



危険な世界のための弾力的なナビゲーション

(Resilient Navigation for a Dangerous World)



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

Problem - GNSS is everywhere



Synchronized,
Precise Time,
Frequency,
Phase

Precise Positioning
& Navigation

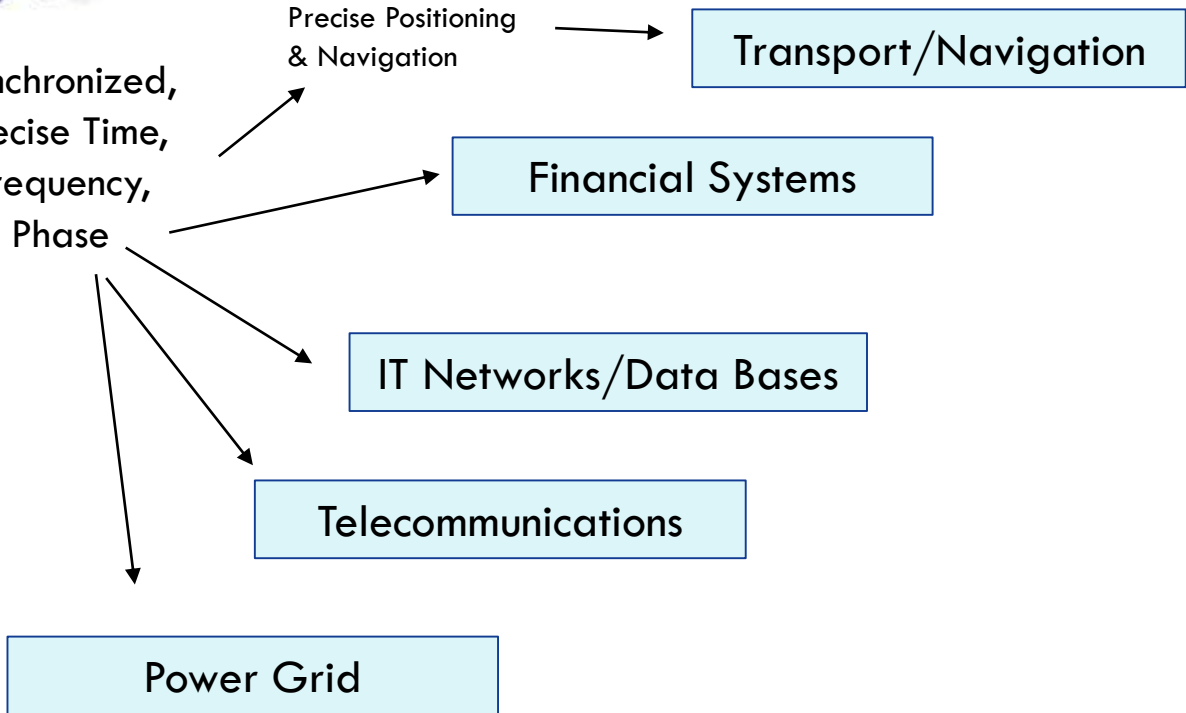
Transport/Navigation

Financial Systems

IT Networks/Data Bases

Telecommunications

Power Grid



“GPS is a single point of failure for Critical Infrastructure” – US Dept. Homeland Security



