



The 8<sup>th</sup> International Conference on Mobile Web Information Systems (MobiWIS)

## **Towards Building Semantic Next Generation Network – A Preliminary Study**

Kidd S.C. Toh<sup>a</sup>, S.M.F.D Syed Mustapha<sup>b</sup>

<sup>a</sup>*Universiti Tun Abdul Razak, Leisure Commerce Square, 46150 Petaling Jaya, Selangor, Malaysia*

<sup>b</sup>*Asia e University, Main Block, No4, Jalan Sultan Sulaiman, 50000, Kuala Lumpur, Malaysia*

---

### **Abstract**

Next Generation Network has drawn great attention by the researchers and telecommunication industries as the future generation in the communication technologies and services. The interest covers all aspects on NGN from the global standards, architecture and services. The management of services provided in the NGN environment has posed great challenges due to the heterogeneity of the service protocols, service requirements and specifications and service functionalities. The recent effort in the autonomies of service management is the initial effort towards achieving this paper. The paper proposes enhancement of the automated service management through embedding the semantic service descriptions that can be referenced to the service ontology for service creation and management. IMS (IP Multimedia System) is used as the core communication platform as it provides various services running on different protocols besides the common internet protocols and web services.

Keywords : IP Multimedia System ; Web Service ; Session Initiated Protocols ; Service Oriented Architecture ; Semantic Next Generation Network

---

### **1. Introduction**

IP Multimedia System (thereafter IMS) provides the underlying infrastructure and foundation of the next generation networks. The paper proposes automated service ontology for service creation and management of IMS or namely Semantic Next Generation Network (SNGN). The service architecture is developed around the IMS functionalities and several majority protocols. The principle and outline of the converged technologies, different types of platforms and network elements are briefly described in the following sections to establish basic understanding on them.

\* Corresponding author. Tel.: +6012 2990578; fax: +603-77273013.

E-mail address: [chokobo\\_k@yahoo.com](mailto:chokobo_k@yahoo.com), [smfdsm@yahoo.com](mailto:smfdsm@yahoo.com)

### *1.1. IP Multimedia System*

IMS is a standard defined by 3rd Generation Partnership Project (3GPP/3GPP2) to support convergence of different types of network, like GSM, WCDMA, CDMA2000, Wired broadband access and Wireless Mobile. It also allows access to, voice, video, messaging, data, and web-based technologies for the users in a mixed network.

IMS based services will bring a new experience to the users. The users now can experience mixed mode communications, this include voice, images, video, text or any combination of these. The experience can be further personalized to suit the liking of the user in a controlled manner.

The business benefits to the operators is the ability to introduce new services to market faster in order to keep up with the ever challenging of the growing consumer markets in the mobility space. The horizontal architecture in providing the services enables reusability of the common services and functions for multiple applications. Service creation and provision process will be simplified to provide a wider space for creative and innovative ideas and for the service management to be realized.

### *1.2. Session Initiated Protocols*

The Session Initiation Protocol (SIP) is an IETF-defined signaling protocol, widely used for controlling multimedia communication sessions such as voice and video calls over Internet Protocol (IP). SIP specification can be obtained from the Internet Engineering Task Force (IETF) Network Working Group under RFC 3261 [1].

SIP is an Application Layer protocol which is independent from the transport layer. It is designed to run on Transmission Control Protocol (TCP), User Datagram Protocol (UDP), or Stream Control Transmission Protocol (SCTP). In November 2000, 3GPP accepted SIP as the signalling protocol for IMS.

### *1.3. Web Service*

The W3C defines web service as a software system which supports interoperability interaction of machines over a network. The interface format describes the attributes of the service using Web Services Description Language (WSDL) [2] which is standard and machine readable. Systems interact with each other by consuming SOAP [3] messages, typically transported using HTTP with an XML serialization.

The development of Web Service is to address the problem of interoperability between different applications of multiple systems. However, the presence of Web Service can only address some of the problems of the different requirements of different systems. A semantic Web Service [2, 3] thus is needed to fill up the requirements gap of the business needs.

