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Improved Goodput for Real-Time Traffic over Multipath Wireless Network

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Abstract— ***The advancements of technologies in wireless infrastructures frameworks facilitate the mobile users for simultaneous video transmission to hand-held portable gadgets. Mounting an operational solution is critical for improving traffic performance and utilization of network. Due to path variety and irregularity in heterogeneous networks, huge end-to-end delay and packet losses can significantly reduce the traffic flow goodput, but current studies mostly emphasis on the delay and throughput performance. This challenges are addressed by goodput-aware load distribution model that contains to effectively integrate the path status estimation, flow rate assignment, and packet interleaving to increase the goodput performance of real-time traffic over multipath networks. Through harvest-then-transmit protocol implementation, the mean of achieving increased transmission goodput in addition to improve video PSNR.***

Keywords— Goodput, Harvest-Transmit Protocol, Wireless Networks, Real-Time Traffic.

I. INTRODUCTION

The massive development in wireless infrastructures and handheld devices allow mobile users to get multimedia contents with universal access routes, for example cellular networks, wireless remote area networks. The network heterogeneity and high degree connectivity to various access medium deliver increased chances to found multiple paths between end devices [6]. Though, a single communication path is not proficient of completely filling the stringent quality of service requirements such as delay, bandwidth and reliability executed by existing and emerging real-time multimedia applications [10]. With the rise of multihomed or multi network clients, new research trends have motivated towards concurrently using these multiple paths for improved transmission reliability and throughput [4]. Supported by the latest achievement in transmission technologies, mobile terminals are prepared with multiple radio interfaces to receive video through concurrent wireless networks. The prevalence of such multihomed mobile workstations, the upcoming wireless environment is probable to incorporates multiple access options to providing high-quality mobile services. Especially, an effective transport-layer protocol is capable to assurance the application-layer quality of service and optimize the utilization of networks. Moreover, only transport protocols require the alteration at communication terminals. The significant research issue in exploiting the available paths between multihomed communication terminals is to efficiently allocate input traffic load for providing sufficient QoS perceived by end users [9]. Certainly, ineffective load sharing can significantly reduce the traffic performance and network utilization such as load inequality, packet reordering, large end-to-end delay, etc. However, these network-level criteria cannot accurately show the benefits of upper-layer applications. Furthermore, the increased throughput may lead to larger end-to-end delays, which in turn prompt video quality degradation. Goodput differs from throughput as it represents the amount of data successfully received by the destination within the imposed deadline [11]. Multi-path transport has to deliver benefits from bandwidth aggregation to increased robustness. Although many devices support multi-homing, the most prominent transport protocol is TCP, but it only supports single-path transmission. The MPTCP extension enhances multipath transmission to TCP. MPTCP uses a single standard TCP socket on the MPTCP level, whereas lower in the stack, several subflows that are conventional TCP connections may be opened. This way, an application only has to deal with a single MPTCP connection and therefore may remain unchanged. MPTCP provides two levels of congestion control, at the subflow level, each sub flow is in charge of its own congestion control [12]. At the MPTCP level, coupled congestion control is provided to fairly share the network links among the subflows. So, by using multiple interfaces simultaneously, can improve quality and provide support for applications requiring high bandwidth.

II. REVIEW OF LITERATURE

Vicky Sharma [1] a Multi-Path LOss-Tolerant (MPLOT) transport protocol that can realize significant bandwidth increases through the actual use of multiple heterogeneous end-to-end paths subject to very high and bursty loss rates. MPLOT provides higher goodput than simple bandwidth aggregation by exploiting multiplicity from multiple paths in the presence of delay heterogeneity across paths, and even with bursty, high, correlated loss rates. It is built on the fundamental principle of separating uniformity and congestion control. MPLOT makes actual use of erasure codes to provide reliability, coupled with loss rate assessment at the aggregate level across paths. However, an intelligent packet mapping design like the adaptive rank established method used by MPLOT is required to make preeminent use of the aggregate goodput across the diverse and dynamic component paths. In MPLOT, these effects are realized by sending the latest feedback on the best path and mapping packets to paths based upon a rank function that values shorter RTT, lower loss, and higher-capacity paths. MPLOT permits us to achieve a required trade-off point between goodput and delay and limit the amount of retransmissions required for block-data recovery. In addition to delivering significantly higher goodput compared to other multipath transport protocols, MPLOT also achieves a lower delay. The delay is better performed, thus making MPLOT further proper for a large assortment of applications that seek reliable delivery under lossy conditions. MPLOT can be efficiently used for a wide range of applications to deliver better performance higher goodput, lower delay than remaining protocols under an extensive series of network conditions.

