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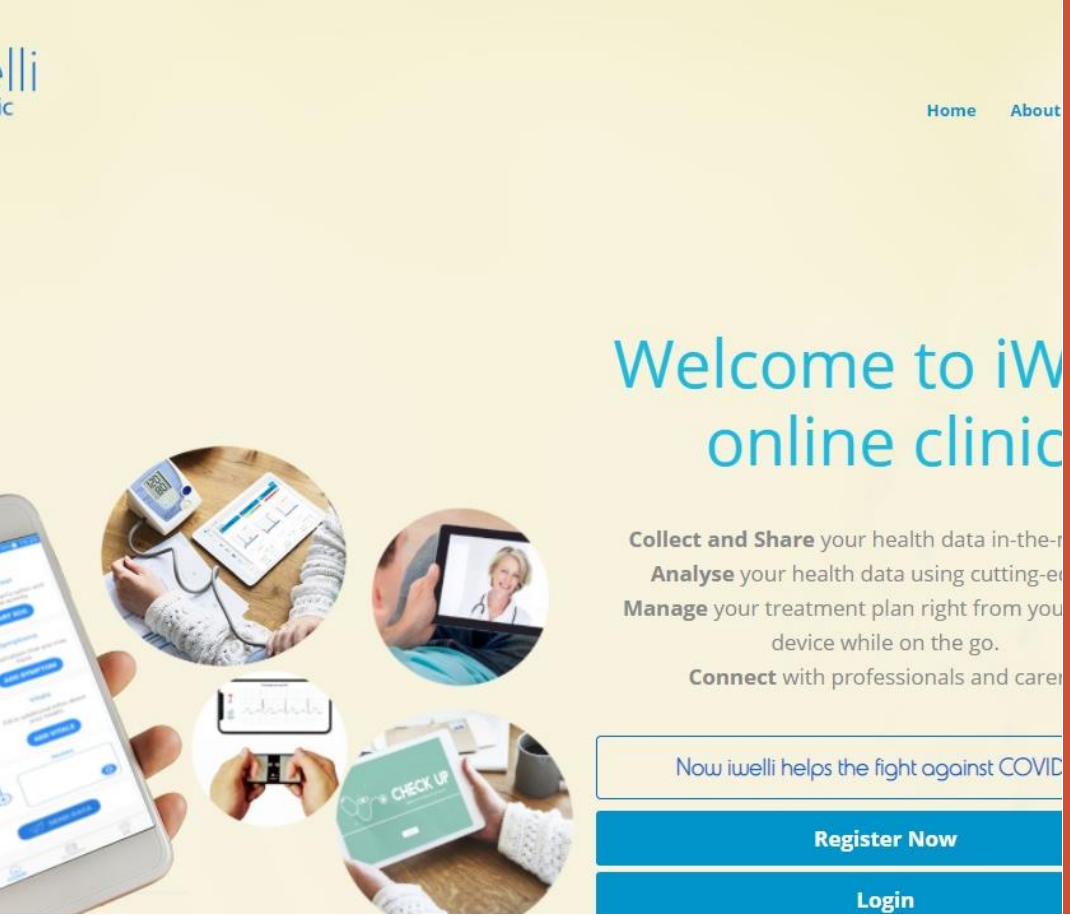
Syndesis Ltd