Synchronized,
Precise Time,
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Precise Positioning
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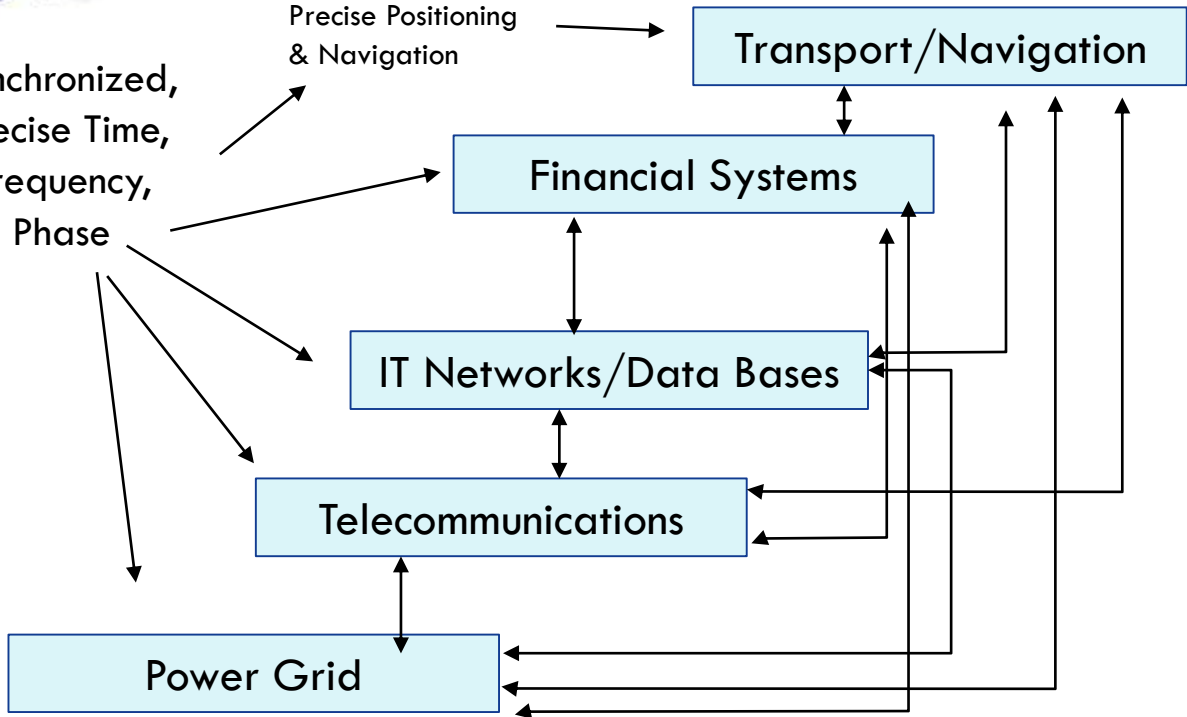
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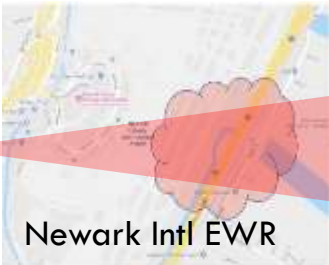






<https://www.youtube.com/watch?v=9zW2bLJXkRU>

Jamming/Denial of Service

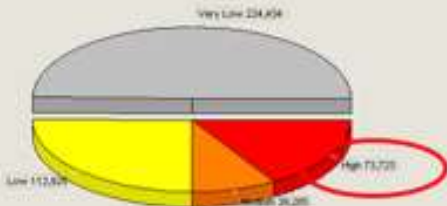


Seconds,
Minutes

Weeks +

Result 2: GNSS Denial Events

Event Priority Levels
(By Classification Type)



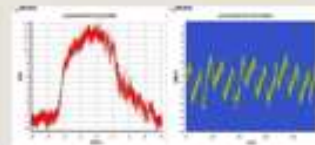
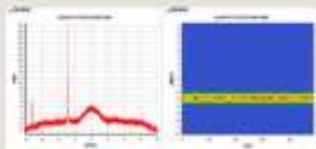
Classification Types



73,000 GNSS denial events

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

[450367] ALL
 [222720] WHITE_WB
 [101811] NB_ST
 [59453] CHIRP
 [13213] CDMA
 [88170] OTHER



WHITE_WB

NB_ST

CHIRP

CDMA

OTHER

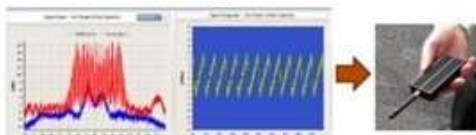
■ 1,065 WHITE_WB
 ■ 11,941 NB_ST
 ■ 59,453 CHIRP
 ■ 570 CDMA
 ■ 694 OTHER



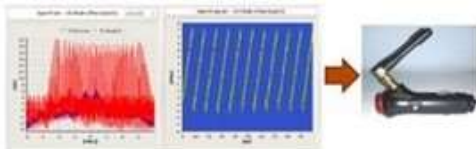


STRIKE3

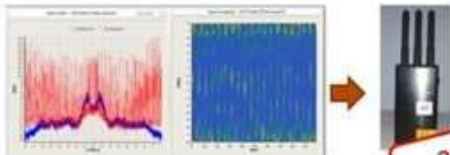
STRIKE3 shows Jammer industry is evolving...



