FORMULATING THE GRID RELIABILITY AND PERFORMANCE MODEL

SETTING THE GRID RELIABILITY EQUATIONS AND MATRICIAL MODEL

NYOUG DBA SIG MEETING OCT. 2008 AT ORACLE CORPORATION

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Overview

- Project Description
  - Objective
  - Motivation and Expected Results
- Conceptual Framework
  - Reliability Model
  - Performance Model
  - Integrating Grid Mathematics
- Proposed Model Methodology
- Math Applications and Model Analysis
- Concluding Remarks

Speaker Qualifications

- Independent Consultant, ADN
- Speaker at NYOUG meetings
- 24 years of IT experience
- 18 years of Oracle experience, 13 as a DBA
- RMAN experience with Oracle8i,9i, 10g, and 11g, since 1999.
- BS Systems Engineering, Universidad del Norte, 1987.
- MS Computer Science, NJIT, 1993
- PhD CIS candidate, NJIT, 1997
- MBA MIS, Montclair State University, 2006
- College Math Proessor and former HS Math Teacher Principal.

Objectives

- Present a mathematical model to customize both grid reliability and performance in terms of:
  - Critical Alerts
  - Warning Alerts
  - Custom Thresholds
- Introduce a useful matrix-driven model providing:
  - BI multi-dimensional capabilities
  - Stochastic Model and random process analysis
  - Capabilities to enable time series analysis via ARIMA

Defining Reliability

- Reliability can be expressed as:

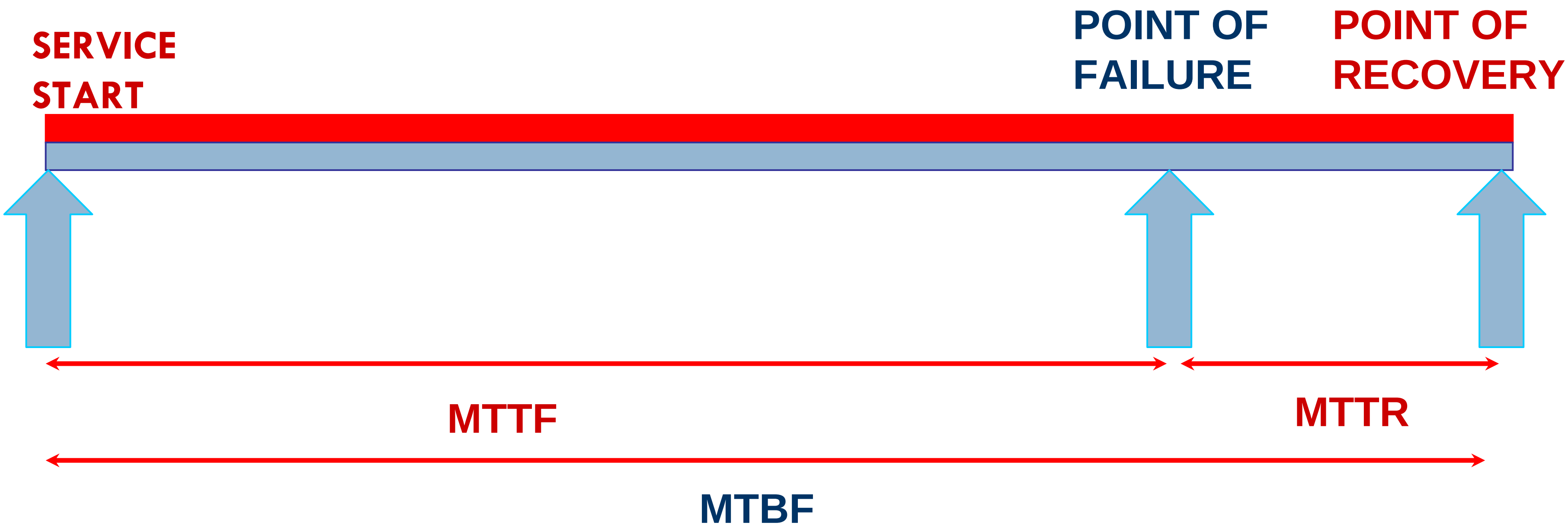
$$R = \frac{MTTF}{MTBF}$$

- And further expanded to:

$$R = \frac{MTTF}{MTTF + MTTR}$$

MTTF is the Mean Time to Failure, and MTBF is the Mean Time Between Failure; and MTBF, and can be decomposed into the Mean Time To Failure plus the Mean Time To Recover (MTTR).

