Business and Application Based Capacity Management

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Pulse 2013
Optimizing the World’s Infrastructure

March 3 – 6
MGM Grand – Las Vegas, Nevada

Turning Opportunities to Outcomes

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  - Goals and Objectives:
  - Metrics Integration
  - IT Service Management Collaboration

Two Capacity Management Challenges:

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Introduction
Background

- What is Capacity Management?
  - Business Capacity Management
  - Service Capacity Management
  - Component Capacity Management

- What is the Capacity Management Information System?
  - Tivoli Data Warehouse as the core of the CMIS

- Why focus on a business and application view of Capacity Management?

- Why integrate the CMIS with other data sources?

- Why collaborate with other IT Service Management disciplines?
What is Capacity Management?

translates business needs and plans into requirements for service and IT infrastructure, ensuring that the future business requirements for IT services are quantified, designed, planned and implemented in a timely fashion

management, control and prediction of the end-to-end performance and capacity of the live, operational IT services usage and workloads

management, control and prediction of the performance, utilization and capacity of individual IT technology components
Capacity Management includes the process framework as well as the organization model and tools architecture.

- **Process Framework:**
  - High-level process overview with a focus on Business Capacity Management (BCM) and the interaction with Service Capacity Management (SCM), and Component Capacity Management (CCM)
  - Process Design: Including methodology descriptions and supporting process flows
  - Sub-processes: Six key activities and tasks
  - Linkages: Key linkages with external processes and required inputs/outputs
  - Current process capability gap analysis (optional)

- **Organization Model and Staffing:**
  - Recommended organization and staffing model for Capacity Management team
  - Key roles and associated skills required to support the execution of the process
  - Responsibilities associated with each role in context of the process activities and tasks
  - RACI diagram mapping roles to key process activities and tasks (optional)

- **Tools / Technology Strategy and Architecture:**
  - Summary of metrics and tool requirements (data collection for monitoring, analysis, forecasting, modeling, reporting, integration with other data sources, etc.)
  - A proposed set of optimal capacity and performance management KPIs/metrics, including recommendations on data collection and setting of alerting thresholds
  - Assessment of the effectiveness of the current tool suite in addressing these requirements
  - Tools and metrics gap analysis
  - Options for positioning of current tools, filling gaps in toolset coverage, and a recommended approach for moving forward
  - Roadmap for implementation of tools strategy
What is the Capacity Management Information System?
Specialized reporting is handled by the TDW and can feed the CMDB.

Here, ITCAMs produces capacity feeds for clustered databases:
- DB2
- Oracle RAC
- Sybase
- MS-SQL

Custom scripting for Informix makes the clustered database reporting complete.
Goals and Objectives

- The main goal of the collaboration and metrics integration is to ensure the business based performance and capacity requirements are met.

- Mapping critical business applications to the infrastructure server components is essential:
  - IT Service Management collaboration
  - Metrics Integration – linking diverse data sources
Metrics Integration

- **Tivoli Data Warehouse (TDW)** is an ideal core data repository for a Capacity Management Information System (CMIS) tools architecture to enable an expert integrated set of solutions that merge:
  - Business,
  - Financial (capex and opex), and
  - Capacity and performance requirements.

- **These custom solutions utilize:**
  - Capacity and performance historical data in the CMIS (ITM/TDW),
  - Incidents in the Configuration Management DataBase (CMDB),
  - Auto-ticketing of incidents,
  - Application to infrastructure mapping data, and
  - Business driver metrics
Rightsizing LPARs and optimizing frames (Opex) results in CPU and frame savings.

Capex avoidance results as unneeded frames are reused or repurposed.

This methodology has saved millions at IBM and their customers.
The CMIS used for both real time performance tickets as well as capacity planning alerting.

This system pre-alerted to resource related outages so well the real-time performance tickets generated fell from hundreds to 2 or three per month.

Hundreds of servers showing non-green on CPU, Memory, IO, etc. were resolved quickly.
The Business Driven Forecasting technique requires data sources for Business Data, Service Data, and Component Data.

