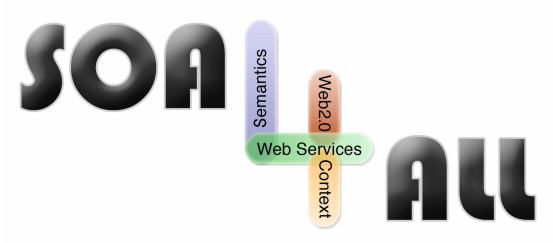

Project Number: **215219**

Project Acronym: **SOA4ALL**

Project Title: **Service Oriented Architectures for All**

Instrument: **Integrated Project**

Thematic Priority: **Information and Communication Technologies**

D8.1 Web21c Requirements

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Dissemination Level		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission)	
RE	Restricted to a group specified by the consortium (including the Commission)	
CO	Confidential, only for members of the consortium (including the Commission)	

Version History

Version	Date	Comments, Changes, Status	Authors, contributors, reviewers
1.0	15/6/2008	ToC and Structure outlined	
1.1	15/7/2008	First draft with initial contributions	
1.2	25/7/2008	Annex A added, with State of the Art	
1.3	4/8//2008	Context section added	
1.4	15/8/2008	V1.4 Updated following internal comments	
1.5	28/8/2008	Final draft ready	

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Glossary of Acronyms

Acronym	Definition
D	Deliverable
EC	European Commission
WP	Work Package
QoS	Quality of Service
SLA	Service Level Agreement
S1	Scenario 1
S2	Scenario 2
SID	Shared Information/Data Model
eTOM	enhanced Telecom Operations Map
TAM	Telecom Applications Map
VoIP	Voice over IP (Internet Protocol)
SMS	Simple Messaging System
SDK	Standard Development Kit
WSDL	Web Service Description Lanaguage
SIP	Session Initiation Protocol
ParlayX	set of Web service APIs for the telephone network
PSTN	Public Switched Telephone Network
SIP	Session Initiation Protocol
IM	Instant Messaging

Executive summary

Work package 8, the BT Web21C case study, will build on the current BT Web21c infrastructure and leverage SOA4All research and technology to allow end-users to access, use and create services based on BT's 'capabilities' (such as VOIP, SMS etc.). Web 2.0 principles, Semantics and Context are used to create a powerful but easy to use platform for discovering, using and combining BT's capabilities, and for incorporating third party services.

Following a detailed analysis of the current Web21c SDK user base, the case study has developed two scenarios as the basis for developing prototypes based on SOA4All technology. The prototypes will aim to provide the next generation of Web21c, addressing the set of requirements identified in this deliverable.

The two scenarios are described in detail in D8.1, and derive the following main requirements:

1) Business Requirements

- Encourage greater uptake of Web21c SDK by providing tools to enable easier use of the services
- Provide tools with a focus on end users with limited technical experience
- Create a community of SDK users, to encourage collaboration and innovation in creating new Telco applications
- Create an infrastructure to allow a third party business to resell BTs SDK services, providing support in design and management of the thirds party services
- Increase overall use of the Web21c SDK, and hence increase revenue

2) Technical Requirements

- Usable without detailed knowledge of Ontologies, WSDL or programming languages.
- Web Browser Based, Drag and drop, easy to use interface.
- Search on functional and non-functional aspects of service, and keywords.
- semi automated assistance with creating service compositions, with facilities to link a GUIs
- Service ranking and help with design time selections based on user context
- Export/share composition with other users
- Fault handling of Service Failures and Error reporting
- Import and link to Industry standard ontologies
- Import and mark-up third party Web Services

Future work in this WP will then be the design (Task 8.3), implementation (Tasks 8.4, 8.6,) and evaluation (Task 8.7) of the prototype.

1. Introduction

1.1 Introductory explanation of the deliverable

This WP8 case study will investigate creating the future Web21C infrastructure based on SOA4All technology.

Web21C is the name currently given to the platform over which BT will provide next generation services on top of its all IP-based 21st Century Network (BT 21CN). Some of these services will be provided by BT and others will be provided by third parties. Web21C is central to BT's transformation from a traditional telecommunications company to a converged software and services business. Web21C will allow third parties to use BT's network as a platform for delivery of their services, for which BT get revenue. These are not typically other network competitors, but a new breed of partner - software companies, developers and content providers.

Currently Web21C comprises of a set of Web services, and software development kits (SDKs) that provide external access to a number of BT capabilities, such as making a voice call and sending an SMS text message.

Figure 1. BT web21c SDK website

Web21C requires detailed technical knowledge of Web service languages (e.g. WSDL) and programming languages (e.g. Java) to be able to access, combine and use the services. The aim of the case study is to provide the next generation of Web21C where the process of discovering, integrating, using and sharing BTs services can be done much more effectively.

Aims:

- Reducing the cost and time of using and combining the services
- Reducing the barriers to entry of utilising services
- Increase innovation in the area for people to create exciting apps utilising BT services
- Increase Revenue for BT

There are also many non-technical issues in moving to a SOA4All based model for conducting business that the case study will investigate:

- Managing Quality of Service (QoS) and Service Level Agreements (SLAs) in composed services

- Trust and Security
- Increasing the use of ontologies and semantic technology in the Telco sector
- Relationship between ontologies and other Telco models/standards
- Regulation, competition and legal issues

Many of the non-technical issues, specifically: market analysis, business models, regulation, competition and legal issues will be investigated in Deliverable 8.2 (Telco 2.0 analysis) and Deliverable 8.5 (Telco 2.0 recommendations).

WP8 has developed two scenarios using Web21c that will be the basis for developing prototypes to test and showcase SOA4All technology, and fulfill the aims described above. The deliverable describes theses scenarios and gives outlines the requirements for each.

1.2 Purpose and Scope

The purpose of this deliverable is to describe the scenarios of the use case and to collect requirements that are derived from them. The requirements will be used as input to the technical work packages (WP1-WP6) in SOA4All, and will also feed into the design of the WP8 prototypes (D8.3).

1.3 Structure of the document

Section 2 describes the two scenarios in the WP8 case study, firstly giving an overview of each scenario, and then describing the requirements. The requirements are split into general business requirements, and more detailed technical requirements. As context will play an important part in the case study, a section is also devoted to the requirements for modeling context. A conclusion of the requirements analysis and summary table is given in section 2.3.

The Annex provides some additional information on state of the art relevant to the case study. The main focus is on related research related projects and ontologies for the telecommunications domain. Where possible the case study will attempt to use results from projects that have synergies with SOA4All or address some issues specific to the case study and telecommunications.

1.4 Methodology

The initial analysis has involved a number of methods for gathering information which have contributed the development of the scenarios described, and the associated requirements. These include surveying current users of the Web21c SDK, interviewing developers of the SDK, attending Telco industrial events and speaking to research experts in Web Services, Semantics and Web 2.0.

As the project progresses it is planned to involve real users in evaluation and testing of the prototypes developed in the case study. A formal evaluation will be undertaken in Task 8.7. Before the formal evaluation takes place it is hoped to try and build a community of users by releasing early prototypes and encouraging collaboration using the web 2.0 aspects of the project. As informal and formal feedback is received, it is envisaged that some requirements

will evolve, and some new requirements will emerge. In addition the second scenario (S2) described in the document will not be developed until the second half of the project (M18+), so there may be some updates and further requirements derived as the case study progresses.

To summarize, the requirements collection will follow an iterative approach. The more detailed the scenarios will be elaborated, the more requirements will emerge. Hence, this deliverable is a working document that is updated on demand during the project.

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2. Requirements

This section gives the requirements of the two scenarios in the WP8 case study. The scenarios have been carefully chosen after consultation with users of the current web21c platform and developers of the SDK. The aim is to provide scenarios that will achieve the maximum benefit from SOA4All technology and also provide the biggest impact to users of the SDK. Another consideration is the timescales for other work in the project, as delivery of some technical results will not occur until the later stages (i.e. month 30). This has lead to the development of two scenarios, which align with the dependencies and timescales of the technical results in WP1-6. The first scenario will developed in the initial stages of the project (M6-M18) and will use the SOA4All results delivered in these timescales. The second scenario will be developed in the latter stages of the project, (M18+) and will make use of all the technology available from the project.

The following sections outline the two scenarios 'web21c application design' and 'business reseller'. For simplicity, they are referred to as S1 and S2 in the document.

2.1 'Web21c Telco application design' Scenario

The 'Web21c Telco application design' scenario (S1) will be the first of two developed in the case study. The Web21c SDK was released to the public in August 2007, as part of the ongoing assessment of the platform a user survey was conducted by BT to try to gain more insight into the demographic the SDK users, and collect some feedback to help with improvements. The survey was conducted by contacting all the current users of the SDK, and asking them to fill in a survey. Out of the respondents that replied, a smaller group were contacted for a more detailed telephone interview

The result revealed that there were roughly two distinct sets of users: (i) Casual users who are interested in the possibility of creating web applications and mashups using Telco services, for fun or to share with friends (ii) Business focused users who see the opportunity to either resell BTs services, or integrate online Telco features into a current business.

S1 will focus on the first set of 'casual users', and investigate how SOA4All technology can be used to help these users create web applications, mashups and compositions in the simplest and most effective way possible.

2.1.1 Involved Data & Users

Data

- **BT Services**

  BTs Current Web21C SDK[1] offers a variety of services for consumption as Web services including: SMS Messaging, Voice Calls, Conference Calls, Authentication, Automated Call Management, Calendar and Address book services. Over the duration of the project, more services will be made available and they will be included in the case study as they are released.

[1] http://web21c.bt.com/

- **Third party services**

One of the main aims of the cases study is to promote the uptake of Web21C by offering tools to encourage innovation in using and combining BT's services. SOA4All will make it easier to consume BT's services but also combine them with other people's services to make new and interesting applications. Any service available over the Internet is a candidate for integrating with Web21C. Initially a set third party of services will be selected and described semantically by the case study in order to provide a pool of services for users to create compositions. It is envisaged via collaboration in the web 2.0 community, advanced users will begin to semantically describe further services, and add to the platform.

- **Ontologies**

Ontologies will be used in the project for the structured representation of data, and for the machine processable semantic descriptions of Web Services. In S1 it is assumed that users will have no knowledge of specific ontology languages so will not interact or edit ontologies in their native form. There is likely to be the use of simple hierarchical ontologies for classification, so that the user can browse categories of services. It is unlikely that more complex industry standard ontologies will be used in this scenario.

Users

The survey conducted on current SDK users revealed that 60% of are in the group targeted by S1. Their main motivation in using the SDK is for personal interest, with the aim of using the Telco services to either create interesting mashups/applications, or simply use directly because of the attractive price plans offered by the SDK. An interesting result of engagement with this user group was that a significant percentage had limited programming experience. This meant that the current method of using the SDK (via a Java, C# or PHP API) was causing problems, and creating a barrier preventing some people using the SDK.

