Predictive Analysis for Migration Schedulers

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Overview:

- Load Balancing
- Fault Tolerance
- Scheduling
- Types of Solutions
- Live Migration
- Predictive Analysis
Load Balancing Example

Process Distribution ...

Front End

Load Balancer

Host1
VM1 / POD1
VM4 / POD4
VM7 / POD7

Host2
VM2 / POD2
VM5 / POD5

Host3
VM3 / POD3
VM6 / POD6
Load Balancing

- Priority Based Upon Urgency

- Even Distribution within categories:
  - Urgent Priority – Mission Critical – Real Time Processing
  - High Priority – High Importance – near Real Time Processing
  - Neutral Priority – Medium Importance – Normal Processing
  - Low Priority – Low Importance - Not Time Critical Processing
  - No Priority – Unimportant – Unimportant Processes
Fault Tolerance

- Failure Types:
  - Network Element Failures
  - Hardware / Resource Failures
  - OS / BIOS / Kernel Failures
  - Process Failures
Fault Tolerance Redundancy Example

High Availability ...

Front End

Host 1 (Active)

Host 2 (Passive)

Storage 1

Storage 2

Data Redundancy
Scheduler Dispatching Concepts Example

Process Queuing ...

Front End → Back End

Host1
- VM1 / POD1
- VM4 / POD4
- VM7 / POD7

Host2
- VM2 / POD2
- VM5 / POD5

Host3
- VM3 / POD3
- VM6 / POD6
Scheduling

- Ability to launch processes based upon needed resources
  - Monitor the amount of resources each process utilizes
- Types of Launching/Migration Scenarios:
  - Initial Launch
  - Migration for Maintenance
  - Re-balancing - Migration to Another Host
  - Fault Recovery – Migrating to mitigate system/process failure.
Policy Units - Attributes of Scheduling Migrations

- Filters
- Weights/Scoring
- Balancers:
  - Even Distribution
  - Power Saving
  - Prioritizing
  - Affinity
  - CPU/NUMA Pinning for Optimal Performance
Types of Solutions For Applying Predictive Analysis:

● Live Migration
  ○ Load Balancing
  ○ Fault Recovery
  ○ Minimizing Live Migration Pausing

● Redundancy
  ○ Distribution of processes running simultaneously
  ○ Fault Recovery
Live Migration:

- Network Connectivity.
- Remote Disk(s) Availability
- Migrating Data on Local Disk(s)
- Copying Memory State in phases
  - All of the current memory contents
  - Current Differences before VM / POD Pausing
  - Minimal Differences during VM / POD Pausing
- Copy CPU State
- The goal is to limit pausing of the VM / POD
- Restarting the VM / POD on the Destination Host
- Cleanup on the Source Host
Live Migration Transitioning Example

Sequence of Events ...

- Runs at Source
- Setup or Synchronize Disk
- Start Memory Transfer
- Paused
- Estimate Minimum Downtime
- Continue Memory Transfer and deltas
- Runs at Destination
- Activate Network
- Complete Memory Transfer and Cleanup.
Live Migration From Host 1 to 2 Transitioning

Host 1
- Controller VM / POD
- Hypervisor
- Storage

Host 2
- Controller VM / POD
- Guest VM / POD
- Hypervisor
- Storage

Host N
- Controller VM / POD
- Hypervisor
- Storage
Predictive Analysis Topics For Discussion

- Predicting future occurrences via analysis of past performance
- Techniques for Predictive Analysis
- Process for Developing a Prediction Model
- Types of Predictive Models with Examples
- Applying These Techniques for Scheduling
Predictive Analytics Methodology

Modeling ...

Historical Data

Training Set

Testing Set

Algorithm

Model

Results
Techniques for Predictive Analysis

- Regression techniques
  - Classification and regression trees (CART)
  - Multivariate adaptive regression splines
- Linear regression model
  - Multivariate adaptive regression splines
- Discrete choice models
  - Multivariate adaptive regression splines
- Logistic regression
  - Machine learning techniques
- Multinominal logistic regression
  - Neural networks
- Probit regression
  - Multilayer perceptron (MLP)
- Logit versus probit
  - Radial basis functions
- Time series models
  - Support vector machines
- Survival or duration analysis
  - Naïve Bayes
- k-nearest neighbours
  - Geospatial predictive modeling
Process for Developing a Prediction Model

Cyclical ...

1. Project Definition
2. Data Collection
3. Data Analysis
4. Statistics: Validation
5. Modeling
6. Deployment
7. Model Monitoring
Types of Predictive Models with Examples

- **Support Vector Machine – Model**
  - Classification – To predict a category
  - Example: Stock prices increase or decrease – Yes or No, True or False answer.

- **Predict Quantity – Regression**
  - Example: Predicting a person's age based upon height, weight, health and other factors

- **Anomaly Detection – Normal Behavior verses Exceptions (Anomaly)**
  - Example: Money withdrawal anomalies

- **Clustering: Discover Structure in Unexplored Data**
  - Example: Finding groups of customers with similar behavior given a large Database of customers containing their demographics and past buying records.
Applying Predictive Analytics to Schedulers

● Criteria for Data
  ○ Processing Time / Iterations - Adjusted for Resource Capacity and Priority
  ○ % of Resources used – Adjusted for Capacity and Priority
  ○ Adjust for anomalies when Calculating Averages

● Ideas - Selective Techniques applied for other scheduling applications:
  ○ Combining regression-like modeling and functional approximation, using the sum of exponential functions, to produce probability estimates.
Predictive Analysis Architecture

Concept Overview ...

Predictor

Historian

Scheduler:
Parameters:
CPU
Memory
Storage
Networking
Scoring

Host1
 VM1 / POD1
 VM4 / POD4
 VM7 / POD7

Host2
 VM2 / POD2
 VM5 / POD5

Host3
 VM3 / POD3
 VM6 / POD6
Tracking Historical Data

- The Time Each Process Starts and Terminates
- The Resources Used By Each Process
- The Time Each Process Uses To Migrate
- The Time / Iterations that Memory / Disk Transfer Occurs Per Size
Considerations Based Upon Analysis

- If Early Migration Can Proceed
- When Early Migration Shall Start
- Error Correction / Anomaly Detection for Accurate Results
Anomaly / Error Calculation Methods to Consider

- **Statistical** - Calculating % of Error From the Mean and Eliminate Results Outside of the Threshold.
- **Signal Processing Techniques** - Smoothing Filter to Eliminate Glitches.
- **Machine Learning** - Analysis of Patterns and Categorize Between Normal And Out Of Range Results.
Thank You

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