

The NoiseFree WhisperZone noise management system (NMS) consists of a suite of software-only digital signal processing technologies and algorithms aimed at eliminating annoying background noise from voice communications. WhisperZone NMS provides dramatic improvements in signal-to-noise ratio (SNR) and Mean Opinion Score (MOS) in wired and wireless voice conversations and speech recognition applications. The quality of user experiences (QoE) and confidence/accuracy levels of speech recognition applications are also improved. WhisperZone NMS consumes few MIPs, requiring little to no additional power, occupies very little program space, and needs no additions to the bill-of-materials (BOM) for a particular device.

WHISPERZONE NMS FEATURES

- **Adaptive Noise Cancellation (ANC)** – ANC dynamically changes the degree and type of noise cancellation applied to any SNR environment. ANC determines the type of noise present and insures that the maximum noise cancellation is applied for a specific noise type while preventing speech distortion from occurring. WhisperZone NMS solutions are extremely effective against loud background noises experienced in applications using speech encoding, echo cancellation, speech recognition, audio conferencing and hands-free telephony.
 - Performance - Convergence rate < 500 ms
- **Voice Activity Detection (VAD)** - All audio communications devices have some form of VAD but in most cases these VADs are limited in performance due to standards restrictions, power consumption, and code space. The WhisperZone NMS VAD enhances the performance of a native VAD by increasing the accuracy of speech and non-speech detection. This results in fewer transmissions of noise (without speech) and conserves power as unneeded transmissions are eliminated. The result is increased battery life in portable communications devices and lower bandwidth utilization. The VAD works very fast resulting in undetectable latency.
- **Intelligibility** – The Intelligibility feature of WhisperZone NMS provides a listener, who finds him/herself in a noisy environment while receiving a voice transmission, with a high signal (voice transmission) to (local) noise ratio resulting in a more comprehensible conversation. Intelligibility accomplishes this by altering the incoming voice signal transmission in a way that allows the voice to be heard with clarity in spite of the ambient noise. An important feature of Intelligibility is automatic gain control (AGC). AGC helps to maintain the optimum gain of the incoming voice in the presence of ambient noise at the transmit end of a voice conversation. Without AGC and in a low SNR (0 to 5dB) environment, comprehension is negatively affected.
- **Acoustic Echo Cancellation (AEC)** - The WhisperZone NMS AEC is a proprietary algorithm designed to continuously and adaptively remove echo from the acoustic path. Acoustic echoes are produced in the open-air path by coupling between the loudspeaker and the microphone in hands-free communication systems. By continuously monitoring changes in this acoustic path, the AEC effectively eliminates the echo, enhancing quality and improving the clarity of the communication. AEC is extremely fast and effective against acoustic echo experienced in systems such as hands-free cellular devices, internet telephony, audio, and video conferencing.
- **Microphone Independence** - There are many types of microphones and microphone placement schemes available in voice applications today. WhisperZone NMS is “microphone independent” operating with single and dual microphones in various placements as well as with array microphones, directional microphones, and others.
 - Performance:
 - Single Microphone - see Table 1
 - Dual Microphone - Table 1 + 3 to 6 dB
- **Smart Discrimination** – Smart Discrimination intelligently determines the types of noise and background conditions and applies the appropriate noise cancellation and voice enhancements to audio signals. Performance of carrier networks and enterprise telephony systems can be enhanced, automatically and intelligently, with no action required by the user. This translates into a better quality of user experience (QoE) and a higher quality of network resources and service.
- **Narrowband/Wideband** - Speech may be sampled and coded by narrowband or wideband coders. Wideband coders sample speech at 16 KHz or twice the rate of narrowband (8 KHz). WhisperZone NMS supports both wideband and narrowband noise cancellation and all above features.

WHISPERZONE™ NMS PERFORMANCE, FUNCTIONS, AND BENEFITS

SNR IMPROVEMENT

Figure 1 contains Before and After graphs comprised of time on the X-axis and sound energy on the Y-axis. Figure 1 was taken from a real conversation in a noisy environment in which SNR=5dB.

The After graph is the result of WhisperZone NMS applied to the conversation. The noise energy has been significantly reduced to the point that even low energy speech can be detected in the presence of the attenuated noise.

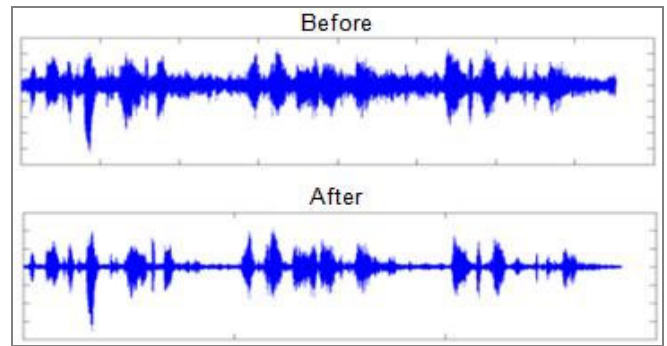


Figure 1

Table 1

Noise Type	SNR Improvement
Babble	10 to 14dB
Automobile	16 to 27dB
Street	12 to 20dB

Table 1 shows the SNR improvement as a result of WhisperZone NMS applied to voice conversations in various noisy environments. Babble is ambient noise emanating from numerous simultaneous conversations typically found in coffee shops and restaurants. These noise types are a small but representative sample of the environments evaluated and tested with WhisperZone NMS.

Discrimination And Detection	Noise Discrimination		Music Discrimination		Voice Discrimination		Tone Discrimination (fax, DMTF, MF)	
	Direct Calls		Out-of-Band Signaling		In-band Signaling			
Mitigation	Transmit				Receive			
	Echo Cancellation							
	1 Microphone Noise Cancellation		2 Microphone Noise Cancellation		Noise Cancellation		Intelligibility/ AGC	

Figure 2

FUNCTIONAL DIAGRAM

The WhisperZone NMS architecture is shown in Figure 2. Noise mitigation, signal processing, smart discrimination, and noise type detection are at the core of this NoiseFree solution. These functions are combined with other unique features to create the WhisperZone NMS which works both on transmitted as well as received voice signals in the presence of noise at both ends of the conversation (or all ends in the case of a conference call environment).

PLATFORMS

Table 2 shows the DSP and processor platforms on which WhisperZone NMS has been tested. Included are the sampling bandwidth, the code space required, and the MIPS consumed for each processor type.

NoiseFree is constantly porting WhisperZone NMS to new DSP and processor platforms. For the most up to date information, please contact NoiseFree.

Table 2

Processor	Bandwidth	Code	MIPS*
TI c55	8 & 16 KHz	6 KB	2.2
TI c64	8 & 16 KHz	10 KB	1.0
ADI bf53x	8 & 16 KHz	7 KB	1.7
Intel/AMD	8 & 16 KHz	19 KB	4.8
Kalimba	8 KHz	9 KB	3.0

Note: * Noise cancellation at 8KHz

APPLICATIONS

- VoIP Devices: Wired and wireless handsets, SIP phones, softphones, single-mode WiFi phones
- Cellular Phones: GSM, GPRS, WCDMA, and CDMA Handsets, dual mode (IP) phones, WiMax, etc.
- Bluetooth: Mono and stereo headsets, hands free car kits

BENEFITS

- **Software-only**...no BOM additions
- Low MIPS and power consumption
- Industry leading noise cancellation performance in different work environments
- Smart noise management for different user noise and environmental scenarios
- Small code size and memory required
- Ease of porting to various DSP and server/device OS platforms