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Quality comparison of wideband coders including tandeming and transcoding

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Wideband codecs

- Last year, wideband extensions of narrowband codecs have been standardised
  - G.729.1
    - providing high packetized wideband voice quality with scalability and interoperability with existing G.729 based VoIP networks and terminals
  - EVRC-WB
    - providing wideband in 3GPP2 networks using the same rate set as the current EVRC.
- Other ITU-T wideband codecs
  - G.722
    - Mainly used in conference call, but introduced also in VoIP networks
  - G.722.2
    - providing wideband in 3GPP networks (also called AMR-WB)

summary

1. Comparison of Wideband codecs
   - G.729.1, G.722 & G.722.2
   - EVRC-WB, AMR-WB & VMR mode0
   - G.722 PLC
2. Impact of transcoding and tandemming
   - Self tandeming
   - transcoding
3. Comparison of wideband codecs with narrowband codecs

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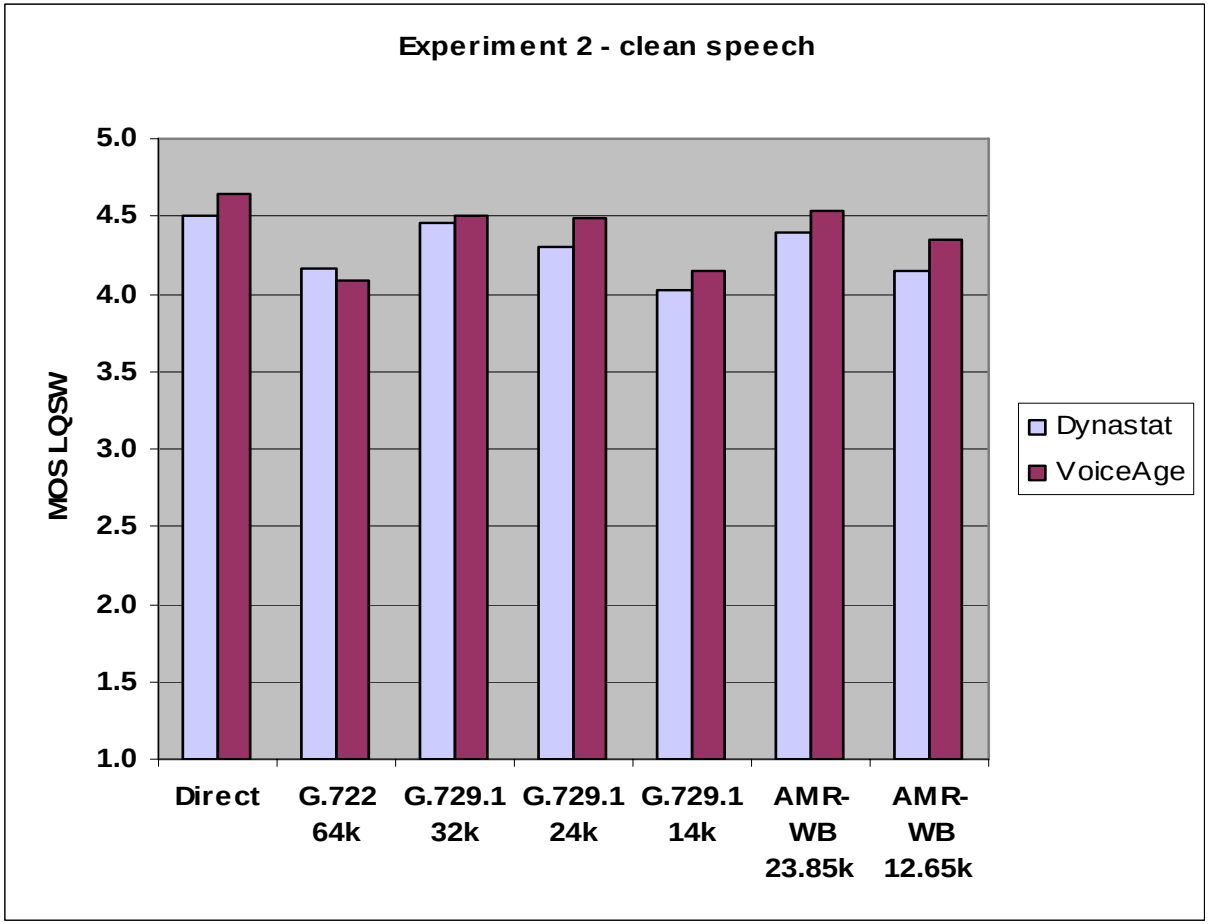
Comparison of Wideband codecs

