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PROPOSED ALGORITHM FOR TCP/IP TRAFFIC OVER ATM NETWORK

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ABSTRACT - In this work, a suggested algorithm is designed that operates at ATM Adaptation Layer (AAL) layer, this algorithm is named Adding Identification number and Matching (AIDM) algorithm. The resulting transport protocol from using AIDM algorithm is named as Improved TCP/IP Reno. AIDM is an efficient recovering technique that attempts to make TCP\IP Reno performance less sensitive to cell losses. Improve TCP/IP Reno is presented and a result is compared with other TCP\IP Reno .This result explain the network performance is enhanced about 20.53 % as average of the enhancement rates of the given samples and the period of time required to recover the damaged cell is reduce .

***Keywords*:-** ATM network , TCP/IP Reno protocol , ATM Layers , Network traffic

1.INTRODUCTION

The popularity of Transmission Control Protocol/Internet Protocol (TCP/IP) coupled with the premise of high speed communication using Asynchronous Transfer Mode (ATM) technology have prompted the network research community to propose a number of techniques to adapt TCP/IP to ATM network environments. ATM offers Available Bit Rate (ABR) and Unspecified Bit Rate (UBR) services for best effort traffic, such as conventional file transfer. However, recent studies have shown that TCP/IP, when implemented using ABR or UBR, leads to serious performance degradations, especially when the utilization of network resources (such as switch buffers) is high. Proposed techniques for switch-level enhancements, which attempt to patch up TCP/IP over ATMs have had limited success in alleviating this problem. [1,2,3]

1-1. TCP/IP Reno

TCP/IP Reno is the most widespread variant of TCP/IP currently. It is derived from the original version of TCP/IP. The TCP/IP stack in Solaris, Linux and Windows is a variant of TCP/IP Reno. TCP/IP Reno uses two key techniques for congestion management. One is slow-start and the other is congestion avoidance .(4)

- **Slow Start: -** Slow start is the mechanism which is used when a TCP/IP session is started. Instead of starting transmission at a fixed rate, the transmission is started at the lowest rate possible and doubled. The rate of doubling is tied to the rate at which acknowledgments come back; thus, the rate is doubled every round trip time. If congestion is detected, the transmission rate is reduced to half of what it is currently and the congestion avoidance process starts. The rate doubling and reduction is nothing but a binary search for the 'right' transmission bandwidth .(5)
- **Congestion avoidance: -** The congestion avoidance algorithm starts where slow start stops. The TCP/IP increases its transmission rate linearly, by adding one additional packet to its window each transmission time. If congestion is detected at any point, the TCP/IP reduces its transmission rate to half the previous value. Thus the TCP/IP seesaws its way to the right transmission rate. Clearly, the scheme is less aggressive than the slow-start phase (note the linear increase against the exponential growth in slow start) .(5)

1-2. ATM Concept

Asynchronous Transfer Mode (ATM) is a switching and multiplexing technology that employs small, fixed-length cells to very quickly and efficiently move all types of traffic. ATM is fast and efficient because its cells fit into spaces too small for larger packets or frames, traffic routes are preplanned, switching is done without the need for time-consuming software, and payload error checking and correction is performed only at the destination node, not at every hop along the way.(6,7)

In this work at TCP/IP Reno over ATM network, the ATM Adaptation Layer (AAL) does its job as an interface between Internet Protocol (IP) layer and ATM layer through performing the Segmentation and reassembly of IP datagram (packet). Segmentation occurs at the sender, where packets are divided into M cells and pass them to lower ATM layer to transmit them to the destination. Reassembly occurs at the receiver to reconstruct a packet by grouping received cells together and if any cell is damaged, this packet will be discarded and ask sender to retransmit that packet .(8,9)

2. PROPOSED ALGORITHM

Proposed algorithm is named as "Adding Identification number and Matching" (AIDM) algorithm. This algorithm makes a minor modification on AAL layer, where AAL layer operates as an interface between IP layer and ATM layer. The transport protocol uses AIDM algorithm named as Improved TCP/IP Reno.

This algorithm is designed to reduce effects of cell loses on the TCP/IP performance and works at the ALL layer and its essential job is to reduce side effect of fragmentation. AIDM is a technique that adds minimal redundancy to each cell. The reason for this addition is to guarantee timeliness and fault-tolerance up to good degree of confidence in spite of cell losses. To explain how AIDM works, suppose there is a packet P of a data object has to be transmitted, and P consists of M cells. By using AIDM algorithm, packet P is divided into M fixed size cells and ID number is added for each cell. The resulting N cells are stored at sender's buffer to be used for recovering purposes if any cell is damaged through transmission process. Now resulting cells are ready for transmission through ATM network. At receiver side, the first/last ID number is used to create matching pattern named as Actual Pattern (AP). And another pattern is made from ID number that is extracted from the received cells; this matching pattern is named Extracted Pattern (EP). If any cells are damaged the receiver will discover that by matching the AP pattern with EP.

After matching, the damaged cells are discovered then the sender is asked to retransmit those damaged cells only. When the sender receives negative acknowledge with ID numbers of damaged cells, it looks for these cells in its buffer to retransmit them to the destination. Figure (1) shows the flowchart of segmentation and reconstruction operations of AIDM algorithm.

2-1. AIDM Characteristics

When a cell is damaged in route, the receiver could not perform the reconstruction process for the packet to which that cell belonged, unless the damaged cell which belongs to that packet is retransmitted, AIDM is designed to do that,so AIDM has the advantage of being effective in terms of its use of available bandwidth, but may result in considerable overhead, especially when the level of fragmentation (i.e. number of cells per packet) is high. In comparison with recent protocol such as TCP/IP Reno the receiver does nothing just discards the received cells which belong to that packet and waits for the sender to automatically retransmit all cells of that packet, so recent approach is not effective in term of its use of available bandwidth especially in multi-hop networks, but it also has the advantage of being quite simple to implement since it doesn't require additional functionality at the sender and receiver ends.

