Chapter 15

INTRODUCING NEW BUSINESS MODELS IN PROVISION OF QOS NETWORKS

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Abstract: This paper presents a novel approach to setting services required inside and across IP networks known as Quality of Service provision. The first decade of 21st century is a turning point for the Internet provision business as the end users are the customers that will select a service with given or chosen Quality of Service. In the case of service providers that means facilitating dynamic creation of both the service and of the customization. This requires new business approach in form of business model known as mediation. Mediation enables smooth transition and satisfaction of the service requirement condition set up by the end user and the involved service providers. This paper provides insight in the business layer and the relevant business model that is introduced in IP networks enabling QoS provision. It describes briefly the developed model and its implementation within the re-engineered provider network.

Key words: re-engineering, service provider B2B, B2C, SOAP, QoS, SLA, SLS, XML, ebXML, Access Mediator, Service Mediator, Resource Mediator,.

1. INTRODUCTION

Regulation, globalisation, the growth of the Internet, and the services supplied over it, are driving the disaggregating process of traditional vertically integrated tele-operators in the past decade. The telecom activities have been reorganised into many more or less independent domains and business entities inside or outside the tele-operator companies. This allows the creation of a wide range of new communications service providers. As a consequence of this diversity of services and technologies tele-operators are facing massive dislocation in the networking platforms used to support new multimedia services for both wire-less and wire-line realisations. Part of this technology shift is the move towards 'ALL IP' networking. However the currently deployed IP networks are based upon a 'best effort delivery' principle that supports mostly data services where delay can be tolerated. Next Generation 'All IP' networks, both wire-line and 3G wire-less, have to support Service Level Agreements (SLA) and Quality Of Services (QoS) Guarantees for combinations of services, some of them delay tolerant, and others such as voice and video, that are delay intolerant. The delivery of these guaranteed QoS New Generation Networks depends on network control mechanisms and management capabilities working together across interconnected networks operated by different operators. This new picture of service provision away of the classical telecom subscriber scheme requires new approach regarding management of the business processes where different parties end users are involved. This paper provides insight in the business layer and the relevant business model that where developed for IP networks with QoS provision. It presents the basic components of the model, the technology used for implementation of the model and illustrates the approach with one service example.

The business model was developed and implemented within the European project CADENUS "Configuration and Provisioning of End-User Services in Premium IP networks" [1] from the 5 Framework Programme [2]. The model is designed in a way that enable automation of a number of business processes with pure technical background, collectively defined as SLA-based service creation for end-user services by introducing new component in the provider network known as mediation. The paper is structured in three parts, starting with the outline of the model followed by its architecture and implementation presentation. The paper at the end summarise the achievements and the prospects in further deployment of the scenarios and models developed in the CADENUS project.

2. OUTLINE OF THE MODEL

The trend toward using e-commerce based on B2B integration of trading partners is not unique to the telecoms industry as the opportunity offered by the B2B technology presents itself way to lower the cost of operation and doing business in many different fields. However, the telecoms activities in connection with the delivering advanced end-user services based on QoS and SLA, together with adequate service level guarantees, requires coordination between providers in the service value chain. Such value chain includes various partners e.g. content and service providers, retailers, third-party service providers, and network connectivity providers. Realization of end-to -end network connectivity from end-user to content provider, which is required in order to deliver the service to the end-user, presents in itself a difficult task regarding coordination and management. The players 'buyers' and 'sellers' involved in the value chain of service provision/consumption with QoS such as: video on demand (VoD), voice over IP (VoIP), video-conferencing or virtual private network (VPN) are expecting the service to run with full automation and speed. Though it is recognised that the value chain of this process may be complex, a simplified baseline configuration could be used for the design of the model, consisting of the following business entities:

User/Customer. A user or a customer could be a residential users or smaller enterprises using dial-up access to the Internet. Larger enterprises are also users but they are usually connected on a permanent basis utilizing leased

Retailers/3rd party broker. This entity is either reselling the services of a single Service Provider (SP), or is brokering between a numbers of SPs. A 'retail SLA' is associated with customer subscription.

