NEXOF-RA
NESSI Open Framework – Reference Architecture
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NEXOF Roadmap

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EXECUTIVE SUMMARY

NEXOF Roadmap will define the NEXOF Construction and Adoption strategy of the reference architecture as resulting of NEXOF-RA. But also it will propose the appropriate mechanisms for the adoption of future results of NEXOF.

Therefore, the main objective of the NEXOF Roadmap is the definition of the strategy to build and adopt NEXOF:

- By means of the definition of the evolution of the NESSI Open Framework from NEXOF-RA results, settling the necessary steps to ensure the success of its construction and growth.

- By the definition of the necessary mechanism to ensure wide NEXOF Adoption into a broad range of application domains by a large number of end-user communities. This will tackle aspects such as the sustainability of the framework, community building, major players’ involvement, potential type of users’ definition and envisaged business models for Adopters.

This deliverable has three releases and is conceived as an evolving document. This first version defines the NEXOF Context. The second version of the NEXOF Roadmap will define the Strategic Construction Plan for NEXOF while its third version will develop the Strategic Adoption plan. This document is the first version of the NEXOF Roadmap. It is intended to provide the NEXOF Context Analysis in order to provide the basis for Version 2 and Version 3, respectively, the Open Construction Process Strategy and the NEXOF Adoption Strategy, that will constitute the NEXOF Roadmap. It analyzes all factors that have the potential to influence the NEXOF construction and adoption strategies: Market Trends and Technological landscape, NESSI Context as well as the Identification of the Added Value and Business Models for the NEXOF Framework. In addition, it has two specific sections, Open Construction and Adoption that analyze the specific context for these areas.

All roadmapping process begin with an assessment of the current state of the environment, in order to capture the knowledge and information that has the potential to impact in the strategic plan development and therefore affect its formulation. Hence, the main objectives of this first version of the roadmap in order to define the strategic plan for NEXOF building and adoption are:

- To provide an analysis of existing methodologies strategic technical roadmapping
- To establish the NEXOF technological landscape and market context, including both major market trends and research topics.
- The positioning of NEXOF in NESSI, study the concordance with the NESSI Holistic view as well as its relation with NESSI Strategic Research Agendas.
• The description of requirements gathered in NEXOF-RA for NEXOF and NEXOF Open Construction process.
• The analysis of Adoption strategies in addition to the identification of Potential Users and the initial definition of the Adoption plan that will guide following versions of the Roadmap.
• To provide an initial analysis of the NEXOF Added value and Competitors in addition to the possible Business Models resultant from NEXOF Adoption.

The analysis of methodologies has included the assessment of existing European projects that have provided their own Roadmaps or Strategic Research Agendas such as NESSI-Grid, Challenges and COCONET. It has also been included well-know commercial methodologies for Road mapping such as T-plan. Based on the previous analysis, the Methodology for NEXOF Roadmap has been defined.

The NEXOF Roadmap Context has been structured in two major parts:

• Analysis of related Market Trends and Technological landscape: The context evaluated has included both major market trends and research topics in relation to NEXOF: the Service economy, the Future of Internet (FoI) and the Internet of Services (IoS), Cloud Computing, Software-as-a-Service (SaaS) and Service Oriented Infrastructures (SOA).
• NESSI Context: In this context it has been included the link of NEXOF with NESSI Strategic Research Agendas and NESSI Holistic View.

Initial analysis of the NEXOF Construction process is structured in two main parts. First, it presents the consolidation of requirements gathered in NEXOF-RA. Afterwards it presents the Open Construction process including the analysis of the Open Construction process for the NEXOF Reference Architecture as well as an initial overview of the Open Construction Process for the NEXOF Reference Implementation. The current process being developed in NEXOF-RA establishes the basis for evolution of the framework, with the aim of ensuring its growth and deployment.

A principal objective of the NEXOF Roadmap is its wide Adoption, in this direction the initial version of the roadmap includes:

• The state-of-the-art on Adoption Strategies including the adoption phases and live-cycle as well as the relation to SOA Adoption.
• An Adoption plan, including the identification of its potential users, that provides with an analysis of the Steps to Adopt and their mapping to the identified potential users.
In this first version of the Roadmap it is also included an analysis of the NEXOF added Value and Competitors and Business Models for Adopters, in order to get a clear picture of the benefits gathered through NEXOF Adoption.
This document is the first version of the NEXOF Roadmap. It is intended to provide the NEXOF Context Analysis in order to provide the basis for Version 2 and Version 3, respectively, the Open Construction Process Strategy and the NEXOF Adoption strategy, that will constitute the NEXOF Roadmap. It analyzes all factors that have the potential to influence the NEXOF construction and adoption strategy: Market Trends and Technological landscape, NESSI Context as well as the Identification of the Added Value and Business Models for the NEXOF Framework. In addition, it has two specific sections, Open Construction and Adoption that analyze the specific context for these areas.

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1 INTRODUCTION

1.1 What this document is about
The NEXOF Roadmap has three releases and is conceived as an evolving document. This first version defines the NEXOF Context. The second version of the NEXOF Roadmap will define the Strategic Construction Plan for NEXOF while its third version will develop the Strategic Adoption plan.

This first version of the NEXOF Roadmap is intended to provide with the Analysis of the NEXOF context; it analyzes all factors that have the potential to influence the NEXOF construction and adoption strategy, and will define the basis for the next steps in the definition of the NEXOF Roadmap: the NEXOF Strategic Construction Plan and Strategic Adoption plan.

This initial version of the document is not public. Nevertheless the consortium intends to publish a public version once all versions are completed, in order to assure the necessary awareness both in NESSI community and broadly in the European Research Community as well as the enterprises, organizations and individuals interested in NEXOF.

1.2 What this document is not about
This initial version of the Roadmap does not define the steps, actors and tools required for making real the strategic plan, the implementation of the strategic plan. This will be work will be performed in the following versions of the roadmap.

1.3 Document structure
The document is structured as follows:

- Section 2 establishes NEXOF Roadmap Objectives.
- Section 3 presents the plan for the NEXOF Roadmap Evolution.
- Section 4 includes an analysis of existing methodologies as well as the definition of the NEXOF Roadmap Methodology.
- Section 5 includes the analysis of the NEXOF Context, it includes:
  - Section 5.1 is an Analysis of related Market Trends and Technological landscape; it includes both major market trends and research topics in relation to NEXOF.
  - Section 5.2 provides the NESSI Context.
- Section 6 includes the initial analysis of the NEXOF Open Construction process.
Section 7 deals with the NEXOF Adoption:

- Section 7.1 presents the State-of-the-Art of Adoption strategies
- Section 7.2 identifies potential users and provides the NEXOF Adoption Plan.
- Section 8 presents NEXOF Added Value and Competitors
- Section 9 provides a initial overview to Business Models for NEXOF Adopters
- Section 10 presents the Future Work plan
2 NEXOF ROADMAP OBJECTIVES

NEXOF, the NESSI Open Service Framework, is foreseen to become an integrated, consistent and coherent set of technologies and associated methods and tools with the intention of:

- To provide European Industry and the Public Sector with efficient services and software infrastructures to improve flexibility, interoperability and quality;
- Master complex software systems and their provision as service oriented utilities;
- Establish the technological basis, the strategies and deployment policies to speed up the dynamics of the services eco-system;
- Develop novel technologies, strategies and deployment policies that foster openness, through the increased adoption of open standards and open source software as well as the provision of open services;
- Fostering safety, security and the well-being of citizens by means of new societal applications, enhanced efficiency of industry and administrations, and competitive jobs.

The overall ambition of the NEXOF is to deliver a coherent and consistent open service framework, ranging from the infrastructure up to the interfaces with the end users, leveraging research in the area of service-based systems to consolidate and trigger innovation in service-oriented economies. Moreover, NEXOF plans to be domain independent and accompanied with a sound methodology and tools to be properly instantiated into a broad range of application domains by a number of end-user communities (including Large, Medium and Small enterprise) on different technologies. The NESSI Open Framework (NEXOF) is defined as the set of principles and tools enabling the deployment of networked software-intensive services that can support the NESSI Vision. NEXOF concept is composed by the following set of building blocks:

- An Open Reference Model (ORM), defining the main concepts from both, the technology, business and citizens viewpoints. The ORM is a technology independent and application-domain independent conceptual model that defines the types of entities and relationships relevant for engineering and maintaining service based systems.

- An Open Reference Architecture (ORA), the architectural specification of potential implementations of NEXOF, defined in order to formalise the reference model into open specifications facilitating a precise implementation of the service environment in different domains and technologies. The ORA will consist in: the description of the system components and their relationship; the definition of the interfaces this components have to external systems; the set of principles, rules and constraints guiding the ORI implementation; as well as the set of...
standardized profiles that specify the interoperability between service components and between instances of NEXOF.

- An Open Reference Implementation (ORI), to make NEXOF happen, serving as the guide for further NEXOF instantiations by different organisations, for different domains and adopting different technological approaches. This is a complex of methods, tools and technologies released as open source allowing derivative works.

- A Compliance Test Suite, to validate each NEXOF instance and the related provided services, not only to be fully operational, but also to be compliant with the ORA in order to assure maximum interoperability.

NEXOF-RA is the first step towards NEXOF construction. It provides the definition of the Open Reference Model (ORM) and Open Reference Architecture (ORA). NEXOF-RA constitutes the basis for the further development and growth of the NESSI Open Framework.

NEXOF Roadmap will define the NEXOF adoption strategy of the reference architecture as resulting of NEXOF-RA. But also it will propose the appropriate mechanisms for the adoption of future results of NEXOF.

Therefore, the main objective of the NEXOF Roadmap is the definition of the strategy to build and adopt NEXOF:

- By means of the definition of the evolution of the NESSI Open Framework from NEXOF-RA results, settling the necessary steps to ensure the success of its construction and growth.

- By the definition of the necessary mechanism to ensure wide NEXOF Adoption into a broad range of application domains by a large number of end-user communities. This will tackle aspects such as the sustainability of the framework, community building, major players’ involvement, potential type of users’ definition and envisaged business models for Adopters.

This first version of the NEXOF Roadmap is indented to provide with the Analysis of the NEXOF context; it analyzes all factors that have the potential to influence the NEXOF Construction and Adoption strategies, and will define the basis for the next steps in the definition of the NEXOF Roadmap: the NEXOF Strategic Construction Plan and Strategic Adoption plan.

All roadmapping process begin with an assessment of the current state of the environment, in order to capture the knowledge and information that has the potential to impact in the strategic plan development and therefore affect its
formulation. Hence, the main objectives of this first version of the roadmap in order to set the context for NEXOF building and adoption are:

- To provide an analysis of existing methodologies strategic technical roadmapping
- To establish the NEXOF technological landscape and market context, including both major market trends and research topics.
- The positioning of NEXOF in NESSI, study the concordance with the NESSI Holistic view as well as its relation with NESSI Strategic Research Agendas.
- Initial analysis of the NEXOF Open Construction process, including the description of requirements gathered in NEXOF-RA for NEXOF and NEXOF Open Construction process.
- The analysis of Adoption strategies in addition to the definition of the Adoption plan that will guide following versions of the Roadmap.
- To provide an initial analysis of the NEXOF Added value and Competitors in addition to the possible Business Models resultant from NEXOF Adoption.
3 NEXOF ROADMAP EVOLUTION

The NEXOF Roadmap is conceived as a living document that will evolve in three phases to define the final NEXOF Roadmap. Figure 1 presents these three phases:

Figure 1: NEXOF Roadmap phases

This Version 1 of the NEXOF Roadmap (M12) corresponds with the Analysis of the NEXOF context; it analyzes all factors that have the potential to influence the NEXOF construction and adoption strategy, and will define the basis for the next steps in the definition of the NEXOF Roadmap. This first version includes:

- An analysis of existing methodologies strategic technical roadmapping.
- It establishes the NEXOF technological landscape and market context, including both major market trends and research topics in relation to NEXOF: the Service economy, the Future of Internet (FoI) and the Internet of Services (IoS), Cloud Computing, Software-as-a-Service (SaaS) and Service Oriented Infrastructures (SOA).
- It positions NEXOF in NESSI, studying the concordance with the NESSI Holistic view as well as its relation with NESSI Strategic Research Agendas.
- It provides an Initial analysis of the NEXOF Construction process. It is structured in two main parts. First, it presents the consolidation of requirements gathered in NEXOF-RA. Afterwards it presents the Open Construction process including the analysis of the Open Construction process for the NEXOF Reference Architecture as well as an initial overview of the Open Construction Process for the NEXOF Reference Implementation.
- It analyses of the state of the art of Adoption strategies and defines a preliminary Adoption plan for NEXOF.
- It also provides an initial analysis of the NEXOF Added value and Competitors in addition to the possible Business Models resultant from NEXOF Adoption.
The **Version 2** of the NEXOF Roadmap (M18) will define the Strategic Construction Plan for NEXOF. This process will set the necessary steps for going from the NEXOF-RA results, the definition of the Open Reference Model (ORM) and the Open Reference Architecture (ORA) to the implementation of the whole NEXOF including the Open Reference Implementation and Compliance Test Suite. The intention is that this process follows the “openness” approach followed in NEXOF-RA for the definition of ORM and ORA. The Version 2 of the Roadmap will be delivered in M18, and will consist in the definition of the Sustainability of NEXOF Framework including:

- The analysis and identification of Funding Schemas for the NEXOF Construction process.
- The Definition and Evaluation of Licensing aspects for NEXOF results.
- The Identification of specific opportunities for SMEs in this process.
- The Definition of the NEXOF Economic Model,
- The creation of a Marketplace for NEXOF adopters.

The **Version 3** of the NEXOF Roadmap (M24) will define the Strategic Adoption Plan for NEXOF, based in the adoption strategies and the initial adoption plan provided in the first version of the Roadmap. It will consist in:

- The definition of actions towards adoption in all identified potential player communities. It will include:
  - The identification of the Benefit for Adopting NEXOF in the particular community
  - The specific vision of future of NEXOF for this community
  - Operational and business models to favour the adoption of NEXOF
  - Definition of guidelines for the instantiation of NEXOF results
- The establishment of timeline and guidelines to adopt NEXOF at mid-term and long-term.

The following picture presents NEXOF Roadmap envisaged evolution:
Figure 2: NEXOF Roadmap Evolution

Version 1: NEXOF Context Analysis
- Existing methodologies for strategic technical roadmap
- NEXOF technological landscape and market context
- NEXOF in NESSI
- Initial analysis of the NEXOF Construction plan
- Initial analysis for the NEXOF Adoption Plan
- NI XOI Added value and business Models

Version 2: Strategic Construction Plan for NEXOF – NEXOF Framework Sustainability
- Identification of funding schemas for the NEXOF Construction process
- Definition and valuation of licensing aspects for NI XOI results
- Identification of specific opportunities for OMs in this process
- Definition of the NI XOI commodisation Model
- Creation of a Marketplace for NEXOF adopters

Version 3: Strategic Adoption Plan for NEXOF
- The definition of actions towards adoption in all identified potential player communities. It will include:
  - The identification of the benefit for adopting NEXOF in the particular community
  - The specific vision for future of NI XOI for this community
  - Operational and business models to favour the adoption of NEXOF
  - Definition of guidelines for the instantiation of NI XOI results
  - Timeline and guidelines to adopt NEXOF at mid-term and long-term
4 ROADMAP METHODOLOGY

4.1 What is a Roadmap?

Generically speaking a roadmap is defined as ‘a detailed plan to guide progress toward a goal’. According to Kostoff and Schaller [1] ‘Science and technology(S&T) roadmaps provide a consensus view or vision of the future landscape in a specific area’. In the same paper it is also pointed out Motorola’s vision: ‘a technology roadmap is a useful instrument that supports strategic technology management and planning, and provides a framework for supporting integrated and aligned multifunctional strategic planning, in terms of both ‘market pull’ and ‘technology push’, achieving a balance between market requirements and technological capability, with a key benefit being the communication associated with both the roadmap and road mapping process’.

