

## Technology Brief

## Dismounted Warfighter – Audio System



Modern warfighter programs are challenged to physically protect open-field personnel from a great variety of life and effectiveness threats, including chemical, biological, laser, ballistic, and percussive weapons. Additionally, these soldiers must work in and around harsh noise environments including machinery, generators, tracked-vehicles, aircraft, and weapon launchers. Protection can be achieved with occlusive armor. Concurrent with protection, programs such as OFW and FIST must *enhance* situational awareness (SA) and task effectiveness. Humans instinctively maintain immediate situational awareness through hearing. Occlusion inhibits hearing severely, isolating the warfighter from the environment, deflating situational awareness, confidence, and effectiveness, thus putting the warfighter at high risk and compromising his ability to detect and assess threats. Soldiers that circumvent hearing protection to gain situational awareness suffer life-long sensory loss which requires 60 years of hearing-aid support from veteran programs.

**AuSIM Inc. and Sennheiser Government Systems Inc.** have teamed along with partners Sensimetrics Corp., and InterSense Inc. to propose an integrated warfighter audio system to support superior hearing despite soldier headgear occlusion.

### The AuSIM Warfighter Audio System

Working with Natick Soldier Systems, ARL at Aberdeen, AFRL at WPAFB, and the Scorpion audio group, the AuSIM-led team identified seven key elements required to provide superior audio to the fully protected warfighter.

#### Seven Key Audio System Elements

##### 1. Passive Hearing Protection

Protecting the warfighter's perceptual sensors and orifices from potentially lethal or maiming threats is a primary concern. Additionally, warfighters are exposed to both continuous and impulsive noise at damaging levels as part of normal operations. Good passive hearing protection, the most critical audio system element, provides the baseline solution as the performance of all other elements depend on it.

##### 2. Basic Aural Comms

To perform basic operations, a warfighter must be able to discretely send and receive aural messages in a harsh environment.

##### 3. Transparent Hearing

Hearing protection and headgear occlusion isolates the warfighter from the environment, deflating situational awareness, confidence, and effectiveness, thus putting the warfighter at high risk and compromising his ability to detect and assess threats. Transparent hearing restores the spatial aural perceptive capability of the soldier such that they can perform tasks equally well with and without headgear.

##### 4. Impulse and Loud Noise Exposure Suppression

Transparent hearing provides a controllable sound path circumventing the direct acoustic path to the ear that can filter or gate signals and noises, averting possible damage or impairment to the warfighter. The complexity and variety of the noise and signal sources dictates the use of innovative signal processing techniques.

##### 5. Active Noise Reduction

Passive noise protection of a small enough size to be worn on a human is physically not effective blocking longer wavelengths of lower frequencies. To provide full-spectrum hearing protection, low frequency sound must be detected inside the passive protection and be actively cancelled.

##### 6. Localization Synthesis for Aural Displays

Information cannot be conveniently displayed visually to a dismounted soldier, and, in many circumstances, doing so may compromise their SA. Leveraging aural perception, the warfighter can obtain SA information and remain focused on the task. To keep multiple aural information signals from masking each other, each signal should be spatially independent to provide the human a perceptual characteristic for filtering the multiple data streams. Most SA information (ie. friend/foe ID "FFP" or nav-aids) inherently contain location-based data. Synthetically-generated location cues can be applied to both communication and data auralization, leveraging head-orientation tracking and GPS for spatial coherency and intuitive display of location-inherent data.

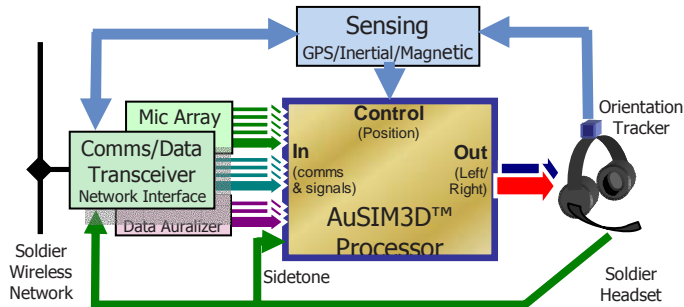
##### 7. Supernormal Listening

With the six elements above in place, the presentation of the surrounding aural environment is completely controllable and may be specifically augmented with user control. Techniques can provide augmented discrimination of signal from noise, augmented aural-focusing on a particular direction or signal, or the elimination of a specific noise.

