D1.6 – FI PPP Capacity Building Analysis – M12 issue

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VERSION HISTORY

VERSION	DATE	NOTES AND COMMENTS
1.02	27/09/2013	Final version released by M4 (previous history omitted for clarity)
2.00	22/04/2014	First release of M12 version for peer review
2.01	30/04/2014	Final release of M12 version

DELIVERABLE PEER REVIEW SUMMARY

ID	Comments	Addressed (✔) Answered (A)
#1	The graphical style of deployment diagrams is sometimes inconsistent	done
#2	The cloud strategy of Trials should be described from a more functional-oriented point of view	Answered

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Executive Summary

This document has a three objectives: to report about the interconnections between FITMAN and the FI PPP Capacity Building projects, to define the long-term *cloud vision* of the FITMAN project, and to state the *cloud strategy* of FITMAN Trials – i.e., to identify which Trials will actually follow a cloud approach in their present and future experimentation, and how are they going to leverage the cloud option.

This deliverable is the final result of the T1.6 task, "FI PPP Capacity Building Analysis", which has been extended up to Month 12. In the Month 4 release, two thread of analysis were considered: A) achievements of the INFINITY project and their connection with the FITMAN Trials; B) FITMAN requirements targeted at the XiFi project. Concerning the latter, a major difficulty was the partial availability of such information at the time of writing. To address this, a second iteration of the T1.6 task was scheduled, so that the FITMAN Trials will have enough time to consolidate their cloud-related requirements. This second release of the D1.6 deliverable is then mainly an update on this topic, which is also re-targeted to a more generic "cloud infrastructure provider" in place of XiFi.

To summarize, this document completes the assessment of the INFINITY infrastructures, which by M4 identified three candidates: iMinds iLab.t, FOKUS Smart Communications Playground, and BonFIRE. In Section 3.5 we report on the outcome of our hands-on experimentation, which ultimately did not yield any useful results for FITMAN.

Then, Section 4.3 updates the M4 FITMAN cloud vision with some insight on the Identity Management topic, which we now perceive as a key IT issue for the sustainability of enterprise ecosystems on the cloud. We also report about an example implementation which attempts to address this issue in a different context – i.e., a different EC research project where a key FITMAN partner is also involved.

Finally, Section 5 deals with the cloud strategy of our Trials: eight over ten are planning a cloud deployment – full or partial – of the FITMAN solution; of these, six will leverage some external commercial infrastructure, while two are going to build their own *private* cloud for internal use. Some details are given about how GEs, SEs and trial-specific components are going to be deployed in these environments, and IT requirements for cloud providers are collected from those Trials which wish to exploit third-party providers.

1. Terms used

FI-PPP - Future Internet Public-Private Partnership: The Public-Private Partnership programme for Internet-enabled innovation, in the scope of which the FITMAN project is funded.
FoF - Factories of the Future: One of the Public-Private Partnership programmes included in the European Commission's recovery package. The objective is to help EU manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures by improving the technological base of EU manufacturing across a broad range of sectors[1] .
SF - Smart Factories: One of the three Domains defined by FoF. Its scope is agile manufacturing and customization.
DF - Digital Factories: One of the three Domains defined by FoF. Its scope is manufacturing design and product lifecycle management.
VF - Virtual Factories: One of the three Domains defined by FoF. Its scope is global networked manufacturing and logistics.
UC - Use Case: The behaviour of a complex system (people + organization + infrastructure + software) targeted at the achievement of a specific business goal. In the FITMAN context, it may refer to one of the implemented experimentations of a Trial, or to one of the abstract and generic cases characterizing the FoF Domains.
GE - FI-WARE Generic Enabler: Software element which offers reusable and commonly shared functions serving a multiplicity of usage areas across various sectors[2] .
SE - Specific Enabler: Software element which offers reusable and commonly shared functions in the context of a specific usage area[2] .
TSC - FITMAN Trial-Specific Component: Software element which offers a set of ad-hoc functions in the context of a specific FITMAN Trial.
FP - FITMAN Platform: A platform constructed as an integrated set of GEs and SEs, targeted at a specific UC.

2. Introduction

2.1. Approach

This document is structured along three parallel *sub-tasks*:

- Sub-Task A) Analysis of INFINITY project achievements in the FITMAN context
- Sub-Task B) Definition of the long-term FITMAN cloud vision
- Sub-Task C) Definition of FITMAN Trial's cloud strategy

These threads have different objectives and have no cross-dependencies. For this reason, their outcomes are presented as separate, unrelated sections, leaving the synthesis of findings to the final chapter.

Sub-Task A follows a *reversed* approach: from the INFINITY database of existing IT infrastructures, a subset of relevant entries are selected that are most likely to fulfil the IT requirements of FITMAN Trials. Most of this work was performed during the first iteration of the main T1.6 task, and was reported in the first release (v1.0) of this document. For clarity, v1.0 content is also included in this second release (v2.0), but we also report about the hands-on experimentation which ran in the M4-M12 period.

Sub-Task B is an also an update over v1.0. Again, we choose to keep the original content, with some minor adjustments. The new release adds a brief analysis of a *federated* Identity Management solution developed in the scope of another EC research project.

Sub-Task C builds on the current status of FITMAN Trial's IT requirements, and targets generic "cloud infrastructure providers" which are expected to fulfil them, on commercial terms, after the end of the FITMAN project. With respect to the v1.0 document, this task contributes new content which replaces the original "FITMAN IT Requirements for XiFi" section entirely.

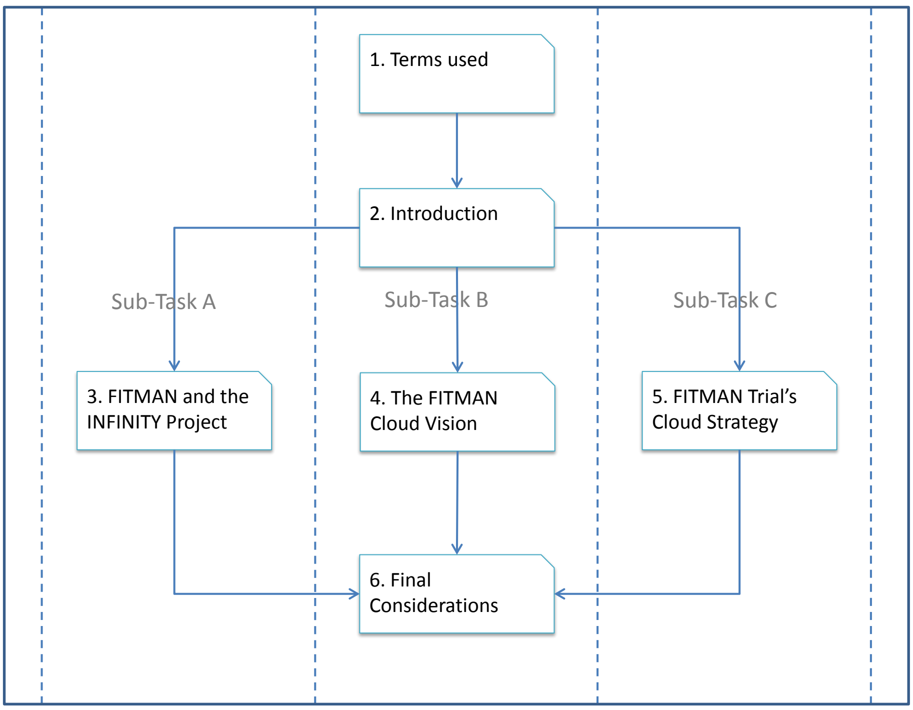

Figure 1 - Document logical flow

2.2. Relationship with other FITMAN Tasks

This deliverable is the outcome of the second iteration of T1.6 task, "FI PPP Capacity Building Analysis", which has been extended up to Month 12 in order to take advantage of similar extensions to other WP1 tasks. More specifically: T1.3 "FI-WARE Generic Enablers final selection for FITMAN", T1.2 " FITMAN Trials IT Requirements for FI-WARE" and T1.4 "FI-WARE Platform Instantiation for FITMAN"[4] . Also, this second iteration is leveraging work done in the scope of WP4, WP5 and WP6 for the specific sub-task of Trial's cloud strategy definition. The picture below illustrates these dependencies:

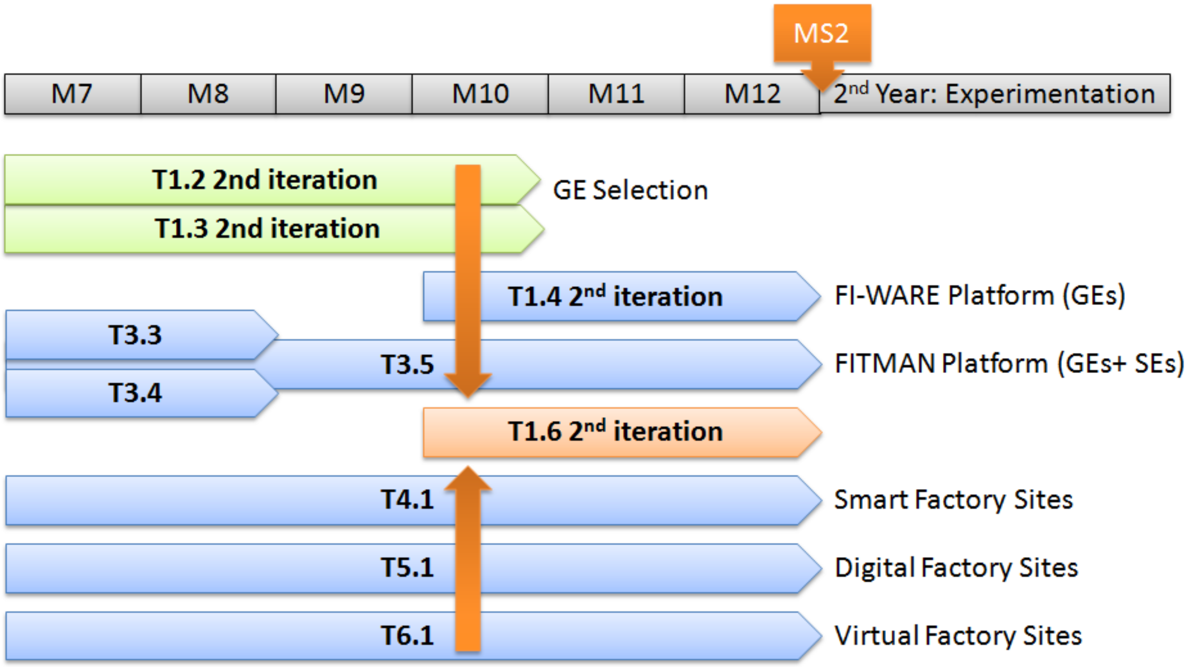

Figure 2 - FITMAN tasks scheduling

3. FITMAN and the INFINITY Project

This section summarises the method and results for ascertaining what INFINITY infrastructures, as hosted in the XiPi repository[3] , are of potential relevance to FITMAN. At the time of writing (June 2013), the XiPi repository contains 150 infrastructures.

3.1. Methodology for INFINITY infrastructure selection

Given the number of infrastructures to deal with, the selection process is an incremental filtering performed over three steps, the first of which is a database query on the XiPi repository: items can be assessed individually only after the data set has been reduced to a manageable size. Details on this process are given below.

