Standby Datenbank in der Wolke: was bieten Oracle und Konkurrenz

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Borys Neselovskyi, Senior Solution Architect
Agenda

1. Current State and Project Scope
2. Performance Analysis and Sizing
3. Target System: Requirements
4. Solution & Costs
5. Comparison and Conclusion
Current State and Project Scope
Current State

- **ODA X7-2M:**
  - Processor Licenses: 4
  - RAM: 384 GB
  - Storage (NVME): 12,8 TB

- **Processor Licenses:**
  - 4 x Oracle Enterprise Edition
  - 4 x Oracle Diagnostic and Tuning Pack
  - 4 x Oracle Partitioning

- **Number of Databases:** 8

- **Various Applications and App-servers**
The aim of the project:
- Calculating of the Standby System by Cloud Vendors:
  - AWS
  - Azure
  - Oracle

Tasks:
- Sizing of the current system
- Calculating of the possible target Standby System

Challenges:
- Calculating of the necessary network bandwidth
- Finding an appropriate solution in the Cloud
Network between on-prem and cloud

- **Dedicated Network vs IPSec VPN Connections**
  - An IPSec VPN Connection utilizes IPSec to establish encrypted network connectivity between your intranet and Cloud network over the Internet.
  - VPN Connections can be configured in minutes and are a good solution for immediate needs, have low to modest bandwidth requirements, and can tolerate the inherent variability in Internet-based connectivity.
  - Dedicated network does not involve the Internet; instead, it uses dedicated, private network connections between your intranet and Cloud Network.
  - VPN connections are very cheap as compared to dedicated network connection as it requires actual hardware and infrastructure and might go in thousands.
Performance Analysis and Sizing
The main goals for sizing the target system

- **CPU Power requirements:**
  - Database CPU Usage Statistics:
  - Host: CPU Utilization

- **RAM requirements:**
  - Database: SGA + PGA Usage
  - Host: Memory Utilization

- **Storage requirements:**
  - Database IO Statistics:
    - Physical reads/writes: Total & IOPS
    - Redo reads/writes: Total & IOPS

- **Network requirements:**
  - Data Guard Traffic
  - Application Traffic
Some tips for sizing

- Talk to customer about known bottlenecks
- Talk to customer about the data growth
- Consider the peak times
- Consider the important time periods
- Use Enterprise Manager/AWR/Statspack statistics
- Check OS Statistics (sar by Linux)
- Check Network Statistics (Network Interfaces / Routers / Switches)
CPU Utilization: example SQL (based on EM Repository)

```
SELECT entity_name,
       ROUND(collection_time,'HH') AS colltime,
       ROUND(avg_value,2)/12*100 AS avgv,  -- 12 is my number of CPU
       ROUND(max_value,2)/12*100 AS maxv  -- same here
FROM sysman.gc$metric_values_hourly mv
JOIN sysman.em_targets t
     ON (t.target_name = mv.entity_name)
WHERE t.host_name = '<server_name>'  -- my database server
AND mv.metric_column_name = 'user_cpu_time_cnt'
AND collection_time>sysdate-14  -- for the last 14 days
ORDER BY entity_name,
       ROUND(collection_time,'HH');
```
Memory Utilization: example SQL (based on AWR Repository)

```
select trunc(SN.END_INTERVAL_TIME,'mi') time, sga.allo sga_gb, pga.allo pga_gb,(sga.allo+pga.allo) tot_gb
  from
(select snap_id,INSTANCE_NUMBER,round(sum(bytes)/1024/1024/1024,3) allo
   from DBA_HIST_SGASTAT
   group by snap_id,INSTANCE_NUMBER) sga,
(select snap_id,INSTANCE_NUMBER,round(sum(value)/1024/1024/1024,3) allo
   from DBA_HIST_PGASTAT where name = 'total PGA allocated'
   group by snap_id,INSTANCE_NUMBER) pga,
    dba_hist_snapshot sn
where sn.snap_id=sga.snap_id
  and sn.INSTANCE_NUMBER=sga.INSTANCE_NUMBER
and sn.snap_id=pga.snap_id
  and sn.INSTANCE_NUMBER=pga.INSTANCE_NUMBER
order by sn.snap_id
;
```
IO und Network Statistics: example SQL (based on AWR Repository)