2.1.2 Scenario description

S1 describes a situation in which SOA4All technology is used for creating simple mashups of BT services and other popular services on the web. The aim is to make it easy for novice users to get access to the facilities of the Web21c SDK and combine them with other services on the Web. SOA4All will be used to overcome some of the current problems that limit the uptake of the SDK, primarily the technical knowledge required and familiarity with a programming language such as Java.

The scenario involves building up Web Service composition to create a new web application using a Web21c service as a starting point. As the focus of S1 is on casual users building and non-critical applications, the scenario will involve minimal security or management infrastructure,

Users will undertake a similar sequence of steps each time they design a new application, although the specific services may differ. The sequence below outlines the generic steps that will be taken:

1. User logs into the system,

2. Selects option to create new Telco application

3. User selects various context parameters to help shape selection (see section 2.1.5 for details)

4. User searches for appropriate service by using one of a number of methods
    a. searching via keywords or more complicated semantic queries regarding goal of service and input/output.
    b. browsing a hierarchy of services sorted by topic

5. Users selects starting service as basis for composition

6. From combination of context and selected services, system decides matching services suitable to compose. Services can be individual atomic services from BT and third parties, or can be composed services already created and exported with the SOA4All architecture by other users

7. User selects service and brings into workspace

8. The system helps user to 'wire' service into composition, by offering matches to input and outputs (or possibly via some mediation service), or plug-in GUI component to enable input of information

9. Where system cannot help, the user may have to manually work out wiring between services. These are captured by the system for re-use in future compositions. interaction with web 2.0 community

10. Repeat steps 5-7 until composition is complete

11. User can further design GUI or add code to finish

12. Execute service to test. Further Iterations of 5-8 until composition is completed to satisfaction.

13. Completed application can be saved and shared with other users of the community.

2.1.3 Business requirements

The use case will investigate a number of key challenges with respect to the Web21c platform:

- **Lower barrier in entry in using SDK**

  The use case aims to provide tools with a focus on end users with limited technical experience, thus opening up the SDK to a greater number of people. Currently the technical knowledge required to use the SDK restricts the number of potential users.

- **Build a community of web21c users**

  The question WP8 is trying to answer is "How to create a semantically enhanced version of Web21c supporting internal and external user communities?"**.** There is a requirement for a Web2.0 enabled community for developers and users to collaborate and create applications or composed services from BTs Web21c services

- **Increase new wave revenue**

  The old business models for Telco's, based on large revenues from fixed line calls and termination fees is shrinking. BT's Strategy is to be a more software focused business, and increase revenue from Web-based and new innovative products. BTs Web21c SDK is key to the strategy increasing new wave revenue, and the potential offered by a SOA4All enhanced version will help to achieve this.

2.1.4 Functional Requirements

S1.R1 Usable without detailed knowledge of Ontologies, WSDL or programming languages

The survey of current users revealed there are a significant proportion of users of the current SDK that had no previous web service or programming experience before attempting to use it. There were several reasons for this, including the attractive price plans offered with the SDK. The web21c support team have spent a significant amount of time helping novice users with basics of web services and programming to allow them to use the SDK. A requirement of the SOAA4ll case study would be to enable the use of the SDK without the need of prior knowledge about Web Services and programming languages.

SOA4All technology also will also use semantic web technology (ontologies, reasoning etc.). It is also a requirement that users do not need detailed knowledge of these technologies in order to use the prototype.

Whilst more advanced features can be made available to expert users (such as direct editing of WSMO ontologies, or access to WSDL descriptions) it should not be a necessity.

Technical Area: Service Deployment and Use (WP2), Service Construction (WP6)

Relevant Tasks: T2.1, T2.2, T6.1, T6.2

S1.R2 Web Browser Based, Drag and drop, easy to use interface

As part of the requirement for use by novices of web services and programming, the user interfaces should be intuitive and easy to use. This should include (where possible)

- Graphical drag and drop interfaces in preference to text based commands for input.
- Simple logical steps to follow, in order to carry out specific tasks
- Contextual menus, hints and auto suggestions for specific objects and actions
- Web Browser based, no additional software required (except JavaScript or web plugins)

Technical Area: Service Deployment and Use (WP2)

Relevant Tasks: T2.1, T2.2

S1.R3 Search on functional and non-functional aspects of service, and keywords

Users will require means to find suitable services from the pool of available services in the SOA4All platform. There is a requirement that users will be able to search for services based on a number of different methods:

- Keyword

  Traditional keyword Search that will locate a service based on matching simple text strings, to the associated WSDL or WSMO descriptions

- Functional

  Search based on a semantic query, using ontological concepts and axioms that express the desired function of the service, or the desired inputs/outputs

- Non-Functional

  Search based on the non-functional aspects of a service, such as its Quality or Service or Location

- Hybrid

  Hybrid allows a combination of non-semantic and semantic search, which aims to bridge the gap between the two. For example a user will type a simple keyword, such as “credit card”, and the system will search information in the ontological descriptions of the services to present the user which a number of results, along with the particular context in which they occur, e.g.

  - a service which had “**credit card** number as an input”
  - a service which has a “**credit card** number as an output”
  - a service which provides a “**credit card** verification”

- a service which provides “application for a **credit card**”

The user can then select the particular context in which they want. This allows a novice user to use traditional keyword search, but then end up with the service, which semantically has the function they require.

Technical Area: Service Annotations and Reasoning (WP3), Service Location (WP5)

Relevant Tasks: T3.1, T3.2, T5.3, T5.4, T5.5

S1.R4 Service ranking and help with design time selections based on user context

The concept of context in relation to web service discovery and consumption is an important pillar in the architecture of SOA4All. S1 and S2 will use context to guide user selection of services at design time. It is therefore a requirement that services can be assessed and ranked based on the context of the user.

For example in S1, if the user has a context that describes him as a “business user”, the system will give a higher ranking to business class services, such as a VOIP with a higher Quality of Service (QoS).

Technical Area: Service in Context (WP4), Service Location (WP5)

Relevant Tasks: T4.2, T4.3, T5.4, T5.5.

S1.R5 Suggestions for compatible services in a web service compositions

S1 and S2 both involve creating compositions of web services. As part of the overall requirement for ease of use, there should be the feature of auto suggestion for compatible services when creating a composition. Based on the functional description of a starting service in a composition, it should be possible to work out further services in the SOA4All platform that are able to be added to the composition. This may be by simple matching of inputs/outputs or may take some higher-level approach where the required goal of the composition is expressed semantically, and the system can identify services that provide partial satisfaction of the goal, and suggest they be added. At each stage of composition, (i.e. after the next service has been added), the system should re-assess the situation and provide a new set of suggested services.

Technical Area: Service Deployment and Use (WP2), Service Construction (WP6)

Relevant Tasks: T2.1, T2.2, T6.1, T6.2

S1.R6 Automated or semi automated assistance with linking services in composition

The process of ‘wiring’ together services in a composition should be made as easy as possible for the user. Where the system can work out semantic equivalence between inputs and outputs between services, this should be presented to the user.

Technical Area: Service Constructions (WP6)

Relevant Tasks: T6.1, T6.2

S1.R7 Link GUI to web service compositions

In S1, once a composition has been created it is likely that the user will wish to invoke it via a Graphical User Interface in a Web Browser. The SOA4All platform should provide support in designing a GUI for a web service composition. Based on the input required for the composition it should be possible to provide certain pre-defined GUI components that the user can integrate. For example if the composition requires a 'date' to be entered, then there a predefined drop down box for specifying a date can be made available. Similar pre-defined components can also be made available (or created by user, and shared) for other things.

Technical Area: Service Deployment and Use (WP2), Service Construction (WP6)

Relevant Tasks: T2.1, T2.2, T6.1, T6.2

S1.R8 Export/share composition with other users

SOA4All supports the ideas of Web2.0 and in S1 we would like to encourage a community of users that can work together to discuss ideas and problems, and also share the results of work they have done within the SOA4All platform. There is a requirement that once a composition has been created, there is the facility to save it, and also share with other members of the community. Compositions (or partial compositions) should be available to be re-used by others once they have been completed.

Technical Area: Service Deployment and Use (WP2), Service Construction (WP6)

Relevant Tasks: T2.1, T2.2, T6.1, T6.2

2.1.5 Role for SOA4All technology

The following table shows which SOA4All work packages will be used in the course of S1. The following symbols indicate the usage:

	**Yes** Work package outcome will heavily be

	used
	**Partly/Maybe** Work package outcome will partly be applied depending on the actual progress of implementation
	**No** Work package outcome will not be used directly within this scenario

Table 1.Role for SOA4All Technology in Scenario 1

WP	Task	Deliverable / Prototype	Use
WP1	T1.2	D1.2.2 - WSMO Data Grounding Tool	
Service Web Architecture	T1.3	D1.3.3 - Distributed Semantic Spaces: A Scalable Approach To Coordination	
	T1.4	D1.4.4 - SOA4All API V2 (service bus)	
WP2	T2.1	D2.1.6 - Provisioning Platform Prototype	
Service Deployment and Use	T2.1	D2.1.7 - Service Modelling Tools Prototype	
	T2.2	D2.2.3 - Consumption Platform Prototype	
	T2.3	D2.3.3 - Monitoring & Management Tool Suite Platform Prototype	
WP3	T3.2	D3.2.5 - Repository Reasoner for WSML	
Service Annotations and Reasoning	T3.2	D3.2.6 - Rule Reasoner for WSML	
	T3.2	D3.2.7 - Description Logic Reasoner for WSML	
	T3.3	D3.3.2 - Established Ontology Tag Clouds	
WP4	T4.2	D4.2.2 - Service Context Ontology Stack	
Service in Context	T4.3	D4.3.2 - Contextual Ontology Repository	
	T4.4	D4.4.1 - Service Parameterization From Context Mechanism	
	T4.5	D4.5.2 - Mechanisms For The Acquisition Of Service Context From Social Networks	
WP5	T5.3	D5.3.2 - Service Discovery Prototype	
Service Location	T5.4	D5.4.1 - Service Selection And Ranking Prototype	
	T5.5	D5.5.2 - Service Adaptation Prototype	

WP6 **Service Constructions**	T6.1, T6.2	D6.2.2 - Prototypes, Tool Integration (containing the integration of the two advanced prototypes of both Lightweight and Adaptive service composition)	

2.2 'Business Reseller' Scenario

S2 will be developed in the second half of the project, and aims to utilise all the technical results of the projects. As it is based on a business scenario, it has additional requirements that stem from the need to have a greater level of control over the execution of services, monitoring and fault handling. S2 will inherit all the requirements from S1, but includes additional requirements describing below. The scenario is outlined below, but is likely to be developed further as the project progresses. This section will be updated at M18 to include a more detailed analysis and description

S2 will Use SOA4ll technology to design and compose their more complex end user applications to resell or use as part of their business, incorporating BT white label web21c services, their own services & OSS and some BT OSS services. Enable people to create a business incorporating BT services, without complex face to face contract negotiations and manual work to integrate services. This will enable businesses to go from 'idea to product' in minimal time.

