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GPS SPOOFING: NO LONGER A FISH STORY

Michael Shalyt

CEO and Co-Founder
Aperio Systems
@MShalyt

Outline

- Intro – the world is being measured.
- Good examples of bad data.
- GPS forgery and pirates.
- “Fingerprinting”: the natural encryption of physics.

Aperio Systems

Michael Shalyt, CEO

Physics: B.E. Electrical Engineering, BA Physics, MSc Quantum Computing, International Physics Olympiad bronze medal.

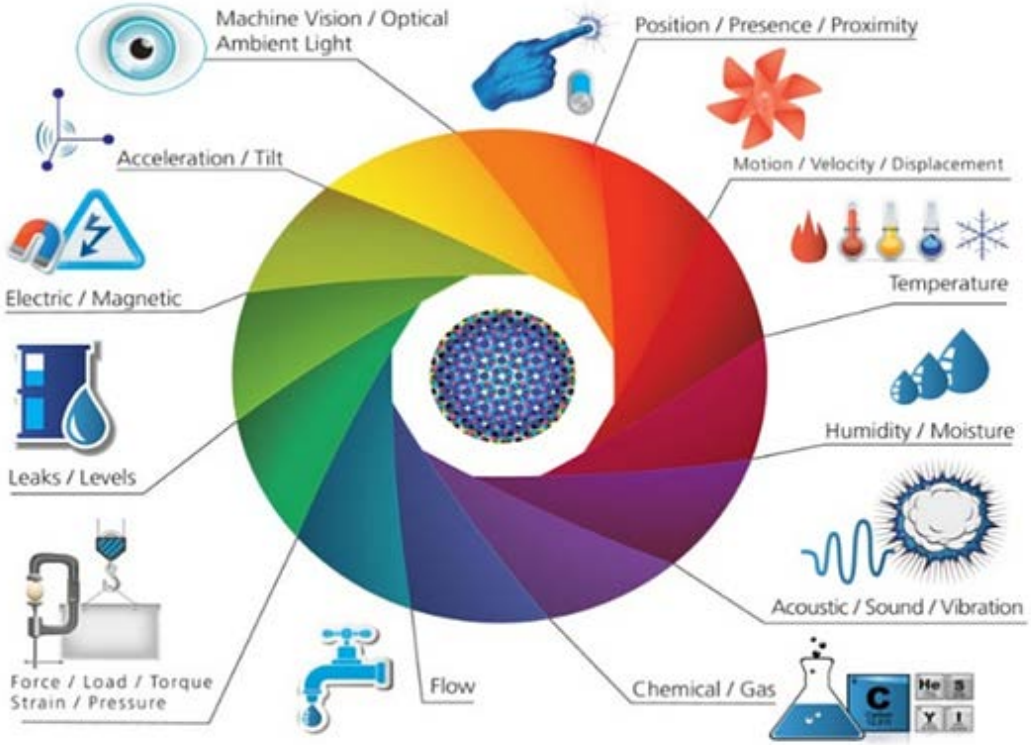
Cybersecurity: Researcher and team leader at 8200 (IDF intelligence). Head of malware research at Check Point.

- **Very multidisciplinary.**
- **Highly skilled.**
- **Background from military intelligence, Cloudlock (now Cisco) and Check Point.**

