Medusa

DELIVERABLE
D622 – Initial Exploitation Plan

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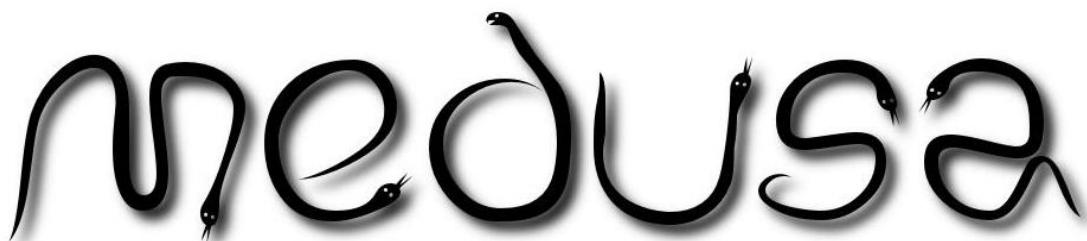
Medical Distributed Utilization of Services & Applications

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1 Introduction

1.1 Aim of activity

This document will provide an overview of exploitable assets per partner and the overall assets of the Medusa project. It also describes the plan on how to exploit these assets. The document lists an overview of the relevant business opportunities and applicable market opportunities and trends.

1.2 Medusa Consortium

In the Medusa project 12 consortium partners work together, complementing each other along different axes. The consortium represents a knowledge chain of universities, (academic) hospitals and R&D centers from SMEs and large industries active in medical imaging, communication technology and security product innovation. The consortium characteristics are as follows:

12 partners participate;
2 European countries are represented;
8 of 12 partners are industrial companies, of which 4 are SMEs;
3 ITEA founding partners participate: Philips, Bull and EADS (Cassidian).

With respect to the Medusa consortium:
The consortium partners complement each other by their contributions in WP3-5 for the three main technological areas considered in Medusa.
The consortium partners complement each other to produce demonstrators in WP1 for the three specific use cases/ clinical applications considered in Medusa: trauma care, stroke imaging and treatment and cancer care.
National consortia likewise complement each other for the production of prototypes and integrated demonstrators at the national level.

Table 1: Consortium Partners

The Netherlands			
Philips Healthcare	Industry	PL, CC, WPL	The Netherlands
AMC Amsterdam	Academia	WPL	The Netherlands
Sopheon	SME		The Netherlands
Technolution	SME		The Netherlands
France			
Bull	Industry	CC	France
Dosisoft	SME		France
Cassidian	Industry	WPL	France
Imstar	SME		France
Institut Gustave Roussy (IGR)	Academia		France
Institut Mines & Telecom (IM-T)	Academia	WPL	France
Pitié Salpêtrière Hospital (HSP)	Academia		France
Prologue	Industry		France

2 Executive summary

Medusa's purpose is to enhance quality of diagnosis and decision making in acute and/or critical situations in a patient's condition by introducing a new service concept in healthcare based on three pillars:

- Advanced imaging as a service
- Secure virtual workspaces as a service
- Medical diagnosis support as a service

This deliverable has been produced to describe how results from the Medusa project can be directed to the market.

The deliverable describes how the assets from the Medusa project can be exploit and describes the relevant markets. The assets can be divided in one of the three mentioned services and are described per partner.

The chapter about Business relevance describes changes and trends on 3 areas of expertise within Medusa:

- Healthcare market
- Decision support
- Remote computing/processing

Every partner also identified the relevant market for his assets obtained in the Medusa project (markets, targets in each market, analysis of competitors, substitutive products, barriers, catalyst)

Finally the initial exploitation plans for each of the partners of the consortium are described.
These individual exploitation plans can be taken as a referent for defining exploitation actions that can be directed to the market.

3 Inventory of exploitable assets per partner

This section described on a high level the expertise per partner, which is relevant for Medusa

The results of the Medusa project will be exploited in the following typical future healthcare IT products:

- Intervention support systems;
- Medical imaging infrastructure;
- Decision support software tools;
- Medical image processing service centers;
- Medical decision support service centers;
- Secure and dependable collaborative products and services in other domains.

3.1 Philips Healthcare

At Philips, we understand that providing quality healthcare means balancing many needs. You need high quality images for fast, confident decision-making. Seamless collaboration is critical so that information gets to the right person quickly. And patients demand quality, more personalized care that addresses their needs for comfort and dose management. All of this must be delivered at a low cost. It's a complicated formula.

Within the Medusa project we want to improve capabilities of the existing portfolio, with advanced image processing and collaboration tools. We also want to offer a new system and services with the Open Philips Imaging Platform

3.1.1 Advanced image processing in the Cloud

Within the Medusa project Philips is deploying legacy imaging systems in a cloud environment. Deploying this model to existing products is an enabler to provide more cost effective and scalable healthcare solutions.
This can also enable deployment of shared, jointly owned applications into market segments were individual users cannot afford such systems.

The reference architecture and designs developed in Medusa are examples of integrating heterogeneous products into one consistent ecosystem.
This is an enabler for deeper integration of these independent products, providing a more cost effective healthcare system.

3.1.2 Video Conferencing

Video Conferencing project will be used in Healthcare platform to provide a conferencing mechanism (Audio, Video and Screen Sharing) for medical application users. Applications users like radiologists can use this feature to trigger a conference amongst a host computer (for e.g. An IntelliSpace portal client) and participating clients to collaborate each other for discussing, clarifying and communicating information, ideas, open issues etc. to provide a better diagnosis.

3.1.3 Open Innovation

Philips Healthcare will use the project results to provide a research platform enabling rapid (clinical) application development for Philips research and for external parties (e.g. Clinical Customers, Research Institutes). The prototypes are basis for the development of real products.
The expected impact is:

1.   Accelerate Idea to Market
2.   Supports rapid development, verification and clinical validation of algorithms and workflows
3.   Enables co-creation and co-innovation with e.g. clinical customers

3.2 AMC Amsterdam

AMC is one of the largest academic medical centers of the Netherlands. It especially focusses on acute care and complex surgery, and neurovascular diseases in particular. In complex and acute situations, information and knowledge from diverse sources are required (life signs, consultation from specialists with different expertises, radiological images, etc.). Furthermore, an important task of the AMC is to educate students. By introducing these new developments to students, the next generation can profit from the advance in image management and collaboration as provided by Medusa. As such we have identified the following inventory of exploitable assets:

- The latest high-tech collaboration environment for specialists;
- High performance image processing for fast and quantitative assessment of radiological images;
- Easy exchange of medical images for treatment selection support.

These exploitable assets results in a number of benefits resulting from the Medusa project:

- Strengthening of the leading position in stroke image processing;
- Advancing and implementing image processing functionality for multi trauma care;
- Allowing to attract the best students and researchers interested in acute care to the AMC;
- Become the opinion leader in image supported acute care;
- Stay an attractive partner in multi-organization projects;
- Improve care by experimenting with the Medusa platform by clinicians and decision makers;
- Improve care by increasing the number of patients to be treated by becoming the referral center for a large area;

The action plan for the AMC consist of hosting Medusa demonstrators, organizing a conference on image-supported acute care and presenting the demonstrators at national and international meetings. Furthermore, the results from Medusa and its implementations will be published in national and international peer-reviewed articles.

3.3 Sopheon

Sopheon provides complete Enterprise Innovation Management (EIM) solutions including software, expertise, and best-practices to achieve exceptional long-term revenue growth and profitability.
One of the big challenges that organizations face is to make informed (investment) decisions. Portfolio Management is a key business process in any organization: the process by which organizations manage the prioritization of initiatives and the allocation of resources. The decisions made in managing portfolios shape the future of the business, driving the innovation agenda. That agenda will determine the competitiveness of a business, its market position, its financial performance and, ultimately, its level of success.

Portfolio Management is a dynamic decision process, whereby a business list of product investments is continuously updated, revised, rebalanced and reprioritized. This ensures the optimal investment mix for the company - the optimal 'Portfolio Value' - and optimal usage of the organization's resources.

The Portfolio Management process is always coping with uncertainties and changing information, with dynamic opportunities and with multiple decision makers spread geographically. It is very clear that such a process has very dynamic information flows. Like the processes represented in the Medusa demonstrators, it needs accurate and immediate, actual data collected from various sources. It also needs support for decision making and tools to communicate decisions into the relevant other processes.

Therefore the following elements of Medusa are exploitable assets for Sopheon:

- Collaboration portal - for gate meetings and portfolio meetings
- Rules engine - for the configuration of portfolio alerts (by the users)
- HTML5 - for dashboards (with portfolio views)
- all browser-based - for next generation Accolade
- new Accolade API - for collaboration with external apps
- SaaS – for next generation Accolade

3.4 Technolution

Over the years, Technolution has built up a leading role as technical software developer and systems integrator in various markets like healthcare and traffic management. Technolution has gained a lot of knowledge and experience as integrator for heterogeneous systems, ranging from state of the art web applications till old legacy applications. This knowledge also has been used to develop products which contribute to a better collaboration between people in a workplace, like the Processmanager™ and MobiMaestro ™.

Technolution sees Medusa as a great opportunity to extend the knowledge about systems integration with very heterogenous systems, to extend the knowledge about deployment of systems in the cloud, and last but not least to develop products that contribute to real collaboration in the workplace. Several technical Medusa innovations will be directly applied in projects with our customers in different domains.

3.5 Bull

Bull is an Information Technology company with €1.3 billion revenue, 9,300 employees, that operates in over 50 countries.

Effectively combining processing power and security, Bull designs, implements and runs internationally renowned solutions for public and private sector organizations alike, that transform information systems into positive drivers for excellence, differentiation and value-creation. As a trusted IT partner, Bull designs, implements, maintains and runs leading-edge digital solutions that effectively combine processing power, security and the integration of complex, heterogeneous systems. With its broad portfolio of technological expertise and its positioning as an independent supplier, Bull works alongside customers, supporting their digital transformation, helping them to reap the full benefit and manage risk.

With the One Bull plan, Bull aims to become the trusted operator for enterprise data. To achieve this goal, the One Bull plan will harness all of the Group's resources to develop solutions and services that will enable businesses to capture the full value of

the data they produce and use. The plan aims to double the Group's EBIT margin over the period to 7% of revenues by 2017, establishing it on a sustainable course for profitable growth.

Bull is one of a very small group of companies with in-depth expertise across the three indisputable foundation stones of computing: processing power; the ability to secure information systems; and the capacity to select, design and integrate technologies to address users' needs.

3.5.1 Extreme computing – Designed without compromise for unlimited innovation

Bull is fully committed to HPC, and has become an internationally renowned player.

As Europe's only computer manufacturer, Bull operates in the ultra-high processing power market, to liberate its customers' ambitions. With its Extreme Computing solutions – focused around its bullx™ supercomputers – Bull delivers all the benefits of a leader in Petascale* technologies to everyone from research centers to the design offices of major multi-nationals to innovative SMEs. When it comes to enterprise servers, bullion™ – proven to be the world's fastest x86 machine – is becoming the server of choice for the Cloud and critical environments.

