How IMS Cross Different Technologies

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Abstract

IMS(IP Multimedia Subsystems) architecture and its main logical components were first introduced by the 3GPP in its Release 5 for UMTS (Universal Mobile Telecommunications System) Networks. 3GPP IMS architecture was later adopted by 3GPP2 for CDMA networks when the two organizations harmonized their architectures during a meeting in Toronto, Canada, in April 2002.

Today, the use of IMS as the service delivery platform of choice is not limited to 3G wireless technologies. Due to its inherent access-agnostic design, IMS has also been adopted worldwide by industry standards organizations that are defining solutions not only for wireless technologies but for wire line networks as well. This event further widened the market for IMS as a worldwide, interoperable system.

This paper presents an overview of the IP Multimedia Subsystem (IMS) standard which is a very popular technology that consolidates different telecommunication technologies. The paper describes the genesis philosophy of IMS and gives an imagination of future telecommunication world with introduction of its offered interactive capabilities. This paper also presents how IMS chains different access technologies and make a single telecommunication network foundation.

Introduction

Next Generation Network is a general concept of networks that aim to bring a wide range of multimedia service with a wide range of flexibilities to offer new interactive services to end users regardless of different access technology and different terminal capabilities they are using, anywhere and anytime. These requirements led standardization bodies to conform service layer structure to new structure with introduction of a new technology which combines different capabilities of two successful networks to take benefit of different technologies. These two successful networks were Internet network and cellular network and the new created technology was so-called IMS.

Internet and cellular network

The Internet has experienced dramatic growth over the last few years. It has evolved from a small network linking a few research sites to massive worldwide network. The main reason for this growth has been the ability to provide a number of extremely useful services that millions of users like. The best known examples are the World Wide Web and email, but there are many more, such as instant messaging, presence, VoIP and etc. One of the advantages of Internet network is its easy and flexible service creation. In addition its service creation tools are available everywhere.

Other successful network that have been mentioned earlier is cellular network that have millions of users over the world and provides a wide range of useful services world wild, which its strength is, its wide coverage and mobility that make its services anywhere and anytime available. These cellular systems grew up rapidly and subscriber's demands for more bandwidth and multimedia services led standardization bodies to present new access technologies to satisfy market demands. Figure 1 shows a view of cellular access technology roadmap. Based on this roadmap, different technologies offer different capabilities and bite rate. That it is assumed to rich up to 1 Gbps with introducing new access technology called 4G for years after 2010.[1]

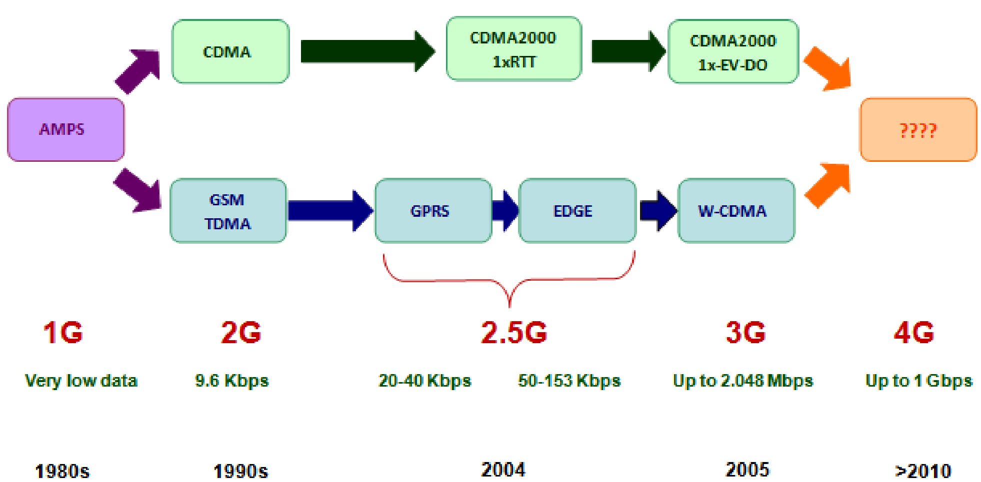

Figure 1: Cellular Access Technology Road Map
(Source: WiMAX Forum)

Besides of these above cellular technologies that are 3GPP standards there are some other technologies that are growing up rapidly in the world such as WiMAX (802.16e) and MBWA (802.20) which are IEEE standards. Figure 2 shows a view of all wireless technologies including cellular and non cellular networks together.