select
    round(min(begin_time),'HH') btime,
    round(max(end_time),'HH') endtime,
    round(sum(case metric_name when 'Physical Read Total Bytes Per Sec' then end)/1024) Ph_Rd_kB_p_s,
    round(sum(case metric_name when 'Physical Write Total Bytes Per Sec' then end)/1024) Ph_Wr_kB_p_s,
    round(sum(case metric_name when 'Redo Generated Per Sec' then end)) Redo_p_s,
    round(sum(case metric_name when 'Physical Read Total IO Requests Per Sec' then end)) Phy_Rd_IOPS,
    round(sum(case metric_name when 'Physical Write Total IO Requests Per Sec' then end)) Phy_wr_IOPS,
    round(sum(case metric_name when 'Redo Writes Per Sec' then end)) redo_IOPS,
    round(sum(case metric_name when 'Current OS Load' then end)) Load,
    round(sum(case metric_name when 'CPU Usage Per Sec' then end)) DB_CPU_Use,
    round(sum(case metric_name when 'Host CPU Utilization (%)' then end)) Host_CPU, --NOTE 100% = 1 loaded RAC node
    round(sum(case metric_name when 'Network Traffic Volume Per Sec' then end)) Net_byt_p_s,
from dba_hist_sysmetric_summary
    group by snap_id
    order by snap_id;

Network bandwidth sizing

- Oracle Enterprise Manager:
  - Total Network Traffic for both (database and non-database) workloads
  - Network Interface Read:
    - avg.: ... MB/s
    - max.: ... MB/s
  - Network Interface Write:
    - avg.: ... MB/s
    - max.: ... MB/s

- AWR Repository:
  - Only Database Point of View!
  - Network Traffic Volume Per Sec:
    - avg.: ... MB/s
    - max.: ... MB/s

- How To Calculate The Required Network Bandwidth Transfer Of Redo In Data Guard Environments:
  - MOS Note: 736755.1
  - Tool oratcptest:
    - Measuring Network Capacity using oratcptest (Doc ID 2064368.1)

- Application Traffic:
  - Inbound
  - Outbound
Target System: Requirements
Target System: Requirements

- **CPU:**
  - Performance of the standby should match the performance of the primary
  - Primary on the ODA:
    - 4 Processor Licences = 8 Physical Intel Cores = 16 Processor Threads
  - possibility to expand

- **RAM:**
  - >= 250 GB

- **Storage:**
  - Databases: >= 6 TB -> 8 TB (Growth)

- **Network for the traffic between on-premises and cloud:** 10 GbBit
  - Redo Traffic
  - Application Traffic

- This estimate does not consider the following components:
  - NICs and elastic IP Addresses
  - Small Components, like Router, VPN etc.
  - Storage for Database & OS Backup
Solution & Costs

aws

ORACLE Cloud

Microsoft Azure
Platform considerations

- Managed Database in the Cloud for the Standby?
  - AWS RDS Oracle:
    - No: Standby is not supported
  - Oracle Autonomous Database?
    - No: Standby is not supported

- Oracle Cloud OCI: VM or Bare metal?:
  - Database VMs: only one Database per VM is possible
  - For 8 Databases: 8 VMs

- AWS EC2 Container / Azure Virtual Computer:
  - Oracle Licences: BYOL
CPU Licenses in the Cloud

- Amazon EC2 and RDS / Microsoft Azure for the DB EE:
  - count two vCPUs as equivalent to one Oracle Processor license if hyper-threading is enabled, and one vCPU as equivalent to one Oracle Processor license if hyper-threading is not enabled.


- AWS EC2 / Azure:
  - 1 Processor License = 2 vCPU (with HT)
  - 1 Processor License = 1 vCPU (without HT)

- Oracle Cloud:
  - 1 Processor License = 2 OCPU = 4 vCPU (with HT)
Solution Overview

Solution 1: EC2 on Amazon Cloud
- EC2 Container
- AWS Direct Connect (10 Gbit)

Solution 2: Virtual Computer on MS Azure
- Virtual Machine
- Azure Express Route (10 Gbit)

Solution 3: Dedicated Host on Oracle Cloud
- Dedicated (Bare Metal Host)
- Oracle Fast Connect (10 Gbit)
Solution 1: EC2 on Amazon Cloud

Solution Overview:

- EC2 Container:
  - x1e.4xlarge
  - 16 vCPU(s)
  - HT enabled: Threads per Core: 2
  - 488 GB RAM
  - OS: Linux – Oracle Enterprise Linux

- Oracle Processor Licenses - Cloud:
  - 8 x Enterprise Edition
  - 8 x Oracle Diagnostic & Tuning Pack
  - 8 x Active Data Guard
  - 8 x Oracle Partitioning
  - 8 x Advanced Security – TDE

- Oracle Processor Licenses - On-premises:
  - 4 x Active Data Guard
  - 4 x Advanced Security - TDE

Storage:

- GP2 HDDs: 24 x 1 TB = 24 TB
- 10000 Transaction Units

Network:

- Dedicated Network: Direct Connect:
  - Bandwidth: 10 Gbit/s
  - Outbound data transfers: 10 TB/Month
## Solution 1: EC2 on Amazon Cloud: Costs

- **Compute:** x1e.4xlarge

<table>
<thead>
<tr>
<th>Name</th>
<th>Effective Hourly Cost</th>
<th>Effective Monthly Cost</th>
<th>1 Year Cost (€)</th>
<th>3 Year Cost (€)</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Year No Upfront Reserved</td>
<td>2.68</td>
<td>1,953.65</td>
<td>23,443.67</td>
<td>70,331.32</td>
<td></td>
</tr>
<tr>
<td>3 Year No Upfront Reserved</td>
<td>1,451.59</td>
<td>1,059.66</td>
<td>---</td>
<td>38,147.79</td>
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</tr>
</tbody>
</table>

**Sum EC2:** 85,035.12

- **Storage:** GP2: 24 TB

<table>
<thead>
<tr>
<th>Service</th>
<th>1 Month Cost (€)</th>
<th>1 Year Cost (€)</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWS Direct Connect 10 Gbit/s</td>
<td>1,872.68</td>
<td>22,472.11</td>
<td>112,360.54</td>
</tr>
</tbody>
</table>

**Sum Network:** 112,360.54
Solution 1: EC2 on Amazon Cloud: Costs

- **Oracle Licenses**

<table>
<thead>
<tr>
<th>Service</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB EE Processor</td>
<td>41,240.00</td>
</tr>
<tr>
<td>Diagnostics Pack</td>
<td>6,512.00</td>
</tr>
<tr>
<td>Tuning Pack</td>
<td>4,341.00</td>
</tr>
<tr>
<td>Partitioning</td>
<td>9,984.00</td>
</tr>
<tr>
<td>Active Data Guard</td>
<td>9,984.00</td>
</tr>
<tr>
<td>Advanced Security</td>
<td>13,023.00</td>
</tr>
<tr>
<td>Sum</td>
<td>952,693.64</td>
</tr>
</tbody>
</table>

- **Summary Solution 1:**

<table>
<thead>
<tr>
<th>Service</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amazon EC2 Service (Frankfurt)</td>
<td>85,035.12</td>
</tr>
<tr>
<td>Amazon GP2 Storage (Frankfurt)</td>
<td>156,175.78</td>
</tr>
<tr>
<td>AWS Direct Connect Service (EU (Frankfurt))</td>
<td>112,360.54</td>
</tr>
<tr>
<td>AWS Support (Business)</td>
<td>21,956.48</td>
</tr>
<tr>
<td>Oracle Licenses and Support</td>
<td>1,653,883.62</td>
</tr>
<tr>
<td>Sum</td>
<td>2,029,411.54</td>
</tr>
</tbody>
</table>

This is the total license price incl. 5 years support without discount.
Solution 2: Virtual Computer on MS Azure

Solution Overview:

- **Azure Virtual Computer:**
  - 1 x E32-16s_v3:
    - 16 vCPU(s), Hyperthreading enabled
    - 256 GB RAM
    - OS: Linux – Oracle Enterprise Linux
  - Oracle Processor Licenses - Cloud:
    - 8 x Enterprise Edition
    - 8 x Oracle Diagnostic & Tuning Pack
    - 8 x Active Data Guard
    - 8 x Oracle Partitioning
    - 8 x Advanced Security – TDE
  - Oracle Processor Licenses - On-premises:
    - 4 x Active Data Guard
    - 4 x Advanced Security - TDE