1. Filter the infrastructures on metadata, extracting only those items that have the 'End User Groups' attribute set with one of the following values:
   - 'General Public / Anyone'
   - 'Other'
   - 'Paying customers / subscribers'
   - 'Range of Business Users'
2. Examine the extracted infrastructures individually, categorising them as follows:
   - N) 'Not relevant' - i.e., discard (see below)
   - I) 'Of possible interest' - i.e., investigate further
   - ?) 'Can't tell' - i.e., not enough information available

   Three criteria exist for marking infrastructures as 'Not relevant', and more than one may apply to the same item:
   - D) 'Domain': infrastructure is restricted to non-FITMAN domains (e.g., assisted living, farming, traffic management, etc.)
   - R) 'Region': infrastructure is restricted to areas that host no FITMAN trials (e.g., a town in Belgium); FITMAN trials are planned to run in France, Germany, Italy, Portugal, Spain and the UK, so infrastructures based in other countries must provide international-level access to be relevant to FITMAN
   - C) 'Constraints': infrastructure is still under development, is not available for external use, or is not accessible to FITMAN Trials for any other reason unrelated with Domain / Region
3. Examine the infrastructures classified as 'I' and '?'individually from a technical point of view, discarding those that are obviously not offering the required services; this simple assessment is based on the infrastructure description, so that actual technical features (e.g., capacity, network bandwidth, etc.) cannot be taken into account.
   The outcome of the technical assessment for each infrastructure is one of following:
   - NDC) 'Not a data centre' - i.e., doesn't support cloud deployment of software
   - NSF)'Not suitable for FITMAN' - i.e., not target at cloud deployment of manufacturing applications and services
   - NSP)'Not suitable for production' - i.e., doesn't offer production-level service
   - OK) 'Feature match'

   While NDC and NSF are discard criteria, NSP and OK mean that the infrastructure is eligible for FITMAN Trials.

The outcome of this process is a list of candidate infrastructures ('NSP' + 'OK'), which is documented in this deliverable.

Each infrastructure provider in the final list should then be contacted directly, and a thorough analysis of the technical and non-technical aspects (like capacity, quality of service, terms and conditions, pricing, etc.) relevant for a FITMAN deployment should be conducted in a collaborative way by each interested Trial. However, this additional step is out of the scope of this task, as it involves direct negotiations between FITMAN partners and infrastructure providers.

3.2. Selection results overview

The selection method described above was executed on 7 June 2013, and yielded the following results:

1. Filter by 'End User Groups':
    - 'General Public / Anyone': 45 infrastructures
    - 'Other': 8 infrastructures
    - 'Paying customers / subscribers': 6 infrastructures
    - 'Range of Business Users': 13 infrastructures

    Some infrastructures fall into more than one category, meaning that although the above numbers sum to 72, the filter yielded a total of 67 unique infrastructures to be categorized in the next step.
2. Categorise: this step resulted in a total of 14 infrastructures (I + ?) being sent to technical assessment.
    - N) 'Not relevant': 53 infrastructures
        - 'Domain' discard criterion applies to 25 items
        - 'Region' discard criterion applies to 20 items
        - 'Constraints' discard criterion applies to 16 items
    - I) 'Of possible interest': 11 infrastructures
    - ?) 'Can't tell': 3 infrastructures
3. Technical assessment: from the starting set of 14 infrastructures, only **3 were found compatible with FITMAN Trials**; of these, only **1 was found compatible with a production environment**.
    - 'Not a data centre' outcome applies to 9 items (discarded)
    - 'Not suitable for FITMAN' outcome applies to 2 items (discarded)
    - 'Not suitable for production' outcome applies to 2 items (accepted)
    - 'Feature match' outcome applies to 1 item (accepted)

The next section provides details for all the above mentioned lists, and the rationale for the *go vs. no-go* decision for each item.

3.3. Selection results details

The three tables below summarise the 67 infrastructures extracted in the first step, grouped by the category assigned in the second. All tables have four columns:

- ID - The unique identifier assigned by the XiPi repository
- Name - The name of the facility as per the XiPi repository
- Assessment outcome - The result of the assessment made in step 2 + 3
- Comments - Summary of the assessment(s) made in steps 2 + 3; text within "double quotes" is taken verbatim from the XiPi repository

The first table is dedicated to the ‘Not relevant’ items: as such, it lists all infrastructures that where discarded right away by the second step. The ‘Assessment outcome’ column is used to display one or more of the *no-go* criteria documented in section 3.1.

The second and third tables are listing items that could not be ruled out prior to step 3, either because the information was insufficient (the ‘?’ or ‘Can’t tell’ case) or because the classification from step 2 was ‘I’ or ‘Of possible interest’. Here, the ‘Assessment outcome’ column is presenting the technical assessment result (this domain is also documented in section 3.1), which is always a single value. Items that are marked ‘OK’ and ‘NSP’ are part of the final selection list, and as such they are highlighted with a yellow background.

‘Not relevant’ infrastructures

ID	Name	Assessment outcome	Comments
893	TEFIS	C	“Not available for external use”
1046	Glasfasernetz-verbundLainsitztal - Open Access Network	C, R	Still under development. Local to Strasbourg.
1064	Dark Fiber Experimental Facility	D	“field testing of optical components or whole systems”
1087	OFELIA Testbed i2CAT	C	“The Infrastructure is still under development”
1130	Fraunhofer FOKUS SmartTV Lab	D	“The Smart TV Lab bundles Fraunhofer FOKUS expertise in the area of hybrid TV, connected TV, IPTV, future web technologies and rich media convergence.”
1171	Open Geospatial Consortium (OGC) Europe Ltd	D	“Open standards developing consortium, focus on geospatial and location standards.” Not clear that this is an actual infrastructure.
1194	Acreo National Testbed	D, R	“The Acreo National testbed is a live network for Internet, IPTV and telemetry services, with a small number of end users, connected via FTTH, LTE or OTT.” “Regions of Stockholm, Hudiksvall, Nordanstig and Sundsvall”
1222	Gestión de Infraestructuras Públicas de Tele-comunicaciones del Principado de Asturias S.A.	D	“GIT is a public company which is 100% owned by the Principality of Asturias.” Broadband provision in Asturias, Spain.
1230	Urban Media / HeerlenLive	R	“HeerlenLive is a local ubiquitous broadband network consisting of a fiber-network (single mode), scalable City Wifi-network based on fiber, Internet Exchange, data center, live streaming video platform, and urban screen network.” They mention Manufacturing as a usage scenario, but are specific to Heerlen. Perhaps useful come Phase III,

ID	Name	Assessment outcome	Comments
			but not now.
1246	FUNDACION CARTIF BUILDINGS	R	Building automation in Valladolid, Spain. Only relevant if we have a trial running there.
1341	Connected Communities	R	A broadband network for some Scottish Islands.
1386	Mira Telecom Research Centre	C	Still under development.
1415	POZMAN	R	A regional infrastructure in Poland.
1432	6net / Kuuskaista	R	A network connecting northern Finnish villages. Irrelevant unless we run trials there.
1453	Stichting Wireless Leiden	R, D	Free wifi access in Leiden, NL.
1464	Mediatuin	D	A testing ground for media companies and governments doing cross-media work.
1493	Digital Region Ltd	D, R	A broadband network in northern England.
1509	National Public DemostratorCenter in Audiovisual Technologies	D	An infrastructure for ambient assisted living and mobility.
1553	HPWNET	C	Not available for external use.
1566	Metropolitan Planning Council	R, D	Regional planning in Chicago, USA.
1600	MyMobileWeb	C	“The Infrastructure is still under development”
1609	Fundació i2CAT RecercaiInnovació en l'Àmbitd'Internet	D	This is not an infrastructure but a research and innovation center.
1619	Broadband Wireless Network in the Kozani Region	D, R	A wireless network in Greece.
1627	Gov2DemOSS	D	A platform for communication, knowledge sharing, and modernisation of services. Primarily for government, but also for ‘organisations’.
1643	RCIKT-NET	C	“The Infrastructure is still under development”
1653	Intellectia Bank S.A.	C	“The Infrastructure is still under development”
1663	MALAGA CITY COUNCIL	C	“Not available for external use”
1682	Rural information Society - network	D	Connecting rural areas.
1736	Turk Telecom	R	An infrastructure specific to Turkey.
1761	RedeComunitária de Banda Larga da Terra Quente	D, R	A network connecting several Portuguese municipalities.

ID	Name	Assessment outcome	Comments
	Transmontana		
1798	IBILNET	D	Traffic-related sensors in Spain.
1828	Wireless Trondheim Living Lab	R	Local to Trondheim, Norway.
1852	MTT CropInfra	D	An infrastructure in the farming domain.
1866	FOTSIS	D	Road infrastructure management.
1874	Arctur-1	R	A high-performance computing service in Slovenia.
1896	espaitec, Science & Technology Park of Jaume I University	D	A living lab in Spain.
1933	Ify	D	An infrastructure for big data analytics on Earth Science resources.
1943	SmartBay Ireland	D	An infrastructure for the maritime sector.
1976	CENTRO ANDALUZ DE INNOVACIÓN Y TECNOLOGÍAS DE LA INFORMACIÓN Y LAS COMUNICACIONES	C	"The Infrastructure is still under development"
1990	RECORD online Living Lab	R, D	A living lab in Norway.
2025	EXPERIMEDIA Schladming Ski Resort	C	"Not available for external use"
2047	EXPERIMEDIA Foundation for the Hellenic World	C	"Not available for external use"
2119	INNOVATION AGENCY OF THE CITY COUNCIL OF VALLADOLID - Smart City	R	A smart city in mid-northern Spain, usage scenario includes manufacturing. Specific to Valladolid.
2135	Smart Street Lighting	C	"The Infrastructure is still under development"
2409	OFELIA Testbed ETHZ	C	"The Infrastructure is still under development"
2554	OpenSand (Open Satellite Access Network Demonstrator)	C	"The Infrastructure is still under development"
2640	ISTS.PL	R	Specific to Krakow, Poland.

ID	Name	Assessment outcome	Comments
2709	SMART NORMANDY	D	Smart city applications for locals and tourists in Normandy, France.
2787	FOKUS FUSECO Playground	C	The Infrastructure is still under development
2794	ADRENALINE Testbed	D	Focused on research in optical networks and systems.
2836	16K Visualization Tiled Display	R	A display in Poland.
2843	GPU Hybrid Cluster	R	An infrastructure for the Polish scientific community.
2912	Pervasive Tourism Platform	D	Specific to the tourism domain.

Table 1 - INFINITY infrastructures in the 'Not relevant' category

'Of possible interest' infrastructures

ID	Name	Assessment outcome	Comments
917	iMinds iLab.t	NSP	"The iMinds iLab.t technology centre offers the experimentation environments, the hardware, the measurement equipment and the software tools needed to develop your ICT innovations, and/or test their performance and service quality". In Belgium, but cloud access via BonFIRE OCCI protocol.
948	Exemplar Network Testbed	NSF	"The Exemplar Network Test-bed is a digital village of various SME's, MNO's, academia and service providers." Accessible via the GEANT network.
972	FOKUS Smart Communications Playground	NSP	"An Open Technology and Application Testbed for Next Generation Service Platforms and Smart Cities". Functions include logistics and utilities. Coverage is a local campus, but that campus is Fraunhofer FOKUS, Berlin, so possibly still relevant (Fraunhofer being a FITMAN core partner).
1772	Barcelona Smart Cities Pilot Network at 22@ District and WIFI/WIMAX Network (30% of the Urban City area: 469 Nodes)	NDC	A wifi/wimax network for corporative and citizen services, and a wireless sensor network for sensoring and smart cities applications. Based in Barcelona, Spain.
1950	CROSS-TEC LABORATORY of ENEA TECHNOPOLE	NDC	One part not yet developed. The other is for rapid prototyping and 3D design. Based in Bologna, Italy.

