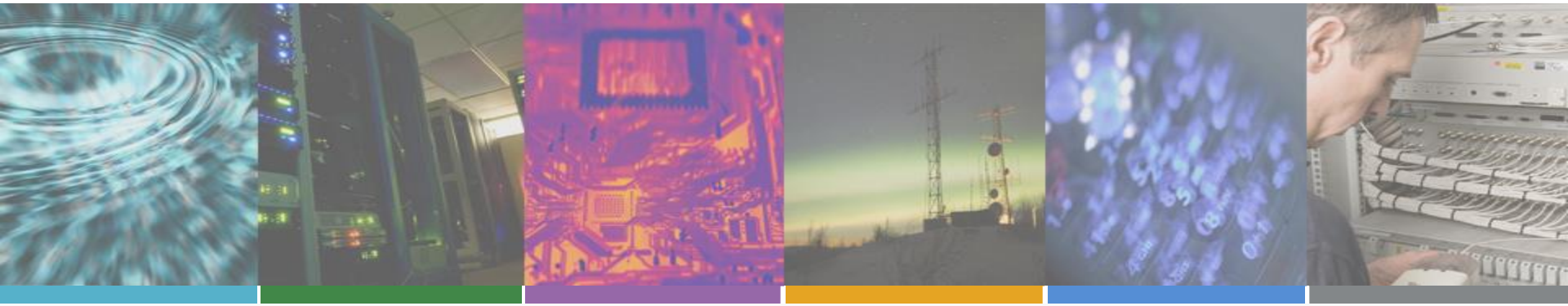
GPS Spoofing Susceptibility Testing



GNSS Vulnerability – Countering the Threat 13th Feb 2013

NPL, Teddington, London

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With acknowledgements to Brent Ledvina et al, Coherent Navigation, Inc

Presentation Contents

- Background
- Spoofing & Meaconing Defined
- Spoofing Testing
- Conclusions

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Background

- Jamming is now better understood
  - GAARDIAN, SENTINEL
- Spoofing and Meaconing
  - Military and Academia
- Bring these GPS Vulnerabilities into perspective
- Assess the threat
- Start to embark on Susceptibility Testing

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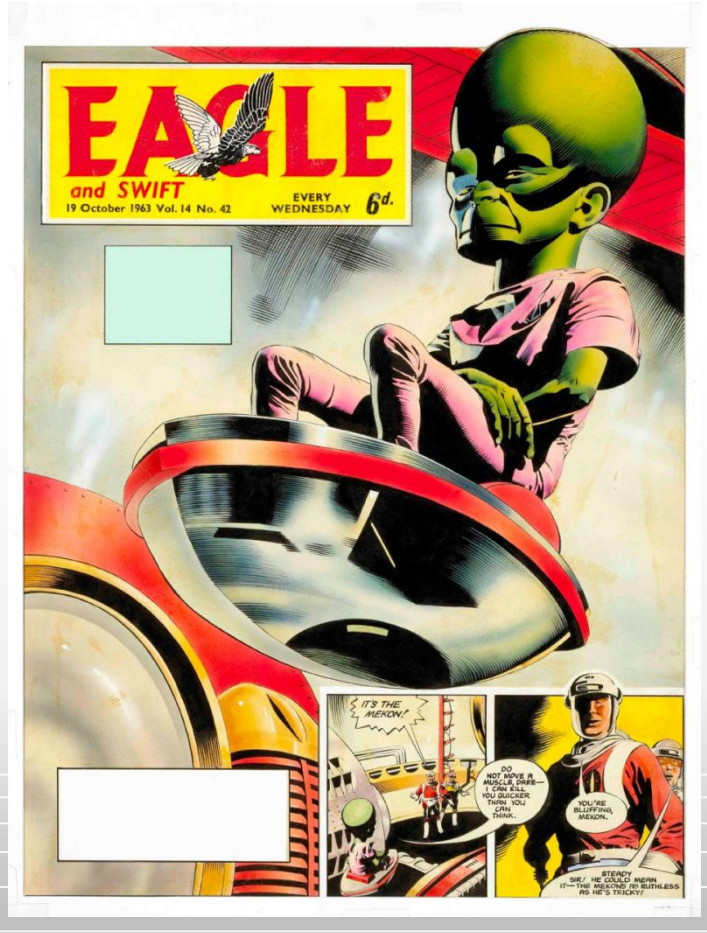
Alternative Definitions!

