Mobile Satellite Communications Services | SIP | FAX Gateway

Technology Reports

Special Articles on WIDESTAR II High-speed Mobile Satellite Communications Service for Diverse Satellite Communications

WIDESTAR II Satellite Core Network System

The new WIDESTAR II mobile satellite communications service supporting faster communications was launched in April 2010. With the aim of expanding the use of data communications services and providing them at low rates, NTT DOCOMO has upgraded the existing PDC-based satellite system with a new IMS-based mobile communications system, which is also used in the FOMA voice network. This system provides voice, FAX and packet services on GPRS and achieves voice-call control using SIP, which enables S-MSs to access supplementary services offered on FOMA and to connect to all FOMA APNs.

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1. Introduction

As an approach to converting voice services provided by circuit switching to IP, NTT DOCOMO is conducting a migration to an IP-based core network called Circuit Switched over-IP Network (CS-IP NW) for controlling and transmitting voice traffic using the IP Multimedia Subsystem (IMS)*1 [1]. A similar approach is adopted in the network handling mobile satellite communications, and to minimize the development load here, a development base common to that of CS-IP NW is used. The packet communication service connects with the Serving/Gateway GPRS Support Node (xGSN) in the FOMA service thereby enabling a Satellite-Mobile Station (S-MS) to connect to any Access Point Name (APN)*2 available in the FOMA network without impacting the server side of existing APNs in any way. A FAX gateway service, moreover, provides functions such as FAX storage not possible with the existing satellite system.

The network configuration of NTT DOCOMO's new satellite system is shown in **Figure 1**. The core network equipment dedicated to this mobile satellite communications system consists of the Access Gateway for Satellite (AGS), Satellite-Call Session control Node (S-CSN), Satellite-Application Serving Node (S-ASN), Satellite-Media Resource Node (S-MRN), which have been newly developed, and the Media Gateway Node (MGN), Media Processing Node (MPN)*3, xGSN and IP Service Control Point (IPSCP), which are existing equipment to which enhancements have been made. The S-CSN, S-ASN, and S-MRN have a common development base with the CS-IP NW, which is a development approach that enabled this mobile satellite communications system to be constructed in an

*1 **IMS**: A communication system standardized by 3GPP for achieving multimedia services by integrating communication services of the fixed-line network, mobile communications network, etc. using IP technology and SIP (see *5) protocol as used in VoIP.

*2 **APN**: The name of a network connection point used by corporate users and others to connect to the network.

