

**C4ADS**

innovation for peace.



RESILIENT  
NAVIGATION  
and TIMING  
FOUNDATION



# Spoofing GPS – Now you see it, now you don't!

NOVEMBER 2018

Assn of Old Crows Webinar



<https://www.youtube.com/watch?v=yhAh-vpuGCg>

# Problem - GPS is everywhere



Synchronized,  
Precise Time,  
Frequency,  
Phase

Precise Positioning  
& Navigation

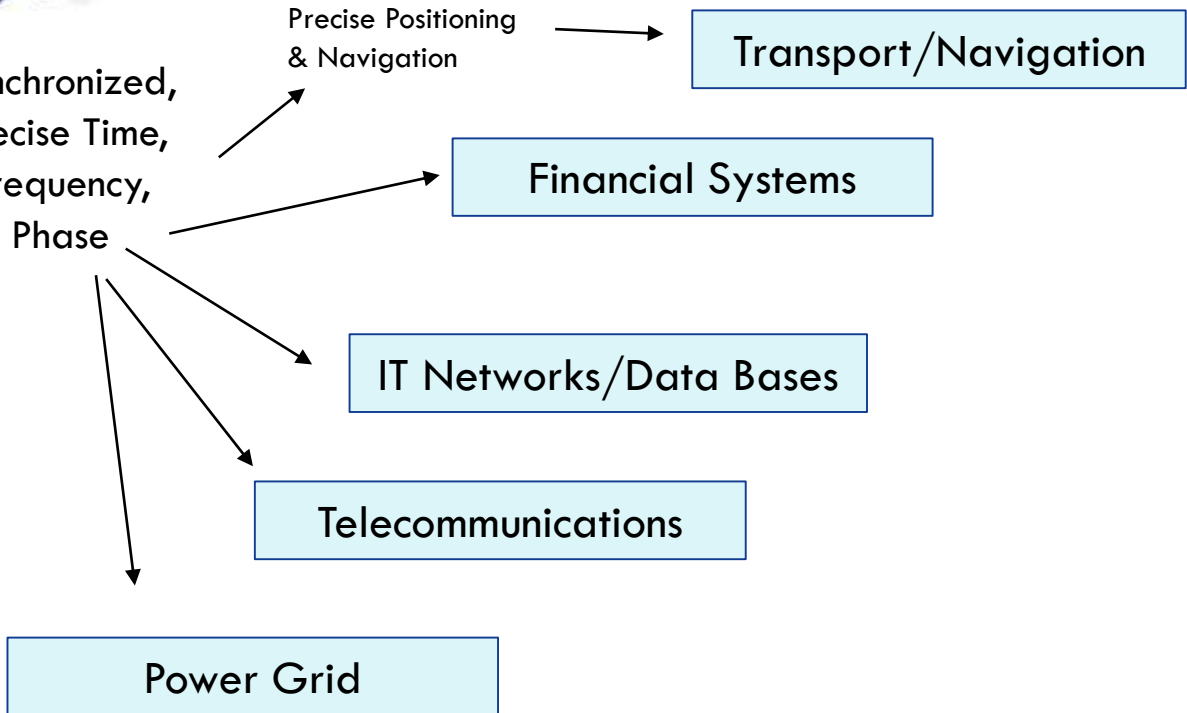
Transport/Navigation

Financial Systems

IT Networks/Data Bases

Telecommunications

Power Grid



# DHS – “GPS is a single point of failure for Critical Infrastructure”



Synchronized,  
Precise Time,  
Frequency,  
Phase

Precise Positioning  
& Navigation

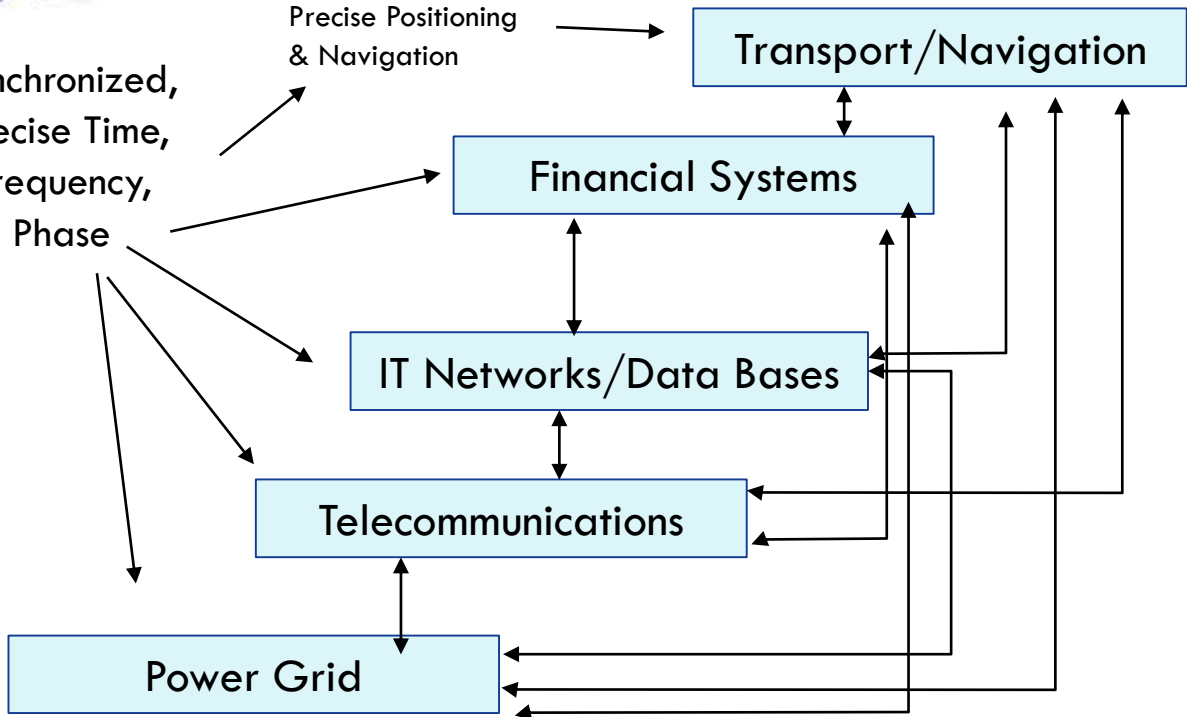
Transport/Navigation

Financial Systems

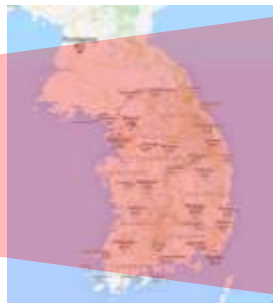
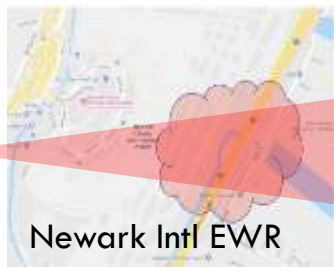
IT Networks/Data Bases

Telecommunications

Power Grid



# But first, there was Jamming

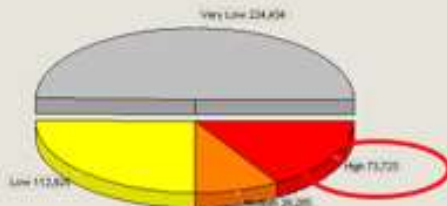


Seconds,  
Minutes

Weeks +

## Result 2: GNSS Denial Events

Event Priority Levels  
(By Classification Type)

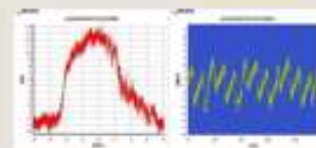
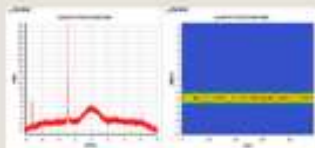


Classification Types

73,000 GNSS denial events

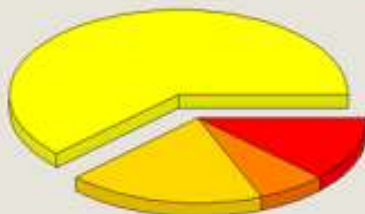
- 59,000 jammers
- 12,000 narrow band
- 2,000 other signals

W [450367] ALL    [222728] WHITE\_WB    [101811] NB\_ST    [59453] CHIRP  
[110213] CDMA    [188170] OTHER



## Result 3: Durations of interference events

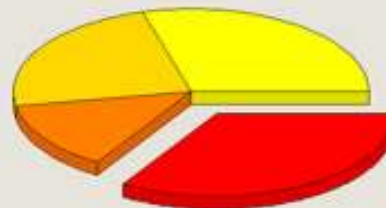
ALL events (450,363 events)



