NORTEL NETWORKS

# *IP Telephony*
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# *Quality-of-Service Aspects*

***Bruce Pettitt***

# Overview - QoS for IP Telephony

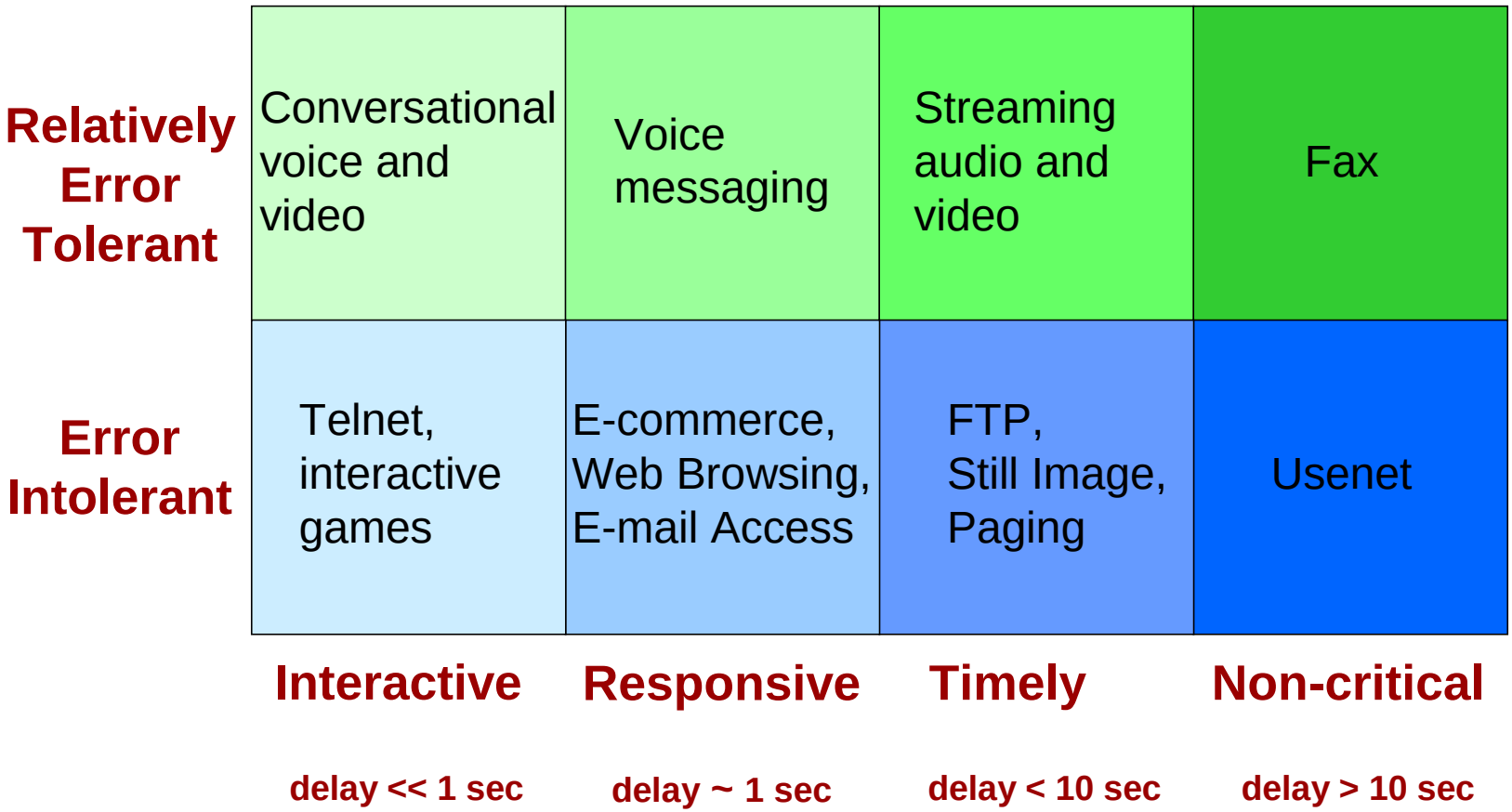
- **Background QoS Concepts**
- **Impact of Packet Loss and Delay**
- **The QoS Challenge for IP Telephony**
- **Technology Solutions supporting QoS**
  - speech coding
  - traffic engineering
  - QoS resource management
- **IP Telephony & QoS - Situation Analysis**
- **Summary - Major Issues**

