Strategy for IT Infrastructure Stability in Heterogeneous Environments

The purpose of this paper is to provide a solution to build a strategy for IT infrastructure stability in heterogeneous environments involving both mainframe and midrange.

This paper is based on a consulting engagement involving six core business processes in the workplace savings business unit and associated IT portfolio (application, middleware and IT infrastructure).

It details a strategy on how customers can handle the future data growth volumes, sustain IT Infrastructure stability and carry out “forward consolidation” in complicated heterogeneous environments. The long-term goal is to successfully implement the recommendations that would help the customer achieve business growth and address the business and IT objectives of risk proofing, operational efficiency, service levels, business and industry alignment.
About the Author(s)

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Strategy for IT Infrastructure Stability

When we stepped into John’s London office, he was worried and there were clearly a few pressing challenges he needed to deal with. A few minutes into the conversation, it was obvious that his current IT infrastructure portfolio remained the biggest cause of concern. The CIO has clearly conveyed that John has to fix the current IT Infrastructure issues as well as to stabilize the application portfolio so that there are no disruptions to the business in the future.

At TCS, we have taken on the challenge and have embarked on the assignment to stabilize the IT Infrastructure portfolio. This paper elaborates how to stabilize large, complex, heterogeneous IT infrastructure environments that supports a wide variety of applications running on both mainframe and mid-range portfolios.

Approach for Building the Strategy

TCS adopted a 4-phased approach towards building the strategy for IT Infrastructure stability in heterogeneous environments:

- Discovery Phase
- Modelling Phase
- Opportunity Identification Phase
- Roadmap and Project Identification Phase

The following table elaborates the detailed steps used in each phase:

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discovery</td>
<td>Key activities in the discovery phase are as follows:</td>
</tr>
<tr>
<td></td>
<td>- Understand the business applications and the associated infrastructure platforms</td>
</tr>
<tr>
<td></td>
<td>- Understand the technical stack of business applications.</td>
</tr>
<tr>
<td></td>
<td>- Understand the business process workflow across applications.</td>
</tr>
<tr>
<td></td>
<td>- Understand the interface for the applications.</td>
</tr>
<tr>
<td></td>
<td>- Understand the underlying infrastructure (server, storage, and disk) components for business applications.</td>
</tr>
<tr>
<td></td>
<td>- Understand the business drivers for the processes.</td>
</tr>
<tr>
<td></td>
<td>- Understand the business growth drivers and projections.</td>
</tr>
<tr>
<td></td>
<td>- Understand throughput requirements and other constraints / SLAs.</td>
</tr>
<tr>
<td></td>
<td>- Understand the current ongoing and planned initiatives / projects.</td>
</tr>
<tr>
<td></td>
<td>- Collect and understand the pain points from business and IT stakeholders.</td>
</tr>
</tbody>
</table>
### Key activities in the modelling phase are as follows:
- Model the baseline application workload (batch and online) behaviour and baseline utilization of infrastructure resource elements (server CPU, storage, disk) against the current business volume.
- Predict/forecast the workload behaviour and resource utilization pattern against the business growth and transaction volume drivers using appropriate correlation factors.
- Come up with the heat map summary detailing the hotspots with respect to scalability for addressing the growth scenario.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Modelling** | Key activities in the modelling phase are as follows:  
- Model the baseline application workload (batch and online) behaviour and baseline utilization of infrastructure resource elements (server CPU, storage, disk) against the current business volume.  
- Predict/forecast the workload behaviour and resource utilization pattern against the business growth and transaction volume drivers using appropriate correlation factors.  
- Come up with the heat map summary detailing the hotspots with respect to scalability for addressing the growth scenario. |
| **Opportunity Identification** | Key activities in the opportunity identification phase are as follows:  
- Determine the inefficiencies in the application and infrastructure landscape with respect to non-functional aspects to address the growth scenario:  
  - Stability  
  - Performance  
  - Availability  
  - Reliability  
- Identify various potential optimization opportunities and remedial measures in both the application and infrastructure landscape to address the analyzed hotspots.  
- Define the target state requirements. |
| **Roadmap and Project definition** | Key activities in the roadmap and project definition phase are as follows:  
- Convert the identified remedial measures into initiatives  
- Define the projects based on their priorities in alignment with the business objectives.  
- Categorize the projects as short term or long term based on benefits and ROI.  
- Derive the critical path sequence containing a list of prioritized projects.  
- Define the implementation road map. |
Environment Overview

