Service software engineering for innovative infrastructure for global financial services

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SERVICE SOFTWARE ENGINEERING FOR INNOVATIVE INFRASTRUCTURE FOR GLOBAL FINANCIAL SERVICES

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Abstract

The recent financial crisis motivates our re-thinking of the engineering principles for service software and infrastructures intended to create business value in vital sectors. Existing monolithic, inward-directed, cost insensitive and highly regulated technical and organizational infrastructures for financial services make it difficult for the domain to benefit from opportunities offered by new computing models such as cloud computing, software as a service, hardware as a service, and utility computing. The scale and global impact of the recent financial and economic crisis justify our domain focus to explore, from a service software engineering perspective, potential for increased uptake of "software as a service" in financial services as well as extrapolating our results to services in other vital domains. We describe in this paper an on going research agenda to develop service software engineering (SSE) for Innovative Global Infrastructure for Financial Services. We propose novel service software engineering involving a coherent blend of domain knowledge, policy modelling, social, cultural, and global factors with converged IT, telecom and media. Parts of this paper are based on an European Union Framework Program FP7 ICT call 5 proposal addressing challenge 1-Objective 1.2 - Service/Software Engineering methods and tools.

Keywords: Infrastructure, Service Software Engineering, Financial Services, Integrative Framework

1 INTRODUCTION

The finance domain can be considered as a challenge for the knowledge based society in light of the recent financial and economic crisis. The recent financial crisis and its aftermath motivate our re-thinking of the role of Information and Communication Technology ICT as a driver for change in the global financial enterprise and a critical factor for success and sustainability. We attribute the recent financial crisis that hit the global market, causing a drastic economic slowdown and recession, to a lack of state visibility, inadequate response to events, and a slow dynamic system adaptation to events. There is evidence that ICT is still used mainly as the tool to store and process data … not to create business value and business intelligence capable of counteracting devastating events.

We describe here a research agenda to develop Service Software Engineering (SSE) for Innovative Global Infrastructure for Financial Services SSE-4-IGIFS.

Following a brief overview of “service software”, also referred to as “Software as a Service SaaS”, we present an approach to develop novel service software for financial services. We consider a motivating case study and describe an associated research workplan. We highlight the potential of the proposed approach in various domains and progress beyond state of the art.

Our research addresses challenges facing “adaptable service / software engineering methods and tools”, “verification and validation”, and “open source software” at the domain level, technology convergence level, global factors level, and governance level. We incorporate domain knowledge, influenced by various factors, coupled with policy modelling in all phases of the service/software life cycle. The aim is to go beyond traditional software engineering and to adopt a new service software engineering integrative framework drawing upon knowledge/experience from a range of disciplines.

2 SERVCE AS A SOFTWARE

According to (Di Nitto et al, 2009), service-oriented computing (SOC) represents one of the most challenging promises to support the development of adaptive distributed systems. Applications can open themselves to the use of services offered by third parties that can be accessed through standard, well defined interfaces. The binding between applications and the corresponding services can be extremely loose in this context, thus making it possible to compose new services on the fly whenever a new need arises. Around this idea a number of initiatives and standards have grown up, some of them focusing on how such roles need to interact with each other, and some others on how to engineer systems based on such a model and on how to provide foundational support to their development. In particular, so-called service-oriented applications and architectures (SOAs) have captured the interest of industry, which is trying to exploit them as the reference architecture to support Business to Business B2B interaction. According to Forrester Research, the SOA service and market had grown by $U.S. 4.9 billion in 2005, and it is forecasted to have an interesting growth rate until 2010, with a compound annual growth rate of 88 percent between 2004 and 2009.

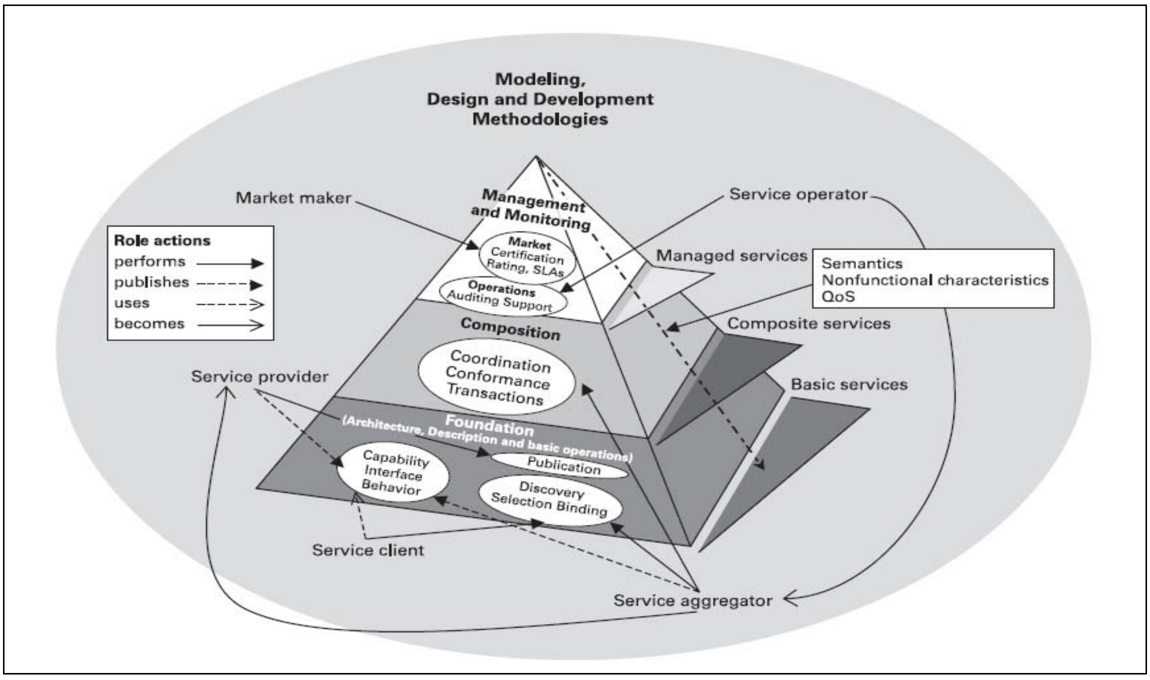

Figure 1. the Service Oriented Computing roadmap - extracted from (Di Nitto et al, 2009)

