



GPS Interference Detection & Mitigation

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MD – Chronos Technology Ltd



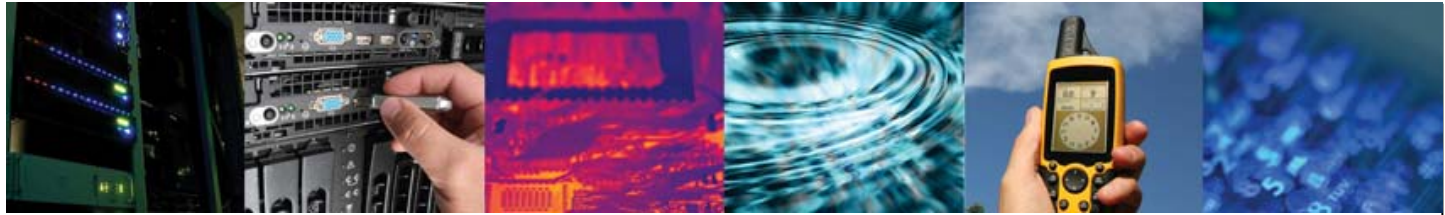
GAARDIAN

GNSS
AVAILABILITY
ACCURACY
RELIABILITY
and
INTEGRITY
ASSessment
for **T**IMING and
NAVIGATION

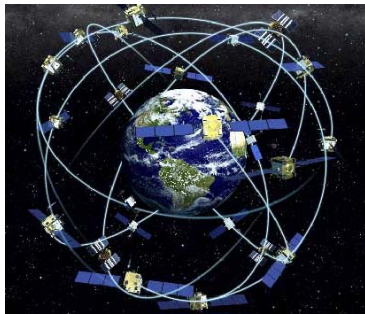


A Technology Strategy Board
funded collaboration
Technology Strategy Board
Driving Innovation

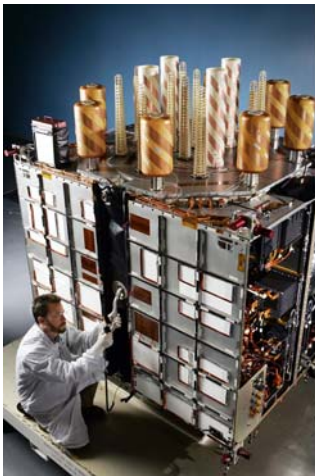




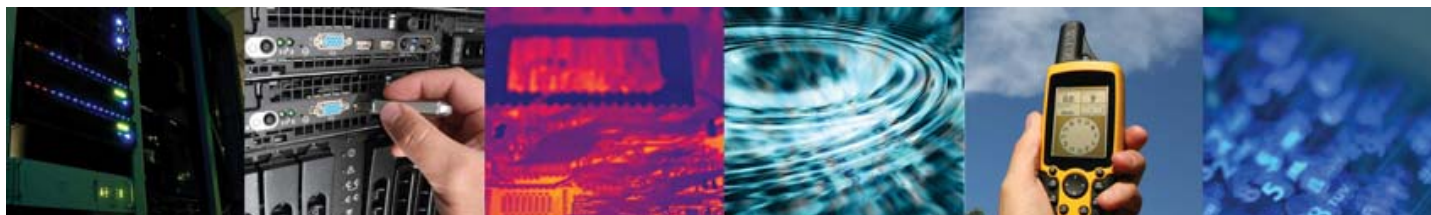
The **GAARDIAN** Project - *GPS Interference Detection & Mitigation*



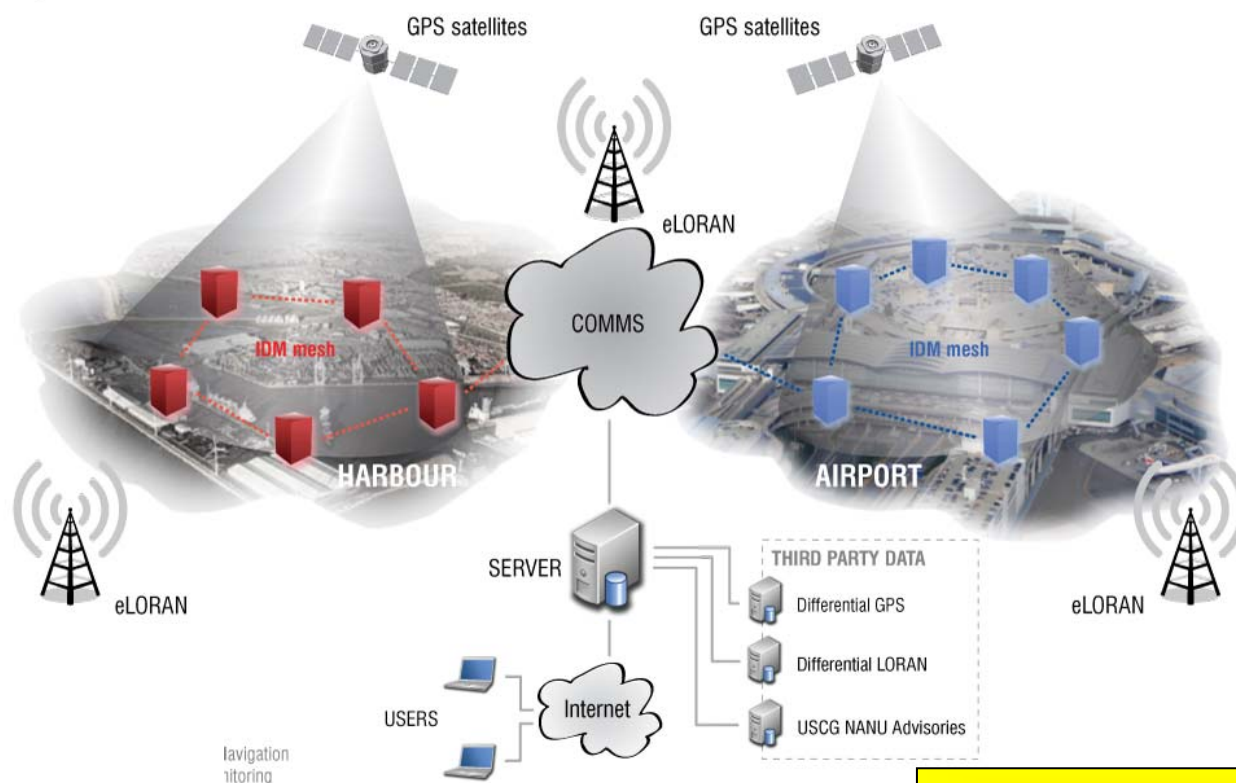
- **G**NSS **A**vailability, **A**ccuracy, **R**eliability and **D**Integrity **A**ssessment for Timing and **N**avigation
- Research Data Gathering necessary to create a GPS Interference Detection & Mitigation (IDM) network
 - At point of use, 24x7x365
 - for mission & safety critical applications
 - Which use GPS (or GNSS) signals
 - **Leveraging eLoran signals for QoS determination**
- UK Government Funded R&D Project (>£2m)
 - through Technology Strategy Board



