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Syhchronous Mapping of C12/Tu12 For Efficient Communication

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***Abstract* - One of important transmission technologies in the broadband ISDN is the synchronous transmission technology based on SDH, which takes NNI (Network Node Interface) as its standard, STM-I frame is formed by the standardized multiplexing procedure of the signals which has the lowest rate required for the optical transmission, and transmitted via a physical medium. The multiplexing principles of SDH follow, using these terms and definitions: Stuffing, Multiplexing, and Aligning**

***Keywords* - Multiplexing, Multi frame Structure SDH, STM 1 Frame.**

I. Introduction

One of important transmission technologies in the broadband ISDN is the synchronous transmission technology based on SDH, which takes NNI (Network Node Interface) [1] as its standard. NNI standard established in 1988 defines STM-1 frame format as 270(bytes) x 9(rows) in the specifications of ITU-T G.707 [2]. In accordance with this specification, the basic structure of the transmission equipment applied to the standard SDH network system is formed depending upon the multiplexing type of per-channel time slot data which composes STM-I frame. In other words, STM-I frame is formed by the standardized multiplexing procedure of the signals which has the lowest rate required for the optical transmission, and transmitted via a physical medium. DS-I **(NA** type 1.544Mbps) and DS-IE (European type 2.048Mbps) signals originated from the existing PDH (P1esiochronous Digital Hierarchy) are reconfigured into TU-11 and TU-I2 signals. The low level signals of STM-I, in SDH class; and through this complex multiplexing process, an STM-I frame is completed. [3] Therefore, in order to configure optical transmission equipment based on SDH, the procedure in which TU-11 and TU-12 signals are multiplexed into high level shall be understood. In addition, the switching system for the switching actions of certain channels of certain signals shall be designed in accordance with the system requirements. This switching design is called data switching by time slot or TSI (Time slot Interchange). [I] In each transmission equipment, a unit or an IC(1ntergrated Circuit) which plays the role of TSI must exist : it shall execute the inter-switching action among channel data in one STM-I frame, as well as playing the role of a basic structure for the inter-switching among STM-I multi-port input channel data. In the actual ADM system configuration, it handles 2-port STM-I frame data switching and also executes the TSI function. [l] In order to configure a system which has high speed, high capacity and high data processing capability for much more optical subscribers, however, a new switching method is required to enhance the TSI function still more. To implement the method, the method of multiplexing the low level signals TU-12 shall be newly analyzed.

SONET and SDH converge at SDH's 155 Mbit/s base level, defined as STM-1 or "Synchronous Transport Module-1." The base level for SONET is STS-1 (or OC-1) and is equivalent to 51.84 Mbit/s. Thus, SDH's STM-1 is equivalent to SONET's STS-3 (3 x 51.84 Mbit/s = 155.52 Mbit/s). Higher SDH rates of STM-4 (622 Mbit/s), STM-16 (2.4 Gbit/s), and STM-64 (10 Gbit/s) have also been defined. Multiplexing is accomplished by combining – or interleaving – multiple lower-order signals (1.5 Mbit/s, 2 Mbit/s, etc.) into higher-speed circuits (51 Mbit/s, 155 Mbit/s, etc.) [5]. by changing the SONET standard from bit interleaving to byte-interleaving, it became possible for SDH to accommodate both transmission hierarchies. This modification allows an STM-1 signal to carry multiple 1.5 Mbit/s or 2 Mbit/s signals – and multiple STM signals to be aggregated to carry higher orders of SONET or SDH tributaries.

Transmission standards in the U.S., Canada, Korea, Taiwan, and Hong Kong (ANSI) and the rest of the world (ITU-T) evolved from different basic-rate signals in the non-synchronous hierarchy. ANSI Time Division Multiplexing (TDM) combines twenty four 64 kbit/s channels (DS0) into one 1.544 Mbit/s DS1 signal. ITU TDM multiplexes thirty 64 kbit/s channels (E0) into one 2.048 Mbit/s E1 signal (an extra two channels provide frame alignment and signaling, making 32 total).An important issue for the ITU-T to resolve was how to efficiently accommodate both the 1.5 Mbit/s and the 2 Mbit/s non-synchronous hierarchies in a single network standard. The agreement reached specified a basic transmission rate of 51 Mbit/s for SONET and a basic rate of 155 Mbit/s for SDH.

