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Bandwidth Efficient Aggregation Mechanism through Concurrent Multipath Transfer Protocol for Quality-Guaranteed Real Time Video over Heterogeneous WSN

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ABSTRACT: Recent technological advancements in wireless infrastructures and handheld devices enable mobile users to concurrently receive multimedia contents with different radio interfaces (e.g., cellular and Wi-Fi). However, multipath video transport over the resource-limited and error-prone wireless networks is challenged with key technical issues: 1) conventional multipath protocols are throughput-oriented, and video data are scheduled in a content-agnostic fashion and 2) high-quality real-time video is bandwidth-intensive and delay-sensitive. To address these critical problems, this paper proposes a bandwidth-efficient multipath streaming (BEMA) protocol featured by the priority-aware data scheduling and forward error correction-based reliable transmission. First, we present a mathematical framework to formulate the delay-constrained distortion minimization problem for concurrent video transmission over multiple wireless access networks. Second, we develop a joint Raptor coding and data distribution framework to achieve target video quality with minimum bandwidth consumption. Wireless communication networks are featured with heterogeneity where multiplewireless technologies exist together. In the intersection of coverage areas of these different technologies, receiver having multiple interfaces can access them concurrently so as to improve the performance and this prompts bandwidth aggregation. A larger logical link can be created by aggregating low bandwidth links. The same link can be used by a multimode terminal for applications that are demanding high-bandwidth. Advantages of bandwidth aggregation and the challenges that are faced in attaining bandwidth aggregation are discussed in this paper. An overview of the architecture, different approaches and bandwidth aggregation techniques employed in various layers of network are highlighted. In proposed work will work on Certificate less Key Management concept for maintain privacy and security to maintain the video aggregation stability.

KEYWORDS: Bandwidth aggregation; concurrent multi path transfer; heterogeneous wireless network

I. INTRODUCTION

Recently handheld devices (e.g., smartphone and iPad) is explosive increasing, on the other hand, mobile video streaming (e.g., Hollywood [1] and Metacafe [2]) has become one of the most popular portion of network flow. According to the Cisco Visual Index [3] report, the percentage of mobile video streaming is 57% in 2012 and will increase to 69% by the year 2017. As a result, focus on mobile video quality guarantee study is meaningful. With the progress of technology mobile devices users could access network with various options (e.g., WLAN, 3G/4G and WiMAX), but problem still existing because bandwidth lim-itation of single wireless causing bottleneck of mobile video quality promotion. Contemporary WLAN systems could not guarantee video streaming quality because of small coverage area and limited bandwidth when there are number of mo-bile users [4-5]. Meanwhile, cellular networks (e.g.,

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UMTS)could provide more reliable service to mobile users, but theirbandwidth is finite for high-quality video transmission [6].The 4G LTE and WiMAX could provide higher transmissionrate and larger coverage area, however, they are not widelyapplied and bandwidth limitation also existing as the numberof mobile users increases. Above all, the limitation of singlewireless network turn research attentions to multi-path videotransmission With the rapid growth of Internet, the advancement of technology and reduced cost of electronic components, more and more number of users are using the mobile data access and data transfer by using various network interfaces for the devices like laptop, notebook, tablet and smart-phone using various wireless technologies like 802.11, Bluetooth, GSM,3G, WiMax etc.[7][8] The existing wireless technologies differ in terms of services provided like bandwidth, coverage, price, quality of service support. If there is a restriction on the usage of these available resources with interfaces on the user device as one interface at a time, then imposes limitation on the flexibility and better utilization. So by using multiple interfaces simultaneously, can improve quality and provide support for applications requiring high bandwidth [8]. Further delay can be reduced when alternate path of communications are kept alive enhancing the reliability of data. Heterogeneous Wireless Network (HWN) is a wireless communication network where Internet services can be accessed through multiple wireless technologies like WiFi, WiMAX, GSM etc[5][6][9]. Nowadays many of the Internet applications are demanding high bandwidth. The bandwidth of an individual technology is not sufficient to meet the current demand. Hence by aggregating the individual low bandwidth links form a high speedy larger logical link. Bandwidth aggregation in heterogeneous wireless network will provide many of benefits for real time applications.Many internet applications like video streaming services (example: YouTube, teleconferencing, online gaming etc) demand high bandwidth. The bandwidth of existing individual technologies is inadequate to support throughput demanding video applications. Hence bandwidth aggregation provides the increased transmission throughput to meet the requirement. A multimode device can use various wireless technologies simultaneously to provide different range of bandwidths and each technology is being operated independently. Thus bandwidth aggregation increases resource sharing by integration of the limited channel resources available.

