



# Resilient time for the future

Listening to the voice of industry



## At a glance: **The National Timing Centre programme (NTC)**

**The NTC will enable UK industry to move away from reliance on Global Navigation Satellite System (GNSS)** - Precise and reliable time, frequency and synchronisation services, which are independent of GNSS, will support the whole of the UK economy.

**The NTC will accelerate innovation in new technologies** - Technologies such as smart grids, time-critical communications, factories of the future, smart cities and connected autonomous vehicles will be key to future prosperity and productivity. Robust timing services are required across the nation to secure their commercial success.

**The NTC will provide training opportunities in time and frequency** - There is currently a skills shortage in specialist timing, synchronisation and frequency solutions. Companies need knowledge and expertise to build competitive advantage in new areas of technology.

# The National Timing Centre programme

The National Timing Centre programme (NTC), led by NPL, was launched in 2019 to develop the UK's first nationally distributed time infrastructure. It has recently surveyed key UK industry players to highlight key issues and common challenges in different sectors. This information will enable the NTC to respond to industry priorities and help deliver a successful timing industry in the UK.

UK industry currently depends on Global Navigation Satellite System (GNSS) which is vulnerable to disruption from solar storms, cyber-attack, jamming and spoofing - meaning there is significant risk of service outages. The signals may also be interrupted or affected by antenna positioning, the built environment and the requirement for clear lines of sight.

The UK's Critical National Infrastructure covers the systems that are essential for the day-to-day functioning of society and the economy. Emergency services, telecoms networks, energy and financial services all increasingly rely on precise, consistent and accurate time received by GNSS. As part of the UK's Critical National Infrastructure, these systems are essential for the day-to-day functioning of society and the economy, and failure in GNSS could potentially impact the UK economy by over £1 billion per day.

NPL has a unique position as the UK's source of Coordinated Universal Time (UTC). The NTC will develop this capability to improve the infrastructure, security, resilience and implementation of timing. It will also provide precise reliable time and frequency, independent of GNSS, to support the whole of the UK.

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**"The power industry is actively looking at backup timing systems and ideally, they would like it synchronised to NPL so that they have a sovereign source of time rather than rely on GNSS, which is outside of their control."**

Timing systems, services and products expert

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**"We don't want to be totally reliant upon a satellite-based system, even if it's three separate satellite-based systems."**

Broadcasting industry expert

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# Listening to the voice of industry

NPL, as part of the NTC programme, carried out a series of interviews with established and potential users and providers of timing, frequency and synchronisation services to understand:

- The timing and frequency capabilities companies are using
- The barriers and drivers to innovation
- The awareness of risks of Global Navigation Satellite System (GNSS)
- The current level of industry knowledge and training mechanisms

This qualitative study is part of ongoing engagement with industry, and while it is not fully representative of all industries it does provide in-depth insights from key experts.

## Each sector has different priorities

Companies that utilise or provide a direct timing signal as part of their activity demonstrated good awareness of the risks to resilience carried by GNSS based timing signals. However, the likely impact of timing failures and the solutions vary according to industry.

**Finance** – A loss of accurate time may cease trading or result in fines because of regulatory non-compliance. These companies are likely to have a financial incentive to invest in non-GNSS timing solutions.

**Telecoms** – Some companies are taking steps to bring timing capabilities in-house to mitigate GNSS resilience risks. There is a move towards distributing timing signals across networks.

**Energy** – With vast, complex systems and long asset lifetime this sector is slow to change. Alternative time sources are being explored and may become more pertinent as Phasor Measurement Units, a key tool to improve visibility of what is happening throughout the network, are deployed throughout the national infrastructure. As legacy equipment is retired, it is likely that standards will continue to evolve and be revised to capture new requirements for timing services.

**Blockchain** – Current methods of distributed ledger validation and resilience built into the architecture do not use a direct timing signal. As future applications extend beyond current cryptocurrency technologies, there may be demand for a resilient, authenticated ‘trusted timestamp’ service.

**Maritime** – This industry relies on GNSS and sensor technologies for positioning, however alternative position, navigation and timing (PNT) solutions will be an important part of a future holistic approach for resilience.

