The Next-Generation FMC (Fixed-Mobile Convergence) Core Network

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Abstract

The IMS (IP Multimedia Subsystem) is an IP-based communication system defined by the 3GPP (3rd Generation Partnership Project), which is the organization that approves standards for the W-CDMA technology. It features the capability of access connections from fixed networks as well as continuing its original purpose of enabling cellular phone access connections. This means that the IMS offers an architecture that is capable of implementing the FMC (Fixed-Mobile Convergence). NEC is implementing FMC using the IMS as well as researching the AIPN (All-IP Network) at the same time with the aim of further improving its performance.

Keywords

IMS (IP Multimedia Subsystem), FMC (Fixed-Mobile Convergence), AIPN (All-IP Network)

1. Introduction

The current communication networks may be divided roughly into: analog telephone networks, ISDN (Integrated Services Digital Networks), the IP telephone networks provided by ISP businesses via the Internet, and the 2G and 3G mobile networks for cellular phones.

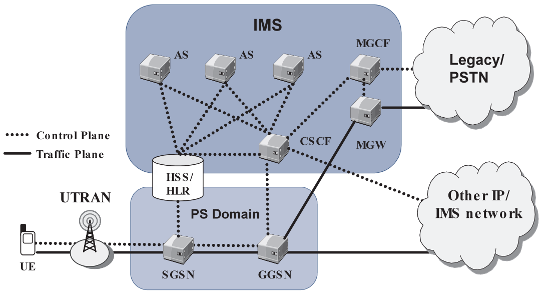
Each of these networks is composed of independent communications equipment. As a result, even the control of call sessions of services that are available both for fixed and mobile communications, such as call transfer and machine answering, is performed using different equipment for each network. The subscriber information and billing information are also allocated separately to each network. When a communication carrier wants to expand a business area from fixed to mobile, it should furnish the additional communications equipment to the mobile network. With regard to the subscribers, they have to subscribe to the carrier of each terminal and pay the communications fees to the actual carrier of each terminal. Since a subscriber utilizes a variety of communications including fixed phone, IP phone and cellular phone, the need for the convergence of services is a very important one, and IP transport implementation is intended to satisfy these needs.

2. IMS

The 3GPP (3rd Generation Partnership Project - The organization that defines the standards for 3G cellular phones based on the W-CDMA technology) has been studying the introduction of the IMS to replace the existing, circuit switching based core networks by new IP technology based core networks since around 2000. The purpose of the introduction is to provide subscribers with attractive multimedia services at low cost and for short periods based on utilizing various applications and contents services that are developed for the Internet. It is also expected that the introduction will bring great advantages to the cellular phone carriers because the IP-based call session control system can be created at a lower price compared to the traditional circuit switching exchanges and transmission paths, which are very expensive.

One of the significant features of the IMS architecture is that the IMS and access networks can be configured independently. This allows the IMS access not only from the PS Domain (packet communication) but also from the various access networks including 3GPP2 (3rd Generation Partnership Project 2, the organization standardizing the 3G cellular phone system based on the cdma-2000 technology), wireless LANs and fixed networks (ADSL, optical, etc.). Thereby increasing the system value of the IMS considerably, **Fig. 1** shows the outline of the IMS architecture.

The CSCF is the core function of the IMS. When an IMS call is originated by UE, the CSCF analyzes the SIP (Session Initiation Protocol, which is the communication control protocol used by the Internet phone standardized by the IETF) signal and transfers it to the CSCF or MGCF of the receiving party to provide the communication service. The CSCF also enables flexible call session control by downloading the subscriber



CSCF : Call Session Control Function
MGCF : Media Gateway Control Function
MGW : Media GateWay function
AS : Application Server
HLR/HSS : Home Location Register/Home Subscriber Server
UTRAN : Universal Terrestrial Radio Access Network
SGSN : Serving GPRS Support Node
GGSN : Gateway GPRS Support Node
UE : User Equipment

Fig. 1 IMS architecture.

profile from the HLR/HSS. The profile contains the information on the multimedia service requested by the subscriber. The CSCF transfers the SIP signal to the AS based on the downloaded information so that the AS delivers the desired multimedia service.

