INTERNATIONAL TELECOMMUNICATION UNION

ITU-T G.707/Y.1322

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

Amendment 2
(08/2002)

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Network node interface for the synchronous digital hierarchy (SDH)

Amendment 2

ITU-T Recommendation G.707/Y.1322 (2000) – Amendment 2

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ITU-T Recommendation G.707/Y.1322

Network node interface for the synchronous digital hierarchy (SDH)

Amendment 2

Summary

This amendment contains editorial and technical additions, to ITU-T Rec. G.707/Y.1322 (2000), with the ODUk (k = 1,2) mapping into C-4-Xc (X = 17,68).

Source

Amendment 2 to ITU-T Recommendation G.707/Y.1322 (2000) was prepared by ITU-T Study Group 15 (2001-2004) and approved under the WTSA Resolution 1 procedure on 6 August 2002.

FOREWORD

The International Telecommunication Union (ITU) is the United Nations specialized agency in the field of telecommunications. The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of ITU. ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Assembly (WTSA), which meets every four years, establishes the topics for study by the ITU-T study groups which, in turn, produce Recommendations on these topics.

The approval of ITU-T Recommendations is covered by the procedure laid down in WTSA Resolution 1.

In some areas of information technology which fall within ITU-T's purview, the necessary standards are prepared on a collaborative basis with ISO and IEC.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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As of the date of approval of this Recommendation, ITU had received notice of intellectual property, protected by patents, which may be required to implement this Recommendation. However, implementors are cautioned that this may not represent the latest information and are therefore strongly urged to consult the TSB patent database.

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ITU-T Recommendation G.707/Y.1322

Network node interface for the synchronous digital hierarchy (SDH)

Amendment 2

1) Clause 2

Add the following reference alphanumerically:

– ITU-T Recommendation G.709/Y.1331 (2001), *Interfaces for the Optical Transport Network (OTN)*.

2) Clause 4

Add the following abbreviations alphabetically:

ODUk Optical channel Data Unit-k

OPUk Optical Payload Unit-k

OTN Optical Transport Network

OTUk Optical channel Transport Unit-k

3) Clause 9.3.1.3

Add the following Signal Label code to Table 9-11 after Hex Code No. 19:

0 0 1 0	0 0 0 0	20	Asynchronous mapping of ODUk (k = 1,2) into VC-4-Xv (X = 17,68)

4) Clause 10.7

Add a new clause for mapping of ODUk into VC-4-Xv as follows:

10.7 Asynchronous mapping of ODUk into a C-4-Xc transported via a VC-4-Xv

The purpose of this mapping is to provide for the transport of a subset of OTN elements, as defined in ITU-T Rec. G.709/Y.1331, over existing SDH transport networks by means of VC-4 virtual concatenation.

The number of VC-4s required to transport an OTN element by means of virtual concatenation is found by dividing the bit rate of the OTN entity by the payload rate of a VC-4-Xv, the C-4-Xc. These are provided in Table 10-2. As this number is not an integer, it is necessary to provide both a fixed stuff to pad the C-4-Xc payload area, and a means of mapping the client into the remainder of the payload area.

Table 10-2/G.707/Y.1322 – Mapping of OTN elements in SDH virtually concatenated VC-4s

OTN entity	Nominal bit rate, kbit/s ODUk	VC-4 virtual concatenation order (X)	Nominal bit rate, kbit/s C-4-Xv
ODU1	239/238 * 2 488 320 (≈2 498 775.126)	17	2 545 920
ODU2	239/237 * 9 953 280 (≈10 037 273.924)	68	10 183 680

The ODUk signal is extended with Frame Alignment Overhead (FAS and MFAS bytes) as specified in 15.6.2.1 and 15.6.2.2/G.709/Y.1331 and an all-0's pattern in the OTUk Overhead field (Figure 10-27).

