

Real-Time Perceptual-Based Objective Methods for VoIP Assessment

Dorel Picovici
21st June 2005



Outline

- Rationale
- Subjective Speech Quality
- Disadvantages of Subjective Speech Quality
- Objective Measures of Speech Quality
- Need for Non-Intrusive Speech Quality Measurement
- Speech-layer, Packet-layer approach using Intel IXP 2400 NP
- Performance Evaluation
- Conclusions

Rationale

- In a highly competitive telecommunication market, the quality of service (QoS) is a critical differentiating factor
- One of the most important dimensions of the QoS is perceived quality of the communicated speech
- Perceived quality of the communicated speech has been traditionally estimated by subjective listening tests
- Automatic objective methods are a realistic alternative to the subjective listening or conversational tests

Subjective Speech Quality

- The perceived quality of the communicated speech has been traditionally estimated by subjective listening tests
- During these tests human participants (subjects) rate the quality in accordance with a defined opinion rating scale
- The most commonly used scales are recommended by the ITU-T, which are basically 5-point category scales:

	Listening-only	Conversational	
Subjective	MOS-LQS	MOS-CQS	<p>5 - Excellent 4 - Good 3 - Fair 2 - Poor 1 - Bad</p>
Objective	MOS-LQO	MOS-CQO	
Estimated	MOS-LQE	MOS-CQE	

Why Subjective Speech Quality Assessment is Not Practical ?

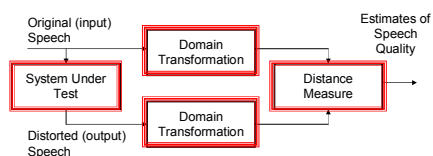
- Subjective Listening Tests are too expensive to run
- A large numbers of subjects must be employed
- Results depends on many uncontrollable attributes of the test subjects including mood, attitude, and culture
- Different aspects of performance are dependent on the opinion scale used
- It will be practical if an automatic assessment exists whereby measures of perceived quality of speech could be obtained

Objective Speech Quality Measure

- Most existing objective assessment methods require measuring some form of distortion between the transmitted and received speech
- Such measures are referred as "input-to-output" assessment
- An Input-To-Output measure typically involves:
 - Normalization of signals powers
 - Time alignment between input and output
 - Computation of one or more objective parameters
 - Distance measure to estimate equivalent subjective quality score

Objective Speech Quality Measure ... continued

- Processing of the speech signals is comonly done in either: Time domain, Spectral domain or Perceptual domain
- Perceptual domain measures have been shown to give the best prediction of subjective quality of speech



Need for Non-Intrusive Speech Quality Measure

- Disadvantages of Input-To-Output quality assesment appraoches:
 - synchronisation between the input and output is not easy
 - situations where original speech is not available
 - it is not always possible to have access to both ends of a network
- In Today's telecom networks there are situations where:
 - too many connections must be monitored
 - specific network behaviour may only occur at specific times
- Having non-intrusive assessment means:
 - use only in-service (received) signal
 - low price non-intrusive units can monitor quality all the time

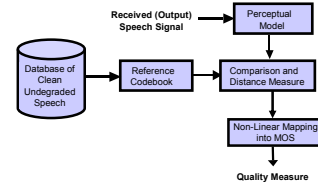
Non-Intrusive Speech Quality Measures

Non-Intrusive objective speech quality measures:

- Speech-layer models: require speech signals to produce estimates of MOS
 - ITU-T Recommendation P.862: PESQ
 - ITU-T Recommendation P.563: 3SQM
- Packet-layer models: exploit IP packet characteristics to produce MOS

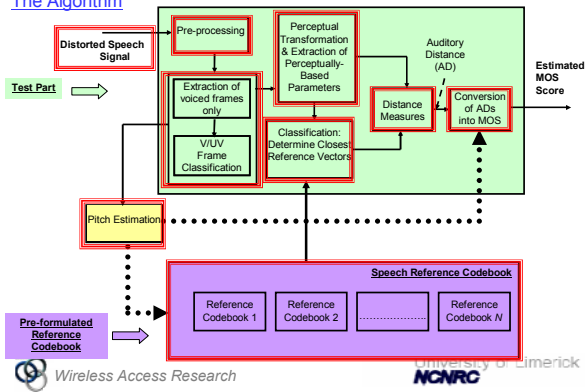
Speech-Layer Non-Intrusive Speech Quality Measure

