Special Article on Satellite Packet Communication Service
System Overview

In order to further promote mobile multimedia communication, and with a view to expanding data communication services and improving their convenience for users, DoCoMo has developed its Satellite Mobile Packet Communication System. The service commenced in March 2000.

In this article, the outline of the features and the configuration of the Satellite Packet Communication System is given, and the service is briefly described.

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1. Introduction

The demand for small, portable devices for data communication has been increasing markedly in recent years. DoCoMo has provided many new services in response. Services added to the original 9.6kbit/s data communication service include the PDC Mobile Packet Data Communication System (PDC-P) [1], that has been running since March 1997, a 32kbit/s PHS data communication service launched one month later, and a 64kbit/s PHS data communication service for high-speed PHS links, in service since December 1998.

The use of such mobile infrastructure to access the Internet and intranets has been dramatically increasing. Some are now predicting that all Internet and Intranet will completely rely on the radio access in five years.

Many of the Internet and Intranet service has the characteristic that the traffic on forward link (from the network to terminals) is dominant and the traffic on return link (from terminals to the network) does not greatly affect the overall throughput. Raising the return link transmission rate leads to the increase of the emission power of mobile terminals and makes the mobile terminal large and heavy. As for satellite communications, however, the forward link transmission rate can be increased to higher speed with relative ease by increasing the transmission output power and the bandwidth of the satellite.

The Satellite Mobile Packet Communication Service [3] (Satellite Packet System) with a high transmission rate on forward link (up to 64kbit/s) was launched at the end of March 2000. The system is for mobile terminals and its service area is the same as that of the existing N-STAR Satellite Mobile Communication System [2]. An outline of the system is given below.

2. Service Overview

Although original service provided data communication service of 4.8kbit/s communication rate adding to the voice service, the new service provides an asymmetrical communication service with communication rates of 4.8kbit/s on return links and 64kbit/s on forward links. The standard Internet protocol is the assumed communication protocol for data terminals connected to satellite packet mobile terminals. PPP (Point to Point Protocol) is adopted as the access protocol.

Mobile terminals for the Satellite Packet System are simultaneously ready for either incoming data packets or incoming voice calls. In addition, the connectionless feature of packet system provides an operational capability for users that are close to that provided in a cable LAN environment. There are two forms of connection, to a company's LAN (Intranet) or to an Internet provider. This is the same as the DoPa service provided by the PDC-P system. IP addresses can be statically or dynamically allocated to data terminals, and closed, private addresses can be used within a given company.

3. Radio System Overview

(1) System configuration

The Satellite Packet System uses four beams, each with a radius of approximately 500 km, to cover Japan and the seas adjoining Japan. As mentioned above the packet data com-

