ENABLING IMS WITH MULTICAST AND BROADCAST CAPABILITIES

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ABSTRACT

Enabling next generation network to support multimedia streaming services across heterogeneous fixed and mobile networks challenges the developers to define a unified triple play framework solution. The IP Multimedia Subsystem (IMS) defined by the 3rd Generation Partnership Projects (3GPP and 3GPP2) represents today a basis framework for a Service Delivery Platform (SDP) for providing triple play services. Several approaches have already been introduced struggling with the need for an integrated solution based on the IMS core or the development of a separated subsystem.

The Fraunhofer Institute FOKUS has launched the "Open IMS Playground" in July 2004 as part of the German 3G beyond national testbed. The IMS Playground has been extended recently as an open environment gathering all major IMS core components, and triple play toolkit originating from own developments as well as major industry players, which can be used by academic and industrial partners for early prototyping of new triple play services, related components, protocols, and applications. This paper introduces the relevant technologies and provides an overview of the "Open NGN/Triple Play Toolkit and Testbed @ FOKUS".

I. INTRODUCTION

The demand and hence evolution of multimedia applications and services has initiated the need for a converged network from both the mobile and fixed domains. These services ranging from conversational services, TV services up to file transfer and gaming are to be delivered via IP packets. The "Triple Play" is the new buzzword describing the convergence of the three terms: "voice (telephony), internet and TV as commercial notation for driving market rather than a new technology. This is challenging the traditional telecoms world dramatically. Multimedia Internet services have paved the way for the emergence of content based services and new business models.

Provisioning of triply play services can be offered over several access technologies with different transmission mode; namely unicast, multicast or broadcast transmission mode. However enabling interactive streaming services over broadcast technologies mandates integration of a cooperation framework on the top of the broadcast network (e.g. DVB) and unicast network (e.g. UMTS).

Building upon the capabilities of the IP Multimedia Subsystem (IMS) [1] as an overlay control subsystem designed to support heterogeneous IP networks and its ability to deliver integrated multimedia streaming and data services, while providing seamless mobility, it is desirable to have a convergence platform for the future wireless networks.

Today, there are many triple play solutions based on non-standardized solution deployed by cable providers and DSL providers, but there is no standardized solution available. Nevertheless there are ongoing activities by several organization bodies such as TISPAN [2], 3GPP MBMS [3], OMA BCAST [4] and DVB [5] to standardize an interactive streaming subsystem.

In face of this, and knowing that the current challenges within the telecommunications market are mainly a consequence of insufficient early access to new enabling technologies by all market players, the Fraunhofer Institute FOKUS, known as a leading research institute in the field of open communication systems, has established a 3G beyond Testbed, known as "National Host for 3Gb Applications" [6]. This testbed provides technologies and related know-how in the field of fixed and wireless next generation network technologies and related service delivery platforms.

As such a testbed is quite complex by its very nature, FOKUS has coined in addition the notion of technology focused "playgrounds". One of these is the "Open IMS Playground @ FOKUS" [7] different access technologies are attached, infrastructure components and management tools. FOKUS implemented all core components of the IMS-based triple play framework and enriched this base infrastructure with components from commercial vendors.

Section two gives a brief overview on the current technologies. Section three introduces the FOKUS NGN Triple Play Testbed where section five illustrates an IMS-based hybrid streaming application over UMTS and DVB-H access network developed and deployed at the FOKUS IMS Playground. Finally section five concludes the paper.

II. TECHNOLOGY OVERVIEW

The demand of multimedia streaming services has resulted in the evolution of various communication technologies and frameworks, in both the mobile and fixed domains. These technologies, still at infant stage, have their own benefits and shortcomings based on the different deployment environments and service scenarios. It is imperative to understand that instead of being developed and deployed as complementary technologies they can be converged under a standard converged architecture. The Telecom and Internet converged Services and Protocols for Advanced Networks (TISPAN) bridges this gap by proposing and standardizing a generic multi-service, multi-protocol, multi-access IP-based framework for converged networks [2].

A. *TISPAN*

The TISPAN Next Generation Network (NGN) architecture is based on various sub-systems which allow smooth integration with other existing and/or emerging sub-systems as depicted in figure 2. The first release of the TISPAN architecture categorizes these subsystems as on transport layer and service layer. The two new sub-systems at the transport layer; Network Attachment Sub-System (NASS) and the Resource and Admission Control Sub-System (RACS) are responsible for IP connectivity and Quality of Service (QoS), respectively. On the service layer the 3GPP IP Multimedia Subsystem (IMS) is adopted to support broadband access (e.g. DSL) and the cellular network. The PSTN/ISDN Emulation Subsystem is defined to emulate PSTN/ISDN legacy services over IP infrastructure with IMS core as its base sub-system.

