Design of converged IN and IP architecture that offers existing and next generation services to both PSTN and IP users

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Abstract: This paper focuses on the convergence between the legacy IN and IP world in order to deliver value-added services in a converged environment to both PSTN and IP clients. The main objective of this paper is to propose and define a converged architecture between the IN and the IP world in order to offer existing and next-generation customized and personalized services that meet the demands of multi-party multi-connection and multimedia calls. The main elements and subsystems, protocols and interfaces of this architecture are presented and analysed. The main advantages of this architecture includes scalability in terms of deployment next generation services, diversity support of VoIP end-users and service access to the next generation services by the PSTN users.

Keywords: IN/IP Convergence, Next Generation Services

1 Introduction

The global telecommunications industry of the early 21st century is one of the most challenging business environments in history, characterized by global deregulations. These dynamics have placed downward pressure on prices and margins, especially for those players that rely on circuit-switched technology. To survive in this competitive market place, operators and service providers must continue reducing costs and differentiating their service offerings. Therefore, sustainable and profitable revenue growth can only be achieved through differentiation. One way to achieve this differentiation is the ability to offer added value though innovative IP-based service offering integrating voice, video, web, email, instant messaging and presence. Such new service offering is the path to generate profitable, new revenue streams attracting new customers and up selling to the existing one.

This paper proposes an architecture for the interworking between the IP- and the existing PSTN/SS7- based services in order to deliver value-added and extended IN services (beyond the CS-2 set) in a converged environment to both PSTN and VoIP clients. The main aim of the architecture concerning the convergence between the PSTN and the IP networks are the following:

- PSTN users must access VoIP services,
- IP users must access PSTN/SS7 services,
- a common service creation environment for both PSTN/IN and IP world

2 Next Generation Networks

IN is a service overlay network in the current telecommunications scene, using the SS7 network. This service intelligence is taken out of the switch and placed in computer nodes that are distributed throughout the network. The IN introduced modular programmable elements, such as Service Control Points (SCPs), the Service Switching Points (SSPs), and the Service Data Points (SDPs). However, the IN has several disadvantages, such as limited scalability, lack of interoperability among different implementations, difficulty of integration, primitive user interfaces and lack of personalization and customization support by the end user. All these limitations of the IN have led to the evolvement of the Next Generation Networks.

It is foreseen that Next Generation Networking (NGN) Architecture will be based on packet-based technologies. The most important part of NGN is the division of network functionality into many distributed functions, which fall into the following categories:

1. Control, management and signalling, which provides the intelligence needed for user control of the connection; this intelligence is distributed
2. Access, routing, switching and transport which provides the functions needed for transporting information between end users and other network elements.
3. Convergence with existing legacy networks (PSTN, SS7, Mobile Networks)

The most prominent class of services offered by the NGN will be interactive communication services. These include real-time multimedia communications services involving personalisation and customisation, multi-party and multi-connection support. Network convergence creates additional opportunities for IN to add value to data services by exploiting the information and control it affords.

- Using Internet-based data connections to control voice services allowing users greater control over their services through better user interfaces
- Extending IN services to data and video. Next generation IN platforms must provide service execution and data management required for circuit and packet-switched networks
- Having a common service creation environment for both IN and IP world.

3 Proposed Converged IN – IP Architecture

Figure 1 provides a detailed description of the proposed architecture for the provisioning of IP-IN-based services.

