

# THE DIGITAL VOYAGE FOR PORTS IN SCOTLAND

ASSESSING THE CURRENT AND  
FUTURE ROLE OF DIGITAL TECHNOLOGIES  
FOR THE PORT SECTOR













## Executive summary

Scottish ports are crucial to the nation's industrial supply chains, export producers, and recreational activities. Digitalisation, the integration of advanced technologies, and the use of management systems, in port management and operations, are imperative for enhancing and sustaining port efficiency, security, and sustainability.

This study found that all participating ports exhibited digital maturity levels adequate or beyond sector expectations based on their relative size and cargo complexity. Nevertheless, gaps were detected and a proactive approach to improve digital maturity will add value to the maritime sector:

- Improve productivity and customer service in the supply chain.
- Increase port capacity and management for new energy transition services.
- Boost skills and innovation around Scotland, with digital ports supporting other sectors of the economy to get value from maritime innovation.

Barriers/enablers for- and risks/opportunities from the port digital path include:

Barriers/enablers	Impact	Risks/opportunities	Impact
Lack of IT and digital capability in the port		Support energy transition	
Gaps in internet connectivity		Retain connectivity of remote communities	
Difficult business case for technology		Competition from ports with digital tools	
Strong digital tech. sector in Scotland		Emissions monitoring and reporting	
Weak plans for digital smart ports		Cybersecurity of supply chains	

## Growing digital maturity in Scotland's Ports

On the voyage to smarter ports and improved digital maturity, ports can take actions on an individual, collective, and national level, including.

**Individually** ports can:

1. Develop a digital strategy
2. Focus on quick wins to resolve gaps, such as:
  - Develop or implement new off-shelf systems (e.g. PMIS).
  - Build skills in-house, e.g. in the use of technologies such as drones.
  - Map and optimise (paper-based) processes.
3. Work together with stakeholders and tenants in the local port community to explore mutual improvements.

**Collectively** ports should:

1. Continue working together in the Digital Ports Working Group to:
  - Share knowledge and experiences.
  - Develop joint guidelines and standards.
  - Engage in joint investments and smart developments.
2. Start up a Scottish Maritime Innovation Hub, together with research institutes and government agencies. This could serve as a safe space to trial/incubate new ideas, before commercial take-up.

**Nationally**, the following barriers can be addressed:

1. Fibre and cellular connectivity issues in ports need to be addressed.
2. Support innovation from the research/trial phase to commercialisation.

Improved digital capability and resilience in ports will provide stronger foundations for industry, supply chains, and the energy transition.

**This report outlines the current levels of port digitalisation, gaps to resolve, benefits to capture, on the path forward for smarter ports in Scotland.**

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**Objective** – to understand the diversity of digital needs at ports in Scotland, across all sectors, assessing their readiness for the future and capture opportunities to become smarter ports, benefiting the future trade and growth of Scotland.

A report for Scottish Enterprise, delivered by Royal HaskoningDHV  
**March 2025**

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Scottish Enterprise wish to thank the participating ports for their support in the Scottish Ports Digital & Data Working Group, whose contributions shaped this report:

- Eyemouth Harbour
- Forth Ports
- Peel Ports Group
- Montrose Port
- Port of Aberdeen
- Peterhead Port
- Port of Inverness
- Global Energy Group; Port of Nigg
- Caledonian Maritime Assets Limited

Along with support from colleagues at South of Scotland Enterprise (SOSE) and Highlands and Islands Enterprise (HIE)

## Introduction

Ports in Scotland are vital to the industrial supply chains, export producers, and recreational activities in the nation; the efficient and resilient performance of these ports is of national importance. Our ports<sup>1</sup>..



Contribute an estimated **£1.5 bn GVA** to the local economy.



Are an essential node in Scottish supply chains. Exports accounted for **48% of the total freight** moved through major Scottish ports in 2021.



Are enabling the UK's energy transition to sustainable sources. Ports are crucial for realising, hosting, and maintaining sustainable energy technologies such as bottom-fixed and floating **offshore wind** parks, **hydrogen** generation and storage, **wave** and **tidal** energy, and **carbon capture** and storage, as well as Oil and Gas decommissioning.



Keep Scotland connected; a total of **6.3 million passengers** and **2.6 million vehicles** were carried on Scottish ferry routes in 2021.



Provide jobs and labour for the local community as well as the nationwide supply chains. Ports directly **employed 18,600 people** in Scotland in 2019 and **supported** a total of **49,202** jobs across Scotland.



Apart from enabling maritime trade and development, ports also ensure a **safe work environment** for people involved in the sector.

This port infrastructure does not only contain civil infrastructure and equipment but also less-visible IT networks and digital technologies that enable ports to be productive and enhance their contributions to Scottish industry and society.

<sup>1</sup> British Ports Association, 2023, *Scottish Ports – Gateways for Growth*

A range of nine representative port and harbour authorities and asset owners participate in this study, to assess the current and future role of digital technologies in Scottish ports, spread across the nation and key sectors of industry.





## The importance of digitalisation in ports

Ports are critical infrastructure for Scotland, and digital, data, and control systems are important for port management and have been so for decades. Continued evolution, integration, and wider adoption of digital systems are important to:

- Support port user and client needs in efficiency, security, cargo tracking and optimised resource usage
- Manage port costs, assets, and business resilience
- Protect supply chains with cyber-resilient systems
- Monitor and prepare for climate change impacts on assets and operations
- Provide the tools for energy transition within the industry, particularly for offshore renewable energy
- Support decarbonisation for key industrial supply chains
- Provide insight to preserve navigational safety
- Maintain reliability of port services, especially island life-line routes

Digital tools, skills, and systems, driven by port community collaboration and innovation are important to industries across Scotland.

## Project objectives

The objectives of this study are as follows:

1. Inform Scottish Enterprise on opportunities for **digital developments in the port sector**.
2. Gauge **digital maturity** for ports working in different cargo sectors.
3. Find **common challenges** to work together on.
4. Recommend initiatives and pathways to **resolve gaps and capture opportunities**.

This project delivers a first view of a common approach to boost smarter ports across the great diversity of maritime facilities in Scotland. This report is a first stage to set the direction for future studies, plans, and investments across the sector.



# Digital Maturity of Ports in Scotland

*Understanding  
readiness for the future*

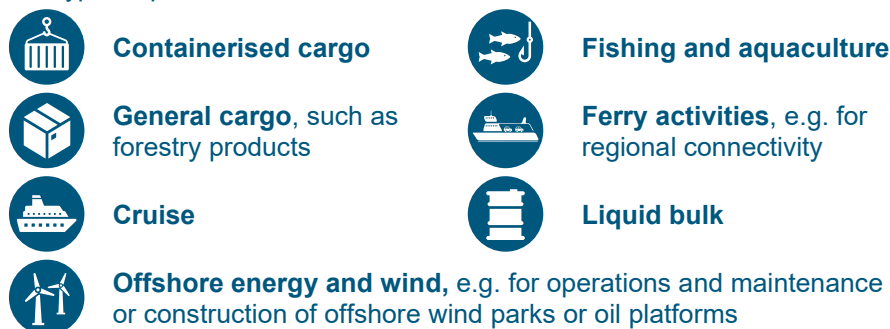
*Identifying strengths &  
opportunities*



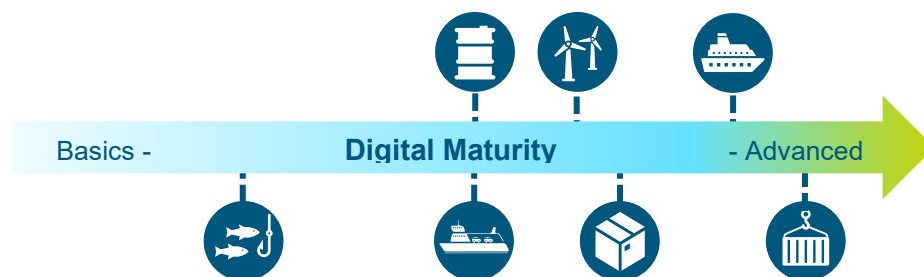
## General Digital Maturity of Scottish Ports

Digital maturity requirements vary among ports, primarily influenced by port size and complexity. The more intricate a port's operations, the greater the value derived from digital tools and systems. Baseline digital maturity refers to the minimum level of digital maturity necessary for a port to operate securely, safely, and efficiently, considering its specific size and cargo complexity. This study found that all participating ports exhibited digital maturity levels equal to or exceeding the expectations based on their relative size and cargo complexity.

Seven types of port activities within the Scottish maritime sector have been identified:



Overall, on a spectrum ranging from the digital basics only, to highly advanced, the digital maturity of ports active in these sectors was found to be as follows:



## Strengths & Weaknesses

Overall, all cargo sectors, and ports, have demonstrated a suitable, business-led use of technology, with a strong appetite for digitalisation evident from all parties interviewed. The role of digital technologies varies between ports because of cargo complexity, volume, revenue-earning capabilities, and client demands. Attitudes towards 'optional' digital technologies also vary, between ports and sectors depending on the local context and requirements.

