Sri Lanka Institute of Information Technology
4th Year Research Project

Analysis & Development of Dynamic TLPs in the use of Smart Mobile Device Communication

Project ID: 15-019

Project Proposal

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Declaration

We hereby declare that the project work entitled "Analysis & Development of Dynamic TLPs in the use of Smart Mobile Device Communication", submitted to the Sri Lanka Institute of Information Technology is a record of an original work done by us, under the guidance of our Supervisor Mr. Dhammika H. De Silva. This project work is submitted in the partial fulfillment of the requirement for the award of the degree of Bachelor of Science (Special Honours) in Information Technology. The results embodied in this report have not been submitted to any other University or Institution for the award of any degree or diploma. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Abstract

Smart Mobile devices has revolutionized the human behavior with the introduction of different apps that helps it users in day today activities. We often see Smart devices are in use to help with not just ordinary activities but also for users with special needs. Data transferring in real time path navigation systems with obstacles has to be high speed, efficient and reliable. This requires information with minimal time to reach its destination to avoid hazardous encounters discover the required path, identify real time changes on the path in the current map and give out alternative routes. Our research will look into models and methods to facilitate the bounded timing of which it takes the minimum time for path finding application for people with vision disabilities.

Given a comprehensive analysis of the requirements that are put forward in path navigation applications, it was identified the existing transport layer protocols are not the best option and is ideal for the requirements that we are looking into. I.e. transporting the data with urgent flags, congestion control in the use of Smart Mobile communication. Our research investigates existing TLPs and proposes extensions and modifications to facilitate the required short comings in the use of Smart Mobile communication and will implement Dynamic TLP to incorporate.

Contents

1. Introduction

Modern world revolves around networks which have access to details, information any corner in world and can be accessible fast. We often use this information to ease our day to day activities be updated with new things, be connected to people around the world and many more.

We have evolved from using information for the purpose of simple/advance activities to real time quick updates for the purpose of medical reasons, navigation, bank transactions, aviation industry etc.

We find it's very important to focus on transport layer protocols which possess reliable, high speed and efficient data transfer methods which are vital factors in real time path navigation systems which require information within a short time duration to discover paths, avoid hazardous encounters providing alternatives. There's always a demand for reliable information that is accessible in quick successions without having to wait for long. A second delay can cause a lot of damage in a real time system. We identify the current protocols that are being used in TLP has certain faults/ draw backs that prevents the quick succession of transfer of data or retransmit to serve information to its uses.

1.1 Literature Survey

- **Packet losses during transmission**

TCP has been deployed in the eighties. Its congestion control is based on the fact that packet losses are mainly due to buffer overthrows and it works quite well in such situations. However, nowadays, many applications use TCP as their transport protocol and hence pass through wireless links, which become common in the Internet. Over these links, packet losses are not due anymore only to overthrows but can also be caused by link errors. TCP, which has no mechanism to distinguish packet loss causes, reduces its rate at each packet loss. This reduction is not justified when there is no congestion and the consequence is that the throughput of TCP over wireless link is lower than what it could be. According to the Ibtissam El Khayat [1].

- **Congestion control in data transmission**

TCP (Transmission control protocol) is a reliable, end-to-end transport protocol, which is widely used for data services and is very efficient for wired networks. However, experiments and research showed that TCP's congestion control algorithm performs very poorly over wireless ad hoc networks with degraded throughputs and severe unfairness among flows by Dr. Thomas Kunz [2].

In fact, the simplest way to solve congestion is to employ the principle of packet conversation in which the sender stops sending a new packet until the previous one is successfully delivered to the receiver. For this reason, the TCP protocol, one of the core protocols of the Internet protocol suite, employs the concept of congestion control which dynamically controls the flow of packet inside a network, and prevents network performance collapse. Research conducted by van Jacobson [3].

- **Error control**

This paper we propose a new scheme that can efficiently deliver multimedia over wireless Internet. Packet losses due to congestion or random error can be distinguished in our scheme. Proper congestion control and error control are performed, which are suited for multimedia applications. Featured with retransmission mechanism, our scheme can also reduce the packet loss ratio caused by fading and random errors, conducted by Fan Yang [4].

