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ROUTING AND SPECTRUM ALLOCATION USING ELASTIC OPTICAL NETWORK.

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Abstract

With the rapid growth of cloud data, the internet of things, social media applications, high-end video streaming, etc WDM[3][3] is slowly becoming insufficient for all these future growths. The elastic optical network is slowly becoming the solution for these problems in the fiber-optic network.It can provide flexibility in the spectrum assignment and can even provide greater bandwidth. But with all these benefits come the problem of routing and spectrum allocation(RSA). In this problem, the frequency slots should be allocated to maintain continuity, contiguity, and nonoverlapping constraints. The paper explores the feasible way of solving the problem so that requests can be transferred through the network with minimum cost production.. algorithms that can solve RSA problem with static traffic demand. So, in this paper we incorporate a layered approach to de-sign efficiently integrated MC-RSA for serving multicast requests in EONs. This algorithm decomposes the physical structure of the graph into several layered auxiliary graphs according to the given multicast request . Then depending on the bandwidth we create a multicast light tree . It solves the routing and spectrum allocation problem by first finding the k-shortest path in the first available contiguous slots. However, the main goal is to allocate the connection request list that we have implemented only if there are available contiguous slots. We have tried to decode the algorithm and make it as efficient as possible.

I. INTRODUCTION

As the demand for data traffic has grown along with emerging applications such as Iot , it has led to the simultaneous growth of network capacity. The elastic optical network (EON) has given us some embarrassing new solution to cope up with the increasing traffic demand. Compared to its predecessor, wavelength division multiplexing (WDM[3][3]),EON enjoys finer channel spacing. It enables finer spectrum allocation in correspondence to the spectrum needed and without wasting large portion of the channel which was happening in case of WDM. Furthermore, unlike WDM[3], EONs allow flexible and dynamic selection of the modulation formats. Optical backbone fiber networks can send relatively large data but with the ever increasing traffic growth we need a data with proper efficiency. There are many more flexible network that can sent that large

II. EON

EON is a technology that allows efficient utilization of available bandwidth with the help of orthogonal frequency division multiplexing(OFDM) which offers finer spectrum granularity.

In the given figure, we can see that WDM[3] based optical network has a frequency spacing of 50 GHz which is relatively large. If the cannel is carrying low bandwidth without facing any traffic, then maximum part of the spectrum allocated becomes wasted.But in the second optical network which is based on OFDM technology, it assigns the given data to several low data rate subcarrier channels. Since, the spectrum of these subcarrier channels are modulated orthogonally they tend to overlap each other, which increases transmission spectral efficiency.

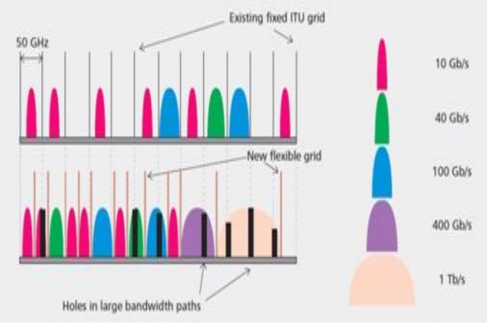


FIG 1: COMPARISON OF DATA ALLOCATION IN EON AND WDM [3] [1]

III. PROBLEM STATEMENT

We consider an elastic all-optical network, where each node is multicast-capable. In such a network, for a given set of multicast demands, we consider spectrum resource allocation and aim to optimize multicast routing, and spectrum assignment in a way that minimizes the required spectrum resources for accommodating all multicast sessions.

IV. CONSTRAINTS

For RSA,the following constraints may be satisfied:

- Spectrum Contiguity:allocated slots must be adjacent to each other.
- Spectrum Continuity:adjacent slots must have the same index all along the end-to-end path.
- Spectrum non-overlapping:slots must not be overlapping over the whole spectrum.

