MULTICAST TRAFFIC GROOMING IN ELASTIC OPTICAL NETWORK UNDER DYNAMIC SCENARIO

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Abstract: Elastic optical networks allow elastic allocation and de-allocation of optical resources to optimize network resources and reduce traffic demand blocking probability for dynamic traffic demands. The routing of dynamic traffic demands is a challenging task since the traffic demands are not predefined, they arrive and leave randomly. The approach presented here is a grooming, routing and spectrum allocation technique for multicast traffic demands in elastic optical networks for dynamic type of traffic demands. The simulation results show reduced blocking probability compared to existing approach.

Keywords: dynamic, flexible-grid, optical grooming

I. INTRODUCTION

Elastic optical network (EON) has mini grid architecture which allows elastic bandwidth allocation for different traffic demands.

There are broadly two types of traffic demands one-to-one (or unicast) and one-to-many (or multicast). Applications of multicast type of traffic are live streaming conferences, Internet television, etc. These type of communication is supported by the broadcast and select mechanism of bandwidth variable transponders (BVT), and the unwanted signals are filtered out using the bandwidth variable optical cross connect (BV-OXC). A multicast-tree is implemented for data transmissions Multicast routing and spectrum allocation in EONs have been well studied in the past [1-3].

Optical grooming of traffic is grouping same type of traffic demands and switching them as a whole.

In EON, spectrum-slicing does not occur early in BVT and grooming reduces wastage of network resources. Groomed traffic demands do not require guard slots in between them. Same source optical grooming is selected over different source optical grooming since orthogonality feature cannot be sustained between optical paths for different source grooming [4].

If two multicast traffic demand have same source and similar set of destinations then they can be transmitted using same light-tree, and adding any guard bands between groomed traffic demands is not necessary, just two guard band slots are added at the beginning and at the end of the allocated spectrum.

In this paper, a grooming, routing and spectrum assignment approach is applied to dynamic (arrive and leave randomly) multicast (one-to-many) traffic. The target of this work is to reduce blocking of traffic demands.

II. RELATED WORK

In dynamic scenario, traffic comes and leaves after certain time duration. In case of dynamic traffic grooming, an incoming traffic demand is matched with any existing traffic demand to find whether they have same source and similar destinations.

The authors in [5] propose traffic grooming policies based on a multi-layer auxiliary graph model and a spectrum reservation scheme incorporated into these policies. The results show the different trade-off present among different traffic grooming policies.

In [6], the authors propose a dynamic source aggregation approach in which the sub-wavelength traffic demands having same source are grouped together and transmitted through a single transmitter. The authors present the benefits of aggregating traffic demands and its impact on spectrum utilization and transmitter saving.

In [7], the authors propose a dynamic traffic grooming approach that uses an auxiliary graph model. They use sliceable bandwidth variable transponder enabled EONs and address electrical and optical grooming for dynamic traffic. Different traffic grooming policies are adopted by adjusting edge weights of the auxiliary graph model. The authors present two spectrum reservation schemes. These schemes efficiently use the capacity of transponders. The authors provide a comparative study of the presented policies and trade-off among these policies.

III. PROPOSED APPROACH

The problem of grooming in dynamic traffic demands along with provisioning the demands and allocating required spectrum to the demands are discussed in this section. Dynamic traffic demands arrives randomly and stays active for their holding time, so while comparing an incoming traffic demand with an existing traffic demand, it needs to check the status of the traffic demands. A traffic demand with status as active is compared with the incoming traffic demand, and if they have same source and some common links in their respective trees, then they can be groomed together. If the spectrum assignment constraints are satisfied then slots are assigned to the traffic demands by applying First-Fit policy. The proposed heuristic for solving grooming problem for the dynamic multicast traffic demands is presented in algorithm 1.

Algorithm 1: Dynamic Multicast Traffic Grooming Routing and Spectrum Assignment (DGRSA) in EON

Input: The physical network topology G (V, E) and one-to-many traffic demand (s, {D}, b)
Output: A solution for the dynamic multicast traffic grooming problem

1. Generate a traffic demand
2. Calculate a multicast tree for incoming traffic demand (using union of shortest paths found by Dijkstra's algo)
3. **if** *an incoming traffic demand and an existing active traffic demand has similar source and same destination set* **then**
4. select the existing traffic demand for grooming
5. **end**
6. check spectrum continuity and contiguity constraint for establishing traffic demands
7. **if** *all the constraints are satisfied* **then**
8. the traffic demands are groomed together (no guard band required between them)
9. assign spectrum using First-Fit spectrum assignment scheme
10.**end**
11.**if** *grooming is not possible* **then**
12. establish the incoming traffic demand by adding guard bands
13. spectrum is assigned using First-Fit spectrum assignment scheme
14.**end**
15. **if** *traffic demand cannot be established at all* **then**
16. drop the traffic demand
17.**end**
18. De-allocate all the allocated slots after its holding duration is completed

V. RESULT DISCUSSION

The performance of the proposed heuristic for dynamic grooming approach is evaluated on two popular network topologies the fourteen nodes NSF network and twenty eight nodes US-Backbone network. The network topologies for NSFNET and US-BACKBONE are shown in the Figure 1 and Figure 2 respectively.