**Service Discovery:** For a requester to find or use the service, the most common approach is to use the Universal Description, Discovery and Integration (UDDI). The problem with UDDI is that the description is not machine-understandable; therefore manual human intervention is needed to interpret the nature of the service. There is a need to fully automate the process and support for keyword based search discovery capabilities as the services can grow exponentially.

**Service Interoperability:** Although the Web Service is interoperable, there are still situations of mismatch cases on data communication for different providers and requestors. The problem further develops for a more complex communication pattern, that the communication between services involves negotiations, responses that are dependent to decision making, and multiple communication acts. Current XML standard and XML schema only help to solve the data mismatch in structural and syntactical level. As the mismatch of the data communication pattern is not address in the current Web Service, semantic message exchange sequence is needed to solve the issue.

**Service Composition:** A requestor can use multiple services offered by the provider without the knowledge of the underlying system of the provider, for example, the hardware being used, operating system that manages the components of the network, programming languages and so on. There is a need of binding the services from the requester to the provider. The current Web Service does not have the possibility and capability of dynamic binding

at the runtime. As the service requestor needs to bind to a specific service, they cannot take the advantages of the large and constantly changing amount of Web Services available.

#### 1.4. Web Service Modeling Ontology

Semantic Web Service is one of the ways to address the issue discussed. Semantic mark-up can be used for an automatic discovery, service composition and interoperability of the services.

The Web Service Modeling Ontology (WSMO) [4] is a conceptual model related to Semantic Web Services. It provides an ontology based framework, which supports the deployment and interoperability of Semantic Web Services. The formal language being used to provide syntactic and semantic for the WSMO is Web Service Modeling Language (WSML).

The four main components of WSMO [4]:

- **Ontologies** – Define formal semantic description and allow the linking of machine to human terminology. It also gives information understandable to components, for both human and machines and provides meanings to other elements (goals, mediators and web services)
- **Goals** – Define the client’s objective and needs when requesting for a Web Service. The requestor will express its goal in one hand to let human to understand the goal and in the other hand for the machine to interpret the nature of the request. The advantage of using the goal is that it does not require one to browse through the UDDI registry to find the appropriate service as the requester already provides a declarative description of what he wants.
- **Mediators** – The connectors between components with mediation facilities. It provides interoperability between different communication protocols.
- **Web Services** - Semantic description of Web Services which include functional capability and usage descriptions. If the requestor and the Web Service use the same ontology the matching between the goal and the capability can be directly established. However, in most cases, the requestor and the Web Service will be using its own ontology, making a need to consult third party to check if the goal and capabilities can be matched. The third party needs to make sure that there are similarities in the goal and the capabilities before establishing connection.

The Web Service Execution Environment (WSMX) [6] is a reference implementation for WSMO designed to support dynamic discovery, invocation and composition of Web Services. Service provider can register their services in WSMX to make it available to the consumer, and subsequently, service requestor can find the service they need in semantic environment.

#### 1.5. Semantic Description of IMS

As WSMO mainly deals with Web Service, and underlying protocol for IMS is SIP, there is a need of integrating both of them together to provide ontology based IMS.

The core IMS protocol which is SIP can be exposed as Web Service which can be consumed by WSMO. Other protocol such as Short Message Peer to Peer (SMPP), Simple Mail Transfer Protocol (SMTP), Hyper Text Transfer Protocol (HTTP) and so on can be integrated to the existing WSMO architecture using the same concept, by exposing them as Web Services. As there is a clear goal for each of the protocol, a semantic description can be tied to each of them. For example, “Make Call” can be related to SIP, “Send email” can be related to SMTP, “Send SMS” can be related to SMPP. Eventually, the protocol is exposed as a service which is reusable both in IMS and WSMO.

## 2. Defining Next Generation Network Semantically (NGN)

### 2.1. Introduction to Next Generation Network

Next generation network (NGN) [5] describes the key architectural evolutions in telecommunication core and access networks. NGN is commonly built around Internet Protocol, usually termed as ‘all-IP’. The general idea of NGN is to build one network which transports all information and services on the Internet and all terminal devices would one day own an IP.