II. SDH Multiplexing

The multiplexing principles of SDH follow, using these terms and definitions:

Mapping – A process used when tributaries are adapted into Virtual Containers (VCs) by adding justification bits and Path Overhead (POH) information.

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Aligning – This process takes place when a pointer is included in a Tributary Unit (TU) or an Administrative Unit (AU), to allow the first byte of the Virtual Container to be located [3].

Multiplexing – This process is used when multiple lower-order path layer signals are adapted into a higher-order path signal, or when the higher-order path signals are adapted into a Multiplex Section.

Stuffing – As the tributary signals are multiplexed and aligned, some spare capacity has been designed into the SDH frame to provide enough space for all the various tributary rates. Therefore, at certain points in the multiplexing hierarchy, this space capacity is filled with "fixed stuffing" bits that carry no information, but are required to fill up the particular frame. Figure 1 illustrates the ITU-T SDH multiplexing structure defined in Rec. G.707. The notations in the boxes, such as C-1, VC-3, and AU-4, are explained in Table 1.At the lowest level, containers (C) are input to virtual containers (VC). The purpose of this function is to create a uniform VC payload by using bit-stuffing to bring all inputs to a common bit-rate ready for synchronous multiplexing. Various containers (ranging from VC-11 at 1.728 Mbit/s to VC-4 at 150.336 Mbit/s) are covered by the SDH hierarchy. Next, VCs are aligned into tributary units (TUs), where pointer processing operations are implemented. These initial functions allow the payload to be multiplexed into TU groups (TUGs). As Figure1 illustrates, the xN label indicates the multiplexing integer used to multiplex the TUs to the TUGs. The next step is the multiplexing of the TUGs to higher level VCs, and TUG-2 and TUG-3 are multiplexed into VC-3 (ANSI mappings) and VC-4. These VCs are multiplexed with fixed byte-stuffing to form administration units (AUs) which are finally multiplexed into the AU group (AUG). This payload then is multiplexed into the Synchronous Transport Module (STM).

