Cyber threats to satellite navigation and available countermeasures

Spoofing a position

By fooling the GPS position the autopilot will compensate and use rudder to get the vessel on track again

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

https://www.youtube.com/watch?v=x7e94INwcVU

Likelihood of being spoofed

The Maritime Executive

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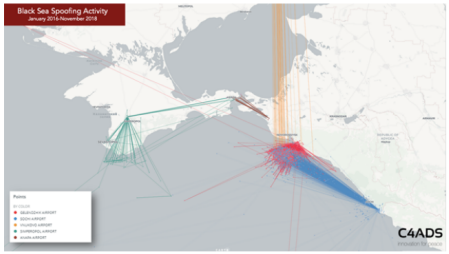
Report: Russian GPS Spoofing Threatens Safety of Navigation



BY DANA A. GOWARD 2019-04-02 10:32:17

A new report by the non-profit analytic group C4ADS shows that Russian jamming and spoofing of GPS signals is far more extensive and frequent that previously thought.

The report - "Above Us Only Stars – Exposing GPS Spoofing in Russian and Syria" - outlines the discovery of almost 10,000 instances of spoofing detected over the course of two years impacting over 1,300 unique vessels. Ship locations ranged from the Mediterranean, Black Sea, and Gulf of Finland, to

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Technology

Study maps 'extensive Russian GPS spoofing'

2 April 2019 Share

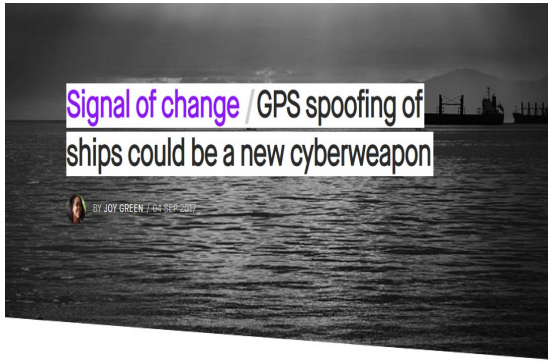
Spoofed GPS signals were used during Vladimir Putin's visit to Crimea's Kerch Strait Bridge, the study said

Russian President Vladimir Putin has a bubble of spoofed GPS signals projected around him when he visits sensitive locations, a study suggests.

It involves the state using strong radio signals to drown out reliable navigation data, says non-profit C4ADS.

The report by the think tank documents almost 10,000 separate GPS spoofing incidents conducted by Russia.

Most incidents affected ships, said C4ADS, but spoofing was also seen around airports and other locations.



