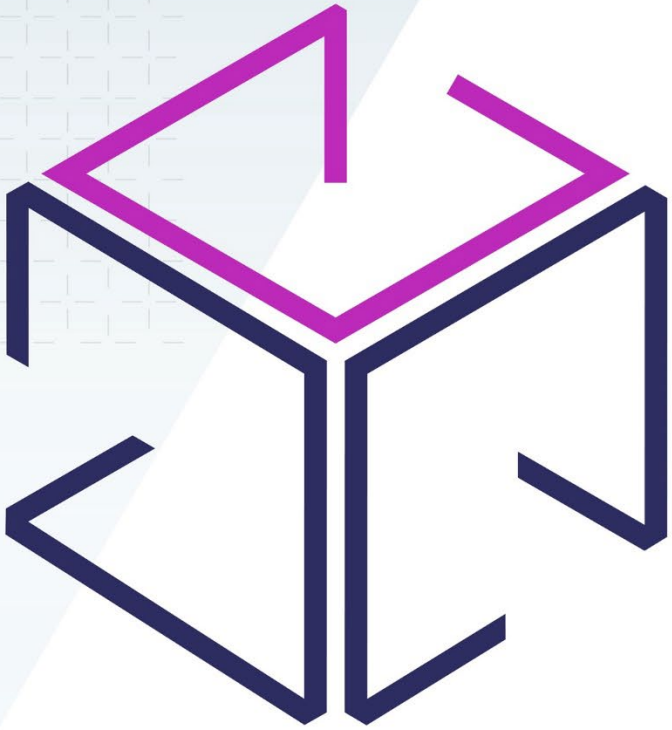
Workforce Foresighting Hub



Advancing standards and protocols for the integration of Non-Terrestrial and Terrestrial Networks

Workforce Foresighting Hub findings report in collaboration with Satellite Applications Catapult.

Acknowledgements

The Workforce Foresighting process integrates data from the following international data sets:

IfATE – Institute for Apprenticeships and Technical Education, England

ESCO – European Skills, Competencies, Qualifications & Occupations, EU

ONet – Occupational Networks Online, USA

In accordance with licence and publishing requirements of these organisations for the use of their data sets, the Workforce Foresighting Hub team states that –

The IfATE data used contains public sector information licensed under the Open Government Licence v1.0.

The ESCO data is used in accordance with the EUROPEAN UNION PUBLIC LICENCE v. 1.2 EUPL © the European Union 2007, 2016

*The ONet data used is under CC BY 4.0 license. (O*NET® is a trademark of USDOL/ETA.) The Workforce Foresighting Hub team has modified all or some ONet information. USDOL/ETA has not approved, endorsed, or tested these modifications.*

Any errors, omissions and incorrect data are the responsibility of the Workforce Foresighting Hub team, and all queries should be addressed to info@iuk.wf-hub.org

The method and process used in the Workforce Foresighting process is under development and there may be errors and omissions in the data provided.

This report was produced following workshops undertaken Nov 2024 – March 2025 using the data set and tools available at that time.

Contents

Executive Summary

Executive Summary

This report outlines findings from the Workforce Foresighting cycle focussing on advancing 5G / 6G standards and protocols for the integration of Non-Terrestrial Networks and Terrestrial Networks. The study was conducted by the Satellite Applications Catapult in collaboration with the Workforce Foresighting Hub, an Innovate UK initiative.

Workforce Foresighting is a systematic approach to planning ahead and anticipating future skills and capability needs associated with new technologies and government transformation targets. It involves identifying and understanding the skills required for tomorrow's jobs, ensuring our education and training systems are prepared so that our workforce is ready to adopt new technologies and support future industrial growth.

This report sets out the findings of the Workforce Foresighting study and recommends actions required of the various stakeholders to ensure a workforce is created that is prepared to effectively implement these new technologies across the sector.

Workforce Foresighting Topic

The UK aims to be a leader in the integration of **Non-Terrestrial Networks (NTN) with Terrestrial Networks (TN)**, a critical step toward ensuring seamless global connectivity, resilience, and security in digital infrastructure. As 5G continues to mature and 6G development accelerates, the demand for ubiquitous, high-speed, and secure communication across remote and urban areas is increasing.

Key government priorities driving this challenge are:

- **National Space Strategy** – The UK's investment in OneWeb and satellite communications positions it as a player in the global satellite ecosystem.
- **Digital Infrastructure Plan** – The push for nationwide 5G and early-stage 6G deployment.
- **Cybersecurity and Resilience** – Increasing threats to network security require advanced encryption, AI-driven security monitoring, and real-time threat detection.

Telecommunication and Satellite Communication organisations face the pressures of convergence as NTNs (satellite constellations) and TNs (fibre optics, mobile networks) must be seamlessly integrated. The main challenges include:

- **Interoperability & Standardisation** – Developing universal communication protocols for 5G/6G NTN-TN integration.
- **Technical Complexity** – The latency, frequency management, and signal interference issues of integrating satellite and terrestrial networks.
- **Skills Shortages** – A lack of skilled professionals in radio frequency (RF) engineering, AI-driven network management, and cybersecurity.
- **Investment and Cost** – High capital costs for satellite launches, ground infrastructure, and network upgrades.

Several solutions were explored to address these challenges:

Technology Solution	Benefits	Challenges
5G/6G NTN-TN Integration	Ensures **ubiquitous, high-speed network coverage** across all environments.	Complex **standardisation and protocol** development; requires global collaboration.
Satellite Constellation Management	Optimises inter-satellite communication for **efficient bandwidth use**.	High **infrastructure investment**: regulatory approvals required.
Delay-Tolerant Networking (DTN)	Enhances **network resilience in remote/off-grid locations**.	Needs new **protocols and compatibility solutions**.
AI-Driven Network Management	Uses **machine learning** to optimise traffic routing and network security.	AI trust, explainability, and regulatory concerns.
Quantum Encryption & Cybersecurity	Enhances **security for next-gen communication**.	**Expensive** to implement; still in early-stage R&D.

Chosen Technology: NTN-TN 5G/6G Integration

The priority technology selected was the integration of NTN with terrestrial 5G/6G networks because:

- It offers global, resilient coverage beyond urban centres, critical for national security and commercial services.
- It aligns with UK Government and Industry strategic priorities in digital transformation.
- It enables secure, high-speed, and AI-optimised connectivity, benefiting key sectors like defence, autonomous transportation, and smart cities.

Scope of Deployment (2025-2030)

- **Initial Phase (2025-2026):** Standards development, pilot trials with industry partners (BT, Vodafone, UK Space Agency).
- **Scaling Phase (2027-2028):** Expansion of NTN-integrated 5G networks in rural, maritime, and emergency response sectors.
- **Full Integration (2029-2030):** Widespread commercial and industrial adoption, enabling next-gen smart cities, IoT, and AI-driven communication ecosystems.

Participants and stakeholders

Industry Participants	Skills Participants	Technology Participants	Other Participants
Cluster Director Space North	Cranfield University	Satellite Applications Catapult	Dept for Science, Innovation and Technology
Celestia UK	University of Bradford	ITP	Ministry of Defence
Hamilton Barnes (recruiter)	Digital INnov8ors	UK Space Agency	UK Telecommunications Innovation Network
IntelSat	University of Suffolk	CGI UK	Inst for Engineering Technology
Open Cosmos	Birmingham City Uni	GSMA	
Lockheed Martin	Nottingham Trent Uni	DayOne People	
Filtronic		PA consulting	
MOD Corsham (Skynet)	UK Space Agency Skills	Pharrowtech	
Prof Space	University of Leeds	Vodafone	
PA consulting		University of Surrey	
		GMV Innovating Solutions S.L	
		Filtronic	
	North East Institute of Technology	UKStratCom	
	University of Northumbria		

The Findings and Insights

The most significant observation is the urgent need to integrate Non-Terrestrial Networks (NTN) with Terrestrial Networks (TN) to enhance connectivity and resilience, in the maturing phase of 5G rollout in the UK, and then the transition from 5G to 6G. This transformation is critical for achieving ubiquitous network coverage and aligning with the UK government's ambitions in digital infrastructure and national security.

Organisational Capability Changes

- A shift towards **design and software engineering-focused capabilities**, with an increasing need for expertise in network integration, cybersecurity, AI-driven automation, and regulatory compliance.
- Greater demand for **cross-functional collaboration** across supply chains, requiring businesses to upskill their workforce in system integration, satellite communications, and advanced software development.

- The rise of **data-driven decision-making** necessitates more focus on AI, predictive analytics, and cybersecurity to manage growing network complexities.

Future Occupational Profiles (FOPs) Generated

- **Senior Engineers and Technicians:** Demand for specialists in cybersecurity, cryptography, Radio Frequency engineering, IoT systems, and network integration; all of which are known areas of deficit.
- **Emerging roles:** Increased need for data architects, digital twin engineers, and AI-driven network optimisation experts.
- **Compliance and regulatory professionals:** As standards evolve, expertise in governance and risk management will be essential.

Key Matches & Concerning Gaps

- **Best Matches:** Telecommunications and network engineering roles show some alignment with existing apprenticeship standards.
- **Gaps Identified:** A significant skills deficit in cybersecurity (including quantum encryption), satellite systems integration, Artificial Intelligence, machine learning, and data architecture. No existing apprenticeship standards fully meet future workforce demands, requiring updates or new training pathways for this challenge.

The Next Steps

Without immediate and coordinated action, the UK risks falling behind in global NTN-TN integration, impacting national security, sovereign capability, digital infrastructure, and economic growth and losing its position as a global leader in the field.

- **Convene a working group** – Engage key stakeholders (IfATE, IUK, DSIT, UKSA, OfCOM, industry leaders) to drive implementation
- **Validate Future Occupational Profiles (FOPs)** – Align with industry demand forecasts.
- **Appoint a sector champion** – Identify a lead organisation to oversee skill development efforts.
- **Develop an action plan** – Address short-term (upskilling existing workforce) and mid-term (curriculum updates) needs.
- **Evaluate further Workforce Foresighting opportunities** – Consider additional studies in emerging tech fields (e.g., AI-driven networks, quantum communication).

Failure to act will hinder industry growth, create severe skill shortages, and limit the UK's ability to compete in next-gen communication technologies. Immediate intervention is necessary to secure a skilled workforce capable of delivering NTN-TN integration successfully.

1. Introduction

1. Introduction

1.1 Background to Workforce Foresighting

The report “Manufacturing the Future Workforce” (Collier et al., 2020) recommended the Skills Value Chain as an approach to avoid shortfalls in workforce capabilities relating to future innovations (see Figure 1). This is the genesis of the Workforce Foresighting programme, which is sponsored by Innovate UK and delivered through the Innovate UK Catapult Network.

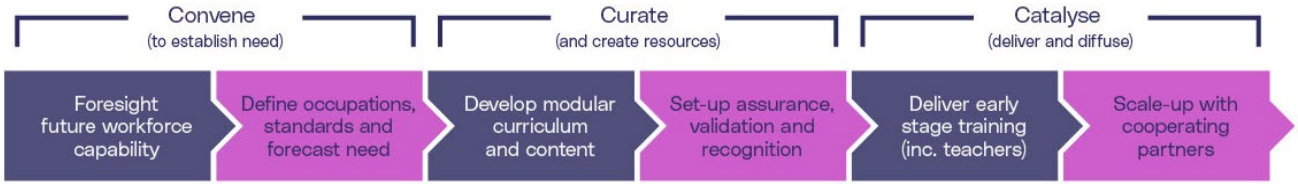


Figure 1: The Skills Value Chain

The first step of the skills value chain is to “Foresight future workforce capability”: This calls for technology, industry, education, and training partners to convene using government as a focal point, to “foresight and articulate future skills needs, standards and qualifications associated with emerging technologies” (Collier et al., 2020).

1.2 Workforce Foresighting - process overview

The core of Workforce Foresighting is convening three groups of relevant specialists to conduct structured, Delphi-style, facilitated workshops to capture and discuss the set of capabilities that could appear within an organisation that will be required to respond to and exploit technology innovation.

Organisational capabilities are captured using a bespoke classification that has been developed by the Workforce Foresighting Hub. The classification uses a structured common language to enable cross sector and cross centre collaboration and integration of data. Additionally, the classification enables data from several other national and international open-source workforce datasets to be integrated through the same common language. The data is held in a cloud based “data-cube” that is dynamically growing as each Workforce Foresighting cycle adds to the shared data relating to future workforce capabilities.

Using cutting edge AI and Large Language Model data tools, the data-cube is used to undertake detailed analysis to ‘map’ future workforce capability requirements against a selected current education and training provision to identify where existing provision can be used and where new provision, CPD or qualifications are required.
As an agile development project, the Workforce Foresighting Hub team are constantly evolving and improving the detailed workshop process and workshop approach, but the process always consists of the following stages:

Considering – Clarifying the Challenge to be met (the 'what' and the 'when') and collating solutions (the 'how') as Foresighting topic suggestions align with strategic priorities

Identifying – Gain clarity and consensus about the solutions to be put forward – make the case for Foresighting

Preparing – The convening of specialists and scheduling of workshops

Carrying out – Run Foresighting workshops with experts, collate and analyse data

Communicating – Insights, findings and recommendations gathered from all research in report

Causing action – The driving of action based on the recommendations (promoting progress down the rest of the skills value chain) built on the findings and recommendations of Foresighting

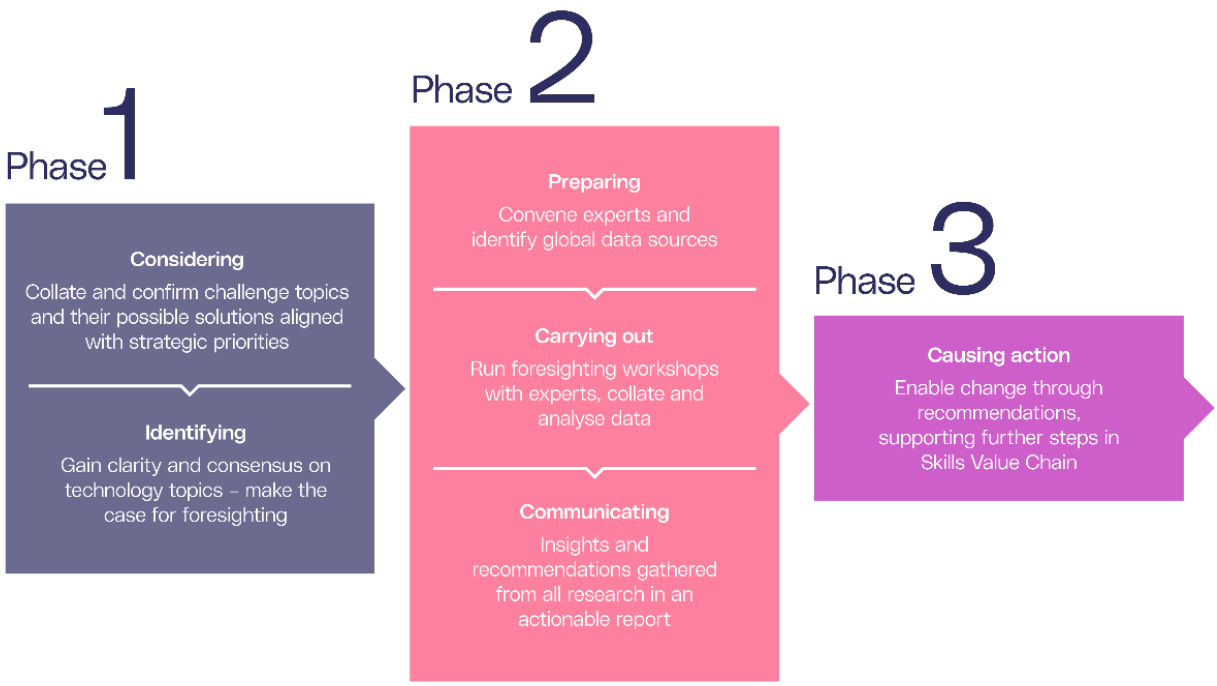


Figure 2 - The Workforce Foresighting process

1.3 Foresighting vs forecasting

Although this study is focussed on workforce Foresighting (capabilities required) it is important to keep in mind parallel findings from forecasting (required capacities and numbers). Forecasting, alongside Foresighting, provides vital input to the sector, feeding into recruitment and development targets for employers, and consideration of economic class sizes and recruitment targets for educators. However, it is beyond the scope of the Foresighting study to carry out independent forecasting, and as such readers should refer to referenced studies for detail on forecasting.