Mainframe Technology Stack

The technology stack of the mainframe environment is given below:

<table>
<thead>
<tr>
<th>Operating System</th>
<th>z/OS V1R8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transaction Manager</td>
<td>CICS TS V3.1, IMS/TM V10</td>
</tr>
<tr>
<td>Database</td>
<td>DB2 for z/OS V8.1, IMS/DB V10</td>
</tr>
<tr>
<td>System Monitors</td>
<td>Omegamon for z/OS</td>
</tr>
<tr>
<td>Performance Monitors</td>
<td>Tritune V4.0, CA-MICS</td>
</tr>
<tr>
<td>Programming Languages</td>
<td>IBM Enterprise COBOL, PL/I, CA/Easytrieve, Assembler</td>
</tr>
</tbody>
</table>

Midrange Technology Stack

The technology stack of the midrange environment is given below:

<table>
<thead>
<tr>
<th>Operating System</th>
<th>Windows</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Server</td>
<td>Websphere Application Server V6.0.2.27 on Windows 2003</td>
</tr>
<tr>
<td>Database Server</td>
<td>DB2 UDB 8.1 on Windows and DB2 UDB 9.5 on Windows</td>
</tr>
<tr>
<td>Business Process Management Software</td>
<td>Websphere Process Server V6.0.2.4</td>
</tr>
<tr>
<td>Performance Monitors</td>
<td>CA-Wily Introscope V9.0.5</td>
</tr>
<tr>
<td>Programming Languages</td>
<td>Java, JSP, C/C++</td>
</tr>
</tbody>
</table>

Business Process Overview

The following six business processes was the key focus for this stability assessment:

<table>
<thead>
<tr>
<th>Business Process</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Business Process 1 (BP1)</td>
<td>This business process deals with enrolling new members in the pension scheme.</td>
</tr>
<tr>
<td>Business Process 2 (BP2)</td>
<td>This business process deals with the contributions made by the employers and the members of the pension scheme.</td>
</tr>
<tr>
<td>Business Process 3 (BP3)</td>
<td>This business process deals with the customer’s personal data changes.</td>
</tr>
<tr>
<td>Business Process 4 (BP4)</td>
<td>This business process deals with cancelling the pension scheme within the cooling period.</td>
</tr>
<tr>
<td>Business Process 5 (BP5)</td>
<td>This business process deals with authorizing the money-out process for the refund.</td>
</tr>
<tr>
<td>Business Process 6 (BP6)</td>
<td>This business process refers to the means by which work-related communication is stored electronically and subsequently assigned to the work queue to be used sooner or later for audit purposes.</td>
</tr>
</tbody>
</table>
## Applications Overview

The above six business processes were supported by the following applications:

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mainframe Applications</strong></td>
<td></td>
</tr>
<tr>
<td>Application 1 (AP1)</td>
<td>Plays a central role in pension and investment business. Its purpose is to provide flexibility in products to meet customer needs, and hence must have the capability to launch new products quickly to market.</td>
</tr>
<tr>
<td>Application 2 (AP2)</td>
<td>Identifies the contract numbers for contributions and premiums for Group Pension Schemes in the contribution schedule, which has been introduced through application 9 (Ap9). It matches the contributions to the policy numbers for the people whose pay has been deducted.</td>
</tr>
<tr>
<td>Application 3 (AP3)</td>
<td>Gives an accurate and up-to-date view of customer details and their relationship with the products.</td>
</tr>
<tr>
<td>Application 4 (AP4)</td>
<td>Controls the Company Direct Debits between the application 9 (Ap9), application 1 (AP1) and application 6 (AP6).</td>
</tr>
<tr>
<td>Application 5 (AP5)</td>
<td>Responsible for producing a number of standard documents that are sent to designated recipients.</td>
</tr>
<tr>
<td>Application 6 (AP6)</td>
<td>Used to make payment to customers, suppliers, employees, and so on, through cheque or direct credit and posts the corresponding payment movements to the general ledger (account the flow of money).</td>
</tr>
<tr>
<td><strong>Midrange Applications</strong></td>
<td></td>
</tr>
<tr>
<td>Application 7 (AP7)</td>
<td>Provides a web interface to allow the pension scheme administrators and company payroll/HR staff to manage pension contribution and new member submissions.</td>
</tr>
<tr>
<td>Application 8 (AP8)</td>
<td>Primarily used for registering the new work and managing the pending tasks. Allow users to submit requests to update application 3 (AP3) by feeding through application 1 (AP1).</td>
</tr>
<tr>
<td>Application 9 (AP9)</td>
<td>Combined batch and online web application for processing and administering payroll information for different organizations. Employers utilize this application to provide pension contribution information for members and employers of a scheme.</td>
</tr>
<tr>
<td>Application 10 (AP10)</td>
<td>Uses a special process, by which, unit totals and values across Life and Pensions investment funds are managed</td>
</tr>
<tr>
<td>Application 11 (AP11)</td>
<td>Allows customers, who are registered on security framework, to view and enquire about their policy, investment and contribution information (requesting unit and benefit statements) and carry out some self-servicing administrative facilities on their implemented policies online.</td>
</tr>
</tbody>
</table>
### Application

