QoS Targets for IP Networks & Services: Challenges and Opportunities

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Presentation Outline

- Speech quality in the PSTN and beyond
- QoS requirements for data and multimedia
- Performance of the IP layer
- The missing link - true end-to-end QoS targets
- New opportunities
- Some closing comments

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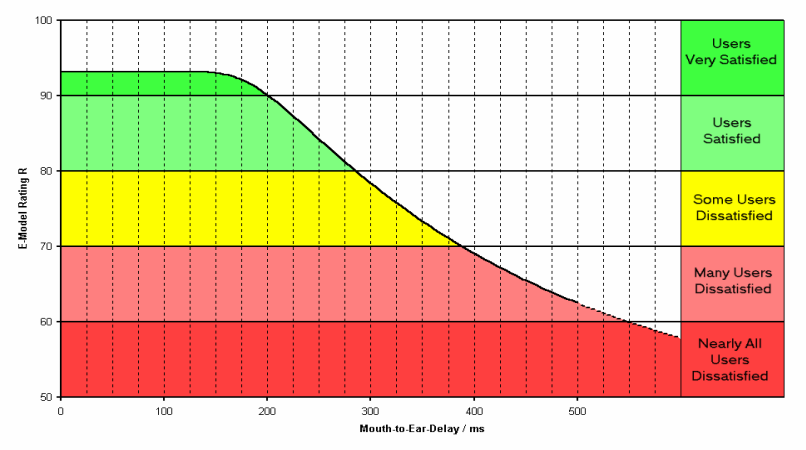
Speech quality in the PSTN & beyond

Speech quality in the PSTN

- The digital PSTN has been optimised to transport G.711 coded speech at 64kbit/s.
- User experience of speech quality in digital networks is generally very good.
- Delay is usually short and echo increasingly well-controlled.
- Many users have some experience of “degraded” quality:
  - international calls over satellite and/or DCME compression;
  - mobile-mobile calls with low signal strength.
- The PSTN usually performs much better than international standards allow.

Speech Quality – G.114 One-Way Transmission Time



Determination of the effects of absolute delay by the E-model

G.109 Definition of Categories of Speech Transmission Quality

R-value range	Speech transmission quality category	User satisfaction
90 ≤ R < 100	Best	Very satisfied
80 ≤ R < 90	High	Satisfied
70 ≤ R < 80	Medium	Some users dissatisfied
60 ≤ R < 70	Low	Many users dissatisfied
50 ≤ R < 60	Poor	Nearly all users dissatisfied
Connections with R-values below 50 are not recommended		

Table 1/G.109

Migrating the PSTN to IP-technology

- CAPEX considerations and the desire to offer new services are driving many operators, including BT, to migrate their telephone networks to IP-based technology.
- It is possible to engineer a high quality voice over IP (VoIP) service suitable for use in the PSTN, but several factors need to be carefully managed:
  - speech packetisation rates
  - low bit rate codecs
  - packet jitter and de-jitter buffers
  - call processing times
- Fairly easy to achieve “best” or “high” speech quality with a few interconnected IP networks with the right codecs.
- More complex interconnect scenarios pose more of a problem...

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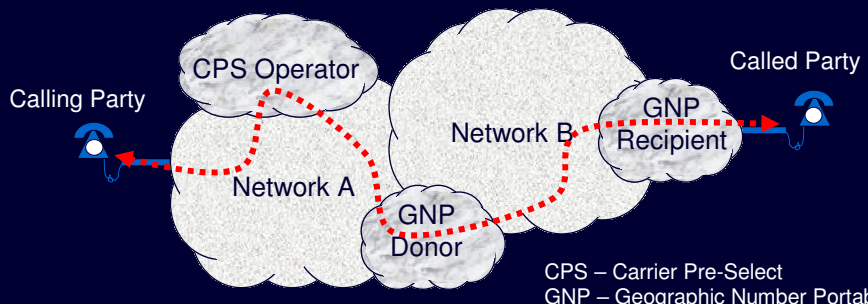
Potential UK PSTN Call Paths

Calls in the UK PSTN can pass through many network operators’ domains for a variety of reasons, including number portability and carrier pre-select.



