

Adaptive Data Transfers that Utilize Policies for Resource Sharing

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Motivation

Scientific data are being collected at unprecedented volumes and rates

The success of large scientific collaborations requires distributed data access with improved latency, reliability

ADAPT Project (Adaptive Data Access and Policy-Driven Transfers)

- Goal: to develop and deploy a general-purpose data access framework for scientific collaborations

Initial implementation: client-based solution building on srm-copy data movement client

- Provide simple transition from current data movement practices to adaptive data movement

Outline

- ADAPT Project
- System Overview
 - Data Movement Service
 - Passive Measurement Archive
 - Policy Service
- Implementation
- Evaluation
 - Adaptive multi-file transfers between two sites
- Summary

ADAPT Project

Provides fine-grained and adaptive transfer management

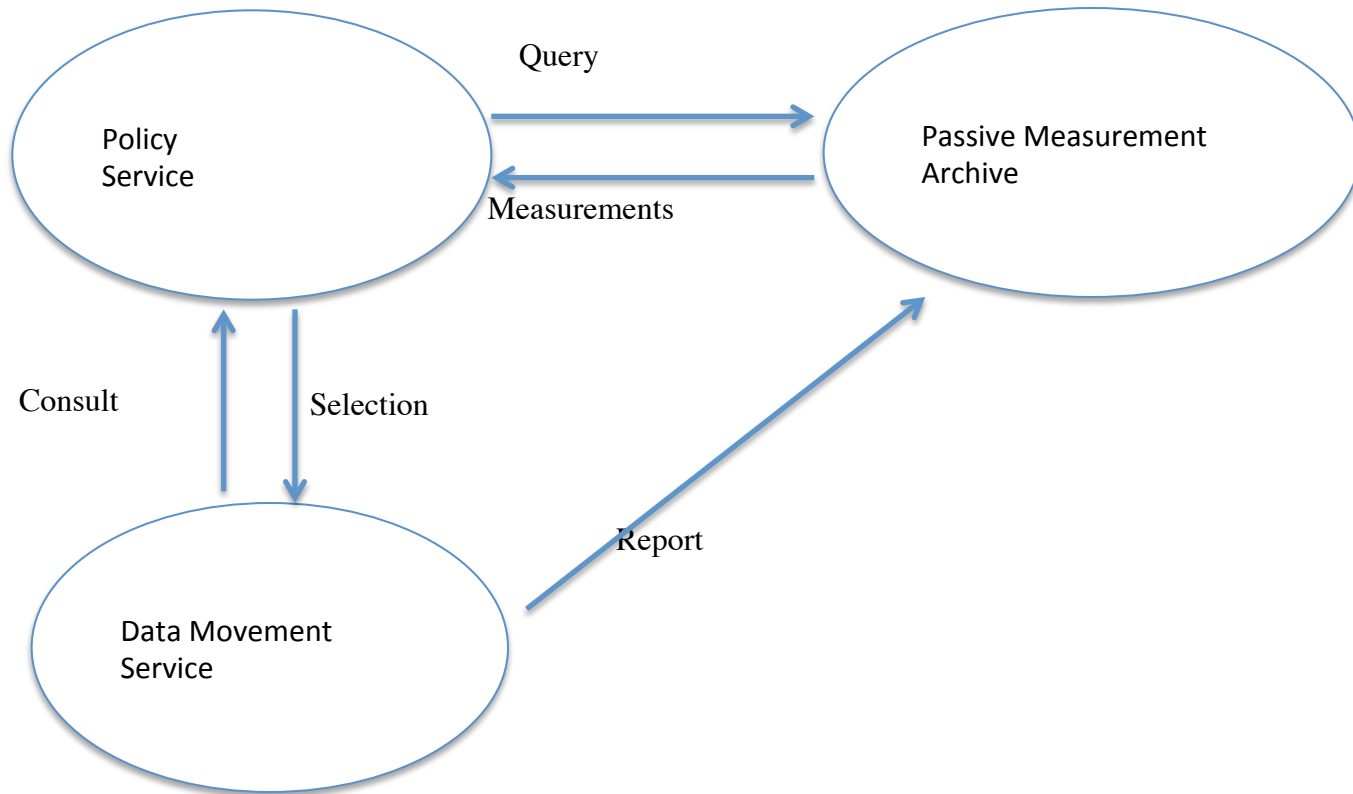
- Select transfer properties based on past performance, available resources
- Adapt properties when observed performance changes due to dynamic load on storage, network, other resources

