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FA-DAR: An Efficient Flow Aware based Distance Adaptive Routing Scheme for Optical Communication Networks

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Abstract: **Routing Protocols have been proposed to enable the network to identify and suggest various routes to number of demanded flows. In the Flow-Aware Network Models, the routes are identified and selected with the help of Flow Tables or Flow Identifiers that proposed by Flow Aggregation Mechanism. That is, users can define a Flow Aggregation Model to suggest routes depend on their defined-demanded flows and this model effectively handles many flows which helps core routers to profit aggregate routing. This is considered as an efficient and effective approach to identify a best route to achieve required performance. However, from our earlier research works, it was observed from the literature survey that that the existing models unable to i. detect and manage bulk flow, ii. Control Traffic Loss and iii. Maintain Deviation of Links Load against Traffic Load. To address the above mentioned issues, this research work was proposed an efficient Flow-Aware based Load Adaptive Routing(FA-LAR) and established better performance in terms of Queueing Delay, Throughput, Power Consumption (Energy Dissipation), and Load Deviation. Further to improve the performance of Optical Networks in terms of Spectrum and Resource Utilization, this research work proposed an Efficient Flow Aware based Distance Adaptive Routing Scheme(FA-DAR). The proposed model was implemented with the Network simulator QualNet 7.4. From the experimental results, it is noticed that the prosed Model, FA-DAR is performing well in terms of Throughput, Queueing Delay, Load Deviation, Spectrum Consumption and Resource Utilization.**

Keywords : **Routing Protocols, Flow-Aware Network Models, Flow-Aware based Load Adaptive Routing, Distance Adaptive Routing, and Spectrum Utilization.**

I. INTRODUCTION

Flow Routing Schemes have used to analyse and evaluate Network Routes which will help to deliver Packets with the required QoS. It is helping to achieve Load Balancing on high speed communication networks. The Flow- Aware Multi-Topology Adaptive Routing (FAMTAR) Routing Scheme[1,2,3] is the Multipath Routing Capabilities which is designed to work on the concept of Flows.

It is capable of identifying different paths between Source and Destination. As it has identified multi paths, whenever the first route gets congested and unable to achieve QoS, it uses the alternate path which already identified to deliver packets with the required QoS to Destination. That is the suspended primary path will be used later when its available bandwidth satisfied to achieve QoS.

Flow Aggregation Mechanism was proposed for FAMTAR (FAMF) [3,4,5,6] and this is to address the above mentioned issue and it noticed that this scheme was reducing the flows entries. It was noticed that the flows entries did not depend on additional signalling between end-nodes.

The Flow-Aware Multi-Topology Adaptive Routing (FAMTAR) is considered as the best Routing Approach to improve the Network Performance. Flow Aggregation Mechanism was proposed to FAMTAR to improve the Network performance. From the literature survey and experimental Results, it was noticed that the Flow-Aware Multi-Topology Adaptive Routing (FAMTAR)[4,8,10] is performed the Flow Aggregation by Edge Nodes of Network. To achieve better performance in terms of Deviation and Maximize Network Life Time and to predict and detect Interval Heavy Flow or Bulk Flow[12,13,14], the better Flow Aggregation mechanism is needed and this research work earlier proposed an efficient Flow Aware-Load Adaptive Routing (FA-LAR) and it was established better performance in terms of Queueing Delay, Throughput, Power Consumption (Energy Dissipation), and Load Deviation[7,9,11]. Further to improve the performance of Optical Networks in terms of Spectrum and Resource Utilization, this research work proposed an Efficient Flow Aware based Distance Adaptive Routing Scheme. The detailed procedure is discussed in the following sections.

The remaining sections are organized as follows. The section 2 describes the Flow Aware-Load Adaptive Routing (FA-LAR). In Section 3, the identified problem of the existing model FA-LAR is described. In Section 4, the proposed model, Flow Aware based Distance Adaptive Routing Scheme(FA-DAR) is discussed. Section 5 presents the performance analysis of the proposed Flow Aware based Distance Adaptive Routing Scheme(FA-DAR) and results findings are concluded in Section 6.

II. FLOW-AWARE ADAPTIVE ROUTING SCHEMES

This research works described and reviewed recently proposed two popular Adaptive Routing Schemes namely i. Load Adaptive Sequence Arrangement-Fixed Minimal Transmission Time (LASA-FMT)[1,2] and ii. Flow-Aware Multi-Topology Adaptive Routing (FAMTAR)[1,2] in this section.