279,328 (0 to 20 sec) 16,832 (20 to 40 sec) 25,319 (40 to 60 sec) 18,984 (60+ sec)

Most events are very short durations  
12% of ALL events are greater than 60 seconds

High Priority events (73,723 events)

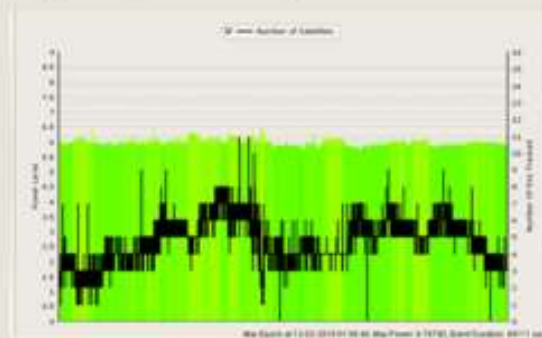


23,440 (0 to 20 sec) 17,275 (20 to 40 sec) 8,863 (40 to 60 sec) 34,145 (60+ sec)

34% priority events are greater than 60 seconds

### Some findings:

- 7191 events > 5 minutes
- 1112 events > 30 minutes
- 610 events > 60 minutes
- 5 events > 1 day
- Longest event = 5 days





## Result 5: Comparisons of Sites

- Results from 8 Airport installations
- Most are “national” airports. Most are air-side installations.
- 30 days data (may not be the same 30 days)

	RFI events	Jammers	Jammer/events ratio	Duration > 60secs	GNSS denial	Denial/events ratio
National Airport	8716	95	1%	282	362	4%
National Airport	759	27	4%	200	211	28%
National Airport	2764	595	22%	395	753	27%
Regional Airport	556	31	6%	6	95	17%
National Airport	904	168	19%	158	182	20%
National Airport	776	19	2%	101	35	5%
National Airport	1819	73	4%	9	252	14%
National Airport	4519	133	3%	352	153	3%

- Helps to diagnose issues with unintentional interference & jamming
- Helps to compare with other sites

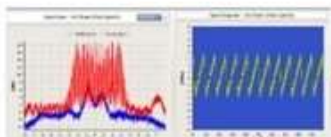




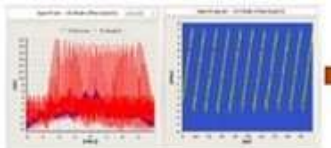


**STRIKE3**

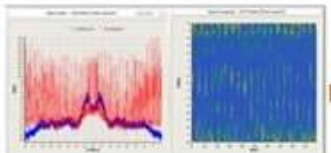
## STRIKE3 shows Jammer industry is evolving...



5Mhz bandwidth, 1575Mhz centred



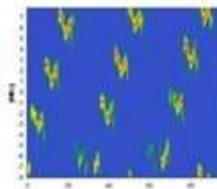
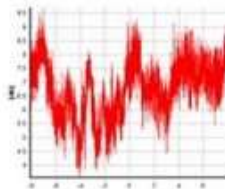
8Mhz bandwidth, drifting centre



Wideband



2012



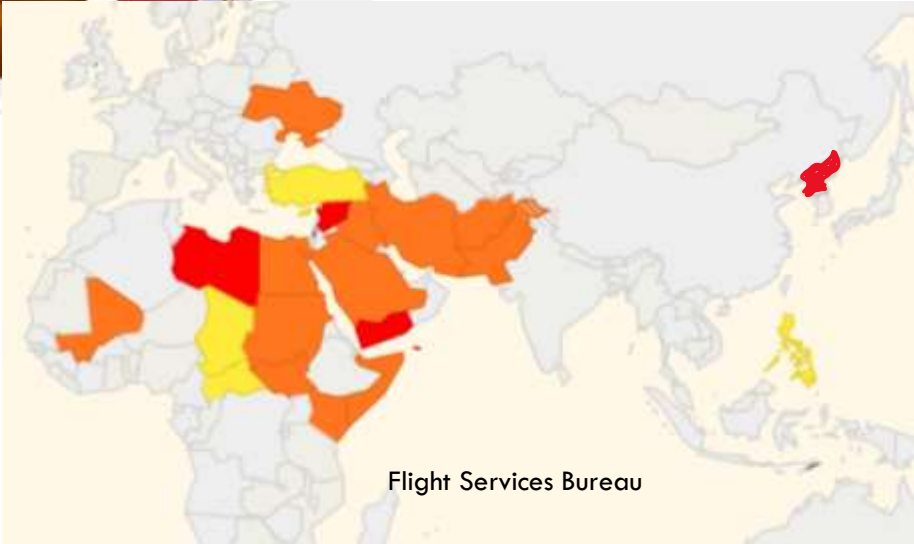
Waveform detected at 4 STRiKE3 sites  
Europe and outside EU



USB L1/L2 jammer



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Flight Services Bureau

# Maritime Jamming Reports

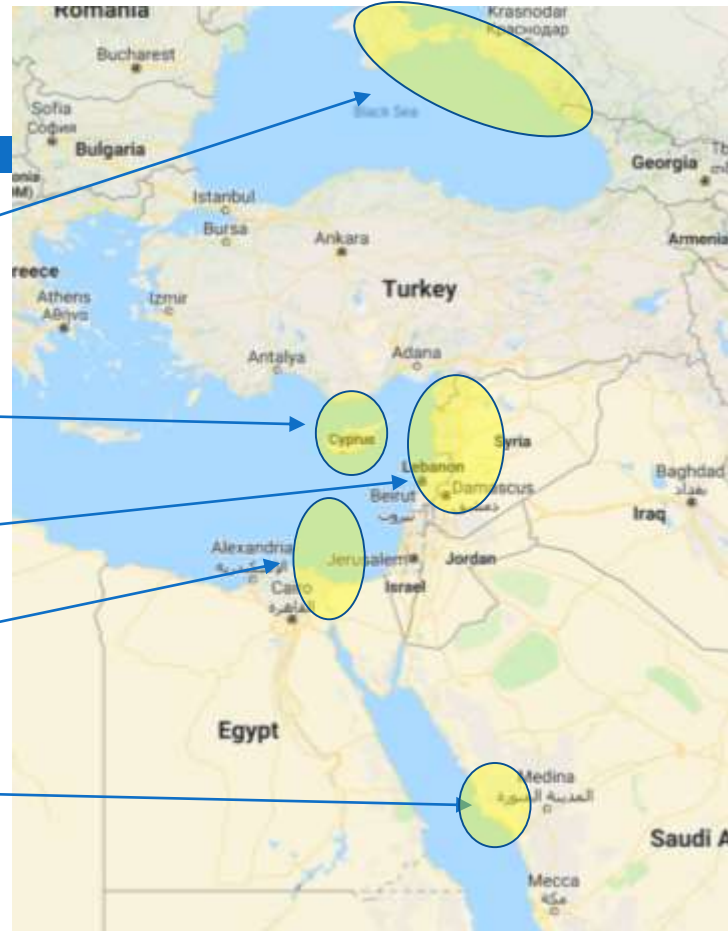
VIP Protection & Conflict

Disrupt Oil/Gas  
Surveys?

Armed  
Conflict

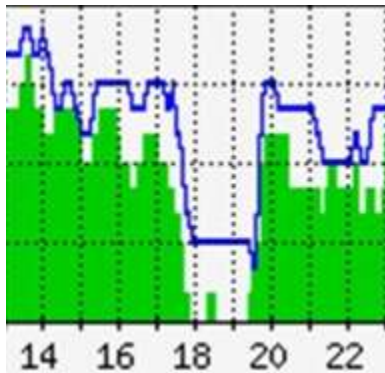
Illegal Fishing?

