A Cloud-Based Collaborative Virtual Environment

1 Problem statement

Recent years have witnessed a huge spread of information, with an increased expectation to stay connected at all times. This is also true for professional environments where being physically present at the office is becoming less relevant. However, this connectivity requirement comes with various challenges:

- There are many legacy applications around that are not accessible via the Internet;
- Not working together physically requires other means of being able to collaborate;
- Making information widely available requires good protection of the information assets during their storage and/or exchange.

As a result, there is a growing need for professionals to have a safe and reliable environment for teams to cooperate remotely.

2 Approach

Over the last three years, Institut Mine Telecom[i] (IMT), Prologue[ii], and Technolution[iii] have participated in the MEDUSA[1] research project to facilitate this transition. MEDUSA proposes to enhance the quality of diagnosis and decision making in acute and/or critical situations of a patient's condition, by providing a secure virtual workspace as a service, advanced image analysis as a service, and medical diagnosis support as a service. The challenges described previously were the main focus of this project.

This resulted in a solution with several breakthroughs:

- It provides a secure collaborative environment for professional teams;
- It includes tools to virtualize legacy applications in the cloud, without any code rewriting;
- It is highly scalable, with dynamic cloud resource management capabilities.

These points are further explained in the following paragraphs.

2.1 Secure collaborative environment

A web-based virtual collaboration framework has been developed by Technolution. Teams logon and work together in a single environment: they can share information, chat, use video conferencing, etc. As such, this is not unique: many solutions are available that offer screen sharing and video conferencing.

However, there are two aspects that make MEDUSA unique: it is not only about screen sharing, but also sharing actual application sessions in real-time. For example, in the same online collaboration session, one doctor can have the medication history of a patient and shares this information with his/her fellows. Another doctor has a local imaging application and shares the content with the team. MEDUSA is the platform where it all comes together, which maintains the integrity of the data by making sure that everyone is looking at the same patient data and interacting on the same content.

The second aspect is about security: participants can only view the information if they're allowed to see it. Security in the context of MEDUSA is a tough subject: there are many different applications, operating on different clouds. How does one guarantee the security of the data in such a context? A thorough analysis has been made to identify all possible threats and risks of the system. As a result, the newest security techniques have been applied and developed. Although mostly transparent to the user, the environment is very secure, and adopts a well-thought combination of techniques like: identity management, single sign on, secure and encrypted communication, reverse proxy, and firewalls.
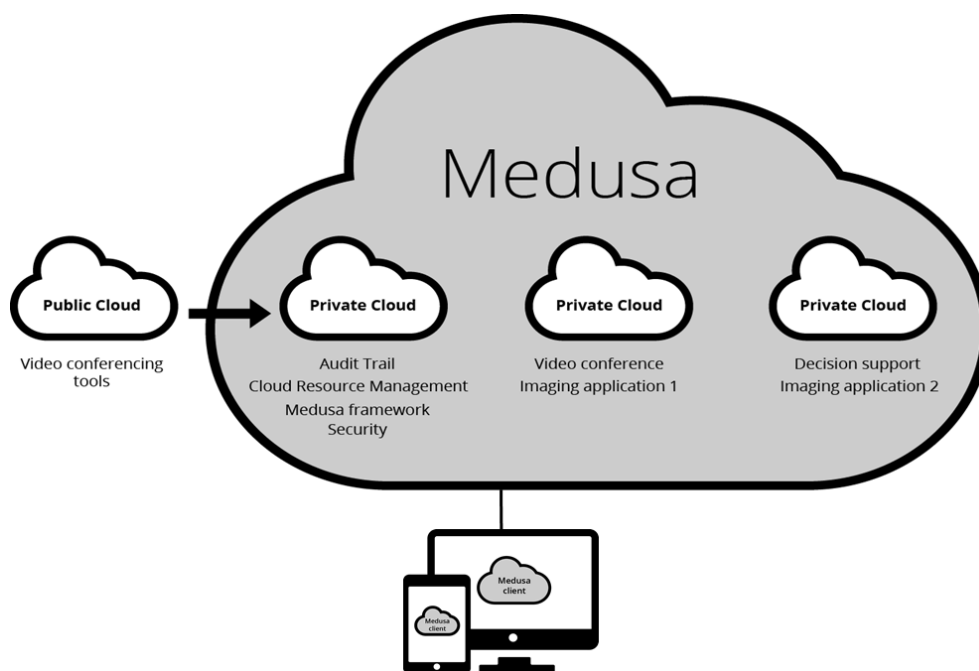

Figure 1: Virtual collaboration workspace

Figure 1 illustrates how the collaboration workspace is built-up:

- The cloud resource management module by Prologue (see section 2.3) handles the dynamic provisioning of applications on various cloud providers, as well as their lifecycle management;
- The browser-based framework offers an integrated access to these applications;
- Authenticated users connect from any device and start or join collaboration sessions through this web framework.