A. Flow Aware-Load Adaptive Routing (FA-LAR)

The proposed Flow-Aware Load Adaptive Routing Scheme is developed based on the models of both Load Adaptive Sequence Arrangement (LASA) and Flow-Aware Multi-Topology Adaptive Routing (FAMTAR). This is the hybrid mechanism which developed to address Load Deviation, Energy Consumption to Maximize Network Life Time and to predict and detect Interval Heavy Flow or Bulk Flow. The flow chart of our earlier work called Flow-Aware Load Adaptive Routing Scheme was as shown in the Fig. 1.

As shown in the Fig. 3, the proposed model has report message with Label to confirm Polling Sequence. This is used to save energy by preventing inefficient sequence arrangement. In other words, the proposed scheme provides sleeping time when route is congested and it can increase average cycle time. This facilitates for optimizing the performance of energy consumption under low-traffic and high traffic as well.

As per the traffic load, the scheme can be improved the energy efficiency of networks. The polling sequence arrangement is executing through label process which was is added in report message as described earlier. While polling sequence was changed, the proposed model will allocate lengthier idle times will sleep longer. This facilitates significant effect on the energy efficiency of the network. This Load Adaptive Sequence Model forward Packets to Flow Aggregation Scheme which aggregates flows to improve Network performance in terms of Throughput, Delay and Load Deviation. The detailed procedure of the proposed model is described in the Fig.3 as follows.

B. Working Procedure and Operations of Flow Aware-Load Adaptive Routing (FA-LAR)

The procedure and operations of the proposed hybrid FA-LAR[2,3,4] is narrated in the Fig. 3. This proposed mechanism is an intelligent method that establishing the all possible routes that aggregates flow through edge routers. The route can be identified and selected based on the collected information with the help of the proposed model which described below.

III. IDENTIFIED PROBLEM

As each and every one of us using Internet, Researchers are focusing Flow-Aware Routing and Topology Aware Routing as well. They developed a few Network Models for the same.

Flow-Aware based Load Adaptive Routing (FA-LAR) is one of the best Flow-Aware Routing Scheme that was our earlier Model. It established better performance in terms of Queueing Delay, Throughput, Power Consumption (Energy Dissipation), and Load Deviation. Further to improve the performance of Optical Networks in terms of Spectrum and Resource Utilization, we needed any efficient Routing Model and thus this research work is proposed an Efficient Flow Aware based Distance Adaptive Routing Scheme(FA-DAR).

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IV. FLOW AWARE-DISTANCE ADAPTIVE ROUTING SCHEME (FA-DAR)

The crying and ever increasing demand of Bandwidth encourages the Researchers to focus to design and develop Intelligent Routing Techniques. It is also noted that the very large data rate ie High-Data-Rate Signals forwarded to very long distance is also a challenging one. In other words, to improve the efficiency and to maximize the Spectral Efficiency in High Speed Networks, the Elastic Optical Networking Model (EON) was proposed. This EON is facilitating users to allowing SPs to support the demands of Network Bandwidth.

