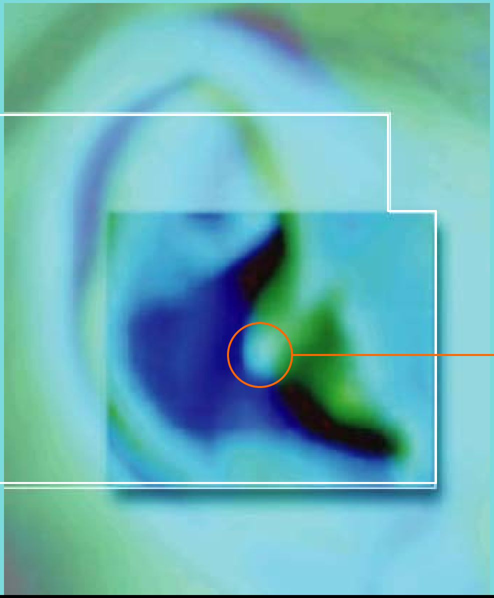


Playout Controller – QoS at the IP Edge Points

For networks with packet loss and jitter

Henrik Åström

GLOBAL IP SOUND

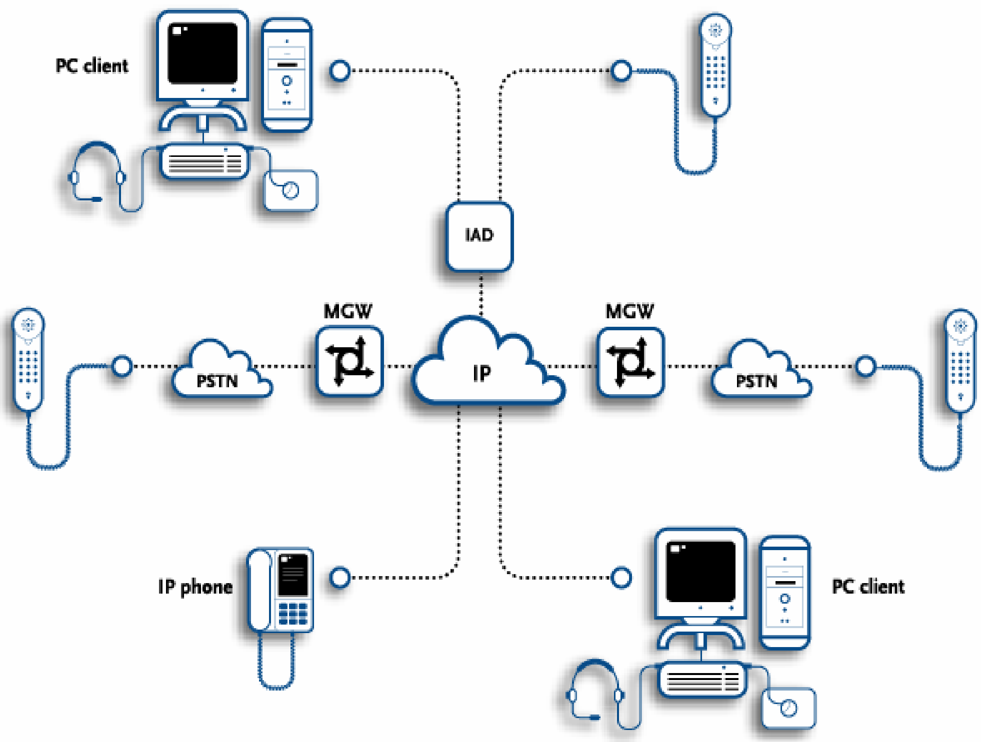
Speech Processing, Transmission and Quality Aspects (STQ) Workshop Feb 2003