The SOC road map, depicted in Figure 1 extracted from (Di Nitto et al, 2009), separates basic service capabilities provided by a services middleware infrastructure and conventional SOA from more advanced service functionalities that are needed for dynamically composing (integrating) services. The SOC road map highlights the importance of service modelling and service-oriented engineering (i.e., service-oriented analysis, design, and development techniques and methodologies that are crucial elements for the development of meaningful services and business process specifications).

3 FINANCIAL STATE VISIBILITY CASE STUDY

The urgent economic problem, linked to the financial crisis, challenges current research and technological development. The scale of the fiscal crisis that undermined the credibility of the financial system motivates the consideration of "Global Financial State Visibility" as a key global challenge that validates research and technological development activities to support the engineering dynamics of automatically adaptable software services along the "global financial supply chain" (Maad et al, 2009).

Risk is an elusive term. Several attempts have been made to define the term risk. In general risk is a probability of a negative occurrence which may be neutralized through pre-mediated actions. Our aim is to mediate state of risk in order to reduce its negative impact, hence, the need to convey the state of risk as a service "Financial Risk Visibility at Your Service"[1]. Prevalent industry efforts in this respect aim at identifying flexible dynamic digital representations to describe risk and taxonomy of risk (e.g. the proposal to use XBRL (XBRL-web) to describe financial risk taxonomy). These efforts would ultimately facilitate the mediation of dynamic risk reporting among various target groups (regulators, policy modellers, investors, etc.).

Our aim is to align the prevalent thinking in terms of mediating risk using reports (static reports; or XBRL dynamic reports) to mediating the state of risk (financial risk visibility) as a service. Key issues to consider are: who will publish, deploy and discover the service and use it, and how the service will be tuned (i.e. automatic adaptation).

Delivering the state of risk as a service raises a key question: "who will manipulate (govern) the service". Various entities (policy makers, regulators, auditors, accountants, investors, consumers, suppliers, producers, individuals) need to access /govern / adapt Financial Risk Visibility Service depending on Service Level Agreements SLA (see Figure 2 below).

Financial state could be conveyed in various ways:
- perception the state of financial risk
- perception of financial events
- percent of the financial activity
- perception of the financial system and regulatory framework

The Financial state visibility challenge has various dimensions:
- *Domain knowledge dimension:* this involves building the financial state knowledge base (the development of techniques to store and manipulate the semantic representation of the financial state by various stakeholders including regulators, investors, and central banks worldwide); and the visual rendering (using techniques such AR/VR) of the financial state knowledge base.
- *Converged ICT and media dimension:* this involves the development of an interoperability layer at the service infrastructure and interface levels to guarantee instant access to financial state via various converged ICT and media devices.

[1] The term "At Your Services" refers to the EU initiative presented in (Di Nitto et al, 2009).

- *Global factors dimension:* financial state knowledge is stored and manipulated in different languages and different structures and formats. This raises geographical cultural, and accessibility technical challenges. Rendering of the financial state needs to adapt to "global context on demand".
- *Governance dimension:* There is an urgent need to support the governance of the financial state with greater perception and manipulation capability tools.

