Tailored IoT & BigData Sandboxes and Testbeds for Smart, Autonomous and Personalized Services in the European Finance and Insurance Services Ecosystem

D6.3- Testbeds Status and Upgrades - III

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0.1	2021-12-27	CP	ToC Version
1.0	2022-03-02	CP	First Version for Internal Review
2.0	2022-03-15	CP, IBM, UNP	Version for Quality Assurance
3.0	2022-03-27	CP, IBM, UNP, CCA	Version for Submission

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Executive Summary

This deliverable reflects the outcomes of T6.1 "Testbeds Analysis, Customization and Continuous Upgrade", in terms of INFINITECH Pilots' progress on the readiness and compliance of the infrastructure (hardware & software) deployments of each pilot, compared to the Reference (Blueprint) Testbed provided and deployed in WP6. According to the goal of T6.1., besides the Pilots resources regarding Testbeds and hosted Sandboxes, gaps and future steps for supporting BigData, IoT, AI experimentation aligned with the INFINITECH way, are also identified and proposed. The following Table 1 provides the updated list of INFINITECH Pilots during the second cycle of project's development.

Table 1 – INFINITECH Pilots' Updated list

Pilot No	Title	Partners
Category 1 - T7.2 Smart, Reliable and Accurate Risk and Scoring Assessment		
Pilot# 2	Real-time risk assessment in Investment Banking	JRC, INNOV, GFT
Pilot# 15	Open Inter-banking Pilot	ABILAB, GFT, HPE
Category 2 - T7.3 Personalized Retail and Investment Banking Services		
Pilot# 3	Collaborative Customer-centric Data Analytics for Financial Services	BPFI, NUIG, BOI, IBM Ireland
Pilot# 4	Personalized Portfolio Management	PRIVE, RB
Pilot# 5b	Business Financial Management (BFM) tools delivering a Smart Business Advice	BOC, UPRC
Pilot# 6	Personalized Closed-Loop Investment Portfolio Management for Retail Customers:	NBG, CP, RB, LXS, GLA
Category 3 - T7.4 Predictive Financial Crime and Fraud Detection		
Pilot# 7	Avoiding Financial Crime	CXB, FTS, FBK
Pilot# 8	Platform for Anti Money Laundering Supervision (PAMLS)	BOS, JSI
Pilot# 9	Analyzing Blockchain Transaction Graphs for Fraudulent Activities	AKTIF, BOUN
Pilot# 10	Real-time cybersecurity analytics on Financial Transactions' BigData	PI, ENG
Pilot# 16	Data Analytics Platform to detect payments anomalies linked to money laundering events	NEXI, GFT
Category 4 - T7.5 Personalized Usage-Based Insurance Pilots		
Pilot# 11	Personalized insurance products based on IoT connected vehicles	ATOS, CTAG, GRAD, DYN
Pilot# 12	Real World Data for Novel Health-Insurance products	SiLO, iSPRINT, RRDD, GRAD, ATOS, DYN
Category 5 - T7.6 Configurable and Personalized Insurance Products for SMEs and Agro-Insurance		
Pilot# 13	Alternative/automated insurance risk selection - product recommendation for SME	WEA, LXS
Pilot# 14	Big Data and IoT for the Agricultural Insurance Industry	GEN

The deliverable is the third and the last one of a set of three (3) deliverables, providing the Pilots progress on Testbeds and Sandboxes deployment. The contents described here, detail those advancements achieved during the period from M21 to M28. In the first version of the Deliverable D6.1, the initial specifications for all Pilots to be integrated to the "INFINITECH way" of development were reported, while the second version (D6.2.) specified the ways that INFINITECH Pilots had to be extended in terms of hardware and/or software resources. This third and final version contains an overview of Pilots' advances vs INFINITECH Reference (Blueprint) Testbed Guidelines, described and visualized for this period. Finally, it introduces the next steps regarding the last year of INFINITECH project, in order for all Pilots to be fully compliant with the "INFINITECH way".

In particular, the deliverable contains:

- The updates of Testbeds infrastructure that each Pilot uses for development and the relative Sandboxes that will be hosted, compared to Deliverable D6.2.
- The different as-is current deployment for each Pilot vs the INFINITECH Reference (Blueprint) Testbed Guidelines
- The upgrade actions that will be required to be implemented until the end of the project in order to support the development of Big Data, IoT and AI-based innovations, according to the Reference (Blueprint) Guidelines for Testbeds and Sandboxes deployment.

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Abbreviations

Agl	Agricultural Insurance
AI	Artificial Intelligence
ALIDA	Microservice-based Platform for Big Data Analytics
AML	Anti-Money Laundering
API	Application Programming Interface
AWS	Amazon Web Services
BFM	Business Financial Management
CF	Cash Flow
CI/CD	Continuous Integration/Continuous Development
CPU	Central Processing Unit
DEV	Development
DL	Deep Learning
DPO	Data Protection Orchestrator
ERC	Ethereum Request for Comment
FIU	Financial Intelligence Unit
GUI	Graphical user interface
HPC	High Performance Computing
IAM	Identity and Access Management
IRA	Infinitech Reference Architecture
IoT	Internet of Things
IT	Information Technology
JAR	Java ARchive
KYB	Know Your Business
KPI	Key Performer Indicator
KYC	Know Your Customer
M(s)	Month(s)
MS-Azure	Microsoft Azure
ML	Machine Learning
MPI	Message Passing Interface
N/A	Not Applicable
PAMLS	Platform for AML Supervision
POC	Proof of Concept
RA	Reference Architecture
RAM	Random Access Memory
REST	Representational state transfer
SaaS	Software as a Service
SEPA	Single Euro Payments Area
SFTP	Secure File Transfer Protocol
SIT	System Integration Test

SME	Small and Medium-Sized Enterprises
SVC	Source Version Control
TAH	Traffik Analysus Hub
TBD	To be defined
TRL	Technology Readness Level
UAT	User Acceptance Test
UI	User Interface
VAR	Value at Risk
WP	Work Package
XML	Extensible Markup Language
YAML	YAML Ain't Markup Language

1 Introduction

1.1 Objective of the Deliverable

Task 6.1 provides the initial Specification for hardware & software, as well as any additional security or special requirements of the existing or planned to be built testbeds for hosting the Pilots' executions in terms of their existing resources and gaps for supporting Big Data, IoT, AI experimentation in-line with the INFINITECH approach.

The deliverable updates the previous reports' reader on the major outcomes and progress in terms of Pilots' current status of the infrastructure (hardware & software) used for all testbeds to host the INFINITECH Pilots, achieved since M21 to M28, and planned activities (overview) for the next year, in order to fulfil the project's and the pilots' testbeds & sandboxes needs. The progress of each Pilot is mentioned, as well as their developments and advances, referring to the corresponding WP6 deliverables/tasks, where these are detailed/expanded.

The major sources of insights for deliverable D6.3, and more specifically for Chapters 3 and 4, are the INFINITECH Pilots and their contributions, based on a specific questionnaire that was distributed for collection of the relative information, regarding the readiness of their Testbeds and Sandboxes deployment compared to the Reference (Blueprint) Testbed and the planned actions or alternative solutions in case of no compliance possible.

In this regard, the deliverable contains four main parts:

- An updated list of incumbent or shared testbeds and the hosting (on-premises/cloud/hybrid) that have been implemented for all INFINITECH Pilots.
- Pilots Testbeds vs INFINITECH Reference (Blueprint) Testbed Guidelines progress, providing the as-is current deployment for each pilot of the ten (10) testbeds hosted from Finance organizations of the consortium and also the one shared Testbed (NOVA) that hosts five (5) FinTech/InsuranceTech pilots.
- Pilots' Guideline coverage work plan until the end of the project (and visual diagram), specifying the planned actions, modifications or alternative solutions in case of not fully matching, which will be performed to comply with the guidelines of the Reference (Blueprint) Testbed, as well as any required upgrades.
- A summary of Pilots' Testbeds and Sandboxes Implementation Upgrade Progress, along with the next steps for full compliance.

1.2 Insights from other Tasks and Deliverables

The deliverable D6.3 is the third and the last one that is released for Task 6.1, so the contents contain the updates of the initial analysis for the current status of the infrastructure (hardware & software) that will be used for all testbeds to host the Pilots of INFINITECH Project and the future steps for fully compliance with the "INFINITECH way". Based on this description the other deliverables of WP6 will be conducted. Task 6.2 and 6.3 will provide an updated deliverable D6.6 Tools and Techniques for Tailored Sandboxes and Management of Datasets-III, to be used for all testbeds. Tasks 6.4 and 6.5 based on the updated specifications for all Testbeds and Sandboxes,

from either incumbent or FinTech/InsuranceTech Pilots will put in place (in the field testbed and sandboxes) the tools and mechanisms defined in Task 6.2 and 6.3. They, as well as, provide the necessary updates for Sandboxes deployment the respective Pilots, as part of the new versions of the relative deliverables D6.9 and D6.12. Task 6.6 will specify and implement processes for certifying and standardizing digital finance/insurance solutions in the project tailored sandboxes and testbeds. The following diagram (see Figure 1) depicts the interconnections between WP6 Tasks:

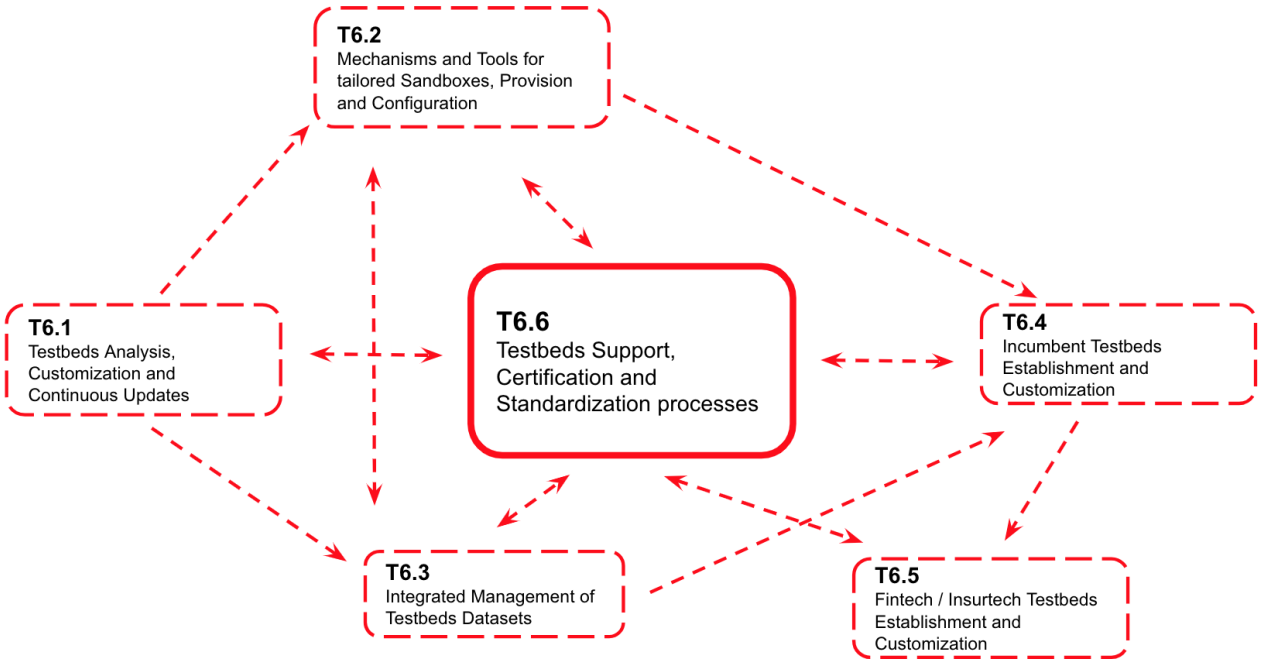

Figure 1 – Schema of the links among Tasks of WP6

1.3 Structure of the Document

This deliverable is composed of five main sections. Chapter 1 is the introduction to the deliverable and includes the description of the objective, insights from other tasks and deliverables and the document structure. Chapter 2 contains an updated overview of Infinitech Pilots' Testbeds and Sandboxes infrastructure. Chapter 3 describes the Testbeds & Sandboxes implementation progress for each Pilot, compared to the Reference (blueprint) Testbed specifications within M21-M28, as well as the relative planned actions for final upgrades or migration. Chapter 4 summarizes Pilots' Testbeds and Sandboxes guidelines compliance and upgrade progress, while Chapter 5 concludes the document.

2 INFINITECH Pilots' Testbeds & Sandboxes Infrastructure

The INFINITECH Tailored Sandboxes and Testbeds provide a number of digital finance/insurance testbeds deployed on cloud providers' or/and private data centers for the incumbent partners (Pilots #3, #4, #5b, #6, #7, #8, #9, #10, #15, #16) and on a shared data center for the FinTech/InsuranceTech partners (Pilots #2, #11, #12, #13, #14) for the experimentation and validation of Big Data, AI and IoT solutions.

Therefore, the fifteen (15) Pilots are hosted and executed in 10 incumbent testbeds +1 shared testbed, held in the NOVA's Data Center, in addition to the INFINITECH (Blueprint) Reference Testbed. The Blueprint Testbed, was setup and designed, using two of the target INFINITECH infrastructures, applied to Pilot#2 and Pilot#5b, in order to support the experimentation of the INFINITECH Reference (Blueprint) Testbed Guidelines.

Most of the Testbeds, except the Nova shared ones, are cloud-based, mainly on AWS Cloud either public or private. In cases of private (e.g. Pilot #7 or Pilot#6 based on Private Microsoft Azure), they are similar to the INFINITECH Reference (Blueprint) Testbed Guidelines for deployment.

The INFINITECH (Blueprint) Reference Testbed is hosted on the Amazon Web Services (AWS), providing Pilots either with a fully automated way of deployment both on AWS and MS-Azure or with a partially automated way (e.g., Pilots #2, #7, #11), thus in a bare metal environment for shared Testbeds in NOVA. INFINITECH Testbed relies on the Kubernetes environment to orchestrate containers and to manage the resources of the control plane or nodes conveniently.

Considering the current status, Testbeds are being deployed in three different variations: a) Cloud infrastructure, where cloud environments are provided from the respective Pilot Host, b) On-Premises Infrastructure, where Pilots' partners use their own infrastructure (e.g. Pilots#4, #8) and c) Hybrid infrastructure, where a mixed approach is implemented, by which the testbed is hosted both on-premise data center or in any cloud provider.

Both incumbent and shared Testbeds host or will host, (e.g. Pilot#16 which is in an early development phase) one or more sandbox environments according to the use cases that they adopt, providing solutions by different sets of applications. All the shared involved Pilots (Pilots #2, #11, #12, #13, #14) have been using the sandboxes in the Nova testbed. The update of the Pilots' Testbeds & Sandboxes Infrastructure is presented in the following Table 2.

Table 2 – INFINITECH Updated list of Pilots' Testbeds & Sandboxes Infrastructure

Incumbent Testbed & Sandboxes	Shared Testbed & Sandboxes	Pilot No Leader	Title	Hosting	Public Cloud Provider	On premise deployment	Hybrid deployment
Category 1 - T7.2 Smart, Reliable and Accurate Risk and Scoring Assessment							
	√	Pilot# 2 **JRC**	Real-time risk assessment in Investment Banking	AWS	√		
√		Pilot# 15 **ABILAB**	Open Inter-banking Pilot	AWS	√		
Category 2 - T7.3 Personalized Retail and Investment Banking Services							

√		Pilot# 3 **BPFI**	Collaborative Customer-centric Data Analytics for Financial Services	BOI		√	
√		Pilot# 4 **PRIVE**	Personalized Portfolio Management	Prive own AWS	√		
√		Pilot# 5b **BOC**	Business Financial Management (BFM) tools delivering a Smart Business Advice	AWS	√		
√		Pilot# 6 **NGB**	Personalized Closed-Loop Investment Portfolio Management for Retail Customers:	Private MS Azure	√		
Category 3 - T7.4 Predictive Financial Crime and Fraud Detection							
√		Pilot# 7 **CXB**	Avoiding Financial Crime	CXB			√
√		Pilot# 8 **BOS**	Platform for Anti Money Laundering Supervision (PAMLS)	BOS		√	
√		Pilot# 9 **AKTIF**	Analyzing Blockchain Transaction Graphs for Fraudulent Activities	AWS	√		
√		Pilot# 10 **PI**	Real-time cybersecurity analytics on Financial Transactions' BigData	GFT AWS (PUBLIC) ENG-ON PREMISE			√
√		Pilot# 16 NEXI	Data Analytics Platform to detect payments anomalies linked to money laundering events	AWS			
Category 4 - T7.5 Personalized Usage-Based Insurance Pilots							
	√	Pilot# 11 ATOS	Personalized insurance products based on IoT connected vehicles	NOVA		√	
	√	Pilot# 12 SILO	Real World Data for Novel Health-Insurance products	NOVA		√	
Category 5 - T7.6 Configurable and Personalized Insurance Products for SMEs and Agro-Insurance							
	√	Pilot# 13 WEA	Alternative/automated insurance risk selection - product recommendation for SME	NOVA		√	
	√	Pilot# 14 GEN	Big Data and IoT for the Agricultural Insurance Industry	NOVA		√	

3 Pilots Testbeds vs INFINITECH Reference (Blueprint) Testbed Guidelines

In the following section, the document reports the Testbeds and Sandboxes deployment progress for each Pilot and how these deployments are following the INFINITECH Reference (Blueprint) Testbed Guidelines, while it provides the actions planned from each Pilot for improvements and fully adoption of the "INFINITECH way". The guidelines of the "INFINITECH way" deployments of project Pilots and technologies are available in project's code repository [1], along with a video presentation (webinar) [2]. Briefly, the guidelines are described in the following Table 3.

Table 3 – INFINITECH Reference (Blueprint) Testbed Guidelines

Guideline # and Title	Guideline Description
1. Source Version Control	Each technology provider/contributor keeps their artefacts on target source version control service with dedicated group/project. On each project, the source code or instructions (e.g., a Docker file) about how to build Docker container images starting from built artefacts, should be placed.
2. Application packaging	All applications delivered or used as part of a pilot are built as Docker containers.
3. Artefacts' versioning	Delivered applications artefacts are published and versioned on the INFINITECH Harbor artifact repository.
4. Microservices architecture	Each Pilot use case application is developed following a microservices based approach and it's deployed on Kubernetes.
5. Automatic use case deployment	Each use case application can be deployed on Blueprint Kubernetes cluster, according to a provided Continuous Delivery pipeline configured on Jenkins.
6. Use of technology components building blocks	Technology components building blocks (provided by technical WPs 3-4-5) are pilot agnostic and instantiated per Use Case, so they are configured and instantiated within use case deployments
7. Testbed	A Testbed is the set of resources (e.g., storage, network connection, compute resources) managed by an orchestrator (in practice a Kubernetes cluster) that deploys on demand applications for a specific application (use case).
8. Sandbox	A sandbox refers to whatever is inside a Kubernetes namespace and provides a specific use case. As a fact, an integrated pilot solution might consist of several use cases, and therefore several sandboxes deployed within the same Kubernetes cluster.

3.1 Pilot #2 – Testbed for Real-time risk assessment in Investment Banking

Pilot#2, which implements real-time risk assessment and monitoring of financial portfolios, is one of Infinitech's blueprint pilots. As a result, its deployment status, which follows the Infinitech way, is in an advanced stage.

Specifically, Pilot#2 had been initially deployed in the dedicated AWS testbed (M18), while between M21-M23, it was successfully migrated to the NOVA infrastructure, the Pilot#2's reference testbed. The Pilot's internal components and the reference testbed implementation have been documented in D6.5 (subsection 7.2). In addition, subsection 3.1 of D6.11 describes the Pilot's sandbox in NOVA and the deployed Kubernetes elements that define the Pilot's deployment in the dedicated sandbox. Furthermore, the second version of Pilot#2, which features sentiment analysis in financial news, has been successfully deployed in the NOVA testbed at M30.

3.1.1 Pilot#2 Testbed AS-IS coverage and status vs guideline

Pilot#2 leverages various innovative Infinitech technologies/components in order to meet its objectives. In addition, Pilot's internal architecture, illustrated in Figure 2, is fully in line with the Infinitech Reference Architecture (IRA) following the proposed microservices approach.