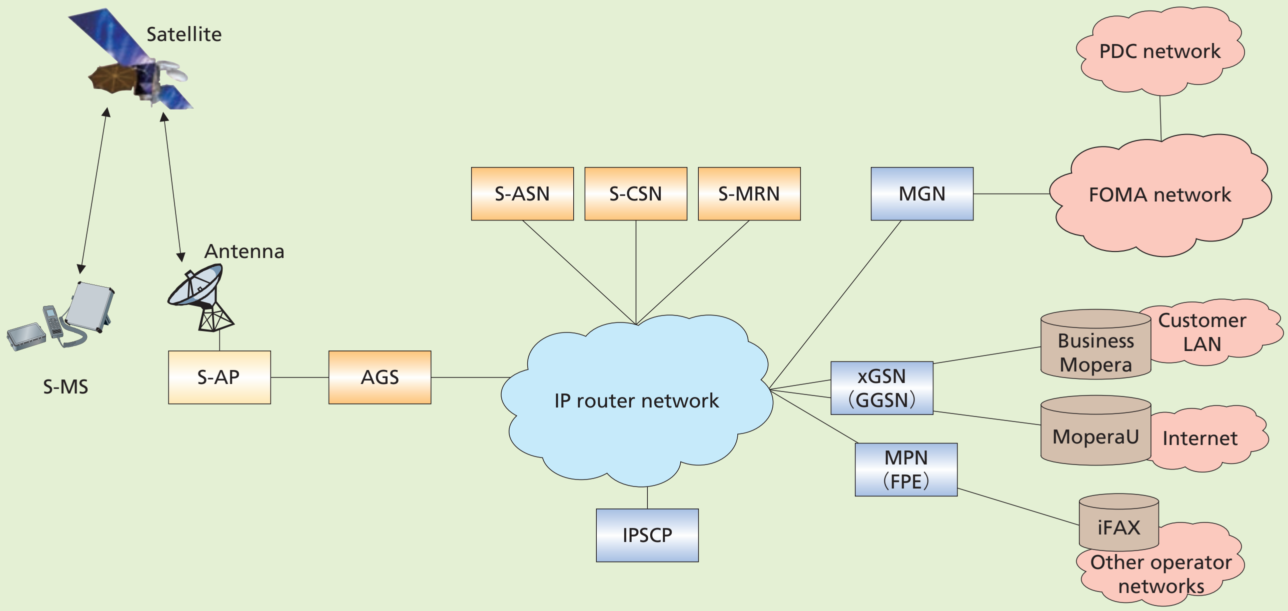


Figure 1 Network configuration of satellite communications system

efficient and effective manner.

In addition, this system, as its predecessor, is expected to be available during times of natural disasters and other calamities, and to this end, a redundant configuration has been adopted. Specifically, network equipment is installed in two physically remote sites so that communication services can continue uninterrupted even if one site should be destroyed.

In this article, we describe the core network equipment making up NTT DOCOMO's new high-speed mobile satellite communications system.

2. Voice Services

2.1 Control System for Satellite Voice Services

To provide voice services over the mobile satellite communications system, a group of equipment based on CS-IP NW is installed specifically for satellite use. The S-CSN, S-ASN and S-MRN perform control functions equivalent to standard IMS, with S-CSN performing session control[*4], S-ASN service control, and S-MRN guidance transmission control. The MGN, meanwhile, controls connections with other networks such as FOMA while also being used in the CS-IP NW.

The new CS-IP NW introduces Signaling Interworking Node for 3G access (SIN) to perform protocol conversion so that it does not impact the existing 3G access network. In contrast, the new satellite system features a newly developed terminal and achieves end-to-end Session Initiation Protocol (SIP)[*5] control between that terminal and the IMS network. There is therefore a need to establish an IP connection between the terminal and IMS, and this is accomplished through the introduction of AGS, which provides General Packet Radio Service (GPRS). There is likewise a need for the new satellite system to inherit existing satellite services like voice mail and call forwarding, and this need is met by S-ASN as an Application Server (AS) that controls voice services.