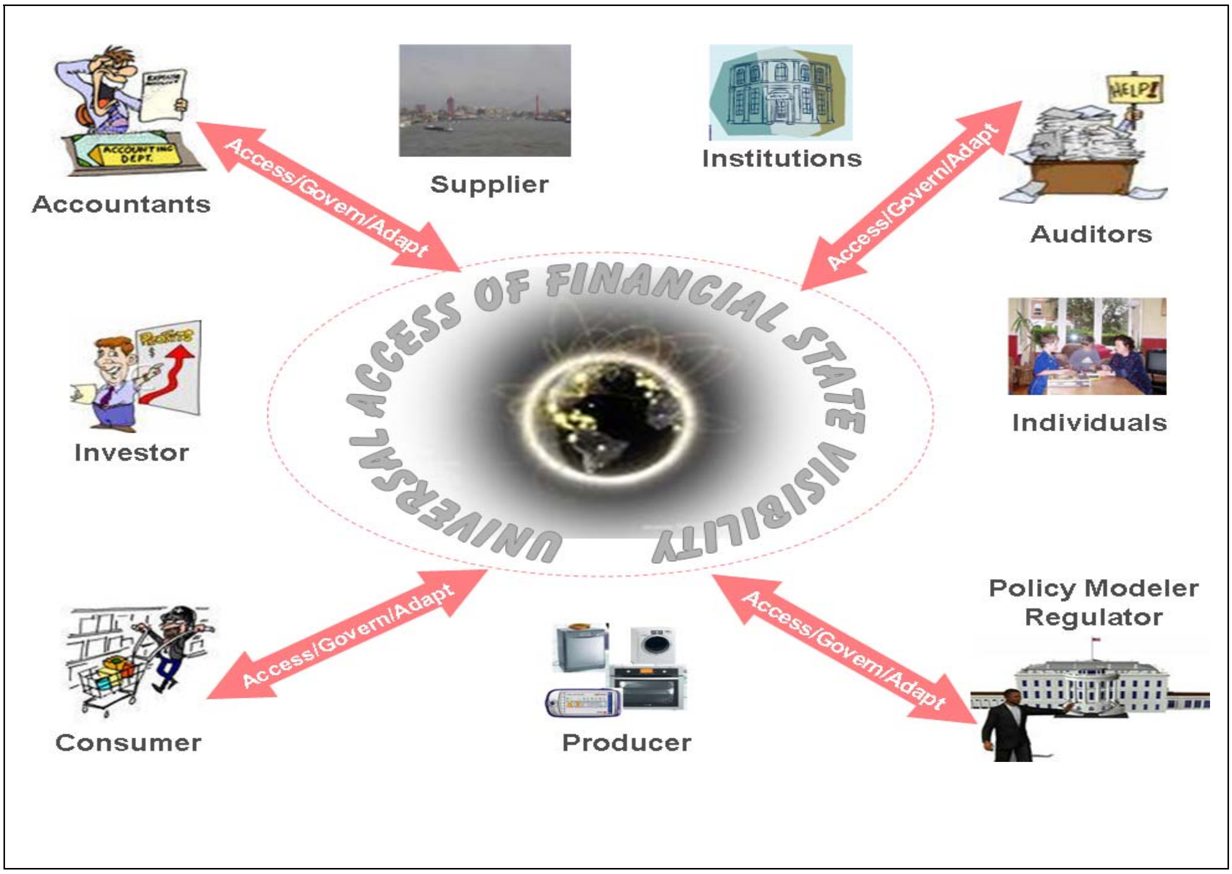

Figure 2. Actors that need to access /govern / adapt Financial State Visibility

4 NOVEL SOFTWARE SERVICES FOR FINANCE

Reference to the above described case study, various financial state visibility services, depicted in Figure 3 below, could be developed taking into account the various dimensions of the financial state visibility challenge. These services can be grouped into various levels and categories:

Domain Levels Services:

- Domain Services: Encapsulate/wrap/Render Domain Knowledge aspect
- Technology Convergence services: Accessibility and Interoperability Services
- Global Factors Services: Encapsulate/wrap/render global factors knowledge
- Governance Services: Encapsulate /wrap/render Governance knowledge

Integration Services Exchange:

Handle exchange communication between domain level services and integrative framework services.

Integrative Framework Services:

- Integrate functionalities of domain level services
- Integrative Framework Services
- Integration Framework Service Exchange

Mediators services:

- Mediate Integrative services to various users at various levels according to Service Governance Level Agreement
- Mediator Service Exchange
- Adaptation Service Mediators