The road mapping process provides a way to identify, evaluate and select strategic alternatives that can be used to archive the specific objective. Roadmaps are employed as decision aids to improve coordination of activities and resources in complex and uncertain environments. The roadmap enables the evolution of markets, products and technologies to be explored, and allow establishing the links between different perspectives.

Roadmaps are commonly also used to help identify areas that have high potential promise and constitute a framework coordinate developments at any level in a community or in a cross-community level.

4.2 Methodologies

Multiple methods and techniques have been developed to guide the road mapping process. NEXOF-RA WP12 has analyzed the following Road mapping methodologies and projects in order to extract the applicable best practices to its roadmap definition:

4.2.1 T-plan

The T-plan technology Road mapping process was developed in the scope of the Strategic Technology Management EPSRC project [1][3]. The process was first developed for Motorola and has been applied to more than 20 Technology roadmaps from many sectors such as industrial coding systems, postal services, security access systems and automotive subsystems.

The T-Plan approach is to focus the development of the technology roadmap by the business drivers in the organization. It provides methods to:

- Support the start-up of company-specific Technology Roadmap processes
- Establish key linkages between technology resources and business drivers
- Identify important gaps in market, product and technology intelligence
- Develop a ‘first-cut’ technology roadmap
- Support technology strategy and planning initiatives in the firm
- Support communication between technical and commercial functions

The following figure presents the T-plan technology Road mapping process:

![T-plan technology road mapping process](image)

Figure 3: T-plan technology road mapping process

The process followed is to first personalize the method for the specific organization or case, then to identify the business drivers and link technology resources to them. Afterwards, based on the results of this process, technology gaps are identified.

The T-plan methodology defines eight areas of application of technology roadmaps. Each one of them has a different graphical format differing the factors they take into account and represent. The areas are:

- Product planning
- Service/ Capability planning
- Strategic Planning
- Long-range planning
- Knowledge asset planning
- Programme Planning
- Process Planning
- Integration planning
4.2.2 **NESSI-Grid**

The NESSI-Grid project [5] has followed the following approach in order to define its Strategic Research Agenda and Research Roadmap.

![NESSI-GRID SRA process](image)

Figure 4: NESSI-GRID SRA process

First of all a significant set of scenarios were produced. Based on these scenarios and resultant requirements, together with proper context analysis and state of the art, the requirements were transformed into a set of challenges. These challenges have been analyzed in terms of timing and priorities and associated to the identified set of business and market indicators.

4.2.3 **Challenges**

The methodology followed in the development of the Challenges Project [6] is presented in the following picture:
The Challenges project has organized a set of workshops with experts in specific Grid related domains. As a result of each of these workshops, a report has been produced and or each of the created reports the process followed is the following: first the definition of a vision, then identification of the context, and prioritization of challenges. After this step, the identification of institutional and policy actions that could guide the development of this vision is made.

**4.2.4 COCONET**

The COCONET methodology for road mapping[4] is based on iterative and interactive processes of scenario construction, identification of core technologies and competencies, roadmap design, roadmap agenda definition, and strategy development. It considers the process of roadmap definition formed by three phases: Start-up, elaboration and construction, and validation. This method integrates four types on analysis:

- Trends and Developments: Opportunities
- Domain Definition: State of the art: Key players: Issues
- Competitive position and Strengths
- Required Strategic Competences and technologies
4.2.5  **NEXOF Roadmap Methodology**

Based on the analysis performed it has defined the following methodology for NEXOF conceived as a combination of elements present in all methodologies and adopting the graphical format from the T-plan Methodology:
Figure 7: NEXOF Roadmap Methodology

The envisaged graphical representation for the NEXOF Adoption plan it has been decided to use an adaptation of the Service/Capability planning T-Plan schema, showing how technology and technological gaps can be aligned to capabilities and Business and Market drivers. An example of the foreseen result is the Technologies-Capabilities-Business Drivers picture:
This figure will summarize part of the project results:

- The identification of Technologies will be based on the work performed in WP7, Reference Architecture: Specifications specifically on the D7.1 State of the Art deliverable.
- The classification of Technological Gaps will be based on the technological Gaps identified by each of the “problem” work packages:
  - WP1- Advanced User-Interface Interactions
  - WP2 - Service-centric systems engineering
  - WP3 – Adaptive service aware infrastructure
  - WP4 – Non-functional aspects.
- The identification of required capabilities will be based on the work performed on WP10 – Requirements and assessment criteria.
- Business and Market drivers will be assessed in the scope of WP12.
5 NEXOF CONTEXT ANALYSIS

5.1 Market Trends and Technology Landscape

5.1.1 The world of services

Services are a key sector in developed economies. Industries delivering intellectual content, support, utility, experience and information have significantly grown over the last three decades, becoming the largest part of most industrialized economies [42]. According to the OECD service sector accounts over the 70% of total employment and value added in EU[43].

Business services entail a broad variety of services that have in common that they are provided to organizations rather than to individuals, it covers a broad spectrum of services that are mainly traded in business-to-business transactions. Business-services sectors consist of two broad groups, the operational services that supply relatively standardized services, and the knowledge-intensive services that generally produce client-specific services with high knowledge content. The wider group of producer services includes business services, but also sectors like transport, logistics, construction, wholesale trade, banking, insurance, and telecommunications. These intermediary services apply to a broad spectrum of application domains, ranging from software development to translation services and from equipment provisioning to legal consultancy.

Business services currently count as one of the largest sectors in the European economy, and have experimented a remarkable growth both in terms of employment and value added. In the EU, they provide the 8.5% of total employment and 15.3% of value added. Furthermore, they contribute to improve the competitive performance of organizations in almost all sectors of the economy in developed countries.

Table 1. Key indicators of the relative importance of business services in the economy, selected countries.

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<td>Real growth</td>
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<tr>
<td>Computer services</td>
<td>12.3</td>
<td>1.9</td>
<td>7.2</td>
<td>10.2</td>
<td>3.2</td>
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<tr>
<td>Other business</td>
<td>2.5</td>
<td>3.1</td>
<td>2.2</td>
<td>2.9</td>
<td>1.9</td>
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<tr>
<td>manufacturing</td>
<td>2.3</td>
<td>2.3</td>
<td>1.2</td>
<td>1.7</td>
<td>2.5</td>
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<td>Share of total value</td>
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<tr>
<td>Computer services</td>
<td>0.3%</td>
<td>1.9%</td>
<td>1.8%</td>
<td>2.3%</td>
<td>0.4%</td>
<td>1.6%</td>
<td>0.4%</td>
<td>1.9%</td>
<td>0.7%</td>
<td>3.1%</td>
</tr>
<tr>
<td>Other business</td>
<td>5.9%</td>
<td>8.0%</td>
<td>1.8%</td>
<td>4.2%</td>
<td>4.9%</td>
<td>8.9%</td>
<td>4.7%</td>
<td>9.2%</td>
<td>2.8%</td>
<td>6.6%</td>
</tr>
<tr>
<td>manufacturing</td>
<td>22.7%</td>
<td>15.6%</td>
<td>28.2%</td>
<td>20.8%</td>
<td>29.7%</td>
<td>22.5%</td>
<td>18.1%</td>
<td>14.0%</td>
<td>21.7%</td>
<td>19.7%</td>
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<tr>
<td>Share of total</td>
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</tr>
<tr>
<td>Computer services</td>
<td>0.3%</td>
<td>1.5%</td>
<td>0.6%</td>
<td>2.1%</td>
<td>0.4%</td>
<td>1.3%</td>
<td>0.3%</td>
<td>1.6%</td>
<td>0.6%</td>
<td>2.2%</td>
</tr>
<tr>
<td>Other business</td>
<td>4.8%</td>
<td>9.1%</td>
<td>2.7%</td>
<td>7.5%</td>
<td>3.3%</td>
<td>10.2%</td>
<td>5.7%</td>
<td>13.8%</td>
<td>2.9%</td>
<td>7.4%</td>
</tr>
<tr>
<td>manufacturing</td>
<td>19.3%</td>
<td>10.3%</td>
<td>23.3%</td>
<td>17.2%</td>
<td>30.6%</td>
<td>19.3%</td>
<td>19.5%</td>
<td>11.2%</td>
<td>23.5%</td>
<td>16.5%</td>
</tr>
</tbody>
</table>

Source: EU KLEMS data base [http://www.klems.net]
Note: Growth is shown as the volume index in 2005 divided by the volume index in 1980.
Business Services’ application of ICT is encouraged by many factors such as:

- Applicability: The intangible nature of many business services makes them suitable for digital delivery
- Demand: To meet new customer demands and expectations
- Quality: To improve the quality and depth of customer relations
- Expansion: To enhance market reach and expand market.
- Efficiency: To increase operating efficiency and gain economies of scale and scope
- Cost reduction: To improve and expand low-cost production and delivery options

ICT facilitates services firms the introduction of new business models, development of new applications, improvement and reformulation of business processes, enhancement of customer services and to raise efficiency throughout the whole value chain.

**NEXOF view**

<table>
<thead>
<tr>
<th>Related NEXOF Objectives</th>
<th>Software has the potential to transform the services sector, altering how activities are conducted, and how value is created. It is a source of dynamism of the Economy by transforming the way services and, generally, business processes, are delivered and organized. The ambition of the NEXOF to deliver a coherent and consistent open service framework is intended to generate innovation and growth in the European Service Oriented Economy mainly in two ways:</th>
</tr>
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<tbody>
<tr>
<td>• <strong>To provide European Industry and the Public Sector with efficient services and software infrastructures to improve flexibility, interoperability and quality</strong></td>
<td>• By allowing European enterprises to improve their competitive position in the globalised market by participating in globally integrated enterprises or enterprise networks and ecosystems. • By allowing SMEs to specialize into highly profitable niches where they can significantly exploit their specific capabilities. These will end up in a improved competitiveness and productivity in the European industry directly related to the well-being of European citizens.</td>
</tr>
<tr>
<td>• <strong>Fostering safety, security and the well-being of citizens by means of new societal applications, enhanced efficiency of industry and administrations, and competitive jobs</strong></td>
<td></td>
</tr>
</tbody>
</table>
5.1.2 Future of Internet and the Internet of Services

The Internet is now a critical infrastructure for overall society in developed countries with more than 1 billion users world-wide. Today, more than an academic network as it was originally designed for, the Internet is used a business platform, and has become a central part of our life. It is expected that the development of wireless technologies the number of users to will grow up to 4 billion users in few years. As the number of users, providers, services and connected devices grows, the current Internet is going to face problems, including but not limited to scalability, security and address space limitation.

In 2007, the ODCE together with US National Science Foundation (NSF)[56][47] identified issues and questions relating to the future of the Internet. Examples of which are:

- The openness of the Internet has been a clear factor in fostering competition and innovation, and is increasingly enabling users to develop, collaborate and distribute content and customise applications, driving a range of new social and economic opportunities.

- Security threats endanger network operation and a trusted online environment at a time when an increasing number and variety of communities and businesses critically rely on the Internet.

- Convergence between previously distinct networks and services toward the use of TCP/IP generates new demands on the Internet and places strains on existing regulatory models.
The Future of Internet Assembly (FIA[54]) is the European response to the challenge of defining the Internet of the Future. It is comparable to similar activities in the US (GENI[52], FIND[51]), Korea(FIF[53]) and Japan(AKARI[50], and New Network Architecture Forum). This initiative is articulated around the following six areas: Future Networks, Services Architectures, Networked Media Systems, Internet of Things, Security and Experimental Test Facilities.

In particular with the Services Architectures area, the Internet of Services, the FP7 ICT Advisory Group [55] has presented the following vision: The infrastructure of the Internet has and will continually evolve to support new services, trends and businesses. Low entry barriers for provisioning, brokering and consumption of services are crucial for large and in particular small enterprises, acting as service providers and trying to access a worldwide market of potential service users. A broadened concept of global and open Service Delivery Platform is required for the Internet of Services vision; going beyond the client-server model for service delivery to support rich mechanisms of global service supply, where third parties have the capability to aggregate services, act as intermediaries for the service delivery and provide innovate channels for consuming services. To realize this vision, this open platform for tradeable, composable, value-added services on the internet is required. Such platform will need to build upon and extend: Web 2.0 concepts to allow for community-driven service innovation and engineering at large scale; global repositories for value-added services; and, semantic support to enhance enable automatic
composition of value added services. This will enhance reusability of services, and allow reasoning to derive further knowledge. Legal, security, logistics business and technical aspects must be simultaneously addressed for an integral approach to the Internet of Services.

NEXOF view

<table>
<thead>
<tr>
<th>Related NEXOF Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>• To provide European Industry and the Public Sector with efficient services and software infrastructures to improve flexibility, interoperability and quality</td>
</tr>
<tr>
<td>• Master complex software systems and their provision as service oriented utilities</td>
</tr>
</tbody>
</table>

NEXOF shares the FoI and IoS objectives of providing the European industry of all sizes and European citizens with a new Internet, as a “global integrated communications network and service platform underpinning the fabric of the European Economy and European society in general”.

NEXOF directly tackles the FoI driver of developing Networked and Service Oriented System intended as a system with “Low entry barriers for provisioning, brokering and consumption of services for large and in particular small enterprises, acting as service providers and trying to access a worldwide market of potential service users”.

What is more, the Future of Internet convergence between users, media, services, devices and networks, and, in particular, the increasing interaction capabilities of electronic devices open the door for further applicability of NEXOF results. Given that it foresees service systems where services develop and interact in changing scenarios, adapting to different business requirements and situations.

5.1.3 Cloud Computing

Cloud computing is evolving and still not a mature concept. There are in the market several definitions of Cloud computing and Cloud capabilities:

• According to the 451 Group[36]: “The Cloud is IT as a service, delivered by virtualized resources that are independent of location”. In their point of view, Cloud computing assumes a shared infrastructure, on-demand characteristics and highly flexible management. A cloud is IT infrastructure as a service, while SaaS is classically an application as a service.
• Gartner defines Cloud[34] as: “Cloud computing is a style of computing where massively scalable IT-capabilities are delivered as a service to external customers using Internet technologies”

• Forrester Cloud’s definition[31] is: “A form of standardized IT-based capability – such an Internet-based services, software, or IT infrastructure - offered by a service provider that is accessible via Internet protocols from any computer, is always available and scales automatically to adjust to demand, is either pay-per-use or advertising-based, has Web- or programmatic-based control interfaces, and enables full customer self-service”.

As can be observed for the different definitions below there is a lot of confusion in the market about what really Cloud offerings, and of course, the hype around Cloud computing does not help its clarification.

Cloud computing first emerged as Infrastructure as a Service, having the Amazon EC Services (EC2 and EC3) as its main representatives. The evolution of the term is moving on to a more generic approach becoming an alternative delivery and acquisition model in which anything, and everything, can be offered as a service. Cloud computing is perceived as the last attempt or a general purpose IT utility that is accessible by anyone, from anywhere at any time as-a-Service. Cloud computing is the convergence of several trends in the past years, it joins a set of technologies and concepts that were around for a while: Software as a Service (SaaS), Grid computing, Virtualization, Utility computing and Hosting. Moreover, it is a change on IT user’s behaviour; users centre’s of attention is on what the service offers rather that in how it is implemented or hosted, changing the focus from buying tools to enable a functionality, towards the contracting of a third-party to deliver this functionality in a elastically, on-demand, in a pay-per-use model. Of course, it is not new, Grid, SaaS and Utility models were already doing it, but it is a clearly a different approach than the classical on-premises, license based models.

Although, as exposed above, there is not a widely accepted definition of Cloud and Cloud Computing, it is possible to describe the scope of things commonly referred as Cloud computing and its segmentation:
Cloud Computing and its underlying “everything as a service” terminology refers to elastic Internet provision of X resources or capabilities. Although there are others, the most known X-as-a-Service terms are:

- **Software-as-a-service** (SaaS) is a model of software deployment where an application is licensed for use as a service provided to customers on demand.
- **Platform-as-a-service** (PaaS) is the set of well defined APIs a Cloud provider offers the developers to implement applications in the Cloud provider’s environment.
- **Hardware-as-a-service (HaaS)** or **Infrastructure-as-a-Service**: Infrastructure as a Service (IaaS) is the delivery of computer infrastructure (typically a platform virtualization environment) as a service.