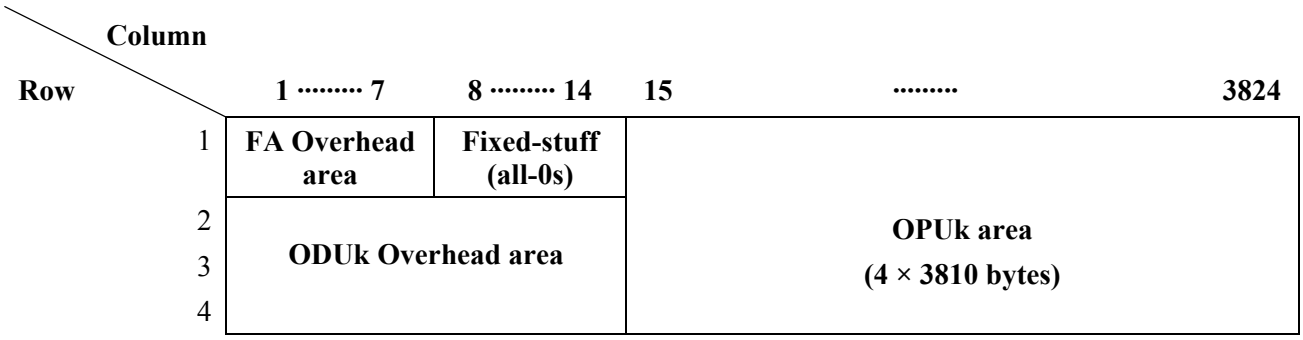

Figure 10-27/G.707/Y.1322 – Extended ODUk frame structure (FA OH included, OTUk OH area contains Fixed Stuff)

Before the extended ODUk signal is mapped into the C-4-Xc, it is scrambled using a self-synchronizing scrambler with polynomial $x^{43}+1$. The scrambler operates over the whole extended ODUk frame and is not reset per frame.

10.7.1 Asynchronous mapping of ODU1 into a C-4-17c transported via a VC-4-17v

The basic C-4-17c structure is as shown in Figure 10-28. It is comprised of 9 rows by 4420 (i.e. 17 × 260) columns.

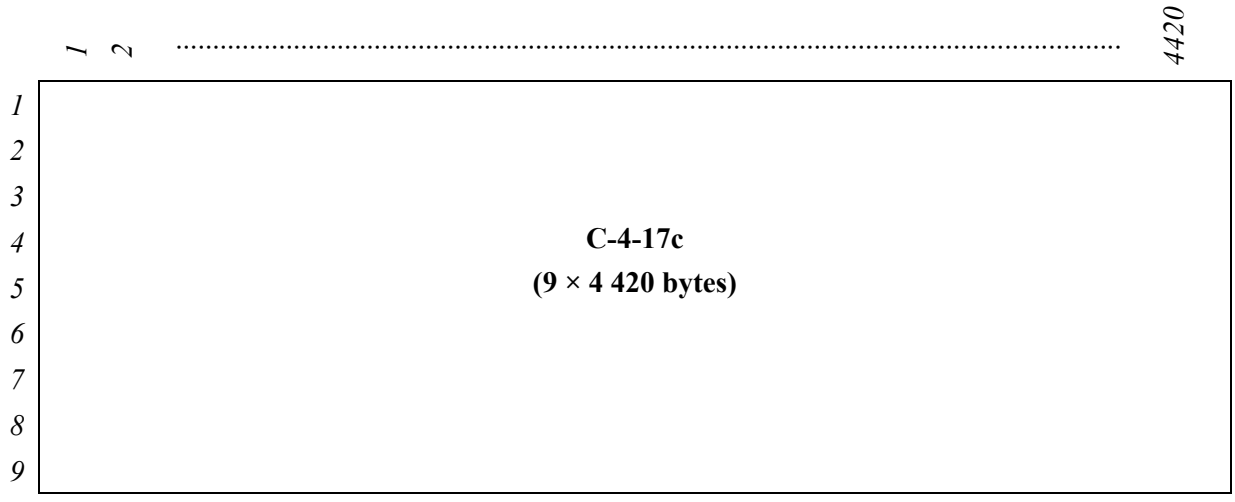

Figure 10-28/G.707/Y.1322 – C-4-17c

This C-4-17c frame is transported via a VC-4-17v. Refer to 11.2.