Attaining bandwidth aggregation through concurrent multipath transfer of data provides greater reliability. Multiple paths or channels are available for the transmission. At any instance, if any path fails, then there is availability of other path for the transmission. Thus bandwidth aggregation can bring in increase in reliability of communication system. The bandwidth aggregation in wireless networks can be defined as the aggregation of bandwidth offered by individual links of multiple technologies to form a high speedy larger logical link. The accumulated bandwidth from multiple wireless interfaces can create a high bandwidth larger logical link. This has several performance benefits [5] as described below.

II. BANDWIDTHAGGREGATION APPROACHES

Bandwidth aggregation approaches are classified as dynamic or static depending on their adaptively to network traffic flow as shown here.

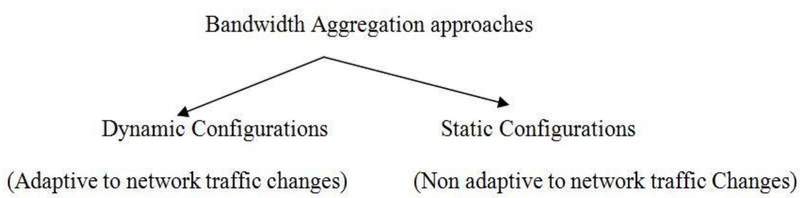

Fig 1: Classification of Bandwidth aggregation approaches

1. Dynamic Configuration / Adaptive approach:

The bandwidth aggregation approach in which the varying network traffic characteristics are considered are known to be dynamic configurations or adaptive approach [4]. The network traffic is characterized by available bandwidth, delay and path loss rate. These are considered periodically for making scheduling decision of packets. Adaptive bandwidth

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aggregation approach have better performance gains over Non-adaptive bandwidth aggregation as changes in network traffic are considered and dynamic configuration of interface selection is carried out.

2. Static Configuration / Non adaptive approach:

The bandwidth aggregation approaches in which the network dynamics are not considered and assume non-varying network traffic are known to be static configuration approach or non-adaptive approach. The scheduling decision of packets is done based on static load balancing and does not take into consideration about network traffic conditions. Implementation of such approaches is easier and contributes for improved throughput and reliability. However performance degrades when paths have different network traffic conditions.

III. REVIEW OF LITERATURE

A survey of bandwidth aggregation solutions addressed at various layers of network protocol stack such as Application layer, Transport layer, Network layer and Link layer is discussed in [4]. Here is a brief look at bandwidth aggregation techniques employed in various layers of network.[6]An application layer protocol for bandwidth aggregation in mobile devices is suggested in [2]. In this paper, a protocol for aggregating WiFi and 3G wireless links on mobile devices is suggested. An algorithm is proposed that can transfer wireless data over both WiFi and 3G interfaces with the aim of minimum battery energy consumption. This service is made simple by providing a mobile application in the mobile devices that is independent of operating system and network protocol stack. In general, application layer bandwidth aggregation mechanism use a middleware for sending packets over multiple interfaces at sender as well as for collecting the received packets in proper sequence at receiver side. Thus a middleware mechanism to be deployed at both sender and receiver side for optimal operation, this limits the widespread uses of application layer bandwidth aggregation approach. [7]

Stream Control Transmission Protocol (SCTP) is the standard protocol at transport layer of network to enable concurrent multipath transfer (CMT) in heterogeneous access network. A distortion aware CMT solution (CMT-DA) for video streaming is provided in [1]. The CMT-DA solution uses estimating path status, allocating flow rate also delay and loss controlled retransmission to have quality of service (QoS) in real time video streaming in multiple wireless interfaces [14]. In this paper, transmission of video streaming is done using the SCTP association from source to a destination node. SCTP transmission involves the sockets. [1] The video is encoded and further encoded data is then divided into several chunks and sent over multipaths. The receiver receives the packets in a receiving buffer and reorders to restore the original video to be given to the upper layer applications. The transport layer mechanisms for bandwidth aggregation require adaptations at node as well as remote server; this limits deployment to specific applications [5].

An important aspect of bandwidth aggregation mechanism is scheduling of data packets onto different interfaces. A network layer solution for bandwidth aggregation is given by proposing a well-known Earliest Delivery Path First (EDPF) scheduling algorithm [5]. A packet-pair scheduling for TCP application was also proposed [7]. Both the approaches involve a network proxy, providing various services like bandwidth aggregation, resource sharing and mobility support to client by accessing multiple network interfaces. Network proxy is responsible for concurrent transmission of data over multi paths and also assembling the packets received at receiver. A mobile host (MH) connected to network via multiple interfaces acquires a fixed IP address from network proxy and uses it to directly communicate with the remote server. The network proxy works based on IP-within-IP encapsulation. This mechanism is similar to the mechanism used in Mobile – IP, but with extension to support multiple interfaces. The network layer solution overcomes the limitations of solutions provided at other layers of network but is always not an efficient approach as it operates at lower layer of the network protocol stack.