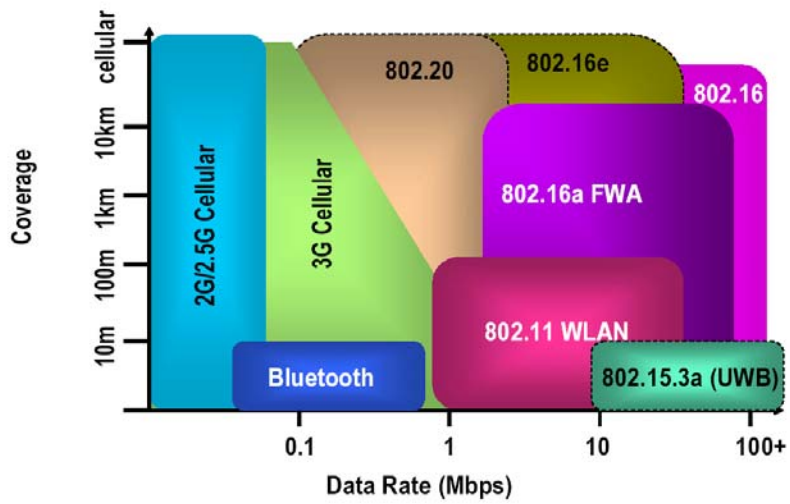

Figure 2: All Wireless Technologies
(Source: WiMAX Forum)

IP Multimedia Subsystem

The IP Multimedia Subsystem is an open, standardized, NGN Multimedia architecture for mobile and fixed IP-based services. It's used by Telecoms in NGN networks (which combine voice and data in a single packet switched network), to offer network controlled multimedia services. The aim of IMS is not only to provide new services but to provide all the services, current and future, that the Internet provides.
The IP Multimedia Core Network (IM CN) subsystem enables PLMN operators to offer their subscribers multimedia services based on and built upon Internet applications, services and protocols. [2]

The situation operators were facing right before the conception of IMS was not encouraging at all. The circuit-switched voice market had become a commodity, and operators found it difficult to make a profit by only providing and charging for voice calls. On the other hand, packet switched services had not taken off yet, so, operators were not making much money from them either. The operator needed a way to provide more attractive packet-switched services to attract users to the packet-switched domain. In this way the IMS was born.
The IMS aims to [1]:

1. Combine latest trends in the technology;
2. Make the mobile internet paradigm (merge cellular networks and the Internet);

3. Create common platform to develop diverse multimedia services;
4. Create mechanism to boost margins due to extra usage of mobile packet switched services.

Let us look at the requirements that led to design of 3GPP IMS (captured in frame work created for the purpose of delivery IP multimedia services to end-users). This framework needs to meet the following requirements.

1. Support of establishing IP Multimedia session;
2. Support for mechanism to negotiate Quality of Service (QoS);
3. Support for interworking with the Internet and circuit-switched networks;
4. Support for roaming
5. Support for strong control imposed by the operator with respect to the services delivered to the end-users;
6. Support for rapid service creation without requiring standardization.

IMS starts with 3GPP release 5 version of 3GPP TS 22.228 [8], it only support basic functions over GPRS network, the release 6 version of 3GPP TS 22.228 added a new requirement to support of 2G/3G/CDMA2000 and WLAN access networks other than GPRS. This release is corresponding of TISPAN NGN release 1 that using 3GPP IMS as core network for fixed NGN access networks. This is the so-called access independence of the IMS, since the IMS provides support for different access networks. After that, 3GPP put the first step forward for Fix Mobile Convergence in its release 7 of its technical specification. In this release support of xDSL access was added and finally now in release 8 of IMS, 3GPP is focusing on common IMS which is a major effort to harmonize all IMS specification in to one IMS as TISPAN also is focusing on common IMS in its TISPAN release 2.

IP Multimedia Sessions

The IMS can deliver a board range of services. Still, there is of special importance for users: audio and video communications. This requirement stresses the need to support the main service to be delivered by the IMS: multimedia sessions over packet-switched networks. Multimedia refers to the simultaneous existence of several media types. The media types in this case are audio and video.
Multimedia communications were already standardized in previous 3GPP releases, but those multimedia communications take place over the circuit-switched network rather than the packet-switched network. [1]