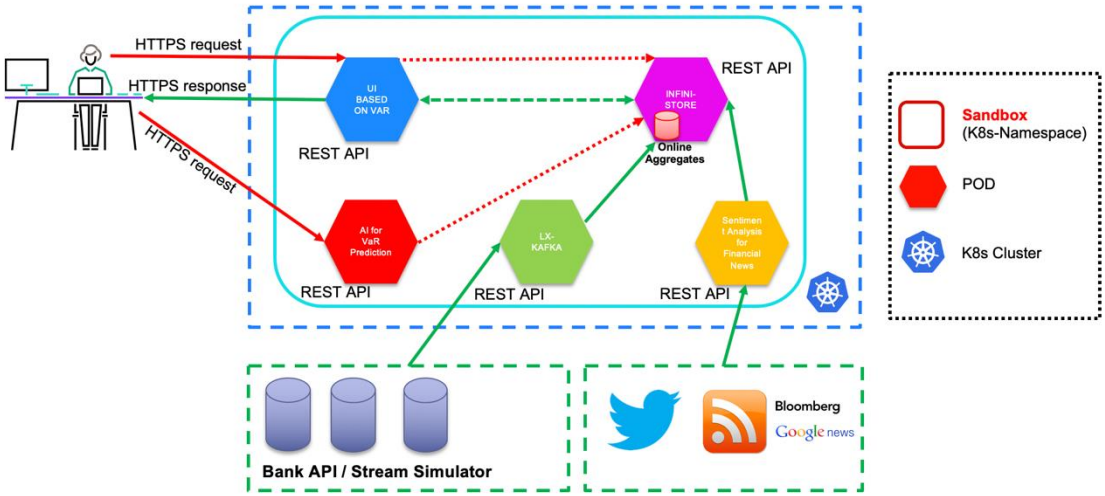

Figure 2 – Pilot #2 Blueprint reference architecture

An overview of the utilized technologies and their current development status is provided in the following Table.

Table 4 – Pilot#2 Components deployment status

Component	Version Control	Packaging	Artefacts' versioning	Architecture	Technological building block	Testbed / Sandbox	TRL	Expected TRL
AI for VaR Prediction	GitLab	Docker	Harbor	Microservice	Analytics (WP5)	Nova / pilot2	6-7	6-7
Sentiment Analysis for Financial News	GitLab	Docker	Harbor	Microservice	Analytics (WP5)	Nova / pilot2	5-6	6-7
LXS-Datastore InfiniSTORE	GitLab	Docker	Harbor	Microservice	Data Management (WP3)	Nova / pilot2	7-8	7-8

LXS-Kafka	GitLab	Docker	Harbor	Microservice	Data Management (WP3)	Nova / pilot2	7-8	7-8
UI based on VaR	GitLab	Docker	Harbor	Microservice	Interface	Nova / pilot2	4-5	5-6

Furthermore, Pilot#2's deployment already follows the INFINITECH DevOps guidelines for CI/CD. Specifically, the source code of Table 4 components and the relevant deployment definitions (Docker-Compose, Kubernetes, and Jenkins YAML files) are stored in the project's GitLab repository. The dedicated Harbor artifacts repository hosts the latest version of the built images of each component, and as mentioned in the introduction, all the components utilized by Pilot#2 are running on the shared NOVA's testbed.

Currently, the Pilot's deployment is partially automated, as illustrated in Figure 3. That is, updates in the source code (i.e., GitLab) automatically trigger the re-build of the respective images hosted in the Harbor repository. However, the instructions for deploying the updated images in the Pilot's reference sandbox are applied manually. Pilot# 2 deployment is partially automated to avoid permanent reservation of computational resources in the testbed. This enables reallocation of the cluster resources to other Pilots when Pilot# 2 does not use them.

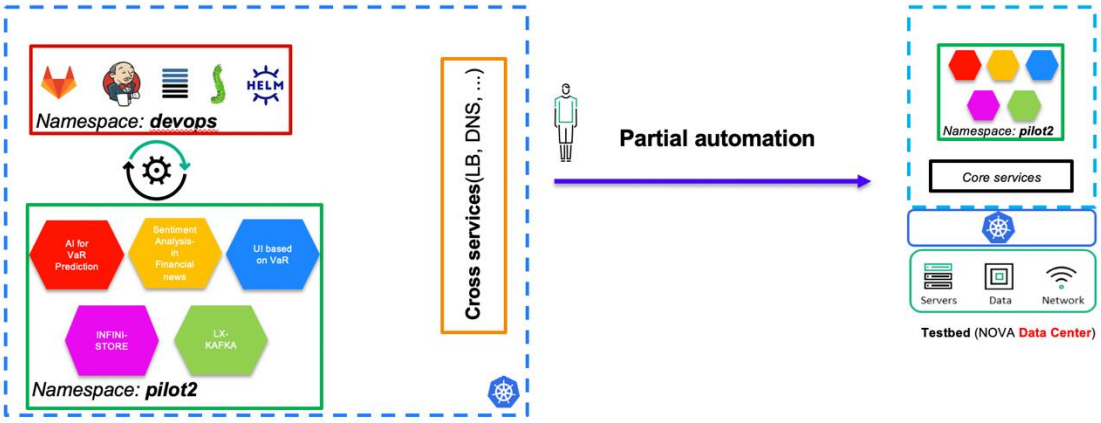

Figure 3 – Pilot#2 Blueprint environment recreation way

The adoption of the INFINITECH way by Pilot#2 application offers numerous business innovations. Namely, the Pilot uses INFINITECH's Analytics and ML libraries to provide quantitative and qualitative risk assessments and, leveraging the project's data management technologies, offers these assessments in real-time. Furthermore, the IRA enables the incorporation of new technologies developed by different partners into the Pilot's workflow with zero downtime. For instance, the sentiment analysis feature incorporated in the second version of the Pilot and offered as a separate micro-service did not cause any side effects in the Pilot's deployment. Accordingly, any updates in one component do not affect operations (e.g., data loss) on the rest. Furthermore, this setup minimizes the required maintenance in the deployed services maximizing at the same time their availability.

From the above subsections, it is obvious that Pilot#2 fulfils all the requirements of INFINITECH reference testbed guidelines while upcoming updates on the Pilot's internal components will not affect these requirements. Table 5 provides the details of the pilot's deployment status, which is in accordance with the project's guidelines.

Table 5 – Pilot#2 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1.Source Version Control	YES	100%	The source code of all the pilot components is placed on the target source version control service (gitlab.infinitech-h2020.eu) within a dedicated group/project.
2. Application packaging	YES	100%	All Pilot's components are followed with a Dockerfile and there is also a docker-compose file implementing the Pilot's application.
3. Artefacts' versioning	YES	100%	The latest version of each component is automatically built as an image and stored in Harbor artifact repository: harbor.infinitech-h2020.eu.
4.Microservices architecture	YES	100%	All Pilot's components are REST APIs and are provided as microservices.
5. Automatic use case deployment	YES	100%	Pilot's source code in GitLab is accompanied by the required Jenkins YAML files for the CI/CD and the Continuous Delivery pipeline is configured.
6. Use of technology components building blocks	YES	100%	Pilot2 leverages the following technology components: 1. AI-for-VaR-Prediction (WP5) 2. Sentiment Analysis for Financial News (WP5) 3. LXS-Datastore (WP3) 4. LXS-Kafka (WP3)
7. Testbed	YES	100%	Pilot is deployed in the NOVA Testbed.
8. Sandbox	YES	100%	There is a dedicated sandbox for the Pilot2 application in the reference Testbed.

3.1.2 Pilot#2 Testbed Guideline Coverage Plan

As stated in the previous subsections, the Pilot's deployment status is already following all the project guidelines, and any advancements in its services do not affect these guidelines. Therefore, the foreseen actions for the third period of the project (beyond M30) are related to extensive testing, code updates, and TRL level advances of the technologies used and not to the development guidelines themselves.

Elaborating on the Pilot's TRL level, it is noted that Pilot's internal components either rely on well-established frameworks used in production or are already in production. For instance, components for analytics tasks (i.e., AI-for-VaR-prediction, Sentiment-Analysis-in-Financial-News) are based on Python frameworks with high TRLs such as NumPy[3], PyTorch[4], SciPy[5], and GluonTS[6]. Accordingly, the used data management technologies (e.g., InfiniSTORE) are extensions of software already available in the market (e.g., LXS datastore). As a result, most of the Pilot's components have already reached their target TRLs shown in Table 3. Moreover, given the advanced

[3] https://numpy.org
[4] https://pytorch.org
[5] https://scipy.org
[6] https://ts.gluon.ai

state of Pilot2 and the planned actions, it is foreseen that the rest of the components (i.e., Sentiment-Analysis-for-Financial-News, UI-based-on-VaR) will have reached their target TRL until M36.

Table 6 – Pilot#2 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End Month
1. Source Version Control	Provide each component's final/updated version that matches the target TRL.	M36
2. Application packaging	Already fulfilled	N/A
3. Artefacts' versioning		
4. Microservices architecture		
5. Automatic use case deployment		
6. Use of technology components building blocks		
7. Testbed		
8. Sandbox		

The following figure reflects Pilot's#2 workplan.

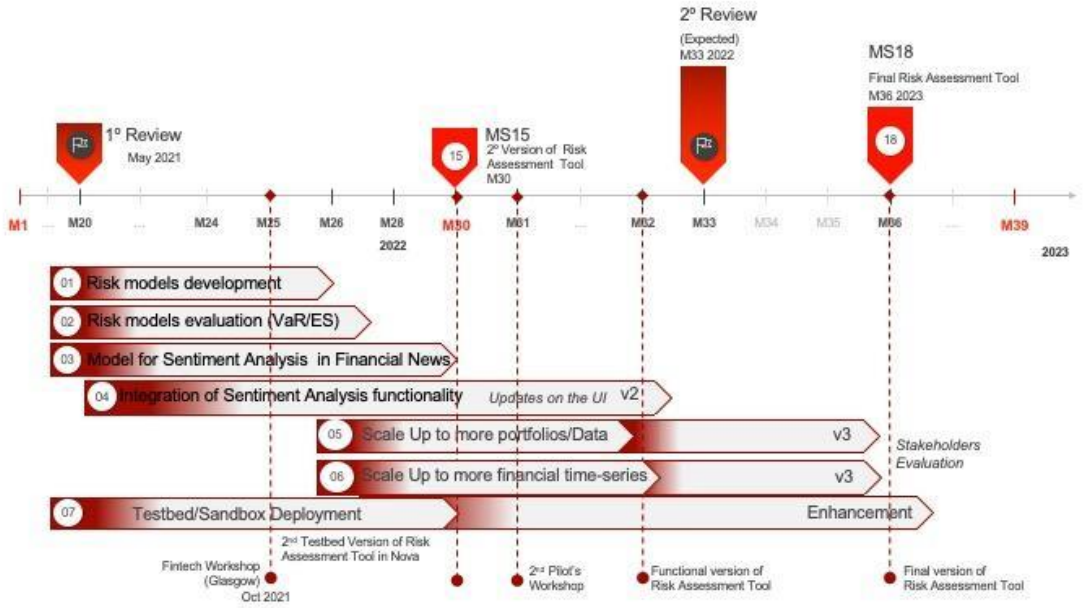

Figure 4 – Pilot# 2 Roadmap

3.2 Pilot #15 – Testbed for Open Inter-Banking

Pilot#15 ("Inter-Banking Open Pilot") aims to leverage Machine Learning and Natural Language Understanding paradigms to implement the prototype of a semantic solution for document management that could tackle the shared business problems related to the complexity of banking texts. The solution will read and analyze large volumes of internal documents of banks in real-time and detect and standardize the involved concepts related

to processes and logistics of the reference bank. This will involve concept taxonomies shared across a wide community of Italian banks as a reference ontology, thus providing a common business glossary. Pilot#15 is currently hosted and deployed on the Testbed blueprint developed according to the pilot requirements. More information on Pilot#15 are documented in Section 2.15 of D7.1. As the project progressed, the performance of the model in terms of accuracy was refined.

3.2.1 Pilot#15 Testbed AS-IS coverage and status vs guideline

The solution integrated into Pilot#15 consists of a use-case deployed in the testbed of the single sandbox loaded on the Kubernetes platform with the name pilot15, according to the following schema:

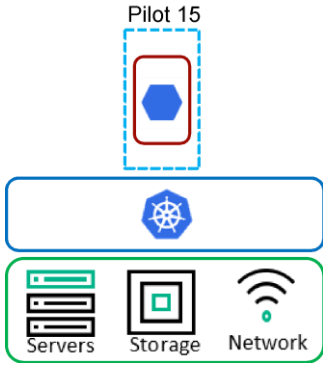

Figure 5 – Pilot #15 Deployment Status

The provided software is implemented in JAVA and through the open-source framework Spring[7], with the Spring Boot variant[8]. The project is composed of three packages, one containing those classes devoted to the startup of the application, one that manages the input text management, and one to summarize and post-process the output of the analysis. The entire project has been loaded on the Infinitech GitLab platform [3], where it is also possible to find the executable JAR files required for the execution of the program on the Kubernetes platform. The Automatic Use Case Deployment is implemented through Jenkins and its confirmation is stored in the above repository (through a dedicated DockerImage) that allows to automatize the construction of the Dockerfile. It allows to automatize the software compile steps, so that the code update in the Gitlab repository starts the pipeline for the creation of the docker image of the project and loads it on the platform harbor [4]. The deployment is realized through a directory in the Blueprint group dedicated to the pilot15 (https://gitlab.infinitech-h2020.eu/blueprint/pilot15) that contains the YAML file for the application deployment. This file contains the path of the Docker image and the POD requirements. Now as of writing 100 CPU cores and a 512MB or RAM are specified.

Table 7 – Pilot#15 Components deployment status

Component	Version Control	Packaging	Artefacts' versioning	Architecture	Technological building block	Testbed / Sandbox	TRL	Expected TRL

[7] https://spring.io
[8] https://spring.io/projects/spring-boot

Client platform for text capture	GitLab	Docker	Harbor	Microservice	Analytics	pilot15	6	7
Application deployment process	GitLab	Docker	Harbor	Microservice	Blueprint	pilot15	6	7

From the above subsections, it is clear that Pilot#15 fulfils all the requirements of INFINITECH reference testbed guidelines while upcoming updates on the Pilot's internal components will not affect these requirements. Table 8 provides the details of the pilot's deployment status, which is in accordance with the project's guidelines.

Table 8 – Pilot#15 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	YES	100%	The source code of all pilot components is placed on the target source version control service within a dedicated group/project.
2. Application packaging	YES	100%	All Pilot's components are followed with a Dockerfile and there is also a docker-compose file implementing the Pilot's application.
3. Artefacts' versioning	YES	100%	The latest version of each component is automatically built as an image and stored in Harbor artifact repository:
4. Microservices architecture	YES	100%	All Pilot's components are REST APIs and are provided as microservices.
5. Automatic use case deployment	YES	100%	Pilot's source code in GitLab is accompanied by the required Jenkins YAML files for the CI/CD and the Continuous Delivery pipeline is configured.
6. Use of technology components building blocks	NO	100%	Pilot15 leverages the following technology components: (*) Document metadata creation by a machine learning system for text classification.
7. Testbed	YES	100%	Kubernetes
8. Sandbox	YES	100%	There is a dedicated sandbox for the Pilot15 application in the reference Testbed.

3.2.2 Pilot#15 Testbed Guideline Coverage Plan

As stated in the previous subsections, the Pilot's deployment status is already following all the project guidelines, and any advancements in its services do not affect these guidelines. Therefore, the foreseen actions for the third period of the project (beyond M30) are related to extensive testing, code updates, and TRL level advances of the technologies used and not to the development guidelines themselves.

Table 9 – Pilot#15 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End Month

1. Source Version Control	Provide each component's final/updated version that matches the target TRL.	M36
2. Application packaging 3. Artefacts' versioning 4. Microservices architecture 5. Automatic use case deployment 6. Use of technology components building blocks	Already fulfilled	N/A
7. Testbed	scale Up to other bank process taxonomies and enhancement of the classification model	M36

The following figure reflects Pilot's#15 workplan.

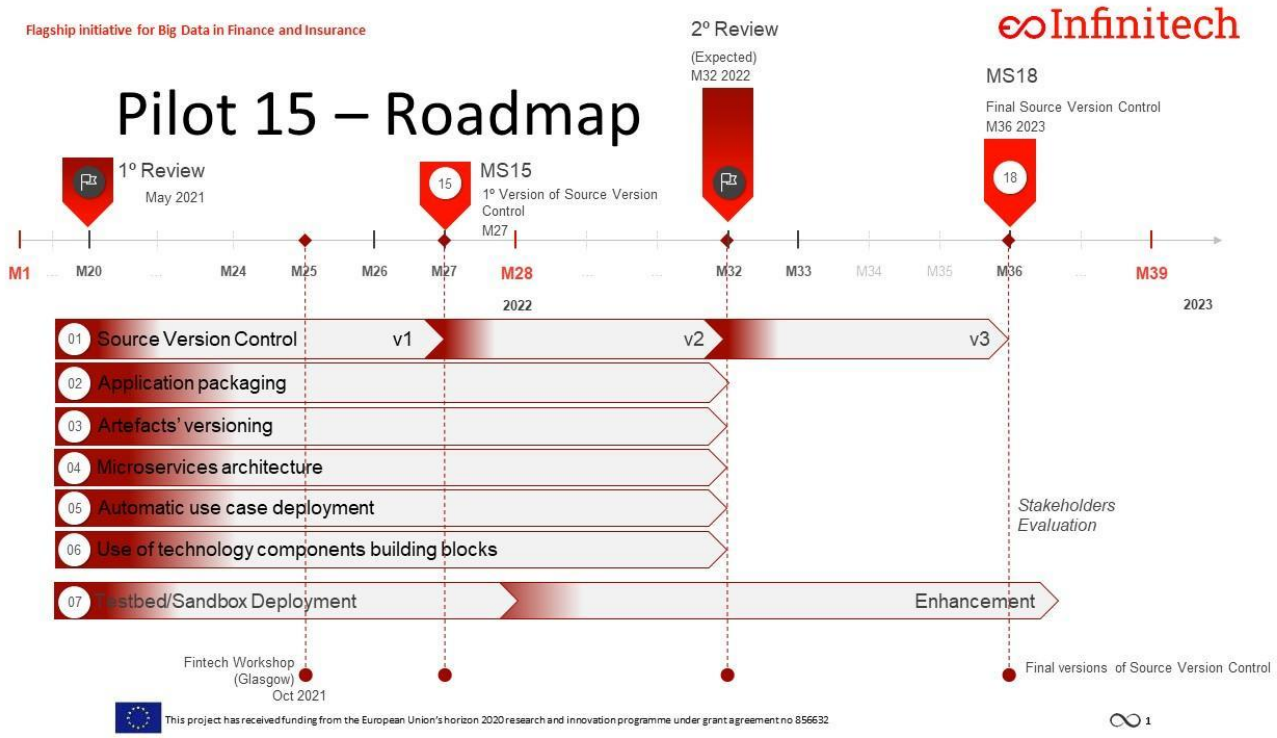

Figure 6 – Pilot# 15 Roadmap

3.3 Pilot #3 – Testbed for Collaborative Customer-centric Data Analytics for Financial Services

Pilot #3 implements KYC/KYB methodologies and uses emerging technologies investigating business innovation opportunities, as well as technology innovation for the banking sector and exploring the ways to reduce constraints that limit the development of new sharing data services. The Pilot participants are primarily financial institutions and organizations, investigating the introduction of data sharing capability to facilitate improvement of core banking and business capability alike the improvement of financial services.

The pilot proposes that KYC/KYB, a service that is well known and extensively used in financial and insurance companies when onboarding new customers, can benefit from the ability to share data securely and effectively between inter-bank departments, banks and also external services. The Pilot looks after identifying data patterns that can be related to unlawful activities and innovate by looking at the potential for fighting against human trafficking activities. KYC/KYB data sharing is a key characteristic for improving the financial sector, particularly now with the advent of FINTECH companies where more people are investing using online platforms making more disruptive businesses, banking sectors need to enable the creation of new products and services.

Pilot #3 leverages innovative INFINITECH technologies/components in order to meet its objectives. The pilot participants collaborate to develop an AI driven capability using KYC/KYB methods and semantic technologies over transactional data generated by the financial activities that identifies money-related profiles based on the data generated. Data profiles then can be associated with human profiles based on their financial activity. These profiles will be built into the Watson AI engine and will be combined with existing technology and data sourced from the TAH human trafficking platform. The results will produce a complete picture of people's profile, people trafficking routes and the corresponding money flows back to the criminal organizations.

The underlying data sharing capability will also introduce the potential of new customer facing capabilities and improve other core banking and business capabilities. The method's interaction or integration of the above capabilities is a key innovation that may have significant impact in terms of effectiveness and efficiency across an entire business ecosystem. Technology is an enabler of these ecosystems but data, process and people also need to be investigated to articulate potential solutions.

