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End-to-End transmission requirements for space-based remote sensing instantaneous services

天基遥感即时服务端到端传输要求

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Foreword

This document was drafted in accordance with the rules given in GB/T 1.1-2020, Directives for standardization - Part 1: Rules for the structure and drafting of standardizing documents.

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1 Scope

This document specifies the transmission requirements in the end-to-end transmission process of space-based remote sensing instantaneous services, comprising the transmission process, the transmission technical requirements, the transmission data format and the performance requirements on the satellite end and the user end.

This document applies to the information transmission service of remote sensing service products over the end-to-end link between civil and commercial remote sensing satellites and the ground receiving end.

2 Normative references

The following documents contain provisions which, through normative reference in this text, constitute indispensable provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document,

including any amendments, applies.

GB/T 2900.54, Electrotechnical terminology - Radiocommunications: transmitters, receivers, networks and operation

GB/T 39348, Space data and information transfer systems - Telemetry synchronization and channel coding

Regulations on the allocation of radio frequencies of the People's Republic of China (Ministry of Industry and Information Technology of the People's Republic of China)

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions. For the purposes of this document, the terms and definitions given in GB/T 2900.54 and the following apply.

3.1.1 instantaneous services - the process of providing a rapid-response information service, using satellite technology and the related resources, when a sudden event or an emergency occurs.

3.1.2 end-to-end transmission - taking the data products of every kind generated on board a remote sensing satellite as the information source and pushing them directly to the ground user terminal over the transmission link.

3.1.3 user terminal - a ground terminal of any type used to receive the space-based remote sensing service information transmitted end-to-end by the remote sensing satellite. Note: for example a fixed ground station, a hand-held receiving device or a vehicle-mounted receiving device.

3.1.4 information rate - the quantity of binary information output by the satellite per unit of time, per second.

3.1.5 modulation - converting the input binary bit stream into complex modulation symbols in a predetermined way, that is, constellation mapping.

3.2 Abbreviated terms. BPSK: Binary Phase Shift Keying. CDMA: Code Division Multiple Access. CRC: Cyclic Redundancy Check. DBPSK: Differential Binary Phase Shift Keying. DQPSK: Differential Quadrature Phase Shift Keying. DSSS: Direct Sequence Spread Spectrum. FDMA: Frequency Division Multiple Access. FEC: Forward Error Correction. LDPC: Low-Density Parity-Check Code. PN: Pseudo-Noise Code. QPSK: Quadrature Phase Shift Keying.

4 Transmission process

Civil and commercial remote sensing satellites, in high, medium and low orbit, may deliver the remote sensing service products generated by direct on-board processing over the end-to-end transmission link, providing instantaneous service information that can be used

directly by receiving ends of many kinds - fixed ground stations, vehicle-mounted terminals, airborne terminals and hand-held terminals.

The on-board product shall first be assembled into a transmission frame; the frame is then encrypted (optional), scrambled, coded, modulated, spread, assembled into a physical frame and baseband-shaped, converted into a bit stream, and transmitted over the end-to-end transmission channel to the ground receiving end.

5 Transmission technical requirements

5.1 Operating frequency. The choice of the data transmission operating frequency follows: a) frequency range - the frequency used shall meet the Regulations on the allocation of radio frequencies of the People's Republic of China, and interference with other satellite communication services shall be avoided; b) the Ka band is chosen by preference (the frequency point has to be applied for).

5.2 Transmission rate. The design of the data transmission rate follows: a) information rate range 2 kbit/s to 1 024 kbit/s; b) the information rate series 2, 4, 8, 16, 32, 64, 128, 256, 512 and 1 024 kbit/s.

5.3 Transmission waveform. The design of the data transmission waveform follows: a) spread spectrum scheme, DSSS; b) frame header modulation, BPSK; c) service data modulation, BPSK, QPSK, DBPSK or DQPSK, with QPSK preferred; d) multiple access, CDMA or FDMA; e) allocation, pre-allocated; f) channel coding, LDPC (1/2, 8192); g) spreading code rate, 4.096 Mcps (note: cps means chip per second); h) scrambling, PN15.

