WIMS 2.0: Enabling Telecom Networks Assets in the Future Internet of Services

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Abstract. WIMS 2.0 initiative, focalized on convergence of telecom networks with web 2.0, provides mechanisms to offer the unique telecom service assets as part of the future Internet of Services. To achieve this, WIMS 2.0 technological foundation lays on the Open APIs concept: a so-called Telecom Exposure Layer at the operator network provides interfaces to easily integrate telecom capabilities with Internet services. Not withstanding, WIMS 2.0 includes other strategies: the telecom Portable Service Elements, providing a widget-based penetration of personal communication services into the Internet loom of services; the telecom-boosted User Generated Content publication and distribution, exploiting telecom services potential to produce UGC in real-time; and the Thin Clients, providing virtual terminal representations, ubiquitously accessible from any point of the Internet. WIMS 2.0 provides a mid-term view for the immediate evolution towards the future Internet of Services from a telecom-convergent view.

Keywords: Internet of Services, Web 2.0, telecom, convergence.

1 Introduction

The present paper condenses the ideas developed in the WIMS 2.0 (Web 2.0 & IMS) initiative. Taking into account the Web 2.0 revolution [2] and the future trends of the Internet of Services [1], WIMS 2.0 proposes an ecosystem for the creation of innovative user-centric services through the provision and exposure of unique telecom operator service assets towards the Internet.

Recently, a new philosophy for the design and development of services has brought about a massive wave of highly-social services in the Internet, creating the current Web 2.0. In this new fashion, the user becomes the centre of the service and the Internet becomes the platform for developing and delivering services, in many cases, through the mixture of functionalities (mashups) and content (syndication) coming from different Internet players. Continuing this approach, the future Internet will follow an open garden philosophy, with a flexible, cost-effective, technology independent deployment of new services in a plug-and-play service activation fashion.

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In order to adapt to this strategy, telecom operators must move from a network-centric to a user-centric approach and concentrate on the role of "Enabling Platform Providers for the Construction of Services". The appropriate exposure of operator's capabilities and platforms towards the Internet will enable the flexible and faster construction of final services by Internet players (e.g., a service provider on the Web or a user generating their own applications).

WIMS 2.0 has identified several strategies for exposing telecom capabilities, ideally based on the IP Multimedia Subsystem (IMS) [3] but not limited to it, from the operator networks to the Internet. Regarding IMS, it has been considered as the basis platform to support the exposure of telecom capabilities due to several reasons. Specifically, IMS is completely based on IP technologies and it was originally designed to support multimedia communications. Also, IMS-based set of standardized service enablers will conveniently enrich the capabilities to be exposed. In addition, apart from the above mentioned advantages, IMS will become the common control system for mobile, fixed and convergent telecom networks and services; thus, the consideration of IMS allows conceiving the telecom capabilities exposure strategy from a general point of view, able to address a widely common telecom operator scenario.

In the first place, in order to illustrate the context of utilisation and motivations of the WIMS 2.0 initiative, this paper shows some of the relevant characteristics of the future Internet. Afterwards, WIMS 2.0 convergence strategies are exposed and organized in different guidelines. Later, the reference architectural model, defined to obtain the desired convergence along the proposed guidelines, is presented. This reference model allows establishing the main architectural concepts for the definition of a specific WIMS 2.0 Service Platform. Finally, and aiming to clarify the viability of the proposed solution, this paper presents the results of one representative proof of concept within the WIMS 2.0 initiative. The positive outcomes and the interest of several WIMS 2.0 proofs of concept and use cases have prompted WIMS 2.0 founders to start a practical implementation of the presented ideas.

2 The Future of the Internet

The future Internet [1] is envisioned as an open garden of services, where new models will be developed for the deployment, distribution and discovery of services in a efficient, controlled and network technology independent way. In this context, Internet will become a flexible open environment for the deployment of new services in an easy plug & play service activation fashion.