Service Provider(s). These entities are delivering content, application services or simply service management. Services considered include managed multi-domain connectivity services and content delivery services such as video-on-demand, VPN, e-learning services. The SP does not own network facilities, but contracts these from Network Providers (NPs), through SLAs for IP connectivity (with Service Level Specifications - SLSs that describes the technical details of the SLAs). The SP may make such contracts with a number of Network Providers (NPs). Connectivity associated with an end-user contract for particular service will typically span from the end-user site to the SP's site, or between a number of end-user sites (e.g. in the case of a managed VPN service).

Network Provider(s). These entities are delivering IP QoS connectivity. Such connectivity might be limited to a **single domain,** in the case in which the NP sells only its own connectivity services, or it could span **multiple domains.** Typically, NPs have agreements with other NPs and the first in the chain can sell to the SP a service integrating the other NPs' services with its own (in this case, such an NP "resells" the services of the other NPs). Network Providers can be further classified with respect to the roles in the value-chains related to the provision of Internet-based services.

Internet Service Providers:

- *Backbone Service Provider*: Offering broadband IP network service. They operate at the root level of interconnection hierarchy and handle aggregated IP traffic;
- *Regional/National Service Provider*: Operating a larger network of Point of Presence offering Internet access for a certain region or even on a national and trans-national level. They may offer value-added services

like VPN and intranet services for enterprises, differentiated service classes, etc;

- *Internet Access Provider*: Offering dial-up access or other access methods to the Internet. Additional services typically include e-mail accounts and web homepage hosting.

Network Operators:

- *Access Network Operators*: Access connectivity is typically provided by the local telephone company through POTS or N-ISDN services;
- *Backbone Network Operators*: Operators offering network services to larger Regional and Backbone Service Providers for linking their routing nodes and interconnecting to Internet exchange points;
- *CIX/NAP Operators*: Commercial Internet eXchange points that provide
- interconnection between Service Providers.

The underlying business framework in that value chain is the Service Level Agreement (SLA) between different members of the value chain and the related networks which can be named in this context a SLA Networks or SLAN. SLA Network is a network in which all traffic classes, including traditional best-effort traffic the most usual today in the Internet are contracted between users and providers in a form of Service Level Specifications (SLS) [9, 10].

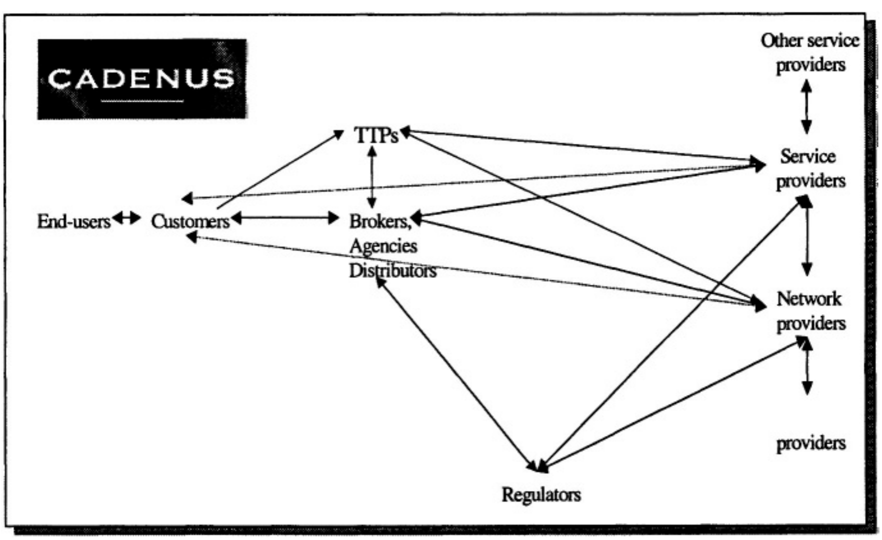

Figure 1. ***Entities of the model and their interactions***

SLS is a sort of technical mapping of the elements agreed and specified in the SLA. The most simple example is the translation of the site with the service such as Video on Demand to its IP network address within the SLS.