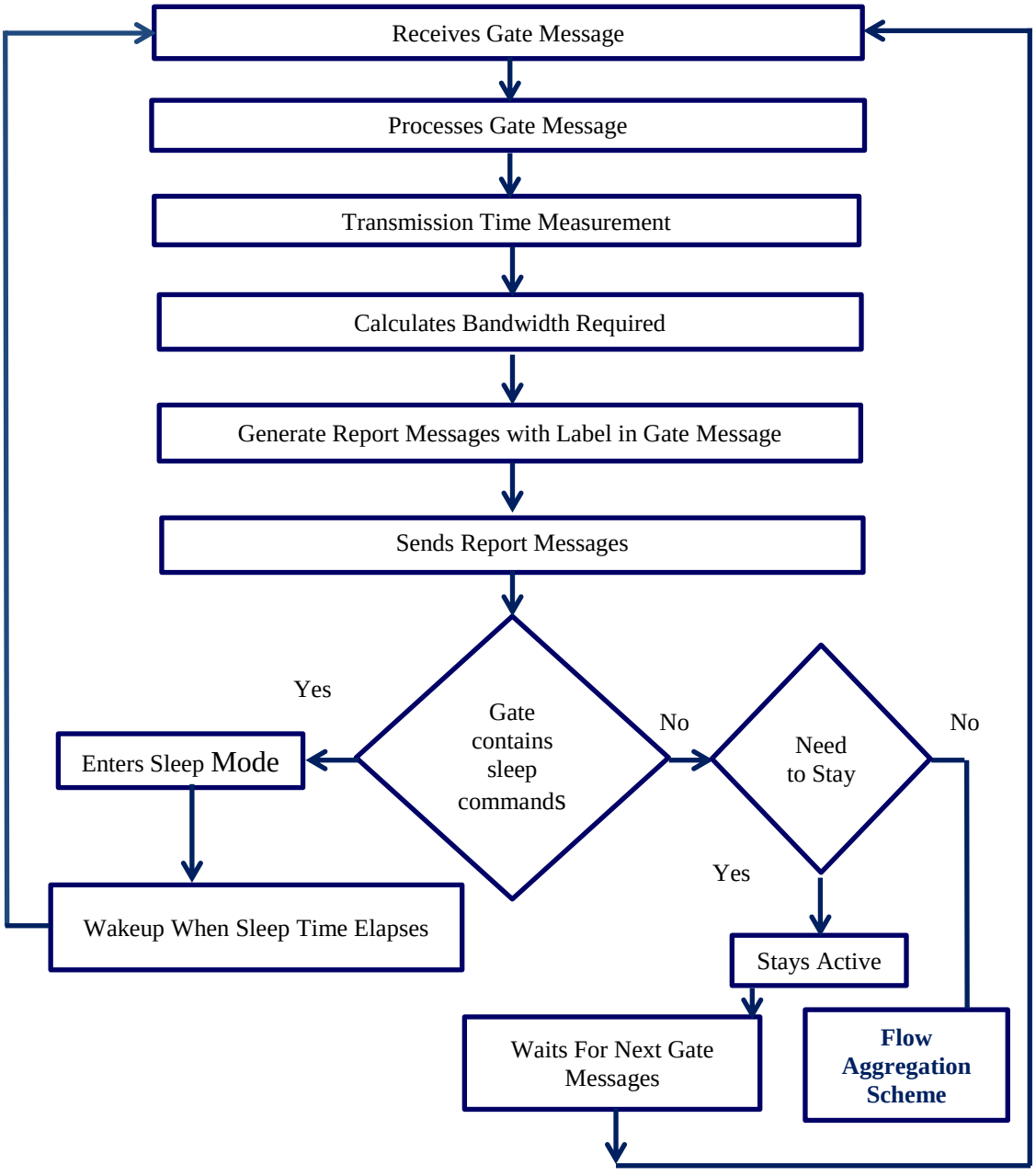

Fig 1: FA-LAR Scheme

The Routing and Spectrum Assignment (RSA) is one of the methodology introduced in EON to achieve Spectrum Utilization and performance of RSA as well on each fibre link along the Route.

This Research work with its Literature Survey and Experimental Results, noticed that the existing Routing Models unable to achieve Optimal Resource Utilization for the EON. To address this identified issue, this work proposed an Efficient Flow-Aware based Distance Adaptive Routing Scheme (FA-DAR). This will allocate optimal spectral resources for light path network demands and this is facilitating to improve Resource Utilization and Routing Efficiency.

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The Link Utilization in a route from "o" to "t" is directly proportional to the Spectrum Consumption in Optical Networks. The prime advantages of this model is to help Fault Tolerant ie if any Node crashed, the Link-Joint back mechanism will help the connections to survive.

A. Operations of Flow Aware-Distance Adaptive Routing Scheme (FA-DAR) for EON

The procedure and operations of the proposed hybrid FA-DAR is narrated as follows. The subcarriers for routing can be calculated as

$$N_i^l = \left(\frac{b_q}{\delta f.M}\right) + N_g \quad \ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where b is the bit rate

q is demand q € Q

M is Modulation

L is link l € L

The alternate route can be calculated as

$$N_i^n = N_i^l \,.|L(i)|$$

$$N_i^n = \left(\frac{b_q}{\delta f.M}\right) + N_g \,.|L(i)|$$

B. FA-DAR Algorithm

begin

Calculates Bandwidth $_{Required}$ for communication between o and t

get o, d, b, q, i, δf, N and M

begin

FlowAware();

end

Distance Adaptive Routing

begin

SpectrumAllocation(Scheme);