Over the years, the evolution of NGN concept has led to definition of IMS. IMS allows realization of versatile, mixed-technology, call schemes, such as UMTS-to-WLAN and PSTN-to-Broadband over IP network.

### 2.2. Semantic NGN

To achieve Semantic NGN (SNGN), Fig. 1 shows the high level architecture and the important components of semantic NGN which integrates IMS and WSMX.

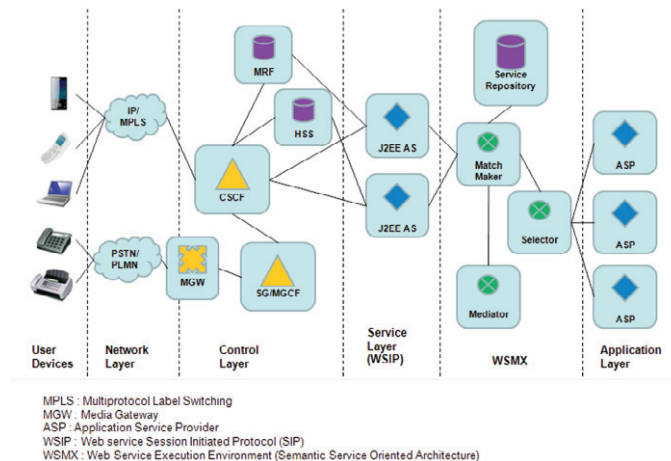


Fig. 1 High Level Architecture of Semantic NGN adopted from [7,8]

Service layer of IMS will be integrated into WSMX Match Maker. IMS services will be exposed as Web Service and register in WSMX service repository as one of the Web Service. A J2EE application server in this case will be used to manage IMS related protocol, for example, SIP and responsible to expose the Web Service endpoint to WSMX.

Match Maker is responsible to find the appropriate service to achieve the requestor’s goal. A goal matching degree should be specified to determine the level of matching of the services, as the requestor might be satisfied to the services which can fulfill to some extend of the goal.

### 2.3. Use Case of Semantic NGN

To illustrate the scenarios, below are some of the use cases:

Mr. Jimmy is a Google calendar user. He’s constantly updating his activities and meetings into the Google calendar as a reminder to himself. With the integration of IMS network and the calendaring service, one can explore further into behavior and contextual based call handling. For example, Mr. Jimmy had set a meeting appointment in the Google calendar from 10am to 12pm. In the calendar note, he had specified, “Please call my secretary”. When Mr. Sean tries to call Mr. Jimmy at 11am, based on the calendar event of Mr. Jimmy, he is not available due to the meeting and the calendar note specifies to call his secretary, the call will be automatically routed to Mr. Jimmy secretary without any intervention. On Mr. Jimmy’s mobile, he will get an email notification or SMS notification saying that Mr. Sean tried to call him on what time the call is being handled by his secretary. This can be further explored to handle the call differently based on the ontology of the user’s behavior based on what he is looking for in his calendar.

The other scenario based on the calendaring service will be, Mr. Jimmy can set his availability status as “Away From Office”, “Do Not Disturb”, “Call My Mobile”, “Contactable via SMS” and so on. If Mr. Sean call Mr. Jimmy, depending on the status of availability of Mr. Jimmy, the call will be handled according to Mr. Jimmy’s preference. For example, “Away From Office” will route the office land line to Mr. Jimmy’s Mobile number, “Contactable via SMS” will convert the voice Memo as SMS text and deliver to Mr. Jimmy and so on.

The services can be further extended by taking the existing ontology and relate them through different services, for example, location map, food finding, event finder and so on. A related case will be when Mr. Jimmy set a golf appointment at evening; a food finding service will recommend to Mr. Jimmy the popular place to dine near the golf club and with this, Mr. Jimmy can send invitation to his partners to have dinner together.

These scenarios are demonstration of the capabilities in linking multiple protocols and multiple services in semantic way and the comprehensive view of how advance service orchestration can be done over Semantic NGN.

#### 2.4. SNGN Architecture

To achieve SNGN, there are 2 main building blocks in the architecture. The first part is the application server which will interface with IMS and other protocols to provide web service interface for the later part, which is the WSMX environment which will define the semantic description to the services.