### Cloud Services Have Six Key Characteristics

<table>
<thead>
<tr>
<th>Cloud service characteristics</th>
<th>Details</th>
</tr>
</thead>
</table>
| Standardized IT-based capability | - IT-based, meaning that it has complete storage, network, or software-based capabilities, solely or in combination  
- Standard offering defined by the service provider, with little or no flexibility for customization outside the offering |
| Accessible via Internet protocols from any computer | - Modern Internet-type protocols over IP such as HTTP, Representational State Transfer (REST), or Simple Object Access Protocol (SOAP) that are part of any modern operating system  
- Uses a standard Web browser to access the user interface, without any unusual software add-ons or specific OS requirements |
| Always available, and scales automatically to adjust to demand | - Resilient and highly available  
- Service provider offers massive capacity, such that any given customer can get as much capacity as they need at a given moment — and give it back when not needed |
| Pay-per-use or advertising-based | - Free or pay-per-use, usually without long-term contracts, setup charges, or exit fees. The service is paid for one of three ways:  
1. Advertising, usually for consumers  
2. Subscription, billed by availability per unit of time, such as a month or less  
3. Transaction billed for actual usage, such as minutes of compute time, gigabytes of network bandwidth, or gigabytes of storage |
| Web or programmatic-based control interface | - Cloud-oriented Web sites with human interfaces host the customer's data, provide interactions with others, and offer a rich Internet application interface, such as Facebook or Microsoft Virtual Earth 3D  
- Service-based interfaces use XML and REST-style software connection standards, such as the Eclipse API of the Amazon S3 API |
| Offers full customer self-service | - Customers can provision, manage, and terminate services themselves, without involving the service provider  
- Control is via a Web interface or programmatic calls to service APIs |

**Figure 11: Cloud X-aaS classification. Source [38]**
Figure 10 presents a selection of Cloud vendors for all the identified categories of XaaS offerings in Cloud computing:

![Cloud vendors and Classification diagram]

**Figure 12: Cloud vendors and Classification**

There have been identified the following benefits associated to Cloud computing:

- **Reduction of the capital investments:** Given its outsourcing nature, Cloud converts IT into an operational expense, paying per use. Also, in the case of infrastructure provisioning, the risk of over provisioning or under-provisioning in the datacenter is reduced.

- **Scalability on-demand:** The elastic capacity provided by Cloud Computing avoids forecasting on compute capacity or compute demand; it can be swiftly and on-demand adapted to business needs, with no need of over- or under-provisioning.

- **Lower Operating costs:** Cloud providers archive economies of scale in their shared infrastructure management due to the greater resource sharing, the greater levels of architectural standardization and operation as well as a better consolidation. These benefits are passed along to services’ customers that obtain are significantly reduced prices. This, together with the fact that the on-demand nature of Cloud offering results in a linearly priced business model. As the use increases cost scales directly, but without any increase on management complexity or any additional overhead.

- **Metered usage and billing:** Differently to many outsourcing models based on a fee or a flat rate, Cloud is a transparent pay-per-use pricing model.
It is not a recurring bill; it is based on the real consumption of the service, allowing a fine granular IT costs assessment.

Forrester in its report “Is Cloud computing ready for the enterprise?”[41] has identified the following typologies of users for the Cloud:

- **Start-Ups**: Given Cloud’s cheap infrastructure and low investment required. Used in: Web-based business, SaaS, collaboration services, widget providers, mobile services, social networking.
- **Entertainment industry, mainly gaming and entertainment providers**: Due to their need of highly scalable and temporary systems.
- **Small businesses**: For online businesses, online presence, collaboration and enterprise integration
- **Enterprises**: Used as quick and cheap experimentation facility by R&D projects, quick promotions, widgets, online collaboration, partner integration, social networking and new business ventures.

The wider adoption of the Cloud model in Enterprise Environments, despite of all previously identified benefits, is related to the problems that remain still unsolved or with no sufficient mature solutions:

- **Security**: Data security is the principal concern in the adoption of Cloud services. Many users do only trust systems they have physical control over; systems with corporate firewalls, with known processes and audits; to outsource to any other model is not perceived as a secure model.
- **Regulations**: Some regulations require of tracking, logging and auditing of enterprise data that for the moment, are not offered by Cloud providers.
- **Reliability**: Nearly all public Cloud providers have suffered episodes of service level failure or unavailability. This severely concerns in enterprise environments, preferring not to outsource services where they lose control.
- **SLA Limitations**: Service Level Agreements provided by current public Cloud providers have very limited and not adequate SLAs for enterprise environments.
- **Existing investments**: Already made investments make the many companies are redundant to abandon current systems and outsource to Cloud providers.

According to Gartner [31][33], during the past 15 years, a continuing trend toward IT industrialization has grown in popularity. IT services delivered via hardware, software and people have become repeatable and usable by a wide range of customers and service providers. This is due to main reasons, first, to the standardization and commoditization of technologies, virtualization and the rise of service-oriented software architectures, and most importantly to the
dramatic growth in popularity of the use of the Internet. These things, all together, constitute a new opportunity to shape the relationship between IT services sellers and vendors. Moving from license-based, on-premises models, dominant in the IT industry for a long time, to “elastic” models represented by Cloud computing. Although this is not a completely new phenomenon; utility computing, Software-as-a-Service and application service providers (ASPs) had their momentum; it is settling the basis for the movement from an Internet seen as “communications channel” to an approach based on “the deliberate delivery of services” over the Internet.

Other visions, as the one provided by the Economist in their special report on Corporate IT[35] go beyond, suggesting that the emergence of Cloud computing could change businesses and the economy. If IT systems really allow companies to become more modular and flexible, this should foster further specialization. It could become even easier to outsource business processes, or at least, those parts that do not constitute a competitive advantage, distinguishing between the core processes and the context. This would also mean that companies will rely more on services provided by others, forming increasingly “process” networks, a term for loosely connected groupings of specialized firms. Both trends could result on “huge clouds” that could provide basic services for a particular sector and, on top of these systems many specialized and interconnected firms could construct their services.

NEXOF view

<table>
<thead>
<tr>
<th>Related NEXOF Objectives</th>
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<tbody>
<tr>
<td><strong>Master complex software systems and their provision as service oriented utilities</strong></td>
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<tr>
<td><strong>Establish the technological basis, the strategies and deployment policies to speed up the dynamics of the services eco-system.</strong></td>
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</table>

Cloud computing and its “everything as a service” culture will definitively influence the NEXOF uptake and adoption. Although currently there are many barriers for Cloud wide enterprise adoption, it represents a change on software user’s behaviour in front of IT systems. The centre of attention is on what the service offers rather that in how it is implemented or hosted, changing the focus from buying tools to enable a functionality, towards the contracting of a third-party to deliver this functionality in a elastically, on-demand, in a pay-per-use model. The gained popularity of Cloud makes easier the realisation of NEXOF objective of provision of complex software systems as service oriented utilities, setting the basis for the necessary paradigm shift to Utility Models for the provision of IT capabilities.

If we go beyond, and we gather the vision that Cloud computing will allow companies to
become more specialized, modular and flexible, and relying more on services provided by others for non-core functions. We see that it shares NEXOF vision of enterprises actively participating into service ecosystems participating into virtual business relationships and virtual collaboration frameworks enabled by the use IT frameworks and tools. In this aspect, NEXOF ambition is higher, including secure and seamless data exchange, protocol and technologies for service networks across service ecosystems.

5.1.4  **SaaS**

Gartner[19] defines the Software as a Service as software that is owned, delivered and managed remotely by one or more providers. The provider delivers an application based on a single set of common code and data definitions, which are consumed in a one-to-many model by all contracted customers anytime on a pay-per-use basis, or as a subscription based on use metrics.

The core value of software as a service is providing access to, and management of, software applications. The potential benefits of the model are significant for both the provider and the customer. This service is different from business process outsourcing (BPO), for instance, where the outsourcing contract encompasses management of entire business processes. It is also differs from hosting services, where the focus of the service is management of the network and servers, but practically it does not cover the application management.

<table>
<thead>
<tr>
<th>Software Delivery Models</th>
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<tbody>
<tr>
<td><strong>FROM TRADITIONAL SOFTWARE…</strong></td>
<td><strong>…TO SOFTWARE AS A SERVICE</strong></td>
</tr>
<tr>
<td>On premise</td>
<td>In the Cloud or a external infrastructure</td>
</tr>
<tr>
<td>Centralized</td>
<td>Decentralized</td>
</tr>
<tr>
<td>Large Upfront Cost</td>
<td>Pay As You Go</td>
</tr>
<tr>
<td>Business Models</td>
<td></td>
</tr>
<tr>
<td><strong>FROM APPLICATION HOSTING…</strong></td>
<td><strong>…TO SOFTWARE AS A SERVICE</strong></td>
</tr>
<tr>
<td>Perpetual license</td>
<td>Subscription</td>
</tr>
<tr>
<td>One-to-Few</td>
<td>One-to-many</td>
</tr>
<tr>
<td>Private Hosting</td>
<td>Public Infrastructure</td>
</tr>
</tbody>
</table>

**Table 1: Evolution Towards SaaS**
SaaS is not a new concept; it started to circulate prior to 1999 and a first generation of online software delivery was produced in late 1990s, although it failed to provide the reliability and quality standards demanded by users. Now the situation is different, several factors are influencing the current grow and wider adoption of SaaS: New software design and delivery models lets many more instances of an application run at once in a common environment allowing real multi-tenancy of applications, bandwidth costs continue to be reduced, making it affordable for companies to purchase the level of connectivity required by SaaS.

Also it is becoming increasingly extended the frustration with traditional software delivery cycle: buying an expensive licence followed by expensive and time-consuming updates and maintenance contracts.

Customers do realise of the benefits that SaaS can provide: lower cost of ownership and operation, higher level of service in addition to flexibility on the provider selection. In addition to other cost aspects: decreased costs in front of traditional software models, both in acquisition, maintenance and support, flexible consumption and predictable and simplified pricing models. All these factors have to be added to the popularity gained by early adopters and providers as Salesforce.com, Amazon and WebEx among others, moreover to the fact that large software vendors, Oracle, Microsoft, SAP, IBM, are now committing to SaaS delivery model. Figure 12 present the SaaS Adoption factors and their importance according to a survey of Forrester research.

Despite of these drivers, still there are concerns in moving from on-premises applications to SaaS. Unsurprisingly, the respondents’ to the Burton Group SaaS Implementation Survey[26] main concern is for data security, followed by the inability to access systems due to connectivity problems. Figure 12 provides an overview of identified potential risks of SaaS.
Figure 14: Potential Risks of SaaS applications. Source[26]

Improvements in the last years in rich Internet applications, better connection speeds and a widespread Internet use have resulted on the generalisation on the application of SaaS model to practically all application categories. The InformationWeek SaaS special report [24] noted that more likely going to be replaced from a conventional licensing model to a SaaS model. In general, e-mail applications, Human Resources Management, Web Conferencing and CRM are first candidate applications. It is worth highlighting, that according to Burton SaaS Implementation Survey[26], there are interesting differences considering the companies' size in the intention of adoption of SaaS solutions, as an example, it reports that 22% of large organizations being likely to replace their on-premises web conferencing tool by a SaaS offering in front of only a 7% of small enterprises.
The emergence of Cloud Computing is altering the SaaS vendors’ landscape; on one hand, some vendors have transformed their positioning from SaaS provider to cloud-computing providers without changing their offerings at all. By the other hand, user communities trend to consider that Cloud Computing is supplanting SaaS. What is clear is that SaaS offerings are gaining an increasing popularity under the umbrella of Cloud Computing. Current market trends are clearly optimistic regarding SaaS uptake: IDC\(^1\) has increased its SaaS growth projection for 2009 from 36% growth to 40.5% growth over 2008

and it foresees by the end of 2009, 76% of U.S. organizations will use at least one SaaS-delivered application for business use. As far as Gartner is concerned, November 2008 predictions note that SaaS sales were expected to surpass $6.4 billion in 2008 - a 27 percent increase over 2007 revenue of $5.1 billion and by 2012 SaaS revenue is expected exceed $14.8 billion$^2$.

As SaaS continues to gain momentum, clients evaluating SaaS products find in the market more mature and viable solutions. As exposed above, SaaS early adoption in multiple enterprise markets, such as CRM, Human Capital Management, workplace collaboration, procurement, e-mail and enterprise integration, constitute the basis for a future growth in other markets. Figure 14 presents major players for some of the software categories previously presented.

![SaaS Major Players](image)

Figure 16: SaaS Major Players. Information Source [24]

A SaaS platform, also known as PaaS, is the set of technologies and services required to develop, host, integrate and deliver SaaS applications.

SaaS platforms differ from traditional software platforms in the following aspects:

- SaaS platforms contain components that are not present (nor necessary) in traditional software platforms, such as billing and metering components.
- SaaS platforms are, due its nature, required to be multi-tenancy, while traditional platforms commonly support a unique tenant.
- SaaS platform components are usually provided as a Service.
- SaaS platforms offer flexible access to components, providing different levels of aggregation and disaggregation, depending on the customer requirements.

Beyond these identified differences, SaaS platforms have to offer the following capabilities:

- **Tenancy**: The ability to distinguish one user from another in the data and execution aspects of a hosted application is a major tenet of SaaS.
- **Effective Monetization and Metering**: Applications, independently of their software code, have to be able of being charged and metered appropriately.
- **Scalability**: It is necessary that SaaS platforms are adaptable to accommodate the customers’ peaks of demand and grow. Flexible infrastructures, such as Cloud computing, are a necessary underpinning for a provider to deliver scalable offering to the market.
- **Reliability**: The ability of a system to perform and maintain its functions in routine circumstances, as well as hostile or unexpected circumstances, is a must to assure customers confidence.
- **Value Added Services**: A part of the core offering, platforms presenting value-added services, extending the value of a platform, is a market differentiating factor for the platform.
- **Ecosystem formation**: An ecosystem is formed with the vendors that host their applications on a given platform and the users using those applications. The ability for SaaS vendors of building a wide community, managing its grow, as well as, sharing tools and best practices, will be critical to deriving value beyond that offered by any single SaaS offering.

Many SaaS Vendors have included in their offerings these platforms and APIs in order to allow users to develop their own applications using their services: among others: Oracle SaaS Platform, Microsoft Azure, Force.com (from Salesforce.com) and Google App Engine.

**NEXOF view**

<table>
<thead>
<tr>
<th>Related NEXOF Objectives</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Master complex software systems and their provision as service oriented utilities</strong></td>
<td>Although SaaS and PaaS share with NEXOF the ambition of mastering complex software systems and their provision as service oriented utilities, NEXOF ambitions to go beyond that and to design a comprehensive and agile service platform with a high level of integration between the different functional components. NEXOF will lead to service platforms that are interoperable and that enable to deliver services with interfaces based on open standards that can be combined in different ways to meet changing</td>
</tr>
</tbody>
</table>
services eco-system. business requirements. The framework will enable development and execution of service applications providing capacities spanning across the whole service lifecycle from requirements and model centric engineering to address complexity, to virtual business relationships and virtual collaboration going through secure and seamless data exchange, protocol and technologies for federation of services.

5.1.5 SOA

According to the OASIS SOA Reference Model (SOA-RM) specification [8], SOA is a paradigm for organizing and utilizing distributed capabilities that may be under the control of different ownership domains. It provides a uniform means to offer, discover, interact with and use capabilities to produce desired effects consistent with measurable preconditions and expectations. The SOA-RM specification bases its definition of SOA around the concept of “needs and capabilities”, where SOA provides a mechanism for matching needs of service consumers with capabilities provided by service providers.