Figure 7 shows the Money Flow and Identity Profiles to identify associations to unlawful activity. This diagram is fully in line with the Infinitech Reference Architecture (IRA) following the proposed microservices approach.

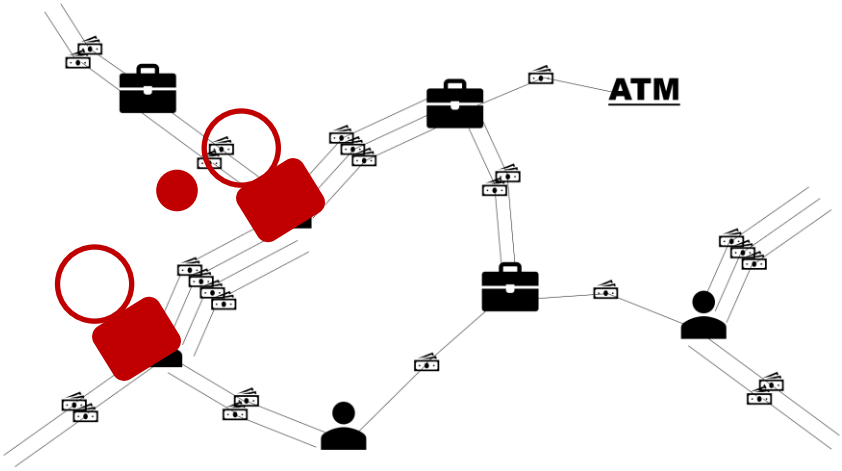

Figure 7 – Pilot# 3 Money Flow and Identity Profiles to identify associations to unlawful activity

The Pilot #3 deployment considers in full BOI infrastructure and security compliance and as possible the INFINITECH DevOps guidelines for CI/CD. Currently, the Pilot's deployment is done as a proprietary host as BOI infrastructure is preparing the infrastructure to migrate the developed components. Additional developments will be deployed in BOI infrastructure and any updates in the source code (i.e., GitLab) will be automatically triggered and re-build the respective images hosted in the git repository. However, the instructions for deploying

the updated images in the Pilot's reference sandbox are applied manually and documented in harbor or MKDocs. An overview of the utilized technologies and their current development status is provided in the following Table.

Table 10 – Pilot#15 Components deployment status/Plan

Component	Version Control	Packaging	Artefacts' versioning	Architecture	Technological building block	Testbed / Sandbox	TRL	Expected TRL
Data Modelling Tool	GitLab	Docker	Harbor or MKDocs	Microservice	Modelling (WP4)	BOI / Pilot3	4-5	6-7
Semantic Engine	GitLab	Docker	Harbor or MKDocs	Microservice	Modleling (WP4)	BOI / Pilot3	5-6	7-8
Data Stream and Mashup Service	GitLab	Docker	Harbor or MKDocs	Microservice	Data Management (WP4)	BOI / Pilot3	5-6	6-7
Typology Analysis for Red Flag Indicators	GitLab	Docker	Harbor or MKDocs	Microservice	Data Management (WP4)	BOI / Pilot3	6-7	7-8
Typology Analysis for Financial News	GitLab	Docker	Harbor or MKDocs	Microservice	Data Management (WP4)	BOI / Pilot3	5-6	7-8
AI driven Service	GitLab	Docker	Harbor or MKDocs	Microservice	UI/UX Interface (WP5)	BOI / Pilot3	4-5	6-7

3.3.1 Pilot#3 Testbed AS-IS coverage and status vs guideline

Pilot #3 target is to build data profiles then can be associated, by use of INFINITECH semantic technologies, to human profiles based on their financial activity. These profiles named Red Flag Typologies will be built into an AI engine and will be combined with existing technology and data sourced from the Traffik Analysus Hub (TAH) human trafficking platform. The expected results are a capability to produce a complete financial profile of people that may incur on illegal activities, trafficking routes and the corresponding money flows back to the criminal organizations. The adoption of the INFINITECH way by Pilot #3 application offers numerous business innovations.

Current Overall Application Scenario(s) for business innovation focuses on:

1) Money flows detection based on transactional data, this is always an interesting topic in the area of finance and banking transactions,
2) The identification of abnormal operations, which in today's banking systems is a trivial activity but the identification and detection of current money data flows and its traceability across different banking entities and financial institutions and organizations is yet a challenge and particularly when those transactions are associated to unlawful operations

3) Detection of potential human trafficking activities, human trafficking is one of the fastest growing crimes in the world today, representing a $150 billion industry, and infiltrating supply chains at many levels.
4) Better understanding in how to fight and disrupt human trafficking crimes and put marked and indicators on transactions and/or operations that can be identified and thus end to the misery suffered by its victims.

The Pilot #3 high level architecture is presented in Figure 7. The Pilot#3 architecture follows the designed INFINITECH Reference Architecture, including onboarding technologies and the WP3-Wp4 and WP5 relevant components.

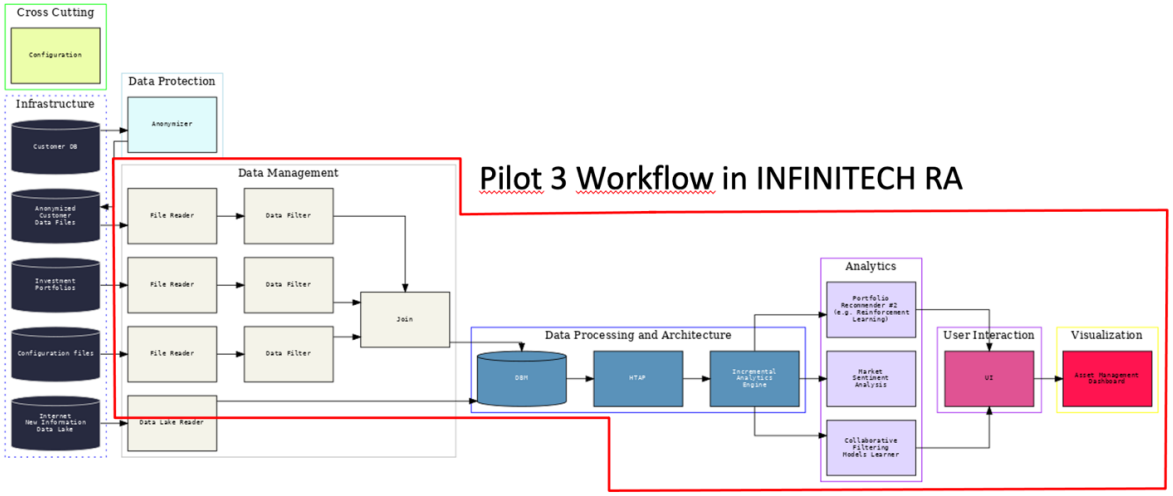

Figure 7 – Pilot# 3 Designed Architecture according to INIFINITECH RA

Pilot #3 has up to date the following on-boarding/Available technology. TAH have developed a unique platform called the Traffic Analysis Hub (TA Hub), which ingests vast amounts of media content from diverse sources and builds an interactive map of people trafficking routes and hotspots. This platform is currently being used by many NGOs, Enforcement Agencies, and Financial Institutions to identify where they can best focus efforts in identifying and exposing the criminal gangs behind the trafficking. The TA Hub prototype runs in a secure IBM Cloud environment that was designed to meet the security needs of these partners, and it includes IBM's Watson AI and other analytical tools that analyze blended data to uncover Trafficking hot spots and routes that have not been evident before. The TAH tools are also pulling in and making sense of open source data, including thousands of daily public news feeds, to augment the data contributed by consortium partners, and to develop predictive capabilities in the future.

Table 11 – Pilot#3 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline	Pilot Testbed AS-IS coverage vs guideline more info	TRL LEVEL
1. Source Version Control	NO	Two new Pilot 3 partners Started officially on M28 (Jan 2022) BOI AML and TAH were incorporated as official partners All previous developments or tests/demos are not yet included in the versioning control We are currently working towards integrating the pilot testbed technologies and have the BOI infrastructure available, thus incorporate the first version of the code.	4-5

2. Application packaging	PARTIAL	The first Semantic Engine Prototype was Implemented and Deployed in Host Server. TAH basics is demonstrated The first Docker version of the SeSA-ME Semantic Engine for Pilot 3 is deployed. Other components will come later.	5-6
3. Artefacts' versioning	PARTIAL	The first financial data sharing service was demonstrated. TAH Red Flags and Initial Typologies Prototyped provide a detailed description of the AS-IS status and progress of Testbed Implementation for the specific guideline	3-4
4. Microservices architecture	NO	Test of current prototypes and Basic Services on SeS-ME and TAH. Undergoing discussions for defining/adopting the INFINITECH Microservice Infrastructure	N/A
5. Automatic use case deployment	PARTIAL	A demonstrator service for Profile Building is deployed FIBO, FIGI, LKIF Data Models are deployed online. INFINITECH Core Data Model is accessible online and machine readable	5-6
6. Use of technology components building blocks	NO	Currently undergoing analysis for extending other components/technologies Plans for extending other components/technologies from WP3 and WP5	N/A
7. Testbed	NO	Deployed locally at Home Servers, undergoing BOI infrastructure preparation BOI AML an TAH were incorporated as official partners in Jan 2022	N/A
8. Sandbox	NO	The first Docker version of the Semantic Engine Prototype was deployed. An improved version is ongoing. Other components will come later.	5-6

3.3.2 Pilot#3 Testbed Coverage Plan

During the coming period and for the next year of the project Pilot #3 is planning to execute a series of activities and innovations which include new services and implementation of demonstrators that once deployed in the plot infrastructure will show the core functionalities targeted for the pilot.

The objectives of the targeted innovations are:

- Develop custom AI models, based on Natural Language Understanding, to identify human trafficking related money laundering typologies derived from the incident reports included in the Traffik Analysis Hub secure Human Trafficking\Modern Slavery data sets
- Provide financial institutions with an advanced pattern matching algorithm based prototype intended to identify where red-flag transaction attributes may be indicating the repeat of historically observed human trafficking scenarios sourced in the Traffik Analysis Hub secure Human Trafficking\Modern Slavery data sets
- Assist financial institutions in addressing bank side challenges on data sharing and data security, based on the principle of data privacy by design, by developing technology and standards to facilitate and streamline the secure sharing of Personal & Sensitive information leveraging advanced encryption techniques within a Blockchain based auditable ledger.
- Provide financial institutions with natural language query options for the Human Trafficking\Modern Slavery data included in the Traffik Analysis Hub data platform, and a recommendation engine based on

combining indicators from historical financial indicators with opensource intelligence data, providing high quality leads to enable financial institutions to perform targeted investigations

- Develop technology to forecast a large variety of spatial-temporal signals, which enable financial institutions to upload and configure models with Human Trafficking specific data. Using techniques to exploit the use of multi-modal context data to identify data indicators which most influence the domain specific spatial-temporal phenomena and generate more accurate forecasts with AI generated natural language forecast explanations.
- Develop and test an application oriented to human trafficking profiles based on financial transaction patterns leveraging geospatial, temporal and attribute driven analytics specifically focused on the investigative requirements of financial institutions for entity identification, identity resolution and criminal network hotspot analysis.

Pilot #3 will continue the evolution of the INFINITECH WAY and target to fulfil all the requirements of INFINITECH reference testbed architecture and guidelines while upcoming updates on the Pilot's internal components should not affect these requirements.

Table 12 – Pilot#3 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month	Expected TRL level
1. Source Version Control	Gitlab Preparation and Initial Source Code Deployed Testbed Deployment, Full Specifications and Documentation	M30 M31	6-7
2. Application packaging	Red Flag Typologies Semantic Engine Traffik Analysis Hub (TAH)	M30	7-8
3. Artefacts' versioning	Semantic Engine V1 Traffik Analysys Hub Enhanced (TAH+) V1	M31	6-7
4.Microservices architecture	Red Flag Typology Service(s) SeSA-ME Mashup Service(s) TAH+ Analytic Service(s)	M31	7-8
5. Automatic use case deployment	- Traffik Analysis Services - Use of markers and indicators on transactions.and services - Money flows detection - Identification of Traffik anormal operations Services - Detection of potential human trafficking activities	M32 M32 M32 M36 M36	7-8
6. Use of technology components building blocks	Data Modeling Tools TAH Semantic Engine Distributed Consent	M31 M31 M31 M33	6-7
7. Testbed	BOI Configuration & requirements. BOI Initial Deployment Use Cases and Services/Experiments Test and Validation	M30 M31 M32 M33	7-8
8. Sandbox	Specification Testing Deployment Validation	M30 M31 M32 M33	7-8

The figure 9 shows the planned overall roadmap diagram of the pilot's workplan focused on this year activities, the planned diagram includes, testbed design and deployment of services, the stakeholder activities and the testing and validation process aligned with the adoption of the INFINITECH Way.

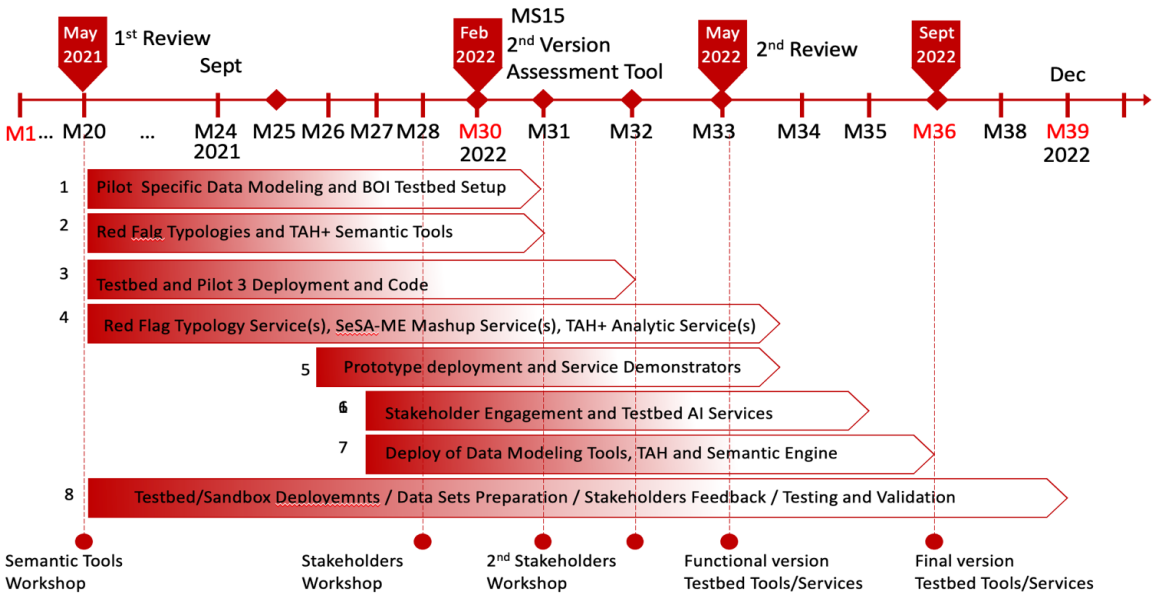

Figure 9 – Pilot# 3 Roadmap

3.4 Pilot #4 – Testbed for Personalized Portfolio Management

Pilot #4 is developing and adapting within SaaS-based Prive Managers Wealth Management Platform a Portfolio Construction and Optimization algorithm (Prive Optimizer or "AIGO"), as well as improving and expanding its capabilities as an artificial intelligence engine to support better and personalized investment propositions for retail clients. The Testbed for Pilot# 4 is hosted on an infrastructure owned by PRIVE Technologies Amazon Cloud in AWS, which will also be used for Pilot# 4 operation.

3.4.1 Pilot#4 Testbed AS-IS coverage and status vs guideline

Pilot#4 operates Software as a Service (SaaS) model. The SaaS platform runs in multiple data centres with a high availability setup over multiple availability zones. Pilot#4 has the following environments: DEV, SIT, UAT and PROD. Data can be transferred via SFTP, FIX or API. Most Prive APIs are REST, but GraphQL is supported too. The architecture is based on microservices, while its deployment managed kubernetes cluster on AWS. Since Pilot#4 provides API via SaaS, it has met its deployment targets. Pilot 4 compliance to INFINITECH Reference (Blueprint) Testbed Guidelines is described below:

Table 13 – Pilot#4 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline	Pilot Testbed AS-IS coverage vs guideline more info
1. Source Version Control		Prive uses its own source code control service

	NO	
2. Application packaging	YES	Deployed on Prive's cloud, Software as a Service model, AWS or GCP
3. Artefacts' versioning	NO	Not Applicable as PRIVE provides API via Software as a Service; APIs follow best practices wrt versioning (no breaking changes, versioning, deprecation, decommission).
4. Microservices architecture	YES	Deployed on Prive's cloud, Software as a Service model, AWS Kubernetes or GCP Kubernetes
5. Automatic use case deployment	NO	Not Applicable as PRIVE provides API via Software as a Service; Prive applies CI/CD internally
6. Use of technology components building blocks	NO	Not Applicable as PRIVE provides API via Software as a Service; Prive's system is a multi-tenant Software as a Service API, hence this requirement can be met by configuring multiple tenants; Use case activation via configuration
7. Testbed	NO	Not Applicable as PRIVE provides API via Software as a Service.
8. Sandbox	NO	Not Applicable as PRIVE provides API via Software as a Service; Prive's system is a multi-tenant Software as a Service API, hence this requirement can be met by running multiple tenants; Sandbox is a separate non-production environment

3.4.2 Pilot#4 Testbed Guideline Coverage Plan

As Prive is operating in the SaaS model, the above AS-IS items also reflect the TO-BE status. Regarding Fitness Factor/s & API/s Development, API Access was provided by ReportBrain, while implementation is ongoing. UI Development, based on Potential Real Customer Requirements, has started by means of the first mock-ups development.

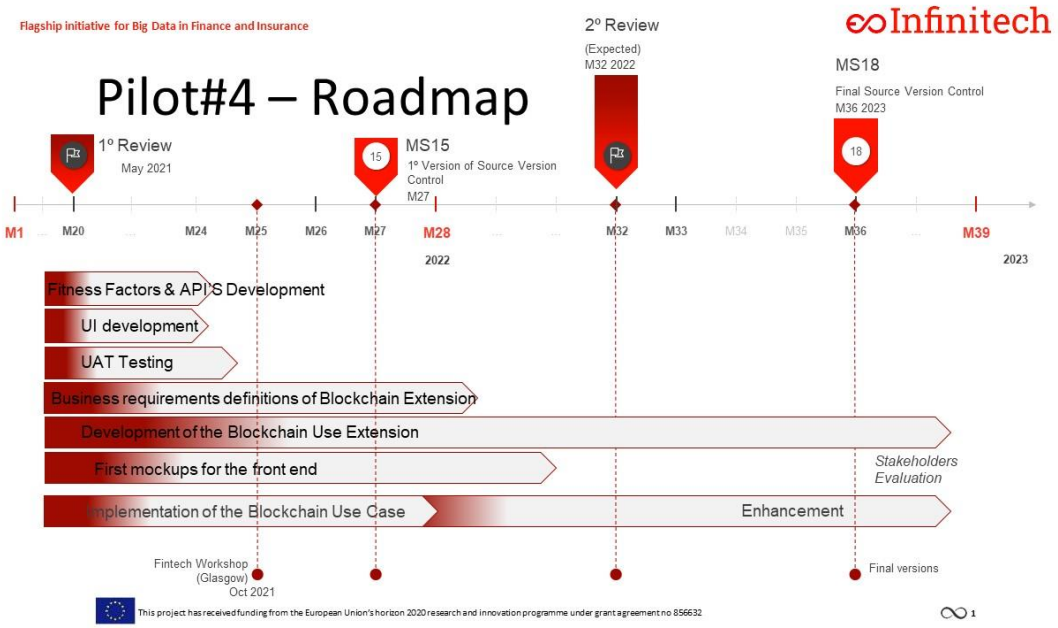

Figure 10 – Pilot# 4 Roadmap

3.5 Pilot #5b – Testbed for Business Financial Management (BFM) tools delivering a Smart Business Advice

BOC and UPRC, the main drivers of Pilot#5b, work on developing an AI based Business Financial Management (BFM) toolkit that assists Small Medium Enterprises (SMEs) clients of the Bank of Cyprus (BOC). In particular, the finalized BFM tools will be comprised of several services such as:

- a Transaction Categorization service, delivering powerful auto-categorization to tag income and expense transactions by utilizing a continuous learning mechanism,
- a Cash Flow (CF) Prediction engine delivering holistic Inflow and Outflow prediction over a 3month prediction horizon,
- a Budget Prediction engine coupled with the Cashflow engine that allows setting easily budget targets through the provision of suggested target values as well as simple budget monitoring
- a KPI engine leading to valuable insights on the SME financial health and performance,
- a transaction monitoring engine that watches out for potential anomalies and savings.
- a Invoice Processing engine that generates meaningful invoice background info to other components (e.g., Cash Flow Prediction) and SMEs. This applies if respective data can be obtained
- a Benchmark engine supporting comparisons to other SMEs with similar profiles

Each of the above-mentioned services/engines will be a different service running on a different node in the same cluster/sandbox. This is mandatory as most of them will share the same Infinistore, which will be the core artefact of the whole implementation. In addition, other components such as APIs and data collectors are developed and may be leveraged as supporting services.