With its bullx supercomputers, Bull can offer research facilities and companies alike world-class HPC solutions that effectively combine power, flexibility and energy efficiency. In 2012, the Group reaffirmed its position among the global leaders in High Performance Computing (HPC).

As an expert in delivering ultra-high-power, Bull is now one of the world leaders in Extreme Computing. As an IT manufacturer, at the end of 2012 Bull had the second biggest presence in the list of the world's top 20 supercomputers, with three bullx systems: Helios, in Japan, for the international F4E (Fusion for Energy) program; CURIE, in France, for GENCI and the European PRACE initiative; and, in partnership with the CEA, Tera 100, Europe's first supercomputer to break the Petaflops barrier. With more HPC specialists than any other player in Europe, Bull is recognized for its technological prowess, its HPC applications expertise and its ability to manage large-scale projects. In 2012, bullx benefited from a major, patented innovation from Bull: direct liquid cooling, which boosts energy performance by 40%. Across the world, numerous institutions (SARA in the Netherlands, IT4Innovations in the Czech Republic, the German Federal Waterways Engineering and Research Institute, the Universities of Dresden, Liverpool and many others) and companies (Asco, Dassault Aviation, Petrobras, Wirth) have turned to Bull to implement powerful, robust systems that are easy to manage and use, and are designed for round-the-clock operation.

3.5.2 Le Cloud by Bull – Practical approach for a smooth transition

With its integrated global approach, Le cloud by Bull™, Bull acknowledges that its customers want to maintain freedom of choice, and helps them implement the optimum Cloud solution for their specific needs.

With its expertise across the entire technology value chain, Bull has designed Le cloud by Bull, a multi-faceted, business-oriented offering that is not only secure and flexible,

but also evolves according to need. Built around the idea of integrating the whole value chain, from design to usage, this offering delivers concrete solutions regarding:

- USAGE: Bull helps its customers implement solutions that truly fit their situation and ensure that the Cloud is a key tool for innovation and the transformation of their business activities.

- TECHNOLOGY: even though it should be easy to use, the Cloud is still a very hi-tech phenomenon. As an expert in leading-edge hardware and software technologies, Bull uses its skills to build made-to-measure Clouds. The Group's independent stance means it uses the most appropriate technologies to meet each customer's needs.

- SECURITY: Bull's comprehensive understanding of this vital aspect of the Cloud ensures it is a secure, trusted space where data, communications and transactions are free from any risks.

- FLEXIBILITY: Le cloud by Bull can take many forms, ensuring that the most effective solution for each organization can be chosen. It covers various types of services (IaaS, PaaS, SaaS) and delivery models from the public Cloud (through Numergy) to private, hosted private, hybrid and HPC Clouds.

As a result, Le cloud by Bull brings together all the elements to make the Cloud a real driver for growth.

3.5.3 Extreme Factory – bringing the computer simulation to the age of Cloud Computing

Leveraging this know-how and infrastructure, Bull can offer a range of HPC hosting services, and has developed its own HPC on-demand solution: extreme factory. Because in Extreme Computing too, organizations have fluctuating processing power needs, or would rather focus on their core activity rather than administrate their HPC system.

Bull has joined forces with leading software vendors to create "extreme factory": the only on-line portal where customers can access their entire High-Performance Computing environment in one place. They can use it to directly manage their projects on line, every step of the way – from data integration to visualizing the final results – using the applications of their choice.

Totally developed, hosted and managed by Bull, Extreme Factory delivers total compatibility with all standard computing codes, total confidentiality for all your data, and total access to all the available power of the very latest systems and components. Based on bullx supercomputers, extreme factory allows you to access as many processing cores as you want. And you can even specify the technical environment (resource allocation mode, processor family, job scheduler, type of storage, network technologies, network isolation levels) and the type of service you have access to (IaaS, Infrastructure as a Service or SaaS, Software as a Service).

3.5.4 Bull Digital Security – Secure and resilient solutions

As an expert in digital security, Bull has developed a wide range of products and services to help businesses and institutions implement made-to-measure, resilient systems that guarantee the security of both people and assets.

With its extensive range of products and services, Bull helps its customers to establish cyber-security policies and implement effective solutions that evolve over time to reflect the nature, scale and diversity of increasingly sophisticated and targeted threats.

With its complementary technological and business skills, Bull has created a unique offering consisting of high-level security solutions for cyber-security that help to ensure the confidentiality and integrity of information and brings digital security on an industrial scale.

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 **HSM[1] solutions**, Bull provides a range of fully compliant HSMs, to suit all specific requirements: Common Criteria, enhanced qualification, RGS +++, FIPS, MEPS,…

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.

TrustWay® Crypto PCI is a cryptographic (co-processor) card in PCI format – 100% developed and manufactured in France by Bull – that both enables cryptographic transactions and provides secure storage and key handling. It features the latest technological developments in terms of cryptographic algorithms. TrustWay® Crypto PCI guarantees:

- Performance, with its technology based on dedicated cryptographic components
- A high level of security and trust, reflected in the qualifications and certifications it has achieved (EAL4+ Common Criteria – ANSSI-approved)
- Successful implementation in critical security and regulatory environments such as PKI, computerized business processes and electronic signatures, Service-Oriented Architectures (SOAs) and database encryption.

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[1]   Hardware Security Module

TrustWay®box is an encryption device – developed 100% by Bull and manufactured in France – that allows organizations to share their cryptographic devices between several application servers and to create high-availability architectures for applications such as banking applications, certificate management, digital signatures and storing/exchanging sensitive data. Although only a single device, TrustWay® box provides:

- Secure generation and storage of the keys used by customers' applications,
- High performance for all algorithms (RSA, ECC, AES, 3DES, SHA...),
- Flexible architecture and support for all kinds of operating systems supporting RPC client
- Easy integration into all infrastructures.

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 centres, 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 centres 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 of SSL for secure connections. IPSec provide confidentiality and authenticity while SSL protocol generate end to end encryption and an encrypted communication channel between client and server.

Communications are protected between user 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 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.

Bull HSM will be used to provide PKI services to the Authentication agent. Associated with EJBCA, an enterprise PKI CA (JCA/JCE), Bull HSM will be used as a Certificate Authority capable of delivering server and client certificates.

3.6 DOSIsoft

DOSIsoft brings their expertise in the field of medical image processing and specially for contouring and segmentation for healthy organs and tumours in the scope of oncology and radiotherapy. This involves the requirements for the demonstrator, methodology and algorithms, and acceptance criteria for a clinical system.

DOSIsoft will use the project results to provide a virtualized workstation for contouring in radiotherapy and patient follow up for therapy response allowing remote collaborative work between several medical specialists i.e. radiotherapists, radiologists and nuclear medicine physicians.

For DOSIsoft the expected exploitation of Medusa work is planned for 2016. It will be integrated in a new software version.

3.7 IMSTAR

IMSTAR has developed a whole range of instruments and dedicated software covering most of the cell-based studies and tests analysis in Life Sciences, notably, innovative solutions for full process automation and high-content quantification. Different PATHFINDER^{TM}. WorkStations configurations for both Research and Clinical laboratories focus on medical applications such as diagnostic in Cytogenetic, Cyto-Pathology and Oncology. The PATHFINDER^{TM} Technology includes a proprietary (patented) structured image Data Base to easily handle the huge volume of data generated by capture and quantitative analysis of multi-dimensional images with dynamic bi-directional link between data and corresponding events on the slides or microtiter plates. Integration of huge Data Base in PATHFINDER™ systems, designed for high throughput applications allows fully automated positioning, data handling and processing, finally results generation while maintaining track records (FDA, 21 CFR Part11 compliant).

IMSTAR will integrate the project results in their improved performance at reasonable price proposition in the application of oncology in clinical environment and of mass cancer screening based on automated tissue/cellular imaging.

3.8 Institut Gustave Roussy

Gustave Roussy (http://www.gustaveroussy.fr/en) is a private, non-profit cancer treatment center. It is the European leader in care, research and education in oncology. The site includes 33 research teams associated either to the CNRS, the INSERM or the Paris XI University. Within the institute, the clinical radiation therapy activities are distributed through the clinical radiotherapy department headed by Pr. Deutsch and the radiation physics units headed by Dr Lefkopoulos. The team has been pioneering safety in the field of radiation therapy since metrology and quality control procedures have been developed at Gustave Roussy. These procedures are now widely used at the national and European levels. The **Radiotherapy Department** has a three-part mission of excellence in patient care, translational and basic research, education of medical students and residents and has developed expertise in most of the fields of radiation oncology.

3.9 Institut Mines & Telecom

The Institut Mines-Télécom (http://www.mines-telecom.fr/en/) is a scientific, cultural and professional public institution placed under the joint authority of the Minister for Industry and of the minister for Electronic Communications in France. The schools of the Institut Mines-Télécom are listed amongst the leading Grandes Ecoles in France. Geared towards economic stakeholders, the activities of the institution involve research, innovation and education for engineers, managers, specialists and professors, and are acknowledged for their excellence at both national and international level. ARTEMIS (Advanced Research and Techniques for Multidimensional Imaging Systems) is an educational and research department within the Institut Mines-Telecom (www.it-sudparis.eu/artemis). Its vocation is to conduct methodological and technological research in the field of digital imaging sciences and technologies, dealing with the image chain from content creation to its transmission.

3.10 Pitié-Salpêtrière Hospital

The Groupe Hospitalier Pitié-Salpêtrière (GHPS) is an academic hospital of 1800 beds providing services in all medical and surgical specialties. The department of medical imaging (50 radiologists) includes different sections: neuroradiology, cardiovascular and interventional radiology, oncologic imaging, general radiology and nuclear medicine. The neuroradiology section works in close collaboration with the Stroke unit. All stroke patients admitted in the hospital have emergency diffusion weighted (DWI) MRI. For emergency decision making in stroke patients, ultra-fast accurate post processing of DWI and sometimes MR perfusion data is needed and could beneficiate of the Medusa project.

The neuroradiology section is also involved in the emergency endovascular treatment of intra-cranial aneurysm. One of the specificity of the Paris neurosurgery emergency system is the "Grande Garde". In this organisation, only one Hospital receives all neurosurgical emergencies of Paris and suburb each day (about 10 million people). GHPS is on duty for all Paris every 3 days. In this system transmission of CT scans of patients from other hospitals, accurate and rapid post processing of CT angiography and teleconference between experts of different hospitals as proposed in the Medusa project could be a great help.

In oncologic patients, the assessment of tumor response after chemotherapy is challenging for imaging techniques. Post processing software permitting the assessment of volume tumor growth and tumor perfusion will support decision making for maintaining or changing interventions. These specific image analysis programs must be usable almost real time during multidisciplinary conferences. Medusa could help achieving this.

3.11 Prologue

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, unified communication, and Enterprise Content Management (ECM) and Exchange (EDI) solutions.

Prologue has also invested for more than 4 years in various advanced R&D projects and recently launched innovative Cloud services providing brokerage and Cloud management, applications marketplace, and Desktop-as-a-Service.