The System

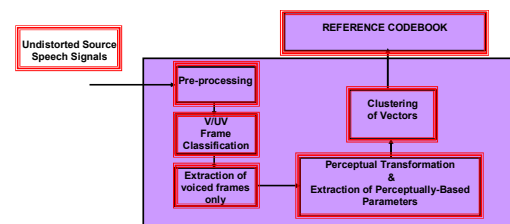


Speech-Layer Non-Intrusive Speech Quality Measure

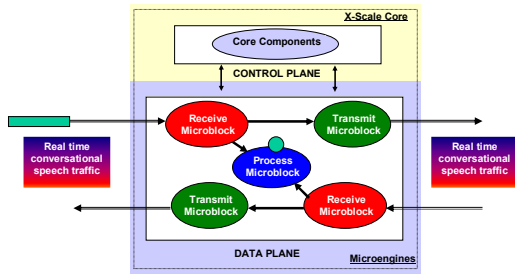
The Algorithm



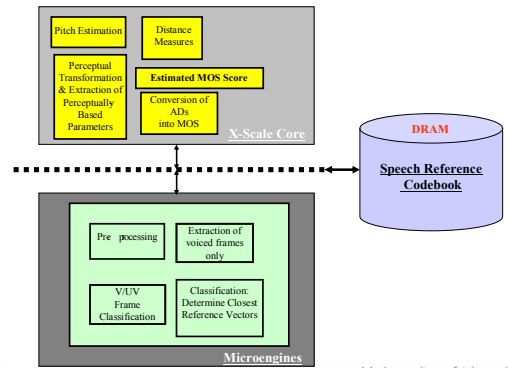
Formulating the Reference Codebook



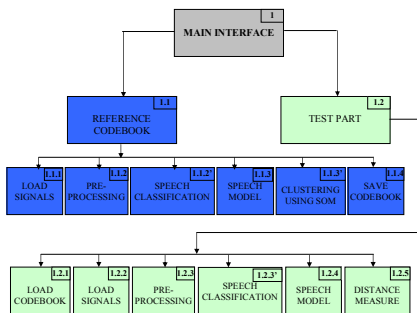
Implementation on the Intel IXP2400 NP



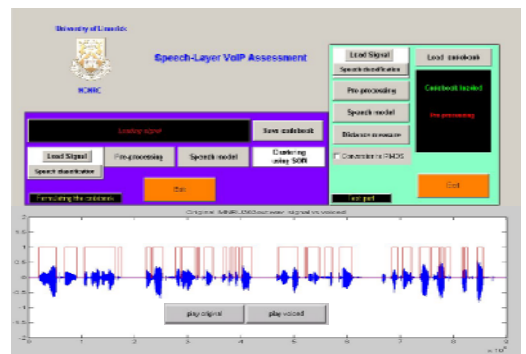
Implementation on the Intel IXP2400 NP



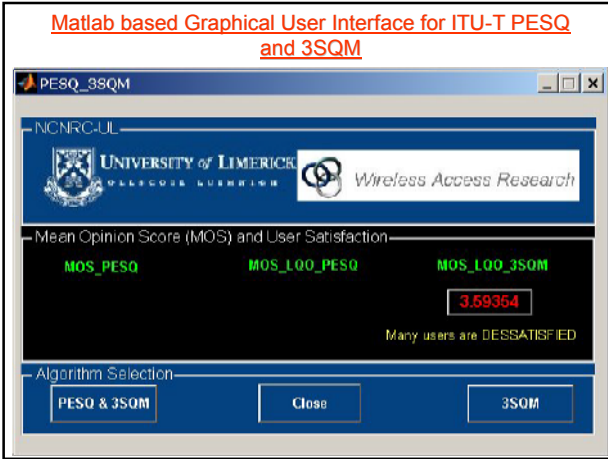
Matlab based Graphical User Interface



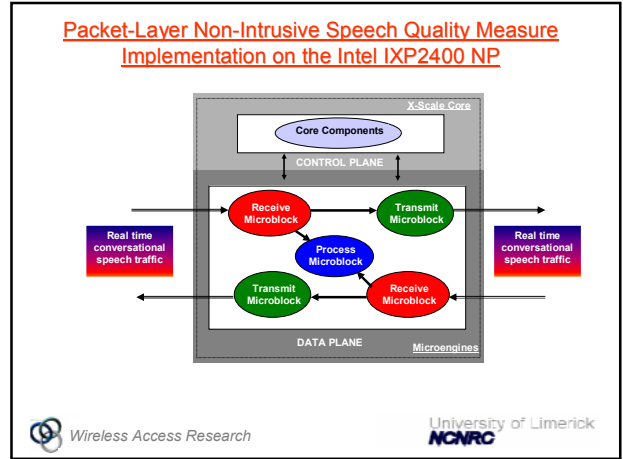
Matlab based Graphical User Interface



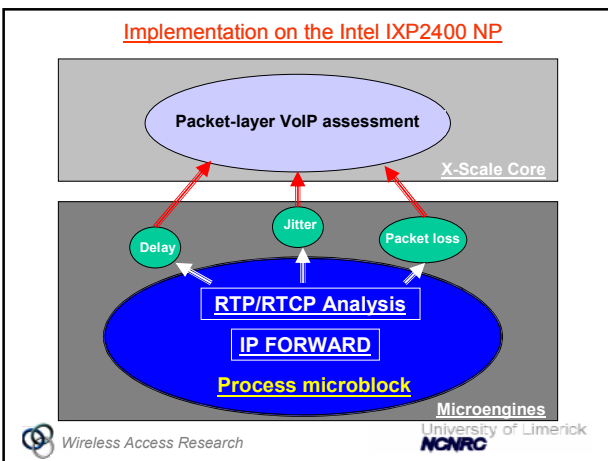
Matlab based Graphical User Interface for ITU-T PESQ and 3SQM