Pilot#5b started as one of Infinitech's blueprint pilots, paving the way towards the Infinitech way of standardizing the deployment process. As a result, its deployment status is still in progress. Specifically, Pilot#5b is currently deployed and keeps developing in the Blueprint AWS testbed, while it should be migrated to the BOC's private AWS infrastructure, which is the proposed pilot's reference testbed. To this end BOC, with the support of UPRC and WP6 partners is doing internal work, including legal and security assessments to purchase and leverage a private AWS cloud infrastructure.

Till now, the development and deployment of 3 of the Pilot's internal components (i.e., transaction categorization, cashflow prediction, benchmarking) along with the Infinistore and a pilot specific API is completed while the other services are under development as documented in D7.7.

Pilot#5b leverages both core INFINITECH technologies/components and pilot-specific ones in order to meet its objectives. In addition, Pilot's internal architecture, illustrated in Figure 8, is fully in line with the INFINITECH Reference Architecture (IRA) following the proposed microservices approach.

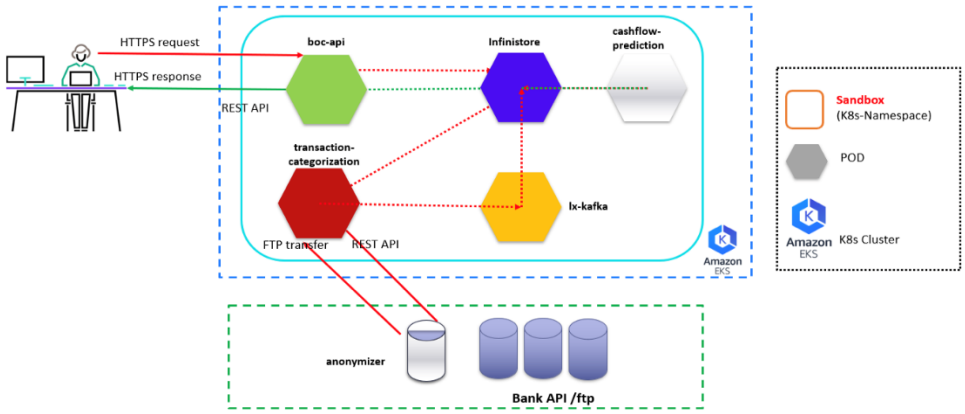

Figure 11 – Pilot# 5b Blueprint reference architecture

An overview of the utilized technologies and their current development status is provided in the following Table.

Table 14 – Pilot#5b Components deployment status

Component	Version Control	Packaging	Artefacts' versioning	Architecture	Technological building block	Testbed / Sandbox
Transaction categorization	GitLab	Docker	Harbor	Microservice	Analytics (WP5)	Blueprint / pilot5b
Cashflow prediction	GitLab	Docker	Harbor	Microservice	Analytics (WP5)	Blueprint / pilot5b
Benchmarking	GitLab	Docker	Harbor	Microservice	Analytics (WP5)	Blueprint / pilot5b
LXS-Datastore InfiniSTORE	GitLab	Docker	Harbor	Microservice	Data Management(WP3)	Blueprint / pilot5b
LXS-Kafka	GitLab	Docker	Harbor	Microservice	Data Management(WP3)	Blueprint / pilot5b
Boc-api	GitLab	Docker	Harbor	Microservice	Interface	Blueprint / pilot5b

Pilot#5b following the respective INFINITECH CI/CD process and also taking into consideration the EBA 2017 guidelines regarding outsourcing banking data to cloud, is fully aligned with the INFINITECH way. Specifically it uses INFINITECH's Datastore and other pilot specific Analytics components and ML libraries to provide the pilot specific analytics tasks. Furthermore, the IRA enables the incorporation of new technologies developed by different partners into the Pilot's workflow with zero downtime. That is, updates in the source code (i.e., GitLab) automatically trigger the re-build of the respective images hosted in the Harbor repository. However, the instructions for deploying the updated images in the Pilot's reference sandbox are applied manually. That means

that from CI/CD process, the CD is triggered manually mainly for debuting reasons as the development of some of the components are still in progress, focusing on continuous delivery.

Specifically, the source code of Table 11 components and the relevant deployment definitions (Docker-Compose, Kubernetes, and Jenkins YAML files) are stored in the project's GitLab repository. The dedicated Harbor artifacts repository hosts the latest version of the built images of each component, and as mentioned in the introduction, all these components utilized by Pilot#5b are running on the dedicated Blueprint AWS testbed. While, every component is deployed in a Pod within the cluster with specific features (e.g. the capability of auto-scaling when needed in terms of the demand). Thus, as a sandbox is defined, all the components deployed under the same namespace allow the interaction and connection between them.

Bank of Cyprus (BoC) is working on purchasing a testbed based on the AWS cloud computing services. The pilot's cloud infrastructure is being developed as a blueprint testbed, with other pilots of the INFINITECH project utilizing similar cloud solutions as the one being established.

3.5.1 Pilot#5b Testbed AS-IS coverage and status vs guideline

Regarding the pilot-specific services/components are developed leveraging stable and well-known libraries and frameworks. All the components are based on Python frameworks with high TRLs such as NumPy[9], PyTorch[10], SciPy[11], GluonTS[12], LightBoost, Scikit and Tensorflow. Accordingly, the used data management technologies (e.g., InfiniSTORE) are extensions of software already available in the market (e.g., LXS datastore). As a result, Pilot#5b specific components have reached high TRLs ranging from 2 to 7, however at the time operating at the shared project testbed, thus not including the TRL Level in the table below which shall be measured once all progress has migrated to the bank's own testbed.

Table 15 – Pilot#5b Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info	TRL LEVEL
1. Source Version Control	YES	100%	INFINITECH WAY of deployment	-
2. Application packaging	YES	100%	INFINITECH WAY of deployment	-
3. Artefacts' versioning	YES	100%	INFINITECH WAY of deployment	-
4. Microservices architecture	YES	100%	INFINITECH WAY of deployment	-
5. Automatic use case deployment	YES	100%	INFINITECH WAY of deployment	-
6. Use of technology components building blocks	YES	100%	INFINITECH WAY of deployment	

[9] https://numpy.org
[10] https://pytorch.org
[11] https://scipy.org
[12] https://ts.gluon.ai

7. Testbed	YES	100%	INFINITECH WAY of deployment	-
8. Sandbox	YES	100%	INFINITECH WAY of deployment	2

3.5.2 Pilot#5b Testbed Guideline Coverage Plan

As stated in the previous subsections, the Pilot's deployment status regarding the Blueprint Testbed is already following all the project guidelines. This shall not be affected by the migration to the BOC private testbed. In addition, the effort will be placed on completing the rest analytic services, an activity not affecting the relevant guidelines. Therefore, the foreseen actions for the third period of the project (beyond M30) are related to the testbed migration and services development and testing. The main focus has currently shifted to completing all the legal, technical and business requirements connected to the acquisition and operation of the AWS testbed by the Bank of Cyprus, expecting the completion of all processes within the following months.

Table 16 – Pilot#5b Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End Month
1. Source Version Control 2. Application packaging 3. Artefacts' versioning 4. Microservices architecture 5. Automatic use case deployment	Already fulfilled	N/A
6. Use of technology components building blocks	5/10 completed Still remaining (KPI engine, Transaction Monitoring,	-
7. Testbed	1 /2 Done, Migration to the BOCs private testbed needed	tbd
8. Sandbox	Done, Migration to the BOCs private testbed needed	-

The following figure reflects Pilot's#5b workplan.

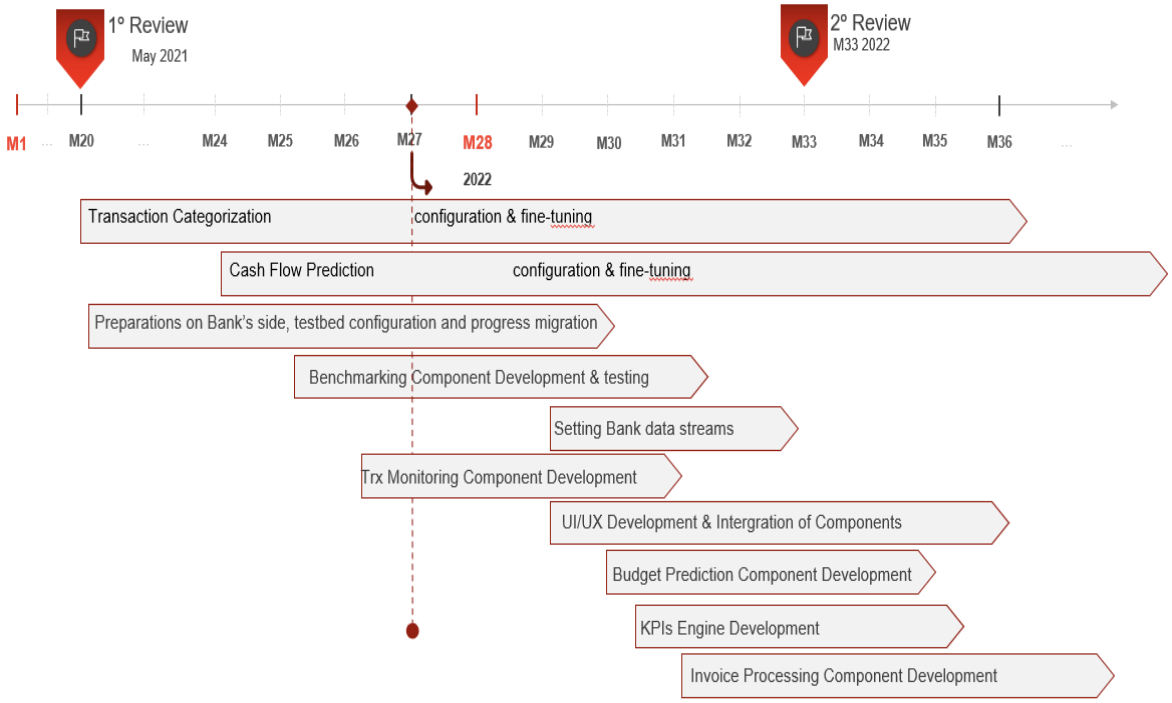

Figure 12 – Pilot# 5b Roadmap

3.6 Pilot #6 – Testbed for Personalized Closed-Loop Investment Portfolio Management for Retail Customers

Pilot# 6 ("Personalized Closed-Loop Investment Portfolio Management for Retail Customers") is managed by NBG. Large customer datasets and large volumes of customer-related alternative data sources (e.g., social media, news feeds, on-line information) will be used to feed ML/DL algorithms. The aim of Pilot# 6 is to create personalized investment recommendations available for all Retail Customers and not only to the highly affluent through the development of algorithms that aimat Customer profiling and categorization according to their intention to invest, based not only in questionnaire input but also on transactional activity. The goal is to create a service, available to financial advisors, which not only examines each Customer's transactional activity but also takes into account similarities and patterns among Customers. Pilot#6 from a deployment point of view, namely in terms of Testbeds (infrastructure) and Sandboxes (components), is treated as Incumbent Testbeds and Sandboxes. Pilot# 6 will have its own infrastructure and technology, which in principle could be different from all the others and even from the Reference (Blueprint) Testbed implementation. At this time point, we are working on Kubernetes deployment. Cloud Infrastructure deployment will be based on a Private MS Azure account deployment being used for Pilot# 6. Below you may find the respective blueprint as it will be implemented for Pilot #6:

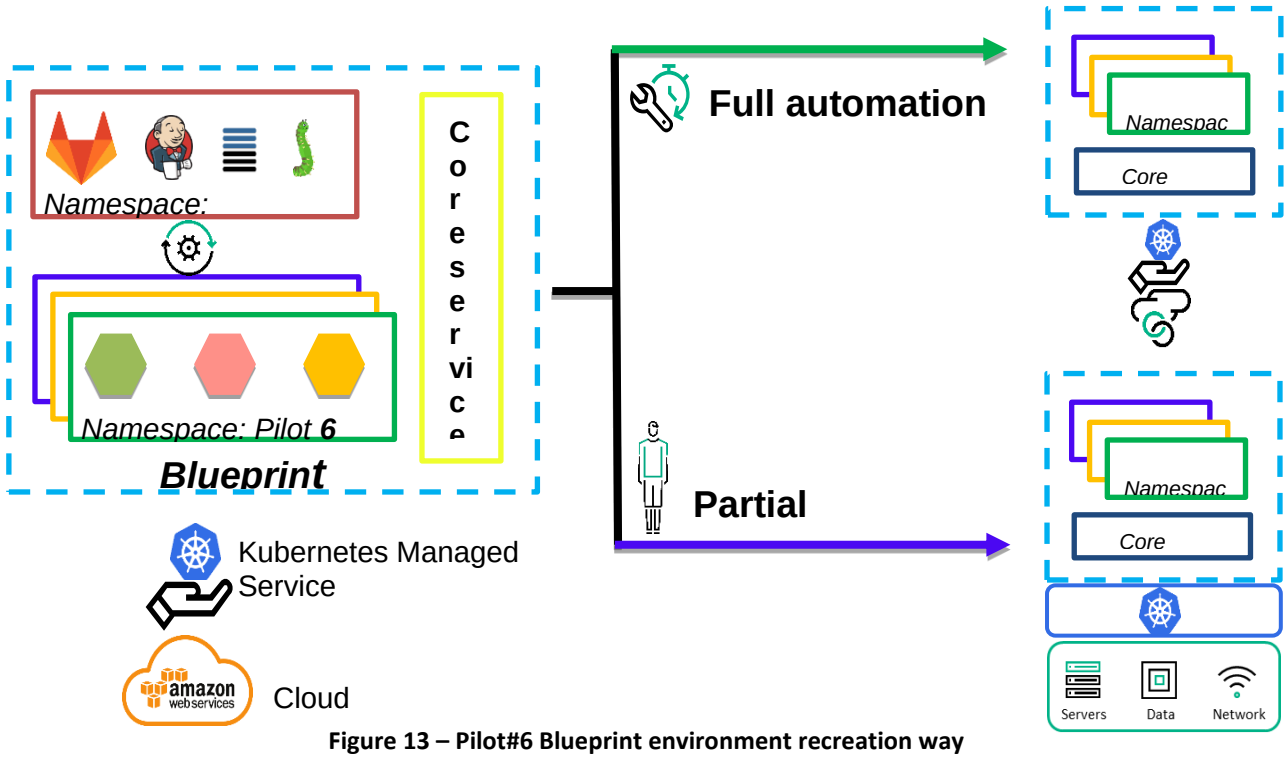

Figure 13 – Pilot#6 Blueprint environment recreation way

3.6.1 Pilot#6 Testbed AS-IS coverage and status vs guideline

Pilot# 6 testbed is hosted on MS-Azure private cloud infrastructure provided by NBG, as part of the infrastructure managed from NBG Group IT division. Below Pilot# 6 response for adoption of main guidelines of INFINITECH Reference (Blueprint) Testbed Guidelines is provided.

Table 17 – Pilot#6 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	NO		Currently developed artefacts are deployed using private source version control service and not INFINITECH GitLab. As NBG will not disclose AI algorithms developed as part of the project a pre-compiled libraries/binary GitLab deployment will be followed.
2. Application packaging	NO		So far, the applications are being built as separate components.
3. Artefacts' versioning	NO		Currently developed artefacts are not published on INFINITECH Harbor artifact repository.
4. Microservices architecture	PARTIAL	50%	All the components being developed as part of the project are already or will be deployed following microservices approach and Kubernetes deployment.
5. Automatic use case deployment	PARTIAL	50%	The CI/CD will be configured in terms of Jenkins file. Not yet finalized.
6. Use of technology components building blocks	YES	100%	The pilot utilizes the following tech tools: Infinistore (WP3), Data Collection (WP5).
7. Testbed	PARTIAL	50%	The pilot is already being deployed using MS-Azure infrastructure provided from NBG. Kubernetes orchestrator is under design and deployment strategy definition from NBG Group Cloud Team.
8. Sandbox	PARTIAL	50%	The pilot's sandbox is already deployed using MS-Azure infrastructure provided from NBG, usage of Kubernetes namespace will be used, as long as the Kubernetes Orchestrator deployment strategy and Kubernetes Cluster will be decided and deployed from NBG Group Cloud Team.

3.6.2 Pilot#6 Testbed Guideline Coverage Plan

The Testbed Pertinent Storage deployment for Pilot#6 is discussed internally with IT partners in order to be modified to include Kubernetes containers methodology in accordance with INFINITECH strategy. The Testbed Enhancement - Kubernetes Deployment is planned to be integrated at the end of M30, when the modifications of Testbed Deployment will be finalized.

Table 18 – Pilot#6 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End Month
1. Source Version Control	NBG contribution will be datasets used for artefacts, stored in Marketplace until the end of M30. TBD if there is going to be a contribution to gitlab.	TBD

2. Application packaging	There is an open procedure with CrowdPolicy about the GUI that will offer graphical representation. The outcome of this will verify the need of Docker containers.	M30
3. Artefacts' versioning	TBD if there is need to contribute to the INFINITECH Harbor, since the datasets will have been already uploaded to the Marketplace	TBD
4. Microservices architecture	Microservices such as LXC database & UBITECH components have already been used. Kubernetes deployment will have been finalized until the end of M30.	M30
5. Automatic use case deployment	NBG will discuss technical details about this topic with the technology providers of Pilot# 6 and provide estimates about this deployment respectively.	TBD
6. Use of technology components building blocks	Already fulfilled	N/A
7. Testbed	Kubernetes is planned to be fully deployed until M30. University of Glasgow is already in charge.	M30
8. Sandbox	Kubernetes is planned to be fully deployed until M30. University of Glasgow is already in charge.	M30

The following figure reflects Pilot's#6 workplan.

