

# Special Article on Satellite Packet Communication Service

## Air Interface

The air interface for the Satellite Mobile Communication System has been expanded to enable it to support a packet-data communication system, and it has been adopted as the air interface for the Satellite Mobile Packet Communication System that provide efficient and high-speed data communication service.

In this article, the outline of the air interface for the Satellite Mobile Packet Communication System is described, along with the main technologies.

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## 1. Introduction

The air interface for the Satellite Mobile Packet Communication System (hereinafter referred to as the "Satellite Packet System") was standardized as ARIB STD-T49 2.0 [1] in March 2000. This air interface is based on the existing Satellite Mobile Communication System to provide a voice communication service, and the interface supports a packet communication system for high-speed transmission on the forward link (from Base Station (BS) to Mobile Station (MS)). In this article, the outline of this interface is described, along with the main technologies.

## 2. Layer 1

### 2.1 Channel Configuration

Major parameters of the air interface are listed in Table 1. The Satellite Packet System is an asymmetric communication system providing different transmission rates, and user rates, for both of return link (from MS to Base Station (BS)) and forward link. The channel configurations the return link and the forward link are specified separately. Frequency Division Multiple Access (FDMA) scheme is used for the return link, similar to the existing Satellite Mobile Communication System. A return link carrier with a 14kbit/s transmission rate is specified as the channel to provide a 4.8kbit/s user rate. On the other hand, Time Division Multiplex (TDM) scheme is newly adopted for the forward link, and a forward link carrier with 154kbit/s transmission rate is specified as the channel to provide a 64kbit/s user

Table 1 Major Parameters of the Radio System

Method	Item	Major Parameter
FDMA	Carrier Frequency Interval	12.5kHz
	Modulation	$\pi/4$ shift QPSK (Roll-off factor = 0.5)
	Transmission Rate	14kbit/s
TDM*	Carrier Frequency Interval	150.0kHz
	Modulation	$\pi/4$ shift QPSK (Roll-off factor = 0.5)
	Transmission Rate	154kbit/s

\* Used for the Forward Link of the Satellite Mobile Packet Communication System

FDMA : Frequency Division Multiple Access

QPSK : Quadrature Phase Shift Keying

TDM : Time Division Multiplex

rate.

#### (1) Physical channel configuration

The physical channel is defined in ARIB STD-T49 as a channel configuration in a carrier. Three kinds of packet physical channels are defined to support the Satellite Packet System (Figure 1). A random access physical channel and a return link packet physical channel are added for the return link, and a forward link packet physical channel is added for the forward link. The random access physical channel is a channel only for assignment request signals, to request return link packet physical channels. The return link packet physical channel transmits packet data from the satellite packet MS to the satellite packet network, and the forward link packet physical channel transmits packet data from the network to the MS.

The packet physical channels have a 720ms period super-frame structure and a 40ms period frame structure, in the same way as the existing Satellite Mobile Communication



