REAL TIME FREQUENCY ORIENT TRAFFIC INFERENCE MODEL FOR IMPROVED QOS IN WDM NETWORKS BASED ON DRWA SCHEME

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Abstract: *An in-depth study of wavelength assignment in Wavelength Division Multiplexing (WDM) networks has been made. DRWA has introduced a number of approaches. These methods have failed to achieve any significant performance in assignment and in QoS. This paper presents a frequency orient traffic inference with the objective of improving the performance of WDM networks. With the use of the same channel for the entire transmission of the same data, the utilization of the channel becomes smaller. An algorithm has been proposed that starts with the identification of the list of routes in the network and precedes with the task of identifying the data flow, frequency of transmission and traffic in the channel at all the routes of the route. On the basis of the features identified, the model computes the Channel Utilization Factor (CUF), the Channel Traffic Rate(CTR) for each route identified. These CUF and CTR values form the basis on which computation of Transmission Frequency Support Measure (TFSM) is made. TFSM forms the basis for identification of a single channel and the route. The selected single channel has been assigned for data transmission. This method has the advantages of improving the performance of WDM networks and support to development of their QoS.*

Keywords: *WDM, DRWA, Dynamic Routing, Channel Utilization, Traffic Inference Model, QoS.*

1. Introduction

The current decade has seen the invention of the optical communication with the optical fiber cables which support higher data transmission. This has resulted in the introduction of the Wavelength Division Multiplexing Networks. The significant feature of the network relates to a single route that has a large number of channels. There are N numbers of channels available between any two communication nodes where each channel is a private one for different communication. This enables transmission of N number of different data between the nodes. This supports the development of modern data applications. As, the modern mobile users prefer the generation networks and access various high speed applications, certain high speed networks are required. The WDM network satisfies such a requirement by providing superior communication properties. The DRWA is mainly focus to maximize the number of connection established by providing best route and required wavelength.

Like any other network, the WDM has a number of nodes connected with each pair of nodes having N number of communication channels each referred to as frequency. Since, the same route can be used by different processes to transmit different data; the selection of the route plays a vital role in achieving a high performance and in improving the quality of service of the network. Different routing approaches are available for the WDM networks, each using different factors like traffic and availability. But, for an efficient utilization of the channel, it is necessary to consider more number of features of the route. This is so because the utilization of the channel depends on the data rate generated by the process despite the assignment of the route and the channel to a particular process. If the data rate is less than a threshold, then it can be considered as the channel is idle and it's similar to the denial of service attack as the process hold the connection but does not use it.

The traffic condition in the nodes keeps on varying in a specific channel. Route selection should consider the flow factor because the flow factor represents the amount of data being produced by the nodes in the channel which varies on each channel. Similarly traffic is the feature which must be considered, because,the presence of a higher traffic identified in a specific node of the route leads to the conclusion that it is an important junction for more other nodes and for various transmissions. An efficient route selection and routing, requires the consideration of the flow, frequency, traffic features of the route. A strategic measure has to be estimated for an efficient routing.

On the other side, routing plays an important role in improving channel utilization which is the measure based on the amount of data being transmitted, the capacity of the channel, the idle time and etc. Higher channel utilization, requires reduction in the idle time with higher data rate in the channel. The routing algorithm enforced in the WDM should achieve higher channel utilization. On the other side, this improves the throughput performance and reduces the latency of the network. This paper presents a frequency orient traffic inference model for achieving these. The traffic inference model collects the details of flow, frequency of transmission in the route and channel. Based on these features, the method computes various factors to select a route to perform data transmission.

2. Related Works:

There are a number of approaches available for the assignment of wavelength in WDM networks and for efficient routing. This section discusses the various methods available towards the problem.

Multicast routing in WDM networks without splitters [1] investigates multicast routing without splitters in directed (asymmetric) graphs. The main objective is to minimize the number of used wavelengths and, if several solutions exists, then the choice of the lowest cost one is advisable. It shows that the optimal solution is a set of light-trails. Therefore, an efficient heuristic method is proposed to minimize conflicts between the light-trails, and also to minimize the number of used wavelengths. The performance of this method is compared withthe existing light-trail based heuristics. This algorithm provides a good and useful solution with a few wavelengths required and a low cost.