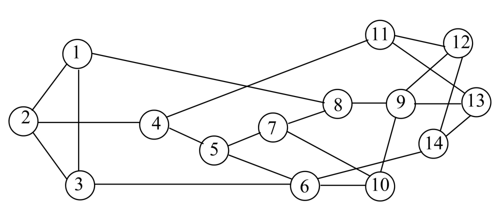

Figure 1: The NSF network topology

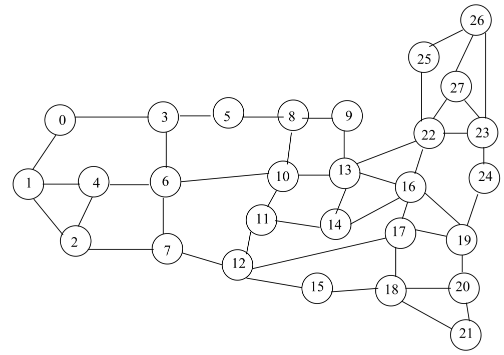

Figure 2: The US-BACKBONE network topology

The performance evaluation of EON provisioning with dynamic multicast traffic demands is shown in Figure 3 and Figure 4. It is observed that the dynamic traffic grooming algorithm (DG-MRSA) has less probability of blocking compared to its non grooming counterpart.
The reason for such results lies in the fact that grooming traffic demands reduces the spectrum usage since groomed traffic demands do not need guard band slots to e inserted in between them. Less spectrum usage means more slots are available for future traffic demands and so blocking reducing.

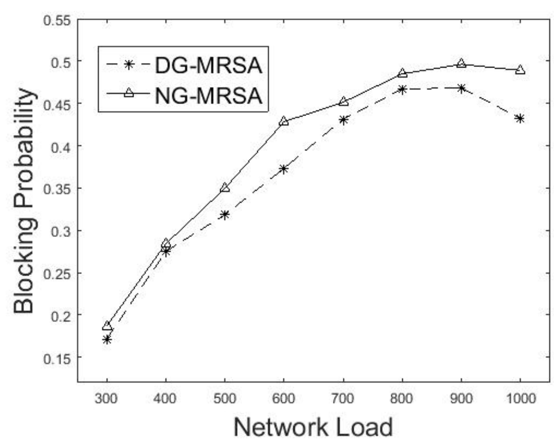

Figure 3: The relationship between blocking probability and network load in NSFNET network.

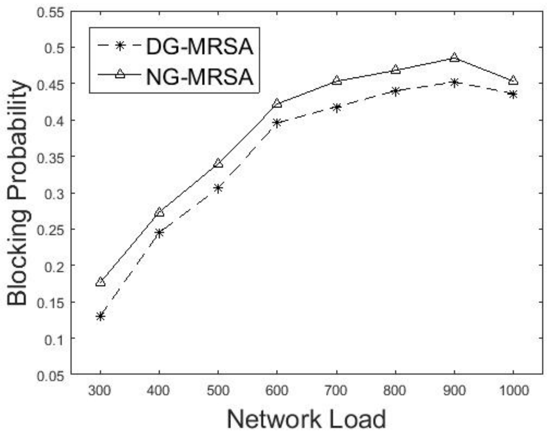

Figure 4 : The relationship between blocking probability and network load in US-BACKBONE network.

VI. Conclusion

Dynamic traffic demands are not known a-priori, they arrive and leave randomly. The approach presented here is a grooming, routing and spectrum allocation technique for multicast traffic demands in elastic optical networks for dynamic type of traffic demands. The simulation results show reduced blocking probability compared to its non-grooming counterpart.

REFERENCES

[1] Li, S., Lu, W., Liu, X., Zhu, Z.: Fragmentation-aware service provisioning for advance reservation multicast in sd-eons. Optics express 23(20) (2015) 25804–25813

[2] Fan, Z., Li, Y., Shen, G., Chan, C.C.K.: Dynamic resource allocation for all-optical multicast based on sub-tree scheme in elastic optical networks. In: Optical Fiber Communication Conference, Optical Society of America (2016) W2A–50.

[3] Moharrami, M., Fallahpour, A., Beyranvand, H., Salehi, .A.: Resource allocation and multicast routing in elastic optical networks. IEEE Transactions on Communications65(5) (2017) 2101–2113.

[4] Zhang, G., De Leenheer, M., Mukherjee, B.: Optical traffic grooming in ofdm-based elastic optical networks [invited]. Journal of Optical Communications and Networking4(11) (2012) B17–B2.

[5] Zhang, S., Martel, C., Mukherjee, B.: Dynamic traffic grooming in elastic optical networks. IEEE Journal on selected areas in communications 31(1) (2012) 4–12.

[6] Khodashenas, P.S., Comellas, J., Spadaro, S., Perell´o, J.: Dynamic source aggregation of sub wavelength connections in elastic optical networks. Photonic Network Communications 26(2-3) (2013) 131–139.

[7] Zhang,J.,Ji,Y.,Song,M.,Zhao,Y.,Yu,X.,Zhang,J.,Mukherjee,B.: Dynamic traffic grooming in sliceable bandwidth-variable transponder-enabled elastic optical networks. Journal of Lightwave Technology33(1) (2015) 183–191.