

Economic Impact of the loss of GNSS to the UK

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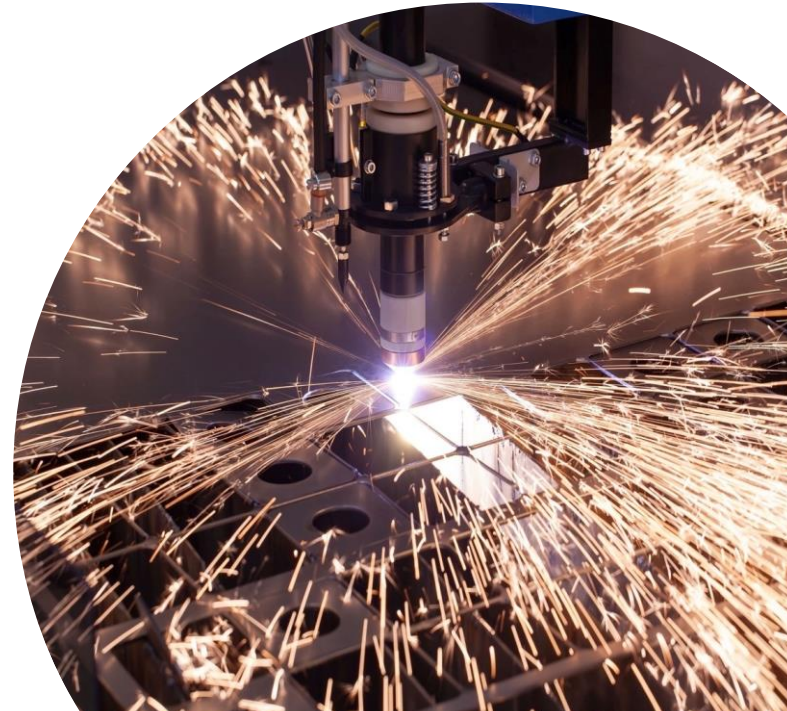
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Innovate UK

Innovate UK – the UK's innovation agency

Innovate UK drives **productivity and growth** by supporting businesses to realise the potential of new technologies, develop ideas and **make them a commercial success**.

To **stay competitive as an advanced economy**, we need to do things that others cannot do, or to do things in different and better ways.



Investment of
£2.2bn
since 2007



industry match
funding taking
the total value
of projects above

£3.75bn



Up to
£16bn
in added value
to the economy



up to

£7.30

for every **£1**
we've invested.



We've funded around
11,000
projects



8,000
unique
organisations
involved

8 jobs for each
organisation
involved

70,000
jobs created in total



Key points in talk

- Motivation for Study
- Research Objectives and exam question
- What did we do?
- Some caveats
- Key findings



Motivation for study

- Widespread use
- Known and increasing vulnerabilities
- Many technical studies about impact of vulnerabilities
- Previous work recommending impact assessments
- No UK economic impact study (gap in knowledge)
- Motivation is to fill the gap