SLAN is considered as a network commitment: provision of a default quality for default services. User part SLA is a User commitment: to use only services which are SLA conformant. SLA between SPs is also a product of an agreement process or a result of a negotiation process between two (or more) providers on functions, parameters and virtual paths (addresses) at both sides of a SLA. Service creation which is the main goal of these processes is a creation of service logic, service data with associated data management and a creation of needed virtual paths that assist the virtual SLA protocol. The entities of the model and their interactions are presented on Fig. 1.

3. THE MODEL ARCHITECTURE

3.1 Components of the model

The approach taken for the architectural design taken in the CADENUS project has a strong focus on enhancing the ability to deliver value-added services to end-users, *by enabling a coordinated behaviour among the actors in the value chain* [5]. Though it is recognized that the value chain may be arbitrarily complex, a simplified baseline configuration in CADENUS has been chosen, consisting of the three main business entities: a retailer, either reselling the services of a single service provider, or brokering among a number of service providers, service provider (SP) and network provider (NP).

To implement this business models a new component known as *Mediation* was set up. The architecture of the CADENUS Mediation Component separates the functionalities of the mediator into 3 major blocks, termed Access Mediator (AM), Service Mediator (SM) and Resource Mediator (RM) (see Fig. 2). By defining these three types of mediators two strategic goals were achieved: first, the business model addresses all points of user/provider/domains interactions, including negotiations, selecting, profiling, etc. and second, it clearly separate not only the service from the resource control and management, but also the service from the service creation machinery. This enables the functionality of Mediation Component to be mapped in a straightforward way to software systems run by the three types of business entities as follows:

- the AM belongs to a 3rd party broker;
- the SM belongs to the SP;
- the RM belongs to the NP.

The **access mediator main** role is to grant access to the services provided by Services Provider. It is responsible for the contract (that is included in the SLA), the compliance of the services supplied to customers, it provides to customers a menu of available services, it authenticates users at the usage process, proceeds their demands and might compose services.

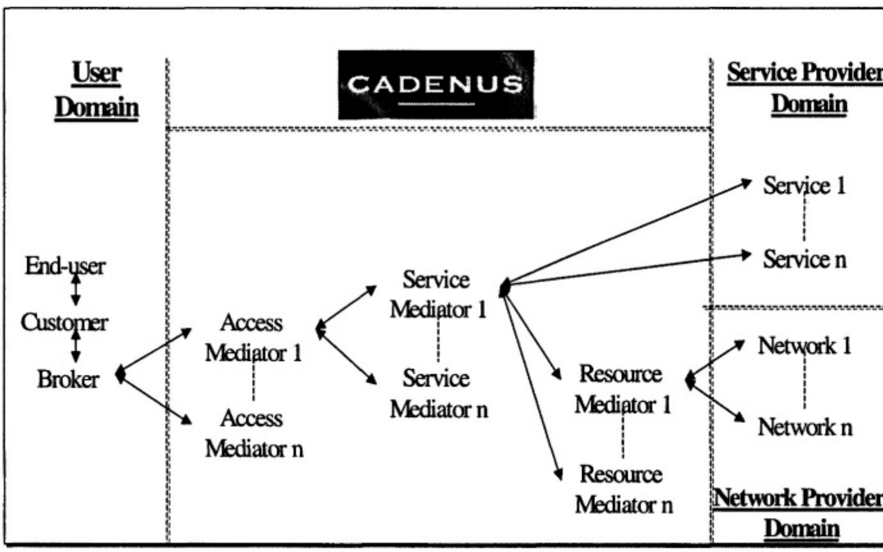

Figure 2. ***The mediator component in the model***

It communicates with several Service Providers in order to processes the access mediation function that grants access to a given Service Provider. The access mediator enable other actors involved in the service value chain to be hidden from his customers as it « screens » the subsequent entities involved in the services delivery. The Access mediator knows both end-users access network link and terminal type they use but it does not perform the accounting normally as it is carried out by the service provider itself

The **Service mediator** provides services that are put in bouquets by the access mediator. It deals with services requests but does not establish a direct contact with end-users (for SLA determination, subscription) nor perform accounting. It deals with other Service Providers to compose its services and with Network Providers to have its services supported. The Service mediator is enclosed within the generic services provider roles as it performs the service treatment.

