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Benchmarking of integrated OGSA-BES with the Grid middleware

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Outline

- **Batch Job Execution Interfaces**
- **Benchmark details**
- **Results**
  - System Level
  - Component Level
- **Conclusions**

Introduction

- **Most Grids offer services to execute batch jobs.**
- **Middleware traditionally used proprietary protocols to provide these services.**
- **OGF standardized job submission in the BES recommendation.**
- **The OMII-Europe project developed BES implementations for three middleware stacks (Globus, gLite and UNICORE).**
- **This benchmarking effort targets this new services and tries to provide information about the performance of the developed solutions.**

UNICORE Atomic Services (UAS)

- **Exposes core functionality via Web-Service interfaces**
- **Specific to the UNICORE 6 stack**
- **Follows OASIS WS-RF pattern**
- **Provides job control, data management and file transfer**
- **We only consider job submission and control**
  - Target System Service for job submission
  - Job service to manage job

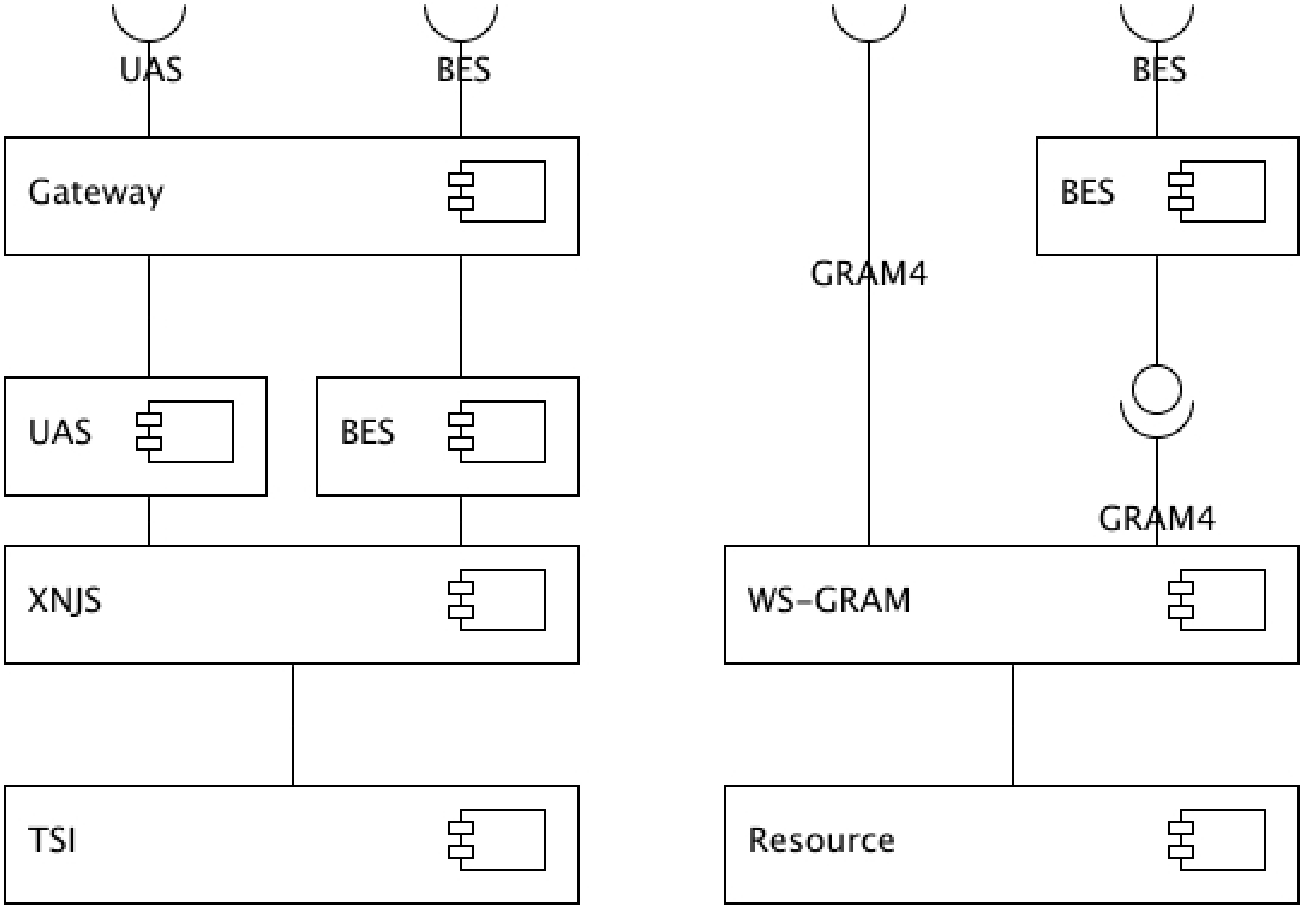
Basic Execution Service (BES)

- **Web-Services based interface for job submission**
- **Standardized by the Open Grid Forum**
- **Consists of three port types:**
  - BES Factory for job creation and bulk job management
  - BES Activity for management of a single job
  - BES Management for service management tasks
- **Excludes security solution**
  - UNICORE 6 uses SAML and optionally VOMS
  - Globus Toolkit uses proxy certificates
  - gLite uses VOMS proxy certificates