Routing and wavelength assignment in WDM network based on Intelligent Water Drops (IWD) based algorithm [2], consider the Routing and Wavelength Assignment problem in WDM optical networks. Here, it considers the dynamic traffic and also assumes the number of wavelengths available in each optical fiber as fixed. In this paper, the author have tried to reduce the call connection blocking ratio with the help of IWD Algorithm for RWA problem in an optical network. The IWD algorithm has modified the consideration of the congestion and length information during the routing decision process for identifying the optimal routes of primary light-path. Inspired by the principle of natural water drops, modified IWD algorithm is proposed for RWA problem in the dynamic WDM networks with a better blocking performance.

A Routing and Re-routing Scheme for Cost Effective Mechanism in WDM Network [3], provides an overview of the different re-routing schemes and also the survivability concept in the event of a failure occurring in the network.This means most of the attention devoted in this paper relates to the use of routing and wavelength assignment (coloring) scheme in first phase and re-routing in later phase. Therefore, after analysis it is observed clearly when compared to other schemes our propose re-routing mechanism at connection level (RRCL) scheme which is a cost effective approach with respect to different metrics terms.

Greenness Link State Advertisement Extension for WDM Networks [4], introduces a new Link State Advertisement (LSA) for a new link characteristic to be used with Constrained Open Shortest Path (CSPF) routing mechanism. The new LSA is considered for building a topology database based on realistic energy. It also gathers data relating to Co2 emission data about each link and the sections of the network. The energy-aware CSPF mechanism utilizes this topology database for incorporating energy and emission information from routing data traffic form greener sections of network.

Routing and Wavelength Assignment in Optical Networks from Maximum Edge-Disjoint Paths [5], propose an algorithm which is based on the maximum number of edge-disjoint paths (MEDP) for solving the RWA problem.Variable neighborhood descent (VND) with iterated local search for RWA [6], are focussed on minimizing the number of wavelengths to route demand requests. Normally, the traffic is carried by light path optically between any sources to destination. Here, VND phase tries to rearrange requests among subgraphs that are associated with subsets of a partition from the set of lightpath requests. Whereas, an iteration algorithm saturates between a VND phase and an ILS phase.Random-key genetic algorithm for routing and wavelength assignment [7] has proposed an innovative genetic algorithm by considering the random keys for routing and wavelength assignment with the goal of reducing the number of different wavelengths. This Random-key genetic algorithm encompasses the best heuristic by embedding it into an evolutionary framework.
Multi-hop Routing and Wavelength Assignment Algorithm for Optical WDM Networks [8], has suggested a new routing and wavelength assignment scheme to improve the blocking probability of WDM networks.This scheme enables very good utilization of the networks resources. This heuristic methodprovides high QoS, prioritization of the LAN networks and also lowers installation cost when compared with the traditional RWA algorithms applied in the WDM networks. This method is based on the distributed Dijkstra sparse placement routing algorithm, where it considers the first-fit wavelength reservation and traffic multiplexing. The authors have embedded the load balancing and a sparse electronic switch placement algorithm while finding the optimal light-path in order to reduce the number of dropped light-path sessions to zero, minimize the number of opaque nodes and maximize the utilization of the network.

Multi-Path Routing and Wavelength Assignment (RWA) Algorithm based on WDM Based Optical Networks [9], has introduced a new routing and wavelength assignment algorithm for the choice of the different suitable paths for the data packets transmission. Based on the available bandwidth and total number of wavelength available in the link, it is classified into two stages, namely constructing alternate paths, selecting best route and wavelength. Adaptive Routing and First-Fit Wavelength Assignment (AR-FFWA) algorithm is used in the proposed work. For each pair of nodes, i.e. between source and destination, the path identifies the minimum granularity values as the primary path in-order to transfer the data, and also by allocating the required wavelength. The performance of this method is evaluated using network simulation models.

Multicast Routing and Wavelength Assignment in AWG-Based Clos Networks [10], focuses on the analysis of the non-blocking multicast RWA problem into two different phases with respect to the cascaded combination of an AWG-based broadcast Clos network, termed as copy network, and a point-to-point AWG-based Clos network. In the first phase, input requests generate broadcast trees in the copy network, and during the second phase, point-to-point connections are established in the AWG-based Clos network. The Clos-type AWG-based multicast networks can be designed from modular AWGs of smaller sizes, for minimizing the number of wavelengths required and also for reducing the tuning range of the wavelength selective converters (WSCs). For solving the multicast RWA problem, the author have enhanced the rank-based routing algorithm for traditional space-division broadcast Clos networks, Hence, broadcast trees can also be generated in the WDM copy network in a contention-free manner. On the other hand, the subset of requests input to each sub network in the middle stage may not satisfy the precondition of the rank-based RWA algorithm due to wavelength routing properties of AWGs.