The element technologies of the IMS include; 1) subscriber authentication; 2) call session control and; 3) service addition facility.

(1) Subscriber Authentication for IMS Access

While the 3GPP adopts hardware authentication using a hardware module called the SIM (Subscriber Identify Module), which is attached to UE, the subscriber authentication of the IMS uses the ISIM (IM Services Identify Module), which is created by adding IMS related subscriber information to an SIM, in addition to the conventional authentication method using the SIM. The authentication information of the ISIM is encrypted and transmitted on the SIP signal in order to strengthen the confidentiality (digest authentication). The digest authentication using the ISIM can be regarded as a subscriber authentication technology that can improve the secrecy of the communication path while maintaining the high security level of the SIM authentication that has been proven in the past by 3GPP subscriber authentication operations.

(2) Call Session Control in the "Home" Network

One of the particular cellular phone services is subscriber "roaming." The traditional circuit switching method performs call session control at the system in the visited network, but the IMS performs call session control always in the system that accommodates the subscriber ("home"). This control method makes it possible to always deliver the same level of service without being affected by the system performance at the visited network ("roam"). In addition, both the CSCF and the AS linked to it can be arranged according to the subcription so that a precise service delivery on a per-subscriber basis is possible by arranging the CSCF according to the service type and scale and customizing the CSCF and AS.

(3) Services Addition Facility

The AS delivering the IMS service communicates with the CSCF using SIF, and with the HLR/HSS using DIAMETER (peer-to-peer protocol that provides AAA). These protocols are used universally on the Internet so they make it easy to add applications and contents developed for the Internet to the IMS. At NEC, we are proposing the use of the SIP-SDP (SIP-Service Delivery Platform) in evolving the AS by making use of this flexibility of the IMS. The SIP-SDP defines a universal service platform that is located at a higher-level layer to the AS that is linked via the HTTP protocol, and provides an easy-to-use high-level API to enable the development/introduction of new network services. The main features of the SIP-SDP include the provision of an environment for the rapid development of attractive services such as the services delivered according to the varying subscriber status in real time and those for controlling voice and image media as well as the implementation of a service platform that leads to greater profit than formerly.

3. FMC Using IMS

The IMS makes it possible to integrate the currently existing networks or network services (**Fig. 2**).

(1) The first integration is that of the communications equipment for use in call connections while the fixed and mobile networks use individual communications equipment at present. The means of access is not important for the CSCF,which is the communications equipment used by the IMS. All that is necessary for the CSCF is that the connecting terminal has an IP address. The CSCF enables unified call processing for all of the access networks that are capable of IP-based accessing, in order that the system operation efficiency of the communications carrier can be improved.

(2) The second integration is that of the services. The terminals connected to the IMS can derive benefit from services regardless of the means of access used. For example, a single terminal can receive a call whether from an ADSL/FTTH connection indoors or from an outdoor cellular phone connection (unification of a terminal into One Phone). Separate telephone numbers for the fixed and mobile networks are not necessary but a single

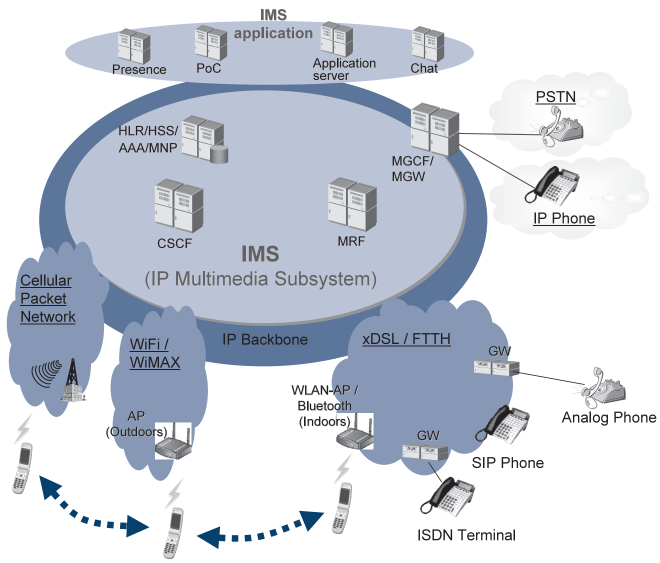


Fig. 2 FMC using IMS.

number can be used to receive any service (unification of number into One Telephone number). These functions will allow users to receive services without being aware of whether the network being used is a fixed one or mobile one.