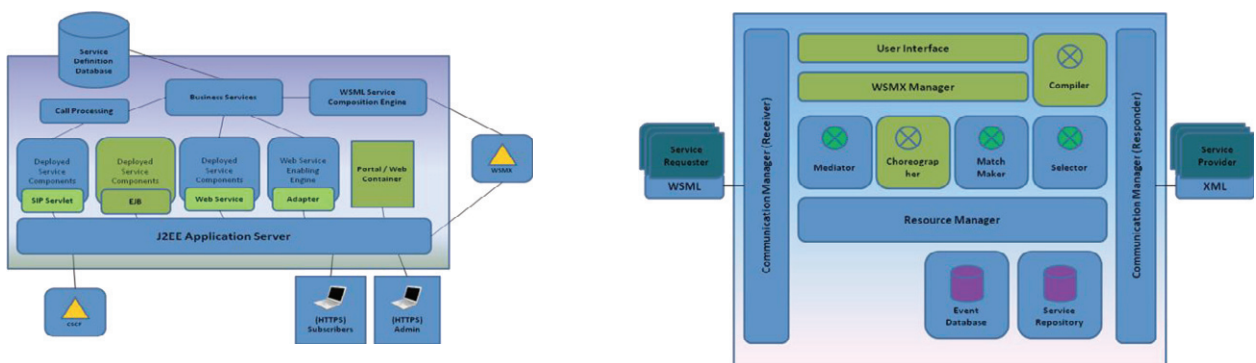


Fig 2 (a) Application Server managing SIP and other protocols adopted from [9]; (b) WSMX architecture adopted from [8].

A J2EE application server will be deployed to intercept IMS signal via SIP servlet. From there, business rules and services are applied according to the call scenario and a semantic description is attached in the request forwarding to WSMX to do the service matching and orchestrations.

To illustrate the operation of SNGN, taking one of the scenarios as an example, the operation comprises of the following steps.

1. Mr. Sean Call Mr. Jimmy
  - a. A -> MPLS -> CSCF -> call handling
2. Mr. Jimmy calendar set to Meeting, Meeting note saying, "call my secretary"
  - a. Check B calendar -> construct semantic description
3. Call route to Ms. Secretary, call connected between Mr. Sean and Ms. Secretary
  - a. Call routing based on semantic description -> CSCF -> Connect A and B
4. SMS / email notification send to Mr. Jimmy
  - a. Event based action -> send SMS / Email after the call connected

The SNGN in the paper is designed for easy integration with WSMX and IMS based applications. The incorporation of the Semantic Web Services provides the standard WSMX with enhancements to support IMS environments which are multiple protocols. One of the important advances is the semantic based switching and call control environment.

#### 2.5. Issues on the Challenges to the Semantic Architecture and Execution in the NGN environment



NGN poses greater challenges to the semantic architectural design in comparison to the existing WSMX as it covers wider ranges of service types, deals with multiple communication protocols, involves an interworking between different operator networks and bridges the communications between IP and non-IP terminal devices.

IMS is chosen as the convergence platform for the NGN as opposed to others such as H.232 and AccesGrid[10] as the former has gained popularity among the telecommunication service providers. There are three main layers in the standard IMS architecture which are the Service Layer, Control Layer and Connectivity Layer. While in the Semantic Web Services, the semantic is built around the application layer through the enhancement on the WSDL description, UDDI directory services and the selection, searching and matching techniques.

The followings are some of the issues and challenges that the Semantic NGN has to consider for the implementation:

**IMS default services:** IMS comes with default common functions such as grouplist management, presence, provisioning, directory, charging and deployment which can be used by the applications built on top of the application layer. These functions are originally defined by the standard body such as 3GPP/3GPP2/TISPAN and to be accepted widely to be compatible with other network providers such as PSTN, WiMAX, WiFi etc. The number of default services will continue to grow as much as the applications that are using them. Hence, the built-in IMS functions require semantic descriptions to describe its capabilities and limitations. For example, “presence” of a user is described differently depending on the application capabilities to detect the attributes of the user’s “presence”. The “presence” could be signing in or out of a user in the online chat room or geo-location information of the user’s whereabouts based on the GPS coordinates.