To explain how AIDM is incorporated in a TCP/IP protocol over ATM network , let us consider the following scenario. The sender divides the packet into M cells, and then adds ID number at the beginning of payload field for each cell. The resulting N cells are stored at the sender's buffer for recovering purpose. The packet of that N-cell is transmitted to the receiver. Now, assume that the receiver gets R of these cells.

If R = N, then the receiver does nothing but remove ID numbers from received cells and reconstruct original packet, and then acknowledge that it has completely received that packet by informing sender that it needs no more cells from that packet. The sender will respond to that positive acknowledge by clearing its buffer and work on next packet.

If R < N, that means (N – R) cells were damaged, so the receiver acknowledges that it has partially received that packet by informing sender that there is need for more (N – R) cells from the original packet and those cells have the following ID numbers, then it sends ID numbers of the missed cells. To that negative acknowledge, the sender will respond by looking for missed (N – R) cells in its buffer, and then retransmitting these cells. The process continues until the receiver receives the damaged cells to be able to reconstruct the original packet.

The incorporation of AIDM algorithm into TCP/IP over ATMs protocol requires only additional functionality at the interface between the IP and ATM layers, where the ATM adaptation layer (ALL) represents that interface. So when AIDM algorithm is used, there is no bandwidth is wasted as a result of packet retransmission or partial packet delivery, and there is no modification necessary to the switch-level protocols.

The Improved TCP/IP Reno is the transport protocol that combines the reliability of TCP/IP with the high speed and flexibility of ATM. In addition, the improved protocol applies AIDM algorithm to its ALL layer, so it has the ability to overcome fragmentation problem and to produce a high performance gain especially when it is deployed over ATM networks .The main functions included in the improved TCP/IP Reno are :-

A. Session Management: The Improved TCP/IP Reno protocol as other recent protocols manages this session in three phases:

1. Connection establishment phase.
2. Data transfer phase.

3. Termination phase.

The roles that are played by these phases are similar to that of corresponding phases that are applied to other implementations of TCP/IP over ATM, except that information specific to AIDM which is required by the receiver for reconstruction purposes are transmitted to the receiver at the connection establishment phase. That needed information includes the number of cells in a packet (N) and first/last ID number that is added to these cells.

B. Packet Management: It has four main processes :-

1. Packet segmentation (at the source).
2. Adding ID number (at the source).
3. Extracting and matching ID number (at the destination).
4. Packet reconstruction (at the destination).

C. Flow Control and Transmission: Flow control determines the dynamics of packet flow in the network, which in turn affects the end-to-end performance of the system. When an Acknowledgment (ACK) arrives, the sender will check that ACK to see if it means that the reconstruction process of the packet is completed successfully or not, if it does the sender will clear its buffer to be ready for next packet transmission. If it doesn't, the sender extracts from the ACK the ID number of damaged cells, then looks for these cells in its buffer and retransmits them at the next retransmission time.

The main objective of this work is to reduce side effect of cell damaged, and turn fragmentation into an advantage for TCP/IP, thus enhancing the performance of TCP/IP in general and its performance in ATM environments in particular. In Figures (2 and 3) the flowcharts of sender and receiver are illustrated, respectively, where they apply Improved TCP/IP Reno.

3. EXPERIMENTAL RESULTS

In this section the TCP/IP Reno and Improved TCP/IP Reno are tested by applied to perform conventional file transfer. It can be used also to compare TCP/IP Reno and Improved TCP/IP Reno in throughput, speed, and their sensitivity for cell losses in the same environment and for the same file with the same number of cells damaged, where these cells are distributed between determined numbers of packet.

The procedure that is performed in this test is repeated about 15 times to compute the standard deviation of these results as shown in Table (1), where the standard deviation is approximately 0.004 when Improved TCP/IP Reno is applied, and it is about 0.005 when

TCP/IP Reno is applied. Those values of the standard deviation are acceptable. Throughput can be computed by dividing the size of file over the required time to transfer that file.

AIDM algorithm was designed to reduce effects of cell losses on the TCP/IP performance. This algorithm works at the AAL layer and its essential function is to reduce the side effect of fragmentation. therefore, the following two cases are taken to get result and are discussed as follows:

- **Case 1**

In this case, file of size 59277 bytes is chosen to be transferred from client to server. Eight samples are taken, where the number of damaged cells ranged between the following values (0, 10, 20, 40, 65, 85, 105, and 150) and all that distortions happened in one packet. Figure (4) shows how throughput changes when cells loss increases in one packet. Figure (5) shows how required time for transmission changes when cells loss increases in one packet. Figure (6) shows how enhancement rate changes when cells loss increases in one packet.

- **Case 2**

In this case, the same file that was selected in case 1 is chosen again with the same value of cells destroyed, but these destroyed cells are distributed between four packets. Figures (7), (8) and (9) show the throughput, time, and enhancement rate, respectively.

From this two case we see when the Improved TCP/IP Reno protocol is applied the throughput decreases as the number of cells loss increases, but throughput sensitivity for cell losses is lower than its sensitivity when TCP/IP Reno is applied as shown in Figure (4) and (7).

Also, when there is no cell loss the throughput of TCP/IP Reno is better than that of proposed protocol, the reason for that disadvantage is due to the ID number that is added to each cell, where that numbers are not used in this case because there is no error. This case is regarded as ideal case and its probability of occurrence is low.

