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Quality Issues for IP Telephony

The E-Model

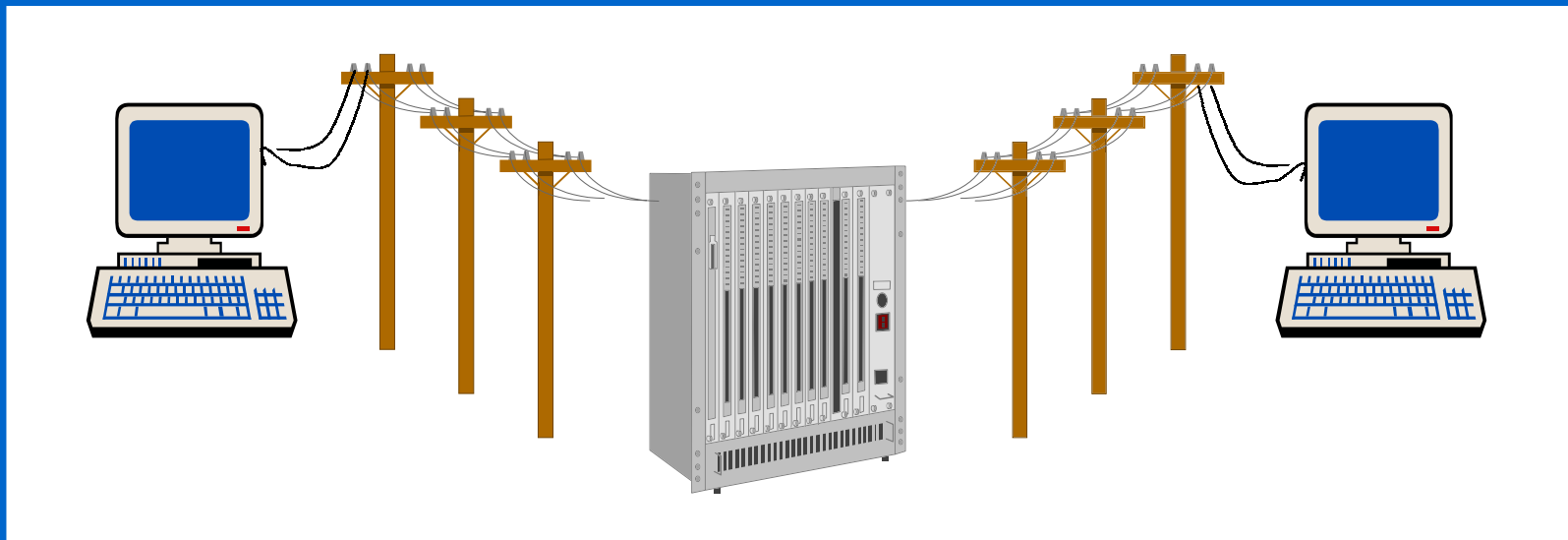
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PSTN to connect 2 terminals

Case #1



2 Modems (machines)



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PSTN to connect 2 terminals

Case #1  2 Modems (machines)

Quality is:

- defined by exactly specified procedures
- the same for each piece of equipment
- a yes / no decision
- an objective measure

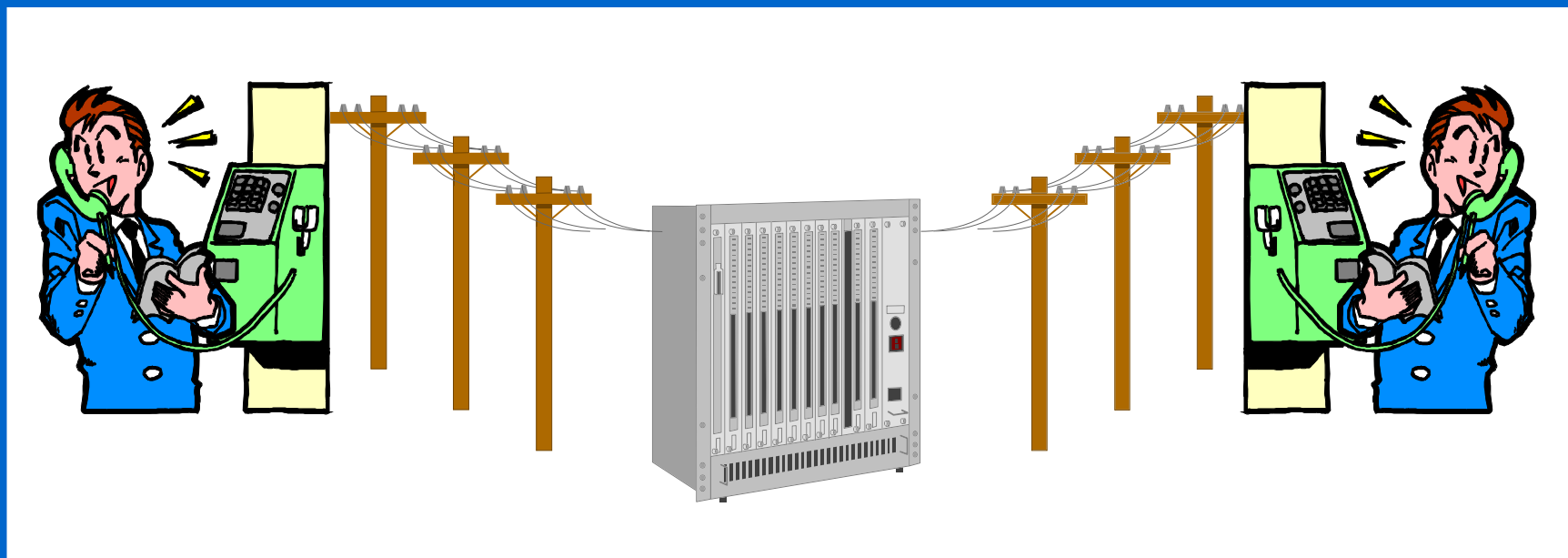
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PSTN to connect 2 terminals

