FEDeRATED PILOT/LIVING LAB ASSESSMENT

Serves as

FEDeRATED MILESTONE 10

FINAL

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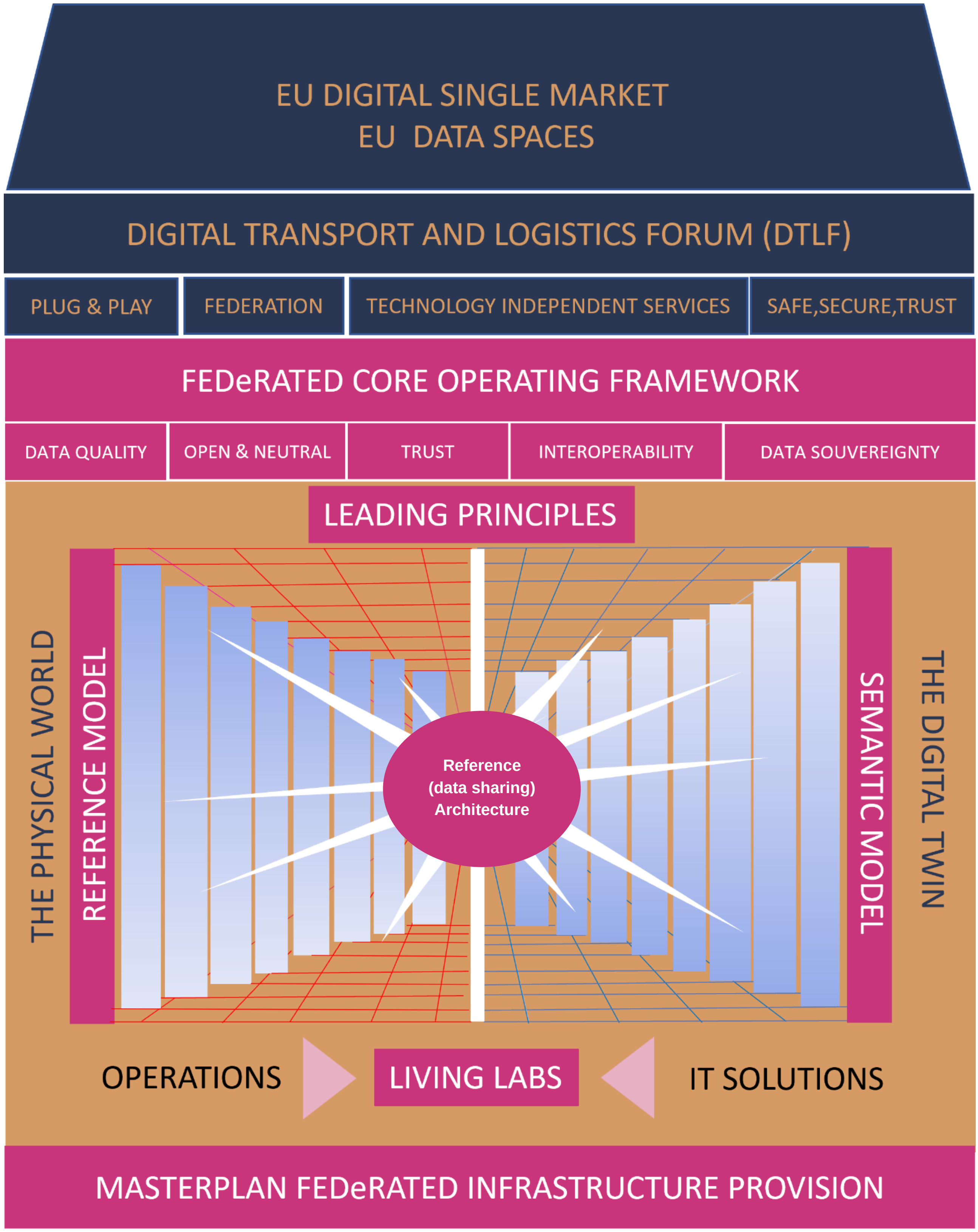
FEDeRATED NETWORK OF PLATFORMS

Co-financed by the Connecting Europe Facility of the European Union


EU DIGITAL SINGLE MARKET
EU DATA SPACES
DIGITAL TRANSPORT AND LOGISTICS FORUM (DTLF)
PLUG & PLAY
FEDERATION
TECHNOLOGY INDEPENDENT SERVICES
SAFE,SECURE,TRUST
FEDeRATED CORE OPERATING FRAMEWORK
DATA QUALITY
OPEN & NEUTRAL
TRUST
INTEROPERABILITY
DATA SOUVEREIGNTY
LEADING PRINCIPLES
THE PHYSICAL WORLD
REFERENCE MODEL
Reference (data sharing) Architecture
SEMANTIC MODEL
THE DIGITAL TWIN
OPERATIONS
LIVING LABS
IT SOLUTIONS
MASTERPLAN FEDeRATED INFRASTRUCTURE PROVISION

EXECUTIVE SUMMARY

This report is the first assessment of the FEDeRATED LivingLabs against the upcoming Master Plan on how to establish an EU federated network of platforms. The EU federated network of platforms – data sharing grid for logistics – can be identified as an interoperable network of virtual worlds based on digital twins and connecting Events that can be accessed at the same time by millions of users, who can exert property rights over virtual items.

The targets to be set in the Master Plan should be feasible. Scaling is essential. For this purpose, LivingLabs assist the development of the Master Plan. The Master Plan sets the architecture conditions. Ecosystems must be interoperable, connected through the functional requirements and technical specifications of the data sharing grid.

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The steps towards a validated Master Plan

To put the infrastructure provision in place, the FEDeRATED project develops a validated Master Plan. This is done in various stages:

1. 2019. A Vision is developed (Milestone 1), The DTLF building blocks are finetuned in a Core Operating Framework. The FEDeRATED consortium has identified a federated network of platforms as *an infrastructure provision containing a set of arrangements and technical applications to enable data in existing IT systems (platforms) of companies and public organizations to become available to users through a publish and subscribe approach*
2. 2019-2020. Interim Master Plan (Milestone 2), containing 37 leading principles, 16 technical components and describing the importance of applying a harmonized data interoperability, for which a Reference Model and FEDeRATED semantic model have been developed.
3. 2019-2021. LivingLab scoping (Milestone 4)., the FEDeRATED partners develop their LivingLabs (total 23), that are based on viable business cases that lead up to actual data sharing practices.
4. 2021-2022. First testing of several LivingLabs (Milestone 8, update will follow). Several LivingLabs seek collaboration. Constant finetuning of the LivingLabs takes place. Guidance is sought for to assist the LivingLabs in their efforts towards interoperability.
5. 2022. A Reference (data sharing) Architecture (Annex to this Milestone 10 report) is developed incorporating the European Interoperability Requirements for logistics, the DTLF building blocks and Milestones 1 and 2 are included.
6. 2022. Assessment of the Pilots/LivingLabs (this report, Milestone 10). The Reference (data sharing) Architecture is translated into functional requirements, the technical specifications, and the organisational requirements of the upcoming FEDeRATED Master Plan. The LL assessment is based on:
   - the Interim Master Plan (assessment done in 2021/2022); and,
   - the technical specifications of the upcoming FEDeRATED Master Plan (assessment 2022).
7. 2023. Final LivingLab testing report (Milestone 12, due Autumn 2023).
8. 2023. The validated Master Plan (Milestone 14). The Master Plan synergizes 1, 3 and 4 with the results of the LivingLabs. The Master Plan should be cohesive with developments relating the implementation of EU acquis, like the eFTI Regulation, under the condition of a federated approach.

This report (nr 4) assesses the value of the Interim Master Plan (nr 1) and Reference Architecture (nr 3) against the LivingLabs (nr 2) and vice versa. This assessment identifies whether the current insights e.g., the Reference Architecture, can serve as the basis for the Master Plan, to be validated in 2023.

The EU policy concept

The policy requirements that enable the development of a data sharing grid for logistics – EU Mobility Data Space – are:

1. An overarching EU and national regulatory approach and policy incentives – to support and stimulate data sharing i.e., fostering the EC data spaces policy for logistics in conjunction with cross sectoral data sharing practices. This relates to the need to:
    a. Define the functional requirements for the data sharing infrastructure provision (the Mobility Data Space for logistics);[1]
    b. Establish a long-term and transparent data sharing infrastructure framework, thus enabling organisations to invest in digital readiness (see paragraph 1.8 for a first proposal);
    c. Enhance the current state of digital competence (readiness) of organisations (companies and public authorities) through dedicated programmes and projects.

2. An EU and national governance structure possibly including standardisation and certification. The governance of the federated data sharing grid should preferably:
    a. Establish and maintain the technical specifications of the data sharing grid, also adjusting it to future developments;
    b. Organize the registration (or certification) of the various organisations that would like to act as a node within the infrastructure provision;
    c. Monitor the development of the infrastructure provision, thereby also checking the compliance and conduct/performance of the various nodes within the grid.

The effective governance of a federated network of platforms should take into consideration the division of tasks - who must play what role supervising the governance – also within the perspective of distributed governance.

The Reference Architecture

The Reference (data sharing) Architecture comprises a conceptual and a functional and technical layer. It is elaborated in the Annex. As requested by the EC FEDeRATED Grant Agreement, the Reference Architecture is simplified into a Master Plan that feature functional requirements, technical specifications and organisational requirements.

The **functional requirements** of the infrastructure provision - a data sharing grid based on a data at source approach - refer to the need for:

[1] Functional requirements - the functionalities to be provided to the organisations surfing or browsing the infrastructure provision (can also be called EU Mobility Data Space)

1. "Common" language – the semantics and interaction order (process choreography) for data processing by heterogeneous systems or platforms.
2. Discoverability or findability of data – it is about being able to search and find (query) service providers and data that an organization needs for its tasks. The latter is filled in with 'Linked Data': an organization receives a link to data as an indication of the data they may access.
3. Security for all participants - to provide trust for all participants.
4. Controlled Access to all participants – enabling any company to give another company or competent authorities access to data that either the company is willing to make available to others or need to provide in accordance with legislation. This can be done through open data or via links that have been shared. In practice, this access will be limited, thus controlled access.

The technical specifications for any data holder or user to participate in the data sharing grid in a FEDeRATED way are:

1. Apply the semantic web technology and a common semantic model (Semantic adapter)
2. Utilize an Identification, Authentication and Authorisation (IAA) infrastructure – the unique identification and authentication of a person and their authority granted by their employer (verification of authorization). Authorisation relates to enabling participation systems, platforms, organisations and their personnel to access or provide data to users and holders of data of each participating organization.
3. Apply a Service Registry – enabling organisations to formulate their capabilities, specify the maximum of queries, events and digital twins they can support, identify the infrastructure they use, and the business service(s) they require or support.
4. Deploy an Index – providing any participating organisation a transparent overview of the event-based data being available to share for conducting business and administrative compliance procedures.

The organisational requirements - the set of agreements enabling organisations to connect based on their capacities - consists of the following implementing protocols (protocol stack):

- **Connectivity protocol(s)** – the technical capability to enable two protocol stacks to implement reliable data sharing.
- **Security protocol(s)** – the safe and secure sharing of data.
- **Presentation protocol(s)** – the syntax and technology (messaging, Application Programming Interfaces) used for sharing data.
- **Linked Event Data protocol (pull)** – sharing of links based on logistics events. It is the interface between two instances of the Index component.
- **Business protocol** – the functionality of each event in its context for sharing data in various business processes between organisations - specifies a structured set of event types (business process choreography) and their minimal data requirements for providing business services. The business layer implements 'search' and pulls data and may pose additional security requirements[2].

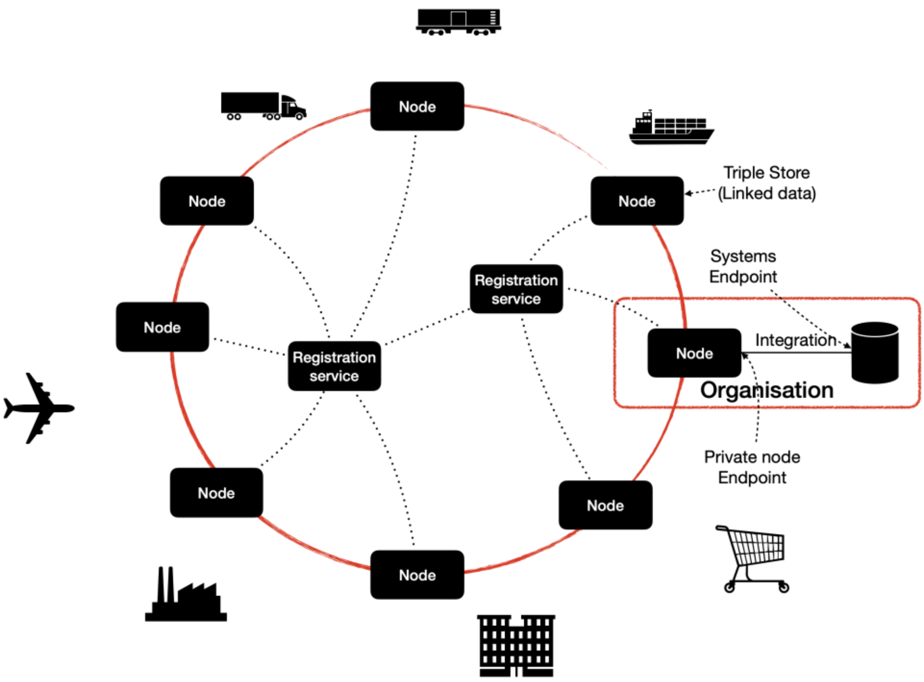
[2] Like authentication of users and/or verifying their credentials, and business service discovery needs.

- **Semantics** – the business – and Linked Event Data protocol make use of a common semantics that are interoperable with existing global standards such as WCO, UNCEFACT, IATA and IMO.

The sum of these architecture requirements and specifications enables the participants to become a node in the data sharing grid – EU Mobility Data Space. The Node:

- always interfaces with a Service Registry and can thus always be configured;
- allows each stakeholder to share data independent of any existing platform while implementing an open source;
- fully supports the language, also supports one or multiple options of the protocol stack, i.e. protocols regarding presentation, security, and connectivity like REST APIs using 'https'. This also requires a so-called 'semantic adapter'.

These requirements and specifications will be further developed and incorporated into the final FEDeRATED Master Plan. As such they establish an interoperable grid of trusted nodes.



Assessment Pilots/LLs

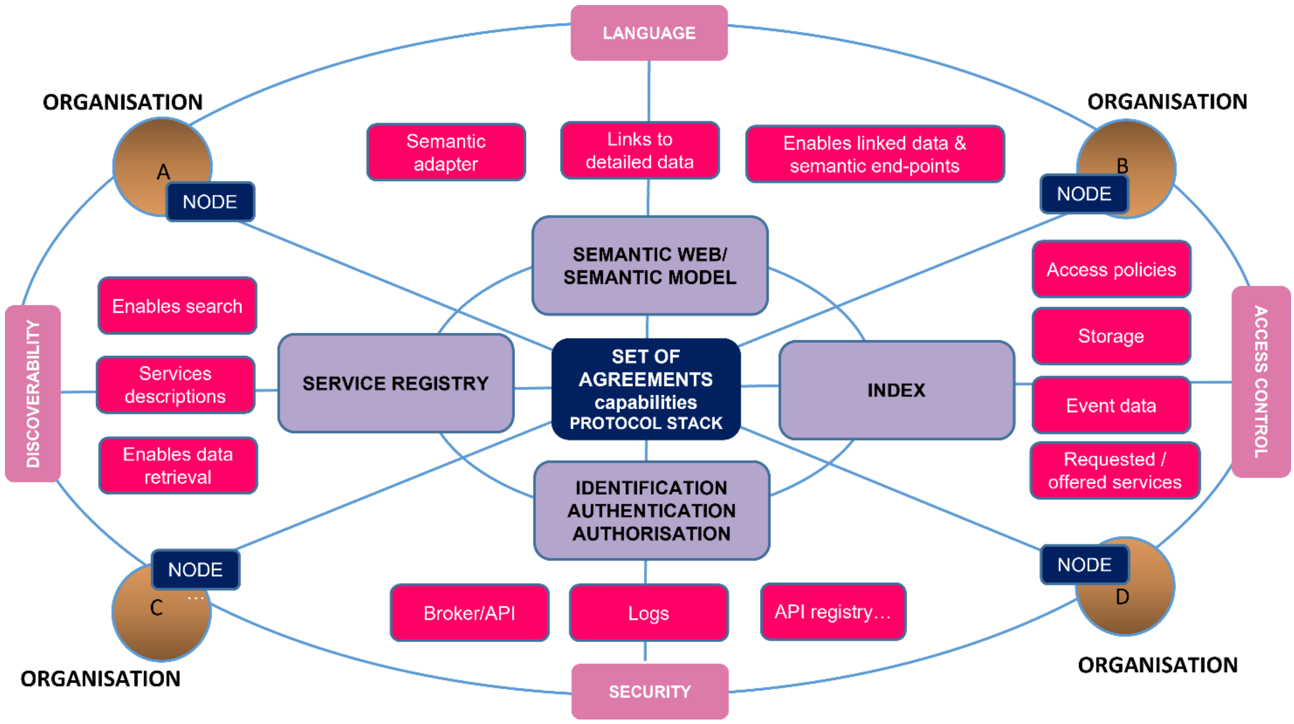
The projected Master Plan requirements and technical specifications need to be validated. Validation will be done by LivingLabs (LLs), containing real time use cases showing how the FEDeRATED concept could work in practice. As a first start towards this validation, the ongoing LivingLabs have been assessed against the Interim Master Plan and the Reference Architecture. This has been done in two phases:

1. The **assessment of the LLs against the Interim Master Plan**. This validation relates to the 37 37 Leading Principles and 16 technical components. The validation has been executed in 2021.