Analytical blocking model for any cast RWA in optical WDM networks [11], develop a new analytical model for computing the network-wide blocking performance for any cast routing and wavelength assignment (ARWA) in wavelength division multiplexed (WDM) optical networks. Specifically, the blocking has been computed using the reduced-load fixed-point approximation analysis on full wavelength convertible and wavelength continuity constrained optical networks. This model is based entirely on the conventional queuing theory for loss systems combined with a conditional probability analysis.

Converter-aware wavelength assignment for WDM networks of arbitrary topologies [12], propose a novel algorithm which can minimize the number of wavelength translations. The algorithm proposed by the author establishes light paths by connecting a minimum number of wavelength-continuous segments. Simulation results show for a given blocking performance, the ability of the algorithm to effectively reduce the number of required converters. From another perspective, with the same conversion capacity, it can significantly improve the blocking performance.

The disadvantage of the existing methods discussed above fails to achieve the higher performance in RWA and routing in WDM networks.

3. Real Time Frequency Orient Traffic Analysis Model

The traffic analysis model acquires network and topological information. Then, routes from the source to the destination have been discovered.

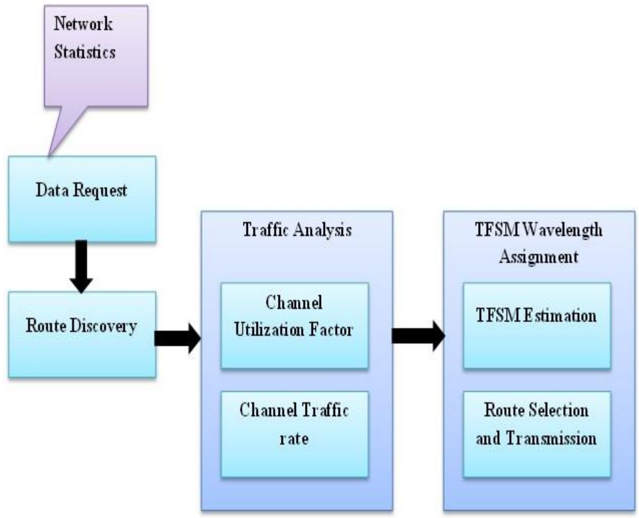

Figure 1: Architecture of Real Time Frequency Orient Traffic Analysis Based Wavelength Assignment Scheme

The method collects the flow, data rate and the frequency of transmission has been identified for each route identified. Using the information collected, the method estimates different factors to select the route for data transmission. Details of the approach are discussed in this section. Figure 1, shows the architecture of real time frequency traffic analysis model based wavelength assignment algorithm along with the various operations engaged with the proposed algorithm.

3.1 Route Discovery

Route discovery is the initial stage of the wavelength assignment. It takes the network statistics as the key with the data request. When a data request is generated for transmission, it collects the network statistics about the topology and flow, traffic, and frequency of data transmission from the statistics information. Using the topological information, the method finds the list of available routes to reach the receiver node. Then it identifies the list of hops or intermediate nodes available for each route. The method extracts the flow, frequency and traffic information for each intermediate node identified. The extracted information is converted into a feature vector and is used for computing different measures in the other stages.

Algorithm for Route Discovery

Input: Network Topology NT, Network Statistics Ns, Source S, Destination D

Output: Feature Vector Fv

Start

Read network topology NT.

Read Network Statistics Ns.

Identify list of routes between S and D.

Neighbor List Nl = $\sum Neighbors(S) \in NT$

Route Set Rs = $\sum_{i=1}^{size(Nl)} \sum Routes \in Nt$

For each route Ri

Identify list of hops present

Hop List Hl = $\sum Hops \in Ri$

For each hop h

Extract data flow Df = $\int NS(h).Data\ Flow$

Extract Traffic at h as Tr = $\int NS(h).Traffic$

Extract Frequency Fr = $\int NS(h).Frequency$

End

Generate Feature Vector fv = hi{Df,Tr,Fr},h_{i+1}{{Df,Tr,Fr},…,Hn}

End

Stop

The route discovery algorithm identifies the list of routes and the hops present in the route. The data flow, traffic and frequency values of each hop of the route have also been extracted from the network statistics. The values are converted into a feature vector and have been used for the estimation of other measures.