All commercial businesses invest in digital technology, driven by client needs, competitive positioning in the market, regulatory obligations, and performance expectations; these elements drive the business case for any technology investment, balancing cost, risk, and gains. Ports have a healthy caution to developing business cases for new technology investments, particularly if any risk or innovation may be required. This has resulted in cautious investment from both publicly funded sources, such as communications and skills development, and private spending, including IT and systems. This attitude varies significantly amongst ports interviewed, some leaning into funding calls and innovation, and others waiting to see the way forward. Ambitions across the sector can be hindered by unclear policy direction or cross-sector coordination issues.

This report should set some clarity of collective direction for the port sector.





General observations from the study are summarised here, applicable to most of the ports reviewed. More specific technology-based maturity results are in the following section.

#### Strengths of Digital Maturity:

- ✓ Ports are investing in technology when their customers need; the approach is market-driven. This can pull digitalisation ahead if clients demand it.
- ✓ Business gains from digital tools are key drivers; ports are conservative in approach due to investment risk.
- ✓ Collaboration between ports on shared challenges is already underway, providing a good communication baseline for digital developments.
- ✓ Progress on digital projects is good, with the transition to cloud-hosting, and cyber-security preparedness being strongly adopted.

#### Challenges to Address:

- ✓ Most ports lack a cohesive future strategy for digital or IT improvements; this creates a reactive (and in some cases disjointed) approach.
- ✓ Communications networks have gaps, with limited fibre, cellular, or network resilience, weakening the foundations for digital adoption.
- ✓ Port users and supply chain operators are afraid of sharing data; this lack of transparency challenges the drive for optimisation that benefits all parties.
- ✓ Skills for managing IT and developing new projects are lacking in smaller ports across Scotland; dependency on outsourced contractors limits innovation and reduces organisational capability for adopting change.
- ✓ Outsourced contracts need procurement and monitoring oversight, which is challenging in the IT-related market.





## National Digital Policies

Scottish ports are aligned with UK-wide policies and regulations, especially in the shorter term. They participate in border processes and support the National Maritime Single Window, maintain adequate cybersecurity, and larger ports have adopted the use of a Port Community System (typically Destin8). However, some ports, in remote locations, but also in some city centres, face insufficient internet connectivity, through fibre broadband or mobile networks, which hinders digital operations. Several (short-term) UK policies and regulations are in focus for the digital journey of Scottish ports and should be considered in future digitalisation efforts:

- **2025 UK border strategy** aims for the widespread use of the National Maritime Single Window: Single Trade Window (STW), which all ports facilitate already. Additionally, the strategy aims for Border Force to work together with ports to enhance the digitalisation of border processes and to identify where detection technology and capacity can be improved.
- **Electronic Trade Documents Act (2023)** aims to facilitate the adoption of electronic trade documents, replacing traditional paper-intensive processes with digital alternatives. Ports, together with authorities, should digitise trade documentation in a (cyber)secure fashion, for faster and more accurate processing.
- **UK Wireless Infrastructure Strategy** recognizes the importance of connectivity in supporting new technologies. It notes that mobile coverage quality can be inconsistent in economically significant areas such as ports and proposes to address this by enhancing public mobile coverage in remote regions. It also seeks to encourage commercial investment in wireless connectivity by helping to establish a clear business case for such investments. Scottish ports can expedite these

initiatives by demonstrating their significant demand for reliable and fast internet connectivity.

- **The Supply of Machinery (Safety) Regulations (2008)** ensures that all machinery, including new technologies and automation systems in seaports, meet essential health and safety requirements before being placed on the market. Proper marking of CE and UKCA marks by UK-approved bodies is therefore essential. This is vital when considering the safe automation and robotising of port equipment.
- **The Companies (Directors' Report) and Limited Liability Partnerships (Energy and Carbon Report) Regulations (2018)** require large businesses to report on their annual energy use and greenhouse gas emissions. It is anticipated that regulations of this nature will become increasingly stringent moving forward. Specialised systems and sensors can be effective tools in monitoring and reporting these emissions accurately.
- **Potential new payment prevention rules from the UK government** may prohibit critical infrastructure such as ports from making ransomware payments. If ports are successfully targeted by cyber or ransomware attacks, it could result in prolonged shutdowns of port operations. Ports across the world are already targeted by ransomware attacks, such as the port of Seattle in 2024.<sup>2</sup>. This highlights the importance of maintaining a reliable and frequently updated cybersecurity system.

In general, Scottish ports are aligned with the UK-wide vision for port digitalisation, but there is still work to be done by ports and policymakers in both nations, to support and align with longer-term policy intentions. Most relevant are the objectives set out in the Department for Transport's Maritime 2050 strategy, prepared in 2019.

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<sup>2</sup> *Port of Seattle reveals details of ransomware attack, says it refused to pay criminal organization, 2024, Geekwire, [Port of Seattle reveals details of ransomware attack, says it refused to pay criminal organization](#) – GeekWire*

## Maritime 2050 strategy - extracts

*Digitalisation and automation will help decrease labour costs while creating new, safer, highly-skilled, job opportunities... helping to make maritime careers more attractive to a more diverse range of people.*

A strong need to identify, plan, train, and recruit skills and re-tool existing staff to capture the benefits that automation and data-driven business can bring. This does create some transition within traditional port workforces, perhaps with lower levels of digital capability historically, that must be managed sensitively over the medium term.

*UK ports will become smart ports, using a wide range of technologies, data-driven, automated, and interconnected. These technologies are essential to ensure growth in efficiency and throughput capacity as well as limiting environmental impacts.*

Scottish ports should identify technologies relevant to their sectors, which are appropriate to enhance productivity and customer service. This will vary by size and sector. Carbon (and other) emissions can be monitored and optimised with technology tools.

*UK ports will act as part of an advanced supply chain. Digitised, integrated with the wider end-to-end supply chain, and efficient.*

Scottish ports should start identifying where integration with stakeholders involved with regionally specific supply chains is possible; major exports (fish, whisky, timber) are key target areas.

*Low margins, long asset life cycles, and the problem of split incentives means that the maritime sector is not always quick to adopt new technologies. Government should work together with industry to develop technology and innovation, especially in the early stages of development towards commercialisation.*

Agencies can help bridge the gap between early-stage innovation to viable business cases for ports to invest in. Collaboration, backed with seed

funding, can boost the adoption of technology in ports. This may be achieved through a Maritime Innovation Hub concept.

*The UK maritime sector should be digital by default with paperless maritime governance and e-registration.*

Long-running operations in ports may lag behind digital trends, but new services, clients, and cargoes can be Digital First when moving into ports, pulling up legacy tenants and operations over time, gradually squeezing out paper-driven processes.

*More bandwidth and increased coverage should be provided to deliver the communication and data requirements of the maritime sector in the future.*

Internet connectivity is currently already a barrier for Scottish port operations. Resolving foundation issues in networking is crucial to enable any future digital ambitions.





## International drive for port digitalisation

There are few standards to consider when reviewing digital adoption in ports on a global scale, as this is tailored to the local needs of trade flows. Container terminals are driven by international standards of data exchange between ships, terminals, and transport (EDIFACT), and this is managed in Scotland with the use of the Destin8 port community system.

IMO obliges some communication of vessel call data (crew lists, etc.) with the long-established FAL Convention, which from 2024 should be electronic through a single window, to streamline data; this can be done with PMIS or through an EU-standard method (CERS), via MCA, and all ports reviewed are managing this.

Global standards and policy objectives are aimed at increasing the minimum level of digital adoption, which ports in Scotland are already far above. Scottish ports are therefore better able to look ahead for future opportunities, learn from international innovations, adopting smarter port technologies over time.

Recognised guidelines by the International Association of Ports and Harbours (IAPH), International Maritime Organisation (IMO), and the World Customs Organisation (WCO), are relevant to consider when assessing Scottish port digitalisation levels against international focus for short- and long-term:

### Port Community System Guidelines 2024 (World Bank & IAPH)

#### Short term

Where relevant, Scottish ports have already adopted PCS usage, with the UK-wide system Destin8.

#### Long term

Increased accessibility for smaller ports to adopt a suitable PCS. PCS architecture must be continuously developed to keep pace with new data and resilience technologies (e.g. AI)

### Accelerating Digitalization 2020 (World Bank – IAPH)

#### Short term

Scottish ports comply with the mandatory single window requirements as defined in the IMO's Facilitation (FAL) Convention (IMO 1965)

#### Long term

Ports work towards connecting tenants and stakeholders in their community and digitise all paper-based processes. Cybersecurity is crucial in this effort.

### Cybersecurity Guidelines for Ports and Port Facilities 2021 (IAPH)

#### Short term

Ports have a cyber risk management strategy and plan to achieve and sustain a defence-in-depth posture. Some ports interviewed had an in-house proactive approach, but with many outsourcing this task, some passivity generates risks that can be addressed.

#### Long term

Ports can strive to increase cyber awareness throughout the organisation (e.g. through training). Over time, allocating resources, and building a cybersecurity-capable workforce.

### Port Cybersecurity 2019 (ENISA - EU)

#### Short term

Ports should define clear governance around cybersecurity. Ports should enforce technical cyber security basics, which many ports have achieved by outsourcing their IT, and/or adopting NCSC Cyber Essentials.