1.4 Introducing the Visualisation Tool

The Workforce Foresighting Hub's Visualisation Tool is a powerful, innovative system, which will enable the reader to explore and analyse Foresighting data to determine the capabilities required for future roles. Links throughout this report make it easy to identify existing standards which meet the needs of these future roles and pinpoint where new standards are necessary to develop a skilled workforce equipped to adopt new technologies.

The data is generated by the Foresighting cycles, integrating the expertise of technologists/domain specialists, employers and educators. The data informs the development of future curriculums and course content as determined by the action plan. Using AI tools validated by human oversight, and by linking to external data sources, the tool identifies differences at the level of occupation/role as well as detailed changes required to help update/refresh knowledge, skills and behaviours thus delivering insights for learners, providers, creators and assurers of skills.

Detailed instructions on how to use the Visualisation Tool can be found in the appendix.

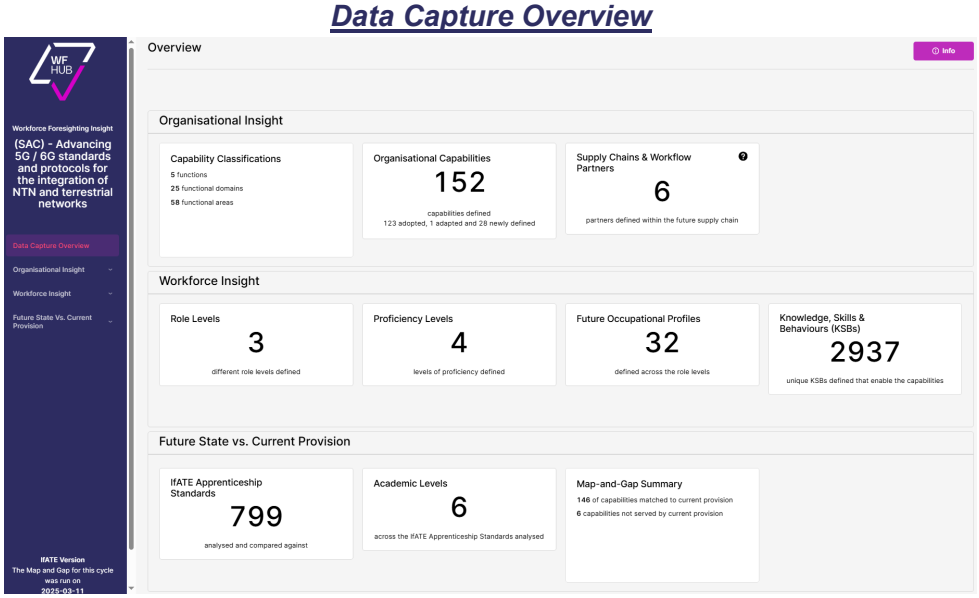


Figure 3 – Visualisation Dashboard

2. The Workforce Foresighting Challenge

2. The Workforce Foresighting Challenge

2.1 Positioning and context of national challenge

The challenge, that this Workforce Foresighting cycle seeks to address, is the integration of Non-Terrestrial networks of satellites (NTN) with Terrestrial Networks for improved connectivity and resilience. The integration of the two network types is essential as the demand for mobility and ubiquitous coverage becomes increasingly important, and we move from 5G to 6G. This involves ensuring resilient, reliable, and secure communication between the two network types, which to date, have been developed independently. New standards for 6G are being developed for implementation by 2030: 6G refers to 3-D networks, including ground, aerial and satellite communications and sensing, all based on internationally agreed standards.

The UK government aims to be a major player in the global development of interconnected satellite constellations and associated technologies. This builds on its 2020 stake in OneWeb and the company's merger with Eutelsat in 2022. This also aligns with the broader goals of achieving net-zero emissions, enhancing digital infrastructure, and improving national security.

The UK's IT and Communications sector is a significant contributor to the economy, employing thousands of people and hosting major companies like BT, Vodafone, and innovative startups. The UK is positioned as a global leader in telecommunications and satellite technology.

The integration of 5G and 6G technologies with satellite networks is expected to revolutionise communication systems. Future advancements will extend coverage and flexibility with greater application of network slicing, virtual integration, and dynamic resource allocation, enhancing connectivity and reliability.

The status of NTN technology in the UK is covered by the 2024 UKTIN "Future Capability paper , Non-Terrestrial Networks". It is clear the UK has significant strengths and opportunities but could be hampered by lack of a skilled workforce, amongst other factors.

2.2 Potential and prioritised technology solutions to the challenge

Several technological solutions were identified to address the challenge of integrating NTNs with terrestrial networks. Technology solution options considered to be part of the scope are shown in Table 1.

Technology Solution	Benefits	Challenges
5G / 6G Integration of TN and NTN	Ubiquitous network coverage from ground level upwards.	Complexity of standards and protocols, increased network overheads, higher signal processing latency, interference and complexity
Satellite Constellation Management	Improved inter-satellite communication and resource allocation	High initial investment
Delay-Tolerant Networking (DTN)	Reliable communication in intermittent connectivity	Protocol development
Security and Encryption	Secure communication and data protection	Implementation of advanced encryption standards

Table 1 Prioritised technology solutions

Each technology solution addresses specific aspects of the challenge. For example, the integration of Terrestrial with Non-Terrestrial networks enhances connectivity making it ubiquitous at all levels, while satellite constellation management improves resource allocation and communication reliability.

2.3 Workforce Foresighting for prioritised technology solutions

The need for a hybrid workforce skilled in both electronic and communication systems engineering and software engineering was highlighted through the topic selection process.

The integration of Non-Terrestrial Networks into existing and proposed 5G/6G terrestrial networks is prioritised due to its potential to significantly enhance ubiquitous connectivity, security, resilience and network efficiency.

The title of the cycle is ***Advancing standards and protocols for the integration of Non-Terrestrial and Terrestrial Networks***

The horizon used here for the new technologies is 2025-2030. The potential impact includes improved national security and resilience within the digital and physical infrastructures. The scale will involve nationwide deployment and will cover the entire supply chain from design to operation. The increasing risk of delays and shortages of components, and the required skilled workforce, pose significant challenges to UK ambitions.

2.4 Current and predicted scale of technology deployment in UK

The current deployment of these technologies is in the early stages, with pilot projects and initial implementations. It is expected that 6G will be ready for early deployment around 2030, (see Ericsson view 6G timeline: growing from 5G to 6G:)

For the full benefits of TN/NTN integration to be realised requires at least 5G stand-alone networks. The delay in 5G roll out in the UK impacts the potential of NTN applications in the period up to 2030 but a lot can be achieved with relatively low-cost upgrades to the existing terrestrial networks.

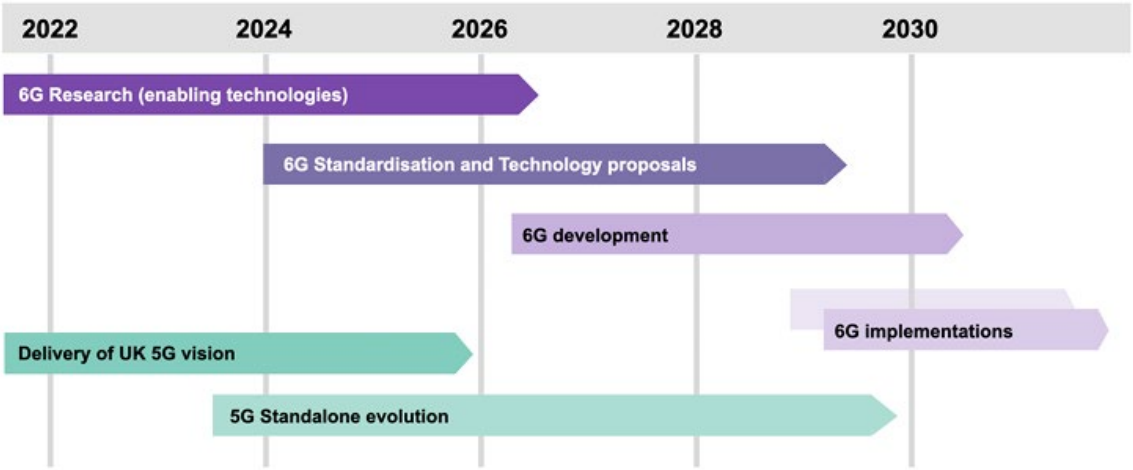


Figure 4 Timeline to 6G (from parliamentary report POST-PN-0734)

The deployment impacts the supply chain by requiring new skills and capabilities in network management, cybersecurity, and satellite operations. Also, there are technology and manufacturing gaps identified in UK capabilities (see UKTIN Future Capability Paper: Non-Terrestrial Networks) like radiation hardened semiconductors, antenna and terminal manufacture, in space optical communications and the lack of a major UK terrestrial network manufacturer.

2.5 Key Stakeholders

Key stakeholders include government bodies like the Department for Science, Innovation and Technology, UK Space Agency, regulatory organisations like Ofcom, and industry leaders like BT, Viasat, Eutelsat and Vodafone.

Stakeholder	Role	Contribution
Department for Science, Innovation and Technology	Government	Policy and funding support
Ofcom	Regulatory	Standards and compliance
BT	Industry	Technology development and deployment
Vodafone	Industry	Network management and services
Satellite Applications Catapult	Research and Technology Innovation	Technology Innovation and development

3. Findings and Results

3. Findings and Results

3.1 Summary of Methodology

Summary information is provided with a narrative based on the underlying data which is also provided using bespoke visualisations to enable greater insight and access to detail. The report is aligned to the needs of those responsible for workforce planning – employers, educators, and skills providers.

Step One – How will the Supply chain change - Organisational Changes

Exploration of organisational changes provides insights into how organisations will need to adapt their current capabilities to implement the solutions that respond to the challenge addressed by the Foresighting project.

Typically, organisational changes will also require the adoption of new capabilities and a change in the distribution of these capabilities across supply chain partners. The change in capabilities within an organisation, as well as their supply chain partners, will determine the knowledge and skill changes required by the role groups within the workforce of each Supply Chain partner.

Step Two – How will the Workforce change - Occupational Changes

A set of 'Future Occupational Profiles' (FOPs) is produced by the foresight process that demonstrates how current occupations may need to change in the future. FOPs are generated using a combination of attributes from the underlying capability classification and from data collected in the workshops. The FOP generation algorithm works to group capabilities into logical sets reflecting role levels, function, proficiency and capability similarity. As part of the foresight process the generated FOPs are reviewed, revised and distilled by the Employer group. The agreed set of FOPs are then compared with selected current education provision; the default reference is the set of Institute for Apprenticeships and Technical Education (IfATE) apprenticeship standards; to assess which current training and education provision could be used in the future. Two bespoke metrics - match and surplus - are used to evaluate the alignment of current provision with the set of FOPs proposed. Summaries are presented of the key findings related to each Supply Chain partner.

Findings are aimed at both Employers, and Education and Training Providers, and identify matches and gaps in future training needs compared with current provision to guide further detailed investigation.

Employers are able to use this information to inform their development of job descriptions for new roles and to support and guide the development of their existing workforce as they begin to deliver and implement new technology.

Step Three – How the current Education provision meets the future need - Highlighted Changes to Future Provision

The report identifies suggested changes or adaptations to education and training provision – principally apprenticeship standards that will deliver the knowledge, skills and behaviours required by the future occupations identified. In some cases, this will also include short courses and continued professional development (CPD) opportunities to upskill the current workforce in order to meet these future needs. Additionally, Foresighting outputs can be used to develop modules, programmes, qualifications, and apprenticeship standards for new entrants to the workforce joining via vocational, taught qualification, or other training programmes.

The insights and data in this part of the report are primarily aimed at educators, training providers, apprenticeship standards bodies and awarding organisations. Combined with insights arising from the Supply Chain capability changes, the provision insight offers an effective way for employers to identify training opportunities that align to their future needs.

3.2 Step One – How will the Supply Chain change - Organisational Changes Insight

Organisation functions

The Workforce Foresighting process uses an information architecture built on five functional areas which are common to any business:

Design	The function of an organisation that focuses on activities relating to product, service or solution design.
Implement	The function of an organisation that focuses on activities relating to producing / making / providing its products or services.
Logistics	The function of an organisation that focuses on activities relating to procurement, delivery, materials, or services necessary for operations – service / manufacturing, etc.
Support	The function of an organisation that focuses on activities relating to users, in-service support, repair / maintenance, recycling, end of life disposal.
Enterprise	Core functions of an organisation - e.g., strategic planning, leadership and management, human resources, digital backbone and data systems, integration of relevant statutory / regulatory requirements and compliance.

The functional structure is developed to levels of detail that enable the foresight process to reference external data sets including ONET (US) Occupational Information Network [.[1]], ESCO – European Skills, Competences, Qualifications and Occupations[.[2]], IfATE (UK) Institute for Apprenticeships and Technical Education[.[3]] .

The five root functions comprise around 40 domains which are broken down to around 140 functional areas. The architecture is used to position ~ 25,000 capability statements which are the building blocks used in the workforce foresight process. Each capability statement has several attributes - some are static and reflect the position of the capability statement in the architecture, whilst others are dynamic and are assigned values through a cycle and set of workshops.

The data architecture is implemented in a bespoke 'data-cube' which underpins the foresight process, workshops, and enables extensive use of LLM and AI tools. Additionally, a key feature of the data-cube is that the data from each foresight topic cycle is added into the data set and can then be used, where relevant, in future cycles. This ensures that the capabilities of the system are dynamic and up to date.

Identifying the Future Supply Chain Capabilities

The following charts and graphs summarise the changes in the set of capabilities that will be required by the supply chain in the future. The pie-charts below reflect the distribution of capabilities across the five functions of the capability classification. The future state data is captured in three technology focused workshops. The current state data is derived from information collected on apprenticeship standards used across current supply chain partners across the sector. This latter information is not as detailed as that produced by the workshops, reflecting that most roles currently in Design particularly are derived from academic study rather than vocational training, but is indicative and used to provide a point of comparison.

These initial pie charts summarise the changes that will be required by the whole supply chain, across the five capability functions. It indicates that there will be a significant increase in Design capabilities and decrease in Enterprise capabilities being required to support the future workforce.

