



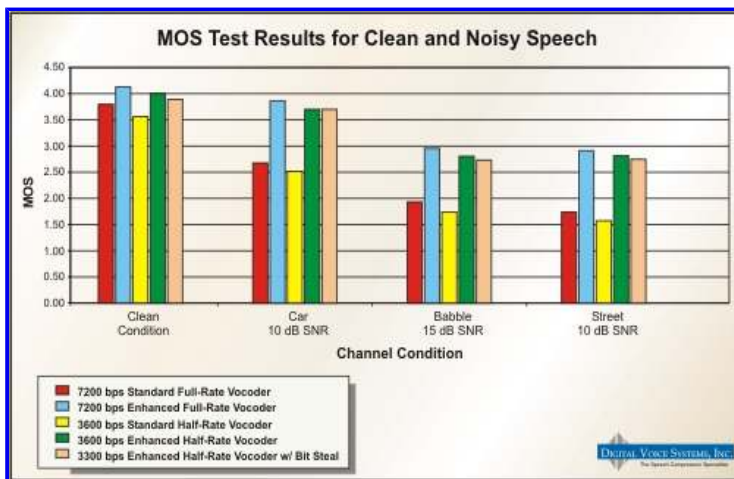
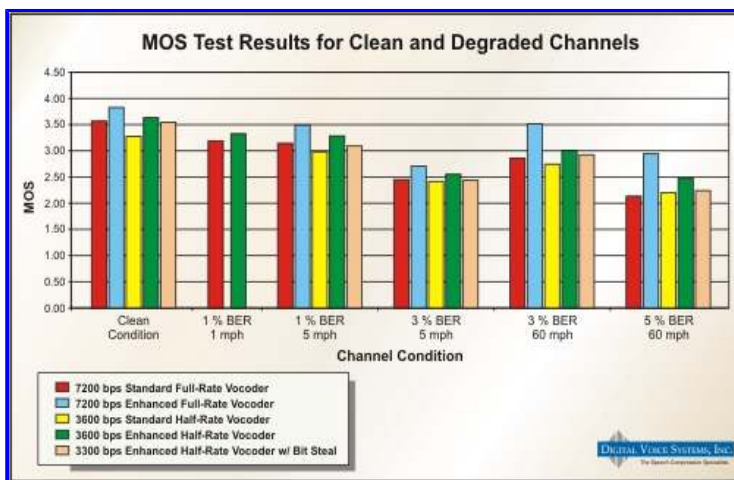
EVALUATION RESULTS

Half-Rate Vocoder
 AMBE+™ Vocoder
 AMBE Vocoder
 IMBE™ Vocoder
 DOD Results
 Tetra Evaluation
 Standards

DVSI Vocoder Independent Evaluation Results

DVSI's Voice Compression technologies have been through extensive independent testing, winning eight of the last eight evaluations. Due to the proprietary nature of the test results, a limited number are presented for review.

NEW Half-Rate Vocoder Voice Quality Test Results



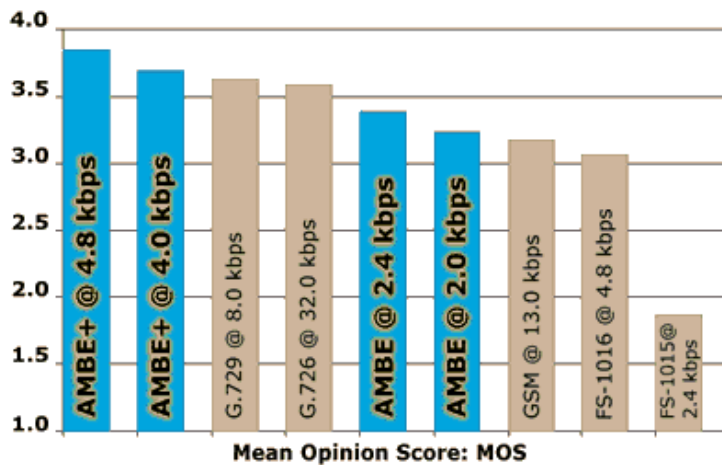
Digital Voice Systems, Inc. (DVSI), developed a Half-Rate Vocoder that has been proposed for use in the APCO Project 25 public safety mobile radio system (P25). Designed as an

extension of the current Full-Rate P25 standard, DVSI's new Half-Rate Vocoder facilitates migration and interoperability between new and existing P25 equipment.

