

MEDUSA

DELIVERABLE

D6.2.4 – Final Exploitation – Standardization plan

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medusa

Medical Distributed Utilization of Services & Applications

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1 Executive summary

At this moment huge efforts across the world are being put into developing healthcare concepts into the cloud. Companies are identifying the rules and regulations associated to storing and accessing medical data in and from the cloud. Many of these initiatives however do not take into account the possibility to collaborate on medical records and the integration of legacy applications into a cloud solution.

The design of a truly successful solution requires that specialized legacy applications and their associated data can be access from the newly developed cloud environment, giving the same level of collaboration and accessibility from anywhere as all the new innovative applications. MEDUSA solutions, concepts, tools and architectures are developed from that vision. The expected results can immediately be applied to the cloud based medical application products of the future and thus give Europe a strategic advantage in this world-wide new field.

This deliverable has been produced to describe how results from MEDUSA can be directed to the market, and takes as a starting point the description of which is the result that will be exploited. In this section every partner has identified an inventory of exploitable assets. These can come from different categories of results:

- Devices and Applications
- Knowledge
- Patents and Standards

Next, every partner has identified the market regarding results obtained in MEDUSA (markets, targets in each market, analysis of competitors, substitutive products, barriers, catalysts ...) within an individual exploitation plan. These exploitation plans per partner include benefits resulting from MEDUSA in each organization, and identifies the exploitable areas of work and concludes with a summary of Action Plan and ROI.

This deliverable provides detailed explanation of exploitation actions that are going to be followed by each of the partners of the consortium. These individual plans can be taken as a referent for defining exploitation actions that can be directed to the market.

The document is structured as follows:

- | | |
|---------------------------------|--|
| • Executive Summary | Current chapter |
| • Introduction | Gather general goals of the project, Consortium description |
| • Results | Provides background information on the results obtained from the project |
| • Market Analysis | Gathering market opportunities from MEDUSA to each partner |
| • General Exploitation Plans | |
| • Individual Exploitation Plans | Explains how MEDUSA results can be directed to the market |
| • Dissemination Activities | |
| • Standardization | |

2 Introduction

2.1 General goals

Medical knowledge is growing at high speed and enables us to increase the wellbeing and life expectancy of patients. Expanded knowledge comes hand in hand with high levels of specialization and an increasing need for information about a patient's condition. In situations where the patient's life is at stake, the support of various specialized physicians is often needed and direct access by these physicians to all relevant knowledge for the given patient is crucial. In practice, the required physicians may be located anywhere in or outside the hospital and instant access to all relevant information about the patient's condition is cumbersome.

Physicians should be able to retrieve actual patient images, highlighting their specific point of interest. It should also be possible for physicians to have these patient images processed according to their own requirements and brought to the actual place of work *wherever that may be*. If the different views of the involved physicians could be brought together in a virtual collaborative workspace, geographically dispersed physicians could consult each other, react on each other's diagnosis, and together come to a collective decision on the treatment and how to optimally counteract the attendant risks.

The MEDUSA project addresses these issues by linking the required levels of knowledge and expertise into a *collaborative diagnosis and treatment support workspace*. Actuality, availability and privacy protection are key quality factors in this workspace. MEDUSA aims to provide a new service concept by introducing:

1. Advanced imaging as a service, by which MEDUSA
 - Ensures the efficient exchange of medical information while satisfying the high levels of safety, security and privacy required for such a secure environment;
 - Supports and encourages the appropriate use of both remote and local advanced medical image processing in real-time, such that the medical professional obtains the required level of detail of information;
 - Supports transparency with respect to geographical location, both fixed and mobile.
2. Secure virtual workspaces as a service, by which MEDUSA
 - Supports a collaborative workspace in a professional medical situation, where knowledge, capabilities and patient data are brought together and made available for clinical processing, respecting medical regulations and clinical procedures and protocols. This is an area where traceability, latency and interoperability are crucial issues;
3. Medical diagnosis support as a service, by which MEDUSA:
 - Enables physicians to virtually group around a patient for diagnosis and treatment decision making

2.2 The MEDUSA vision

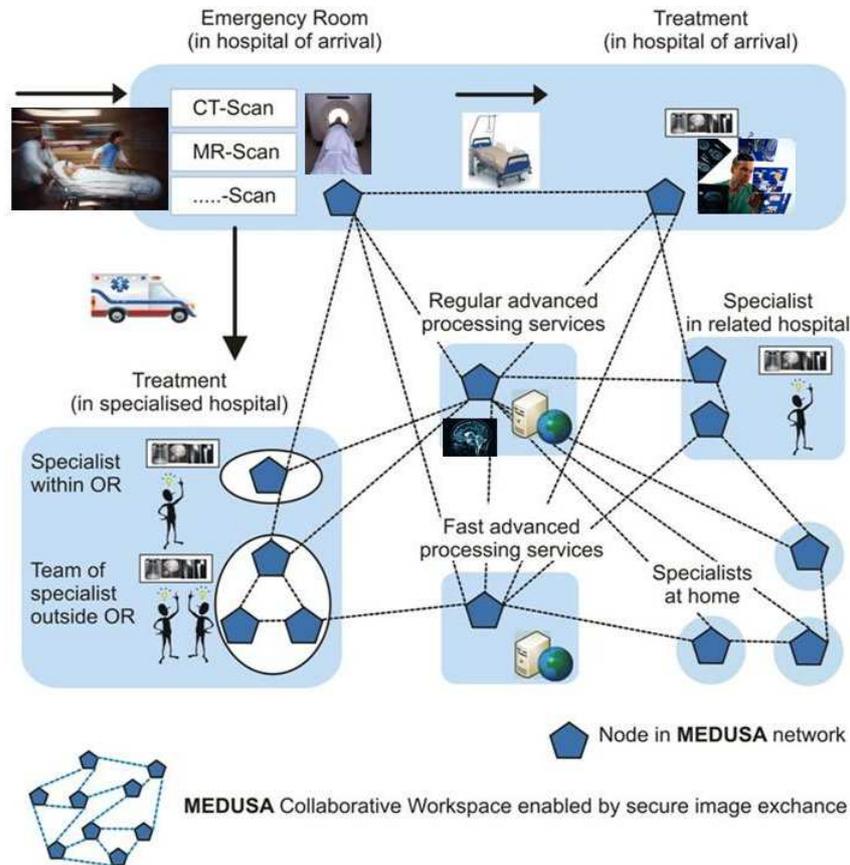


Figure 1: Illustration of MEDUSA's distributed collaborative workspace

The envisaged collaborative workspace is schematically illustrated in Figure 1. Physicians can share images and other relevant medical information (e.g. laboratory results) in real-time, while safeguarding the patient's privacy. In doing so, the appropriate physicians virtually group around a patient for diagnosis and treatment decision making. In many cases a patient cannot wait for the physical grouping of these physicians. To assist the virtually grouped physicians in their joint diagnosis, physicians have interactive access to advanced image processing (e.g. highlighting of specific elements or cropping of information). As such the virtually grouped physicians are able to quickly make an optimal decision, and thereby saving crucial time and possibly even lives.

2.3 Relevance of MEDUSA

2.3.1 Market trends in Healthcare

As a market, healthcare, health & wellness represent up to 25% of the EU economy (when measured in terms of employment, expenditure and added value), making it the largest industry of the economy (source: EC, DG Information Society and Media, ICT for Health - Aug. 28, 2009). The size and growth of the healthcare market is driven by several global trends, leading to formidable challenges for society and healthcare at large:

- Global economic growth: increased spending on health related services, access to healthcare for a larger number of people and increased awareness of available healthcare options
- Dramatic changes in demographics; aging population
 - By 2045 more people will be over 60 than under 15 years, rising from 600 million to 2 billion.
 - Rise in number of patients with age-specific, chronic and degenerative diseases (cardiac, cancer, diabetes, Alzheimer's, Parkinson's). The number of US patients with a chronic illness is estimated to grow to 157 million in 2020.
- Healthcare professional staffing shortages rise, due to higher demand for patient attention
- Efficiency and effectiveness of healthcare: need to further improve hospital work flow efficiency, integration of diagnosis and treatment. E.g. the average length of stay for acute care has fallen in nearly all OECD countries - from 9 days in 1990 to 6 days in 2005
- Skyrocketing healthcare costs: global health care spending expected to grow from 9% of worldwide gross domestic product (GDP) in 2006 to 15% by 2015

MEDUSA takes up the challenge to:

- Improve work flow efficiency, effectiveness of medical treatments (and prevent unnecessary transport of vulnerable patients)
- Contribute to lower healthcare costs by sharing images and expertise
- Deal with healthcare professional staffing shortages by providing expertise through a dedicated virtual expert group

Chronic diseases are now responsible for the consumption of the vast majority of healthcare resources (more than 70% in developed countries) and are inflicting a transition in healthcare practice from acute to - much more expensive - chronic care. For example, cardiovascular diseases alone are responsible for 42% of all deaths in the EU, for 21% of productivity losses and cost the EU economy a staggering €192B a year (source: EC, DG Information Society and Media, ICT for Health - Aug. 28, 2009).

MEDUSA enhances the treatment of chronic diseases by saving time, sharing expertise and enabling novel treatments.

2.3.2 Market trends in Medical Imaging and Collaborative Systems

The global market for medical imaging (diagnostic and interventional imaging) is estimated to be \$20B (2007 TriMark study). The European market is about a quarter of this total and the US market almost half. The medical imaging market records solid

growth percentages. Depending on the modality, the average compound annual growth rate (CAGR) is about 4% (for interventional imaging this is 8%). There are a few specific areas where growth is markedly higher than average.