Outline

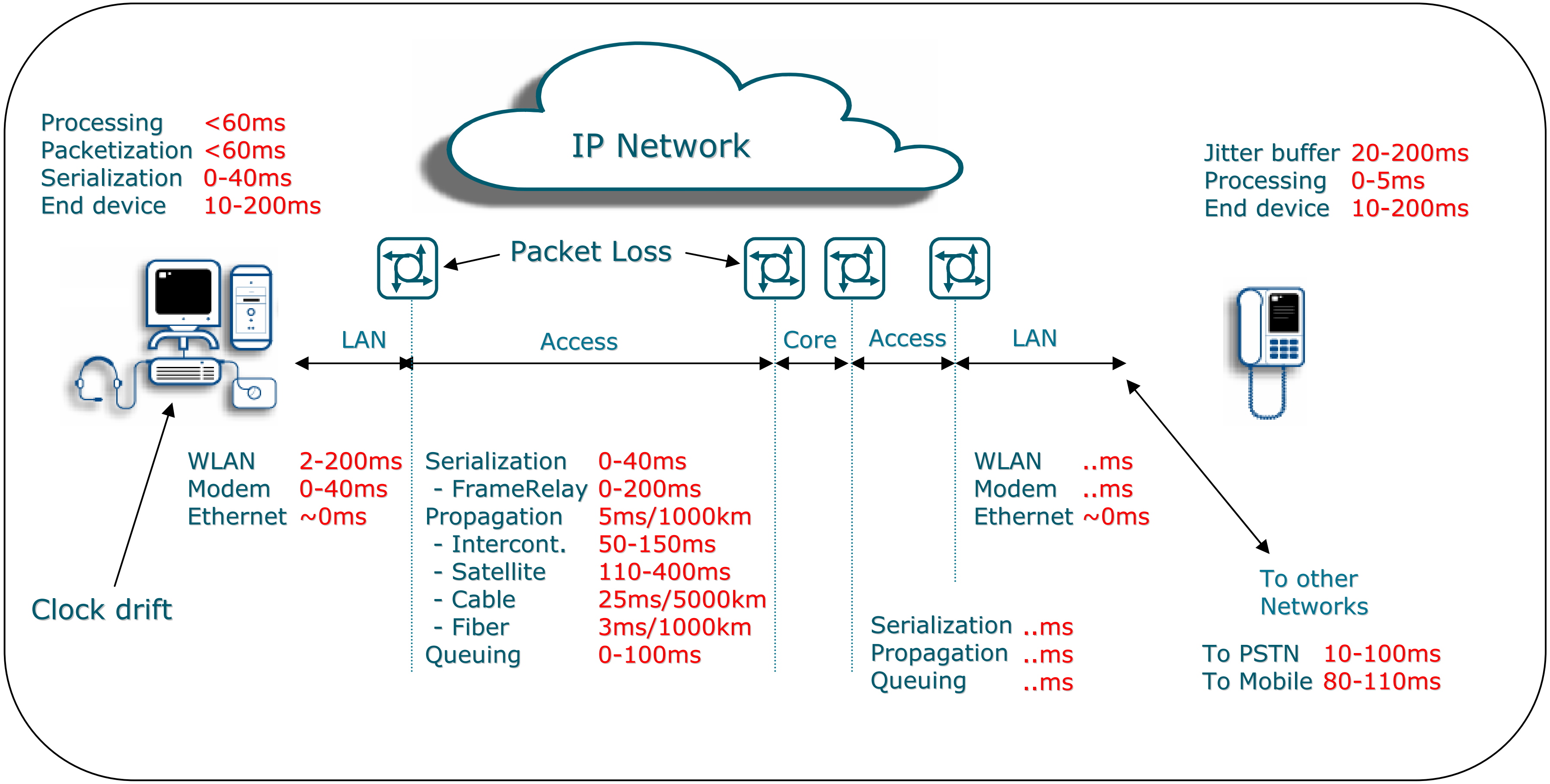
- VoIP Quality Issues
- Traditional Algorithms
- NetEQ Playout Controller
  - Speech Quality
  - Delay
  - Total Quality (with E-model)
- Conclusion

VoIP and Quality

- VoIP - flexibility, cost savings and new features
- Quality issues - delay, jitter, packet loss, clock drift
- Efficient algorithms - ensure the speech quality in VoIP
- Overprovisioning and tight network management expensive and inflexible
- Edge point Playout Controller Solution to lots of the Problems



Delay & Packet Loss Sources

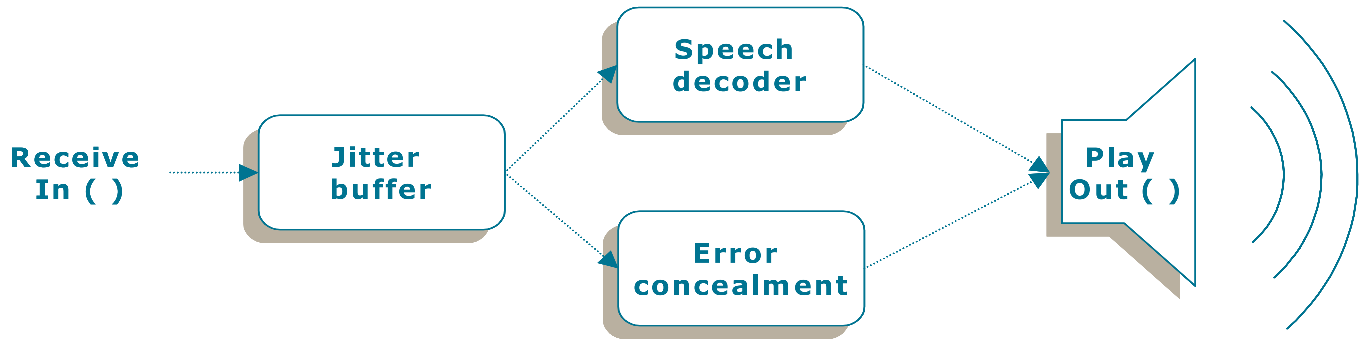


The packets can be lost due to queing effects at the access points and in the routers. Packet loss also occurs when there are bit errors during the transmission (mostly for WLAN and satellite transmissions)

