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

GPS Jamming & Interference – A Clear and Present Danger
National Physical Laboratory, Teddington
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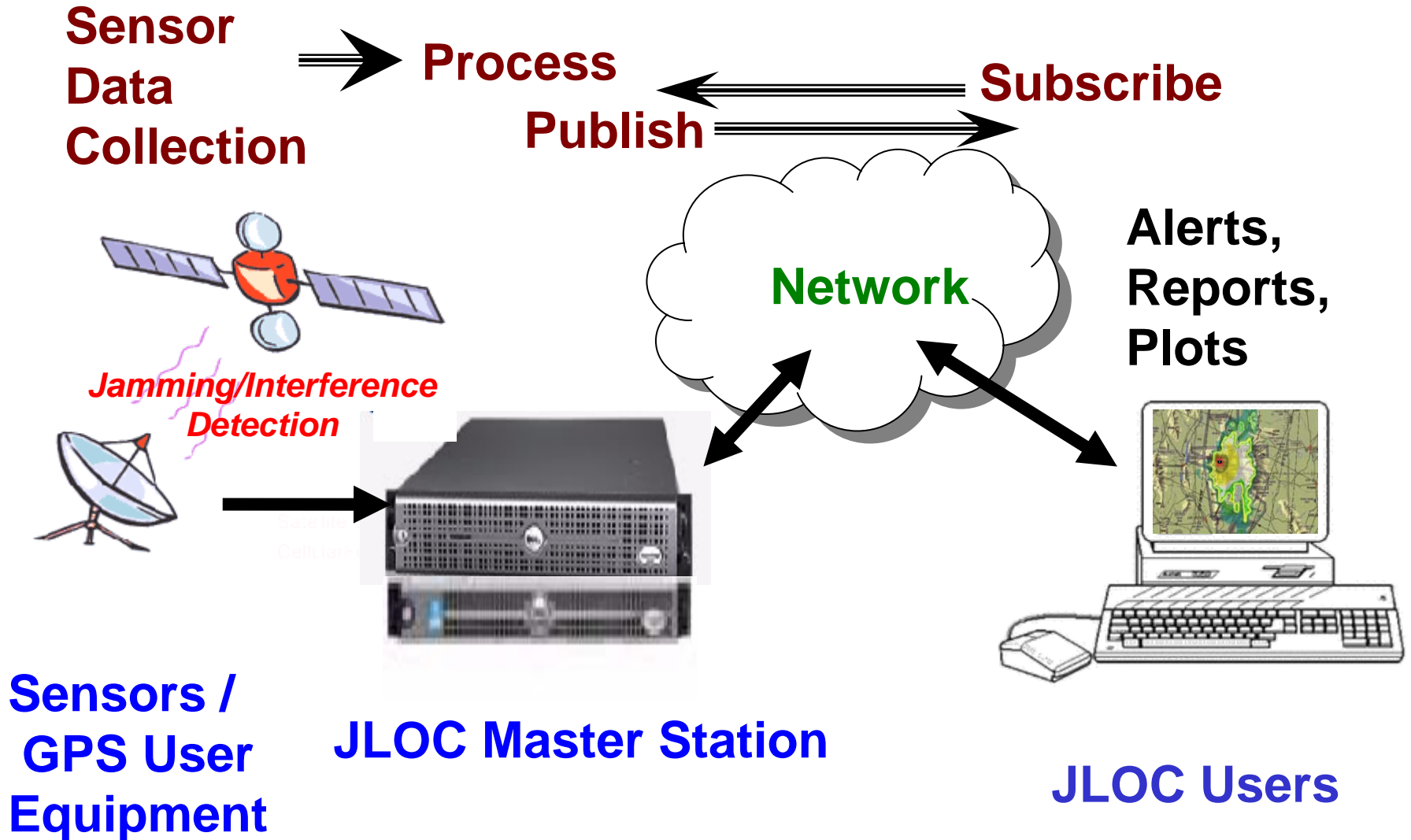
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JLOC System Purpose

