Fast Near Optimization Algorithm for Wireless Optical Broadband Access Network

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Abstract*: This paper presents an Energy saving algorithm with excellent security which exploit the properties of wireless connectivity to provide improved quality of service to users for next generation optical access networks. Network survivability, reflecting the ability of a network to maintain an acceptance level of service during and after failure is an important requirement for hybrid wireless optical broadband access network (WOBAN). The Passive Optical Network (PON) is having tree architecture and due to wireless mesh in the front end, the scenario of the network can be made more robust by exploiting the properties of wireless mesh. With the increase of bit rate requirement in access network, future proof access technology should be energy efficient. This work include energy efficient fuzzy logic based wireless sensor and use Ant Colony Optimization (ACO) for finding shortest path during rerouting of traffic.*

Keywords: WOBAN, Survivability, ACO, Energy efficiency

1. Introduction

The hybrid wireless optical broadband access network (WOBAN), a combination of two major technologies wireless and optical is a promising architecture for access network. It combines the reliability and high capacity of optical network with the flexibility and cost effectiveness of wireless network. A WOBAN is comprised of a number of segments each containing a wireless mesh network (WMN) at the front end and a PON at the back end. In a WOBAN segment, each optical network unit (ONU) of the PON is connected to a wireless gateway in the wireless mesh network (WMN) so that users within the coverage area of the WMN are connected to the central office (CO) via the WMN and the PON.

Various TDM-PON technologies have been developed, including ATM PON (APON), broadband PON (BPON), gigabit PON (GPON), and Ethernet PON (EPON). As end users demand more bandwidth, there is the need to further increase the PON bandwidth using wavelength division multiplexing (WDM). A WMN consists of a collection of wireless routers, a few of which have wired connections to the Internet and are called the gateways. The wireless routers in a WMN form a wireless backbone to provide multi-hop connectivity between the clients and the gateways[1].

The remainder of this paper is organised as follows. Section II covers a survey of different survivability techniques in WOBAN. Section III includes the proposed protection scheme and algorithm. Section IV present FAST NEAR OPTIMIZATION ALGORITHM (FNOA). Section V covers simulation result. Section VI concludes the paper.

2. Survey of Survivability Techniques in Woban

Network survivability may be defined as network’s ability to continue functioning correctly in the presence of failures of any network components. In general, there are two ways to provide recovery from failures, namely, protection and restoration. Upon a failure, network has to search spare resources to reroute each disrupted connection around the failure. Author in [1] presented an integer linear programming (ILP) model for the minimum cost and maximum flow (MCMF) in WOBAN. In [3], a wireless protection scheme against ONU failures is proposed with a QoS aware dynamic resource allocation for video service in WOBAN. In [4], a novel scheme Risk and Delay Aware routing (RADAR) is proposed where traffic is rerouted in the wireless mesh during network failures to minimize connection restoration/path switching time, delay and packet loss for improved QoS. Author in [5] have analyzed the survivability problem of Next Generation Passive Optical Networks (NGPONs) and emerging hybrid Fiber Wireless (FiWi) networks in terms of failure-free connections. All optical and mixed optical-wireless networks were analyzed. The performances of various schemes to select optical network units (ONUs) were compared and interconnect them wirelessly through a wireless mesh network (WMN). Author in [6] has proposed a novel technique for survivable routing in WDM optical Networks. It is able to work with random network topologies and allows to proactively generate primary and secondary paths that share a tunable number of nodes specified by the source. It performs on-demand generation and resolution of requests to establish survivable routes. Further it can provide rapid failure recovery. Author in [7] proposed a restoration framework for WOBAN. The proposed scheme tries to select optimum number of protection clusters for the WDM-PON segments at the backend of WOBAN. It further considers the optimum deployment of the fibers between the backup ONUs so that the restored traffic propagates with the minimum delay. Author in [8] investigated Radio over Fiber Passive Optical Network RoF-PON/PON systems. The authors focused on novel millimeter-waveband (mm-WB) radio over fiber (RoF) system architecture for wireless services with the use of dense wavelength division multiplexing (DWDM). Some models were proposed for PON/ RoF-PON. The proposed models were compared using Expected Survivability Function. Expected Survivability Function is a simple and intelligent tool to provide the measure of network survivability.

