MELPe Enhanced Mixed-Excitation Linear Predictive Vocoder

OVERVIEW

MELPe - Enhanced Mixed-Excitation Linear Predictive (MELP) vocoder, known as military standard MIL-STD-3005 and NATO STANAG 4591, is a dual-rate low rate coder that operates at 2400, 1200 and 600 bps. Its quality surpasses that of the old MELP vocoder.

Traditional pitched-excited LPC (Linear Predictive Coding) vocoders use either a periodic pulse train or white noise as the excitation for an all-pole synthesis filter. These vocoders produce intelligible speech at very low bit rates, but they sometimes sound mechanical and are prone to annoying thumps and tonal noises. These problems arise from the inability of a simple pulse train to reproduce all kinds of voiced speech. The MELP Vocoder uses a mixed-excitation model that can produce more natural sounding speech because it can represent a richer ensemble of possible speech characteristics. The MELP Vocoder is also robust in difficult background noise environments such as those frequently encountered in commercial and military communication systems.

Voiceboard's MELPe vocoder implementation includes also compressed bit-stream transcoding between the two rates, optional Noise Pre-Processor (NPP), DTMF detection and regeneration, tone signal generation and jitter-buffering. Voiceboard MELPe will operate on all recent generations of Voiceboard products.

MELPe MIPS Utilization at 2400 bps

Process	Rate
NPP + Encoder	44
Encoder	21
Decoder	15
Transcoder	15

MELPe DSP Channel Capacity

Number of DSPs	Channels
3	24
6	48
12	96

FEATURES

The MELPe software suite includes the following features:

- Hand optimized assembly-language real-time implementation of all algorithm components
- C-callable high-level functions
- Multi-channels per DSP
- Example of main C program that initializes and runs the MELPe vocoder functions available
- "Packetized-Network-Ready" to maintain high quality even in severe FER conditions Operation mode can be switched on the fly (no need to reload the program to the DSP)
- Comprehensive and detailed documentation that allows for smooth and easy configuration
- MELPe at 2400 bps - high rate encoder and/or decoder
- Compressed bit-stream transcoding between the two rates
- Noise pre-processor - for reducing background noise
- Postfilter - for quality enhancement of the reproduced speech
- Optional components available:
    - MELPe at 1200 bps - mid rate encoder and/or decoder
    - MELPe at 600 bps - low rate encoder and/or decoder
- Voiceboard support and service

ADVANTAGES

MELPe is robust in difficult or high background noise environments, such as those frequently encountered in commercial and military communication systems. MELPe is very efficient in its computational requirements. This translates into relatively low power consumption, an important consideration for portable systems. MELPe uses extensive lookup tables and models of the human voice to extract and regenerate speech. Finally, the codec is tuned to regenerate the English language.