Unknown



# Domestic US Jamming

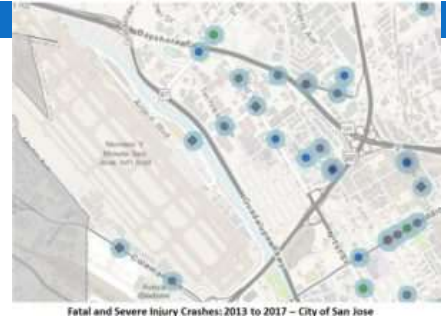
“GPS Disruption Halts Ports,  
Endangers Ships” – US Coast  
Guard



GPS Disruption Halts Wireless  
Provider in Kansas, 150 Mile -Wide  
Area Impacted

# Domestic US Jamming

Qulsar Sees About 3 Jamming Events a Day  
Near San Jose Airport - Impact Unknown



GPS Tracker Shows Child  
90 Miles From School

# Spoofing — Hazardously Misleading Information

December 2011



# Spoofing Demo

June 2012

University of Texas,  
Austin

Prof Todd Humphreys





# Spoofing Demo

June 2013



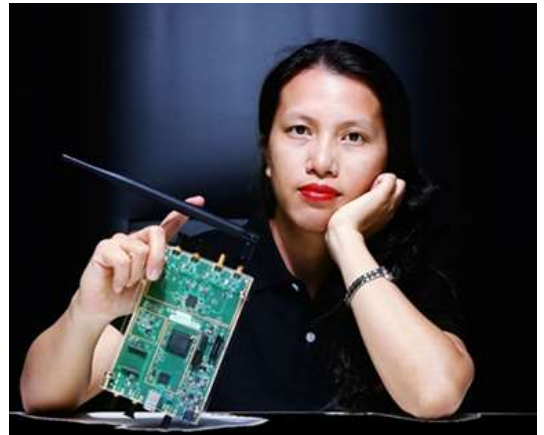
[https://www.youtube.com/watch?time\\_continue=17&v=ctw9ECgJ8L0](https://www.youtube.com/watch?time_continue=17&v=ctw9ECgJ8L0)

# Tutorial – Build Your Own GPS Spoofer

December 2015



Hackers Convention  
Las Vegas



# First Open Source Spoofing Report

December 2015

DHS: 'Drug Traffickers Are Spoofing Border Drones' –  
Defense One





January 12, 2016

Reposition 2 RCB 90s  
from Kuwait to Bahrain  
through International  
Waters



January 12, 2016



January 12, 2016



Spooofing?



January 12, 2016



Spoofing?

- Right after US/Iran nuclear agreement
- Same day as President's last major speech to the nation



January 12, 2016



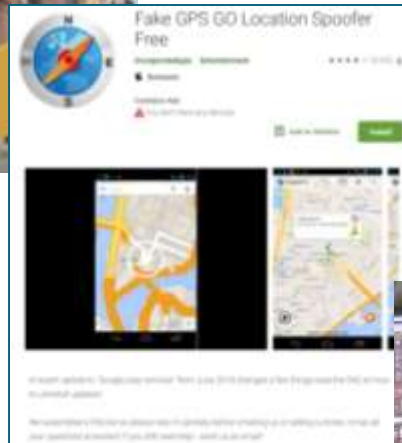
## Spoofing?



- Right after US/Iran nuclear agreement
- Same day as President's last major speech to the nation