Jiyan Wu, and Yuen et al. [2] a Bandwidth-efficient multipath streaming (BEMA) protocol is marked by the priority-aware data scheduling and forward error correction based on consistent communication. This protocol is enlarged to increase the performance of data communication and utilization of networks. Author proposes a protocol is to facilitate quality-guaranteed immediate video gushing over multiple wireless networks. They also develop a joint raptor coding and data distribution framework to get video quality with least use of bandwidth. BEMA protocol is capable to efficiently ease packet rearranging and path asymmetric to network consumption.

Singh et al. [3] a multipath real-time transport (MPRTP) protocol extends real-time transmission protocol (RTP) to multipath message development. However, it does not offer consistent data transfer aligned with channels losses. The implementation of this protocol shows that it is secure to install and facilitate load allocation and ability aggregation in different situation. MPRTP may support well in collecting various wireless networks for vehicular internet access. This protocol differentiates the communication paths through the congestion level and the allocation of bandwidth to delay.

Tianjiao Liu et al. [4] a novel Quality-aware adaptive concurrent multipath transfer (CMT-QA) scheme uses SCTP for FTP similar to data communication and concurrent video release in multiple wireless networks. This method examines and analyses frequently all paths data handling ability and creates data delivery correction decisions to choose the qualified paths for parallel data transfer. CMT-QA includes a series of devices to allocate data chunks over several paths intensely and control the data transfer rate of each path individually. The objective is to diminish the out-of-order data response by redundant fast retransmissions and decreasing the altering delay. It can efficiently distinguish between special forms of packet loss to avoid difficult congestion window modification for retransmissions. CMT-QA outperforms offered solutions in terms of quality and performance of service.

S. Han et al. [5] an effective end-to-end multipath transmission system to enable steady exist video gushing over multiple wireless networks stand on fountain code. Author also propose packetization-aware fountain code to incorporate several physical paths well and raise the fountain decoding possibility over wireless packet switching networks. They present a straightforward but useful physical path selection algorithm to make best use of the efficient video programming rate although fulfilling delay and fountain decoding failure rate constraints. These system is fully executed in software and observed over existent Wireless local area networks and High Speed Downlink Packet Access networks. Here mapping algorithm can maintain superior video quality than the predictable random mapping algorithm over wireless networks. The entire system is implemented using java and C/C++.

Vinh Bui [6] Online Policy Iteration (OPI) algorithm also uses a path state monitoring mechanism that complies with the end-to-end principle and captures congestion states of overlay paths. The Join the Shortest Queue (JSQ) algorithm is selected as the starting policy. When a new data bin arrives, OPI observes the current system state and takes an appropriate action following the current policy to distribute the data bin. Then, it evaluates the immediate reward for the action taken.

Sumet Prabhavat [7] Effective Delay Controlled Load Distribution (EDCLD) is to minimize the latency differences among different network paths for reducing packet reordering at the receiver and to efficiently balance load across these paths. E-DCLD consists of three functional components: traffic splitter to derive flow rate allocation ratios for different paths, path selector to select an appropriate path for each packet, and load adaptor to dynamically estimate the end-to- end delays on each path.

III. PROPOSED WORK

A. Objectives

- To increase transmission goodput for by transferring video through multipath real-time traffic.
- To increase the video PSNR by considering the video encoding rate.
- To increase the reliability by providing alternate path to transfer video.

B. 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. A multiple overlap network integrating multiple communication paths between two terminals. The end-to-end connection can be constructed by binding a pair of IP addresses from the source and destination node, respectively. The flow rate allocator is responsible for partitioning the input traffic into several subflows and dispatching each of them to the available paths. The allocated sub-flows will be temporarily stored in the sending buffers for different communication paths. The system overview of the proposed protocol as shown in Fig. 2.

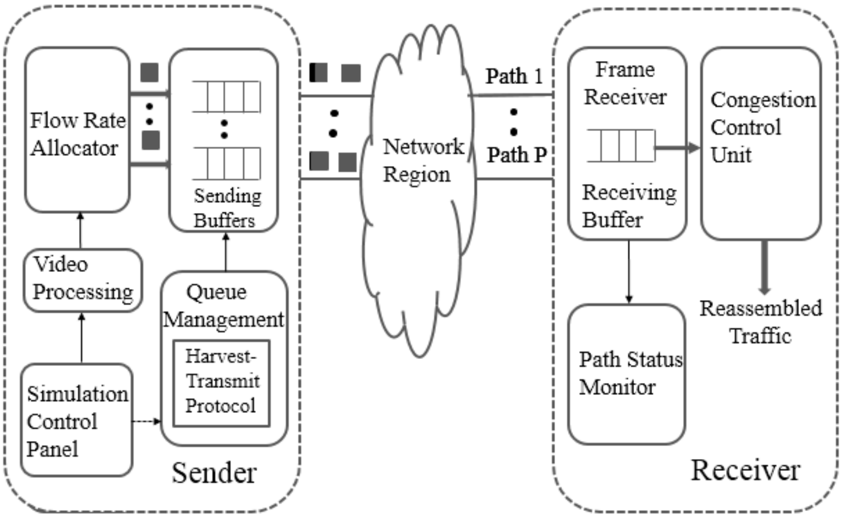

Fig. 1: Overview of the System Architecture

The system consists of following modules:

1) 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 Wi-Fi or WiMAX and are termed as base stations. One of the machines acts as a server for hosting the video frames and other as the client.

