Framework of Integrated Semantic Web Services and Ontology Development for Telecommunication Industry

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Abstract— **The concept of web services is loosely coupled, location transparent, and protocol-independent software system for distributed platform. Literature review indicates that existing web services content is composed for humans to read whereas Semantic Web Services (SWS) have emerged as a new paradigm for meaningful data retrieval in a distributed environment. SWS have automated the information processing by interpreting human and machines content comprehensively. Telecommunications industry with its increasing demand of services and adapting nature of frequent changes forces service providers to support automated service discovery for cutting cost and response time. The objective of this paper is not only to overcome the existing limitation of automated discovery for heterogeneous and homogenous services in one model for industrial application as discussed in this paper but also to provide a way for an integrated enhancement of semantic web services. The proposed framework is an integrated approach for enhancement for goal based services discovery for telecommunication industry. We have developed domain and billing application ontologies and a prototype to validate the proposed framework by integrating Web Service Execution Environment (WSMX) and Internet Reasoning Service (IRS-III).**

Index Terms— **Semantic web services, SWS, telecommunication ontology, semantic application, services discovery, goal based services discovery.**

I. Introduction

Enterprises envision “plug and-play” business IT infrastructures by using web services to develop, enable and deliver applications more efficiently [1]. Web service assists in developing of large, complex systems; reducing inter-enterprise computations as necessary in e-business environment, and it also allows flexible business network that makes free flow of products and services [2]. Web service allows building of large, complex systems by linking together any number of modules that each performs one or more tasks; ease inter-enterprise computing as required in Business-to-Business (B2B) e-business environments, and finally it permits flexible business network through which aggregations of products and services can flow freely which is not possible in the past. Web services enable us to access relevant applications but still need to be supported by human interaction; this is the point where semantic Web comes to act, combining the strength of web services and the added value of Semantic Web will result in a concrete base for enterprise applications [3]. In [30] Ohlms has highlighted some of the following benefits which business application can attain using semantic web technology as shown in above table: 1.

Current web services by and large depends on special hard-wired solutions however, Semantic Web Services (SWS) in contrast sustains, “Late-binding” that binds a user request and “on-the-fly” services [7]. According to [6], Semantic web services provide automated integration to e-business application in order to handle any dynamic change in business process’s strategies or structure changes, provides support to correct matching based on semantic knowledge between description of business process and web service and automatic discovery and selection of web service.

According to [5] the enhanced services of Semantic Web Services (SWS) can offer following prospects: 1) enhanced automation of service selection 2) automated translation of message content 3) automated or semi-automated service composition, with more easy ways to service monitoring and improvement from breakdown.

Telecommunication is growing enterprise offering plethora of services that increases the cost, request-response time and network load. There is a drastic urge for semantic web services that enhances performance level in telecommunication industry. Recent research reveals that semantic Web and Semantic Web Technologies (SWTs) offers seamless interactions among humans and service; solutions for data/processes heterogeneity, interoperability and semantic accuracy [4]. This paper is an expansion of the previous work, focusing at the existing drawbacks such as:

- Manual discovery of services by browsing or searching within service registry [8];

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TABLE I.
INFORMATION TECHNOLOGY TRENDS AND BENEFIT FROM SEMANTIC TECHNOLOGY, (ADAPTED FROM [30]).

Trend	Description	Benefit from Semantic Web technology
• Information management	• Metadata, content, and document management, business intelligence, and EIP	• Precise, elaborate knowledge modelling, generation, navigation, and retrieval
• System integration	• Process, application, and data integration, both intra- and inter-enterprise	• Flexible data integration through shared metadata layers/ontologies
• Multi-device capability	• Connectivity to ubiquitous electronic devices, e.g., active/passive sensors, and smart devices	• Multi-device capability through unambigious definition and specification of any web resource
• E-procure-ment	• E-enabling/tight integration of the supply chain, private/public exchanges	• Indirect benefits through easier information management/system integration
• CRM	• Mobile sales/field force, call center, self-service, e-/m-commerce	• Indirect benefits through all of the above

• No auto notification for newly accessible services [9];

• Machines inability to read information, thereby making it difficult to draw new information [10].

Formerly models in [13],[14],[19] have been presented for automated services discovery however the main demerit was its inability to support for heterogeneous and homogenous services features in one single model. The proposed framework is an integrated approach for enhancement for goal based services discovery, for heterogeneous and homogenous services having parallel functions at dissimilar service providers ends for telecommunication industry. It has been designed to synchronize ever-growing changes in enterprises. Goal oriented dynamic service innovation has facilitating the searching. We have also incorporated domain along with billing application ontologies for telecommunication. Lastly, semantic web service discover setting is executed whilst using Web Service Semantic Execution Environment (SEE) [11], Web Service Modeling Toolkit [12], Web Service Execution Environment (WSMX) [13], Internet Reasoning Service (IRS-III) [14], WSMO Studio, TopBraid Composer and Protégé [36].