Case #2



2 Telephones (humans)



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PSTN to connect 2 terminals

Case #2  2 Telephones (humans)

Quality is:

- a subjective perception (feeling, emotion)
- different for every human being
- varying with time / occasion

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Quality in transmission planning

- Easy for machine communication



defined objective measures

- Difficult for speech communication



varying subjective (different) perception

Quality by transmission planning

Planning for speech transmission with the goal to achieve good quality - for the human beings involved - needs either

- subjective tests or
- objective measures or
- a tool based on subjective test results



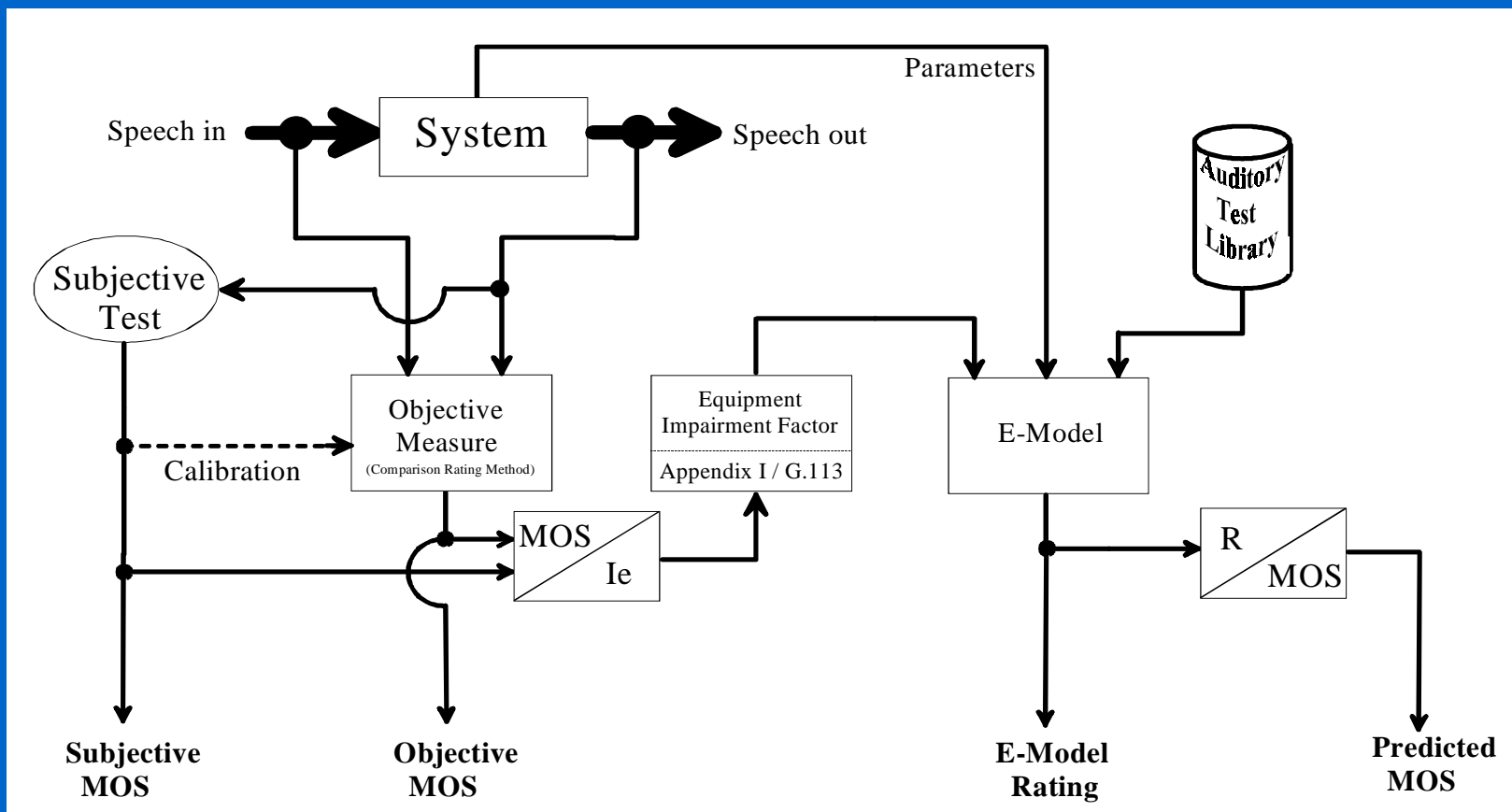
Transmission Rating Model

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Subjective Tests

- At least 24 untrained subjects evaluate specific speech quality parameters
- Subjects document their quality impression by filling in a questionnaire
- Processing of subjects' scores
- Result as "Mean Opinion Score" = MOS in the Range from 1 through 5