#### Long term

Consider security by design in the acquisition of new systems and equipment. Enforce detection and response capabilities to react quickly to cyberattacks.

### Guidelines on cooperation between customs and PA 2023 (WCO - IAPH)

#### Short term

Customs and ports should create collaboration frameworks to share digital information. This is achieved with Destin8 and HMRC systems.

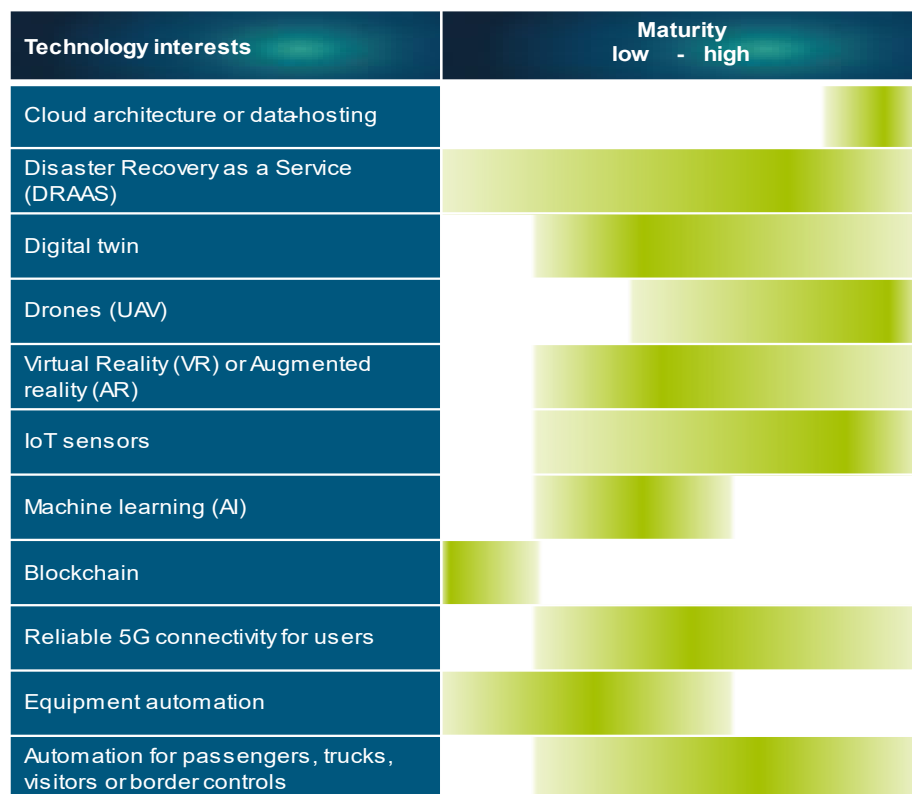
#### Long term

Close data collaboration between customs and ports throughout the whole supply chain, by converging the different digital platforms.

## Key Port Technology and Management Systems

All ports interviewed were asked about their interests in certain technologies and systems, which are presented in the graphs below. On the left side of the spectrum, ports indicated that they were not or mildly interested. In the middle of the spectrum are the ports that are very interested in the technology but have not started implementing it yet. And on the right side of the spectrum are the ports that are implementing or already operating the system.

The spread of the spectrum indicates the variety of interest and adoption; the density of the bar indicates the average across all ports reviewed.



### Technology-centric Observations:

- ✓ Transition continues towards cloud-hosting, where appropriate (some on-premise persists in smaller ports).
- ✓ Widespread adoption and interest in the benefits of drone usage.
- ✓ AI is potentially interesting, but unsure where to obtain real value.
- ✓ 5G is hyped, but the business case is weak, with very limited adoption of private 5G networks currently
- ✓ Automation has potential in container ports; concerns over staff and skills.





System interests	Maturity			
	low	-	high	
Vessel traffic management and information system (VTMS/VTMIS)				
Port management information system (PMIS)				
National Maritime Single Window (NMSW)?				
Port community system (PCS)				
Port call optimization tool (PCO)				
Use systems to track cargo, e.g. terminal operating system (TOS)				
Ferry freight and pax booking system integrated with the port				
Gate operations system (GOS) to manage automated gates				
Truck appointment system (TAS/VBS)				
Port security system				
Crisis management system				
Integration of ERP with systems of suppliers				

#### Management-systems Observations:

- ✓ Where navigational supervision is required, then VTMS deployment is sophisticated. Many ports only operate low-tech Local Port Services
- ✓ Adoption growing for PMIS and PCS, with smaller ports scaling up to implement
- ✓ Complex cargo-driven technology needs are in place where needed – currently, in container and general cargo ports only
- ✓ Automation for truck gates, traffic, and access control is a growth area.



## Port Technology Baseline Capability

All ports have obligations to maintain a safe, resilient, secure, and commercially functional organisation, adhering to regulations, serving clients, and preserving water and land assets for the future.

To fulfil this mission, a common toolkit of technology is necessary, which is outlined in the below maturity spectrum diagram, with the results from port reviews.

Overall technology maturity	Low...	Maturity	...High
Network coverage & resilience			
System redundancy & back-up			
IT & Organisation capability for digitalisation			
Cyber security controls			
Security monitoring & access control			
Safety management, training and incidents			
Asset management & maintenance			
Vessel visit & services management			
Energy & carbon monitoring			
MetOcean monitoring			

### Baseline Capability Observations:

- ✓ Weak areas exist in data networks, fibre or wireless, and supporting resilience of hardware and backup systems.
- ✓ Organisational capability and cyber-security is strong, although often only through outsourcing to (possibly unaudited) suppliers
- ✓ Security controls and asset management are manual or ad-hoc systemised, and options for digital and automation could be adopted
- ✓ Newer demands in carbon emissions and energy efficiency may benefit from additional investment in tools and technology.

The larger ports in Scotland have revenue, capability, and demand for technology, so score strongly on all base measures. Smaller port authorities have less motivation (commercially or performatively) to upgrade and expand beyond the basic toolkits.

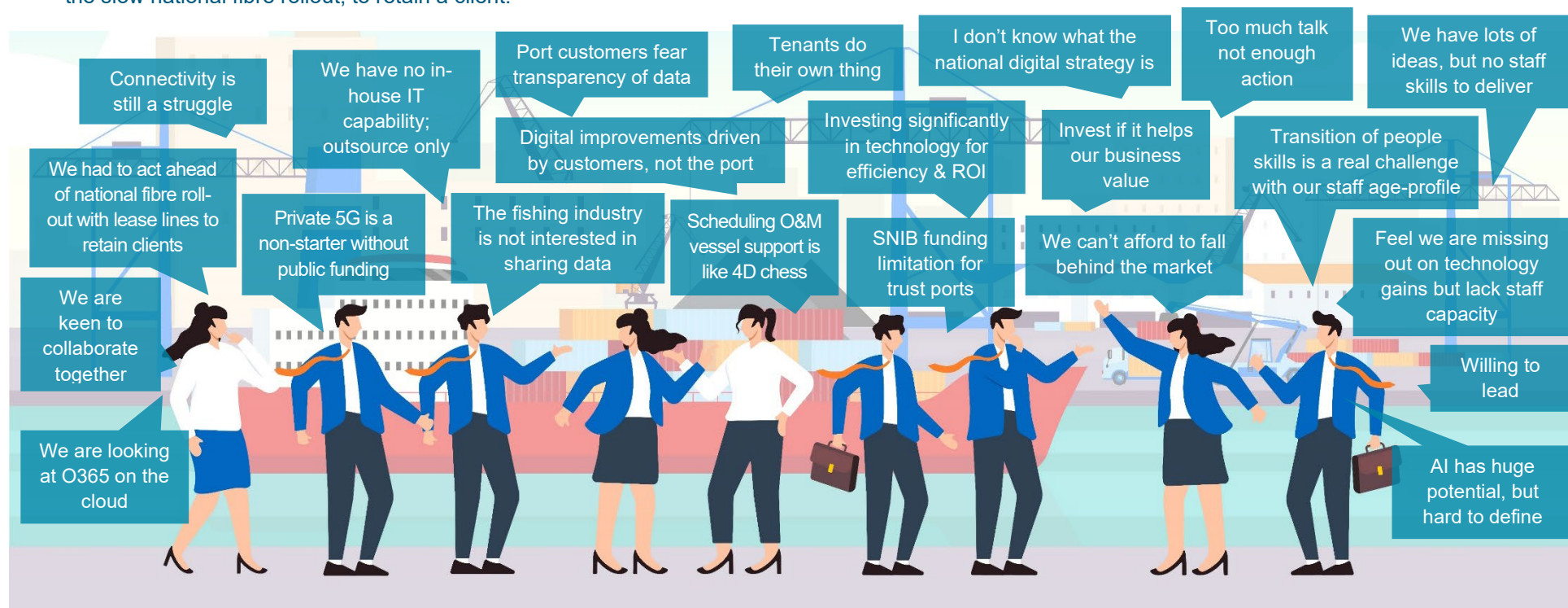
For the benefit of the broader maritime-centric supply chains in the nation, a gradual strengthening of port digital baseline capability should be an objective.