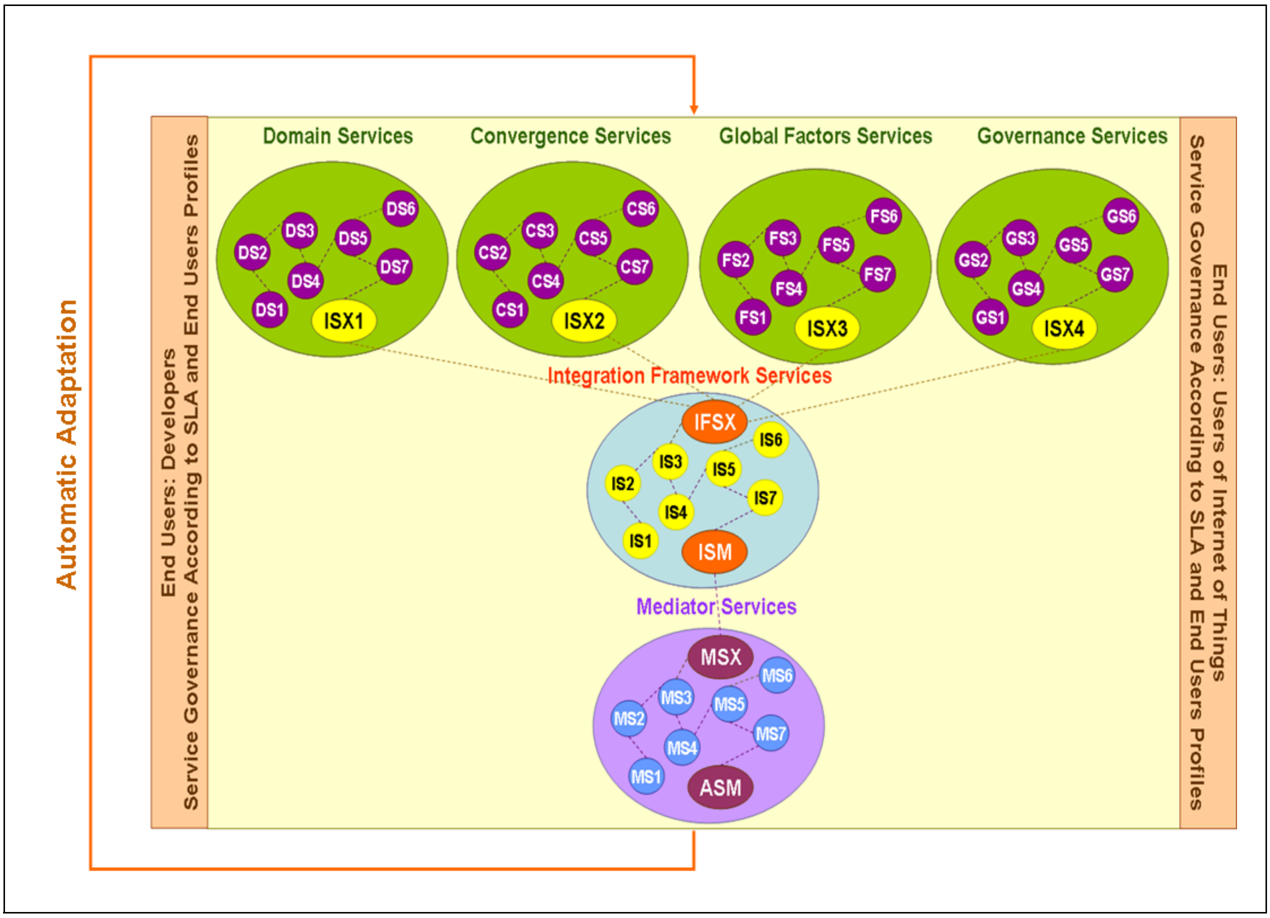

Figure 3. Financial State Visibility Services

The design and engineering of these state visibility services involves: composition, workflow, adaptation at design time and run time consideration, agency interaction, verification and validation.

Users of the services are conceived at two levels:

- *Level 1 end users:* developers of internet of things
- *Level 2 end users:* end users of internet of things

Users at both levels govern access, discovery, and manipulation of state visibility services according to Governance Service Level Agreements GSLA.

The aim is to align the software service development cycle to the counterpart real world processes and governance infrastructural set ups. Alignment of domain level services involves the alignment of composition, workflow, adaptation at design time and run time consideration, agency interaction, verification and validation to real process and governance development cycles. Alignment of services depends on the identified level and categories of services.

The alignment of domain level services involves the alignment of workflow and composition of services to the real world activities of knowledge resources:

- selection
- collection
- mash-up
- extraction
- modelling
- abstraction

The alignment of mediators services involves the alignment of workflow and composition of services to the real world activities of:

- Gap measurement
- Dissemination
- Policy Modeling
- Policy adjustment
- Policy control

This alignment depends on process management and infrastructural set up at end users points.

5 APPLICATION TO VARIOUS DOMAINS

The above described services are generic and can be used across different domain verticals. Power is achieved by focusing on target end users at level 1 and level 2 in a domain vertical.

Various case studies could be used to test and validate the balance between genericisity and power of our integrative service software engineering framework. These are briefly described in table 1 below.

Generic Aspects across domain verticals and cross verticals	**Domains**	**Case Studies (examples) in Various Domains**
Mediating risk	Healthcare	Preventive Healthcare i2010 priority
Bridging gaps and greater uptake	e-governance	Participative e-governance
Building knowledge base	Education	Lifelong learning
Shift from data governance to service governance	The Enterprise	Data Centre in the enterprise
Adaptable knowledge enabled change	Global Business	Global supply chain

Table 1. Genericisity of the approach across domain verticals

We consider below a potential application, “the global financial supply chain”, that could benefit from the developed approach.

The global supply chain is defined as a process that begins with a purchase order and ends with the liquidation of the purchase (Schurr, 2007). In between there are separate but linked supply chains: physical (logistics and carriage), financial (treasury management and finance) and information (technology), all of which must be managed in concert with each other in order to maximize the benefit of the buyers and sellers in terms of reduction in Days Sales Outstanding, faster payment, more accurate cash flow forecasts, increased visibility, and lower borrowing cost. A typical physical supply chain involves forecasting, procurement, production, shipment, receipt and reconciliation, and compliance. The financial supply chain involves procurement, risk mitigation, fulfillment, payment decision, and cash management. The information supply chain relies on greater information visibility in respect to shipment, order payment and all activities carried out along the physical and financial supply chain. The information supply chain is heavily dependent on a technology infrastructure that can cope with the scale, volume, timeliness, distribution, and workflow associated to the physical and financial supply chain.

Various actors involved in the global supply chain include:

- Financial Institutions
- Manufacturers
- Distributers
- Subcontract Manufacturers
- Consumers
- Suppliers
- Retailers
- Logistic Providers

The global supply chain spans various business domains including:

- Finance: This involves financial markets, banks, investments companies, and insurance companies.
- Manufacturing: Manufacturing is the use of machines, tools and labor to make things for use or sale. The term may refer to a range of human activity, from handicraft to high tech, but is most commonly applied to industrial production, in which raw materials are transformed into finished goods on a large scale.
- Production: This involves the act of making products (goods and services), assessment of costs, and pricing.

Regulatory and Governance setups are keys in shaping interaction across domain boundaries.

A scenario in context can be identified by giving fixed values to the following context related variables along the global supply chain:

- *Geographic boundaries* crossed along the supply chain (e.g. US, Asia, Europe)
- *Type of production* (e.g. oil, corn, wheat)
- *Manufacturing resources* (equipment, labors, etc)
- *Financial intermediation* (institutions, markets, systems, legislation). Financial legislations, audit, and regulations are heterogeneous in various countries; hedge financial instruments (for producer, supplier and consumer) vary from one financial market to another
- *Global knowledge* sharing (cultural, market, information, and systems barriers). Actors along the global supply chain have to deal and validate documents in different languages
- *Business process and workflow*
- *Heterogeneous systems across geographic boundaries*

6 WORKPLAN

Our proposed research work plan is broken down into eight work packages that reflect the various considerations for progress beyond state of art. These work packages are classified into 4 levels (Level 0 – Management; Level 1 – Knowledge construction for SSE; Level 2 – Knowledge integration in SSE; Level 3- bridging gaps).

