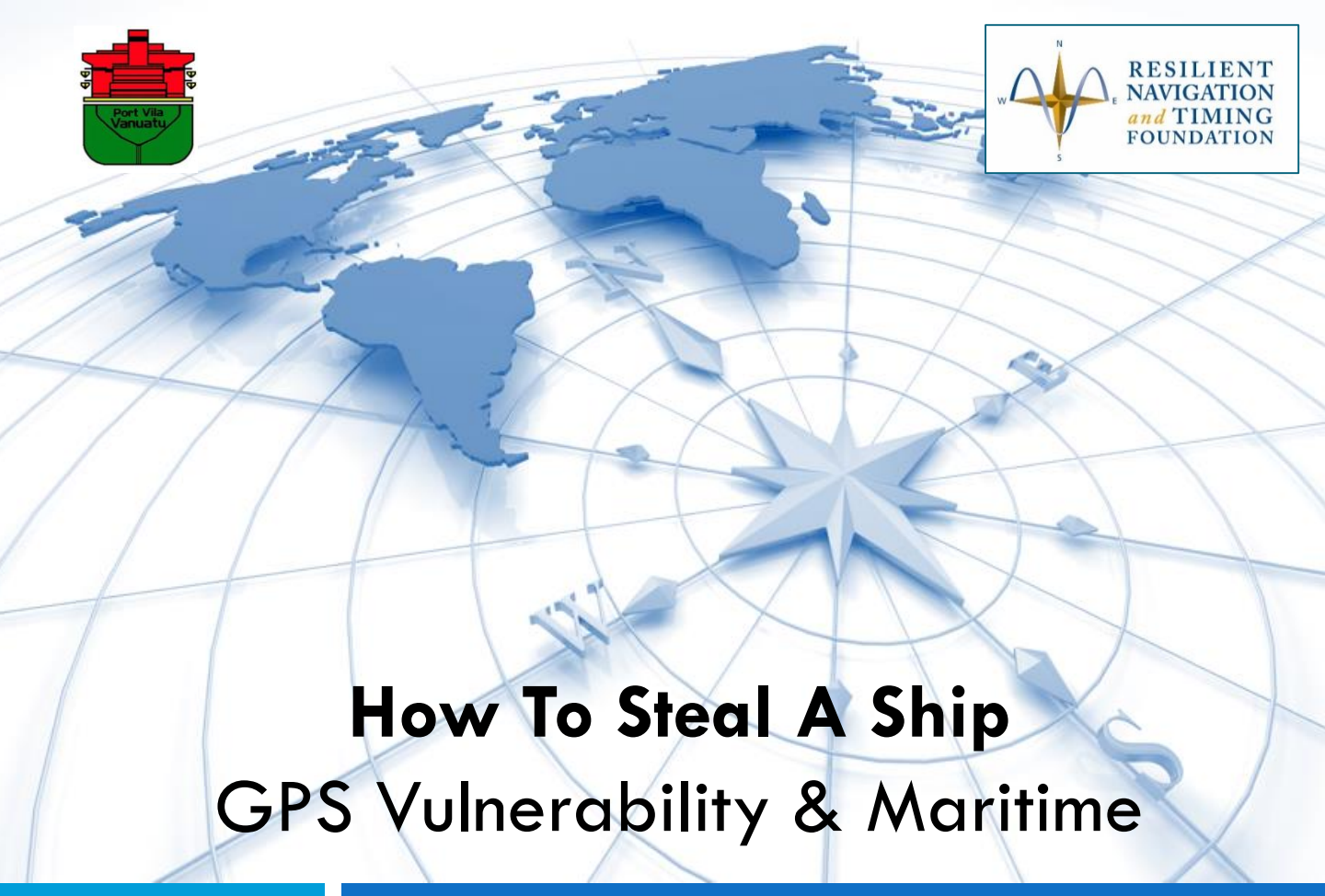


How To Steal A Ship

GPS Vulnerability & Maritime

MAY 2019, NYC

VMSL Safety Seminar 2019

Problem - GPS is everywhere

Synchronized, Precise Time, Frequency, Phase

Precise Positioning & Navigation → Transport/Navigation

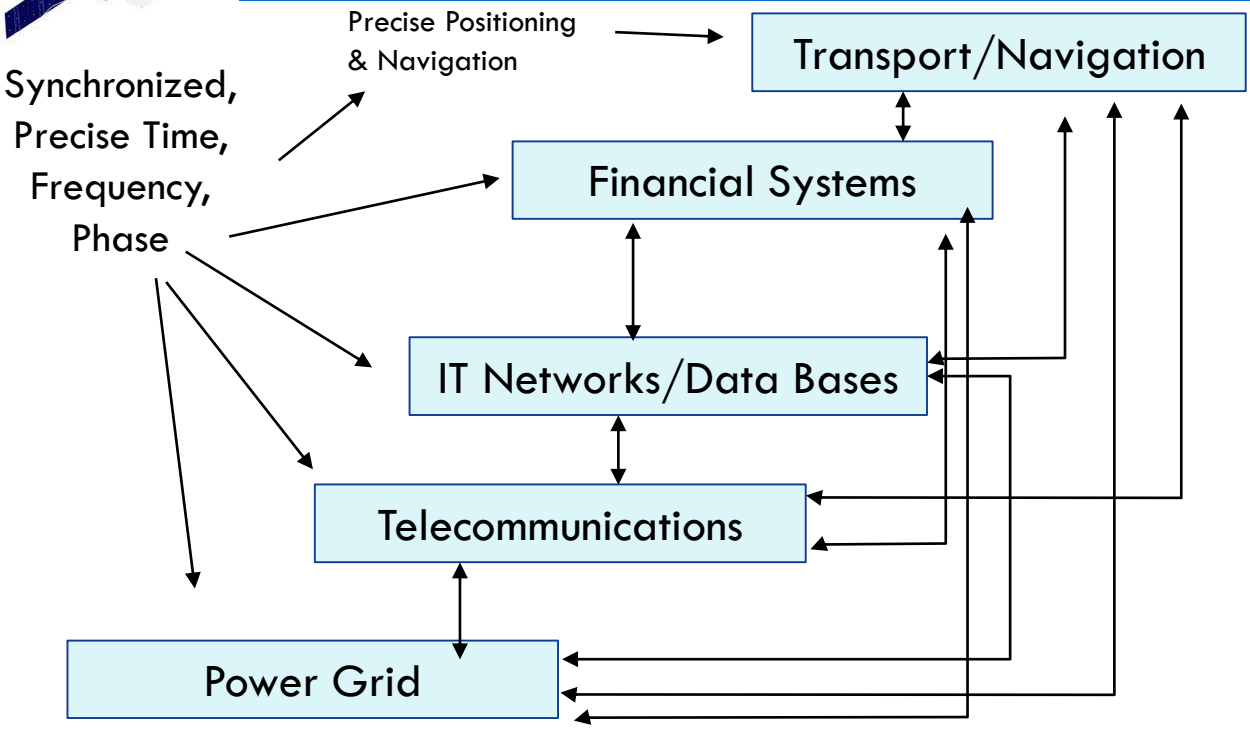
→ Financial Systems

→ IT Networks/Data Bases

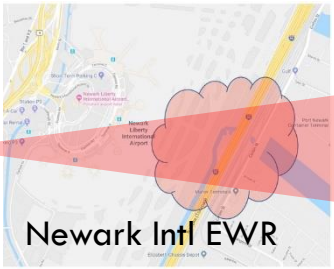
→ Telecommunications

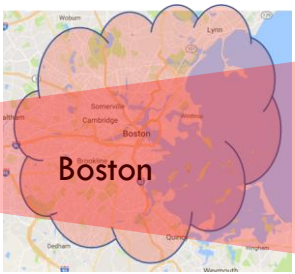
→ Power Grid

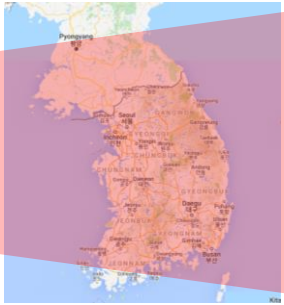
DHS – "GPS is a single point of failure for Critical Infrastructure"



