

SOURCE: Japan
TITLE: Protocol data unit in H.222.1 layer
PURPOSE: Proposal / Discussion

1. Introduction

In the Kamifukuoka meeting, the Reed-Solomon forward error correction (FEC) frame shown in figure 1 was proposed as the protocol data unit (PDU) in the H.222.1 layer for both constant bit rate (CBR) and piecewise CBR (PCBR) data transmission [1][2].

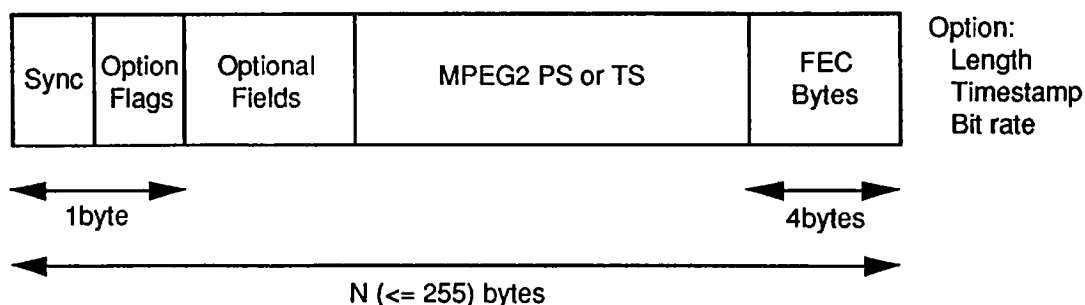


Figure 1. H.222.1 PDU proposed in the Kamifukuoka meeting [1][2]

This contribution addresses the issues related to this PDU. Assuming that FEC is optional, system clock recovery methods and packetization methods are investigated for both the PCBR and the CBR case.

2. Necessity of FEC

FEC function is necessary for long distance transmission of video where some transmission errors are unavoidable. On the other hand, FEC requires some additional hardware which may increase terminal cost. In the ATM Forum, a VOD set-top which is used in limited circumstances has been specified without using FEC.

Considering this VOD set-top and our A1 type receiver are very similar, FEC function at the A1 receiver should be optional. This means that FEC function at the A1 transmitter should also be optional. As for A2 terminals, FEC function can be mandatory. Considering interworking between A1 and A2 terminals, however, the A2 terminal must be able to transmit data without FEC. In the same manner, the A2 terminal must be able to receive data without FEC.

3. PCBR data transmission

Terminals which receive PCBR MPEG2 Transport Streams (TS) or Program Streams (PS) can be categorized by their system clock recovery methods into the following three types:

- (a) Terminals which utilize timestamps of a common or pseudo-common network clocks [1].
- (b) Terminals which use the adaptive clock method for PCBR bitstreams. Although the details of implementation is for further study, this is theoretically possible by weighting the amount of data in the buffer by the reciprocal of the bit rate. By using the bit rate field in the H.222.1 PDU, the buffer size and the delay of presentation can be reduced.

- (c) Terminals which use the exact time at which the program clock reference (PCR) or system clock reference (SCR) has been received. This terminal adopts the same mechanism as the ATM Forum terminals for CBR MPEG2 TS.

The optimal terminal type should be determined considering network conditions such as the existence of a common network clock and the upper limit of cell delay variance (CDV). Possible terminal types for various network conditions are shown in table 1.

Table 1. Network conditions and possible terminal types

	small CDV	large CDV
network clock available	(a), (b) or (c)	(a) or (b)
network clock not available	(b) or (c)	(b)

Table 2 shows the optional fields in the H.222.1 PDU that each terminal type uses.

Table 2. Necessity of optional fields for each terminal type

terminal type	timestamp	bit rate
(a)	X	.
(b)	.	X (for low delay)
(c)	.	.