Measure(SpectrumReq);

CompareRoute(Lightpaths);

PriorityRoute();

Calculate N_i^l for all Routes in eqn(1);

Calculate N_i^n for all Routes in eqn(2);

Select Route$_{best;}$

Select the first k routes as alternate routes and discard the remaining;;

Measure(SpectrumUtilization);

end

return alternate route;

end

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V. PERFORMANCE ANALYSIS

This research work is created Network Topology as shown in the Fig. 2. This model created around 100 FSs and 1G Bandwidth is assigned with uniform distribution. The number of Data Centers, say 3 to 5 were introduced during simulation and tested. The Spectrum efficiency is Monitored during the Simulation, it is established that the proposed model achieves the higher efficiency when k=3.

This Research Work implemented the existing Flow Aware-Load Adaptive Routing (FA-LAR) Schemes and the proposed Flow Aware-Distance Adaptive Routing Scheme (FA-DAR) in QualNet7.4. For each Node, 1G is reserved and for each flow, 0.1 GB is reserved as well. We created Nodes in Clusters with a fixed Topology and introduced 1ms delay. The simulation was carried out for 350 seconds.

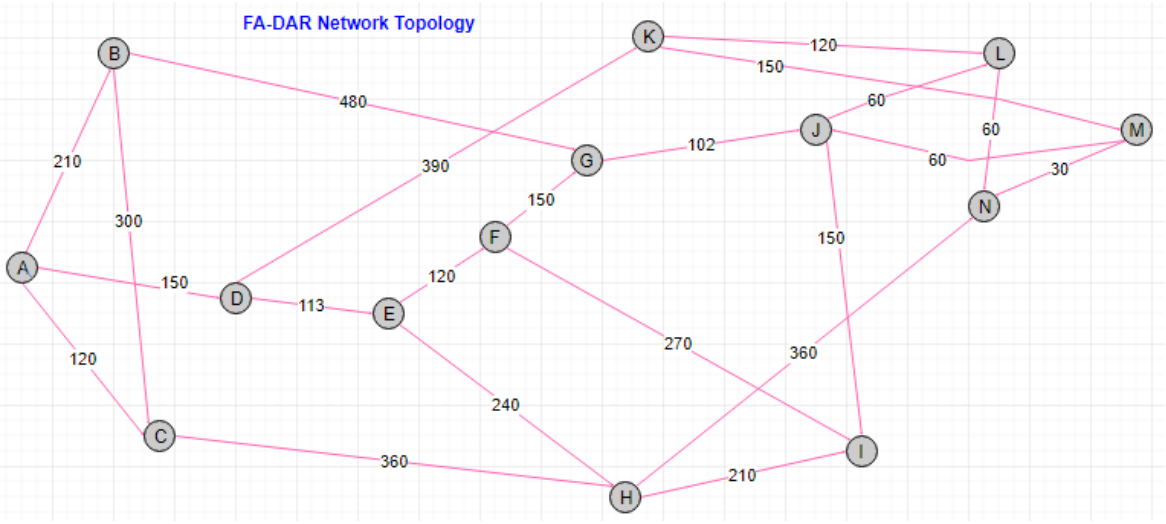

Fig 2: Network Topology

The proposed Distance Adaptive Routing Scheme (FA-DAR) is studied thoroughly and analyzed in terms of Throughput, Queueing Delay, Load Deviation, Spectrum Consumption and Resource Utilization.

