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A UDP-Based Protocol for improving packets loss in unstable networks

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ABSTRACT

With the rapid development of network, multimedia is largely applied in several areas, and it needs high bandwidth for network to transmit multimedia. At present UDP is always applied as lower layer for transmitting multimedia because it has high-speed transfer rate. However, UDP loses more packets under the condition of insufficient network bandwidth. Therefore in this paper we add the controller to improve the UDP. The proposed protocol maintains the high-speed transfer rate, and solves the problem of packets loss. We demonstrate that the proposed protocol is more efficient than traditional UDP by NS-2.

Keyword: UDP, wireless network, traffic control

1. INTRODUCTION

With the rapid development of network, multimedia is largely applied in several areas, User Datagram Protocol (UDP) [1] and Transmission Control Protocol (TCP) [2] are two well-known protocols of Transport Layer. UDP is standardized by IETF RFC 768, and its concept is different from TCP. UDP uses a simple connectionless transmission model with a minimum requirement of protocol mechanism. It has no handshaking dialogues, and thus exposes unreliability of the underlying network protocol to the user's program. There is no guarantee of delivery, ordering, or duplicate protection, though UDP provides checksum for data integrity, and port numbers for addressing different functions at the source and destination of the datagram.

Overall, UDP is an efficient protocol for transferring in the network condition of sufficient bandwidth. However, UDP cannot transmit efficiently in the unstable network such as wireless network.

Thus, in this paper we propose a new UDP variant, which is called "Adaptive Network Rate Adjustable UDP (ANRA-UDP)", and is based on UDP to control the traffic. We conduct the simulation under a low bandwidth network environment, and demonstrate the mechanism can decrease the rate of packet loss.

2. METHODOLOGY

The packets loss probability of UDP is increased when the bandwidth is insufficient, especially in wireless network. We propose the mechanism based on UDP to decrease the rate of packet loss, and show the mechanism as follows.

1. We define some terms: standard_rate, send_rate, and recv_rate which will be used in our mechanism.
   (a) standard_rate: The transmission rate, when application layer transmits packet to the next lower layer, and the transmission rate is recorded in the field of packet header.
   (b) limit_rate: The limit_rate is upper bound of send_rate, and it is less than or equal to standard_rate in the field of packet header.
   (c) send_rate: The transmission rate of packet in senders, and it is recorded in the field of packet header.
   (d) recv_rate: The receive rate of packet in receivers.
2. Deceleration mechanism : When recv_rate is lower than send_rate, we suggest that the network bandwidth may be insufficient, therefore receivers will return ACK, and limit_rate will be assigned to $\text{recv\_rate} + \frac{\text{send\_rate} - \text{recv\_rate}}{2}$.
3. Acceleration mechanism : When recv_rate is equal to send_rate, it is sufficient for network bandwidth to transmit packets. However, it is ineligible for the demand of the application layer on the condition that send_rate is less than standard_rate.

   The mechanism will assign $\text{send\_rate} + \frac{\text{stand\_rate} - \text{send\_rate}}{2}$ to limit_rate.
4. When recv_rate is equal to send_rate, it is sufficient for network bandwidth to transmit packets. On this condition, if send_rate is equal to stardard_rate, the mechanism stands aside. Because standard_rate is the transmission rate application layer transmits packet to the next lower layer, it is not influence for more and more packet transmission that the mechanism increase the send_rate beyond the standard_rate, and then send_rate is different from recv_rate after that. Network bandwidth is irrelevant to inequality between send_rate and recv_rate.