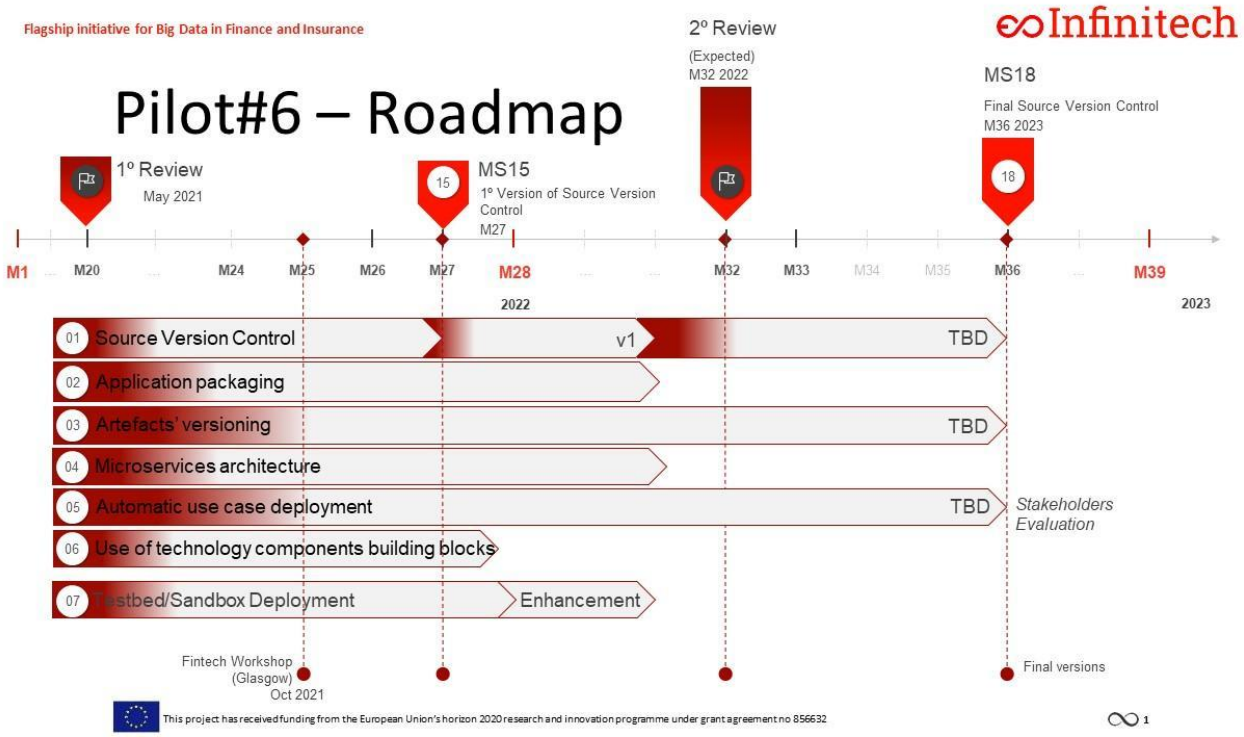

Figure 14 – Pilot#6 Roadmap

3.7 Pilot #7 – Testbed for Avoiding Financial Crime

Pilot#7 - Avoiding Financial Crime is managed by CXB, aiming to improve the detection of Financial Crime using refreshed customer data and AI based analysis of customers 'transaction behaviour. Due to the restrictions within the on-premise environment, only a partial automation can be achieved within P#7. This means:

- Integration of Pilot into INFINITECH CI/CD ecosystem i.e., the INFINITECH blueprint server.
- A dedicated Kubernetes environment for the pilot will be deployed and configured appropriately as testbed within the CXB test & innovation environment, e.g., the CXB GarageLab.
- Within this testbed the pilot's use case is deployed in a sandbox with the pilot's namespace.
- Within this testbed the pilot's use case is deployed in a sandbox with the pilot's namespace. The specific way of deployment is under investigation

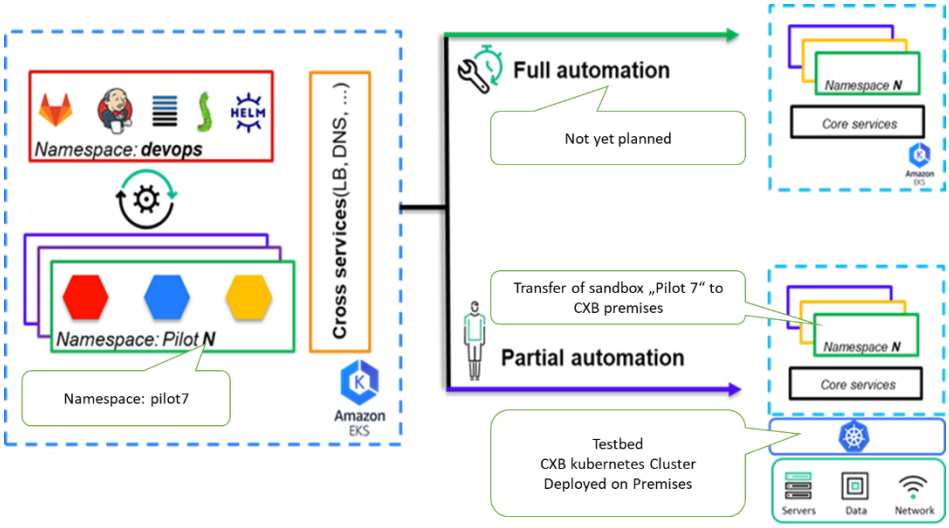

Figure 15 – Pilot#7 Blueprint environment recreation way

3.7.1 Pilot#7 Testbed AS-IS coverage and status vs guideline

For Pilot#7 the INFINITECH adoption has very clear benefits, the most notable is the flexibility in terms of adoption and personalization, which are crucial when deploying AI models to detect new patterns and time is vital. Apart from flexibility, the fact that INFINITECH is built in modules provides a set of capabilities that can be adapted depending on particular necessities, therefore the bank is able to choose which tools will be necessary and take advantage of them in a very easy way. Based on Pilot#7 deployment, the compliance to INFINITECH Reference (Blueprint) Testbed Guidelines is described below:

Table 19 – Pilot#7 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info	TRL LEVEL
1. Source Version Control	PARTIAL	30%	The major source used within the pilot is related to the AI-Model scoring fraudulent actions requesting instant loans. The development of the model at FTS is ongoing for optimizing accuracy and explainability and sources	**3**

			are part of the regular FTS source control system based on an internal gitlab. Sources will be provided in the INFINITECH gitlab in a further step.	
2. Application packaging	PARTIAL	10%	The module is prepared to be integrated in a docker container.	**2**
3. Artefacts' versioning	NO	0%	For the sake of a simpler development this has been planned when a higher accuracy has been reached.	
4. Microservices architecture	PARTIAL	10%	The deployment of the testbed and the sandbox has been specified. Deployment has been planned (see below). Due to a single use case with static data the focus is currently on optimizing accuracy and preparing the testbed	**2**
5. Automatic use case deployment	PARTIAL	10%	The pilot's deployment pipeline for the blueprint cluster is under development.	
6. Use of technology components building blocks	PARTIAL	25%	The required modules supporting the use case have been identified. The specific way of instantiation is under evaluation.	**2**
7. Testbed	PARTIAL	50%	Setting up a Kubernetes cluster on CXB premises, e.g. GarageLab, has been scheduled	**3**
8. Sandbox	PARTIAL	50%	As the pilot consists of just one use case the sandbox is more or less defined specifying the namespace of the pilot: pilot7	**3**

3.7.2 Pilot#7 Testbed Guideline Coverage Plan

The future steps for Pilot#7 in order to be compliant with INFINITECH Reference (Blueprint) Testbed Guidelines are described in the following Table.

Table 20 – Pilot#7 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End Month	Expected TRL level
1. Source Version Control	Improve accuracy of model and publish a 2nd version in the INFINITECH development environment. Update regularly with new versions The development of the model utilizes the Fujitsu internal github. This way source version control is ensured. A stable model will be provided on the INFINITECH gitlab and version control will be applied. Instructions about how to build Docker container images will be placed in the project.	**March 2022 (M30)** **May 2022 (M32)**	**6**
2. Application packaging	The model is provided as packaged application in a docker container; Wrap the model in a docker container as microservice.	**May 2022 (M32)**	**5**

	Implement a separate docker containerized lean visualization in case ENG tool is not applicable	**July 2022 (M34)**	
3. Artefacts' versioning	The most relevant application artefacts are the synthetic datasets and the AI model. It is planned to publish those on the INFINITECH artifact repository when an appropriate level of accuracy has been validated.	**July 2022 (M34)**	**5**
4. Microservices architecture	Define interfaces and develop the docker image of the AI model using the INFINITECH ML/DL library The use case application consisting of the AI model and a visualization – each following a services approach – will be deployed at a Kubernetes cluster at CXB	**May 2022 (M32)** **July 22 (M34)**	**5**
5. Automatic use case deployment	The use case application will be deployed on the blueprint cluster for a transfer to CXB's on premise environment	**July 22 (M34)**	**5**
6. Use of technology components building blocks	Data Collection and Visualization modules will be defined and configuration will be specified. Clarify the tools' capabilities and interfaces with respect to the specific use case deployment. Specify usage and integration. Develop deployment pipeline for INFINITECH blueprint server. Tools under investigation are, Anonymization, INFINISTORE, Data Collection, Visualization	**March 2022 (M30)**	**4**
7. Testbed	A Kubernetes cluster will be deployed on CXB's premises as testbed for application of the use case with synthetic and real data	**April 2022 (M31)**	**5**
8. Sandbox	As the pilot consists of just one use case the sandbox is more or less defined specifying the namespace of the pilot. Transfer the sandbox from INFINITECH blueprint server to CXB Testbed and configure it.	**July 2022 (M34)**	**5**

The following figure reflects Pilot's#7 workplan.

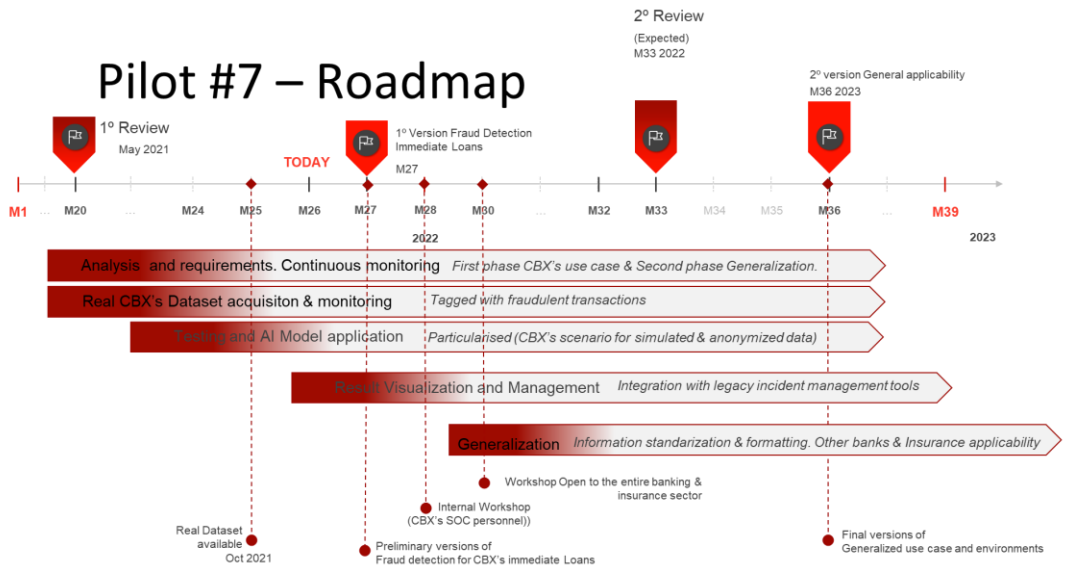

Figure 16 – Pilot#7 roadmap

3.8 Pilot #8 – Testbed for Platform for Anti Money Laundering Supervision

The Pilot# 8 develops a platform named **PAMLS (Platform for AML Supervision)** with several tools to enhance and improve Bank of Slovenia (hereinafter: BOS) AML risk-based supervision. Main tools within PAMLS are Risk assessment tool and Screening tool.

Risk assessment tool is fully deployed on internal JSI servers for testing and development purposes and fully deployed on BOS testbed. Testbed deployment is fully functional and operational. Deployment on BOS testbed is provisioned by date tagged Docker images.

Screening tool is fully deployed on JSI internal servers for development purposes with pseudo-anonymized historical data. Testbed deployment runs on the same hardware as Risk assessment tool and is packaged into multiple Docker containers for each of the components. Testbed deployment is currently focused on historical pseudo-anonymized data that can be manually explored and explained to produce more labeled data points. Containers are prepared in such a way that an independent production environment can be run simultaneously.

Based on the technological choices of INFINITECH project, the reference (Blueprint) testbed has been created on BOS infrastructure. Due to the delicate nature of data involved in both Screening tool and Risk assessment tool, BOS testbed is only accessible physically and external connections are limited to data input/exports. Components deployed on testbed (or BOS data importing infrastructure) are provided as prebuilt and versioned self-sufficient Docker images.

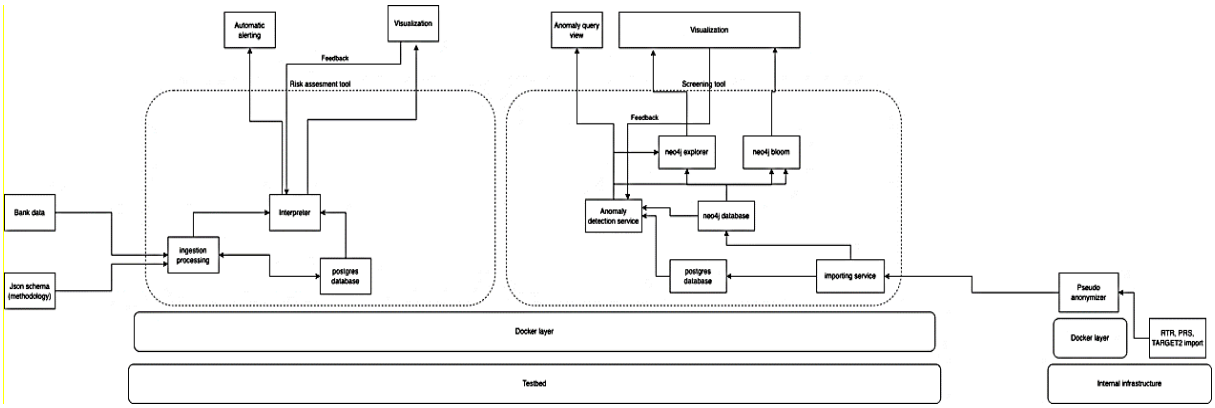

Figure 17 – Pilot#8 Docker images

3.8.1 Pilot#8 Testbed AS-IS coverage and status vs guideline

BOS testbed deployment follows Infinitech principles as described in the following table.

Table 21 – Pilot#8 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	PARTIAL	80%	Existing repos need to be checked for non public information
2. Application packaging	YES	90%	All components (except for Neo4j database) were manually packed as Docker images to deploy them on BOS infrastructure.
3. Artefacts' versioning	PARTIAL	70%	Clear repos and provide automatic packaging and upload them
4. Microservices architecture	PARTIAL	70%	No Kubernetes deployment
5. Automatic use case deployment	PARTIAL	60%	Provide automatic deployment for all but Pseudoanonymizer
6. Use of technology components building blocks	YES	95%	Components are pilot agnostic (Pseudoanonymizer and screening tool were tested on unrelated data)
7. Testbed	YES	90%	No Kubernetes, deployment is manual due to security measures
8. Sandbox	YES	85%	Dockerfiles are deployed on testbed for all provided components

3.8.2 Pilot#8 Testbed Guideline Coverage Plan

The future steps for Pilot#8 are described in the following Table, while the diagram reflects Pilot's#8 workplan.

Table 22 – Pilot#8 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month	Expected TRL level
1. Source Version Control	Part of the components is kept fully compliant with Infinitech way on the Infinitech repo. Components related to specific deployment are kept on private Github until all possibly revealing comments and private information is cleaned and reviewed.	**February 2022 (M29)**	4
2. Application packaging	Already Fulfilled	**N/A**	4
3. Artefacts' versioning	Artifacts are prepared locally (scripts for automatic packaging are in progress). We still need to upload and version them.	**March 2022 (M30)**	3
4. Microservices architecture	Components are designed as microservices (dockerimage) packaged, but the decision was made to not deploy them on Kubernetes cluster locally.	**N/A**	1
5. Automatic use case deployment	Automatic deployment pipeline needs to be prepared for all. Some components (Peudoanonymizer) are already partially compliant.	**July 22 (M34)**	2
6. Use of technology components building blocks	Technology components are project agnostic. Pseudoanonymizer has been tested on unrelated data and connected with external data sources. Risk assessment and Screening tools are able to ingest non Pilot specific data if properly formatted.	**March 2022 (M30)**	4-5
7. Testbed	Testbed is prepared and working (without Kubernetes)	TBD	6
8. Sandbox	Sandboxes are deployed on testbed. Risk assessment sandbox is fully operational. Screening tool is prepared and deployed and in research phase using historical data. Automatic ingestion of real time data is in preparation	**May 2022 (M32)**	6

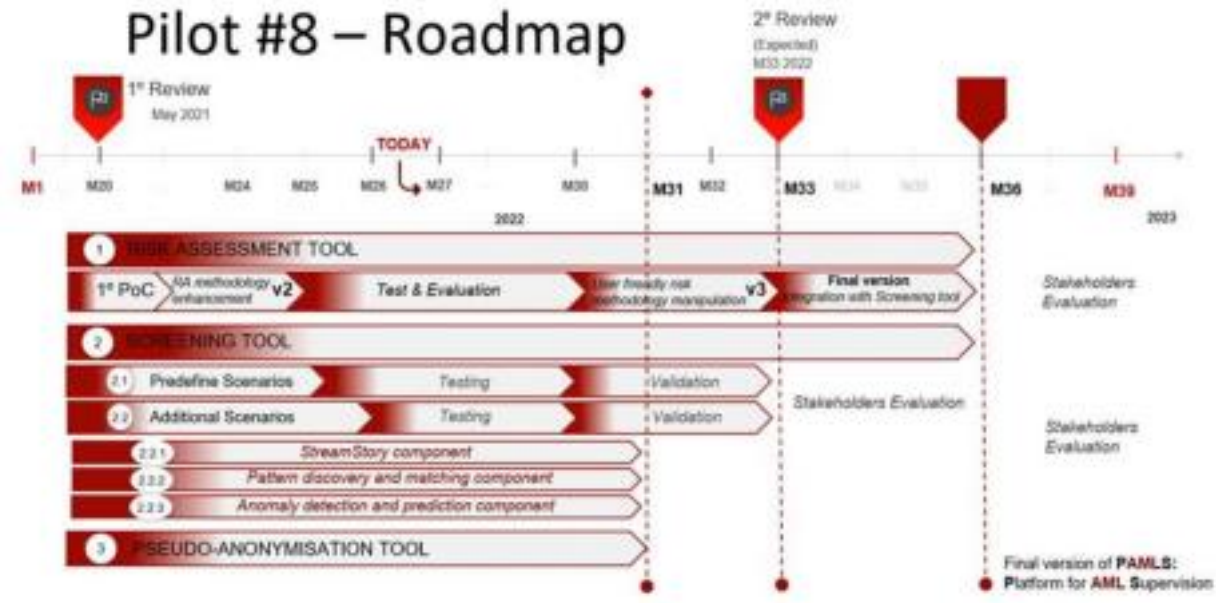

Figure 18 – Pilot#8 Roadmap

3.9 Pilot #9 – Testbed for Platform for Analyzing Blockchain Transaction Graphs for Fraudulent Activities

Pilot# 9 ("Analysing Blockchain Transaction Graphs for Fraudulent Activities") is managed by AKTIF and BOUN. It aims to leverage HPC technologies to analyze huge blockchain graphs in order to detect fraudulent activities in crypto currency transactions. Testbed Pilot#9 is currently hosted on Amazon cloud where Ethereum raw blockchain data is stored.

The following components have been developed in Pilot# 9:

1. Blockchain Transaction Dataset Preparation Component
2. Scalable Transaction Graph Analysis Component
3. User Interface for Blockchain Transaction Reports and Visualization Component

Overall detailed architecture of Pilot# 9 is given in the figure below. Scalable Transaction Graph Analysis Component and the User Interface component communicates via RabbitMQ service. User interface component issues commands to RabbitMQ. Scalable Transaction Graph Analysis Component returns traced subgraphs of fraudulent transactions. RabbitMQ passes traced subgraphs to the user interface. Our system is set up on AWS. It operates in a partially automated way.

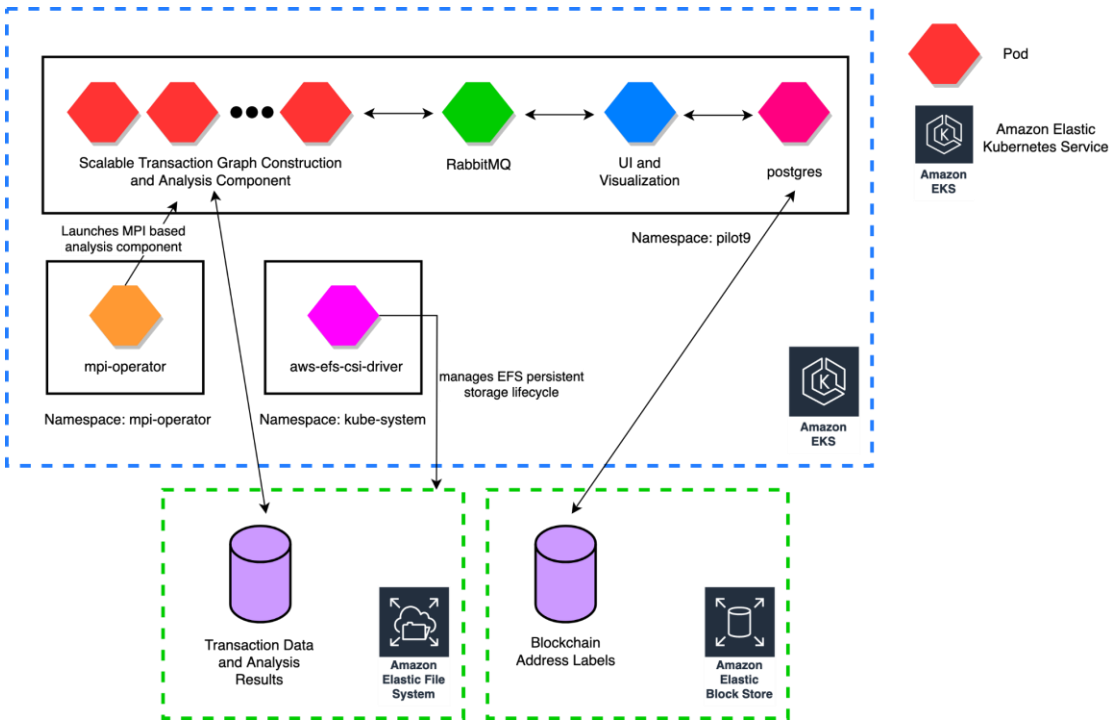

Figure 19 – Pilot#9 Deployment

Before using the INFINITECH way of adoption, Pilot#9 was using the StarCluster tool to launch its parallel program. It only worked on Amazon Cloud and required some manual steps. With the INFINITECH way of adoption, it switched to the mpi-operator developed by Kubeflow. Now, it no longer requires manual steps and

is automated. Since it is Kubernetes based, the pilot can be run both on Amazon Cloud and on-premises. Using Kubernetes allows us to automate things more, makes the processes cross provider (you can choose any cloud platform or run on-premise), increases uptime by its self-healing abilities (containers are restarted if they crash), frees us from the burden to choose a machine to run our code (it schedules the containers across the nodes according to the workloads).

