GPS-Free UTC TimeScale Using eLoran

ITSF 2015, Edinburgh, Scotland
4th November 2015

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Presentation Contents

- Review of eLoran Research by Chronos
- Synchronising a Cs to eLoran
- Latest International eLoran Situation
- Latest UK eLoran Situation
- Recommendations & Conclusion

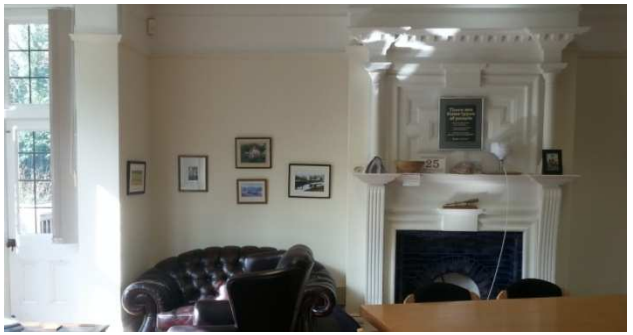
UK Research on eLoran

GAUL

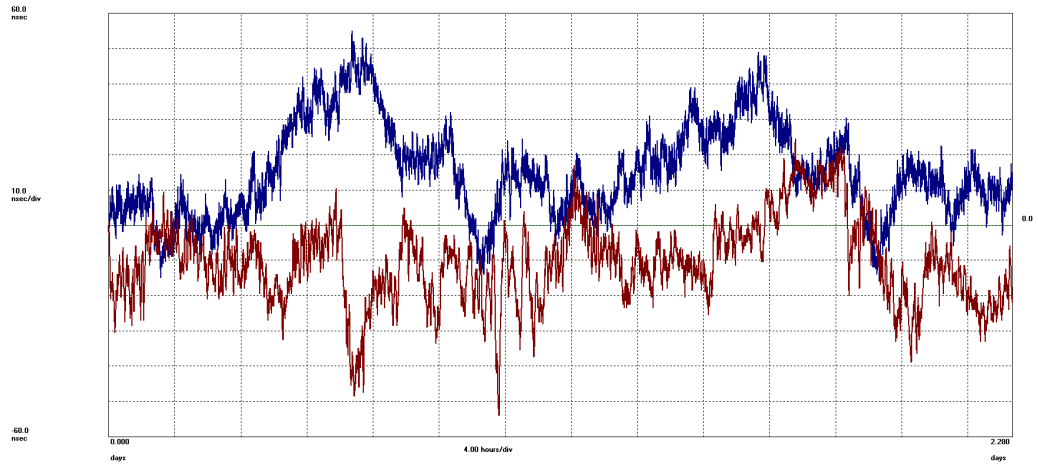
Innovate UK
Technology Strategy Board

Research Tools

- SENTINEL Research Platform
- Combined eLoran and GPS PoC Timing Receiver CTL8200
- H-Field Antenna