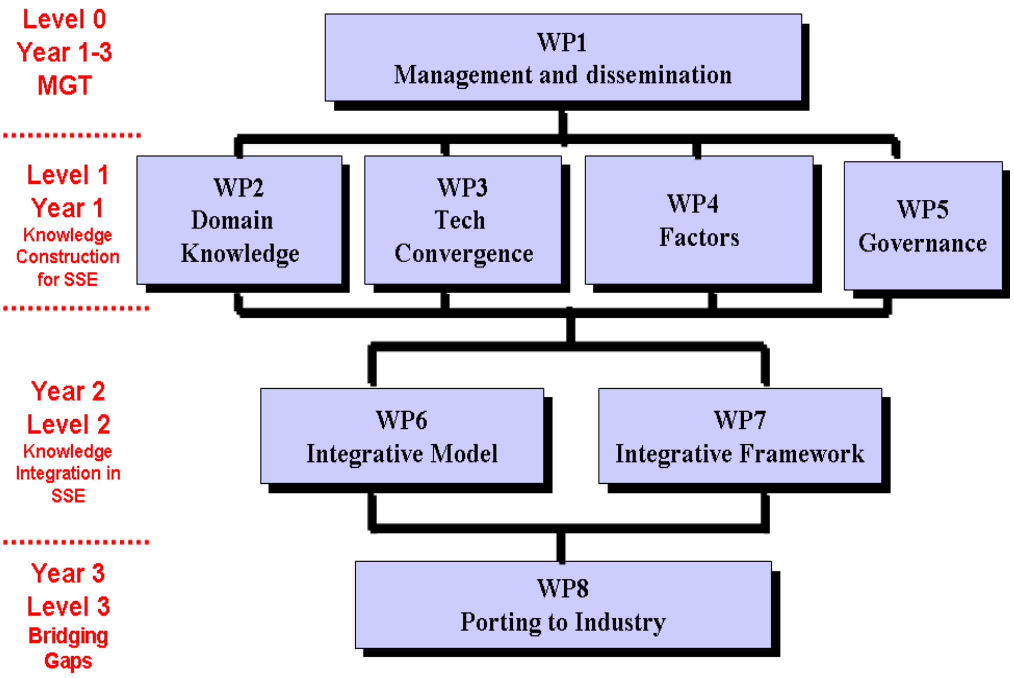

Figure 4 Research Workplan

- *Level 1- Knowledge Construction for SSE:* four work packages WP2, WP3, WP4, WP5 are dedicated to capture various aspects of knowledge respectively (domain, converged ICT and media, factors, and governance). These work packages attempt to model aspect of knowledge and incorporate it in SSE. Modelling in each of the work packages is thought at the foundation, composition and management and monitoring levels. A conceptual SSE model and prototype is developed for each aspect of knowledge.
- *Level 2 – Knowledge Integration in SSE:* two work packages WP6 and work packages 7 are dedicated to consolidate outcomes of WP2-5, in an integrative SSE framework model and prototype. Run time and design time frame consideration are important consideration in the development of the integrative framework. Road map of the future internet is inferred from the integrative framework model and potential extrapolation of findings to various vital domains is assessed from the prototype integrative framework.
- *Level 3 – Bridging gaps, enabling change and increasing uptake of software service:* WP8 Demos help in developing industry benchmarks for greater uptake of service software and bridging gaps.

Modeling is thought at three levels: Foundation (semantic knowledge and ontology, interface); Composition (alignment of the real business process to service composition); Management and monitoring (integration of governance and market SLA).

We consider two key time frames, run time and design time (Figure 5). State visibility, instant response to events, real time process, and dynamic access to knowledge are key considerations at run time.