2.2.1 Involved Data & Users

Data

- **BT Services**

  BTs Current Web21C SDK[2] offers a variety of services for consumption as Web services including: SMS Messaging, Voice Calls, Conference Calls, Authentication, Automated Call Management, Calendar and Address book services. Over the duration of the project, more services will be made available and they will be included in the case study as they are released

- **Reseller Services**

  In S2 the reseller will build a complete service offering by using BT services and including additional functionality or OSS by combining with their own services. The services could potentially be anything depending on the business. The business may simply resell a simple BT service (such as VOIP), but include its own branding. In this case it would only need to add its own OSS services (such as billing and authentication). Alternatively the business may choose to incorporate a BT service into a more complicated offering, such as adding an SMS facility to an existing service.

[2] http://web21c.bt.com/

- **Third Party Services**

  The reseller may also choose to bring in third party services that are not owned by BT or itself. As with S1, third party services can be described semantically and brought into the system.

- **Ontologies**

  Ontologies and semantic descriptions will form the basis for data and process, and service representation in SOA4All. Where possible the case study will aim to use established ontologies and data models.

  An important set of standards for Telecommunications are called NGOSS (Next Generation Operations Systems and Software) an industry-wide specification developed by the TeleManagement Forum[3] which purpose is to organize and guide the design and development of next generation operation systems in Telco domain. It contains a set of frameworks, high-level architecture and methodology. There is a detailed description of the NGOSS specification in Annex A, section 5.3. This includes description of work carried out in previous EU projects to create ontologies based on NGOSS. There are other important standards relating to the Services that BT offer, such as ParlayX and SIP, and where appropriate WP8 will use these standards.

Users

The survey conducted on current SDK users revealed that approximately 40% are in the group targeted by S2. Their main motivation for using the SDK is for a business interest, to either resell BTs services directly, or incorporate into another business offering. These users have different needs than that of the casual users targeting in S1. From the perspective of the end customer it is not BT who is providing the service, but the reseller. This means the reseller requires BT to provide a reliable service, and needs a higher degree of management and accountability for services. In addition, the end customer will not be paying BT directly for use of the services; the reseller will be responsible for the relationship with the end user.

2.2.2 Scenario Description

The scenario description below gives an example of the sequence of steps that will be taken to design a new 'business reseller' application. In this case, the example of a VOIP application is given, but in practice, the sequence of steps taken will be similar in any application that is created

1. User logs onto system and chooses to create new VOIP application using BT SDK VOIP services.

[3] http://www.tmforum.org

2. User wished to integrate VOIP service with its own Billing and Authentication services

3. The User selects the 'Web Service mark-up wizard' and enters the endpoint of its Billing and Authentication services.

4. The system parses the Web Service definitions and presents user with options to mark-up the services semantically.

5. The User selects an industry standard Telco ontology, from available ontologies and begins process of linking concepts to the data in the Web Services. Where syntactic matches are found, the system offers suggestions for mark-up.

6. When mark-up is complete, the services added to the user's private pool of available services in the SOA4All platform.

7. The user begins the process of creating a new 'business class' composition (selecting the appropriate context parameters), and selects the VOIP service as the primary service from BT.

8. The users selects that he wishes for a service level agreement (SLA) to be attached to this service. He is presented with a number of SLA parameters (such as minimum downtime), from which he can choose the correct level required. The system stores these context parameters for the SLA.

9. From the starting VOIP service the user begins to build up a composition using his own billing and authentication services.

10. The system helps user to 'wire' service into composition, by offering matches to input and outputs (or possibly via some mediation service), or plug-in GUI component to enable input of information

11. Where system cannot help, the user may have to manually work out wiring between services. These are captured by the system for re-use in future compositions. interaction with web 2.0 community

12. When the composition is complete, it is invoked. A monitoring tool oversees the execution, and ensures that the SLA conditions are not breached. If a particular SLA parameter is breached, then depending on the 'context' a particular action will be taken (such as sending an error report BT)

2.2.3 Business requirements

At the business level, S2 will address a number of issues described below. These are in addition to the business requirements detailed for S1, in section 2.1.3:

- **Rapid Assembly of Products and Services**

  A big challenge for BT is to reduce time to market for new products and services in the highly competitive Telco and ISP business. SOA4All technology offers the opportunity to build working products from a number of services quickly, with the associated management and OSS infrastructure.

- **Managing Quality of Service (QoS) and Service Level Agreements (SLAs) in composed services**

  SLAs and QoS are an important consideration for businesses, as they need some levels of guarantee about services they are paying for. Defining and managing SLAs in a disturbed SOA infrastructure on the web is an important consideration, and needs to be addressed in this scenario.

- **Increasing the use of ontologies and semantic technology in the Telco sector & understanding relationship between ontologies and other Telco models/standards**

  There are a number of standard models in telecommunications for data and processes, but the uptake of semantic technology and ontologies in the Telco industry is still relatively small. BT is a supporter of semantic technology in the Telco sector, and S2 will address the requirement for greater adoption of semantic standards by demonstrating the advantages they bring in service composition and management.

2.2.4 Functional Requirements

S2.R1 Monitoring of process state and Quality of Services (QoS) for service compositions

In S2 there is the necessity to give some level of guarantees to end customers about the Quality of Service they can expect, which is detailed in a service level agreement (SLA). There is therefore the requirement to monitor service executions and assess the QoS (such as response time) of services, in order to ensure they meet SLA.

Technical Area: Service Deployment and Use (WP2)

Relevant Tasks: T2.3

S2.R2 Fault handling of Service Failures and Error reporting

Unlike S1 where services will be of a non critical nature, in S2 there will be business critical services that will need a suitable level of fault handling and error management for service compositions. If a particular service in a composition fails, it will be necessary to record this and understand if any corrective action needs to be undertaken (such as roll back, or service replacement).

Technical Area: Service Deployment and Use (WP2)

Relevant Tasks: T2.3

S2.R3 Import and link to Industry standard ontologies

The telecommunications industry has a number of standardised models and ontologies that it will be necessary to use when describing services semantically and linking to other services. There is a requirement that industry standard ontologies described in OWL or RDF can be imported and used within the SOA4All platform.

Technical Area: Service Deployment and Use (WP2), Service Annotations and Reasoning (WP3) Service Construction (WP6)

Relevant Tasks : T2.1, T3.1, T3.2 T6.1, T6.2

S2.R4 Import and mark-up third party Web Services

In S2 business resellers will use a combination of BT services (such as VOIP or SMS) and their own services (such as billing) to create a final product. This will require that they can bring their own services into the system, and if necessary mark them up semantically to build a product by composing them with BT services. The requirement is to have the facility to import and mark-up the services in a GUI based environment that is intuitive and easy to use.

Technical Area: Service Deployment and Use (WP2), Service Annotations and Reasoning (WP3) Service Construction (WP6)

Relevant Tasks: T2.1, T3.1, T3.2 T6.1, T6.2

2.2.5 Role for SOA4All technology

The following table shows which SOA4All work packages will be used in the course of S1. The following symbols indicate the usage:

	**Yes** Work package outcome will heavily be used
	**Partly/Maybe** Work package outcome will partly be applied depending on the actual progress of implementation
	**No** Work package outcome will not be used directly within this scenario

Table 2. Role for SOA4All Technology in Scenario 2

WP	Task	Deliverable / Prototype	Use
WP1	T1.2	D1.2.2 - WSMO Data Grounding Tool	
Service Web Architecture	T1.3	D1.3.3 - Distributed Semantic Spaces: A Scalable Approach To Coordination	
	T1.4	D1.4.4 - SOA4All API V2 (service bus)	
WP2	T2.1	D2.1.6 - Provisioning Platform Prototype	
Service Deployment and Use	T2.1	D2.1.7 - Service Modelling Tools Prototype	
	T2.2	D2.2.3 - Consumption Platform Prototype	
	T2.3	D2.3.3 - Monitoring & Management Tool Suite Platform Prototype	
WP3	T3.2	D3.2.5 - Repository Reasoner for WSML	
Service Annotations and Reasoning	T3.2	D3.2.6 - Rule Reasoner for WSML	
	T3.2	D3.2.7 - Description Logic Reasoner for WSML	
	T3.3	D3.3.2 - Established Ontology Tag Clouds	
WP4	T4.2	D4.2.2 - Service Context Ontology Stack	
Service in Context	T4.3	D4.3.2 - Contextual Ontology Repository	
	T4.4	D4.4.1 - Service Parameterization From Context Mechanism	
	T4.5	D4.5.2 - Mechanisms For The Acquisition Of Service Context From Social Networks	
WP5	T5.3	D5.3.2 - Service Discovery Prototype	
Service Location	T5.4	D5.4.1 - Service Selection And Ranking Prototype	
	T5.5	D5.5.2 - Service Adaptation Prototype	

WP6 **Service Constructions**	T6.1, T6.2	D6.2.2 - Prototypes, Tool Integration (containing the integration of the two advanced prototypes of both Lightweight and Adaptive service composition)	

2.3 Context

The context framework provided in SOA4All (WP4) will be used in the case study, in both a design time and run time capacity. At design time, context will be used to assist the selection of services when building a composition. Services will be ranked according to their relevance to the particular context the user has selected. Runtime context adaptation will allow the actions to be taken based on the contextual information received during the execution of services. This may shape the particular sequence of services in a composition, or cause a running services to be terminated

There are a number of context parameters applicable for both design time and runtime situations. There are likely to be further context parameters realised as the case study progresses, and this list will be updated accordingly.