X = used, . = not essential

Problems related to this H.222.1 PDU when applied to PCBR MPEG2 data transmission are listed as follows:

- The implementation of type (a) terminals should be simpler if a timestamp always exists in a PDU which includes a TS packet with a PCR. Should this be mandatory? If mandatory, does this increase the complexity of the transmitter?
- In the current definition of the H.222.1 PDU, the bit rate field indicates “the bit rate at which the following data will be transmitted (forward bit rate)”. However, as depicted in figure 2, it seems difficult to transmit PCBR MPEG2 TS with already written PCRs using this PDU structure. To solve this problem, is it necessary to define a different bit rate field which indicates “the bit rate at which the previously transmitted data has been transmitted (backward bit rate)”?
- Is it necessary to quantize the transient bit rate in PCBR transmission as in the case of CBR transmission? Such quantization seems to make the implementation of type (b) terminals easier.
- In order to make the implementation of type (c) terminals easier, minimization of the packetization jitter is necessary. This means that the AAL PDUs, the H.222.1 PDUs, and the TS packets should be aligned. Can both the alignment and the efficiency of packetization be achieved at once when the PDU length varies by the existence of the optional fields?

Currently, it is unknown which type of terminal is feasible and will be dominant in the future market. Moreover, it is still unknown how much the network parameters such as CDV and bit error rate (BER) in PCBR data transmission differs from the CBR case. If we specify the H.222.1 PDU for PCBR applications now with so many open issues, we may well define many useless options that will be seldom used in the future. To avoid such mistakes, we propose that the H.222.1 PDU for PCBR applications should be left for further study until the specifications of PCBR terminals become clear enough.

It is agreeable that the inclusion of timestamp and bit rate fields in the H.222.1 PDU is useful

for PCBR applications. However, it seems premature to define the detailed specifications of such fields now.

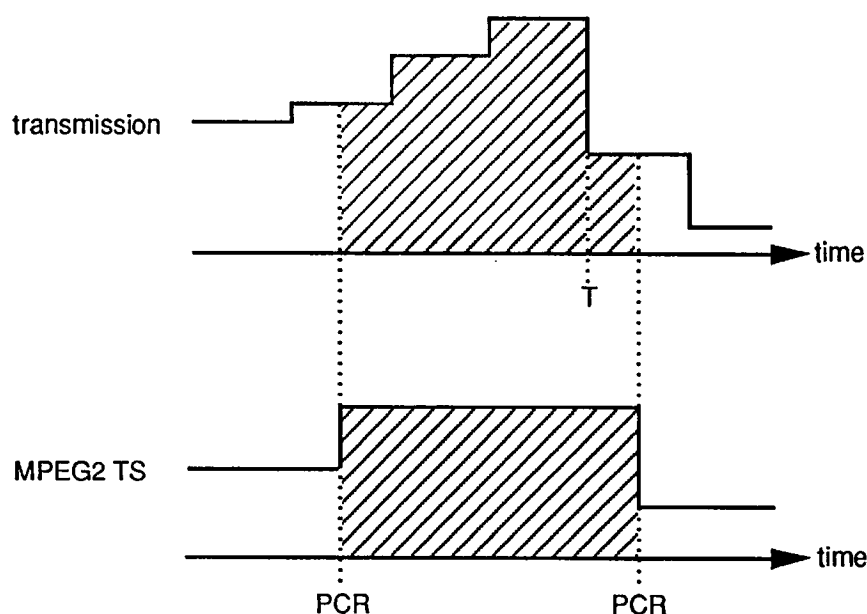


Figure 2. PCBR transmission of PCBR MPEG2 TS when the PCRs are written beforehand. In order to make it possible for (a), (b) and (c) type terminals to correctly decode the bitstream, the transmitter always has to transmit the PCRs at the correct time. This means that the transmitter has to control the transmission so that the area (= number of bits) of the two hatched regions always be the same. If the PCRs are already written in the MPEG2 TS, therefore, the transmitter must know at T where (how many bits later) the next PCR exists. Otherwise, it is impossible for the transmitter to calculate the correct bit rate at T.

4. CBR data transmission

As in the case of PCBR terminals, CBR terminals can also be categorized by their system clock recovery methods into the following three types:

- (d) Terminals which use timestamps of a common network clock (SRTS method).
- (e) Terminals which use the adaptive clock method.
- (f) Terminals which use the exact time at which the PCR or SCR has been received (ATM Forum implementation). To cope with this type of terminals, "PCR (SCR) awareness" is necessary at the transmitter for the minimization of the PCR or SCR jitter caused by packetization.