# Pokémon Go – Location Deception for All

July 2016



Phone App



Software Defined Radio

June - July 2016



RUSSIA BEYOND English

Lifestyle Culture Travel Education Business His

## Why is the Kremlin 'transporting' GPS users to Vnukovo airport?

LIFESTYLE OCT 26 2016 YEKATERINA BENEISHCHIKOVA RBTH



# The Moscow Times

Oct. 21 2016 · 03:10

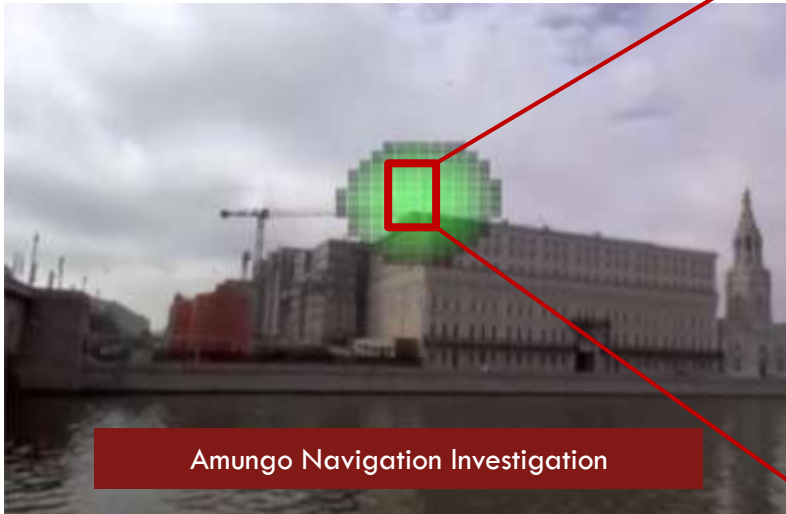
## The Kremlin Eats GPS for Breakfast

Why geolocation in central Moscow has become a real headache

October 2016



September 2017





June 2015 Street View, Google



September 2016 Street View, Google



June 2015 Street View, Google

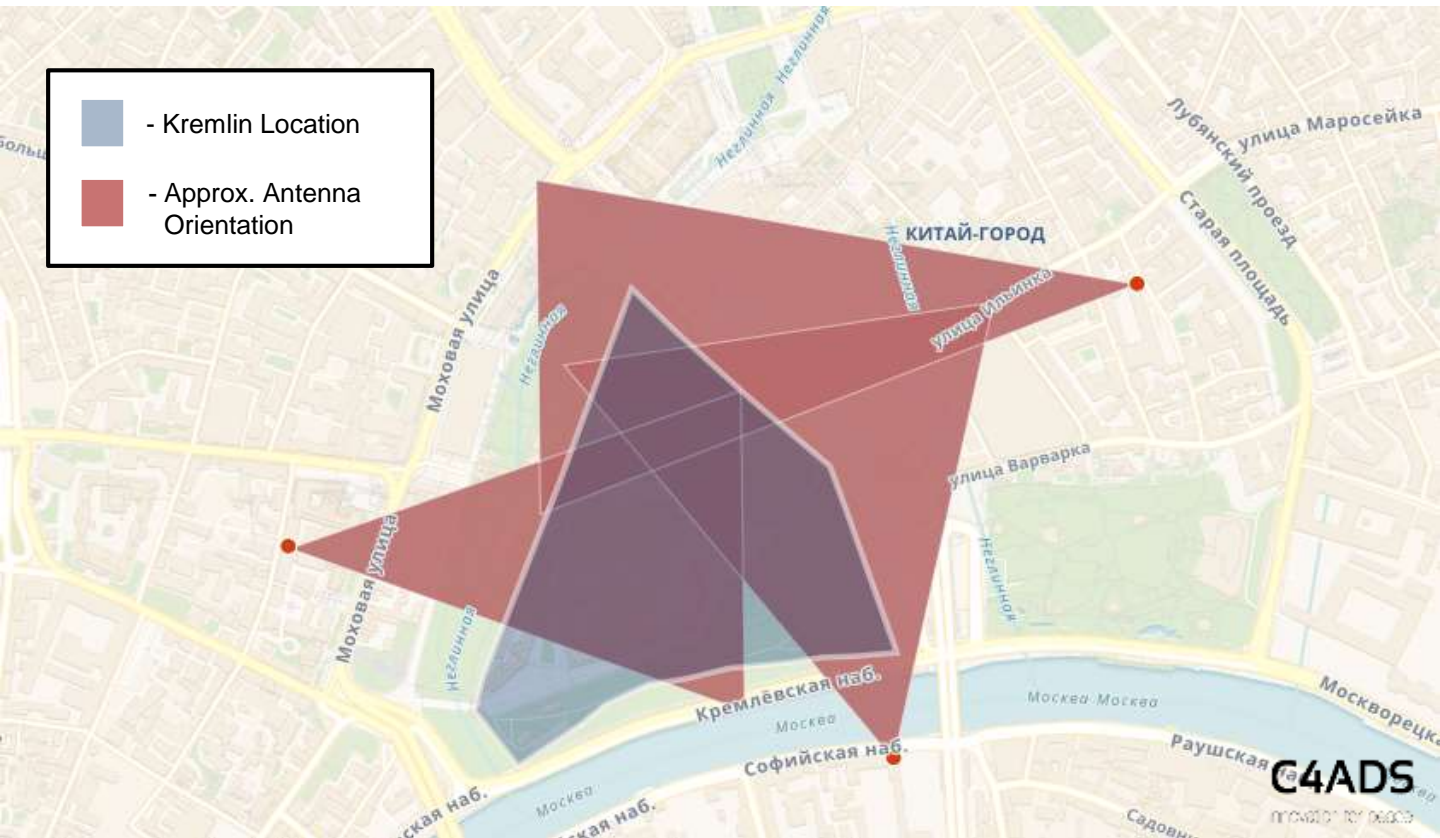


September 2016 Street View, Google

### June 2016: First Public Reports of GNSS Spoofing Near Kremlin

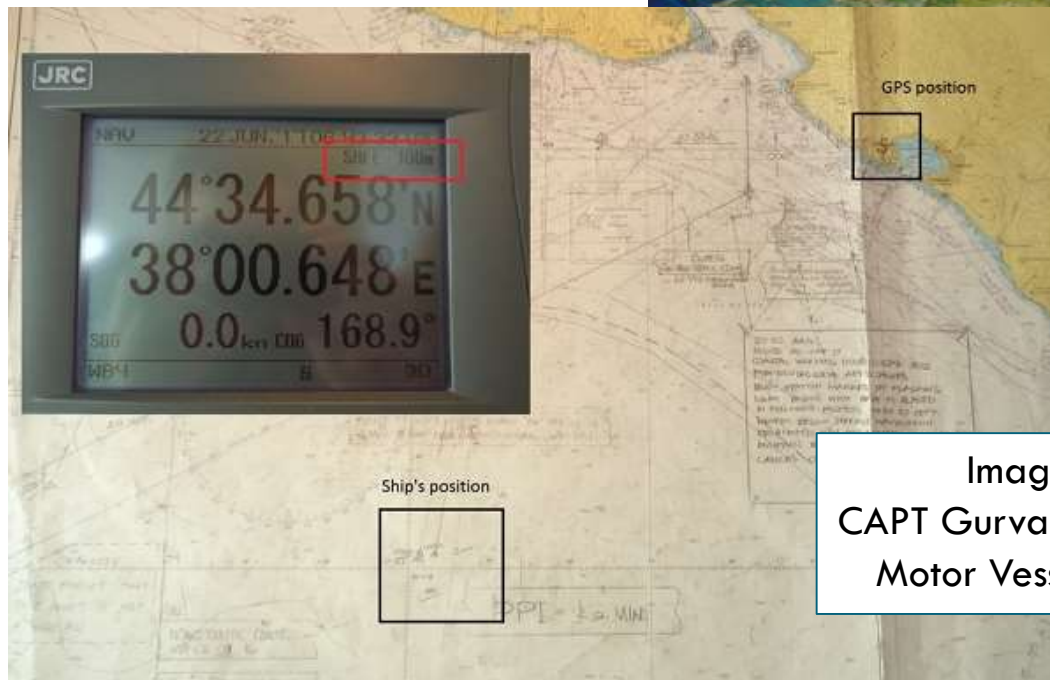
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June 2017, M/V Atria

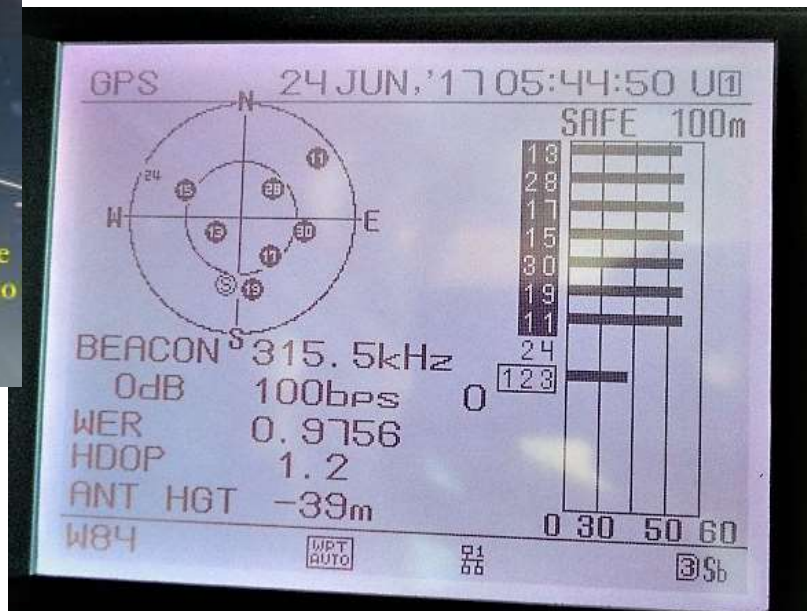


Images  
CAPT Gurvan LE MEUR  
Motor Vessel Atria

June 2017, M/V Atria

Images  
CAPT Gurvan LE MEUR  
Motor Vessel Atria

According to AIS: all ships in the area are next to each other. There were actually no radar echo there.

