FINAL TESTING REPORT PILOTS/LIVING LABS

Final Version

FEDeRATED MILESTONE 12

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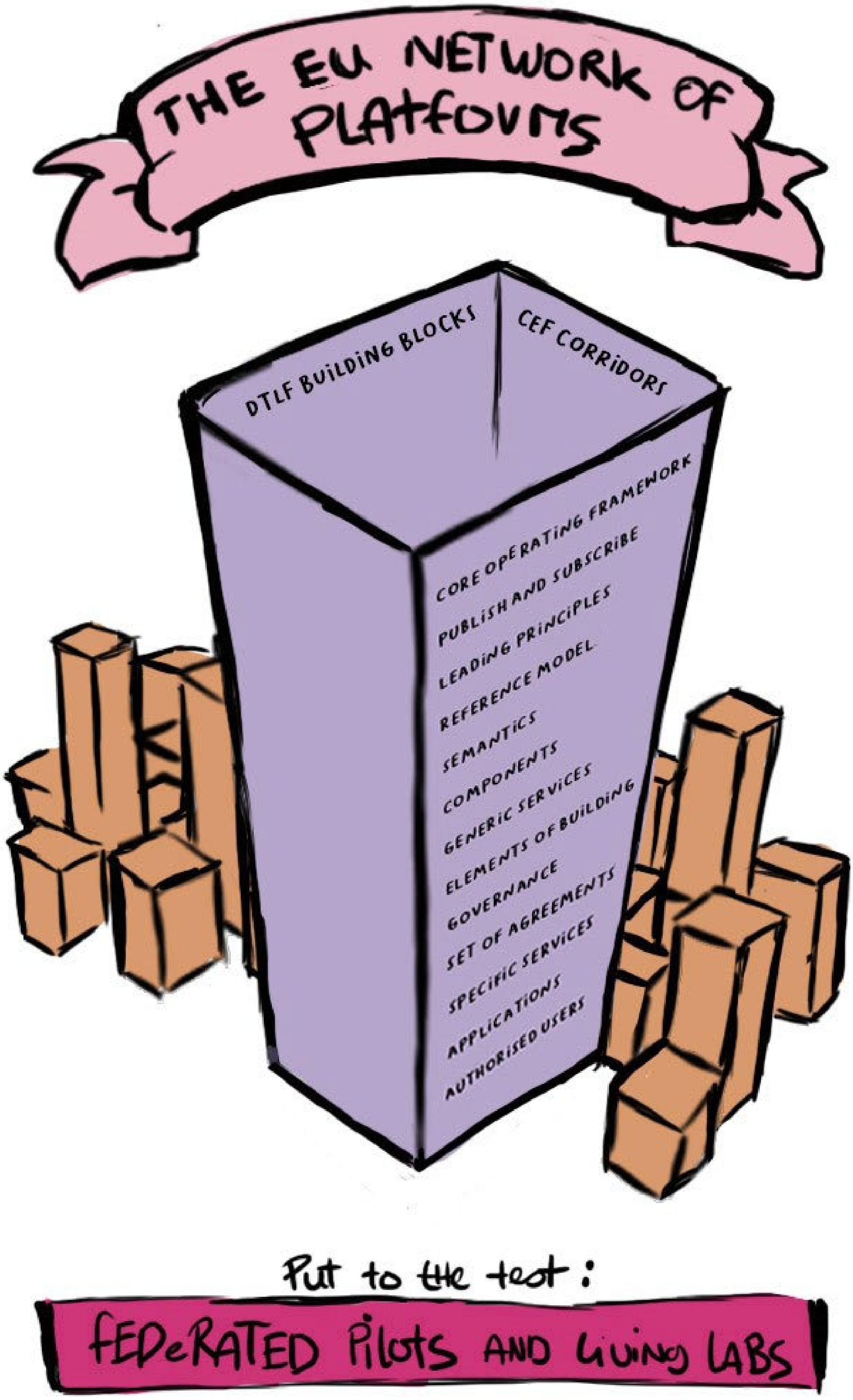

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EXECUTIVE SUMMARY

This report represents the Final Testing Report on Pilots & Living Labs (Technical FEDeRATED Pilots & Living Labs validation report). A total of 23 FEDeRATED Living Labs (LL) were developed as innovation environments whereby the FEDeRATED Master Plan (M14) could be validated.

The Living Labs concerned both public administration processes in e.g. the monitoring and control of the movement of transport means and goods, as well as logistics processes related to e.g. the tracking and tracing of cargo and planning tools. Some Living Labs focussed on specific roles, platforms and services while others addressed more specific aspects.

The four EU Digital Transport and Logistics Forum (DTLF) design principles – building blocks - of a federative network of platforms concept constituted the basis of the LL development as well as the development of an operational framework for setting the DTLF policy concept in motion.

The scope of the different Pilots and Living Labs encompassed all transport sectors and additional public administration sectors such as Customs. They were conducted over seven Corridors as well as reaching out to non-EU countries. They represented B2A, A2B, A2A and B2B data sharing.

Building on existing platforms, the LLs focussed on the different aspects of the FEDeRATED Reference Architecture in order to ensure full coverage of the technical capabilities as set out in the FEDeRATED Master Plan. In addition to the technical capabilities, the functional and organisational requirements were also assessed and provided input and feedback to the Master Plan.

The initial implementation mode of the LLs represented Peer-to-Peer (P2P), Single Platform, Multiple Platforms or a combined P2P/Platform approach. The implementation mode adopted by an individual LL ultimately had an influence on the Leading Principles and Capabilities that were eventually implemented and tested by them. The LLs worked on their specific Business Cases, which were later enhanced with collaborations between various LLs in order to test interoperability aspects of federated data sharing. The largest of these collaborations, also referred to as the Common Living Lab, also utilised the prototype Node prototype and various other tools that were developed within FEDeRATED.

This testing report is based on validating the so-called FEDeRATED Operational Framework, as provided for in the FEDeRATED Master Plan, against the Living Labs and vice versa. The Operational Framework consists of:

- Organisational Requirements, more specifically the need for:
    - Suitable Business case;
    - Stakeholder engagement;
    - Set of agreements/governance.
- Functional requirements, relating to the application of the FEDeRATED Leading Principles in connection to the DTLF building blocks;
- Technical specifications, testing based on the Assessment framework relating to the 4 capabilities and non-functional requirements.

Overall, 5 steps have been taken in the development of the living labs as an innovative environment for validating the Master Plan:

Steps	Focus	Description applicability for FEDeRATED LL
1	BUSINESS CASE	A suitable use case within the logistics or supply chain that requires information exchange between data user(s) and data holder(s) serving specific objectives.
2	DATA DRIVEN	The competence of any stakeholder to deal with data (paperless transport) instead of paper-based information, often this refers to the application of data and standardized data sets (paperless transport)
3	CAPABILITIES	The technical specifications any stakeholder must comply with to fully benefit from a federative network of platforms concept, which covers language alignment, discoverability, security, and controlled access (including a set of nonfunctional requirements)
4	INFRASTRUCTURE PROVISION	An overarching trusted network – set of agreements - enabling stakeholder to agree on what data to share for what purpose enabling compliance, and business transactions procedure to be executed.
5	PULL BASED DATA SHARING NODE	Allowing any stakeholder, the opportunity to share data based on alignment, customization, and sufficient capabilities to act as a node.[1]
Based on these 5 steps validation took place. The basic concept being collaborative collaboration, requiring a high degree of interaction and involvement between the policy demands, operational restraints and opportunities, and technical specifications.		
COLLABORATIVE INNOVATION		Overall, developing a successful federated Living Lab requires stakeholder commitment, willingness to overcome IT legacy adaption problems and a governance structure to solve possible bottlenecks.

Starting 2019, most LivingLabs were designed to cope with 1 and 2, thereby applying their technical capabilities to allow for data sharing based on a Peer2Peer, Platform or combined P2P/Platform approach. The capabilities for federated data sharing, 3 and 4, were developed in the course of the FEDeRATED project. Step 5, pull based data sharing, was advocated from the start of the FEDeRATED project, but how to reach this goal was only to be discovered after implementing steps 3 and 4.

The Master Plan, including Operational framework, covers 1 until 5, whereby pull based data – combined with data at source - is identified as one of the major Leading Principles based on the FEDeRATED Core Operational Framework requirement for data sovereignty and data quality, based on an open, neutral and trustworthy network. A federated, decentralized approach is key.

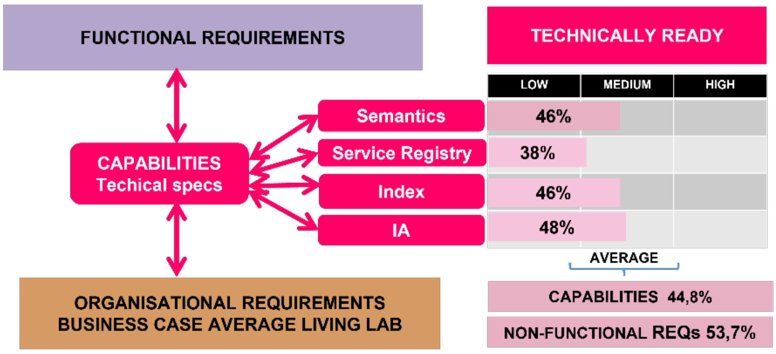
Assessment of the FEDeRATED Living Labs teaches us that basically those Living Labs that are the most advanced in adopting the Operational Framework capabilities:

- are driven by public authorities executing a dedicated national policy approach, including programmes and a set of agreements between stakeholders;

[1] See Milestone 10, chapter 1 for more information.

- can establish a set of agreements, including standards and semantics, for a tangible and dedicated number of stakeholders;
- have developed a mature and internally harmonized business approach based on a flexible technical setting for dealing with data sharing issues with a dedication to expand their business ventures to third parties.

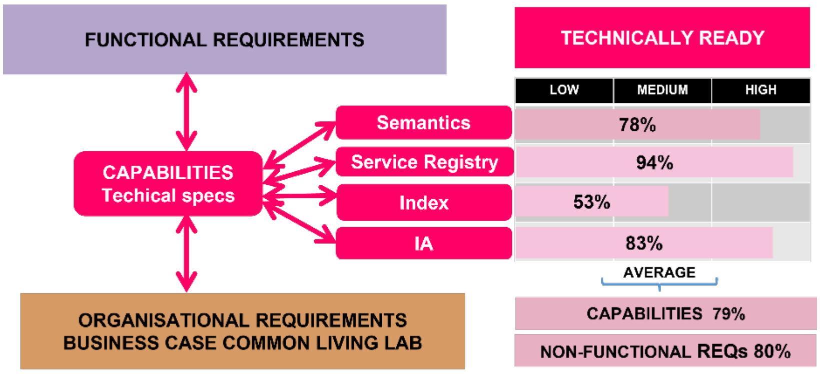
An assessment framework with weighting scales was developed and executed to validate whether the Living Labs as an innovative environment can comply with the prescribed capabilities for federated data sharing. The assessment results of the capabilities by all Living Labs engines are illustrated in the figure hereunder.



Average Technical assessment score of all Living Labs engines together

This figure shows that on average the Living Labs engines score the highest on the implementation of IA (48%). Second are semantics (46%) and index (both 45%). The Service Registry (38%) has been given the least attention. The average capabilities score for all Living Labs is 42%. As the federative network of platforms as advocated and perceived in many Living Labs in the FEDeRATED project is rather advanced and challenging – see the 5 steps (above and chapter 1 -, the average score of the Living Labs, whereby several Living Labs reach really high scores on most capabilities, is satisfying and promising at the same time..

Apart from various Living Labs implementing their business cases based on stakeholder engagement and their technical setting (capabilities), a FEDeRATED Node prototype was developed and implemented between various Living Labs aimed at establishing a federation. Various Living Labs managed to comply with this prototype, this enabling data sharing based on a federated approach. The prototype technical assessment is illustrated hereunder.



Technical Assessment Common Living Lab prototype

The scores represented hereabove only show the realised maturity of each Living Lab (or engine) as set against the full set of capabilities as determined for a federative network of platforms. Even though the Living Labs were designed to validate the Master Plan, it was not the intention or ambition that every Living Lab would realise all aspects of the capabilities. Stakeholder interaction and involvement - the human touch – define the common sense of purpose why technology choices can be made. Further analysis of the technical assessment shows that combined the Living Labs were able to return a maximum score for technical implementation and readiness for 26 of the 27 aspects technical components of the capabilities.

Overall, the aim of the Living Labs was to set operational steps course towards the adoption of the federative network of platforms concept:

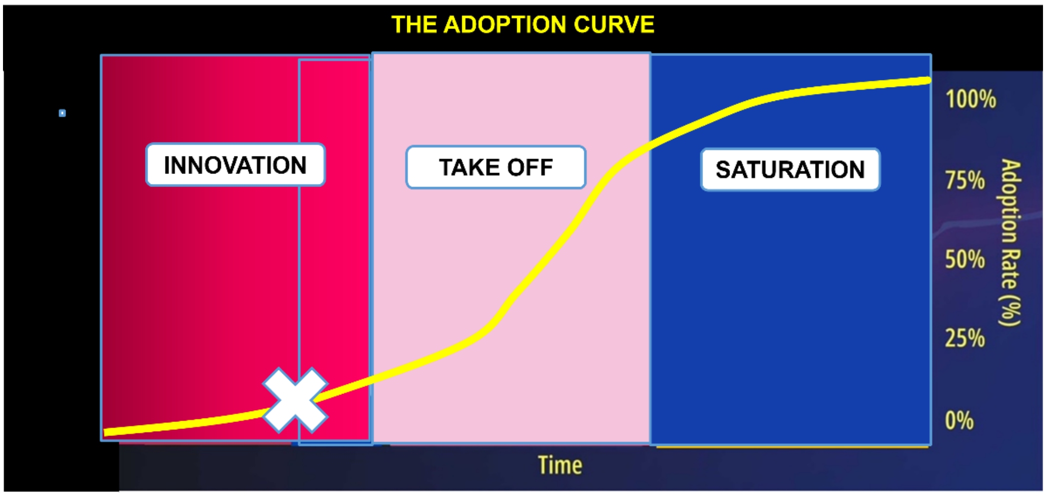
- With respect to Organisational Requirements, it has been shown that stakeholder engagement is a major success factor in the furtherance of the federative network of platforms concept, whereby sound business cases, and (active) participation of the e.g. problem owners, are essential. In the 23 Living Labs some 200 different stakeholders were involved, covering all transport modes, shippers, forwarders, terminal operators, ports, public authorities, industry associations, standardization bodies and It service providers.
- With respect to the Functional Requirements, it has been shown that the FEDeRATED Leading Principles have been applied in the Living Labs and that these are aligned with the DTLF building blocks. 36 Leading Principles have been validated and are included in the Master Plan (Milestone 14[2]).
- With respect to the Technical specifications, or Capabilities, it has been shown that the technical components and the specifications can be implemented. However, it should be mentioned that many Living Labs are still in the mid-stages of migration depending on aspects such as:
    - business cases (e.g. through influencing the scope of federation aimed at (i.e. through involvement of trusted stakeholders);
    - knowledge and skills (in particular with regard to semantics);
    - IT legacy as well as IT strategy and
    - EU and national policy commitment

  The use of tools developed within FEDeRATED, such as the FEDeRATED emantic Model and FEDeRATED Node prototype, proved successful in enhancing interoperability, and provided significant impacts on e.g., maturity levels.

All Living Labs have indicated that they will (or wish to) continue to execute their business cases and further develop their technical setting after the FEDeRATED Action (31 March 2024). Further developments include integration into operational systems for implementation in the short-term, expansion to involve more stakeholders and adaption towards new initiatives, both national as EU wide. Tangible project results delivering measurable impacts based on a transparent and EU wide accepted assessment framework would be an interesting next stage for setting the federative network of platforms into its next, operational gear.

[2] The Masterplan

The progress achieved by the 23 Living Labs also in connection to the development of the tools (mentioned above) and the common Living lab providing a prototype for federated data sharing proto in terms of adoption is illustrated hereunder. In general, one could say: the federative network of platforms still needs some work before full adoption can take place. Some Living Labs and the common Living Lab experienced a take-off. In Milestone 14. In chapter 7 of this report some recommendations are provided. Regarding the capability and nonfunctional requirements development.



The Living Labs, incl common Living Lab, experience scaled in the adoption curve

As a final note, all Living Labs have indicated to appreciate the positive impact the established innovative FEDeRATED environment on the development of their Living Labs. This environment should be perceived as an enabler for many living labs to continue their work after the FEDeRATED project. The FEDeRATED project results in connection to the Living Labs increasingly resonate with many stakeholders. The exchanges of information and experiences gained constitute a positive feedback loop for many participants, constituting a learning curve.

TABLE OF CONTENTS

INTRODUCTION

The aim of this report is to present the FEDeRATED Living Labs as innovation environments for validation of the FEDeRATED Master Plan. The four EU Digital Transport and Logistics Forum (DTLF) design principles – building blocks - of a federative network of platforms concept[3] constituted the basis of the LL development.

Between 2019-2023, the Living Labs provided feedback to the Reference architecture as developed by the FEDeRATED project, especially the IT Architecture Board and Semantic Modelling Group. Various Living Labs, executed by the 15 FEDeRATED partners were developed in connection to the work of the (DTLF), i.e., presenting their work and seeking interaction at DTLF meetings. Synergies between the various Living Labs have been sought and established.

According to the EC-FEDeRATED Grant Agreement, the Living Labs comply as a minimum to the following requirements:

- Beneficiaries and stakeholder engagement, - participation, and - management.
- Defining SMART objectives (Specific, Measurable, Attainable, Relevant, Timely) and functionalities of the Living Labs.
- Registration of beneficiaries and stakeholder (distributed Registries);
- Access Points for interoperability between IT systems and the federative network of platforms. Any data transformations have to be constructed by individual stakeholders. Potentially, these Access Points support a Graphical User Interface (GUI) as an application on a smart device.
- The federative network of platforms concept (and services) for B2A, B2A, A2A and B2B data sharing.
- Multimodal (road, rail, etc.) data applicability (re-use).

The Living Labs have been developed and organised by the beneficiaries to incorporate one or more of the following elements:

- Physical cross-border B2A data exchange issues (across core network and corridors).
- Identification, authentication, and integrity issues (including certification).
- Elaboration on governance issues.
- B2B data exchange issues in an open and neutral environment.
- Common Living Labs[4] to demonstrate seamless use of platform services.
- National Living Labs[5] to address the further processing of data within (national) authority systems for re-use.

The experiences and results are made available to all Beneficiaries, through various project deliverables and website contributions (www.federatedplatforms.eu). The Living Labs are used to

[3] Plug&Play, Technology independent services, Federation, and Safe, Secure and Trust

[4] Common Living Labs are conducted by two or more Beneficiaries.

[5] National Living Labs are conducted by individual Beneficiaries.

validate the functional and organisational requirements and the technical specifications developed under Activity 2 (Master Plan) through the assessment of the Pilots and Living Labs regarding the appropriateness and viability of the issues addressed in the Master Plan.

Whereas this report focusses on the assessment of the organisational, functional and technical elements of the Operational Framework and the ultimate validation of the Master Plan, each Living Lab also ensured own testing was conducted and documented accordingly. The individual testing regimes adopted and conducted by each Living Lab are provided for separately in an Addendum to this report.

The structure of this report

This report is called Final Testing Living Labs and Pilots. The testing has been executed in relation to the Master Plan development focussing on the Operational Framework for the federative network of platforms concept, being the organisational, and functional requirements and technical specifications. This report contains the following chapters:

1. The scoping of the Living Labs - the process to develop SMART Living Labs applying a federated approach.
2. The operational requirements – developing business cases and generating stakeholder engagement.
3. The functional requirement – application of the DTLF building blocks in correlation with the FEDeRATED Leading Principles
4. The technical specifications – the generic assessment of the technical LL results including some remarks about the applicable migration strategy
5. The capability assessment, including nonfunctional requirements of 13 LL data sharing engines.
6. The common LL – prototype for data sharing between various Living Labs based on a federated Node prototype.
7. Conclusions and recommendations.

The Annex sets out the Assessment Framework as used for the technical capabilities and the non-functional requirements.

Further, a separate Addendum to this report is available, wherein the individual test use cases developed and used by the individual Living Labs are provided[6].

[6] Milestone 12 Addendum Testing use cases Living Labs (federatedplatforms.eu)

1. SCOPING THE LIVING LABS AND TESTING

1.1 The need for Living labs

Since 2019, the scoping process of the Living Labs has been established in a two-way street approach. On the one hand, realising stakeholder engagement within the context of an appropriate business case. On the other hand, complying with the architecture design, which was constantly evolving during the FEDeRATED project.

Combined the Living Labs aimed:

- to validate the Master Plan (containing the functional, technical and organisational requirements) for an EU federative network of platform concept to be implemented with respect to the federative network of platforms concept (based on the 4 DTLF building blocks) and;
- to possibly contribute to a prototype of a data sharing environment for business and public sector.

