RIDGE: Combining Reliability and Performance in Open Grid Platforms

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1. Introduction

**RIDGE - Reliable Infrastructure for Donation-based Grid Environments**

- implemented on top of BOINC (Berkeley Open Infrastructure for Network Computing) architecture
- system designed to maximize reliability and performance of the underlying infrastructure
• RIDGE - analyze past behavior and estimating a reliability rating for each of the worker node
  - Correctness
  - Timeliness

• RIDGE - different workload allocation strategy.

• Comparison between RIDGE and BOINC
  – RIDGE will match, or surpass the best BOINC configuration
2. BOINC Architecture

- Centralized server - distributes task to worker nodes (arbitrary), collects the results and verify them - Validation

- Pull based approach

- Workunit – unit of computation

- Tasks – workunit are replicated into a fix number

- Verification techniques: Majority voting (2M-1), M-first voting

- Validation – successful: workunit completed, remaining tasks are purge
  – unsuccessful: more tasks are created in an incremental fashion
3. RIDGE Scheduling Framework

- Reputation-based scheduling technique
- Target Success-Rate (TSRate)
- Exec-Threshold (ExecThrld)
- MinClients
- MaxClients
• Worker Reliability Estimation

\[ r_i(t) = \frac{n_i(t) + 1}{N_i(t) + 2} \]

- \( n_i(t) \) nr of valid responses generated
- \( N_i(t) \) total nr of tasks

• Scheduling Algorithms: First Fit, Best Fit, Random Fit
  – select workers in the order they arrive at the server
Component Architecture

Figure 1: The RIDGE scheduling framework
Figure 2: Workunit Life-Cycle
4. Evaluation

- 120 nodes PlanetLab
- BOINC/RIDGE server run on dedicated machine outside the PlanetLab infrastructure
- M-first voting
- Re-schedule is disabled in the first results, re-enabled after
Evaluation Metrics

- **Success-Rate:** ratio between nr of successful workunit (without rescheduling) and total nr of workunits

- **Throughput:** total nr of workunits completed

- **Makespan:** completion time of the workunit minus dispatch time of first task

- **Group-Size:** number of workunit tasks that are assigned to workers

- **Quorum-Size:** nr of workunit tasks completed when the validation succeeds.
• **Correctness Evaluation of Reliability**
  
  – all results are ‘timely’
  
  – primary objective is getting correct results
  
  – Goal: how BOINC, RIDGE work with respect to resource consumption and throughput
  
  – M-first voting, $M=2$
  
  – $TSRate = 0.75$

  – 3 different probability distributions:
    
    • HighRE – majority of reliable workers
    
    • LowRE – majority of unreliable workers
    
    • ModRE – mix of reliable and unreliable workers
Impact of BOINC Replication Factor

Figure 3: Performance Comparison of different BOINC configurations
BOINC vs. RIDGE Comparison

- RIDGE server configuration:
  - $TSRate = 0.75$
  - $MinClients = 2$
  - $MaxClients = 6$

Figure 4: Comparison of RIDGE with best (BOINC$^{Bst}$) and conservative (BOINC$^{Con}$) configurations of BOINC.
Figure 5: Makespan Comparison
4.2 Timeliness Evaluation of Reliability

- Primary objective – getting the work done
- assume that every worker is 100% reliable
- M-first voting, M=1
- TSRate 0.9
Emulation of Reliability Environments

- higher values of ExecThrld correspond to more reliable environments:
  - LowRE (a)
  - ModRE (b)
  - HighRe (c)

Figure 6: Different reliability environments
Learning Behavior of RIDGE

- Results logged every 10 min

- Reliability of a worker at time $t = \text{average reliability of the worker through the 1 hour time interval around } t$

- Mean Error at time $t = \text{actual reliability} - \text{estimated reliability averaged over all workers}$
Performance of BOINC

Figure 8: Comparison of different BOINC configurations
Figure 9: Comparison of RIDGE with the best and conservative configurations of BOINC.
Figure 10: Makespan Comparison
Conclusion

• RIDGE - match or surpass the throughput of the best BOINC configuration under different reliability environments

• RIDGE - lower workunit makespans compared to BOINC