# Traffic Control in The Center of Conjugation of Heterogeneous Networks

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**Summary**
This article presents an analysis of the effectiveness the speed coordination mechanisms of heterogeneous networks, interacting through the center of conjugation, study of the sliding window mechanisms; the transmission rate control and "leaky bucket".
***Key words:***
*Heterogeneous networks, Flow control, Sliding window, Transmission rate control, "Leaky bucket".*

## 1. Introduction

The success of many organizations and companies are now directly depend on the means of communication. The corporate network is becoming a major information resource of the enterprise.
The target deployment of corporate networks has its own problems. These problems are mainly related with the organization of effective interaction of individual parts of distributed systems. To perform the interaction, the various and heterogeneous network must be joined together.
The heterogeneity of networks includes several aspects: different length, different data rates that depend on the quality of the channel and the traffic load on networks belonging to different functional levels of OSI model, different topologies, and different system/ application software. Function of integration and harmonization is performed in the centers of conjugation (CC) heterogeneous networks of different levels and purposes - bridges, switches, routers, gateways.
Today, the information technology market offers a wide range of hardware and software means for interfacing different standard networks. Effective solution of the pairing requires the adequate use of possible mechanisms and means to ensure the pairing.
For example, even in the best possible procedure for routing of messages sometimes suffer from network delays due to the congested areas on the way to the destination. This can happen because of unexpected failures of network elements and other natural changes of traffic loading that exceeds the capacity level, which was designed based on the routing algorithm (Figure 1).

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## 2. Traffic control of heterogeneous networks.

The above underlines the importance of the choice of flow control mechanism, which is implemented in the ports (channel modules - CM) center of pairing (CP) of heterogeneous networks. In the center of pairing the right side, for example CM1, should work as a network node 1, and the left side CM2 as network node 2 (Fig. 2). CM1 receives packets from the input port speeds $\upsilon 1$, and transmits the output CM2 with a speed of $\upsilon 2$ [1].
The main function of the harmonization of velocities in the CC is to maintain a uniform load on the different ports of the CC, and, consequently, to different parts of the network [2]. Flow Control performs a set of mechanisms through which data flows are maintained within the confines of available resources. The purpose of the application of various procedures for flow control in the CP is to avoid reducing the efficiency of the network. Under the reduction in the efficiency is understood as a fall in bandwidth as a whole or its individual fragment, and a sharp increase in time delivery of packets through the network due to congestion [3, 7].

2 In this paper a model of harmonized velocities are represented by three mechanisms: "sliding window", "transmission rate control" and "leaky bucket". It seems timely to evaluate the effectiveness of the above mechanisms in the CC at the matching of heterogeneous networks.
Assume that the confirmation of VC is transmitted through the network with the highest priority. This

