

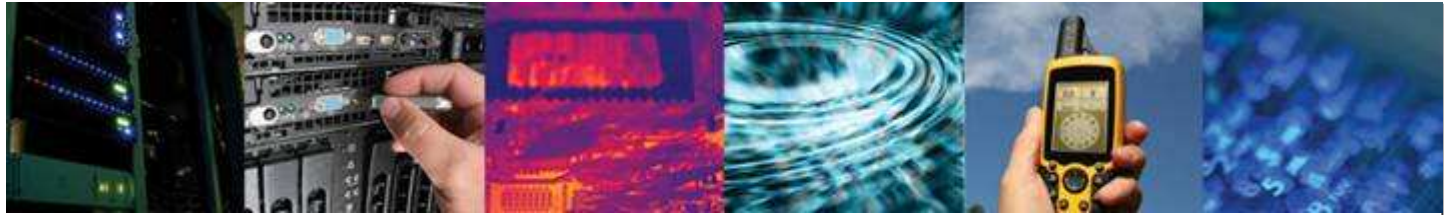
eLoran – Terrestrial PRS Quality Timing

**Charles Curry B.Eng, FIET
MD, Chronos Technology Ltd**

ITSF 3-5 Nov 2009 - Rome

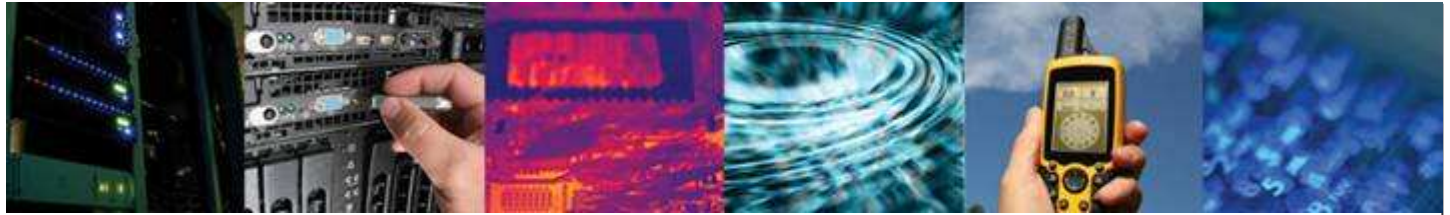
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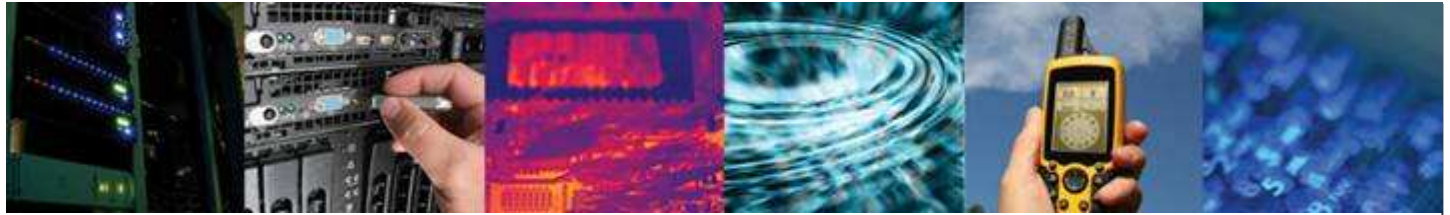
Contents

- Introduction & Background
- The Loran System
- New UK Loran Station
- Test Results
- Report from ILA38 in Portland, Maine
- Latest Loran Developments
- The GAARDIAN Project



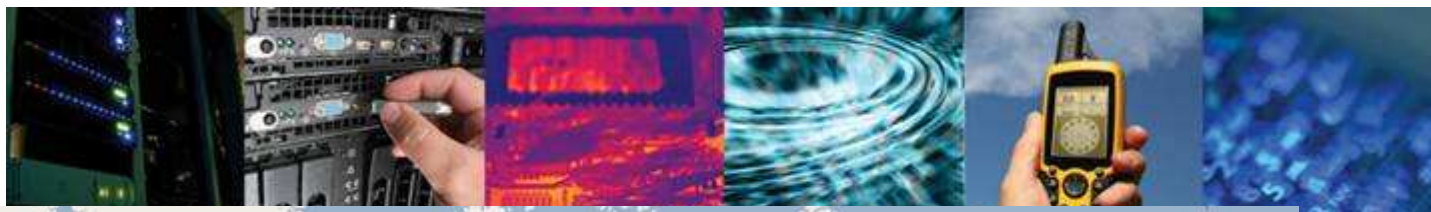
The Enhanced Loran (eLoran) System

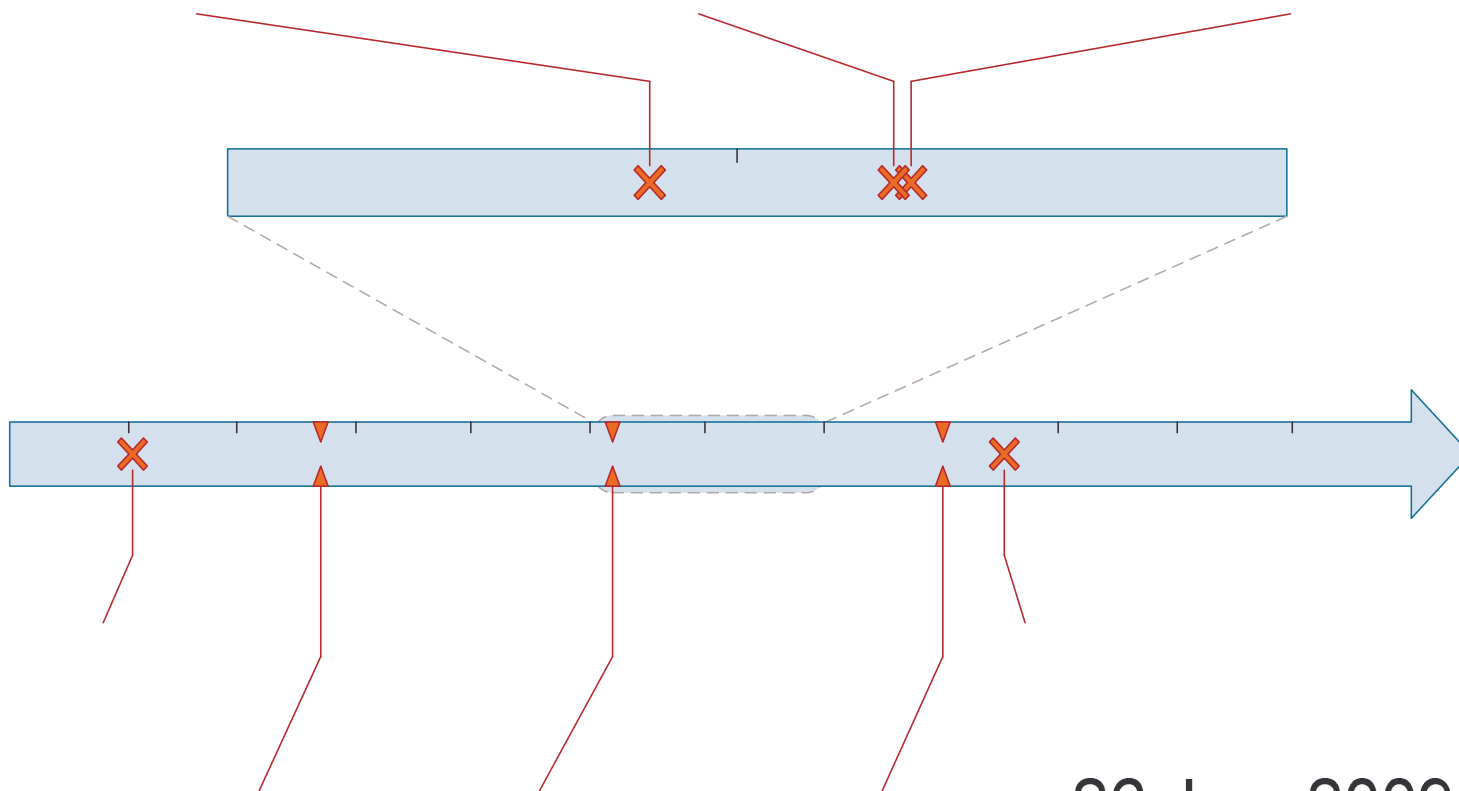
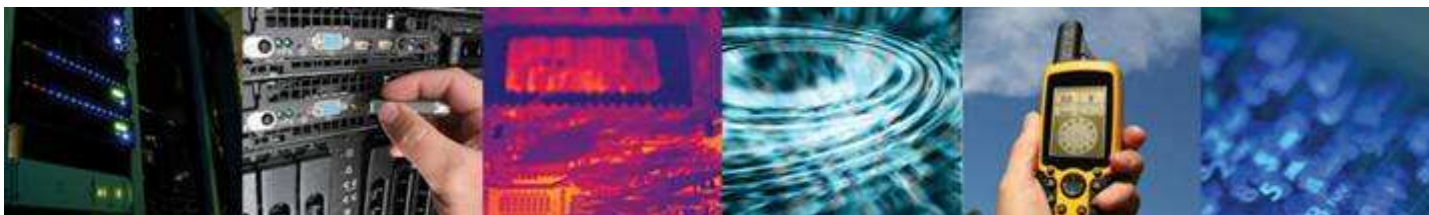
- Internationally Standardized PNT System (Positioning Navigation and Timing)
- Latest evolution of the **LO**ng **RA**nge **N**avigation system
- Meets Accuracy, Availability, Integrity and Continuity requirements of
 - Aviation non-precision instrument approaches
 - Maritime harbour entrance and approach manoeuvres
 - Land-mobile vehicle navigation
 - Location-based services
 - Precise source of time and frequency for applications such as telecommunications
- Independent, Dissimilar complement to GNSS Systems
 - Uses a different part of the electromagnetic spectrum
 - Time traceable to UTC **independently** of GNSS
 - Interoperable with GNSS for positioning, navigation and timing