- **Storage:**
  - S30 HDDs: 24 x 1 TB = 24 TB
  - 10000 Transaction Units

- **Network:**
  - Dedicated Network Express Route:
    - Bandwidth: 10 Gbit/s
    - Outbound data transfers: 10 TB/Month
Solution 2: Virtual Computer on MS Azure: Costs

- **Compute:**
  - E32-16s_v3 + S30 HDD
  - Storage: 24 TB

<table>
<thead>
<tr>
<th>Service</th>
<th>Effective Monthly Cost</th>
<th>1 Year Cost (€)</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Computer E32-16s_v3</td>
<td>930.80</td>
<td>11,169.60</td>
<td>55,848.00</td>
</tr>
<tr>
<td>Storage S30 HDD 24 TB</td>
<td>953.35</td>
<td>11,440.20</td>
<td>57,201.00</td>
</tr>
<tr>
<td><strong>Sum:</strong></td>
<td>1,884.15</td>
<td>22,609.80</td>
<td><strong>113,049.00</strong></td>
</tr>
</tbody>
</table>

- **Network:**
  - Express Route: 10 Gbit/s
  - Outbound data transfers: 10 TB

<table>
<thead>
<tr>
<th>Service</th>
<th>1 Month Cost (€)</th>
<th>1 Year Cost (€)</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Network: Express Route: 10 Gbit/s</td>
<td>4,848.98</td>
<td>58,187.76</td>
<td>290,938.80</td>
</tr>
<tr>
<td>Outbound data transfers: 10 TB</td>
<td>250.43</td>
<td>3,005.16</td>
<td>15,025.80</td>
</tr>
<tr>
<td><strong>Sum Network:</strong></td>
<td>5,099.41</td>
<td>61,192.92</td>
<td><strong>305,964.60</strong></td>
</tr>
</tbody>
</table>
### Solution 2: Virtual Computer on MS Azure: Costs

#### Oracle Licenses

<table>
<thead>
<tr>
<th>Service</th>
<th>List Preis</th>
<th>List preis Support</th>
<th>Sum 1st Year</th>
<th>Support 2 – 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB EE Processor</td>
<td>8</td>
<td>41,240.00</td>
<td>9,072.69</td>
<td>402,501.52</td>
</tr>
<tr>
<td>Diagnostics Pack</td>
<td>8</td>
<td>6,512.00</td>
<td>1,432.53</td>
<td>63,556.24</td>
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<tr>
<td>Tuning Pack</td>
<td>8</td>
<td>4,341.00</td>
<td>955.02</td>
<td>42,368.16</td>
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<tr>
<td>Partitioning</td>
<td>8</td>
<td>9,984.00</td>
<td>2,196.55</td>
<td>73,516.37</td>
</tr>
<tr>
<td>Active Data Guard</td>
<td>12</td>
<td>9,984.00</td>
<td>2,196.55</td>
<td>110,274.55</td>
</tr>
<tr>
<td>Advanced Security Option</td>
<td>12</td>
<td>13,023.00</td>
<td>2,865.06</td>
<td>143,836.11</td>
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</table>

**Sum:** 952,693.64  711,189.98

#### Summary Solution 2:

<table>
<thead>
<tr>
<th>Service</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Machines Germany Central</td>
<td>113,049.00</td>
</tr>
<tr>
<td>Express Route Germany Central</td>
<td>305,964.60</td>
</tr>
<tr>
<td>Oracle Licenses und Support</td>
<td>1,653,883.62</td>
</tr>
</tbody>
</table>

**Sum:** 2,072,883.62

This is the total license price incl. 5 years support without discount.
Solution 3: Bare Metal on Oracle Cloud (OCI)

Solution Overview:

Bare Metal Dedicated Server:
- 1 x BM.DenseIO1.36:
  - 32 OCPU(s)
  - Activated: 8 (4 Processor Licenses)
  - 512 GB RAM
  - OS: Linux Oracle Enterprise Linux

Oracle Cloud Subscription:
- Cloud:
  - 8 x EE Extreme Performance Licenses
- On-premises:
  - 2 x Active Data Guard
  - 2 x Advanced Security

Storage:
- 51,2 TB NVME

Network:
- Oracle Fast Connect
  - Bandwidth: 10 Gbit/s
  - Outbound data transfers: 10 TB/Month
### Solution 3: Bare Metal on Oracle Cloud (OCI): Costs

