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Robust and resilient PNT: the key to our future

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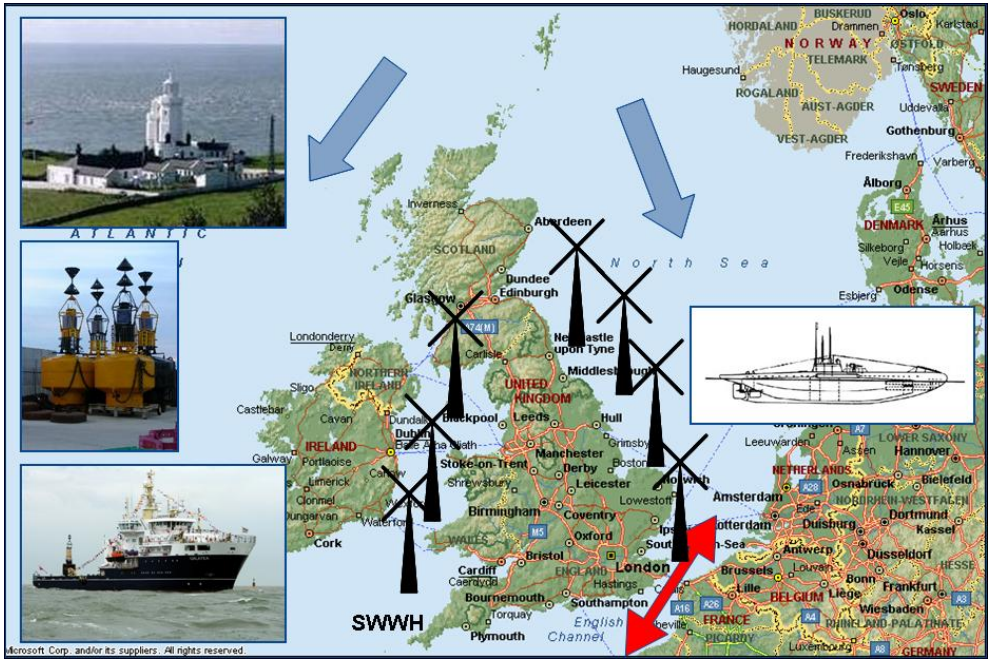
Our Future