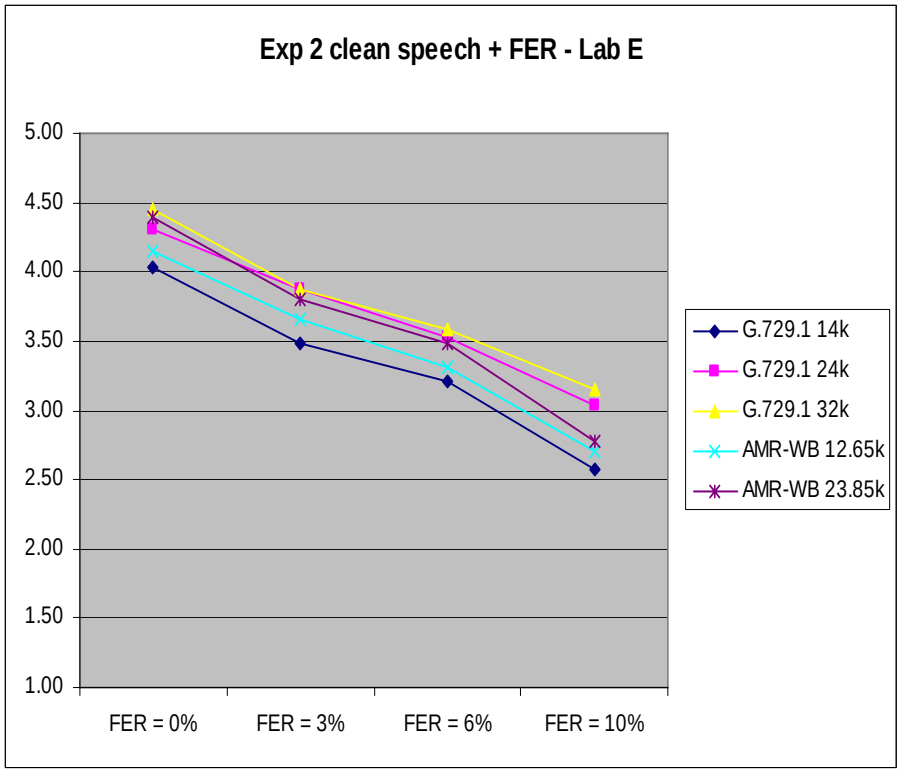
Compared Subjective WB quality of G.729.1, G.722 & G.722.2

