Wireless TCP: To Improve Performance of End To End Transmission with Improved Performance of Transport Layer

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Abstract-*There are different classes of approaches that attempts to provide improved transport layer performance over wireless networks. This paper describes about the approaches are one is link layer enhancements; this approach has the drawbacks such as end-to-end delay. It is unlikely that there will be sufficient number of duplication ACKs for the snoop module to detect a packet loss and perform a local retransmission. The snoop module needs to reside on the base station of the wireless network.*

I. INTRODUCTION

Networking is a major component in successfully implementing open systems, and a network's architecture should help to solve industrial automation problems as well as to achieve business objectives. When planning a network infrastructure, a business typically has several objectives. Open connectivity to a wide range of plant floor devices is one objective, while data sharing and gathering is another. Another objective is to have the flexibility to incorporate future advances in technology; without flexibility, businesses may be caught with dying technology that makes them unable to compete in tomorrow's opportunities.

TCP/IP protocols map to a four-layer conceptual model known as the DARPA model, named after the U.S. government agency that initially developed TCP/IP. The four layers of the DARPA model are: Application, Transport, Internet, and Network Interface. Each layer in the DARPA model corresponds to one or more layers of the seven-layer Open Systems Interconnection (OSI) model.

Upgrading the base station is in the hands of the wireless network provider and it is unlikely that a wireless network provider will allow for arbitrary code to be injected into the base stations. Another approach is Indirect protocols also attempt to mask the characteristics of the wireless portion of a connection from the static host, but do it by splitting the connection at the base station. Specifically, a single transport connection between a static host and a mobile host is split at the base station, and two simultaneous connections are maintained.

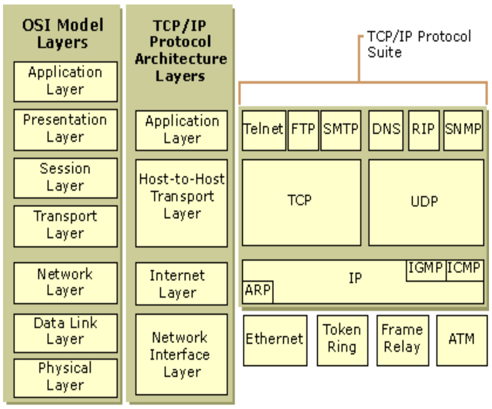

Fig. TCP/IP Protocol Architecture

This allows the second leg of the connection (between the base station and the mobile host) to be customized to address the unique characteristics of the wireless component. They typically involve intelligence at the base station to maintain the simultaneous connections, and have custom protocols to handle the wireless component of the connection. This approach has the following drawbacks (i) Break in end-to-end semantics. As described earlier, it is possible for the sender and receiver in I-TCP to believe in states inconsistent with each other. This can happen when the mobile host stays disconnected from the base station for a prolonged period of time, or there is a failure at the base station. (ii) Processing overhead. Since I-TCP is a transport layer mechanism, all packets will have to go up to the transport layer at the point of split, and come down again through the protocol stack. This will introduce unnecessary overheads into the end-to-end data transfer. (iii) The base station needs to maintain state on a per-connection basis and it is less likely that a wireless network provider will allow for a connection-specific state to reside on the devices inside the wireless network. In this paper we proposed an approach that is end to end protocol W-TCP

The WTCP protocol is an end-to-end approach to improve transport layer performance over wireless networks. Although the flow control and connection management in WTCP are similar to those in TCP, WTCP uses unique mechanisms for its congestion control and reliability schemes that in tandem enable WTCP to comprehensively overcome the characteristics of wireless networks discussed in Section 13.3. Briefly, WTCP uses rate-based transmissions at the source, interpacket separation at the receiver as the metric for congestion detection, mechanisms for distinguishing between congestion and non-congestion losses, and bandwidth estimation schemes during the start-up phase as part of its congestion control framework. It also uses selective ACKs, no dependence on RTTs and RTOs, and a tunable ACK frequency as part of its approach for achieving reliability. We elaborate subsequently on how each of these mechanisms contributes to improving WTCP's performance over wireless networks. WTCP requires change of the protocol stacks at both the sender and the receiver. This is in contrast to the earlier approaches that either require no changes at the end hosts or require changes only at the mobile host. The authors of WTCP argue that although WTCP requires changes at both the sender and the receiver, since most mobile hosts communicate with a proxy server in the distribution network of the wireless network provider, any such changes would need to be done only at the proxy and the mobile host. We now elaborate on each of the mechanisms used in WTCP: Connection Management and Flow Control. WTCP uses the same connection management and flow control schemes as TCP.