As described in section 2 of this contribution, we assume that the FEC is optional for A1, B1, A2 and B2 terminals. In the following part of this section, the packetization method of the TS packets and the PS packs into the FEC frames and the AAL PDUs is investigated. This may serve as the baseline for further discussion.

4.1 Transmission without FEC

FEC frames are not necessary in this case. Hence the main issue is how to pack the TS packets or the PS packs into the AAL PDUs.

4.1.1 AAL1 case

Since AAL1 chips usually include the function of recovering the CBR bitstream using SRTS or adaptive clock, type (f) terminals are unlikely. Therefore, PCR or SCR awareness is not necessary. One TS packet is packed into 4 AAL1 PDUs. Alignment of PS packs with the

AAL1 PDUs is not necessary.

4.1.2 AAL5 case

Allowing for type (f) terminals, a packetization mode with PCR or SCR awareness needs to be specified. Figure 3 depicts the transmission of PS with SCR awareness. Some problems are listed as follows:

- A mandatory packetization mode needs to be specified. Shall the PCR and SCR awareness be mandatory? The answers may be different for TS and PS.
- In the case of transmission without PCR or SCR awareness, is the alignment of the TS packets or the PS packs with the AAL5 PDUs necessary? For the sake of efficiency of transmission, the answer is "No". However, alignment is necessary if we pursue commonness with the ATM Forum specifications.

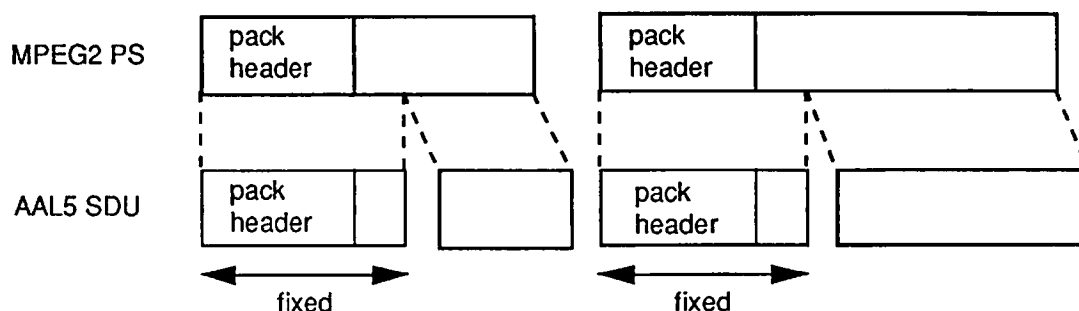


Figure 3. Transmission of PS with SCR awareness.

4.2 Transmission with FEC

The main issues in this case is the length of the FEC frames, and the packetization of the TS packets or the PS packs into the FEC frames and the AAL PDUs.

4.2.1 AAL1 case

After the AAL1 chip recovers the CBR bitstream including FEC bytes, FEC is performed on this recovered CBR bitstream. As shown in figure 4, this causes jitter in the output bitstream after FEC.

In order to minimize the PCR or SCR jitter, alignment of the TS packets or the PS packs with the FEC frames is necessary. This is because such alignment realizes constant delay for PCR or SCR. Considering the agreement in the Kamifukuoka meeting that the FEC must be smaller than 255 bytes, a fixed FEC frame length of 193 bytes (1 FEC sync byte + 1 TS packet + 4 FEC bytes) or 192 bytes (1 TS packet + 4 FEC bytes) seems appropriate for TS. The sync byte of the FEC frame is not essential in this case, since the sync byte of the TS packet can be used instead. The absence of the FEC sync byte makes the transmission slightly efficient by 0.5%.