But first, there was Jamming





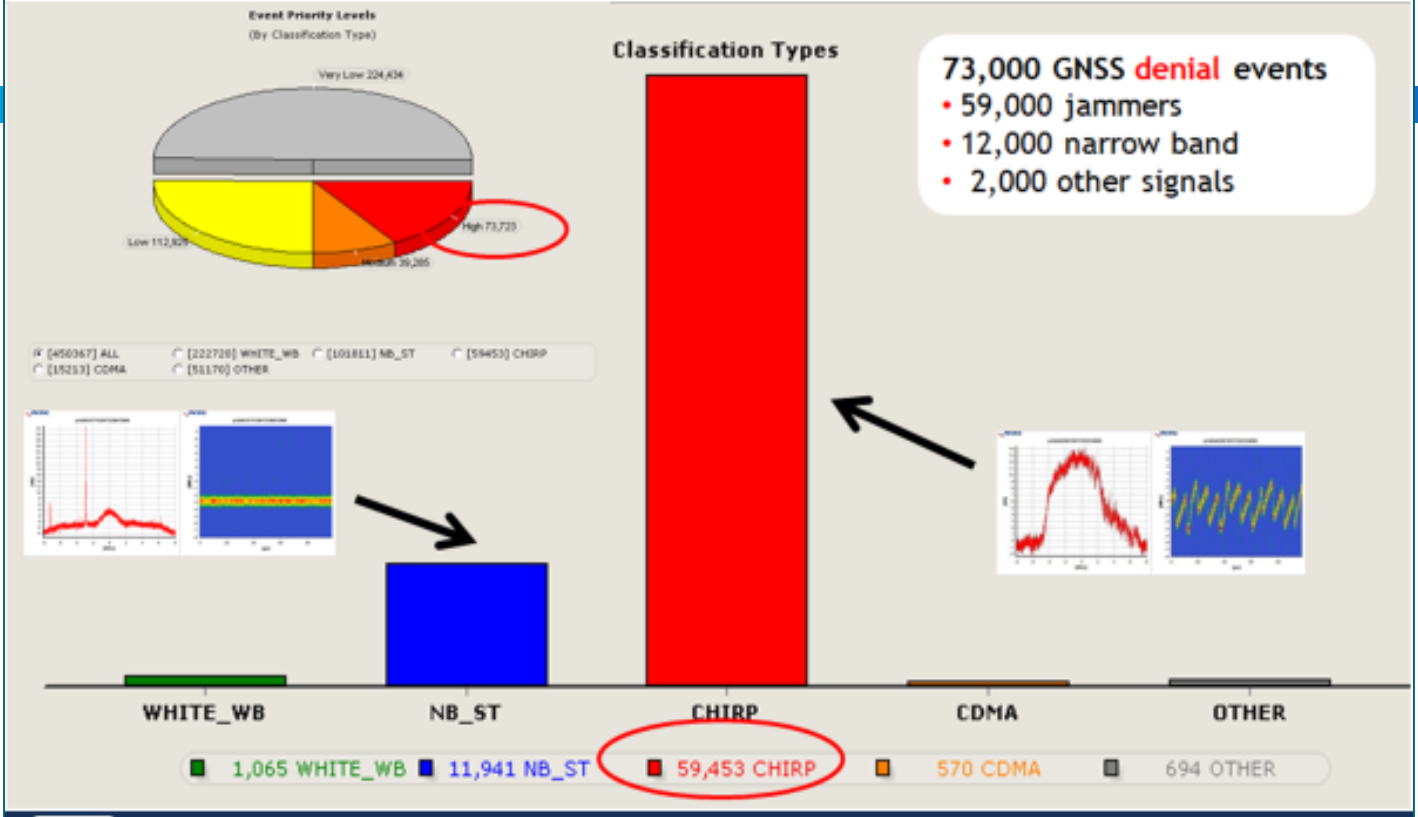


Seconds, Minutes

Weeks +

STRIKE3

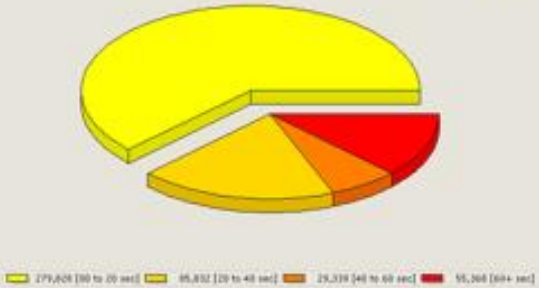
Result 2: GNSS Denial Events



STRIKE3

Result 3: Durations of interference events

ALL events (450,363 events)

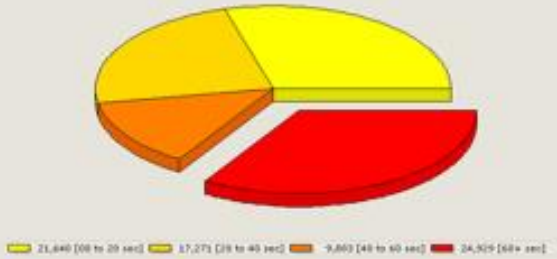


Most events are very short durations
12% of ALL events are greater than 60 seconds

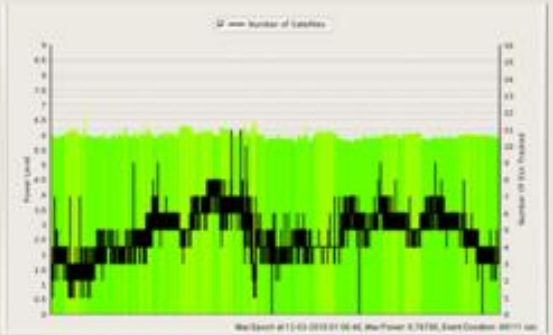
Some findings:

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

High Priority events (73,723 events)



34% priority events are greater than 60 seconds



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)

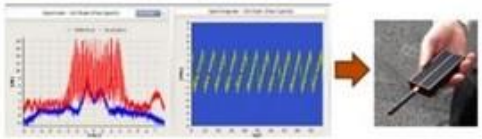
	RFI events	Jammers	Jammer/events ratio	Duration > 60secs	GNSS denial	Denial/events ratio
National Airport	8716	95	1%	282	362	4%
National Airport	759	27	4%	200	211	28%
National Airport	2764	595	22%	395	753	27%
Regional Airport	556	31	6%	6	95	17%
National Airport	904	168	19%	158	182	20%
National Airport	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

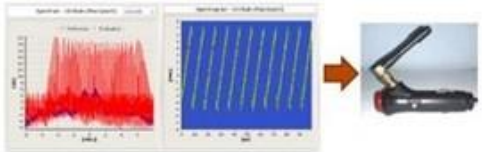
European Commission Project

STRIKE3

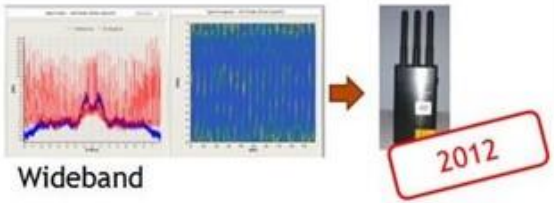
STRIKE3 shows Jammer industry is evolving...



5Mhz bandwidth, 1575Mhz centred

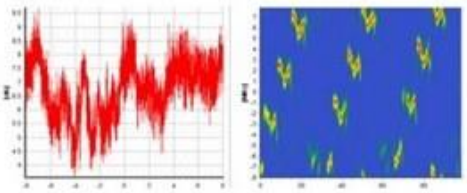


8Mhz bandwidth, drifting centre



Wideband

2012

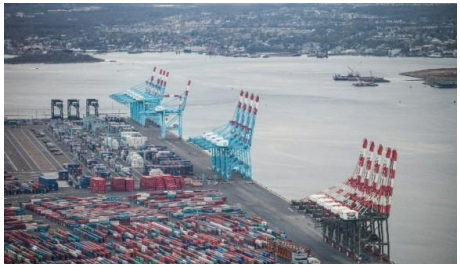


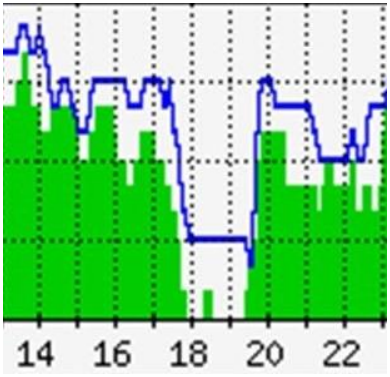
Waveform detected at 4 STRiKE3 sites Europe and outside EU

USB L1/L2 jammer

Domestic US Jamming

"GPS Disruption Halts Ports, Endangers Ships" – US Coast Guard





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

Maritime Jamming Reports

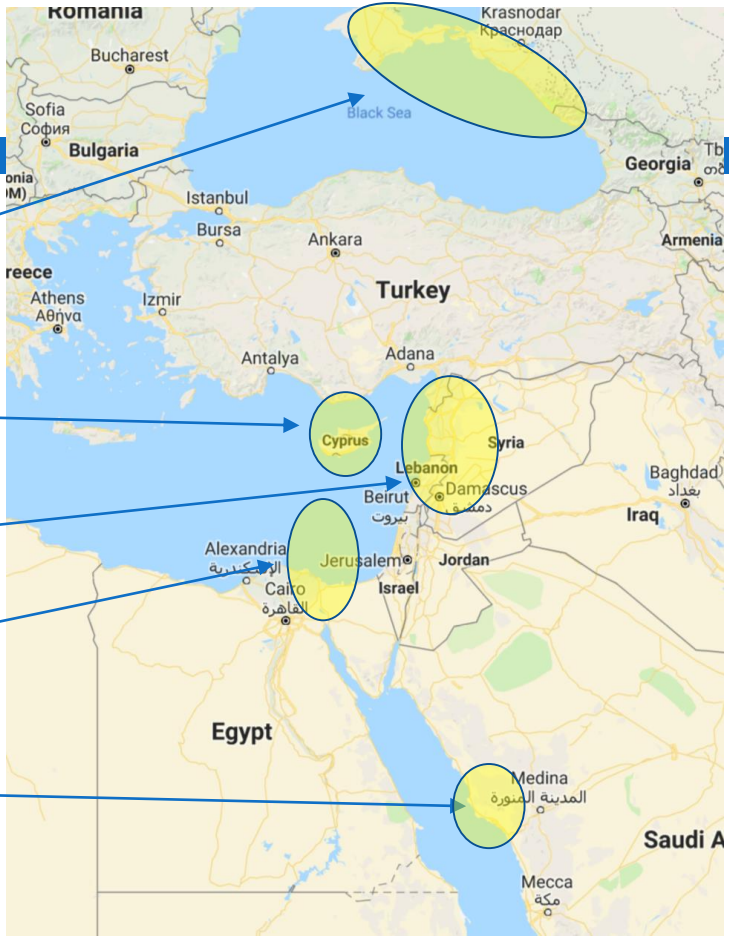
VIP Protection & Conflict

Disrupt Oil/Gas Surveys?

Armed Conflict

Illegal Fishing?

Unknown



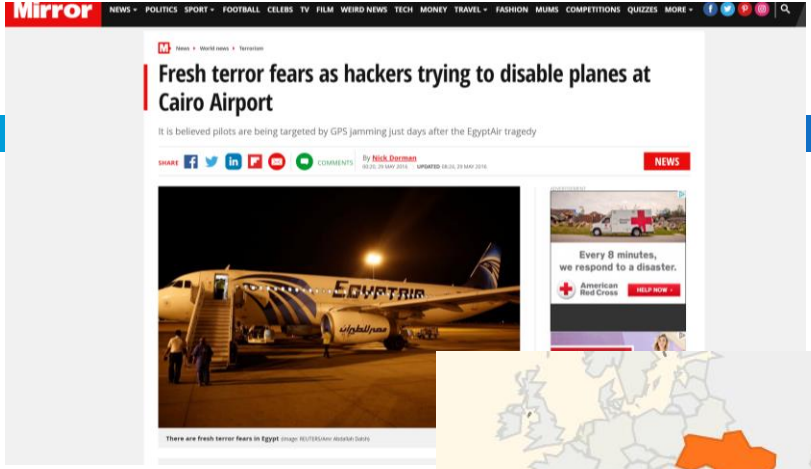
GPS WORLD
GNSS POSITION NAVIGATION TIMING

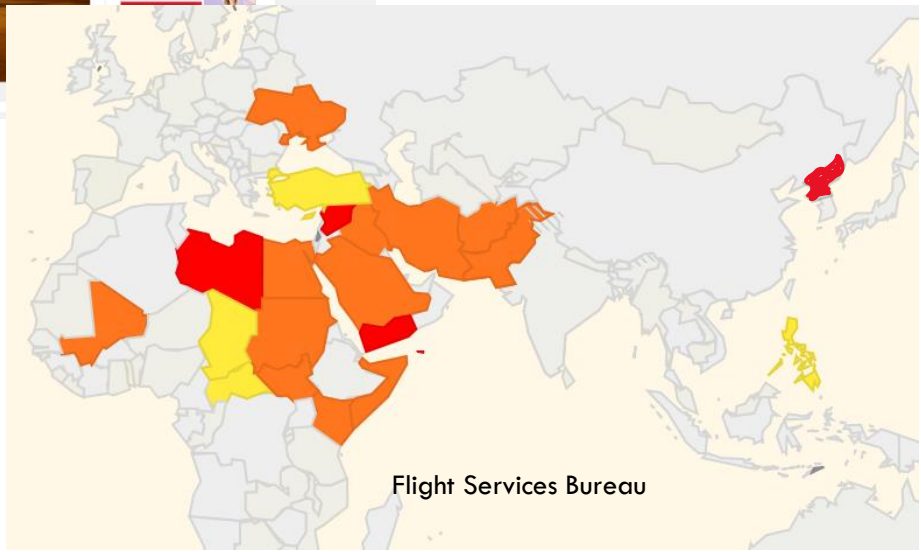
13 March 2019

Year-Long ocean cruise finds GPS disruption… everywhere

Figure 5. Vessel route from September 2017 to January 2018 recorded by DLR's GNSS receiver prototype.