When the Improved TCP/IP Reno protocol is applied the required time to transfer the selected file with determined number of cells damaged is lower than what is required when TCP/IP Reno is applied, and that time increases as number of damaged cells increases, also the difference in time between proposed protocol and TCP/IP Reno is increased as the number of packet that has problem increases as shown in Figure (5) and (8).

Figure (6) and (9) show the enhancement rate of throughput and time, where that enhancement is made by Improved TCP/IP Reno that applies AIDM algorithm. Also, there is one disadvantage if and only if when no cell is damaged through the transmission process, where enhancement rate is -2 %.

Figure (10) shows the enhancement rate of four cases. We explain the enhancement rate will be increased when the number of packets that have problems increases too. So the enhancement rates can reach 38 % when damaged cells are distributed between four packets. The average of enhancement rate for these four cases is approximately equal to 20.53 %. In consequence, this can be regarded as a good improvement in the recent TCP/IP Reno protocol.

4. COMPARISON BETWEEN IMPROVED TCP/IP RENO AND TCP/IP RENO IN ANALYTICAL ENVIRONMENT

To perform this comparison the following parameters are supposed:-

1. The size of file to be transferred is 1 MB = 1048576 byte.
2. The size of a packet is 9180 byte.
3. The size of a cell is 53 byte.
4. The time required to transfer one cell is 0.5 microsecond.
5. Total number of packets in that file is 114 packets.
6. Total number of cells in a packet is 173 cells.

These parameters were used to extract results and show AIDM algorithm effect on time consumed, Let there be five damaged cells (the reasons for that distortion are not important, in this work, because the intention is about recovering the damaged cells).

Figure (11) shows comparison between these two protocols , when using Improve TCP/IP Reno and TCP/IP Reno ,the last cell from the first packet is transferred, the receiver checks the number of cells and finds there are five cells damaged. So, the receiver asks the sender to retransmit the damaged cells only. That is done by using Improve TCP/IP Reno . But when the TCP/IP Reno is applied the time required to recover damaged cells is longer than what was needed at Improved TCP/IP Reno, because the TCP/IP Reno when it was discovered the cells loss in the received packet, it would be discarded that packet and request is sent to sender to retransmit that packet, so longer interval of time is needed and link bandwidth is damaged.

This comparison shows that the proposed Improve TCP/IP is better than TCP/IP Reno, because its ability to accept incomplete packets (as opposed to counting such packets as lost ones) is likely to impact the flow control behavior by making it less sensitive to network congestion, and thus more aggressive in its use of network bandwidth. It brings an increased effective throughput, which in turn results in an overall increase in other performance categories, such as response time, retransmission rate, and cell loss rate.

5.CONCLUSIONS

The Improved TCP/IP Reno is better than TCP/IP Reno in throughput and time, because the average of this enhancement is about 20.53 %, the reason for this enhancement is due to its ability to recover damaged cells in a short interval of time .The transmitted cells that belong to the same packet are useful in spite of the damaged cells. This is due to the ability of AIDM algorithm to determine damaged cells and recover them by asking the sender to retransmit these cells only. The Improved TCP/IP Reno turn's ATM 53-bytes cell oriented switching architecture into an advantage for TCP/IP Reno. In other words, The Improved TCP/IP Reno overcomes fragmentation problem. The Improved TCP/IP Reno has one disadvantage which can be noted when no cell is damaged through transmission process. So its throughput in this case is lower than that of recent TCP/IP Reno by 2 %.

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Table (1): Standard deviation of time required to transfer selected file within the same conditions.

Test	Time required when using Improved TCP/IP Reno (sec)	Time required when using TCP/IP Reno (sec)
1	3.109	3.063
2	3.110	3.047
3	3.110	3.047
4	3.110	3.047
5	3.110	3.046
6	3.110	3.046
7	3.109	3.046
8	3.110	3.046
9	3.110	3.046
10	3.110	3.062
11	3.110	3.047
12	3.109	3.047
13	3.110	3.047
14	3.110	3.046
15	3.110	3.046
Average	3.111 second	3.049 second
Standard deviation	0.004	0.005