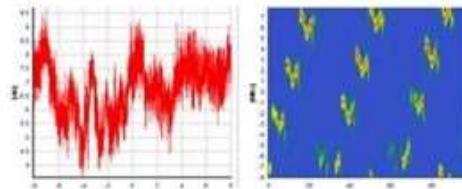
5Mhz bandwidth, 1575Mhz centred



8Mhz bandwidth, drifting centre



Wideband



Waveform detected at 4 STRiKE3 sites Europe and outside EU



USB L1/L2 jammer



Mirror HOME • POLICE SPORT • FOOTBALL COLUMN TO FILM VIDEO NEWS TESTS BOARD TRAVEL • MAGAZINE HOME COMPETITIONS QUizzes MORE •

Fresh terror fears as hackers trying to disable planes at Cairo Airport

It is believed pilots are being targeted by 007s jamming just days after the Egyptian tragedy

SHARE Facebook Twitter LinkedIn WhatsApp Email Print

NEWS

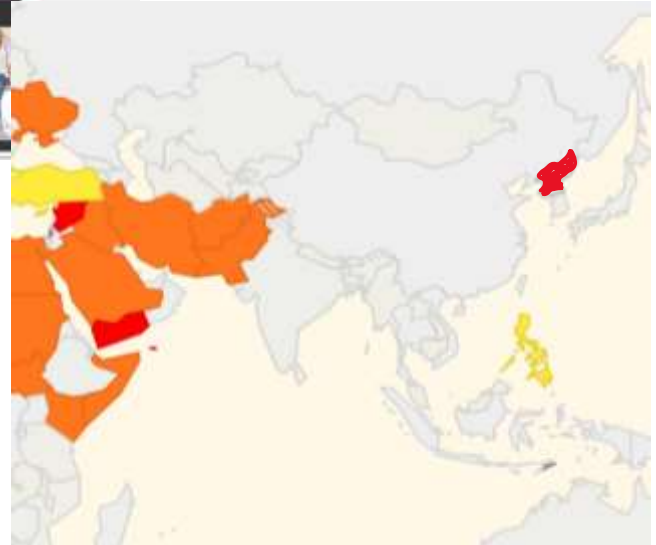


More on Egypt terror attacks Egypt

Every 8 minutes, we respond to a disaster. [Advertisement](#) [Red Cross](#)

It's only moments made by powerful people. [Advertisement](#)

Aviation Jamming Reports



Maritime Jamming Reports

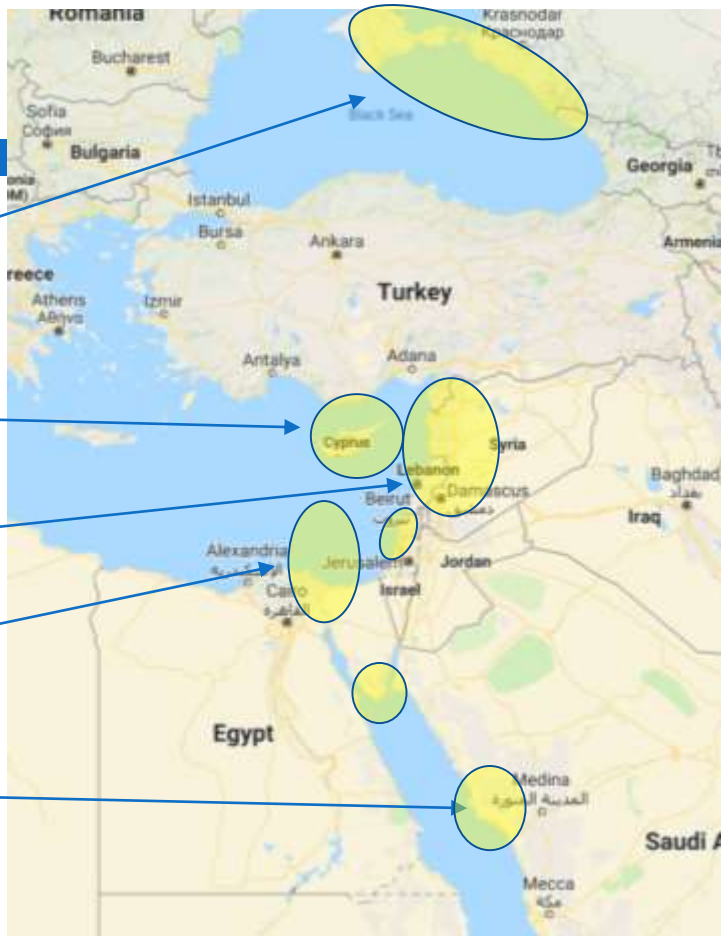
VIP Protection & Conflict

Disrupt Oil/Gas
Surveys?