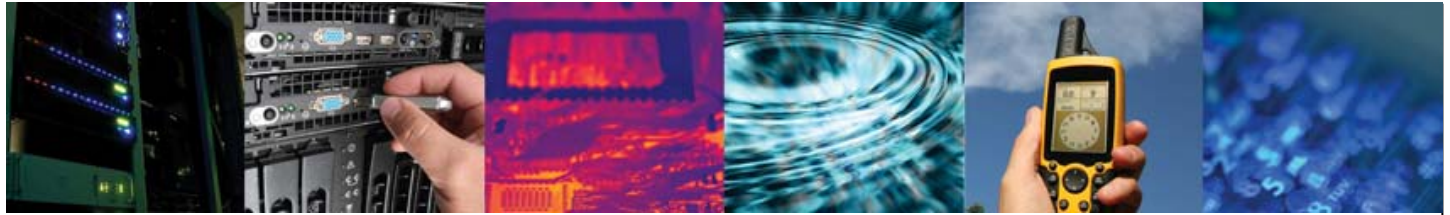
GNSS – Global Navigation Satellite Systems – e.g. GPS, Glonass, Galileo, Compass, QZSS
QoS – Quality of Service



GARDIAN



USCG – US Coast Guard
NANU – Notice Advisory to Navstar Users

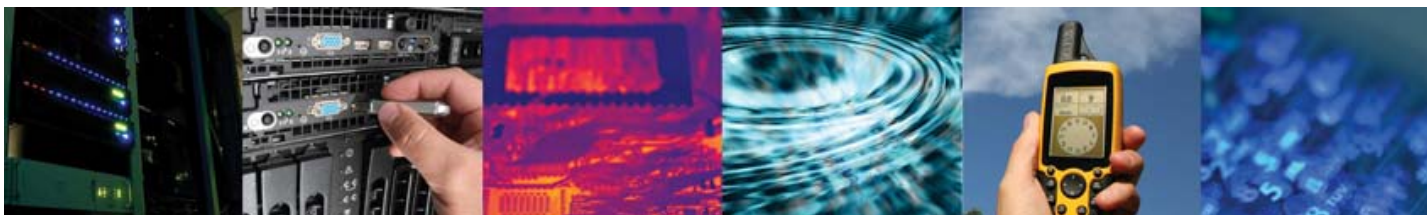


Background & Motivation



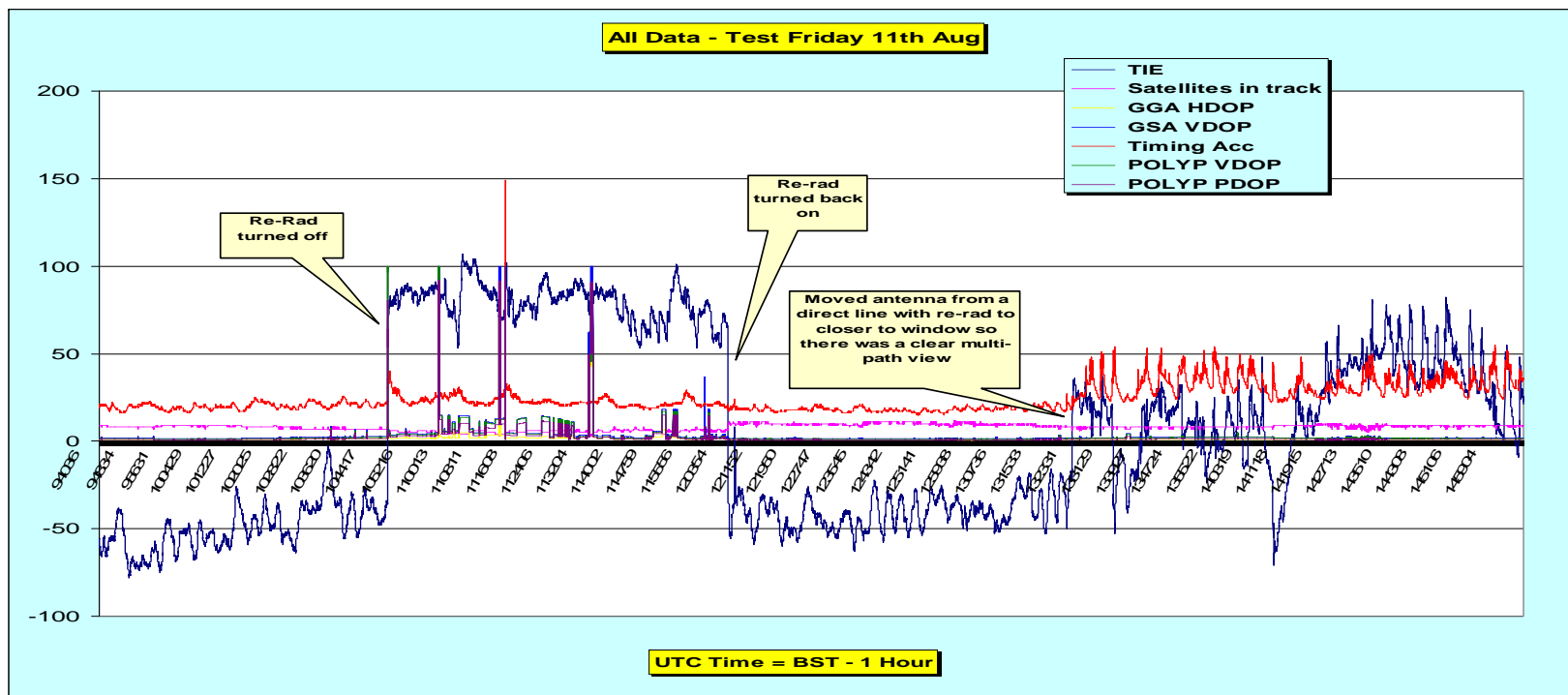
- Chronos had experienced GPS anomalies - 2005
 - Interference
 - Multipath
- Started talking to Academia - 2006
 - University of Bath (UoB)
- Started watching UK eLoran renewal project - 2006
 - General Lighthouse Authorities (GLA)
- Started a group of like minded organisations
 - GLA, UoB, NPL, BT
- Identified a Technology Strategy Board Grant programme
 - Created the GAARDIAN consortium
 - Bid 2007, Awarded Q3 2008
 - Commenced Q4 2008