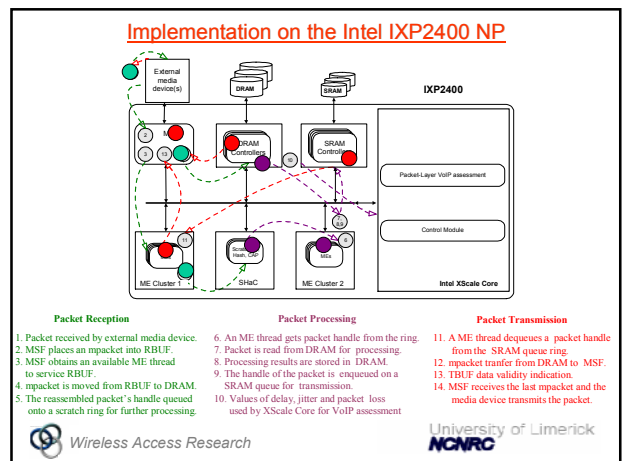
Packet-Layer Non-Intrusive Speech Quality Measure Implementation on the Intel IXP2400 NP

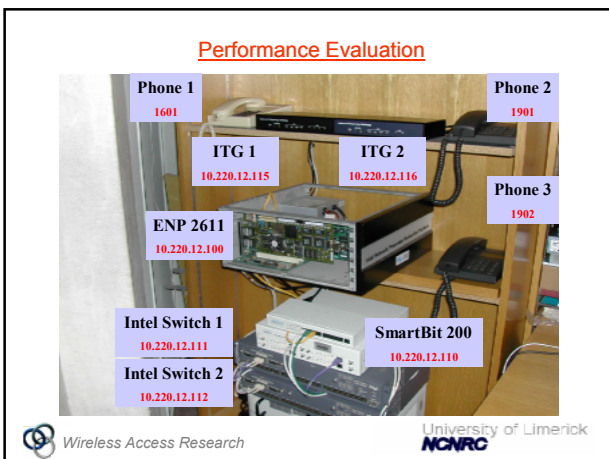
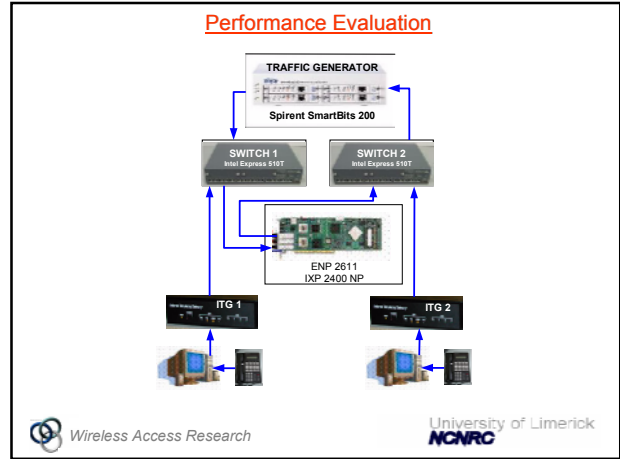
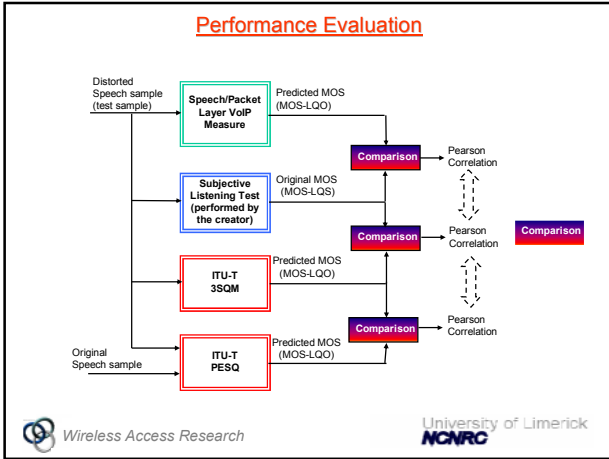


Implementation on the Intel IXP2400 NP



Implementation on the Intel IXP2400 NP





Conclusions

- A total of four tests were carried out to evaluate the performance of the IP Forwarding.
- Tests were carried out using "SMB-200" packet generator and "smart applications" software.
- These tests are: -
 - ✓ Throughput test
 - ✓ Latency test
 - ✓ Packet Loss Test
 - ✓ Back-to-back test
- Each test was run for the full range of packet sizes from 64 to 1,518 bytes.

Logos for Wireless Access Research and University of Limerick NCNRC are present at the bottom.

Conclusions

- delays bigger than 150 ms would affect the user satisfaction.
- ✓ delay in the microsecond range which is the signature of high speed forwarding engines.
- ✓ negligible impact on the performance perceived by the user.
- ✓ relatively independent of packet size.

Thank You !