Cutting Edge Seismic Sensor Technology for Border Security Industry

Precision Sensors & Instruments, LLC
Yerevan, ARMENIA
Samvel G. Gevorgyan, Chief Technology Officer
06 February, 2015
Background

2011 Science & Technology Directorate of HLS (DHS S&T), in support of U.S. Customs & Border Protection (CBP) tested/assessed a variety of Unattended Ground Sensor (UGS) technologies for improving surveillance on US borders. Massachusetts Institute of Technology – Lincoln Laboratory (MIT-LL) directed the testing and performed the results analysis.

- DHS rated Russian Radiobarrier RS-U sensor as “best performing” – 46 meters detection range for a walking person and 55 m for a pick-up truck at 10 MPH.

2013 Armenian Precision Sensors & Instruments LLC (PSI) supported by the U.S. Global Innovations, Inc. (GII) field tested prototype seismic subsystem in comparison with best in class geophone based seismic sensor system. Side by side tests convinced GII that the PSI sensor system outperforms all geophone based sensor subsystems by a significant margin – footstep detection ranges > 100 meters.

2013 DHS M. Borkowski’s office twice invited GII to present PSI’s emerging technology. “... if you measure claimed detection ranges, we want it....” during last visit 11 Sept. 2013.

2013 U.S. Flight Test Aerospace, Inc. (FTA) approached GII to jointly evaluate Precision Sensors & Instruments innovative seismic sensor potential. GII organized demonstrations for DHS and other DoD companies in January 2014 (Raytheon and Northrop Grumman).
Background

- **2014** GII sponsored Mojave Desert field tests, conducted by FTA, 29/30 Oct. 2014, comparing PSI sensor system side by side with RS-U. The results confirmed GII’s 2013 year claim that PSI’s sensor subsystem outperforms the RS-U by a significant margin.
  - Fixed magnitude impulse drop tests: 4.5 kg dropped from 1 meter height (44.5 Joules),
  - Nominal Person Walking: 200 lb person walking normally (not attempting to conceal presence),
  - Vehicles slow drive-by on unprepared surface: Grand Caravan & Range Rover.

Mojave Desert test results convinced FTA that GII’s sponsored PSI seismic sensor technology sets a new world standard for seismic sensors.

- Independent data analyses by FTA is provided in separate report (see attached).

- PSI presents the following preliminary summary to potential customers interested in high performance seismic sensor subsystems for deployment and integration into the Early Warning Border Security Systems (EWBSS).
Seismic Sensor Subsystem Performance Comparison in 2015 Market

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Detection radius for all human activities and % confidence level</td>
<td>10 – 30 m (*)</td>
<td>≤ 30m with &gt; 90%, ~ 50m with ≤ 50%, ~ 70m with &lt; 10%</td>
<td>200 – 350 m (*)</td>
</tr>
<tr>
<td>Detection radius for Intruder footsteps</td>
<td>------</td>
<td>------</td>
<td>100 – 250 m (*)</td>
</tr>
<tr>
<td>Detection radius for SUV class vehicles</td>
<td>50 – 100 m (*)</td>
<td>50 – 200 m (*)</td>
<td>1.5 – 3 km (*)</td>
</tr>
<tr>
<td>Detection radius for falling 10 lb (~ 4.5 kg) weight from 1 m height</td>
<td>------</td>
<td>------</td>
<td>more than 300 m (44.5 joules impulse)</td>
</tr>
<tr>
<td>Detection radius for falling soft 10 lb (~ 4.5 kg) sand bag from 1 m height</td>
<td>------</td>
<td>------</td>
<td>more than 250 m (44.5 Joule Impulse)</td>
</tr>
</tbody>
</table>

* Depending on soil composition and condition, and depending on ground level environmental activity (GLEA).

