DiPerF: automated DIstributed PERformance testing Framework

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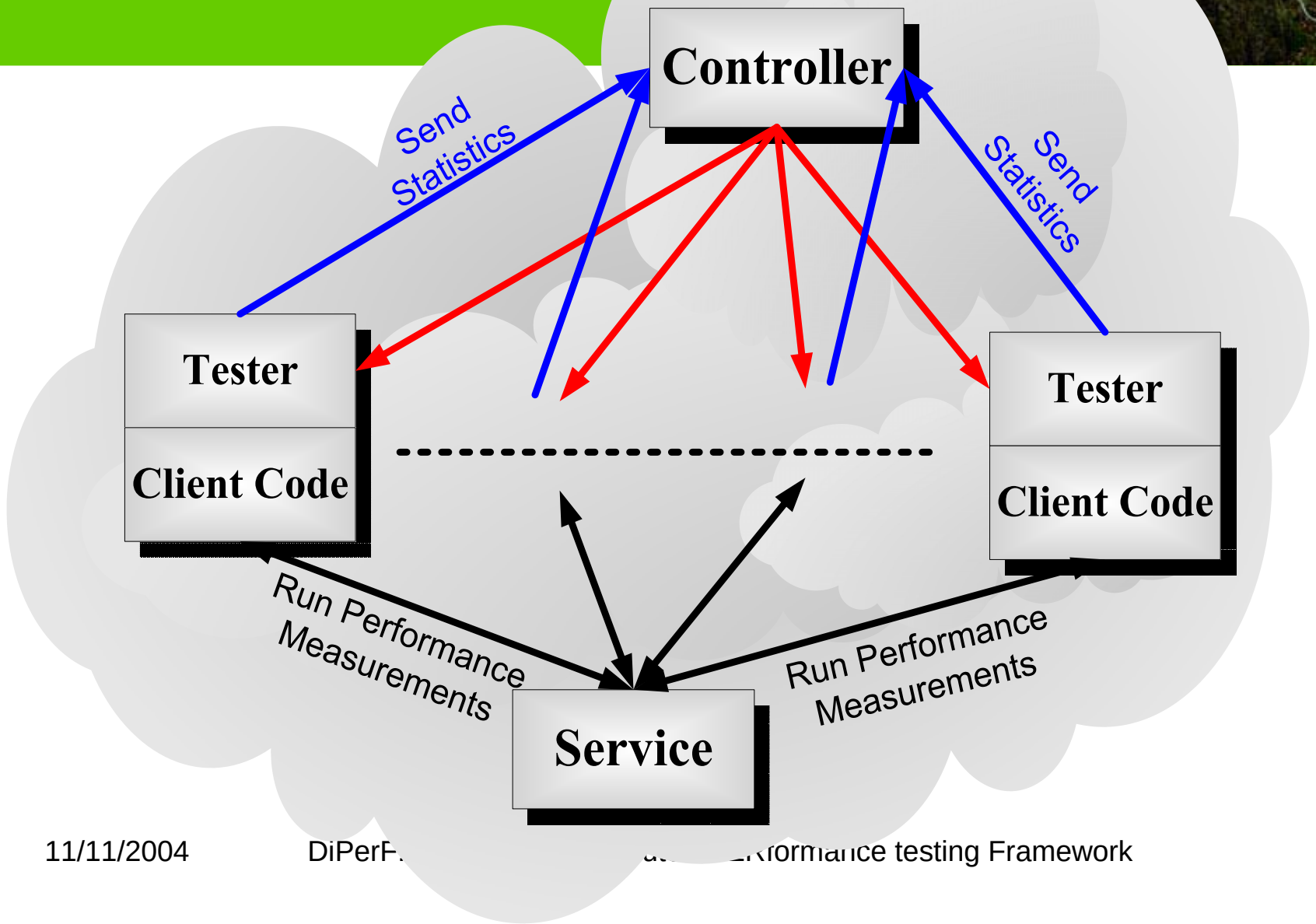
Introduction

- Goals
  - Simplify and automate distributed performance testing
    - grid services
    - web services
    - network services
  - Define a comprehensive list of performance metrics
  - Produce accurate client and server views of service performance
  - Create analytical models of service performance
- Framework implementation
  - Grid3
  - PlanetLab
  - NFS style cluster (UChicago CS Cluster)