- Spoof

- Meaconing (Mekon)



Meaconing

- Local re-broadcast of GPS Signals
- Giving false time and/or position
- Current examples (non-military)
  - Faulty Antennas
  - Bad Re-Radiator deployments

Spoofing

- Masquerading as a genuine GPS signal
- Taking over the input to a GPS Receiver
- Steering the GPS Rx off position and/or time
- Without triggering alarms!
- Currently evolving out of Academia
- Emerging threat
- It’s Invisible (unless you have detection)!

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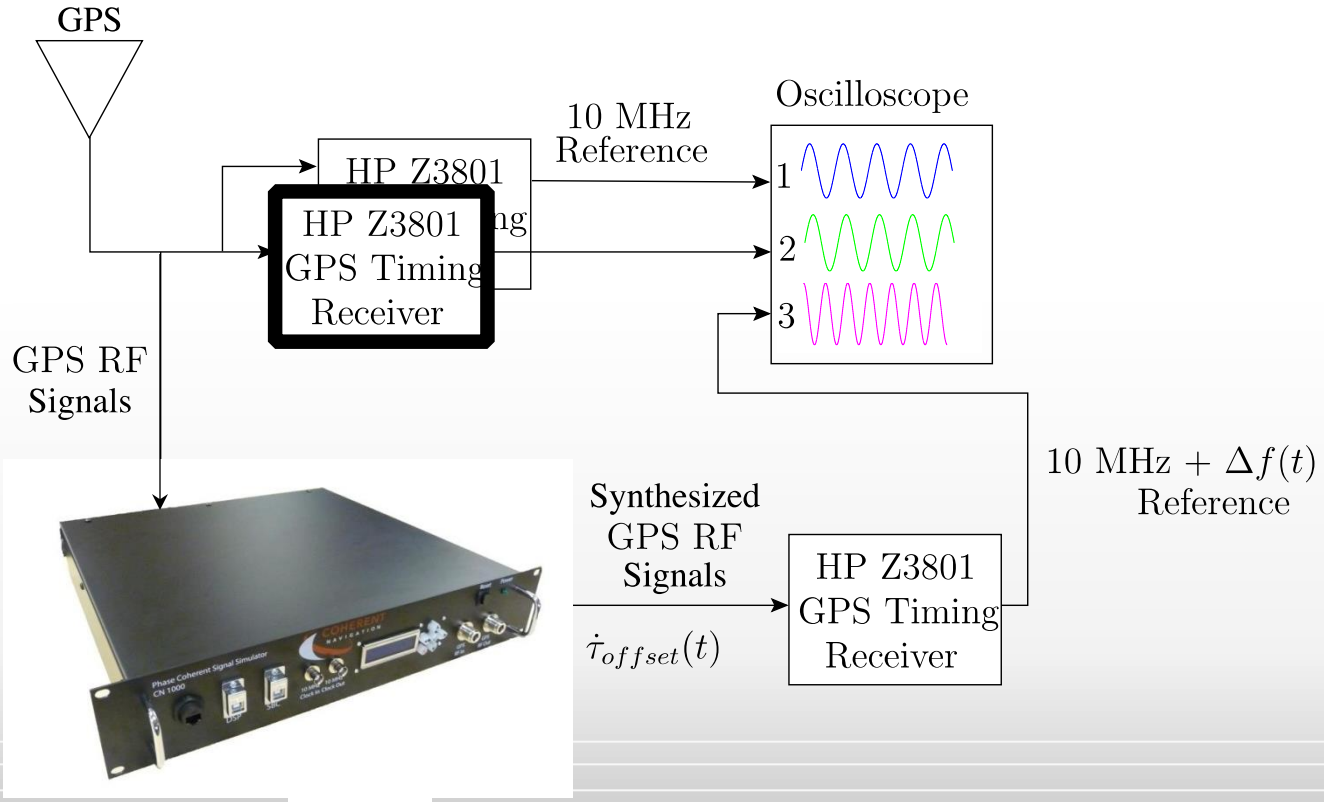
Spoofing Testing