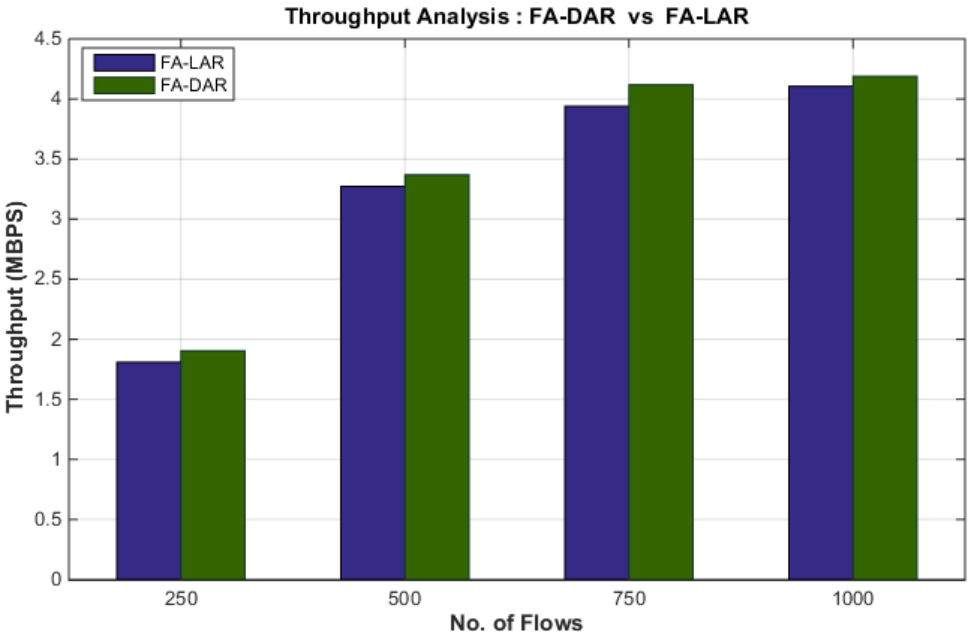

Fig 3: Throughput Analysis of the Proposed FA-DAR

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The experimental results of the simulation are shown at the Figures Fig. 3 to Fig. 7. As shown in the Fig. 3, the proposed FA-DAR is performing better in term of Throughput as compared with the existing our previous Routing Scheme FA-LAR. It is also noticed that the proposed model is performing well to achieve better Throughput for Low Load and Heavy Load as well that fails to achieve by our previous work FA-LAR.

That is the FA-DAR is achieving higher Throughput for all 1000 Flows. This is happened because the proposed model focussing Traffic Loss and Maintain Deviation of Links Load against Traffic Load as well.