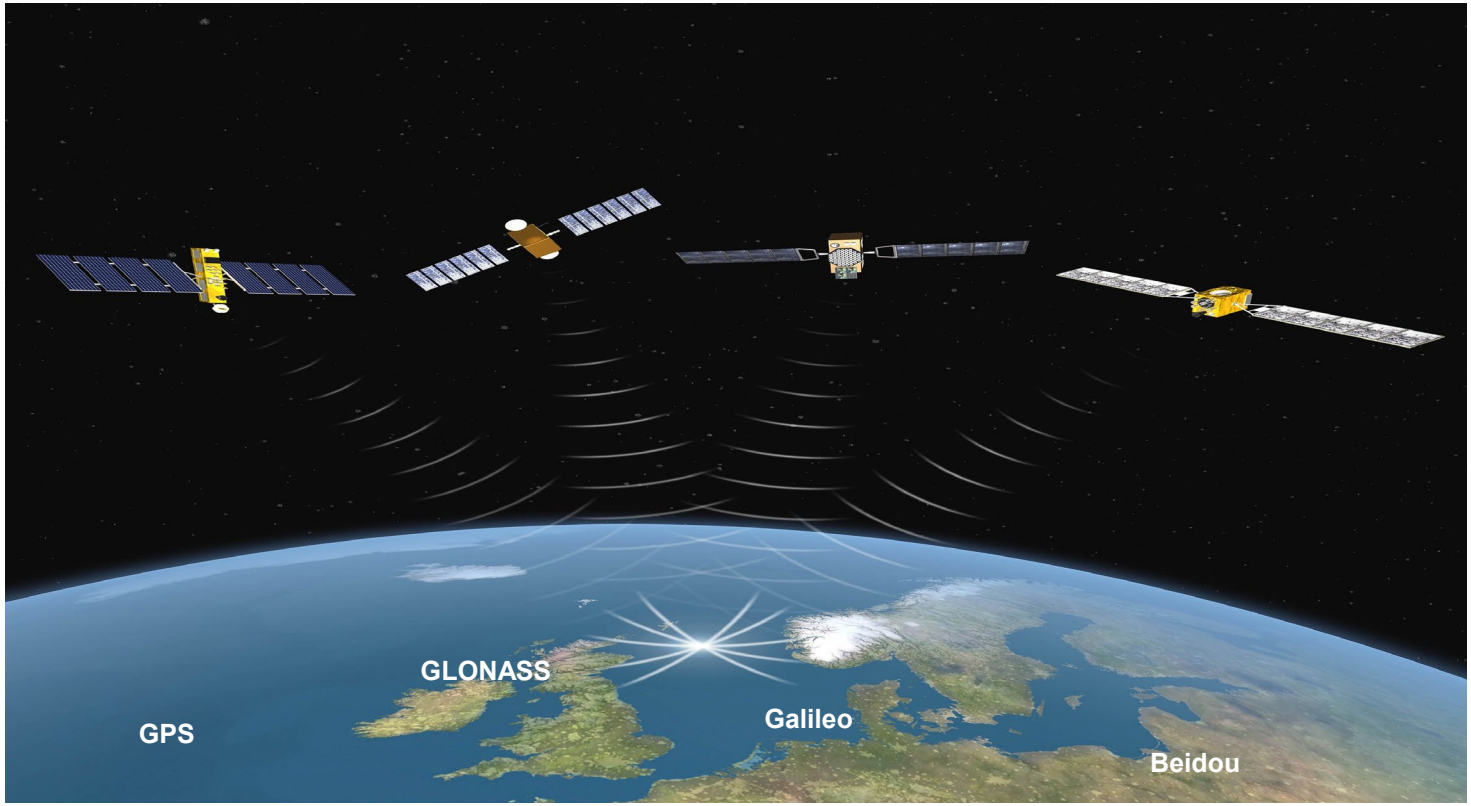
At the end of June, at least 20 ships in the Black Sea were hit by what appears to be the first documented case of GPS misdirection used as an attack, also known as spoofing. The affected ships' GPS systems incorrectly placed them 32 km inland, at Gelendzhik Airport.

GPS spoofing is caused by sending a false signal from a ground station, which confuses the receiver, potentially luring it off course. Experts think that this episode may be a sign of Russia experimenting with a new cyberweapon, as GPS spoofing has been occurring in central Moscow over the past year. A fake signal centred on the Kremlin redirects anyone nearby to Vnukovo Airport, 32 km away – playing havoc with phone apps (the scale of problem was apparently first revealed when people tried to play Pokemon Go).

Countermeasures to spoofing

1. GNSS Spoofing Detection Based on Consistency Check of Velocities
2. Experimental valida ays for maritime applicatio
3. Specially designed
4. GPS Anti Spoof - A
5. Oceanstar

Countermeasures to spoofing



In the 1980 Fugro designed a product for precise positioning.
It is a GNSS based navigation sensor which achieve accurate position by using satellite navigations systems with Fugro corrections signals.
Corrections signals became compulsory in 1986, and vessels, the rig and offshore industry all are users of the service.

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Global Navigation Satellite System (GNSS) Signals

GNSS = GPS | GLONASS | Galileo | BeiDou

Spread spectrum signal
L-band
Open service
Interoperable

GPS (US)

SPS – PPS
L1, L2, L5
30 MEOs

GLONASS (RU)

L1, L2
24 MEOs

Galileo (EU)

OS, PRS, CS, SoL
E1, E5, E6
22 MEOs

BeiDou (CN)

B1, B2, B3
BeiDou-2:
3 MEOs + 7 IGSOs + 5 GEOs
BeiDou-3:
18 MEOs

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GNSS Interference

Spoofing

Generating counterfeit GNSS signals and transmitting into the victims GNSS antenna

Meaconing

Observing the full GNSS signal image at a selected location and re-transmitting into the targeted GNSS receiver antenna

Jamming

Transmitting broadband RF noise in the L-band to mask the GNSS signals

Unintentional interference

Any RF source transmitting into the GNSS bands

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What does it take to spoof?