2.2   Legacy adapters

A large percentage of the software applications in the field are not designed to be used via the Internet. Actually, they are rather designed to be installed and accessed on a fixed computer, with a given operating system and storage/processing capabilities. In order to use these applications in the cloud, irrespective to their particularities, the concept of a 'legacy adapter' has been put forward: it is a software module serving as an interface between the legacy application and the online user. The legacy application can then be directly (with no code rewriting) run on a virtual machine in the cloud and be accessed from anywhere, with any device (PC, phablet, tablet, smartphone, etc.) through the adapter acting as middleware.

Moreover, some legacy applications are not designed for shared user sessions. Collaboration on these applications is then made possible with the adoption of a virtualization component that efficiently captures content from a remote machine and makes it available to other users as HTML5 content rendered on the browser. This technique does not require any modifications to the legacy applications' code or any local installation of the application. That way, in the MEDUSA context, authenticated users with proper access rights can participate in content-driven medical collaboration sessions, by viewing and interacting on the shared content related to a given patient through their preferred web browser. The adapters and virtualization components for MEDUSA have been implemented by IMT.

2.3   Cloud management

Several applications make use of software and hardware resources that do not necessarily need to be assigned in a permanent mode for a specific task. For example, during an event or a large calamity, many resources may be required, but when the event is over, these resources can be freed up and used for other purposes. Therefore, all software components composing the MEDUSA system are deployed on a cloud infrastructure, in order to take advantage of the on-demand, flexible, high-performance, and cost-effective options that cloud providers can offer. The deployment is managed by the cloud management layer, implemented by Prologue.

The cloud management platform orchestrates the on-demand allocation and release of resources on the cloud provider's infrastructure, and acts as an intermediary between the MEDUSA client environment and the cloud resources. It also oversees the lifecycle of the deployed resources, ensures their availability and scalability, and links the legacy applications from the virtualization server back to the collaboration workspace client environment.

At the core of the cloud management layer lies the cloud broker component. It is the result of various research projects that are transformed into a commercial platform operated as a service (called Use it Cloud Broker, or UiC-B). UiC-B selects cloud resources and services that meet customer requirements (technical, operational, regulatory). Moreover, it permits running applications on multiple clouds, leveraging specific features of each cloud, and seamlessly managing multiple cloud providers. This platform wraps several cloud APIs and offers a uniform and secured way to provision and deploy workloads across different IaaS and PaaS services. It also incorporates a monitoring service that operates by accessing directly the VM resources deployed, and has the possibility to integrate other monitoring solutions from the cloud provider as well.

UiC-B is aligned with the Cloud Computing Reference Architecture of the National Institute of Standards and Technology (NIST) and based on OCCI (Open Cloud Computing Interface specifications). It is independent from any cloud provider and can integrate all cloud services' existing and future characteristics. It brings important features, such as interoperability, portability, manageability, governance, security, and quality of service on all cloud layers.

In the MEDUSA context, technical requirements for computing, storage, network, and security resources have been identified for each application to be deployed. In addition, business, and policy requirements of applications can be defined. All requirements are then translated into machine-readable code used by UiC-B engine to provision resources. More specifically, they are described in an XML template that is general-purpose, extendible, and reusable.

Finally, it is worth noting that the cloud management platform by Prologue is designed as a Service-Oriented Architecture with a REST API.

2.4   Reusability

The MEDUSA architecture is open and flexible. One of its strengths is that it utilizes available techniques in an innovative setup. For example, video conferencing based on the WebRTC protocol, which is a readily available solution, is integrated in a safe manner in the context of MEDUSA. Proprietary applications can easily be integrated and configured in the collaboration workspace.