	IN BOLOGNA		
2009	EXPERIMENTA PLATFORM	NDC	A testbed for FI experimentation and validation based in the region of Barcelona, Spain. Network-oriented platform, not cloud-oriented
2479	BonFIRE	**OK**	6 geographically distributed testbeds across Europe, offering heterogeneous Cloud resources including compete, storage and networking. Access via the BonFIRE API.
2663	Community-Lab.net	NSF	A FIRE experimental testbed based in Barcelona, Spain.
2855	National NGN (Next Generation Network) Test Centre	NDC	A test centre for technology providers working on mobile phone applications.
2872	awiloc® testbed	NDC	A testbed for urban and indoor 3D positioning.
2943	NDIX B.V.	NDC	Supports the development of new ICT services. Based in the Netherlands but coverage encompasses several countries. They provide advanced connectivity services to create private networks between infrastructure providers and infrastructure users

Table 2 - INFINITY infrastructures in the 'Of possible interest' category

'Can't tell' infrastructures

ID	Name	Assessment outcome	Comments
1210	OFELIA TUB-Island	NDC	"The project creates a unique experimental facility that allows researchers to not only experiment "on" a test network but to control and extend the network itself precisely and dynamically."
1838	SQS Mobile Excellence Center	NDC	A Spanish infrastructure for testing mobile applications.
2447	CITC-EURARFID	NDC	An innovation centre of contactless technologies, based in Lille (northern France) but encompassing platforms in Belgium, UK, NL and Germany too.

Table 3 - INFINITY infrastructures in the 'Can't tell' category

3.4. INFINITY infrastructures of interest for the FITMAN UC Trials

Each of the infrastructures composing the final selection list (see 3.3 section) is presented here as a *data sheet*. This information is taken from the XiPi online database, but its structure has been re-arranged and normalized in order to make it more readable and to allow an easier comparison between infrastructures.

3..4.1. iMinds iLab.t

Overview	
Owner	iMinds (formerly known as IBBT)
Country	Belgium
Address	Zuiderpoort Office Park Gaston Crommenlaan 8 (box 102) B-9050 Ghent-Ledeberg, Belgium
Components	• Sensor Network • Application Service Delivery

	• WIFI Network • Wired Access Network • Cloud Network
Usage scenario	All Sectors
Constraint on participation	na
End users	• Paying customers / subscribers • Selected Users (Targeted) • Students / Researchers • Employees (of a company (ies))
Number of end users	100-1k
Categories	• Test bed
Governing entities types	• European / National / Regional / Local Government • Private Organisation • Research Institution • Industry Organisation
End users' Feedback	Yes
Aware of FI-PPP Programme	Yes
FI-WARE compatibility	unknown
Economic perspective	
Commercial status	• Government Funded (Free to use) • Government Funded (With fees for use)
Funding entities	• National Funding (iMinds/ Flemish government) • Project Funding
Technical perspective: general info	
QoS	na
Number of simultaneous users	10-100
Number of experiments	100
Log end user usage patterns	Yes
Infrastructure data provided	• Usage (accounting data)
Availability	99% - 99.9%
Assurance	• Help Desk • Fault management • Performance monitoring/reporting • Trend analysis • Trouble ticketing
Technical perspective: cloud network	
Virtualization platform	• Only physical (bare-metal) images are allowed: one image per hardware node
Dates of unavailability	• Part of the infrastructure (8 nodes) is permanently available, while the whole infrastructure (100 nodes) can be reserved on req
Extensibility of services	No
Kind of Cloud Hosting	na
Security services	na
Services offered	IAAS
Interconnection with other infrastructures	The iLab.t Virtual Wall is integrated in the FP7 BonFIRE multi-site cluster and is thus interoperable with the other BonFIRE clusters. This will enable the OCCI protocol on top of the virtual wall.The virtual wall is however usable through the emulab API + user interface since 2009.
Open interfaces (API)	na
Year of starting operation	31/12/2012
Planned evolution	The iLab.t Virtual Wall can be used for Cloud Computing experiments over controlled and adaptable networks through the FP7 BonFIRE OCCI (Open Cloud Computing Interface) protocol.
Authentication	na

3..4.2. FOKUS Smart Communications Playground

Overview	
Owner	Fraunhofer Institute FOKUS Berlin
Country	Germany
Address	Kaiserin-Augusta-Allee 31, Berlin, Germany
Components	• Sensor Network • Customers Device

	• Data Context Management • Application Service Delivery • Mobile Network • WIFI Network • Wired Access Network • Cloud Network • Backbone Network
Usage scenario	• Information & Communication • Profession, Scientific & Technical Services
Constraint on participation	na
End users	• Paying customers / subscribers • Range of Business Users • Selected Users (Targeted) • Students / Researchers • Employees (of a company (ies))
Number of end users	na
Categories	• Test bed • Pilot trial • Research project
Governing entities types	• European / National / Regional / Local Government • Research Institution • Industry Organisation
End users' Feedback	No
Aware of FI-PPP Programme	Yes
FI-WARE compatibility	High
Economic perspective	
Commercial status	• Commercial Fee Based (Not for profit)
Funding entities	• Operators • Vendors
Technical perspective: general info	
QoS	na
Number of simultaneous users	na
Number of experiments	na
Log end user usage patterns	No
Infrastructure data provided	• Other
Availability	na
Assurance	• Help Desk • Trouble ticketing
Technical perspective: cloud network	
Virtualization platform	na
Dates of unavailability	na
Extensibility of services	Yes
Kind of Cloud Hosting	na
Security services	• Support for TLS/SSL for communication with cloud resources • Identity management (authentication) of cloud users • Access control over who can use cloud resources. • Firewall • VPC • CloudWatching mechanisms
Services offered	• SAAS • PAAS
Interconnection with other infrastructures	na
Open interfaces (API)	• OpenNebula (C) • OpenStack (C) • Other
Year of starting operation	2010
Planned evolution	na
Authentication	• user/password given by the cloud provider • user/password given by the customer

3..4.3. BonFIRE

Overview	
Owner	The BonFIRE Consortium
Country	Spain
Address	Av. Diagonal 200, 08018 Barcelona, Spain
Components	• Cloud Network
Usage scenario	All Sectors
Constraint on participation	• Limited to certain nationalities
End users	• Students / Researchers • Industry, including SMEs
Number of end users	100-1k
Categories	• Test bed
Governing entities types	• Private Organisation • Research Institution • Industry Organisation
End users' Feedback	Yes
Aware of FI-PPP Programme	Yes
FI-WARE compatibility	unknown
Economic perspective	
Commercial status	• Government Funded (Free to use)
Funding entities	na
Technical perspective: general info	
QoS	BonFIRE provides a complete Monitoring Framework to be used by users / experimenters, which supports all different kinds of monitoring metrics (network, infrastrucutre, node, VM, service) including many QoS metrics.
Number of simultaneous users	10-100
Number of experiments	2000
Log end user usage patterns	na
Infrastructure data provided	• Traffic data • BonFIRE provides a complete Monitoring Framework to be used by users / experimenters, which supports all different kinds of monitoring metrics (network, infrastructure, node, VM, service).
Availability	na
Assurance	• Trouble ticketing • Other
Technical perspective: cloud network	
Virtualization platform	• Amazon • Xen • KVM • HP Cells • Emulab
Dates of unavailability	End 2014
Extensibility of services	No
Kind of Cloud Hosting	• Hybrid Cloud
Security services	• Identity management (authentication) of cloud users • Access control over who can use cloud resources. • Traffic routed through private network
Services offered	• IAAS • Experiment as a Service
Interconnection with other infrastructures	BonFIRE's infrastructure itself is a federation of multiple cloud sites across Europe hosted at: • EPCC (http://www.epcc.ed.ac.uk) • HP (http://www.hpl.hp.com) • iMinds (http://www.iminds.be) • Inria (http://www.inria.fr) • USTUTT (http://www.hlrs.de) • PSNC (http://www.psnc.pl) • Wellness Telecom (http://www.wtelecom.es) BonFIRE is interconnected to the following networks: • FEDERICA (http://www.fp7-federica.eu) • GEANT (http://bod.geant.net) • AutoBAHN (http://www.geant2.net/server/show/nav.756) • Amazon EC2 (http://aws.amazon.com/ec2)
Open interfaces (API)	• Open Cloud Computing Interface (OCCI)

Year of starting operation	01/03/2011
Planned evolution	na
Authentication	• user/password given by the customer

3.5. Final conclusions on INFINITY infrastructure selection

At the time of the previous release of this deliverable, 10 infrastructures were dismissed for the sole reason that they were described in XiPi as "still under development". These were:

- 1046 Glasfasernetz-verbundLainsitztal - Open Access Network
- 1087 OFELIA Testbed i2CAT
- 1386 Mira Telecom Research Centre
- 1600 MyMobileWeb
- 1643 RCIKT-NET
- 1653 Intellectia Bank S.A.
- 1976 CENTRO ANDALUZ DE INNOVACIÓN Y TECNOLOGÍAS DE LA INFORMACIÓN Y LAS COMUNICACIONES
- 2135 Smart Street Lighting
- 2409 OFELIA Testbed ETHZ
- 2554 OpenSand (Open Satellite Access Network Demonstrator)
- 2787 FOKUS FUSECO Playground

In mid-March 2014, each of these infrastructures was revisited in XiPi to check if a reassessment was required. All ten were still marked as being "under development".

In the previous release of this deliverable, 3 infrastructures were listed as being of being potentially viable options for the FITMAN project. These were:

- 917 iMinds iLab.t
- 972 FOKUS Smart Communications Playground
- 2479 BonFIRE

In the event, none of these three infrastructures has been used by FITMAN. iMinds iLab and FOKUS Smart Communications Playground were not suitable for the production environment of FITMAN, with the former offering a network test environment and the latter focusing on telecommunications. BonFIRE offered the better potential among the three infrastructures, and indeed FITMAN obtained access to the BonFIRE facility for a limited time, in order to perform some hands-on experimentations. However, it soon became clear that this environment was not suitable for FITMAN, for very specific technical reasons:

- There is no way of uploading custom-built virtual machine images: only those which are in the standard BonFIRE catalogue are available for deployment.
- In the standard BonFIRE catalogue, there are no pre-defined virtual machine images for deployment of FI-WARE Generic Enablers: all available ones are empty, default installations of a basic operating system. This limitation, together with the previous one, implies that all FITMAN-related software should be installed from scratch and configured on empty systems: not a road-blocking issue by itself, but see the next point.
- The only operating system currently available in BonFIRE – i.e., the OS of all the VMs in the standard catalogue, which is Linux Debian – is not supported by most FI-WARE Generic Enablers, which run on Linux Ubuntu or CentOS. During the hands-

on experimentation, we also tried to install some GE on these Debian machines, but we did not manage to get them working.

As a final consideration, although the infrastructures we identified via XiPi were not useful for FITMAN, the repository was clearly informative, particularly in signposting the BonFIRE project. The primary reason why XiPi was not as useful to FITMAN as might have been hoped is simply that the objectives of INFINITY differ from those of FITMAN: the two projects have different goals, the former being focused on research, smart cities and telecommunications, the latter on the manufacturing industry. We further hypothesise that the XiPi repository might have been more useful had FITMAN had less tight constraints. This is demonstrated by the process of narrowing down the field of potential infrastructures: 25 were removed due to inappropriate domain, 20 due to inappropriate region, and 16 due to constraints. Of the remaining 14, 9 were not a data centre and the final five were inappropriate for various reasons. It does not appear to be the case that XiPi infrastructures are biased in a certain direction or are all inappropriate to FITMAN for one specific reason. Indeed, XiPi hosts a wide variety of infrastructures that offered potential to FITMAN. However, FITMAN's industrially-focused, close-to-market nature and associated tight constraints meant that no suitable XiPi infrastructure was found.

4. The FITMAN Cloud Vision

This section is introducing the overall vision of the FITMAN project with respect to Future Internet cloud. In the first part, we describe a long-term perspective which, even if out of the project’s scope, we believe might be have a strong impact on manufacturing. We than switch to a more practical topic: how the XIFI project, being a reference implementation of this Future Internet architecture, can be leveraged by FITMAN to achieve its shorter-term, concrete objectives. Finally we focus on Identity Management in Future Internet scenarios, that we perceive as a key enabling technology.