<table>
<thead>
<tr>
<th>Application</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application 12 (AP12)</td>
<td>Online web-application used for modifying, viewing and maintaining customer’s personal and/or contact details which are maintained by application 3 (Ap3). The application use web services supplied by the SOA architecture to retrieve and modify these details.</td>
</tr>
<tr>
<td>Application 13 (AP13)</td>
<td>Provides users (employers, trustees, intermediaries, payroll administrators and staff) with the facility to obtain information from an existing scheme and to perform selected functions on that scheme.</td>
</tr>
<tr>
<td>Application 14 (AP14)</td>
<td>Administration console that is designed to manage member scheme data.</td>
</tr>
<tr>
<td>Application 15 (AP15)</td>
<td>Used to load the details of the customers who wish to join their employer’s pension scheme. Primary purpose is to load bulk data thereby significantly reducing the processing cost and time of loading new business data.</td>
</tr>
<tr>
<td>Application 16 (AP16)</td>
<td>Enables the querying and limited update of transactions on the database.</td>
</tr>
<tr>
<td>Application 17 (AP17)</td>
<td>Used for triggering and subsequently accessing reports for Occupational Rules business on AP1. It is used by the internal staffs who trigger scheme level reports.</td>
</tr>
</tbody>
</table>

### Data Extraction Process

#### Data Extraction for Mainframe Applications

In order to assess the current performance levels of the mainframe applications:

- CPU utilization data and the response time of the online transactions are extracted using the CA-MICS reports for the specified online window.
- CPU utilization data and the response time of the batch jobs are extracted using the CA-MICS reports.

#### Data Extraction for Midrange Applications

In order to assess the current performance levels of the midrange applications:

- Average response time and CPU utilization data of all the midrange applications are collected using CA Wily Introscope.
TCS adopted a top-down analysis approach for this IT Infrastructure stability assessment starting from business processes, followed by application and subsequently the underlying IT Infrastructure on the mainframe and mid-tier platform. The analysis approach was twofold; the first step was to analyze the current behavioural pattern and second to project the target state behavioural pattern.

The current application behaviour was analyzed from the following four dimensions:

- CPU resource utilization
- Memory resource utilization
- Response/turnaround time
- Stability/quantum of failures analysis

The outcome of this step helped to:

- Determine the current application behaviour
- Determine the business workload currently being processed
- Identify/infer application/infrastructure design bottlenecks

Based on the above analysis, the applications can be categorized into 4 broad categories, namely:

- **C1**: Current stability and performance behaviour and future readiness is low
- **C2**: Current stability and performance behaviour is high, however the future readiness is low
- **C3**: Current stability and performance behaviour is low and future readiness is high
- **C4**: Current stability and performance behaviour is high and future readiness is high
Based on the current behaviour and business growth projections, we analysed the projected application behaviour. An analytical scalability forecast model was built using the calibrated linear regression and queuing principles to analyze projected behaviour. This modelling helped in categorizing applications into quadrants (as shown below). These quadrants reveal the current and projected behaviour of various applications in terms of preparation to meet business growth.

The following are the findings of the current state analysis:

- There is a need to stagger the workload processing on mainframe over a period of days because the average elapsed time of allocating contributions to an individual account increases with an increase in number of contributions. This will have a cascading effect on the overnight batch elapsed time as well.
- In Q2 2012, there would be an increase in number of contributions by 47%, which will result in an increase in the batch window duration by 78 minutes i.e. the batch window which currently ends at 7 AM will end in the projected situation at 8.18 AM.
- Owing to high memory consumption, regular event processing will be insufficient for large workload volumes. Issues have been observed when AP7 is trying to process more than 15,000 records. Hence, changes are required in the application before Q4 2012.
- There are known high resource consumption issues in application-8. Before Q4 2012, the in-flight project on WPS upgrade and platform migration should be pursued.
- In the light of increased workload volumes, a capacity planning exercise and subsequent provisioning of IT infrastructure has to be carried out for the applications supporting the six business processes before auto-enrolment starts in Q4 2012.
- Messaging exchange infrastructure has to be upgraded before the auto enrolment starts owing to increase in workload volumes.