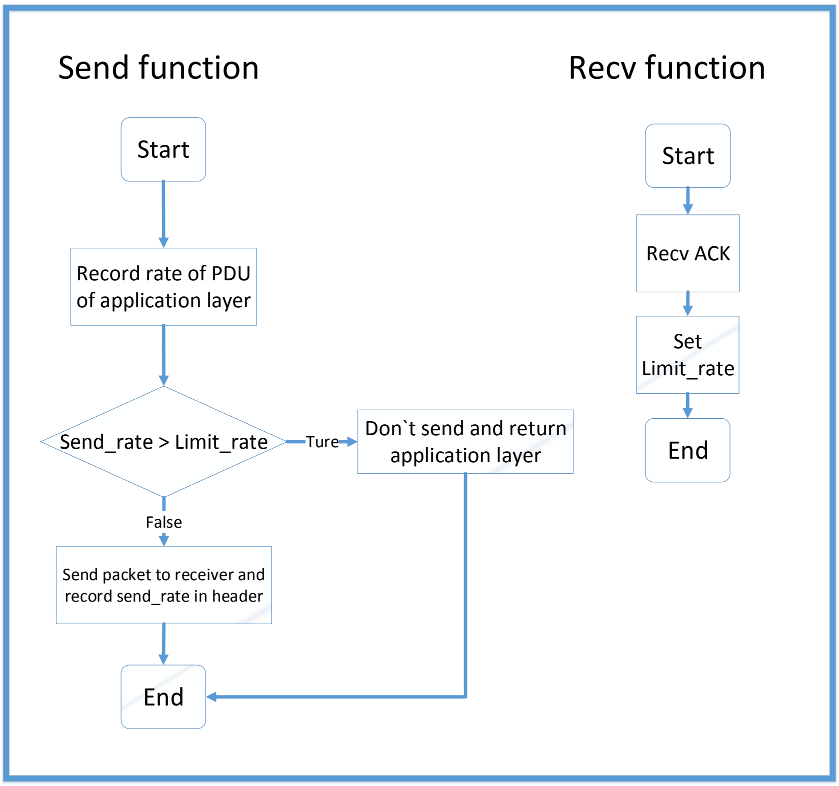

Figure 1. Control flow of Sender

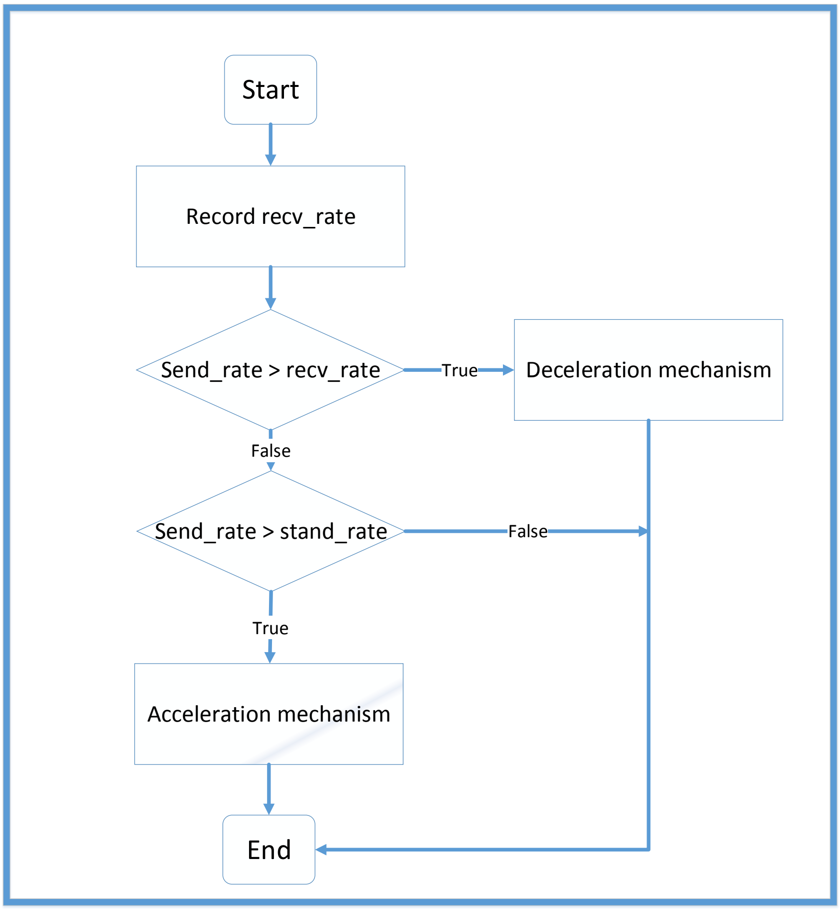

Figure 2. Control flow of receiver

3. DISCUSSION

The simulation is conducted by NS-2(The Network Simulator) [3]. We design three scenarios for experiments and demonstrate the results using UDP and ANRA-UDP as follows.

(a) Scenario 1: Fig.3 shows the first scenario. The bandwidth of the path that connects source to router A is 2.0M, delay is 20ms. The bandwidth of the path that connect router A to router B is 1.7M, delay is 20ms. The bandwidth of the path that connects router B to the destination is 2.0M, delay is 20ms. The size of queue in router is 10 packets.