Passive performance monitoring of transfers

Use of site and Virtual Organization policies for resource sharing

- Regarding replication, resource allocation
- Priorities for resources, users
- Balance user requirements for data access with load on resources

System Overview: Component Interactions



- Data Movement Service (DMS)
- Passive Measurement Archive (PMA)
- Policy Service (PS)

System Overview: Components

- **Data Movement Service (DMS)**
 - Performs data transfers
 - Records performance information about completed transfers in the **Passive Measurement Archive (PMA)**
 - Before initiating a new data transfer, DMS requests advice on transfer parameters from **Policy Service (PS)**
 - Number of parallel streams, concurrency, buffer size
 - DMS may modify the recommended transfer parameters before initiating the transfers
 - For long-running, multi-file transfers, DMS periodically:
 - Requests new advice from the **PS**
 - Adapts transfer parameters to accommodate changes in resource availability

System Overview: Components

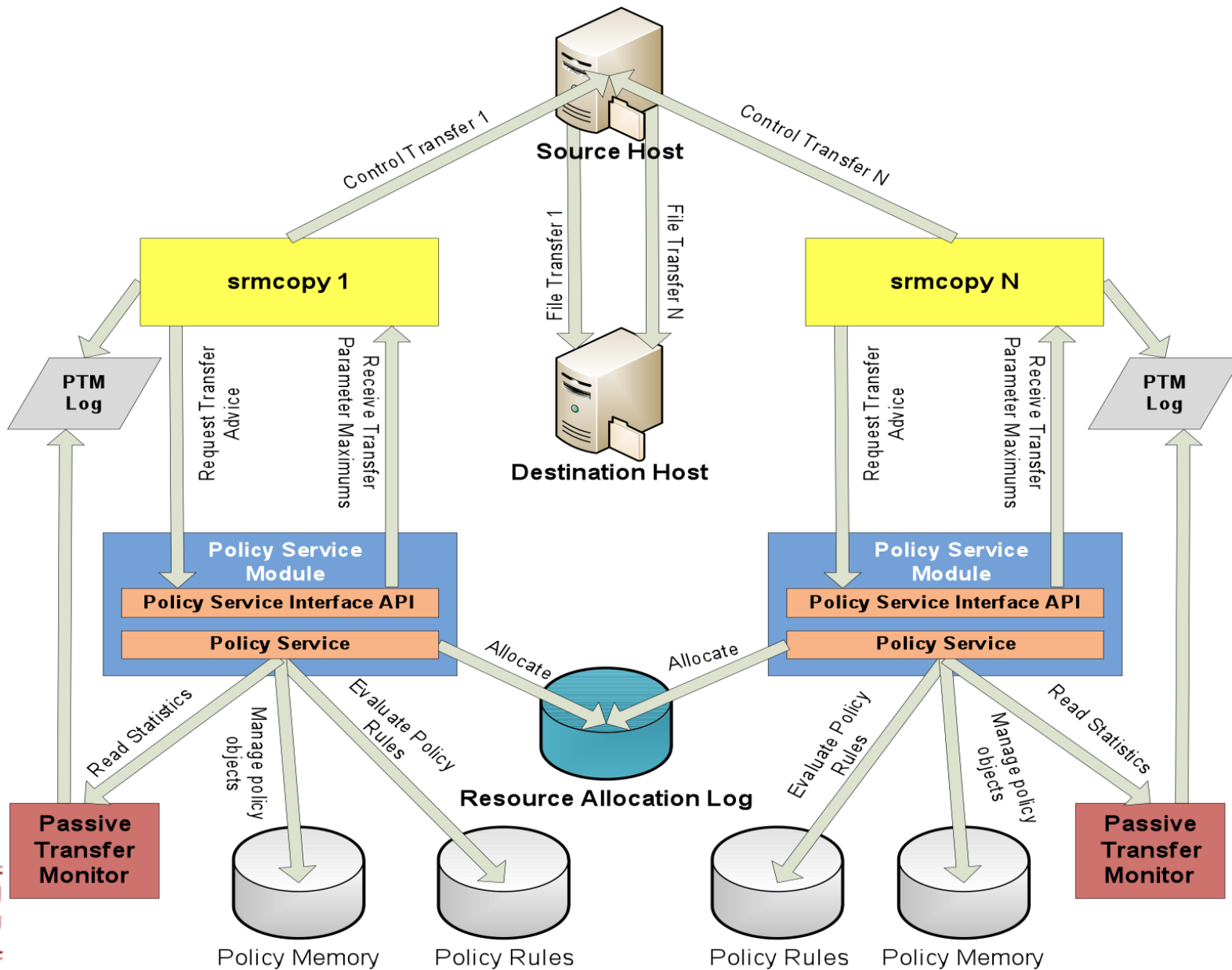
Policy Service (PS)