Defining Reliability

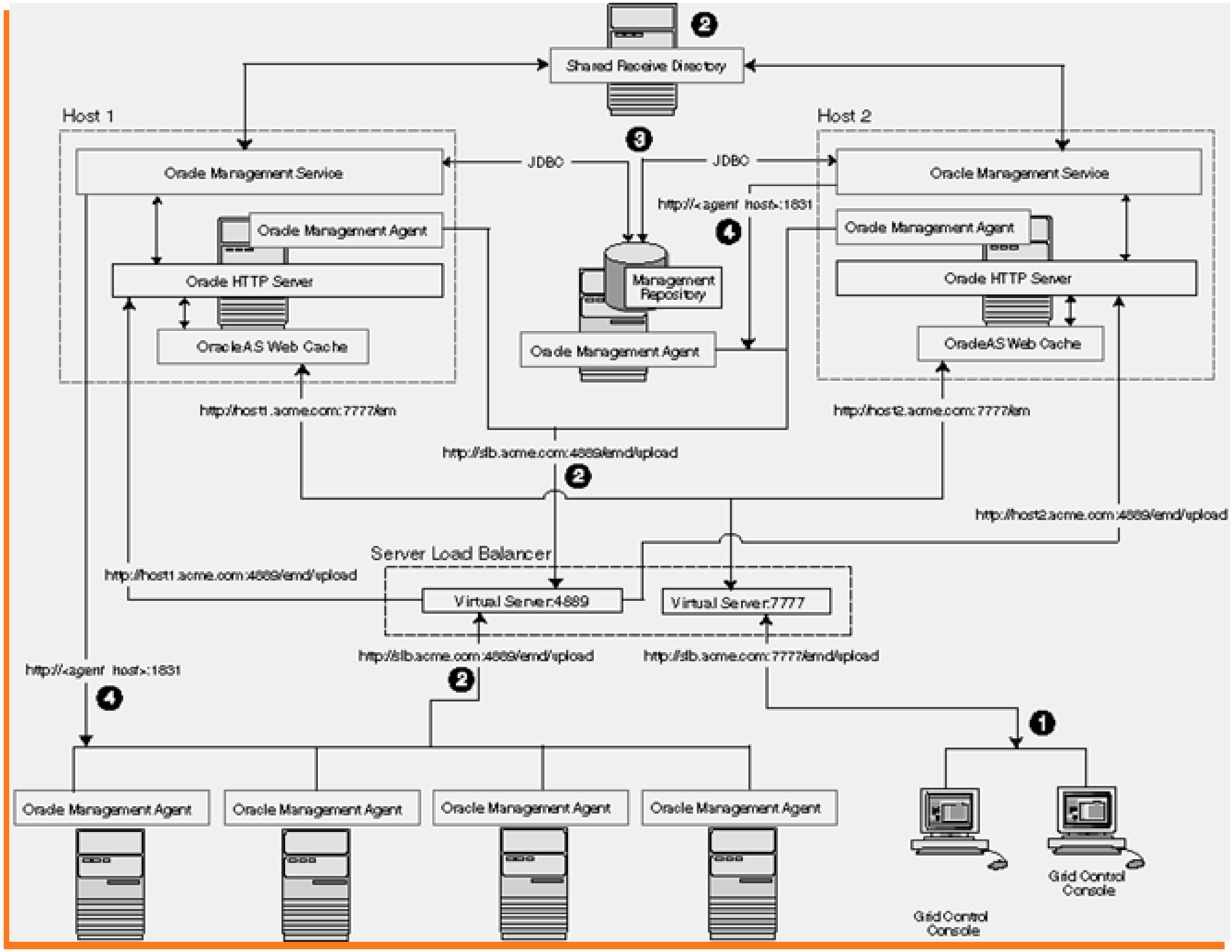


Continuous Reliability Model

$$R = e^{-(\lambda t)} \frac{(\lambda t)^k}{k!}$$

The stochastic model (Poisson process)

Complexity of Grid Infrastructure



General Performance Control Model

- A general performance control model must involve:
- A Proportionate approach. $$Rc = ke^{-(\lambda t)}\frac{(\lambda t)^k}{k!}$$
- An Integrative Approach $$Rc = \int e^{-(\lambda t)}\frac{(\lambda t)^k}{k!}dt$$
- A Derivative Approach. $$Rc = \frac{d}{dt}\left(e^{-(\lambda t)}\frac{(\lambda t)^k}{k!}\right)$$
- So, PID, is the principle to derive performance control based on a continuous reliability model.
- A Transformative or Transformational Approach, such as Laplace transform, is also suitable for complex systems, where encryption is appropriate.