**Broad Inferences**

The following are key inferences related to anticipated “break points” for applications specific to the 6 business processes:

- **Critical Transaction Outages**: There are some critical, high frequency and high volume applications which face outages fairly regularly.
- **Un-supported IT Infrastructure Environment**: Some applications, including a few critical ones, are running on unsupported hardware or operating system versions and this presents a major risk both from a business continuity perspective as well as from an overall management and control perspective.
- **Application Siloed Infrastructure**: The IT infrastructure is largely differentiated based on applications, there are different infrastructure solutions for different applications belonging to the 6 business processes.

There is a significant amount of spending involved in developing, maintaining and operating multiple infrastructure solutions.
Technology Diversity: Given the siloed nature of the infrastructure setup, there is a lack of common enterprise-wide standards for infrastructure design.

Also, all three storage architectures coexist today i.e., DAS, NAS and SAN even within a single application's infrastructure thus leading to management challenges.

Need for Future Proofing: The infrastructure landscape has evolved over time both organically and inorganically and supports a set of monolithic application islands. This clearly presents an opportunity to future proof the infrastructure landscape through strategizing and planning.

Guiding Principles for Target State IT Infrastructure

It is clear from the analysis that the current IT Infrastructure design and management is siloed by applications. This has resulted in stability issues, multiple pockets of under-provisioning and management complexity. It is important that the infrastructure design and management for such large, complex heterogeneous environments should follow the key architecture principles listed below:

**Principle 1: Reduce IT complexity**

**Rationale:**
- Reduction of IT complexity will allow lower ‘Total Cost of Ownership’
- Consolidation of infrastructure will continue to keep TCO down by streamlining the support and administration effort

**Implications:**
- Elimination of redundant infrastructure components
- Rationalization of infrastructure to achieve optimal cost to value

**Principle 2: Exploitation of managed, shared infrastructure promotes cost-effective and timely solutions delivery**

**Rationale:**
- Reduction of risks, development and operational costs will help to keep a lower TCO
- Speedy product time-to-market which helps to maintain a competitive advantage over time

**Implications:**
- Implementation will demand a proactive infrastructure program to allow usage by multiple products and services
- Exploitation of the existing infrastructure services and skills to eliminate overbuilding or replication of infrastructure capability
**Principle 3: Business product and technology strategies must be aligned**

**Rationale:**
- Cohesive product and technology strategies to enter new markets rapidly

**Implications:**
- Technology and product planners need to collaboratively plan for all the new initiatives

**Principle 4: Timely delivery, reliability, and future proofing will be hallmarks of the IT infrastructure environment**

**Rationale:**
- Timely delivery of product solutions is critical to success in a rapidly evolving and competitive market

**Implications:**
- Exploitation of standard infrastructure and adherence to published integration design models

Having a standardized set of platforms that support diverse application requirements will allow the infrastructure to be better managed and meet emerging needs of the enterprise (more adaptable and flexible as a whole).

**Strategy for the Target State IT Infrastructure**

The strategy is to move towards a shared technology framework, which adequately addresses current state issues stemming from an application-siloed infrastructure. The key features of the recommended shared technology framework are:

- **Alignment with Service Classes:** The target state will have a separate infrastructure design corresponding to each of the service demand classes

- **Layer-wise Design:** The design will include the processing/consumption patterns and non-functional requirements for each of the layers (web layer, application layer, and database layer).

- **Standardized Technology:** The technology for each service class and layer will be based on formally defined standards.

- **Supported Technology:** Only vendor-supported technologies will be used in the target environment for each service class and layer.

- **Scalable Design:** The design will take into consideration the patterns/paradigms in each layer to ensure the scalability to meet future growth.

- **Optimal Leverage-based Design:** The design will ensure that capacity resources are not locked up in specific silos and are sharable across components in specific service classes.

