QoS Routing Algorithms for Networks

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1. Aim and Objectives

Generally speaking, my research mainly focuses on the design and analysis of algorithms such as network routing algorithms, approximation algorithms and scheduling algorithms.

As networks modernize and expand with the increasing deployment of high-speed technology, routing protocols that use shortest-path algorithms for single-metric path computation are inadequate for real-time huge-volume data transfer applications which often require guaranteed quality of service (QoS). To support QoS requirements, a routing protocol must supply explicit information on resources available in the network so that applications can make proper resource reservation. So we need a more complex model of the network, taking into account important network parameters such as bandwidth, delay, jitter rate and loss probability. This, however, has raised a number of challenging technical issues for routing protocols. In this thesis, we will identify the complexity structure of different metrics since multiple routing metrics have important implications on the complexity of path computation while the problem of finding a path subject to multiple constraints is usually difficult. We will also design new efficient algorithms that are able to compute paths that satisfy multiple constraints.

2. Idea and Approach

- To conduct a comprehensive study of hybrid MANET and optical networks architecture, find some intrinsic problems and basic design rules through detailed comparison.
- To set up a framework for the relationship of different QoS metrics in large networks and hybrid systems.
- To develop techniques that are efficient, scalable and fault-tolerant for routing issues in the large networks.
- To design approximation algorithms for the survivable facility location problem and the QoS multicast tree with inner nodes problem.
- To propose effective routing and scheduling schemes for both Optical Nets and MANETS.

The following are the major techniques we will use to develop a hybrid network QoS routing framework which should be efficient, flexible, scalable and fault-tolerant:

- Clear classification and analysis of the QoS architecture in large networks.
- Multiple disjoint restricted paths solutions for QoS fault-tolerant routing.
- Energy efficient multicast routing algorithms for Mobile Ad Hoc Networks and Sensor Networks.
- Approximation algorithms design for queuing, scheduling and routing.
- Efficient QoS constrained survivable sub-graph computing for networks.
- The hybrid optical switching (HOS) approach that combines OCS and optical burst switching (OBS).

3. The Progress In the Past Year

- Algorithms for bandwidth efficient Video on Demand service have been designed and implemented. Several papers have been published or submitted.
- The framework of a routing protocol for the Mobile Ad hoc Networks has been designed.
- Algorithms for finding two QoS-constrained edge-disjoint paths in a network have been designed and experiments have been conducted.
- Improved approximation algorithms for the minimum spanning tree with inner cost problem have been designed. An innovative framework has been proposed for this problem.
- Wavelength conversion and splitter limited routing path algorithms for optical networks have been studied and algorithms presented.

4. Future directions

- To build a simulation project for my routing protocol for the Mobile Ad hoc Networks. Then measure the performance of this protocol and improve on it. Several publications to be expected.
- The conduct experiment simulations and test the Routing Protocol for Optical Networks, both Unicast and Multicast.
- To implement the collision avoidance algorithm on the OMNET++ simulation platform.
- To combine all the algorithms designed and propose a fault-tolerant routing framework for large networks.
- To design improved Approximation Algorithms or Randomised Algorithms for the metric version of facility location problems and MSTI problem.

5. Papers

1. Chao Peng, Hong Shen, "A Localized Algorithm for Minimum-Energy Broadcasting Problem in MANET", Springer-Verlag, Lecture Notes in Computer Science 3795, December, 2005.

2. Chao Peng, Hong Shen, "An Improved Approximation Algorithm for Computing Disjoint QoS Paths", to appear in the 5th IEEE International Conference on Networking (ICN'06), April 21-26, 2006, Mauritius.

3. Chao Peng, Hong Shen, "Fault Tolerant QoS Routing for Sensor Networks", submitted to the Fifth International Conference on Information Processing in Sensor Networks (IPSN 2006).

4. Chao Peng, Hong Shen, "New Algorithms For Fault-Tolerant QoS Routing", submitted to the International Conference on Dependable Systems and Networks (DSN-2006).

5. Chao Peng, Hong Shen, "Discrete Broadcasting Protocol for Video-on-Demand", submitted to IEICE.

6. Chao Peng, Hong Shen, "Improved Approximation Algorithms for 2-Disjoint Restricted Shortest Path Problem", submitted to Operation Research Letters.

7. Chao Peng, Hong Shen, "Approximation Algorithms for Minimum Spanning Trees with Inner Nodes Cost Problem", submitted to Networks.