Joint Development of a Non-Magnetic Azimuth Sensor for Dismounted Targeting Operations in All Environments

NDIA 44th Annual Gun & Missile Systems Conference & Exhibition

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NSWC Dahlgren

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Overview

• Problem with Current Azimuth Sensors for the Dismounted User
• Key Performance Parameters
• Joint Approach to Obtaining a Solution
• Azimuth & Vertical Angle Measurement (AVAM) Joint Working Group (JWG)
• Path to AVAM JWG Success
• Schedule of Joint Development Efforts
• Pros & Cons of Current Solutions
The Task

• What Are We Trying to Do?
  – We are attempting to develop a High Accuracy, Non-Magnetic Azimuth & Vertical Angle Module
    • Joint, Long Term Goal: To Support Joint Effects Targeting System (JETS) with production in 2014

• Why?
  – **Magnetic anomalies, especially ON the User, are common** and result in potentially significant Target Location Error (TLE). Majority of cases, the User is unaware of the interference.
    • Current gear in the field causes azimuth errors of up to 150 mils!
  – GPS guided munitions require more accuracy than is available in current dismounted targeting sensors
    • Require <20m (T), <10m (O) according to Naval Surface Fire Support requirement

• Users are unaware of magnetic anomalies caused by their gear which affect azimuth error by up to 150 mils
• Munitions have already been fielded requiring a solution within as short a timeframe as possible
Target Location Error 50 (TLE50): TLE50 is a measure of deviation from the actual location of a target and defined as the radius of a circle which is centered at the actual target coordinate in which 50% of the observations are contained.
# Key Performance Parameters

<table>
<thead>
<tr>
<th>Key Parameter</th>
<th>Near-Term External / Tripod Mount Threshold (T)</th>
<th>Long-Term Internal / Fully Integrated Objective (O)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Azimuth Accuracy</strong></td>
<td>±4 mils Probable Error (PE)</td>
<td>±1 mil PE</td>
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<tr>
<td><strong>Vertical Angle Accuracy</strong></td>
<td>±4 mils PE</td>
<td>±1 mil PE</td>
</tr>
<tr>
<td><strong>Orientation Range</strong></td>
<td>Pitch: ±500 mils (~30°)</td>
<td>Pitch: ±1511 mils (~85°)</td>
</tr>
<tr>
<td></td>
<td>Bank: ±270 mils (~15°)</td>
<td>Bank: ±500 mils (~30°)</td>
</tr>
<tr>
<td><strong>Slew Rate</strong></td>
<td>30° per second</td>
<td>1000° per second</td>
</tr>
<tr>
<td><strong>Set up Time</strong></td>
<td>&lt; 180 seconds</td>
<td>&lt; 1 second</td>
</tr>
<tr>
<td><strong>Operational Temperature</strong></td>
<td>-40°C - +70°C</td>
<td>-40°C - +70°C</td>
</tr>
<tr>
<td><strong>Shock</strong></td>
<td>40g / 11 ms</td>
<td>2000 g / 1.5 ms (weapon fire)</td>
</tr>
<tr>
<td><strong>Vibration</strong></td>
<td>MILSTD 810/ min integrity</td>
<td>MILSTD 810/ min integrity</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>≤50 cu in</td>
<td>≤0.25 cu in</td>
</tr>
<tr>
<td><strong>Weight</strong></td>
<td>≤4.0 lbs (≤2.0 lbs preferred)</td>
<td>≤0.2 lbs</td>
</tr>
<tr>
<td><strong>Power</strong></td>
<td>≤10.0 W (≤2.0 W preferred)</td>
<td>≤250 mW</td>
</tr>
<tr>
<td><strong>Average Unit Production Cost</strong></td>
<td>$20K</td>
<td>TBD</td>
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<td>(FY07 dollars)</td>
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</table>
AVAM JWG Participants

- Naval Surface Warfare Center (NSWC), Dahlgren Division (Chair)
- Army Product Manager (PM) Soldier Sensors & Lasers (SSL)
- Office of Naval Research (ONR)
- Marine Corps Systems Command (MCSC) Program Manager (PM) Fire Support Systems (FSS)
- Night Vision & Electronic Sensors Directorate (NVESD)
- Johns Hopkins University (JHU) / Applied Physics Lab (APL)
- NSWC, Crane Division
- Air Force Research Lab (AFRL)
- Defense Advanced Research Projects Agency (DARPA)
- Marine Corps Warfighting Lab (MCWL)
AVAM JWG History

