How to Rise Above the Challenges of Deploying z/VM and Linux on the Mainframe and Thrive

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Client context

... DGTIC ...
• IT service provider for many Québec government offices (125)
  • Already a mainframe shop
  • 5 z/890 + 1 z/800 + 1 G5 on the floor on 3 sites
  • 1 z9-EC dedicated to Linux on z/VM
  • 450+ physical servers (750+ logical) (HP, SUN, pSeries, …)

• DGTIC orientations :
  • Promote the mainframe environment
  • z/VM is the prime choice for future projects
  • Server consolidation is a priority
  • This project is in line with the new « online government » policy
Client context
Project origin

- Initial needs:
  - Must solve many issues with the intermediate platform
    - Many operation systems
    - Many versions
    - Unsupported software
    - Unsatisfactory DR
    - Fast growing (unprecedented growth)
  - Understaffed
  - Need a flexible solution with rapid deployment
- Mainframe is a stable and mature environment
  - Staff is available and at early stages of their careers
  - Solid and well controlled DR process (MVS-like)
- The conclusion: GO with z/VM
The Oracle/DB migration project was the leader for all tasks around the Linux on z/VM environment, including:

- Planning, Controlling and Executing of all the tasks
  - Installation, Cloning engine development, Initial architecture, Training, …
- Communication plan
- Change and risk management
- Senior mentors were brought in (on site) as project manager and system architects.
- In conclusion, the big project was a big melting pot !!! With a project manager who was responsible for everything !!!
Client context
The first steps

- In 2003, beginning of the proof of concept (end-to-end)
  - A mainframe was available (z/800)
  - Installation of the software (z/VM, SuSE Linux, Oracle/DB, WAS, TAM and LDAP)
  - The objective was to prove the functionality and stability of the solution, plus the transportability of the tested applications
    … performance characteristics were secondary
- Spring 2005, first version of the business case which demonstrates benefits (financial, intangibles and human resources)
- Obtained approval from the board of directors: GO
- Autumn 2005, installation of the new mainframe (z9-EC)
- Start of the first phase of the project
  - Oracle/DB migration
• Winning hearts and minds …
• Groups supporting physical servers (intermediate platform) worry about large box virtualization.
• Introduced (- or reintroduced -) S/370 through System z concepts emphasizing guaranteed isolation:
  • Privacy on the box while still sharing resources
  • Virtual storage since 1970
  • Virtualization of CPU, I/O, storage and networks
  • Securing resources through the operating system and RACF
    • Password and rules based authorizations
    • Separation of systems and security tasks by staff in different departments
• z/VM: over 35 years of virtualizing!
Client context
Environment

• 1 z9-EC mainframe with 5 IFLs (~ 3000 mips)
• 5 LPARs
  • Oracle/DB
  • WAS
  • TAM & LDAP
  • Service Zone
  • Lab Zone
• 40 internal networks
• Software
  • SuSE Linux (versions 8 & 9)
  • z/VM v.5.2 +
  • Oracle/DB (versions 9i & 10g)
  • Velocity Software Performance Tools
  • CA products (Automation, Scheduler)
Client context

Environment

- Oracle/DB – Migration Project Status
  - Golden images
  - 165 Oracle instances with 125 Linux virtual machines
  - Growth of over 100 new instances planned per year for the next few years
  - 25 instances in production as part of the government portal
  - For the first migrations (~ 60), on average
    - 1 migration per day (20-25 databases per month)
- WAS – Beginning of the project
- TAM & LDAP – Beginning of the project
- Our current challenge is to synchronize the migrations with date restrictions imposed by our external clients
Technical Challenges
Technical Challenges

As a new and rather large implementation we encountered many technical challenges:

- Improving the technical skills of the project personnel.
- Ensuring the system and applications are safe and secure.
- Guaranteeing that the clients are isolated from each other while still capitalizing on resource sharing.
- Implementing networks that integrate seamlessly into the existing topology and practices.
- Tiers of redundancy based on cost and defined need.
- Need to satisfy the application needs of multiple clients and their data.
Technical Challenges
Training … training … training …

Winning hearts and minds through training …

Challenge: acquiring technical skills

- Over 200 person days of training to staff:
  - Mainframe Systems programmers
  - Unix administrators
  - Security officers
  - Network administrators
  - Architects
  - Analysts
Winning hearts and minds through training ...

