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A Comparative Analysis of Transmission Control Protocol (TCP) for MANETs

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Abstract*—Mobile Ad-hoc Networks (MANETs) is a collection of mobile devices dynamically forming a communication networks without any centralized control and pre-existing network infrastructure. Due to the presence of mobility in the MANET, the interconnections between stations are likely to change on a continual basis, resulting in frequent changes of network topology. Consequently, routing becomes animportant factor and a major challenge in such a network. This article aims to Comparative analysis of transportlayer perspective, it is necessary to consider Transmission Control Protocol (TCP) as well for MANETs because of its wide application, which enjoys the advantage of reliable data transmission in the Internet. However, the factors such as scalability and mobility cause TCP to suffer from a number of severe performance problems in an ad-hoc environment and also presents the various parameters comparison of Transmission Control Protocols solutions for ad-hoc wireless network.

Keywords: MANET, TCP-F, TCP-ELFN, TCP-BuS, ATCP and Split-TCP.

I. INTRODUCTION

Like traditional mobile wireless networks. Ad hoc networks do not dependent on any fixed infrastructure. It represents complex distributed system that comprises wireless mobile nodes that can freely and dynamically self organize into arbitrary and temporary, “ad hoc” network topologies, allowing people and device to seamlessly internetworks in areas with no pre-existing communication infrastructure. These nodes can be arbitrarily located and are free to move randomlyat a given time thus allowing network topology and interconnection between nodes to change rapidly and unpredictably[1,2]. The transport layer is responsible for end-to-end connection establishment, end-to-end packet data delivery, congestion control and flow control[3,4,5]. There exist simple, unreliable and connectionless transport layer protocols such as UDP and reliable, end-to-end, byte-stream-based and connection oriented transport layer protocol such as TCP for wired network[7].In this paper we design theissues and challenges in designing a transport layer protocol for ad hoc wireless networks.

Issues in designing a TCP for ad hoc networks

- Induced traffic
- Induced throughput unfairness
- Separation of congestion control, reliability and flow control
- Power and bandwidth constraints
- Misinterpretation of congestion
- Completely decoupled transport layer
- Dynamic topology[8].

II. GOALS OF TCP FOR AD-HOC NETWORKS

The followings are the important goals to be met while designing a transport layer protocol for ad hoc wireless networks:

- The protocol should maximize the throughput per connection.
- It should provide throughput failure across contending flows.
- The protocol should incur minimum connection setup and connection maintenance overhead.

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- The TCP should have mechanism for flow and congestion control in the network.
- It should be able to provide both reliable and unreliable connections as the requirements of application layer.
- The most important available bandwidth must be used efficiently.
- The protocol should be aware of constraints such as battery power and buffer sizes and make efficient use of them.
- The TCP should make use of information from lower layers in the protocol stack for improving the network throughput.
- It should have a well defined cross-layer interaction framework for effective, scalable and protocol-independent interaction with lower layers.
- The protocol should maintain end-to-end semantics[6].

III. CLASSIFICATION OF TCP SOLUTIONS

A classification tree for some of the transport layer protocols as shown in fig.1 The top level classification divides the protocols as extensions of transmission control protocol for ad hoc wireless networks and other transport layer protocols which are not based on Transmission layer protocols. The solution for TCP over ad hoc wireless networks can further be classified into split approaches and end-to-end approaches. The end-to-end approach can be classified as TCP-ELFN, TCP-F, TCP-BuS and ATCP.

TCP over ad hoc wireless network

TCP in its traditional form was designed and optimized only for wired networks. Extensions of TCP that provide improved performance across wired. Since TCP is widely used today and efficient integration of an ad hoc wireless network with the internet is paramount wherever possible,it is essential to have mechanisms that can improve TCP's performance in ad hoc wireless networks. This would enable the seamless operation of application level protocols such as FTP,SMTP and HTTP across the integrated ad hoc wireless networks and the internet[9].

Split TCP: One of the major issues that affects the performance of TCP over ad hoc wireless networks is the degradation of throughput with increasing path length. The short connections generally obtain much higher throughput than long connections. Split-TCP provides a unique solution to this problem by splitting the transport layer objectives into congestion control and end-to-end reliability. This split-TCP splits a long TCP connection into a set of short concatenated TCP connections with a number of selected intermediate nodes as terminating points of these short connections[11].

TCP-ELFN: The uses of TCP with Explicit Link Failure Notification(TCP-ELFN) for improving TCP performance in adhoc wireless networks. This is similar to TCP-F, except for handling of ELFN and the use of TCP probe packets for detecting the route establishment. This can be implemented in two ways: (i) by sending an ICMP destination unreachable(DUR) message to the sender, or (ii) by piggy-backing this information on the router Error message that is sent to the sender[12].

TCP-F: The TCP-F means Feedback based TCP proposes modifications to the traditional TCP for improving performance in ad hoc wireless networks. The TCP-F requires the support of a reliable link layer and a routing protocol that can provide feedback to the TCP sender about the path breaks. The TCP-F aims to minimize the throughput degradation resulting from the frequent path breaks that occur in ad hoc wireless networks. In TC P-F, an intermediate node, upon detection of a path break, originates a route failure notification (RFN) packet[12, 14]. [13] discussed that the activity related status data will be communicated consistently and shared among drivers through VANETs keeping in mind the end goal to enhance driving security and solace. Along these lines, Vehicular specially appointed systems (VANETs)

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require safeguarding and secure information correspondences. Without the security and protection ensures, the aggressors could track their intrigued vehicles by gathering and breaking down their movement messages. A mysterious message confirmation is a basic prerequisite of VANETs. To conquer this issue, a protection safeguarding confirmation convention with expert traceability utilizing elliptic bend based chameleon hashing is proposed. Contrasted and existing plans Privacy saving confirmation utilizing Hash Message verification code, this approach has the accompanying better elements: common and unknown validation for vehicle-to-vehicle and vehicle-to-roadside interchanges, vehicle unlinkability, specialist following capacity and high computational effectiveness

TCP-BuS: The TCP with buffering capability and sequence information (TCP-BuS) is similar to the TCP-F and TCP-ELFN in its use of feedback information from an intermediate node on detection of a path break. But the TCP-BuS is more dependent on the routing protocols compared to TCP-F and TCP-ELFN. It was proposed with Associativity-Based Routing (ABR) protocol as the routing scheme[2].