QoS

Traditionally control of Quality of Service (QoS) within telecommunications networks has been achieved by a combination of best-effort data delivery, network resources reservation (IntServ) or data packet marking (DiffServ) on data communication paths. However the design of emerging Next Generation Network (NGN) architectures will render this approach no longer viable. A key feature of network topology within the various NGNs is that the signaling required to negotiate a data transfer (the application signaling) may not travel on the same logical path as the actual data transfer itself (the

data traffic). Therefore an entity must be inserted to link the application signaling on the "upper" service plane to data traffic on the "lower" transport plane, to allow a means for applications to request QoS to be performed on the traffic plane. To achieve this, the policy entity requires a variety of functions such as QoS authorization, service-to –traffic QoS mapping and the means to provision the resultant QoS policy decided. This policy entity should also (ideally) take into account the QoS control end-to-end, i.e. operating across combinations of networks, carriers and service providers which will comprise the future NGNs.[4]
Based on this approach 3GPP has defined following IMS QoS requirements [2]:

- Independence between QoS signaling and session control;
- Need for both end to end QoS signaling and resource control;
- Restricted access to the IP Bearer Service by means of a policy-based control element.

Interworking

Support for interworking with the Internet is an obvious requirement, given that the Internet offers millions of potential destinations for multimedia sessions initiated in the IMS. By requiring interworking with Internet the number of potential sources and destinations for multimedia sessions dramatically expanded.
The IMS is also required to interwork with circuit-switched networks, such as the PSTN, or existing cellular networks. The first audio/video IMS terminals that will reach the market will be able to connect to both circuit-switched and packet-switched networks. So, when a user wants to call a phone in the PSTN or a cellular phone the IMS chooses to use circuit-switched domain.
So, interworking with circuit-switched networks is not strictly required although, effectively, most of the IMS terminals will also support the circuit-switched domain. The requirement to support interworking with circuit-switched networks can be considered as long term requirement. This requirement will be implemented when it is possible to build IMS terminals with packet-switched support only.[1]
As we explained before IMS aims to be an access independent network, based on this approach, the release 6 version of 3GPP TS 22.228 added a new requirement to support of 2G/3G/CDMA2000 and WLAN access networks other than GPRS

Roaming

Roaming support has been a general requirement since the second generation of cellular networks; users have to be able to roam to different networks (e.g., a user visiting a foreign country). Obviously this requirement is IMS inherent, so it should be possible for users to roam to different countries (subject to the existence of a roaming agreement signed between the home and the visited network).[1]

Service Control

There are two categories Operators typically want to impose policies on the services delivered to the users:

- General policies

This type of policy comprises a set of restrictions that apply to all users in the network. For instance operator may want to restrict the usage of bandwidth audio codec, such as G.711 (ITU-T Recommendation [6]), in their networks. Instead they may want to promote lower bandwidth codec like AMR (Adaptive Multi Rate specified in 3GPP TS 26.071[7]).

- Individual policies

This type of policy includes a set of policies which are tailored to each user. For instance, a user may have some subscription to use IMS services that do not include the use of video. The IMS terminal will most likely support video capabilities, but in case the user attempt to initiate a multimedia session that includes video the operator will prevent that session being set up. This policy is modeled on a user-by-user basis, as they are independent on the term of usage in the user's subscription [1]. These policies apply on subscriber profile based on a set of Filter Criteria triggers one or more SPTs (Service Point Trigger in the SIP signaling)in order to send the related request to one application server. The set of Filter Criteria that is stored for a service profile of a specific user is called "Application Server Subscription Information".

Rapid Service Creation

The requirement about service creation had a strong impact on the design of IMS architecture. This requirement states that IMS services do not need to be standardized. This requirement represents a milestone in cellular design, because in the past, every single service was either standardized or had proprietary implementation, even when services were standardized there was no guarantee that the service would work when roaming to another network. They may already have experience that lack of support for call diversion to voice mail in GSM networks when user is visiting another country. The IMS aims to reduce the time it takes to introduce a new service. In the past the standardization of the service and interoperability tests caused a significant delay. The IMS reduces this delay by standardizing service capabilities instead of services.[1]

Multiple Accesses

The multiple access requirements introduce other means of access than GPRS. The IMS is just an IP network and like another IP network, it is lower layer and access independent. Any access network can in principle provide access to the IMS. For instance, the IMS can be accessed using WLAN (Wireless Local Access Network), an ADSL (Asymmetric Digital Subscriber Line), an HFC (Hybrid Fiber Coax), or a Cable Modem. As we mention earlier IMS is access independent and support of 2G/2.5G.3G and WLAN was added to the release 6 version of 3GPP TS 22.228 and xDSL after in release 7. Figure 3 shows a view of a complete network including different access networks are connected to IMS platform.

