FInest – **F**uture **In**ternet **e**nabled optimi**s**ation of **t**ransport and logistics networks

SEVENTH FRAMEWORK PROGRAMME

D4.1

Initial Requirements Study

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Lead Beneficiary	IBM	
Editor(s)	Fabiana Fournier	IBM
	Guy Sharon	IBM
Contributors	Michael Zahlmann	KN
	Michael Stollberg	SAP
	Lone S. Ramstad	MRTK
	Tor Knutsen	ARH
	Metin Turkay	KOC
	Oyvind Olsen	NCL
	Evert-Jan van Harten	AFKL
Reviewers	Cyril Alias	UDE

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	Evert-Jan van Harten	AFKL
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Abstract

Work package 4 in the FInest project deals with the identification and design of an experimentation environment for testing, demonstrating, and evaluating the technologies developed during the project based on FInest use cases and real data, on large-scale trials. The activities are closely related to the specification of FInest use cases and provision of real-data from the Infinity project.

This document describes the initial technical, functional, and non-functional requirements of this experimentation environment. This list of requirements will be further refined as the project progresses, insights are gained, and more information becomes available.

Document History

Version	Date	Comments
V0.1	17-08-2011	First draft
V0.2	28-08-2011	Updates of section 3 and 4
V0.3	31-08-2011	Update of section 5
V0.4	4-09-2011	Addition of abstract
V0.5	9-09-2011	Inclusion of partner comments after face-to-face meeting in Istanbul
V0.6	12-09-2011	Conceptual architecture using TAM terminology
V0.7	14-09-2011	Submitted version for internal review
V1.0	30-09-2011	Submitted version

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Acronyms

Acronym	Explanation
3PL	Third Party Logistics
AIS	Automatic Identification System
EE	Experimentation Environment
FInest	Future Internet Enabled Optimisation of transport and Logistics Business Networks
FI-PPP	Future Internet Public Private Partnership
FIRE	Future Internet Research and Experimentation
IoT	Internet of Things
PCS	Port Community Systems
SME	Small and medium Enterprises
T&L	Transport and Logistics
ULD	Unit Load Device
WP	Work Package

1. Introduction and motivation

The Future Internet Public Private Partnership (FI-PPP) focuses on the development of innovative open network and service platforms with generic common enablers serving a multiplicity of demand-driven use cases in "smart applications". The work in Objective FI.ICT-2011.1.8: Use Case scenarios and early trials, focuses on vertical use case scenarios whose intelligence, efficiency, sustainability and performance can be radically enhanced through a tighter integration with advanced Internet-based network and service capabilities. The work includes use case characterization; specification of platform requirements; development and technological validation prototypes, and large scale experimentation and validation [1]. In the FInest (Future Internet Enabled Optimisation of transport and Logistics Business Networks) project we aim at developing such an infrastructure on the basis of the Future Internet technologies for the Transport and Logistics (T&L) domain. Modern transport & logistics is often a highly distributed inter-business activity spanning across several countries with each of the involved business partners aiming at optimizing their individual, commonly complex supply and production chains. Our use case addresses the international transport & logistics business that is concerned with the planning and execution of world-wide shipment of goods and people and constitutes a backbone of the European economy. As a highly competitive industry, this demands novel ICT solutions for enhancing the inter-organizational collaboration in cooperative business networks [2].

The FI-PPP is based on a three-phased approach and includes a strong experimentation and validation dimension (Work Programme 2011, [1]). One of phase 1 FI-PPP outcomes for Objective FI.ICT-2011.1.8 is a phase 2 implementation plan, including a detailed analysis of the potential experimentation infrastructures, and a plan for user community building. Work Package 4 (WP4) – *Experimentation Environment* in FInest directly addresses this outcome. One of the main focuses of the FInest project is the design of an Experimentation Environment (EE) for conducting large-scale trials in preparation for user community building and industrial uptake. As a result, one of FInest main activities is concerned with the design of an experimentation environment that is suitable for testing, demonstrating, and evaluating the developed technology during the project in large-scale trials. The intended approach for conducting large-scale experiments that are planned in phase 2 of the FI PPP is to run FInest use case scenarios within the experimentation environment, and evaluate the achievable improvements and business benefits. A ‘virtual test & simulation environment’ for the T&L EE appears to be sufficient because [2]:

- The relevant information is mostly ‘paper & data’ that can be best processed electronically
- Simulation is most adequate for testing, demonstrating, and evaluating the FI-enabled technical solution; additional parties can be integrated in later stages of large-scale trials
- Easily extensible with data from physical test sites for real-world integration experimentation

As a consequence, the Future Internet experimentation environment for the transport and logistics domain is planned to consist of two facets: (1) test and simulation software that allows running experiments on real-world logistics processes in order to evaluate the achievable improvements by the Future Internet enabled collaboration and integration platform, and (2) the integration of physical test sites in order to obtain the necessary test data, particularly for transport monitoring and tracking on the basis of integrating real-world information from sensor networks.