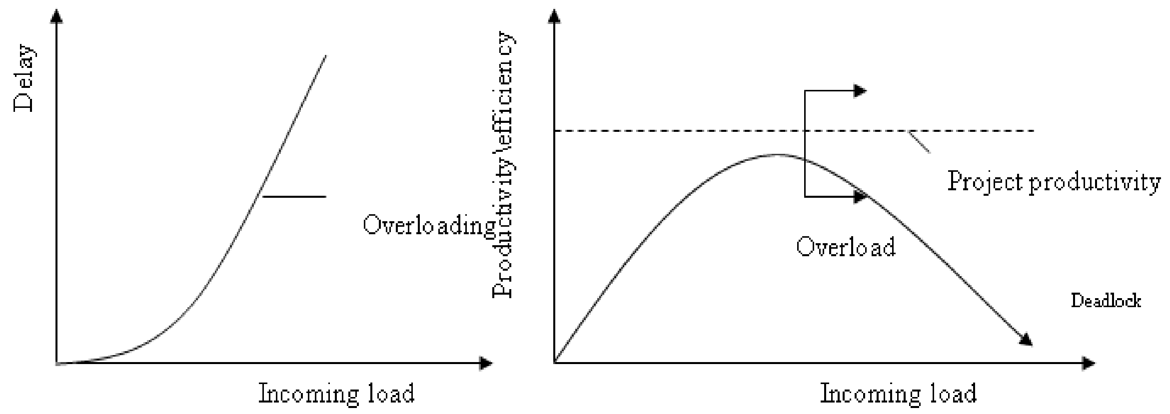


Fig. 1 - Overloading the network

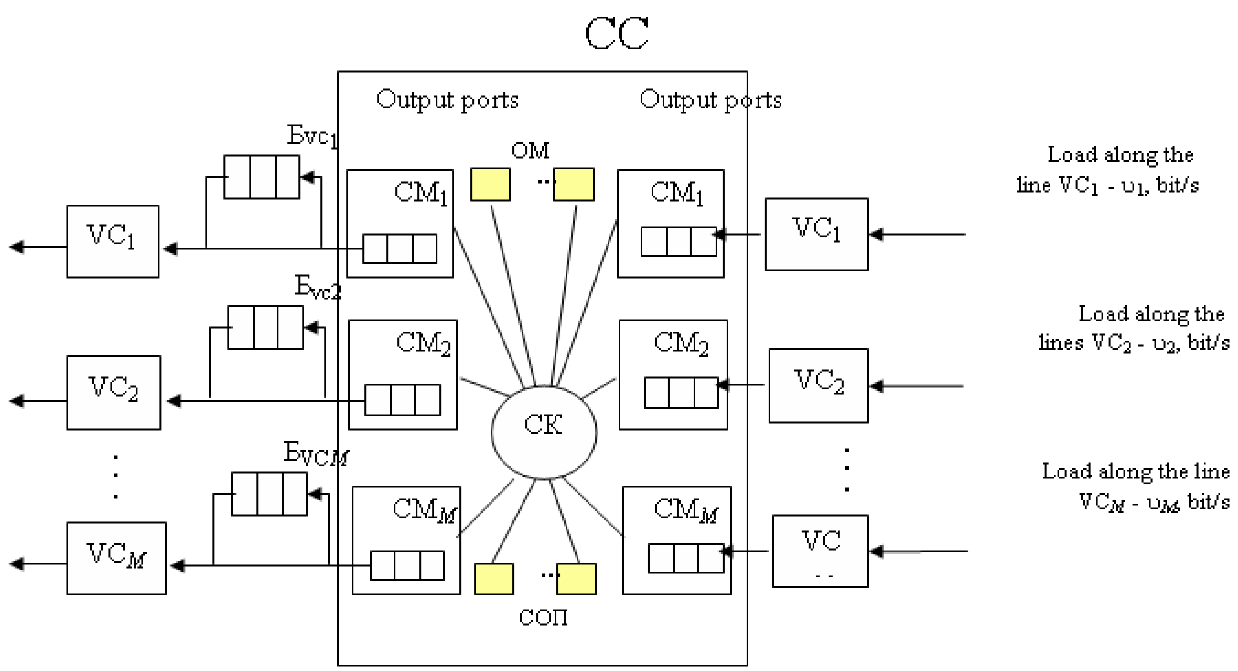


Fig. 2 – Rate matching, which is realized in CM

enables us to neglect the delay in returning receipts. This restriction allows for the analysis of control through the mechanism of the sliding window to use the model of a closed queuing system (Fig. 3). In this model, CC-source and recipient of the CC-related additional artificial system of care, is M +1. The intensity of service in the M +1 is $\lambda$, which corresponds to the intensity of the input stream in the virtual channel (VC), with which a dedicated port. In a closed system circulates a fixed number of N packets. If in the VC (*M* upper Service

Systems) is *N* packets, lower service system *M +1* is empty and can not serve. This simulates the state of the lock, which packets encounter when entering the time of exhausted capacity of the window. At a time when one of the *N* packets in the VC goes to the recipient, it appears in the service system *M +1* (this is the assumption of zero delay confirmation to be transferred back to the source). Channel can now send packets with intensity λ. This condition occurs whenever in the VC is less than *N* packets, in this case, the rest of them are accumulated in an artificial system service *M +1*.