## Industry Voices

Beyond the general observations in the previous sections, some strong viewpoints and locally specific points were raised, shown in the comment cloud.

- ✓ Although digitalisation is considered very important it is difficult to construct a business case for digital tooling, both internally and for potential funding or investors.
- ✓ Tenants often operate independently of the port authority, with little influence or engagement on digital topics by port authorities.
- ✓ A port had to invest in laying fibre internet connectivity for a tenant, due to the slow national fibre rollout, to retain a client.
- ✓ There is no business case for private 5G without public funding.
- ✓ Ports are open to sharing and keen to work together.
- ✓ The staff-age profile of some ports may slow the digital transition and skill building.
- ✓ Ports are keen to begin exploring new digital technologies as part of their transition to becoming smart ports.





# Port sector overview



*Sector trends for digital demand*

-

*Maturity and future technology options*





## Container Terminals

### Sector Description:

Two main container ports handled units transhipped from near Europe or other UK ports, serving the import needs of Scottish industry and, major export flows. The technology baseline for container terminals is very high, as a hurdle to secure shipping line calls, with electronic transactions and real-time tracking of operations needed, linked to Port Community Systems and shipping line and transport operator control systems.

Managing a container terminal requires mission-critical networks, hardware and software, supported by a dedicated IT team; the investment required is linked to traffic volume & revenue.

### Ports active in sector:

- Peel Ports/Clydeport [Greenock]
- Forth Ports [Grangemouth]

### Sector Future Trends:

In the future increase is expected in: Direct deepsea calls from niche shipping line routes from Med-region, Asia and North America.

Larger feeder vessel sizes and exchange size potential (peak demands). Potential for southbound transshipment (reverse) from deepsea direct calls.

### Supply Chain Role:

High-value exports are often containerised; seafood, fish, whisky, as facilitation for Scottish trade.

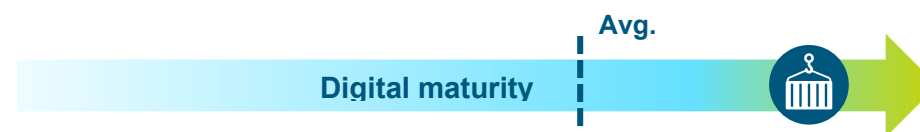
Imported industrial and consumer goods flow through the two feeder ports from deepsea transshipment in southern UK or near Europe.

Tight links with road and rail transport.

### Digital Maturity:

Container terminals in Scotland have all the key systems, IT capability, and resilience required to operate as feeder terminals.

Container-handling ports are at the highest level of the digital port spectrum:



### Future Smart Port Opportunities:

Sector trends may present further expansion, and correlating digital opportunities, alongside supply chain demand for transparency and ever-improving efficiency and productivity.

Opportunity	Benefits	Effort
<b>Equipment &amp; Gate Automation</b>	Unmanned equipment: <ul style="list-style-type: none"> <li>• Reduce operating cost</li> <li>• Improve performance reliability</li> <li>• Upgraded equipment reduces carbon emissions</li> </ul>	Major terminal upgrades £MM
<b>Supply chain scheduling</b>	Integration of scheduling: <ul style="list-style-type: none"> <li>• Reduce peak congestion</li> <li>• Improved service reliability</li> <li>• Reduced transport costs</li> </ul>	Data sharing & collaboration Commercial loss of congestion-fees
<b>Predictive Maintenance</b>	Data-driven asset management: <ul style="list-style-type: none"> <li>• Extend asset lifecycle</li> <li>• Reduce maintenance costs</li> <li>• Improve availability &amp; safety</li> </ul>	Equipment & network updates Data Science

**Working Group Role:** Sector ports lead digitalisation & innovation.

### Digital Tools Required:

Function	Yard & Process Management	Vessel Handling Productivity	Cargo Transaction Coordination
<b>Tools:</b>	Terminal Operating System (TOS), Gate Automation	Terminal Operating System (TOS), Port Management Information System (PMIS)	Port Community System (PCS: MCP Destin8)



## Fishing and aquaculture

### Sector Description:

The Scottish fishing sector is significant, with 2,014 active vessels landing 487,000 tonnes of sea fish and shellfish in 2023.<sup>3</sup> Scotland is the UK's largest aquaculture producer, with farmed salmon as the top food export, in trailers and containers. Fishing ports require minimal infrastructure, with fuel, waste reception, water, electricity, and ice-making facilities. Fishing boats often operate as independent businesses, with limited coordination or engagement with port authorities.

### Ports active in sector:

- Eyemouth
- Peterhead
- Montrose
- Clydeport

### Sector Future Trends:

In recent years, the Scottish fishery sector has shown limited growth or even a slight decline in certain areas. For ports, this presents a medium-term strategic risk if the fishing industry does not recover.

Additionally, the workforce of the Scottish fishing industry seems to be aging and declining compared to, for example, the EU.<sup>5</sup>

### Supply Chain Role:

The supply chain of the fishing industry involves multiple stages, including fishing and harvesting, processing, distribution, and retail, with various stakeholders ensuring the fish reaches consumers in a timely manner.

Around 80% of seafood caught, is consumed outside the UK, and therefore exported in for example reefers suggesting that the fishing sector supply chain is also closely connected with the Scottish container sector.<sup>4</sup>

### Digital Tools Required:

Function	Weather & sea conditions monitoring	Port safety and security
Tools:	Weather forecasts, tide, and swell condition monitoring and dashboards displaying conditions using sensors.	CCTV, safety reporting and training systems, visitor and contractor management systems

### Digital Maturity:

Fishing ports in Scotland have a relatively low digital maturity compared to the other sectors. However, this is appropriate for the low digital demand from fishers and the limited level of complexity.



### Future Smart Port Opportunities:

Although the operational role of fishing ports is limited, digital tooling can be used to create even more productive and safe working conditions for fishers and farmers.

Opportunity	Benefits	Effort
<b>Weather &amp; sea conditions monitoring</b>	More transparency for fishers on sea & tide conditions with buoys and gauges, linked to the network: <ul style="list-style-type: none"> <li>• Improve safe working conditions</li> <li>• Reduce port congestion &amp; carbon emissions with remote data access</li> </ul>	Medium investment Tide gauges & wave buoys connected Public-facing dashboards
<b>Safety management systems</b>	Operational safety management of staff with incident reporting & induction/skill training: <ul style="list-style-type: none"> <li>• Transparency of hazards and incidents</li> <li>• Improve standards of training for staff</li> </ul>	Low investment Coordination of new platforms, as an industry, or with port authorities

**Working Group Role:** Active team member/investor in joint innovation efforts

<sup>3</sup> Scottish Government, 2024, *Provisional Scottish Sea Fisheries Statistics 2023*, [Provisional Scottish Sea Fisheries Statistics 2023 - gov.scot](https://gov.scot/Scottish-Sea-Fisheries-Statistics-2023)

<sup>4</sup> The Scottish Parliament, 2022, *Seafood Scotland*, [REUL Seafood Scotland](https://www.scottish.parliament.uk/REUL/Seafood-Scotland)

<sup>5</sup> Scottish Government, 2014, *An Assessment of the Conditions Affecting Entry into the Scottish Fishing Industry and Potential Policy Responses*





## General cargo

### Sector Description:

Not all cargo is exported or imported in containers but as General Cargo. For example, Forestry is a major export industry, handled as general cargo (break-bulk), and imports of paper, steel, building materials, as well as bulk handling of salt, animal feed, and grain all feature in the nation's ports.

The digital needs for general cargo are complex (similar to containers), involving stock management, operations, equipment and resource planning, and supply chain scheduling. However, due to its diverse nature, a wide range of systems are needed to manage bespoke cargo terminals.

### Ports active in sector:

- Aberdeen
- Eyemouth
- Forth Ports
- Inverness
- Montrose
- Clydeport

### Sector Future Trends:

Over the past two decades, the handling of general cargo in the UK has remained stable<sup>6</sup>. Many ports have a diverse and evolving cargo mix, so general cargo terminals need to be flexible and adaptive in handling different products.

### Supply Chain Role:

General cargo ports have tight connections with local industry such as forestry or manufacturers of products for offshore oil, gas, and wind projects (e.g. anchors). Industrial processing and manufacturing also rely on specific general cargo terminals, e.g. farming, printing, and construction. For imports, ports in remote locations are often a vital link between local consumers and the (inter)national supply chain.

### Digital Tools Required:

Function	Yard & Process Management	Vessel Handling Productivity	Cargo Transaction Coordination
Tools:	Terminal Operating System (TOS), Gate Automation	Terminal Operating System (TOS), Port Management Information System (PMIS)	Port Community System (PCS: MCP Destin8)

<sup>6</sup> UK Department of Transport, 2024, *Port freight annual statistics 2023: Overview of port freight statistics and useful information*, *Port freight annual statistics 2023: Overview of port freight statistics and useful information* - GOV.UK

### Digital Maturity:

General cargo terminals in Scotland have a range of systems to suit the needs of their cargo (and clients) but digital maturity is lagging behind in some areas when compared to equivalent container-handling ports.