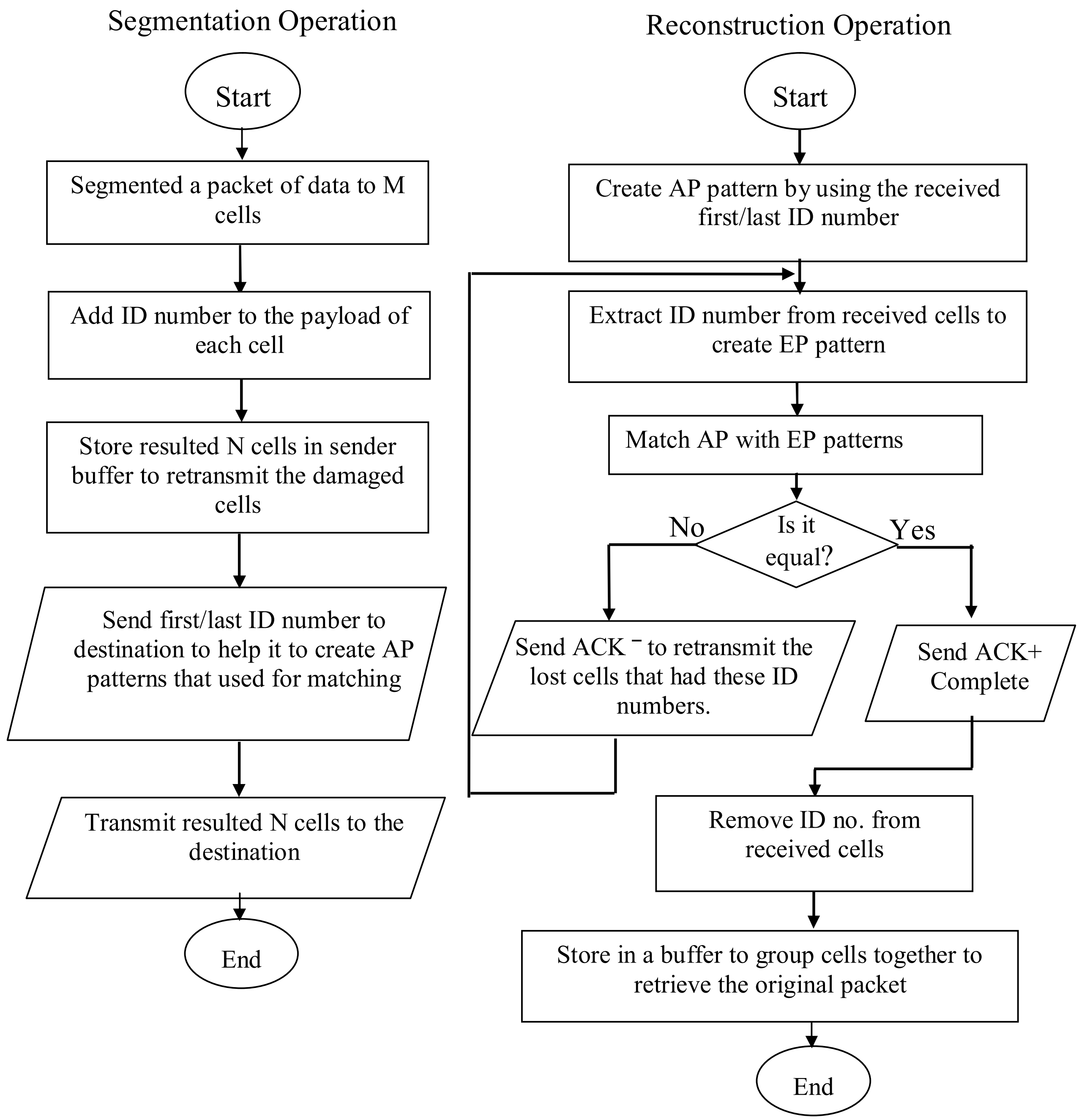

Fig. (1): The Segmentation and Reconstruction operations of AIDM algorithm.