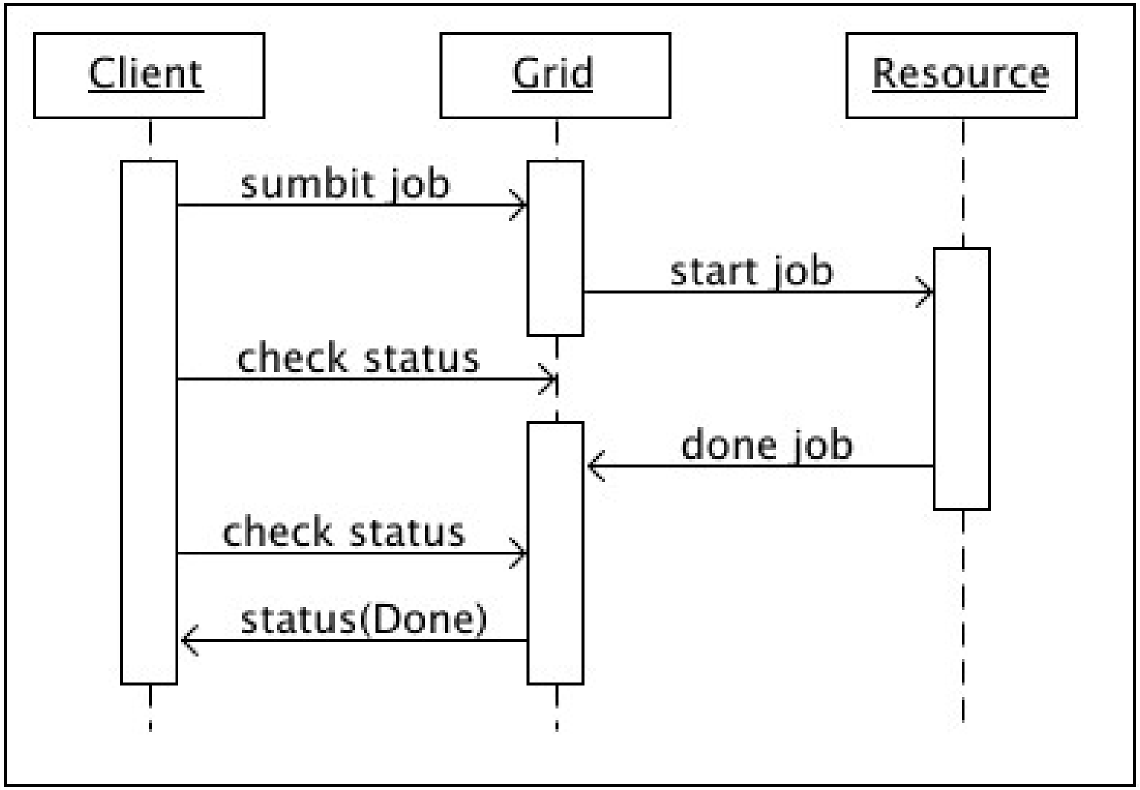
BES Implementations

- **Three Implementations were provided by OMII-Europe**
- **Independent Services**
  - UNICORE BES above XNJS backend
  - gLite CREAM-BES as plugin for the CREAM-CE
- **Wrapper/Adapter approach**
  - Globus BES as a wrapper for a WS-GRAM service
- **CROWN Metascheduler**
  - Can submit jobs to multiple BES instances.
  - Provides its own BES interface.

BES Implementations



The Benchmark



Measure the overhead that the Grid middleware adds to job execution.

Benchmark Variants

- **System Level Approach**
  - Use command line clients provided by MW.
  - Provides performance from end-user perspective.
  - Includes client side startup overhead.
  - High load on client machine limiting factor.
  - Utilizes bulk submission capabilities if available.
- **Component Level Approach**
  - Directly use the web service interface of the MW.
  - More appropriate for server performance measurements.
  - Only overhead for making the WS call are included.
  - More complicated to adopt to new MW stack.

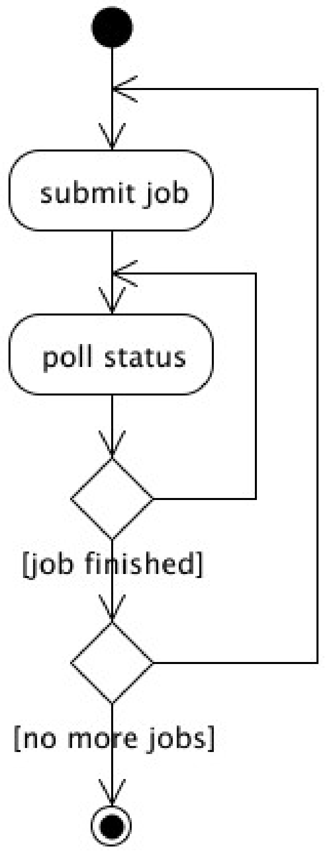
System Level Benchmark

- **Advantages**
  - Measures end-user performance
  - Relatively simple to add new MW stack
  - Shows client side performance
- **Disadvantages**
  - Includes client start up costs
  - Limited by client side performance
  - Complicated to simulate “real” life usage scenario
  - Problems in obtaining compareable results

Component Level Benchmark

- **Advantages**
  - Measures service performance
  - Allows direct comparison between different MW stacks and interfaces.
  - Lower client side load
- **Disadvantages**
  - High development effort to add new MW or interface
  - Cannot benchmark client behavior (e.g. CLIQ)
  - Faces interoperability problems (e.g. security)