Armed
Conflict

Illegal Fishing?

Unknown

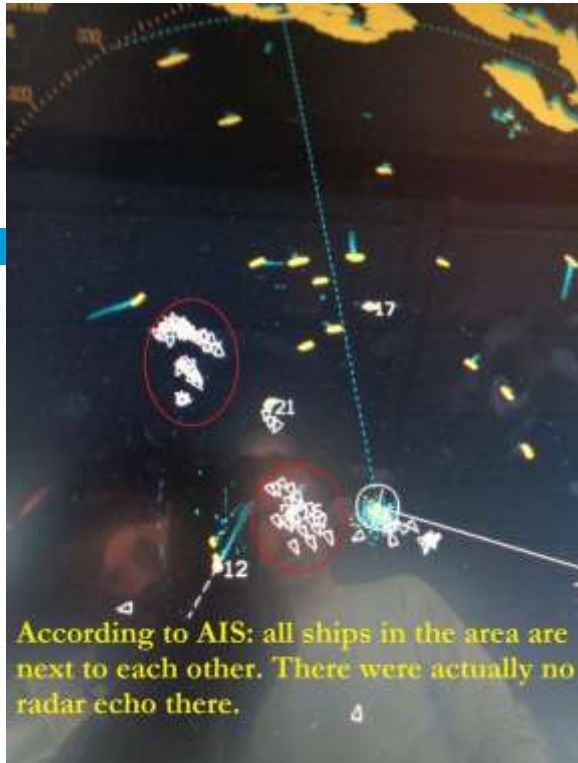


Spoofing – Hazardously Misleading Information

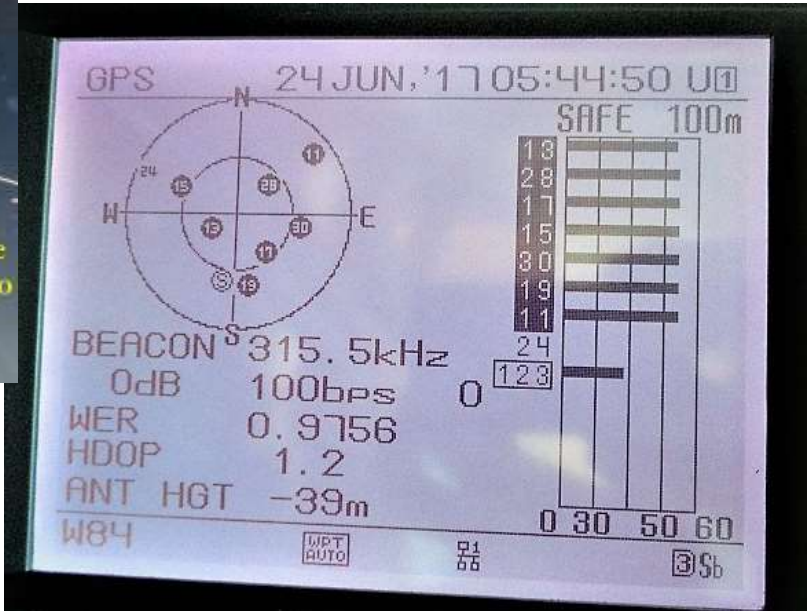
December 2011



June 2017, M/V Atria



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



Ships at Gelendzhik Airport



С/Т "ВИНОГРАДАРЬ-3"

С/Т "ВЕТЕРАН"