To be successful in today's T&L highly competitive global markets it requires all organizations in the supply chain to introduce innovations and improvements quickly and efficiently. Complexity of today's T&L networks makes managing the testing of upgrades and the launching of new products or services difficult. Experimentation is an attempt to simulate the real environment. It gives the operators of the new technology/application/service an opportunity to try different operating scenarios, to rehearse responses to a variety of situations and to evaluate the value it brings before its deployment to the market. Following are potential benefits of an efficient and representative test environment for the Finest project:

- Evaluation platform for Finest and eventually the FI-WARE project on the specific application of transport and logistics (see section 2.2.2)
- More accurate evaluation of the new change impact across a wide variety of scenarios to ensure robustness and efficiency. Efficient evaluation of new processes and applications would be enabled by using real test data and possible test-beds across Europe (to ensure as much as close to realistic scenarios). Tests on real scenarios can provide insights with respect to accurate time-to-market and potential deviations. Furthermore, through interactions of simulations of potential future scenarios the virtual environment can stimulate the imagination of new concepts [3].
- Large scale IoT (Internet of Things) experimentation and evaluation under realistic operational conditions. Future Internet technologies can facilitate radical improvements not only for optimizing existing processes in international T&L but also for completely new and innovative logistics processes. The need for increased realism that an experimental facility has to offer to accurately reflect the real world usage conditions of the developed Internet of Things (IoT) technology requires an EE as similar to real conditions as possible.
- Better understanding of the potential socio-economic impact of IoT solutions and the inclusion of the human in the experimentation loop.
- An additional channel for disseminating FInest – exposing the project outcomes through potential scenarios as a means of demonstrating FInest capabilities.

Deliverable 4.1 *Initial requirements study* is the first step towards the identification and realization of an experimentation environment platform suitable for the T&L domain and the FI-PPP objectives. This deliverable deals with the initial definition of the requirements for such a platform. The goal of this document is to provide an initial list of requirements based on the study carried out in *Task 4.1 Requirements Analysis for the Transport and Logistics Experimentation Environment* of the project. The requirements detailed in this document constitute an initial list, mainly a result of inputs provided by all domain partners of the project during the accomplishment of T4.1, and will be refined and updated in the subsequent deliverable D4.2 *Requirements and design of transport and logistics experimentation environment* in month 12, as more progress in the project is achieved.

2. Relationships with other FInest work packages and projects

As WP4 is concerned with experimentation environment for the envisioned FInest technology and it aims at testing use cases scenarios in the T&L domain, it is inherently tightly coupled with the domain requirements and use cases (WP1-2). In addition, WP4 is much related to other ICT and FI-PPP projects as described below.

2.1. Relationships of D4.1 to other FInest WP and Tasks

D4.1 is in particular related to the following deliverables as they are concerned with the specification analysis of T&L and the use cases which will be tried and evaluated in the EE:

- D1.1 (Tasks: T1.1, T1.2, and T1.3) - Initial report on the transport and logistics domain analysis (M6)
- D1.3 (Tasks: T1.2) - Business requirements for future transport and logistics ICT solutions (M12)
- D2.2 (Tasks: T2.2) - High level specification of use case scenarios (M6)
- D2.3 (Tasks: T2.2) – Detailed specification of use case scenarios (M12)

2.2. Collaboration with other ICT and FI-PPP projects

2.2.1. Infinity project

As pointed out in the Work Programme [1], the definition and preparation of the experimentation sites may be complemented by the provisions made under Objective 1.9. The main challenge for the Infinity (http://www.fi-infinity.eu) project is to establish an approach that can quickly engage with infrastructure owners and application developers Europe-wide, building as far as possible on existing data, information, projects and programmes, to create a new, useful and valuable repository of infrastructure capability and capacity that facilitates the creation of an international community that can collaborate to deliver the Future Internet. The FInest team will work in cooperation with the Infinity team to identify suitable test sites for conducting these tests and get access to appropriate data. Collaboration with Infinity is carried out via the following channels:

- E-mails
- Meetings
    - First face-to-face meeting (joined by phone) on June 29, 2011
    - First Concertation Board workshop is planned for the end of September or beginning of October

FInest in general and WP4 in particular, deals only with specific data provided by the domain partners based on scenarios delineated in the project. Therefore, we explicitly requested Infinity to generalize on those scenarios/requirements in order to:

- Provide a website repository of available infrastructure, stakeholders (including owners, operators, and end users), and data for large trials in the domain of T&L (real large amounts of data from sensors to provide "physical world" information). Infinity could be able to reach across FInest scope to more organizations, companies, and test sites to gather data that might lead to more insights, better understanding, and hopefully refinement of the list of requirements.