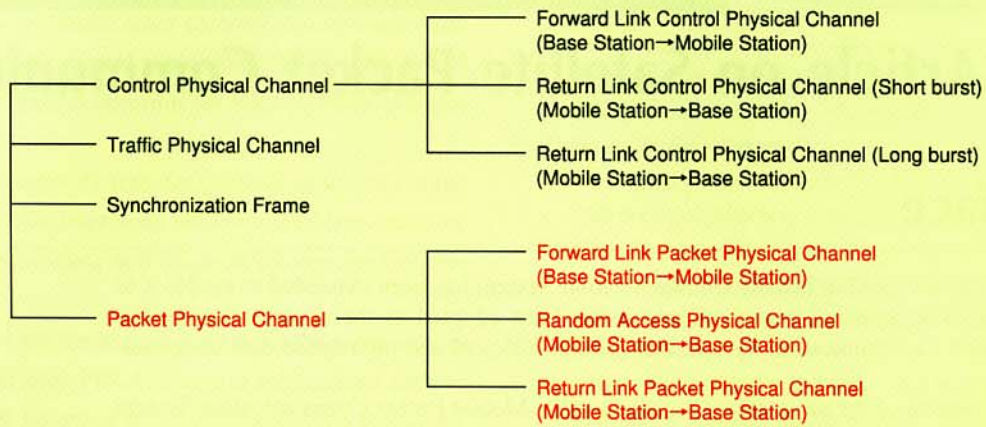


Figure 1 Classification of Physical Channels

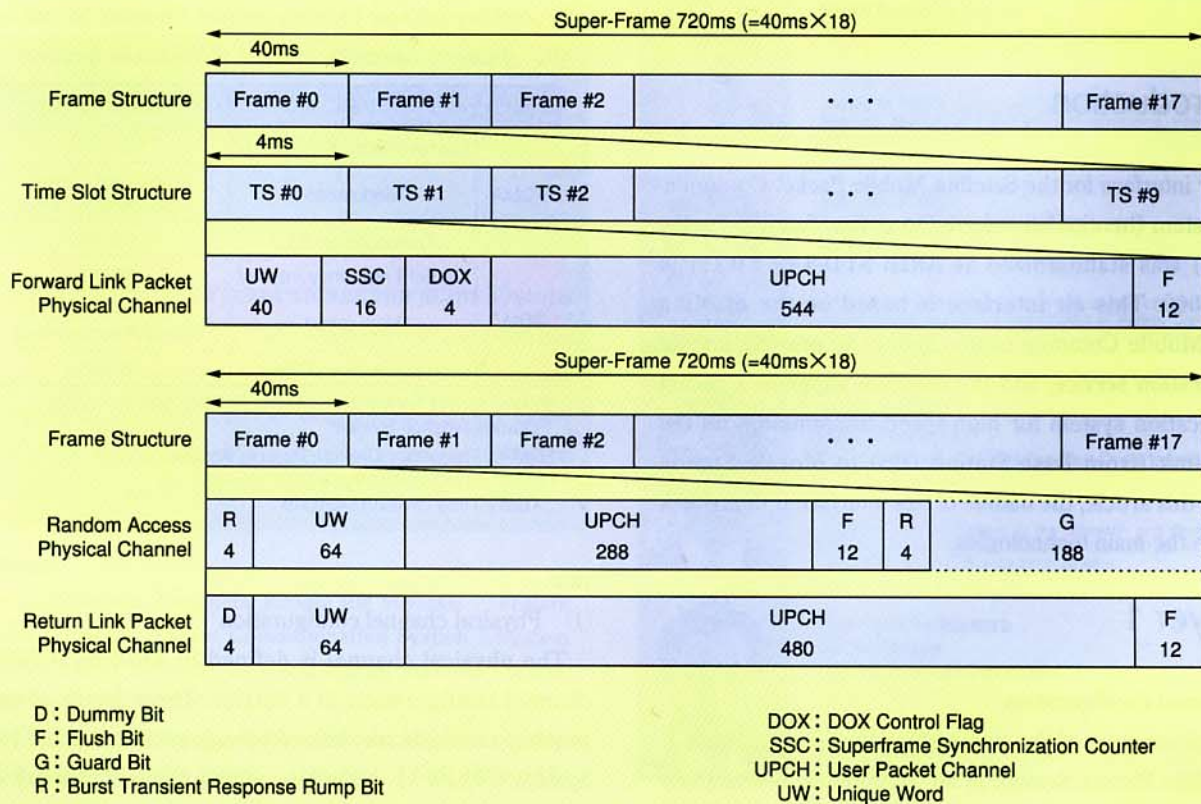


Figure 2 Frame and Channel Structures of Packet Physical Channels

System. Furthermore, the forward link packet physical channel has a 4ms period time slot structure in a frame (Figure 2). The minimum unit for the return link packet physical channel is made a frame. On the other hand, in order to reduce the redundant bits that are occurred by low-volume data transmission, the minimum unit for the forward link packet physical channel is made a slot.