More specifically, Prologue offers 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.

Today, enterprises are facing the challenge of selecting a specific Cloud that meets their requirements (technical, operational, regulatory), and moreover, be able to run their applications on multiple Clouds, leveraging each Cloud specific features (high performance computing, content delivery…). Prologue helps enterprises in achieving this customized deployment on multiple Clouds (Public, Private, or a Mix).

This deployment follows a well-defined life cycle: from expressing the needs in a Manifest, which will be parsed and transformed into a Provisioning plan, then contracting with the appropriate Clouds, and deploying the Workloads over their corresponding infrastructure.

In addition, Prologue solutions allow enterprises and software vendors to port their applications to the Cloud and operate them as SaaS. Buyers can subscribe and use the SaaS of their choice and pay this usage according to defined commercial terms. A Desktop-as-a-Service is also associated, which facilitates access of a variety of terminals (desktop, mobile) to the applications.

In Medusa, Prologue will use this expertise to manage the deployment and lifecycle of applications and components over the infrastructure resources available at the cloud provider.

4 Business relevance

4.1 Healthcare market

4.1.1 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** (see Figure 1 and 2)
  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 grows from 118 million in 1995 to 157 million in 2020.
  For Europe, a few key numbers are (Frost & Sullivan 2005):
  - neurodegenerative diseases: 3,600,000 people affected with Alzheimer
  - cardiovascular disease: 460,000 deaths of stroke
  - oncology: 240,000 deaths for breast cancer
- **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 (see Figure 3)
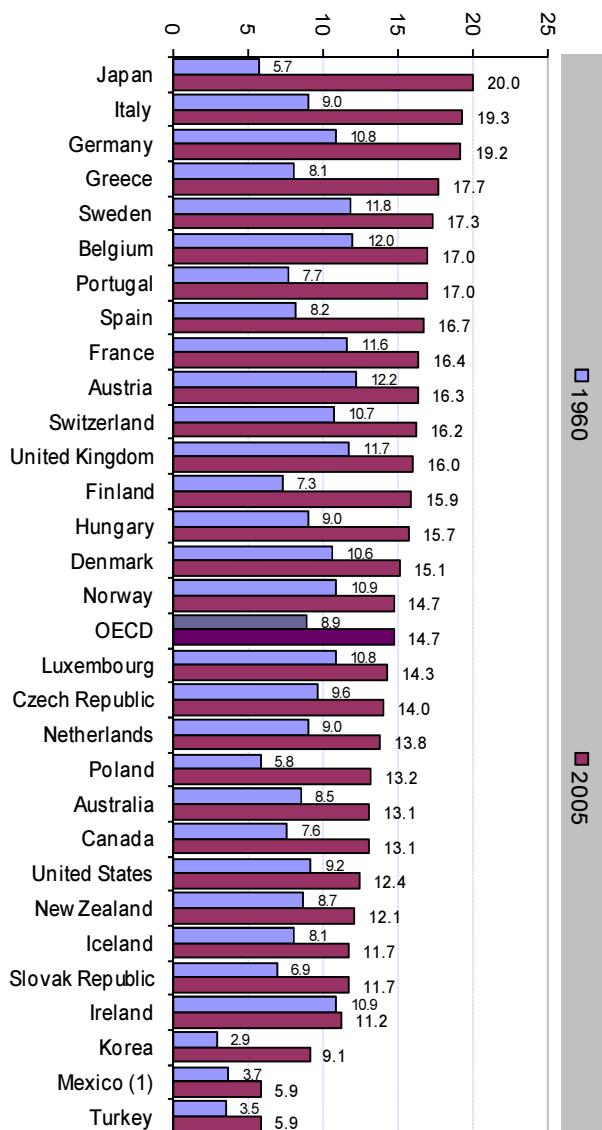
Figure 1: Share of population aged 65 and over, 1960 and 2005 (OECD Health Data 2007)

Country	1960	2005
Japan	5.7	20.0
Italy	9.0	19.3
Germany	10.8	19.2
Greece	8.1	17.7
Sweden	11.8	17.3
Belgium	12.0	17.0
Portugal	7.7	17.0
Spain	8.2	16.7
France	11.6	16.4
Austria	12.2	16.3
Switzerland	10.7	16.2
United Kingdom	11.7	16.0
Finland	7.3	15.9
Hungary	9.0	15.7
Denmark	10.6	15.1
Norway	10.9	14.7
OECD	8.9	14.7
Luxembourg	10.8	14.3
Czech Republic	9.6	14.0
Netherlands	9.0	13.8
Poland	5.8	13.2
Australia	8.5	13.1
Canada	7.6	13.1
United States	9.2	12.4
New Zealand	8.7	12.1
Iceland	8.1	11.7
Slovak Republic	6.9	11.7
Ireland	10.9	11.2
Korea	2.9	9.1
Mexico (1)	3.7	5.9
Turkey	3.5	5.9

Figure 2: Percentage of population >65 years old (OECD Health Statistics World Population Prospects 2012)

Percent of population >65 years old

Japan
US
Canada
UK
Netherlands

2015 2020 2025 2030 2035 2040 2045 2050

Percent of GDP spent on Healthcare
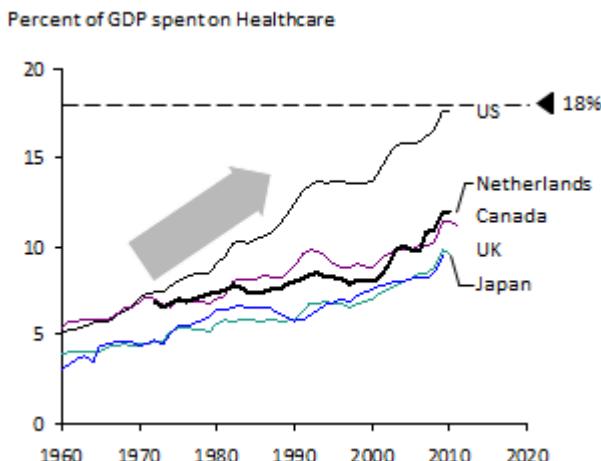
Figure 3: Percentage of GDP spent on Healthcare (OECD Health Statistics World Population Prospects 2012)

Medusa takes up the challenge to:
1. Improve work flow efficiency, effectiveness of medical treatments (and prevent unnecessary transport of vulnerable patients);
2. Contribute to lower healthcare costs by sharing images and expertise;
3. Deal with healthcare professional staffing shortages by providing expertise through a through a dedicated virtual expert group

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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.

4.1.2 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 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:

- 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" organisations, 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 (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.
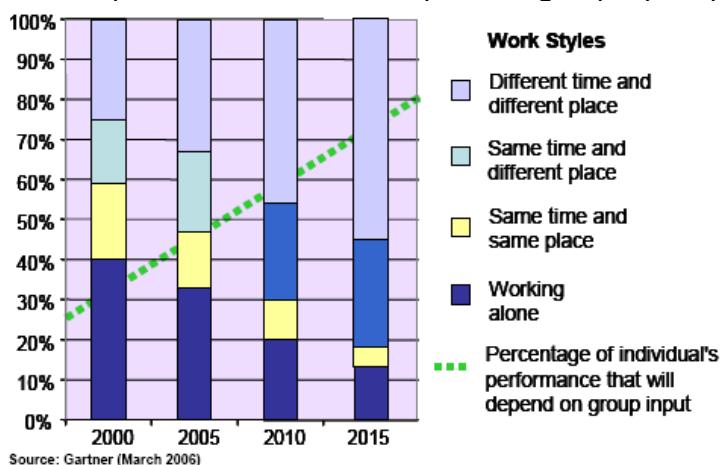
Figure 4: Evolution of working styles

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

4.1.3 Market impact of Medusa

Research [*SAW2005*] in six countries on avoidable medical examinations shows 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.

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

Table 2: Envisaged results for the Medusa Stakeholders

Stakeholder		Market impact	Envisaged result
Users of Medusa			
	Hospitals	Provide better care due to: • 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 inter-pretation 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: • 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: i) Less medical staff has to be physically available ii) More effective use of the medical equipment iii) 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 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 provide		Provide secure and highly available communications networks and bring secure virtual workspaces to the healthcare market	Connect partners in Medusa

rs		

4.2 Decision Support

4.2.1   The analytics market

Decision support is part of a larger market more and more designated as business analytics. According to Gartner [GAR2014], business analytics continues to be "a crucial investment area for 2014". It covers "applications, infrastructures, tools and best practices that enable access to, and analysis of, information to improve and optimize decisions and performance".

Business analytics for healthcare exists at different levels. It helps healthcare organizations to cope with all kinds of developments that force them to adapt their business models and strategy. But analytics also play a role at deeper levels in the organization. The decision support developed for Medusa is an analytical application that helps healthcare professionals to choose the best strategy for treating a patient.

There are different types or styles of analytics as shown in the figure below, depending on the perspective taken: it can range from a purely descriptive to a prescriptive approach. In general decision support is considered to belong to prescriptive analytics, as it 'tells' the users what to do in a certain situation. In Medusa the decision support generates not so much instructions, but alerts on potentially dangerous situations. However, whether it generates alerts or instructions is up to the experts that it will support : a fundamental feature of the decision support is that the rules to apply are configurable and defined by human experts.
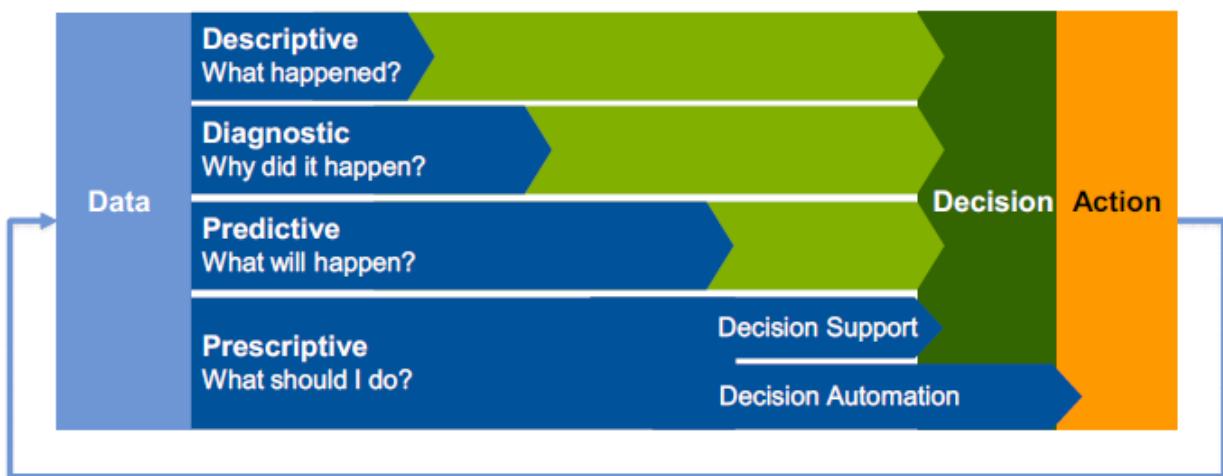
Source: Gartner (January 2014)

Figure 5: Different types or styles of analytics

Analytics helps healthcare providers to face "fundamental changes in the nature of healthcare delivery and practice of medicine, making it more personalized, precise, collaborative, evidence-based and outcome-driven, and extending the sphere of care beyond hospitals and physician's offices".[GAR2014]. This is exactly what the Medusa project is about.
These challenges have an impact on the way healthcare providers achieve objectives such as high quality care, efficiency and reliability.