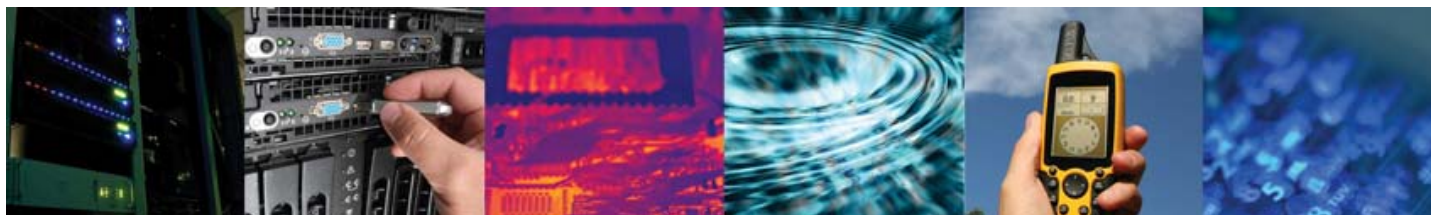
NPL – National Physical Laboratory



Multipath Detection

- Time Interval Error (TIE) very sensitive to multipath events



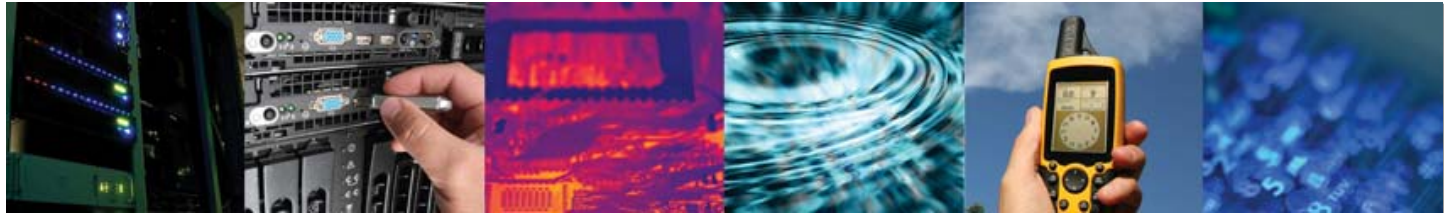


The **GAARDIAN** - Partners



- GLA – General Lighthouse Authorities
 - User Community - Maritime
 - eLoran
- Imperial College London - Dept of Civil Eng
 - User Community - Transport
 - Integrity Monitoring Algorithms
- University of Bath - Dept of Electrical & Electronics
 - GPS & Space Weather
- BT – Adastral Research Laboratories
 - User Community – Telecoms
- Ordnance Survey
 - User Community – Land Geolocation
- NPL – National Physical Laboratory
 - Time, UTC Traceability
- Chronos Technology Ltd
 - Real time Timing measurement to ns granularity
 - GPS products, components & system integration
 - GAARDIAN Project Leader

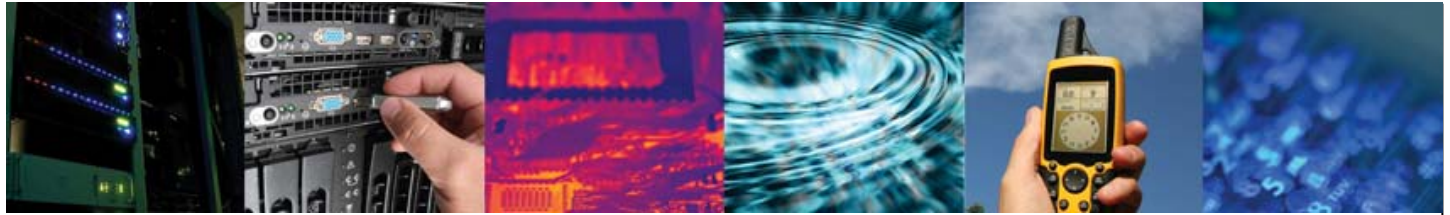




Real Time GNSS & eLoran Integrity Monitoring at Point of Use

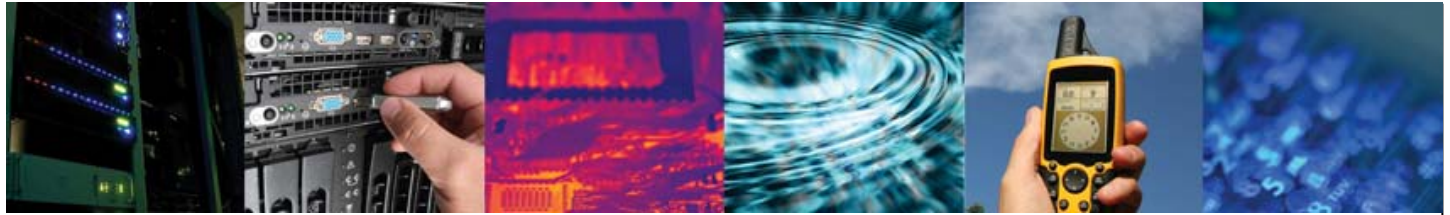
- **GAARDIAN** – is aimed at Mission/Safety Critical Users
 - A **mission or safety-critical system** is a system whose failure or malfunction may result in:
 - Death or serious injury to people, or
 - Loss or severe damage to equipment, or
 - Environmental harm
- **GAARDIAN** – The Challenges!
 - Manage vast amounts of data from within PNT engines
 - In real time
 - Report unambiguous integrity, accuracy, continuity, reliability
 - Observing many different parameters
 - In all environments and service denial situations

PNT – Positioning, Navigation & Timing



GAARDIAN – How will PNT Systems be affected?

- Different systems will exhibit different vulnerabilities
 - Some systems may be unaffected
- Different user groups will be susceptible to different vulnerabilities
 - Some industries do build in mitigation
- Vulnerabilities will be evident at different times
 - Environmental impact – weather, space weather
 - Satellite visibility
 - Local infrastructure
 - User movement
- Problems will not be systematic or deterministic



GAARDIAN – Mission & Safety Critical Users

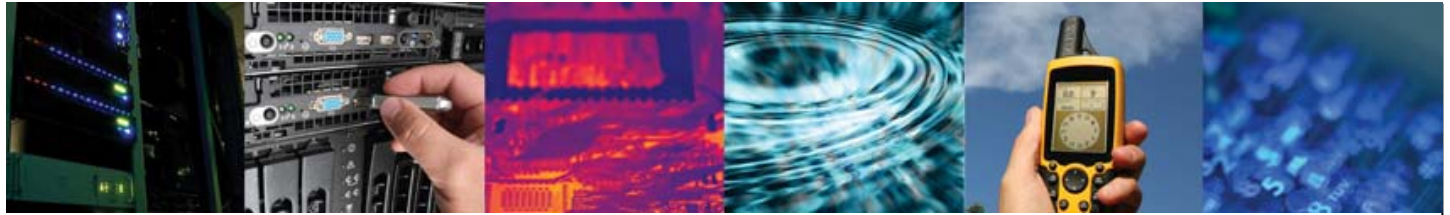


- Emergency Services
- Military
- Homeland Security
- Transport – Marine, Road, Rail, Air
- Government
- Communications Networks
- Power Utilities
- Container Terminals
- Asset Tracking
-



- GPS silicon now costs €3!
 - So new products proliferating!





