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Editor:	Alice Benini

Author(s) – in alphabetical order		
Name	Organisation	E-mail
Alice Benini	IBI	benini@ibinnovation.eu
Massimo Bagozzi	DBALab	massimo.bagozzi@dbalab.it
Valentin Carlan	UA	Valentin.Carlan@uantwerpen.be
Giulio Menghini	IBI	menghini@ibinnovation.eu
Mohseni Seyed Abolfazl	UA	SeyedAbolfazl.Mohseni@uantwerpen.be
Christa Sys	UA	Christa.sys@uantwerpen.be

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Abbreviations and Acronyms

The following are the main acronyms and abbreviations used in current document.

Acronym	Definition
4PL	Fourth Party Logistic Service Provider differs from third party logistics in the following ways; 1) 4PL organization is often a separate entity established as a joint venture or long-term contract between a primary client and one or more partners; 2) 4PL organization acts as a single interface between the client and multiple logistics service providers; 3) All aspects (ideally) of the client's supply chain are managed by the 4PL organization; and, 4) It is possible for a major third-party logistics provider to form a 4PL organization within its existing structure. The formal definition of the term is "A supply chain integrator that assembles and manages the resources, capabilities, and technology of its own organization with those of complementary service providers to deliver a comprehensive supply chain solution."
AS4	Applicability Statement 4. AS4 is an open technical specification based on OASIS ebMS 3.0 for the secure and payload-agnostic exchange of data using Web Services. It was chosen by the EU Member States participating in the e-SENS Large Scale Pilot (LSP) as the primary protocol for B2B, B2A, A2B and A2A message exchange.
B2B	Business to business. Business-to-business refers to a situation where one business makes a commercial transaction with another.
CluCS	Cluster Community System (CluCS) is an IT platform supporting the governance of Proximity Terminal Networks (PTNs) and operations through the efficient management of information: cargo flows and assets within the nodes of the PTN and in relation to the surrounding logistics nodes. This allows a coordinated management of multiple terminals with different specializations. The CluCS is an attempt to establish co-ordination and collaboration between neighbouring and regional terminals on the one side and pooling cargo under coordinated processes on the other side.
EC	European Commission
EU	European Union
GA	Grant Agreement
ITU	Intermodal Transport Unit. These are the cargo units utilized in intermodal transport. They can be Maritime Containers, Swap Bodies or Semitrailers.
LSP	Logistics Service Provider. Companies that provide any single type of Logistics Service. Can be divided in the following general categories: <ul style="list-style-type: none"> • Road Carrier • Rail Operator • Maritime Line • Terminal • Warehouse / Depot • 3PL • 4PL
PO	Project officer
PKI	Public key infrastructure as a set of policies and procedures needed to create, manage, distribute, use, store, and revoke digital certificates and manage public-key encryption

Terminology

The following are the main terms used in current document.

Acronym	Definition
Access Point	Generically the Access Point is a piece of software that allows data exchange between parties in the same business domain. This piece of software can be deployed in each party or shared. It does not need to be the same piece of software, as long as a common specification is followed.
Cargo Consolidation	Combining two or more shipments in order to lower transportation rates. For example, a train carrying containers from different shippers to the same destination.
Cargo Flow	The logistics process of transporting goods from origin to destination including all the involved actors.
Cargo Pooling	The practice of combining shipments from multiple shippers into a truckload (swap body, container or semitrailer – ITUs-) in order to reduce shipping charges by improving the cargo units (ITUs) fill rate.
Connector	Connector is a piece of software that links the party internal applications or other messages' systems, with the Access Point. As this depends on the specific situation of each party and/or its own requirements, hardly it can be shared.
E-Sens	It is a completed pan-European project with the aim of strengthening the EU digital single market and facilitate public services across borders. It has been completed on 31st March 2017.
Intermodal transport	Transport that uses two or more transport modalities with a cargo change between these modes. It usually utilizes maritime containers, swap bodies or semitrailers, also called ITUs that can be easily changed from one transport modality to another without deconsolidating and reconsolidating the goods contained.
Logistics Process	All the logistics operations involved in a particular cargo flow.
Logistic Services	Classically, the transportation of goods from point A to point B. Other services are cargo handling (terminals), temporary storage, cargo consolidation and cargo pooling.
Node	Terminals within the PTN.
PTN Manager	Third party entity that coordinates the PTN, aiming for an optimal utilization of resources and assets within the terminals by which it is formed. In order to achieve this, it is supported by the CluCS.
Semitrailer	Separate part of the truck used to transport the goods, usually identified by a license plate.
Shipper	The party who originates a shipment of goods. The sender of a freight shipment, usually the seller.
Terminal	Cargo handling logistics service provider. Terminals are usually points in which the intermodal process takes place. Road to Rail, Road to Maritime, Rail to Road, Rail to Maritime are examples of intermodal change operations.

Table of Contents

Executive Summary	7
1. Introduction	8
1.1 Purpose of Document	8
1.2 Intended Audience	8
2. Capitalization of input from task 2.3 providing CluCS requirements and design.....	9
2.1 CluCS users and their roles	9
2.2 CluCS components	10
2.2.1 Communications Network	10
2.2.2 Web Based Application	10
2.3 CluCS main services to users.....	11
2.3.1 Intermodal Logistic Services Booking management.....	11
2.3.2 Cargo Consolidation Process.....	12
2.3.3 Cargo Pooling Process	13
2.3.4 CluCS and CargoStream communication process	14
2.3.5 Terminal Operations Visibility	15
3. Definition of CluCS technical architecture	16
3.1 CluCS development strategy	16
3.2 Database design	18
3.3 Design of GUI.....	23
3.3.1 Web Based Applicative access	23
3.3.2 CluCS services graphic interfaces	23
3.4 PTN and Cluster communication network design	28
3.5 Design of integration interfaces.....	30
4. Development of CluCS	31
4.1 CluCS Central Node development.....	31
Architecture of the module	31
Technology stack	32
4.2 Development of CluCS web-based application.....	32
Modules architecture.....	32
Technology Stack	32
4.3 Development of integration with sub-systems (terminal / hub) and over-systems (CargoStream platform).....	33
4.4 Definition of CluCS test phase specification	34
4.5 Go-Live Session	35
5. Conclusion	36
6. References.....	37
https://ec.europa.eu/inea/en/connecting-europe-facility	37
6.1 Actual standards.....	37

List of Figures

Figure 1: Intermodal Logistic Services Booking management.....	11
Figure 2: Cargo Consolidation Process	12
Figure 3: Cargo Pooling Process	13
Figure 4: CluCS and CargoStream communication process	14
Figure 5 Terminal Operations Visibility	15
Figure 6: Waterfall model as <i>rigid</i> sequential steps	16
Figure 7: Cluster 2.0 iterative approach	17
Figure 8: CluCS communication network.....	17
Figure 9: CluCS ER schema (first quadrant)	19
Figure 10: CluCS ER schema (second quadrant).....	20
Figure 11: CluCS ER schema (third quadrant)	21
Figure 12: CluCS ER schema (fourth quadrant)	22
Figure 13: CluCS mock-up – Main page	23
Figure 14: CluCS mock-up – Intermodal main logistic services	24
Figure 15: CluCS mock-up – Intermodal logistic services booking request	25
Figure 16: CluCS mock-up – Cargo pooling opportunities	26
Figure 17: CluCS mock-up – Cargo consolidation opportunities	27
Figure 18: CluCS communication network.....	30
Figure 19: Four-corner model	31
Figure 20: Example of integration: CluCS and CargoStream	33
Figure 21: The V model.....	34

Executive Summary

The report presents the final shape of the Cluster Community System (CluCS) tool which results from an interactive process of progressive improvements in joint cooperation with task 2.3. CluCS is an IT platform which functions as a connector between the Cluster's different sub-systems and allows a coordinated management of multiple hubs with different specializations creating synergies and linking the Cluster to different TEN-T corridors. The report defines also the requirements for CluCS test phase that is performed in WP5 – Living Lab 1 “Proximity Terminal Network & Cluster Community System”.

The document is organized as follows:

Chapter 1 reports on the purpose of the document and the addressed audience.

Chapter 2 defines the capitalization of input from task 2.3 providing CluCS requirements and design.

Chapter 3 defines CluCS technical architecture. It details, CluCS development strategy, database design, graphic interface of the web-based application and the design of integration interfaces.

Chapter 4 regards the development of CluCS, detailing the development of CluCS Central Node, CluCS web-based application, the integration with sub-systems and over-systems and the definition of CluCS test phase specification.

The document is closed by chapter 5, that summarises the main findings and outcomes of the deliverable, thus paving the way towards CluCS test phase that is performed in WP5 – Living Lab 1 “Proximity Terminal Network & Cluster Community System”.

1. Introduction

1.1 Purpose of Document

The present document is devoted to the development of Cluster Community System (CluCS) enabling the Cluster management and its optimized functioning.

CluCS is an IT platform supporting the governance of Proximity Terminal Network (PTN) and operations through efficient management of information: cargo flows and assets within the PTN nodes and in relation of surrounding logistics nodes, especially ports configured as Clusters.

Basing on task 2.3 scenarios and requirements, applications for the CluCS are designed and CluCS tool is developed.

More in detail, CluCS technical architecture is defined including CluCS development strategy, the database establishment and the definition of User and integration interfaces. Moreover, CluCS test phase specification is explained.

1.2 Intended Audience

The intended audience of this document are the Clusters 2.0 project partners.

With regard to the functional aspects, the document aims to address:

- all the supply chain roles that can be involved in the development of the Cluster Community System in practical terms, with a focus on the need for collaboration in a competitive environment;
- all the actors of the supply chain that could benefit from operational advantages and positive impacts from the Cluster Community System development.

2. Capitalization of input from task 2.3 providing CluCS requirements and design

This section summarizes the main concepts discussed in Deliverable 2.3 “Cluster Community System preliminary requirements and architecture” that will be used as building blocks for this document.

2.1 CluCS users and their roles

For the successful implementation and function of the Cluster Community System there are three main users with different functions and tasks:

- Logistic Service Providers (LSPs): The platform allows LSPs to publicize their services to a wide audience of shippers, both in the local PTN and in the Cluster. These transport services are bookable via platform. LSPs’ main task is to communicate to CluCS their Logistic Services Catalogs (information about the offered services) and keep them updated in case of changes or cancellations, allowing in this way CluCS to provide up to date information to the rest of the users.
- Shippers: In a way, they are the “main users” of the platform services. Shippers within the PTN and the Cluster benefit from the possibility to book intermodal logistic services departing from the cluster and with destination both intra and extra cluster. The platform also keeps an updated status of all services, letting know shippers when a booked service has been cancelled or delayed.
- Cluster Community Manager: This role is performed by a neutral third party, whose main function is to provide shippers and LSPs with optimization suggestions in base of the data provided by CluCS. Cargo consolidation (based on information provided by CluCS) between points united by rail services should be promoted by the Cluster Community Manager in order to follow the Clusters 2.0 main guidelines. Cargo pooling opportunities among shippers that have expressed (published in the platform) their will to “bundle” sub optimal recurring cargo flows should be encouraged and sponsored by the Cluster Community Manager.

2.2 CluCS components

The logical architecture of CluCS can be made explicit in the software two main components, namely communications network and web-based application as described below.

2.2.1 Communications Network

Through the implementation of the CluCS communication network each actor of a regional or sovra-regional PTN could become a node using standard transport protocol and security policies. The communication network of CluCS guarantees a secure and reliable exchange of documents and data (structured, non-structured and/or binary): each node of CluCS to exchange information has to be conformant to the same technical rules.

As mainly consequence of developing the CluCS communication network is that existing IT systems could start to communicate once they are connected to their own CluCS node. In other words, CluCS communication network could be seen as an interoperability layer among heterogeneous systems rising their security offered by internet. Furthermore, offering high capability of scalability and performance: the number of nodes could grow easily as well as the number of exchanged messages.

CluCS communication network is an e-SENS AS4 conformant solution and the main characteristics are:

- Interoperability
- Security
- Scalability & Performance
- Accountability

In this way, CluCS supports a standardized message exchange protocol that ensures interoperable, secure and reliable data exchange: AS4 is an open technical specification for the secure and payload-agnostic exchange of data using Web Services. According to OASIS, the AS4 protocol is the modern successor of the AS2 protocol.

2.2.2 Web Based Application

The web application of the CluCS is held by the Central Node and has the scope of providing CluCS users with the services of:

- Cargo consolidation
- Cargo pooling
- Intermodal services booking

The web-based application allows also to non-Cluster users to take advantage of high value-added services offered by the Cluster. It also allows to give visibility of the overall status of the Cluster promoting an anonymized and impartial offer of services.