Aviation Jamming Reports





Spoofing – Hazardously Misleading Information

December 2011

Spoofing Demo

June 2012

University of Texas, Austin

Prof Todd Humphreys

Spoofing Demo

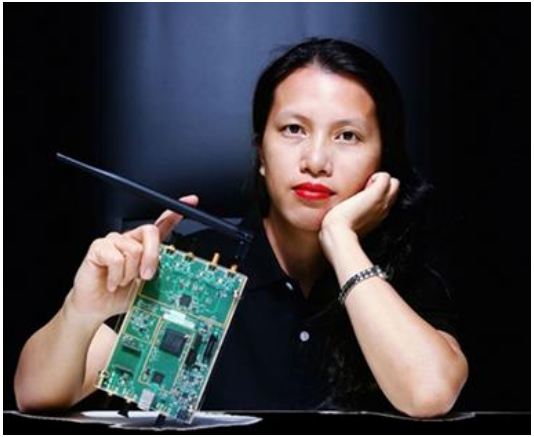
June 2013

https://www.youtube.com/watch?time_continue=17&v=ctw9ECgJ8L0

Tutorial – Build Your Own GPS Spoofer

December 2015

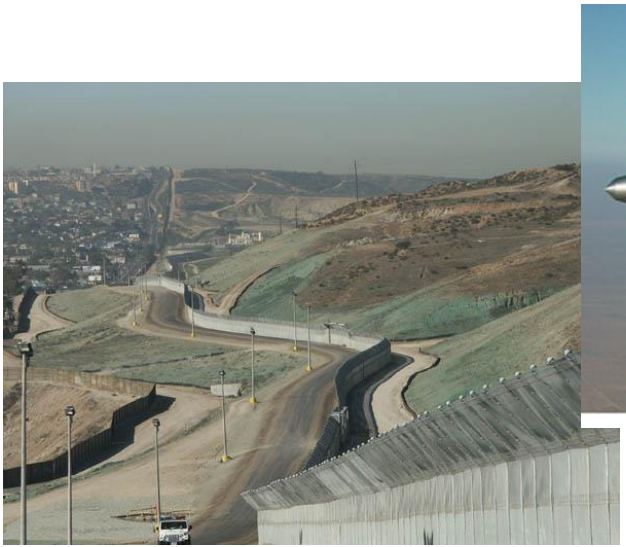
Hackers Convention
Las Vegas



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

Spoofing?

January 12, 2016

Spoofing?

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

January 12, 2016

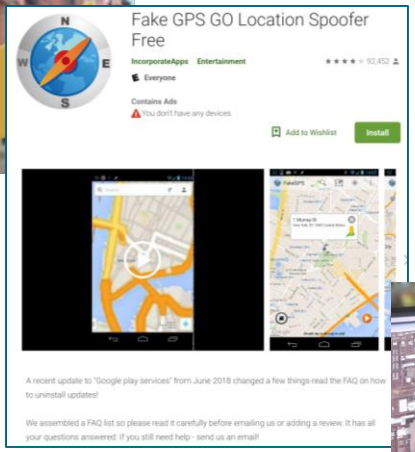
Spoofing?

- 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 24 2016 YEKATERINA SINELSCHIKOVA RBTH

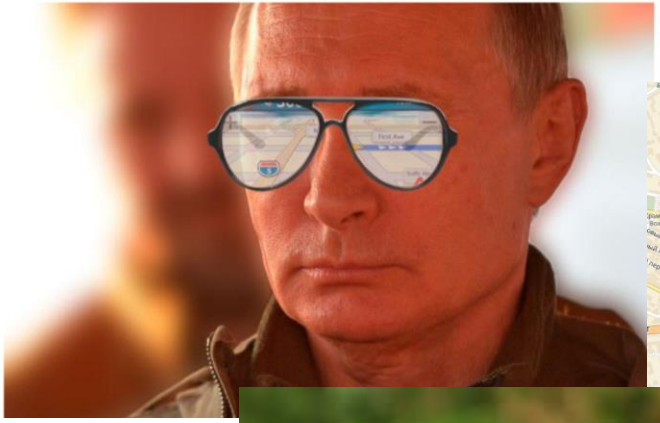
The Moscow Times

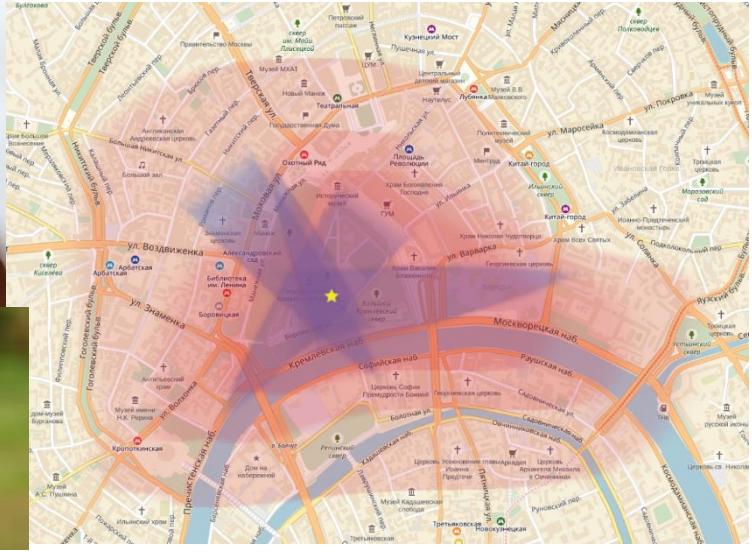
Oct. 21 2016 - 03:10

The Kremlin Eats GPS for Breakfast

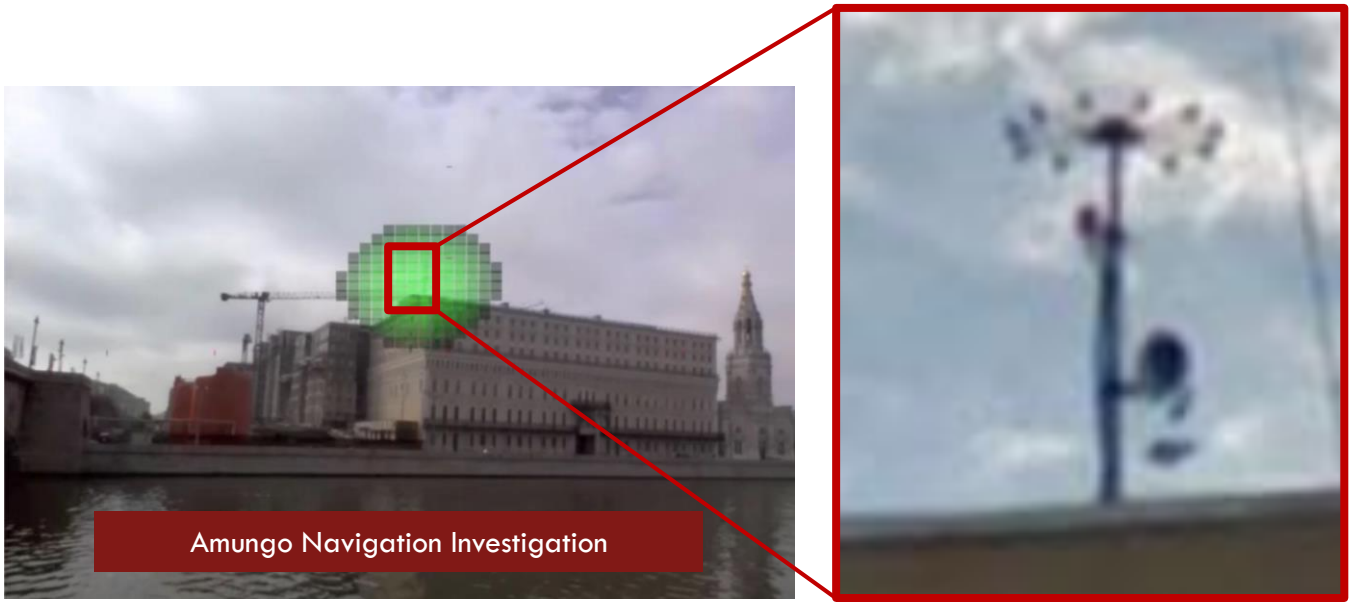
Why geolocation in central Moscow has become a real headache

