

Army Acoustics Needs
**DARPA Air-Coupled Acoustic
Micro Sensors Workshop**

by

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Goals and Objectives Battlefield Acoustics



BATTLEFIELD ACOUSTICS

- To research, explore, and develop innovative and state of the art signal processing techniques in acoustics and other passive sensor technologies
- To apply these techniques to perform detection and classification of ground troops, ground vehicles, airborne vehicles, artillery and sniper
- To transition real-time and robust algorithms to on-going Army acoustic programs

**Army Battlefield Acoustics Research
conducted at ARL, ARDEC and CRREL**



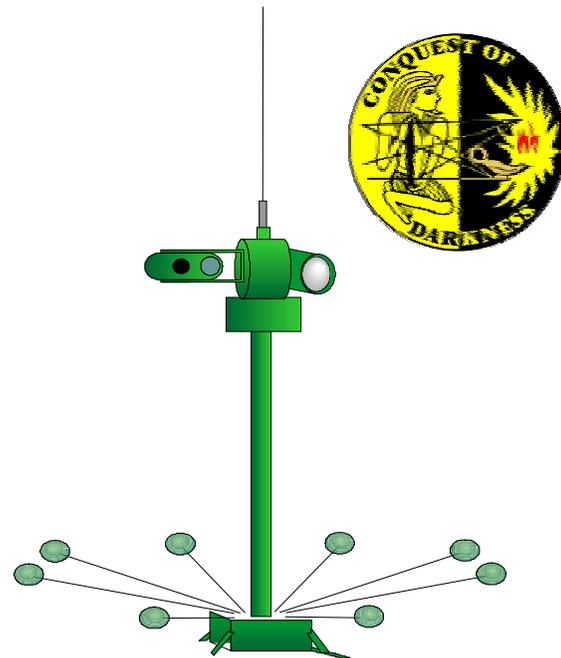
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Acoustic Advantages



BATTLEFIELD ACOUSTICS

- Attractive technology for the Army
 - Passive
 - Non-line of sight (NLOS)
 - Low cost
 - Small and rugged
 - Provides 360° coverage
 - Target signatures are hard to suppress
- Capability includes target detection, bearing estimation, tracking, localization, classification and ID
 - Provides wake-up and cueing of optical sensors