- Provide a repository for standards, regulations, and policies regarding infrastructures for the domain of T&L.

2.2.2. FI-WARE project

FI-WARE (http://www.fi-ware.eu) will deliver a novel service infrastructure, building upon elements (called Generic Enablers) which offer reusable and commonly shared functions making it easier to develop Future Internet Applications in multiple sectors. FInest technology will be developed realizing these generic enablers provided by FI-WARE core platform and will extend them to the T&L domain (see Figure 2). As FInest EE is one of the application areas for FIWARE and, as aforementioned in the introduction section, large-scale experimentation is planned for phase 2, we believe that through the EE we will be able to indirectly evaluate to some extent some of the FIWARE modules for T&L during phase 2 of the FInest project.

2.2.3. FIRE projects

The Future Internet Research and Experimentation (FIRE) Initiative (http://cordis.europa.eu/fp7/ict/fire/) aims at creating a multidisciplinary research environment for investigating and experimentally validating highly innovative and revolutionary ideas for new networking and service paradigms. FIRE is promoting the concept of experimentally-driven research, combining visionary academic research with the wide-scale testing and experimentation that is required for industry. FIRE also works to create a dynamic, sustainable, large scale European Experimental Facility, which is constructed by gradually connecting and federating existing and upcoming testbeds for Future Internet technologies. Ultimately, FIRE aims to provide a framework in which European research on Future Internet can flourish and establish Europe as a key player in defining Future Internet concepts globally. With a strong network focus, the first wave of FIRE projects was launched in summer 2008, with a budget of 40 million Euros and each year sees this increasing along with the scope of the projects.

The FInest WP4 team will strive to collaborate with current running projects under FIRE initiative, such as the SmartSantander project (http://www.smartsantander.eu) and along with Infinity to test the potential reuse of existing European test sites developed in the course of the FIRE initiative.

3. Experimentation AS-IS overview

Requirements analysis for FInest EE involves the understanding of current experimentation environments employed by FInest domain partners and the existing gaps or needs that dictate future requirements. First step is to gain an understanding of the main factors that influence the experimentation environment in the T&L domain, such as:

- Current technologies and procedures applied today in testing
- Common changes that require a formal procedure for testing
- Examples of frequent changes through typical scenarios
- Underlying hardware and device technologies employed today, and data formats

To this end, WP4 has held several discussions with the domain partners as explained in the next section.

3.1. Mode of work towards the preparation of D4.1

IBM leads and coordinates the different activities in WP4. However, the content regarding the current partner activities around experimentation and needs can only be originated from the domain partners. Therefore, in order to understand and articulate the initial list of requirements included in this document (see Section 5) along with the set of desired capabilities that eventually drive these requirements, the following plan has been devised.

- Information from all domain partners (all partners have some resource allocation in WP4) would be given as input to IBM through iteratively template documents. IBM would elaborate the findings coming from the domain partners. New issues serve as basis for the next iteration. Figure 1 depicts the activities carried out towards the preparation of D4.1. The output of these discussions and provided input is an internal document, approved by the domain partners, that serve as basis for the AS-IS overview of this document and the identification of required capabilities of FInest experimentation environment.
- Bi-weekly WP conference calls to discuss findings, get feedback, and monitor the progress of the work in the WP in accordance to the work plan.

