5-2 WINDS Satellite Networking Protocol for Bent-pipe Mode

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WINDS has two types of transponders; regenerative mode and bent-pipe mode. In this section, the networking protocol for using the bent-pipe mode is described. There are two types of communication mode in the bent-pipe mode. One is the bent-pipe continuous wave mode, which is used at traditional communication satellite. Another is the bent-pipe TDMA mode, which can communicate at the same time with the regenerative mode.

Keywords
WINDS, Regenerative mode, Bent-pipe mode, Networking protocol

1 Introduction

The Wideband InterNetworking Engineering Test and Demonstration Satellite (WINDS) features two transponders. The bent-pipe transponder, used in conventional satellites, converts the frequency of the uplink signal issued from earth stations, amplifies it, and downlinks the signal back to earth stations. The regenerative transponder, on the other hand, demodulates in the satellite the uplink signal issued from earth stations, performs baseband-switching with respect to the signal, modulates the signal, and then downlinks the signal to earth stations.

The protocol for use of the regenerative transponder is described in the previous article[1].

Two modes of use are available for the bent-pipe transponder. One mode employs the Time Division Multiple Access (TDMA) method, as in regenerative mode, while the other mode makes use of continuous-wave processing.

This article mainly describes the protocol for use of the bent-pipe TDMA mode.

2 Bent-pipe continuous wave networking protocol

Bent-pipe continuous wave communication does not specify a protocol.

Instead, the users must set the required protocol themselves.

3 Bent-pipe TDMA networking protocol

Unlike the regenerative mode, the bent-pipe TDMA mode uses a method of pre-assignment in which the time slot and frequency to be used are set prior to the experiment.

3.1 TDMA format

Bent-pipe TDMA mode uses the same TDMA frame format used in regenerative mode. Thus, regenerative and bent-pipe modes can be mixed, which allows for experiments in both modes within a given period. Figure 1 shows the TDMA frame format. This format uses a 2-ms time slot, as in regenerative mode. Twenty time slots constitute a frame (40 ms), and 16 frames constitute a super frame

(640 ms). The time slot and the frequency are assigned to each user in units of super frames.

The first slot of each frame is the notification slot used for the reference burst from the Network Management Center (NMC). The second slot is secured as a signaling slot for future expansion of functions. (Bent-pipe mode uses the pre-assignment method and does not perform signaling.) The remaining 18 slots are the traffic slots used for communications between user stations.

When regenerative and bent-pipe modes are mixed, the first slot is used as the notification slot for regenerative mode, the second slot is used for bent-pipe mode, the third slot serves as a signaling slot for bent-pipe mode, and the remaining 17 slots are used as traffic slots.

3.2 Data burst format

The bent-pipe TDMA signals are classified into reference bursts and traffic bursts. Although a traffic burst requires a burst length featuring a guard time of 75 ms or longer (Fig. 1), it has no other restrictions, and users can set their own modulation methods, error-correction methods, and data-transmission rates.

3.3 Reference burst format

The reference burst is received by each user station and is also used for synchronization with the TDMA network. Table 1 shows the parameters of the reference burst. Figure 2