Protocol-based decision support can contribute to a better quality of care in a collaborative setting within, between and beyond hospitals in the following ways :

- help align healthcare professionals by providing them with a common set of rules for diagnosis and treatment defined by experts as part of a medical protocol
- enable to work in accordance with evidence-based best practice
- help make the diagnosis more precise by identifying trends in the patient data
- help make the treatment 'tailor made' by taking into account historical and real-time data from the patient

If protocol-based decision support enhances the quality of diagnosis and treatment, this will have an impact on the efficiency as well as it will improve the accuracy of the triage processes in emergency care and within a hospital. It will avoid to overestimate the severity of a patient's condition and enable healthcare providers to have a better capacity management, both in terms of resources and infrastructure.

4.2.2 Decision support for radiotherapy

Radiotherapy is a very complex process of planning and dose delivery, based on many successive steps involving several medical specialists and medical techniques. Such complexity may lead in a multitude of opportunities for errors. Although major accidents are very rare, the consequences can be very dramatic.
The evidence is well established that the incidents and accidents are caused by both human errors and failures of technical systems. New technological progress in recent years have brought new risks if they are not properly controlled. Feedback and lessons learned from past accidents allow to develop essential guides for safety and security policy and since 2000, many publications on this subject can be identified [IAE2000].
In France, the sadly well-known accident of the department of radiotherapy of the hospital of Epinal [AUT2006] triggered an awareness unprecedented within the trustee authorities and health professionals. It was followed by the establishment of a list of requirements and regulations aimed quantitative control of the delivered dose: double calculation of processing time and implementation of in vivo dosimetry. In parallel, the proper organization of radiotherapy services has become one of the primary objectives in order to offer patients the best treatment. In this respect, standardization of treatment protocols is one of the benefits of the feedback [SEN2004].
The requirements of radiotherapy are based not only on an expression of the dose to be delivered but also on the most accurate definition of the target volumes to receive the prescribed dose and the sensitive organs to be spared to reduce the toxicity of the treatment. The use of standardized protocols provides the ways of redundant verification methods, allowing the expected definition of irradiation time values, and streamline the essential phase of contouring of target volumes and volumes at risk [BOE2006], [GIR2006], [HON2004]. Many collaborative works reflect the desire to reduce the substantial variations in practices of volume delineation [COL2003], [GIR2002], [GRE2003], [LEN2007], [TAY2005], [WEI2003].
The use of the results of Medusa to address the aspects "contouring for radiotherapy" is part of the idea to promote collaboration work of specialists from different medical image modalities radiologists for anatomical imaging (CT, MRI) and nuclear medicine physicians for functional modalities (PET, SPECT) to work on the same plan of treatment with radiotherapists in order to bring their own skills [HOR2006].

4.3 Remote computing / processing

According to the Wikipedia definition[2], "Cloud computing involves computing over a network, where a program or application may run on many connected computers at the same time. It specifically refers to a computing hardware machine or group of computing hardware machines commonly referred as a server connected through a communication network such as the Internet, an intranet, a local area network (LAN) or wide area network (WAN)". Figure 6 illustrates the different elements and concepts involved in cloud computing.
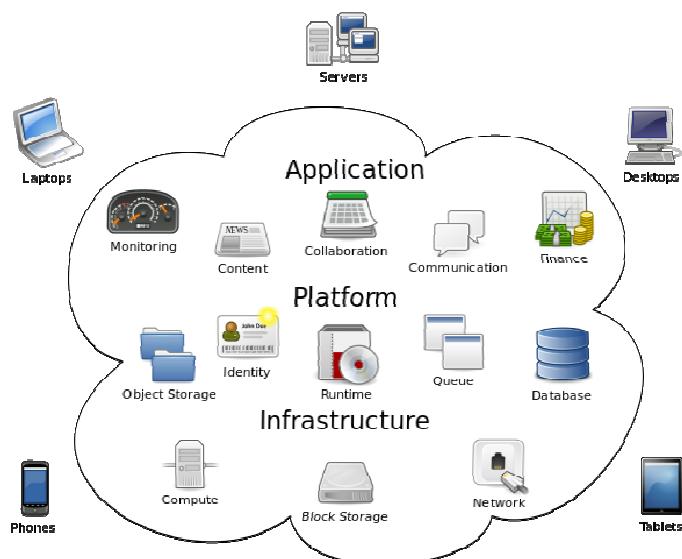
Figure 6: The Cloud Computing model

From an historical and technical standpoint, Cloud computing is the result of well-in-place architectures or usage concepts that, for some of them, were already present in the 1970's:

- Time sharing technology, that was originally invented to remotely compute programs,
- Outsourcing and hosting of computing resources,
- Grid Computing,
- Grid storage,
- Utility Computing

In some common usage, "the cloud" is simply another word standing for "the Internet". It is of course not our ambition in this document to provide an market analysis of the Internet as a whole as it this would have no real significance for our perspective.

Cloud computing also refers to the way applications, platforms or infrastructure are used or sold, in an "as a service" model, meaning remotely through the Internet. In this approach, the provider ("the one who sells the service") has actual energy-consuming servers which host products and services that can be used from a remote location.

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[2] See http://en.wikipedia.org/wiki/Cloud_computing

End users do not own the physical servers and can simply log on to the network without installing anything.

Gartner describes cloud computing as a style of computing in which scalable and elastic IT-enabled capabilities are delivered "as a service" using Internet technologies. It heralds an evolution of business in positive and negative ways. It has also become a hot industry term that has been used in many contradictory ways.

"There is a flawed perception of cloud computing as one large phenomenon," said Mr. Howard. "Cloud computing is actually a spectrum of things complementing one another and building on a foundation of sharing. Inherent dualities in the cloud computing phenomenon are spawning divergent strategies for cloud computing success. The public cloud, hybrid clouds, and private clouds now dot the landscape of IT based solutions. Because of that, the basic issues have moved from 'what is cloud' to 'how will cloud projects evolve'."

Mr. Howard said that private cloud gets a lot of attention and is today the most popular form of cloud across various sectors. However, private cloud is not appropriate for all services and, while the majority of midsize and large enterprises will deploy private cloud services over the next few years, private cloud will only be used for specific services.

Need to optimize time-to-market, more flexible support for business strategies by IT and faster response time to competitive environments seems to be key reasons for enterprises to accelerate acceptation of cloud computing solutions.

From Fortune 500 corporations to small businesses just beginning to evaluate cloud-based CRM and manufacturing systems, enterprises need applications that keep pace with how fast they want to move on new business strategies.

According to Gartner [GAR2013], cloud computing will become the bulk of new IT spend by 2016. They said 2016 will be a defining year for cloud as private cloud begins to give way to hybrid cloud, and nearly half of large enterprises will have hybrid cloud deployments by the end of 2017. There are very real trends toward cloud platforms, and also toward massively scalable processing. Virtualization, service orientation and the Internet have converged to sponsor a phenomenon that enables individuals and businesses to choose how they'll acquire or deliver IT services, with reduced emphasis on the constraints of traditional software and hardware licensing models," said Chris Howard, research vice president at Gartner. "Services delivered through the cloud will foster an economy based on delivery and consumption of everything from storage to computation to video to finance deduction management."

McKinsey & Company's reports that the total economic impact of cloud technology could be $1.7 trillion to $6.2 trillion annually in 2025. Of this total, $1.2 trillion to $5.5 trillion could be in the form of surplus from use of cloud-enabled Internet services, while $500 billion to $700 billion could come through productivity improvements for enterprise IT. The graphic hereafter, issued from the study, summarizes the results.

Exhibit 6

Sized applications of cloud technology could have economic impact of $1.7 trillion to $6.2 trillion per year in 2025

Sized applications		Potential economic impact of sized applications in 2025 $ trillion, annually	Estimated scope in 2025	Estimated potential reach in 2025	Potential productivity or value gains in 2025
	Surplus from cloud-based Internet	1.2– 5.5	2–3 billion more Internet users, most in developing economies	Nearly all Internet applications use cloud as a core enabler	$25–85 surplus per user per month
Enterprise productivity[1]	Infrastructure and operating expenses	0.3– 0.4	$1.26 trillion or 40% of global IT spending in base scenario[2]	Varying levels of cloud adoption across enterprises • All enterprises could have potential to use cloud • Most enterprises may use a hybrid cloud • The share of public cloud usage may increase as cybersecurity improves	20–30% productivity gains • Reduced infrastructure and facilities footprint • Higher task standardization and automation
	Application development and packaged software	0.2– 0.3	$1.68 trillion or 60% of global IT spending in base scenario[2]		10–15% productivity gains • Standardization of application environment and packages • Faster experimentation and testing
	Other potential applications (not sized)				
	Sum of sized potential economic impacts	1.7– 6.2			

1 We have not sized the impact of increased flexibility and convenience to enterprises.
2 Estimates for enterprise cloud based on a global IT budget that does not include telecommunications.
NOTE: Estimates of potential economic impact are for some applications only and are not comprehensive estimates of total potential impact. Estimates include consumer surplus and cannot be related to potential company revenue, market size, or GDP impact. We do not size possible surplus shifts among companies and industries, or between companies and consumers. These estimates are not risk- or probability-adjusted. Numbers may not sum due to rounding.
SOURCE: McKinsey Global Institute analysis

Figure 7: the total economic impact of cloud technology could be $1.7 trillion to $6.2 trillion annually in 2025 (MC Kinsey).

IDC predicts public IT cloud services will reach $47.4B in 2013 and is expected to be more than $107B in 2017, as shown by Figure 7. Over the 2013–2017 forecast period, public IT cloud services will have a compound annual growth rate (CAGR) of 23.5%, five times that of the IT industry as a whole. The growing focus on cloud services as a business innovation platform will help to drive spending on public IT cloud services to new levels throughout the forecast period. By 2017, IDC expects public IT cloud services will drive 17% of IT product spending and nearly half of all growth across five technology categories: applications, system infrastructure software, platform as a service (PaaS), servers, and basic storage. Software as a service (SaaS) will remain the largest public IT cloud services category throughout the forecast, capturing 59.7% of revenues in 2017. The fastest growing categories will be PaaS and Infrastructure as a service (IaaS), with CAGRs of 29.7% and 27.2%, respectively.