SOA has represented a change in the philosophy in the design of information systems. SOA is based on the ancient principle of ‘divide and conquer’, breaking down business logic into its smaller pieces. These small pieces in this context are Services. Services represent concrete business tasks that are self-contained, modular, and communicate and interoperate using standard protocols. This fact enables complex business processes to be tackled as a flexible combination of simpler services. A summary of the main evolutions introduced by SOA is presented in table 2:

<table>
<thead>
<tr>
<th>FROM…</th>
<th>TO…</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development Architecture</td>
<td>Integration Architecture</td>
</tr>
<tr>
<td>Products</td>
<td>Products + Services</td>
</tr>
<tr>
<td>Functional Orientation</td>
<td>Process Orientation</td>
</tr>
<tr>
<td>Created to last</td>
<td>Created to change</td>
</tr>
<tr>
<td>Prolonged development cycles</td>
<td>Incremental Development and implementation</td>
</tr>
<tr>
<td>Application silos</td>
<td>Orchestrated Solutions, Loosely coupled pieces</td>
</tr>
<tr>
<td>Point-to-point connection</td>
<td>Interconnection</td>
</tr>
<tr>
<td>Strong linkage</td>
<td>Weak linkage</td>
</tr>
<tr>
<td>Object orientation</td>
<td>Message orientation</td>
</tr>
<tr>
<td>Known implementation</td>
<td>Abstraction</td>
</tr>
<tr>
<td>Technological Services</td>
<td>Business Services</td>
</tr>
</tbody>
</table>

Table 2: Information Systems Evolution towards SOA
Current business applications coexist with a very changing environment characterized by globalization of supply chains, continuous acquisitions and mergers, requirements to adapt customer preferences, ever-evolving legislations, along with pressures to reduce time-to-market on services or products in order to better react to extremely competitive markets... In this context, SOA presents the following business advantages:

- **Business Flexibility:** The flexible composition of services provided by SOA facilitates the rapidly production of new solutions by the combination of existing services. This result in a faster-time-to-benefit compared with the traditional way of developing and integrating solutions, improving organization’s ability to manage and adapt core processes. In addition, in contrast to previous technologies, SOA focuses on business services, rather than in revolving around technical problems, services are oriented towards resolve business problems. All these concludes in a better IT and business alignment.

- **Reduction of Integration Expenses:** SOA reduces integration expenses in mainly in two ways. First by providing an abstraction of technology that make that services are independent from the technology they are implemented. The implementation of the service customer is independent of the technology used to implement the service itself. Being able to abstract of the technology, based on the usage of standard protocols integration is reduced in comparison to previous protocols. Also, SOAs is able to provide a standard-based integration layer that abstracts the mappings and transformations necessary for joining two or more systems, avoiding the need of developing multiple point-to-point custom integrations.

- **Reutilization:** SOAs is designed for adaptability and reuse. The fine grained nature of SOA services make them available to be reused in multiple business processes. In addition to it, SOA enables organizations to reuse existing assets from existing legacy systems and EIS.

- **Business Process Visibility and Improvement:** SOA and BPM joint capabilities to provide role-based real-time visibility of business processes is the first steps towards business process improvement. It provides the basis to control and asses full lifecycle business process. The visibility of the performance of business processes based on defined KPIs, allow organizations to improve business processes faster based on the information gathered.

The SOA vendor offerings have evolved to the provision of a platform or suite delivering most of the functionality needed in contrast to the specialization of products and services that was present in the early developments. This trend towards the provision of complete suites has been gained both in internal developments and third party acquisitions by the most significant vendors. Examples of these complete suites and platforms are: Oracle SOA or Event Driven Architecture (EDA) suites, Red Hat’s Enterprise SOA platform, SAP Netweaver or the IBM Web Sphere Process Server or Portal.
Many predictions have been given for the SOA adoption; IDC [11] in 2007 foresaw that at least more than 50% of large companies will be involved in SOA projects by 2012, and provided the following figures for SOA market growth from 58% in 2008 to 27% in 2011. Gartner’s predictions[12] for SOA in 2007 expected a big growth for applications designed around a service-oriented architecture, estimating 50 percent of new mission-critical applications and processes will be SOA-based in 2007, and by 2010 as many as 80 percent of these new initiatives will be designed around SOA.

Although all these optimistic predictions, at the moment there are not clear figures on current SOA market uptake; contradictitory figures are provided by different analysts while the estimation of the SOA market size usually varies from one study to another. In the following pictures can be observed very different levels of SOA uptake depending on the analysts views; the Gartner 2008 SOA User Survey: Adoption Trends and Characteristics[14] shows SOA adoption in Europe nearly universal, moderate in North America and lagging in Asia arriving to figures 53% of current adoption status as a consolidated figure. By the other hand, if we analyze the figures provided by 451 Group in its The missed promise of SOA[13] report, figures presented in July 2008 for current SOA developments do not arrive to the 20% while the respondents with no plans to deploy any SOA solution were to the 64%.

Figure 17: The missed promise of SOA[13], 451 Group (2008)  
Figure 18: 2008 SOA User Survey: Adoption Trends and Characteristics [14]

Many reports have shown that the levels of adoption of SOA solutions are higher in large organizations than in medium small organizations. Among others some of the arguments recognized as barriers to the adoption of SOA are the following: lack of required skills, no identification of a clear business case for its development, as well as, lack of organizational buy-in, high costs of development and complexity of the related standards.
NEXOF view

### Related NEXOF Objectives

- Master complex software systems and their provision as service oriented utilities.
- Develop novel technologies, strategies and deployment policies that foster openness, through the increased adoption of open standards and open source software as well as the provision of open services.

SOA has represented a change in the philosophy in the design of information systems, where Services represent concrete business tasks that are self-contained, modular, and communicate and interoperate using standard protocols. This fact enables complex business processes to be tackled as a flexible combination of simpler services.

Existing SOA suites are a set of products that provide these capabilities. They combine components such as ESB, application server, workflow engine, development tools to provide means to integrate, deploy, secure and manage business processes and composite applications. Multiple existing solutions provide similar functional coverage and implement the same standards, but their weakness is the complexity of this products and the lack of integration between these products. Based on existing standards and tools, but also considering new developments, NEXOF will go beyond that, designing a comprehensive, agile and integrable service platform to foster openness. NEXOF will lead to interoperable open service platforms that enable to deliver open services with interfaces based on open standards.
5.1.6 Analysis of NEXOF Context and its relationship to NEXOF objectives

The following table presents an analysis of NEXOF Objectives and its direct relationship to the trends and technologies previously presented.

<table>
<thead>
<tr>
<th>NEXOF Objectives</th>
<th>Service Economy</th>
<th>Future of Internet and the Internet of Services</th>
<th>Cloud Computing</th>
<th>SaaS</th>
<th>SOA</th>
</tr>
</thead>
<tbody>
<tr>
<td>To provide European Industry and the Public Sector with efficient services and software infrastructures to improve flexibility, interoperability and quality</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Master complex software systems and their provision as service oriented utilities</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Establish the technological basis, the strategies and deployment policies to speed up the dynamics of the services eco-system</td>
<td></td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Develop novel technologies, strategies and deployment policies that foster openness, through the increased adoption of open standards and open source software as well as the provision of open services</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Fostering safety, security and the well-being of citizens by means of new societal applications, enhanced efficiency of industry and administrations, and competitive jobs</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.1.7  **NEXOF in NESSI**

NEXOF has been defined by NESSI with the aim of providing a framework for building service-based ecosystems regardless the size of the business, the domain and the supporting ICT. In particular, NEXOF is intended to be the technological environment that will make happen the recent and continuous advances in mobile communications and embedded solutions that are transforming the environment, at home, at work and on the go, into an intelligent interface to information – shielding users from the complexity of software, networks and computers.

As quoted by the *NESSI Vision Document* [68], NEXOF aims are to:

- Provide European Industry and the Public Sector with efficient services and software infrastructures to improve flexibility, interoperability and quality
- Master complex software systems and their provision as service oriented utilities
- Establish the technological basis, the strategies and deployment policies to speed up the dynamics of the services eco-system
- Develop novel technologies, strategies and deployment policies that foster openness, through the increased adoption of open standards and open source software as well as the provision of open services
- Foster safety, security and the well-being of citizens by means of new societal applications, enhanced efficiency of industry and administrations, and competitive jobs.

NEXOF results will consist of a Reference Model, a Reference Architecture and a Reference Implementation of a complete service environment, to be properly instantiated into a broad range of application domains by a number of end-user communities (including Large, Medium, and Small enterprises) on different technologies. Moreover, a Compliance Test Suite will be delivered, to validate each NEXOF instance and the related provided services, not only to be fully operational, but also to be compliant with the Reference Architecture so as to assure maximum interoperability.

Moreover, with respect to the NESSI’s approach, NEXOF plays a fundamental role.

As described in the *NESSI’s Holistic View* [69], and reaffirmed in the *NESSI SRA Vol. 1* [70], in order to promote and make real the transformation of the European economy from a product-based economy to fully service-based economy, major European ICT stakeholders defined the European Technology Platform NESSI in the context of a holistic approach to an ecosystem in which all the parties involved coexist and which can develop into a new economic model. This holistic model embraces the whole service area and, as depicted in
the following figure, puts NESSI as a key element in the EU economy. The model illustrates the three main constituent parts of the context of NESSI:

- ICT Technologies, represented by the **NESSI Framework**, where the services, the key elements of the ecosystem, are engineered
- The **NESSI Landscape**, where the services as implemented by the NESSI Framework are applied to specific businesses and domains, and for cross-domain cooperation
- The set of instantiation mechanisms based on regulations, rules and policies which, constituting the **NESSI Adoption**, make services real and thus usable by the consumers.

![Figure 19: The NESSI's Holistic Model](image)

With respect to the above model, NEXOF is intended to deliver the NESSI’s Open Framework, a coherent and consistent **open service framework**, ranging from the infrastructure up to the interfaces with service consumers, leveraging research in the area of service-based systems to consolidate and trigger innovation in service-oriented economies for the benefit of the whole European Economy. In this context, NEXOF has to:

- Ensure the openness of the service runtime environment for any service provider. It is based on current standards and, if those are not sufficiently
developed, provides the context for their evolution (infrastructure and - in a second step also - domain-specific standards)

- Be vendor independent
- Face the integration of different systems which at this moment is still a challenge. Indeed, nowadays they exist in the markets many systems which are hosted by different service runtimes (e.g. OSGi, WCF, JAVA EE). In this context the integrated solution has to fulfil:
  - Technical requirements (e.g. QoS like performance and security)
  - Non-technical requirements (e.g. legal issues)
  - Mediation of semantic differences (e.g. in the usage of roles, meaning of service contracts, workflows, variability in the data model).

As a consequence, NEXOF has to ensure that the NESSI Landscape services can be accessed:

- By anybody (citizens and businesses alike)
- At anytime
- Anywhere
- On any device
- In a safe, secure and reliable way.

According to the NESSI SRA Vol. 2 [71] and the NESSI SRA Vol. 3 [72], NEXOF purpose is to research and develop solutions for exploiting the full potential of services:

- Providing technologies and supporting tools for modelling and developing user-centric, context aware, and platform-neutral User Interface building blocks which would be easily assembled into novel services;
- Developing notations, models, methods and tools that support the complete analysis and reasoning about service-centric systems, where complete means taking into consideration business, QoS and technological aspects. At the design level, NEXOF focuses on developing and analysing architectural models for service-centric systems that accommodate services of different nature allowing dynamic service composition. At the deployment and operation level, NEXOF focuses on tools and techniques for the validation, testing and run-time monitoring of services and service-centric systems;
- Providing services and tools relating to a rich ICT infrastructure consisting of network connectivity, storage, data, processing, networked devices, generic software components such as operating systems, application servers and other containers. Tools will allow these services
to be used effectively by the various stakeholders (service providers, software developers, service consumers etc);

- Influencing future generations of standards, particularly standards for service that are currently under early usage or development.
6 NEXOF OPEN CONSTRUCTION PROCESS

6.1 NEXOF Requirements Consolidation

In general, a requirement describes a condition or capability to which a system must conform, either derived directly from user needs, or stated in a contract, standard, specification, or an otherwise obligatory document.

The requirements collection within NEXOF-RA aims to align the project with the actual needs of the market. The collected requirements formalize the requirements concerning the delivery of services to users from a service-centric (potentially Web based though not exclusively web based) perspective.

The general purpose of the consolidation process is to find the overlap of two requirement sets with respect to the functionality they convey. The consolidation process is the process of finding the differences between the requirements in the repository and the newly arrived requirements, in terms of new and changed requirements [81].

Consolidation of new requirements with existing avoids reanalysis of previously elicited requirements and allows to complement existing requirements with new information [81].

As a starting point, we collected 47 high level requirements from the state of the art, categorized as follows (the id of the requirement is given in brackets):

- Service publication
  - Data model (L1.1)
  - Publication APIs (L1.2)
  - Registry architectures (L1.3)
  - Push mode publication mechanisms (L1.4)
  - Pull mode publication mechanisms (L1.5)
  - Categorization and selective publication (L1.6)
  - Up-to-dateness of published information (L1.7)
  - Scalability (L1.8)
  - Applicability (L1.9)
  - Mobile users (L1.10)
  - Extensibility and evolution (L1.11)
  - Support to legacy systems (L1.12)

- Service dependability
  - Availability requirements
    - Registry availability (L2.1)
    - Registry correctness (L2.2)
    - Monitoring information (L2.3)
    - Service availability (L2.4)
    - Workflows (L2.5)
    - Service addressing (L2.6)

- Reliability requirements
  - Atomic transaction notifications (L3.1)
• Long running transaction notifications (L3.2)
• Co-ordination semantics (L3.3)
• Awareness of unreliable services (L3.4)

• Safety requirements
  • Testability (L4.1)
  • Risk determination (L4.2)
  • Determination of failure consequences (L4.3)

• Security and trustworthiness requirements
  • Basic security features (L5.1)
  • Interoperability between different security domains and infrastructures (L5.2)
  • Support to different kinds of Certificate Authorities (CA) (L5.3)
  • Use of ratings for evaluating trustworthiness (L5.4)
  • Privacy by contract (L5.5)

• Service performance requirements
  • Limitation of communication overhead (L6.1)
  • On-the-fly service switching (L6.2)
  • Scalable performance and throughput (L6.3)

• Service monitoring
  • Functional and non-functional qualities (L7.1)
  • Event based monitoring (L7.2)
  • History based monitoring (L7.3)
  • Assertion based monitoring (L7.4)
  • Environmental Monitoring (L7.5)
  • Dynamic regulation of monitoring activities (L7.6)
  • Service Data Collection (L7.7)
  • Environmental Data Collection (L7.8)
  • Dynamic renegotiation of constraints (L7.9)
  • Extensible framework for data collectors, data analyzers and constraint metrics (L7.10)
  • Process instrumentation through appropriate development time tools (L7.11)
  • Multi level constraints definition (L7.12)
  • Adaptability (L7.13)
  • Monitoring process (L7.14)
  • Compliance-based service monitoring (L7.15)

The project partners collected 17 scenarios and a list of requirements were derived and prioritized from them in order to provide the necessary guidance to the work performed by WP7 with respect to the design of the reference architecture of the Open Service Framework.

The scenarios were collected from the following domains (the id of the scenario is given in brackets):

• Networked IT service provision
• **Service procurement (S1):** describes a service procurement scenario, in which a potential consumer can query a search engine for services corresponding to his needs. The advantages of such an approach includes flexibility, reduced costs (particularly in pay per use environments) and the ability to switch between suppliers as the need arises, to benefit from either better pricing or better service.

• **Service lifecycle support (S2):** describes a facility that supports the entire life cycle of a service. This starts from defining a service concept and then goes right through to ultimate withdrawal and decommissioning. As services in the ecosystem envisaged by NESSI may have complex relationships with each other, which are not under the sole control of a single party, it is important that the Reference Architecture ensures that services are manageable throughout their whole life.

• Grid- and service networks
  - **Management services for grid and service platforms (S3):** describes services to manage and maintain grid and service networks. As a concrete example, the Large Hadron Collider computing Grid in CERN is discussed.