- Suggests transfer parameter values based on:
 - Past performance measurements stored in the **PMA** (if available)
 - Available system resources
 - Maintains a log of allocated resources
 - Site or Virtual Organization policies, such as:
 - Default parallelism for transfers
 - Maximum number of streams between source, destination
 - Resource or user priorities

Passive Measurement Archive (PMA)

- Transfer performance written by **DMS** as transfers complete
- Queried by **Policy Service**

Implementation



Implementation

Data Movement Service (DMS)

- Modified standard srm-copy data movement client
- Add Adaptive Data Transfer (ADT) library
- Periodically, gradually adjust number of concurrent streams up to optimal point

Passive Measurement Archive (PMA)

- Initial implementation: log file associated with srm-copy client
- Passive Transfer Monitor (PTM)
 - Implemented as a library of the srm-copy client
 - Writes transfer performance data to PMA log file
 - Answers queries by Policy Service
- Next phase: will use perfSONAR repository for PMA

Implementation

Policy Service (PS)

- For first phase of ADAPT, implemented as a library for srm-copy
- Generates advice based on historical information, VO & site policies, knowledge of resources allocated
- Policy library implemented using Drools open source policy engine
- Second phase: stand-alone Policy Service
 - Easier to share policy, resource allocation state across clients, nodes

Greedy Allocation Policy

- Policy sets a threshold for number of streams or bandwidth allocated between {source, destination} sites
- When a request for transfer advice arrives at PS:
 - Check Resource Allocation Log to determine streams/ bandwidth that have already been allocated
 - If unallocated streams/bandwidth remain below the threshold to satisfy the new request, then return advice to allocate requested resources
 - Otherwise, allocate resources up to threshold
 - Once threshold is reached:
 - Refuse additional requests, or
 - Allocate low level of resources to avoid starvation

Evaluation

Compare performance of adaptive data transfers with unmodified srm-copy client performance

Transfer data from LBNL in Berkeley, CA to Open Science Grid site at University of Nebraska at Lincoln (UNL), 1 Gbit/sec network

