IMPAIRMENT-AWARE REACTIVE DEFRAGMENTATION SCHEME FOR DYNAMIC ELASTIC OPTICAL NETWORKS SERVING TELE HEALTHCARE ORIENTED TRAFFIC

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ABSTRACT

In the modern world, the need for high-speed, high-quality, and high-capacity internet traffic is greatly driven by the emerging bandwidth-intensive applications such as telemedicine, online gaming, cloud services, and 5G data networks [4, 3]. As a result, advanced Orthogonal Frequency-Division Multiplexing (OFDM) based Elastic Optical Networks (EONs), which is scalable, flexible, and resource-efficient, is accepted as the next evolution in internet backbone networks [4]. When the amount of internet traffic increases, the available capacity of the optical networks becomes a limiting factor, leading to blocked or dropped connections [1]. One reason which leads to traffic blocking or dropping is spectrum fragmentation which is caused by isolated, non-aligned and non-contiguous spectrum slots that cannot be used to allocate new connection requests [2]. On the other hand, if a traffic connection of a certain application (e.g. remote medical surgery over the internet) is blocked or dropped or re-routed along a path with a higher latency due to the capacity limitations caused by the spectrum fragmentation, it may produce a faulty outcome [1]. Thus, it is important to prioritize certain traffic connections and give them the precedence over connections with relatively low importance. Better performance can be expected if incoming high priority (HP) connections can be accommodated by disrupting (i.e., re-routing, re-tuning, re-modulating) a minimal number of low priority (LP) connections. Taking the above into consideration, we propose a novel PLI-aware, reactive defragmentation scheme that increases the resource utilization of EONs, while ensuring low latency and traffic blocking of prioritized tele health oriented traffic at the expense of disrupting a minimal number of LP connections. In the proposed scheme, the traffic connections are served in the corresponding order they arrive. Instead of using a fixed guard band, the algorithm perform an accurate PLI calculation using Gaussian Noise model before allocating a traffic connection. The algorithm is to designed to minimize the maximum sub-carrier index of the network which is considered as a measure of spectrum utilization [3] and hence, tries to serve each incoming traffic connection with the highest order modulation format and the first available spectrum block. The priority level (either HP or LP) of the traffic is defined based on the source node from which the traffic is generated. The algorithm serves the high prioritized traffic in the best-possible path between the source and destination nodes thereby reducing the latency while LP traffic is routed via any possible path. Depending on the requirement of the client, the best path is defined either as the path with the minimum distance or the path with the minimum hop-count. If an incoming HP traffic connection cannot be served along the best path due to lack of spectrum, the algorithm begins to explore the possibility of re-allocating a LP traffic along a different path to accommodate the HP traffic. The re-allocation of LP connections are done in a way that it minimizes the spectrum fragmentation of the network. To demonstrate the validity and superiority of our algorithm, we compared the results of our proposed PLI-aware proactive defragmentation scheme against a generic first-fit fixed guard band and random-fit fixed guard band resource allocation schemes with no defragmentation. The results were simulated on the 14-node NSF network. It was observed that compared to the generic first-fit allocation scheme, our method increases resource utilization by 27.3%, while ensuring a blocking rate less than 1% of total traffic and reduced spectrum fragmentation by 32.6% at the cost of only 8.83% of LP traffic being disrupted. Compared to generic random-fit allocation scheme, our method increases resource utilization by 48.3%, while ensuring a blocking rate less than 1% of total traffic and reduced spectrum fragmentation by 35.6% at the cost of only 8.83% of disrupted LP traffic. The proposed impairment-aware, proactive defragmentation algorithm can be used to effectively utilize the spectrum resources of an EON while prioritizing the important traffic (tele healthcare oriented traffic) in the network.

References

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