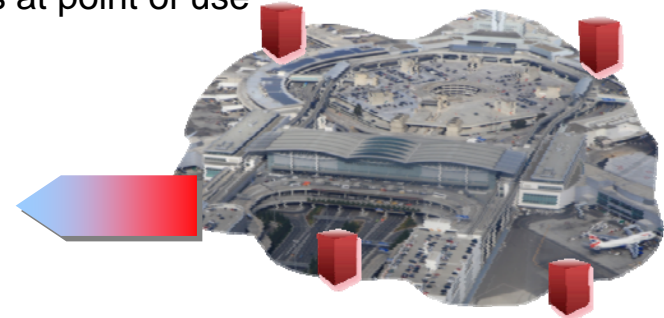
GAARDIAN – Deliverables

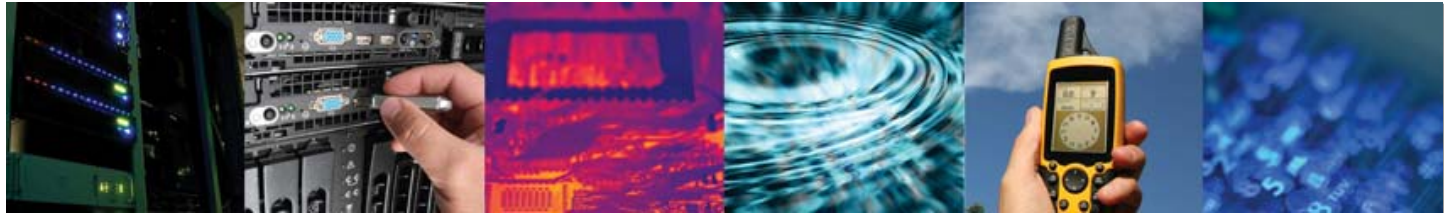
Users



- Develop 24x7 web enabled IDM sensors
 - IDM – Interference, Detection & Mitigation
 - Which can be deployed as networks
- Locally deployed networks of IDM sensors in the vicinity of the user
 - GAARDIAN will deploy trial sensors to analyse data
 - Reduce data at source without losing “content”
 - Heartbeats and “Event” communication back to Server
 - Store for user viewing over internet
- Enable Real-Time GPS, Galileo, Glonass or eLoran (PNT) monitoring
 - For Mission/Safety critical users at point of use

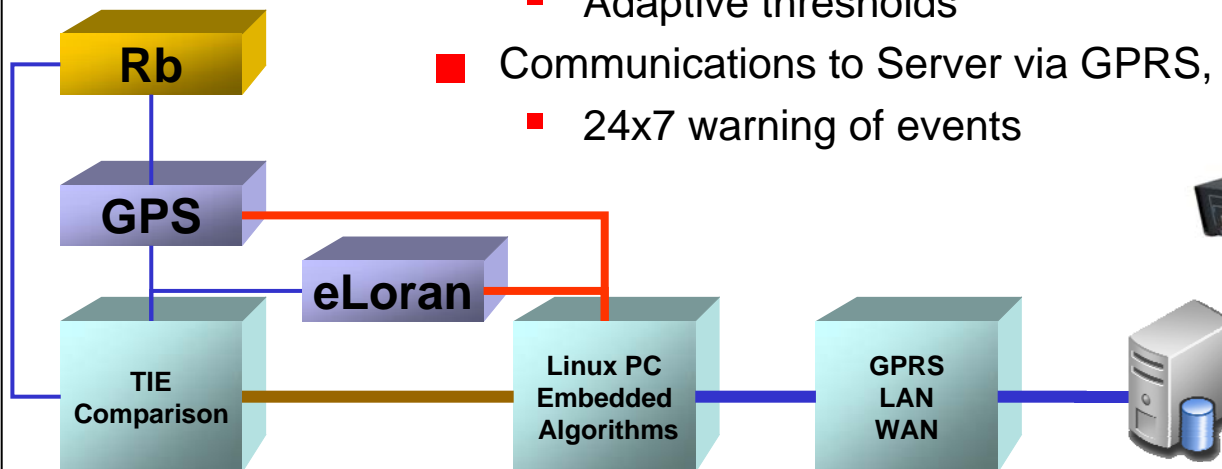
**GAARDIAN
Server**

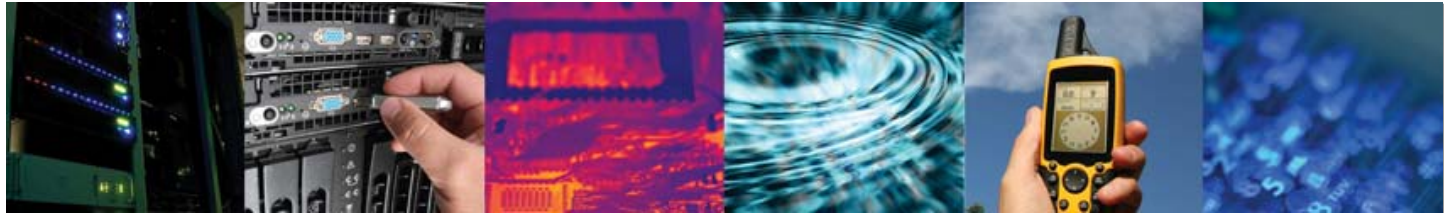




GAARDIAN – IDM Sensor

- IDM Sensors based on Chronos SyncWatch probes
 - Watching GPS & eLoran Signals
- Time Interval Error (TIE) Monitoring between PNT signals from BT
- Embedded Linux to process TIE and PNT data
 - Algorithms from CTL, GLA, ICL and UoB
 - Event severity and manageability discrimination
 - Adaptive thresholds
- Communications to Server via GPRS, LAN or WAN
 - 24x7 warning of events





GAARDIAN – What we will monitor?

■ GPS

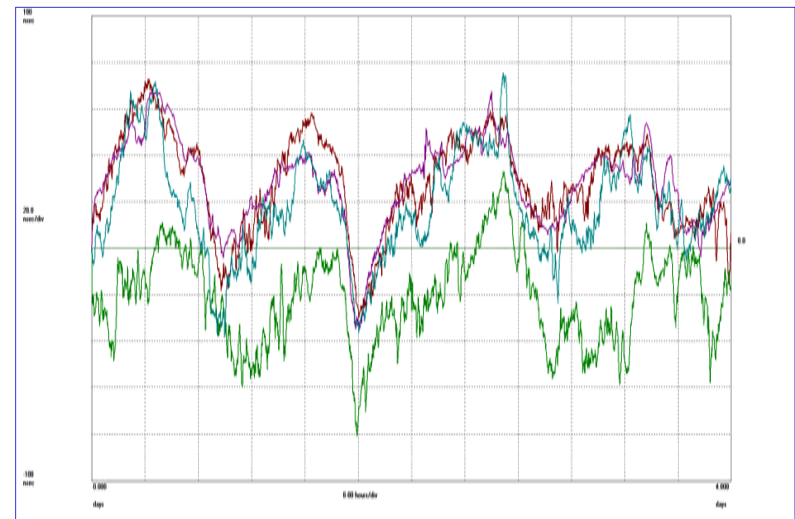
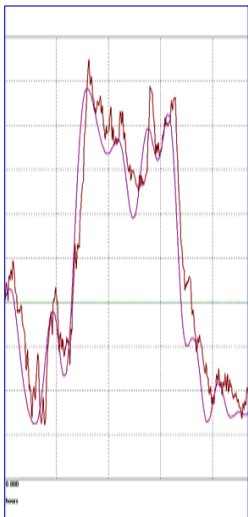
- Navigation Message
- Signal to Noise
- Carrier to Noise
- Doppler Frequency
- Carrier Phase
- Pseudorange
- Total Electron Count
- 1pps