- Training sessions with lectures and labs:
  - Architecture seminar
  - z/VM Systems Workshop
  - Linux on the Mainframe Workshop
  - z/VM Networking and Security Workshop
- Briefings for team leaders and management
- Summary presentations to executives
Technical Challenges
Security under z/VM

Challenge: securing the environment …

- Secured z/VM resources through standard commands and products:
  - Logons secured through RACF password protection.
    - Extended password checking with system exit.
  - Minidisk linkage, Vswitch membership, and other points of access controlled by RACF via rules database.
Technical Challenges
Security of Linux on System z

Challenge: securing the environment …

- Secured Linux on z/VM access points by combining:
  - PAM authentication for logins
  - Removal of unneeded packages
  - Usage of secured facilities instead of weaker facilities (SSH versus TELNET)
  - File system changes secured and monitored with TRIPWIRE
  - Ethical hacking attempts to ensure compliance and fortress galvanizing
Technical Challenges
Isolation of clients while still sharing resources

Challenge: Isolate the applications of over 100 offices and agencies

• Now, through the training client understands how System z and z/VM provides storage, CPU and I/O isolation.
  … and VM has been doing it for 35 years …
• Network isolation provided via using unique OSA ports and Vswitch technology.
Challenge: provide high availability access to data and applications.

- Rule: “pay more get more”
- Currently providing physical switch and OSA network redundancy to selected production applications.
- Considering providing redundant LPAR with mirrored databases for selected applications.
- Will possibly evolve to a multi-machine multi-site environment (if needed)
Technical Challenges
Sharing & Cloning

• Capitalizing on z/VM virtual network technology
• Linux on z/VM replication mantra: « install once clone often »
• Creating the Linux golden images:
  • Linux Operating System = base golden image
  • Add administration tools = enhanced golden image
  • Add software = service golden image
  • Golden image certification before going to production
  • General deployment
• Responding to the Challenge: Guaranteeing Client Isolation
• Transcending Technical Cultures
Technical Challenges
Multiple clients

Challenge: enabling clients to thrive with z/VM and Linux on System z.

• Many OSAs and Vswitches defined to support the different clients.

• Different physical networks map to Vswitch networks, which are associated with correct zone and application.
Technical Challenges
Competing technologies

- **Intangibles:**
  - Backup/restore: mainframe strategy (via z/OS)
  - Disaster Recovery: mainframe stability with an external provider
  - Virtualization
  - Cloning
  - High availability
  - Performance (I/O) for Oracle
  - Security
  - Resource sharing
    - IPL pack
    - Linux Kernel
    - Oracle executables
    - Golden images
    - Partitioning (EAL 5 security level)
  - On demand
Technical Challenges
Competing technologies

• **Intangibles:**
  • Flexibility of the solution
    • Fast track (no acquisition)
      • Creating/Installation a new server
        • Linux on z/VM : 30 min
        • SUN, AIX, Windows : between 1 week and 3 months (if RFP needed)
  • Cloning and deployment engine
  • Cloning/Installation an Oracle/DB instance
    • Under Linux on z/VM : 30-45 min
    • Under SUN : 10-14h
  • Adjustments to the cloning engine for a new service (ex. WAS):
    • Coding changes done within 2 weeks
## Technical Challenges