The remaining structure of this paper is organized as follows: Section II discuss the Related Work. The proposed framework is further substantiated in section III. The ontology development methodology in VI and implementation of framework is explained in section V. Finally, last section ends with conclusions and research implications.

II. RELATED WORKS

In this section we describe the relevant contributions to the field of Semantic web Service discovery and their relationship to our proposed approach. Our work is basically related to three aspects of Service discovery (i) Automate the service discovery in a distributed environment (ii) Infer service requester's goal to discover matching services (goal based service discovery) (iii) Service discovery for heterogeneous as well as services with similar functionalities by different service providers (operators). Several recent studies have suggested the concept of semantic in services discovery. They include the abstract level architecture and framework for semantic web service discovery and composition such as [21] framework in the context of SAP's Guided Procedures [18] and Business-to-Business (B2B) integration architecture [13]; User-supplied context-specific ontology mapping technique such as [15]; Discovery algorithm to addresses the semantic heterogeneity such as [20]; Semantic web service discovery with hybrid OWL-S such as OWLS-MX [16]; System to support decentralized service query such as Peer-to-Peer (P2P) indexing [22]; Skip Graph based Semantic Web Services discovery such as SNet [17]; Reasoning-based approach for resource discovery and composition such as BiOnMap [19], as well as approaches for discovery based on geometrical vector spaces such as Conceptual Situation Spaces (CSS) [14].

Preist's abstract level architecture of semantic web services lifecycle (Discovery, interaction, mediation and composition) for large scale effective deployment presented in [21]. Authors proposed macro-architecture and micro-architecture service requestor and service provider agent. Projected framework maintains service choreography, orchestration, and mediator if required. It supports the communication and source organization, supervising and data parsering. One year later in [15] the authors proposed a framework for semantic web services that relies on user-supplied context-specific ontology mapping during service discovery. Their work is bit similar to our approach for selecting between different service provider and support heterogeneous web services but we specifically focus on WSMO to overcome interoperability mismatches on structural, semantic, or conceptual (representation, data, functional, process) level that occur between different web services. In the same context [20] presented discovery algorithm, which addresses semantic heterogeneity with respect to multiple ontologies from the same domain based on METEOR-S Web Service Discovery Infrastructure.

Klusch and fellow researchers presented in [16] offered semantic web service discovery with hybrid OWL-S service matchmaker that complements logic based reasoning with approximate matching based on syntactic Information Retrieval (IR) based similarity computations called OWLS-MX. In [18] authors expressed a framework for semantic web service discovery and composition including annotations of both functional (include input, output parameters as well as preconditions and effects) and non-functional attributes (refer to other relevant characteristics such as accuracy, quality of service, price, owner, access control restrictions). Authors have implementation mixed initiative semantic web service discovery and composition framework in the context of SAP's Guided Procedures. For another way to service discovery [17] suggested, a Peer-to-Peer (P2P) indexing system is proposed to support decentralized service query (discovery) with semantic requirement. Authors purposed layered model of discovery system that support semantic service discovery by publishing advertisement of semantic Web services on a structured overlay network through a distributed trie.

Yu et al. in [22] suggested SNet, a Skip Graph based Semantic Web Services discovery. SNet support finding the extensive services in Skip Graph, compare the given key with the local keys at the current peer node to look up its neighbors, forward the query message and matches exact services in matching engine until the given key is found or it reaches the lowest level neighbors and fails; this process continues. In [18] suggest a Business-to-Business (B2B) integration architecture using Semantic Web services. Their approach based on WSMX to provide strong partner de-coupling and facilitate a conversation between heterogeneous services that support both the RosettaNet standard and proprietary information models.

In recent times, [19] implemented "BiOnMap", a reasoning-based approach for resource discovery and composition. BiOnMap service is comprised of metadata catalog which uses domain ontologies to annotate resources semantically and express domain rules that capture path equivalences at the level of the ontology graph and a reasoning engine. In our purposed work, we support multiple discovery engines and different levels of discovery such as Keyword Discovery, Discovery based on Description Logic and Quality of Service based discovery. Lastly service discovery as proposed in [13] and [14] are closely related with our approach. In [13], authors suggest a Business-to-Business (B2B) integration architecture using semantic Web services. Their approach is based on WSMX to provide strong partner de-coupling and facilitate a conversation between heterogeneous services that support both the RosettaNet standard and proprietary information models. In compression to our context, [14] introduce a relatively different concept. Authors proposed a Conceptual Situation Spaces (CSS) that enable description of situation characteristics as members in geometrical vector spaces. Authors also aligned CSS and SWS with established semantic web service standards. Their proposed architecture supports runtime reasoning on CSS through a semantic Execution Environment (SEE) by implementing IRS-III.

Our work is similar to the former work. However, our work entails: dynamic service discovery to figure out heterogeneous as well as homogenous services. Our work is based on integration between Web Service Execution Environment (WSMX) and Internet Reasoning Service (IRS-III) for support heterogeneity in service discovery without any hard-wired manual configurations of services or workflows. WSMO framework provide assistance to all three design principles including basic Web, Semantic Web and distributed service oriented design principles. Proposed framework also supports the communication and resource management, monitoring and data parsering [29]. The framework is used by service providers and requesters both for invoking, finding and using Semantic Web Services that are described using WSMO.

