Abstract

DataPorts will boost the transition of European seaports from connected and digital to smart and cognitive, by providing a secure environment for the aggregation and integration of data coming from the different sources existing in the digital ports and owned by diverse stakeholders, so that the whole port community could benefit from this data in order to improve their processes, offer new services and devise new AI based and data driven business models.

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1. Excellence

1.1. Objectives

1.1.1. Background and motivation

Freight transport activities are projected to increase\(^1\) by 40% between 2005 and 2030, and by 80% between 2005 and 2050, transforming the current mobility and logistics processes to become significantly more efficient. The mobility and logistics sector can benefit radically from big data technologies, as it already manages massive flows of goods and people whilst generating vast datasets that support innovative Big Data solutions. Big Data can deliver 28% improvement in asset management via predictive maintenance, and an improvement of operational efficiency of 5% via real-time data visualization and predictive analytics\(^2\). To contextualize, a 10% improvement in efficiency can lead to cost savings of EUR 100 billion in the whole transport sector. This represents huge opportunities for improving operational efficiency, delivering a better customer experience while creating new business processes and business models.

DataPort focusses on a key transport domain in the global supply chain: seaports, and on making it significantly easier, faster and more trustworthy to deliver big data solutions by integrating data assets from a variety of stakeholders. Seaports are key components of logistic and transport chains, and imply complex ecosystems where many players with different interests interact and operate in an intricate network of stakeholders. Additionally, the shipping industry is facing some important challenges in the next future with a slower sea trade growth, a regional trade transformation, shipyard capacity management and the zero emissions agenda. Vessels with increasing sizes and cargo volumes add pressure to ports and terminals operations, and competition among different ports and operators has intensified in the last years. Shipping containers have produced a revolution in the movement of goods driving efficiency throughout the global supply chain and contributing to the market globalisation. Yet, the transport industry agrees that next revolution in container handling will be container terminal automation. However, only a small amount of container terminals around the world are already automated today (less than 3% of such terminals exist today). In order to deal with such complexity and challenges, ports have gone through a structural and functional evolution over the past decades mainly supported by ICT enablers; leading to a digital transformation by embracing innovative technologies: development and deployment of connected platforms, such as Port Community Systems (electronic platform that connects multiple systems operated by a variety of organisations that make up a seaport, airport or inland port community) and software platforms for the management of freight forwarders, sensors and IoT devices monitoring their assets, cloud based services, mobile devices and apps, etc. This innovative revolution has implied the transformation of industrial ports into digital and connected, where the different stakeholders through the supply chain are able to monitor their activities, and manage and support their infrastructure, generating a huge amount of data that could be useful for future processes and other members of the community. As an example, at local level, the Port Community System of the port of Valencia has more than 700 companies already connected exchanging more than 40 million transactions per year to organize the container freight transport. In an upper level, the International Port Community System Association (IPCSA) members operate across the world, exchanging electronic information at more than 200 seaports and airports, rail and inland waterways, and border crossing points. This equates to more than 500 million TEU (twenty-foot equivalent unit) and 10 billion tonnes of world trade a year. Their members have over 1 million users, and the exchange of more than 30 million messages per day in support of efficient sea and air ports.

Big Data techniques applied to this huge amount of data could provide the necessary tools for automating decision processes and controlling job queues. They would allow dynamic job assignment for container handling, integrating not only operational data but also global data coming from other actors along the value chain. Applying this approach a carrier could know in advance metrics such as, the expected waiting times or the retrieving turnaround of a container. Additionally, port authorities would be able to get an overview of how different terminals are performing

\(^{1}\) “Demand Side Requirements for Logistics”, Rod Franklin (ALICE ETP), Presentation at EPoSS Brokerage Workshop in IoT Large Scale Pilots, June 2015

in real-time and react accordingly to improve traffic flow. In other words, unlocking the current big data from port operations would optimize the usage of resources and infrastructure.