October 2016

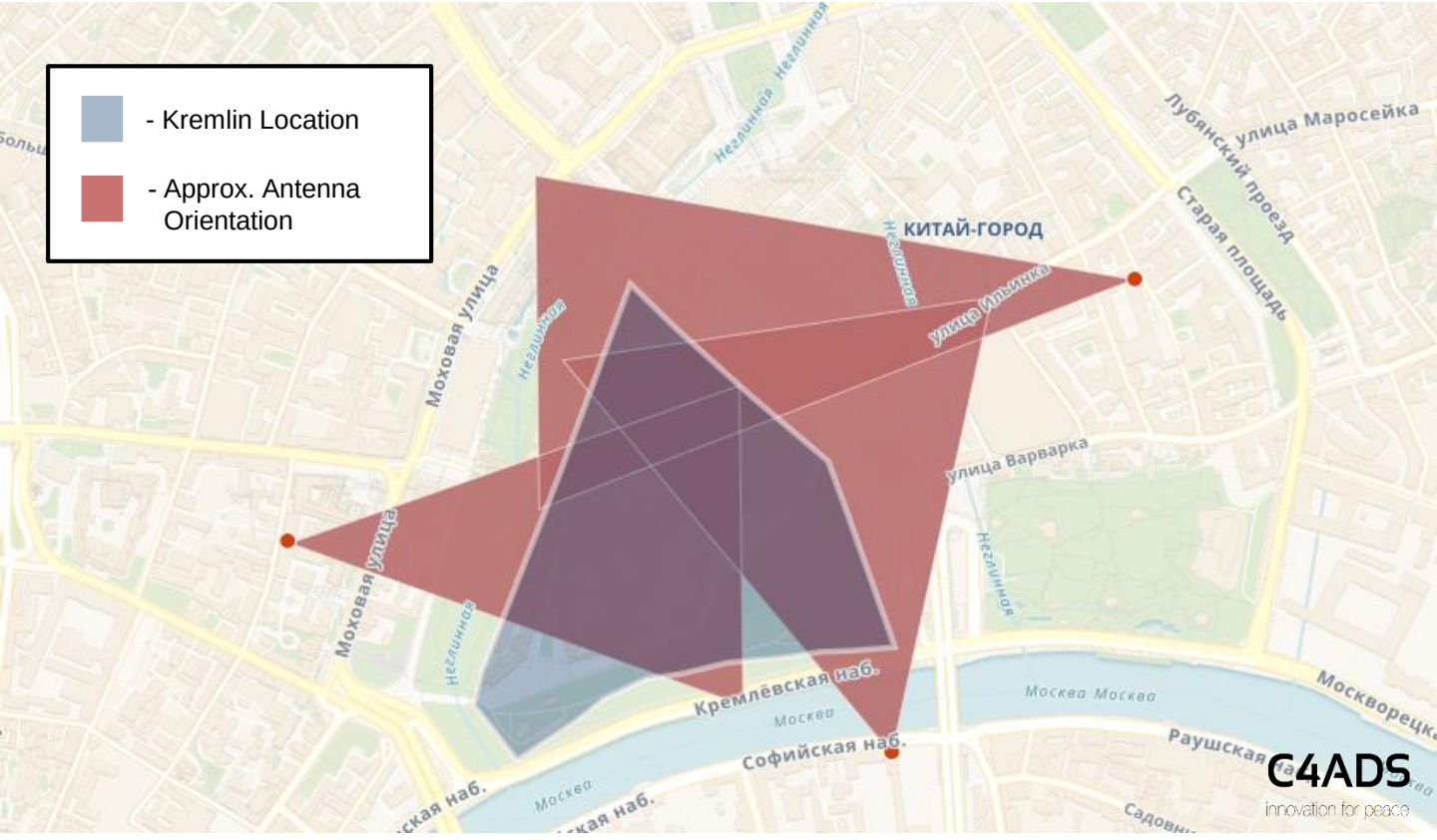




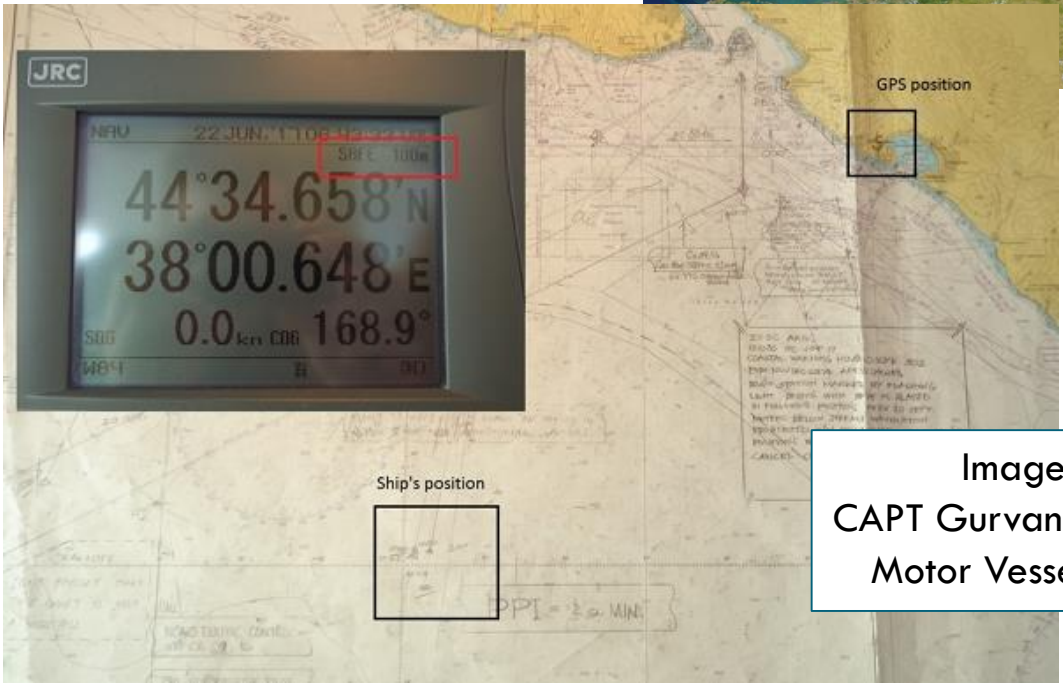
September 2017



June 2016: First Public Reports of GNSS Spoofing Near Kremlin



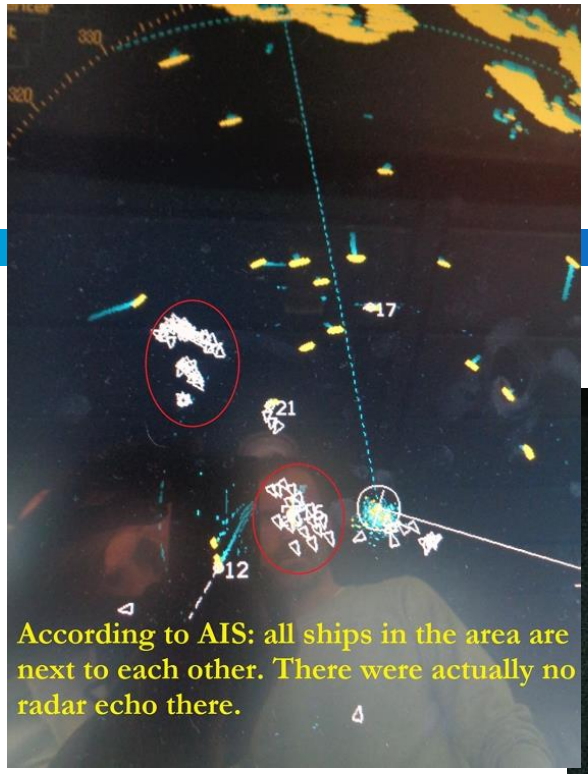
June 2017, M/V Atria

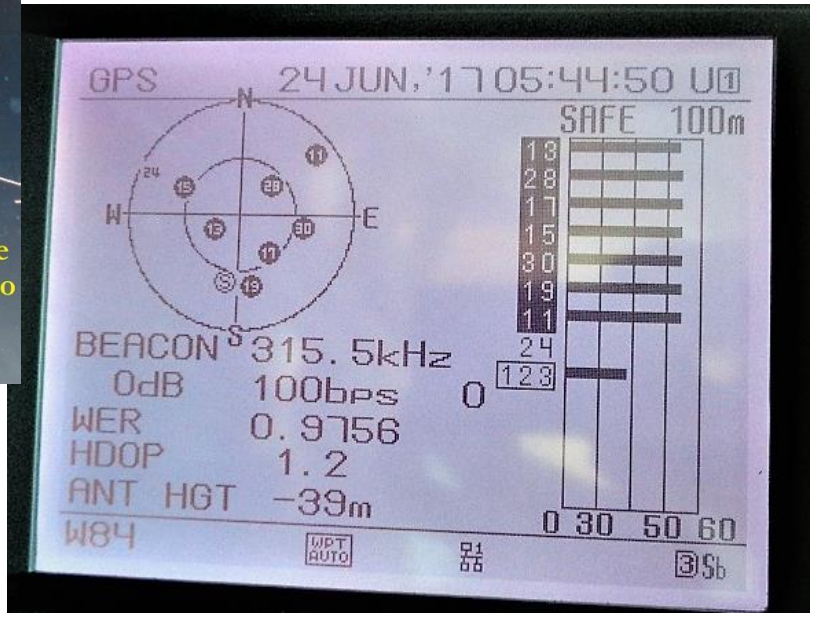


Images
CAPT Gurvan LE MEUR
Motor Vessel Atria

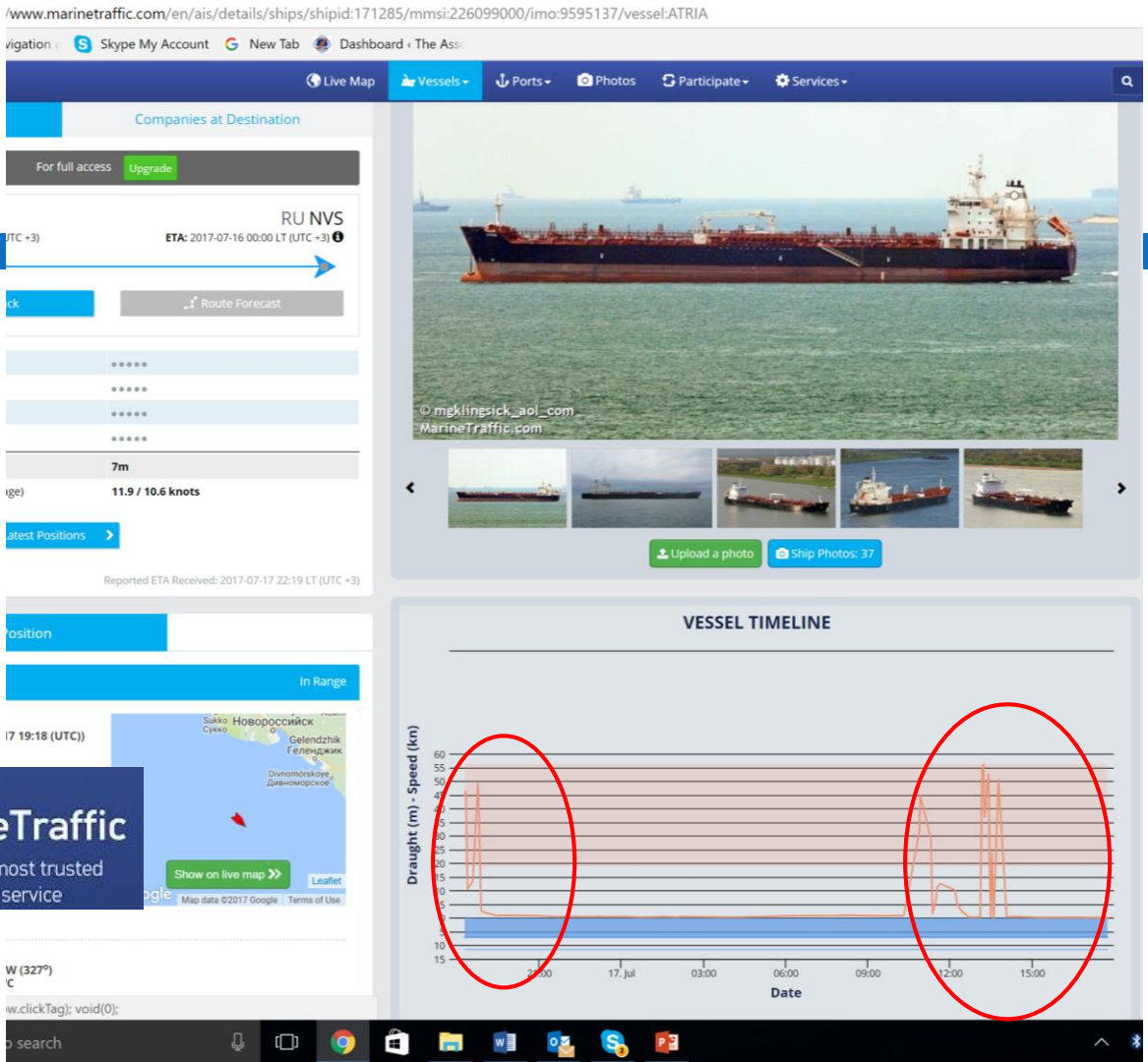
June 2017, M/V Atria

Images
CAPT Gurvan LE MEUR
Motor Vessel Atria



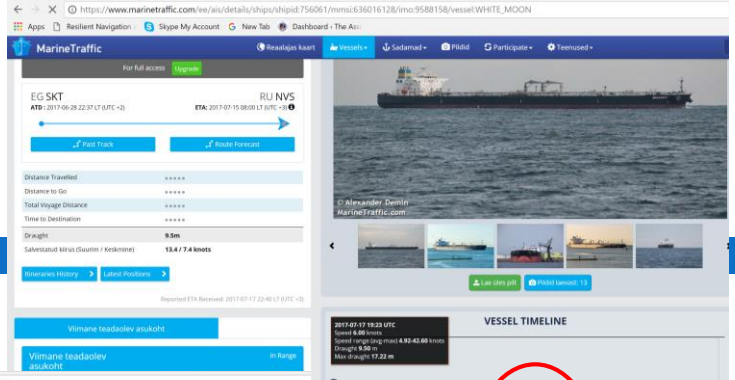


