Overview of non-intrusive voice transmission quality measurement techniques
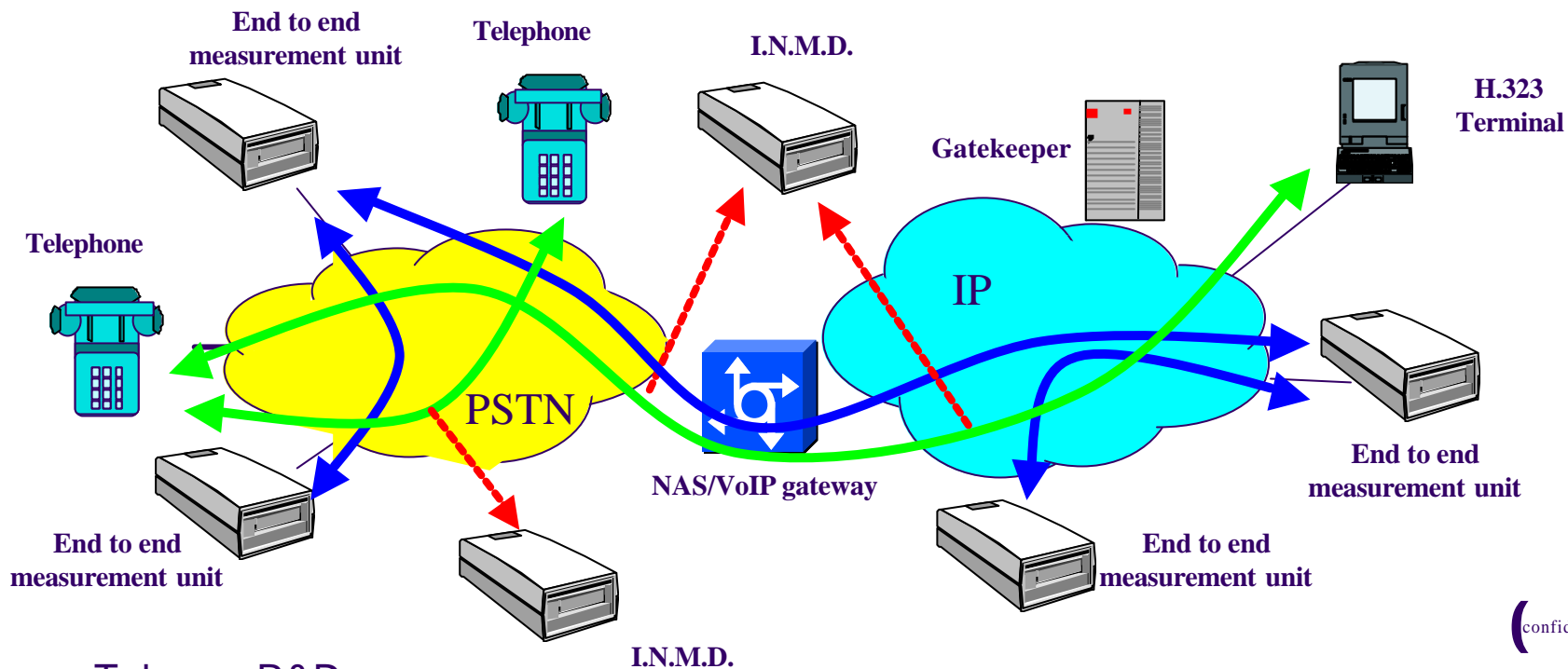
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(confidential)

How to measure voice quality ?

Two types of tools :

➔ **Non-intrusive (I.N.M.D.)** : on real communication without reference signal, better for the supervision of network quality of service,

➔ **End-to-end intrusive** : on test calls with reference signal, better fitted for the measurement of quality as perceived by end users.

End to end
measurement unit

Telephone

I.N.M.D.

H.323
Terminal

Gatekeeper

Telephone

IP

Telephone

PSTN

NAS/VoIP gateway

End to end
measurement unit

End to end
measurement unit

End to end
measurement unit

End to end
measurement unit

I.N.M.D.

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What is a non-intrusive technique ?

➔ The non-intrusive measurement techniques are not done at the users interfaces, but in network nodes.

➔ They can be implemented as part of network equipments (switches) or in stand-alone devices

➔ They do not require tests signal since they are performed on real communications.

➔ With no additional cost, such systems gives the possibility to supervise a great amount of communication, and thus to have a very reliable idea of the quality of the network.

➔ The tools used to perform those measurement are generally called I.NM.D.s (for In service Non-intrusive Measurement Devices). They are generally connected through a high impedance probe to a E1/T1 link (DS1 interface), but they can also be applied on Ethernet links.

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Which parameters ?

→ The parameters that one can measure with non-intrusive systems are of two kinds :

⑦ related to protocol or signalling

- calling and called number,
- call duration,
- packet loss,
- one point and two point jitter,
- RTP delay, etc.