Test Environment



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Transmission rating model(s)

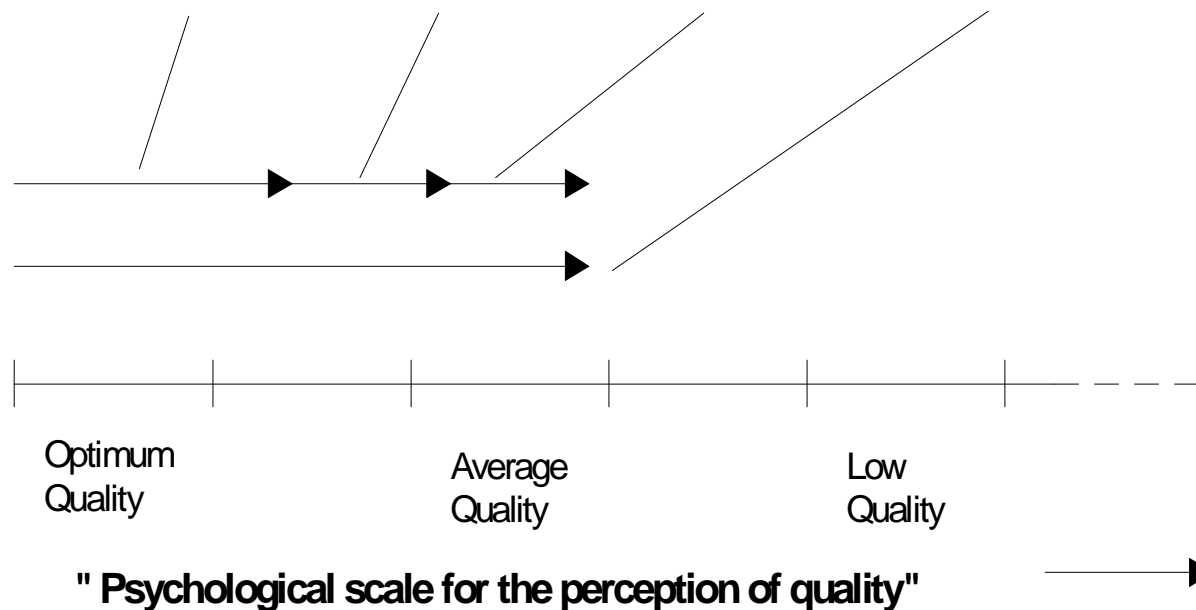
- In the past described in Supplement 3 to the P-Series of ITU-T Recommendations
- Now available as the common transmission rating model:

The E-Model, a Computational Model for use in Transmission Planning

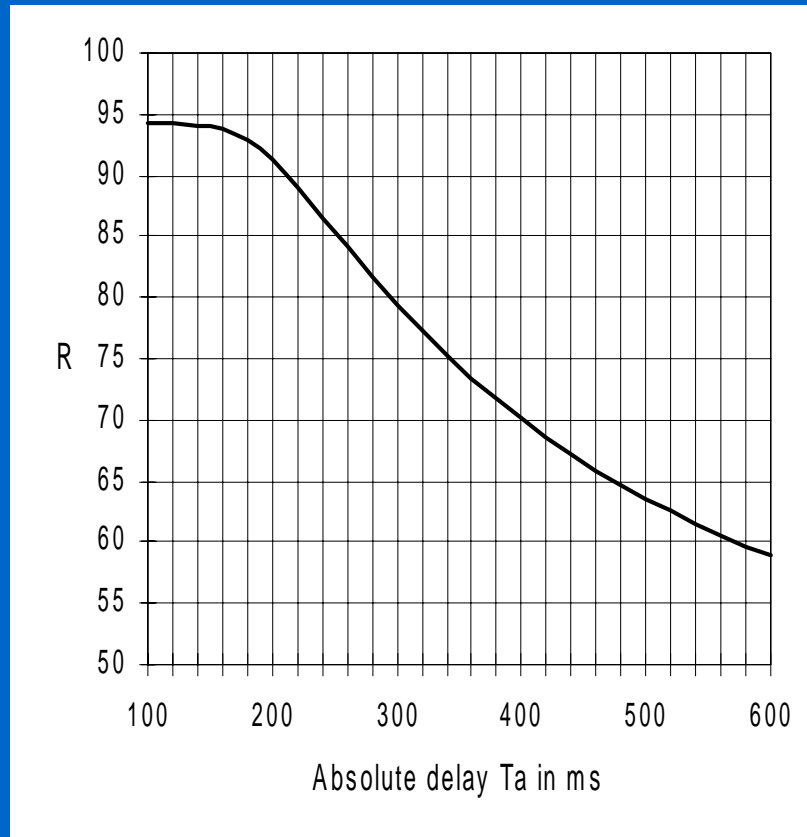
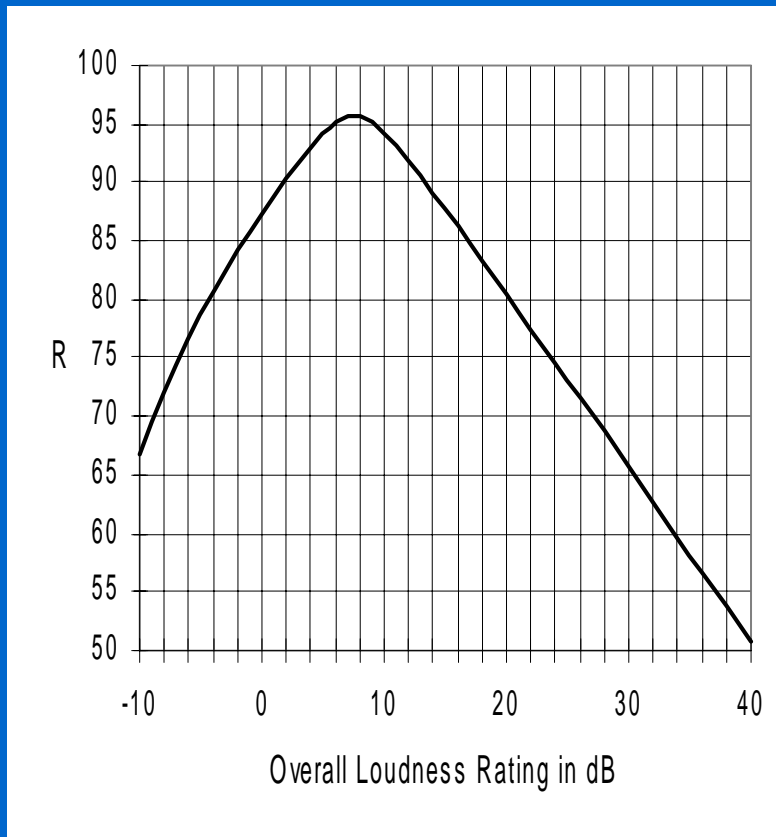
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Impairment Factor Method

