Progress Report

DOE Award number: DE-SC0004909
Name of recipient: University of Massachusetts, Dartmouth
Project Title: Coordinated Multi-layer Multi-domain Optical Network (COMMON) for Large-Scale Science Applications
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Date of Report: Dec 10th, 2010
Period covered by the report: Oct 5, 2010 - Nov 30, 2010

Introduction

We intend to implement a Coordinated Multi-layer Multi-domain Optical Network (COMMON) Framework for Large-scale Science Applications. In the COMMON project, specific problems to be addressed include 1) anycast/multicast/manycast request provisioning , 2) multi-layer multi-domain quality of service (QoS), and 3) multi-layer multi-domain path survivability. In what follows, we outline the progress in this quarter for catogories 1) and 2) (Year 1 deliverables).

Activities

After the DOE kick-off meeting held at Lawrence Berkeley National Laboratory (LBNL) in California, USA on the 5th and 6th of October, 2010 the entire research team at the University of Massachusetts Dartmouth, consisting of three graduate/under graduate research assistants (Jeremy Plante, Derek Rousseau and Bharath Ramaprasad) and one visiting scholar from Spain (Joan Triay) were updated with the proceedings of the meeting as well as the specifics of the project. On October 26^{th} 2010, a research associate (post-doc); Dr. Arush Gadkar was hired to work on the COMMON project.

Goals

In this section we describe the progress and accomplishments in each of the tasks (labeled T1, T2) as outlined in the project proposal:

- T1: Multicast/Manycast/Anycast Request Provisioning

  There is a substantial amount of work in the literature on multicasting in optical networks. To accomplish multicasting at the optical layer, these works assume *all-optical* switches/cross-connects that require optical splitters to make them multicast capable. To efficiently support multicast requests the network creates *light-trees*. Work has also been conducted by limiting the *fan-out* degree of each optical crossconnect. In our initial work, we addressed the problem of routing and wavelength assignment for multicast *advance reservation* in all-optical wavelength-routed WDM Networks. Here it was assumed that the optical crossconnects were capable of splitting an incoming signal on one input port to multiple output ports (i.e., they are multicast capable). Since the nodes on the Energy Sciences Network (EsNet) are not multicast capable (i.e., their fan-out degree is 1), we propose an overlay model to support multicasting on the EsNet. In what follows, we outline in brief the work conducted thus far on this subject.

  Work Performed:

Our objective is to provide the multicast functionality for the EsNet by using as few wavelengths as possible to support a given set (static) of multicast requests. To this end, we first plan to a mathematical model i.e., an integer linear program (ILP) for each of the following two models

1) Drop At Member Only (DAMO)

2) Drop At Any Member (DAAM)

with an objective of minimizing the total number of wavelengths used. Both the models provide the multicast overlay functionality. The difference between the above models is as follows: For a particular multicast request, in the DAMO model we allow a lightpath (LP) to be terminated/dropped at a node only if the node is a candidate member of the multicast request, whereas in the DAAM model we allow a LP to be dropped at any node in the network.

We also plan to developed an ILP for multicasting via WDM unicast (i.e., single hop model). This model will serve as a base case to compare the number of wavelengths required to satisfy a given multicast request set. Lastly, we plan to simulate the Manycasting and Anycasting communication paradigm and observe their performances as compared to multicasting. We also plan to evaluate the performance of the DAMO and DAAM for the dynamic traffic scenario, wherein multicast requests arrive to the network according to some stochastic process.

We have also examined provisioning holding-time-aware dynamic circuits using a technique called lightpath switching (LPS). Instead of using the same lightpath for the duration of the data transmission, in LPS we allowed a request to switch lightpaths over time. Data transmission may begin on one lightpath from the source to destination, then at a later time a different lightpath from the source to the destination may be selected to continue data transmission. Allowing LPS creates a number of segments that can use independent lightpaths. We first plan to evaluate the effects of LPS by using a static routing scheme in the heuristics and then extending this work to dynamic routing and AR requests.

- T2: Multi-layer/Multi-domain QoS

  Work Performed:

  Regarding the multi-layer/multi-domain (MLMD) QoS, this task involves the design of new provisioning mechanisms to immediate and advance reservations (IR/AR) on a multi-layer and multi-domain scenario. The beginning of such task is planned for next year (11/2011). However, we have already initiated work in the field to better understand the scope of the problem and solution. Specifically, the following tasks have been set during the present period:

  – State-of-the-art and background research on multi-layer/multi-domain QoS, with a special focus on networks supported by an optical layer (wavelength-routed networks).
  – Proposal of an IR/AR multi-layer service differentiation. This is an ongoing task.
  – Implementation and evaluation through simulation of IR/AR performance without QoS policies. This is also an ongoing task.

Cost Status & Unexpected Funds

See attached document

Next Quarter Deliverables

- Compare the performance of the ILPs for the static multicast overlay problems for the two models (DAMO) and (DAAM) to the baseline case (single-hop model).
- Develop efficient heuristics to solve the Overlay problems.
- Multi-layer QoS in optical networks.
- Develop efficient heuristics to solve the IR and AR systems with LPS and possibly extend this work to cover the anycasting communication paradigm.