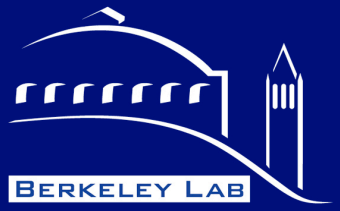

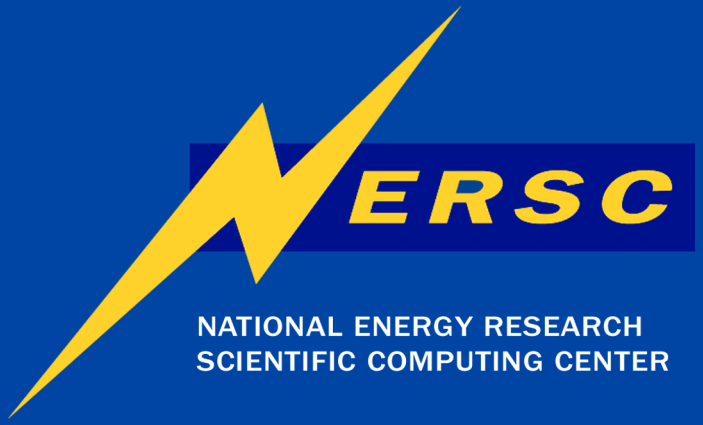

Performance Monitoring on NERSC's POWER 5 System

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Prequel

- Although this talk centers around identifying system problems, it also highlights the stability and excellent design of the p575 POWER 5 system.
- Virtually all the problems we've had with Bassi can be attributed to software complexity.
- Take away-point: Application testing and monitoring are necessary to ensure proper system function.

Outline

- Why monitor performance?
- What are we monitoring?
- Procedure
- Data and results
- Discussion
- Summary

Why monitor performance?

- To provide stable, consistent high performance scientific computing resources.
- To ensure that system performance and reliability never decreases over the machine's lifetime.
- To recognize when software, hardware, and configuration changes impact performance.

What are we monitoring?

- Parallel application performance – looks at the system from a user perspective.
- High-level "component" tests: IO, memory bandwidth, MPI latency and bandwidth.
- Serial application performance on a single packed node.
- The goal is to monitor, maintain, improve the user experience.

Three parallel applications

- GTC (Gyrokinetic Toroidal Code)
  - Studies energy transfer via plasma microturbulence in fusion device plasmas. PIC code.
- PARATEC (Parallel Total Energy Code)
  - Ab-initio quantum total energy calculations via pseudo-potentials and plane wave basis set. Self-consistent field conjugate gradient.
- CAM (Community Atmospheric Model)
  - Complicated multi-physics and chemistry.

Three standard parallel benchmarks

- NPB 2.4 Class D: SP
- NPB 2.4 Class D: MG
- NPB 2.4 Class D: FT

- These were chosen as models of memory-intensive kernels that benefited from good memory bandwidth

Three "Component" Tests

- MEMRATE
  - Single-node memory bandwidth.
- MPITEST
  - MPI latency
  - MPI bandwidth
- PIORAW
  - Parallel IO performance

Procedure

- Goals
  - Monitor the system in production mode
  - Small impact on users
  - Fast and flexible way to test SW and HW changes
  - Automatically run suite, gather data and post results
- Implementation
  - Run suite of codes approximately weekly
  - Each code typically runs a few minutes on 8 (of 111) nodes
  - End to end workflow accommodated through scripts that run, parse, import into DB and results displayed on the web.