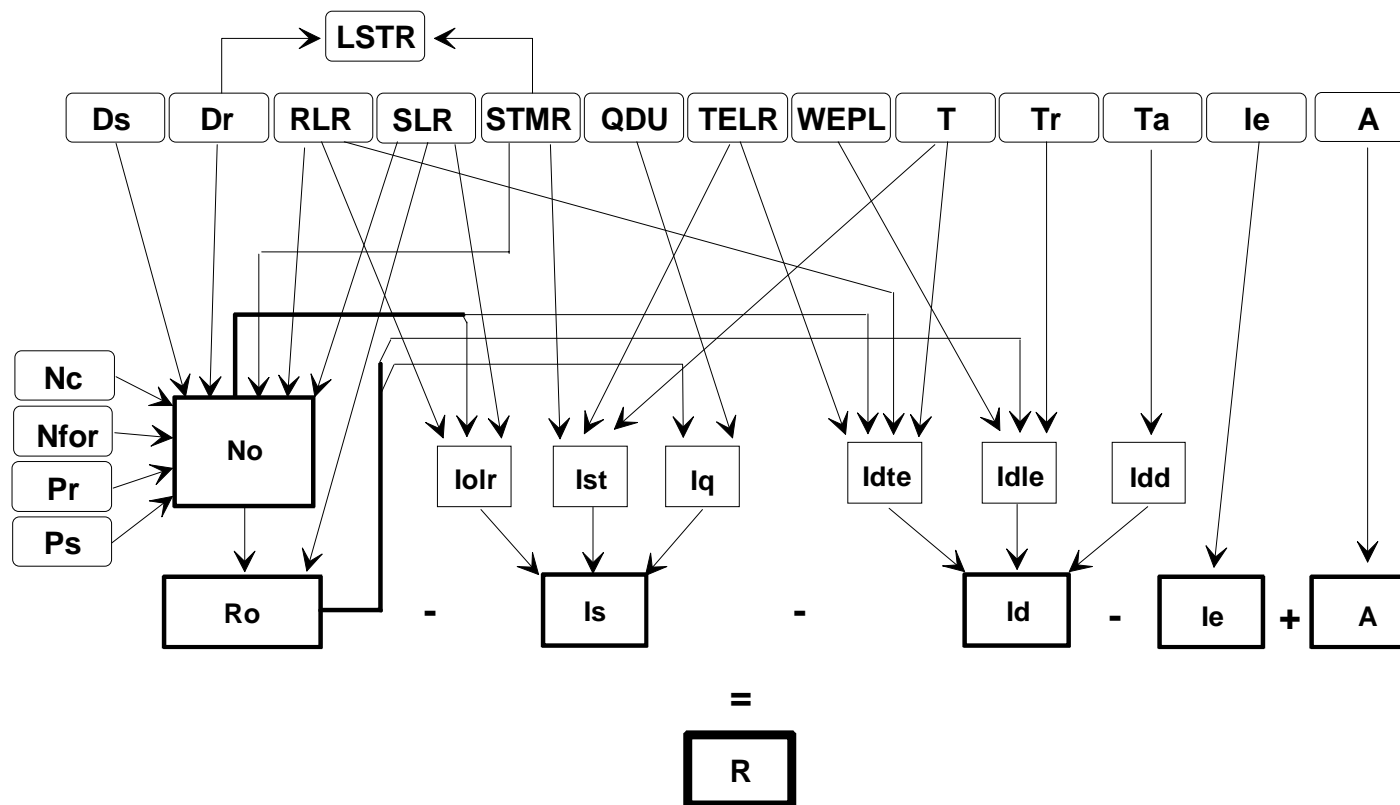
I-Value for Echo + I-Value for le + I-Value for OLR = Sum of Impairments