Benchmark Implementation

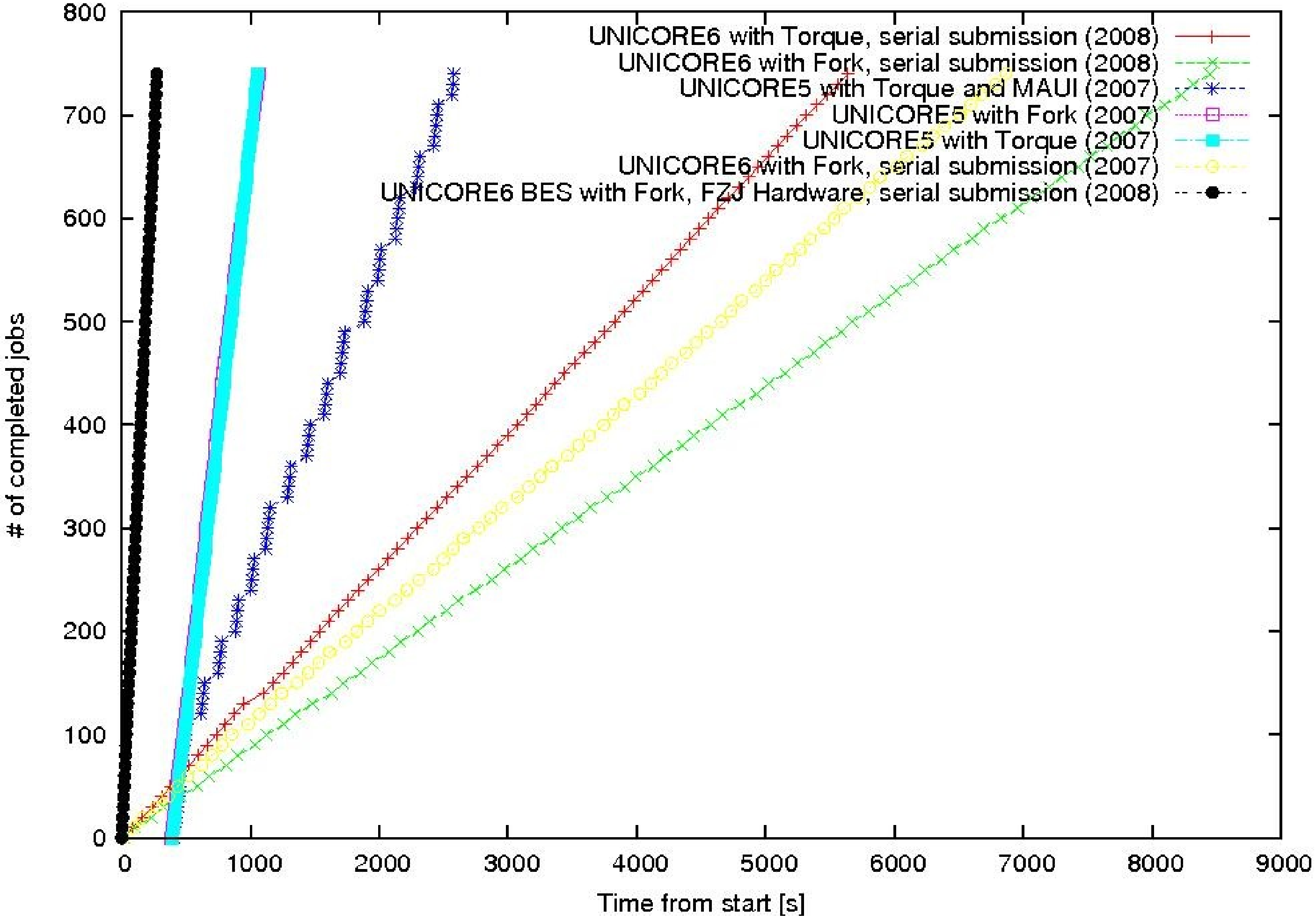


- Serial BM for UAS and BES uses only one single thread.
- System level BM uses a thread pool to first submit all jobs and then poll for status (except for CondorG and CLIQ).
- Concurrent BM for UAS and BES uses two thread pools, one for submitting jobs and one for polling status.

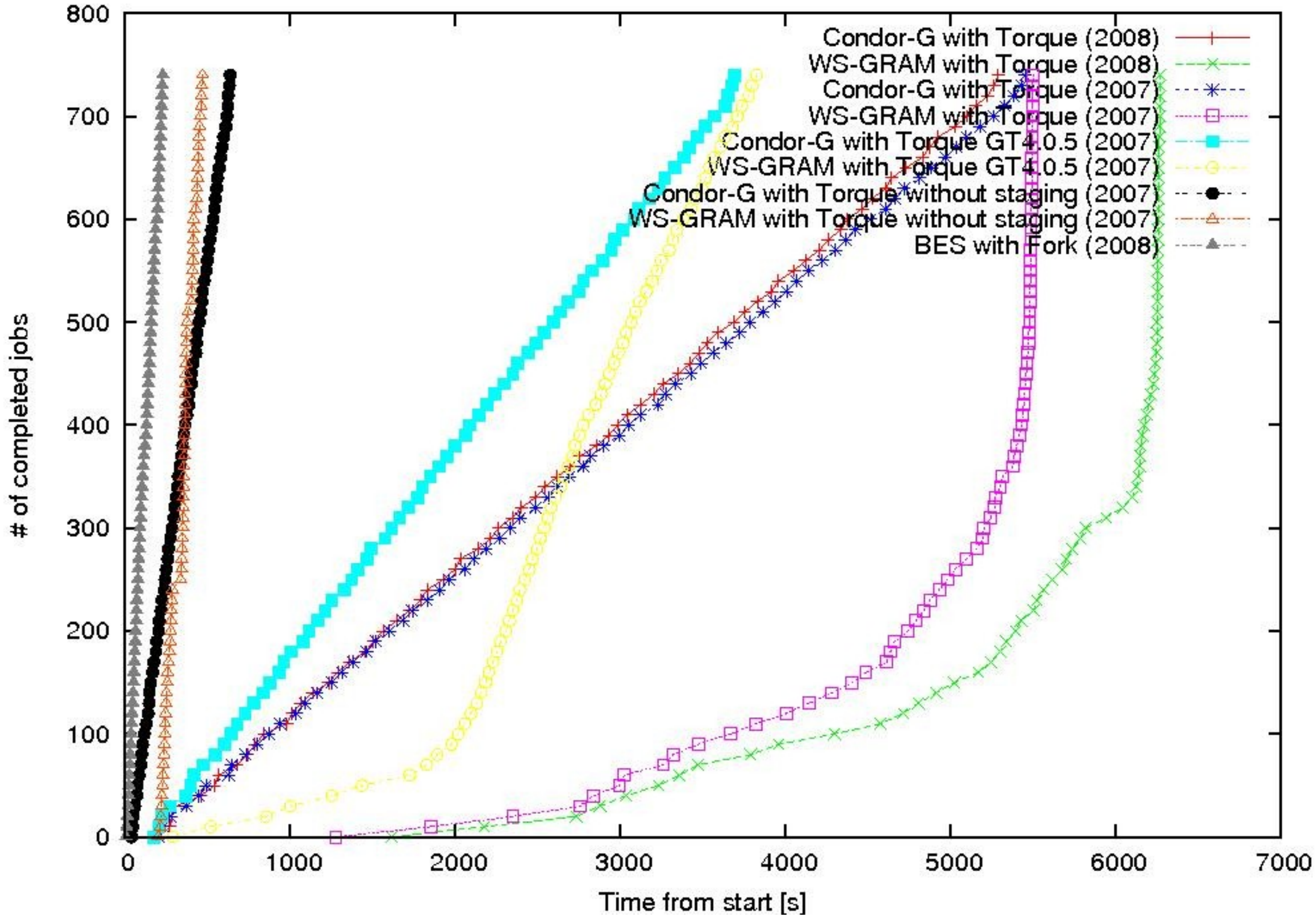
Benchmark Limitations

- **Uses only 0 length jobs**
- **All jobs are submitted in the beginning of a run**
- **Uses only polling, no notifications**
- **Needs command line client tools**
- **Code for different MW stacks not unified**

System Level Performance (UNICORE)