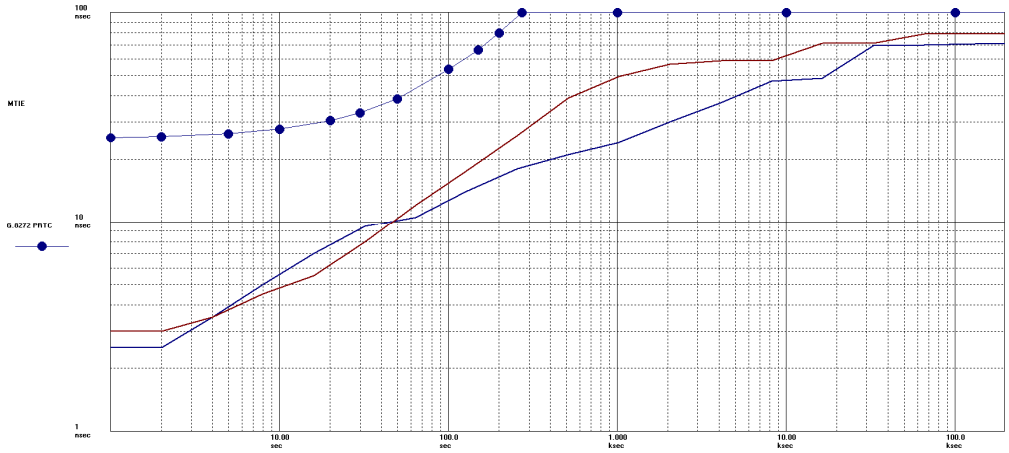


Some Results – TIE and MTIE

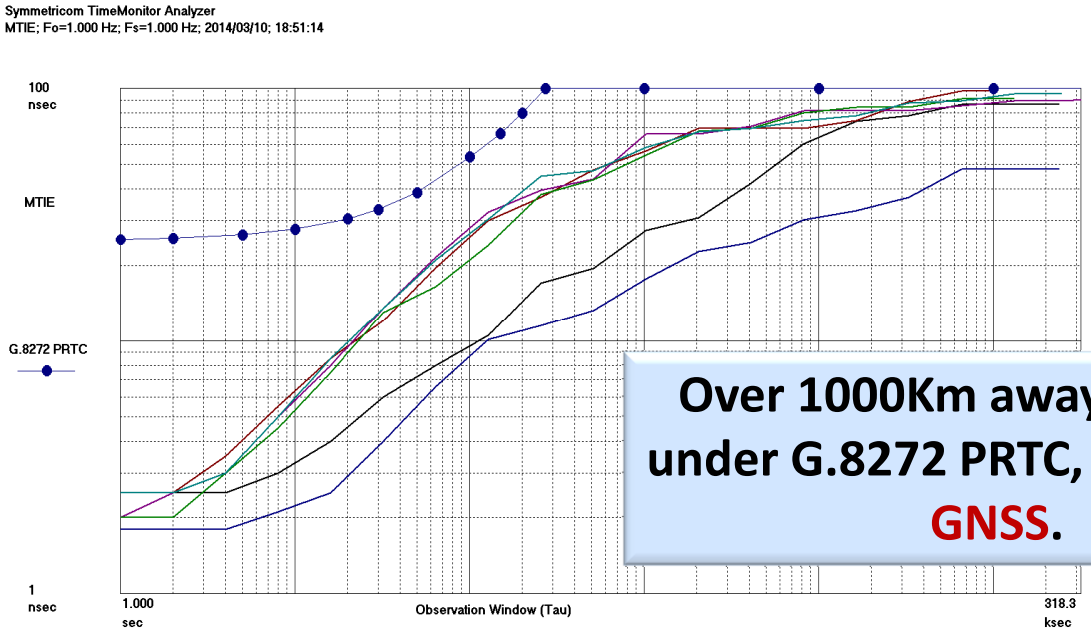


TIE Graphs
Blue: GPS
Red: Indoor eLoran
3 days, 10ns/div

MTIE Plots
Mask: G.8272 PRTC
Blue: GPS
Red: Indoor eLoran
3 days



Distant Station Testing



Over 1000Km away! indoors, under G.8272 PRTC, no external GNSS.

Colour	Station	Range	Location	Path
Red	Lessay	300km	Northern France	Land and Sea
Blue	Anthorn	350km	North-West England	Land
Cyan	Sylt	800km	North Germany	Land and Sea
Green	Soustons	900km	Southern France	Land and Sea
Magenta	Vaerlandet	1150km	South-West Norway	Land and Sea

GAUL – **G**alileo **A**ssist **U**sing e**L**oran

- Latest Innovate UK Grant – Oct 1st 2015
- Using Loran Data Channel
- Research Regional Differential UTC Corrections
- Broadcast Galileo (& GPS) Ephemeris Data
- Broadcast Local UTC corrections
- Broadcast System Health Information

