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End to End Wideband speech quality enhancements

Enterprise Environment

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Agenda

- Introduction
- Enterprises communication Environment
  - IP PBX
  - Terminals
  - Networks
- Narrow Band VoIP Enhancements
  - Signal issues
  - Network issues
  - Diagnostic tools
- Wide Band VoIP Enhancements
- Conclusion

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Introduction

- Objectives of this presentation are to :
  - provide some background on the Alcatel-Lucent VoIP telephony Solutions for Enterprises.
  - Give an overview of VoIP quality issues encountered from the field.
  - Show how the voice quality issues were enhanced and fixed including troubleshooting aspects
- Finally give some Guidance on QoS enhancements foreseen for Wideband class in Enterprises environment.

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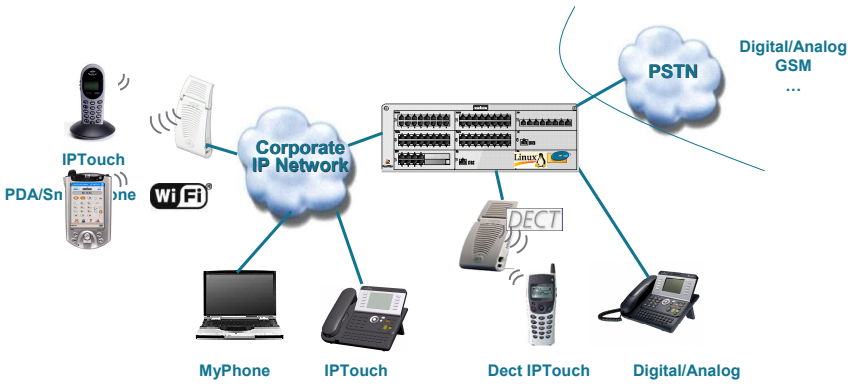
Alcatel-Lucent Omnipcx



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Enterprise IP Telephony

- Alcatel-Lucent Enterprise End Users
  - Wire lines
    - Proprietary Digital & Analog
    - HW IP phones IPTouch
    - MyPhone (PCs, Laptops)
  - Wireless
    - Dect
    - WIFI
      - IPTouch
      - Smart phones
      - PDAs
      - Laptops
  - External access
    - Internet
    - Digital (E1/T1)
    - Analog trunk
    - GSM
    - IP Trunking

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e2e Degradation factors and Origins

	Network	Signal Processing	Environmental
Delay (echo perception & Double Talk)	✔	✔[1]	
Delay Variation	✔	✔[2]	
Packet Loss	✔		
Signal Distortion	✔	✔	
Back ground Noise			✔
Acoustic			✔
Music			✔
Tandeming	✔		
Bandwidth Optimization		✔	
DTMF Relay (Bad Digit)		✔	
DTMF Relay (Double Digit)		✔	
Fax Relay (Tones misclassification)		✔	

Note 1: Due Essentially to codecs (packetization, look a head, processing)
Note 2: Non real Time Operating Systems I.e. SoftPhones

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Solution Functions

	Function	Gateway	Terminal	Complexity
Delay echo perception & Double Talk)	Echo cancellation	✓	✓	High
Delay Variation	Dynamic De-jittering	✓	✓	Medium
Packet Loss	Packet loss concealment	✓	✓	Medium
Signal Distortion	Waveform fitter, AGC	✓	✓	Low
Back ground Noise	Noise Reduction, CNG	✓	✓	High
Acoustic	AEC, AGC, Equalization	✓	✓	Medium
Music	classification enhancement	✓		Medium
Tandeming	TFO	✓		Low
Bandwidth Optimization	Low bitrates codecs, VAD	✓	✓	High/Medium
DTMF Relay (Bad Digit)	Voice Immunity	✓		Medium
DTMF Relay (Double Digit)	Enhanced PLC	✓		Medium
Fax Relay (Tones misclassification)	classification enhancement	✓		Medium

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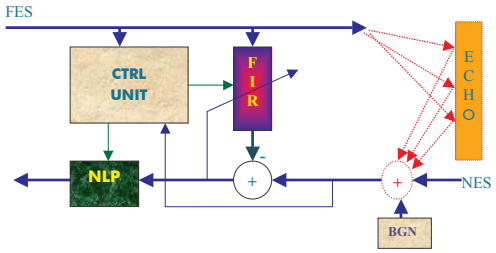
Echo Cancellation



FES: Far End Signal
NES: Near End Signal
BGN: Back ground Noise
NLP: Non Linear Processing

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Echo Cancellation

- Alcatel-Lucent Echo Cancellation
  - enhanced High Performance Echo Cancellation 128ms
    - designed to remove echo up to 128ms echo tail.
    - It runs on Media Gateway DSP & PC platforms
    - Embedded Signal metrics & diagnostic tools
    - Tests
      - G.168 2004 full compliance as minimum requirement
      - Subjective tests
      - Noise based tests (ALU Database)
  - Robust Double Talk Detection & NLP
    - Included in the echo cancellation module
    - Tests
      - Objective tests (based on the signals correlation)
      - Subjective stress tests : voice clipping, background noise ....