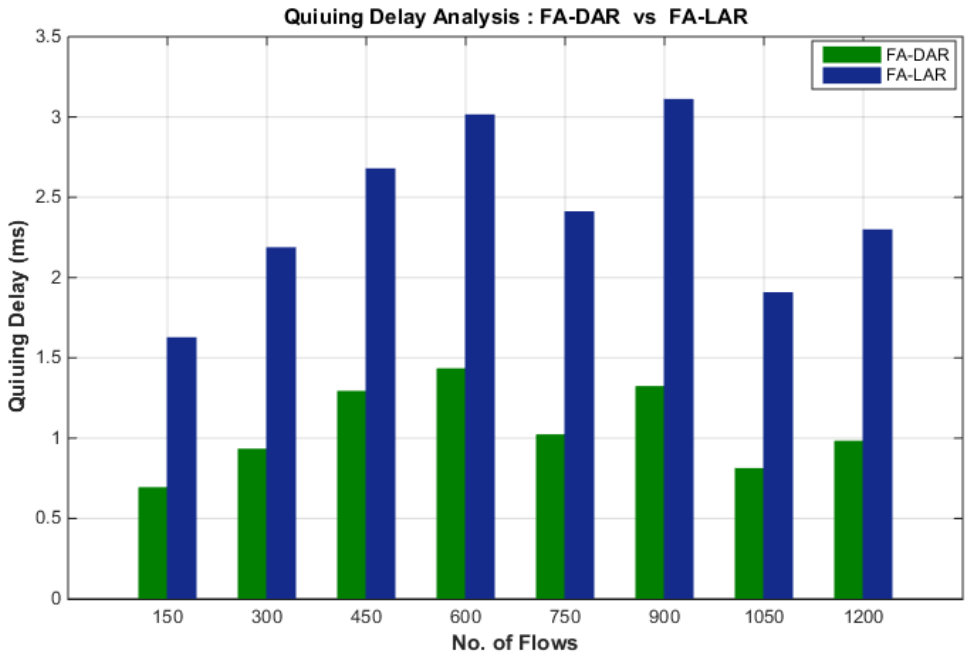

Fig 4: Queuing Delay Analysis of the Proposed FA-DAR

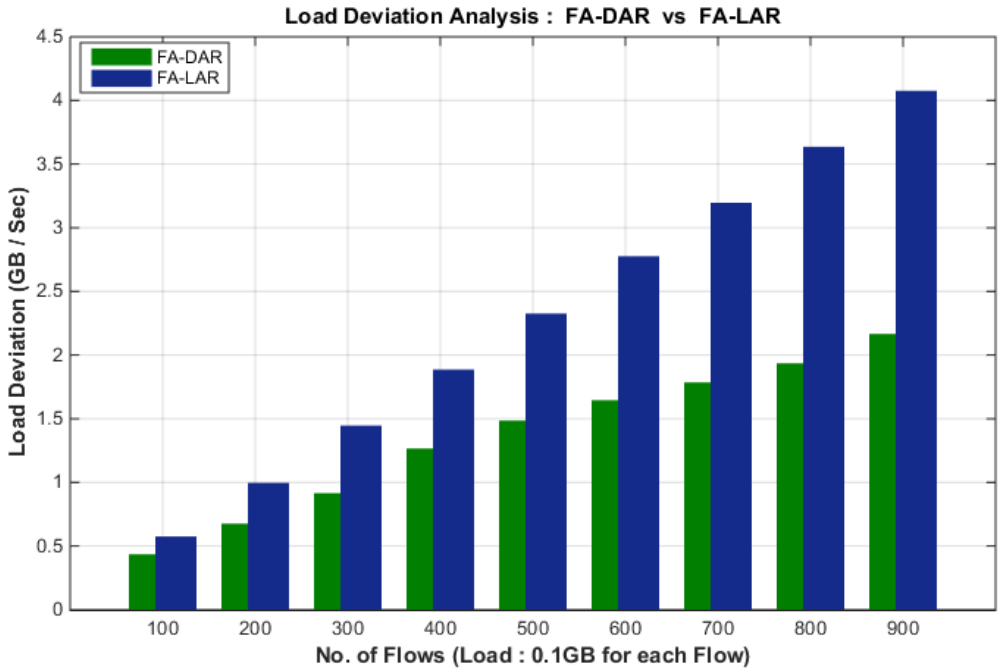

Fig 5: Load Deviation Analysis of the Proposed FA-DAR

As this research work proposed an efficient Flow-Aware and Bandwidth Utilization Mechanism, that handle Traffic Congestion situation efficiently and effectively that facilitate to achieve lesser and fair Queueing Delay as compared with Flow Aware-Load Adaptive Routing (FA-LAR) Scheme, which is shown in the Fig. 4.

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The proposed FA-DAR achieves better Load Deviation ie Bandwidth Utilization and Usage as well with Link Load against various Network Traffic Loads. The simulated output of the proposed model is shown in the Fig. 5 and Fig.6.

As shown in the Fig. 4, Fig. 5 and Fig. 6, the proposed FA-DAR achieves higher Fairness in terms of Queuing Delay, Load Deviation and Bandwidth Utilization as well. This is achieved as the Spectrum Efficiency is achieved in the proposed Model which is shown in the Fig. 7.