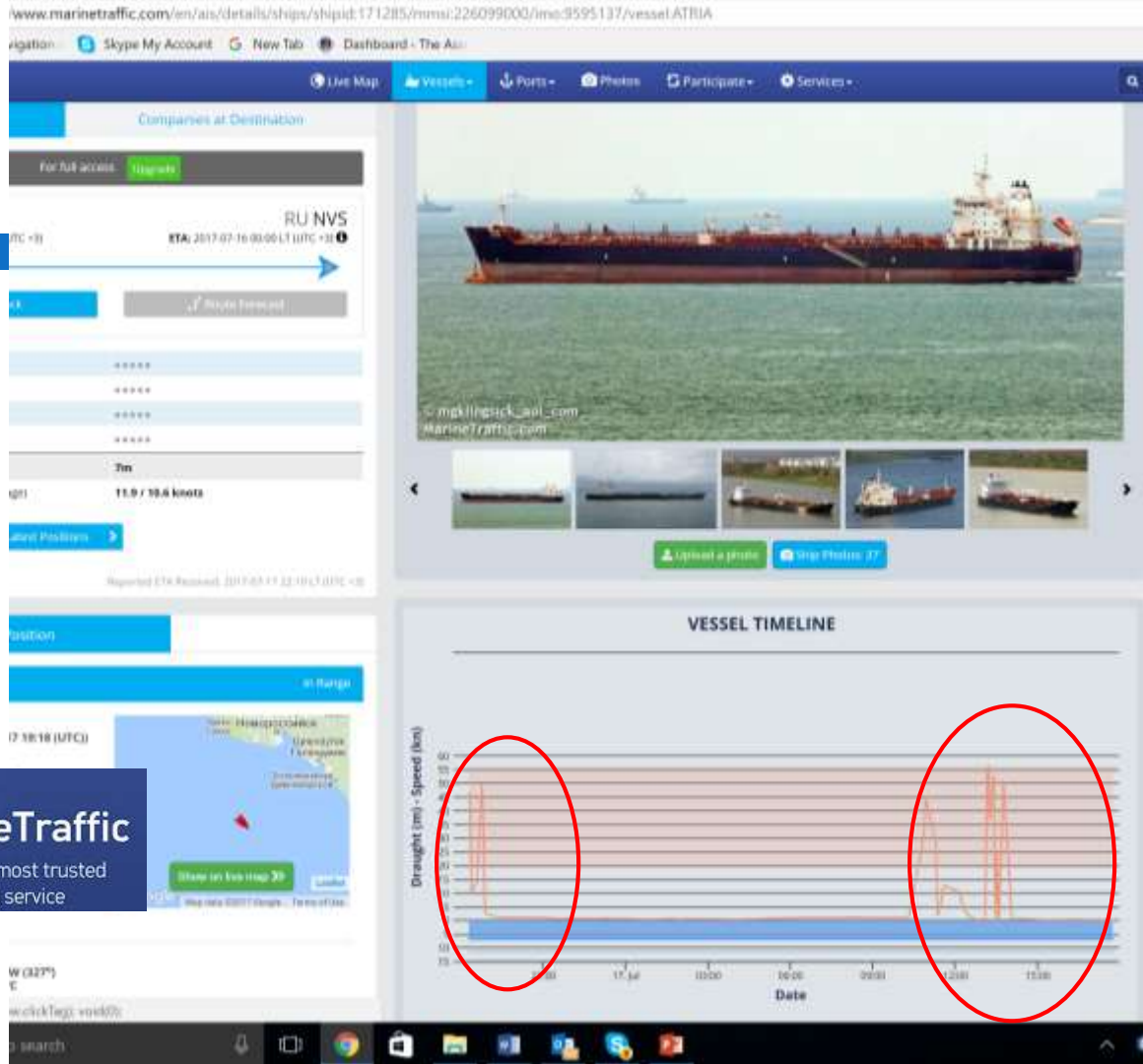


July 2017

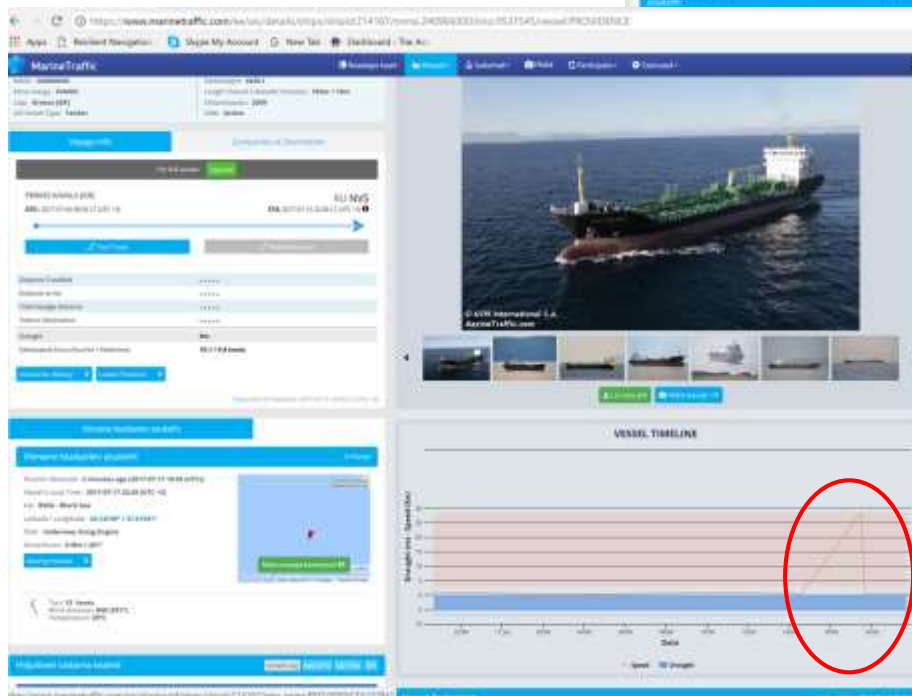


**MarineTraffic**

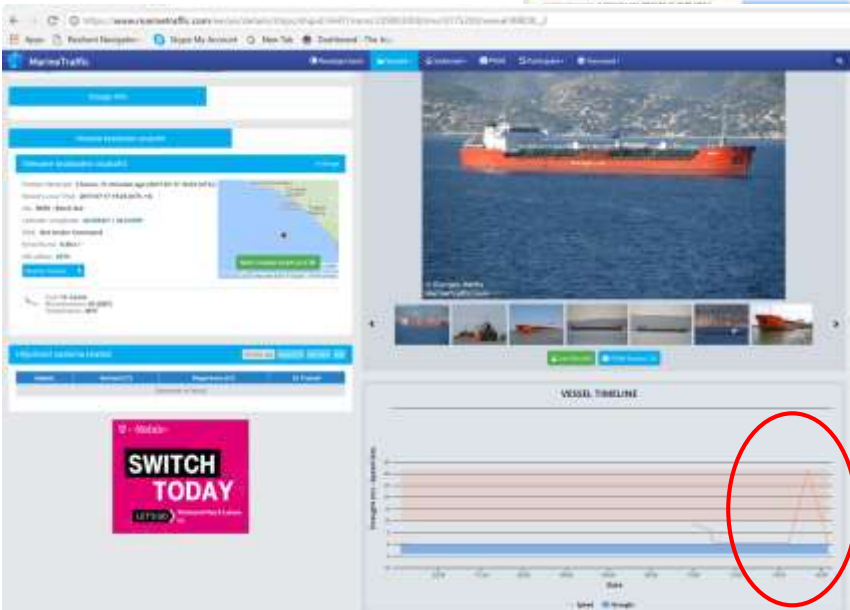
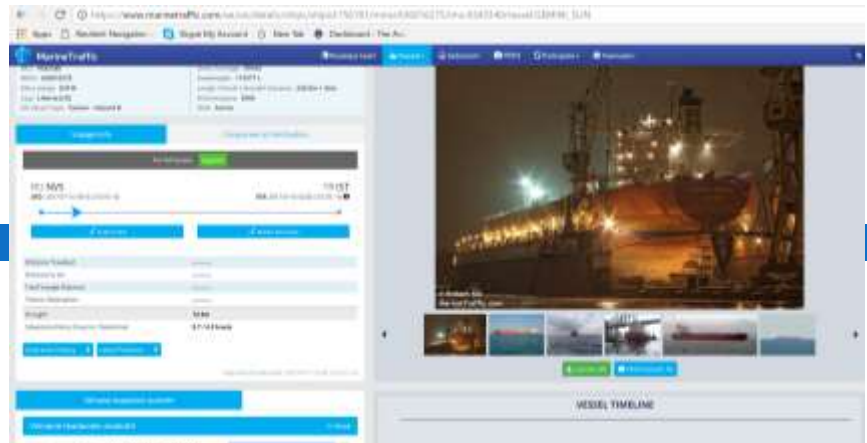
The world's most trusted  
ship tracking service