4.1. Future Internet application architecture

A good starting point when considering FITMAN and FI application architectures is the INFINITY-led FI-PPP White Paper on trade-offs in the FI-PPP [7] . This White Paper covers several relevant issues, the most important of which for FITMAN is concerned with the formation of an ecosystem (Figure 2 from [7] , which for convenience is reproduced here):

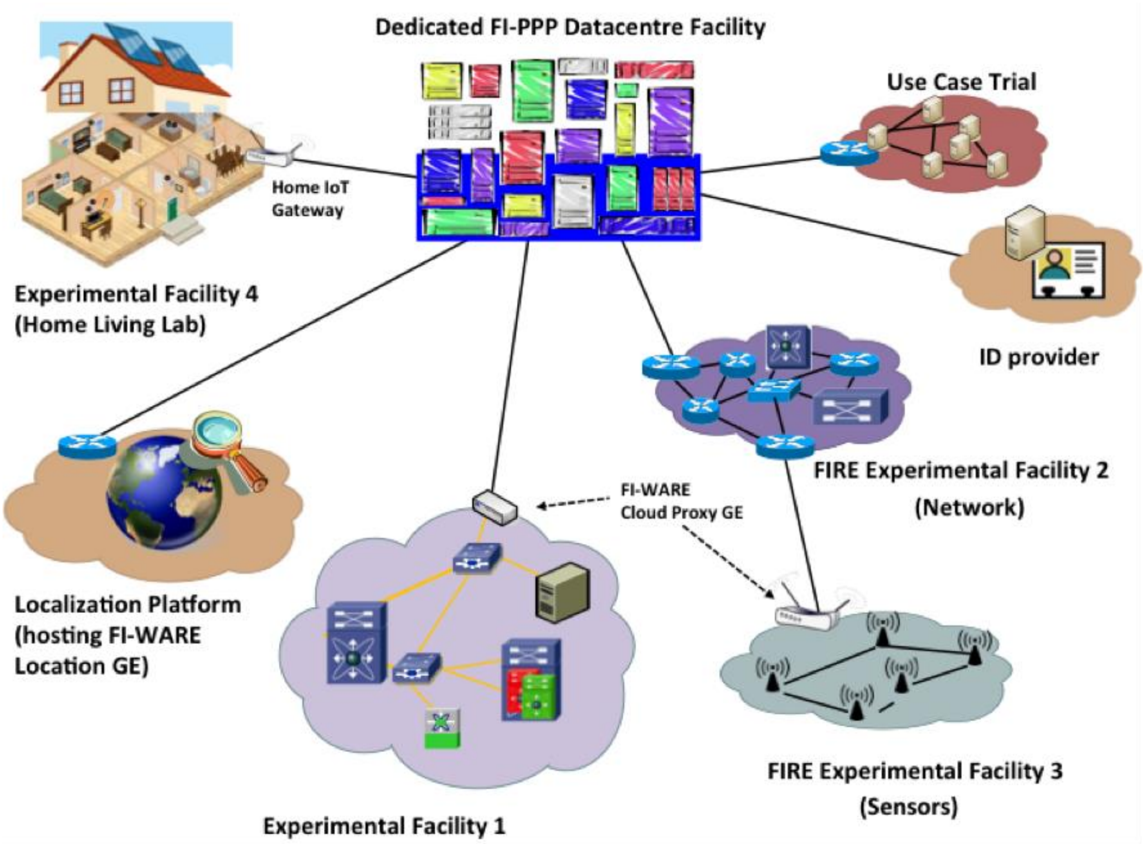

Figure 3.An FI-PPP trials ecosystem (from [7])

This shows the characteristic structure of any Future Internet application which includes:

- data sources that provide information about the real world, e.g. embedded sensors in smart spaces such as factories, mobile sensors in smart devices such as phones, user content arising from participation in social networks, or simulations such as weather forecast models, etc;
- data centres supporting data storage, integration and analysis, from which actionable information can be derived, e.g. more efficient production schedules, warnings of possible risks such as safety violations, or of opportunities such as teaming to meet demand from a potential customer.

These exist in an ecosystem in which the relevant actions can be taken. This usually has both physical and business dimensions, and the actions normally influence one or both of these. This is true even if the action itself is limited to the ICT domain, e.g. delivering content to a consumer, enhancing the business dimension by increasing their customer satisfaction level. This coupling of ICT with physical and business contexts underpins the ability of the Future Internet to create value, by increasing operational efficiency, reducing unwanted side effects, or enabling identification and/or exploitation of new opportunities.

Manufacturing represents just one of many real-world (physical/business) domains that could be coupled with the Future Internet. Others include the delivery of health care services, the management of the natural environment, transport and logistics, production of food, timber or bio-fuels, education and entertainment services, or government services. The FI-PPP aims to address all these domains in the same way via a common platform, bringing several benefits:

- the platform becomes a commodity, allowing its cost to be shared across many domains with large numbers of users, so reducing the cost to each individual user;
- data sources and analytics become uniformly accessible as services, including basic services at platform level, and specialised domain-specific variants;
- the ICT skills needed to use the platform and services become commonplace, allowing smaller companies to access those skills and develop and operate FI applications;
- applications can use ICT to link multiple domains, allowing optimisation at the level of entire enterprises, rather than only within individual business domains.

In this long term vision, therefore, manufacturing capacity would become just like any other physical/business service. Information transmitted to and from factories will be analysed and used by different stakeholders for different purposes:

- by the suppliers of manufacturing tools to factories, to plan and improve maintenance and support services, and possibly (where tools are leased) to bill factory owners;
- by the factory owners to optimise the use of production capacity, while minimising adverse impacts on aspects such as the environment and worker safety;
- by product designers to assess the investment needed in manufacturing capacity, and the cost of manufacturing the proposed product using that capacity;
- by customers of factories to specify work items and determine which factories can best deliver them;
- by business entrepreneurs to orchestrate the production of physical goods that play a role in their business proposition.

To see how this might work, it helps to envision a possible future scenario. Consider an entrepreneur who notices that deckchairs on his local beach are not much used if the sand is dry. He realises this is because sand is blown onto the chair, reducing user comfort, unless the chair has its back to the wind. He begins a discussion on a social network, and queries a social analytics service, discovering that this problem is found on many beaches throughout Europe. He designs a better deckchair which works with a much wider range of wind directions, using cloud-based flow modelling SaaS. He then hooks up with a studio that markets online games and is about to commission a beach volleyball game. They agree to include the chair as a digital prop in their online game, as long as the physical chairs carry marketing material for the game. They can also contribute to manufacturing costs for chairs that carry their imagery.

The entrepreneur now has the design and the finance, and he needs to organise manufacture and delivery. He wants to sell to the public, but he knows that initially he needs to target deckchair rental companies operating on specific beaches. They are happy to lease the chairs if the price depends on the amount of use. The entrepreneur therefore has to stimulate demand among their customers, and engages an advertiser who will raise awareness through social and other media. The game company can also help with this, but they need the campaign to run all summer, and they can't provide the final volleyball game imagery for that release until late spring. To meet all these constraints will mean targeting different beaches throughout the summer wherever local weather conditions make the advantages of his design most apparent.

To deliver against the business plan, the entrepreneur now has to select factories to produce the chair with a short lead time. He needs different suppliers for the plastic frame and printed fabric elements, and the sensors that record the amount of use so he can bill the chair rental companies. He can't afford to stockpile chairs, and finds he will need to trade-off between manufacturing and logistics schedules and costs to deliver chairs to beaches around Europe when they are needed. The plan must respond to variations in the weather, and in the response of beach visitors to his advertising campaign.

To do all this, he creates several linked Future Internet applications. Inputs include the design of components making up the chair including the volleyball game images, but also sales of the online volleyball game in each region, weather forecasts, social network feeds, and usage data from chairs once deployed on beaches. One application uses data analytics to predict demand. Another finds the optimum schedule for production and delivery of chairs to each region such that returns are maximised without breaching cash flow limits. The third orchestrates manufacturing and logistics services to produce chairs at the right time in each region. To monitor the success of the deckchairs, the entrepreneur adds a fourth component to provide sentiment analysis of posts to social networks to gain insight into opinions on the deckchairs as they are released.

Because all these applications run on a common platform which provides interoperability guarantees and security services, it is easy to compose them to produce a trustworthy application to support the end-to-end business process. The entrepreneur sets up the overall system so that it will notify him when important changes occur (e.g. changes in demand forecasts, delays in manufacture of components or delivery of deckchairs, or large swings in customer sentiment). An integrated information dashboard provides an up-to-date view of his business, bringing together data from sensors and data analytics. This shows the status of deckchair manufacturing and transportation processes, deckchair usage levels, and customer sentiment and demand forecasts in different locations.

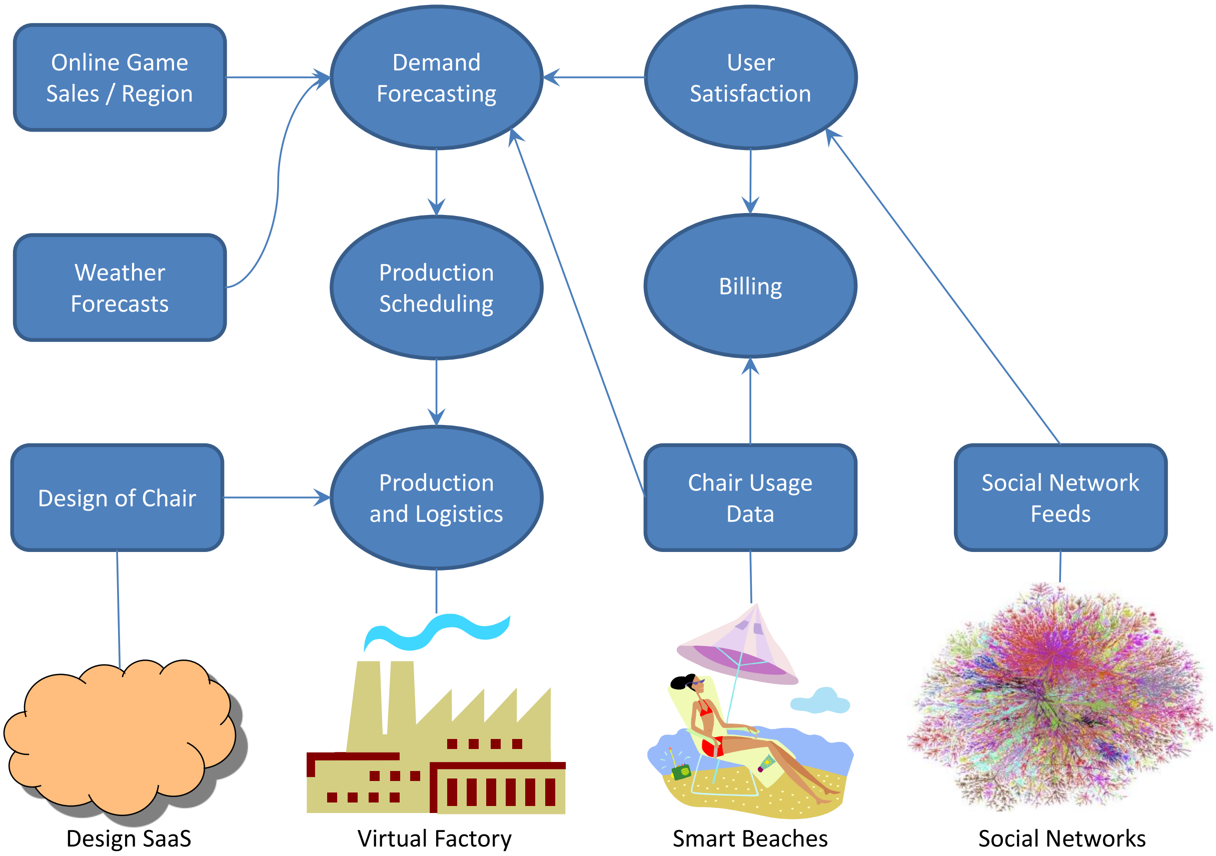

Figure 4. Linked FI applications and their inputs[1]

4.2. FITMAN on XIFI

Now we need to discuss how XIFI would be involved in realising benefits from FITMAN.