SWWH
North Sea
English Channel
ATLANTIC
SCOTLAND
IRELAND
UNITED KINGDOM
NORWAY
SWEDEN
DENMARK
NETHERLANDS
BELGIUM
FRANCE
GERMANY
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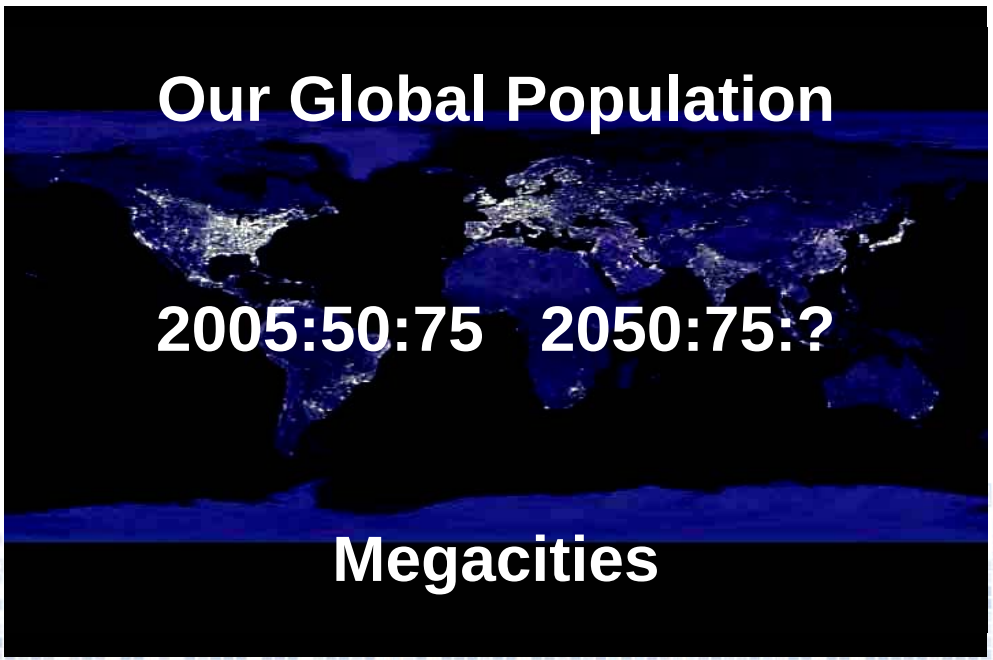
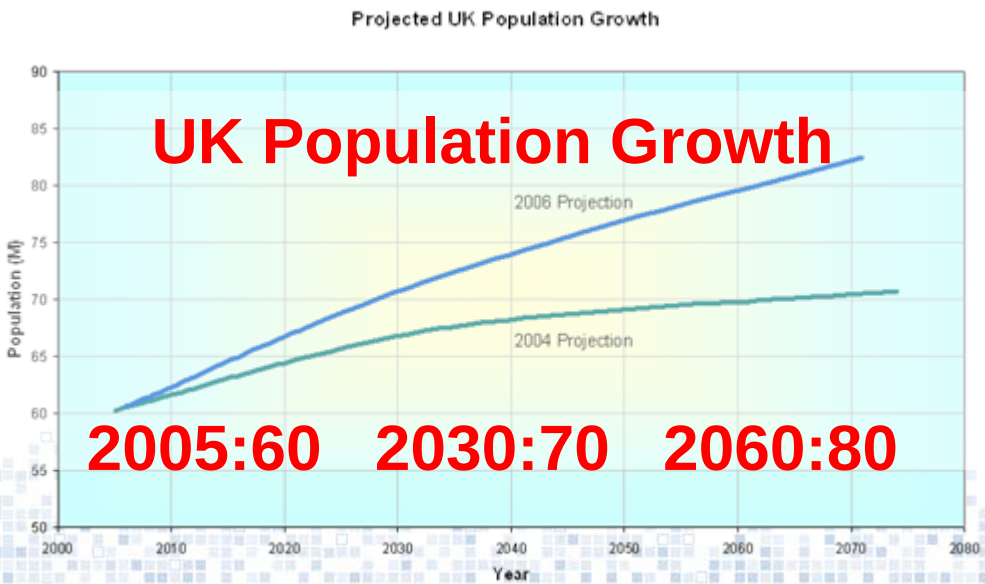
Social & Business Networks
Facebook 52
Myspace 144
21c Telecoms


Our Global Population
2005:50:75
2050:75:?
Megacities


Projected UK Population Growth
UK Population Growth
2006 Projection
2004 Projection
2005:60
2030:70
2060:80
Population (M)
Year
90
85
80
75
70
65
60
55
50
2000
2010
2020
2030
2040
2050
2060
2070
2080