Image-based software applications that support intervention processes in healthcare

The MEDUSA consortium is active in several medical imaging software segments such as for 3D/4D medical imaging software, clinical decision support systems (CDSS), navigation software and user interfaces. To illustrate these growth opportunities, take a look at historical growth:

- The European market for 3D/4D imaging software has a CAGR of 14% from 2004-2014
- The global CDSS market has grown from €159M to €289M during 2006-2012

Collaborative work is becoming more and more important in almost all the domains of economic life and this in addition to the rising portion of mobile workers. Facing the rapid evolution of technology, and ever increasing competition and constraints, the human capital is considered to be an essential competitive advantage for business entities. Traditional enterprise “static” organizations, aiming at optimization of efficiency and productiveness, move their focus towards creativity. This may be illustrated, for example, by the development of so-called Professional Virtual Communities, built on some kind of collective intelligence with the objective of promoting innovation and maximizing the realization of expert resources. A recent study¹ has shown that workplace innovations account for 89% of multifactor productivity gains.

According to an IDC study the size of the market for collaborative environments in 2004 was \$1.9B. Western Europe had the largest market share with 41.4%. Another study by Gartner Group in March 2006 (Figure 4 below) illustrates foreseen evolution of working styles that will impact the requirements for collaborative interactions between individuals. At the same time, the study highlights the trend in the percentage of individual's performance that will depend on group input up to some 70% in 2015.

MEDUSA leaps into the new possibilities offered by advanced image processing techniques, real-time processing and exchange of huge data sets, in collaborative environments.

2.3.3 Market impact of MEDUSA

Research² (in six countries on avoidable medical examinations) show that between 6% and 18% of all patients experience multiple examinations. For trauma care we face 38,000 patients each year, 20% of which require transfer to another hospital (7,600). If 12% of these patients received a double CT-scan that could have been avoided by MEDUSA, we would save 900 CT-scans with a cost of approximately €1,000 per scan. We could annually save €900,000 for trauma in these countries, not including costs for personnel etc.

¹ source: Black and Lynch, San Francisco Federal Reserve, 2004.

² Peter T. Sawicki, Qualität der Gesundheitsversorgung in Deutschland Ein randomisierter simultaner Sechs-Länder-Vergleich aus Patientensicht, in Medizinische Klinik, 2005;100:755–68 (Nr. 11), Urban & Vogel, München

The total cost for neurological and neurosurgical diseases (including direct medical and indirect cost caused by productivity loss etc.) in Europe is estimated to be €92B each year³. If MEDUSA could decrease the cost for these diseases by just 0.5% (time in brain, faster treatment will lead to better outcome), MEDUSA has the potential of saving more than €40M each year.

The market impact of MEDUSA is particularly relevant for the stakeholders in healthcare:

Stakeholder	Market impact	Envisaged result
Users of MEDUSA		
Hospitals	Provide better care due to: <ul style="list-style-type: none"> Enhanced diagnoses and treatments due to increased availability of physicians and more effective use of knowledge & expertise Reduction of medical errors by offering images for interpretation by remote experts and consultation with their peers Less exposure to radiation for patients due to double scanning Prevention of unnecessary transport of vulnerable patients 	Less lasting injuries and increase in life expectancy of patients
	Enrich jobs of physicians since: <ul style="list-style-type: none"> Expert advice is available Increased independence of physical availability, which allows the hours that a physician has to work to be reduced 	Makes the hospital a more interesting working place, since expertise will be available to other institutes and shared by peers
Hospitals & Health Insurers	Improved efficiency and (cost) effectiveness, due to: <ul style="list-style-type: none"> Less medical staff has to be physically available More effective use of the medical equipment More effective use of images and information (avoiding double scanning) 	Reduction of healthcare costs
Providers of MEDUSA		
Hospitals	Specialized hospitals and data analyses centers can provide medical diagnosis support as a service e.g. to regional hospitals	Hospitals get access to specific expertise and experience that nowadays are not

³ Costs of Disorders of the Brain in Europe, European Journal of Neurology, Volumen 12, Supplement 1, June 2005

		on hand due to the low number of patients
OEMs of medical systems	Can offer – besides high tech image processing machines – advanced image processing as a service to hospitals and their physicians	Hospitals get access to advanced imaging systems that nowadays are too expensive for the low number of patients.
System integrators	Can organize ICT such that they can connect to the virtual collaborative workspaces	Fit in hospitals and OEMs in MEDUSA
Communication providers	Provide secure and highly available communications networks and bring secure virtual workspaces to the healthcare market	Connect partners in MEDUSA

2.3.4 Technical and strategic relevance

The MEDUSA project provides support for a group of medical professionals in collaborative workspaces. As such it addresses the group domain. The project addresses the growing need of medical professionals for sharing medical data and images in a distributed workspace. As such it belongs to the Content & knowledge technology category. Knowledge obtained from the images provides new ways of interacting with the medical professional, increasing their efficiency. As such it also belongs to the Interaction technology domain.

2.4 Project results

The MEDUSA project results can be summarized as:

- A proof point for hosting advanced image processing as a service in a cloud accessible environment
- A proof point for hosting legacy medical applications in a cloud accessible environment
- A proof point for enabling collaborative capabilities to new and legacy applications
- A proof point for enabling development of new medical applications in a cloud based environment
- A proof point for enabling enrichment of (new) medical applications with cloud enabled technologies
- A proof point for securing data, access and collaboration from and to medical applications in a cloud environment

2.5 MEDUSA consortium

The MEDUSA consortium (see Table 1) is composed of 12 companies from 2 countries with relevant experience in the domains related to the development of the MEDUSA concepts and services. This experience is based upon their business activities or from their participation in other European projects.

		Countries	
		NLD	France
Industry	Philips		Bull
			Cassidian CyberSecurity (CCS)
			Prologue
SME	Sopheon		Imstar
	Technolution		DOSIsoft
University	Academic Medical Center, University of Amsterdam (AMC)		Institut Gustave Roussy (IGR)
			Institut Mines & Telecom (IMT)
			Pité Salpêtrière Hospital (HSP)

Table 1: MEDUSA Consortium Overview

The composition and capabilities of the consortium (see Table 2) with industrial partners, SME and Universities gives the project a good consistency to MEDUSA in the following areas:

- Exploitation plans in several sectors of activity
- Dissemination activities that will reach different markets

Partner	Image processing	Secure data transfer	Collaborative workspace	Medical expertise & validation
Philips	√	√	√	√
AMC	√			√
Sopheon			√	
Technolution		√	√	
Bull		√	√	
DOSIsoft	√			
CCS		√		
Imstar	√			
IGR	√			√
Institut Mines & Telecom	√	√	√	
HSP	√			√
Prologue			√	

Table 2: Consortium Capabilities

3 Results of the MEDUSA project

3.1 MEDUSA detailed results overview

Medical knowledge is growing exponentially, enabling us to boost the wellbeing and life expectancy of patients. This growing knowledge comes hand in hand with high levels of specialization and an increasing need for information about a patient's condition. In situations where the patient's life is at stake, the support of various specialist physicians is often needed and direct access to all relevant knowledge for that patient is crucial. The missing piece in the puzzle is a virtual collaborative workspace (see Figure 2) so that physicians, wherever they are, can consult with each other, react to each other's diagnosis and come to a collective decision on the treatment, thus minimizing the attendant risks for the patient.



Figure 2: Schematic approach to MEDUSA

The ITEA 2 MEDUSA project addresses these issues by linking the required levels of knowledge and expertise into a collaborative diagnosis and treatment support workspace in which actuality, availability and privacy protection are key features.

Based on common use cases where collaboration and distributed data are critical, three demonstrator concepts have been identified to serve as a proof-of-concept and are used for testing the user experience. The demonstrated scenarios are in the field of acute trauma, acute ischemic stroke and on cancer treatment and have been deployed and evaluated by real potential users of the MEDUSA platform.

3.2 Inventory of exploitable assets per partner

Analysis and investigations that have been conducted to obtain and accomplish different aims of the MEDUSA projects have provided different exploitable assets for each organization involved into the project.

This section summarizes what exploitable assets MEDUSA has provided to each partner. The assets are references into different categories of results:

- Devices and applications used into the project, including architecture level, devices and applications running on the framework.
- Knowledge generated to conduct the project in different areas, such as conducted user-centered research, design tools, generation of scenarios, MEDUSA ontology.
- Patents and standards that have resulted from the project.

3.2.1 Industry

3.2.1.1 Philips

Philips has taken up the Healthcare challenge that the world is facing. By 2050, one third of the population will be over 60, and it is estimated that 75% of us all will be living with chronic diseases. 50% of the total healthcare spending today is accounted for by only 5% of the general population.

In order to deal with these challenges a new approach to health is needed, and this increased focus on health will be driving the demand for data-driven innovations.

Advancements in technology are igniting a digital revolution. Speed and bandwidth of the internet have exponentially improved in the past decade, paving the way for cost-effective solutions for remote storage and the processing of vast amounts of data. Devices are producing more data than ever before. Combined with cloud-based services, this data can be gathered and analyzed to provide a wealth of information previously not available or easily accessed. The proliferation of mobile devices and other smart devices are connecting this information with people through new tools and services that provide the insights needed to make better decisions.

