Economic Impact of the loss of GNSS to the UK

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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.

GNSS in the UK

$2bn Turnover pa

Directly supports 4000 jobs

Supports 11.3% of GDP ($250bn pa)

Motivation for study

- Widespread use
- Known and increasing vulnerabilities
- Many technical studies about impact of vulnerabi
- Previous work recommending impact assessmen
- No UK economic impact study (gap in knowledge)
- Understanding Innovation gaps
- 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?

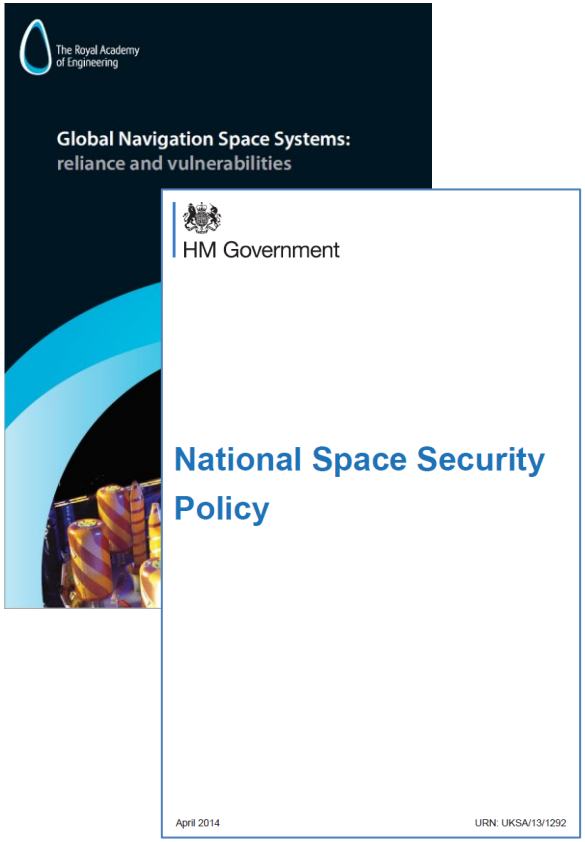
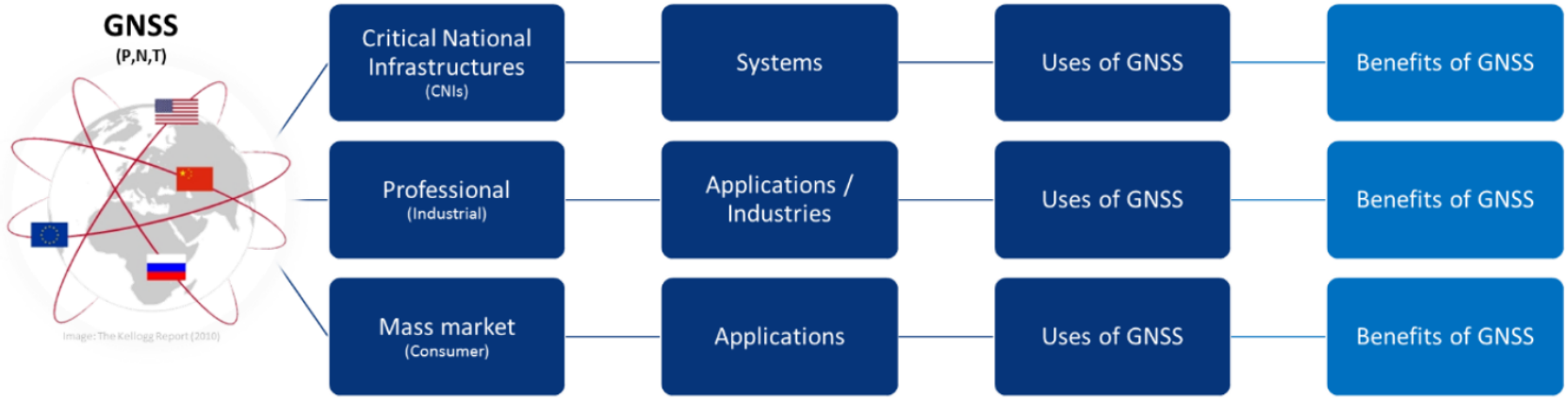
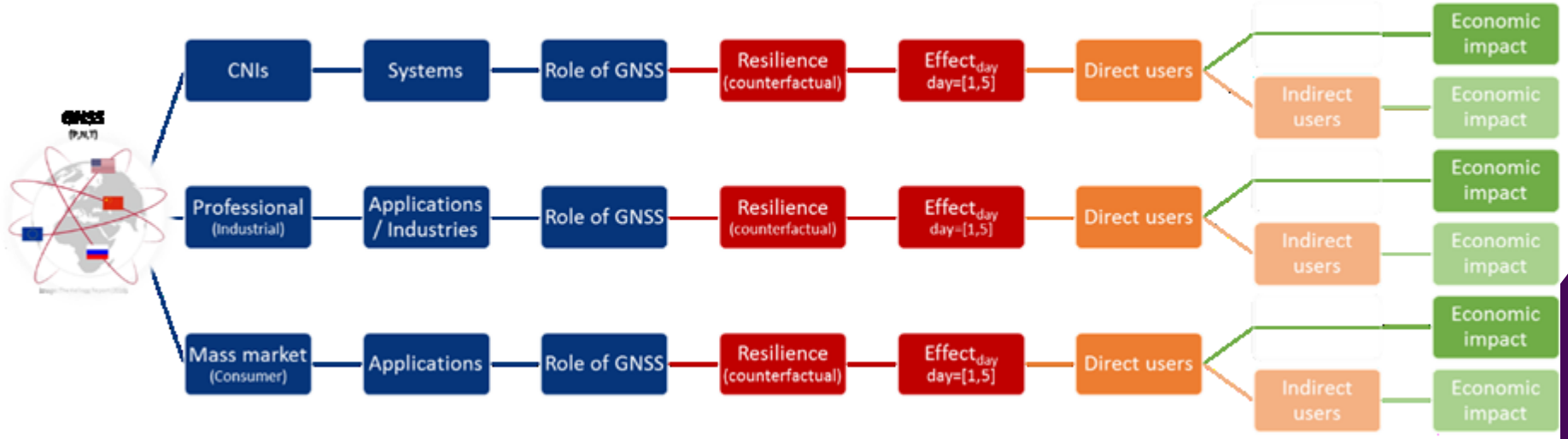


