Designing a Model to Attain Bandwidth Aggregation through Concurrent Multipath Transfer of Data in Wireless Network

[1]Sharada Ramani, [2]R.M. Goudar
[1,2]MIT Academy of Engineering, Pune, Maharashtra, India

Abstract
Wireless communication systems of next generation are featured with heterogeneity where multiple wireless technologies exist together. At the intersection of coverage areas of these multiple technologies, receiver can access multiple interfaces simultaneously for better performance and prompts for bandwidth aggregation. This paper proposes to design and implement a logical link for attaining bandwidth aggregation through concurrent multi path transfer of data with the aim of achieving increased transmission throughput as well as resource sharing. In the proposed work, a multipath environment is set up where a proxy server performs forwarding of data packets along concurrent multi paths. Reordering of the received data packets is performed at client before delivering to the application.

Keywords
Bandwidth Aggregation, Concurrent Multi Path Transfer, Heterogeneous Wireless Network.

I. Introduction

In recent years, the wireless networks are enormously increasing with more and more users being added every day. The usage of WiFi enabled mobile devices such as laptops, tablet PC's, smart phone's has been increasing rapidly. Many wireless applications are widely used such as e-commerce, education, entertainment, banking etc. Access of multimedia for watching videos, playing games, online conferences requires high bandwidth [3].Wireless networks have evolved from 2G to 3G and recently with 4G cellular networks with increased bandwidth and high throughput [2]. Still the hunger for more bandwidth is not met. This has led to an idea of using available channel resources simultaneously thus prompting for the bandwidth aggregation. A multi homed device can access multiple interfaces simultaneously to meet the requirement of high bandwidth demanding applications [6].
This paper proposes to design and implement a logical link for attaining bandwidth aggregation through concurrent multipath transfer of data. For this a special logic is incorporated at both the ends performing aggregation/de-aggregation of data packets.

II. Proposed work

The objectives are as follows:
- To increase transmission throughput by transferring data through concurrent multi paths.
- To increase resource sharing by integration of the limited channel resources available.
- To increase the reliability by providing alternate path to transfer data.

A. System Architecture

A simulated version of multi path environment is set up where multiple machines are connected amongst a wireless local area network. These specific machines are depicted as heterogeneous wireless network mode. Individual machines will have their own transmission rates. The paths along specific machines constitute for concurrent multipath transfer. Aggregation on multipath is done to get accumulated bandwidth. Fig. 1 shows high-level overview of architecture to support bandwidth aggregation through concurrent multipath transfer.

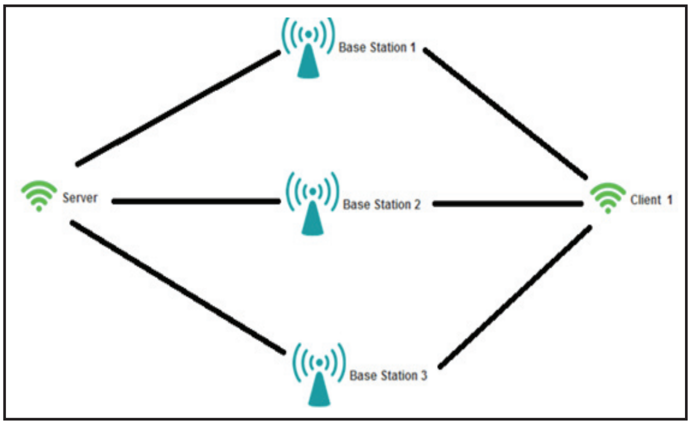

Fig. 1: Overview Architecture for Attaining Bandwidth Aggregation

The system consists of following modules:

Module 1: Network Generation

Since this is a simulation process, multiple PCs are connected in a Wireless Local Area Network. Some of the machines act as medium of transport such as wifi or WiMax and are termed base stations. One of the machines acts as a proxy server for hosting the data packets and other as the client.

Module 2: Forwarding of Packets

When a client requests for a media stream, proxy server fetches it from Media stream server. A proxy server is connected to multiple paths in network. Each path in network is independent and are characterized by following properties
- The available bandwidth -the number of bits transferred in unit time.
- The round trip time - the total amount of time taken to send the data packet as well as receive the acknowledgment of that packet.
- The path loss rate - the probability that there is loss of packet.

Based on the above mentioned factors, transmission capacity for each path is assigned. Utility Maximization Based Flow Rate Allocation Algorithm [1] would be implemented for scheduling of data packets so as to obtain a total optimum throughput. This is an adaptive (dynamic)approach of bandwidth aggregation [4] as network traffic are considered.

