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Improved Bandwidth Aggregation using Available Lower Bandwidth Links

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Abstract— As Wireless Communication Networks (WCN's) are getting more and more popular, many applications are accessed through WCN's. The lower bandwidths of individual network interfaces can be aggregated to have a larger logical link to meet the demands of applications requiring high bandwidth. This paper proposes a bandwidth aggregation scheme through a concurrent multipath transfer of data with the aim to achieve increased transmission throughput. Incorporating compression\decompression technique can further enhance the transmission throughput.

Keywords—Bandwidth Aggregation; Transmission Throughput; Concurrent Multipath Transfer

I. INTRODUCTION

In the recent decade, there is widespread use of Wireless Communication Networks. Varied users are accessing the WCN's, like scientists for their research activities, doctors for medical emergencies, businessmen for their e-commerce activities, students for their studies, kids for gaming and common men for communication (like Face Time), entertainment(audio, video, online TV) etc. All such applications requiring multimedia services need to transfer a huge amount of data [1]. The bandwidth offered by individual wireless technologies is not sufficient and thus prompts for bandwidth aggregation.

Wireless communication networks of next generation are facilitated with heterogeneity where multiple wireless technologies exist together. At the overlapping coverage areas of these multiple technologies, a receiver can access multiple interfaces simultaneously. This paper proposes to design and implement a logical link for attaining bandwidth aggregation through a concurrent multi-path transfer of data. In the proposed work, a multi-path environment is set up where a proxy server performs forwarding of data packets via Base stations to the client along concurrent multi-paths. Reordering of the received data packets is performed at the client before giving to the application.

The main goals of the proposed work are to achieve increased transmission throughput, resource sharing and reliability. This scheme collectively addresses the issue of accessing available channel resources so that individual low bandwidth links can be aggregated to form a larger logical link. Reliability is achieved as there is alternate path to transfer the data.

The rest of the paper is organized as specified. Highlight on previous research work related to bandwidth aggregation incorporated at various layers of network is described in the related work section. Introduction of the architecture and system flow is done in the proposed work. Experiments conducted and data collected to evaluate the proposed work is described in Experiments and results section. Finally conclusion of the paper is done.

II. RELATED WORK

Various researchers have done their extensive works to bring in bandwidth aggregation in wireless networks by considering different layers of a network [2]. Here is a brief description of their works.

A. Application Layer

A protocol at the application layer for bandwidth aggregation, named ALP-A (Application Layer Protocol based Aggregation) is proposed in [3]. In this paper dynamics of wireless links are taken specifically, by considering mobile devices equipped with both Wi-Fi and 3G network interfaces. An online algorithm is proposed to dynamically schedule data transmission on both network interfaces with the objective of minimizing energy consumption and also guaranteeing the Quality of service.

B. Transport Layer

The transport layer is taken by many researchers to apply their bandwidth aggregation scheme. Concurrent Multipath Transfer protocol (CMT) is considered to be a promising solution for supporting video streaming in future wireless networking. CMT with distortion awareness (CMT-DA protocol) is proposed in [4]. An effective CMT solution that uses an estimation of path status, flow rate allocation, and retransmission to improve the quality of real-time video in integrated heterogeneous wireless networks is proposed.

One of the standard protocols incorporated at transport layer for aggregating bandwidths of multiple interfaces is Stream Control Transmission Protocol (SCTP). A protocol called

Distributed Stream Control Transmission Protocol (DSCTP) is proposed in [5]. It supports multi-homing and multi-streaming to aggregate bandwidths of multiple interfaces of a device. DSCTP make use of available active streams simultaneously at the same time.

C. Network Layer

The earliest work is done in bandwidth aggregation by Kameshwari Chebrolu in [6]. A well-known Earliest Delivery Path First (EDPF) is provided. This work is proposed at Network Layer so that there are minimal changes in existing infrastructure. Earliest Delivery Path First (EDPF) works on the principle that ensures packets meet their playback deadlines by scheduling packets based on the estimation of a transmission time of the packets. The EDPF performs similarly to idealized Aggregated Single Link (ASL) discipline, where a single interface replaces the multiple interfaces having same aggregated bandwidth.

D. Data Link Layer

Bandwidth aggregation at Link Layer is given by Koudouridis [7]. A generic link layer (GLL) approach is proposed in which multiple radio access networks are used while communicating with a particular destination node.
Some of the researchers are concentrating with a transmission of multimedia data on aggregating the bandwidths. The consequences faced with respect to the quality of service are also addressed.