⑦ derived from the analysis of the voice signal

- echo,
- levels,
- clipping,
- voice quality, etc.

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Back in history

➔ First mention of the acronym I.N.M.D. in the late 1980's.

➔ New digital signal processing techniques and processors.

➔ The pioneers : AT&T, C-Tel, Telstra.

➔ First standard in 1991 : ANSI T1M1 221 (North America).

➔ 1993 : launching of Q.24/12 at the I.T.U.-T. (rapporteur : P. Sheppard, B.T.).

➔ 1994 : revision of T1.221

➔ 1996 : P.561 Recommendation (INMD classes, requirements for performance of INMDs and testing procedures).

➔ 1997 : Q.24/12 becomes Q.15/12 (same rapporteur).

➔ 2000 : P.562 Recommendation (analysis and interpretation of INMD voice-service measurements).

➔ A small market with two main manufacturers : EC-Tel (Qualiview) and Tektronix (Net-C)

➔ 2001 : New Q.16/12 (rapporteur : V. Barriac, F.T.) expands the scope to packet switched networks.

Required measurement functions in P.561

➡️ **Speech and noise characterization**

  ⑦ active speech level;

  ⑦ noise level (psophometric weighted);

  ⑦ speech activity factor.

➡️ **Echo characterization**

  ⑦ speech echo path delay (single or multiple reflection measurements)

  ⑦ and at least one of the following echo measurements:

  ● echo loss (single or multiple reflection measurements);

  ● echo path loss (single or multiple reflection measurements);

  ● speech echo path loss (single or multiple reflection measurements).

➡️ **Other parameters are optional**

⑦ originating and terminating address digits;

⑦ facility or circuit identification;

⑦ time and duration of connection;

⑦ signal classification (voice/data/other);

⑦ customer identification (dedicated circuits only);

⑦ DS1 performance measurements;

⑦ 3 kHz flat noise level;

⑦ connection disposition measurements;

⑦ data analysis and reports;

⑦ saturation clipping;

⑦ measurement interval;

⑦ double talk;

⑦ front-end clipping;

⑦ one-way transmission;

⑦ crosstalk;

⑦ stability loss;

⑦ distortion.

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Measurement ranges and accuracies in P.561

Parameter		Range		Mean accuracy	Resolution
		Lower	Upper		
Active speech level (dBm)		-35	0	± 0.3	0.1
Speech activity (%)		0	100	± 0.3	0.1
Noise level (dBm0p)		-70	-40	± 0.3	0.1
Speech echo path loss (dB)	Class A	6	25	± 0.3	0.1
	Class B	6	35	± 0.3	0.1
	Class C	6	45	± 0.3	0.1
Speech echo path delay (ms)	Class A	0	50	± 0.3	0.1
	Class B	0	150	± 0.3	0.1
	Class C	0	1000	± 0.3	0.1

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Links with perceived quality : P.562

➔ The interpretation of measurement results is possible :

⑦ For single calls,

⑦ For multiple calls : minimum sample sizes required.

➔ It depends also on the position of the measurement devices

⑦ Ex. : before of after echo cancellation

➔ The analysis of measurement results can be done for individual parameters or by combining several parameters : use of a customer opinion models :

⑦ E model (G.107)

⑦ CCI (Call Carity Index)

➔ Benefits of using a model to interpret INMD measurements include:

⑦ The identification of combination effects that are incorrectly classified when using individual measures.

⑦ Reduction in data volume (a single figure now represents the measured quality compared to many individual measurements).

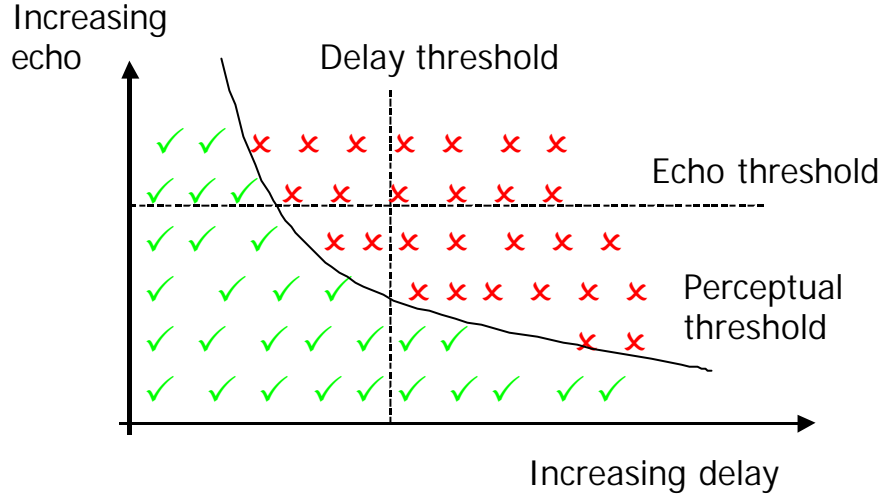⑦ The model encapsulates expert knowledge about the effects of impairments on customer perception.