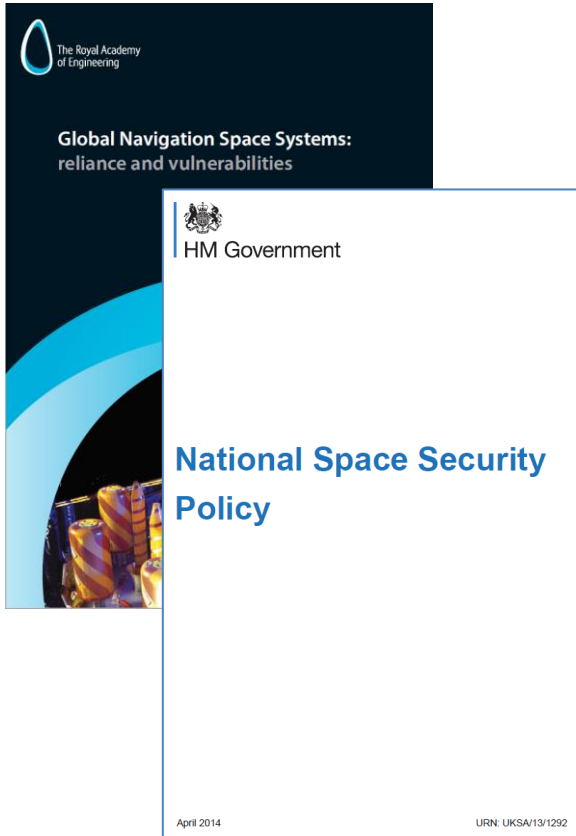


Research Objectives

- Identify sectors using GNSS
- What is the economic benefit that GNSS technology and services bring to the UK?
- Estimate the economic impact to the UK (government and private sector) of a disruption to GNSS functionality of up to five days
- Identify the cost and effectiveness of mitigation strategies.
- High-level assessment of the impact of UK public funding of GNSS

What would be the economic impact on the UK through the loss, howsoever caused, of GNSS, for **up to five days?**

Why 5 days?



The Royal Academy of Engineering

Global Navigation Space Systems:
reliance and vulnerabilities

HM Government

**National Space Security
Policy**

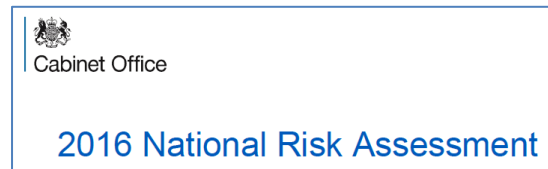
April 2014

URN: UKSA/13/1292

The image shows the cover of a document titled 'National Space Security Policy' published by HM Government in April 2014. The cover features the Royal Academy of Engineering logo and the text 'Global Navigation Space Systems: reliance and vulnerabilities'. The document is dated April 2014 and has the URN UKSA/13/1292.



Image: NASA (2014)

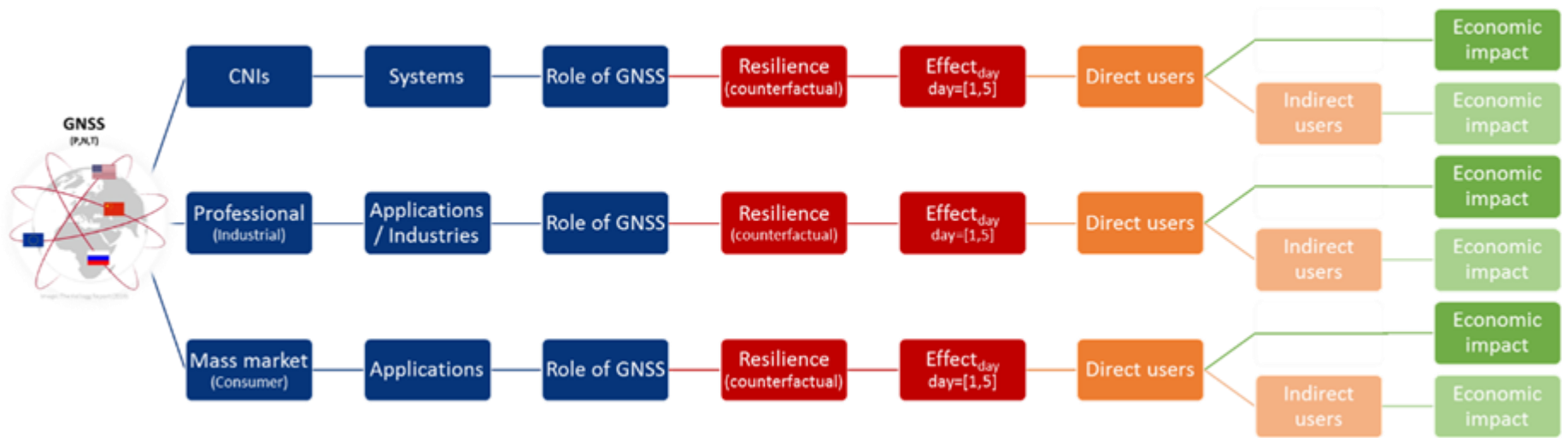


Cabinet Office

2016 National Risk Assessment

The image shows the cover of the '2016 National Risk Assessment' document published by the Cabinet Office. The cover is white with a blue border and features the Cabinet Office logo and the title '2016 National Risk Assessment' in blue text.