1.2 The LL scoping

A clear scope is the basis for a sound Living Lab. The Living Labs (LLs) scoping process in connection to the Master Plan took quite some time. A major reason being, in 2019 the FEDeRATED Action first had to develop specific guidance documents for the LL to comply with (see paragraph 1.4). Thus, in the beginning of the project the Living Labs were developed based on a standalone basis, left to themselves. Additional reasons why the scoping took some time were:

1. Federative data sharing is a novel approach. Many LLs found it difficult to grasp the essence of the federative network of platforms concept;
2. Many LivingLabs were based on use cases rather than developing a federative data sharing infrastructure provision;
3. Constant changes in stakeholders' engagement (also due to the COVID pandemic) took place.

Overall, the federative network of platforms concept, leading to data sharing, does not easily comply with the ongoing data sharing practice. It is perceived as a next, rather futuristic step, only to be taken after positive experiences gained through P2P and Platform based data sharing practices in logistics. As trust is a major bottleneck towards data sharing, the federative network of platforms concept is not a very tangible focus for many stakeholders and Living Labs. Nonetheless, the FEDeRATED partners showed great enthusiasm developing LivingLabs. The need was increasingly felt to be there; the how to be a challenging concept which fascinated all FEDeRATED partners along the FEDeRATED timeline.

The steps to take realizing federated data sharing Living Labs are:

Steps	Focus	Description applicability for FEDeRATED LL
1	BUSINESS CASE	A suitable use case within the logistics or supply chain that requires information exchange between data user(s) and data holder(s) serving specific objectives.

Steps	Focus	Description applicability for FEDeRATED LL
2	DATA DRIVEN	The competence of any stakeholder to deal with data instead of paper-based information, often this refers to the application of data and standardized data sets (paperless transport)
3	CAPABILITIES	The technical specifications any stakeholder must comply with to fully benefit from a federative network of platforms concept, which covers language alignment, discoverability, security and controlled access (including a set of nonfunctional requirements)
4	INFRASTRUCTURE PROVISION	An overarching trusted network – set of agreements - enabling stakeholders to agree on what data to share for what purpose enabling compliance, and business transactions procedure to be executed.
5	PULL BASED DATA SHARING NODE	Allowing any stakeholder, the opportunity to share data based on alignment, customization, and sufficient capabilities to act as a node.[7]
COLLABORATIVE INNOVATION		Overall, developing a successful federated LL requires stakeholder commitment, willingness to overcome IT legacy adaptation problems and a governance structure to solve possible bottlenecks.

Most Living Labs were initially designed around steps 1 and 2, thereby pursuing to extend their technical capabilities to allow for data sharing based on a P2P, Platform or combined P2P/Platform approach. The Master Plan covers 1 until 5, whereby pull based data – combined with data at source - is identified as one of the major leading principles based on the FEDeRATED Core Operation Framework requirement for data sovereignty and data quality, based on an open, neutral and trustworthy network. [8] As the Living Labs matured then they aligned increasingly with the further steps.

1.3 Applying the SMART method

According to the Grant Agreement, the Master Plan should present the functional, technical and organisational requirements (called operational framework) of the federative network of platforms concept. The SMART principles were applied to enable the testing of the Living Labs versus the proposed Master Plan. Overall, the application of SMART on the LivingLabs stands for:

SMART	Explanation	Issues covered by FEDeRATED LLs
Specific	What do you want to achieve?	Data sharing between users and holder based on a business case applying the federated operational framework, which has a focus on open, neutral and trust

[7] See Milestone 10, chapter 1 for more information.

[8] See Milestone 1, Vision, explaining the power of pull and the need to cope with the upcoming tsunami of data and effective development of services which do not need to necessarily be kept in your own IT system.

SMART	Explanation	Issues covered by FEDeRATED LLs
	Who is involved or responsible?	A FEDeRATED beneficiary is responsible for the LL. Multiple business and public stakeholders are involved
	Where does it take place or is?	EU area, CEF corridors, third countries
	The importance of the goal	Validation Master Plan and Reference Architecture, i.e. to test the Operational Framework
Measurable	How to track the progress of the goal?	Milestones, workshops questionnaire, use case testing, stakeholder engagement, PR
	Key Performance Indicators	Operating Framework, Business case participation, Stakeholder engagement, Assessment framework,
	How will you measure when the goal is achieved	Data exchange between data user and data holder, applying all Leading Principles
Achievable/ Attainable	Is the goal realistic given your constraints (if any)	Depends on business case. capacity of stakeholders to apply capabilities (technical specifications) of the Operational framework, including adaption of existing IT legacy systems.
	What actions do you take reaching your goal?	Interaction and involvement – consultation panels - Applying stakeholder intervention, project dissemination and applying tools
	Do you have the necessary skills and support?	Depends on capacity for stakeholder engagement – easy for P2P) and assistance to put an appropriate technical setting, in place
Relevant	Does the goal align with your objective?	Goal is federated data sharing in a LL in combination with various objectives.[9].
	Will it contribute to your long-term growth?	Various benefits (long term growth) are defined by the LLs[10]
	Is now the right time to pursue this goal?	Depends on stakeholder engagement to engage in data sharing based on a technical setting
Time	When will you start working on the goal?	2019 – All LL have developed their timelines
	What is target complete date?	2023, most want to continue after 2023

[9] Objectives are cargo, container and transport tracking; asset and infrastructure monitoring; compliance monitoring; Automated Services; Platform Interoperability

[10] Benefits: Supply chain visibility (situation awareness); Increased Capacity and Asset Utilization; Supply Chan resilience; Effective Law Enforcement; Trusted and seamless data flow management

SMART	Explanation	Issues covered by FEDeRATED LLs
	Are there checkpoints along the way?	Milestone Reporting, testing data exchange, meetings, workshops, questionnaires etc

1.4 LL Background

According to the Grant Agreement, the federative 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 and executed 23 Living Labs (LLs) with the aim to:

1. Execute business cases pursuing the above benefits;
2. Assist the development of an operational framework constituting the FEDeRATED Master Plan.

Applying the SMART approach, the LivingLabs are developed based on:

1. A specific business case for data sharing;
2. Engagement of various participants (stakeholder engagement);
3. Inclusion of various transport modes and CEF corridors;
4. Digital adaptability of the participants (competence);
5. Availability data share mechanisms (engines - capabilities);
6. Potential value added of the applied data sharing solution for the business case (benefits).

In addition, a testing scheme was developed for assessing the technical setting of the LLs (see 1.6).

1.5 Process of LL scoping in interaction with the FEDeRATED project

As the LLs needed to evolve in coherence with the FEDeRATED operational framework as a guiding process of interaction and involvement was executed, whereby guiding documents were provided.

- End 2019, the FEDeRATED Vision providing the Core Operating Framework and defining the federative network of platform concept as: *an infrastructure provision to enable authorized users access to data based on a set of agreements and technical specifications, applying a publish and subscribe approach.*
- In February 2020, the FEDeRATED Interim Master Plan further defined the DTLF building block, including identifying 37 Leading Principles guiding the LivingLabs in their development.
- Between 2020 – 2023, much work was dedicated on establishing a Reference Architecture, based on which the major ingredients of the Master Plan - the organisational, functional, and technical requirements (operational framework) –(LPs) took shape. To assist the Living Labs in their work also some tools, such as a semantic model, were developed.

The development of the Living labs was monitored and measured in different stages.

- 2019 - Presentation of project plans
- 2020 - A LL questionnaire on the application of the LPs and technical components
- 2021 - The development of LL factsheets, containing various issues such as: the business cases, stakeholders, corridors covered, organisational issues and technical setting - and a second LL questionnaire on the application of the LPs and technical components
- 2022 A specific LL questionnaire on testing and technical setting
- 2023 A LL Project Book, containing information on scope, stakeholders, technical setting, testing and impacts.

Along with the provision of the documentation, various LL workshops were organised to accommodate the information gathering and adjusting to the federated data sharing concept. The Living Lab development process resulted in three deliverables (Milestone 4, 8 and this report).

YEAR	DTLF/FEDeRATED INPUT	LIVING LABS DEVELOPMENT
2019	DTLF Subgroup 2 report	27 LL project plans
	M1 VISION	
2020	M2 INTERIM MASTER PLAN	1st LL WORKSHOP
	FENIX – FEDeRATED ARCHITECTURE DISCUSSIONS	LL QUESTIONNAIRE
		M4 LL SCOPING
2021	FEDeRATED SEMANTIC MODEL	FACTSHEETS 23 LLs
	M5 PEER REVIEW	
	M6 MID TERM EVENT	LL QUESTIONNAIRE
2022		M8 INTERIM TESTING
	DTLF sbg 2 INTERIM REPORT	
	Draft REFERENCE ARCHITECTURE	3 LL WORKSHOPS
		LL TESTING QUESTIONNAIRE
	M10 LL ASSESSMENT	
2023	CAPABILITIES (TECHN SPECS)	LL INTERVIEWS
	LL IT ASSESSMENT FRAMEWORK	FINAL LL WORKSHOP
	NODE PROTOTYPE	LL PROJECT BOOK QUESTIONNAIRE
	M15 FINAL EVENT (all LLs)	THE SOUL OF THE MACHINE
2024		M12 FINAL TESTING LL
	M14 MASTER PLAN	

In addition, LL Factsheets were published on the FEDeRATED website, as well as interviews with all LL leaders, The human touch and The Soul of the Machine [11]

Within this process, the development of many FEDeRATED Milestone reports depended on the activities of the IT Architecture Board (October 2019 – Beginning 2024) and the Semantic Modelling Group (March 2020 – October 2023).

1.6 The testing through Living Labs

It took the FEDeRATED Action 4 years to develop and specify the operational framework in connection to the Master Plan. The Operational Framework is illustrated hereunder:

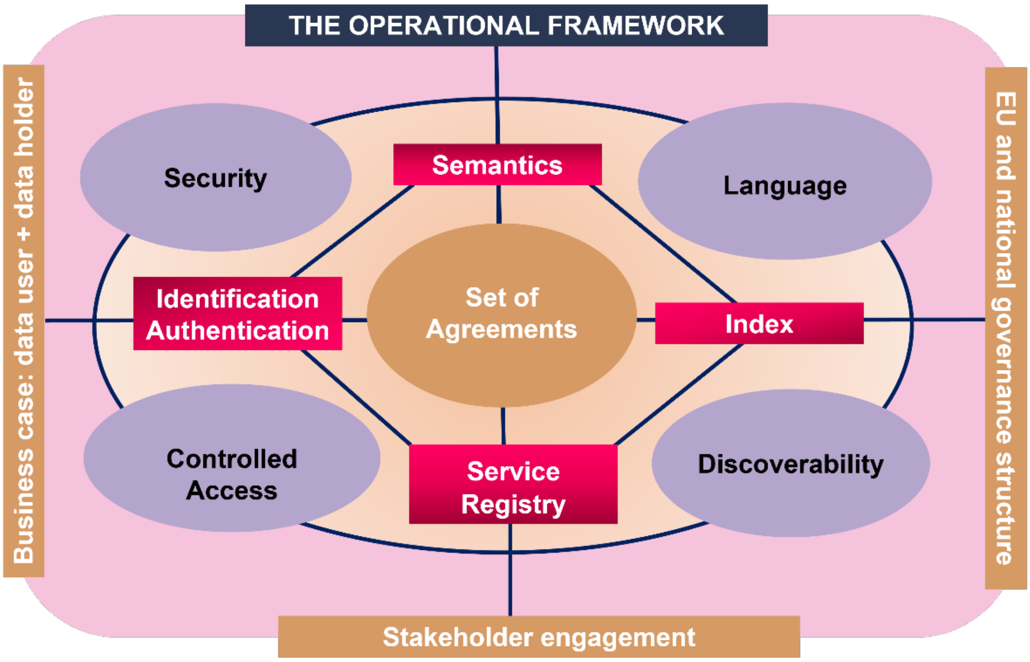


Figure 1 The Operational framework

The LL testing contains the following elements[12]:

1. Organisational requirements (chapter 2).
    - Stakeholders involved, (corridors covered)
    - Valid business case
    - (Set of) agreements between data user and data holders.
2. Application of the functional requirements relating to the DTLF Building Blocks and FEDeRATED Leading Principles (chapter 3)
    - Common language
    - Controlled access
    - Security
    - Discoverability

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[11] Human touch (interviews) and The_Soul_of_The_Machine_16102023_FINAL_version.pdf (federatedplatforms.eu)

[12] These requirements are elaborated in various documents available on the FEDeRATED website, i.e. Products (federatedplatforms.eu)

3. Technical specifications or capabilities validated through an assessment framework (chapters 4, 5, and 6):
   - Semantics
   - Service Registry
   - Index
   - Identification and Authentication

2 THE LIVING LABS – ORGANISATIONAL REQUIREMENTS

The organisational requirements relating the federative network of platforms concept relate to:

1. Valid business cases based on the goal of data exchanges between data users and data holders enabling the execution of a use case.
2. Stakeholder engagement - identifying whether:
   a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this;
   b) an IT solution was already chosen;
   c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place;
   d) existing IT legacy was a dominant force;
   e) dedicated first movers participated.
3. An EU and national governance structure, including a set of agreements [13] on:
   a) the collaboration between the stakeholders;
   b) installing and maintaining hardware and software;
   c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures.

These issues are elaborated in the following overview of the 23 Living Labs.

2.1 Overview of all 23 LivingLabs

In the table hereunder, the business cases of the various LLs have been identified, including transactions, use cases, challenges and established collaborations. Every Living Lab heading includes a link connecting to additional information (in case data exchange based on a use case has taken place this is indicated)[14].

#	Living Lab descriptions	
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
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Seamless data sharing for automated border crossing (paperless process) on a 24/7 basis for perishable goods with the aim to improve transparency of transportation, more flexibility for supply chain planning, for Customs better dedication on resources for high-risk cases, and on reducing costs. The data exchange has been tested.

[13] A set of agreements can be structured in various ways like Legal acts, Standards, proprietary Terms of Use, bilateral/multilateral Set of Agreements, or legal contracts. Can also be a combination. Based on technology developments, these requirements and specifications will be constantly updated.

[14] This testing is available in an Addendum document to this Milestone 12 report in the FEDeRATED website – see Milestone 12 Addendum Testing use cases Living Labs (federatedplatforms.eu)

#	Living Lab descriptions	
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this - **NO** b) an IT solution was already available - **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place - **YES** d) existing IT legacy was a dominant force -.**PARTLY** e) dedicated first movers participated - **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders - **YES** b) installing and maintaining hardware and software -**YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures - **NO**
	CHALLENGES	• Coping with emerging world events, i.e. war in Ukraine. Thus, changes in original transportation route and reduced the demand for this Northern route. • Time period for such a work is relatively long, • There are no exceptions from official processes.
	COLLABORATION	**LL#1, LL#2, LL#3, LL#20**
2	**CaaS Technology LL on North Sea - Baltic corridor - Vediafi**	
	BUSINESS CASE	PoC IoT real time data devices and transport unit to smart infrastructure communication for cargo tracking (incl. eSeal, ETD/ETA capabilities) and transport tracking (shipments) to optimise production scheduling and enable carbon footprint monitoring
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Visibility of transport data and events on driver, vehicle, load and location for supply chain stakeholders, with special focus on eFTI capabilities. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this - **NO** b) an IT solution was already available - **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place - **YES** d) existing IT legacy was a dominant force - **PARTLY** e) dedicated first movers participated - **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders - **YES** b) installing and maintaining hardware and software - **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures - **NO**
	CHALLENGES	• Real world pilots are not linked to operative systems, due the living lab phase, which means that some simplifications and simulations are needed. • eFTI is one of the main topics of Finland Estonia collaboration, but the regulation has not been finalised yet, thus living lab actions can support this development only with some assumptions and pilots. • End-to-end supply chain reliability by allowing involved parties to manage operations based on real time data

#	Living Lab descriptions	
		• Transport status information is available on main check points, where cargo is transferred from an actor to another. This causes uncertainty and opacity. • To test how IoT devices and smart infrastructure can enhance supply chain transparency and controllability, with respect of data sharing requirements. • To adapt IATA One Record data sharing model and iSHARE trust network solution to tests and link that way other hub operator and Estonian partners. • Intensified PublicPrivatePartnership
	COLLABORATION	**LL#1, LL#2, LL#3, LL#20**
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.
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Transparency and trackability (data, goods and CO_2) of logistics supply chains in customer home deliveries. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this - **NO** b) an IT solution was already available - **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place - **YES** d) existing IT legacy was a dominant force - **PARTLY** e) dedicated first movers participated - **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders - **YES** b) installing and maintaining hardware and software - **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures - **NO**
	CHALLENGES	• Real world pilots are not linked to operative systems, due the living lab phase, which means that some simplifications and simulations are needed, and real integrations cannot be done due the lack of business agreement. • Matching the rising customer demand of traceable and transparent logistics processes on both the end-customer as well as the cooperating business. • The lack of benchmarkable and transparent data about carbon footprint
	COLLABORATION	LL#1, LL#2, LL#3, LL#20
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

#	Living Lab descriptions	
		technology and business opportunities.
	TRANSACTIONS	B2A, A2B, B2B, B2C(Consumer)
	USE CASE	To develop an extended data space for enhanced decision-making on what and when to move goods for subcontracted shippers in city logistics, with a focus on stakeholder commitment
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **PARTLY** b) an IT solution was already available: **NO** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **NO** d) existing IT legacy was a dominant force. **NO** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **NO** b) installing and maintaining hardware and software. **NO** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Educating the various stakeholders on the FEDeRATED principles and ideas and achieve a common ground on the principles. • Identifying the key elements to be incorporated in a systematic approach • Creating an atmosphere of trust between various stakeholders necessary for the FEDeRATED data sharing approach to be a practical and implementable solution. Since the FEDeRATED data sharing approach requires various commercial stakeholders to share various key-business data.
5	RFID in Rail - STA	
	BUSINESS CASE	Reduce administrative time/work in terminals, harbours, shunting yards etc. Track and trace railway vehicles all over Europe-
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Installation of RFID-tags and connected information management in a cross border railway transportation based on an administrative standard for data exchange. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **NO** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **YES**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**

#	Living Lab descriptions	
	CHALLENGES	• There is lack of information in rail operation along the European corridors due to poor global exchange information systems. • The industry is keen to get real time information along the transport chain, when RFID information will be provided the competitiveness in rail will be strengthen. • An administrative standard for data exchange between stakeholders must be established in a European context. • Discussions between stakeholders about global data exchange of traffic data is an issue. Main issue are the principles of "who" have access to the data and how can this be distributed in a proper way.
	COLLABORATION	LL#21 (through Deplide)
6	**Rail-road Terminal CDM - STA**	
	BUSINESS CASE	Information sharing along the intermodal transport chain for collaborative decision-making at inter-modal rail-road terminals.
	TRANSACTIONS	A2B, B2B
	USE 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 increase efficiency and transparency amongst customers and operators of intermodal transports
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **NO** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **NO** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Lack of real-time information about delayed or cancelled trains creates unnecessary waiting times. • Customers experience lack of real-time information regarding the location of containers/goods. • The profitability of an intermodal terminal is affected by the number of containers loaded on the train. Shuttle trains often run with less than full capacity due to lack of efficient and flexible solutions.
	COLLABORATION	Through Deplide
7	**Real Time Port Visit Service - SMA**	
	BUSINESS CASE	Seamless data flow management through for system interconnectivity between various organisations. Technical applications, such as API, and protocols.
	TRANSACTIONS	B2A, A2B
	USE 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

#	Living Lab descriptions	
		ports by accurate timestamps of the incoming ships for port planning purposes. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **NO** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **PARTL**Y e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **NO** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Security and resource related issues in developing the solution due to the increased focus on Cybersecurity as a result of the ongoing war in central Europe. • Due to the above SMA has been forced to completely redesign our integration platform to be able to expose external endpoints for secure information sharing. • Coping with existing agreements for sharing static ship specifics.
	COLLABORATION	LL#20,
8	Multimodal Information Sharing III - STA	
	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, i.e., ETA.
	TRANSACTIONS	A2B, B2B
	USE CASE	Enabling track and tracing between shippers, transporters and terminal operators, and possibly other operators and Customs, through sharing and retrieving vital logistics data facilitated by the Deplide platform
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **NO** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **NO** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Getting lorry companies like the road transporter to share data. They are currently using paper for all the transports and booking information. • To understand, who is the owner of specific data in the ports or who can provide specific data needed. E.g., does the port or the port operator have the data?

#	Living Lab descriptions	
	COLLABORATION	LL#20 (through Deplide)
9	Transparent Transport City Helsingborg - STA	
	BUSINESS CASE	Reduction of uncoordinated urban logistics movement through digital monitoring and data exchange between the various operators with the aim to enhance safety, more cost efficiency, and lowered emissions
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Coordination of urban freight transport movements through digital collaboration and data sharing based on an independent data sharing platform – called SAM - established by the city of Helsingborg aimed for the simplest and cost-effective solution for tracking deliveries. Therefore, the app is logging truck position, delivery company with contacts and timestamps in its first simplified iteration. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral, and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **NO** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **NO** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **YES**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **NO** b) installing and maintaining hardware and software. **PARTLY** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Transition from traditional handling of municipal goods distribution into digital tooling. • Monitoring compliance in public procurement contracts. This challenge is partly based on the difficulties for the municipalities to access transport and delivery data, as they are not the owners of this data. Municipal units experience several deliveries per day from different carriers, which requires personnel to sign for and handle the goods. Many and frequent deliveries create problems with traffic safety, as they can occur in areas and at times when children are present. • Reduced transport flow, which will result in a lowering of emissions. This will be achieved through joint loading and requirements set by the municipality for the type of vehicle and fuel used for delivery. • The situation now is problematic. A lot of procurement is being done in all the municipal units, but with no visibility or sync. We now must seize every opportunity to make a change in the behaviours and the processes leading up to too much procurement activities that are out of sync. • The city of Helsingborg is doing public procurement for 3.4 billion a year, causing 150.000 tonnes of Co2e. This must change in order to reach the ambitious goals of climate neutrality 2030. Causes. The city does not have data about how many deliveries and the Co2e the transports cause. The lack of delivery data makes it harder to measure and become climate neutral. • Connecting to potentially supporting initiatives for teaming up, , i.e. shop less and share more, eat more local and similar activities an electrical fleet of delivery.

