Digging Into The Real-Life Enterprise Interoperability Areas Definition And Overview Of The Main Research Areas

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ABSTRACT

Enterprise Interoperability is perceived as a capacity of two or more enterprises, including all the systems within their boundaries and the external systems that they utilize or are affected by, in order to cooperate seamlessly, in an automated manner, in depth of time for a common objective.

The different layers of Interoperability define in high level the necessary stack for interoperable systems, however, their abstraction level hinders researchers and practitioners to really identify problems and provide solutions, as those levels do not only overlap in many cases, but they also hide important low level aspects that deal with technologies and methods that span across all levels. In order to identify a proper structure for Enterprise Interoperability, which can at a second stage be mapped to the four fundamental layers adapted by the European Interoperability Framework, one has to focus on the real object of observation, which is the "Enterprise", and by analysing it in its core components to identify the interoperability needs within them. Starting from those core ingredients of an Enterprise, and by analysing the current technological trends and the background knowledge of the domain the present papers presents the twelve main Scientific Themes of Enterprise Interoperability

Keywords: EI Scientific Areas, Interoperability, Layers, Enterprise 2.0, Science Base

1. INTRODUCTION

Interoperability is defined in the US, NATO and Australia as "the ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together". IEEE defines interoperability as "the ability of two or more systems or components to exchange information and to use the information that has been exchanged". Interoperability means the ability of information and communication technology (ICT) systems and of the business processes they support to exchange data and to enable the sharing of information and knowledge [13]. Through the years, however, interoperability tends to obtain a broader, all-inclusive scope of a repetitive, well organized, and automated at ICT level feature of organizations, as indicated in the definition of the draft EIF 2.0 [29]: "Interoperability is the ability of disparate and diverse organizations to interact towards mutually beneficial and agreed common goals, involving the sharing of information and knowledge between the organizations via the business processes they support, by means of the exchange of data between their respective information and communication technology (ICT) systems" and the Enterprise Interoperability Research Roadmap [8] "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, organisations, or with other business units of the same enterprise, in order to conduct their business».

Today, we propose that Enterprise Interoperability is perceived "as a capacity of two or more enterprises, including all the systems within their boundaries and the external systems that they utilize or are affected by, in order to cooperate seamlessly, in an automated manner, in depth of time for a common objective".

2. DEFINING THE EI SCIENTIF AREAS

Although the continuous efforts that are put in the advancement of this domain, Enterprise Interoperability still lacks a generally accepted definition of a "Science Base", which can describe comparable constructs in a range of scientific domains. However, since domain research has continued for than a decade, there is a significant body of reported research and application, which can contribute to the population of the Science bases, but is classified in broad themes and thus makes it difficult for researchers and practitioners to actually identify their problems and the main technologies behind them.

In order to formulate an inclusive, yet flexible taxonomy for the EI domain, which will facilitate focused and targeted research by scientific communities, the approach adopted bears the following steps:

1. Consideration of the terms "Enterprise" and "Business Transaction" and decomposition of the enterprise concept in its major ingredients (e.g. people, assets, processes, knowledge, etc.).
2. Analysis of the major technologies behind the term "Enterprise 2.0" (like Cloud Computing, Social Networks) and of current technological trends that are related to the Enterprise world (like Internet of Services, Internet of Things, etc.).
3. Identification of the key EI challenges, as documented in the EI Research Roadmaps
4. Definition of a common EI taxonomy glossary in order to ensure common understanding of the key underlying terms. During this step, four different granularity levels for the EI taxonomy have been defined based on the prerequisites they require.

Granularity Levels of EI Scientific Areas

The different layers, as currently proposed in the bibliography, define in high level the necessary stack for interoperable systems, however, their abstraction level hinders researchers and practitioners to really identify problems and provide solutions, as those levels do not only overlap in many cases, but they also hide important low level aspects that deal with technologies and methods that span across all levels. For example, when we talk about data interoperability, semantic interoperability is applied as far as the concepts and their relations are concerned and technical interoperability is also related as far as the syntax and the data exchange is concerned.

In this context, in order to identify a proper structure for Enterprise Interoperability, which can at a second stage be mapped to the four fundamental layers adapted by the European Interoperability Framework (EIF), one has to focus

on the real object of observation, which is the "Enterprise", and by analysing it in its core components to identify the interoperability needs within them.