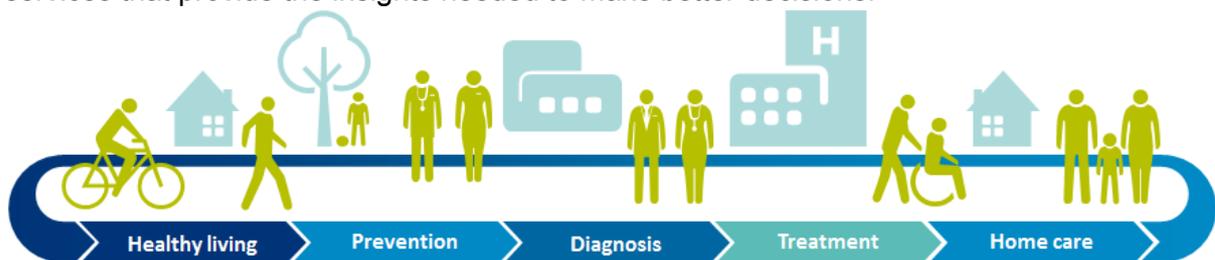


Figure 3: Continuum of care

Philips has made it its mission to assist people throughout the continuum of care as seen in Figure 3: *We are committed to create meaningful digital innovations that bring together the people, devices, systems and data that will enable more informed and coordinated care and healthier living for all.*

In order to be able to live up to this promise, Philips is creating the **HealthSuite** digital platform (Figure 4).

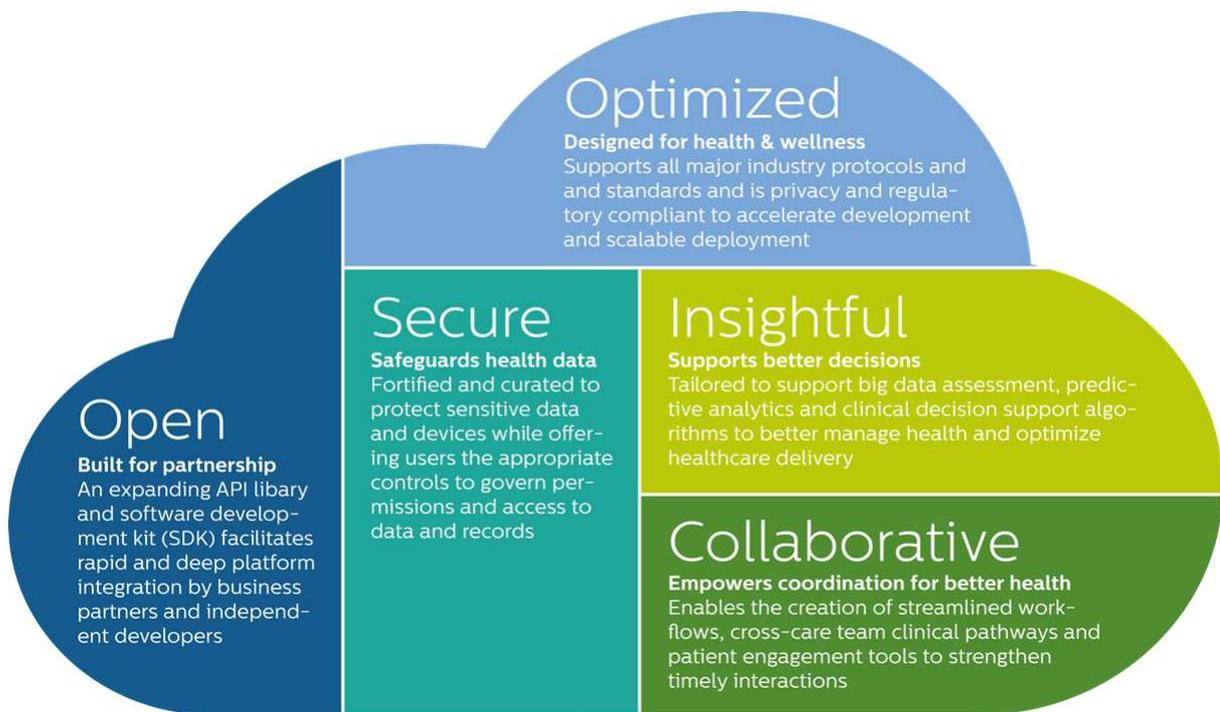


Figure 4: HealthSuite digital platform

Many assets identified during the MEDUSA project have found their way into this innovative platform:

- Having an open platform, built for partnership. The **IntelliSpace Discovery** (the platform for research institutes to develop clinical assets on by combining their specific domain-driven algorithms and visualizations together with the basic medical imaging platform) is a good example on this.
- Collaboration to empower coordination for better health. A way to open up communication and sharing between caregivers, patients and healthy populations.
- Optimization designed for health and wellness. The ability to treat all data from caregivers, patients and the healthy population with support for protocols and standards, as well as privacy and regulatory aspects.

3.2.1.2 BULL

Bull has been bought by ATOS in the summer 2014. The Bull R&D activities have been integrated in the new ATOS organization in the Big Data & Security Division. This has impacted the strategy for the exploitation of the project results especially the ones that were related to Cloud. The exploitable results for HPC-Cloud sector are now jointly in the HPDA (High Performance Data Analysis) chapter that is in line with the new organization and market addressing strategy.

HPDA

Through Medusa project, Atos (Bull) has built and provided a High performance and Real-time infrastructure for Cloud computing named HiPeRT-Cloud.

HiPeRT-Cloud, which is based on Openstack, is mainly designed for real-time computational with intensive workloads, requiring interactive remote visualization capabilities, thus allowing different users to work on a common platform.

However, this solution is flexible enough to support applications with standard requirements. The HiPeRT-Cloud is designed as a collaborative tool that enables users to work together on highly sophisticated software in the Cloud, thus avoiding the need for individuals to purchase expensive software on their own. HiPeRT-Cloud combines the expertise of Bull in the field of high performance computer architectures and flow visualization HD/3D and video. While many internet-based applications are now available in the cloud, high-performance applications still face a number of technological obstacles before they are cloud-ready. HiPeRT-Cloud will provide industry grade solutions for handling complex applications in the field of real-time computational and data-intensive tasks in the cloud.

HiPeRT-Cloud is initially targeting the following high performance applications:

- Research environments such as universities or technical institutes where high performance computing is a requirement
- Online gaming (serious games) and simulation
- Low-latency interactive video streaming
- Data-intensive HPC-based application
- Online three-dimensional imaging for medical use

HiPeRT-Cloud ambitions to make this technology available to small and medium enterprises that would not be able to afford either the software or the hardware for all those applications requiring highly intensive calculations.

Security

As a European leader in integrated security, Bull has built up a unique body of expertise in information systems security, bringing together consulting and systems integration expertise and an in-depth understanding of corporate security technologies.

Bull's experts capitalize on a recognized expertise gained during the course of some of the biggest international security programs, involving millions of users. With Bull, our customers can assess the risks they face, and implement and manage appropriate solutions to protect their business.

TrustWay® is a complete range of encryption solutions delivering high levels of security, ranging from sensitive but unclassified right up to defense-level security.

TrustWay® VPN solutions include Encryption appliances for building Virtual Private Networks (VPNs), Administration station and Audit station. With TrustWay VPN, Bull offers a high-security solution, geared to providing complete protection of sensitive networks, and of all their end-points. A tried and tested solution – which has been implemented on some of the largest sensitive networks in Europe – TrustWay® VPN guarantees end-to-end security, protecting you against intrusions and ensuring the confidentiality and integrity of all IP data exchanges, in line with your organization's security policy. Data is encrypted in real time, and transparently as far as each of your individually authenticated users are concerned. With TrustWay VPN, only the designated recipient will be able to access the data sent to them

With its **HSM⁴solutions**, Bull provides a range of fully compliant HSMs, to suit all specific requirements: Common Criteria, enhanced qualification, RGS +++, FIPS.

⁴ Hardware Security Module

TrustWay® Proteccio is a new cost-effective, industry compliant, rack-mountable, network-attached hardware security module from Bull that delivers reliable future-proof cryptographic services:

- Superior design combining a cryptographic core and a protected application environment
- Strong cryptography reflected in the certifications it has achieved (On-going)
- Easy implementation in critical security and regulatory environments like digital signature
- Service-Oriented Architecture and database encryption.

TrustWay Proteccio meets all key market demands when it comes to seamlessly add hardware key protection and security to mission critical systems such as:

- Public Key Infrastructures
- Certificate Authority servers - Certificate validation and signing
- Time Stamping servers
- Database encryption
- SOA architectures
- Web applications
- Digital signature
- Document signing
- eDocuments
- Code signing

Exchanging sensible information in a secured manner is important in various environments and applications, as is the case for Medusa, a cloud based collaborative work space.

In contrast to traditional solutions, where the IT services are under proper physical, logical and personnel controls, cloud computing moves the application software and databases to the large data centers, where the management of the data and services may not be fully trustworthy.

With the increasing adoption of cloud computing and virtual applications, more and more data and computing power are being shifted to data centers and servers. A major challenge is that the data and more importantly, these servers need to be secure. Data should always be protected when stored and transmitted.

Threat of data modification and data interruption is a serious issue in a cloud network. Public Key Infrastructure (PKI) enables IPsec or SSL for secure connections. IPsec provide confidentiality and authenticity while SSL protocol generates end to end encryption and an encrypted communication channel between client and server.

Communications are protected between users and host but also from host to host. IPsec is compatible with any application and requires IPsec client while SSL is built into every browser.

Certifying agencies are required for certifying physical infrastructure servers, virtual servers, environment users and network devices. A certification authority builds the necessary strong credentials for all physical and virtual entities in the cloud.

Bull HSM is a high-performance network-attached hardware security module that delivers secure cryptographic services as a shared resource for distributed application instances and virtual machines.