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

Subscribe

Publish

Network

Alerts, Reports, Plots

Jamming/Interference Detection

Sensors / GPS User Equipment

JLOC Master Station

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

SENSORS	PORTAL	CLIENT

GPS UE C/N0 Sensors

GPS Threat Locations

NGA JLOC Master Station

JLOC Portal

SIPRNET
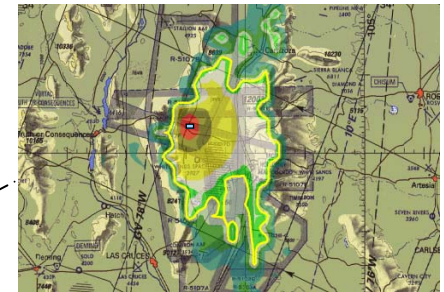
JLOC Client
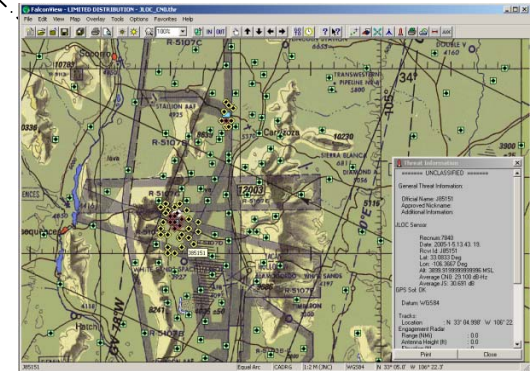
JLOC Client

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 |
| 1.4 km | | |

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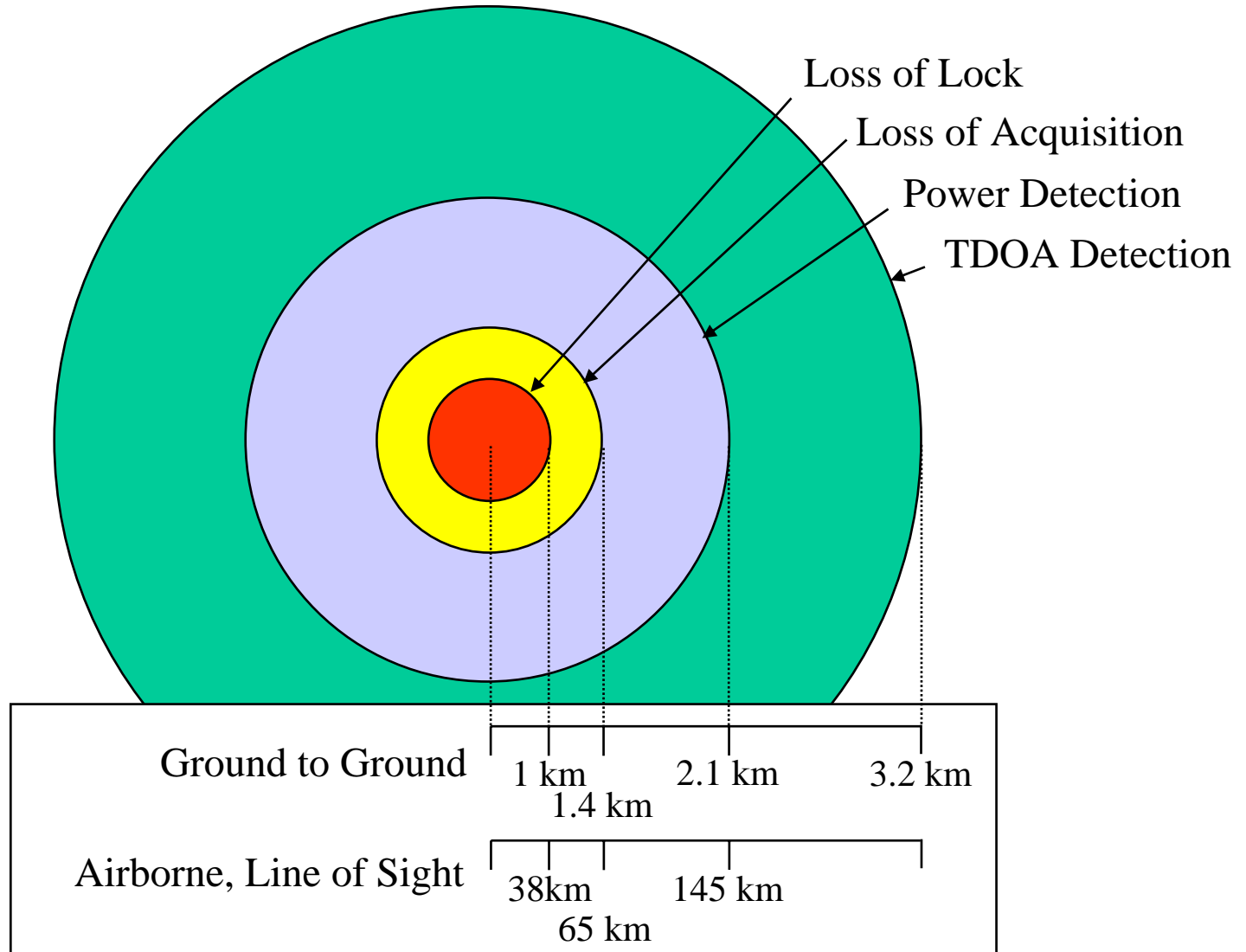
JLOC Sensor Types