Qualitative representation of the control through the mechanism of the sliding window can be obtained without analysis. Imagine that the intensity of the incoming packets λ increases. In the absence of control overflow queuing systems begins at the nodes on the way of VC, the delay from end to end is growing rapidly, there is an overload. In the presence of control congestion is limited, because in the VC (when VC is in the transit state) maximum only *N* packets. The delay depends on the N value; if the value of N is small the value of end to end delay will be small respectively. However, when *N* increases the productivity increases, but the delay also increases. Consequently, the best management scheme is such a scheme, which provides a minimum delay for a given performance, or, equivalently, the best performance at a given time delay. Also we take into account *M* dependence, i.e the number of re-received packets in the transmission process via the virtual channel.

For quantitative analysis we use the Norton's theorem for public service networks [4]. This theorem states that *M* consecutive service systems between points *S* and *R* may be replaced by one service system, depending on the state, without changing the statistical characteristics between the points *S* and *R*. The theorem provides a very valuable simplification. Applying Norton's theorem to the study of the mechanism of control through a sliding window, this is described by a closed public service networks (Fig. 4). First, we simplify the analysis, taking all the intensity of service μ1… μM equal to one and the same value μ. It follows that all the channels on the way VC have the same bandwidth, each of them, on average, carries the same load. This allows define the delay of the virtual channel $t_з^{VC}$ from one end to another one as the ratio of the average number of packets $\bar{n}$ in VC to the performance γ:

$$t_з^{VC} = \bar{n}/\gamma = \sum_{n=1}^{N} n\, p_n/\gamma \tag{1}$$

Where, $p_n$ - probability of n packets in VC.

Managing the rate of transmission on the virtual route, works as the following. Initially, for this virtual path is assigned a fixed window *k*. This number is set to counter the *PC* to control the rate and stored in local memory *LM*, which is linked on this VC. When any packet enters the

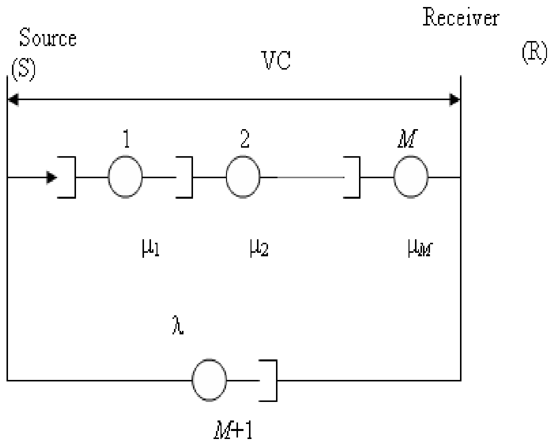


Figure 3 – Management model with a sliding window

virtual route, the counter reduces its value by one. When the counter value is zero, the supplement of packets in VC is delayed for some time.

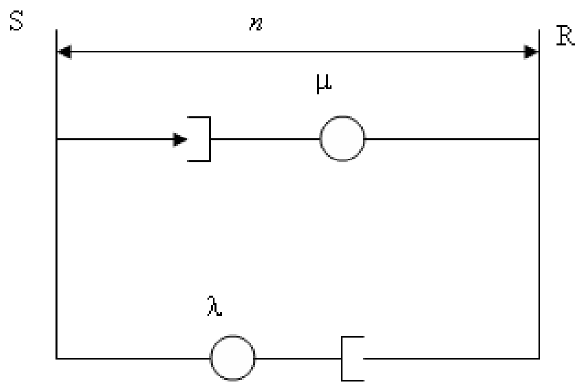


Figure 4 - Equivalent circuit Norton, cyclic public service network (CPSN)

In the mechanism of controlling the rate of transmission, the first packet in the given window will be acknowledged (with an urgent priority) by recipient after receiving process. The given packet enters the source and causes an increase in the current value on the size of the window. Thus, when at stationary position, counter changes in the range $0 \le PC \le 2k-1$.