Bull HSM can operate in OEM mode, which is to say in the form of an appliance integrating client applications. In this mode, TrustWay Proteccio provides a single security appliance for the combination of a standard application server platform and a dedicated hardware security module. TrustWay Proteccio code signing capability ensures the integrity of the application in a trusted OEM appliance.

Bull HSM provides cryptographic functions for key generation, key storage, encryption and decryption, digital signature and verification used by application systems that provide cryptographic support functions.

Digital Certificates are time tested, successfully securing networks and data for nearly two decades. Their basis in public key encryption technology makes them an excellent choice for strong authentication - significantly more secure than just passwords.

Managing digital certificates, which are based on public key cryptography, requires a Public Key Infrastructure (PKI). The main function of PKI is to distribute the certificates (and the associated public keys) accurately and reliably to users and devices, and to manage the certificate lifecycle.

Within Medusa, Bull HSM is used to provide PKI services to the Authentication agent. To deploy the PKI, TrustWay Proteccio has been configured to operate in OEM mode that is in the form of an appliance integrating EJBCA application.

The appliance is connected to Medusa network, and can be accessed by Medusa Administrator and the Registration Authorities to create end entities and certificates.

Bull HSM can be partitioned in several virtual HSMs while guaranteeing the compartmentalization of cryptographic key structures. This property has been exploited to enforce the security of Medusa PKI, using different virtual HSMs for each certificate authority.

3.2.1.3 Prologue

Prologue launched Use it Cloud Broker and Marketplace and defined marketing targets in various segments, including Healthcare. The Use it Cloud solution from Prologue is being extended and validated in the MEDUSA context with challenging system requirements. New features, such as published REST APIs, network management, VPNaaS, users management, monitoring, etc. are being added to the marketing catalogue of the Use it Cloud product. Moreover, Prologue developed cloud security-aware deployment scenarios that support scalability and efficiency for both legacy and service-based applications, with resources possibly allocated on both private and public Clouds.

3.2.2 SME

3.2.2.1 Sopheon

Sopheon provides an Enterprise Innovation Management (EIM) platform called Accolade that is designed to help companies to innovate and achieve revenue growth and

profitability. The Decision Support component developed in Medusa will enable Sopheon to offer smarter portfolio management capabilities as part of EIM solutions. Portfolio management is a dynamic decision making process, whereby a business list of product investments is continuously updated, revised, rebalanced and reprioritized. This ensures the optimal investment mix for an organization - the optimal 'portfolio value' - and optimal usage of an organization's resources. As the portfolio management process is always coping with uncertainties and changing information, with dynamic opportunities and with multiple decision makers spread geographically, it draws many parallels to the medical collaboration processes that are in the heart of Medusa. Like in an acute care scenario, portfolio decision makers need:

- Instant access to accurate, and actual data collected from a variety of sources
- Alerts in potential risk situations
- Tools to configure alert conditions and messages
- Tools to communicate decisions into relevant other processes.

Next to the Decision Support component, Sopheon developed a video component and a 3D viewer making use of new web technologies, WebGL and WebRTC. These technologies will be exploited in the Intelligence tools that are part of the Accolade suite.

Overview of Sopheon's exploitable assets in Medusa:

Decision Support component

- A new Accolade configuration for protocol management, available through the Cloud, that includes the new Rule Engine as well as export mechanisms for real-time usage
- Rule Engine: application specific business rules and logic
- Rule Editor: UI to create and edit rules
- Rule Runner: backend for executing the rules

New Accolade API

- Connects Protocol Management System with Decision Support
- Allows collaboration of Accolade with other external apps

Sensor apps

- Communication of real-time sensor data via mobile apps to the cloud

New technologies to support cross-platform mobile applications

- Browser-based apps
- HTML5

WebRTC-based video component

- Real-time audio and video communication that improves the experience of participants in virtual collaboration sessions (in the medical or business world)

WebGL-based 3D Viewer

- Provides new analysis capabilities, specifically for knowledge association based innovation research

Software-as-a-Service (SaaS)

- New distribution models are relevant for next generation Accolade

3.2.2.2 Technolution

For Medusa Technolution was leading work package two which deals with the Medusa architecture. Based upon the discussions with all partners an architecture was designed to build a platform for collaboration by doctors and other medical professionals. This architecture was designed using the TOGAF enterprise architecture method.

All partners had the chance to contribute with specific technology, for example cloud management, security, imaging and so on. Technolution developed an application framework that connects all the applications and components to act as one system. User management, security, video conferencing, cloud resource management, and cloud resources are applications that provide the basis and are connected by the Technolution framework. The functional applications like imaging and decision supports are added and operate within this framework.

Also an audit trail application was developed which gathers the important events of a collaboration session. All applications write important events to this audit trail. At the end of a session, the audit trail is written to a file on disk.

3.2.2.3 Imstar

Imstar contribution in Medusa is based on its in-vitro diagnostic platform Pathfinder. The extensions to this platform developed within Medusa represent the exploitable assets. They can be subdivided into two categories: infrastructure extensions and (use-case) specific imaging procedures. The detailed description can be found in the D3x3.

The infrastructure-related assets include:

- Compliance of Pathfinder application with the virtualization platform provided by Medusa and integration of the Pathfinder application with the Medusa framework. These features give Imstar platform high-performance remote execution capacity and marketing advantage with the sites already using Medusa platform for other applications.
- Compliance of Pathfinder distributed image processing platform with cloud-based execution environment.
- License server that allows Imstar to securely provide its solution as the service; it is responsible for the authorization of the execution of Imstar applications, accounting of time and number of analyses performed.

The use-case specific assets are family of specialized image processing procedures allowing partial automation of some cancer diagnostic, including:

- Cervical cancer diagnostic on the cell spreads: cell segmentation and classification based on the ploidy-analysis.

- Colon cancer lymphocyte infiltration level in the on the tissue sections: detection of the glandular and interstitial regions, segmentation of the lymphocytes and measurement of their infiltration level in the glandular regions.
- Breast cancer diagnostic on the tissue sections: detection of the tumor cells and classification of the cells in positive and negative in specific membrane labeling.
- Prostate cancer diagnostic on the tissue sections: evaluation of the quantity of the tumor tissue revealed by labeling specific protein.
- Breast cancer Her2New amplification analysis on the tissue sections.

3.2.2.4 DOSIsoft

DOSIsoft Company is involved in software products for medical imaging in the scope of radiotherapy and nuclear medicine.

As a SME in its domain, the product managers responsible of products definition and the specification of the functionalities are always part of the stakeholders of the company.

The contribution of DOSIsoft to MEDUSA project has been an opportunity to change the way to specify product functionality and to learn more about how to take into account the user needs.

Especially, by working with an external expert in radiotherapy from Gustave Roussy hospital, the writing of the document "D111 Use case scenarios and User requirements" has led to provide dedicated use cases which fit the reality of this clinical routine work.

This experience is expected to consider in the future this new way of working in the upcoming projects. It is a motivation to move closer to agile development methods and to give up the waterfall approach.

3.2.3 University

3.2.3.1 AMC Amsterdam

During the running of the MEDUSA project, the AMC has developed and adapted image processing algorithms for Neurovascular diseases, and stroke in particular. We have created autonomously running segmentation software for infarct core quantification, ventricle segmentation, and hemorrhage detection. Furthermore, we have made use of the high-performance machines using the cloud structure.

The AMC foresees commercial benefits for this combination in the image analysis support of medical trials. Since these activities require commercial aspects, it cannot be part of the AMC. For this reason, we have created a spin-out company: NICo-Lab, which focusses on cloud-based image analysis for the processing of large amounts of image data.

Moreover, the achieved knowledge on cloud based analysis; automated image processing and remote collaboration is disseminated through lectures, internships of engineering, physics, and medical students.

3.2.3.2 Institut Gustave Roussy

Firstly, the applications developed in the project have provided new contouring tools in radiotherapy for tumor delimitation. Such tools will be used for academic purpose or clinical research at the end of the project.

Secondly, MEDUSA has also provided platform for collaboration, patients information sharing and various applications increasing experts' synergy. Such tools can either be used in intern or in an international context for exchanges with its distant partners.

Lastly, the development of MEDUSA follows the actual direction adopted by the institute that is to move progressively to personalized medicine. This means to provide multi-modality imaging, and to improve the diagnosis and treatment by gathering experts on each patient case. Besides, this project also permits experts to use interactive tools, so as to make them familiar to innovative technology.