3.9.1 Pilot#9 Testbed AS-IS coverage and status vs guideline

Currently, most of the pilot's components are versioned and deployed following the project guidelines. Pilot# 9 readiness and compliance regarding deployment based on INFINITECH Reference (Blueprint) Testbed Guidelines are described below:

Table 23 – Pilot#9 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info	TRL LEVEL
1. Source Version Control	YES	100%	Currently, pilot's artefacts are kept on Gitlab.	5
2. Application packaging	YES	100%	Currently, applications are built as Docker containers.	5
3. Artefacts' versioning	PARTIAL	80%	Currently, most of the pilot's artefacts are published on the INFINITECH Harbor.	4
4. Microservices architecture	PARTIAL	80%	Currently, most of the pilot use case applications are deployed on Kubernetes.	5
5. Automatic use case deployment	NO		Currently, a Continuous Delivery pipeline is not configured.	N/A
6. Use of technology components building blocks	YES	100%	Currently, ERC20 Token implementation is being used in the pilot.	6
7. Testbed	YES	100%	The pilot is currently deployed in AWS.	5
8. Sandbox	PARTIAL	80%	Currently, most of the pilot use case applications are deployed on Kubernetes.	5

3.9.2 Pilot#9 Testbed Guideline Coverage Plan

In the next year of the project, all the pilot's components will be updated to their final versions in compliance with the project guidelines. Foreseen actions to be implemented are described below:

Table 24 – Pilot#9 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month	Expected TRL level
1. Source Version Control	Each component will be updated to its final version	M36	6
2. Application packaging	Already fulfilled	N/A	6

3. Artefacts' versioning	Pilot's remaining artefacts will be uploaded to harbor.infinitech-h2020.eu.	M36	6
4. Microservices architecture	Pilot's remaining use case applications will be deployed on Kubernetes.	M36	6
5. Automatic use case deployment	CI/CD according to a provided Continuous Delivery pipeline is planned for M36.	M36	6
6. Use of technology components building blocks	Already fulfilled	N/A	6
7. Testbed	Already fulfilled	N/A	6
8. Sandbox	Pilot's remaining use case applications will be deployed on Kubernetes.	M36	6

The following figure reflects Pilot's#9 workplan.

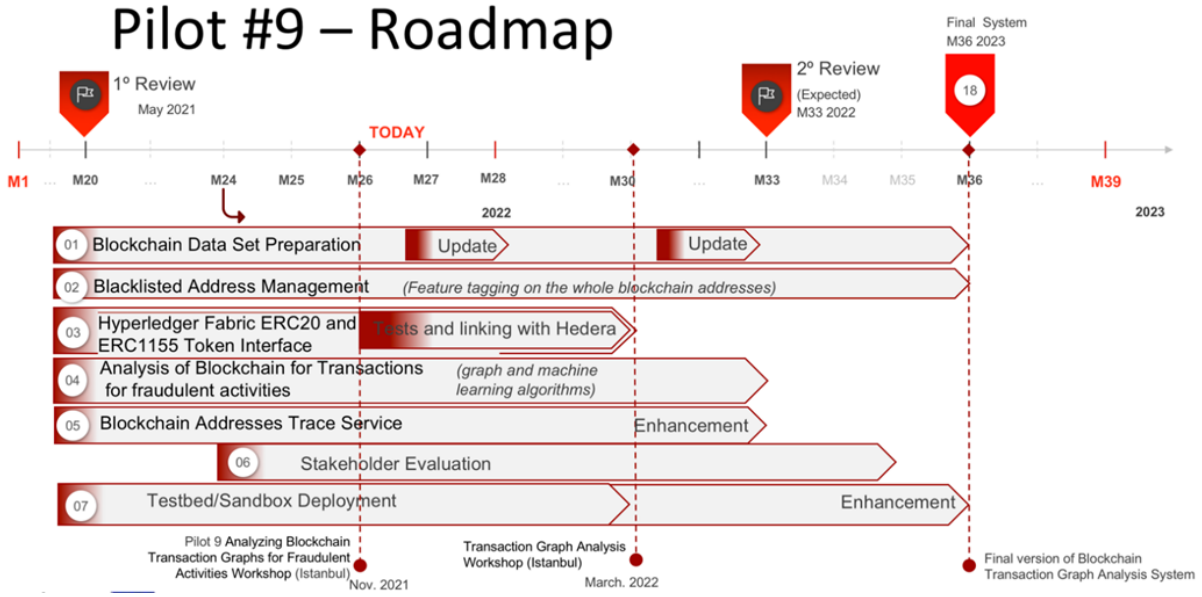

Figure 20 – Pilot#9 Roadmap

3.10 Pilot #10 – Testbed for Platform for Real-time cybersecurity analytics on Financial Transactions' BigData

This paragraph provides an overview of the reference blueprint designed for Pilot#10, developed by ENG. The whole environment adopts a hybrid solution, as the sandbox includes some components hosted in the Amazon cloud infrastructure managed by GFT and some other components are hosted in a cloud infrastructure managed by ENG. The team takes advantage of the fully automated approach of the INFINITECH way methodology for the development and maintenance of both the source-disclosed and undisclosed components adopted in Pilot#10 (Figure 21).

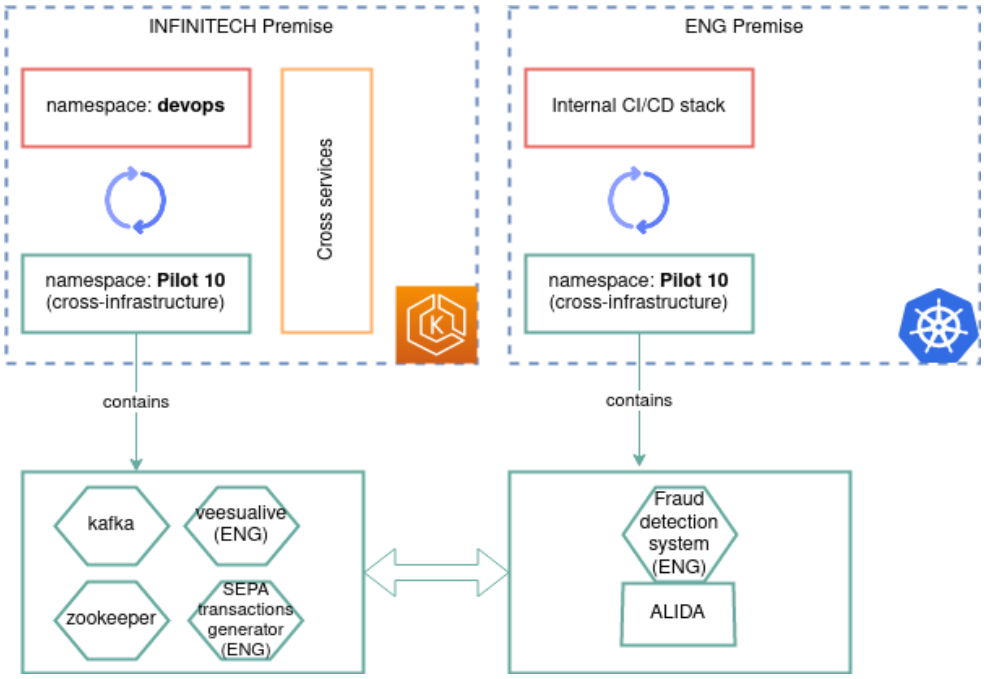

Figure 21 - Pilot#10 Sandbox overview

3.10.1 Pilot#10 Testbed AS-IS coverage and status vs guideline

The testbed dedicated to Pilot#10 is already designed and partially in place. The blueprint contains the following elements:

- Helm template and default-configured values.yaml file to deploy kafka brokers and zookeeper nodes,
- the SEPA transactions generator resource files for the deployment,
- the configuration and the networking setup, as well as
- the references to the remote connection to the environment hosted in the cluster where ALIDA (https://home.alidalab.it) framework runs.

Templates of Veesualive (the visualization software coming from task T4.6 by ENG)' will be added by next March, in order to have the blueprint completed, covering this way all the requirements gathered from the use case.

Table 25 – Pilot#10 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	YES	100%	Blueprint and CICD pipelines are already in SVC. All the components are already in line with the guideline and the testbed is completed at the 80%
2. Application packaging	YES	100%	All the artifacts are shipped as Docker images The docker images are already stored in INFINITECH's Harbor registry. Some dependencies can be pulled from the official Docker Hub registry.

3. Artefacts' versioning	YES	100%	All the artifacts are versioned in the INFINITECH's Harbor registry.
4. Microservices architecture	YES	100%	There's no legacy software, every part is cloud native.The whole pilot is based on microservice-based applications
5. Automatic use case deployment	YES	100%	The automation is in place (jenkinsfiles have been already implemented). CI/CD pipelines are already defined
6. Use of technology components building blocks	YES	100%	Pilot 10 uses technology component deployments fully dedicated to itself. Full compliance with this guideline
7. Testbed	YES	100%	In its hybrid approach, the resource management and the infrastructures are fully compliant with INFINITECH cloud-native specifications. The whole Pilot runs on a dedicated testbed across two environments, therefore it is fully compliant with the guideline.
8. Sandbox	YES	80%	The whole pilot is sandboxed. Veesualive will be added soon to the sandbox.

3.10.2 Pilot#10 Testbed Guideline Coverage Plan

The Pilot's sandbox is at 80% of its full working condition. The integration test of the components already available has already been performed to guarantee a smooth transition to the complete environment once the addition of the missing component (Veesualive) will be performed. The next steps are reported in the following table:

Table 26 – Pilot#10 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month
1. Source Version Control	Veesualive code will be added in version control as it is not present in INFINITECH gitlab right now.	**March 2022 (M30)**
2. Application packaging	Veesualive component will be released as docker image. Push of Veesualive's docker image in INFINITECH's harbor registry	**March 2022 (M30)**
3. Artefacts' versioning	Veesualive docker image will be added in the INFINITECH's Harbor registry	First version of the release on **March 2022 (M30)**
4. Microservices architecture	Already fulfilled	N/A
5. Automatic use case deployment	Veesualive CI/CD pipeline will be defined	**March 2022 (M30)**
6. Use of technology components building blocks	Already fulfilled	ND
7. Testbed	The testbed will use the final version of the Sandbox once Veesualive will be introduced	**March 2022 (M30)**
8. Sandbox	Veesualive will be integrated within the blueprint of Pilot#10	**March 2022 (M30)**

It is worth noticing that Pilot#10 blueprint will be completed in March 2022, anyway the per- component development lifecycle will continue till the end of the project to provide bug-fixes and improvements. The following diagram shows the Pilot#10 roadmap.

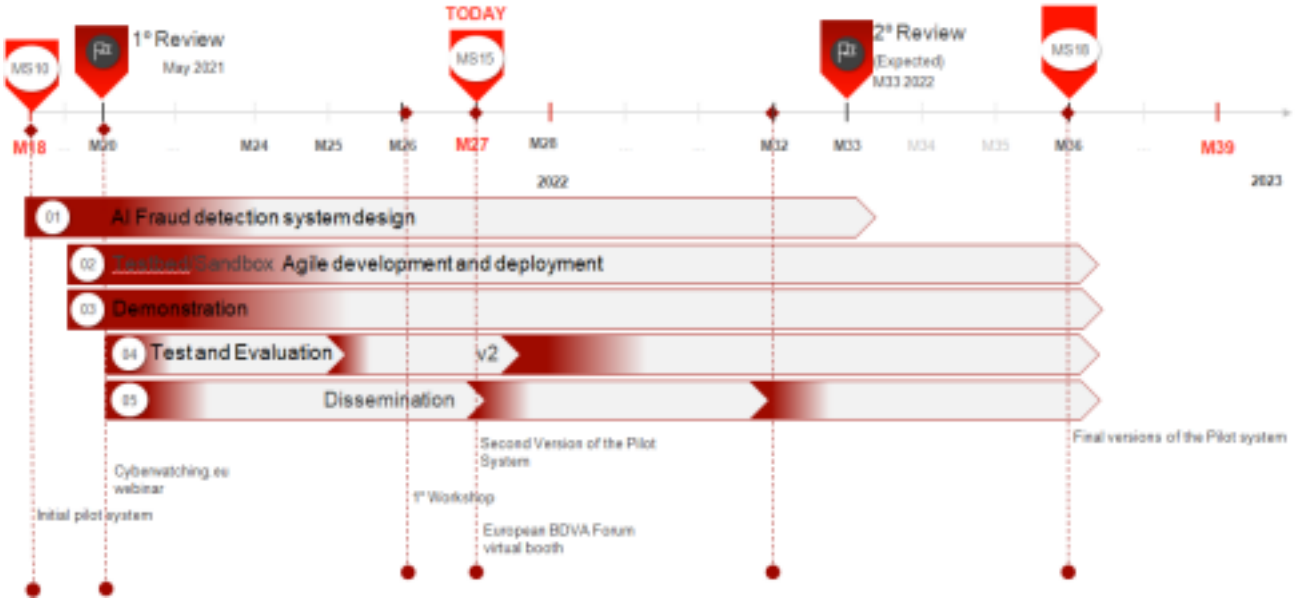

Figure 22 – Pilot#10 Roadmap

3.11 Pilot #16 – Testbed for Platform for Data Analytics Platform to detect payments anomalies linked to money laundering events

Pilot#16 is building a data analytics platform to help the Nexi AML team to identify anomalous scenarios linked to money laundering through digital card payments, adhering to European AML regulatory compliance policies, by notifying detected cases to the Italian Financial Intelligence Unit (FIU).

Pilot# 16 Joined the project on M24, therefore the development of the pilot in the period under report regarded mainly the context info acquisition and monitoring, and the start of the development of the testbed/sandboxes.

1- Rule based suspicious activities match:
   - Complex path of self financing

2- Graph based Ranking:
   - Each node (individual or an organization) has its own risk indicators
   - The pilot starts from nodes labeled as anomalous (prev. reported to authorities)
   - We look up those nodes closer (x hops) to anomalous nodes
   - Rank definition proportional to x hops and weighted sum of node risk indicators

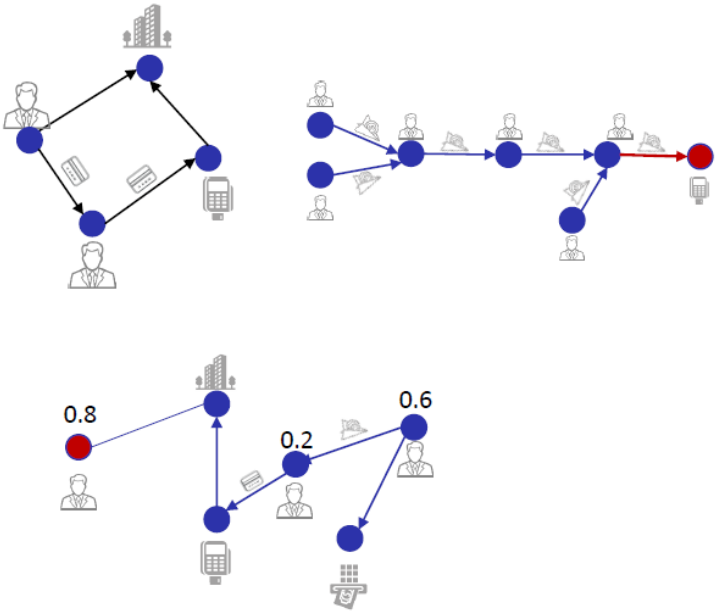

Figure 23: Pilot#16 - Use case development

The data platform will develop two services that are going to be used by AML Customer Due Diligence team users during their analysis:

- Graph-based Anomaly Detection platform (Business Service 1)
- Graph-based Anomaly risk score (Business Service 2)

3.11.1 Pilot#16 Testbed AS-IS coverage and status vs guideline

Testbed Pilot#16 is currently hosted on Amazon cloud. Its readiness and compliance regarding deployment based on INFINITECH Reference (Blueprint) Testbed Guidelines are described below:

Table 27 – Pilot#16 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	PARTIAL	5%	Since pilot#16 is in an initial phase, it is focusing on producing exploratory data analysis notebooks to test use case assumptions. All these notebooks are versioned into Nexi local repository. Once it produces some code it is going to push to Infinitech repository.
2. Application packaging	NO	0%	No docker container has been developed yet.
3. Artefacts' versioning	NO	0%	No applications artefacts has been developed yet.
4. Microservices architecture	NO	0%	No code is yet available.

5. Automatic use case deployment	NO	0%	No automatic deployment pipeline is yet developed.
6. Use of technology components building blocks	NO	0%	Technology components building blocks won't be used
7. Testbed	NO	0%	Not yet
8. Sandbox	NO	0%	Not yet

3.11.2 Pilot#16 Testbed Guideline Coverage Plan

The table below describes Pilot#16 Testbed deployment planned actions regarding readiness to INFINITECH Reference (Blueprint) Testbed Guidelines, while the following figure 24 presents its roadmap.

Table 28 – Pilot#16 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month	Expected TRL level
1. Source Version Control	We're going to push code of both Pilot16 use cases into Infinitech gitlab repository	End of June 2022 for most of Pilot software.	7
2. Application packaging	The pilot code will be containerized into a docker container.	End of June 2022 for most of Pilot software.	7
3. Artefacts' versioning	At this moment an artifact development is not in the pilot roadmap	After June 2022)	6
4. Microservices architecture	The application should be developed following microservices approach	After June 2022	7
5. Automatic use case deployment	No CI/CD pipeline has been designed yet.	After June 2022	7
6. Use of technology components building blocks	The Pilot will follow the guidelines provided by WPs 3,4,5.	After June 2022	6
7. Testbed	A testbed will be provided to manage resources according to compliance requirements	After June 2022	7
8. Sandbox	The Sandoboxes will be provided to deploy Pilot16 use cases	After June 2022	7

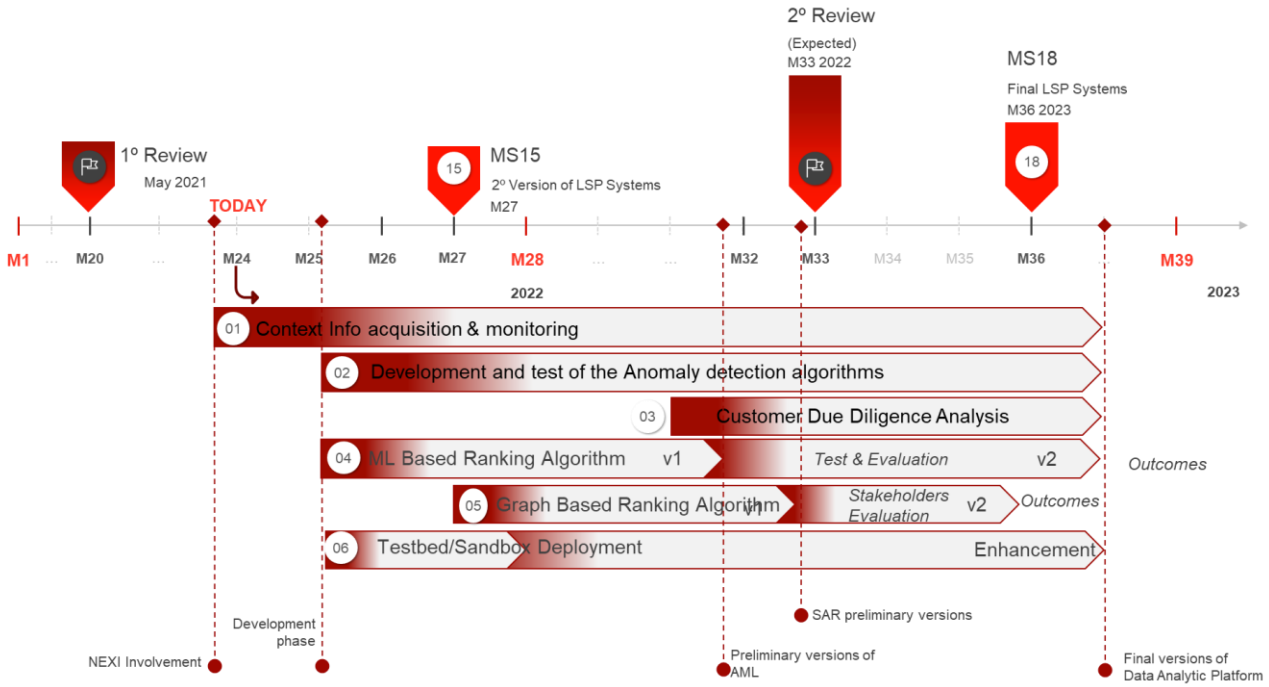

Figure 24 – Pilot#16 Roadmap

3.12 Pilot #11 – Testbed for Personalized insurance products based on IoT connected vehicles

Pilot#11 improves the risk insurance profiles using the information collected by connected vehicles and applying IoT, HPC, Cloud Computing and AI technologies. Pilot#11 Testbed is hosted in NOVA Shared Testbed, and supported by the infrastructure detailed in D6.2, section 3.1.3. This testbed is a mirror copy of the main instance supporting the pilot's services (hosted by ATOS, the pilot's leader), but only fed with the public datasets. Currently, the Pilot's deployment is partially automated.

