GPS Interference Detection & Geolocation Technology

October 2015

Joe Rolli

Business Development

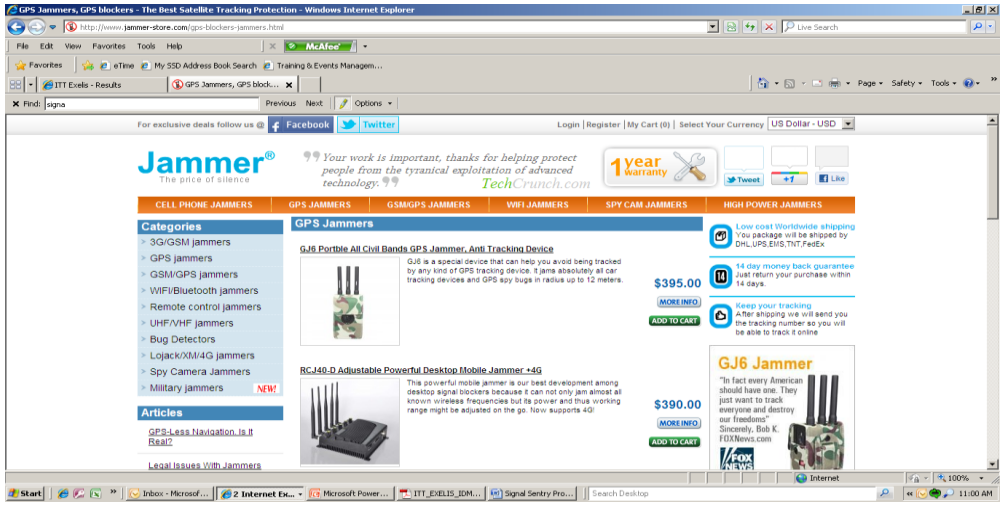
Jamming

GPS susceptible to outages due to intentional & unintentional jamming

A small jammer can disrupt the GPS signal for a mile or more

People jam because they are smuggling, stealing or trying to escape tracking

Availability of low-cost GPS jamming devices has increased the risk

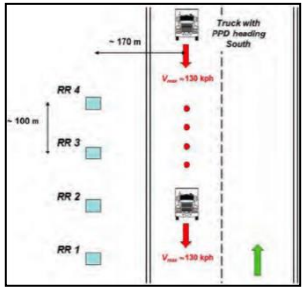


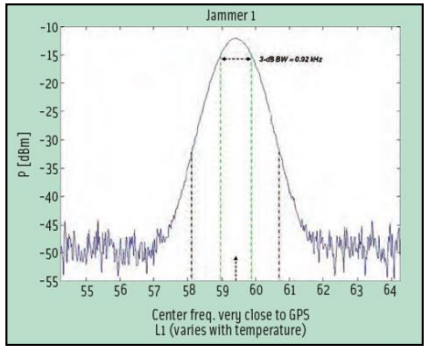
Real Risk of GPS Disruption

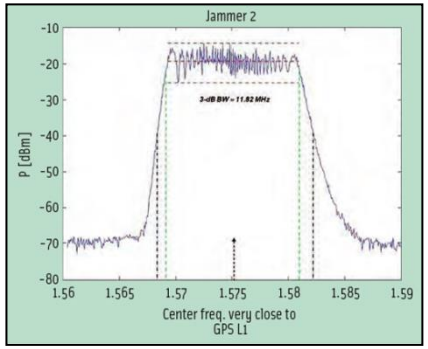
November 2009 Newark New Jersey

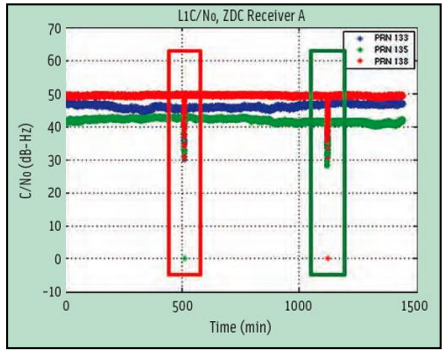
Ground-based Augmentation System (GBAS) Jammed