July 2017

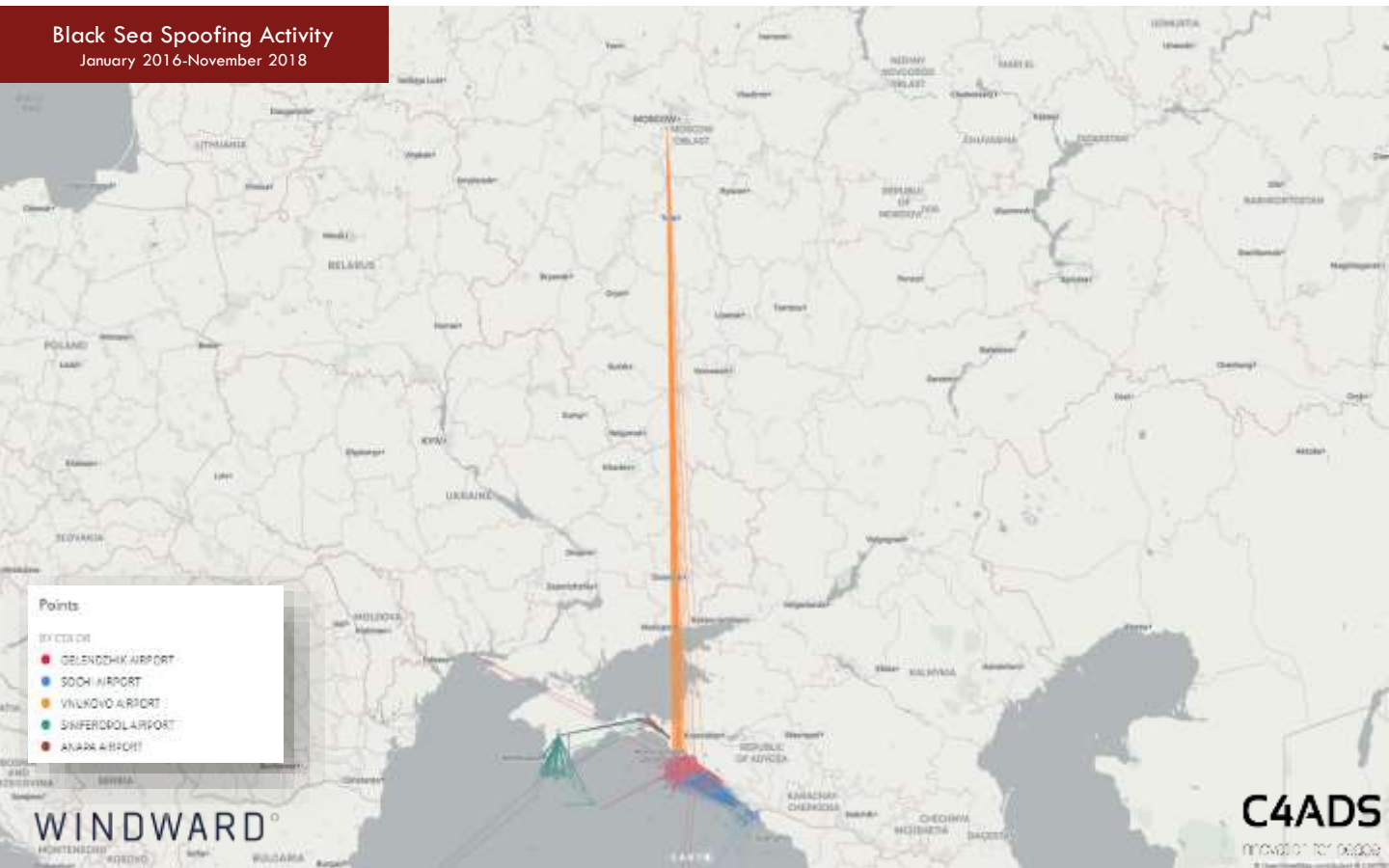


July 2017





## Black Sea Spoofing Activity January 2016-November 2018



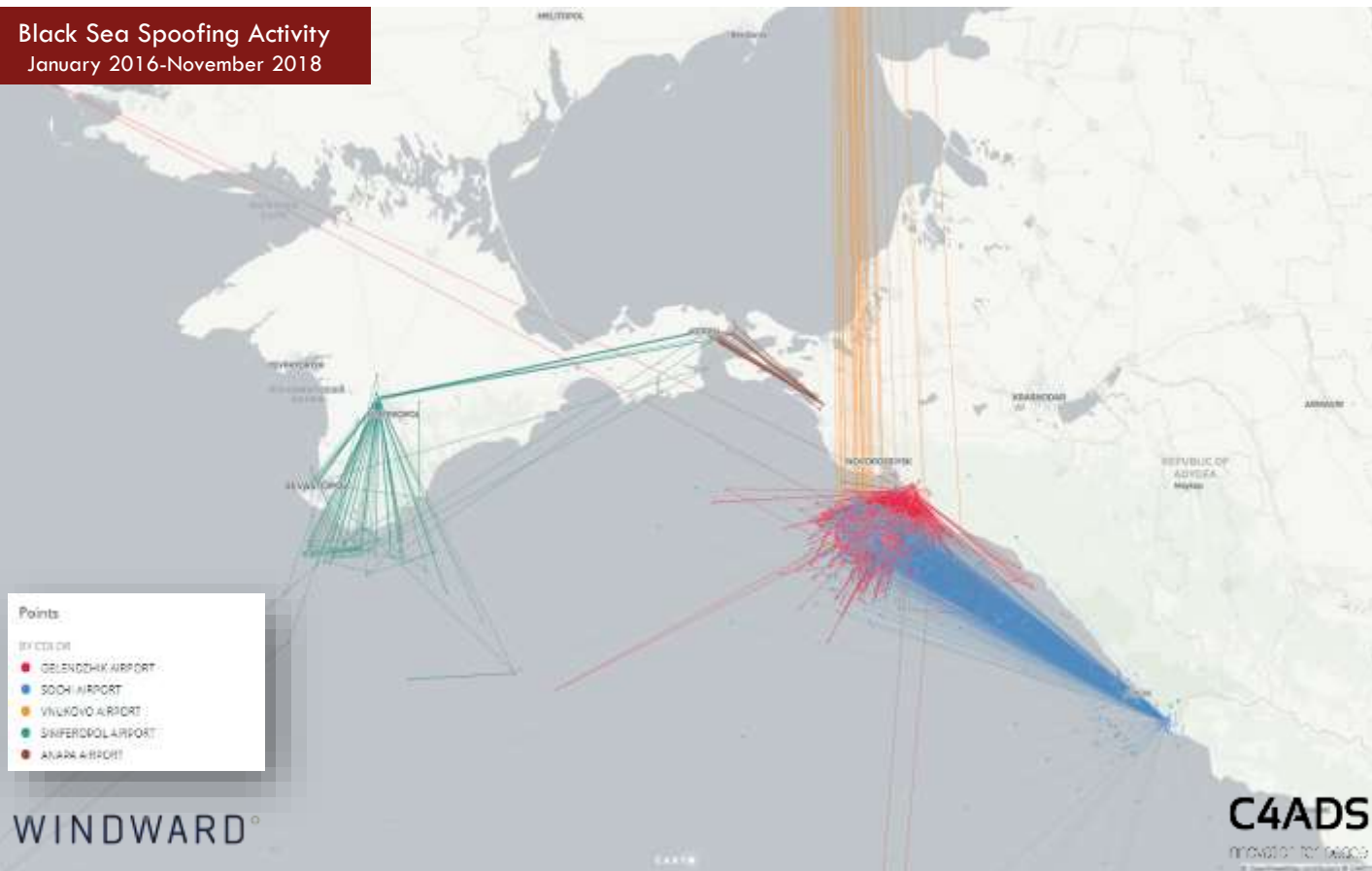
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# Ships at Gelendzhik Airport