## Integrated Solution

A thoroughly integrated audio system optimizes the delicate balance between performance, weight, and resource consumption. In the AuSIM integrated solution, all analog components are closely placed with the transducers in the helmet, all signals are routed digitally providing scalability, all algorithms are analytically combined, and the signal processing is tightly architected.

### Aural Display System Block Diagram

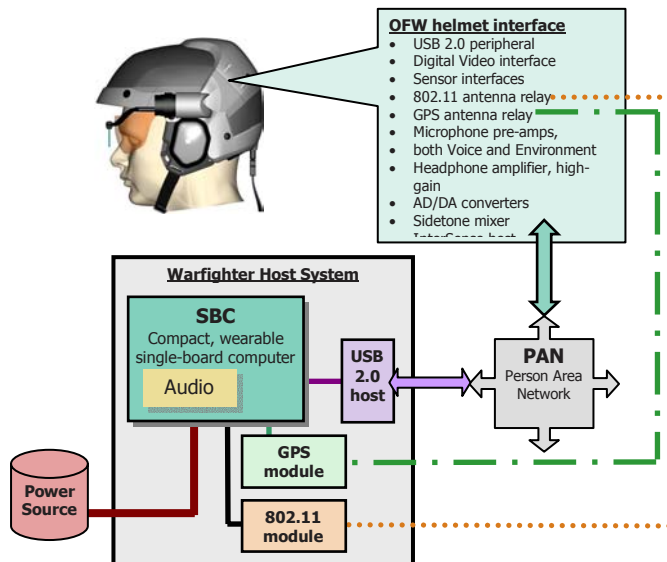


In the block diagram above, signals generally flow from left to right. Comm voices stream from the secure wireless IP network along with their respective location data. Microphone arrays sense the local aural environment and the data auralizer generates signals from SA info. All streams are fed into the processor; all location data is fed to the control point and compared with the local data. The soldier's own voice routes to the net and feed back into the processing engine for sideband. The soldier's position and orientation is also routed on to the network.

## Objective Force Warrior Implementation

Despite the criticality of these audio system elements for OFW, they have not been previously integrated or implemented satisfactorily in full for any system. Further the audio system must be tightly integrated into the warfighter's headgear and advanced information system. The interdependencies are very high. For example, the transparent hearing system is dependent on the helmet's acoustic "signature, which is affected by any large headgear accessory.

### Audio System for Objective Force Warrior



The system diagram above shows a possible audio system implementation as proposed to the OFW LTI's in 2002.

## Scorpion Transparent Hearing Audio Project



Scorpion was a risk-reduction program sponsored by Natick Soldier Systems in advance of the Objective Force Warrior (OFW) down-select. Hearing was identified as a critical make-or-break issue surrounding the deployment of an enclosing helmet. In 2002 AFRL funded an exploration of the issues involved with hearing transparently through headgear. AuSIM led a team that produced 10 prototypes with 52 derivatives, and tested against 9 COTS products. The project showed that the OFW objectives can be achieved through technology maturation.

### AuSIM Warfighter Audio Team

#### AuSIM, Incorporated

Mountain View, CA

AuSIM addresses mission-critical audio with products and solutions driven by AuSIM3D™, the world-leading audio simulation technology. AuSIM maintains core competencies in system integration, acoustic models, human auditory perception, sound localization, aural displays, and sound transfer function measurement.



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#### Sennheiser Government Systems

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Sennheiser Government Systems provides solutions for high noise military environments such as combat vehicles, aircraft flight and ground crews, and engineering spaces. Sennheiser headsets are top quality, high-performance, and high fidelity. Sennheiser's core competencies include transducers (both microphones and headphone drivers), passive hearing protection, active hearing protection, active noise reduction, and cost-effective, robust military manufacturing.

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#### Sensimetrics Corporation

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Sensimetrics is a research and development think tank affiliated with MIT and Boston University specializing in augmentative technologies for human hearing. Sensimetrics maintains core competencies in algorithm and filter development for microphone array processing, human aural perception, hearing augmentation, physical acoustics, and hearing protection.

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#### InterSense, Incorporated

Burlington, MA



InterSense is a world-leader in precision motion tracking, utilizing hybrid multi-sensory technologies. InterSense's strategic specialty is fusing redundant or overlapping data from multiple sensors to create a hybrid tracking output with few of the deficiencies of individual sensor technologies. InterSense's core competencies include inertial sensing, motion prediction, position reckoning from motion, signal processing, digital filtering, and immersive technologies.

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