Framework

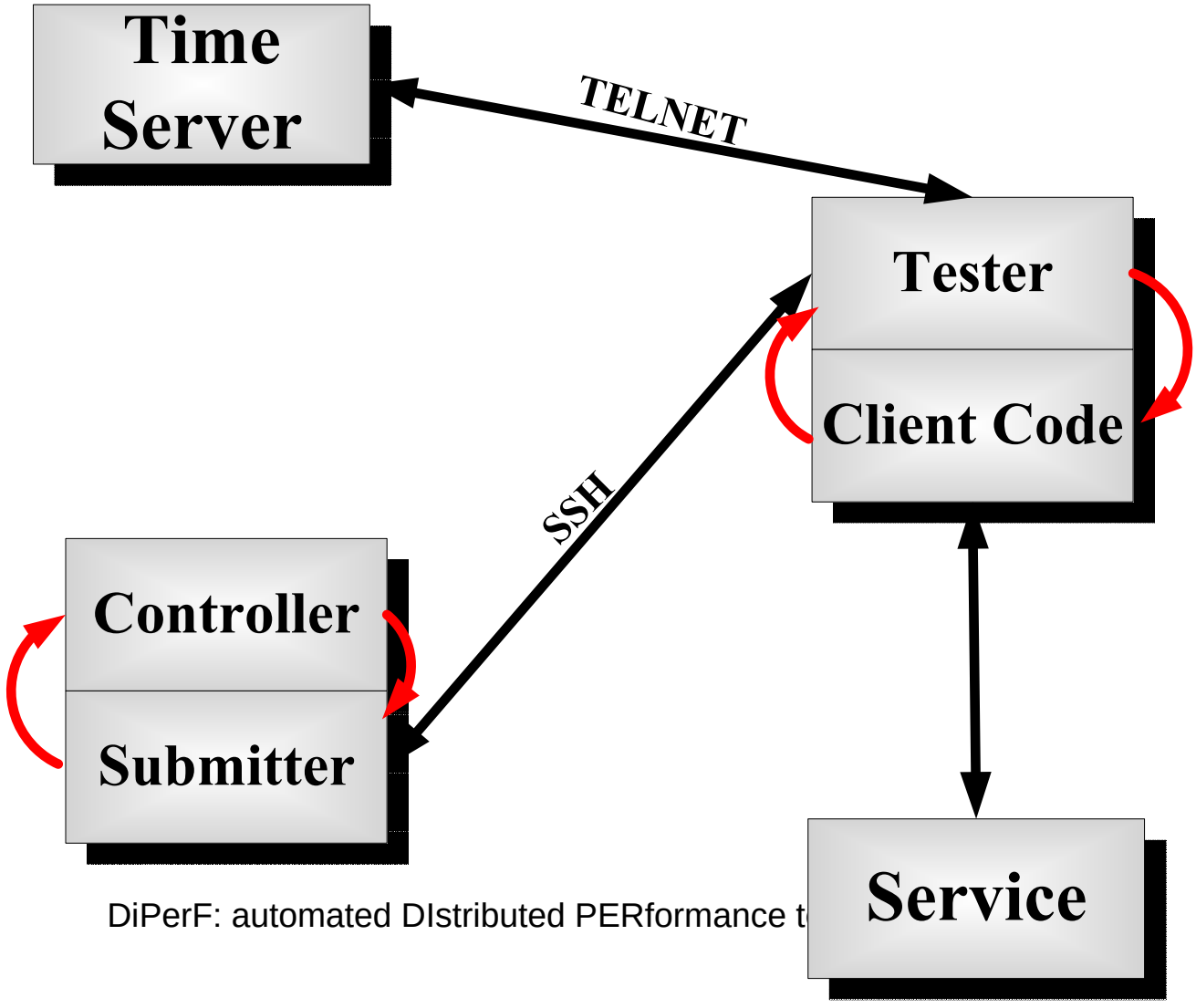
- Coordinates a distributed pool of machines
  - This paper used 100+ clients
  - Scalability goals: 1000+ clients
- Controller
  - Receives the address of the service and a client code
  - Distributes the client code across all machines in the pool
  - Gathers, aggregates, and summarizes performance statistics
- Tester
  - Receives client code
  - Runs the code and produce performance statistics
  - Sends back to “controller” statistic report