Real-time capability due to advances in CPU and DSP technology



Army Applications



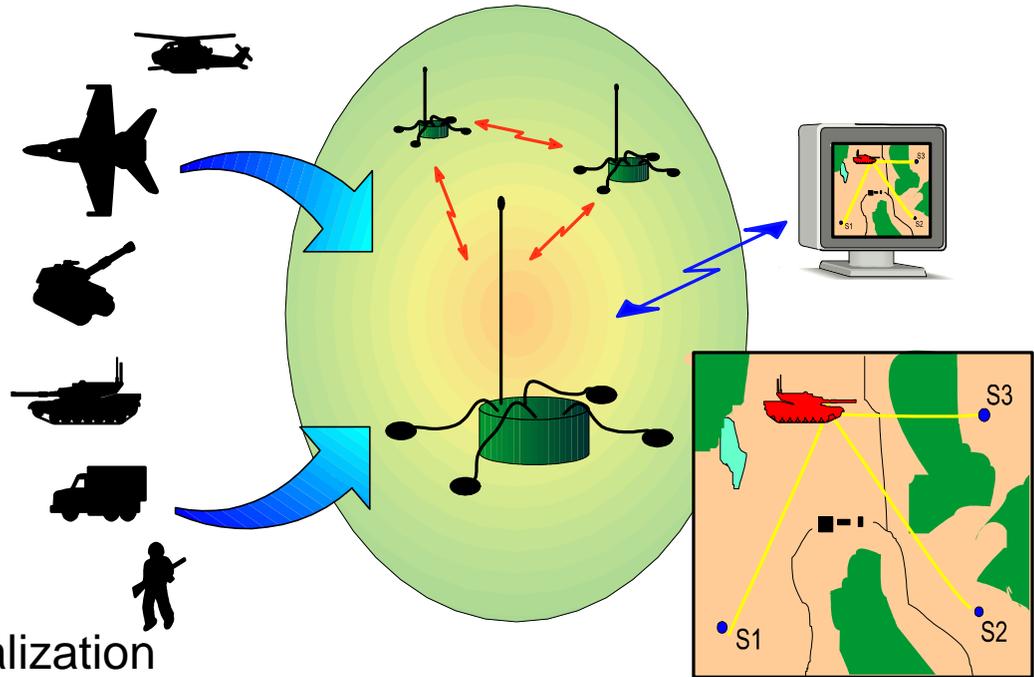
Detection, tracking and classification

- Ground vehicles
- Troop movements
- Fixed and rotary wing aircraft's



Surveillance and monitoring

- 360° field of view coverage
- Excellent “wake-up” and cueing sensor
- Tactical decision aid



Other Applications

- Infrasonic detection and localization
- Physiological monitoring of soldiers
- Detection and localization of gun fire (e.g., sniper), artillery / mortar fire, rocket launch, etc.

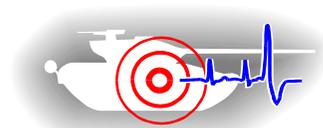
- Noise Cancellation:
 - Need to cancel out platform noise for acoustic sensors mounted onto idle or moving vehicles to allow detection and identification of surrounding targets.
 - Need to cancel out wind / flow noise from acoustic sensors positioned on the ground or on top moving vehicles.
- Lack of data from acoustic sensors mounted on top vehicles.
- Lack of research conducted in this topic





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Current Army Needs



BATTLEFIELD ACOUSTICS

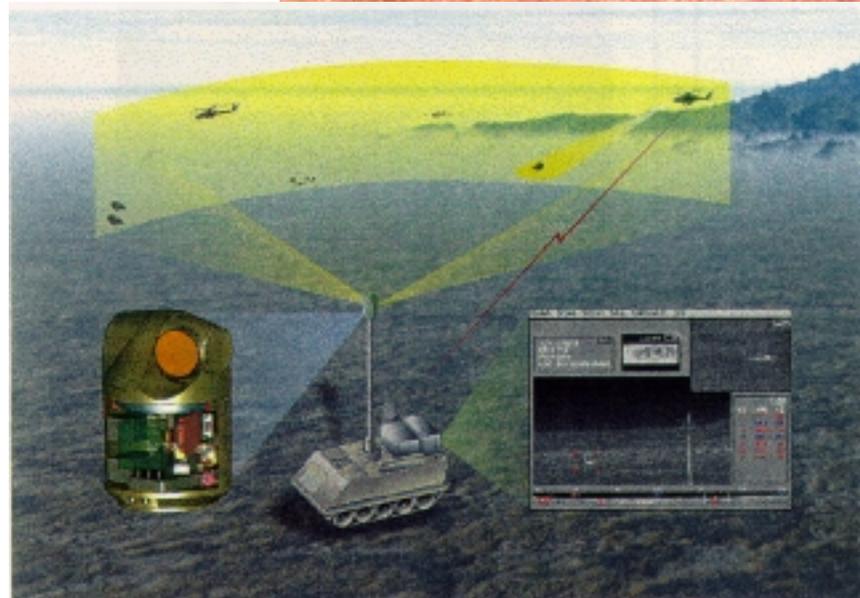
- **Research Issues**

- Noise cancellation / Platform and Wind
- Multi Target Recognition
- Sensor fusion
- MEMS Acoustic / Seismic



- **Programs**

- MFS3 / FSV
- DEMO III Robotics
- Sniper Detection Systems
- Unattended Ground Sensors





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R&D Transition / Programs

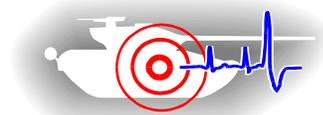


BATTLEFIELD ACOUSTICS

- **Transition R&D into future Army programs in support of RDECs and Battle Labs**
 - Infrasonic research
 - Modeling of acoustic sensors
 - Anti-Personnel Landmine Alternatives (APLA)
 - Warrior Extended Battlespace Sensors (WEBS)