However, this scenario is far from being real. The lack of interoperability among data, reliable data sharing schemes, and a trusted environment for data trading and brokerage, is hampering the real adoption of data driven solutions in the seaports. In fact, there are several challenges that have to be addressed in order to take real advantage of the existing technical infrastructure and the availability of the huge amount of data generated by the different stakeholders, and to make it real the transition of seaports from digital/connected to smart/cognitive:

- **Secure and trusted environment** for an efficient and effective data sharing between stakeholders. Nowadays, the actors in the transportation and logistics supply chain are reluctant to share their data, which entails a creation of silos and not to get real value from them.

- **Interoperability and integration of data collected from multiple** sources for enabling real-time decisions and control of assets at seaport level and along the whole supply chain.

- **Connection with other data platforms** to use further / external information (data from external sources) in the decision processes.

- **Scalability** to allow a real connection among connected ports, sharing data for a better performance of global operations, and managing data sovereignty with independence of data volume.

- **A reliable source of truth** in the data management that guarantees the quality, validity and veracity of data, including procedures and policies for data governance.

- **Reduction of the administrative burden**, for users and smart objects in large multi-organizational IoT infrastructures to collaborate in data exchange under different privacy constraints.

**DataPorts will provide a scenario where seaports could connect and share data, making it possible the continuous tracking along the supply chain through different ports, and the application of AI based and data driven techniques at global level, in order to provide cognitive services, obtain a higher efficiency of processes and reduce the environmental impact.**

1.1.2. Project overview

| VISION: a trusted and secure environment where all actors operating in the diverse supply chains involved in European seaports could share and trade their data, in order to boost the transition from digital / connected to smart / cognitive ports, involving the setting-up of new services, an increase of the efficiency of the ports, and a reduction of the environmental impact. |

| MISSION: DataPorts aims to take advantage of the huge amount of data generated around modern connected seaports, and the high level of digitalization that these ports have achieved, leveraging on the existing digital platforms and tools, to establish an industrial data platform where data coming from different stakeholders and external sources can be combined and processed and get real value from them, in order to improve existing processes, establish novel cognitive and AI-based applications, and allow new business models. |

*This is done by focusing on the following:*

a. To provide all the technical tools for the acquisition, aggregation, processing and analysis of the data coming from the different stakeholders, data sources and existing platforms.

b. To implement the secure methods and the governance rules needed to offer to the involved stakeholders a reliable and efficient environment to share their data, offering also a clear value proposition.

c. To implement a set of advanced cognitive and AI based applications that will rely on the available data to provide a higher efficiency of processes and new data driven business models.

d. To move towards a real data driven inter-connection of digital ports involved in common routes and supply chains, so global value could be obtained from locally generated data.

e. To scale-up the platform at European level, becoming the de-facto data platform for the connection of European seaports.
DataPorts aims to **design, develop, set-up and operate a data platform** for the trusted, secure and reliable data sharing and trading among the actors operating in the diverse supply chains involved in the seaports, also enabling the connection with other stakeholders in the logistics environment. The adoption and use of this Data Platform by existing connected / digital ports will imply their transition to actual cognitive ports, taking real advantage of the huge amount of data produced by the stakeholders and opening the way to **new capabilities as real-time control of operations, streamlined decision making, accurate prediction of future events and situations, and prescriptive analytics**.

DataPorts will offer all the necessary services to provide security and protection features of data shared and traded between the diverse stakeholders of the freight transport chains, and easily plug them into different Port Community Systems, Single Windows and other government systems, for formalities and controlling trade and transport, ensuring a unique source of truth. DataPorts will ensure the needed anonymization or de-identification mechanisms while preserving the individual features that are required for effective big data analytics, and will also provide a better, more secure and resilient environment to exchange data for conducting business, running operations and reconcile them with financial flows on a real time and individual operation. The platform will provide a smart, secure, reliable and trusted ecosystem, a clear framework for the stakeholders to safely exchange and share data, and clear rules on where the data will be stored and how will be accessed, a flexibility of the policies on data distribution, different platform governance capabilities and interoperability among different platforms. DataPorts will rely on existing digital and computing platforms in the port community, such as Port Community Systems, Freight Forwarding and Logistics Operator Systems, Global Shipping Platforms (i.e. Tradelens, INTTRA, etc.), Terminal Operating Systems, Banking, Financial and Insurance Systems, and other government systems. Besides, DataPorts will enable the connection to external sources of data (including both internal and external freight movement business like banking, insurance, government, ocean shipping, ports, airports, international logistics and parcel industries), which will enrich the data-driven process in the Smart Freight Transport. Finally, the platform will also enable a real connection among ports, allowing them to share data and knowledge, to track vessels and other assets through the entire supply chain, and to share best practices and find synergies for a more efficient management.