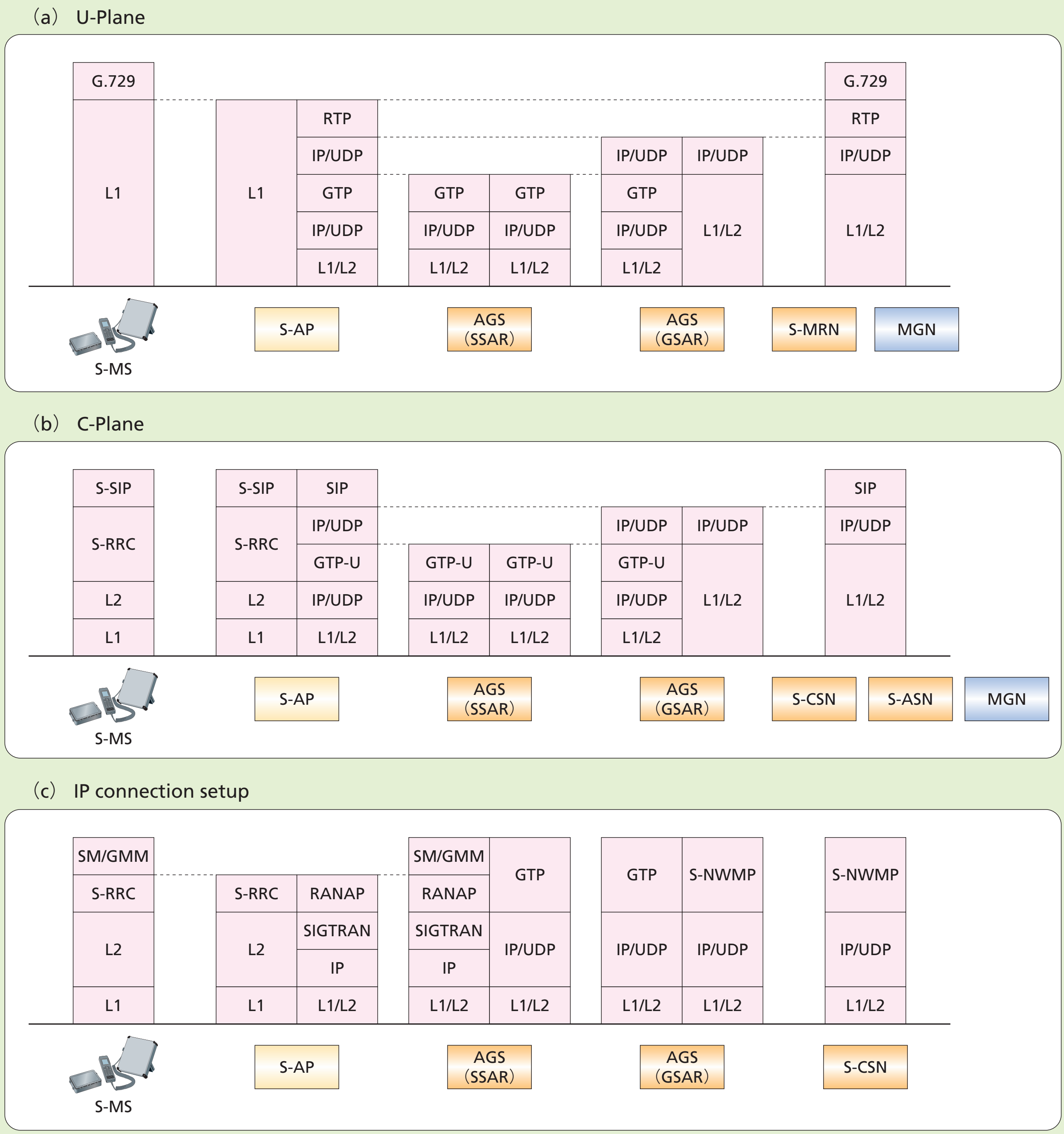
A key feature of the new mobile satellite communications system is that an S-MS terminates Satellite-SIP (S-SIP), a specially-designed SIP for satellite use, but does not terminate IP or Real-time Transport Protocol (RTP)[*6]. The protocol stacks indicating which protocols each of the above nodes terminate are shown in **Figure 2**. While SIP exchanges information for sending

*3 **MPN**: A node developed for the purpose of unifying media service enablers to enhance the value of supplementary services in the future network.

*4 **Session control**: A function for controlling end-to-end IP communications over the network.

*5 **SIP**: A call contorol protocol defined by the Internet Engineering Task Froce (IETF) and used for IP telephony with VoIP, etc.

*6 **RTP**: A protocol defined by IETF for real-time distribution of audio, video or other such media.



C-Plane : Control Plane
GSAR : Gateway Satellite Access Router
GTP : GPRS Tunnelling Protocol
L1 : Layer 1
L2 : Layer 2
RANAP : Radio Access Network Application Part
S-NWMP : Satellite-Network Management Protocol
SSAR : Serving Satellite Access Router
UDP : User Datagram Protocol
U-Plane : User Plane

Figure 2 Protocol stack for voice communications

and receiving media using Session Description Protocol (SDP)*7, the Satellite-Access Point (S-AP) terminates RTP, which means that the SDP information provided by SIP must be notified not only to S-MS but also to S-AP. Thus, on receiving an SIP signal to which SDP is attached, the S-CSN notifies necessary information to S-AP via the AGS.

2.2 Originating/Terminating Call Processing Sequence for Satellite Voice Services

On power ON, an S-MS sends a signal in GPRS Mobility Management (GMM) protocol*8 to AGS, which then performs attach procedure. The S-MS also sends a signal in Session Management (SM) protocol*9 to AGS to establish a Packet Data Protocol (PDP) context for a voice-dedicated APN. In other words, an IP connection is provided through GPRS. After this, the terminal sends out an SIP signal requesting registration*10, which prompts IMS registration control to be performed with respect to upper nodes (S-CSN/S-ASN/IPSCP) and profile information to be created at each node. Basic originating/terminating call processing after registration is shown in **Figure 3**.