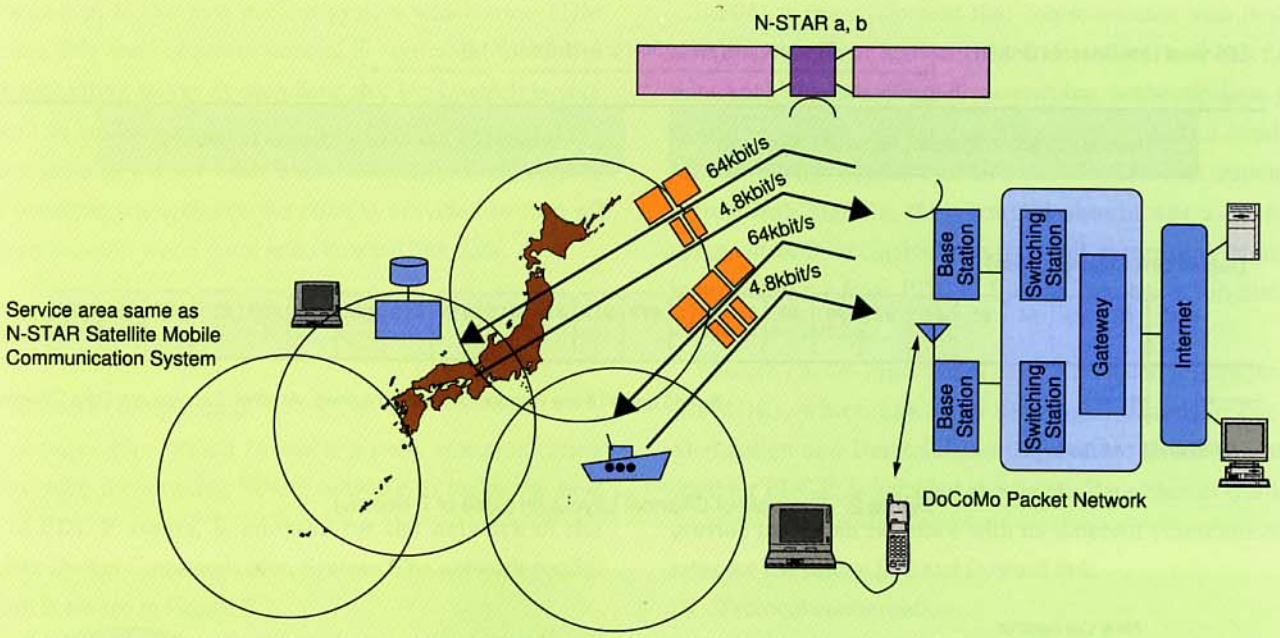


Figure 1 Satellite Packet System Image

Table 1 Major Parameters of the Radio System

Item	Major Parameters	
	Satellite Mobile Communication System	Satellite Packet Communication System
Radio Frequency Band	Feeder Link : C band (6/4GHz) Service Link : S band (2.6/2.5GHz)	As the at left
Channel Frequency Interval	12.5kHz	Return Link : 12.5kHz Forward Link : 150kHz
Modulation and Demodulation	π/4-QPSK coherent detection	As the at left
Communication Mood	Full-Duplex	
Access Method	FDMA	Return Link : FDMA (Signal Transmission : Artificial Link Switching Connection) Forward Link : TDM
Data Transmission Rate	4.8kbit/s	Return Link : 4.8kbit/s Forward Link : 64kbit/s

FDMA : Frequency Division Multiple Access
QPSK : Quadrature Phase Shift Keying
TDM : Time Division Multiplex

munication service features a 64kbit/s forward link and 4.8kbit/s return link, using the N-STAR satellite, which has been providing a voice service since 1996. Figure 1 is a schematic illustration of the system as a whole, and Table 1 is a list of the major parameters of the radio system.

(2) Radio link control

TDM (Time Division Multiplex) is used on the forward link and FDMA (Frequency Division Multiple Access) is used on the return link. A transmission rate of 4.8kbit/s was adopted for return link, because the mobile terminals will be small, low power devices, with economy of use a major consideration. A new scheme, which once the return link channel is assigned to the terminal then the terminal holds the channel dedicatedly for certain time, is adopted as the return link channel assignment method, in order to avoid the decrease of the throughput [4].

(3) Channel layout

Figure 2 shows an example of the layout of a channel. At least one channel of the 64kbit/s forward link channel group is carried by each beam and all of the mobile terminals within a given beam's area share the common channel. The 4.8kbit/s return link channel group consists of a sub-group of random access channels, with at least one such channel per beam, and a sub-group data channel. The assignment of