Other Loran Facts

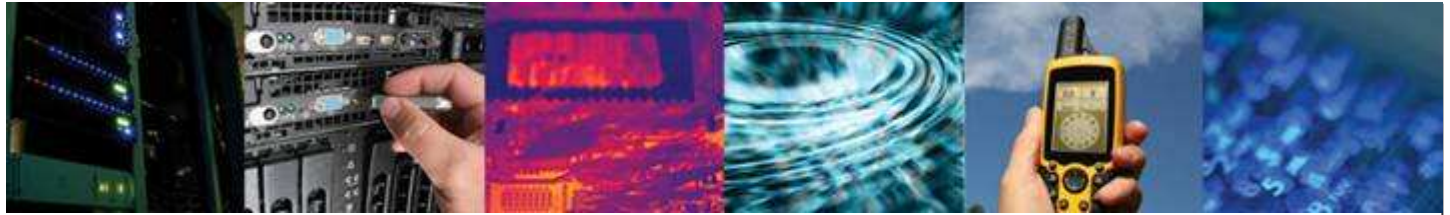
- Loran/Chayka networks in many countries/regions
 - USA, Europe, Russia, Saudi Arabia, China, Japan, India, South Korea
 - All funded and active with different functional capabilities
- Interference Immunity
 - Not susceptible to GPS impacting interference
 - Unique adaptive notch filtering to mitigate LF interference
- 100KHz LF Transmission Frequency
 - Different part of spectrum to GNSS (1-2 GHz)
 - Better building penetration
- Pulsed signal transmission
 - Allows separation of ground/skywave
 - Different to DCF77 or MSF 60KHz





26 Jun, 2009

House provides \$36 million



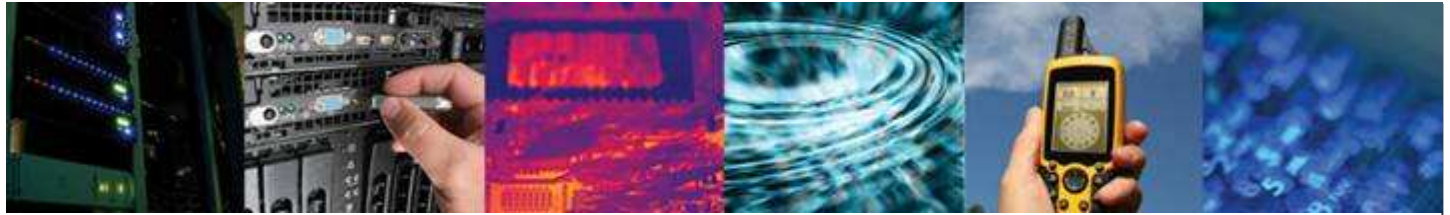
Recent Events

■ Press Release, 30 May 2007

- “Today, the General Lighthouse Authorities of the United Kingdom and Ireland announce the award of a prestigious fifteen-year contract to VT Communications (part of VT Group plc) for the provision of a state-of-the-art enhanced Loran (eLoran) radionavigation service to improve the safety of mariners in the UK and Ireland”
- 15 Year Funded Program by UK Government (Dept for Transport)

■ Anthorn Progress

- 7 July 2007 – experimental transmitter moved from Rugby
- 1 October 2007 – first signals from Anthorn for test and verification
- 1 December 2007 – trial signals operational
- ***21 January 2008 – UK eLoran Station “Enters Service”***