The XIFI project aims to provide access to European infrastructure by creating a federation of infrastructure operators, within which it is easy to find and access infrastructure using the FI-WARE generic enablers. The XIFI federation is intended to provide part of the launch pad for the FI-PPP expansion in Phase 3, as well as supporting Phase 2 projects like FITMAN. XIFI should therefore interact with Phase 2 projects like FITMAN in the following ways:

- providing FITMAN with access to infrastructure capacity running FI-WARE GEs
- incorporating FITMAN trial sites into the XIFI federation, so they can be accessed in the same way by FITMAN trials, and also in Phase 3
- supporting the deployment of FITMAN platforms (for Smart, Digital and Virtual Factories) on suitably chosen infrastructures
- supporting the deployment of FITMAN Specific Enablers on suitably chosen infrastructures.

The deckchair scenario in Section 4.1 uses all three of FITMAN's added value propositions. The virtual factory paradigm allows the entrepreneur to find the most cost-effective suppliers of the two types of components and their assembly. The digital factory allows the entrepreneur to share product data with suppliers and customers, and allows suppliers to

[1] Social network diagram was originally published by the OPTET project, and is reproduced under Creative Commons Licence CC BY-NC-SA 1.0.

rapidly define and implement their production processes for producing and assembling the chairs. The smart factory enables each physical factory to predict its future capacity, and to produce the deckchair components with very high efficiency.

The integration with other sectors arises at two levels:

- at the digital factory level: the exchange of product and production data between the entrepreneur and his suppliers (i.e. factories and their customer);
- at the virtual factory level: allowing the selection of manufacturers to be optimised to meet business requirements for delivery in each region.

FITMAN does not currently envisage cross-sector trials, and 'embedding' manufacturing into the wider future Internet in this way is unlikely to be achieved within the FITMAN project. It is helpful to envision three broad steps by which such a cross-sector integration might occur:

	1: Common Platform	**2: External Engagement**	**3: Cross-Sector Aspects**
Smart factory	Use common platform event management and IoT enablers to support smart factory monitoring and decision support.	Use data management and analytics in the cloud so it can be used by SMEs, and to allow access by other stakeholders.	Use common analytics services to process data from smart factories and other sources (e.g. from social analytics, weather observations, etc.).
Digital factory	Use common platform mediators and mash-up enablers to manage the flow of production and product data.	Integrate with social analytics to engage with external stakeholders such as customers/consumers.	Develop cross-sectoral data transfer, e.g. between manufactured product data and digital product data.
Virtual factory	Use common platform marketplace, semantics and mediators to enable advertising and matching of capacity and customers.	Enable access to factory capacity as a service, by using digital and smart factory capabilities to automate aspects of the engagement by customers.	Advertise manufacturing capacity in a cross-sector marketplace, to enable end-to-end optimisation of business ventures that involve manufacturing.

Table 4. Integrating manufacturing into the Future Internet

The scope of FITMAN covers Step 1, and a significant part of Step 2, but very little of Step 3.

During Step 1 the main focus is on integrating Generic Enablers from the FI-WARE common platform into Smart, Digital and Virtual factory platforms, and developing Specific Enablers to fill gaps in FI-WARE or to provide sector-specific capabilities on top of FI-WARE. The real challenges here stem from real-world technical issues such as interfacing between manufacturing control systems and generic FI-WARE protocols and standards. In principle, the Smart and Digital factory trials can use in-house facilities at trial sites, with no communications beyond those sites. The Virtual Factory is in essence a federation platform which can also be hosted in-house by the federator, although it does need to communicate externally, of course.

In practice, during Step 1 it will be necessary for FITMAN to use external infrastructure for some purposes, due to the constraints on access to some FI-WARE generic enablers. Where FI-WARE enablers are available only as a service, FITMAN will need to get those services from somewhere else within the FI-PPP in order to develop and test its software. This could be the FI-LAB public infrastructure, or XIFI data centres.

By Step 2, the trials will be ready to scale up and engage with user communities beyond the trial sites in at least some cases. At that stage it may become necessary to host at least some elements of a trial in the cloud to provide the required scalability or external access. At this stage, the FI-LAB facility should not be used (since it is only intended to support developer testing), and the services should come from XIFI. FITMAN requirements for XIFI capacity will be much tighter at this stage, because of the increasing scale of some trials, and because some trials involve the use of personal data about real users, etc.

To reach Step 3, manufacturing will have to become embedded into the Future Internet, and that implies that FITMAN Specific Enablers and trial sites may need to become available as services through the cross-sector XIFI federation and marketplace. At that stage, requirements will include support for the business models and processes used by FITMAN SE developers and FITMAN trial sites, etc. The FITMAN trials do not intend to go this far during the project.. However, it is likely that cross-sector trials may be in scope in Phase III of the FI-PPP.

At this stage, FITMAN has analysed its requirements for Steps 1 and 2, and these are covered in Section 5. Requirements for Step 3 have not yet been considered as these are beyond the scope of the two-year FITMAN project.

4.3. Identity Management in a Multi-Stakeholder Environment

This exploration of Future Internet scenarios brought to our attention one very specific issue which, in our opinion, is not currently addressed by the technological foundation of the FI-PPP programme: identity management in a multi-stakeholder environment.

What a multi-stakeholder environment is, in the first place? In our context, it's a distributed IT environment (i.e., a well-defined network of privately-owned and/or cloud-deployed systems and storage) where access to shared IT resources is under control of multiple *authorities*, each of them responsible for its own *local* group of resource consumers. E.g., a business ecosystem with several members, including enterprises and public service providers, which runs some collaborative system on the cloud and must enforce some access policies for its users.

From as software engineering point of view, problems of this class are typically decomposed into user authentication and user authorization, with the former implemented by some single-sign-on (SSO) architecture, and the latter managed either at the application level, or in a more *open* way by the adoption of some OAuth-based technology[2]. However, the multi-stakeholder option is adding some very specific requirements to this problem: user credentials and attributes (i.e., information about the user which is released by a *trusted* party, like the real-world identity and contact info, or the *roles* that the user is allowed to play in the environment) are sensitive data belonging to the different organizations which compose the business ecosystem, and should not be disclosed to a centralized authority. The solution – as long as authentication is concerned – is a federation of mutually trusting security authorities,

[2] http://oauth.net/. It should be noted that OAuth, while a flexible and powerful authorization framework, is of little use in this context: it empowers the user who *owns* some centrally-managed resources to decide how they should be shared (i.e., which application has access to user-owned information), but does not help for user profiling (i.e., which application-owned functionality / data are accessible to a given user). In other words, it is user-centric instead of application-centric, and as such it's better suited to enforcing access policies on user-generated content.

possibly (for the user's convenience) exposing a unified SSO service. This scenario is well-known in the industry, and is partially addressed by the OpenID standard[3].

It is worth noting that in FI-WARE the authentication problem is taken seriously: four distinct implementations exist of the Identity Management open specs. That said, after a thorough analysis of the available documentation, we reached the conclusion that none of the available FI-WARE Generic Enablers meets the requirements of our advanced *federated-security* scenario[4]. We see this as a gap in the technological foundation of the Future Internet. For this reason, here we briefly describe a Federated Single-Sign-On solution (F-SSO) [8] as developed in the scope of another EC-funded ICT research project: MSEE[5].
In the MSEE vision, which is fully-compatible with the Future Internet scenario described above, multiple organizations may take part in a single business ecosystem, and the same organization may take part in different ecosystems. A set of one or more ecosystems which are managed by the same F-SSO service is called an *ecosystem federation*. In such a network, the login-in service is centralized but user data (including security credentials) is local: organizations can join the federation without sharing any sensitive information.

Users of a F-SSO system are either registered globally or at the organization level: each single organization may opt to play the role of Local Security Authority (LSA). Every LSA is responsible for authenticating their own users. This happens by delegation: when any user logs-in with the central F-SSO service, this will match the user ID to the proper LSA[6], and will then delegate authentication to it. This back-end conversation happens in the background and is totally transparent to the user.

The F-SSO solution also supports the attributes release feature, which is the LSA capability of "annotating" users with useful information after a successful authentication. Attributes are propagated to applications using the Security Assertion Markup Language (SAML 2.0) open standard.

While this F-SSO prototype has several limitations[7], we believe that it might be used as a blueprint for next-generation, Future Internet-enabled identity management solutions targeted at the enterprise world.

[3] http://openid.net/. OpenID has one limitation: it does not support a totally integrated, transparent SSO solution. Users are redirected by applications to their actual identity manager to perform authentication. In other words: each enterprise in a business ecosystem willing to play the identity manager role on behalf of its corporate users, must deploy its own OpenID-compliant authentication service and front-end.
[4] This is not the proper context for a technical discussion of the pros and cons of each GE. Basically, these implementations are either the expression of a proprietary, centralized identity management service, or they don't support federation, or both.
[5] http://www.msee-ip.eu/
[6] IDs in F-SSO follow a special naming convention, like in john.smith@gmail.com#acme.com – where john.smith@gmail.com is the actual User ID and acme.com is the LSA ID.
[7] Just to mention two: it's not OpenID-compatible, and it only supports username/password as an authentication method.

5. FITMAN Trial's Cloud Strategy

This section is dedicated to the collection and consolidation of non-functional requirements originating from FITMAN Trials and targeted at cloud-based IT infrastructure providers. The purpose is to draw a clear and coherent picture of the FITMAN Trial's cloud strategy. To this goal, all requirements are organized by category, and a structured template is used to present the results from each source.

Every requirement belongs to one the following categories (examples are given for each):

- 01) FI-WARE GEs
  Supported FI-WARE implementations, either as multi-tenant shared instances (infrastructure) or as installable packages (owned)
- 02) Capacity
  Min/max number of CPU cores, min/max amount of physical RAM, min/max sizing of storage, min/max number of deployed VMs, etc.
- 03) Connectivity
  Geographical location (trial site vs. cloud facilities), dedicated bandwidth on shared connection (trial site vs. cloud facilities, cloud facilities vs. public internet), dedicated connection (trial site vs. cloud facilities, trial sub-site vs. trial sub-site), wireless connection support, etc.
- 04) Resiliency
  Infrastructure redundancy (and data synchronization model: how long slave nodes are allowed to "lag behind" the master), failover automation, disaster recovery plan, etc.
- 05) Scalability
  If and how the infrastructure capacity should automatically adapt to the actual workload: elasticity vs. scalability (grow the capacity of single nodes vs. increase the number of parallel nodes), runtime monitoring (how load is determined), reaction time, etc.
- 06) Security/Confidentiality
  Identity provider service, encrypted data storage, restricted physical access to facilities, etc.
- 07) Quality of service
  Service level agreements on system downtime, network traffic, data integrity, application/service performance, etc.
- 08) Management services
  IaaS/PaaS management, managed FI-WARE GE instances, managed backup and recovery, 24x7 monitoring, 24x7 support, OS patching/updating, etc.
- 09) Value-added services
  FI-WARE GE-specific support (integration and development), consultancy, etc.
- 10) Other
  Special hardware and/or software requirements, customer physical access to facilities, etc.