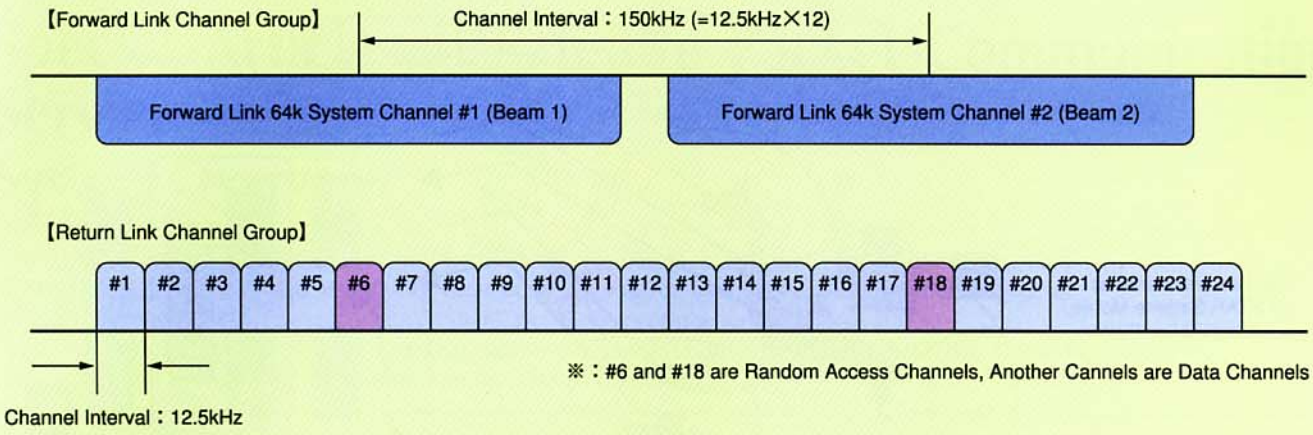


Figure 2 Example of Channel Layout (in Case of 2 Beams)