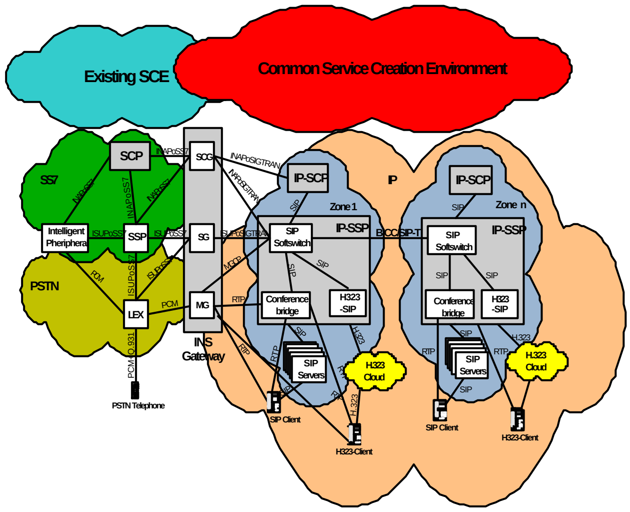

Figure 1: Proposed Converged IN and IP Architecture

The main objective of this architecture is to offer existing and next-generation customized and personalized Intelligent Network (IN) services in an IP based environment to meet the demands of multi-party multi-connection and multimedia calls. This necessitates the design of a modular and scalable architecture for the provisioning of IP-IN-based services and the definition of all elements of this architecture in terms of entities, protocols and interfaces.

The proposed IP/IN architecture is based on the following assumptions:

1. The above architecture is focused on the adoption of SIP as the dominant technology to deploy NGN services.
2. IP endpoints (H.323 or SIP end-users) request access to IN services that are provided by the SS7 world.
3. VoIP endpoints request access to value-added services that are handled by a central server within the IP domain. This server may be considered either a proxy or redirect SIP server.
4. VoIP endpoints request access to services that may be managed in different administrative domains.

This architecture exhibits the following attributes:

1. **End-user diversity:** According to the general requirements, the proposed architecture must support both H.323 and SIP end-users. This means that appropriate interworking modules

(H.323-to-SIP and vice versa) are employed to ensure the versatile use of this architecture.

2. **Use of enhanced SIP servers:** These servers are distributed within the IP domain and are responsible for the deployment and management of value-added services within the IP world. These services will be invoked by employing either specific number ids (800@domain1.com) or specific alias names (in_service@domain1.com). Moreover such servers have the capabilities to handle/invoke requests to/from the SS7 world. This will be accomplished by employing an IN overlay service model in order to handle/invoke requests from the SS7 world. Such servers are called IP-SSPs. More detailed information about the IP-SSP functionality is provided at the following sections.
3. **SIP servers networking architecture:** The SIP servers are arranged in a hierarchical manner. Each terminal will be registered to a SIP local proxy, which may handle simple SIP requests. If a user requests a service with the predefined prefix (800@domain1.com or in_service@domain1.com), this request will be forwarded to IP-SSP which resides at the top of the hierarchy, since this is the one that can handle/manage this call. If the service is an IP-based value-added service, the IP-SSP communicates with the application server and service-related data are sent to the user. Otherwise, the request must be forwarded towards the SS7 world. This means that the IP-SSP must translate the SIP messages to the corresponding SS7 messages (ISUP/INAP). The SS7 messages are then conveyed to the signaling gateway using SIGTRAN.
4. **Zone Architecture:** We assume that under each IP-SSP responsibility there is a certain number of hierarchical SIP servers, within a zone. Each zone may consist of several SIP servers, capable to serve hundreds of end-users. There are various configurations regarding the zone architecture:
   a. **Each zone has direct connection with the SS7 world**: This means that there are multiple signaling gateways that convey messages from PSTN world towards the IP world and vice versa. The selection of the appropriate route (Signaling Gateway) is based on certain parameters such as availability, remaining call capacity, route selection, load balancing, least-cost routing etc.

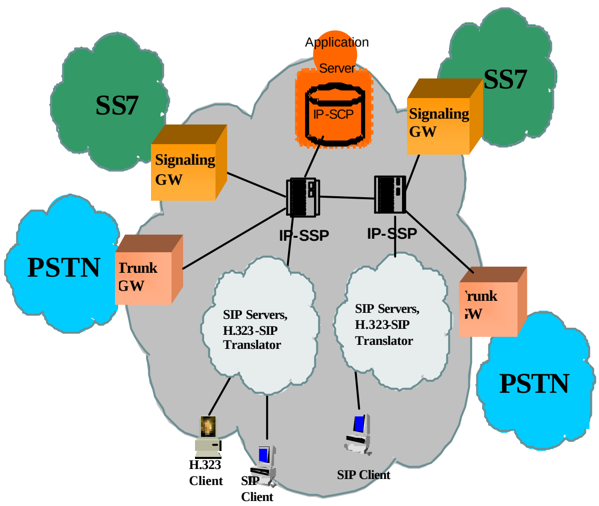

Figure 2: IP/IN architecture whereby each zone has a direct connection with the SS7 world

   b. **There is one IP-SSP that communicates directly with the Signaling Gateway**. This means that invokes of other IP-SSPs are proxied towards this IP-SSP using SIP-T protocol.