The major outcomes of this validation are

- Most Leading Principles (LPs) are applicable to all LivingLab (LLs);
- Some LPs need more explanation within the context of individual LLs;
- Not all LPs fit into daily practice yet, but there is often a consensus that these will be applicable in a medium time frame.
- Onboarding is important and difficult to do, especially to enable stakeholder engagement and knowledge gathering about the technical setting.
- A reference architecture is required to provide more practical insights and guidance on what to do for the ICT professional.

2. The **assessment of the LL against the Reference Architecture**. This validation relates to a set of criteria based on the Reference (data sharing) Architecture and is illustrated as an interoperable LL framework hereunder:



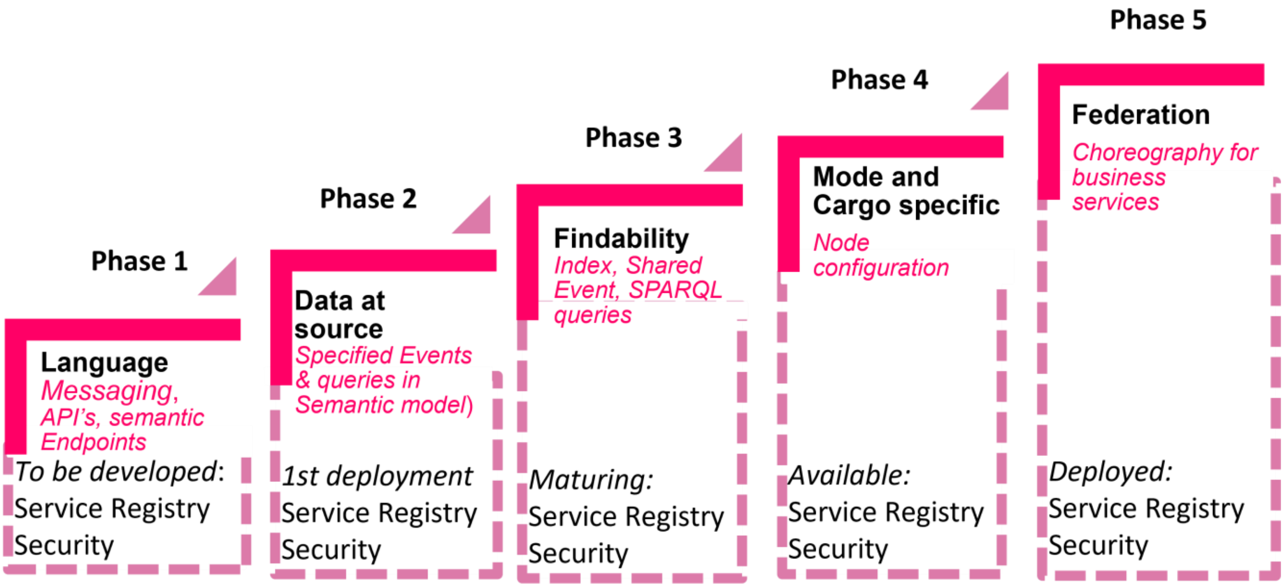
The validation has been executed in 2022. The major outcome of the validation is:

- The semantic model is difficult to apply for many LLs. They need additional guidance and senior modelling assistance how to align the semantics of their existing ecosystem with a common semantic model towards interoperability.
- Semantic web technology is applied by just a few LLs.
- Most LL confirm that the FEDeRATED semantics approach will mature over a time period of 2 to 5 years.
- Many LLs focus on non-complex business relations which do not (need to) exploit the entire federated architecture.
- 20% of the LLs apply a Service Register.

- IAA is primarily developed within the propriety domain of the LL participants.
- More information and guidance are required on the semantic adapter, Index, Service Registry and IAA.
- Nodes are being developed by 2 LLs.
- The data sharing practice within the 23 LLs is done by 10 engines that have the capability to configure digital twins for logistics objects that share events in a publish/subscribe mode or as semantic endpoints.
- Common LLs are fostered to enhance the learning curve towards interoperability in a federated network of platforms setting. There is an opportunity for 5-10 LLs to cooperate, thereby also validating LL interoperability.
- The Reference Architecture provides a sufficient basis for a FEDeRATED Master Plan to be validated by the LLs.
- Many business operators do not seem to be sufficiently digital ready yet to incorporate all necessary digital technologies allowing fully-fledged federated data sharing; A step-by-step approach is often necessary.
- The phasing of the adoption and the deployment of the Reference Architecture is important to provide clarity to all LLs on what steps to take in future.
- Additional guidance to the LLs will be provided.

The adoption and deployment phases

The adoption and deployment of the Reference Architecture through the LLs will be most likely done in 5 phases i.e.:



These phases will not be easy to implement. Every organisation has its own preferences and business cases. Thereby, many organisations do not structurally envisage to fully open their IT systems to all stakeholders, thus complete interoperability is difficult to establish. They prefer to develop federated data sharing in a step-by-step approach according to their traditional business cases. Thereby, the step-by-step evolution from one phase onto the next phase can sometimes be disrupted, e.g., phase 2 above can sometimes be of a lesser priority than phase 3. Therefore, the LLs do not necessarily need to follow the 5 phases in a chronological sequence. It also means that not all phases will be fully completed necessarily before a next phase is engaged upon. The correlation between the various phases requires more study.

The way forward

The FEDeRATED action list for additional guidance of the LLs enabling them to validate a FEDeRATED Master Plan identifies:

- Need for FEDeRATED guidance on:
    - semantic adaptor;
    - service register;
    - Index; and
    - IAA.
- A focus on the interoperability between LL with the objective to finetune the Reference Architecture using hands-on experience
- Specifying the different adoption and deployment phases.
- Need for a prototype and showcases.
- Elaboration on the most appropriate governance.

TABLE OF CONTENTS

INTRODUCTION

In 2023, the FEDeRATED Action will deliver a validated Master Plan for an EU federated network of platforms concept and a prototype of a data sharing environment for business and public sector use in logistics. Thereto a Vision document (Milestone 1), an Interim Master Plan (Milestone 2) and a Reference Architecture (Annex) have been developed between 2019 - 2022. These documents constitute the guidance for the development and execution of the LivingLabs. Most LivingLabs started in 2019 and 2020. In 2021 and 2022 many LivingLabs reached the stage of piloting. [3]

This Milestone 10 report is about assessment of the FEDeRATED LivingLabs/Pilot against the Interim Master Plan and the draft Reference Architecture. In October 2023 a follow up document will be called the validated Master Plan (Milestone 14). The LL assessment in this report is a prelude to the final validation of the Master Plan. This assessment is based on measuring the compliance of the LLs with the Interim Master Plan (Milestone 2) and its follow up document the Reference (data sharing) Architecture (Annex to this report), and the lessons learnt.

Design and benefits

In connection to the European Interoperability Framework (EIF) and the EU DTLF Building Blocks, the FEDeRATED Action was commissioned to design the federated network of platforms based upon:

1. Open and de facto standards based on a common semantic model (See FEDeRATED semantic interoperability (federatedplatforms.eu);
2. The definition of organisational, functional and technical specifications for a federative network of platforms for the entire Core Network in real life operational conditions (see chapter 1 of this report, further elaborated in the Annex);
3. The development and validation of the federative network of platforms along various EU transport Core Network Corridors in the form of Pilots and LivingLabs (FEDeRATED Activity 3, Milestone 4 LivingLab scoping, updated based on FACTsheets incorporated in the FEDeRATED website Living Labs (federatedplatforms.eu);
4. The collaboration with relevant stakeholders including standardization bodies, software developers and platform providers (FEDeRATED Activity 2, 3 and 4, Collaborative Platforms).

According to the FEDeRATED – EC Grant Agreement, the federated network of platforms concept will allow for (benefits):

A. Smooth interaction between and among the different logistic chain operators and public administrations involved.
B. Enterprises to optimise the use of supply chains.
C. Dynamic planning to enable various ways of collaboration and optimize capacity utilization.

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[3] The pilots are tested based on an agreed questionnaire - https://www.survio.com/survey/d/F0C3C9C4G5K3O8B2Y The results will be presented in an updated Milestone 8 (December 2022) and Milestone 12 (September 2023) report.

D. Recognizing existing (partial) systems.
E. Streamlining multimodal transport.
F. Decreasing or removing costs derived from lack of interoperability.

These benefits will be made clear through the various use cases – business cases – incorporated in the LivingLabs.

The structure of this report

This Milestone 10 report is divided into 2 parts.:

- Part 1 deals with the various architecture aspects towards developing a mature FEDeRATED Master Plan. This Master Plan will be based on the draft Reference (data sharing) Architecture (Annex to this report). In the chapters 1 and 2 the Reference Architecture is translated into specific requirements and specifications which should be anchored into the final version of Master Plan, to be released end-2023. As this Master Plan under development needs to be validated by and against LivingLabs, chapter 2 identifies the overarching framework for interoperability, also in relation to the LivingLabs assessment.
- Part 2 briefly identifies the scope of the LivingLabs (chapter 3). In chapter 4 the LivingLabs are assessed against the Interim Master Plan. Chapter 5 describes the assessment of the LivingLabs against the upcoming Master Plan under development (Reference Architecture) as described in chapter 1. Both chapters 4 and 5 provide lessons learnt. These lessons learnt are assembled in chapter 6, containing some major conclusions.

The Reference (data sharing) Architecture is made available as an Annex.

PART 1
THE CONCEPTUAL FEDeRATED MASTERPLAN ARCHITECTURE: REQUIREMENTS AND SPECIFICATIONS

Just as there is one Internet, made up of many different networks and services, that have more value for being connected, there should be one data sharing grid, made up of many virtual worlds, or rather platforms. Many of these worlds or platforms already exist. For them the next steps will include scaling them up to support more users (many platform providers carefully limit their numbers), making them more realistic and accessible, and devising new hardware to allow greater immersion. Progress is being made on all those fronts. But by far the biggest challenge will be to make connections between what are currently separate worlds, especially different propriety systems or ecosystems. New platforms will emerge benefitting from the experiences acquired.

The urge is for EU collaboration between companies and public authorities towards devising and adopting open standards. The market that this will unlock will be much bigger than any of them could create alone; - a common format creates a bigger market. For various ecosystems already taking shape within the supply chain, it makes economic sense to share data and interoperate. Portability of data, or for that matter property rights, over virtual items will drive standardisation and interoperability over time (Source: The metaverse, Matthey Ball Liveright, 2022).

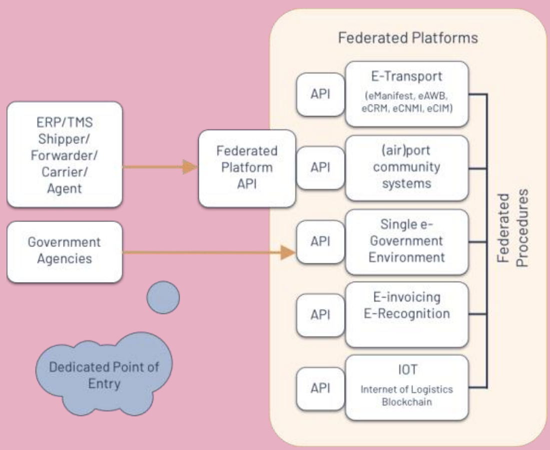


Illustration What FEDeRATED wants published on the FEDeRATED website

1 ARCHITECTURE REQUIREMENTS AND SPECIFICATIONS

1.1 The federated network of platforms

FEDeRATED aims to **apply digital technology to achieve supply and logistic chain interoperability**. The goal is EU seamless multimodal transport. This can only be achieved by solving some major bottlenecks i.e., fragmented legislation, different languages (data semantics) and no level playing field. In overcoming these bottlenecks many companies and public bodies involved in logistics and freight transport will enter unknown territory based on our proposals.

The goal of the FEDeRATED project is to solve the above bottlenecks and to develop and set in place the concept of a federated network of platforms to enable data sharing in the supply and logistic chain under the condition of providing semantic, technical, legal, and organizational (EIF) interoperability. To elaborate:

- **Semantic interoperability,** ensuring that the precise format and meaning of exchanged data and information is preserved and understood throughout.

- **Technical interoperability,** covering applications and infrastructures linking systems and services. Including Interface specifications, data integration, exchange and interconnection services, and secure communication protocols.

- **Legal interoperability,** ensuring that organisations operating under different legal frameworks, policies and strategies are able to work together.

- **Organisational interoperability,** documenting and integrating or aligning business processes and relevant information exchanged.

Based on the EIF, the 4 DTLF design principles – building blocks - and the FEDeRATED Core Operating Framework, in 2019 the FEDeRATED Action defined the network of platform concept as "*an infrastructure provision containing a set of arrangements and technical applications to enable data in existing IT systems (platforms) of companies and public organizations to become available to users through a publish and subscribe approach.*"[4] (Milestone 1). Milestone 1 also defined the FEDeRATED Core Operating Framework (COF). As a follow up, in 2020 FEDeRATED identified in its Interim Master Plan (Milestone 2):

- 37 leading principles for a federated network of platforms to work;
- a reference model for semantic interoperability (Milestone 2, chapters 3 and 5);
- 16 technical components;
- First overview of security requirements (Milestone 2, paragraph 6.3.1.4);
- Platform Services.

These features have been further incorporated in a comprehensive Reference (data sharing) Architecture document, see Annex. This Architecture document will be updated in 2022 and 2023 by the FEDeRATED IT Architecture Group and will constitute the backbone of the FEDeRATED

[4] Transposed into Internet terminology, an "existing IT system" should be considered as a Decentralised Data Resource (DDR) acting as a node in a data sharing grid.

Master Plan. It will be validated by the LivingLabs (LL).

Towards a data sharing grid for logistics and freight transport

Between 2019-2022, FEDeRATED has developed its Reference (data sharing) Architecture (Annex). This Architecture aims to enable the DTLF (Digital Transport and Logistics Forum) concept of a federated network of platforms to be developed as a technology grid enabling all parties in freight transport and logistics to share data according to the European Interoperability Framework (EIF). The *DTLF federative network of platforms* policy approach is based on 4 Building Blocks: 1) plug & play, 2) federation, 3) independent technology services and 4) safe, secure, trust. In practical terms this policy approach can be explained as a policy impulse to develop a future proof *EU data sharing grid for logistics and freight transport* enabling Distributed Data Resources (DDR) - i.e., IT systems/platforms that provide or use data aimed at delivering services - to connect with one another. This EU *data sharing grid* would enable millions of IT systems/platforms to draw data at some times and supply data at other aimed at providing tailor made services to all participants, including compliance with legislation.

The LivingLabs constitute a reality (bottom-up) check of the (top-down) Reference Architecture approach and at the same time the Reference Architecture sets the requirements and specifications on how to achieve a future proof network of platforms approach for all logistic and supply chain operations. FEDeRATED should develop a product that brings value to the conceptual architecture developments and also make business and operational sense.