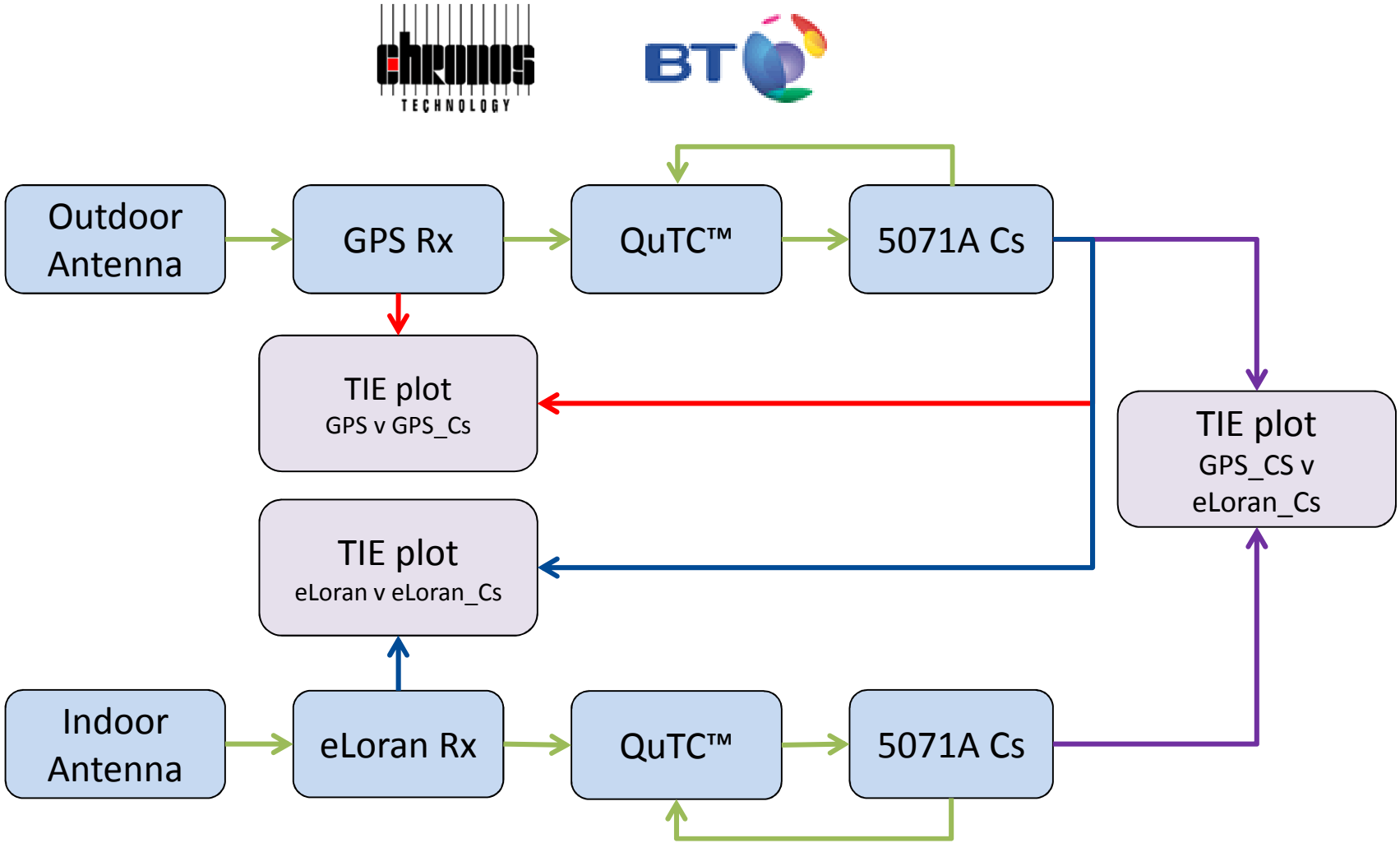
Loran Data Channel Structure

LDC Message Type 13 Reserved for ASF Differential Corrections for the Timing Community