Traditional Jitter Buffer & PLC Approach

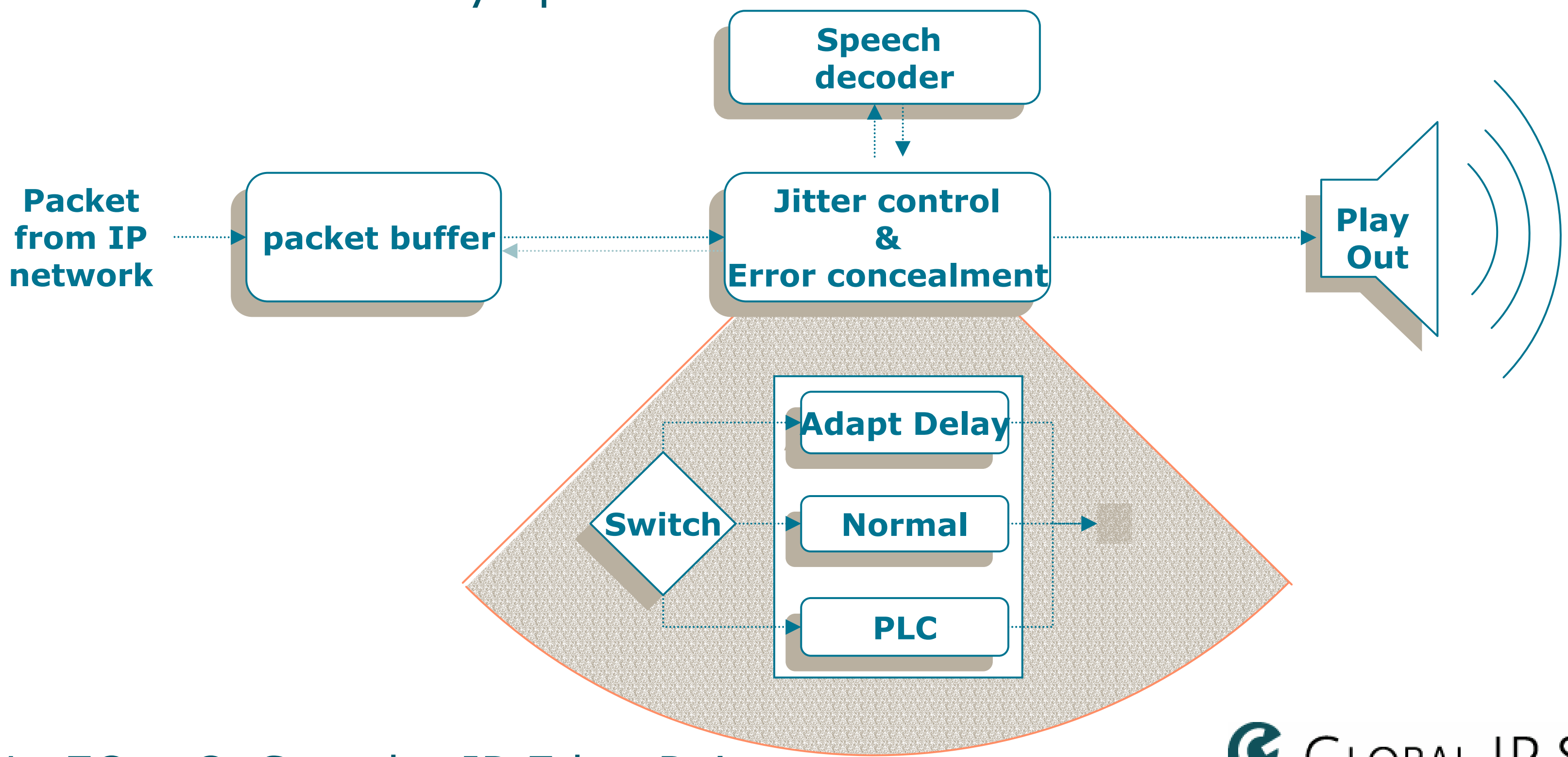
Traditionally - Jitter Buffer and PLC, two separate units

- Jitter Buffer
  - Fixed – simple, high delay, not flexible
  - Adaptive – lower delay, each adaptation gives distortions
- Packet Loss Concealment
  - Zero Stuffing – bad quality
  - Packet Repetition – up to 2-3% packet loss
  - G.711 Appendix I – better quality
  - Built-in PLC – codec dependent



NetEQ Approach

- Playout Controller - Combined Delay Adaptation and PLC
- Integrated Design - Cooptimizations
- Signal Processing techniques enables good quality
- Better performance, Delay and Packet Loss Concealment
- Works with any speech codec