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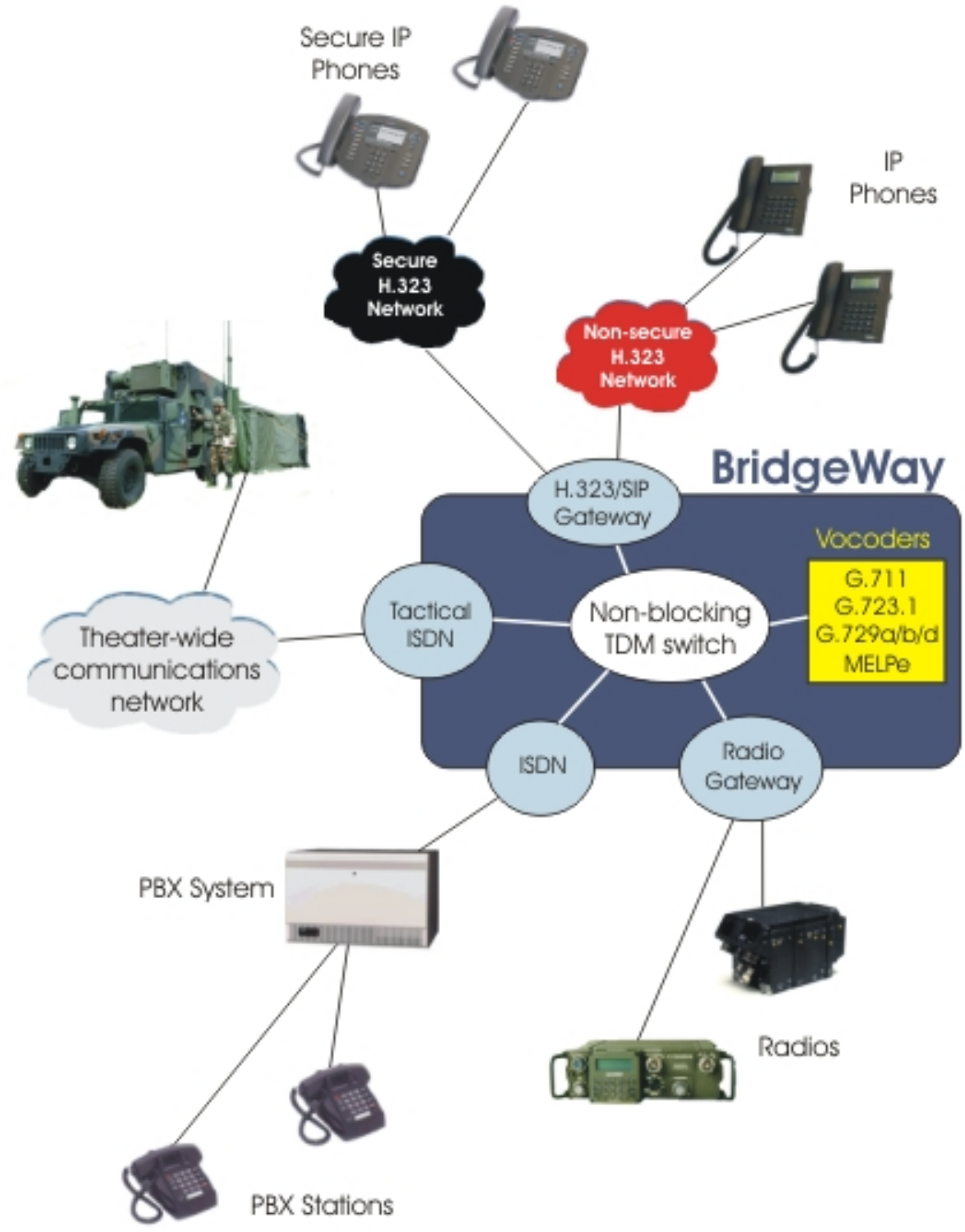
Military Communications Network with Voiceboard MELPe



