ISSN 2229-5518

Power Aware Transport Protocol for Ad hoc Networks

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Abstract

An ad hoc network is a network connection temporary designed for a specific purpose like transferring data from one computer to another which does not required router or a based station. Transport layer is the foundation of the Internet, provides end-to-end control and information transfer. Transmission Control Protocol (TCP) is a transport layer protocol and is planned for a wired network that can handle network congestion successfully. It is end-to-end connection oriented transport layer protocol that gives byte stream based service. Because of the characteristics such as lack of infrastructure, mobility, shared channel and limited bandwidth, TCP implementation leads to poor performance in the ad hoc networks. Therefore several transport layer protocols have been designed and developed exclusively for ad hoc networks.

Among these protocols ATP (Ad hoc transport protocol) finds to be more suitable for ad hoc networks. ATP, by designed, is an antithesis of TCP and consists of: rate based transmission, quick-start during connection and routing switching, network supported congestion detection and control, no transmission timeouts, and decoupled congestion control and reliability. By designing of ATP, the performance of sending TCP is concentrated but the performance and load of the intermediate node is not considered. In this thesis a simple approach is proposed to address the intermediate node problem by making it to operate in three layers rather than operating in four layers. This enhanced ATP is called as PATPAN (Power Aware Transport Protocol for Ad hoc Network). This enhanced ATP; PATPAN is designed based on two schemes. One is the PATPAN in IP datagram and the other is the PATPAN in data link layer. Both the schemes operate in three layers.

Key **word** TCP,ATP,ATCP,ACTP,ABR,ACK,CSM,A,CSM,A/CA,ECN,ERDN,ERFN,ERSN,ERSN,FTP,FN, HiperLAN,ACRONYM,ICMP,LACK,LQ,,MAC,MSS,PN,RTT,RF,SACK,TCP,TPA,TCP-F,TCP-ELFN,TCP-BuS,UDP,ACRONYM,PRNET,ALOHA,SURAN,GloMo,NTDR,IETF,TDMA,PCMCIA cards

INTRODUCTION

An ad hoc network is an infrastructure less wireless network in which all nodes are mobile and can be connected dynamically in an arbitrary manner. It does not require any communication support facilities such as base station and router. In this type of networks all nodes are responsible for discovering the nodes and take maintenance of route to other node in the networks. They are very useful in emergency situations. Therefore ad hoc networks become very popular.

In computer networking, transport layer provides end-to-end communication services for many applications within a layered architecture of network components and protocols. It also provides many services such as connection orientation data stream, reliability, flow control, multiplexing, and congestion avoidance and control. There are many transport layer protocols which are suitable for different application such as TCP (Transmission Control Protocol), UDP (User Datagram Protocol), DCCP (Datagram Congestion Control Protocol), SCTP (Stream Control Transmission Protocol) etc. Among the transport layer protocols, TCP found to be consistent transport layer protocols for wired network [4]. Even though TCP is well suitable for wired network, it is not suitable in the ad hoc networks. It is because ad hoc network is characterized by lack of infrastructure, multihopping, self organization, energy conservation, scalability, limited bandwidth and security [5]. Therefore several researches proposed several protocols for ad hoc networks by extending the TCP performance and by designing the protocols exclusively for ad hoc networks. Among these protocols ATP (Ad hoc transport protocol) found to be more suitable for ad hoc networks. ATP is

anti thesis of TCP. It means ATP uses coordination between different layers, rate based transmission and also supports congestion avoidance, congestion detection and control, congestion control and reliability are decoupled, quick start during connection initialization and route switching, and no retransmission timeouts etc [19]. Since the energy conservation is one of the important characteristic of ad hoc networks, there is a problem in ATP for providing power aware and reliable transport protocol over the ad hoc networks. Therefore enhancement is done in ATP so as to act as power aware transport protocol. The next section describes the definition of power aware transport protocol for ad hoc networks (PATPAN) and how it is designed and what are the protocols required in PATPAN.

PATPAN (Power Aware Transport Protocol for Ad hoc Networks)

PATPAN is the transport layer protocol for ad hoc networks which is specially designed to address the problem of power aware and reliable transport over the ad hoc networks in ATP. It is based on ATP. Like in ATP, PATPAN uses rate base transmission and assisted congestion control and finally, congestion control and reliability are decoupled. It also uses information from lower layers for many purposes such as estimating of initial transmission rate, congestion detection, congestion avoidance and control, and detection of path breaks. It also obtains network congestion information from intermediate node while the flow control and reliability are obtained from the PATPAN receiver. Unlike in ATP, where intermediate nodes operates in four layers i.e., physical layer, data link layer, network layer and transport layer to increase the performance of TCP, PATPAN operates in three layers i.e., physical layer, data link layer, and network layer to reduce the processor power consumption.

