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Optimization of RWA Problem through OSNR
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Abstract

This documentary provides a kind of routing optimization method. In the basic of RWA solution method, both the output power of the route and the OSNR value of the optical signal noise ratio are considered. The selected optimal route has a lower bit error rate and the whole communication network performance is improved.

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1. Introduction

RWA is one of the core issues in the optimization of network performance. Currently, due to a variety of physical and technical constraints, optical network cannot provide all the required physical properties, thus the study and solution of the problem plays a vital role to optimize the network and improve the utilization rate of cyber source.

The Routing and Wavelength Assignment (RWA) is one of the key problems of the optimization of network performance. At present, the RWA problem is usually solved by being decomposed into the routing sub problem and wavelength assignment problems.

However, in the existing solutions of RWA, the allocation of routing and wavelength only considers the network performance such as network throughput, required wavelength, optical fiber number and optical path blocking rate, while the output power and the Optical Signal Noise Ratio (OSNR) index after establishing optical path are not considered.

In the long distance transmission of the optical transport network (OTN), the output power and optical signal-to-noise ratio (OSNR) of optical path will seriously affect the BER of communication system, so that the routing based on RWA algorithm is not the best, which impacts the overall network performance of communication system.

So this method has taken a comprehensive consideration of the channel output power POUT and the OSNR performance in the existing RWA solution, in order to achieve the optimizing routing.

1.1. Terminology

RWA: Routing and Wavelength Assignment.

Wavelength Conversion: The process of converting an information bearing optical signal centered at a given wavelength to one with "equivalent" content centered at a different wavelength. Wavelength conversion can be implemented via an optical-electronic-optical (OEO) process or via a strictly optical process.

OTN: Optical Transport Networks.

OSNR: Optical Signal Noise Ratio

OLA: Optical Line Amplifier

ASE: Amplifier spontaneous emission noise

2. Conventions used in this document

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in RFC 2119 [RFC2119].

3. Overview

In dynamic optical transport network, research on the resource optimization and constraint-based routing problem mainly includes the following aspects:

(1)path selection and wavelength assignment problem in optical layer.

(2)Constraint-based routing problem under dynamic business in Multi-layer network.

(3)resource optimization problem under dynamic business in the multi-layer network.

3.1. RWA Problem

Optical layer path selection and wavelength assignment problem, which is called RWA (Routing and Wavelength Assignment, routing and wavelength assignment) problem, is mainly caused by the require of consistency and constraints of wavelength in the optical fiber link.

Optical layer routing based on Dijkstra algorithm is usually started with the different parameters which are chosen refer to the least costly path. Common optical path selection algorithms contain mainly fixed routing algorithm, fixed alternate routing algorithm, adaptive routing algorithm and adaptive shortest alternate routing algorithm.

Wavelength assignment algorithm is usually based on heuristic algorithms, aiming to obtain the minimum blocking rate under a certain number of wavelengths. There are several common wavelength assignment algorithms such as randomly assigned wavelength method, first-fit, the minimum application method, the most widely used method and the lightest load method. The core problem of dynamic business constraints routing issue is how to combine electrical and optical layers to find proper routes.

4. Calculation formula

There are three important formula in this documentary.

(1) Output power formula

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P_out=P_in+SUM[Gi-Li];0<i<=n
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where P_out is the route output power, P_in is the fiber input power of the corresponding optical path sending end, Gi is the gain of the i-th optical amplifier in the corresponding route, Li is the loss of the i-th optical amplifier section in the corresponding route, n is the total number of optical amplifiers in the corresponding route. Power is in dBm and gain or loss is in dB.

(2) ASE formula

P_asei=NF+G+10*lg(h*v*B0)

where P_asei is ASE power of the i-th OA, NF is noise figure of the i-th OA, in dB. h is Planck constant, v is the frequency of light, and B0 is the reference light bandwidth .

(3)OSNR formula

OSNR=P_in-sum[P_asek-sum[Lm]+sum[Gi]];0<m<=k,0<i<=k+1

where P_in is the fiber input power of the corresponding optical path sending end, P_asek is ASE power of the i-th OA, Lm is the loss of the m-th optical amplifier section in the corresponding route, Gi is the gain of the i-th optical amplifier in the corresponding route. k is the total number of optical amplifiers in the corresponding route. OSNR is in dB.

5. Optimization of RWA problem through OSNR

Through routing algorithm and wavelength assignment algorithm, we calculate the K feasible routing of a specific business wavelength. K feasible routing pathes are arranged according to preset priority, among them, the ith routing is recorded as Ri , i=1,2,3 We choose the first reachable optical path and calculate the output power and OSNR value of the first path, and do the following operations according to whether the two indicators have reached the threshold .

Firstly, calculate the output power according to the formula of the optical path and compare with the optical fiber output power threshold standard. If the output power does not meet the threshold requirement which determines by the average output power of the corresponding fiber, it means that the receiving terminal has not detected the signal, so the OSNR value will not be calculated. Therefore, in order to meet the requirement of output power, it is necessary to choose a new path with larger Optical amplifier gain to recalculate.

Secondly, if the output power meets the threshold requirement, the OSNR value of the optical path is calculated. Moreover, if the OSNR value meets the OSNR threshold requirement at the same time, then the optical path is established successfully. If the OSNR value does not meet the threshold requirement, then the routing needs to be reselected by the following ways.

(1)Choose the optical path routing which has less relay. One OLA increase in the light path will amplify the signal and noise at the same time, and the ASE noise brings by OLA will be superimposed in the signal. Therefore, the value of OSNR will be reduced after the signal is released by OLA. As a result, under the premise of meeting the power requirements of the receiving terminal, we choose less optical path and increase the corresponding OSNR value to achieve the threshold requirement.

(2) If the number of relays in the optical path is the least, then the suboptimal path is adopted, in which is to choose a light path with a large number of OLA and smaller gain G.

6. Formal Syntax

The following syntax specification uses the augmented Backus-Naur Form (BNF) as described in RFC-2234 [RFC2234].

7. Security Considerations

This model is very similar with a security standpoint of the information that can be currently conveyed via GMPLS routing protocols. This kind of information includes network topology, link state and current utilization, as well as the capabilities of switches and routers within the network, which is owing to that the information should be protected from disclosure to unintended recipients. In addition, the intentional modification of this information can significantly affect network operations, particularly due to the large capacity of the optical infrastructure has been controlled.

8. IANA Considerations

This informational document does not make any requests for IANA action.

9. Conclusions

This document discussed an information model for RWA computation in OTN and presented the method has taken a comprehensive consideration of the channel output power POUT and the OSNR performance in the existing RWA solution, in order to achieve the optimizing routing.

10. References

10.1. Normative References

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10.2. Informative References

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