IDC
Analyze the Future
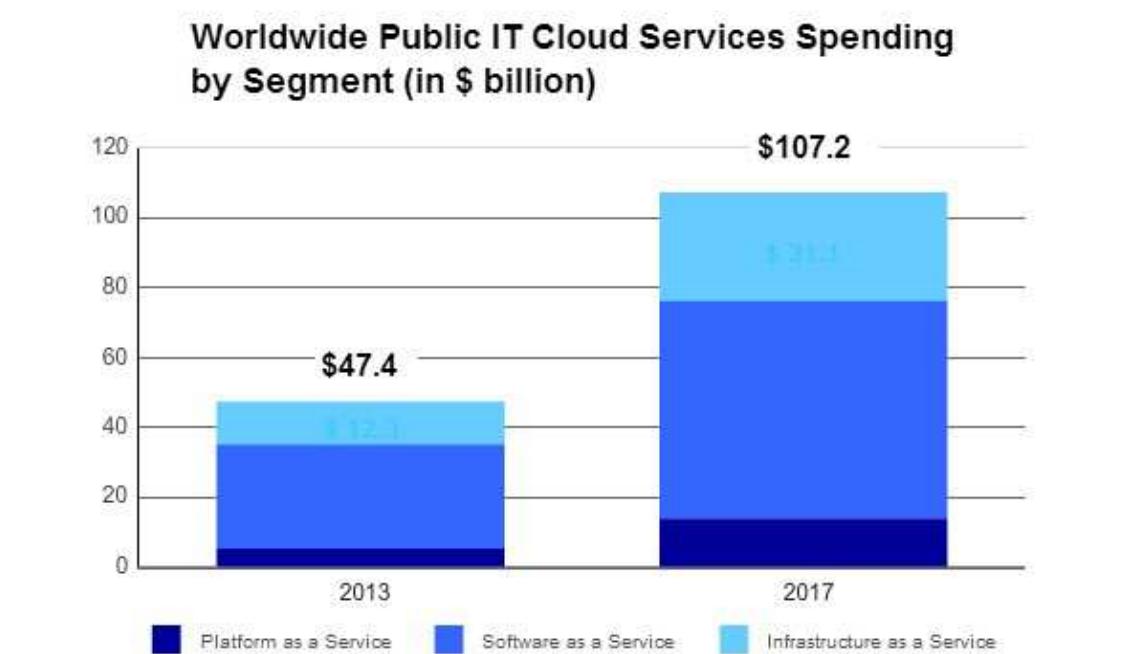
Figure 8: Worldwide Public IT cloud services Spending by segment (in $ billion)

4.3.1 Infrastructure as a Service

Gartner predicts infrastructure services will accelerate cloud computing growth.

As public cloud computing gains greater adoption across enterprises, there's an increased level of spending occurring on infrastructure-related services including Infrastructure-as-a-Service (IaaS). Enterprises are prioritizing how to get cloud platforms integrated with legacy systems to make use of the years of data they have accumulated. From legacy Enterprise Resource Planning (ERP) to Customer Relationship Management (CRM) systems, integrating legacy systems of record to cloud-based platforms will accelerate through 2016.

Gartner predicts that Infrastructure-as-a-Service (IaaS) will achieve a compound annual growth rate (CAGR) of 41.3% through 2016, the fastest growing area of public cloud computing the research firm tracks. The following graphic provides insights into relative market size by each public cloud services market segment.
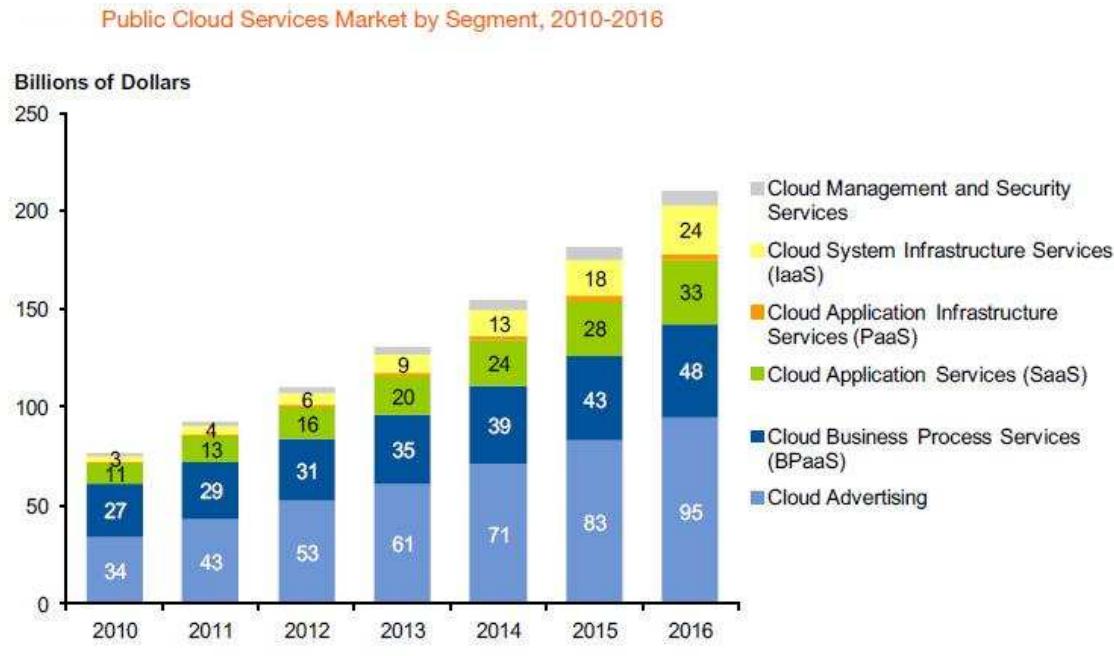
Figure 9: Public cloud services market by segment, 2010-2016

4.3.2 Platform as a Service

Platform-as-a-Service (PaaS) will achieve a 27.7% CAGR through 2016, with Cloud Management and Security Services attaining 26.7% in the same forecast period. Software-as-a-Service's CAGR through 2016 is projected to be 19.5%. The following graphic illustrates the differences in CAGR in the forecast period of 2011 – 2016.
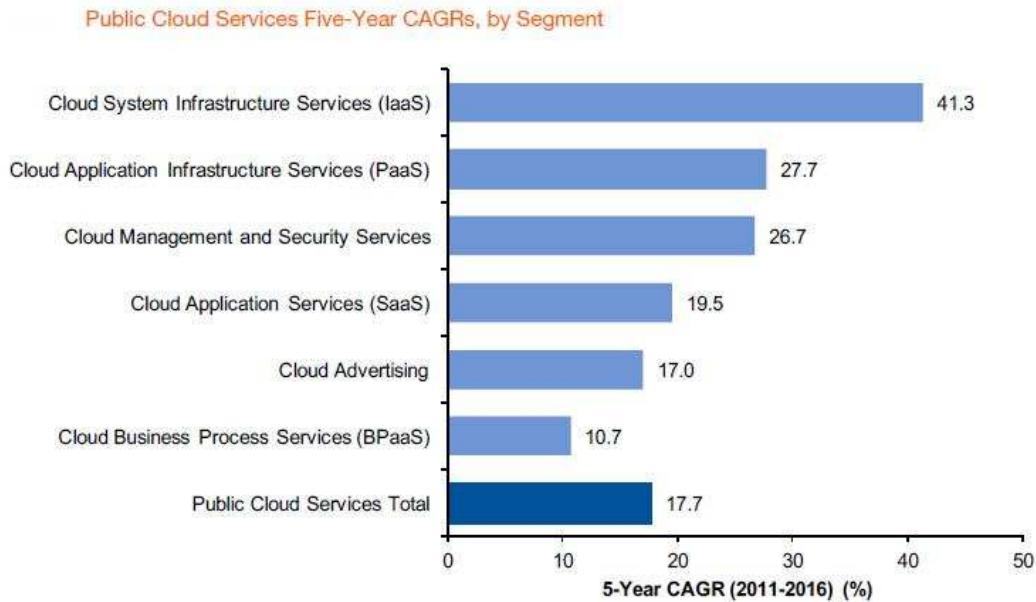
Figure 10: Public Cloud Services Five-Year CAGR by Segment

4.3.3 Software as a Service

Gartner is projecting the SaaS market will grow at a steady CAGR of 19.5% through 2016, having increased the forecast slightly (.4%) since its latest published report. Global SaaS spending is projected to grow from $13.5B in 2011 to $32.8B in 2016.

CRM will continue to be the largest global market within SaaS, forecast to grow beyond $5B in 2012 to $9B in 2016, achieving a 16.3% CAGR through 2016.   The highest growth segments of the SaaS market continue to be office suites (49.1%), followed by digital content creation (34.0%). The following graphic rank orders CAGRs across all public cloud services segments from the forecast period.
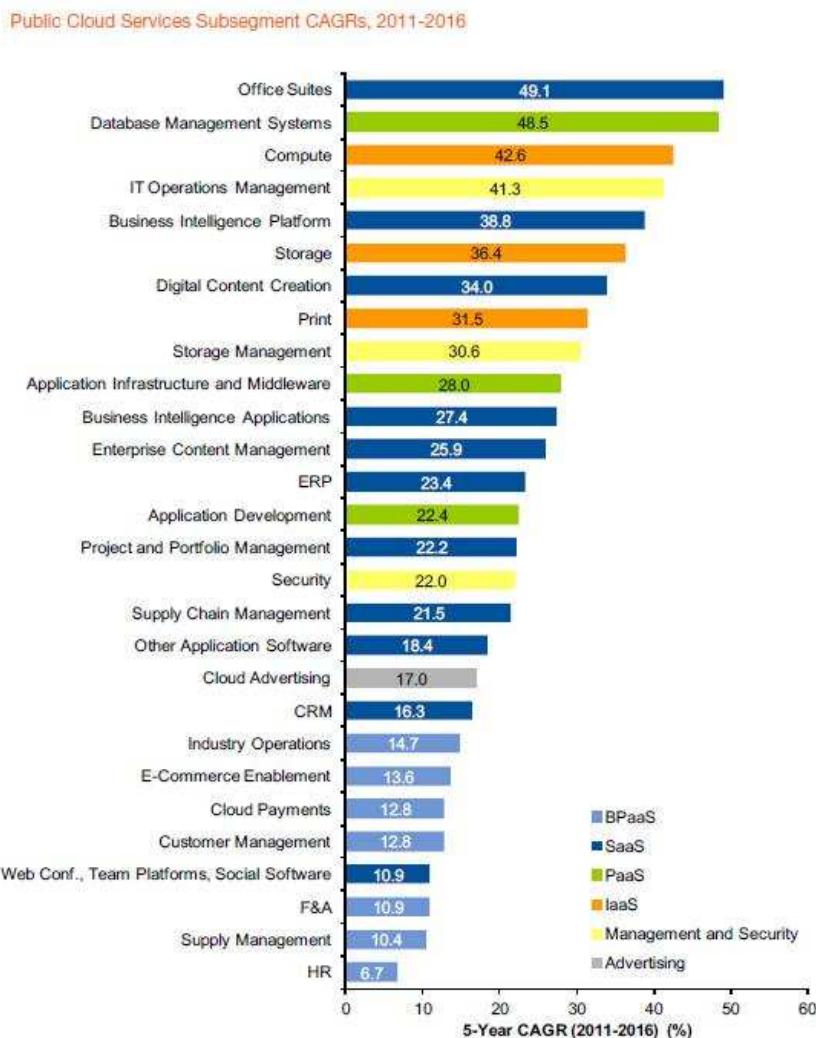
Figure 11: SaaS 5-Year CAGR by application domain

Boston Consulting Group writes that SaaS is a $15B market, growing at three times that rate of traditional software. BCG estimates that SaaS is 12% of global spending on IT applications. BCG interviewed 80 CIOs and found they were willing to consider SaaS solutions for 35% to 60% of their application spending. BCG also evaluated how

the economics of cloud software adoption vary for on-premises versus SaaS customers.

