Demonstrating the Effect of the Fragmentation Process Regarding Selecting an Optimal Route

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Abstract – **The heterogeneous nature of the Internet communications is transparent for the end user. The leading position in the system of the users' criteria is given to the access speed characteristics. The evolution in the communication technologies presents the problem of the adequate choice of metrics for estimating the route and the corresponding routing algorithm as decisive factors for setting the real access speed parameters. One of the factors determining the transit delays is the presence of fragmentation and reassembly of the IP datagrams.**

Keywords - **Internet, IP, Fragmentation, Reassembly, Routing**

I. INTRODUCTION

The fragmentation and reassembly function ensures compatibility of different network architectures, connected in an internetwork when the different networks in a route supports different maximal datagram size. Fragmentation of an Internet datagram is required when it comes from a network that permits a large-sized packet but it should pass through a network that limits the package size in order to reach its destination. Although the IP protocol requires a gateway to fragment a packet if it is too large to be transmitted, it can lead to poor performance or complete communication failure. [1]

The modern IP routing protocols aimed to select the best path for the user's datagrams, but in their implementations are not taken to consider the additional delays, caused by the process of fragmentation and reassembly. The term "best path" is given different mean in the various routing protocols, but in the end the ultimate goal is to minimize the overall delay for the user's packet.

Different routing protocols use various criteria to measure the routes and to select the best path, these criteria are called "metrics". After all we can define two basic types of routing protocols:

– *hop-based metric routing protocols* – the criteria for choosing a better route is actually the number of hops, or routers to be passed between the source and the destination. These protocols are quiet simple, but they do not always select the fastest path. In other words their criterion for a better path is actually the shortest path. The most common member of this class is RIP (Routing Information Protocol) [2], developed by Xerox in 1970 and is still widely used in many networks.

– *delay-based metric routing protocols* – their criteria for choosing a better path is often a combination of a different factors, like bandwidth or delay of the links, but in the end they tend to choose the fastest path. These protocols are often more sophisticated than the previous ones, but their decision is closer to the user's criteria for a better route. Typical members of this class are OSPF (Open Shortest Path First), described in [3], and the Cisco's EIGRP (Enhanced Interior Gateway Routing Protocol) [4].

The metrics of both types of routing protocols do not account for the necessity of datagrams' fragmentation in the route chosen by them, therefore, the route is set without taking into considerastion the time delay caused by that process while the data is being transmitted.

The present study aims at proposing a method for modification of the existing routing protocols to the effect that they should take into consideration the process of data fragmentation when the optimal route is fixed.

II. EXPERIMENTAL SETTINGS AND RESULTS

Two experimental settings are chosen for the purposes of the present study. Each of them aims at demonstrating the differences between the time delays of the users' packets along the route chosen by the routing protocol that does not account for the process of fragmentation and reassembly of the packets and the better route that could be chosen if that process is taken into consideration. The routers used are Cisco 2501. All the described experiments are conducted sending 1000 packets with the size of 1500 bytes, which is usual for the Ethernet networks. The packets are sent and the time for each packet's transition to its destination and its way back to the source is measured. That is performed by a specially written C-language program, running on the first host.

Some of the packets (about 1 in 40) showed times that deviated significantly from the average result. Those are the packets that are detained by the router when its routing table is being actualized. Being a process of different nature, not related to the aims of the present study, these data are ignored.

For both the experimental settings are conducted experiments with three of the most frequently used in Internet routing protocols - RIP, EIGRP and OSPF. The first one belongs to the hop-based metric type; the other ones are delay-based metrics type.

The first experiment is presented on fig. 1. Two computers are connected with the corresponding router via 10 Mbit/s Ethernet interface. There are serial links with the speed of 4 Mbit/s between the routers. The maximum transmission unit (MTU) that can be transmitted through route 1 is 576 bytes – the official smaller MTU in Internet. Consequently, to pass along that route each packet of 1500 bytes will be separated in 3 smaller fragments. For route 2 the maximum size of the packet is 1500 bytes, which means that the packets will be transmitted unchanged.

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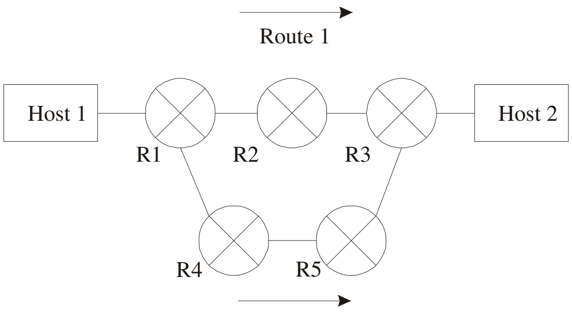

Fig. 1. Experiment 1.

For route 1 the packets pass through three routers and 2 serial lines with the speed of 4 Mbit/s each, for route 2 – they pass through 4 routers and three links with the speed of 4 Mbit/s.

Irrespective of the routing protocol the average values of the packets' transmission time are 30,8 ms for route 1 and 27,6 ms for route 2.

All the three routing protocols under examination select route 1. Actually that route would be the most convenient if there were no fragmentation/reassembly of the packets. The time delays, registered above, show that if they follow the route chosen by the protocol the user's packets will travel for a longer period of time which is determined by the additional delay caused by the process we are studying.

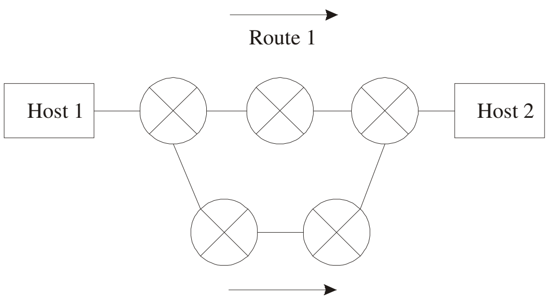

Fig. 2. Experiment 2.

The second experimental setting is shown on fig 2. There are serial connections at the speed of 2 Mbit/s and MTU = 1500 bytes by route 1 and another serial connections at the speed of 4 Mbit/s and MTU = 576 bytes by route 2. There should be no packets' fragmentation on the first route. However, fragmentation is expected on the second route.

The experiments show that the time delay on Route 1 is 41, 5 ms and on Route 2 it is 53,8 ms. The RIP protocol chooses route 1 but the other two protocols choose route 2 because they consider the speed of the linking lines. Route 2 would be the better choice if there were no processes of fragmentation/ reassembly of the packets.

The registered time delays indicate that if the user's packets follow the route chosen by the both protocols they will travel for a longer time, which is determined by the additional delay, caused by the process of fragmentation and reassembly.

III. Conclusions

The present paper aims at demonstrating that there are situations in which the current routing algorithms do not choose the best route for the users' packets because of the fact that they do not consider the time delays, generated by the process of fragmentation of the Internet packets. After estimating those time delays it is necessary to correct the algorithms used by the routing protocols so that they can select the best path. What the results show is that if these delays are taken into consideration the routing protocols could function more adequately to the operating Internet configurations. Since there are different types of routing protocols that use different metrics for setting the optimal route to the receiver of the message, the correction in the different protocols should have different value and dimension.

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