In this context, combination and flexibility becomes major principles for the design and development of final services, being currently essentials of the Web 2.0 revolution as the first step of the future Internet of Services. In this respect, the worldwide adoption of Internet and IP connection capabilities, along with the appropriate use of remote procedure execution schemes (i.e. open Web APIs), is enabling the mixture of service functionalities (mashups) and content (syndication). The possibility to combine resources coming from different locations of the Internet, as if it were a huge computer, provides an extraordinary flexibility to create new services in a short time. Thus, the Internet becomes the platform for developing and delivering new cost-effective services, virtually to any part of the world.

In addition, a new philosophy based on user-centric approach is emerging in the design and development of new services. In this paradigm the user is the centre: the user is now regarded as the main active driver of the service, so that he can freely express his preferences. The users create the service content, they can customize service features, they effectively affect the service evolution and they can even participate in service development, directly constructing modules and applications in order to fulfill their own needs.

Additionally, the new universe of forthcoming services will effectively consider the situation and context of users, capturing their environment and localization at each time. These new services will provide extended (multimode, ubiquitous, personal, contextual, pro-active, self-learning, etc) and multi-device interaction with users, bringing forward the preferences and necessities of users at each moment. Besides, the future of internet will be associated with mobility, dynamism and advanced connectivity. Always-on connectivity will be essential, with services always available independently of the device and access technology (fixed or mobile, etc).

Taking into account some of these future trends, telecom operators must adapt their service architecture and business models for converging, being involved and provide advanced service connectivity for the future Internet. Thus, telecom operators must implement a service architecture based on the offer of network operator capabilities and provision of means for users to be always connected and interacting with the future service-oriented Internet.

3 Exposure of Telecom Operator Service Assets to the Internet

The main objective of WIMS 2.0 is to make the telecom network operator services available into the future Internet of Services, being the first step to make them available into the current Web 2.0. Following this approach, the final service is actually provided by a Third Party located in the Internet, but the operator offers an added value, maintaining an active role through the provision of unique telecom service assets, apart from providing connectivity. WIMS 2.0 proposes a strategy organised in several guidelines. The first three general guidelines are considered within WIMS 2.0 initiative to cover this approach:

Guideline 1: Incorporation of IMS capabilities into the Internet of Services through open Web APIs, allowing the integration of IMS and telco capabilities into the Internet of Services, currently enabling this integration into Web 2.0 mashups. This potentially applies to any IMS capability and by extension to any telecom service capability, which would therefore be usable by/from any Internet service. Two different, but interrelated, strategies are proposed here:

1. **Portable Service Elements (PSEs):** IMS and telco applications can be incrusted into the Internet of Services in the form of web-widgets, which would be the technology-specific implementation of a PSE. The PSEs provided by the operator (or a Third Party) can be easily integrated by end users into current Web 2.0 sites and, once incrusted, they are able to handle the interaction with the operator's open Web APIs, thus, enabling the use of IMS communication capabilities from Web 2.0 sites.

2. **Direct incorporation into Internet mashups:** Once IMS and telco capabilities are exposed through open Web APIs, they can be directly incorporated into any service of the Internet in order to provide complementary functionalities, just like any other regular mashup. Of course, the inclusion of IMS and other telco capabilities is a decision of the Internet service (i.e. the Third Party); however, the final outcome is a complete integration of telecom capabilities in the resulting service. Due to the fact that current Web 2.0 service operation must be modified to consider the use of IMS APIs, the application of this strategy is not immediate, but for the mid and long-term it enables a convergence of great impact and further applicability.

Guideline 2: Publication of user-generated content enabled by IMS. Mobile handsets are expected to be one of the main sources of multimedia content in the future. This convergence guideline aims to obtain new ways for content publication through the usage of IMS or legacy multimedia transmission capabilities. Operators can provide new solutions to receive the multimedia content from the user and automatically upload it to Internet and currently more concretely to the Web 2.0 sites. An example application is "YouTube real-time video generation", where users video-call YouTube to create a spontaneous clip. Other examples may explore the use of other types of user-generated data, such as IMS Presence or other user's context information. By extension, pre-IMS capabilities like e.g. videotelephony are good candidates to be considered in this guideline too.