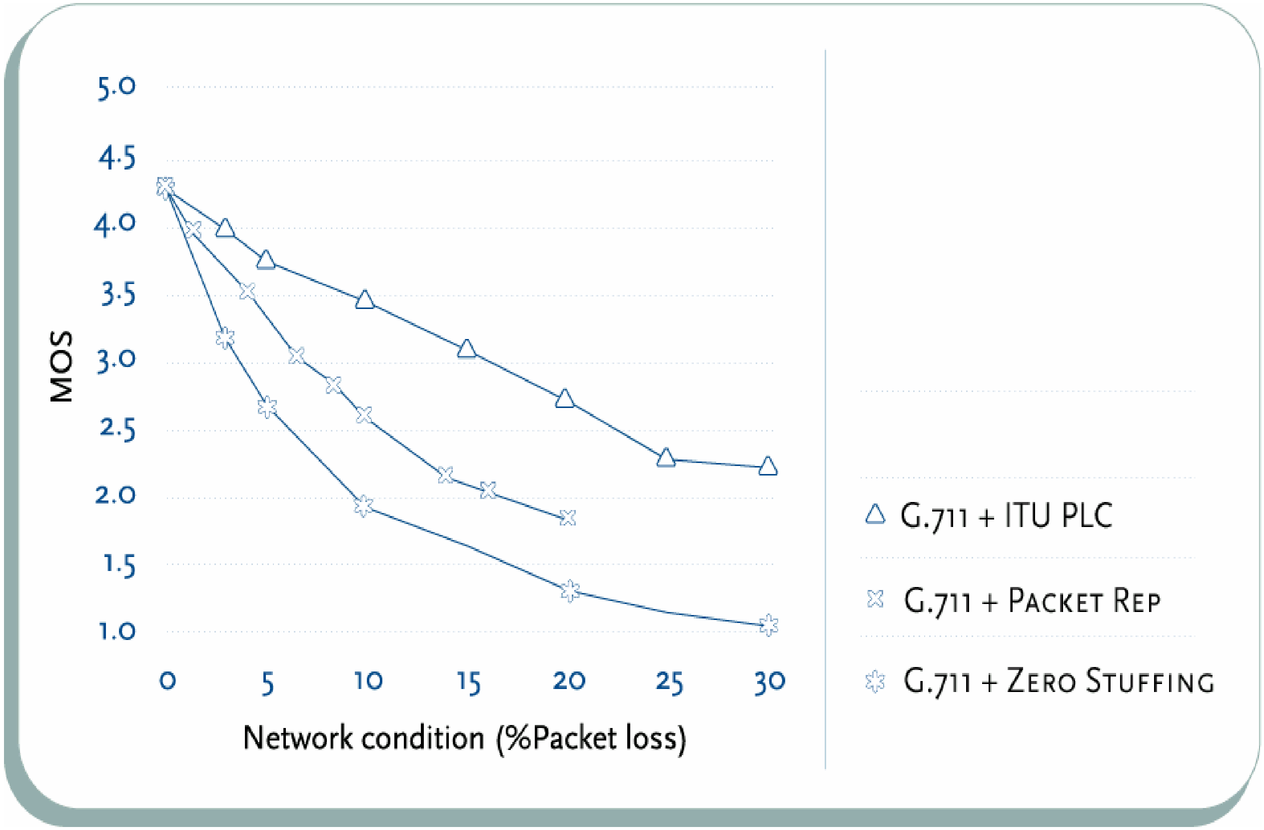


NetEQ vs Traditional Methods

Traditional Algorithms	NetEQ Playout Controller
1. Operation @ Packet level (10-60 ms)	Operation on Decoded Speech Resolution (1-2 ms)
2. Delay Modified by Adding/Dropping Packets	Signal Processing to Increase/Decrease Delay
3. Error Concealment on Packets	Error Concealment on Speech/Audio
4. Clock Drift/Skew can cause Delay and Quality Problems	Automatic and Instant Adjustment to Clock Drift/Skew