1.2 Considerations on a multi-layered approach

Developing the essential elements of building for the proposed infrastructure provision requires a multi-layered approach. Many different opinions exist regarding the terminology to be used. In addition, the development of a sustainable data sharing infrastructure provision must incorporate many different domains, disciplines and faculties, taking into consideration concurring interests of the stakeholder involved: different policy agendas and business models are to be involved.

FEDeRATED is requested to identify the functional requirements, technical specifications, and organisational requirements. Generally, different disciplines apply the same words with a different meaning. In the context of the FEDeRATED project the basic concept is to use terminology that can be understood by policy people as well as ICT professionals. Within the FEDeRATED project:

- Functional requirements identify the facilities a data sharing grid should provide any supply and logistic chain operators enabling any data holder and data user to do business with another i.e., engaging and fulfilling any kind of contract, execute transactions, providing (Value Added) service and complying with legal obligations.
- Technical specifications relate to the minimum technical attributes that a data sharing grid

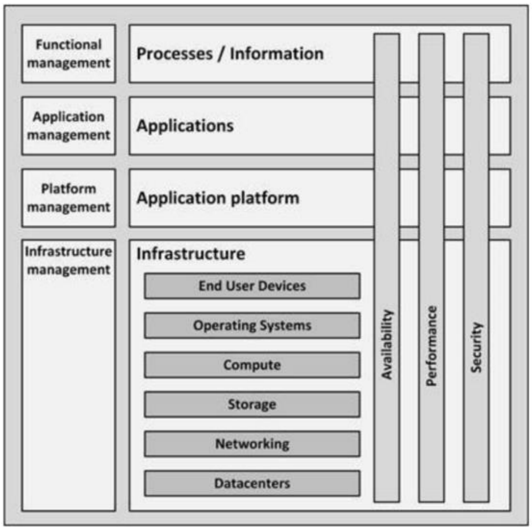
should provide for the participating organisations.[5]

- Organisational requirements relate to organisational interoperability, more specifically to what organisations that want to conduct their business processes through data haring have to comply with and how they can be stimulated to participate.

IT Infrastructure Architecture Model

IT Infrastructure Architecture describes the overall design and evolution of the infrastructure that enables all hardware and software components needed to run IT applications. Various models have been developed on how infrastructure components work on an architecture level. A model illustrates a simplified version of reality. A model is not perfect, as it often lacks full details. However, it is useful in providing a high-level description of the building blocks to build an infrastructure, identifying:

- Functional management: containing identification of processes and information building blocks that organisations implement for their business processes – configured to perform the needed business functions.
- Application management: to connect clients, office and business specific applications – responsible for the configuration and technical operations of the applications.
- Platform management: the building blocks that provide specific services, such as Front end servers (http servers), Application Servers (running the actual application, Java and networks), Connectivity (like Enterprise Service Buses) and Database management Systems (e.g. MySQL). Managed by system managers specialized in the specific technology.
- Infrastructure management: such as End user devices, Operating Systems, Compute (=Servers), System Storage, Networking connecting components, routers, switches) and Datacentres (hosting the hardware). This is about the types of applications.
- Non-functional attributes, like security, performance, and availability.



Source: Sjaak Laan, IT Infrastructure Architecture, Infrastructure Building Blocks and Concept, 3rd edition, 2017

[5] This is different from what in IT terms is identifies as technical requirements, which is rather about the choice of technology, hardware, etc.

The functional requirements and technical specifications relate to semantic and technical interoperability. The FEDeRATED project does not touch upon legal interoperability other than identifying that the participants must comply with existing rules and legislation.

1.3 Policy requirements for the FEDeRATED infrastructure provision

Enabling full interoperability is very dependent on the overarching policy setting. The development of a federated network of platforms is difficult and challenging. In fact it requires for many stakeholders a paradigm shift from a propriety based approach towards an open network approach. To be successful, the EU DTLF and Data Spaces policy should not only deal with the interoperability concept but also with the question on "How organisations can be stimulated to participate in a data sharing grid – infrastructure provision?" The two major challenges are:

1. **The move towards a pull based – data at source - business model** incorporating the need for collaboration and enabling themselves to act in non-propriety business environment. This requires companies and public bodies to position themselves as a Decentralized (Data) Resources, being part of an overarching grid, in addition to their ongoing process integration activities.
2. **The full adoption of the Internet, web technology**, for all stakeholders engaged in logistics and freight transport activities, including the engagement of the public authorities. It requires the need for organisations that do not drive their operation on data to enhance their operational brainpower – the need to become digital savvy, call it digital readiness. If not, the opportunities to profit from data sharing will not materialize.

Both challenges relate to change management within the structure of all organisations involved. An innovative transition process must be undertaken leading up to possible transformational, often unknown, profits. Also unknown, costs. The process takes time and perseverance. The benefits of data sharing need to be made visible to all stakeholders, not in the least through a stimulating public policy approach, possible based on a carrot and stick approach to motivate logistics operators to share their data in a secure and trusted environment. A long-term perspective and commitment is necessary.

Change is difficult to achieve and will take place time. It requires an appropriate governance and business model:

- Governance enabling the participants ''the confidence to try something new in the way forward and create a level playing field for all."[6],
- The business model for many participants shall follow a step-by-step approach. Initially, many organisations will be using API (Application Programming Interfaces) to expose the data in their ERP and TMS systems with supply chain partners and mandated authorities.

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[6] Jamie Susskind, The Digital Republic, On Freedom and Democracy in the 21st Century, 2022. Bloomsbury Publisher. Page 303/304: " Stable governance regimes also bring the economic benefits of harmonization. Rather than inefficient competing standards … the consolidation of regulatory standards allows business to compete on a large and level playing field (.,,,) to facilitate 'data-driven business across national borders' contrary to myth, governance regimes do not destroy the incentives to innovation. Page 304 "with good governance… the genius, energy and investment can … cohere with society's values, as laid down in the law."

Identifying the organisational requirements enabling federated data sharing relates to two features:

- Competences - Bottom up. This is about the digital business interface level, including legal compliance, whereby any stakeholder can participate in the grid e.g., act as a node within the grid.
- Enablers - Top down. This is about the development and maintenance of an overarching sustainable data sharing grid, providing secure access to any stakeholders willing to provide or use services for supply chain and logistics operations.

The development of the competences and the enabling mechanisms go hand-in-hand. The one does not go without the other. In practical terms:

1. The **enabling mechanisms** set the framework for any companies and public authorities to:
    - Connect with any IT platform;
    - Know what data and which stakeholders are trustworthy;
    - Find the data they need to;
    - Know the IT system requirements;
    - Translate paper information into data.
2. The **competences of** companies and public authorities enable them to answer questions like:
    - Why don't I know what my clients will order tomorrow?
    - Where are my goods actually located?
    - Why is it impossible to produce an actual sales report?
    - Why does my planning always gets mixed up?
    - Why is my forecast so poor?
    - How do I get hold of the legaly required data?
    - How can I simplify my legal compliance obligations or enforcement tasks?

The competences mentioned above relates to the issue of digital readiness: the capacity to act as a full stakeholder in a digitized setting. Figure 1 illustrates the level of maturity of various companies relating their digital readiness.

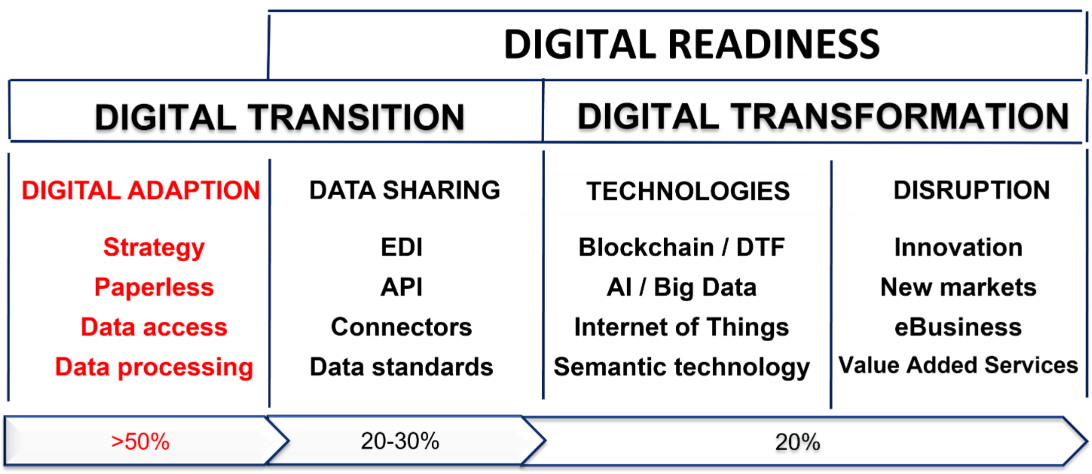

Figure 1 Digital readiness

As can be seen, most companies are not ready for data sharing yet. Digital adaptation is the first bridge to cross. Over 50% of companies and public authorities are not sufficiently digital ready to comply, yet. The figures are based on a dutch questionnaire involving 380 companies, most SMEs, executed in 2021.[1] A Finnish logistics digitalization study from May 2019 pointed out similar results and findings. Although, the management level is already internalized the benefits of digitalization and data sharing, those has not yet achieved the level of implementation. Based on the survey results the digital readiness level and capability to utilize digital tools and data sharing solutions gets weaker, when moving down on company hierarchy from management to operative levels. However, the same survey pointed out that the importance of these topics has already flowed through organizations (From fragmented to distributed, from documents to data, from an actor centred approach to interoperable ecosystems - Finnish Transport and Communication Ministry 2019:12

A data sharing grid can only be realized through a pro-active public policy engagement. In the current market there is not any one company that will take the lead in developing a whole new market with free entries for all possible stakeholders. In order to be successful, enabling and competences go hand in hand.

The public authorities engaged in developing and maintaining a data sharing grid must take into consideration:

1. **From a top-down** - enablers - perspective, four principles should be considered:
    - Preservation – not to erode the integrity of the democratic process.
    - Domination – reduce the unaccountable power of digital technology – keep it to a minimum.
    - Democracy – specify what technologies may not do or be used for.
    - Parsimony – place firm limits on the power of the state – no more than necessary to perform it regulatory function.[7]

2. **From a bottom-up** – competence – perspective, the participating companies and public bodies should be empowered by provided:
    - Transparency on requirements to participate.
    - A trusted and scalable grid.
    - Tools and technical applications to participate
    - Possibly incentives to participate (Value for Money).

The policy requirements - the top-down and bottom-up approach taken together – are:

1. An overarching EU and national regulatory approach and policy incentives – to support and stimulate data sharing i.e., fostering the EC data spaces policy for logistics in conjunction with cross sectoral data sharing practices. This relates to the need to:
    d. Define the functional requirements for the data sharing infrastructure provision (the Mobility Data Space for logistics).[8]
    e. Establish a long-term and transparent data sharing infrastructure framework, thus

[7] See Jamie Susskind, The Digital Republic, On Freedom and Democracy in the 21st Century, 2022. Bloomsbury Publisher.

[8] Functional requirements - the functionalities to be provided to the organisations surfing or browsing the infrastructure provision (can also be called EU Mobility Data Space)

enabling organisations to invest in digital readiness (see paragraph 1.8 for a first proposal).

f. Enhance the current state of digital competence (readiness) of organisations (companies and public authorities) through dedicated programmes and projects.

It is recommended to develop an EU Toolbox (How to Guide) advising organisations striving to share data how to comply with the required technical specifications for Semantics, Discoverability, Security, and Controlled Access.

2. An EU and national governance structure possibly including standardisation and certification. The governance of the federated data sharing grid should preferably:
    d. Establish and maintain the technical specifications of the data sharing grid, also adjusting it to future developments
    e. Organize the registration (or certification) of the various organisation that would like to act as a node within the infrastructure provision.
    f. Monitor the development of the infrastructure provision, thereby also checking the compliance and conduct/performance of the various nodes within the grid.

    The effective governance of a federated network of platforms should take into consideration the division of tasks - who has to play what role supervising the governance – also within the perspective of distributed governance. See paragraph 1.7.

1.4 The functional requirements for the infrastructure provision

The functional requirements of the infrastructure provision identify the facilities a data sharing grid should provide any supply and logistic chain operators enabling any data holder and data user to do business with another i.e., engaging and fulfilling any kind of contract, execute transactions, providing (Value Added) service and complying with legal obligations. Any participant of the infrastructure provision should be able to randomly query – not being prescribed queries - the grid and do business with any other participant.

The functional requirements of the infrastructure provision - the core requirement is data at source - refer to the need for:

1. "Common" language – the semantics and interaction order (process choreography) for data processing by heterogeneous systems or platforms;
2. Discoverability or findability of data – it is about being able to search and find (query) service providers and data that an organization needs for its tasks. The latter is filled in with 'Linked Data': an organization receives a link to data as an indication of the data they may access;
3. Security for all participants - to provide trust for all participants;
4. Controlled Access to all participants – enabling any company to give another company or competent authorities access to data that either the company is willing to make available to others or the need to provide in accordance with legislation. This can be done through open data or via links that have been shared. In practice, this access will be limited, thus controlled access. Not everybody will have access to all each other's data.

Together, ‘discoverability’, 'security' and access constitute ‘data sovereignty’, being the (main) principles of data sharing infrastructures. A common language is needed to process data.

Overarching principle: Data sovereignty – data at source
Any IT system/platform - Distributed Data Resource (DDR) - participating in the data sharing grid should comply with the basic principles of the EU Data Policy, the EU DTLF and the FEDeRATED Core Operating Framework (COF), especially data sovereignty; - more in particular data at source, pull data made available through a publish and subscribe approach for both data holders and users. This should be established in combination with the need for an open, neutral, and trusted digital grid, and enabling interoperable data distribution of high quality. The consequence being that on a local or national scale, DDR's – in paragraph 1.4 in technical terminology this is identified as a node - will be empowered to scale their activities onto an overarching – interoperable - EU grid. Very complex to plan for, orchestrate and keep in balance. Innovative and transitional at the least.

1.5 The technical specifications

The technical specifications for any data holder or user to participate in the data sharing grid in a FEDeRATED way are:

1. Apply the semantic web technology and a common semantic model (Semantic adapter)
2. Utilize an Identification, Authentication and Authorisation (IAA) infrastructure – the unique identification and authentication of a person and their authority granted by their employer (verification of authorization). Authorisation relates to enabling participation systems, platforms, organisations and its personnel to access or provide data to users and holders of data of each participating organization.
3. Apply a Service Registry – enabling organisations to formulate their capabilities, specify the maximum of queries, events and digital twins they can support, identify the infrastructure they use, and the business service(s) they require or support.
4. Deploy an Index – providing any participating organisation a transparent overview of the event-based data being available to share for conducting business and administrative compliance procedures.

The technical specifications are elaborated in the Reference (data sharing) Architecture (Annex) which is under constant review.

1.6 The organisational requirements - set of agreements (protocol stack)

The functional requirements and the technical specifications together – enabling semantic and technical interoperability – define the basis for any organisation to participate as a node in a data sharing grid. However, before the organisations can start sharing data a login, rapid on-boarding and registration onto the data sharing grid is required. This is organised through a set of agreements, or protocol stack, enabling organisational interoperability.

The set of agreements defines and identifies the roles and the capacities of the organisation to act as a node acting within the grid - the prospected EU Mobility Data Space. Figure 2 illustrates that the nodes enable any organisation to connect and be interoperable in relation to any transport mode and multiple business services and compliance procedures.