### Future Smart Port Opportunities:

Sector trends will present further expansion of digital opportunities, alongside growing supply chain demand for transparency, ever-improving efficiency, and carbon emissions tracking.

Opportunity	Benefits	Effort
<b>Gate &amp; Weighbridge Automation</b>	Unmanned truck entry/exit operations: <ul style="list-style-type: none"> <li>• Reduce operating cost</li> <li>• Improve performance reliability</li> <li>• Reduce congestion</li> </ul>	Major gate infrastructure and system upgrades
<b>Supply chain scheduling</b>	Integration of end-user scheduling: <ul style="list-style-type: none"> <li>• Reduce peak congestion</li> <li>• Improved service reliability</li> <li>• Reduced transport costs</li> </ul>	Data sharing & collaboration Commercial loss of congestion-fees
<b>Predictive Maintenance</b>	Data-driven asset management: <ul style="list-style-type: none"> <li>• Extend asset lifecycle</li> <li>• Reduce maintenance costs</li> <li>• Improve availability &amp; safety</li> </ul>	Equipment & network updates Data Science

**Working Group Role:** Lead role for industry-specific solutions



## Ferry activities

### Sector Description:

Ferries play a crucial role in the connectivity and trade of Scotland's islands and remote locations. In 2023, CalMac transported over 5 million passengers and approximately 80,000 commercial vehicles. For ferry ports, digitalisation projects are often led by shipping lines, although these ports may also use digital tools to manage physical assets and record weather conditions.

### Ports active in sector:

- Caledonian Maritime Assets
- Aberdeen

### Sector Future Trends:

Continuation and resilience of this sector are needed to support lifeline and commercial services in Scotland.

Service and asset resilience with impacts of climate change remain vital and improved reliability may drive greater monitoring and supervision.

Automation of port check-in services is a growing international trend.

### Supply Chain Role:

Ferries support trailer and accompanied freight transits for key exporters (especially on the islands), such as seafood, and provide FMCG connections across the nation.

Tourism is a major contributor to the economy, facilitated by the ferry networks, as is the travel of Scots for work, leisure and personal needs to and from the islands.

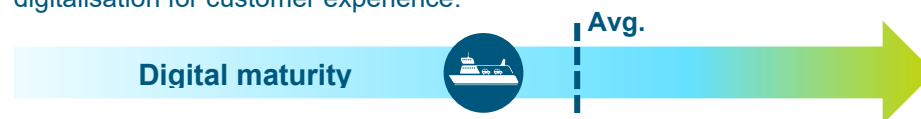
The reliability and just-in-time nature of these supply chains need a regular and predictable service; this need will continue.

### Digital Tools Required:

Function	Weather & sea conditions monitoring	Passenger booking and check-in	Asset management
Tools:	Wind, tide, swell, dashboards displaying conditions at port with sensors and video, to guide safe navigation	Passenger booking systems. Check-in/out for pax, trucks, and drop trailers.	Computerised Maintenance Management System (CMMS)

### Digital Maturity:

Ferry ports in Scotland have advanced weather and sea monitoring and are implementing digital tools for asset management. Freight and pax system operations are managed by the ferry operators. This division may hinder holistic digitalisation for customer experience.



### Future Smart Port Opportunities:

Ferry ports can use digital tooling to support more reliable and customer-focused ferry operations.

Opportunity	Benefits	Effort
Supply Chain Scheduling Integration	<p>More transparency for freight operators by integrating vessel sailing and port processing into fleet management.</p> <ul style="list-style-type: none"> <li>• Improved end-user service times</li> <li>• Reduced delays in poor weather</li> </ul>	<p>Data sharing (APIs)</p> <p>Teamwork with logistics fleet operators</p>
Automated check-in	<p>Automated check-in of pax and freight with portals and kiosks</p> <ul style="list-style-type: none"> <li>• Reduce operating cost</li> <li>• Correct size/weight for bookings</li> <li>• Automated damage detection</li> </ul>	<p>Major gate infrastructure and system upgrades £M</p>
Predictive Maintenance	<p>Data-driven asset management:</p> <ul style="list-style-type: none"> <li>• Extend asset lifecycle</li> <li>• Reduce maintenance costs</li> <li>• Improve availability &amp; safety</li> </ul>	<p>Equipment &amp; network updates</p> <p>Data Science</p>

**Working Group Role:** Active team member/investor in joint innovation efforts





## Cruise

### Sector Description:

In Scotland, there are five ports that serve as stops for larger cruise vessels: Invergordon, Edinburgh, Kirkwall, Lerwick, and Greenock. These ports collectively handle approximately two-thirds of all Scottish cruise calls. Smaller cruise vessels, such as those with a 100-passenger capacity, visit various ports throughout Scotland, mainly concentrated around the Highlands and Islands.

The use of digital tools in cruise ports is centred on ensuring safe navigation and berthing, managing passenger movements securely, and enhancing customer experience. Adequate connectivity for passengers in ports of call is also considered beneficial.

### Ports active in sector:

- Aberdeen
- Eyemouth
- Clydeport
- Forth Ports
- Inverness
- Montrose
- Peterhead

### Supply Chain Role:

Ports play a crucial role in facilitating the efficient movement of goods to service cruise vessels, providing essential services such as provisioning, waste management, and maintenance.

### Sector Future Trends:

In recent years, there has been a notable increase in cruise tourism, and this trend is anticipated to persist and grow in the foreseeable future.

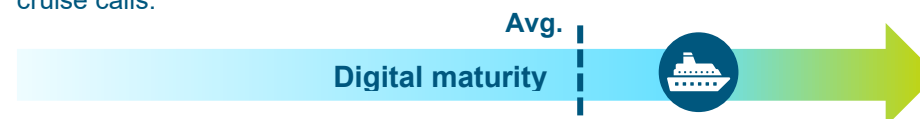
Some home ports for the change-over of pax have a wider role in check-in and baggage handling, with a need for buildings, parking, and staff.

### Digital Tools Required:

Function	Vessel berthing and planning	Passenger check-in	Customer Wi-Fi
<b>Tools:</b>	Port Management Information System (PMIS)	Operated by cruise line usually	Connectivity inside the port for visitors can be required (5G use case)

### Digital Maturity:

Cruise ports in Scotland have high digital maturity, but this is because (the surveyed) ports are larger and in general have more advanced digital capabilities for broader needs. Very few specific solutions are needed solely for cruise calls.



### Future Smart Port Opportunities:

Cruise ports can use digital tooling to accommodate an even more user-friendly passenger experience.

Opportunity	Benefits	Effort
<b>Berth Schedule planning</b>	Optimise port calls and berth use for peak, time-critical seasons with data-driven simulation of call times: <ul style="list-style-type: none"> <li>Optimise the capacity of cruise calls at busy berths</li> <li>Insight into poor weather delays</li> </ul>	Install PMIS features Data analysis on historical port call times, for line schedulers
<b>Marshalling of passengers using digital tools</b>	Digital tools for passenger marshalling could include: <ul style="list-style-type: none"> <li>Electronic signage</li> <li>CCTV to alert unsafe situations (e.g. passenger in the water)</li> <li>Digital/automated check-in</li> </ul>	Equipment & network updates Possible integration with cruise operator systems (pax lists)
<b>Weather Modelling at Berth</b>	Use weather and vessel windage modelling to forecast mooring risks and guide on lines arrangement.	Weather & mooring analysis software

**Working Group Role:** Support role

## Liquid bulk

### Sector Description:

Many ports in Scotland handle liquid bulk like oil, LNG, vegetable oils, and fuels. With efforts to reduce fossil fuel use, some major sectors (crude oil to Grangemouth) are expected to decline. However, many ports serve local communities reliant on oil and gas for heating, and fuel and fertilizer for farming. Digital tools support industry standards for the safe handling of liquids, monitoring and preventing environmental disasters like oil spills, and maintaining storage tanks; operation of these facilities is tenanted out at ports and the sophisticated systems required are operated by the terminal operators and refineries, without port involvement.

### Ports active in sector:

- Clydeport
- Forth Ports
- Inverness
- Peterhead

### Sector Future Trends:

Since 2000, the volume of liquid bulk handled by British ports has significantly decreased, and it is anticipated that this trend will continue.

The importance of new energy carriers, such as hydrogen products, may well increase, leading to major port retrofit projects.

Other liquid bulk cargoes (non-fuel-related) continue to evolve in the future.

### Supply Chain Role:

The role of ports in the liquid bulk supply chain can have both an international focus and a local/regional focus.

On the international side, petroleum and gas are being exported and imported by Scottish ports, connected to the rest of the world.

Other bulks are vital for manufacturing and processing, as well as farming and fuel for local communities, with specific supply chains developing across the country.

### Digital Tools Required:

Function	Vessel port call planning Navigation Support	Environmental monitoring	Asset management
Tools:	Port Management Information System (PMIS) VTMS where needed	Incident reporting and spill tracking	Computerised Maintenance Management System (CMMS)

### Digital Maturity:

Port-centric digital maturity appears low because the complex needs of liquid bulk terminals are outsourced to terminal operators, with only marine and environmental-related concerns for port authorities.