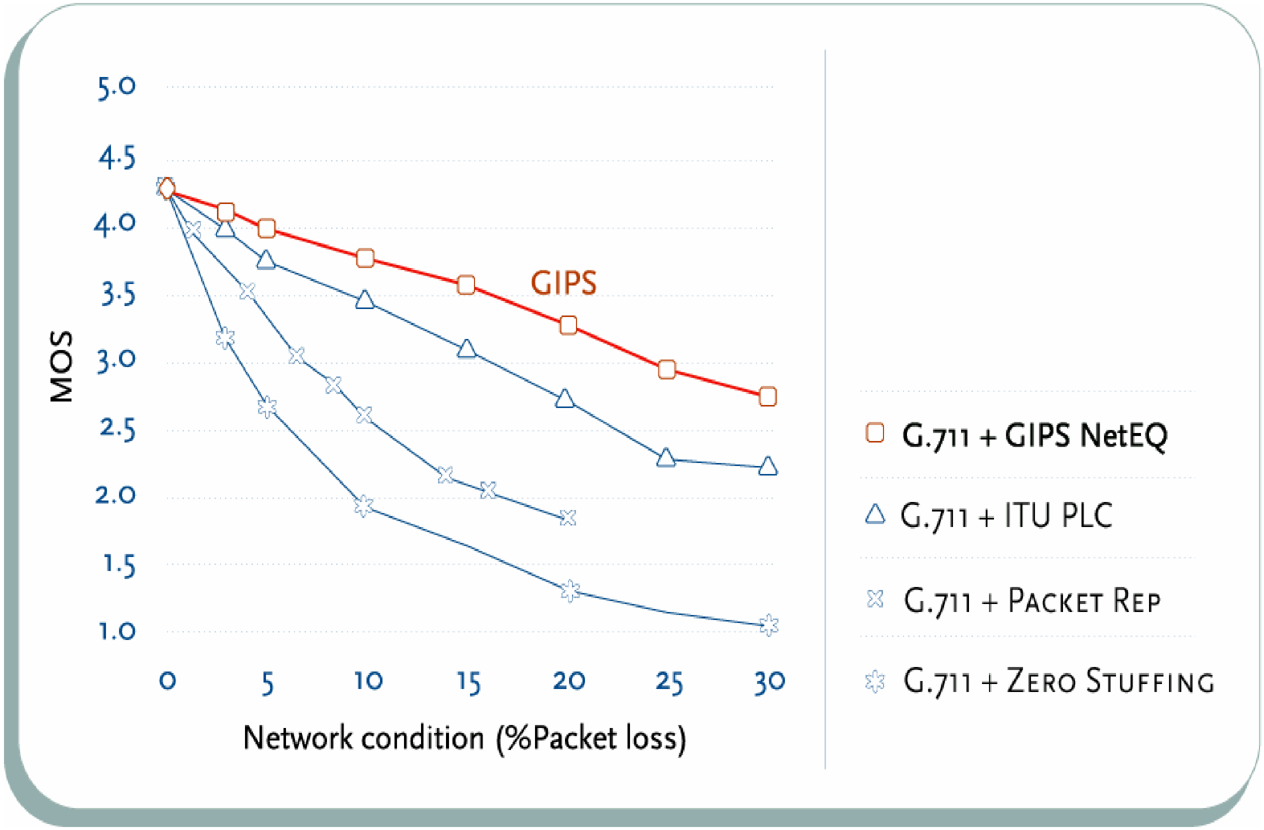
Voice Quality During Packet Loss

Results of Listening Test at COMSAT



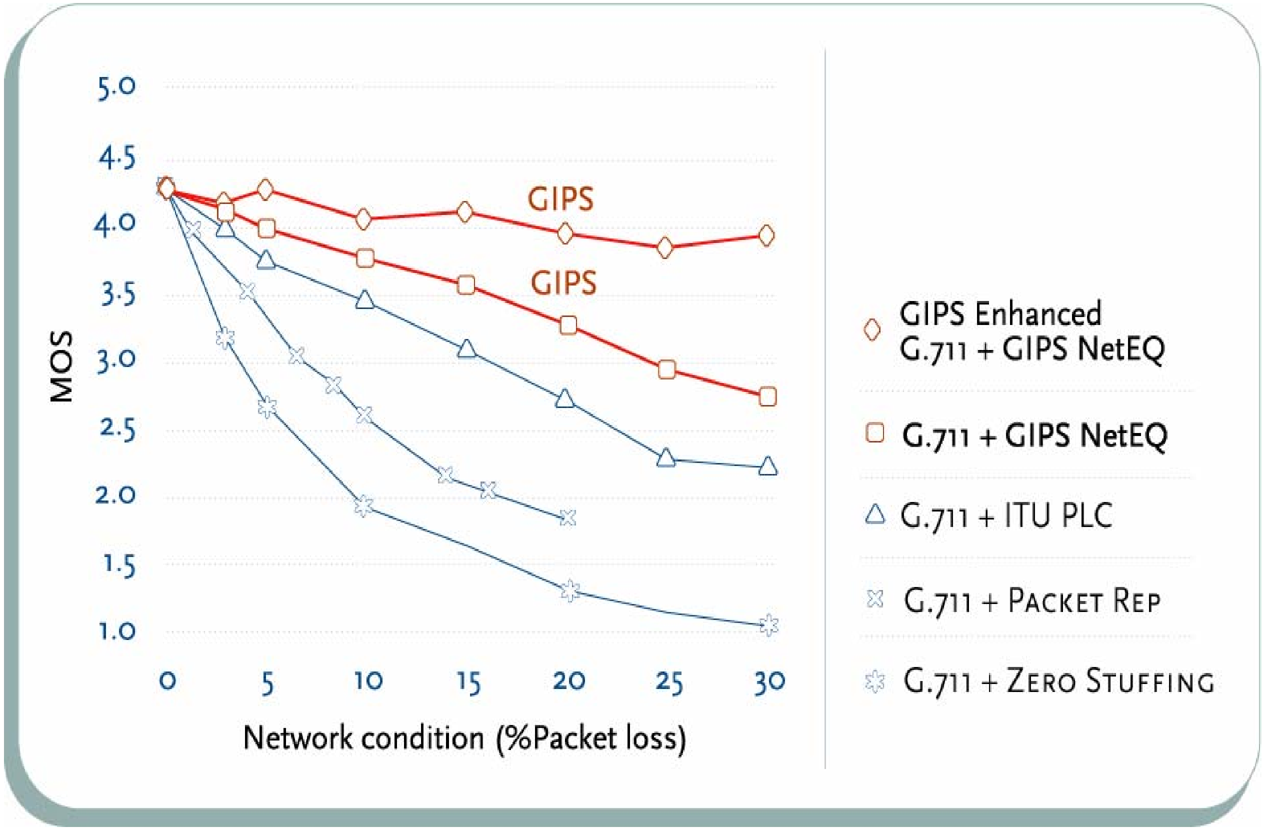
Voice Quality During Packet Loss