---

[1] ONET - Occupational Information Network - https://www.onetcenter.org/
[2] ESCO - European Skills, Competences, Qualifications and Occupations - https://esco.ec.europa.eu/en
[3] IfATE – Institute for Apprenticeships and Technical Education - https://www.instituteforapprenticeships.org/

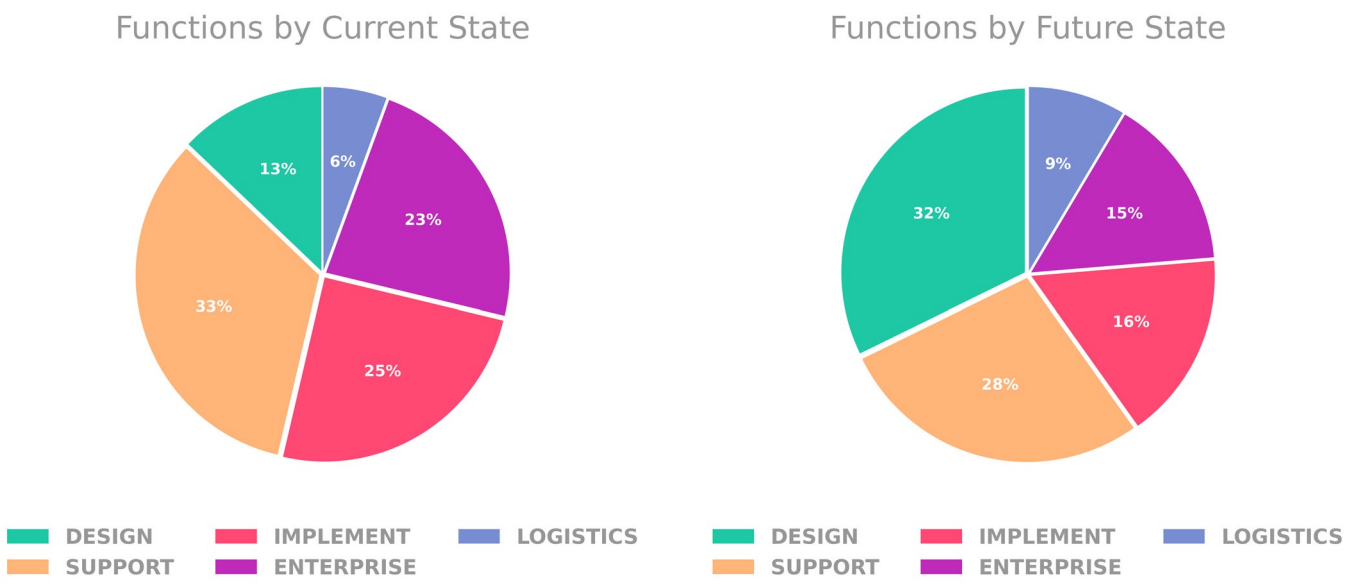


Figure 5: Current and Future – Whole Supply Chain - Capability Function Distribution %

Whilst the information on current and future Supply Chain capabilities is useful to indicate relative changes, factors such as volume of activity will also determine which functions may have greater future significance.

The graphs below show the distribution of capabilities assigned at domain level within the five main functions for this cycle. These graphs provide insight into the relative importance of each domain for the sector in the future.

Design Domains

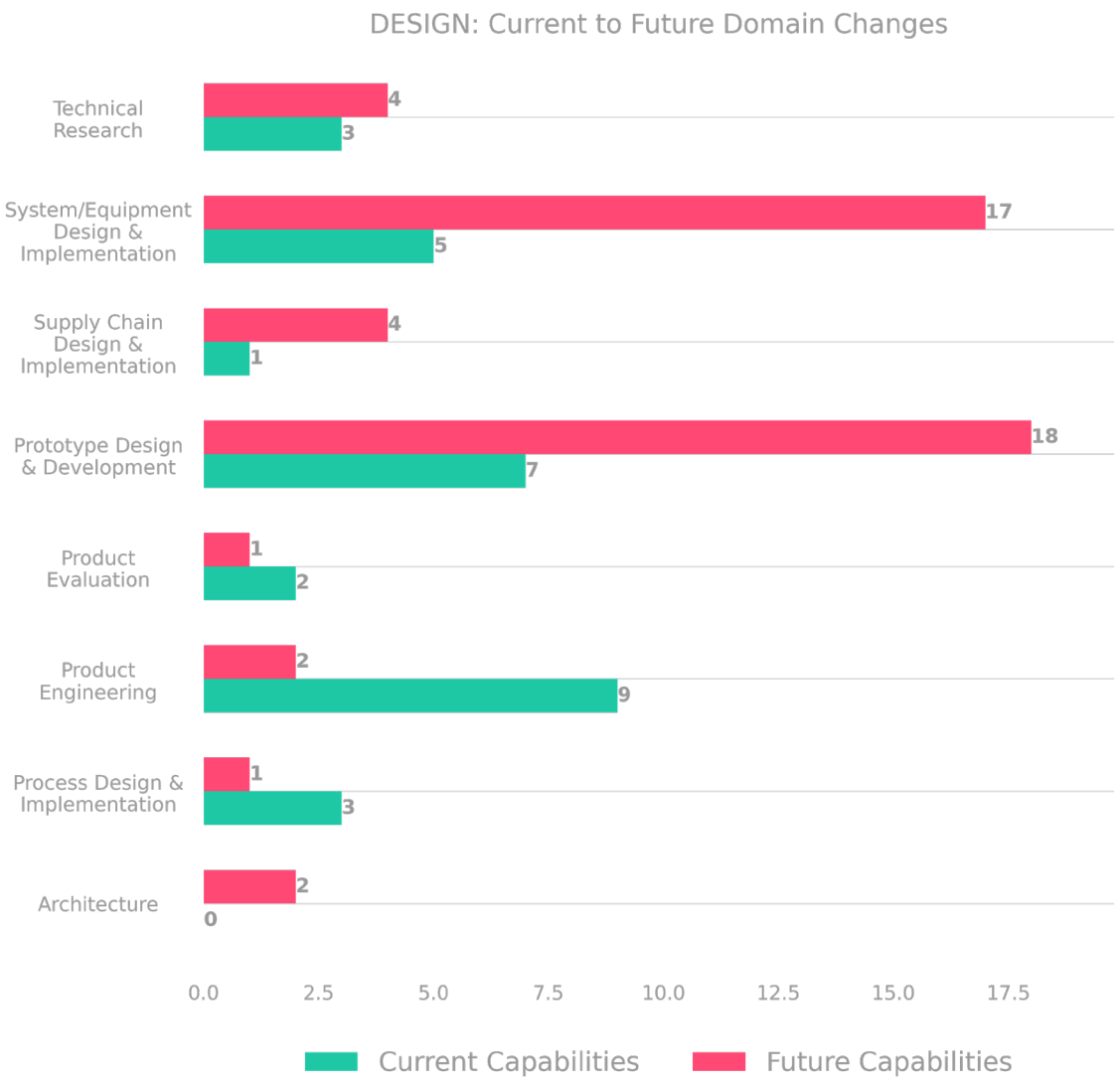


Figure 6: Design Future Domain Spread of Capabilities

The design function has the **highest number of organisational capabilities with 49 out of a total of 152 capabilities for this cycle**, reflecting the cycle focus on the challenges around the convergence of the two existing technologies. At Design domain-level, the highest numbers of capabilities exist currently within Prototype Design and Development and System/Equipment Design and Implementation.

Enterprise Domains:

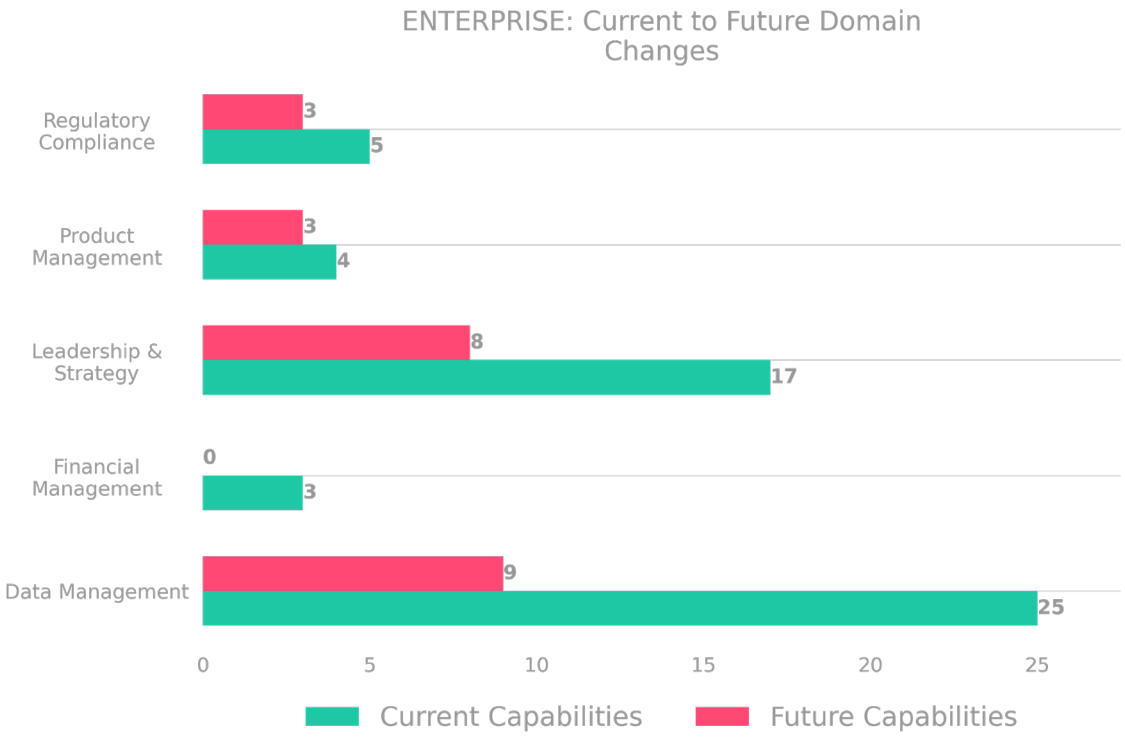


Figure 7: Enterprise Future Domain Spread of Capabilities

The Enterprise function suggests an overall decline in the demand for specific capabilities (23 out of 152). Most capabilities sit in the **Data Management domain; focusing on areas such as performing data analysis; data storage design and evaluating data quality.** Capabilities in the domain of leadership and strategy include identifying new business partnerships for this emerging technology; identifying business threats and opportunities; and evaluating environment impact. Regulatory compliance capabilities also feature in this function including coordinating compliance activities and monitoring compliance and regulation changes.

The current / future comparisons in the Enterprise area show the increased need associated with a maturing and competitive regulated market and the need to increase human resources. The reduction in proportions may be due to omissions during the data gathering and analysis.

Implementation Domains

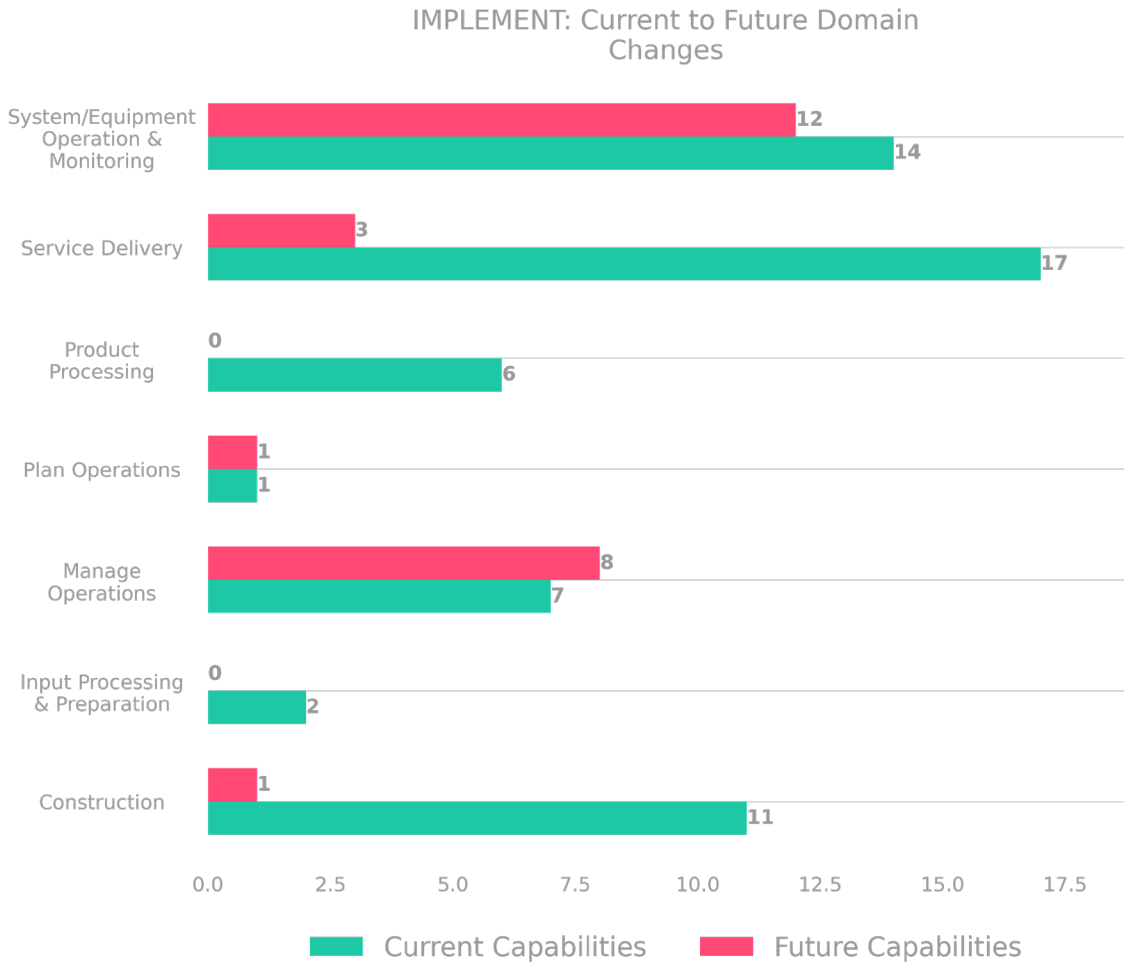


Figure 8: Implementation Future Domains Spread of Capabilities

Of the 152 cycle capabilities for the cycle, **25 sit in the 'implement' function with most operating in the service delivery domain in areas such a**s system and equipment monitoring and manage operations.

The current / future comparison of implementation functions reflects the changes associated with greater adoption and product sales volume.

Logistics Domains

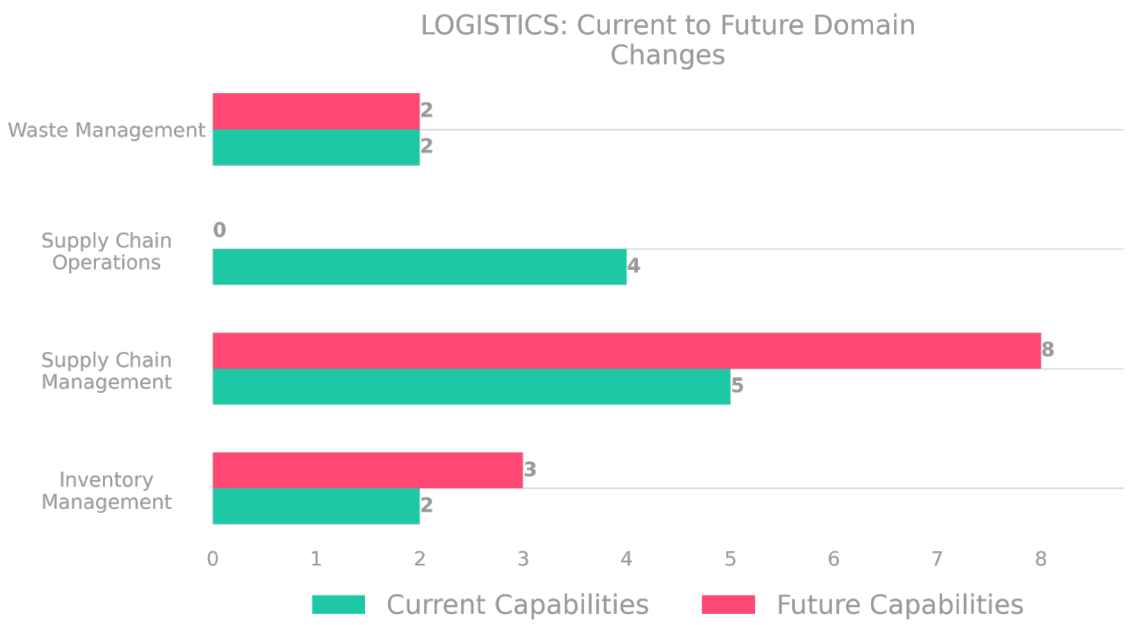


Figure 9: Logistics Future Domains- Future Spread of Capabilities

Only 13 capabilities out of 152 sit in the logistics function. Of those, 13 capabilities, 8 operate in the supply chain management.

The current and future comparison for logistics is as expected for organisations gearing up to work at a higher scale of production.