Guideline 3: IMS on-line applications. Through the use of AJAX and other technologies, current Web 2.0 applications have achieved major advances in the field of user interfaces. WIMS 2.0 favours for the usage of these technologies in order to build on-line application that directly use the operator's communication services. The objective of this convergence guideline is to achieve that web applications act as the user terminal. The benefits of such kind of IMS/telco applications are, mainly, ubiquity and a great simplification of service development and deployment, since the client service logic actually resides on the operator's network. An example of application is to enable a virtual IMS terminal within an end-user's browser.

Additionally WIMS 2.0 incorporate a fourth guideline for the integration of generic multimedia content and events from the Internet within telco services. This strategy will enhance end-user experience, completing in this way Internet and telecom network operator convergence:

Guideline 4: Incorporation of future Internet content and events into telecom services. Since Web 2.0 services are already holding the successful content (the user-generated content) the WIMS 2.0 initiative champions new mechanisms and functionalities for obtaining generic multimedia content and events from the Internet. Among the content, we may find videos, advertisements, podcasts, news, etc. Among the events, we may find contextual information associated to social networks, new content publication alerts, etc. The introduction, integration and distribution of all this information within IMS services is of great interest, since it can enhance end-user's satisfaction. As example services, we may consider special feed readers for mobile handset, the inclusion of social networks events into IMS Presence or Web 2.0 video and music automatic distribution using IMS/legacy multimedia transmission capabilities.

4 A Reference Model for the WIMS 2.0 Service Platform

This section introduces a reference model for the WIMS 2.0 service architecture. The proposed reference model covers the WIMS 2.0 strategic convergence guidelines presented above. From a high level point of view, the WIMS 2.0 service architecture must be a service platform that, acting as an intermediary for the adaptation between the operator network and the Internet, enables the convergence in the desired terms. The proposed reference model is reflected below in Fig. 1.

The above reference model defines a framework that identifies the required logical entities, as well as the relationships existing among them. Due to the different natures of the systems to be converged, this level of abstraction permits to settle the main concepts and design principles prior to the definition of a concrete service architecture considering specific technologies.

Two main groups of entities can be identified in the WIMS 2.0 reference model: entities exposing telco capabilities to the Internet of Services, including the ones providing IMS/telco-based online applications to the end-user's browser, and entities for the exchange of multimedia content and events between the Internet of Services and the operator network. For these two groups, a common entity is set as the axis of the reference model, the IMS Exposure Layer entity for exposing telco and IMS capabilities. For clarity reasons, we will present this basic entity within the first group.