The extended ODU1 signal is asynchronous mapped into this C-4-17c with the following structure:

– Each of the nine rows is partitioned into 5 blocks, consisting of 884 octets each (Figure 10-29).

– Each block is partitioned into 17 subblocks, consisting of 52 octets each.

  • In each subblock, one negative justification opportunity octet (S) and five justification control bits (C) are provided.

  • The first byte of each subblock consists of either:

    – a fixed stuff byte (R); or

    – a justification control byte (J), which consists of seven fixed stuff bits (bits R; bits 1 to 7) and a justification control bit (bit C, bit 8); or

    – a negative justification opportunity byte (S).

  • The last 51 bytes of one subblock consist of data bytes (D).

  NOTE – Each block contains a total of (17 × 51) = 867 data bytes.

The sequence of all these bytes is shown in Figure 10-29.

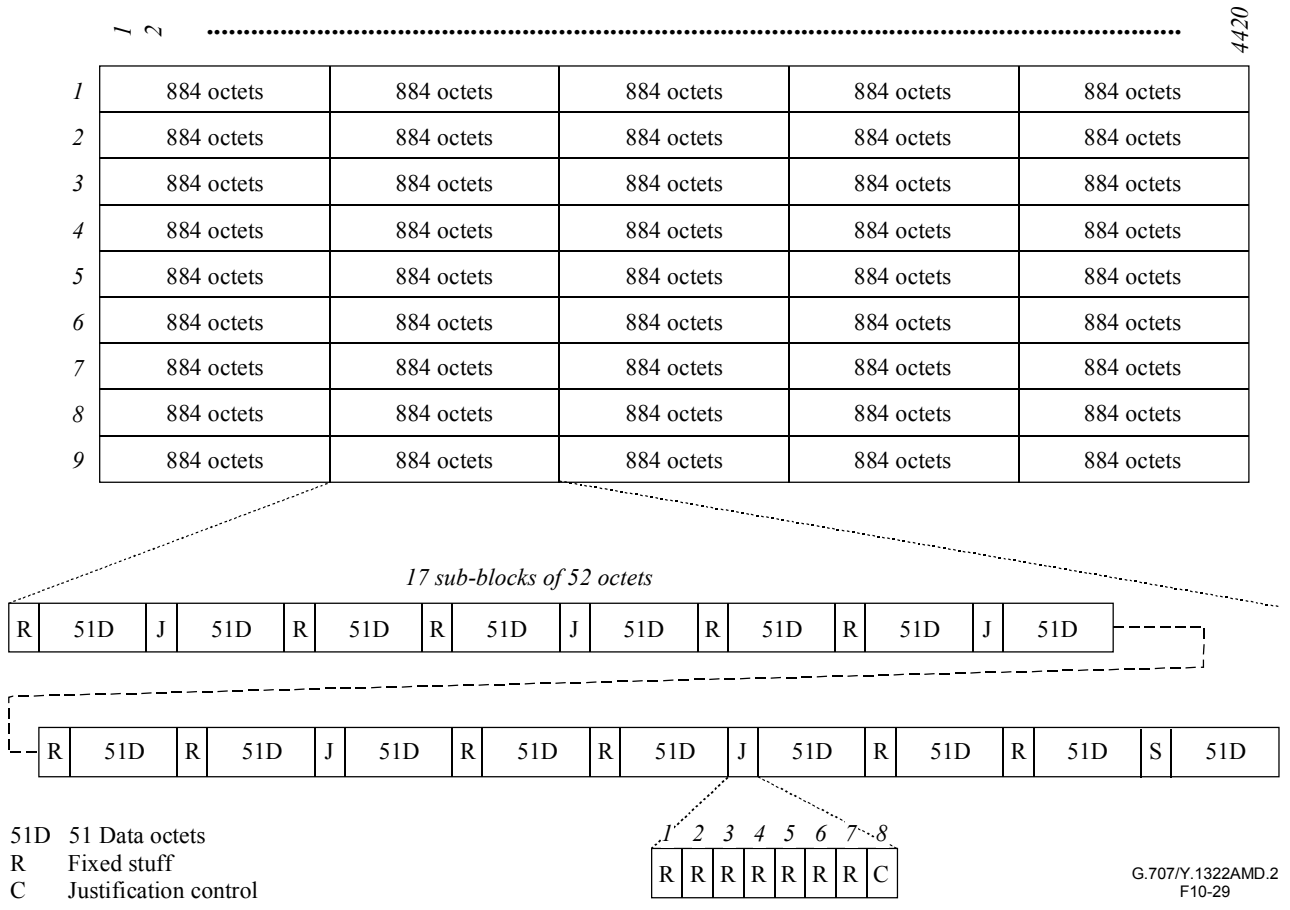

Figure 10-29/G.707/Y.1322 – Block structure for ODU1 mapping into C-4-17c

The set of five justification control bits (C) in every subblock is used to control the corresponding negative justification opportunity byte (S). CCCCC = 00000 indicates that the S byte is an information byte, whereas CCCCC = 11111 indicates that the S byte is a justification byte.

At the synchronizer all five C bits are set to the same value. Majority vote (3 out of 5) should be used to make the justification decision at the desynchronizer for protection against single and double bit errors in the JC bits.

The value contained in the S byte when used as justification byte is all-ZEROs. The receiver is required to ignore the value contained in this byte whenever it is used as a justification byte.

The value contained in the R bits and bytes is all-ZEROs. The receiver is required to ignore the value contained in these bits/bytes.

NOTE – The maximum bit-rate tolerance between C-4-17c and the ODU1 signal clock, which can be accommodated by this mapping scheme, is approximately –720 to +420 ppm. The nominal justification ratio is 75/119, which is approximately equal to 0.630252. Here, the justification ratio is normalized to 1, i.e., it is the long-run average fraction of justification opportunities for which there is a justification.

10.7.2 Asynchronous mapping of ODU2 into a C-4-68c transported via a VC-4-68v

The basic C-4-68c structure is as shown in Figure 10-30. It is comprised of 9 rows by 17 680 (i.e. 68 × 260) columns.