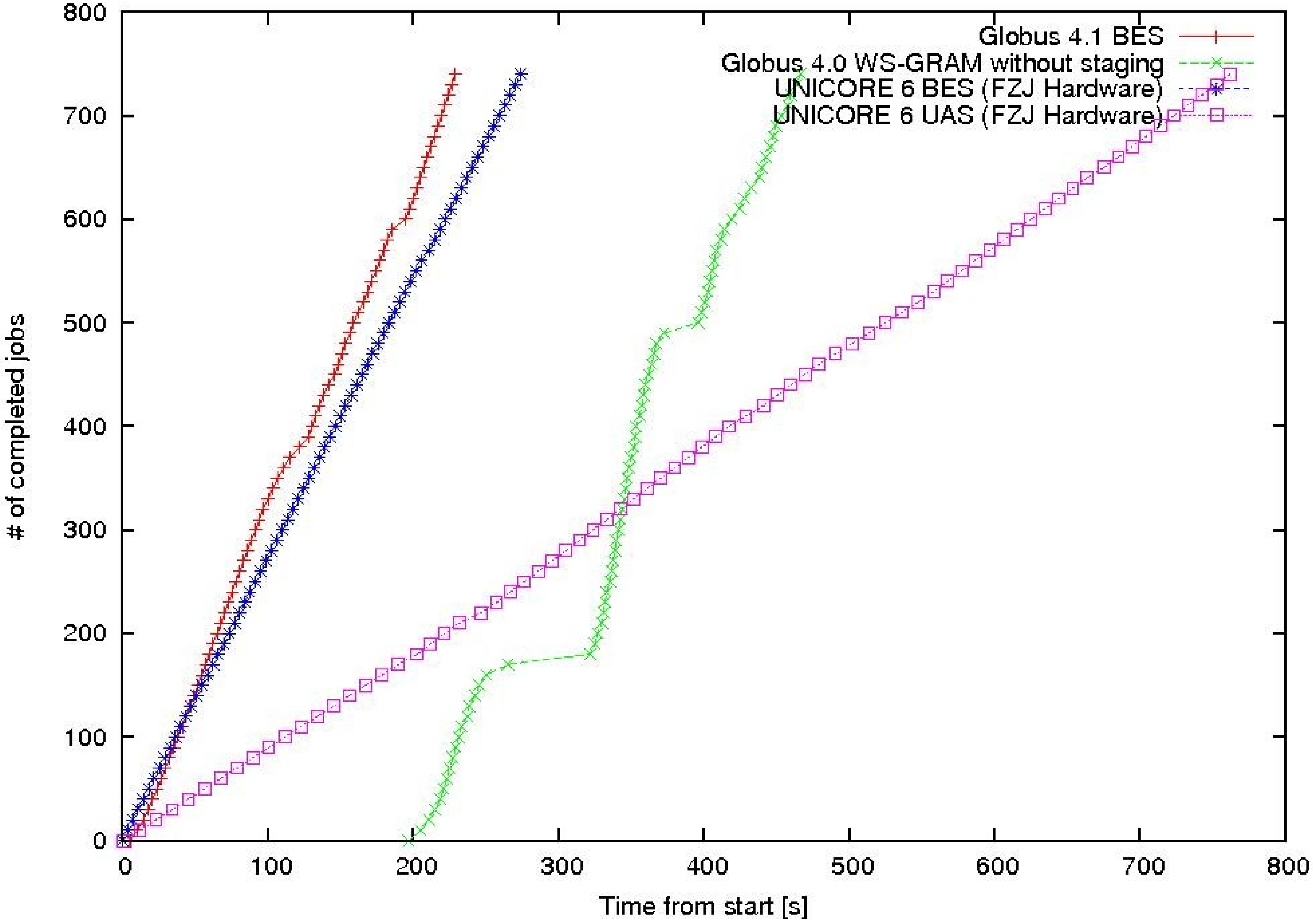
System Level Performance (Globus)