II. CONGESTION CONTROL

WTCP uses the following unique schemes for its congestion control: (i) Rate-based transmissions. Since the bursty transmissions of TCP lead to increasing and varying delays, WTCP uses rate-based transmissions and hence spaces out transmissions of packets. This further plays a significant role in WTCP's congestion detection. (ii) Congestion detection based on receiver interpacket separation. Congestion is detected when the interpacket separation at the receiver is greater than the separation at the sender by more than a threshold value. Such a congestion detection scheme is valid because queue buildups that occur because of congestion result in interpacket separations between packets increasing as the packets traverse the network. Further, using such a detection scheme, congestion can be detected before packet losses occur, thereby optimally utilizing the scarce resources of wireless networks. (iii) Computation at the receiver. The receiver does most of the congestion control computation in WTCP. Thus, WTCP effectively removes the effect of reverse path characteristics from the congestion control. (iv) Distinguishing between congestion- and non congestion-related losses. WTCP uses an interpacket separation-based scheme to distinguish between congestion and non congestion-related losses [19]. Thereby, the congestion control scheme in WTCP reacts only to congestion-related losses. (v) Start-up behavior. WTCP uses a packet pair-like approach to estimate the available rate, and sets its initial rate to this value. When the connection experiences a blackout, WTCP uses the same estimation scheme as when it recovers from the blackout.

III. RELIABILITY

A unique aspect of WTCP is the fact that it decouples the congestion control mechanisms cleanly from the reliability mechanisms. Hence, it uses separate congestion control sequence numbers and reliability sequence numbers in its data transfer. WTCP has the following features in its reliability scheme:

(i) Use of selective acknowledgments. Unlike TCP which uses only cumulative Acknowledgments, WTCP uses a combination of cumulative and selective acknowledgments to retransmit only those packets that are actually lost, thereby saving on unnecessary transmissions.

(ii) No retransmission timeouts. Although TCP suffers from not being able to accurately Measure RTT, and hence experiences inflated RTOs, WTCP does not use retransmission timeouts. Instead, it uses an enhanced selective acknowledgment scheme to achieve reliability.

(iii) Tunable ACK frequency. The ACK frequency in WTCP is tunable by the sender, depending on the reverse path characteristics.

Performance results (both real-life and simulation experiments) show that WTCP performs significantly better than regular TCP. For packet error rates of around 4%, WTCP shows a performance improvement of about 100% over regular TCP. As the packet error rate increases, the difference in WTCP's performance in comparison with regular TCP keeps increasing.

IV. TCP

This W-TCP also has some drawbacks as follows

(i) WTCP assumes that interpacket separation is a good metric for the detection of Congestion. Although this might be true when the bottleneck link is definitely the wireless link, the same is not evident when the bottleneck link can be someplace upstream of the wireless link.

(ii) Loss distinguishing mechanism. The loss detection mechanism currently used by WTCP is a heuristic. However, the heuristic can be shown to fail in several Scenarios.

(iii) WTCP requires changes in the protocol stack at both the sender and the receiver. Hence, in the absence of proxy servers, static hosts will have to have a dedicated Protocol stack for communications with the mobile hosts.

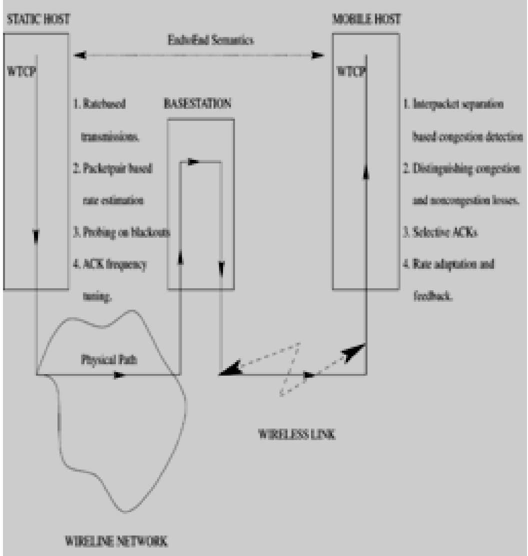

Fig2: The WTCP protocol

The Transmission Control Protocol / Internet Protocol is the main protocol suite used with the Internet. Local Area Networks (LANs) were used to connect different computers on a local site, e.g. computers within an office or building. This allows users to share and distribute information across the local network. Large enterprises, however, usually have several sites situated in different areas of the same country and more recently, different countries as well. To connect sites that are situated within the same country, companies lease transmission lines between those sites, from the public carriers such as British Telecom. This forms a Wide Area Network (WAN). To connect sites that are situated in other countries, companies use different types of communication, for example satellites, optic fibers across land and / or sea etc. The networks that are formed from this type of communication are called Internetworks or just Internets. TCP/IP consists of a suite or a layered stack of two core protocols The internet and transport protocols. The Internet Protocol (IP) provides a number of core functions that assist the process of internetworking across dissimilar networks. These are:

1. Addressing: There are three types of address used with the current version of the internet protocol (IPv4), unicast, broadcast and multicast. Unicast addressing is used when a packet of information or datagram is to be sent to a single destination. Broadcast addressing is used when a message is to be delivered to every host on a destination LAN. A multicast address is used to deliver a datagram to a specific set of hosts, called a multicast group. This type of addressing is called IP Multicast. Hosts can join a multicast group at anytime and receive the data grams that are sent to the group.