### Future Smart Port Opportunities:

Future smart port opportunities will allow liquid bulk ports to manage assets, track reliability and reduce carbon and environmental impacts of operations.

Opportunity	Benefits	Effort
<b>Oil spill Digital Twin</b>	Interactive model with wind/tide to predict the spread of oil spillages. <ul style="list-style-type: none"> <li>• Improve clean-up performance.</li> </ul>	Develop spill model (Industry/ Academia)
<b>Asset inspection using drones</b>	Advanced drones are capable of scanning storage tanks, pipes, and jetties, above and below water. <ul style="list-style-type: none"> <li>• Quick and frequent scanning</li> <li>• LIDAR is very accurate</li> <li>• Monitor potential weak points over time</li> </ul>	Acquire specialised drones using LIDAR  Train staff to use drones and analyse drone data
<b>Predictive Maintenance</b>	Data-driven asset management: <ul style="list-style-type: none"> <li>• Extend asset lifecycle</li> <li>• Reduce maintenance costs</li> <li>• Improve availability &amp; safety</li> </ul>	Equipment & network updates  Data Science

**Working Group Role:** Active team member/investor in joint innovation efforts





## Offshore energy and wind

### Sector Description:

The offshore oil and gas industry has traditionally been a significant component of the Scottish maritime sector. As the production of offshore oil and gas is anticipated to decline due to the energy transition, offshore wind farms are gaining importance. Both the offshore oil and gas industry and offshore wind farms require ports for the manufacturing of infrastructure elements, construction, management, maintenance, and supply. Many ports can handle management and maintenance, while construction and manufacturing are supported by a few specialised ports.

Overall, ports have a facilitator role for operators of offshore infrastructure. Digital tooling is therefore required for the management of vessel calls and for facilitating port operations by tenants.

### Ports active in sector:

- Aberdeen
- Clydeport
- Eyemouth
- Forth Ports
- Inverness
- Montrose
- Nigg
- Peterhead

### Supply Chain Role:

Ports play a critical role in facilitating all the steps throughout an asset's lifetime, from construction through operational periods, to decommissioning.

### Sector Future Trends:

Decommissioning works and recycling of oil and gas platforms will become increasingly important.

Ambitious UK targets for offshore wind will require significant port capacity ramp-up for construction and operational services.

If floating offshore wind farms become feasible in the future, the manufacturing of floaters could be a strong opportunity.

Large laydown and manufacturing facilities for turbines, cables, and blades are needed.

Smaller ports can capture O&M services with spares, crew hosting, and repair facilities.

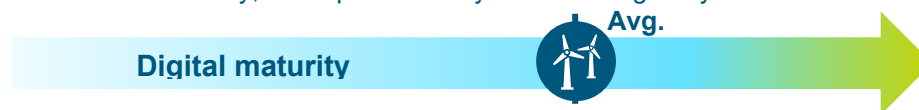
Supply to port gateways requires upstream trucking and sea transport services.

### Digital Tools Required:

Function	Weather & sea conditions monitoring	Vessel port calls
Tools:	Weather and tide monitoring for safe construction and marshalling.	Port Management Information System (PMIS) to schedule berths and port services

### Digital Maturity:

Ports involved in offshore energy and wind focus more on infrastructure and physical capacity than digital tools. Most have basic digital infrastructure like network connectivity, with operational systems managed by tenants.



### Future Smart Port Opportunities:

Energy transition is led by infrastructure needs, often on a project basis, so long-term digital investments can be hard to justify, but as the sector grows more tools can add value:

Opportunity	Benefits	Effort
Open-facing GIS platform	A GIS platform can be used by clients and tenants, with the detailed location and capacities of the port assets. <ul style="list-style-type: none"> <li>Important for geospatial planning</li> </ul>	Develop and maintain the GIS platform
Digital Twin for modelling heavy loads	A model capable of modelling heavy loads in the port can be used to: <ul style="list-style-type: none"> <li>Showcase that the port's bearing capacity is sufficient in tenders.</li> <li>Determine necessary load-spreading measures</li> <li>Determine safe handling procedures (e.g. at high winds)</li> </ul>	Develop a physical land and underwater model of the port capable of modelling loads at the quay and in the yard With academia
Automation for manufacturing	Robotics for manufacturing of elements (e.g. foundations): <ul style="list-style-type: none"> <li>Reduce operating cost</li> <li>Improve performance reliability</li> <li>Upgraded equipment reduces carbon emissions</li> </ul>	Major terminal / facility upgrades £MM

**Working Group Role:** Lead role for specific needs of this sector.

# Smarter Ports for Scotland

*Digital initiatives to  
improve performance*

-

*Approach to deliver  
progress*





## Roadmap for Smarter Ports in Scotland

Five port digitalisation themes have been identified that form a smarter port journey, shown in the diagram below.

Through workshop discussions with port authorities, and reviewing the key gaps and challenges identified in the maturity review, a collection of initiatives was formed where ports in Scotland can work together on a range of projects, progressing towards smarter port operations.

These initiatives range from short-term policy development, to longer-term investment in technology innovations, working alone or as a part of nationwide collaboration.

This roadmap identifies the strongest initiatives in the short and long term, especially from a business impact & value perspective.

Some initiatives are relatively quick wins with high impact, but low effort to implement. Other initiatives can be impactful but take significantly more effort to implement, over a longer timescale.

The initiatives and roadmap in this section are a starting point for ports to work together for a smarter future, and remain open to further development, refinement, and study.







**High impact barrier/risk:**  
To be addressed








**Possible barrier/risk:**  
To be mitigated








**Enabler/opportunity:**  
To be captured

## Barriers and enablers for digitalisation

#	Barrier / Enabler	Impact	Consequence
1	<b>Lack of IT and digital capabilities</b> throughout the port organisation		Planning, investing, and innovating for effective digital tools is challenging.
2	<b>Internet connectivity</b> may have gaps at ports		High quality, reliable internet is a prerequisite for digitalisation
3	<b>Quantification</b> of benefits of digital innovation is required		Without a concrete business case, finding funding is challenging.
4	<b>Digital and maritime technology sectors</b> are large and mature in the UK and Scotland		Other sectors in the Scottish economy can support driving digital innovation in ports
5	<b>Future plans are weak</b> for digital tools and systems that can benefit each port		Ports lack insight on their digital maturity relative to industry standards.

## Risks and opportunities for the economy

#	Theme	Impact	Risk / Opportunity
1	<b>Energy transition</b> is focussed around port-cities		Digitalising maritime infrastructure is key to maximising capacity, essential to reach energy transition targets.
2	<b>Connectivity</b> of remote communities is centred around ports		Ports require digital tooling to maintain high performance, essential for local communities and economies.
3	<b>Digital trade corridors</b> make ports more attractive		Lack of supply chain integration may send clients to competitor ports.
4	<b>Emission Monitoring</b> and reporting is gaining economic importance		Digital tools and systems provide means to manage this effectively.
5	<b>Cyberattacks</b> are an ever-increasing risk for supply chains		Port cybersecurity is critical area to maintain supply chain resilience.



## Smarter Port Initiatives

The following section outlines identified projects that can be adopted to move the port sector forward on the smarter ports voyage.




Each project has been captured using the format outlined in the legend, with a high-level description, benefits, and time/cost effort to deliver.



Port authorities meeting to discuss opportunities for smarter ports (January 2025)

### Legend:



All initiatives are presented in boxes with the following information per cell:

Title of initiative			
Brief description of initiative		Sectors for which this initiative is most relevant	
<b>indicative costs:</b>  <i>Indicative cost to implement initiative</i>  £ = < £ 50.000 ££ = £ 50.000 - 250.000 £££ = £ 250.000 – 1.000.000 ££££ = > £ 1.000.000	<b>Indicative time:</b> <i>Time to implement initiative</i>  = < 1 yr.  = 1-3 yrs.  = >3 yrs`	<b>Other efforts:</b>  <i>This implies other investments and efforts that need to be made to realise this initiative, such as stakeholder management</i>	
<b>Benefits:</b> <i>A list is presented of the most important benefits for a port, that this initiative could bring</i>			
<b>Type of project:</b> <i>Four project types are distinguished:</i>			
Policy & Strategy	People & Skills	Technology Investment	Innovation opportunity



The initiatives highlighted in this roadmap were developed and validated with the port representatives supporting the project.