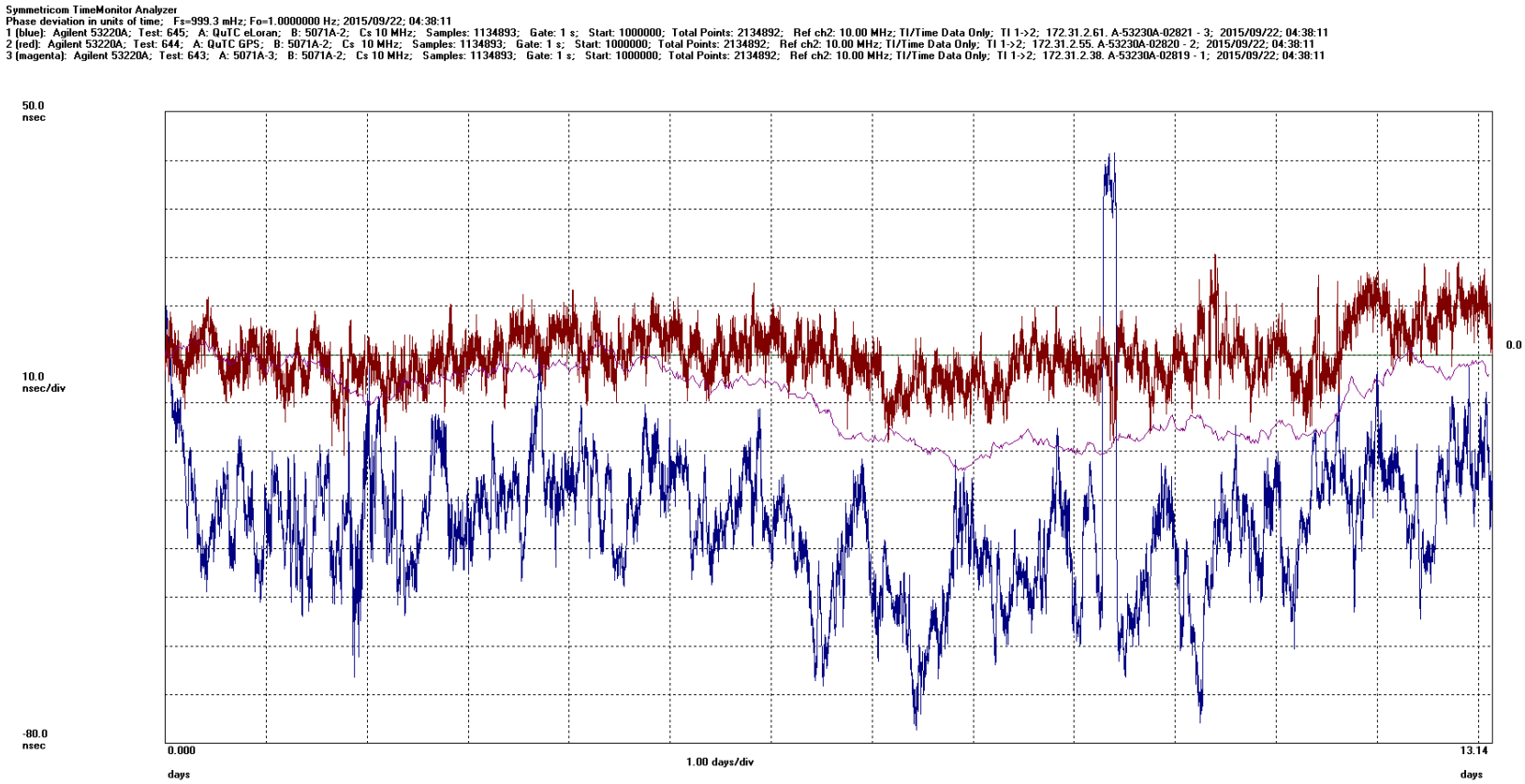
TABLE 2-3. EUROFIX MESSAGE DESCRIPTION AND STATUS

Message Type	Bits	Description	Status
1	0001	Eurofix DGPS correction (single sat)	Fixed
2	0010	Eurofix DGlonass correction (single sat)	Fixed
3	0011	Reserved	
4	0100	Eurofix Station ID/Health message	Fixed
5	0101	Short Message Service (SMS)	Fixed
6	0110	Loran UTC Message	Fixed
7	0111	Reserved	
8	1000	Reserved	
9	1001	Reserved	
10	1010	Differential eLoran Phase Corrections	Fixed
11	1011	Differential eLoran Almanac data	Tentative
12	1100	Third Party Data Client	Fixed
13	1101	Reserved	
14	1110	Reserved	
15	1111	Reserved	
16	0000	Reserved	