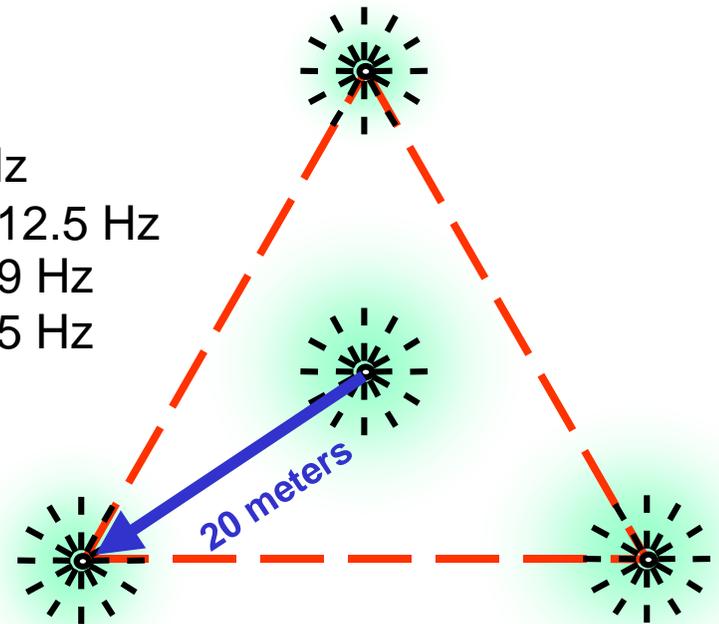


Infrasonic Research



- **Objective:** to develop state-of-the art infrasonic sensors and signal processing algorithms to detect, classify, localize of impulsive signals below 20 Hz
- **Army applications**
 - Artillery and mortar firings
 - Missile and rocket launches
- **Other infrasonic signals of interest:**
 - Nuclear tests: 0.02 Hz - 4 Hz
 - Earthquakes: 0.125 mHz - 12.5 Hz
 - Volcanoes, meteors: 23 mHz - 0.29 Hz
 - Winds, tornadoes, etc.: 10mHz -0.125 Hz

- Six 20 ft. porous hose lengths at each sensor
- Met sensors located with central microphone.