## Black Sea Spoofing Activity January 2016-November 2018



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# Ships at Sochi Airport



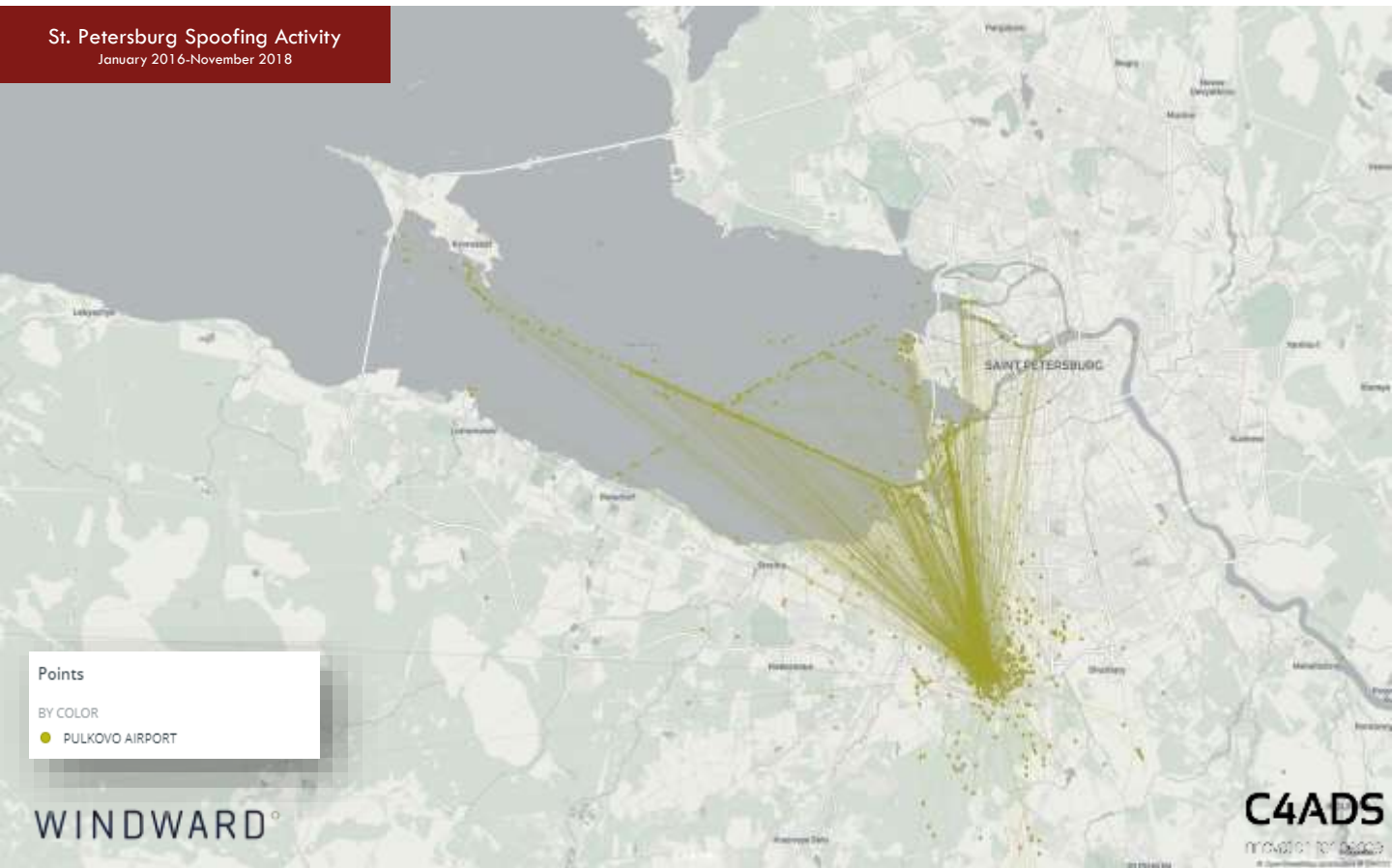
Sochi International Airport

Mooring area

WINDWARD

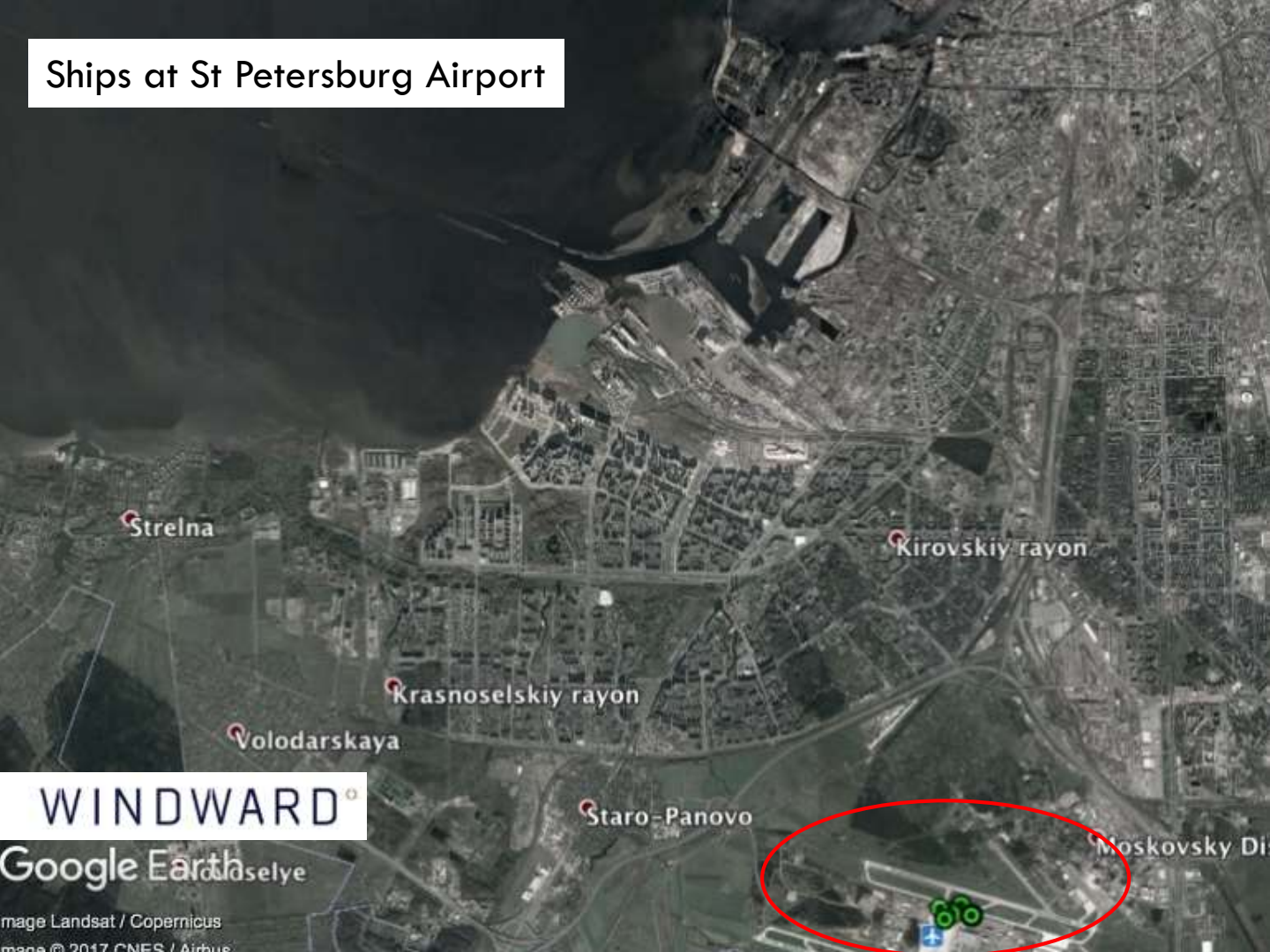
## St. Petersburg Spoofing Activity

January 2016-November 2018



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# Ships at St Petersburg Airport



WINDWARD®

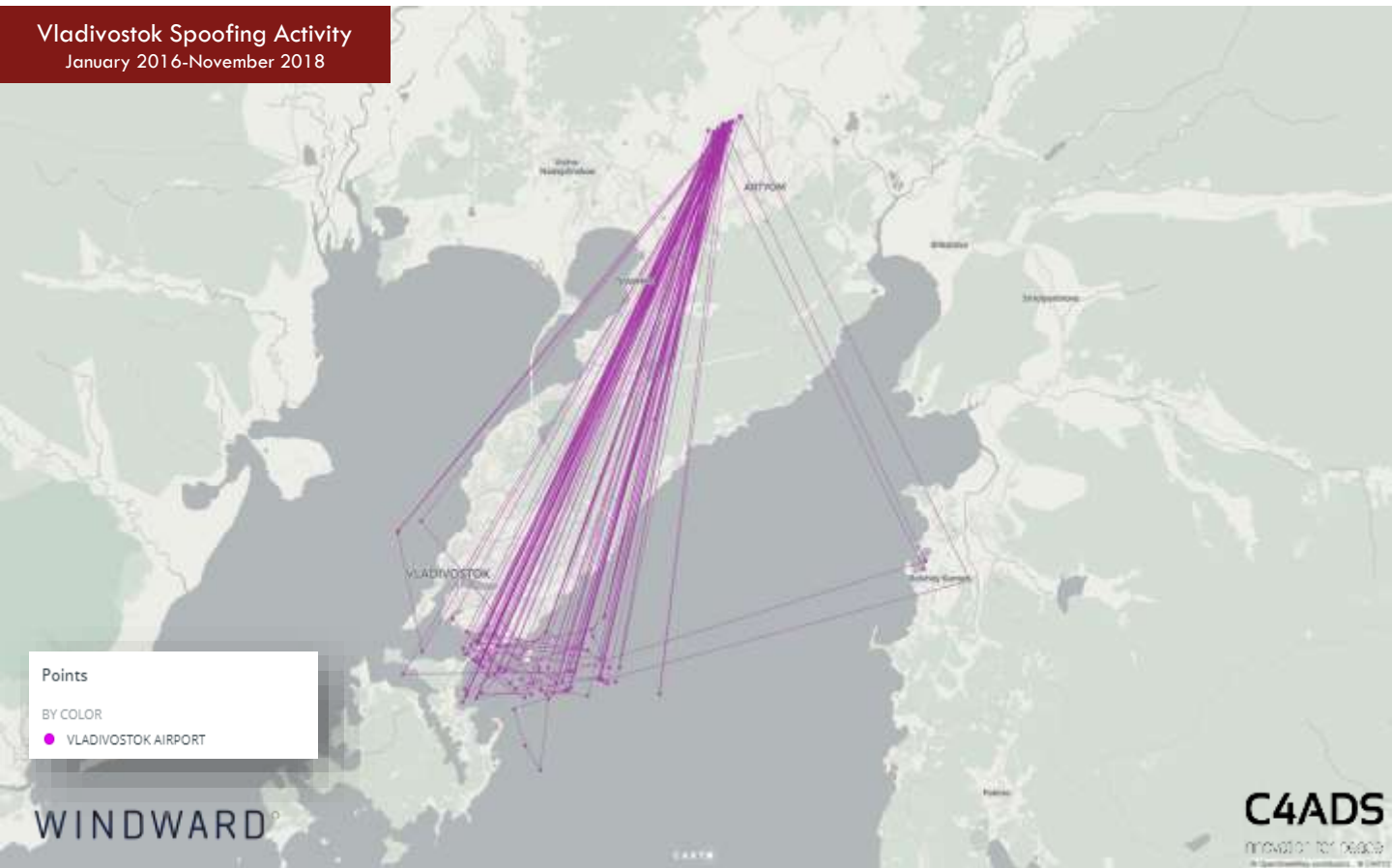
Google Earth

Image Landsat / Copernicus  
Map © 2017 CNES / Airbus



## Vladivostok Spoofing Activity

January 2016-November 2018



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# GPS Spoofing Nails Cell Phones in Portland