Took 8 months to find the source



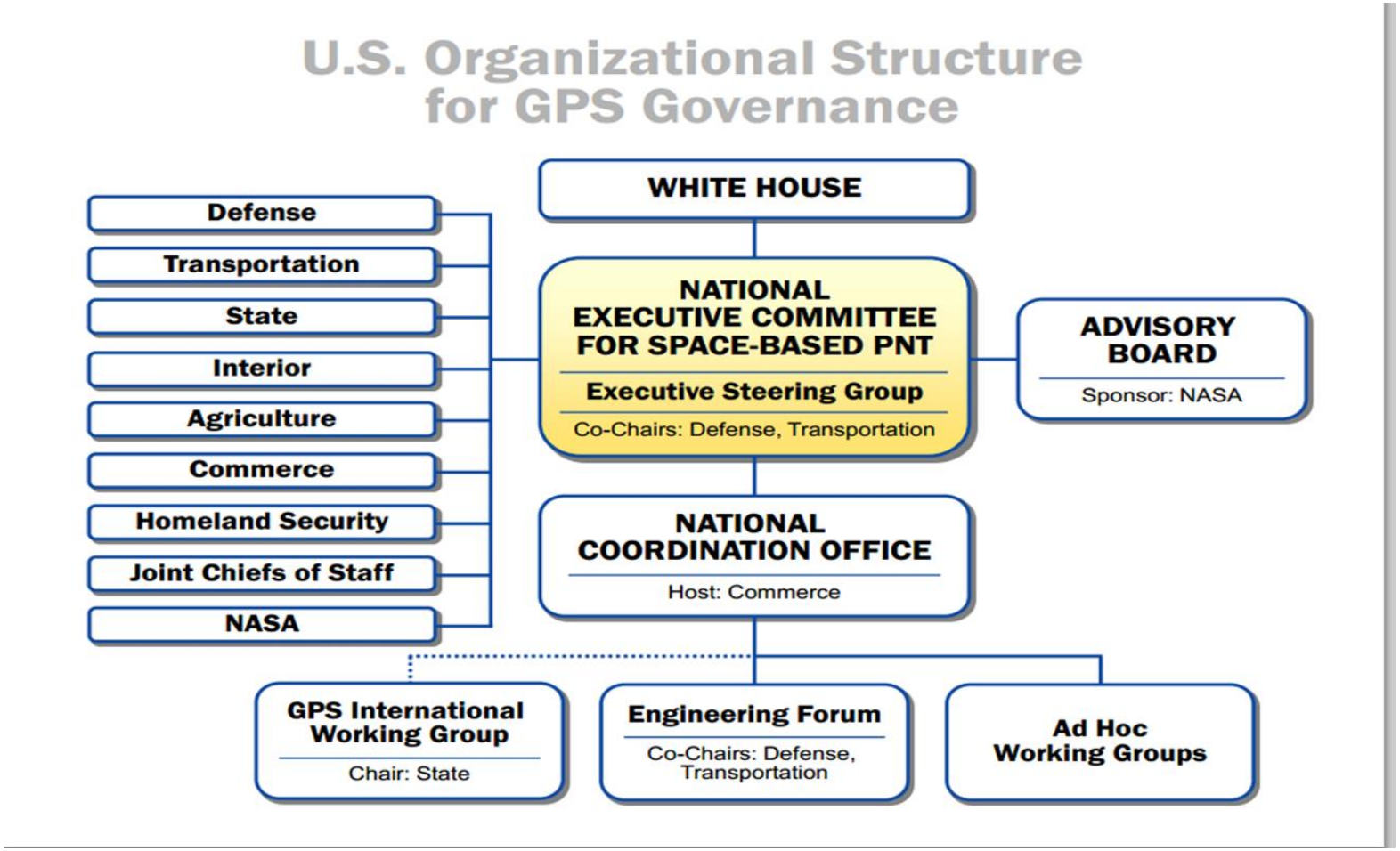






PNT Advisory BD “We must quickly develop and field systems that will rapidly locate, mitigate and shutdown the interference”

PNT Advisory Board



PNT Advisory Board Notice

Summary: The United States is now critically dependent on GPS. For example, cell phone towers, power grid synchronization, new aircraft landing systems, and the future FAA Air Traffic Control System (NEXGEN) cannot function without it. Yet we find increasing incidents of deliberate or inadvertent interference that render GPS inoperable for critical infrastructure operations.

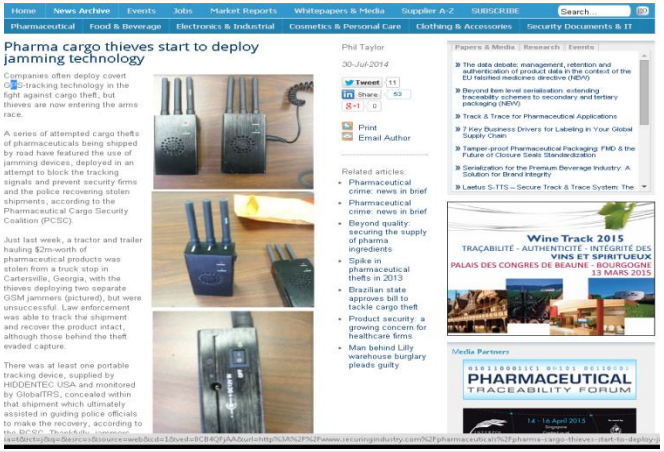
Most alarming, the very recent web availability of small GPS-Jammers suggests the problem will get worse. These so-called personal protection devices (PPDs) as well as other, readily available, more powerful devices can deliberately jam the Global Positioning System (GPS) signal over tens of square miles. They also can be devastating to the other, new foreign satellite navigation systems being deployed worldwide.

PPDs are illegal to operate, but many versions are available (for as little as $30) from foreign manufacturers over the Internet. The simplest models plug in to a cigarette lighter and prevent all GPS reception within a line of sight range of 5 to 10 miles. Current penalty for operation is simply that the device is confiscated.

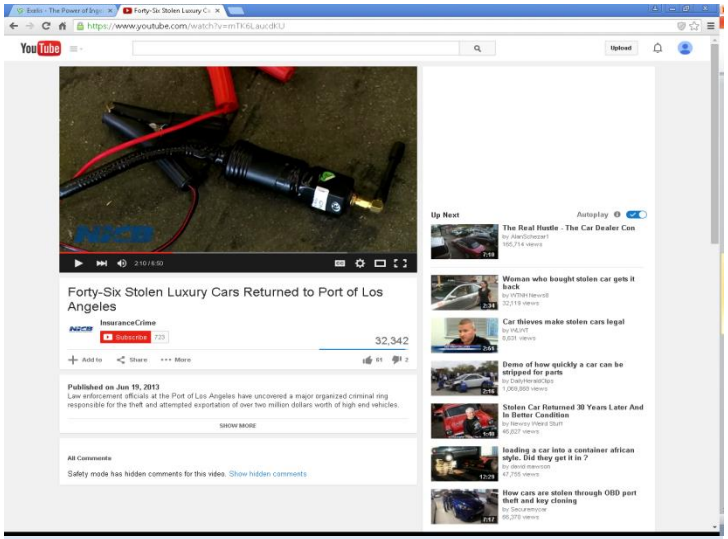
We currently lack sufficient capabilities to locate and mitigate GPS jamming. It literally took months to locate such a device that was interfering with a new GPS based landing system being installed at Newark Airport, NJ.

We must quickly develop and field systems that will rapidly locate, mitigate and shutdown the interference.