Our climate

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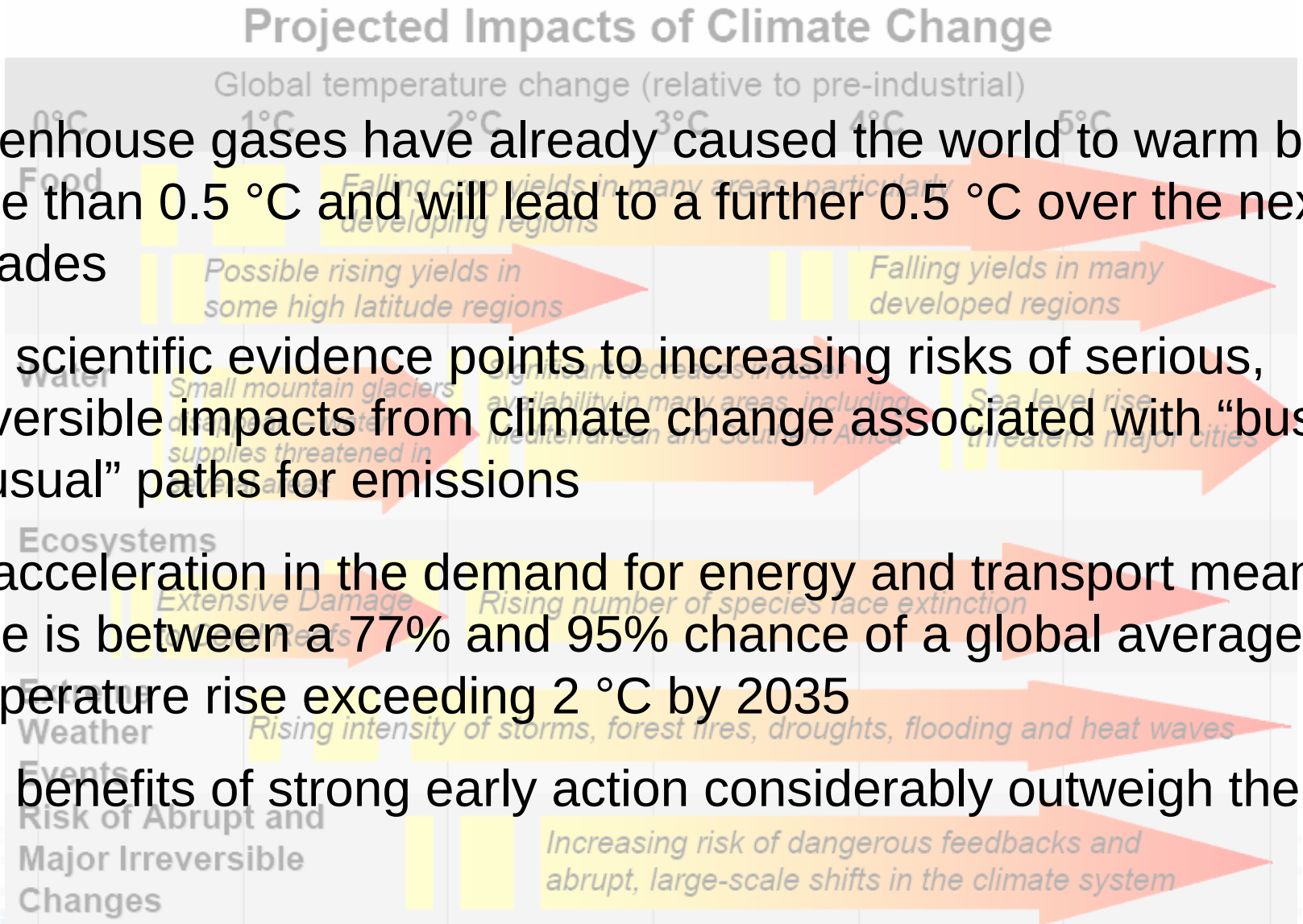

- Greenhouse gases have already caused the world to warm by more than 0.5 °C and will lead to a further 0.5 °C over the next few decades
- The scientific evidence points to increasing risks of serious, irreversible impacts from climate change associated with “business as usual” paths for emissions
- An acceleration in the demand for energy and transport means there is between a 77% and 95% chance of a global average temperature rise exceeding 2 °C by 2035
- The benefits of strong early action considerably outweigh the costs

Ref: HM Treasury, Stern Review of the economics of climate change, www.hm-treasury.gov.uk

Our coast

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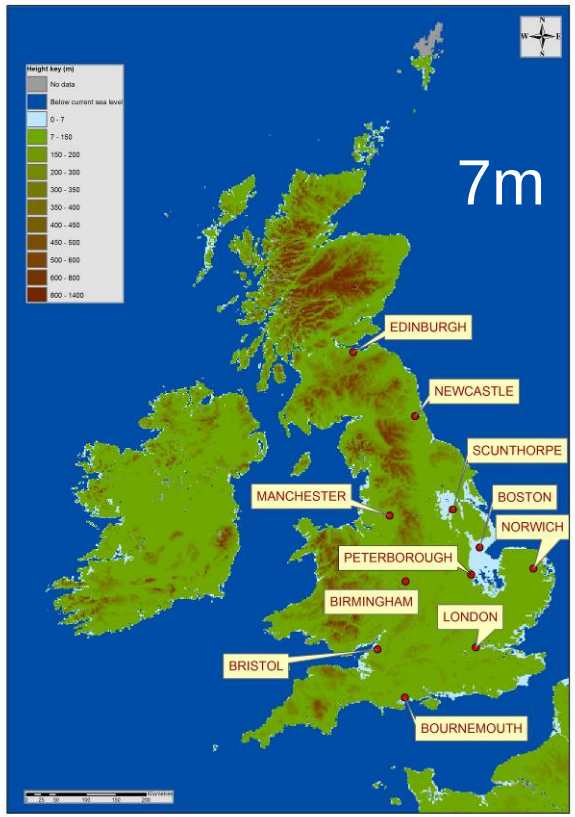