3. Protection Scheme

The Proposed protection scheme utilizes wireless connectivity to provide survivability for WOBAN. In case of a network element failure, an alternate path through the wireless-wireline integrated network may be selected, if it exists. Such a network can provide reliable high-capacity connectivity to wireless devices which may be mobile as well. For such wireless-optical broadband access networks, FNOA algorithm is presented to make it fault-tolerant and self-healing in case of failures.

The scheme works as follows: The nodes are deployed in big geographical area so that no two segments can communicate with each other. The PON used in this work is Gigabit PON(GPON). Each node including optical and wireless is provided with power and bandwidth.

In case of failure which occur either due to the breakage of optical fiber or failure of wireless sensor, a survivable path is searched through wireless mesh using ACO whichsearch path in forward and backward direction both.In case of failure, the request is transferred and every node is checked for sufficient amount of power and Bandwidth. When the criteria is met the request is passed otherwise the request is passed to other node. The proposed scheme is energy efficient because it requires no additional infrastructure. Simulation results shows that the run time to provide survivability is comparatively less than the other scheme because the algorithm works in clockwise and counter clockwise direction both . This scheme provides overall survivability of optical part as well as wireless part.

4. Algorithm

1. BEGIN /* Setup Network */
2. Initialize required variables put flag to 0
3. Place random nodes
4. x <--------------- store value in the deployment area at x axis of first node
5. y <--------------- store value in the deployment area at y axis of first node
6. For I <--------------- 1 to max
7. xd, yd <-------------- compute angular distance
8. xd, yd <--------------- deploy a node /* Operation */
9. tid <------------------- 'A101' /* transmission code */
10. energy <----------------- 0.2 or 0.5 joules
11. /* initial energy to each node */
12. inenergy <--------------- energy/n /* no of nodes */
13. Status <----------------- 'Active'
14. /* set status of each node to active */
15. bw <----------------- 2.488
16. /*set bandwidth to 2.488 GBps for GPON*/
17. time <----------------- tic /*start time */
18. For I <--------------- 1 to max
19. rbw <----------------- compute
20. /*required bandwidth (random) */
21. reqenergy <---------------- compute
22. if tid <---------------- 'A101' /* accept request */
23. if reqenergy < inenergy
24. if rbw < bw
25. /* calculate cost */
26. tr = trate/i;
27. cost = trate - tr;
28. bw <---------------- update balance bw of node
29. energy <---------------- update balance energy of node
30. else
31. flag <---------------- 1
32. /*unauthorized user detected*/
33. end
34. else
35. flag <---------------- 2
36. /*insufficient energy passing the request*/
37. end
38. else
39. flag <---------------- 3
40. /*insufficient BW passing the request*/
41. end
42. if flag NOT 0
43. if flag is 1 or flag is 2 or flag is 3
44. send request to next node
45. repeat steps 17 through 34
46. end
47. end
48. end for
49. for I <---------------- 1 to max
50. compute balance bw
51. compute balance energy
52. end for

Formula for energy
Balance energy = $\sum_{1}^{max} \Delta e$
Δe= node.energy-renergy