Real Risk of GPS Disruption Is Getting Worse



Pharmaceutical Cargo Security Coalition Symposium
* Novartis Pharmaceutical East Hanover February 10-11 2015



46 Stolen Cars and exported from LA Port Using GPS PPD

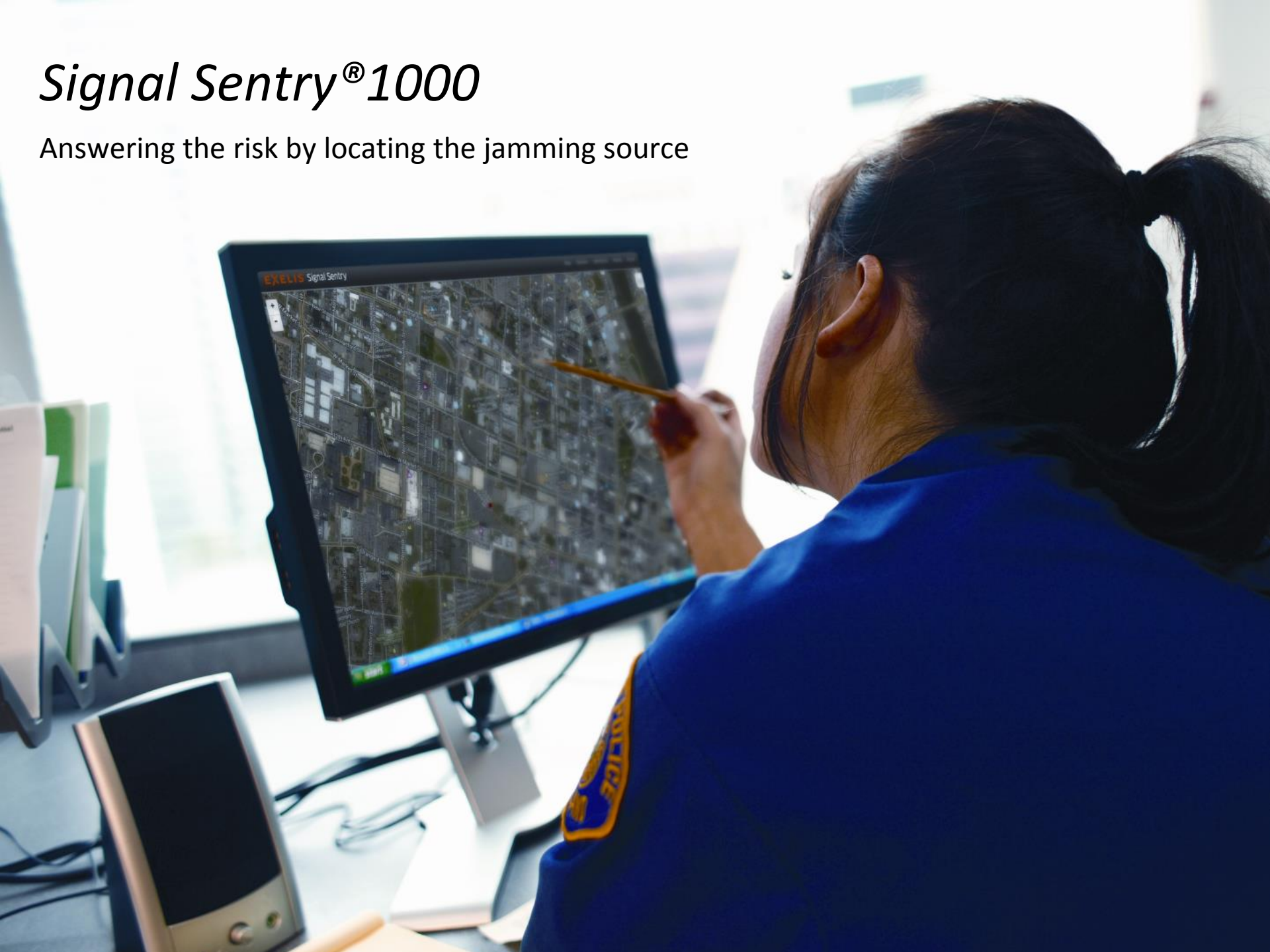
The FCC said an aircraft tracking system at Newark Liberty International Airport experienced interference from a GPS jamming device used by a Readington man who claimed he was simply trying to hide his whereabouts from his employer. The FCC fined the driver $31,875 Aug 2012

Coast Guard Vice-Admiral Chuck Michel saw it happen in one Eastern Seaboard port.

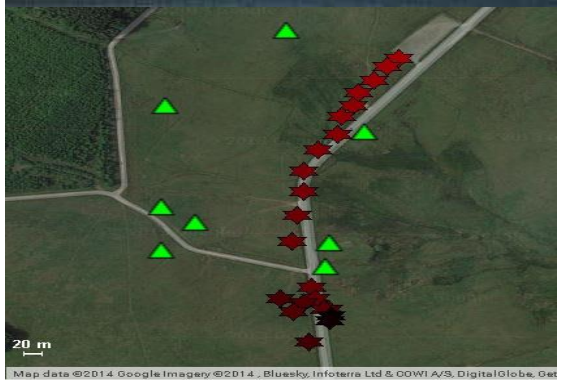
"It was believed to be sort of a vandal or a person messing around, actually blocked that GPS signal from that computer's ability to do that, and the port came to a halt," he said.
*Maritime Cyber Security Symposium March 2-3 2015

Signal Sentry®1000

Answering the risk by locating the jamming source



Signal Sentry



Signal Sentry

- Designed to protect critical infrastructure from GPS disruption jamming & spoofing
- Situational Awareness of GPS Interference
- Real time geolocation of GPS interference
- Actionable Intelligence for quick mitigation of GPS disruption