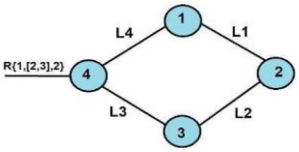
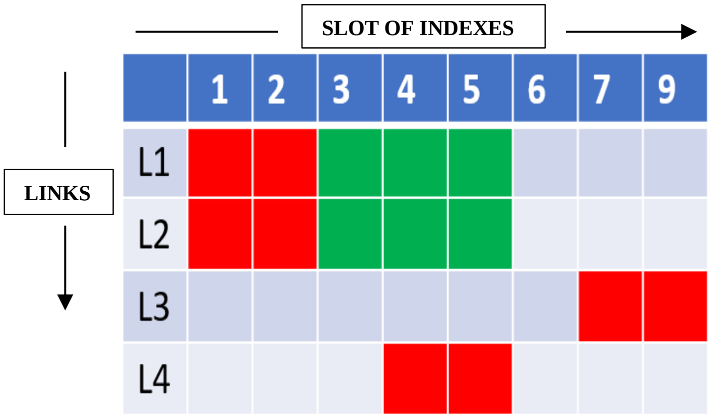


FIG 2: Sample Graph(i)


SLOT OF INDEXES

LINKS

	1	2	3	4	5	6	7	9
L1	🟥	🟥	🟩	🟩	🟩			
L2	🟥	🟥	🟩	🟩	🟩			
L3							🟥	🟥
L4				🟥	🟥			

FIG 3: Illustration of slot allocation followingconstraints.

Algorithm: Integrated MC-RSA Algorithm for layered approach

```
1: initializing LT and FS to null.
    2: For all i starting from 1 to (FR-N+1)
        2.1 : insert all vertices in the ith layered
              auxiliary graph.
        2.2 : for all links L belonging to the set of
              all edges of the main graph.
            2.2.1: IF sum of the values from ith to
                   (i+n-1)th index of Lth row of
                   the Network Utilisation Matrix
                   is zero then
                2.2.1.1 : insert L into ith layered
                          auxiliary graph.
            END IF.
        END FOR.
        2.2.2 : IF source of ith graph can reach all
                destinations then
            2.2.2.1 : apply MST in the ith layered
                      graph.
            2.2.2.2 : form a LT containing source
                      and destinations of the ith
                      layered graph.
            2.2.2.3 : initialize frequency slots
                      to FS.
                BREAK.
        END IF.
    END FOR.
3: return LT and FS.
```

V.ALGORITHM DISCUSSION

GRAPH AND REQUEST INPUT

In this report, we have taken a graph as an example to represent the physical topology of an EON. Here L denotes the links between each node. Below we attach a graph considering which we have forwarded with our project. We are sending a multicast request R having source as s and destination as D. There is ‘n’ number of frequency slots. For a multicast request R(s, D, n), the MC-RSA needs to find a light-tree LT that roots at s and can reach all destinations in D, and to assign n FS’s on each link L ∈ LT under the spectrum continuity and spectrum non-overlapping constraints. We assume that there are FS frequency slots on each fiber link. As there are multiple multicast requests, we assign a unique index value to each request and denote it as Ri.

For simplifying our work, we have taken the adjacencymatrix of the following graph as: [0,3,8,9,0],[0,0,0,10,6],[0,0,0,7,0],[0,0,0,0,8],[0,0,0,0].

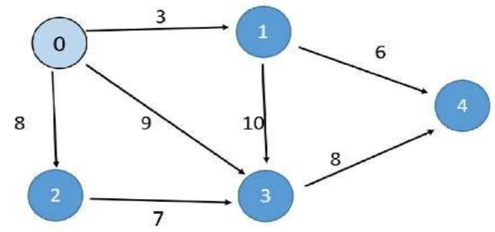


FIG 4: Sample Graph(ii)

For Example : R{0,[4,3],5}
where

- 0 = source
- 4,3 = destination
- 5 = number of slots required

Creating an Empty Matrix and its Initialization:

We are creating an empty matrix and initializing itwith 0 because here 0 denotes that the slots are available for allocation. If any value is denoted as 1 then it means that the slots are occupied and cannotbe used further for slot allocation.

	SLOTS							
LINKS	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0

Adding vertices to the layered graph:

In the algorithm, for loop starting from i=1 to FR-N+1, whenever the loop runs every time vertices are added to the layered auxiliary graph.