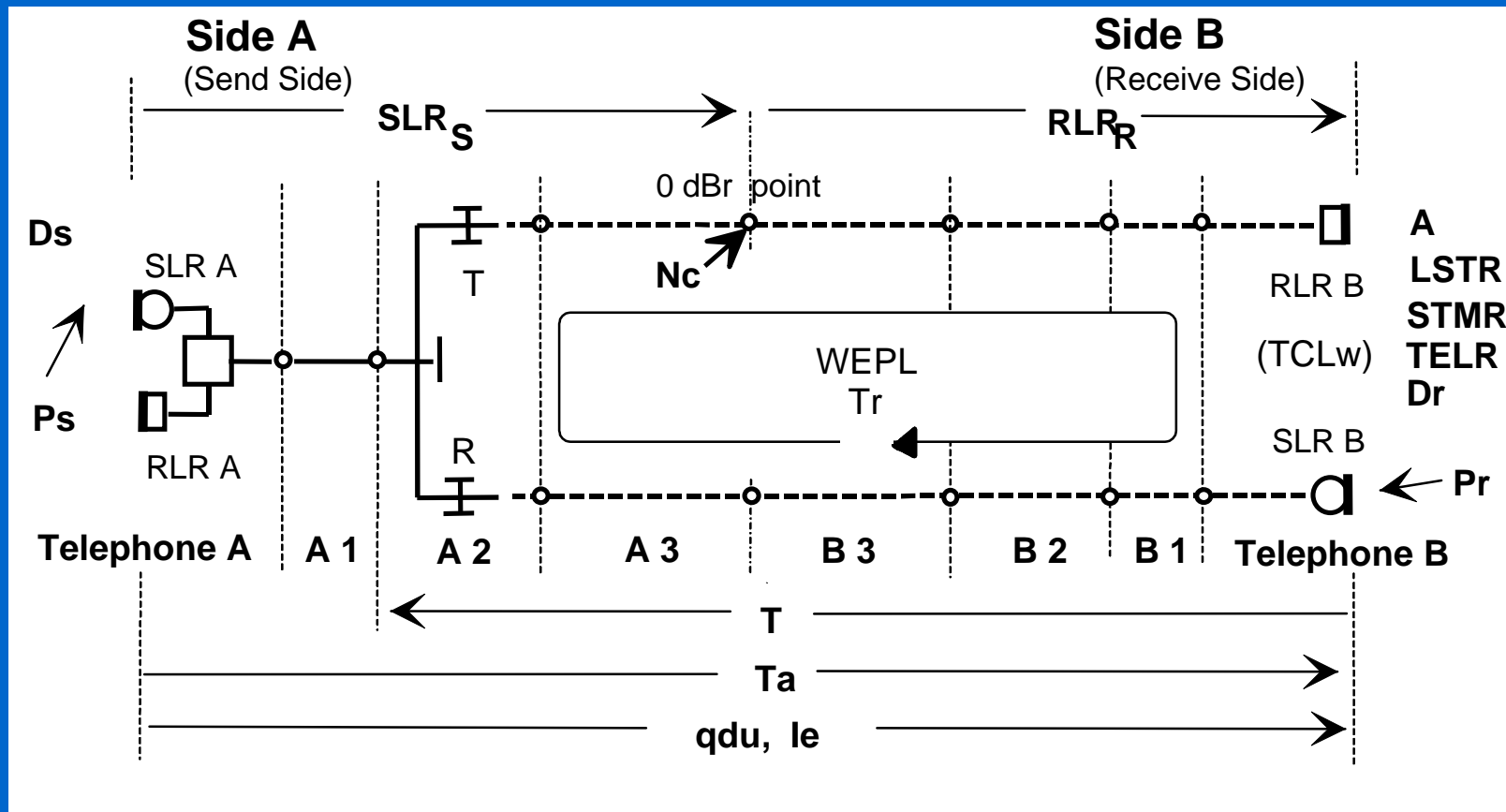
Single parameter treatment



Structure of the E-Model



Working Configuration



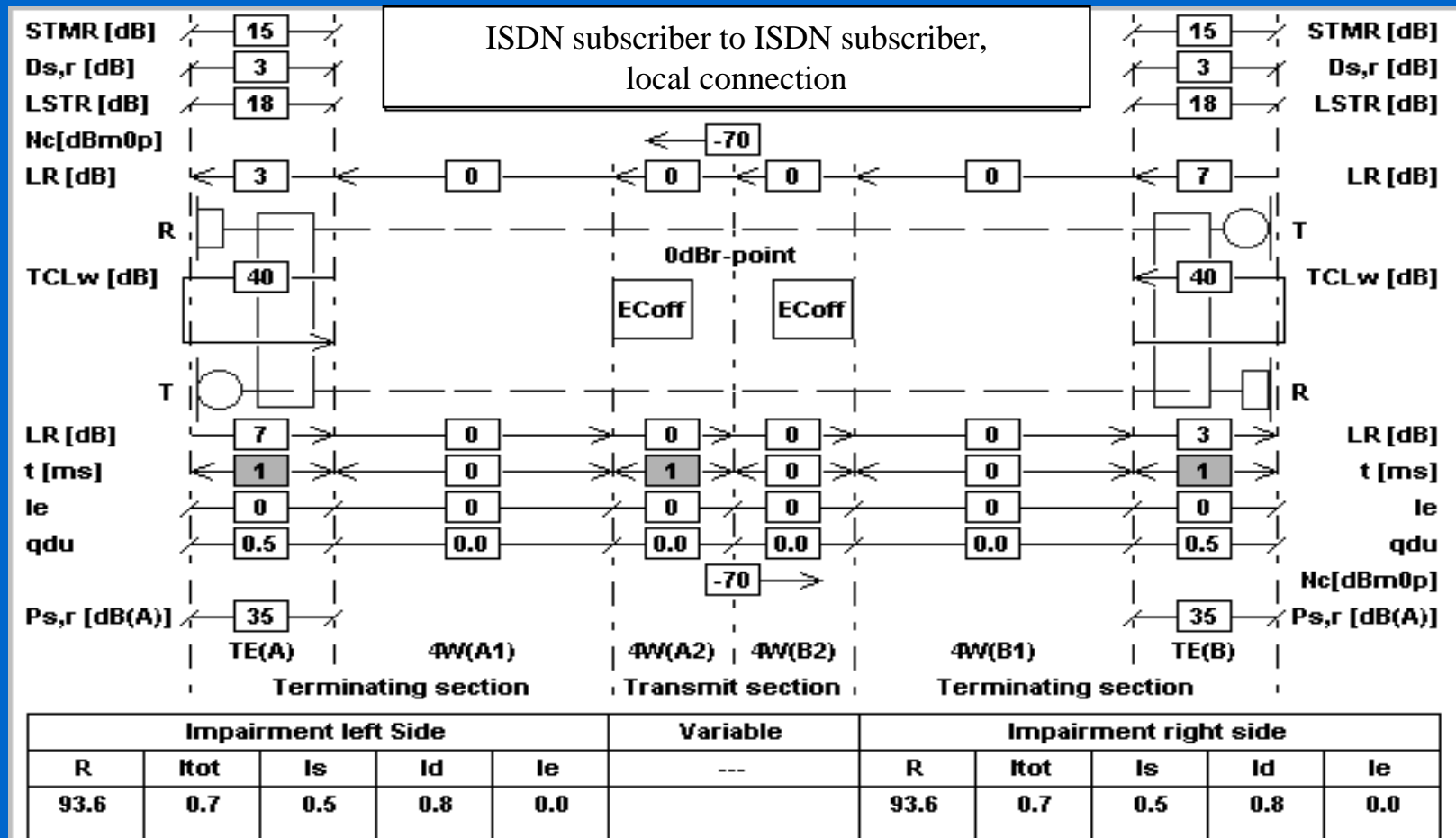
Definition of Categories of Speech Transmission Quality

R-Value Range	Speech Transmission Quality Category	User satisfaction