An algorithm for Bandwidth Aggregation using Game Theory for Multimedia Transmission is proposed in [8]. A protocol to improve QoS (Quality of Service) in a heterogeneous network is given in [9][10]. A novel Loss - Tolerant Bandwidth Aggregation approach is given in [11] to proactively leverage the channel diversity in heterogeneous wireless networks for overcoming the burst loss.

III. PROPOSED WORK

In this section, proposed work is described by mentioning the architecture to support bandwidth aggregation and the system flow indicating various activities carried out.

A. System Architecture

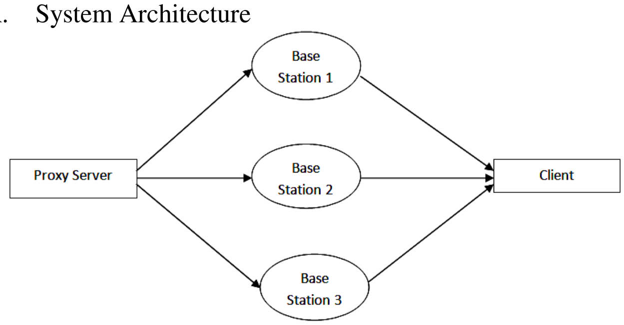

Fig 3.1 Architecture to support bandwidth aggregation

A Multi-Path Environment is set up by having a Wireless Local Area Network (WLAN). In this we have a proxy server, intermediate nodes enacting as Base station1, Base station2 and Base station3. We can have one or more clients. We deploy our network in an area of radius of 10 meters wide. The architecture is as shown in Figure 3.1.

A. Experimental Set Up

In the proposed work, three paths are established from server to client along three base stations. We consider some of the assumptions as there is a single hop scenario. The capacity of each of the transmission paths is calculated. Dynamically the bandwidth available along each of the path is checked. The round trip time which is the sum of the time taken to transmit the packet and receive the acknowledgment is calculated for each of the paths. Based on the parameters, available bandwidth and round trip time, the capacity of each path is calculated. The path capacity is directly proportional to available bandwidth and inversely proportional to round trip time.

Path_Capacity = Available Bandwidth / Round Trip Time

B. Dataset Design

An array list is maintained to keep track of a number of transmission paths. An array to keep information on bandwidths along each path and is kept in a sorted order so as to select a path with maximum available bandwidth. A database of files to be transmitted is maintained at server side and also another database to hold the received files is maintained at the client side. The buffer is maintained at client side to receive the incoming packets.

C. Data Transmission

The system flow is as depicted in Figure 3.2. A data file transmission is requested by the client. The server picks the file from the database. In order to improve transmission throughput, a Deflate compression algorithm is applied and the file is compressed. This compressed file is divided into packets of fixed size say 1000 bytes and maximum utilization algorithm is used to forward the packets along multi – paths [4].

The packets are assigned a sequencing number as packet id. At the receiver side, a buffer is maintained to receive the arrival packets through multipath. There are chances of encountering packets arriving as out of order. Based on packet id of each packet, reordering of the packets is done. Decompression of the received data is performed so as to restore original data before delivering to the application.