There is growing, strong, cross-government support for eLoran

Department for
Transport

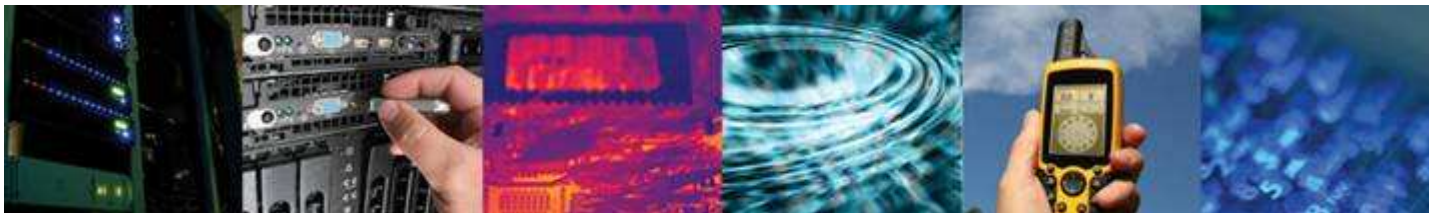
 Ministry of Defence

eLoran

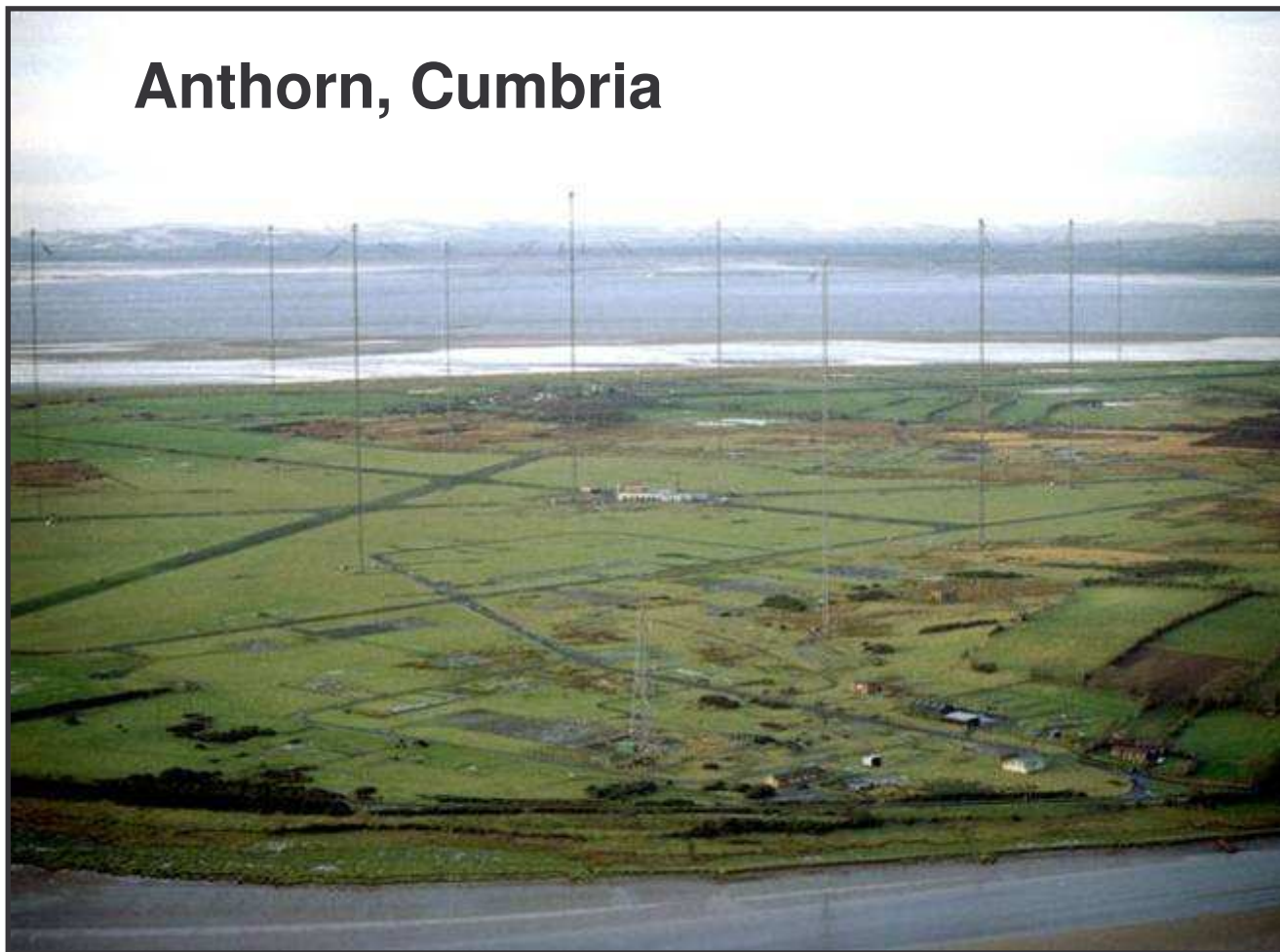
 FOREIGN & COMMONWEALTH OFFICE

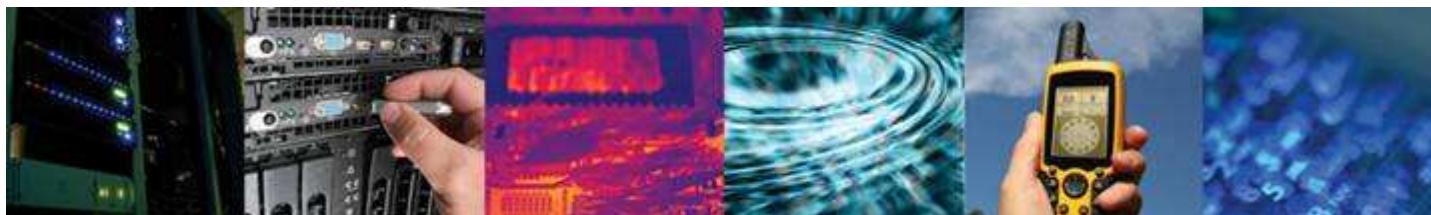
BIS
Department for
Business
Innovation
& Skills


Home Office



Anthorn, Cumbria



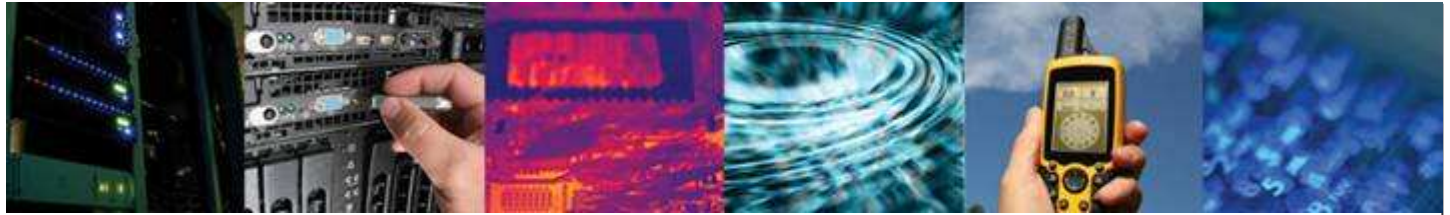


The containerised transmitter and connection to the T-antenna



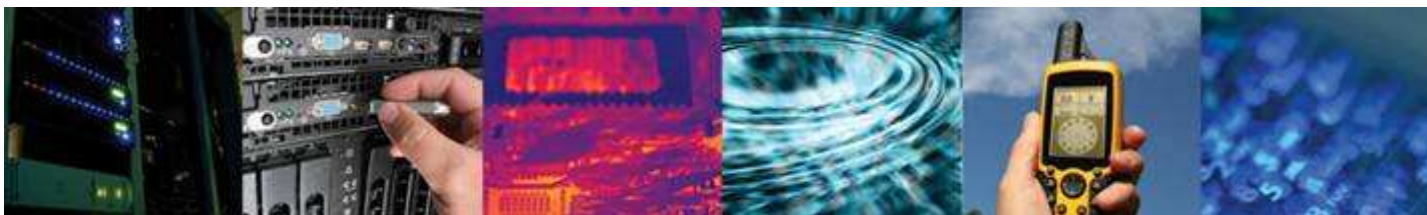
Source: VT Communications



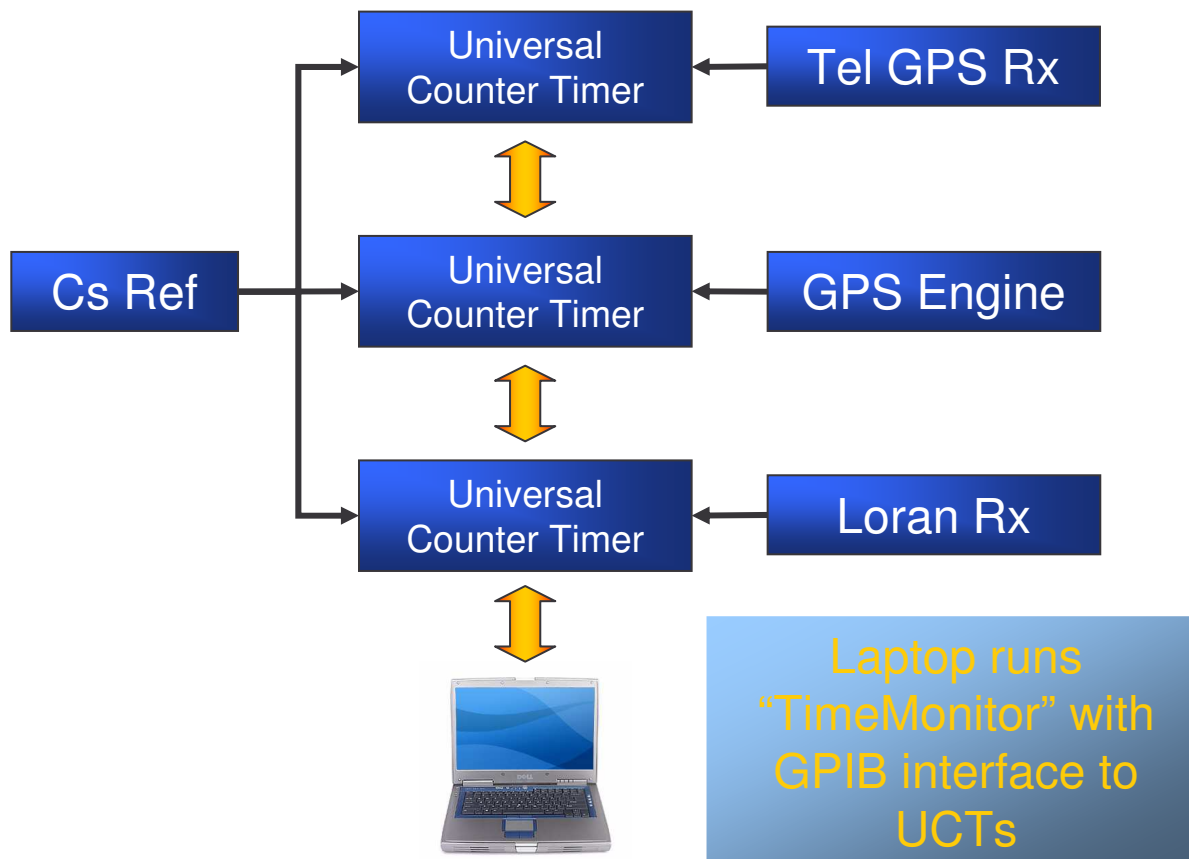


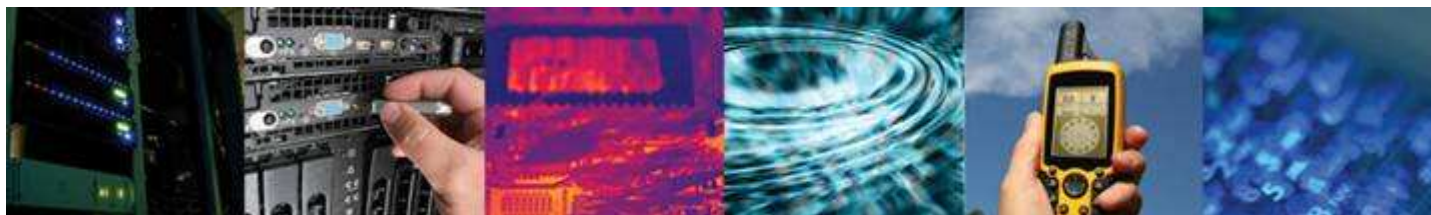
Chronos Testing

- Chronos Commissioned to “Type Approve” eLoran for Telecom Network Stability
- ITU G.811 used as Benchmark
 - = Standard Network Stability metric for a Telecom Primary Reference Clock (PRC)
 - = GPS
 - = Cs
- Will eLoran step up to the mark?
- Used two test setups....