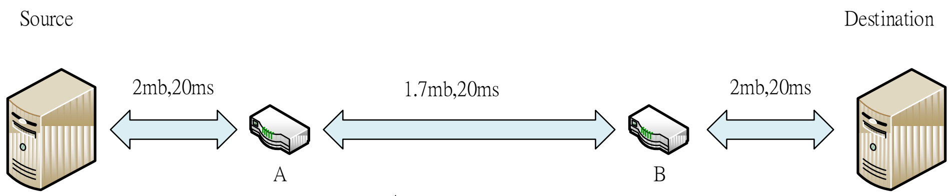

Figure 3. 1st Scenario of simulation

The Fig.4 shows the result of that the source sends packets to the destination with UDP, and the CBR (Constant Bit Rate) is 2MB/s in the first simulation scenario. In the following figures, "send throughput" stands for the send_rate of the source, and "receive throughput" stands for receive_rate of the destination. The send rate of sender equals to the receive rate of receiver under the condition that network bandwidth is sufficient. However, send rate of sender is greater than the receive rate of receiver in the first scenario, and packet loss occurs in the first scenario obviously.

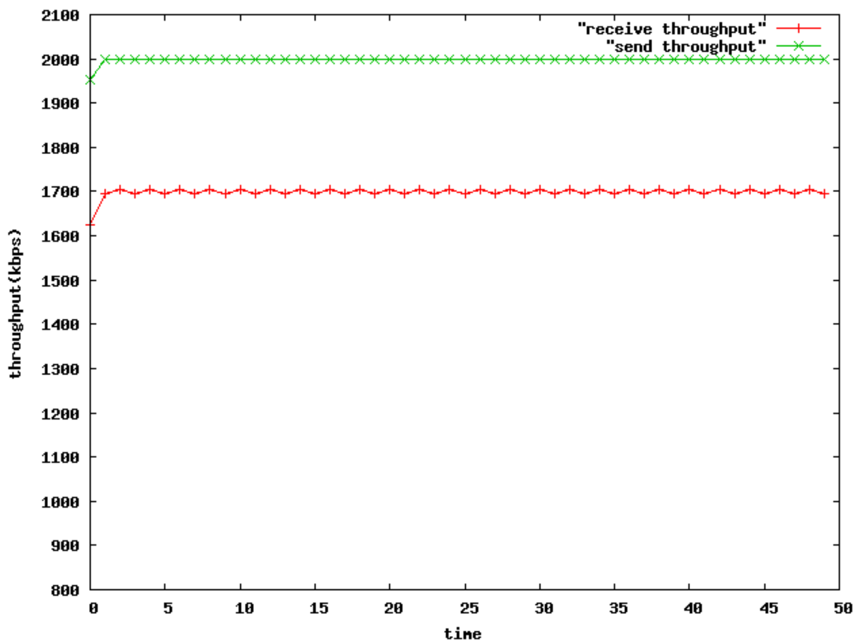

Figure 4. 1st Scenario using UDP

The Fig.5 shows the result of that the source sends packets to the destination with ANRA-UDP, and the CBR is 2MB/s in the first simulation scenario. The send rate of ANRA-UDP is close to the receive rate of ANRA-UDP in comparison to UDP. We compare the packet loss rates of UDP and ARNA-UDP in Table 1, and the table shows that the packet loss rate of ANRA-UDP is lower than that of UDP. We demonstrate that ANRA-UDP can adjust tranfer rate according to network speed.