## Initiatives: Connectivity, Cyber and IT



### Prioritise fast-track of port town & city area mobile network upgrades (public-4G&5G) to provide connectivity for port users

<p>Reliable mobile connectivity is critical for operating data-driven systems; patchy coverage around (and inside) ports is a barrier to progress. Ports to be prioritised in network roll-out (e.g. project Gigabit).</p>		
		
<b>Indicative costs:</b> ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Lobbying Ministry & Telecoms
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Enables mobile digital solutions in port operations</li> <li>Attracts customers/tenants that require reliable connectivity</li> </ul>		
<b>Technology Investment</b>		


### Resolve connectivity gaps for remote sites with satellite internet

<p>Identify locations where cellular or cabled data access is not feasible in the medium term and deploy point-solutions of data capture using Star Link satellite comms, e.g. for CCTV or sensors at remote jetty locations. Work together for standardised specification and procurement.</p>		
		
<b>Indicative costs:</b> ££	<b>Indicative time:</b> 	<b>Other efforts:</b>
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Connects remote port locations to data networks</li> <li>Supports security, weather, and asset management</li> </ul>		
<b>Technology Investment</b>		

### Define vendor qualifications for procuring and auditing outsourced IT & cybersecurity services



<p>Reduce risk in supplier selection and supervision with a port-specific standard for IT hosting, support, and cybersecurity. Utilise international standards, such as ISO27001, AWS, MS certifications, blended with port experience, allowing ports to vet suppliers. Leads to a nationally approved contractors list.</p>		
		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b> NCSC input
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Improved resilience of port IT with ongoing best-in-class support</li> <li>Supports attraction of new tenants and port users</li> </ul>		
<b>Policy &amp; Strategy</b>		



### Form a Port-IT Technical Group to work together on common challenges



<p>Ports are working alone on common challenges; create a skill-sharing safe space for port IT staff to learn from each other on products, tools, and methods. Regular meet-ups at each port, or within the Innovation Hub concept.</p>		
		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b> Travel & port staff time
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Solve problems by sharing practical and tested solution ideas</li> <li>Improves maturity and capability of smaller port authorities</li> </ul>		
<b>People &amp; Skills</b>		





## Initiatives: Optimising operations



National adoption of Port Management Information System (PMIS)		
For smaller ports without digital systems for port calls, adopting a standardised format of PMIS lowers the cost barrier to adopting this off-shelf system. Common process development, data analytics, and metrics, with shared hosting of a PMIS product. Learn from larger ports already using such products.		
<b>Indicative costs:</b> ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Working Group collaboration
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Reduces admin costs and errors with automation</li> <li>Captures data for business performance analysis</li> </ul>		
Technology Investment		



Standardised multi-port Visitor App platform		
Shared development of a gap for many ports; a platform to manage pre-visit safety induction, permit to work, access registration, segmented by port. Using a phone app to track visitors and vehicles onsite for evacuation events.		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b> Working Group collaboration
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Supports safe management of visitors and contractors</li> <li>Reduces admin costs for port authorities</li> </ul>		
Innovation Opportunity		



Develop process mapping skills to map and seek efficiency for port process automation		
Understanding information processes is a key step to remove waste. Develop tools and skills to enable (smaller) ports to self-diagnose waste and identify revenue leakage, delays, and opportunities to improve manual and digital processes.		
<b>Indicative costs:</b> £ - ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Working Group training
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Find opportunities for process optimisations</li> <li>Basis for investable business cases in digital tooling</li> </ul>		
People & Skills		

## Initiatives: Supply chain value


Develop a port-specific digital strategy		
Ports are mostly reactive/passive to digital developments. Each port can develop a locally specific digital strategy for investment, skills, and related business benefits. Strategy development can follow a common framework (efficient) enabling a view of public/private investments needed. Collaborative marketing of “smart ports Scotland”.		
<b>Indicative costs:</b> ££	<b>Indicative time:</b> 	<b>Other efforts:</b> External Skills & Tools for smaller ports
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Support business growth, resilience, and energy transition plans (master plans)</li> <li>Align with stakeholders and supply chain own strategies for joined-up gains</li> </ul>		
Policy & Strategy		


Develop and trial a multi-modal container export schedule digital twin		
A dedicated container export scheduling platform for major exporters can increase transparency for feeder vessel, rail, and road transport, to schedule arrival times and container loading, linked to deepsea schedules for vessels from UK and European ports. A model to digest historical movements and schedules to simulate optimised routing choices.		
<b>Indicative costs:</b> £££	<b>Indicative time:</b> 	<b>Other efforts:</b> Data sharing & support from major exporters & lines
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Transparency allows improved routing and cost efficiency</li> <li>Supports modal shift to rail and water (carbon reduction)</li> </ul>		
Innovation Opportunity		


Host local Port User technology forums		
Ports have many stakeholders and users. By establishing a regular Port User Technology Forum, each port can engage with clients, generate value-add digital ideas, and build trust for data sharing between stakeholders.		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b> Port staff time
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Ideas and requests by clients can be used as business case for funding</li> <li>Increased (digital) transparency between supply chain users</li> </ul>		
Policy & Strategy		

Roll out weather & sea conditions toolkit for access of all port users		
Activities for port users such as fishers, recreation, and ferries are weather-dependent. Installation of off-shelf weather stations, tide gauges, wave swell buoys, and the collation and publishing of data onto port websites will enable safer and more productive decision-making of port users.		
<b>Indicative costs:</b> £ - ££	<b>Indicative time:</b> 	<b>Other efforts:</b> CMAL has designed a standard deployment
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Improve navigational safety for fishers and sailors</li> <li>Collate data for tracking gradually increasing impacts of climate change</li> </ul>		
Technology Investment		

## Initiatives: Resilience and growth



Develop port-specific carbon calculator toolkit		
Carbon emissions reporting is obliged on ports, but general industrial tools don't fit easily. Create a tailored toolkit for ports to capture Scope 1-2-3 emissions, with sensitivity to complex tenancy and vessel operations in local ports. Collaborative development.		
<b>Indicative costs:</b> ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Working Group shared investment
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Nation-wide view on port-related emissions supports policy-making</li> <li>Reduced cost/complexity for ports to fulfil fast-moving obligations</li> </ul>		
Innovation Opportunity		




Design metrics and architecture for port-specific data visualisation		
Smaller ports lack the capability to structure, extract, and visualise performance data: forming a typical set of metrics and calculations, with data sources, and guidance on extraction, pooling, and dashboarding could upgrade port capability to self-service performance measures.		
<b>Indicative costs:</b> £ - ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Potential data architecture expert involvement
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Advanced structuring and storage of data</li> <li>Information for business decisions</li> </ul>		
Policy & Strategy		



Create and host a Scottish Maritime Innovation Hub		
A Scottish Maritime innovation hub can be a joint effort between Scottish ports, research institutes, and the government which could serve as a safe space to trial/incubate new ideas, before commercial take-up. Promising initiatives from the Innovation Hub may be expedited for testbed funding. Provides a vehicle for ports, and the users, to learn from each other.		
<b>Indicative costs:</b> ££ For establishing the hub  £££ - ££££ For developing promising ideas	<b>Indicative time:</b> 	<b>Other efforts:</b> Physical location preferred Management role for Scottish Maritime Cluster
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Increases the global position of Scotland PLC as a maritime innovator</li> <li>Ports can gain from smart innovations generated at the Hub</li> <li>Improved collaboration between the Scottish technology and IT sector, and the ports with challenges to resolve</li> </ul>		
Policy & Strategy		





## Initiatives: Assets & People

Form a drone pilots club		
Many ports already use drones for promotion and asset management. Form a knowledge-sharing group to do more with this technology, to maximise the value of air/sea drones, collating data and sensors, and feeding systems (eg GIS). Shared investment in hardware and software tools between multiple ports.		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b> Working Group collaboration
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Improved operational safety and asset monitoring for resilient ports</li> <li>Sharing costs from the acquisition of expensive drone hardware and software</li> </ul>		
People & Skills		

Develop a port asset GIS platform (→ Digital Twin for Asset Maintenance)		
Ports have many assets and liabilities for maintenance. Mapping and integrating information for multiple ports into one GIS platform enables decisions on inspections, and repairs and enables emergency response. Over time, data collated can feed a geospatial digital twin, guiding predictive maintenance based on asset lifecycle and port operations.		
<b>Indicative costs:</b> ££ GIS Platform ££££ Digital Twin	<b>Indicative time:</b>  GIS  Digital Twin	<b>Other efforts:</b> Academia and external suppliers
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Efficient asset monitoring and guided maintenance investment</li> <li>Support planning for climate change impact risk mitigations</li> </ul>		
Innovation Opportunity		

Grow staff digital skills and transition to new ways of working		
Building smart ports needs people skills; create new job-skill definitions (for smaller ports) and bespoke up-skilling training and awareness for existing staff. Encourage transition from manual working to digital-based tasks. Capture an innovation mindset with motivation/award schemes at ports.		
<b>Indicative costs:</b> £ - ££	<b>Indicative time:</b> 	<b>Other efforts:</b> Maritime Innovation Hub role
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Knowledge sharing and internal boosting of capacity</li> <li>Cross-industry skills sharing with universities and tech. firms</li> </ul>		
People & Skills		

Develop guidelines for data standards in equipment procurement		
Modern equipment can produce a lot of data; Form a port-equipment-specific set of data and interface guidelines to insert into equipment/asset tenders, to ensure ports can extract and digest data formats for performance and maintenance needs. A standardised approach, with vendors, will reduce costs and complexity for port teams.		
<b>Indicative costs:</b> £	<b>Indicative time:</b> 	<b>Other efforts:</b>
<b>Benefits:</b> <ul style="list-style-type: none"> <li>Improved value from equipment purchases, reducing integration costs</li> <li>Improve cyber-security management for endpoints at networked equipment</li> </ul>		
Policy & Strategy		

## Roadmap for Smarter Ports

The 18 initiatives outlined in the previous sections can be mapped into a holistic strategy for the port sector, which is outlined diagrammatically on the following page.