Architecture Overview



Se
Client

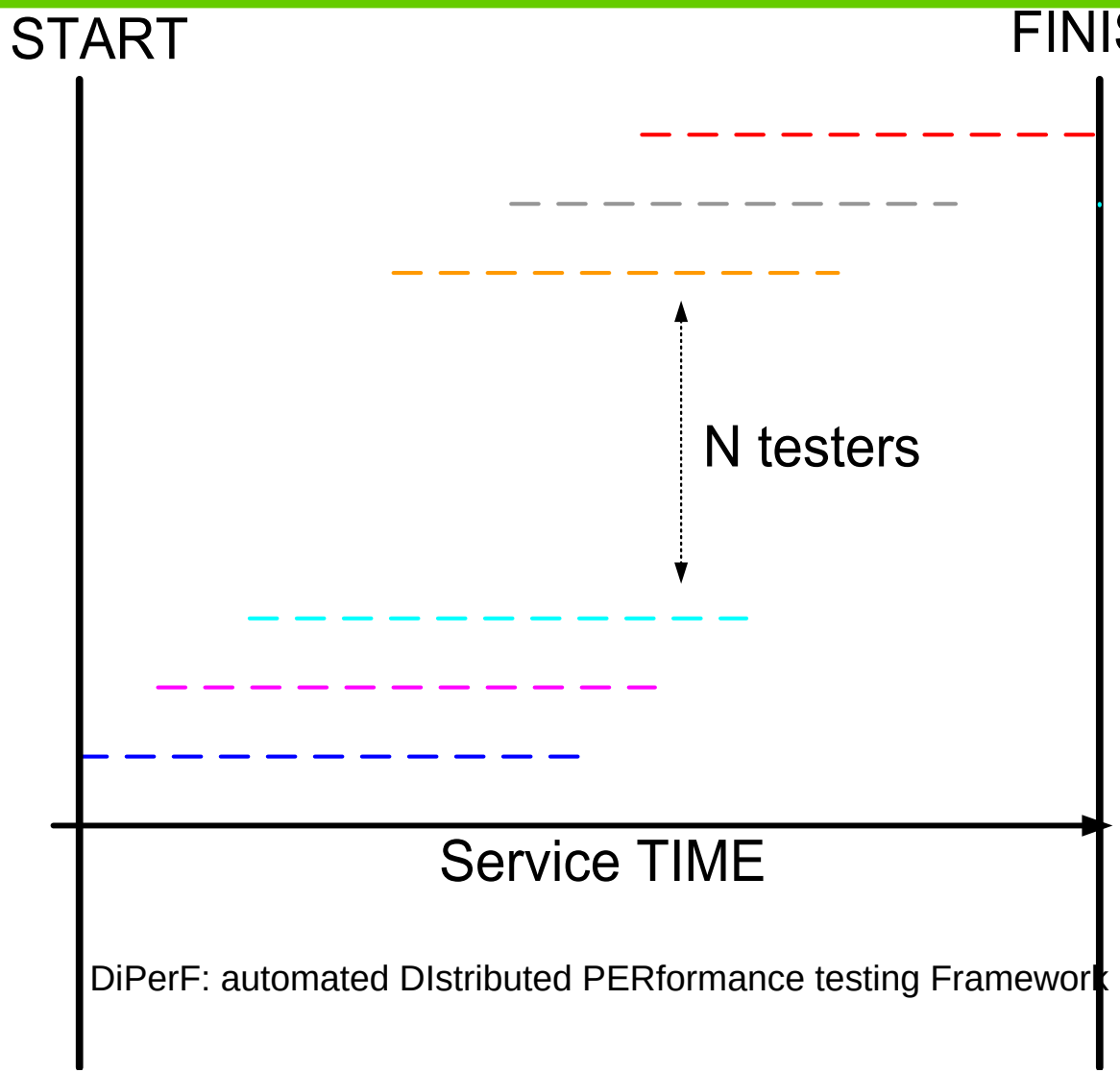
Communication Overview



Time Synchronization

- Time synchronization needed at the testers for data aggregation at controller?
  - Distributed approach:
    - Tester uses Network Time Protocol (NTP) to synchronize time
  - Centralized approach:
    - Controller uses time translation to synchronize time
    - Could introduce some time synchronization inaccuracies due to non-symetrical network links and the RTT variance