It results from this study that SaaS applications are no longer just for midsize businesses and niche users. Enterprise-software decision makers have dramatically increased their consideration of cloud software. The ones we interviewed were already investing 5 to 10 percent of their software spending in SaaS solutions. More important, they were willing to consider SaaS solutions for 35 to 60 percent of their applications spending, provided that the timing and the vendor were right. Figure 12 illustrates these trends.
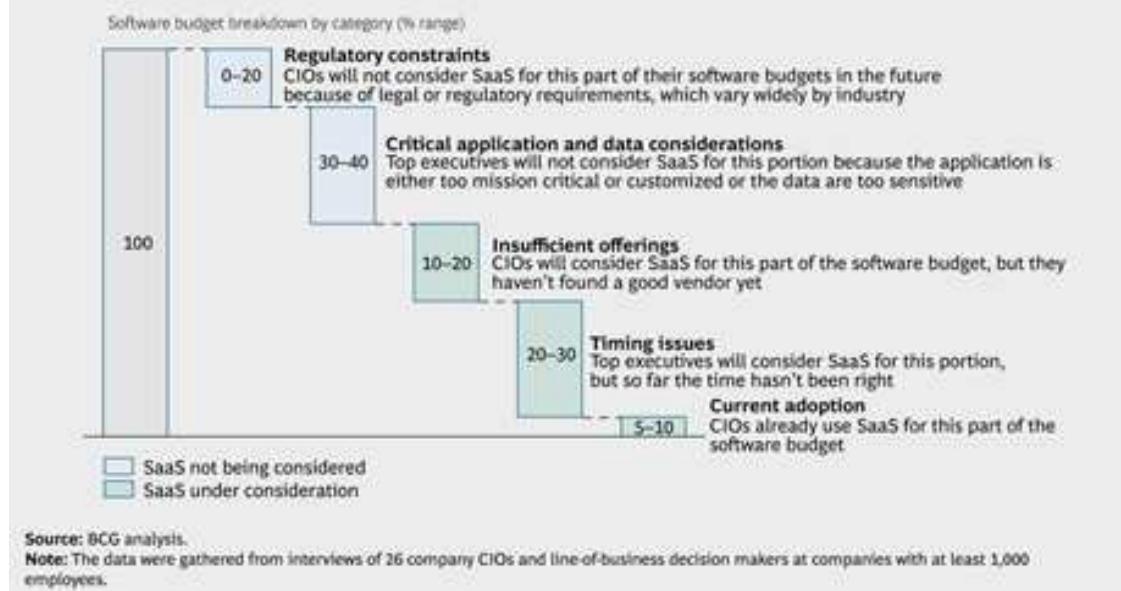
Figure 12: The place of SaaS expenses in global software spending

The adoption of Cloud-based solutions for different aspects of the enterprises business has been witnessing a continuous growth [*BAR2013*]. With the availability of IaaS and the pay-per-use Cloud model, many businesses are choosing to outsource their infrastructure to the Cloud to reduce storage and computing costs. Moreover, SaaS and PaaS are also gaining wider interest for the many advantages they offer: lower cost, less time to install and configure, scalability, and seamless upgrades and integration.

A study conducted in 2013 on Cloud computing-related businesses in France[1] found that the market of solutions and services is growing at a fast rate since 2010, reaching € 3400 million in 2013 and expected to exceed € 4000 million in 2014, as shown in Figure 12. The study covered various activities in Cloud computing, such as consulting, hosting, development, etc.

France, 2010-2015
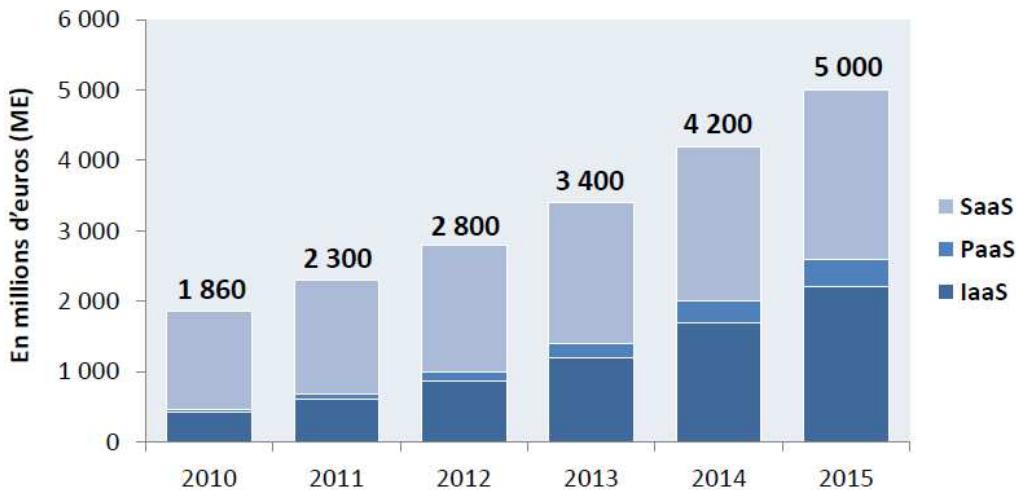
Figure 13 : International prospects for Cloud solutions and services

In the published results, higher demand is observed in small and medium enterprises, both for SaaS and IaaS, while demand for PaaS remains relatively low. The average duration for client engagement contracts spans over 2 years. Furthermore, more than 14% of the business revenues are invested in R&D targeting Cloud computing solutions, also recording a steady increase over previous years.

It is also worth noting that 70% of the responding businesses in the study reported that Cloud computing has generated new employment opportunities.

In the medical domain, there is a growing need to manage and share all medical images and documents online from any computer or any device anytime, anywhere. This is crucial for better decision-making and it improves data collection and care coordination.

A main requirement is to ensure integration with existing and future technologies by providing robust, scalable solutions, without sacrificing the privacy, security, and precision that medicine demands.

The expectations in this area are high, as shown in Figure 13, as some studies predict that the global healthcare Cloud computing market could hit $5.4 billion by 2017.

Prologue has a wide experience in providing the enterprises planning to move their applications to the Cloud with the right tools for porting, improving, and deploying workloads, and ensuring they are well managed in the new environment. Prologue also helps enterprises at large in selecting the best Cloud to support their applications (legacy and new) by providing a combination of multi-Cloud deployment scenarios: Public Cloud only (one or more), Private Cloud only (one or more), a mix of Private and Public Cloud(s). This allows enterprises to achieve their business, financial, and operational goals. With the platforms that Prologue delivers, "Use it Cloud Broker and Use it Marketplace", management functions are provided covering a wide range of services, such as identity management, billing, requirement and SLA description, provisioning plan building and execution, contract negotiation, information gathering, and knowledge base to perform semi-automatic or fully automated arbitrage in choosing the Cloud provider at IaaS or PaaS level.

Through these platforms, Prologue acquired greater experience in designing solutions to meet all enterprises needs in terms of technical, economical, security, operational, and regulatory requirements. This experience is exploited in the Medusa project to enhance resource deployment and management and to facilitate remote collaboration and heavy image processing tasks. In fact, Cloud computing know-how is expected to leverage Medusa system with state-of-the-art medical collaborative tools, with

software and hardware capabilities available to medical specialists anytime, anywhere to support acute care and diagnostic imaging of all kinds.

HOW MUCH DO YOU ENVISION CLOUD COMPUTING WILL SAVE ON YOUR OPERATING EXPENSES?

We will not use the cloud — 26.6%

Will not save money — 32.6%

Will save 40% or more — 1.9%

Will save up to 30% — 4.1%

Will save up to 20% — 14.2%

20.6% — Will save up to 10%
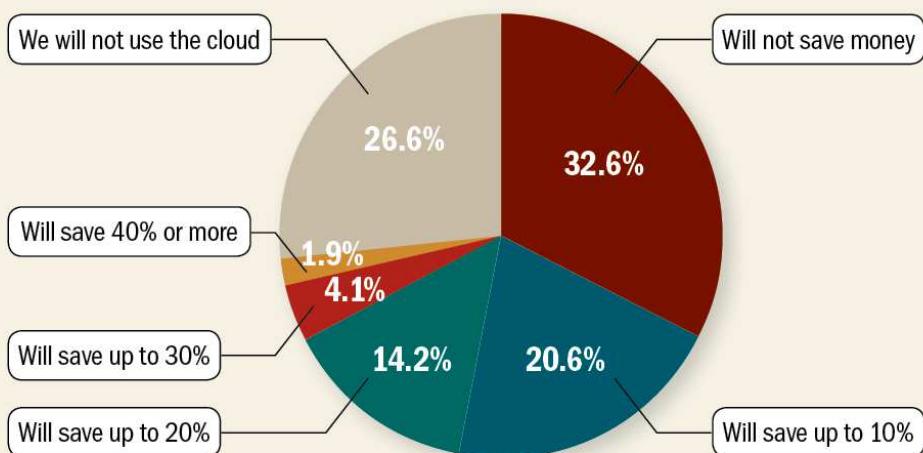
Source: *Managed Healthcare Executive* original research, October 2013

Figure 14: Expected savings with Cloud computing in Healthcare

4.3.4 Conclusions related to Cloud and remote processing

From the figures and analysis presented above, it becomes quite clear that the Cloud computing/remote computing/remote processing has reached a certain level of maturity, not only becoming a perspective and a promise, but now a reality, impacting the whole IT value chain in almost all the application domains.

There are probably many different reasons for this evolution.

Getting more flexibility and making the enterprise more agile is a general trend. The Cloud approach, in an enterprise-private version, follows this logic and provides flexibility and agility for its IT system or a subset of this.

For some organizations, transforming their costs structure, moving from a capital expenses (CAPEX) dominant model to an operational expenses (OPEX) model is the key factor.

At the same time, many application or solutions providers change or at least complete their business model, moving to the "as a Service" (XaaS) paradigm.

5 Market analysis

5.1 Philips Healthcare

To create the future of healthcare, Philips wants to develop innovative healthcare solutions across the continuum of care in partnership with customers to improve patient outcomes, provide better value, and expand access to care. Solutions of the future will be more patient centric and span the continuum of care. They will be integrated, enable better collaboration among healthcare professionals, and support the delivery of higher quality care at a lower cost through the use of analytics and integrated clinical decision support.