- 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

SENSORS | PORTAL | CLIENT

NGA JLOC Master Station (JLOC Threat Sensor)

Network Guard

JLOC CN0 Sensors

US CivilSources
CORS/IGS
NDGPS
WAAS/LAAS
USCG AIS

International Sources
GAARDIAN (UK)
GRAS (Australia)
QZSS (Japan)

INTERNET

Civil JLOC Master Station

Civil JLOC Portal

JLOC Client

JLOC Client

Multiple C/N0 sensor reports indicate region of GPS jamming

4 watt 20 MHz noise jammer

Flight Profile 1 - 4 watt 20 MHz noise jammer
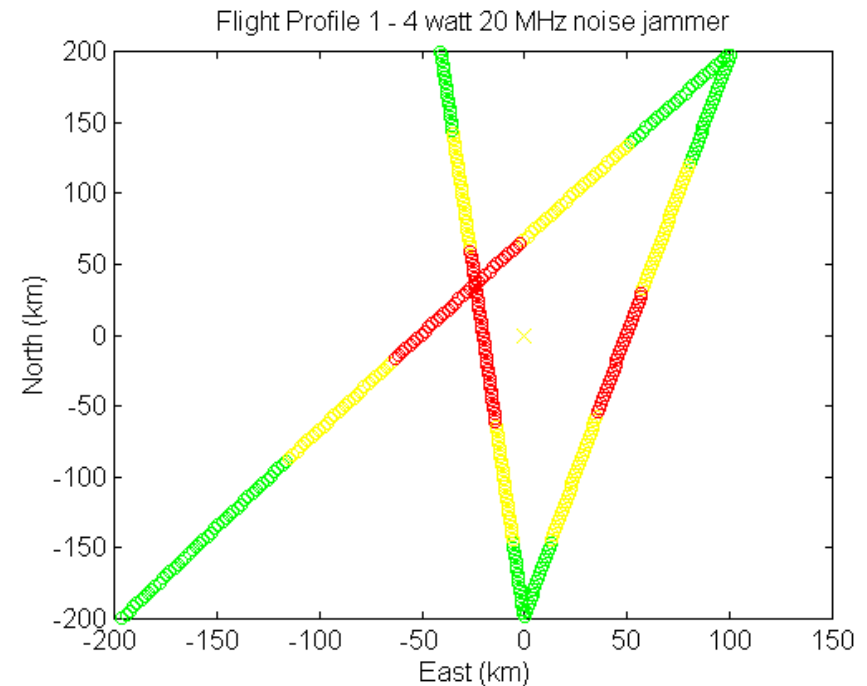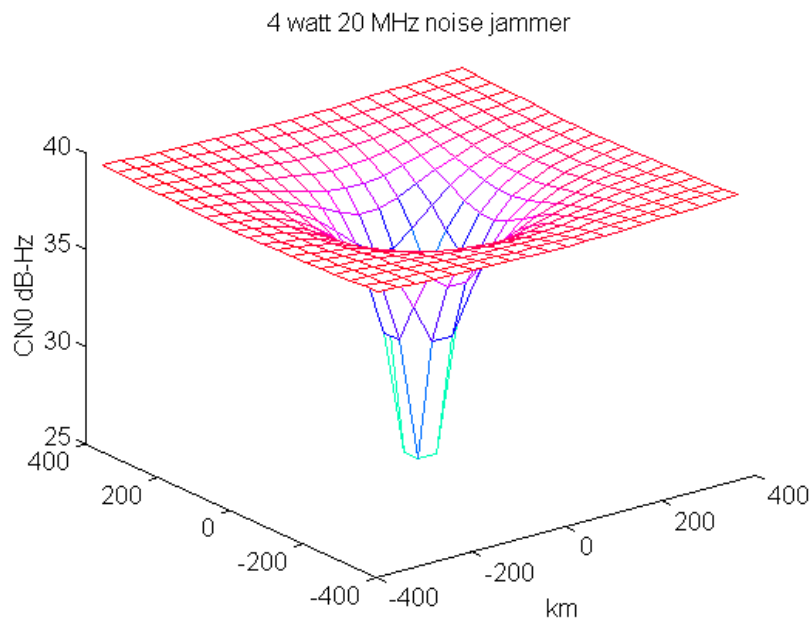
JLOC Receiver Unit AOA Sensor
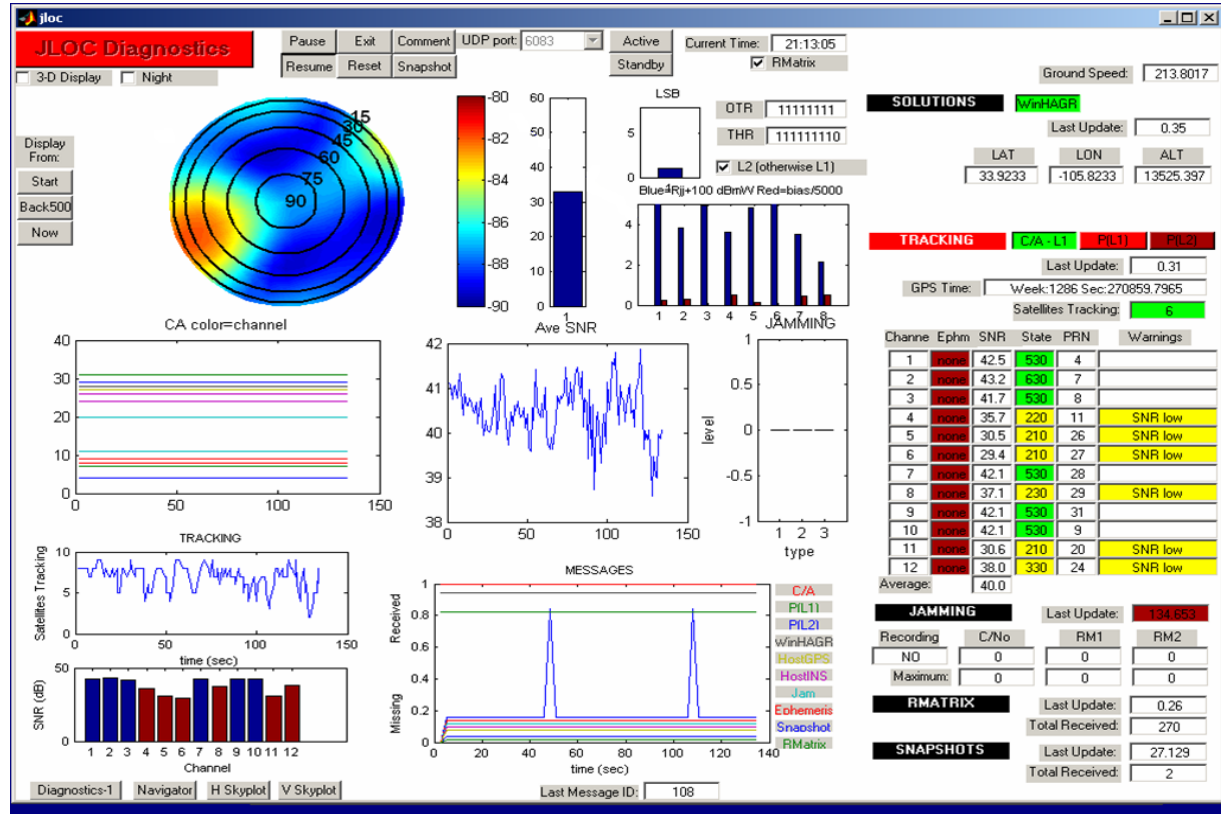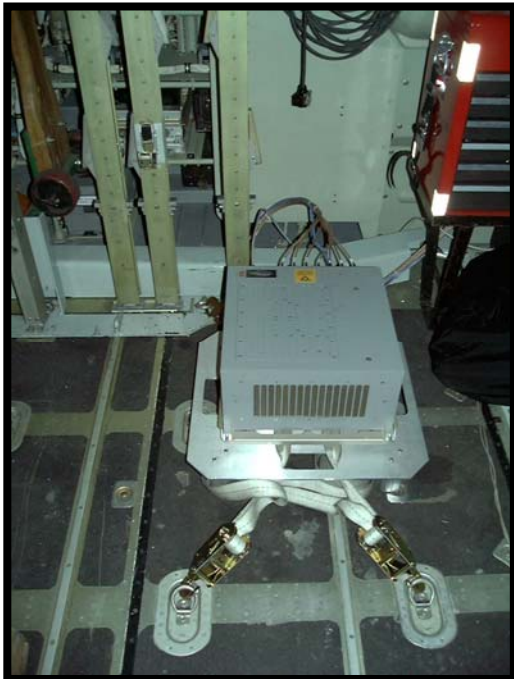
Example JRU real-time display showing AOA of jammer and I/S diagnostics