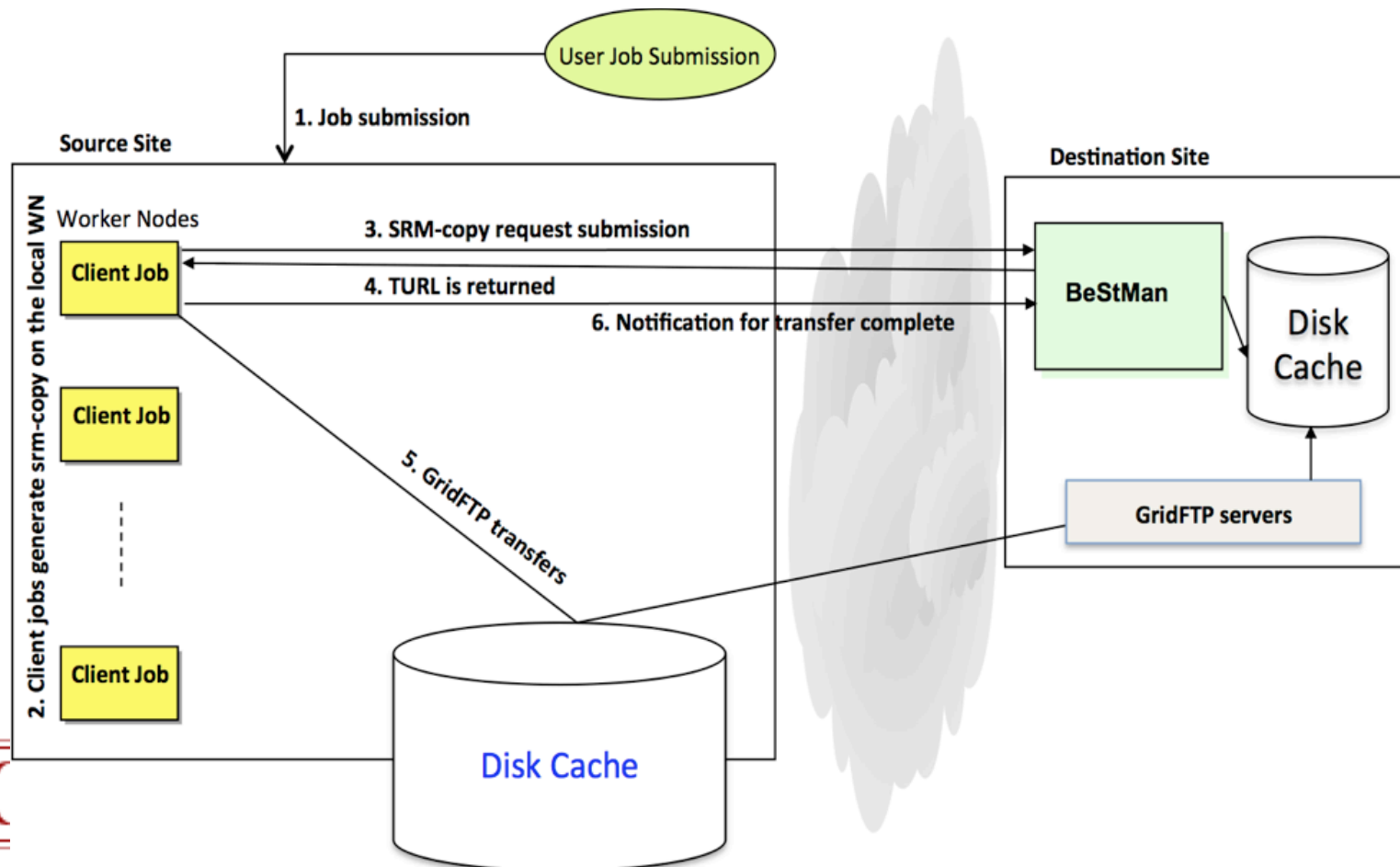
6 srm-copy clients performing multi-file transfers: 205 GBytes

Threshold 100 streams; each client requests 80 streams; minimum allocation 4 streams