2. Fragmentation and reassembly: If the datagrams sent by a host are larger than the packet sizes used by a particular part of the internet, the datagrams will have to be fragmented into smaller chunks so that they can be transmitted. When these smaller packets are received, they have to be reassembled into the original sized packet, so that they can be used.

3. Routing: This is used to determine which subnets, within the internet, the datagrams must travel to get to the destination host. This could involve travelling over several different LANs or WANs.

4. Error reporting: This consists of several functions that will detect errors, for example the process of reassembly could cause several packets to be discarded, and report them back to the IP in the source host. Link Layer Enhancements

The approaches that fall under this category attempt to mask the characteristics of the wireless network by having special link layer mechanisms over the wireless link. Such approaches are typically transparent to the overlying transport protocol. Further, the approaches can either be oblivious to the mechanisms of the transport protocol, or make useof the transport layer mechanisms for improved performance. They typically involve buffering of packets at the base station and the retransmission of the packets that are lost due to errors on the wireless link. Consequently, the static host is exposed only to congestion induced losses. Link layer enhancements thus have the following characteristics: They mask out the unique characteristics of the wireless link from the transport protocol; (ii) They are typically transparent to the transport protocol and, hence, do not require any Change in the protocol stack of either the static host or the mobile host; (iii) They can either be aware of the transport protocol’s mechanisms or be oblivious to it the “transport protocol aware” class of protocols can be more effective because of the

Additional knowledge ;(iv) They require added intelligence, additional buffers, and retransmission capability at the base station;(v) They retain the end-to-end semantics of TCP since they do not change the transport Protocol. Several schemes including reliable link layer approaches and the snoop protocol belong to this category. We will now provide an overview of the snoop protocol. In the previous sections, we have summarized the key mechanisms of TCP, identified the unique characteristics of wireless networks, and discussed how the characteristics impact the performance of TCP. In this section, we examine three different classes of approaches that attempt to provide improved transport layer performance over wireless networks. The approaches that we discuss are: (i) link layer enhancements, (ii) indirect protocols, and (iii) end-to-end protocols. For each class of approaches, we present an overview, following which we consider an example protocol that belongs to that particular class, describe the protocol, and discuss its performance. Finally, we present a comparative discussion of the three classes of approaches.

V. LINK LAYER ENHANCEMENTS

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VI. COMPARATIVE DISCUSSION

In order to provide intuition as to how the above-discussed approaches compare with each other, we now provide a high-level discussion on their drawbacks.

Link Layer Schemes: Link layer schemes suffer from the following drawbacks:

Indirect Protocols: Indirect protocols suffer from the following drawbacks when compared with the other approaches.

(i) Break in end-to-end semantics. As described earlier, it is possible for the sender and receiver in I-TCP to believe in states inconsistent with each other. This can happen when the mobile host stays disconnected from the base station for a prolonged period of time, or there is a failure at the base station.

(ii) Processing overhead. Since I-TCP is a transport layer mechanism, all packets will have to go up to the transport layer at the point of split, and come down again through the protocol stack. This will introduce unnecessary overheads into the end-to-end data transfer.(iii) The base station needs to maintain state on a per-connection basis and it is less likely that a wireless network provider will allow for a connection-specific state to reside on the devices inside the wireless network.

End-to-End Protocols. The drawbacks of WTCP are:

(i) WTCP assumes that interpacket separation is a good metric for the detection of congestion. Although this might be true when the bottleneck link is definitely the wireless link, the same is not evident when the bottleneck link can be someplace upstream of the wireless link.

(ii) Loss distinguishing mechanism. The loss detection mechanism currently used by WTCP is a heuristic. However, the heuristic can be shown to fail in several scenarios

(iii) WTCP requires changes in the protocol stack at both the sender and the receiver.

Hence, in the absence of proxy servers, static hosts will have to have a dedicated protocol stack for communications with the mobile hosts.

VII. CONCLUSION

The TCP assumes that any loss is due to congestion and consequently invokes congestion control measures. This has been shown to yield poor performance in the presence of wireless links as a large number of segment losses will occur more often because of wireless channel errors or host mobility. We present an efficient transmission control scheme (WTCP) that requires the base station to buffer data packets destined for the mobile host and retransmit lost packets.

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