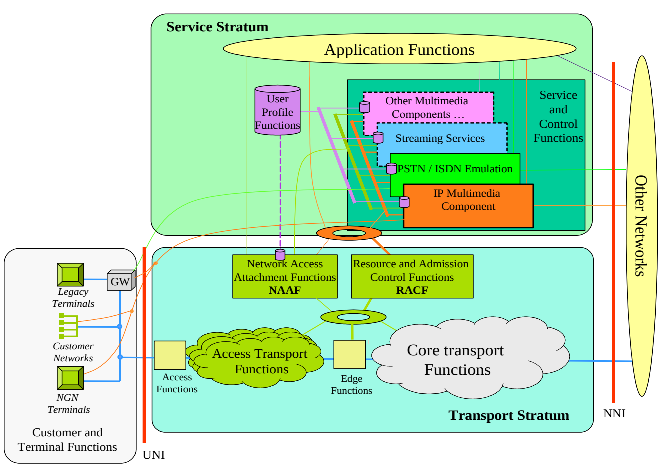

Figure 1: TISPAN logical architecture

The next release of TISPAN NGN comprises of infrastructure standardization and service packetization which enables service convergence at the data plane; voice, video and data share the same physical medium and a common transport layer in IP.

B. *3GPP IP Multimedia Subsystem (IMS)*

IMS is an overlay control subsystem of IP-based multimedia applications, standardized by 3GPP Release 5 and 6 to support IP-based mobile multimedia services in a sub-domain of the packet-switched part of the UMTS core network provided to a mobile subscriber [1]. Figure 1 shows the IMS layered architecture, which consists of three planes: the delivery plane, the control plane, and the service plane. The main functions of the IMS core network can be classified into four categories:

- Multimedia session management
- Service activation/initiation on the application server
- Network information provisioning to IMS applications
- Enable applications to make use of network functionalities through open standardized interfaces

The IMS controls several bearer technologies and this will enable provisioning of multimedia applications over various access networks with multicast and mobility support.

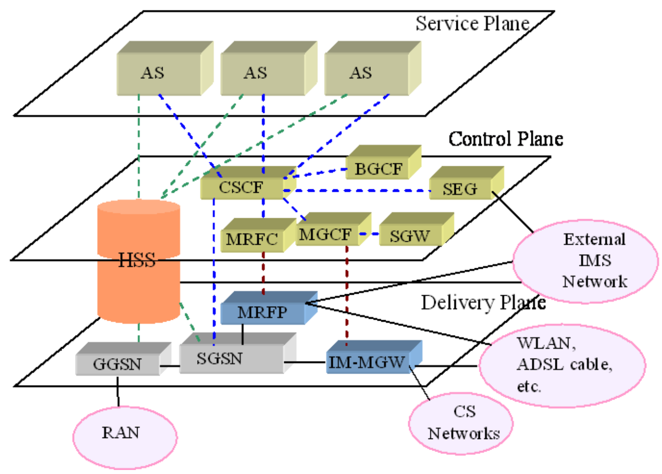

Figure 2: IMS logical layered architecture

C. *3GPP Multimedia Broadcast Multicast Services*

As the mobile communication networks were primarily voice centric and hence designed for point to point communication, IMS also supports only unicast mode of transmission. The emerging communication scenarios and requirements mandate the need for support of broadcasting and multicasting of streaming services. The Multimedia Broadcast/Multicast Services (MBMS) is primarily regarded as a unidirectional point to multipoint bearer service which allows data to be transmitted from a single source entity to multiple recipients based on multicast or broadcast transmission schema for cellular network. The specification has been standardized by 3GPP in release 6 [3] and will continue in release 7 to support a full integration of the architecture of MBMS and IMS with same extensions on the radio link.

D. *Digital Video Broadcast*

Similarly, the Digital Video Broadcasting (DVB) is designed for broadcasting TV services by the DVB project since 1993 [5]. DVB-T (Terrestrial) is mainly targeted for stationary receivers and is not suitable for mobile devices. To overcome this limitation DVB-H (Handheld) was proposed, which enhanced the physical and link layers of DVB-T to reduce power consumption and improve performance in urban indoor environments. It uses IP protocol for streaming and thus might support multicast transmission in addition to the initial broadcast mode.

E. OMA Service Enablers

The Open Mobile Alliance (OMA) was established in 2002 by many mobile operators and manufacturers as a global organization for standardizing mobile services based on open global standards, protocols and interfaces and not dependent on proprietary technologies.