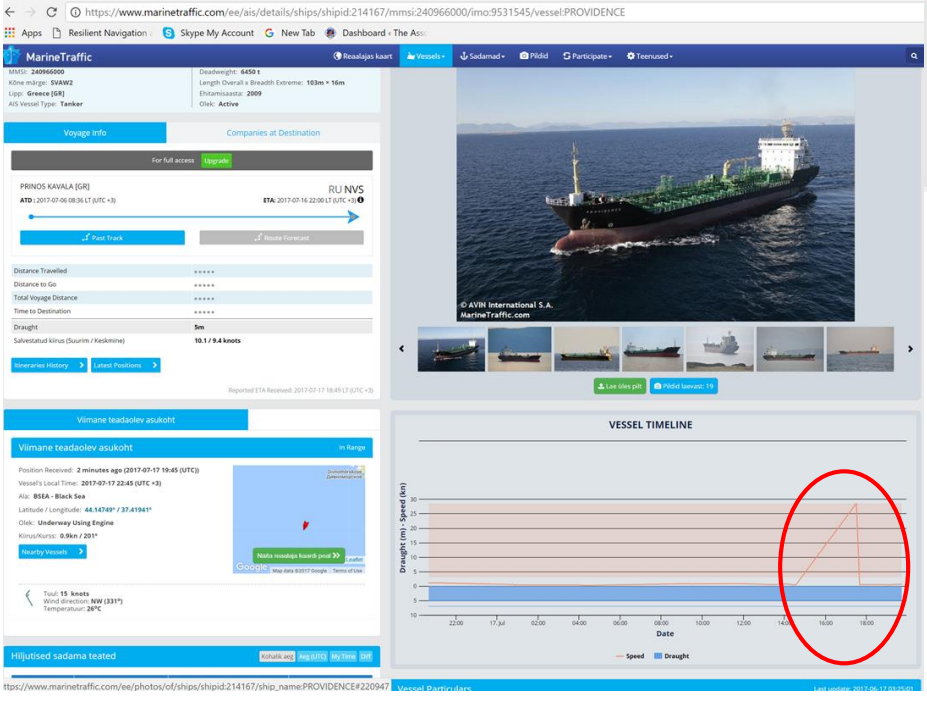
July 2017



MarineTraffic
The world's most trusted ship tracking service

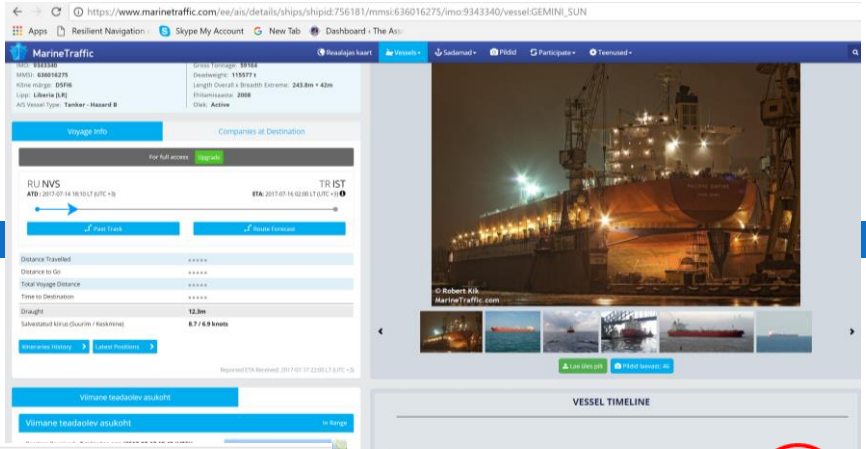
July 2017

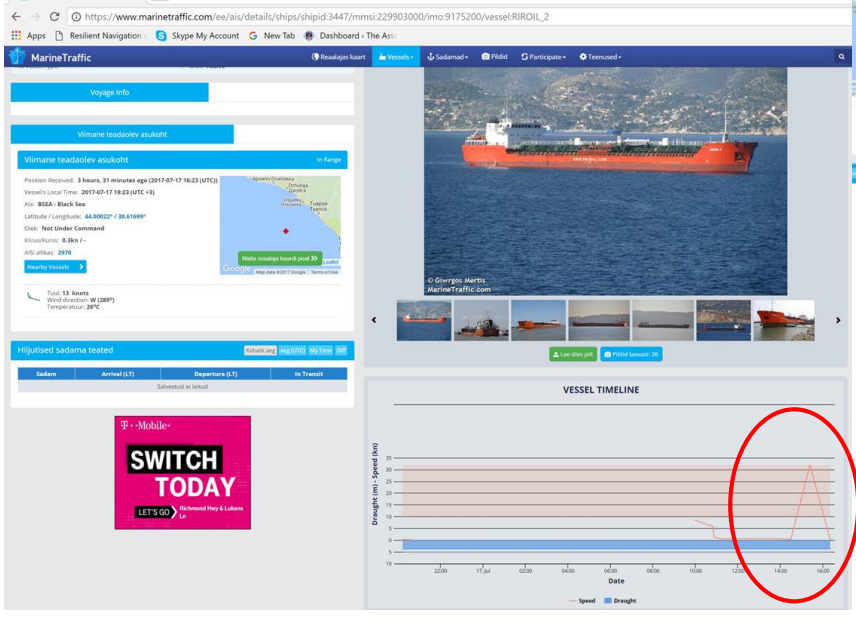




MarineTraffic
The world's most trusted ship tracking service

July 2017


MarineTraffic
VESSEL TIMELINE
Speed
Draught

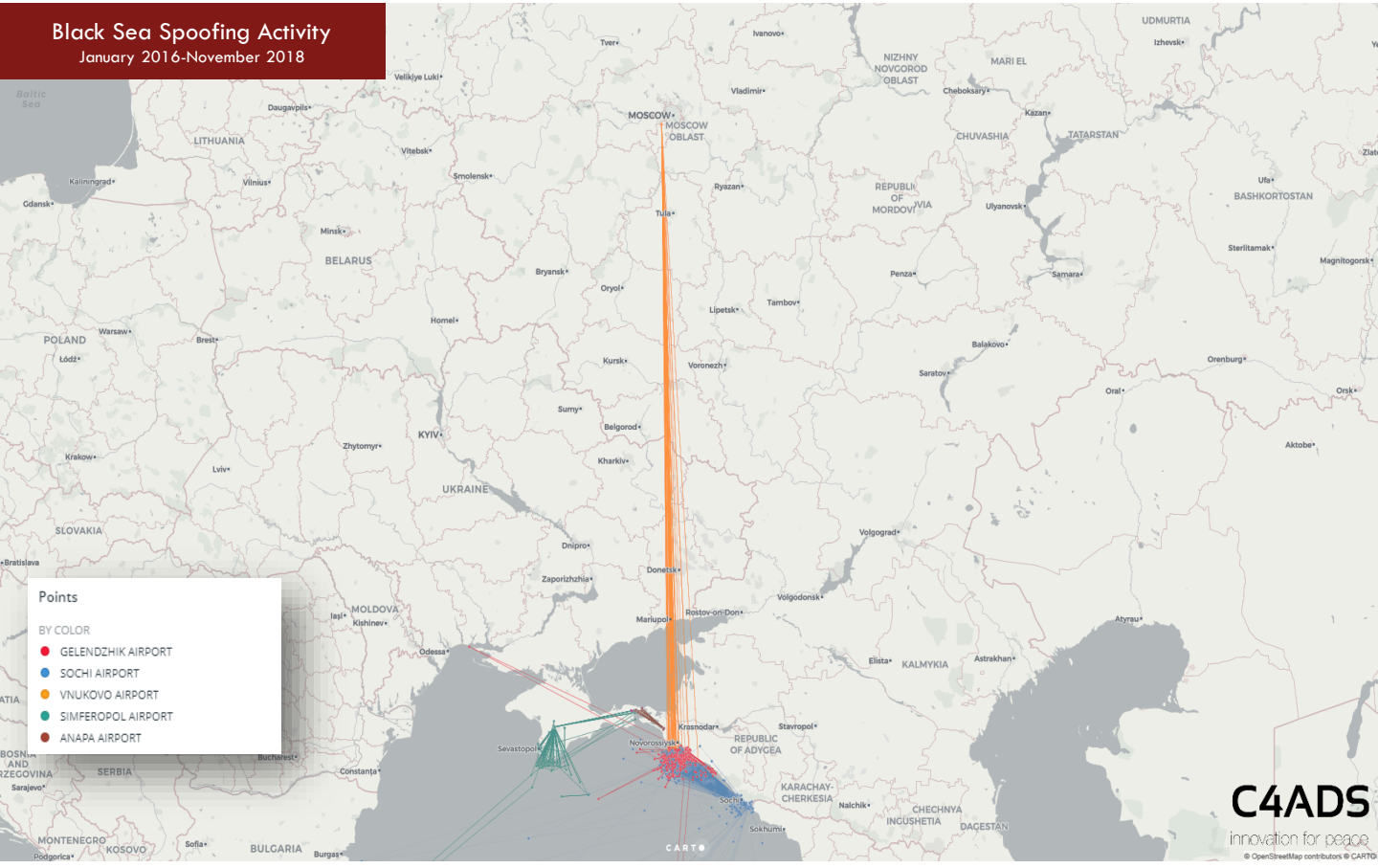

MarineTraffic
Voyage Info
Viimane teadaolev asukoht
Hiljutised sadama teated
VESSEL TIMELINE
Speed
Draught