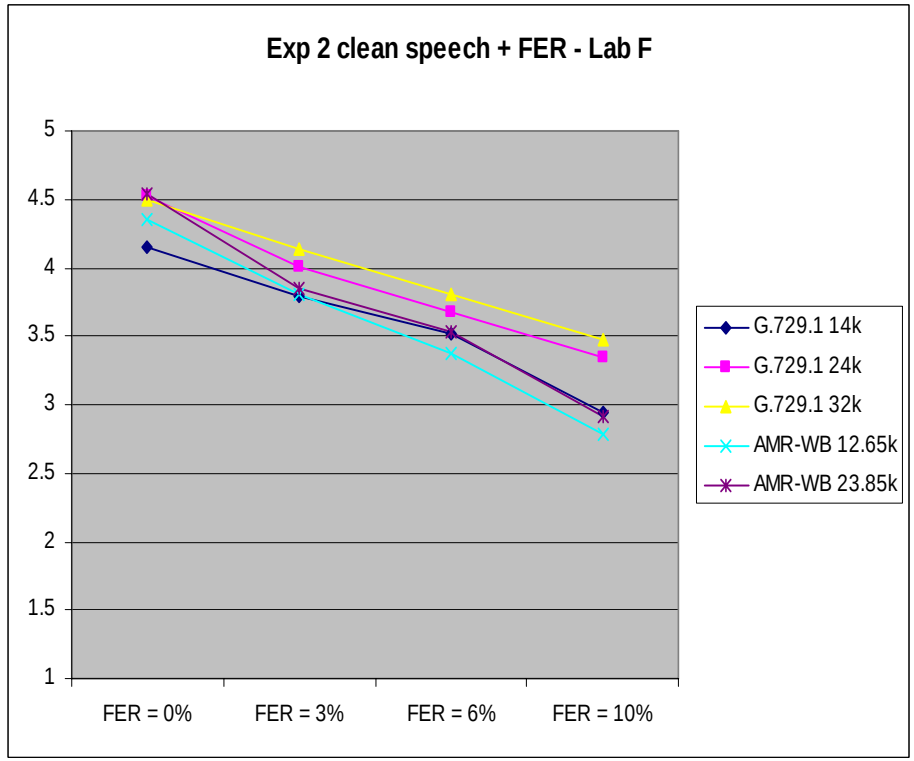
- Extract from the characterisation phase (step 2)
  - Experiment 1
    - narrowband
  - Experiment 2
    - Purpose : evaluate the performance of G729.1 algorithm with respect to well known references, in wide band clean speech (free of background noise) conditions with a variety of input levels and frame error rates.
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : French (Canada) & English (US)
    - Subjects : 32 naïve listeners
  - Experiment 3
    - Wideband Music

Compared Subjective WB quality of G.729.1, G.722 & G.722.2 (no FER)



Compared Subjective WB quality of G.729.1, G.722 & G.722.2 (FER)