Image: NASA (2014)

Establish Benefits Determine Impacts



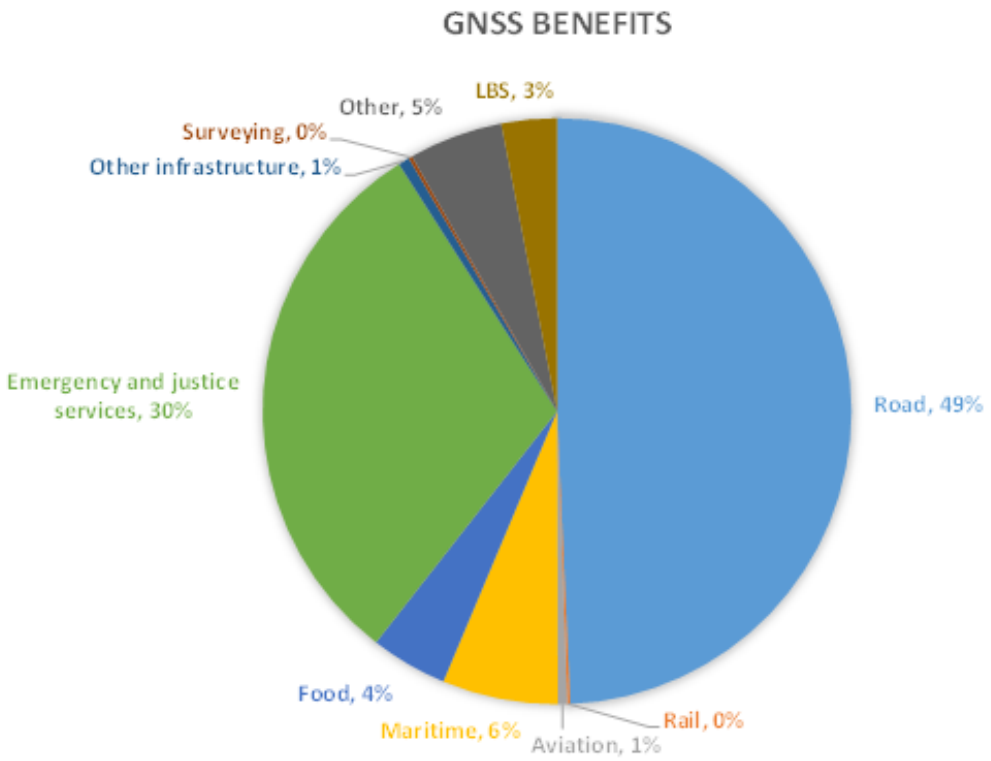


Assess impact of public funding

- 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,
- Perform a qualitative analysis of the impact of UK public funding – including Impact Logic Models.