Motivation

External spoofer

Self-spoofer

Limited skills needed

The required tools are available

Equipment

Software Defined Radio

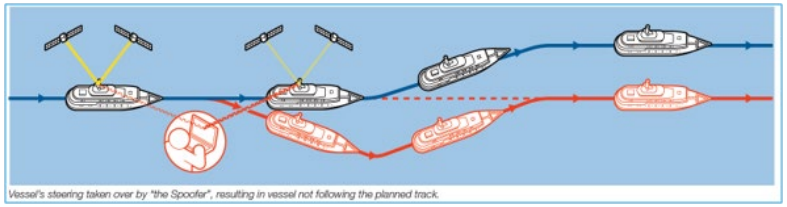
PC

Internet

Open signal simulation software

Execution

1. Generate signals
2. Align to target antenna
3. Raise signal strength
4. Drift signal away
5. Receiver now deceived
6. The adversary maneurvers the vessel!



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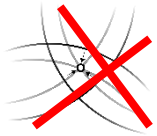
Spoofing protection



- RAIM
- Position comparisons

- GPS PPS
- Galileo PRS
- Galileo CS AUTH

- Authentication services
  - SATGUARD
  - Galileo OS NMA
- Receiver authentication
  - Dual or multi antenna systems
  - CRPA – bulky & expensive

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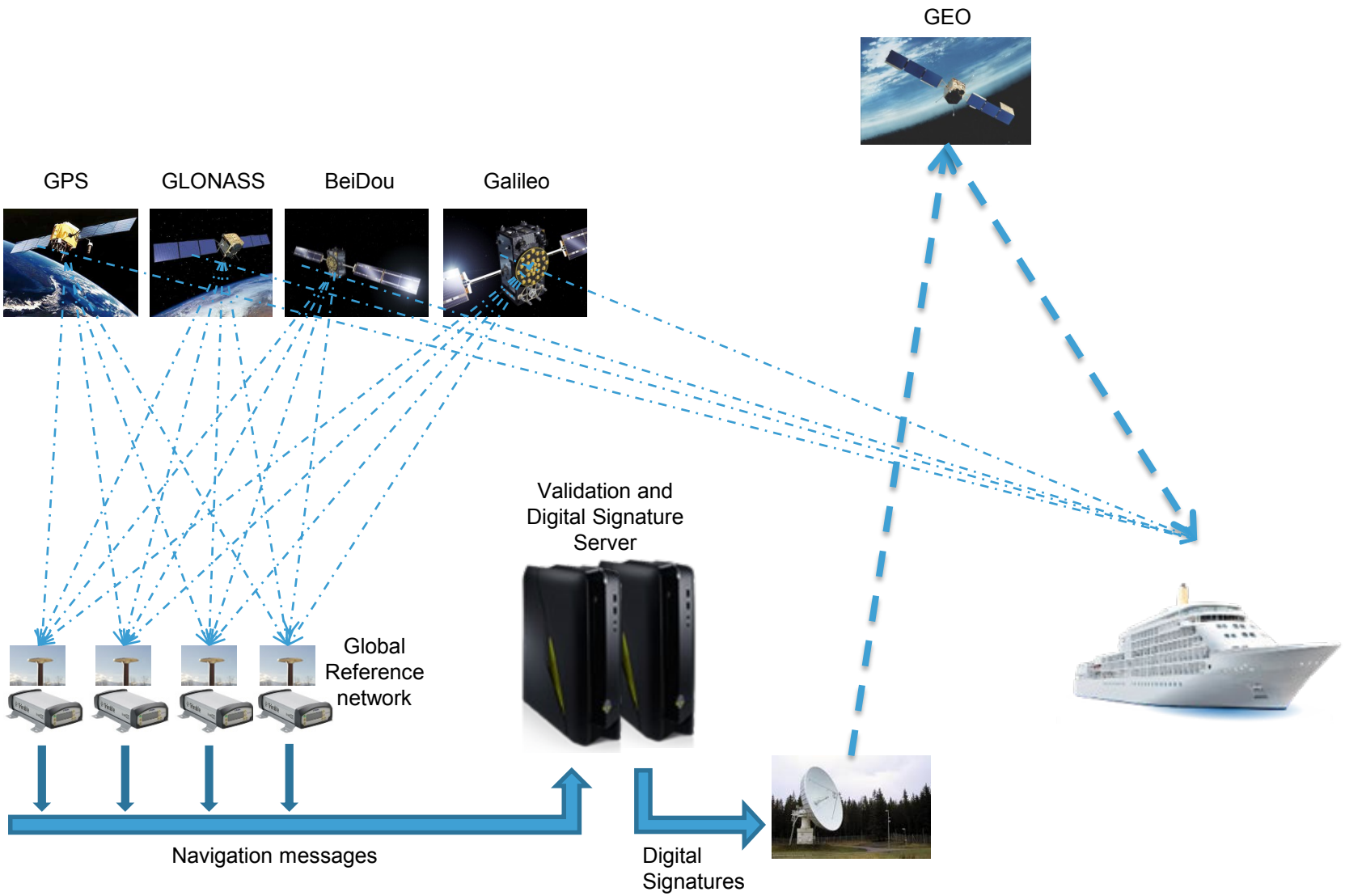
GNSS Navigation Message Authentication (NMA)