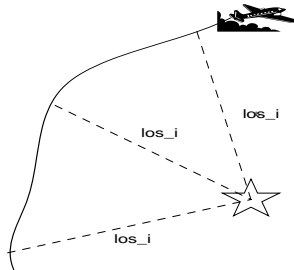# *JLOC AOA Sensor Network Concept*

SENSORS	PORTAL	CLIENT

AOA Sensor Network

AOA networked geolocation

los_i

los_i

los_i

JLOC Client

Civil JLOC Portal

JLOC Master Station

INTERNET

JLOC Client   11

JLOC Portal

JLOC TDOA Sensor Network Concept

SENSORS	PORTAL	CLIENT

JLOC Snapshot TDOA Sensor Network
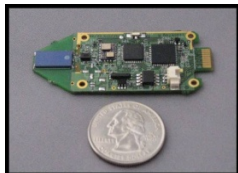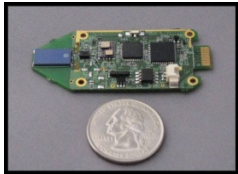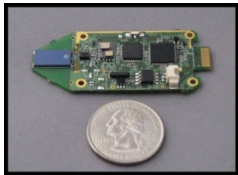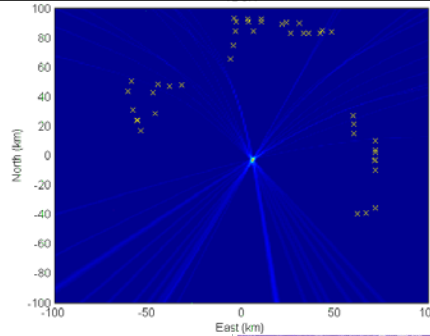
TDOA precise geolocation