- **High Availability Design:** The design will take into consideration the business criticality of service demand as well as price/performance considerations to ensure high availability
The table below describes the service classes to which the target infrastructure will be aligned:

<table>
<thead>
<tr>
<th>Service Class</th>
<th>Business Function Category</th>
<th>Service Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service Class 1</td>
<td>Customer facing functions, Functions critical to revenue generation</td>
<td>24x7 scheduled, 99.9% availability (&lt;45 min/mo.), RTO = two hrs.; RPO = zero hrs</td>
</tr>
<tr>
<td>Service Class 2</td>
<td>Less critical revenue generation functions</td>
<td>24x6-3/4 scheduled, 99.5% availability (&lt;3.5 hrs/mo.), RTO = 8-24 hrs.; RPO = four hrs</td>
</tr>
<tr>
<td>Service Class 3</td>
<td>Departmental functions, Enterprise back-office functions, Dev/Test environments</td>
<td>18x7 scheduled, 99% availability (&lt;5.5 hrs/mo.), RTO = three days; RPO = one day</td>
</tr>
</tbody>
</table>

**Roadmap and Project Definition**

The purpose of a roadmap is to provide an overview of the implementation process. This is useful for anyone who will be affected by the implementation and for executive management who will need this higher-level perspective. In order to create the roadmap, each of the project/action is typically reviewed and classified by the approximate target time period for completion.

The high-level roadmap is created by considering the following:

- Business priorities
- Solution feasibility
- Cost implications

The roadmap is presented in terms of three horizons. The route envisaged is sequential, for example, achieve horizon I, then horizon II, and so on.
Horizon I: Stabilize and Strategize

The focus of the first Horizon-I will be to stabilize the existing infrastructure environment by carrying on with the currently planned activities and business critical projects. All business critical enhancements that need to be implemented in the Horizon I (within 6 months) period will have to be done in the existing environment. Horizon-I also includes the initiative to strategize the stream of activities to lay the foundation to transform the current infrastructure landscape in a phased manner.

- Stabilize IT Infrastructure environments
- Improve heterogeneous workload isolation
- Trim IT Infrastructure portfolio
- Tune performance of database server environments
- Consolidate server environments
- Tune and resize common infrastructure support functions
- Design IT Infrastructure architecture using patterns

Horizon II: Build and Validate Shared Technology Capability

The focus of the Horizon II will be to build and validate the shared technology capability based on the foundation laid by Horizon I.

- Procure the target state technology stake
- Build the target state environment
- Validate the target state environment

Horizon III: Rollout and Leverage Shared Technology Capability

The focus of the Horizon III would be to rollout, operationalise and leverage the new Target State technology environment, based on the preparation done in Horizon II.

Conclusions

In large heterogeneous environments, it is very important to build a strategy to improve the stability, reliability and availability of the IT Infrastructure portfolio in order to meet business needs.

To summarize, this paper has provided a typical approach and strategies for improving IT Infrastructure stability in heterogeneous environments and they involve the following:

- Alignment with IT vision
- Business impact
- Implementation risks
- Technical complexity of the solution
- Cost of implementation
- Additional investments (hardware, software and tools)
- Investments to address contingency
Abbreviations and Acronyms

The following table provides the expansion of abbreviations used in this document:

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Expansion</th>
</tr>
</thead>
<tbody>
<tr>
<td>CA</td>
<td>Computer Associates</td>
</tr>
<tr>
<td>CICS</td>
<td>Customer Information Control System</td>
</tr>
<tr>
<td>CPU</td>
<td>Central Processing Unit</td>
</tr>
<tr>
<td>DB</td>
<td>Database</td>
</tr>
<tr>
<td>DB2</td>
<td>IBM Database 2</td>
</tr>
<tr>
<td>GCP</td>
<td>Global Consulting Practice</td>
</tr>
<tr>
<td>IMS</td>
<td>IBM Information Management System</td>
</tr>
<tr>
<td>ROI</td>
<td>Return on Investment</td>
</tr>
<tr>
<td>RPO</td>
<td>Recovery Point Objective</td>
</tr>
<tr>
<td>RTO</td>
<td>Recovery Time Objective</td>
</tr>
<tr>
<td>SLA</td>
<td>Service Level Agreements</td>
</tr>
<tr>
<td>SOA</td>
<td>Service Oriented Architecture</td>
</tr>
<tr>
<td>TCO</td>
<td>Total Cost of Ownership</td>
</tr>
<tr>
<td>TCS</td>
<td>Tata Consultancy Services</td>
</tr>
<tr>
<td>WPS</td>
<td>Websphere Process Server</td>
</tr>
</tbody>
</table>
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