DataPorts also includes the deployment, testing and showcase of the data platform in two relevant European ports (Valencia, Thessaloniki), where it will be connected to the existing digital platforms to collect data, will provide sharing rules and added value to data owners, and on top of which the pilots will develop AI and cognitive applications to solve specific problems and improve processes for each pilot. The project also includes two global use cases involving those ports where the platform provides inter-port data sharing and connect to other actors to improve processes at a large scale.

Therefore, the ultimate goal of DataPorts is the development, set-up and operation of a **Cognitive Port Data Platform that will entail the interconnection of a wide variety of systems into a tightly integrated ecosystem, so that seaports all across Europe** could benefit from the results of this project in order to create an even more trusted, reliable and efficient way of conducting businesses in Europe and reinforce the European Single Market.

### 1.1.3. Specific objectives

**DataPorts** will demonstrate, in a realistic, measurable, and replicable way, **transformative effects use of an industrial data platform** will bring to transportation and logistics in seaports environment. These effects will be shown in solution of two actual large-scale demonstration pilots and two global use cases, thereby fostering further extendibility and adoption by other seaports and TEN-T routes. Further, results of **DataPorts** will be prepared to be customized and applied to other industries, dealing with industrial data markets. In order to achieve the main objective, the following specific objectives have been identified (summarised, together with the main results and verification measures in Table 1):

**O1. To address real-life data market use cases in two relevant European seaports and related community** where current solutions do not utilize/underutilize existing tools for acquisition, aggregation, processing and analysis of the data coming from the different stakeholders, sources and existing platforms, **including pilot deployment and evaluation of progress against benchmarking-existing deployments KPI’s**.

**O2. To design and validate next-generation set of advanced interoperable data related and AI based services**, that will rely on the available data for a higher efficiency of the operational processes; bringing together: (i) improved data acquisition mechanisms, (ii) data sanitization algorithms to guarantee data quality; (iii) create machine learning models over a variety of privacy-preserving scenarios; (iv) ability of federating data varying in syntax and semantics; and (v) efficient and effective techniques for data wrapping that will represent the underlying mechanism for supporting selective release, storage and analytics on data enabling efficient processing over protected data while preventing (or limiting) access to the actual data content by other parties.
O3. **To define an engineering methodology facilitating application of DataPorts architecture and tools,** to support cognitive, privacy-aware and secure data sharing processes in adequate locations within the DataPorts platform (and ecosystem) and a guide to automate each process (identification, design, implementation, deployment, test, maintenance). Thus, setting the data-driven ecosystem ready for a comprehensive exploitation of data, providing guidelines, graphical facilities, engineering patterns, and data repositories. Additionally, necessary supporting materials (guidelines/best practices/manuals) for deployment of DataPorts-compatible solution will be delivered, to provide the necessary knowledge to users that would like to take advantage of DataPorts in the industrial domains of the presented use cases.

O4. **To define, design and incorporate a novel, scalable, resilient, semantic approach for data sharing** that builds upon existing semantic interoperability solutions, annotating data at selected points in the multi-layer architecture, improves data quality, and enables a variety of features, such as application of reasoning, semantic rule engines, semantic translation, and more. Novel semantic solutions for Big Data analytics will be developed and analyzed (in the context of the different pilots), including: (i) semantic stream processing and analytics; (ii) semantic data compression; and (iii) declarative, distributed data aggregation and sanitization. Reliability and scalability will be included by design.