3   Results and future work

The integration of the various developed components has resulted in a powerful collaboration environment that can be used by professionals. An illustration of this workspace is shown in Figure 1.
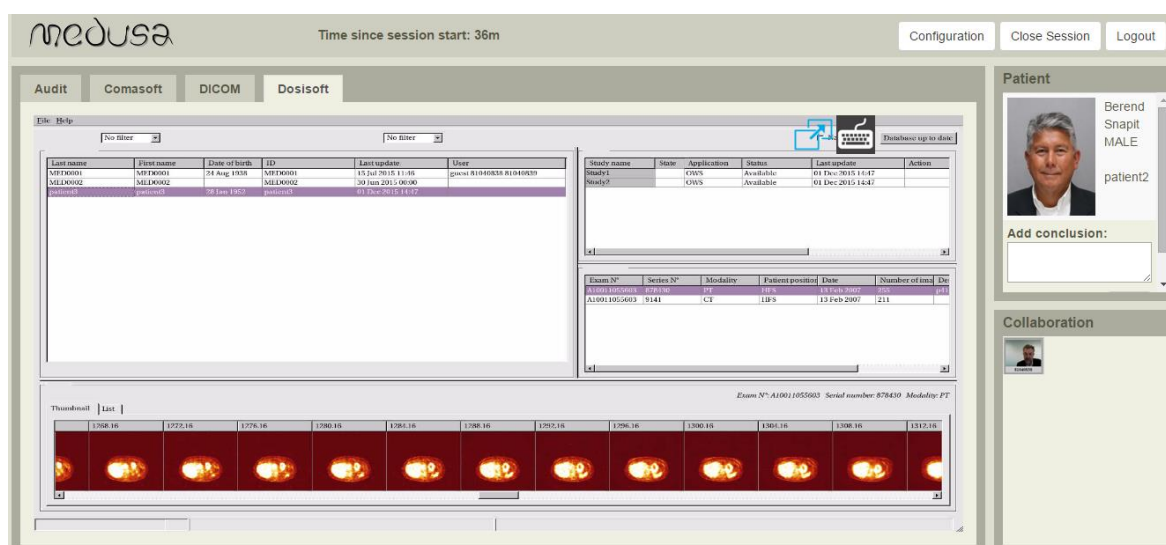

Figure 1: Screenshot of MEDUSA collaboration workspace

The MEDUSA project has shown that the combination of the right techniques and partners is able to produce a rich tool adaptable to various domains of expertise. The cooperation among the partners has been very fruitful and will be continued in following projects to extend the system's capabilities and incorporate real-time connected sensor data and intelligent big data analysis.

This article was written by the following partners participating in the MEDUSA ITEA2 project:

[i] **IMT**

Institut Mines-Télécom is a public institution dedicated to higher education and research, under the aegis of the Ministries for Industry and Digital Technologies, working on a broad spectrum of themes and with extensive geographical coverage to boost innovation policies. Always attentive to the economic world, it combines strong academic legitimacy, close corporate relations and a unique focus on 4 key transformations of the 21st century in Digital Technologies, Energy, Ecology and Production. Its activities are conducted in 9 engineering schools and 1 business school: Mines Albi, Mines Alès, Mines Douai, Mines Nantes, Mines ParisTech, Mines Saint Etienne, Télécom Bretagne, Télécom ParisTech, Télécom SudParis and Télécom École de Management, as well as two subsidiary schools: Eurecom and Télécom Lille. It has close relations with two strategic partners, Armines and Mines Nancy, part of Lorraine University. Finally, 13 "Institut Mines-Télécom Associate Schools" complete the overall organization.

The Institut Mines-Télécom schools rank among the leading graduate schools in France. Their activities geared towards the main economic players and including training for engineers and managers, Masters and PhD courses, research and innovation, are recognized nationally and internationally for their excellence.

Institut Mines-Télécom plays an active role in national research programming alliances. The quality and intensity of its research partnerships have also been rewarded by two Institut Carnot labels in 2006, renewed in 2011. Each year, some one hundred start-ups come out of the schools' incubators.

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[ii] Prologue

Founded in 1986, Prologue Group delivers solutions in three key areas that are fundamental to an optimized IT solution servicing the private enterprise or public sector organizations:

• Cloud Computing with a brokerage platform for tailoring cloud solutions to the needs of each business and tools for porting and managing applications in the cloud with optimized, controlled, and cost-effective deployment.

• Unified communication including telephony and fax over IP systems that are fully integrated within the enterprise information system.

• Enterprise Content Management (ECM) and Exchange (EDI) solutions of all business documents: incoming and outgoing flows of documents, internal documents (including all formats and types of media, both paper and electronic), whether intended for customers, suppliers, administrations, partners, or employees. Prologue delivers solutions to manage multiple flows of documents related to critical processes in the enterprise.

The know-how of the group is concentrated in three entities: Prologue s.a., Alhambra Eidos, and Imecom Inc., which together offer a perfect combination of skills and services to deliver optimal technological solutions.

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[iii] Technolution

Technolution is an innovative project agency specialized in technical automation. It is developing hardware and software solutions for technical information systems and embedded systems. Technolution strives for long-lasting relationships with their customers. In the Technolution way of working the focus is always on well-functioning solutions and customer-oriented thinking and acting.

Technolution has been in business since 1987 and is growing at a controlled speed. Currently Technolution has 170 employees.

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