These three services aim to meet the project's core demands regarding visibility of cargo flows, interoperability and intermodality between terminals in the PTN and Cluster and the optimization of the logistics flows and asset utilization.

Shippers are able to access a web interface in which they select a departing and destination point and detail all the cargo units involved in the desired logistics process.

Based on the logistics services catalogs (provided by the LSPs), CluCS offers a set of solutions for the received request. These solutions are anonymized and include (in the necessary cases) all the intermodal combinations needed to reach the destination point.

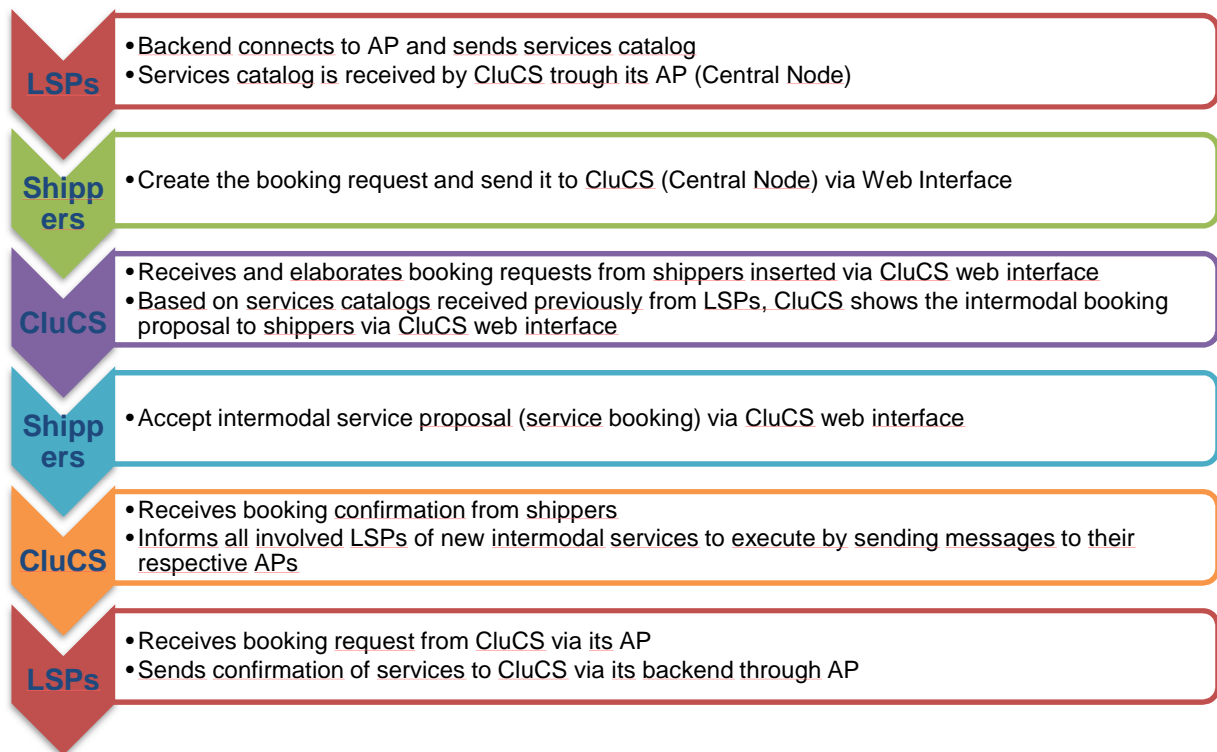
At this point, the shippers can opt for one (or none) of the solutions presented, when the

acceptance takes place, CluCS informs all Involved actors (LSPs – Terminals) about the services booked to be provided. A final confirmation is sent to the shipper that has booked the service in the first place when the LSPs acknowledge the booking of the logistics services.

2.3 CluCS main services to users

2.3.1 Intermodal Logistic Services Booking management

Figure 1: Intermodal Logistic Services Booking management



CluCS offers their users the ability to book services offered by terminals and Logistics Service Providers. As explained before, nodes communicate with each other sharing information of intermodal services available, that is, the Logistic Services Catalogs published and updated by the LSPs are transmitted to the central node of CluCS. With this piece of information at hand, users can also decide to use the platform to book a combination of intermodal services in order to reach the desired destination for their cargoes.

Following this logic, the communication process for the booking process between nodes should be as follows:

- LSPs backend connects to AP and sends services catalog to CluCS central Node through its AP.
- Shippers send a Booking Request via CluCS web interface indicating information about desired dates, departure, destination and type and quantity of cargo.

At this point, the Central Node has information about:

- 1) Shippers Booking Requests
- 2) All terminals and LSPs Services Catalogs

Clusters 2.0

With this piece of information, the Central Node can decide the best option to fulfill the shipper's logistic needs.

- CluCS (central node) receives and elaborates booking requests from shippers inserted via CluCS web interface. Based on services catalogs received previously from LSPs, CluCS shows intermodal booking proposal to shipper's via CluCS web interface.

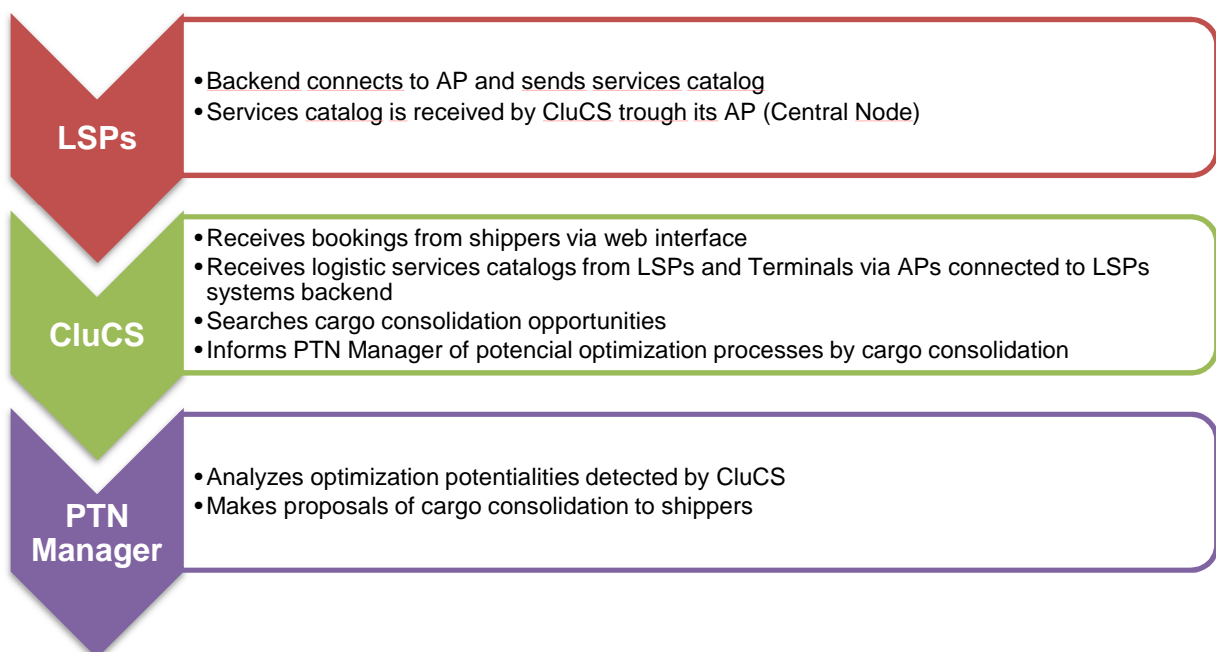
At this point, the shipper has to decide whether the offered service fulfills its needs and accept or decline the booking. If the shipper accepts, the communication continues as follows:

- Shippers now can accept (or refuse) intermodal service proposal (services booking) via CluCS web interface.
- If accepted, CluCS receives booking confirmation from shippers and then proceeds to inform all involved LSPs of new intermodal services to execute sending messages to their respective APs.

Finally, LSPs receive booking requests from CluCS via their AP and send confirmation of services to CluCS via their backend through their AP.

2.3.2 Cargo Consolidation Process

Figure 2: Cargo Consolidation Process



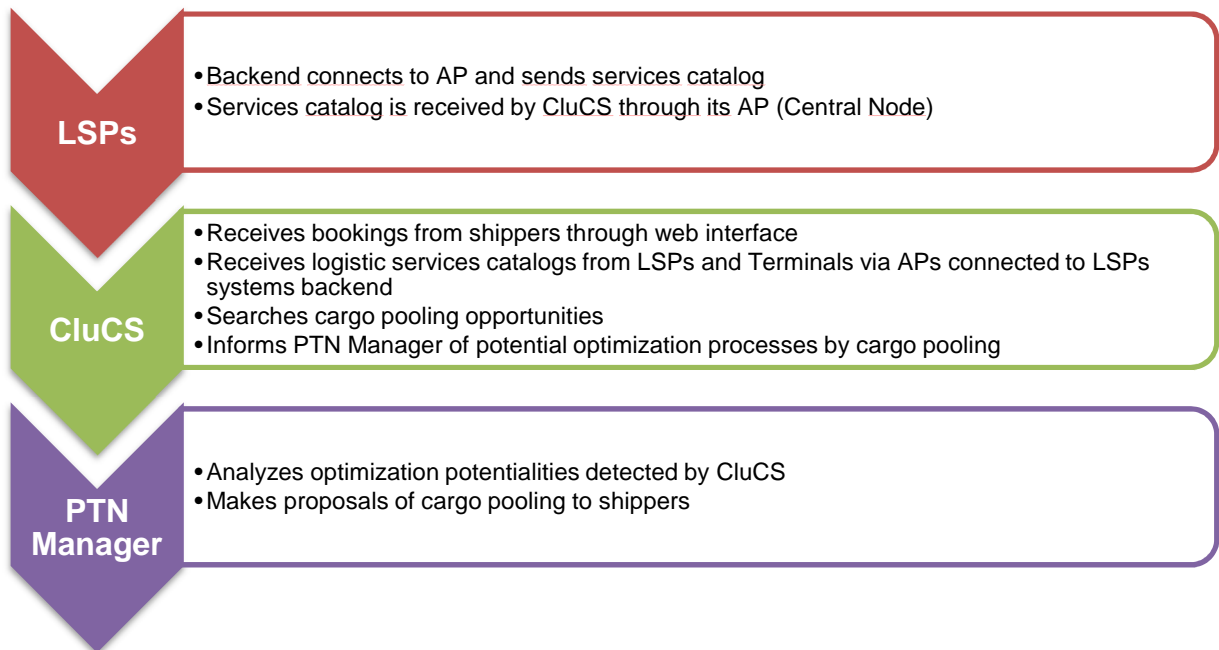
The Cargo Consolidation Process is defined as the combining of two or more shipments in order to lower transportation rates. An example within the Cluster could be a train carrying containers from different shippers to the same destination.

CluCS aids the PTN Manager in the identification of opportunities of optimization of logistics flows through Cargo Consolidation processes, in this manner trying to reduce road traffic in benefit of rail traffic. As said before, CluCS has visibility of logistic flows within the Cluster as shippers use the platform to book intermodal services. Furthermore, it has visibility of the Logistic Services Catalogs provided by the LSPs. CluCS aims to find rail idle capacity (empty wagons) and tries to match it with road cargo flows to destinations reachable by train.

CluCS identifies these opportunities and presents them to the PTN Manager, who can now contact the shippers and offer an optimized logistic solution involving Cargo Consolidation.

2.3.3 Cargo Pooling Process

Figure 3: Cargo Pooling Process



One of the main scopes of the Clusters 2.0 project is the reduction of idle cargo capacity in the Supply Chain. This means that vehicles and cargo units (containers, semitrailers, swap bodies, etc. -ITUs-) use should be optimized, aiming for a decrease in the number of vehicles utilized.

There are two principal factors to be considered when trying to optimize a truck / cargo unit idle load factor:

- Volume
- Weight

The classic example of a cargo pooling process is the one of two industries: Industry A produces goods that are very heavy with a low volume (for example ceramic tiles) and, Industry B produces goods that have a very high volume but a low weight (for example toilet paper or similar products).

Industry A has the problem that when filling a truck or a cargo unit and arriving to the maximum permitted weight, the utilized volume is only a part of the total.

Industry B has the opposite problem, when filling a truck or a cargo unit and arriving to the maximum possible volume, the utilized weight capacity is only a part of the total.

Considering the previous problems, a possible solution arises: pooling cargo from Industry A and Industry B, optimizing trucks or cargo units volume and weight fill rates. For this to happen, Industry A and Industry B must share at least part of the logistic corridor and must be able to “pool” their goods in logistic hubs offering this kind of service.