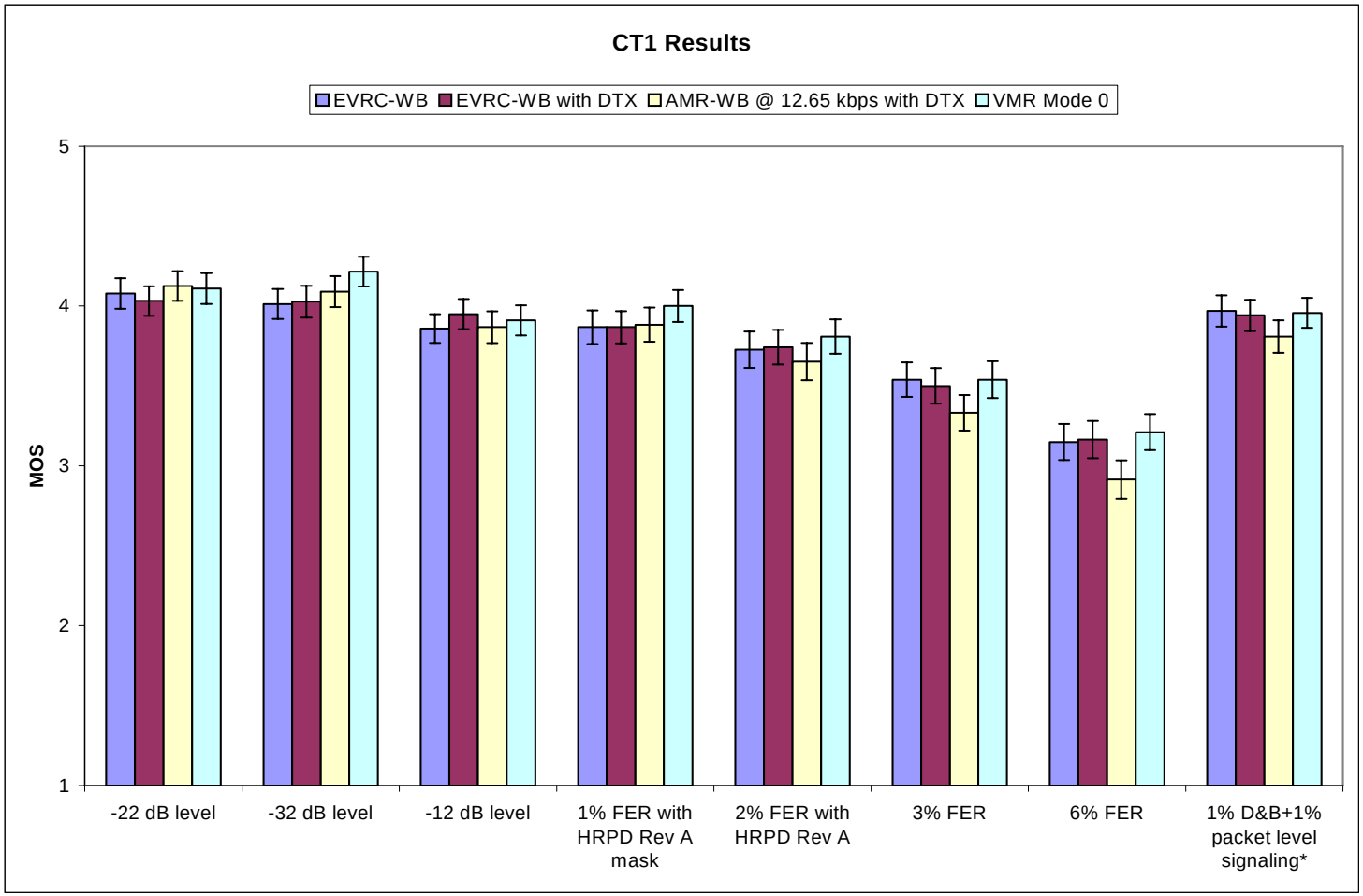




Compared Subjective EVRC-WB quality with AMR-WB and VMR Mode-0

- Extract from EVRC-WB Characterization test
  - Experiment 1
    - Purpose : evaluate the performance of EVRC-WB algorithm with respect to well known references, in wide band clean speech (free of background noise) conditions with a variety of input levels and frame error rates.
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : English (US)
    - Subjects : 32 naïve listeners
  - Experiment 2
    - Purpose : evaluate the performance of EVRC-WB algorithm with respect to well known references, in wide band noisy speech, and VAD/DTX scheme
    - Methodology : P.835
  - Experiment 3 & 4
    - Narrowband