CPS – Carrier Pre-Select
GNP – Geographic Number Portability

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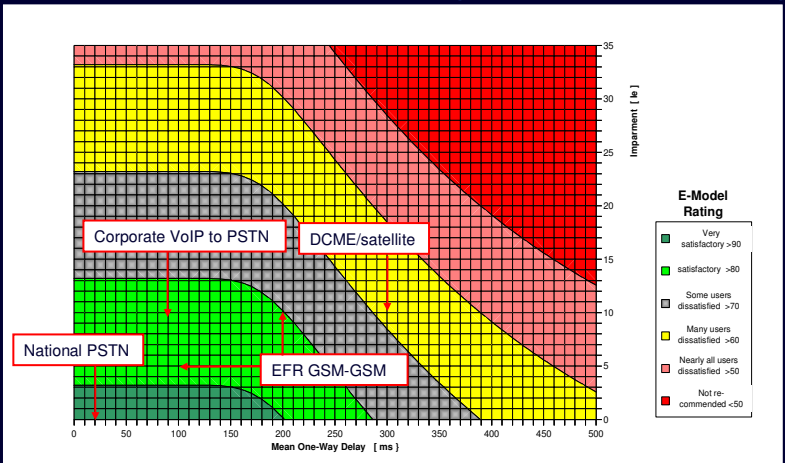
Revised UK Transmission Plan

- ND1701 Recommended Standard for the UK National Transmission Plan for Public Networks Issue 5 - approved by NICC membership in March 2006.
- Contains guidance on the incorporation of IP-based technology into the PSTN including:
  - delay and echo
  - codec rules
  - packet loss rules
  - post dial delay

Speech quality beyond the PSTN

- Should we be constrained by PSTN voice quality?
- Many users are satisfied with lower quality:
  - international calls over satellite and/or DCME compression;
  - mobile-mobile calls with low signal strength;
  - “free” VoIP services.
- Some users want higher quality – such as wideband speech.
- IP technology allows us to provide a wide range of different quality levels over the same infrastructure – e.g. PSTN voice plus a derived VoDSL service on copper access.

The effect of impairment and delay in the absence of echo (ITU-T E-Model)



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QoS requirements for data and multimedia

What QoS characteristics do we want?

- For many sessions, including typical Internet applications like file transfer, web browsing and email we want:
  - sufficient bandwidth
  - that's about it – TCP/IP can normally cope with delay, jitter etc.
- But for interactive sessions, such as conversations and videoconferencing we want:
  - low end-to-end delay and jitter
  - low packet loss
  - a guaranteed bandwidth

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G.1010 End-user multimedia QoS categories

Model for user-centric QoS categories

	Interactive (delay <<1 s)	**Responsive** (delay ~2 s)	**Timely** (delay ~10 s)	**Non-critical** (delay >>10 s)
Error tolerant	Conversational voice and video	Voice/video messaging	Streaming audio and video	Fax
Error intolerant	Command/control (e.g. Telnet, interactive games)	Transactions (e.g. E-commerce, WWW browsing, Email access)	Messaging, Downloads (e.g. FTP, still image)	Background (e.g. Usenet)

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Observations on the G.1010 Model

- Based on user perception so it is suitable for use with any underlying transmission technology.
- It indicates upper and lower bounds for delay and loss – providing poorer quality for a given set of applications is likely to result in user dissatisfaction and providing higher quality may mean that networks resources are being wasted.
- It provides a simple way to assess the suitability of a given bearer channel for supporting particular applications.
- It shows how QoS classes for differentiating service performance can be appropriately grouped without implying that one class is better than another.
- Important - G.1010 makes no recommendation on end-to-end QoS targets.

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Performance of the IP layer

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The Challenge of IP-Related QoS

G.1000 highlights the fact that there are many issues presented by the use of IP-based networks and services, including:

- dynamic allocations of resources
- assuring that end-to-end NP objectives can be met
- signalling of desired end-to-end QoS across both network and peer interfaces
- performance monitoring of IP-based networks and services that is meaningful to the user experience

QoS Concepts in the IETF

- There is not much we can control at the packet level – queuing delay, jitter, loss.
- IETF have defined several qualitative QoS mechanisms:
  - Resource ReSerVation Protocol (RSVP)
  - Integrated Services (IntServ)
  - Differentiated Services (DiffServ)
  - Multiprotocol Label Switching (MPLS)
- ITU-T has defined quantitative QoS classes.