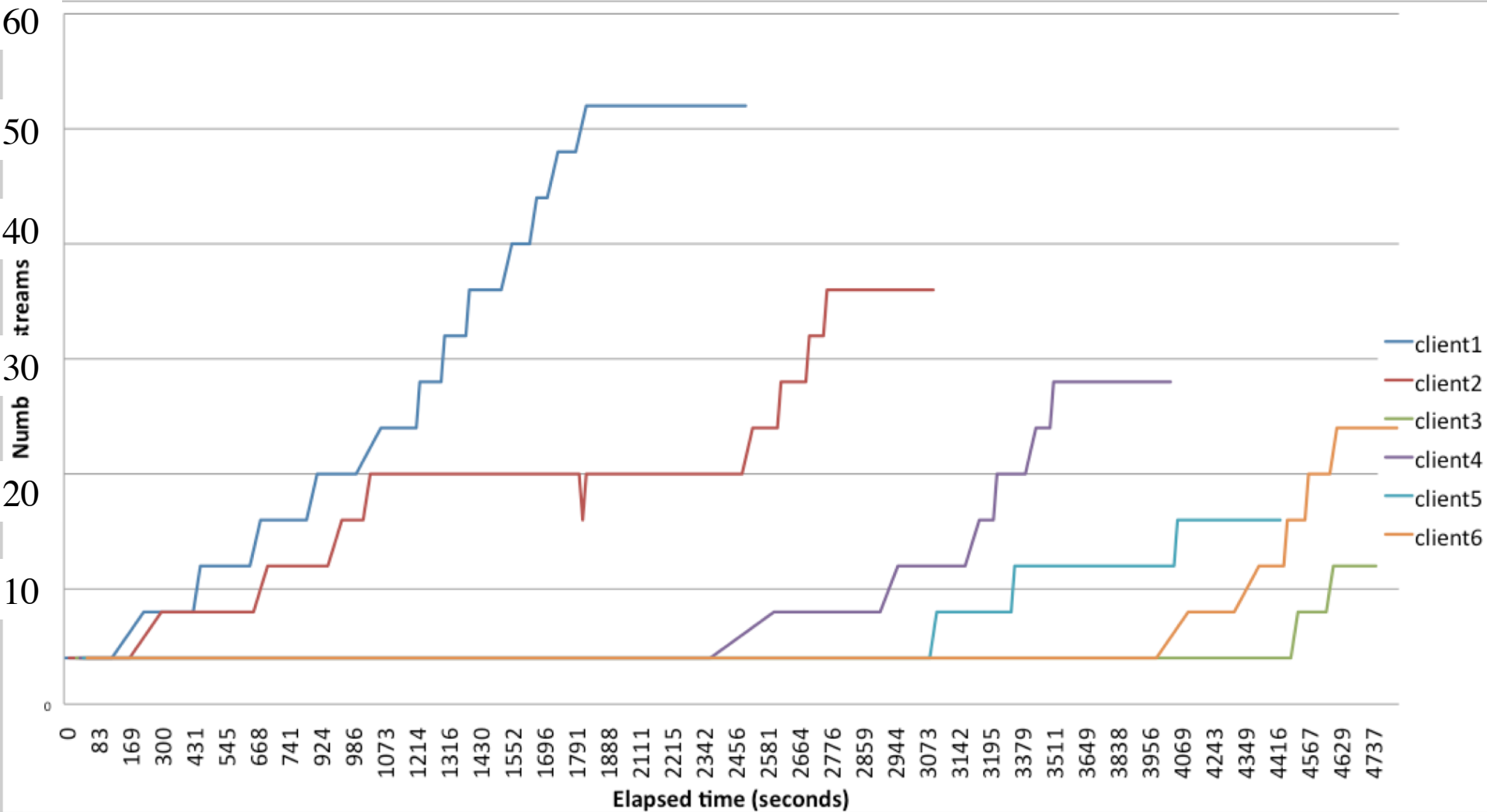
Client	Total data transferred	Total files	File sizes
1	45749 MB	84	45x957MB, 39x132MB
2	43571 MB	80	40x957MB, 40x132MB
3	21786 MB	40	20x957MB, 20x132MB
4	33768 MB	62	31x957MB, 31x132MB
5	31589 MB	58	29x957MB, 29x132MB
6	33768 MB	62	31x957MB, 31x132MB

Experiment Represents a Common Use Case

Users want to run analysis on an Open Science Grid site
Must first stage data from a remote location