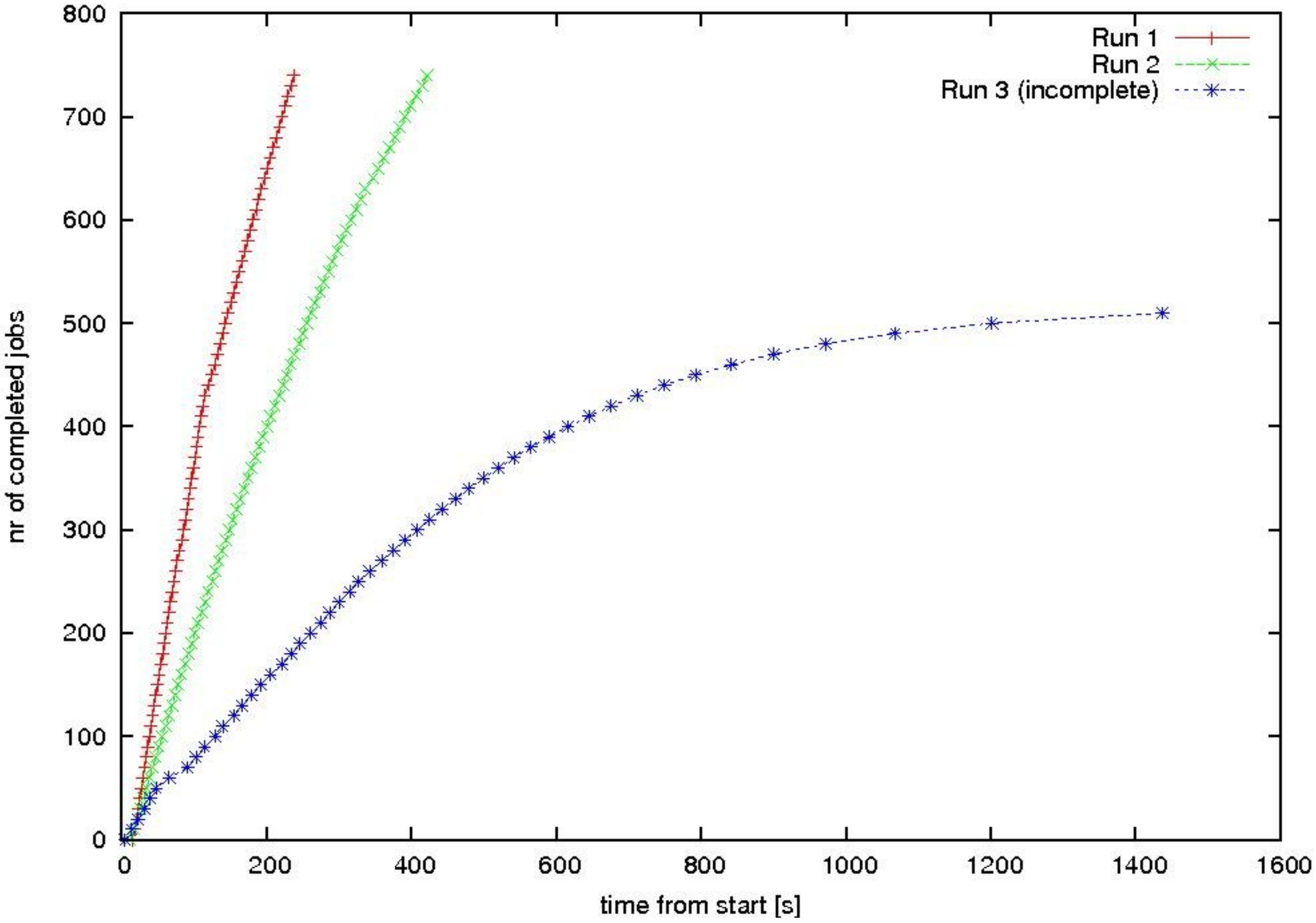
System Level Performance

- Data staging has biggest influence.
- Bulk submission modes (CLIQ, CondorG) better that many single job submissions.
- Polling leads to congestion in the end of Globus experiments, possibly caused by client start-up costs.
- Relatively big spread between different runs of the same experiment. Carefully controlled environment necessary.
- UNICORE seems to be better adopted to the presented benchmark.

Component Level Performance (Serial)