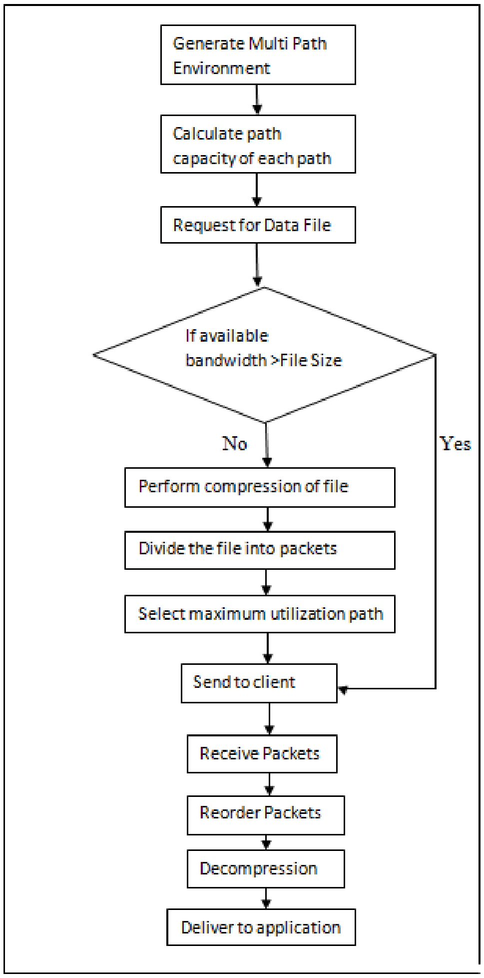

Fig 3.2 System Flow

IV. Performance Metrics

- Packet Delivery Rate: The percentage of packets received by the client with respect to the number of packets sent by the proxy server is calculated as packet delivery rate. Comparison of packet delivery rate with a Base system using CMT and Proposed system using CMT – compression is in Fig 4.1. We could see there is 20 to30 percent increase in packet delivery rate in the proposed system.
- Packet Loss Rate: The number of packets lost during transmission as well as a number of packets received after deadline time constitute for packet loss rate. A comparison of packet loss rate in a Base system with CMT and Proposed System with CMT - compression is as shown in Fig 4.2. A decrease in effective loss rate is observed in the proposed system.
- Transmission Time: The time taken to transmit a complete data file is the transmission time. Here as the file is divided into packets and sent along multipath, the transmission time is reduced. As we are incorporating compression of file, it further reduces the transmission time. Comparison of transmission time in a Base system using CMT and Proposed system using CMT – compression is done in Fig. 4.3. We can see there is 10 to 20 percent decrease in transmission time.

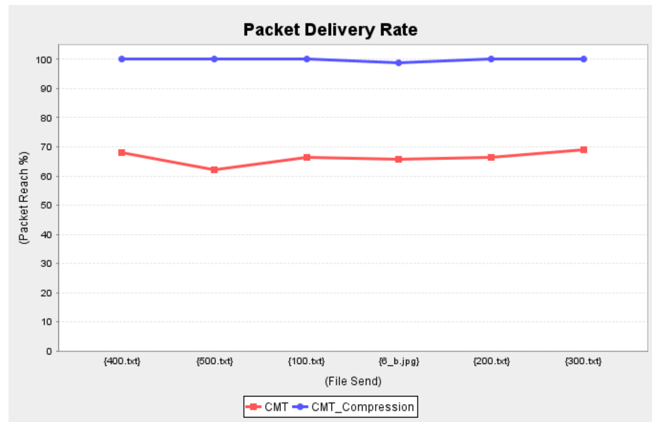

Fig 4.1 Comparison of Packet Delivery Rate

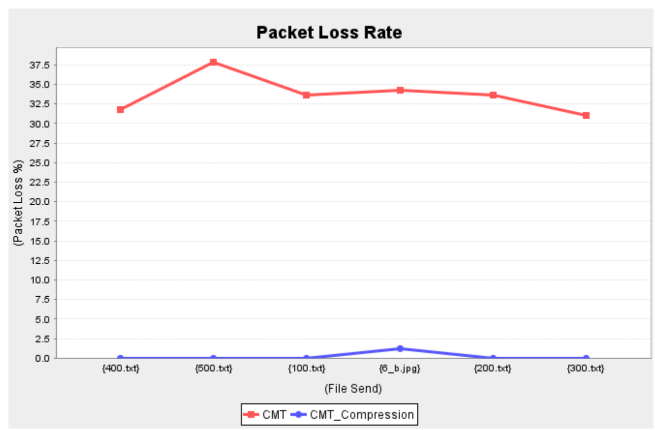

Fig 4.2 Comparison of Packet Loss Rate

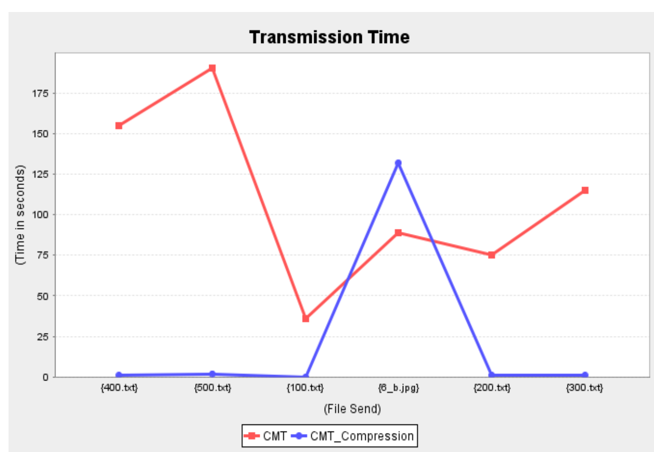

Fig 4.3 Comparison of Transmission Time

V. EXPERIMENTAL RESULTS

Experiments on a transmission of various data files of different sizes are carried out and measure the different parameters considered in the previous section. The files varying in size as around 100KB, 200KB, 300KB, 400KB, 500KB, and 700KB are considered and transmitted. Transmission throughput percentage is calculated as a percentage of the ratio of a total number of bytes received to a total number of bytes sent. The graph that gives a comparison of Base System with Concurrent Multi - Path Transfer (CMT) and Proposed System incorporating CMT with compression is as depicted in Figure 5.1. Here an increase in transmission throughput rate can be seen in proposed system which is the main goal of our work.