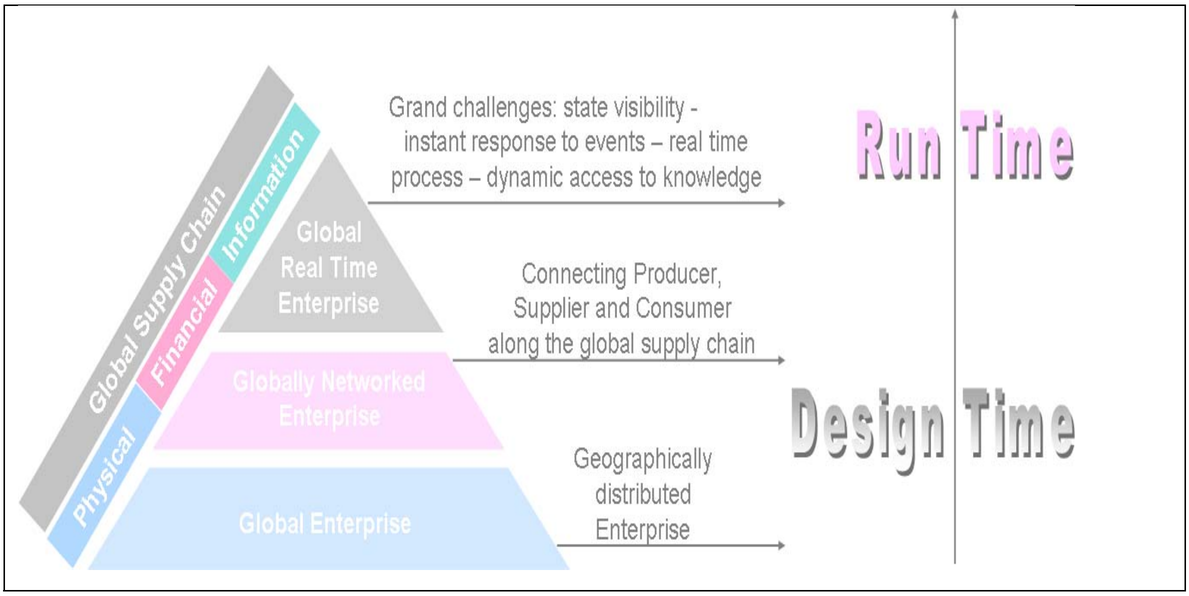

Figure 5. Time Frames

Our aim is to align the service software engineering life cycle to the engineering dynamics of the continuously constructed knowledge. We adopt Model Driven Software Engineering to incorporate domain knowledge, influenced by various factors, coupled with policy modelling in all phases of the service/software life cycle. This is depicted in figure 6 below.

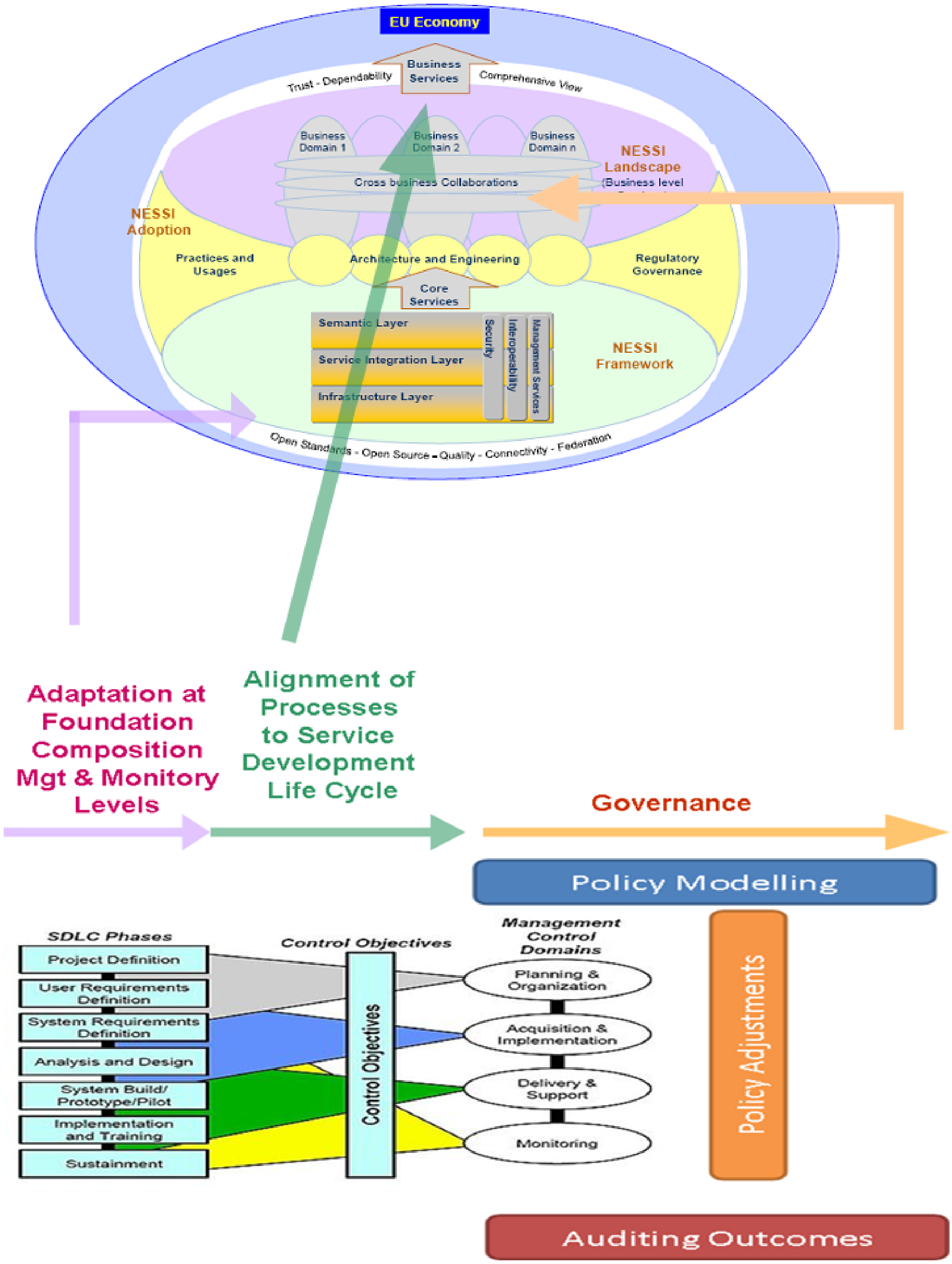

Figure 6. The alignment process - adapted from NESSI holistic Model extracted from (Di Nitto et al, 2009)

7 PROGRESS BEYOND STATE OF THE ART

Our proposed research will complement the efforts developed within the various FP7 projects in the area of service software engineering by adding a greater depth to the study of the up take of Service as Software in financial services.