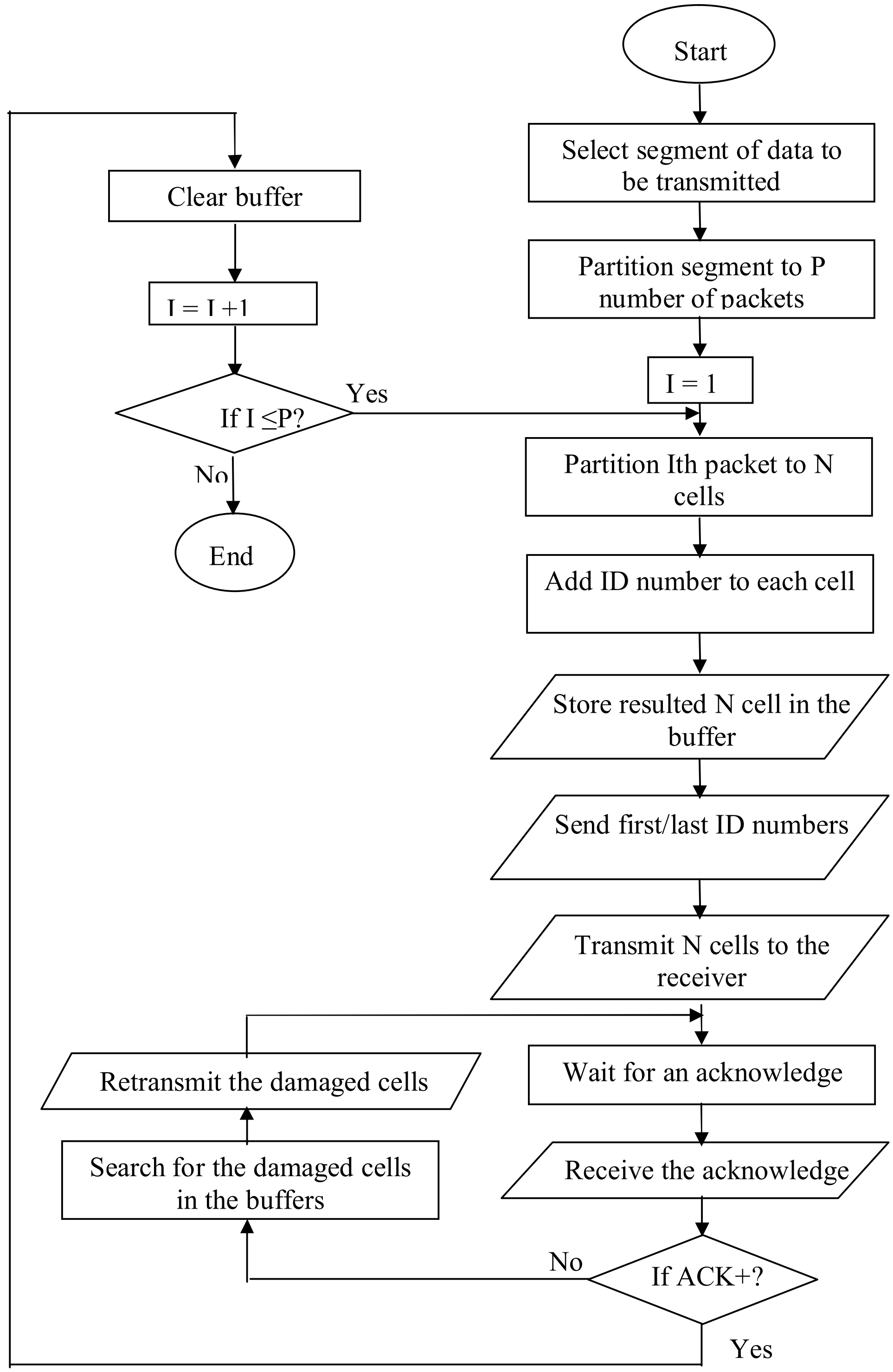

Fig. (2): The flow chart of sender, using improved TCP/IP Reno.

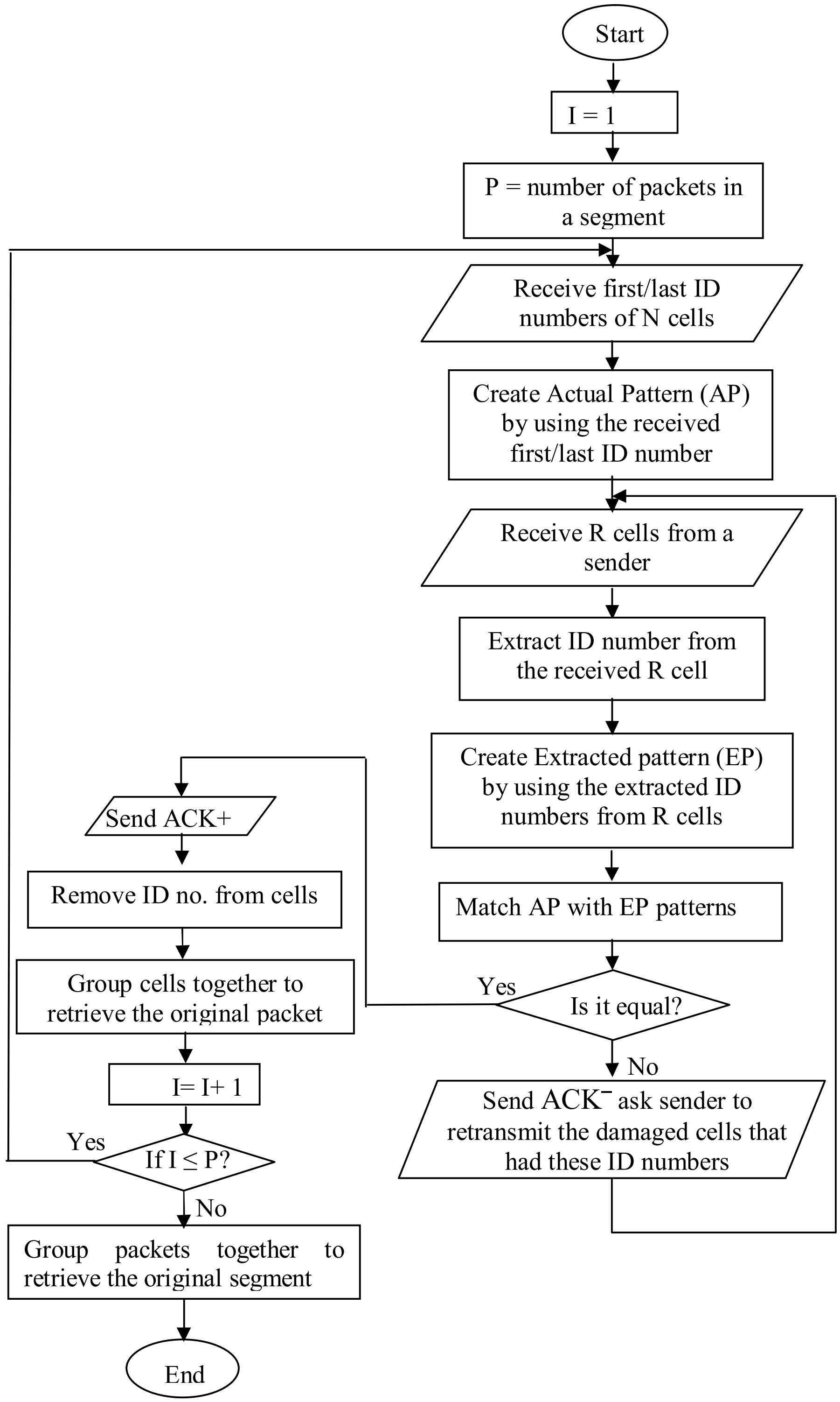

Fig. (3): The flow chart of receiver, using improved TCP/IP Reno.