- Todd's Ted Talk
  - http://www.ted.com/talks/todd_humphreys_how_to_fool_a_gps.html
- Coherent Navigation, Inc – Spoofer Demonstrator
  - PCSS CN1000 on Chronos Booth
- Why Spoofing Testing?
  - Assess vulnerability of application
  - Assess defences to an attack
  - Assess mitigation options

GPS Time Spoofing Experiment

- HP Z3081A GPS Time and Frequency Reference Receiver
  - Contains ovenized crystal oscillator, Motorola GPS receiver, and control logic circuitry



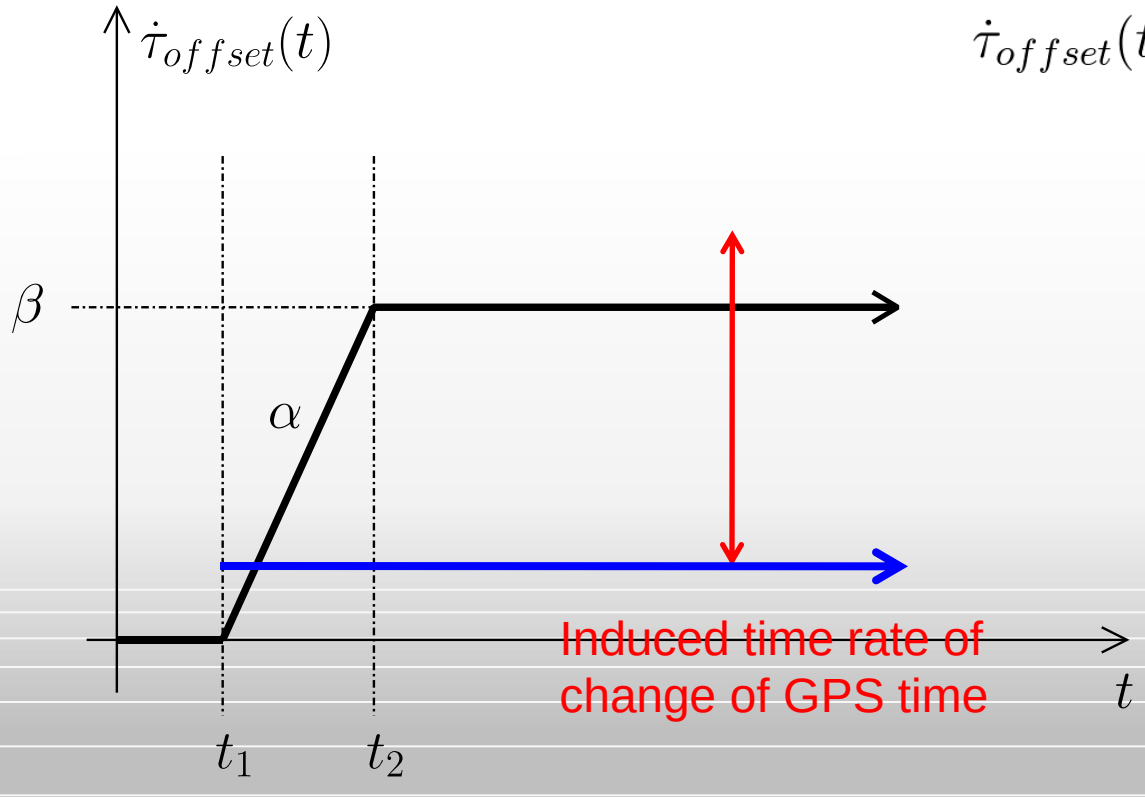
Coherent Navigation Phase-Coherent Signal Simulator (PCSS)

Slide Courtesy of Coherent Navigation

Spoofer Attack Methodology

- Spoofer induces erroneous time rate of change of GPS time,
- Must be careful not to trip alarms programmed into control loops within GPS timing receiver

$$\dot{\tau}_{offset}(t) = \begin{cases} 0 & t < t_1 \\ \alpha(t - t_1) & t_1 \le t < t_2 \\ \beta & t \ge t_2 \end{cases}$$