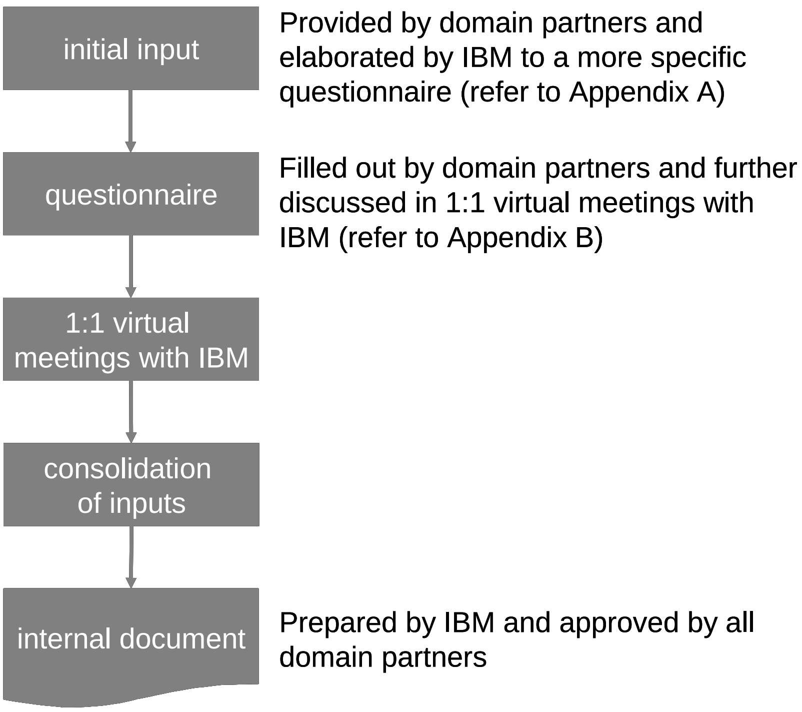

Figure 1 – activity flowchart towards the preparation of D4.1

3.2. Findings

From the conversations with the domain partners in the project, we can categorize the tests performed today with regards to partners' operational systems into two groups:

- *Technical changes* – These include the implementation of both hardware (i.e. rack feeder systems) and software (i.e. a new update or release to an existing application, or a migration to a new application that offers more advanced functionality). In software changes, conventional application testing procedures are applied, that is, a test environment which is identical to the production system is built to test the new software.
- *Organizational changes* – Within the context of FInest these can be process improvement methodologies or a replacement of certain functionality in a production system can yield to changes in current processes or to complete new processes. In general, when tests are performed to a new or updated process, there is need to specify the selection/creation of relevant scenarios for testing and ensure that tests reflect realistic operational business conditions. Tests and results are documented and reported to stakeholders. Issues and risks identified during testing are highlighted.

Most of the scenarios given by the domain partners with regards to experimentation emphasize the following characteristics that directly influence the types of tests carried out in today's T&L environments:

- *Lack of interoperability* - Current systems are proprietary and there is no standard open solution covering the whole chain. Thus, any change or addition of one partner or component in the chain requires adaptation of the existing system or the introduction of new interfaces due to interoperability issues. Examples:
    - Orders placed in Excel files due to differences in the logistic systems applied by the different stakeholders.
    - Login to third parties systems in order to locate freights (for example, logon to the shipping companies to locate the ships, or call a service supplier to get information with regards to certain shipping).
- *Processes are not fully automated* and are rich with manual tasks. Example:
    - The Port Community Systems (PCS) are manual, meaning the port personnel needs to manually feed data and information on various tasks of the different running processes that they are responsible for.
- *Documentation is mostly manual*
- *Tracing and monitoring of freights/containers/trucks/ships is seldom done by real-time devices* such as RFID or GPS. As pointed out in [4], there are time-slots in which products disappear and go into black-holes and there is no real-time information about the location and the status of the products that is sometimes necessary for dynamic re-routing. Examples:
    - Tracking of containers is done on the vessel (on vessels there is a software component to locate/allocate containers). On the quay in the port they can only know the containers location via the operators in the port.
    - PCS systems usually are not connected to the AIS (Automatic Identification System - http://en.wikipedia.org/wiki/Automatic_Identification_System) and therefore tracking the vessels and the processes is done manually via different systems.
    - Sometimes, tracking and tracing of freights is done via a third party platform, e.g. Zebraxx (http://www.zebraxx.de/engl/index.html) which enables virtualization of the shipment and estimation of the delivery time.

- *No standards that encompass the whole end-to-end process*. In general, except air cargo, there are no recognized standards for the T&L domain. In air cargo the majority of organizations follow Cargo 2000 which is an industry initiative aiming at implementing a new quality management system for the worldwide air cargo industry (http://www.iata.org/whatwedo/cargo/cargo2000/Pages/index.aspx). The objective is simple: to implement processes, backed by quality standards, which are measurable to improve the efficiency of air cargo.

As a result, the use of virtual simulation in order to test an end-to-end process is impractical and other types of testing are employed. We identify four types of tests carried out by the domain partners in FInest:

1. *no testing is performed* – some of the situations involve changes in third parties and not in the processes or applications of the partners themselves, so basically the partners just verify that the third (responsible) partner has performed acceptance tests for the required change. The changes are transparent to the domain partners and no testing is required. This is common in partners that only deal with planning but outsource all their logistic processes. Examples:
    a. A software migration in one of the suppliers, as long as the interface hasn't change the FInest partner is indifferent to that change.
    b. Compliance to a new regulation that doesn't directly affect the FInest partner.
2. *dry runs* – a simulation of the actual process including participation of the different stakeholders, but without testing in real environment. Its objective is to identify major flaws and discrepancies between test activities, product functionality, and documentation. In dry runs the process is mimicked with stakeholders and upon its outcome a decision is made whether to go live. Sometimes dry-runs are used when a physical test is not feasible (e.g. not enough room in the warehouse to store a container). In most cases, an end-to-end dry run in the T&L domain is not possible, thus only parts of the supply chain/network are simulated. Examples:
    a. Transferring a cargo between two airlines – each task is walked through verbally by a stakeholder representative and the shaking-hands between tasks and shifts of responsibilities are exercised.
    b. Protocol message interchange - Part of establishing a new interchange with a partner is to agree upon the protocols and messages by which the two partners will interact at different points of the shipment process, whether financial or operational. As part of the testing, validation and eventually acceptance criteria, the communication between the two systems is tested by virtually running the process with the relevant stakeholders, meaning sending test message scenarios that are expected to be generated by the production system.
3. *pilots* – the test is carried out in the real environment. Often used before full scale development or implementation. During a pilot, the new process is run for real but scope of the process is constrained, e.g. one customer, one flight line, one port. The pilot can be constrained by time as well; run the pilot for six months and then evaluate its effectiveness. A pilot is slightly more risky than a dry run or simulation because it involves real products, customers, and services. Pilots are usually carried out in the following cases (a) the changes might have unintentional wide reaching consequences; (b) costly implementations; and (c) changes are difficult to reverse. The advantages of a pilot are several: (a) risk is constrained. Pilots are closely monitored so potential downsides can be prevented by pre-testing under "lab conditions"; (b) the people working in the pilot can become trainers as the process is rolled out to the rest of the

organization; (c) in-depth learning of the applied software; (d) the pilot is another opportunity for skeptics to visit the pilot process and learn from those working in it. Examples:

   a. sending one ULD (Unit Load Device) to a new destination (testing a new route), or sending a new product for the first time. In most cases the trial shipment is organized together with the customer. The test may include exercising specific request/agreements that will be made for this new type of shipment such as special security requirements or special custom handling needs.

   b. simulating the allocation of resources and services to a vessel that has just entered the quay in order to test the performance of the operator at shore in real conditions

4. *parallel adoption* – FInest domain partners usually choose this option for software implementation. In order to reduce risk, the old and new system run simultaneously for some period of time after which, if the criteria for the new system are met, the old system is disabled. The idea behind parallel adoption is that if a problem with the new software is encountered, there is still the old system to fall back on and the results of the two systems can be easily compared immediately and constantly. When the new process has been debugged, the old system can be shut off and the new one becomes the production system.

3.3. Problems in today's experimentation environments

Some common problems in the AS-IS situation with regards to testing:

- *Virtual simulation that encompasses the whole T&L supply chain is impractical* as explained in the previous section, raising the risk of an unsuccessful adoption.
- *No physical environment exists* - Partners don't possess any dedicated physical environment for testing. In cases in which physical pilots are carried out, they are done in the production environments. In tests of software components, partners own test environments identical to production ones in which tests are performed and only after approval they are implemented in the real production environments; or rely on the company they have outsourced the software or part of the process.
- *No repository of real data is available for testing* – in best cases, partners can only use their own historical data, which doesn't always ensure a good forecast about performance in real time. However, historical data often faces issues of obsolescence due to the dynamic nature of the T&L domain, which makes its use even harder.

4. Experimentation TO-BE overview

Applying any change in an organization implies much more than just a software update. It usually involves process changes (radical in some cases) and organizational changes (usually people are involved). In FInest we aim at developing a new platform based on FI technology that will open a new spectrum of new e-business processes for T&L. Transformation is not simply the addition of new technology; rather it is the synergistic effect of new concepts and processes used in conjunction with new technology. The challenge is to develop these concepts and processes in the most effective and efficient manner. Therefore, the importance of a good, maximum close to real environment for testing is essential.

As mentioned in the introduction in this document, a virtual simulation environment is the most suitable environment for experimentation in the T&L domain. Simulation can be used to test, observe, and gain understanding of new concepts, processes, and technologies under current and future scenarios [3]. A virtual simulation of an end-to-end scenario can improve the AS-IS and enable the evaluation of future Internet technologies. By extending simulations to include real-data we can achieve a better understanding and evaluation of real-world scenarios.

4.1. Potential Stakeholders

Potential stakeholders of the envisioned virtual simulation environment are all parties involved in international freight transport & logistics, including [2]:

- Global logistic providers (“3PL”)
- Various ‘T&L suppliers’ involved in international logistic supply chains (including Small and medium Enterprises - SMEs)
- Secondary logistic providers (insurance, finance, etc.)
- Public authorities (customs, trade organizations, national traffic management, etc.)