- **Improve wireless TCP performance**

This paper, they describe the design and implementation of a simple protocol to alleviate this degradation and present the results of several experiments using this protocol. Their aim is to improve the end-to-end performance on networks with wireless links without changing existing TCP implementations at hosts in the fixed network and without recompiling or relinking existing applications. They achieve this by a simple set of modifications to the network-layer (IP) software at the base station. These modifications consist mainly of caching packets and performing local retransmissions across the wireless link by monitoring the acknowledgments to TCP packets generated by the receiver. Their experiments show speedups of up to 20 times over regular TCP in the presence of bit errors on the wireless link. They have also found that their protocol is significantly more robust at dealing with multiple packet losses in a single window as compared to regular TCP. Conducted by Hari Balakrishnan [5].

This paper makes two important contributions. First, they design a network-based solution called the Window Regulator that maximizes TCP performance for any given buffer size at the congested router. Second, they present a scheduling and buffer sharing algorithm that reduces the latency for short flows while exploiting user diversity, thus allowing the wireless channel to be utilized efficiently [6].

This research, explore a new way to make TCP adapt to frequent route changes without relying on feedback from the network. It is based on TCP detecting out-of-order delivery events and inferring route changes from these events. They call it Detection of Out-of-Order and Response

(DOOR). Their study has shown that this approach can significantly improve TCP performance over mobile ad-hoc networks [7].

- **Flow Control**

The performance of TCP degrades over wireless links due to high rate of data losses, which are falsely perceived as network congestion state. TCP performance metrics also diminish due to low data rate, since large delays may occur in last link i.e. wireless link. Similarly in heterogeneous wireless network, packet loss may also occur due to mobility-events that can cause burst-losses, service-disconnection. This motivates to reevaluate TCP control operations and embed some mobility related services to optimize its performance for new generation of wireless networks. TCP for mobile, wireless environment with the help of link-layer triggers which shall be standardized by IEEE 802.21 standard, through its media independent handover (MIH) services. These services are used to detect link layer events in the TCP control operations, and act accordingly to adjust flow and congestion control in a way that does not seriously hamper TCP performance by Muhammad Saeed Akbar. [8]

- **Performance Enhancement of TCP**

Nodes in are distributed and can be statics or mobile. The main advantage of Ad-hoc Networks is that its nodes can be self-organize allowing nodes to connect to each other. The connections between the nodes do not need to establish preexisting infrastructure like other networks. Each node can work as a router to route data to its neighbor nodes. Ad – hoc networks can be used in places that can be difficult to prepare it with infrastructures like open areas. [9]

- **Improving Transport Layer Performance in Multihop Ad Hoc Networks**

TCP congestion control has an implicit assumption, i.e., any packet loss is due to network congestion. However, this assumption is no longer valid in the ad hoc networks as packet losses may well be due to channel errors, medium contention, and route failures.

Several works have pointed out that greedy TCP can result in severe congestion in ad hoc networks and hence performance degradation. Subsequently the TCP source will reduce congestion window size before it becomes excessively large. To avoid congestion, Chen et al. dynamically adjusted the congestion window limit according to path length of TCP flows, a neighborhood RED scheme was proposed to alleviate TCP fairness problem by adjusting marking/dropping probability in light of observed channel information. [10]

1.2 Research Gap

These existing Transport Layer Protocols (TLP's); mainly TCP since it has a high rate of data packet loss and high retransmission time when operating in wireless networks.

There are various additions and enhancements of both TCP and UDP, such as Multipath TCP[15], Datacenter TCP[16] or UDP-Lite. These protocols are often designed for a specific use case or mitigate a common drawback of the original transport protocol. TCP does more than just break things up into packets. It also makes sure that the data arrives, resending packets where necessary. But for a question that fits in a single packet, we don't need all the complexity of TCP to do this. There's always a demand for reliable information that is accessible in quick successions without having to wait for long. A second delay can cause a lot of damage in a real time.

There are also entirely new protocols like SCTP, that provide a different set of features. For instance, SCTP combines features of UDP and TCP and allows multiple parallel transmission streams using a single connection.

