Title

Pin-pointing Node Failures in HPC Systems

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Pin-pointing Node Failures in HPC Systems

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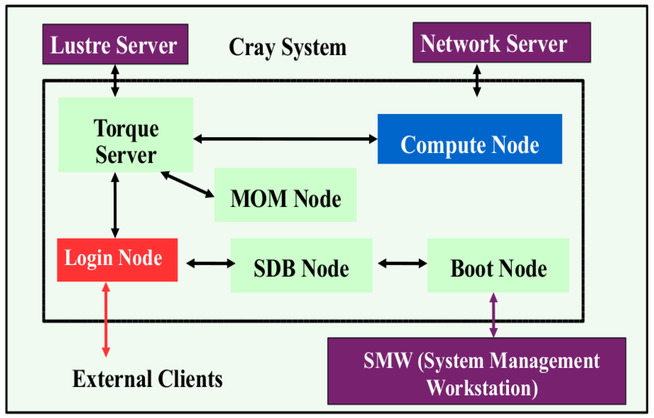
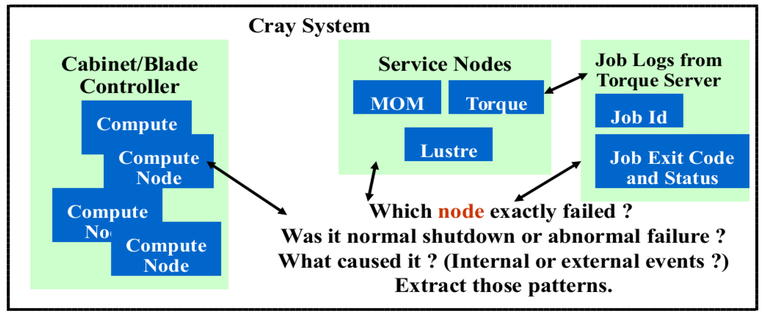
Motivation



Problems ? *Overwhelming raw logs from* ***several sources****, diverse & complex, Finding* ***infrequent*** *node failures is painful, How to detect node failures ?*
Aim - *Quantify node failures, Devise a way to automate data processing and node failure identification.*

Problem Statement



Challenges ? *Detecting faults* ***independently*** *without* ***pin-pointing*** *node failures is less effective for node resilience, Correlation extraction is hard.*
Goal - *Can automated Machine Learning Techniques help us? What features are required to extract node failures? Study logs to extract required patterns.*

Contributions

Identification of patterns for indicating node failures distinguishing from mass service shutdown for maintenance based on size and time.

Leverage TOT - Topics Over Time (continuous time based LDA - Latent Dirichlet Allocation algorithm) to estimate dynamic change in log messages.

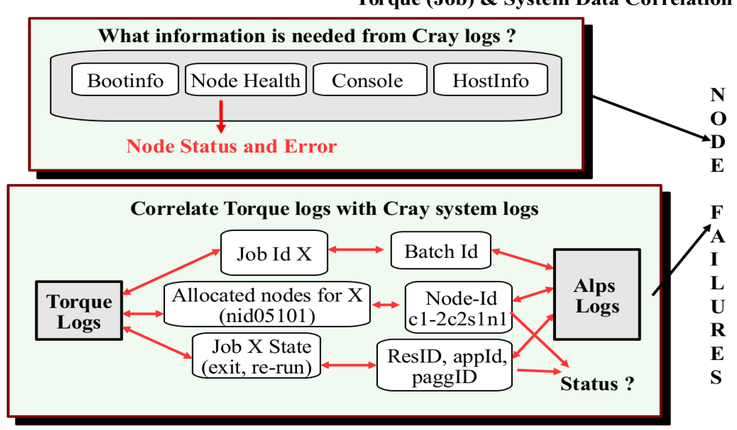
Derivation of ways to correlate Torque (Job) logs and Cray system logs to pin-point node failures.