# Background QoS Concepts

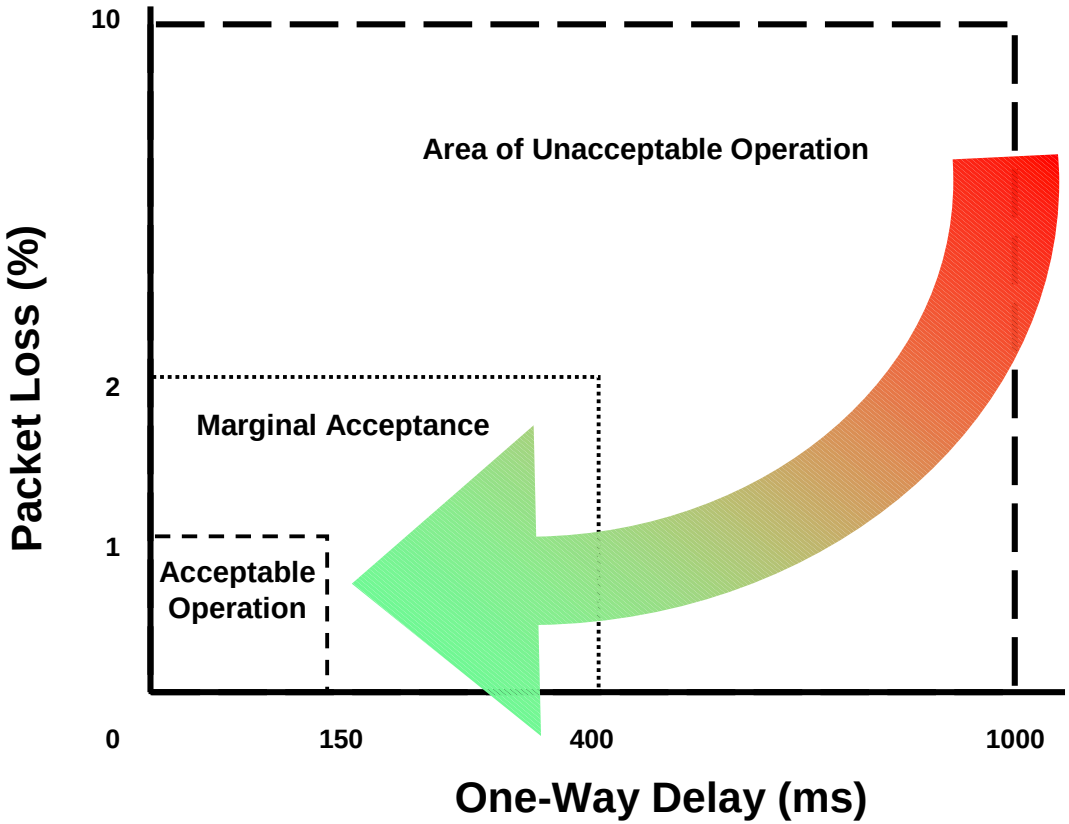
- Original “Best-Effort” Internet was designed
  - to guarantee network survivability
  - not to support high-speed, real-time applications
- New mechanisms now support “mission-critical” real-time, interactive applications
- QoS/Performance “guarantees” are described in Service Level Agreements
- IP Telephony presents QoS challenges, especially when inter-working with the traditional telephone network

**Quality of Service addresses:**
- **end-user satisfaction**
- **efficient operations / cost savings**

# Impact of Packet Loss (Error) and Delay
## - from the user perspective



# The QoS Challenge for IP Telephony




**Challenge:** Provide highly-reliable, ubiquitous, real-time service with acceptable speech quality while ensuring adequate performance for other traffic types.

# Technology Solutions supporting QoS

- Speech Coding Aspects
- Traffic Engineering
- QoS Resource Management

# Speech Coding Techniques

- **Traditional digital telephony at 64 kbit/s**
  - provides analog-to-digital conversion
  - using Pulse Code Modulation (PCM) technique
  - for “3.1-kilohertz” audio channel
- **Lower bit-rate encoding techniques**

  - good results obtainable at bit rates as low as 8 kbit/s
- **Wideband encoding schemes**
  - provide “Broadcast Quality” for 7-kHz channel

Lower bit rates typically involve some delay interval while a speech burst is observed - as well as additional processing delay to implement the encoding algorithm.

# Audio Demonstrations

- Samples of Encoded Speech
- Packet-Loss Effects
- Wideband Capabilities

# Samples of Encoded Speech

(1) PCM at 64 kbit/s - as a reference 

(2) 8 kbit/s speech codec 

- “Rice is often served in round bowls.”
- “The soft cushion broke the man’s fall.”
- “The small pup gnawed a hole in the sock.”
- “The meal was cooked before the bell rang.”

# Packet-Loss Effects

Reference without packet loss: 64 kbit/s PCM 

With 5% packet loss:

(1) 64 kbit/s PCM 

(2) 64 kbit/s PCM with packet-loss concealment 

(3) 8 kbit/s speech codec 

- "The term ended in late June that year."
- "Open the crate but don't break the glass."
- "Weave the carpet on the right-hand side."
- "Paste can cleanse the most dirty brass."

# Audio Demonstration - Wideband

- **Speech**
  - 64 kbit/s PCM for reference
  - 128 kbit/s wideband “broadcast quality”
- **Music**
  - 64 kbit/s PCM for reference
  - 8 kbit/s speech codec
  - 128 kbit/s wideband “broadcast quality”

# Traffic Engineering in IP-based Networks

- Capacity management / Network design
- Long-term planning to handle traffic growth
- Traffic measurement
- Traffic characterization / modelling
- Adaptive / dynamic transport routing

As normally applied to IP-based networks, the term “Traffic Engineering” has a broader meaning than in traditional telephony networks.

# QoS Resource Management

- Service differentiation / Priority mechanisms
- Resource allocation / Bandwidth reservation
- Admission controls
- Special QoS requirements for signalling
- Allocation of traffic to virtual networks

- Current standardization efforts are refining these techniques.
- Supporting signalling protocols are also being developed.

# IP Telephony & QoS - Situation Analysis

- Many different techniques, standards, and various supporting tools exist to address specific aspects of QoS for IP Telephony
- The solution in a particular case may depend critically on:
  - end-user service specifications
  - need for inter-working with other networks
  - requirements for integration with legacy infrastructure
  - size and complexity of the network
- QoS standards for IP Telephony need further refinement
- Network design remains quite complex - especially when several operators or administrative domains are involved
- Opinions vary on the need for fine-grained call control
- Wireless, cable, and digital subscriber loop systems present special requirements

# The Future of IP QoS - Major Questions

- **In the near term:**

  **Is "over-dimensioning" network bandwidth better, or more cost-effective, than the use of more complex "traffic-engineering/QoS" methods ?**

- **In the longer term:**

  **Can general IP-oriented QoS solutions be developed to enable true multimedia convergence ?**