#### Database OCI - EE Extreme Edition Dense IO

<table>
<thead>
<tr>
<th>Service</th>
<th>PAYG (€)</th>
<th>Monthly Flex 1 Year (€)</th>
<th>Monthly Flex 4 Year (€)</th>
<th>Cost 5 Years (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database OCI - EE Extreme Edition Dense IO 2 OCPU</td>
<td>10,009.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Capacity: 6 OCPU</td>
<td>10,104.00</td>
<td></td>
<td></td>
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<tr>
<td><strong>Sum:</strong></td>
<td>20,113.00</td>
<td>12,068.00</td>
<td>10,727.00</td>
<td>659,712.00</td>
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</tbody>
</table>

#### Oracle On-Prem Licences

<table>
<thead>
<tr>
<th>Processor</th>
<th>List Preis</th>
<th>List preis Support</th>
<th>Sum 1st Year</th>
<th>Support 2 – 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active Data Guard</td>
<td>4</td>
<td>9,984.00</td>
<td>2,196.55</td>
<td>48,722.20</td>
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<tr>
<td>Advanced Security Option</td>
<td>4</td>
<td>13,023.00</td>
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<td></td>
<td><strong>112,274.44</strong></td>
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</table>

This is the total license price incl. 5 years support without discount: 196,877.99 €

#### Fast Connect 10 Gbps * 744 Hours

<table>
<thead>
<tr>
<th>Service</th>
<th>1 Month Cost (€)</th>
<th>5 Year Cost (€)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FastConnect 10 Gbps * 744 Hours</td>
<td>852.00</td>
<td>51,120.00</td>
</tr>
</tbody>
</table>

Total Sum: 907,809.99 €
**Solution Overview: Costs for 5 Years**

**Solution 1: EC2 on Amazon Cloud**
- EC2 Container
- AWS Direct Connect (10 Gbit)

2,029,511.54 €

**Solution 2: Virtual Computer on MS Azure**
- Virtual Machine
- Azure Express Route (10 Gbit)

2,072,883.62 €

**Solution 3: Dedicated Host on Oracle Cloud**
- Dedicated (Bare Metal Host)
- Oracle Fast Connect (10 Gbit)

Database System

907,809.99 €
Comparison and Conclusion
## Comparison

### Hardware Equipment

<table>
<thead>
<tr>
<th></th>
<th>AWS</th>
<th>AZURE</th>
<th>Oracle Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU (max)</td>
<td>16 vCPU +</td>
<td>16 vCPU +</td>
<td>32 OCPU ++</td>
</tr>
<tr>
<td>RAM</td>
<td>488 GB +++</td>
<td>256 GB +</td>
<td>512 GB +++</td>
</tr>
<tr>
<td>Storage</td>
<td>24 TB HDD (GP2) +</td>
<td>24 TB HDD (S30) +</td>
<td>51,2 TB SSD NVME +++</td>
</tr>
<tr>
<td>Storage Performance (IO)</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
</tbody>
</table>

### Costs

<table>
<thead>
<tr>
<th></th>
<th>AWS</th>
<th>AZURE</th>
<th>Oracle Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Costs</td>
<td>2,029,511.54 € +</td>
<td>2,072,883.62 € +</td>
<td>907,809.99 € +++</td>
</tr>
</tbody>
</table>
## Comparison

### Miscellaneous

<table>
<thead>
<tr>
<th></th>
<th>AWS</th>
<th>AZURE</th>
<th>Oracle Cloud</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management</td>
<td>Hardware and Network: AWS, VM: Customer ++</td>
<td>Hardware and Network: Azure, VM: Customer ++</td>
<td>Hardware and Network: Oracle, Dedicated VM: Customer with Cloud Tools +++</td>
</tr>
<tr>
<td>Environment:</td>
<td>Shared -</td>
<td>Shared -</td>
<td>Dedicated ++</td>
</tr>
<tr>
<td>Dedicated or</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shared</td>
<td></td>
<td></td>
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<tr>
<td>Geo Redundancy</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Performance</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
</tbody>
</table>
Conclusion

- The best solution from the price-performance ratio perspective is the solution 3 (Oracle Cloud)

- Considerations for hybrid cloud solution?
  - Problem: Outbound Network Traffic
  - New: Partnership Oracle and Microsoft: new opportunities?
Über mich...

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