Results of Listening Test at COMSAT

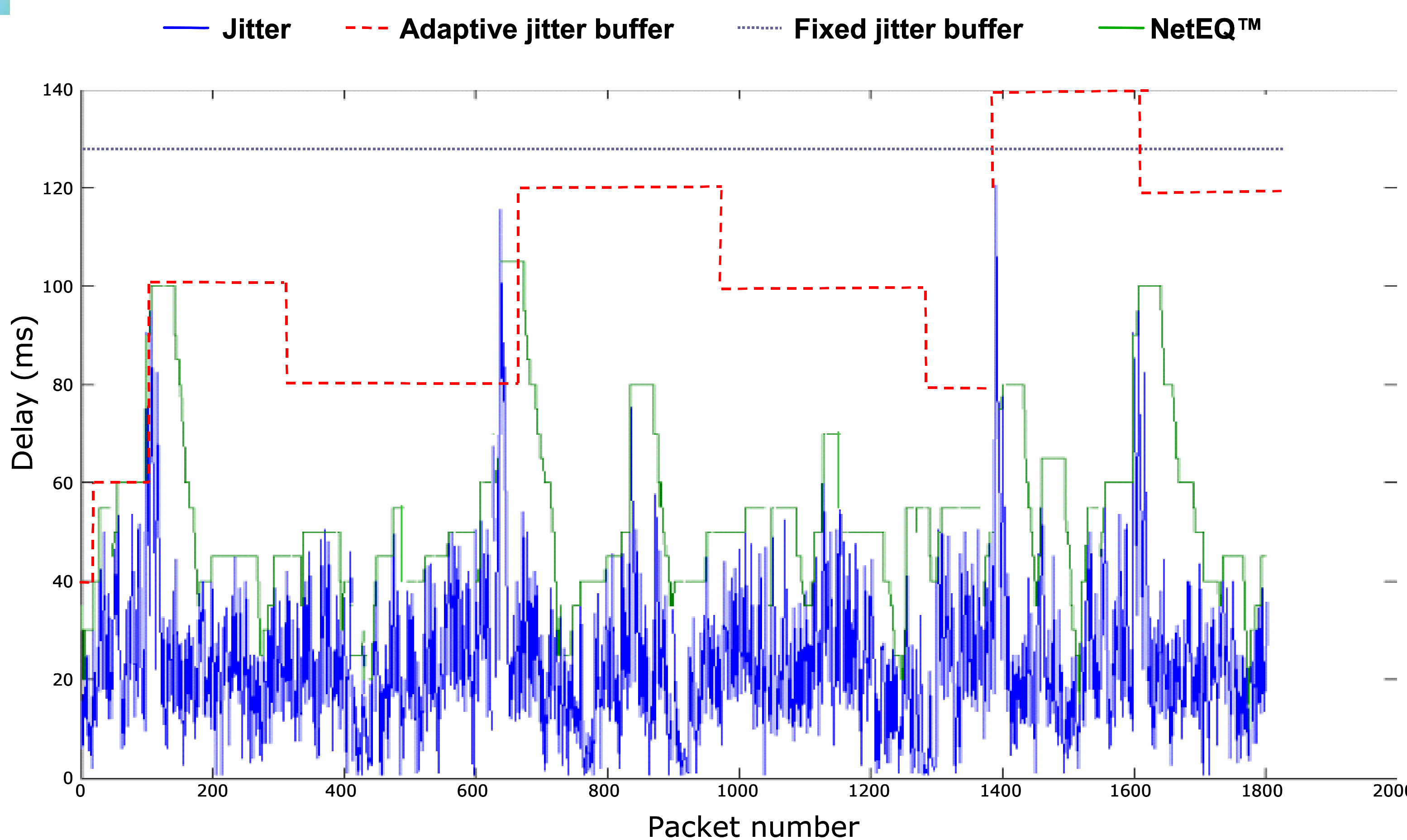


Voice Quality During Packet Loss

Results of Listening Test at COMSAT



Delay Performance



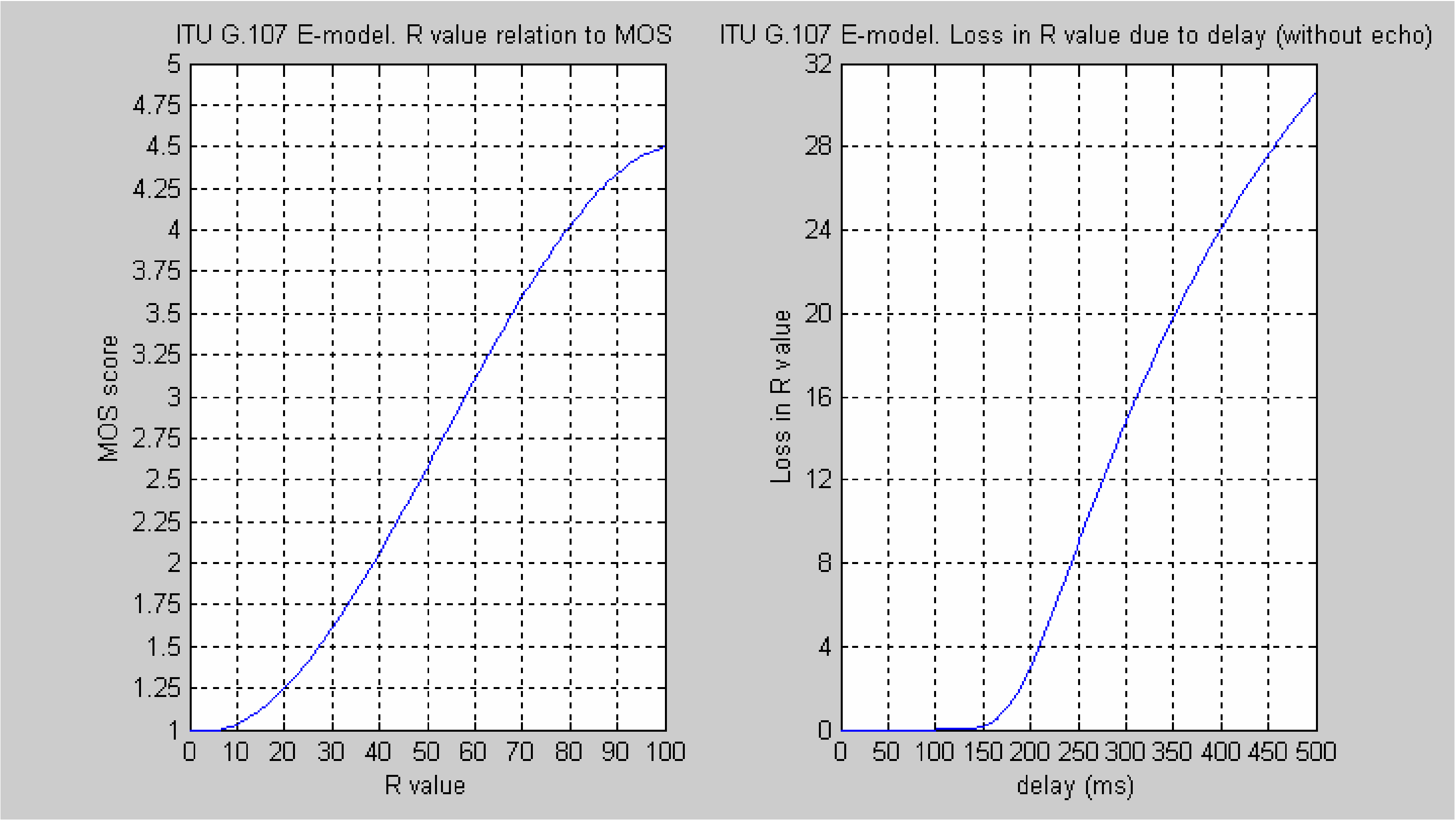