Bandwidth aggregation at link layer allows multiple data link paths to be grouped into a single larger logical path with the capacity greater than individual path's capacity. In link layer protocol, data units are split across multi paths to achieve increased throughput. A concept of Generic Link Layer (GLL) [6] offers a link layer functioning over heterogeneous wireless interfaces to have improved performance. A similar concept as Cognitive Convergence Layer (CCL) [9] which synchronizes the various functions of link layer and create a unique virtual link layer interface between upper and lower layers of network interfaces. The CCL performs traffic distribution at sender and reordering of packets at receiver. Some more link layer approaches have been proposed. [2] However, link layer bandwidth aggregation solution require specific hardware or software, this limits the deployment of this approach to local domains under the control of same operator [3].

IV. CHALLENGES IN BANDWIDTH AGGREGATION

1) Stringent QoS requirements. High-quality live video streaming is bandwidth-intensive and delay-sensitive.The throughput demand for high-definition video distribution mainly ranges from 2−6 Mbps. Besides, the one-way delay is limited to be less than 150 ms to achieve excellent real-time video quality [5].

2) Network bandwidth limitation. The radio resources inwireless platforms are scarce and time-varying. Recentstudies [4], [6] reveal that the available bandwidth forindividual mobile users in 4G LTE networks generallyranges from 1.5to2.5 Mbps.

3) Path asymmetry. The different physical properties and time-varying network status result in the path asymmetry of heterogeneous access networks [4]. The involvement of an unreliable communication path in multipath video transport only degrades the average quality.

4) TCP (MPTCP) [7] and Stream Control Transmission Protocol (SCTP) [8] are the transport-layer proto-cols recommended by IETF (Internet Engineering Tas Force) to enable parallel data transfer over multiple communication paths. However, both MPTCP and SCTP are ineffective for real-time video delivery since the packetretransmission mechanism incurs large end-to-end delay.

V. SYSTEM ARCHITECTURE

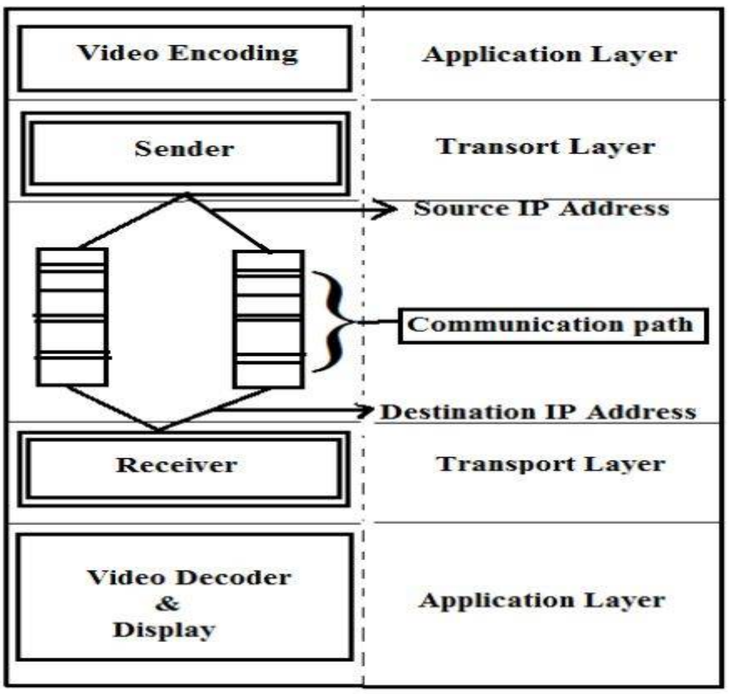

Fig 2: Overview architecture to support bandwidth aggregation

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Fig 2 shows high-level overview of architecture to support bandwidth aggregation through concurrent multipath transfer. The figure depicts heterogeneous wireless network with two wireless interfaces say (WiMax and GSM). When the coverage areas of these wireless technologies overlap, a multimode device in this area can use them simultaneously [5]. 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 has specific transmission speed being characterized by following properties [1].