In Bologna PTN these two principal factors are present:

- Industries like P&G are likely to ship very light goods wasting weight capacity

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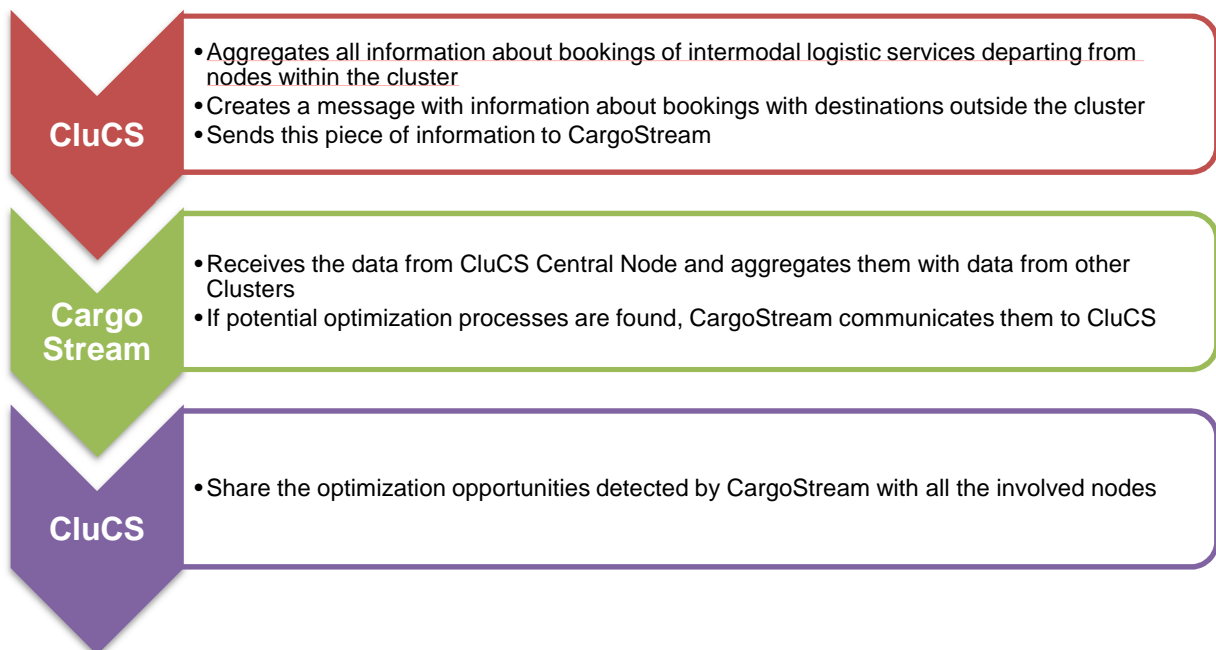
- Industries like Ceramiche Caesar are likely to ship very heavy goods wasting volume capacity
- Local and Main Terminals within the PTN can act as service providers in charge of the activity of pooling cargo
- LSPs acting in the PTN can provide the transport services needed
- CluCS can function as a tool to identify cases of potential load factor optimization and getting in contact the different stakeholders involved.

At first, CluCS manages cargo bundling for stable and periodic shipments, then, in a further development phase of the platform, it could offer “ad hoc” solutions for particular shipments. For this to happen, a communication between nodes is necessary:

- Shippers book intermodal logistic services through CluCS platform. As explained before, in the booking process information about goods (packing type, volume, weight), departure and destination points and service frequency is entered. Shippers communicate directly with their assigned Terminal / Nodes.
- Local Terminal / Node receives the piece of information and re-sends it to Bologna Main Terminal / Node.
- Bologna Main Terminal / Node receives the piece of information and re-sends it to the Central Node.
- Central Node receives this piece of information and tries to match it with a suitable partner/s considering departure and destination points, frequencies, volumes and weights. Central Node uses the information regarding the “intermodal services available” (aggregation of logistic services catalog) to assign one / various LSPs and terminals to the proposed solution.

2.3.4 CluCS and CargoStream communication process

Figure 4: CluCS and CargoStream communication process



The communication process between CluCS and CargoStream platform could be implemented as follows: CluCS share information with CargoStream about logistics flows

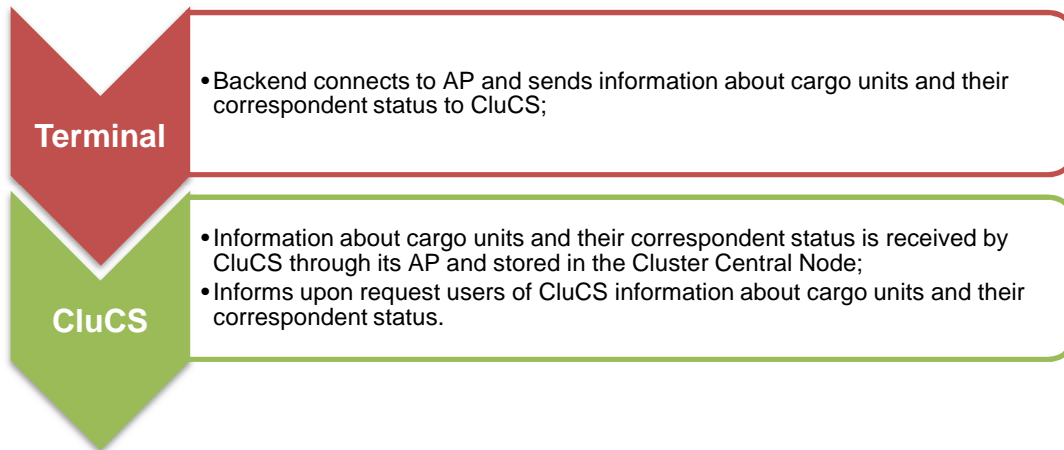
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originating from inside Piacenza-Bologna-Trieste Cluster and with a destination outside it, especially in other European clusters.

CargoStream platform looks for collaboration opportunities and shares these matches to CluCS that, on its turn, shares them with all involved nodes.

2.3.5 Terminal Operations Visibility

Figure 5 Terminal Operations Visibility



In this case, CluCS offers the possibility to its users to see the specific status of their own cargo units.

The screen shows a list of cargo units relevant to each user (users can see only their own cargo units, whereas the Cluster Community Manager can visualize all cargo units handled by the system).

By accessing one particular unit, the user should see detailed information about it, such as status, ETD and additional notes from the Terminal.

3. Definition of CluCS technical architecture

3.1 CluCS development strategy

The CluCS system is a high complexity project in terms of size, functionality, technical architecture, availability, performance, and integration requirements.

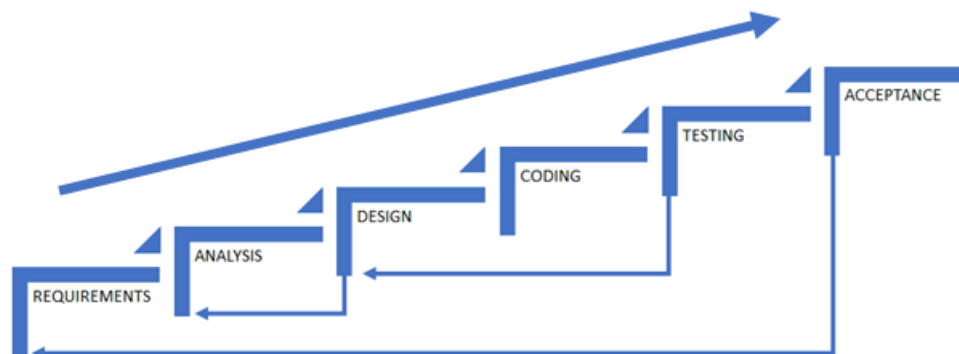
For this kind of project, where many participants (developers) are involved, there are sensitive and mandatory deliveries and, not least, fixed cost, the waterfall model could be one of the wide recognized appropriate methodology to use to guarantee the investment and the deliveries.

The waterfall model is a sequential design process used in software development processes, in which progress is flowing steadily downwards (like a waterfall) through the phases of analysis, design, construction, testing, implementation and maintenance (Figure 5). Progress flows from the top to the bottom, like a cascading waterfall. The following phases are followed in order:

- Requirements specification
- Analysis
- Design
- Construction (implementation or coding)
- Testing and debugging
- Acceptance (UAT)
- Deploying in a production environment
- Maintenance

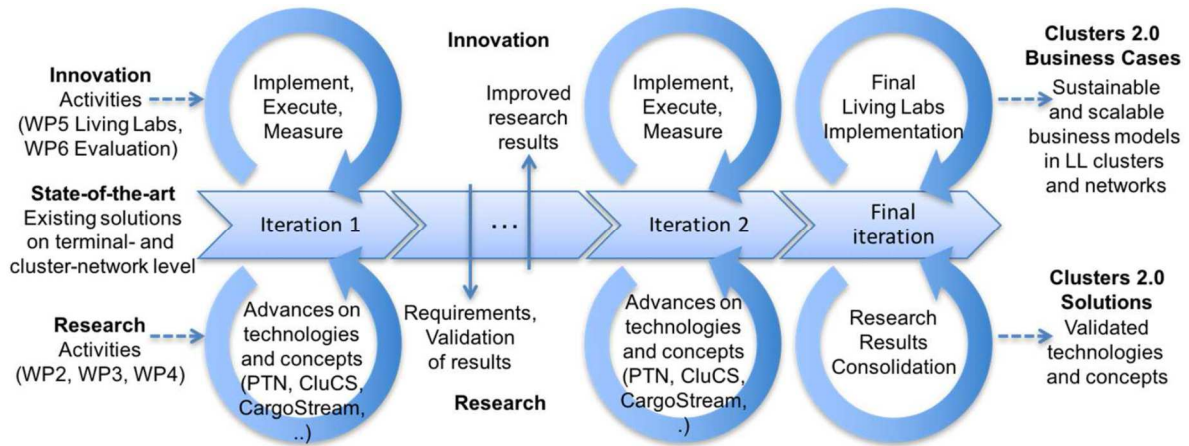
A strong argument of the waterfall model is that it places emphasis on documentation such as requirements documents and design documents.

Figure 6: Waterfall model as *rigid* sequential steps



In previous figure the classic waterfall model was ordered upward rather than downward to emphasize how risky, and possible it may be to get hardly to acceptance and having, for example, to re-establish the requirements. The deploying in production environment and maintenance activities fall into the product's operating life cycle and for this reason (it is widely recognized that a project ends with the acceptance by customer) are not showed in the figure.

On the other hand, the development of the CluCS software platform is only a part of the overall Cluster 2.0 project, which has many and various objectives within 36-month time frame. This 3-year project has been divided in 3-phase incremental iteration where the main underlying approach and methodology is based on delivery solutions in clearly defined, incremental phases and stages (Figure 6). Moreover, this innovative project involves reducing the risk of wasting resources in technologies and tools that users do not need or unsustainable business

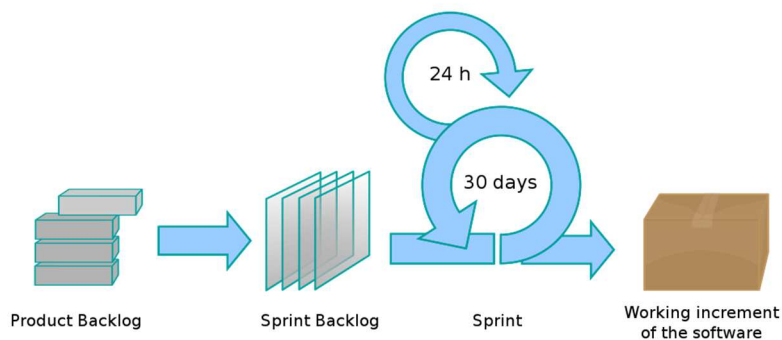
Figure 7: Cluster 2.0 iterative approach


The previous figure clearly shows that the main aim of each iteration is to refine progressively Cluster 2.0 solutions in all their elements, validating and consolidating in each living lab the current results, ensuring: a) the development of sustainable and scalable business models, b) the validation of concepts and theories and c) the right choose of technologies.

Clearly, waterfall methodology is exactly the opposite to Cluster 2.0 iterative approach but at the same time to start to development of the CluCS software platform are required, at least, the analysis of user requirements and the design documents with a sufficient level of detail.

How DBA LAB, the IBI IT partner, in charge to develop the CluCS platform decided to solve this seeming incompatibility?

From the start of the second Living Lab (M17), where analysis and overall design of the platform will be defined, all the coding phases will be managed by DBA LAB using SCRUM framework (Figure 7) as Agile development methodology.

