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Spectrum fit allocation techniques for SLICE optical networks

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ABSTRACT

Orthogonal frequency division multiplexing technology is used to satisfy the ever increasing traffic demand. This technology is been used in SLICE optical network for the spectrum allocation. For effective resource utilization, bandwidth allocation is done at sub-wavelength and super-wavelength level. Routing and spectrum allocation problem is solved by many researchers using heuristic methods and many algorithms have been proposed for this problem. However the light path established must satisfy the spectrum continuity constraint. Here we consider the RSA problem which is divided into routing problem and spectrum allocation problem. The routing problem is solved by two methods such as shortest path routing (SPR) and balanced load spectrum allocation routing (BLSA).Heuristic algorithms are proposed for spectrum allocation techniques such as best fit, Next Best fit, Worst fit and Gold fit. For these techniques simulation is developed and its performance is analyzed by the parameters such as fragment utilization and blocking frequency.

1. Introduction

Elastic optical network can achieve higher spectral utilization efficiency by eliminating standard bandwidth allocation and reducing the spectral guard bandwidth. Orthogonal-Frequency-Division-Multiplexing (OFDM) technology is used for better spectrum utilization and for handling sub-wavelength and super- wavelength and multicarrier [1–3]. It provides an opportunity to operate optical networks in much finer granularity. The advantages offered by the OFDM in terms of flexibility and scalability originate from the unique multicarrier nature of this technology compared with wavelength division multiplexing (WDM). Although the sub-wavelength (sub-carrier) level allocation capability of spectrum-sliced elastic optical path (SLICE) network [4] leads to more effective resource utilization, it also leads to additional complexities in network control and management i.e., Routing and spectrum assignment (RSA) in optical network. Many researchers have solved this problem in different approaches like heuristics algorithms, Integer linear programming, for static and dynamic traffic, online and offline etc. [5–21]. Different fragment aware, defragment aware, fragmentation management approaches for RSA problem have been addressed. Many heuristic spectrum allocations such as hitless fragmentation, first fit, exact fit, first-last exact fit allocation, random fit etc. have been introduced [22–29].

RSA can be defined for a network topology and for a set of call requests with varying demands (in terms of the number of sub-carriers) find a route for each request and allocate a number of sub-carriers to each request, so that the utilized part of the spectrum is minimized. This can be done through shortest path and balanced load spectrum allocation (BLSA) [13]. Shortest path is calculated using Dijkstra's algorithm [30,31].

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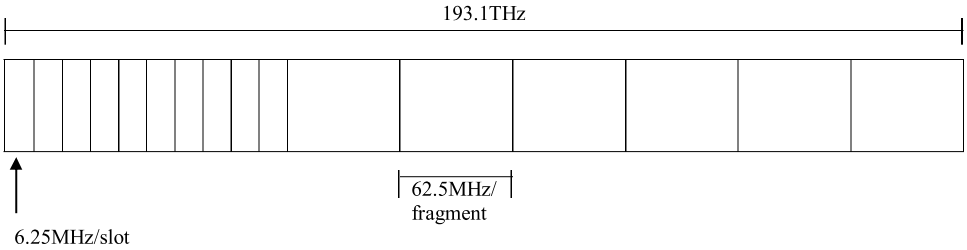

Fig. 1. Representation of fragments, slots in frequency of C-band.

Here we are introducing fragment aware spectrum allocation technique to solve RSA problem in SLICE optical network. The techniques are best fit, next best fit and worst fit. These techniques are used in memory management for solving bin-packing problem. We are using this technique in solving the RSA problem. The ̈best fitälgorithm chooses the smallest portion of spectrum slot that is big enough to fit in the available free slot. The ̈worst fitälgorithm chooses the largest portion of slot available. The ̈next fitälgorithm keeps track of where each frequency slot was allotted. The ̈next fitälgorithm is faster than ̈best fiẗ[32]. The golden ratio also known as golden-section is a search technique for finding the minimum or maximum of a unimodal function by successively narrowing the range of values inside which the minimum or maximum is known to exist. Two quantities are said to be in the golden ratio if their ratio is the same as the ratio of their sum to the larger of the two quantities [32,33].

2. RSA problem statement

2.1. Routing

The Routing is been done in two ways first using Dijkstra's algorithm for shortest path routing (SPR), in this case the path with shortest distance from source to destination is considered. Second using balanced load spectrum allocation routing (BLSA) here the path which is least loaded is considered for spectrum allocation.

2.2. Spectrum fit allocation techniques

Let us consider the frequency range of C-band (193.1 THz), and divide it into fragments of size 62.5 MHz each. Each fragment is further divided into 10 slots/subcarriers of 6.25 MHz as in Fig. 1. Here in this paper we have proposed four different spectrum fit techniques such as best fit, next best fit, worst fit and gold fit discussed in next sections.

3. Analytical relations for spectrum fit allocations

Let us consider the following parameters where
t_q = demands
f_s = number of free fragments,
n = total number of fragments
M_s = Maximum number of subcarriers
L_f = Length of the fragment
For best fit and next best fit spectrum allocation the probability for the spectrum allocated is defined by using Poissons distribution,

$$p(m, f_s) = \frac{m^{f_s}}{f_s!} e^{-m} \tag{1}$$

The mean of frequency distribution for best fit is

$$m = \frac{\sum f_s t_q}{\sum t_q} \quad P = \frac{m}{n} \tag{2}$$

The mean of frequency distribution for next best fit is

$$m = \frac{\sum f_s t_q}{\sum t_q} \quad P = \frac{m}{c} \quad n = c = count \tag{3}$$

For worst fit spectrum allocation:

Here $f_s = M_s$,