Table 3. Context Parameters in Case Study

Context	**Use**	**Design Time**	**Run Time**
Location	The geographical location of a user has an impact on decisions of service selection, especially for telephony where there are there may be variations in price.	Selection of best-priced telephony services for current location	Routing of calls e.g. If not in home country try to route via VOIP, rather than standard PSTN
Role	(i.e. business, pleasure) for selection of appropriate services and setting QoS of call e.g. you want higher QoS on a business call	Design of 'business class' services, i.e. select services that have a guaranteed QoS	Monitoring and fallback. e.g. for a non business call if the connection fails then do nothing, for a business call log an error report, and try to find a replacement service
Time	Different tariffs depending on peak/off peak		Select best telephony service at runtime depending on price
Presence	Route call appropriately depending on presence		When attempting to contact a person, different actions can be taken depending on

			the users presence e.g In the office – Ring them directly In a meeting – Forward to voicemail Away on leave – leave an email

2.4 Table Summarising Requirements

Table 4. Table Summarising Requirements

Requirement ID	Description	Key Technologies	Tasks
S1.R1	Usable without detailed knowledge of Ontologies, WSDL or programming languages	Service Deployment and Use (WP2), Service Construction (WP6)	T2.1, T2.2, T6.1, T6.2
S1.R2	Web Browser Based, Drag and drop, easy to use interface	Service Deployment and Use (WP2)	T2.1, T2.2
S1.R3	Search on functional and non-functional aspects of service, and keywords	Service Annotations and Reasoning (WP3), Service Location (WP5)	T3.1, T3.2, T5.3, T5.4, T5.5
S1.R4	Service ranking and help with design time selections based on user context	Service in Context (WP4), Service Location (WP5)	T2.1, T2.2, T6.1, T6.2
S1.R5	Suggestions for compatible services in a web service compositions	Service Deployment and Use (WP2), Service Construction (WP6)	T2.1, T2.2, T6.1, T6.2

S1.R6	Automated or semi automated assistance with linking services in composition	Service Constructions (WP6)	T6.1, T6.2
S1.R7	Link GUI to web service compositions	Service Deployment and Use (WP2), Service Construction (WP6)	T2.1, T2.2, T6.1, T6.2
S1.R8	Export/share composition with other users	Service Deployment and Use (WP2), Service Construction (WP6)	T2.1, T2.2, T6.1, T6.2
S2.R1	Monitoring of process state and Quality of Services (QoS) for service compositions	Service Deployment and Use (WP2)	T2.3
S2.R2	Fault handling of Service Failures and Error reporting	Service Deployment and Use (WP2)	T2.3
S2.R3	Import and link to Industry standard ontologies	Service Deployment and Use (WP2), Service Annotations and Reasoning (WP3) Service Construction (WP6)	T2.1, T3.1, T3.2 T6.1, T6.2
S2.R4	Import and mark-up third party Web Services	Service Deployment and Use (WP2), Service Annotations and Reasoning (WP3) Service Construction (WP6)	T2.1, T3.1, T3.2 T6.1, T6.2

3. Conclusions

We presented business as well as technical requirements that have been derived from this scenario, in particular with respect to the technologies that will be developed in the technical work packages of SOA4All. Future work in this WP will be the design (Task 8.2), implementation (Tasks 8.4 8.6), and continuous evaluation (Task 8.7) of the prototype.

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4. Annex A. State of the Art

4.1 Introduction

This section, whilst not forming part of the main deliverable on requirements has been included to give background and state of the art of some areas relevant to the case study. A key pillar of the SOA4All project is the use of Semantic Technology, such as ontologies and reasoning as a means representing data in a structured and machine processable form. BT along with other partners in WP8 (OU and ISOCO and UNIMAN) have been directly involved in previous work looking at the Semantic Web and its application in Telecommunications domain. Section 5 aims to give a background to some of the relevant projects that have been undertaken (and are still ongoing), as well as some result of these project that will be used in WP8. One important result is the development of ontologies from the Telecommunication Standards NGOSS. The NGOSS standards have been widely accepted, and as part of the results of the SUPER project ontologies were developed based on these. The NGOSS ontologies will be used in WP8, and will aim to help with their adoption in the Telco industry. More detail is given in Section 5.5

4.2 Research Projects

Computer science is entering a new generation. The emerging generation starts by abstracting from software and sees all resources as services in a service-oriented architecture (SOA). In a world of services, it is the service that counts for a customer and not the software or hardware components, which implement the service. Service-oriented architectures are rapidly becoming the dominants computing paradigm. However, current SOA solutions are still restricted in their application context to being in-house solutions of companies. A service Web will have billions of services. While service orientation is widely acknowledged for its potential to revolutionize the world of computing by abstracting from the underlying hardware and software layers, its success depends on resolving a number of fundamental challenges that SOA does not address today.

SOA4All will help to realize a world where billions of parties are exposing and consuming services via advanced Web technology.

The outcome of the project will be a comprehensive framework and infrastructure that integrates four complimentary and revolutionary technical advances into a coherent and domain independent service delivery platform:

- Web principles and technology as the underlying infrastructure for the integration of services at a worldwide scale.
- Web 2.0 as a means to structure human-machine cooperation in an efficient and cost-effective manner.
- Semantic Web technology as a means to abstract from syntax to semantics as required for meaningful service discovery.
- Context management as a way to process in a machine understandable way user needs that facilitates the customization of existing services for the needs of users.

Next, we mention a number of European research projects that include any of the aforementioned technical advances.

The DIP[4] Project

One bottleneck in conducting Internet based business is the integration of the underlying ICT (Information and Communication Technology) systems. This integration problem is exacerbated by the fact that large enterprises typically contain tens of thousands of databases each with its own internal structure. The Integrated Project DIP is working in this context. DIP tackles the integration of business services through a combination of Semantic Web and Web Service technologies.

The Semantic Web is an extension of the current Web, which is readable by machines facilitating the delegation of certain classes of task to intelligent computer agents. Web Services are computer programs, which can be invoked over the Internet using standard protocols. More importantly Web Services can act as proxies for business services.

Although Web Services have led to a dramatic increase in the amount of business that is conducted online, considerable human effort is still required to find and configure a set suitable of Web Services into a single coherent business software system.

With the goal of decreasing such an effort, DIP provides a platform for semantically describing Web Services, in which many of the steps involved in application development are automated. Additionally, the DIP architecture enables the construction of brokers able to mediate between the goals of a client or consumer and the capabilities provided by online services.

The Semantic Web Services Architecture provided by DIP is called WSMX[5] (Web Service Modelling eXecution environment), which is the reference implementation of WSMO (Web Service Modelling Ontology), and is open source. WSMX is an execution environment for business application integration where enhanced web services are integrated for various business applications. The aim of this architecture is to increase business processes automation in a very flexible manner while providing scalable integration solutions.

Within the project, the produced technologies were tested in three real world case studies in different areas:

- Telecommunication Area: facilitating B2B (business-to-business) integration across ISP partners, and supporting the management of product catalogues. DIP project provides service bundling and service reselling through dynamic supply chains. The challenges in these areas include data mediation, product catalogue compilation, billing and self-service service configuration and QoS (Quality of Service) management.
- eBanking Area: supporting online mortgage application and stock brokering In the eBanking area, the marketplace has at the centre of its focus the issue of customer retention and, like the telecoms sector, is exploring the techniques of service bundling and dynamic supply chains to deliver novelty to attract new customers. However, like the eGovernment area there are compliance, identity management and security issues that must be robustly solved. DIP project offers the individual private share trader a level of service previously unknown in the personal banking sector.

[4] http://dip.semanticweb.org

[5] http://www.wsmx.org

- eGovernment Area: providing a single citizen portal which dynamically integrates services across three tiers of government, and supporting emergency planning through online context aware maps. In the eGovernment area, issues of concern include a demand for services to be made available on line, with improved workflow and reduced manual intervention; but all of this should be delivered at no-to-low risk and at no extra cost to the existing (small) IT budget. Within this sector, there are many cultural barriers to change as well as organisational inertia. Beyond these normal soft issues lay some really difficult additional soft problems related to client privacy, data protection and legal/regulatory aspects of service delivery. The DIP approach can support a level of service delivery previously unattainable.

In summary, through Semantic Web Services DIP offers the possibility to provide interoperable and seamless information exchange between heterogeneous business systems.

The SUPER[6] Project

Business Process Management (BPM) emerged as a domain in the research and business community, to address areas where the old Business Process Reengineering paradigm failed. BPM focuses on managing the execution of IT-supported business operations from a business expert's process view rather than from a technical perspective. The underlying motivation for BPM is that organizations need to continuously align their running business processes, as executed within multiple heterogeneous systems, with the required processes as derived from business needs. In this context, the Integrated Project SUPER aims to create the technological framework for BPM, enriched with machine readable semantics by employing Semantic Web and Semantic Web Services.

Thus, the main goal of SUPER is to raise BPM to the business level, where it belongs, from the IT level where it mostly resides now. This goal requires that BPM is accessible at the level of semantics of business experts. For achieving this goal SUPER intents to use Semantic Web and, in particular, Semantic Web Services (SWS) technology, which offer the possibility of integrating applications at the semantic level.

Therefore SUPER aims at providing a semantic-based and context-aware framework, based on Semantic Web Services technology that acquires, organises, shares and uses the knowledge embedded in business processes within existing IT systems and software, and within employees' heads, in order to make companies more adaptive.

SUPER approach is testing in large-volume applications in the telecommunication industry. And in this sense, by combining SWS and BPM, and developing one consolidated technology SUPER will create horizontal ontologies which describe business processes and vertical telecommunications oriented ontologies to support domain-specific annotation.

The INFRAWEBS[7] Project

[6] http://www.ip-super.org

[7] http://www.infrawebs.org

Web services are used in a wide range of applications, but their usefulness is limited by a lack of effective means for different types of web services to work together. Existing software tools and systems are mostly incoherent and "static", usually due to proprietary aspects or features that prevent information from being exchanged effectively. As a result, existing development and networking platforms are missing important features such as re-configurability, adaptability and self-organisation. This step from static to dynamic web services requires the use of semantic technologies, so as to structure information sources and domains in a way that can be processed by machines. This, in turn, requires a bridging between web service and Semantic Web (SW) technologies in order to implement semantically-rich service descriptions.

To build such a bridge, the Infrawebs project has as main goal the development of an application-oriented software toolset for creating, maintaining and executing Semantic Web Services (SWS), based on WSMO, within their whole life cycle. These SWS offer a new dimension in collaborative work and service production, service provision and service maintenance in run-time environments.

Infrawebs approach is a novel one to problem solving in the creation of SWS applications that involves a tight integration of similarity-based (non-semantic) and logic-based (semantic) reasoning.

The SLA@SOI[8] Project

The ongoing transformation of a product-oriented economy towards a service-oriented economy has come to a critical point. IT-supported service provisioning has become of major relevance in all industries and domains. However, the nature of these setups is typically quite static because it requires significant effort to create service offers, to negotiate provisioning details with customers and to manage and control provided services.

The research project SLA@SOI will provide a major milestone for the further evolution towards a service-oriented economy, where IT-based services can be flexibly traded as economic goods, i.e. under well defined and dependable conditions and with clearly associated costs. Eventually, this will allow for dynamic value networks that can be flexibly instantiated, thus driving innovation and competitiveness.

SLA@SOI is an Integrated Project researching the systematic management of service-oriented infrastructures on the basis of formally specified service level agreements (SLAs).

The technical approach of SLA@SOI is to define a holistic view for the management of service level agreements (SLAs) and to implement an SLA management framework that can be easily integrated into a service-oriented infrastructure (SOI). SLA@SOI will provide 3 major benefits to the provisioning of services: (1) predictability and dependability, (2) transparent SLA management, and (3) automation.

SLA@SOI approach will be tested in industrial use cases that include scenarios from hosted Enterprise Resource Planning systems, Enterprise IT management, and service aggregation in telecommunication, eGovernment and Finance Industries.