Establish Benefits Determine Impacts



Caveats

- Based on codified publicly available information, LE knowledge of downstream GNSS applications, and information gathered through interviews with more than 35 stakeholders
- The report is agnostic to the actual source of the considered disruption.
- The disruption to GNSS is considered as a standalone event – pre-existing redundancy systems are assumed to operate as planned.
- Report presents up-to-date information (Mar 17) gathered.
- Two counterfactuals: The benefits of GNSS are estimated against a baseline in which each application has evolved along a different path using the next best alternative to GNSS. The loss estimated against a baseline in which GNSS is the chosen technology, and considers also degradation in skills associated with increasing reliance on GNSS over time.

Identify Mitigations and possible costs (not shown)

Technology	Potential Coverage	2D/3D Positioning	Accuracy
eLoran	National / Global	2D	10-20m – improving to 5m with <u>eDLoran</u>
<u>Locata</u>	Local / Regional	3D	< 1cm
<u>Omnisense S500</u>	Local	3D	20cm-2m
Iridium STL service	Global	3D	Horizontal: 20m-50m unassisted and 10m in augmentation scenarios (1σ)

Source: London Economics research based on sources referenced in this section.

In addition to the four positioning and navigation-relevant technologies, four additional technologies have been identified specifically for the Timing property of GNSS. Table 4 summarises the findings for all eight technologies that are discussed in turn in this section.

Table 4 Timing Accuracy of Mitigation Technologies

Technology	Accuracy
NTP timing servers (NPL)	$\leq 1\text{ms} - 30\text{ms}$
NPL MSF 60 kHz radio signal	10ms
PTP	10ns ($1 \cdot 10^{-5}\text{ms}$) - 100ns (0.0001ms) – but dependent on network setup and clock used as a timing source
NPL-Time	100ns (0.0001ms)
eLoran	100ns (0.0001ms)
<u>Locata</u>	2.5ns ($2.5 \cdot 10^{-6}\text{ms}$) – potentially much better
<u>Omnisense S500</u>	100 μs (0.1 ms) – possibly up to <u>10ns</u> ($1 \cdot 10^{-5}\text{ms}$) in the future
Iridium STL service	Compatible with IEEE-1588 standards: 10ns-100ns

Source: London Economics research based on sources referenced in this section.

Assess impact of public funding

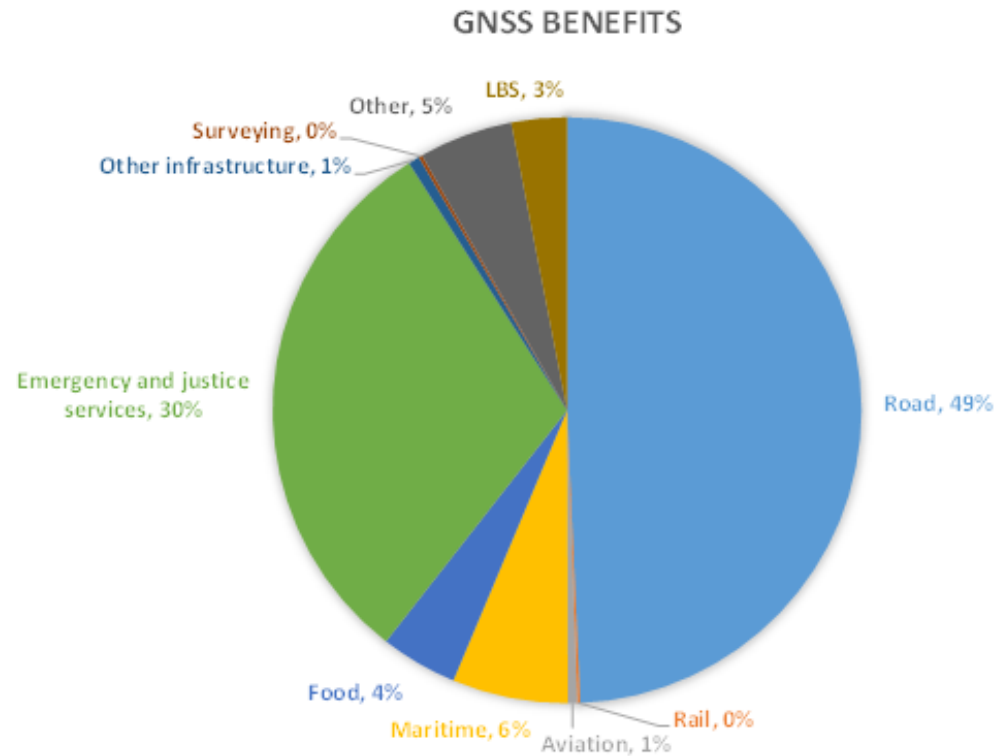
- High-level assessment of the impact of UK public funding of GNSS.
- Considering the economic rationale for public intervention in GNSS
 - and then summarises (known) UK funding invested in the field of GNSS to date,
- Performs a qualitative analysis of the impact of UK public funding – including Impact Logic Models.

