Routing in the Front-End of WOBAN with Reduced Processing in the Intermediate Nodes

Asad Ali

***Abstract*—Wireless-Optical Broadband Access Network (WOBAN) is a hybrid network technology. The performance of Front-End is very low as compared to the Back-End. In recent years, research has been accelerated to reduce the delay in forwarding the data packet in the wireless part of WOBAN. So number of protocols and algorithms have been designed and proposed in this regard. In order to find the shortest path with the least delay, the intermediate nodes have to do so many calculation, processing and decision making. So in this paper we propose a technique for forwarding the packet through shortest path having least delay while having very lesser calculation in order to save processing time thus reducing the delay in forwarding the packet in the wireless part of WOBAN.**

***Index Terms*—Network technology, protocol, WOBAN, reduced processing.**

I. Introduction

Wireless Broadband Access Network (WOBAN) is the hybrid of Wireless and optical network. WOBAN combines the best features of both optical and wireless networks in an efficient and cost-effective manner. It was proposed to overcome the increase in the demand of the access network. It provides flexibility and high performance due to the presence of the optical. WOBAN consist of Optical part-The back end and the wireless part-The front end. The back end consists of Central Office (CO). Optical Line Terminal (OLT) resides in the CO. The front end-The wireless part consist of WMN nodes. The speed, bandwidth and the capacity of the optical network is very high as compared to the wireless part. So the performance of the wireless part must be brought at par with that of the optical part. For data communication in downward direction, that is, from OLT towards ONUs, it is simply broadcast. The optical splitter splits the signal equally among the ONUs. In downward direction, the data packet generated by the end user will have to first come to the ONU and than it is broadcast in the similar fashion. For instance, when an end user wants to send data, it does so by passing data to its nearby node. The nearby node will pass the data packet to its neighboring node in the direction of OLT. Similarly data packet will be passed hop by hop among various nodes to reach ONU. From ONU, it is forwarded to OLT. So data packet ultimately reaches the OLT passing through the same optical splitter. So when data pass through these so many nodes, there comes a delay in the delivery of the data packet. Several algorithms have been proposed to overcome this delay. Traditional algorithm like SPRA and MHRA are based on the shortest path. They find the shortest path for end user to the ONU. But as is obvious, the shortest path may not be the best path. As there are number of other factors to be considered like congestion, packet loss, throughput etc. Another Algorithm PTRA selects the path with the highest throughput. Again, the path with the highest throughput might not be the shortest path. In DARA [2] and CaDAR [3] the authors calculate the delay of the individual links and than for the whole path. They have identified four types of delay that is, Transmission delay, Slot synchronization delay, Queuing delay, Propagation delay. All the delays are calculated one by one for each link and then for the entire path. So it involves so many processing which not only wastes time but also consumes lot of power. So in this paper we propose a technique that does not involve so much of processing and thus reducing the overall delay.

Rest of the paper is organized as follows. Section II contain over proposed scheme, III presents a typical scenario, Section IV shows a comparison with different algorithms, Section V shows the conclusion.

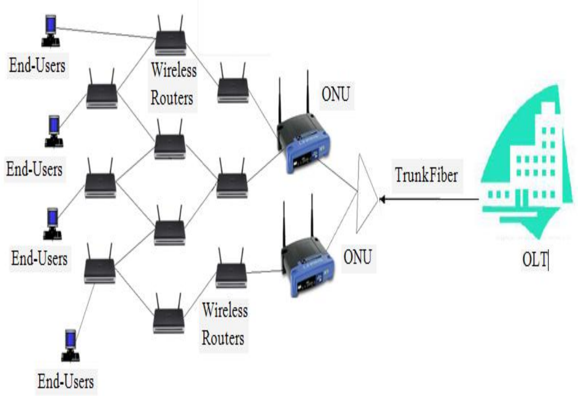

Fig. 1. Architecture of a WOBAN.