Leveraging SPSS allows for integration of multiple and varied data sources, statistical analysis, and a presentation layer for communication and reporting.
IT Service Management collaboration

- Defining interfaces between these multiple data sources involves collaboration from an IT Service Management perspective, linking:
  - Capacity Management with
  - Event Management,
  - Incident Management,
  - Configuration Management to enhance the services provided in support of a midrange server environment.

- Further enhancements can also involve:
  - Demand Management,
  - Change Management, and
  - Performance Engineering
Cognos Development Reporting Project:

Approach
Approach: Requirements

- **Deliverable:** Customer reporting enhancements – IBM to guide the customer for reporting requirement’s to manage the customers large server farm.

- *The IBM Cognos development team created reports to manage large server farms with multiple operating systems.*

- **Phase 1 requirements created Cognos customer reports cloned from the current Brio reports.**

- **Phase 2 added customer report updates to the phase 1 developed IBM customer Cognos reports. The customer submitted 200 PTR’s with enhancements and changes to the reporting.**

- **These changes would allow for ease of use within the customers user base.**
Approach: Release Information

- **Production Cognos:**
  - Cognos 8.4 base release.
  - Models are the ITM 6.2.2 Capacity and Performance design.
  - TCR 1.3.
  - Tivoli Data Warehouse.

- **In progress Cognos:**
  - Cognos 8.4.1 base release.
  - Models are the ITM 6.2.3 Capacity and Performance design
  - TCR 2.1.1
  - Tivoli Data Warehouse
**Approach: Solution**

- The Cognos team developed 27 reports by operating system including each area (CPU, Memory, Disk, & Network) for capacity planning, performance, and exception reporting based from the Brio code and further enhanced with customer input.

- The team created on-line enhancements to Cognos to give the customer the ability to filter reports by applications and/or servers for their specific user departments.

- The team further included new report metrics and report format changes.

- The team closed a total of 900 PTRs: 700 PTRs during Phase 1 and 200 PTRs during Phase 2. These resulted in over 1000 changes to the reporting system.

- The team opened 15 PMRs to Tivoli.

- The below matrix shows the reports that were designed for Performance and Capacity Management teams in order to better review large server farms periodically and ensure important metrics were co-located.

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Virtualized Host</th>
<th>LPAR/Rightsizing/CPU</th>
<th>Memory</th>
<th>Disk</th>
<th>IO</th>
<th>Network</th>
<th>Other</th>
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<tr>
<td>AIX</td>
<td>AIX - pSeries Frame Utilization</td>
<td>AIX - Capped Rightsizing Report</td>
<td>AIX – Memory Report</td>
<td>(contained in UNIX reports)</td>
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<td>AIX – System p Rightsizing Savings report</td>
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<td>VMWARE</td>
<td>VMware ESX Host Capacity Summary</td>
<td>VMware Guest Utilization Summary and Right sizing</td>
<td>VMware Cluster Average Memory Daily Trend</td>
<td>VMware ESX Host Disk Report</td>
<td>VMware ESX Host Network Report</td>
<td>VMware ESX Host Movement Report</td>
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<td>Cluster CPU Daily Trend</td>
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<td>Intel Stand-alone</td>
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<td>INTEL Logical Disk Exception Report</td>
<td>INTEL Network Detail Report</td>
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<td>UNIX – Network Statistics</td>
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<td>(contained in UNIX Reports)</td>
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### Solution: Cognos Report Design Process and End-Product Features

- **Report Design Process**:
  - Two Cognos report developers managed all report changes and designs.
  - Capacity team lead assisted with report design and UAT.
  - Capacity team lead managed all time frames for completion.
  - Versioning into source control designed to manage each phase of report source code.
  - Multiple phases have been developed to include many enhancements and changes.

- **Report Design End-Product**
  - Designed to be 'like' out of box reporting with prompts.
  - Reports include detailed and summary reports.
  - All reports designed the same to allow for ease of use across all platforms.
  - Reports contain multiple queries so all specific metrics are included into one report.
  - Models changed to include application mapping changes for customer data.
  - Initial reports are weekly reports utilizing hourly data.
  - *Ad hoc* and specialty reports developed and included with weekly reports.
  - Appendix pages added to all reports.
  - Column organization designed so all columns and metrics are in specific order for ease of use.