• Health care
  - **PhiMas: personal health information monitor and alert service (S4):** describes the services involved with PhiMas, a personal monitor and alert system for elderly people; people who need personal care while recovering from injuries or people that are disabled.
  - **e-Health: complex diagnostic workflow (S7):** describes services useful in the workflow of determining the patient’s complete health status.
  - **e-Health: assisted living (S8):** describes services used in assisted living systems, systems that support persons with a chronic illness or those with a need for constant medical surveillance. This scenario refers to devices such as, for instance, blood pressure units or blood glucose meters that are operated either by the patient, by a nurse, by a paramedic or by another member of an ambulance crew.

• e-Learning
  - **Collaborative e-learning scenario (S5):** describes the services used within a collaborative learning approach based on the definition and execution of a learning experience.
  - **Deployment and configuration of a generic platform (S6):** describes the services used for the deployment of a platform.

• Crisis management
  - **Traffic management: large scale emergency handling (S9):** this scenario describes services used in the traffic management domain to handle emergency cases, like the direction of rescue
forces to the location of the accident as well as the deviation of traffic through places not intended for heavy traffic.

- **Crisis management system of systems (S10):** describes services used for the necessary interactions between different organizations in order to mitigate the crisis and reduce the impact of a crisis situation occurring at for example an airport.

- **Effective and efficient collaborative decision making (S11):** describes services used in collaborative decision making applications, i.e. the sharing of business operation (e.g. flight plan operation) information between multiple and different systems, and implementation of new collaborative components and services to improve the efficiency of the operations based on a “system-wide” approach.

- **e-Commerce**
  - **e-Commerce information sharing (S12):** describes the services used in the commercialization of Software-As-A-Service (SAAS) solutions.

- **Ubiquitous computing**
  - **Mobile office for an owner of a micro-enterprise (S13):** describes the services used in a business involving the placement and maintenance of vending machines in different locations, all supported by a national or international franchise network.

- **Construction sector**
  - **Safety at work in the construction sector (S14):** describes the services used for a wireless enabled device moving around a work site in order to verify that all the safety requirements are fulfilled.

- **e-Government**
  - **e-Government online application submission service (S15):** describes the services used in an e-Government service portal to submit applications and receive replies online.
  - **e-Government online fee visualization and payment Service (S16):** describes services used in an e-Government portal to review and to pay taxes and fees online.

- **Assisted Maintenance**
  - **Assisted Industrial Maintenance (S17):** describes the scenario of improving the speed and quality of repairs of technical repair staff by giving access (via an ordinary display rendering the 3D virtual world and an avatar or via a dedicated virtual reality display) to expert knowledge, audio and visual information, as well as 3D repair instructions.

Additionally, assessment criteria have been defined, i.e., statements specifying the standards that must be met and the evidence that will be gathered to demonstrate the achievement of a requirement.

Besides the scenarios and the related requirements already collected, new ones will be collected through the definition of an open process. Such new
scenarios and requirements will be used to verify the ability of the architecture to satisfy the new needs and provide support for its evolution.

The list of requirements derived from the scenarios is as follows:

- **SLA processing (R1):** describes the requirements to define and manage consumer provider interaction in a service-oriented ecosystem.
- **Uniform service representation (R2):** discusses properties necessary to allow potential consumers of services be able to discover, compare and choose between services.
- **Service discovery mechanisms (R3):** discusses mechanisms need to accommodate searches for services based on both functional and non-functional properties
- **Decentralised architecture (R4):** discusses the requirement of a decentralized architecture.
- **Service description (R5):** discusses the need for a consistent approach among service providers to the description of functional and non-functional characteristics of services
- **Service deployment (R6):** discusses the requirement to introduce new services without reference to a central authority.
- **Service decommissioning (R7):** discusses the need for a service provider to cease offering a particular service.
- **Interoperability and flexible communication requirement (R8):** discusses the need that information and management services are able to communicate with existing services and with each other.
- **Federated identity management (R9):** discusses the need of trust and identity management when information is shared across multiple organisations.
- **Location based routing (R10):** discusses the routing of a service request depending on the location of the end user.
- **Services integration by semantic mash-up (R11):** discusses the integration of services based on a mash-up server to manage integration, setting, choice and coordination of available services resting on environment ontologies.
- **Harmonization of several heterogeneous information sources (R12):** discusses the harmonization of several heterogeneous information sources by means of semantic technologies.
- **Unified communication (R13):** discusses collaboration and communication services to allow interaction among heterogeneous services and sources.
- **Integration of an application with legacy applications, ERP, etc. critical and foremost for the client (R14):** discusses the integration of services with legacy applications.
- **Adaptive deployment (R15):** discusses the ability to deploy the application according to the model of software deployment of the client.
- **Workflow management and integration (R16):** discusses the integration of new services in the business processes of the client.
• **Aided configuration (R17):** discusses the capability of the architecture and an application, which is based on it, to support the configuration task during the deployment phase and during maintenance.

• **Modelling capabilities (R18):** discusses the need to allow modelling the company whose business will benefit of the new application/platform based on the architecture itself.

• **Technical interoperability (R19):** discusses the need of the interoperability between services regarding distributed workflows and individual service interaction.

• **Device integration / vertical integration (R20):** discusses the requirement of vertical integration of devices in service-oriented architectures.

• **Distributed workflow (R21):** discusses the integration of workflows from different stakeholders.

• **Stateful, device adaptive service transfer (R22):** discusses the need of statefulness during service interaction.

• **Adaptability (R23):** discusses the adaptability of deployed services considering autonomously reacting systems.

• **Rapid reconfiguration (R24):** discusses the reconfiguration of a system in case of an emergency by selecting a new strategy and the propagation of the new rules to the system.

• **Integrity (self-diagnosing and self-healing) (R25):** discusses the need that no one can override the decisions of a critical system (such as a traffic management system) from outside by either manipulating the sensors and the control devices or by introducing harmful strategies.

• **Dependability for device integration (R26):** discusses the need of performance, reliability and availability when integrating embedded devices with services.

• **Compliance to privacy, and security policies (R27):** discusses compliance to privacy, and security requirements of services.

• **Collaborative business process acquisition, modelling and effective management (R28):** discusses the capacity to acquire/form, model and manage effectively and efficiently collaborative business processes for what concerns CDM applications.

• **Distributed architecture (R29):** discusses the exchange of information in a distributed way.

• **Integration of services (R30):** discusses the integration of services considering the user interface.

• **Monitoring and reliability (R31):** describes the need of monitoring in order to ensure a continuous operation of systems.

• **Orchestration (R32):** describes the need of a careful orchestration of all involved components.

• **Trust and confidence (R33):** describes the need of trust and confidence in applications such as e-Commerce Service discovery (R34): describes the need of service discovery.

• **Information as a service (R35):** describes the need of providing information in a coherent and trusted way.
• **Execution of human-based process steps (R36):** describes the integration of services with human interactions and manual decisions.

• **Information integration (R37):** describes the requirement for a service architecture to provide support for information integration.

• **Distributed transaction support (R38):** describes the need to support distributed transactions.

• **Single sign on (R39):** describes the need to support single sign on.

• **Non-repudiability of data transfer (R39):** describes the need to prove that the recipient really received the message and that the sender really sent the message.

• **Cross-certification (R40):** describes the need arising from interfacing multiple organisations having their own but different PKI certification policy.

• **Resilience & Continuity of service (R41):** describes the requirement of resiliency, i.e. the ability to avoid, minimize, withstand, and recover from the effects of adversity.

To achieve a higher alignment of the project with the actual needs of the market an Open Requirements process to collect additional scenarios and requirements will be started.

The following template will be used to collect scenarios:

- **Short name:** a short name for the scenario
- **Detailed, step-by-step scenario description:** a textual description of the scenario. Additionally, the domain, the sub domain or the main objective as well as contextual information about the system environment should be specified.
  
  It is strongly suggested to add UML diagrams such as a use case diagram or a sequence diagram to clarify textual descriptions.
- **Rationale:** describes the reasoning and justification for the scenario - that is some important background for why the scenario is what it is. This will be important to help those of us less familiar with the domains to work with the scenarios.
- **Service consumer:** for each user and location (the location indicates where the consumer stays, e.g., customer-home; customer-office; technician-office, etc) the following has to be specified:
  - Primary requests, problems to solve or needs
  - Required performances or needs
  - How and when the user prefers to obtain the service etc. (subscription, pay for use.) and if it is useful or necessary
- **Service provider:** a possible description of who provides the requested service.
- **Service integrator/developer:** a possible description of who integrates or develops the requested service.
- **Problems and challenges:** the specific problems that each scenario addresses or that consumers and providers face.
- **Architecture and constraints:** all involved devices (PC, PDA, etc.), hardware, software, and possible integration with existing applications.
how communication is accomplished (GPS, GPRS, Bluetooth, infrared, etc.)

The following template will be used to collect requirements:

- **Short name**: a short name for this requirement.
- **Requirement type**: one of the following
  - Functional requirement: what the product has to do or what processing actions it is to take
  - Quality attributes: properties that the functions must have, such as performance and usability
  - Project constraints: restrictions due to the budget or the available time
  - Design constraints: restrictions on how the reference architecture must be designed
  - External constraints: restrictions because of business or law restrictions
- **Related to**: the scenario ID to which this requirement is related
- **Description**: the intention of the requirement
- **Rationale**: a justification of the requirement
- **Domain**: the domain and sub-domain of this requirement.
- **Target**:
  - Domain-independent requirement
  - Cross-domain requirement
  - Domain-specific requirement
- **Originator type**
  - Service consumer
  - Service provider
  - Service integrator/developer
- **Fit criterion**: a measurement of the requirement such that it is possible to test if the solution matches the original requirement (i.e., the assessment criterion).
- **Comments**: additional comments if needed.
- **Conflicts**: requirements that cannot be implemented if this one is.
- **Supporting materials**: a pointer to documents that illustrate and explain this requirement.
- **Importance within the NEXOF-RA project**
  - Must have
  - Should have
  - May have

The Open Requirements Process will allow to collect and to consolidate new requirements from different stakeholders and to identify gaps in the architecture based on the new needs.

The following describes the steps carried out in the Open Requirements Process:

- Submission of the request for proposals to mailing lists, forums, publication on NEXOF-RA website
• Responses must be received within one month after the publication of the request for proposals
• One/several phone conference/s among the WP10 members will be scheduled to discuss the submitted proposals
• The accepted proposals will be integrated with the existing requirements and submitted to all work package leaders

The request for proposals will contain the following sections:

• Background information on NEXOF-RA
• NEXOF-RA stakeholders and goals
• Questionnaires for the scenario and requirement/s

The submitted proposals will be evaluated considering the completeness and motivation of the submitted requirement, the client references, and the potential impact on the existing architecture.

The results will be part of the second version of the roadmap.
6.2 NEXOF Open Construction Process

6.2.1 Introduction

NESSI Open Framework philosophy is based on collaboration and open contribution from and to various communities. Openness is critical for the NEXOF construction, development and adoption:

- Openness in the sense of using open standards and open source software.
- Openness in the sense of being open to evolve, to adapt to new requirements and sprouting technologies.
- Openness in the sense of being open to the contribution of all.

As previously described NEXOF is defined as the set of principles and tools enabling the deployment of networked software-intensive services that can support the NESSI Vision. NEXOF is composed by the following set of building blocks:

- An Open Reference Model.
- An Open Reference Architecture.
- An Open Reference Implementation.
- An Open Compliance Test Suite

In the context of NEXOF-RA the initial version of Open Reference Model and Architecture (ORM and ORA) is being implemented following an Open Architecture Specification Process that is described in section 1.3. This initial version will evolve together with the construction of NEXOF to include advancements in the State of the Art and a wider technology footprint.

The Open Reference Implementation will be produced as a future result of the NESSI Community research activities and will define Open Reference Implementation process. An overview of this process is provided in section 1.4. The Open Reference Implementation will be made available to the European software industry and more generally to the whole European economy as open source software fully allowing derivative works to be exploited as commercial or freeware solutions.

6.2.2 Contributors

Currently entities contributing to the construction of NEXOF are organised in three groups which differ in the intensity of their participation in the process:

- Custodians: This group consists of the entities which have accepted the (contractual) responsibility of maintaining and enhancing the NESSI
Open Framework. This corresponds initially to the NEXOF-RA project and consortium members. The concept of NEXOF belongs to the community, members and partners of the NESSI European Technology Platform (ETP). NESSI will ensure that structured, funded teams will carry the mission of evolving NEXOF over time.

- **Strategic Contributors**: This group consists of entities which have a formally specified objective of contributing to the NESSI Open Framework and accepted specific conditions to this contribution (including open standards and open software). Admission in this group is by invitation only and managed inside the NESSI Community, and it is conditional to the establishment of a binding agreement or contractual clause in the form of specific commitment in their Description of Works for the NSPs, and a Letter of Intent for all the others. Today, this group includes the projects which are running and have been formally endorsed by the NESSI ETP as Strategic Projects; i.e. EzWeb, MASTER, RESERVOIR, SLA@SOI, and SOA4ALL. Currently, these contributors are involved in the “Open Architecture Specification Process”. This group will growth with the definition of new NESSI Strategic Projects and are candidates to contribute to the Open Reference Implementation process.

- **Contributors**: This group consists of all parties who wish to contribute to the construction of the NESSI Open Framework, regardless of their formal links with NESSI or Europe. This group includes both the horizontal NESSI Working Groups (NWG) and research projects (including, but not only, wide research programmes such as IST, Eureka, CELTIC and ITEA) which have a stated objective (regardless this is defined at projects start or during its life) to contribute to the NESSI Open Framework.

### 6.2.3 Open Architecture Specification Process

The **Open Architecture Specification Process** (OASP) has the intent to support the openness in the creation of the NESSI ETP initiative’s agenda, for what concern the description and implementation of the NESSI Open Framework.

This process is based on collaborative relationships, where a wide community sharing the NESSI vision contributes to adopt common references, such as shared principles, definitions, models, architectures, standards, and processes. As stated in the previous paragraph, contributors of such community are divided in Strategic Contributors and Contributors. They come from the NESSI Strategic Projects, the NESSI Working Groups and any research project or group aiming to contribute to the NESSI Open Framework.
The process is driven, managed and supervised by custodians, under the technical supervision of an Architecture Board (AB), while the participation is voluntary and is not funded by the custodian.

The Architecture Board is the technical decisional authority. It meets every trimester in a face-to-face manner, as well as any time it is required to meet important milestones. Its role is to review all major technical deliverables prior to their release as final documents. It includes both the key architects of the custodian project as well as the key architects of the major contributing initiatives which have made a formal commitment to work with and contribute to NEXOF (i.e. Strategic Contributors). This external group currently includes only the NESSI Strategic Projects, but it can be extended to include other initiatives.

The OASP is open, in the sense that it has to implement proper channels to consider all contributions. The contributions themselves have to be open; i.e. they have not to include or imply the use of any proprietary components in the implementation of what is defined by the contribution. Finally, the result has to be open. It means that it has not to be a static specification but it has to allow for the integration of changes and evolutions which result from research or changes in the state of practice.

The OASP is centred on parallel execution of Open Construction Cycles (OCC). It is conceived in a modular manner, as follows for the initial implementation in the NEXOF-RA project:

1. The Problem Area Work Packages of the NEXOF-RA project (WP1 through WP4), in coordination with the caretakers of the model and architecture (WP6 and WP7), identify bounded sets of (architectural) requirements and associated functionalities which should be investigated.

2. A set of requirements and functionalities, which is referred to as a topic, is clearly defined. They don’t cover all the aspects and modules of the architecture, but that ones promising the most fruitful and significant results to be constructed in an open community. Each OCCs focuses on a specific, well defined topic.

3. To enhance visibility, OCCs are grouped in batches of topics, with the primary benefit of pooling up advertising efforts and thus maximizing exposure and return. Template documents are created to present the purpose of the project, encourage participation, introduce the open process, provide instructions on how to contribute, and describe each topic.