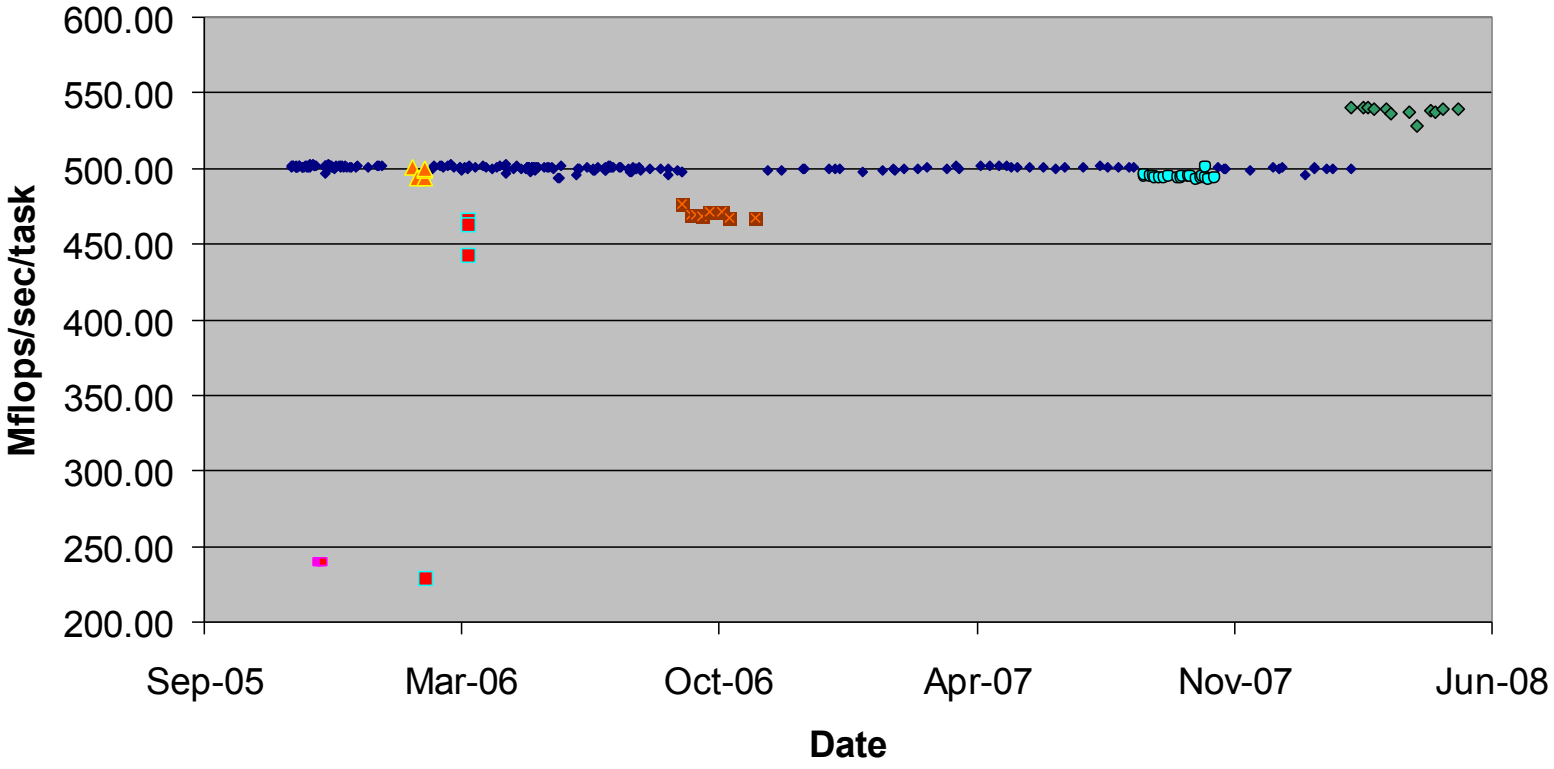
Results Web Interface

- The monitoring results are publicly available on the web
  - http://www.nersc.gov/nusers/systems/bassi/monitor.php
- This is useful for visually scanning for anomalies.
- Data is quickly available to IBM management and technical staff.