Figure 8: CluCS communication network


In a very concise way, SCRUM is a process framework that plans to divide the project into quick work blocks (Sprint) at the end of each one to obtain an increase of software availability. It indicates how to define the details of the work to be done in the immediate future and plans various meetings (with precise characteristics) to create opportunities for inspection and control of the work performed: this allows validating the current result many times during each living lab (all SCRUM iteration is of 4 weeks), to measure progress towards the users'

objectivities and setting the baseline for research to be persuaded in the next iterations. Moreover, as user requirements they will be better defined according to initial design for each Sprint iteration reducing the risk of inappropriate module coding and the need of re-coding. Agile processes fundamentally incorporate iteration and the continuous feedback as shown in the following figure.

3.2 Database design

The database design is schematized by the ER diagram below. The scheme is divided into several groups of tables, each of those describes an entity within the system.

The identified groups are:

- Company, describes the companies that are involved in the process
- Person, defines the people that are involved in the process
- Location, specifies the locations
- Cluster node, identify the nodes of the Cluster net
- Service catalog, defines all the services that the companies make available on the Cluster nodes
- ITU, describes the load unit
- ITU goods, details the type and quantity of each batch of goods in every ITU
- Goods document, specifies the documents of each goods
- Booking request, characterizes the service request made by the user
- Booking solution, describes the set of intermodal services used to satisfy the user booking request

The role of each table on the database can be identified using different colours:

- Orange, the main entities of each group
- Blue, the data tables and the secondary entities
- Green, the tables used for the data internationalization

Figure 9: CluCS ER schema (first quadrant)

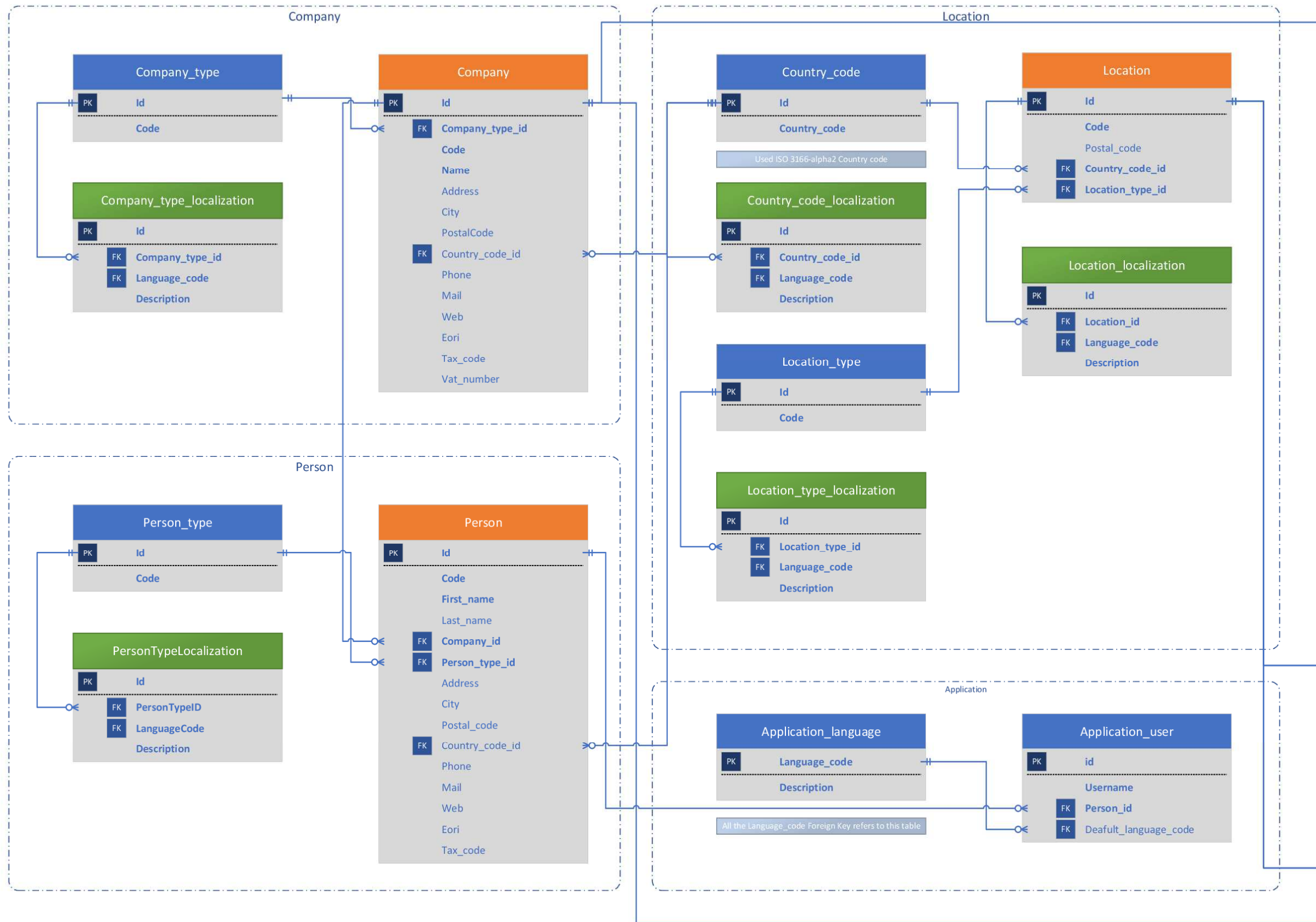


Figure 10: CluCS ER schema (second quadrant)

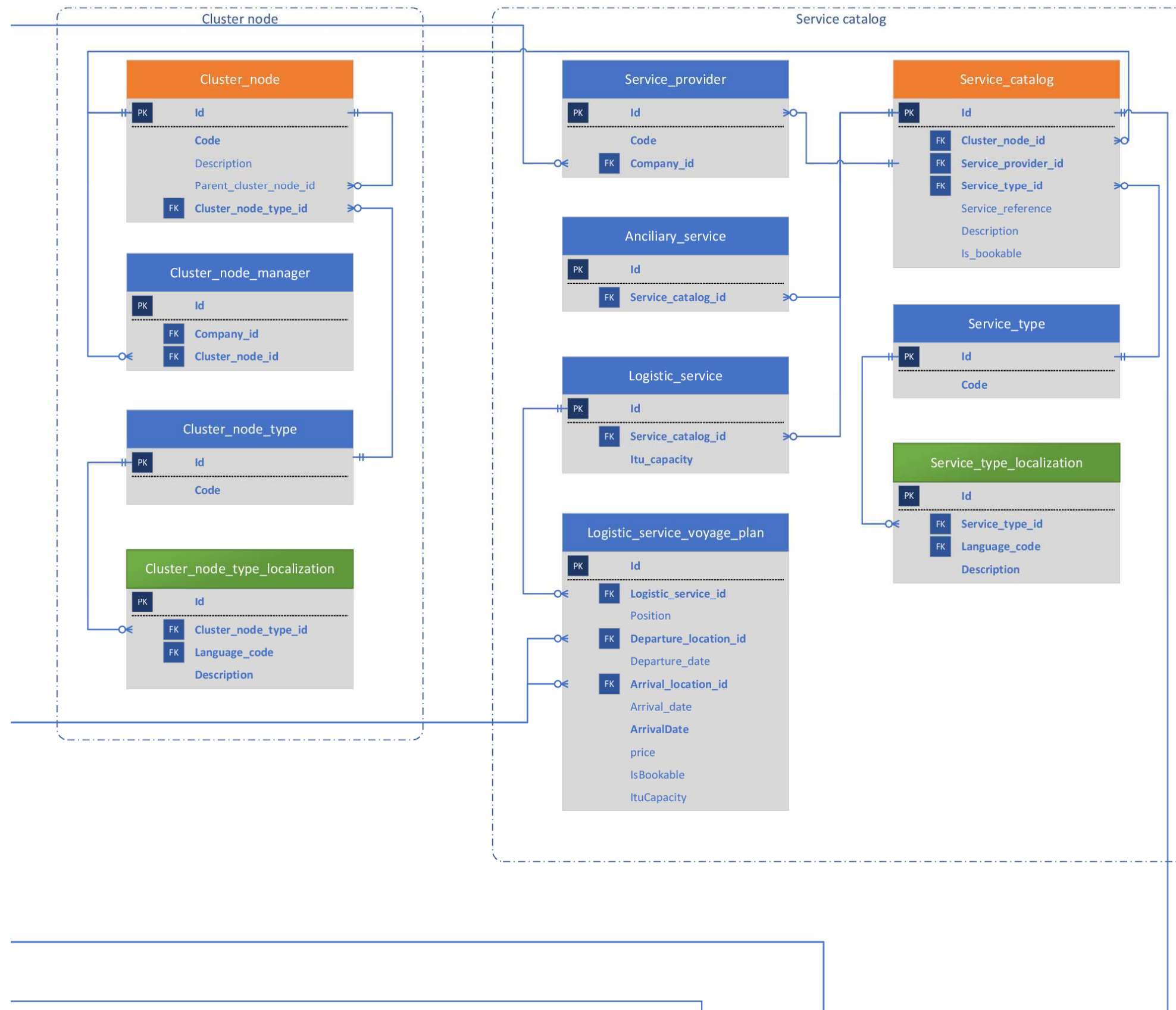


Figure 11: CluCS ER schema (third quadrant)