Compared Subjective EVRC-WB quality with AMR-WB and VMR Mode-0

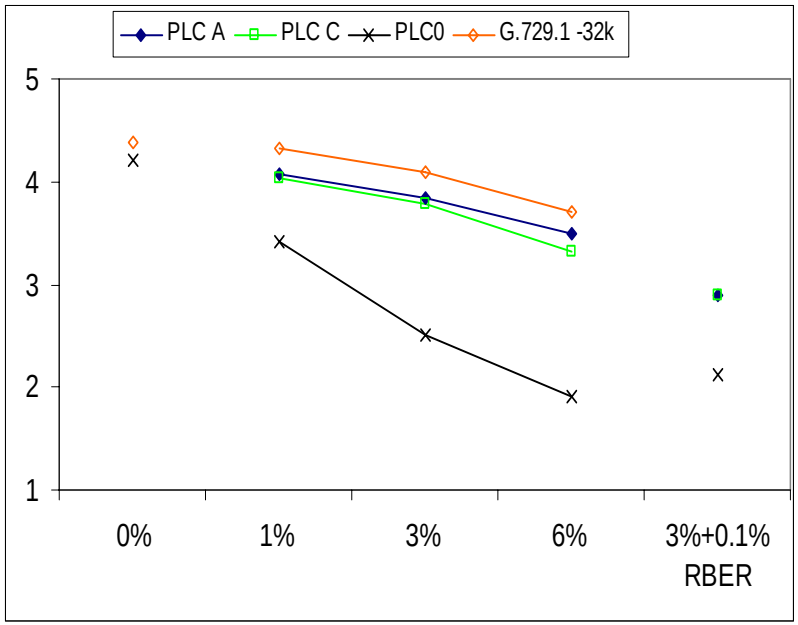


Performance of G.722 with packet loss concealment

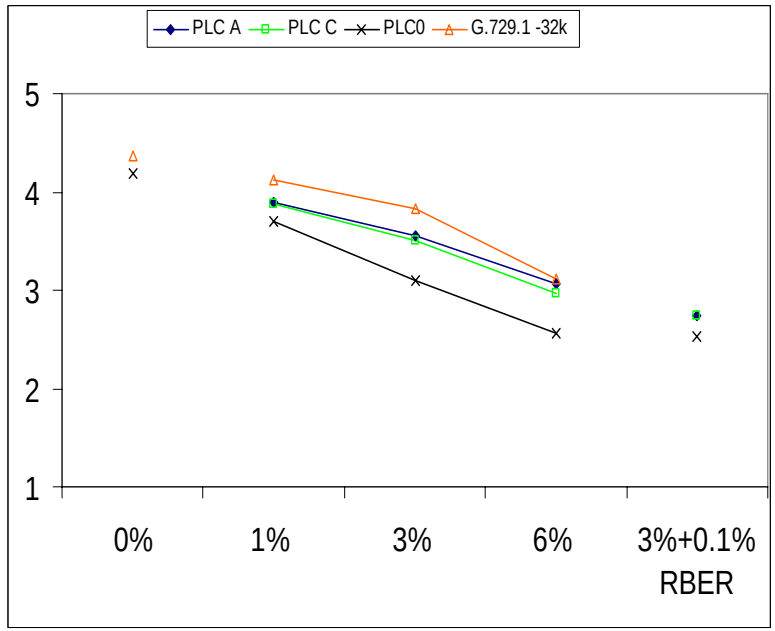
- Extract from G.722 PLC Selection test
  - Experiment 1a &1b
    - Purpose : evaluate the performance of PLC algorithm with respect to well known references, in wide band clean speech (free of background noise) conditions with a variety of frame error rates (random for exp1a, burst for exp 1b).
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : Japanese, French & English (US)
    - Subjects : 32 naïve listeners
  - Experiment 2a &2b
    - Purpose : evaluate the performance of PLC algorithm with respect to well known references, in noisy speech, (random for exp2a, burst for exp 2b).

Performance of G.722 with packet loss concealment

Clean peech, Random FER



Clean speech, Bursty FER



Conclusion on Wideband Quality

- All these codecs provide high wideband quality that can be roughly divided into 2 categories:
  - Maximum wideband quality for the most recent codecs at their maximum bit rates: very close to "direct" quality in the test conditions
  - Slightly lower quality for these codecs when operating at reduced bit rates around 12-14 kbit/s and for G.722 at 64 kbit/s but for much reduced complexity