[8] http://www.sla-at-soi.eu

The SHAPE[9] Project

Modelling is now an integral part of software engineering approaches. Business process models are ideally used to describe how work is done within an organization, while various product models describe what is done. Various approaches based on model-driven engineering (MDE) concepts, such as the OMG MDA (Model Driven Architecture) and related efforts around domain-specific languages have gained much popularity.

The SHAPE project aims to support the development and realization of enterprise systems based on a Semantically-enabled Heterogeneous service Architecture (SHA)**.** SHA extends Service Oriented Architectures (SOA) with semantics and heterogeneous infrastructures (Web services, Agents, Semantic Web Services, P2P and Grid) under a unified service oriented approach. To achieve this, the consortium of the SHAPE project will develop a Model-Driven Engineering (MDE) tool-supported methodology and will take an active role in the standardization of metamodels and languages for SHA.

The main challenges addressed by the SHAPE project are:

- How to map the flow of business logic and data to services and functionality in a platform independent way?
- How to integrate the various models of processes, requirements, services and functions in a common model that can also be adopted by individual projects and their implementation environment?
- How to manage such models and provide links between them that can be used for service composition or managing changes?

The SHAPE project will promote a new development paradigm with a higher degree of involvement of joint users and development communities through minimising the gap between business and system modelling, in particular by lifting the system specification models to a higher platform independent level.

The Service Web 3.0[10] Project

Even after four decades of rapid advances, computing is currently subject to revolutionary changes at all levels, including hardware, middleware, network infrastructure, but more importantly intelligent applications. Emerging technologies such as the Semantic Web or Web Services transform the Internet from a network of information to a network of knowledge and services. The number of services which will be offered on the Internet is expected to rise dramatically in the next few years.

It is the mission of Service Web 3.0 to address these emerging developments and contribute to the implementation of framework programmes and their projects, and support the preparation of future community research and technological development.

[9] http://www.shape-project.eu

[10] http://www.serviceweb30.eu/cms

The focus of Service Web 3.0 will be to:

- Create, maintain, and publish roadmaps as a means to plan and coordinate framework and community activities for a future service world
- Set-up of dedicated cross-project clusters focusing on Semantic Web Services within STI International
- Provide information material such as white papers, feasibility studies, promotional movies for raising the awareness for the technology in industry, introducing new business models and systematically facilitating Semantic Web Services and Semantic Web technology adoption, in particular for SMEs
- Support standardization activities for semantic service descriptions
- Exploit synergies through networking and cross-fertilization with other research and network projects related to this area
- Organize special focused conferences and seminars

Service Web 3.0 will pave the way to realize a world where billions of parties are exposing and consuming services via advanced Web technology.

The ACTIVE[11] Project

Europe is in transition to a knowledge economy. Effective knowledge management is fundamental to successful economic activity, yet enterprises find it hard to transform much of their essential knowledge into transferable, easily accessible, and actionable knowledge assets. Such hidden knowledge is typically held by individual knowledge workers, being either tacit (unarticulated) or explicit but not widely available (e.g. emails, personal desktop files).
ACTIVE aims to increase the productivity of knowledge workers in a pro-active, contextualised, yet easy and unobtrusive way. The aim is to convert tacit and unshared knowledge – the "hidden intelligence" of enterprises – into transferable, interoperable and actionable knowledge to support seamless collaboration and to enable problem solving. A key aspect will be support for informal procedural knowledge - the informal collaboration and problem-solving tasks that drive much knowledge work in the enterprise. ACTIVE will integrate concepts, methods and tools from the fields of (i) Social Software and Web 2.0, (ii) Semantic Technologies, (iii) Context Mining, Context Modelling, and Context Sensitive Task Management, and (iv) Knowledge Process Mining, Knowledge Process Modelling and Pro-Active Knowledge Process Support into highly innovative application systems. The development will be accompanied by an analysis of key economic and organizational factors and incentive mechanisms, and strongly user-centric system development and evaluation.

The key result of ACTIVE will be a breakthrough that empowers enterprises to make knowledge technology effective for a much larger share of their essential knowledge. ACTIVE will generate sustainable impact by deploying the tools and applications in three industry sectors: consulting, telecommunication and engineering (“ACTIVE technology”). The added value of ACTIVE technology will be evaluated in economic, organizational, and user studies, which conclude with rigorous field tests. A major focus of ACTIVE will be uptake by

[11] http://www.active-project.eu

industry beyond the immediate consortium.

4.3 State of the Art in Ontologies for the Telco Domain

SID, eTOM and TAM ontologies capture telecommunication sector knowledge from NGOSS's standards. SID model contains domain concepts related to market, product portfolio, customer, services, resources, the enterprise and supplier/partner, as well as common business terms called Core Business Entities (CBE), which are captured in the CBE Ontology (CBEO). eTOM map defines a set of functional areas which serves as a reference classification for the business goals a process fulfills, which are captured in the business goals ontologies (BGO) **Error! Reference source not found.**. TAM map defines the typical IT systems map of telecommunication companies, and serves as a reference classification for a company's services map.

4.3.1 SID

4.3.1.1 Functional Overview **Error! Reference source not found.**

From CRM and Billing to Networks and Elements, the SID delivers the data definitions to support the complete range of business information in the modern, agile service provider's business. Service providers today are automating their operations by engineering streamlined business processes using another element of NGOSS[12] – the eTOM. In order to be consistent with this business process approach, the SID information definitions are linked directly to the eTOM process definitions.

The adoption of the SID as the industry's standard information model is growing rapidly, with many service providers, system vendors, equipment vendors and systems integrators using the SID as the basis for their development and integration. And the influence is widening as the principles are adopted by other industry forums through our industry liaison program.

The SID model focuses on what are called "business entity" (**Error! Reference source not found.**) definitions and associated attribute definitions. A business entity is a thing of interest to the business such as customer, product, service, or network, while its attributes are facts that further describe the entity. Together, the definitions provide a business-oriented perspective of the information and data that you need to run your organization.

To classify the data in a usable fashion, the SID is designed as a layered framework, which partitions the shared information and data into eight domains.

[12] http://www.tmforum.org/BestPracticesStandards/NGOSS/1911/Home.html

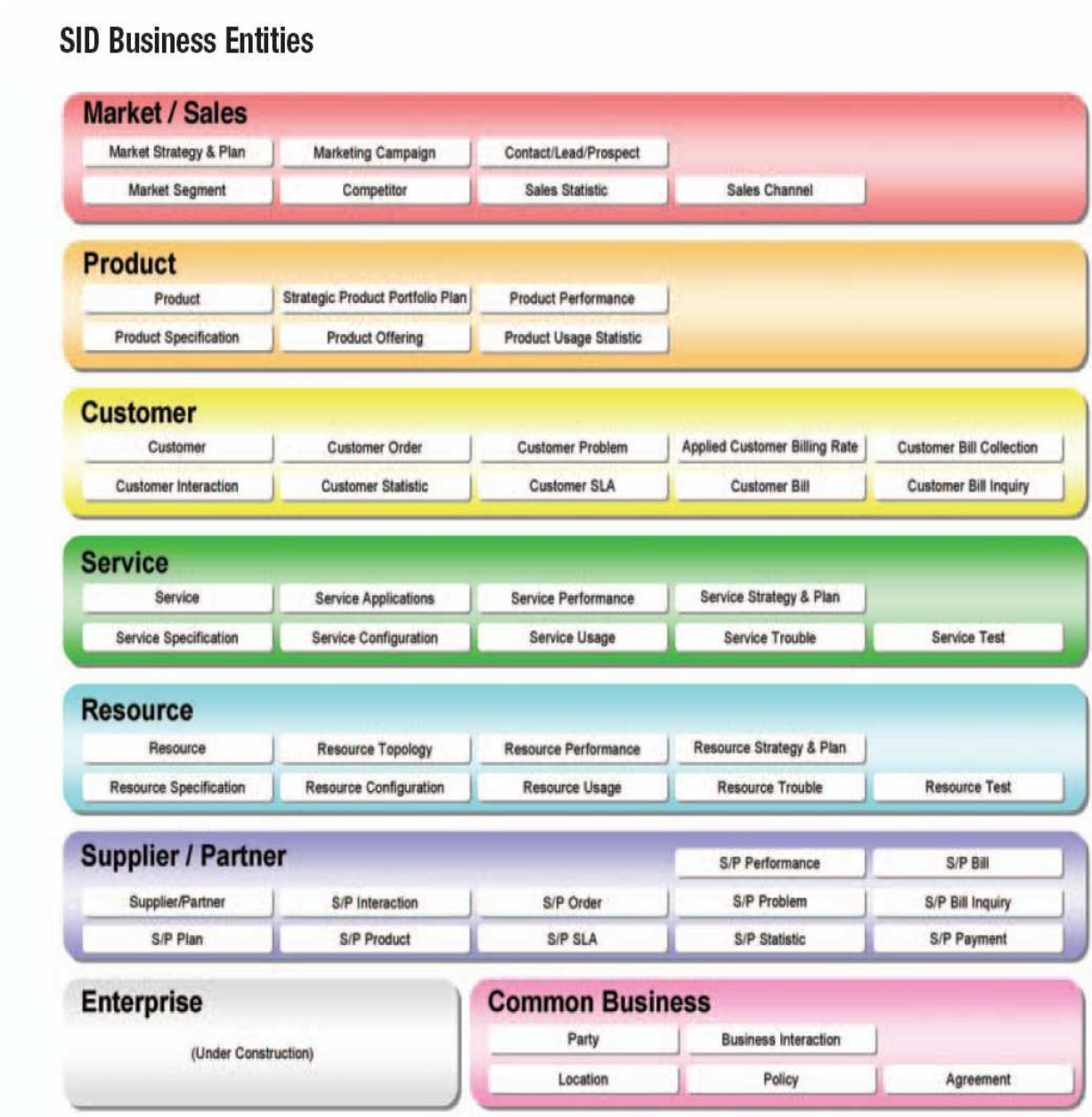

Figure 2. SID Business Entities

At the top layer, each of the eight SID domains is aligned with the eTOM business process framework. Within each domain there is a high degree of cohesion between the business entities, and between the domains, there is a loose coupling. This arrangement enables segmentation of the total business problem into manageable pieces and allows resources to be focused on a particular area of interest. In other words, for a particular eTOM business process that you are automating, you can identify the shared information and data that is needed to support that process.

Within each SID domain, multiple “Aggregate Business Entities” (ABEs) are defined. ABEs are the containers for a series of business entities related to their respective areas. Each business entity contains finer-grained business entities and their associated attributes. Using

this layered approach, the large universe of information is packaged into understandable, usable pieces.

4.3.1.2 Ontology Overview

This ontology development follows a relative unusual way, because the entire domain has already been captured by the TMF[13]. This information is gathered in several forms: a set of PDF documents describing each object in a semi-formal form and a Rational Rose model that captures the domain in a formal way (UML diagrams).