**Interworking between service providers:** IMS supports the convergence between the wire-line and wireless line as well the legacy PSTN network. The applications available from the terminal devices of these services vary depending on device capabilities. Due to these variations, the information of these devices is difficult to be captured at designed level and even so maintaining them can be arduous. The devices are upgraded with new features by the manufacturers in many cycles of product releases. For example, some new smart mobile phones are equipped with telephony capabilities that may allow network hopping when call is made on the GSM network to the WiFi when the latter is cheaper or free. The operation will complicate when the equipment is not WiFi-ready or not equipped with it and the switching will occur when the WiFi access is available. Building the ontology to describe the service availability and the device capability will assist the selection of appropriate service.

**Access-aware of network capabilities:** IMS deals with various networks with different capabilities and constraints. In the NGN environment, smooth transition between networks is the upmost requirements and therefore network information is essential in order to decide based on the network latency, QoS, device-support, bandwidth availability and protocols. Applications run on the server refer to the network format whether it is packet-switched or circuit-switched and therefore the traditional semantic language such as DAML, OWL-S, WSDL Extended and others are not suitable for this purpose. Ontology to describe the complex information of the network is required.

The issues raised above are not exhaustive but sufficient to illustrate the needs of the ontology-based support for managing service creation and management for NGN environment.

## *2.6. Facing the challenges of SNGN*

The challenge of SNGN is of the nature of the service environment. For WSMX, it’s dealing with single protocol, which is the web service. There is no clear implementation in the WSMX to handle multiple protocols other than web service. The WSMX framework also does not provide detail on how to create and design for multiple protocols. This is the main challenge of bringing IMS into WSMX environment and to have a SNGN.

The IMS environment will be more complex than Web Services, as IMS environment is highly dependent on the underlying network and devices capability. As the relationship between network and devices alone can be complex, there is a need for semantic description to handle between network environment and device capabilities.

To easy integrate the multiple protocols of IMS, a standard SOAP/XML interface will be used to package the underlying heterogeneous protocols. The important feature of the SOAP/XML interface is the ability of call control. ECMA had proposed ECMA-348 [10], Table 1 which provides a standardized abstraction layer of call and device control in telecommunication environment. The idea is introduced as Web Service SIP (WSIP) [11]. This has to be further extended to include not only IMS protocols but also the mass protocols supported by NGN networks like

SMPP, SMTP, HTTP, FTP and so on. By having an encapsulated web service layer, Web Service NGN (WSNGN) which supports multiple underlying protocols, it will be beneficial to apply into Semantic NGN environment.

Table 1: An example of XML element specified in ECMA-323 with XML Data reference [12]

|  |   |
|--|---|
| <pre> &lt;xsd:element name="AnswerCall"&gt;   &lt;xsd:complexType&gt;     &lt;xsd:sequence&gt;       &lt;xsd:element name="callToBeAnswered" type="csta:ConnectionID"/&gt;       &lt;xsd:element ref="csta:correlatorData" minOccurs="0"/&gt;       &lt;xsd:element ref="csta:userData" minOccurs="0"/&gt;       &lt;xsd:element ref="csta:extensions" minOccurs="0"/&gt;     &lt;/xsd:sequence&gt;   &lt;/xsd:complexType&gt; &lt;/xsd:element&gt; </pre> | <pre> &lt;AnswerCall&gt;   &lt;callToBeAnswered&gt;     &lt;callID&gt;james@sip.com&lt;/callID&gt;     &lt;deviceID&gt;135.10.52.22&lt;/deviceID&gt;   &lt;/callToBeAnswered&gt; &lt;/AnswerCall&gt; </pre> |
|--|---|

The proposed WSNGN will only solve the first half of the problem, which is to handle the multiple protocols environment in NGN network. A semantic representation of the call control needs to be introduced, thus, there is a need to extend the semantic description to device, network, and the user profile.