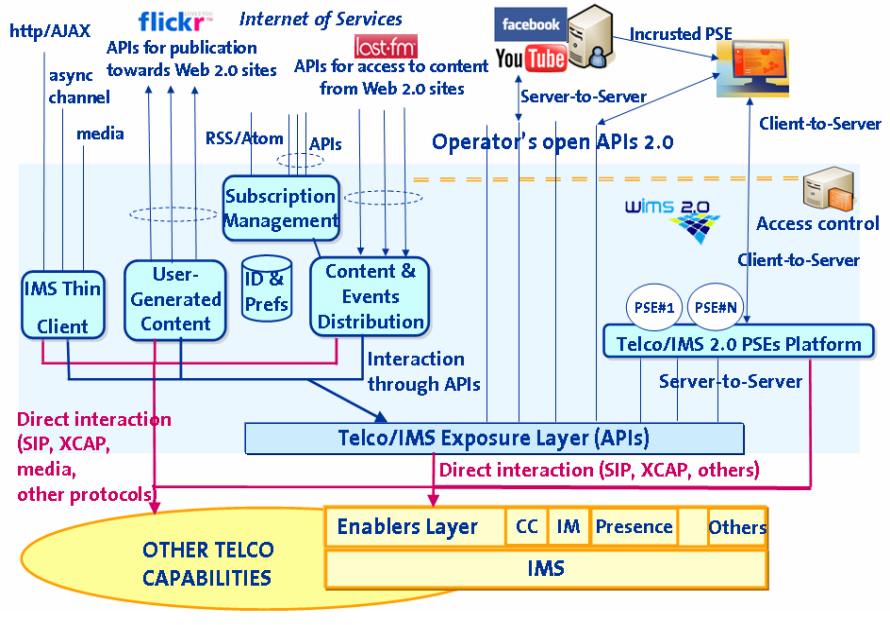

Fig. 1. Architectural reference model for the WIMS 2.0 service platform

The entities dedicated to the exposure of telco capabilities to the Internet, and their functionalities are presented below:

- **IMS Exposure Layer:** The entity for the exposure of IMS capabilities is the IMS Exposure Layer. This entity exposes IMS capabilities to the outer world through open Web APIs. Concretely, WIMS 2.0 focuses on the use of REST (Representational State Transfer) [4][5] for these APIs, since it is simpler and lighter than other RPC-based approaches (e.g. SOAP Web Services) [6] and, more importantly, REST APIs are the predominant technology in today's Internet mashups. Therefore, on the outer side, the IMS Exposure Layer manages RESTful HTTP messages [11] requesting or responding to the execution of a specific procedure [7], while, on the inner side, it interacts with IMS/telco capabilities using the appropriate protocol (SIP [8] or XCAP [9]). As it can be noticed, it is actually a gateway between HTTP and other telco protocols. In principle, all the available IMS/telco capabilities can and should be exposed by this entity following this approach.
- **IMS 2.0 PSEs Platform:** This entity hosts and serves telco widgets or PSEs to be incrusted into Internet sites (user's browsers). These PSEs are provided by the operator and they offer telecom service features using the operator's APIs exposed to the Internet of Services environment. This platform can expose simplified APIs and translate the interactions through those APIs towards the "complete" APIs exposed by the IMS Exposure Layer. IMS 2.0 PSE may also access the telco capabilities directly.
- **IMS/Telco Thin client:** Entity for the delivery of IMS on-line applications. On one side, this entity interacts with IMS/Telco capabilities, acting as the final IMS/Telco client. On the other side, it shows a rich multimedia Web interface to the user, according to the service being provided. This entity must also handle a continuous media interface towards the user, as well as an asynchronous interface to signal the need to refresh the Web interface due to an incoming network event. As the final result, this entity enables the virtual terminal within the end-user's browser.
- **Access control entity:** To secure the use of the operator's APIs, performing identity authorization and authentication and parameters conversions.

The entities for the exchange of multimedia content and events, and their functionalities, are the following:

- **User-Generated Content enabler:** This is the most relevant entity in terms of providing user generated content in real time towards internet services. This entity receives content from IMS/Telco terminals and, after adapting its format, it uploads this content to the Internet, and more concretely currently to Web 2.0 services. To receive the content from the user, it uses a specific set of IMS capabilities.
- **Subscription Management enabler:** It subscribes to content and events of any kind generated in the Internet of Services. Currently it subscribes through RSS/Atom [10] channels to contents and events of Web 2.0 services. Subscriptions may be made on behalf of the operator or directly on behalf of the final user. This entity talks with the Content & Events Distribution enabler to inform about the existence of new content/events to be obtained.

- Content & Events Distribution enabler: It downloads, adapts and transmits content and events from the Internet of Services to IMS/Telco users. To perform the transmission on the telecom network side, it uses a specific set of IMS/Telco capabilities.
- IDs & Preferences: Database that stores the relationships between IMS identities and the identities used by the Internet of Services. The other entities of this group consult this database to perform the conversion of identities when using Internet services APIs.