• Government funded efforts laid a foundation for current collaboration
  – Limited coordination across DoD resulted in duplication of efforts
  – Spurred initiation of quarterly JWG meetings
• The 2007 Joint Precision Azimuth Sensing Conference (JPASC)
  – Opportunity for ALL government stakeholders to listen to industry representation
  – Determine what progress was being made in the field of azimuth sensing
  – Present unified front to industry and demonstrate the need & market for azimuth sensing
• Close collaboration between Naval Surface Warfare Center (NSWC), Marine Corps Systems Command (MCSC) Program Manager Fire Support Systems (PM FSS), Office of Naval Research (ONR) 30 (Fires), Army Product Manager Soldier Sensors & Lasers (PM SSL), Night Vision & Electronic Sensors Directorate (NVESD), Special Operations Command (SOCOM), Johns Hopkins University / Applied Physics Lab (JHU/APL), and others (2007-present)
  – Several development efforts underway to meet a joint requirement for a non-magnetic azimuth sensor
  – Collaboration during proposal evaluation prevented duplication of efforts
  – Joint attendance encouraged at status meetings with contractors
<table>
<thead>
<tr>
<th>Organization</th>
<th>Contract Vehicle</th>
<th>Contractor</th>
<th>Direction Provided</th>
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<tbody>
<tr>
<td></td>
<td></td>
<td>NSWC Dahlgren</td>
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<tr>
<td></td>
<td></td>
<td>AFRL</td>
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<td></td>
<td></td>
<td>Army PM SSL/NVESD</td>
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<td>NSWC Crane</td>
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Prior to FY08

FY08

CONCEPTUAL PURPOSES ONLY
AVAM JWG Evolution (cont.)

Organization
AVAM JWG

Contract Vehicle
NSWC Dahlgren
Army PM SSL
NVESD
NSWC Crane

Contractor
1
2
3
4
5
6
7
8
9

Direction Provided

FY09 & Future

CONCEPTUAL PURPOSES ONLY

DISTRIBUTION STATEMENT A
Path to JWG Success

• Significant effort & vigilance by all involved is required to establish & maintain joint forum
  – Frequent & open communication
  – Quarterly JWG meetings
  – Joint proposal evaluations
  – Joint attendance at contractor status meetings
  – Report distribution
  – Joint demonstrations / tests
  – JPASC / industry days
  – Tools for sharing information

• Set aside differences early
  – Goal is to find a solution, regardless of funding source
  – Define common requirements
  – Acknowledge differences in implementation
  – No feelings of ownership towards specific technologies

Deliberate collaboration is required to achieve a successful Joint Working Group
Tools

- Online tools are used to share data within the AVAM JWG
- All government support contractors must have appropriate, active Non-Disclosure Agreements on file

AVAM JWG meetings are scheduled using the Discussion & JWG Announcements page. Notification can be sent to all members when items are posted, simplifying the scheduling process.
Joint Development Efforts for AVAM

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<tr>
<td>S&amp;T Efforts</td>
<td>JPASC</td>
<td>JPASC-II</td>
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<tr>
<td>MCSC SBIR</td>
<td>Phase I</td>
<td>Phase II</td>
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<tr>
<td>NVESD SBIR</td>
<td>Phase I</td>
<td>Phase II</td>
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<td>ONR 30 (Fires)</td>
<td>NMAS Short Term</td>
<td>NMAS Long Term</td>
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<tr>
<td>Army PM SSL</td>
<td>HAAVM</td>
<td>Near Term Solution (HAAD)</td>
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<tr>
<td>NVESD SBIR</td>
<td>Phase I</td>
<td>Phase II</td>
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<td>DARPA Long Term Sol’n</td>
<td>Phase III</td>
<td>Phase IV</td>
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<td>NVESD (LEAD &amp; contracting agency), ONR Fires (via NMAS), Army PM SSL, MCSC PM FSS (via NMAS)</td>
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NSWC Dahlgren chairs the AVAM JWG. Members include Army PM SSL, MCSC PM FSS, ONR 30 Fires, NVESD, JHU/APL, and others.
## FY09 Alternatives Analysis

<table>
<thead>
<tr>
<th>Approach</th>
<th>Perf. &lt; 4 mil (T)</th>
<th>Size &lt; 50 in³</th>
<th>Weight &lt; 2 lb</th>
<th>Power &lt; 5 W</th>
<th>Cost &lt; 20 K</th>
<th>Maturity FY09</th>
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<tbody>
<tr>
<td>GPS</td>
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<tr>
<td>Ring Laser Gyro</td>
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<td>Fiber Optic Gyro</td>
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<td>Hemispherical Resonator Gyro</td>
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<tr>
<td>Fluid Based Gyro</td>
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<tr>
<td>MEMS</td>
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<tr>
<td>Celestial</td>
<td>requires unobstructed view of the sky</td>
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**Note:**
- Green indicates Low Risk
- Yellow indicates Medium Risk
- Red indicates High Risk

**Approach Characteristics:**
- Performance: < 4 mil (T)
- Size: < 50 in³
- Weight: < 2 lb
- Power: < 5 W
- Cost: < 20 K
- Maturity: FY09

**GPS Ring Laser Gyro**

**Hemispherical Resonator Gyro**

**Fluid Based Gyro**

**MEMS**

**Celestial** requires unobstructed view of the sky
Summary

• All services currently have the capability to very precisely miss targets
• All services require small, lightweight, precise azimuth sensor unaffected by the environment
• Joint development efforts are capitalizing on DoD investment to develop suitable azimuth sensors