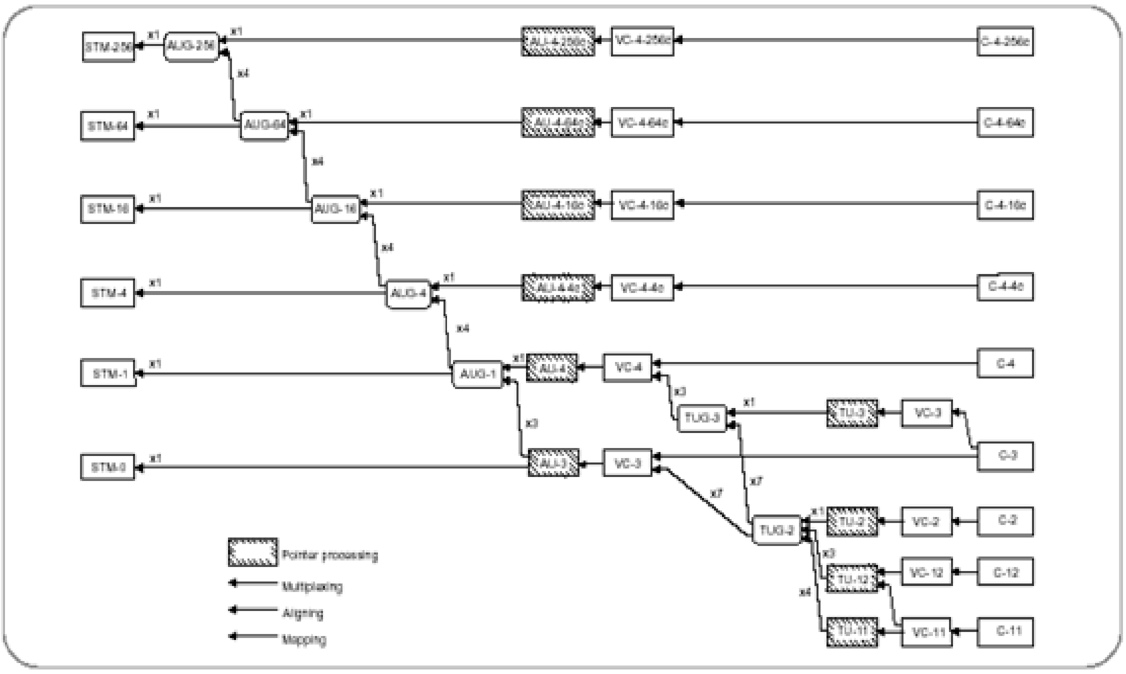

Fig.1. Multiplexing structure

Table 1 SDH Multiplexing Structure

Term	Contents	User
C-N	N = 1 to 4	Payload at lowest multiplexing level
VC-N	N = 1, 2 (Lower-Order)	Single C-n plus VC POH
VC-N	N = 3, 4 (Higher-Order)	C-N, TUG-2s, or TUG-3s, plus POH for the specific level
TU-N	N = 1 to 3	VC-N plus tributary unit pointer
TUG-2	1, 3 or 4 (TU-N)	Multiplex of various TU-Ns
TUG-3	TU-3 or 7 TUG-2s	TU-3 or multiplex of 7 TUG-2s
AU-N	N = 3, 4	VC-N plus AU pointer
AUG	1, 3 (AU-n	Either 1 AU-4 or multiplex of 3 AU-3s
STM-N	N = 1, 4, 16, 64 AUGs	N synchronously-multiplexed STM-1 signals

POH = Path Overhead
C = Container
TU = Tributary Unit
AU = Administrative Unit
VC = Virtual Container
TUG = Tributary Unit Group
STM = Synchronous Transport Module

III. SDH Tributary Multiplexing

In order to accommodate mixes of different TU types within a VC-4, the TUs are grouped together (refer to the previous SDH Multiplexing Hierarchy diagram – Figure 1). A VC-4 that is carrying Tributary Units is divided into three TUG-3, each of which may contain seven TUG-2s or

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a single TU-3. There can be a mix of the different TU Groups. For example, the first TUG-3 could contain twelve TU-12 and three TU-2, making a total of seven TUG-2 groups. The TU groups have no overhead or pointers; they are just a way of multiplexing and organizing the different Tus within the VC-4 of a STM-1. The columns in a TU Group are not consecutive within the VC; they are byte-interleaved column-by-column with respect to the other TU groups. It also shows several columns allocated for fixed stuffing. NPI (Null Pointer Indicators) are used to indicate when a TUG-2 structure is being carried, rather than a TU-3 with its associated TU-3 pointer [3].

IV. Tributary Unit Group

The first TUG-2 Group within a TUG-3, called Group 1, is found in every seventh column, skipping columns 1 and 2 of the TUG-3, and starting with column 3. The Tributary Unit columns within a group are not placed in consecutive columns within that group (Figure 3). The columns of the individual Tus within the TU Group are byte-interleaved as well. Tributary Units are optimized in different sizes to accommodate different signals. Each size of TU is known as a “type” of TU. A 36-byte structure, or 4 columns by 9 rows, could accommodate the 2.048 Mbit/s signal. This particular TU is simply designated a TU-12. In this case the four columns provide a signal rate of 2.304 Mbit/s, allowing capacity for overhead. Other signals require TUs of different sizes. With each TU Group using 12 columns of the VC-4, note that the number of columns in each of the different Lower-Order TU types are all factors of 12. As a result, a TU group could contain one of the following combinations:

Three TU-12s (with four columns per TU-12)

One TU-2 (with twelve columns per TU-2)