An Enterprise, as defined in [26] is "…an organization designed to provide goods, services, or both to consumers." The main ingredients of such a system are Infrastructures, Data, Processes, Policies and People. Starting from those core ingredients of an Enterprise, and by analysing the current technological trends and the background knowledge of the domain of Enterprise Interoperability, the first Scientific Areas (SA) are formulated, which are labelled as the fundamental areas and constitute the 1st granularity level of EI, as following:

- SA.1 - Data Interoperability
- SA.2 - Process Interoperability
- SA.3 - Rules Interoperability
- SA.4 - Objects Interoperability
- SA.5 - Software Systems Interoperability
- SA.6 - Cultural Interoperability

Those scientific areas, although being the core components and as such the most important areas of Enterprise Interoperability, are however incapable of solving all interoperability related problems, as enterprises are constantly becoming more complex, with disappearing boundaries, loosely coupled architectures and virtual resources. As such, the issue of interoperability becomes even more complex, as not only new technologies such as social networks or e-ID are constantly being taken up by enterprises, but also as there is a need for constant and flexible collaboration between all enterprise systems in order to correspond in a timely and effective manner to the requests of the global market.

In order to achieve these transformations and the seamless collaboration, new scientific areas of EI have been developed, which derived through the combination of scientific areas that sit in lower granularity levels. In other words, the scientific areas that belong to a higher EI granularity level are regarded as super-sets of areas that belong in a lower level.

Following this approach, the 2nd granularity level, which is populated with scientific areas that derive by the combination of the core scientific areas of the 1st level includes:

- SA.7 - Knowledge Interoperability, which consists of elements coming out of "Data Interoperability", "Process Interoperabilty", "Rules Interoperabilty" and "Cultural Interoperabilty"
- SA.8 - Services Interoperability, which incorporates facts from "Process Interoperability", "Data Interoperability", "Rules Interoperability" and "Software Systems Interoperability"
- SA.9 - Social Networks Interoperability, consisting of elements coming out of "Cultural Interoperability" and "Data Interoperability", and
- SA.10 - eID Interoperability, which is strongly related with "Objects Interoperability", "Software Systems Interoperability" and "Rules Interoperability"

In the same way, the 3rd granularity level of EI includes:

- SA.11 - Cloud Interoperability, which takes elements from "Services Interoperability", "Knowledge Interoperability" and "eID Interoperability" and tries to infuse them with cloud characteristics

Lastly, the 4th granularity level of EI includes:

- SA.12 - Ecosystems Interoperability, which deals with virtual and digital enterprises and is related to "Cloud Interoperability", "Strategy Interoperability" and "Social Networks Interoperability"

It needs to be noted that the proposed scientific areas aim to promote more focused and concrete research attempts towards the goal of establishing interoperable enterprise systems, as they belong to a smaller abstraction level of that of the four fundamental interoperability layers adapted by EIF.

3. ANALYSIS OF THE EI SCIENTIFIC AREAS

Scientific Area 1: Data Interoperability

Data Interoperability is defined as the ability of data (including documents, multimedia content and digital resources) to be universally accessible, reusable and comprehensible by all transaction parties (in a human-to-machine and machine-to-machine basis), by addressing the lack of common understanding caused by the use of different representations, different purposes, different contexts, and different syntax-dependent approaches [18].

Data interoperability issues have aroused the interest of the research community since the late 1960s when EDI (Electronic Data Interchange) that facilitated the application-to-application exchange of standard business documents between companies, independently of software, hardware, and communication networks, was introduced. With the exponential growth of the Web that opened new opportunities for businesses to transact across all types of boundaries (geographical, national, business category, etc.), early research had focused on providing a lingua franca for B2B e-Commerce, XML, that went beyond HTML to reflect the richness of the data being published [15]. In progress of time e-Business modelling frameworks went through an evolutionary path from monolithic and proprietary standards towards flexible and standardized XML-based stacks covering the requirements from different industries

In order to tackle the data interoperability issues, much progress has been made in terms of developing conceptual and algorithmic frameworks and deploying semi-automatic tools for schema matching and data mapping, promoting semantic reconciliation and mediation techniques, and creating adapters and wrappers. The methods and proofs-of-concept proposed are accompanied by experiments that prove their offerings and the weaknesses, yet such laboratory-oriented approaches need to expand and improve in order to cover real-life situations in enterprise environments.