T-Mobile
SWITCH
TODAY
LET'S GO


MarineTraffic
The world's most trusted
ship tracking service

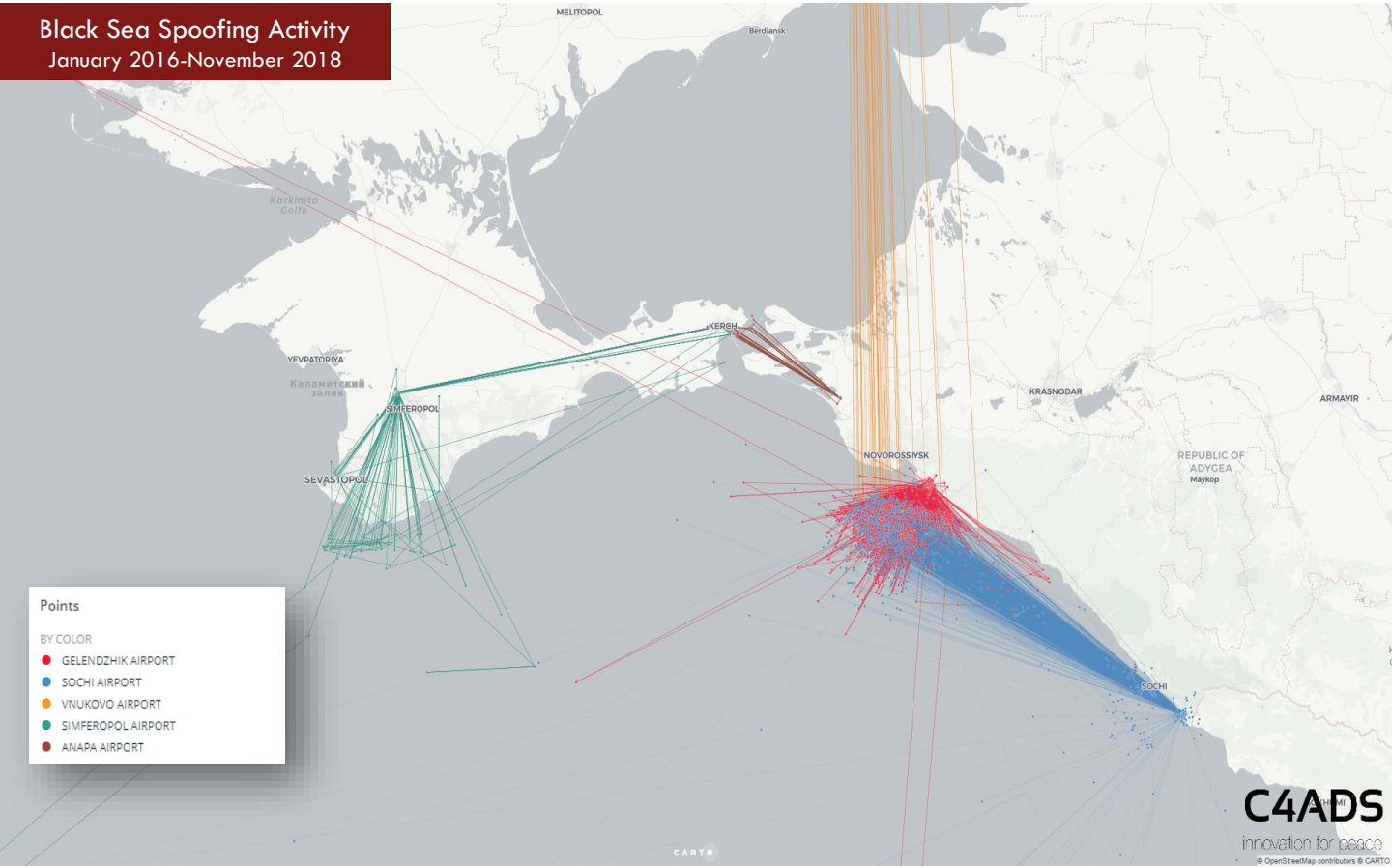
Black Sea Spoofing Activity

January 2016-November 2018

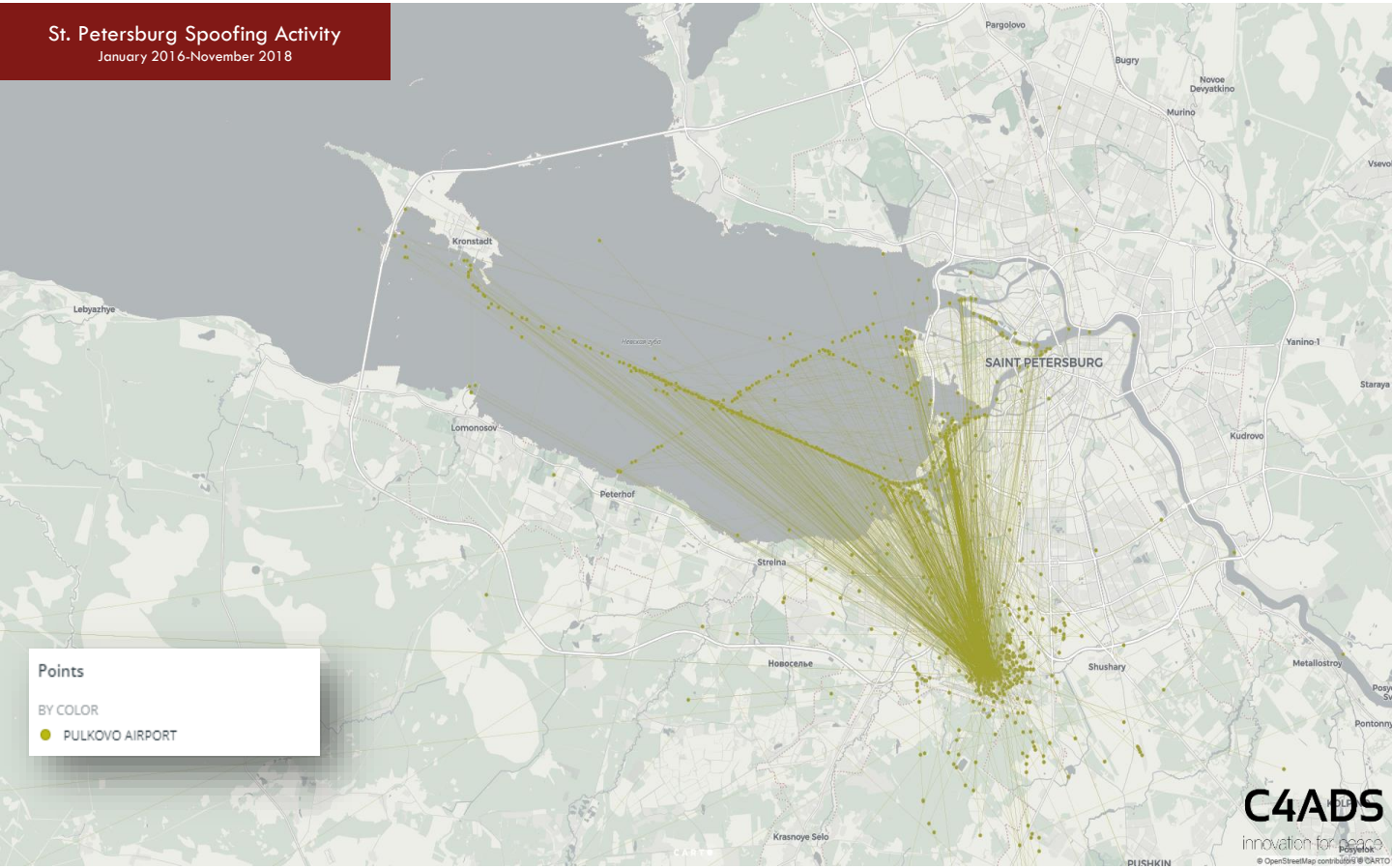


Ships at Gelendzhik Airport

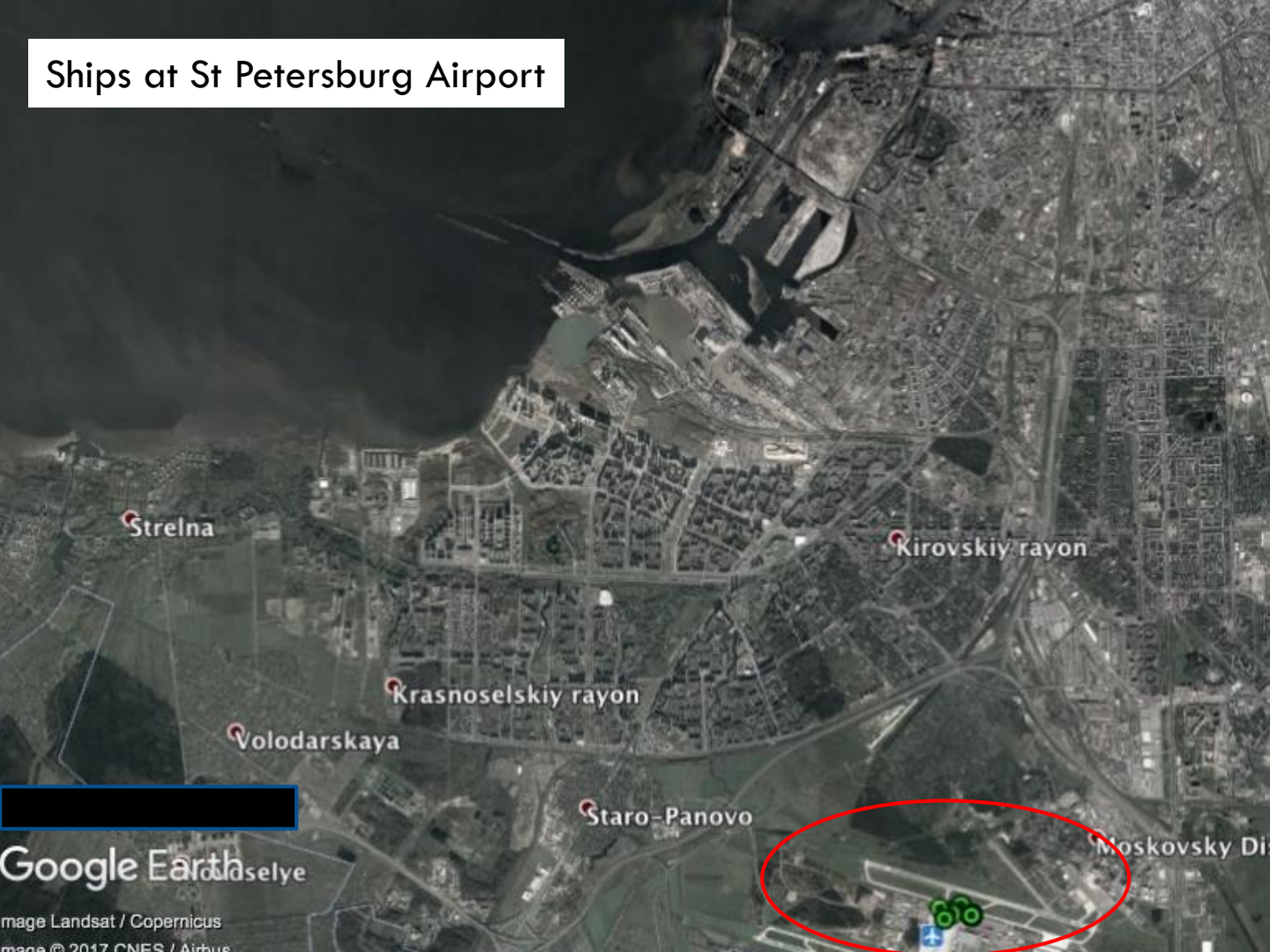
Black Sea Spoofing Activity
January 2016-November 2018