ATCP: Ad hoc TCP similar to TCP-F and TCP-ELFN, ad hoc TCP(ATCP) also uses a network layer feedback mechanism to make the TCP sender aware of the status of the network path over which the TCP packets are propagated. Based on the feedback information received from the intermediate node, TCP sender changes its state to the persist state, congestion control state, or the retransmit state[15].

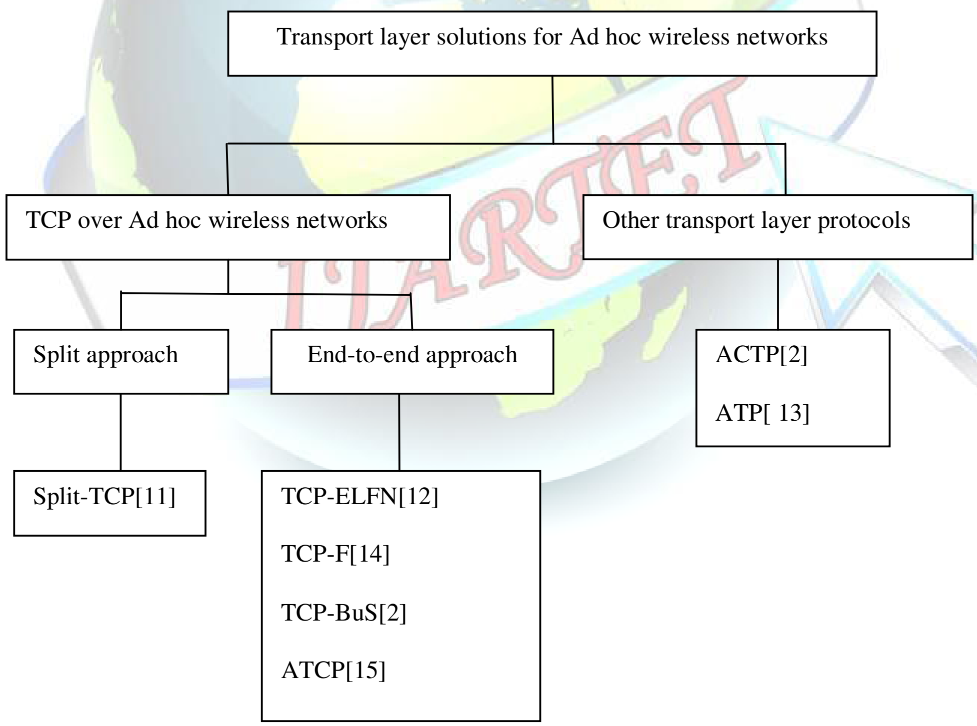

Figure 1:Classification of transport layer solutions

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IV. COMPARISON OF TCP SOLUTIONS FOR AD-HOC NETWORKS

The following Table.1 compares how various issues are handled in the Transmission Control Protocol extensions[8,14].

Issue	TCP-F	TCP-ELFN	TCP-BuS	ATCP	Split-TCP
Packet loss due to BER or collision	Same as TCP	Same as TCP	Same as TCP	Retransmit the lost packets without invoking congestion control	Same as TCP
Path breaks	RFN is sent to the TCP sender and state changes to snooze	ELFN is sent to the TCP sender and state changes to standby	ERDN is sent to the TCP sender, state changes to snooze, ICMP DUR is sent to the TCP sender and ATCP puts TCP into persist state	Same as TCP	Same as TCP
Out-of-order packets	Same as TCP	Same as TCP	Out-of-order packets reached after a path recovery are handled	ATCP reorders packets and hence TCP avoid sending duplicates	Same as TCP
Congestion	Same as TCP	Same as TCP	Explicit messages such as ICMP source quench are used	ECN is used to notify TCP sender. Congestion control is same as TCP	Since connection is split, the congestion control is handled within a zone by proxy nodes
Congestion window after path reestablishment	Same as before the path break	Same as before the path break	Same as before the path break	Recomputed for new route	Proxy nodes maintain congestion window and handle congestion
Explicit path break notification	Yes	Yes	Yes	Yes	No
Explicit path establishment notification	Yes	No	Yes	No	No
Dependency on routing protocol	Yes	Yes	Yes	Yes	No
End-to-end semantics	Yes	Yes	Yes	Yes	No
Packets buffered at intermediate nodes	No	No	Yes	No	Yes

Table 1: Comparison of TCP solutions for Ad-hoc Wireless Networks

V. CONCLUSIONS

In this paper, the major challenges involved in the design of a TCP and the various parameter comparison of transmission control protocol solution for ad-hoc wireless networkswere described. The major goal in providing TCP in Ad-hoc wireless network the protocol should maintain end-to-end connections, end-to-end delivery of data packets, flow control and congestion control and also it should have a well defined cross-layer interaction framework for effective, scalable and protocol-independent interaction with lower layers.

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