Metric Aggregation

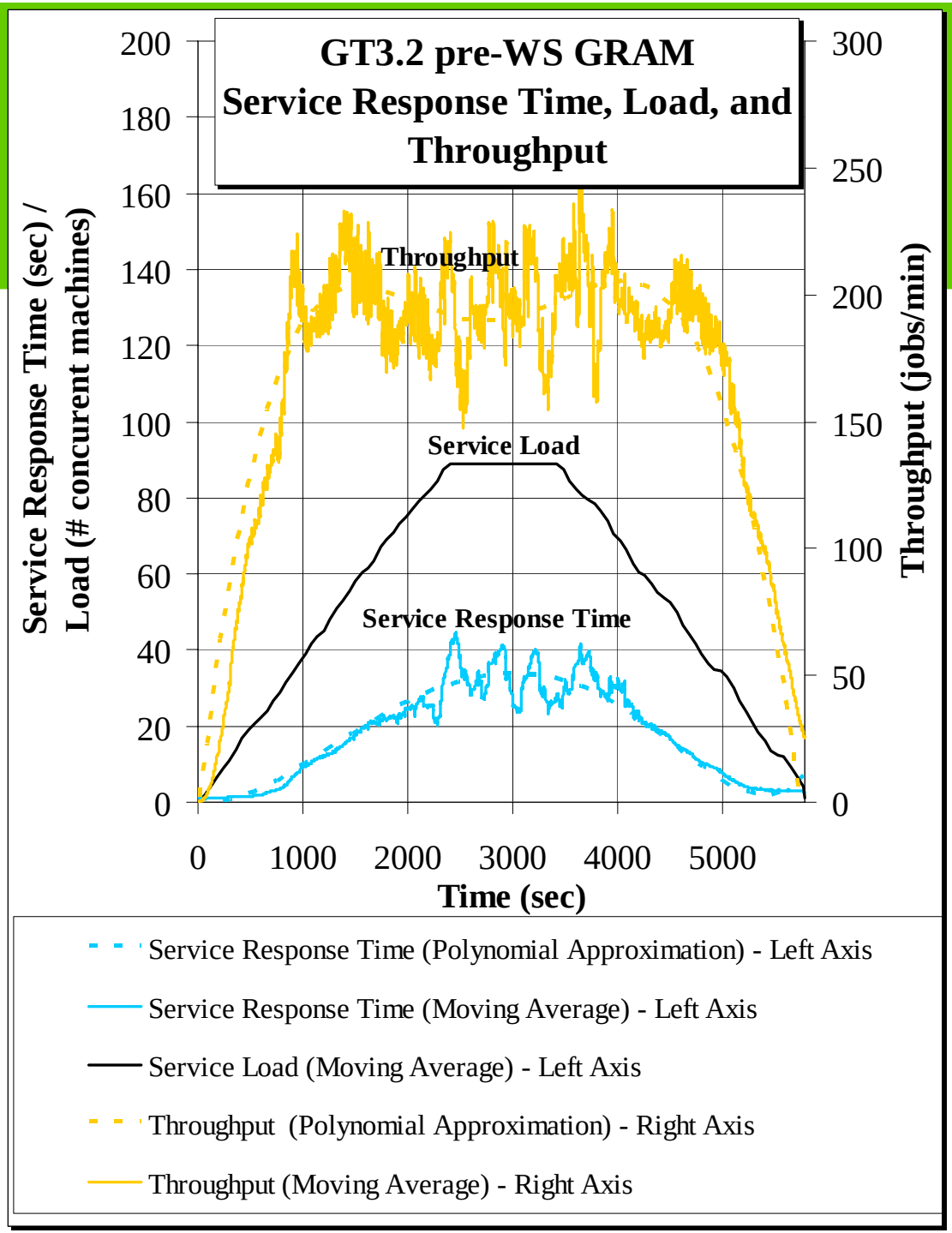


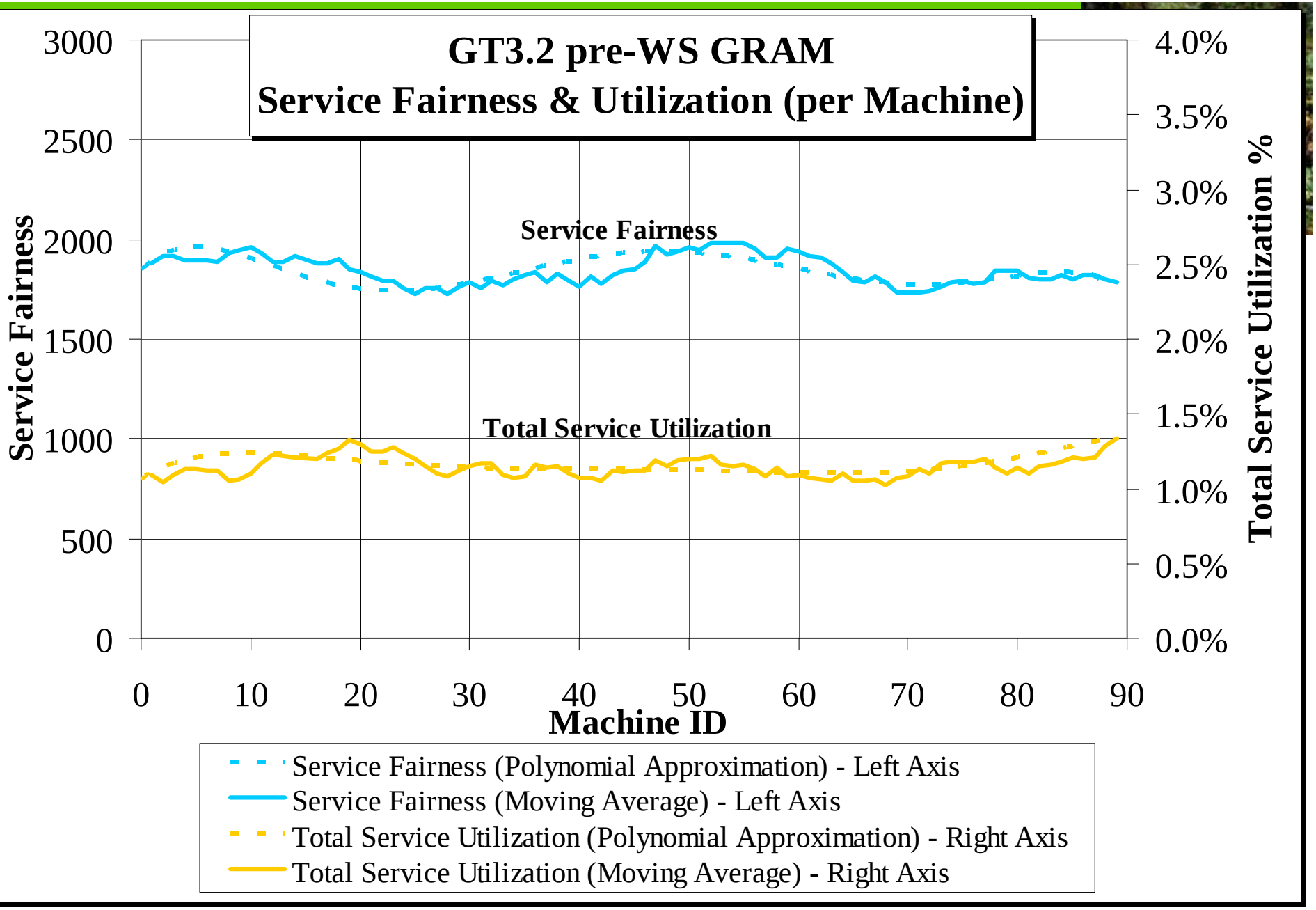
Performance Metrics

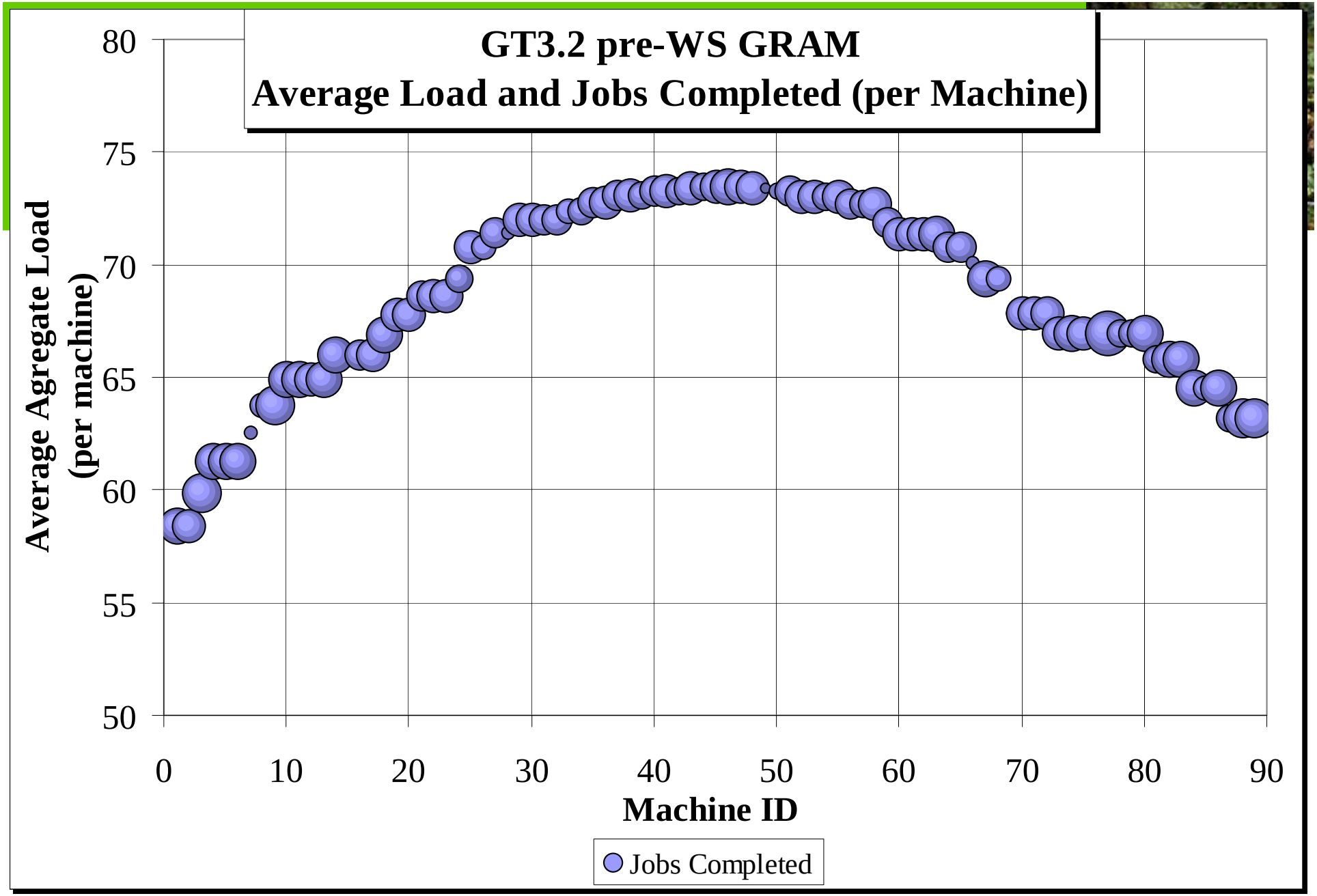
- ***service response time:***
  - the time from when a client issues a request to when the request is completed minus the network latency and minus the execution time of the client code
- ***service throughput*:**
  - number of jobs completed successfully by the service averaged over a short time interval
- ***offered load*:**
  - number of concurrent service requests (per second)
- ***service utilization* (per client):**
  - ratio between the number of requests served for a client and the total number of requests served by the service during the time the client was active
- ***service fairness* (per client):**
  - ratio between the number of jobs completed and service utilization
- **network latency to the service:**
  - time taken for a minimum sized packet to traverse the network from the client to the service
- **time synchronization error:**
  - real time difference between client and service measured as a function of network latency variance
- **client measured metrics:**
  - Any performance metric that the client measures and communicates with the tester