- **Issues in Designing a Power Aware Transport Protocol for Ad hoc Networks**

This section describes the issues in designing a power aware transport for ad hoc networks.

- Semi node to node transport protocol
- Intermediate node problem
- Limitation's of data copying

- **Semi node to node transport protocols**

According to the general procedure followed by TCP/IP internet, TCP is end to end protocol. It means that end to end architecture of TCP allow packets to pass through the transport layer from the source to destination nodes only. TCP allows packet only to pass through the transport layer at the source and destination nodes. While, network and data link layer are node to node protocols that operates in source, destination, and all the intermediate nodes between the source and destination. Therefore, in end to end protocols, there are problems that occur at the interior nodes which cannot be handled until they propagate to the source and destination nodes. To overcome the limitation of end to end problem, node to node transport protocols have been proposed. In node to node protocols of TCP packet are passes to the transport layer at every intermediate node in source to destination path. Therefore, rate adjustments can be made anywhere by allowing intermediate nodes to respond to adverse network conditions where they occurred. But in case of the reliable transport protocol for ad hoc networks, ATP transport protocol is semi node to node transport protocol. It is because the transport layer of intermediate node in ATP processes all the packets only to append the delay (D) and not to control the transmission rate at each hop. On the other hand, the rate estimation and rate adaptation is done only by the end system i.e., the transport layer of source and destination. Therefore, it is required to design a derivative of ATP which does not operate in the transport layer of intermediate node.

- **Intermediate node problem**

In ATP, intermediate node maintains the sum of average **queuing delay (Q_t)** and average **transmission delay (T_t)** which are experienced by packets traversing through them. Q_t is an exponential average of the queuing delay experienced by packets traversing the node, while T_t is also an exponential average of the transmission delay experienced by the head-of -line packet at the node. These two values are computed over all the packets traversing the node irrespective of the specific flow the packets belong to. Thus, Q_t and T_t are maintained on a per-node basis, and not on a per-flow basis. For every outgoing packet, an intermediate node updates its Q_t and T_t values. Each packet consists of rate feedback field D that contains the maximum $Q_t + T_t$ value at the upstream nodes the packet had traversed through. When the packet is dequeued for transmission, the transport layer of intermediate node will check to see the value of D. If the value of D is found smaller than the $Q_t + T_t$ value , then the intermediate node updates the D on the packet to its $Q_t + T_t$ value. When the receiver receives the packet, the D field in the packet indicates the maximum delay that is experienced by the packet at any of the intermediate node. According to the idea of ATP, D is calculated at the MAC layer while D is updated at the transport layer header. Then the delay D has to be copied from the MAC layer to the network layer and again from the network layer to the transport layer as shown in the fig. 1.1. It means it takes two copies as shown in fig. 1.1 as 1and 2. This is done only to append or update the value of D. Due to this reason, the whole transport layer segment along with the header and data must be copied from network layer to transport layer as shown in fig 1.1 as 3. This unnecessary copying of data causes a problem which is called intermediate node problem in ATP.

Limitation's of data copying

In protocol processing, data movement operation specially copying of data results in high overhead. Avoidance of data copying decreases the processing overhead. Several researches show that copying is responsible for substantial amount of processing overhead and carefully implemented system eliminating copies significantly reduces overhead. In [5], Clerk et al shows that TCP overhead is attributable to both the cost associated with processing individual bytes, specifically computing the checksum and moving of data in memory and to the operating system costs such as interrupts, context switches, process management, buffer management, and timer management. They found that moving of data in memory is more important of the costs, and their experiments also show that memory bandwidth is the greatest source of limitation. According to the data presented, 64% of the measured microsecond overhead was attributable to data touching operations, and 48% was attributable for data copying. Several researches studies and shows that eliminating data copies substantially reduces overhead. In [2], Chase et al measuring CPU utilization and shows that avoiding copying reduces CPU time spent on data access from 24% to 15%. This means 9% is improved due to the copy avoidance. Therefore, the total CPU utilization was 35% when data access is accounting for 24%. Thus the relative importance of reducing copies is 26%. Hence data copying problem is also related with respect to the power consumption.

Advantages of PATPAN in Data Link Layer Frame

Some advantages of PATPAN in data link layer over ATP are given below:

- Less power consumption in the intermediate node.

- By minimizing copying of data the performance of PATPAN increases as compare with ATP. Since, PATAPN operates only in three layers i.e. physical, data-link, network layer while ATP operates in four layers i.e. physical, data-link, network, and transport layer.