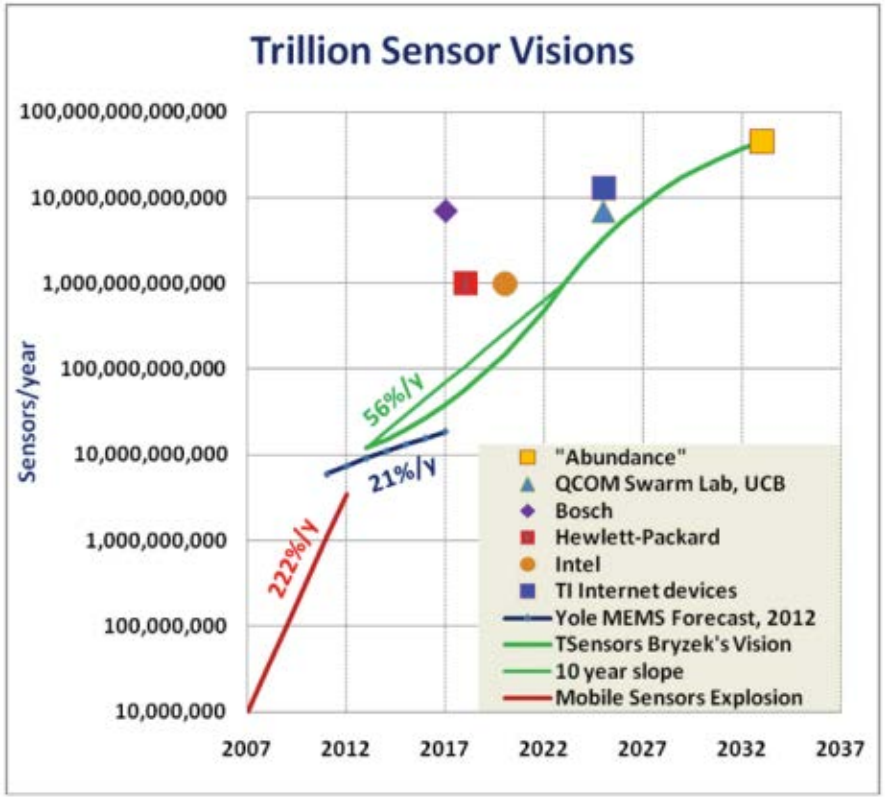
APERIO

THE MEASURED WORLD

The Trillion Sensor World



The Trillion Sensor World



Operational Data Flow

- HMI, Historian etc.
- OPC servers
- Switches
- PLC
- Modbus
- A/D
- Sensors
- Reality

WHEN GPS IS LYING

On Device – Voluntarily

Fake GPS Location - Hola

Hola Tools

9,310

PEGI 3

Offers in-app purchases

This app is compatible with all of your devices.

Add to Wishlist Install

On Device – Voluntarily

- Spoofing for cheating.

- Bans if spoofing detected.

- Example: “Rubber Banding” effect.

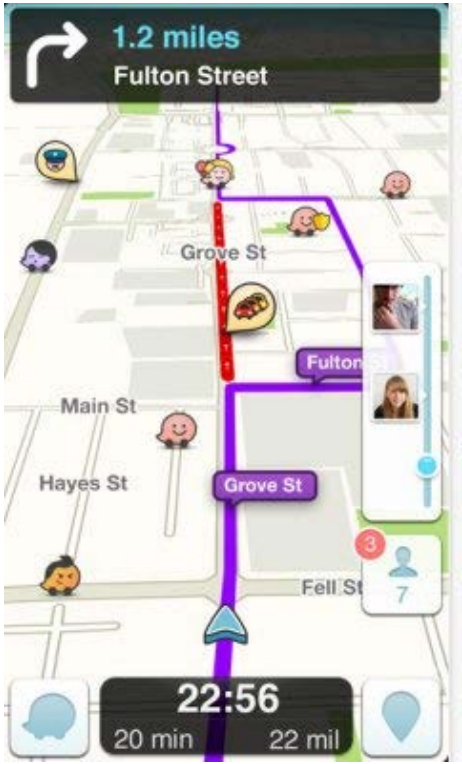
On Device – Non-Voluntarily

Unmanned Aircraft Capture and Control via GPS Spoofing

Andrew J. Kerns
Department of Electrical and Computer Engineering
The University of Texas at Austin
Austin, TX 78712
akerns@utexas.edu

Daniel P. Shepard, Jahshan A. Bhatti, and Todd E. Humphreys
Department of Aerospace Engineering
The University of Texas at Austin
Austin, TX 78712
dshepard@utexas.edu, jahshan@utexas.edu, todd.humphreys@mail.utexas.edu

On Fictional Devices



- On March 2014, 2 graduate students from the Technion (Haifa, Israel) created fake drivers on the Waze framework – thus fooling the system into believing in a traffic jam.
- Waze went on to reroute traffic to other streets – while the actual road remained empty.

GPS Jamming

The Register®
Biting the hand that feeds IT

NTRE SOFTWARE SECURITY DEVOPS BUSINESS PERSONAL TECH SCIENCE

Data Centre ▸ Networks

US military tests massive GPS jamming weapon over California

Aircraft warned to stay out of area

By Iain Thomson in San Francisco 7 Jun 2016 at 22:21 56 SHARE ▼

GPS Jamming

Jamming GPS Signals Is Illegal, Dangerous, Cheap, and Easy

GPS Forgery (Spoofing)

WIRED Technology | Science | Culture | Video | Reviews | Mag

Hacking

When a tanker vanishes, all the evidence points to Russia

In June, 37,000-tonne tanker vanished from GPS off the Russian coast. All the evidence points to Russia. But what's really going on?