### Competing technologies

<table>
<thead>
<tr>
<th>Category</th>
<th>Weight</th>
<th>Description</th>
<th>Level</th>
<th>Description</th>
<th>Level</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disciplin-ability (production mentality)</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td></td>
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<tr>
<td>Change management</td>
<td>5</td>
<td>Formal &amp; part of the culture</td>
<td>5</td>
<td>Formal</td>
<td>5</td>
<td>30</td>
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<tr>
<td>Start-up disk</td>
<td>5</td>
<td>Unique IPL pack (like z/OS)</td>
<td>5</td>
<td>Starting a project for a cloning engine</td>
<td>5</td>
<td>2</td>
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<tr>
<td><strong>Performance hardware</strong></td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>65</td>
<td>30</td>
</tr>
<tr>
<td>Partitions</td>
<td>3</td>
<td>Partitions take only what they need (determine by the weight)</td>
<td>5</td>
<td>Partitions take everything available (determine by the weight)</td>
<td>5</td>
<td>28</td>
</tr>
<tr>
<td>Processor(s) I/O</td>
<td>3</td>
<td>Dedicated processors</td>
<td>5</td>
<td>Same processors (CPU &amp; I/O)</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Flexibility (ad-hoc demand)</td>
<td>3</td>
<td>A partition can use unused cycles from other partitions</td>
<td>4</td>
<td>Partition will always use all cycles available (determine by the weight)</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>On demand</td>
<td>2</td>
<td>Annual cost for the service</td>
<td>3</td>
<td>Must purchase additional processors</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Experience (virtualization)</td>
<td>2</td>
<td>Close to 20 years</td>
<td>4</td>
<td>2 years +</td>
<td>4</td>
<td>2</td>
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<tr>
<td><strong>Performance software</strong></td>
<td>75</td>
<td>61</td>
<td>61</td>
<td>61</td>
<td>61</td>
<td>35</td>
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<tr>
<td>Virtual machines</td>
<td>4</td>
<td>Virtual machines only use what they need</td>
<td>5</td>
<td>See Partition</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Control</td>
<td>4</td>
<td>Weight &amp; priority</td>
<td>4</td>
<td>Weight only</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Flexibility (ad-hoc demand)</td>
<td>4</td>
<td>A virtual machine can use unused cycles from other virtual machines</td>
<td>4</td>
<td>N/A</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Utilisation reporting</td>
<td>3</td>
<td>Performance ToolKit</td>
<td>3</td>
<td>In-house tool</td>
<td>3</td>
<td>2</td>
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<tr>
<td><strong>Deployment (speed)</strong></td>
<td>50</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td>44</td>
<td>21</td>
</tr>
<tr>
<td>New environment creation</td>
<td>4</td>
<td>Define a new virtual machine &amp; use the cloner</td>
<td>5</td>
<td>Define a partition &amp; install the operating system</td>
<td>5</td>
<td>4</td>
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<tr>
<td>Network</td>
<td>3</td>
<td>New definitions VLAN (VM) &amp; firewalls</td>
<td>4</td>
<td>Network cards, cables, ports in router if new server and firewall</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>I/O</td>
<td>3</td>
<td>Shared FICON/ESCON ports</td>
<td>4</td>
<td>HBA + ports in director, cables if new server</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Easiness to manage software keys</td>
<td>10</td>
<td>8</td>
<td>8</td>
<td>Add all processors on which the software is running, must consider virtual vs physical</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Calculated with the number of IFLs per partition</td>
<td>4</td>
<td>Add all processors on which the software is running, must consider virtual vs physical</td>
<td>4</td>
<td>4</td>
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<tr>
<td><strong>Disaster recovery</strong></td>
<td>130</td>
<td>117</td>
<td>117</td>
<td>117</td>
<td>117</td>
<td>82</td>
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<tr>
<td>Exercises</td>
<td>4</td>
<td>Remote installation</td>
<td>5</td>
<td>Staff on site (New Jersey)</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Operating system recovery</td>
<td>5</td>
<td>Disk recovery (from backup)</td>
<td>5</td>
<td>Installation of the operating system</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Testing results</td>
<td>4</td>
<td>Complete &amp; successful (the process is identical as z/OS)</td>
<td>4</td>
<td>Not enough time to complete the tests</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Hardware isolation</td>
<td>4</td>
<td>z/VM is independent of the hardware</td>
<td>4</td>
<td>Must have compatible hardware (might need the same identical hardware)</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Backups</td>
<td>5</td>
<td>Well known &amp; integrated process (from mainframe expertise)</td>
<td>4</td>
<td>Limited trust in the process</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Inventory</td>
<td>4</td>
<td>One unique inventory</td>
<td>5</td>
<td>Multiple inventories</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td><strong>Security</strong></td>
<td>25</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>7</td>
</tr>
<tr>
<td>Certification</td>
<td>3</td>
<td>LPAR EAL5A</td>
<td>5</td>
<td>Partition EAL 4+</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>Cryptography</td>
<td>2</td>
<td>CPACF + Crypto cards</td>
<td>4</td>
<td>Software</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>RAS</strong></td>
<td>55</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>48</td>
<td>26</td>
</tr>
<tr>
<td>Redundancy</td>
<td>4</td>
<td>Backup processors always available</td>
<td>5</td>
<td>Backup processors only available if on demand package available ($)</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Operating system</td>
<td>4</td>
<td>100% of planned time</td>
<td>4</td>
<td>AIX, Windows, SAN</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Disks</td>
<td>3</td>
<td>Partitions 9980 &amp; FICON</td>
<td>4</td>
<td>HDS 9585 &amp; FPC &amp; disk towers</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>460</td>
<td>407</td>
<td>407</td>
<td>407</td>
<td>407</td>
<td>237</td>
</tr>
</tbody>
</table>

88.48%  36.96%
Business Case
Business Case
Start of the project

• Identifying the potential for the client:
  • Databases
  • WebSphere Application Server (WAS)
  • WAS/Portal + LWWCM
  • Firewalls
  • TAM & LDAP
  • EDGE servers
• Identifying the most cost efficient project – Oracle/DB
  • Reduction of the number of licenses
  • Success stories
  • Easy conversion (data transfer; unload/reload)
Business Case Summary

- **Oracle/DB**
  - Hardware cost is about the same
  - Software cost has a big gain by a huge reduction of the number of licenses (result: z9-EC paid within 2-3 years)
- **WebSphere Application server (WAS) including WBI, MQ**
  - Hardware cost is little more expensive for the System z
  - Software cost has a big gain by reducing the number of licenses (we are saving money)
- **TAM & LDAP**
  - Hardware cost is more expensive on the System z
  - Redundancy, Backup/Restore and DR are easier
  - Installing secondary servers on the mainframe for redundancy purposes (reducing the cost and having the mainframe gains)
Business Case Summary

- Firewalls
  - Uncertain about the business case
  - Migration is a major impact on the organization
  - Investigation needed for the licensing (/CPU, /instance, /site)
- EDGE servers
  - Hardware cost is a little more expensive for the System z
  - Need to introduce the mainframe in the access zone (complexity and security concerns)
  - The benefits are at the intangibles level
- WAS/Portal + LWWCM
  - Potential for a big financial gain
  - Performance on the mainframe must be confirmed
  - Need a proof of concept
The business case is a comparison between the server environment (Intel, SUN, …) and the System z environment.

The business case is based on:
- The cost of the software and hardware
- The effort of installation and deployment
- Training needed
- Expertise needed (consultants)

All efforts needed for migration were transferred to future projects. All new projects must be approved by the board of directors. (NOT included in the business case)

The DGTIC’s theory is “a migration is mandatory”:
- If applicable and economical sound
- Migrating from SUN to pSeries ~ Migrating from Sun to System z
• Overall, the cost of the software and hardware is reduced by 30%. Every extra instance will help to reduce the cost.
• The Oracle/DB migration project will break even within two years.
• Within the first two phases of the project (Oracle/DB and WAS), the mainframe will be repaid within three years. It was very important to build the business case around a worst case scenario. It can only be better, not worse.
• The business case doesn’t consider the following:
  • Electricity
  • Floor space
  • Air conditioning
  • UPS

... All of which are favorable with System z ...
The Future
The Future Restructuring of the project

• The project has grown so fast that changes were mandatory:
  • Breakdown in several sub-projects with different project managers
  • One major project was created to integrate all sub-projects for controlling and monitoring purposes
    • Project status
    • Planning
    • Staffing
  • Mentoring is still a major activity inside each sub-project and managing dependencies
  • Project highly political with high visibility inside and outside the Québec government
The Future
Next steps, targets, clients benefits

• Each new Oracle database is created under Linux on z/VM environment. There will be no new hardware purchases for intermediate platforms for Oracle.
• Starting new projects
  • WAS migration
  • TAM & LDAP migration
  • Proof of concept for WebSphere/Portal & LWWCM
• Potential projects
  • Domino migration
  • Open Source
  • Service Oriented Architecture (SOA)
Conclusion

• z/VM and Linux on the mainframe: a powerful combination for the DGTIC
• Supported open source software on the mainframe provides the stability of z/VM with the ability to run modern applications.
• Service being offered to many government offices and agencies.
• The word is out that z/VM and Linux on the mainframe is a good place to host your applications:
  • Internal government emails and announcements from the project office promoting z/VM and Linux on the mainframe solution.
• Rapid growth is forecasted:
  • *and the DGTIC is ready to keep up with the demand.*
• DGTIC providing infrastructure to many offices and agencies.
• Building and nurturing business case critical to success of the project.
• The training was a vital part of the client acceptance of the concept.
• Architecture was developed and polished for over one year.
• z/VM and Linux on the mainframe natural fit for the vertical and horizontal.
• Project success will continue into the future!
Questions?

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