Los Alamos





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Infrasonic Detection

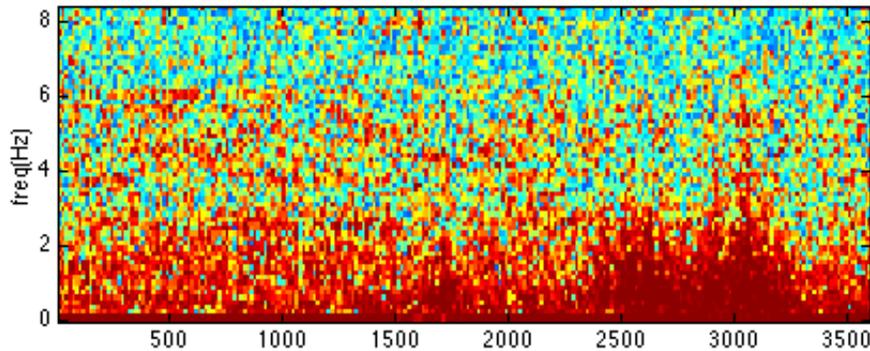


BATTLEFIELD ACOUSTICS

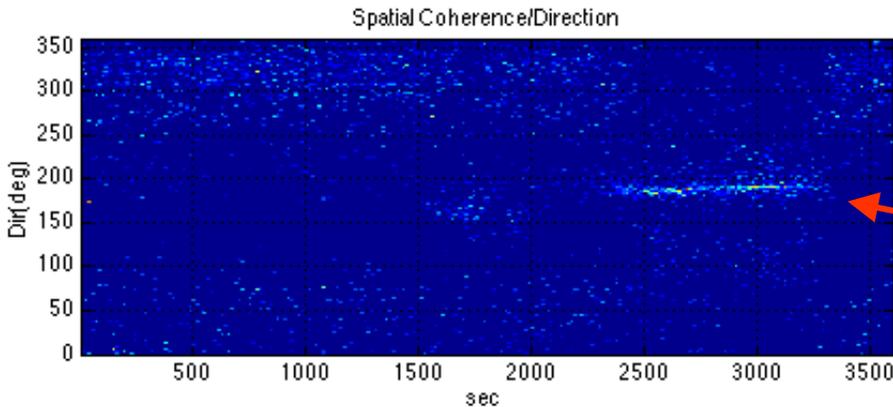


**Space Shuttle Launch
4 Dec 98
From Blossom Point, MD**

Date: 12/4/98 Time: 3:54:28



**1200 km
1 hr delay**



Direction of arrival



Modeling of Acoustic Sensors



Objective:

- Database: to centralize acoustic data archives from various programs & organizations, to expedite data access and to ease data maintenance
- ATR Lab: to expedite algorithm development & performance evaluation against various battlefield conditions

The screenshot shows a web-based database application interface. At the top, there are tabs for 'Files', 'Targets', 'Sensors', 'Data Collections', and 'SQL Commands'. The 'Targets' tab is active. Below the tabs, there is a 'Select table:' dropdown menu set to 'Ground_Info' and an 'Open Table' button. The main area contains a form with the following fields:

Target_ID:	5
Target:	2.5-Ton Truck
Class:	light wheeled
Country:	USA
Weight (kg):	5900
Length (m):	6.7
Width (m):	2.4
Height (m):	2.92
Engine:	6-cylinder in-line multi-fuel diesel, 140 hp @ 2600 rpm
Transmission:	manual gearbox with 5 forward and 1 reverse gears
Max_Speed (mph):	21.6
Crew:	1+2
Picture:	2-5ton_1.gif; 2-5ton_2.gif
Signature:	y

On the right side of the form, there are several control panels:

- Move record:** Buttons for 'First', 'Prev', 'Next', and 'Last'.
- Sort by:** A dropdown menu set to 'Target_ID' and a 'Sort' button.
- Edit:** Buttons for 'Add', 'Add/C', 'Modify', 'Update', 'Clear', and 'Delete'.
- Search by:** A dropdown menu set to 'Target_ID', an 'Enter text:' input field, and a 'Go' button.
- A 'Print Record' button.
- A small image of a 2.5-ton truck with the caption '2.5 TON TRUCK' below it.

At the bottom of the interface, there is a status bar with 'acoustic database' on the left and '# Records: 6' on the right.