Support Domains

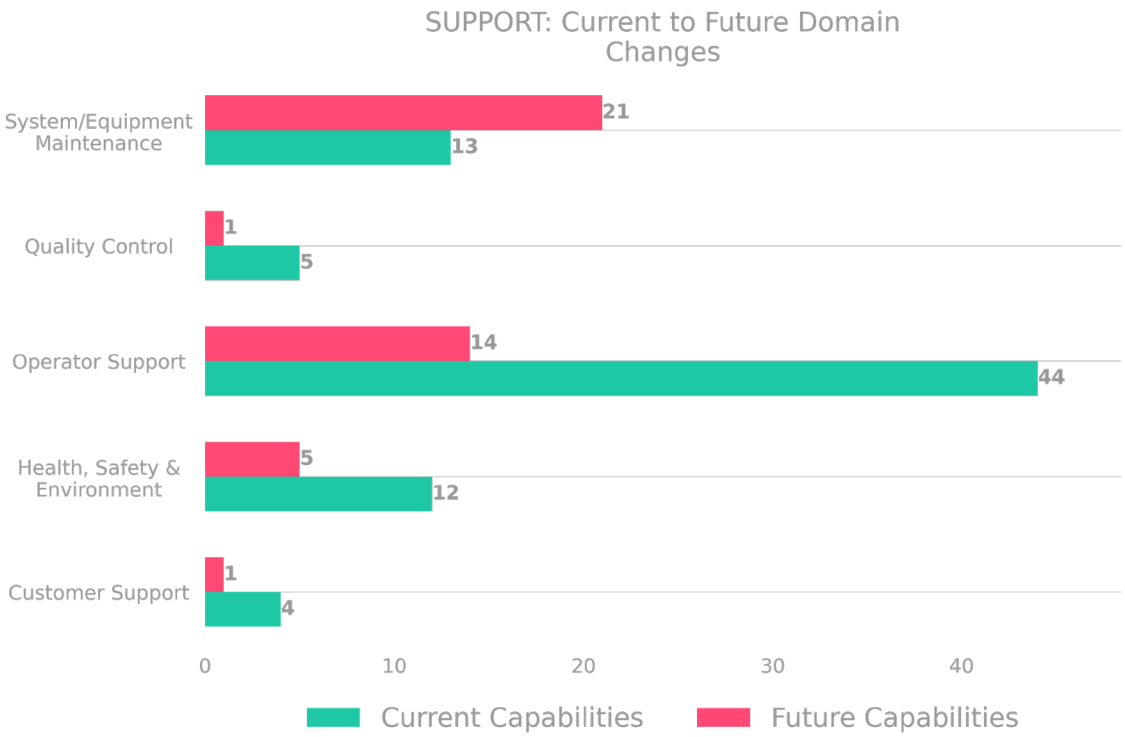


Figure 10: Support Future Domains - Future Spread of Capabilities

The 'support' function has **42 capabilities of the 152 for the cycle**, with the System/Equipment maintenance domain being the highest.

The current and future support comparison reflects the current prominent levels of Health and Safety – the reduction in proportions may be due to omissions during the data gathering and analysis.

Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
Organisational Capabilities	The page provides details of the capabilities required by each supply chain partner and the supply chain as whole. The information is presented using the Capability Classification Framework , Design / Implement / Logistics / Support / Enterprise and can be interrogated and then exported to suit specific user requirements and interest. The information provided also identifies capabilities supported by existing training provision, and where there may be gaps that require the development of new courses or training provision to equip the future workforce.

3.3 Step Two – How will the Workforce change - Occupational Change Insight

Insight into occupational change uses the understanding of how capabilities will change across business functions (section 3.2) to inform proposals for how occupations and their associated skills sets for each supply chain partner may need to be revised to reflect change for each role level within that supply chain.

Supply Chain partner organisation types

The Workforce Foresighting process recognises that different partners in a Supply Chain will require appropriate capabilities, and these are determined and agreed in the initial workshops. In this cycle, the following Supply Chain partners were identified and then used during participant workshops and data analysis to determine the organisational needs:

1. Systems Design
2. Infrastructure and terminal Providers (hardware / software)
3. Manufacturers
4. System and Network Integrators
5. Operators and Service Providers
6. End User interface

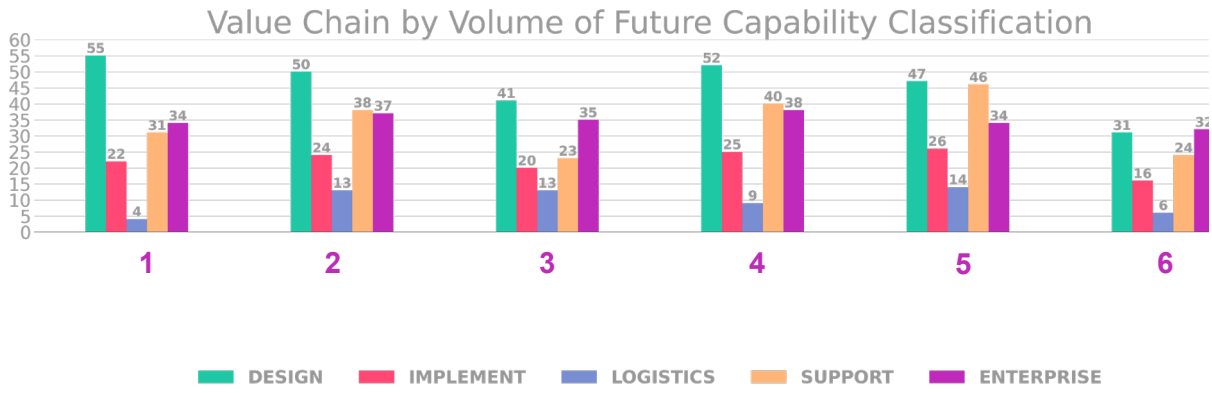


Figure 11: Distribution of Functions across each Supply Chain Partner

The graph illustrates the distribution of capabilities by function across the Supply Chain Partners. These capability sets are used to form the set of Future Occupational Profiles within each role level.

Visualisation Instructions

Detailed instructions can be found in the appendix.

Visualisation Data Link	What is it and what can it be used for?
Supply Chain Capabilities	This page provides an overview of the identified capabilities at a Supply Chain Partner level. By selecting/deselecting each Supply Chain Partner you can review the capabilities identified as required in that area of the Supply Chain. This can be used to generate organisational capability profiles for each area of the Supply Chain to help prioritise and focus the acquisition of new capabilities that will be required in the future. It can also be used to generate combined organisational profiles, where an organisation may be involved in more than one area of the Supply Chain.

Role Levels

The Foresighting process uses the concept of Role Levels to represent future occupations. Utilising this approach acknowledges that the workforce is not homogeneous, there will be varying levels of proficiency required across a workforce and qualifications and training may be aligned/require different types of vocational or academic qualifications. Additionally, the role level approach seeks to avoid presuming that the future workforce will be operating at a different level to the current state.

However, the future workforce for manufacturing constellations of satellites may indeed be working at different levels as there is the likelihood that the number of apprentices recruited and developed across the sector will increase

Role Levels determined through workshops:

1. Senior Engineer (SA cycle)
2. Engineer (SA cycle)
3. Technician (SA cycle)

Proficiencies

Each of these role levels will require proficiency that reflects their role and the needs of each Supply Chain Partner. The Foresight process uses a three-point scale to capture and differentiate the proficiencies required. This information is used both in the generation of the Future Occupational Profiles, and to assist the definition of training needs identified. Within the Workforce Foresight process proficiency is defined as:

> **Awareness (A)** - Has a foundational knowledge of tools, technology, techniques relevant to sector, industry, or organisation. Sufficient comprehension to know where to seek further information/details as necessary for a particular issue.

Practitioner (P) - Has the ability to apply and use independently a tool, system, or process. Understands the implications, consequences, and impact for their role/function. A Practitioner knows what key actions are required and in what context.
Expert (E) - Has detailed knowledge of process, system, tool, or technology. Can support others and identify improvements required for a process, system, or tool. An Expert can implement improvements personally or direct and guide others.

During the workshops participants applied their insight to assign proficiency for each role group to each capability. Individual responses were aggregated by the system to arrive at a consensus.

A summary of the distribution of required proficiency for the role levels in this cycle are:

	Senior Engineer	Engineer	Technician
Awareness	51	9	1
Practitioner	106	152	23
Expert	104	22	4

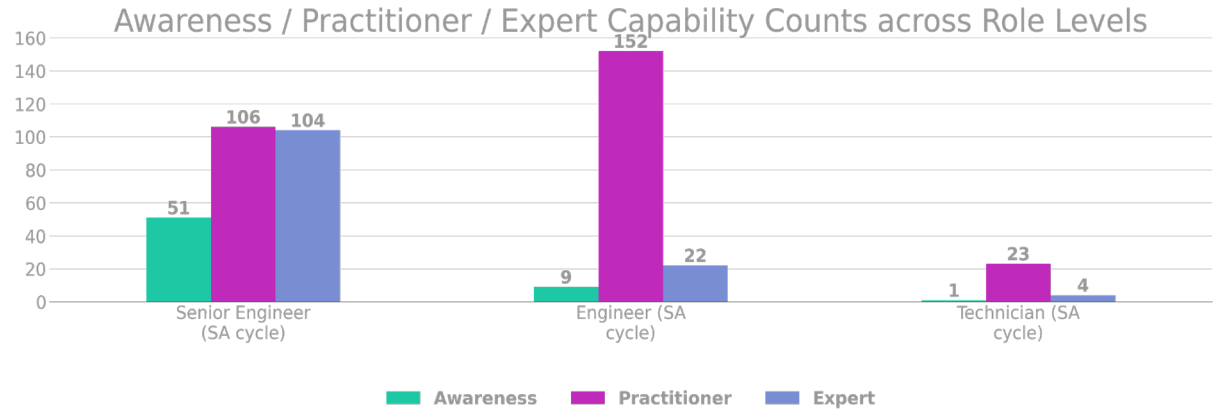


Figure 12: Proficiency details by Role Level

Future Occupational Profiles

FOPs are used to describe and suggest occupations, or roles, that may be required in the future and provide a framework to indicate capabilities and related duties. They can be used to review the impact on current roles and the adaptation that may be required in the future.

Educators can review current apprenticeship standards with the Knowledge, Skills and Behaviours identified against the requirements of the FOPs and interpret which apprenticeship standards may need to be changed to fill the gaps between the current and future state or where adaptation of existing HE provision, or development of short courses is required to upskill and develop existing workforce.

Employers can consider existing apprenticeship standards and make a judgement on adapting an existing apprenticeship standard to upskill their workforce to meet the requirements of a particular FOP, seek out appropriate training or develop their own in house.

FOPs and indicative skills need

Combining proficiency with the identified FOPs, the following graphs indicate the priority needs across the supply chain for each Role Group to deliver future capabilities.

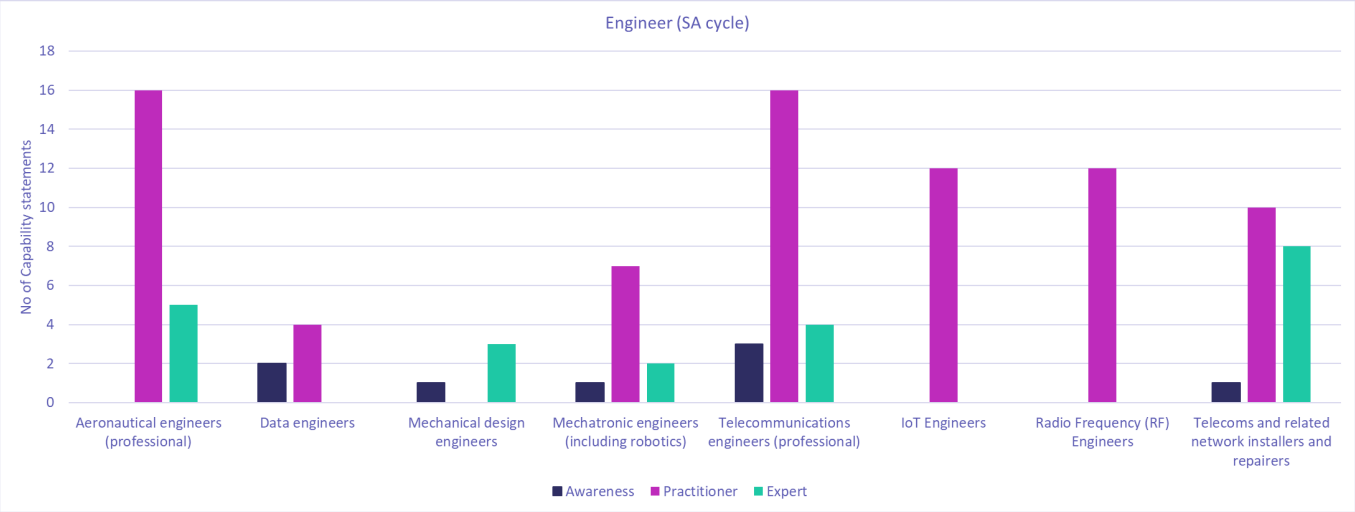
Senior Engineer Role Level FOPs:

In this cycle the Senior Engineer role level was defined as occupations and roles requiring Level 6 (minimum / plus L7/8 or several years of experience) qualifications or apprenticeships.

Figure 13: Priority FOPs - Senior Engineer Role Level

Engineer Role Level FOPs:

In this cycle the Engineer role level was defined as occupations and roles requiring Level 6/7 qualifications or apprenticeships.



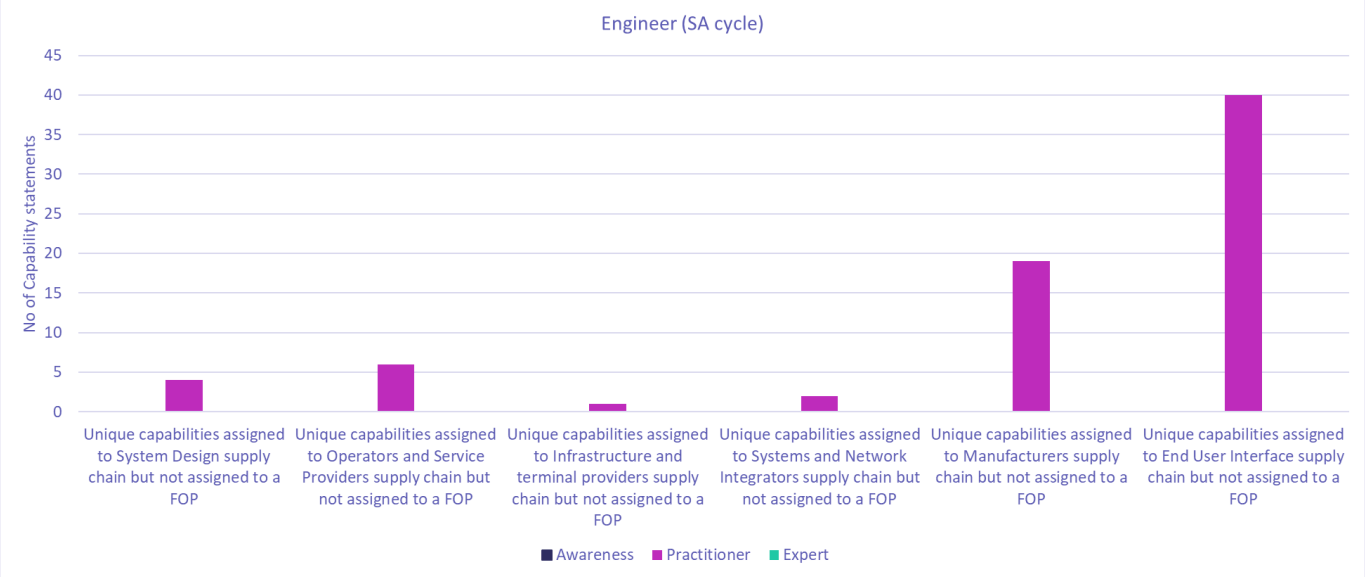


Figure 14: Priority FOPs - Engineer Role Level

This cycle has also identified capabilities (as above) that are required by the supply chain but have not been incorporated into a future occupational profile. The category **'Unique capabilities assigned to (X) supply chain but not assigned to a FOP'** highlights these gaps.