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3 The first group, covering 11 initial topics, was published on July 21st, 2008.
4. OCC topics are made public through an Invitation to Contribute. Each batch of Invitations to Contribute is distributed to the widest community possible. Any party can participate in the construction cycles, including academic institutions, industry players of all sizes, and individuals. The only requirement is a commitment to contribute in a proactive and constructive fashion.

5. During the 2 months following the publication of the Invitation to Contribute, prospective contributors should register their interest and formulate a position through a position paper. During this period, the lead for each topic answer questions, review registrations and submissions, and verify interest to build the Investigation Team which is the operative body of the next phase.

6. During the following 2.5 months, the Investigation Team formulates a common position based on the consensual convergence of various proposals. This position is then refined by the NEXOF-RA project team for inclusion in the relevant architecture documents.

7. All contributions must be compatible with the inclusion of results in an open document with derivative rights. This document contains the selection of consolidated standards based on compatibility and architectural compliance, augmented by contributed specifications committed to be submitted to standardization bodies. Furthermore, it identifies gaps and alignment problems in consolidated or proposed standards, and issues recommendations to be presented to standardization. Specifications or amendments to standards which have not been approved as standards at time of publication may only be included or referred to on a provisional basis.

6.2.4 Open Implementation Process

The Open Implementation process It is envisioned that follows the philosophy defined in the Open Architecture Specification Process. It’s important to note that the Open Reference Implementation will also be designed to integrate requirements, needs and results (i.e. components, services, processes) coming from other Research Projects and initiatives both coming from Strategic Contributors and Contributors.

An overview of the process can be observed in the following Figure:
Figure 20: Overview of the Open Implementation Process
7 NEXOF Adoption

7.1 Adoption Strategies

7.1.1 State-of-the-Art of adoption strategies

The success of an innovation heavily depends on its degree of adoption in the intended target market. The term adoption traditionally refers to the act of using and degree of acceptance of an innovation by an individual or a company. The adoption of technology innovations in the ICT area has become an even more critical issue due to fast changing environments. Accordingly, a lot of different theories and approaches have been developed, analysed and improved within the business information system and management domain. This domain is a lot more mature than all the emerging trends described in section 5 and therefore these existing approaches have been taken into consideration in order to reuse results for the creation of an adoption plan for NEXOF-RA.

Although there exist a lot of those approaches for building information systems in a standardized way like ARIS (ARchitecture of integrated Information Systems) [57] SOM (Semantic Object Model) [58] or BSP (Business System Planning) [59], none of them proved to be directly relevant for NEXOF-RA. The problem with these approaches mainly was that they all were developed for a very specific type of information system concentrating on the business process view. Although the business process view is also a very important factor for SOA or SaaS these context are more complex and additionally introduce a new paradigm around which the IT Infrastructure as well as processes have to be aligned. Furthermore, these approaches provided either process descriptions on how to implement the according information system or provided means for structuring the different important process modelling views. None of the existing approaches tried to capture such a holistic view of a domain as NEXOF-RA does on a reference level so that several different concrete service-based architectures can be derived. However, the steps concerning the preparations, decisions and barriers that may hamper the adoption of the approaches still can be useful in the NEXOF-RA context.

Therefore, the following subsections will shortly describe some of the general elements that should be considered in an adoption plan like the different phases of a technology adoption lifecycle as well as attributes. A more detailed analysis of those elements has been performed within the FP7 project SeCSE [65] with a similar intention as in this document. Accordingly, here only the most relevant factors are presented and for further information it is referenced to the according deliverable. Furthermore, adoption approaches are revisited that are closely related to the context of NEXOF-RA in additional subsections.

7.1.2 Adoption lifecycle phases

Everett Rogers has put an enormous effort in analysing the adoption of innovations in target markets. He produced a theory about diffusion and defined a technology adoption lifecycle that still is used in business as well as information system engineering domains already 1962 [61]. In this lifecycle he
identified five different phases of adoption in which the according innovation is in different maturity levels and the adopters have different goals, opportunities and obstacles. Accordingly, these different phases should be addressed differently in the adoption plan for NEXOF-RA. In detail he identified the following types of adopters:

- **Innovators** are the companies/individuals that are more prosperous, more risk-oriented than others and are generally committed to the introduction of new technologies to improve the economy.
- **Early adopters** tend to be community leaders who try out new ideas in a careful way.
- **Early majority** are more conservative but open to new ideas and accept changes quicker than others do.
- **Late majority** are fairly conservative, more sceptical and will not use new ideas until the majority does.
- **Laggards** are very conservative, stick to the traditional ways and will not adopt new ideas until they also have become tradition.

It is important to recognise that no innovation will become mainstream immediately but needs some time to influence the market. That is also valid for NEXOF-RA. Furthermore, it is important that over time different adopters of NEXOF-RA need to be addressed and their needs and problems need to be captured and supported in the adoption plan. Accordingly, the success of NEXOF lies in the identification of the early adopters and in convincing them of the benefits. The next section will address attributes of an innovation that are important to all the adopters and therefore carefully should be addressed when approaching the early adopters.

### 7.1.3 Important attributes for adoption

Besides the definition of different phases of technology adoption, Roger has also worked on the identification of characteristics of an innovation that might impact the degree of its adoption. These characteristics are relative advantage, compatibility, complexity, trialability and observability and should be analysed concerning NEXOF-RA before creating the adoption plan so that those
characteristics that might be critical in the context can be addressed adequately. The following detailed description of the factors is taken from [61]:

1. Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms such as faster development, less maintenance, and cost saving, but strategic advantages and prestige for using emerging technologies are also important factors. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be.

2. Compatibility is the degree to which an innovation is perceived as being consistent with the existing technologies and past experiences of potential adopters. This is important to allow users going on using their current systems and applications, while they create new ones and improve existing ones in a progressive way. Migrations are hard and expensive, so it is important to avoid that kind of situations.

3. Complexity refers to the degree to which an innovation is perceived as difficult to understand and use. This characteristic is very important, because users prefer to work with tools which are easy to understand. The adoption of these tools by IT consumers may further simplify the adoption of the standard.

4. Trialability refers to the degree to which an innovation may be experimented with on a limited basis. Clients of new technologies do not adopt them if they cannot test them to analyse if they are a good alternative to do their business. If a company can try a new technology and the results they obtain are good enough, they will adopt it. If the investment to adopt the technology is high and the company cannot evaluate it, it is likely that technology will not be adopted.

5. Observability is the degree to which the benefits of the proposed innovation are visible. It is important that the clients of the new technologies can perceive the advantages with relation to technologies that are in use. If those advantages cannot be observed, it is likely that the advantages are not enough to make great investments in order to adopt the new technologies in the overall company.

In order to foster a high degree of adoption the combination of these factors should be as positive as possible, i.e. high relative advantage, high compatibility, low complexity, high trialability and observability.

Since NEXOF-RA tries to develop a Reference Architecture for service-based software systems from which easily different specific architectures can be derived by using existing building blocks as well as best practices and pattern descriptions the relative advantage will be the faster development of service-based software systems. Furthermore, NEXOF-RA aims at providing a holistic and interoperable solution which does not exist in existing service-based architecture frameworks so far. This characteristic also addresses the second factor: compatibility. One of NEXOF-RA’s main goals is to ensure interoperability. Since the reference architecture itself is technology neutral and does not prescribe how it should be implemented, adopters might still be able to stick to existing solutions as long as they adhere to different compliance
specifications. NEXOF-RA will only provide recommendations for implementations so that together with best practices and assembly specifications the interoperability between different NEXOF-RA compliant systems can be assured to some extend. However, adopting the new SOA paradigm might not be compatible with existing solutions in any case. Accordingly, migration aspects should be part of the adoption plan.

Since NEXOF-RA tries to create a holistic view of a SOA, its complexity is very likely to be high. Nevertheless, the mentioned best practices, pattern descriptions and assembly information will provide some kind of user guide on how to derive a specific NEXOF-RA architecture and thus try to ease the use of it. Furthermore, it will define some kind of building blocks on a higher abstraction level to avoid that users are getting lost in details. The main goals will be to preserve the main benefits of using NEXOF-RA, namely providing a construction kit for implementing SOAs, over the effort that is needed to understand its complexity.

These factors should influence the definition of the NEXOF reference architecture and be considered during the definition of adoption strategies in order to gain a high adoption rate. The next sections will concentrate on approaches that describe concretely how SOA or related approaches can or should be adopted. None of these approaches provides a reference architecture and therefore the descriptions are not directly applicable to NEXOF-RA. However, the complexity of this new technology showed some specific problems and needs which also will be valid for NEXOF-RA.

7.1.4 Approaches towards SOA Adoption

According to a survey made by the Computer Economics, Inc. [60] in 2007, SOA adoption is still in its early phases. Figure 20 shows some figures from this survey, revealing that only one-fifth of all involved companies already have a SOA in place of which 12% plan to increase their use of SOA and 7% have no further plans. Another third of the questioned companies are about to adopt SOA whereas 11% are currently implementing or starting to implement SOA and 22% are investing in researching their benefits of using SOA. The others which are about the half of the questioned companies are not in a state yet where they consider SOA to be important for them and therefore have not planned any adoption activities.

Although the number of adopters drastically increased in 2008 to three-fifth, a large part of this might due to the connection of several concrete technologies to the Buzzword SOA rather than a strategic change.

One reason for this is that a SOA adoption strategy is complex and comprises several aspects and factors also affecting the general business strategy of companies. In order to help understand how such an adoption can be influenced and defined within NEXOF-RA this section will analyse existing SOA adoption approaches, plans and strategies. However, it is important to understand, that the scope of NEXOF-RA does not address all of these relevant factors but only the architectural part that needs to be realized as the baseline for a service-based business strategy.
7.1.5 **Existing SOA adoption approaches**

Currently there is no continuous strategy for SOA adoption in every context. Although, a lot of literature emerged giving complete views on SOA adoption or implementation respectively, these describe different factors how the SOA paradigm can be integrated into a company's strategy focusing on how to create the needed business services.

First of all these approaches can be distinguished between an iterative process and a completely change of the system at once. According to Hau et. al. the realistic scenario for companies to adopt SOA is the iterative development in small steps [62]: “This means that isolated projects are conducted which follow a subset of the SOA principles. After a few projects have implemented services it might be recognized that SOA makes project management more efficient and that one should consider coordinated action to broadly enforce the adoption of SOA methods. In such a setting project management is likely to evaluate the concepts available and use those that provide a superior cost benefit ratio. If SOA is to be chosen it must be better than other approaches or yield benefits that no other approach can provide.”

Legner and Heutschi for example examined companies that took a stepwise approach to SOA implementation that included three different types of activities[63]. The examined companies usually started their SOA projects by introducing changes in their IT organization and governance as well as introducing new architectural guidelines. The third activity, which is based on the two mentioned, addressed the actual development of services in terms of application development and integration projects. The authors described the three activities in more details as follows:

1. Organization and governance: In order to establish SOA architectural principles in the organization, the companies defined new architectural roles and competencies or extended the tasks of existing roles respectively. To
this end, they appointed central architecture boards and specific roles which define and communicate SOA principles and supervise their enforcement in IS projects. These central boards in a next step defined the objectives of and the areas of application for SOA. The development of the SOA is governed using metrics to measure the outcome of the architectural programs and principles.

2. Formulation of architectural principles: The specific objectives which the companies pursued with their SOA implementation formed the basis for the formulation of architectural principles. These comprise guidelines as to when and how to develop services, standardized development and review processes, or principles for the service design amongst others.

By designing a domain architecture, the companies structured their application architectures from a business point of view and thereby supported the decisions where and by who services are to be developed: Interfaces between applications of different domains are to be implemented as services, whereas alternative coupling mechanisms are allowed to integrate applications within a domain. The domain architecture serves as a long-term plan for the future development of the application architecture.

The central boards and architects also decided on the architecture of the technical SOA-infrastructure (which central integration capabilities to support, which platforms and standards to use) and defined corresponding technical architectural principles.

3. SOA realization in application development and integration infrastructure projects: All companies implemented a central integration infrastructure for the service layer. This infrastructure standardizes service interfaces, offers central integration mechanisms (repository, message bus etc.) and forms the basis for a simple and platform neutral usage of services. Whereas early SOA projects often developed their infrastructures in a best-of-breed approach combining products from several vendors, companies increasingly use comprehensive SOA platforms from a single vendor (e.g. IBM WebSphere or SAP NetWeaver).

The first task is out of scope for NEXOF-RA since no roles will be defined for the derivation of a NEXOF compliant architecture except the one of the architect responsible for this task. Furthermore, NEXOF-RA does not only aim at addressing the derivation of enterprise architecture where well defined roles exist. The architectural principles however, are inherent a part of the NEXOF reference architecture as far as it concerns the creation and usage of the architecture. Context dependent rules might be needed to be defined additionally to some extend. The third activity is obsolete due to NEXOF-RA since integration and interoperability are inherent characteristics of a NEXOF compliant architecture. The usage of existing vendor solutions and combining them is explicitly fostered.

Another approach that addresses the stepwise SOA adoption is based on the SOA Maturity Model [79]. It is intended to prepare organisations for successful SOA adoption, to set a SOA vision and to measure the progress. The model
consists of five maturity levels, the Initial Services, the Architected Services, the Business Services, the Measured Business Services and the Optimised Business Services (see figure 21). In the following each of these levels will be delineated shortly (taken from [79]):

- **Initial Services** lead to new functionality. An enterprise service bus, a service registry and a service level management are introduced.

- **Architected Services** foster the reusability of services and define standards for the enterprise SOA. The architecture is enlarged by a service and policy repository.

- **Business/Collaborative Services** focus on the connection between business and technology. There are two strategies which can be performed. On the one hand business services focus on the improvement of internal business processes. On the other hand collaborative services focus on the improvement of processes with external partners, and connect internal services with external ones.

- **Measured Business Services** introduce a business activity monitoring and rules and an event database control the triggering of messages to services.

- **Optimized Business Services** foster the optimization enabled by the ability to react and respond automatically using event driven automation.

![Figure 23: The SOA maturity model [79]](image)

Hau et. al. [62] use the terms “top-down” and “bottom-up” to distinguish the two possible approaches for SOA adoption. “In a top down scenario, top management would realize the potential of SOA and conduct a high level project to establish SOA paradigms within the organization. This scenario is not unrealistic and there are several examples […]. However, the bottom up approach appears to be the more relevant scenario because often SOA might not be considered to be of strategic importance.” Accordingly the first presented approach represents a top down approach and the maturity model a bottom up approach.
In the authors opinion top level approaches have only been used where an inability to change the IT landscape has been arisen and become a top management problem thus that the SOA adoption has become a high priority issue for long term strategies. Although several examples exist like the one of the German Post as described in [63] it is unlikely that the adoption has this high priority. Instead realizing SOA adoption in one step seems not to be reasonable and highly risky in most cases considering the huge amount of work that needs to be done, the high costs, the complex context that needs to be considered and the high risk of failure. This is valid for Enterprise Architectures as well as other types like Industrial SOAs etc. that are addressed by NEXOF-RA. Some of the factors that might cause the SOA adoption to fail and therefore make a one-step adoption strategy not applicable are described in the next section.

7.1.6 Barriers to the adoption

In the SeCSE roadmap a survey has been considered [65] in which the main barriers to the SOA adoption have been queried. The identified topics are the following:

- Incomplete Standards 68%
- Security 68%
- Lack of Awareness by decision makers 62%
- Performance/Availability 54%
- Lack of Skills 52%

Furthermore, the lack of buy-in from other organizations as well as the limited support from current vendors were identified as factors that could hamper and slow down the SOA adoption.

Concerning the first barrier the lack of mature standards but the enormous number of webs service standards has been addressed. The industry mentioned their concern about the lack of interoperability and the fragmentation of the market. Regarding the NEXOF Reference Architecture this barrier should not apply since the collection usage, analysis and recommendation of standards will be an inherent result. Furthermore, the interoperability will be increased by the combination of existing standards, the NEXOF patterns and the NEXOF guidelines. The project also fosters the extension of existing standards as well as the creation of new ones where gaps exist.