4.2. Users of FInest EE

We can group the different users into two categories:

- *Experimenters*: the actual user of the system, the person who designs and runs experiments. Experimenters possess knowledge about the T&L domain (domain experts) and in the simulation domain. They are also experts in the functioning and operation of the simulation environment.
- *Participants*: people/organizations that form part of the test or experiment. These can be providers or consumers of services employed in the tests or anyone of the potential stakeholders described above.

4.3. High level architecture of FInest EE

Although the design of FInest EE is part of D4.2 *Requirements and design of transport and logistics experimentation environment* due to M12 of the project, we include below in Figure 2, an initial high level conceptual architecture, as this is a prerequisite to understand some of the initial capabilities/features required from the EE system. Furthermore, we feel that it is important to understand the mutual relations between FInest EE, FInest, Infinity, and FI-WARE. Figure 2 will be further refined and updated in D4.2.

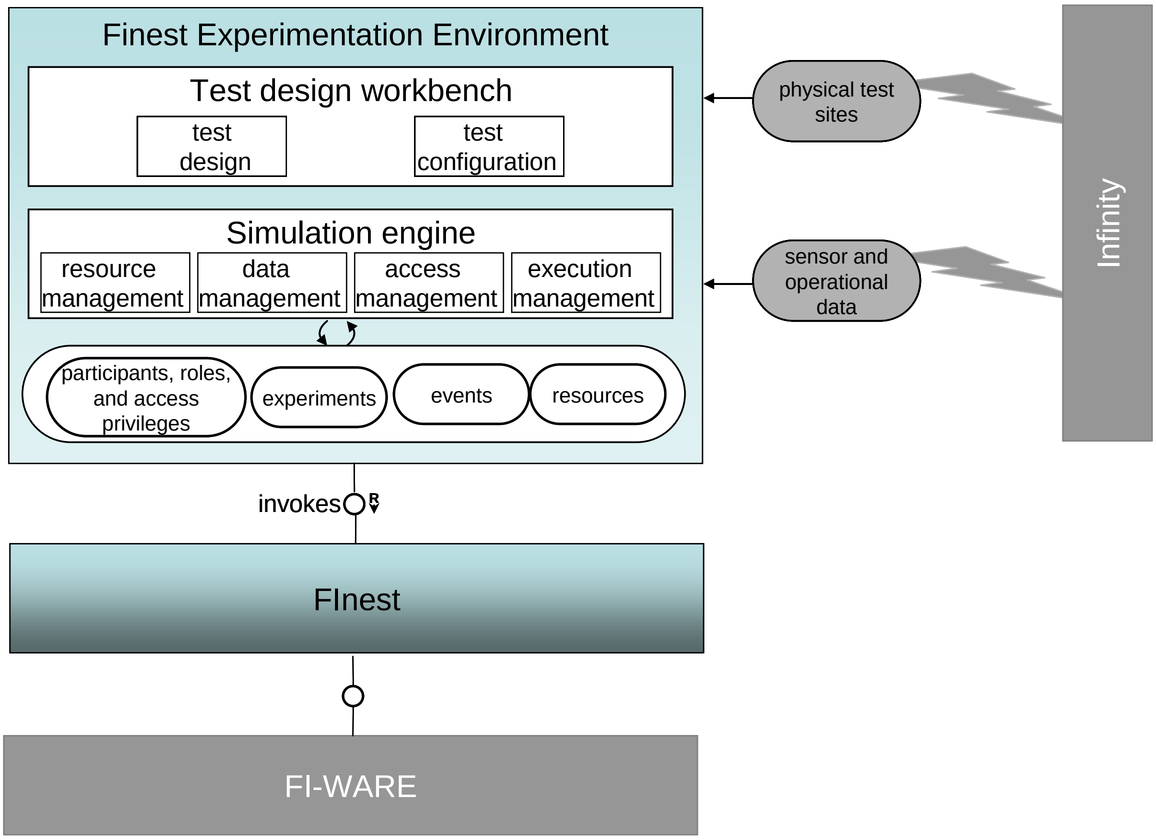

Figure 2 - High level conceptual architecture FInest experimentation environment

FInest EE will operate on top of FInest platform and will invoke it in each simulation of a test or experiment, employing FInest technologies and databases. As one of the main goals of FInest EE is to utilize real-data and physical test sites, the envisioned EE architecture will utilize data stores provided by Infinity (Figure 2):

a) The *physical test sites* data store will hold information about test-bed facilities available for the experiment, such as a quay in a port or an airport.

b) The *sensor and operational data* data store will hold real data from sensor networks and operations to be utilized by the EE during simulation.