Philips envisions that applications will cover the continuum of care: from self-care and prevention, to diagnosis and treatment through recovery and wellness. The envisioned solutions will enable collaboration and workflow, as well as integration of data from multiple sources worldwide, including electronic medical records, diagnostic and treatment information obtained through Philips' imaging equipment, monitoring equipment, personal devices and technologies like Apple's HealthKit.

Moreover, cloud-based solutions are designed to be highly scalable with built-in privacy and data security. By combining the data, the solutions will allow for analysis that will enhance decision making by professionals and engage patients. Solutions are expected to be open to developers and are expected to result in a vibrant ecosystem of partners creating applications. As a result, the envisioned solutions have the potential to transform both professional healthcare delivery and continuous personal health management.

Philips is focused on establishing a common healthcare platform, delivering leading informatics and big data analytics, and offering world-class integration and consulting services. Philips wants to deliver an open, cloud-based healthcare platform, leveraging Philips' leading positions in medical technology, clinical applications and clinical informatics. The collection of data and subsequent analysis to enhance clinical decision making by professionals and enabling patients to take a more active role in managing their personal health.

5.2 Sopheon

Being a provider of Enterprise Innovation Management solutions, Sopheon's target market is not limited to healthcare but comprises a variety of industries. The most important industries among Sopheon's customers 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.

5.3 Technolution

Over the years, Technolution has built up a leading role as technical software developer and systems integrator in various markets. In areas like healthcare or traffic management, many information systems are used. However, these systems do not collaborate, and information is often not available where it is needed. The systems need to be integrated, and made available to all relevant team members in a secure environment.

Medusa offers the means to extend existing products and projects with new capabilities: making meaningful information available to a team working on a specific task. The members of these teams do not have to be on the same location. Examples of these tasks are an ambulance and a hospital first-aid team dealing with a patient with a stroke, or emergency response teams dealing with a big car-crash.

The technologies required to provide secure, integrated systems throughout the working process are developing rapidly, and many of them are tested in Medusa. Examples of these technologies are cloud computing, big data, and secure data transfer. Technolution has developed a framework which integrates very heterogeneous applications into a single cloud-based environment and makes them available to users. This framework is used in the Medusa demonstrators.

Technolution will use the parts of the Medusa demonstrators in various projects of its customers: deployment of applications in a cloud environment, integration of heterogeneous applications, and online collaboration within teams are good examples where the experience build up in Medusa will be a direct benefit for our customers.

5.4 Bull

5.4.1 HPC

In every sector of the economy, computer simulation is now the main tool for innovation.

From fundamental physics to medical research, from aeronautical engineering to financial modeling, High-Performance Computing is everywhere: the vital tool being used to push back the boundaries of knowledge and innovation. Computer simulation is one of the three pillars of research, alongside theory and experimentation. Today, 97% of companies that use HPC cannot imagine returning to their old ways and still remaining competitive.

5.4.2 Cloud

Nowadays, with the advent of Cloud computing, mobile applications have come to symbolize new technologies, not only because they have grown at a staggering pace, but because they herald the future of information systems. As a catalyst for innovation, growth and competitiveness, Cloud computing has established itself as a powerful strategic driver for all kinds of organizations.

By providing IT services on demand, the Cloud is speeding up business transformation, facilitating the implementation of new ideas and freeing up room for manoeuvre, both technically and financially.

Just like applications, the line between systems and the way they are used is starting to blur. We are in an age when solutions are designed for precise purposes and where the underlying technology is increasingly hidden behind the user interface. The same goes for applications: delays are no longer tolerated, as guaranteed response times

have become the norm in a world where digital technology is omnipresent and fixed levels of responsiveness, availability and security are increasingly demanded.

According to the Gartner, the System Infrastructure Services or Infrastructure as a Service (IaaS) was estimated to $6.1 billion in 2012 and is supposed to progress by 41.3% during the period 2011-2016.

5.4.3 Security

The effective spread of technology depends on trust and therefore on security. An everyday reality, cyber-attacks are inflicting more and more significant financial and reputational damage on organizations. Effective cyber-security is all about protecting the system itself, and/or the information it holds, against actions that threaten to undermine its confidentiality, integrity and/or availability.
Bull TrustWay HSM will be used to provide PKI services to the Authentication agent. Associated with EJBCA, an enterprise PKI CA (JCA/JCE), Bull TrustWay HSM will be used as a Certificate Authority capable of delivering client certificates.

As we can see below, the market of Identity and Access Management based in the use of digital certificates is and will continue growing.

Among the most salient findings announced by the Global Encryption Trends Study of Ponemon Institute (February 2013), Identity and Access Management followed by the discovery of data at risk are the top two data protection priorities.

Compared with the first encryption trends study conducted in 2005, new additions to this year's study are application level protection of data and the need for data protection in the cloud computing environment.

The next figure provides a list of 10 aspects that are considered an important part of an organization's data protection strategy in descending order.

The top data protection priorities are: identity and access management, data discovery, protecting data in use within business applications and protecting data in outsourced or cloud environments.

Identity and access management	8.76
Discover data at risk	8.68
Protect data in use within business applications	8.57
Protect data in outsourced or cloud-based environments	8.45
Protect data at rest on file servers, storage infrastructure and archives	7.39
Classify data at risk	6.71
Protect data at point of collection	6.65
Protect data at rest on laptops and workstations	6.39
Protect data in motion over external networks	5.52
Protect data in motion over internal networks	3.10

Figure 15: Ranking of data protection priorities

According to Gartner's report Market Trends: Cloud-Based Security Services Market, Worldwide, 2014, the market for cloud-based security will hit $ 2.1 billion global value this year and will rise to 3.1 billion in 2015, an almost 33% increase.

Among the security services in the cloud most popular, Gartner cites the e-mail security, web security services and identity and access management (IAM). In the 2013-2014 period, the highest growth will be in systems based on encryption and security token, security information and event management (SIEM) tools, systems vulnerability assessments and firewalls for Web-based applications.

While SIEM and IAM sees the growth, functions such as encryption are likely to become more and more popular in the future. However, issues of trust and regional variations mean that suppliers will have to carefully consider every opportunity to market before deciding on which one to target.

Overall transition to SaaS based applications, and other cloud-based services is pushing organizations to adopt cloud-based security controls. They are implemented either as a standalone function, or in the SaaS-integrated package.

Gartner also predicts some trends that will drive the increase in cloud security. One factor, Gartner noted, is that cloud-based security-as-a-service will become more popular with organizations' IT departments as they gain more experience with cloud-based software-as-a-service (SaaS) options. Another factor driving the increase will be that enterprises will look for more and better ways to protect corporate networks as more employees introduce consumer-grade technology to the business via the bring-your-own-device trend.

Cloud security services segment is expected to grow faster than the market of remote security monitoring equipment installed at the customer site. In the next two years, the

major suppliers of network and IT services will be offered to the new security-as-a-service, giving specific management tools for cloud-based IT resources with an eye to the original customers of small and medium-sized businesses. Gartner expects that small suppliers will be most affected by the introduction of these services, and among them will accelerate consolidation.

The greatest interest is noticeable to the means of encryption in the cloud security intermediaries because of their relative ease of deployment and management of encryption capabilities on the part of the customer itself. Gartner expects cloud hosting providers and suppliers of IaaS show a greater interest in the potential of cloud encryption.

The report added that the strongest interest will be in encryption products from cloud security brokers, which are relatively easy to deploy and have options for on-premises encryption management

Within the IAM space, interest in cloud-based security has been driven mostly by small and medium-sized enterprises' needs to extend their basic IAM functions and serve employees who are accessing SaaS and some internal web-architected applications. An increasing number of organizations seem to be adopting cloud-based IAM services to replace IAM on-premises tools. Larger businesses are often looking to use IAM as a mixture of legacy- and web-architected cloud and on-premises.

5.5 DOSIsoft

5.5.1 Business relevance

The knowledge acquired during the Medusa project leads Dosisoft to develop applications for remote collaborative work between medical specialists. These functionalities, based on cloud technology, will allow proposing a wider range of applications for DOSIsoft's products. More precisely:
DOSIsoft will propose software for remote access to the same patient study and share the data in order to perform contouring for radiotherapy. Several medical specialists from different knowledge (i.e. radiotherapists, radiologists and nuclear medicine physicians) will bring their skill to perform and to improve, in real time, the contouring for healthy organs and tumors and create a treatment plan for radiotherapy.
The same application will be used to allow distant medical specialists to work on the same case in the field of oncology for therapy response and patients follow up.
The architecture of the solution, based on cloud environment, is particularly suitable to share a remote and secure database and thus will consider to use the application for medical trials involving imaging series in the scope of oncology.

5.5.2 Business Targets

The virtualization work done within Medusa will be included in our products released in 2016. This allows us to introduce a new product to the market where we expect 10% to 20% annual sales growth.

5.5.3 Benchmarking

Emerging markets hold vast growth potential for radiotherapy. According to recent studies, the Asia-Pacific region has known an annual growth of 8% in radiotherapy equipment (materials and software) during the last decades. The expansion will continue for the market due to the renewing of the old existing equipment. The same growth is expected for North America.

The population of the planet must pass from 7 billion in 2012 to 8.3 billion in 2030 and the number of people with cancer should evolve from about 12.7 million in 2008 (latest available figure) to 20.3 million in 2030 (Lancet Oncology 2012). Currently, 60% of these patients receive radiotherapy treatment with a chance of recovery of 50%. However, the number of cancer deaths remains very high and expected to increase from 7.6 million in 2008 to 13.2 million in 2030.

The market for molecular imaging, still developing sector, is expected to reach global sales of $ 6 billion by 2015. The software is estimated at $ 1.7 billion and expected to reach $ 2.4 billion in 2017.

The global market for radiation therapy equipment was $ 4.4 billion in 2011 and expected to reach $ 5.8 billion by 2016.

Therefore, a total of 10% to 20% annual sales growth is expected.

5.6 Prologue

In recent years, Prologue has been developing a Cloud brokering and Cloud marketplace platforms. The brokering solution builds on the ACCORDS platform to interface with different Cloud providers and offer resource management, monitoring, and billing capabilities.

This platform, which started at the heart of research projects, is under continuous development and improvement with the goal of commercializing it to respond to the market's needs in Cloud brokering and intermediation.

A market analysis conducted by Prologue showed that it has very few competitors in Europe. In fact, Prologue's solutions have a competitive advantage in their support for multi-Cloud and hybrid Cloud deployments and easy integration of new Cloud providers in an extensible object-oriented architecture.

The Medusa context allows Prologue to validate the technical and business models developed and to extend them in order to cover the medical domain requirements. In fact, according to a report by MarketsandMarkets, a market research and consulting company, the global healthcare Cloud computing market could hit $5.4 billion by 2017. While Cloud-computing penetration in healthcare was around 4% in 2011, many more healthcare organizations will be migrating to the Cloud over the next five years, according to the report.