V. TU Multiframe

In the floating TU mode, four consecutive 125-microsecond frames of the VC-4 are combined into one 500-microsecond structure, called a TU Multiframe. In other words, the 500-microsecond multiframe is overwritten on, and aligned to the 125-microsecond VC-4s. The occurrence of the TU Multiframe and its phase is indicated in the VC-N Path Overhead, by the Multiframe Indicator byte (H4). A value XXXXXX00 in the Multiframe Indicator byte indicates that the next STM frame contains the first frame in the TU Multiframe; a value XXXXXX01 in the Multiframe Indicator byte indicates that the next VC-4 contains the second frame in the TU Multiframe, and so on. (Only the last two bits of the H4 byte have a value of 0 or 1 assigned; the first six bits are unassigned and this is denoted by the X.)

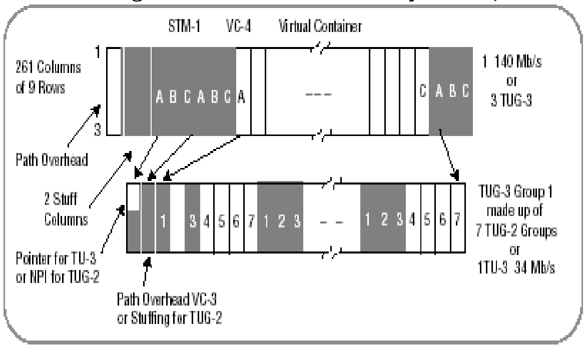

Fig.2. SDH Tributary Structure for multiplexing for TUG

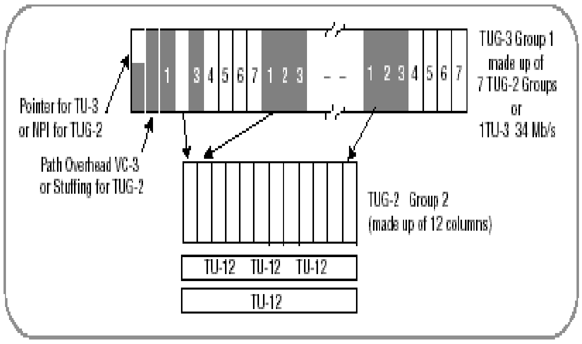

Fig.3. Tributary Unit Structure

The Tributary Units also contain payload pointers to allow for flexible and dynamic alignment of the VC. In this case, the TU pointer value indicates the offset from the TU to the first byte of the VC. TU pointers allow AU and TU payloads to differ in phase with respect to each other and the network while still allowing AUs and TUs to be synchronously multiplexed. The TU Multiframe overhead consists of four bytes: V1, V2, V3, and V4 (see Figure 4). Each of these four bytes, V1 to V4, is located in the first byte of the respective TU frame in the TU Multiframe. The payload pointers V1 and V2 indicate the start of the payload within the multiframe and V3 provides a 64 kbit/s channel for a payload pointer movement opportunity. The V4 byte is reserved. The remaining bytes in the TU Multiframe define the TU container capacity which carries the Virtual Container, and the Path Overhead. The container capacity differs for the different TU types because their size varies according to the number of columns in each type. The container capacity for each type of TU is shown in Table 1.