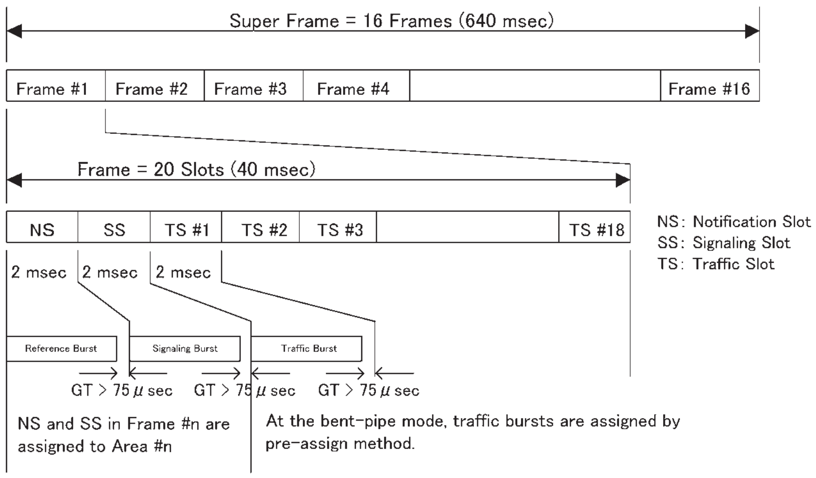

Fig.1 *Bent-pipe TDMA frame format*

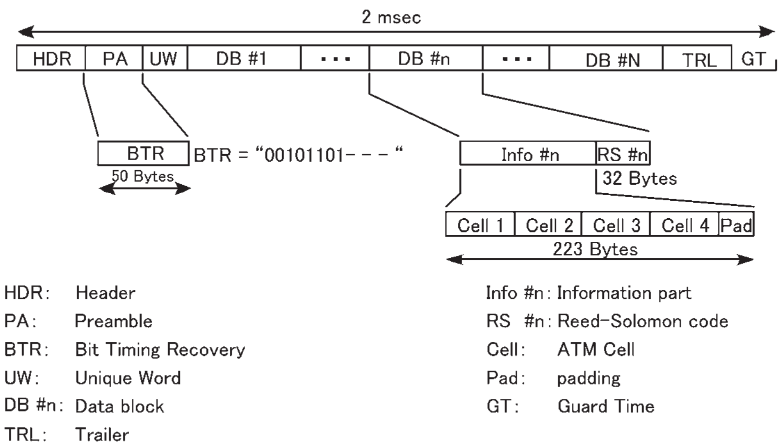

Fig.2 *Bent-pipe mode reference burst format*

shows its format.

Similarly to the reference burst for regenerative mode, for bent-pipe the reference burst uses 155-Mbps transmission, Quadrature Phase Shift Keying (QPSK), and the RS (255, 223) error-correction code.

The reference burst is roughly divided into the preamble of the bit timing recovery (BTR) section and the data section, which holds the data. The BTR consists of the repetition of the series “00101101”.

Table 2 shows the unique words used.

The data section uses an ATM cell structure. A data block consists of four cells and 11 bytes of padding, with each cell containing 48 bytes of data and five bytes of header. The reference burst contains 180 data blocks.

At the head and end of the reference burst, a header and a trailer are attached, respectively, to absorb the transient responses arising when the burst is received.

3.4 Notification information contained in reference burst

As shown in Table 3, the reference burst contains satellite orbital information, reference-burst information, and path information of the bent-pipe link.

The satellite orbital information includes the position and velocity of the satellite orbit and the epoch time. The distance between the satellite and the earth station is calculated from this satellite orbital data and the position of the earth station, and the resultant value is used for burst transmission positional correction. The reference burst information includes the correspondence between the beam number and the reference burst transmission slot num-

Table 1 Parameters of reference burst

	data rate	number of bits for header	number of bits for trailer	number of data block	symbol rate
reference burst	155 Mbps	144	656	180	101.75 Msps

Table 2 Definition of unique words

type of burst signal	I-channel	Q-channel
reference burst	1100101111000100 (0xCBC4)	0011010000111011 (0x343B)

Table 3 Notification message

	item	location	size (byte)	description
1	message length	0	2	size of message : 17432 (byte)
2	protocol ID	2	1	0x81 : notification message for bent-pipe link
3	type of message	3	1	0x01 : notification information for bent-pipe link
4	sequence counter	4	4	OxFFFFFFFF (fixed value)
5	orbit information	8	48	
6	RB beam data	56	48	information of RB slot number
7	path information of bent-pipe link (block 1)	104	2888	data for route 1
8	path information of bent-pipe link (block 2)	2992	2888	data for route 2
9	path information of bent-pipe link (block 3)	5880	2888	data for route 3
10	path information of bent-pipe link (block 4)	8768	2888	data for route 4
11	path information of bent-pipe link (block 5)	11656	2888	data for route 5
12	path information of bent-pipe link (block 6)	14544	2888	data for route 6
total			17432	

ber. This information and the beam number for the earth station determine the starting point of the super frame.

The path information for the bent-pipe link includes the transmitting user ID, the transmitting user port number, the receiving user ID, the receiving user port number, and the frequency band used, for each slot. The earth station can determine the position of its transmitting slot based on this information.

3.5 Rain-attenuation compensation

The user station autonomously performs compensation in the uplink for attenuation due to rain.

The user station measures downlink rain attenuation by measuring the signal intensity of the reference burst transmitted at a constant power or the network monitoring link signal. From this attenuation value, the station estimates uplink rain attenuation and controls transmission power to compensate for the attenuation.

Rain-attenuation compensation is not performed in downlink communications.

4 Conclusions

This article describes the WINDS bent-pipe protocol. The bent-pipe continuous wave mode does not specify a networking protocol. The bent-pipe TDMA mode uses the same TDMA frame format employed by the regenerative mode, which enables simultaneous use of the two modes.

References

1 YOSHIMURTA Naoko, et. al., "5-1 WINDS Satellite Networking Protocol for Regenerative Mode", This Special Issue of NICT Journal.

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