- Procedure 1:

  In response to an originating call from an S-MS, the AGS executes security procedures with the terminal such as authentication and ciphering processing and transfers the originating request (INVITE) to S-CSN.
- Procedure 2:

  The S-CSN sends INVITE to S-ASN where registration has been performed.
- Procedure 3:

  The S-ASN identifies the originating subscriber and performs service control on the originator's side such as assessing subscription status.
- Procedure 4:

  The S-CSN accesses the IPSCP accommodating the terminating subscriber, obtains the address of the S-CSN on which the terminating subscriber has been registered, and sends INVITE to that S-CSN.
- Procedure 5:

  The terminating S-CSN identifies the terminating subscriber and sends INVITE to the terminating S-ASN, which assesses the subscription status of the terminating subscriber and sends a provisional response (183) to the originating side. The terminating S-ASN also performs service control on the terminator's side.
- Procedure 6:

  The terminating S-ASN sends INVITE to the terminating S-MS via the terminating S-CSN without being aware of the existence of the terminating AGS.
- Procedure 7:

  The terminating AGS queues the arriving IP packet and performs paging. Then, on receiving a response from the terminating S-MS, it performs authentication/ciphering processing and PDP context establishment and sends the queued packet to the terminating S-MS.
- Procedure 8:

  The terminating S-ASN which has received a ringing signal (180) from the terminating S-MS sends INVITE to the S-MRN to make a connection to Ring Back Tone (RBT). The S-MRN, in turn, responds to the terminating S-ASN with a success response (200) that is set the SDP for sending out the RBT.
- Procedure 9:

  Once SDP updating is completed, the terminating S-ASN sends a ringing signal (180) to the originating S-ASN, which sends the ringing signal to the originating S-MS via S-CSN. Here, the S-CSN (Proxy-Call Session Control Function (P-CSCF)) sends SDP information to the S-AP via the AGS. Then, in parallel with this, the terminating S-ASN sends back an acknowledgment request (ACK) with respect to procedure 8 to S-MRN, which sends the RBT to the originating side.
- Procedure 10:

  At the time of subscriber response, the terminating S-CSN (P-CSCF) which received the success response (200) for the first INVITE from the terminating S-MS

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*7 **SDP**: Protocol for describing IP addresses and other information necessary for beginning a multimedia session. Also used for describing session information in SIP.

*8 **GMM protocol**: Protocol for performing mobility management such as location registration and authentication in the packet switched domain.

*9 **SM protocol**: Protocol for connecting with the network including call originating and call terminating in the packet switched domain.

*10 **Registration**: In SIP, refers to the registration of a contact address by a mobile terminal with a registrar server, and in IMS, to registration processing by an IMS terminal with respect to its home network.