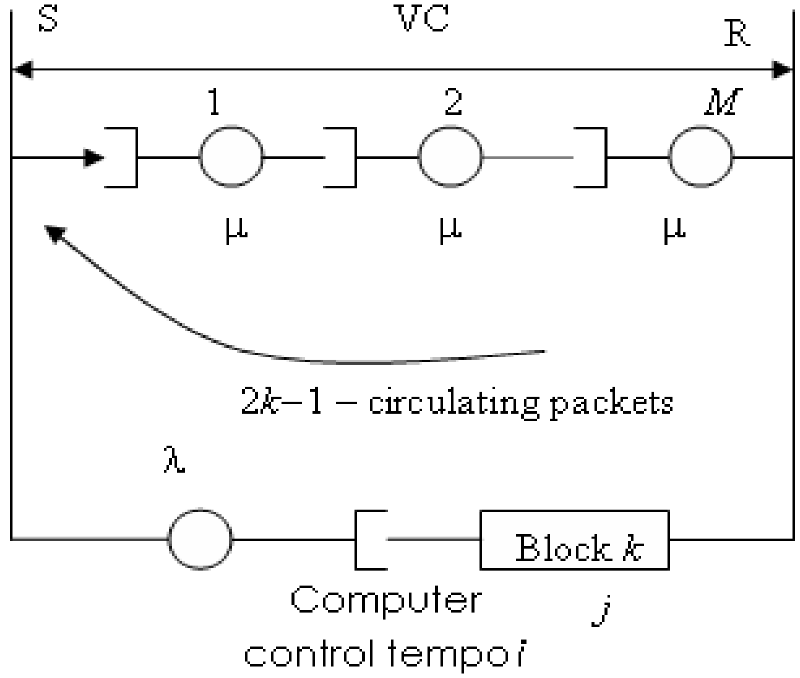


Fig. 5 - Transmission rate control model via VC

To describe the mechanism of "transmission rate control" model using a closed public service network as shown in Figure 5, the virtual route of the M sites described as series of connections M of service systems. It is assumed that packets arrive in the source, as soon as they appear in the destination. Entering the block k, k-1 accumulated packets. Entering k-th packet unloads block k and the service system, which simulates the computer, instantly receives k packets. Thus, in this model will be a process of group entering.

Note the following. When the service system, which simulates the counter PC, is empty, purpose have already been delivered and are waiting in the fictitious k-block j≤ k-1 packets, while the (2k- 1)-j packets are in transit somewhere along the virtual route. Thus packets from entering virtual channel blocked. If PC>0, packets leave the virtual channel (service system) in the form of Poisson's flow with intensity λ.

Delay, as defined by this mechanism, defined as follows:

$$t_3^{VC} = \left( \frac{2k - 1 + k}{2\mu} \right), \tag{2}$$

Where, $\mu$ – the productivity/efficiency of the port.

Harmonization velocities using 'leaky-bucket' mechanism can be described by single-line queuing system with constant service time of requests [5].

Indeed, imagine a bucket with a small hole in the bottom [6]. Regardless of the speed with which water is poured into a bucket, the output stream has a constant velocity when there is water in the bucket, and zero velocity, when the bucket is empty. Furthermore, when the bucket is filled, all excess water pours over the edge and lost (ie does not fall in output under the hole).

The same idea applies to packets, as shown in fig. 6.