3.2 Channel Utilization Factor

Channel utilization factor is the measure which represents the usage of the channel by different nodes. The measurement has been made on the basis of the data flow and the frequency of data transmission. The conclusion based on the channel utilization factor relates to how free or engaged the channel is with the data transmission. The data rate has been computed based on the data flow and the entire amount of data being transmitted in the particular time window.

$$CUF = \frac{\sum_{i=1}^{size(Fv)} Fv(i).Df}{Dr/_{Nodt}} \times \frac{\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Fr}{Nodt} \quad (1)$$

Where Fv – Feature Vector

Dr – Data Rate

NS - Network Statistics

R - Route

Algorithm for Channel Utilization Factor

Input: Feature VectorFv, Route R, Network Statistics NS
Output: CUF
Start
Read Networks Statistics NS
Read Feature Vector Fv.
Compute data rate Dr = $\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).DataLength$

Compute total no of data transmission Nodt = $\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Route == R$

Compute channel utilization factor CUF = $\frac{\sum_{i=1}^{size(Fv)} Fv(i).Df}{Dr/_{Nodt}} \times \frac{\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Fr}{Nodt}$

STOP

The above discussed algorithm estimates the data rate using the data flow information and estimates the channel utilization factor required to support wavelength assignment

3.3 Channel Traffic Rate

Channel traffic rate is the measure which represents the amount of traffic present in the route and the channel considered at any point of time. It is necessary to consider the traffic factor in selecting or assigning the wavelength to the process. It has been measured on the basis of the data flow at each hop, traffic features and frequency of transmission and on the collective details of all the hops as follows:

$$CTR = \frac{\sum_{i=1}^{size(Fv)} Fv(i).Tr}{Tr/_{Nodt}} \times \frac{\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Fr}{Nodt} \quad (2)$$

Where Tr – Traffic rate

Algorithm for Channel Traffic Rate

Input: Feature Vector Fv, Route R, Network Statistics

Output: CTR

Start

Read Networks Statistics NS

Read Feature Vector Fv.

Compute traffic rate Tr = $\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Traffic$

Compute total no of data transmission Nodt = $\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Route == R$

Compute channel traffic rate factor CTR = $\frac{\sum_{i=1}^{size(Fv)} Fv(i).Tr}{Tr/_{Nodt}} \times \frac{\sum_{i=1}^{size(R)} \sum_{i=1}^{size(NS)} NS(j).Fr}{Nodt}$

Stop

The above discussed algorithm estimates the channel traffic rate required to support wavelength assignment.

3.4 TFSM Wavelength Assignment

At this stage, when a data transmission request is received, the method performs route discovery to produce the feature vector for different route available. Then the method computes the channel utilization factor and channel traffic rate values for each route. Using these two, the method computes the Transmission Frequency Support Measure (TFSM). Based on the TFSM value, a single channel and route has been selected.

Algorithm for TFSM Wavelength Assignment

Input: Data Request DR, Network Topology NT, Node Statistics NS

Output: Null

Start

Read Data request DR.

Read network topology NT.
<Route Set Rs, Feature Vector Fv>=
Perform route discovery.

For each route Ri

CUF = Channel Utilization(Ri).

CTR = Channel Traffic Rate (Ri)

Compute TFSM = $\frac{CUF}{Bandwidth} \times \frac{CTR}{Bandwidth}$

End

Choose the route with higher TFSM value.

Stop

The above discussed algorithm computes the transmission frequency support measure required to select an optimal route to perform data transmission.

4. Result and Discussion

The proposed algorithm has been implemented and evaluated for its efficiency. The method has been implemented using a network simulator with varying simulation conditions. The method has produced efficient results in different parameters considered. The proposed method has been evaluated for its efficiency using varying simulation conditions. The evaluation has been carried out with a scenario of 15 nodes and another of 20 nodes.

The performance of the approach can be measured on the basis of the light paths being active throughout the simulation. It depends on the efficiency of working of the allocation policy. It has been measured for the proposed algorithm and compared with other approaches.

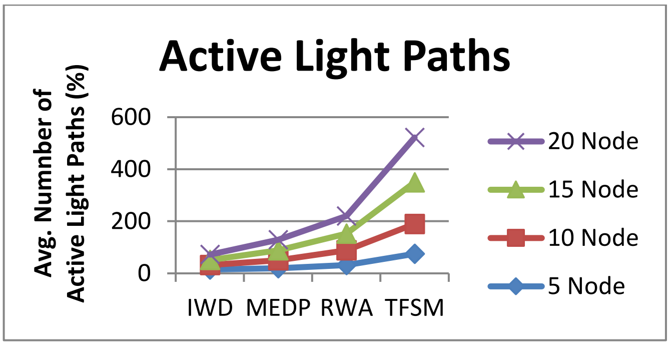

Figure 2: Comparison on average light paths on different topologies

Figure 2 shows the comparative results of average light paths produced by different methods under different topology conditions. According to this, the proposed TFSM algorithm has produced higher efficient results than other methods.

