TELECOMMUNICATION TECHNOLOGY, RADIO SYSTEMS AND DEVICES, MICRO- AND NANOELECTRONICS

Effectiveness of Virtual Concatenation Alghorithms for Next Generation SDH/SONET Networks

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***Abstract* – The paper presents a hybrid mechanism for virtual concatenation (H-VCAT), which allows increasing channel utilizing by 10% compared with virtual concatenation and by 50-70% in comparison with contiguous concatenation. The evaluation of network parameters at the stage of optical transport system designing provided. The optimum set of containers for transferring traffic from FTTx access networks with 99.7% channel utilizing was proposed.**

Key words – NG SDH, VCAT, H-VCAT, GFP, LCAS, channel utilization.

I. Introduction

For successful interaction between different access networks, the channels of the backbone network should be standardize according to the PDH and SDH hierarchy. Initially, the development of transport networks assumed that there are only primary channels data [1-3]. The backbone network considered as a set of channels. Further separation of network traffic segments and segments greatly enhanced the access network scalability. Solutions for transport networks and access networks have become less formal and less standardized, compared with the solutions for the primary and secondary networks [4, 5].

The main problem that arises when transmitting packet traffic over SDH network is inconsistency throughputs of Gigabit Ethernet networks with a capacity of payload that can be transport by STM. This mismatch significantly reduce the efficiency of channel resources while packet traffic transmitted. One of the possible mechanisms of solving this problem is to use virtual concatenation (VCAT) in conjunction with general framing procedure (GFP) and link capacity adjustment scheme (LCAS).

II. Mechanisms of concatenation transport containers in NG SDH systems

The concatenation principle leads in combining of multiple virtual containers. As result, their combined capacity used as a block for transmission of data, which size exceeds the size of single container. There are two types of concatenation – contiguous and virtual. Concatenation of both types forms a path of bandwidth is n times greater than the rate of a single container CVC, but with different principle of transmission between two nodes. The set of containers that deliver IP-traffic between two nodes A and B called contiguous concatenation (CCG) or virtual concatenation (VCG) group [6]. The disadvantage of contiguous concatenation is that permissible speed transmission is strictly defined standard SDH hierarchy [7,8]. The virtual concatenation utilizing channel resources more flexible by non-hierarchical speeds.

Information capacity of contiguous- concatenated group is defined as:

$$r_{CCG} = \sum_n r_n^{\{VC_x\}}, n \in [1, 4, 16, 64, 256], \text{[bits]} \qquad (1)$$

where $r_n^{\{VCx\}}$ - information capacity of the container VC_x, bits.

Accordingly, the transmission speed of useful information in contiguous concatenation is:

$$C_{CCG} = f \cdot \sum_n r_n^{\{VC_x\}}, n \in [1, 4, 16, 64, 256], \text{[bps]} \qquad (2)$$

where f – frames rate STM-n.

The disadvantage of contiguous concatenation is that permissible speed of transmission is strictly determined by standard of SDH hierarchy. That is to transfer a payload of X bps should be used nearest in the hierarchy stream the speed of which is higher than a given load. In contrast to the contiguous concatenation a virtual concatenation allows more flexibly use channel resources by not hierarchical speeds. Transfer rate of useful information for virtual concatenation can be selected multiple of the size of the virtual container corresponding level [9].

The efficiency of use channel resources for virtual concatenation is significantly higher. Information capacity of virtual-concatenated group is defined as:

$$r_{VCG} = \sum_n r_n^{\{VC_x\}}, n \in N, \text{[bits]} \qquad (3)$$

Accordingly, the transmission speed of useful information in virtual concatenation is:

$$C_{CCG} = f \cdot \sum_n r_n^{\{VC_x\}}, n \in N, \text{[bps]} \qquad (4)$$

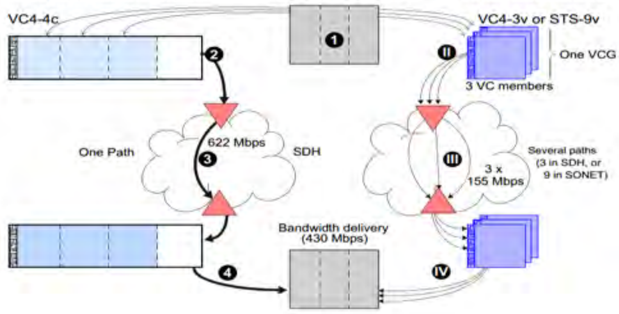

Fig. 1. Comparison of contiguous and virtual concatenation of transport containers