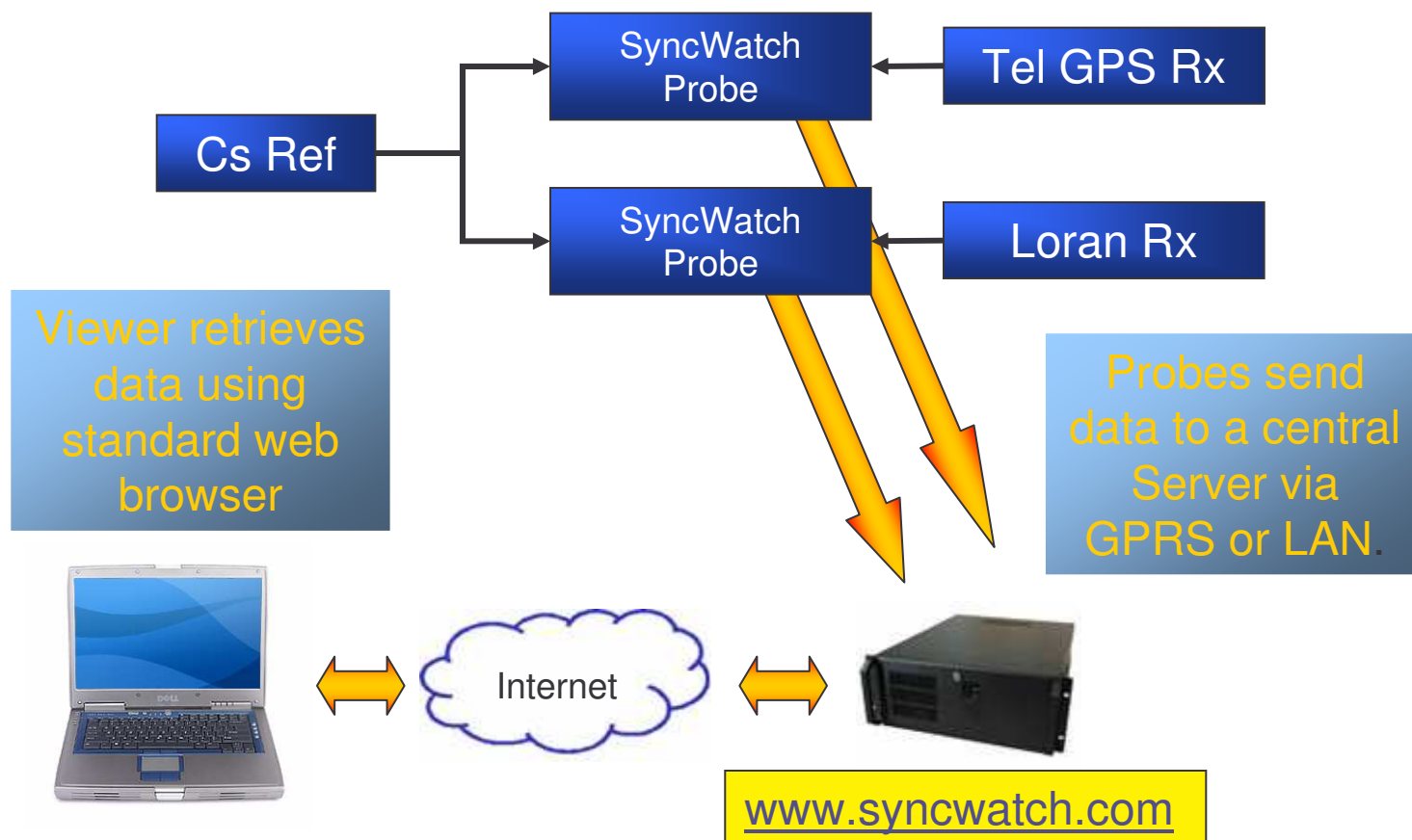


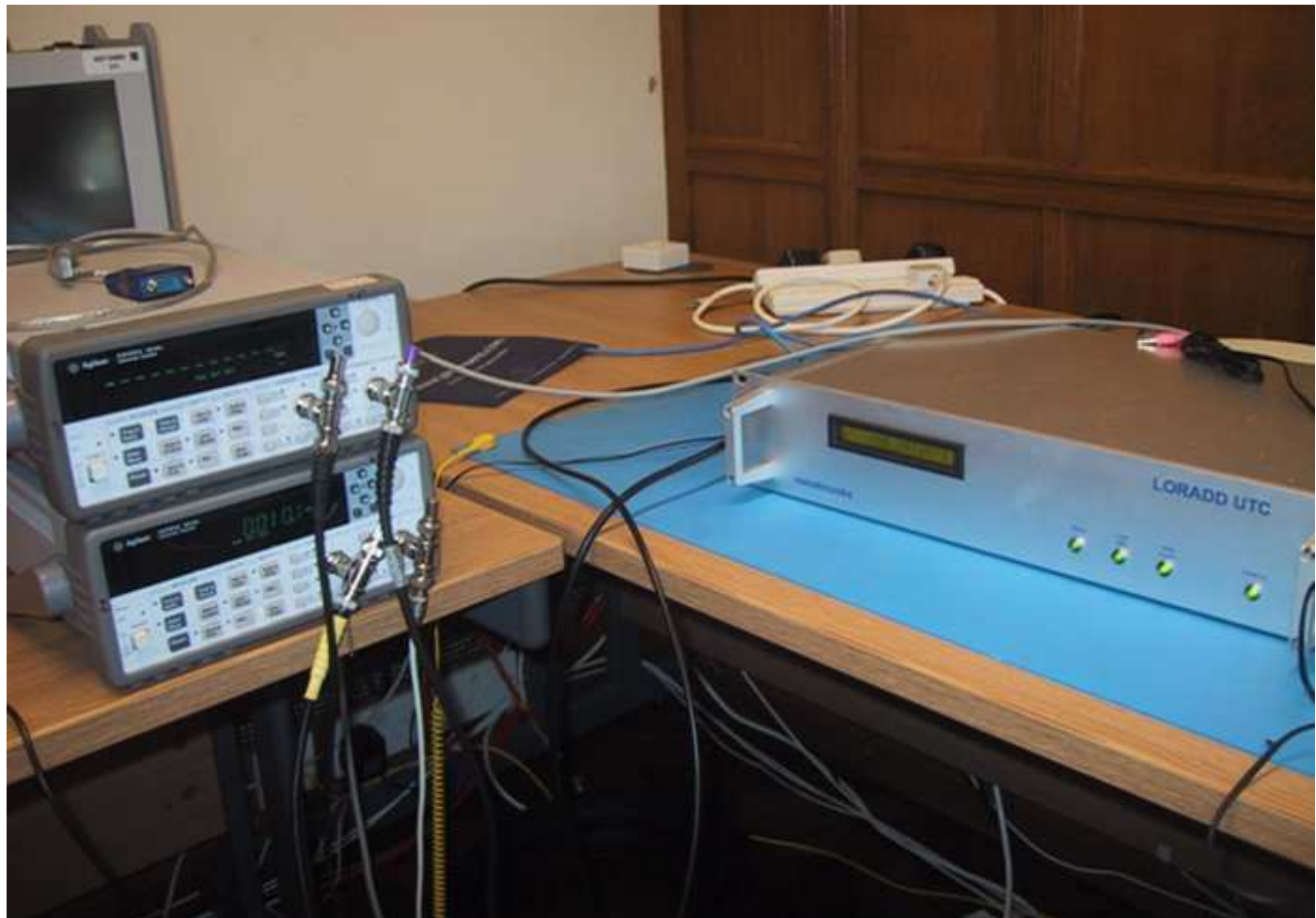
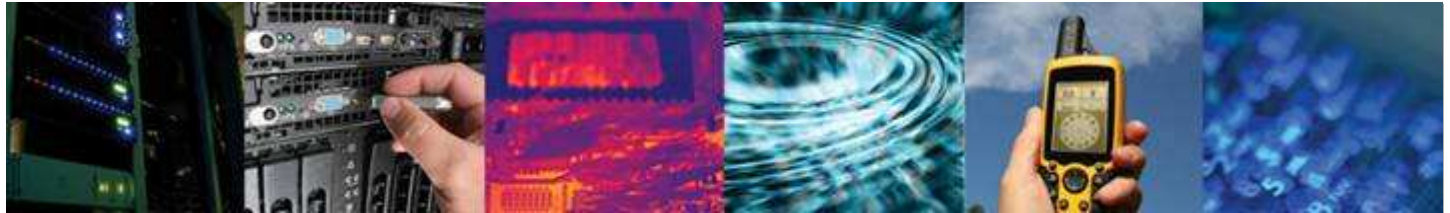
Test Set-up #1 – Lab Test Bench