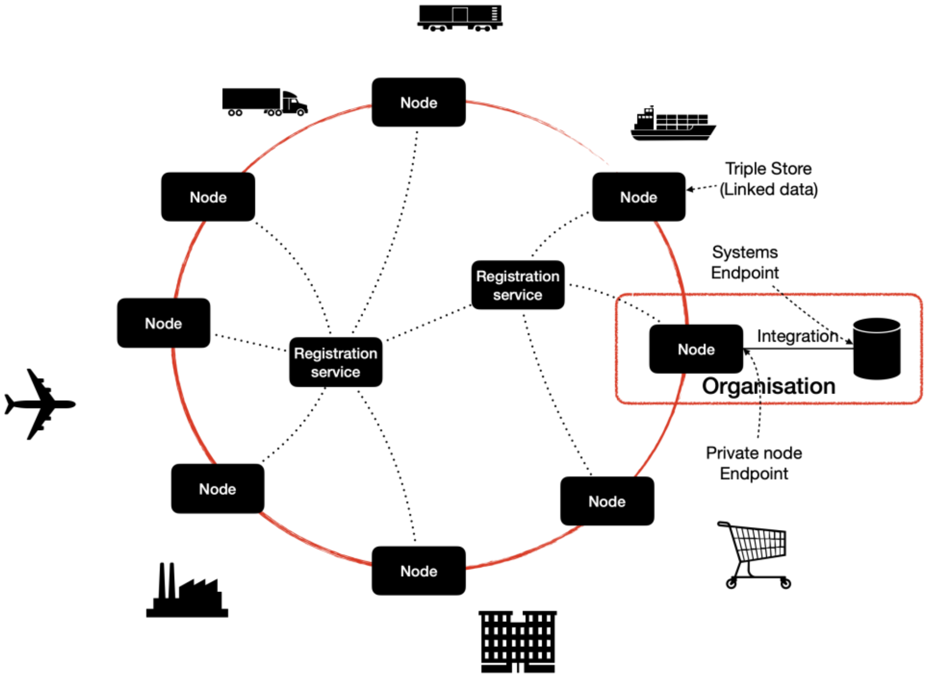

Figure 2 The data sharing infrastructure grid through connecting nodes

The organisational requirements - the set of agreements - consists of the following implementing protocols:

- **Connectivity protocol(s)** – the technical capability to enable two protocol stacks to implement reliable data sharing.
- **Security protocol(s) –** the safe and secure sharing of data.
- **Presentation protocol(s)** – the syntax and technology (messaging, Application Programming Interfaces) used for sharing data.
- **Linked Event Data protocol (pull)** – sharing of links based on logistics events. It is the interface between two instances of the Index component.
- **Business protocol –** the functionality of each event in its context for sharing data in various business processes between organisations - specifies a structured set of event types (business process choreography) and their minimal data requirements for providing business services. The business layer implements 'search' and pulls data and may pose additional security requirements[9].
- **Semantics –** the business – and Linked Event Data protocol make use of a common semantics that are interoperable with existing global standards such as WCO, UNCEFACT, IATA and IMO.

[9] Like authentication of users and/or verifying their credentials, and business service discovery needs.

Overall, the data sharing grid policy and architecture requirements and specifications are illustrated in Figure 3

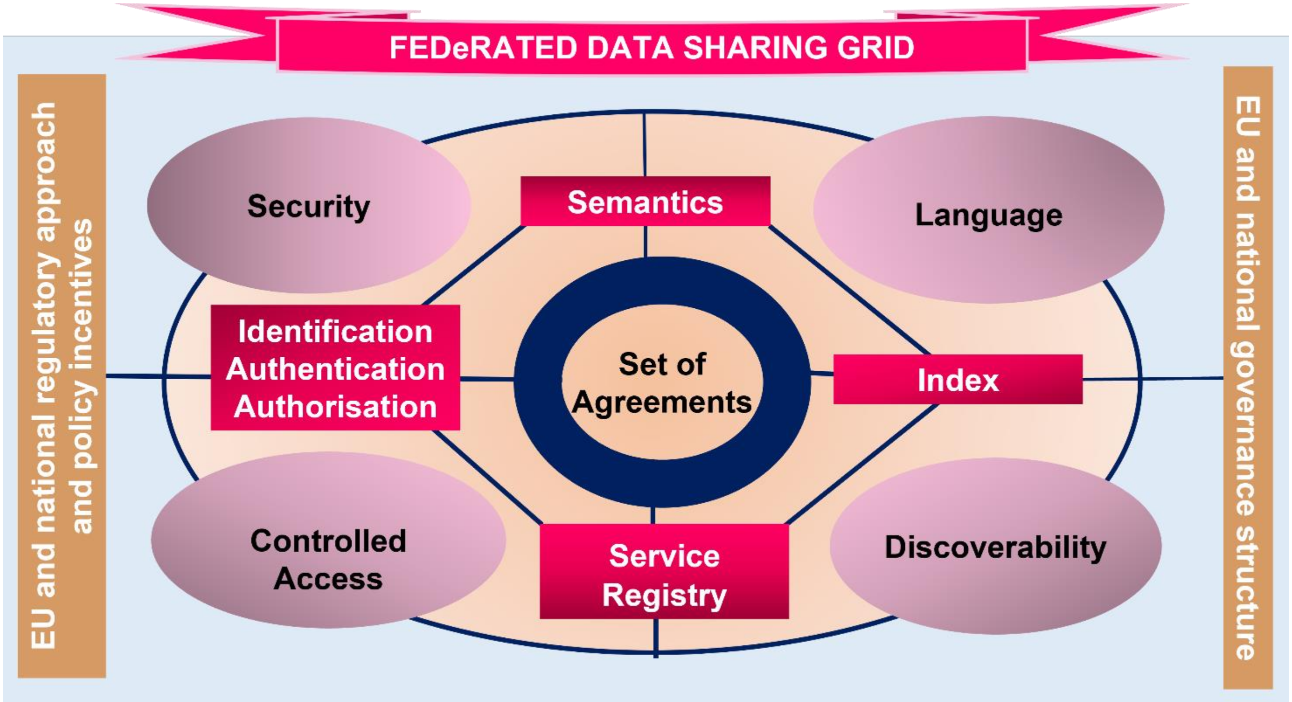

Figure 3 The Policy and Architecture Requirements and Specifications

1.7 Reflections on governance in connection to the EU Mobility Data Space perspective

The policy framework for a data sharing grid should preferably be the EU data policy – EU Digital Single Market and EU Data Spaces – and the data driven policy engagements of many EU Member States. These policies – as well as the federated network of platform approach very much depend on the opportunities provided by the Internet and its connecting web technologies. The DTLF building blocks and FEDeRATED Core Operating Framework (COF) apply. To be effective EU policies should resonate in the EU Member States and relate to business practices.

As indicated in 1.3., governance is essential to enable multi stakeholder engagement and to safeguard the open and trusted character of the EU Data Spaces and federated network of platforms approach. Governance of the federated network of platforms – also to be identified as EU Data Mobility Space – should be based around the principles of justice, equality and freedom. The organisational and functional requirements as well as the technical specifications should be incorporated.

A division of EU and national oversight responsibilities on developing and maintaining the various requirements and technical specifications is necessary. EU involvement relates to the need to safeguard interoperability. Hereunder a first proposal for a governance structure that needs further elaboration.

THE GOVERNANCE BLOCKS		Overarching EU Mobility Data Space (DTLF)	Local/ National/ platform
PARTNERSHIPS – PLATFORM INTEROPERABILITY – relationship various stakeholders with connected ecosystems (platforms)			
Services and operational governance	*Business case*		X (choreography)
	Incentives	X	X
	Participation requirements	X (protocol stack)	
	B2B/B2A service provisions	X (protocol stack)	
	Marketplace development	X	X
NETWORK OPERATIONS			
Technical & Security governance	*Interoperability*[1]	X	
	Semantics	X	
	API development	X	
	System Maintenance		X (protocol stack)
	Contingency Plans		X (protocol stack)
	Security requirements	X	X (protocol stack)
	Cybersecurity	X *(EU Cyber Security Act)*	X (protocol stack)
DATA MANAGEMENT			
Data and Digital Identity governance	*Data ownership/privacy*	X	X
	Digital Identity & Authentication Register	X	X (protocol stack)
	Quality and Traceability	X	X (protocol stack)

1.8 Legislative framework for an EU Data Mobility Space

A proactive approach by the EU is advocated to establish the infrastructure provisions for federated data sharing for logistics. The goal is to enable interoperability, harmonisation and a level playing for all stakeholders to participate in an open and trusted grid. Most likely, a legislative framework is urged for. Data sharing requires a long-term commitment supported by a legal setting.

The FEDeRATED project can help to deliver the components such a legislative framework would require. The legislative framework could be identified as an EU Data Mobility Space. For logistics, this could be further developed under the auspices of DTLF.

The reasoning for a legal framework Data Mobility Space could be as follows:

- Data availability fosters seamless multimodal transport, also solving interoperability bottlenecks;
- There should be a grid for organizations that share and have access to logistics, supply and mobility data;
- The framework is about participation of an organization in the grid (access);
- The following aspects are relevant: access to, functionality of, and evolution of the grid;
- Access to the grid is decomposed into trust of an organization and its behaviour;
- Trust is about registration and compliance to acts and regulations like GDPR, cyber-security act, data (governance) act, etc. It ensures also that an organization has implemented IAA with access control. The role must be clear: enterprise active in mobility and logistics, authority, R&D institute, platform provider, VAS provider;
- Behaviour is about implementation of the protocol stack and publication of a profile;
- Implementation of the protocol stack and a profile must be validated (possibly certified);
- Service providers and authorities must provide their profile; customers may provide their profile;
- An authority profile defines the area in which that authority is governing regulations, the moments in time and place that authority needs to be informed, and the access to data that is required;
- Organizational profile is supported by the Service Registry;
- The protocol stack is implemented by the participating organizations thus enabling them to register as trusted node in the network;
- A trusted node must at least support one enterprise active in mobility and logistics; in case it supports more than one it is called a 'platform';
- Existing platforms and ecosystems can participate in the grid by (collectively) acting as trusted node and providing the profiles of their users/members (interoperability with existing data spaces and platforms);
- The functionality of the grid is about the semantic model, including the capability for VAS development by trusted stakeholders;
- The functionality of the grid is developed in a distributed way (per modality, cargo type, etc.), but must adhere to agreed rules and procedures (governance);
- The functionality should always be backwards compatible to assure that data is not lost and business processes are not interrupted (governance);
- Each 'trusted node' must contain an update mechanism for implementing the functionality of the grid and make this functionality available when published (governance);
- There can be multiple trusted registration authorities. A trusted node has a unique identifier assigned by a registration authority;
- Evolution is about new functionality and innovation in technology providing new possibilities, resulting in major changes of the grid (to be defined);
- Applicability of the framework – it is applicable to mobility and logistics within, into, and out of the EU.

2 INTEROPERABILITY

2.1 Grid interoperability through a node

Conceptually, the perceived data sharing infrastructure provision – the grid - consists of nodes that are interoperable. A node is any data holder or data user (a company, platform, public body) that is willing to engage to do business or execute their public duties within a federated network of platform. [10] The interoperability capacities that a node provides for enabling any participating organisation in the data sharing grid to:

- Assemble the actual components, sharing of (linked) data and (semantic) queries formulated by the semantic model[11];
- Identify the data distribution algorithm, i.e., who receives which links, and how data quality can be assured (event logic, correctness/completeness of data, etc.);
- Interface with a Service Registry and can thus always be configured;
- Allow each stakeholder to share data independent of any existing platform while implementing an open source;
- Support the language, also support one or multiple options of the protocol stack, i.e. protocols regarding presentation, security, and connectivity like REST APIs using 'https'. This also requires a so-called 'semantic adapter' [12];
- Support the Index, containing Linked Event Data that are received from or shared by a user with another user of the infrastructure;
- Support the Query for additional data by a data user to a data holder, based on links contained by the index;
- Support Individual user (or user group, in which case a platform implements - part of - the node functionality). The node of each user contains different data;
- Support all required functionality for safe and secure data sharing, including functionality supporting non-repudiation (log and audit trail) and data integrity.

Running a node within a data sharing grid enables participating organisations to deploy Value Added Services (VAS) with the potential of transformational profits. A VAS is defined as any third-party service provision that utilizes links and access to data - provided by those links – enabling one or more users of the infrastructure to generate new data. Examples of a VAS are:

- ETA prediction;
- Dynamic routing;
- Risk assessment;
- Maintenance prediction;
- Corridor management.

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[10] The node can be perceived as a Decentralized Data Resource within a federated network of platforms that represent any organisation that can act as data holder as well as a data holder. Often these functions go together.

[11] A 'node' can be implemented by a stakeholder and a platform (including existing IT systems of stakeholders) or can be provided as a (cloud) solution.

[12] Transformations between various presentation protocols via the semantic model

A VAS can be based on data analytics. [13]

2.2 A framework for LivingLab assessments

A node constitutes interoperability based on a combination of the functional and organisational requirements and the technical specifications (chapter 1). A node should be perceived as a highly sophisticated tool enabling any organisation – platform, company or public authority – to engage and participate in an interoperable data sharing grid. For most organisations, running a node is a bridge too far. Apart from the time and effort the development of a node would take for an organisation, the infrastructure provision (data sharing grid) on which the node should run is in a premature stage. The FEDeRATED Master Plan is in its infant phase. In its development, the LivingLabs should validate the various aspects of the architecture as proposed in chapter 1. The framework is proposed in figure 4.

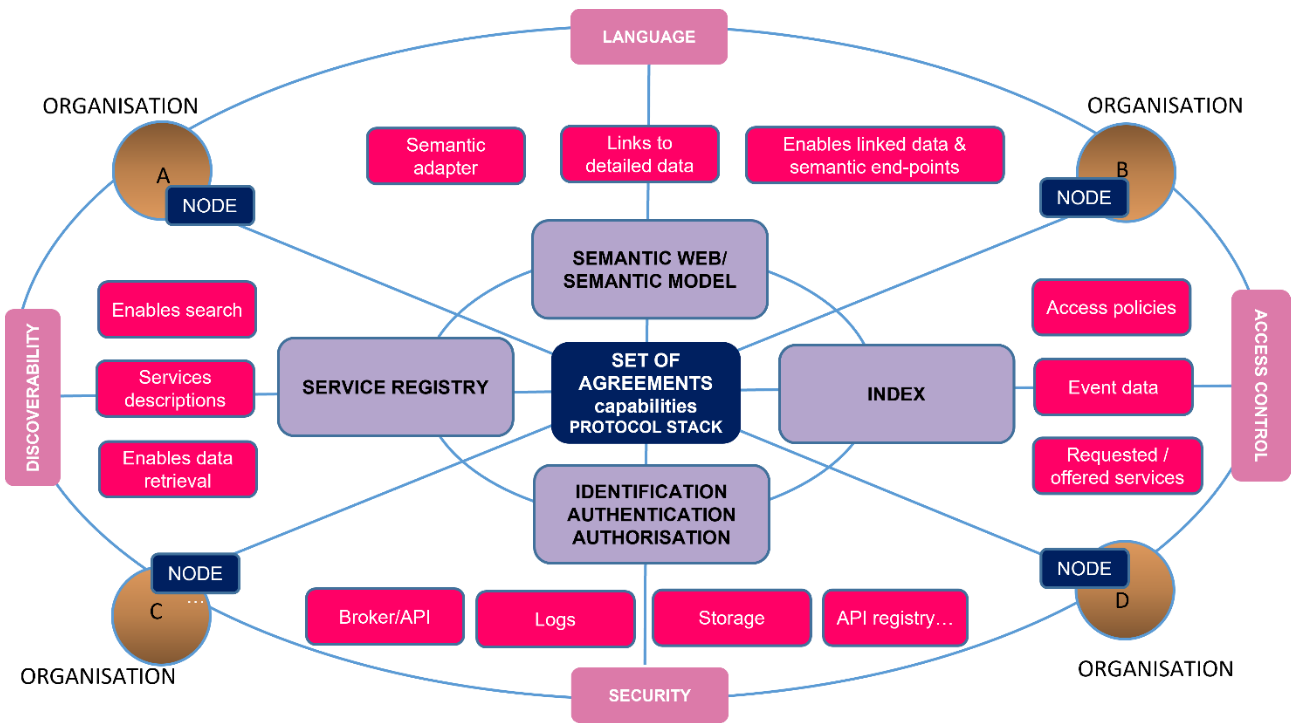


Figure 4. The LL assessment framework identifying to the functional requirements (light pink), technical specifications (purple/fuchsia colour) and the connecting nodes.

This framework assesses the LivingLabs from mid-2022 onwards. Much finetuning needs to take place, not in the least to enhance the comprehensibility of the framework to a multitude of users.