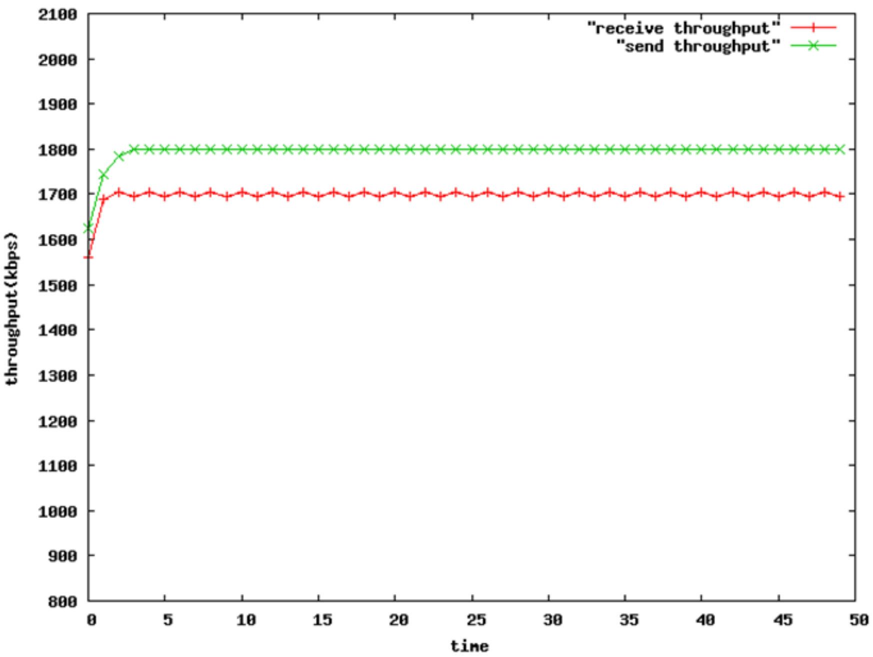

Figure 5. 1st Scenario using ANRA-UDP

Table 1. Packet loss rate in 1st Scenario

	Total packet	Loss packet	Packet loss rate
UDP	12501	1867	14.93%
ANRA-UDP	11224	600	5.34%

(b) Scenario 2: Fig.6 shows the second scenario. The bandwidth of the path between the source and router A is 2.0M, delay is 20ms. The bandwidth of the path between router A and router B is 1.0M, delay is 20ms. The bandwidth of the path between router B and the destination is 2.0M, delay is 20ms. The size of queue in router is 10 packets.

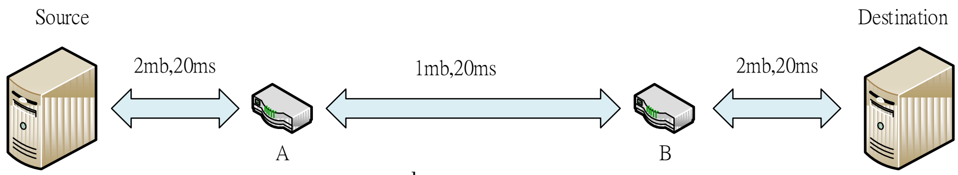

Figure 6. 2nd Scenario of simulation

The network bandwidth of the second scenario is the most insufficient among all given scenario in this paper. The Fig.7 shows the result that the source sends packets to the destination with UDP, and the CBR is 2MB/s in the second simulation scenario. The Fig.8 shows the result of that the source sends packets to the destination with ANRA-UDP. We demonstrate that ANRA-UDP can adjust send rate of sender in the network condition of insufficient bandwidth. We compare the packet loss rates of UDP and ARNA-UDP in Table 2.