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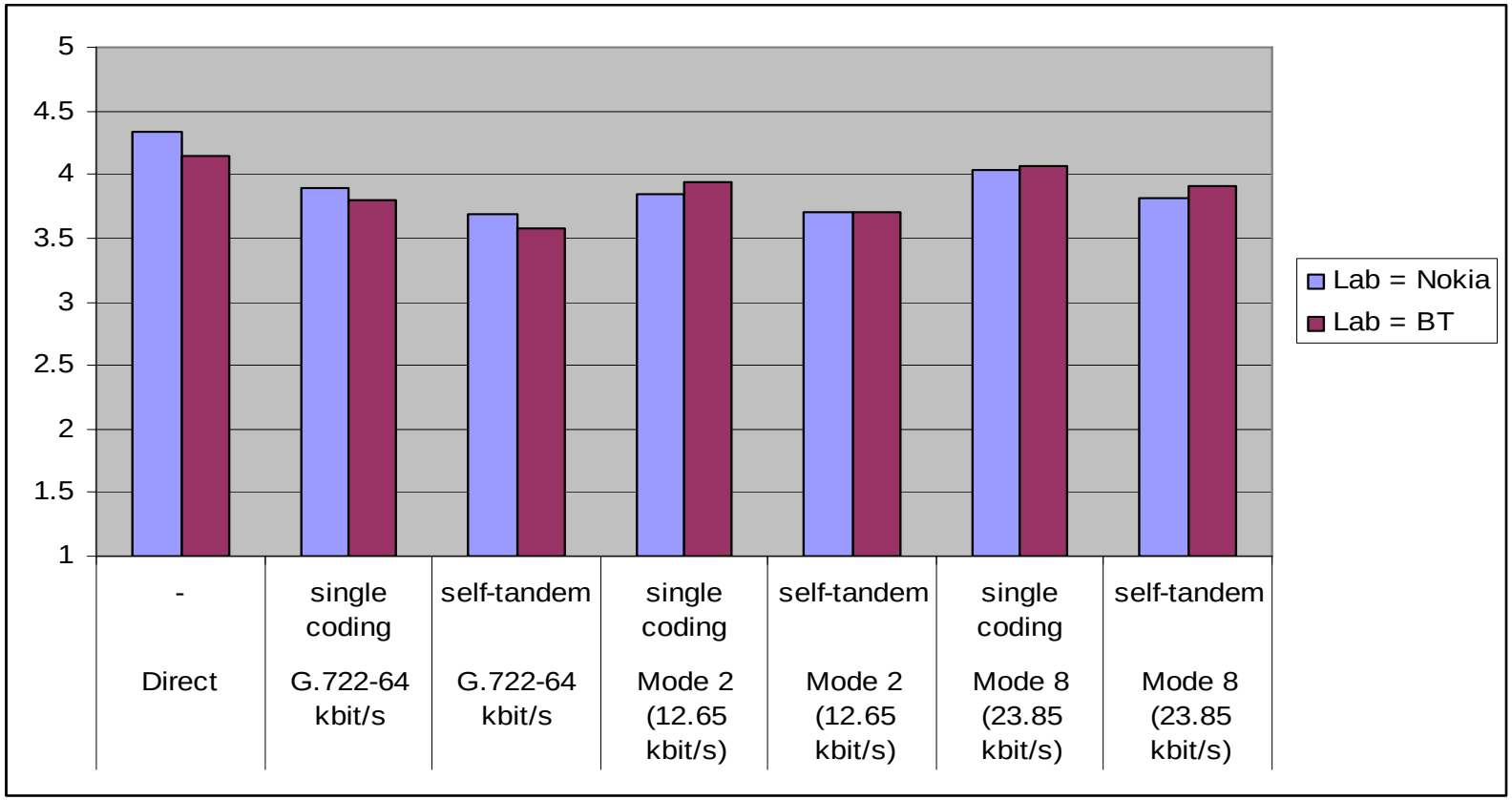
Impact of transcoding and tandemming