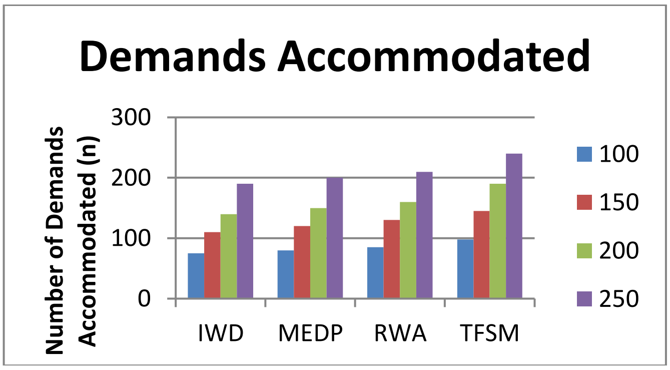

Figure 3: Comparison on demands accommodated

Figure 3 shows the comparison of a number of demands accommodated by different algorithms on a given number of demands according to allocation policy. The result shows improvement made by the proposed algorithm on the number of demands than other methods.

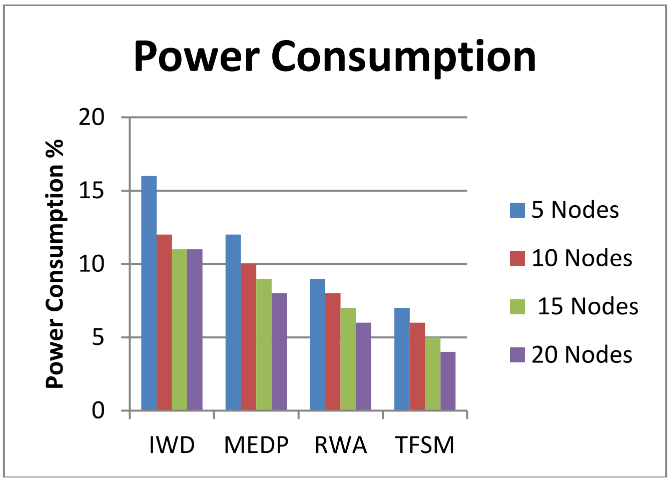

Figure 4: Comparison on power consumption

Figure 4 shows a comparison of power consumption produced by different methods on varying number of nodes. The results obtained show the production of smaller power consumption by the proposed method than the other methods in all the topology conditions.

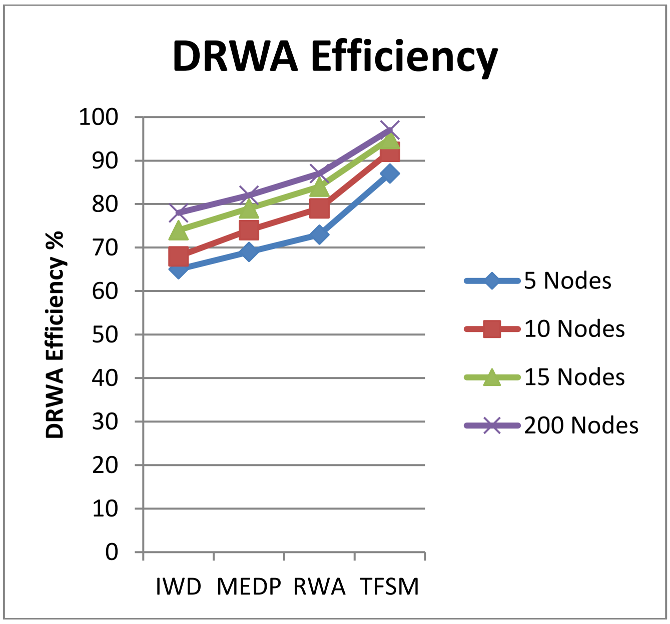

Figure 5: Comparison on wavelength assignment efficiency

Figure 5 shows a comparative result of the efficiency of wavelength assignment produced by different methods. The proposed TFSM algorithm has produced a higher efficiency when compared with IWD, MEDP and RWA methods**.**