In this model, the IMS Exposure Layer is of paramount importance since it provides a basis for the rest of entities to access the telco capabilities in a simple way, while permitting other external applications in the Internet of Services ecosystem to access the telco environment and its service creation assets. Thus, the IMS Exposure Layer is responsible for enabling the so-called network mashups combining functionalities from the Internet and the telco world. The use of RESTful APIs in the IMS Exposure Layer provides non-telco developers with an understandable and familiar view of the telco service capabilities, which is ultimately intended for the promotion of its extensive use within the Web 2.0 world.

The proposed reference model has been tested through several proofs of concept: IMS communication widgets, telco-enabled mashups based on IMS APIs, and content publication and distribution services that use telco transmission capabilities for exchanging Web 2.0 contents. The result of these proofs of concept have validated the correctness of the proposed architecture, although a high capacity, industrial environment still needs to be developed in order to test the scalability of the system. An example of such proofs of concept is presented in the next section.

5 Proof of Concept: Mashing up Telecom Services with Web-Oriented Applications. The FindUs Application for Social Networks

In order to illustrate the WIMS 2.0 concept, a use case “Find Us Application for social networks” has been implemented. This use case is in the scope of the first guideline of the WIMS 2.0 service strategy presented above: Incorporation of IMS capabilities into the Internet of Services through open Web APIs, featured for the current Web 2.0. Specifically, this use case is materialized as a gadget application which implements a mashup re-mixing several external functionalities/services. The gadget application is included in a social network container. In this example, the host social network is the popular Facebook. In this social network environment, this kind of gadget applications are not provided by the social platform operator, but rather by end-users. Even though the end-users are required to entitle some developing skills, this ratifies the user-centric approach as one of the axis of the new-era Internet. In the near future, developing tools for User Generated Services will allow almost anyone to synthesize smart applications by combining available service resources in the Internet of Services.

The end-user service concept of the FindUs application is shown in Fig. 2 below. As shown, the gadget is embedded in Facebook, thus user interface of the application

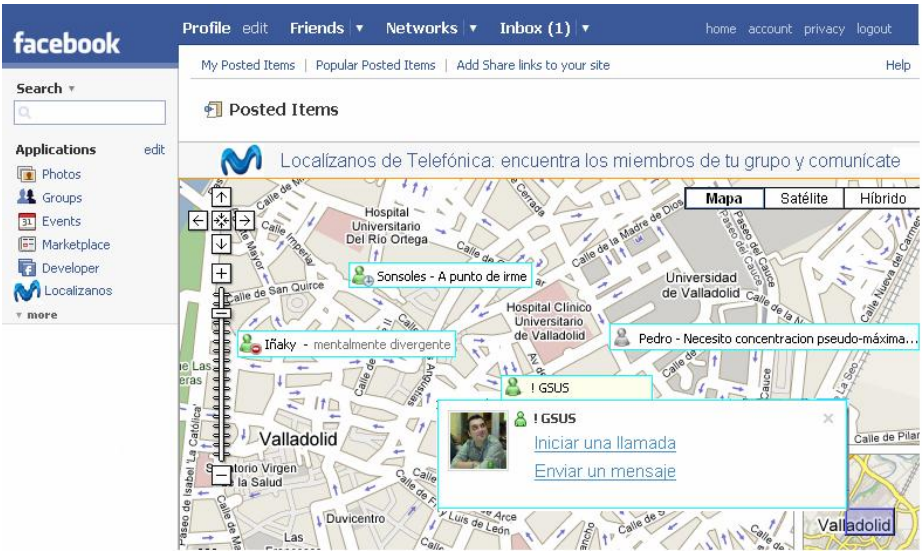

Fig. 2. Service concept of FindUs gadget application

is rendered by web technologies. With this application, a social network user can locate his/her group of friends in a map and if available, their position is calculated utilizing mobile location. Alternatively, the civil address included in the social network user profile is utilized and marked as such. For each located user, an icon is drawn representing the user's current presence communicating status and the personal note describing current user context. This personal note is normally imputed by the user in his/her mobile terminal or Communicator application and automatically obtained by the FindUs application.