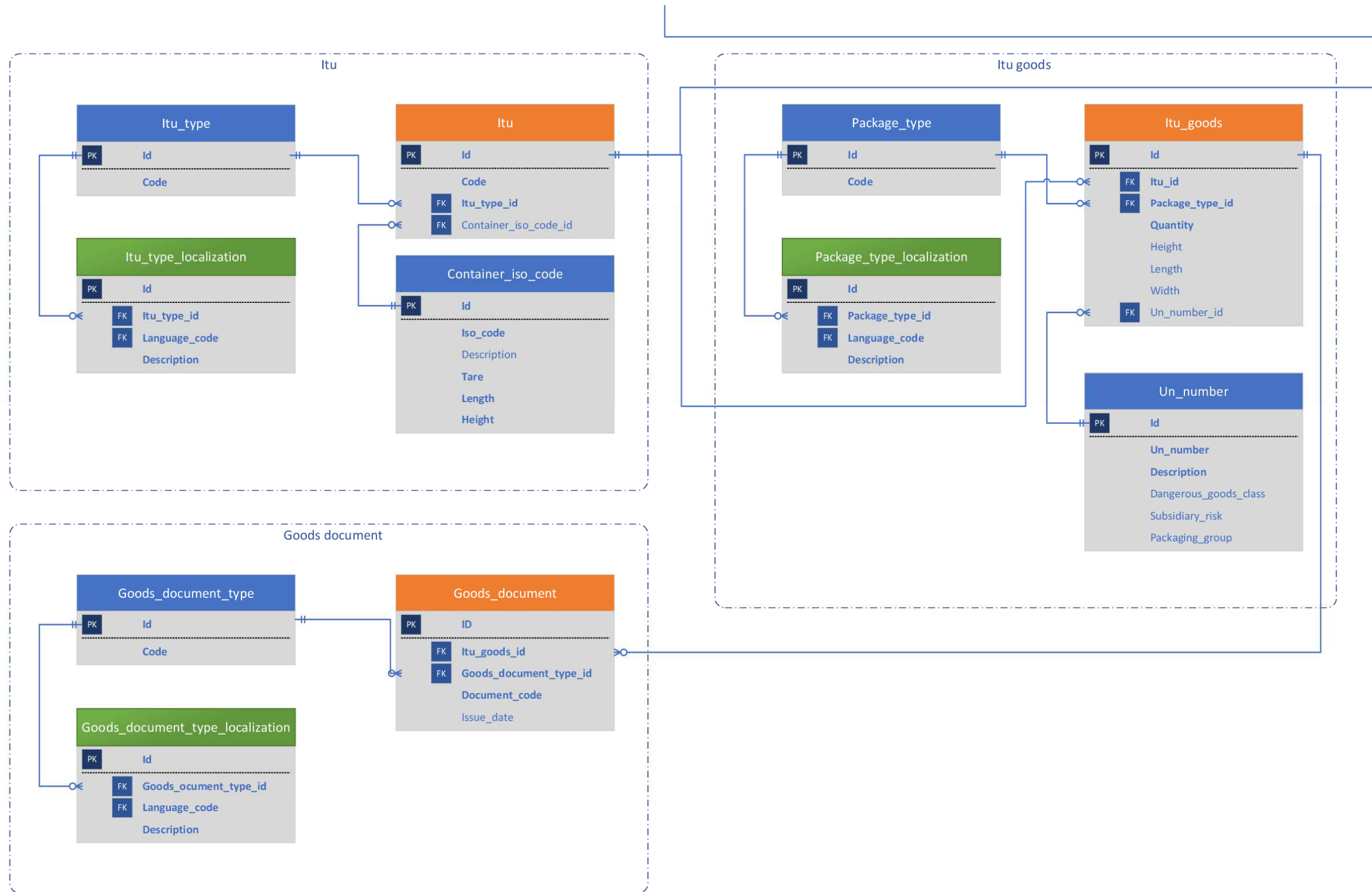
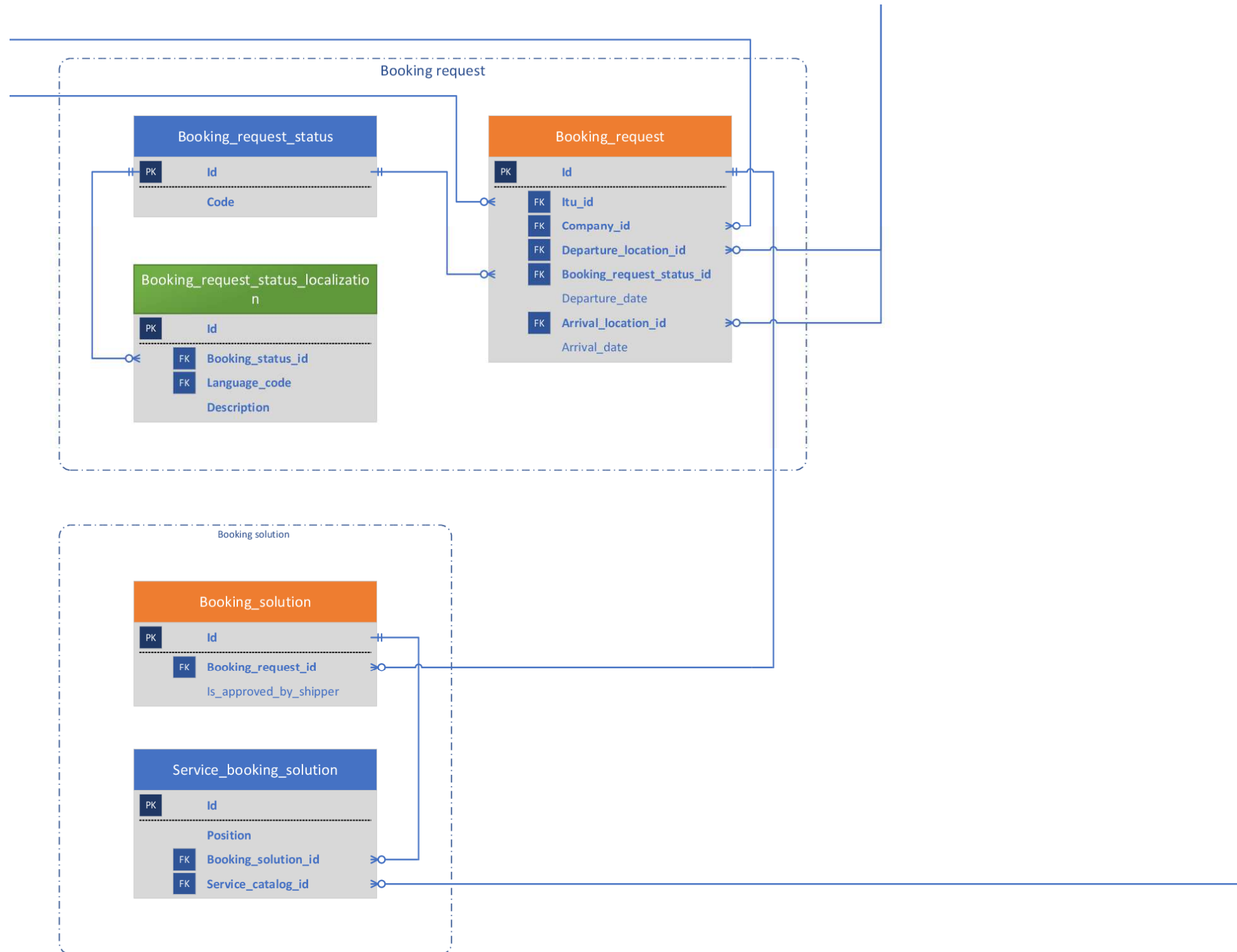


Figure 12: CluCS ER schema (fourth quadrant)



3.3 Design of GUI

This section describes the graphic interface of the web-based application that permits CluCS users to interact between each other and access to Intermodal Logistics Services offered in the PTN and the Cluster.

3.3.1 Web Based Applicative access

The system has to guarantee the user's authentication and authorisation. For this, there is a login screen where users are able to enter their credentials (provided in a first instance by the Cluster Community Manager). Once this accreditation takes place, users, depending on their roles, are able to access CluCS different functionalities.

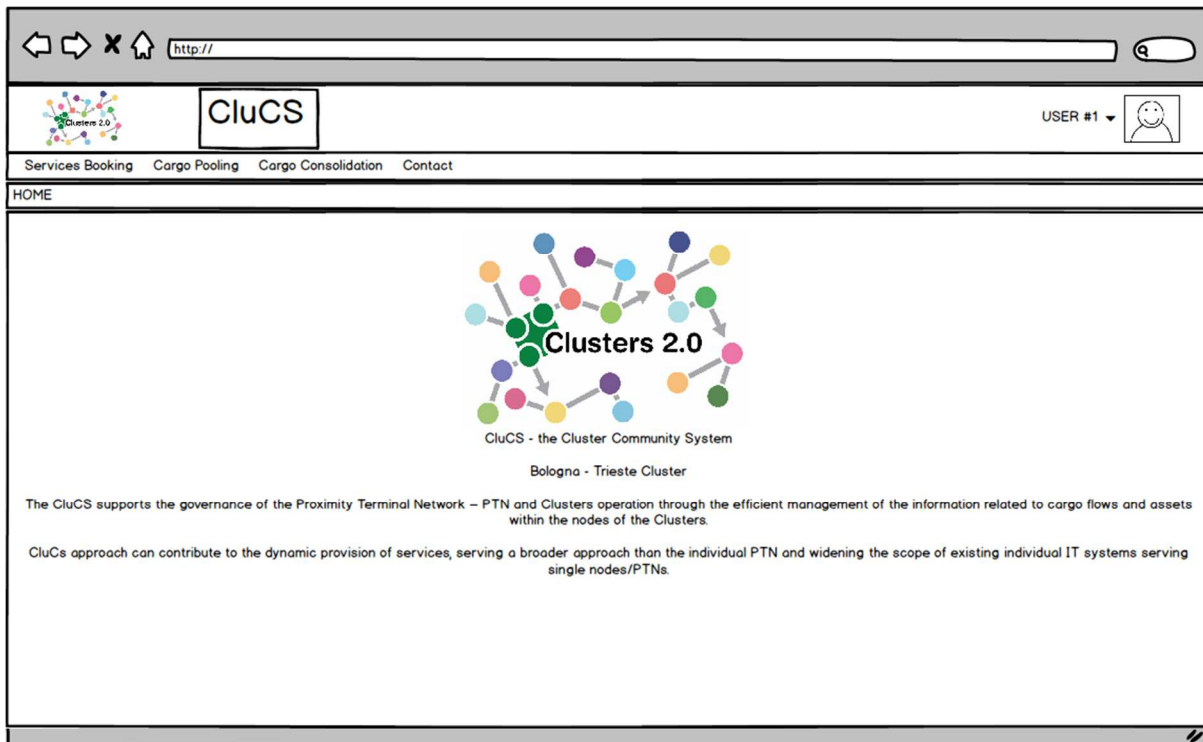
3.3.2 CluCS services graphic interfaces

As explained before in this document, CluCS objective is to provide its users with three main functionalities: Intermodal Logistic Services Booking (for shippers), Cargo Consolidation opportunities (For Cluster Community Manager) and Cargo Pooling opportunities publication (for Shippers and the Cluster Community Manager). It follows a description of the different screens the users are presented with.

3.3.2.1 Main screen

The main screen (Figure 12) shows to users a brief presentation of CluCS and its functionalities and provides access to the Intermodal Logistic Services Booking screen and the Cargo Pooling screen. In addition to this, it permits users to access to the "contact us" page in which contact data of the Cluster Community Manager are displayed.

Figure 13: CluCS mock-up – Main page

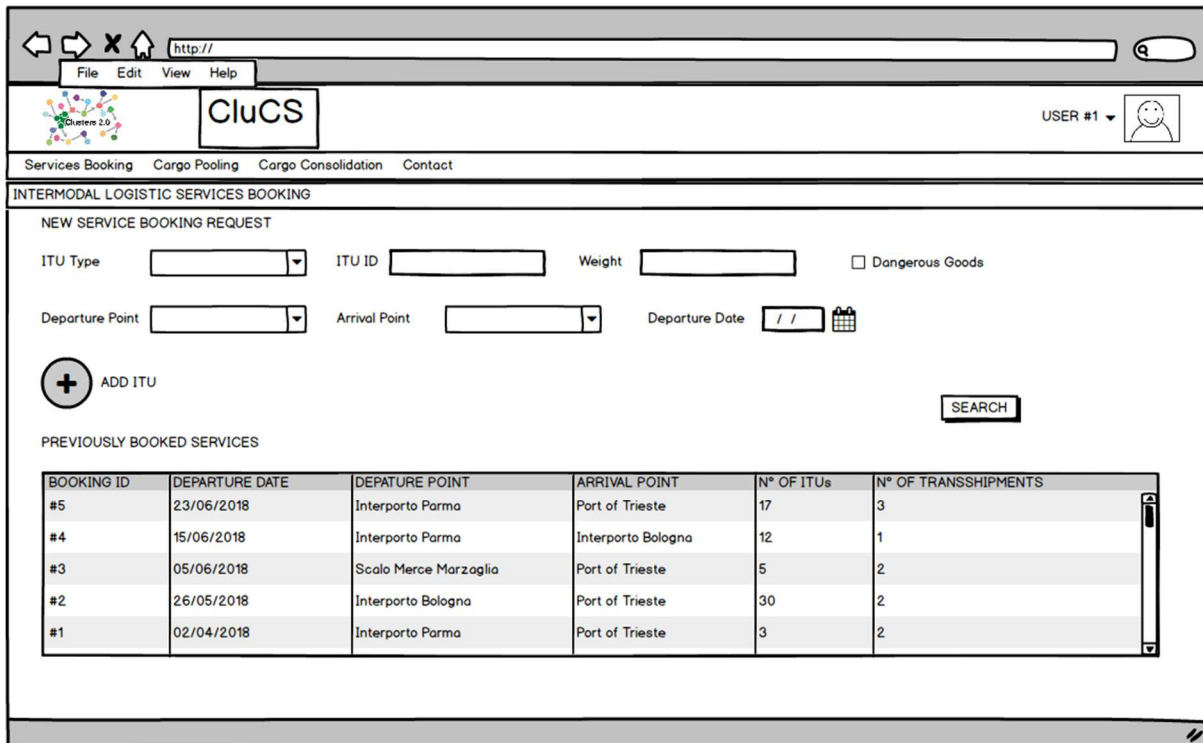


3.3.2.2 Intermodal Logistic Services Booking screen

This screen (Figure 13) is accessible through the Home screen. Users are presented with a set of dialog boxes that permits them to enter the details of the logistic service desired such as departure point, destination point, N° of ITUs, Type of ITUs, desired departing date, desired arrival date, etc. Once all information is entered, CluCS searches for possible solutions for the shippers and present them in a new screen in form of a list, listing first the options that involve a higher percentage of the transport process executed by a rail vector. Next to each option presented, there is a button that allows the user to “book” the selected solution (Figure 14). For users that have already booked a logistic service, when entering this screen there is a list of previously booked services.

In the case of the Cluster Community Manager, when entering this screen, it visualizes a list of all logistic services booked in the platform.