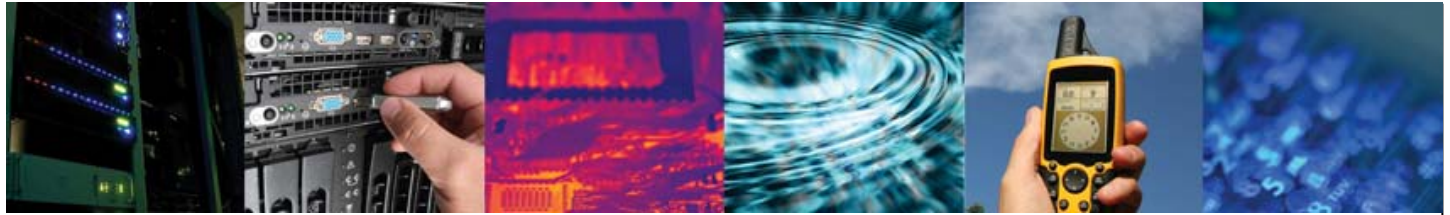
■ eLoran

- Time of Arrival
- Signal to Noise
- Envelope to Cycle Difference
- Additional Secondary Factors
- 1pps

■ 3rd Party Data

- USCG NANU
- Differential GPS Data
- Differential Loran Data



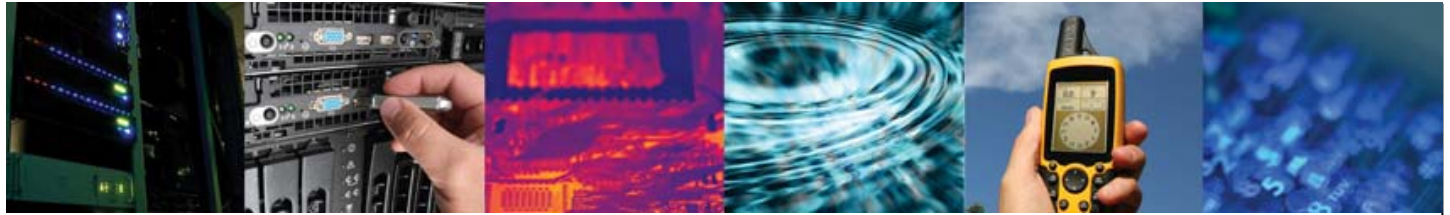


PNT Vulnerabilities – What are the Causes?

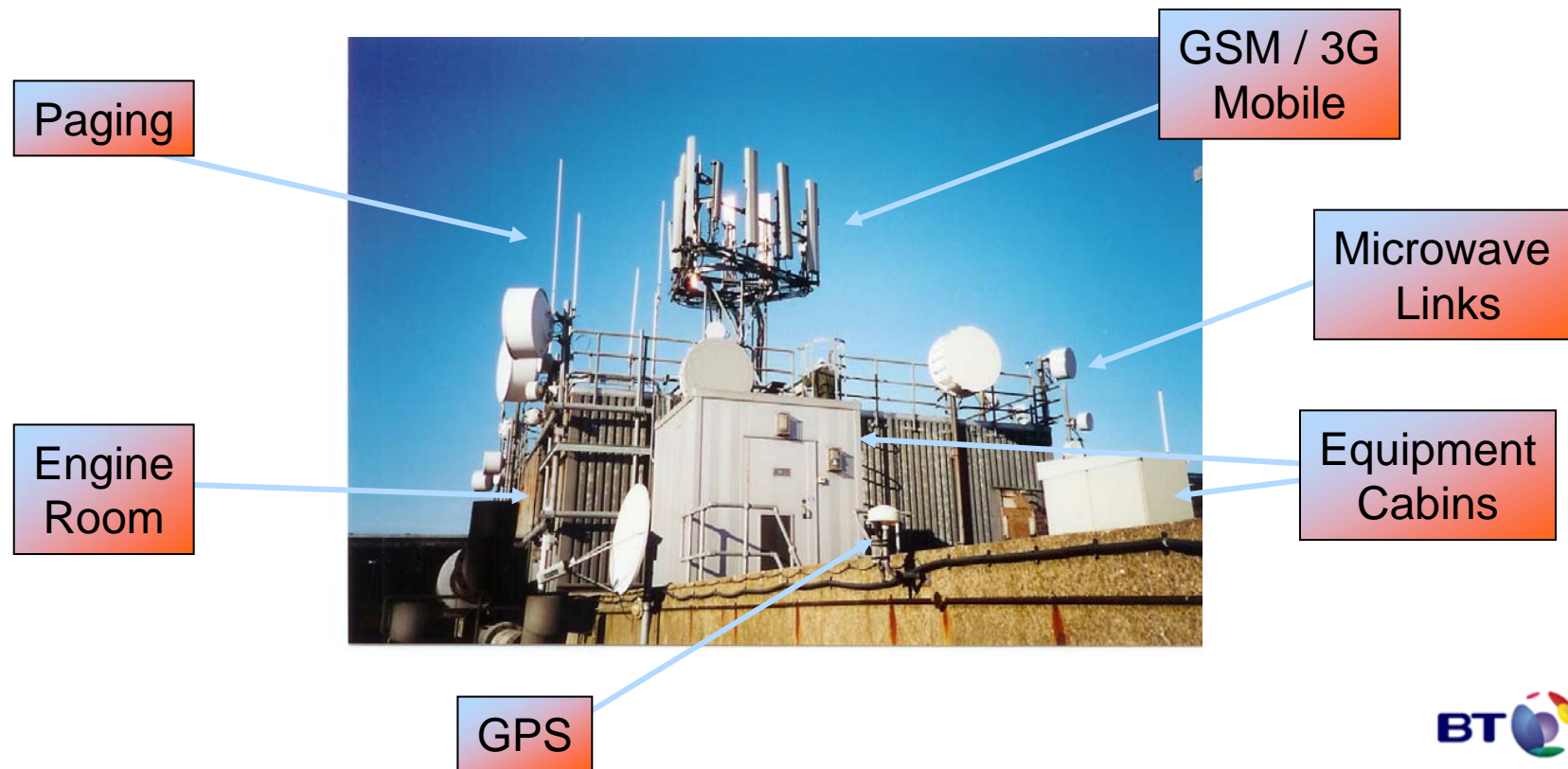
■ IDM Sensors will assess the following.....