The **Resource Mediator** is responsible for the network performance asked by Service Providers. It translates services demands into specific resources demands and is granting access to the most appropriate resources when the resources provider is given. Otherwise, it chooses the most appropriate IP resources provider thus performing a broker role. The Resource Mediator is granting access to the IP QoS edge of the backbone. It communicates with other Resource mediator(s) to ensure the IP network connectivity. The Resource Mediator performs the so-called “access to the resources function” but it does not carry out the network resource control function. This is left to co called **Service Authority and directory** (see Fig.3) that is ensuring traditional “Gold, Silver, Bronze” classification of the service common and guaranteed by all actors involved in the value add chain. It registers all the actors and all the services, which could be offer to the end users. It should be noted here that QoS agreements are contracted between:

- End-Users and the Service (via the access mediator and/or service mediator),
- Service and Resources Providers (via the resources mediator).

For better understanding this model is compared with other traditional business models. The most known and familiar is the travel agency model. In the CADENUS model the AM acts as the travel agency, which proposes many providers for the same holidays destination. The SM corresponds to the tour operator, which offers complete or partial bundles (i.e. flight, hotel, car rental). The service logic corresponds to the individual offer (i.e. hotel, flight). Like the service logic may be resold by many SMs, the same room location can be purchased from different tour operators. Finally, the RM acts as the central reservation place for the different parts of the trip and the NC performs the real job.

3.2 Message flows between components

Interfaces and message flows between CADENUS mediation architecture components are defined in the context of the different scenarios implementing different services but they have the following common components (see Fig.3):

- Propose New Service - between SM and SA (Service Authority),
- Publish Service Profile - between SM and SD (Service Directory),
- Set up a new SLA - between user, AM, SM, SD and RM,
- *Renegotiate SLA - between user, AM and SM,*
- *Delete SLA - between user, AM and SM*