JLOC Master Station

Civil JLOC Portal

INTERNET

JLOC Client

**JLOC Client**

JLOC Portal
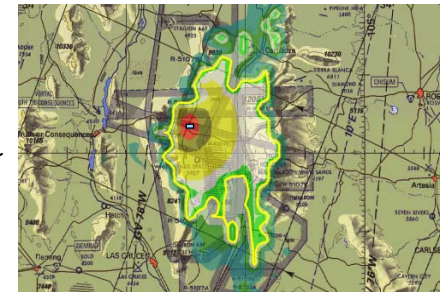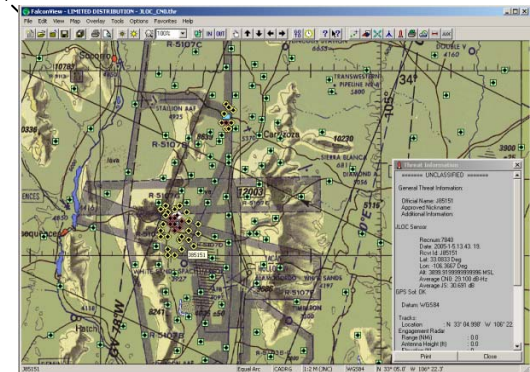
Commercial GPS Threat

- 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 up to $11K per device sold
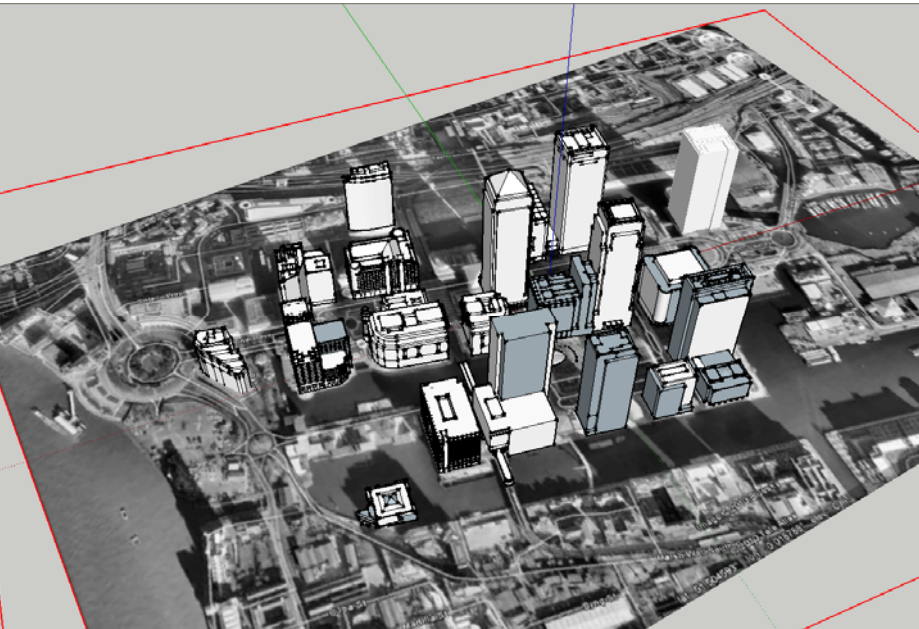
Example Jammer Simulation