3.2.3.3 Institut Mines & Telecom

MEDUSA project gave to IMT the opportunity to gain three types of exploitation assets, as follows:

- Gathering academic knowledge in the field related to:
 - Hierarchical mathematical representation for multimedia content spatio-temporal orchestration,
 - Cross-standard user representation,
 - Privacy and security threats for medical content distribution and processing.
- Designing, prototyping and integrating technological bricks for novel functionalities in medical oriented virtual collaborative environments:
 - Collaboration as a service,
 - Legacy application virtualization,
 - Information tracking for user privacy purposes, by both active and passive techniques,
 - On-line remote medical image exchange (DICOM) with progressive quality restoration for an efficient time management during virtual collaborative diagnosis,
 - Image analysis tools for collaborative medical decision around a patient file simultaneously with the image data transfer.
- Proof of concepts for legacy application cloud portability :
 - This PoC was transferred by IMT towards uStartApp, a spin-off created in 2015; it was the basis in developing zeroDev, the first product of uStartApp

➤ 10 clicks to cloud

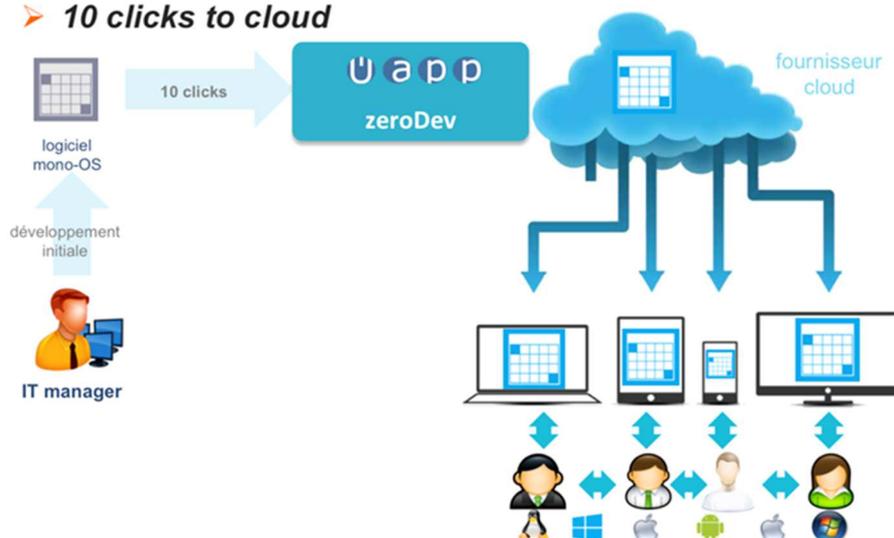


Figure 5: zeroDev - 10 clicks to cloud

Thanks to zeroDev, any legacy application can be deployed in 10 clicks in cloud, without any modification in its source / executable codes.

3.2.3.4 Pitié Salpêtrière Hospital

Throughout MEDUSA project, Pitié Salpêtrière Hospital gained two types of exploitable assets:

- Integrating existing proprietary clinical applications in a SaaS framework which allows deploying clinical expertise and developing collaborations with clinical partners
- An efficient remote on-line image data access for virtual collaboration meetings respecting the lossless quality constraints and associated image analysis tools

4 Market Analysis

4.1 Market trends

4.1.1 Healthcare market

Market trends in healthcare

As a market, healthcare, health & wellness represent up to 25% of the EU economy (when measured in terms of employment, expenditure and added value), making it the largest industry of the economy (source: EC, DG Information Society and Media, ICT for Health - Aug. 28, 2009). The size and growth of the healthcare market is driven by several global trends, leading to formidable challenges for society and healthcare at large.

Global economic growth

Increased spending on health related services, access to healthcare for a larger number of people and increased awareness of available healthcare options.

- Dramatic changes in demographics and the aging population.
By 2045 more people will be 60+ than <15 years, rising from 600 million to 2 billion. Rise in number of patients with age-specific, chronic and degenerative diseases (cardiac, cancer, diabetes, Alzheimer's, Parkinson's). The number of US patients with a chronic illness is estimated to grown to 157 million in 2020.
- Healthcare professional staffing shortages rise, due to higher demand for patient attention
- Efficiency and effectiveness of healthcare: need to further improve hospital work flow efficiency, integration of diagnosis and treatment. E.g. the average length of stay for acute care has fallen in nearly all OECD countries
- Skyrocketing healthcare costs: global health care spending has grown from 9% of worldwide gross domestic product (GDP) in 2006 to 15% by 2015

Chronic diseases are now responsible for the consumption of the vast majority of healthcare resources (more than 70% in developed countries) and are inflicting a transition in healthcare practice from acute to - much more expensive - chronic care. For example, cardiovascular diseases alone are responsible for 42% of all deaths in the EU, for 21% of productivity losses and cost the EU economy a staggering €192B a year (source: EC, DG Information Society and Media, ICT for Health - Aug. 28, 2009).

Market trends in medical imaging and collaborative systems

The global market for medical imaging (diagnostic and interventional imaging) is estimated to be \$20B (2007 TriMark study). The European market is about a quarter of this total and the US market almost half. The medical imaging market records solid growth percentages. Depending on the modality, the average compound annual growth rate (CAGR) is about 4% (for interventional imaging this is 8%). There a few specific areas where growth is markedly higher than average.

Image-based software applications

The Medusa consortium is active in several medical imaging software segments such as for 3D/4D medical imaging software, clinical decision support systems (CDSS), navigation software and user interfaces and support for intervention processes in healthcare.

To illustrate these growth opportunities:

- The European market for 3D/4D imaging software has a CAGR of 14% from 2004-2014
- The global CDSS market grows from €159M to €289M during 2006-2012 (Frost & Sullivan)

Collaborative work is becoming more and more important in almost all the domains of economic life and this in addition to the rising portion of mobile workers. Facing the rapid evolution of technology, and ever increasing competition and constraints, the human capital is considered to be an essential competitive advantage for business entities. Traditional enterprise “static” organizations, aiming at optimization of efficiency and productiveness, move their focus towards creativity. This may be illustrated, for example, by the development of so-called Professional Virtual Communities, built on some kind of collective intelligence with the objective of promoting innovation and maximizing the realization of expert resources. A recent study [BLA2004] has shown that workplace innovations account for 89% of multifactor productivity gains.

According to an IDC study the size of the market for collaborative environments in 2004 was \$1.9B. Western Europe had the largest market share with 41.4%. Another study by Gartner Group in March 2006 illustrates foreseen evolution of working styles that will impact the requirements for collaborative interactions between individuals. At the same time, the study highlights the trend in the percentage of individual's performance that will depend on group input up to some 70% in current times.

Market impact of Medusa

Research in six countries on avoidable medical examinations; indicate that between 6% and 18% of all patients experience multiple examinations. For trauma care we face 38,000 patients each year, 20% of which require transfer to another hospital (7,600). If 12% of these patients received a double CT-scan that could have been avoided by Medusa, we would save 900 CT-scans with a cost of approximately €1,000 per scan. We could annually save €900,000 for trauma in these countries, not including costs for personnel etc.

The total cost for neurological and neurosurgical diseases (including direct medical and indirect cost caused by productivity loss etc.) in Europe is estimated to be €92B each year [EJN2005]. If Medusa could decrease the cost for these diseases by just 0.5% (time in brain, faster treatment will lead to better outcome), Medusa has the potential of saving more than €40M each year.

4.2 Individual market analysis

4.2.1 Industry

4.2.1.1 Philips

Philips is a Private Organization, with the mission statement to be committed to create meaningful digital innovations that brings together the people, devices, systems and data that will enable more informed and coordinated care and healthier living for all.

Philips has identified the following markets regarding the exploitable assets:

- **Medical Imaging**
Philips has a huge knowledge and history in the development of medical equipment ranging from Ultrasound Stations, to MRI scanners, CT scanners, Nuclear Medicine devices and so on. Giving focus and direction into the increasingly digital era will enable new possibilities for improved medical imaging. The use of cloud-enabled services to enable collaboration and vast data analytics are spin-offs from the MEDUSA project.
- **Clinical Platform Hosting**
Philips has many years of experience on creating algorithms and procedures valuable for clinical image reconstruction and analysis. With this knowledge Philips has created a clinical platform enabling internal stakeholders to develop medical relevant products and services based on these assets. Opening this platform to other companies will also bring these features to external partners, and enables these companies to increase their focus of development towards enhanced and new algorithms and/or visualization capabilities.

Several of Philips' clients, both public and private organizations, can be (and are) interested in the **HealthSuite** digital platform.

4.2.1.2 BULL

IDC, in "IDC's Top 10 HPC Market Predictions for 2015 – 15 January 2015", outlines that new users are entering HPC for HPDA (High Performance Data Analysis) managing large IT infrastructures, Internet-of-Things and new SMB buyers. IDC points out that 67% of HPC sites use some form of HPDA today.

The HPDA market represents the convergence of long-standing, data-intensive modeling and simulation (M&S) methods in the HPC market segments and newer high-performance analytics methods that are increasingly employed in these segments as well as by commercial organizations that are adopting HPC for the first time.

IDC forecasts that the server market for HPDA will grow rapidly at 23.5% compound annual growth rate (CAGR) to reach \$2.7 billion in 2018 and the related storage market will expand to about \$1.6 billion in the same year. The most serious technical challenge to liberating HPDA growth is data movement and management, although the HPDA market should be seen more fundamentally as a war among clever algorithms.

The growing market for high performance data analysis (HPDA) — using HPC for data-intensive challenges — is already enlarging HPC's contributions to science, commerce and society. HPDA promises to play a major role in helping to address the major opportunities and challenges of the 21st century.

In addition in the white paper "Software Engineering, key enabler for innovation" the NESSI (Networked European Services and Initiative) predicts that the traditional split into software and hardware and thus their respective business models will disappear.

Atos realizes a turnover of more than € 300 million in health market in Europe, including € 40 million in France and aims to achieve more than 15% of annual sales in health market, to 3 years, on such HPDA projects.

4.2.1.3 Prologue

The cloud management market includes technologies and software to fulfill functions such as infrastructure, service, platform, security, and data and analytics management. These functions are designed for the efficient operation and delivery of applications and computing services to end-users and enterprises.

Many sources have conducted research studies on this market and they note that it is rapidly maturing and evolving^{5 6 7}. More specifically, the global virtualization and cloud management software market is expected to grow at a CAGR of 14.81% over the period 2014-2019.

This is because various businesses are increasingly adopting virtualized infrastructure to reduce CAPEX and OPEX costs and improve performance, and other organizations are deriving growing percentages of their revenues from analyzing and monitoring applications and cloud infrastructure. Therefore, the cloud management software market is beginning to mature as major vendors are increasingly supporting unified infrastructure, middleware and application provisioning, monitoring, scaling, and optimization across private and public cloud platforms.