#	Living Lab descriptions	
		• The implementation plan is both simple and complex, one solution that is close at hand is demanding the suppliers to share their transportation data either through this solution (the service Sam) or a similar way. The simple part of it is the usage of the web-based tracking app for mobile phones. The more complex part is making everyone come onboard voluntarily and see the benefit of sharing. • We think we will have a ROI within a few years due to reduced costs in the transport chain. But the best part of this is the ROI in reduced carbon emissions.
	COLLABORATION	
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.
	TRANSACTIONS	B2B
	USE CASE	3 use cases - Data sharing throughout the supply chain enabling supply chain and ships visibility of own fleet also in connection to third party terminal interoperability The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **YES**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **YES**
	CHALLENGES	• To become more efficient and be able to provide better information services to its drivers and clients, • To increase the integration and information exchange with other transport producers and infrastructure owners. • To enhance the efficiency in the maritime transport chain by digital data sharing enabling supply chain and ships' visibility through seamless integration throughout the transport chain. • To apply the FEDeRATED principles on digital data sharing to align the customers and the vector (Grimaldi), as the initiator of the transport, with other transport actors and infrastructure owners (such as car manufacturer Fiat Chrysler Automobiles (FCA), terminals, ports and all stakeholders involved in the commercial chain). • Grimaldi operates approximately 150 ships, which only 90 of them are equipped with IoT devices and provides a service centre for managing the fleet as well as the interface to its clients through digital means.
	COLLABORATION	LL#18

#	Living Lab descriptions	
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
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	14 use cases have been piloted. All between various air cargo stakeholders applying the OneRecord standards for data sharing between various platforms around the globe. Sometimes connected through SPARQL endpoints for transparent exchange of data in the digital ecosystem of air cargo stakeholders, including end-to-end participants from shipper to consignee also checking applicability for eCommerce. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **YES**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• The (air freight) logistics supply chain is currently supported by a fragmented data platform eco system that does not facilitate data sharing and innovation between supply chain partners. • Current data exchange systems are based on outdated technology which slows down innovation and progress. • The transition from the current use of incompatible data standards and versions - that require costly data processing and conversions - into the Internet of Logistics Living Lab requires a structural change for many stakeholders. • Next to suitable architectural solutions and semantic models, the readiness of stakeholders in understanding, applying, and implementing such new concepts. Although this leads to slow uptake curve, it also creates a core of experts to support the era of data sharing and federation of platforms.
	COLLABORATION	LL#1, LL#2, LL#3, LL#17, LL#20
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.
	TRANSACTIONS	B2B
	USE CASE	Optimising the resources available regarding the data related to loading units

#	Living Lab descriptions	
		handled on the terminal yard and travelling on the railway network. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **YES** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Reduce the dwell time for hauliers. • Decrease the pollution, especially the CO_2 emissions. • Optimize the management of the terminal buffer areas as well as the daily operations.
	COLLABORATION	LL#16
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.
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	To identify and address the improvement potential in the transshipment processes to enhance the overall transport flow through data sharing between two transport hubs. RFID readers will be installed in the port of Umeå to retrieve data on trains and wagons arriving and departing from the Hillskär terminal, also to track and monitor the status of trains throughout their routes to the Hillskär terminal. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Transport flow services, i.e. loading and unloading of carriers, carrier storage, and shunting of carriers to and from the ferry, need to be made available. For railway operators to provide these services, certain digital capabilities are expected to be available at the terminal. These digital

#	Living Lab descriptions	
		services might include information such as the weight of cargo carriers, estimated arrival times, loading and unloading times, pick-up and departure times for trucks, and instructions regarding the loading position of cargo on the train. • By sharing time stamps related to physical movements and operational status, both as estimates and actual times, the actors involved in the goods flow will be informed about the status as well as the intentions of other actors. This information exchange enhances their ability to plan and re-plan their respective operations effectively
	COLLABORATION	LL#5, (through Deplide), LL#23
14	**Sustainable Inter-Modal Chains (SIMC) - STA**	
	BUSINESS CASE	To demonstrate the benefits and feasibility of standardized data sharing and to foster a culture of collaboration and standardization through the calculating CO_2 emission along the supply chain, enhanced planning capabilities, and reduced administrative burden
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Connecting the two transport hubs covered by Kvarken ports with digital data sharing capabilities enabling predictions and progress of the movement of freight within and between the two transport hubs and adding value to the transhipment of freight, i.e. calculating CO_2 emission along the supply chain, enhanced planning capabilities, and reduced administrative burden. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **NO** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• The current state of integration among different transport events in the supply chain from the cargo owner to the end customer is characterized by inefficiencies. There are challenges in effectively connecting and coordinating the various stages and actors involved in the transportation process. • The Living Lab initiative recognizes this issue and aims to address it by focusing on a specific part of the transport chain involving participating actors. By closely examining and understanding the dynamics and interactions within this specific section, the Living Lab intends to develop and establish best practices that can be extended and adopted in other parts of the chain as well. • One aspect that the Living Lab seeks to improve is standardized data sharing between up-stream and down-stream information sharing environments or communities. Currently, there may be inconsistencies and disparities in the way data is exchanged and communicated among

#	Living Lab descriptions	
		different stakeholders in the supply chain. This can hinder efficient decision-making, planning, and collaboration. • The objective is to enhance visibility, transparency, and coordination throughout the supply chain by enabling smooth and standardized data sharing practices. This will facilitate more accurate and timely information flow, allowing for better planning, improved operational efficiency, and enhanced collaboration among all parties involved. • It is important to note that the adoption and implementation of these standardized data sharing practices may require active participation and cooperation from stakeholders across the supply chain. Challenges such as varying technological capabilities, data security concerns, and organizational differences may need to be addressed and overcome for successful integration.
	COLLABORATION	LL#20 (through Deplide), LL#23
15	**Optimized Port Operations - STA**	
	BUSINESS CASE	Reduced cost per handled unit within the port logistics infrastructure. Transport, cargo tracking, Follow time of pilotage.
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Integrated operations with cargo owners and the sharing of data on planned and conducted operations. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **PARTLY** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Effectively optimizing port operations: One of the challenges is identifying how to effectively optimize Kvarken Port Umeå's operations to align with future digital logistics solutions. This requires a thorough understanding of the needs and requirements of cargo owners and stakeholders. It involves identifying the most efficient and effective ways to utilize digital technologies, data sharing platforms, and automation to streamline processes, improve efficiency, and meet the expectations of cargo owners. • Standardizing the sharing of business-critical data: To enhance information transparency and facilitate seamless collaboration among involved actors, there is a need to standardize the sharing of business-critical data. • Organizing internal coordination and expectations: Within the port, there is a need to improve internal coordination among different departments and teams. This includes aligning expectations on warehousing and re-loading operations to ensure smooth and efficient processes. Sharing data on available cargo in the port, expected cargo arrivals, cargo loaded

#	Living Lab descriptions	
		on ships per day, and the remaining amount until the ship is fully loaded is crucial for effective planning and resource allocation. Similarly, sharing information about outgoing transports, including ship arrival and departure planning, and unloading and loading schedules, helps optimize the flow of goods and ensure timely operations. • Addressing these challenges requires collaboration among port operators, cargo owners, shipping lines, and other relevant stakeholders. It involves establishing clear communication channels, implementing data-sharing protocols, and fostering a culture of cooperation and coordination. By overcoming these challenges, Kvarken Port Umeå can enhance its operational efficiency, improve customer service, and leverage digital technologies to meet the evolving needs of the maritime industry.
	COLLABORATION	LL#20 (through Deplide)
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
	TRANSACTIONS	B2B
	USE CASE	2 use cases: Automated decision-making through data sharing based on an extended data lake approach. TMS adoption of a node for eCMR application. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• To federate the various internal systems within Codognotto in such a way that they can interoperate with each other and above all to preserve a large amount of information in a system that allows its use based on codified semantics. This relates to three streams for different business areas: • FTL: Codognotto carries out an Enterprise Architecture design and Software prototypes to facilitate the federation of the silos inside the company with the aim of digitalizing and automate the processes to collect information (data) from various data sources and create its data lake using semantic and ontology shared with FEDeRATED guidelines. The architecture is designed to openness (data sharing) with an external system that could be federated. • YARD: To improve his yard management in a digital way. • The segment WMS (Warehouse Management System), of contract logistics, requires a complex bundle of several logistical services such as transportation and warehouses as well as a potentially wide range of

#	Living Lab descriptions	
		value-added services. Codognotto provides a study on how it automates the interfaces between different parties (supplier and customers).
	COLLABORATION	LL#20
17	**EU Gate CMR/eFTI/OneAPP - 51Biz**	
	BUSINESS CASE	To reduce the administrative burdens for commercial, transport to effectively report to law enforcement authorities as well as to transport and logistics service providers
	TRANSACTIONS	B2A, B2B
	USE CASES	3 Use cases. Applying an EU eFTI gateway API/GUI prototype for data sharing between various road transport companies in Europe, involving public authority stakeholders. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **PARTLY** b) an IT solution was already available: **YES** c) from the start an effective organisation of the work, from design to implementation, was chosen. **PARTLY** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **PARTLY** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• To enable the same structured data can be used for commercial, transport and compliance purposes. • Logistics service providers often do not have the technical and organizational capability to share data with external business partners as semantic endpoints that can be queried as an alternative to transaction-based application programming interfaces (API). • Small and Medium size enterprises (SME) delay IT investments and projects if there is no clear short-term business value, due to limited resources. • The semantic ontology approach, initiated by the DTLF SG2, is considered to be rather difficult to apply as it is different from what one is used to do. • The IT maturity of the leading transport and logistics providers is years ahead of the maturity of the public sector. • Few professionals that have inside knowledge and experience in data modelling. • The European Commission does not have the resources available to develop a EU Federated Architecture that can be used for B2B and B2A data sharing. Today, the Commission depends on individual resources and consortiums that have a time span of 4-5 years. • The growing communication gap between IT technology experts and business experts due to an acceleration of the emerging technologies. • European standards must be interoperable with global standards because of the global nature of supply chains.

#	Living Lab descriptions	
	COLLABORATION	LL#11, LL#20, LL#21
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
	TRANSACTIONS	B2B
	USE CASE	2 use cases - Seamless interoperability and supply chain visibility through trailer tracking data exchange and trailer pickup booking within the terminal area and with a shipping line. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• The growing volume of maritime cargo, both in number and capacity of vessels, is entailing a progressive saturation of operating spaces at terminals' yard; the primary means for addressing the problem are optimized planning and (semi-)automated handling of containers, trailers and break-bulk cargo, which are only achievable through specialized machinery and sophisticated ICT platforms. • The great number of operators in the port ecosystem, their different "digital maturity" and the uncoordinated deployment of heterogeneous technologies (often having conflicting requirements and operation) led to a sort of "platform jungle" that prevents single actors from taking full advantage of their investment.
	COLLABORATION	LL#10
19	**DEFlog - NL Ministry of Infrastructure and Watermanagement**	
	BUSINESS CASE	Streamline actual and reliable mobility data via a platform to TMS and FMS of LSP's, leading to more efficient and effective road transport operations, leading to faster clearance of the roads and less costs due to
	TRANSACTIONS	A2B, B2B
	USE CASE	1 use case - Streamlining public data (municipal time windows, environmental zones, roadworks, roadblocks, diversions, ...) through platform connectivity to logistics operators The data exchange has been tested.

#	Living Lab descriptions	
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **YES** e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• How to become stand alone • Develop viable business model. • Long term funding • Complexity of geo-data (ArcGIS etc) and usage for logistics parties • Ways of working with REST API's for parties that are used to DATEX II XML's
	COLLABORATION	LL#20
20	**eGovernment Logistics - NL Ministry of Infrastructure and Watermanagement**	
	BUSINESS CASE	Developing and establish a genuine federated data sharing infrastructure provision (BDI) providing a toolbox and governance for authorised users within the concept of paperless transport, i.e., eFTI regulation for ship
	TRANSACTIONS	B2A, A2B
	USE CASE	3 Use cases, (Tradelens, Singapore and Codognotto) to optimise law enforcement operations through overall and transparent supply chain visibility based on a pull approach - (pre)arrival data, eCMR data and im- and export. The data exchange has been tested
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **YES** b) an IT solution was already available: **NO** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **PARTLY** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **PARTLY** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Change management issues relating to the need for all participants to adhere to a new working concept of federation, instead of propriety data and system development • The development of software components that support the BDI vision in practice. It is about: supporting many use cases requiring similar services, but all slightly different; the ability to enable communities (industry

#	Living Lab descriptions	
		associations, authorities) to align their developments utilising the FEDeRATED ontology, and to support existing data carriers (open standards and their implementations). • To implement the abstract BDI concepts in practical settings, especially viable business models, that have a scaling potential. It is about the product/solution development to construct a generic infrastructure provision that can be applicable for many stakeholders versus support of specific use cases. In the short term, it is always easier to develop a solution fitting a use case, but such a solution is not necessarily applicable to another use case. • Develop and show convincing cases - Since the architecture was developed parallel to the development of the solution and the development of the solution fed the architecture, it has been a real LL, perseverance is required, and disappointments must be expected.
	COLLABORATION	LL#1, LL#2, LL#3, LL#5, LL#6, LL#7, LL#8, LL#9, LL#11, LL#13, LL#14, LL#15, LL#16, LL#17, LL#19, LL#21, LL#23
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.
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	3 use cases. To provide 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. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **YES** b) an IT solution was already available: **PARTLY** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **YES**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• Define a functional scope that covers a relevant spectrum of the full set of logistics processes. Implement digitalisation in transport and logistics to enhance efficiency and simplification, reusing all the existing data between different actors, and between different modes of transport, assuring the traceability of goods, contributing to a better use of existing resources and infrastructure (more transport activity with less empty routes, means or infrastructure). • Develop a Semantic Model align with what is defined in the FEDeRATED Semantic Model and its future updates and developments, in order to keep the interoperability and compliance with the EU standardization in semantics and ontology.

#	Living Lab descriptions	
		• Network effect: to attract as much stakeholders as possible, including not only the main stakeholders in terms of size, but also the rest, small and medium sized stakeholders, to generate traction and a network effect. • Define a business model to make the platform sustainable in the long-term considering the governance and incentive system under definition. • Avoid the potential resistance to change, due to the need of the different entities involved in the transport chain to adapt its operation to the use of a new tool (platform) and the possibility of recording additional information and data beyond of what is currently required. • Data sovereignty. SIMPLE considers data sovereignty at source, and deals with the potential needs and requirements in this matter, with the aim of keeping, in the best way, data sovereignty and, at the same time, the essence of an integrated and collaborative platform for data sharing. • SIMPLE API. Get all SIMPLE users to adapt to the SIMPLE API, by developing an API and associated documentation that allows its easy integration into any external system or platform that would like to communicate with SIMPLE. • Functional issues: i.e. Interrelation of Consignments, Events and Transactions in the registers through the SIMPLE API. In order to automate the registration of Events via API, some algorithms are being developed to automatically assign Events to Shipments or interrelate Consignments, through certain references (booking number, container registration...) in combination with dates and locations (Events associated with a train or a ship can have a systematic report to the Shipments generated in SIMPLE that go within those transport means).
	COLLABORATION	LL#5, LL#17, LL#20
22	**Automated capture and sharing of environmental data in collaboration B.E.A.standard -ELSA - STA**	
	BUSINESS CASE	To introduce a uniform standardised purchasing requirement for climate data reporting in Sweden, comprising of Automated reporting of environmental data. This should lead to cost-efficient digitalisation of the industry with short lead-time while establishing a sustainability reporting mechanism,
	TRANSACTIONS	B2A, A2B, B2B
	USE CASE	Various use cases - To establish a data exchange platform mechanism for all transporters based on a data standard for the reporting in construction and maintenance works in road and rail infrastructure. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **YES** e) dedicated first movers participated. **PARTLY**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**

#	Living Lab descriptions	
	CHALLENGES	• Many details have to be sorted out on exactly what to report and how. Management routines and technology that may need to be introduced and developed. Below is a list of examples encountered by a new contractor. • Type of fuel was given by pre-selection in app for chosen work machine. • There is no common standard for reporting fuel quantity and quality. • Initially, manual procedures are necessary for each individual machine, which is time and resource consuming. • Pavement machines cannot measure fuel consumption, only operating time. • High cost of installing machine controller area network bus (CANBUS), also postulating permission from the machine owner. • Subcontractor is able to deliver generic data only, instead of data on real fuel consumption. • Large hauler may have own IT department, but it may be harder for a smaller subcontractor. • A lot of communication is needed when subcontractors are involved. • The work process of filling fuel and "glue" for a paving "glue moped" was mapped to understand the process, but not measured yet. • Tried digital reporting of loading and unloading sites for masses but did not work in this (part of) project. • Correctly verified data
	COLLABORATION	--
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
	TRANSACTIONS	B2B
	USE CASE	Various use cases - Within a multimodal transport context providing a visibility of data and emissions reporting functionality based on data sharing among the participants of the logistics chain. The data exchange has been tested.
	STAKEHOLDER ENGAGEMENT	a) From the beginning an open, neutral and decentralized data sharing approach was pursued, whereby stakeholders felt committed to pursue this. **NO** b) an IT solution was already available: **YES** c) from the start a transparent and straightforward organisation of the work, from design to implementation, was set in place. **YES** d) existing IT legacy was a dominant force. **PARTLY** e) dedicated first movers participated. **NO**
	SET OF AGREEMENTS ON	a) the collaboration between the stakeholders **YES** b) installing and maintaining hardware and software. **YES** c) a manual on how to hold and use the data, also for providing services and fulfilling compliance procedures. **NO**
	CHALLENGES	• The data is frequently locked in legacy systems, and there are no methods in place to retrieve it nor the willingness of data owners to share it. Despite the benefits of data sharing, there is hesitation to share.

#	Living Lab descriptions	
		• Digitalization - very often small companies do not have TMS/WMS in place and operate with 'pen and paper'. Although these companies are looking for digital solutions, many existing options are too heavy for them. Moreover, we do not have ways to receive the data without first setting up the basic services. • Will to change - not all companies are eager to adopt new technologies and adjust their ways of working. • Various approaches - although the core of operations is the same, every company has its own way of operations and has different requirements, and this must be considered when developing any service. Every solution must be adjustable to client's needs in an efficient manner.
	COLLABORATION	LL#14, LL#20

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.[15] Most of the Living Labs have indicated their intention to continue their work after the FEDeRATED expiration date.

2.2 *Background Facts and Figures*

Following are some facts and figures relating to the overall exposure of the LLs in representing the various dimensions of coverage, whether geographical, data types, stakeholders, data sharing engine types, etc.

2.2.1 Geographical and Means Coverage

Corridor																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Mediterranean										Y	Y							Y		Y	Y		Y	6
Atlantic								Y		Y	Y				Y						Y			5
North Sea - Mediterranean										Y	Y					Y	Y							4
North Sea - Baltic	Y	Y	Y							Y	Y			Y	Y					Y				8
Scandinavian - Mediterranean	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y						Y	Y	17
Rhine - Alpine										Y	Y					Y	Y		Y	Y				6
Baltic – Adriatic											Y													1
Other ...											Y													1
Total	2	1	2	1	1	1	1	2	1	6	8	1	1	2	3	3	2	1	1	3	2	1	2	

2.2.2 The LL objectives

Objectives																								
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Cargo, container, and transport tracking.	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	20
Asset and infrastructure use monitoring.	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	20
Compliance monitoring.	Y	Y	Y	Y					Y		Y						Y		Y	Y	Y	Y		11
Automated services.	Y	Y	Y	Y							Y		Y			Y	Y		Y		Y	Y		11
Platform interoperability.	Y	Y	Y	Y	Y				Y	Y	Y			Y	Y	Y	Y	Y		Y	Y	Y	Y	17
Total	5	5	5	5	2	2	1	2	4	2	5	1	3	3	3	4	5	3	4	4	4	4	3	

[15] More information is also available in Milestone 8, Annex, pages 44-49.