Deployed Systems

- 2014 Super Bowl at Met Life Stadium
- Southampton Port United Kingdom
- Newark N.J DHS & Essex County Sherriff

Field Tested

- Sennybridge Test Range UK
- Vidsel test range in Sweden

Signal Sentry 1000 Components

Includes antennas, sensors and a server

- **Each Sensor has two antennas**
- **Sensors are connected to either a local or cloud-based server**

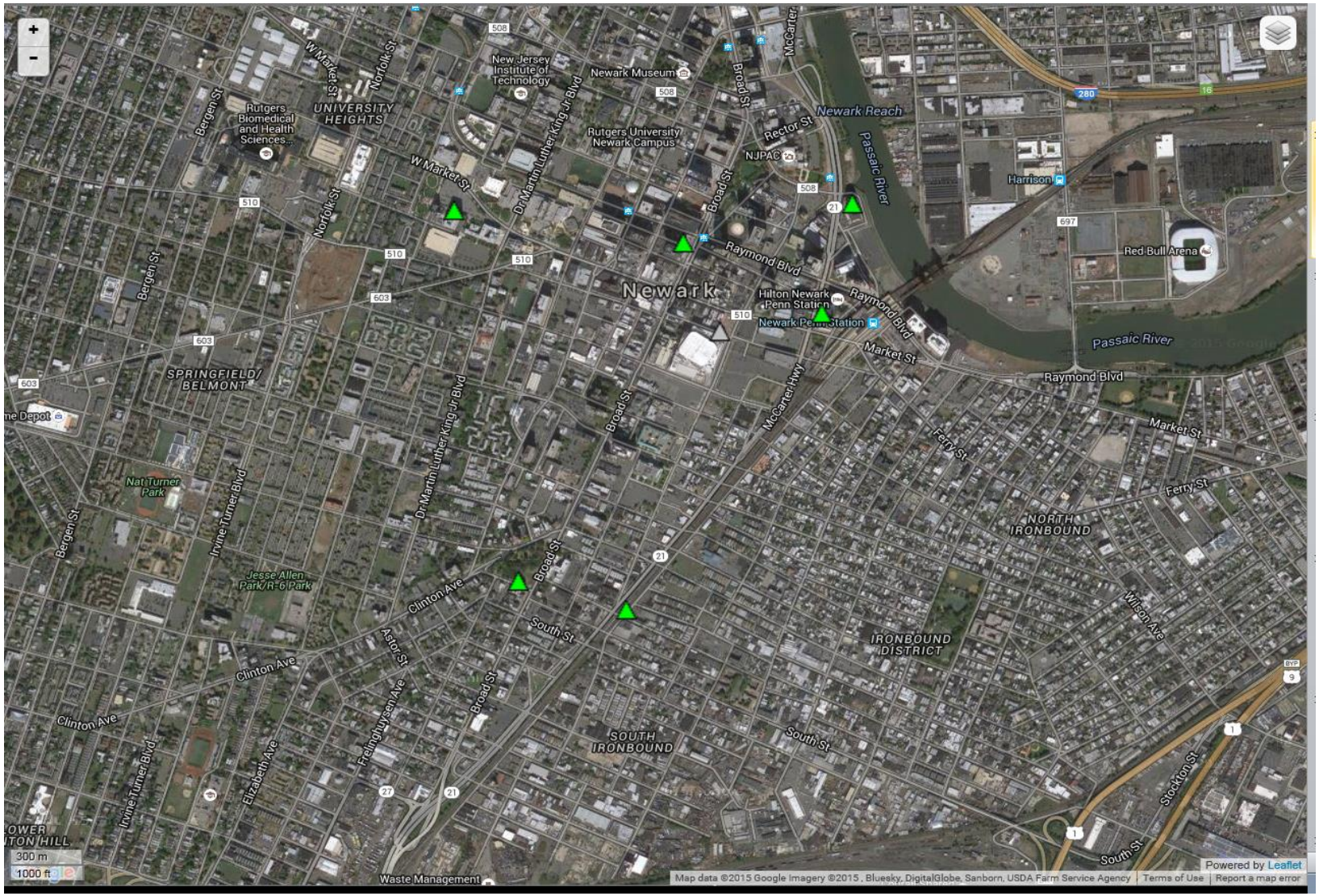
System detects, locates and maps the jamming source

Data is available through an easy-to-use web enabled GUI

Information used for action – change navigation methods, alert authorities…




Signal Sentry Home Page Newark NJ



Sensor Location

Sensors

Name	Configured Address/Port	Reported Address	Status	Interference State	Event Started
sw200403 - Essex County Sheriff: FBI Building	71.250.253.59:12623	71.250.253.59	Registered	No Event	N/A
sw200464 - Essex County Sheriff: Salvation Army	71.250.253.60:12623	71.250.253.60	Registered	No Event	N/A
sw200470 - Essex County Sheriff: Integrity House	71.250.253.61:12623	71.250.253.61	Registered	No Event	N/A
sw200474 - Essex County Sheriff: Prudential Center	166.249.121.42:12623	166.249.121.42	Communication Fault	Unknown	N/A
sw200478 - Essex County Sheriff: Prudential Building	166.249.121.29:12623	166.249.121.29	Registered	No Event	N/A
sw200486 - Essex County Sheriff: Court House	71.250.254.137:12623	71.250.254.137	Registered	No Event	N/A
sw200487 - Essex County Sheriff: One Gateway	71.250.242.196:12623	71.250.242.196	Registered	No Event	N/A

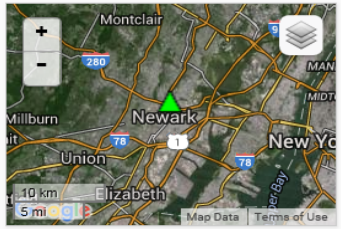
Sensor Information

sw200403 - Essex County Sheriff: FBI Building

Sensor Info

Interference State	No Event
Sensor Status	Registered
GPS Fix Status	Has GPS fix
Configured Latitude	40.73820702
Configured Longitude	-74.1645826
Configured Geoid (MSL) Altitude (m)	64.567
GPS-Reported Latitude	40.7381801
GPS-Reported Longitude	-74.16459790000002
GPS-Reported Geoid (MSL) Altitude (m)	57.182
Configured Address/Port	71.250.253.59:12623
Reported Address	71.250.253.59
Last Application Ping	9/24/2015 2:39:55 PM
Last Position Report	9/24/2015 2:39:51 PM
FFT Processing	Healthy
Firmware Version	2.18.01
GPS Version	CTL414V05 rev 2.15

Spoof ?