Further analysis during the **Cause Action** phase will be necessary to determine whether these capabilities:

- Support the development of existing roles,
- Can be integrated into future occupational profiles already identified, or
- Indicate the need for a new occupational profile.

Technician Role Level FOPs:

In this cycle the Technician role level was defined as occupations and roles requiring Level 4 qualifications or apprenticeships.

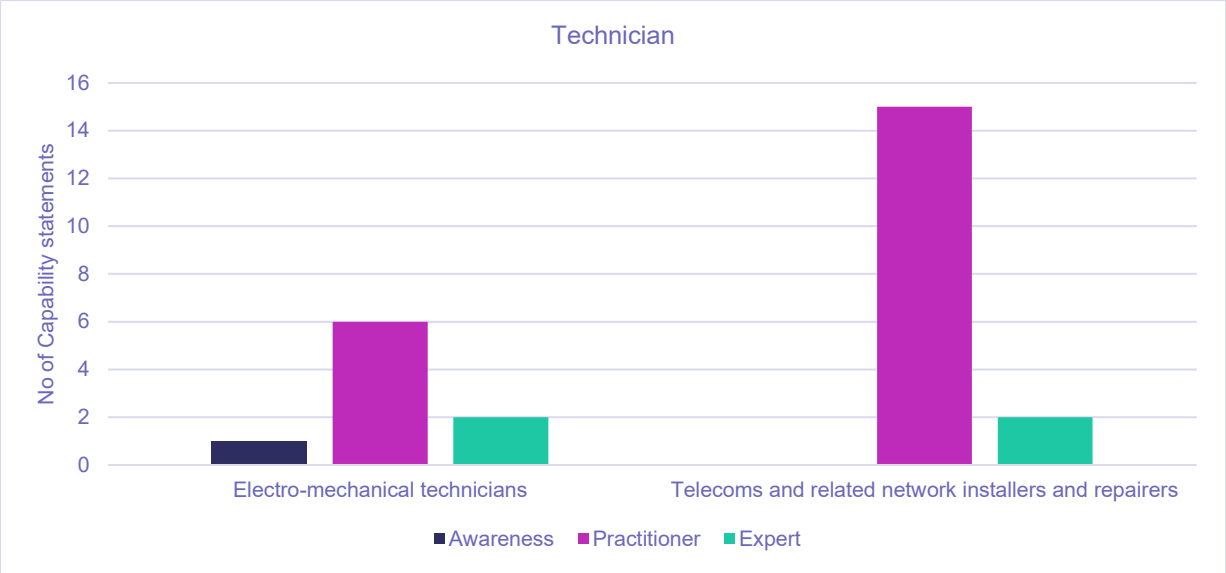


Figure 15: Priority FOPs - Technician Role Level

Visualisation Instructions

Detailed instructions can be found in the appendix.

Visualisation Data Link	What is it and what can it be used for?
FOP Matrix	This page provides a detailed breakdown of future occupational profiles that could be required in the future workforce. These were generated using a combination of attributes collected through the workshops and an algorithm. These suggested profiles were then reviewed and ratified by small groups of employers who were able to add/remove capabilities and uprate/downrate proficiency levels required. You can view all the FOPs in a role level by selecting one (or more) of these from the drop down. This will then allow you to select the FOPs aligned to that role level. The populated table allows you review and compare different FOPs within or across role levels. You can view the capabilities in each FOP and the assigned proficiency levels.

3.4 Step Three – How the current Education provision meets the future need - Highlighted Changes for Future Provision

The Future Occupation Profiles (FOPs) outlined below have been identified as critical roles within the evolving workforce, essential for advancing standards and protocols for the seamless integration of Non-Terrestrial and Terrestrial Networks. The convener has identified 6 priority Future Occupational Profiles (FOPS)as these capabilities will be fundamental to driving industry transformation, facilitating the adoption of next-generation network technologies, and ensuring resilient and efficient connectivity across diverse environments.

While there is some alignment with existing education and training programs, key emerging competencies in this domain remain insufficiently addressed by current offerings across the IfATE provision. Further work will be required to look at the provision through Higher Education and expert training providers. This gap presents a strategic opportunity for innovation, necessitating the development of new education and training provision tailored to the evolving demands of integrated network ecosystems.

A comprehensive analysis of how current education and training initiatives align with the FOPs identified in this Workforce Foresighting cycle is available within the data visualisation tool: FOP vs Provision link.

However, for the purposes of this analysis, the following FOPs have been selected for prioritisation:

Priority Future Occupational Profiles (FOPs)

- Compliance and regulatory professionals
- Cyber operational defence specialists
- Radio Frequency (RF) Engineers
- Telecommunications engineers (professional)
- IoT Engineers
- Electro-mechanical technicians

Below is a comparison for each priority FOP with existing education programmes, highlighting the additional capabilities required within the future workforce. These capabilities could form the basis of a curriculum for future education and training provision, to be delivered through adaptation of existing education programmes or as short continuing professional development (CPD) courses to upskill the current workforce.

Compliance and regulatory professionals

FOP vs Provision	58.3% fit with Engineering manufacturing technician apprenticeship standard
Capability ID	**Unmatched FOP Capabilities**
49410	Develop methodologies to assess the viability or success of sustainability initiatives.
180615	Identify radiation hazards associated with work activities, facilities and equipment. Identify who may be at risk from the hazard and use technical knowledge to estimate the magnitude of the risk e.g. by appraising workplace monitoring results, manufacturers' data, dose histories and shielding calculations as appropriate.
212626	Understand regulatory, technical, or market issues related to sustainability
213859	Develop detailed equipment guidelines to ensure compliance with specific safety and performance standards.
194979	Complete legal documentation for customers and employer.

Cyber operational defence specialists

FOP vs Provision	85.0% fit with Cyber security technologist (2021)
Capability ID	**Unmatched FOP Capabilities**
75910	Implement operational and emergency procedures.
210465	Manage secure data communication with robotic and autonomous systems.
213856	Authorise maintenance activities to ensure system reliability and operational status.

Radio Frequency (RF) Engineers

FOP vs Provision	38.5% fit with Network Engineer
Capability ID	**Unmatched FOP Capabilities**
194731	Lead end to end cell site installation and maintenance activities, having the responsibility for teams and contractors simultaneously on site.
183683	Select new cell site locations and design new cell sites in relation to network planning which is required to meet site specific targets including containment of coverage. This should also include consideration of Health & Safety procedures and applicable national and international legislation and regulations. This may include sites to be permanently part of the network or for a temporary purpose.

213853	Assemble and install communication equipment for wireless communications, e.g., antennas, RF front ends; and free-space optical equipment to ensure operational connectivity
51920	Develop system engineering, software engineering, system integration, or distributed system architectures.
210843	Identify potential suppliers with relevant expertise
150690	Review new product plans, and make recommendations for material selection, based on design objectives such as strength, weight, heat resistance, electrical conductivity, and cost.

Telecommunications engineers (professional)

FOP vs Provision	**56.7% fit with Radio network technician**
Capability ID	**Unmatched FOP Capabilities**
112110	Participate in network technology upgrade or expansion projects, including installation of hardware and software and integration testing.
213854	Assemble energy-efficient optical communications systems to enhance performance and sustainability.
210799	Engineer instrumentation and software for satellite surveillance and tracking.
25440	Communicate with telecommunications vendors to obtain pricing and technical specifications for available hardware, software, or services.
71230	Gather data pertaining to customer needs, and use the information to identify, predict, interpret, and evaluate system and network requirements.
124680	Prepare detailed network specifications, including diagrams, charts, equipment configurations, or recommended technologies.
51920	Develop system engineering, software engineering, system integration, or distributed system architectures.
150690	Review new product plans, and make recommendations for material selection, based on design objectives such as strength, weight, heat resistance, electrical conductivity, and cost.
210843	Identify potential suppliers with relevant expertise

IoT Engineers

FOP vs Provision	**30.8% fit with Digital and technology solutions professional**
Capability ID	**Unmatched FOP Capabilities**
188973	Develop innovative technology qualification processes and field integration programmes

189219	*Develop innovative solutions to engineering challenges, focusing on cost-effectiveness, manufacturability, and ease of maintenance.
205701	Implement real-time monitoring and adjustment using advanced sensors and monitoring technology
188673	Define test plans and procedures and compile test reports, managing test data and results for development and verification of the subsystem and spacecraft design.
210379	Integrate remote systems via high-speed protocols for coordinated operations.
120080	Plan or schedule engineering research or development projects involving microelectromechanical systems (MEMS) technology.
150690	Review new product plans, and make recommendations for material selection, based on design objectives such as strength, weight, heat resistance, electrical conductivity, and cost.
210843	Identify potential suppliers with relevant expertise

Electro-mechanical technician

FOP vs Provision	**80.0% fit with Broadcast and media systems technicians**
Capability ID	**Unmatched FOP Capabilities**
146940	Request bids from suppliers or consultants.

The table below lists the statements defined through this Foresighting cycle, with an overview of the number of FOPs which require these capabilities. This data highlights the anticipated demand for specific capabilities within the future workforce and overlap in skills across future job roles, providing valuable insights for the development of future education and training programmes. Further details on the FOPs these capabilities correspond to can be found within the visualisation tool. FOP Distribution link

Capability ID within Visualisation tool	Organisational Function	Capability Statement	Total capability count across 32 FOPs
51920	DESIGN	Develop system engineering, software engineering, system integration, or distributed system architectures.	11
150690	IMPLEMENT	Review new product plans, and make recommendations for material selection, based on design objectives such as strength, weight, heat resistance, electrical conductivity, and cost.	10
210843	DESIGN	Identify potential suppliers with relevant expertise	8
47520	SUPPORT	Develop and implement solutions for network problems.	8
124680	DESIGN	Prepare detailed network specifications, including diagrams, charts, equipment configurations, or recommended technologies.	7
48020	DESIGN	Develop application-specific software.	7
56740	SUPPORT	Discuss and plan systems with solution architects, system engineers, or cybersecurity experts to meet customer requirements.	7
183335	SUPPORT	Consider security implications of proposed design to ensure that security considerations are built in from inception and throughout the development process.	7
71230	DESIGN	Gather data pertaining to customer needs, and use the information to identify, predict, interpret, and evaluate system and network requirements.	6
213853	IMPLEMENT	Assemble and install communication equipment for wireless communications, e.g., antennas, RF front ends; and free-space optical equipment to ensure operational connectivity	6
183317	IMPLEMENT	Investigate and problem solve to address technical performance issues in networks to return the network to successful operation and escalate as necessary	6
203474	SUPPORT	*Design and maintain secure network infrastructure solutions	6

Link to full data set - Visualisation Instructions

Visualisation Data Link	What is it and what can it be used for?
FOP Detail	This page allows you to review a specific Occupational Profile, including the capabilities contained within it and the Knowledge, Skills & Behaviour (KSB) tags associated with the capability. You can select an individual Role Level and linked FOP in the two available dropdowns. The table in the lower section of the page will then be populated with all relevant capabilities. The search control above the table allows you to filter content of any of the columns of data. A key piece of functionality in this table is the presence of the KSB tags associated with the capabilities.
Future KSBs Summary	This page provides a view of the complete set of capabilities within the cycle along with all of the associated KSB tags which are linked to them. It is, essentially, the superset of all details displayed on the FOP detail page. This is used to: • To review the identified Knowledge, Skill and Behaviour tags for a given capability, to support development of future education and learning material. • To review the requirements from a capability level, rather than a role level/occupational profile grouping.
Capabilities Matched to Current Provision	This page allows you to review and compare individual capabilities against 'Duty' statements in an Apprenticeship / Occupational Standard. You can select individual capabilities to review their specific matches. These matches are shown in the bottom panel, including the Standard, the Level and the Duty Statement this is matched to. You can filter in several ways to focus your review: • By the Capability Classification Framework (left-hand panel). • By capabilities that **are** served by the reference mapping framework – the default is Institute for Apprenticeships and Technical Education (IfATE) provision. • By capabilities that **are not** served by the reference mapping framework, e.g., IfATE provision – these are capabilities required in the future that may require new/bespoke training and CPD materials to be developed to upskill/re-skill the workforce. This page can be used to identify where existing provision may exist across the broad spectrum of Apprenticeship standards, and not just within a narrow range of sector-specific Standards. The data also allows you to identify where provision may already exist to support specific capabilities.

Fit & Surplus Factors	This page allows you to review the 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). It is possible for the 'Fit' and 'Surplus' comparison to total over 100%, as they are two separate calculations based on a two-way comparison.
Fit & Surplus Matrix	This page is a visual representation of the 'Fit and Surplus Factor' insight. You can visually review 'Fit' and 'Surplus' of Prototype Future Occupation Profiles (FOP) against existing training provision e.g. Institute for Apprenticeships and Technical Education (IfATE). This can help you identify which provision may align strongest, or which may require adaptation, to provide the suitable provision fit for each future role. It will help you focus in on which provision to focus your attention for analysis.
FOP Capability Matches	This page allows you to view the matches between Capabilities and Institute for Apprenticeships and Technical Education (IfATE) Duty Statements. Clicking the arrow next to a number in the 'Matches' column will open a popup with more detail for each Capability. Each capability also includes Knowledge, Skill and Behaviour Tags, to support with scaffolding future education provision. You can review individual Prototype Future Occupational Profiles (FOPs) or review all FOPs under a Role Level, to give a more holistic view of Capabilities and Matches Where a future capability has been matched to existing provision (currently, by default, IfATE apprenticeship standards) it is possible to interrogate the data and identify specific statements in standards that align to enable identification of existing training materials and activities that could be used or adapted to meet future requirements. This can be used to review the capability requirements for Role Levels and FOPs, from Job / Occupation level through to Knowledge, Skill and Behaviour level

4. Conclusion and Next Steps

4. Conclusions and Next Steps

4.1 Summary of Key Insights

The integration of **Non-Terrestrial Networks (NTN) with Terrestrial Networks (TN) in the UK** presents both a significant opportunity and an urgent challenge. While technological advancements in **5G/6G, AI-driven network management, and satellite communication** are progressing rapidly, the **workforce, regulatory landscape, and infrastructure readiness** remain key concerns.

If the UK fails to act swiftly in upskilling its workforce and aligning policy frameworks with industry needs, it risks **falling behind global competitors** in next-generation telecommunications. A coordinated effort between **government, industry, and education providers** is essential to secure the UK's leadership in NTN-TN integration and digital connectivity.

Key Reflections	Why it matters
Urgency of NTN-TN Integration - The demand for **ubiquitous, resilient, and secure connectivity** is accelerating. NTN-TN integration is no longer optional; it is a necessity for **economic growth, national security, and industry competitiveness**.	Delays in adoption could leave the UK dependent on **foreign infrastructure and expertise**, reducing economic sovereignty.
Skills Deficit & Workforce Transformation - The UK faces a **significant shortage of professionals** in **AI-driven network management, RF engineering, and cybersecurity**. Many existing training programs do not fully prepare workers for NTN-TN roles.	Without **targeted upskilling and training investments**, the UK may lack the skilled workforce needed to deploy and maintain NTN-TN infrastructure at scale
Industry & Education Collaboration is Critical - Engagement with **education providers, technical colleges, and universities** is essential to **update curricula** and ensure future talent is industry-ready.	Without alignment between **training programs and employer needs**, the skills gap will widen, slowing sector growth.
Need for a Regulatory & Standardisation Framework - The success of NTN-TN integration depends on **clear policies, frequency spectrum regulations, and cybersecurity protocols**.	Without regulatory clarity, businesses and investors may be hesitant to commit, stalling infrastructure deployment.
Cross-Sector Collaboration Will Drive Innovation - NTN-TN technology is not just for telecommunications—it will **transform logistics, healthcare, smart cities, and autonomous transportation**	Cross-sector engagement will help identify **unexpected use cases and funding opportunities**, accelerating adoption.

