals, TTC & operation)

=> less than U.S. $ 2 Billion/10 years

ITU-T

Summary of trials

1, Video in an ambulance shall effective to support real-time telemedicine.

2, 3G (IMT-2000) cannot afford because of its limitation of the data speed.

3, IP-based multimedia for ambulatory applications can save human life and reduce the medical cost.

4, We need challenge !!

Thank you !

This study was performed through special coordination funds of the Ministry of Education, Culture, Sports, Science and Technology, the Japanese Government.

Thanks to Prof. Leonid Androuchko (ITU-D SG-2 Q14/2 Telemedicine) and Mr. Yasuhiko Kawasumi (Q10/2 Rural communications) for their many useful suggestions.