After having made some modelling decisions, it was possible to generate the content of the ontology from these UML sources. It was thought that generating the ontology automatically was an important direction because of two reasons:

- It creates an easy way to generate the SID ontology when a new version of SID will appear.
- It avoids adding human errors by introducing data by hand.

This task is not easy since the appropriate tools are still not available. The generation consists of several sequential steps of transformation between various modelling formats.

It was provided a set of experiments in order to find the optimal way of automatic generation of SID ontology from TM Forum UML model.

First simple generation produced a relative poor version with the main disadvantage that it lacked many extractable relations. However, the concept list and attributes were well generated and despite that some manual work that could be done, this version contains a good base for an ontology.

The second generation fixed this lacks of relation problem. But had two critical problems: the tool generated one file for each UML package and the OWL files generated contained specific OWL properties that could not been converted to WSML.

The decision was made to stay on the first generation and to do this manual work. By doing this semi-automatic solution, it was discarded the possibility to generate easily a new version of SID. However, we still avoid a lot of human errors possibilities, since the main part of SID was generated automatically **Error! Reference source not found.**.

The SID ontology development was focused on two things: hierarchy of concepts, which, on the one hand, should be clear and on the other hand, should be aligned as precisely as possible with the hierarchy of SID classes in the UML model. This is not always possible looking at the level of complexity of SID model. We must remember that it is a model which is continuously being developed and thus undergoes constant change.

The information that should be kept is also the grouping of SID entities into packages which has logical meaning, but is not coherent with the hierarchy of classes. This classification should be important for reasoning and therefore it is advisable to keep this information in the SID ontology. The two ideas to consider: representing packages by instances which has only non-Functional meaning (strictly informative for ontology engineers), representing packages by concepts which allows impressing the hierarchy of packages.

[13] http://www.tmforum.org/browse.aspx

4.3.2 eTom

4.3.2.1 Functional Overview **Error! Reference source not found.**

The telecom industry is up against unprecedented challenges in the face of more competition, higher customer expectations, falling market share and growing price pressures, all while networks and services are converging.

The industry has a need to clearly define and understand the business processes involved with running a telecom business in a competitive environment in order to be profitable.

The Enhanced Telecom Operations Map (widely known as eTOM) is an ongoing TM Forum initiative to deliver a business process framework for use by service providers and their suppliers within the telecommunications industry. The eTOM sets a vision for the industry to enable it to compete successfully through the implementation of business process-driven approaches to managing the telecom enterprise. This includes ensuring integration among all vital OSS/BSS systems that deliver and support services to customers.

The eTOM is a reference framework for categorizing all the business activities that a service provider uses in a structured manner, and it addresses them at various levels of detail. The focus of the eTOM is on the business processes, the linkages between these processes, the identification of interfaces, and the use of customer, service, resource, supplier/partner and other information by multiple processes. It also drives requirements from this business view throughout the NGOSS development cycle.

Using eTOM, the value, cost and performance of individual processes within an organization can be assessed in a systematic fashion. The eTOM Business Process Framework can be used as a tool for analyzing existing processes and for developing new processes. Different processes delivering the same business functionality can be identified, duplication eliminated, gaps revealed, new process design speeded up, and variance reduced.

The eTOM facilitates relationships with suppliers and partners by identifying and categorizing the processes used in business-to-business interactions. In a similar manner, the all important customer relationship processes can be identified and evaluated for whether they are meeting customers' expectations.

The eTOM defines a business-oriented view of the service provider's enterprise. This view is useful for planners, managers, and strategists who need to view the enterprise in business terms, without immediate concern for how these business needs are organized or automated within the business. The eTOM emphasizes process structure, process components, process interactivity and the business roles and responsibilities to which these relate. As such, the eTOM provides a basis for setting requirements for system solutions, technical architectures, technology choices and implementation paths.

The eTOM represents an industry-consensus on the service provider processes based on many years of effort through TM Forum member contributions. In using the eTOM, this consensus view will typically be tailored and/or extended for use within an individual company.

The eTOM defines business processes through a hierarchical process decomposition that begins at the overall Enterprise level (Level 0), and captures process descriptions, inputs and outputs, as well as other key elements for each process at each subsequent level (Level 1. 2, etc). The eTOM process modelling includes Level 1 views of functionality that span horizontally across an enterprise's internal organization. For example, managing customer relationships spans an enterprise from marketing to ordering to billing to after-service support and follow-on sales. The eTOM framework also groups processes in a vertical “swim lane” Level view that drives end-to-end process and process flow-through between the customer and the supporting services, resources and supplier/partners.
The eTOM Level 0 and Level 1 process areas are shown in **Error! Reference source not found.**. At the overall conceptual level, eTOM can be viewed as having the following three major (Level 0) process areas:

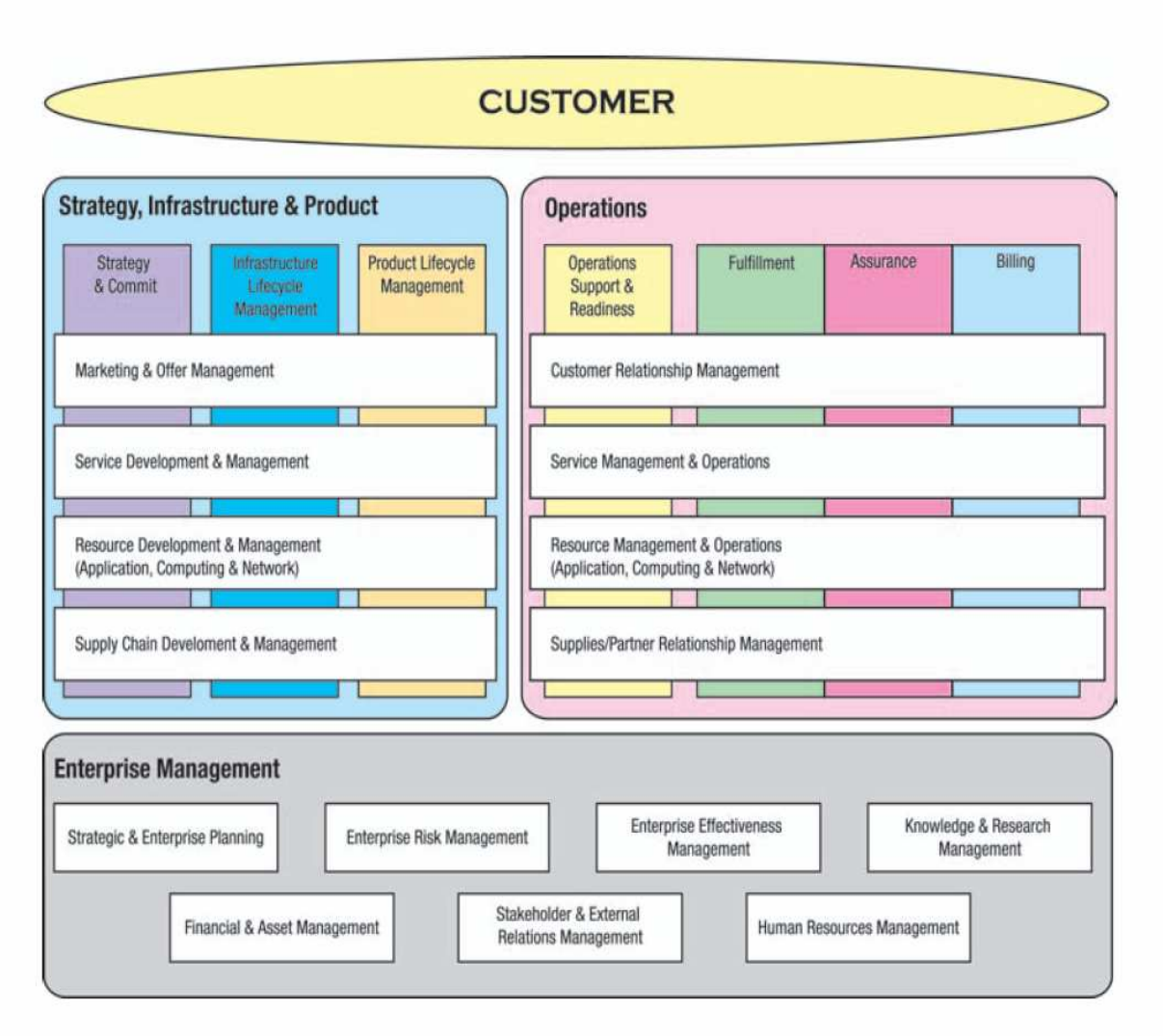

Figure 3. eTOM Levels View

The eTOM Framework contains seven end-to-end vertical Level 1 process groupings across OPS and SIP, representing the processes required to support customers and to manage the business.
The focal point of the eTOM is around the core customer operations processes of Fulfillment, Assurance and Billing (FAB) within OPS. Operations Support & Readiness (OSR) forms the fourth vertical grouping within OPS, and is differentiated from FAB real-time processes to focus on enabling support and automation of the FAB processes. The SIP process area contains more “back-office” processes that typically work on different business time cycles than the real-time Operations. The SIP processes enable, support and direct the work in OPS.
The eTOM also includes horizontal views of functionality across a service provider's organization, in OPS and SIP. These Level 1 horizontal functional process groupings gather together functionally-related processes, e.g., customer-facing processes such as Marketing, Selling, etc, within Customer Relationship Management.
Finally, EM is decomposed into seven Level 1 process groupings that represent the “corporate” processes common to most enterprises, like HR management, etc.

4.3.2.2 Ontology Overview

eTOM intends to be classifier of business functions. The BusinessFunction concept is in UPO ontology **Error! Reference source not found.** to allow business modellers to annotate their business processes, business goals, etc from a functional perspective. eTOMBusinessFunction is the upper concept of eTOM functional classification, and thus is linked to UPO, the same way another classification maps (standards or not) could be used for other domains extending this UPO concept.

eTOM is organized in levels from 0 (most abstract) to 3 (most concrete). These levels mark the hierarchy level of a business function. The eTOM map is also defined by two coordinates. An eTOM business function can be either a vertical business function, horizontal business function or none of them (the last ones are named neutral business functions). These coordinates are related but they have their own features, so they are modelled as different upper concepts of the ontology. eTOM upper concepts can be seen in **Error! Reference source not found.**.

