

Modeling and Simulation of Load Balancing Strategies for Computing in High Energy Physics

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Motivation



- 1
- **2**

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Palladio Simulator



- Model driven software architecture simulator
- Developed at KIT, FZI and University of Paderborn
- Enables performance predictions

(Reussner et al., 2016)



Palladio Logo (http://palladio-simulator.com)

- Extended for simulation of Cloud Computing/HPC
 - Architectural Templates (Lehrig & Becker, 2016)
 - SimuLizar (Becker et al., 2013)
- Successfully used for optimizing cloud infrastructure

(Ostberg et al., 2014)

Model



- Model each kind of computing job with its resource requirements
 - CPU & I/O
 - Required job slots
 - Number of events
- Model each type of computing node
 - Number and processing speed of cores
 - Processing speed of I/O
 - Number of job slots
 - Number of instances of node

- Model load balancing strategy
 - First fit search based on available job slots
 - Easily modifiable to evaluate new strategies
- Model high load on system
 - Closed workload
 - Enough jobs to guarantee that systems never idles
 - Each job type has configurable share of load

Model





Scheduling: ProcessorSharing Number of Replicas: 16 Processing Rate: 16.3125 MTTR: 0.0

Scheduling: FCFS Number of Replicas: 1 Processing Rate: 1 MTTR: 0.0 MTTF: 0.0 Write Processing Rate: 1 Read Processing Rate: 1

♦ HDD

Number Of Replicas

47

JobSlot Capacity

16

< BasicComponent>> SEFFCompartment **PassiveResourcesCompartment** ComponentParameterCompartment \$x CPU DEMAND \$x VALUE = DoublePDF[(14588:0.4671826625387 \$x IO_RATIO \$x VALUE = DoublePDF((0.00262395163602015:0. \$x RESOURCE_DEMAND_ROUNDS \$x VALUE = 10 **Required Slots**

IntPMF[(1;0.1137835) (4;0.4794943)(8;0.4067222)]

Model Parameter Calibration



Data sources:

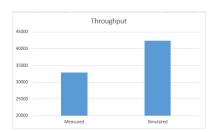
- Historical job monitoring data
 - JobMonitoring, WMArchive job reports
 - From CERN Hadoop analytix cluster using CMSSpark framework (Kuznetsov)
- Site VO resource share and node benchmarks

Obtaining model parameters:

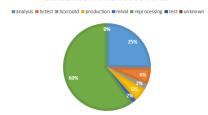
- Match jobs and node performance information
- Group computing jobs by type and requirements
- Extract resource demand distributions and load composition

Results

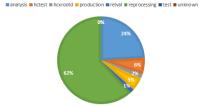








MEASURED SHARE OF JOB TYPES



Results





■ 1: CPU [20] in Intel(R) Xeon(R) CPU E5-2630 v4 @ 2.20GHz

Outlook



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- **2**

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