Synchronising Cs to eLoran



Results

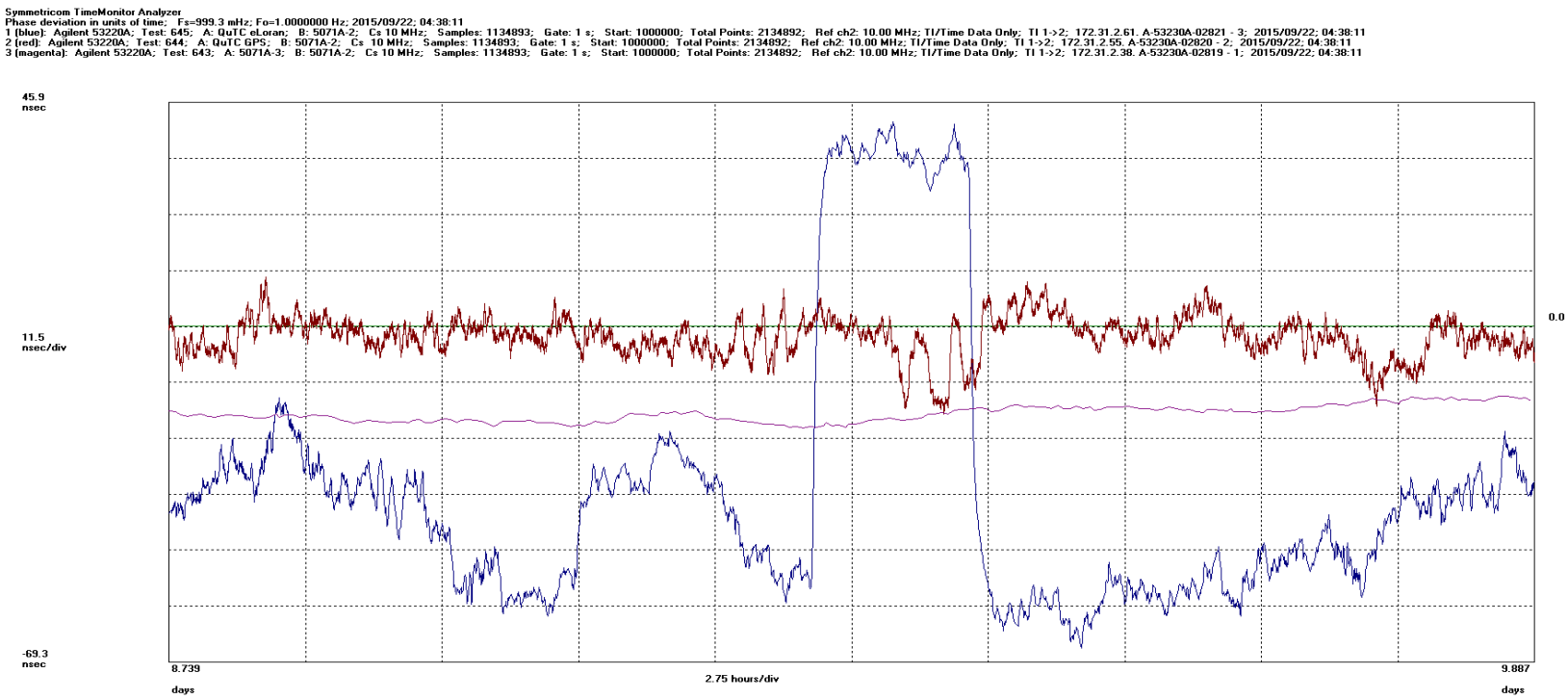


Red = GPS Caesium v GPS

Blue = eLoran Caesium v eLoran

Magenta = Caesium synchronised to eLoran v Caesium synchronised to GPS

First Thursday



Red = GPS, Blue = eLoran, Magenta = Cs synchronised to eLoran
Phase jump on eLoran due to adjacent transmitter maintenance causing ground plane change.
Note minimal impact on Magenta Cs performance