**Broadcasting** – The use of multi-GNSS receivers for timing was seen as a potential risk, so other innovative timing sources, such as long wave radio transmission and non-GNSS sources, were being investigated.

“In terms of our business it’s not appropriate to rely on something that is totally outside our control.”

Telecoms industry expert


“Whenever the GNSS system will be down, then we will just get an inaccurate time on our servers, which will violate some regulation’s requirement.”

Finance industry expert

# Standards and regulations

Standards provide the agreed way to make a product, manage a process, deliver a service or supply a device. As new standards are developed technical knowledge is collected and shared for the benefit of companies and industry. For sectors within regulated parts of the Critical National Infrastructure, standards work as a mechanism to stipulate the specifics of timing accuracy and measurement.

Standards and regulations enable companies to demonstrate compliance and gain confidence for new or emerging products and technologies. Existing standards and regulations for timing serve to minimise the risk of existing and new deployments by providing an agreed reference to adhere to and benchmark against. Each industry has its own nuanced requirements in relation to timing in standards, depending on the degree of regulation and international operation.

An aerial photograph of a large container ship sailing on the ocean. The ship is viewed from above, showing its deck covered with numerous colorful shipping containers in shades of red, yellow, blue, and white. The ship's wake is visible in the blue water. The image is set against a dark blue background with a purple gradient at the top and bottom.

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**“We do the fundamental research [...]. We show the art of possibility. And our industry partners will take it to standards.”**

Telecoms industry expert

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**“You can’t develop new innovative products and hope for them to be used without having the regulatory framework that enables that.”**

Energy industry expert

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# Innovation

The innovation ecosystem is complex, with many factors being interconnected – systems using timing are complex, budgets vary and there are differing attitudes to the inherent risk associated with research and development.

## Drivers for innovation

- Optimising and increasing performance of technologies, services, systems or processes
- Increasing efficiencies, lowering costs or optimising productivity
- Responding to external demand such as the needs of industry, standards or regulation
- Developing new applications for existing processes and technologies or extending an existing product or service
- Implementing new infrastructure or upgrading existing infrastructure

## Barriers to innovation

- Limited awareness or knowledge of timing
- High cost of R&D including implementation of outputs
- Complexity of systems design mean integration and redesign may be required

**“The challenge is defining and designing systems which can be upgraded as the requirements change. So, you’re trying to build in resilience against technology obsolescence, which is always a challenge.”**

Energy industry expert

**“We don’t just build something and admire it and then walk away and then ten years later we come back to it; it’s a continual process [...] we’re continually involved in how this whole space is evolving and what we do is evolving. It’s probably fair to say it doesn’t stand still.”**

Telecoms industry expert

**“What we need to do in the research community, together with NPL and other like-minded organisations, is to come up with a less expensive way of making the time information available in all the environments we are working in.”**

Telecoms industry expert

**“I can only evolve our networks by using the new technology, but it has to be fit for purpose. It has to be in an available, fit for purpose, commercial position. Getting that out of research institutes and businesses can sometimes be quite a lengthy process.”**

Telecoms industry expert

# Resilience

Industry standards and regulations can stipulate the accuracy and traceability of timing signals, however companies expressed most concern about achieving resilience in their timing signal. While **NPLTime**<sup>®</sup> offers industry a highly accurate and resilient service, the cost of service, fibre and infrastructure requirements may serve as barriers to access for some companies.

Companies demonstrated good awareness of the outage risks of GNSS and recognised the need for a resilient timing infrastructure. Each company, industry or sector has a specific systems architecture and legacy assets, but most have taken steps to meet requirements based on business needs including:

- Additional time sources – so they are not dependent upon one sole time source
- Diversity of timing sources – companies may use GNSS and fibre for their signal
- Multiple time distribution locations over a wide geographical area
- Holdover clocks – these are deployed with GNSS receivers at key locations to maintain the time output within a certain range in the event of a GNSS outage period
- Correct installation of GNSS receivers to minimise outage risks

However, there are significant costs associated with these solutions.

Monitoring is important to identify faults in timing equipment and signal distribution. Some companies are offering access to monitoring platforms, and reporting on time performance to their customers, as part of a managed timing service.