GPS Forgery (Spoofing) – How To

GPS Forgery (Spoofing)

29 Jul 2016 | 19:00 GMT

Protecting GPS From Spoofers Is Critical to the Future of Navigation

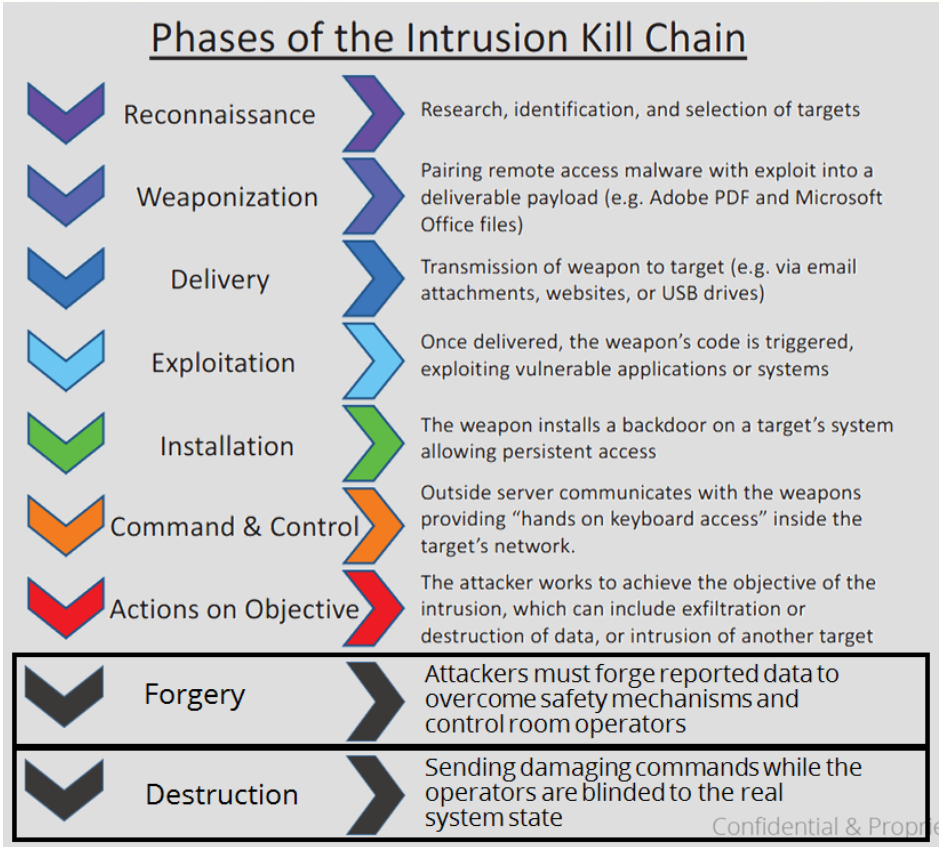
GPS is vulnerable to spoofing attacks. Here's how we can defend these important navigation signals

https://spectrum.ieee.org/telecom/security/protecting-gps-from-spoofers-is-critical-to-the-future-of-navigation

GPS Forgery (Spoofing) – What For?

- Military deception.
- Hijacking cargo: directing victims into a trap.
- Hijacking cargo: hiding the theft from “homebase”.
- Tampering with “homebase” state awareness (shipping, air control, Waze etc.)
- Autonomous movement control (cars, ships, drones…)
- And many other scenarios.

Kill Chain for Damaging Physical Systems



GPS Forgery (Spoofing) – How?

- Hardware based (antennas, broadcast signals)

GPS Signal Repeater Forwarder Transmitter Amplifier Antenna L1 DB2 15 Meters

$149.00
Buy It Now
or Best Offer
Free Shipping

The outdoor antenna with RF cable connect to the "INPUT" of repeater, the antenna connect to the "OUTPUT" of repeater, and then power the repeater you will see indication light, then it work. - Reflec...