5.4 Transmission link performance. The design follows: a) bit error rate better than 1 x 10^-6; b) link margin of the transmission link not less than 3 dB.

5.5 Scrambling. The information sequence shall be scrambled before coding. Scrambling is carried out on each baseband frame, and the frame synchronization word is not scrambled; the same pseudo-random sequence is used at the transmitting and the receiving end to scramble and descramble. The scrambling scheme that may be used is as follows: the scrambling polynomial is x^15 + x^14 + 1, the scrambling period is 2^15 - 1, the initialization sequence is 001001001001001, and it is reloaded once for each coded block; the rightmost bit 1 of the sequence sits in the fifteenth register.

5.6 Coding. The physical-layer error-correcting code is low-density parity-check coding (LDPC) at a code rate of 1/2. The length of the scrambled input transmission frame is 4 096 bit; the frame enters the FEC coding system and is LDPC coded, and the coded LDPC codeword length is 8 192 bit. The code group of LDPC (1/2, 8192) follows Annex A. Other coding schemes may be selected as required.

5.7 Modulation. The link uses BPSK for the frame header and BPSK, QPSK, DBPSK or DQPSK for the service data area, the modulation being selectable with QPSK preferred; the

phase mapping of each modulation is given in Table 1, where BPSK maps 0 to pi/4 and 1 to -3pi/4, and QPSK maps 00 to pi/4, 01 to -pi/4, 10 to 3pi/4 and 11 to -3pi/4.

5.9 The service data rate is adjustable over several steps (laid down in 5.2), each symbol rate step corresponding to a number of code blocks; taking QPSK modulation of the service data as the example: 2 ksps (1 code block), 4 ksps (2), 8 ksps (4), 16 ksps (8), 32 ksps (16), 64 ksps (32), 128 ksps (64), 256 ksps (128), 512 ksps (256) and 1 024 ksps (512 code blocks). Where there is no valid data, the synchronization header of the physical frame should be valid and the data area of the physical frame filled with 5A5A.

5.10 Baseband shaping. Square-root raised-cosine roll-off filtering is generally applied to the narrow baseband pulse signals of the I and Q paths by FIR filtering, with a roll-off factor of 0.25 preferred.

6 Transmission data format

6.1 Convention on the transmission frame format. In this document one byte is 8 bit, low-order first and high-order last. Where several bytes are used, transmission is in order from the high byte to the low byte.

6.2 Definition of the transmission frame data format. What is mainly transmitted between the satellite and the ground receiving end is the instantaneous service data generated after on-board processing; the transmission data has to be assembled into a transmission frame according to the rules and then transmitted according to the end-to-end transmission requirements. The format and the field definitions are given in Figure 3 and Table 2.

Figure 3 shows the frame as: synchronization header 4 B, frame length 2 B, frame-length error control 2 B, spacecraft identifier 1 B, frame type 4 bit, priority 4 bit, frame identifier 2 bit, frame count 14 bit, reserved field 33 B, the valid data area, and the frame CRC 2 B, with the CRC region running from the frame length to the frame CRC and the payload area variable from 0 B to 465 B.

Table 2 defines the fields: 1 synchronization header, 32 bit, the identifying information used to determine the position of the whole link frame, specifically 0x1ACFFC1D; 2 frame length, 16 bit, the total length of the link-layer frame counted from the frame length field inclusive to the frame CRC inclusive; 3 frame-length error control, 16 bit, used to check the frame length field, the CRC-16 initial value being 0xFFFF and the generator polynomial X^16 + X^12 + X^5 + 1; 4 spacecraft identifier, 8 bit, the first 4 bit distinguishing the type of satellite and the last 4 bit distinguishing the individual satellites of the same type; 5 frame type (reserved), 4 bit, indicating the current frame type; 6 priority (reserved), 4 bit, indicating the service priority of the frame.