With the Medusa demonstrators, Prologue's solution will prove its capabilities to address remote collaboration and heavy image processing tasks in a resource effective approach. The Cloud Collaboration Management component will give the capability to develop Cloud deployment scenarios that support scalability and efficiency for both legacy and service-based applications, with resources possibly allocated on both private and public Clouds. This target is possible through the analysis of the different components and applications that make up the Medusa system, the integration of the Cloud providers' offers, and a resource lifecycle management aware of the loads and costs. Prologue's Cloud model also aims to incorporate security components necessary for the nature of interactions supported in the medical domain.

6 Exploitable plans

6.1 General

An important aim for Medusa is to bring the results of the project to the European market. The Medusa partners agree that internal exploitation within organisations is good, but further mechanisms are required to go beyond the project. Industrial partners in exploiting the project results within their organisations, to improve their market position, will perform great effort.
The project results provide the options of the industrial partners to provide affordable services to their customers.
The Medusa project builds on longer existing relationships between involved partners. Some of the Dutch partners already have a business relationship in the area of medical image processing. If the project results are satisfactory, the project results will improve this business relationship.

Table 3: Market opportunities for each industrial partner

Industrial partner		Software/ system to be developed in Medusa	Market opportunity
Philips Healthcare	NL	Software platform for medical intervention systems	Medusa allows Philips to increase sales and strengthen its leadership in the market of medical imaging systems, including image storage systems such as PACS and diagnostic work stations
Sopheon	NL	Software platform for protocol management, for embedded decision making in a distributed environment	Medusa allows Sopheon to bring advanced decision making system of the Medusa nature to the market. Sopheon expects tens of millions revenue out of this.
Technolution	NL	Secure grid to share large datasets and on-line decision support	Medusa allows Technolution to strengthen its position in the healthcare and traffic domains by enhancing its technical design capabilities and building blocks needed to set up virtual collaborative workspaces, including sharing of large datasets.
Bull	FR	Infrastructure and middleware components suited to build flexible collaborative distribute medical applications	The project results will help Bull building a distributed medical image processing infrastructure offer. Bull expects to sell ~1000 medical image processing systems per year during four years through OEM or direct channels.
Dosisoft	FR	Remote access software for medical imaging and treatment planning system for radiotherapy	Medusa allows Dosisoft to introduce a new product for remote treatment planning system in radiotherapy and medical imaging software. This will lead an increase the annual sales with an important factor.
Cassidian	FR	Identity management platform for secured data exchange in multi-domain environments	Medusa allows Cassidian to provide on the safety market an identity management platform allowing multi-organisational cooperation by taking into account the control of information which they share.
Imstar	FR	HW & SW platform for high throughput, high content tissue section (TMA) test analysis for oncology in vitro diagnostic	Medusa allows Imstar to spread its imaging instruments over a significantly larger user base via organisation, with other partners, of services hosting Imstar applications

Prologue	FR	Multi-User Collaboration management platform.	Reposition its approach from the standard multi-user multi-process paradigm towards a collaborative and more resource effective approach.

6.2 Individual exploitation activities

6.2.1 Philips

Philips will use the solutions offered by Medusa to integrate them in their future systems offered to the hospitals. This enables our clients to do fast consultation while physical face-to-face meeting are less needed, saving a lot of time of the medical professionals and increasing the outcome of the meeting. In addition, Philips provides image storage solutions that can be amended by powerful image processing capabilities, to enable image processing service centers that serve a collection of hospitals.

The minimal invasive intervention market space is estimated to be 10 times the size of interventional imaging today and enjoys higher growth and better gross margins. Philips aims to raise its share in the interventional imaging market by offering integrated solutions including the support offered by Medusa. On basis of successful market propositions, Philips expects to generate 500M extra annual sales in five years.

6.2.2 AMC Amsterdam

The action plan for the AMC consist of hosting Medusa demonstrators, organizing a conference on image-supported acute care and presenting the demonstrators at national and international meetings. Furthermore, the results from Medusa and its implementations will be published in national and international peer-reviewed articles.

6.2.3 Sopheon

In the Medusa project Sopheon plays an active role in the development of 2 demonstrators: the Trauma demonstrator and the Remote Visit demonstrator. In both cases we develop new technology that Sopheon later may build into its products. In the case of the Trauma demonstrator, we are expanding our decision support rule engine with the ability to identify trends and establish rules based on trends in (combinations of) real-time patient data . In the Remote Visit demonstrator trends also play an essential role, but there the storage and transfer of historical and live video data presents a big challenge. Sopheon explores and develops new ways of storing such significant amounts of data in the browser allowing for high performance search and retrieval.

Both the integration of trends and the ability to store and index large amounts of data in the browser can be used by Sopheon to elaborate and enhance its product offering for innovation management, esp. portfolio management. However, at this point in time further details for exploitation are not available.

6.2.4 Technolution

Technolution is developing the Medusa integration framework and actively participating in the integration testing and deployment of the Medusa demonstrators. Based on experience with Medusa, Technolution will include several innovations in their products and projects. Scheduled are a collaboration workspot for ambulances and hospital emergency departments, and mobile units that can be used in traffic management.

6.2.5 Bull

Thanks to the work conducting for Medusa project, Bull is assembling and integrating different technological elements that will improve its "Infrastructure as a Service" solutions and capabilities. The application domain of Medusa as well as the use cases considered lead to provide this solution with security, dependability, quality of service and low latency capabilities.

This solution could lead to a commercial offer, that would enrich the cloud enrich the cloud services offering of Bull. The first business target for this solution is the image processing market, mainly in the medical domain, even though opportunities in other application domains could be considered.

Such a solution could be sold either directly by Bull itself, or through partners, such as providers of Image Processing services.

The developments carried out in the context of Medusa and the analysis of security requirements of cloud architectures will allow 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.

The target for the exploitation of Bull TrustWay new generation cryptographic modules will be the OEM market for integrators of security solutions.

In this regard, Bull Trustway exploitation plan includes partnerships with system integrators to sell its appliance.

6.2.6 DOSIsoft

DOSIsoft will use the project results to provide a virtualized workstation for contouring in radiotherapy that enables an optimized workflow between multiple medical specialists.
This solution will be extended to other software products of DOSIsoft in order to provide distant and collaborative functionnalities in the scope of molecular imaging and clinical trials.

6.2.7 Institut Gustave Roussy (IGR)

The Medusa project will bring improvements at the academic level and enable Gustave Roussy to strengthen its cancer treatment leading position in radiotherapy procedures, and participate to its international development.

Firstly, the Medusa project represents an academic challenge for Gustave Roussy. Thanks to the remote and in real time aspects of the developed applications, specialists will be able to train and provide assistance to the medical students for contouring tumors and organs at risk, before introducing the resulting images in the treatment planning systems for the dosimetric calculations.
Medusa will be able to provide cutting-edge tools to its interns.

Secondly, the development of this new technology will enable Gustave Roussy to stay a leader in the current contextin patient care. The radiation therapy procedures in use

for tumor contouring will be improved thanks to the easier active collaboration between experts (radiotherapist, radiologist and nuclear medicine physician) and the new segmentation toolscontouring on anatomical and functional images.

Lastly, the institute is increasing collaborations at the international scale. On March 31st 2013, Gustave Roussy signed a partnership agreement with the Sharjah hospital university center (United Arab Emirates) where the development of a new multidisciplinary breast cancer unit is going-on. In this context, thanks to the Medusa work, the experts will be able to physically stay at Gustave Roussy while bringing their expertise to the new institutes: firstly, in order to train the new arriving specialists, and secondly to help with remote diagnosis and treatment decision making, enabling the specialists to gather around a patient case in a virtual workspace. This will open partnership for Gustave Roussy with those who are interested in its expertise.

6.2.8   Institut Mines-Télécom

Within Medusa, the IMT exploitation expectancies are incrementally structured on three directions, related to teaching, standardization and spin-off creation, as follows:

First, the Medusa research synergies will allow IMT to broad the education topics covered by the ARTEMIS department professors, at all levels (undergraduate, graduate, PhD). At Telecom SudParis, undergraduate engineering students can benefit from 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-Helath care*, respectively. 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*. Finally, note that Medusa also allows 2 PhD students to be financed at IMT.

Secondly, Medusa allows IMT to develop and complete (from the technical point of view) the ISO/IEC JTC1/SC29/WG11 MPEG-UD actions initiated during the ITEA2 SPY project. Specifically, contributions related to use cases and work-draft specification have already been done during the first 15 months of the Medusa project. The next 24 months will be crucial for allowing us the specification, demonstration and promotion of MPEG-UD related technologies for medical-oriented virtual collaborative environments. This will open market opportunities to all interested Medusa industrial partners, to whom IMT is willing to transfer its technologies.

Finally, discussions inside the IMT ecosystem are to going-on in order to check the opportunity for the creation of a spin-off related to the Medusa use-cases.

6.2.9   Pitié Salpêtrière Hospital (HSP)

Pitié-Salpêtrière Hospital will use the project results to facilitate communication between remote physicians working in different centers through a virtual secure space. This is particularity expected in order to obtain a second opinion.

Pitié-Salpêtrière is a center of reference in neurosciences, cardiovascular and metabolic diseases, and oncology, in which many physicians are highly solicited for expertise in patient care or clinical research.

The first application of Medusa results will be to respond to the demands of the community hospital with which Pitié-Salpêtriere has developed alliance. The second application will be to improve efficiency of multidisciplinary meetings by matching for any given patient imaging data performed in different centers in order to help diagnosis and treatment decision making.

6.2.10 Prologue

Prologue is participating in the Medusa demonstrators with an active role in the integration of the Cloud infrastructure provided by Bull and the deployment of software components on the Cloud. The individual applications constituting the Medusa system are various in nature, and range from Web to desktop applications, some are single-user while others support client-server functionalities. Therefore, a solution for efficiently integrating legacy applications in the overall Medusa Cloud system is also being tested and evaluated.

The existing ACCORDS platform for Cloud deployment is being extended to handle optimization and scalability of legacy applications deployment. In addition to software packages are developed to handle the lifecycle of the resources needed by the Medusa system at different points in time, with the changing number, properties, and requirements of active collaboration sessions.

The validation of the brokering and Cloud management platforms in the Medusa scope, with the challenging system requirements, will facilitate the industrialization of these platforms and an expansion on national and international clients. Demonstrators developed with Medusa partners will be potentially reused for marketing and joint business ventures after the completion of the Medusa project.

With the investment in Prologue's Cloud competence center composed of 15 experts, 3 of which dedicated to Medusa, an expected growth in revenue will reach 22M€ in 2018 (annual revenue), and cumulatively 44M€ over the period. If those business targets are met, it will constitute a good return on investment (ROI), counting the additional investment in Sales and Marketing.

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Appendix A

The table below describes the dissemination requirements needed to sustain the exploitation plans. The dissemination requirements are translated into dissemination activities described in the dissemination plan.

Exploitation activity	Dissemination requirement
To be filled-in during the project	