[13] An important Value-Added Service is that a node provides any third party the opportunity to optimization data as a service to users of the infrastructure and as a facility used by one of the users for its own optimization. See also FEDeRATED Platform services

2.3 *Interoperability via the Adoption and deployment phase*

Full stakeholder engagement towards achieving federated data sharing is not easy to do. It relates to the willingness and maturity of the various stakeholders to participate and to comply with the technical specifications. The adoption and deployment of the FEDeRATED technical specifications has 5 phases. They are briefly specified as follows:

1. **Language** – this phase is about applying the semantic model for interoperability (see: FEDeRATED semantic interoperability (federatedplatforms.eu). Each individual pair of stakeholders or a Living Lab may decide on the interactions, their proposed sequencing, their implementation, etc., but they all stem from the semantic model. Deployment can be by messaging, (REST) APIs with JSON(-LD) or XML data, and a semantic endpoint.
2. **Data at the source** – this phase is about specifying events and queries with the semantic model.
3. **Findability** – this phase is about implementing the data pull mechanism. Each participant implements an Index, shares events, and implements SPARQL queries. Indexes share RDF data and can locally interface with existing IT systems of a stakeholder via for instance (REST) APIs.
4. **Mode and or cargo specific**. This phase is a about the configuration of a node for a user group, community, or data space, supporting visibility from acceptance to final delivery of (a type of) cargo by one modality and/or at multimodal chain level. Road transport implementing eFTI and eCMR is an example of such a data space, configured for functionality like (road) visibility compliant with (eFTI) regulations. Another example would be a node specific to transport of (bulk) commodities via sea.
5. **Federation** – this phase is fully-fledged deployment of the business choreography for business services like transport, load and discharge, and storage. These are the Technology Independent Services. Each organization deploys its business services via the Service Registry and implements (relevant parts of the) semantic model and the business process choreography to support its business services. Thus, implementing plug and play.

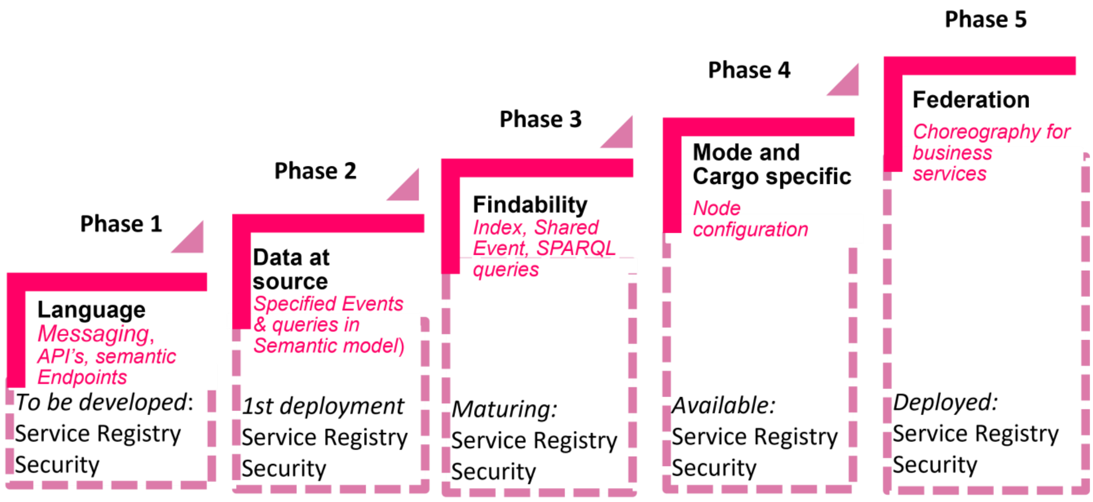
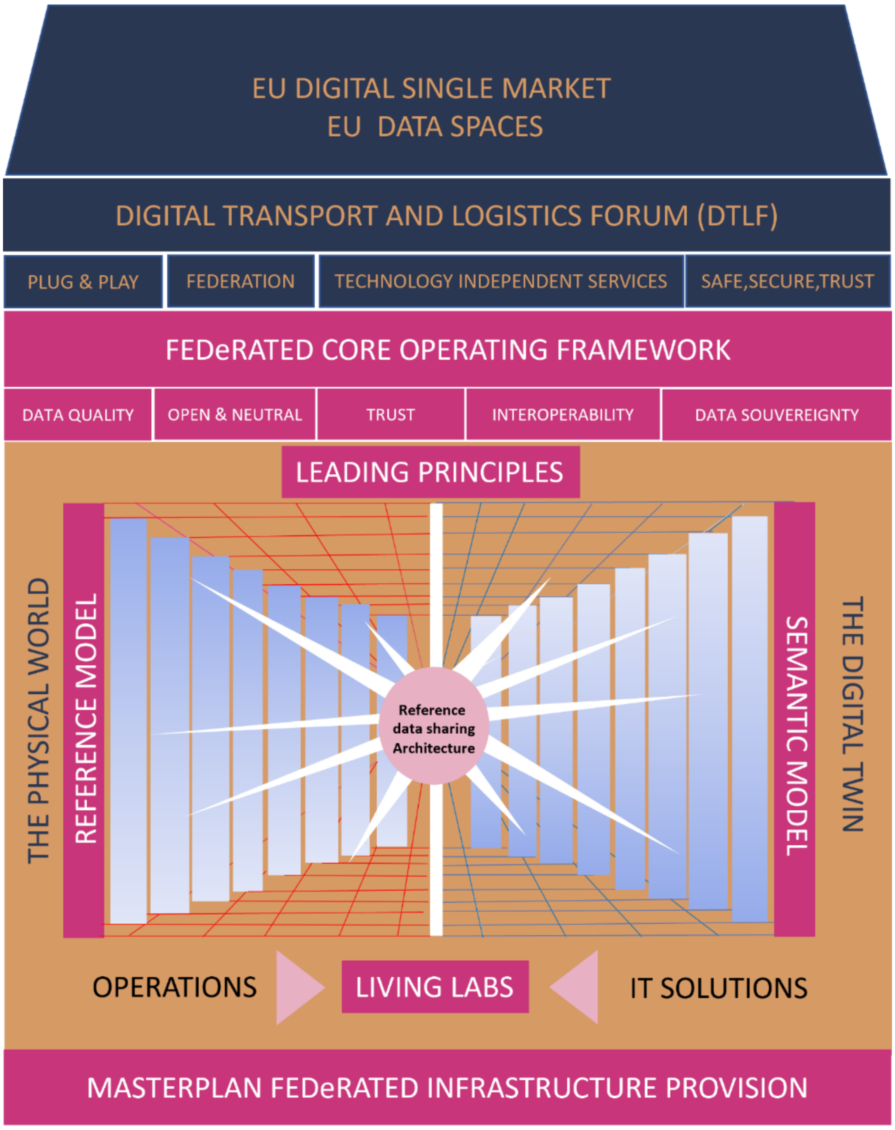


Figure 5. Adoption and deployment phases technical specifications

Figure 5 depicts the adoption and deployment phases, also illustrating the requirements for a Service Registry and Security increase, until they are completely deployed in the last phase. Moving up the adoption scale the functionalities of the Service Registry will increase. The same counts for the security requirements, encompass Identity and mechanisms for non-repudiation (log and audit trail).

The phases also indicate the development and execution of the LivingLabs. The phases are detailed in chapter 8 of the Reference Architecture document (Annex).

PART 2
THE PILOTS/LIVING LABS ASSESSMENT AGAINST:
1. THE INTERIM MASTERPLAN AND
2. THE CURRENT FUNCTIONALE REQUIREMEMNTYS AND TECHNICAL SPECIFICATIONS



3 THE LIVINGLABS

3.1 Background

The federated network of platforms concept should benefit:

- Smooth interaction between and among the different logistic chain operators and public administrations.
- Enterprises to optimise the use of supply chains.
- Dynamic planning to enable various ways of collaboration and optimize capacity utilization.
- Recognizing existing (partial) systems.
- Streamlining multimodal transport.
- Decreasing or removing costs derived from lack of interoperability.

The partners of the FEDeRATED Action have developed Living Labs (LLs). The LLs are designed to illustrate these above benefits and to comply with the FEDeRATED Interim Master Plan (especially the EU EIF, DTLF building Blocks, the FEDeRATED COF, the 37 Leading Principles, and the 16 technical components) and the Reference (data sharing) Architecture. These LivingLabs are developed based on

1. Specific use cases (business case).
2. Engagement of various participants (stakeholder engagement).
3. Inclusion various transport modes and CEF corridors.
4. Digital adaptability of the participants.
5. Availability data share mechanisms (engines).
6. Potential value added of the federated data sharing solution for the business case (preferably with tangible results).

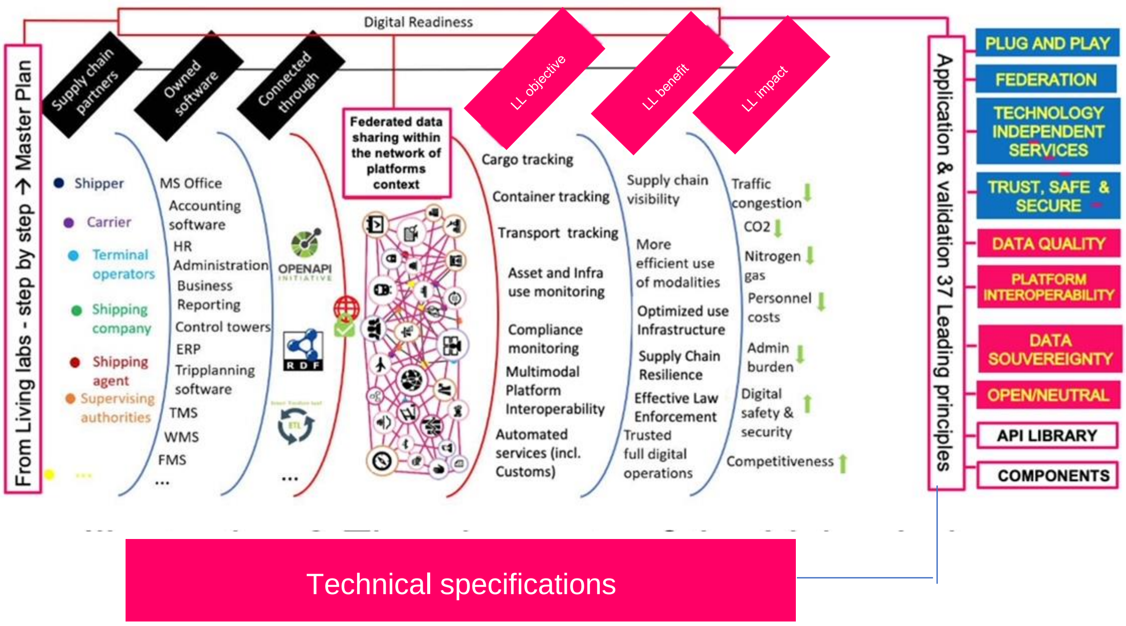


Figure 5. The LLs in relation to the Interim Master Plan and Technical Specifications

Figure 5 illustrates the core ingredients of the LLs:

- The actors;
- Their technology input – software being applied;
- Their software access to the grid;
- The LLs objectives;
- The LLs benefits;
- The LLs impacts.

All LLs relate to the FEDeRATED validation process being:

1. The DTLF building blocks and the FEDeRATED Core Operating Framework.
2. The application of the 37 Leading principles ((elaborated in the Interim Master Plan. chapter 4 in this report).
3. Technical components (elaborated in the Interim Master Plan, chapter 4 in this report).
4. The FEDeRATED technical specifications (chapter 1 in this report).

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3.2 Brief overview of the LLs

The objectives of the various LivingLabs (LL) relate to:

1. Cargo, container, and transport tracking;
2. Assess and infrastructure use monitoring;
3. Compliance monitoring;
4. Automated services;
5. Platform interoperability.

The benefits of the LL relate to:

1. Supply chain visibility (Situational awareness);
2. Increased Capacity and Asset Utilization [14];
3. Supply chain resilience;
4. Effective law enforcement;
5. Trusted and seamless data flow management.

The (anticipated) impact of the LLs relate to:

1. Less traffic congestion;
2. CO2 and/or NOx reduction;
3. Faster lead times;
4. Less administrative burdens;
5. More safety and improved emergency response.

In table 1 hereunder, the business cases and the emphases of the various LLs have been identified. Every LivingLab heading includes a link connecting to additional information – a LivingLab FACTsheet. These FACTsheets inform on a wide range of issues, i.e. objectives, business case, emphasis, actors, countries and corridors involved, transport modes, technical setting, challenges, organisational issues, planning, and connection to the DTLF architecture. The FACTsheets can be

[14] *Including More efficient use of modalities*

considered to be an update to the FEDeRATED Milestone 4 report Pilots/LivingLabs Scoping FEDeRATED (2020b, section 3.1).

#	Living Lab name	
1	CaaS Asia Gateway for perishables - Vediafi	
	BUSINESS CASE	The use of IoT devices (eSeals) for tracking vehicles, goods and CO_2 in multimodal cross-border logistics (incl. ETD/ETA capabilities) • Integration with IATA OneRecord capabilities
	MAIN EMPHASIS	Automated border crossing creating transparency and data sharing for customs stations and processes
2	CaaS Technology LL on North Sea - Baltic corridor - Vediafi	
	BUSINESS CASE	PoC IoT real time data devices for cargo tracking (incl. eSeal, ETD/ETA capabilities) and transport tracking (shipments) to optimise production scheduling and enable carbon footprint monitoring
	MAIN EMPHASIS	Visibility of transport data on driver, vehicle, load and location for Norwegian and Finnish Customs on EU Border
3	Scandinavia-Mediterranean corridor - Vediafi	
	BUSINESS CASE	IoT based cargo and transport tracking (incl. ETD/ETA capabilities) Seamless integration of consignor to freight forwarder and end customer enabled by digital applications used by involved parties - CO_2 emissions tracking and monitoring that generates a reliable benchmark of the service in terms of sustainability.
	MAIN EMPHASIS	Transparency and trackability (data, goods and CO_2) of logistics supply chains in customer home deliveries
4	Data sharing SME Last Mile Delivery -STA	
	BUSINESS CASE	Enhanced business and operational efficiency for subcontracted shippers in last-mile transport, also arising from the market entry of actors offering new technology and business opportunities.
	MAIN EMPHASIS	Extended data space for enhanced decision-making on what and when to move goods for subcontracted shippers in city logistics
5	RFID in Rail - STA	
	BUSINESS CASE	RFID and information management in a cross border railway transportation based on an administrative standard for data exchange
	MAIN EMPHASIS	Reduce administrative time/work in terminals, harbours, shunting yards etc. Track and trace railway vehicles all over Europe-
6	Rail-road Terminal CDM - STA	
	BUSINESS CASE	The use a digital data sharing platform for the import and export flows at two intermodal terminal Solåsen - located in the region of Jönköping - to

#	Living Lab name	
		increase efficiency and transparency amongst customers and operators of intermodal transports
	MAIN EMPHASIS	Information sharing along the intermodal transport chain for collaborative decision-making at inter-modal rail-road terminals
7	Real Time Port Visit Service - SMA	
	BUSINESS CASE	Exchange of shipping data, e.g. arrival and passing times of ships, to third parties enabling low-cost traffic management for other transport modes and in ports by accurate timestamps of the incoming ships for port planning purposes.
	MAIN EMPHASIS	Seamless data flow management through for system interconnectivity between various organisations. Technical applications, such as API, and protocols.
8	Multimodal Information Sharing III - SMA	
	BUSINESS CASE	To increase the performance of the supply-chain and minimise tied equity in export cargo, also by reducing the implementation costs for connecting parties to a digital infrastructure – ETA
	MAIN EMPHASIS	New means of sharing and retrieving vital logistics data for and from supply chain actors by providing track and tracing
9	Transparent Transport City Helsingborg - STA	
	BUSINESS CASE	Monitoring compliance in public procurement contracts. Enhanced safety, enhanced cost efficiency, and lowered emissions by reduction of the amount and frequency of deliveries
	MAIN EMPHASIS	Coordination of city transport enabled by digital collaboration and data sharing
10	Hermes Fleet Performance Monitoring System - Grimaldi	
	BUSINESS CASE	Capitalising on shared data for enhanced use of sea transport, by reducing administrative burden through digital technologies, enhancing planning horizons for involved transport operators, and provision of carbon footprint data.
	MAIN EMPHASIS	Digital data sharing throughout the supply chain enabling supply chain and ships visibility of own fleet also in connection to third party terminal interoperability
11	Internet of Logistics - IATA	
	BUSINESS CASE	Improving end-to-end supply chain process efficiency and maximise capacity utilisation by enhanced supply chain visibility and transparency, including application of OneRecord
	MAIN	Easy and transparent exchange of data in the digital ecosystem of air