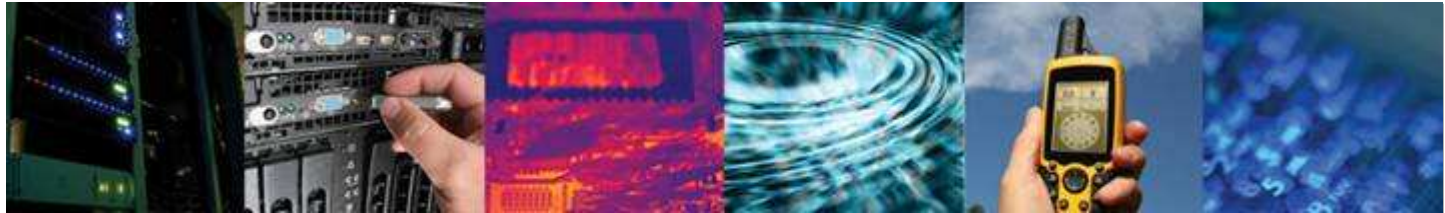




Test Set-up #2 – Web Enabled Testing







TIE Data – GPS Rx (x2) v Loran Rx – Test Setup #1

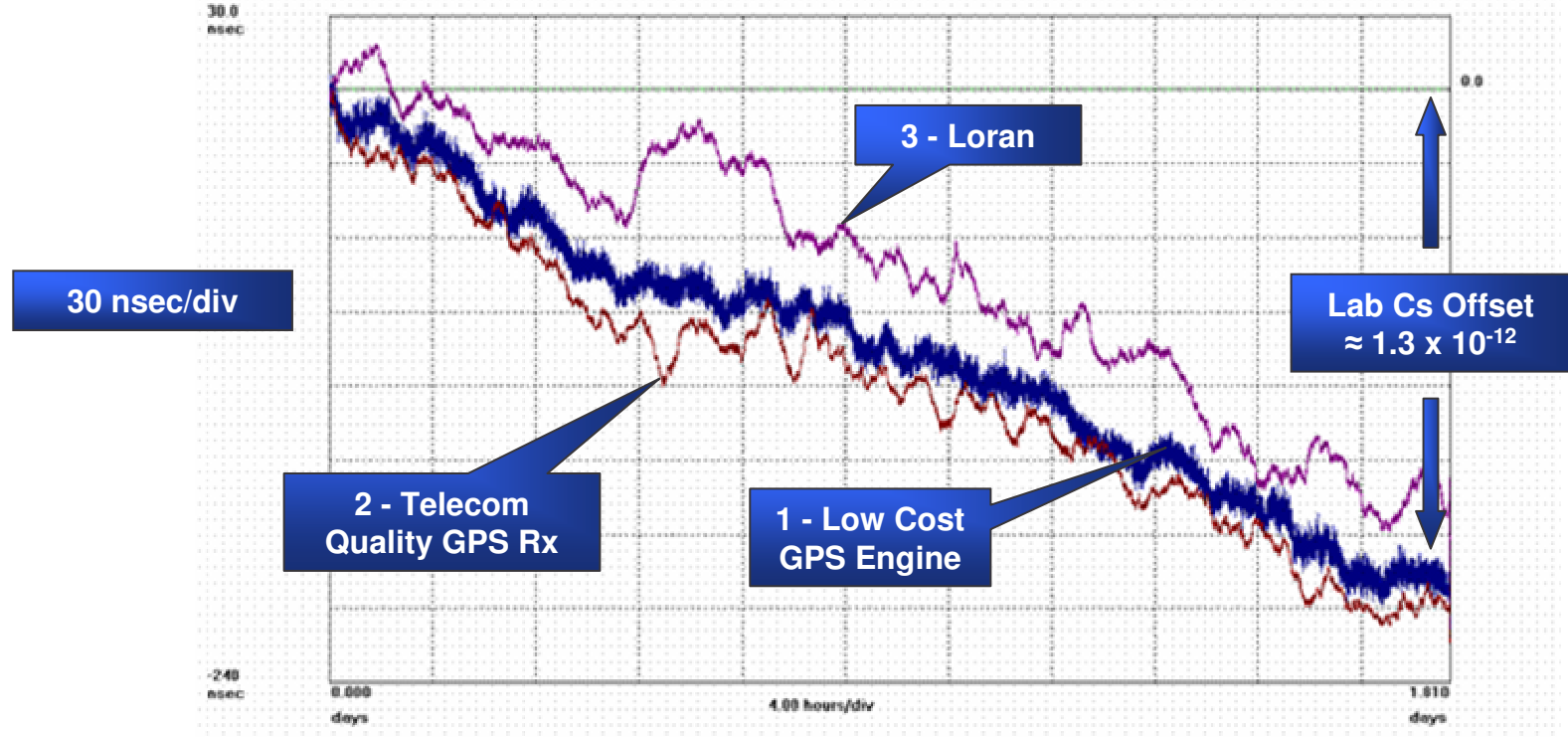
Symmetricon TimeMonitor Analyzer

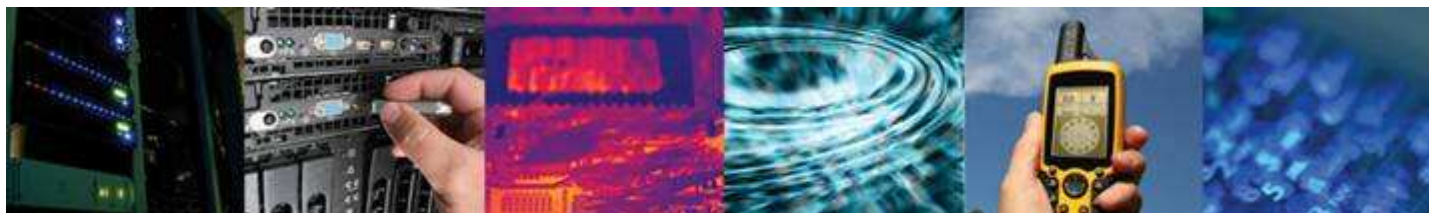
Phase deviation in units of time: Fs=999.9 MHz; Fo=2.0480000 MHz; 2006/11/30; 04:28:23

1: HP 53132A; Test: 987; A - SW31 GPS; B - Cs/33120; 2.048 MHz; Samples: 156372; Gate: 1 s; Ref ch2: 2.048 MHz; T/Time Data Only; T11->2: 53131A sa 3736; 2006/11/30; 04

2: HP 53132A; Test: 988; A - TS3100; B - Cs/33120; 2.048 MHz; Samples: 156372; Gate: 1 s; Ref ch2: 2.048 MHz; T/Time Data Only; T11->2: 53131 sa 6250; 2006/11/30; 04:28:2

3: HP 53132A; Test: 989; A - LORADO 2040; B - Cs/33120; 2.048 MHz; Samples: 156372; Gate: 1 s; Ref ch2: 2.048 MHz; T/Time Data Only; T11->2: 53132A sa 252; 2006/11/30;





Test results - MTIE

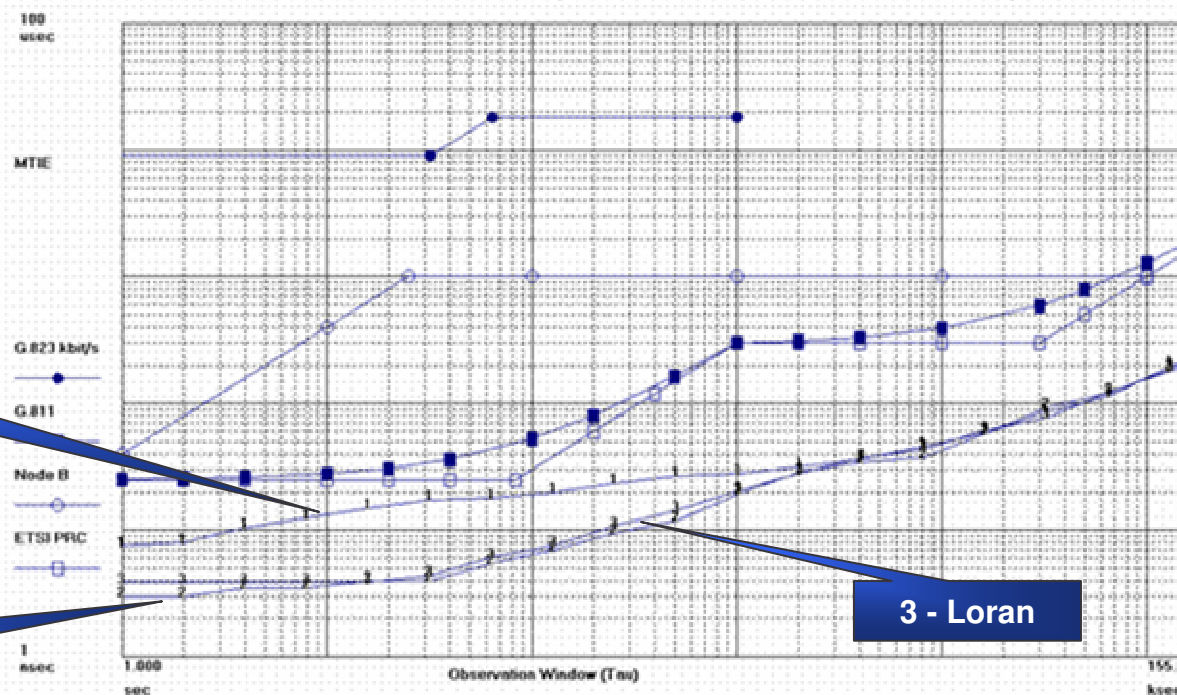
Symmetricom TimeMonitor Analyzer

MTIE on zoomed area: -1.334 mdays to 1.803 days; Fo=2.048 MHz; Fs=999.9 mHz; 2006/11/30; 04:28:23