Smarter Heterogeneous Data Sets -SHDS

Final Review - Telco

Online , Friday 13-11-2020



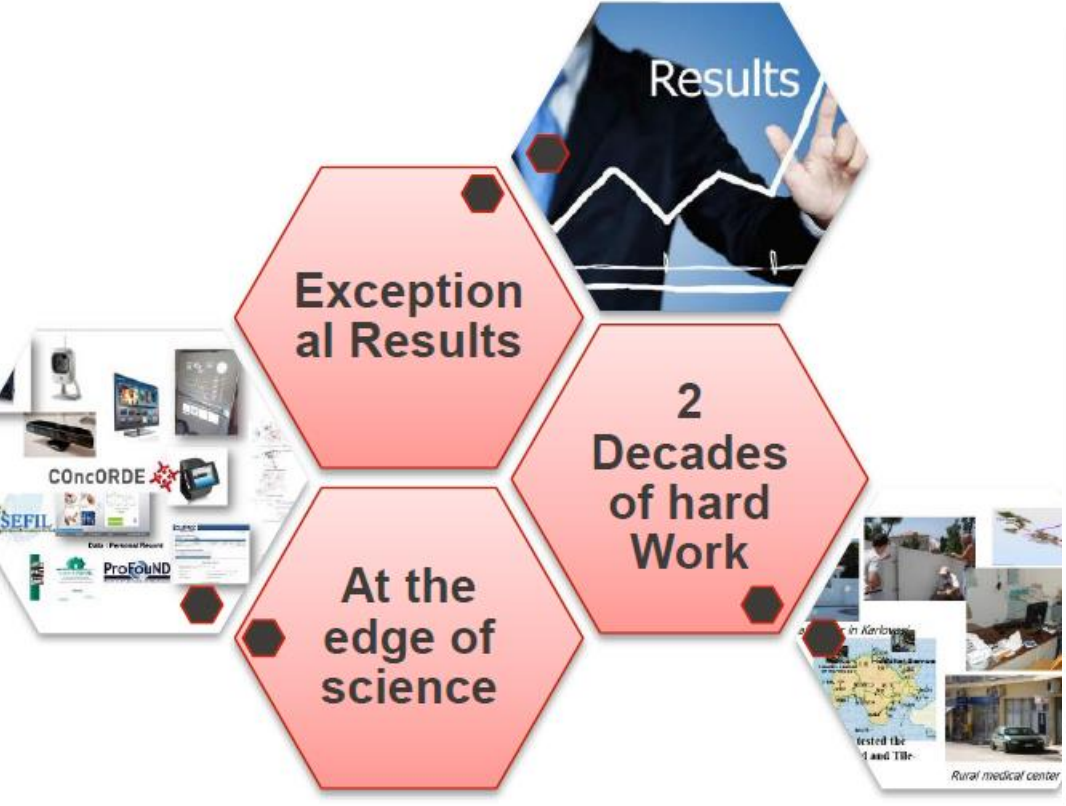
SYNDESIS

Intelligence in Health and Welness

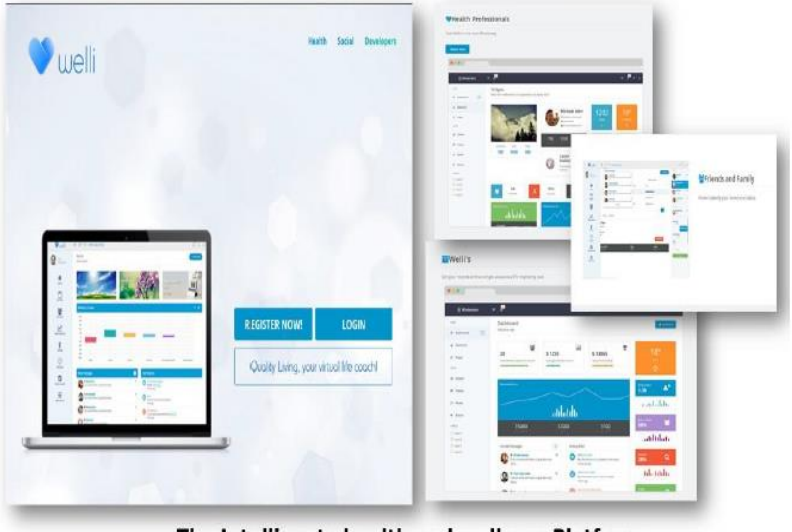
Smarter Heterogeneous Data Sets -SHDS

BIG DATA MANAGEMENT FOR HEALTHCARE SYSTEMS

Background and Motivation



www.iWelli.com



The Intelligent ehealth and wellness Platform

Syndesis ltd – a Spin Of company of NCSR D

Experiment Description

Motivation

There is a growing amount of Big and Heterogeneous data in the healthcare industry:

Medical Data:

- Electronic Health records (medical history, claims and billing, doctors notes etc)
- Genomic sequencers
- Devices such as MRIs, x-rays and ultrasounds
- Medical equipment telemetry

Real World Data:

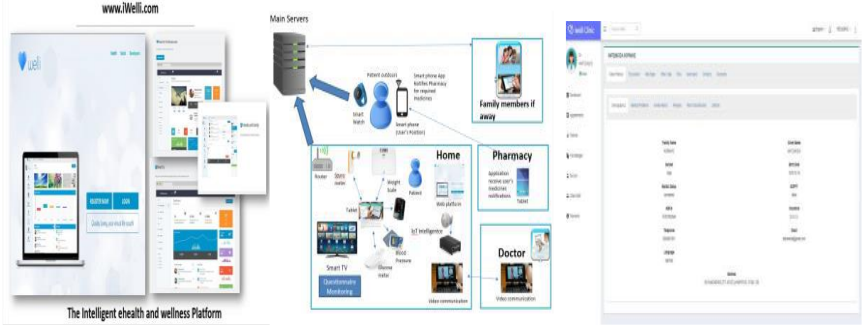
- Sensors and wearables for patients
- Mobile applications

This has made inevitable the adoption of **big data management techniques <u>to improve the quality of healthcare delivery</u>**.

Background

The clinic.iwelli.com platform is part of the iwelli.com ecosystem of applications enabling doctors to **store and manage heterogeneous data**.

The clinic.iwelli.com is more than an EHR.



We are working towards an **<u>intelligent platform</u>** that will allow the:

- storage,
- the digitalization
- and the analysis

of the stored data streams.

Experiment Description

Concept

1.The clinic.iwelli.com platform enables doctors **to store** heterogeneous data.

2.We try to **extract information** out of the heterogeneous content we store in the iwelli.com platform **digitising and analysing** all images and documents stored in the platform using machine learning capabilities.

3. **Generate fully automated service (scripts)**.

4.The experiment concept concerned the **usage of the Tengu as a platform for big data experimentation** together with open source frameworks (HAPI FHIR Server, ElasticSearch etc) to allow us to store and analyse clinical heterogeneous data **at a comparable quality with professionals' web platforms**.