5.1. Trial #1 – Volkswagen (Digital Factory)

Volkswagen (VW) is not going to run any software deployed on external premises. VW is one of the world largest automotive OEM, and data is one of its key assets. Due to this, all VW data has to be treated with the highest confidentiality and should not be accessible by unauthorized parties under any condition. It is difficult to enact this requirement on the cloud, where data and information flows are not under direct and exclusive control of the owner. Sometimes, as has been recently demonstrated in the USA, even top-level commercial ISPs cannot be entirely trusted, due to intrusion of government agencies. Industries which are mainly based on the knowledge they produce – like the automotive industry – or businesses with very sensitive data – like in the financial and health sectors – must be extremely restrictive when it comes to information handling. The safest policy is that no sensitive data should ever leave the owner's premises. This can only be guaranteed by a private cloud. As a consequence of this design, no requirements for cloud providers are collected in this document.

5.2. Trial #2 – TRW (Smart Factory)

Cloud hosting offers general purpose computing resources in the Smart Factory domain that can be consumed and paid according to demand, without the need for a large initial investment in the infrastructure. To reach the goal of the improvement in the workforce safety and the production reliability in the TRW shop floor, a *hybrid cloud strategy* have been devised: the use of an externally-provided cloud as well as a TRW-private one. The main reasons for this strategy are listed as follows:

- The TRW trial will interact with other factory systems for ergonomic risk analysis such as manual handling and repetitive movement assessment on factory local basis.
- The TRW private cloud is designed for the ergonomic risk prevention system inside the factory intranet with more efficient security control of sensitive data.
- The private cloud will be combined specifically with existing local legacy system of risk modelling, detection and analysis.
- An externally-provided cloud will supplement the private one to extend online storage space or composite data analysis services for anonymous data.

This architecture is described in the block diagram below:

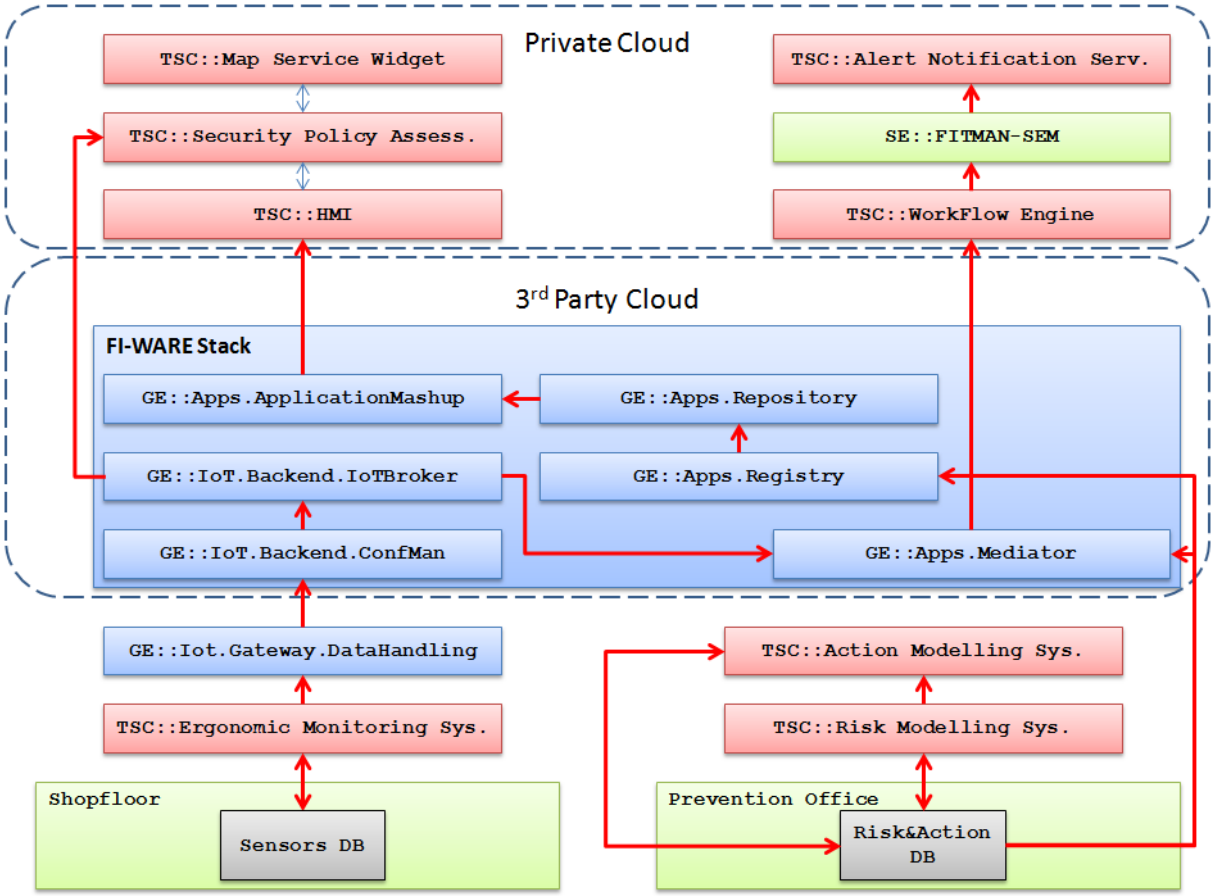

Figure 5 - Deployment diagram for Trial #2 - TRW

IT requirements for cloud providers are listed in Table 5. Being a typical Smart Factory scenario, the focus is on low latency and resiliency. No custom virtualization – that is, software components which are not from the FI-WARE catalogue – is required.

Category	**Description**
FI-WARE GEs	IoT.Backend.IoTBroker - RI by NEC
FI-WARE GEs	IoT.Backend.ConfMan - Orion Context Broker by Telefonica
FI-WARE GEs	Apps.ApplicationMashup – WireCloud by UPM
FI-WARE GEs	Apps.Repository – RI by SAP
FI-WARE GEs	Apps.Registry – RI by SAP
Capacity	4 VMs on each replicated cloud node: • 2 * Medium size: 2 cores / 4GB RAM • 2 * Large size: 4 cores / 8GB RAM *Note: Repository and Registry share the same VM*
Capacity	500MB total filesystem space on each replicated cloud node
Connectivity	Dedicated connection vs. customer premises (min. bandwidth 1Mbs)
Resiliency	Replication of the entire platform on 2 physically distinct cloud nodes ("*availability zones*"), transparent data replication, fast and transparent failover (no need to reconfigure client applications) with minimal loss of data
Resiliency	Disaster recovery plan
Security/Confidentiality	Stored data accessible to authorized users only
Quality of service	Guaranteed system uptime 99,99% (1 minute max. downtime per week), max. single system downtime 10 minutes

Quality of service	Max. network latency 100ms
Management services	Infrastructure management
Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 5 - Requirements from Trial #2 - TRW

5.3. Trial #3 – AgustaWestland (Digital Factory)

AgustaWestland (AW) is not going to run any software deployed on external premises. AW is a leader in a number of the world's most important helicopter markets, offering the widest range of advanced rotorcraft available for both commercial and military applications. This puts AW in a position similar to the one described for Trial #1 (see section 5.1): all data has the topmost confidentiality, and no external cloud provider, given the stakes, may be left in charge of enforcing such very strict access policies. Again, no data will be allowed to leave AW's premises. For this reason, the FITMAN experimentation will be entirely run on locally-deployed software: no requirements for cloud providers are collected in this document.

5.4. Trial #4 – Whirlpool (Smart Factory)

Whirlpool Europe (WHR) derives its cloud strategy from the overall OT strategy decided at global level. The overall cloud strategy received an interesting drive last year when Whirlpool Corporation announced its intention to adopt Google technology in replacement of IBM Lotus Notes and Sametime. This choice implies the shift from a local repository server to the Google Drive repository. The rationale is to allow workers to access e-mail and other productivity tools independently of their physical and geographical location. Even though this choice has an impact only on office automation tools and on white collar workers, the trend is formally launched, and a cloud strategy has to be depicted also for manufacturing.

For the FITMAN experimentation, WHR decided to deploy all the GEs and the SEs of the FITMAN SF platform – plus the Notification Manager trial-specific component – on the cloud. This choice has been motivated by the opportunity to leverage the cloud capacity available in the scope of the FI-PPP programme. This architecture is depicted in the following figure:

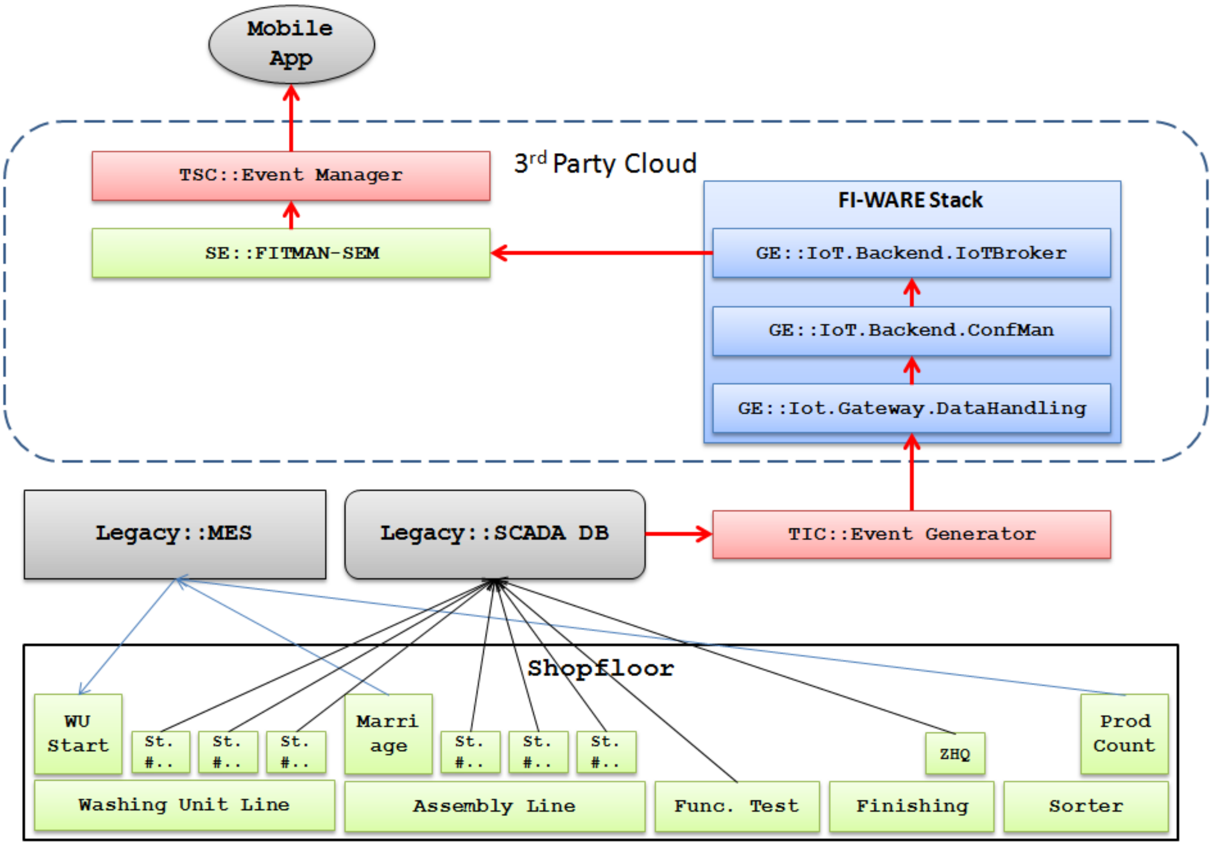

Figure 6 - Deployment diagram for Trial #4 - WHR

IT requirements for cloud providers are listed in Table 5. Being a typical Smart Factory scenario, the focus is on low latency and resiliency. Besides the FI-WARE components, two custom virtualized services are deployed on the cloud: the FITMAN-SEM SE and the trial-specific Notification Manager.