#	Living Lab name	
	EMPHASIS	cargo stakeholders, including end-to-end participants from shipper to consignee.
12	Terminal Track and Trace System - Zailog	
	BUSINESS CASE	To improve the daily arrangement of the loading units in the buffer area, to reduce the empty running of trains, to decrease the CO_2 emissions as well as to enhance the overall terminal efficiency.
	MAIN EMPHASIS	To maximise the potential of an intermodal chain by optimising the resources available regarding the data related to loading units handled on the terminal yard and travelling on the railway network
13	BetterFlow - STA	
	BUSINESS CASE	Enhanced (integrated) performance in the shift of transport modes, enabled by enhanced planning capabilities. RFID reader on trains and ferries. Follow ETA. Cargo and transport tracking.
	MAIN EMPHASIS	Digital data sharing for predictions and progress of the movement of freight within and between transport hubs
14	Sustainable Inter-Modal Chains (SIMC) - STA	
	BUSINESS CASE	Establish foundations for calculating CO_2 emission along the supply chain, enhanced planning capabilities, and reduced administrative burden
	MAIN EMPHASIS	Integration of transport information across the end-to-end supply chain channelled to the control centre of the transport buyer
15	Optimized Port Operations - STA	
	BUSINESS CASE	Reduced cost per handled unit within the port. Transport, cargo tracking, Follow time of pilotage.
	MAIN EMPHASIS	Integrated operations with cargo owners and the sharing of data on planned and conducted operations
16	D4YOU - Codognotto	
	BUSINESS CASE	Optimizing asset management by obtaining a clear view of available capacity to manage shipments and intermodal shifts, also leading to other sustainability impacts
	MAIN EMPHASIS	Automated decision-making through data sharing based on an extended data lake approach. TMS adoption
17	EU Gate CMR/eFTI/OneAPP - 51Biz	
	BUSINESS CASE	Reduced administrative burden for commercial, transport and compliance reporting to control authorities as well as to transport and

#	Living Lab name	
		logistics service providers
	MAIN EMPHASIS	Digital integration of internal and external data following shipments and transport.
18	smarTSGate - Terminal San Giorgio	
	BUSINESS CASE	Optimised access to the terminal and enhanced interoperability among interconnected systems, aiming to achieve a global and accessible supply chain visibility as well as creating new business opportunities for logistic operators and technology providers
	MAIN EMPHASIS	Seamless interoperability and supply chain visibility through trailer tracking data exchange and trailer pickup booking)
19	DEFlog - NL Ministry of Infrastructure and Watermanagement	
	BUSINESS CASE	Integrated use of actual and reliable mobility data in TMS and FMS of LSP's, leading to more efficient and effective road transport operations - Faster traffic management by automated use of actual and reliable load data, leading to faster clearance of the roads and less costs due to delays.
	MAIN EMPHASIS	Independent public-private data sharing platform for public data (municipal time windows, environmental zones, roadworks, roadblocks, diversions, ...) and logistics data
20	eGovernment Logistics - NL Ministry of Infrastructure and Watermanagement	
	BUSINESS CASE	Optimise law enforcement operations and supply chain resilience of the supply chain through overall and transparent supply chain visibility - Develop data sharing perspective within the concept of paperless transport, i.e., eFTI regulation
	MAIN EMPHASIS	To develop and establish the genuine federated data sharing infrastructure provision providing a toolbox and governance for authorised users
21	SIMPLE - Puertos del Estado/ADIF/MITMA	
	BUSINESS CASE	Optimise the multimodal logistics chain by unifying the communication channel between the different modes and nodes of the transport chain - B2B & A2B services enable the exchange of documents and the flow of data and information in the multimodal freight transport - digitalisation of the administrative and legal proceedings.
	MAIN EMPHASIS	An integrated and collaborative space for the exchange of data between the different nodes and modes of the transport chain. Authorities can access this data, and it might act as the eFTI focal point.

#	Living Lab name	
22	Automated capture and sharing of environmental data in collaboration B.E.A.standard -ELSA - STA	
	BUSINESS CASE	Uniform – cost effective - standardised purchasing requirement for climate data reporting, comprising of Automated reporting of environmental data. Standardisation of data for emission monitoring, thus should lead to cost-efficient digitalisation of the industry with short lead-time while establishing a sustainability reporting mechanism
	MAIN EMPHASIS	To establish a common future path for the applicable semantics and data exchange mechanism regarding environmental data for construction and maintenance works for road and rail infrastructure.
23	Real Time Multimodal Transportation Visibility Platforms - Ahola/Attracs	
	BUSINESS CASE	Resolving the inefficiencies of the logistics chain and improving the execution of operations by developing a safe, trustful platform for data sharing among the participants of the chain - Fostering the cooperation between the parties for greener logistics Data visualisation in multimodal context environment and emissions reporting
	MAIN EMPHASIS	Data sharing among the participants of the logistics chain in a multimodal context including visibility of data and emissions reporting functionality

Table 1 The LLs in short

The FEDeRATED LivingLabs cover all transport modes, relate to private participants - shippers, transporters, forwarders, and terminal operators – as well as public administrations and cover the EU CEF corridors. More information is also available in Milestone 8, Annex, pages 44-49.

4 ASSESSING THE LIVINGLABS AGAINST THE INTERIM MASTER PLAN

Originally, the LivingLabs were designed to comply with the FEDeRATED Interim Master Plan, including compliance with 37 Leading Principles and 16 technical components. In 2021 and beginning 2022, the LLs were assessed against the Interim Master Plan, more specifically:

1. 37 Leading Principles (elaborated in 4.1)
2. 16 Technical components (4.2)

4.1 *The applicable leading principles*

The Leading Principles refer to the implementation of the DTLF Building blocks and the FEDeRATED Core Operational Framework (COF). The leading principles are:

No	Leading Principle	Description
1	Level Playing Field	Ability for all stakeholders to participate.
2	Electronic format	The information is to be encoded digitally, using a revisable structured format
3	Compliance rules	Data sharing compliant to existing legislation and privately agreed rules.
4	Business service	Each participant formulates prided and required business service(s)
5	Business relations	Trust between enterprises is primarily driven by their real work relationships.
6	Supply/logistics chains	Business relations according to their outsourcing hierarchy
7	Data requirements enterprises	Business services and commercial mechanisms specify the data to be shared.
8	Data requirements authority	Data requirements are related to legislative basis afforded to that authority
9	Data processing	Any organization can specify its internal processing.
10	Fit for purpose	Public authorities that access enterprise data require a legal basis
11	Publication data requirements	Public authorities publish their data requirements in machine-readable form
12	Business Service Discovery	Business services are discoverable through harmonized search criteria
13	Data as proof	Organisations must be able to proof compliance or non-compliance with data.
14	Authorities providing data	Public authorities can share their data with enterprises within legal framework
15	Push/pull mechanism	B2A: Shared Push data duplicated. Shared Pull data can be made accessible
16	Publish/subscribe	Relevant new data made available when fit for purpose or commercial relation
17	Combining data requirements	Public authority responsible for 2 or more legal acts combine all data in 1 data set
18	Identification of organizations	Each organization is able to identify itself uniquely according to agreed attestations with transparent validation processes of these attestations
19	Identification of users	Persons acting on behalf of participating organization can identify themselves as such

No	Leading Principle	Description
20	User capabilities	3rd party transparency of capabilities or on performance of any identified user
21	Data sensitivity	Non accessibility or non-data change ability unauthorized users or 3rd party
22	Metadata data sharing	Specifying unauthorized 3rd party meta data availability.
23	Identification of systems	Uniquely identifiable IT systems support roles of the data provider & -receiver
24	Data sharing policy	Policy or agreement specifies use/reuse of data & how it is stored or removed
25	Data sovereignty	Data owner determines the data to share; retains full data rights and controls
26	Data at source	Single sharing of links, multiple (controlled) access to data
27	Data sets	The data sets identifying links can be shared according to reference architecture
28	Baseline standards	Used to providing common terminology, data formats, code values, etc.
29	Data timestamps	Event for sharing milestones has own timestamp
30	Unique identifier datasets	Used to create and share links of relevant data sets between any 2 companies
31	Data sharing solution	Organizations select a solution of their choice for data sharing with others
32	Federation	Organizations are able to share or access data with others
33	Data validation	Data validated by a data provider or -receiver against sharing specifications
34	Data Exchange integrity	Accuracy and consistency of data over its entire lifecycle is required
35	Historical data	Historical data sets are stored based on legal requirements (e.g. archiving)
36	Logging and audit trail	Organizations store (shared) immutable log and audit trail of the data shared
37	Monitoring	Full traceability to check with whom at what time particular data was accessed/shared

Table 2 The Leading Principles overview

The LivingLabs have been requested to implement the leading Principles since 2020. In 2021 the implementation and adaptability of these principles within the LLs was monitored. In the template hereunder an overview is presented to indicate the applicability of the Leading Principles per LivingLab, based on the individual LivingLab reporting in 2021.

Leading Principle	Living Lab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
1	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	22
2	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	22
3	Y	Y	Y	N	Y	M	Y	N	Y	Y	Y	Y	M	M	M	Y	Y	Y	Y	Y	Y	Y	Y	17
4	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	20
5	M	Y	Y	N	Y	N	Y	M	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	18
6	Y	Y	Y	M	Y	N	N	M	Y	Y	Y	Y	M	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	17

Leading Principle	Living Lab																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
7	Y	M	Y	N	Y	N	Y	N	M	Y	Y	M	M	M	M	Y	M	Y	Y	Y	Y	Y	Y	13
8	Y	Y	Y	N	Y	N	Y	N	Y	N	Y	N	Y	M	M	Y	Y	N	Y	Y	Y	Y	Y	15
9	Y	Y	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	20
10	Y	Y	Y	N	Y	N	N	N	Y	N	Y	N	M	M	M	Y	Y	N	Y	Y	Y	N	Y	12
11	M	M	M	N	Y	N	Y	N	N	N	Y	N	N	N	N	Y	Y	N	N	Y	Y	N	Y	8
12	M	M	M	M	Y	N	Y	N	N	N	Y	N	M	M	M	Y	N	M	N	Y	Y	N	Y	7
13	Y	Y	Y	N	Y	N	Y	N	N	Y	Y	Y	M	M	M	Y	Y	N	N	Y	Y	Y	Y	14
14	M	M	Y	N	Y	N	Y	N	Y	N	Y	N	M	N	N	N	Y	N	Y	Y	Y	Y	Y	11
15	Y	Y	Y	N	Y	N	N	Y	N	N	Y	N	M	M	M	Y	M	N	Y	Y	Y	N	Y	11
16	M	Y	Y	M	Y	N	Y	Y	N	Y	Y	N	M	M	M	Y	M	Y	Y	Y	Y	N	Y	13
17	M	M	Y	N	Y	N	N	N	N	N	Y	N	M	M	M	N	N	N	Y	Y	Y	M	Y	7
18	Y	Y	Y	N	Y	N	Y	Y	M	N	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	17
19	Y	Y	Y	Y	Y	M	Y	Y	M	Y	Y	M	Y	Y	Y	Y	M	N	Y	Y	Y	N	Y	17
20	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	M	N	N	Y	Y	N	Y	18
21	Y	Y	Y	Y	Y	N	N	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	18
22	Y	Y	Y	Y	Y	N	Y	Y	M	Y	Y	N	M	M	M	Y	M	N	N	Y	Y	N	Y	13
23	M	Y	Y	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	18
24	Y	Y	Y	M	Y	Y	Y	N	Y	Y	Y	Y	M	M	M	Y	M	N	Y	Y	Y	N	Y	15
25	Y	Y	Y	M	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	20
26	M	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	20
27	M	Y	Y	N	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	M	Y	N	Y	Y	N	Y	16
28	Y	Y	M	M	Y	Y	Y	Y	Y	Y	Y	Y	M	M	Y	Y	M	Y	Y	Y	Y	Y	Y	18
29	Y	Y	Y	N	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	19
30	Y	Y	Y	N	Y	N	Y	Y	N	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	17
31	Y	Y	Y	M	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	20
32	Y	Y	Y	N	Y	M	Y	Y	Y	Y	Y	Y	M	M	M	Y	Y	Y	Y	Y	Y	N	Y	17
33	Y	Y	Y	Y	Y	N	Y	M	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	19
34	M	M	Y	N	Y	N	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	16
35	Y	Y	Y	Y	Y	N	Y	N	N	Y	Y	Y	M	M	Y	Y	N	Y	N	Y	Y	N	Y	15
36	Y	Y	Y	N	Y	N	Y	N	N	Y	Y	M	M	M	M	Y	M	M	N	Y	Y	N	Y	11
37	Y	Y	Y	Y	Y	N	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	19
TOT	27	31	34	11	37	6	25	22	19	28	37	21	21	20	22	34	23	24	25	37	37	11	37	

Table 3 The Leading Principles per LL

The Table 3 overview related to the state of play of the LivingLabs (LLs) identifies:

- 10 LLs apply more than 75% of the Leading Principles (LPs);
- The majority of the LLs need to invest more time and research comprehending most LPs. Based on this assessment additional interaction with these LLs in order to upgrade their level of LP application was organized. The assessment indicated:
    - 9 LLs score between 60-75% of all Leading Principles, LL #7, #8, #12, #13, #14, #15, #17, #18, and #19.
    - 4 LLs score below 50% of all Leading Principles, LLs #3, #6, #9, #22

The Table 3 overview related to the applicability of the Leading Principles (LPs) in the LLs identify:

- 21 LPs are applied in more than 75% of the LLs i.e., LPs #1, #2, #3, #4, #5, #6, #9, #18, #19, #20, #21, #23, #25, #26, #28, #29, #30, #31, #32, #33, and #37
- Some LPs need more elaboration or are not directly suited for some LLs (can also be because some LPs are rather advanced in their perspective e.g., deal with data sharing practices for Public Authorities and data at source, which is not fully realistic to expect parties to deliver on). Some LPs are not applicable to some LLs by design, and not for technical weakness; e.g. LP #8, #10, #11, #13, #14, #15 and #17 relate to interoperability with Public Authorities, which is not applicable to LLs that operate in a pure B2B environment.
    - 9 LPs score between 50-75%
    - 7 LPs - #10, #11, #12, #14, #15, #17, and #36 - appear to be the most difficult LPs to apply.

Based on the outcome of this questionnaire it was decided to give some special attention to:

- Dedicated workshops on semantic interoperability for all LLs;
- Additional assistance to LLs #3, #6, #9 and #22 – especially for semantics;
- Identify the long-term applicability of LPs #7, #10, #11, #12, #15, #16, and #17 for the LLs. It appeared that these LPs are rather difficult to apply in the early stages of a LL as they relate to:
    - specific data requirements set by LL parties – this depends on the stage of the LL;
    - Ability for public authorities to share data – often unknown;
    - Discovery mechanisms – in the first stage of a LL this is unexplored territory;
    - Data as proof – requiring organisation to work paperless;
    - Push/pull-publish and subscribe – rather advanced requirement for most;
    - One data set public authorities-most public authorities have insufficient digital readiness to do this;
    - Log and audit trail – starts to be relevant in the advanced stage of a LL.