5. Test and compare the iwelli Tengu instantiation versus **the FHIR Google platform**

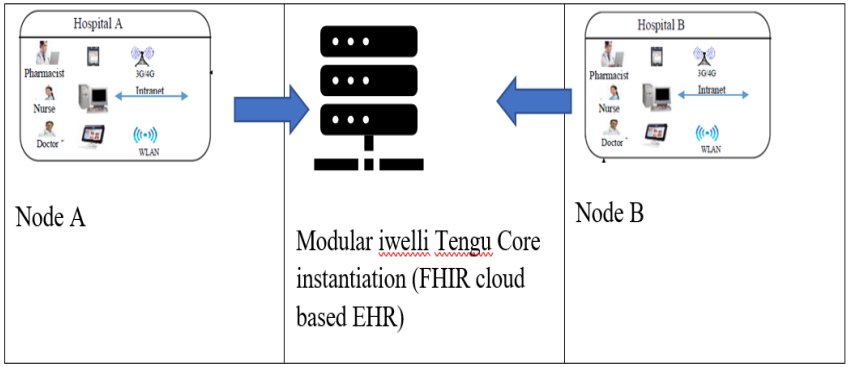
Objectives

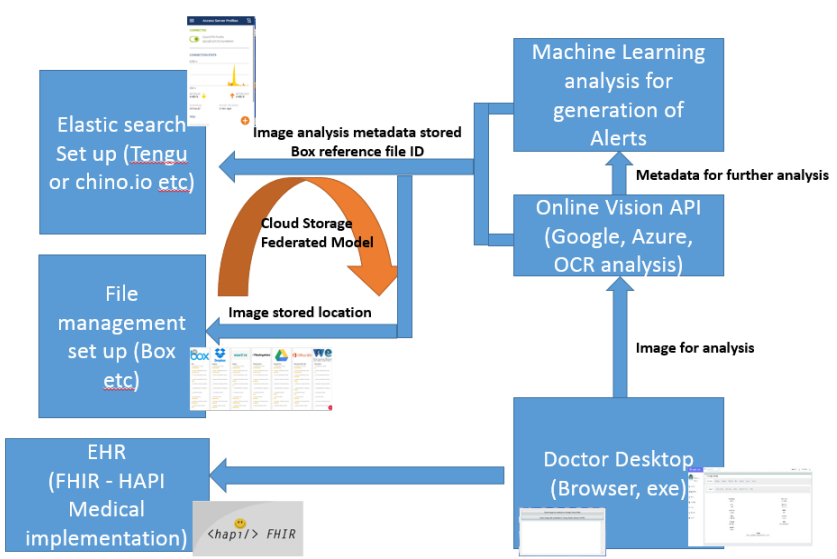
Specific Objectives were:

- Obj1.LeverageTengu cloud-based platform functionalities and apply **smart data aggregation** and **cloud storage federation model** on the stored content developing automated intelligent services.
- Obj2.Automate the service that will apply **optical character recognition (OCR)** to the documents stored in the Tengu platform, decoupling the management of file metadata and data.
- Obj3.Automate the service that will apply **image recognition and relevant generation of alerts to the stored diagnostic images like MRI images** to the Tengu platform.

Experiment Set Up

We set up in Tengu an instantiation of the FHIR EHR platform.



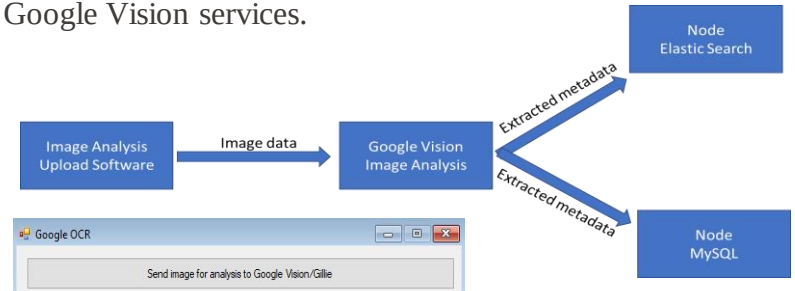


The proposed architecture for interchanging data using the FHIR standard **provides rules** about how data contents should be exchanged.

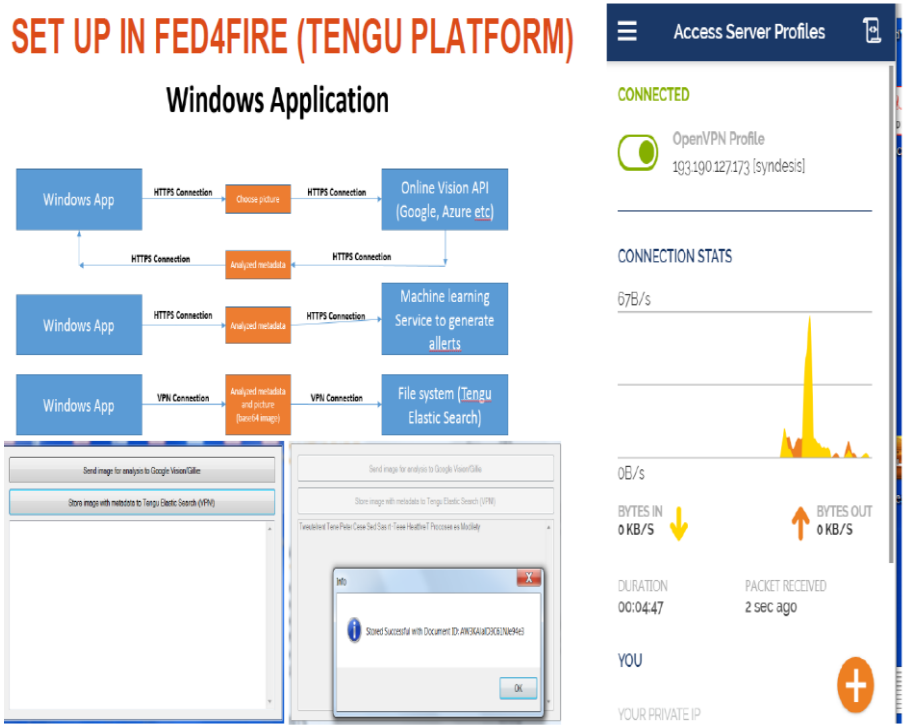
We adopted a **cloud storage federation model integrating multiple cloud storage providers** into a single virtual storage pool, improving data availability, storage scalability and data processing performance