Y.1541 IP QoS Classes

QoS Class	IPTD	IPDV	IPLR	IPER
Class 0	100ms	50ms	$1x10^{-3}$	$1x10^{-4}$
Class 1	400ms	50ms	$1x10^{-3}$	$1x10^{-4}$
Class 2	100ms	unspecified	$1x10^{-3}$	$1x10^{-4}$
Class 3	400ms	unspecified	$1x10^{-3}$	$1x10^{-4}$
Class 4	1s	unspecified	$1x10^{-3}$	$1x10^{-4}$
Class 5	unspecified	unspecified	unspecified	unspecified
Class 6	100ms	50ms	$1x10^{-5}$	$1x10^{-6}$
Class 7	400ms	50ms	$1x10^{-5}$	$1x10^{-6}$

IPTD = IP packet transfer delay
IPDV = IP packet delay variation
IPLR = IP packet loss ratio
IPER = IP packet error ratio

Class 5 is equivalent to “Best Effort”
Classes 6 & 7 are provisional classes

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3GPP UMTS QoS Classes

	Conversat-ional Class	Streaming Class	Interactive Class	Background Class
Intended for:	Real-time conversation	Real-time streaming	Interactive best effort	Background best effort
Example applications supported	Speech	Streaming video	Web browsing	Background download of emails
Transfer delay	maximum 100ms	maximum 280ms	n/a	n/a
SDU error ratio	10^{-2} to10^{-5}	10^{-2} to10^{-5}	10^{-3} to10^{-6}	10^{-3} to10^{-6}
Residual bit error ratio	$5x10^{-2}$ to10^{-6}	$5x10^{-2}$ to10^{-6}	$4x10^{-3}$ to $6x10^{-8}$	$4x10^{-3}$ to $6x10^{-8}$

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The missing link – true E2E objectives

What QoS should we expect in a mixed NGN and 3G environment?

We cannot to achieve the 100ms delay objective of Y.1541 Class 0 as the delay in the UMTS bearer may be up to 100ms. G.1010 gives some guidance on the QoS requirements of multimedia applications but recommends no targets. Work is needed to map specific multimedia needs to the IP layer performance across all network components.

New work in ETSI and ITU-T

- ETSI STQ and ITU-T SG12 are both working on standards on end-to-end requirements for multimedia applications.
- This work will build upon the general guidance given in G.1010, the aim being to make recommendations on the true end-to-end QoS to be achieved to support multimedia.
- Scope should include home network, corporate network and terminal aspects.
- ETSI (and maybe SG12) will create a set of end-to-end QoS classes – these should be mapable to the Y.1541 IP layer classes.

New opportunities

Opportunities in the IP world

- Increased service innovation – faster and easier to introduce new services. Easy for third parties to develop services. If it will fit into an IP packet the network can carry it.
- Service packages can be tailored to suit a corporation's or single user's needs.
- Different quality levels can be provided over the same network.
- Potentially huge operational cost advantages.

Opportunities in the NGN world

- Adds telco robustness and performance to the many advantages of an IP network.
- Allows many services to run over one network.
- Enables fixed-mobile convergence, with terminal, service and user mobility.
- Allows support of many different terminal and access types.
- Offers users integrated voice, data, multimedia and TV services from a single supplier (or different suppliers if desired).

Some closing comments

Closing comments

- IP technology and NGNs offer cost and service advantages to network operators, service providers and users.
- QoS targets need not be tied to PSTN levels – although user requirements must still be considered. There is likely to be a need to still provide a plain telephony service (with PSTN reliability and performance) and to support fax, ISDN and other dial-up applications.
- Standards offer guidance on suitable QoS targets and how to achieve these across multiple networks.
- For many new services competition, innovation and user-specific tailoring can drive QoS levels.

Thank you for listening.

Any questions?

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