O5. **To define, design and provide a data governance framework and associated tools for the DataPorts architecture.** The issue of significantly improving the trust of stakeholders of the logistics domain so that they share their data with other business counterparts or with third party service providers is a dominant one in industrial data spaces. Recent advances in the blockchain technology, including smart contracts, have created a transparent environment for auditing transactions across the chain and for ensuring only verified transactions are being compensated for. DataPorts will introduce a novel, decentralised architecture, where business analytics or AI-driven decisions are recorded on a datapoint-by-datapoint basis, on a blockchain. In this way, decisions and processing activities may be audited and data providers may be ensured that records have not been tampered with. The platform will be fully compliant to GDPR regulation, emphasizing on the parts of how even non-IT-experts from logistics SMEs may be ensured of the former compliance with an innovative smart semantic user interface to guide the user in specifying privacy and data access policies.

O6. **Impact creation.** Besides standard dissemination activities, e.g.: presenting/promoting approach/results, at conferences, website, exhibitions, and workshops, DataPorts will perform two showcases, including demonstrations, to widely present main outcomes and promote concrete advantages of using data spaces in ports of the future, to stakeholders and potential clients. Exploitation and business models are also means to strengthen impact and they will be goals of DataPorts.

O7. **Establishment of a new cooperation and business framework.** DataPorts will define and validate credible and scalable business models, which will ensure wide and sustainable use of the proposed solution. Business modelling will be fully aligned with technical capabilities of the ecosystem and functionalities of deployed pilots. In addition to devising credible and viable business models, action will attempt at their generalization and extendibility towards reuse in scope of cross domain environments. Furthermore, action will introduce and validate a framework for regulatory analysis, including privacy and ethics aspects, as part of a holistic approach to reach a reliable implementation.

### Table 1. Overview of specific DataPorts project objectives and related measurable results

<table>
<thead>
<tr>
<th>Obj.</th>
<th>Main Result</th>
<th>Verification (Success Criteria)</th>
<th>WPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>O1</td>
<td>Two demonstration pilots, two global use cases and a set services built, deployed, demonstrated, expanded and grown using DataPorts architecture and proposed technologies and tools.</td>
<td>Extensive testing of deployment of DataPorts within four seaports in real-world scenarios, validated by relative stakeholders. Measuring performance against relevant industry validated KPIs.</td>
<td>WP2, WP3, WP5</td>
</tr>
<tr>
<td>O2</td>
<td>To move towards the connection of cognitive ports sharing routes and involved in common supply chains, by the sharing of data and getting real value for a higher efficiency of shared processes.</td>
<td>Improvement of services provided by the seaports to share data following a cognitive approach, including AI and big data analytics.</td>
<td>WP3, WP4</td>
</tr>
<tr>
<td>O3</td>
<td>Reference DataPorts architecture for data spaces ecosystems associated with cognitive seaports supporting a set of tools that facilitate its implementation and deliver new services and components.</td>
<td>Functional and non-functional validation of DataPorts (iteratively improved) carried out experimentally in real-world uses cases.</td>
<td>WP2, WP3, WP5</td>
</tr>
</tbody>
</table>
1.2. Relation to the work programme

This project addresses the topic ICT-13-2018-2019 of the H2020 Work Programme 2018-20: “Supporting the emergence of data markets and the data economy”. More specifically, this proposal focuses on the innovation actions aimed at setting up and operating platforms for the secure and controlled sharing of industrial data (Industrial Data Platforms). The following table describes how the project tackles the different challenges and scope of the topic:

<table>
<thead>
<tr>
<th>Challenge &amp; Scope</th>
<th>How the project addresses these challenges</th>
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<tbody>
<tr>
<td><strong>Challenge 1:</strong> Lack of trusted and secure data platforms and privacy-aware analytics methods for secure sharing of proprietary / commercial / industrial data</td>
<td>The main outcome of the project is an industrial data platform that will offer the actors involved in seaport communities in particular and logistics supply chain in general, a trusted and secure environment for an efficient and reliable sharing and trading of their data. DataPorts aims to take advantage of the huge amount of data generated around modern connected seaports, and the high level of digitalization that these ports have achieved, leveraging on the existing digital platforms and tools, to establish an industrial data platform where data coming from different stakeholders and external sources can be aggregated and processed in order to get real value and to improve existing processes (related to objectives O2 and O3). DataPorts platform will connect to digital infrastructures and platforms already existing in the port communities, and already operated and used by multiple companies (PCS of Valencia involves more than 700 companies), many of them SMEs. It means that all these actors will automatically benefit from all the services provided by DataPorts. Additionally, DataPorts will guarantee scalability and interoperability to allow external or additional players to connect to the platform. The consortium includes SME partners that will validate this approach. On the other hand, the project will collaborate with different initiatives at European level (BDVA, IPCSA, ALICE), to foster the adoption and use of the platform by companies in general and SMEs in particular (related to objective O7). The data platform implemented and deployed in DataPorts will include all the necessary elements to guarantee, on the one hand, security and protection of the data within the platform, and, on the other, trusted and reliable sharing and trading of these data among stakeholders in the port community and the supply chain. To this end, a whole work package (WP4) is devoted to design a trusted environment and provide data governance rules so that business analytics and AI-driven decisions are recorded on a datapoint-by-datapoint basis,</td>
</tr>
<tr>
<td><strong>Challenge 2:</strong> Involve SMEs and give them access to data and technology</td>
<td></td>
</tr>
<tr>
<td><strong>Scope 1:</strong> Setting-up operating platforms for trusted, secure and controlled sharing of proprietary / commercial data</td>
<td></td>
</tr>
</tbody>
</table>
1.3. Concept and methodology

1.3.1. Conceptual approach and positioning of the project

In recent years, due to a great interest of both Industry and Academy in researching and developing data management technology, many solutions for different verticals and merging different data sources (e.g. from IoT devices to full-fledged IoT platforms) have been implemented. However, there is no global reference standard for data platform technology and we do not foresee one in the near future. Data platforms scenarios are characterized by a high-degree of heterogeneity at all levels (middleware, application service, data/semantics, scalability and governance), preventing deployment, federation and interoperability of existing solutions. Although many projects/initiatives have dealt and/or are dealing with developing data platforms architectures in diversified application domains, not many projects have addressed integration in port environments with the possibility of including cognitive
services/applications and extending/federating the platform to whole transportation routes covering whole Europe. Furthermore, no proposals (to date) have been put forward to deliver a general, fully reusable, and systematic approach to solve data platform deployments associated with port community systems and associated data.

Lack of interoperable, scalable, reliable data platforms causes major technological and business issues such as impossibility to plug non-interoperable data sources into heterogeneous data platforms, leading to impossibility to develop applications exploiting heterogeneous data in homogeneous and/or cross domains, slowness of data technology introduction at a large-scale, discouragement in adopting data sharing technology, increase of costs, scarce reusability of data, user dissatisfaction, and lack of unified data.

Figure 1. DataPorts concept

Figure 2. DataPorts value chain and stakeholders

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governance mechanisms. Thus, the main goal of the DataPorts project is to comprehensively address non-covered aspects of data platforms (e.g. semantic interoperability: scalability; resilience or data governance), with a specific application to transportation logistics in port environments in order to achieve cognitive PCS and improve data management between involved stakeholders.

DataPorts will provide a data platform in which transportation and logistics companies around a port will be able to manage data like any other company asset, in order to create the basis to offer cognitive services (see Figure 1). DataPorts data platform will contemplate different aspects that may allow for a scalable, semantic, privacy-aware and secure by design sharing of data. Besides logistics and freight transport players, DataPorts data market inherently will provide support for different stakeholders, third party services providers and developers, taking into account the ever growing number of product features, ever shorter product lifecycles, shorter delivery times, legal guidelines, and value creation processes getting increasingly globalized. Data platform heterogeneity will be turned from a crucial problem to a great advantage as there will be no need to wait for a unique standard for an interoperable environment, neither developing proprietary ad-hoc bridges between data sources. DataPorts data platforms will provide the support for advanced services for cognitive ports, linking the platform with existing initiatives and results from areas like IoT, Big Data analytics or Artificial Intelligence.