Table 2. The contribution of our research to the portfolio of EU FP7 projects ECOM(2008)

FP7 Project	Our Contribution
ProTest property based testing	Software Engineering Approaches for the Reliability of future service-oriented networks developed within Protest project will be validated for the finance domain in light of the recent financial crisis
DIVA	Methodologies and tools developed by DIVA for managing variability in adaptive system and in particular, crisis management system will be validated in light of the challenges in the financial domain.
mancoosi managing software complexity	Studying the potential of Open Source Infrastructure for Finance and its potential benefit for better finance awareness among the global community will be studied in light of the MANCOOSI project findings.
alive	ALIVE Engineering approaches for distributed software systems based on the adaptation of coordination and organisation mechanisms (human and society) to Service Oriented Architecture will be considered for the global finance community.
ImPrESS	SSE-4-IGIF will add the finance domain to the Q-Impress agenda of bringing the advantages of service orientation to relevant domain such as industrial, production, telecommunication and critical enterprise applications
COMPAS	SSE-4-IGIF will complement effort of COMPAS to explore domain specific languages.

An empirical approach (Beynon, 1999) will be adopted to apply Model Driven Engineering MDE to service software life cycle for the financial enterprise, market, analysis, engineering, education, and global supply chain. This will be considered in light of the NEXOF Layered Functional View (Pevtschin et al, 2008) for size, domain, technology "Independence Principle"; the evolution of service software engineering; the ECSS classification scheme ; the Open Modelling Framework depicting the software development process at the IT and Business Modelling Levels (BOC GmbH, 2008); and Language Engineering Workbenches (Solberg A., 2008) for efficient service engineering (High Level Service Description Languages – shifting from general purpose languages to domain and task specific languages).

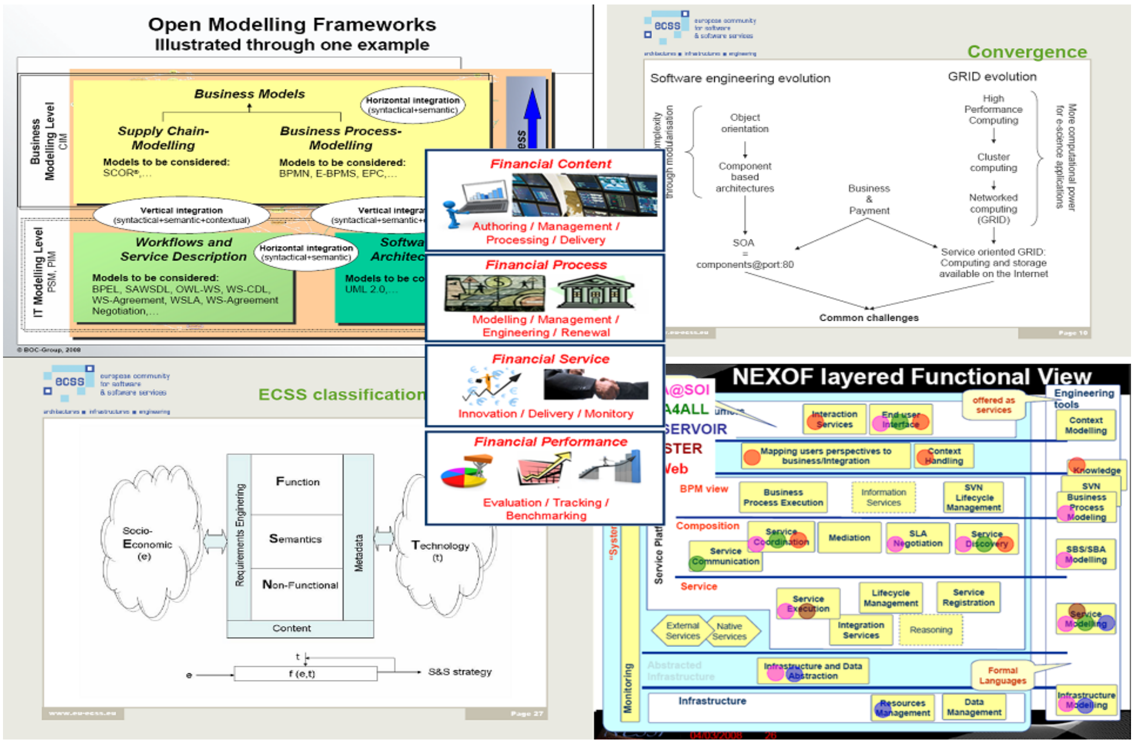

Figure 7. Nexof Layered Functional View, ECSS Classification, Open Modelling Framework

A novel software engineering culture capable of consolidating inter-disciplinary expertise in ICT and finance domain specific expertise will be developed based on the ECSS (European Community for Software & Software Services) Software Services Conceptual Framework (see Figure 8). We will develop service/software engineering methods and tools focusing on innovative approaches to dynamic service networks systems evolution and acquisition, and incorporation of finance domain specific knowledge in all phases of the service/software life cycle. We will consider a broad range of software for finance including: financial service innovation, delivery and monitory; financial process modeling, management, engineering, and renewal; financial content authoring, management, processing, and delivery; and financial performance evaluation, tracking, and benchmarking.