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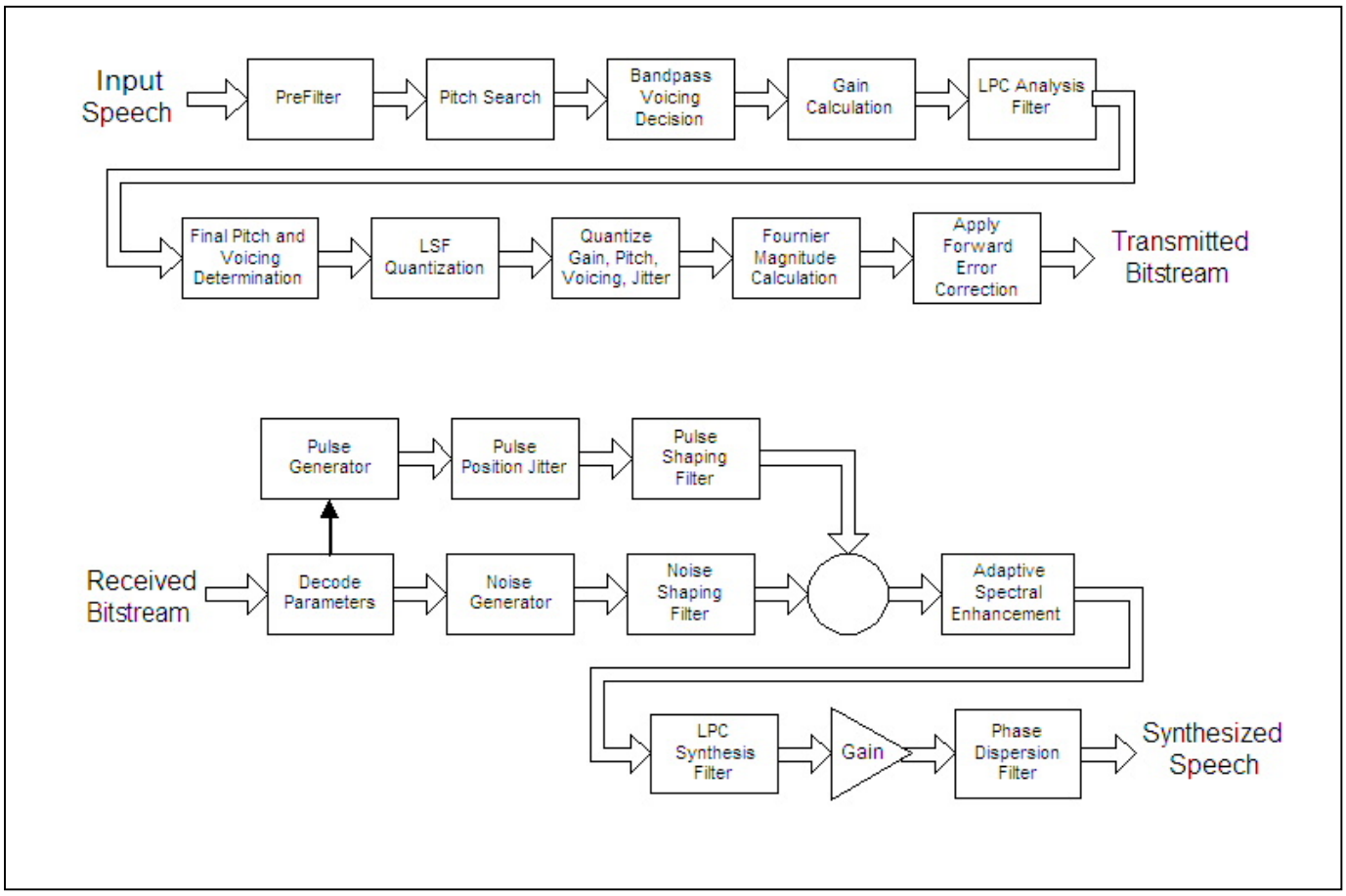
ALOGRITHM DESCRIPTION

The MELP Vocoder is based on the traditional LPC parametric model, but also includes four additional features. These are mixed-excitation, aperiodic pulses, pulse dispersion, and adaptive spectral enhancement. The mixed-excitation is implemented using a multi-band mixing model. This model can simulate frequency dependent voicing strength using a novel adaptive filtering structure based on a fixed filterbank. The primary effect of this multi-band mixed-excitation is to reduce the buzz usually associated with LPC vocoders, especially in broadband acoustic noise. When the input speech is voiced, the MELP vocoder can synthesize speech using either periodic or aperiodic pulses. Aperiodic pulses are most often used during transition regions between voiced and unvoiced segments of the speech signal. This feature allows the synthesizer to reproduce erratic glottal pulses without introducing tonal noises.

The pulse dispersion is implemented using fixed pulse dispersion filter based on a spectrally flattened triangle pulse. This filter has the effect of spreading the excitation energy with a pitch period. This, in turn, reduces the harsh quality of the synthetic speech. The adaptive spectral enhancement filter is based on the poles of the LPC vocal tract filter and is used to enhance the formant structure in the synthetic speech. This filter improves the match between synthetic and natural bandpass waveforms, and introduces a more natural quality to the speech output. The first ten Fourier magnitudes are obtained by picking peaks in the FFT of the residual signal. The information embodied in these coefficients improves the accuracy of the speech production model at the perceptually important lower frequencies. This increases the quality of the coded speech, particularly for males and in the presence of background noise.

MELPe Block Diagram



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