The OMA has recently specified an OMA Service Environment (OSE), which is a flexible and extensible architecture that offers support to a diverse group of application developers and service providers. The OSE considers the issues of how to manage the access from an application towards the enablers or between two enablers from the same or different domains by enforcing policies.

Currently the Open Mobile Alliance is working on standardizing a Mobile Broadcast Services (BCAST) enabler for supporting mobile broadcast services. OMA BCAST deals with a variety of functional areas: distribution and definition of an Electronic Service Guide (ESG), methods for broadcast file distribution and stream distribution, Mechanisms for service and access protection with/without content protection, service interaction, service provisioning, terminal provisioning, and user and application notification. Requirements for the above functional areas along with the requirements for the Enabler as whole are given in the BCAST requirements specification [4].

III. 3 FOKUS Triple Play Service Architecture

Provisioning of triple play multimedia streaming services with mobility support will introduce different players on the value chain ranging from consumer, network operator, service provider up to content provider. This will imply new requirements on the systems and new challenges. These players have to interact smoothly to fulfil the task to provide a whole new service experience to the end user. These requirements were derived from an abstract view to all theses players [9].

As TISPAN NGN is based upon the concept of cooperating subsystems sharing common components and provides a framework for an end-to-end all converged network, it will act as the beacon architecture. Building upon the capabilities of 3GPP IMS as an overlay control subsystem designed to support heterogeneous IP networks and its ability to deliver integrated voice and data services while providing seamless mobility, it will be used as the foundation convergence platform. As discussed in previous section, TISPAN has also standardized IMS in its reference architecture. However IMS only supports the unicast mode of transmission and needs to be enhanced to support future multicast/broadcast services. Integration with 3GPP MBMS and DVB-H will bridge this gap in 3G networks and thus enable IMS to be extended to support streaming services in an efficient manner.

All these issues have been considered in the design process of the FOKUS 3Gbeyond NGN Testbed as a SOA-based Service Delivery Platform (SDP) for provisioning and delivering of triple play services. Figure 3 shows the high level logical architecture of the tesbted that comprises four layers as follow:

Access and Delivery Layer: This layer is the lowest level that offers IP-based transport covers wired and wireless access technologies ranging from UMTS, DSL, DVB, WiMax and LAN. All these technologies should enable unicast, multicast and broadcast transmission with (and sometimes without) QoS support and seamless service mobility for converging networks. Also this layer should perform media processing and delivery from content provider to consumers.

Control Layer: This layer is on the top of the access and delivery layer and based on the IMS core that includes the Call Session Control Functions (CSCF), the Home Subscriber Function (HSS) and gateway to the legacy networks. This layer is responsible for session control and service triggering on the service enabler layer based on defined filter criteria stored for each user on the HSS.

IMS-based Service Enabler Layer: This layer is a cooperative service platform between the service provider, network operator and user. It contains several enablers that each offers intrinsic and elementary function and thus performs all related control functions among these four actors and makes of the resources of the underlying layer. This layer should follow the OMA approach and OMA Service Environment that have been mentioned in section 2.5. Design and development issues of such layer can be found in more details in [10].

Application Layer: This layer hosts services that utilize from the basic functions offered on the IMS-based Service Enabler layer through open and policy-based standardized interfaces such as Parlay X. Services on this layer are deployed as standalone service or hosted in an application server. Such application provides a base for the validation of underlying entities. Sophisticated application development tools and model driven architecture (MDA) tools provide a highly comfortable way to develop services.

User Premises Plane: This plane presents all possible interconnected access technologies either wired or wireless and enables the user to get IP connectivity directly or via a residential gateway hosted at user premises. This gateway offers the user the ability to build up a meshed network within his home environment. Every network capable device is connected to this gateway to offer incorporation with other local devices or connect to the core network. Examples are IPTV clients, VoIP client, Set-Top-Boxes (STB), PCs and smart IP devices to control the digital home. The Home Gateway may be used for authentication towards the operator's network or act as an authentication proxy for other devices.