Formula for bw
Balance bw = $\sum_{1}^{max} \Delta bw$
Δbw= node.bw-rbw

5. Simulation Results

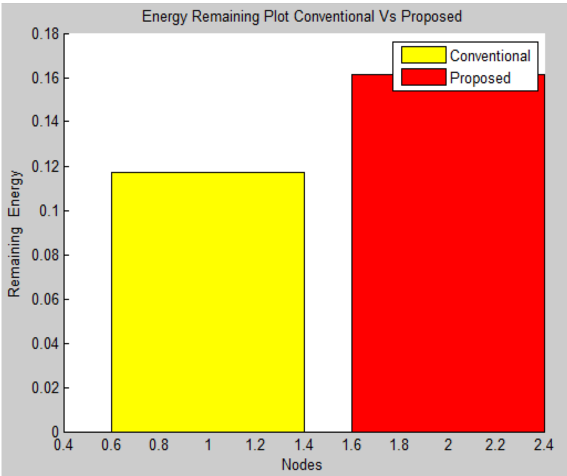

Figure 1: Energy Remaining Plot

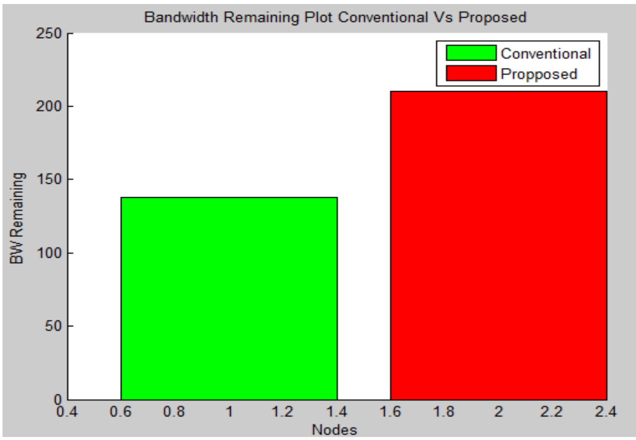

Figure 2: BANDWIDTH Remaining Plot

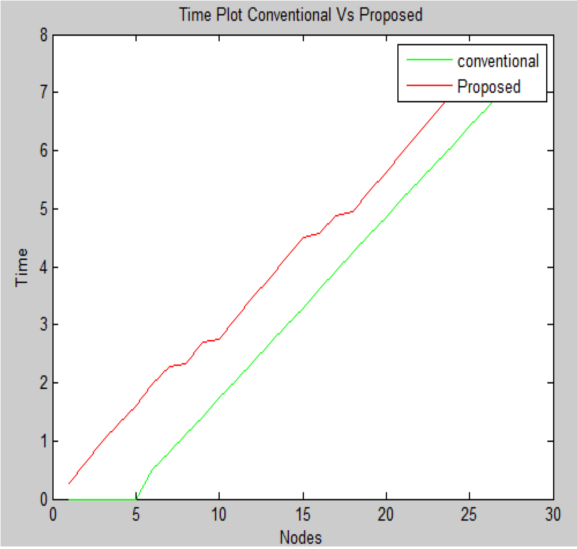

Figure 3: Time Plot

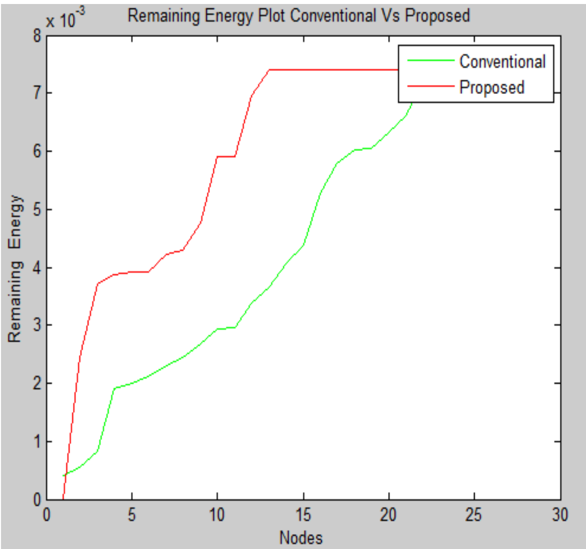

Figure 4: Remaining Energy Plot

Fig 1(a) shows that the proposed scheme provide green survivability by intelligently rerouting the traffic to wireless nodes. Fig 1(b) shows that the bandwidth remaining is more in this scheme than other conventional schemes(which is not using ACO) as robustness is achieved without additional infrastructure. Fig 1(c) shows that the run time of proposed scheme is more as it has to reroute traffic by selecting eligible nodes for continuous service. Fig 1(d) shows comparison between energy remaining after applying ACO in proposed scheme.

6. Conclusion

Network Survivability is one of the major issue in WOBAN for providing seamless service to users. This work presents Green Survivability by presenting energy efficient using ACO FNOA algorithm which provide the complete survivability including optical part as well as wireless part with security due to the authentic ID provided to optical and wireless part. Upon failure of any link either optical or wireless the traffic is rerouted to wireless part due to existence of multiple path in wireless mesh. Much other research work could be done in this area including survivability of different segments. This work devise a novel energy saving survivable technique for WOBAN to improve its energy efficiency and network utilization. This scheme is cost effective as robustness is achieved without additional infrastructure (capital expenditure).

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