All seismic sensor performance vary, proportional & dependent on ground geological composition.
Emerging seismic sensor system outperforms all existing seismic sensors used in many intrusion detection systems:
- Resolve decades long border security challenge

Record wide security footprint:
- Best in class existing sensors provide 100 m wide Security Corridor
- PSI Seismic Sensor Subsystem (SSS) cutting edge sensors provides 450 m wide Security Corridor
- 20 to 1 advantage in surface area security

 Significant Operational & Cost Advantages:
- Tunnel activity detection
- Multiple wide corridors
- Demilitarized zones
Emerging Early Warning Border Security System

- PSI Introduces its New Game Changing competitive Early Warning Border Security Systems (EWBSS)
  - Integrate COTS Radar and Cameras
  - Integrate COTS Communication subsystems
  - Results in most competitive and effective EWBSS

- Establish various security corridor widths, as required, to secure borders and “hot-spots”

- Monitor and communicate the intruder’s location on networks and monitors per customer requirements
BORDER INTRUSION DETECTION SYSTEM
MODULAR ARCHITECTURE

One Modular PSI SSS Secures 1 kilometer of Border
The side by side field test in the Mojave desert confirmed that PSI’s seismic sensors are superior to the RS-U seismic system. The superiority quality of the new seismic sensor is irrefutable based on comparative field test results. To date, for reference, two of the best in class seismic sensor systems have been tested in the field side by side to compare the quality of detection range performances.

The 1st sensor system, built by U.S. Qual-Tron inc., & used in the USA/Mexico border. The 2nd is built by Russian Radiobarrier company, which is regarded as the best by the US Navy.

None of the above seismic sensor systems are competing in quality and performance with the new sensor technology developed by the Armenian start-up company PSI. This game changing technology is producible and provides better Early Warning Border Security System (EWBSS). Please see the summary performance comparison table here in.
New Sensor Technology

Game Changing Advantages:

- Best USA & Russian seismic sensors detect up to **50 m**
- PSI’s New technology sensor detection range is **225 m**
- Highest performing security systems can be provided by integrating these sensors into EWBSS.
Each footstep is distinctly countable up to 250 meters. Alarms can be processed up to 300 meters. Footstep clarity is directly proportional to the GLEA.

**Test Scenario:** 80 Kg man taking distinct 14 steps, wait ~10 seconds, continue with another 14 steps, wait, continue until 300 meters away from the sensors in the ground.

### Example of processed Signals showing footstep detection

<table>
<thead>
<tr>
<th>Distance from PSI SFCO Sensors - 0-120 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D sensor D3</td>
</tr>
<tr>
<td>X</td>
</tr>
<tr>
<td>Z</td>
</tr>
<tr>
<td>SFCO Sensor D0 (uni directional)</td>
</tr>
<tr>
<td>Z1 (lf)</td>
</tr>
<tr>
<td>Z2 (hf)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from PSI SFCO Sensors - 120-190 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D sensor D3</td>
</tr>
<tr>
<td>X</td>
</tr>
<tr>
<td>Z</td>
</tr>
<tr>
<td>SFCO Sensor D0 (uni directional)</td>
</tr>
<tr>
<td>Z1 (lf)</td>
</tr>
<tr>
<td>Z2 (hf)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from PSI SFCO Sensors - 190-260 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D sensor D3</td>
</tr>
<tr>
<td>X</td>
</tr>
<tr>
<td>Z</td>
</tr>
<tr>
<td>SFCO Sensor D0 (uni directional)</td>
</tr>
<tr>
<td>Z1 (lf)</td>
</tr>
<tr>
<td>Z2 (hf)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Distance from PSI SFCO Sensors - 260-300 meters</th>
</tr>
</thead>
<tbody>
<tr>
<td>3D sensor D3</td>
</tr>
<tr>
<td>X</td>
</tr>
<tr>
<td>Z</td>
</tr>
<tr>
<td>SFCO Sensor D0 (uni directional)</td>
</tr>
<tr>
<td>Z1 (lf)</td>
</tr>
<tr>
<td>Z2 (hf)</td>
</tr>
</tbody>
</table>

Footstep clarity is dependent on many factors, including how people walk, and GLEA.
**Test Scenario:** Start by measuring GLEA at 280m, jump three times to start, wait, take 14 steps, wait, jump twice, wait, continue with 14 steps, repeat until approaching sensors.