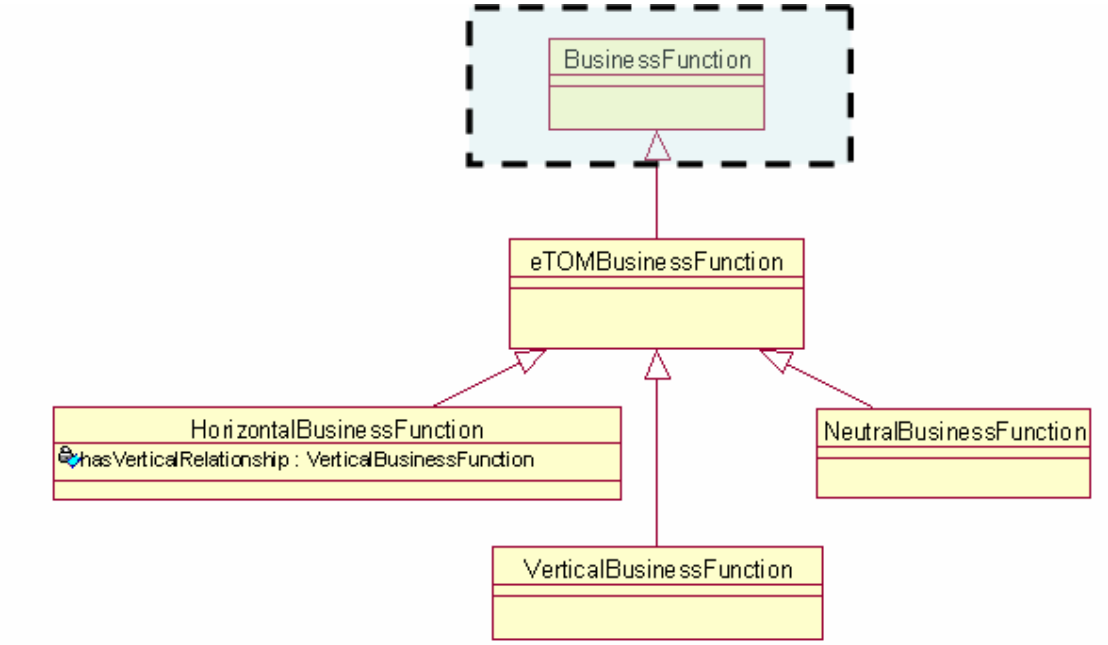

Figure 4. eTom Ontology Upper Concepts

Vertical business functions are addressed for end-to-end functionality between the enterprise and final customers. Vertical hierarchy is not so complex since there are not a lot of categories and only level 0 and 1 vertical areas exists in current versions (see **Error! Reference source not found.**).

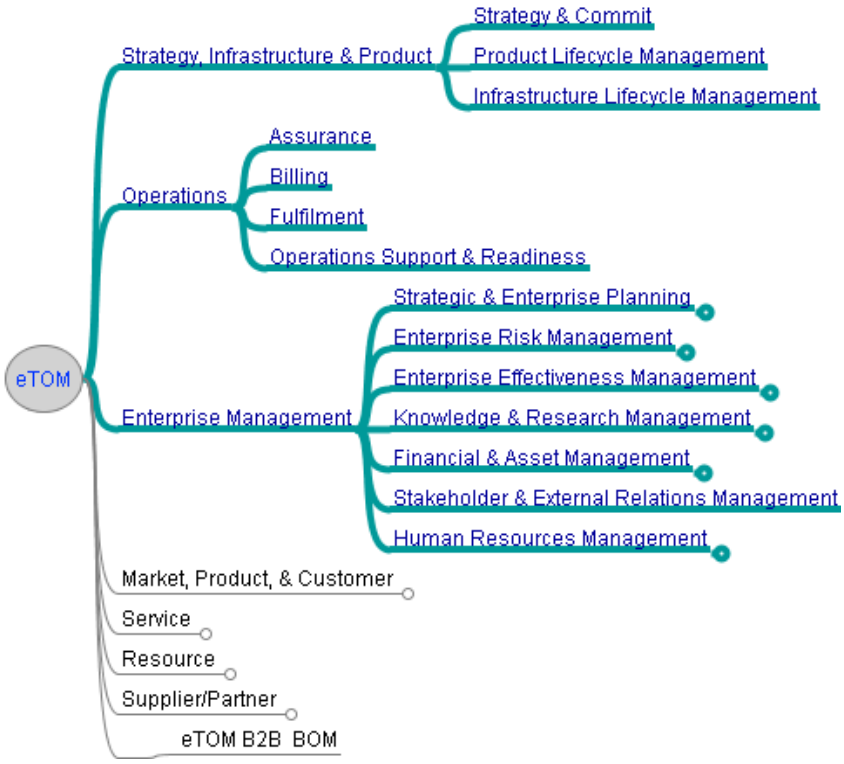

Figure 5. eTOM vertical hierarchy

The horizontal hierarchy is used to decompose eTOM business functions. It defines business functions which are transversally present in the end-to-end services development, relating horizontal business functions to vertical business functions (i.e.: Customer relationship management is related to Fulfillment, Assurance, Billing and Operations Support & Readiness vertical functions according to the standard definition). The horizontal hierarchy is much more complex, covering all eTOM levels. Levels up to 2 are depicted in **Error! Reference source not found.**.

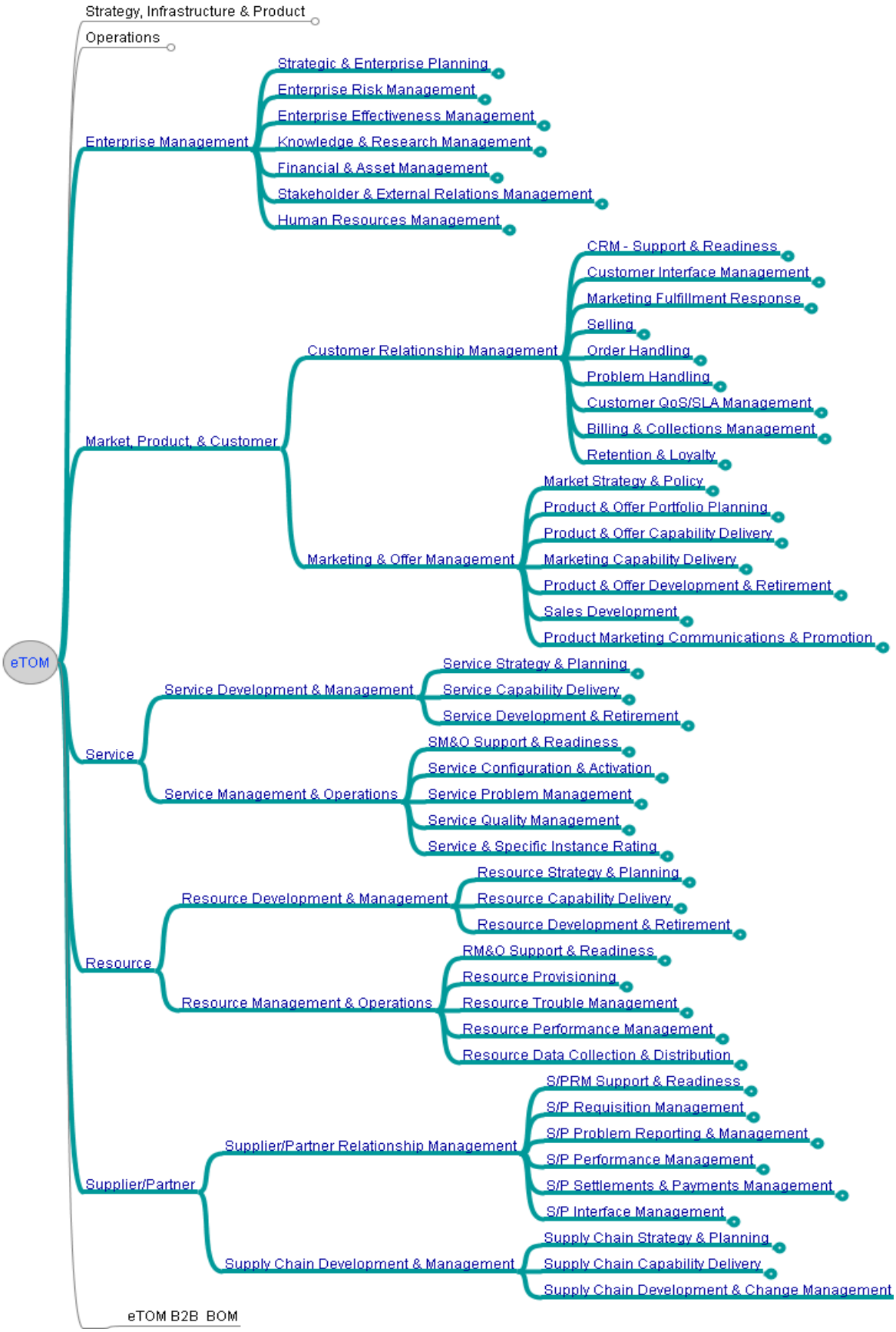
Strategy, Infrastructure & Product
Operations
Enterprise Management
Strategic & Enterprise Planning
Enterprise Risk Management
Enterprise Effectiveness Management
Knowledge & Research Management
Financial & Asset Management
Stakeholder & External Relations Management
Human Resources Management
Market, Product, & Customer
Customer Relationship Management
CRM - Support & Readiness
Customer Interface Management
Marketing Fulfillment Response
Selling
Order Handling
Problem Handling
Customer QoS/SLA Management
Billing & Collections Management
Retention & Loyalty
Marketing & Offer Management
Market Strategy & Policy
Product & Offer Portfolio Planning
Product & Offer Capability Delivery
Marketing Capability Delivery
Product & Offer Development & Retirement
Sales Development
Product Marketing Communications & Promotion
eTOM
Service
Service Development & Management
Service Strategy & Planning
Service Capability Delivery
Service Development & Retirement
Service Management & Operations
SM&O Support & Readiness
Service Configuration & Activation
Service Problem Management
Service Quality Management
Service & Specific Instance Rating
Resource
Resource Development & Management
Resource Strategy & Planning
Resource Capability Delivery
Resource Development & Retirement
Resource Management & Operations
RM&O Support & Readiness
Resource Provisioning
Resource Trouble Management
Resource Performance Management
Resource Data Collection & Distribution
Supplier/Partner
Supplier/Partner Relationship Management
S/PRM Support & Readiness
S/P Requisition Management
S/P Problem Reporting & Management
S/P Performance Management
S/P Settlements & Payments Management
S/P Interface Management
Supply Chain Development & Management
Supply Chain Strategy & Planning
Supply Chain Capability Delivery
Supply Chain Development & Change Management
eTOM B2B BOM

Figure 6.eTOM level 2 horizontal hierarchy

Neutral business functions refer to functionality within an enterprise which is intended to perform enterprise management functions. These are not related to end-to-end functionalities at all, so they can't be considered neither vertical nor horizontal business functions. However, neutral business functions maintain a hierarchical relationship according to eTOM level of each business function which has to be modelled in the same way vertical and horizontal functions are, and this hierarchy is modelled with the subConceptOf inheritance relationship between business functions, which are concepts in our eTOM ontology.