Lat: 40.7382 Lon: -74.1646

Geoid (MSL) Alt: 64.5670 m

- GPS DOP/TACC
- GPS Quickthresh
- GPS Satellites
- GPS Multipath by Azimuth
- GPS SNR by PRN
- Sensor Log
- Raw Data
- Event Frequency

- Interference Settings
- SNR Settings
- GPS Settings
- Position Override Settings

Unregister Sensor

Real Event 10/20/2014

Interferer Details

Interferer Map

Interferer Map

Essex County College Center for Technology

Interferers

Interferer Frequency Chart

Min. Interference Duration (hh:mm:ss) 2 : 0 : 0

- (•) Show only Geolocated Interferers
- ( ) Show only Non-geolocated Interferers
- ( ) Show all Interferers

Update

Geolocated Interferers Lasting at Least 2 Hours

Interferer	Interference Duration (hh:mm:ss)	Interference Ended
Ended event started 10/20/2014 9:51:26 AM	2:31:17	10/20/2014 12:22:43 PM

Displaying interferers 1-1

Interference Frequency Events > 5 Min

Interferers

Interferer Frequency Chart

Min. Interference Duration (hh:mm:ss) 0 : 5 : 0

- (•) Show only Geolocated Interferers
- ( ) Show only Non-geolocated Interferers
- ( ) Show all Interferers