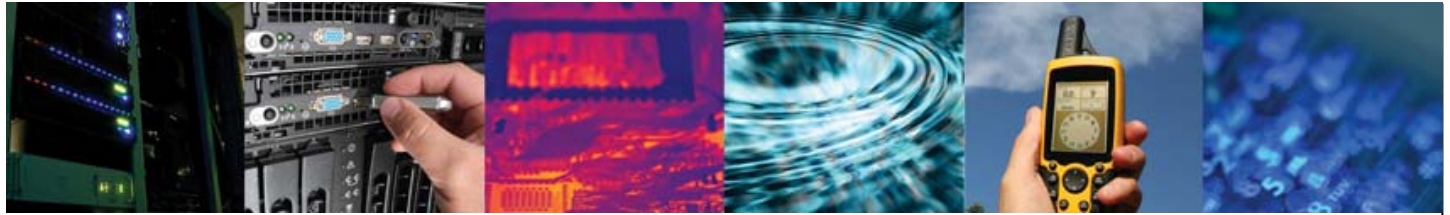
- Interference
- Scintillation
- Multipath
- Jamming
- Spoofing
- Space Weather
- Weather (eLoran)
- Additional Secondary Factors (ASF) (eLoran)
- Renewal & Upgrade Events





Interference

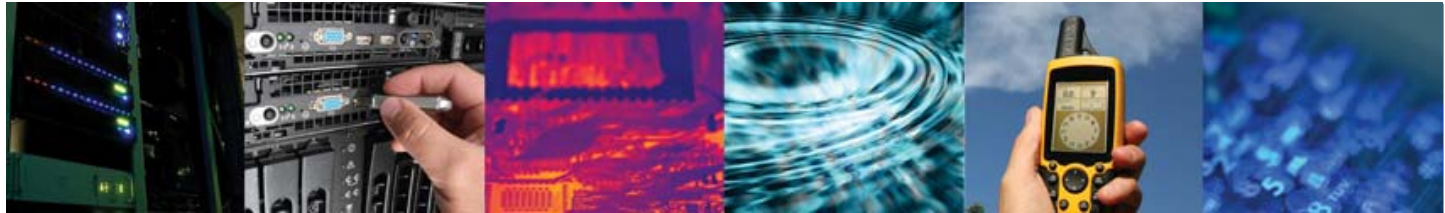




Multipath

- Signal reaches receiver using different routes
- “Reflected” route longer
- GPS Receiver reports wrong location or speed





Jamming

■ Deliberate & Accidental

- Terrorists, Thieves
- Military, Homeland Security
- Designs on the web
- *Commercially available!*

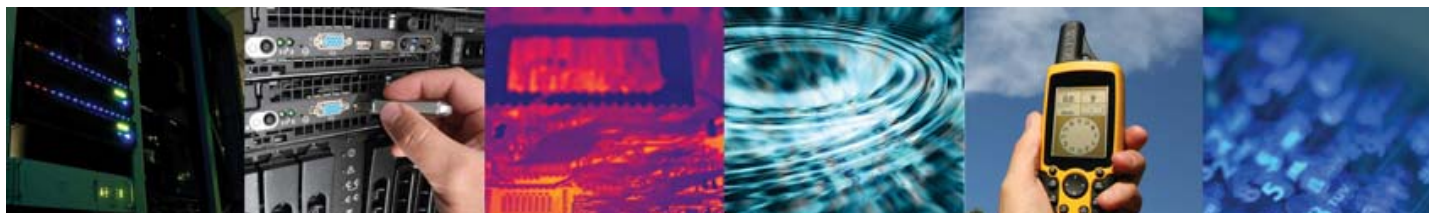


■ San Diego Incident

- No GPS in San Diego for 2 hours!
- <http://forums.groundspeak.com/GC/index.php?showtopic=160821>
- <http://mg.gpsworld.com/gpsmg/article/articleDetail.jsp?id=418420#H2>

■ Try Google & You-Tube!





Buy GPS Jammers for L1 NETWORK CTS-GBOX from C.T.S Technol...

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C.T.S Technology Co., Limited

CTS-GBOX
25W 300M



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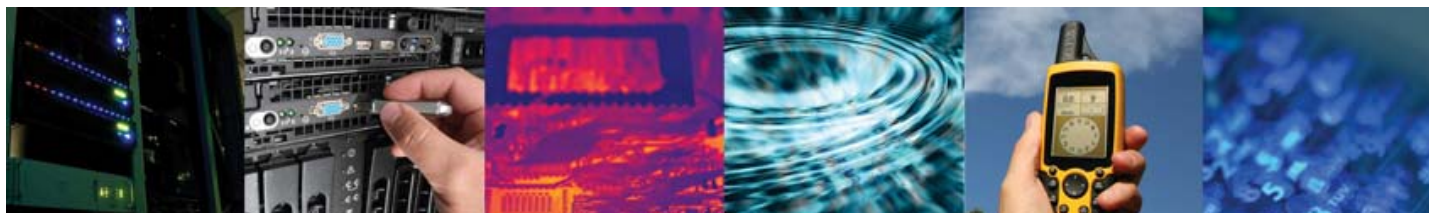
Description

1. 25W out put Big power, Up to 300M Coverage
2. GPS L1 network
3. 24/7 long time working
4. 110-240V power supply

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Crisis First Light
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In the village is the GPS Jamming Device. On the water are patrol boats. Pull out your binoculars and use them to find all the enemies in the village. Go prone on top of the ...
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Crisis Contact First Light part 1
09:48 - 5 months ago
Mission 2.Right, we need to get rid of a GPS jamming device. Hope you enjoy watching me get shot to pieces xD ... Crisis Contact First Light part ...
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K40 Radar Detector and Laser Jammer Test
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of Lida* from the popular radar detector and jammer forum www.radar detector.net. In this video the K40 laser jammer failed to jam any of the police lidar devices that were ...
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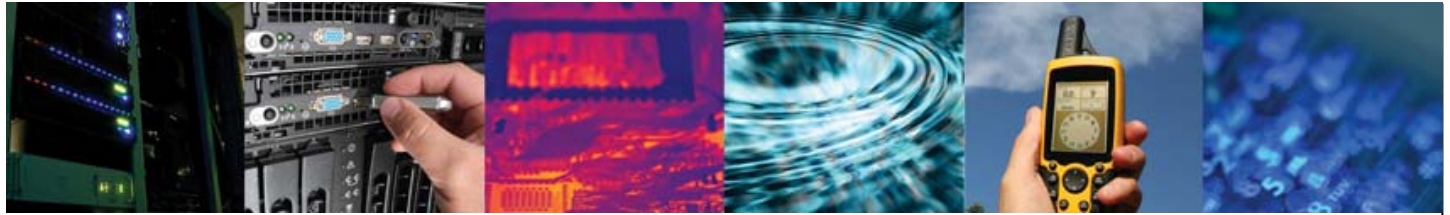
Civilian & Military GPS under jamming
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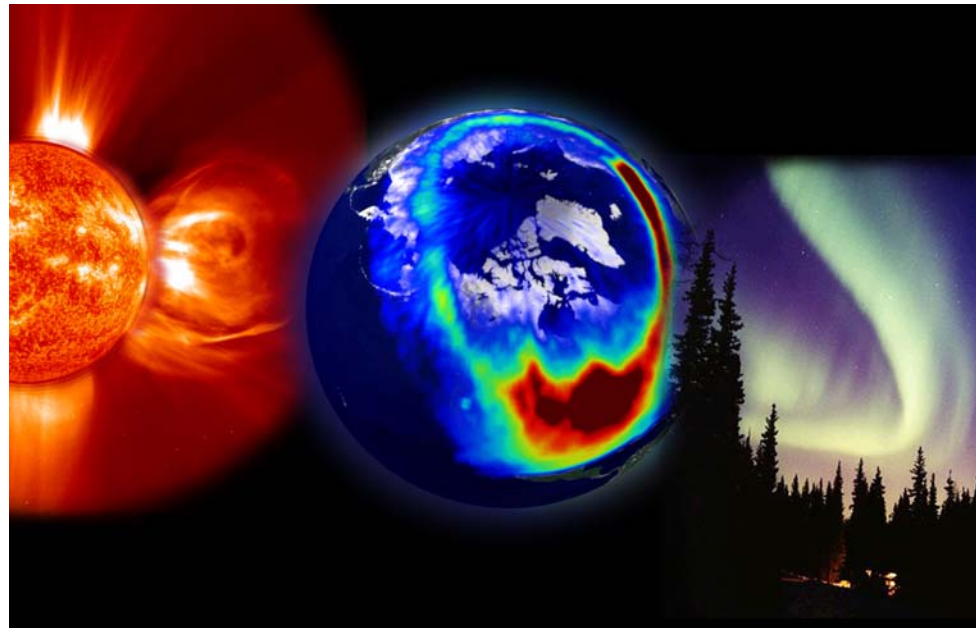
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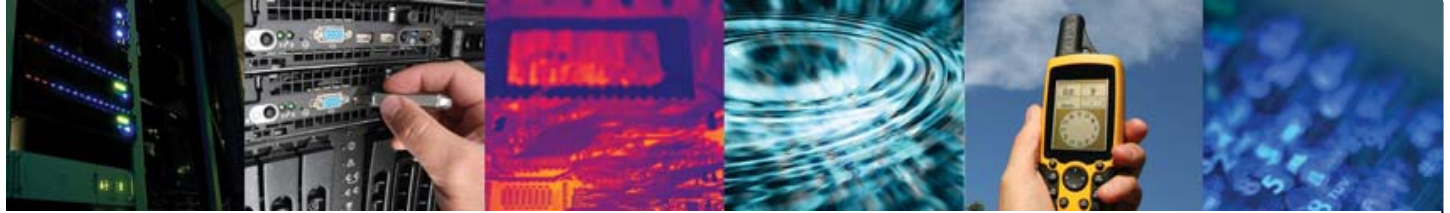
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Space Weather