International Situation - USA

- Strong movement to bring back eLoran- Initially for Timing
- ***"You Placed this Country at Risk"*** Highlights of 7/28 Congressional Hearing - A shortened summary is available here..
  - https://www.youtube.com/watch?v=MrZg8QdHvQQ&utm_source=Annual+Mtg+FINAL+evite+LIST&utm_campaign=81e150a82a-ummer_eNews&utm_medium=email&utm_term=0_147758946a-81e150a82a-165977625
- The full hearing is here (~1 Hour)
  - https://www.youtube.com/watch?v=8Tb6xW4XkYk
- Report by Dee Ann Divis - Washington Correspondent for Inside GNSS
  - http://rntfnd.org/2015/08/01/key-lawmakers-move-to-make-dod-responsible-for-eloran-gps-backup/

International Situation - USA

"GPS use by Military… a Vulnerability" 2014

- US administration (Army acting as the agent for Defense) has asked industry for quotes on 50,000 eLoran sets
- Department of Transportation went out for public comment and got overwhelmingly positive response on proposal to establish eLoran
- Because of the above plus rumors heard, expect USA to announce in the next couple weeks it's going to look for a commercial partner to build an eLoran timing system

UK Situation

- Anthorn & Sylt
  - Operated by the General Lighthouse Authorities of United Kingdom and Ireland
- Public/Private Partnership Discussions Underway
- Innovate UK - GAUL
- Defence Select Committee – SDSR Submission
  - Chronos

Europe Situation

- France will switch off Dec 31st 2015
  - Control Centre Brest (CCB)
  - Transmitter @ Lessay
  - Transmitter @ Soustons
- Norway
  - Norway likely to follow France
- Denmark
  - Ejde – Will lose French finance support

UK Government - SDSR

Strategic Defence and Security Review Public Engagement

From: Ministry of Defence, Foreign & Commonwealth Office, Home Office, Department for International Development and Cabinet Office
First published: 5 August 2015

Work on the 2015 National Security Strategy (NSS) and Strategic Defence and Security Review (SDSR) is now under way.