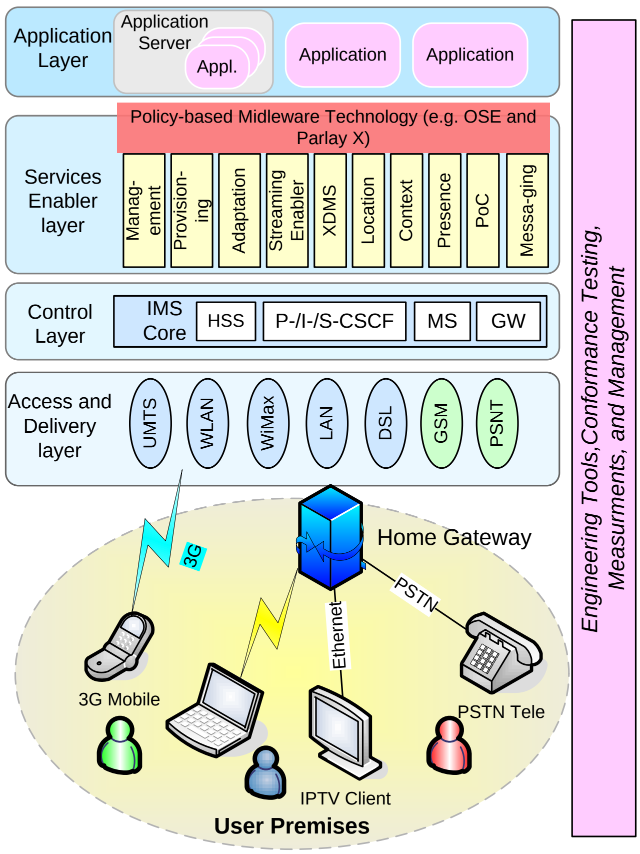

Figure 3: The FOKUS 3Gb/NGN Testbed

Across all these layers FOKUS provides engineering, conformance testing, measurement, benchmarking tools and management tools. Thus, FOKUS provides for all layers more than one realization option which results in plenty of combinations and a high complexity of the testbed. However, this is a highly valuable prerequisite for performing feasible R&D projects in the context of NGN. In addition, the infrastructure is provided to third parties on an "as needed" basis.

IV. Application Scenarios and Validation with the FOKUS NGN/IMS

The application layer in the FOKUS triple play architecture includes several service enablers that allow developing more intelligent application easily. Such applications are developed and deployed on the testbed as standalone solution or hosted on an application server. The testbed includes several types of application servers [6]. Figure 4 shows the SIP Servlet Execution Environment (SIPSEE) developed by FOKUS as an IMS application server based on the SIP servlet technology. The SIPSEE interfaces with the S-CSCF via the ISC interface, with the HSS via the Sh interface and with the online charging system via the Ro interface [8]. The SIPSEE implemented on the open IMS core developed at FOKUS [7].

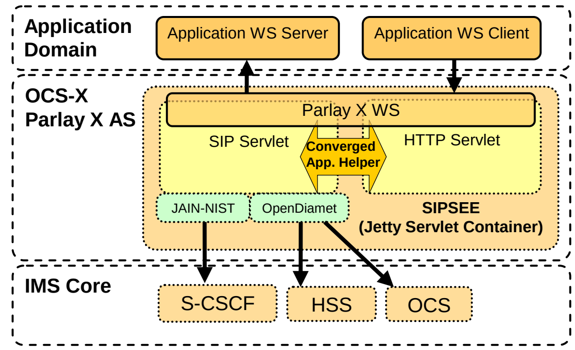

Figure 4: FOKUS SIP Servlet Execution Environment

The SIPSEE includes a SIP container and HTTP container and thus it allows development of converged SIP and HTTP applications that share the same Servlet context through a converged application Helper.

Several service enablers are developed on the top of the SIPSEE and offer their functions through Parlay and Parlay X interfaces based on CORBA and web service technologies, respectively.

There are several Demo-applications deployed at the testbed as SIP servelt hosted on the SIPSEE or as Parlay or Parlay X application. The service enablers provide the applications on the application layer mentioned before implementing necessary functionalities to support various advanced services and applications. Demo-applications are used for demonstration purposes and for validation of concepts and software components through the real life. The next two sections give two examples of such demo applications deployed at the testbed.

A. IMS-based hybrid streaming application

To accelerate the process for providing multimedia streaming service with interactive and more mobility features over unicast, multicast and broadcast bearers we have developed an IMS-based hybrid streaming architecture over UMTS and DVB-H access networks. Also it can be considered as proof of concept for FOKUS IMS-based management architecture discussed in the last section. It was integrated in the Open/NGN triple play Playground at Fraunhofer FOKUS 3G tesbed.

Providing streaming services over DVB-H and through IMS raises the possibility to combine the advantages of DVB-H in delivering streaming in with high quality at the same time

IMS core for secure, chargeable, personalized, and interactive transfers. Further more IMS provides an overlay of several access technologies and thus mobility across these networks would be feasible.