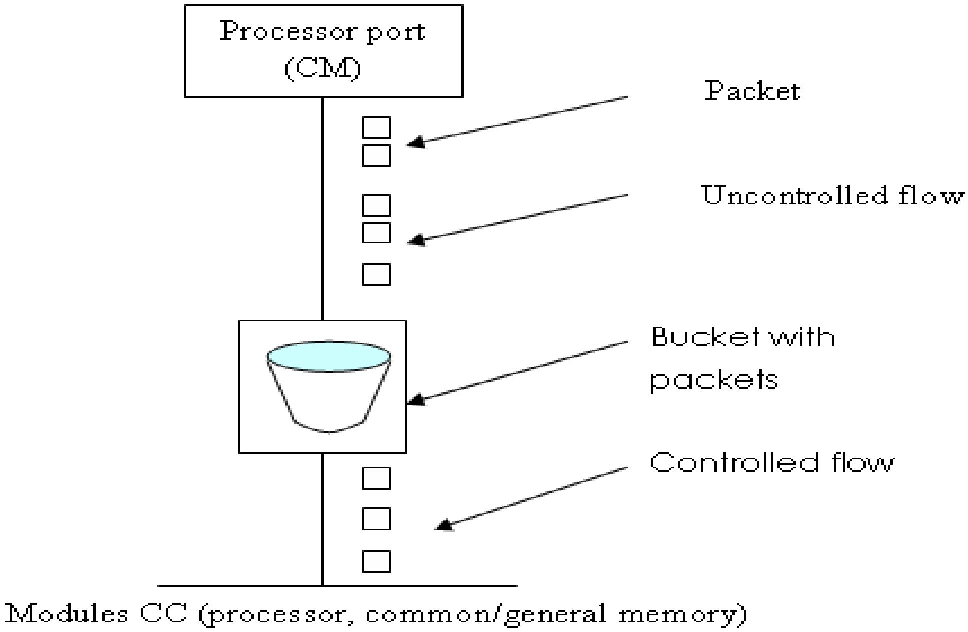


Fig. 6 - Leaky bucket with packets, implemented in the CM the center of pairing

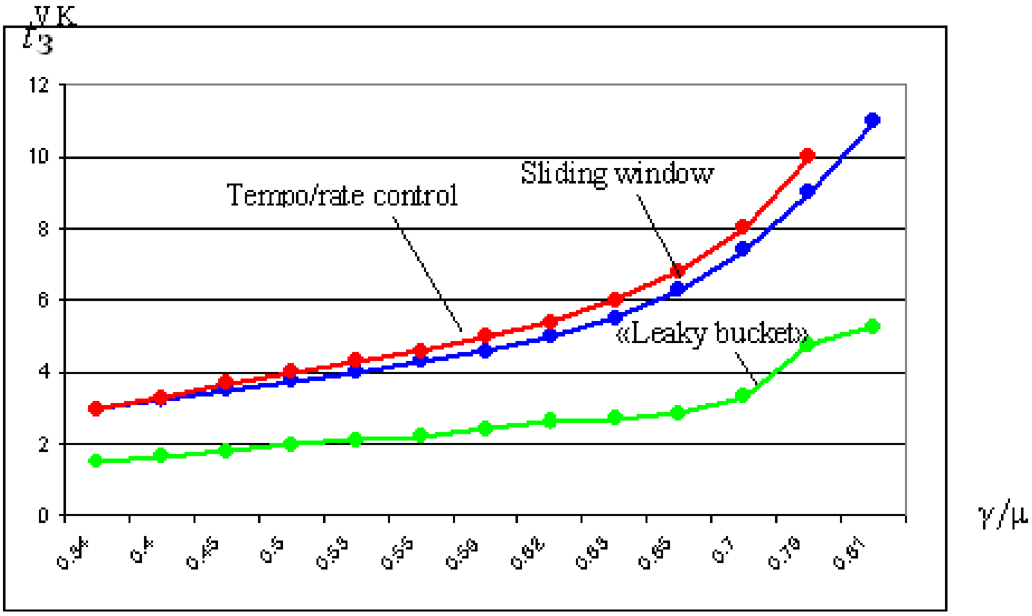


Figure.7 – Comparison of mechanisms to coordinate velocities in CC

In each port CC is an interface containing the "leaky bucket", that is the ultimate inner part of the port. If a packet arrives at the port when the queue is full, the packet is ignored. Such an interface can be implemented in both hardware and software.

The delay time of the request (packet) in the QS, this describes the mechanism of “leaky bucket”:

$$t_3^{VC} = \frac{1}{\mu(1-\rho)} \quad (3)$$

Where, $\mu$ – performance of the port;

$\rho$ – Port loading indicator.

Comparison of all the presented mechanisms is shown in figure. 7.

## 3. Results of study

The results show that the mechanism of "leaky bucket" is more effective and has less delay than the others that mentioned above, and this explains the popularity of the application of this mechanism to harmonize rates across heterogeneous networks of centers of conjugation.

## 4. Conclusions

1. Analytical model to describe the mechanisms for moving a window, control the rate of transmission and "leaky bucket", which can be used to reconcile velocities of inhomogeneous networks, interacting through the center of conjugation CC;
2. As a result of the analysis of the effectiveness of the above mechanisms to obtain results that speak in favor of the mechanism of "leaky bucket", which explains the popularity of this mechanism.

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