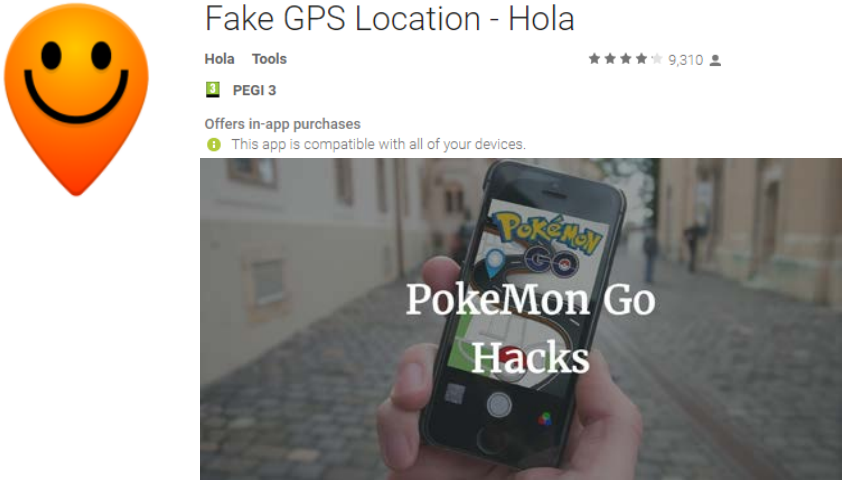
GPS Signal Repeater Forwarder Transmitter Amplifier Antenna L1 DB2 30 Meters

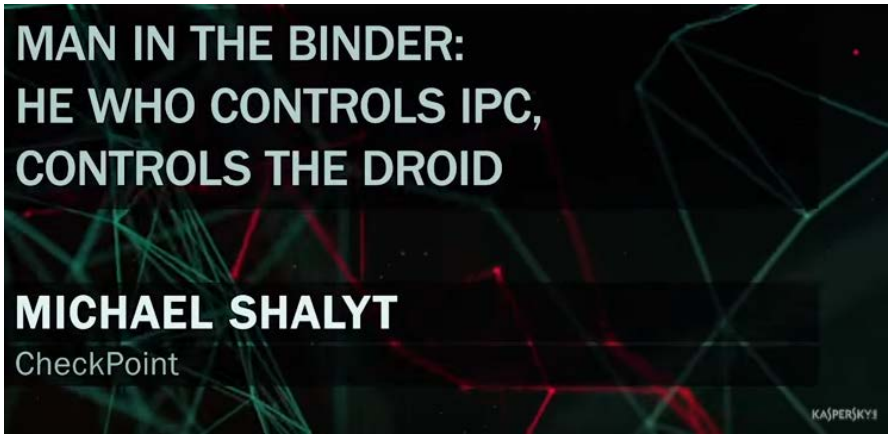
$425.60
Buy It Now
or Best Offer
Free Shipping

The outdoor antenna with RF cable connect to the "INPUT" of repeater, the antenna connect to the "OUTPUT" of repeater, and then power the repeater you will see indication light, then it work. - Interf...

GPS Forgery (Spoofing) – How?

- Software based (go between the hardware + driver + OS layer and the app layer).





SAVING THE DAY
(AND LOCATION BASED PRODUCTS)

Defending Against Spoofing

According to The Department of Homeland Security (Nov 2017):

- Obscure antennas. Install antennas where they are not visible from publicly accessible locations or obscure their exact locations by introducing impediments to hide the antennas.
- Add a sensor/blocker. Sensors can detect characteristics of interference, jamming, and spoofing signals, provide local indication of an attack or anomalous condition, communicate alerts to a remote monitoring site, and collect and report data to be analyzed for forensic purposes.

Defending Against Spoofing

- Extend data spoofing whitelists to sensors. Existing data spoofing whitelists have been and are being implemented in government reference software, and should also be implemented in sensors.
- Use more GPS signal types. Modernized civil GPS signals are more robust than the L1 signal and should be leveraged for increased resistance to interference, jamming, and spoofing.
- Reduce latency in recognition and reporting of interference, jamming, and spoofing. If a receiver is misled by an attack before the attack is recognized and reported, then backup devices may be corrupted by the receiver before hand over.