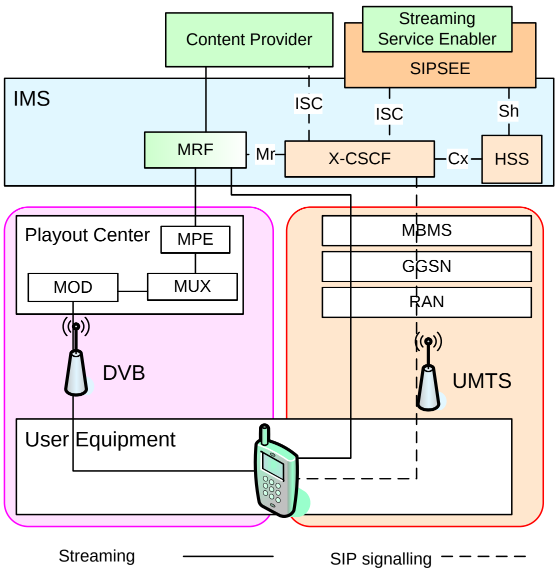

Figure 5: IMS-based hybrid streaming Architecture

Figure 5 shows an overview of the implementation reference architecture of such subsystem and the interfaces between the entities. The Streaming sErvice Enabler (SEE) is the essential element in this architecture which interfaces with the IMS core via the ISC interface and with the content provider via the IMS. The SEE is also interfaces with the HSS via the Sh reference point to store or read user profiles. The user makes use of the IMS client developed at FOKUS to interact with the SEE through the IMS ISC and the Ut interfaces [11]. To provide the user with advance feature it also makes use of the other parallel service enablers such as presence, messaging, conferencing etc. The SEE is a SIP Servelt application Based on the user availability and makes the decision for the optimal transmission medium via a unicast UMTS bearer or broadcast DVB-H bearer. The streaming service enabler plays a central roll in this solution where it controls and manages all streaming sessions and thus hosts all related service logics. For content delivery from a certain content provider to one or a set of consumers the SEE behaves as a back-to-back SIP user agent between the both players.

To support session mobility from UMTS bearer to DVB-H or other access network such as WiMax user terminal has to be equipped with such access networks.

B. *Streaming Notification Service*

Streaming Notification Service (SNS) – offers a user the possibility to subscribe for any streaming event such as news, a sports event, lecturers, etc. that might be live or will take place in the future. When such event occurs, the operator of the service triggers a SIP messages to the subscribers' end devices which have been already registered with the IMS core. Based on a redirected resources carried on the SIP message each end device (mobile or fixed) invokes the stream in a unicast mode. The video codec of choice is the 3GPP compliant H.264 video codec, for audio encryption we use the Adaptive Multi-rate (AMR) codec which has also been specified by 3GPP.

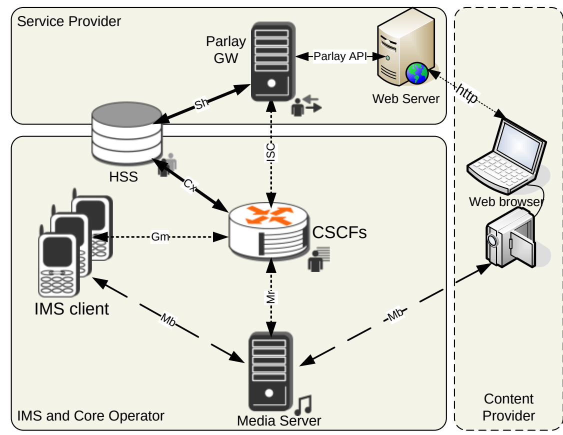

Figure 6: Stream Notification Service

The user subscribes to the service through a web-based application which offers the possibility to choose desired the events. The operator administrates the choice of these event streams and can also overview the entries of the subscribers. The Streaming Notification Service is based on the Parlay Interfaces and uses the Parlay Foundation Classes developed by FOKUS.

V. Conclusion and Further Work

Traditionally provisioning of triple play services is tight coupled to particular access technologies such as cable TV, DVB or DSL. The next generation of mobile multimedia streaming service architecture will enable developing of new and loosely-coupled streaming services. This paper has been presented the Fraunhofer FOKUS triple play testbed as open environment with the target to prototype and validate existing and emerging IMS standards and to extend the IMS appropriately to be used on top of new access networks as well as to provide new seamless multimedia applications. All major IMS core components, i.e., x-CSCF, HSS, MG, MRF, Application Servers, Application Server Simulators, service creation toolkits, and demo applications are integrated into one single environment and can be used and extended for R&D activities by academic and industrial partners. All these components can be used locally on top of all available access technologies or can be used over IP tunnels remotely.

Based on this experience the FOKUS triple play testbed offers a rich spectrum of services ranging from infrastructure leasing, technology consultancy and training, application and prototype development and performance and conformity testing to solutions design, operational support, feasibility studies and technology assessment.

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