2) Module 2: Video Processing

When a client requests for a video file, first protocol find out efficient path for transmission which is connected to multiple paths in network. Each path in network is independent and has specific transmission speed being characterized by following properties:

i) The available bandwidth - the raw per-path capacity in unit time as perceived by end-to-end flow.

ii) The round trip time - the total amount of time taken to send the video packet as well as receive the acknowledgment of that packet.

iii) 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 Assignment Algorithm would be implemented for scheduling of video frames so as to obtain a total optimum goodput.

3) Module 3: Network Communication

The end-to-end delay of each path varies. Harvest-then-Transmit protocol is used to optimize the goodput performance using decision making process and queue management, where energy efficient path is selected to transmit the video.

IV. MATHEMATICAL MODEL

The mathematical model of the project can be represented by using Number of nodes V, Transmission links E, Transmission Cost C, and Access Point AP.

Process 1: Network Communication

Given a Network Graph (System) G = (V, E)

Where, V is the set of n vertex, V = {V 1; V 2; V 3; …. Vn}

E is the set of m directed edges, E = {E1; E2; E3; …. Em}

For each edge (i, j) in V

c(i, j) - cost per unit flow on (i, j)

u(i, j) - maximum amount of flow on (i, j)

l(i, j) - minimum amount of flow on (i, j)

x(i, j) - the flow on (i, j) that needs to be determined

$P = \text{Min} \sum c(i, j)x(i, j)$

Min Cost(Dist)

Process 2: Queue Management

Where, B = buffer size;

S = arrival time of previous packet;

T = current time;

b = number of bytes in current packet;

VQ = number of bytes currently in the virtual queue,

s = source node,

t = sink node,

F = bandwidth transmission.
At each packet arrival do
VQ = max (VQ - C(t - s)
If VQ + b > B
Then store packet in the queue
Else VQ = VQ + b
C = max (min (C + C(t-s); C))
F = S←T

Output: Routing (path) P ← Min (s, t).
Success: Get routing path P while Broadcasting.
Failure: Packet drops while maximum network congestion.

V. ALGORITHMS

A. Flow Rate Assignment Algorithm

To maximize the aggregate goodput of input traffic load, use the linear approach for the flow rate assignment based on utility theory. The utility theory based algorithms are inclined to assign loads to communication paths with higher quality. To assign a large amount of flow rates to network paths with higher quality and transmission capability.

INPUT: Input traffic load
OUTPUT: Packets stream
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 load to each path p
End FOR
IF INPUT traffic load ≤ path-capacity
THEN call single-path-transfer
ELSE call multi-path-transfer ()
ENDIF
ASSIGN indexes to packets
UPDATE free resources of path p
END

B. Path Status Estimation Algorithm

To effectively utilize the channel resources available in wireless networks, it is important to accurately estimate the status of each communication path. We use the path probing traffic adjustment algorithm to improve the measurement accuracy and reduce the network overhead.

BEGIN
FOR each communication path p in P
Do
IF number of wireless loss occurs
THEN update the loss parameters of path p
ELSE
Decrease the probing rate
Spread the probing packets
ENDIF
IF confidence interval not equal
THEN increase the probing packet size to improve accuracy
THEN set the packet size to the normal value
ENDIF
Send the probing packets to path p at time
ENDFOR
END

VI. PERFORMANCE METRICS

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

A. Goodput: Goodput is the number of useful bits successfully received by the destination within the deadline.
B. Effective Loss Rate: The effective loss rate is the rate at which video is not received successfully at the destination.

C. Transmission Time: The time taken to transfer the video file from server to the destination is the transmission time.
D. PSNR (Peak Signal-to-Noise Ratio): It is a standard metric of video quality and is a function of the mean square error between the original and the received video frames.

VII. CONCLUSIONS

The growth of real-time traffic over the internet has become a major driving force for multihomed communications over corresponding network paths. It is a challenge to effectively deliver real-time applications with stringent delay, goodput, and reliability requirements. So, harvest-then-transmit protocol is used to improve the goodput performance of multipath Real-time traffic over wireless networks. This protocol finds out the efficient path and then transmit video using queue management and decision making process. In future, the next generation wireless networks would be the convergent of various networks, incorporating diverse transmission features and capabilities.

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