When clicking on any of his/her located contacts, the user can obtain a list of service features that can be invoked to communicate with the located users. For instance, the user can request a click-to-call service to establish a communication between his/her mobile phone and the located user's mobile phone. Alternatively, the user might be able to start an instant messaging conversation from the web interface of the gadget towards the located user's mobile phone, or just send a single message to this located user.

In the specific case of the FindUs gadget application, several resources from a current instantiation of the Future Internet of Services are utilized. The application is mashing up programmatically-controllable Maps from Google and User Profile data provided by Facebook with telecom service assets like IMS Presence, IMS Third Party Call, IMS IP messaging and cellular location. All these service resources are made available to the wide Internet by means of Open APIs interfaces, which expose the functionality and perform service invocation. Figure 3 shows this new paradigm for service creation with the utilization of telco operator service assets as service resources available in the Internet. Concretely, in our example, telco services assets consisting of person-to-person conversational capabilities (i.e. click to call), user context information (i.e. presence) and messaging capabilities (i.e. instant messaging)

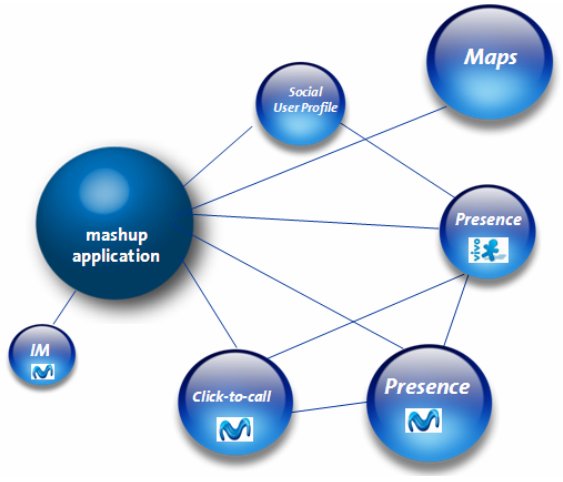

Fig. 3. Example of the Internet of Services for the FindUs gadget

are exposed and made available for combination together with other service resources across the Internet, such as the social user profile information from Facebook, maps from Google or Presence information from an Internet Server. The combination of this range of services brings about innovative and enhanced mashup applications also able to be combined and used as service resources.

Regarding the proof of concept implementation, Fig. 4 shows a high level overview of the interworking between the entities from the Web 2.0 and the operator network that supports the present use case. From the operator network side, some of the entities from the WIMS 2.0 reference model presented above are involved. Concretely: the Telco/IMS Exposure Layer, the Telco/IMS PSEs Platform and the Access Control together with a series of enablers (i.e. location, presence, telephony and instant messaging) that finally provide the telco capabilities. In order to avoid current State of the Art restrictions with regard to telco capabilities, enablers are not mandatory based on IMS, being pre-IMS telco enablers also considered in this implementation. This fact validates and remarks that WIMS 2.0 is viable for general Telco environments, not just for those based on IMS.

For this use case, the FindUs application is hosted within the PSEs platform, which is in charge of invoking the necessary telco APIs (usually based on REST technology) and other Web APIs from the Internet. In this scenario, when a Facebook user starts a session in Facebook and executes the FindUs application, the Facebook platform acts as a merely HTML traffic intermediary, forwarding requests and responses between the user's browser and the PSEs platform. As the first step in order to provide the FindUs functionality previously presented, the PSEs platform invokes a particular Facebook Rest API including the Facebook credentials of the user to obtain the contact details of his/her group of friends. Subsequently, when the telephone number from each friend of the group is retrieved, the PSEs platform invokes the cellular location API exposed by the Telco/IMS Exposure Layer. This location information will be forwarded back to the user's browser, being .the location of any friend of the