Points to highlight:

Limited Industry Awareness of NTN-TN Workforce Needs

- Many industry leaders recognise the importance of NTN-TN technology, but few have identified clear workforce strategies to address future skills gaps.
- **Impact on Next Steps**: More work is needed to engage trade associations, industry bodies, and businesses in skills forecasting efforts.

Overlapping Yet Fragmented Stakeholder Efforts

- Several organisations - including IfATE, Innovate UK, trade councils, and sector working groups - are working on related skills initiatives, but there is limited coordination between them.
- **Impact on Next Steps**: A centralised working group or task force is needed to align efforts, avoid duplication, and drive a unified skills development strategy.

Cross-Sector Applications Are Emerging Faster Than Expected

- Industries beyond telecoms (e.g., maritime, logistics, agriculture, and aerospace) are increasingly interested in NTN-TN solutions.
- **Impact on Next Steps**: Future Foresighting studies should expand scope beyond telecoms and space to explore NTN-TN's impact across multiple sectors.

The table below categorises the number of IfATE standards by suitability score for each FOP. The table selects the top 10 IfATE standards from the visualisation tool that support each FOP and indicates whether each standard has low, some, or good suitability and is colour-coded accordingly.

Additionally, the table identifies the potential Supply Chain Partner(s) that each FOP is likely to support. This insight enables educators to prioritise FOPs that are in demand across a broad supply chain network, ensuring their training aligns with industry needs. The visualisation tool in not restricted and a review of other standards can take place.

Role Level	Supply Chain Partner(s)	Future Occupation Profile	Low	Some	Good	Overall Suitability RAG
Senior Engineer (SA cycle)	Operators and Service Providers	Information security directors	8	2	0	Low
Senior Engineer (SA cycle)	Operators and Service Providers	Information technology operations directors	10	0	0	Low
Senior Engineer (SA cycle)	Operators and Service Providers	Network managers	9	1	0	Low
Senior Engineer (SA cycle)	Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers, End User interface	Business Operations Manager	8	2	0	Low

Senior Engineer (SA cycle)	Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers, End User interface	Application Specialist	7	3	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers	Cyber operational defence specialists	8	2	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers	Power systems engineers	10	0	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers	Supply chain directors	10	0	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers, End User interface	Compliance and regulatory professionals	8	2	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers, End User interface	Quality assurance professionals	7	3	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, End User interface	Avionics engineers	9	1	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers	Cyber security management and governance specialists	8	2	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers	Data architects	8	2	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers	IT solutions architects and designers	8	2	0	Low
Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers	IT systems architects	8	2	0	Low

Senior Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers, End User interface	Software developers	8	2	0	Low
Engineer (SA cycle)	Systems Design	Radio Frequency (RF) Engineers	4	6	0	Low
Engineer (SA cycle)	Systems Design	Unique capabilities assigned to System Design supply chain but not assigned to a FOP	10	0	0	Low
Engineer (SA cycle)	Infrastructure and terminal Providers (hardware / software)	Unique capabilities assigned to Infrastructure and terminal providers supply chain but not assigned to a FOP	10	0	0	Low
Engineer (SA cycle)	Manufacturers	Unique capabilities assigned to Manufacturers supply chain but not assigned to a FOP	9	1	0	Low
Engineer (SA cycle)	System and Network Integrators	Unique capabilities assigned to Systems and Network Integrators supply chain but not assigned to a FOP	8	2	0	Low
Engineer (SA cycle)	Operators and Service Providers	Unique capabilities assigned to Operators and Service Providers supply chain but not assigned to a FOP	10	0	0	Low
Engineer (SA cycle)	End User interface	Unique capabilities assigned to End User Interface supply chain but not assigned to a FOP	9	1	0	Low
Engineer (SA cycle)	Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators	Mechanical design engineers	5	5	0	Some
Engineer (SA cycle)	Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators	Mechatronic engineers (including robotics)	8	2	0	Low
Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network	Data engineers	8	2	0	Low

	Integrators, Operators and Service Providers					
Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators	IoT Engineers	10	0	0	Low
Engineer (SA cycle)	Systems Design, Infrastructure and terminal Providers (hardware / software), System and Network Integrators, Operators and Service Providers	Telecommunications engineers (professional)	3	7	0	Some
Engineer (SA cycle)	Systems Design, Operators and Service Providers	Telecoms and related network installers and repairers	1	7	2	Some
Engineer (SA cycle)	Systems Design, System and Network Integrators, Operators and Service Providers	Aeronautical engineers (professional)	4	6	0	Low
Technician (SA cycle)	Infrastructure and terminal Providers (hardware / software), Manufacturers, System and Network Integrators, Operators and Service Providers	Electro-mechanical technicians	4	6	0	Some
Technician (SA cycle)	System and Network Integrators, Operators and Service Providers	Telecoms and related network installers and repairers	4	5	1	Some

Top Fits

By reviewing the FOPs against the suitability grid, we can determine which of the groups of current apprenticeship standards are more applicable than others.
Many of the FOPs that have IfATE standards identified as 'Good suitability' when compared with current IfATE standards and provision are:

1. Telecoms and related network installers and repairers (Engineer)
2. Telecoms and related network installers and repairers (Technician)

Suitable standards are listed in the table below:

Role Level	Future Occupation Profile	IfATE Apprenticeship Standard	Suitability
Engineer (SA cycle)	Telecoms and related network installers and repairers	Radio network technician	Good
		Information communications technician	Good
		Broadcast and media systems engineer (integrated degree)	Good
		Network engineer	Good
		Network cable installer	Good
		Smart home technician	Good
		CNFE - Cellular network field engineer	Good
		Digital and technology solutions profession	Good
		Post production engineer	Good
		Creative industries production technician	Good
Technician (SA cycle)		Radio network technician	Good
		Information communications technician	Good
		Smart home technician	Good
		Network engineer	Good
		Network cable installer	Good
		CNFE - Cellular network field engineer	Good
		Creative industries production technician	Good
		Maritime electrical fitter	Good
		Telecoms field operative	Good
		Installation and maintenance electrician	Good

The use of the data visualisation tool is recommended to access the next layer of detail and review the specific standards that have been identified as having Good Suitability / Some Suitability or Low Suitability.

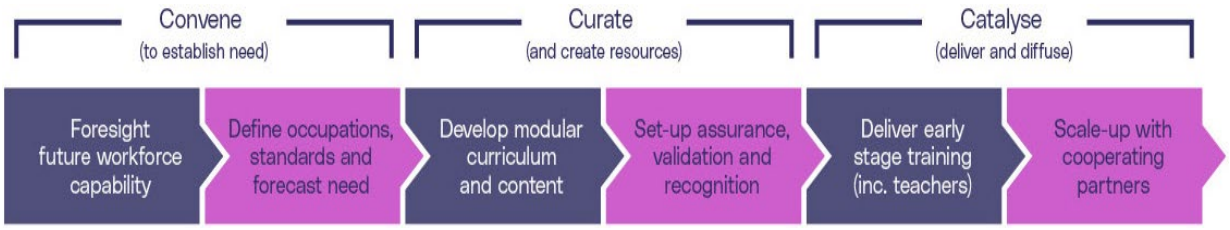
As a comparison we can also list the standards that score lowest against the required FOPs, suggesting that there are few, if any suitable standards within the IfATE library to support these Future Role Profiles. During the Cause Action phase these will be further informed through discussion with Educators.

FOPs with some of the lowest scores are:

1. Information technology operations directors
2. Network managers
3. Business Operations Manager
4. Application Specialist
5. Power systems engineers
6. Supply chain directors
7. Quality assurance professionals
8. Avionics engineers
9. Radio Frequency (RF) Engineers
10. Mechatronic engineers (including robotics)
11. IoT Engineers
12. Telecommunications engineers (professional)
13. Aeronautical engineers (professional)

4.2 What this means for Industry and the Workforce

Workforce Foresighting has been developed to provide insight and the detailed information required to enable action by relevant stakeholders but is the first step of the Skills Value Chain. Collective action will be required by all stakeholders to ensure that the changes identified by Foresighting – to the supply chain, the workforce and education provision are implemented.



Employers in the converging Satcomms and Telecoms sectors must take proactive steps, both individually and collectively, to ensure that the development of skilled professionals meets industry needs. It is essential for employers to embrace upskilling and reskilling initiatives across various sectors, actively fostering a pipeline of future talent from schools, colleges, and universities.

As the industry evolves, particularly with advancements in technology, greater technical collaboration among partners will be crucial. This collaboration should commence early in the project lifecycle, including the design phase. It is expected that there will be an increase in working groups and interface design teams, led by industry leaders, to address the specific needs of emerging roles. Employers should review the organisational changes that have been identified as a result of the technology to start to plan for the changes across their entire supply chain. This insight is valuable in strategic planning and coordinated thinking.

To effectively tackle the anticipated skills gap, the converging Satcomms and Telecoms technology sectors must engage with key stakeholders to develop realistic workforce demand forecasts. This includes collaboration with educational institutions and industry organisations to ensure that training programmes are aligned with current and future job requirements. By taking these coordinated actions, the sector can secure a skilled workforce capable of meeting the demands of rapidly evolving technologies.

4.3 What this means for Education

The findings from the Workforce Foresighting study suggest that future needs will be addressed through modifications to existing courses and degrees. The capabilities and potential occupational profiles generated through the cycle suggest that, in general, modifications to existing courses and degrees are sufficient to meet future needs. A modular approach is more likely to be achievable within the required timescales, compared to wholesale course design.

It is noted, that whilst there was a dominant focus on Radio Frequency (RF) Engineers within the cycle findings, the groups noted that there is also a strong Security component required at all levels which could include cyber-, crypto- or quantum key technology.

Education modules for HE and FE courses can be developed with reference to the P-FOPs and capability sets for example Cyber security management and governance specialists.

Other standards identified by the fit- / surplus-factor analysis may also be suitable for adaptation including example Telecoms and related network installers and repairers, Electro-mechanical technician and Cyber operational defence specialists.

Where there are more specialist technical areas that require capability development, these should be addressed through routes such as PhD sponsorships and engagement with industry. University-led PhD studies can investigate problems and technologies in detail, before professionals in industry and RTOs provide support to refine and scale up solutions. It is important that these types of specialist areas are identified in good time.

A challenge for academia is to engage with industry proactively, supporting ongoing dialog so that research topics can be identified collaboratively. Foresighting can provide the catalyst to bring together industry and academia to explore the direction of travel. This should be recognised as a two-way street.

4.4 Recommended next steps

The first step will be to convene a working group to **Cause Action** for development of selected skills for the sector. This should include representatives of UKspace Satcomms Working Group, TechUK, ADS, Space Universities Network and Space Academic Network, Space Skills Advisory Panel, IfATE, IUK.

It will also be critical to gain wider stakeholder engagement to drive the results forward into action. This will involve:

Industry Stakeholder Engagement

- Strong engagement from telecom companies, satellite operators, and cybersecurity firms indicates a shared recognition of the need for NTN-TN workforce planning.
- **Next Steps**: Industry councils and trade associations should be more directly involved in shaping apprenticeship standards and workforce training.

Education Sector Collaboration

- Universities are in a good position to integrate NTN-TN content into courses particularly if they are involved in the research on which this is based and already have strong industry partnerships. FE Colleges will require more support and guidance on curriculum design and industry partnerships.
- **Next Steps**: Convene a joint working group with IfATE, Innovate UK, higher education institutions and industry representation to establish training pathways for NTN-TN careers.

Cross-Sector Discussions

- Cross-sector dialogue revealed that NTN-TN's impact extends far beyond telecoms and space, requiring an interdisciplinary approach to skills development.
- **Next Steps:** Establish or engage with sector-wide knowledge-sharing forums to explore NTN-TN's role in logistics, transport, smart cities, and national security.

Failure to address workforce challenges, regulatory gaps, and industry collaboration inefficiencies will:

- Delay the UK's 6G rollout and digital infrastructure ambitions.
- Create critical workforce shortages, leading to reliance on foreign expertise.
- Limit the economic potential of NTN-TN, slowing down industry growth and innovation.

The time to act is now - a coordinated effort from government, industry, and education will ensure the UK leads in NTN-TN integration, securing long-term national and economic benefits.

To ensure the UK telecommunications and space sectors are prepared to meet future demands, particularly in respect to advancing standards and protocols for the integration of Non-Terrestrial and Terrestrial Networks the following actions are recommended:

Leverage Future Occupational Profiles (FOPs):

- Utilise FOPs to address current and anticipated skill gaps by updating industry standards and creating Continuing Professional Development courses for both those currently employed in this sector and those transitioning from other sectors.
- Advocate for the revision of apprenticeship standards / higher education provision to align with future workforce needs, ensuring the sector remains competitive.

Short-term Actions:

- Reskilling and Upskilling:
  - Educators, awarding bodies, and employers should collaborate to tailor course content that aligns with new capabilities and existing apprenticeship standards, focusing on design and lifecycle activities.
  - Immediate efforts are needed to prepare short-term training solutions that meet the current demands of technology.

Mid-term Actions:

- Integration of Future Skills Training:
  - Formalise the integration of future skills requirements into existing apprenticeship standards and training programs, particularly for new entrants, based on prioritised FOPs.
- Modular Course Updates:
  - Implement modular changes to existing educational programs rather than complete overhauls. This approach allows for quicker adaptation to evolving industry needs, ensuring flexibility and responsiveness.

General Actions for Educators:

- Assessment and Feedback:
  - Review of the Institute for Apprenticeships and Technical Education (IfATE) standards and relevant qualifications in partnership with employers is essential, as happens with Trailblazer groups but mechanisms should be available to ensure that relevant data from Foresighting can be incorporated outside review periods. This process should focus on identifying gaps and providing necessary feedback.
- Commissioning New CPD Courses:
  - Evaluate existing CPD provisions and commission new courses where necessary, promoting collaboration among stakeholders and industry to maintain a unified approach to workforce development. These mechanisms should be embedded into Skills England and DfE policy.

Dissemination and Review:

- Dissemination of Findings:
  - Establish a working group to create an action plan and widely share the findings among stakeholders. This will influence workforce development initiatives and ensure strategic alignment.
- Ongoing Review and Adaptation:
  - Regularly review findings with stakeholders, adapting Future Occupational Profiles (FOPs) as needed to better fit emerging roles. This will ensure that actions remain robust and validated.

By implementing these recommended actions, the advancement of standards and protocols for the integration of Non-Terrestrial and Terrestrial Networks will be significantly strengthened, ensuring a skilled workforce capable of supporting the demands of evolving communication technologies. These strategies highlight the necessity of coordinated efforts among policymakers, industry leaders, and research institutions to bridge capability gaps and position the UK as a global leader in seamless.

5. Appendix

5. Appendix

Section	Title
5.1	Cycle timeline
5.2	Access to output data - link and authorisation
5.3	Glossary - common language
5.4	Visualisation links and illustrations
5.5	Fit and Surplus analysis against current provision

5.1 Cycle timeline

Workforce Foresighting cycle started the Carry Out phase in November 2024. The Carry Out phase concluded in February 2025. The Findings report was prepared following the data validation period and published in March 2025.