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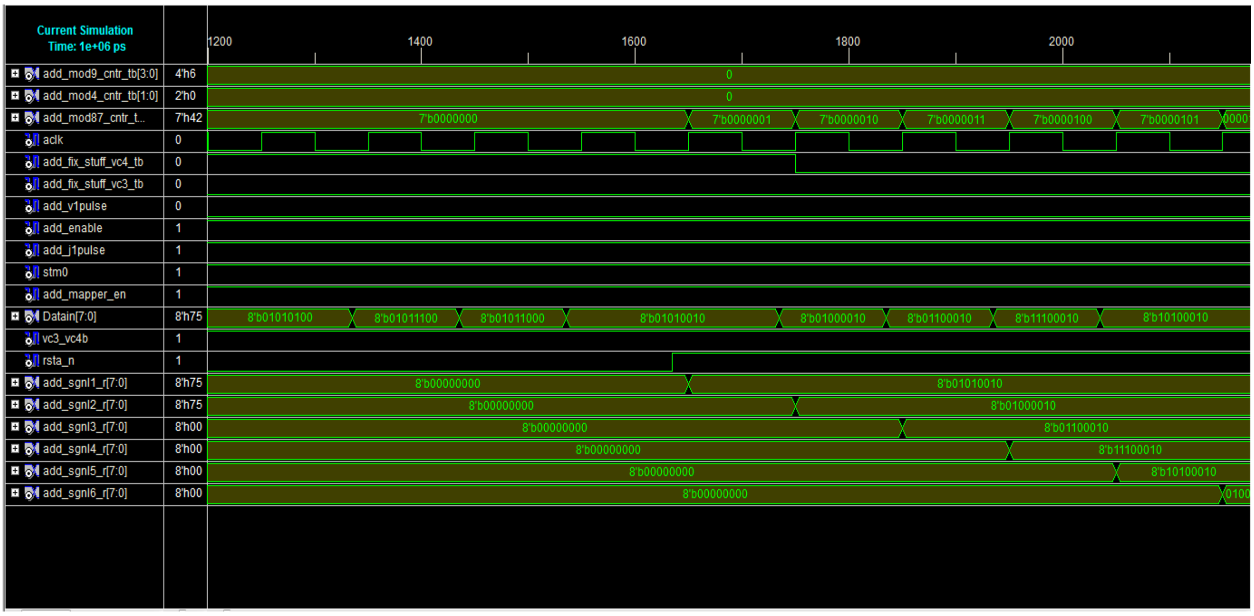

Fig.4. in the SONET payload we had seven Virtual Tributary Groups (VTG).

In SDH we have same thing except that they're called Tributary Unit Groups (TUG).The seven TU can multiplex to form one TUG. The first TUG-2 Group within a TUG-3, called Group 1, is found in every seventh column, skipping columns 1 and 2 of the TUG-3, and starting with column 3. The Tributary Unit columns within a group are not placed in consecutive columns within that group. The columns of the individual TU within the TU Group are byte-interleaved as well. Tributary Units are optimized in different sizes to accommodate different signals. Each size of TU is known as a "type" of TU. A 36-byte structure, or 4 columns by 9 rows, could accommodate the 2.048 Mbit/s signal. This particular TU is simply designated a TU-12. In this case the four columns provide a signal rate of 2.304 Mbit/s, allowing capacity for overhead. Other signals require TUs of different sizes. With each TU Group using 12 columns of the VC-4, note that the number of columns in each of the different Lower-Order TU types are all factors of 12. As a result, a TU group could contain three TU-12s (with four columns per TU-12).