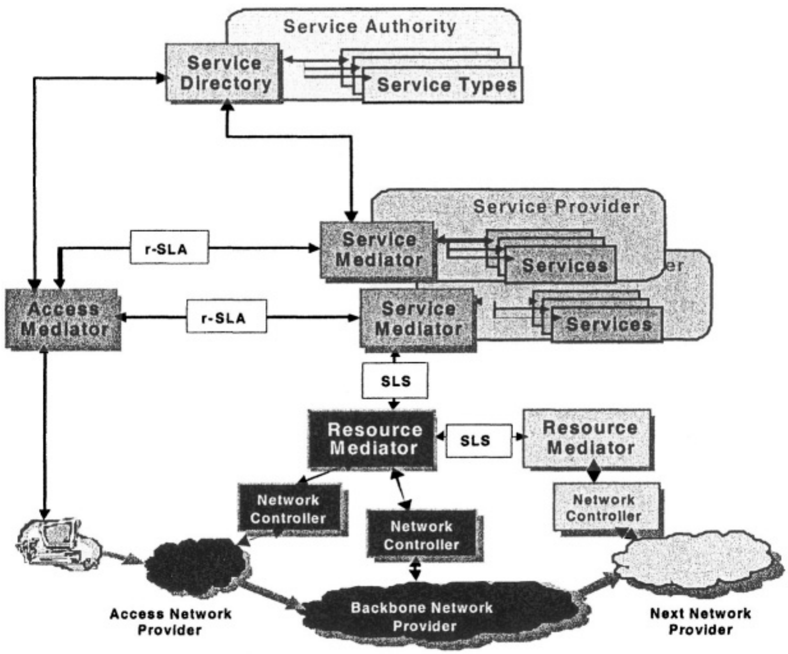

Figure 3. The CADENUS Architecture

The creation and exchange of these messages in creation of real service can be best understood with a description of an example service scenario. The CADENUS model was implemented to three different scenarios for a service: IP Virtual Private Network, Video Distribution Service and Voice over IP. Here the creation and delivery of a *Video Distribution* service, or, more in general, of Distributed Multimedia Applications is used as an example. Such services include audio/video transmissions where a user connects to a video-server archive containing a number of movies that can be sent, in a streaming fashion, to a client host. In the same category are also classified applications such as Videoconference and Tele-medicine, where video and audio data are generated from live sessions. There are four main steps involved in the service creation process:

- define and put in a standard format a description of the business process associated with service trading – in this case Video distribution;
- define a standard Graphical User Interface needed to allow user's customization of the service parameters, as an a example see Fig.4;
- define a standard template for the Service Level Agreement, as an example see Fig.4;

- define the rules to be applied in the translation from the SLA to the corresponding SLS(s) at negotiation time.

When these tasks have been completed, the only remaining operation is the publication of the business process specification, together with the newly defined components (the service GUI and SLA template) into an on-line registry/directory.

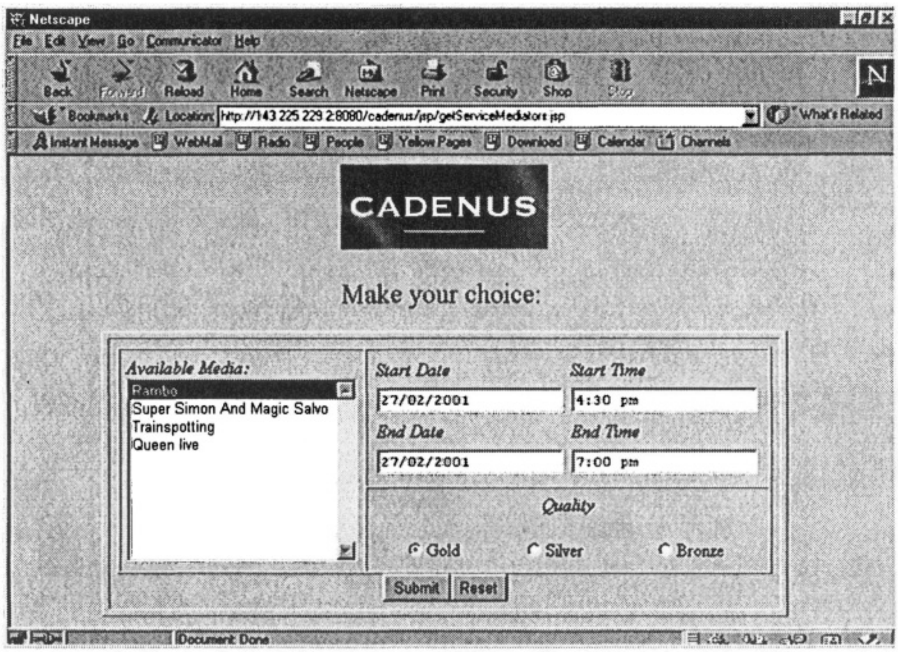

Figure 4. **GUI for Video Distribution service**

4. IMPLEMENTATION OF THE MODEL

The architecture defined in CADENUS (AM, SM and RM) was implemented in 6 blocks: the access mediation (AM), the service mediation (SM), logic of service, the service authority, the resources mediator(RM) and the resource control (network controller)[7]. The two more services e.g. logic of services and resource control help in translation of the services requests into resources that belong to the service plane. The resource control controls the resources and the QoS inside its sub-domain

CADENUS model implementation embraces the latest standard proposals coming from the electronic business research community, with respect to both the modelling methodology and the actual design for implementation. The business process specification selected is fully compliant with the ebXML (electronic business XML) framework, and the distributed, on-line registry has been implemented via UDDI (Universal Description, Discovery and Integration).