DataPorts aims to create a reliable data platform addressed to port community environments to support transportation and logistics processes and designed to be scalable and extendable up to European level. The stakeholders of the data platform may be categorised in general in: (i) Data Providers as scalable heterogeneous sources that will feed data into the data platform. In this sense, IoT platforms, IT systems (open or private), PMS/PCS controlled by the ports or Market Agents and (ii) Data Consumers that can be the same data providers or interested parties related with transportation and logistics. Further detail on DataPorts stakeholders is provided in Figure 2. DataPorts platform will embrace all agents that would get value over the industrial data, following the strict data governance rules, supported by ICT enablers. Moreover, the platform will give particular emphasis on the facilitation of cognitive service providers that are benefitted from the decentralised, privacy-aware architecture proposed below. The main enabling technologies that facilitate this is a combination semantic interoperability, artificial intelligence, blockchain techniques and big data analytics enablers supported by a scalable architecture, combined with smart contracts and encryption solutions.

1.3.1.1. DataPorts Technology Readiness Level (TRL)

DataPorts will be based on the integration of previous developments in the area of data platforms: IoT, blockchain technologies and privacy and security fields in order to achieve a data platform to be used in the area of transportation and logistics associated with ports. Due to its inter-disciplinary nature, DataPorts includes different items with different TRLs. The different technologies and components do already exist and have been validated separately, which indicates that they are located in a TRL 5/6 (although some components provided from partners have a higher TRL). Validations have provided data identifying potential upscaling and operational issues. DataPorts will build on these state-of-the-art technologies and will develop a data platforms with semantic interoperability capabilities; scalability and reliability enabler; access API and data governance capabilities to compose a cognitive PCS that later could be extended to other areas in transportation and logistics. The different components will be fully integrated and tested in the proposed pilot sites involving real users, stakeholders and data. The interaction between the components will be assessed and fine-tuned, including additional developments mainly aimed at integration as this is an Innovation Action. Since the result will be system prototypes tested and demonstrated in relevant environments, the Technology Readiness Level, DataPorts is expected to achieve is TRL 7/8. DataPorts therefore provides multiple technical innovations that are on the path to market development and will strongly benefit from being tested in field trials. Thus, such innovations will be disseminated to a large set of potential stakeholders and users.

<table>
<thead>
<tr>
<th>DataPorts Technology</th>
<th>Initial TRL</th>
<th>Final TRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semantic Interoperability enabler</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>Common vocabulary and semantic discovery component</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Smart contracts enabled ledger</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Data spaces aggregator</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>AI and big data services</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Smart API for cognitive services</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>Data Governance enabler</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>Decision Support Module</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>DataPorts Monetization enabler</td>
<td>5</td>
<td>7</td>
</tr>
</tbody>
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1.3.2. Architecture

DataPorts relies in the experience and leadership of its partners in the port transportation and logistics domain to address the identified open challenges, and cover technology gaps as described in detail in the objectives. DataPorts will enable the new generation of cognitive data-supported digital services addressing more open, connected, transparent and nimble technological frameworks that provides dynamic and self-adaptive configuration capabilities, intuitive and ubiquitous interactions, ambient pro-activeness, learning capabilities, data processing and modern graph-based storage and analytic services under a protected data & privacy environment. However, current landscape of platforms in the domain have addressed these needs partially, and frequently without a multidimensional approach. DataPorts will use a multi-dimensional approach considering every economic, social and technological aspects, what makes DataPorts a unique approach for implementing the new generation of cognitive PCS services. DataPorts will address these identified needs and propose the first representative of a New Generation Data Platform addressing the ports transportation and logistics domain. DataPorts platform aims at providing to seaports a secure and private aware-environment where data coming from different sources can be shared by the stakeholders in a trusted and reliable way, in order to get real value from those data, providing a set of novel AI and cognitive tools to the port community. DataPorts is created as a global frame for new cognitive services that will follow the IoT Reference Architecture (HLA) functional model described by the AIOTI-WG3 which is compliant with ITU-T Y.2060 IoT Reference Model, OneM2M reference architecture, IIC’s Industrial Internet Reference Architecture (IIRA) and mainly RAMI 3.0. With these models in mind, DataPorts Platform will interact with the ports in the following ways (see Figure 3):