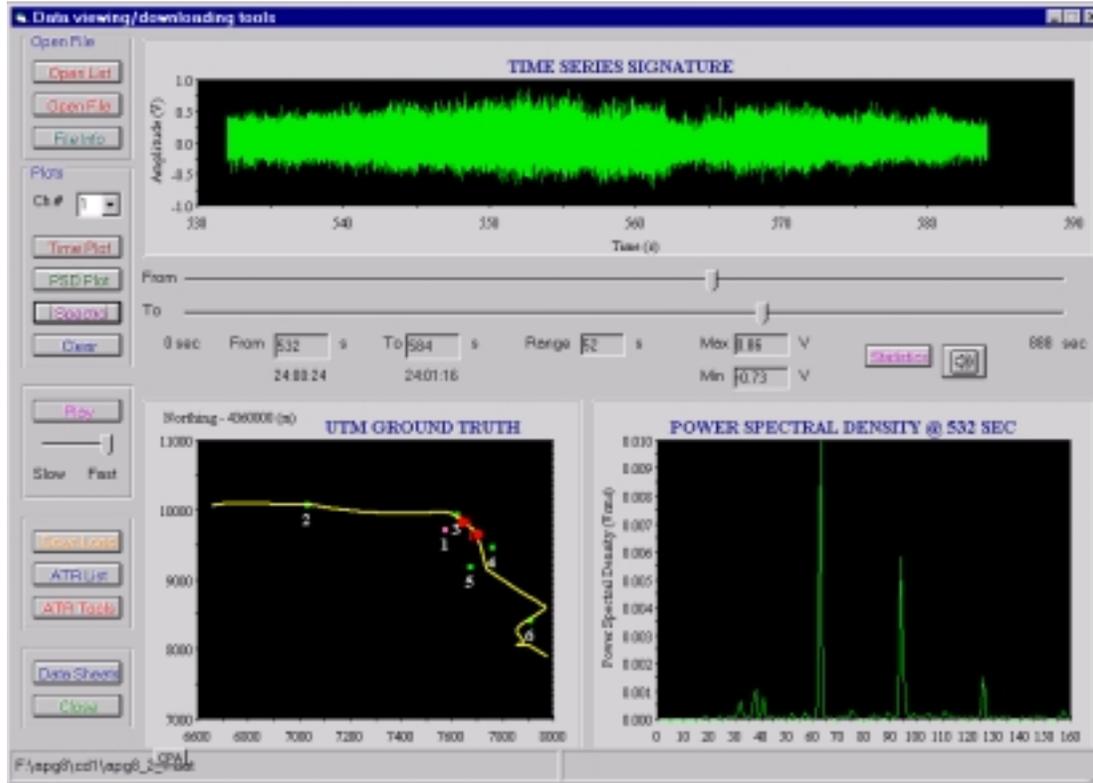


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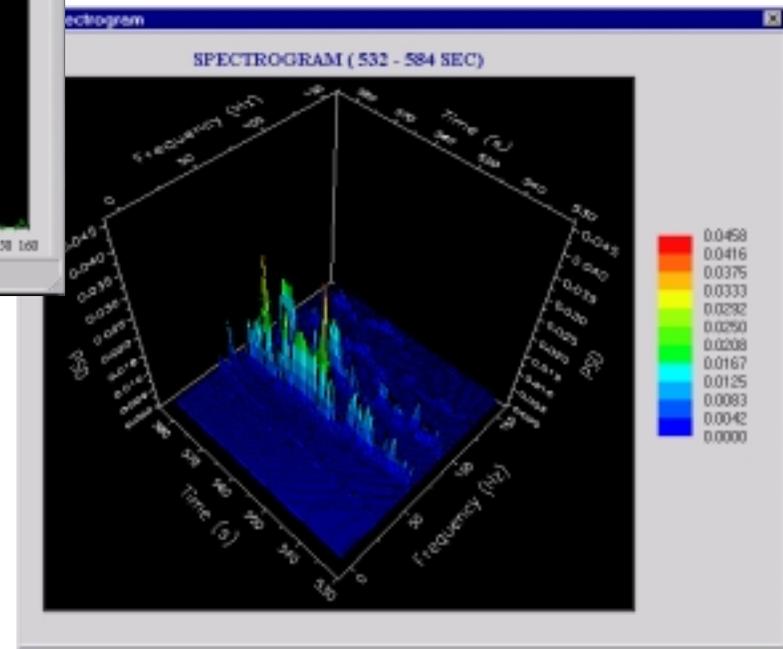
Data Management and Processing



BATTLEFIELD ACOUSTICS



Large selection of trucks, tanks and helicopter signatures collected at different environment and time of year



Server - Client environment will allow user to access data on-line.



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Anti Personnel Landmine Alternative (APLA)



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- **Current Progress**

- Experimenting with existing small, sensor systems capable of detecting personnel using acoustic / seismic / magnetic sensors.