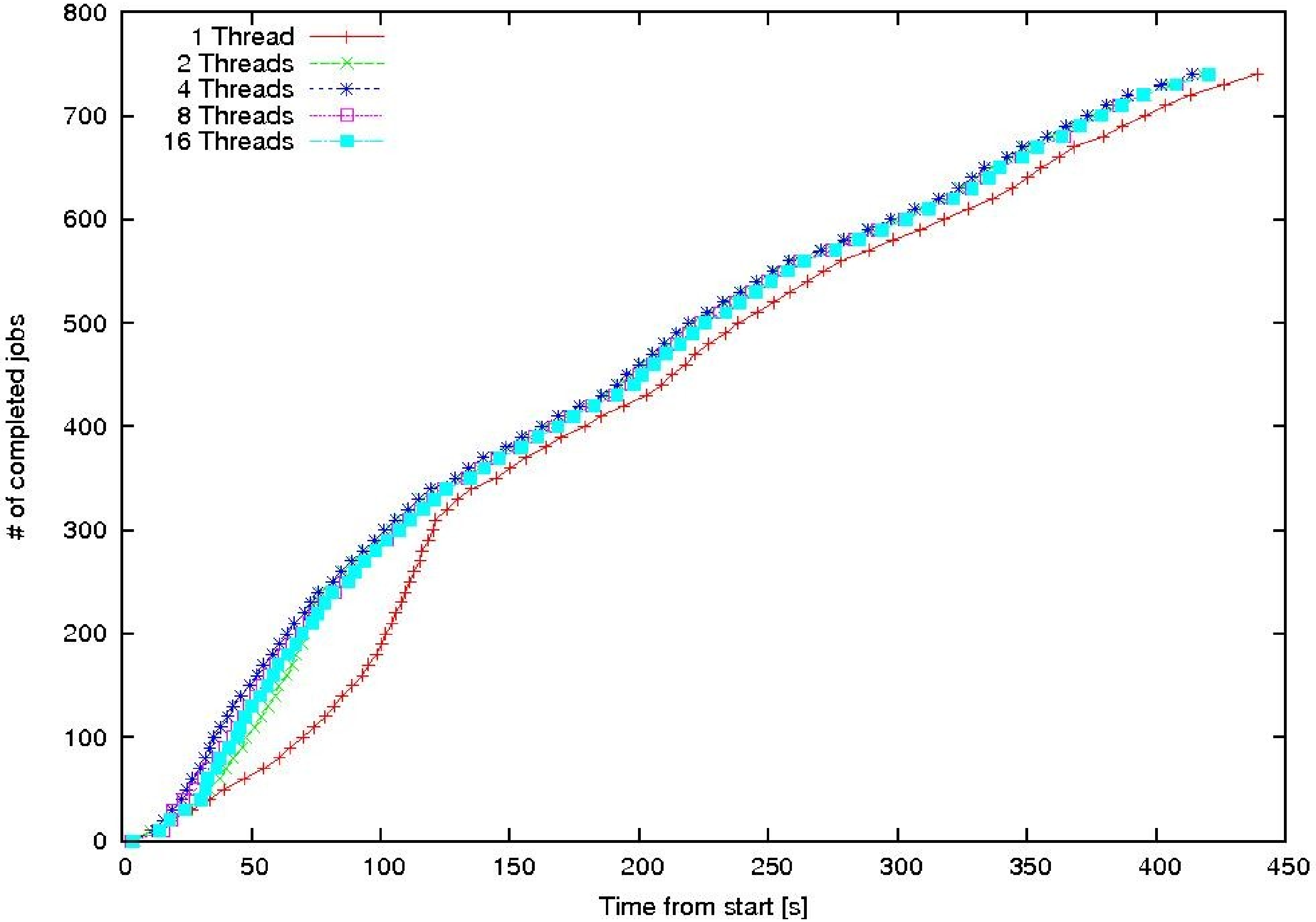
BM as Stress Test Tool



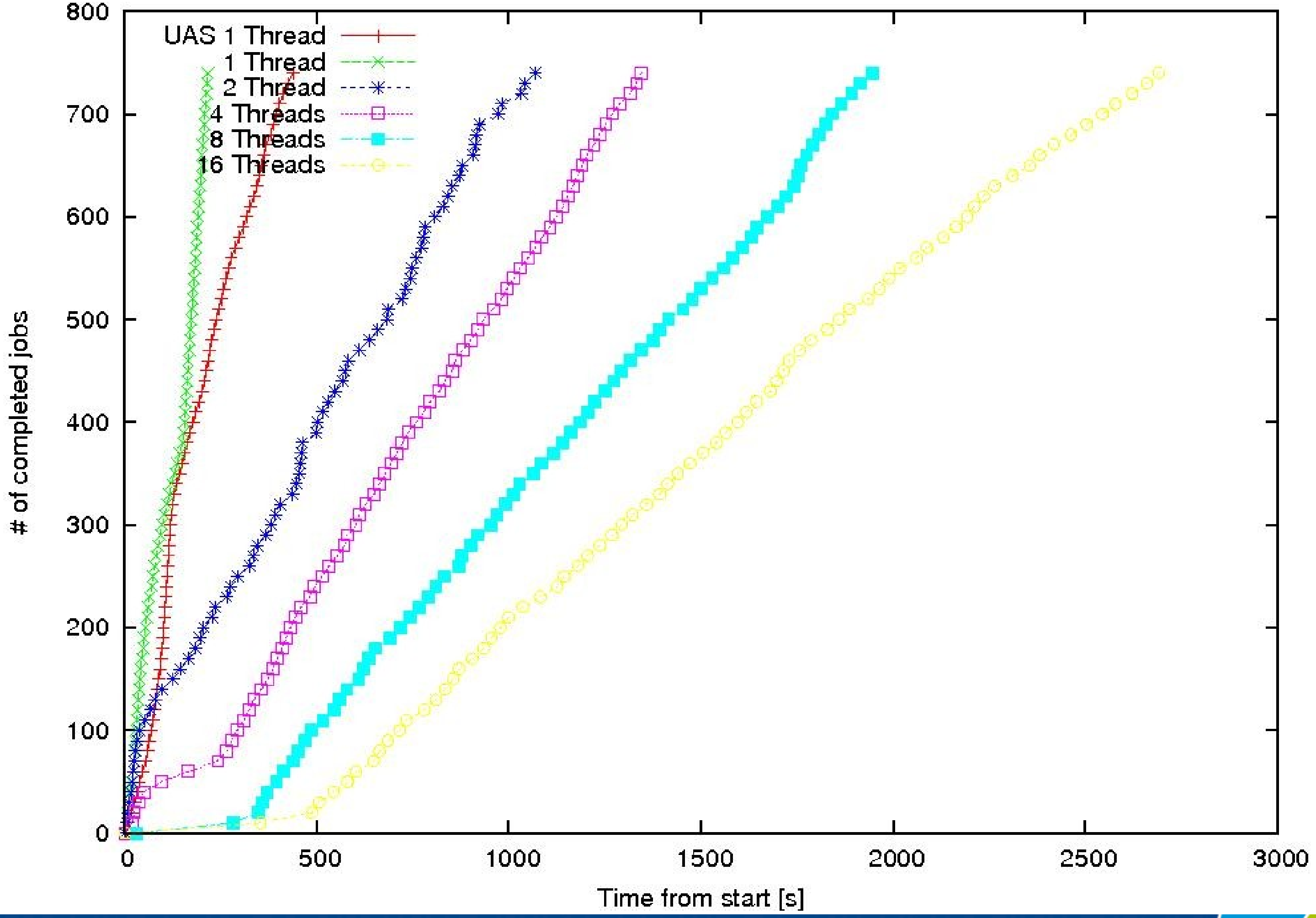
Component Level Performance

- **Serial submission does not suffer from polling congestion.**
- **However experiments show resource leaks and memory problems.**
- **Sensitive to latency of submission and polling interval.**
- **BES components compareable to legacy interfaces.**

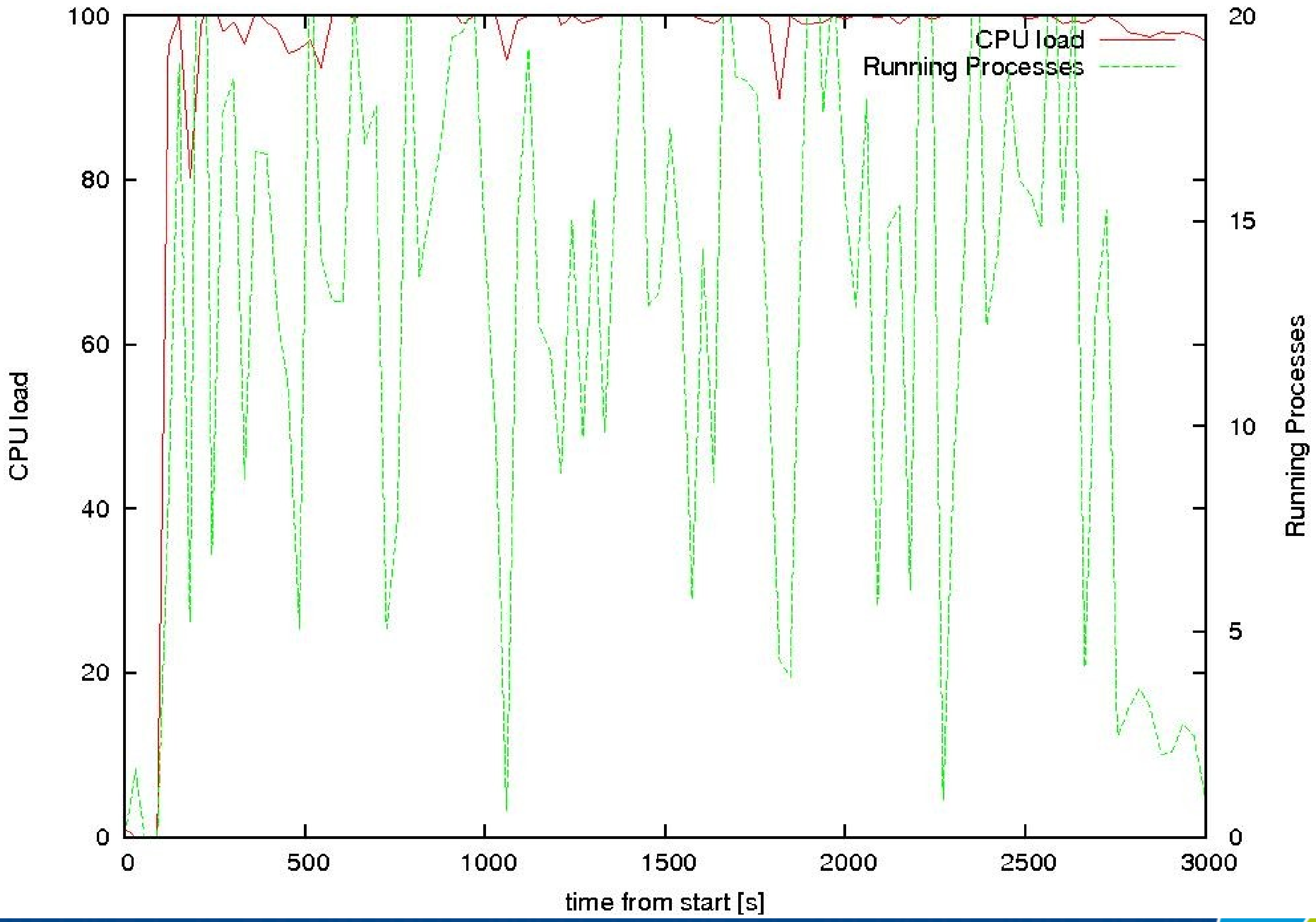
UAS Performance (Concurrent)