Defending Against Spoofing – The Reality

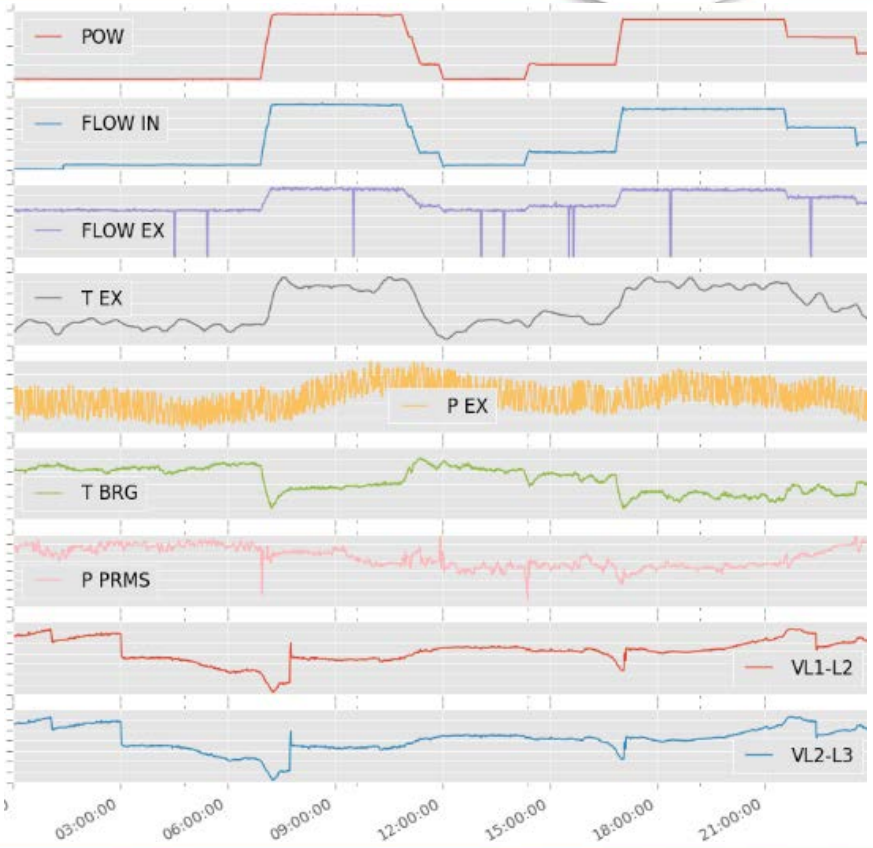
- “Hide antennas” – engineering complication and questionable efficiency (overriding signal can easily be strong enough to bypass obstacles).
- “Dedicated sensor” – can be very efficient with the right algorithms, but adds hardware, bandwidth and engineering requirements.
- “Whitelisting sensor hardware” – yeah…
- “Use better GPS tech” – that’s rarely up to the end costumer/operator.
- “Detect and report forgery ASAP” – the key concept. But how?

Apply

- Next week/month:
  - Standard best practices for endpoint device health.
  - Sanity tests – when device is in a known location make sure the readings show it correctly, accurately and without “glitching”.
- Next 6 months:
  - Compare internal location logs to planned/known routes (if you aren’t collecting location logs – start collecting location logs ☺).
  - Try achieving at least 1 redundancy layer (different location protocol, inertia/speed sensors etc.) for cross-validation.
  - Get an anti-forgery algorithm or product.