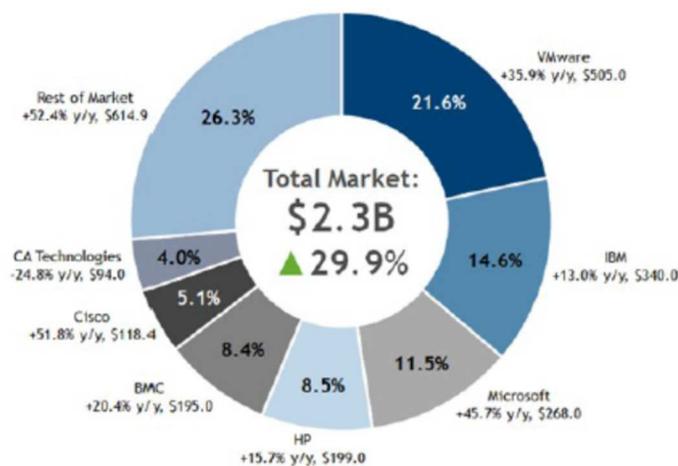


Figure 6: Cloud management software shares worldwide by International Data Corporation (IDC) study (Revenues are in \$M)

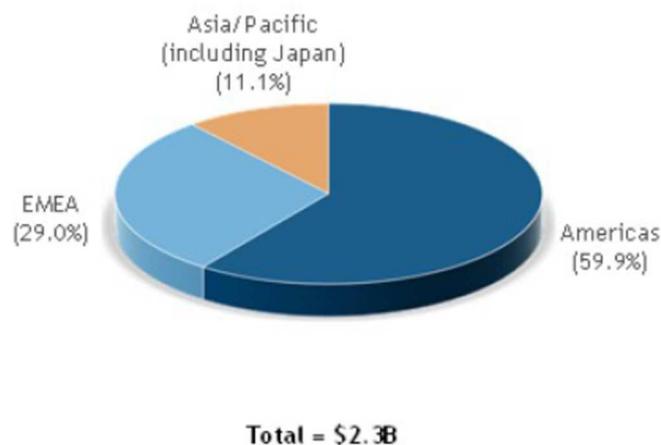


Figure 7: Source IDC June 2015

The worldwide cloud management software market totaled \$2.3 billion in 2014, as shown in Figure 6 and Figure 7, which represented an increase of 29.9% over 2013.

⁵ <http://www.businesswire.com/news/home/20151118006070/en/Research-Markets-Global-Virtualization-Cloud-Management-Software>

⁶ <http://www.transparencymarketresearch.com/cloud-management-market.html>

⁷ <https://www.vmware.com/files/pdf/vrealize/vmware-cloud-management-market-share-2014.pdf>

Prologue intends to take part of this growing market share by consolidating and enriching its cloud management offer and serving a wider client base including healthcare.

4.2.2 SME

4.2.2.1 Sopheon

Sopheon's target market consists of a variety of industries, the most important of which are: Aerospace and Defense, Chemicals, Consumer Goods, Food and Beverage, High Tech and Electronics, Industrial Manufacturing. For companies in all of these industries, Portfolio management is at the heart of their innovation competence. It forms the 'switch' process between business strategy and actual product development and it is the decision making process for current product innovation investments within the overall strategic plan. All these industries are candidates for using the user configurable decision support system developed in Medusa. Sopheon's solutions have been implemented by over 200 customers with over 70,000 users in over 55 countries.

4.2.2.2 Technolution

Technolution is developing technical solutions for customers in different domains like healthcare, energy, traffic management and national infrastructures (like highway agencies, railroad management, etc.).

These solutions typically require knowledge from a lot of different technical domains. Medusa has offered the opportunity to build knowledge from these domains. This was especially true for:

- Cloud resource management
- Security
- Systems integration

In its role as system developer and system integrator, Technolution has the opportunity to apply these state of the art technologies.

4.2.2.3 Imstar

The Global market of digital quantitative cyto-pathology in Oncology represents over US\$10B.

In-vitro diagnostic systems based on the IMSTAR Pathfinder™ platform are validated for several key applications in this market, such as detection and characterization of:• Circulating Tumor Cells, Cervical abnormal cells, FISH signals.

Up to now the access to the market was limited and for IMSTAR the sales could not go over USD\$1M per year because of the problems with expertise availability and complexity of the cross-expert validation.

4.2.2.4 DOSIsoft

DOSIsoft was created in 2002 from a partnership between Gustave Roussy and Institut Curie, two major cancer treatment centers and pioneers in treatment planning systems for radiotherapy.

The two institutes initially developed their own software solutions to address their internal needs, DOSIGRAY and ISIS, which were commercialized in the 80's and covered 42 % of the French market. The expertise of the two institutes has also convinced European cancer centers as well as the IAEA which distributes ISIS and ISOgray® in emerging countries.

DOSIsoft applies a strategy of continuous innovation and is implicated in numerous French and European research projects aimed at optimizing radiotherapy planning tools and widely spreading them, to the benefit of a large number of patients.

From 2007, within the MINIARA (Multimodality Imaging Investigation for Novel oncology And Radiotherapy) project, followed by the cluster for innovative therapies and advanced technologies in healthcare MEDICEN Paris Region, DOSIsoft has designed and built a multimodal workstation dedicated to imaging diagnosis, aid in diagnosis for oncology, therapy Response and contouring for Radiotherapy based on the mutual contributions of anatomical imaging modalities CT and MRI associated with functional imaging modalities from the nuclear medicine PET and SPECT.

With its dose calculation skills to external beam radiation therapy and management of functional series, DOSIsoft has then evolved its software product for molecular Imaging to internal radiation therapy and particularly liver treatment using 90Y radioactive microspheres.

4.2.3 University

4.2.3.1 AMC Amsterdam

The Academic Medical Center, University of Amsterdam is a private organization aiming at patient care, education, and research. With the results of Medusa important steps have been made to improve efficacy of patient care and supports the current set up of Stroke-Net: a multi-center collaboration of the care of patients with an acute ischemic stroke.

Medusa has also taught us about the added value of cloud-based methodology. Although this is not suitable for acute care and common clinical care, it is very valuable for large-scale image processing applications. The AMC has recognized this opportunity and has started a spin-off called "NICo-Lab" (www.nico-lab.com), which focusses on trial image based automated image analysis.

4.2.3.2 Institut Gustave Roussy

Gustave Roussy is a non-profit making private health establishment, with a public role. It has no access to the market. Besides, Gustave Roussy could use the MEDUSA cloud-enabled services in its partnerships.

4.2.3.3 Institut Mines & Telecom

As an academic partner, IMT has no direct access to the market. However, uStartApp, the spin-off of IMT which commercialize zeroDev, already realized a technical analysis of its market competitors, as illustrated in the Figure 8 below.



Paysage concurrentiel

	Solution pour cloud public	System d'exploitation en cloud	Aucune installation sur le terminal de l'utilisateur final	Contenu multimédia sur le terminal de l'utilisateur final
 Systancia 70 000 clients	 Privé	 €->Microsoft	 Aucune installation	 Installation supplémentaire
 DELL 100 000 clients	 Public/Privé/Hybride €->Amazon	 €->Microsoft	 Aucune installation	 Installation supplémentaire
 CITRIX Croissance annuelle de 50%	 Public/Privé/Hybride €->Amazon	 €->Microsoft	 Fonctionnalités limitées	 Installation supplémentaire
 ERICOM	 Privé	 €->Microsoft	 Aucune installation	 Contenu multimédia
 zeroDev	 Public/Privé/Hybride €->OVH	  €->OVH €->Microsoft	 Aucune installation	 Contenu multimédia

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Figure 8: uStartApp technical competitor analysis

This analysis demonstrates that thanks to the research activity, zeroDev is the only solution on the market reaching the trade-off between technical and functional constraints. However, its competitors are already very well recognized on the market.

4.2.3.4 Pitié Salpêtrière Hospital

As academic partner, Pitié Salpêtrière Hospital has no direct access to the market. However, the achievements of MEDUSA in terms of on-line remote image exchange during collaborative meetings have shown an alternative to the deployment of national PACS systems by allowing considering a decentralized storage of patient data, directly in the hospital centers where it is produced. This could indirectly impact the national healthcare policy in terms of patient data management and consequently the market related to the associated products (namely the PACS solutions).

5 Exploitation plans

5.1 General exploitation plans

The MEDUSA project contributes in a positive way to the employment by actively stimulating research and cooperation in several of the fastest growing businesses of the coming decennia. A broad spectrum of applications and services can be build using the MEDUSA knowledge, models and proof points. It enables a new competitive edge to existing businesses and gives companies aiming at opening new business lines based on the products, applications and services developed and demonstrated in MEDUSA an excellent starting point. Next to that it provides opportunities for starting up new businesses, known for their high social value and job potential.