The proposed approach supports functional (capability) and non-functional attributes such as Quality of Service (QoS), accuracy, robustness, security, scalability and trust as promise by semantic middleware we have implemented. Moreover, also support the P2P approach for distributed goal based service discovery by adapting hybrid topology in order to support scalability. In addition orchestration and choreography are our distinctive concepts which are utterly required in P2P. Furthermore, our approach is dissimilar former work as we have matched the goals of service requesters with capable web services based on sender preference. The approach for semantic web services is different from mentioned approaches as our framework is based on a distributed architecture composed of the server, the publishing platforms, and clients.

III. Proposed Framework

The formerly projected model in [22], [15], [20], and [13] for semantic web service discovery had some merits like decentralized service discovery, and context-specific ontology mapping. On one side [23] offers a paradigm for the discovery, selection, mediation and invocation of semantic Web services and in contrast [24], supports one-click. At this point the question for the need of new service discovery framework may arise? The answer to this important question is that, though a number of model, frameworks or architectures were proposed in the past, none of the work was intended towards focusing on the integration between WSMX and IRS (in telecommunication domain) to maximize the advantage of both. Figure 1 depicts the proposed framework, which integrates WXMS with IRS-III to enforce integrated enhancement in service discovery. The aim of proposed framework is to support service discovery that does not call for any change in data format. Following we elaborate on the distinct components of the proposed framework for the service discovery.

Billing Service Providers: Services providers are telecommunication service providers or mobile phone operator that publishes services related to billing application. In our scenario service provider exposes both homogenous and heterogeneous services through a public interface based on WSMO description. This later can be invoked by requestors of the service.

Ontology: Ontology is the back bone of the semantic web services. Proposed framework can identify services by using application and domain ontology. Application ontology entails customer billing, interrelated settlement and data mediation while domain ontology explains the generic vocabulary of telecommunication.

Semantic Middleware: Semantic middleware permits billing service providers to lay up their service descriptions and WSMO goal oriented ontologies. Service provider can use Java, Java WS or Lisp for publishing services. SEE adds value by replacing middleware services [24]. The projected framework not only incorporates WXMS with IRS-III but also provides supervision and messages management by SEE.

Services Requestors: Services requestors are the sender of Simple Object Access Protocol (SOAP) based message to invoke particular web services based on its respective goal. All SOAP messages are sent via Hypertext Transfer