Figure 14: CluCS mock-up – Intermodal main logistic services



Services Booking Cargo Pooling Cargo Consolidation Contact

INTERMODAL LOGISTIC SERVICES BOOKING

NEW SERVICE BOOKING REQUEST

ITU Type ITU ID Weight Dangerous Goods

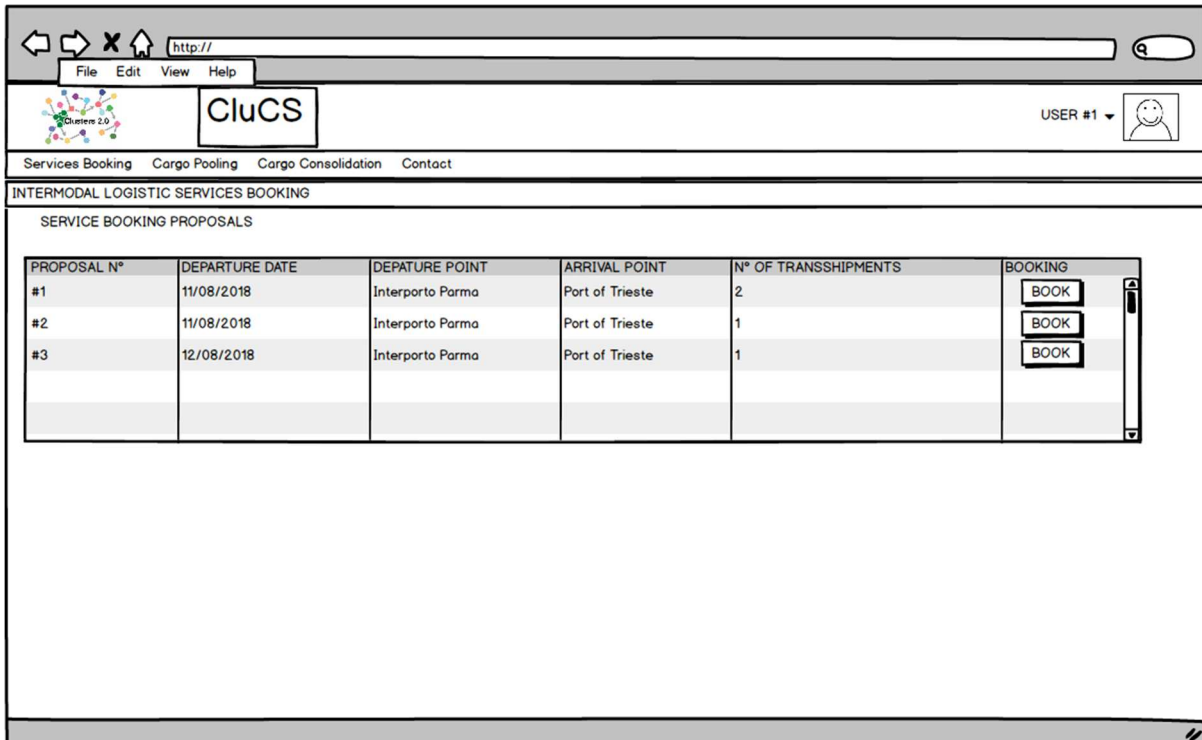
Departure Point Arrival Point Departure Date

ADD ITU

PREVIOUSLY BOOKED SERVICES

BOOKING ID	DEPARTURE DATE	DEPARTURE POINT	ARRIVAL POINT	N° OF ITUs	N° OF TRANSSHIPMENTS
#5	23/06/2018	Interporto Parma	Port of Trieste	17	3
#4	15/06/2018	Interporto Parma	Interporto Bologna	12	1
#3	05/06/2018	Scalo Merce Marzaglia	Port of Trieste	5	2
#2	26/05/2018	Interporto Bologna	Port of Trieste	30	2
#1	02/04/2018	Interporto Parma	Port of Trieste	3	2

Figure 15: CluCS mock-up – Intermodal logistic services booking request



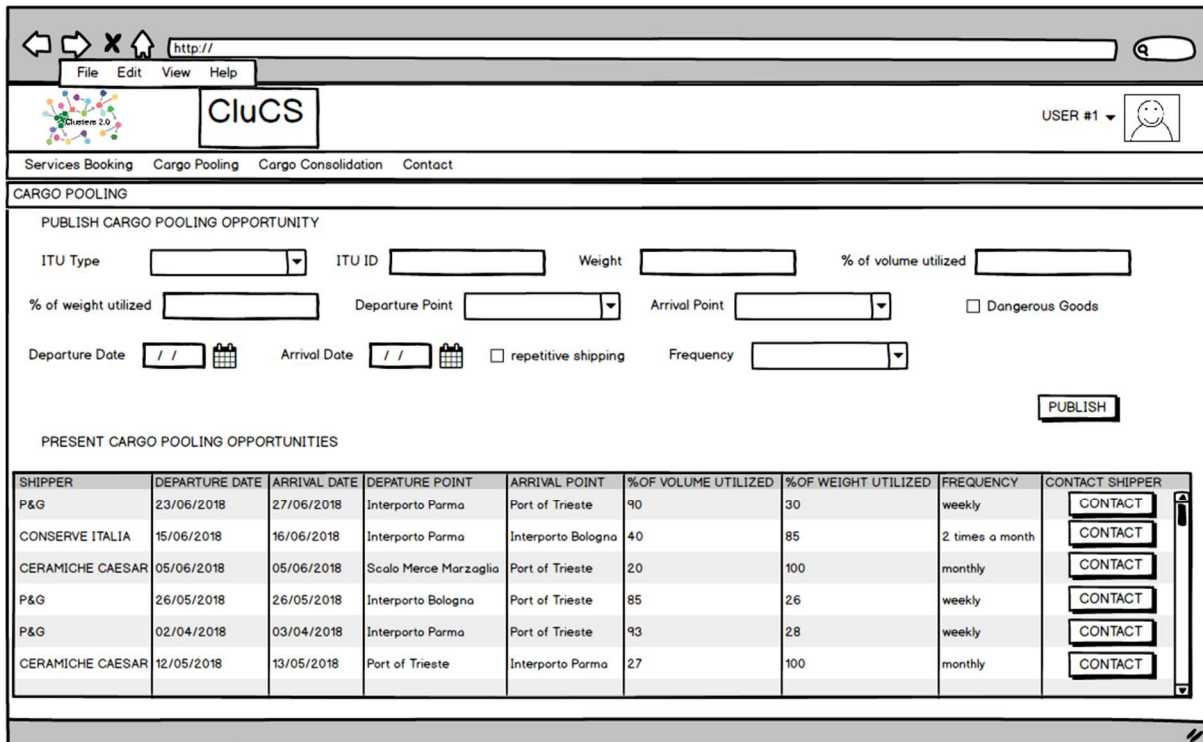
The screenshot shows a web browser window with the CluCS application. The browser's address bar contains 'http://'. The application header includes the CluCS logo, a 'USER #1' dropdown menu, and a navigation menu with options: 'Services Booking', 'Cargo Pooling', 'Cargo Consolidation', and 'Contact'. The main content area is titled 'INTERMODAL LOGISTIC SERVICES BOOKING' and displays a table of 'SERVICE BOOKING PROPOSALS'.

PROPOSAL N°	DEPARTURE DATE	DEPARTURE POINT	ARRIVAL POINT	N° OF TRANSSHIPMENTS	BOOKING
#1	11/08/2018	Interporto Parma	Port of Trieste	2	BOOK
#2	11/08/2018	Interporto Parma	Port of Trieste	1	BOOK
#3	12/08/2018	Interporto Parma	Port of Trieste	1	BOOK

3.3.2.3 Cargo Pooling Opportunities

This screen (Figure 15) is accessible through the Home Screen. When accessing this screen, the users visualize two main parts. The first is a list of all present cargo pooling opportunities published by other users. The second, is a set of dialog boxes that permits users to enter the details of the sub optimal logistic flows they wish to share in order to find another shipper to bundle cargo together, indicating data such as departure point, destination point, N° of ITUs, Type of ITUs, N° of packages inside ITUs, weight of packages, volume of packages, desired departing date, desired arrival date, etc. Once all data is entered, users are able to click the “publish” button, and the provided information will be available to all users. In the case of the Cluster Community Manager, when accessing this screen, a list of all present cargo pooling opportunities published by other users is visible.

Figure 16: CluCS mock-up – Cargo pooling opportunities



The screenshot shows a web browser window with the CluCS application. The browser address bar shows 'http://'. The application header includes the CluCS logo and a user profile icon labeled 'USER #1'. A navigation menu contains 'Services Booking', 'Cargo Pooling', 'Cargo Consolidation', and 'Contact'. The main content area is titled 'CARGO POOLING' and is divided into two sections:

PUBLISH CARGO POOLING OPPORTUNITY

This section contains a form with the following fields:

- ITU Type: dropdown menu
- ITU ID: text input
- Weight: text input
- % of volume utilized: text input
- % of weight utilized: text input
- Departure Point: dropdown menu
- Arrival Point: dropdown menu
- Dangerous Goods
- Departure Date: date picker (// /)
- Arrival Date: date picker (// /)
- repetitive shipping
- Frequency: dropdown menu

A **PUBLISH** button is located at the bottom right of this section.

PRESENT CARGO POOLING OPPORTUNITIES

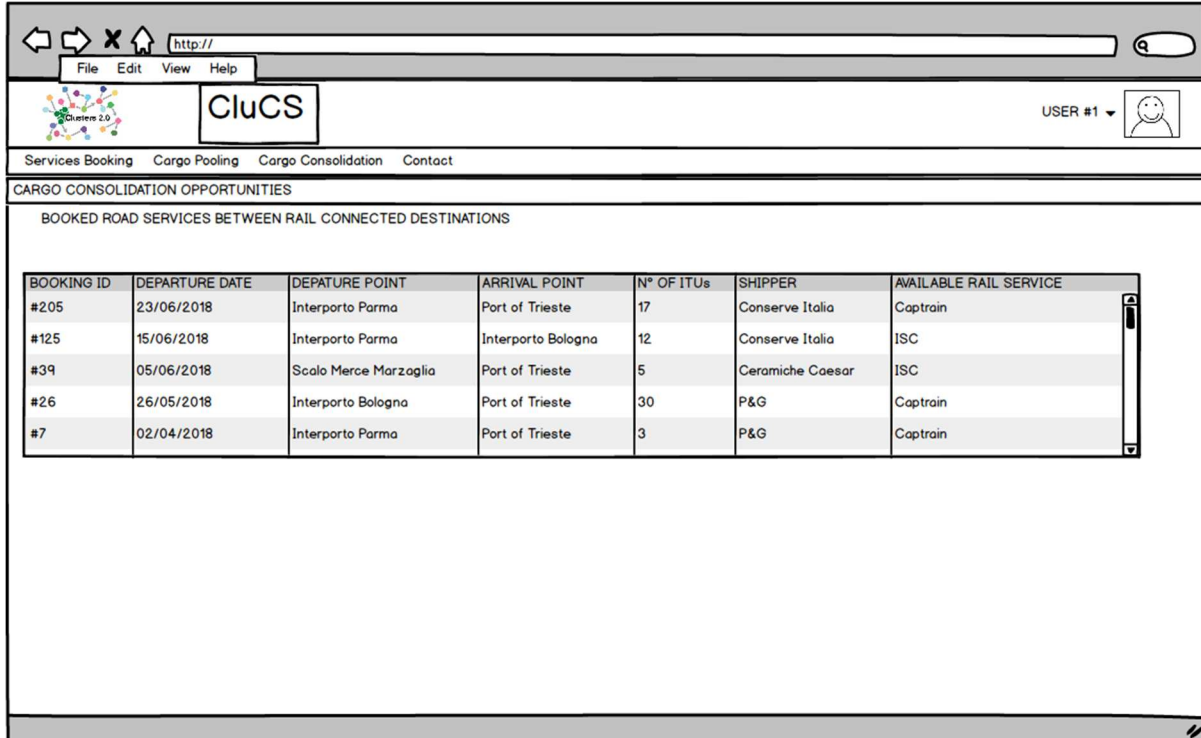
This section displays a table of existing opportunities. Each row includes a 'CONTACT SHIPPER' button.

SHIPPER	DEPARTURE DATE	ARRIVAL DATE	DEPARTURE POINT	ARRIVAL POINT	%OF VOLUME UTILIZED	%OF WEIGHT UTILIZED	FREQUENCY	CONTACT SHIPPER
P&G	23/06/2018	27/06/2018	Interporto Parma	Port of Trieste	90	30	weekly	CONTACT
CONSERVE ITALIA	15/06/2018	16/06/2018	Interporto Parma	Interporto Bologna	40	85	2 times a month	CONTACT
CERAMICHE CAESAR	05/06/2018	05/06/2018	Scalo Merce Marzaglia	Port of Trieste	20	100	monthly	CONTACT
P&G	26/05/2018	26/05/2018	Interporto Bologna	Port of Trieste	85	26	weekly	CONTACT
P&G	02/04/2018	03/04/2018	Interporto Parma	Port of Trieste	93	28	weekly	CONTACT
CERAMICHE CAESAR	12/05/2018	13/05/2018	Port of Trieste	Interporto Parma	27	100	monthly	CONTACT

3.3.2.4 Cargo Consolidation Opportunities

This screen (Figure 16) will be accessible through the Home Screen. The only user of this screen is the Cluster Community Manager, as it presents him with a list of booked logistic services by truck that covers routes in which a rail service is present and available. The Cluster Community Manager visualizes the mentioned list with the newest entries at the top.