The security issue is also connected to the lack of maturity in security standards. The low trust of adopters in the existing security mechanisms slows down the adoption process since opening up interfaces for integration is rarely done. Forrster performed a survey in November 2004 by Forrester [66] in which the primary use of SOA adoption within 116 North American decision-makers familiar with programming technologies, application software architecture, and application platforms was surveyed. The results showed that more than a third(37%), used it for internal integration while only 15% used it for external integration. This barrier is also addressed within NEXOF-RA to a large amount...
and security will be fostered also addressing security mechanisms for cross domain federations etc.

The lack of awareness by decision makers is considered to be the most important barrier in a survey conducted within the SeCSE project [65]. “Vendors must support business by educating both the business audience on the benefits of SOA and by training the IT teams on how to design and implement an SOA.” Since this factor is not directly addressed by the results produced within NEXOF it has explicitly addressed within the roadmap. In [65] consolidated SOA portals, offering success stories, best practices, business cases and based self-assessment tools are described as potential approaches to overcome this barrier.

The non-functional issues addressing the performance and reliability of existing technologies due to inappropriate use are also seen as important barriers. In [65] it is said that “Vendors must provide education on appropriate use of SOA and how to work around performance issues by designing suitable service granularity.” This approach is also explicitly applied for the NEXOF Reference Architecture.

The barrier due to lack of skills is mainly related to complexity of SOA adoption as well as the lack of methodologies. Since the goal of NEXOF is to provide a reference architecture from which specific architectures can more easily be derived than building it from scratch and thus is to guide developers in their work, this barrier will be obsolete.
7.2 Adoption Plan

7.2.1 Introductory Analysis

7.2.1.1 Categorisation

Just like any standard, de facto or de jure, the value of NEXOF is in its implementation and successful use – i.e. its adoption. Thus this adoption is a key success factor to NEXOF-RA, NEXOF and indeed NESSI and it is essential to have a clear and tangible roadmap which plots the way forward in terms this factor.

Adoption of NEXOF is dependent on the involvement and uptake of others; notably:

- Primary:
  - SME ICT Organisations
  - Large ICT Organisations
  - Users Organisations

- Secondary
  - Academics
  - Current and Future NESSI Strategic projects (NSPs)
  - Current and Future involvement of other projects
  - NESSI related National Initiatives (e.g. NESSI Slovenia)
  - Other Standardisation and Fora organisations

Another important split at an orthogonal to this is perhaps more related to the pace and likelihood of adoption:

- Early adopters and proactively interested parties
- Followers with link to the “NESSI Community” but are not so proactive
- Externals - General public/community

This section does not justify why these stakeholders and interest level is key, since this is anticipated to be self-apparent to the knowledgeable reader but below some important drivers for adoption assessed in relation to the prime intentions of NEXOF which are listed as: Efficientising through flexibility, interoperability and quality; mastering complex systems; developing novel technologies; and fostering citizen related parameters. Note that the latter one is not assessed since citizens will not directly adopt the architecture.
<table>
<thead>
<tr>
<th>Organisation Type/Driver</th>
<th>Efficientising</th>
<th>Complex Systems</th>
<th>Novel Technology</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME ICT Organisations</td>
<td>One stop shop</td>
<td>See efficientising</td>
<td>Less pertinent</td>
<td>Costs/Knowledge investment in duplicating technologies&lt;br&gt;De facto Standards</td>
</tr>
<tr>
<td></td>
<td>Level playing field with large players</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lower costs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Large ICT Organisations</td>
<td>Level playfield between large players</td>
<td>Part of toolkit</td>
<td>Speedier development</td>
<td>Costs/Knowledge investment in duplicating technologies&lt;br&gt;De facto Standards&lt;br&gt;Strategic leadership</td>
</tr>
<tr>
<td>Users</td>
<td>As per SME/Large organisation(s)</td>
<td>Cost reduction through decreased interoperability costs</td>
<td>Less pertinent</td>
<td>Costs of development or outsourcing&lt;br&gt;Holistic solutions</td>
</tr>
<tr>
<td>Academics</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>As a core building block for developing value added concepts</td>
</tr>
<tr>
<td>Current and Future Nessi Strategic projects (NSPs)</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>As a holistic framework to integrate their technology and to provide critical mass</td>
</tr>
<tr>
<td>Current and Future involvement of other projects</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>As a holistic framework to integrate their technology and to provide critical mass&lt;br&gt;As a kick start to the fruition of further ideas</td>
</tr>
<tr>
<td>National Initiatives</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>As a base to interested the stakeholders in their community</td>
</tr>
<tr>
<td>Standardisation and Fora organisations</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>Not pertinent</td>
<td>As a basis to integrate their technical ideas and innovations</td>
</tr>
</tbody>
</table>
7.2.1.2 Analysis

An analysis matrix from the above suggests the following intersections – for example it is more likely larger organisations have the capacity for early adoption rather than SMEs.

<table>
<thead>
<tr>
<th>Organisation Type/Pace</th>
<th>Early Adopters</th>
<th>Followers</th>
<th>Externals</th>
</tr>
</thead>
<tbody>
<tr>
<td>SME ICT Organisations</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Large ICT Organisations</td>
<td>++</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Users</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Academics</td>
<td>++</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Current and Future Nessi Strategic projects (NSPs)</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Current and Future involvement of other projects</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>National Initiatives</td>
<td>+</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Standardisation and Fora organisations</td>
<td></td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

It should be noted that the primary users are the real targets. If they adopt NEXOF, it will be successful regardless of the secondary targets. On the other hand, the secondary targets definitively assist in facilitating the Primary movers. For example, academics won't adopt per se, but they can both promote framework furtherance and can certainly school a new intake of student in the merits of forthcoming technologies like NEXOF.

However, lets us first look at the pit-stops on the adoption road to NEXOF. The steps below are broadly speaking sequential but the precise timing cannot be specified since it is very dependent on the category of party and indeed their individual drive. What can be suggested is that Awareness should begin when NEXOF is more concrete but whilst NEXOF-RA is active and that if there is sufficient solidity, POC implementations through further projects or parties could begin within 1-2 years after the project.

Steps:

- Market Awareness and Visibility
- Guidance Information and Case Studies
- Specification and Handbooks
- Technical Reference Implementations
- Real-World business Implementations
- Education, Knowledge and Training
This can now be mapped against the adoption targets as tabulated below. The results from the above analysis, made with after assessments by parties within NEXOF, NESSI and associated groups such as the NESSI SME Working group, suggest that the prime movers need the prime help. Note that the grid does not infer, for example, that Academics or NSP are not interested in NEXOF simply that since they will not physically adopt...they are less interested in facets associated with adoption.

<table>
<thead>
<tr>
<th></th>
<th>SME ICT</th>
<th>Large ICT</th>
<th>User</th>
<th>Academic</th>
<th>NSP</th>
<th>Other projects</th>
<th>National</th>
<th>Standards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market Awareness and Visibility</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>+</td>
<td>++</td>
</tr>
<tr>
<td>Guidance Information</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Specification and Handbooks</td>
<td>+++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Technical Reference</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Real-World business</td>
<td>++</td>
<td>-</td>
<td>++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>++</td>
<td>-</td>
</tr>
<tr>
<td>Education, Knowledge</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Pilot Use</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Production Use</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Improvement and Feedback</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

It also appears that the ICT SMEs have the greatest wants in terms of a roadmap to adoption so this section then studies these SMEs in detail and thereafter highlights any nuances for other pertinent groups.
### 7.2.2 ICT SME Adoption

#### 7.2.2.1 Market Awareness and Visibility

<table>
<thead>
<tr>
<th>Activity</th>
<th>Responsibility/Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interface with the appropriate groups for ideas to promote adoption and interface with parties</td>
<td>WP12 NESSI ICT SME Group</td>
<td>NESSI Sponsorship and Resources and tangibleness of architecture</td>
<td>2008/9</td>
</tr>
<tr>
<td>Create approachable webpages/leaflets identifying the concrete benefits for this target market and the adoption resources</td>
<td>WP12 NESSI Communications</td>
<td>NESSI Sponsorship and Resources</td>
<td>2008/9</td>
</tr>
<tr>
<td>Disseminate to mailing list and relevant Associations</td>
<td>WP12 NESSI-SMEs UEAPME/SME PIN-SME</td>
<td>Cooperation with other groups and tangibleness of architecture</td>
<td>2008/9</td>
</tr>
</tbody>
</table>

#### 7.2.2.2 Guidance Information and Case Studies

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide entry level guidance information aimed at identifying how the different parties could pave a way to adopt NEXOF</td>
<td>NESSI (there is not a task in NEXOF)</td>
<td>Full and Clear NEXOF specifications</td>
<td>2009/10</td>
</tr>
<tr>
<td>Stimulate contributing NSP to provide similar guidance information</td>
<td>NESSI/NSP</td>
<td>NSP Cooperation</td>
<td>2009/10</td>
</tr>
<tr>
<td>Document at business and technical level some of the more complete (in terms of flow) proof of concepts</td>
<td>NEXOF-WP8</td>
<td>Sufficient Resource in WP8 since currently not a deliverable</td>
<td>2009/10</td>
</tr>
</tbody>
</table>

#### 7.2.2.3 Specification and Handbooks

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>For</td>
<td>every WP6/7</td>
<td>Sufficient depth</td>
<td>2009/10</td>
</tr>
</tbody>
</table>
concept/element/package of the technical deliverables of NEXOF, primarily those coming out of WP6/7, ensure that clear descriptive and understandable specifications are published

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publish specification information</td>
<td>WP12 NESSI</td>
<td>As above</td>
<td>2010</td>
</tr>
<tr>
<td>Stimulate a more in-depth handbook (aka “Dummies guide to NEXOF”).</td>
<td>To be identified</td>
<td>Realistically only feasible once sufficient level of proof/interest/adoption</td>
<td>2011</td>
</tr>
</tbody>
</table>

7.2.2.4 Technical Reference Implementations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate a follow on NEXOF-RA project aimed at SMEs only to identify an entry point for them</td>
<td>NESSI</td>
<td>Sufficient support of partners and eventual selection</td>
<td>2009</td>
</tr>
</tbody>
</table>

7.2.2.5 Real-World business Implementations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little can be done by NEXOF-RA to stimulate this except to ensure its work is valid and well received and that other steps are complete. NESSI itself should ensure that its larger partners in particular are encouraged to do this and also that they feedback and publish results as identified under pilot use</td>
<td>NESSI</td>
<td>Usefulness of the NEXOF Deliverables Enthusiasm of relevant parties</td>
<td>2011-</td>
</tr>
</tbody>
</table>

7.2.2.6 Education, Knowledge and Training

See under academic

7.2.2.7 Pilot Use

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies</th>
<th>Time</th>
</tr>
</thead>
</table>
## 7.2.2.8 Production Use

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once implementations/project have proved successful to encourage and provide mechanisms for sharing the results</td>
<td>Relevant implementers</td>
<td>Enthusiasm of relevant parties</td>
<td>2011-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other simpler/better/cheap alternatives</td>
<td></td>
</tr>
</tbody>
</table>

## 7.2.2.9 Improvement and Feedback

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide a mechanism in terms of process and organisation to proactively generate feedback and to reactively receive it in order to improve and augment NEXOF</td>
<td>NESSI</td>
<td>Resource of NESSI</td>
<td>2011-</td>
</tr>
</tbody>
</table>

## 7.2.3 Large ICT Organisations (Deltas)

### 7.2.3.1 Technical reference implementations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate NESSI larger partners to adopt</td>
<td>NESSI</td>
<td>Sufficient support of NEXOF and party interest</td>
<td>2010</td>
</tr>
</tbody>
</table>

Stimulate a follow on NEXOF-RA project (NEXOF-RI = Reference Implementation) possibly within

| NESSI | Sufficient support of partners and | 2009     |

*Time Line: 2009-2011*
IST and similar to that defined in the initial NEXOF proposal | eventual selection

### 7.2.4 Users (Deltas)
None

### 7.2.5 Academics (Deltas)

#### 7.2.5.1 Guidance Information and Case Studies

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beyond the guidance material academic/research partners will be encouraged to included (elements of) NEXOF in their teachings/studies/further-researches to promote its intent to the next generation</td>
<td>NESSI Academic Parties</td>
<td>Usefulness of the NEXOF Deliverables</td>
<td>2011-</td>
</tr>
</tbody>
</table>

#### 7.2.5.2 Improvement and Feedback

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate the research community to lead and advance NEXOF into NEXOF 2</td>
<td>NESSI Academics Academics</td>
<td>Resource of NESSI</td>
<td>2011-</td>
</tr>
</tbody>
</table>

### 7.2.6 Current and Future Nessi Strategic projects (NSPs) (Deltas)

#### 7.2.6.1 Improvement and Feedback

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSPs represent a core of expertise in a certain subject area related to the architecture. As NEXOF evolves, or the ideas evolve, this insight need to been returned to</td>
<td>NSP</td>
<td>NSP will terminate before NEXOF has reached its ultimate goal</td>
<td>2009-</td>
</tr>
</tbody>
</table>
NEXOF to improve it

### 7.2.7 Current and Future involvement of other projects (Deltas)

#### 7.2.7.1 Technical Reference Implementations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other project may provide either their own technology or in some cases utilise NESSI as a bedrock for value added technology. Such use or technical knowledge can improve the quality of reference implementations in both real world scenarios and can offer good insight?/ensign? for others</td>
<td>Other Projects</td>
<td>Availability and feasibility to reuse NEXOF</td>
<td>2010-</td>
</tr>
</tbody>
</table>

### 7.2.8 National Initiatives (Deltas)

#### 7.2.8.1 Real-World business Implementations

<table>
<thead>
<tr>
<th>Activity</th>
<th>Resource</th>
<th>Dependencies and Risks</th>
<th>Time Line</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulate NESSI National Initiatives to adopt NEXOF and spread the world through their closeness to the business/user community</td>
<td>National Initiatives</td>
<td>Sufficient support and funding/interest</td>
<td>2010</td>
</tr>
</tbody>
</table>

### 7.2.9 Standardisation and Fora (Deltas)

None
7.3 Recommendations and Conclusions

The NEXOF adoption path follows any typical technical adoption path. Most of the actions are relatively generalised and common across stakeholder types. Adoption success relies on a few major dependency and risk factors:

- Enthusiastic players (market leader/stimulators)
- Solidity of the architecture
- Provision of awareness information during NEXOF-RA
- Sufficient founding and support to create a nexus
- Continuation of NEXOF in terms of a reference implementation
- Continued support of stakeholders for NESSI

Many of these factors are not in control of NEXOF-RA with the exception of those related to solidity, enthusiasm and awareness. Thus it is key in the roadmap and thus NEXOF-RA to not loose sign of related actions.
8 **ADDED VALUE AND COMPETITORS**

NEXOF aims at supporting next generation service oriented systems. Competitors include SaaS platform providers, SOA infrastructure suites vendors and services platform vendors.

8.1 **SaaS platform providers**

8.1.1 **Force.com (Salesforce)**

Force.com platform provides a database, a 'Java-like' language, integration tools, workflow capabilities and tools for designing user interface for creating business applications on the cloud infrastructure of Salesforce.

Its extension for Amazon Web Services will allow to exploit the services offered by Amazon EC2, including S3 storage service for applications built on the Force.com platform with salesforce.com development tools.

Developers will be able to freely download APIs to build on Force.com software that will appear in Facebook social network.

8.1.2 **Google App engine**

The Google App Engine is a platform for building and hosting web applications on google web servers. It is aimed at developers who wish to write quickly and easily scalable Web applications.

The environment includes the following features:

- dynamic web serving, with support for common web technologies
- persistent storage with queries, sorting and transactions
- automatic scaling and load balancing
- APIs for authenticating users and sending email using Google Accounts
- local development environment that simulates Google App Engine on the user’s computer

Google App Engine applications are implemented using the Python programming language. The runtime environment includes the full Python language and most of the Python standard library.