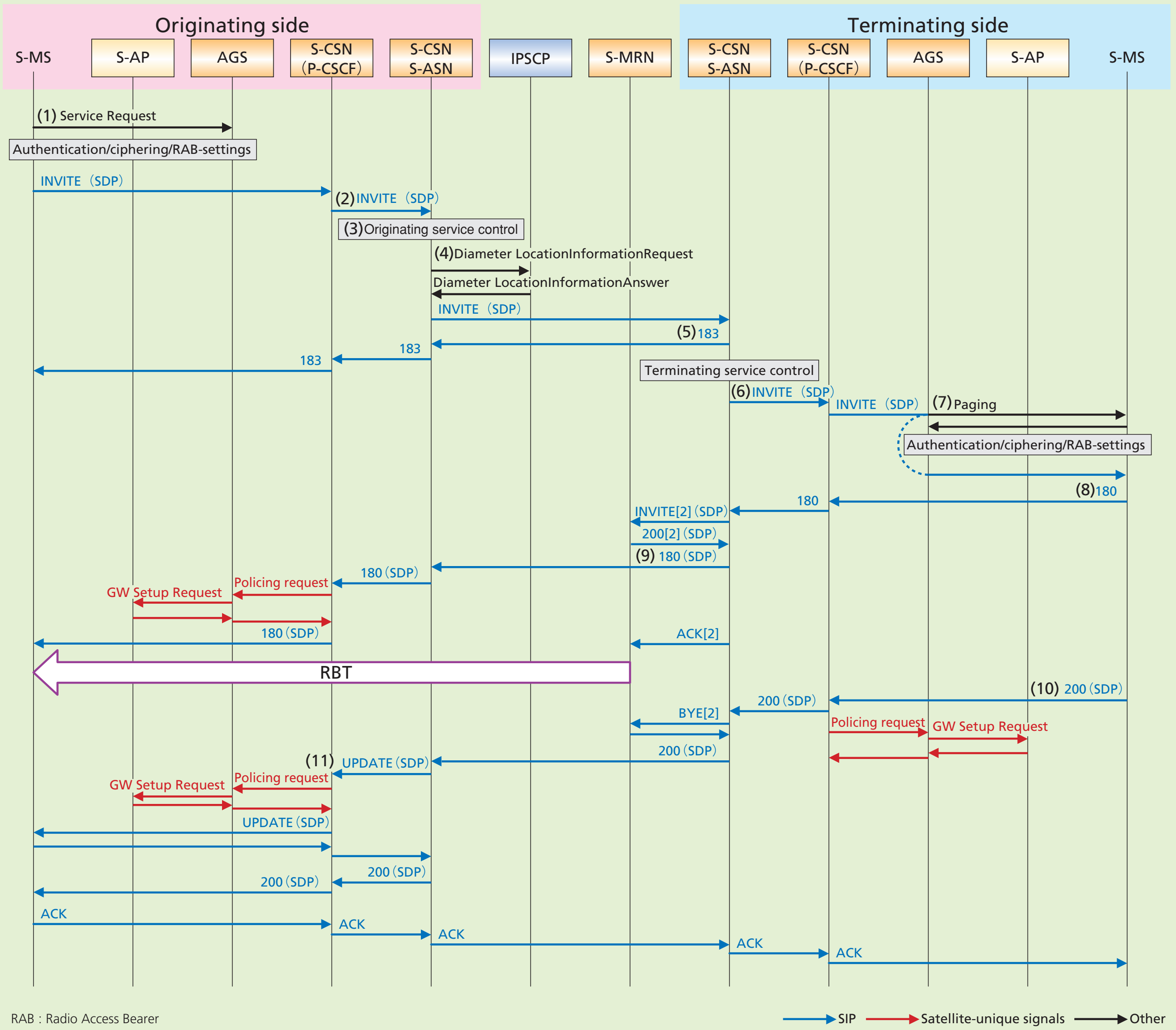


Figure 3 Overview of originating/terminating sequence

sends SDP information to the terminating S-AP via the terminating AGS. In addition, the terminating S-ASN releases the session release with respect to S-MRN and also sends the success response (200) including the SDP of the terminating S-MS to the originating S-ASN so that the state in which the originating S-MS and S-MRN are exchanging SDP can be changed to the state in which the originating S-MS and terminating S-MS are connected.

- Procedure 11:

The originating S-ASN which has received the success response (200) from the terminating S-MS sends update information (UPDATE) including the SDP of the terminating S-MS to the originating S-MS and receives a response from the originating S-MS. At this time, the originating S-CSN sends SDP information to the S-AP. After this, the originating S-ASN sends the success response (200) to the originating S-MS with respect to the original INVITE. The above processing enables a call to be made in the satellite system.

3. Data Communications Services

In addition to IP connections for voice communications on the satellite system as described above, the AGS also provides IP connections for data communications services. These services can be broadly divided into the FAX gateway service, packet communication service, and direct connect service from the network connection point of view.

3.1 FAX Gateway Service

The launching of NTT DOCOMO's FAX gateway service in April 2010 provided users with an alternative to the existing satellite FAX service. Based on a circuit switched system, the existing satellite FAX service was unable to forward FAXs if the other party was in a line-busy or out-of-range state, and it suffered from a long communication time due to a narrow bandwidth (maximum 4.8 kbit/s in the uplink and maximum 64 kbit/s in the downlink; best-effort communications).

In contrast, the new satellite FAX gateway service enables the sending and receiving of FAXs over the IP network using G3FAX machines. Adopting the International Telecommunication Union (ITU) T.37[*11] standard (mail system), the FAX gateway service incorporates a new FAX storage function (three-day maximum) in the NTT DOCOMO network so that FAX communications can later be realized if the other party should be out of range. This new service also features a short communication time due to a broad bandwidth (maximum 144 kbit/s in the uplink and maximum 384 kbit/s in the downlink; best-effort communications) providing users with an even higher level of convenience.