II. Proposed Scheme

In our proposed scheme, we will calculate a threshold of throughput and time to deliver a packet, in other words delay for various shortest paths. Once the path is selected for an end user, that particular end user will send its entire data packets on the same path unless the throughput falls below that particular threshold and delay rise above that threshold. In this way there will be no processing or any routing decision making on the data packet. All the data from the end user will move smoothly across the WMN nodes and thus there will be considerable reduction in the delay. There will be no calculation for queuing delay, transmission delay for any data packet. Since, we are only concern with the threshold of the throughput and the time. If throughput fall under certain level

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Asad Ali is with the School of Electrical Engineering and Computer Science, National University of Science and Technology (NUST), Islamabad, Pakistan (e-mail: asad.ali@seecs.edu.pk).

and delay rise above certain level, only then we will calculate the delay and throughput of new path, otherwise there will be no calculation and no routing decision making. In this way, we will pre-define the path for the data packet, the intermediate nodes know in advance where to forward the data packet. Thus the processing and decision making is decreased and data packet forwarding speed will increase and thus overall the delay will be reduced. We'll set the threshold for throughput as the expected throughput and the threshold for delay as the expected time a packet will take to reach. The threshold for throughput is calculated as below [5]:

$$ETP = \frac{P_f \cdot P_r}{\sum_{j \in S \cap P} \frac{1}{r_j}} \quad (1)$$

where

$P_f =$ Probability of success of a packet in forward direction

$P_r =$ Probability of success in reverse direction

$\frac{1}{r_j} =$ The bit rate

$S \cap p =$ All the links contending with a particular link

Similarly we can calculate the threshold for delay as well. The formula is given below [7]:

$$ETT = \frac{1}{P} \times \frac{S}{B} \quad (2)$$

where

$P =$ The probability of success of a packet

$S =$ Size of the packet

$B =$ The bandwidth of the link

After calculating the threshold for time for a single link, the threshold for time will be calculated for the whole path.

$$ETT_t = \sum_{i-1}^{n} ETT_i \quad (3)$$

where ETT_t Is the delay threshold for the entire path.

Sometime there is trade-off between the throughput and the delay. If an alternate path is giving a high throughput and also the delay is not that much or is slightly above the threshold, then we may still remain on the same path having delay above the threshold. Similarly if a path has very low delay and the throughput is not that much that is, slightly above the threshold than we may remain on the path having throughput above the threshold level. So it depends on what we prefer. If applications are delay sensitive, then we may choose the path with the least delay. But if the applications are not delay sensitive and throughput is desirable feature then we may choose the path with the highest throughput. So overall choosing a path depends upon the nature of the application. Below is the algorithm of our proposed scheme.

Algorithm.1: choosing the path with least delay and highest throughput

BEGIN

1) Calculate the threshold for congestion and delay &
2) Select the path with the highest throughput and least delay
3) If (throughput above the threshold and delay below the threshold)

Remain on the same path
else
{
Do you want to change the path? Yes or No
If No
Remain on the same path
Else
If Yes
Go To step 1
}
END

The above algorithm first calculates the path throughputs and delay for various paths. The path with the least delay will be then selected, and then if the throughput falls below the threshold and delay rise above the threshold, new path will be selected according to the requirement and the application. An equivalent flow chart is shown in the Fig. 2 below.

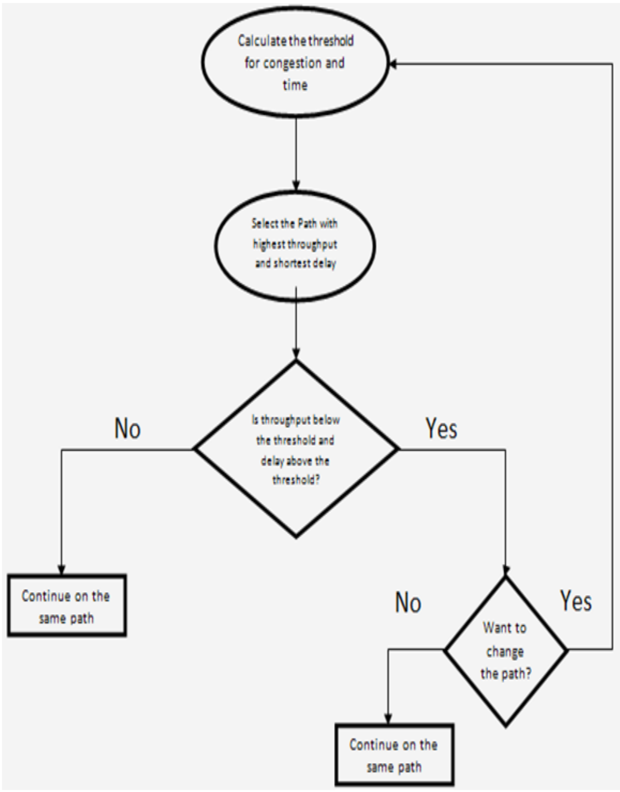

Fig. 2. Flow-chart showing the proposed scheme.