Experiment Set Up

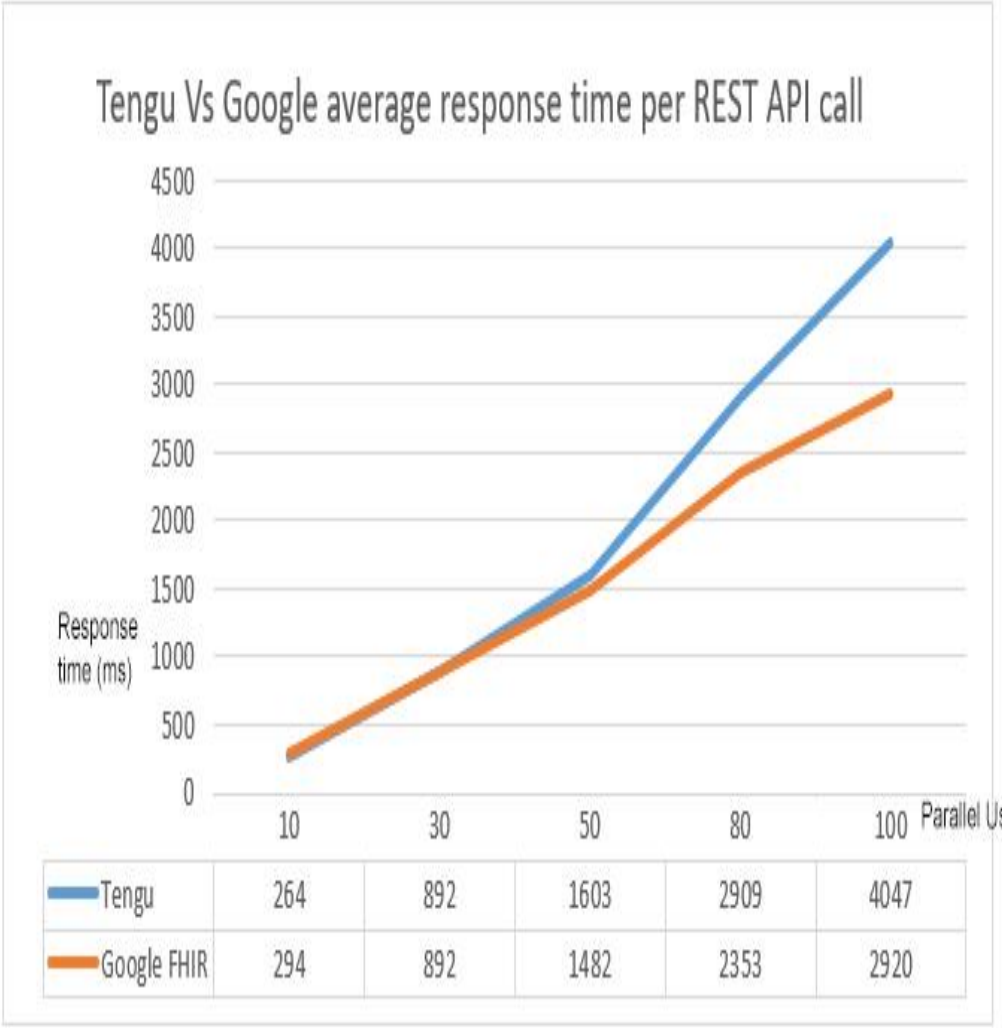
We developed a software script to automate the process of storing the image metadata after uploading an image into the Google Vision services.



Use case: The doctor uploaded a diagnostic image in the iwelli Tengu EHR and we were sending that image file to an image viewing platform to analyse it eg OCR or flag abnormalities as labels and then apply these labels as file metadata in the Tengu FHIR Server.



We accessed the servers in the Tengu platform **though an OpenVPN** profile.



Project Results

Project results

MEASUREMENTS

We produced a **set of outcome measures that was used as endpoints in** measuring the effectiveness of the applications we used in the Tengu platform in terms of end-to-end message travel delay times and others.