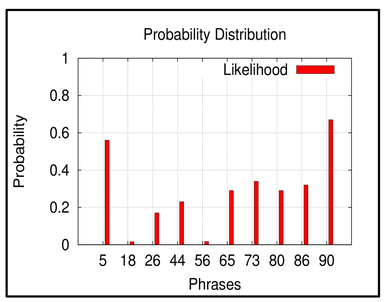
Table 1: Some Typical Node Failures

NodeId	Node-Type	Error
c0-0c0s0n2	Service	Node BIOS communication error
c4-0c2s0n1	Service	NMI Fault
c1-0c0s1n2	Service	Disk Queue Fatal Error
c2-0c0s7n0	Compute	Lustre Error
c3-0c2s13n3	Compute	LNET Router Error

Solution Approach

- Node Status and Events
- Torque (Job) & System Data Correlation





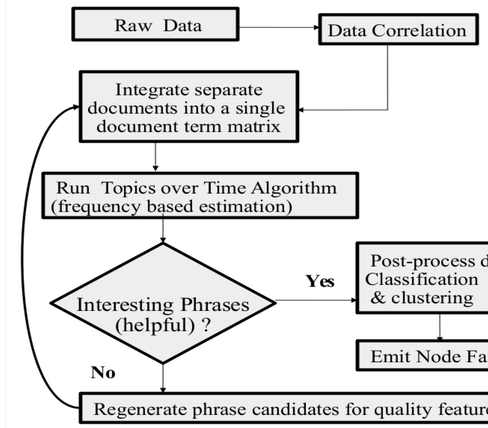
Log Data Details

Edison, Hopper, Cori based Cray logs – Approx 3698961 files, more than 600 GB data.

Factorie toolkit, scikit-learn python packages for various libraries.

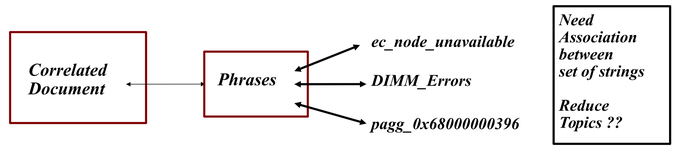
LogDiver Tool for high-level data analysis.

Overall Methodology



Node failures

- **Internal Errors**
  - **Job related**
  - **System/Kernel**
  - **Disk based**
- **External Errors**
  - **Compute Node OK but something wrong in the Blade or Cabinet**
  - **Aries/Gemini Interconnect issues**
  - **Routing Errors**
  - **Lustre Errors**
  - **Entire Blade going down**



Insights and Findings

- ***Normal node shutdowns very frequent for maintenance (multiple chassis going down in groups of 4) & periodic reboots, compute node failures relatively infrequent compared to service nodes (Job failures & error logs)***
  - ***Service nodes – 12 times a month***
  - ***Compute Nodes – 3 per week***
- ***Some Key phrases of interest for node failures: Failing node c1-0c0s1n2, node_unavailable, node status down, Errors, Fatal, exit codes, allocated nodes for Jobs, etc.***
- ***Leverage Job Id & state coupled with node Id & state to correlate Job logs and Cray system logs for pin-pointing node failures.***

(2013-04-26T00:00:41.948135-05:00, AER_BAD_TLP, 0.064),
(2013-04-26T00:00:41.948135-05:00, ec_hw_error, 0.56)

TOT provides the dynamic phrase distribution over continous timeseries data.

Conclusions

- ***Extracted patterns of distinction between normal mass shutdown versus an infrequent single compute node failure.***
- ***Devised correlation between job logs with system logs.***
- ***Performed continuous time likelihood estimation of topics from the preprocessed document for subsequent out-lier detection and prediction.***
- ***Employed the idea of long-term correlation using probability distribution of more likely events.***

Future Work

- ***Investigate unsupervised temporal and spatial log analysis alternatives suitable for failure pattern detection.***
- ***Study of efficient techniques to pre or post process raw data aiding Machine Learning tools for fault extraction.***
- ***Devise ways to predict failures before node goes down.***

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