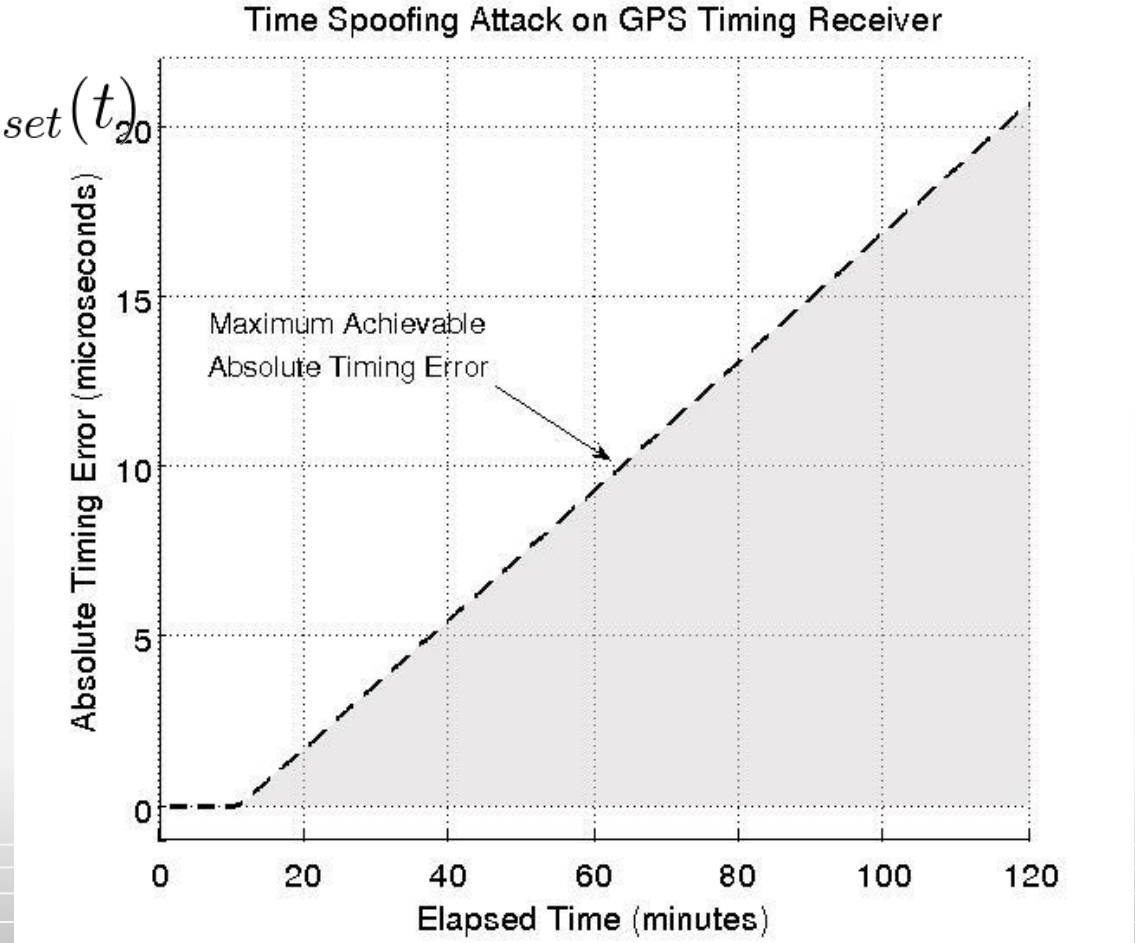
Estimates of GPS timing receiver internal control parameters $\{\alpha, \beta\}$

Slide Courtesy of Coherent Navigation

GPS Time Spoofing Attack

Slide Courtesy of Coherent Navigation

How Long to a 20 µsec offset?



Graph Courtesy of Coherent Navigation

Vulnerable Applications

- Financial Trading - HFT time stamping
- Mobile Base Stations using GPS (Not UK)
- Increased slips in a telecom network
- Erroneous relay protection switching in power networks
- Inability to monitor phase angle on SMART Grid
- Inability to analyse any time stamped data

Chronos Time Spoofing Trials

- Chronos - Spoofing Susceptibility trials
  - CTL Time labs
  - Later this week
- Various GPS Timing Receivers
  - TCXO, OCXO, Rb, CSAC
- Answering Questions…
  - How far can we change time?
- How quickly?
- Without alarms being triggered

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Conclusions

- Spoofing & Meaconing – Emerging Threats
- Meaconing here today
  - but few people realise this!
- Spoofing Susceptibility testing available now

Questions?

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