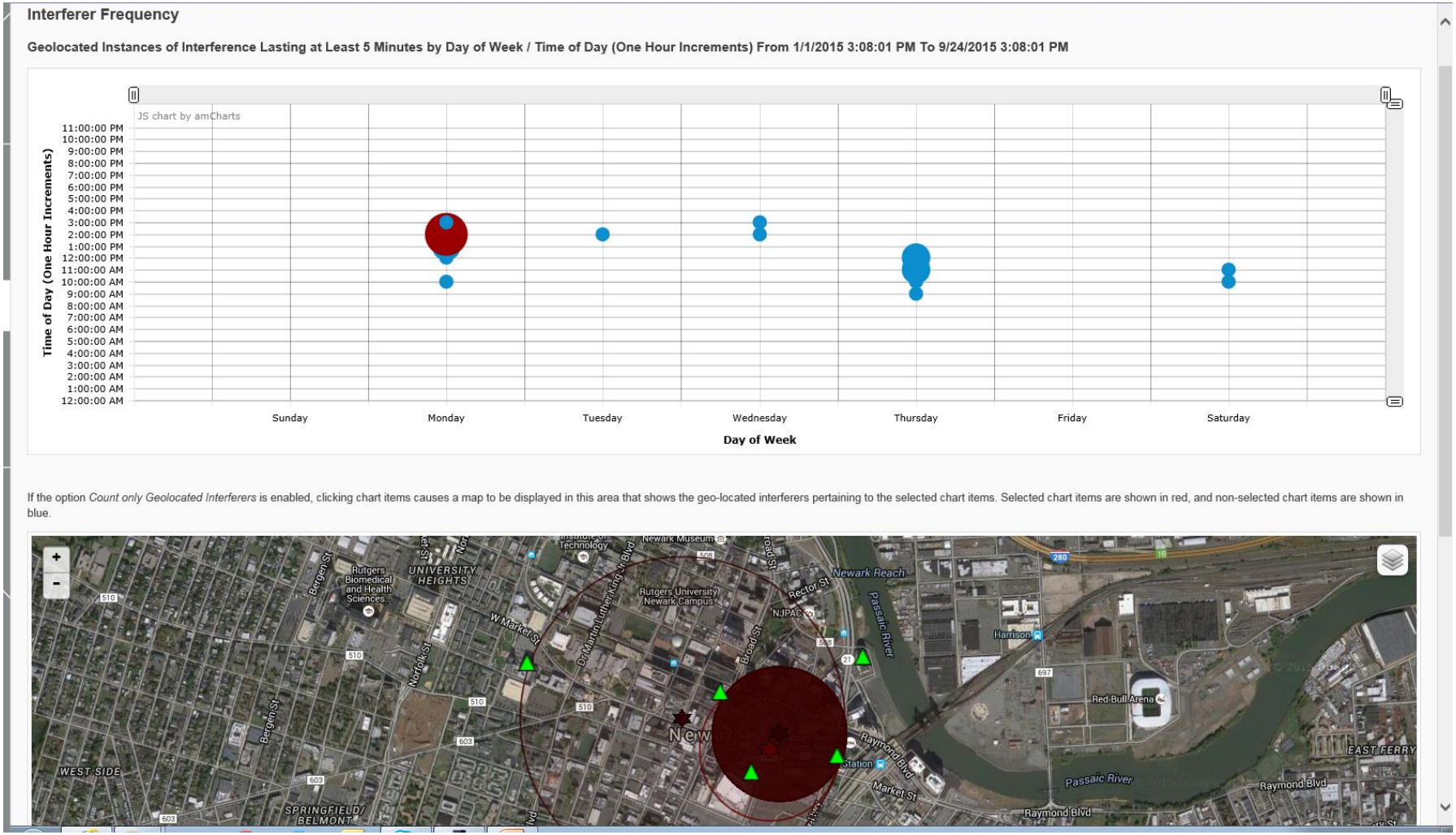
Update

Geolocated Interferers Lasting at Least 5 Minutes

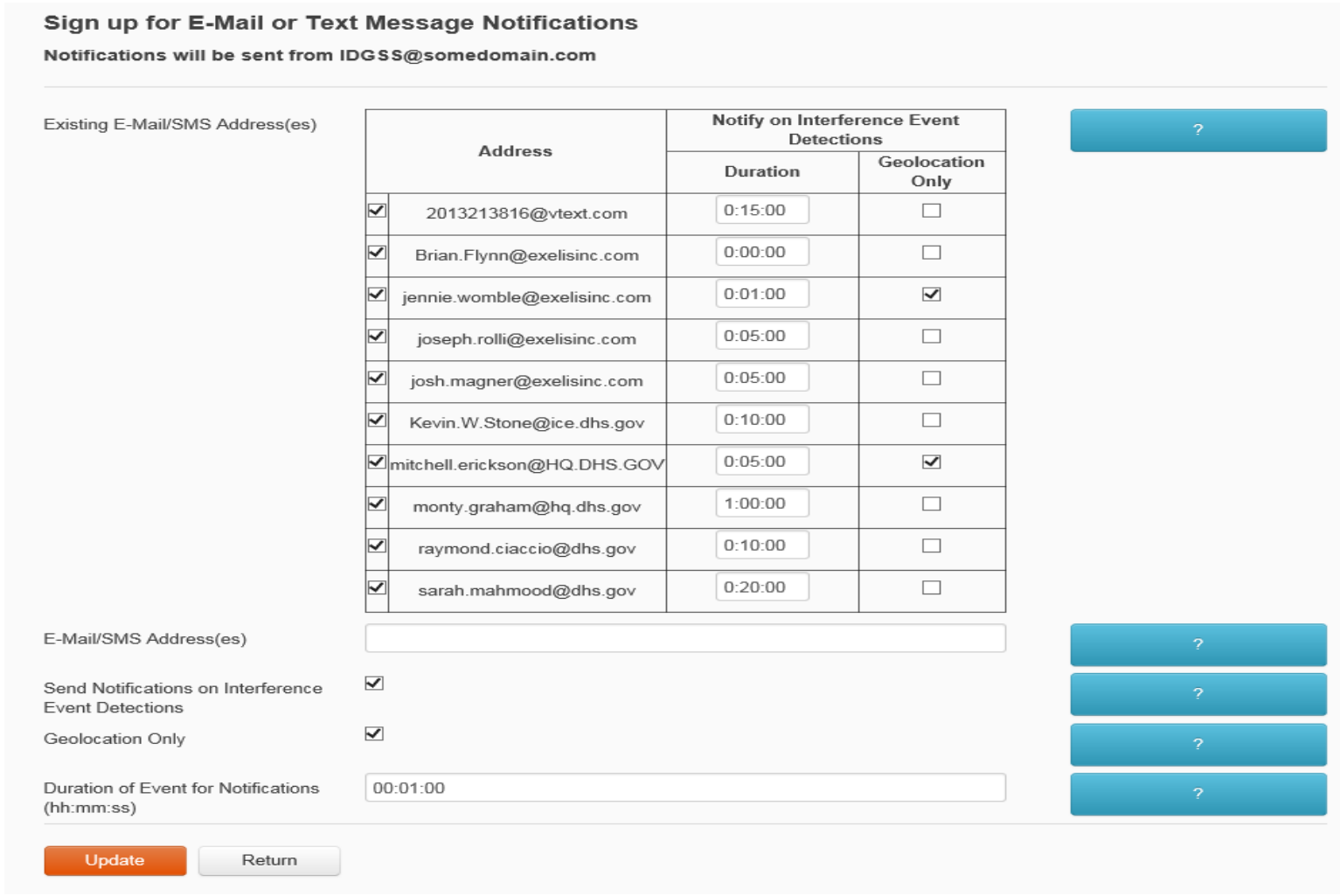
Interferer	Interference Duration (hh:mm:ss)	Interference Ended
Ended event started 6/16/2015 2:07:07 PM	0:11:42	6/16/2015 2:18:49 PM
Ended event started 6/11/2015 9:43:00 AM	0:05:44	6/11/2015 9:48:44 AM
Ended event started 5/11/2015 2:58:29 PM	0:56:16	5/11/2015 3:54:45 PM
Ended event started 4/30/2015 12:18:59 PM	0:07:30	4/30/2015 12:26:29 PM
Ended event started 4/30/2015 11:21:06 AM	0:10:28	4/30/2015 11:31:34 AM
Ended event started 4/30/2015 10:19:01 AM	0:39:22	4/30/2015 10:58:23 AM
Ended event started 4/27/2015 12:01:48 PM	1:24:00	4/27/2015 1:25:48 PM
Ended event started 3/30/2015 10:20:44 AM	0:12:46	3/30/2015 10:33:30 AM
Ended event started 3/16/2015 2:29:07 PM	0:15:15	3/16/2015 2:44:22 PM
Ended event started 3/16/2015 2:10:00 PM	0:18:28	3/16/2015 2:28:28 PM
Ended event started 3/16/2015 1:22:09 PM	0:13:15	3/16/2015 1:35:24 PM
Ended event started 1/28/2015 1:46:58 PM	0:19:07	1/28/2015 2:06:05 PM
Ended event started 1/24/2015 9:04:08 AM	1:23:12	1/24/2015 10:27:20 AM
Ended event started 1/8/2015 10:47:07 AM	0:24:10	1/8/2015 11:11:17 AM

When Events Occur

Where Events Occur



Email Alert Notification



Sign up for E-Mail or Text Message Notifications

Notifications will be sent from IDGSS@somedomain.com

Existing E-Mail/SMS Address(es)

	Address	Notify on Interference Event Detections	
		Duration	Geolocation Only
☑	2013213816@vtext.com	0:15:00	☐
☑	Brian.Flynn@exelisinc.com	0:00:00	☐
☑	jennie.womble@exelisinc.com	0:01:00	☑
☑	joseph.rolli@exelisinc.com	0:05:00	☐
☑	josh.magner@exelisinc.com	0:05:00	☐
☑	Kevin.W.Stone@ice.dhs.gov	0:10:00	☐
☑	mitchell.erickson@HQ.DHS.GOV	0:05:00	☑
☑	monty.graham@hq.dhs.gov	1:00:00	☐
☑	raymond.ciaccio@dhs.gov	0:10:00	☐
☑	sarah.mahmood@dhs.gov	0:20:00	☐

?

