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Report on Research Progress

Genetic Algorithms-based Dynamic Routing and Wavelength Assignment in Optical WDM Networks

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Purpose

All optical networks using wavelength-division-multiplexing (WDM) technology are promising for serving as the backbone of next generation Internet, because optical WDM networks can provide huge bandwidth capacity effectively. In wavelength-routed WDM networks, data are routed in optical channels called lightpaths. Given a set of connection requests, the routing and wavelength assignment (RWA) problem involves finding a route (routing) and assigning a wavelength to each request. The RWA problem is usually divided into two types: static RWA and dynamic RWA. In the static RWA problem, the entire set of connections is known in advance, and the problem is to set up lightpaths for these connections so that used network resources are minimized. In the dynamic RWA problem, since connection requests arrive randomly, it is more difficult to be solved. The dynamic RWA problem becomes more complex if other constraints are taken into consideration, such as the wavelength conversion capability, the survivability requirement, multicast requirement, etc. Genetic algorithms (GAs) a class of search strategies based on the mechanism of biological evolution. GA is able to reduce search space but can also converge to a global good solution of the problem. Thus, GAs is one promising approach to solve dynamic RWA problems in WDM networks.

Our research focuses on applying genetic algorithms to solve the challenging dynamic routing and wavelength assignment in WDM optical networks.

Methodology

A dynamic (adaptive) RWA algorithm aims to minimize the overall blocking probability in the entire network. To make the RWA problems more tractable, they are usually decoupled into two sub-problems that are solved separately: the routing problem and the wavelength assignment problem. The former problem is more important and complicated than the latter problem, thus the research focus on the routing problem. There are three major routing schemes: fixed routing, fixed-alternate routing and adaptive routing. In the first routing scheme, a single fixed route is predetermined for each source-destination pair. Whenever a request arrives, its fixed route is attempted for wavelength assignment. Fixed routing scheme is simple for implementation but causes a high blocking probability. In second routing scheme, a set of routes is pre-computed for each source-destination pair. As a connection request arrives, one route is selected from the set of pre-computed routes. Fixed alternate routing always achieves a better performance than that of fixed routing. In the final routing scheme, the route is computed at the arrival of a request based on the current network state; therefore it obtains the best performance. However, adaptive routing is difficult to be implemented and has a high computational complexity.

To fully understand the feasibility of using GA to solve the dynamic RWA problem, we have been conducting our research step by step as follows:

1. We have developed a GA-based dynamic RWA algorithm for WDM networks without wavelength conversion.

2. We have proposed a GA-based dynamic RWA algorithm for WDM networks with sparse wavelength conversion.

3. We are now developing GA-based dynamic RWA algorithm for survivable WDM networks

4. We will develop GA-based dynamic multicast routing algorithm for WDM networks without and with wavelength conversion

Research Achievement

Until now we have proposed new algorithms to solve the problems in part 1 & 2. The detail as follows:

1. V.T. Le, S.H. Ngo, X. Jiang, S. Horiguchi, M. Guo, "A Genetic Algorithm for Dynamic Routing and Wavelength Assignment in WDM Networks"*, in Proc. International Symposium on Parallel and Distributed Processing and Applications* (ISPA), Hong Kong, China, December 2004

2. V.T. Le, X. Jiang, S.H. Ngo, S. Horiguchi, "Dynamic RWA Based on the Combination of Mobile Agents Technique and Genetic Algorithm in WDM Networks with Sparse Wavelength Conversion", *to appear in the 19th IEEE International Parallel and Distributed Processing Symposium* (IPDPS), Colorado, USA, 2005

3. V.T. Le, X. Jiang, S.H. Ngo, S. Horiguchi, "Dynamic RWA Based on the Combination of Mobile Agents Technique and Genetic Algorithm in WDM Networks with Sparse Wavelength Conversion", *IEICE Transaction On Information and Systems* (Conditionally Accepted.).

Future work

1. Jan, 2005 – April, 2005: To develop GA-based algorithms for dynamic routing and wavelength assignment in survivable WDM networks.

2. May, 2005 – June, 2005: To finish papers for conferences and journals based the GA-based survivable RWA algorithms.

3. July, 2005 – Aug, 2005: To develop GA-based algorithms for multicast routing in WDM networks without and with wavelength conversion.

4. Sep, 2005 – Nov, 2005: To finish papers for conferences and journals based the GA-based algorithms for multicast routing in WDM networks without and with wavelength conversion

5. Dec, 2005 – Jan, 2006: To develop algorithms based on combination of other searching algorithms and genetic algorithms for dynamic routing and wavelength assignment in optical WDM networks.

6. Feb, 2006 – March, 2006: To finish papers for conferences and journals based algorithms that combination of other searching algorithms and genetic algorithms for dynamic routing and wavelength assignment in optical WDM networks.

7. April, 2006 – June, 2006: To finish the thesis