As the EE requires data in a way that can be utilized in its experiments, we assume at this point, that some manipulation over the source data provided by Infinity should be done so it can be integrated into FInest tests by retrieving it from the two above data stores (shown by the two "*lightning bolts*" in the diagram).

The envisioned architecture has two main components (Figure 2), briefly described below:

Simulation engine: The simulation engine provides the run-time support for the EE. When operating, it maintains four kinds of information (shown using “rounded rectangles”) on:

a) *participants, roles, and access privileges* –In this data store information about all registered users of the EE will be stored. In addition to the basic information like username and password, information about the user access privileges will be kept as well.

b) *experiments* – This data store will hold descriptions of historical and ongoing experiments. For each experiment a log will be kept and accessible.

c) *events* – This data store will store events relevant to the T&L domain to be used in the running of specific scenarios, e.g. a new airport destination, longer waiting time in customs, change in the size of a container.

d) *resources* –This data store will hold descriptions of all resource data available at a given moment. The data store will be searchable by keywords to identify resources required for an experiment or for a service. We assume that raw data from sensors will be processed out by FIWARE and store into this database in a way the EE system can access it.

Operation is achieved by the four components shown in the *Simulation engine* layer:

a) *resource management* - required for the undergoing test

b) *data management* – required for the undergoing test

c) *access management* – of users according to their access rights

d) *execution management* – this module is accountable for the execution of the scenario workflow. The analysis of existing available simulation tools is, as aforesaid, part of D4.2 and not in the scope of this report. At this stage we envision that this module will be accountable for the invocation of the FInest platform to run the test scenario.

Test design Workbench is the front-end of the virtual simulation environment. It is composed of two main modules:

a) *test design* – a visual tool that facilitates the design of a new test or experiment. At this stage, we assume that this module will utilize FInest front-end for the test design.

b) *test configuration* – customization of the test to the specific environment (change of parameters in a specific test and a re-run of the process using the new set of parameters).

5. Experimentation environment initial requirements

We distinguish between technical, functional, and non-functional requirements. Technical requirements refer to capabilities of the systems external to the EE and with which, through which, and on which, the experimentation environment will function. Functional requirements capture and specify intended behavior of the experimentation environment while non-functional requirements relate to the experimentation environment itself and how well it performs its functions. Tables 1-3 describe the initial list of requirements for these categories respectively.

5.1. Technical requirements

Table 1 – FInest EE initial list of technical requirements

Category	ID	Title	Text
EE interfaces	TR001	Underlying run engine	The EE should be able to invoke FInest system to run its tests in an automatic and easy way.
	TR002	Front end	The EE should be able to invoke FInest system front-end to design the desired

Category	ID	Title	Text
			test in an easy way.
	TR003	Use of real data	The EE should be able to access external data stores of test sites and sensors provided by the Infinity project.
	TR004	Amount and quality of real data	The EE should have access to real large amount of data for large scale trials. Furthermore, the data should come from heterogeneous devices based on different technologies, so a representative sample of IoT can be obtained. Data should encompass air, land, and sea transport in order to be able to test any possible scenario in FInest.
	TR005	Mobility	Support for tracking mobile devices such as vessels, containers, and trucks. Most entities in the T&L domain may move around in a real world environment, thus making the IoT devices attached to them mobile. A particular challenge is the tracking of entities in cases where no Internet connectivity exists (e.g. a vessel located in deep sea).
User involvement and impact	TR006	Impact evaluation	Allow some kind of mechanism for the evaluation of the social impact and acceptance of FInest platform in the T&L community.

5.2. Functional requirements

Table 2 – FInest EE initial list of functional requirements

Category	ID	Title	Text
Authentication, Authorisation, and Accounting	FR001	Authentication	When an experimenter provides his personal credentials to FInest EE, the latter must authenticate the experimenter.
	FR002	User account management	At any time the EE shall enable the experimenter to grant and revoke user access privileges.
	FR003	Session management	The user must logon only one time in order to be able to access the EE and begin a session. During the session period there will be no need to re-type

Category	ID	Title	Text
			the user credentials.
	FR004	Multiple sessions	Multiple stakeholders shall be able to login into the same experiment.
	FR005	Authorization	When a user wants to execute any action, the system has to verify that they are authorized to do this action.
Experiment Management	FR006	Experiment configuration	When an experimenter designs a test, the system must provide a mechanism to specify and configure experiments including test name, version, working directory, and more. What-if scenarios will be easily configured changing some of the test parameters.
	FR007	Logs	For each test a separate detailed log will be kept, shared, and be accessible.
	FR008	Executable	The resulting test should be viewable, sharable, and executable (can be run and compared to the actual log).
	FR009	Reusability	An experiment data store will store all the information regarding the experiments, including a specific and detailed log. A test can be easily retrieved and adapted to support new scenarios.
Resource management	FR010	Reservations	When the experiment includes one or more test beds in the experiment (quay in a Port, a warehouse), the system should force the experimenter to make reservation for the test beds before starting the experiment.
Storage	FR011	Inventory DB	The system shall support an inventory DB where it shall keep track of available data and resources
Network	FR012	Connectivity	The experimentation environment of FInest is envisioned as a fundamentally distributed facility with network connections among all FInest partners.
Validity	FR013	Applicability	FInest EE shall be able to test any possible scenario that can be run in FInest.