The Half-Rate vocoder operates at 2450 bps and includes integrated forward error correction (FEC) that brings the total channel rate to 3600 bps. This represents a 2-to-1 improvement in capacity over the existing 7200 bps Full-Rate IMBE™ Vocoder currently used in P25. DVSI's new Half-Rate Vocoder not only improves system efficiency (by doubling the number of voice channels), but also improves overall system performance

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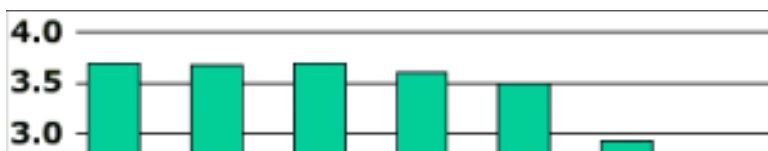
AMBE+™ and the AMBE® Vocoder Voice Quality

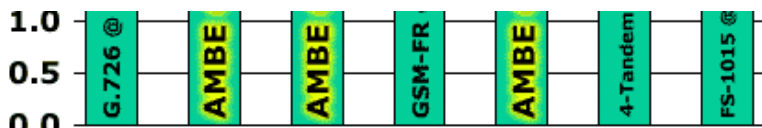


In 1998, an independent evaluation tested the AMBE+™ and the AMBE® Vocoders along with a variety of standards-based vocoders. Operating at 4.0 kbps and 4.8 kbps, the AMBE+™ Vocoder out performed both G.729 and G.726A, operating at 8.0 kbps and 32.0 kbps respectively. The MOS scores from this absolute category rating (ACR) experiment prove that the AMBE+™ Vocoder provides toll-quality speech at 4.0 kbps.

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Voice Quality vs. Bit Rate





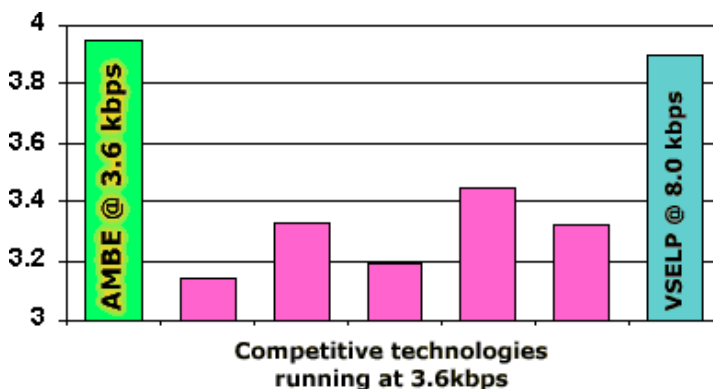
Mean Opinion Score : MOS

Efforts to determine the quality of low-data-rate vocoders furnished proof that the AMBE® Vocoder provides near toll-quality speech at data rates much lower than conventional vocoders.

This MOS test was conducted using phonetically-balanced sentences from a data base of four male and female talkers. The 95% confidence limit on the scores is 0.11.

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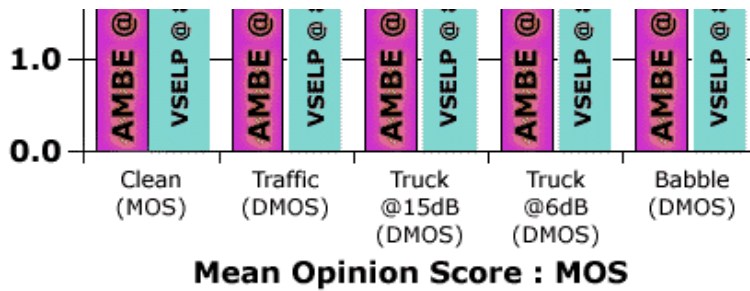
Voice Coder Quality for Clean Speech



In selecting the best voice coder for their Mini-M satellite based application, Inmarsat, in conjunction with Comsat Laboratories, performed a MOS test on six 4.8 kbps voice coders (3.6 kbps speech + 1.2 kbps FEC). Both waveform and model-based coders were compared under a variety of conditions. The results in Figure 3 show that the AMBE® Vocoder substantially outperformed all of the other 4.8 kbps vocoders and performed approximately equal to the 8.0 kbps VSELP coder used in the IS-54 wireless standard.