$90 \leq R < 100$	Best	Very satisfied
$80 \leq R < 90$	High	Satisfied
$70 \leq R < 80$	Medium	Some users dissatisfied
$60 \leq R < 70$	Low	Many users dissatisfied
$50 \leq R < 60$	Poor	Nearly all users dissatisfied

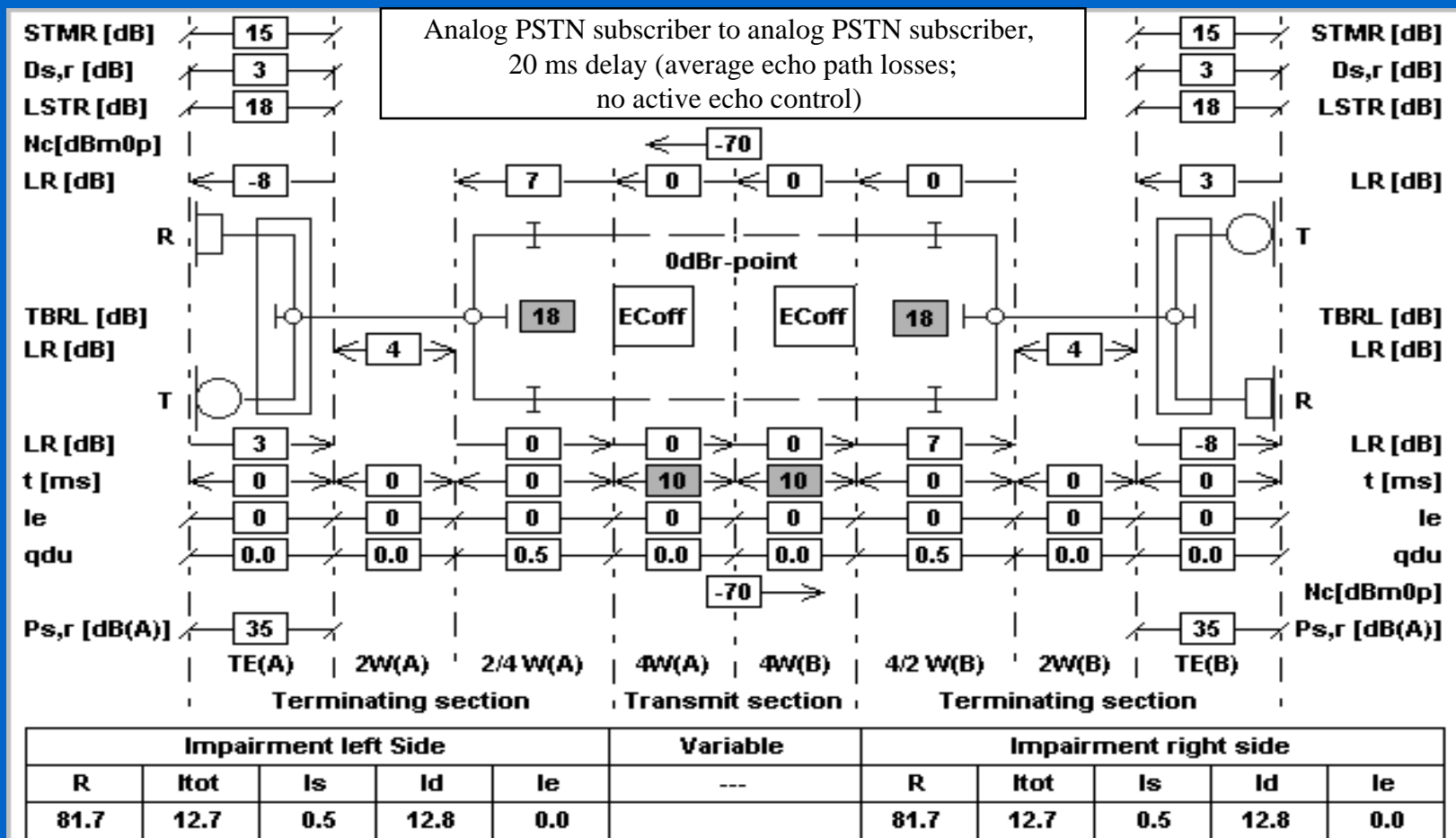
Examples of Speech Transmission Quality provided in Typical Scenarios