1: HP 53132A; Test: 987; A- SW31 GPS; B- Cx/33120; 2.048 MHz; Samples: 156372; Gate: 1 s; Ref ch2: 2.048 MHz; TV/Time Data Only; TI 1->2: 53131A sn 3736; 2006/11/30; 04

2: HP 53132A; Test: 988; A- TS3100; B- Cx/33120; 2.048 MHz; Samples: 156372; Gate: 1 s; Ref ch2: 2.048 MHz; TV/Time Data Only; TI 1->2: 53131 sn 6255; 2006/11/30; 04:28:2

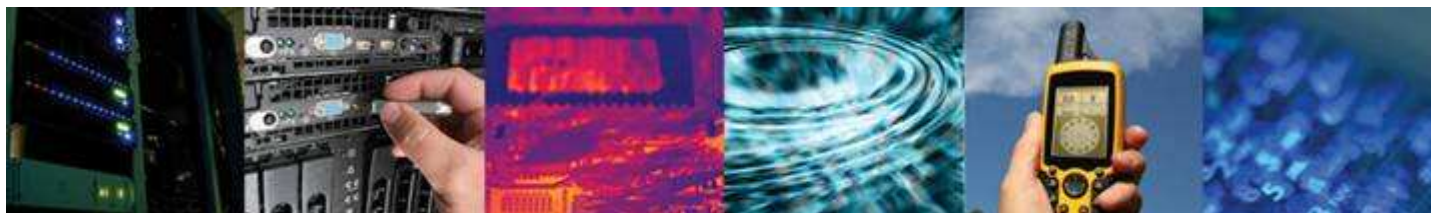
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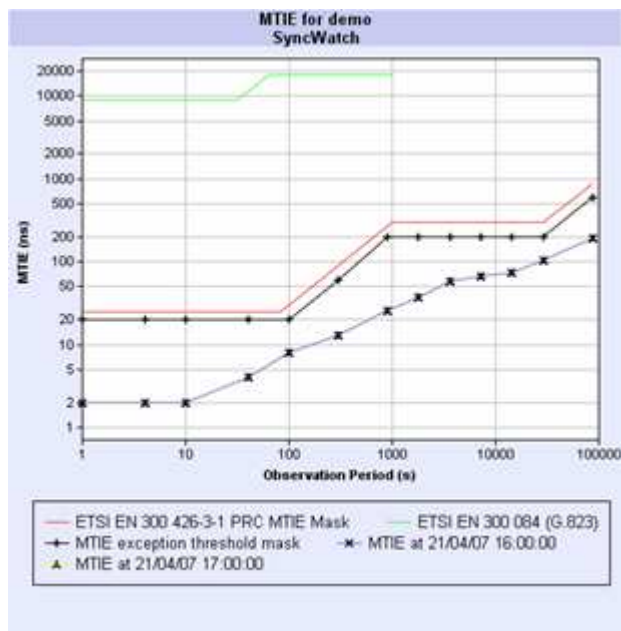
1 - Low Cost
GPS Engine

2 - Telecom
Quality GPS Rx

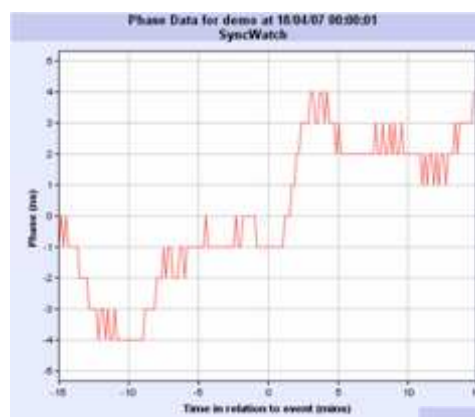
3 - Loran



Long Term Testing using Test Setup #2



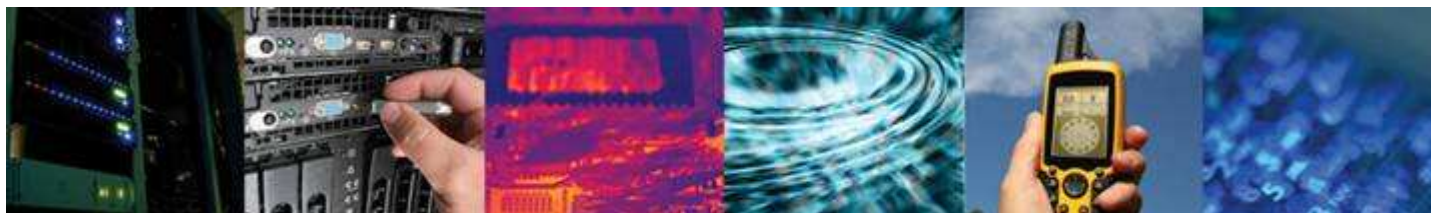
Data can be viewed
on
www.syncwatch.com



Steady State
Data.

Catch
Transients
for later
study, refine
firmware



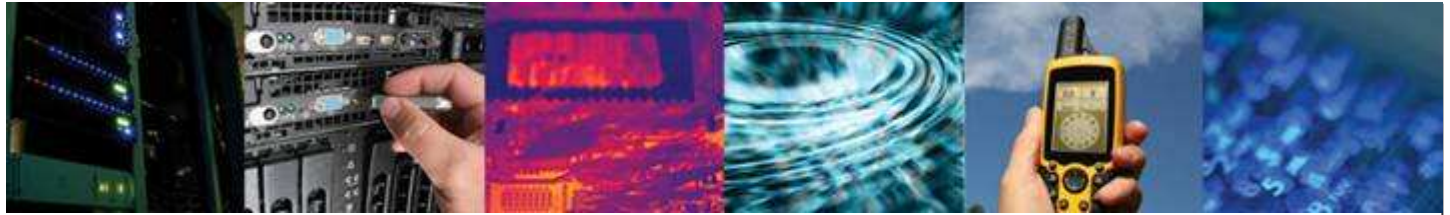


ILA38 Portland, Maine, USA

International
Loran
Association

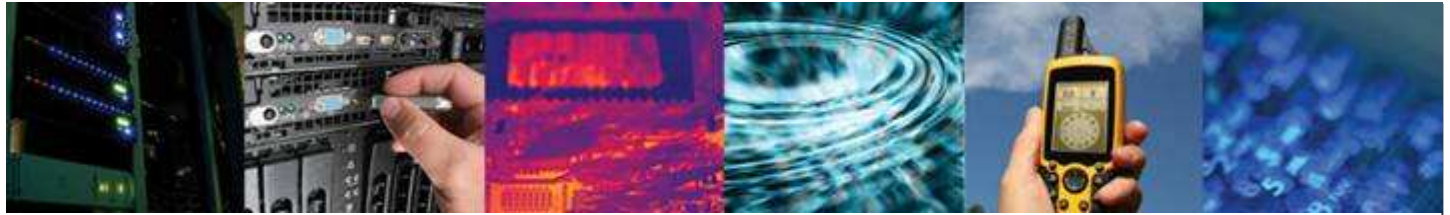
- The Loran community is very much alive
 - 2 Days of Papers, 60 Delegates
- Review of Hardware Supply (excluding China and Russia)
 - Two major transmitter manufacturers
 - Megapulse
 - Nautel
 - One Global Tx System Integrator
 - UrsaNav
 - One Supplier of the Tx Loran Timing Suite
 - Symmetricom
 - Two Receiver manufacturers
 - Reelektronika
 - CrossRate
 - R&D
 - Various Academic & R&D Projects





Loran & Politics

- Basic Stance
 - Obama wants to shut off Loran-C.
 - Administration has not taken a stance on eLoran.
- Current Law (signed Oct 2009)
 - Department of Homeland Security (DHS) Appropriations
 - If Commandant of the Coast Guard certifies that Loran-C is not needed for maritime navigation; and
 - Secretary of DHS certifies that the Loran-C infrastructure is not needed for a backup to GPS.
 - Then Loran-C can be shutoff on Jan. 4, 2010. Including selling all equipment and land associated with Loran-C.