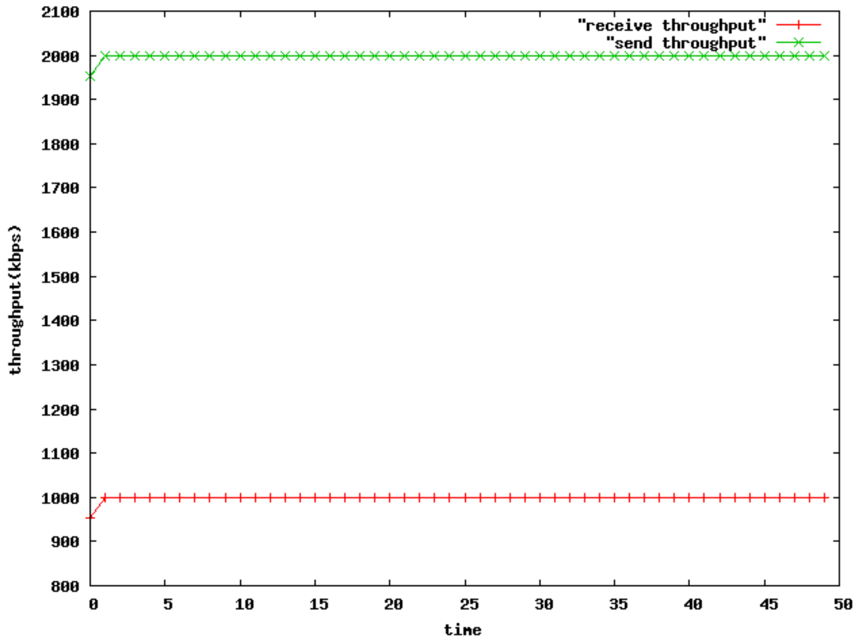

Figure 7. 2nd Scenario using UDP

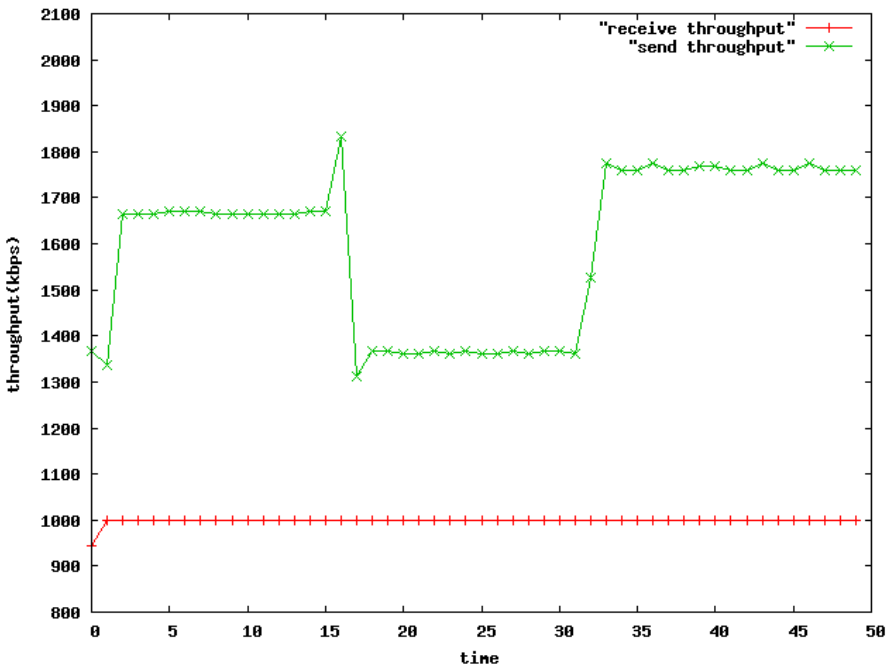

Figure 8. 2nd Scenario using ANRA-UDP

Table 2. Router to Destination (rate : 1.0 MB/s)

	Total packet	Loss packet	Packet loss rate
UDP	12501	6242	49.93%
ANRA-UDP	9983	3724	37.30%

(c) Scenario 3: Fig.9 shows the third scenario. The bandwidth of the paths between two sources and router A is 1.0M, delay is 10ms, respectively. The bandwidth of the path between router A and router B is 1.7M, delay is 20ms. The bandwidth of the path between router B and the destination is 2.0M, delay is 20ms. The size of queue in router is 10 packets.

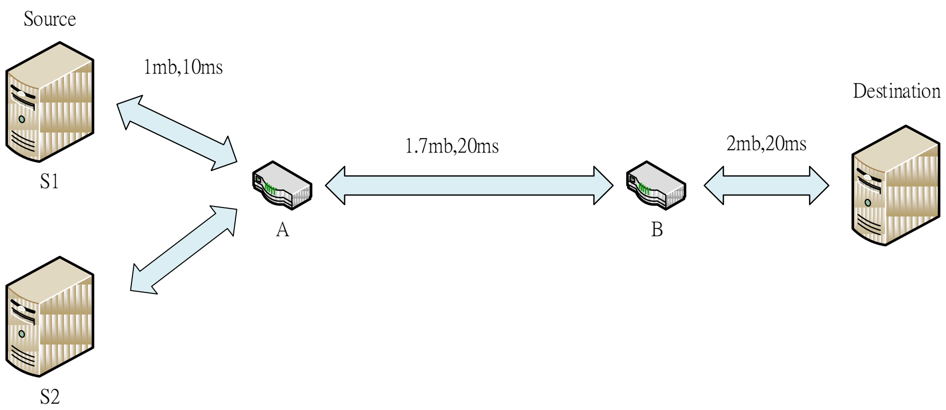

Figure 9. 3rd Scenario of simulation

The Fig.10 shows the result of that source S1 sends packets to the destination with TCP, and source S2 sends packets to the destination with UDP, and the CBR is 1MB/s in this scenario. In Fig.10, where “tcp_throughput” stands for receive rate of the destination from source S1, and “udp_throughput” stands for receive rate of the destination from source S2. The Fig.11 shows the result of that source S1 sends packets to the destination with TCP, and source S2 sends packets to the destination with ANRA-UDP, and the CBR is 1MB/s in this scenario. Note that, “anra_udp_throughput” stands for receive rate of the destination from source S2 in Fig.11. Because UDP do not have Congestion Control mechansim under the condition that UDP and TCP transferring data simultaneously, UDP occupies more bandwidth. We demonstrate ANRA-UDP is a more fair protocol in comparison with UDP.