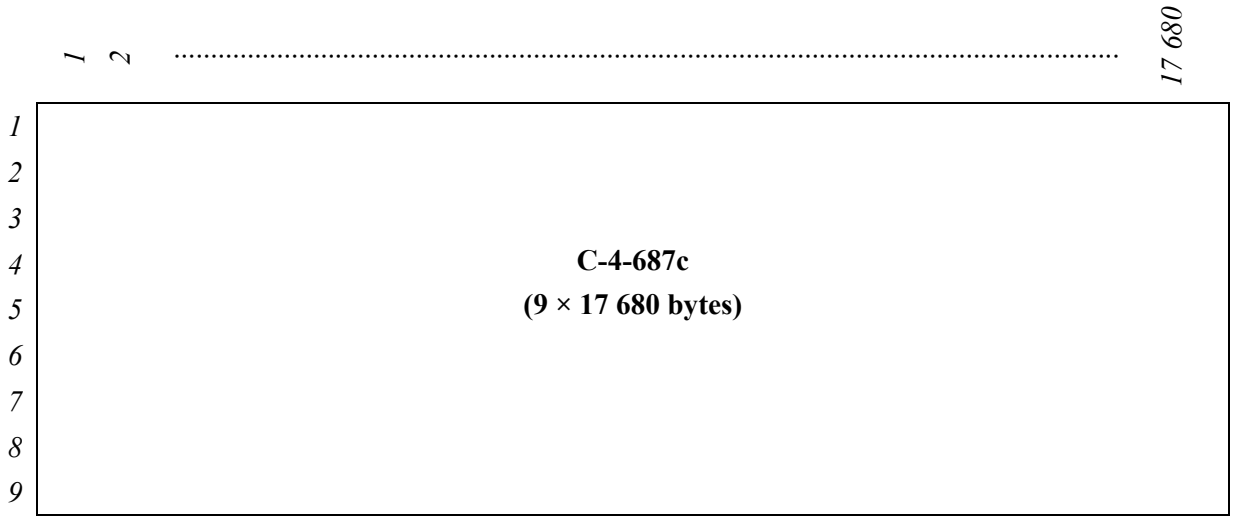

Figure 10-30/G.707/Y.1322 – C-4-68c

This C-4-68c frame is transported via a VC-4-68v. Refer to 11.2.

The extended ODU2 signal is asynchronous mapped into this C-4-68c with the following structure:

– Each of the nine rows is partitioned into 20 blocks, consisting of 884 octets each (Figure 10-31).

– Each block is partitioned into 13 subblocks, consisting of 68 octets each.

  • In each subblock, one negative justification opportunity octet (S) and five justification control bits (C) are provided.

  • The first byte of each subblock consists of either:

    – a fixed stuff byte (R); or

    – a justification control byte (J), which consists of seven fixed stuff bits (bits R; bits 1 to 7) and a justification control bit (bit C, bit 8); or

    – a negative justification opportunity byte (S).

  • The last 67 bytes of one subblock consist of data bytes (D).

  NOTE – Each block contains a total of (13 × 67) = 871 data bytes.

The sequence of all these bytes is shown in Figure 10-31.