Ships at Sochi Airport

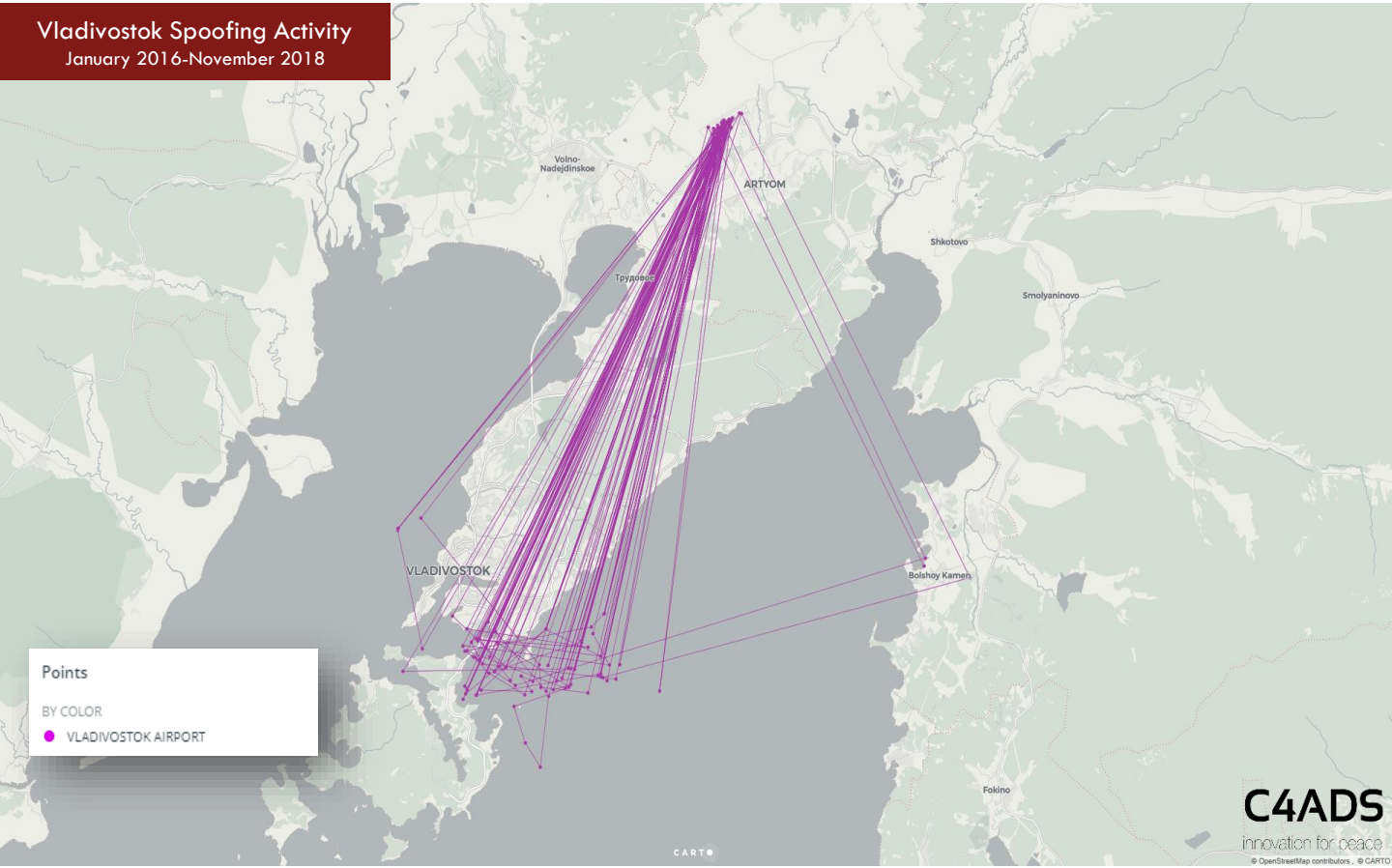


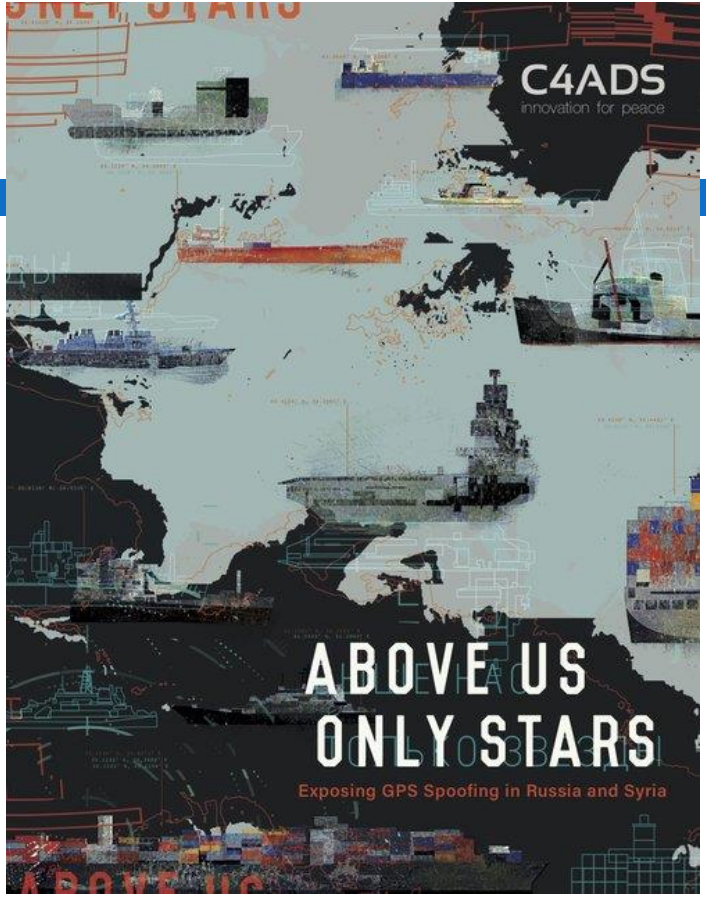
Ships at St Petersburg Airport



Vladivostok Spoofing Activity

January 2016-November 2018

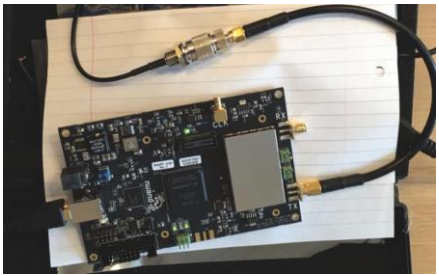




https://c4ads.org/reports

GPS Spoofing Nails Cell Phones in Portland

Oct 2017



June 2018

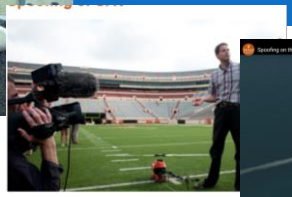
Easily Spoofing Them All at Once – Inside GNSS

Spoofing GPS & Your Maps – Next Level of Danger

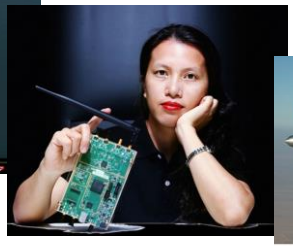
Virginia Tech & China Institute
July 2018

Spoofing – Cost ↓ Capability ↑ Ease of use ↑

Iran, Dec 2011



UT Austin, 2012-13

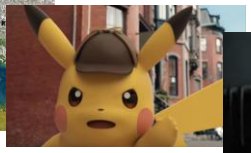


Las Vegas, Dec 2015

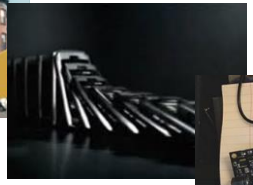
US Southern Border
Dec 2015

Persian Gulf, Jan 2016

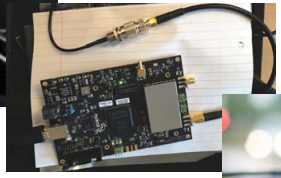
4 sites Russia
1,300+ ships
2016 - Present