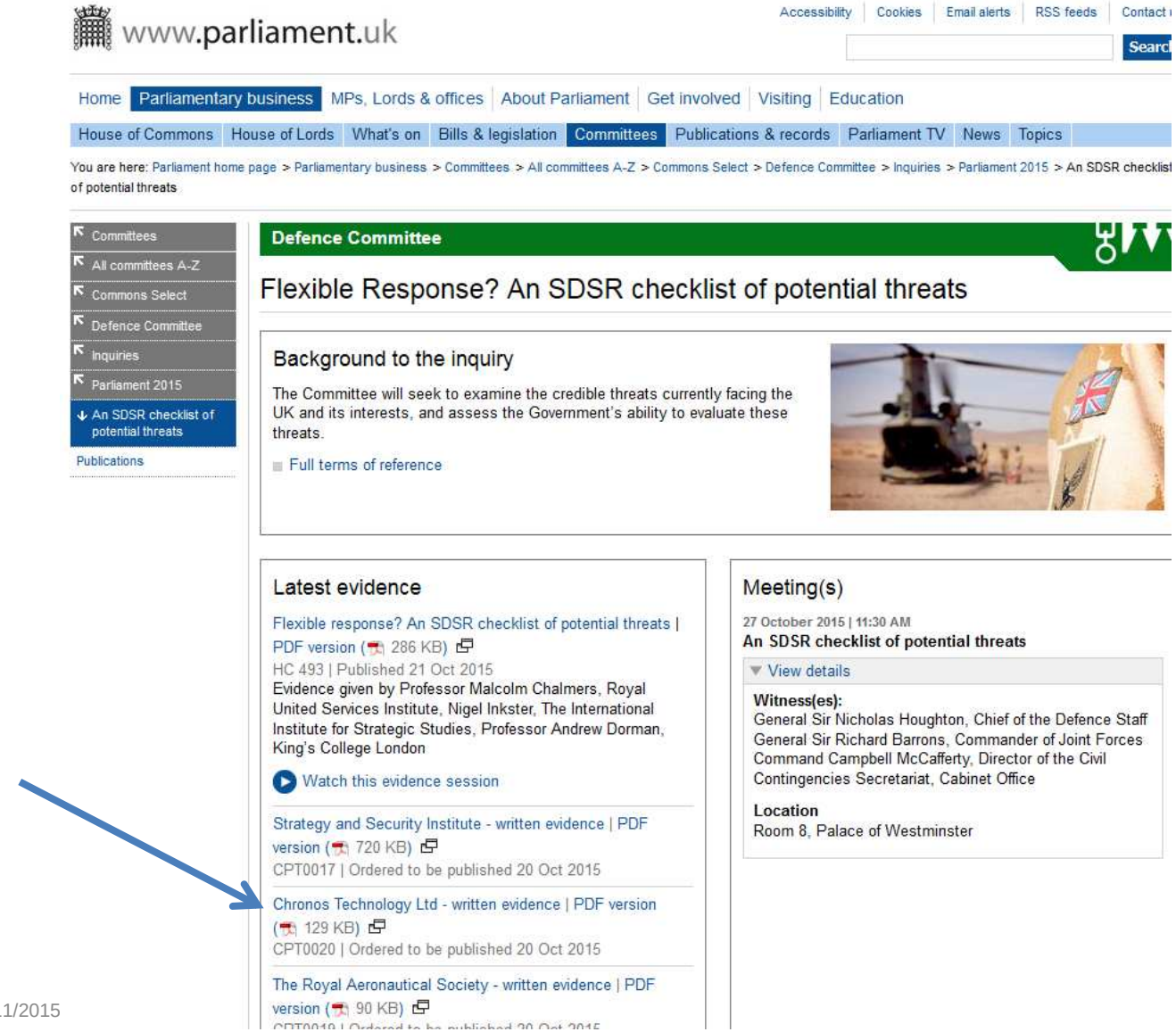
Whitehall

The Cabinet Office, Department for International Development, Foreign and Commonwealth Office, Home Office, Ministry of Defence as well as other departments are working together on the NSS and SDSR. This review will look at the full range of threats that we face; it will examine the capabilities we need to counter them; and help us judge how to resource those capabilities.

As part of this work, we are engaging with a range of audiences, including Parliament, academics, industry, think tanks, Allies and partners, non-governmental organisations and the public. This is why we

http://www.parliament.uk/business/committees/committees-a-z/commons-select/defence-committee/inquiries/parliament-2015/an-sdsr-checklist-of-potential-threats/

SDSR - Submission



SDSR – Credible Threats

- A surge in serious, organised crime such as to have direct economic/social consequences
- Hostile attacks upon UK cyber space
- Severe disruption to information received, transmitted or collected by satellites, possibly as the result of a deliberate attack by another state
- A large scale conventional military attack on the UK
- International terrorism

- What are the credible threats to the UK and its interests posed in maritime, land and air domains