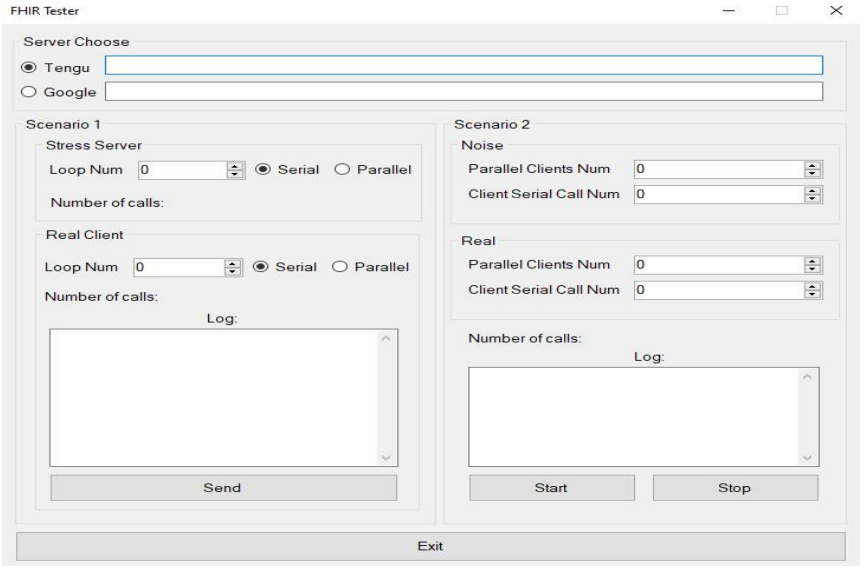
We **performed tests to the deployed HAPI server** in the Tengu platform in order to compare the effectiveness of the platform compare to the Google Cloud FHIR platform relative to end-to-end message travel delay times.

We developed a software that allows us to send data into the FHIR server synchronously and asynchronously. In this way we can emulate multiple current user access.

We measured end-to-end message travel times in the presence of variable platform loads in the background.

We measured from another service **the time delay** between publishing a message and receiving it on a subscribed topic.

MEASUREMENTS



The testing software has been developed using Microsoft C#. The two platforms compared are:

- HAPI FHIR platform installed in TENGU server (Server's Specifications are attached)
- Google FHIR services included Cloud Healthcare API.

Project results

MEASUREMENTS

Five stress testing scenarios have been simulated in both platforms using the testing software. **We begin by increasing the number of parallel simultaneously users.** The testing software simulates:

- Ten simultaneously users make one hundred serial REST API requests (GET) to the platform (1000 REST API calls in total).
- Thirty simultaneously users make one hundred serial REST API requests (GET) to the platform (3000 REST API calls in total).
- Fifty simultaneously users make one hundred serial REST API requests (GET) to the platform (5000 REST API calls in total).
- Eighty simultaneously users make one hundred serial REST API requests (GET) to the platform (8000 REST API calls in total).
- One hundred simultaneously users make one hundred serial REST API requests (GET) to the platform (10000 REST API calls in total).

Each REST API call response is measured providing us with a total average REST API call response for each scenario and platform.

MEASUREMENTS

GET REST API CALLS	TENGU (average response time/call) ms	GOOGLE (average response time/call) ms	TENGU CPU Usage (%)	Successful transactions
10 parallel clients sending 100 serial calls	264	294	100%	100%
30 parallel clients sending 100 serial calls	892	892	100%	100%
50 parallel clients sending 100 serial calls	1603	1482	100%	100%
80 parallel clients sending 100 serial calls	2909	2353	100%	100%
100 parallel clients sending 100 serial calls	4047	2920	100%	100%