The Power of Physics

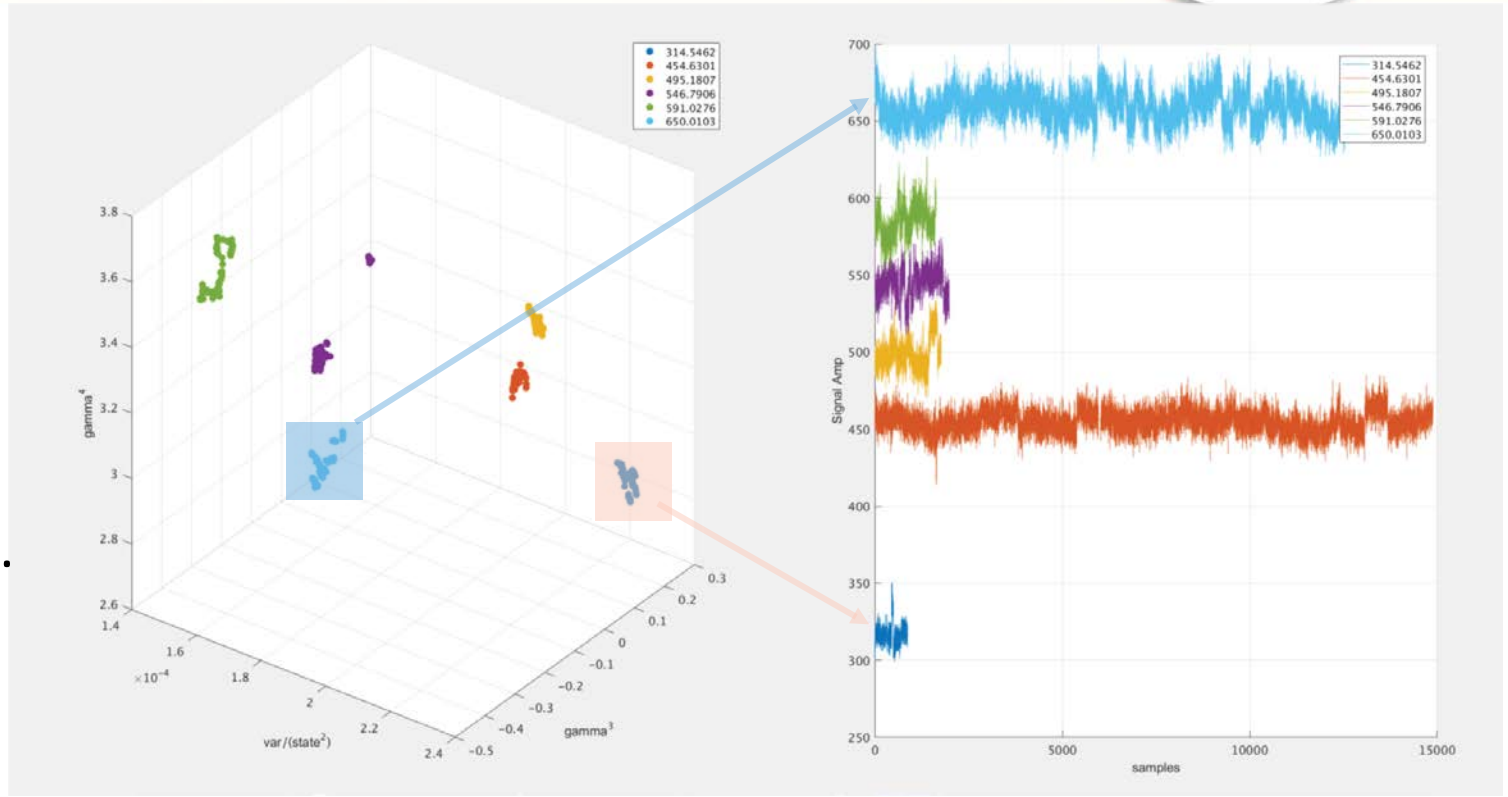
- Gas powered power plant (~1GW capacity).
- ~5K sensors measuring every part of the process.
- Important values like RPM, gas flow rate, temperature etc.
- Easy to see modes of operation.