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Echo Cancellation (Cont'd)

- Alcatel-Lucent Echo Control for Low-end terminals
  - AEC
    - Designed to Removes acoustic echoes up to 400ms
    - Robust to signal distortion (Low end equipment)
    - Low complexity (Smart phones, PDAs ...)
    - Subjective Tests
      - Echo
      - Double talk situations
      - Signal levels

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Echo Cancellation WB evolution

- Echo Cancellation:
  - Use of Bi band decomposition for Medium complexity
    - Each band is processed mainly like a NB version
    - Extra delay is introduced by the decomposition and synthesis filtering
  - Adaptation of the existing EC
    - Filtering coefficients size
    - Extra consumption : ~ 4 * MIPS more than NB
    - Double Talk Detection & NLP
      - Noise analysis/Comfort noise generation
  - Diagnostic tools: idem to NB
  - Characterization :
    - Which standard? G.168++ for network and G.167? For terminals
    - Objective and subjective tests

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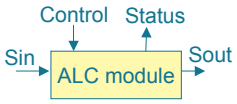
Signal Enhancement

- Automatic Level Control (ALC)



  - The ALC is a speech processing network module that belongs to voice enhancement devices (VED)
  - Automatic level control algorithm is designed to work in conjunction with the system echo canceller
  - The goal of the desired ALC is to adapt the gain of the signal if its energy is too high (above a defined upper threshold)
  - the ALC algorithm should only modify gain during speech periods and keep the gain unchanged during silence period: (it includes a VAD)
  - Compliant with G169 recommendation
  - Objective (ALU proprietary) and subjective tests done with/without echo canceller
- WB Portability
  - The included VAD to be adapted
  - Testability : G.169 + ?

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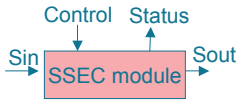
Signal Enhancement (cont'd)



- Signal Saturation Effect Cancellation (SSEC)
  - The SSEC is a signal processing module that removes saturation effects
  - The SSEC includes an ALC (AGC) and a Saturated Sample Cancellation module (SSC)
    - The ALC (AGC) reduces the signal level if necessary.
    - The SSC removes each saturated sample and replaces it with its linear prediction
  - The SSEC reduces the non linearity introduced by the saturation
  - Improves subjective voice quality
  - Improves the echo cancellation quality and stability
- WB Portability
  - A VAD is included in the AGC block
  - Testability :
    - Subjective tests
    - Objective tests to check impacts on the Echo Cancellation

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Tones Detection & generation

- Tones Detection WB portability
  - Modules can be recoded to detect tones in WB
  - Use of down sampling
    - The input signal can be down sampled by 2,
    - and the detection will be done on the 0-4kHz band using modules of NB.
- Tones Generation WB Portability
  - Modules can be recoded to detect tones in WB
  - Use of up sampling method
    - Generate tones on the 0-4kHz band using NB modules
    - And up sample the generated signal by 2
- Testability :
  - Test equipment must be WB compliant.
  - Objective tests to check impacts on the Echo Cancellation

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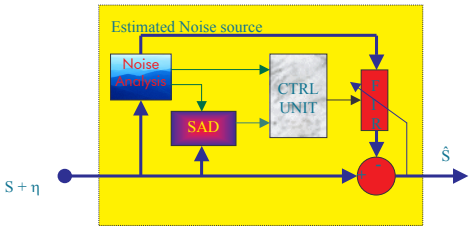
Noise Reduction

- The ALCATEL-LUCENT Noise reduction



  - Avoid extra delay processing
  - Extract estimated noise source from the input signal
  - WB Portability :
    - Noise analysis to be recoded
    - Adaptive filter to be adjusted
  - WB testability

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Network perturbation

- PLC
  - Packets loss during transmission is due to network errors, route changes, link failures or routers congestion
  - PLC generates a synthetic voice signal to replace missing packets
    - PLC is built in G.723 and G.729 Codec
    - for G.711, Annex 1 describes the PLC
  - WB CODECs include PLC

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Bandwidth optimization

- Voice Activity Detection (VAD)
  - Voice and silence/noise are discriminated
  - Silence or ambient noise is characterized and a descriptor is sent
  - Next silence frames are not sent
  - Voice quality must be favored
  - WB Portability
    - VAD is built in main WB CODECs
    - Noise characterization must be adjusted to WB situation
- Comfort Noise Generation (CNG)
  - Comfort noise is generated when receiving SID or silence frame
  - Noise generation must be adjusted to WB situation

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NB Embedded Diagnostic tools

- Necessary in development & integration phases
  - Based on real word captured signals from the field experience
  - Easy to analyze in simulation mode
- QoS monitoring and troubleshooting
  - Non intrusive
    - for customer System management and statistics
    - Problems anticipation
    - In both directions (TDM <=> IP)
    - Signal metrics captures during each call
      - Signal level
      - Noise level
      - Echo(es) Return loss
      - Echo(es) Delay
      - …

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NB Embedded Diagnostic tools (cont'd)

- QoS monitoring and troubleshooting
  - Intrusive
    - Provide probes for all signal processing modules inputs/outputs
      - TDM signal in/out analysis
      - Codecs tests vectors play out for real word verification
      - Signal processing modules parameters History
        - Echo Canceller coefficients
        - Pre/post processing signal
        - Impulse response
        - …

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Conclusion

- WB foreseen enhancements
  - Acoustic Control
  - Noise Control
  - ALC
  - NB/WB Interoperability
  - Enhancement complexity
    - Do we need centralized Signal processing functions in the network (G.160?)

- QoS monitoring and troubleshooting adaptation
  - Non Intrusive Signal & Network metrics
  - Intrusive same as for NB

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- THANK YOU

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