The interdependencies of systems across sectors in the Critical National Infrastructure poses the risk of 'cascade failure' where an outage in one sector, can impact another.

**“There’s need for improved communication and timing, but alongside there is a major need for a concentration on resilience. So, the major concerns are the potential contagion between telecoms networks and electricity [...] and you end up with a terrible cascade failure of large parts of the infrastructure.”**

Energy industry expert

**“There have been occasions where firms have had to stop operations due to the unavailability of accurate timing services. And it is a key dependency for the continued operation of certain financial services companies. So, ensuring that there is a sort of resilient service that underpins that is quite important for us.”**

Finance industry expert

**“For a fair few services and firms, resilient time is going to be one of those key dependencies in which they operate. And once you’ve identified that stuff, you need to start thinking about [...] what vulnerabilities exist with the supplier.”**

Finance industry expert

# Skills and knowledge

There is a skills shortage for specialist timing expertise, both in terms of depth and breadth of knowledge. Companies often rely on a single expert who interacts with specialists in legacy assets and equipment. This represents a major risk from staff leaving and sickness to lack of succession planning. Training budgets are limited, as is the time available to free up employees to attend.

- Online training may help with breadth of awareness of issues in a flexible way
- Bespoke training activities, which reflect the specific requirements of companies, are required to make training relevant to the 'job in hand'

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**"In reality, we can't get enough skilled people in to meet the demand for jobs that we actually have. All of the employers we're working with at the moment are skill constrained."**

Energy industry expert

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**"In terms of in-house training, given the level of knowledge that's required in such a small number of people, I think it's very hard to do [training] formally, because if you start to say, 'well, I've got to have an expert in this and the backup for that and an expert in this other subject', you end up with an unmanageable problem centrally."**

Broadcast industry expert

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**"It will be true to say that in the end users there is a limited knowledge in many areas to do with timing and synchronisation. So yes, it's not a widespread expertise, I think that would be fair to say."**

Timing systems, services and products expert

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# Validation of the NTC programme

The National Timing Centre (NTC) programme is paving the way for trusted and assured time and frequency across the UK, by developing the first nationally distributed time infrastructure.

The NTC programme activity is based on evidence from industry and ongoing engagement. The findings of these detailed interviews confirm the approach being taken by the NTC Programme.

## Standards and regulations

The NTC is ensuring that there is input on relevant timing, synchronisation and frequency standards bodies, which would support the UK timing industry. Both NPL staff and industry stakeholders should contribute their expertise to relevant working groups and ensure that they maximise their involvement.

## Resilience

The NTC is investigating the interdependencies of systems for time to support resilient timing across the critical national infrastructure and engage with companies directly. This is becoming increasingly important and should be a future priority for the NTC.

## Innovation

The NTC Programme has set up three innovation nodes, two with fibre links to NPL, to allow local access to trusted timing services and develop timing applications for key sectors, including transport, telecommunications, fintech and quantum. The NTC is mapping sectors according to test and evaluation requirements so innovation can be supported, which will help develop a robust supply chain.

## Skills and knowledge

Companies were contacted to identify knowledge gaps, ideal training duration and budgets, which fed into a blueprint for training. The NTC ran a new training course 'Introduction to Time and Frequency Measurement' and is developing additional training with more technical and engineering detail.

**The National Timing Centre programme, based on evidence from industry, is:**

- **Developing a resilient timing infrastructure for the UK by building and linking a new atomic clock network distributed geographically in secure locations**
- **Providing innovation opportunities for UK companies by funding projects in partnership with Innovate UK**
- **Working with diverse industries to support innovation and tackle common challenges**
- **Participating in the development of standards and regulations**
- **Responding to specialist skills shortage in timing and synchronisation solutions by training specialists, post graduates and apprentices**

**By co-ordinating activity in timing and synchronisation sector in the UK, the NTC programme will deliver a resilient timing infrastructure.**

**If you want to know more or work with us, please get in touch.**

**Web: [www.npl.co.uk/ntc](http://www.npl.co.uk/ntc) Email: [ntc@npl.co.uk](mailto:ntc@npl.co.uk)**