Total average REST API call responses for both platforms in milliseconds

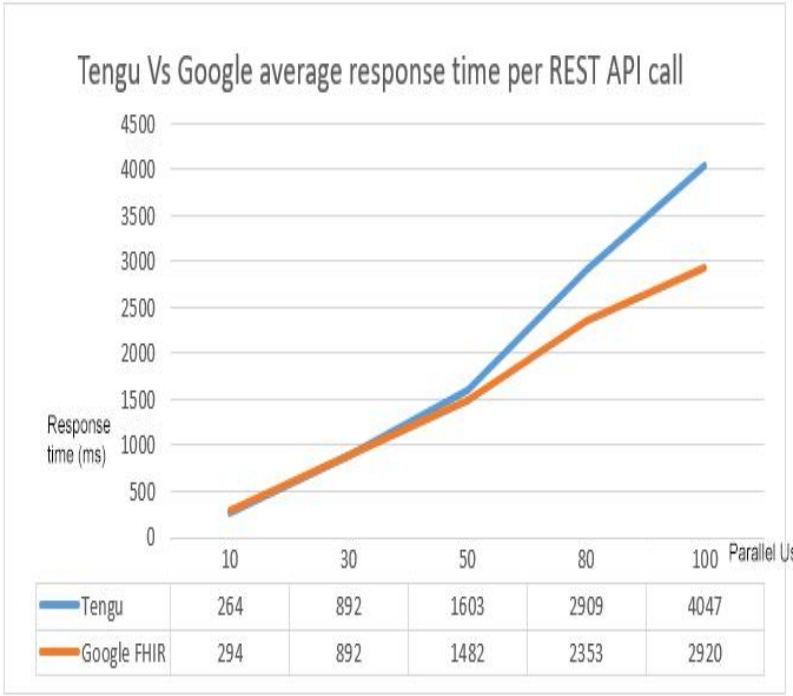
Project results

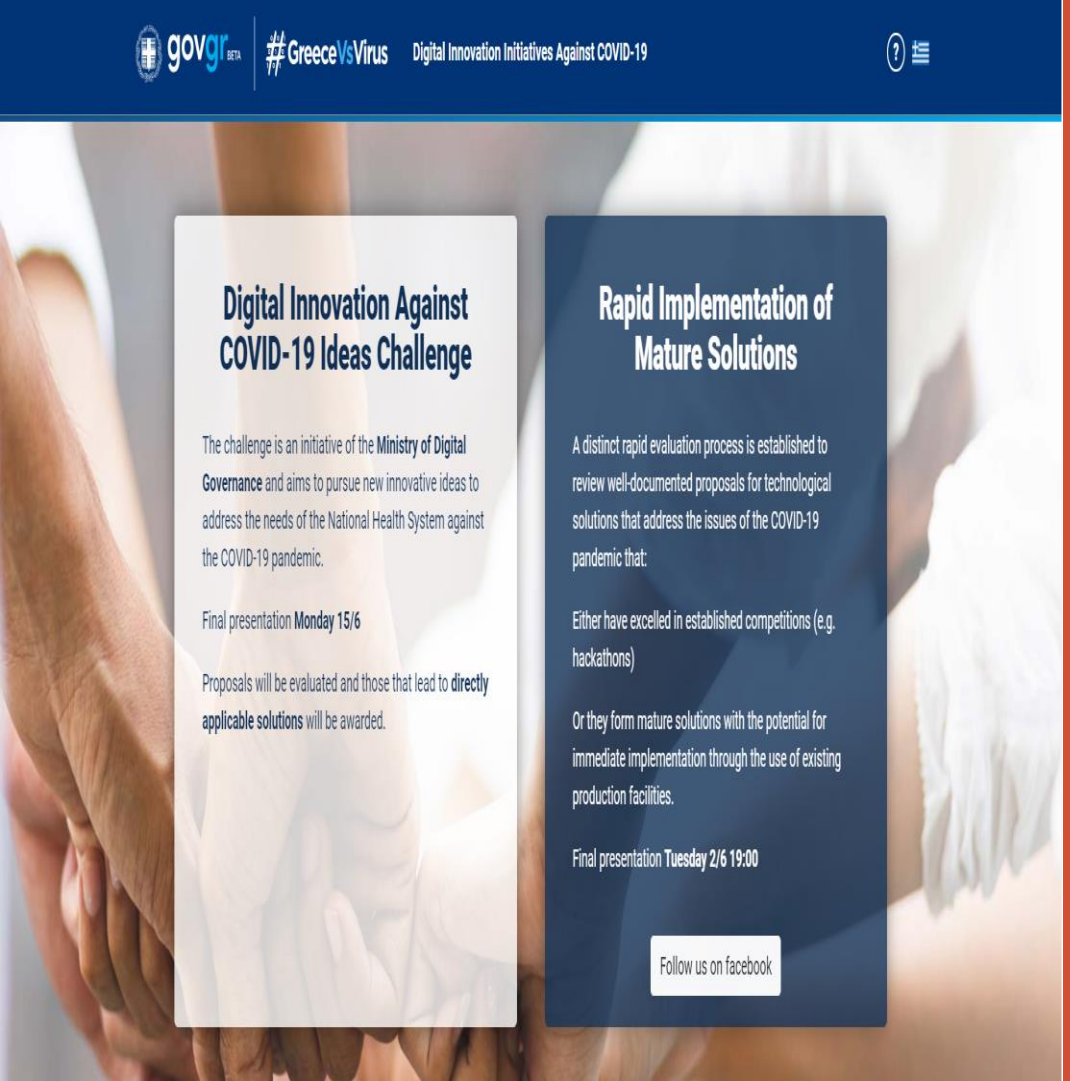
LESSONS LEARNED

Although performance tests and FHIR servers were not on the same machine and **some notable limitations to this analysis were not considered (**network latency, variations in the host OS and test scenarios are a limited to a basic load test) we learned that:

- **Hapi server above all is a good fit** for supporting EHRs cloud based implementations and it will be less costly than GCP.

However, considering the limited test we conducted in the SHDS experiment, although Hapi may be a good pure FHIR server, anyone considering using Hapi as a base server for their application, **should do a more thorough investigation into more performance characteristics such as the search implementation and others.**





Business Impact

Business Impact

IMPACT ON SYNDESIS BUSINESS

The experiment allowed us **to test methods to automate the digitalization** and creation of metadata of all data forms (images, documents).
The produced metadata were accessible from applications **generating useful intelligent services of diagnosis and prevention**.

We incorporated some of the results in our professional platform clinic.iwelli.com that we offer to the healthcare professionals.