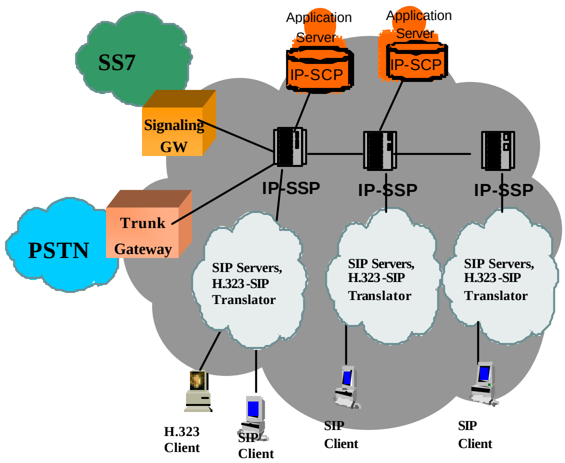

Figure 3: IP/IN architecture whereby a IP-SSP provides access to the SS7 world

This architecture, introduces the following functional entities:

3.1 Intelligent Network Services Gateway (INS-GW)

The INS-GW is the key component for interconnecting the PSTN network to the IP network. The INS-GW comprises the protocol translation modules providing for the interworking between the PSTN/SS7 and IN/IP network domains. These comprise the following functionalities:

- **Signaling Gateway Function (S-GF)**: The S-GF performs correct lower-layer protocol and address translation functions. It provides for re-mapping between ISUP over MTP and ISUP over SCTP/IP.
- **Service Control Gateway Function (SC-GF)**: The SC-GW contains an instance of the SS7 SCCP protocol layer that provides SCCP services to peers residing in both the PSTN and IP domains. The SC-GF can appear to the SS7 network as a SS7 Signalling Point.
- **Media Gateway Function (M-GF)**: This functional entity is responsible for transforming CSN media to IP media (RTP/RTCP). The M-GW will be able to support conversion between IP voice coding and PSTN voice coding.

3.2 IP-based Service Switching Point (IP-SSP)

The IP-SSP is an IP network node handling call control and maintaining the ability to make queries to an SCP and/or an IP-SSP. Actions appropriate to the response, are subsequently performed. In general, the originating and terminating messages are switching or call routing related. IP-SSP requirements also include media-gateway control capabilities and provision of conversion between SIP-T and ISUP message formats. It is important that the IP-SSP entity will be able to provide capabilities normally provided by traditional switches, including operating as an SSP for IN features. It should also maintain call state and trigger queries to IN-based services, as traditional switches do. Additionally, in the context of a SIP-based IN/IP environment, the IP-SSP can provide the following functionalities:

- **Proxy Server**: This concerns routing of SIP messages to the desired SIP capable elements in the IP/IN domain.
- **Registar**: The IP-SSP provides capabilities relating to the update of the deployed location services on receipt of REGISTER requests from the IP-SCP. This procedure allows for the configuration (arming) of the IP-SSP, in order to bypass default routing of calls without any need to request redirection services from the IP-SCP.

3.3 IP based Service Control Point (IP-SCP)

The IP-SCP will be the entity hosting the service intelligence for services in the IP domain. In the converged architecture, these services could be provided also to the PSTN/SS7 domain through the INS-Gateway and requested by a SSP in the PSTN/SS7. The communication with the IP-SCP is SIP-based, and SIGTRAN-based with the INS-Gateway, according with the previously described architecture. Internally the IP-SCP responds the requests for service from the IP side based on a SIP-Servlets engine that checks the requests from the IP-SSP and triggers the related service SIP Servlet accordingly. Each SIP Servlet will perform the actions related to the service (access data bases, SIP communication with IP-SSPs, trigger other Servlets, etc). The creation of services within the IP-SCP is performed through the common SCE. The IP-SCP implements a higher-level API that the common SCE and other service developers use to create the service logic. This concept is illustrated in Figure 2. The SIP-Servlet API lays below this API. The IP-SCP also provides access for customers to customize the different services.