2.2.3 The LL benefits

Anticipated Benefits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Supply chain visibility (Situational awareness)	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	21
Increased Capacity and Asset Utilization	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	21
Supply chain resilience;	Y	Y	Y		Y		Y	Y			Y		Y	Y	Y		Y			Y	Y	Y	Y	15
Effective law enforcement;	Y	Y	Y								Y			Y			Y		Y	Y	Y	Y		10
Trusted and seamless data flow management.	Y	Y	Y		Y	Y	Y	Y		Y	Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	19
Total	5	5	5	0	4	3	4	4	2	3	5	2	4	4	4	3	4	3	4	5	5	4	4	

2.2.4 The LL impacts

Anticipated Impacts	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
Less traffic congestion	Y	Y	Y		Y	Y				Y	Y						Y	Y	Y	Y		Y	Y	13
CO2 and/or NOx reduction;		Y	Y			Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	18
Faster lead times;	Y	Y	Y		Y				Y	Y	Y	Y	Y	Y		Y	Y	Y		Y	Y	Y	Y	17
Less administrative burdens;	Y	Y	Y	Y	Y	Y		Y	Y		Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	20
More safety and improved emergency response		Y					Y		Y	Y	Y		Y	Y	Y			Y	Y	Y	Y	Y	Y	14
Total	3	5	4	1	3	3	2	1	4	4	4	2	4	4	3	3	4	5	4	5	4	5	5	

2.2.5 The LL data types

Data types	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	
Visibility	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	22
Ordering& Planning	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		-	X		X		X	19
Publish/Search				X	-	-	-	-	-		-	X	-	-	-	-	X	-	X	X	X		X	7
Booking	X	X	X	X	X	X	X	X	X	X		X	X	X	X	-		-			X		X	15
Total	3	3	3	4	3	3	3	3	2	3	2	4	3	3	3	2	2	1	3	2	4	1	4	

2.2.6 Stakeholder Involvement

Stakeholder Type	No. of LivingLabs	
Logistic chain operators	**National/local**	**EU/International**
Shipper	12	11
Forwarder/Agents	11	9
Transporter	17	11
Terminal operators	14	8
Retailer	6	5
Public Authorities	**National/local**	**EU/International**
Policy/regulator	15	3
Inspection/law enforcement	4	0

Stakeholder Type	No. of LivingLabs	
Traffic management	10	3
Police	5	1
Customs	7	6
Other	9	1
Other third parties	**National/local**	**EU/International**
Port	12	7
Transport service provider, e.g., pilotage	7	3
Standardisation organisation	4	7
Software developer	11	9
Platform provider	18	11
Hardware provider	5	5
Bank	1	0
Insurer	0	1

2.2.7 Joint Living Labs

The established joint LLs (collaborations) were:

1. LL#1/2 and 3 (CaaS) with LL#11 Customs use case (OneRecord)
2. LL#1 (CaaS) with LL#17 - eCMR (potential) and Ukraine
3. LL#2, 3 (CaaS) with LL#11 (IoL) - CO2 across transport modes
4. LL# 5, 6, 8, 9, 13, 14, 15, applying Deplide
5. LL#5 (SE) with LL#21 (ES) –focus is on RFID use case
6. LL#10 Grimaldi with LL#18 TSG (IT) –: ETA/position data and road planning
7. LL#19 en LL#20 – NL collaboration Traffic management and Im- and Export notifications
8. LL #13 and LL# 14 with LL#23 – port (incl. Wasaline – road – rail)
9. LL#16 (D4YOU) with LL#20 (eGovernment Logistics)
10. LL#17 (EU Gateway) with LL#16 and LL#21

In addition a Common LL was realised through LL#20, bringing together LL#1, LL#2, LL#3, LL#5, LL#6, LL#7, LL#8, LL#9, LL#11, LL#13, LL#14, LL#15, LL#16, LL#17, LL#19, LL#21, LL#23.

2.3 Stakeholder Engagement

The preceding sub-sections show the overall coverage of the Living Labs, confirming the inclusion and involvement of multiple stakeholders, types of data sharing, transport modes, etc. involved as well as potential benefits and impacts.

With respect to organisational requirements, the stakeholders, and more specifically stakeholder engagement, are a critical factor in realising not only the Living Labs, but ultimately the furtherance of the federative network of platforms concept. Drawing on lessons learnt during the study/definition phase moving through to eventual piloting and testing can assist in gaining insight into potential considerations for improving general understanding and knowledge on the concept (towards third parties) as well as contribute to eventual onboarding, upscaling and further implementation.

In respect of the validation of the Master Plan, stakeholder engagement in itself is not a key aspect to be assessed. However, assessments conducted in FEDeRATED in relation to the e.g. the progress of the Living Labs, identified a number of aspects that could have a bearing on eventual migration and adoption strategies.

It is important to note that the majority of LLs are coming from different angles, e.g. to name a few they may be:

- Led by authority/administrative bodies (public sector) that have the main aim to facilitate data sharing by developing the basic infrastructure which other public and private sector bodies can (later) utilize, i.e. the strategy is to first develop the capability for own use and thereafter engage with potential third parties.
- Led by authority/administrative bodies (public sector) that have the main aim to address a particular data sharing example (business case) with pre-determined stakeholders in mind, i.e. the strategy is to focus on (a combination of) a particular mode/sector or process first, and later determine potential for further cross-pollination and/or upscaling.
- Led by industry organisations (private sector) on behalf of (and with the mandate of) a particular transport mode that have the aim to streamline data sharing for own operational purposes across the sector at the same time as determining and testing potential/conditions for cross-sector utilization, i.e. the strategy is to develop existing (agreed) initiatives and assess impact on and by the wider FEDeRATED approach.
- Led by business (private sector) in the role of (transport) operator that have the main aim to address data sharing capabilities from first within their own organization and then to the outside world, i.e. the strategy is to first collect and organise own data capabilities to then open up for further sharing.
- Led by business (private sector) in the role of (IT) service provider that have the aim to adapt and adopt (existing systems and the FEDeRATED architecture) for existing clients and/or potential new collaborations for specific processes whether related to goods flow or reporting requirements, i.e. the strategy is to develop and deliver solutions that are FEDeRATED compliant with the least possible impact on clients.

It is also important to note that the LL leaders, themselves stakeholders, represent different interests in the transport and logistics chain as well as in the chosen LL business cases themselves. A typical business case involves three or more stakeholders. These stakeholders vary from authorities through to transport operators, platform providers and cargo owners. Depending on the type and role of the stakeholders involved all Living Labsa have indicated that the degree of involvement of certain stakeholders is of vital importance to ensuring commitment and eventual progress. It is possible to identify multiple responsibilities and roles for the stakeholders involved. Following is a list, in no particular order or logical grouping, of the type of roles involved:

- Data user;
- Data holder / owner;
- IT provider;
- Authority / network manager;
- Cargo owner;
- Transport company;
- Administration;
- Service provider;
- Platform provider;
- Problem owner;
- Problem solver;
- Solution owner;

- Standards developer.

Based on the practical experiences and lessons learnt from the various LLs, success was related to the following three main success factors:

- The mandate of the primary stakeholders within any given LL (e.g. the pre-determined authority, role or task to facilitate or provide a data sharing solution);
- The (active) participation of the problem owner (e.g. the stakeholder that has the data and the need to share the data);
- The capabilities and knowledge of the problem solver (e.g. the (long-term) vision and grasp of the concept, as well as the ability to commit third parties based on perceived (positive) impacts).

Problem ownership is herein a major factor. To illustrate, problem owners related to city logistics/last-mile delivery were reluctant to (actively) participate when this could be perceived as a threat to e.g. current business models and practice. This was, for example, the case for both LL#4 and LL#9. On the other hand, when the case for the (active) participation of the problem owner was apparent, as was the case with e.g. LL#11 (with IATA) and LL#20 (with Customs), there is a clear drive to be more open to the potential of federated data sharing. This is also reflected in the eventual assessment of the technical capabilities realized (see 5).

3 THE FUNCTIONAL REQUIREMENTS

The functional requirements of the infrastructure provision 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 of business services – it is about being able to search and find (query) service providers and data that an organisation needs for its tasks. The latter is filled in with 'Linked Data': an organisation 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.

3.1 The DTLF Building Blocks

The functional requirements were developed based on the DTLF 4 Building blocks setting the foundations of a federative network of platforms concept. These building blocks were applied by FEDeRATED to develop a Core Operational Framework (COF) which led in turn to developing the Leading Principles.

The LivingLabs have been requested to implement the Leading Principles since 2020. Starting 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 Living Lab, based on the individual Living Lab reporting in 2023. The LLs Leading Principles score in relation to the DTLF building blocks are:

1 PLUG & PLAY			
No	**Leading Principle**	**Description**	**No LL**
2	**Electronic format**	The information is to be encoded digitally, using a revisable structured format	22
4	**Business service**	Each participant formulates prided and required business service(s)	19
7	**Data requirements enterprises**	Business services and commercial mechanisms specify the data to be shared.	**12**
8	**Data requirements authority**	Data requirements are related to legislative basis afforded to that authority	**15**
11	**Publication data**	Public authorities publish their data requirements in machine-readable form	**8**

1 PLUG & PLAY			
No	**Leading Principle**	**Description**	**No LL**
	requirements		
12	Business Service Discovery	Business services are discoverable through harmonized search criteria	7
13	Authorities providing data	Public authorities can share their data with enterprises within legal framework	14
16	Combining data requirements	Public authority responsible for 2 or more legal acts combine all data in 1 data set	20
17	Identification of organisations	Each organization is able to identify itself uniquely according to agreed attestations with transparent validation processes of these attestations	20
18	Identification of users	Persons acting on behalf of participating organization can identify themselves as such	17
19	User capabilities	3rd party transparency of capabilities or on performance of any identified user	19
22	Identification of systems	Uniquely identifiable IT systems support roles of the data provider & -receiver	17
25	Data at source	Single sharing of links, multiple (controlled) access to data	19

2. TECHNOLOGY INDEPENDENT SERVICES			
No	**Leading Principle**	**Description**	**No LL**
2	Electronic format	The information is to be encoded digitally, using a revisable structured format	22
6	Supply/logistics chains	Business relations according to their outsourcing hierarchy	15
25	Data at source	Single sharing of links, multiple (controlled) access to data	19
26	Data sets	The data sets identifying links can be shared according to reference	15

2. TECHNOLOGY INDEPENDENT SERVICES			
No	**Leading Principle**	**Description**	**No LL**
		architecture	
27	**Baseline standards**	Used to providing common terminology, data formats, code values, etc.	**18**
28	**Data timestamps**	Event for sharing milestones has own timestamp	**19**

3. FEDERATION OF PLATFORMS			
No	**Leading Principle**	**Description**	**No LL**
2	**Electronic format**	The information is to be encoded digitally, using a revisable structured format	**22**
14	**Push/pull mechanism**	B2A: Shared Push data duplicated. Shared Pull data can be made accessible	**11**
15	**Publish/ subscribe**	Relevant new data made available when fit for purpose or commercial relation	**10**
25	**Data at source**	Single sharing of links, multiple (controlled) access to data	**19**
27	**Baseline standards**	Used to providing common terminology, data formats, code values, etc.	**18**
28	**Data timestamps**	Event for sharing milestones has own timestamp	**19**
29	**Unique identifier datasets**	Used to create and share links of relevant data sets between any 2 companies	**16**
30	**Data sharing solution**	Organizations select a solution of their choice for data sharing with others	**20**
31	**Federation**	Organizations are able to share or access data with others	**17**

4. TRUSTED, SAFE AND SECURE			
No	**Leading Principle**	**Description**	**No LL**
1	Level Playing Field	Ability for all stakeholders to participate.	22
3	Compliance rules	Data sharing compliant to existing legislation and privately agreed rules.	15
5	Business relations	Trust between enterprises is primarily driven by their real work relationships.	17
6	Supply/logistics chains	Business relations according to their outsourcing hierarchy	15
10	Fit for purpose	Public authorities that access enterprise data require a legal basis	11
20	Data sensitivity	Non accessibility or non-data change ability unauthorized users or 3rd party	18
21	Metadata data sharing	Specifying unauthorized 3rd party meta data availability.	13
23	Data sharing policy	Policy or agreement specifies use/reuse of data & how it is stored or removed	15
24	Data sovereignty	Data owner determines the data to share; retains full data rights and controls	20
33	Data Exchange integrity	Accuracy and consistency of data over its entire lifecycle is required	16
35	Logging and audit trail	Organisations store (shared) immutable log and audit trail of the data shared	11
36	Monitoring	Full traceability to check with whom at what time particular data was accessed/shared	18

Table 2 The Leading Principles overview and LL score in connection to the DTLF building blocks

The DTLF Building Blocks aspects most adopted by the Living labs are:

#	DTLF Building Block	Leading Principle
1	Plug and Play	2. Electronic Format 4. Business services 16. Combining data requirements 17. Identification of organizations 25. Data at source
2	Technology Independent Services	2. Electronic Format 25. Data at source 28. Data Timestamp
3	Federation	2. Electronic Format 28. Data Timestamp 30. Data Sharing Solution
4	Trusted, Safe, and Secure	1. Level Playing Field 24. Data Sensitivity 36. Monitoring

The DTLF Building Blocks least adopted by the Living labs are:

DTLF Building Block		Leading Principle
1	Plug and Play	11. Publication data format 12. Business Service Discovery
2	Technology Independent Services	
3	Federation	14. Pull 15. Publish & Subscribe
4	Trusted, Safe, and Secure	18. Fit for Purpose 26. Logging in Audit Trail

In Milestones 8 and 10[16] specific scores per Living lab in relation to the Leading Principles were provided.

- 10 LLs applied more than 75% of the Leading Principles (LPs); LL#1, #2, #5, #10, #11, #17, #19, #20, #21, #23
- 8 LLs scored between 60-75% of all Leading Principles: LL #7, #8, #12, #13, #14, #16, and #18.
- 5 LLs scored below 50% of all Leading Principles: LLs #3, #4, #6, #9, #22

[16] See for FEDeRATED Milestone reports: 6. MILESTONE reports (federatedplatforms.eu)

The application of the LPs in the LLs:

- 15 LPs are applied in more than 75% of the LLs i.e., LPs #1, #2, #4, #5, #9, #19, #20, #22, #24, #25, #28, #30, #31, #32, and #36
- 15 LPs are applied in 50-75% LLs
- 7 LPs appear to be the most difficult LPs to apply: - #7, #10, #11, #12, #14, #15, and #16.

To conclude:

- The LPs most feasible to achieve for most LLs relate to level playing field, data at source, data sovereignty, linked data to events, knowledge of their specific IT systems and business services and interactions, and monitoring seem to be very feasible indeed.
- The least feasible LPs to achieve seem to include: Publishing data in a machine readable format, making the data available to facilitate discoverability, applying publish and subscribe and push/pull mechanisms, providing 3rd party access to meta data and providing a logging and audit trail.

3.2 DTLF Implementation Mode

Three different data sharing mechanisms can be identified:

1. **Bilateral P2P** - One organisation shares data with another organisation through a direct link
2. **Platform** - A central entity provides the platform to which individual parties connect, enabling these parties to share data with each other, greatly reducing the links for parties to share with each other.
3. **Federated** (multiple, open en neutral - - Any party (node in a grid) is capable to non-prescribed M2M querying of any other party (node) and to share readable data through an access point with any other.

DTLF identified 4 data sharing implementation modes, based on a variant of the above 3 mechanisms. The Living Labs adoption was the following:

DTLF Implementation Mode																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
A. Peer-to-peer (p2p) data sharing	Y	Y	Y		Y				Y		Y							Y		Y				8
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				5
D. A combination of peer-to-peer (p2p) and a platform											Y					Y	Y	Y		Y	Y	Y	Y	8
Total	2	2	2	0	2	1	1	1	2	1	4	1	2	2	2	1	1	2	0	4	1	1	1	

The implementation mode adopted by an individual LL had an influence on the Leading Principles and Capabilities that were eventually implemented and tested by them.

4 THE LIVING LABS TECHNICAL SPECIFICATION – CAPABILITIES

The infrastructure provision can only be developed based on the capabilities of its participants to participate. The technical specifications – capabilities - for any data holder or user to participate are:

1. Apply the semantic web technology and a common semantic model (Semantic adapter). Semantics - discussed in the context of semantic web, instead of modelling data – can add contextual meaning around data so it can be better understood, searched, and shared within supply chains, full of varied and complex logistic operations and compliance procedures.
2. Utilize an Identification and Authentication (IA) infrastructure – the unique identification and authentication of an organisation and its authority granted by a recognized registration authority.
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.

4.1 Assessing the Living Labs

In 2023, based on the Living Lab technical progress reporting (see Milestone 10), an assessment framework was developed. The goal of the assessment framework was to test whether the various Living Labs sufficiently complied with the details of the technical specifications as indicated above. The Assessment framework is explained in Annex 1.

As a number of the 23 Living Labs deploy the same technical setting, the assessment of the LLs was focussed on their operating LL engines enabling federated data sharing. The assessed LLs (engines) are:

1. **ABC CaaS** - combining the **LLs #1, #2 and #3** – eCustoms and monitoring systems through sensors, also applying eCMR
2. **Deplide** - covering the **LLs #5, #6, #8, #13, #14, and #15** – focussing on providing federated platform interoperability focusing on operational data choreography for various use cases.
3. **Real Time Information Services (RETIS – LL#7)** - extended Single Window application for seamless hinterland interconnectivity
4. **Internet of Logistics (LL#11)** – IATA aviation cargo data sharing management approach based on a standardized approach establishing a trusted network with an option for third party interoperability
5. **Terminal Track and Trace System (LL#12)** – terminal interoperability for road and train, also in connection to D4YOU (LL#16) – platform interoperability
6. **Hermes (LL#10) in association with Smart TSGate (LL#18)** – Shipping monitoring system also in connection with terminal interoperability, with special focus on developing a semantic

adapter for third party data sharing[17]

7. **D4You (LL#16)** Data-lake interoperability within and between B2B and Zailog will possibly integrate their activities. Special focus on eCMR/eFTI
8. **EU eFTI Gateway (LL#17)** – Data Access through existing semantic standards, applying an easy-to-use OneAPP Gateway focussing on eCMR/eFTI applicability
9. **DEFlog – Data Exchange Facility (LL#19)** – A platform facility enabling the exchange of incident road transport information between data holders and data users
10. **eGovernment Logistics (LL#20**) – Federated node prototype development for eCustoms, in close connection to third party - PCS, Codognotto and third countries - interoperability
11. **SIMPLE (LL#21)** – data access and platform interoperability for sea, rail and road transport, extending MSW functionalities and possibly eFTI applications
12. **ELSA BEA-st (LL#22)** – data sharing platform based on a data standard to monitor the environmental footprint of construction material transport.
13. **Realtime Multimodal Transport Visibility Platform Services (LL#23)** - an inhouse data sharing mechanism providing emission monitoring and visibility services to third parties

This numbering is used in the overviews given hereafter. The next sections provide a detailed assessment of each solution, including a proposal for potential next steps for a solution.

4.2 Overview of capability assessment

The following figure shows the assessment of the overall implementation of the capabilities by the Living Labs. The average attention to the different capabilities by the Living Labs have a same weighting factor.

The average implementation of the capabilities by all Living Labs engines is as shown in figure 2.

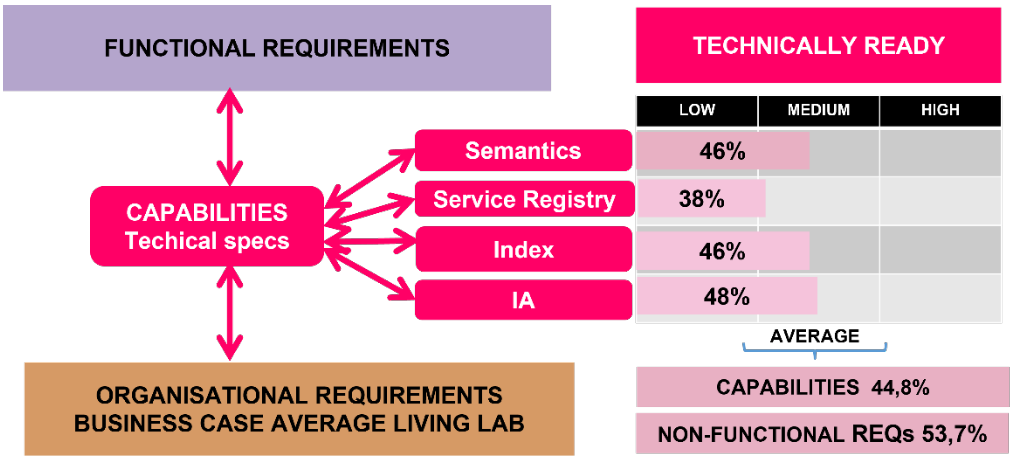

Figure 2. Overall implementation of the capabilities Living Labs engines

Figure 2 shows that on average the Living Labs engines score the highest on the implementation of IA (48%). Second are semantics (46%) and index (both 45%). The Service Registry (38%) was given the least attention. The average capabilities score for all Living Labs is 44,8%.

[17] TSG and Grimaldi are combined into one setting, since Grimaldi provides APIs to TSG, which functionality is also available via a semantic endpoint.