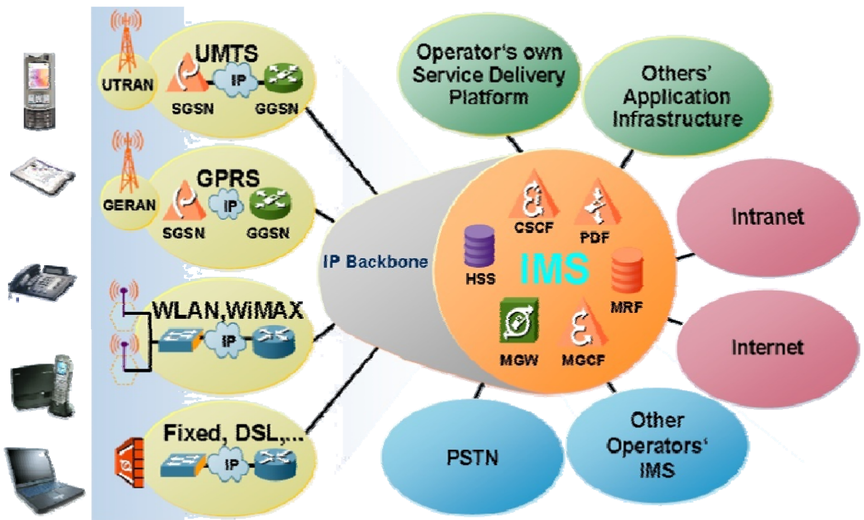

Figure 3: Different Access Networks Connected to IMS Platform
(Source: Nokia Siemens Networks)

IMS-base Fixed Mobile Convergence

As we explained before IMS integrates different wire line and wireless access networks. This convergence of fixed and mobile networks enables users to move between fixed and mobile access networks and still have access to the same set of IMS-based services [3]. One of the fundamental characteristics of FMC is the consistence of user experience that provide through a generic service delivery environment, which satisfies the needs of the fixed and mobile networks. The users are able to obtain services in a consistent manner as allowed by the connectivity and terminal device capabilities. Services are offered in accordance with FMC capabilities. For example, an ongoing call could be downgraded for some reasons such as, change of access technology or terminal device capability. A video communication may be downgraded to a voice communication when the user migrates to mobile only coverage where the access technology is not able to support it. FMC aims to provide [3]:

1. Seamless service operation from the end user perspective across heterogeneous fixed networks (i.e. PSTN, ISDN, PSDN, WAN/LAN/CATV, etc.) and mobile networks (i.e. GSM, CDMA2000, WiMAX, etc.), subject to any limitations imposed by the characteristics of the particular access technology being used.
2. Seamless service provisioning from the service provider's perspective across heterogeneous fixed and mobile networks, subject to any limitations imposed by the characteristics of the particular access technology being used.

3. Support terminal device mobility, user mobility and session mobility defined in ITU-T Y.2001.
4. Ubiquity of service availability where the end users can enjoy virtually any application, from any location, on any terminal device subject to any limitations imposed by the characteristics of the particular access technologies and terminal devices being used, given that the service has been subscribed.
5. Support of multiple user identifier and authentication/authorization mechanisms.

Conclusion

The telecommunications industry is just at the beginning of an exciting move to a truly converged communication world. Besides, IMS Continues to seep through the world's network infrastructure and users will begin to notice that their providers will be offering them more and more new interesting services, at reasonable price. IMS revitalized how services are deployed for both wireless and wireline communications, and will give the average user capabilities undreamt of just a few years ago. And finally the IMS will need to ensure that all these services will meet the end user needs including QoS.

References

[1] Gonzalo Camarillo and Miguel A.Garcia-Martin." The 3G IP Multimedia Subsystem (IMS)", Second Edition.2006
[2] 3GPP TS 23.228:"IP Multimedia Subsystem", 06/2005
[3] ITU-T Rec. Q.1762/Y.2802:"Fixed-mobile convergence general requirements" 09/2007
[4] Cathal Mc Daid." Overview and Comparison of QoS Control in Next Generation Networks", http://www.palowireless.com/3g/qos.asp
[5] ITU-T Rec.Y.2001 "General overview of NGN"12/2004
[6] ITU-T Pulse code modulation (PCM) of voice frequencies. Rec.G.711,11/1988
[7] 3GPP.AMR speech codec; General description. TS 26.071, 06/2005
[8] 3GPP. Service requirement for the internet protocol (IP) multimedia core network Subsystem (IMS); stage 1.03/2005

Biography

BABAK AHSANT obtained his Master degree in Electrical Engineering in telecommunication Systems in 2005. He is currently working at Mobile Communication Company of Iran (MCCI) as NSS fault management expert His areas of interest are NGN, FMC, and WiMAX, Cellular and 3G planning and optimization.

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