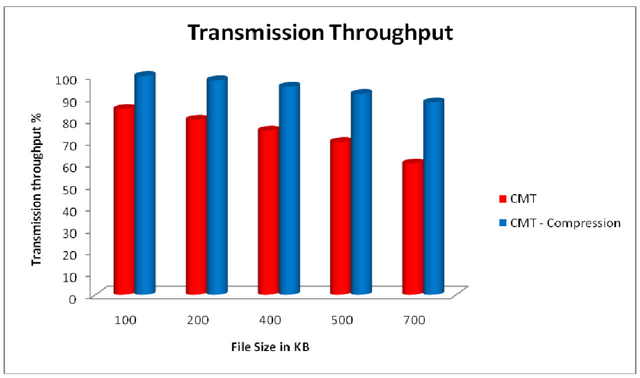

Fig 5.1 Comparison of Transmission Throughput

VI. CONCLUSION AND FUTURE SCOPE

The Concurrent Multipath Transfer of data can bring in performance benefits to meet the requirement of bandwidth demanding applications. The proposed system of CMT with Compression can further increase transmission throughput. Even the transmission time is also reduced as noticed in experiments. Here wireless LAN laid around an area of radius 10 meters and a single hop network is considered. In Future, the same can be enhanced to Multi-hop network and expanded to WWAN.

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REFERENCES

[1] Swaminathan Seetharaman, Dr. S. Srikanth,"Integrated approach towards Bandwidth Aggregation (BAG) in multihomed devices", 3rd International Conference on Signal Processing, Communication and Networking (ICSCN) March 2015.

[2] Allen L. Ramabolin, Olabisi E.Falowo, Anthony H.Chan "Bandwidth aggregation in heterogeneous wireless networks: A survey of current approaches and issues", Journal of Network and Computer Applications 35, Elsevier Ltd. June 2012.

[3] Zaiyang Tang, Zirui Wang, Peng Li, Song Guo, Xiaofei Liao, and Hai Jin "An Application Layer Protocol for Energy-Efficient Bandwidth Aggregation with Guaranteed Quality-of-Experience", IEEE Transactions on Parallel and Distributed Systems 2014

[4] Jiyan Wu, Bo Cheng, Chau Yuen, Yanlei Shang, Junliang Chen,"Distortion-Aware Concurrent Multi path Transfer for Mobile Video Streaming in Heterogeneous Wireless Networks", IEEE Transactions on Mobile Computing, Vol.14, No. 4, April 2015

[5] Mohammad Mamun Elahi, Shahin Khan, "A Distributed SCTP Scheme for Bandwidth aggregation", 16th International Conference of Computer and Information Technology, 8-10 March 2014.

[6] Kameswari Chebrolu, Ramesh R.Rao,"Bandwidth Aggregation for Real-Time Applications in Heterogeneous Wireless Networks", IEEE Transactions on Mobile Computing, Vol. 5, No. 4, 2006

[7] Koudouridis GP, Aguero R, Alexandri E, Choque J, Dimou K, Karimi HR, Lederer H, Sachs J, Sigle , "Generic link layer functionality for multiradio access networks", In Proceedings of mobile summit, 2005.

[8] Tanima Dutta, Samar Sailendra, P. Balamuralidhar, "An Efficient Bandwidth Aggregation Algorithm using Game Theory for Multimedia Transmission" IEEE 25th International Symposium on Personal, Indoor and Mobile Radio Communications. 2014

[9] Juan Carlos Fernandez, TarikTaleb, Mohsen Guizani, Nei Kato "Bandwidth Aggregation-Aware Dynamic QoS Negotiation for Real-TimeVideo Streaming in Next-Generation Wireless Networks" IEEE transactions on Multimedia, VOL. 11, NO. 6, October 2009

[10] Ze Li, Haiying Shen,"A QoS-Oriented Distributed Routing Protocol for Hybrid Wireless Networks", IEEE Transactions on Mobile Computing, Vol. 13, No. 3, March 2014.

[11] Jiyan Wu, Jingqi Yang, and Junliang Chen, "Loss Tolerant Bandwidth Aggregation for Multihomed Video Streaming over Heterogeneous Wireless Networks", Globecom-2013 Symposium

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