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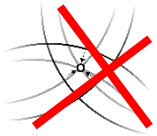
Spoofing protection



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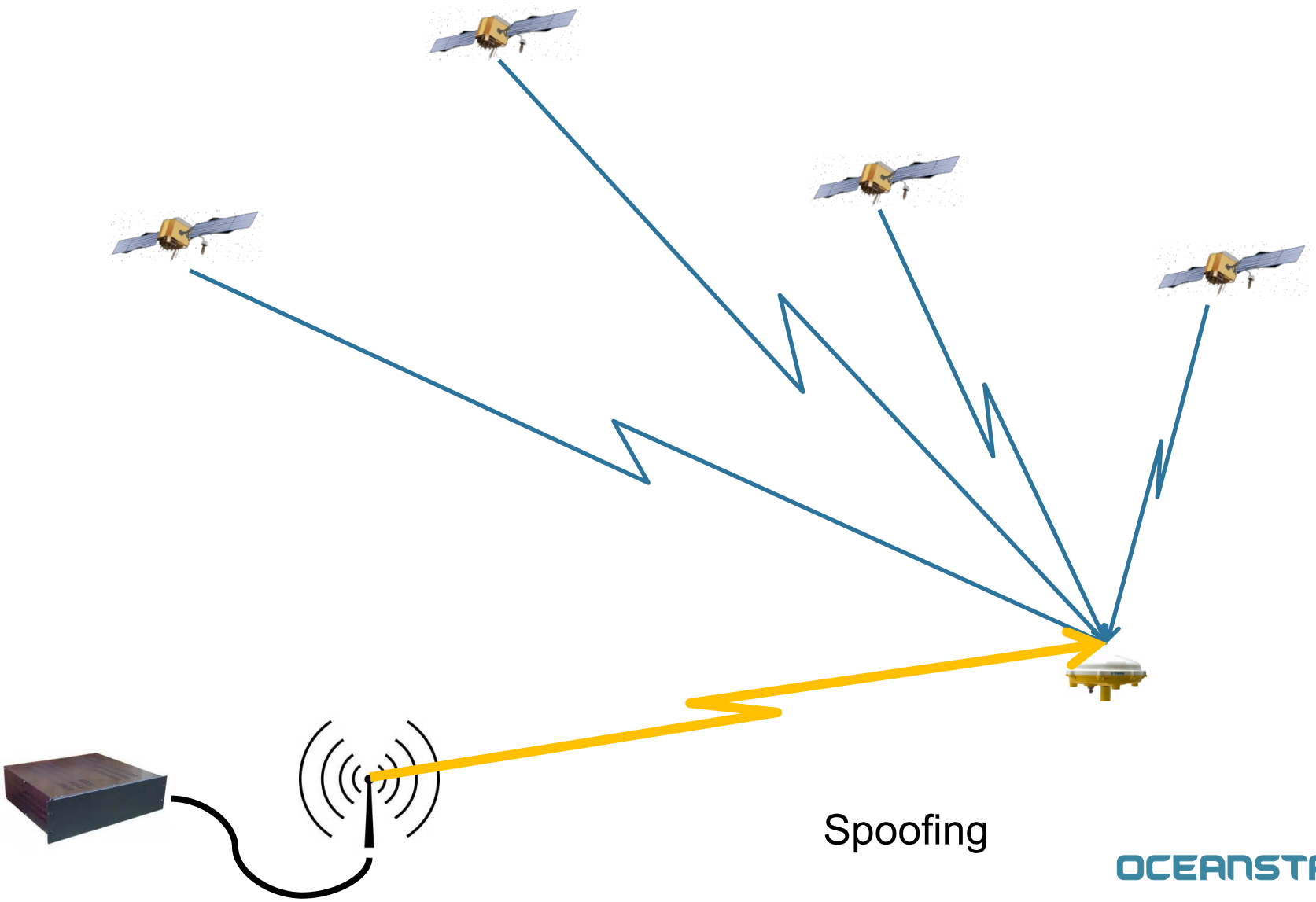
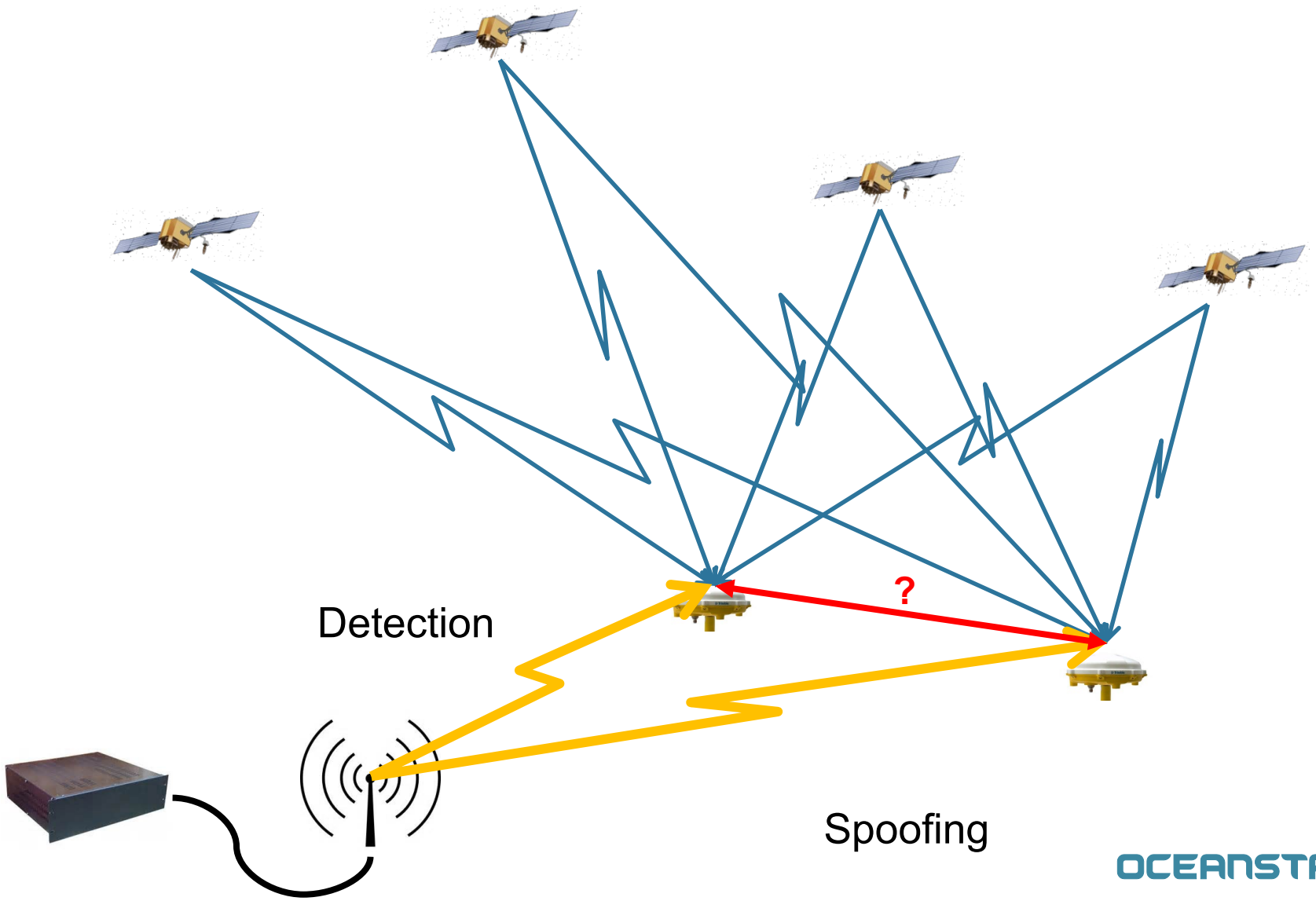
Spoofing Attack