The average score on all 4 capabilities and the nonfunctional requirements is depicted hereunder:

No	LL Engine	Average % capabilities	Nonfunctional requirements %
1	ABC Caas – LL#1, #2, #3	37	64
2	Deplide - LLs #5, #6, #8, #13, #14, and #15	28	77
3	RETIS (LL#7)	25	39
4	Internet of Logistics (LL#11)	72	46
5	Terminal Track and Trace System (LL#12)	26	34
6	Hermes (LL#10) - Smart TSGate (LL#18)	36	46
7	D4You (LL#16)	36	41
8	EU eFTI Gateway (LL#17)	64	63
9	DEFlog – Data Exchange Facility logistics (LL#19)	17	26
10	eGovernment Logistics (LL#20)	80	80
11	SIMPLE (LL#21	55	62
12	ELSA BEA-st (LL#22)	27	40
13	Realtime Multimodal Transport Visibility Platform Services (LL#23)	79	80
TOTAL AVERAGE BASED ON INDIVIDUAL LL		44.8	53,7
Common Living Lab based on collaboration between all LL engines mentioned above, except 6, 9 and 12		79	80

In relation to the Master Plan (M14), and the validation thereof, it is important to note that the scores above represent the realized capabilities against the full-fledged FEDeRATED Architecture as provided in the Master Plan (M14). It was not the ambition or intention that each and every Living Lab would implement and/or test the complete package of requirements and specifications. When comparing the individual Capabilities then it is to be noted that 26 of the 27 specified capabilities scored a maximum "high" in at least two Living Labs. This showed that for those Living Labs having these capabilities as a focal point, they were shown to be feasible.

Three LL engines score relatively high, namely 4 (LL #11), 10 (LL#20) and 13 (LL#23). These have either focused on one of the capabilities, like semantics (LL#20) or index (LL#11 and LL#23), either with the conforming to the FEDeRATED Node prototype or with their proprietary models and approach (LL#23). One Living lab scores low, namely DEFlog. It provides an API Registry for data sources, acting as a proprietary data broker. The capabilities of the LLs in relation to the migration path

Five steps have been identified towards adopting the federative network of platforms concepts by the participating organisations. This can be identified as a migration strategy.[18] The migration strategy illustrated in the figure 3[19].

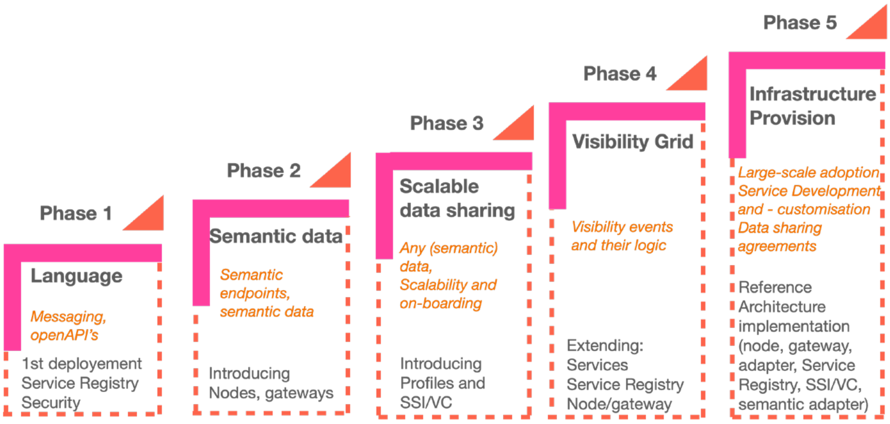

Figure 3 The migration path

Phase 1 Language

The Living Labs have adopted this first phase, which is about applying a semantic model for generating openAPIs. Most LLs manually developed openAPIs and did not generate them from their semantic model. This implies a potential maintenance issue might occur in future; whenever a semantic model changes, their openAPIs may have to be changed too and vice-versa. In most cases, when openAPIs change, the semantic model is not amended since only openAPIs are implemented.

Some LL engines aligned their model with the FEDeRATED semantic model (e.g. LL#11, Internet of Logistics), whereas others have developed their semantic model with the FEDeRATED one (e.g. LL#21 SIMPLE). eGovernment Logistics (LL#20) applied the FEDeRATED semantic model to configure openAPIs. RETIS (Living Lab #7) is considering applying the prototype Service Registry used by LL#20 for developing their data requirements with the FEDeRATED semantic model.

Phase 2 Semantic data

Most Living Labs also moved to the second phase in the migration path which is about introducing semantic technology implemented by a node or gateway hiding complexity and the Index APIs supporting the functionality developed in phase 1. For instance, Terminal San Giorgio and Grimaldi (LL#10 and LL#18), 51Biz (LL#17), and eGovernment Logistics (LL#20) have a semantic endpoint and others intend to implement this (e.g. Deplide, e.g. LLs #5, #6, #8, #13, #14 and #15).

All Living Labs, except LL#19 DEFLog and LL#22 ELSA-BEA-st. are event based (phase 4), meaning they share visibility data with (potential) links to additional data. Whereas DEFLog provides

[18] See more on migration strategy: [Migration_Strategy_towards_federated_data_sharing.pdf (federatedplatforms.eu)](Migration_Strategy_towards_federated_data_sharing.pdf)

[19] See Milestone 14, chapter 7.4.2.

a very basic version of a Service Registry for open data, ELSA-BEA-st takes a traditional approach. They are not within scope of any of the steps of the migration path and thus do not scale.

In this case, visibility offered by LL#20 eGovernment logistics is fully based on semantic technology with configuration of openAPIs generated directly from the model. It implements de facto events such as those provided in the context of an experiment with Singapore and those of Codognotto (LL#19 D4YOU). This means that changes to the semantic model can be made available rapidly to those that require them. It lowers maintenance issues; discussions are only on semantics and not on technology.

Phase 3 – Scalable data sharing

Although all Living Labs have implemented authorization tokens, which illustrates the high score for IA, the third phase of the migration path requires support of VCs and SSI. None of the Living Labs has implemented these. VCs and SSI require trusted issuers and issuing policies based on public or private regulation (which is not yet available for large scale applicability). Only eGovernment Logistics uses a proprietary mechanism that reflects VC functionality. eGovernment Logistics (LL#20) also experimented with authorization tokens, but these did not add value to the proprietary mechanism.

Phase 4 Visibility Grid

This Phase is about implementing new services, such as visibility service. Both the Index and Service Registry functionality are not fully implemented by the Living Labs. LL #20 is the most advanced by using a tool, Semantic Treehouse, for configuring openAPIs of the Index functionality (the node)[20]. This tool can be used to configure a node for events, profiles, business activities, or whatever tree structure is required according to the architecture (providing a user of this tool has sufficient experience and safeguards consistency and completeness of generated output). The node of eGovernment Logistics supports the eventAPIs of the Index APIs. Additional functionality, for instance event logic or query federation, is not yet supported.

Phase 5 – Infrastructure Provision

The fifth phase is about data sharing between various nodes, applying the capabilities and providing services. The Common Living Lab – chapter 6 - is about federation of the various Living Labs. It has been executed by various Living labs implementing the multimodal visibility node prototype services provided by the LL#20, Government Logistics, connecting events. This is the approach that for instance SIMPLE (LL#21) and Codognotto (LL#16) will take for federation.

[20] See Node prototype and installation, incl codes . The latest version of the node prototype and updated documentation can be found at: https://github.com/Federated-BDI/FEDeRATED-BDI for the semantic treehouse see Service Registry and presentation

5 CAPABILITY ASSESSMENT OF THE LIVING LABS

5.1 CaaS Living Labs

The CaaS Living Labs focus on enabling paperless transport of perishables by road, water, and air at different corridors like Asia (Living Lab 1), Estonia (Living Lab 2), and Mediterranean (Living Lab 3).

5.1.1 **Capability support**

The LL project leader, Vediafi, has developed its own proprietary type of platform integrating various stakeholders in different Living Labs. Living Lab 1 is based on ONE Record, Living Lab 2 relates to eFTI, and Living Lab 3 is complementary to the Living Labs #1 and #2.

As such the solution is based on all types of interfaces, supports standard syntaxes, and has open APIs. It is a type of 'data/event router or switch' and can also be positioned as API Gateway. It supports routing of events or data from a sender to a recipient, according to agreed implementation guides of standards for a Living Lab. It is not an index as such since all index functionalities must be implemented by stakeholders. Similarly, it does not have a Service Registry, also because many functionalities are still in a prototype phase.

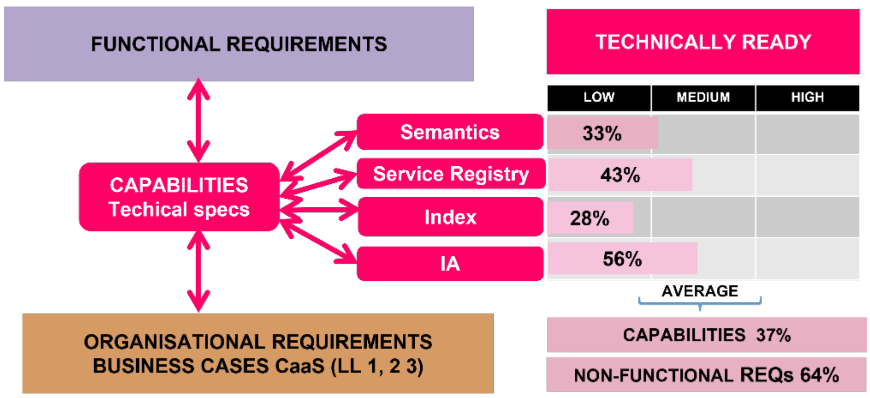

Figure 4 Technical Assessment CaaS (LLs 1,2, and 3)

5.1.2 **Overall support of capabilities and non-functional requirements**

Figure 4 shows that 64% of non-functional requirements are implemented, because the functionality is still in a prototyping phase. The average on capabilities is 37%.

5.1.3 **Positioning the solution**

The platform being provided functions as a type of router or switch for events/data. It is agnostic of the data that is shared. Data semantics of others is applied to create interoperability in a Living Lab. The main emphasis of Vediafi has been to figure out which type of application is required by stakeholders. At this moment, it seems to be a solution for supporting data sharing for eCMR and eFTI.

5.2 Deplide

RISE has developed and applies a common solution, called Deplide, to several Living Labs in Sweden, namely LLs 5, 6, 8, 13, 14, and 15. Deplide is an implementation of a Kafka broker. Kafka has been developed for handling large volumes of sensor data and extracting all types of value out of these streams. These are called ‘topics’ to which one can subscribe. A topic is for instance ‘train composition’ in Living Lab #5 (RFID in Rail).

5.2.1 Capability support

Deplide has been developed to support different use cases in Living Labs, each with its interaction sequencing. When required, extensions to Deplide for a use case are made, for instance to support specific data structures for business interactions.

This results in the assessment as shown in the following figure. Semantics is per interaction, with proprietary (use case) formats. Standard tools are used for publishing APIs with Deplide. The Index is about sharing or extracting events from data streams, where the format and syntax is of choice by a use case. Identity and Authentication are based on a single Identity and Access Management Registry.

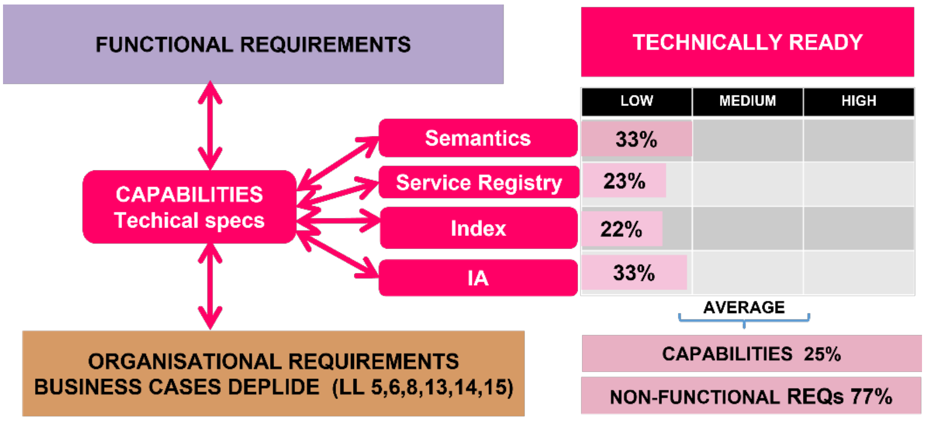

Figure 5 Technical Assessment Deplide (LLs 5, 6, 8, 13, 14, and 15)

5.2.2 Overall support of capabilities and non-functional requirements

Nonfunctional requirements are relatively well supported by Deplide, for 78% since these are part of Kafka. Capabilities are supported for 25%.

Extendibility and flexibility of the solution is low, each new use case requires software development and – testing.

5.2.3 Positioning the solution

Deplide is a Kafka based centralized solution for sharing data amongst stakeholders. These stakeholders can specify their use cases with data requirements, which are implemented by Deplide. One could say that there is a separate version of Deplide for each use case since each use case can result in additional software (modules) of Deplide.

One separate module is the development of a module supporting semantic web standards like RDF and OWL/SHACL. This is under development; it could potentially lead to the ability of Deplide to function as a node in the infrastructure provision.

5.3 RETIS (LL#7)

SMA (Swedish Maritime Agency) has applies a technical setting that differs a bit from that of the other Living Labs. It relates to Collaborative Decision Making for synchronizing logistics processes (also called: synchromodality) by sharing event data.

5.3.1 Capability support

In this Living Lab, SMA has taken the lead by specifying in semantics and selecting other required features. This results in additional requirements for implementing the Index functionality and future integration other partners in FEDeRATED via a node (see the Common Living Lab, chapter 6) and application of Semantic Treehouse (to model events)[21].

5.3.2 Overall support of capabilities and non-functional requirements

This capabilities assessment relates to the assessment of Deplide (see 5.2.2). For the nonfunctional requirements, RETIS scores 39%. See figure 6.

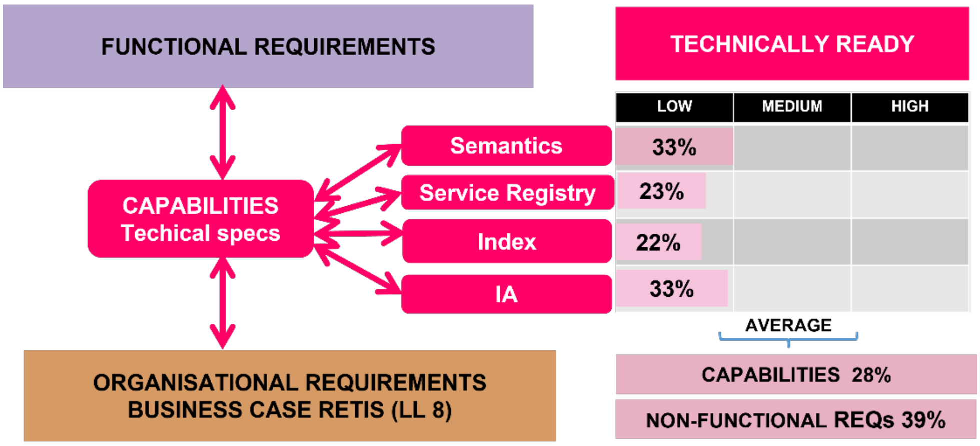

Figure 6 Technical Assessment RETIS (LL 7)

5.3.3 Positioning the solution

SMA has indicated to start the applicability of Semantic Treehouse for specifying events and other data structures. This could well be done in collaboration with for instance Dutch Customs Administrations that also requires reception of various logistics (maritime and others) events.

5.4 Internet of Logistics (LL#11)

This Living Lab is about the implementation of ONE Record by airlines. ONE Record is developed with and maintained by IATA on behalf of its members (some 290 airlines in 120 countries with about 82% of air traffic). ONE Record is based on semantic web technology. The required capabilities are implemented for various services required for business process collaboration in air freight transport. ONE Record is implemented as openAPIs that must be integrated with various legacy systems of airlines.

5.4.1 Capability support

Semantic technology and semantics is available, but must support the implementation by various stakeholders. Specific tools have been developed like the NEON server supporting browsing

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[21] See more on semantic treehouse: Service Registry (semantic treehouse) see also presentation

semantically rich ONE Record data.

With respect to various toolsets, like the Service Registry, the functionality is available in a type of hardcoded way. ONE Record, event patterns/logic, and openAPIs are the standard. These openAPIs can be implemented and integrated with IT legacy systems by for instance airlines, shippers, and forwarders.

Identity and Authentication is fully implemented with mechanisms like OpenID and JWT. Identities are fully decentralized by federated IAM Registries (IAM – Identity and Access Management).

5.4.2 **Overall support of capabilities and non-functional requirements**

The implementation of functional (capabilities) is 72% and 46% of the nonfunctional requirements are implemented. See figure 7.

Since the implementation of ONE Record is fully distributed, it must be noted that support of non-functional requirements depends on end-users' implementation.

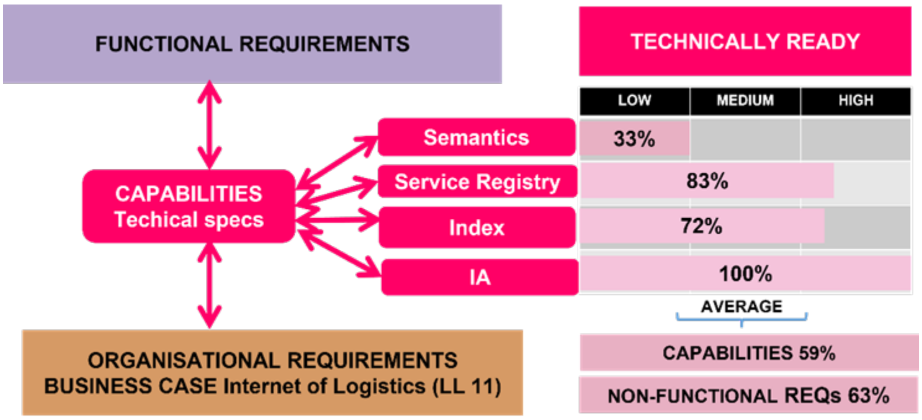

Figure 7 Technical Assessment Internet of Logistics (LL11)

5.4.3 **Positioning ONE Record implementations in FEDeRATED**

The assessment of the Living Lab shows they develop openAPIs with a semantic model. This is the first migration phase of creating an infrastructure. Since they also have developed various services and supporting event logic, that covers the fifth migration phase.

Although there is a relatively limited number of airlines, the number of freight forwarders for air transport is quite significant (over 6.000 are registered by Cargolink). These, and many others like shippers, will have to implement the openAPIs. They will have to implement API Gateways acting as an interface with airlines, thus being able to transport freight with all airlines of choice. Such an API Gateway not only provides API support with various airlines, but also verification of authentication tokens. Federation of IAM Registry must be developed separately.

API Gateways are offered as a service with a pay per usage, for instance including a free tier of one million APIs per month (Amazon Web Services). Installation of an API Gateway costs around 100 US dollars for SMEs. All costs depend on factors such as traffic volume, data transfer, caching, and additional features.

Thus, from a scalability perspective, only federation of IAM Registries could become an issue. Utilizing Verifiable Credentials may address this situation. Only in case customers of airlines also interface with other modalities utilizing other APIs, complexity increases and thus costs of implementing a larger variety of APIs.

Although ONE Record is based on semantic modeling, the implementation is based on (hardcoded) APIs. It is the standard, which requires time (and money) to include new functionality (extendibility and flexibility of the solution). An API Gateway might provide decoupling between openAPIs standards of airlines and a user of those openAPIs, thus hiding changes for these users and making them available upon request.

5.5 HERMES (LL10) and smarTSGate (LL#18)

This is about creating a visibility environment for truck, trailer, and container movements of the Terminal San Giorgio in collaboration with the Hermes system of Grimaldi. Carriers or forwarders can access the status (e.g., ETA) of their cargo (truck, trailer, container).

5.5.1 Capability support

The solution is based on two approaches, namely implementation by REST APIs and a SPARQL endpoint. It has a subscription mechanism for events. The APIs for subscription (and overall management) have been published and validated on a Swagger solution has its own model and events are partly aligned with the FEDeRATED semantic model. It is basically about publication of events that are accessible by various mechanisms, including subscription.

The solution is completely machine-to-machine, implying that for instance GUI functionality is available via IT systems of participants.

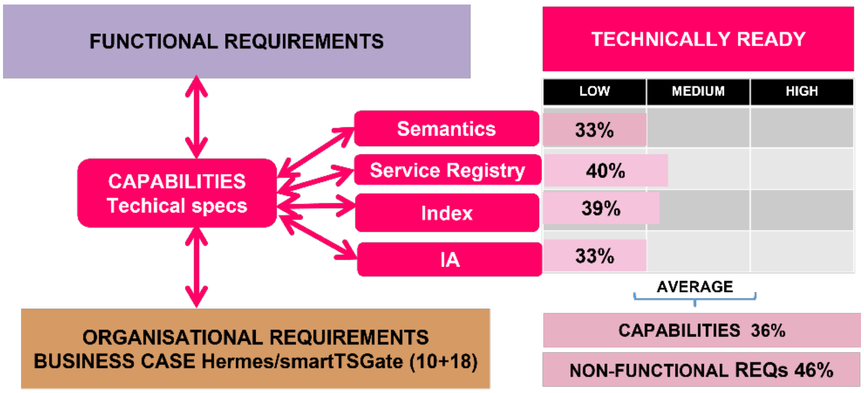

Figure 8 Technical Assessment Hermes/smartTSGate (LLs 10 and 18)

5.5.2 Overall support of capabilities and non-functional requirements

This LL complies with 46% of all nonfunctional requirements and 36% of all capabilities, see figure 8. The overall support of non-functional requirements is based on dockerisation. There is no contingency plan, yet. Whilst various options for data sharing are also implemented from a proprietary model, their specification and implementation must be governed manually since they are not generated by a tool. They cannot be configured. For instance, the SPARQL endpoint has been developed with open source (Apache Fuseki), which is recommended, but needs to be programmed manually (e.g. data validation is to be programmed).