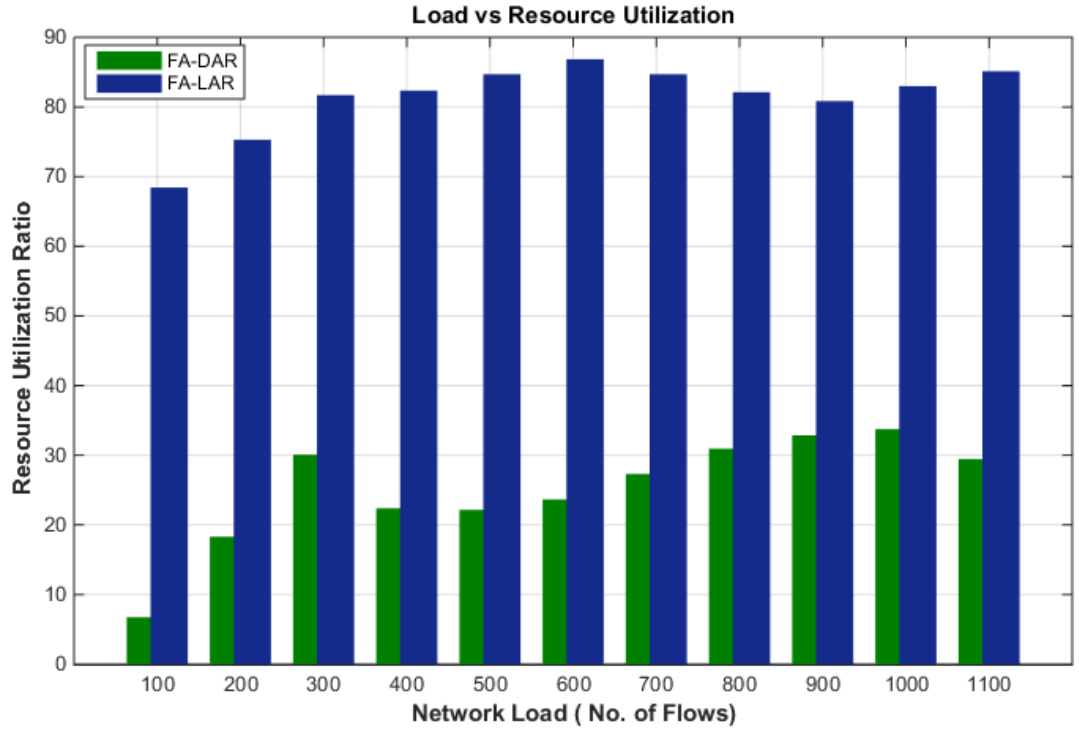

Fig 6: Resource / Bandwidth Utilization Analysis of the Proposed FA-DAR

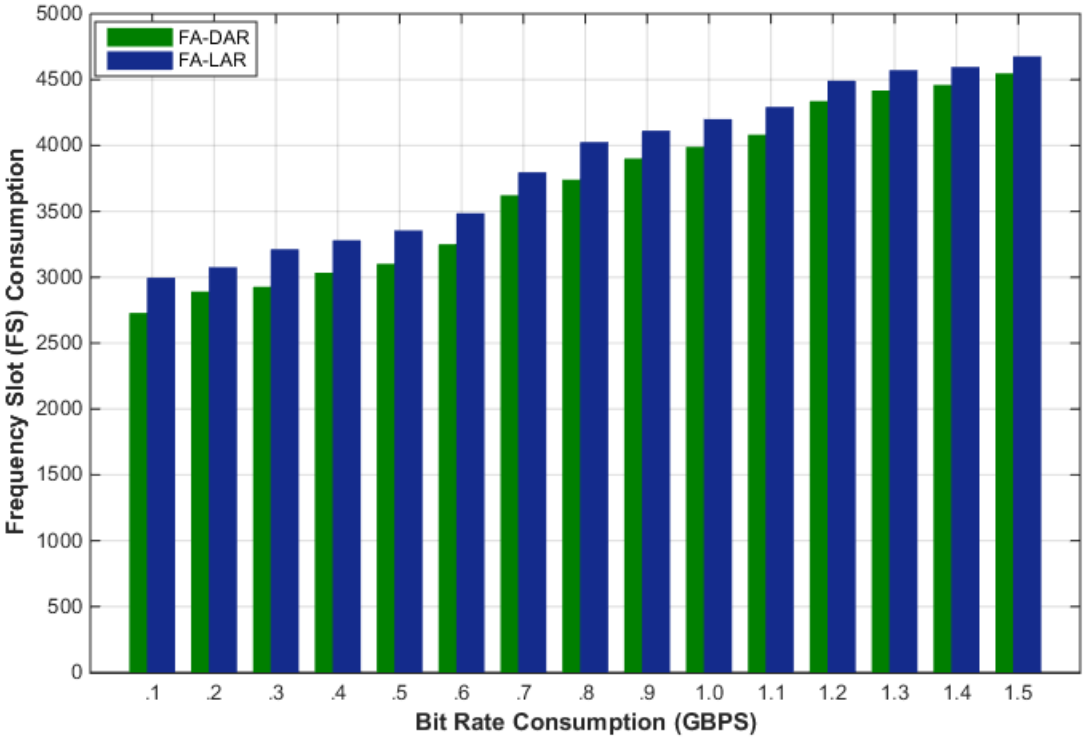

Fig 7: FS Spectrum Usage/Consumption Analysis of the Proposed FA-DAR

VI. CONCLUSION

The Flow-Aware based Load Adaptive Routing (FA-LAR) that we proposed earlier observed that this model unable to improve the performance of Optical Networks in terms of Spectrum and Resource Utilization. Thus, this research work proposed an Efficient Flow Aware based Distance Adaptive Routing Scheme and implemented with the Network simulator QualNet 7.4. From the experimental results, it is noticed that the prosed Model, FA-DAR is performing well in terms of Throughput, Queueing Delay, Load Deviation, Spectrum Consumption and Resource Utilization.

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