### CMR018 - AIX - Capped Rightsizing Report

<table>
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<tr>
<th></th>
<th>Avg CPU Busy %:</th>
<th>Avg Time Over Threshold (&gt;80) %:</th>
<th>Max CPU Busy %:</th>
<th>Avg CPU Count</th>
<th>Max CPU Count</th>
<th>Avg IO Wait CPU %:</th>
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<td>0 - 80</td>
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Cognos Development Reporting Project:

Results
Results: Benefits

- Cognos reporting has the capability to manage large server farms by providing reporting by operating systems. This customization project had the following impact:
  - **Decreased Manual Effort:** Capacity and performance no longer has to write and run their own reports. Time can now be spent researching and reviewing technical problems due to the enhanced automation of the reports.
  - **Custom Reporting for Cost Savings** – Reports were designed for rightsizing LPARs.
  - **Exception Reporting for Closed Loop** – Closed Loop Ticketing process is supported by custom exception reporting.
  - **Custom Time Series in Reporting** – Data is used for standard reporting at the hourly level, providing more granularity than the out-of-box reports.
  - **Customized Prompts for Time Selection** – Choice of an hour or range of time can now be done in the on-line interface.
  - **Migrating from a sunset product (Brio).**
  - **Scalable reporting**

These reports provide a level of automation and intellectual capital that should be reused across IBM and our Tivoli Customers.
Results: Challenges

- The customer was a little challenging.
Results: Customer Application Mapping Definition:

- **Application Mapping Description:**
  - The customer requested that Cognos custom reports to include application mapping into the reporting. The metrics that are used in multiple reports.
  - Most of the metrics used are for the businesses reference.
  - The metrics for the application mapping is taken from the IBM TSRM database and transposed into a Excel spread sheet. This spread sheet is then imported into a DB2 table by the DBA on a periodic basis.
  - The original 8.4 Cognos models utilized application mapping in the dimensions tables and some of the query subjects.

- **Application Mapping Metrics:**
  - Environment – Production, Test, Development, etc.
  - Application Name – Primary application as defined on the servers, for example Websphere Marketing
  - Virtual – If the server is virtualized or standalone
  - OS Name – The name of the operating system (for example Windows 2003)
  - Platform – Whether the application runs on xSeries, pSeries, or Solaris hardware.
  - Application ID – Used in application definitions (as shown to the right)
Business Driven Forecasting and Analytics:

Approach
Approach for Business Driven Forecasting and Analytics: Requirements

Executives often want to know how a change in their business will impact IT demand and if they have sufficient capacity to satisfy the demand:

- **We are bringing in four more hospitals over the next 6 months. Do we have enough capacity in our infrastructure?**

- **With the new healthcare laws we expect significant growth in the number of clients. Do we have enough capacity to handle the peak enrollment period?**

- **We are shifting our bank tellers to an automated system that will allow us to increase the number of customers we serve from our branch locations. Will we have enough capacity in our infrastructure to handle the increase in customers using new video, audio, and scanning technology?**
Business Driven Forecasting is a technique that can help address these questions.

Language difference between business and IT

- When the business launches a marketing campaign, the IT organization should be informed to take appropriate measures, for instance to increase the number of application servers because more customers will connect with the internet environment.

- The business cannot be expected, however, to tell the IT which components should be adjusted and how much. They even might not know at all which components are involved. For the same reason it will be difficult for IT to understand how a business statement like “we expect 30% more internet visitors” translates to more CPU, memory, disk space, etc.

- Without the ability to use business plans in Capacity planning, one can only use historical information to forecast the future demand. This is essentially the same as “driving a car while only using the rear view mirror”.