## (2) Function channel configuration

The function channel is defined in ARIB STD-T49 as a logi-

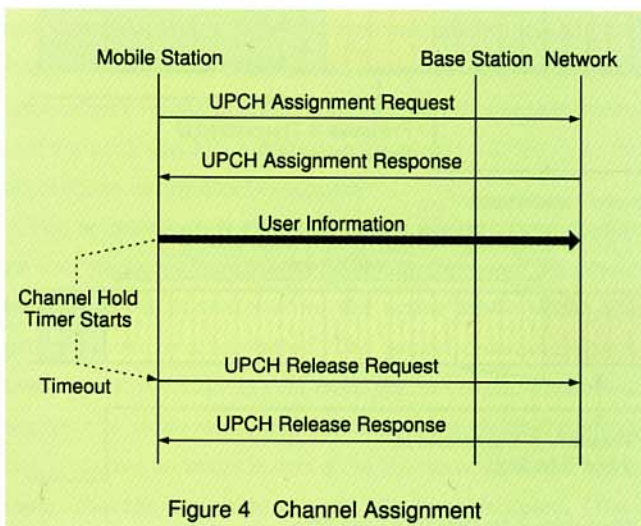
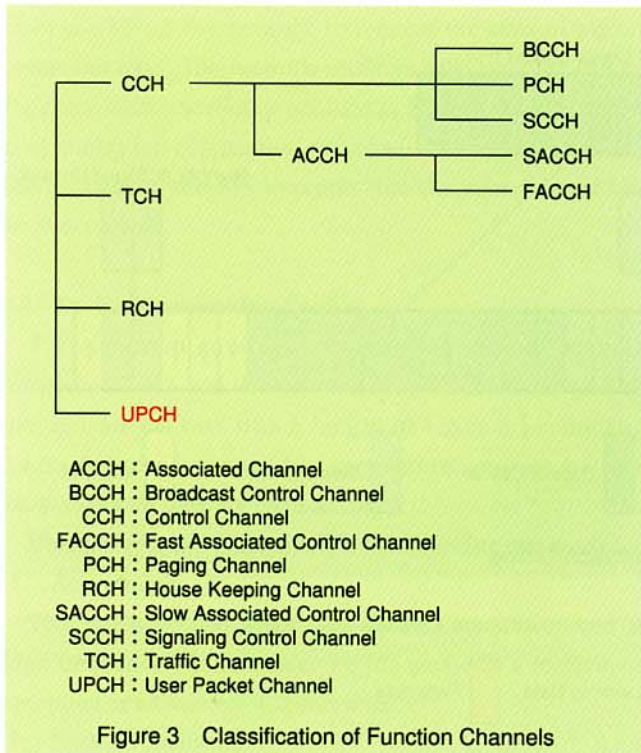
cal channel configuration in the physical channels. The User Packet Channel (UPCH) is defined as the function channel (Figure 3). User packet data and control signals are transmitted by UPCH.

## 2.2 Signal Transmission Method

### (1) Channel assignment

The return link packet physical channel is assigned to the MS, in the following steps (Figure 4).





- ① When there is data to be transmitted at the MS, the MS requests assignment of the return link packet physical channel with the random access physical channel (UPCH Assignment Request).
- ② The network assigns a return link packet physical channel of unassignment status to the MS and transmits the channel information as a response to the MS (UPCH Assignment Response).
- ③ After reception of the UPCH assignment response, the MS transmits data by the assigned return link packet physical channel.
- ④ The MS starts the channel hold timer after transmission of data. When no data is transmitted up to the time expiration,

tion, the MS releases the return link packet physical channel (UPCH Release Request).

- ⑤ The network starts the channel hold timer after reception of data. When UPCH release request is received or no data is received up to the time expiration, the network releases the return link packet physical channel (UPCH Release Response).

## (2) Signal transmission timing

The return link packet physical channel is assigned to an the MS which received the UPCH assignment response message, and the MS holds the channel dedicatedly for certain time and continuously transmits user data. On the other hand, the forward link packet physical channel is by several MSs, and user data is arranged at a slot of the channel in the arrival order from the network to BS and is transmitted (Figure 5).