- **FY00**

- Research and evaluate personnel detection algorithms with low false alarm.
- Use fusion techniques between suite of orthogonal sensors to enhance detection and recognition



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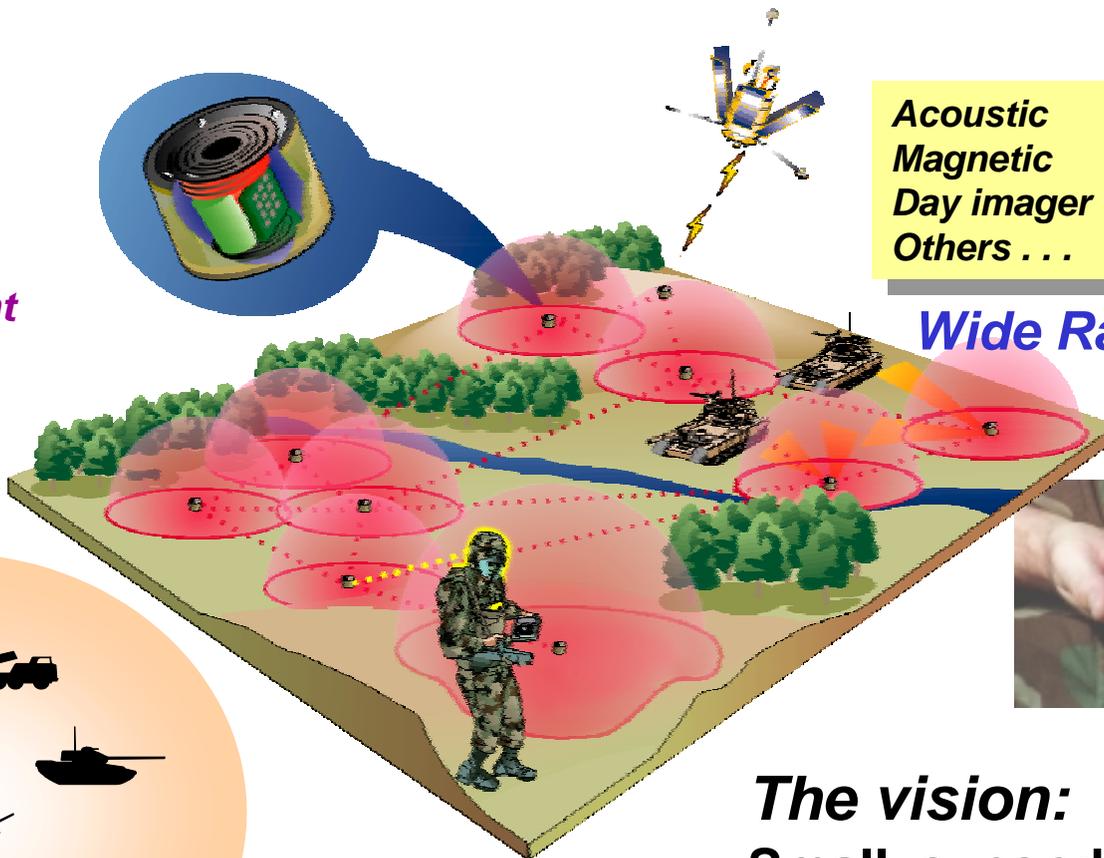
Warrior Extended Battlespace Sensors (WEBS)



BATTLEFIELD ACOUSTICS

A network of sensor nodes using multiple types of sensors can accurately locate and identify battlefield targets

*Small
Passive
Real Time
Very Low Cost
Non-line of sight
360° Coverage*



*Acoustic
Magnetic
Day imager
Others . . .*

*Seismic
Low cost IR
Passive RF*

Wide Range of Sensors



*The vision:
Small, expendable sensors*



Wide Range of targets

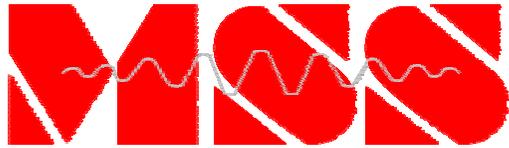


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Upcoming Symposia



BATTLEFIELD ACOUSTICS



Military Sensing Symposia

Yearly event, established to share battlefield acoustic research knowledge between government, industry and universities.

Battlefield Acoustic Symposium Sept 13 - 15, 1999
Johns Hopkins University, MD, [Security Clearances Required](#)

National Symposium Nov 16 - 19, 1999
SPAWAR Systems Center, SC

SPIE - *The International Society for Optical Engineering*

Sensor Technology for the Urban Battlefield
Orlando, FL April 24 - 28, 2000