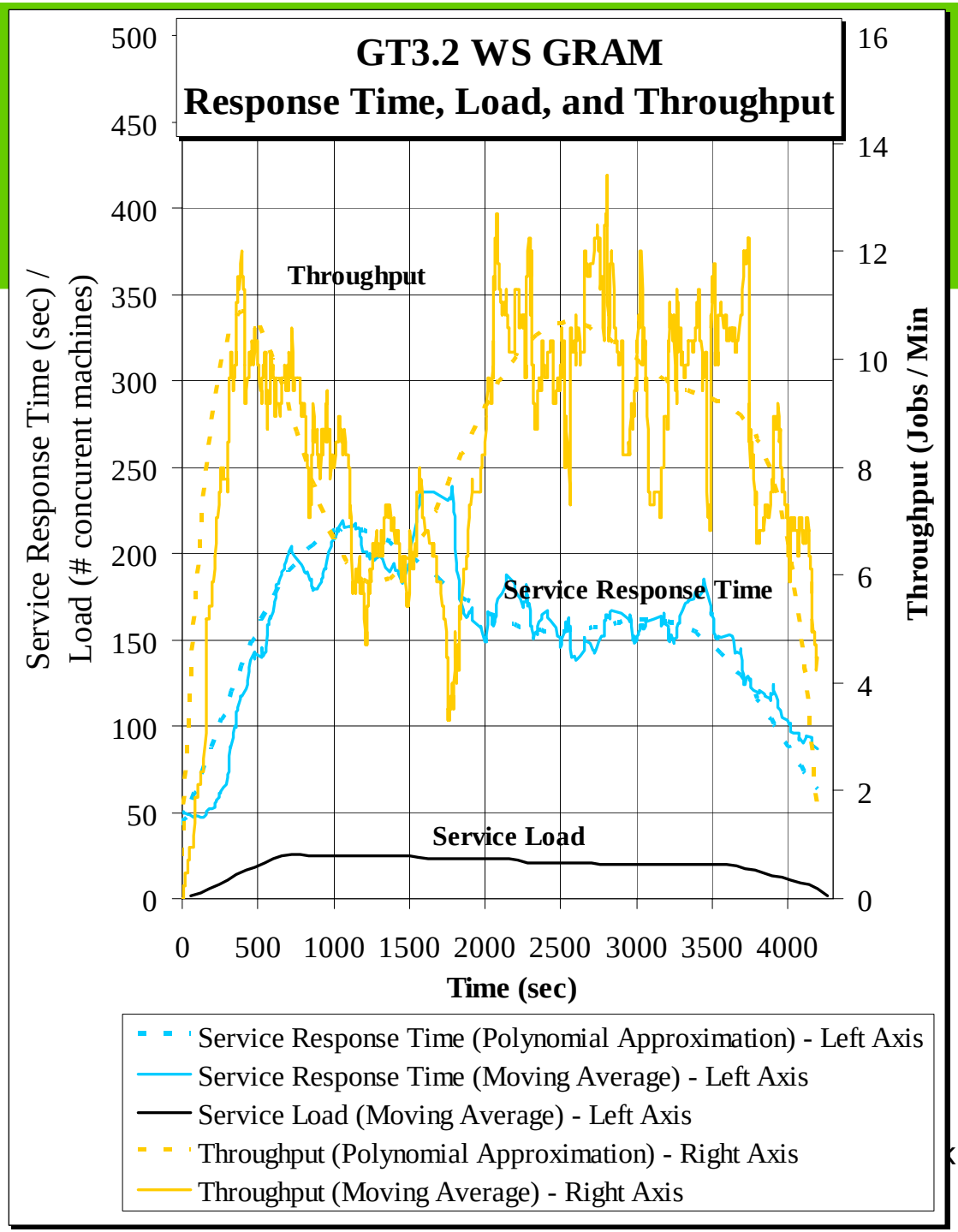
Services Tested

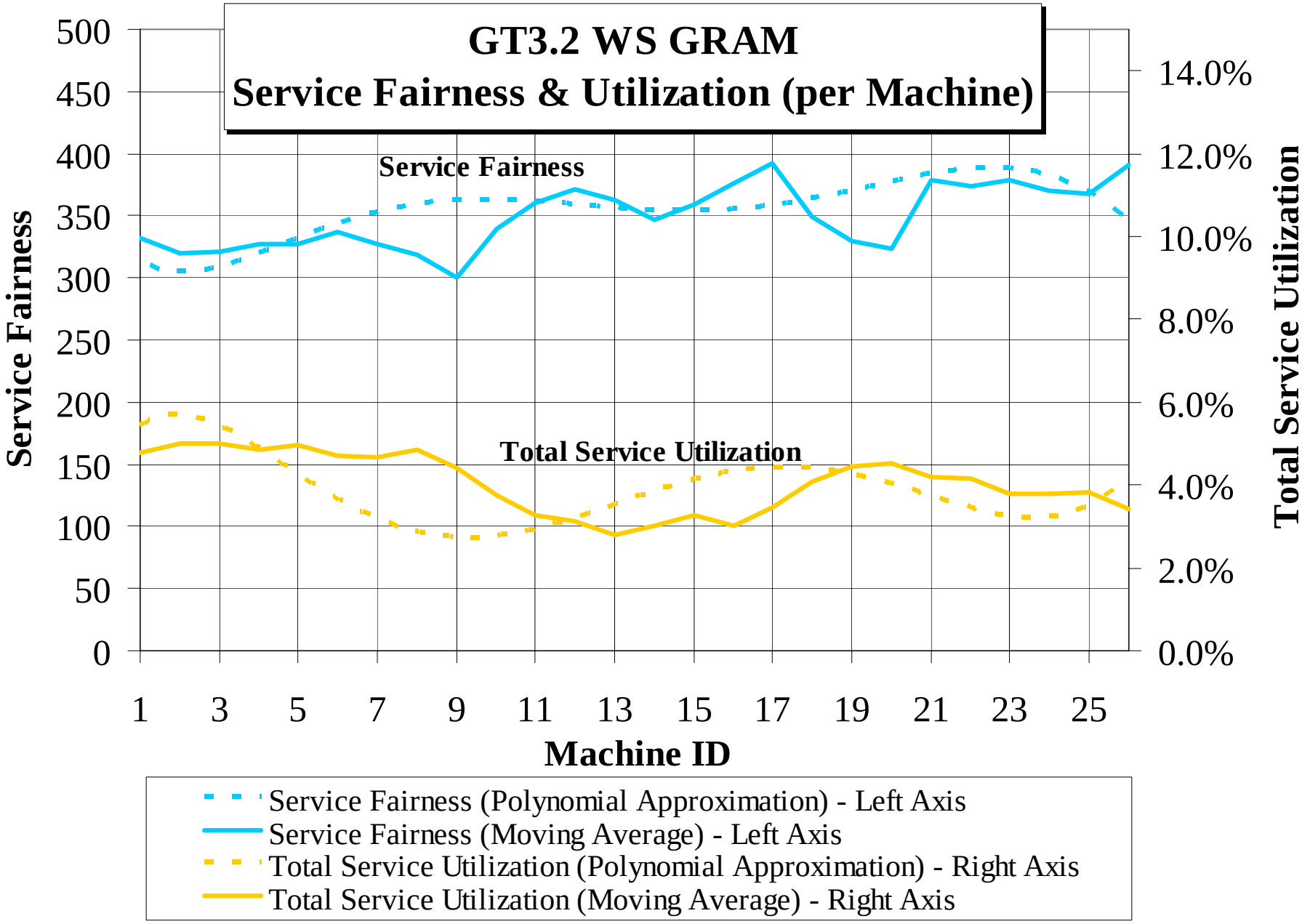
- GT3.2 pre-WS GRAM
  - job submission via Globus Gatekeeper 2.4.3 using Globus Toolkit 3.2 (C version)
  - a gatekeeper listens for job requests on a specific machine
  - performs mutual authentication by confirming the user's identity, and proving its identity to the user
  - starts a job manager process as the local user corresponding to authenticated remote user
  - the job manager invokes the appropriate local site resource manager for job execution and maintains a HTTPS channel for information exchange with the remote user
- GT3.2 WS GRAM
  - job submission using Globus Toolkit 3.2 (Java version)
  - a client submits a *createService* request which is received by the Virtual Host Environment Redirector
  - attempt to forward the *createService* call to a User Hosting Environment (UHE) where mutual authentication / authorization can take place
  - if the UHE is not created, the Launch UHE module is invoked
  - WS GRAM then creates a new Managed Job Service (MJS)
  - MJS submits the job into a back-end scheduling system