## (3) Data operated transmission function

The forward link packet physical channel has a Data Operated Transmission (DOX) function that turns off a carrier when there is no transmission data (Figure 6). It is judged at each frame, whether data exist or not. At a frame just before the carrier is turned off, a DOX control flag indicates the last frame. When the carrier is turned on, a 20ms preamble is transmitted before the first frame transmission. When there is no data for a long time, in order to keep the MS in synchronization state, a preamble and idle units of certain length are transmitted at a determined timing.

Since unnecessary carriers are turned off, the load of the amplifier mounted on the satellite is reduced and the satellite power is effectively used.

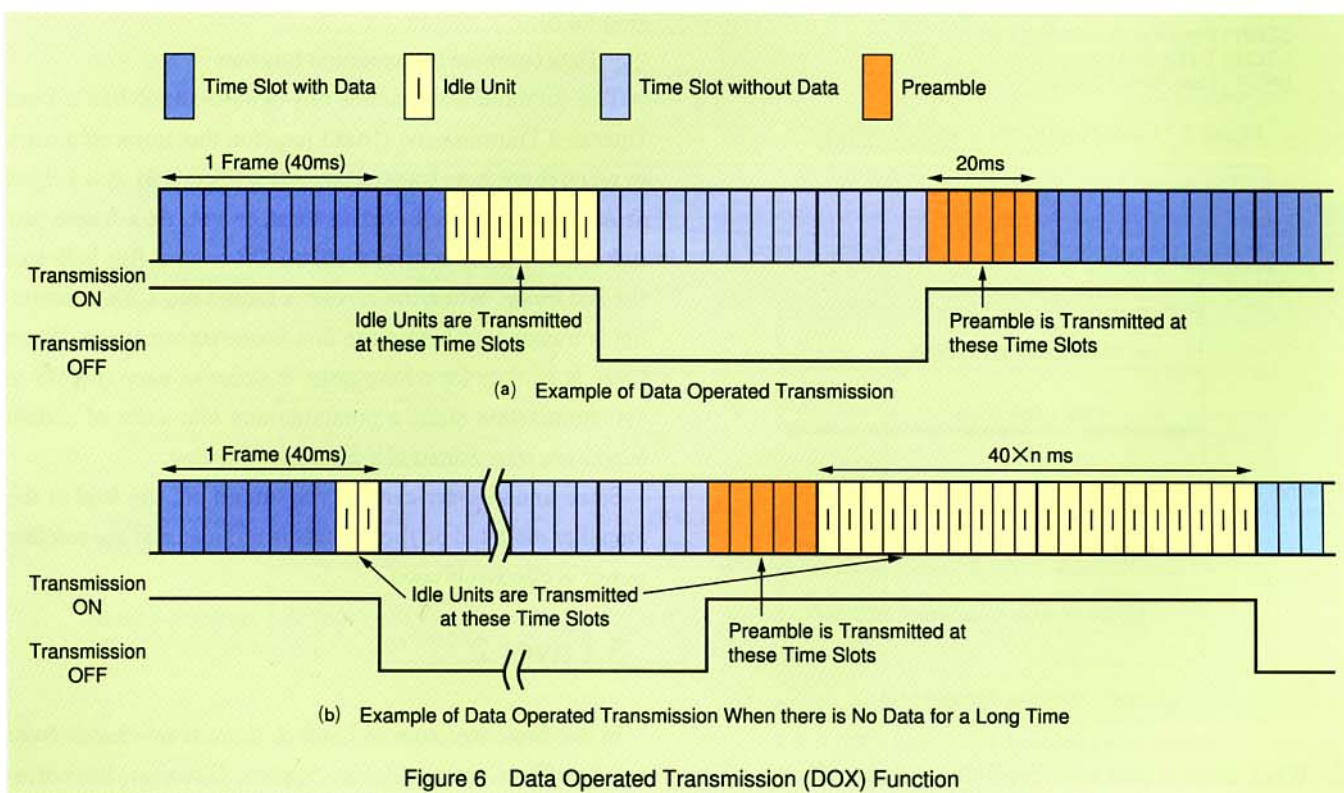
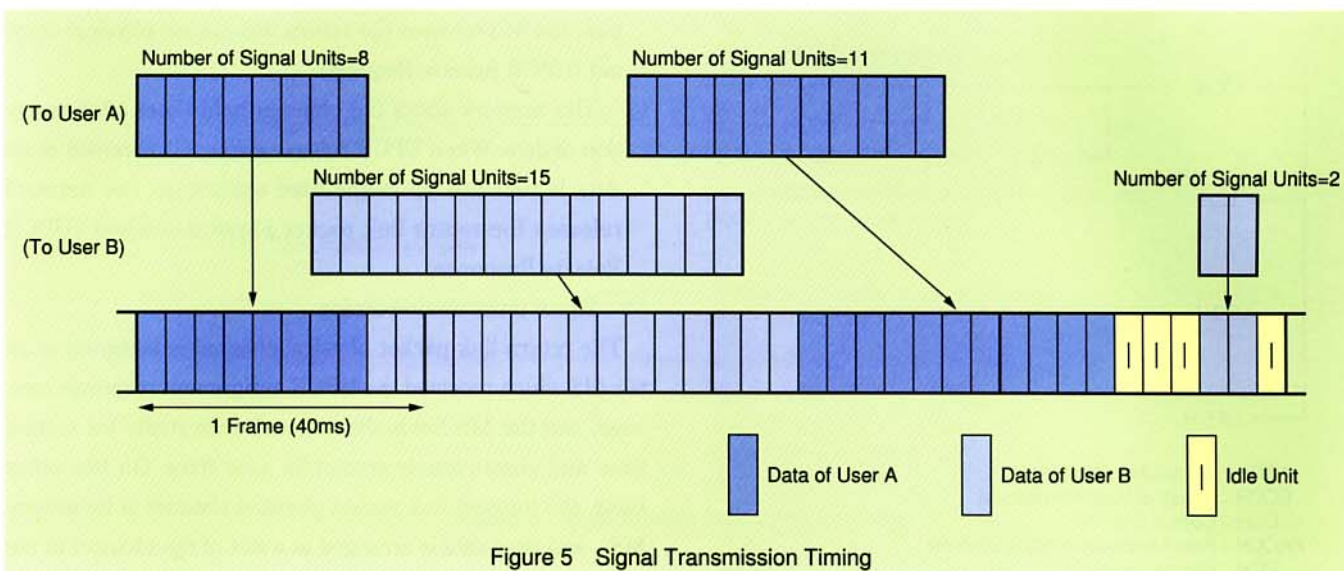
## 3.Layer 2