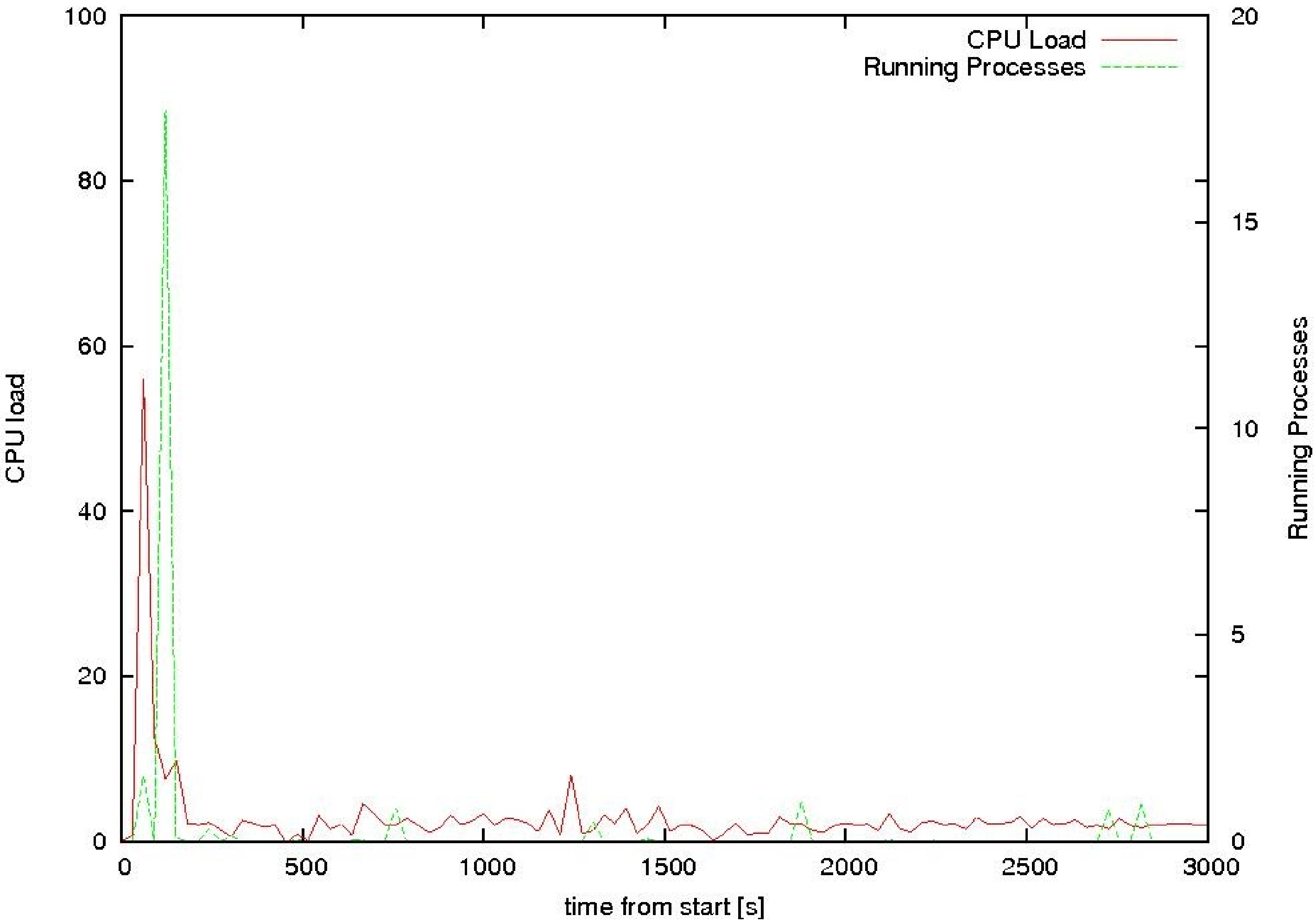
BES Performance (Concurrent)



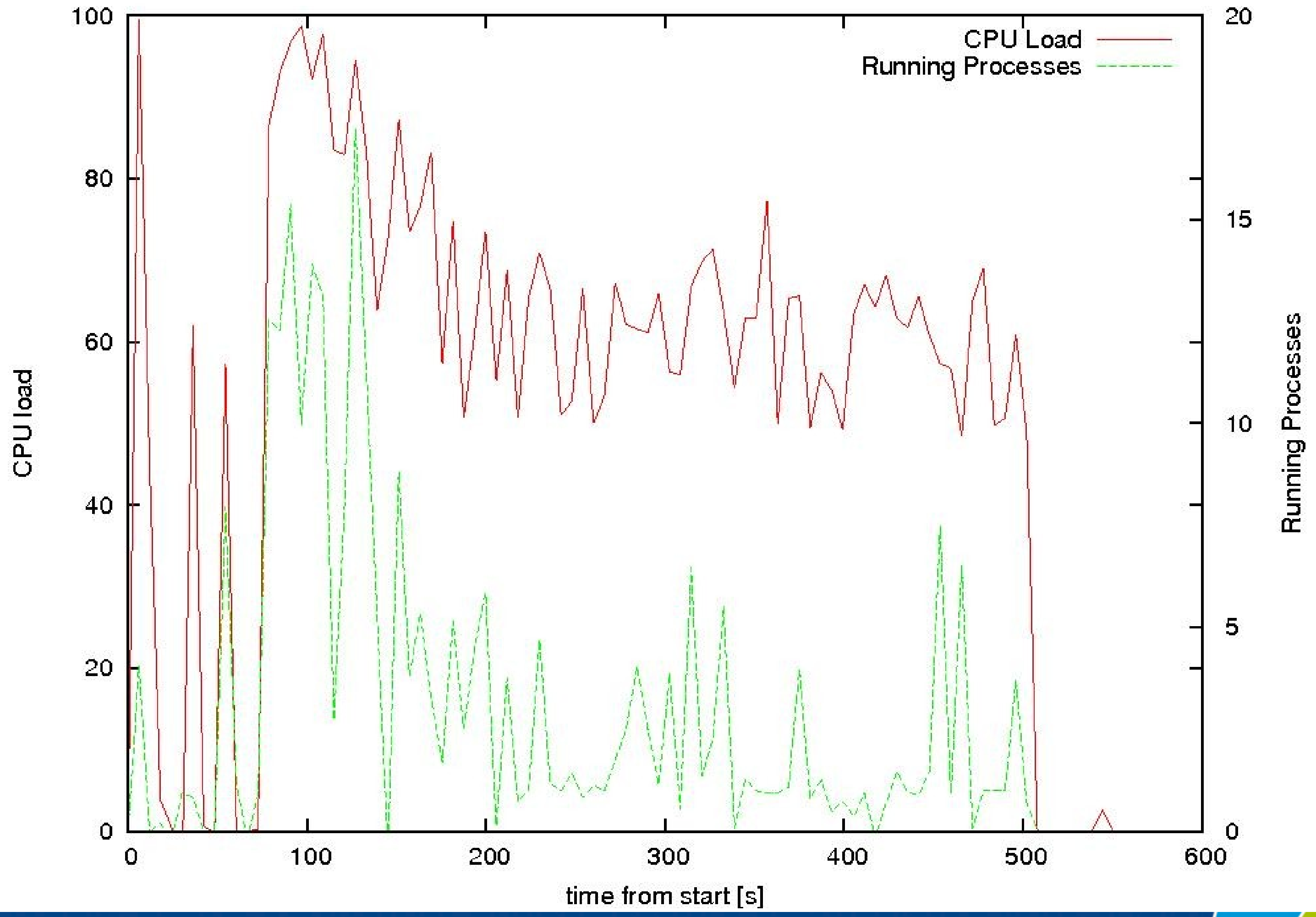
Server Load (BES 16 Threads)