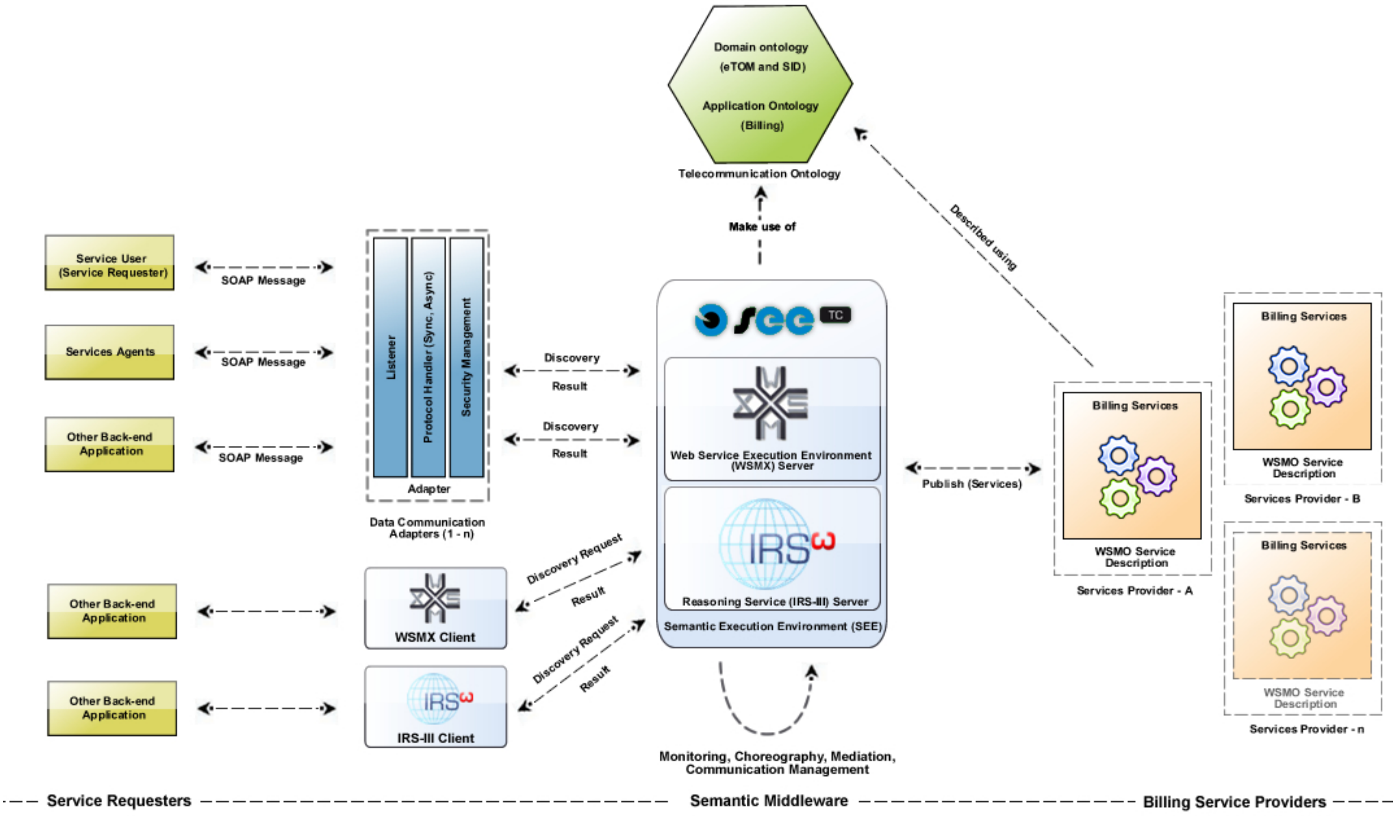

Figure 1. Proposed framework for service discovery.

Protocol (HTTP). Services requestors can be telecommunication services operator, service agents, or it may be a back-end application. Proposed framework keeps the integration between back-end systems to the semantic middleware through semantic descriptions. These adapters control data mismatches and convert the format of a received data into Web Service Modeling Language (WSML). Proposed fretwork has loosely coupled components having no hard-wired constraints.

IV. Ontology Development

This section explains the methodology adopted for both application and domain ontology development in details of the proposed framework. The first step of the implementation of proposed framework is the billing ontology development. To serve the purpose of step 1, we require application ontology for Billing System and in order to maximize the advantage of semantic in Billing System we also require domain ontologies (in our case for telecommunication domain) to interact with other application, automate services discovery based on shared concept with in telecommunication domain. In order to develop ontology there is needs to have awareness about the different methodologies like [31], [32], [33], [34], [35]. In most of the above discussed/mentioned methodologies required documentation/procedure has not been available, so author decides to go for the interviewing method. However after lecture review we have proposed and followed the iterative method for application of ontology development as depicted in figure 2. At first motivational scenarios are created in order to fulfill the need of specification of ontology on the basis of these scenarios. Competency questions are developed to keep focus towards the ontology based on these scenarios. Following are some examples of the competency questions:

- What activities have to be made to achieve the goal of landline to mobile phone services discovery?
- How specific batch of services was used by one or more services requester over a given period of time?
- Under what condition(s) settlement collection are traceable for illegal usage record?
- What are the best tariff policies for rated usage record?
- What are the tax policies and bill data to run for invoice?
- What happens when Duplicate CDR files are aggregated?
- What are the different collection points during pay cycle?
- What are the characteristics to keep the log and status during different stages of processing?

In search of domain knowledge different telecommunication standards studied. There are several standards and worldwide standardization bodies that exist to cover the telecommunication domain such as 3GPP (3rd Generation Partnership Project), WiMAX Forum, NGN (Next Generation Networks), IEEE (Institute of Electrical and Electronics Engineers) and The TeleManagement Forum (TMForum). New Generation Operations Systems and Software (NGOSS), is one such industry-wide standard (Solution Frameworks) developed