This is shown in four key stages:

### Year 1: Start Smart Port Voyage

Continue the work from this working group with the formation of deeper strategy plans and early collaboration on easy wins, to build teamwork.

### Year 1-3: Quick Wins

Demonstrate success by landing quick wins and benefits, centring around the Innovation Hub, with some shared innovation and investment projects.

### Year 3-8: Upgrade & Innovate

Stretching capability with more in-depth projects, bringing in support from universities and the broader digital ecosystem in Scotland

### Year 8 on: Stretch Goals

Maturing the nationwide approach with the delivery of more complex projects evolving out from ports and wider-industry strategic needs

Several of the initiatives are interdependent, enabling progress through each stage, for example, where the formation of port-specific strategies, feeds back ideas into the collaborative Maritime Innovation Hub objectives. As initiatives are executed over time, they will create opportunities for new smart initiatives that are not currently yet foreseen.

Further refinement and exploration are required for all the initiatives to identify lead parties (sponsors) and sources of funding and support.

## Delivery Approach

The execution of a multi-faceted roadmap requires different strands to deliver progress, with port authorities and public agencies working together. This approach will vary depending on the benefits, investment, and control that each individual project will require.

Several of the initiatives require some port-specific direct effort and investment, such as the creation of individual digital strategies, which are business-specific and, to some degree, confidential.

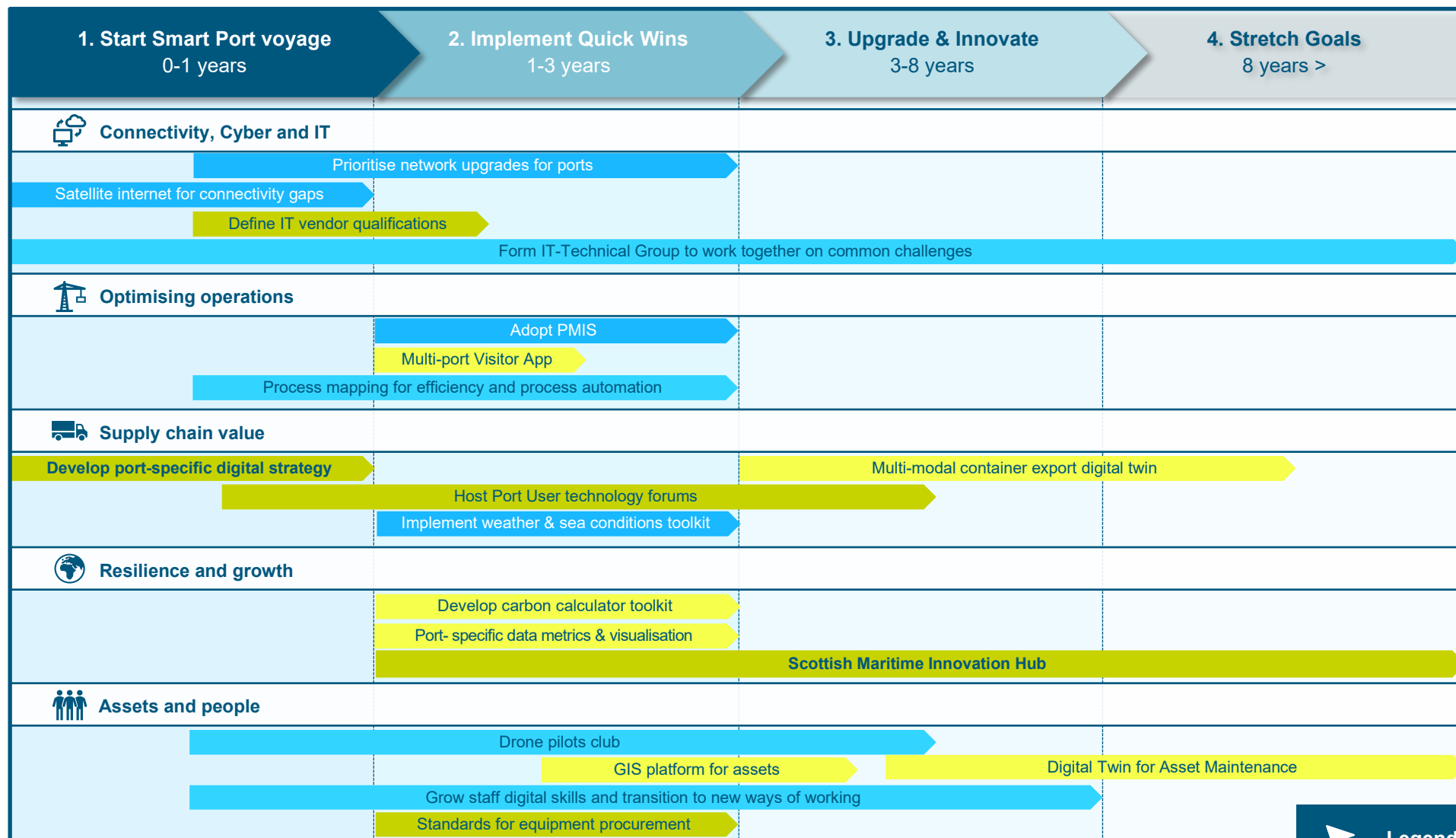
Most of the initiatives are open to collaboration; either with larger (more digitally mature) ports supporting smaller ports, or particularly topics of shared interest, as seen in the formation of a drone pilots club. Often these require some commitment of staff time and effort, but little capital investment.

Investment in technology or infrastructure may be shared between ports, such as a common PMIS platform, or supported by agency grants or match funding. In some cases, the investable business case may also attract external or private finance funding, particularly around sustainability.

Four of these initiatives are classed as Innovation Opportunities where a viable business case, or technical solution, is not within reach today and collaboration with wider stakeholders (through the Hub) for design, trialling, and deployment is needed; here a need for innovation-driven grant funding by agencies is relevant to pursue.

**In all cases, the ports involved in this project have the capability, staff, facilities, and experience to bring into this roadmap, so the door to progress together is ajar.**

## High-level Smarter Ports Roadmap



Legend



# Conclusions

*Benefits to Scotland's  
industry  
-  
Actions*



## Why should Scottish ports become smarter?

This study found that all participating ports exhibited digital maturity levels adequate for their cargo sector expectations based on their relative size and cargo complexity. Nevertheless, further growth of digital maturity is important to stretch productivity, sustainability, and resilience in supporting supply chains.

All ports are on a voyage to maximise the value of assets, systems, resources, and people to remain competitive, flexible, and ready for the energy transition of industry, where digital tools can be valuable. This includes:

### Productivity & Performance

Ports form the gateways for both regional and national industries, communities, and supply chains. All rely on the ports' performance for their livelihoods and economic growth. With relatively limited capital investment, digital technology enhances port productivity and bolsters a port's license to operate; this may include port management systems or process automation. These tools can improve resource efficiency, reduce revenue leakage, and support customer services.

### Energy Transition

Scotland has ambitious targets for technologies such as offshore wind energy, carbon capture, and hydrogen traffic. Technologies such as these cannot be realised, operated, and maintained without ports. Given that the current port infrastructure lacks the capacity to support these large-scale ambitions,<sup>7</sup> it is essential to consider where digital tools, such as asset management and geospatial optimisation, can extract the best value from port facilities.

### Scaling Supply Chain Innovation

Hubs like Singapore and Rotterdam may lead smart maritime innovation, but Scotland has potential to grow skills, local innovation, and cross-sector capability to strengthen the nation's position in this global marketplace.

## Next steps

On the voyage to smarter ports and improved digital maturity, ports can take actions on an individual, collective, and national level, including:

### Individually ports can::

1. Develop a digital strategy, defining both short-term actions and long-term, smart port ambitions. The strategy should encompass elements of supply chain management a holistic viewpoint for joined-up benefits.
2. Focus on quick wins to resolve gaps, boost digital skills, and gain momentum on the rollout of a smart port strategy, including:
  - Develop or implement new off-shelf systems (e.g. PMIS).
  - Build skills in-house, e.g. in the use of technologies such as drones.
  - Map and optimise (paper-based) processes.
3. Work together with stakeholders and tenants in the local port community to explore mutual improvements.
4. Include the digital topic in long-term port plans and business strategy.

### Collectively ports should:

1. Continue working together in the Digital Ports Working Group to:
  - Share knowledge and experiences.
  - Develop joint guidelines and standards.
  - Engage in joint investments and smart developments.
2. Start up a Scottish Maritime Innovation Hub, together with research institutes and government agencies. This could serve as a safe space to trial/incubate new ideas, before commercial take-up.

### Nationally, the following barriers can be addressed:

1. Fibre and cellular connectivity issues in port towns need to be addressed.
2. Support innovation from the research/trial phase to commercialisation.

<sup>7</sup> NSEC, 2023, *North Seas offshore wind port study 2030 – 2050*, p. 66



*Puirt didseatach airson fàs gnìomhachais na h-Alba san àm ri teachd*

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Prepared by:



With the grateful collaboration of:

