Build-and-Test Workloads for Grid Middleware Problem, Analysis, and Applications

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Grids are far from being reliable job execution environments

Server	• 99.99999% reliable
Small Cluster	• 99.999% reliable

In today's grids, reliability is more important than performance!

DAS-2	• >10% jobs fail [Ios06]
TeraGrid	• 20-45% failures [Kha06]
Grid3	• 27% failures, 5-10 retries [Dum05]

Sources of failure in grids and what to do about them

1	User applications	- Failures [HLi07] - Error propagation [Tha02]
2	Grid + User Middleware	- **No large-scale study** - Adopt industry practices [NMI06]
3	Machine + OS	- Desktop grids [Kon04] - Resource availability [Ios07] - Availability-aware scheduling

Outline

1. Introduction
2. The Build-and-Test problem
3. The NMI Build-and-Test Environment
4. Build-and-Test workloads
    1. Arrival patterns
    2. Workflow structure
    3. Observed failures
5. Applications
6. Conclusion

2. The Build-and-Test problem

- Industry practice for complex software development:

Industry practice:
do (build-and-test environments)
or die!

- **Problem**: following industry practice, build a build-and-test environment for grid software development
  - Unknowns (build): workload characteristics, size
  - Unknowns (operation): response time, accuracy

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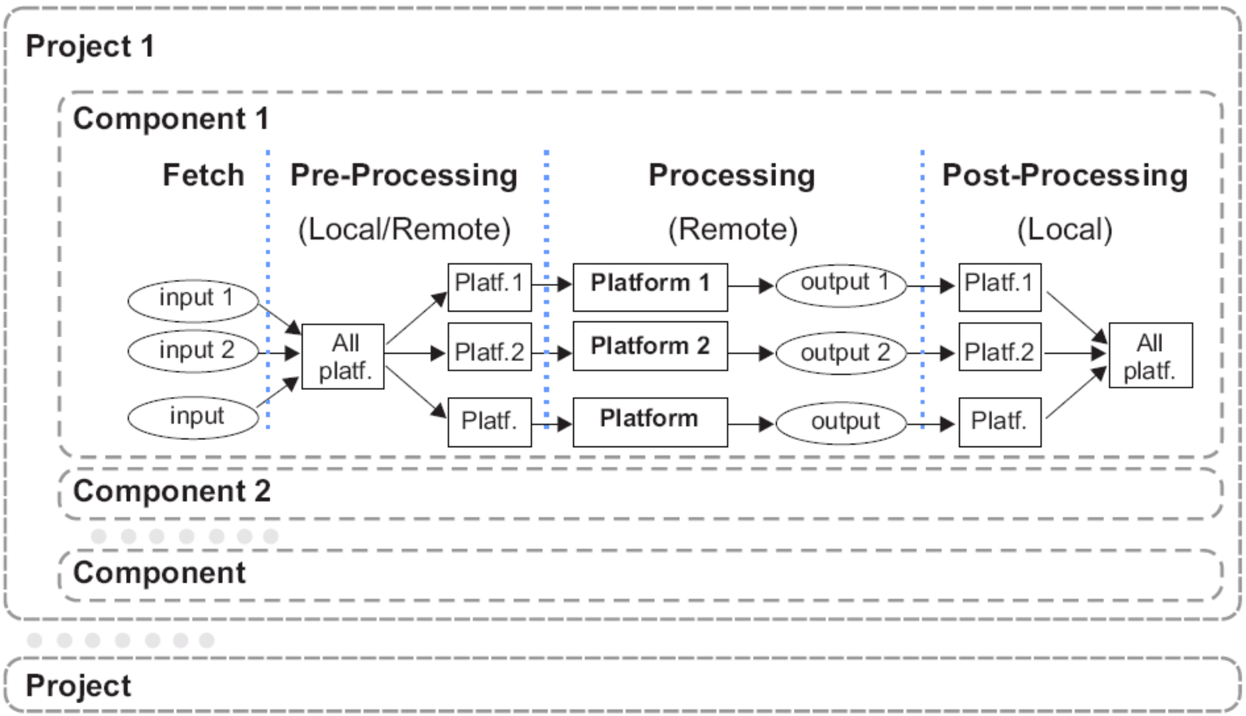
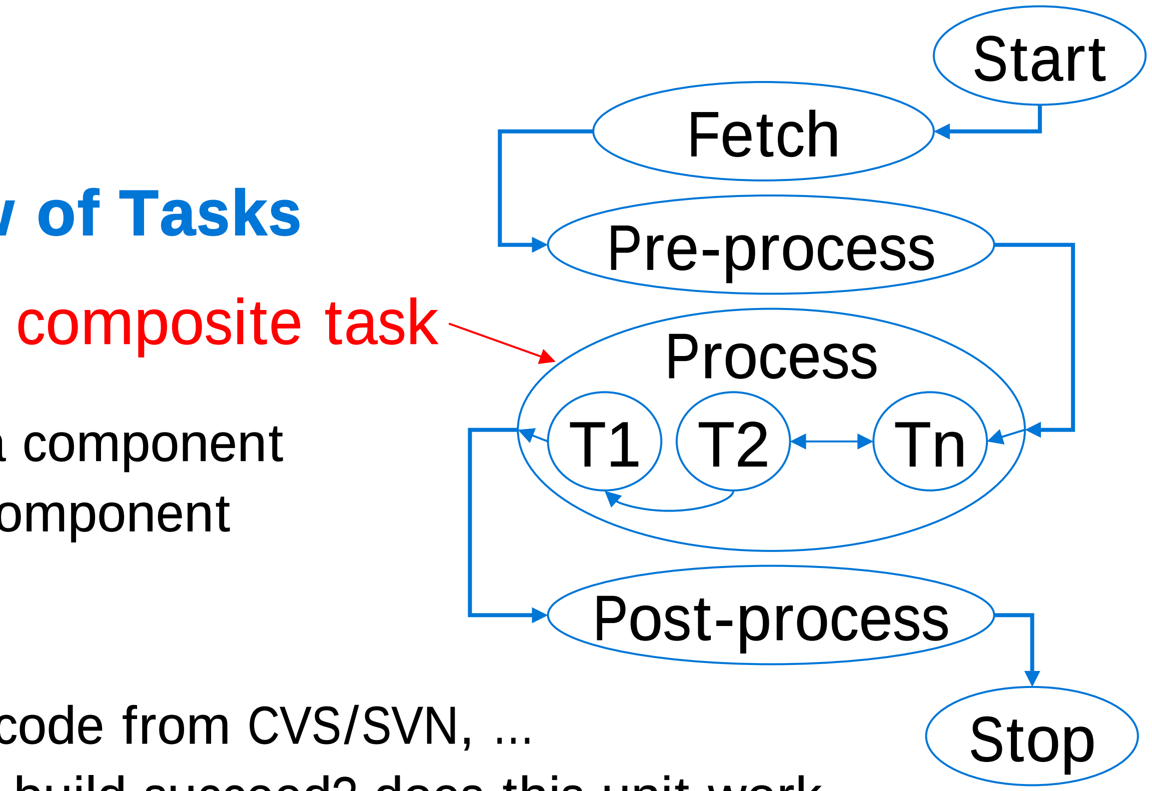
3. NMI, U. Wisc.-Madison: Sample Build-and-Test Environment (1)

- NMI U.Wisc.-Madison: 112 hosts, >40 platforms (e.g., X86/RH/9)
- Serves >50 **projects,** >100 **components**: Condor, Globus, VDT, gLite, GridFTP, RLS, NWS, INCA(-2), APST, NINF-G, BOINC ...



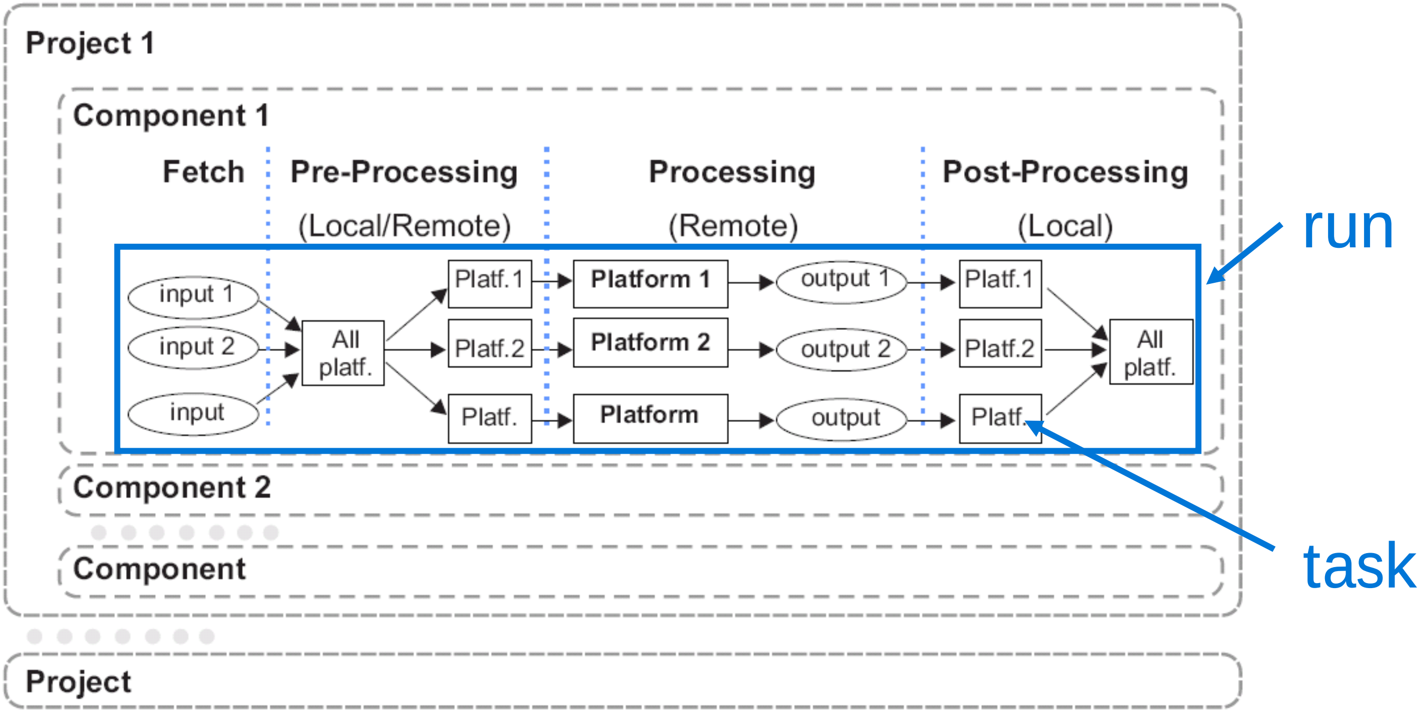
3. NMI, U. Wisc.-Madison: Sample Build-and-Test Environment (2)



- **Run = workflow of Tasks**
- Two Run types
  1. BUILD: building a component
  2. TEST: testing a component
- Many Task types
  - Setup Job: fetch code from CVS/SVN, ...
  - Test Job: did this build succeed? does this unit work according to the specifications?
  - Composite: a suite of setup and/or test jobs

3. NMI, U. Wisc.-Madison: Sample Build-and-Test Environment (3)

- Traces: 2 years (10/04-11/06), 90 CPUYrs (50% load), 35,000 **runs**, 2,400,000 **tasks** (73% in TEST runs)



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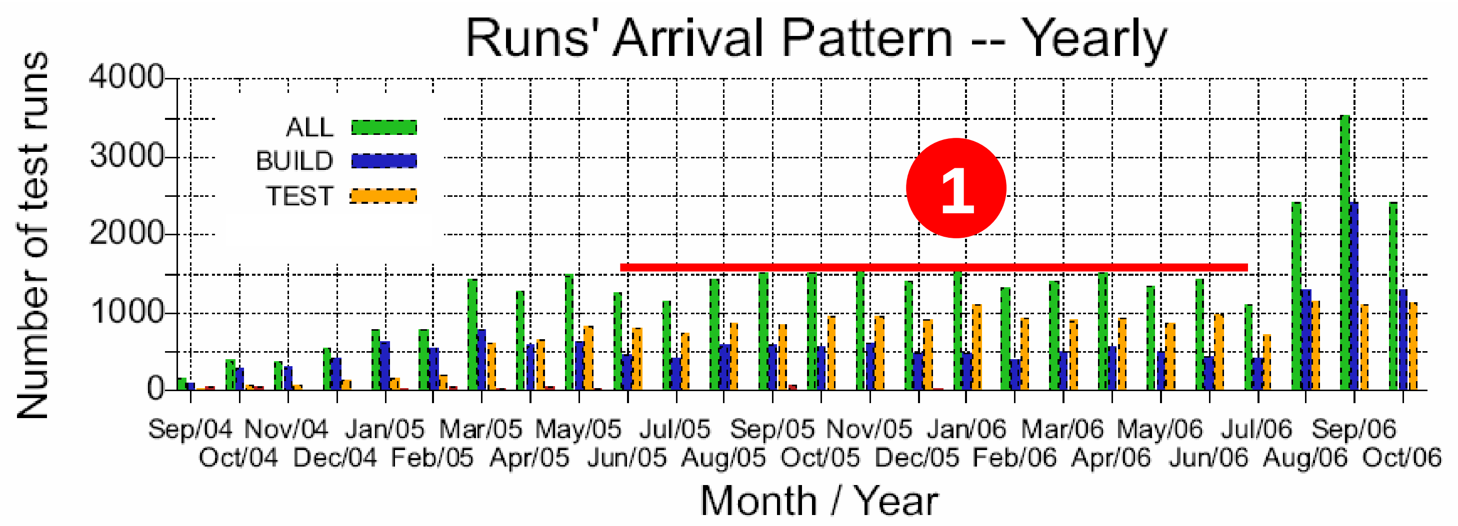
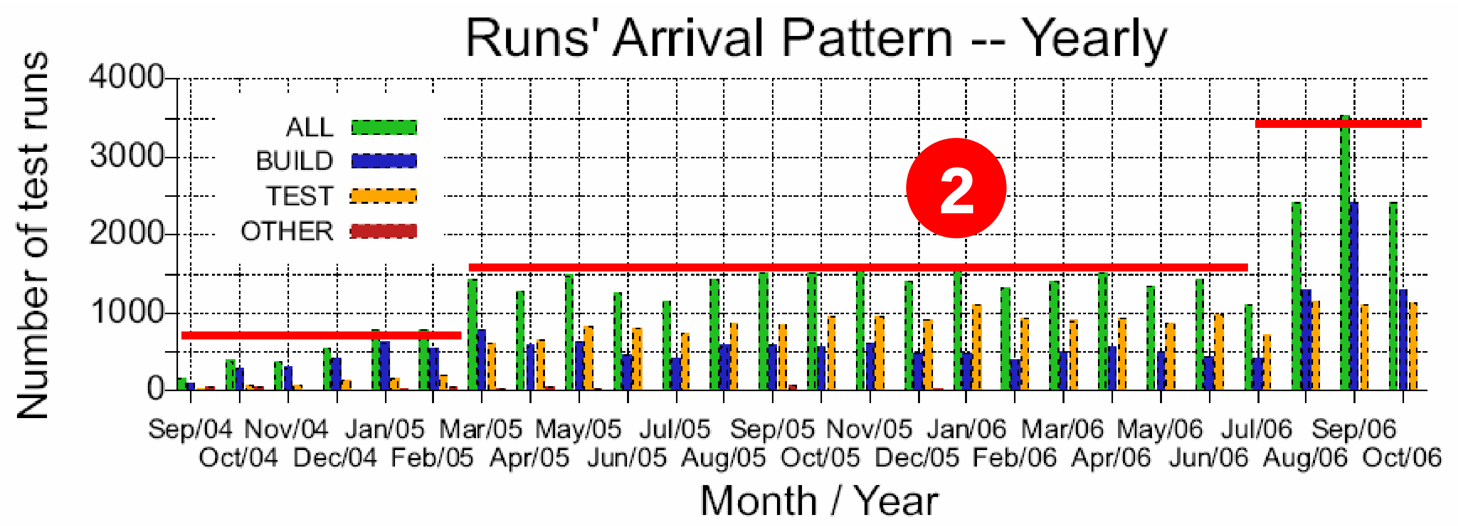
4.1. Build-and-Test Workloads: Arrival Patterns



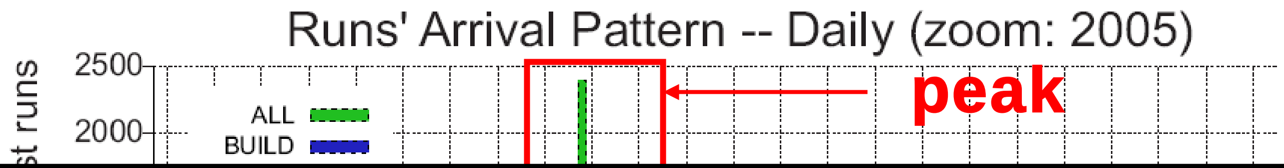
1. Arrival rate is constant throughout the year
   - 1500 runs per month in Jun’05-Jul’06
   - 6-months shift: year starts in July (dead production month)
   - Slow month: -20%, July both in 2005 and 2006

4.1. Build-and-Test Workloads: Arrival Patterns



1. Arrival rate is constant throughout the year
2. System evolution in 12-18 months cycles
   - Level 1: 800 runs per month
   - Level 2: 1500 runs per month
   - Level 3: 3500 runs per month

4.1. Build-and-Test Workloads: Arrival Patterns

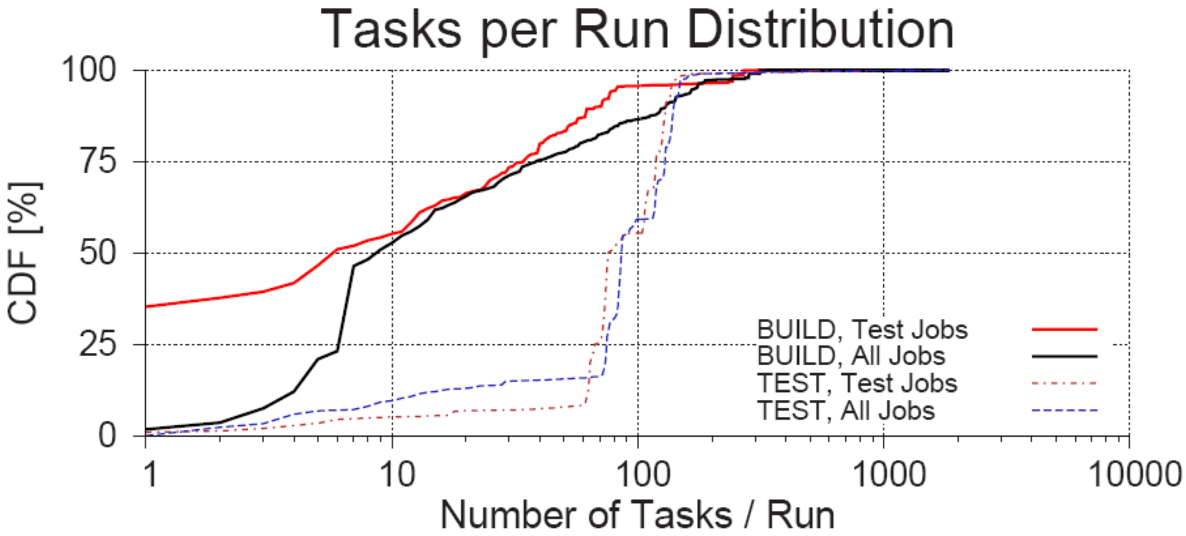


Build-and-Test workloads: heavy load, constantly.

1. Arrival rate is constant throughout the year
2. System evolution in 12-18 months cycles (4x in 2 yrs)
3. Daily pattern (Madison, WI base time: GMT-8)
   - High level of intensity 16h/day
   - Peak hours 09-10GMT

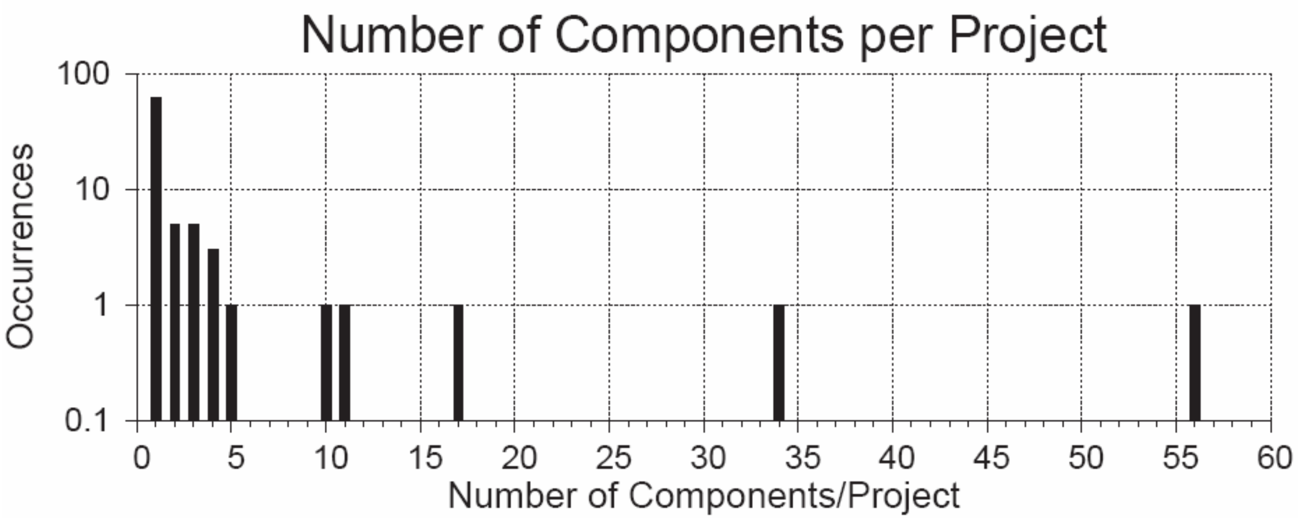
4.2. Build-and-Test Workloads: Workflow structure