All new TCP-like protocols are only modification of basic TCP - Protocols. In them there are no essential changes. The behavior of these new Protocols is more or less good, but all of them have not only advantages but also lacks. Process of replacement is very slow and should be very long.

We identify the current protocols that are being used in TLP has certain faults/ draw backs that prevents the quick succession of transfer of data or retransmit to serve information to its uses.

There's always a demand for reliable information that is accessible in quick successions without having to wait for long. A second delay can cause a lot of damage in a real time system.

In our proposed system we focus to develop a protocol that support minimal packet drops and takes a low retransmission to transmit data in quick successions with in a wireless environment. This has been identified as a very important factor in real time systems which are focusing on path navigation applications and other related areas which gather information on critical information like patients, avoid accidents for disabled while providing alternate routes in navigation systems in instances of impediments.

2. Objectives

2.1 Main Objective

To design an enhanced dynamic transport layer protocol which adapts itself according to the data that's being transmitted across a network. For an example if there's any urgent data that needs to be transmitted immediately, a different approach will be used rather than using the conventional transport layer protocol, TCP, which is proven to be inefficient in such situations.

2.2 Sub Objectives

- Analysis & classification of application layer data in order to determine which method/functionality to be used in transmitting those data.

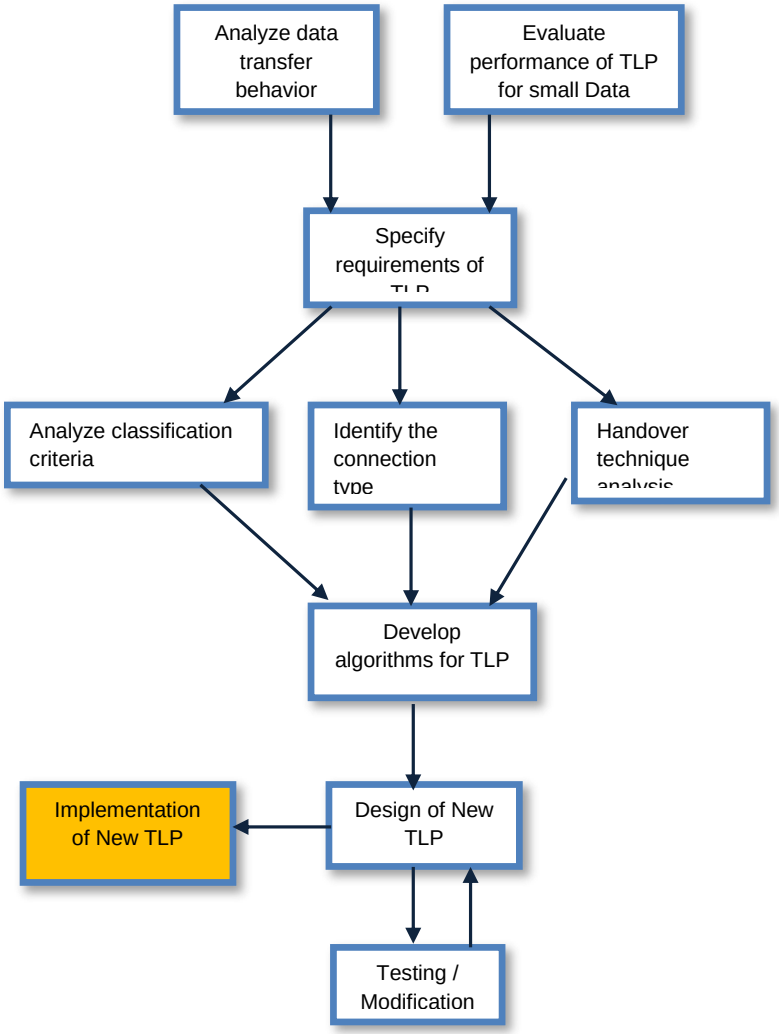
- Examining the currently available transport layer protocols & analyzing their behavior to identify their drawbacks.

- Handover method analysis to significantly improve the connection establishment process & to reduce the no of times a particular client has to establish a connection.