5.5.3 Positioning the solution

The integrated solution of Terminal San Giorgio and Grimaldi can be considered as a first step towards developing an infrastructure provision. Especially, when the events at the SPARQL endpoint are transformed into events according to the semantic model. An event push mechanism is already available. Furthermore, scaling requires the implementation of VCs, together with agreed issuing policies for onboarding. If VCs are not available and large-scale onboarding is not the case, authorization tokens (JWT/OAUTH) will work well.

5.6 Terminal Track and Tracing System (LL#12)

The objective of this Living Lab, led by Zailog Srl, is to introduce a virtual fast lane concept as a service for reduction of waiting times of trucks and optimization of planning by the terminal operator. It has been tested by Codognotto via REST APIs.

5.6.1 **Capability support**

The Living Lab is about tracking Codognotto boxes with IOT devices. It is about a datastream provided via an API by Codognotto to Zailog (and others). A technical solution is developed whereby for instance semantics is part of the JSON data structure of the API. The API is available via Swagger and integrated with the Zailog Terminal Operating Systems (TOS) via a standard data structure (EDIGES standard). It has been fully integrated into the TOS and no additional functionality has been developed. Identification and Authentication is based on OAUTH2.1 and JWT.

5.6.2 **Overall support of capabilities and non-functional requirements**

The non-functional requirements for an API integration are implemented (average 34%). This means that usability, flexibility, and extendibility are not addressed. The API as such is implemented. Availability of the API depends on Codognotto and is not applicable to Zailog. The average technical assessment on the capabilities is 27%. See figure 9.

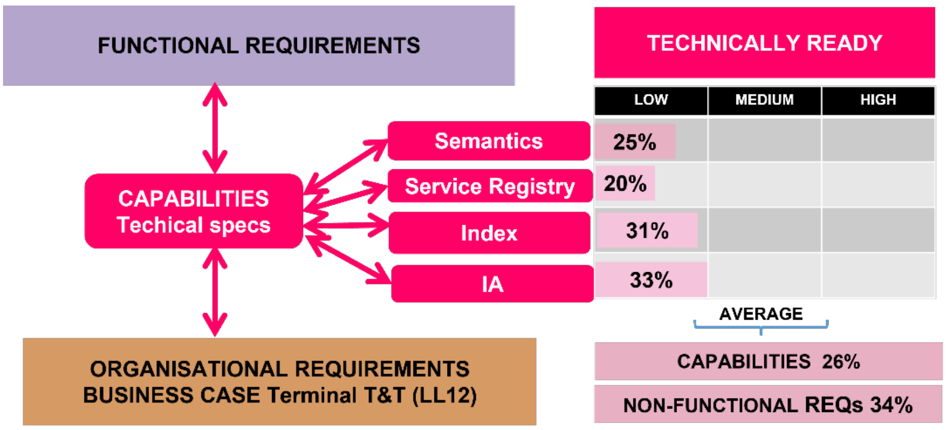

Figure 9 Technical Assessment Terminal Track and Tracing System (LL12)

5.6.3 **Positioning the solution**

The solution is focused on establishing a visibility API. It requires a tight coupling between the API caller (Zailog) and the API provider (Codognotto), where the API, its endpoint and JSON structure are. Such a type of integration is only scalable if for instance Zailog implements an API gateway and Codognotto supports a standardized API, based on for instance the generic multimodal visibility service. By positioning a node, as Codognotto plans, decoupling is provided and Zailog and Codognotto would only have to implement a single (Index) API with a node to share data with all relevant stakeholders. This also requires a proper IA mechanism.

5.7 D4YOU

The objective of Living Lab # 16, (D4YOU) is to improve data sharing with customers and service providers for various corridors by implementing state of the art technology. A data lake of events is created to provide supply chain visibility for full truck load (FTL) shipments.

5.7.1 Capability support

The solution is fully Azure based. It contains openAPIs to forwarders and customers/suppliers, including GUIs (apps on smart devices, e.g. for drivers). The openAPIs (JSON/XML) are extracted from the Codognotto TMS (Transport Management System) data structure and support all types of interfaces. In addition, EDI/XML based messaging interfaces are also supported.

As the assessment shows, development of the index functionality (event data lake) with various interfaces is the focus. All other functionality is to support development, like a (Swagger) API Registry. Identity and Authentication is based on tools provided via Azure, e.g. role-based access control with Active Directory including LDAP support.

5.7.2 Overall support of capabilities and non-functional requirements

The overall D4YOU support of capabilities is relatively low compared to others (36%). Like said, the focus was on developing the index (data lake). Therefore, to comply with non-functional requirements is more important. (41%) These still need to be upgraded. See figure 10.

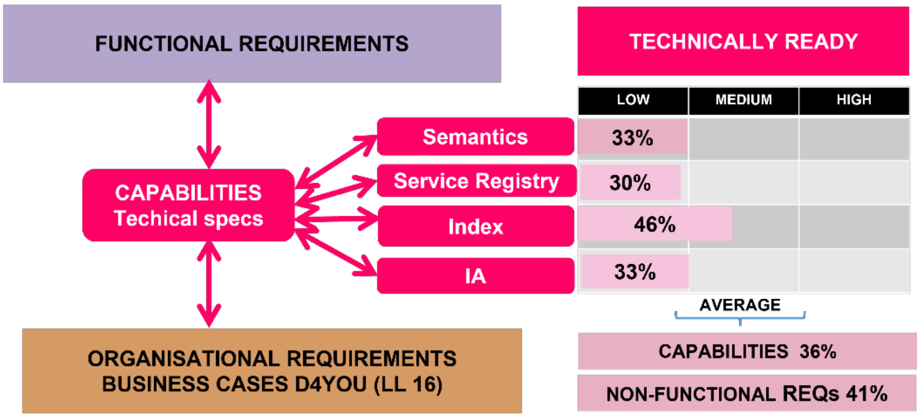

Figure 10 Technical Assessment D4YOU (LL16)

5.7.3 Positioning the solution

The assessment shows that the solution is still in phase 1 of the migration phases towards a federated data sharing, whereas the openAPIs are proprietary and constructed from a proprietary data model. Thus, it does not scale and is not extendible and flexible for new functionality. It constitutes capabilities with respect to events (data lake) that Codognotto can provide and share with external stakeholders. The solution can open up according to the approach given in the Common Living Lab, where Codognotto integrates its data lake with a node.

5.8 EU eFTI Gate eCMR/eFTI OneAPP Access (LL#17)

The goal of LL#17 is to develop functionality for various use cases with a focus on paperless road transport (eCMR and eFTI Regulation). This is supported by its name: EU-Gate eCMR/eFTI Access Point and OneAPP/API for authorities.

5.8.1 Capability support

The combination of an EU-Gate, which could be considered as an API – and messaging Gateway, that could function as an Access Point with a single API, where the functionality of this API is provided to authorities, is ambitious. This is reflected in the support of the capabilities where different types of interfaces and data sets are supported, like IATA ONE Record APIs and eCMR – and eFTI data sets. Furthermore, various syntaxes (JSON-LD, EDIFACT, XML) are supported.

The Living Lab uses its models to support these syntaxes, including applying graph databases (NEO4J) for data transformation. This is all reflected by the assessment of capability support by this Living Lab, resulting in the implementation of 2/3 of all required capabilities as the Living Lab has formulated itself.

With respect to Identification and Authentication, the implementation supports OAUTH2.0 and aims to implement the iSHARE solution and Verifiable Credentials.

5.8.2 Overall support of capabilities and non-functional requirements

The average implementation of capabilities is 64% and the implementation of the non-functional requirements 63%. See figure 11.

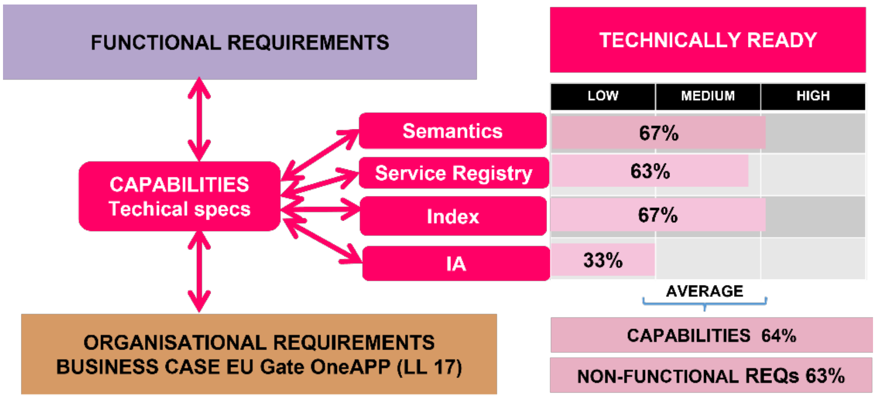

Figure 11 Technical Assessment EU Gateway OneAPP (LL 17)

5.8.3 Positioning the solution

LL#17 provides a solution with its own internal model, supporting all types of interfaces via EU-Gate and a single API (set) provided by this gate. Technically, this is a sound solution. It is typical for service providers like forwarders. They must interface with many stakeholders (shippers, carriers, ports, hubs, etc.), each with their own interfaces. Having such a solution, which can be an API – and messaging Gateway (see IATA assessment), comes with a configuration and maintenance cost. The more interfaces, standards, implementation guides, syntaxes, etc. must be implemented, the higher the configuration and maintenance costs, especially for SMEs.

The previous also has impact on extendibility and flexibility of the solution. Since everything is hardcoded (although generated), changes need time.

Since the solution supports (REST) APIs (not openAPIs) generated from a (proprietary) model, the implementation is considered as one in the first phase of migration. There is a minimum support for semantic data (RDF and SPARQL) and no FEDeRATED services with event logic are supported.

As the assessment shows, the Identity and Authentication aspect are not fully developed (yet). This is required for scalability of the solution.

5.9 DEFlog (LL#19)

The Data Exchange Facility Logistics (DEFLog) Living Lab provides a web-based solution where data holders can publish data sources, including their interfaces and conditions (like pricing schemes) for accessing the data. Current data sources are all open. As facility, DEFlog is provided via Portbase.

5.9.1 **Capability support**

Since Deflog is a type of API Registry, its focus is on providing capabilities to data holders for publishing data sources and data users to find these. There is no prescription on semantics and APIs, it is up to a data holder to publish their APIs. The Open Trip Model is a common data carrier that is applied by several data holders. This is illustrated in figure 12 showing that there is no index functionality. This is out of scope for Deflog; it is done in a peer-to-peer solution. Furthermore, there is limited functionality of a Service Registry, namely via the API Registry functionality provided by Portbase, including the Identity and Access Management (IAM) Registry of Portbase for Identity and Authentication.

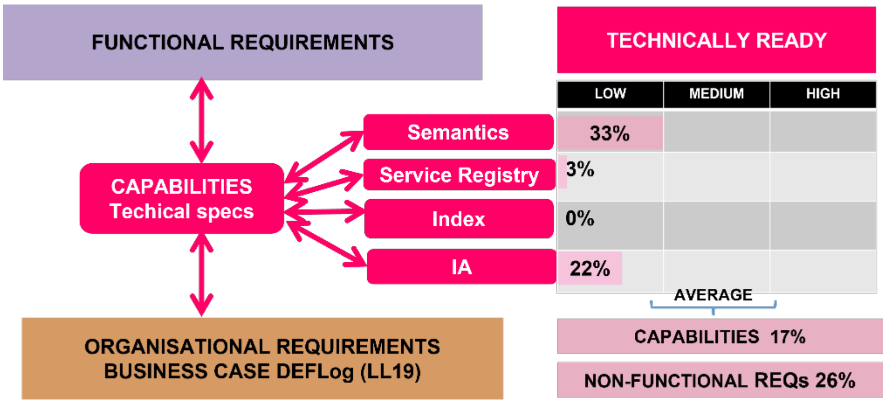

Figure 12 Technical Assessment DEFLog (LL 19)

5.9.2 **Overall** support **of capabilities and non-functional requirements**

DEFlog supports all the capability for an average of 70% and the non-functional requirements for 26%. The DEFLog provision depends on Portbase, operating in the AWS cloud. Two prominent non-functional requirements, extendibility and flexibility, are fully supported by DEFlog, since it enables all types of data sources without prescribing any format or semantics.

5.9.3 **Positioning the solution**

DEFlog positions itself as a marketplace for data. It is a type of API Registry that includes description of data sources. In future, DEFlog could potentially function as a Service Registry for Information Services in an infrastructure provision. A condition to do so would be to adopt the FEDeRATED semantic model to specify data sources and specifying conditions to the data accessibility using the standard ODRL (Open Document Rights Language). In terms of the IDSA Reference Architecture, DEFlog acts as data broker (without a vocabulary hub as a Service Registry is called in IDSA).

5.10 eGovernment Logistics (LL#20)

LL#20 is based on the Dutch Ministry of Infrastructure and Water management policy to develop a

Basic Data Infrastructure (BDI) to enable data sharing. In this LL the focus is on B2A data exchange. The BDI development has been a major driver for developing and validating the architecture. Dutch Customs Administration is its first user, although it is currently also applied for product passports in the context of circularity. Circularity is identified as a future area for supervision by customs administrations.

5.10.1 **Capability support**

The solution that has been developed consists of amendments of an existing tool (Semantic Treehouse) to generate as Service Registry configurations for a node implementing the Index functionality. The node functionality supports sharing events and accessing links to data accessible via these events. This is why the Index functionality scores relatively low: base functionality for events with data pull is implemented.

The figure shows that semantics is implemented, both by the Service Registry functionality and the Index. Since standard (freeware) software has been used to construct a node, this functionality supports onboarding and Identification and Authentication with a proprietary VC mechanism. This is the Corda software.

5.10.2 **Overall support of capabilities and non-functional requirements**

Most of the non-functional requirements are supported by the Corda components. 80% of all non-functional requirements. For instance, Corda also has a notary network for non-repudiation. However, the solution that has been developed is a prototype solution and still requires amendments and testing for operational use. On average 80% of the capabilities are applied. See figure 13.

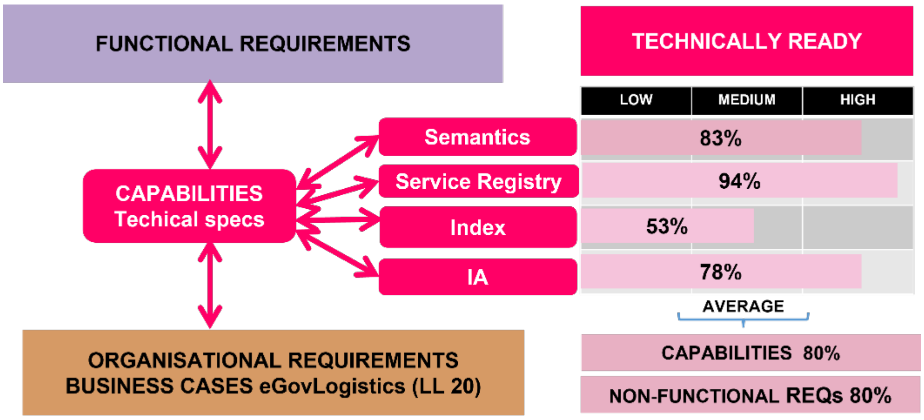

Figure 13 Technical Assessment eGovernment Logistics (LL 20)

5.10.3 **Positioning the solution**

The solution is developed in parallel with the reference architecture, based on the ability to share events and access data shared by those events. Its APIs are the generic ones given by the architecture. They are fully configurable from the semantic model by using the Service Registry. These settings can be for services and/or profiles.

The solution is configurable for all types of interfaces. For instance, a fully compatible eFTI and eCMR infrastructure provision for business and authorities can be configured and implemented, but also another one to support logistics events of shipping lines interfacing with ports and authorities. This will raise the requirement to implement ‘profile’: how can a single organisation configure its generic APIs for various interfaces.

The solution is based on freeware with its proprietary IA mechanism. This is not according to the architecture. There are different ways to deal with these aspects. For instance, seeking for assistance by the supplier of Corda (R3) to assess the feasibility of implementing the architecture or to rebuild the solution with open-source components, preferably aligned with data space technology (for instance by including a triple store in a data space API Gateway with generic, configurable APIs). In the latter case, the generic, configurable API and capabilities are leading for rebuilding.

In the meantime, the prototype can be further tested and extended to fully support the architecture.

5.11 SIMPLE (LL#21)

SIMPLE is an infrastructure for data sharing between different nodes and modes, including authorities. It consists of a core with for instance business process support and blockchain, with specific tooling for API support.

5.11.1 **Capability support**

SIMPLE has its own internal semantic model that is developed according to the semantic model developed by FEDeRATED. Thus, it will differentiate since it supports its own functionality.

The openAPIs of SIMPLE are developed from the model. Therefore, the Service Registry functionality is not fully supported as the next diagram shows. It is implemented by an API Registry (Swagger). Besides the APIs, the focus is also on user support by providing a GUI for various roles, including monitoring functionality. The implementation does not support data mapping tools.

The solution has its own IAM Registry and proprietary authorization rules.

5.11.2 **Overall support of capabilities and non-functional requirements**

Since the objective of SIMPLE is the development of an operational infrastructure provision, it fully supports the non-functional requirements of an openAPI based system, also supported by a GUI. Extendibility and flexibility are hardcoded via the APIs and thus not fully implemented. In total 62% of the non-functional requirements are integrated in the SIMPLE solution. On average 55% of the capabilities are fulfilled. See figure 14.

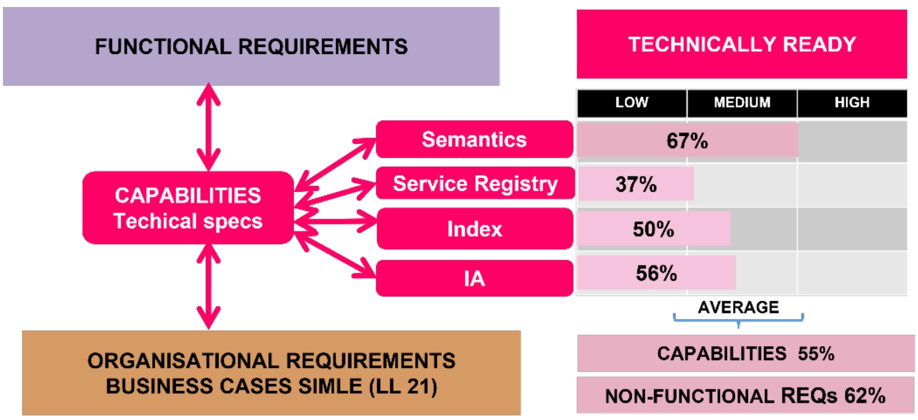

Figure 14 Technical Assessment SIMPLE (LL 21)

5.11.3 **Positioning the solution**

Although the system is developed with a semantic model aligned with the FEDeRATED semantics model, it is based on openAPIs. Thus, it can be positioned in phase 1 of the migration phases, noting that the openAPIs (and supporting GUI) are not generated but hardcoded. Therefore, the solution has limited flexibility and extendibility.

SIMPLE could potentially serve as an API Gateway for business-to-business data sharing (it already does so for business-to-government) by providing standardized APIs to various roles in supply and logistics chains. However, enterprises can consider it to be a centralized solution (platform) with (temporarily) data storage, which might be a barrier for adoption.

With respect to Identity and Authentication, scalability depends on capabilities of the IAM Registry and its supporting organization. Preferably, Verifiable Credentials (of organisations) are required.

5.12 ELSA – BEA-st (LL#22)

Living Lab #22 focusses on data and its semantics for construction and maintenance works for road and rail infrastructures and its environmental impact. It is based on an electronic message structure for construction, rental, and building (BEA-st) with an internal digital system of Trafikverket for monitoring energy and material flows due to contract works (ELSA).

5.12.1 **Capability support**

The solution is based on a data pull mechanism according to PEPPOL. Not only are the BEA-st messages available for implementation by their various stakeholders, also other PEPPOL messages like electronic invoice is available.

The semantics is defined by the message structures, which are documented and available as XSDs. Data is not shared via events but duplicated between systems. This is why not much of the index functionality is supported. Furthermore, structures (XSDs, JSON formats) are published. There is a type of profile of an organization, the so-called Service Metadata Locator, supported by a tool, the Service Metadata Publisher, as specified by PEPPOL.

Elsa supports Identity and Authentication via a central IAM Registry.

5.12.2 **Overall support of capabilities and non-functional requirements**

The assessment of non-functional requirements indicates that 40% support. This is due to the distribution of functionality: each participant must implement its own functionality for messaging. Thus, eventually the implementation of non-functional requirements depends on its weakest partner. On average 26% of the capabilities are implemented. See figure 15.