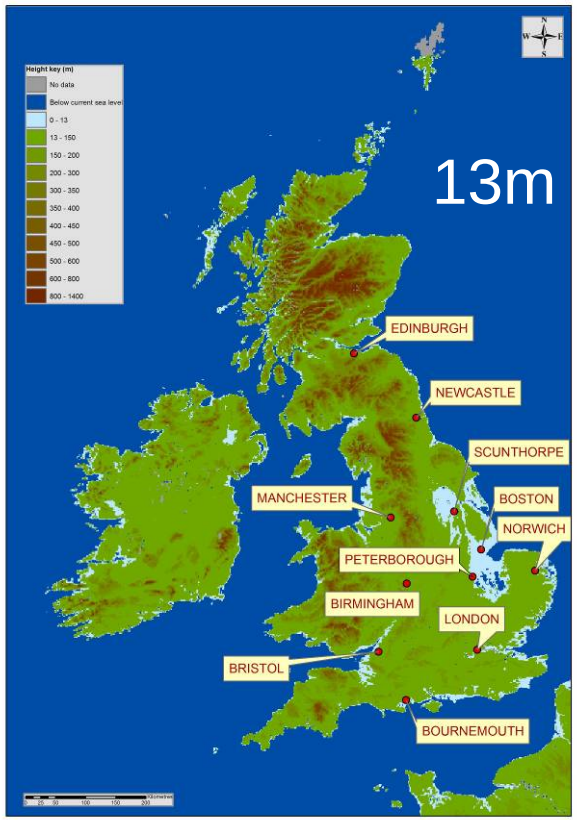

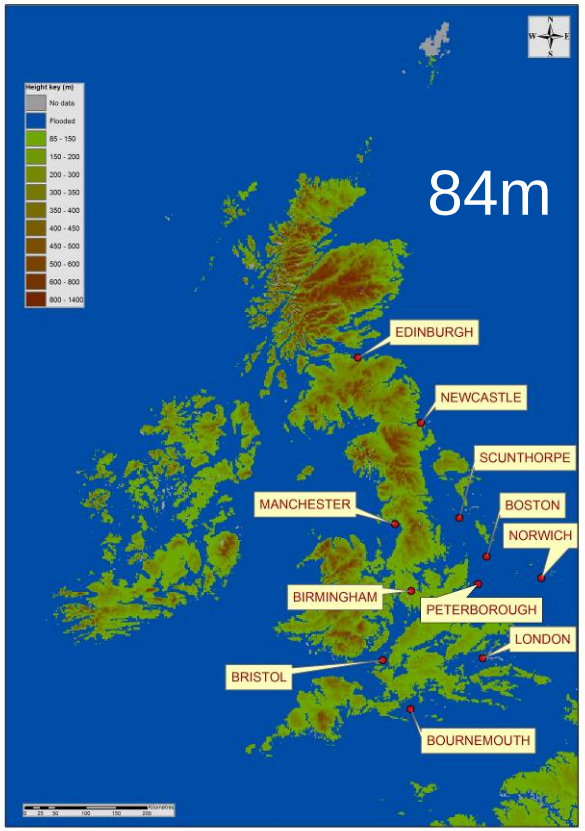

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The Strategic Requirement for PNT

Critical Infrastructure: the lifeblood of modern society

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"*The security and economy of the European Union as well as the well-being of its citizens depends on certain infrastructure and the services they provide. The destruction or disruption of infrastructure providing key services could entail the loss of lives, the loss of property, a collapse of public confidence and morale in the EU. Any such disruptions or manipulations of critical infrastructure should, to the extent possible, be brief, infrequent, manageable, geographically isolated and minimally detrimental to the welfare of the Member States, their citizens and the European Union*."