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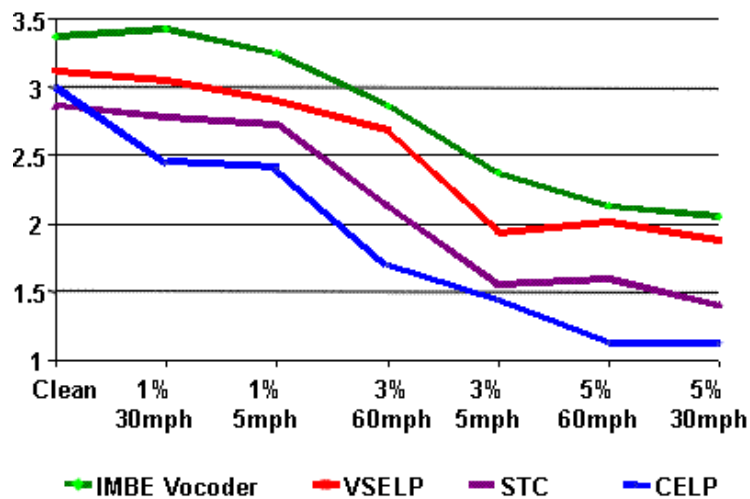
Vocoder Evaluation Background Noise Condition



Continual improvements to the DVSI speech technology resulted in the introduction of the Advanced Multi-Band Excitation (AMBE®) Vocoder. The 3.6 kpbs, AMBE® Vocoder has been independently tested by Inmarsat and the results proved that the AMBE® Vocoder offers significant advantages over the full-rate (8.0 kpbs) VSELP coder, operating at over twice the data rate.

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Voice Coder Channel Condition Evaluation

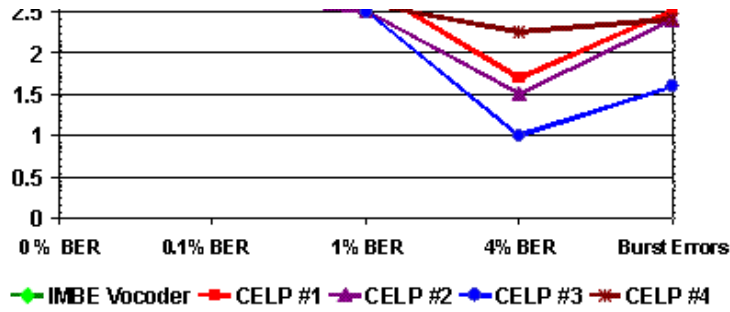


The evaluation of four 7.2 kbps speech coders by the Telecommunications Industry Association (TIA) for the purpose of selecting a speech coder for the APCO Project 25 North American land mobile radio communication system produced the above results.

During this evaluation, the IMBE™ Vocoder out performed all codecs in every category.

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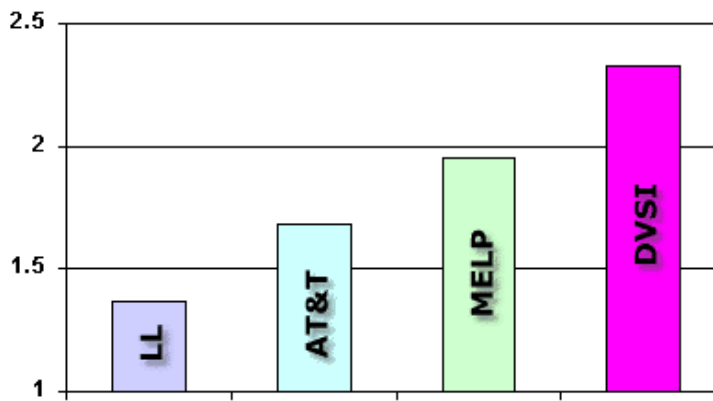
Speech Quality vs. Channel Condition



Inmarsat has formally tested the IMBE™ Vocoder against a variety of CELP based coders to determine the speech quality under various channel conditions. The results of this evaluation illustrate that the IMBE™ Vocoder is very resilient to high Bit Error Rates.

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Department of Defense Evaluation