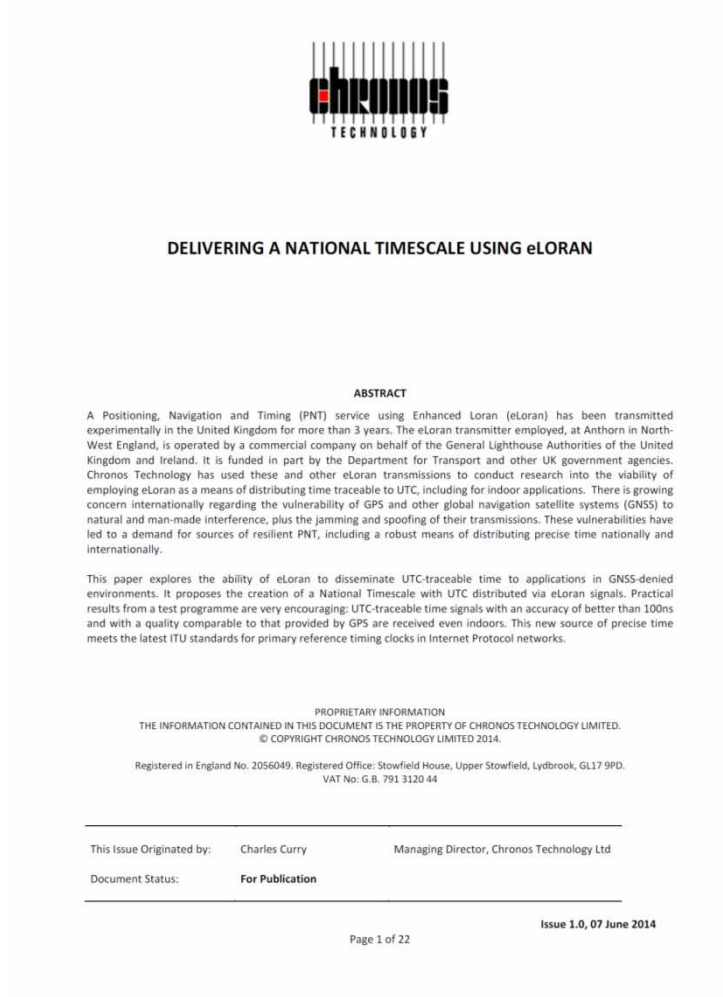
SDSR - Threat Evaluation

- What is the government's ability to evaluate credible threats to the UK and its interests?
- What is the government's ability to 'think the unthinkable' and how flexible are the UK's thought process and planning process to meet the wide range of credible potential dangers?
- Does the government have the ability for generic capability and capacity building in the event of an unforeseen threat?

Chronos Recommendations

- Acknowledge threat from GPS (GNSS) Jamming and Spoofing
- Vulnerability to precise time used to support Critical National Infrastructure Operations
  - Applications < 1 Microsecond
- Urgently review Mitigation Solutions that can deliver sovereign time and position
  - eLoran
- Acknowledge that the existing NW Europe infrastructure could serve in excess of 350 million people

Further Reading



DELIVERING A NATIONAL TIMESCALE USING eLORAN

ABSTRACT

A Positioning, Navigation and Timing (PNT) service using Enhanced Loran (eLoran) has been transmitted experimentally in the United Kingdom for more than 3 years. The eLoran transmitter employed, at Anthorn in North-West England, is operated by a commercial company on behalf of the General Lighthouse Authorities of the United Kingdom and Ireland. It is funded in part by the Department for Transport and other UK government agencies. Chronos Technology has used these and other eLoran transmissions to conduct research into the viability of employing eLoran as a means of distributing time traceable to UTC, including for indoor applications. There is growing concern internationally regarding the vulnerability of GPS and other global navigation satellite systems (GNSS) to natural and man-made interference, plus the jamming and spoofing of their transmissions. These vulnerabilities have led to a demand for sources of resilient PNT, including a robust means of distributing precise time nationally and internationally.

This paper explores the ability of eLoran to disseminate UTC-traceable time to applications in GNSS-denied environments. It proposes the creation of a National Timescale with UTC distributed via eLoran signals. Practical results from a test programme are very encouraging: UTC-traceable time signals with an accuracy of better than 100ns and with a quality comparable to that provided by GPS are received even indoors. This new source of precise time meets the latest ITU standards for primary reference timing clocks in Internet Protocol networks.

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Document Status:	**For Publication**	

Issue 1.0, 07 June 2014

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- **Chronos White Paper**
  - "Delivering a National Timescale using eLoran"
- http://www.chronos.co.uk/index.php/en/product-groups/time-and-timing/eloran-timing

Find Out More?

RESILIENT NAVIGATION and TIMING FOUNDATION

http://www.rntfnd.org

- Improve anti-jamming and spoofing deterrence and enforcement
- Promote establishment of resilient terrestrial navigation and timing systems
- Looking at setting up an EU/UK Chapter

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