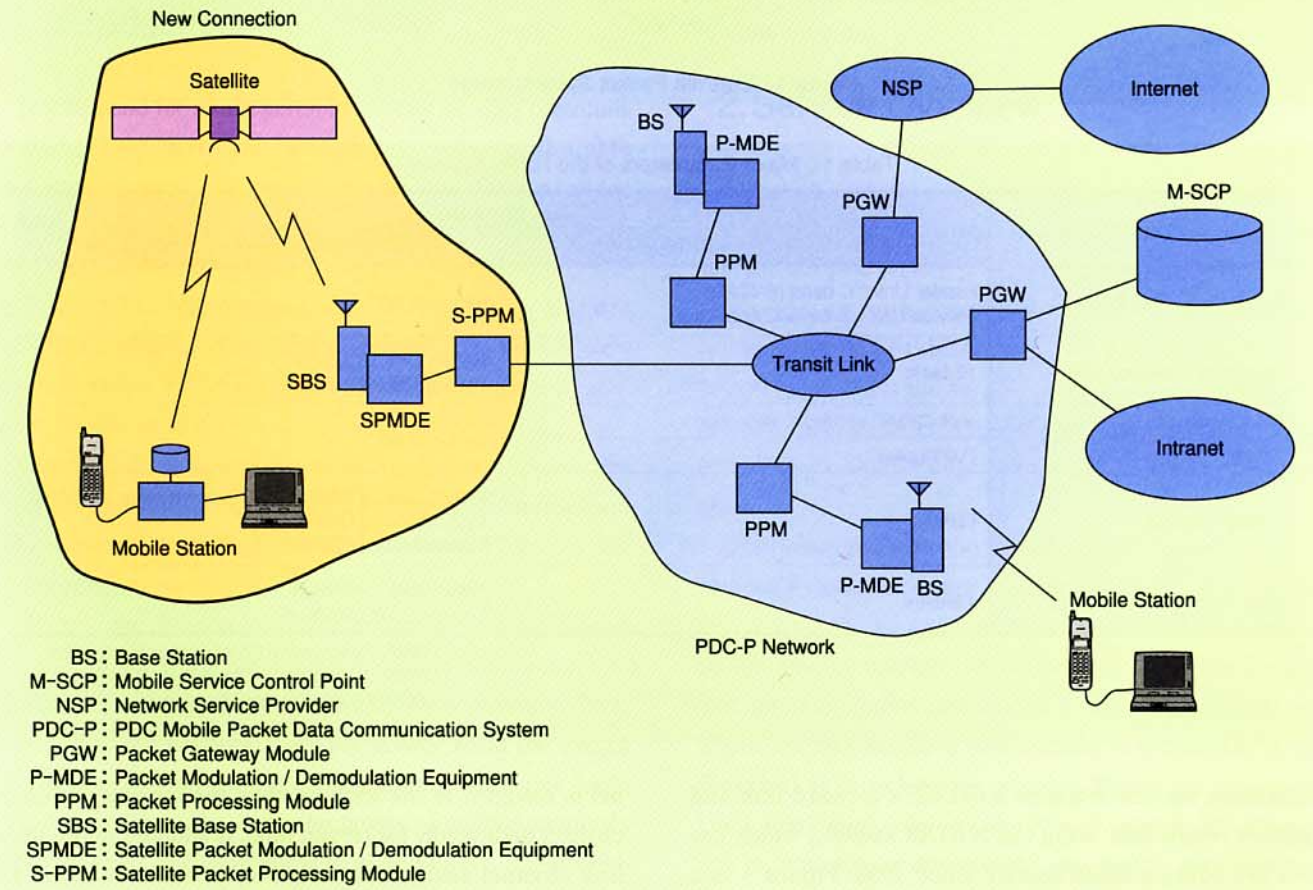


Figure 3 Network Configuration Diagram

data channels can be changed flexibly by changing the system parameters at the ground stations, in order to be able to respond flexibly according to the change of the traffic.

(4) High reliability

The radio system equipment has a duplex configuration equivalent to that of the present Satellite Mobile Communication System. This configuration ensures that the unit will continue to function despite failure in one unit.

(5) Effective usage of satellite power

In terms of capacity, the satellite' transmission power is the limiting factor. In the original circuit switched satellite voice communication system, the forward link satellite power is controlled for each channel so that the appropriate transmitting power is applied for each terminal based on the link

performance. In the new packed system which uses TDM scheme, this level of power control is equivalent to control the transmitting power at each time slot level, which is very difficult to implement. Accordingly, a function to control the transmission power for each beam is furnished, and further data operated transmission function is provided to turn off the transmission when there is no forward link data.

4. Network Overview

(1) Network configuration

A configuration, which connects a radio communication system with the existing PDC-P network to make the best use of PDC-P assets, is adopted for the network of the Satellite Packet Communication System. The network configuration is shown in Figure 3.

Packet Gateway Module (PGW) is already installed in the PDC-P network for interconnection with other networks such as Internet. PGW has a function to access location Information in Mobile Service Control Point (M-SCP) when user packet comes from other networks and to conduct routing to Satellite Packet Processing Module (S-PPM) that holds the areas where mobile terminals exist, and it also has the charging function for packets to the Internet side.