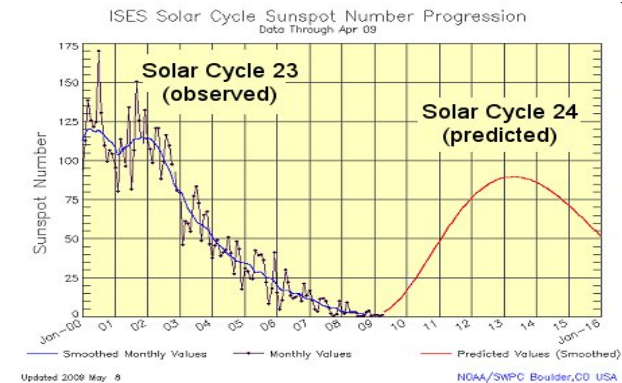
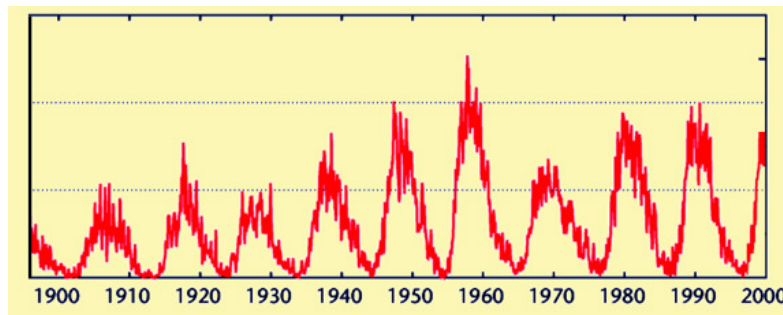
- Solar Flares
- Ionising radiation hits Earth
- Causes Aurora Borealis
- Ionospheric disturbances disrupt GPS signals
 - Report incorrect location
 - or even loss of lock

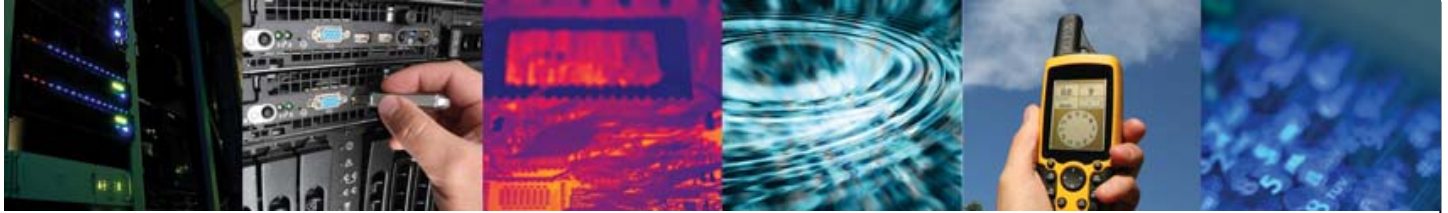




Solar Cycle

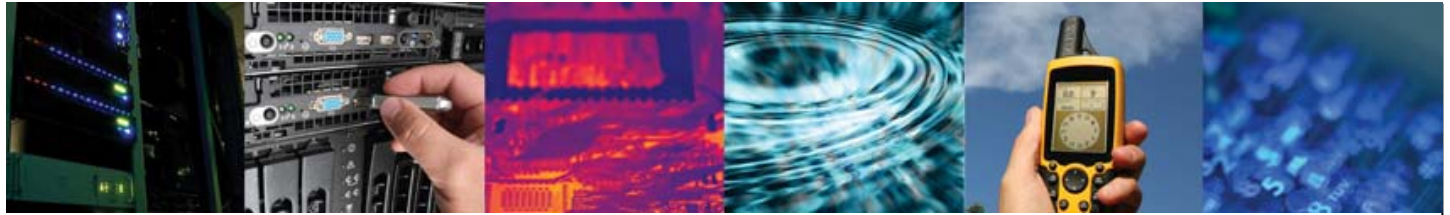
- Currently in Solar Minimum
- 11 Year cycles
- Have not experienced major solar maximum since GPS has become an everyday utility
- www.spaceweather.com
- Next Solar Maximum – May 2013!





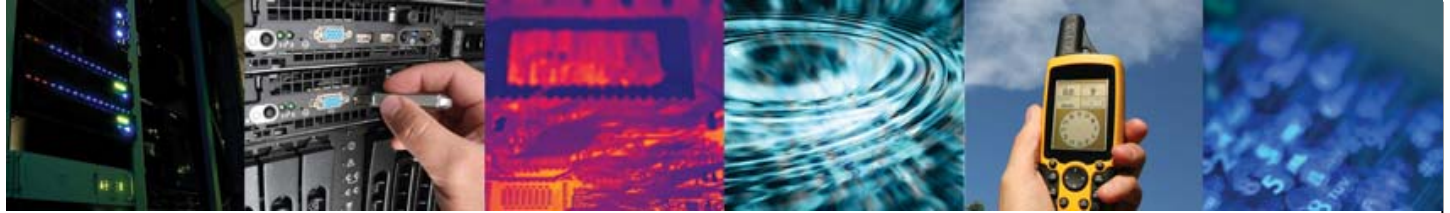
PNT Renewal & Maintenance Programs

- Interference from L5 Transponder on SV49
 - Caused SV49 to appear 150m too low!
- Delays in renewal program
 - Probability of maintaining 24 satellites will fall below 95% - 2010 - 2015
 - May fall as low as 80%
- LORAN station outages
- eLORAN station renewal program
 - Depending on strategic review
- Politics!!