λ Inter-Arrival Rate Based on Alerts

- **Critical Inter-arrival rate, i.e., based on critical alerts.**

$$\lambda_c = \frac{\#ofCriticalAlerts}{\#TestUnit}$$

λ Inter-Arrival Rate Based on Alerts

- **Non-Critical Inter-arrival rate, i.e., based on critical alerts.**

$$\lambda_w = \frac{\#ofWarningAlerts}{\#TestUnit}$$

Weighed Inter-Arrival Rate λ

- The Model Weighed Inter-arrival Rate Lambda .

$$\lambda = \frac{n_c \lambda_c + n_w \lambda_w}{n_c + n_w}$$

Adjusting the Inter-arrival rate λ

- **Biased Model Weighed adjusting the Critical Inter-arrival Rate λ (Lambda) .**

$$\lambda = \frac{n_c(k\lambda_c) + n_w\lambda_w}{n_c + n_w}$$

Adjusting the Inter-arrival rate λ

- **Biased Weighed Model adjusting both the Critical Inter-arrival Rate λ (Lambda) and its cardinality .**

$$\lambda = \frac{kn_c\lambda_c + n_w\lambda_w}{kn_c + n_w}$$

Weighed Inter-Arrival Rate λ

- **The Model Weighed Inter-arrival Rate Lambda (using a constant for warnings).**

$$\lambda = \frac{n_c \lambda_c + n_w c_w}{n_c + n_w}$$

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Aggregate Reliability Model

- **The Aggregate Time-Driven Reliability Continuous Model .**

$$\int_{t_0}^{t_1} \frac{e^{-(\lambda t)}(\lambda t)^k}{k!}\,dt$$

RAC Reliability Model

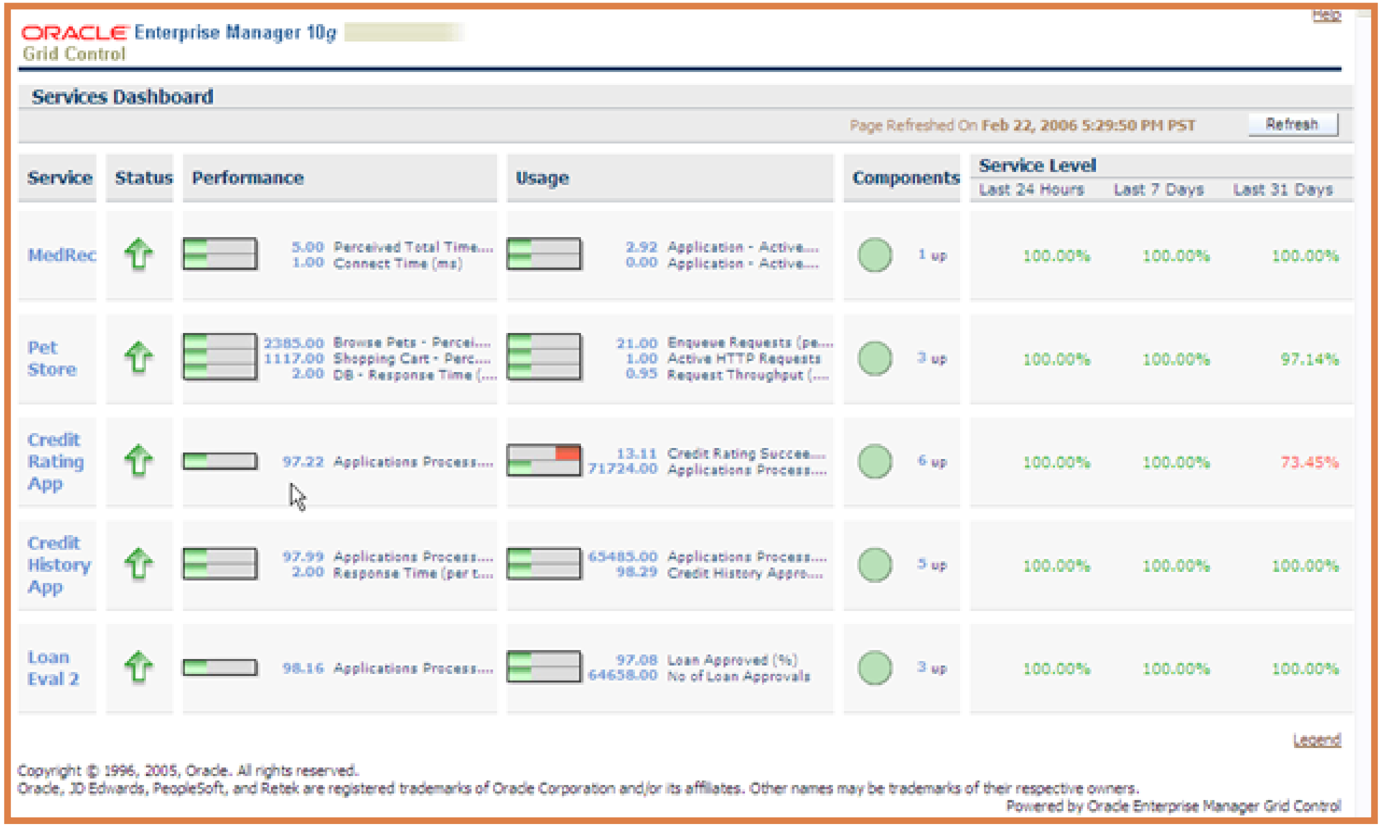
- **RAC Node-based Reliability Expectation.**