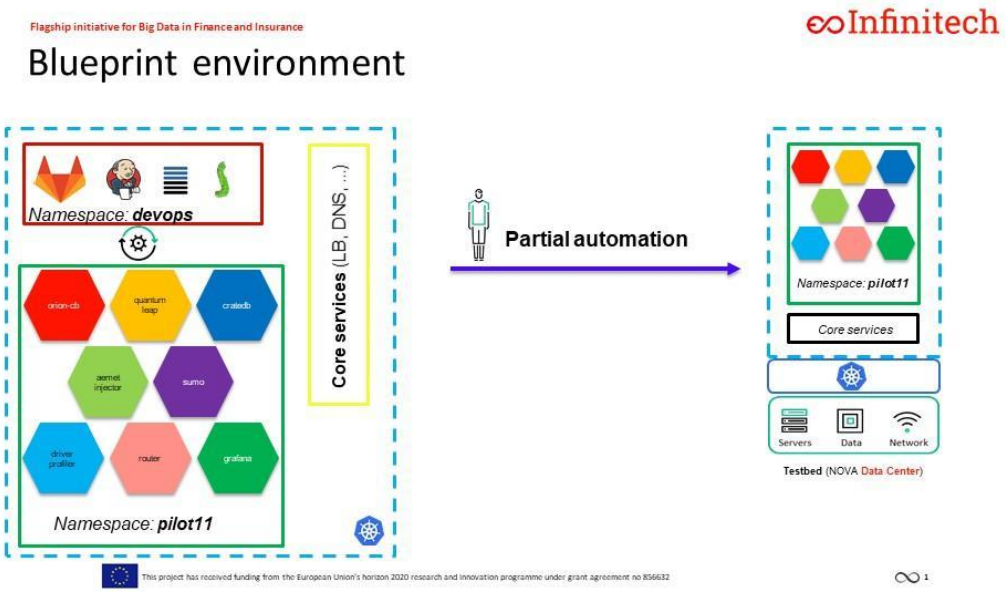

Figure 25 – Pilot#11 Blueprint environment recreation way

3.12.1 Pilot#11 Testbed AS-IS coverage and status vs guideline

During this period, the pilot has been updating and upgrading their corresponding components in the testbed (code, docker images and yaml files) to align the main pilot's instance achievements and TRLs. Progresses are shown in the table below.

Table 29 – Pilot#11 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info	TRL LEVEL
1. Source Version Control	YES	100%	Code for the SmartFleet (fully functional) backbone is deployed in the corresponding Gitlab repo (Blueprint / Pilot11). First version (operative) of the code for Driving Profiling and the service to expose it (Pay as U drive) is also 100% available	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4
2. Application packaging	YES	100%	SmartFleet components are fully dockerised. First versions of AI models and Pay as U drive service are also dockerised. All Docker images are available	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4
3. Artefacts' versioning	PARTIAL	60%	All images created within and for INFINITECH P11 deployment are uploaded. Other public images are not. FIWARE images to run the SmartFleet core are public and available in the FIWARE docker hub.	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4

4. Microservices architecture	YES	100%	Services (and components) that implements Pilot 11 follows Kubernetes' approach to deploy.Required Yaml files are provided to deploy components and services according K8s guidelines	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4
5. Automatic use case deployment	YES	100%	Micro-services and P11 components are configured according to CI/CD Infinitech instructions. SmartFleet components and AI services have been configured using Jenkins based pipelines (when applicable)	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4
6. Use of technology components building blocks	YES	100%	Workpackages are configured specifically for pilot's environment First version of the Driving Profile Model is deployed as containers to be configured by each pilot using it. Pilot 11 has configured its own instance of Driving Profiles Model and the Anonymizer tool	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4 TRL GRAD Anonymizer 5
7. Testbed	YES	100%	Pilot's 11 Testbed backbone is replicated from the Main Pilot's 11 infrastructure. Due to the protected data sources used (real connected cars), Pilot 11 main deployment runs in ATOS premises. A copy of this infrastructure (but only with open datasets) is replicated in Pilot's 11 NOVA Testbed	TRL SmartFleet 7 TRL Driving Profile Model 5 TRL Pay as You drive Model/Service 4 TRL GRAD Anonymizer 5
8. Sandbox	PARTIAL	50%	50% of the open datasets from the original testbed is available To complete the sandbox and run some of the Pilot's scenarios, ALL open datasets (Open data and Synthetic Data) are in uploading/updating process	

3.12.2 Pilot#11 Testbed Guideline Coverage Plan

Pilot's #11, as it deals with no public datasets from their connected vehicles, runs on top of a dedicated instance managed by Atos. The Infinitech Pilot's #11 testbed replicates the main instance but with no private datasets. Beyond M30, Pilot #11 will update its testbed with the final datasets from weather, traffic alerts, roads and synthetic vehicle's data coming from the improvements, modifications and evolutions previously tested in the main instance, to reach the final TRLs expected and aligned with the ones in the pilot's main deployment. Latest public version of the simulation scenario will also be updated. These actions are summarized in the table below.

Table 30 – Pilot#11 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month	Expected TRL level
1. Source Version Control	New code versions for models and services shared in GitLab repo	Pay as U Drive /Fraud detection services M32 (V2) / M36 (V3) Driving Profile Model V3 M33	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6

2. Application packaging	Docker images for new versions of components tested and ready	Pay as U Drive /Fraud detection services M32 (V2) / M36 (V3) Driving Profile Model V3 M33	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6
3. Artefacts' versioning	Images for new versions published in harbor repository	Pay as U Drive /Fraud detection services M32 (V2) / M36 (V3) Driving Profile Model V3 M33	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6
4. Microservices architecture	Already fulfilled	N/A	
5. Automatic use case deployment			
6. Use of technology components building blocks	Deploy and configure new versions of components	Pay as U Drive /Fraud detection services M32 (V2) / M36 (V3) Driving Profile Model V3 M33	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6
7. Testbed	Deploy and configure new versions of components in NOVA Testbed	Pay as U Drive /Fraud detection services M32 (V2) / M36 (V3) Driving Profile Model V3 M33	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6
8. Sandbox	100% of available datasets (Open data sources and Synthetic data-Weather, Traffic Alerts, Roads and Vehicles' synthetic data-) from the Pilot's 11 main instance will be updated	M36	TRL SmartFleet 7 TRL Driving Profile Model 7 TRL Pay as You drive Model/Service 6 TRL GRAD Anonymizer 6

The main components of Pilot #11 are already available and being updated in its testbed. Its workplan is now based on providing the updates on code, models and datasets coming from its main instance, indicated in the following figure.

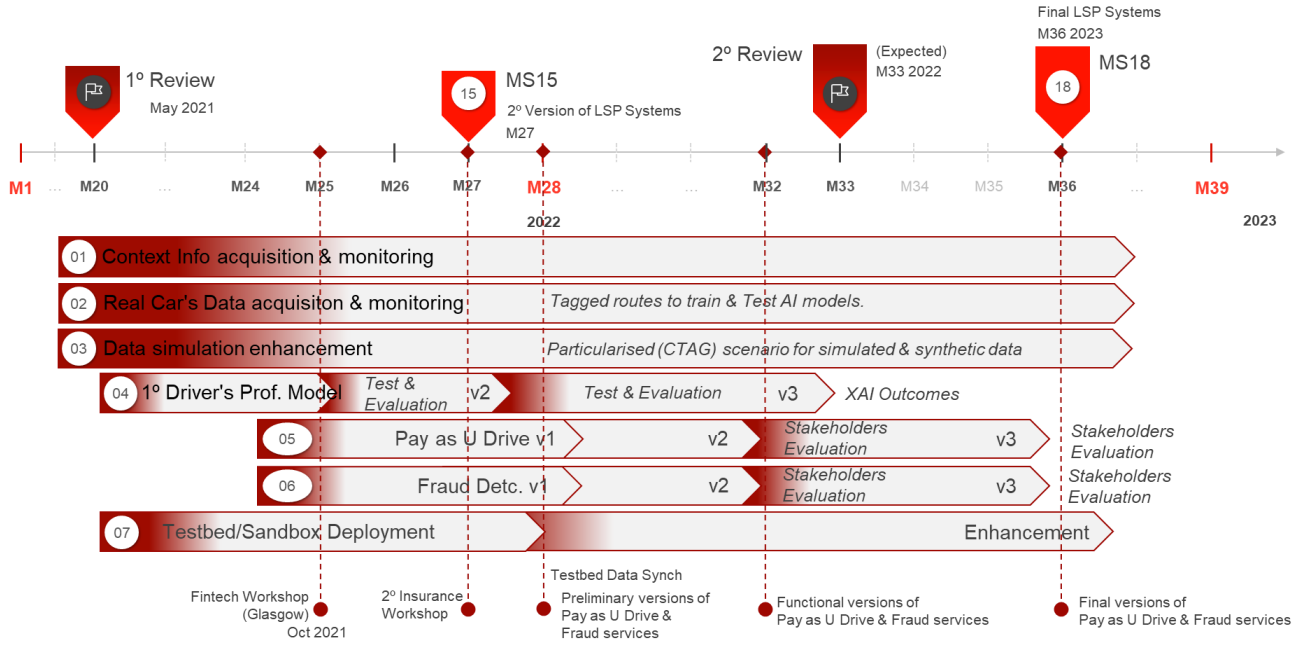

Figure 26 – Pilot#11 Roadmap

3.13 Pilot #12 – Testbed for Real World Data for Novel Health-Insurance products

Pilot#12 improves the risk insurance profiles using the information collected by activity trackers & questionnaires and applying IoT & ML technologies. All the components of Pilot#12 are now developed, with most of them following the INFINITECH way for CI/CD. Regarding the deployment of Pilot #12 technologies, Pilot #12 makes use of a testbed created on NOVA. The testbed deployment follows the INFINITECH way, so it can be re-created from scratch. The testbed is partially automated, in a bare metal environment. As the date of this deliverable, three main INFINITECH technologies have been deployed in Pilot#12 testbed: the *infinitstore* (from the *data management* namespace), the *anonymization tool* (*security privacy* namespace) and the DPO - Data Protection Orchestrator (*security privacy* namespace). These tools are INFINITECH technologies that will be employed across multiple INFINITECH Pilots. Therefore, they belong to specific namespaces, but can be deployed in any Pilot's *namespace* by following the INFINITECH way. In addition, each technology is composed of multiple microservices (data stores, data processing, REST APIs or frontends), and makes use of Continuous Integration and Continuous Delivery (CICD) pipelines to generate and deliver the last version to the different incumbent testbeds.

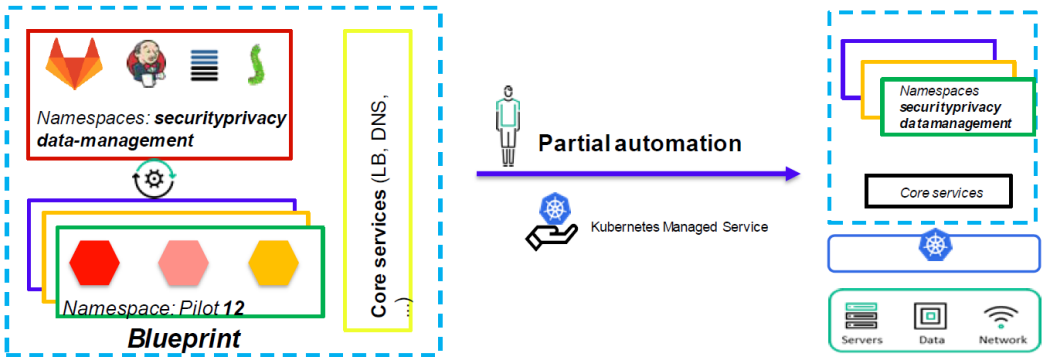

Figure 27 – Pilot#12 Blueprint environment recreation way

During the next months, the remaining technologies of Pilot#12 will be deployed in the testbed following the INFINITECH way.

3.13.1 Pilot#12 Testbed AS-IS coverage and status vs guideline

Currently Pilot#12 partially complies with the INFINITECH way of deployment. While the service-oriented approach has been designed and the individual services are developed, the model learning pipeline still lacks dockerization, handling via Harbor and Kubernetes.

GRADIANT's anonymization tool has been developed following the INFINITECH way: It focus was on leveraging the INFINITECH platform to ease the development of the anonymization tools while ensuring the quality of the developed software. The Continuous Integration pipeline runs for every push to any branch of the repository, and runs the set of unitary and integration tests to ensure that new code changes do not invalidate the application functionality. Once the code is ready to be merged to the main development branch, and if all tests are successful, the pipeline generates a new image to be pushed to the INFINITECH repository. This aligns with the INFINITECH way to ensure Continuous Delivery of new features: the deployment configuration on the testbeds will look for any new image of the anonymization service, ensuring that new features that have been tested and verified get delivered as soon as possible.

The application is therefore packaged as a Docker container that can be deployed directly or through Kubernetes. The Anonymization Tool follows a microservices architecture, with each sub-component (such as the REST API, the frontend or the distributed computing nodes) being deployed independently, and able to be scaled up or down on demand. As of now, an initial version of the tool has been deployed on NOVA testbed. However, GRADIANT needs to update the deployment scripts to take into account new microservices that are required for the full operation and integration of the component.

The GRADIANT's anonymization tool is currently at TRL 5, expected to achieve TRL >6 at the end of the project.

ATOS's Data Protection Orchestrator (DPO) has been developed following the INFINITECH way. The facilities provided by INFINITECH platform have been used to ease the development and integration of DPO. For every push of the repository, the Continuous Integration pipeline prepared for DPO is executed, generating a new

image that is pushed to INFINITECH's docker registry (Harbor). This is aligned with the INFINITECH way to ensure Continuous Delivery of new versions of the component. The application is then packed as a Docker container that can be deployed using Kubernetes.

Currently, an initial version of DPO has been deployed on NOVA testbed. This will be updated completing the development and integration and adapting the deployment scripts. The ATOS's DPO is currently at TRL 5, expected to achieve TRL >6 at the end of the project.

The model learning components from iSprint have been fully developed, but their compliance with the INFINITECH CI/CD pipeline is still pending. The components have been tested on the proprietary testbed of iSprint (where all the pilot 12 components have been deployed prior to the availability of the NOVA testbed). The deployment in NOVA will be done via the automated CI/CD pipeline. The iSprint's model learning components are currently at TRL 4, expected to achieve TRL 6 at the end of the project. The following table summarizes Pilot#12 status of readiness compared to INFINITECH Reference (Blueprint) Testbed Guidelines.

Table 31 – Pilot#12 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	PARTIAL	75%	UBITECH's data collection, GRADIANT's anonymization, ATOS's DPO and LeanXcale database are in place. Model learning pipelines are not in Gitlab.
2. Application packaging	PARTIAL	60%	GRADIANT's Anonymization Tool and ATOS' DPO are packed as a Docker container. Some updates to the DPO dockerfile might be happening. Model learning pipeline is not yet packed.
3. Artefacts' versioning	PARTIAL	60%	GRADIANT's Anonymization Tool and ATOS' DPO: yes, each new version on the development branch generates a new version in Harbor Model learning pipeline: No
4. Microservices architecture	YES	100%	Service oriented approach is followed. GRADIANT's Anonymization Tool: yes, including REST API, Frontend, DASK distributed computing or MINIO storage. ATOS' DPO: yes, including REST API. Model learning pipeline: yes, including MinIO integration.
5. Automatic use case deployment	PARTIAL	67%	GRADIANT's Anonymization Tool and ATOS' DPO: yes, each new version of development branch will generate a new version on Harbor that will be picked up and deployed in a Kubernetes cluster Model learning pipeline: No
6. Use of technology components building blocks	YES	100%	UBITECH's data collection, GRADIANT's anonymization, ATOS's DPO and LeanXcale database are INFINITECH components employed
7. Testbed	PARTIAL	50%	Partial deployment on temporary testbed, now that the official one is available deployment is moving over there
8. Sandbox	YES	100%	Single sandbox in the testbed for pilot 12

3.13.2 Pilot#12 Testbed Guideline Coverage Plan

The planning for the next period involves the compliance of the model learning pipeline to the INFINITECH way for CI/CD and the transfer of the sandbox from the temporary testbed provided by Innovation Sprint to the official one managed by NOVA.

GRADIANT's anonymization tool deployment configuration needs to be updated to the new architecture of the application: we included a new micro-service recently to allow distributed computing of large datasets that don't fit in memory, leveraging the use of Dask[13]. The deployment script needs to be updated to include the new component, and to ensure that the Dask nodes can be scaled up or down on demand. ATOS's DPO deployment configuration needs to be updated to customize the integration with all the components in pilot#12. The deployment script needs to be updated accordingly. iSprint's model learning components need to follow the INFINITECH CI/CD pipeline.

Table 32 – Pilot#12 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month
1. Source Version Control	Decide whether the model learning pipeline code, or a docker image will be provided	M29
2. Application packaging	Model learning pipeline to be dockerized	M29
3. Artefacts' versioning	Model learning pipeline to be delivered with versioning	M29
4. Microservices architecture	Model learning pipelines need to be transformed in a series of Flask services. Kubernetes deployment needs to be configured.	M30
5. Automatic use case deployment	Once all the above steps are completed, Kubernetes will be managing the model learning pipeline	M30
6. Use of technology components building blocks	Already fulfilled	N/A
7. Testbed	Current deployment is almost complete at a temporary testbed provided by Innovation Sprint. Deployment at the NOVA testbed is underway. GRADIANT's Anonymization Tool: we need to update the Kubernetes deployment YAML to adapt them to the new services included in the last version of the tool (DASK distributed computing) ATOS' DPO: It's needed to update the Kubernetes deployment YAML to adapt them to new services calls Model learning pipeline Kubernetes file will be updated for the NOVA testbed.	M30
8. Sandbox	The single sandbox planning has been concluded. Single sandbox now deployed at proprietary testbed will be copied to NOVA	M30

The following figure shows the Pilot#12 roadmap.

[13] Dask: scalable analytics in python https://dask.org/

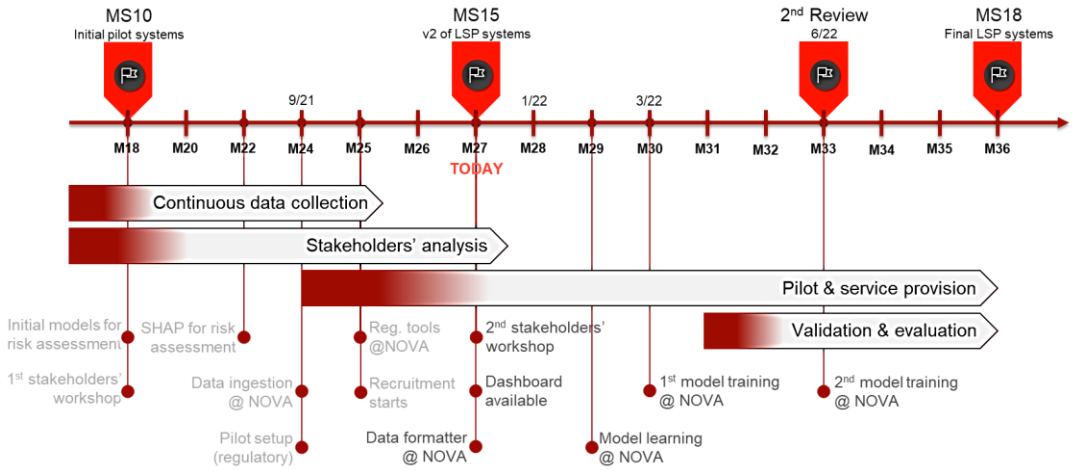

Figure 28 – Pilot#12 Roadmap

3.14 Pilot #13 – Testbed for Alternative/automated insurance risk selection - product recommendation for SME

Pilot#13 will implement an automation of the subscription process that helps insurance companies to reduce costs. In addition, it will enable the verification of the data that has been entered is correct with a double verification that avoids possible errors in the cost of the insurance premium. The monitoring and identification of real-time risk changes allows the company to know if the insurance cost really corresponds to the real risk of the SME or if it should increase or decrease it in order to adapt it to the current situation.