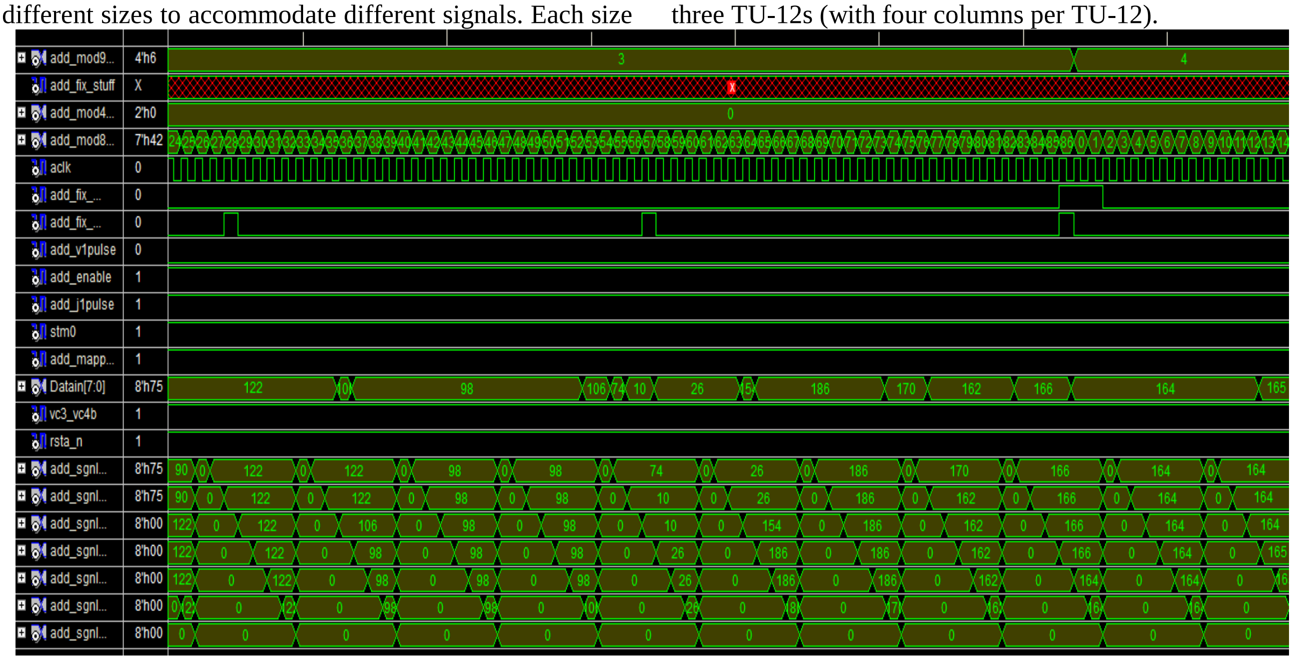

Fig.5. Frame consists of 2430 bytes which can be considered as a structure of 270 columns x 9 lines

In SDH we have same thing except that they're called Tributary Unit Groups (TUG).The seven TU can multiplex to form one TUG .It multiplex 87 bytes of second row in STM frame and then increment the row counter for next 87 bytes of payload. In order to accommodate mixes of different TU types within a VC-4, the TUs are grouped together (refer to the previous SDH Multiplexing Hierarchy). A VC-4 that is carrying Tributary Units is divided into three TUG-3, each of which may contain seven TUG-2s or a single TU-3. There can be a mix of the different TU Groups. For example, the first TUG-3 could contain twelve TU-12 and three TU-2, making a total of seven TUG-2 groups. The TU groups have no overhead or pointers; they are just a way of multiplexing and organizing the different TU within the VC-4 of a STM-1. The columns in a TU Group are not consecutive within the VC; they are byte-interleaved column-by-column with respect to the other TU groups.

CONCLUSION

The introduction of SDH and SONET presents greatly increased demands on network synchronization. The synchronization performance of most telecommunications networks requires improvement to support SDH and SONET. Short-term wander performance is crucial, requiring the use of excellent clocks. Stress operation performance also needs to be greatly limited. This requires the shortening of synchronization chains, necessitating the use of multiple primary reference clocks in many networks and the use of clocks with excellent rearrangement. The result shows that the memory capacity is reduce with increase in gate size.

REFERENCES

[1] Design of TU-ll/TU-12 Level Switching Structure in Optical Transmission Equipment which supports SDH (Synchronous Digital Hierarchy) Standard JiHoon Bang, YongSerk Kim, YongWhan Kim ASIC Center, Corporate Operations, Samsung Electronics Co., LTD Suwon, Kyungki-Do, Korea

[2] John E.Abate, Edgar W.Butterline, etc., AT&T's New Approach to the Synchronization of Telecommunication Networks, IEEE Communications Magazine, April 1989, pp.35-45

[3] A scalable SDH/SONET Framer architecture for datacom application A. Herkersdorf, P. Buchmann, R. Clauberg, W. Lemppenau1, H.R. Schindler, and D. Webb IBM Research, Zurich Research Laboratory, 8803 Rüschlikon, Switzerland 1 FH Gelsenkirchen, Abteilung Bocholt, Postfach 1441, D-46364 Bocholt, Germany

[4] http://grouper.ieee.org/groups/802/17/ documents/presentations/may2001/hk_sonet_2.pdf

[5] ITU-T G.704 – Synchronous frame structures used at 1544, 6312, 2048, 8448, and 44736 kbit/s hierarchical levels