Loran & Politics (continued)

- Ongoing Debate: Is eLoran going to be the backup to GPS?
 - Solid support for this in Congress.
 - PNT Executive Committee and PNT Advisory Board strongly recommend eLoran as the backup to GPS.
- Question Remains in U.S.
 - Will the Secretary of DHS ignore the scientific/technical recommendations and terminate Loran-C and with it eLoran?
- Confused?
- US Government Position
 - <http://pnt.gov/policy/legislation/bills.shtml#loran>



GPS Interference Detection & Mitigation

Charles Curry, B.Eng, FIET
MD – Chronos Technology Ltd



GAARDIAN

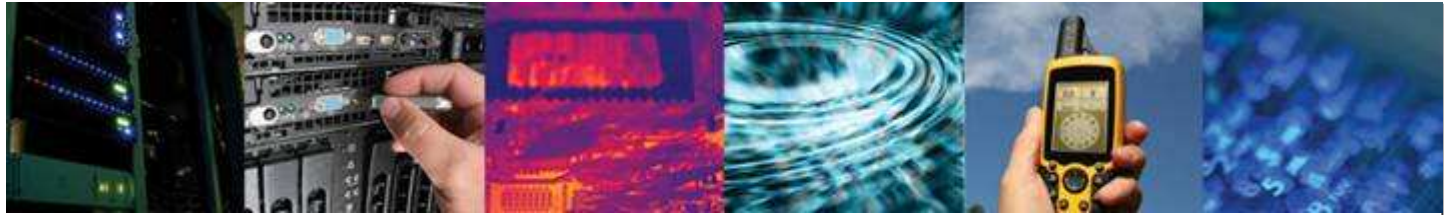
GNSS
AVAILABILITY
ACCURACY
RELIABILITY
and
INTEGRITY
ASSessment
for **T**IMING and
NAVIGATION



**A Technology Strategy Board
funded collaboration**

Technology Strategy Board
Driving Innovation

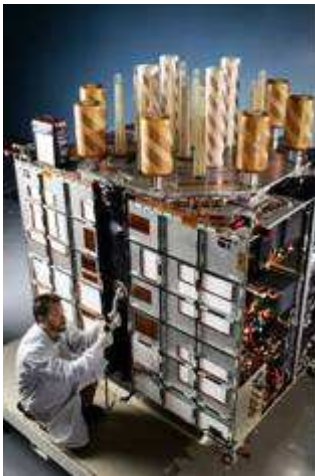




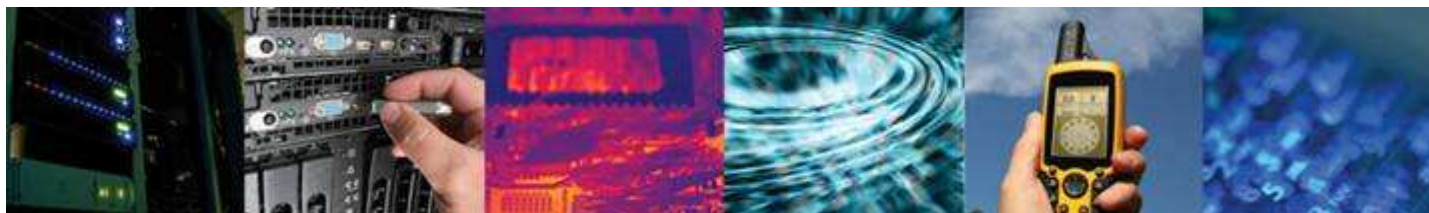
The **GAARDIAN** Project - *GPS Interference Detection & Mitigation*



- **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



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



GPS jammer

GPS Jammers
[CTS-GBOX] [China]

Posted Date: June 16,

[SilverKey Member](#)

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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

[Contact Now](#)

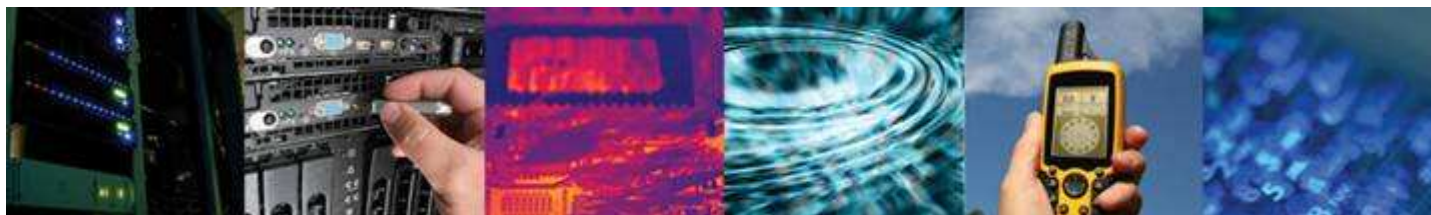
[Send Email](#)

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CTS-GBOX
25W 300M



GPS Jammer



The **GAARDIAN** - Partners



- GLA – General Lighthouse Authorities
 - User Community - Maritime
 - eLoran
- Imperial College London - Dept of Civil Eng
 - User Community - Transport
 - Integrity Monitoring Algorithms

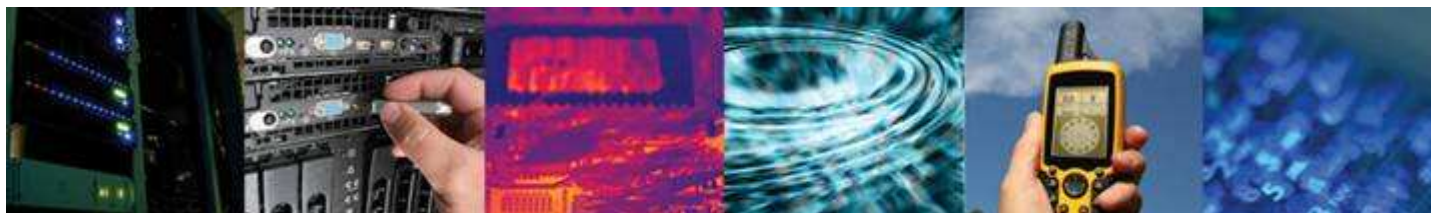


- University of Bath - Dept of Electrical & Electronics
 - GPS & Space Weather
- BT – Adastral Research Laboratories
 - User Community – Telecoms

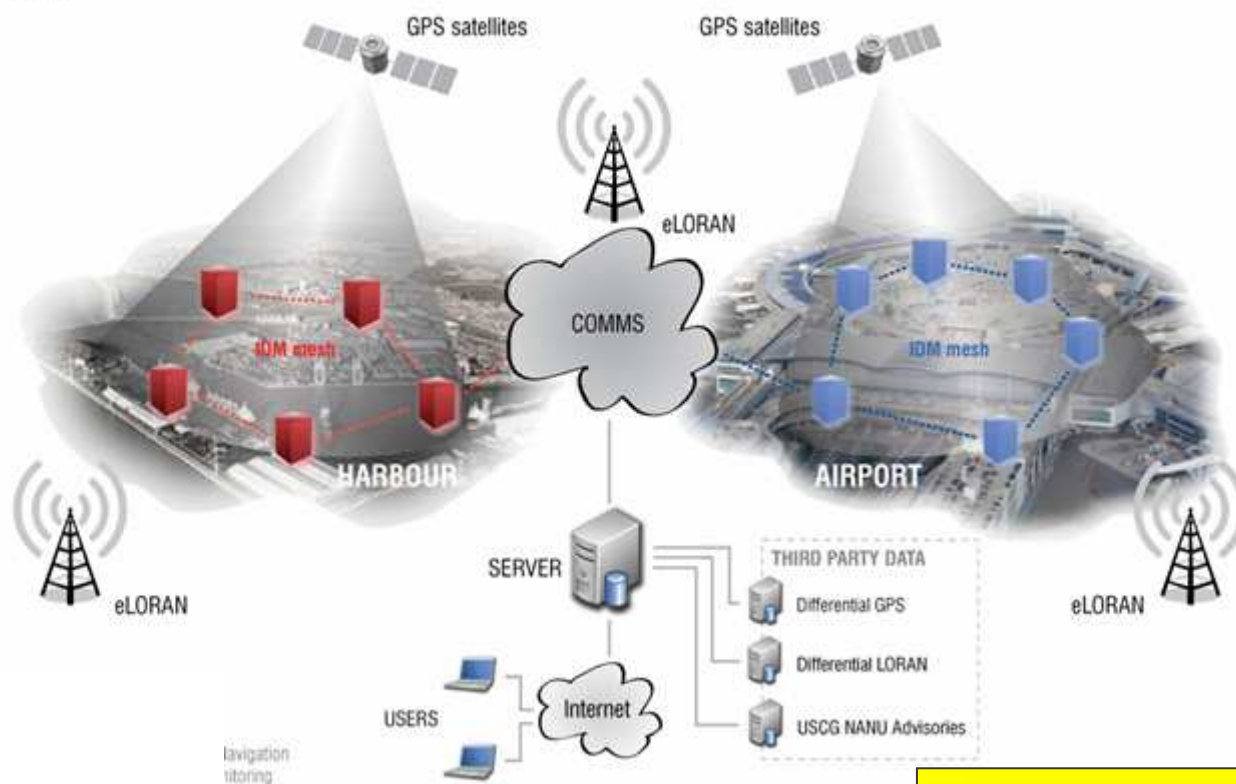


- Ordnance Survey
 - User Community – Land Geolocation
- NPL – National Physical Laboratory
 - Time, UTC Traceability
- Chronos Technology Ltd
 - Real time Timing measurement to ns granularity
 - GPS products, components & system integration
 - GAARDIAN Project Leader