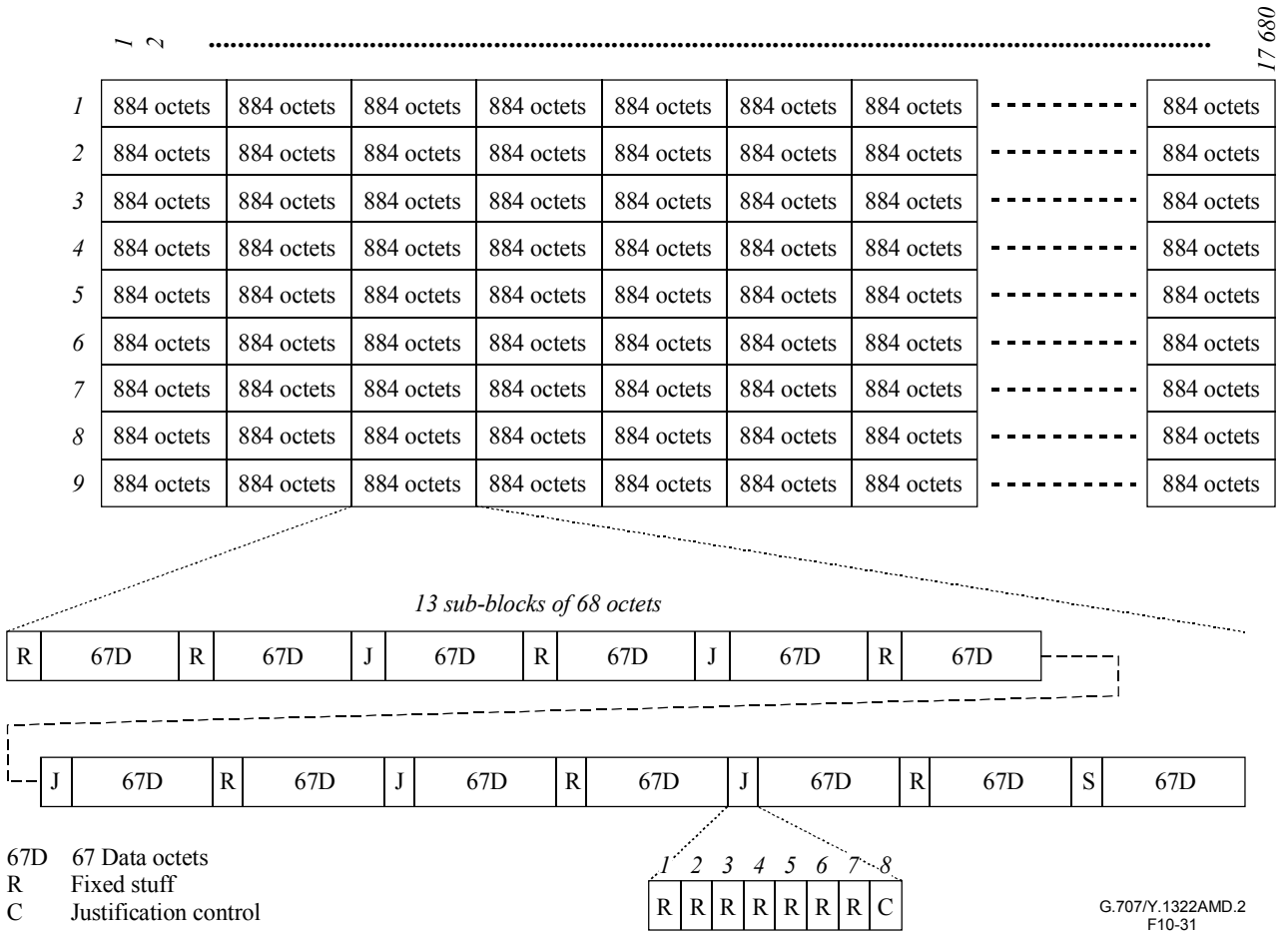

Figure 10-31/G.707/Y.1322 – Block structure for ODU2 mapping into C-4-68c

The set of five justification control bits (C) in every subblock is used to control the corresponding negative justification opportunity byte (S). CCCCC = 00000 indicates that the S byte is an information byte, whereas CCCCC = 11111 indicates that the S byte is a justification byte.

At the synchronizer all five C bits are set to the same value. Majority vote (3 out of 5) should be used to make the justification decision at the desynchronizer for protection against single and double bit errors in the JC bits.

The value contained in the S byte, when used as justification byte, is all-ZEROs. The receiver is required to ignore the value contained in this byte whenever it is used as a justification byte.

The value contained in the R bits and bytes is all-ZEROs. The receiver is required to ignore the value contained in these bits/bytes.

NOTE – The maximum bit-rate tolerance between C-4-68c and the ODU2 signal clock, which can be accommodated by this mapping scheme, is approximately –330 to +810 ppm. The nominal justification ratio is 23/79, which is approximately equal to 0.291139. Here, the justification ratio is normalized to 1, i.e., it is the long-run average fraction of justification opportunities for which there is a justification.

5) New Appendix XI

Add the following new Appendix XI and renumber existing Appendix XI as Appendix XII:

Appendix XI

Nominal justification ratios for asynchronous mapping of ODU1 into C-4-17c and ODU2 into C-4-68c

Appendix V/G.709/Y.1331 provides a relation between justification ratio and frequency offset, for the case of either CBRx or ODUk mapped into ODUn (n > k). Following the notation there, let α be the justification ratio, i.e., the average number of justifications per C-4-Xc frame; also, as is done there, let positive α correspond to negative justification and negative α correspond to positive justification. Then $0 \le \alpha \le 45$ for mapping ODU1 into C-4-17c and $0 \le \alpha \le 180$ for mapping ODU2 into C-4-68c. In addition, as is done in Appendix V/G.709/Y.1331, define the following notation:

N = number of fixed stuff bytes in the C-4-Xc payload area;

S = nominal ODUk client rate (bytes/s);

T = nominal C-4-Xc frame period (s);

y_c = client (ODUk) frequency offset (fraction);

y_s = server (C-4-Xc) frequency offset (fraction);

N_f = average number of client bytes mapped into a C-4-Xc frame, for the particular frequency offsets (averaged over a large number of frames).