- ISDN subscriber to ISDN subscriber, local connection
- Analog PSTN subscriber to analog PSTN subscriber, 20 ms delay (average echo path losses; no active echo control)
- Mobile subscriber to analog PSTN subscriber as perceived at mobile side
- Mobile subscriber to analog PSTN subscriber as perceived at PSTN side
- Voice over IP connection using G.729A + VAD with 2% packet loss

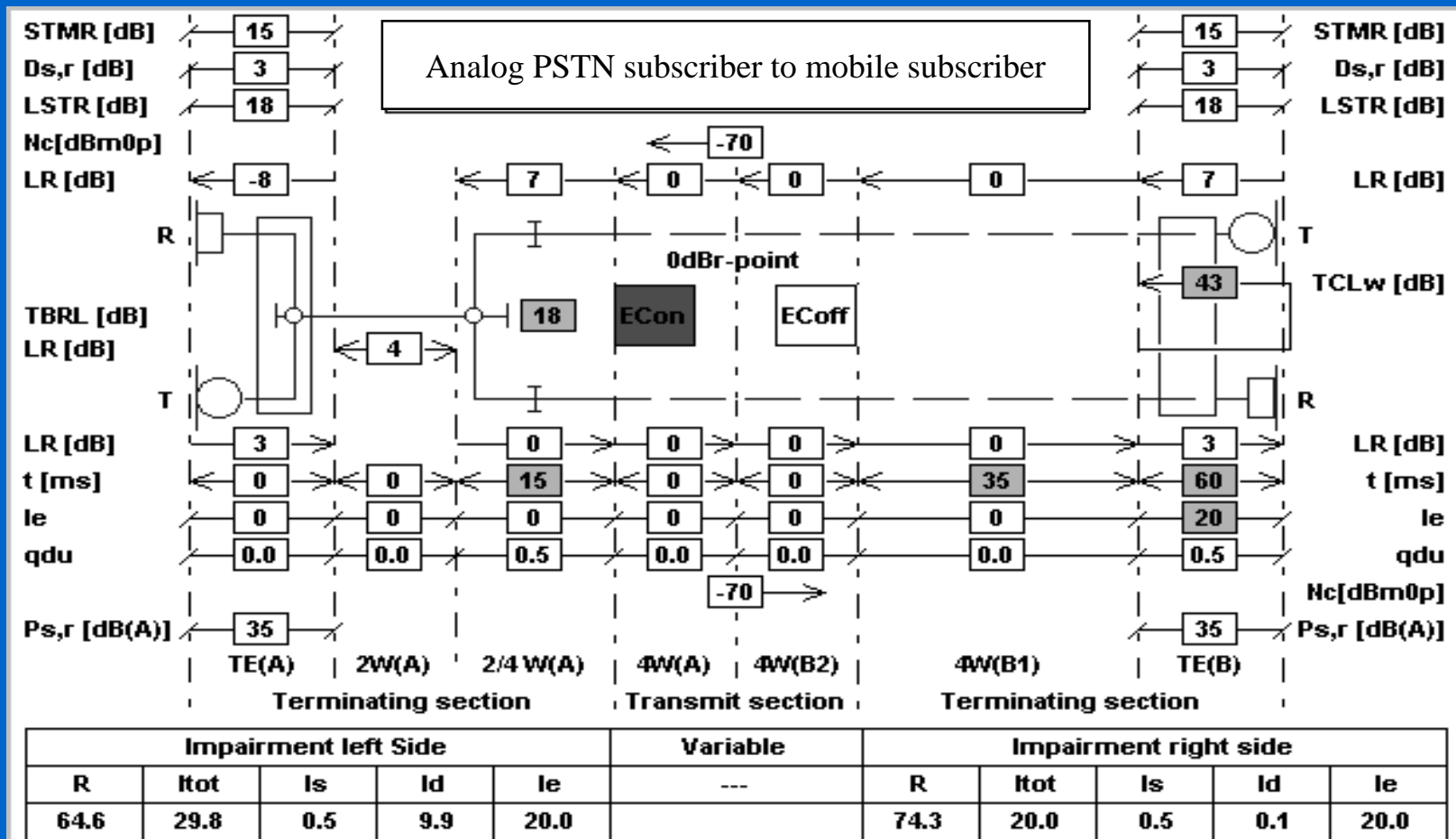