Gelendzhik Airport

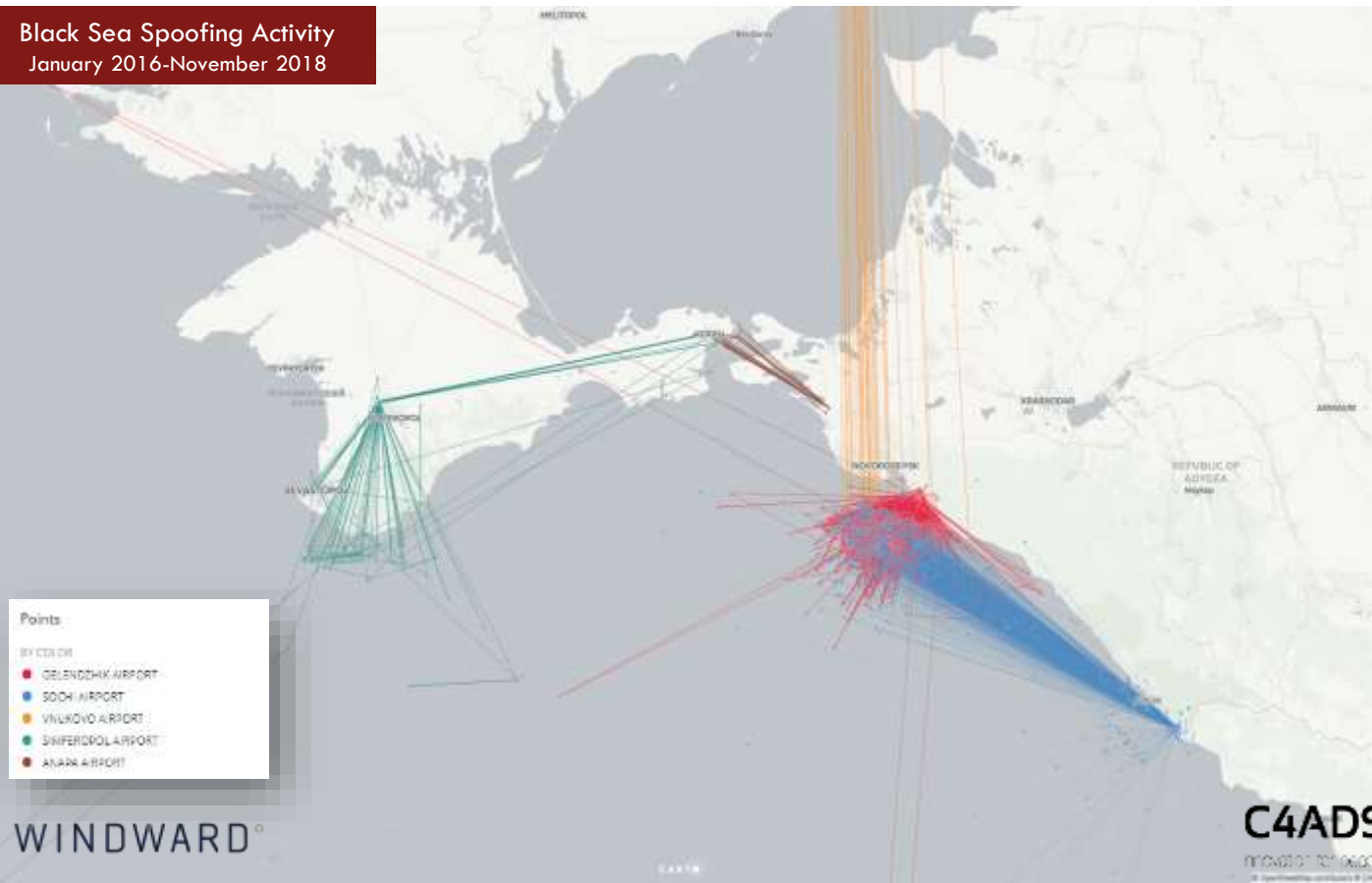
GOLUBAYA BUKHTA

SOLNTSEJAR

Mooring area

Mooring area

Black Sea Spoofing Activity January 2016-November 2018



- Points
- BY CTA OR
 - OLENDIHK AIRPORT
 - SDOH AIRPORT
 - VNUKOVO AIRPORT
 - SNIFFERPOL AIRPORT
 - ANAPA AIRPORT

WINDWARD

C4ADS
INNOVATION FOR GOOD

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The Moscow Times

Oct. 21 2016 · B310

The Kremlin Eats GPS for Breakfast

Why geolocation in central Moscow has become a real headache

October 2016



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

Spooing — Cost ↓ Capability ↑ Ease of use ↑



Iran, Dec 2011



UT Austin, 2012-13



Las Vegas, Dec 2015



US Southern Border
Dec 2015



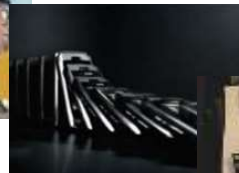
Persian Gulf, Jan 2016



4 sites Russia
600+ ships
2016 - Present



Pokemon
July 2016



Portland
Oct 2017



All GNSS at Once
June 2018



Signals & Maps
Jul 2018

“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

1 White Van Man
+
All-GNSS & Map Spoofer

\$255



PNT Out of Balance

What to Do? -

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



What to do? - Users



Protect — GPS Signals

- Don't Interfere!
- Monitor for interference
- Fix interference



What to do? – Governments



Protect – GPS Signals

- Interference detection
- Enforcement



What to Do? - Users



Toughen — Users & Equipment

NOT PROTECTIVELY MARKED

Lot's of anti-jam products on the market...

Roke
Part of the
Electronic Group

Raytheon

Rockwell Collins

NovAtel

Plus Mayflower, Cobham, BAE,
Thales, Harris, Lockheed, L-3, and
others...