Pokemon
July 2016

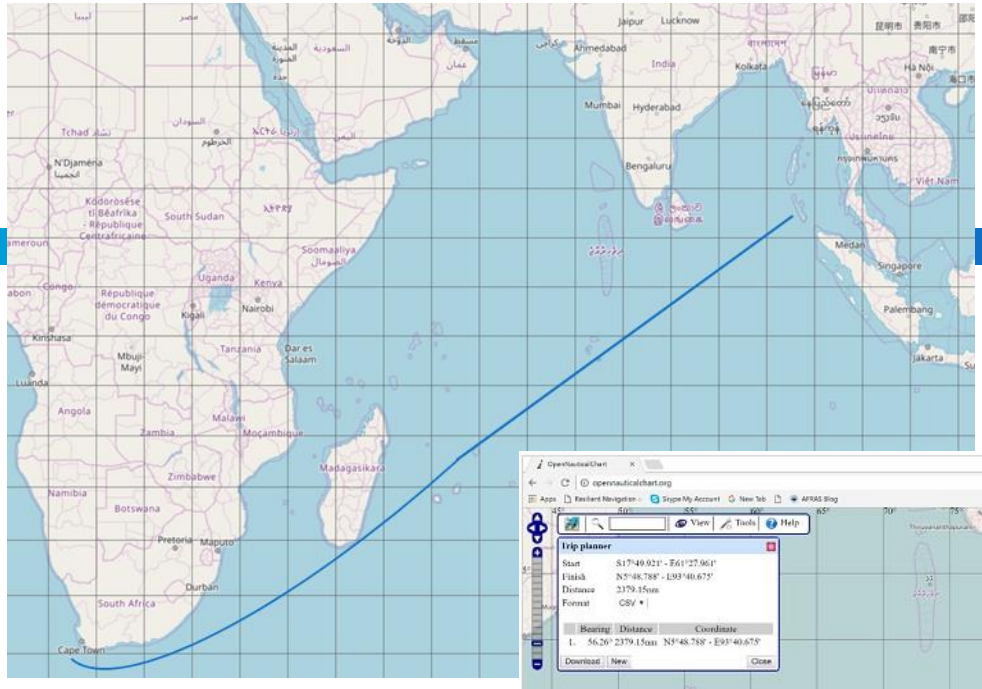


Portland
Oct 2017



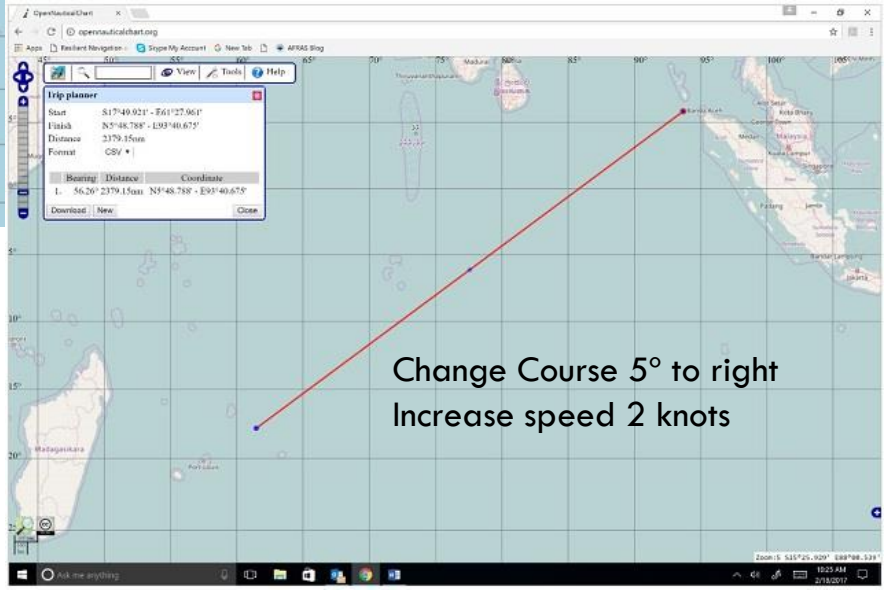
All GNSS at Once
June 2018

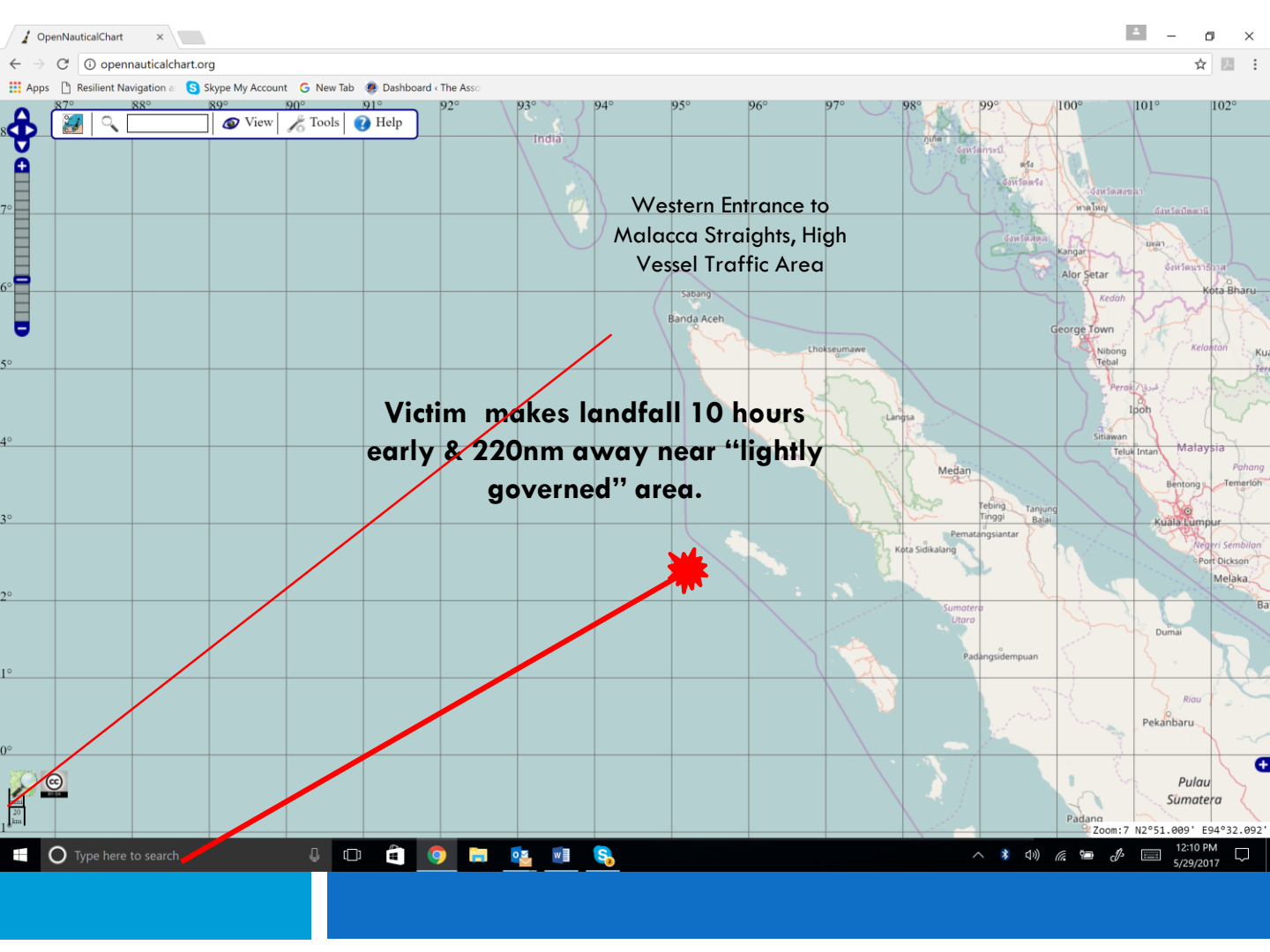
Signals & Maps
Jul 2018



The MARITIME EXECUTIVE
INTELLECTUAL CAPITAL FOR EXECUTIVES

"How To Steal A Ship"
2 June 2017




OpenNauticalChart
opennauticalchart.org
Apps
Resilient Navigation a
Skype My Account
New Tab
Dashboard ‹ The Assc
View
Tools
Help
Western Entrance to Malacca Straights, High Vessel Traffic Area
Victim makes landfall 10 hours early & 220nm away near "lightly governed" area.
India
Banda Aceh
Lhokseumawe
Medan
Kangar
Alor Setar
Kota Bharu
George Town
Ipoh
Malaysia
Kuala Lumpur
Port Dickson
Melaka
Pekanbaru
Pulau Sumatera
Padang
Zoom:7 N2°51.009' E94°32.092'
Type here to search
12:10 PM
5/29/2017

What to Do?

- Protect – GPS Signals
- Toughen – Users & Equipment
- Augment – w/other signals & sources

What to Do? - Masters

- Protect –
  - Who and What is Aboard?
  - Interference detection

The Maritime Executive

How To Steal a Ship, Part 2
12 June 2017

- Toughen –
  - Secure proximity to GPS/GNSS antennas
  - Standards, requirements, costs

- Augment –
  - Prudent mariner - “Every means available”

What to Do? - Companies

- Protect –
  - Support masters per above

How To Steal a Ship, Part 2
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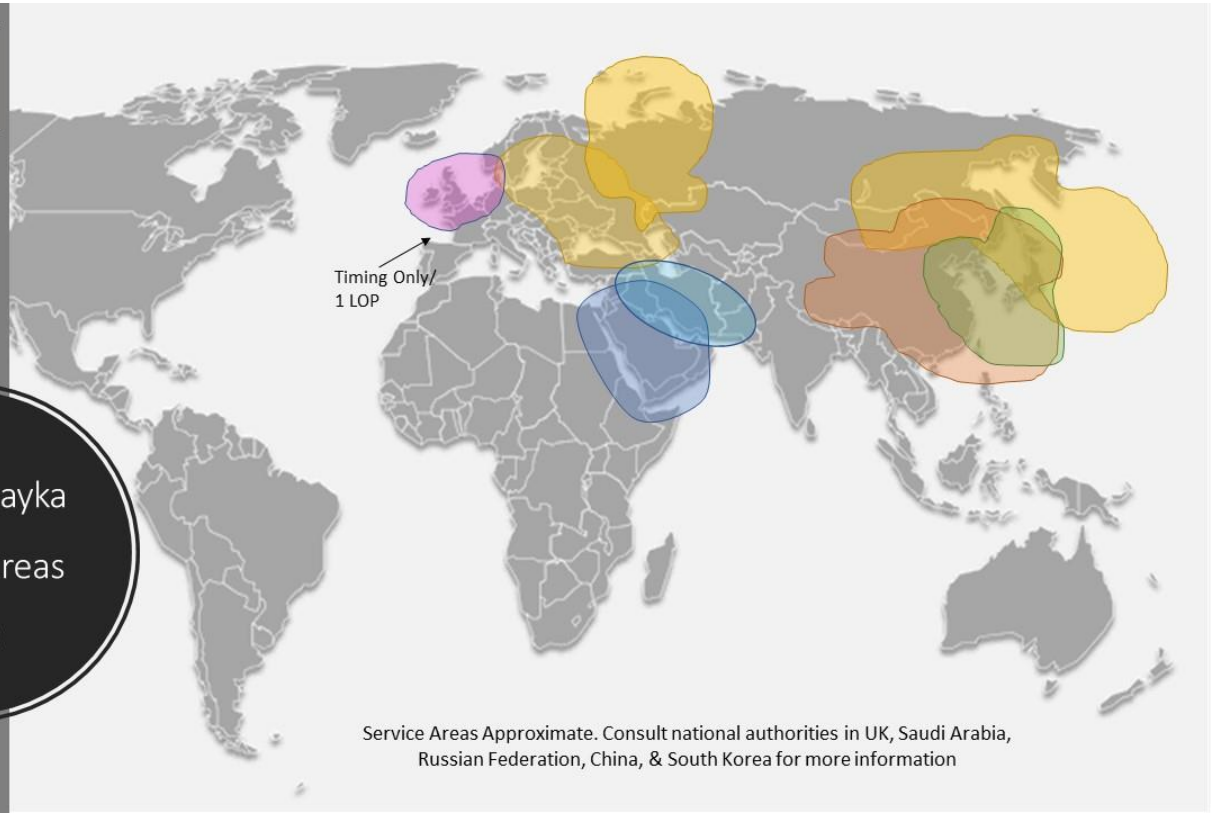
- Toughen –
  - GPS receivers w/ anti-jam & anti-spoof
  - GNSS receivers using multiple constellations
  - Two antennas

- Augment –
  - Loran, eLoran, Chayka
  - Engage w/ Govts, IMO, etc.

RESILIENT NAVIGATION and TIMING FOUNDATION

Loran/Chayka Service Areas 2019



Service Areas Approximate. Consult national authorities in UK, Saudi Arabia, Russian Federation, China, & South Korea for more information

What to Do? - Nations

- Protect – GPS Signals
  - Interference detection
  - Enforcement

How To Steal a Ship, Part 2
12 June 2017

- Toughen – Users & Equipment
  - Anti-jam, anti-spoof
  - Standards, requirements, costs

- Augment – w/other signals & sources
  - US Govt Announcements 2008, 2015 “eLoran”

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