- Reminder: **Run = workflow of Tasks**



1. Number of Tasks per Run
   - 39±61 Tasks / BUILD Run
   - 96±75 Tasks / TEST Run

4.2. Build-and-Test Workloads: Workflow structure



1. Number of Tasks per Run: 10-100 BUILD, 50-120 TEST
2. Number of Components per Project
   - 1 component most often
   - Few projects over 5 components

4.2. Build-and-Test Workloads: Workflow structure

Build-and-Test workloads are complex, and require a heterogeneous environment

1. Number of Tasks per Run: 10-100 BUILD, 50-120 TEST
2. Number of Components per Project: mostly 1
3. Number of Platforms per Component
   - 1-15 platforms most often
   - Few projects over 15 platforms

4.3. Build-and-Test Workloads: Observed failures

37% failures:
Build-and-Test environments critical for grid development!

- BUILD Runs fail more than TEST Runs (so is our software mature enough to create The Grid?)
- Take into account the failures due to the environment! (10-20% failures due to environment)

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5. Applications
Test optimization

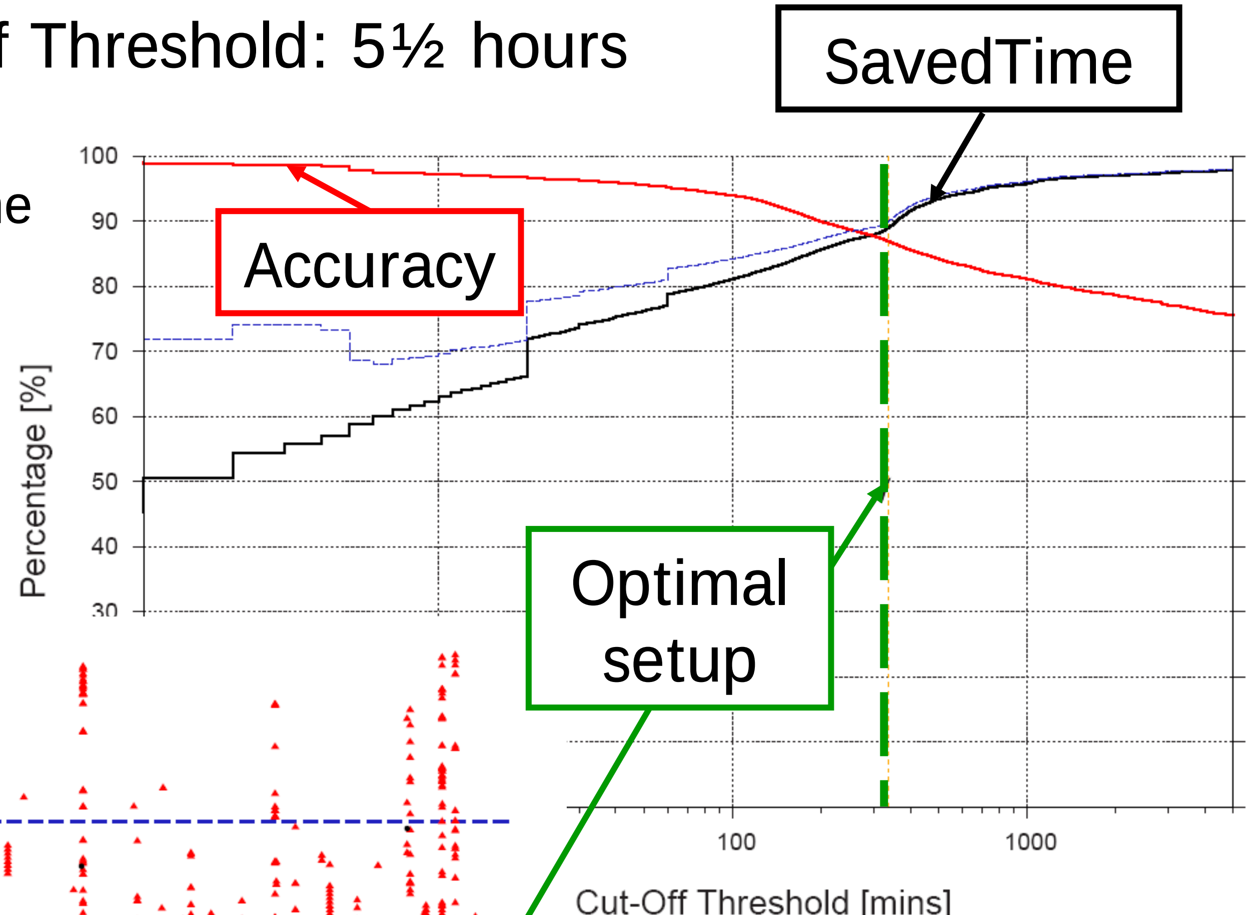
- Testing: trade-off between accuracy and runtime