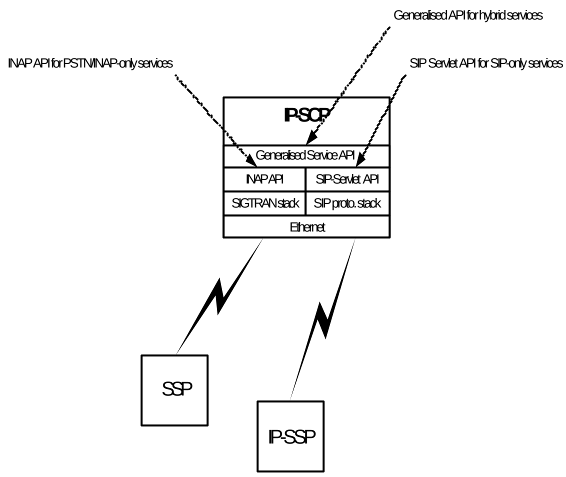

Figure 4: Generalized API for access from the Common SCE

3.4 Common SCE

The Common SCE will be an advanced Service Creation Environment that enables design of services for both the PSTN and IP worlds, with light-fast deployment. Services should be designed from a friendly user interface (Web-based GUIs), extending thereby the group of service designers to include every competent web developer in the market. The distributed SCE will be based on open Application Programming Interfaces (APIs) where possible and will additionally allow the support of multi-vendor platform components. This will also involve deployment of novel interfaces enabling the definition of service logic and configuration of execution parameters. Under this framework, Java technology comes into play: With its appealing "write once-run anywhere" capability, Java readily meets the basic requirements for such new-generation SCEs for telecommunications services [9]. Apart from the SCE, several other components are deemed necessary in a system responsible for developing and supporting services for the Internet, including [10]:

- ***User and subscription management:*** An effective service delivery platform must be able to track and manage customer subscriptions.
- ***Platforms for the Support of Customized and Personalized Services***
- ***Open, published API's*:** The system must be based on openly available client-server software supporting such APIs.
- ***Service management:*** Service management capabilities ensure that customers are allowed to access the services they subscribed to and that the services are delivered with the level of quality expected, and paid for, by the customer.
- ***Security management:*** Enforcement of access control (authentication, authorization) and possibly distribution of certificates.
- ***Revenue management (usage tracking, accounting, billing):*** Interfaces to a new and even legacy billing systems, to capture revenue from value-added services.
- ***Content distribution:*** A mechanism for intelligently routing service content through the network.
- ***Service Provisioning Management, Statistics and Alarms:*** As a centralized facility, supporting internationalised log messages e.g. with timestamps and preferably also with complete stack traces.

4 Conclusions

This paper proposes a converged architecture for the interworking between the IN and the IP worlds. This architecture is designed in order to offer existing and next generation services to both PSTN and IP users. The main advantages of this architecture includes scalability in terms of deployment next generation services, diversity support of VoIP end-users and service access to the next generation services by the PSTN users.

5 Acknowledgments

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References:

[1] Introduction to Intelligent Network Capability Set 1, ITU-T Rec. Q.1211

[2] Introduction to Intelligent Network Capability Set 2, ITU-T Rec. Q.1221

[3] Introduction to Intelligent Network Capability Set 3, ITU-T Rec. Q.1231

[4] Introduction to Intelligent Network Capability Set 4, ITU-T Rec. Q.1241

[5] Principles of telecommunication services supported by ISDN and the means to describe them, ITU-T Rec. I.210

[6] Introduction to CCITT Signaling System No.7., ITU-T Rec. Q.700

[7] IETF RFC 3261, SIP: Session Initiation Protocol

[8] S.Salloum, A.Dagiuklas, M.Skoura, A Scalable SIP-based Architecture to Offer Value-added Services in a Converged IN/IP Environment, SIP 2003

[9] Tom McGuire, Jibe With Java: The New-Generation Telecom Service Creation Environments, INTERNET TELEPHONY, October 2001.

[10] S. De Beule, Alcatel open services platform enabling new generation services, Alcatel Telecommunications Review, 2nd Quarter 2000