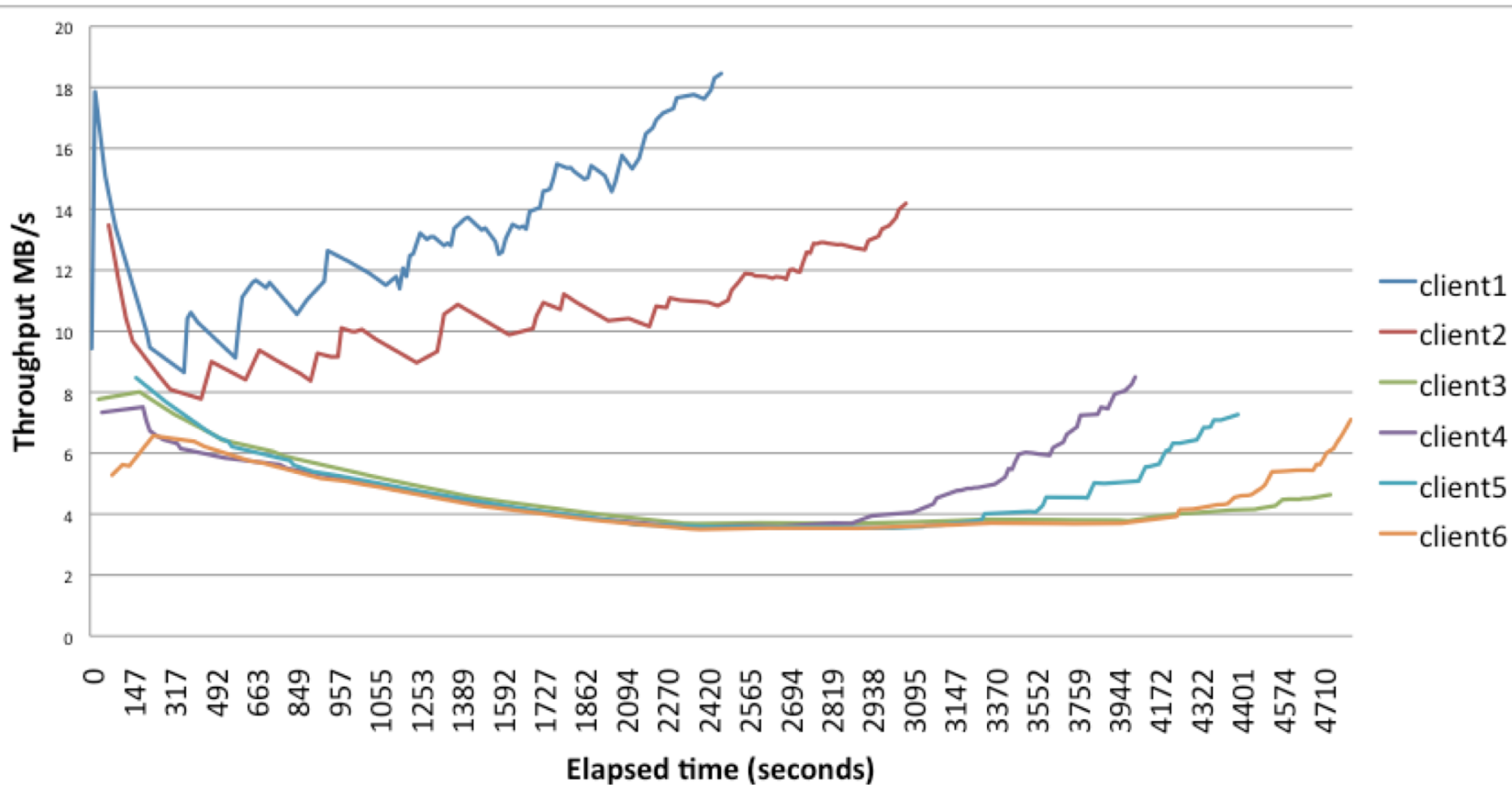


Performance with Adaptation: Number of Streams Allocated vs. Elapsed Time



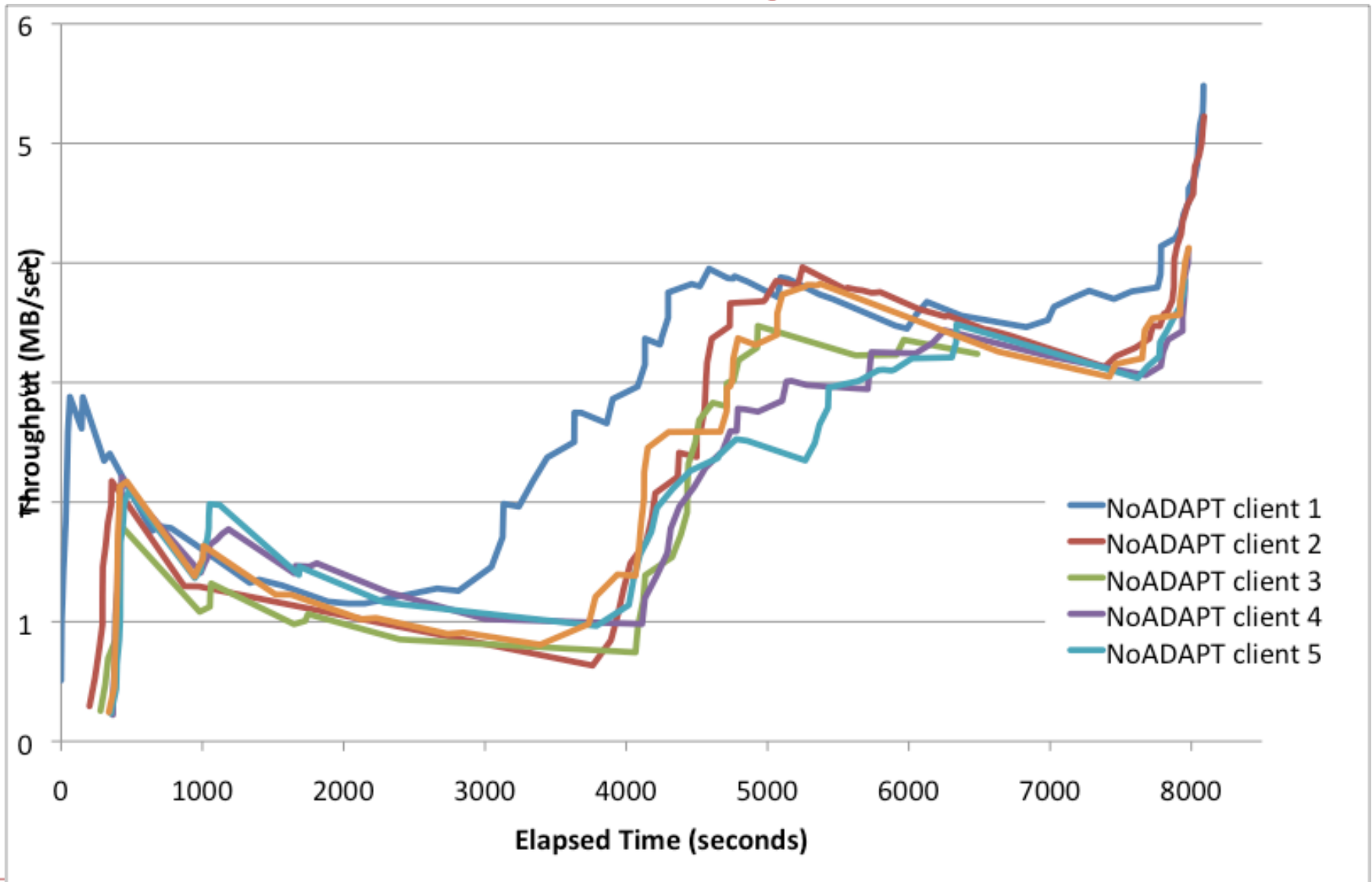
First two clients gradually increase allocation to 80, 20 streams. Other clients get minimum level of 4 streams, then adjust

With Adaptation: Throughput vs. Elapsed Time



Bandwidth increases as additional streams are allocated
All clients achieve at least 3.7 MBytes/sec throughput

Without Adaptation: Throughput vs. Elapsed Time



Network resources become oversubscribed
Overall took 30% longer to complete data transfers

Summary

First phase of ADAPT project

- Client-based solution based on srm-copy
- Goal: provide simple transition from current data movement practices to adaptive data movement

Plans for second phase:

- Enhancing Adaptive Transfer
- Deploying standalone Policy Service
- Integrating perfSONAR as Passive Measurement Archive
- Exploring richer policies for managing resources, adaptation
- Work with application communities to deploy and evaluate ADAPT software