5.2 Access to output data - link and authorisation

Link to Visualisation tool - Data Capture

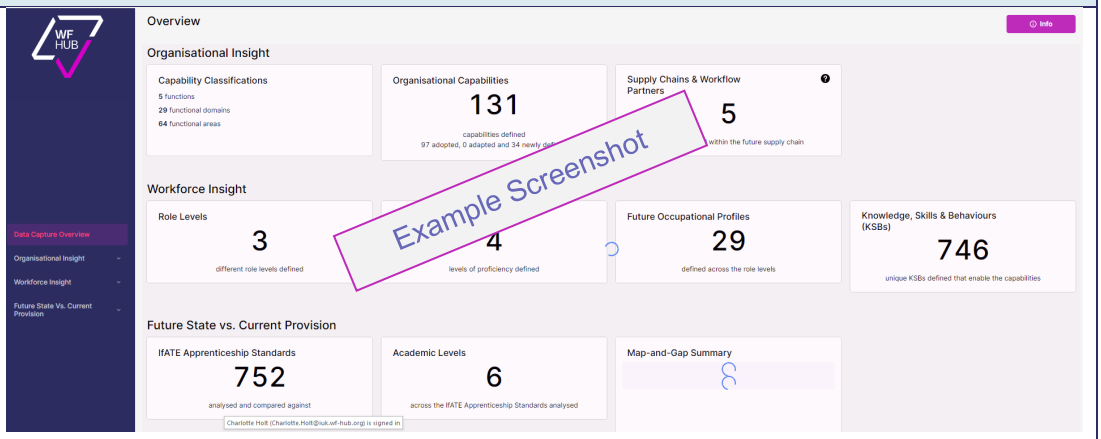
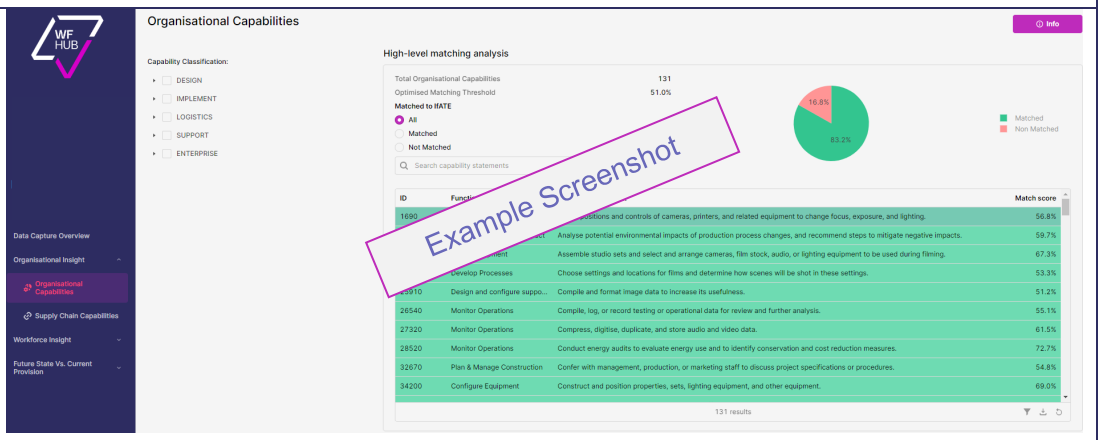
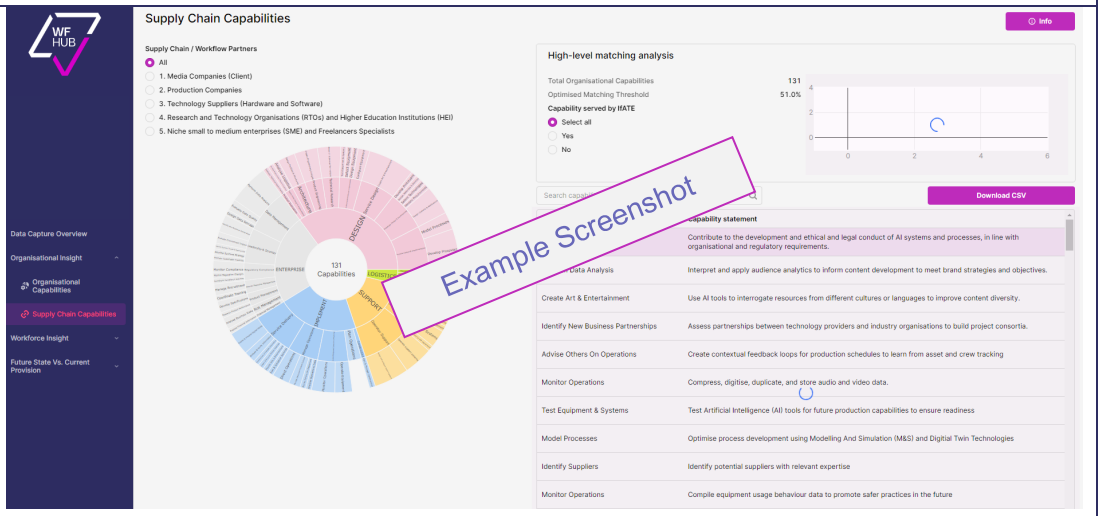
5.3 Glossary - common language

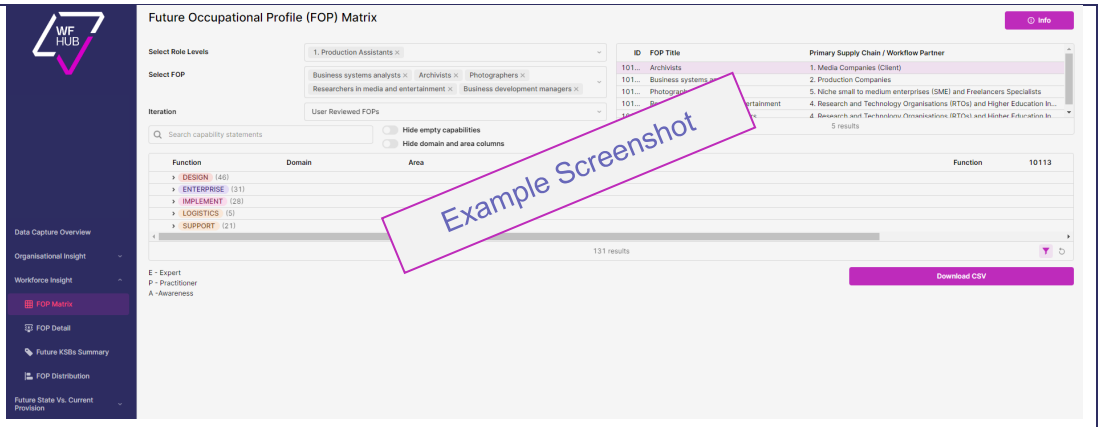
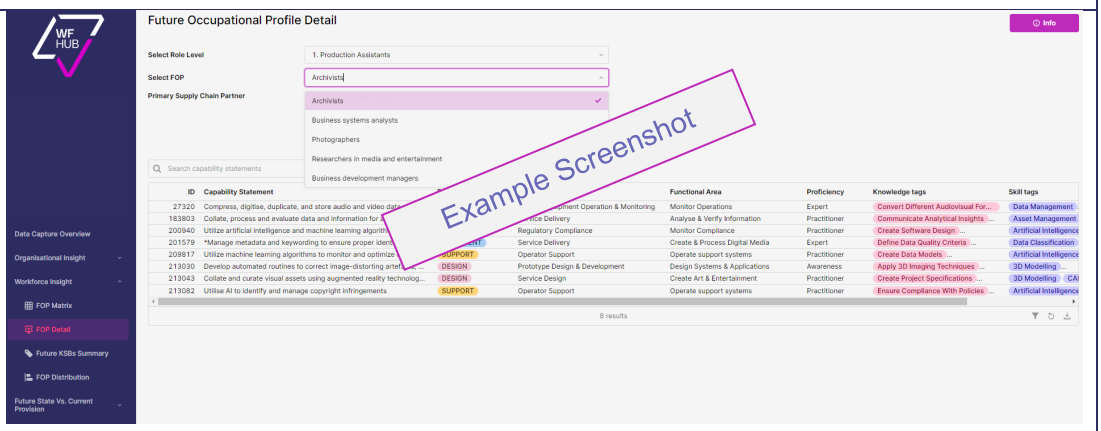
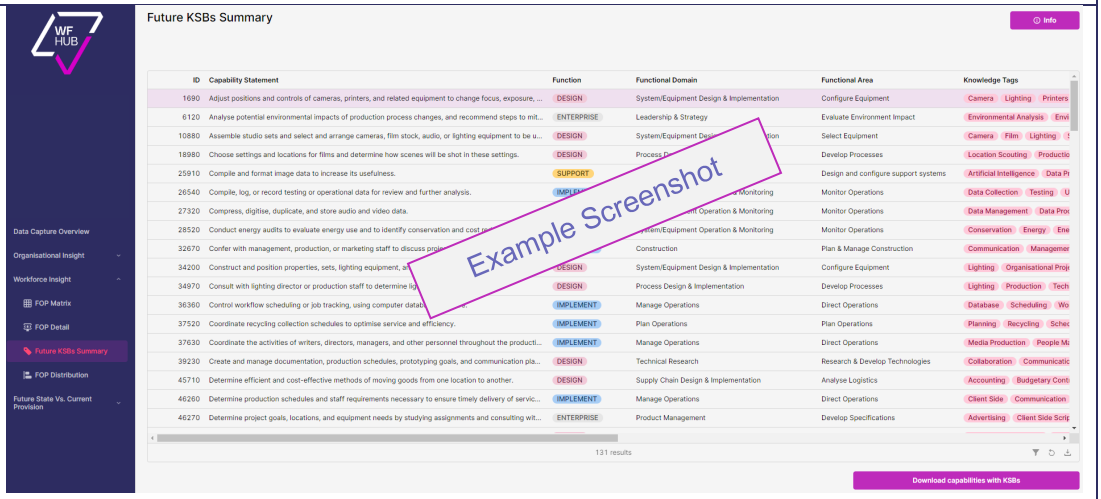
Term	Definition
Impact Domains	Innovate UK domains used as Strategic Categories to assist setting and monitoring priorities
National Challenge (Industry / Sector / Region)	A recognised technological or socio-political threat or opportunity for which there is consensus that workforce action is necessary
Challenge Response	Specific intervention aimed at the challenge
Capability (Organisation)	The collective abilities, and expertise of an organisation to carry out a function, because provision and preparation have been made by the organisation
Capability Classification	Classification provides a common, structured vocabulary to define capability
Capability Statements	Description of the depth and nature of each capability within an organisation
Capability Syntax	Common language to describe each capability application within organisation type
Competencies (Workforce / Individual)	'Proficiency, aptitude, capacity, skill, technique, experience, expertise, facility, fitness related to capability
Competency definition 'KSBs' (Knowledge, Skills and Behaviours)	Knowledge, Skills, and Behaviours are the elements used to express the required competencies for each Role Group
Competency Domain	Used during Foresighting analysis to provide focus on existing and emerging competency needs
Delphi Process	Foresighting takes a Delphi approach which has come to represent consulting expert opinion. (Harking back to the Delphic Oracle of ancient Greece)
Foresight Cycle	Set of workshops, analysis and reporting that implements the Foresight Process for each subject

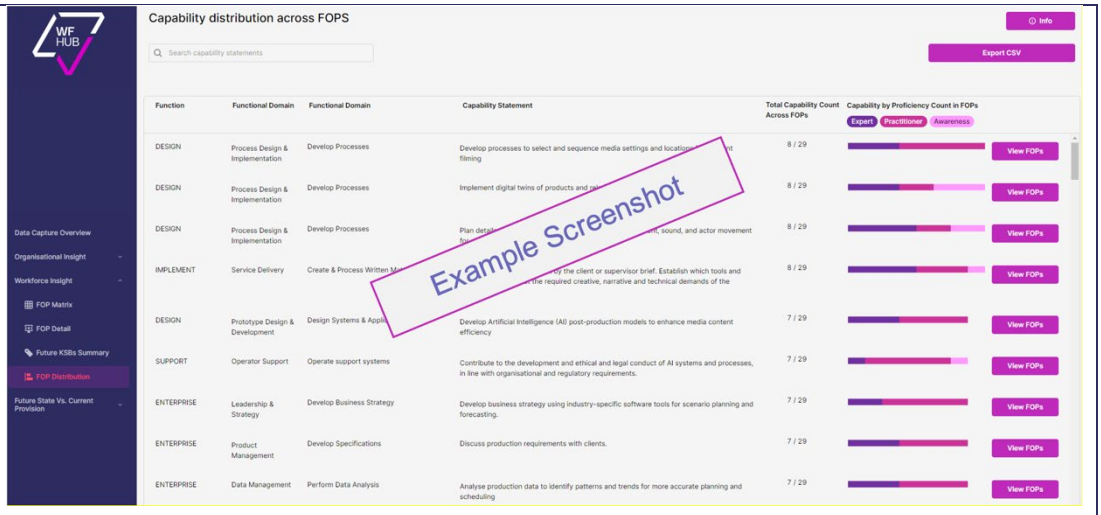
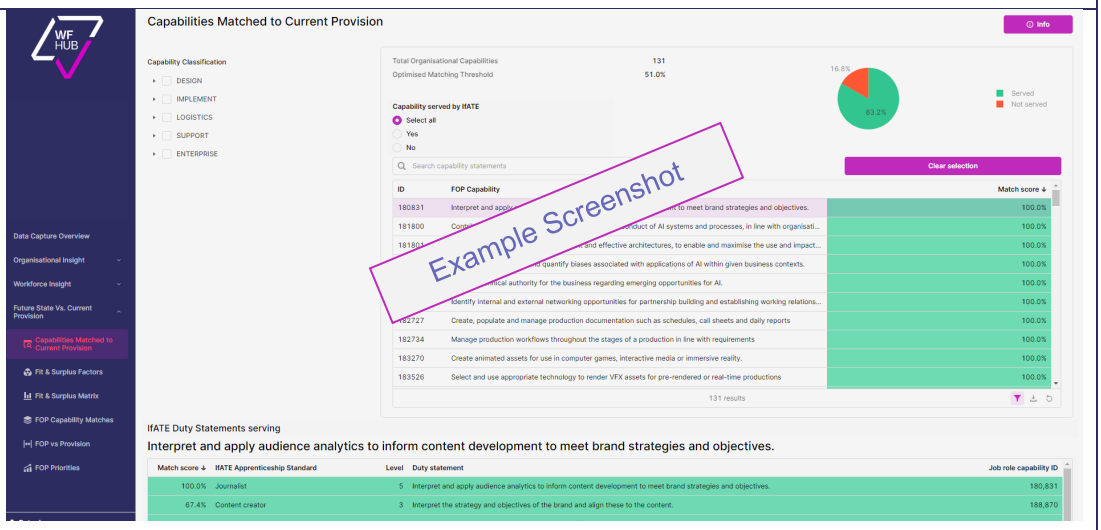
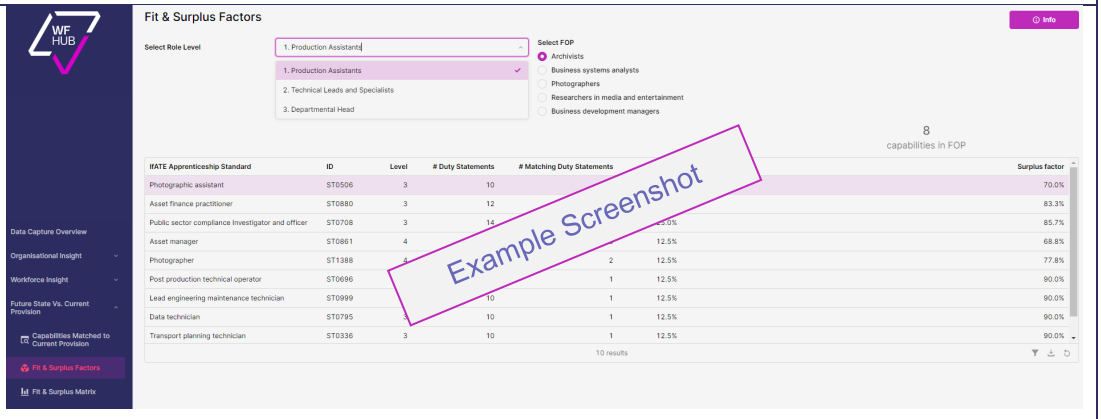
Foresight Process	A series of activities which are convened to understand future competence needs, the opportunities available and actions required to deliver the right skills at the right time and place
Foresighting Champion	An individual nominated within a new user organisation of Foresighting to facilitate and lead the use of Foresighting processes and tools with the support of the Project Team
Foresighting Subject	The application of specific technologies in the context of a given challenge and which are candidates for Foresighting
Future Competency Set	The KBS output from the Educator workshop for each Role Group
Map and Gap Analysis	A combined expert and automated process that maps the Future Competency Set against a selected reference framework
Organisation Type	Simple description of nature of organisation for which capability is required
Proficiencies	Proficiencies differentiate the degree of competencies required from differing Role Groups to support capabilities
Project Sponsor	Typically, a stakeholder in the challenge being successfully met who requires information to under-write plans to act
Role Group	Role groups are a collective of roles that exist in a typical manufacturing business / industrial sector
Syntax	The way in which a statement is phrased to ensure reliable, repeatable and meaningful interpretation
Technologies	The technology that could be used to address the challenge
Working Scenario	To provide further context in relation to the subjects and used to position participants thinking during the detailed identification of future capabilities
Workshops	Online sessions used to undertake each step in the Foresight process
Roadmaps	Sector, Industry, Regional view of emerging opportunities and their market entry
Participants	Technologists, Educators, Employers