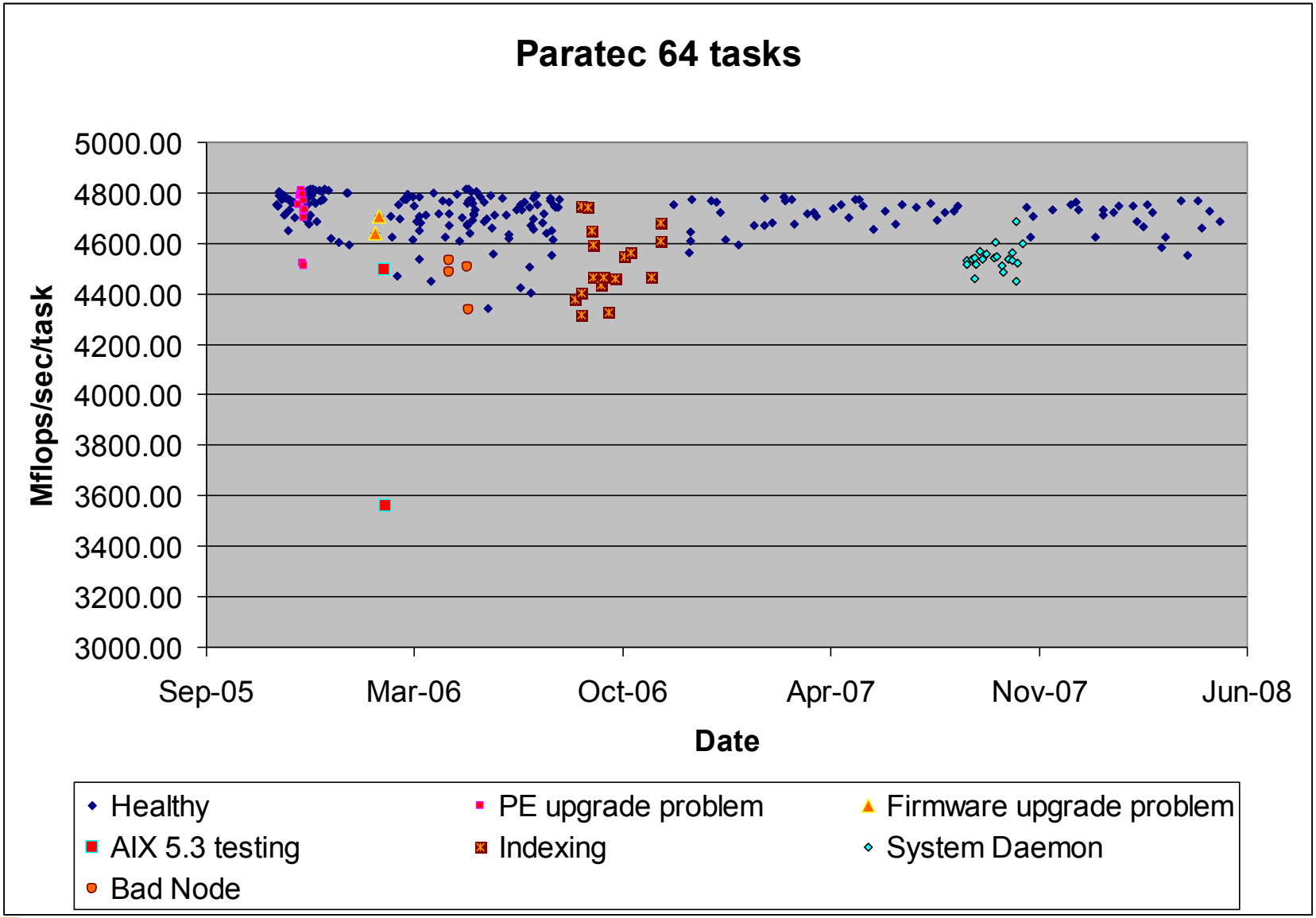
Examples of Problems Revealed

- PE upgrade problem
- HPS firmware upgrade problem
- AIX 5.3 upgrade problem
- Password file indexing problem
- System daemon problem
- Compiler upgrade issues
- Random hardware problems (e.g., L3 cache)