Signal Fingerprinting

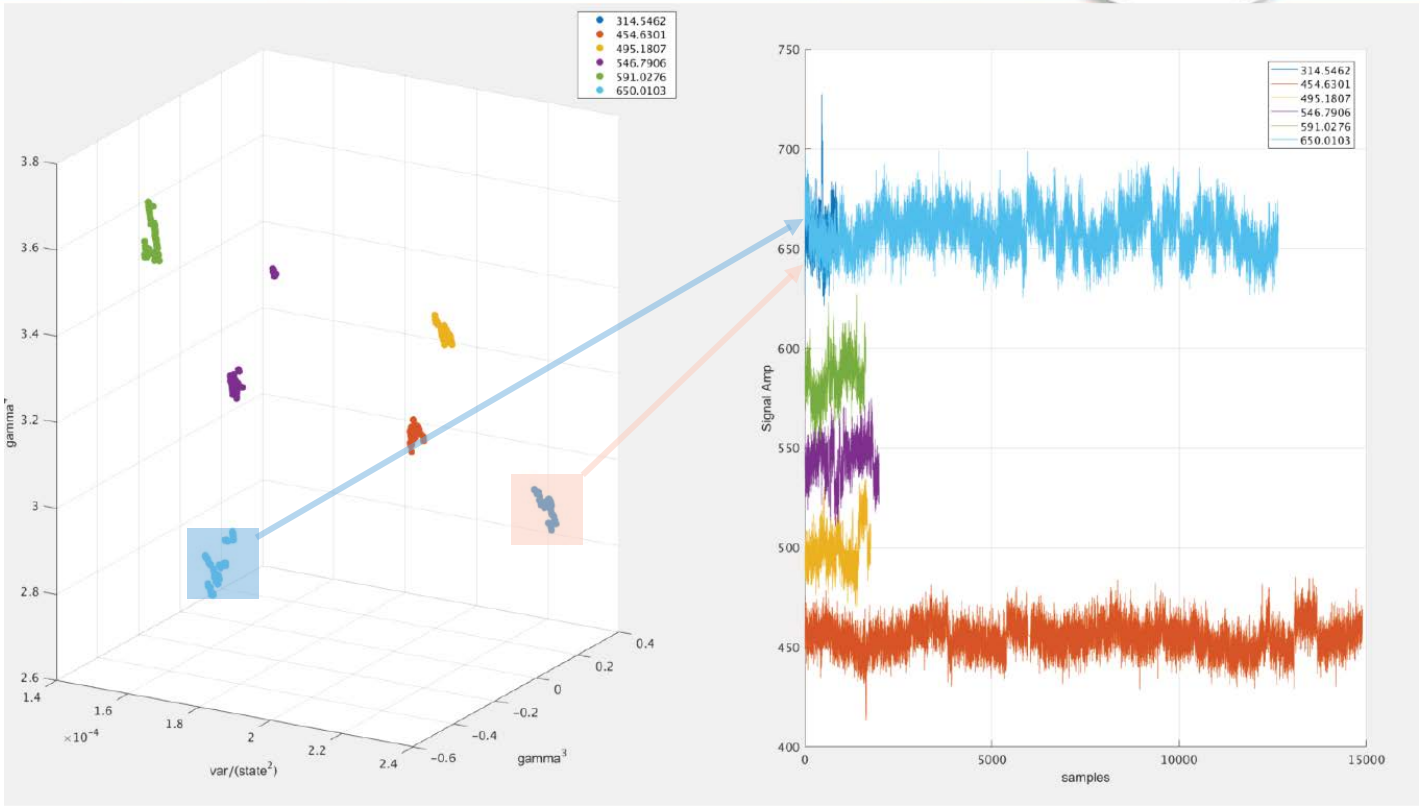
Gas flow rate during different modes of operation.

Each mode and each sensor can be fingerprinted.