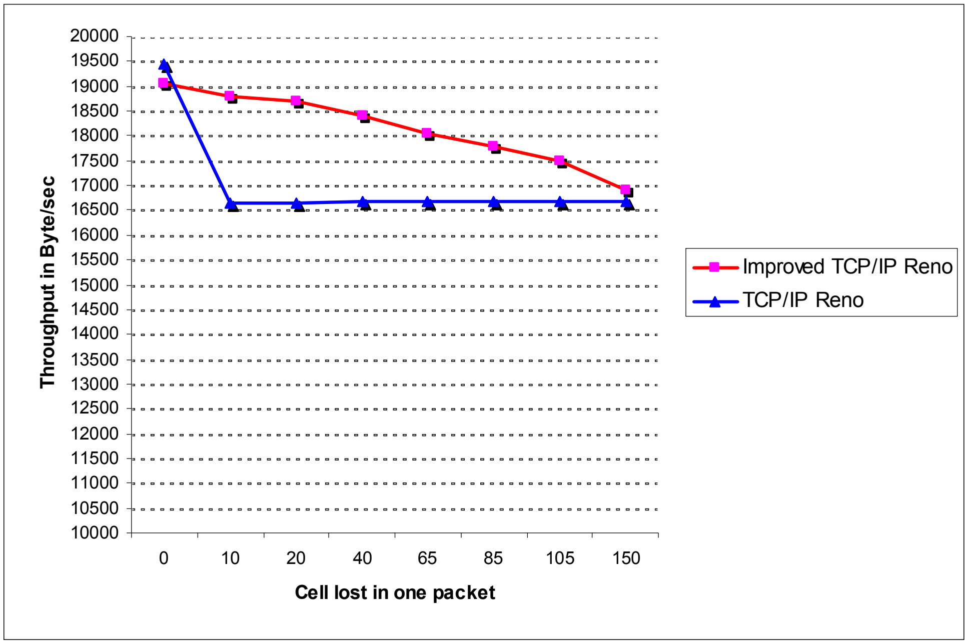

Fig. (4) : The throughput changes when cells loss increases in one packet.

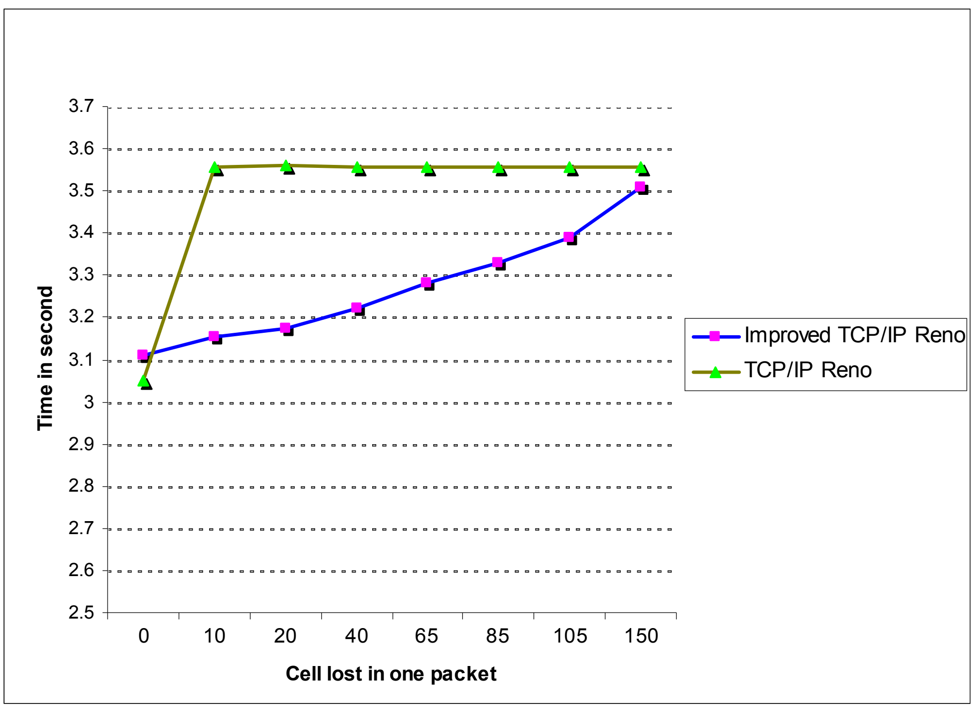

Fig. (5): The required time for transmission changes when cells loss increases in one packet.

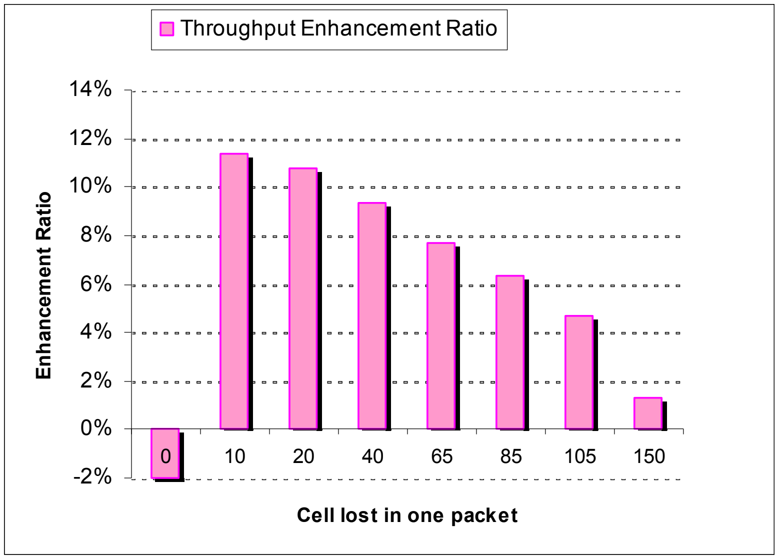

Fig. (6): The enhancement rate changes when cells loss increases in one packet.