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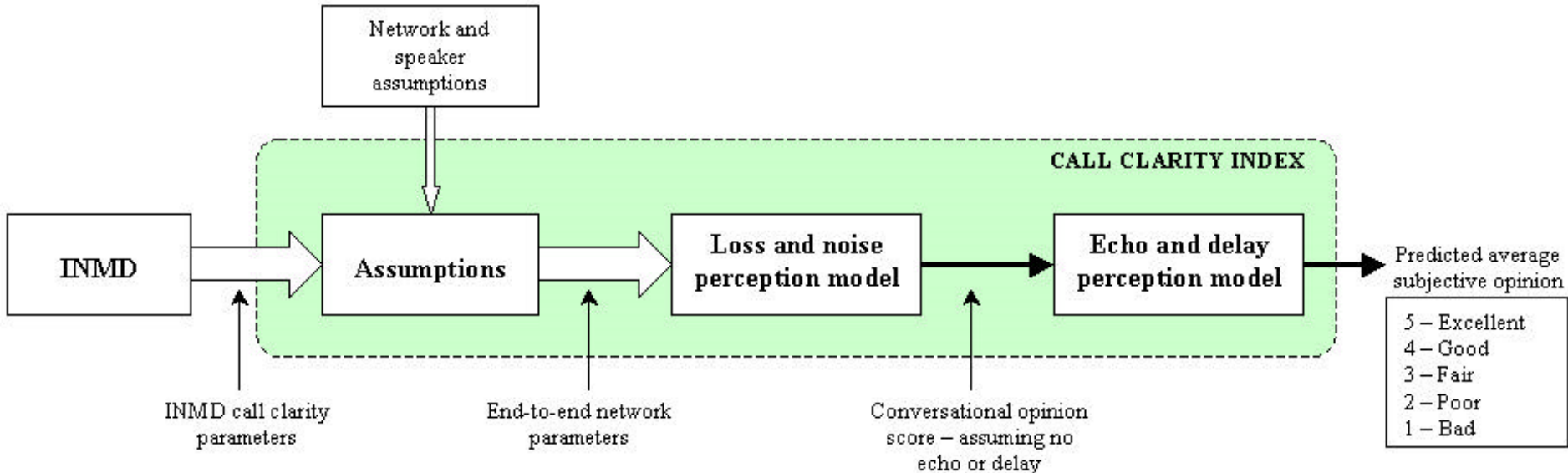
Benefit of using a model : the example of echo
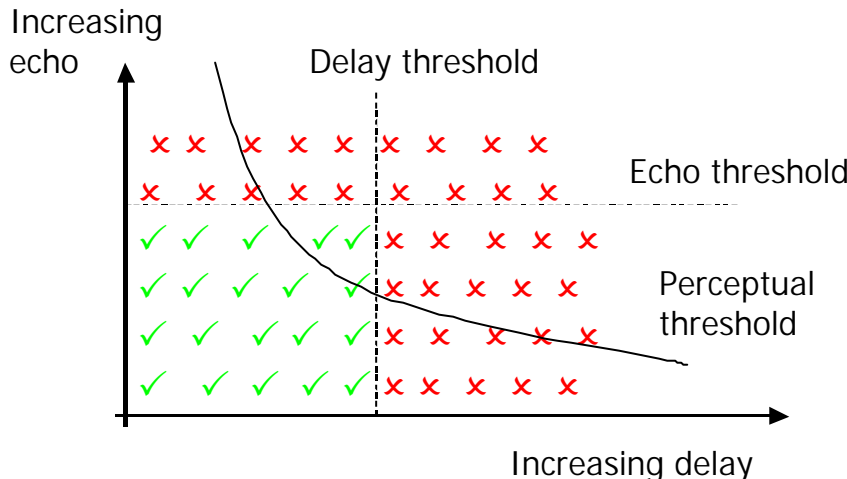
Using individual measures for thresholding

Using a model for thresholding

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Call Clarity Index

Recommended CCI threshold values :

Threshold name	Value
Upper threshold	3.5
Lower threshold	2.5

New and future challenges

→ Voice quality in packet switched networks is time variant
(«unguaranteed quality»)

  ⑦ causes : non constant packet path (and thus transmission time) and network load
  (and thus packet loss rate),

  ⑦ consequences : classical subjective and objective assessment methods must
  evolve to adapt.

→ Packet-based networks are also characterised by new types of degradations :

  ⑦ packet loss,

  ⑦ jitter,

  ⑦ distortion du to low bit rate coding.

→ New opportunies offered by digital signal processing :

  ⑦ detection and characterisation of perceived impairments directly linked to subjective
  opinion,

  ⑦ use od psycho-acoustical models (PESQ-like, but without reference).

→ Need for new or revised standards :

  ⑦ revision of P.561 (and P.562 ?) before the end of the 2001-2004 study period,

  ⑦ new standards on new assessment methods.

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QUESTIONS ?