Furthermore the experiment is part of the tests and validations we are conducting to further update the iwelli.com suit of services. We used this experiment to **validate the HAPI Server and different implementations and compare it with the professional services of the Google platform.**

Now we have two alternative installations of the iwelli.com EHRs:

- The one we are using for the clinic.iwelli.com platform for B2C services.
- And one that is using the open source instantiation we tested in the SHDS experiment. For the customers that are asking for their own server we are using the installation we created in Fed4Fire SHDS experiment. Within this realm we are implementing a similar instantiation we did in the Tengu platform in the municipality of Hrakleia, East Macedonia, Greece.

Since the validation test was successful, **we intend to try** for the 2nd stage (objective 3) to further test the security of the services.

Business Impact

IMPACT ON SYNDESIS BUSINESS

The results of the experiment **helped us further improve the clinic.welli.com platform that is ready for the market**.

SYNDESIS LTD participated with the clinic.iwelli.com application to the challenge of the Ministry of Digital Governance aiming to pursue new innovative ideas to address the needs of the National Health System against the COVID-19 pandemic.

The clinic.iwelli.com application **evaluated as one of the 15 most mature solutions out of 160 submitted proposals**, that can lead to directly applicable solutions against the COVID-19 pandemic.

We are in the process to implement part of the clinic.iwelli.com platform **using the results of the SHDS experiment** (set up the whole service using the Happi server) for a customer.

Also we are implementing this instantiation in the municipality of Hrakleia and we will implement the Tengu instantiation together with NCSRD, to a municipality in North Macedonia.

https://covidhackgr.gov.gr/index-en.html

https://www.facebook.com/GreeceVsVirus/photos/a.114865393519171/130300145309029/?type=3&theater

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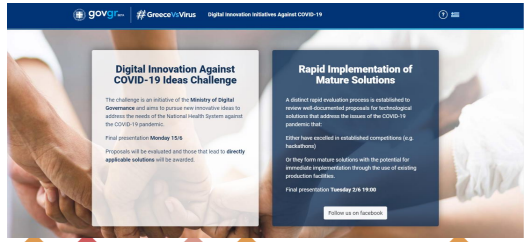


Business Impact

VALUE PERCIEVED

Fed4Fire experimentation gave us a competitive advantage over the competition of traditional EHRs since we managed to:

- Offer **online machine learning capabilities** to clinic.iwelli.com platform
- **Automate the digitalization** of some forms of files and images stored in the platform
- Allow doctors **intelligently manage** their unstructured data in the cloud.
- Allow us to move **from Big data to Smart data**

Business Impact

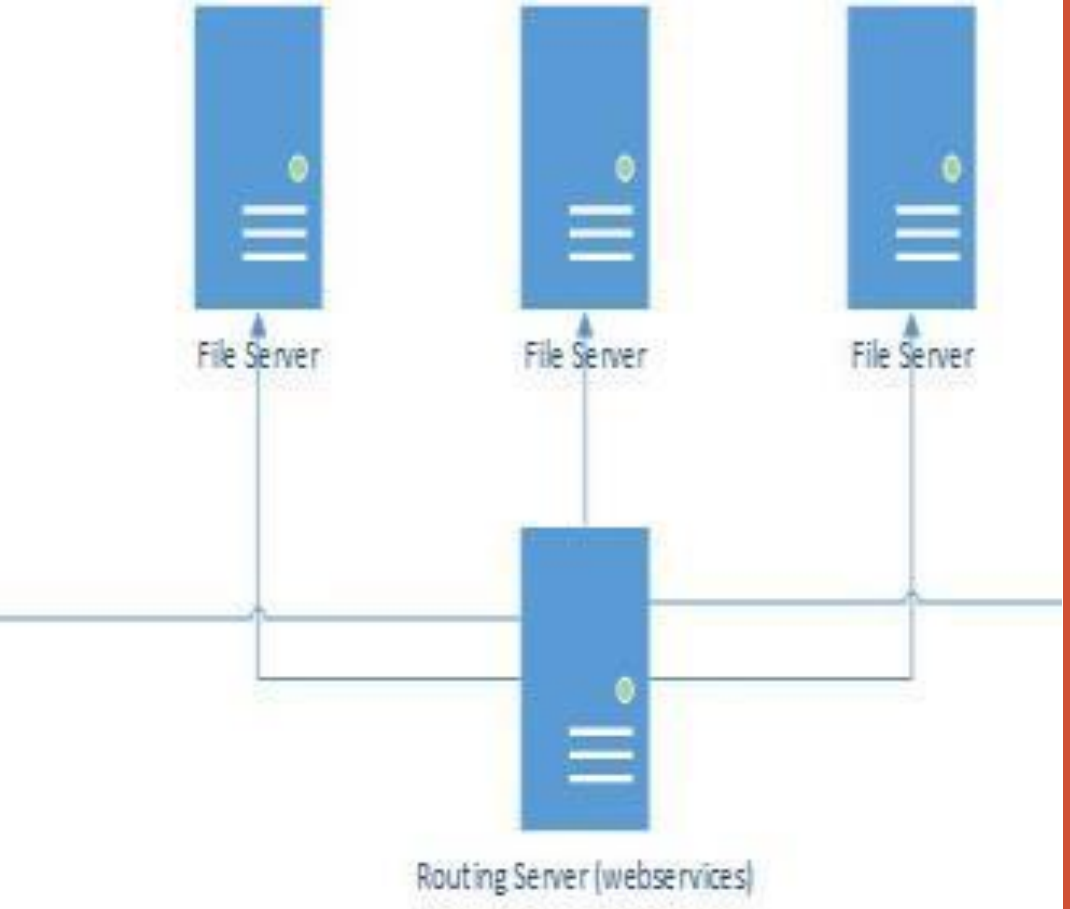
VALUE PERCIEVED

Fed4Fire helped us to gain knowledge and test the **reliability of a practical implementation** of an FHIR EHR open source solution **for healthcare practitioners** and SMEs that are working in the e-health domain.