An example of a network configuration for providing the FAX gateway service is shown in **Figure 4**. To send and receive FAXs, the user connects a G3FAX machine to the FAX adaptor of the S-MS. The FAX adaptor performs mutual conversion between G3FAX signals and mail. There are three patterns of service provision: fixed-line telephone to S-MS, S-MS to fixed-line telephone, and S-MS to S-MS. The iFAX®[*12] service provided by NTT Communications Corporation is used to send and receive FAXs between an S-MS and fixed-line telephone, and the MPN is used to send and receive FAXs between two S-MSs.

On receiving mail, the MPN notifies the FAX adaptor connected to the S-MS of the incoming mail. The FAX adaptor, in turn, establishes a network connection with the MPN to receive the mail. Then, after receiving the mail, the FAX adaptor converts the mail to G3 protocol and passes it to the G3FAX machine, which proceeds to output the FAX. It is also possible to receive FAXs from other Internet Service Providers (ISPs) that provide services similar to iFAX.

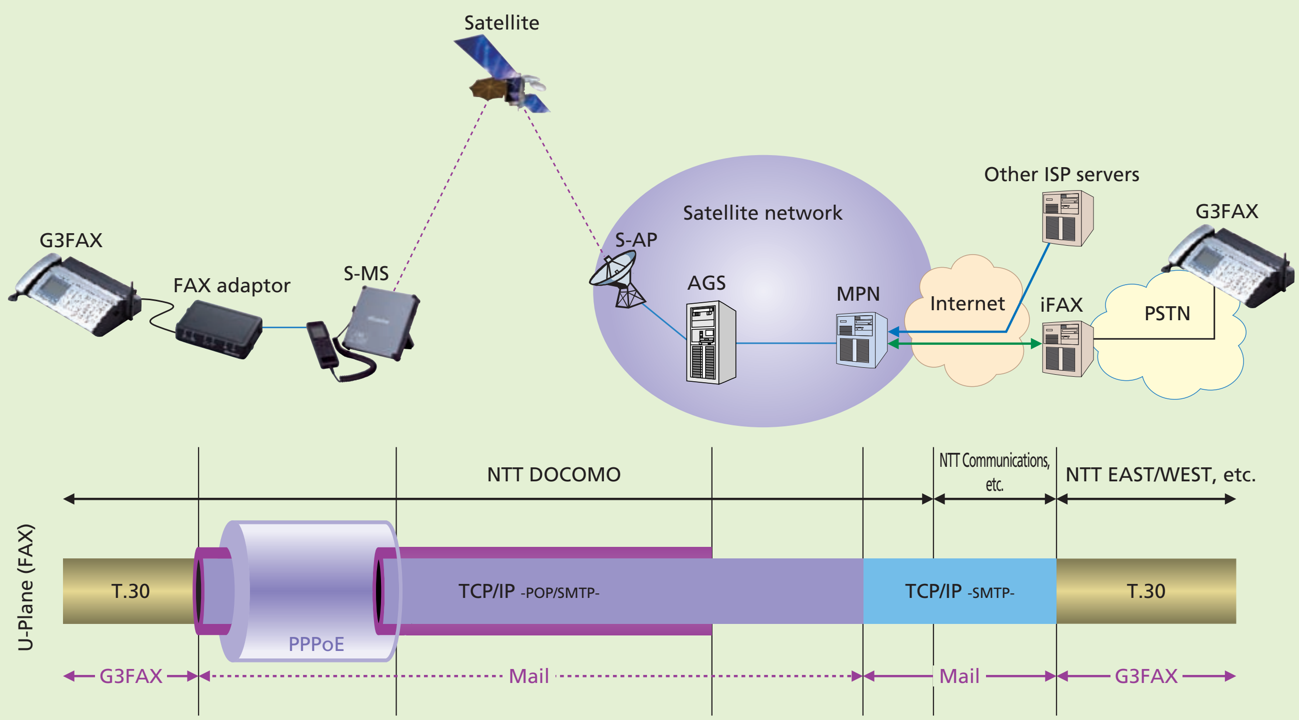
New Fax Processing Equipment (FPE) has been developed and installed in MPNs in the NTT DOCOMO network to provide the FAX gateway service. The FPE installation configuration within an MPN is shown in **Figure 5**. This FPE, which has T.37 functions, makes effective use of existing software while making original extensions to general-purpose software and general-purpose interfaces. This approach, which flexibly utilizes high-value-added and inexpensive general-purpose solutions, has been successful in significantly reducing development time and expenses.