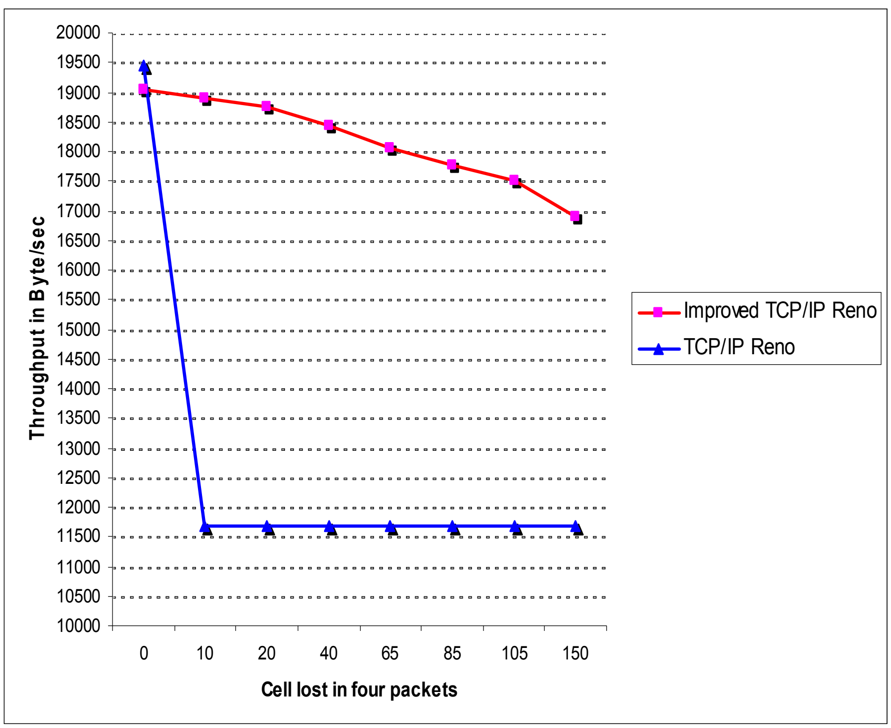

Fig.(7) : The throughput changes when cells loss increases in four packets.

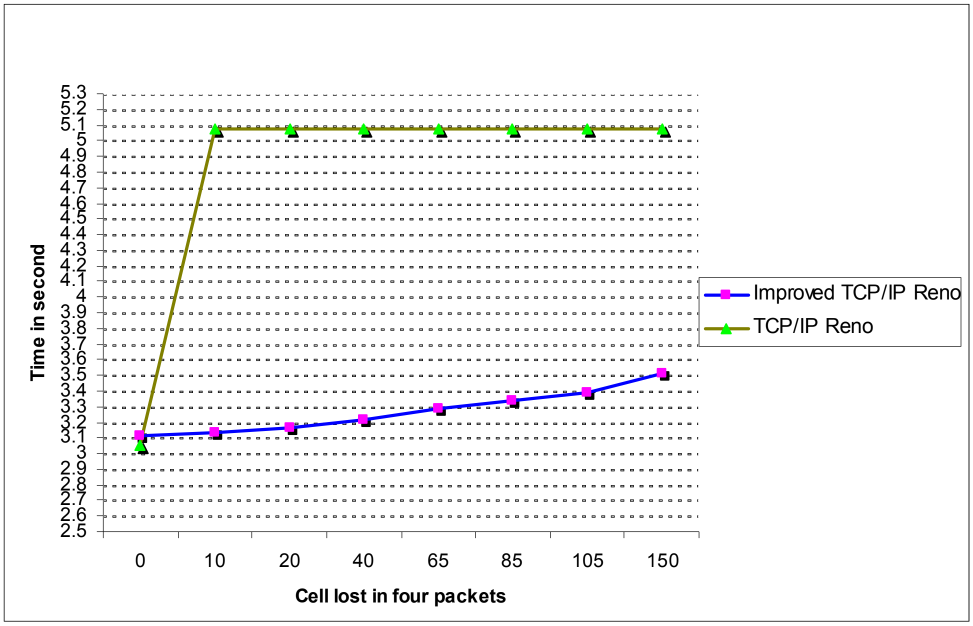

Fig. (8) : The required time for transmission changes when cells loss increases in four packets**.**

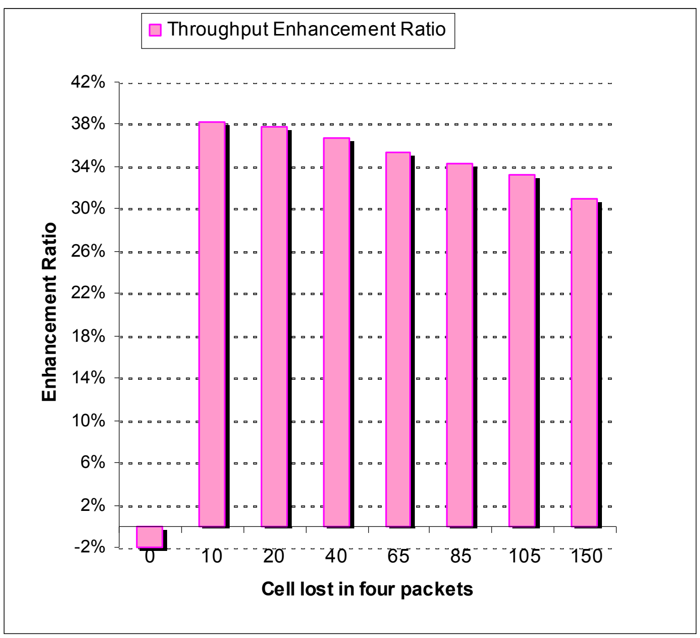

Fig. (9): The enhancement rate changes when cells loss increases in four packets.