$$E(\rho_{RAC}) = E\left(\sum_{i=1}^{n} \frac{MTTF_i}{MTTF_i + MTBF_i}\right)$$

$$E(\rho_{RAC}) = \frac{1}{n}\sum_{i}^{n}\left(\frac{MTTF_i}{MTTF_i + MTBF_i}\right)$$

Grid Reliability Metrics

- Actual Grid Reliability Metrics via Service Level Management.



RAC/Grid Pro-Reliability Model

- **Weighed RAC/Grid Inter-Arrival Rate**

$$\lambda_{RAC} = \frac{\sum_{i}^{m}\sum_{j}^{n} n_{c_{ij}} \lambda_{c_{ij}} + \sum_{i}^{m}\sum_{j}^{n} n_{w_{ij}} \lambda_{w_{ij}}}{\sum_{i}^{m}\sum_{j}^{n} \left(n_{c_{ij}} + n_{w_{ij}}\right)}$$

- **This can also be presented as the generalized model with cubic features for BI analytic purposes.**

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General Performance Control Model

- A general performance control model must involve:
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$$Rc = \int e^{-(\lambda t)}\frac{(\lambda t)^k}{k!}dt$$

- A **Derivative** Approach.

$$Rc = \frac{d}{dt}\left(e^{-(\lambda t)}\frac{(\lambda t)^k}{k!}\right)$$

- So, PID, is the principle to derive performance control based on a continuous reliability model. As mentioned, a **Transformational** Approach is also possible.

Grid Targets

```
$ emctl config listtargets
TZ set to US/Eastern

Oracle Enterprise Manager 10g Release 10.1.0.3.0.
Copyright (c) 1996, 2004 Oracle Corporation.  All rights reserved.
[dnlvnjtools, host]
[EnterpriseManager0.dnlvnjtools_HTTP Server, oracle_apache]
[dnlvnjtools:1810, oracle_emd]
[EnterpriseManager0.dnlvnjtools_home, oc4j]
[EnterpriseManager0.dnlvnjtools_BC4J, oracle_bc4j]
[EnterpriseManager0.dnlvnjtools_Web Cache, oracle_webcache]
[EnterpriseManager0.dnlvnjtools, oracle_ias]
[EnterpriseManager0.dnlvnjtools_OC4J_EM, oc4j]
[EnterpriseManager0.dnlvnjtools_JServ, oracle_jserv]
$
```

Matricial Models

- **Aggregation can be implemented via block matrices.**

$$\begin{bmatrix} R & F \\ A & C \end{bmatrix}$$

- **The Middleware Block Matrix involving RAC, Application Farms, Applications, and Collaboration Suite Target's Metrics**

