COMMON:
Coordinated Multi-layer Multi-domain Optical Network Framework for Large-scale Science Applications

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Outline

• Introduction
• Project Objectives
• Experiments and Implementation
• Project Facts and Figures
• Project Tasks
Introduction (i)

• To support large-scale science applications we need to provision network resources across multiple layers and multiple domains.
• The network needs to provision connections between clients efficiently.
  – Immediate reservation (IR): network provisioning “immediately” when the connection request arrives.
  – Advance reservation (AR): resources can be reserved at some point in the future.
Introduction (ii)

- Advance reservation can improve the performance of the network by increasing the connection success rate and guaranteeing the availability of resources for the application.
  - Some extra parameters (start time, end time, and duration) are needed.
  - Open research problems to be addressed for AR:
    - Multi-layer multi-domain survivability,
    - Multi-layer multi-domain QoS, and
    - new communication paradigms, such as anycast.
Communication Services - Introduction (iii)

- Unicast vs Anycast and Multicast vs Manycast

Unicast: 
- "s" connects to just one destination

Anycast: 
- "s" selects one destination (k=1) from the group

Multicast: 
- "s" connects to all nodes in the group (k = m)

Manycast: 
- "s" connects to a subset of m (k <= m)
What is Manycast?

- Point to multi-point communication paradigm
- Source communicates with any $k$ destinations from a larger candidate set, $D_c$
- Defined as: $(s, D_c, k)$ (e.g. $(1, \{3,5,6,7\}, 2)$)
- Multicast: $|D_c| = k$ (e.g. $(1, \{3,5\}, 2)$)
- Unicast: $|D_c| = k = 1$ (e.g. $(1, \{3\}, 1)$)
- Anycast: $k = 1$ (e.g. $(1, \{3,5,6,7\}, 1)$)
Project Objectives

• Implement a Coordinated Multi-layer Multi-domain Optical Network Framework for Large-scale Science Applications.

• This involves the definition of new algorithms and mechanisms for advance and immediate reservation of network resources.

• Specific problems to be addressed in COMMON:
  – Multi-layer multi-domain path survivability (Task 1 - T1).
  – Multi-layer multi-domain quality of service (T2).
  – Anycast (multicast-/manycast-overlay) request provisioning (T3).
T1: Multi-layer Multi-domain Path Survivability

- Survivability for immediate and advance reservation of dynamic connections.
- Issues to investigate:
  - Definition of parameters and design of basic IR/AR survivability schemes
    - Number of connection requests to re-route.
    - Time-shifted backup reservations.
  - Multi-layer survivability
    - IP layer vs Ethernet vs WDM/SONET
    - How higher layers (in OSCARS) can be mapped to lower-layer survivability mechanisms.
  - Multi-domain survivability
    - New topology abstractions with temporal information.
# T1: Multi-layer Multi-domain path survivability

## Summary of Tasks

<table>
<thead>
<tr>
<th>Task ID</th>
<th>Task Description</th>
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</thead>
<tbody>
<tr>
<td>T1.1</td>
<td>Provisioning of multi-layer path survivability for IR requests.</td>
</tr>
<tr>
<td>T1.2</td>
<td>Handling different failure scenarios for multi-layer multi-domain IR survivability.</td>
</tr>
<tr>
<td>T1.3</td>
<td>Handling different failure scenarios for multi-layer multi-domain AR survivability.</td>
</tr>
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## Deliverables

<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Start</th>
<th>End</th>
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</thead>
<tbody>
<tr>
<td>D1.1</td>
<td>Develop algorithms for coordinated multi-layer survivability and deployment on OSCARS</td>
<td>7/2011</td>
<td>10/2012</td>
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<tr>
<td>D1.2</td>
<td>Extend multi-layer and multi-domain survivability techniques and deployment on OSCARS</td>
<td>4/2012</td>
<td>9/2013</td>
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</table>
T2: Multi-layer Multi-domain QoS

- Ensure the QoS for different CoS defined in the multi-layer framework, especially for high priority traffic.
- Issues to be addressed:
  - Mapping of IP QoS (DHCP) and Ethernet VLAN priorities to circuit priorities
  - Multi-layer QoS → Guarantee the QoS metrics across multiple layers.
  - Multi-domain QoS → Ensure minimum level of service is guaranteed across different domains.
# T2: Multi-layer Multi-domain QoS

## Summary of Tasks

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<thead>
<tr>
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<tbody>
<tr>
<td>T2.1</td>
<td>Provisioning of multi-layer QoS to IR requests.</td>
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<tr>
<td>T2.2</td>
<td>Provisioning of multi-layer QoS to AR requests.</td>
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<tr>
<td>T2.3</td>
<td>Incorporation of QoS metrics into multi-layer multi-domain path setup.</td>
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<tbody>
<tr>
<td>D2.1</td>
<td>Implementation of requests preemption on OSCARS to support multiple CoS.</td>
<td>10/2011</td>
<td>12/2012</td>
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<tr>
<td>D2.2</td>
<td>Implementation of multi-layer QoS on OSCARS.</td>
<td>10/2012</td>
<td>9/2013</td>
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T3: Anycast/Multicast/Manycast service

- There exist other communication paradigms that could be very beneficial for large-scale experimentation.
  - Anycast: communication from a source to a unique destination within a candidate destination set.
  - Multicast: communication from a source to all the destinations from the destination set.
  - Manycast: communication from a source to a group of destination from a larger candidate destination set.

- We aim to provide support for these communication paradigms in the IR/AR framework.

- We may have to support these as overlays over point-to-point unicast connections in OSCARS.
# T3: Anycast/Multicast/Manycast service

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<tr>
<td>T3.1</td>
<td>Anycast (multicast and manycast) IR algorithms.</td>
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<tr>
<td>T3.2</td>
<td>Anycast (multicast and manycast) AR algorithms.</td>
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<tr>
<td>T3.3</td>
<td>Provide multi-domain extensions for anycasting (multicast and manycast)</td>
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<td>D3.1</td>
<td>Deploy anycast (multicast and manycast) IR algorithms on OSCARS</td>
<td>10/2010</td>
<td>9/2011</td>
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<td>D3.2</td>
<td>Deploy anycast (multicast and manycast) AR algorithms on OSCARS</td>
<td>1/2011</td>
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Project Facts and Participants

• Project timeline:
  – October 2010 – August 2013

• Number of work packages and tasks:
  – 13 tasks in 3 different WPs.

• Number of deliverables:
  – 2 deliverables per WP.

• Number of researchers/students involved:
  – Principal Investigator (PI).
  – 1 Full-time Post-Doctoral Researcher.
  – 1 Full-time Visiting Scholar.
  – 2 Ph.D. students (from Spring/Fall 2011).
  – 3-4 Master’s thesis students.
# Project Timeline

<table>
<thead>
<tr>
<th>ID</th>
<th>Deliverable Name</th>
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<th>Finish</th>
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<tr>
<td>2</td>
<td>Deliverable 1.2</td>
<td>4/2/2012</td>
<td>9/30/2013</td>
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<tr>
<td>4</td>
<td>Deliverable 2.2</td>
<td>10/1/2012</td>
<td>9/30/2013</td>
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<td>5</td>
<td>Deliverable 3.1</td>
<td>10/1/2010</td>
<td>9/30/2011</td>
</tr>
<tr>
<td>6</td>
<td>Deliverable 3.2</td>
<td>1/3/2011</td>
<td>3/30/2012</td>
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Research Group Background