Scientific Area 2: Process Interoperability

As processes are the core operational elements of enterprises, they are first in line when dealing with interoperability, as the overall interconnection and collaboration of enterprises is based finally on the alignment of their business processes.

In this essence, Interoperability is coupled with the term of business process, as it is self-understanding that the former cannot be achieved without any kind of business process compatibility. Following these claims, Business Process Interoperability is the ability to align business processes of different entities (enterprises), in order to conduct business in a seamless way. In more detail, the realisation of automated and co-operative execution of business transactions requires two or more parties that have compatible business processes, with defined and matching process interfaces, in order for the different parties that take part in the complete transaction to be able to exchange successfully data, avoiding conflicts and loss of data or process control. In this context, process modeling and process reengineering is essential towards interoperable enterprises, as they support the formal representation and the structured reform of them when it comes into cases where two or more entities need to collaborate.

Although during the last decade substantial progress has been made in the field of business process Interoperability, the problem still persists. A report by Gartner back in 2000 claimed, "By 2003, more than 90 per cent of e-businesses will be exploiting process automation technology"[5]. Based on the bloom of research at that time, this assumption seemed quite realistic. However, the research conducted has shown that there are still many obstacles to overcome to be in a position to claim full interoperable processes. As a result, one has witnessed many new developments, either commercial or open source, in areas such as enterprise modelling frameworks, business process modelling, advanced transaction models for business processes, architectures and mechanisms for business process management systems, etc. This progress has however led (to an extent) to further fragmentation of the field, and for quite a time the decisions taken by enterprise on which method/tool to use have more or less defined their degree of Interoperability with other entities, resulting in isolated market silos (e.g. enterprises utilising a specific process modelling and notation language could only interoperate with enterprises that had made the same decision).

Scientific Area 3: Rules Interoperability

Business transactions are generally conducted in a "rule-based" framework, which exists in order to guarantee and safeguard their smooth completion and to resolve any issues that may arise between the different communicating parties. During the automation of enterprise transactions, one has to consider two different kinds of rules that exist and should be treated at the same time for achieving the desired result; Business Rules, and Legal Rules. As a result, rules are considered quite essential for interoperability between systems and their transactions, as they can have either a positive or a negative impact. A negative impact is experienced when rules are not compatible, either due to differentiations in the business models and the business mentality of the transacting entities, or due to different laws and legal frameworks. However, rules can also impact positively enterprise interoperability, as in some cases they can dictate the way a transaction should be carried out (for example banking sector transactions following international standards).

In this context, the term Rules Interoperability describes the ability of entities to align and match their business and legal rules, in order to perform transactions that are both legitimate in each country and do not break the internal operational rules of each other.

Although rules interoperability is closely related with process and data issues, this dimension of transactions has not been extensively studied in the past years. The reason behind this could be a combination of the conditions that are slowly evolving in the global market, which aim to homogenize business rules, regardless of the business sector to which an enterprise belongs, and to establish slowly a common legal framework for all entities to respect (e.g. the common directives issued by the EC that are regarded as the first steps towards the foundation of a new and unified legal environment, or various rules and mechanisms that are proposed by international organizations, such as the World Bank Institution, the International Atomic Energy Agency, etc.).

Scientific Area 4: Objects Interoperability

Objects interoperability refers to the networked interconnection of everyday objects [28]. These objects can embrace aspects besides and beyond software components, consistent with the concept of Internet of Things [11]. Objects can be really seen as orthogonal concepts, each one having its own specific and distinguishing features. In this context, devices or hardware components interoperability can be seen as a particular case of the object interoperability domain.

Objects Interoperability refers to the networked interconnection of everyday objects. Devices or hardware components interoperability can be seen as a particular case of the object interoperability domain. According to the Commission of the European Communities about future network and the Internet regarding object interoperability [9], a number of policy challenges needing consideration can be identified such as Identity Management, Naming and Interoperability and Standardisation. Research literature on objects interoperability is mostly limited to RFID technology. The majority of research work on relevant research subjects, such as Internet of things, factory-of-things and device interoperability are restricted to concepts and position papers. Further work is required towards applicable and validated methods, architectures and tools that will enable object interoperability in a practical manner.