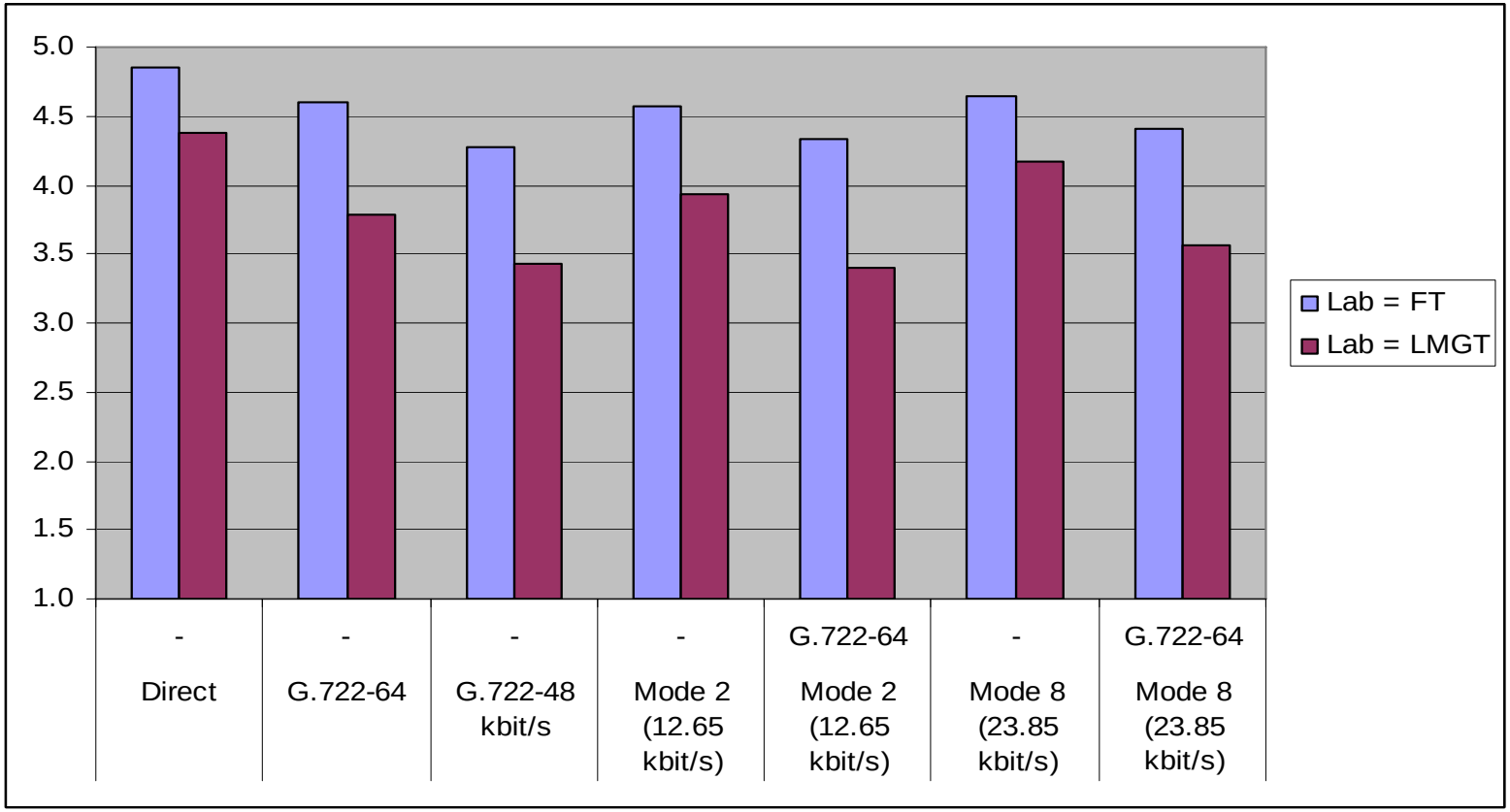
Impact of transcoding/tandeming G.722.2 & G.722

- Extract from the characterisation phase of AMR-WB
  - Experiment 1
    - Purpose : evaluate the performance of AMRWB algorithm, in wide band clean speech (free of background noise) tandeming conditions with a variety of input levels.
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : Finnish & English
    - Subjects : 32 naïve listeners
  - Experiment 2
    - Purpose : evaluate the performance of AMRWB algorithm, in wide band clean speech (free of background noise) conditions in transcoding with other wideband standards
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : French & English (US)
    - Subjects : 32 naïve listeners

Compared Subjective WB quality of G.722 & G.722.2 in self tandeming



Compared Subjective WB quality of G.722 & G.722.2 in transcoding



Conclusion on tandemming and transcoding

- Codecs self tandemings produce quite limited quality degradations of around 0.2 MOS-LQSW.
- Transcodings between different wideband formats produce more significant degradation :
  - G722↔AMR-WB transcoding quality score 0.2 to 0.4 MOS-LQSW below G.722 64 k quality.