Module 3: Reordering of Packets

The end-to-end delay of each path varies. While transferring of packets in concurrent multipath, there are more chances of getting

ISSN : 0976-8491 (Online) | ISSN : 2229-4333 (Print)

packets receiving as out of order. Therefore the packet scheduling scheme [5] is suggested to arrange the transmission sequence so as to minimize the delay caused due to reordering of packets at the receiver. At proxy server, the data file to be transferred is divided and sequence numbers to data packets is assigned. The output at the receiver is generated by resequencing of packets. This not only aggregates the available bandwidth of multi paths, but also reduces the delay caused due to reordering of packets at the receiver.

B. Methodology

- **Step 1:** Find the available paths in network
- **Step 2:** Characterize each path based on factors considered such as bandwidth, round trip time and assign the capacity to each path.
- **Step 3:** Perform packet forwarding based on path capacity.
- **Step 4:** At client side, generate output by reordering the packets received through multi paths.

III. Mathematical Model

The mathematical model can be represented by using a tuple <U; P; F> Where U is main set of users like u1, u2, u3. . .
U = {u1, u2, u3..}
P is set of communication paths p1, p2, p3...
P = {p1, p2, p3..}
Every path p is an independent communication path. They are characterized by the following properties:

- The available bandwidth
- The round trip time
- The path loss rate

F is the set of functions like f1, f2, f3. . .
F = {f1,f2,f3..}
Where
f1 = Find the available paths in the network
f2 = Assign Path capacity to each of the paths
f3 = Perform packet forwarding
f4 = Perform packet reordering

Input: Source Data file to be sent
Output: Buffered stream of data packets at receiver

NP hard or NP complete:
The set of all decision problems that can be solved in a polynomial time by using the given algorithm is considered to be NP Complete. Here the solution for the problem is generated within definite time. So the project is NP Complete.

IV. Algorithms

Algorithm at Proxy Server

```
INPUT : Input data file
OUTPUT : Packets stream, METADATA
BEGIN
Let P be set of paths
Check for available paths p
FOR each path p in P
DO
Check the available bandwidth
Calculate round-trip time
Calculate path loss rate
end DO
ASSIGN path-capacity to path p
End FOR
IF INPUT media-stream _ path-capacity
THEN call single-path-transfer()
ELSE
call multi-path-transfer()
ENDIF
ASSIGN sequences to packets
CREATE METADATA of sequences
SEND METADATA to client
SEND packets stream to client
UPDATE free resources of path p
END
```

Algorithm at Client

```
BEGIN
REQUEST media stream
SEND request to proxy server
RECIEVE METADATA of packets
PERFORM reordering of packets
Give streaming media to applications.
END
```

V. Performance Metrics

The evaluation results are measured with the performance metrics as mentioned below:

1. **Goodput:** Goodput is the number of useful bits successfully received by the destination within the deadline.
2. **Effective Loss Rate:** The effective loss rate is the rate at which data is not received successfully at the destination.
3. **Transmission Time:** The time taken to transfer the data file from proxy server to the destination is the transmission time. In the proposed system this is significantly reduced as there is concurrent transfer of data along multiple paths.

VI. Conclusion

Bandwidth aggregation approaches are proposed so that a multiple network interfaces can be accessed through concurrent multi paths. When compared to conventional single interface, bandwidth aggregation can provide better Performance by giving increased throughput, resource sharing and reliability. A larger logical link with high bandwidth can be created by aggregating multiple lower bandwidth links so as to meet the demands of applications requiring higher bandwidth. In future, the next generation wireless networks would be the convergent of various networks, incorporating diverse transmission features and capabilities. Bandwidth aggregation is facilitated in multi homed mobile terminals for increased transmission throughput and enhanced reliability.

References

[1] 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
[2] Swaminathan Seetharaman, Dr. S. Srikanth,"Integrated approach towards Bandwidth Aggregation (BAG) in multi-homed devices", 3rd International Conference on Signal Processing, Communication and Networking (ICSCN) 2015.
[3] 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.
[4] 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, 2012.
[5] 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
[6] Mohammad Mamun Elahi, Shahin Khan, "A Distributed SCTP Scheme for Bandwidth aggregation", 16th International Conference of Computer and Information Technology, 8-10 March 2014.

Sharada Ramani, PG Scholar, perceiving ME(Computers) from MIT Academy of Engineering, Pune, India Areas of interests are computer networking, data warehousing.

R.M. GOUDAR, Associate Professor at Department of Computer Engineering, MIT Academy of Engineering, Pune, India. Areas of interests are computer networks, wireless communications.