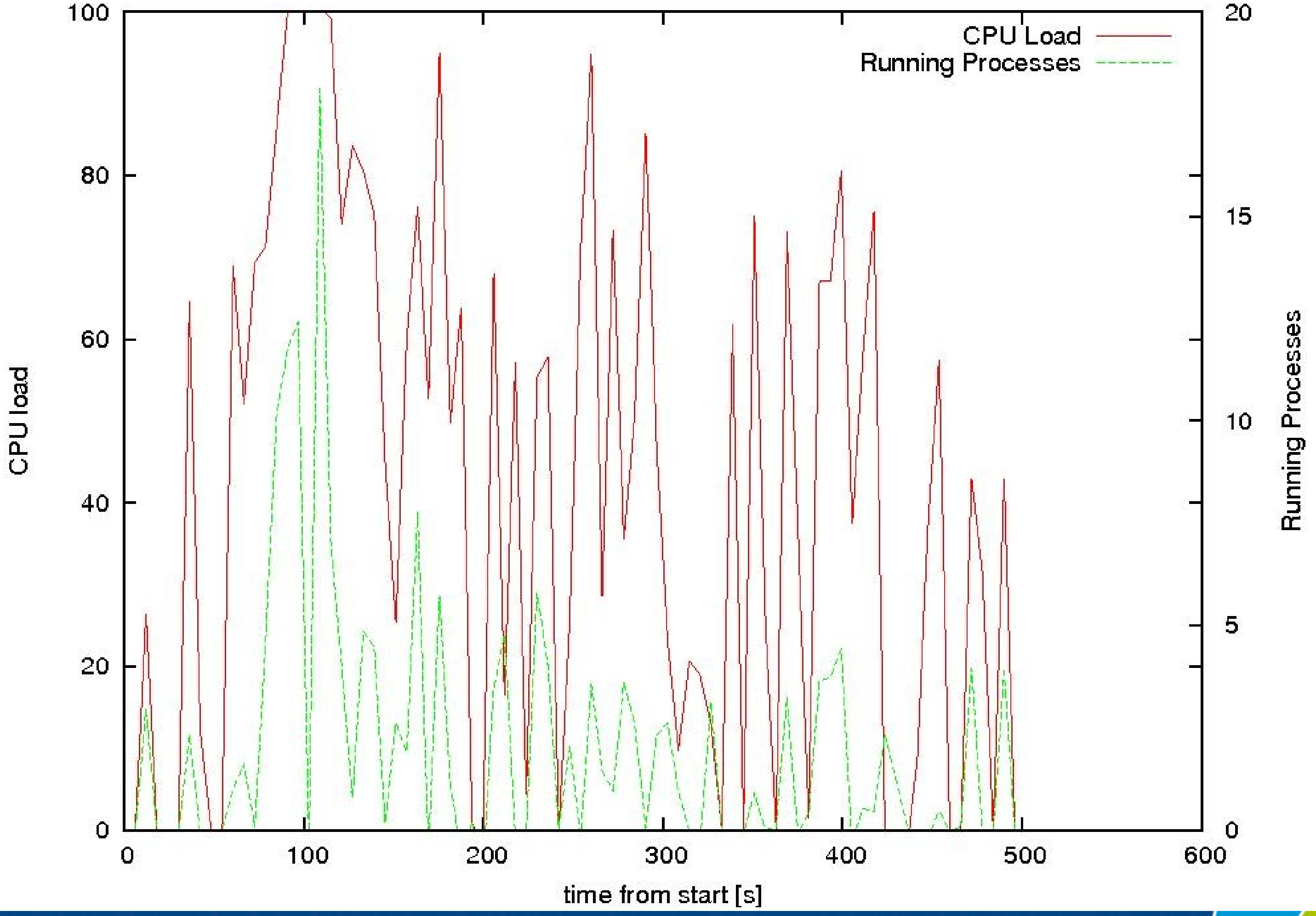
Client Load (BES 16 Threads)



Server Load (UAS 16 Threads)



Client Load (UAS 16 Threads)



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Component Performance – Concurrent Jobs

- **BES shows some concurrency problems causing performance to drop.**
- **UAS shows balanced load between client and server.**
- **UAS is slower than BES for single threads, maybe because jobs need to be started explicitly.**
- **BES drops some jobs during concurrent submission, around 2 jobs out of 750, perhaps due to server overload.**
- **More investigation needed to find out if we found a bug in BES or BM implementation.**

Conclusions

- Type of service dominates over mechanism
- Careful control of test environment is needed
- Installation and configuration of MW takes time
- Preliminary results show that BES is compareable to legacy mechanisms
- However, UNICORE BES currently cannot handle concurrent requests as good as UAS does.
- BM experiments have been able to uncover a number of implementation bugs in early BES services.

Further Work

- Use more than one client node to stress server.
- Use BES Activity instead of only BES Factory.
- Extend concurrent BM to WS-GRAM and GT BES.
- Use other than 0-length jobs.
- Allow for extended job submission simulating steady state.

Acknowledgements

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Software can be downloaded from the project repository at:

http://www.omii-europe.org

Or contact Gilbert Netzer:

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