Category	**Description**
FI-WARE GEs	IoT.Backend.IoTBroker - RI by NEC
FI-WARE GEs	IoT.Backend.ConfMan - Orion Context Broker by Telefonica
FI-WARE GEs	IoT.Gateway.DataHandling - Esper4FastData by Orange
Capacity	5 VMs on each replicated cloud node: • 3 * Medium size: 2 cores / 4GB RAM • 2 * Large size: 4 cores / 8GB RAM
Capacity	500MB total filesystem space on each replicated cloud node
Connectivity	Dedicated connection vs. customer premises (min. bandwidth 1Mbs)
Resiliency	Replication of the entire platform on 2 physically distinct cloud nodes ("*availability zones*"), transparent data replication, fast and transparent failover (no need to reconfigure client applications) with minimal loss of data
Resiliency	Disaster recovery plan
Security/Confidentiality	Stored data accessible to authorized users only
Quality of service	Guaranteed system uptime 99,99% (1 minute max. downtime per week), max. single system downtime 10 minutes
Quality of service	Max. network latency 100ms
Management services	Infrastructure management

Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 6 - Requirements from Trial #4 - WHR

5.5. Trial #5 – Piacenza (Smart Factory)

Piacenza is fully committed to cloud experimentation for both of its business scenarios: all the relevant components from the FITMAN Platforms (GEs + SEs), together with one trial-specific one, are going to be deployed on the cloud, as detailed in the two pictures that follow:

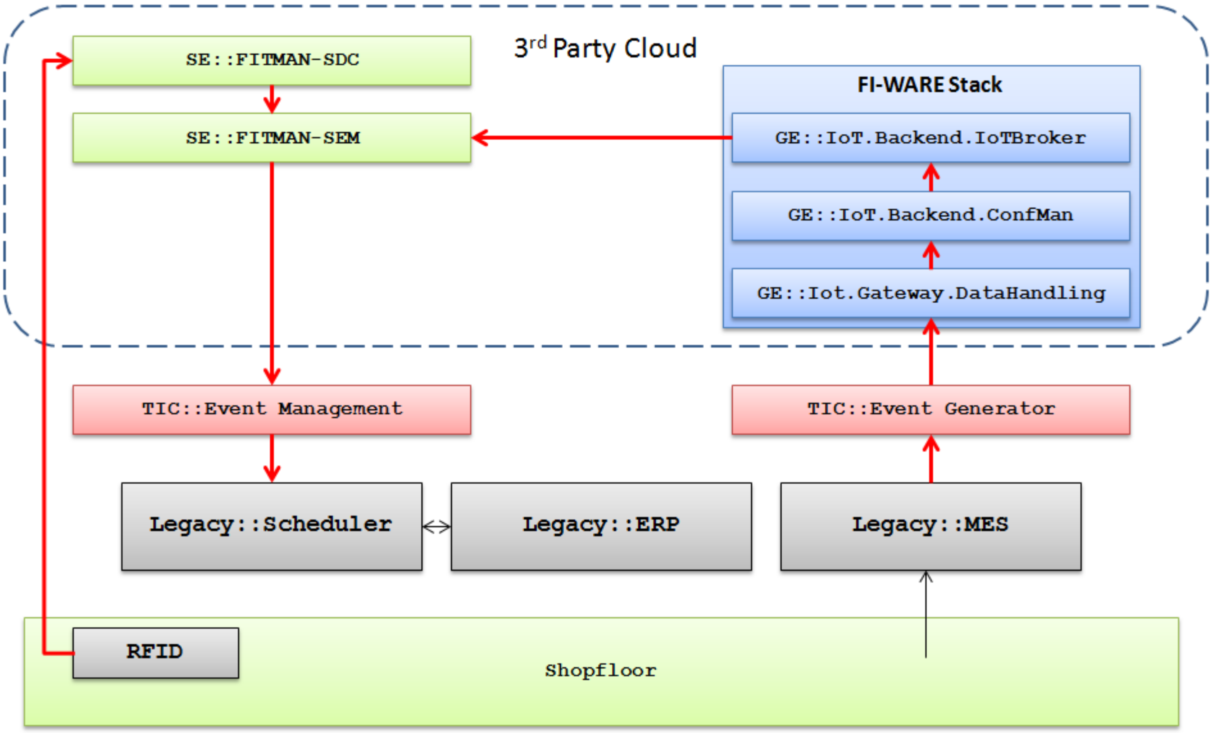

Figure 7 - Deployment diagram for Trial #5 – Piacenza SF scenario

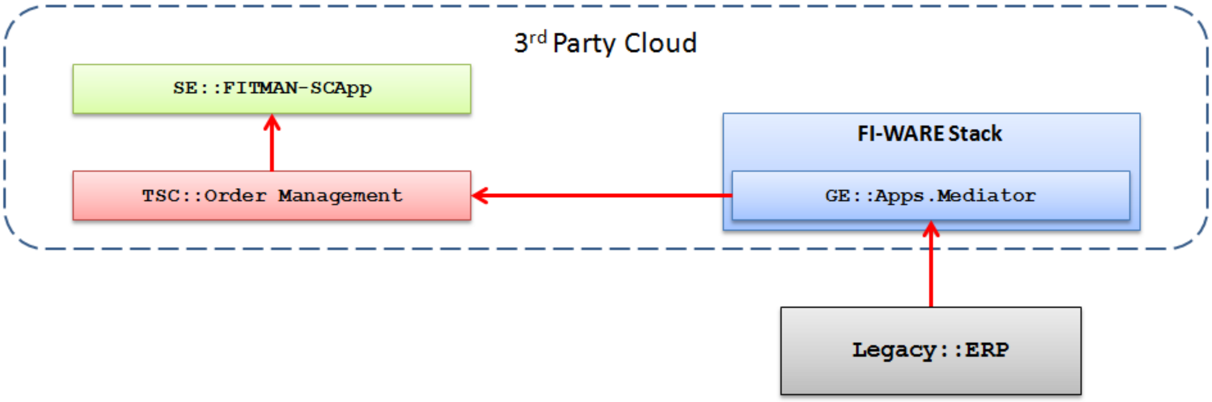

Figure 8 - Deployment diagram for Trial #5 – Piacenza VF scenario

IT requirements for cloud providers are listed in Table 7. The focus is on low latency, while resiliency – as opposed to the typical Smart Factory scenario – is not considered as a key issue. Besides the FI-WARE components, four custom virtualized services are deployed on the cloud: the FITMAN-SEM, FITMAN-SDC and FITMAN-SCApp SEs, and the trial-specific Order Management.

Category	Description
FI-WARE GEs	IoT.Backend.IoTBroker - RI by NEC
FI-WARE GEs	IoT.Backend.ConfMan - Orion Context Broker by Telefonica
FI-WARE GEs	IoT.Gateway.DataHandling – Esper4FastData by Orange
FI-WARE GEs	Apps.Mediator – RI by Telecom Italia / Thales
Capacity	7 VMs: • 4 * Medium size: 2 cores / 4GB RAM • 3 * Large size: 4 cores / 8GB RAM *Note: SE FITMAN-SCApp and trial-specific Order Management share the same VM*
Capacity	500MB total filesystem space
Connectivity	Dedicated connection vs. customer premises (min. bandwidth 1Mbs)
Resiliency	Disaster recovery plan
Security/Confidentiality	Stored data accessible to authorized users only
Management services	Infrastructure management
Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 7 - Requirements from Trial #5 - Piacenza

5.6. Trial #6 – APR (Virtual Factory)

Several APR products are specific or prototypes. They are produced under strict collaboration contracts reducing the perimeter of engineering and production data exploitation. Typically, these data should be accessible between 06h00 and 21h00 at the APR premises. Also, no requirements for IT infrastructure flexibility/elasticity exist which may justify the adoption of a private cloud. For this reason, the FITMAN experimentation will be entirely run on locally-deployed software: no requirements for cloud providers are collected in this document.

5.7. Trial #7 – Consulgal (Digital Factory)

In Consulgal, the FI-WARE cloud is deemed a good opportunity for reducing IT-related costs in both solution development and application management. Still, data confidentiality issues are perceived as a substantial risk. To address both security and economic concerns, Consulgal opted for a limited use of the externally-provided cloud: only those component which are not managing sensitive data are deployed on the cloud, while more critical components will run on local premises. This architecture is described in Figure 9:

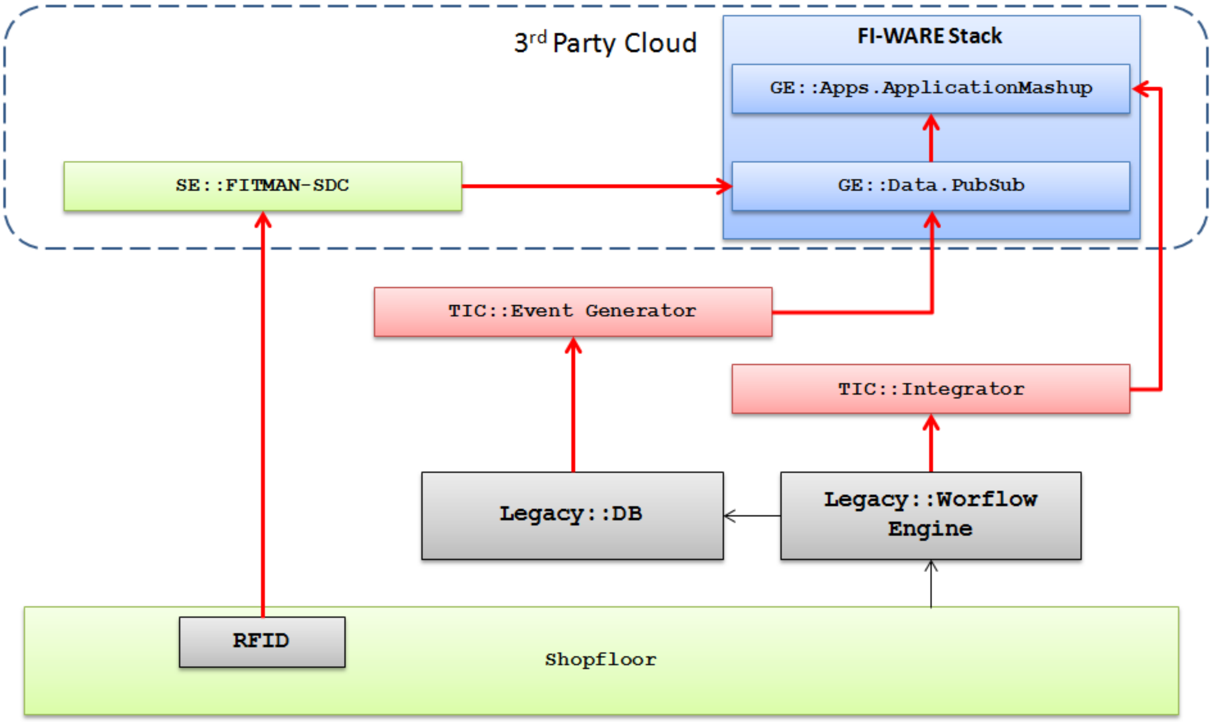

Figure 9 - Deployment diagram for Trial #7 - Consulgal

IT requirements for cloud providers are listed in Table 8. The focus is on high network bandwidth and storage capacity, as is typical for Digital Factory scenarios, but also high-availability is mandatory.

Category	Description
FI-WARE GEs	Apps.ApplicationMashup - Wirecloud by UPM
FI-WARE GEs	Data.PubSub - Context Awareness Platform by Telecom Italia
Capacity	2 VMs on each replicated cloud node: • 2 * Large size: 4 cores / 8GB RAM
Capacity	100GB total file system space on each replicated node
Connectivity	Reserved bandwidth vs. public Internet (min. 30Mbs)
Resiliency	Entire platform has to be replicated in all the cloud nodes, without (or minimal) effort to reconfigure the GEs. Mashup GE doesn't involve storage of data so data loss in not applicable but for PubSub GE minimal loss is expected.
Security/Confidentiality	Stored data accessible to authorized users only
Quality of service	Guaranteed system uptime 99,9% (10 minutes max. downtime per week), max. single system downtime 10 minutes
Management services	Infrastructure management
Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 8 - Requirements from Trial #7 - Consulgal

5.8. Trial #8 – TANet (Virtual Factory)

The general ethos of the strategy regarding the cloud is to prioritise cloud deployment where possible. This is due to the generally high availability which cloud infrastructures provide and, from the user perspective, to the low maintenance required. However this is not possible in all cases, and some specific components will need to run on local premises – e.g., the processing of high frequency shopfloor sensor's events is not compatible with internet latency. Moreover, some TANet-specific components will also be deployed locally due to security issues. Figure 10 illustrates the Virtual Factory scenario in TANet. It is worth noting that a Smart Factory scenario exists as well for this Trial, and that it's not represented here as it will be entirely managed on local factory premises.

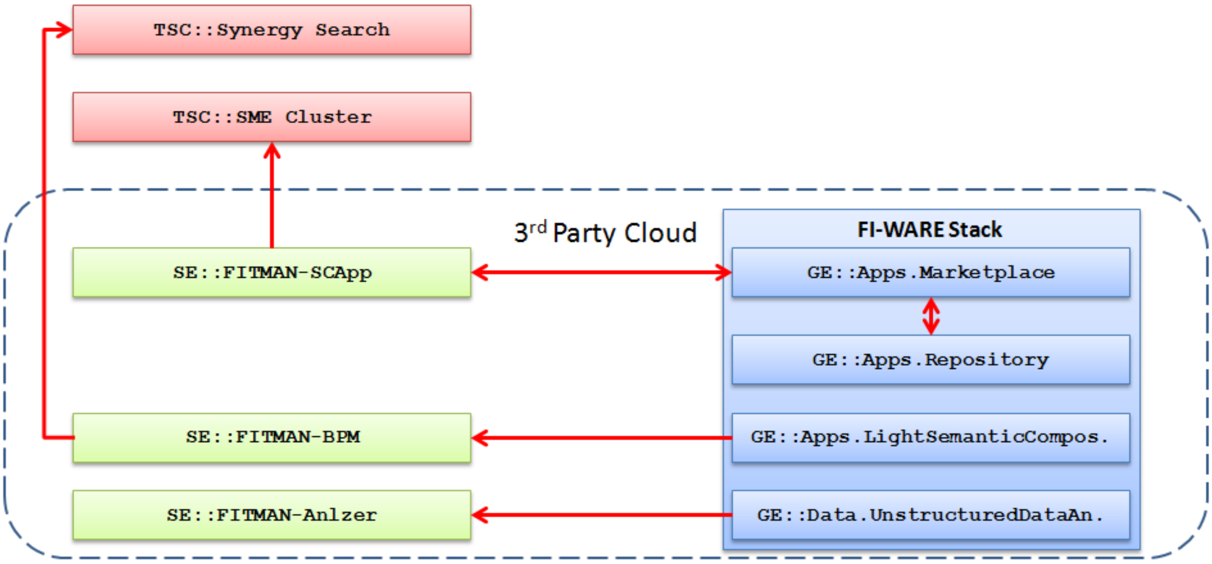

Figure 10 - Deployment diagram for Trial #8 - TANet

IT requirements for cloud providers are listed in Table 8. The focus is on storage capacity and on network bandwidth.

Category	**Description**
FI-WARE GEs	Apps.Marketplace - RI by SAP
FI-WARE GEs	Apps.Repository - RI by SAP
FI-WARE GEs	Apps.LightSemanticComposition - COMPEL by ATOS
Capacity	3 VMs: • 3 * Large size: 4 cores / 8GB RAM *Note: SE FITMAN-SCApp, SE FITMAN-CAM, GE Marketplace and GE Repository come packaged in one single VM; the same is true for SE FITMAN-BPM and GE LightSemanticComposition*
Capacity	1TB total filesystem space
Connectivity	Reserved bandwidth vs. public Internet (min. 10Mbs)
Resiliency	Disaster recovery plan
Security/Confidentiality	Stored data accessible to authorized users only
Management services	Infrastructure management
Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 9 - Requirements from Trial #8 - TANet

5.9. Trial #9 – COMPlus (Virtual Factory)

COMPlus has a *private cloud* strategy. The SME network services provided by COMPlus require a dedicated infrastructure which supports data security and trust as well as extensibility. Currently, the network has a relatively small number of companies; this however may change due to the increasing volume of production, number of products and involved companies. For this reason, flexibility of IT infrastructure is of paramount importance, and the FITMAN business scenarios relies on a private cloud concept for the SME network environment. It is envisaged that a private cloud, possibly managed by means of the Cloud Hosting chapter GEs, might fit nicely in the COMPlus business model. No requirements for external cloud providers are collected in this document.

5.10. Trial #11 – AIDIMA (Digital Factory)

The AIDIMA global cloud strategy is to instantiate the three applications developed and its respective components (GEs, and SEs) on the cloud. The main reasons are:

1. Cost savings: some of the components, such as the Unstructured and Social Data Analytics SE, need intensive computing power and massive storage capacity. Cloud solutions make it easy to fit IT solutions to specific needs and to dynamically adapt them as needs change.
2. Availability: web crawlers gathering information for analyzers require dedicated machines available 24x7. A commercial cloud infrastructure can provide this level of service to AIDIMA.
3. Scalability: depending of the number of sources and reports, storage and CPU needs will vary widely. In order elastically adapts to the end user needs, a cloud solutions is needed.

The cloud architecture is shown in Figure 11 below:

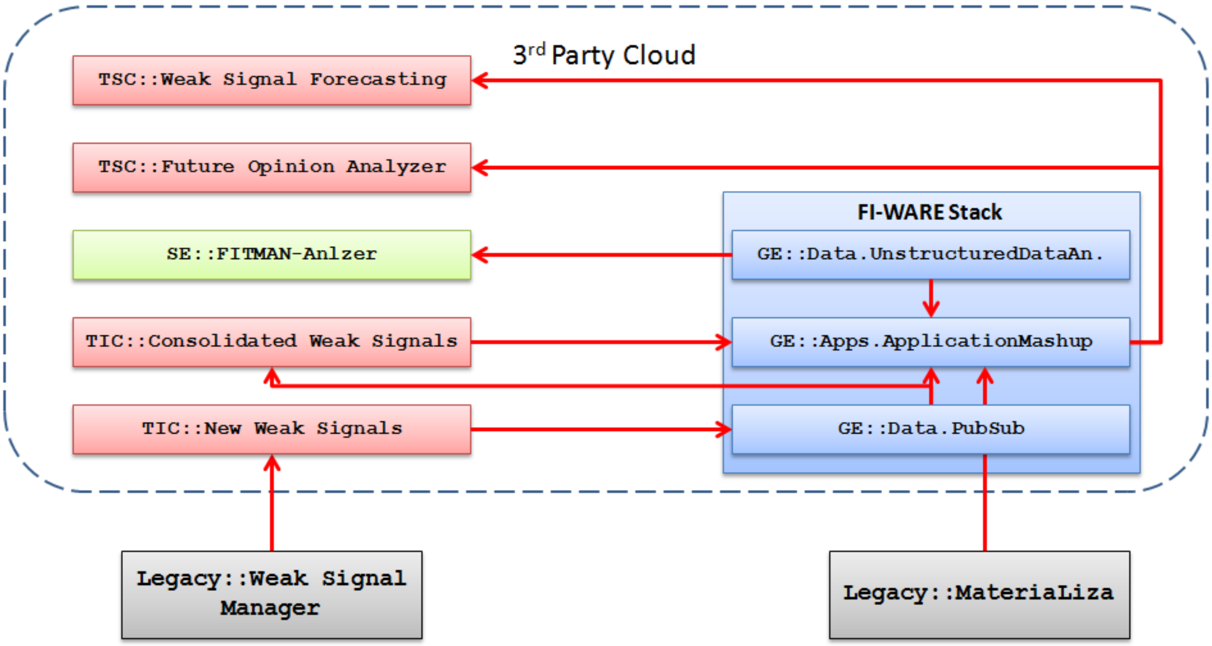

Figure 11 - Deployment diagram for Trial #11 – AIDIMA

IT requirements for cloud providers are listed in Table 10. Again, as already seen for other Digital Factory scenarios, high network bandwidth and massive storage capacity are mandatory.

Category	**Description**
FI-WARE GEs	Apps.ApplicationMashup – Wirecloud by UPM
FI-WARE GEs	Data.PubSub – Context Awareness Platform by Telecom Italia
FI-WARE GEs	Data.UnstructuredDataAnalysis – ref. impl. by Atos
Capacity	4 VMs: • 1 * Large size: 4 cores / 8GB RAM • 3 * Medium size: 2 cores / 4GB RAM *Note: SE FITMAN-Anlzer and GE Data.UnstructuredDataAnalysis share the same VM, and the same is true for the trial-specific Weak Signal Forecasting and Future Opinion Analyzer components*
Capacity	1TB total filesystem space
Connectivity	Reserved bandwidth vs. public Internet (min. 30Mbs)
Resiliency	Disaster recovery plan
Security/Confidentiality	Stored data accessible to authorized users only
Management services	Infrastructure management
Management services	Automated data backup and recovery
Management services	24x7 monitoring and support
Other	Remote admin access to VMs on secure connection

Table 10 - Requirements from Trial #11 - AIDIMA

6. Final Considerations

This second release of the D1.6 report had the objective of finalizing an analysis which was only partially done at the time of the first release. In particular, the assessment of INFINITY data centres in the FITMNAN context had to be completed with some concrete, hands-on experimentation, while the IT requirements section was only a draft.

The objective has been fully achieved, even if the INFINITY-related experimentation didn't yield the expected results: of the three candidate infrastructures identified by M4, no one was found to meet the basic needs of FITMAN Trials. Moreover, the ten entries on which our judgement was suspended, due to an "under development" disclaimer, did not change their status in the following ten months. This led us to conclude that there is a fundamental mismatch between INFINITY's and FITMAN's objectives and scope, the former being more focused on research, the latter on production.

The main contribution of this second iteration, however, comes from the IT requirements which have been collected from all FITMAN Trials that are going towards an external cloud deployment in the final phase of the project and beyond. Basically, these trial-specific requirements are confirming the domain-level ones drafted by M4, with some extra detail.

As an additional feature, this release includes a brief analysis of the identity management problem in the context of collaborative, multi-enterprise cloud environments. As reported in the document, we see a lack of support from FI-WARE on this matter, and we propose a reference architecture which might, to some extent, fill this gap.

As a final word, we see that FITMAN Trials are approaching the cloud facet of Future Internet with mixed sentiments. Large enterprises are, as a rule, less concerned about cost savings as they are about security and, ultimately, control over their valuable knowledge assets – however, even within the limited FITMAN landscape we can witness different LE use cases (TRW, Whirlpool) where security does not get in the way, and a sustainable cloud roadmap is envisioned. SMEs, on the other hand, are probably more interested in reduction of costs and of time-to-market – again, some exceptions exist (APR) to this general rule. We also have one specific case (COMPlus) where the FI cloud is perceived as a brand new business opportunity - i.e., add cloud services to the existing offering. Overall, FITMAN is proving itself as really complete testbed of FI technologies for manufacturing.

7. References

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[4] FITMAN Description of Work
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