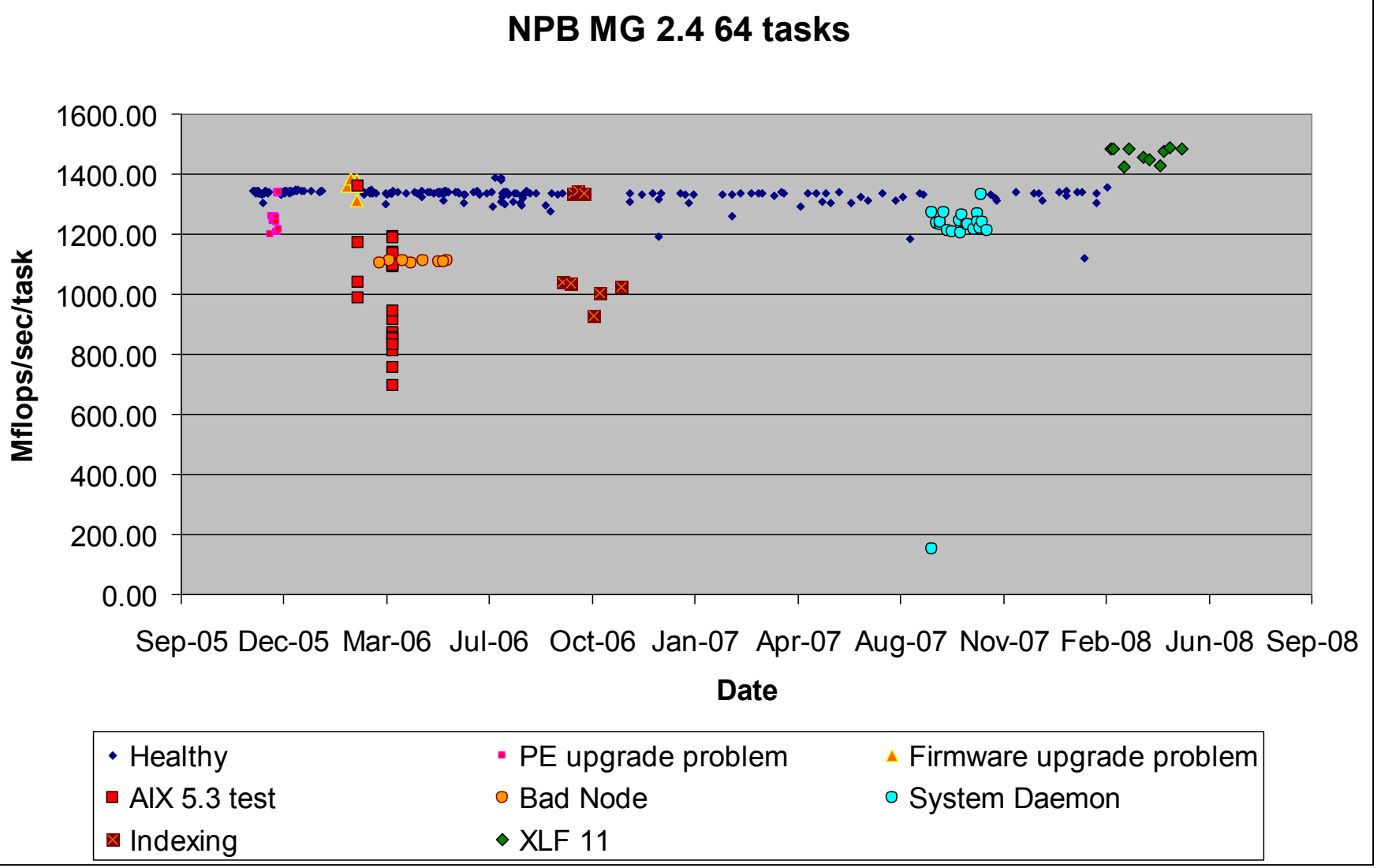
CAM 3.0 Results



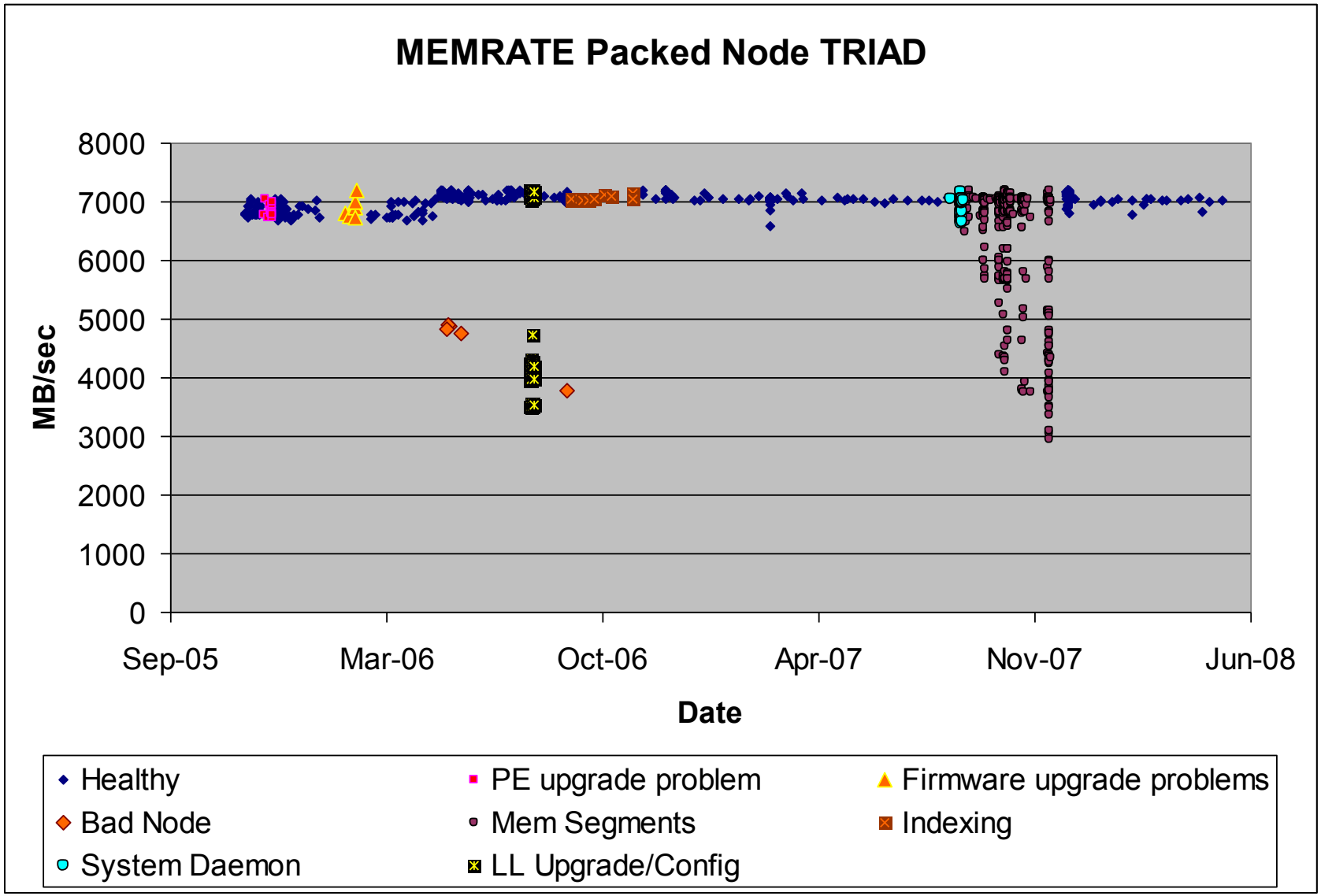
PARATEC Results



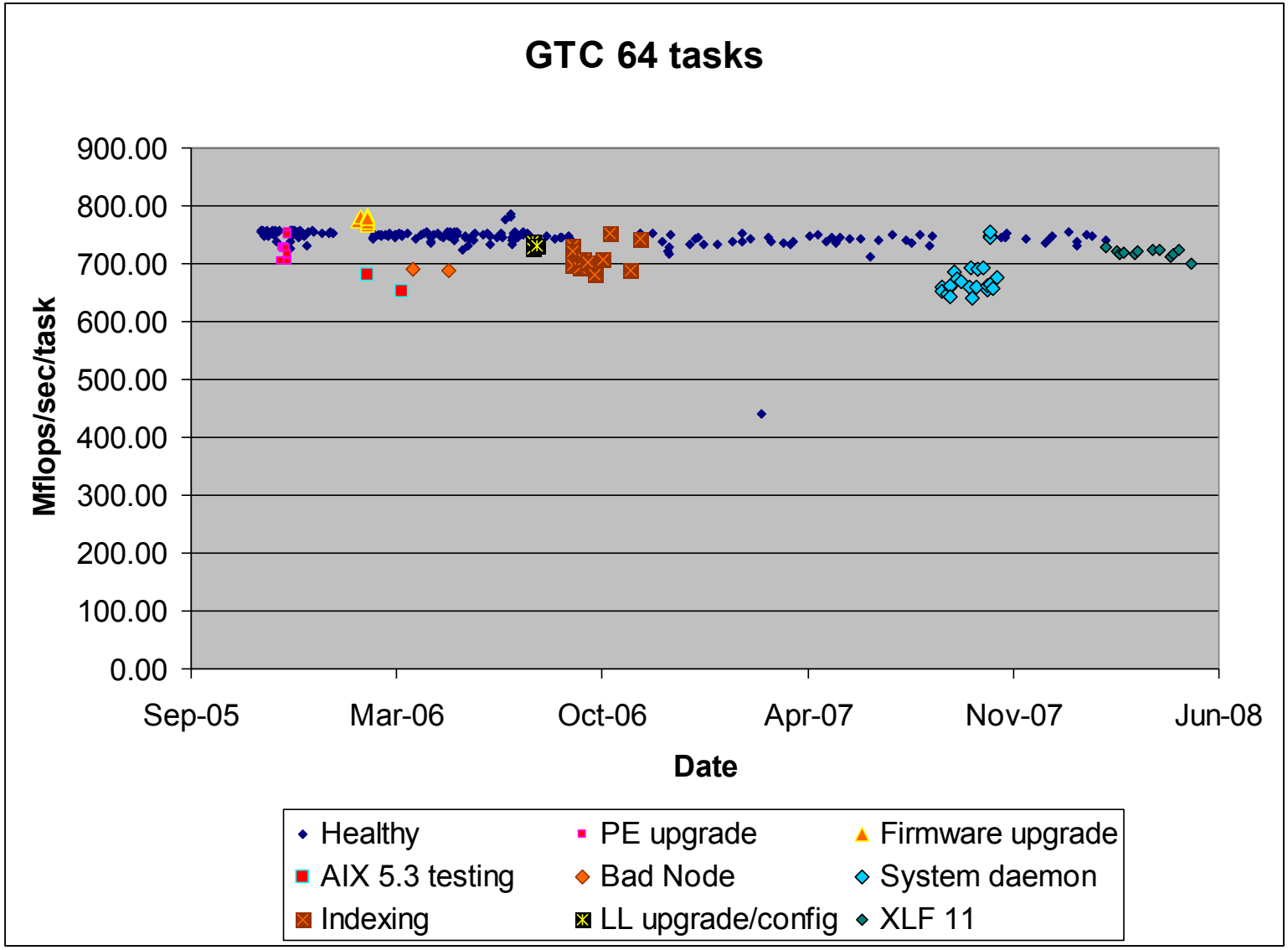
NPB MG Results



MEMRATE Packed Node



GTC Results


GTC 64 tasks
Mflops/sec/task
900.00
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
Sep-05
Mar-06
Oct-06
Apr-07
Nov-07
Jun-08
Date
Healthy
PE upgrade
Firmware upgrade
AIX 5.3 testing
Bad Node
System daemon
Indexing
LL upgrade/config
XLF 11

Discussion

- Most of the problems we uncovered involved software upgrades or configuration changes
- None of these issues were known before monitoring revealed them
- None except the bad L3 caches and compiler changes were identified by "system" tests or had simple resolutions

Healthy Results Summary

Benchmark	Avg. MFlop/s	Std. Dev.	COV
CAM 16	502	1.4	0.28%
PARATEC 64	4719	80	1.69%
GTC	747	8.9	1.20%*
NPB MG D 64	1331	26	1.95%
MEMRATE	7070	42	0.60%