Scientific Area 5: Software Systems Interoperability

Software Systems Interoperability refers to the ability of an enterprise system or a product to work with other enterprise systems or products without special effort from the stakeholders [17] This can be achieved with a large number of alternative IT architectures stakeholders [4], and solutions stakeholders [2], including custom, in-house development of APIs, message-oriented middleware and message brokers, service-oriented architecture implementations, or comprehensive stand-alone B2B software gateways.

Interoperability among software systems has been one of the main goals in the software engineering research in the last two decades stakeholders [24]. One of the most challenging problems has been that of architectural mismatch stakeholders [27]. In general, it is therefore almost impossible to combine components designed for different systems into a working solution. Most approaches for making interoperable software systems overcome this fundamental problem by defining a coherent component model that standardizes the notion of an adapter to be used as a mediator stakeholder [22]. Besides standardizing the properties of the software components to be used, an interoperable software model usually defines a technical infrastructure. With a view to overcoming these problems, recently in service-oriented engineering and its technical foundation, SOAP-style web services, have been employed to extend the component based software engineering approach in order to make completely independently designed software systems work together. However, forming complete business solutions out of service based systems still requires a lot of implementation efforts: data and process mediation problems have to be addressed before services from different systems can be combined.

There is a variety of research literature, standards and frameworks that address Software Systems Interoperability, including methods and tools for component-based software engineering. Nevertheless the value of the majority of these findings and tools is rapidly decreased over time since the underlying software and application technologies are often deprecated. Major challenges lie ahead in the scientific area of Software Systems Interoperability in view of new technological and computer science's advances that indicate the need of a ubiquitous approach that guarantees a high degree of maintainability against the rapid software technology evolution.

Scientific Area 6: Cultural Interoperability

With the world evolving into a unified marketplace, the business context in terms of culture, language and various regional particularities proves to be a great challenge regarding the communication between organisations as well as between their underlying ICT systems [12]. Global trading represents a good example of a domain in which cross-cultural information systems between enterprises are really required. Experts in the global trading domain are under a growing pressure to exchange actual and correct information on very local and unique regions. Different regions in the world share many business processes and data although each region still is unique in terms of different processes, data and business rules due to religion, cultural and social customs [21]. This makes it, on the one hand, difficult to generalize B2B solutions and present them centrally, but on the other hand it is also clear that knowledge about aspects of each situation can be shared. Interoperability between organizations, people and enterprises systems that have different languages and different cultural aspects such as Politics, Religion, regional Art, Traditions and Social Customs defines the concept of Cultural Interoperability [6]. As such, Cultural Interoperability is the degree to which knowledge and information is anchored to a unified model of meaning across cultures. Enterprise systems that take into consideration Cultural Interoperability aspects can be used by transnational groups in different languages and cultures with the same domain of interest in a cost-effective and efficient manner. Cultural interoperability mechanisms are based on the assumption that both high-level and low-level layers of Enterprise reflect culture and that the linguistic encoding of knowledge and information is therefore culturally biased. These interoperability mechanisms and considerations address the ability of enterprises to understand and co-manage context from any source and of any kind, therefore realizing the cooperation between enterprises with major cultural differences.

Scientific Area 7: Knowledge Interoperability

Business Knowledge Interoperability defines the ability of two or more different entities to share their intellectual assets, take immediate advantage of the mutual knowledge and utilize it, and to further extend them through cooperation. As a result, Knowledge Interoperability does not only describe only knowledge repositories which may come in the form of reports, articles, patents, reviews, inventions, etc.

Other very important issues, which are included under this term, include Ontology Matching Approaches and Data to Knowledge mappings. Today, with the evolution of the Semantic Web, ontology matching has taken a critical place for helping heterogeneous resources to interoperate. The Semantic introduces a new environment where both humans and software agents can unambiguously determine the meaning of resources and make better use of them. As quoted by Tim Bernes-Lee [3] the Semantic Web is "a web of data that can be processed directly and indirectly by machines."

In parallel, Business Knowledge Interoperability also includes human resources, which are the creators and the carriers of knowledge within the boundaries of an enterprise, and which can be either individuals or teams that carry expertise and knowledge in specific domains. In this context, the aforementioned term also includes the ability of business units of enterprises to be extracted from the company they originally belong to, and to be seamlessly integrated in a new business environment (company) for collaboration, a situation which is closely related with Ecosystems Interoperability and with the creation and set up of Virtual Enterprises, which consist of business units from different enterprises that come together.