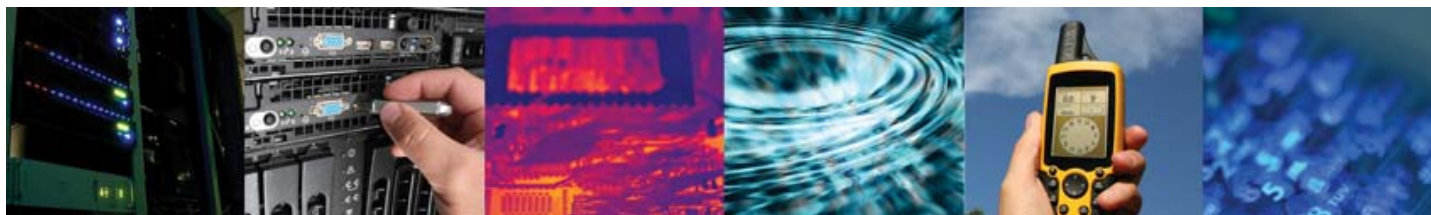
Interference Detection & Mitigation

- 24x7 Real-Time Detection enables appropriate Mitigation
 - Timely
 - Proportionate
- Lie Back and Enjoy!
- Get the FCC on the case!
- Is it Red Team or Blue Team?
- Test & compare different GNSS receivers with different mitigation capability
- Test & compare different Loran receivers
- Assess accuracy of differential corrections at point of use

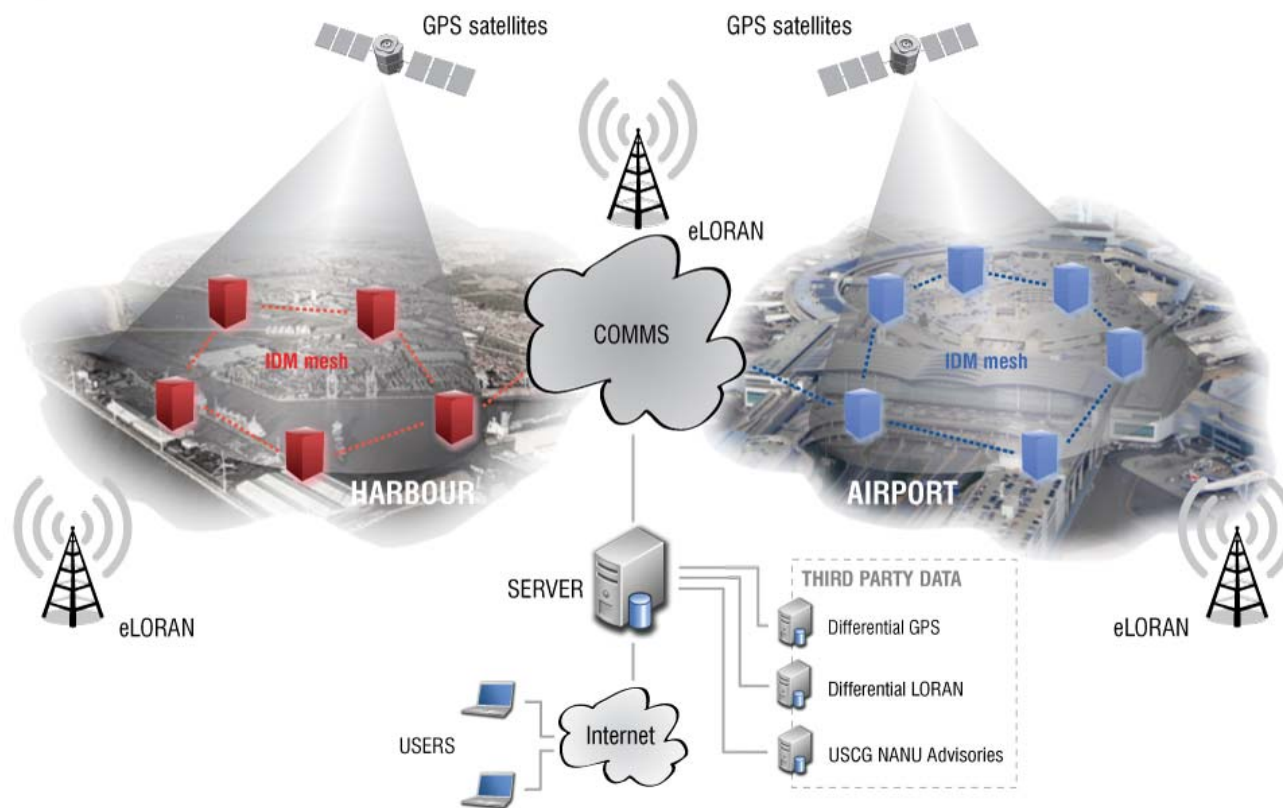


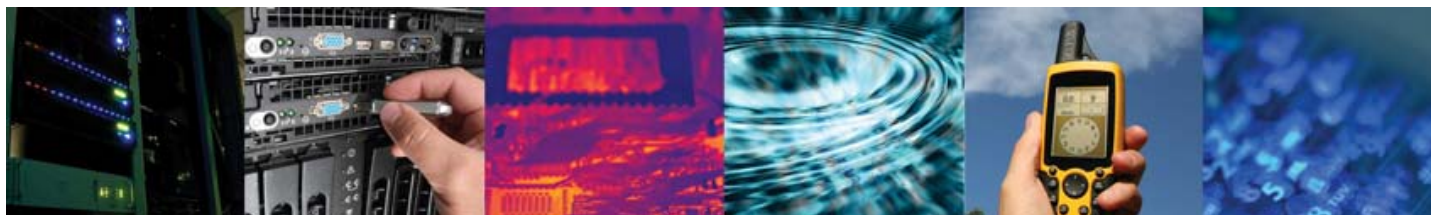
GAARDIAN Project

- We are moving GPS IDM activity from scientific research into everyday use
 - Evolving high cost complex scientific analytical systems to low cost industrial/commercial products
- Realise an easily deployable network of sensors
 - In vicinity of mission safety critical application
 - e.g. Airports, Road Systems, Docks
 - Anywhere where GPS is leveraged into critical infrastructure
- IDM sensors will filter data and report anomalies to central server
 - Server alerts users when there is an anomaly
 - Users access data from server via Internet from any location
- See the concept in action on www.syncwatch.com for the telecom industry
- Monitoring recent Loran outages in Europe – 28th Sept to 9th Oct



GARDIAN





For Further Information contact:-

GAARDIAN@chronos.co.uk

or any of the partners

or visit

www.gps-world.biz/gaardian/index.php