- The available bandwidth – the number of bits transferred in unit time
- The round trip time – the total amount of time for sending the data packet and the time for receiving the acknowledgement of that packet
- The path loss rate – the probability that the packet gets lost in that path

Based on the above mentioned factors, transmission capacity for each path is assigned so as to obtain a total optimum throughput. However end-to-end delay of each path varies. While transferring of packets in concurrent multipath, there are more chances of packets arriving 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. The output at the receiver is generated by reordering of packets received through multi paths. This not only aggregates the available bandwidth of multi paths, but also reduces the delay due to reordering of packets at the receiver.

VI. MATHEMATICAL MODEL

Let us consider S as a system for Bandwidth aggregation analysis in WSN:
Assume that node *j* is in the small region of *Ax* with the width of *ε*. Denote *x* as the distance between *Ax* and the sink, and *θ* as the angle formed by *Ax* and the sink. If each node generates one data packet per round, the average data amount sent by *j* in a round at *S*0 is,

$$P_j^{(0)}=\begin{cases}(z_1+1)+\frac{z_1\,(1+z_1)r}{2x} \\ \frac{1}{2}(z_2+2)\varepsilon^2\theta\rho+\frac{1}{2}\end{cases} z_2(z_2+1)\mathrm{r}\varepsilon\theta\rho, \qquad \text{otherwise}$$

Where,
z_1=∟(R-x)/r⌋ and z_2=∟(R-ε)/r⌋
Since node *j* is in the small region of A_x, its traffic load can be calculated as the average traffic load in *Ax* according to our analytic model. Therefore, we first calculate the average traffic load in A_x. *ε*is the width of *Ax* and *θ* denotes the angle formed by *Ax* and the sink; thus, we can obtain the number of nodes in *Ax* As these nodes receive and forward the data from the upstream regions, the number of sensor nodes in the upstreamregionsA_{x+ir},

$$N_{A_{x+ir}}=\begin{cases}(x+ir)\epsilon\theta\rho|0<i\le z_{1,} \\ \left(\frac{\varepsilon}{2}+ir\right)\varepsilon\theta\rho|0<i\le z_2\end{cases}$$

Where,
z_1=∟(R-x)/r⌋ and z_2=∟(R-ε)/r⌋
Since each node only generates a data packet per round, the number of data packets equals to the number of the involved nodes. Thus, the number of data packets sent by *Ax* is,
$D_{A_x}=N_{A_x}+N_{A_{x+r}}+\ldots\ldots\ldots\ldots+N_{A_{x+zr}}$

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We have the average traffic load of *Ax* as $\frac{D_{A_x}}{N_{A_x}}$.Since the traffic load of the node *j* approximately equals the average traffic load of the sensor nodes in *Ax*, the traffic load of the node *j* at S_0should be $P_j^{(0)}$=$\frac{D_{A_x}}{N_{A_x}}$. With some simplecalculation, we have$P_j^{(0)}$.
S= {……

INPUT:
Identify the inputs
F= {f_1, f_2, f_3 .....,f_n| 'F' as set of functions to execute commands.}
I= {i_1, i_2, i_3…|'I' sets of inputs to the function set}
O= {o_1, o_2, o_3….|'O' Set of outputs from the function sets}
S = {I, F, O}
I = {Number of sensor node, sink node, nearest nodes, data packet size, transmission rate}
O = {Bandwidth Aggregation.}
F = {Functions implemented to get the output}

Shortest Path Problem:-
Input: a weighted graph
G= (V, E)
The edges can be directed or not
Sometimes, we allow negative edge weights

VII. CONCLUSION

From the consideration of all the above points we conclude that supported by the technological progresses in wireless communication systems and mobile devices, there are increased opportunities for multipath data transfer over heterogeneous access networks. Developing an effective multipath transport protocol is critical to enhance the data transmission performance and network utilization. Motivated by the surprising proliferation of mobile multimedia services, this paper proposes a bandwidth-efficient multipath streaming (BEMA)protocol to enable quality-guaranteed real-time video streaming over heterogeneous wireless networks. Bandwidth aggregation approaches are proposed so that a multimode terminal equipped with multiple network interfaces can access through concurrent multi paths [2]. Bandwidth aggregation services can bring in significant improvements in performance over conventional single interface use by providing increased throughput, resource sharing and reliability. By the aggregation of existing lower bandwidth links so as to create a larger logical link, can serve the applications demanding high bandwidth. This paper presents a survey of bandwidth aggregation approaches developed to have concurrent multipath transfer across multiple wireless technologies simultaneously. In future, the wireless communication networks would be the convergent of various access networks, incorporating diverse transmission features and capabilities. Bandwidth aggregation is facilitated in multihomed mobile terminals for increased transmission throughput and enhanced reliability.

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