III. Mechanism of hybrid virtual concatenation H-VCAT

Despite a high efficiency of resource use, virtual concatenation has a significant disadvantage - merging group only single-level containers. To improve the effectiveness of the proposed formation of virtual concatenation hybrid groups - HVCG. This mechanism is the formation of groups with different levels of virtual containers, providing a more accurate allocation of resources at the desired speed transmission. For of hybrid virtual concatenation groups are used containers VC-3 and VC-4. When you send your packet traffic, the capacity of the container used in full, as there is no need for matching bits and bits of fixation are added to the container when transmitting tribe PDH. Thus, the capacity of the container VC-3 increases with 4096 bits to 4608 bits, and VC-4 with 16384 bits to 18576 bits, respectively. This will reduce redundancy characteristic of networks with channel switching. Comparing the efficiency of channel resources are shown in Table. 1. Information capacity of of hybrid virtual-concatenated group is defined as:

$$r_{HVCG} = \sum_{n} r_n^{\{VC-4\}} + \sum_{m} r_m^{\{VC-3\}},$$

$$n, m \in N \text{, [bits]} \quad (5)$$

Accordingly, the transmission speed of useful information in virtual concatenation is:

$$C_{HVCG} = f \cdot \left(\sum_{n} r_n^{\{VC-4\}} + \sum_{m} r_m^{\{VC-3\}} \right),$$

$$n, m \in N \text{, [bps]} \quad (6)$$

TABLE 1

EVALUATING THE EFFECTIVENESS OF THE USE OF CHANNEL RESOURCES WHEN TRANSMITTING PACKET TRAFFIC FOR GIGABIT ETHERNET NETWORK

Type of concatenation	Group Type	Speed	Efficiency
CAT	STM-256	33,6 Gbps	32 %
VCAT	73xVC-4	11 Gbps	98 %
H-VCAT	72xVC-4 + 2xVC-3	10,03 Gbps	99.7 %

Block diagram of the process of transmission packet traffic between two networks access via NG SDH transport network is shown in Fig. 2. Transmission of packet traffic transport module STM-n is provided by the interaction of three mechanisms [4]:

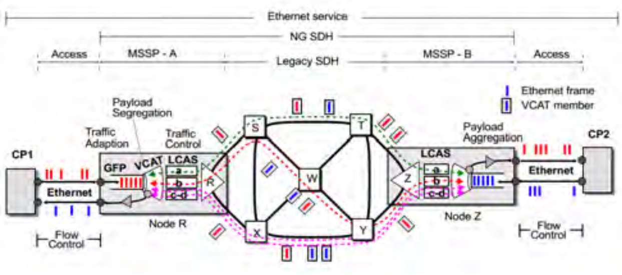

Fig. 2. The block diagram of the formation of the channel packet data of transmission over SDH networks

• GFP (General Framing Procedure) - designed to adapt packet traffic according to the capacities of virtual containers;

• (H) VCAT ((Hybrid) Virtual Concatenation) - mechanism of improving the efficiency of the transport system channel resources SDH;

• LCAS (Link Capacity Adjustment Scheme) - control mechanism for changing loads.

Conclusion

This paper presents new mechanism of hybrid virtual concatenation. The difference of this mechanism is more effective channel utilization. We calculated efficiency of specrum utilization for three types of concatenations: contiguous, virtual and hybrid-virtual. Thoretical calculations proves that HVCAT 10% increases the effectiveness of channel utilization compared with conventional virtual concatenation and up to 50-70% in comparison with contiguous concatenation.

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