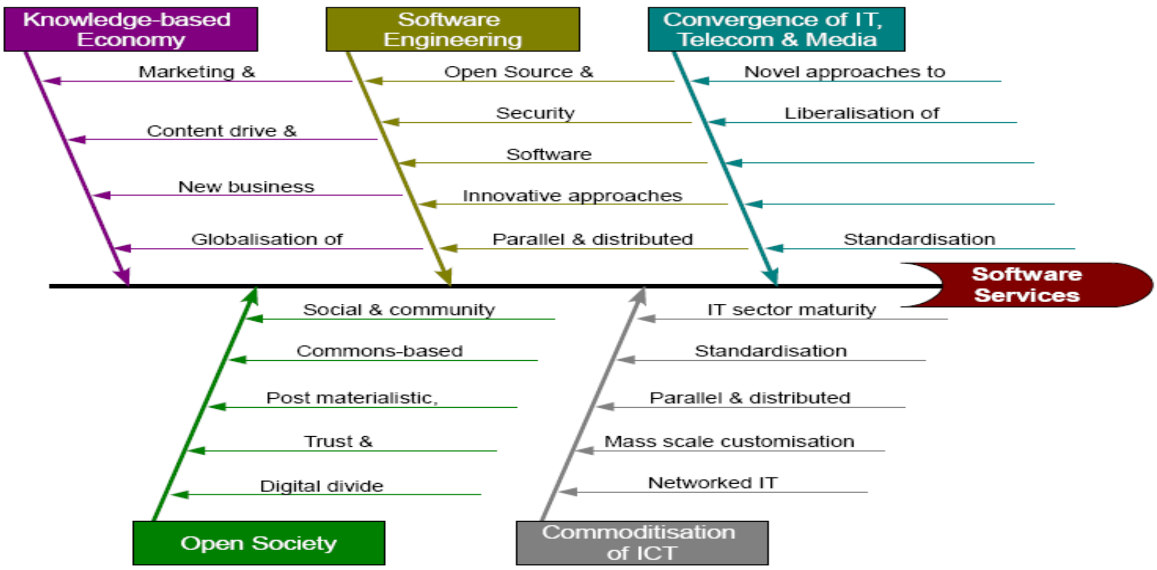

Figure 8. Factors shaping the evolution of Software Services - Extracted from ECSS (2008)

The development of our case study will built on existing approaches adopted in various successful EU projects:

- ASTRO (Supporting the composition of distributed business processes in the e-government domain) TARSU Case Study (Citizen Tax Payment System in Italy) (Di Nitto et al, 2009).
- Exploiting semantic interfaces at design time and run time (SIMS Project) (Di Nitto et al, 2009).
- Quality of Service Ontology Language and Vocabulary (Amigo project) (Di Nitto et al, 2009).
- Policy Modeling GridTrust Security By Contract (Di Nitto et al, 2009).
- Cross Organizational Business Processes (Athena Framework) (Di Nitto et al, 2009).
- Financial Supply Chain Management with SAP (SAP AG, 2005)

8 CONCLUSION

We presented in this paper an ongoing research aiming at the development of service software engineering for innovative global infrastructure for financial services.

The expected outcomes of our research are:

- novel SSE aiming at lowering the social, political and technical barriers and bridging the gap between vital domains and utility computing;
- high level abstract representation and low level technical implementations of an integrative SSE model for a Global Infrastructure for Financial Services;
- a roadmap of SSE engaging new stakeholders
- new technology infrastructures and future internet models based on a greater integration between service software engineering and domain knowledge.
- Novel software / service engineering based on an integrative service software engineering model.
- Lowered barriers for standardised open source development by considering factors that creates transformational shift from “cost insensitive” to “cost sensitive” domains.
- A greater uptake of “software as a service” and “software as a utility” in domain applications that face a certain degree of rigidity in accepting these concepts.
- A strengthened service software industry: adaptable software development and better response to events and crisis, lower risk and better control, new software models for greater business value from ICT, sustainable global software market growth, and new service software engineering principles for industry.

References

Maad S and Coghlan B (2009), The Next Generation Grid: An Infrastructure for Global Business Systems, International Journal for Business Information systems: Business Modelling and Simulations IJBIS (in press).

Di Nitto E., Sassen A.M., Traverso P. and Zwegers A., At Your Service - Service-Oriented Computing from an EU Perspective, The MIT Press 2009)

XBRL-web, BRL eXtensible Business Reporting Language, http://xbrl.org/frontend.aspx?clk=LK&val=20

COM(2009), Internet of Things — An action plan for Europe, COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, COMMISSION OF THE EUROPEAN COMMUNITIESBrussels, 18.6.2009, COM(2009) 278 final

Schurr C. (2007), Managing the Global Supply Chain, White paper, National City, https://www.nationalcity.com/content/commercial-banking/solutions/global-treasury

Beynon, W.M. (1999) "Empirical Modelling and the Foundations of Artificial Intelligence, Computation for Metaphors, Analogy and Agents", Lecture Notes in Artificial Intelligence 1562, Springer, 322-364, 1999.

ECOM(2008), European Commission, Information Society and Media, Software & Services FP7 Project Portfolio, Software and Services Architecture, Infrastructures, and Engineering, FP7-ICT-2007-1 - Objective 1.2, JUNE, 2008

Pevtschin V., Theilmann W. (2008), The NESSI Contribution through NESSI-Soft & NESSI-Grid, Software & Services Priorities for WP 2009-10, NETWORKED EUROPEAN SOFTWARE & SERVICES INITIATIVE , NESSI Project, Brussels – 4th March 2008

BOC GmbH (2008), Mapping of business process models and ICT system models, Software & Services, Priorities for WP 2009-10 Workshop, March 4, 2008, www.boc-group.com

Solberg A. (2008), Language Engineering Workbenches for efficient service engineering, S&S Priorities for WP 2009-2010, Brussels March 4 2008

ECSS (2008), ECSS White Paper on Software and Service Architectures, Infrastructures and Engineering – Action Paper on the area for the future EU competitiveness, Volume 2: Background information, Version 1.2, SIXTH FRAMEWORK PROGRAMME, PRIORITY 2: Information Society Technologies, page 12.

SAP AG (2005), SAP White Paper mySAP ERP, Financial Supply Chain Management with SAP, http://public.intensum.eu/brochures/BWP_WP_FSCM.pdf