(Note that in Appendix V/G.709/Y.1331, a quantity p, representing the fraction of the payload area for the client in question, was defined. Here, $p = 1$ because there is only one client being mapped; i.e., there is no possible multiplexing as there was in Appendix V/G.709/Y.1331.)

Then N_f is given by:

$$N_f = ST\frac{1+y_c}{1+y_s} \tag{1}$$

For frequency offsets small compared to 1, this may be approximated

$$N_f = ST(1+y_c-y_s) \equiv ST\beta \tag{2}$$

The quantity β-1 is the net frequency offset due to client and server frequency offset.

Now, the average number of client bytes mapped into an C-4-Xc frame is also equal to the total number of bytes in the payload area available to the client for data mapping (i.e., excluding any fixed stuff bytes (N)), plus the average number of bytes stuffed for this client over a very large number of frames. The latter is equal to the justification ratio. The former is equal to:

Number of data bytes in payload area for ODU1 mapped into C-4-17c

(51 data bytes/subblock)(17 subblocks/block)(5 blocks/row)(9 rows/frame) = 39 015 data bytes/frame.

Number of data bytes in payload area for ODU2 mapped into C-4-68c

(67 data bytes/subblock)(13 subblocks/block)(20 blocks/row)(9 rows/frame) = 156 780 data bytes/frame.

Combining the above with Equations (1) and (2) produces:

ODU1 mapped into C-4-17c

$$ST\beta = \alpha + 39015 \tag{3}$$

ODU2 mapped into C-4-68c

$$ST\beta = \alpha + 156780 \tag{4}$$

The nominal stuff ratio occurs when the frequency offsets are zero, i.e., when $\beta = 1$. We now set $\beta = 1$ and solve for α for each case.

ODU1 mapped into C-4-17c

The quantity *ST* is the nominal number of ODU1 bytes in the nominal C-4-17c frame period. The latter is equal to 125 μs. The former is equal to (239/238)(2.48832×10^9 bits/s)(1 byte/8 bits). Then

$$\begin{aligned}
\alpha &= (125\times10^{-6})\left(\frac{239}{238}\right)\left(\frac{2.48832\times10^{9}}{8}\right) - 39015 \\
&= \left(\frac{239}{238}\right)(38880) - 39015 \\
&= \frac{(239)(38880) - (238)(39015)}{238} \\
&= \frac{6750}{238} \\
&= \frac{3375}{119} \\
&\approx 28.361345
\end{aligned} \tag{5}$$

Then, on average, there are approximately 28.361345 negative justifications per C-4-17c frame out of a total possible 45. The long-run average fraction of justification opportunities for which there is a justification is equal to the above divided by 45 (denote this quantity by α')

$$\alpha' = \frac{3375}{(119)(45)} = \frac{75}{119} \approx 0.630252100840 \tag{6}$$

ODU2 mapped into C-4-68c

The quantity *ST* is the nominal number of ODU1 bytes in the nominal C-4-17c frame period. The latter is equal to 125 μs. The former is equal to (239/237)(29.95328×10^9 bits/s)(1 byte/8 bits). Then

$$\begin{aligned}
\alpha &= (125\times10^{-6})\left(\frac{239}{237}\right)\left(\frac{9.95328\times10^{9}}{8}\right) - 39015 \\
&= \left(\frac{239}{237}\right)(155520) - 156780 \\
&= \frac{(239)(155520) - (237)(156780)}{237} \\
&= \frac{12420}{237} \\
&= \frac{4140}{79} \\
&\approx 52.405063
\end{aligned} \tag{7}$$

Then, on average, there are approximately 52.405063 negative justifications per C-4-68c frame out of a total possible 180. The long-run average fraction of justification opportunities for which there is a justification is equal to the above divided by 180 (denote this quantity by α')

$$\alpha' = \frac{4140}{(79)(180)} = \frac{23}{79} \approx 0.291139240506 \tag{8}$$

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