(3) The third integration is that of subscriber data. In the current networks, the subscriber data of each subscriber is stored separately, that is, in the subscriber's exchange for fixed networks and in the HLR for mobile networks. In the case of the IMS, the subscriber data is integrated and managed in the HSS so that the services to be delivered can be performed easily by referring to the common subscriber data.

(4) The fourth integration is that of the communications fee payment destination. The user previously had to subscribe to different businesses for fixed and mobile communications. With the IMS, however, the user can receive the services through both the fixed and mobile networks by subscribing only to one business that is an IMS provider. They can also pay a combined communications fee for both the fixed and mobile communications.

In this way, the IMS realizes the FMC by providing services uniformly to various accessing networks including fixed and mobile networks by means of IP.

Although the FMC can deliver services regardless of the fixed or mobile network, convergence of various access networks into a single network leads to a new service requirement. Previous mobile networks allowed the user to move in the service areas while holding communications such as voice calls, and the FMC is required to provide the same environment, allowing the user to move across various access networks while holding the same communications.

The Mobile IP technology is the mechanism for supporting the movement of the users in an IP network. The concept of this technology is transferring the packets that are destined to the original IP address to the network where a user "roams". This function is realized by the mobility management between the MN (Mobile Node) and the HA (Home Agent). **Fig. 3** shows the operation of Mobile IP.

When Mobile IP is applied to FMC, data can be exchanged between moving terminals and an IMS network, even when the mobile and fixed networks are built using different IP networks. However, as the Mobile IP procedure for switching the packet transfer destination is required immediately after an access network change, the time interval required to perform this process may cause a perceivable disruption in the case of a voice communication. As shown in Fig. 3, this corresponds to a drop in the data transfer operation from ② to the end of ④. Although the "roaming" function, with which a terminal can receive the same service via different networks, is made possible by the Mobile IP technology, further improvements are required to provide a "handover" service between different networks with the same quality as the current mobile networks provide.

4. FMC Improvement Using AIPN

As described in Section 3, even when FMC is possible by integrating services and networks based on IMS, high-speed handover should be implemented in order to provide the same quality service as with the current mobile networks.

What is required for the high-speed handover is a close link-

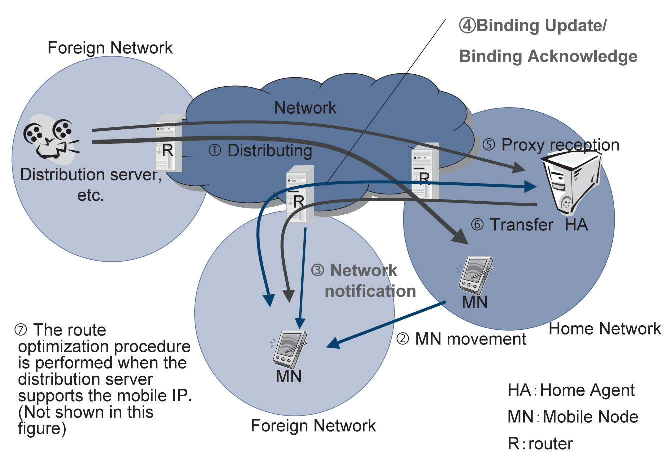


Fig. 3 Outline of Mobile IP operation.

age between the terminal movement following the user movement and the mobility control of the network and this may be achieved by either of the following two methods.

One of the methods is to provide the terminals with advanced mobility control functions.