Table 2: An example of Semantic description of NGN for call handling

|  |
|--|
| <pre> concept answerCall   recipientID ofType xsd:string   connectionAvailable ofType connectionListType   ... concept connectionListType   connection (0 *) ofType connectionList_withAttrRecipientID   ... concept connectionList_withAttrRecipientID subConceptOf subscriberDesc   connectionId ofType xsd:integer   connectionType ofType xsd:string   connectionPriority ofType xsd:integer   ... concept subscriberDesc   subscriberId ofType xsd:string   subscriberStatus ofType xsd:integer   ... concept deviceProfile   deviceId ofType xsd:integer   deviceCapabilities ofType deviceCapabilitiesListType   ... concept subscriberProfile   subscriberId ofType xsd:integer   subscriberServices ofType subscriberServiceListType   ..... </pre> |
|--|

To handle the call, the semantic representation will gather all the available connections of the destination call and according to the priority of the call type, a decision will be made to control and route the call using the appropriate connection protocol and handle the connection between caller and recipient. The consideration of device capabilities

and network environment will also need to be described, to be able to have a semantic reference when deciding on how to handle the call.

### 3. Future Works

In the near future, we want to research and propose on handling of the device profiles in the SNGN. As the mobile device market is a fast and rapid growing sector, there is a need for automated device handling and discovery in SNGN so that not only current, but future devices are capable to be automatically discovered and registered into SNGN. Beside device profile handing, we will also focus on describing multiple protocols semantically in SNGN network.

### 4. Conclusions

This paper only describes the concept and preliminary study of the SNGN. We are addressing the challenges in building the SNGN, which are mainly on the device profiling and protocols handling both in semantic context. The needs of SNGN will become more significant as the devices and the services growing rapidly in the mobile space. As the underlying network technology is also growing to support the growing of the device, or vice versa, ontology to describe the complex information of the network is required. These are sufficient to illustrate the needs of the ontology-based support for managing service creation and management for SNGN environment to bring together devices, networks and services.

### References

- [1] Internet Engineering Task Force. RFC 3261: Session Initiation Protocol (SIP). <http://tools.ietf.org/html/rfc3261>
- [2] D. Booth, H. Haas, F. McCabe, E. Newcomer, M. Champion, C. Ferris, and D. Orchard. Web services architecture. W3C Working Note, <http://www.w3.org/TR/ws-arch>, 2004.
- [3] S. Burbeck. The evolution of Web applications into service oriented components with Web services. <http://www-106.ibm.com/developerworks/webservices/library/ws-tao/>.
- [4] U. Keller, M. Stollberg, and D. Fensel. WOOGLE meet semantic web. In *Proceedings of the Workshop on WSMO Implementations*, 2004.
- [5] Enterprise Communication in Next Generation Corporate Networks (NGCN) involving Public Next Generation Networks (NGN) <http://www.ecma-international.org/publications/files/ECMA-TR/TR-091.pdf>
- [6] M. Kifer, R. Lara, A. Polleres, C. Zhao, U. Keller, H. Lausen, and D. Fensel. A logical framework for web service discovery. In *ISWC 2004 Workshop on Semantic Web Services: Preparing to Meet the World of Business Applications*, 2004.
- [7] Ericsson AB 2004. IMS – IP Multimedia Subsystem (The value of using the IMS architecture)
- [8] Armin Haller ,Emilia Cimpian, Adrian Mocan, Eyal Oren, Christoph Bussler. WSMX - A Semantic Service-Oriented Architecture
- [9] W. Bruggeman, June 2008. Transformations of a SIP Service Model
- [10] P. Papageorgio, “A Comparison of H.323v4 and SIP,” Technical Report, University of Maryland, 2001, Unpublished - <http://www.cs.umd.edu/~pavlos/papers/unpublished/papageorgiou01comparison.pdf>.
- [11] Feng Liu, Wu Chou, Li Li, and Jenny Li, 04. WSIP – Web Service SIP Endpoint for Converged Multimedia/Multimodal Communication over IP
- [12] Web Services Description Language (WSDL) for CSTA Phase III. <http://www.ecma-international.org/publications/files/ECMA-ST/Ecma-348.pdf>