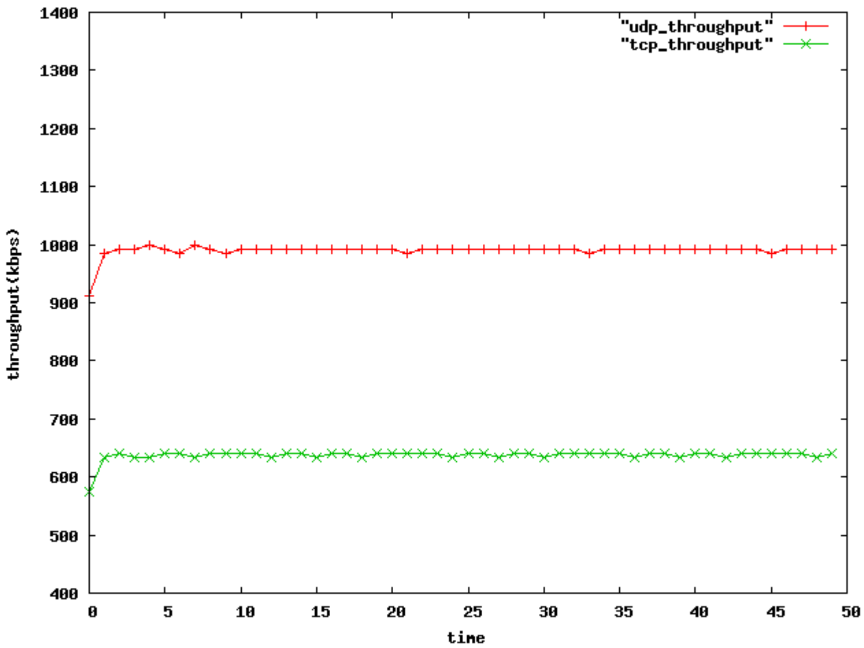

Figure 10. 3rd Scenario using TCP and UDP

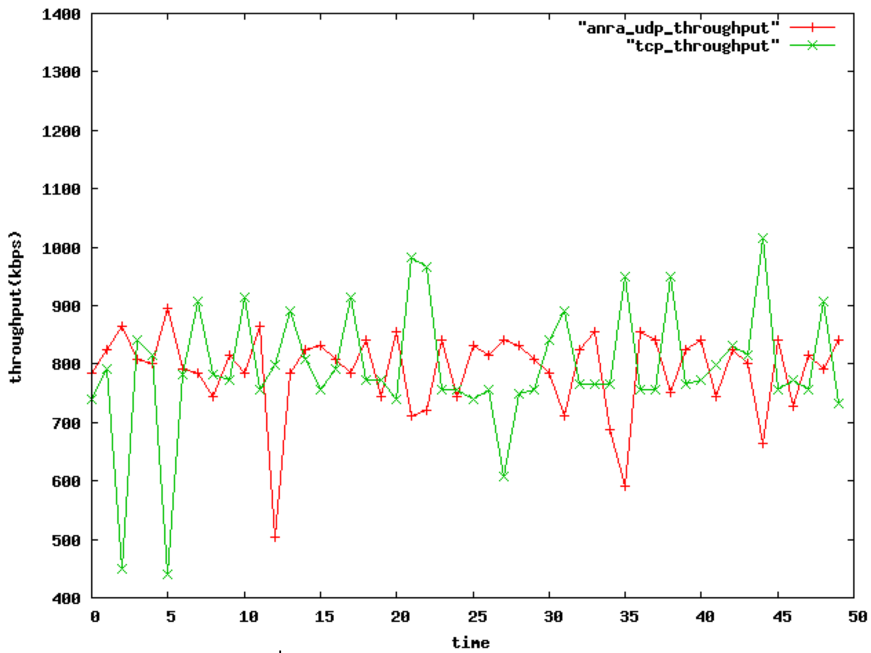

Figure 11. 3rd Scenario using TCP and ANRA-UDP

From above figures and tables, we demonstrate that the purposed method can improve the performance of UDP protocol and decrease the packet loss rate.

4. CONCLUSION

In this paper, we analyze the pros and cons of different protocols in different network conditions. The proposed protocol ANRA-UDP can aptly adjust the network speed but UDP not. ANRA-UDP is more effective than UDP in the condition of insufficient bandwidth. Finally, we demonstrate that ANRA-UDP is better than UDP in the network condition of insufficient bandwidth.

5. ACKNOWLEDGMENT

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