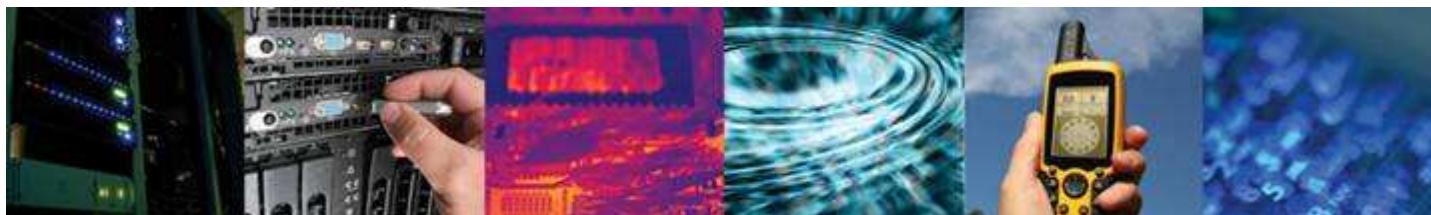




GARDIAN



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

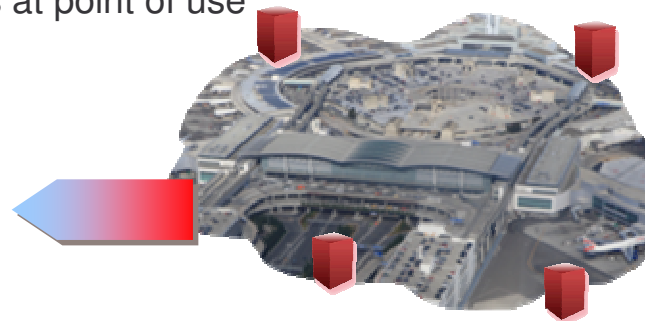


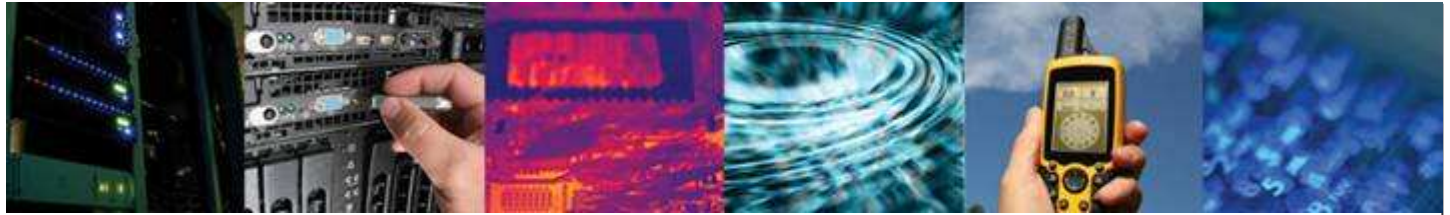
GAARDIAN – Deliverables

Users



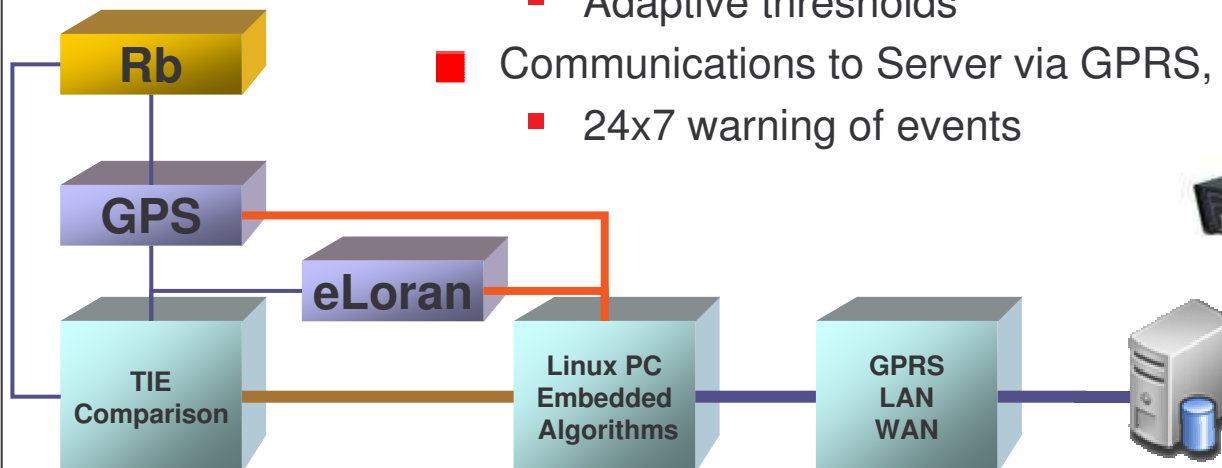
- Develop 24x7 web enabled IDM sensors
 - IDM – Interference, Detection & Mitigation
 - Which can be deployed as networks
- Locally deployed networks of IDM sensors in the vicinity of the user
 - GAARDIAN will deploy trial sensors to analyse data
 - Reduce data at source without losing “content”
 - Heartbeats 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

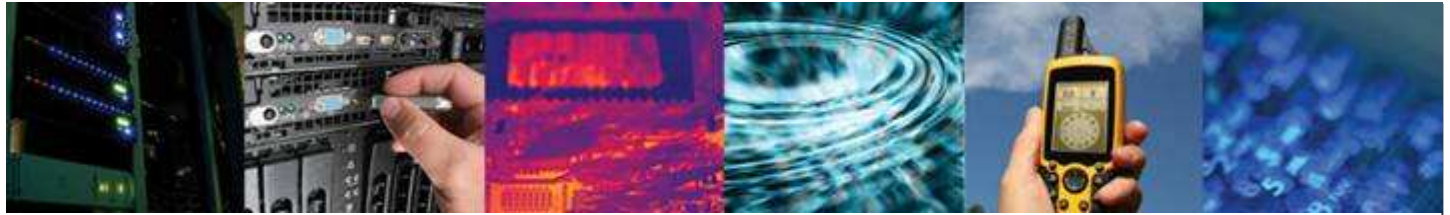




GAARDIAN – IDM Sensor

- 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

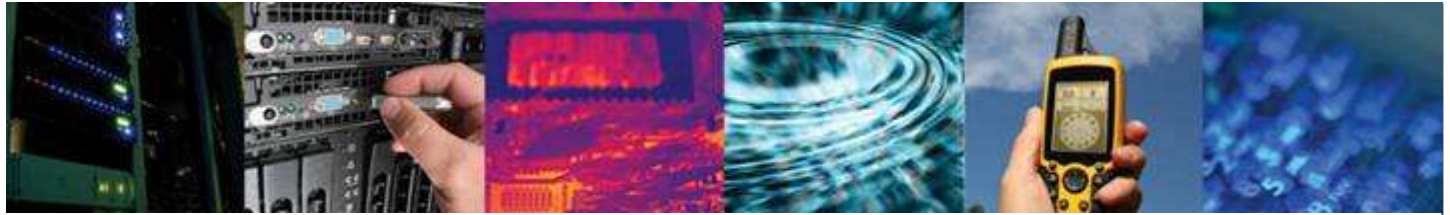




GAARDIAN – eLoran Timing Receiver



- Stratum 1 Frequency
- 1 PPS and 10 MHz outputs.
- External Loran H-Field antenna
- Completely independent from GPS
- Can deliver PRS frequency and UTC traceable time and timing with single transmitter.



Thank You & Questions

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www.chronos.co.uk

www.syncwatch.com

www.gps-world.biz