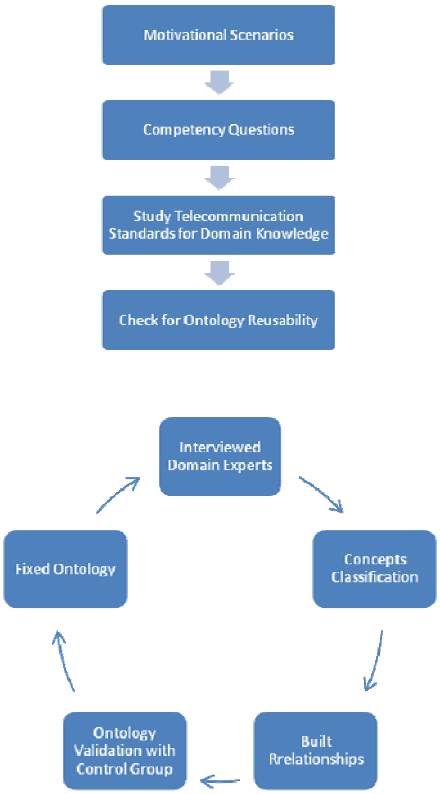

Figure 2. Ontology Development Cycle

by TM Forum. In parallel also searched various internet based ontology repositories for ontology reusability. Next interviewed domain experts; the participants in this stage were telecom operators, vendors and regulatory authorities i.e. government based in Pakistan. Domain experts from management and all functional departments were involved (viz., system analyst, system designer, core technical team, end users, and documentation team). The practitioners sampled within organization are representative of participants in organization as a whole. The selection of the participants from each organization is based on their availability of time and relevant experience. Concepts were then classification and built relationships among them. Before fixing the ontology, it was validated with control group. This process has been carried out in an iterating manner as discussed in [31]. During ontology elicitation, analysis and fixing phases we relied on extensive professional experience of stakeholders due to limited historical data documentation. The major contribution in this research is that this proum has been carried out in an interactive manner for the validation of results against the specific requirements and at last proposing the ontology on this basis. Protégé ontology editing tool by Stanford Center for Biomedical Informatics Research available at [36], have been used for application ontology development (see appendix A).

In second step, we have developed domain ontology for telecommunication. Enhanced Telecom Operations Map (eTOM) and Shared information/data model (SID) are two key components of the NGOSS solution frameworks which provides the shared understanding for a telecommunication domain [25]. Systems integrators and their partners, capture the past best practices (Global knowledge to local focused solution), Intelligent problem solving, provide direction to the industry, more over already in industrial use, which help us to integrate other application based on NGOSS. We have considered eTOM and SID for the domain ontologies due to following reasons. There combination addresses the need of all stakeholders (Service Providers). The focus of eTom (eTOM), are the business processes, aiming to develop linkages among processes; the identification of interfaces; and the use of customer, service, resource, supplier/partner and other information by multiple processes since it provides a reference framework for categorizing all business activities at all levels of the enterprise.

On the other hand (SID), provides a common information model (common vocabulary) to identify and describe the data with pertinent business processes as well as a standardized meaning for the relationships that exist among logical entities [27]. For example, a common definition of what is "customer" and how it relates to other elements, such as mailing address, purchase order, billing records, trouble tickets, and so on. eTOM and SID both frameworks are under ongoing development by TM Forum. The current models are published in set of different format (XSD, XMI, UML, and HTML browsable document) but in order to make use for Billing System as a domain ontology we need to express this framework in formal ontology language. Web Ontology Language (OWL), is a semantic markup language to describe, publish and share the ontologies on the World Wide Web, and make it understandable for both human and machines. eTOM is organized into different hierarchal levels. Level-1 is the highest level of business process framework. It is then further elaborated into different conceptual levels as shown in Figure 3. We have transformed these processes into OWL class by using Protégé ontology editor.

SID is much complex than eTOM and time consuming to transform manually for this purpose we have used TopBraid Composer, to convert XSD (XML Schema Definition) format to OWL classes [28]. Later these ontologies (application and domain) imported into WSMO Studio, to convert form (Web Ontology Language) OWL to WSML format. Once the ontologies are ready to work with the next phase is semantic web service and Goals creation. Furthermore, alignment of these ontologies together with functional, non-functional, and interface description of services and publish them to the semantic middleware repositories.

V. IMPLEMENTATION

This section enlightens about execution of the planned framework for service discovery enrichment. We require both application and domain ontology to communicate with other application. For application ontology