E-Mail/SMS Address(es) ?

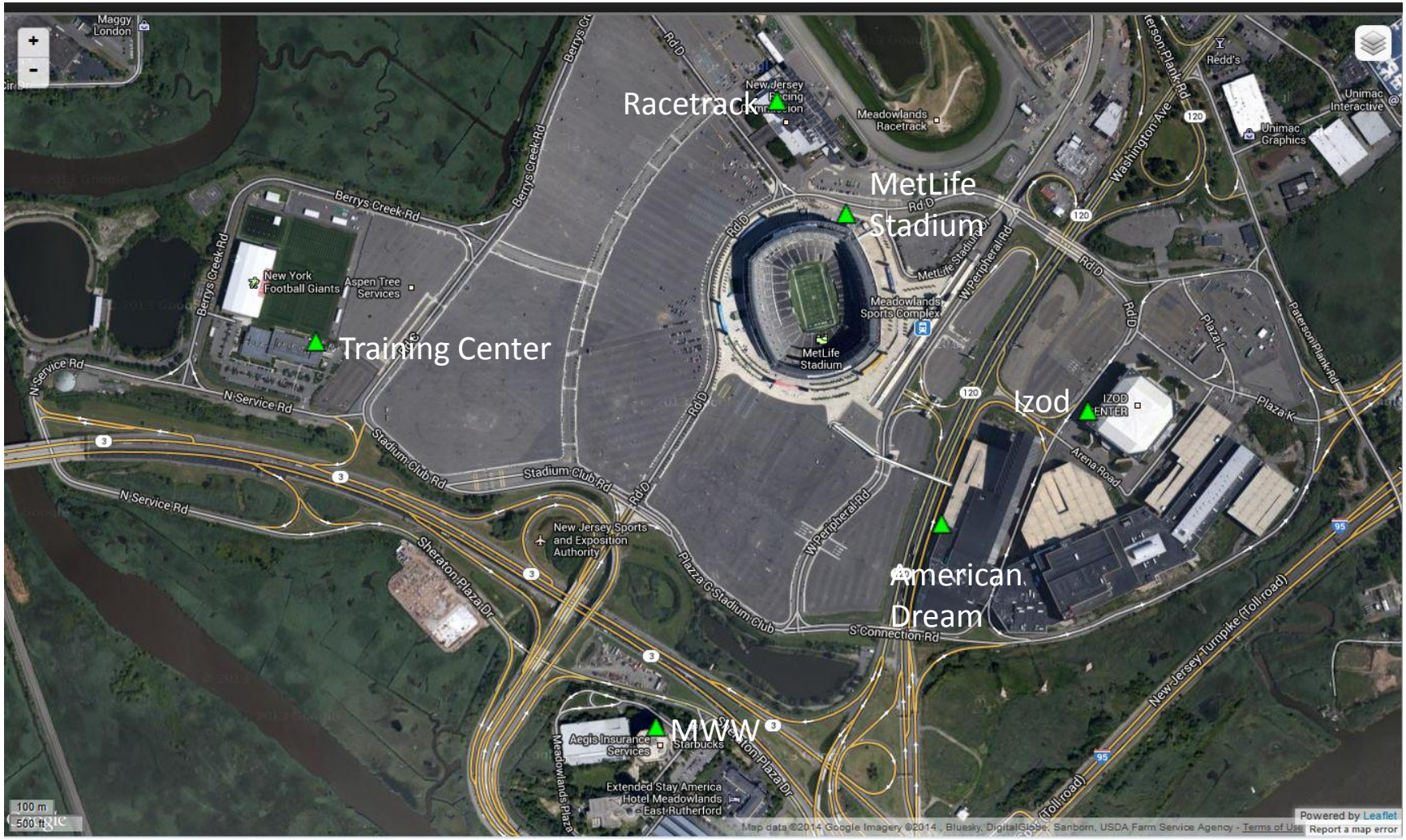
Send Notifications on Interference Event Detections ☑ ?

Geolocation Only ☑ ?

Duration of Event for Notifications (hh:mm:ss) 00:01:00 ?

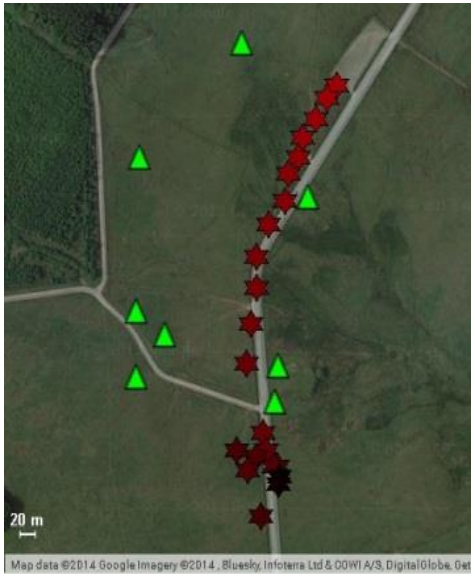
Update Return

Signal Sentry Home Page Super Bowl 2014



Signal Sentry 1000 Test Results

- **Tested during GPS jamming trials in Sennybridge, UK in September 2014**
- **Trials administered by the Defence Science and Technology Laboratory**
- **Off-the-shelf jamming devices were used during the tests**
- **Located stationary & moving jammers in open & obstructed environments**
- **Jammers in a moving vehicle scenario were located with an average accuracy of 10 meters**