In the PS case, the problem is more complicated. Alignment of the PS packs with the FEC frames is necessary for the minimization of the SCR jitter. If we fix the FEC frame length, therefore, stuffing bytes are necessary at the end of each PS pack to fill the last FEC frame of the pack. The transmitter has to perform this stuffing, while maintaining CBR transmission on the other hand. No stuffing is needed if we use variable length FEC frames, but maintaining CBR transmission is also difficult in this method. Shall the alignment be mandatory, or shall the receiver tolerate the SCR jitter? If we fix the FEC frame length, a FEC frame length of 193 or 192 bytes may be appropriate for commonness with the TS case. The sync byte of the FEC frame is necessary in this case.

As in the case described in section 4.1.1, alignment of the FEC frames with the AAL1 PDUs is not necessary.

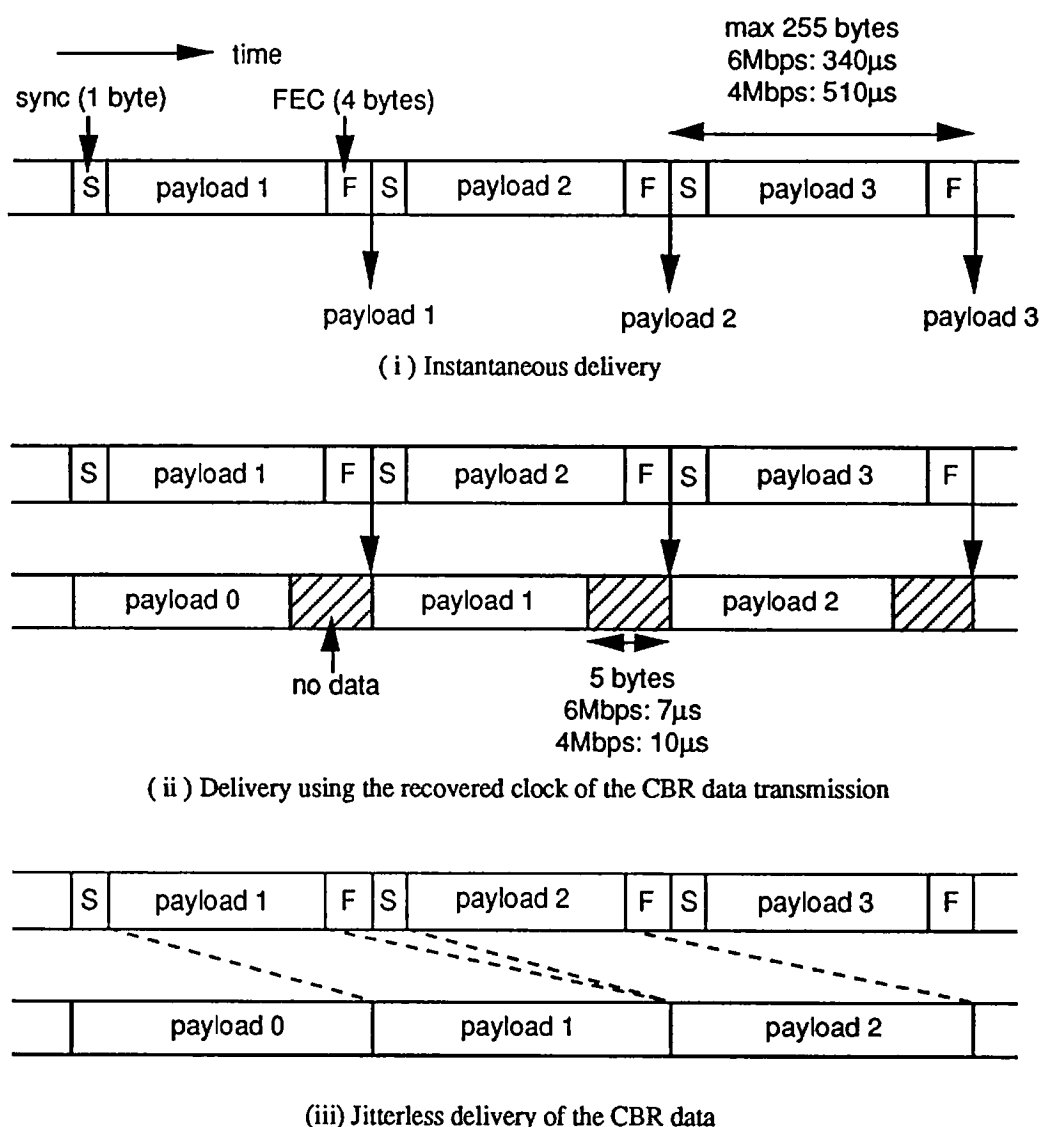


Figure 4. Jitter caused by FEC when the TS packets are not aligned with the FEC frames. In (i), all the bytes in the payload of the FEC frame is delivered to the TS decoder at once after error correction. The estimated PCR jitter is about 340μs at 6Mbps, and 510μs at 4Mbps when the length of the FEC frames is 255 bytes. In (ii), the error-corrected bitstream is delivered to the TS decoder using the CBR transmission clock fed from the AAL1 chip. The estimated jitter is about 7μs at 6Mbps, and 10μs at 4Mbps. Jitterless recovery of the CBR data is shown in (iii).

4.2.2 AAL5 case

