Civil Applications of the GPS Jamming Detection and Location (JLOC) System

GPS Jamming & Interference – A Clear and Present Danger
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JLOC System Purpose

1. Monitor for GPS threats
   • Uses networked GPS receivers and other interference sources as JLOC Sensor Inputs

2. Provide automated alerts to users when a GPS threat is detected
   • JLOC Master Station maintains threat data-base
   • JLOC subscribers define area of interest

3. Situational awareness on GPS threat effect
   • JLOC Client predicts effect of threats on mission
   • Assists in developing tactics to counter threats
JLOC is Network-Centric

Sensor Data Collection → Process Publish → Subscribe

Network

Alerts, Reports, Plots

Sensors / GPS User Equipment → JLOC Master Station

Jamming/Interference Detection

JLOC Users
GPS JLOC History

- ’98: AFRL initial JLOC contract awarded
  - Developed JLOC system design and lab units
- ’00: GATOR Space Battlelab Initiative: JLOC prototype testing at White Sands & Woomera
  - Built prototype JLOC system for field testing
  - Located jammers from ground and airborne units using conventional and modified GPS UE
- ’04: AF TENCAP JLOC Phase III contract
  - Built and tested operational JLOC system
- ’07: JLOC Operational Capability
  - JLOC Master Station located at NGA’s Monitor Station Network Control Center (MSNCC)
**Current JLOC Operations**

<table>
<thead>
<tr>
<th>SENSORS</th>
<th>PORTAL</th>
<th>CLIENT</th>
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<tbody>
<tr>
<td>GPS UE</td>
<td>NGA JLOC Master Station</td>
<td>JLOC Client</td>
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<tr>
<td>C/N0 Sensors</td>
<td>JLOC Portal</td>
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<td>GPS Threat</td>
<td>SIPRNET</td>
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<td>Locations</td>
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JLOC Client Predicts Jammer Effects from Calculated J/S

- Loss of Lock
- Loss of Acquisition
- Power Detection
- TDOA Detection

Ground to Ground:
- 1 km
- 2.1 km
- 3.2 km

Airborne, Line of Sight:
- 38 km
- 65 km
- 145 km
JLOC Sensor Types

- **C/N0 Sensors**
  - JLOC reports generated when signal degradation or I/S increase observed

- **Threat Sensors**
  - Provide estimated geolocation of threats

- **AOA Sensors**
  - Provide angle of arrival (direction) of threat

- **TDOA Sensors**
  - Provide raw data for estimating threat location
# Examples of Potential Civil JLOC Feeds

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<tbody>
<tr>
<td>NGA JLOC Master Station (JLOC Threat Sensor)</td>
<td>Civil JLOC Portal</td>
<td>JLOC Client</td>
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<tr>
<td>JLOC CN0 Sensors</td>
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<tr>
<td>US CivilSources</td>
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<tr>
<td>CORS/IGS</td>
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<td>NDGPS</td>
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<td>WAAS/LAAS</td>
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<td>USCG AIS</td>
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<td>International Sources</td>
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<td>GAARDIAN (UK)</td>
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<td>GRAS (Australia)</td>
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<td>QZSS (Japan)</td>
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Multiple C/N0 sensor reports indicate region of GPS jamming
Example JRU real-time display showing AOA of jammer and I/S diagnostics
JLOC AOA Sensor Network Concept

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<tr>
<td>AOA Sensor Network</td>
<td>JLOC Master Station</td>
<td>JLOC Client</td>
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<tr>
<td></td>
<td>INTERNET</td>
<td>JLOC Client</td>
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<tr>
<td></td>
<td>Civil JLOC Portal</td>
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<td></td>
<td>AOA networked geolocation</td>
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JLOC Portal
# JLOC TDOA Sensor Network Concept

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<td>JLOC Snapshot</td>
<td>TDOA precise geolocation</td>
<td>JLOC Client</td>
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<tr>
<td>TDOA Sensor Network</td>
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</tbody>
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- **SENSORS**: JLOC Snapshot, TDOA Sensor Network
- **PORTAL**: TDOA precise geolocation
- **CLIENT**: JLOC Client

**INTERNET**

- JLOC Master Station
- Civil JLOC Portal
- JLOC Portal

JLOC Client
Commercial GPS Threat

- Designed to Block GPS/GSM signals for 7 meters
- With booster range could be extended

- U.S. Communications Act prohibits blocking or interfering with radio communications
- FCC Threatened fines up to $11K per device sold
Example Jammer Simulation

- 1 watt jammer from London Eye with receiver J/S = 41 dB
- Cigarette size battery pack gives 10 hrs jammer operation

Scale:
20 x 20 km
Google Sketch-Up Simulation with Jammer Propagation
Simulation Results showing TIDGET TDOA Sensor Geolocation
Conclusion

• JLOC System allows publication of jammer alerts using a variety of sensor feeds
• Provides jammer situational awareness and threat effects prediction
• JLOC Master Station is currently being used by US Military and being integrated into AOC baseline
• A Civil JLOC Master Station could be used to provide GPS interference detection & mitigation using civil JLOC sensor sources
BackUp
JLOC Program Objectives

- **Situational Awareness** of jammer effects to the warfighter for use in mission planning and execution
  - **Detect** GPS interference by exploiting GPS user equipment as JLOC sensors
  - **Locate** precisely the sources of interference by processing the GPS JLOC sensor data
  - **Disseminate** jammer alerts and reports

- The JLOC system approach:
  - Use various **sensors** and reporting systems to **collect information** about GPS jamming and interference
  - **Analyze** the navigation **denial impacts** of this data and centralizes jamming/interference information
  - **Publish** alerts, reports, and effectiveness plots essential **to warfighters** and mission planners reliant on GPS.