More specific, the partners plan to exploit the MEDSA results through:

- Setting up inter-hospital networks of regional hospitals for care and image exchange for patients with acute ischemic stroke
- Creating an AMC-spin off for cloud-base image analysis on large amounts of image data, typically collected for randomized and controlled trials
- Enabling advanced medical image processing in the cloud
- Enable remote patient monitoring by utilizing video conferencing capabilities in a secure and stable way
- Establishing and increasing open innovations on a broad and solid imaging platform to enable researchers and developers the capability to focus on specific medical algorithm developments and validation
- Offering new and enhanced services in the field of medical applications, design, consulting and development
- Integration of new cloud architectures and middleware products, services and medical environments
- New options for future products and services. The expectation is that the project will generate a large potential of future product options that will find their way to commercialization directly by the consortium partners or during a later stage.
- The promotion of the emergence of new companies, since many of the partners in the consortium have an excellent track record of working in close cooperation with technology centers, new campus companies, research groups, high tech SMEs, university partners and technology villages aiming at the conversion of research ideas into business.
- The consortium includes large companies, smaller companies and SME's with a large joint turnover. All partners expect that participation in MEDUSA will, and has strengthened their position in the dynamic field of cloud-based medical application technology and products, and increase their turnover through joint and individual exploitation after the end of the project.

The project has the overall aim to ensure exploitation and dissemination of the MEDUSA results. Into the project is chosen for a way of working and approach that will maximize the exploitable possibilities after the project, and is characterized by:

- Parallel development of the technical solutions and the assessment of business opportunities; by benchmarking, market research and by contacts with business stakeholders on requirements, needs and future interest.

- Careful selection of the most attractive concepts for the demonstrators. People, technology, market and business inputs will be taken into account in this selection process.
- Co-design and validation of the demonstrators with users of the solutions.
- The definition and development of a clear business framework for the commercial exploitation of the MEDUSA products, framework and architectures.
- The definition of exploitable strategies highlighting the unique selling points of the MEDUSA results.
- Workshops will be established in which the results of the project will be presented to industry, consulting firms and potential users.
- The demonstrators as build during the project showcase the total outcome of all the work packages. They have been carefully selected, designed and communicated with potential users of MEDUSA, that through their functional appearance and application domain, they will be appealing examples of the exploitation of the MEDUSA results.

5.2 Individual exploitation activities

This section gives insight in the exploitation activities that every partner of the consortium has identified to carry out during and after the finalization of the project. It addresses views from each of the partners to questions such as the benefits for the organization, identifies exploitable areas (new products, product upgrades, software packages, tools, methodologies and such) but also gives insight in possible return on investments and commercialization and developments of products.

5.2.1 Industry

5.2.1.1 Philips

MEDUSA has brought Philips the possibility to validate the proof points needed to set up the basis for a collaborative medical imaging environment, and to strengthen their position as a provider of knowledge on the development of medical imaging products and features.

5.2.1.2 BULL

With the experience and development work achieved within MEDUSA project, BULL intends:

- To reinforce its positions of specialist in high performance computing applied to the medical domain and of complex architectures integrator.
- And to address the HPBA market while covering and converging hardware and software business.

The results will be exploited at different levels

- From a technical point of view, MEDUSA project will contribute to the improvement of ATOS BigData Offering by selecting, integrating, the best of breed technologies (GPU based HPC offering servers –i.e. bullx B515 air cooled blades/B715 direct liquid cooling blades), and by maintaining a high level of expertise in our teams, to build scalable architectures for information management (storage and processing). In addition the characterization of the MEDUSA project's architecture will provide tools (figures and guidelines) to customize, architectures according to customers' expectations. Results will be injected in the new Big Data Platform solution from ATOS BDS named Starlings.

- From business point of view, MEDUSA project will reinforce the Image of Bull as An Innovative Technology Brand by providing proof of business value creation in the implementation of medical use cases, and by preparing Bull's BigData offer improvements.

MEDUSA project allows hardware and software to be provided as a service, which is an important challenging of modern IT. MEDUSA project will bring the opportunities to develop partnerships, to enhance the ATOS portfolio of value added services, with innovative solutions from our partners, in the field of data mining, machine learning, and predictive analytics for example.

Security

The developments carried out in the context of Medusa and the analysis of security requirements of cloud architectures allowed us to develop and expand our offer of hardware security modules.

Bull TrustWay contribution to Medusa is a continuation of studies and developments carried out in the context of projects CompatibleOne and PISCO, both collaborative projects sustained by French Administration.

One of the outstanding innovations of TrustWay Proteccio (last generation Bull HSM) relies on the deployment of custom applications that are integrated then securely executed in the appliance.

Thus, TrustWay Proteccio provides a single security appliance for the combination of a standard application server platform and a dedicated hardware security module. In addition, TrustWay Proteccio code signing capability ensures the integrity of the application in a trusted OEM appliance.

The project outcomes enable us to address the HSM market in an innovative way. The ability to embed a signed full user environment (OS and critical applications) is a major technological differentiator.

We have many prospects in France and abroad with software editors of PKI, electronic signature, time stamping, electronic invoicing, and encryption of emails.

5.2.1.3 Cassidian CyberSecurity

MEDUSA helped Cassidian CyberSecurity to clarify its business model relative to the secure cloud protection.

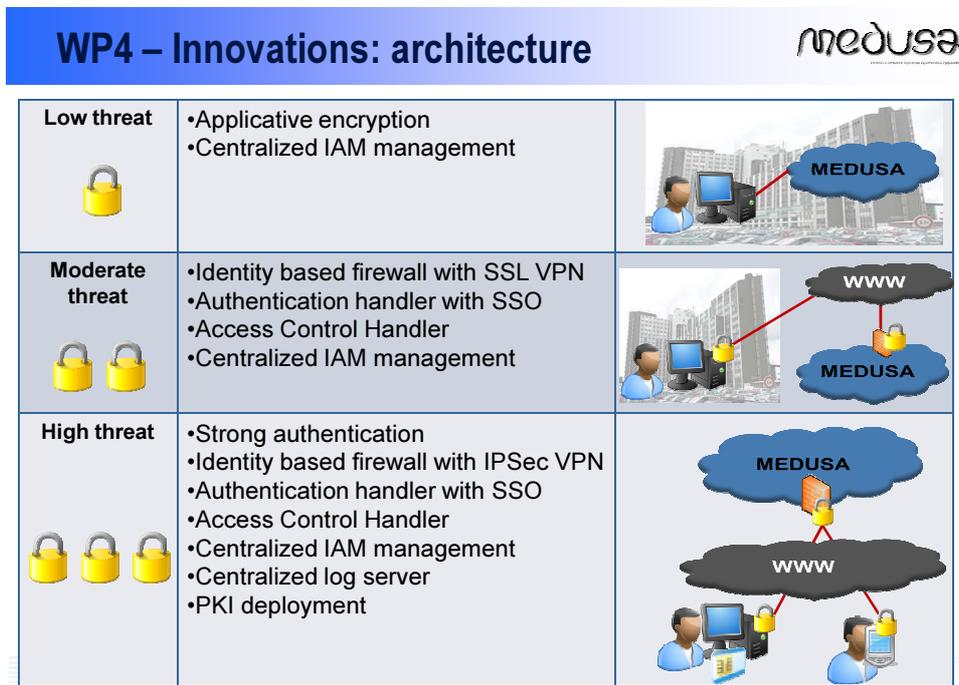


Figure 9: Private Cloud Protection by CCS

CCS can propose to its customers on this specific market 3 protection levels, regarding the attacker level model: “Low Threat”, “Moderate Threat” and “High Threat”. Of course, the more the considered attacker is powerful, the more expensive the solution will be sold by CCS. If we consider internal attackers (here, a hospital), only applicative encryption (https) and a centralized IAM management will be needed (see Figure 9). However, if the cloud can be accessed from the outside, then we will have to implement more countermeasures. In this case, CCS will then propose some products contained in its catalogue to reach these high protection levels (e.g., firewalls and VPN, PKIs, etc.).

5.2.1.4 Prologue

With the development advancements achieved in MEDUSA, the exploitation perspectives of Prologue following the MEDUSA project can be foreseen around the following axes:

- Integrating the developed cloud management components into Prologue’s Use it Cloud offer:
 - Resource deployment and lifecycle management
 - Collaboration orchestration
 - Security components
 - Standard RESTful APIs
- Consolidating the MEDUSA Cloud-based framework and managed applications into a marketable product:
 - Build on our contribution to MEDUSA and the collective know-how of the partners to service the Health segment
- Building upon MEDUSA results to participate in new European research projects:
 - Extend cloud management functionalities into emerging research areas such as the cloud of things.

5.2.2 SME

5.2.2.1 Sopheon

From Sopheon's perspective, the main benefit of Medusa is that it opens up the market for real-time portfolio management. Sopheon is a market leader in collaborative innovation portfolio management and develops software for the decision making processes related to this. Today portfolio management is not real-time or pro-active. It always analyzes historical data over a certain period, like a month or a quarter. With the user configurable decision support system developed in Medusa we can realize real-time portfolio management, whereby the system receives product and market data (big data), and analyses on the fly the position of the portfolio - for example product managers see the buying behavior of consumers and can react instantly.

Another benefit is that Medusa may provide Sopheon with new opportunities in the Healthcare market, esp. in the field of protocol-based decision support.

This is how Sopheon plans to exploit the Medusa results:

Exploitable new area	Exploitation
Decision support for project and portfolio management <ul style="list-style-type: none"> • Ability for users to configure personal alerts at deliverable, project or portfolio level • Instant Portfolio Management 	To be added to Sopheon's innovation management platform Accolade.
Communication with external apps <ul style="list-style-type: none"> • Ability to provide users with smart services through external apps 	To be added to Sopheon's innovation management platform Accolade.
Internet of Things <ul style="list-style-type: none"> • Ability to use real-time sensor data via mobile apps in decision support calculations 	To be explored for integration in Sopheon's innovation management platform Accolade.
Real-time communication <ul style="list-style-type: none"> • Enhance communication between e.g. gatekeepers through secure video and audio communication in the browser 	To be added to Sopheon's innovation management platform Accolade.
3D Viewer	Currently being explored for use in Sopheon's search and text mining tool. To be explored for integration in Sopheon's innovation management platform Accolade.
New distribution models: SaaS	To be explored for next generation Accolade

5.2.2.2 Technolution

Technolution is executing technical projects for its customers in various domains. There are no direct plans for product development, but the knowledge build up in this project is already used in various projects for customers. The quality and reliability of the deliverables in this projects, and hence the expectations of our customers benefit from this project.