Fixed one-way delay 80 ms.

NetEQ's Delay ~150ms, Adaptive Jitter Buffer ~190 ms

ITU E-Model

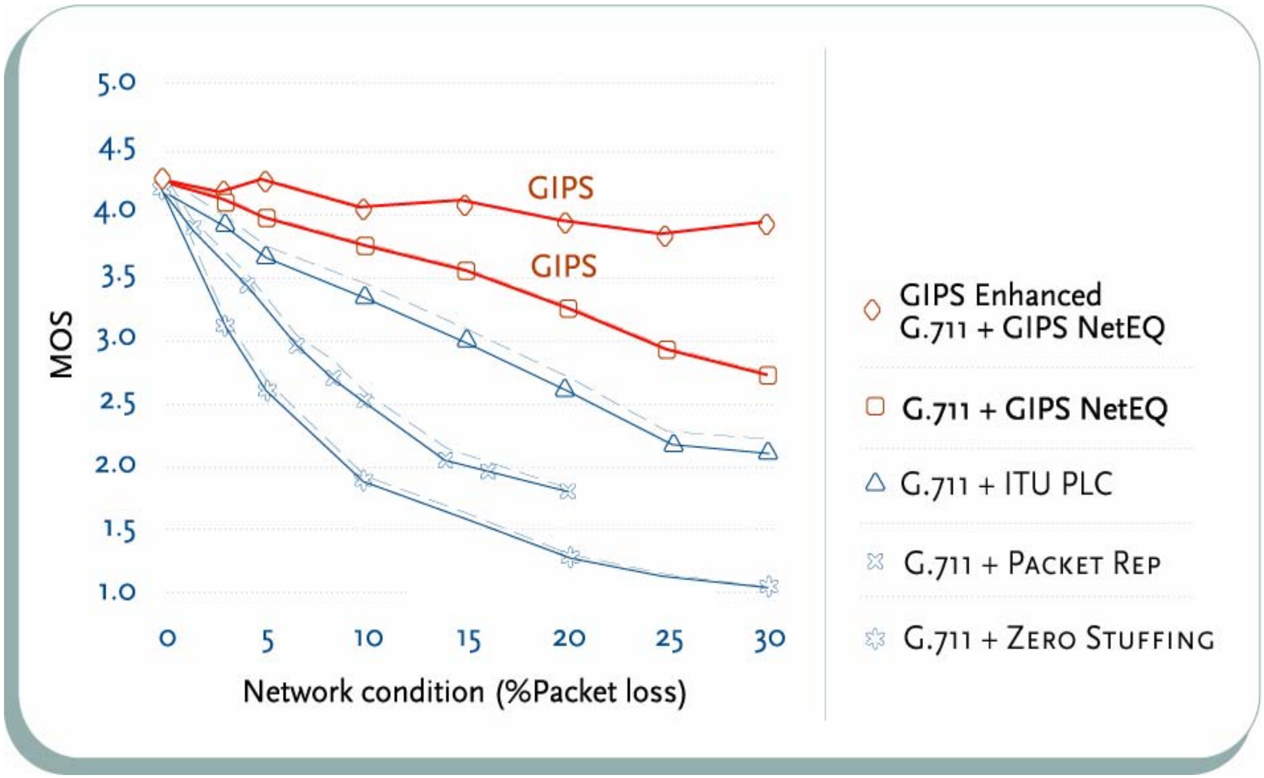
- Delay also affects the quality. This is not shown in a MOS test