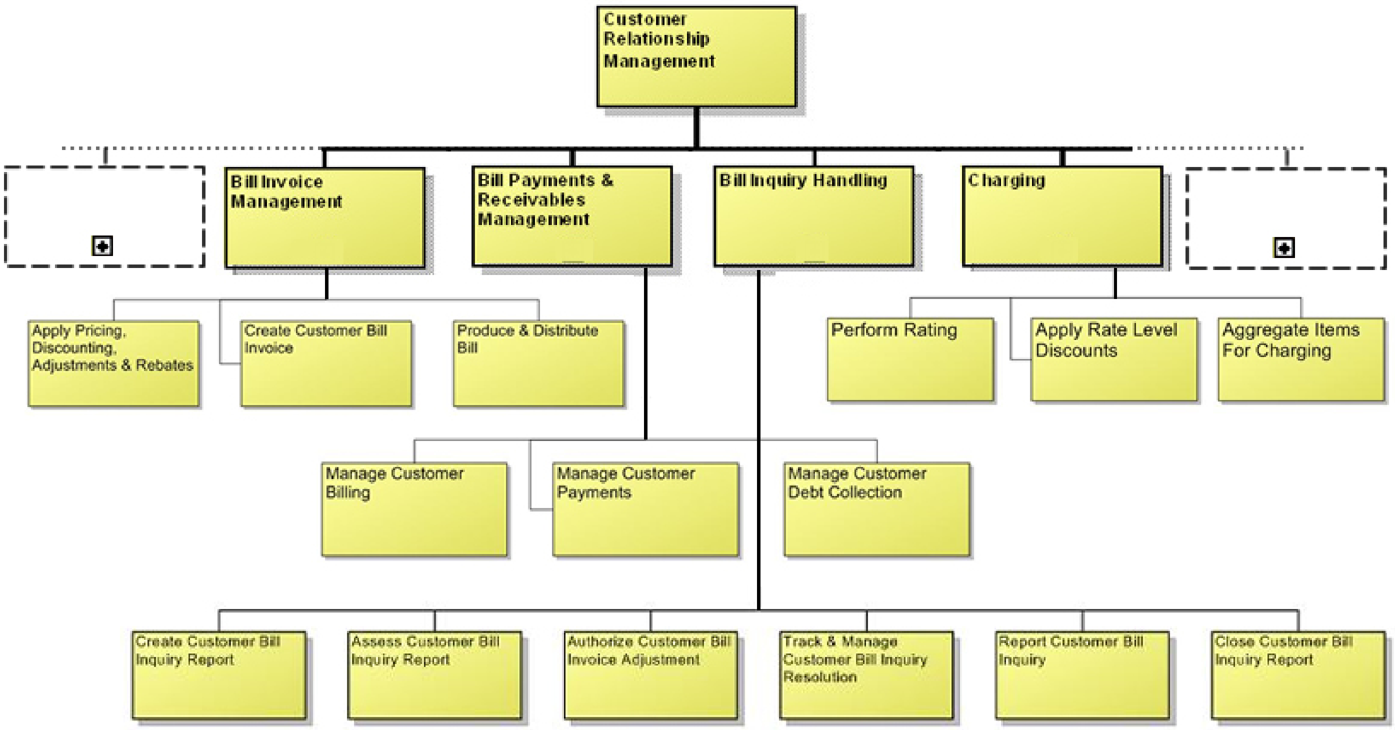

Figure 3. eTOM Hierarchy Level adopted from [26]

development different stockholders have also been interviewed and included like system analyst, system designer, core technical and functional teams, billing executives, documentation teams and domain experts from different telecommunication service providers and operators who are based in Pakistan. After ontology development these application and domain ontologies are brought into WSMO Studio to convert from OWL to WSML format. Having the ontologies developed and check for their quality, the next stage is goal creation. In addition to configuration of these ontologies along with functional, non-functional, and interface description of services is needed that helps in information retrieval and service discovery. The final stage pertains to publishing these services into semantic middleware. Both design-time and run-time mechanism are supported by proposed framework. In our work, SEE functions like semantic middleware. We have executed both WSMX and IRS-III consisted of conceptual model given by WSMO. This mechanism puts the telecommunication operator at ease to figure out goal oriented and in finding heterogeneous as well as homogenous services by different service provider. The evaluated results are based on prototype implementation, using sample data of a leading telecommunication operator in Pakistan, which has its distributed computer centres in nine different cities of Pakistan (name is not cited for privacy conditions).

We performed a typical process of interconnect settlement service discovery. Service have been composed on the bases of agreed rates of billing, subsequently performed all the required configuration which includes number series, trunks, and tariffs selection. We have used bottom-up approach for services creation, given that the billing service providers have WSDL description with web services.

Semantic Web Services and Goals are explained with reference to the definition of WSMO service and WSMO Goal. Although they have the same structural definition, they differ in representation [11]. Service discovery based on our proposed framework allows automating process using goal based discovery instead of keywords. At second step dispatched a SOAP message to find out suitable web services. Number of services having similar nature are available by different service providers hence service discovery is required.

Data/communication protocol adapters convert the received data into WSML compliant format and sort out the mismatches in data representation. Semantic middleware manage monitoring, and choreography of services. Steps may entail format translation (XML-WSML), authenticates, assembles, and stores WSML description files, data and process mediator while using set of mapping rules as shown in Figure 4. However we realized in order to implement SWS in industry great number of experiments and evaluation is required. We believe that as system will mature progressively, it will rise above the existing challenges and unfold new horizons of opportunities.

VI. Conclusion and Future Work

In this research, we have explored the drawbacks which our industry is exposed to in contemporary state-of-the-art services and offer cost-effective and efficient solution using semantic web services. The inspiration behind