- Raises the level of accuracy and objectivity associated with forecasting IT resource usage
- Minimizes associated risks
- Helps to better meet customer service and business requirements
- Helps Forecasting Specialists get in step with the business leaders
- Expands the scope of traditional Component Capacity Management by combining both technical and business issues, preferences and practices of the enterprise
A Business Driven Forecasting methodology consists of eight basic steps:

1. Identify the major applications of interest to be included in the analysis
2. Identify the candidate business metrics used in business planning and operational measurements, and map these metrics to the selected applications and associated business transactions
3. Quantify the business driver values and associated IT performance metric levels over time
4. Evaluate the correlations between business drivers and IT metrics, and identify correlated sets of drivers and metrics
5. Develop a regression curve to define the relationship between the selected business drivers and IT metrics
6. Define the forecasted values for the selected business drivers
7. Translate the business driver forecasts into IT metric levels as a function of time
8. Assess the capability of the existing infrastructure to support forecasted business driver levels and identify infrastructure configuration changes required to achieve IT metric service level targets over time
Approach for Business Driven Forecasting and Analytics: Solution

- Prior techniques have relied heavily on manual data entry and analysis using spreadsheet and basic statistical functions for correlation and coefficients.

- Recent Capacity Management services solutions are using an innovative Use Case based approach to address stability, performance, and scalability objectives:

- The solution involves development of a set of re-useable SPSS Models to formalize the:
  - Collection of multiple and varied data sources
  - Integration of these data sources into a set of SPSS streams
  - Statistical analysis for a variety of Use Cases
  - Presentation of results

- One of the Use Cases is to “Estimate the impact of planned business change” based on Business Driven Forecasting techniques:
  - **Goal**: Determine, via the SPSS Capacity Model, what the expected impact is with respect to resource usage in an application chain when a change in usage of the chain is considered.
Business Driven Forecasting and Analytics:

Results
Results using traditional methods showed an acceptable correlation between Number of Visits and CPU Utilization

- Analysis validated that the number of visits is correlated with the server CPU utilization levels
  - “Good” correlation for full month of data
  - Weekly data demonstrates clear and reasonably consistent correlation
  - Correlations generally (but not always) somewhat stronger for Monday through Friday data
  - Keep in mind that we have a small number of data points per week where the server CPU utilization is noticeably higher than anticipated given the number of visits (valid points or outliers?)

- Conclusion: Number of visits should be a valid predictor of server CPU utilization levels
  - This is not to say that number of visits is the only valid, or the best, predictor of server CPU utilization
  - May also want to consider visitor minutes, which measures the total number of minutes the website is visited regardless of the number of visitors
  - This metric may provide a better correlation with the peak CPU utilization levels?

Correlation between number of visits and CPU utilization

Server ABC: 0.79
The next step was to project CPU Utilizations based on the forecasted business volumes

- Focus is on CPU utilization for server ABC
- Business driver used as basis for projected CPU utilization: Number of visits
- Model for CPU projection based on ~95th percentile peak hour average CPU utilizations
- Server CPU utilization threshold level: peak hourly average of 70%
- Business volume (number of visits per hour) growth ranging from 2.5% to 25% per quarter
- Application profiles for March are consistent with and representative of the forecast period
- No major environmental changes which impact server CPU utilization levels
Modernized traditional Capacity Management techniques:

- Leveraged SPSS Modeling to manage and analyze relationships of multiple data sources:
  - Business metrics – candidate drivers of IT resource consumption
  - IT component usage metrics:
    - Capacity: cpu, memory, disk, bandwidth
    - Performance: response time, throughput, latency
  - Event and incident metrics – capacity shortage related:
    - Cpu, memory, io, buffer pools, threads
- Apply SPSS Statistics and develop algorithms:
  - Application Profile of workload characterization – time series based patterns of behavior
    - Seasonal load (hourly, daily, weekly, monthly, annually)
    - Event based peak load (marketing campaigns, M&A
    - Major changes that will impact capacity, performance, and scalability
  - Impact of changes over time
Goal: Determine, via the Capacity Model, what the expected impact is with respect to resource usage in a application chain when a change in usage of the chain is considered.

Example: Use case 2: Estimate impact of planned business change
Maximum peak growth possible in Application abc123 and xyz456 usage is 90%.

The Capacity Model is excellent:
Predicted CPU values (red) are very near the actually measured CPU values (blue).
Predictions are made with abc123 and xyz456 activity as input parameters.