Source: *European Commission Communication on the European Programme for Critical Infrastructure Protection (EPCIP)*

What happens when it fails? - Broadband networks

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- Example: recent damage to sub-sea cables in the Mediterranean and the Gulf Region caused major disruption to internet traffic in Egypt, the Gulf and South Asia. Even though the service outages were very short and rapidly overcome by re-routing, the economic impacts were reported as very severe.
- Swiss analysts have shown that a deliberate denial of service would cost the Swiss economy €200M for 24 hours or €3.5B for one week
- Simple scaling from the Swiss results indicates that the cost of a 24-hour broadband outage across Denmark, France, Germany, Netherlands, Norway and the UK might be as high as €3.4 billion.

Source: *An Economic Damage Model for Large-Scale Internet Attacks*, Thomas Dubendorfer, Arno Wagner, Bernhard Plattner, Computer Engineering and Networks Laboratory (TIK), Swiss Federal Institute of Technology, ETH-Zentrum, CH-8092 Zurich

What happens when it fails? - Power systems

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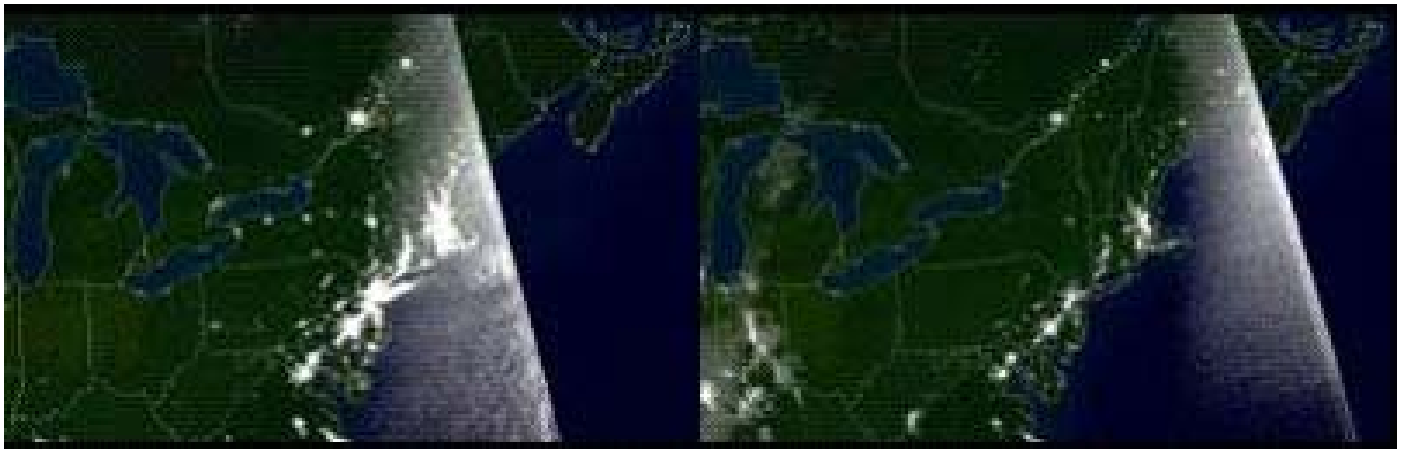

- On August 14, 2003, large portions of the Midwest and Northeast United States and Ontario, Canada, experienced an electric power blackout. This affected about 50 million people with a demand for 61,800 MW of electricity. In some parts of the US, the blackout lasted for 4 days.
- Estimates of the total costs of these events in the United States ranged between €2.5B and €6.3B.

Source: "Final Report on the August 14, 2003 Blackout in the United States and Canada: Causes and Recommendations," U.S.-Canada Power System Outage Task Force, April 5, 2004.
Source: The Economic Impacts of the August 2003 Blackout, Prepared by the Electricity Consumers Resource Council (ELCON) - February 9, 2004.

What happens when it fails? - Marine navigation

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- Evidence from the Norwegian Hull Club directly links the rise in the number of accidents at sea with human and navigational error. Statistics show that between 2002 and 2006, groundings and collisions accounted for 21% of claims by number but 37% by cost.
- The MSC Napoli was damaged in a storm in Jan 2007. It was then intentionally beached to minimise its potential environmental impact. To April 2008, the salvage and clean-up has cost €85M.
- In March 1989, the Exxon Valdez ran aground in Alaska spilling more than 32000 tonnes of oil. The clean-up cost was over $2B.