5.2.2.3 Imstar

With the input of the technology issued from Medusa program, IMSTAR will be able to have more ambitious proposition in partnership with Chinese companies acting in the cytopathology field.

The Business Plan, already initiated, expect to reach for the targeted digital quantitative cytopathology tumor marker market the following 5 years figures:

- Year 1 = TO US\$1,5M
- Year 2 = TO US\$3M
- Year 3 = TO US\$6M
- Year 4 = TO US\$15M
- Year 5 = TO US\$28M

5.2.2.4 DOSIsoft

Benefits for the organization

Within the MEDUSA project, DOSIsoft has moved one step further in the right direction to be able to provide to its customer a solution for a remote and collaboration application dedicated to contouring for radiotherapy and also a workstation for molecular imaging.

Especially, some technological barriers have been lifted to allow users, even if they are far away, with the ability to work together on the same image series.

Identified exploitable areas

The project strengthens the idea to improve the range of offers for the workstations available to customers. In addition to traditional workstation, we imagine to propose dematerialized stations for utilization on demand.

Action plan and Commercialization and development of products

User feedbacks from French and international congress for nuclear medicine and molecular imaging (SFMN, EANM, SNMMI) show a growing interest for dose computing for internal radiotherapy and specially solutions for SIRT 90Y- microspheres dosimetry. DOSIsoft has developed a solution for that purpose which is a new software product on this emerging market.

We plan to study the interest of MEDUSA technology for this new product.

5.2.3 University

5.2.3.1 AMC Amsterdam

- The AMC has benefited from Medusa by learning from the opportunities for image exchange and distant collaboration. With this knowledge, the AMC has taken the lead by setting up Stroke-Net, in which 12 hospitals are connected to exchange patients, and their patient (image) data.
- Exploitable areas are the recognized fore-runner role of the AMC, resulting in multiple collaborative projects, the continuation and extending of high-performance neurovascular image processing. Next to that the AMC also sees opportunities with the high-performance high-throughput image processing applications for histological image data.
- The AMC is planning to showcase the Medusa demonstrator to the national neurological and neuroradiological society in order to share the gained knowledge, and plan implementation of image data exchange, remote collaboration, and offer the advanced image processing.

- It is expected that the AMC will save resources; however, it is too early to estimate to what extent.
- Cloud-based image processing services will be commercialized through the spin-off "NICo-Lab" (www.nico-lab.com)

5.2.3.2 Institut Gustave Roussy

Benefits for the organization

Thanks to MEDUSA, Gustave Roussy expects to strengthen its cancer treatment leading position in radiotherapy. Indeed, this project reinforces its position with the participation in the development of such cutting-edge technology.

Besides, working on this project created privileged ties with DOSIsoft. This relationship helps this latter to improve its software and meet our clinical needs.

Identified exploitable areas

The methodology developed in Medusa brings another way of thinking. Using modern technology, it opens the door of an easy and distant collaboration between its experts. Thus, this leads to improvement of the diagnosis and patient treatments.

The institute aims at using such technology in order to increase training and collaboration with its de-localized partners.

Action plan

The developed tools will be used in several clinical projects to better understand the content of multi-modality imaging and to improve delineation of targets for radiotherapy. The knowledge and methodology acquired will help Gustave Roussy to attract new partners.

5.2.3.3 Institut Mines & Telecom

As an academic partner, IMT took the opportunity of the Medusa research synergies to broaden the education topics covered by the ARTEMIS department professors, at all levels (undergraduate, graduate, PhD).

At Telecom SudParis, undergraduate engineering students benefited from a 3h conference reflecting the cutting-edge results connected to virtual collaborative environments and medical imaging under the framework of the course on De l'imagerie numérique à la réalité virtuelle (delivered in French).

At graduating engineering level, the HighTech Imaging major students (which include each year at least 5 international students) are taught advanced image protection techniques during the lecture Digital content protection and new issues related to medical image processing during the lecture on e-Health care, respectively. The Medusa benefit is expressed by two new conferences of 3hours each. Medusa also allowed two HTI students to carry out internships to industrial partners (Dosisoft and Technolution).

With the advent of the Paris-Saclay campus (which currently gathers together more than 20000 researchers and whose expansion is a priority for the French government), such lectures are scheduled within the masters Multimedia networking (the first 2h of laboratory works related to medical content tracking are scheduled in December 2015). Finally, note that Medusa also allows 2 PhD students to be financed at IMT.

In order to directly access the market, a spin-off of IMT was created. Note that this spin-off integrates research results obtained by IMT within 4 collaborative research projects, founded by European and French national resources, as illustrated below.

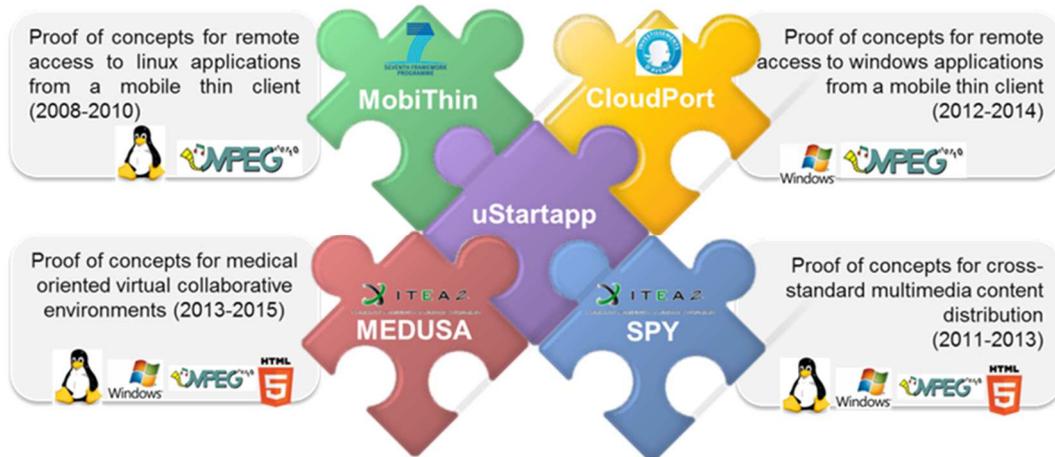


Figure 10: uStartApp – a spin-off of IMT capitalizing on the research results obtained within the MobiThin, CloudPort, SPY and MEDUSA projects

5.2.3.4 Pitié Salpêtrière Hospital

MEDUSA project opens several opportunities for exploitation in terms of both existing clinical applications and workflow organization, as follows:

- Regarding the ComaSoft application, the possibility to deploy it as a service within the MEDUSA framework, in parallel with a standalone deployment. This would increase the market target by including hospital services that would need this application occasionally for a limited amount of time.
- Possibility of totally reshaping the organization of collaborative decision meetings for oncology on a remote basis, by exploiting, on one side, the MEDUSA framework as a collaborative platform, and on the other side the on-line remote image exchange using the progressive quality restoration developed in WP3, for an efficient time management of the diagnosis process.
- Possibility of extending the remote image access implemented in WP3 to other clinical applications requesting the distant consultation of patient image data.

6 Dissemination plans

6.1 Dissemination activities

All partners have disseminated the results of the MEDUSA project in order to strengthen their reputation, attract potential customers, attract high potential personal and students and/or stimulate the exchange of valuable research results and standardization.

Dissemination into the project has been carried out mainly through publications into internet, papers to international and national conferences and seminars, newspaper and technical magazines as well as coverage on television. Further dissemination activities after the project can be characterized in the next points:

- MEDUSA brings together partners from different countries, regions and disciplines. While respecting the intellectual property rights of each of the partners (consistent with the ITEA guidelines) the MEDUSA consortium will commit to a maximum transfer of information within and outside of ITEA).
- The research institutions and companies with strong links to (or alliance with) universities will setup university courses on the subject and disseminate the results through their networks of other research institutes, SME's, new start-ups and industrial contacts.
- The internet will be a major vehicle for publishing and disseminating relevant project results. A MEDUSA website will be established, summarizing the most relevant results of the project. This website will consist of private and public sections. The private part will contain the consortium-confidential information; while the public part will contain all freely available material, such as published papers, proposals to standardization bodies, conference contributions, showcases etc.
- Next to the public part of the MEDUSA website, several partners plan to setup local websites aiming at dissemination specific work package results to their internal, national and international networks.
- Technical workshops will be organized in which participants will explore user requirements and present their work, ideas and results with the aim of sharing relevant knowledge with all people involved in the project. Some of these workshops might also be open to the public.
- A set of reference designs and proposals will come out of the project with which industries can be supported to carry out their projects.

6.2 Conferences

IMT actively disseminated its research results among the scientific international community.

6.3 Press releases

IMT made an initial press release for the MEDUSA project.

6.4 Standardization

The AMC has developed automated tooling for determining the infarct volume on follow-up CT. This software has been used in a large multicenter trial and is currently being evaluated by 3 other trials. As such this software has the potential to become the standard for this type of analysis.

IMT had an active standardization activity (more than 20 technical reports) related to the ISO/IEC efforts on user description (ISO/IEC 21000-22) and the emerging ISO standard related to wearable devices and Internet of things.