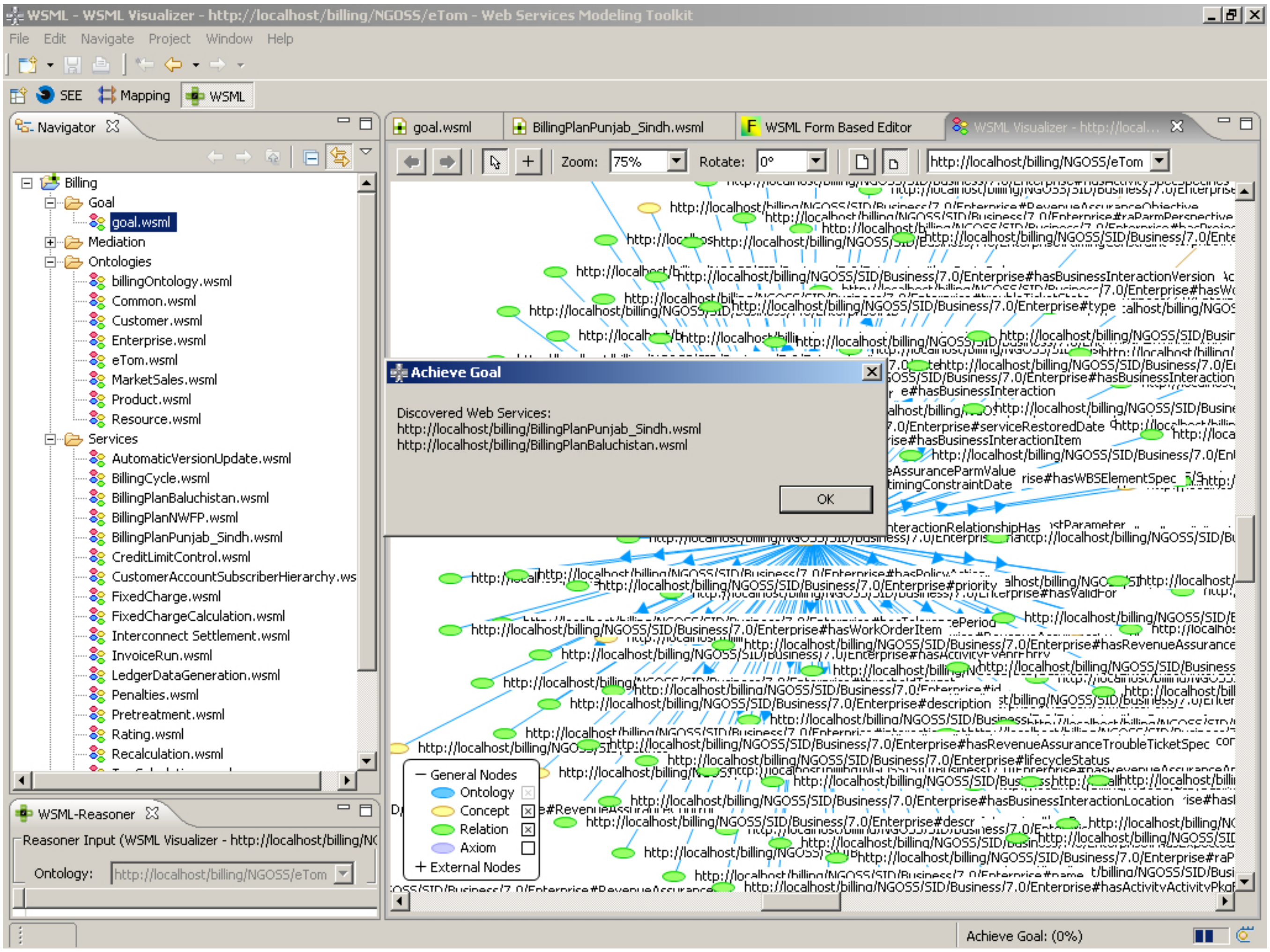

Figure 4. Goal based services discovery

embarking upon this work is the basic transfer of technology to the semantic web services in order to secure automated service discovery. We have projected an integrated framework composed of WSMX and IRS-III that can efficiently handle excessive volume of telecommunication services. Projected framework along with its components is discussed in detail.

Our current and future work is oriented to further harness our ontologies with the help of professional telecommunication engineers and domain experts. We are conscious of the challenges ahead that semantic web services could confront particularly during execution in a broad-based industrial applications and hence working on to lessen them. Moreover, we are focusing to figure out further drawbacks and challenges of the semantic web services. More efforts are being made to make the semantic web service in perfect resonance with the modern needs and challenges in order to make it highly dynamic intelligent business application.