BI Analysis and Forecasting

- **Block Matrix Design, which allows for multi-dimension and Business Intelligence Analysis**

$$\begin{bmatrix} r_{1,1} & r_{1,2} & \cdots & r_{1,n/2} & f_{1,1} & f_{1,2} & \cdots & f_{1,n/2} \\ r_{2,1} & r_{2,2} & \cdots & r_{2,n/2} & f_{2,1} & f_{2,2} & \cdots & f_{2,n/2} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ r_{n/2,1} & r_{n/2,2} & \cdots & r_{n/2,n/2} & f_{n/2,1} & f_{n/2,2} & \cdots & f_{n/2,n/2} \\ a_{1,1} & a_{1,2} & \cdots & a_{1,n/2} & c_{1,1} & c_{1,2} & \cdots & c_{1,n/2} \\ a_{2,1} & a_{2,2} & \cdots & a_{2,n/2} & c_{2,1} & c_{2,2} & \cdots & c_{2,n/2} \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ a_{n/2,1} & a_{n/2,2} & \cdots & a_{n/2,n/2} & c_{n/2,1} & c_{n/2,2} & \cdots & c_{n/2,n/2} \end{bmatrix}$$

Block-Based Grid Visualization

- **Therefore, one could conceive the grid as a block-based matrix, in general, as displayed**

$$
\begin{bmatrix}
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] \\
[\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,] & [\,]
\end{bmatrix}
$$

Binomial Model Perspective

Assuming that a grid contains N such block matrices, it is also possible to establish that the probability that a warning or critical alert message reaches one of these blocks over a unit of time is a Bernoulli sequence given by:

$$B(\lambda N, 1/N) = \binom{\lambda N}{k} \left(\frac{1}{N}\right)^{k} \left(1 - \frac{1}{N}\right)^{\lambda N - k}$$

Where $p = \frac{1}{N}$ is the probability of success, i.e., that an alert reaches a block in the grid over a unit of time.

Binomial Model Perspective

The same Bernoulli trial/sequence perspective can be seen over a period of time as:

$$B\left((\lambda t)N, 1/N\right) = \binom{(\lambda t)N}{k}\left(\frac{1}{N}\right)^{k}\left(1-\frac{1}{N}\right)^{(\lambda t)N-k}$$

Where $p = \frac{1}{N}$ is the probability of success, i.e., that an alert reaches a block in the grid over a duration of t units of time. The discrete view is consistent with the continuous model previously introduced.

Unified Grid Middleware Model

- Matrix displaying the Unified Grid Middleware Model

$$
\begin{bmatrix}
m_{1,1} & m_{1,2} & \cdots & m_{1,n/2} & m_{1,(n/2)+1} & m_{1,(n/2)+2} & \cdots & m_{1,n} \\
m_{2,1} & m_{2,2} & \cdots & m_{2,n/2} & m_{2,(n/2)+1} & m_{2,(n/2)+2} & \cdots & m_{2,n} \\
\cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\
m_{n/2,1} & m_{n/2,2} & \cdots & m_{n/2,n/2} & m_{n/2,(n/2)+1} & m_{n/2,(n/2)+2} & \cdots & m_{n/2,n} \\
m_{(n/2)+1,1} & m_{(n/2)+1,2} & \cdots & m_{(n/2)+1,n/2} & m_{(n/2)+1,(n/2)+1} & m_{(n/2)+1,(n/2)+2} & \cdots & m_{(n/2)+1,n} \\
m_{n/2+2,1} & m_{(n/2)+2,2} & \cdots & m_{(n/2)+2,n/2} & m_{(n/2)+2,(n/2)+1} & m_{(n/2)+2,(n/2)+2} & \cdots & m_{(n/2)+2,n} \\
\cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\
m_{n,1} & m_{n,2} & \cdots & m_{n,n/2} & m_{n,(n/2)+1} & m_{n,(n/2)+2} & \cdots & m_{n,n}
\end{bmatrix}
$$

Mathematical Applications

- Time Series (ARIMA, Smoothing and Moving Averages Methods).
- Markov Chains and Bayesian Models
- Monte-Carlo Simulation
- Structured Matrices, namely, Toeplitz, Hankel, Vandermonde, Cauchy.

Concluding Remarks

- Affinity and congruency derived from breaking constraints due to data asymmetry.
- Model is statistically and mathematically valid.
- Various mathematical applications.
- Performance Optimization driven by Proportionate, Integrative, and Derivative PID Reliability Control options.