4.2 The applied technical components

The Interim Master Plan identified various the technical components (Milestone 2, paragraph 6/1) for developing a federated network of platforms approach. In 2021, LL's have indicated whether they apply these components. Hereunder the overview:

Technical components	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
1 Access point	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	M	M	Y	Y	Y	N	Y	Y	Y	Y	18
2 Certification authority	Y	Y	Y	N	Y	N	Y	N	N	N	Y	N	N	N	N	Y	Y	Y	N	N	Y	Y	Y	12
3 Chain modelling toolset	M	N	N	Y	Y	N	N	N	N	N	Y	N	N	M	M	Y	Y	N	N	N	N	Y	N	6
4 Component	Y	Y	Y	N	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	16
5 Configuration toolset	M	Y	Y	N	Y	N	N	N	M	Y	Y	Y	N	N	M	Y	Y	N	N	Y	N	N	M	9
6 Connector	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	17
7 Endpoint	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	19
8 End-user	Y	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	21
9 Federated platform	Y	Y	Y	Y	N	Y	Y	Y	M	N	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	N	18
10 Identity Provider	Y	Y	Y	N	Y	Y	Y	Y	N	N	Y	N	N	N	N	Y	Y	M	Y	Y	Y	N	N	13
11 Maintenance toolset	N	Y	Y	N	Y	N	N	N	M	N	Y	M	N	N	N	Y	Y	N	N	Y	Y	N	Y	9
12 Modelling toolset	N	N	N	Y	M	N	N	N	M	N	Y	N	N	N	N	Y	Y	N	N	Y	Y	Y	N	7
13 Platform	Y	Y	Y	N	N	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	N	Y	18
14 Platform Services component	Y	Y	Y	N	N	Y	N	Y	M	N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	16
15 Registry component	Y	N	N	N	N	N	N	N	M	N	Y	Y	N	N	N	Y	Y	M	Y	Y	Y	N	Y	9
16 Storage component	M	Y	Y	Y	M	Y	Y	Y	M	N	N	M	Y	Y	Y	Y	N	N	N	Y	Y	Y	N	13
TOTAL	11	13	13	4	9	10	9	10	6	2	15	8	9	8	8	16	13	9	7	12	13	7	9	

Table 4 The Technical components per LL

The Table 4 overview related to the state of play of the LivingLabs (LLs) identifies:

- 7 LLs apply more than 75% of all the Technical Components (TCs);
- Some LLs need more attention and better interaction to identify whether it is feasible to apply what technical components:
    - 12 LLs score between 50-75% of all Technical Components, LL #1, #5, #6, #7, #8, #12, #13, #14, #15, #18, #19, #20, and LL#23
    - 4 LLs score below 50% of all Technical Components, LLs #4, #9, #10, and #22

The Table 4 overview related to the applicability of the Technical Components in the LLs report:

- 7 TCs are applied in more than 75% of the LLs i.e., TCs #1, 4, 6, 7, 8, 9, 13
- Some TCs need more elaboration or are not directly suited for some LivingLabs (can also be because some CP s are rather advanced in their perspective, e.g. deal with data sharing practices for Public Authorities and data at source, which is not fully realistic to expect parties to deliver on).
    - 6 TCs score between 50-75%
    - 3 TCs (modelling) score below 50%

4.3 Results Assessment – Lessons learnt LLs compliance with Interim Master Plan

Many LLs find it difficult to identify their data requirements and set a data sharing engine including a federated provision in place. Generally, most LLs first focussed on getting into action by applying the technology they have available. A second step would be to start accommodating towards all Leading Principles. For over 50% of the LLs this was not fully matured in the beginning of 2022. Especially the LivingLabs 4 – 9, 10, 12 – 15, 17 and 22 found it difficult to develop or set in place data sharing mechanisms applying the FEDeRATED LPs.

Based on this first assessment it was felt necessary within the FEDeRATED project to wrap the LPs and TCs together and incorporate them in a Reference Architecture. Thus, enabling IT people to really get started and provide them the opportunity to interact with one another and build together a cohesive architecture. The prospect is that a Reference Architecture:

- Would enable the LLs more guidance and possibly limit the number of LLs by refocussing them from being on different business cases towards technological capabilities.
- Makes onboarding easier.
- Allows the concept of nodes to further evolve.

5 ASSESSING THE LLs AGAINST THE REFERENCE ARCHITECTURE

In addition to the assessment of the LL against the Interim Master Plan, mid-2022 the LivingLabs were validated against the Reference Architecture, more specifically:

1. The functional requirements.
2. The use of the semantic model.
3. Functionalities related to the technical specification.
4. The implementation mode.

5.1 The functional requirements

All Living Labs have indicated whether their data sharing implementation solutions shall comply with the functional requirements. The results are illustrated hereunder:

Functional Requirements	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Language	y	Y	Y			Y	Y		X	Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y		17
Discoverability	Y	Y	Y	Y	Y	Y		y						Y	Y		Y			Y	Y			11
Security	Y	Y	Y		Y	Y	Y			Y	Y	Y	Y	Y	Y		Y [15]	Y	Y	Y	Y	Y		16
Access	Y	Y	Y	Y		Y	Y	y	Y	Y			Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	19

Table 5 The Functional requirements per LL

In addition, the LLs were requested to fill in questions relating semantics, and the concept to be implemented. Hereunder in brief the results.

5.1.1 **The use of the semantic model**

For FEDeRATED, harmonized data interoperability is core business. Therefore, the LLs were asked what use is made of a common, FEDeRATED semantic model and how would you like to use it? These questions relate to the:

- Mapping of data flows to transaction patterns. Each set of two communicating stakeholders should map their interactions to the pattern containing the following elements with their interaction types:
    - Publish, search, and find logistics services and/or spare capacity
        - Publish – service provider provides its services, capacity, timetables, etc.
        - Search – a potential customer formulates its goal that can be met by services
    - Booking resulting in a (framework) contract

[15] LL17 is implementing iSHARE as security architecture and introduced a B2A discoverability component as part of the eFTI exchange environment

        - Booking or request for offer – a customer request capacity (and its costs) for performing a business service
        - Quotation or offer – the offer and prices/conditions for providing the particular service meeting the requirements
        - Contract – the confirmation of a customer to a quotation. An order can also serve as confirmation of a quotation.
    - Ordering and planning
        - Order – the expectation of a customer for providing the business service, according to agreements of the previous phase.
        - Plan – additional refinement of customers expectation
    - Visibility – these are all visibility events of a service provider to its customer(s) and potential an authority(-ies) with two basic functions
        - Reporting event for completion of an action
        - Update events of a plan, e.g. ETA event
- Mapping of data objects to the semantic model.
- Interactions and their structure:
    - Are the interactions identified in the data flows developed by the case?
    - Is an existing data carrier applied and an implementation guide of that data carrier constructed?
    - What syntax is used for sharing data (e.g. XML, JSON, RDF, or other)

Use of semantic model (SM)	**LivingLab**																							
	1	2	3	4	5	X	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Mapping of data flows	IATA One Record			X	SE LL Semantic models					X	X 16	X 17	SE LL Semantic models			X	X	X	X	X	X		X	
Publish/Search	-	-	-	X	-	-	-	-	-	TBD	-	X	-	-	-	-	X	-	X	X	X		X	
Booking	X	X	X	X	X	X	X	X	X	X	23	X	X	X	X	-		-			X		X	
Ordering& Planning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		-	X		X		X	
Visibility	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	
Mapping data objects to SM	X	X	X	X	SE LL Semantic models					N	X	X	SE LL Semantic models			X	X 18	X	N	X	X		X	
Interactions & their structure	X	X	X	X	Deplide					TBD	X	X	Deplide			X		TBD	X	X	X		X	
Through case	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X		X	
Data carrier	X	X	X	X	X	X	X	X	X	REST API JSON	X		X	X	X		REST, CEF AS/4			X	X		X	

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[16] OneRecord

[17] Own SM T&Tmode

[18] Events

Use of semantic model (SM)	LivingLab																							
	1	2	3	4	5	X	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Implementation Guide	X	X	X	X	X	X	X	X	X	REST API JSON	X		X	X	X		X			X	X		X	
Syntax	REST, JSON, JSON-LD			X	REST APIs with JSON – can be others					JSON	JSON LD TTL	REST API JSON	REST APIs with JSON			REST API JSON	Rest XML JSON-LD TTL	Rest apis JSON	OTM	RDF	JSON SPARQL		REST, JSON, JSON-LD	

Table 6 The use of the Semantic Model per LL

5.2 Functionalities related to the technical requirements implemented into the LLs

The following questions were asked in order to identify how the LL have implemented various functionalities related to the technical requirements set by the Reference Architecture:

- Identification and authentication – how is it implemented, are there multiple identity providers, is there one or are there multiple identity brokers, etc. Is there a specific standard selected like OAUTH2.0?
- Service Registry – is there a (distributed) service registry (synonym: data broker and/or data holder) identified where stakeholders can define the functionality they support?
- Visibility/index – what is stored in the index? Who are the users of the index? Does the index contain URIs to additional data? How does the index work with a data broker /holder (if identified)?
- Access policies – is each enterprise able to formulate its access policy? What is the basis for this access policy, their internal model or a common (FEDeRATED) semantic model? Are authorities able to formulate their access policies? How easy is it for enterprises to implement these access policies?
- Data transformation (e.g. semantic adapter) – is data transformation foreseen, what data carriers should it support, and is there an internal structure (i.e. semantic model) for data transformation?
- Data storage – is there, besides the index, any data stored by some other component or is the alternative solution developed where data can be stored by each participant?

The answers have been transferred into table 7, hereunder.

Technical setting	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Identification & authentication	Y	Y	Y	N	M	M	M	M	M	Y	Y	Y	M	M	M	Y	Y	Y	Y	Y	Y	M	Y	13
Multiple ID provider/user	OneRecord Auth model			-	Deplide TBD					Basic http AUTH	-	n	Deplide TBD				Y 19[19]	-	Y 20[20]	-	-		-	
Multiple ID brokers											X	--				LDAP Act Dir Std	X509 serversX.	Basic http AUTH	JWT	Y	Keycloak		Y	

[19] iSHARE

[20] iSHARE

Technical setting	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Selected standard											OAUTH2.0	OAUTH2.0					OAUTH2.0		OAUTH2.0	OAUTH2 more	OAUTH2 more		Y	
Service Registry	Y	Y	Y	N	M	M	M	M	M	N	Y	N	M	M	M	Y	Y	N	Y	Y	Y	M	Y	10
Data broker/broker	OneRecord node			-	Deplide nothing planned					--		- NA	Deplide TBD			X	X	NA	Data.deflog.nl	planned			Y	
Visibility/index	Y	Y	Y	N	M	M	M	M	M	N	Y	N	M	M	M	Y	Y	Y	Y	Y	Y	M	Y	11
Stored in Index	URI per shipment			-	Deplide based on FEDeRATED design					-	-	NA	Deplide based on FEDeRATED design			-	-	-	Data.deflog.nl	X	-		-	
Functioning Index with data broker/holder	-			-	-					-	X	TBD	-			X	X	-		X	X		X	
Access policies	Y	Y	Y	N	N	N	N	N	N	N	Y	N	N	N	N	Y	Y	N	Y	Y	Y	M	Y	10
Free to decide for every participating organisation											-												Y	
What semantic model	One Record: data access through shared link			-	-	-	-	-	-	Need to develop SM	OneRecord		-	-	-	INTERNAL	UNECEFACT+1R+WCO	-	OTM	FEDeRATED	FEDeRATED		GraphUL	
Easy to implement											Y					Y	Y[21]		Y	Y	Y		Y	
Data transformation e.g. semantic adapter	N	N	N	N	N	N	N	N	N	M	M	N	N	N	N	Y	Y	M	Y	Y	Y	M	Y	5
Data carriers should support	Not necessary			NA	NA	NA	NA	NA	NA	-	-	-	NA	NA	NA	Y	Y		Y	Y	Y		-	
Structure available										-	-	-				Synapse	SSI Docker		OTM	JSON toRDF	Y		Y	
Data storage	N	N	N	N	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	17
Inside index	Not necessary			-	Deplide tbd					-	-	-	Deplide tbd			-	-	-	-	At source	-		-	
Data stored by other component than index										Y[22]	Y	Codognotto				Integration layer	Y	Need to develop SM	Portbase	RDF SPARQL	nodes		X GraphQL	

Table 7 The technical context of the LLs

[21] iSHARE

[22] Need to develop Semantic Model

The Table 7 overview indicates that:

- The majority of the LLs have established a data storage facility, either separate or within their Index
- For most LLs a Service Registry and Visibility/Index are still under consideration
- An Access policy has been developed by all LLs that have an open character to a wide range of different stakeholders
- A semantic adapter will be used the minority of the LLs. LLs that apply the OneRecord standard do not seem to need a semantic adapter. It is not sure how Deplide will solve this semantic interoperability issue. In table 9 it shows Deplide will use an adapter.
- LLs 4 and 22 still have to identify what they what to do in terms of concept

5.3 Types of implementations

Regarding the implementation mode the LL were asked to indicate the following:

- Platform – providing functionality for more than one stakeholder – possibly also connecting various platforms:
  - Single solution
  - Multiple federated platforms
  - Commercial provider
  - New platforms
  - Interconnected nodes used same technology
  - Data transformation
- Adapter – this refers to the technical solutions enabling individual nodes to function i.e.,
  - Adapter without data storage
  - Adapter with (local) data storage
  - Adapter with data transformation
  - Functionality implemented by each stakeholder
- Data broker/holder. This refers to the data sharing pattern of the participants within the LL network i.e.:
  - A single broker/holder
  - multiple brokers/holders operated by third parties
  - multiple brokers/holders implemented by adapters in the network
- Identity and authentication
  - Identity provider platform
  - Independent 3rd party identity providers
  - One's own identity provider
  - One Identity provider
  - Support eIDAS Identity provider
- Lay-out of the network
  - Star network – there is a single node in the network to which all others have to connect. A platform can act as a node
  - Meshed Network – all nodes are interconnected. Each stakeholder has its own implementation
  - Combination of a star and meshed network. Two or more nodes in the network

interconnect and meshed. All other nodes interconnect

The input provided by the LLs is provided the following table.

Implementation type	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Platform																								
Single solution		-	-	Y	Deplide					Y	Y	Y	Deplide			-	Y	Y	-	-	-	-	Y	15
Multiple federated platforms	-	-	-	-	Deplide					-	Y	-	Deplide			Y	-	-	-	Y	Y	-	-	12
Commercial provider	Y	Y	Y	Y	-	-	-	-	-	--	Y	-	-	-	-	-	-	-	-	-	-	-	-	5
New platforms	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	-	-	Y	-	Y	-	-	3
Interconnected nodes used same technology	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	-	--	-	Y	Y	Y	-	Y	5
Data transformation	-	-	-	Y	-	-	-	-	-	-	Y	-	-	-	-	Y	Y	-	-	Y	-	-	Y	5
Adapter																								
without data storage	CaaS			-	-	-	-	-	-	M	-	Y	Y	-	-	Y	Y	M	Y	Y (temporary)	Y	--	-	9
with (local) data storage	-	-	-	-	-	-	-	-	-	M	-	-	-	-	-	-	Y	M	Y	Y	-	---	Y	5
with data transformation	-	-	-	--	Deplide					M	Y	-	Deplide			-	Y	M	-	Y	Y	--	-	12
functionality implemented by each stakeholder	-	-	-	-	-	-	-	-	-	M		M	-	-	-	-	-	-	-	Y (planned)	-	--	-	1
Data broker/holder																								
A single broker/holder	-	-	-	Y	Deplide					Y	Y	Y	Deplide			Y	Y	Y	Y	-	-	-	-	16
multiple brokers/holders operated by third parties	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	-	4
multiple brokers/ holders implemented by adapters in the network	-	-	-	Y	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	Y (planned)	Y	-	Y	5
Identity & authentication																								
Identity provider platform	Y	Y	Y	-	Deplide tbd					Y	-	--	Deplide tbd			Y	-	Y	Y	-	Y	-	Y	9
Independent 3rd party identity providers	-	-	-	-						-	-	-				-	Y	-	Y	-	-	-	Y	3
One's own identity provider	-	-	-	-						-	Y	-				-	-	-	-	Y	-	-	-	2
One Identity provider	-	-	-	-						-	-	Y				-	-	-	-	Y	-	-	-	2

Implementation type	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Support eIDAS Identity provider	-	-	-	-						-	-	-				-	Y	-	-	-	Y	-	-	2
Lay out network																								
Star	-	-	-	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	-	Y	-	-	-	-	-	14
Meshed	Y	Y	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	Y	-	-		5
Combined	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Y	-	-	-	Y	-	Y	3

Table 8 The technical implementation LLs

DTLF, Subgroup II, foresees 4 different types of implementation:

A. Peer-to-peer (p2p) data sharing – different organizations use their own internal solutions to share data with each other. They implement identified interfaces and components of the architecture themselves.
B. Single platform – each organization interfaces with a single platform, where the platform implements (a subset of) the Technology Independent Services.
C. Multiple platforms – each organization connects to a platform of choice and is able to share data (via another platform) with another organization.
D. A combination of peer-to-peer (p2p) and a platform – one organization uses a platform and an own data sharing solution. They have to interface with one or more platforms and other p2p solutions of organizations.

All Living Labs (LLs) have indicated their preferred implementation variant, whereby a variation can be identified. The results are illustrated hereunder

Implementation mode	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
A Peer-to-Peer	Y	-	-	-	-	-	-	-	-	-	Y	-	Y	-	-	Y	-	Y	-	-	-	Y	-	6
B Single Platform	Y	Y	-	-	-	Y	Y	Y	Y	-	Y	Y	Y	Y	Y	Y	-	-	Y	-	Y	-	Y	15
C Multiple platforms	-	-	-	-	Y	Y	-	-	-	Y	Y	-	Y	Y	Y	-	-	Y	-	-	-	-	-	8
D P2P and a Platform	-	-	Y	Y	Y	-	-	-	-	-	Y	-	-	-	-	-	Y	-	-	Y	-	-	Y	7

Table 9 The implementation mode

5.4 Technology assessment LLs

Based on the tables above a summarizing table has been developed. The list identifies the technical specifications that are be covered and require more development before they can be fully deployed by the LLs.