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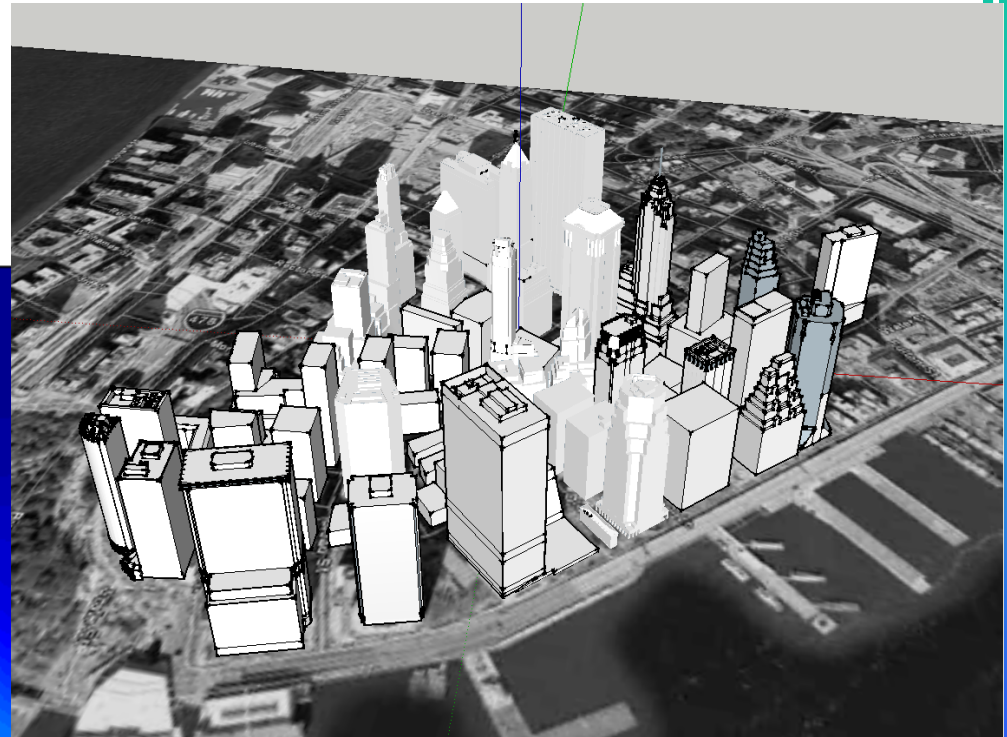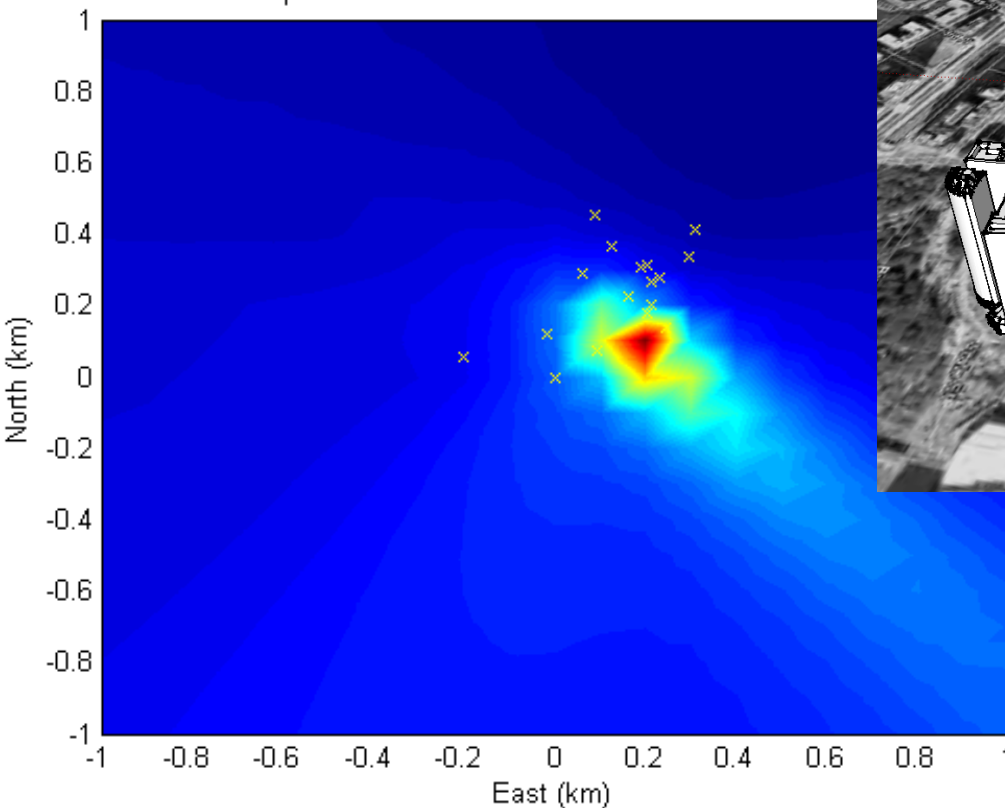
Scale:

20 x 20 km
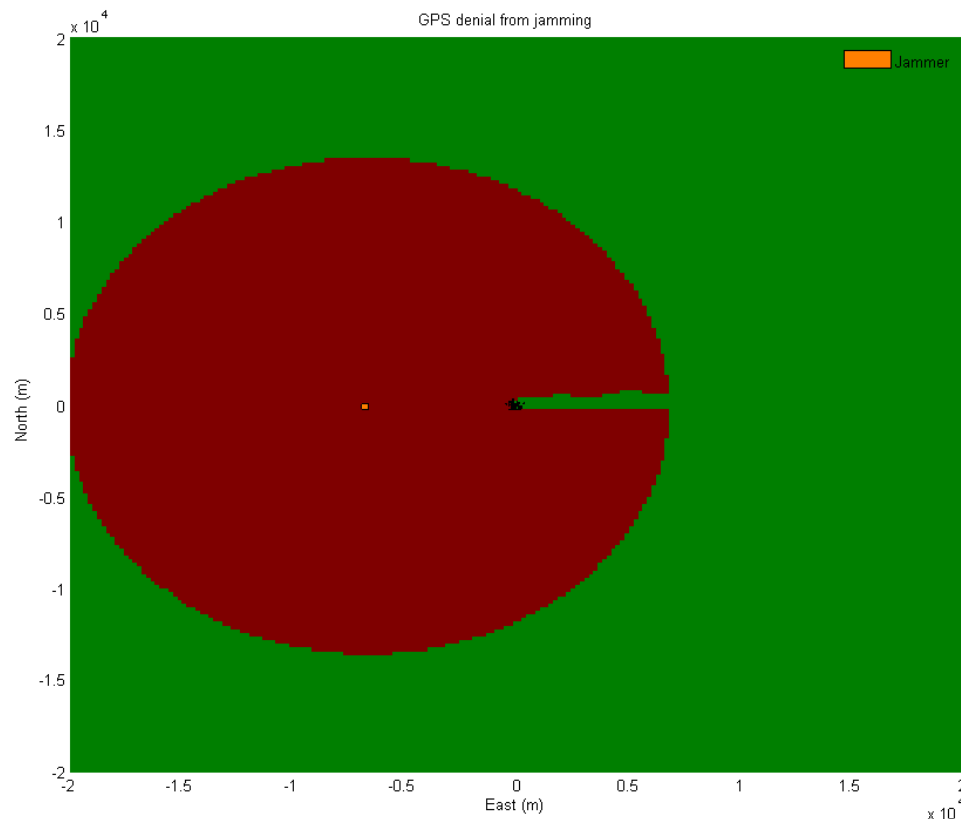
Google Sketch-Up Simulation with Jammer Propagation

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

- **<u>Situational Awareness</u>** of jammer effects to the warfighter for use in mission planning and execution
  - **<u>Detect</u>** GPS interference by exploiting GPS user equipment as JLOC sensors
  - **<u>Locate</u>** precisely the sources of interference by processing the GPS JLOC sensor data
  - **<u>Disseminate</u>** jammer alerts and reports
- The **JLOC** system approach:
  - Use various **<u>sensors</u>** and reporting systems to **<u>collect information</u>** about GPS jamming and interference
  - **<u>Analyze</u>** the navigation **<u>denial impacts</u>** of this data and centralizes jamming/interference information
  - **<u>Publish</u>** alerts, reports, and effectiveness plots essential **<u>to warfighters</u>** and mission planners reliant on GPS.