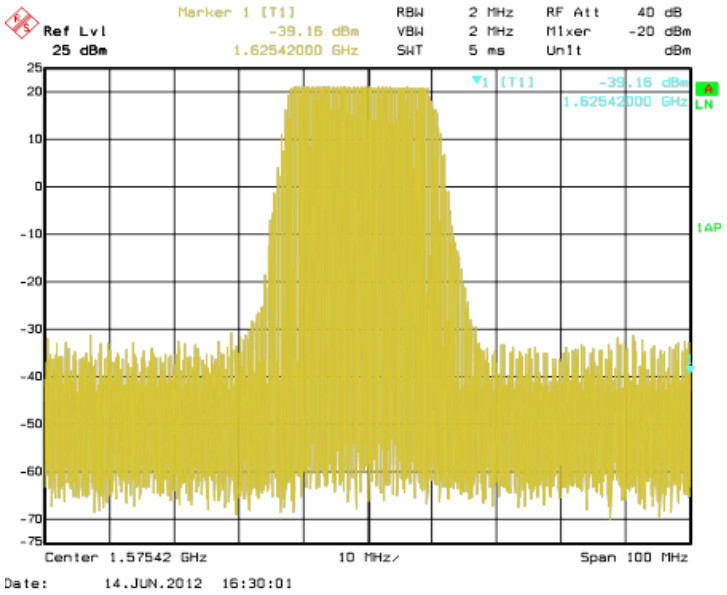
Jammer in car at 40 mph

Jammer Description

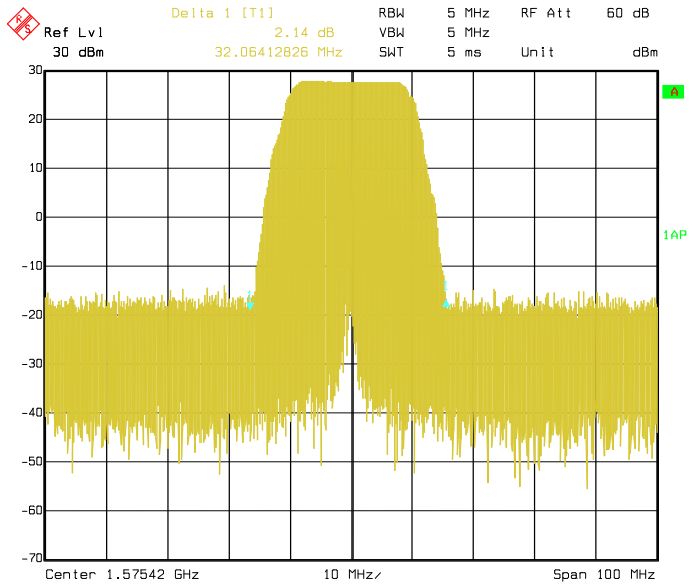
Two Jammers utilized during the trials

150mW and .5W

Used to disrupt the GPS L1CA code that operates at 1575.42 MHz



150mW jammer waveform



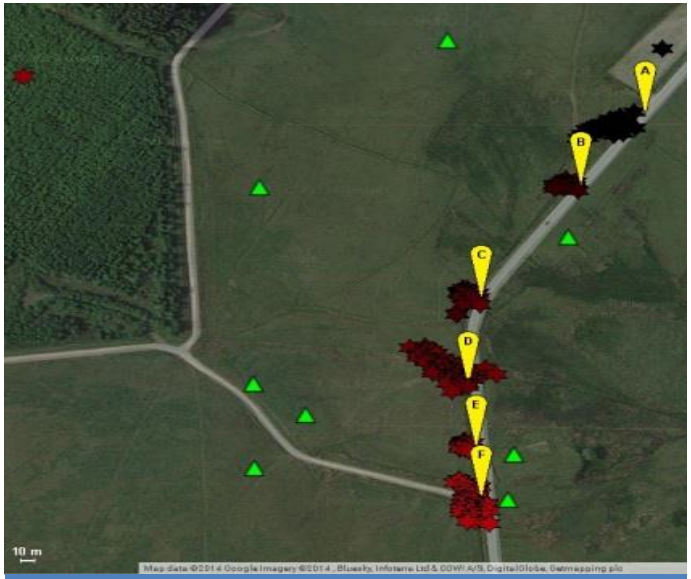
.5w jammer waveform

Open Field Tests

Test was constructed to geolocate jamming in an area with no obstructions

Test included static jammers and dynamic jammers

Six waypoints were surveyed for the purpose of evaluating location accuracy



Open Field Static Jammer Locations

Lessons Learned

- **GPS Interference events occur on average of ~4 a month in Newark**

- **Law Enforcement Essex County Sheriff & NY/NJ Port Authority Police**
  - **Not illegal to possess a GPS Jammer & can't prosecute**
  - **Most officers won't recognize GPS Jammer Devices**
  - **Recommended State & Local legislation to make possession of Jammers Illegal**
  - **" Should not refer to them as Personal Privacy Devices they are Jammers"**

- **Jammers used by thieves to steal cargo put ports at risk of GPS disruption**
  - **Pharmaceutical Cargo Security Coalition Symposium**
  - **46 Stolen Cars exported from LA Port found with GPS Jammers**
  - **DHS Maritime Cyber Security Symposium Port came to halt GPS signal was blocked**

- **Testing this technology in a real environment is challenging due to very limited opportunities to use live GPS jammers**

For more information visit:

www.exelisinc.com/signalsentry