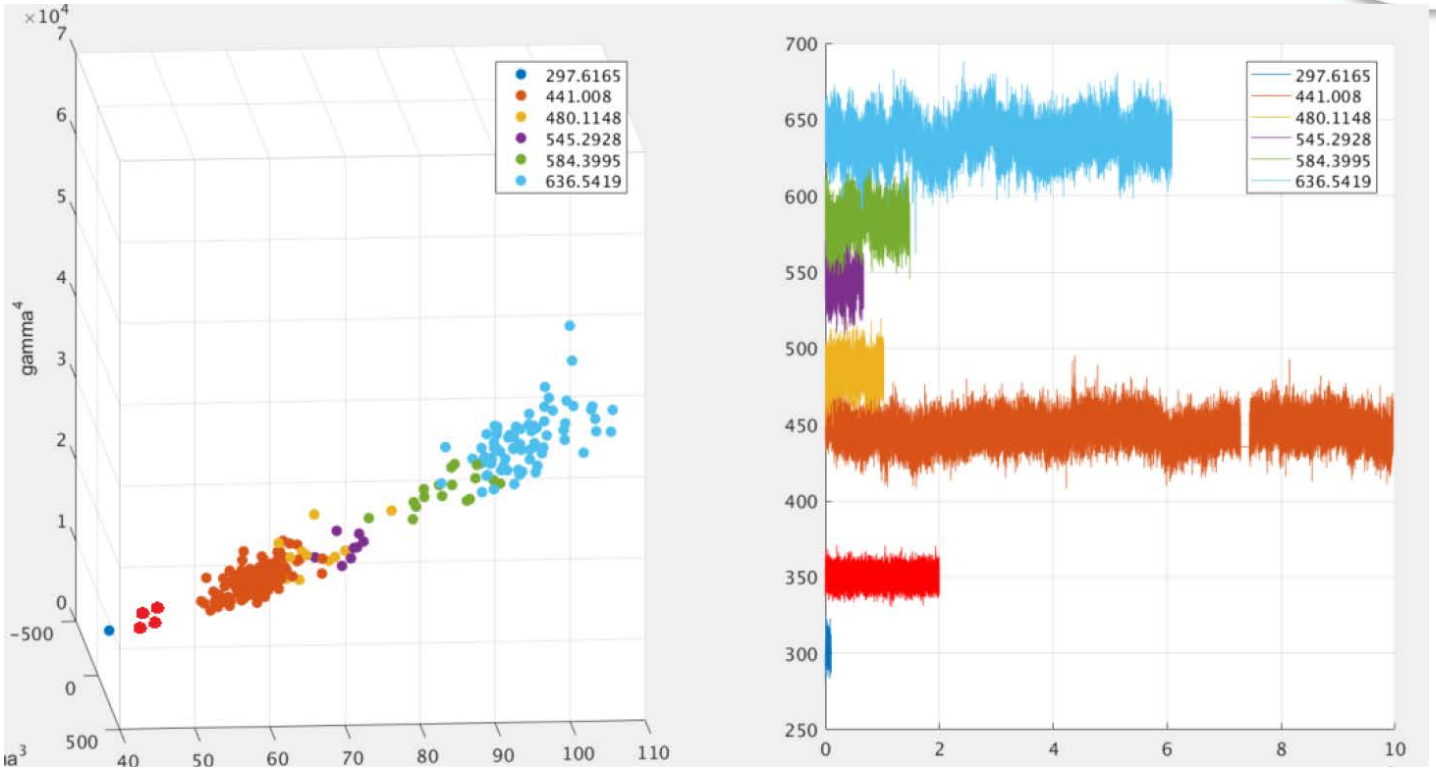


Signal Fingerprinting

Physical fingerprinting is a strong tampering and spoofing detection tool.



“Is This State Physical?”



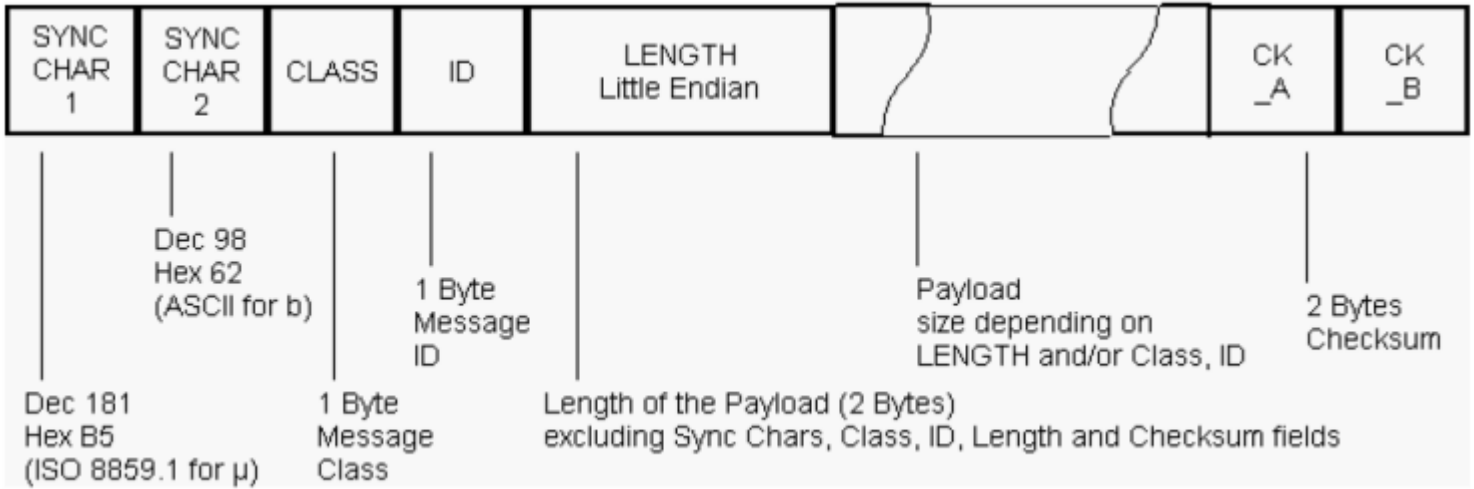
THANKS FOR LISTENING!

Michael Shalyt

shalyt@aperio-systems.com

WWW.APERIO-SYSTEMS.COM

Data Structure



Defending Against Spoofing – Add Sensors

- For civil users, multi-constellation receivers that can track multiple GNSS such as GPS, GLONASS, Galileo, and BeiDou simultaneously can be effective against spoofers, because an adversary would have to produce and transmit all possible GNSS signals simultaneously to spoof the target receiver.
- An additional measure of protection can be added by aiding the navigation solution with an inertial measurement unit (IMU), as an adversary cannot spoof the Earth's gravitational field or vehicle dynamics and cause the inertial unit to think it has moved in a way that it hasn't.