III. SCENARIO

Consider End-User 2 in the fig 3 below. Let for this user the shortest path with the least delay and with the highest throughput comes out to be {A, B, C}. Now that we have pre-defined the path from the source to the destination, End-User 2 will send its entire subsequent data packet on this very path until it finds that the throughput has fallen down the threshold or the delay has increased beyond the threshold value for the delay. So the only time the calculation for the delay is made is at the beginning of selecting the path. After that there will be no calculation for delay or throughput or any routing decision making on any packet. Thus the packet will move smoothly across the nodes. Thus there is a significant reduction in processing on the data packet and thus in the overall delay of the data packet. Also there is a trade-off between throughput and the delay, as discussed above. Sometime user may sacrifice the time for the throughput. Another path, say for instance, {A, H, I} may have much lesser delay then {A, B, C} but that path may have lesser throughput. So in that case we will remain on the same path, if we need the path with better throughput. Similarly another path may have better throughput but delay above the threshold. So we will again remain on the same path, if we need the path with the least delay. So overall it depends upon the nature of the application and what we want. Either our desired feature is throughput or the delay? Accordingly then we will select the path that best suits our requirement. Overall the path having throughput above the threshold and delay lesser then threshold is selected for packet transmission.

Similarly all the end user, 1, 2, 3…n, knowing the throughput and delay of various paths will select the path according to their requirement and according to their application. They will then, forward all its data packets on the path selected until it finds that the throughput has fallen considerably and the delay has increased significantly. In that case it will choose another alternate path that suits it requirement.

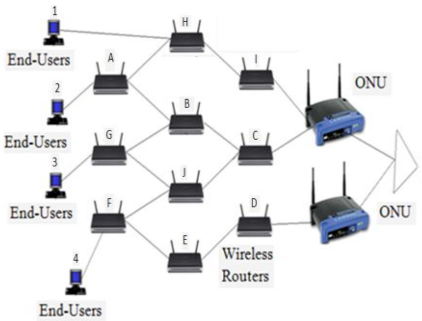

Fig. 3. Back-end of a WOBAN-- The wireless part.

IV. Conclusion

DARA and CaDAR, both involve too much computation and decision making for each individual packet for selecting the shortest path. For every end user’s packet, all the four type of transmission would have to be calculated for all the links and then for the entire path. So in our proposed scheme there will be no processing on the data packet and no routing decision, since the path is pre-defined. Thus the overall delay for transmitting the packet is much reduced. Thus, in this paper we have shown a fine technique to reduce the overall delay in the packet transmission. We have shown a technique in which the processing on the data packet will be lesser. Also it involves less decision making. So due to less calculation and lesser decision making, overall delay is considerably reduced.

References

[1] N. S. C. Correia, J. Coimbra, and G. Schutz, “Multi-radio hybrid wireless-optical broadband access networks,” PTDC/EEA-TEL/71678/2006.

[2] S. Sarkar, H.-H. Yen, S. Dixit, and B. Mukherjee, “DARA: Delay-aware routing algorithm in a hybrid wireless-optical broadband access network (WOBAN),” in *Proc. IEEE ICC, Glasgow, Scotland*, Jun. 2007.

[3] A. Reaz1, V. Ramamurthi1, S. Sarkar, D. Ghosal, S. Dixit, and B. Mukherjee, “CaDAR: an efficient routing algorithm forwireless-optical broadband access network,” *IEEE Communications Society ICC Proceedings*, 2008.

[4] S. Sarkar, S. Dixit, and B. Mukherjee, “Hybrid wireless-optical broadband –access network (WONBAN): A review of relevant challenges,” *Journal of Lightwave Technology*, vol. 25, no. 11, November 2007.

[5] V. P. Mhatre, H. Lundgren, and C. Diot, “MAC-aware routing in wireless mesh networks,” *WONS '07. Fourth Annual Conference*

[6] D. S. J. De Couto, D. Aguayo, J. Bicket, and R. Morris, “A high throughput path metric for multi hop wireless Routing,” in *MOBICOM*, 2003.

[7] R. Draves, J. Padhye, and B. Zill, “Routing in multi-radio, multi-hop wireless mesh networks,” MobiCom’04, Sept. 26-Oct. 1, 2004, Philadelphia, Pennsylvania, USA