- Analyzing the modifications that can be applied to the currently available protocols.

3. Methodology

As it was discussed in the objectives, this research shall look into design and develop a Dynamic Transport Layer (DTL) protocol which is ideal for transporting the data with urgent flags, congestion control in the use of Smart Mobile communication. In order to design DTL protocol, following stages are required.



Network Simulator 2 (NS2) is used in the initial phase of this research in order to simulate stages mentioned above. The simulated provides a significant support for simulation of TCP over the proposed wireless communication techniques of Smart Mobile communication and provides very good approximations of the overall process and come closer to the reality regarding the final values [11][12][13]. Firstly it is necessary to simulate with existing Transport Layer protocol such as TCP, UDP and SCTP. This information will be used to established benchmark and baselines for comparison to the proposed DTL protocol. This simulation requires several iterations with each change of the DTL protocol [14].

3.1 Main Tasks and the respective sub tasks to be performed

- **Analyze data transfer behavior**

TCP has been in the use throughout the world & it has evolved up until now since it has been introduced in 1981. It has improved in so many ways since then & has been highly optimized for wired networks. But in the scenario that we're proposing mostly uses wireless networks because the devices being used here are the mobile devices & it is proven that TCP protocol is not suitable in such situations. Therefore data transfer behavior has to be analyzed in terms of wireless environments/networks & the below mentioned criterions should also be addressed.

1. How often a given connection establishes & terminates itself.
2. Time taken to finish the 3-way handshake of a particular connection.
3. Data transfer speeds during peak hours.

- **Evaluate performance of TLP for small Data**

Currently used TLP is TCP. TCP datagram has a header of 20 bytes no matter what its data content size is. If a small amount of data comes from the application layer & if it needs to be transmitted urgently; there's a huge impact on transmission time of that particular packet if we use TCP and add 20 bytes of data as the header. Therefore dynamic protocol has to be developed which adjust its header size according to the data size.

- **Specify requirements of TLP**

Newly developed protocol should possess the following requirements.

1. Dynamic header which adjusts itself according to the scenario where it is being used.
2. Applying error controlling, congestion controlling where necessary but not always.
3. Keeping the existing established connection alive without needing to initiate separate connections for each data transmission.

- **Analyze classification criteria**

In order to determine the optimal data transfer method first we need to analyze the data which are coming to the Transport Layer & according to that we can define classification criteria.

1. Size of data (Small/Medium/Large)
2. Reliability required (Yes/No)
3. Urgent Data(Yes/No)
4. Connection type (Adhoc/Infrastructure)

- **Identify the connection type**

In order to identify the connection type, we shall closely go through the types of wireless networks available

WLANS: Wireless Local Area Networks

WPANS: Wireless Personal Area Networks

WMANS: Wireless Metropolitan Area Networks

WWANS: Wireless Wide Area Networks

Comparison of Wireless Network Types

Type	Coverage	Performance	Standards
Wireless PAN	Within reach of a person	Moderate	Wireless PAN Within reach of a person Moderate Bluetooth, IEEE 802.15, and IrDa Cable replacement for peripherals
Wireless LAN	Within a building or campus	High	IEEE 802.11, Wi-Fi, and HiperLAN
Wireless MAN	Within a city	High	Proprietary, IEEE 802.16, and WIMAX
Wireless WAN	Worldwide	Low	CDPD and Cellular 2G, 2.5G, and 3G

- **Develop algorithms for TLP**

- **Design of New TLP / Implementation of New TLP**

To implement the new dynamic transport layer protocol we analyze the existing TLP and try to find their drawbacks and weak points in wireless network communication. Then we can come up with better solution. In order to do that we use existing TCP, UDP, SCTP etc protocols. So when we are developing new dynamic protocol, we eliminate existing TLP drawbacks and add our researched solution for that.

- **Testing / Modification**

To test new dynamic protocol we use Network Simulator 2 (NS2). This NS2 is an open-source event-driven simulator that runs on Linux, designed specifically for research in computer communication networks.

3.2 Logical Framework Summary

- AIM:

Design and develop a new Dynamic transport layer protocol for communication in wireless environment in an effective, efficient and reliable manner.