Technical Specifications	LivingLab																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	TOT
Semantic Model	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	22
Semantic adapter	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	N	Y	M	M	Y	18
Data broker	N	N	N	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N	N	N	M	Y	14
IAA	Y	Y	Y	M	M	M	M	M	M	N	Y	M	M	M	M	Y	Y	N	Y	Y	Y	M	Y	10
Index	Y	Y	Y	M	M	M	M	M	M	N	Y	N	M	M	M	Y	Y	N	Y	Y	Y	M	Y	10
Data storage	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	Y	Y	M	Y	20
Service Registry	Y	Y	Y	M	M	M	M	M	M	N	Y	N	M	M	M	Y	Y	N	Y	Y	Y	M	Y	10
Access policy	N	N	N	M	N	N	N	N	N	Y	Y	N	N	N	N	N	Y	Y	Y	N	N	M	Y	6
Platform Interoperability	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	Y	M	Y	Y	Y	Y	Y	Y	N	Y	Y	M	Y	19
TOTAL YES	7	7	7	1	5	5	5	5	5	5	9	3	5	5	5	8	9	6	7	8	7	0	9	

Table 10. Overview applicable technical specifications by LLs

Table 10 relates to the state of play of the LLs identifying:

- More than 75% of all LLs will try to apply the FEDeRATED semantic model, develop a semantic adapter, realize data storage (possibly through an index), will use a data broker, and endeavour platform interoperability.
- Around 60% of the LLs will further investigate on how to develop an appropriate IAA, Service Registry, and Index, whereby the technology to apply data at source still requires further study.
- For only 25% of all LLs access policies is an important issue
- Two LLs (#4 and #22) still must identify how to develop their technological skills in order to make data sharing happen.

5.5 Lessons learnt; LLs compliance with the Reference Architecture vice versa

In general, the necessary steps to be undertaken for every LL to prepare for engagement into a data sharing infrastructure provision relate to the capacity of the LivingLabs to:

1. Comply with the FEDeRATED semantics.
2. Use a services registry/index.
3. Use data at source.
4. Make use of an existing IAA provision and develop additional provisions.
5. Federate based on an Interface, possibly using a gateway.

The assessment of the LL's based on the outcome of the questionnaire is:

- Many LLs indicate that they want to comply with the FEDeRATED semantic model. However, most LLs prefer to use their own semantic model or apply existing data standards. Various LLs request FEDeRATED to define the building criteria for a semantic adapter.
- Most of the LLs have started to implement a Visibility Index and to develop a service registry. Many still need some FEDeRATED guidance on how to do this.
- Data at source is a difficult concept to implement. In technical terms it implies adaptation to the semantic model enabling participants to query the Indexes and Services Registry of various parties. Two LLs aim to do this by developing nodes, LL#20 and LL#21. Most do not do this. This is mainly because nodes are difficult to construct, require specific choices on the technology, like blockchain (LLs 21 and 20 do this), that are alien to the current daily operations. In addition, nodes are necessary to accommodate federated data sharing in complicated business cases with many different stakeholders. For many LLs this is not the case yet. Most LLs are developed based on a rather linear business case.
- Most LLs have started to implement IAA (Identity, Authentication and Authorisation). OAUTH2 seems to be a useable standard to be used as a starting point. More guidance is necessary on what it takes to develop a federated IAA approach.
- It is advocated to start developing common (collaborative/cooperation) LLs to actually move up to a rather more federated approach.
- In some countries various LLs have started to work together to mutually benefit from the data sharing technologies available:
    - In Sweden most LLs will be further developed based on Deplide. In order to develop Deplide to a rather sophisticated engine enabling data sharing the focus would rather be on providing Deplide with all technical specifications required to enable federated data sharing according to the FEDeRATED Reference Architecture.
    - In Italy, the 4 LLs (LLs #10, #12, #16 and #18) are making steps to get together and exchange knowledge and data related to various use cases. More collaboration could possibly lead to further develop and insights into semantic adaptors, application of the FEDeRATED semantic model (including Events), a Service Registry useful for all LLS and IAA.
    - In Finland the LLs #1, 2 and 3 are fully connected with one another through the technological choices made in CaaS. The experience can be further developed in connection to LL#17 for road transport and eCustoms services. IAA, a service Registry and Index and further adjustment to the FEDeRATED semantic model would be recommendable.
    - The B2B LL23 already connects to a Swedish LL and develops cross border data sharing services to Baltic companies. Special attention needs to be given on how this LL can contribute to experimenting on eFTI requirements, thereby also connecting to LL#17 and possibly LL#20.

- In the NL the LL#20 is developed as a follow up from LL19, thereby upgrading the technological choices made. As a consequence, LL#20 will provide input to a next stage of LL#19 in the end leading up to LL#19 and #20.
- LL#20 consists of two use cases. One use case in LL#20 aims to support the implementation of scenario 6 of the eFTI scenarios developed by RINA/Circle for the eFTI Implementing Act.
- The IATA LL#11 enables data sharing for many use cases. Most likely this LL can assist many LLs in applying OneRecord, also in connection to FEDeRATED Semantic modelling.
- All LLs suffer from the problems of developing an open federated approach onto quite concise and rather closed business cases. Thus, it is difficult to create AN OPEN NETWORK PERSPECTIVE. In addition, many stakeholders feel not always tempted to engage in a new IT road if they are not sure whether this will support the current business model. Transition requires persuasion, guts and a consistent message and effective toolbox.

Based on the first generic assessment of the application of the Reference Architecture onto the LivingLabs LL interoperability should be further developed whereby special attention should be given to:

- API Access;
- Semantic adapter;
- Service registry and Index;
- Security (IAA) provisions.

5.6 *Feasibility of the Master Plan to be validated against the LLs*

The assessment of the 23 LLs in relation to the FEDeRATED functional requirements and technical specification show that the Master Plan can basically be validated through their data sharing capabilities, their engines. More specifically:

- The Reference Architecture provides a sufficient basis for a FEDeRATED Master Plan. The basis of the projected validation is at least 10 LLs be capable of validating specific technical specifications.
- A selection of the LLs that can validate the Reference Architecture in 2023 is necessary. Currently, the scope of most individual LL use case is too limited to successfully execute this validation. Collaboration between LLs and their engines will enable successful validation.
- LL collaboration is based on the positive assessment that the available data sharing engines in total can validate all technical specifications.
- LL collaboration is already emerging. This collaboration is based on: operations, implementation, infrastructure, and knowledge. Also collaboration with external parties/LLs is to be identified.

- The emerging LL collaborations are:
  1. LL#1/2 and 3 with LL#11 Customs use case (OneRecord)
  2. LL#1, with LL#16, LL#17 and LL#20 - # eCMR (potential)
  3. LL#1 with LL#17: Ukraine corridor
  4. LL#2, 3 with LL#11 - CO2 across transport modes
  5. LL# 5, 6, 7, 8, 9, 13, 14, 15 around Deplide
  6. LL#10 Grimaldi with LL#18TSG (IT) –: ETA/position data and road planning
  7. LL#19 en LL#20 – NL collaboration Traffic management and port arrival
  8. LL#5 (SE) with LL#21 (ES) –focus is on RFID use case
  9. LL #13 and LL# 14 with LL#23 – port (incl. Wasaline – road – rail)

- To practically validate the upcoming Master Plan, including its technical specifications, current 23 LLs should preferably be focussed on their operating LL engines enabling federated data sharing. These LLs engines are:
  1. CaaS, combining the LLs #1, #2 and #3 – eCustoms and monitoring systems through sensors
  2. Last Mile Delivery, LL#4. External data sharing between commercial platform and city access
  3. Deplide, covering the LLs #5, #6, #7, #8, #9, #13, #14, and #15 – federated platform interoperability focusing on operational data choreography.
  4. Hermes (LL#10) in association with TSG (#18). Semantic adapter between platforms
  5. Internet of Logistics (LL#11) – semantics, security
  6. D4You (LL#16) Data-lake interoperability within and between B2B, Codognotto and Zailog will possibly integrate their activities
  7. OneApp (LL#17) – Data Access through existing semantic standards, including eFTI and eCustoms applications
  8. BDI, an association of DEFlog (LL#19) and eGovernment Logistics (LL#20) – Data sharing node for eFTI applications and eCustoms
  9. SIMPLE (LL#21) – data access and platform interoperability sea, rail and road transport
  10. Realtime Multimodal Transport Visibility Platform Services (LL#23)

- There is a need to further elaborate IAA and the Service Registry and its application for each of the phases. Some LLs use an API registry and particular tooling for modelling their use case, where others don't have any form of registering a specification electronically. The latter will allow the configuration of a platform for any use case (see before).

- Possibly more guidance on how to build or develop a semantic adapter, Service Registry, Index and IAA to the LLs can be provided.

- Platform interoperability between the various LLs, based on their engines is advocated. This could be achieved for sharing events with links to data (as triples) and (SPARQL) queries to data holders. A fictive use case can be specified for this purpose. The reasoning is that if these platforms are fully agnostic of the events and queries, they can be applicable to use cases implementing this pattern. This is the phase 3 of our proposed adoption strategy. If this is the case, they can also be configured to support phases 4 and 5, with additional functionality like query processing, event distribution, and event logic specified in these phases.

- In future the LLs should be assessed against the technical specifications. This would also relate to the 5 deployment and adoption phases (see chapter 2.3 and the draft Reference (data sharing) Architecture, Annex, chapter 9). It is important to identify the maturity level of the 4 technical specifications

- The maturity level of the various LLs in relation to the technical specifications is rather low. The LLs require more attention to bridge the gap between their business cases and the preferred technical setting. Per LL, possibly also LL collaboration, attention should be given to every LL on their specific maturity level referring the adoption of the technical specs. Figure 5 illustrates the overall picture – all LLs taken together – mapping the LLs against the Technical specifications. This figure needs a lot of finetuning until the end of the FEDeRATED project

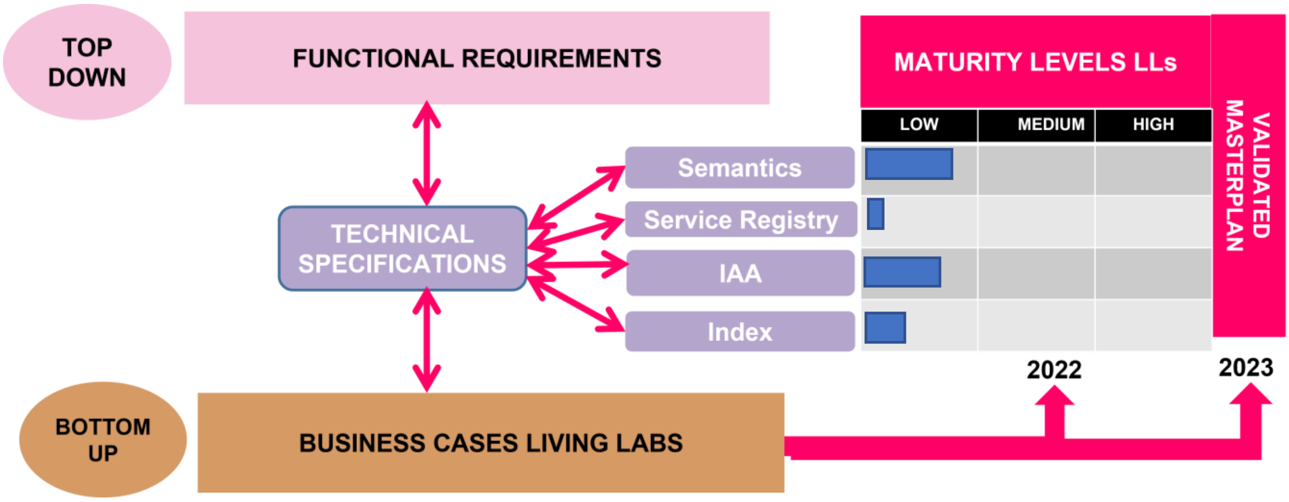

Figure 6 validation process of the LLs against the Master Plan (under development

- It is projected the mapping should also illustrate the state of play of these LLs in terms of scaling and on-boarding new users – to be executed in 2023.

6 CONCLUDING REMARKS

The Interim Master Plan was issued in 2020. This has evolved during 2020-2022 as a result of both further study as well as insights and experiences (lesson learnt) from the Pilots and Living Labs and has resulted in the current Reference (data sharing) Architecture document. This has been a parallel process.

The major finding in this Assessment Pilots/LL report are:

- The Pilots and Living Labs, especially during their study phases, highlighted the need for certain aspects of the federated architecture to be further clarified and detailed. This is done through the Reference (data sharing) Architecture. The Reference Architecture enables a coherent and harmonised implementation of the Leading principles and technical components and specifications, thereby securing interoperability between the various platforms. In effect the Reference (data sharing) Architecture as it has evolved now represents the state-of-the-art regarding the (Interim) Master Plan, already incorporating the first round of lessons learnt.

- On the one hand LLs identified a need for clarification or further (more detailed) specification of certain elements of e.g., the Reference Architecture. On the other hand the further specification of the IMP (Milestone 2) under "next steps" was cross-referenced with the works and experiences of the LLs. This approach was supported through representatives of each of the LL "engines" being actively involved in the IT Architecture Board.

- Besides the lessons learnt on the functional and technical issues, the Living Labs have also helped identify a number of issues that demonstrate areas requiring further attention with regard to the comprehension, uptake (onboarding) and eventual implementation of the federative network of platforms concept, e.g. concerning the organisational interoperability.

- The perception of, and affinity with, the overarching goals of "true" (or complete) federation in enabling (total) supply chain visibility represent a shift in more than just technology and data sharing methods. It represents a complete change in mindset on how data can be made available and accessed. In the main, the FEDeRATED LLs have been established based on known cooperation's between stakeholders. Both within and outside of FEDeRATED there are many more stakeholders (and potential business cases) that operate within their own (current) environment (ecosystem) and have limited need/reliance on data from other sources in order to conduct their business today.

- The wider perspective, incorporating the potential for authorities to e.g. dig down into data (i.e. in-depth (detailed) information/data on e.g. the cargo (attributes)), for which the identified functionalities are essential, is not necessarily a goal for a B2B relationship where minimal knowledge of e.g. the cargo is the preferred/required option. This has had a direct impact on the uptake of e.g. the FEDeRATED Semantic Model in that many of the LL business cases are focussed on specific processes and partnerships where the stakeholders are known to each other (including their "language" requirements) and do not fully represent (as yet) an entirely open transport and logistics domain. The integration of the existing semantics of each LL ecosystem with a common FEDeRATED Semantic Model is a technical challenge that is currently be explored by several pairs of LL.

- Having successfully transitioned from the Interim Master Plan to the Reference Architecture, the next phase of FEDeRATED needs to ensure that the validation of the Master Plan focusses on interoperability capabilities. A number of cooperation’s between LLs (engines) have been identified and these will serve to highlight the requirement for a transition in thinking from the inter-ecosystem to intra-ecosystem way of operating as well as further contribute to the organisational interoperability issues.

In the short-term (2022-2023) the following actions are advocated to ensure that the FEDeRATED Master Plan will be validated on the core functionalities and technical requirements:

- Make clear why semantic technology is a prerequisite to reach the final phase of adoption called Federation. The main questions to be answered are - can phase 5 be reached without applying semantic technology and what would be the impact to do it otherwise.
- Further elaborate and specify the adoption phases with detailing the functional – and technical specification for each phase. Possibly connect these phases onto LLs
- Develop a prototype (‘instances’) of the technical specifications.
- Need for guidance on the technical specifications (how to guide, see also previous recommendations)
    - semantic adaptor,
    - service register and
    - IAA
- Draft implementation guides for each of the 5 adaption and deployments phase. Distinguish for instance between chains (in networks), bilateral data sharing (like customs and economic operators), and a single participant (phase 5 – federation).
- Set up a test lab for interoperability amongst the various data sharing capabilities developed by the LLs, as much as agnostic to the type of events (with links) and (SPARQL) queries that are shared.
- Develop common LLs, i.e., for interoperability.
- Further elaboration of the governance.

FEDeRATED
NETWORK OF PLATFORMS

Co-financed by the Connecting Europe Facility of the European Union