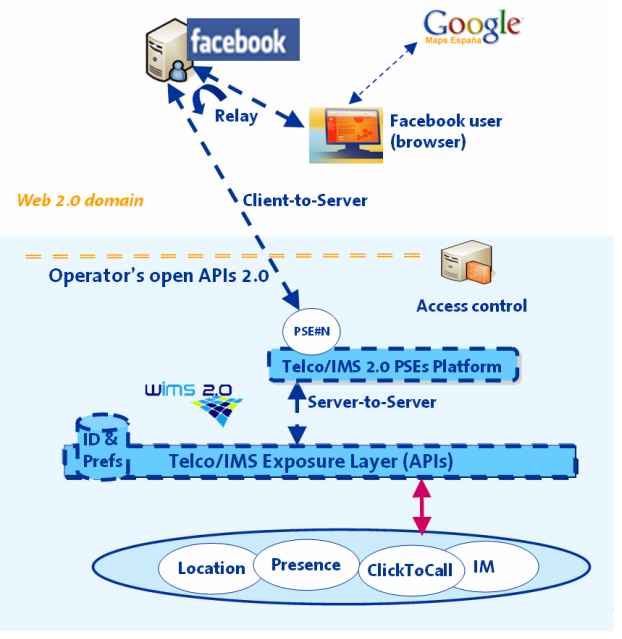

Fig. 4. High level overview of the interworking between Web 2.0 and WIMS 2.0 Reference Model for "The FindUs" application

group available at the user's browser. Finally the user's browser will access the REST API from Google Maps, to obtain the maps for the graphical representation of the location of each friend of the group. A similar procedure will apply for the case of retrieving friends' presence information from the operator network, where PSEs platform will invoke the presence API of the Telco/IMS Exposure Layer. Regarding, the remaining telco functionalities, for instance, if the user wants to starts a conversational or instant messaging session, the PSE platform will send the necessary requests towards the appropriate telco capabilities exposed by the Telco/IMS Exposure layer.

This proof of concept clearly reflects the power of a typical Web 2.0 concept that, this time, is applied in the telco environment: service mashups. The combined used of different Open Web APIs has enabled the fast creation of a service that mixed standard-web services, like social User Profile and Maps, with IMS/Telco communication and user context features. As it can be observed, this represents a powerful tool for creating new application by combining resources made available in the Internet of Services.

6 Conclusions

The future internet is envisioned as an open garden of services, where services will be deployed easily in a plug & play service activation fashion, resulting from the flexible

combination of resources and services from anywhere. In this context, telecom operators must follow this new philosophy adapting their infrastructure and business model with new mechanism for exposing their unique service assets as service resources towards the Internet. Thus, operators will integrate into the future of internet value chain in order to be not only a connectivity provider but also an added-value provider in the creation of innovative services.

WIMS 2.0 establishes a series of strategies for efficiently exposing telecom operator network services to the future Internet of Services and for enabling the convergence of telco and Internet worlds. WIMS 2.0 is based on the aperture of telecom capabilities through Open APIs providing web friendly interfaces to easily integrate telecom capabilities with Internet services. Together with this Open API strategy, WIMS 2.0 establishes additional strategies for convergence that include: Portable Service Elements, providing a widget-type penetration of personal communication into Internet applications, User Generated Content publication and distribution for exporting UGC in real time, and the so-.called Thin Clients, providing telco-based online applications, like virtual terminal representations, ubiquitously accessible from any point of the Internet.

To materialize this convergence approach, a reference model for the WIMS 2.0 Services Platform has been proposed following the general idea of providing an intermediate layer to break the frontiers and adapt the interactions between telco and Internet domains. This core reference model mainly lies upon the exposure of telco/IMS capabilities via open APIs, based on a Web 2.0-friendly approach in order to maximize the effective and widespread adoption. Besides the entities exposing telco capabilities to the Internet, this reference model includes several entities for the exchange of multimedia content and events between the Internet and the operator network to establish a full convergence.

Finally, one proof of concept, based on the strategy of incorporating and remixing IMS capabilities along with other Web 2.0 services through open Web APIs has been implemented and presented in this paper, as an example to illustrate and validate the potential of the WIMS 2.0 principles.

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