5.3. Non-functional requirements

Table 3 – FInest EE initial list of non-functional requirements

Category	ID	Title	Text
User interface	NFR001	Easy to use	The user must find the user interface intuitive and easy to use. The capability of designing the scenario must be sufficiently user friendly to be used routinely by the test designers themselves, with minor set-up times.
	NFR002	Web interface	An experimenter should be able to login to FInest EE from a remote location via a web-client.
Stability	NFR003	Experiment fallback	In case of failure the system should enable reset to the initial settings
Scalability	NFR004	Scale-up	The EE should cope with large volumes of data, variety of producers, sensors, and actuators for large trials.
Usability	NFR005	Easy to operate	The tool should be easy and intuitive to use. While closed form simulations can be run without human intervention, they require considerable work to set-up the scenarios, which are very specific and include all the decision criteria that will be required during the run [3]. Meaningful messages from the system.
	NFR006	High performance	High performance of the simulation environment can stimulate its use as a test environment.
Privacy and security	NFR007	Information security	Access to all data and information will be based on access rights and privileges of the EE users.
	NFR008	Compliance	In addition to information security, the EE should ensure compliance with all company IT/Information security policy.

6. Summary and next steps

This document concludes our preliminary study of requirements for FInest experimentation environment. The goal of such environment is to enable large-scale testing, demonstration, and evaluation of the technologies developed during the project based on FInest use cases and real data. Deliverable 4.1 *Initial requirements study* is the first step towards this goal.

In this document we review the as-is environments of FInest partners and arise gaps and challenges that indicate future, to-be environment, and constitute the initial list of requirements as described in section 5. This list is preliminary and will be further refined in the subsequent D4.2 *Requirements and design of transport and logistics experimentation environment* deliverable to be submitted at month 12 of the project. The final list of requirements will eventually be the basis for the specification of FInest EE and phase 2 implementation plan.

Appendix A - High level input on experimentation environment

Organization:

Written by:

Related use case (1, 2, or 3): General

Please choose 3 different and common activities you do and require some kind of testing/experimenting before their deployment. For each of these 3 different scenarios, fill out the following sections.

Scenario 1:

Name:

Description:

What kind of physical test you perform today?

Problems today:

How would you like to improve the process today? (Different infrastructure, equipment, and software you could require)

High level requirements already identified at this point from the experimentation environment

Scenario 2:

Name:

Description:

What kind of physical test you perform today?

Problems today:

How would you like to improve the process today? (Different infrastructure, equipment, and software you could require)

High level requirements already identified at this point from the experimentation environment

Scenario 3:

Name:

Description:

What kind of physical test you perform today?

Problems today:

How would you like to improve the process today? (Different infrastructure, equipment, and software you could require)

High level requirements already identified at this point from the experimentation environment

Appendix B - FInest questionnaire on experimentation environment

Organization: Written by:

In the following answers please relate to one possible experimentation environment that fits your organization, a scenario in which virtual testing or simulation won't be sufficient (such as: sending an empty container to a new route, testing a new service or launching a new product by carrying out a pilot). Please detail your responses as much as you can.

Describe the scenario:

What countries in Europe are involved?

What kind of test beds/physical testing environment/equipment is required? (examples: port with X quays, storage size up-to Y tons, sensors)

What kind of data or information is required for such testing? Please state if this data is manually or automatically obtained today (including sensor network information)

Please list the stakeholders that participate in your scenario (examples: customs, users, port) along with their role

Please list standards and regulations applicable to your case

Please list company guidelines or policies applicable to your case

Please state possible concerns regarding data security and privacy

Please specify evaluation criteria (success/failure) for your experiment?

Describe possible challenges (such as: connectivity of network, data integrity, i.e. different stakeholders use different data formats through the supply chain)

Expected benefits from such an environment (examples: decrease the time-to-market of the new product, foresee possible issues with the new process)

Comments

7. References

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[3] Ceranowicz, A., Dehncke, R. and Cerri, A. (2003) Moving toward a Distributed Continuous Experimentation Environment, Proceedings of the 2003 Interservice/Industry Training Simulation and Education Conference.

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