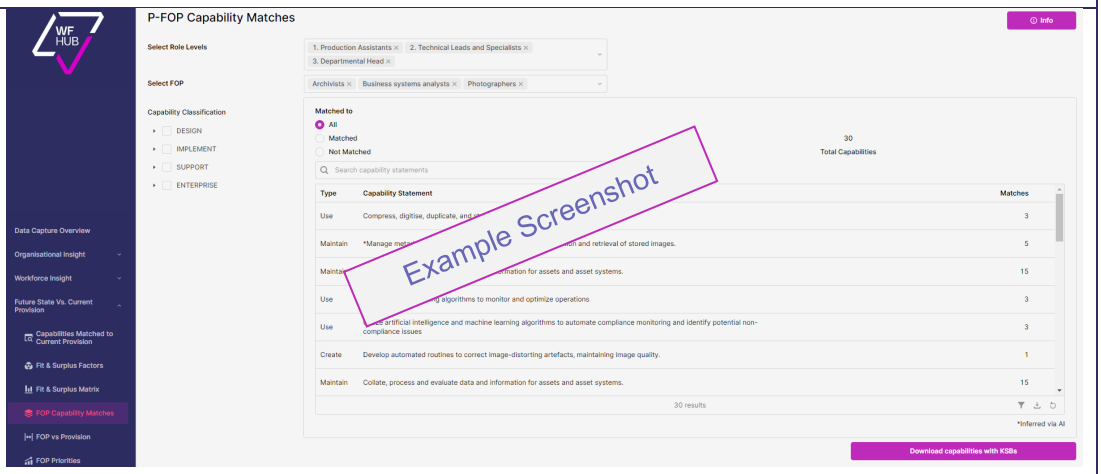
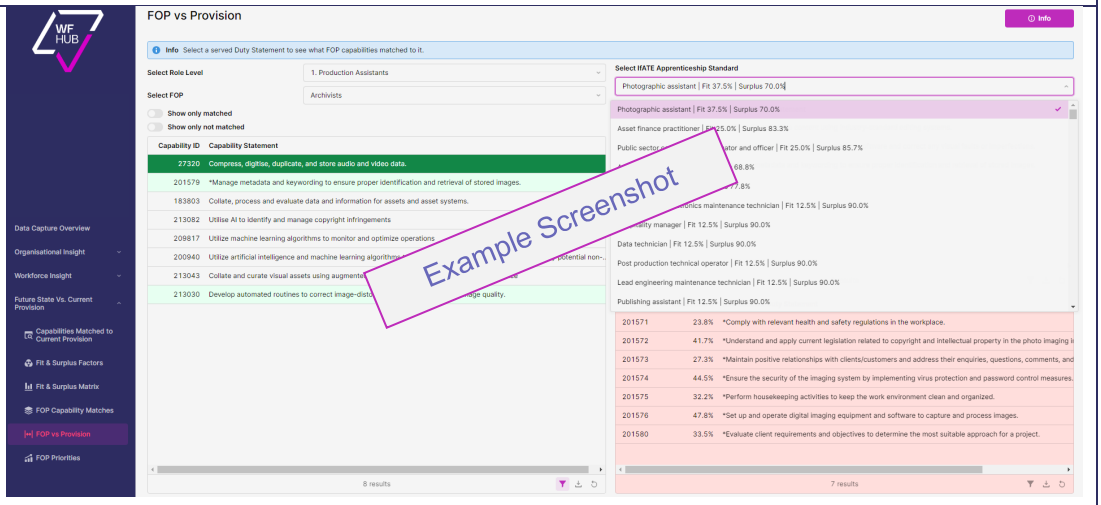
5.4 – Visualisation links and Illustrations

Images are not cycle specific and just for guidance purposes

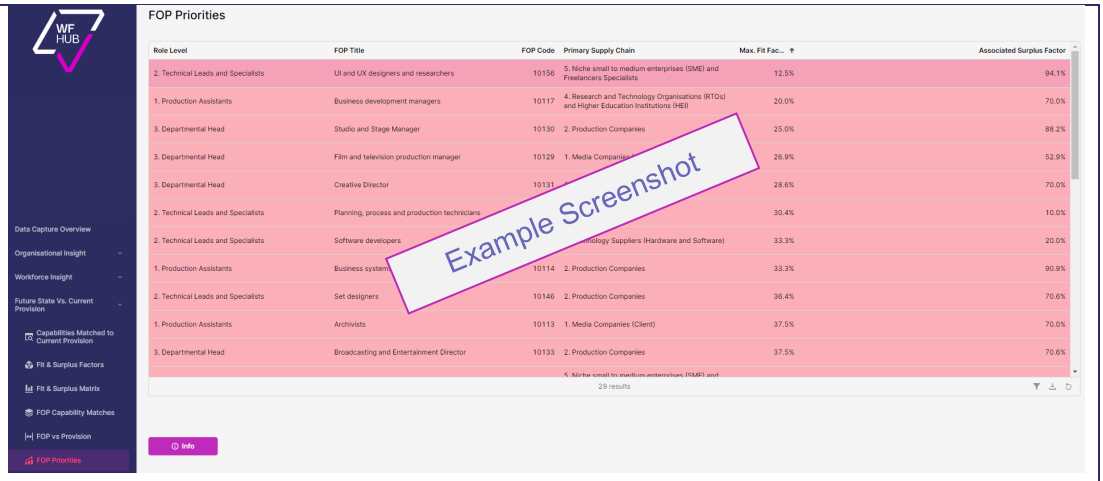
Link to Visualisation	View of data
Data Capture Overview	
Organisational Capabilities	
Supply Chain Capabilities	

[FOP Matrix]	
	
[Future KSBs Summary]	

FOP Distribution	
Capabilities Matched to Current Provision	
Fit & Surplus Factors	

[Fit & Surplus Matrix]	
[FOP Capability Matches]	
[FOP vs Provision]	

FOP Priorities



5.5 - Fit and Surplus analysis against current provision:

The Workforce Foresighting process has developed two metrics to quantify the alignment between a FOP and a current standard or qualification.

Fit – expressed as a %, it is a measure of the proportion of a FOP that is covered by an existing standard or qualification.
Surplus – expressed as a %, it is a measure of the not relevant material in an existing standard that is not required for a FOP.

An ideal existing qualification or standard would have a high fit and low surplus – this implies good coverage of the FOP but with little material that is not relevant to the FOP. Conversely a poor candidate would have a low fit and high surplus. Using these two metrics it is possible to quantitively evaluate, rank, and compare a range of existing provisions against a set of FOPs describing future needs.

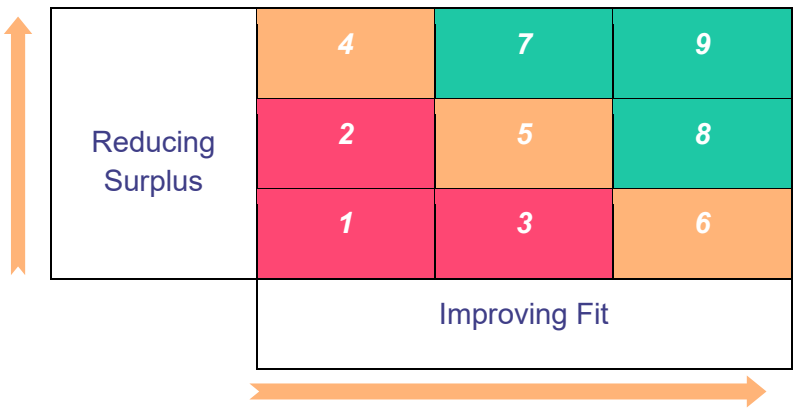
Our interpretation is represented by a simple nine-box model to position the suitability of a given current occupational standard to a future occupational profile:

Factor scores

Fit Factor	Fit score	Surplus Factor	Surplus score
0 - 32%	1	81-100%	1
33-65%	2	51-80%	2
66-100%	3	0 - 50%	3

(Multiplying the Fit score by the Surplus score gives a Suitability Grid score of 1-9 as below)

Suitability Grid



Fit Factor scores and Suitability Grid

Using this score and indicated 'RAG status' the following interpretations can be made:

High Suitability – 7,8,9 – for standards that have good coverage of FOPs.
Represents good candidates from current apprenticeship standards used as the basis of development to meet FOP requirements and inform elements of short course and CPD provision.

Some Suitability– 4,5,6 – for standards that have only partial coverage of FOPs.
These are likely to require extended work to meet FOP requirements, further review of the data may be necessary. They are likely to contain some useful information to inform elements of short course and CPD provision.

Low Suitability – 1,2,3 – for standards that have poor coverage of FOPs.
These are unlikely to be adaptable to meet future needs but may contain some useful information to inform elements of short course and CPD provision, which can be assessed using the data visualisation tools.

FOP findings compared with current standards

Using the approach described above and applying the 'RAG' scores to each FOP indicating the suitability of current apprenticeship standards selected from the IfATE set, the following table begins to identify areas of action and concern for the provision of future skills for each Supply Chain Partner to respond to the challenge.

Supply Chain Partner - Systems Design

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Power systems engineers	Low
Senior Engineer (SA cycle)	IT systems architects	Low
Senior Engineer (SA cycle)	IT solutions architects and designers	Low
Senior Engineer (SA cycle)	Data architects	Low
Senior Engineer (SA cycle)	Cyber security management and governance specialists	Low
Senior Engineer (SA cycle)	Cyber operational defence specialists	Low
Senior Engineer (SA cycle)	Supply chain directors	Low
Senior Engineer (SA cycle)	Avionics engineers	Low
Senior Engineer (SA cycle)	Software developers	Low

Engineer (SA cycle)	Unique capabilities assigned to System Design supply chain but not assigned to a FOP	Low
Engineer (SA cycle)	Telecoms and related network installers and repairers	Some
Engineer (SA cycle)	Telecommunications engineers (professional)	Some
Engineer (SA cycle)	Radio Frequency (RF) Engineers	Some
Engineer (SA cycle)	IoT Engineers	Low
Engineer (SA cycle)	Data engineers	Low
Engineer (SA cycle)	Aeronautical engineers (professional)	Some

Supply Chain Partner - Infrastructure and terminal Providers (hardware / software)

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Software developers	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Power systems engineers	Low
Senior Engineer (SA cycle)	IT systems architects	Low
Senior Engineer (SA cycle)	IT solutions architects and designers	Low
Senior Engineer (SA cycle)	Application Specialist	Low
Senior Engineer (SA cycle)	Avionics engineers	Low
Senior Engineer (SA cycle)	Business Operations Manager	Low
Senior Engineer (SA cycle)	Supply chain directors	Low
Senior Engineer (SA cycle)	Cyber operational defence specialists	Low
Senior Engineer (SA cycle)	Cyber security management and governance specialists	Low
Senior Engineer (SA cycle)	Data architects	Low
Engineer (SA cycle)	Data engineers	Low
Engineer (SA cycle)	Telecommunications engineers (professional)	Some

Engineer (SA cycle)	Mechatronic engineers (including robotics)	Low
Engineer (SA cycle)	Mechanical design engineers	Low
Engineer (SA cycle)	IoT Engineers	Low
Engineer (SA cycle)	Unique capabilities assigned to Infrastructure and terminal providers supply chain but not assigned to a FOP	Low
Technician (SA cycle)	Electro-mechanical technicians	Some

Supply Chain Partner - Manufacturers

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Business Operations Manager	Low
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Cyber operational defence specialists	Low
Senior Engineer (SA cycle)	Power systems engineers	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Supply chain directors	Low
Engineer (SA cycle)	Data engineers	Low
Engineer (SA cycle)	Mechanical design engineers	Low
Engineer (SA cycle)	Mechatronic engineers (including robotics)	Low
Engineer (SA cycle)	Unique capabilities assigned to Manufacturers supply chain but not assigned to a FOP	Low
Technician (SA cycle)	Electro-mechanical technicians	Some

Supply Chain Partner - System and Network Integrators

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Supply chain directors	Low
Senior Engineer (SA cycle)	Software developers	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Power systems engineers	Low
Senior Engineer (SA cycle)	IT systems architects	Low
Senior Engineer (SA cycle)	IT solutions architects and designers	Low
Senior Engineer (SA cycle)	Application Specialist	Low
Senior Engineer (SA cycle)	Avionics engineers	Low
Senior Engineer (SA cycle)	Business Operations Manager	Low
Senior Engineer (SA cycle)	Data architects	Low
Senior Engineer (SA cycle)	Cyber operational defence specialists	Low
Senior Engineer (SA cycle)	Cyber security management and governance specialists	Low
Engineer (SA cycle)	Aeronautical engineers (professional)	Some
Engineer (SA cycle)	Unique capabilities assigned to Systems and Network Integrators supply chain but not assigned to a FOP	Low
Engineer (SA cycle)	Telecommunications engineers (professional)	Some
Engineer (SA cycle)	Mechatronic engineers (including robotics)	Low
Engineer (SA cycle)	Mechanical design engineers	Low
Engineer (SA cycle)	IoT Engineers	Low
Engineer (SA cycle)	Data engineers	Low
Technician (SA cycle)	Electro-mechanical technicians	Some
Technician (SA cycle)	Telecoms and related network installers and repairers	Some

Supply Chain Partner - Operators and Service Providers

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Data architects	Low
Senior Engineer (SA cycle)	Supply chain directors	Low
Senior Engineer (SA cycle)	Software developers	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Power systems engineers	Low
Senior Engineer (SA cycle)	Application Specialist	Low
Senior Engineer (SA cycle)	Business Operations Manager	Low
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Cyber operational defence specialists	Low
Senior Engineer (SA cycle)	Cyber security management and governance specialists	Low
Senior Engineer (SA cycle)	Network managers	Low
Senior Engineer (SA cycle)	IT solutions architects and designers	Low
Senior Engineer (SA cycle)	IT systems architects	Low
Senior Engineer (SA cycle)	Information security directors	Low
Senior Engineer (SA cycle)	Information technology operations directors	Low
Engineer (SA cycle)	Aeronautical engineers (professional)	Some
Engineer (SA cycle)	Unique capabilities assigned to Operators and Service Providers supply chain but not assigned to a FOP	Low
Engineer (SA cycle)	Telecoms and related network installers and repairers	Some
Engineer (SA cycle)	Telecommunications engineers (professional)	Some
Engineer (SA cycle)	Data engineers	Low
Technician (SA cycle)	Electro-mechanical technicians	Some

Technician (SA cycle)	Telecoms and related network installers and repairers	Some

Supply Chain Partner - End User interface

Role Level	Selected Future Occupational Profiles	Current Suitability Summary
Senior Engineer (SA cycle)	Application Specialist	Low
Senior Engineer (SA cycle)	Avionics engineers	Low
Senior Engineer (SA cycle)	Business Operations Manager	Low
Senior Engineer (SA cycle)	Compliance and regulatory professionals	Low
Senior Engineer (SA cycle)	Quality assurance professionals	Low
Senior Engineer (SA cycle)	Software developers	Low
Engineer (SA cycle)	Unique capabilities assigned to End User Interface supply chain but not assigned to a FOP	Low