A specific example of this approach is the Fast Handover of Mobile IP (FMIP,) which is an extension of Mobile IP.

The other method is to provide the network edge nodes with a mobility control function (edge mobility).

3GPP has studied this as the All-IP Network (AIPN), and the IETF began a similar study by calling it the Network based Localized Mobility Management (NETLMM).

Fig. 4 shows the outline of the AIPN architecture.

Each of the above approaches has its own advantages and disadvantages and its applicability varies depending on the particular field. However, we believe that the latter method will be more appropriate for the advancement of FMC.

This is because the purpose of providing broadband services for any terminal can be made easier by the following two properties of edge mobility:

(1) The non-necessity of incorporating the mobility control function in every terminal

→ Terminals that are not specialized for mobile services can use other services.

(2) The low quantity of the control signals exchanged between terminals and access nodes

→ The wireless access bandwidth can be utilized more effectively.

In addition, the edge mobility-based network architecture does not require the terminals to be equipped with the new mobility control function, it allows existing terminals and access networks to be accommodated easily as a means of FMC access. This feature also makes this architecture suitable for use in step-by-step migration to the mobile Ubiquitous services.

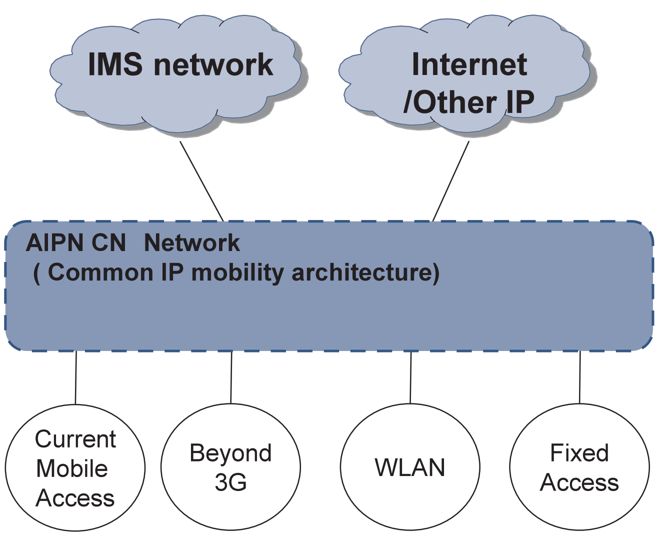


Fig. 4 Outline of the AIPN architecture.

5. Efforts Being Carried out by NEC

At NEC, we have adopted a policy of developing open products for use in the open architecture of the core network by leading the world in this field. Included are the aTCA (Advanced Telecom Computing Architecture) and the CGL (Carrier Grade Linux) OS as well as the NEC-original HA-MW (High Availability MiddleWare). We have already developed some products that incorporate this architecture, such as the packet core nodes, SGW (Signaling GateWay) and HLR (Home Location Register) for the 3G cellular core network and a CSCF and MRF for the IMS core network. With these products achieving excellent results in the market, we are making a significant contribution to the IP implementation of networks.

To implement the FMC core network, we will develop it on the well proven common architecture in order to meet the needs of carriers and end users by packaging an FMC service with the CSCF, enhancing the HSS-HLR linkage and offering the gateway to enable connections between various access networks and the IMS network that feature high quality, low cost and high speed. We also intend to actively support the ongoing standardization activities so that we can rapidly incorporate the appropriate industrial standards in our products.

With regard to the migration from the FMC to the NGN (Next Generation Network), we will also offer an optimum core network that can distinguish NEC products from those of our competitors, by ensuring the flexible scalability of C-Plane with a blade extension capability and increasing the capacity of U-Plane by the use of HW.

6. Conclusion

Internet Protocol (IP) implementation of the communication network transport enables the provision of diverse means of access and the promotion of convergence of services. Aiming at the realization of the Ubiquitous society in which mobile terminals will enable the enjoyment of a wide range of broadband services, NEC will provide the next-generation (FMC) core network with the smooth migration from the existing networks.

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