As bibliography reveals, the main effort of the research community when tackling the issue of Business Knowledge Interoperability lies in the area of Semantics for constructing common dictionaries that will support and ease out the operations of sharing and spreading knowledge amongst various entities. However, Knowledge Interoperability is not solely about semantics, as it includes other facets as well, ranging from business units alignment to context aware systems. Methodologies, standards, tools and not to mention large-scale experiments and case studies on those aspects are absent and need to be researched as well, as sharing knowledge is not only concentrated in the exchange of documents and tangible assets but also relies heavily on human individuals, operating on their own or as part of business units.

Scientific Area 8: Services Interoperability

Services interoperability refers to the ability of an enterprise to dynamically register, aggregate and consume composite services of an external source, such as a business partner or an internet-based service provider, in seamless manner [20].

The major significance of service interoperability was evident when during the last decade the business world warmly embraced the concepts of Service-oriented Architecture (SOA) and Web Services in their everyday operations. Service-oriented architecture (SOA) is a flexible set of design principles used during the phases of systems development and integration in computing [7].

Throughout the foundation of the Internet of Services, the conception of service interoperability has characterized the formation of a number of innovative concepts such as Service Engineering, service level agreements (SLAs) and Mash-ups. Penetration of the Internet of Services, Service Engineering, SLAs and the Enterprise mash-ups is just beginning to proliferate and there are many pending research issues to be resolved. While these technologies are not mature enough and working drafts of the next specifications are in the works, designers and developers have to interpret the meaning in parts of the current specifications. Interpretation allows interoperability problems to seep into service composition, discovery and as well as in the definition of request/response mechanisms. Furthermore future interoperability challenges involve increasing the flexibility and ease of implementation of tangible and intangible services on specific business domains, the architecture of an integrated framework between existing service-front ends and back-end platforms, the enhancement of "as-a-service" models in enterprises as a result of global-wise and distributed activities of the enterprises and their supply chain enhancing the movement towards internet of services and lastly the ability to quickly and effectively assess partner capability, creative thinking about incentive systems to motivate appropriate behaviour, fail soft mechanisms to protect against potential disruptions and clear specification of outputs.

Scientific Area 9: Social Networks Interoperability

Social networks are a major evolution coming out of Web 2.0 and in the last years they have attracted the interest of enterprises, not only for promotional and advertising reasons, but also for operational purposes. Not long ago, enterprises have realised that the power of social networks can also positively or negatively impact their business operations. The impact of them are also underlined in JRC-IPTS report [14], which amongst others states that Social Computing is now mainstream and companies and policymakers cannot afford to

overlook, has the potential to reshape work, health and learning and is a driver for growth and employment.

Keeping aside the dimension of reputation management in social media, enterprises steadily understand the value behind social networks integration to their operation and try to exploit the advantages offered by these networks in terms of collaboration between themselves and also between their own employees. As [1] states "Social networks provide means for enterprises to capture and expose many informal connections between their stakeholders."

Social Networks Interoperability can be defined as the ability of enterprises to seamlessly interconnect and utilise social networks for collaboration purposes, by aligning their internal structure to the fundamental aspects of the social networks. This ability should concentrate into two different operations. Firstly, enterprises should be able to manage and interconnect all their social media accounts, and secondly enterprises need to redefine their services, operation and internal structure in order to integrate social network characteristics to their daily operation. In those terms, interoperability for the enterprise should follow a research into a two layer approach, focusing both of the underlying technologies of the social web but also on the social web as a coherent "platform". Until recently, most scientific attempts focus on the proposal of methodologies for infusing the characteristics of the Social web to the enterprises. However, these methodologies focus on very specific topics and there is a huge lack regarding the proposal of standards and frameworks, which would enable the seamless integration of such features in the operational functionality of businesses. An obvious reason behind the lack of scientific resources dealing with social networks interoperability is the fact that this area is quite young and immature, and innovation activities are preceding research on fundamental aspects.

Scientific Area 10: Electronic Identity Interoperability

An electronic or digital identity is a means for people to prove electronically that they are who they say they are and thus gain legitimate access to services. Electronic identity interoperability defines the ability of different eID systems within or across the boundaries of an enterprise to collaborate in order to automatically authenticate and authorise entities and to pass on security roles and permissions to the corresponding eID holders, regardless the system that they originate from. eID interoperability can provide the advantages such as reducing costs for businesses and administration activities by simplifying procedures and optimizing resources, improving security of eID systems, improving the quality of services making the public sector's and businesses' process more open and transparent, and facilitate transactions between enterprises and public bodies and also harmonizing data and security architecture for a complete international interoperability.[19].