R = Ro – Is – Id – Ie,eff + A



Delay Adjusted MOS Score

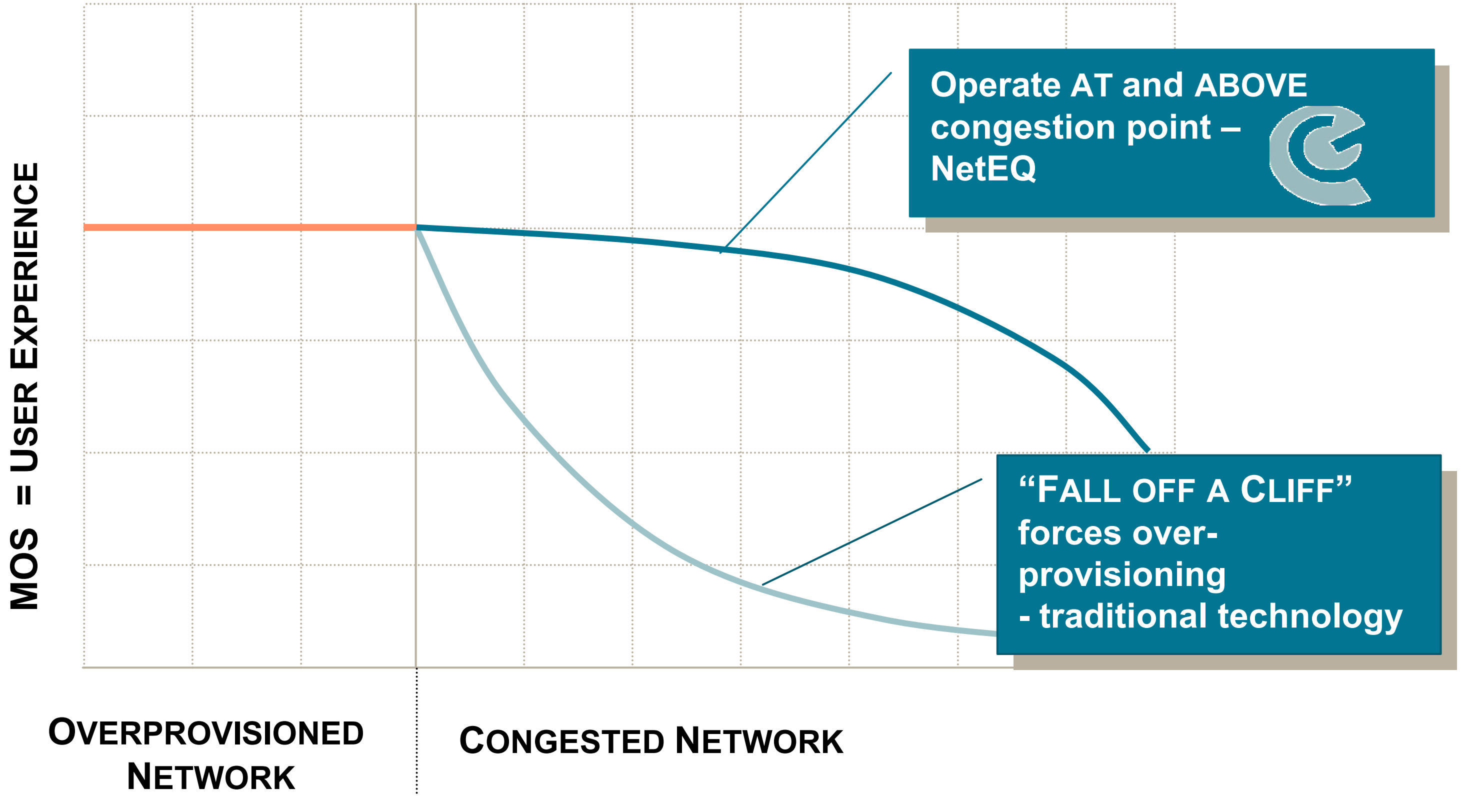
- The E-model + normal MOS chart give delay modified MOS
- NetEQ has lower delay, this keeps the total quality higher



Using values from jitter chart. NetEQ has average 150 ms delay, standard adaptive jitter buffer has 190 ms delay

Summary

- Important - Low Delay and good PLC
- Advanced Playout Controller - Higher Quality and Better Bandwidth Utilization
- Demo



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