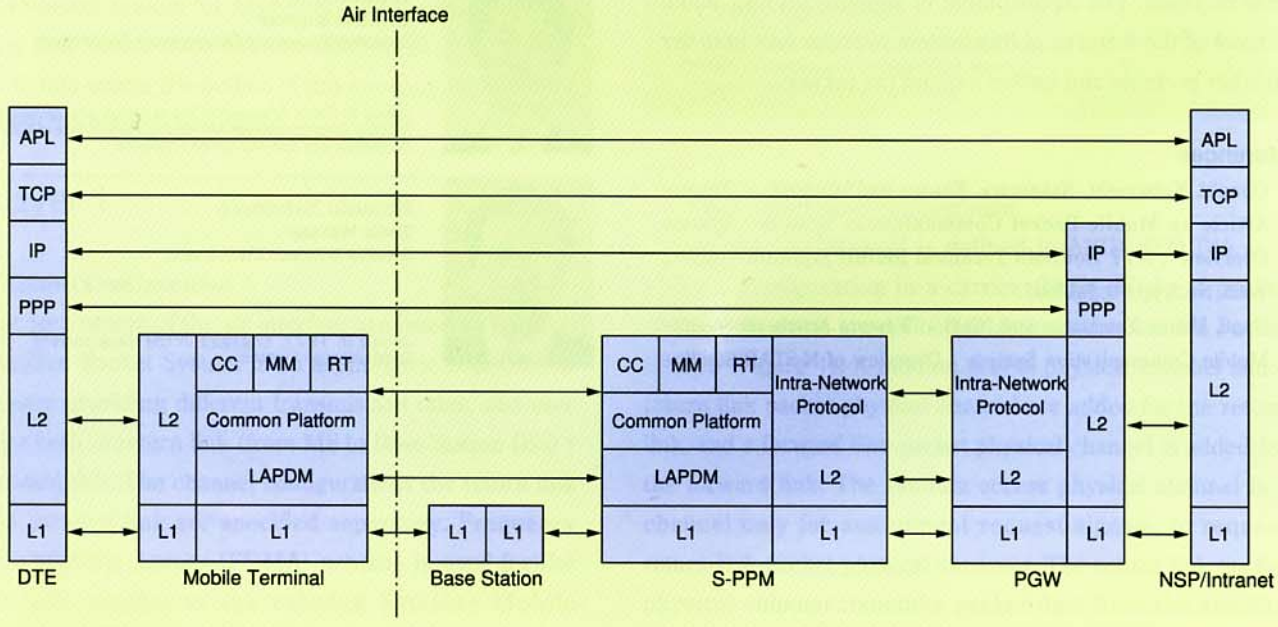
S-PPM is the equipment that communicates with mobile terminals via Base Station (BS) and satellite, and has functions such as assembling, disassembling, authentication, and charging for packets to the radio section. In the satellite Mobile Packet System, when a mobile terminal transmits return link signals, the terminal should use a channel assigned to it exclusively to transmit return link signals, being different from PDC-P. S-PPM also has a function to assign this channel.

Satellite Packet Modulation and Demodulation Equipment (SPMDE), which has been developed based on Packet Modulation and Demodulation Equipment (P-MDE) developed for PDC-P, is installed at Satellite Base Station (SBS) to provide packet air interface with its different communication rates for the return link and forward link.

(2) Protocol configuration

The protocol configuration in the Satellite Packet Communication System is shown in Figure 4.

The air interface is an extended version of PDC-P air interface. A new channel allocation interface is defined for the existing packet communication physical channel in layer 1. Link Access Procedure for Digital Mobile Channel (LAPDM) is applied in layer 2. Call Control (CC), Mobility Management (MM), Radio Frequency Transmission Management (RT) and a common



APL : Application Layer
CC : Call Control
DTE : Data Terminal Equipment
L1 : Physical Layer Protocol
L2 : Data Link Layer Protocol
LAPDM : Link Access Procedure for Digital Mobile Channel
MM : Mobility Management
NSP : Network Service Provider
PGW : Packet Gateway Module
PPP : Point to Point Protocol
RT : Radio Frequency Transmission Management
S-PPM : Satellite Packet Processing Module

Figure 4 Protocol Configuration

platform are defined in layer 3. A radio control function for the selection of radio channels, other mobility management function such as packet channel registration and hand off, and transmission/reception function for user packets are also implemented in layer 3.

The same intra-network transfer protocol as is used in the PDC-P is used as the inter-node interface. The transmission, reception, authentication, and hand-off of user packets are controlled.

PPP is adopted for the access control, in the same way as DoPa service that uses PDC-P. Internet applications such as E-mail and WWW browsing are made available by this protocol and TCP/IP at data terminals.

(3) Network management

An identification number is attached to each connected network for the network management of satellite packets, in the same way as in a PDC-P network. Networks are logically separated from each other by an intra-network transfer protocol. Security is assured by this measure.

5. Conclusion

The Satellite Mobile Packet Communication System entered service on March 27, 2000. This system has brought the 64kbit/s high-speed packet communication service to the whole of Japan. The development of applications that make the most of the features of this system is under way in order to further promote and further expand the service.

References

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