Business functions are modelled as concepts, and are sub concepts of either VerticalBusinessFunction or HorizontalBusinessFunction upper concepts. Horizontal business functions are related to vertical functions through the relationship hasVerticalRelationship. This relationship has been modelled from horizontal to vertical functions and not the opposite because i) it's the way eTOM is modelled and ii) categorization of horizontal areas is more fine-grained, what will help for searching since will provide a more discriminatory classification for business goals. Searching business goals will be the most important objective of the ontology.

All business functions have some non functional properties defined. The most relevant ones are:

1. The description of the functions.
2. The eTOM level, as defined in the standard. This is a number from 0 (most abstract) to 3 (most concrete).
3. The process identifier. If follows this convention: [level].[vertical coordinates initials](.[matrix coordinates]*). Where level is the eTOM level of the function. The vertical coordinate's initials identify which vertical group(s) the business function is related to, and matrix coordinates defines the coordinates inside the vertical group of the business function. The absence of coordinates means that it is related to the entire vertical group, the presence of one coordinate means it is related to a whole row in the matrix, while the presence of two specifies a concrete position within the matrix, and more than two would mean process decomposition beyond level 2.
4. UUID: Identifier of the business function defined by the TeleManagement Forum.

4.3.3 TAM

4.3.3.1 Funcional Overview **Error! Reference source not found.**

The TM Forum Telecom Applications Map (TAM) is the latest addition to the NGOSS family, adding a common language for OSS/BSS software components that are procurable as either applications or services. This in depth guidebook names and describes a set of applications, together with the data they act upon and the functions they perform. It provides the bridge between the NGOSS framework building blocks (the eTOM business process map and the SID shared information language) and real, deployable management applications.

There are a number of benefits to the industry in using a common Telecom Applications Map:

- Common Application Language**:** Having a common language for information exchange within the industry will result in reduced investment risks and costs through industry alignment. The procurement process will be made easier and less error

prone by using a common map and application definition, and component license costs will be reduced through higher reusability and lower custom development. As the TAM is adopted by the industry, the market for suppliers based on operators procuring from the standard applications model will grow.

- Systems Rationalization**:** In the process of streamlining operations, often service providers find that they have multiple systems that handle similar functions. The TAM provides a effective tool for mapping existing OSS/BSS environments and determining where overlaps and gaps exist.
- Standard Application Requirements**:** A key deliverable of the TAM is an industry set of standard application requirements that will enable the development of reusable components leading to a more modular approach to application development. This reuse will result in lower costs through economies of scale. Similarly, the component approach will encourage the adoption and development of standard interfaces between components which will again reduce development costs.
- Enable Automation**:** The standard, deployable components that result from the adoption of the TAM will enable a higher degree of automation within the service providers' businesses which will in turn reduce human errors and improve operational efficiency. With solutions based on a standard application map, it will be easier for organizations to change they way in which they work by adding or changing components within their support systems. Similarly, mergers and acquisitions will be easier to manage through the common understanding of applications delivered by the TAM's common language and the business integration points easier to identify.

The Telecom Applications Map, shown below **Error! Reference source not found.**, is segmented by the primary eTOM process area: Fulfillment, Assurance, and Billing functions along with the layering of Market/Sales Process, Product Process, Customer Relationship Management processes, Service Management Process, Resource Management and Operations processes, Supplier Partner Process, Enterprise Management Process and the Integration Infrastructure Process.

The TAM also recognizes managed resources including network based resources, content servers, intelligent network platforms, and related network control technologies such as element management systems, as well as the OSS/BSS infrastructure fabric – e.g., bus technology, business process management engines, etc.

The TAM is used to describe the primary functions and roles of each of the layers of the map and each of the main segments (as shown in **Error! Reference source not found.**). The main segments are then broken down into sub-segments where additional clarity would help the reader. For each segment, the TAM identifies the key workflows and their associated data entities that support the applications.

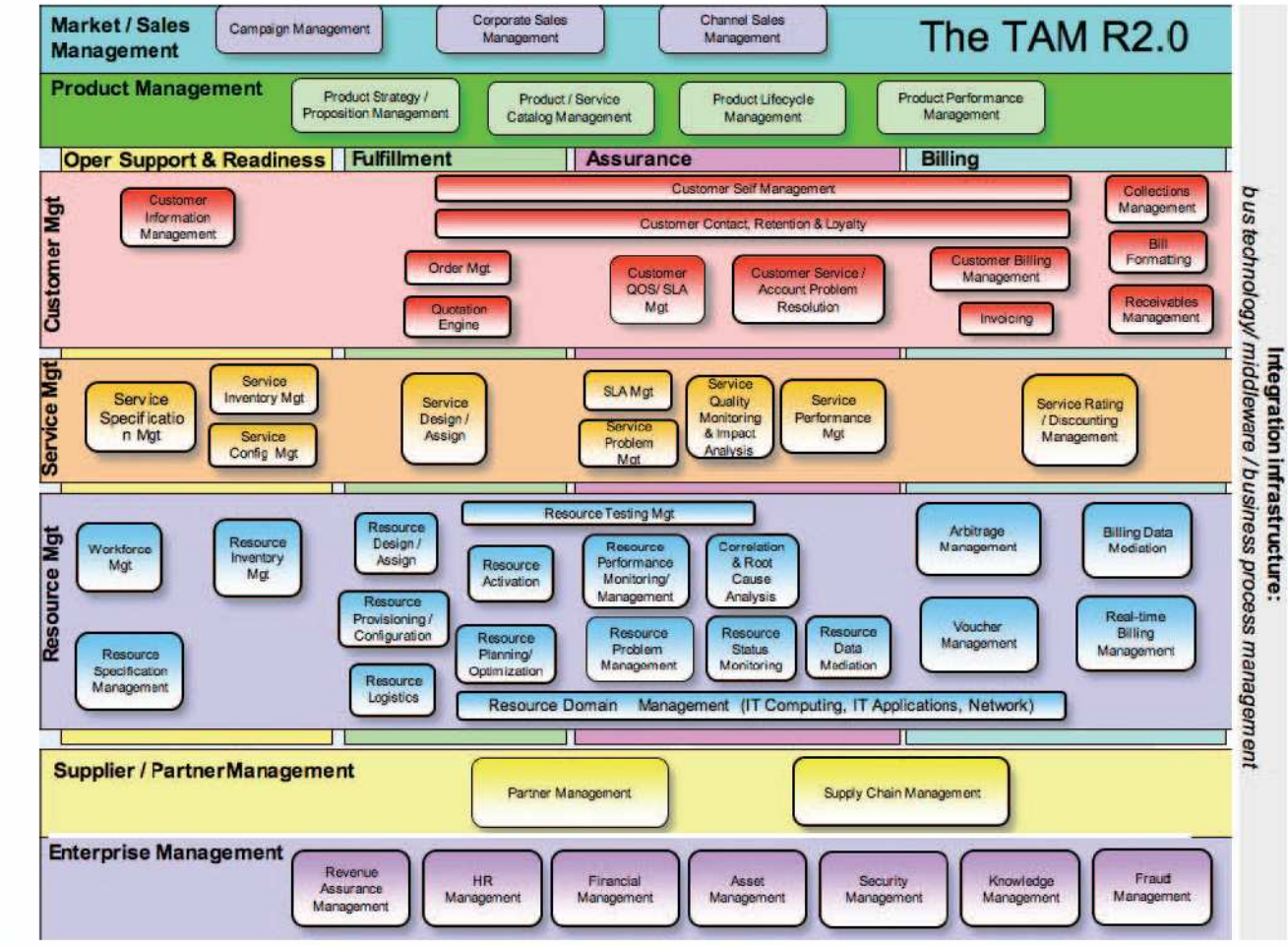

Figure 7. The Telecom Applications Map

4.3.3.2 Ontology Overview

TAM ontology models the domain of IT applications in a Telecom enterprise. It contains a concept for application. The description of an application uses the concepts of functionality and the concept of process area. Such a description is sufficient and adequate for it. It is enough to know the functionalities of an application to decide whether or not to employ it for a certain task. Part of the description of an application is its rendering as specific for a certain functional process, for example specific for customer management. The groupings according to the horizontal functional process areas as described in eTOM standard are closely related with an application. To model them, the concept of application has subconcepts which reflect these groupings.

The formalization of TAM standard closely resembles the standard. The standard is well organized and allows for a direct capture into an ontology. Still there are concepts which are not included, like supported contracts, because it is suspected it will be a concept in either eTOM or SID ontology. If this is so, TAM can simply have a reference to the respective ontology that contains supported contract as a concept.

TAM Standard contains supported contracts which were not introduced in the current version of TAM ontology. This modeling decision was taken after a deep analysis of the uses of supported contracts within the standard. There is no unique use but the meaning of

supported contract concept in the standard is opaque and hinders its capture into a concept in the ontology. In case that the demonstrator or the use case prototypes make use of supported contracts, it will be introduced into the ontology as a concept.

In TAM standard applications are grouped in such a way so as to align to primary eTOM end-to-end level 1 vertical business functions, from one hand, and to SID domains, from the other hand. These groupings are reflected in the ontology in two ways. SID domains are used to group Telecom Applications into subclasses. eTOM vertical processes are included as a separate concept, eTOMVerticalProcessArea, and this concept is linked to TelecomApplications by means of introducing an attribute of TelecomApplications, namely hasAreaOfApplication. This attribute refers to which eTOM level 1 vertical process and to which SID domain is aligned the application being modelled.

The main concept, TelecomApplication, has three properties: (1) isLevel1Application with default value true and datatype boolean, (2) hasFunctionality the cardinality of which is set to be minimum 1 and maximum to an unspecified value, and (3) hasAreaOfApplication (as explained above). The latter property hasFunctionality serves to relate the concept TelecomApplication to the second important concept in the ontology, namely to Functionality.

The subclasses of the concept TelecomApplication are of two types. On one hand, there is the division that TAM standard imposes on the applications, i.e. it divides them according to their area of application which corresponds to SID domains. On the other hand, there is a division between proper subclasses, i.e. between general and more specific applications, for example CustomerSelfManagement (application) and CustomerSelfEmpoweredBilling (application)

As for the numerous applications listed in TAM standard, there are two options. One is to capture them as instances of the various TelecomApplication subconcepts. The drawbacks of this approach would be that 1) we would have to omit level 2 applications, and 2) if TAM ontology is used to annotate IT systems of Telco operators, in order to succeed either the IT systems should bear the same names as the instances of TelecomApplication or there should be a manual of how to match IT systems names with the names of TelecomApplication instances. The second option is to formalize the applications listed in TAM as classes in the ontology.

Level 1 Applications in TAM standard are modelled as subConcepts of TelecomApplication and Level 2 Applications in TAM standard are modeled as subConcepts of level 1 applications

In the next release of the TAM ontology most of the functionalities listed in the standard will be included as instances of the concept Functionality.

The concept Functionality has the property isKeyApplicationFunction with default value true and datatype Boolean.

Most of the functionalities listed in TAM Standard are modelled as instances of the concept Functionality.