Allowing for type (f) terminals, a packing mode with PCR or SCR awareness needs to be specified. If we only consider the minimization of the PCR jitter, a fixed FEC frame length of 193 or 192 bytes seems appropriate for TS. However, this FEC frame length causes inefficiency of packetization. If an AAL5 PDU includes n 192 byte FEC frames, it requires $4n + 1$ AAL5 cells. The last cell of the AAL5 PDU must include 40 padding bytes, regardless of the value of n . This is shown in figure 5. Achieving both PCR awareness and efficiency of packetization seems difficult.

For PS, the same problem as described in section 4.2.1 arises. If we allow for type (f) terminals, alignment of the PS packs with the AAL5 PDUs is necessary to minimize the SCR jitter.

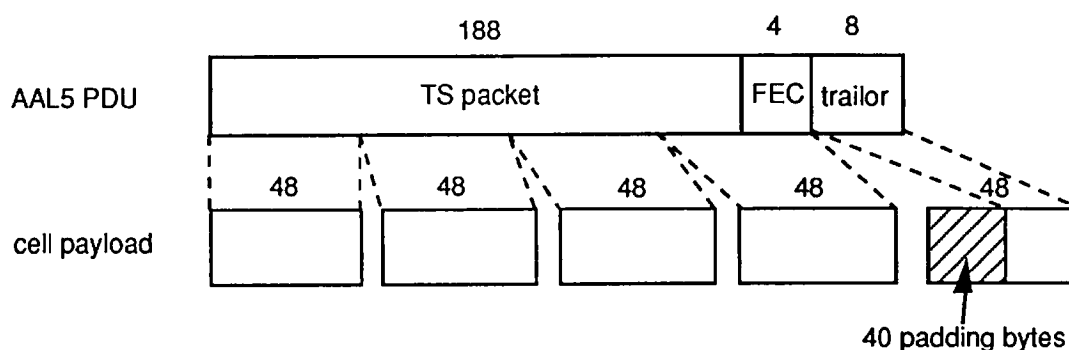


Figure 5. Packetization of a 192 byte FEC frame into an AAL5 PDU.

5. Conclusion

- FEC should be optional for A1, B1, A2, and B2 terminals.
- The specifications of the H.222.1 PDU for PCBR data should be left as "for further study" until the implementation of the PCBR terminals is clarified.
- The length of the FEC frames and the packetization method of TS and PS into FEC frames and AAL PDUs need further discussion. Is SCR awareness necessary in the transmission of PS? Shall the FEC frame length be fixed at 193 or 192 bytes? In the transmission of TS with FEC using AAL5, achieving both PCR awareness and efficiency of packetization at once seems difficult.

References

- [1] AVC-742, "H.222.1 issues", BT, Jan. 1995.
- [2] TD-22 (Kamifukuoka), "Network adaptation for the broadband audiovisual communication terminals", ITU-T SG15 Experts Group, Jan. 1995.