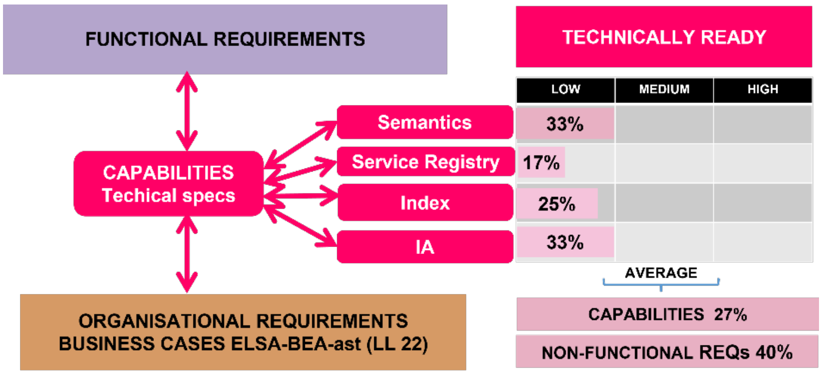

Figure 15 Technical Assessment ELSA-BEA-st

5.12.3 **Positioning the solution**

This LL is a traditional messaging solution, where each participant must implement relevant messages with their implementation guides. They share data by messages (XML, JSON) amongst each other. Access control and authorization are not applicable in messaging applications since a sender decides itself to push data to a recipient. This also defines event distribution.

These types of messaging applications require less functionality than data pull implementations like the one promoted in the FEDeRATED approach. This also indicated that the implementation may work quite well in a community but is difficult to scale outside the community. The entry barrier for new entrants is higher, especially for SMEs with no (or limited) IT skills and budget to invest in messaging solutions.

5.13 Realtime Multimodal Transport Visibility Platform Service (LL#23)

Realtime Multimodal Transport Visibility Platform Services (LL#23) provides a blockchain based visibility solution, firstly to be applied by Ahola. The (Hyperledger Fabric) based ledger is used for data sharing amongst organizations, where each of these organizations connects its server via APIs with the ledger.

5.13.1 **Capability support**

Although the ledger fully implements the concepts like sharing events with links to data, retrieval of data based on these links, and a publish/subscribe mechanism based on commercial relations amongst stakeholders, the underlying semantic model is proprietary. Thus, semantics is supported, but differs from the FEDeRATED semantic model. The ledger is the index operated by Ahola Digital. As illustrated in figure 16, it almost fully implements the required functionality.

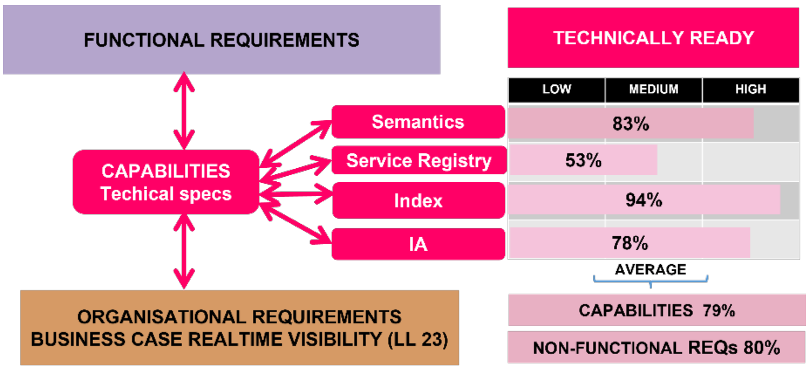

Figure 16 Technical Assessment Multimodal Transport Visibility Platform Service (LL 23)

The Service Registry functionality is limited, since the interfaces of the ledger are type of fixed: they are provided by the ledger. Identity and Authentication is based on tokens (JWT for client-server identification and authentication). Access control is role-based.

5.14 Overall support of capabilities and non-functional requirements

Many of the non-functional requirements are implemented (80%). As said, the ledger interfaces are specified. They can be extended and are flexible, but changes require time. Since the solution has been developed for Ahola, onboarding rules for others are not yet defined.

5.15 Positioning the solution

The blockchain based Index is a good example of a distributed implementation. It is not clear how transparency is handled by the solution since it is operated by Ahola Digital. As such, it can also be considered as a platform-based index (i.e. to be used by multiple organizations) that can become part of the infrastructure provision by supporting the generic (configurable) APIs of a node. The data is available in the ledger, the (proprietary) data structure can be matched with the FEDeRATED model.

If Ahola Digital decides to make their solution a multi-organizational node in an infrastructure provision, it may use its own IA mechanism and apply its own onboarding rules, if they adhere to the IA mechanism and onboarding rules of an infrastructure provision.

Besides visibility, the solution also provides sustainability data. This is an extra service that may be a future requirement.

Thus, the solution can become a (multi-organisational) node in an infrastructure.

6 COMMON LIVING LAB – PROTOTYPE

6.1 Setting of the Common Living Lab

A special Living Lab, designed as the integration of all Living Labs by providing common capabilities to each of the Living Labs, was developed and executed in 2023. Its capability and non-functional requirement support are those that are developed in LL#20 (see chapter 5.10).

All LL engines mentioned in the previous chapter, except those of LL#12 and LL#22, participated in the Common Living Lab. The setting is shown in the following figure. LL#11 and LL#10/18 used their own solution. All other participants have implemented a node and interfaced with that node. Implementation of a node took half a day, integration with another LL took another half day.[22]

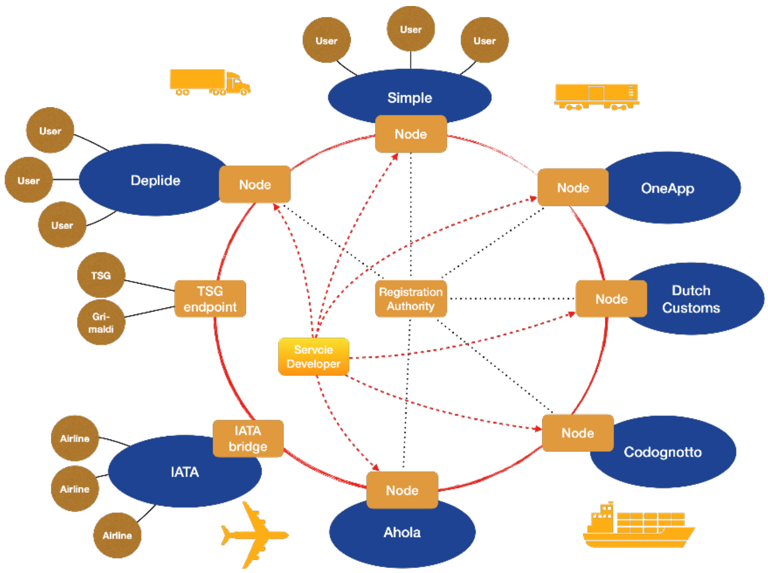

Figure 17 Common Living Lab

Vediafi is not shown in the setting of the common Living Lab. It installed a node but does not consider it to add value (at this moment).

A Service Developer with Semantic Treehouse functioning as Service Registry and as Registration Authority with the Corda functionality was provided guiding towards a multimodal visibility service. The various interactions of that service were configured in a node.[23]

IATA shared event data with Dutch Customs Administration via nodes, which accessed AWB data from IATA Bridge. There was no IA for the latter, meaning that there is no authentication and access

[22] A presentation of this Common Living Lab is available at: federatedplatforms.eu/images/Library/Activity4/FINALEVENT/Stairways_to_Heaven.pdf

[23] See description of the common living lab in Common Living Lab and Multimodal Visibility Infrastructure - Hackathon 25-26 October 2024

control implemented by IATA Bridge.

SIMPLE shared rail visibility events with Sweden, via its node. These events are received by Deplide supporting rail visibility.

Terminal San Giorgoi provided an endpoint to interface for instance with Codognotto. Codognotto explored sharing data on the corridor to the UK, where Dutch Customs Administration took the role of supervising authority.

Ahola investigated the node functionality but did not consider it to add functionality to what they have been doing. This is exactly in line with the assessment of Ahola functionality, since that overlaps the node functionality. Rather, the ledger of Ahola could be opened to interface with nodes.

Several Living Labs have recognized the challenge to federate and take the 'node' developed as part of the Base Data Infrastructure as a means. Taking this approach, figure 18 hereunder illustrates for these Living Labs an overall assessment of the capabilities of the prototype.

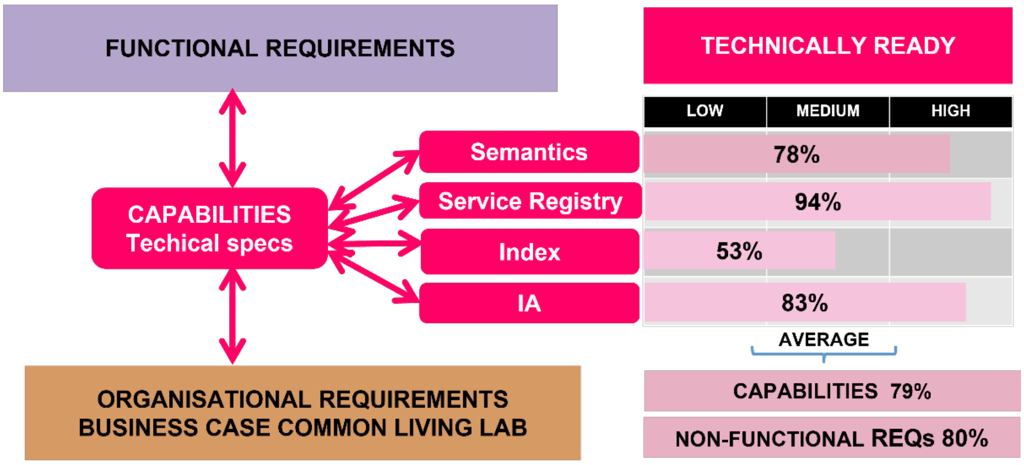

Figure 18 Technical Assessment Common Living Lab – prototype

6.2 Next steps

The following steps have been formulated by the participants:

- Deplide – extend the functionality with semantic technology and become a node in an infrastructure provision.
- IATA / Dutch Customs Administration – share events providing access to AWB data for air freight transport.
- Terminal San Giorgio/Grimaldi (TSG endpoint) – integration with carriers (like Codognotto) via its SPARQL endpoint.
- Codognotto – set up a pilot with a customer using a node and exploit the feasibility to implement nodes with customers.
- 51Biz – consider a node as an option for interoperability in supply and logistics supporting B2A (eFTI) data gateway capabilities between multiple platforms.
- Dutch Customs Administration – continuation of the Singapore-Rotterdam corridor for incoming and outgoing containers (besides the air freight solution).
- SIMPLE – explore the implementation of 'node' for interfacing supply and logistics stakeholders with the Simple solution.
- Ahola Digital– exploit the existing solution first and investigate becoming a node in an

infrastructure provision later on.

Each of the participants must make its own decision on how to progress. This could possibly lead to commonly develop and execute a node in the infrastructure provision. Of course, it also depends on the maturity of the solutions that are provided, i.e. its Technology Readiness Level, the functionality provided, and support of (de facto) standards (like those of eSens and Data Spaces).

7 CONCLUSIONS AND RECOMMENDATIONS CAPABILITIES

7.1 Conclusions adoption

The innovative environment established for the Living Labs should be perceived as an enabler for many living labs to continue their work after the FEDeRATED project. The FEDeRATED project results in connection to the Living Labs increasingly resonate with many stakeholders. The exchanges of information and experiences gained constitute a positive feedback loop for many participants, constituting a learning curve.

The progress achieved by the 23 Living Labs also in connection to the development of the tools (mentioned above) and the common Living lab providing a prototype for federated data sharing proto in terms of adoption is illustrated in figure 19. In general, one could say: the federative network of platforms still needs some work before full adoption can take place. Some Living Labs and the common Living Lab experienced a take-off. Saturation would be a next level.

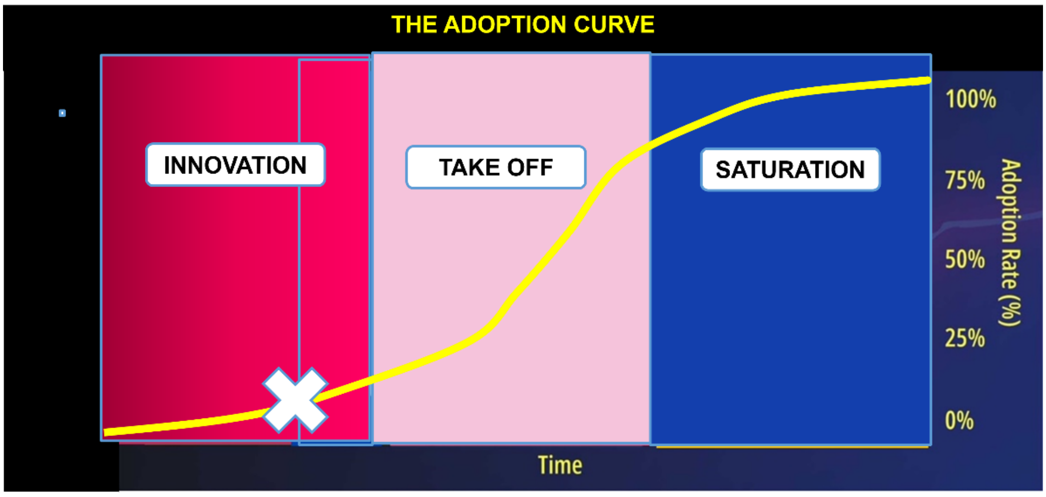

Figure 19 The Living Labs, incl common Living Lab, experience scaled in the adoption curve

All Living Labs have indicated to appreciate the positive impact the established innovative FEDeRATED environment on the development of their Living Labs. This environment should be perceived as an enabler for many living labs to continue their work after the FEDeRATED project. The FEDeRATED project results in connection to the Living Labs increasingly resonate with many stakeholders. The exchanges of information and experiences gained constitute a positive feedback loop for many participants, constituting a learning curve

7.2 Conclusions capabilities and nonfunctional requirements

The following conclusions with regards to the capabilities and nonfunctional requirements can be made:

- **Semantics**. All Living Labs consider semantics to be important. Many implement their proprietary semantics (like Ahola, Deplide, Italian Living Labs, and 51BBiz), IATA aligns its semantics with FEDeRATED, CaaS implements the IATA solution, and SIMPLE implements their interpretation of the FEDeRATED semantic model.

The Living Labs starting from proprietary semantics focused on their internal IT systems. They were in the process of replacing or updating their IT with additional (visibility) functionality. They could have used the FEDeRATED semantic model for this purpose however, it was under development during the project and technical providers in these Living Labs were not acquainted with semantic web standards and – technology.

- **Knowledge and skills**. During the project, the knowledge of semantic technology by the technology providers of the Living Labs increased. They became aware of the capabilities and the Living Labs implemented semantic technology to federate. There is a learning curve.

- **Federation**. Many Living Labs have a limited scope in terms of the number of participants. They may have the intention to become open, but many are still in their initial phase where participants know and trust each other. Therefore, IA can be implemented with 'traditional' mechanisms like authorization tokens and there is not much requirement of a Service Registry. Every partner in a Living Lab implements the same functionality.

  Several Living Labs intend to federate by locally integrating with a 'node' as their interface with external participants (Codognotto, SIMPLE, SMA, and Deplide), whereas others have their semantic endpoints (IATA and TSG/Grimaldi).

- **IT legacy**. Implementation of openAPIs according to the Open API Specifications (OAS) is considered as a main innovation to these legacy systems (potentially utilizing microservices and Docker/Kubernetes for scaling and maintenance/extensibility). IT legacy systems are not expected to support semantic technology; either completely new systems must be developed, or some type of 'node' or semantic endpoint is the least to support, whereby a node (or an API gateway) should provide a set of openAPIs for legacy integration.

  IT legacy integration via openAPIs is the approach taken by IATA, where API users can potentially implement an API Gateway for interfacing with airlines. This solution is up to those airlines and/or freight forwarders. It opens the market for new platform functionality. For scalability and openness, issues like Identity and Authentication need to be addressed, e.g. the introduction of organizational Verifiable Credentials replacing authorization tokens.
- **IT strategy and policy**. IT strategy and policy is driven by technical innovation and adoption of new technology according to internal governance structures. This is especially the case for large enterprises and authorities. Technical innovation towards cloud environments (like Azure), IT technology (OAS, Kafka technology), and scalability/portability (Docker/Kubernetes) were the main issues addressed by the Living Labs. However, during the project, a prototype 'node' has been developed, utilizing these technologies. Whereas the prototype is based on freeware with most of the required functionality implemented in a proprietary way, the overall solution does not always meet requirements of an IT strategy and policy. Open source supporting protocols that are an open or de facto standard seem to be acceptable.

- **Traditional approach**. There are two Living Labs with an overall low score on the capabilities, namely DEFlog and Elsa-BEA-st. Both lack the knowledge of semantic technology and commitment to apply the various capabilities. They take a traditional approach to providing data services (DEFlog) where a data source publishes its APIs with data structures or develops implementation guides for standards (Elsa-BEA-st). DEFlog can be upgraded easily, whereby data sources have to implement their data according to the semantic model. It requires governance and the necessary skills. Elsa-BEA-st requires a completely different approach; it requires knowledge and adoption of semantic web standards and technology if it wants to become open and neutral, applying a pull-based approach.

7.3 Recommendations

Whereas many Living Labs focused on technical innovation (Docker/Kubernetes, Azure, openAPIs), the next step is to focus on (logistics) system innovation. How to make logistics agile, resilient, and robust, whilst still safe and compliant to (new) regulations. It requires introduction of semantic technology as a next phase logistics innovation. From a technical perspective, there are two issues to be solved, namely:

- integration of semantic technology with IT legacy systems and
- acceptance of a solution by the IT governance structure of an organization (a 'user' or a platform acting on behalf of users).

7.3.1 **Recommendation – implement semantic technology for federation with openAPIs for IT legacy integration.**

Most of the semantics and Service Registry functionality will become available. By also providing a set of openAPIs, for instance for posting and receiving events and requesting access to data, visibility, eFTI, and eCMR/eB/L data sharing and many other types of data sharing applications are supported by the node.

Following this recommendation, the complexity of semantic technology is hidden. Technical innovations like openAPIs and dockerization/Kubernetes are introduced. It allows for a learning curve of IT employees to get acquainted with the technology and allows a gradual migration of IT legacy towards this new technology. It also enables an organization to share data in a federative network of platforms with a solution of choice and explore business cases for data sharing. To rapidly pilot a use case with such a node, a GUI (Graphical User Interface) is required.

7.3.2 **Recommendation – develop and implement a gateway solution.**

Where a node acts like a type of API Gateway providing configurable Index APIs (only the eventAPIs are supported by the prototype), this requires changes to IT legacy systems that are not always feasible (or are costly and take time). Therefore, a gateway (see Master Plan) can be useful for adaptation of internal openAPIs of IT legacy with the Index APIs. API transformation is required, where the IT legacy APIs are mapped to the Index APIs.

7.3.3 **Recommendation – migrate to standardized protocols.**

The node (or gateway) functionality is based on freeware utilizing standardized connectivity protocols (like TLS and message queueing protocols), implemented in a proprietary way. There are many other connectivity protocols, like those that are developed or under development by the so-called data spaces and eSens eDelivery.

Not all these solutions can be implemented by a participant. They have clear IT strategies and policies with respect to IT implementation, not only from a security perspective, but also a cost perspective. They require standardized open protocol specifications to procure a solution.

Whenever the node functionality migrates to open and standardized protocols, it is recommended to support the Index APIs provided by that node. This allows for decoupling the migration of a node and that of IT legacy.

7.3.4 Recommendation – innovate IT legacy with the FEDeRATED architecture.

This 'configurability' of a node supports full flexibility and extensibility. In due time, an organization will have to support many services (see Master Plan) with different stakeholders, resulting in the current issues of implementing different guides of open standards.

The question now becomes: how to formulate an organizational profile for interfacing with different stakeholders operating in different communities? Examples of this issues become apparent, for instance when integrating as a single participant with a tradelane (MIEW with Singapore Tradelane) and different modalities (air freight according to IATA or container sea freight via DCSA).

A proposed solution can be derived from the approach taken by forwarders and logistics service providers as for instance Ahola, 51Biz, and Codognotto illustrate, although a solution should be based on FEDeRATED - and not proprietary semantics. The FEDeRATED semantic model and the architecture can be leading for IT legacy innovation by implementing an organizational profile for applicable business activities and – services. One interface with a node can be configured, where the node handles all types of guides and services with peers (e.g. via the semantic adapter).

Preferably, new IT systems should be extensible and flexible for rapidly supporting changes and alignments of the semantic model. Their implementation of the semantic model (and its alignments) should be via reference to that model and (preferably) not a hardcoded version. Of course, non-functional requirements like performance may require some type of transformation for implementing the relevant part of the semantic model.

7.3.5 Recommendation – an open and neutral federative network of platforms requires VCs.

Most LLs use authorization tokens for Identity and Authentication. This requires some type of central IAM (Identity and Access Management) Registry or a federation of IAM Registries of participants. A centralized IAM Registry is scalable to a certain number of users and participants but is not open and scalable to support supply and logistics organizations.

The recommendation is to provide organizational VCs to participants with their 'profile'. Preferably, these VCs fit into the Architectural Reference Framework (ARF2.0) of eIDAS2.0, which makes them applicable for B2G/G2B and B2B. Since eIDAS2.0 becomes operational mid-2025, there will be issuers of VCs. Private initiatives focus on development of the infrastructure with organizational wallets, which should become part of a 'node'.