Figure 17: CluCS mock-up – Cargo consolidation opportunities



The screenshot shows a web browser window with the CluCS application. The browser address bar shows 'http://'. The application header includes the CluCS logo, a menu (File, Edit, View, Help), and a user profile icon labeled 'USER #1'. Below the header is a navigation menu with 'Services Booking', 'Cargo Pooling', 'Cargo Consolidation', and 'Contact'. The main content area is titled 'CARGO CONSOLIDATION OPPORTUNITIES' and contains a table of 'BOOKED ROAD SERVICES BETWEEN RAIL CONNECTED DESTINATIONS'.

BOOKING ID	DEPARTURE DATE	DEPARTURE POINT	ARRIVAL POINT	N° OF ITUs	SHIPPER	AVAILABLE RAIL SERVICE
#205	23/06/2018	Interporto Parma	Port of Trieste	17	Conserve Italia	Captrain
#125	15/06/2018	Interporto Parma	Interporto Bologna	12	Conserve Italia	ISC
#39	05/06/2018	Scalo Merce Marzaglia	Port of Trieste	5	Ceramiche Caesar	ISC
#26	26/05/2018	Interporto Bologna	Port of Trieste	30	P&G	Captrain
#7	02/04/2018	Interporto Parma	Port of Trieste	3	P&G	Captrain

3.4 PTN and Cluster communication network design

It was decided to base the design of the CluCS communication network on the results of a previous European initiative named eDelivery. This initiative is one of the building blocks of the European Commission's Connecting Europe Facility (CEF).

eDelivery initiative had helped and helps public administrations to exchange electronic data (structured, non-structured and/or binary) and documents with other public administrations, businesses and citizens, in an interoperable, secure, reliable and trusted way.

Even if eDelivery is conceived for the exchange of documents and data across borders, it is also possible to use it to link up different regions, municipalities, etc. in one Member State.

The continuous goal of eDelivery, and Cluster 2.0 is a great challenge, is to overcome the difficulty to exchange data between organizations because generally their information systems are developed independently. For this reason, EU encourages also the private sector to use, as possible, all CEF building blocks, that are reusable specifications, software and services that form part of a wide variety of IT systems in different policy domains of the EU.

In addition to this fact, the main reasons that have guided this choice are:

- eDelivery solutions implement **common technical specifications** that enable diverse organizations to exchange data and documents.
- eDelivery is a **distributed model** because it is based on the e-SENS AS4 messaging protocol, open and free for all, developed by the OASIS standards development organization. According to this specification, distributed and heterogeneous nodes are able to interact with each other if they agree to be conformant to the same technical rules. Moreover, a distributed model approach is more resilient to bottlenecks than other models such as hubs and concentrators.
- with eDelivery every participant becomes a node in the network using standard transport protocols and security policies. As a result, organizations that have developed their IT systems independently from each other can start to securely communicate after they have connected their systems to an eDelivery node. Concerning **interoperability**, among other features, the solution helps to satisfy the following business needs:
 - exchange of documents and/or data using a standardized messaging protocols other than e-mail;
 - exchange of attachments in addition to messages (XML documents);
 - information about participants (what messages they can process, the message protocol that they support, ...) is easily discoverable and accessible by any part of data exchange network;
 - change and discover the registered address of nodes;
 - execute asynchronous request-response interactions.
- eDelivery promotes an atmosphere of trust among all participants in the message exchange network. Practically, the trust between two nodes is achieved through PKI or more clearly each node participating in the message exchange needs to have registered the public key from the other nodes. Concerning **security**, among other features the solution helps to satisfy the following business needs:
 - data and documents are secured against any modification (integrity);
 - documents are encrypted during transmission (confidentiality);
 - the origin and the destination of the data and documents are trustworthy;
 - access to advanced and configurable logging of events related to the exchange of data and documents.
- eDelivery network allows for the number of participants in the data exchange network to grow as well as the number of exchanged messages. Concerning **scalability**, among other features the solution helps to satisfy the following business needs:



Clusters 2.0

- exchange documents and data files larger than 50 Mb;
- back-office has different ways to connect to the message exchange network;
- the message exchange network adapts to an increasing number of nodes, as opposed to a stable number of nodes.
- The eDelivery solution promotes a high level of transparency and confidence among all participants in the message exchange network by addressing **accountability features** such as:
 - guarantee that data and documents are delivered once and only once (retries, receipts, duplicate elimination);
 - messages are delivered even if sent to temporarily unavailable channels (store and forward);
 - evidences of the several steps of the exchange of documents and data;
 - certainty of the non-repudiation of receipt and/or origin of every exchange through signature;
 - time synchronization in the message exchange process.

3.5 Design of integration interfaces

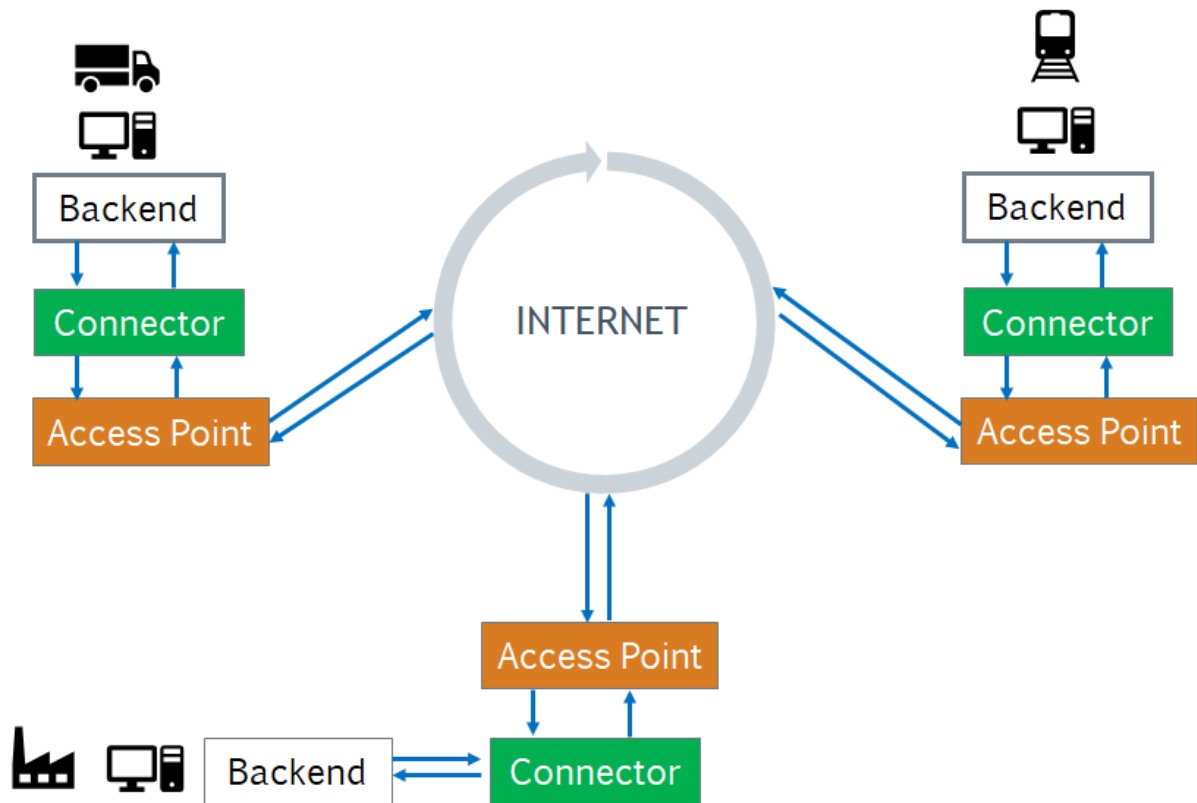
As stated before, all eDelivery solutions (then also CluCS communication network) are based on e-SENS AS4 messaging protocol which has its hinge in the “four-corner model”.

This means that Backend systems do not exchange messages directly with each other but via Access Points, in any given exchange, playing the sender or receiver role.

According to this specification, all sub-systems (e.g. LSP) and over-systems (e.g. CargoStream) must implement their Access Point conformant to the same technical specifications to join the CluCS network. In order to further facilitate the integration between third party’s IT systems and an Access Point, a Connector can be put in place.

An eDelivery Connector may also be used to facilitate the integration between backend systems and Access Points. The next diagram shows the same exchange scenario with the use of Connectors as bridges: the connector offers capabilities of linking up to legacy systems, advanced monitoring and evidences (figure 17)

Figure 18: CluCS communication network



4. Development of CluCS

4.1 CluCS Central Node development

Architecture of the module

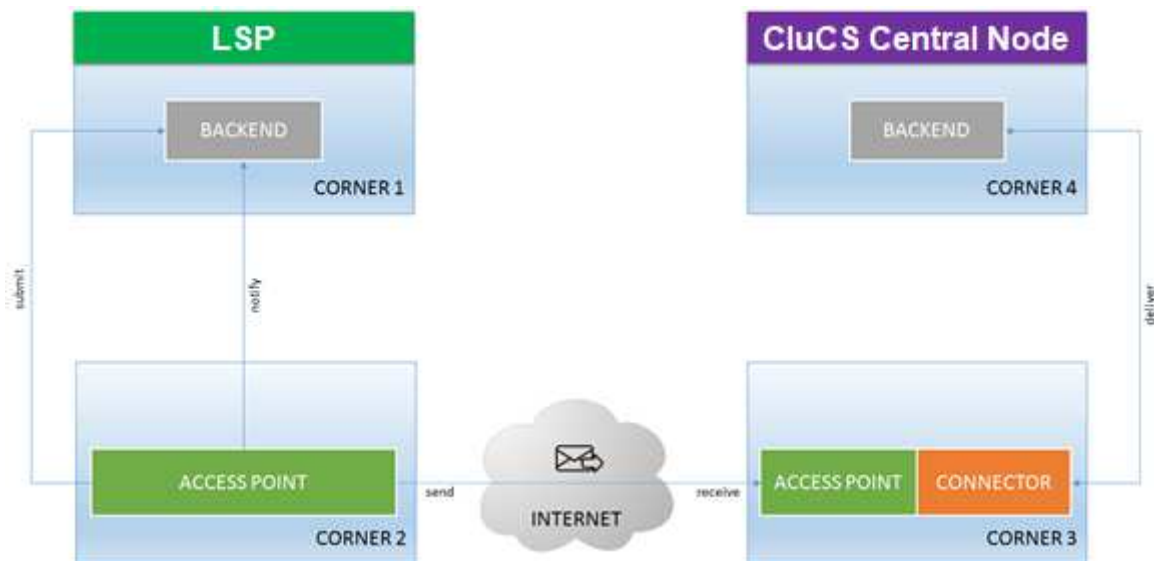
For the development of CluCS central node it was decided to use the Domibus software for the implementation of its Access Point. Domibus is the Open Source project of the AS4 Access Point maintained by the European Commission and may be used as a working solution in a production environment. Currently (October 2018), the latest version of CEF's sample implementation of an AS4 Access Point is v4.0 (released in September 2018).

A comprehensive architectural overview of the Domibus 4.0, regulated by European Union Public License (EURL) is available [here](#)¹.

Whereas, the Connector for CluCS central node is implemented from scratch with Spring Framework Technology.

Figure 18 shows the conceptual model called “four-corner model” where Backend systems (corner one [C1] represents an LSP and corner four [C4] represents CluCS Central Node) do not exchange messages directly with each other but via Access Points (corner two [C2] and corner three [C3]). And besides, the connector concept of CluCS central node is represented as well.

Figure 19: Four-corner model



Architectural design layers of the connector are divided into:

- Data logic, which is responsible for the storage and data access;
- Application or operational logic, which enables the processing of data;
- Service layers, which enable the interaction between corner 4's backend and access point via connector;
- Communication layers, which enable the interaction between connector and access point via JMS.

¹[https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Domibus?preview=/65980193/70222572/\(eDelivery\)\(AP\)\(SAD\)\(4.0\)\(1.13\).pdf](https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Domibus?preview=/65980193/70222572/(eDelivery)(AP)(SAD)(4.0)(1.13).pdf)

Here follows the description of the technology stack of corner 3 connector.

Technology stack

4.1.1.1 Business and data layer

The business layer is developed in pure Java, maintaining a clear distinction between the component, that is dedicated to routing and delivery of messages (communication layer), and the actual business logics. Access to data occurs through the Hibernate framework as JPA implementation.

4.1.1.2 Communication layer

The communication layer is developed using Spring framework to develop a JMS consumer/producer client for Domibus access point.