What to Do? - Governments



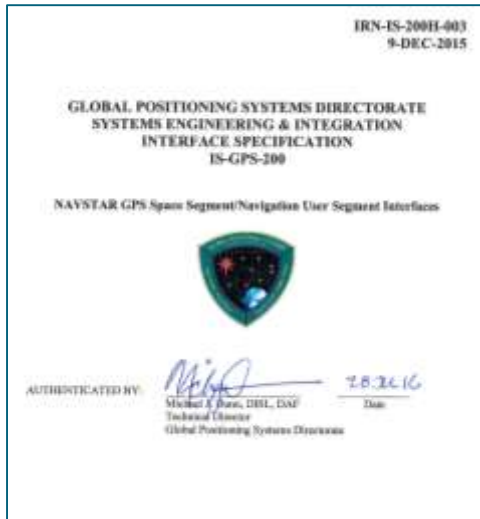
Toughen — Users & Equipment



Radio Equipment Directive — GNSS Receivers

What to Do? - All

Toughen

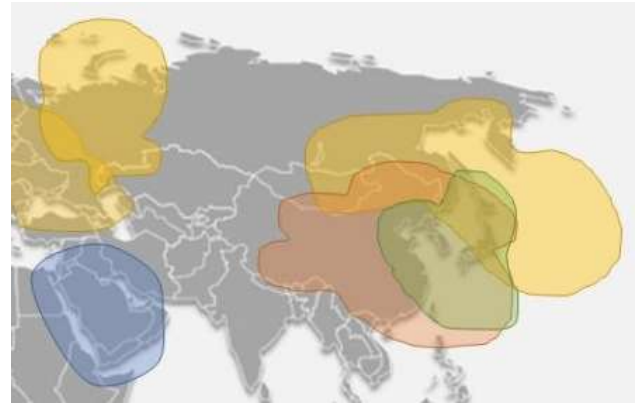


Google Maps

Thousands Fail After Air Force GPS Change:
Receivers Did Not Comply w/ Specification

What to Do? - Users

Augment — w/other signals & sources



What to Do? - Governments



Augment — w/other signals & sources

In United States:

- Five major studies – “eLoran is best/only solution”
- Telecom Industry Stds Assn (ATIS) - 2017
 - Telecom needs resilient wireless time now, even more urgent for 5G
 - suggest eLoran

What to Do? – Governments

Augment — w/other signals & sources

In United States

- Presidential Directive
 - Dept. Transportation to acquire backup capability for GPS
- US Laws Passed by Congress
 - Preserve Loran-C Infrastructure pending GPS backup system
 - \$10M provided in 2018 for GPS backup Tech Demo
 - By 2020 Dept. Transportation to establish GPS backup timing
 - Mandates a system with characteristics of eLoran



eLoran – low cost, high performance

- Terrestrial, high-power, low-frequency system
- Modern digital technology
- No common mode of failure with GNSS
- Plug-and-Play Compatible GNSS augmentation
- Accurate positioning
- Precise UTC timing and frequency
- Robust data communications
- Autonomous operation





<https://www.youtube.com/watch?v=wbJMExW9Rvo>



RESILIENT
NAVIGATION
and TIMING
FOUNDATION

すべての神の子どもたちは、
ポジショニング、ナビゲーション、
タイミングが必要です!

The Resilient Navigation and Timing Foundation is a 501(c)3 scientific and educational charity registered in Virginia