Oct 2017



June 2018

Easily Spoofing Them All at Once –  
Inside GNSS

Spoofing GPS & Your Maps –  
Next Level of Danger



Virginia Tech & China Institute  
July 2018

# Spoofing — Cost ↓ Capability ↑ Ease of use ↑



Iran, Dec 2011



UT Austin, 2012-13



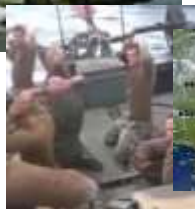
Las Vegas, Dec 2015



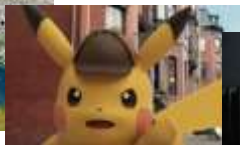
US Southern Border  
Dec 2015



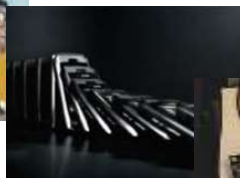
Persian Gulf, Jan 2016



4 sites Russia  
600+ ships  
2016 - Present



Pokemon  
July 2016



Portland  
Oct 2017

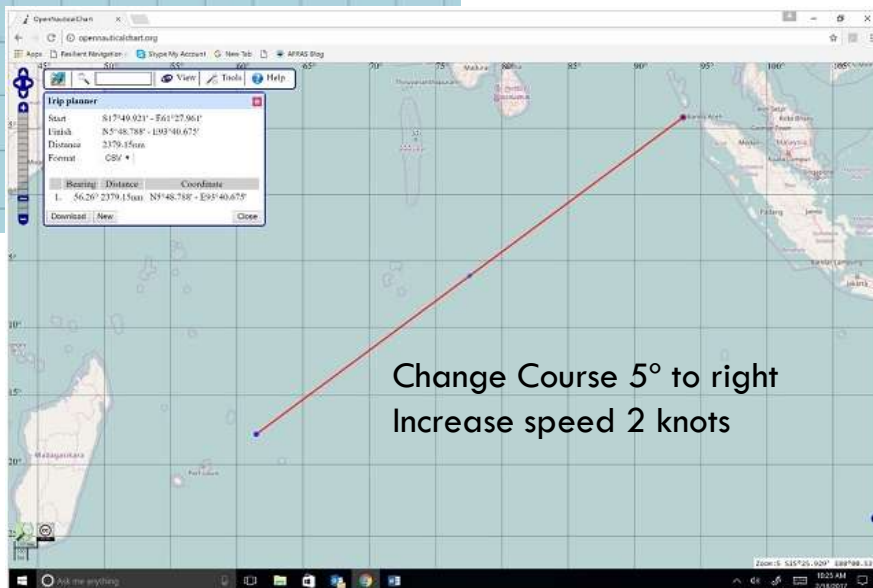
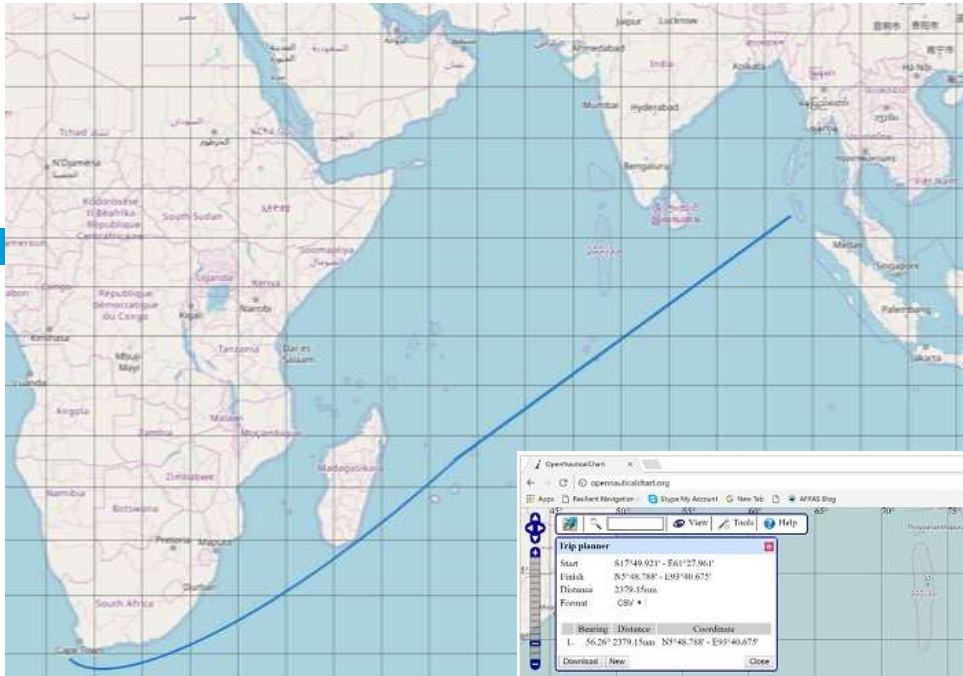


All GNSS at Once  
June 2018



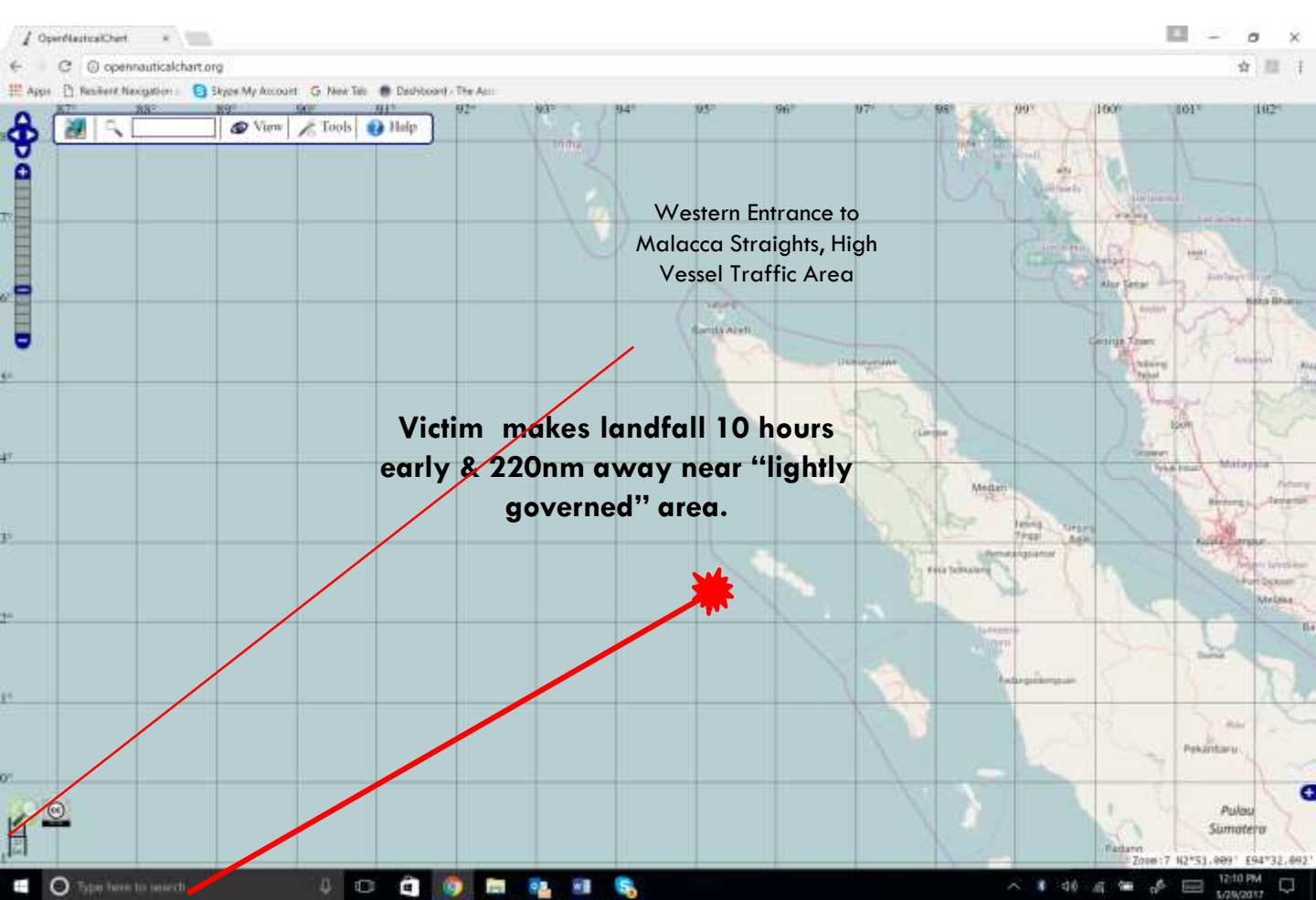
Signals & Maps  
Jul 2018

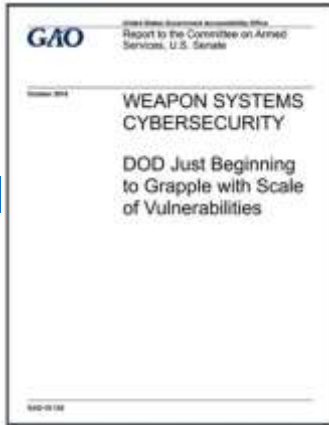




**The MARITIME  
EXECUTIVE**  
INTELLECTUAL CAPITAL FOR EXECUTIVES

“How To Steal A Ship”  
2 June 2017





‘GPS Hackers could send weapons to wrong target.’ 17 Oct 2018

Russia claims US spoofed drones to attack base. 25 Oct 2018



# ***“GNSS alone is insufficient for Safety of Life and other critical applications” – European Union***



**\$100,000,000,000** invested +  
**\$6,000,000,000** per year to run +  
**200,000** people in industry

**PNT Out of Balance**

**1 White Van Man**  
+  
**All-GNSS & Map Spoofer**

**\$255**



# What to Do?

- **Protect** — GPS Signals
  - Interference detection
  - Enforcement
- **Toughen** — Users & Equipment
  - Anti-jam, anti-spoof
  - Standards, requirements, costs
- **Augment** — w/other signals & sources
  - US Govt Announcements 2008, 2015 “eLoran”





The Resilient Navigation and Timing Foundation is a 501(c)3  
scientific and educational charity registered in Virginia  
[www.RNTFnd.org](http://www.RNTFnd.org)