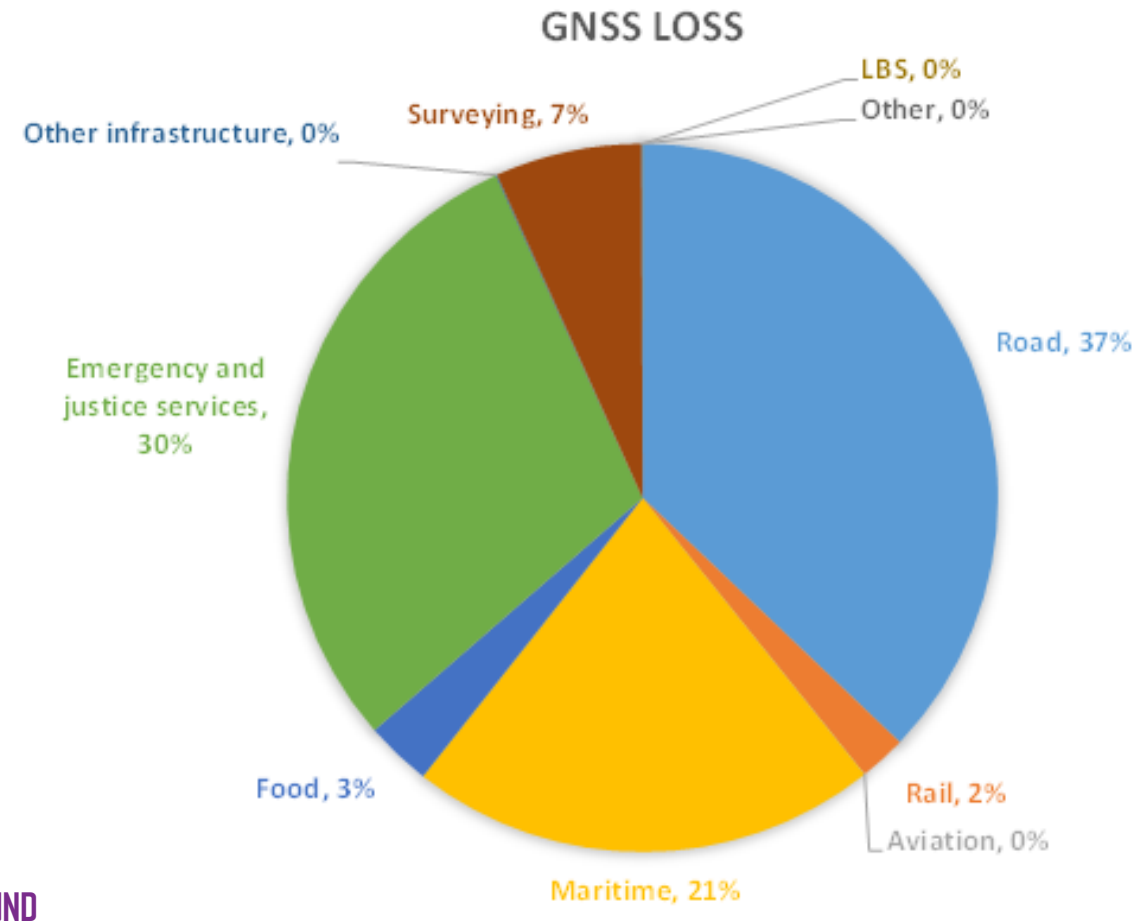
Economic Benefits of GNSS

- 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.**



Consider this a LOWER BOUND

Critical Applications

Infrastructure	Aspect	RAG	Loss of GVA (direct+secondary) (five days)	Loss of utility benefits (five days)
Space	Satellite communications		£22.5m	*See Maritime transport infrastructure*
Transport infrastructure	Maritime transport infrastructure		£1,069.3m	*See Maritime usage applications*
Application	**Aspect**	**RAG**	**Loss of GVA (direct+secondary) (five days)**	**Loss of utility benefits (five days)**
Surveying	All applications		£344.8m	£-
Rail	Automatic train doors			£2.8m
	Train cancellations		£77.7m	£12.7m
Road	Navigation		£-	£1,869.7m

Identify Mitigations and possible costs (not shown)

Technology	Potential Coverage	2D/3D Positioning	Accuracy
eLoran	National / Global	2D	10-20m – improving to 5m with eDLoran
Locata	Local / Regional	3D	< 1cm
Omnisense S500	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)	≤ 1ms – 30ms
NPL MSF 60 kHz radio signal	10ms
PTP	10ns (1*10^-5ms) - 100ns (0.0001ms) – but dependent on network setup and clock used as a timing source
NPL-*Time*	100ns (0.0001ms)
eLoran	100ns (0.0001ms)
Locata	2.5ns (2.5×10^{-6}ms) – potentially much better
Omnisense S500	100µs (0.1 ms) – possibly up to 10ns (1*10^-5ms) in the future
Iridium STL service	Compatible with IEEE-1588 standards: 10ns-100ns

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

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
  - GNSS supports >11% of UK GDP

£1.5bn invested since 2000

Thank You

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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.