APPENDIX A BILLING APPLICATION ONTOLOGY

- owl:Thing
  - Account
  - AccountContact
  - AccountRelationship
  - AccountTaxExemption
  - AppliedBillingRate
    - AtomicAppliedBillingRate
      - AppliedBillingCharge
        - AppliedBillingProductCharge
          - AppliedBillingProductUsageRate
      - AppliedBillingCredit
        - AppliedBillingProductAlteration
          - AppliedBillingAllowance
          - AppliedBillingDiscount
        - AppliedBillingRebate
      - AppliedBillingTaxRate
    - CompositeAppliedBillingRate
  - Automatic_Version_Update
  - Bill
  - Bill_Processing
    - _-Account-Subscriber_Hierarchy
    - Credit_Limit_Control
    - Fixed_Charge_Calculation
      - Fixed_Charge_Calculation_For_Main_Service_Value_Added_Service
      - Support_Different_Tariff_Setting_Based_On_Different_Geography_Region
      - Support_Different_Tariff_Setting_Based_On_Subscriber_Attributes
      - Tariff_Setting_for_Fixed_Charge
    - Invoice_Run_Account_Export
      - Adjustments_and_Re-adjustments
        - Adjustment_Based_on_Single_Subscribers_Single_Fee_Type
        - Batch_Adjustment_of_Single_Fee_Type_Based_On_Equipment_Type
        - Daily_Adjustment_Report
        - Full_Database_Adjustment_Log
        - Monthly_Adjustment_Report
        - Querying_Adjustment_Log
      - Automatic_Check_for_Free-Service-Number
      - Bill_Data_Transfer_from_Billing_to_Receivable_System_In_Batch
      - Bill_Data_Transfer_from_Billing_to_Receivable_System_Single_Subscriber
      - Integrity_Check_Before_and_After_Bill_Data_Transfer
    - Ledger_Data_Generation
      - Aggregate_Ledgers
      - Detection_and_Storage_of_Exceptional_Charge_Record
      - Exceptional_Usage_Charge_Record_Reprocess
      - Integrity_Check_between_Usage_Charge_and_Account_Item
      - Ledger_Re-aggregation
      - Real-Time_Ledger_Aggregation
    - Penalties__This_feature_is_part_of_Receivables_System
    - Tax_Calculation
    - Volume_Discounts
      - Re-Enterable_Discount
      - Single_Level_Volume_Discount
  - BillFormat
  - BillingCredit
    - Allowance
    - Discount
  - BillingCreditBalance
    - AllowanceBalance
    - DiscountBalance
  - BillingCycle
    - Bill_Generation_Cycle
    - Pay_Cycle
  - BillingCycleSpecification
  - BillingPeriod
  - BillingStatistic
    - AccountChargeSum
    - BillingProductChargeSum
    - UsageCharacteristicSum
  - BillingStatisticBalance
    - AccountChargeSumBalance
    - BillingProductChargeSumBalance
    - UsageCharacteristicSumBalance
  - BillingStatisticSpec
    - AccountChargeSumSpec
    - BillingProductChargeSumSpec
    - UsageCharacteristicSumSpec
  - BillPresentationMedia
  - BillSpec
  - Churn_RetentionStatistic
  - CreditProfile
  - CustCreditProfileReference
  - Error_Exception_Management
    - Error_Usage_Record_Correction
    - Error_Usage_Record_Query
    - Error_Usage_Record_Reprocessing
    - Error_Usage_Records_Storage
    - Fixed_Charge_Re-calculation
    - Recovery
    - Rollback
    - Unmatched_Usage_Record_Query
    - Unmatched_Usage_Record_Reprocess
    - Unmatched_Usage_Records_Storage
  - External_Interfaces
  - First_Time_Rating
    - Charge_Caller_or_Called_Party
    - Combination_of_Different_Tariff_Policies
    - Content_Based_Tariff
    - Data_Flow_Based_Tariff
    - Geography_Distance_Based_Tariff
    - Many_Charges_for_One_Rec
    - Special_Tariff_Based_On_Cal
    - Tariff_Based_On_User_Attrib
    - Tariff_Policies
    - Time_Based_Tariff
    - Types_of_Tariff_Identification
    - Unit_Based_Tariff
  - Interconnect_Settlement
    - Error_Detection_Settlement
    - Error_Management
    - Error_Usage_Record_Correction_Settlement
    - Error_Usage_Record_Query_Settlement
    - Error_Usage_Record_Reprocessing_Settlement
    - Error_Usage_Records_Storage_Settlement
    - Group_Division
    - Reports
    - Settlement_Account_Types
    - Settlement_Collection
    - Settlement_Decision_Process
    - Settlement_of_Prepaid_Calling_Cards_PCCS
    - Settlement_Process
    - Standard_Usage_Records_Duplication_Detection
    - Tariff_Policies_Settlement
    - Useless_Usage_Record_Filtration
  - Invoice
  - Mediation
  - Notification
  - p1:BusinessInteractionItem
    - OrderItem
  - p1:PartyRole
    - p3:billing
  - p1:Request
    - InquiryRequest
      - BillingInquiry
      - Inquiry
      - InvoiceInquiry
    - Order
      - AccessServiceRequest
      - DirectoryServiceRequest
      - LocalServiceRequest
      - ProductOrder
    - Usage_Record_Retrieval
      - Balance_Check_between_Mediation_System_and_Billing_System
      - Database_Log_Support
      - Duplicate_File_Detection
      - File__Auditing
      - Online_File_Transmission
  - p1:Response
    - InquiryResponse
      - Quote
  - p1:ServiceLevelAgreement
    - ServiceLevelAgreement
  - Payment
  - Payment_Blacklist
  - Pluggable_Task
  - Pretreatment
    - Duplicate_Usage_Record_Detection
      - Duplicate__Usage_Record_Detection
      - Duplicate_Usage_Record_Storage
    - Duplicate_Usage_Record_Exception_Detection
    - Validation
      - Error_Detection
      - Rounding_off_to_unit_time
  - Problem
  - Process
  - Rating
    - Batch_Rating
    - Convergent_Rating_Engine
      - Rating_of_IN_Services
      - Rating_of_PSTN_Service_Called_Record
      - Rating_of_PSTN_Service_Caller_Record
    - Real-Time_Rating
  - Second_Time_Rating
    - Free_Minutes_Discount
    - Ordinary_List_Discount
  - Signup
  - Task
  - Usage_Processing
  - Work_Force_and_Work_Flow_Integration

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