The ebXML framework aims at creating a single global electronic marketplace where enterprises of any size and in any geographical location can meet and conduct business with each other through the exchange of XML based messages.

The specification of a business process is the main required activity while creating a new service; then, in order to enable effective negotiation, it is needed that any interested party defines and publishes a Collaboration Protocol Profile (CPP), where a reference to the business process is made, together with the definition of the role that the party wants to play inside such a process. The CPPs, in turn, form the basis for Collaboration Protocol Agreements (CPAs) established between business parties.

Ultimately, the business processes specified in the CPAs drive the business service interfaces to execute those processes and send the required documents. A detailed description of the application of the ebXML framework to the mediation architecture may be found in [10], [11].

The Graphical User Interface (GUI) for the service and the SLA template have been implemented as customisable web components, whose goal is to ease the negotiation process. The GUI for Video Distribution is shown in Fig.4. It is implemented as a friendly web-based interface, which can be easily exploited even by users who are totally unaware of the technical details related to the service. The GUI is obtained and shown to the user whilst negotiating the service, as the outcome of a series of interactions between the various components of the CADENUS architecture.

The template SLA is an XML file that contains all the information necessary to uniquely identify the two parties user and service provider), together with the service instance that has been negotiated; XML style sheets are applied to this file in order to customise the way the SLA is presented to the final user.

The user must first indicate the service to which he wants to subscribe, specifying the QoS level and, optionally, the service lifetime (seeFig.4).

As stated in the previous section, the negotiation process is implemented in ebXML. The following steps formalise the sequence:

- the user subscribes to (or is authenticated from) the proper AM;
- the user asks for the negotiation of a new service instance;
- the AM allows the user to choose one of the available services (in this case Video Distribution is the user's choice);
- the AM contacts a centralised repository in order to retrieve the service GUI associated with the selected service: in the simplified, case as

presented on Fig.4 a GUI contains the list of the available movies, the time schedule for the service and the possible levels of QoS. Every movie title which appears in the GUI is available at least from one SM;
- the service GUI and the data are sent to the end-user.

At this stage, the AM does not make any semantic interpretation of the service under negotiation, but simply acts as a broker between the end-user and the Service Mediator. This has the advantage of relieving the AM from the responsibility of being aware of any specific service definition: the only entity involved in the definition process is, as one would expect, the SM.

Having received the service GUI, the user fills in the required fields and submits his request to the AM. This event triggers the following actions on the AM's side:

- the AM contacts all the SMs which registered as sellers of the specified service (in our case, Video Distribution). The list of such SMs may either have been obtained with the previous access to the repository (when the service GUI has been fetched), or be retrieved through a further access. A document containing the service parameters specified by the user is sent to the SMs in the list, in order to let them become aware of the service the AM (on behalf of the end user) is willing to receive;
- starting from the document just received, each SM creates one or more associated Service Level Specifications (SLSs) which are delivered to RMs;
- the RMs, based on the received SLSs, make an evaluation of the impact that the service is going to have on the network and translate it in the form of a 'cost' to be paid for service enforcement: such a cost is then returned to the SM;
- the SM is now capable to formulate an offer, which is sent back to the AM: the offer comprises a contribution coming from the cost information provided by the RMs and an additional fee related to its own value-added service (e.g. content provisioning, brokerage activity with respect to network configuration, management of service options, etc.);
- once all of the quotations coming from the SMs have arrived, the AM sorts them according to the user's preferences, which may be derived from the user's profile. The sorted list of available offers is presented to the user: each single offer is built on the basis of the standard SLA template defined during the service creation phase;
- the user selects the offer which he deems most suitable. This operation, which has a legal value, is in all respects equivalent to the signature of a formal contract (Service Level Agreement).