Source: Crew quality hits marine claims. Lloyds List, No 59650, 14 April 2008

PNT is the core enabler

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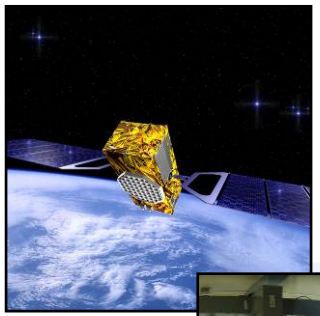
Energy & Communications

Positioning, Navigation & Timing



The Strategic Requirement

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“Always On” PNT

Robust, resilient and cost-effective PNT foundation

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Making PNT Robust and Reliable


While allied with Iron Man, Spider-Man wore a new costume that was equipped with … a short-range GPS microwave communications system (with a built-in fire, police and emergency scanner)
Source: www.marvel.com
MARVEL

How vulnerable is GPS?

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"If a car remote door opener operated continuously at the GPS frequency, GPS reception would not be possible within a radius of less than ~0.5km"

Source: Qinetiq. *Study into the impact on capability of UK commercial and domestic services resulting from the loss of GPS signals*. August 2001

"Like any radionavigation system, GPS is vulnerable to interference that can be reduced but not eliminated … The consequences of loss of the GPS signal can be severe … As GPS penetrates into the civil infrastructure, it becomes a tempting target."

Source: John A Volpe National Transportation Systems Center. *Vulnerability assessment of the national transportation infrastructure relying on GPS*. August *2001*

"Fewer than 40 of the 137 applications analysed would remain operational following the loss of GPS and its augmentations … Critical infrastructure applications (e.g. telecommunications and other utilities) should therefore implement diverse services to mitigate vulnerability and ensure continuity of service"

Source: Helios Technology Ltd. *Recommendations Towards a European Union Radionavigation Plan (ERNP) Executive Summary. October 2004*

Making PNT "Always on"

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- Rightly, GPS and Galileo will form the core of the global PNT system. Together, possibly enhanced by augmentation systems, these systems will overcome some of the systemic vulnerabilities of GPS alone, e.g. system failures in one or other of the satellite constellations
- Enhancing system diversity through eLoran will mitigate common GNSS signal and user vulnerabilities
- eLoran is an independent, dissimilar, complement to GNSS. It allows GNSS users to retain the safety, security, and economic benefits of GNSS, even when their satellite services are disrupted

"The ultimate compliment to GPS is that it is taken for granted … a contingency augmentation, like eLoran, is essential and would act as a deterrent to terrorism"

Source: Prof Brad Parkinson, US National Space Based PNT Executive Board minutes, 29-30 March 2007

The Strategic Requirement

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"Always On" PNT

- Robust, resilient and cost-effective PNT foundation

The *de facto* standard providing continuity	GPS
Mitigate system vulnerabilities	Galileo
Mitigate signal and user vulnerabilities	eLoran

Three systems – the 3-D "cocked hat"

The Global PNT Consensus

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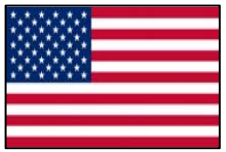
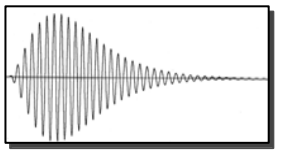
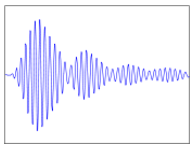
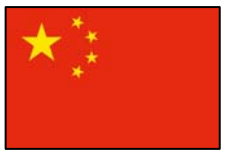
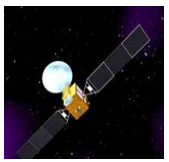
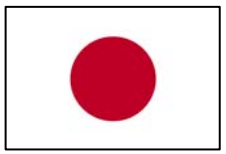
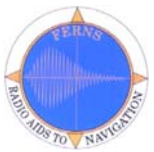
Core constellation providers	Core constellation	Complementary systems
 United States of America	 GPS	 LORAN-C / enhanced LORAN
 Russia	 GLONASS	  LORAN-C / Chayka
 Peoples Republic of China	 COMPASS / BeiDou II	 LORAN-C
 Japan	 QZSS	 LORAN-C
 European Union	 Galileo	?