- In ATP, Rate estimate $D = Q_t + T_t$ is calculated in MAC layer and it is appended by transport layer in ATP data packet header. So, $D = Q_t + T_t$ must be copied from data link to network layer and then from network to transport layer. Hence, copying of data decreases the performance of the system. While in PATAPN in data link layer, D is appended in data link layer so it is not required to copy the D from data link layer to network layer and from network layer to transport layer. In addition as unlike in ATP copying transport layer segment from network to transport layer is not needed. Therefore the three unnecessary copying is avoided in the data link layer PATPAN. Hence increase the performance of the system.

Incompatibility Problem with Traditional TCP

To address the intermediate node problem that is occurred in the ATP, PATPAN is designed. In the second scheme of PATPAN the delay (D) is transmitted in the data link layer frame. Hence rate estimate is appended in the data link layer header rather than in TCP segment. Therefore some modification is done in the data link layer frame format so that D can be included in the data link layer header. Same as in first scheme there is also a minor change in the compatibility problems that comes into pictures. Therefore the data link layer frame format for PATPAN is not compatible with the traditional IP. It means with the traditional TCP, nodes using the ATP cannot communicate directly with the internet. Since the major disadvantage of ATP is same as the compatibility problem so this disadvantage in PATPAN cannot be become a big issue.

LITERATURE SURVEY

Several researches proposed various schemes to address the problem of TCP performance over cellular wireless networks. This includes:

- **Improving the reliability at the link layer**: To improve the performance of TCP, C. Parsa and J.J. Garcia-Luna-Aceves presented the transport unaware link improvement protocol (TULIP) over lossy wireless links without competing or modifying the transport or network layer protocols. TULIP is made for the half-duplex radio links and it provides a MAC acceleration feature to improve throughput. TULIP's timer depends on a maximum propagation delay over the link instead of estimating a round-trip timer of the channel delay. It does not require a base station and keeps no TCP state. It is strong and sturdy in high bit error rate i.e. the packets are retransmitted only when necessary and there is dropped packets on the wireless link. Its advantages are: it keeps no TCP state and therefore does not necessary to look into the TCP packet headers even TCP headers are encrypted. It does not restrict the network to the presence of a base station so it can be applied to multi-hop wireless networks. Again, it also conserves wireless bandwidth by piggybacking TCP ACKs with link-layer

ACKs and returning them immediately across the channel through MAC acceleration .

- **Introducing TCP aware smarts at a central entity like the base station**: To improve the TCP performance over wireless link, the snoop protocol modifies the networks layer software at the base station and preserves end to end TCP semantics. It introduces a snoop module at the base station so that it monitors the every packet that passes through the TCP connections in both directions, and maintains a cache of TCP segments that have not yet been acknowledged by the receiver. Then a packet loss is detected by the arrival of duplicate acknowledgements or by a local timeout. So, the snoop module retransmits the lost packet if it has it cached, and suppresses the duplicate acknowledgements. Its advantage is that it suppresses the duplicate acknowledgement for lost packet and retransmitted locally thereby avoiding unnecessary fast retransmission and congestion control invocation by the sender. The per-connection state maintained by the snoop module at the base station is soft, and is not essential for correction. The disadvantage of the snoop approach is that it suffers from not being able to completely shield the sender from wireless losses .

- **Split connection methods**: Split-connection method splits each TCP connection into two separate connections at the base station. One is between the sender and the base station and the other is between the base station and the receiver. A specialized protocol tuned to the wireless environment may be used. In 1994, R Yavatkar and N. Bhagwat proposed two protocols: one in which the wireless hop uses TCP and another in which the wireless hop uses a selective repeat protocol (SRP) on top of UDP.

CONCLUSION

In ad hoc network, the behavior of TCP is not suitable so that various new protocols are proposed specially for ad hoc networks over the extension of TCP and non TCP. From the various new protocols, ATP is most suitable for ad hoc networks. ATP addresses all the problems that TCP faces when deployed over the ad hoc networks. In ATP, the performance of sending TCP is concentrated but the performance of the intermediate node is not considered while designing it. Therefore, the intermediate node suffers a problem in the context of power consumption. Due to the intermediate node problem, ATP sucks more power. To overcome the intermediate node problem, enhanced ATP is proposed by operating in three layers instead of four layers called PATPAN. PATPAN is designed same as the ATP except in the intermediate node. To address the intermediate node problem the PATPAN is designed based on two schemes. First scheme is the PATPAN in data link layer and the second is the PATPAN in data link layer.

Scope of the Future Work

The proposal can be implemented in the concept of operating system and parameters such as CPU usage, physical and kernel memory usage, processor power consumption can be compared with ATP. According to the concept of operating system minimizing the copying of data the system performance will be increased. This can be implemented at the kernel level of Linux laptops. The laptops can be arranged in a multi hop topology. The implementation can be executed under different topology set up and their output can be measured. Processor power consumption can be compared with that of ATP. Again, this proposal can be implemented at the user in Linux system and the parameters such as memory usage and CPU usage can be compared with ATP.

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