Spoofing Attack - detection



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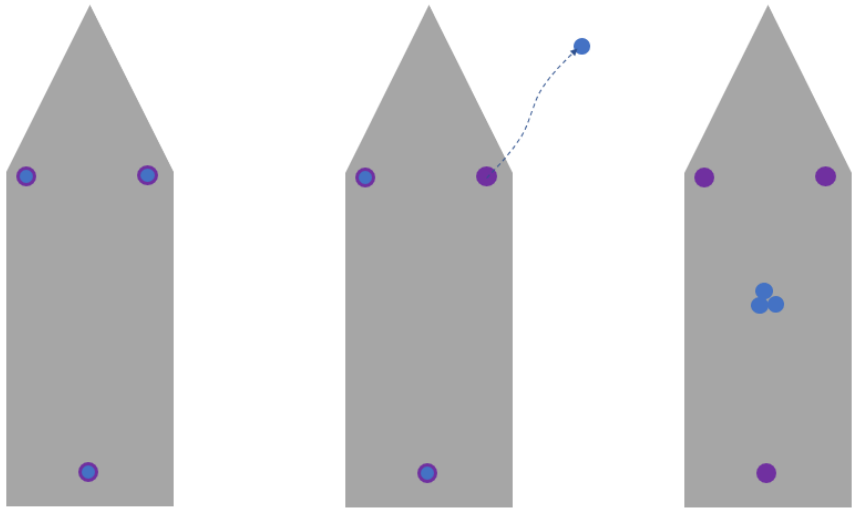
Multi antenna spoofing detection



Observed position

Antenna offset position

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Other mitigations

Raise the threshold

- Multi GNSS (GPS; GLONASS, Galileo, BeiDou)
- Multi frequency

Knowledge level

- Information – no ignorance

Legal preparations

- Laws and regulations
- Enforcement

Repel the spoofer

- Put good systems in place
- Apply good procedures

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Trends and Developments

GNSS nowadays

- Widespread
- Billions of receivers
- Mass market
- No. of GNSS receivers → No.of internet users
- The story of internet and viruses is well-known
    - And remember, you do not need to be the target to be a victim!

- *You can expect spoofing now!*
- *Your systems need protection now*
    - *Technology is available today*

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Conclusions

GNSS authentication should allways be a part of ship risk assessment

Fugro offers

Navigation Message Authentication

SATGUARD™
TRUST YOUR POSITION

Multi antenna solution

Multi GNSS solutions
Multi frequency solutions

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Fugro works continuously to provide reliable and accurate positioning

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Thank you!

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