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The New UK eLoran Station

Process

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- 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"
- Progress
  - 7 July 2007 – transmitter moved from Rugby
  - 1 October 2007 – first signals from Anthorn for test and verification
  - 1 December 2007 – trial signals operational
  - 15 January 2007 – service launched
- Next Steps
  - UTC, DGPS, DLoran from Anthorn

Site Pictures

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Source: VT Communications

The containerised transmitter and connection to the T-antenna

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Source: VT Communications

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Summary

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Robust, reliable and high-performance positioning, navigation and timing (PNT) is the lifeblood of a modern society's critical infrastructure

In the future, GPS and Galileo will rightly form the cornerstone of the future European PNT environment

Playing a supporting role, eLoran will make our PNT foundations robust and resilient and allow PNT users to retain their safety, security and economic benefits even when their satellite services are disrupted

It is important for policy makers, service providers and users to recognise the benefits of having two satellite navigation systems, Galileo and GPS as well as the benefits of system diversity based on eLoran

European eLoran Forum

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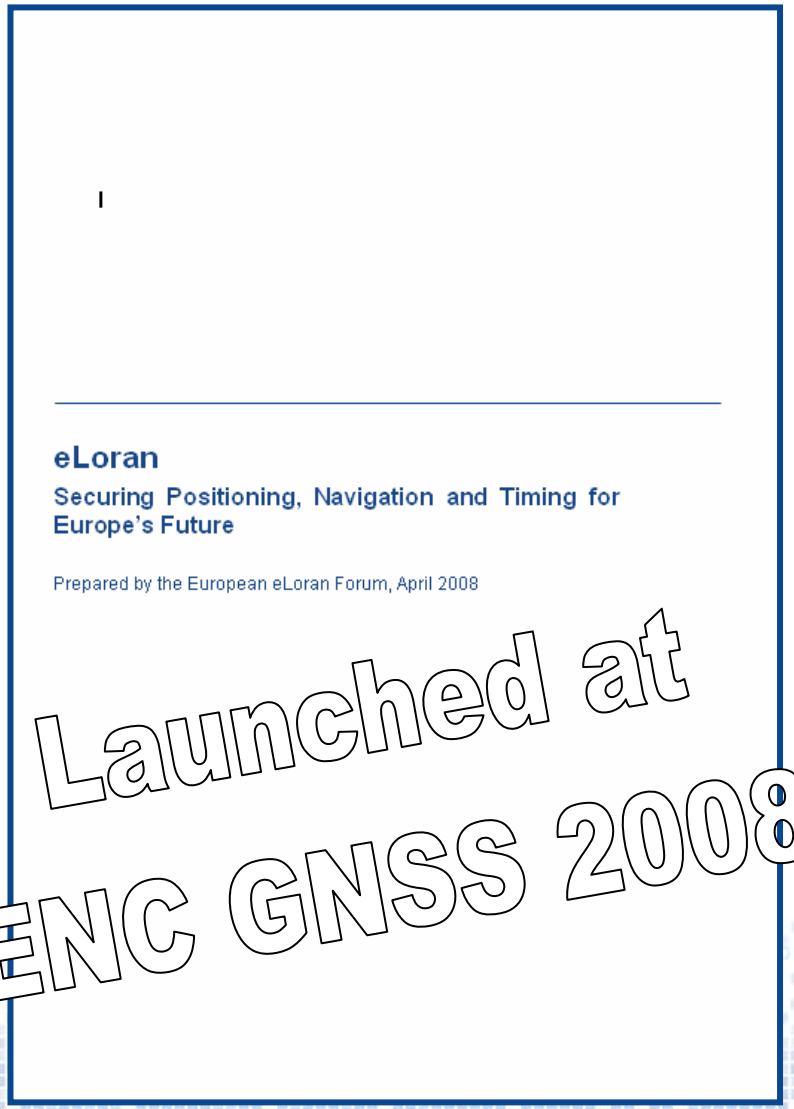
The EEF is an *ad hoc* group of European organisations that have an interest in eLoran because they currently operate, fund or host eLoran infrastructure. Current members include the Danish Maritime Safety Agency, France, and the General Lighthouse Authorities of the United Kingdom and Ireland. Its purpose is to support the successful introduction, operation and provision of eLoran services in Europe as part of a European Radio Navigation Plan.



The Danish Maritime Safety Administration (DMSA) hosts the Ejde station, currently funded by France. Norway is an observer