The Capacity Model for CPU showing the predictors and their coefficients

- Application abc123 * 0.00001445 +
- xzy456_Agent * 0.0001091 +
- xzy456_OfficeUser * 0.0001622 +
- Xzy456_OperationUser * 0.0002455 +
- 0.1014

Growth of 90% in abd123 and xyz456 peak hour activity leads to 100% CPU usage
Business Driven Forecasting and Analytics: Future opportunities

- Modernize traditional Capacity Management techniques using new data, tools, and analytics capabilities:
  - Develop industry templates
  - Productize
  - Automate
  - Align Business Analytics with Infrastructure Analytics

- Leverage Capacity Planning functions in Tivoli’s Smart Cloud Monitoring (SCM)

- Expand on the library of reusable SPSS models
Special Thanks.

- Thanks to the following individuals:
  - Chris Malone
  - Harriet von Moltke
  - James Jackson
  - Joseph Caldwell
  - Kinjal Patel
  - Maris van Sprang
  - Mike Scully
  - Russ Egeland
  - Wayne Peterson

- References
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  - Business-driven capacity planning for AIX, AIX update #111, January 2005
  - Business-driven capacity planning for AIX: concepts and principles, AIX Update #109, November 2004:
Approach: Solution – Phase 1

- **Phase One: Initial Report Production**
  - Rewrite the Brio code utilizing COGNOS.
  - Update the reports with customer requirements for filtering and prompting to allow for individual customer departments requirements.
  - Include metrics from the customer provided table for applications and sever description definitions.
  - New on-line changes would allow for individual customer departments to filter for only specific servers and LPARs.

Sample COGNOS report exported to Excel
Approach: Solution – Phase Two.

- **Phase Two: Updating Reports to Customer Requirements**
  - Update all reports to include additional data requirements and refresh production reports.
  - Install customer-requested changes data items and formats to allow for more meaningful metrics to the individual departments.
  - 200 PTRs closed.

Sample COGNOS report exported to Excel
Solution - Major Customization Points: Prompting and Dynamic Thresholds

- Prompt pages developed to allow for:
  - Scheduling of reports.
  - Reducing refining to within an hour.
  - Detailed metrics allowing reduction to specific areas.
  - Scheduling and prompts for detailed metrics to allow users to reduce the reporting to specific areas.

- Dynamic thresholds have been built into report prompt pages and report columns which allow:
  - The ability to be changed to meet customized requirements.
  - Management at the prompt page.
  - Thresholds have been built into report prompt pages and report columns.
  - The ability to change to meet customer department adjustments. The threshold metrics can be at the prompt page.
Solution - Major Customization Points: Prompting and Dynamic Thresholds

- All prompt metrics are displayed on the report headers. This allows for:
  - Inclusion and elimination of week days and week ends.
  - Calculated shift metrics for flexibility.
  - Thresholds from prompt are displayed with color coded metrics in the report header.
  - Date count added to report header for ad hoc reporting. Displays on number of days used in the report.

- Report Output is designed for:
  - Scheduling and emailing to users.
  - Save a report copy in TCR for reuse

- Report Appendix is added:
  - Consistently to all reports.
  - Comes with report overview.
  - Includes column definitions and often formula definitions.
Results: Future

- **Cognos Reports Production and Development:**
  - Monthly reports with charts and metrics - Development stage.
  - WAS (Web Application Systems) with charts and metrics - Development Stage.
  - Ad hoc reports in production and development stage.
  - SPE weekly reports.

- **Additional Scheduled Cognos Projects:**
  - Update out of box reports with weekly report prompts.
  - Add drill through to specific reports.
  - Add charts and graphs to specific reports.
  - Add trending and forecasting to specific reports.
  - Add dashboards to specific reports.
  - Upgrade to TCR 3.1.1 and Cognos 10.

Next steps with the Tivoli team?

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<tr>
<th>Project # Order</th>
<th>TASK NAME</th>
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<td>Ongoing Projects</td>
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<tr>
<td>Project # 001</td>
<td>SPE Reports</td>
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<td>Project # 002</td>
<td>6.2.3 Application Mapping Model Change</td>
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