Adding edges to the layered graph:

For each link e belonging to the total number of linksor edges in the graph, we are inserting the edges in the layered graph. We have initialized the no of edges as null first and then added as and when we are getting a non-zero element in the adjacency matrix. Now in the empty matrix that we already created if in each link the sum of the slots becomes equal to null then we will understand that all the slots in the link are empty and we can insert our slotsfollowing the design constraints. So if i=0 and i+N-1=8 then we will find the sum of the slots from 0to 8 in the first row. If the sum is not null then we will append the column index of the adjacency matrix as the source in the list sources[i] and row index as destinations in the list dest[i] and the weightof the links are appended in the list weight[i].

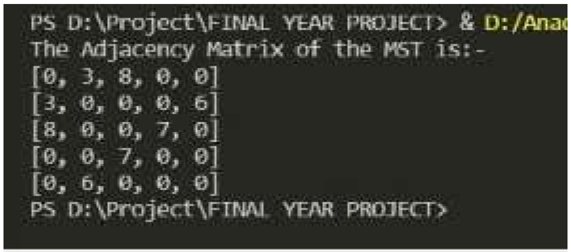
Traversal using depth first search(DFS):

Now, after obtaining our layered auxiliary graph we need to check if in that layered graph we can reach all the destinations from the given source. For example, in the request R{0,[4,3],5}, we are applying depth-first traversal to check if we can reach our destination 4 and 3 from source 0.

Creating Minimum Spanning Tree:

We are applying Prim's algorithm [2] to the obtained layered auxiliary graph, to get the Minimum Spanning Tree of the multicast request.

VI. RESULTS



```
PS D:\Project\FINAL YEAR PROJECT> & D:/Anac
The Adjacency Matrix of the MST is:-
[0, 3, 8, 0, 0]
[3, 0, 0, 0, 6]
[8, 0, 0, 7, 0]
[0, 0, 7, 0, 0]
[0, 6, 0, 0, 0]
PS D:\Project\FINAL YEAR PROJECT>
```

FIG5:Adjacency matrix of MST

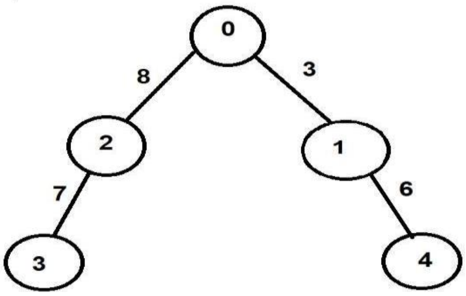
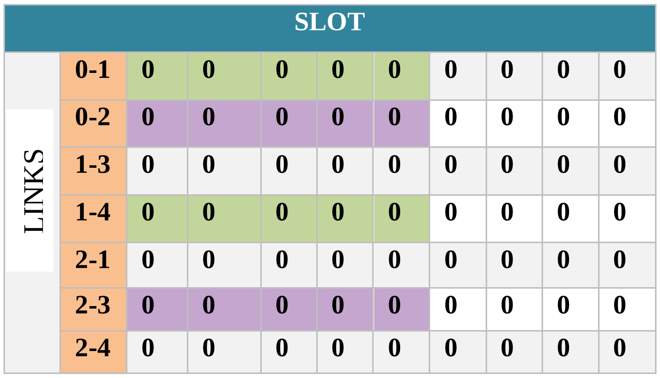


FIG 6:Tree representation of MST



		SLOT								
LINKS	0-1	0	0	0	0	0	0	0	0	0
	0-2	0	0	0	0	0	0	0	0	0
	1-3	0	0	0	0	0	0	0	0	0
	1-4	0	0	0	0	0	0	0	0	0
	2-1	0	0	0	0	0	0	0	0	0
	2-3	0	0	0	0	0	0	0	0	0
	2-4	0	0	0	0	0	0	0	0	0

FIG 7:SLOT ALLCATION MATRIX FOR THE MULTICAST REQUEST R{0,[4,3],5}

🟩 → **SLOT ALLOCATED FOR REQUEST 0-4**

🟪 → **SLOTS ALLOCATED FOR REQUEST 0-3**

VI.CONCLUSION

The EON has proved itself as a high end technology providing data transmission utmost flexibility. We have discussed the basic concept of elastic optical network and have implemented the layered approach algorithm to solve the routing and spectrum allocation in the EON. We have used the Prims algorithm to obtain our MST and have provided the expected tentative results.

VII.REFERENCES

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