Discussion

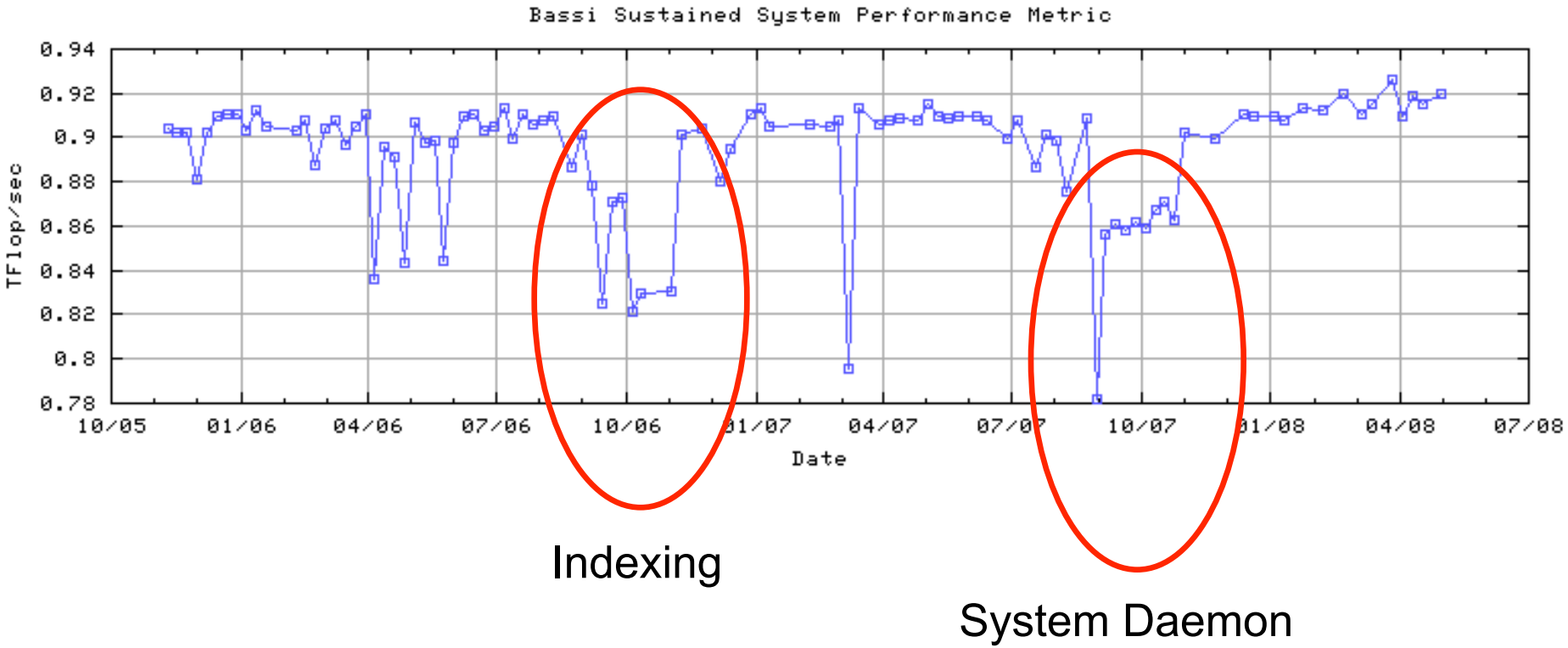
- When you run and examine the results over time you get a “feel” for when something is wrong
- The measured variation on a healthy system allows you to quickly evaluate the significance of an outlying result
- Even minor variations in run time can indicate that a system is sick
- The historical results provide quantitative evidence that a problem exists

Discussion

- A healthy Bassi has remarkably consistent run time performance characteristics.
- This is especially notable because the system is heavily loaded with a diverse workload.
- We don't have comparable long-term data for other systems at NERSC (yet!)
- Aggregate measures (SSP) are also useful, but are not as diagnostic for as many problems

Sustained System Performance (SSP)

The SSP is an aggregate metric derived from a (geometric) average of application benchmarks and standard parallel benchmarks.



Summary

- Application testing and monitoring are necessary to ensure proper system function.
- When configured properly application performance on Bassi is remarkably consistent.
- Most problems we've had with Bassi can be attributed to software complexity.