Today, the technologies deployed for identity management are manifold and coined by long-term development and integration. Therefore, the systems are heterogeneous and meaningful for different security aspects such as identity repositories, directories, authentication mechanisms and tools, authorisation and access control [23]. There is a lack of IT compliance for integrated, process supportive identity management and at the moment, the mapping of external identity certifications with internal ICT specific identifiers still needs to be researched, as several problems are still unsolved. As a result, Current eID solutions are not interoperable, as the development of identity management systems is still not coordinated and comprehensive.

Scientific Area 11: Cloud Interoperability

Cloud Computing holds the potential to provide small and large enterprises with a flexible model for delivering added-value solutions by composing best of breed internal and external services which combine diverse data sources deployed across multiple cloud infrastructure providers and possibly reconfigured while running, or with limited interruption, to respond to changes in usage patterns or resource availability.

Today, numerous vendors have introduced paradigms and services based on non-compatible underlying technologies, making the cloud landscape diverse, heterogeneous and vendor-locked [25]. In this context, interoperability which is definitely a challenge for on-premise applications is magnified in the cloud. Cloud Interoperability refers t the ability of cloud services to be able to work together with both different cloud services and providers, and other applications or platforms that are not cloud dependant. The scope of interoperability refers both to the links amongst different clouds and the connection between a cloud and an organization's local systems [10] in order to realize the seamless fluid data across clouds and between cloud and local applications.

Although standardization appears to be a worthwhile track and many efforts are under way to standardize clouds' important technical aspects, resolving the cloud interoperability problem is still far from reality. Most approaches emphasize on cloud deployment issues, with interoperability not having appeared yet on the pressing agenda of major industry cloud vendors and researchers. There are some positions, definitions and visions on the benefits from addressing cloud interoperability, yet experimentation efforts and proof-of-concept implementations are rather limited.

Scientific Area 12: Ecosystems Interoperability

Globalisation is becoming a fact of our age, and markets evolve from domestic environments to global and cross-border dimension. As a result, sustainability and survival of enterprises (especially of SMEs) is asking for business transactions and collaboration that follow a similar expansion, not only over geographical domains, but also over core business domains. Businesses are constantly concentrating into domain specific environments, called digital ecosystems in accordance to biological ecosystems. The term "business ecosystem" describes a community of enterprises, which all work together towards their main goal which is no other than covering their needs and working together and in a complementary way for the production of added value services and products.

As stated in [16] there are three types of ecosystems; Digital ecosystems, Business ecosystems, and Innovation ecosystems. Ecosystems Interoperability focuses on the ability of different business sectors to interconnect and to achieve a close and automated collaboration, which will benefit not only the dominant companies of an ecosystem, but the whole population of it. As such, Ecosystems Interoperability is defined as the ability of instant and seamless collaboration between different ecosystems and independent entities, entities within the ecosystems and as the ability of different independent entities to formulate virtual structures for specific purposes.

Being a quite young and immature scientific area, the research that has been performed during the last years has not produced milestone results and as most identified references depict, most efforts have been made in the direction of proposing concepts and simplistic methodologies for constructing such ecosystems, based on standards that are "borrowed" from neighbouring and

underlying scientific areas, such as business process interoperability, data interoperability, etc.

4. CONCLUSIONS

Investigation of the scientific themes within interoperability research yields an immense body of research and knowledge relevant to both enterprise interoperability and science base foundation, even where the research is not directly focused on enterprise application.

This body of knowledge has been reviewed in depth and linked to the identified scientific areas through detailed study of the relevant literature, review of EU FP6 and FP7 projects related to the domain, review of major community events, and of the relevant initiatives. This resulted to the formation of a first level taxonomy of 12 scientific areas, which form the base of knowledge available towards the foundation of the Science Base for Enterprise Interoperability.

ACKNOWLEDGEMENT

Part of this work has been financed by the European Commission in the frame of the FP7 Specific Support Action "ENSEMBLE - Envisioning, Supporting and Promoting Future Internet Enterprise Systems Research through Scientific Collaboration" (Contract No: FP7-ICT-257548).

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