4.1.1.3 Service layer

The service layer is developed using Spring framework to develop a RESTful Web Services to permit the communication between back-end and connector.

4.1.1.4 Design patterns

The following design patterns are used widely:

- Dependency Injection using Spring;
- Chain of responsibility used to determine the connector's business layer, to be adopted according to Domibus payload request.

4.2 Development of CluCS web-based application

Modules architecture

An open source Platform framework, which consents the RAD (Rapid Application Development) of applications in visual mode, has been chosen to develop terminal operations management module.

Technology Stack

The framework has two main components: Web Designer and Web Interpreter.

The Web Designer is used to design and configure the web application from scratch.

It includes the definition of data models and relations, business components, application menu, windows, panels and events, web services, reports, shell commands.

The Web Interpreter is the language interpreter of the web applications defined through the Web Designer and it is used to render panels (from grids to detailed forms), trees, charts, maps, images, folders, documents and create consequent actions to events.

Other technical characteristics:

- High decoupling between software tiers;
- Rich user interface via EXT-JS framework;
- Easy charting and reporting: export data in Excel/CSV directly from grids and configure report templates using iReport;
- Multi-database: several relational DBMS are supported (Oracle, MS SqlServer, MySql, PostgreSQL are full supported);
- Multi-user with access control and segregation of duties: the application menu can adapt according to the user roles. Grid and form toolbars can adapt according to the user roles;
- Multi-language support;
- Cross browser;
- SSL support;
- A change applied to metadata through the full integrated CMS is immediately available, by simply reloading the web application. No deploy activities are required;

Clusters 2.0

- SOA Oriented: all the business logic can be easily accessed, not only by the web tier but also from any other system: this feature has been exploited to manage the authentication and archiving of documents of the applications that make up the module for management of the terminal area and gate.

4.3 Development of integration with sub-systems (terminal / hub) and over-systems (CargoStream platform)

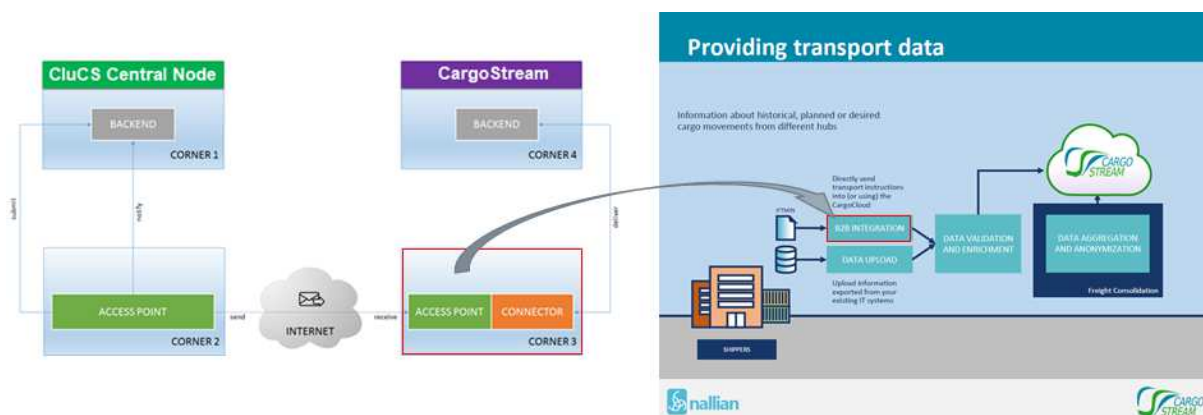
The process through, two generic entities adopting the CEF eDelivery Building Block can easily and safely become interoperable, is specified on the e-SENS AS4 profile, which is an open specification for the secure and payload-agnostic exchange of data using web services.

A third party may join the CluCS network following this simple step:

- Install, on Corner 3, the same or higher version of Access Point software used by CluCS (currently Domibus 3.2.5);
- Exchange its public certificate with CluCS Central Node;
- Install the CluCS public key into its AP trust zone;
- Configure PMODE (AP configuration file) to accept and/or send message from/to CluCS Central Node;
- Develop Corner 3 connector to translate CluCS messages into its format and to implements proper business logic.

Figure 19 shows CluCS integration with CargoStream.

Figure 20: Example of integration: CluCS and CargoStream



Domibus, to facilitate B2B communication, provides a very flexible plugin model which allows the integration with nearly all back-office applications. A plugin is the building block based on which a connector is built, and it is described very well in Domibus Plugin Cookbook². It enables a set of functions to be issued by the connector to the Access point, for instance, to send a message or to download a pending message.

A third party, to develop its own working Domibus plugins, have to implement at least two interfaces and extend one abstract class:

1. *eu.domibus.plugin.AbstractBackendConnector* (abstract class to extend)
2. *eu.domibus.plugin.transformer.MessageSubmissionTransformer* (interface to implement)
3. *eu.domibus.plugin.transformer.MessageRetrievalTransformer* (interface to implement)

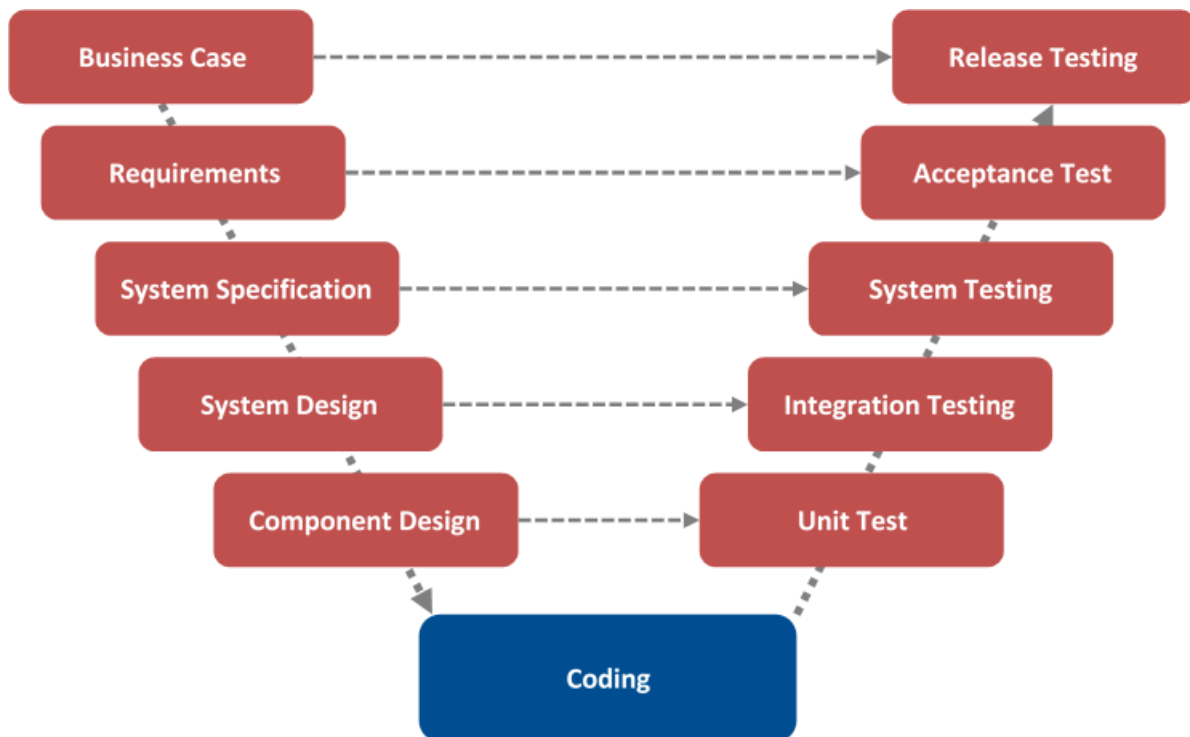
²[https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Domibus?preview=/65980193/70222565/\(eDelivery\)\(AP\)\(CB\)\(Domibus.4.0\)\(2.10\).pdf](https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Domibus?preview=/65980193/70222565/(eDelivery)(AP)(CB)(Domibus.4.0)(2.10).pdf)

4.4 Definition of CluCS test phase specification

As testing methodology uses the “V” model (Figure 20). Such testing model provides a framework for test execution in all crucial stages – unit testing, integration testing, system testing and final User Acceptance Testing (UAT). Testing are timely defined and always managed at project management level. Testing task also has (pre)defined user for smooth execution. All test results are documented to certify a high code quality.

The “V” model is a methodology where development and testing take place at the same time with the same kind of information available to both teams (Figure 20). This methodology could be used both in waterfall development approach and within SCRUM framework because, basically, it can be decided to treat each SCRUM Sprint as a separate “V-model”: to have a stable and conformant product it needs to be validated and to validate this product the specifications, functionalities, and documentation all need to be checked as soon as available.

Figure 21: The V model



As a generalization, four testing phases, associated with the V-model, should be respected:

- I. **Unit test** (also known as developer or component testing) is typically conducted by the developer to ensure that their code meets its requirements and is the lowest level of testing normally identified. Unit testing can be a manual process (often involving a test harness or some other means of simulating other planned software components that would communicate with the component under test, but which had not been coded at that point). If possible, unit testing is usually conducted by using one of the many developer testing tools that are available (e.g. JUnit).
- II. **Integration testing** (also known as modular testing) is used to demonstrate that the modules that make up the application under test, interface and interact together correctly. As a rule (but clearly dependent on the size and importance of the project), integration testing is conducted by the developers under the supervision of the project leader.



Clusters 2.0

- III. **System test** is employed to establish confidence that the application under test will pass its acceptance test. During system testing, the functional and structural stability of the system is examined, as well as the non-functional aspects of the application under test, such as performance and reliability.
- IV. **Acceptance test** (also known as user acceptance test or **UAT**) is used to ensure that the application under test meets its business requirements, and to provide confidence that the system works correctly and is usable before being formally handed over to the end users. Typically, UAT is conducted by final user representatives with the assistance of testing representatives: UAT acts as a final verification of the required business function and proper functioning of the system, emulating real-world usage conditions. Below tasks are followed by the UAT testing team:
 - a. final user representative who understand the business functions run the tests detailed in the test plans, according to the scripts developed during the design and development phases;
 - b. the testers formally document the results of each test, and provide error reports and correction requests to the appropriate developer(s) or writer(s);
 - c. the developers and writers correct the system, installation procedures, online help, user documentation, and training materials, as required;
 - d. steps a-b-c are repeated as often as needed, until the system is approved;
 - e. the test team completes the User Acceptance Test for application deliverables;
 - f. UAT is signed by both parties;
 - g. the developer(s) create the production system and installation procedures, using the frozen development system containing all the corrections implemented because of User Acceptance test;
 - h. the team gathers the testing documentation together and forwards it to the methodology representative for review.
 - i. the methodology representative reviews the documentation and completes the compliance form before returning the materials to the project team.

4.5 Go-Live Session

Although Cluster 2.0 project follows an iterative approach, the go-live sessions have been hypothesized to be carried out during the third iteration of the project.

5. Conclusion

This report, elaborated within WP2, defines Cluster Community System (CluCS) development and test phase specification. The final shape of CluCS has been developed through an interactive process of progressive improvements in joint cooperation with task 2.3.

This report defines CluCS technical architecture, the software modules development and CluCS test phase specification.

In the end, CluCS functions as a connector between the Cluster's different sub-systems and allows a coordinated management of multiple hubs with different specializations creating synergies and linking the Cluster to different TEN-T corridors.

It was decided to base the design of the CluCS communication network on the results of a previous European initiative named eDelivery (one of the building blocks of CEF) which allows to exchange electronic data (structured, non-structured and/or binary) and documents in an interoperable, secure, reliable and trusted way.

Moreover, as regards test phase specification, the methodology used is "V" Model where development and testing take place at the same time with the same kind of information available.

In conclusion, this report is the documental release of the Cluster Community System, the tool for Clusters' systemic management, and defines the requirements for CluCS test phase that is performed in WP5 – Living Lab 1 "Proximity Terminal Network & Cluster Community System".

6. References

Clusters 2.0 Description of Action

<https://ec.europa.eu/inea/en/connecting-europe-facility>

<https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/eDelivery>

<https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/Domibus>

6.1 Actual standards

OASIS Standard - OASIS ebXML Messaging Services Version 3.0: Part 1, Core Features. Available at: http://docs.oasis-open.org/ebxml-msg/ebms/v3.0/core/os/ebms_core-3.0-spec-os.pdf

OASIS Standard - AS4 Profile of ebMS 3.0 Version 1.0. Available at: <http://docs.oasis-open.org/ebxml-msg/ebms/v3.0/profiles/AS4-profile/v1.0/os/AS4-profile-v1.0-os.html>