Quotas limit storage and bandwidth per day.

8.1.3 **Amazon Web services**

Amazon Web Service (AWS) is positioned as a flexible infrastructure platform to support all types programs. Amazon Web Services provide online services for other web sites or client-side applications. Most of these services are not
exposed directly to end users, but instead offer functionality that other developers can use.

Such services include

- Elastic Compute Cloud (Amazon EC2™) – A web service that provides resizable compute capacity in the cloud. Configure an Amazon Machine Instance (AMI) and load it into the Amazon EC2 service.

- Simple Storage Service (Amazon S3™) – A web services interface that can be used to store and retrieve large amounts of data.

- CloudFront™ – A web service for content delivery. It integrates with other Amazon Web Services to give developers and businesses an easy way to distribute content to end users.

- SimpleDB™ – A web service for running queries on structured data in real time. This service works in close conjunction with Amazon Simple Storage Service (Amazon S3) and Amazon Elastic Compute Cloud (Amazon EC2), collectively providing the ability to store, process and query data sets in the cloud.

- Simple Queue Service (Amazon SQS™) – A hosted queue for storing messages as they travel between computers. By using SQS, developers can move data between distributed components of their applications that perform different tasks, without losing messages or requiring each component to be always available.

8.1.4 **Microsoft Azure services platform**

The Azure Services Platform uses a specialized operating system, Windows Azure, to run a cluster hosted at Microsoft's datacenters that manages computing and storage resources of the computers and provisions the resources (or a subset of them) to applications running on top of Windows Azure.

The platform includes five services — Live Services, SQL Services, .NET Services, SharePoint Services and Dynamics CRM Services — which the developers can use to build the applications that will run in the cloud.

A client library, in managed code, and associated tools are also provided for developing cloud applications in Visual Studio. Scaling and reliability are controlled by the Windows Azure Fabric Controller so the services and environment don't crash if one of the servers crash within the Microsoft datacenter and provides the management of the user's web application like memory resources and load balancing.

The Azure Services Platform can currently run .NET Framework applications written in C#, while supporting the ASP.NET application framework and associated deployment methods to deploy the applications onto the cloud platform. Two SDKs have been made available for interoperability with the Azure Services Platform: The Java SDK for .NET Services and the Ruby SDK.
for .NET Services. These enable Java and Ruby developers to integrate with .NET Services.

8.2 SOA suites vendors

8.2.1 Red Hat

JBoss Enterprise SOA Platform is a comprehensive second-generation SOA integration and business automation platform. It brings together several integration technologies including: enterprise application integration (EAI), SOA integration with an ESB and business-event management with JBoss ESB's event-driven architecture (EDA). Further, with JBoss jBPM, business processes and workflows may be automated and finally, JBoss Rules is designed to enable complex event processing in the next release of JBoss Rules and the JBoss Enterprise SOA Platform.

The SOA Platform is designed to be flexible, enabling small, focused ESB deployments that may be federated across the enterprise. Leveraging JBoss Enterprise Application Platform, the SOA Platform can take advantage of clustering and JEE features to enable a scalable integration deployment.

8.2.2 IBM

IBM has exploited its expertise in different areas of software from its product brands to deliver SOA Foundation which provides a comprehensive suite of SOA infrastructure capabilities based on Websphere, Rational and Tivoli.

8.2.3 Sun

Sun Java CAPS (Composite Application Platform Suite) combines business process modeling and orchestration, interface design, metadata management, and development tools in a platform built on open standards. It provides modular ESB suites as well as advanced management of events (complex event processing) and business process management (BPM), adapted to the latest versions of open source server applications Sun GlassFish Enterprise Server interface and the NetBeans Integrated Development Environment (IDE).

8.2.4 SAP Enterprise SOA

The foundation of SAP enterprise SOA is NetWeaver, with MySAP ERP as the application platform that uses the enterprise Web services.

8.2.5 Oracle

Fusion Middleware provides comprehensive tooling and infrastructure for the development and deployment of service-oriented applications based on J2EE applications, BPEL processes and ESB flows.
Fusion Middleware rely on the SCA model to combine standards (SOAP, Jax-WS, WSDL, WS-*, BPEL, UDDI, etc) together into a common service infrastructure. This service infrastructure is shared across the whole middleware platform, guaranteeing a common, interoperable basis for deploying enterprise applications. Developers can configure services deployed on the service infrastructure to leverage these standards using a composite service descriptor defined by the Service Component Architecture (SCA) standard.

8.3 Service platform vendors

8.3.1 Alcatel-Lucent Open service platform

The Alcatel-Lucent 8690 Open Services Platform (OSP) is an IT-based system providing support for the development and deployment of services through which operators can generate additional revenue.

It provides a service creation environment integrated in Eclipse as a plugin to allow Java developer to build telecom services based on JAIN SLEE.

8.3.2 IBM – service delivery framework

The Service Provider Delivery Environment (SPDE) is a framework to create, deliver and manage new telecommunications, digital media and Internet-based services. It is based on telecom and IT standards that leverages IBM software products.

SPDE 3.0 include:

- Solutions to expose core network capabilities -- such as telephony and messaging -- so they can be easily blended with popular Internet applications such as social networking and mapping.
- Media-based composite services through media extensions built into WebSphere SOA middleware.
- Dynamic SOA Business Processes
- Business Intelligence to identifies and analyzes consumer usage behaviors and trends
- End-to-end service management capabilities to help automate and secure a dynamic infrastructure of applications, systems and networks needed to deliver the composite services demanded by subscribers.

8.4 Added value of NEXOF-RA

Existing SOA suites are a set of products that provide SOA capacities. They combine components such as ESB, application server, workflow engine, development tools to provide means to integrate, deploy, secure and manage
business processes and composite applications. Existing solutions provide similar functional coverage and implement the same standards. The weakness of such suites is the complexity of product options and the relatively low the integration level between the products.

SaaS platforms mostly focus on hosting infrastructure, computing power, storage, associated with a development environment to build applications.

Service platforms currently target only the telecommunication domain.

NEXOF-RA proposes to go beyond the combination of SOA and SaaS approaches to design a comprehensive and agile service platform with a high level of integration between the different functional components. NEXOF-RA specifications will lead to service platforms that are interoperable and that enable to deliver services with interfaces based on open standards that can be combined in different ways to meet changing business requirements. The framework will enable development and execution of service applications providing capacities spanning across the whole service lifecycle from requirements and model centric engineering to address complexity, to virtual business relationships and virtual collaboration going through secure and seamless data exchange, protocol and technologies for federation of services.
8.5 NEXOF SWOT analysis

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>Support of EU and major Telco and IT companies.</td>
<td>Complexity to align various actors’ roadmap</td>
</tr>
<tr>
<td>Industry-driven since ETP</td>
<td>Strategy to replace/evolve legacy systems</td>
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<tr>
<td>Leverage of research (existing, to come)</td>
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<tr>
<td>Strongly anchor on Future Internet X-ETPs Initiative (focus on Future Internet of Services)</td>
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<tr>
<td>NESSI Community together with Cluster of Projects supporting NEXOF (NESSI Strategic Projects committed to deliver and NESSI Compliant Projects committed to contribute)</td>
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<tr>
<td>Open Specification Process we defined (successive OCCs)</td>
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<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
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<tbody>
<tr>
<td>No comprehensive integrated and Open Trustworthy Service Infrastructure and Platform.</td>
<td>Vendors consolidation to address higher volume markets.</td>
</tr>
<tr>
<td>Market demand for interoperability lead vendors to adopt the the NEXOF RM+RA (incl. accompanying standards).</td>
<td>Level of ambitions and so time to market of the whole Framework</td>
</tr>
<tr>
<td>Strong needs of such an open and domain-independent service framework (wide adoption expected)</td>
<td>Capacity of NEXI Strategic Projects to deliver</td>
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<td></td>
<td>Capacity of NEXOF-RA to deliver and subsequent NESSI project(s) to be set-up and implement the RI and conformance test suite.</td>
</tr>
<tr>
<td></td>
<td>Conflicting design goals of creating a universal modular environment that is supposed to have perfect integration and usability with very different levels of virtualisation.</td>
</tr>
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Table 3: NEXOF SWOT Analysis
9 BUSINESS MODELS

Business models in a straightforward definition [73] are defined as “the method of doing business by which a company can sustain itself -- that is, generate revenue”. Although the concept is as old as business itself, and not directly related to ICT, its broadly use has been related to the explosion of dot.com phenomenon, globalisation and the rise of the eBusiness era. In this context companies’ services and products are facing shorter life-cycles, more intense competition in global markets as well as the generalisation of use of ICT, which, in many cases, has impacted in the companies’ productive processes. Osterwalder in his Business Model Ontology [74] defines the business model as the glue between business strategy, business organization and ICT. Figure 22 show how these three elements are affected by external factors such as: competition, legal, social or technological changes as well as change in customer demand. The identification of a clear Business model provides organizations with the knowledge required to evolve accordingly to the external factors forces and pressures.

![Figure 24: Environment, Business Models, Strategy, Process and Information Systems. Source[74]](image)

NEXOF ambitions of providing European Industry with efficient services and software infrastructures, their provision as service oriented utilities, as well as, the establishment of the technological basis, the strategies and deployment policies to speed up the dynamics of the services eco-systems, derive in the following possible business models for the NEXOF adopters.

As previously mentioned the following are examples of existing business models applicable for NEXOF adopters. More research in this field will be provided on the following versions of the roadmap.

9.1 Utility Business Models

Utility business models are based in the concept of metered usage, payment is done in the basis of usage. It relates to the concept of public services, just following the model of electricity or water provision. It is characterised by elements that are usually associated with these public utilities:

- Necessity: Services are necessary for the day-to-day operation.
• Reliability: Services have to be available when it is required.
• Usability: No matter which is the internal complexity, services have to be simple to use.
• Utilization: Service utilization rates have to be measured.
• Scalability: Services have to be adaptable to utilisation peaks.

9.1.1 Software-as-a-Service Business Model

Software-as-a-service (SaaS) model has been intensely described in Grid Business models literature [75]. In contrast to the traditional software model where software is purchased from a retailer, in this model the user utilizes software remotely, with neither the need of installation nor acquisition of both infrastructure where to run the software as well as licenses for the software. It is based on the metering usage and “pay-per-use” approach.

SaaS business model provides benefits for both the software owners and the users. The advantages for the customer, as already mentioned in the SaaS section, include: reduction in the cost of ownership and operation both in hardware and software, as well as, opportunity to access to more expensive software. This is especially interesting in the case of SMEs, as it opens the door to product and services that, due to its elevated cost, are traditionally are only affordable for larger companies. The benefits this model offers for providers are: a broader market, including customers not being able to buy an expensive software license but to purchase usage units; disappearance of license agreement violations; and possibility to externalize resource infrastructure, both in a Grid or in a Cloud.

9.1.2 Subscription Business Model

Unlike SaaS Business Model Subscription Business Model are not based in actual usage rates but fixed fee over a period. These fees are equally incurred although there isn’t usage of the service. The benefits for the provider in this type of models is that they assure constant source of revenue and the fact that the provider knows in advance the number of subscribers to a service, reducing the high scalability requirement at the provider’s side. From a customer’s point of view, this model is convenient if the usage of the service is frequent. Depending on the usage ratio the commitment to paying for a package may be more expensive than a pay-per-use model.

9.2 Service Ecosystems Business Models

As presented in [78], traditional value chains present a scenario where customer needs and product definitions are quite static, stable and well-known. Traditional Value Chains present a linear value flow from providers to the organization and from the organization to its customers. Today’s business environment demand for a more multi-directional and multifaceted framework able to capture the complexity of business-to-business (B2B), business-to-customer (B2C) and customer-to-customer (C2C) relationships. This framework has commonly defined as a Value Network. A Value Network represent how
products and services are designed, created, delivered, and provided to customers via complex processes, exchanges, and relationships that creates both tangible and intangible value either to the immediate customer or to the end customer. The value network approach assumes the organization to be part of a larger network or grid of organizations that together create value, and influenced by the social, technological, economic and political context. The Enterprise Interoperability Research Roadmap [79] defines Enterprise Interoperability (EI) as "a field of activity with the aim to improve the manner in which enterprises, by means of Information and Communications Technologies (ICT), interoperate with other enterprises, organizations, or with other business units of the same enterprise, in order to conduct their business. This enables enterprises to, for instance, build partnerships, deliver new products and services, and/or become more cost efficient". EI is recognized as an enabler for value networks, where an enterprise’s competitiveness is largely determined by its ability to seamlessly interoperate and collaborate with other organizations.

The EC report on Value Proposition for Enterprise Interoperability [80] presents the following classification of Enterprise Interoperability Business Models:

<table>
<thead>
<tr>
<th>Enterprise Interoperability Business Model</th>
<th>Description</th>
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<tbody>
<tr>
<td>Type 1 – Undifferentiated</td>
<td>Comprising companies whose business models are commodity-based, competing purely on price and availability.</td>
</tr>
<tr>
<td>Type 2 - Somewhat differentiated</td>
<td>Comprising companies whose products and services have some degree of uniqueness, which however can be easily imitated and therefore overtaken</td>
</tr>
<tr>
<td>Type 3 – Segmented</td>
<td>Comprising companies that compete in different market segments simultaneously, offering differentiated products and services based on the characteristics of the individual market segments, and therefore can also spread risks, but nevertheless remain vulnerable to major technical shifts in the marketplace.</td>
</tr>
<tr>
<td>Type 4 - Externally aware</td>
<td>Comprising companies that have started to open themselves to external ideas and technologies in the development and execution of the business and have some relationships with outsiders for access to the planning of their internal innovation activities.</td>
</tr>
<tr>
<td>Enterprise Interoperability Business Model</td>
<td>Description</td>
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<tr>
<td>Type 5 - Integrated with the innovation process</td>
<td>Comprising companies whose business model plays a key integrative role within the company. Suppliers and customers enjoy formal institutional access to the company's innovation process and reciprocate in kind. Companies therefore begin to experiment more directly with the business model itself.</td>
</tr>
<tr>
<td>Type 6 - Fully open and adaptive</td>
<td>Comprising companies who are fully open to innovation, highly sensitive and adaptive to change, and have a strategic commitment to experiment with business models as a continuous, “normal” part of the business. For these companies, suppliers and customers are business partners, with whom the companies share risks as well as benefits. The business models of these partners are incorporated into the company’s business model(s) and vice versa. A key integration enabler is the company's ability to make its technologies a platform of innovation for the value network, or even the entire market.</td>
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Table 4: Enterprise Interoperability Business Models: Source [80]
10 CONCLUSION AND FUTURE WORK

This deliverable has three releases and is conceived as an evolving document. This first version has defined the NEXOF Context. The second version of the NEXOF Roadmap (M18) will define the Strategic Construction Plan for NEXOF while its third version (M24) will develop the Strategic Adoption plan.

**Version 1: NEXOF Context Analysis**
- Existing methodologies for strategic technical roadmapping
- NEXOF technological landscape and market context
- NEXOF in RI SSI
- Initial analysis of the NEXOF Construction plan
- Initial analysis for the NEXOF Adoption Plan
- NEXOF Added value and Business Models

**Version 2: Strategic Construction Plan for NEXOF – NEXOF Framework Sustainability**
- Identification of Funding Schemes for the NEXOF Construction process
- Definition and Evaluation of Licensing aspects for NEXOF results
- Identification of specific opportunities for SMEs in this process
- Definition of the NEXOF Economic Model
- Creation of a Marketplace for NEXOF adopters

**Version 3: Strategic Adoption Plan for NEXOF**
- The definition of actions towards adoption in all identified potential player communities. It will include:
  - The identification of the benefit for adopting NEXOF in the particular community
  - The specific vision of future of NEXOF for this community
- Operational and business models to favour the adoption of NEXOF
- Definition of guidelines for the instantiation of NEXOF results
- Timeline and guidelines to adopt NEXOF at mid-term and long-term
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