- WHY:

Reduce congestion problem.
Maintain a stable connection.
Lower latency when transferring urgent data.

- OUTCOME:

Design a protocol suitable for a wireless environment which has a faster, efficient and reliable at flagged transmissions than other transport layer protocol.

- HOW:

Deep study about existing protocols.
Algorithm design for protocols.
Code for algorithms.
Simulate protocols.
Do a comparison between the expected dynamic protocols against existing protocols.

3.3 Resources to carry out the project

When we are carrying out the tasks related to final outcome we need to gather information about available protocols. This using a personal computer/laptop simulation task can be done with help of Network Simulator II (NSII) software.

Software resources:

- Wireshark software to study behaviors of existing protocols.
- Network Simulator: simulate how new protocol perform.
- C language editor/terminal console and compiler.
- Linux and Windows 7 operating systems.

4. Budget and Budget Justification

Hardware Cost:

Item	**Price (Rs.)**	**Justification**
Routers	3000*2 = 6000	Analyses the bounce back speed

Software Cost:

Item	**Price (Rs.)**	**Justification**
Wireshark	FREE	to study behaviors of existing protocols
Network Simulator 2 (NS2)	FREE	Simulate how new protocol performs.
C language editor/terminal	FREE	Edit suggestions, develop
Linux and Windows 7	FREE	To Authenticate Windows 7 and Linux
Android Software	FREE	To authenticate the smart phone

5. Description of personal and facilities

Group member	Activities
Member 1	• Gaining a deep knowledge about available protocols by going through TCP protocol and other transport layer protocols. • Simulate the proposed protocol in a Network Simulator (NS-2) • Identification and verification of application layer data ❖ Data classification criteria - Size of data (Small/Medium/Large) - Reliability required (Yes/No) - Urgent Data(Yes/No) - Connection type (Adhoc/Infrastructure) ❖ Data types analysis - GPS data - Wi-Fi data - Map data - Sensor data - Location data ❖ Classification of data types according to classification criteria
Member 2	• Deep analysis about available protocols by going through TCP protocol and other transport layer protocols and their details. (TCP, UDP, SCTP, DCCP etc.) • Analysis of drawbacks of currently available protocols. • Simulate the proposed protocol in a Network Simulator (NS-2).

Member 3	• Gaining a deep knowledge about available protocols by going through TCP protocol and other transport layer protocols. • Find out the suitable modifications and do the improvements • Handover method analysis & research to reduce connection establishment times. • Define the dynamic protocol • Simulate the proposed protocol in a Network Simulator (NS-2).
Member 4	• Gaining a deep knowledge about available protocols by going through TCP protocol and other transport layer protocols. • Identify the datagram coming from the Application Layer • Actual development of the dynamic TPL protocol - Kernel level access - Socket API analysis, access and modification • System call modification Simulate the proposed protocol in a Network Simulator (NS-2).

6. Risk Analysis

The following risks have been identified by the team that can be considered as causes for the Incompletion of this research (if any).

- Project Planning Risks - Research does not go as scheduled
  Resources allocated are not working
- Scheduling Risks - Project Dependencies
  Parts Delays
  Estimation errors
  Decision Delays

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8. Appendix

Congestion control: A technique for monitoring network utilization and manipulating transmission or forwarding rates for data frames to keep traffic levels from overwhelming the network medium.

Mobile nodes: A node is either a connection point, a redistribution point communication endpoint

Packet loss: Packet loss is the failure of one or more transmitted packets to arrive at their destination. This event can cause noticeable effects in all types of digital communications

QoS: Quality of Service is the overall performance of a telephone or computer network, particularly the performance seen by the users of the network

Multi-hop: Multi-hop or ad hoc, wireless networks use two or more wireless hops to convey information from a source to a destination.

Wireless ad hoc networks: The ad hoc network does not rely on a pre-existing infrastructure, such as routers in wired networks or access points in managed (infrastructure) wireless networks. Instead, each node participates in routing by forwarding data for other nodes, so the determination of which nodes forward data is made dynamically on the basis of network connectivity.