For the actions described above, depending upon the application requirements, it might be requested the SLA to be translated into more than one SLS. This can happen, for example, when the application needs a duplex channel to work properly: one way to reserve resources (for the streamed multiplexed audio/video content) on the path from the video server to the end-user's system and the other to cope with streaming control data flowing in the opposite direction. This is true for the most common streaming protocols (RTP/RTSP, modified UDP versions, etc.) available nowadays. The situation obviously changes in those cases where the application needs to reserve completely independent audio and video channels (thus requiring one SLS each) or, stated in more general terms, whenever it is desirable to make a reservation for multiple, separate flows. It could be necessary to create more than one SLS also when different guarantees are to be assured over different time intervals

The traffic characterisations in the example presented on Fig.4 are expressed in the form of a sequence of time slots and related QoS parameters, generally in the form of a token bucket. Such characterisations are usually represented as *metadata* (i.e. "data about data"): in this way the information is linked closely to the media and becomes easily accessible to the Service Mediator in an automatic fashion. This approach of integrating metadata with multimedia content for the guaranteed delivery of digital resources looks to be extremely useful, in so far as users don't need to know anything about the communication requirements for the delivery of a certain multimedia document. All the work related to the negotiation of QoS guarantees with the network infrastructure can be managed and performed transparently by the mediation entities.

The Service Directory assumes a role which is of paramount importance for the CADENUS framework:

- it contains the business processes of the standardised services, together with the associated components (GUI and SLA template);
- it gives a SM the possibility to publish its own profile, together with the services it offers;
- it gives the AM the possibility to retrieve information about the portfolio of services and about the SMs that are offering them;
- it acts both as a registry and as a repository.

The directory is implemented by exploiting the UDDI (Universal Description, Discovery and Integration) technology, a framework for the description and discovery of services based on the creation of a world-wide registry aimed at facilitating integration. UDDI uses XML to represent data and SOAP (Simple Object Access Protocol) to exchange messages, thus solving the integration and interoperability problem via a layered approach. XML provides a cross-platform approach to data encoding and formatting, whereas SOAP makes it simple to package information that has to be exchanged across system boundaries. The Publisher's API enable companies to register information about the Web Services they offer; such information can then be retrieved by other companies via the Inquiry API. The data provided in a business registration are built of three different components:

- white pages, including name, address, phone number and other contact data related to a business entity which is providing services;
- yellow pages, basically a categorization of the companies/services based on taxonomies and/or standard identification mechanisms;
- green pages, containing technical information about the Web Services offered by a company (e.g. endpoint URL, names and arguments of the methods that can be invoked, etc.).

The problems related to scalability and reliability of the UDDI business registry are coped through an implementation that is logically centralized but physically distributed, with multiple root nodes (also called site operators) that replicate each other's data on a regular basis. Once a registration is made at a specified root node, the data are automatically shared with the other site operators, thus becoming freely available to anyone who is interested in discovering the Web Services that have been exposed by a given company.

5. CONCLUSION

The next generation IP networks are gaining more and more proselytes. Its appeal is due to the given opportunity of a standard and consistent way for network configuration, independently of the underlying architecture and QoS provisioning model assumptions. While this technology is powerful and alluring, it's also generally untested and unproven. The IST project from the 5th Framework Program of EU, CADENUS–Configuration and Provisioning of End User Services in Premium IP Networks has developed an architecture that aims to test and validate the policy and business based approach in a real network providing QoS. For that the consortium has developed a business layer in the service provider network and the underlying business model introduced to enable an automated QoS provision.

The successful deployment of an automated Service Level Agreement management system based on the CADENUS architectural framework intuitively introduce efficiencies in areas such as sales, order capture, order management etc., as well as provide an important mechanism through which companies can expand their business and market reach. The CADENUS architecture has been shown to be flexible and adaptable to likely future market developments. The functional separation inherent in the design allows for various mediator configurations, which permit the business roles of a commonplace in marketplaces to be provided for all services. The architecture has been shown to potentially deliver significant benefits to the user as well. While the potential viability of the CADENUS architecture has been presented and demonstrated, there are however a number of developments and refinements necessary before these benefits can be realised. Principally network operators need to complete their automated service activation programmes.

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