- Acquiring, processing and storing data coming from the different data sources and digital infrastructures existing in the digital seaports.
- Getting from the owners of these data the rules for the sharing and trading, offering them a clear value proposition. Data consumers will be granted access to those data under the mentioned rules, with the application of smart contracts if necessary.
- Providing, on top of the data analytic services offered by the platform, a set of AI and cognitive applications to the port community, aimed at solving specific problems of the port and boosting the evolution to smart and cognitive ports.

In order to perform the aforementioned functionality, the Data Platform will include the following blocks:

- **Data access.** The platform will guarantee the access to the digital infrastructures of the port, including IoT devices and mobile apps, and to legacy databases and systems. It will also consider the access to open data sources, and the connection to external sources, including both internal and external freight movement business like banking, insurance, government, ocean shipping, ports, airports, and international logistics and parcel industries.

- **Data abstraction and virtualization.** Given the very different type of sources, the platform will have to cope with the variety of data, the different velocity depending on legacy systems and the veracity depending on the type of source. The data platform will guarantee semantic inter-operability in order to provide a unified virtualized view of the data for its use by the different data consumers and the data analytic services.

- **Data governance.** The data platform will provide all the tools for a secure and trusted sharing and trading of the data, considering the rules proposed from data providers for data consumers, and offering a clear value proposition to data owners, implementing smart contracts if necessary. Besides, data governance will keep the information about who owns the data, what is the quality of data, and what are the potential uses for data.

- **Blockchain.** In order to keep provenance of the data entering the platform and to implement the functionalities of data governance, DataPorts platform will implement blockchain technology taking as reference Hyperledger Fabric (https://www.hyperledger.org/projects/fabric), the most mature permissioned blockchain (open source) available today.

- **Privacy and Security.** The data platform will provide end-to-end secure and trustful environment for the activities in scope by a holistic end-to-end approach of cybersecurity that at the same time includes privacy. Based on this, the platform will offer secure and trustful environment where most of the risks are mitigated to an acceptable level, providing a governance of the security efforts in order to create a dynamic model capable to adjust to new threats.
- **Advanced Big Data Analytics.** DataPorts will offer Big Data Analytics as a Service (BDAaaS), providing a level of abstraction to application developers about the implementation and set-up details of the data platform regarding configuration, services, adaptability and deployment. This module will take advantage of the huge amount of data available in the platform, and will provide app independent services, such as pattern recognition, predictive and prescriptive analytics, trend forecasting, etc ...

![DataPorts Architecture Diagram]

*Figure 3. DataPorts architecture*

The architecture of DataPorts will also follow the approach of the **International Data Space (IDS)**\(^3\), in the sense that it offers i) endless connectivity, ii) trust between different security domains, and iii) governance for the data economy. At the same time, it also is aligned with IDSA’s mission statement about i) secure data exchange, ii) use cases and iii) business models. DataPorts platform data sharing will provide a data shared semantics solution for the interoperability of diverse datasets using existing ontologies, moreover it will be provided as a solution for semantic integration using linked data principles as main standard from the W3C and promoted as best practices for sharing data in many other domains. The semantic interoperability infrastructure will be part of the semantic framework and will be connected to the interoperability framework. The semantic models will be used in all use cases on the pilots where semantics will be required for extra interoperability services. The DataPorts platform data sharing will include analytics, exploration, discovery and adaptability and support for development of a marketplace. Finally, and in order to ensure compatibility with IDS reference model, DataPorts will provide the following:

- **Data owners and providers** will have the possibility to describe the *Connector* to clearly state the type and conditions of the data to be offered to other actors when accessing those data. This operation will be performed through the blockchain methods and implemented by the blocks “Data abstraction and virtualization” and “Data governance”.
- The blockchain block will act as the *Broker*, registering the description of all data and providing *Data Consumers* the most suitable data in terms of their attributes.