3.14.1 Pilot#13 Testbed AS-IS coverage and status vs guideline

Testbed for Pilot 13 will be also hosted in NOVA Shared Testbed infrastructure as described in paragraph 3.1.3 above. Due to the fact that the NOVA infrastructure was deployed during April 2021, the status of readiness compared to INFINITECH Reference (blueprint) Testbed Guidelines described below, is based on the deployment done so far utilizing AWS resources to deploy the components that are part of the INFINITECH platform:

Table 33 – Pilot#13 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline	Pilot Testbed AS-IS status vs guideline more info

1. Source Version Control	YES	100%	All software artefacts that will be deployed inside the sandbox are available in gitlab
2. Application packaging	YES	100%	All software artefacts that will be deployed inside the sandbox are built as Docker images
3. Artefacts' versioning	YES	100%	The pilot artefacts are already published and versioned on the Infinitech Harbor artifact repository
4. Microservices architecture	YES	100%	Although the architecture of this solution does not require a micro-service approach, it is deployed using Kubernetes and automate the instantiation of the solution via configuration parameters provided in as Kubernetes configmaps
5. Automatic use case deployment	YES	100%	CD pipelines have been defined and the automatic use case deployment takes place on the NOVA testbed.
6. Use of technology components building blocks	YES	100%	This pilot relies on the INFINISTORE and related technologies, that are pilot agnostic and they can be configured by Kubernetes ConfigMaps to instantiate them according to the needs of each pilot.
7. Testbed	YES	100%	A cluster configuration for this pilot is in place on the NOVA testbed with all required resources.
8. Sandbox	YES	100%	The use case is fully function as a sandbox deployed on the NOVA testbed

3.14.2 Pilot#13 Testbed Guideline Coverage Plan

As stated in the previous subsection, the Pilot's#13 deployment status regarding the Blueprint Testbed is already following all the project guidelines.

3.15 Pilot #14 – Testbed for Big Data and IoT for the Agricultural Insurance Industry

Pilot#14 provides insurance companies with a robust and cost-effective toolbox of functions and services- allowing them to alleviate the effect of weather uncertainty when estimating risk of AgI products, reduce the number of on-site visits for claim verification, reduce operational and administrative costs for monitoring of insured indexes and contract handling, and design more accurate and personalized contracts.

During this period, Pilot#14's weather component was deployed in NOVA infrastructure. AgroApps image containing the source code of the pre-processing of the input data and the weather forecasting model itself was introduced into the Kubernetes environment. Proper yaml files were created, containing the private registry location within docker-hub and the associated Kubernetes secret to pull the private image. The needs of the model and especially the need to download and store the input data as well as the storage needs for the raw output of the model, led to the creation of blueprint files that create two separate volumes. These volumes are defined inside the blueprint file that launches the weather forecasting image. The work-flows necessary to execute the weather forecasting model and its pre-processing steps are prepared within bash scripts that call the code of the model (in C++ and Fortran). As weather models are traditionally parallelized work-flows based

on Message Passing Interface (MPI) protocols, the model is able to run successfully on one Kubernetes worker within pilot#14's nodes. Currently the model has been successfully tested to run on a worker with 24 cores labelled as kind job within the blueprint file. Work under processes is mainly focused to scale up the work to all the pilot# 14's workers without comprising the successful execution of the model driven by MPI. As soon as a solution is found, the model will be introduced to run as kind: "cronjob" within the blueprint file. This is essential as the weather forecasting model is fed with new observations and input data sub-daily producing forecasts that are more reliable. The AglTool's blueprints for the weather component, based on the version-control image by the private registry of AgroApps, have been deployed on the Kubernetes cluster in NOVA infrastructure. A blueprint of type job, and two volumes define the weather component, while the workflow and the call to the source code are dictated by a bash script defined in the blueprint. As the weather model relies on MPI protocols, the communication between workers is currently under investigation so that the successful execution of the weather model is not compromised. Successful runs have been currently conducted on one worker of 24 cores. The final version, after a solution is introduced for MPI, will be executing the model as cronjob automatically on all workers providing input to the AglTool.

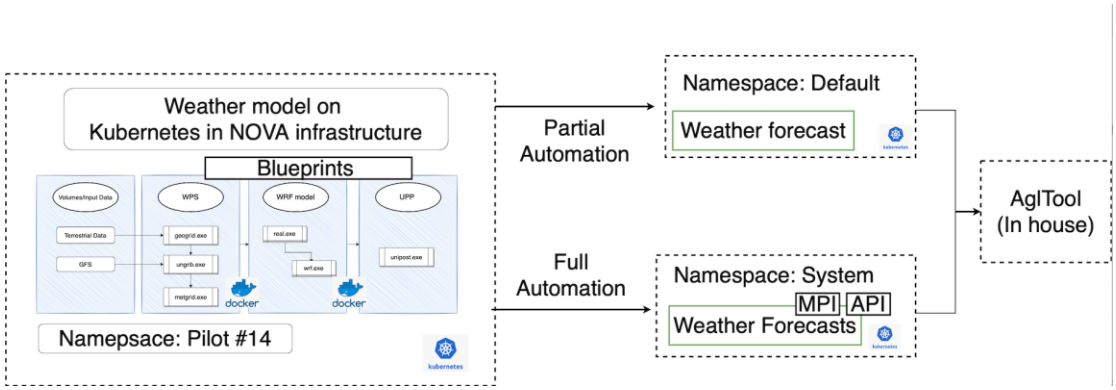

Figure 29 – Pilot#14 Blueprint environment recreation way

Pilot#14 and the AgI toolbox are significantly benefited by INFINITECH infrastructure and way of deployment both:

- In terms of AgI toolbox capabilities, by migrating the Weather Intelligence Engine from AgroApps infrastructure to NOVA infrastructure, enabling us to provide more detailed and accurate weather and climate information to the Agri-Insurance companies.
- The AgI toolbox added value to the development and deployment of new Index and parametric insurance products, through the initiation of climate analysis for Croatia as a first process of designing a new index insurance product coverage for frost.

3.15.1 Pilot#14 Testbed AS-IS coverage and status vs guideline

The status of readiness of Pilot#14 compared to INFINITECH Reference (Blueprint) Testbed Guidelines is summarized below:

Table 34 – Pilot#14 Testbed AS-IS coverage and status vs guideline

Guideline # and Title	Pilot Testbed AS-IS coverage vs guideline		Pilot Testbed AS-IS status vs guideline more info
1. Source Version Control	NO		Private registry
2. Application packaging	YES	100%	Everything is dockerized.
3. Artefacts' versioning	NO		Private registry
4. Microservices architecture	YES	100%	It concerns Weather component, the rest is in house (AgroApps)
5. Automatic use case deployment	PARTIAL		Weather component does not use the CD pipeline of Jenkins.infinitech-h2020.eu. A cronjob type will execute the model resulting in gridded spatial coverage, as soon as the MPI solution is found/applied.
6. Use of technology components building blocks	YES	100%	Already pilot agnostic
7. Testbed	YES	100%	Weather is in kubernetes cluster, will be automatically executed as cronjob, as soon as the MPI solution is found/applied.
8. Sandbox	YES	100%	Weather is under one name space

3.15.2 Pilot#14 Testbed Guideline Coverage Plan

After the successful upscaling of the weather component to leverage all the power of Pilot#14's computational resources in NOVA infrastructure, the weather forecasts will be made available to the in-house AglTool of AgroApps. Use cases will be set according to the pilot needs and the final testbed and sandboxes will be configured in the Infinitech way.

Table 35 – Pilot#14 Guideline coverage plan

Guideline # and Title	Pilot Testbed TO-BE actions vs guideline	End month
1. Source Version Control	Not applicable	N/A
2. Application packaging	Already fulfilled	N/A
3. Artefacts' versioning	Not applicable	N/A
4. Microservices architecture	Already fulfilled for Weather	N/A
5. Automatic use case deployment	Upscaling to more workers with MPI and running as cronjob	April 2022 (M31)
6. Use of technology components building blocks	Connection of weather on Nova to inhouse AglTool	August 2022 (M35)
7. Testbed	Final resources for use cases	November 2022 (M38)

8. Sandbox	Final components for use cases	January 2023 (M40)

The following figure shows the Pilot#14 roadmap.

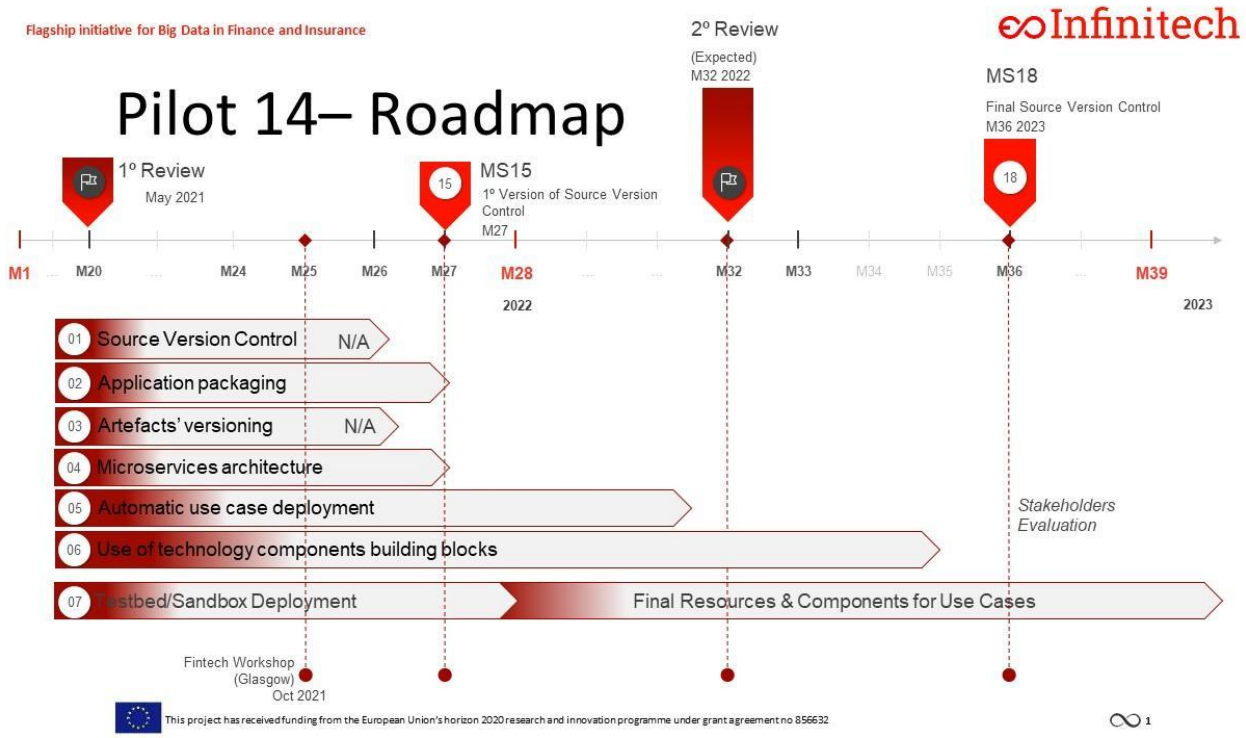

Figure 30 – Pilot#14 Roadmap

4 Pilots Testbeds and Sandboxes Implementation Upgrade Progress

A summary feedback of the guidelines coverage as-is progressed in M1-M28, provided, from all pilots regarding readiness and compliance to INFINITECH Reference (Blueprint) Testbed Guidelines for deployment of the Testbeds on which each Pilot will be hosted, is depicted in the table below:

Table 36 – Pilots Testbed Readiness vs INFINITECH Reference (Blueprint) Testbed Guidelines

Pilot	Testbed Hosting	INFINITECH Reference (Blueprint) Testbed Guidelines							
		#1 Source Version Control	#2 Application packaging	#3 Artefacts' versioning	#4 Microservices architecture	#5 Automatic use case deployment	#6 Use of technology components building blocks	#7 Testbed	#8 Sandbox
#2 (JRC)	NOVA	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%
#15 (ALILAB)	AWS	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%
#3 (BPFI)	On-premises	NO	PARTIAL	PARTIAL	NO	PARTIAL	NO	NO	NO
#4 (PRIVE)	AWS Private	NO	YES (on Prive's cloud)	NO	YES (on Prive's cloud)	NO (CI/CD internally)	NO	NO	NO
#5b (BOC)	AWS	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%
#6 (NBG)	MS-Azure	NO	NO	NO	PARTIAL	PARTIAL	YES	PARTIAL	PARTIAL
#7 (CXB)	On-premises	PARTIAL 30%	PARTIAL 10%	NO	PARTIAL 10%	PARTIAL 10%	PARTIAL 25%	PARTIAL 50%	PARTIAL 50%
#8 (BOS)	On-Premises	PARTIAL 80%	YES 90%	PARTIAL 70%	PARTIAL 70%	PARTIAL 60%	YES 95%	YES 90%	YES 85%
#9 (AKTIF)	AWS	YES 100%	YES 100%	PARTIAL 80%	PARTIAL 80%	NO	YES 100%	YES 100%	PARTIAL 80%
#10 (PI)	AWS	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%
#16 (NEXI)	AWS	PARTIAL 5%	NO	NO	NO	NO	NO	NO	NO
#11 (ATOS)	NOVA	YES 100%	YES 100%	PARTIAL	YES 100%	YES 100%	YES 100%	YES 100%	PARTIAL 50%
#12 (SILO)	NOVA	PARTIAL 75%	PARTIAL 60%	PARTIAL 60%	YES 100%	PARTIAL 67%	YES 100%	PARTIAL 50%	YES 100%
#13 (WEA)	NOVA	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%	YES 100%
#14 (GEN)	NOVA	NO	YES	NO	YES	PARTIAL	YES	YES	YES

Based on the previous section 3 and the table above, the following inferences are provided:

- Along with Pilot#2 Testbed, the second Blueprint Testbed, Pilot#5b, is already deployed. Both of them are in full compliance with the INFINITECH RA Development, while following the proposed microservices approach, the respective INFINITECH CI/CD process, using INFINITECH's Datastore and other pilots' specific analytics components. Furthermore, Pilot#2 was successfully migrated to the NOVA infrastructure.
- As far as all the involved Pilots (#2, #11, #12, #13, #14) that have been using the sandboxes in Nova testbed concern, their Testbed upgrades and releases have been performed incrementally according to "the INFINITECH WAY", since the migration process is being executed in order for them to be deployed in the final infrastructure, following the Blueprint guidelines.
- The development of the hardware and software infrastructure of most of the Pilots testbeds results in a number of sandboxes configured according to the Continuous Integration / DevOps approach.
- The majority of the Pilots have followed a partially automated way for recreating the Blueprint environment.
- Pilot# 16 joined the project on M24 & Pilot#3 partners were incorporated officially on M28; therefore, the actual state of these pilots' development is less developed compared to the other pilots.
- Since Pilot#4 development is targeting on expanding the capabilities of its own software solutions, it cannot follow Blueprint Testbed guidelines. Thus, it applies CI/CD and deploys AWS Kubernetes internally.
- Most of the Pilot's components (#2, #15, #5b, #8, #9, #10, #11, #12, #13,) are in line with the guideline 1 and they are placed on the target source version control service. For a few pilots' (#6, #7 and #16) sources in the Gitlab will be provided in a further step, while Pilot#4 and Pilot#14 use a private source code control service.
- While the delivered applications of most of the Pilots are built as Docker containers fulfilling the respective guideline, thus a few Pilots (e.g., #7, #12) are planning packaging within the next months.
- The majority of the Pilots' artefacts are published and versioned on the INFINITECH Harbor repository. For a few Pilots (eg., #6, #7) these will be provided within next months, when a higher accuracy of the artefacts, after validation, will be reached.
- The majority of the Pilots' are following a microservices based approach and they are deployed on Kubernetes. However, few of them (#8) have adopted the microservices architecture, without kubernetes orchestration due to security measures.
- For the majority of the Pilots, except #14, continuous delivery pipeline is configured on Jenkins [5].
- Kubernetes orchestration for Testbed and Sandbox deployment is planned for some Pilots (e.g. #6, #7, #11) to be applied within the next few months based on the maturity of their deployment.

According to these inferences, the progress status both of the incumbent and the NOVA Shared Testbed deployed Pilots has been upgraded within this period, thus some future activities and steps are needed in order for the "INFINITECH WAY" to be fully adopted, as described in the next section.

5 Conclusions and next steps

This is the third version of the deliverable of the three versions, which are meant to provide the outcomes of task T6.1, intending to report available updated details for each testbed used (or will be used) in order to support the Pilots' execution, since the initial specifications were reported in the first version D6.1. and the mapping of each Testbed to the Reference (Blueprint) Testbed deployed and described in D6.2, serving as guidance for all Pilots to follow the "INFINITECH way" of development.

The document reports the as-is status regarding the readiness and compliance of the relative infrastructure (hardware & software) deployments from each pilot, focusing on advances within M21 to M28, compared to the Reference (Blueprint) Testbed Guidelines, as well as the planned activities that will be performed within the next months of each pilot deployment plan.

Based on this updated information and in order for all the Pilots to follow a similar way of Testbed and Sandbox deployment, utilizing dockerized developed components and following Kubernetes Orchestration, a list of proposed actions is proposed as following, aiming at the fully adoption of the "INFINITECH way", as their implementation of the third iteration of the Project.

- Under the full deployment of the two "INFINITECH blueprint pilots" (#2, #5b), the description of the actual and concrete implementation of the "INFINITECH way" Blueprint guidelines has been provided. Thus, based on a) the finalization of Blueprint guidelines and the general updates of the INFINITECH Blueprint Reference Testbed with in D6.6.- Tools and Techniques for Tailored Sandboxes and Management of Datasets – III (M33) and b) Pilots' testbed migration plan, the transformation of more "Blueprint pilots" can be achieved, such as Pilot#10.
- Furthermore, for some incumbent Pilots (#16, #3) that joined the project in the second cycle of development or were under restructuring phase during this reference period, further support from WP6 partners and Pilots' Tech Proxies to Pilot's technical partners will be required in order to take the necessary actions and milestones in order for all Blueprint guidelines to be adopted.
- For few Pilots (e.g. #4, #8, #14), which due to technical or other reasons cannot follow the guidelines at all or some of them, a technical report documentation should be provided and stored in INFINITECH Gitlab.
- What is more, in cases of not following the guidelines, suggested alternative solutions, such as Pilot#4 to meet guidelines 6 &8, by configuring multiple tenants within its use cases deployment, should be evaluated by the INFINITECH Technical partners.
- According to the indicated Blueprint Pilots INFINITECH Reference Architecture deployment, INFINITECH Technical partners should recommend and check Pilots partners for moving towards Blue Reference Architecture to the highest possible degree.
- As far as Kubernetes orchestration requirements concern for Testbeds and Sandbox deployment, for few Pilots, Kubernetes deployment needs to be configured, the resources and components for uses should be finalized within next few months, so as to deploy pilot's remaining use case applications on Kubernetes.

- For the NOVA Shared Testbed deployed Pilots, NOVA constructed the required architectural stack to manage involved Pilots' sandboxes, providing an actual set of application and orchestration specific artifacts, deriving in a fully- working sandbox for each of them. Thus, improvement and tuning of the infrastructure in order to support new capabilities in sandbox tailoring is suggested.
- Some further actions in order for all Pilots to be migrated to the targeted infrastructures to host them concern some updates to the docker images and docker containers, the finalization of CI/CD configurations, the updates and uploading of their remaining components and artifacts to the corresponding INFINITECH repositories.

Following these and based on the maturity of development of all Pilots, the full adoption of INFINITECH Reference (Blueprint) Testbed Guidelines by them will be further enhanced and described in the future deliverables of WP6. The development of the testbeds and the relative sandboxes life cycle will continue until the end of the project to provide dynamic upgrades in order to fulfill the INFINITECH project and the relevant pilots' Testbeds & Sandboxes needs.

6 References

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