Example: ISDN - ISDN



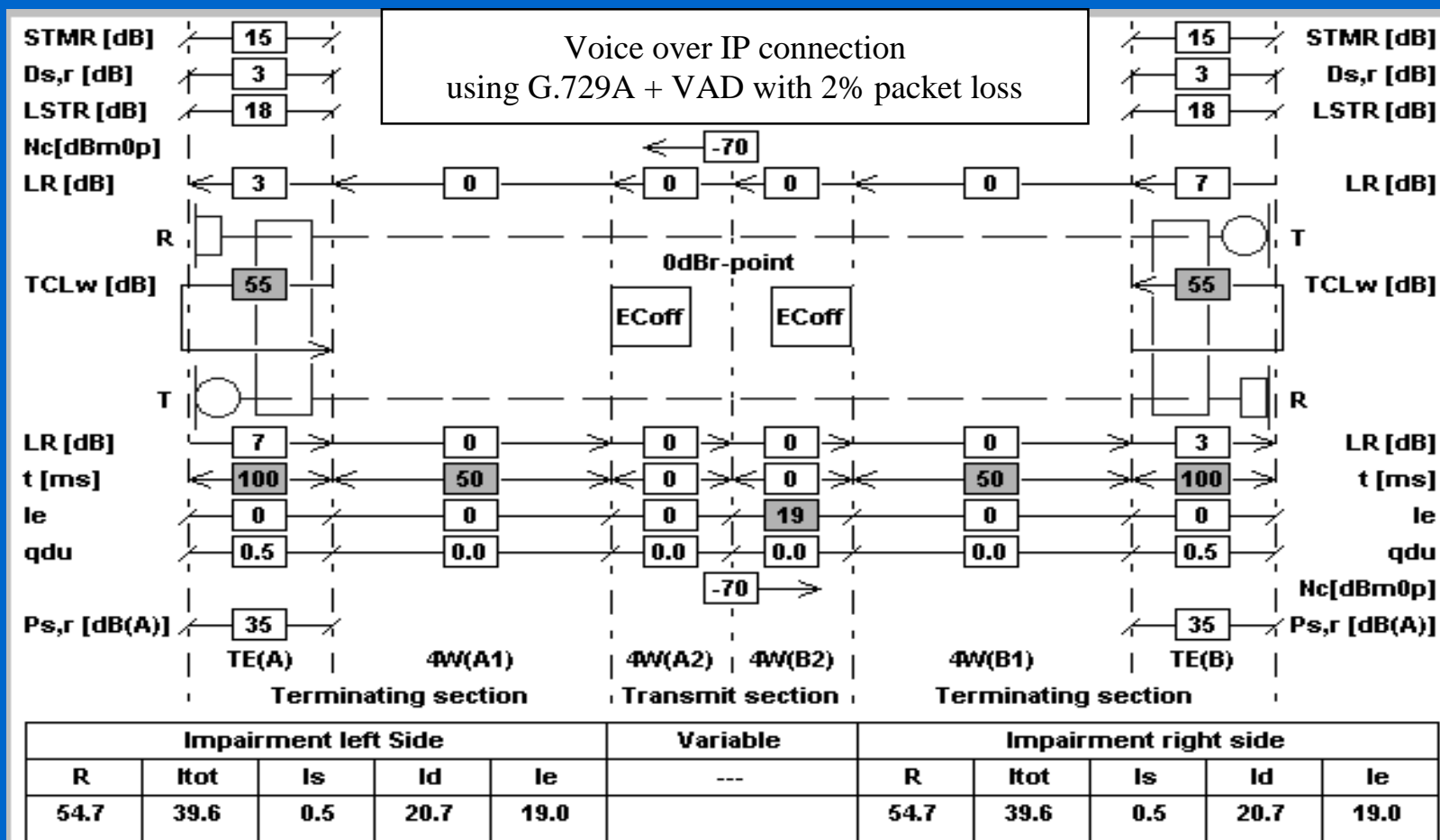
Example: PSTN - PSTN



Example: PSTN - Mobile



Example: VoIP with G.729A



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History

- Idea and culmination of the career of Nils-Olof Johannesson
- Developed jointly by TM5, TE4 & BTC2
- Involved several STQ experts
- Developed in period 1992 - 96
- Defined in ETR 250 (July 96)
- Adopted by ITU-T (G.107/Dec. 98)