\(^3\) [https://www.fraunhofer.de/content/dam/zv/de/Forschungsfelder/industrial-data-space/IDSREFERENZARCHITECTURE.PDF](https://www.fraunhofer.de/content/dam/zv/de/Forschungsfelder/industrial-data-space/IDSREFERENZARCHITECTURE.PDF)
The Connectors will be available to Data consumers to allow access to the different datasets in the platform, according to the rules defined by the owners and through “Smart Contracts” if necessary. At the same time, the block “Advanced Data Analytics” will use those Connectors to access the data in order to allow the exploitation of the platform by the beneficiaries.

- The **Data abstraction and virtualization** block will act as **Vocabulary Provider**, managing the ontologies and metadata to provide port domain specific vocabulary.
- The different apps and services provided by the platform will be submitted for certification by the **IDS-approved certification bodies**.

### 1.3.3. Motivating applications. Demonstration pilots and use cases

As part of the project execution, **real-life deployment, testing and evaluation of the data platform** will take place in two local demonstration sites (Valencia and Thessaloniki pilots, led by VPF and TPHA respectively), where the platform will be deployed and connected to the existing digital infrastructures of each port, given access to the different data sources and operated by relevant stakeholders, to whom the data platform will offer data driven services to address concrete problems. Additionally, the DataPorts platform will be tested and showcased at a pan-European scale **in an inter-port basis in two global use cases** led by TRX and PRO, involving indirectly multiple ports and actors. In the first case, the platform will be fed by the **tracking devices with which TRX equips shipping containers** all over the world. This use case will showcase the benefits of DataPorts in combining data coming from all those containers will local information coming from the ports. The second use case will integrate a **management system developed by PRO and used by more than 200 ports all over the world (Posidonia Management)** with DataPorts platform. These use cases will show how DataPorts in combination with existing technology providers can help ports to expand their services to multiple stakeholders. The description of the demonstration pilots and the use cases are explained in detail below.

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**Figure 4. DataPorts demonstration scenarios**

<table>
<thead>
<tr>
<th>Port of Valencia</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pilot site location and general description</strong></td>
</tr>
<tr>
<td>The port of Valencia was ranked in 2018 as the first container port in the Mediterranean and fifth container port in Europe. The figures for the port of Valencia in 2018 are 76 million tons of total traffic, 5,182,665 TEU, 820,221 cars and 1,071,963 passengers. The Port of Valencia is a port highly specialized in the traffic of containerized merchandise that also attends to other traffics such as liquid and solid bulk and ro-ro cargo. It also manages regular passenger and merchandise traffic with the Balearic Islands, and receives a large number of cruise ships annually in its facilities. The port has three big container terminals managed by the most important shipping lines in the world with 4.7 km of berths.</td>
</tr>
</tbody>
</table>

| **ICT Infrastructure**  |
| The port of Valencia has electronic platform that connects the multiple systems operated at the port community called ValenciaportPCS. This platform provides several services to promote the collaboration of the port community members, most of them SMEs, public authorities and border protection agencies. Recently, the execution of two relevant projects (INTER-IoT and Transforming Transport) has consolidated the adoption of IoT and big data, and partners participating in the Consortium have deployed two test-bed platforms to connect these two disrupting technologies to operational systems of the port, such as PCS, Terminal TOS, shipping line TMS and hauliers’ fleet management systems. |

| **Data sources and datasets**  |
| This pilot will be set-up and carried out in the port of Valencia, and will connect to the following five data sources:  |
| i) ValenciaportPCS ([https://www.valenciaportpcs.com](https://www.valenciaportpcs.com)), the Port Community System of Valenciaport, where |