Key Findings

- GNSS – Invisible Utility
- PNT derived £1.4bn of turnover and 4000 jobs (2014/15) in the UK
- Sectors generating 11.3% of UK GDP are supported directly by GNSS

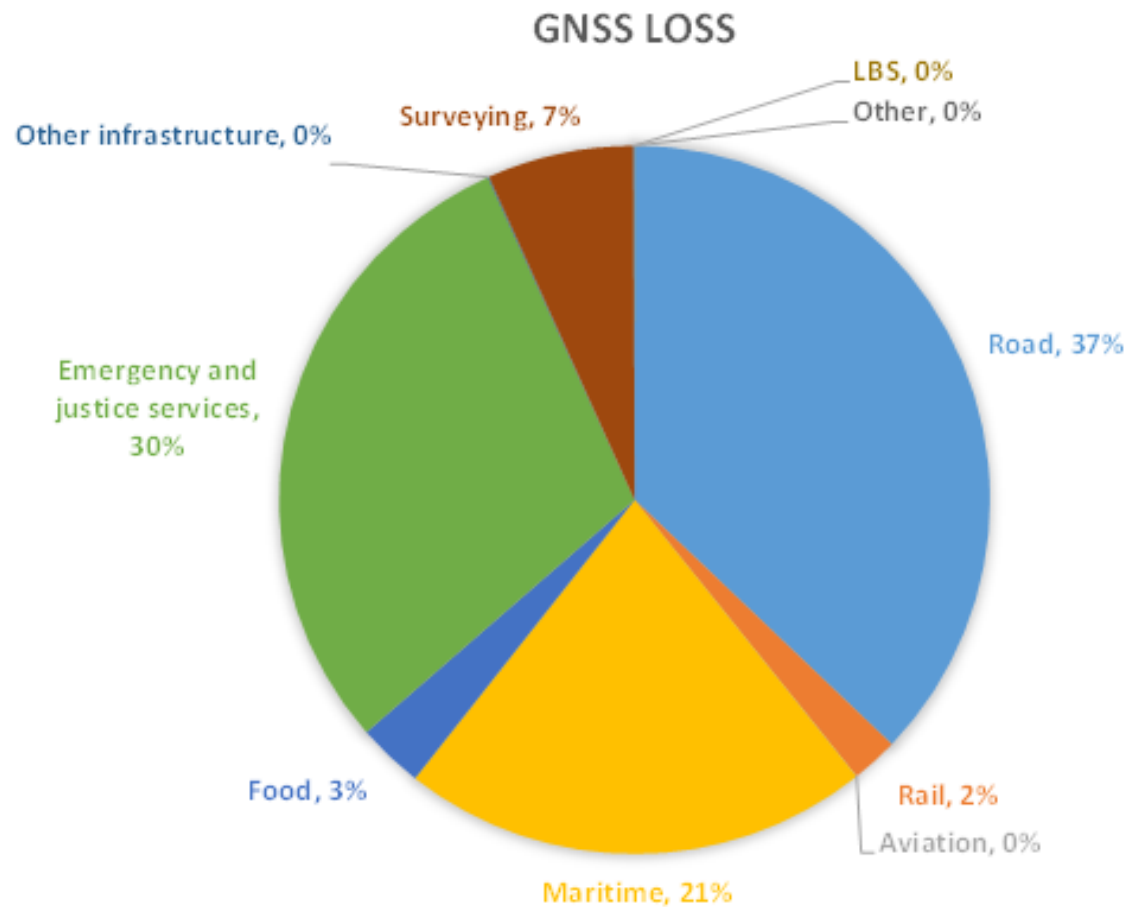
Economic Benefits of GNSS

- Quantified **economic benefits** to the UK of GNSS have been monetised at **£6.7bn per annum**, comprised of £1.2bn in Gross Value-Added (GVA) benefits and £5.5bn in utility benefits (efficiency, safety, etc.)
- Conservative estimates
- Cannot monetise all benefits
- **Consider this a LOWER BOUND**



Impact of Loss of GNSS (for 5 days)

- The economic impact to the UK of a five day disruption to GNSS has been **estimated at £5.2bn.**



Domain	Applications	RAG	Loss of GVA (£m)	Loss of utility (£m)	Total loss for five days (£m)
Road	Road transport infrastructure Road navigation / Advanced Driver Advisory Systems Logistics and fleet management Insurance telematics Emergency and breakdown call	Red	24.2	1,896.0	1,920.2
Rail	Rail transport infrastructure Passenger information systems Asset management Driver advisory systems	Red	94.9	15.5	110.4
Aviation	Automatic Dependent Surveillance – Broadcast system Air transport infrastructure Navigation under visual flight rules Cospas-Sarsat search-and-rescue (SAR) system Mobile satcoms	Yellow	0.1	0.3	0.4
Maritime	Maritime transport infrastructure Navigation and shipping Search and rescue applications Fishing Recreational boating	Red	1,103.7	0.1	1,103.8
Food	CAP and CFP compliance monitoring Cultivation Livestock tracking, hunting and silviculture	Yellow	151.6	4.3	155.7
Emergency and justice services	TETRA Public-safety answering point Emergency vehicles Offender tracking	Yellow	0.4	1,531.5	1,531.9