Footstep clarity is dependant on many factors, including how people walk, and GLEA.
Early Warning Border Security Systems (EWBSS)

(general operational description)

Virtual Fence

The Border

Virtual Fence is Passive & Invisible to Intruders
New technology sensor provides significant operational & cost advantages:

- Less sensors/mi
- Less transceivers/mi
- Lower operational costs

**Discriminating Advantages**

20x Larger Security Footprint
“Walking" Footsteps

1. Quality of sensors
   - Radius = 50 m
   - Small security footprint
   - Response time: 2 min

2. Geophone Based Detection

New Sensor Radius = 225 m provides large security footprint
- Response time: 12 min.

Virtual Fence

The Border

Headquarters

Radius = 50 m
Small security footprint
Response time: 2 min
Significant Operational Advantage

Operational & Cost Advantages

<table>
<thead>
<tr>
<th>PSI Sensor</th>
<th>All Geophone based EWBSS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.</strong>&lt;br&gt;900 – 1,500</td>
<td>200&lt;br&gt;Security Corridor width (ft)</td>
</tr>
<tr>
<td><strong>2.</strong>&lt;br&gt;8&lt;br&gt;200&lt;br&gt;Sensors /mi</td>
<td></td>
</tr>
<tr>
<td><strong>3.</strong>&lt;br&gt;80&lt;br&gt;50&lt;br&gt;Transceivers / 10 mi</td>
<td></td>
</tr>
<tr>
<td><strong>4.</strong>&lt;br&gt;no need&lt;br&gt;2 - 4&lt;br&gt;Replace batteries/year</td>
<td></td>
</tr>
<tr>
<td><strong>5.</strong>&lt;br&gt;High&lt;br&gt;Low&lt;br&gt;System performance</td>
<td></td>
</tr>
<tr>
<td><strong>6.</strong>&lt;br&gt;Low&lt;br&gt;High&lt;br&gt;Operational costs</td>
<td></td>
</tr>
<tr>
<td><strong>7.</strong>&lt;br&gt;Low&lt;br&gt;High&lt;br&gt;Cost of ownership</td>
<td></td>
</tr>
</tbody>
</table>
FTA’s Mojave Desert field tests proves PSI seismic sensor subsystem superior to all existing global seismic sensors

( refer to attached FTA report )

Game changing seismic sensor performance:

- Detection range performance is 4–6 times further than competition now,
- 20 times more security surface area than competitors’ sensors,
- Provides wider security corridors. Can provide several wide corridors,
- Tunnel depth detection range is beyond currently discovered illegal tunnels
- Lower acquisition/installation/maintenance/life cycle costs
  - 80% less hardware per mile required,
  - Bury & Forget sensors (battery replacement eliminated).

Summary Conclusion
Summary  Conclusion

- Expect better detection range performance in production:
  - Project 6 – 9 times better detection range than competition, with production hardware / software configuration
  - 50 times more security surface per sensor than any competitors sensors

- With additional software development significant target intelligence can be provided:
  - Acquire tunnel location and depth
  - Differentiate humans, animals & vehicles
  - Provide drastic reduction in false alarm rate automatically

- Next step is development to transition to production
Path Forward Recommendations

- HLS’s border and tunnel security requirements can be resolved with the demonstrated new sensor capabilities.

- Respectfully recommend following path forward with HLS:
  - HLS with GII and PSI team to mutually conduct sensor subsystem validation tests for border and tunnel scenarios,
  - Border scenario test validation can be at HLS designated site,
  - Tunnel scenario test validation can be at HLS San Diego tunnel laboratory.

- GII recommends the following border security network integration test and evaluation:
  - HLS with GII and PSI team to mutually conduct sensor system integration & validation tests with existing HLS border security network systems.
Precision Sensors & Instruments
“PSI” Ltd., Armenia
http://www.psi.am

Contact Information:
Samvel G. GEVORGYAN – Professor
(374-93) 519 – 729 (Armenia)
gevs.sam@gmail.com

Vardan S. Gevorgyan – Ph.D.
«PSI» Project manager
Phone: + (374 - 94) 555 - 421 (Armenia)
Email: vargevorgyan@gmail.com