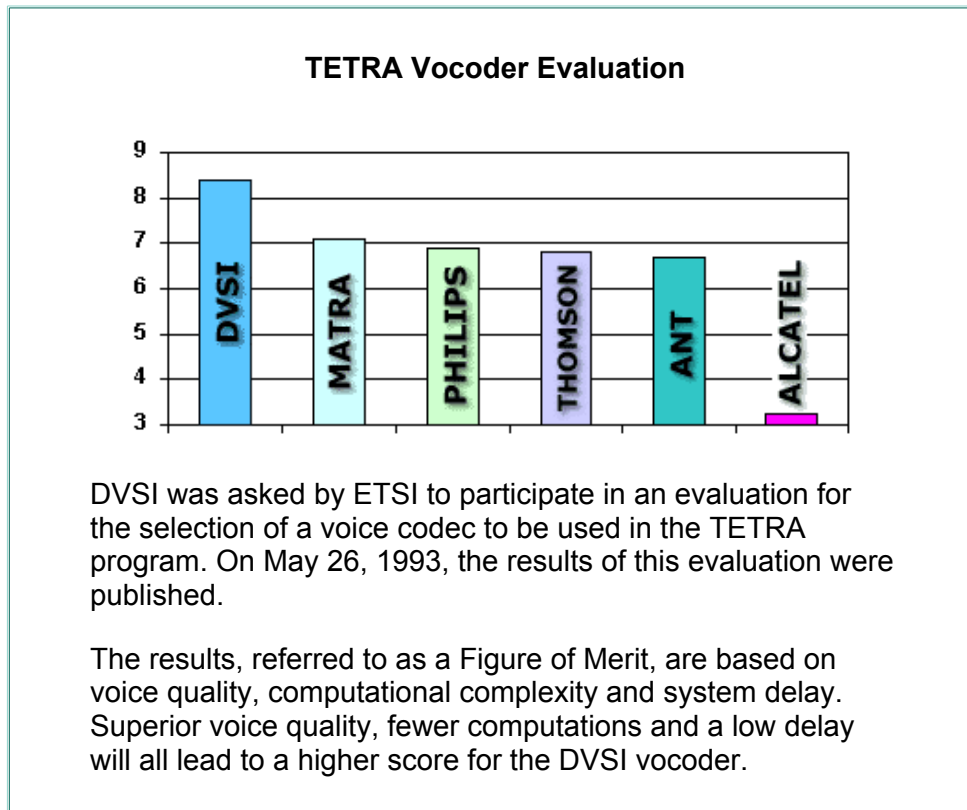


DVSI achieved the highest overall rating in the Department of Defense Digital Voice Processing evaluation for the selection of a new Federal Standard for 2400 bps speech coding, yielding better overall voice performance and lower complexity than any other candidate.

The process began in 1993, with the results being published in 1996. During the course of this extensive evaluation, the AMBE™ Vocoder was proven to have the highest overall rating defined as a figure of merit (FOM) score.

The DVSI coder achieved a FOM score of 2.330, followed by the MELP coder with a 1.955, the AT&T coder with a 1.686 and the Lincoln Labs coder with a score of 1.365. Providing yet further proof of the superiority of the DVSI vocoder.

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Due to winning these independent evaluations, DVSII's speech compression technology has been selected as the standard in the following systems, for which we provide numerous hardware and software solutions:

- [ICO](#) - Satellite communications system designed to provide voice, data, facsimile and messaging services to a single terminal and dedicated number, to and from anywhere in the world.
- [Iridium](#) - Worldwide wireless telecommunications network designed to provide telephone, paging facsimile and data services to subscribers using hand-held telephones and pagers.
- [ACeS](#) - Satellite based mobile communication system providing digital voice, facsimile and data transmission to hand-held mobile and fixed terminals deployed within the Asian service area based on the GSM standard.
- [Inmarsat](#) - An international organization representing over 70 member nations for mobile satellite communications. DVSII was selected for use in the following systems: Inmarsat-M; Inmarsat Mini-M; Inmarsat Aero-I.
- [Optus](#) - Australian national satellite-service provider.
- [APCO-NASTD-Fed Project 25](#) - North American digital mobile radio for public safety.
- [AMSC-TMI](#) - North American mobile satellite communication system.

DVSII Licenses software for the standard systems listed above, and also customizes implementations with unique capabilities to satisfy special

requirements for channel BER characteristics, frame size, tone detection, etc.

There are numerous other programs that utilize the AMBE™ and IMBE™ technologies. For more information about existing systems or custom implementations using our speech compression products, please contact our Sales Department.

For additional information on MOS testing and evaluations, please review the following papers:

S. F. C. Neto et. al., "Performance Assessment of 4.8 kbps AMBE Coding under Aeronautical Environmental Conditions", IEEE 1996, pp. 499-501.

Siu-Wah Wong, "An Evaluation of 6.4kbit/s Speech Codecs for Inmarsat-M System", IEEE 1991, pp. 629-632.

S. Dimolitsas et.al., "Evaluation of Voice Codec Performance for the Inmarsat Mnin-M System", Tenth International Conference on Digital Satellite Communications 15 -19 May, 1995, pp. 101-105.

Nick Hart, Paul Robertson, Paul Bartels, "Mobile Services in Australia", IEEE Communications Magazine, November 1991, pp.36-40.

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