In the basic structure of Layer 2, there is no change from the Satellite Communication System. However, the corresponding part to packet communications complies with air interface RCR STD-27H [2] that supports the PDC Mobile Packet Data Communication System (PDC-P), and the parameters are set to cope with propagation delay through the satellite.

## 4.Layer 3

Layer 3 is composed of three functions, a Radio Frequency Transmission Management (RT) function for controlling radio resources including packet communication physical channels, a Mobility Management (MM) function for man-





agement of MS location and authentication, and a Call Control (CC) function for transferring user packets. These three functions operate harmoniously and conduct the following controls by using existing Layer 3 messages and new messages defined for Satellite Packet System.

#### 4.1 Simultaneous Waiting Control

This function enables the MS to wait for a message that switches from the standby state to packet communication and a message that switches from the standby state to voice communication simultaneously in the control physical chan-

nel. The network notifies the MS of voice paging and packet paging by sending the paging message. When the MS starts packet-originating or receives a paging message, the communication start function starts.

#### 4.2 Communication Start Control

This function controls the start of packet communications between the MS and the network. The MS acquires information of the packet physical channels from the broadcast information. After the MS selects packet physical channels autonomously, The packet communication registration request message is sent



from the MS to the network to request the start of packet communication. The network confirms validity of the MS by the same authentication procedure as PDC-P, and the packet communication registration response message is sent from the network to the MS to report that the start request has been accepted.

#### 4.3 Packet Transmission Control

This function controls transmission of user packets between the MS and the network. The MS and the network divide user packets into a length of Layer 2 I-command frame. Security is achieved by concealment process for user packets before they are transmitted.

User packets are transmitted in the following two modes.

##### (1) Active mode

This mode is used when user packets are transmitted at high frequency. In this mode, the MS performs a continuous reception or an intermittent reception.

##### (2) Packet standby mode

This mode is used when no user packet is transmitted. In order to reduce the MS's battery consumption, the MS performs a superframe intermittent reception or a hyperframe intermittent reception. The hyperframe intermittent reception reduces the MS's battery consumption more than the superframe intermittent reception.

The active mode is switched to the packet standby when no user packet is transmitted for a long time, and the packet standby mode is switched to the active mode when user packets must be transmitted. The packet channel registration request message is sent from the MS to the network to request the mode switching, and the packet channel registration response message is sent from the network to the MS to report that the switching request has been accepted. These messages contain the information that indicates whether the mode is "active" or "packet standby".

#### 4.4 Channel Handover Control

This function controls handover of packet communication physical channels, resulting from zone migration by MS's movement, degradation in communication quality or restriction of packet physical channels in use. After the MS selects new packet physical channels autonomously, The packet channel registration request message is sent from the MS to the network to request the channel handover, and the packet channel registration response message is sent from the network to the MS to report that the handover request has been accepted. However, when the MS switch to another terminal

registration area, the packet communication registration request message is sent from the MS to the network to request the reconnection type channel handover, and the packet communication registration response message is sent from the network to the MS to report that the handover request has been accepted.

#### 4.5 Network Initiative Handover Control

Network initiative handover control is a newly added control to the Satellite Packet System. It lets the MS migrate to the same zone under another satellite during the sun transit phenomenon when a sun, a satellite, and a BS locate in a straight line or during BS switchover. To perform the network initiative handover control, the handover radio packet channel set message is sent from the network to the MS. This message contains the information that indicates destination packet physical channels and whether handover type is "forced" or "voluntary".

When the MS receives the handover radio packet channel set message that indicates "forced", the MS handovers immediately to the packet physical channels indicated by the message.

When the MS receives the message that indicates "voluntary", the MS does not handover immediately. If there is some Layer 3 messages or user packet to be transmitted at the MS, the MS migrates to the packet physical channels indicated by the message and transmits signals after completion of the migration.

#### 4.6 Cycle Registration Control

This function enables the MS to notify the network that it continues the packet communication. At a determined cycle, the packet channel registration request message is sent from the MS to the network to request the cyclical registration, and the packet channel registration response message is sent from the network to the MS to report that the cyclical registration request has been accepted.

#### 4.7 Communication End Control

This function controls the end of packet communication between the MS and the network. The packet communication deregistration request message is sent from the MS to the network to request the end of packet communication, and the packet communication deregistration response message is sent from the network to the MS to report that the end request has been accepted.

## 5. Conclusion

In this article, the outline of the air interfaces for the Satellite Mobile Packet Communication System has been described. As described above, by adding the functions of the packet data communication service to the air interface for the existing Satellite Mobile Communication System, efficient and high-speed packet data communication service can be provided.

### References

- [1] Association of Radio Industries and Businesses : "S BAND DOMESTIC MOBILE SATELLITE COMMUNICATION SYSTEM ARIB STANDARD", ARIB STD-T49 Ver.2.0, March 2000.
- [2] Association of Radio Industries and Businesses : "PERSONAL DIGITAL CELLULAR TELECOMMUNICATION SYSTEM ARIB STANDARD", RCR STD-27H, February 1999.