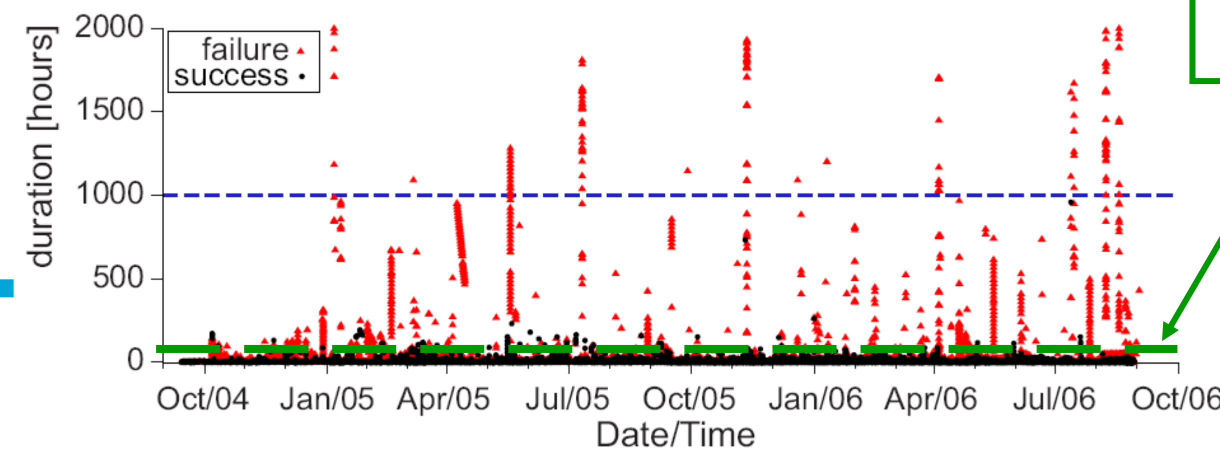
- **How long should we let the test jobs run?**
  Consider stopping jobs with runtime exceeding a cut-off threshold (administrator or automatic setup). Then,
  What is the optimal cut-off threshold?

- Metrics: accuracy (fraction of errors actually diagnosed), saved time (time saved because of cutting of jobs)

5. Applications
Test Optimization

- Optimal Cut-Off Threshold: 5½ hours
  - 95% accuracy
  - 93% saved time





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Take home message

Create your B&T environment or perish!

- **Build-and-Test environments**
  - critical for grid software development
  - high load 16h/day, >1M tasks / year
  - build-and-test workflows, 20-150 tasks
  - 1 environment can serve 100s of projects

- **Applications**
  - Team / Project management [paper]

In today's grids, reliability is more important than performance!

- **Future research**
  - Test optimization
  - Test environment management / provisioning [paper]

Thank you! Questions? Remarks? Observations?

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