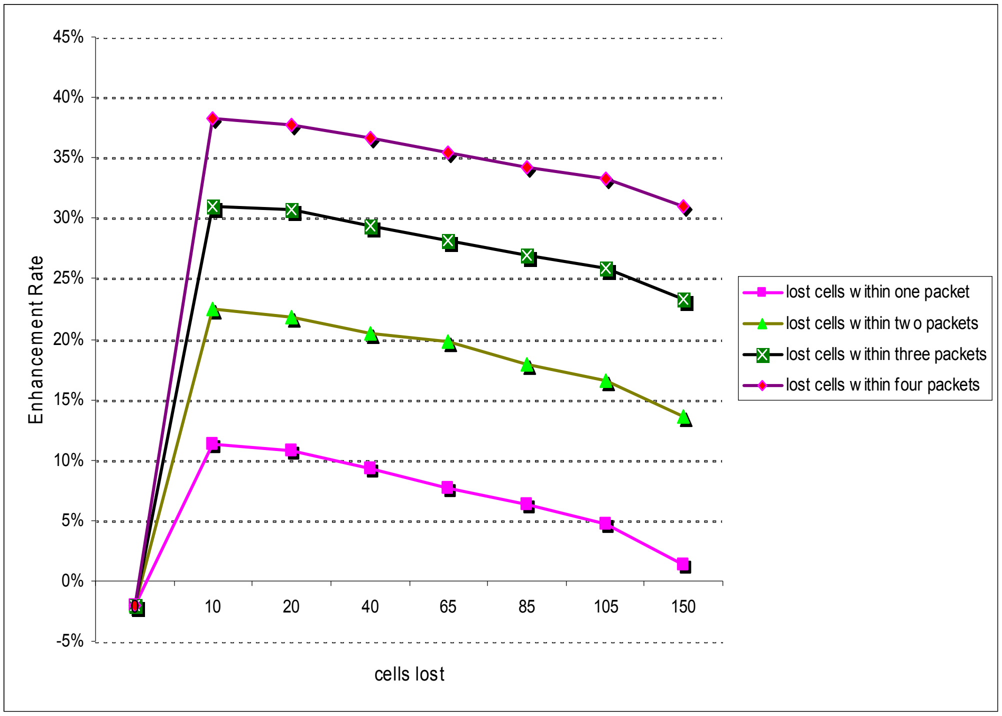

Fig. (10) : The enhancement rate changes when cells loss increases in one, two, three, and four packets.

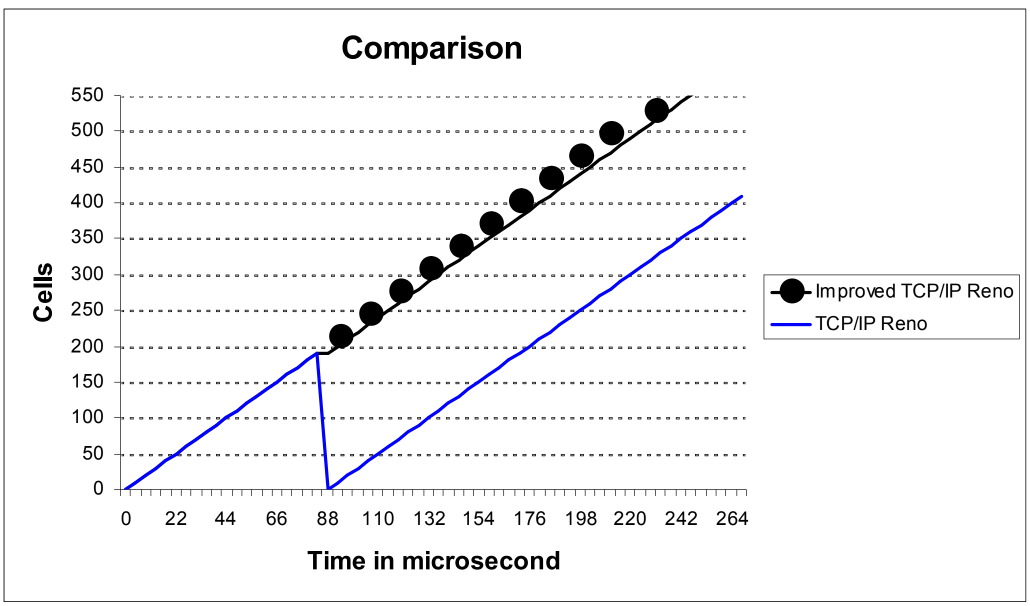

Fig. (11): Comparison between Improved TCP/IP Reno and TCP/IP Reno with respect to time.

خوارزمية مقترحة لبرتوكول سيطرة النقل(TCP) باستخدام شبكات نظام النقل غير المتزامن (ATM)

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الخلاصة

في هذا البحث تم الاعتماد على الموثوقية التي يتمتع بها البرتوكول (TCP/IP) ومن السرعة العالية التي تتميز بها شبكات (ATM) باقتراح برتوكول محسن (Improve TCP/IP Reno) والذي يدمج عمل (TCP/IP Reno) فوق (ATM) حيث يقوم بتحويل خلايا الشبكة (ATM) ذات ٥٣ بايت الى فوائد بالنسبة الى (TCP/IP Reno) والخوارزمية المستخدمة في هذا البحث هي خوارزمية اضافة ارقام التعريف والمطابقة (AIDM) وهي عملية استرجاع كفوئة تجعل الأداء الخاص بـــ (TCP/IP Reno) اقل حساسية لفقدان الخلايا, والنتائج التي تم الحصول عليها بينت ان نسبة تحسن أداء ال (Improve TCP/IP Reno) مقارنة الى اداء ال (TCP/IP Reno) السابق بنسبة ٢٠،٥٣ % .

الكلمات الدالة: ATM network , TCP/IP Reno protocol , ATM Layers , Network traffic .