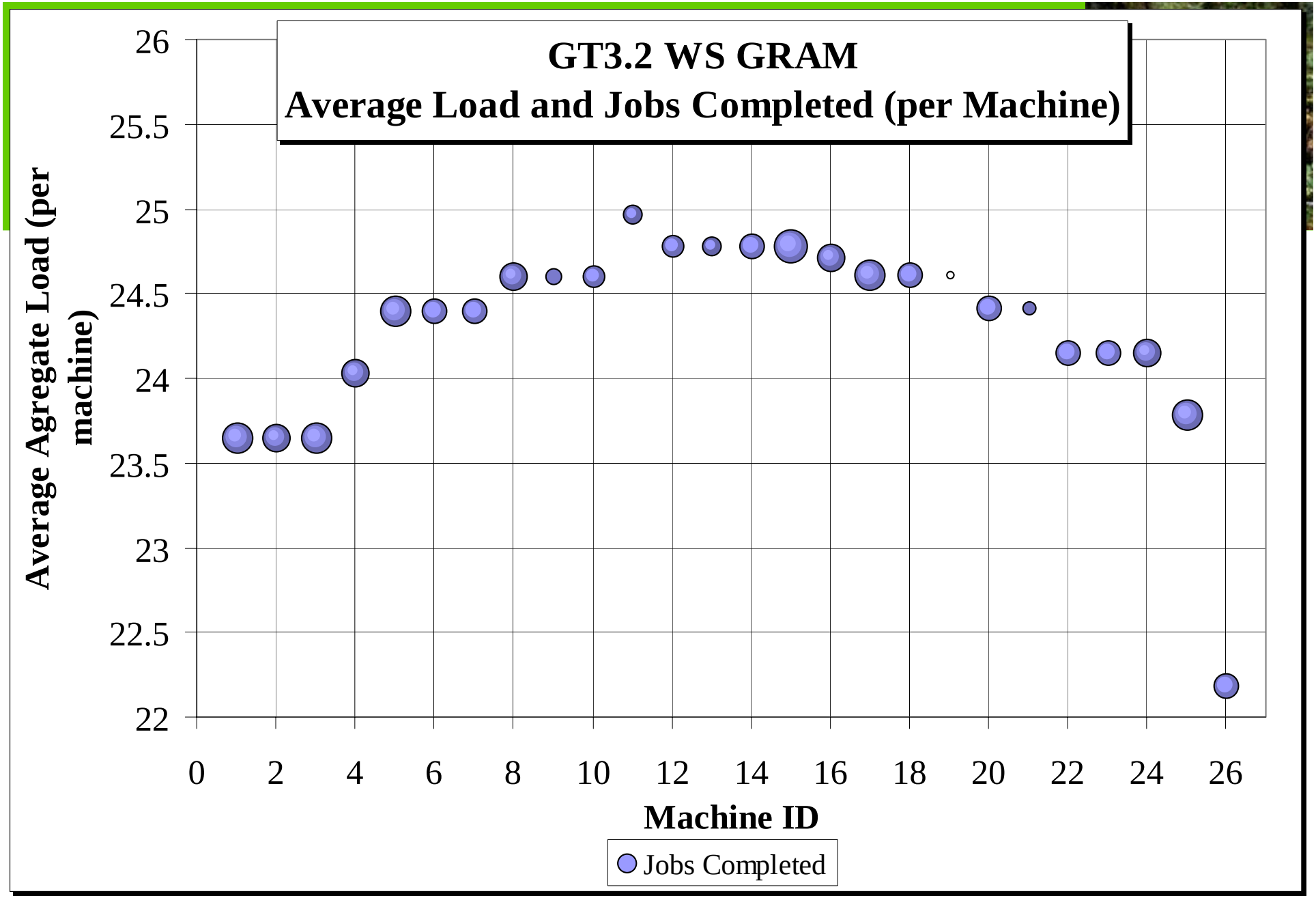

GT3.2 pre-WS GRAM
Service Response Time, Load, and Throughput
Service Response Time (sec) / Load (# concurent machines)
Throughput (jobs/min)
Throughput
Service Load
Service Response Time
Time (sec)
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
250
300
0
1000
2000
3000
4000
5000
Service Response Time (Polynomial Approximation) - Left Axis
Service Response Time (Moving Average) - Left Axis
Service Load (Moving Average) - Left Axis
Throughput (Polynomial Approximation) - Right Axis
Throughput (Moving Average) - Right Axis


GT3.2 pre-WS GRAM
Service Fairness & Utilization (per Machine)
Service Fairness
Total Service Utilization
Service Fairness
Total Service Utilization %
Machine ID
3000
2500
2000
1500
1000
500
0
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0.5%
0.0%
0
10
20
30
40
50
60
70
80
90
Service Fairness (Polynomial Approximation) - Left Axis
Service Fairness (Moving Average) - Left Axis
Total Service Utilization (Polynomial Approximation) - Right Axis
Total Service Utilization (Moving Average) - Right Axis


GT3.2 pre-WS GRAM
Average Load and Jobs Completed (per Machine)
Average Agregate Load (per machine)
80
75
70
65
60
55
50
0
10
20
30
40
50
60
70
80
90
Machine ID
Jobs Completed


GT3.2 WS GRAM
Response Time, Load, and Throughput
Service Response Time (sec) / Load (# concurent machines)
Throughput (Jobs / Min
Throughput
Service Response Time
Service Load
Time (sec)
0
50
100
150
200
250
300
350
400
450
500
0
2
4
6
8
10
12
14
16
0
500
1000
1500
2000
2500
3000
3500
4000
Service Response Time (Polynomial Approximation) - Left Axis
Service Response Time (Moving Average) - Left Axis
Service Load (Moving Average) - Left Axis
Throughput (Polynomial Approximation) - Right Axis
Throughput (Moving Average) - Right Axis


GT3.2 WS GRAM
Service Fairness & Utilization (per Machine)
Service Fairness
Total Service Utilization
Service Fairness
Total Service Utilization
Machine ID
500
450
400
350
300
250
200
150
100
50
0
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
1
3
5
7
9
11
13
15
17
19
21
23
25
Service Fairness (Polynomial Approximation) - Left Axis
Service Fairness (Moving Average) - Left Axis
Total Service Utilization (Polynomial Approximation) - Right Axis
Total Service Utilization (Moving Average) - Right Axis


GT3.2 WS GRAM
Average Load and Jobs Completed (per Machine)
Average Agregate Load (per machine)
26
25.5
25
24.5
24
23.5
23
22.5
22
0
2
4
6
8
10
12
14
16
18
20
22
24
26
Machine ID
Jobs Completed

Contributions

- Service capacity
- Service scalability
- Resource distribution among clients
- Accurate client views of service performance
- How network latency or geographical distribution affects client/service performance
- Allows the collection of the appropriate metrics to build analytical models

Future Work

- Test more services
  - Job submission in GT3.9/GT4
  - WS GRAM in a LAN vs. WAN
  - Perform testbed characterization
- Complete DiPerF scalability study
- Analytical Models
  - Build
    - Neural networks, decision trees, support vector machines, regression, statistical time series, wavelets, polynomial approximations, etc…
  - Validate
  - Test predictive power

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Questions?

- More info on DiPerF:
  - http://people.cs.uchicago.edu/~iraicu/research/diperf/
- Questions?

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