Surveying	Cadastral surveying Mapping Mining Construction (person and machine-based) Marine surveying Infrastructure monitoring	Red	344.8	-	344.8
LBS	Smartphones Pedestrian navigation Fitness tracking	Green	-	0.8	0.8
Other infrastructure	Transport of dangerous or classified goods Telecommunications – fixed-line & cellular Broadcast – DVB & DAB Internet data centres Electricity transmission Fixed-location noise loggers	Yellow	0.7	2.3	3.0
Other	Banking and stock exchanges Weather forecasting People tracking LEO satellites and ground stations Timesheets and billable hours	Yellow	2.5	1.1	2.6
Total			1,721.9	3,451.8	5,173.6

Impact of Mitigations

- The mitigation technologies can reduce the loss by up to £4.2bn if all users implement the solution that would precisely meet their requirements
- In reality, these conditions are not likely to hold, so a more realistic estimate, is £1.2bn.

Impact of Public Funding

- Estimated societal benefits at between £4 and £5 per £1 of public investment.
- The UK has made a €1.5bn investment in GNSS since 2000.
 - Most of this investment (94%) impact in GNSS is strongly tied to the UK's benefits from the European GNSS programmes (EGNOS and Galileo).
 - The UK's **€94.9 million** downstream investments since 2000 have also unlocked significant benefits to end-users and the rest of society that would have been lost without UK funding
- Report presents a strong case for continued public investment in GNSS.

Summary

- Economic Impact of a 5 day loss of GNSS to the UK
 - **Est £5.2bn in 5 days**
 - **~£1bn per day**
- Use of complimentary technologies can reduce impact by
 - **Between £1.2bn and £4.2bn**
- UK public funding in GNSS returns
 - **Between £4 and £5 for every £1 invested**



£1.5bn invested
since 2000

Thank You

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