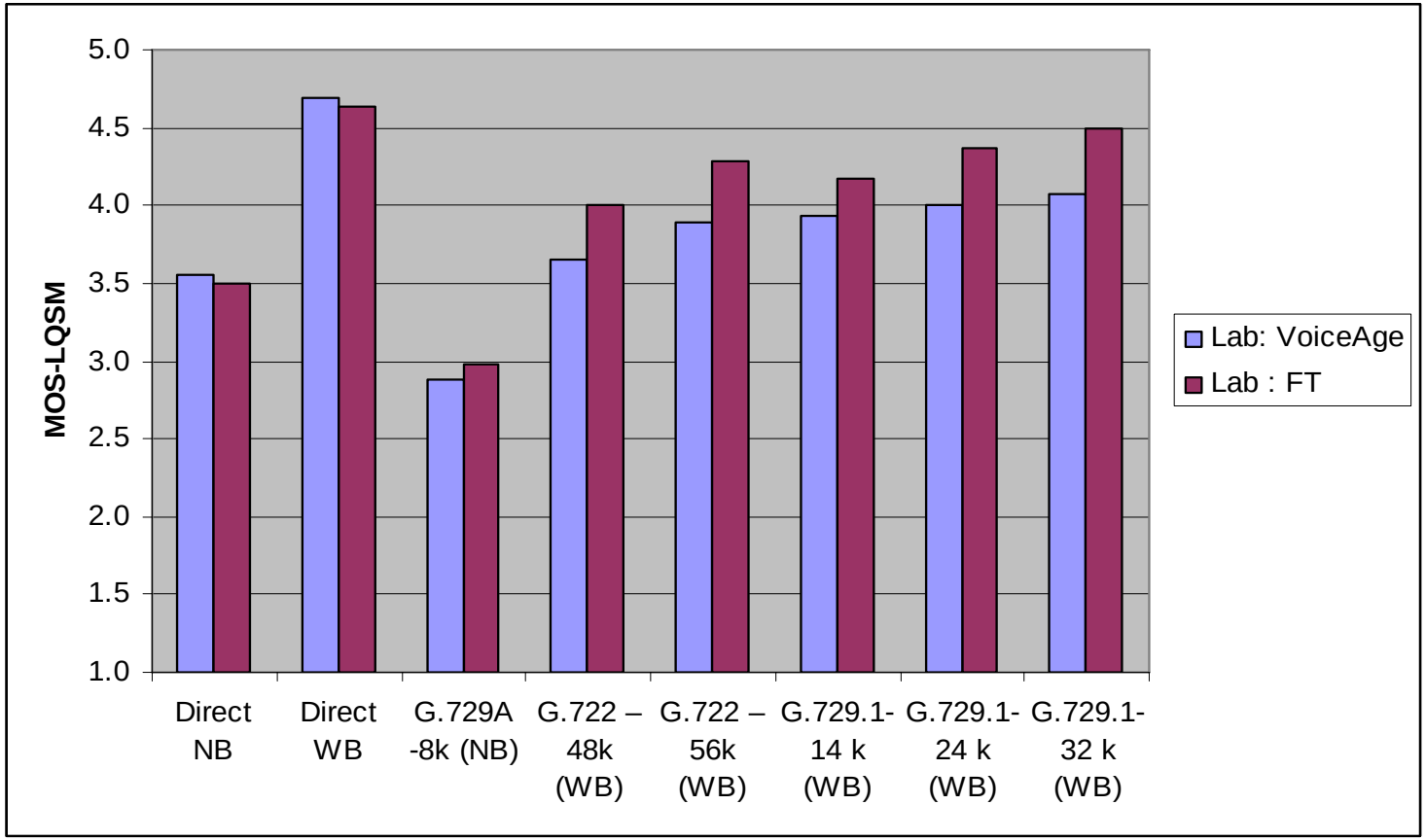
3

Comparison od wideband codecs with narrowband codecs

Comparison of wideband codecs with narrowband codecs (1)

- Extract from the G.729.1 characterisation phase (step1)
  - Experiment 1a
    - Narrowband
  - Experiment 1b
    - Purpose : evaluate the performance of G.729.1 algorithm, in wide band clean speech (free of background noise) with a variety of input levels.
    - Methodology : Absolute Category Rating (ACR) method with the Mean Opinion Score (MOS) rating scale for WB subjective tests (MOS-LQSW).
    - Languages : French & English (US)
    - Subjects : 32 naïve listeners

Comparison of wideband codecs with narrowband codecs (2)



Conclusion WB versus NB

- Results show that wideband voice, even coded at the lowest bit rates of G.722 (48 kbit/s), gets better score than direct narrow band quality with a gap up to +0.5 MOS-LQSM

- MOS-LQSM difference between narrow band and wideband direct speech is greater than 1 MOS-LQSM and remain between 0.5 MOS-LQSM and 1 MOS-LQSM between direct narrow band and high quality wideband coded speech.

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- G.722 Packet Loss Concealment references
  - ITU-T-SG16-TD217(WP3/16), " Report of Question 10/16 “Software tools for signal processing standardization activities and maintenance and extension of existing voice coding standards"", Source: Rapporteur for Question 10/16, Geneva, 14 - 24 November 2006Extract from the G.729.1 characterisation phase (step1)