3.2 Other Services

The packet communication service is the same as the data communication service provided by FOMA. It aims to provide connections to all APNs provided by FOMA with the exception of i-mode related communications. To this end, we adopt a network architecture in

*11 **T.37**: A transmission-control protocol for achieving G3FAX communications via e-mail on the IP network.

*12 **iFAX®**: A registered trademark of NTT Communications Corporation.



PPP : Point-to-Point Protocol
PPPoE : Point-to-Point Protocol over Ethernet
SMTP : Simple Mail Transfer Protocol

Figure 4 Network configuration of FAX gateway service

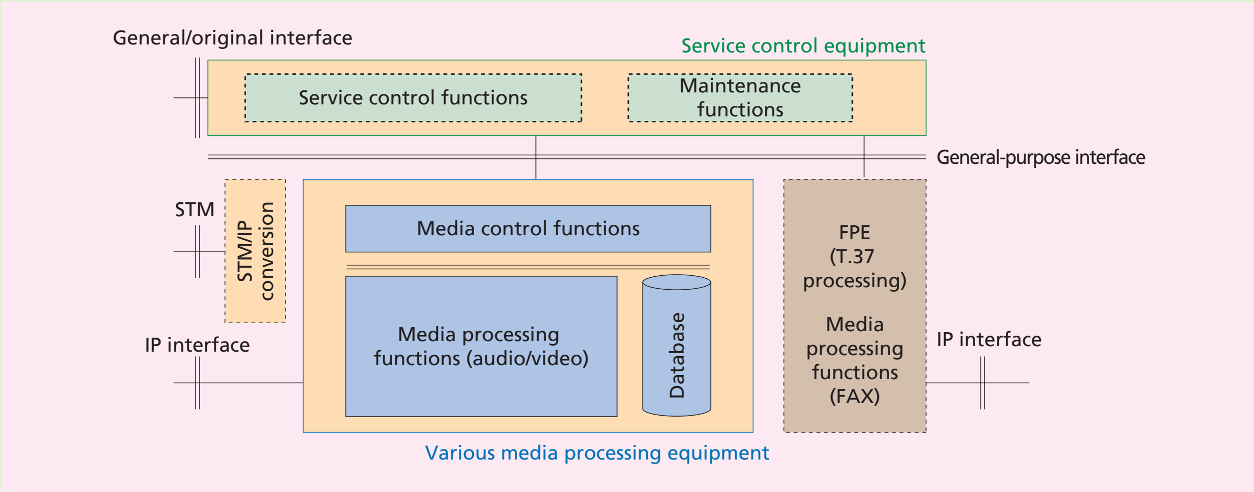


Figure 5 FPE installation configuration in MPN

which the AGS connects to the xGSN (GGSN). The advantage of this scheme is that connections from S-MSs can be made without having to add new facilities or change settings on the APN side. Furthermore, by adopting in the AGS a

GPRS system that is completely the same as that of the xGSN (SGSN), communications from the satellite can be achieved without affecting the xGSN (GGSN) in any way.

The direct connect service enables S-MSs to communicate with each other at the IP level as an alternative means to data communications performed via circuit switching on the existing satellite system. In the new service, each terminal is assigned a fixed IP address enabling an originating S-MS to connect to any other S-MS.

4. Conclusion

This article described CS-IP NW equipment supporting NTT DOCOMO's new WIDESTAR II high-speed mobile satellite communications system. Looking to the future, we can expect the addition of new xGSN (GGSN) functions to expand data communications and the addition of new MPN functions to expand FAX communications. We can envision a broadcast service for providing emergency information by voice, mail and FAX to users in areas not covered by mobile-phone networks such as off-shore and mountainous areas, as well as enhanced services that exploit the capabilities of this new satellite network based on IMS architecture.

Reference

[1] Y. Shimada et. al: "IP-based FOMA Voice Network toward Enhanced Services and Improved Efficiencies," NTT DOCOMO Technical Journal, Vol.12, No.1, pp.4-14, Apr. 2010.