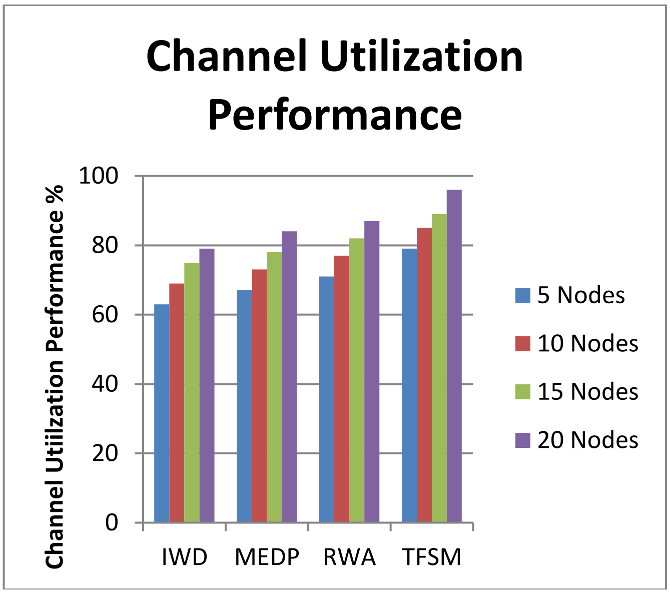

Figure 6: Comparison on channel Utilization performance

Figure 6 shows a comparison of channel utilization performance produced by different methods. The proposed TFSM algorithm has produced higher utilization when compared with IWD, MEDP and RWA methods.

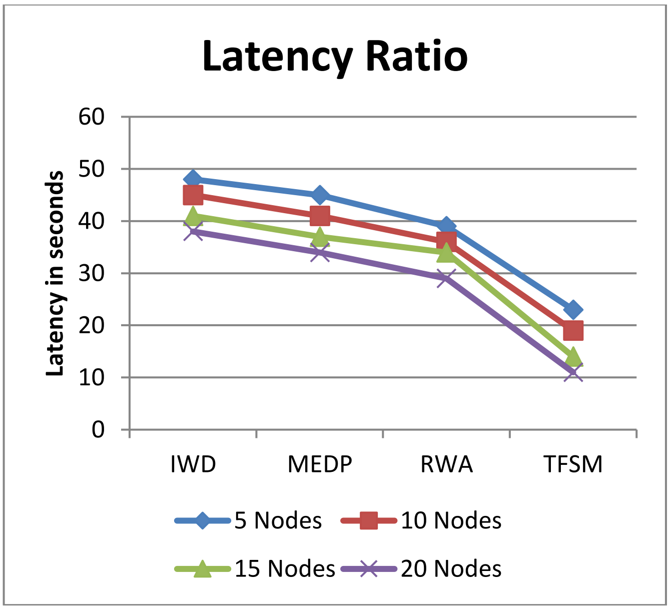

Figure 7: Comparison on latency ratio

Figure 7 shows a comparison of results on latency ratio produced by the different methods. The proposed TFSM algorithm has produced less latency than the other methods.

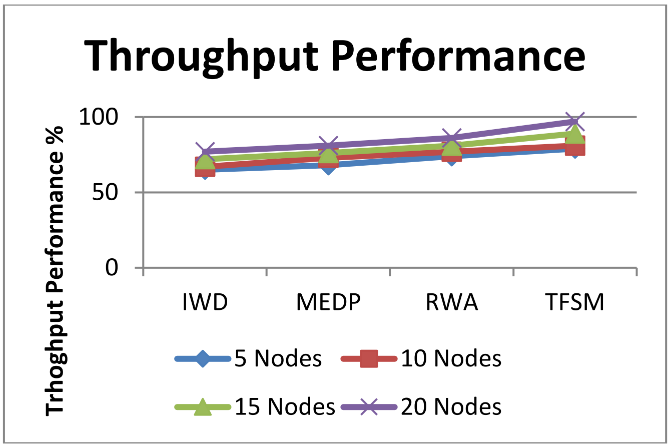

Figure 8: Comparison on throughput performance

Figure 8 shows a comparative result on throughput performance produced by different methods. However, the proposed TFSM algorithm has produced a higher throughput performance than the other methods.

4. Conclusion

In this paper, an efficient real time frequency traffic analysis model has been presented. The method estimates the channel utilization factor and channel traffic rate for identified routes. Based on the factors estimated, the method computes the transmission frequency support measure for each route. Finally, based on the TFSM value measured, a single route has been selected and the wavelength has been assigned for the data transmission. The method produced efficient result in wavelength assignment and route selection. Also the method improves the performance of different QoS parameters considered.

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