The results showed us that this implementation **is a reliable solution** to work with and build professionals services with this.

Without this experiment we would not be sure about the reliability and scalability of the implementations of some of the services we are now offering.

Fed4Fire helped us to **accelerate the decisions** taken to implement specific services.



Used resources and added value

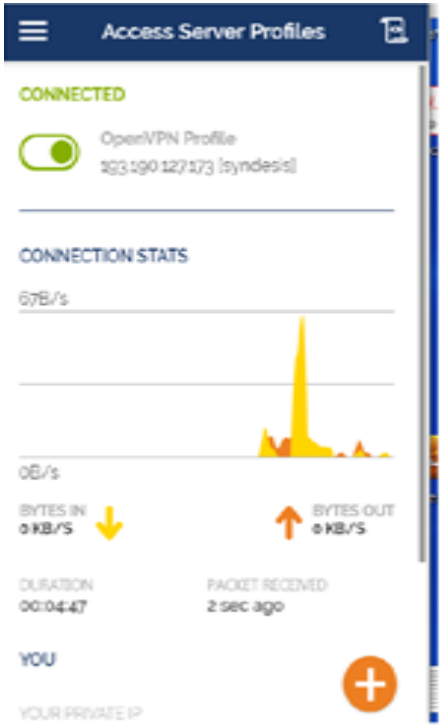
FeedBack

USED RESOURCES AND TOOLS

We conducted the experiments with a cluster formed by 3 nodes with settings:

Database		**MySQL**
Database		Elastic Search
Web server		Tomcat 7.0
Software test		HAPI FHIr Server
VPN		OpenVPN

Other			
	Tengu – big data (imec)	Yes	3 nodes were provided for our tests. 10.10.139.203 Node 1 (Elastic Search) 10.10.139.139 Node 2 (MySQL) 10.10.139.135 Node 3 (UBUNTU 18.04 Virtual Machine)



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FeedBack

USED RESOURCES AND TOOLS

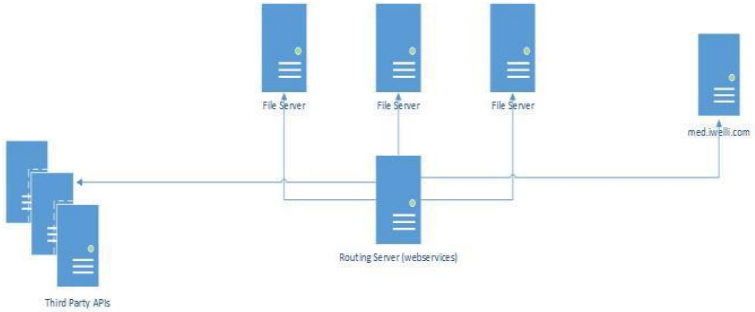
Technical specs of the testing nodes:

1.Tengu Platform (3 nodes):

Elasticsearch:10.10.139.139 : Intel(R) Xeon(R) CPU E5645 @ 2.40GHz
MySQL: 10.10.139.135 : Intel(R) Xeon(R) CPU E5645 @ 2.40GHz
FHIR Server: 10.10.137.203 : Open Source EHR where we host the medical patient data in HL7 -FHIR format which are loaded into JSON documents into HAPI server: configured with an Intel CORE™ i7-4770 processor (3.40GHZ, 1 Cores, 1GB RAM, Linux).

2. File Management system node:

The storage service is our main storage file management system where all files (Images,PDFs, ECGs) are secured stored into this platform that is a cloud content management and file sharing service. Storage size: 10GbMax file size:250mb



FeedBack

ADDED VALUE FROM FED4FIRE

The Added Value of Fed4Fire concerns the **low cost (free) environment for testing of big data techniques** and models using standardised technologies.

It allowed us to experiment with different models in real test bed **without worrying about creating the backend infrastructure**. This allowed us to identify the best solutions for the services we are offering.

For the first phase the learning process as well as the setup of the experiments were easy. **We had support from the patron and the choice to choose and set up the experiment** out of many available resources and the tools offered.

FeedBack

ADDED VALUE FROM FED4FIRE

Access to resources that **otherwise would not be affordable** (compare to the cost of AWS, GCP etc) and the availability of tools (Tengu platform with no cost) to experiment with new instantiations and validate open-source platforms compare to expensive cloud-based services.

We did the experiment at an available testbed infrastructure like the Tengu **with high bandwidth platform and with zero operational costs.**

We believe that Fe4Fire can help us:

- Further support and scale our services providing us with more tools like security tools , or allow us to implement in this infrastructure open-source tools
- Low the barriers for SMEs to set up and experiment with big data technologies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Co-funded by the Swiss Confederation

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WWW.FED4FIRE.EU