ANNEX 1 ASSESSMENT FRAMEWORK

Assessment criteria for capabilities

The FEDeRATED reference architecture contains functional requirements and technical specifications/capabilities (technology independent). The technical specifications are supported by technical components (implementation that will be validated against the FEDeRATED technical specifications, using its own technical components. Thereto an assessment framework has been developed. This framework is elaborated in various tables in this document. The tables contain information about:

1. The technical specifications and the technical components
2. The weighting scale regarding the technical components, based on which every LL can identify its compliance.
3. The non-functional requirements
4. The weighting scale regarding the non-functional requirements

The FEDeRATED IT architecture development process has led to an architecture of a 'federative network of platforms' or possibly an EU Mobility 'data space':

1. Vision is detailed into 37 leading principles.
2. Leading principles are supported by functional requirements. One functional requirement can support one or more leading principles and a leading principle can affect one or more functional requirements.
3. Technical specifications detail the functional requirements, or rather they indicate what capabilities a Living Lab or node should comply with.
4. Technical specifications lead to technical components. Their functionality is specified in more detail.

In line with the standard for IT architecture, TOGAF (see figure 19) these aspects cover the vision, business architecture (leading principles), information architecture (language: data and processes), and technology architecture, where the latter is not completely covered since the technical specifications and the functionality of the components is technology independent.

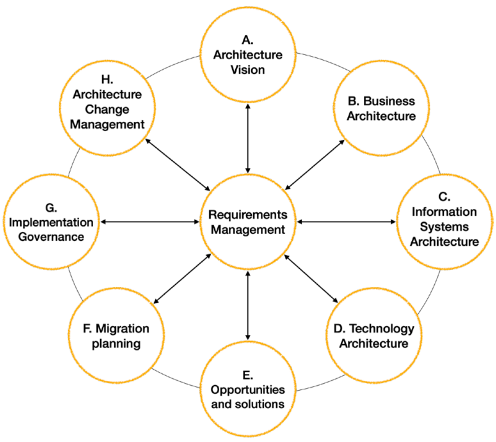

Figure 19 The TOFAF IT architecture standard

Hereunder the Assessment framework containing various tables based on which the technical setting of every Living Lab can be validated against The FEDeRATED Architecture will be validated against the LivingLabs. It is a two-way street.

1.1. Description of the technical components

TECHNICAL SPECIFICATIONS - CAPABILITIES		
No	**Technical component**	**Description**
1. SEMANTICS		
1.1	**Semantics - specification**	Specification of the data that can be shared by all stakeholders. The specification may take various forms: • A model per interaction • A consignment/shipment based model • A model for all data that can be shared. Such a model can also have various forms, e.g. an ontology, a class diagram, or a hierarchical structure (similar to XML structures)
1.2	**Interaction pattern**	The structured sequence of interactions. There are different options: • There is only a single interaction (e.g. a data representation of a business document) • Sequencing is represented by sequence diagrams for the use case (chain) • Sequence diagrams for any two stakeholders • Support of (part of the) normal operation, for instance booking, ordering, and/or visibility Interaction patterns can also be specific to a particular business activity like transport of containers by rail. Interaction patterns are the technology independent services, e.g. a booking -, ordering - , and visibility service. These interaction services can be implemented differently, e.g. with multiple openAPIs and as triples (RDF), see later questions.
1.3	**Modeling alignment or -mapping**	In case a LL has developed its own model, the model can be aligned or mapped to the FEDeRATED semantic model: • Alignment – identifying overlapping concepts and data between two models • Mapping – construct an overlap of a LL model with the FEDeRATED model Alignment is achieved via a representation of a LL model as ontology, most probably as a manual exercise. Mapping can be supported by technical components like a mapping tool and a semantic adapter, see next questions.
1.4	**Access policy specification**	Specification of access policies. Access policies are required in case of a data pull. As such they are specified by the individual interactions taking the relevant parts of the semantic model that is applied by a LL. In case of data push, no specific access policy is required; a message supporting data push contains for instance all data that is duplicated. The syntax and technology (messaging, (open/webhook) APIs (Application Programming Interfaces) with JSON(-LD) (Java Script Object Notation – Linked Data), semantic web protocols (SPARQL (Standard Protocol and RDF Query Language), RDF (Resource Description Framework))) used for sharing data.

TECHNICAL SPECIFICATIONS - CAPABILITIES		
No	**Technical component**	**Description**
2. SERVICE REGISTRY		
2.1	**Modelling toolset**	The capability to specify and publish the organizational profile of a user participating in a Living Lab. An organizational profile must refer to a LL model and/or the interactions that are applicable for the LL. The latter could be formulated by for instance APIs or standards applied for data carriers. The capabilities must be accessible for rapid on-boarding and upscaling of a use case to new users.
2.2	**Organisational profile**	The technical component(s) for a user to configure and publish its organizational profile. These tools should refer to capabilities like import/export of models and must support open standards. An openAPI environment like Swagger can be an example of publishing openAPIs with their endpoints.
2.3	**Toolset to construct and publish an organisational profile**	The syntax applied for sharing data. Options are: XML, EDI(fact), JSON(-LD), RDF, or a proprietary format.
2.4	**Syntax**	The technological paradigm to share data messaging, (open/webhook) APIs, etc. In case APIs are applied, the toolset to publish an organizational profile will be probably an environment like Swagger.
2.5	**Technology**	Use of an (open/defacto) standard for sharing data. This can be any standard (GS1, UN CEFACT, other) and/or a specific implementation guide of a standard (e.g. UN CEFACT eCMR, DCSA eB/L, etc.). Please mention.
2.6	**Data carrier / standard**	A technical component that transforms data between an external syntax/data carrier to another, where the latter is mostly an internal format. The semantic adapter is a specific implementation where RDF is used as external format and needs to be integrated with existing standards, technology, or databases. This can be via so-called RDF plugins, RML (Rule Markup Language) tools, etc.
2.7	**Data transformation (semantic adapter)**	A technical component to configure data transformation. Data transformation can be supported by mapping tools. Examples are those provided by integration brokers/enterprise service busses; others are so-called RML mappers. LLM (Large Language Models) can also be considered, although they are still in an experimental phase.
2.8	**Data mapping tools**	A users' view of events that are received from or send to other users. Event storage is required in case events have links to additional (upstream) data. It supports data provenance and authorization. Event storage can be part of a log and audit trail for non-repudiation.

TECHNICAL SPECIFICATIONS - CAPABILITIES		
No	**Technical component**	**Description**
3. INDEX		
3.1	**Event storage**	Rules for sharing events with another user. Event distribution can be implemented in different ways, for instance based on a legal obligation (mandatory) or a commercial relation (dynamic configuration). A user may apply publish/subscribe, where the subscription is configured by the one that publishes the events.
3.2	**Data validation**	Validation of agreed interaction sequencing. Validation is only applicable in case multiple interactions and their sequencing is defined
3.3	**Event distribution**	The right to access data and use functionality This is about data provenance: links to data are passed between stakeholders and need to be accessible downstream. Delegation might be a mechanism for avoiding query federation but is considered to be static.
3.4	**Event logic**	Access to data by a data user via an intermediary acting as data holder to the data user. This is about data provenance: links to data are passed between stakeholders and need to be accessible downstream. Delegation might be a mechanism for avoiding query federation but is considered to be static.
3.5	**Authorisation**	A technical component for presentation of data presentation to a human. A (temporary) GUI might be provided in case full integration with existing IT systems is not yet feasible. The GUI will include data validation functionality (see Linked Event Protocol).
3.6	**Query federation**	The technical capability for reliable, safe, and secure data sharing with a (defacto) standard. Current list of connectivity protocols: FENIX connector protocol, IDSA connector protocol, EDS (Eclipse Data Space) protocol, Message queueing protocols (like AMQP), blockchain protocols (like Baseline, Hyperledger Fabric, Ethereu), and AS4 implemented by CEF eDelivery. Note: not all data sharing implementations require a separate connectivity protocol since they may use an openAPIs wit https/TLS.
3.7	**Graphical User Interface (GUI)**	The technical component (and its vendor or open source/freeware) implementation of a single or multiple (layered) protocols. Please be aware that even if the protocols are identical, their implementation by a component is not necessarily interoperable with an implementation of another component.
3.8	**Connectivity protocol**	The immutable proof that data is shared. An implementation is by a log and an audit trail. It contains all data that is shared according to the presentation protocol (events, messages, queries, etc.). Although there may not be a specific connectivity protocol, there may still be a log and audit trail.

TECHNICAL SPECIFICATIONS - CAPABILITIES		
No	**Technical component**	**Description**
3.9	**Connectivity component**	The connectivity between various stakeholders should be supported by an individual user In case an external agreed protocol is implemented, this might not be supported by existing systems and solutions. For instance, APIs using https may have to be mapped to the eDelivery or IDS protocol.
3.10	**Non-repudiation**	The safe and secure sharing of data with PKI certificates, utilizing standard protocols (e.g. https, TLS).
3.11	**Internal connectivity**	Unique identification and authentication of users (organizations). Use of open standards like OAUTH2.1, Verifiable Credentials (VCs) and Decentralized Identities (DIDs), JWT (JSON Web Tokens), or others.
3.12	**System security protocol**	The right to access data and use functionality. This relates to access policies (see before) and is supported by index functionality like event storage and - distribution. In case an event storage and - distribution are not implemented by a technical component, authorization must be defined separately.
4. IDENTIFICATION AND AUTHENTICATION		
4.1	**Identity and Authentication (IA)**	Specification of the data that can be shared by all stakeholders. The specification may take various forms: • A model per interaction • A consignment/ shipment based model • A model for all data that can be shared. Such a model can also have various forms, e.g. an ontology, a class diagram, or a hierarchical structure (similar to XML structures)
4.2	**Authorisation (other than link)**	The structured sequence of interactions. There are different options: • There is only a single interaction (e.g. a data representation of a business document) • Sequencing is represented by sequence diagrams for the use case (chain) • Sequence diagrams for any two stakeholders • Support of (part of the) normal operation, for instance booking, ordering, and/or visibility Interaction patterns can also be specific to a particular business activity like transport of containers by rail. Interaction patterns are the technology independent services, e.g. a booking -, ordering - , and visibility service. These interaction services can be implemented differently, e.g. with multiple openAPIs and as triples (RDF), see later questions.

TECHNICAL SPECIFICATIONS - CAPABILITIES		
No	**Technical component**	**Description**
4.3	**Distributed versus centralised implementation**	In case a LL has developed its own model, the model can be aligned or mapped to the FEDeRATED semantic model: • Alignment – identifying overlapping concepts and data between two models • Mapping – construct an overlap of a LL model with the FEDeRATED model Alignment is achieved via a representation of a LL model as ontology, most probably as a manual exercise. Mapping can be supported by technical components like a mapping tool and a semantic adapter, see next questions.

1.2 Measuring against the technical components – scoring/weighting

No	TECHNICAL COMPONENT	SCORING APPROACH – VALIDATION		
		Low	Medium	High
SEMANTICS				
1.1	**Semantics - specification**	A model per message/interaction	Proprietary model	FEDeRATED model as basis
1.2	**Interaction pattern**	Single interaction between stakeholders	Message sequence diagrams	Interaction patterns specifying interaction sequencing between two participants in a business transaction for a business activity. Please mention which you support and from which perspective (visibility of a transport means or cargo, booking a shipment, etc.)
1.3	**Modeling alignment or - mapping**	Users must implement the data carriers and semantics developed for the use case.	Mapping with FEDeRATED model, implying data can be expressed in the semantics of ones' own model and the common ontology. Users can select to implement the data carrier and	Alignment with the FEDeRATED model, meaning that common concepts and properties in two aligned models are part of the upper ontology. Users are able to implement both the functionality of the common ontology and that of the specialization.

No	TECHNICAL COMPONENT	SCORING APPROACH – VALIDATION		
		Low	Medium	High
			semantics of either the use case or provided by the common ontology.	
1.4	**Access policy specification**	Data push based on peer-to-peer solution	Platform arranging Identity and Access management based on message structures	Access policies related to interaction patterns with business transaction states and events for state synchronisation
SERVICE REGISTRY				
2.1	**Modelling toolset**	Technical level (e.g. API toolset like Swagger)	Technical and functional level (metadata related to openAPIs)	Technical, functional, and business level (business activities, business services)
2.2	**Organisational profile**	Unstructured (word, excel, drawing tools, etc.)	Proprietary toolset based on the solution/platform for publishing the profile	Toolset supporting the agreed structures for specifying a profile
2.3	**Toolset to construct and publish an organizational profile**	Proprietary format	One of the selected options (XML, EDI, JSON)	Full support of RDF/JSON-LD
2.4	**Syntax**	(EDI/XML) messaging	openAPIs	openAPIs, webhook APIs, SPARQL endpoint(s)
2.5	**Technology**	proprietary data carrier	support of an open, standard/defacto data carrier (including its potential subset like an eCMR based on UN CEFACT)	Structures in a syntax (RDF(s) or JSON-LD) directly integrating with a semantic model
2.6	**Data carrier / standard**	only a selected data carrier is supported, no data transformation	Data transformation to a selected number of data carriers	full support of data transformation to other data carriers
2.7	**Data transformation (semantic adapter)**	no tools, hardcoded data transformations	data transformation tools supporting the selected technology(-ies)	(semi-)automatic tools based on ontology alignment and matching

No	TECHNICAL COMPONENT	SCORING APPROACH – VALIDATION		
		Low	Medium	High
2.8	**Data mapping tools**	Events are directly derived as such in existing IT systems	Separate storage of events in existing IT system	Events that are shared are explicitly stored in a separate database or other mechanism (e.g. triple store)
INDEX				
3.1	**Event storage**	An event distribution mechanism implemented by internal data processing policies supported by humans	Support of pub/sub configurable by any data user/peer organization	(semi-)automatic distribution of events based on rules in all relevant commercial transactions and for compliance (implemented by for instance pub/sub), triggering by events that are received from stakeholders.
3.2	**Data validation**	Simple event logic based on order level (order centric operation with for instance consignment/shipment identifier)	Validating progress of logistics operation based on time and place of the execution of the transport of a consignment/shipment	Event logic based on common agreements of interaction patterns reflecting real world states (Digital Twins, infrastructure)
3.3	**Event distribution**	Authorization defined by a data holder receiving a query of a data user	Authorization by a data holder to access data is based on a link that is shared. Only access to the data holders' data	Authorization by a data holder to access data based on a link that is shared with a data user and a link that is received from another data holder (query federation)
3.4	**Event logic**	A data user duplicates data and makes it available as data holder to another data user	Manual evaluation a data holder of a query received from a data user, resulting potentially in a (manual) query to another data holder	IT capability by a data holder to combine internal data and data at the source upon a query of a data user
3.5	**Authorisation**	simple (data carrier based) GUI	GUI functionality for one or more employee roles to support data sharing.	Integrated in the GUI (and processing functionality) of internal IT systems
3.6	**Query federation**	proprietary protocol	support of a single	support of more than one

No	TECHNICAL COMPONENT	SCORING APPROACH – VALIDATION		
		Low	Medium	High
			agreed protocol based on open/defacto standard(s)	protocols (based on open/defacto standards) common to relevant relations (business relations, authorities)
3.7	**Graphical User Interface (GUI)**	a proprietary developed component	a single (open source/freeware/vendor) component	multiple (open source/freeware/vendor) components
3.8	**Connectivity protocol**	up to each organization to decide upon	a shared community component (e.g. a clearing house as identified in the IDSA reference architecture)	each participant must implement non-repudiation functionality
3.9	**Connectivity component**	a single prescribed interface between a gateway/node/etc. to an internal IT system (for instance an open/REST API)	more than one interface (e.g. open/REST API and webhook API) supported by for instance a gateways solution or enterprise service bus acting as gateway	Completely free, supported by for instance a gateways solution or enterprise service bus acting as gateway
3.10	**Non-repudiation**	no link security	Support of https with eIDAS certified PKI-certificates	Support of TLS with eIDAS certified PKI-certificates
3.11	**Internal connectivity**	Peer-to-peer data sharing between known organizations only	IA is specific to a community	IA is independent of any business collaboration and reporting to authorities
3.12	**System security protocol**	Proprietary rules specified between any two peers that share data	Common rules specified by a community. These may include delegation	Common rules for commercial transactions and compliance implemented by stakeholders
IA		*Completely centralized solution*	*Centralized solution with peer components interfacing with the central solution*	*A combination of centralized and distributed solution*
4.1	**Identity and Authentication (IA)**	A model per message/interaction	Proprietary model	FEDeRATED model as basis
4.2	**Authorisation**	Single interaction	Message	Interaction patterns

No	TECHNICAL COMPONENT	SCORING APPROACH – VALIDATION		
		Low	Medium	High
	(other than link)	between stakeholders	sequence diagrams	specifying interaction sequencing between two participants in a business transaction for a business activity. Please mention which you support and from which perspective (visibility of a transport means or cargo, booking a shipment, etc.)
4.3	**Distributed versus centralised implementation**	Users must implement the data carriers and semantics developed for the use case.	Mapping with FEDeRATED model, implying data can be expressed in the semantics of ones' own model and the common ontology. Users can select to implement the data carrier and semantics of either the use case or provided by the common ontology.	Alignment with the FEDeRATED model, meaning that common concepts and properties in two aligned models are part of the upper ontology. Users are able to implement both the functionality of the common ontology and that of the specialization.

2.1. The non-functional requirements

NON-FUNCTIONAL REQUIREMENTS		
No	Requirement	Description
1	**Performance**	i.e. the system's ability to respond to user requests in a timely and efficient manner. It includes factors such as response time, throughput, and scalability.
2	**Performance efficiency**	i.e. the system's ability to use resources (such as memory, CPU, and network bandwidth) in an optimal way. It includes factors such as efficiency, speed, and optimization.
3	**System security**	i.e. the measures taken to protect the system and its data from unauthorized access, modification, or destruction. It includes factors such as data encryption, access control, and authentication.

NON-FUNCTIONAL REQUIREMENTS		
No	**Requirement**	**Description**
4	**Reliability**	i.e. the system's ability to perform its intended functions without failure over a period of time. It includes factors such as fault tolerance, error handling, and disaster recovery.
5	**Maintainability**	i.e. the ease with which the system can be modified, repaired, or enhanced over time. It includes factors such as modularity, documentation, and code maintainability.
6	**Usability**	i.e. the system's ability to be used effectively and efficiently by its intended users. It includes factors such as ease of use, accessibility, and user satisfaction.
7	**Availability**	i.e. the system's ability to be accessible to its users whenever they need it. It includes factors such as uptime, downtime, and service level agreements (SLAs). This also relates to MTBF (mean time between failure) and a contingency plan. It can also be the failure of a single component of one stakeholder in its role of data holder. Indicate mechanism/means for testing and expected form of results.
8	**Scalability**	i.e. the system's ability to handle increasing amounts of data, traffic, or users over time. It includes factors such as horizontal scaling, vertical scaling, and load balancing. This is of relevance in the case of a single platform; a P2P environment can probably handle more. Indicate aspects/means for testing and expected form of results.
9	**Compatibility**	i.e. the system's ability to operate with other hardware, software, or systems. It includes factors such as interoperability and compliance with industry standards.
10	**Contingency plan**	i.e. any fallback procedures when (crucial) systems components fail. Are there procedures, and if so, outline type of procedures and to be tested aspects.
11	**Onboarding**	i.e. procedures for including new stakeholders to the LL. Are there procedures, and if so, outline type of procedures and to be tested aspects.

2.2. Scoring against the non-functional requirements

No	Requirement	SCORING APPROACH		
		Low	**Medium**	**High**
1	**Performance**	Not considered	Performance per use case	Fully support of performance requirements required by individual

No	Requirement	SCORING APPROACH		
		Low	Medium	High
				stakeholders
2	**Performance efficiency**	Not considered	Manual intervention	Dynamically scalable
3	**System security**	not implemented	a limited number of measures taken	full system security (data encryption, access control, authentication, etc.) and cyber-security measures
4	**Reliability**	Not considered	a limited number of measures taken	Reliable system according to requirements
5	**Maintainability**	Not considered	Manual intervention required	Automatic distribution and availability of updates
6	**Usability**	Not considered	Preset options provided	fully configurable to a user's requirements
7	**Availability**	Not considered or requires manual intervention	Limited availability, no testing capabilities	24x7 availability supported by a published MTBF and a contingency plan, testing facilities provided
8	**Scalability**	An implementation based on predefined scalability requirements	Scalability for all users (manual/dynamical; central solution)	Dynamically scalable by each user (distributed implementation)
9	**Compatibility**	Applicable for a single type of hardware/OS	available for a predefined set of hardware/OS solutions	fully portable, independent of hardware/OS
10	**Contingency plan**	No contingency plan	fallback procedure with impact to a user (e.g. based on a central solution)	fallback procedures to provide 24x7 operation without impact to a user, operational for each user
11	**Onboarding**	Onboarding a user influences the configuration of all other users (bilateral agreements)	Onboarding of each user with installation requirements and data distribution to access capabilities of other users	Onboarding of each user with full (automatic) data sharing capabilities to all other users

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