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DALLAS ORACLE USERS GROUP

Oracle Engineered Systems

A fresh look based on a new reality

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Unsafe Harbor

- This room is an unsafe harbor
- You can rely on the information in this presentation to help you protect your data, your databases, your organization, and your career
- No one from Oracle has previewed this presentation
- No one from Oracle knows what I'm going to say
- No one from Oracle has supplied any of my materials
- Everything we will discuss is existing, proven, functionality

Agenda

- **Introduction**
- Why Engineered By Oracle Matters
- Oracle Engineered System
  - Oracle Database Appliance (ODA)
  - Exadata (Exa)
  - Exadata Cloud Machine (ExaCM)
  - Private Cloud Appliance (PCA)
  - Oracle Cloud Machine (OCM)
- Infrastructure as Code (IaC)

Daniel Morgan

- Oracle ACE Director Alumni
- Oracle Educator
  - Curriculum author and primary program instructor at University of Washington
  - Consultant: Harvard University
  - University Guest Lecturers
    - APAC: University of Canterbury (NZ)
    - EMEA: University of Oslo (Norway)
    - Latin America: Universidad Cenfotec, Universidad Latina de Panama, Technologico de Costa Rica
- jIT Professional
  - First computer: IBM 360/40 in 1969: Fortran IV
  - Oracle Database since 1988-9
  - Beta Tester 10g, 11g, 12c, TimesTen, GoldenGate
  - Member Oracle Data Integration Solutions Partner Advisory Council
  - Co-Founder International GoldenGate Oracle Users Group
  - Co-Founder International Oracle Cloud Users Group
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System/370-145 system console

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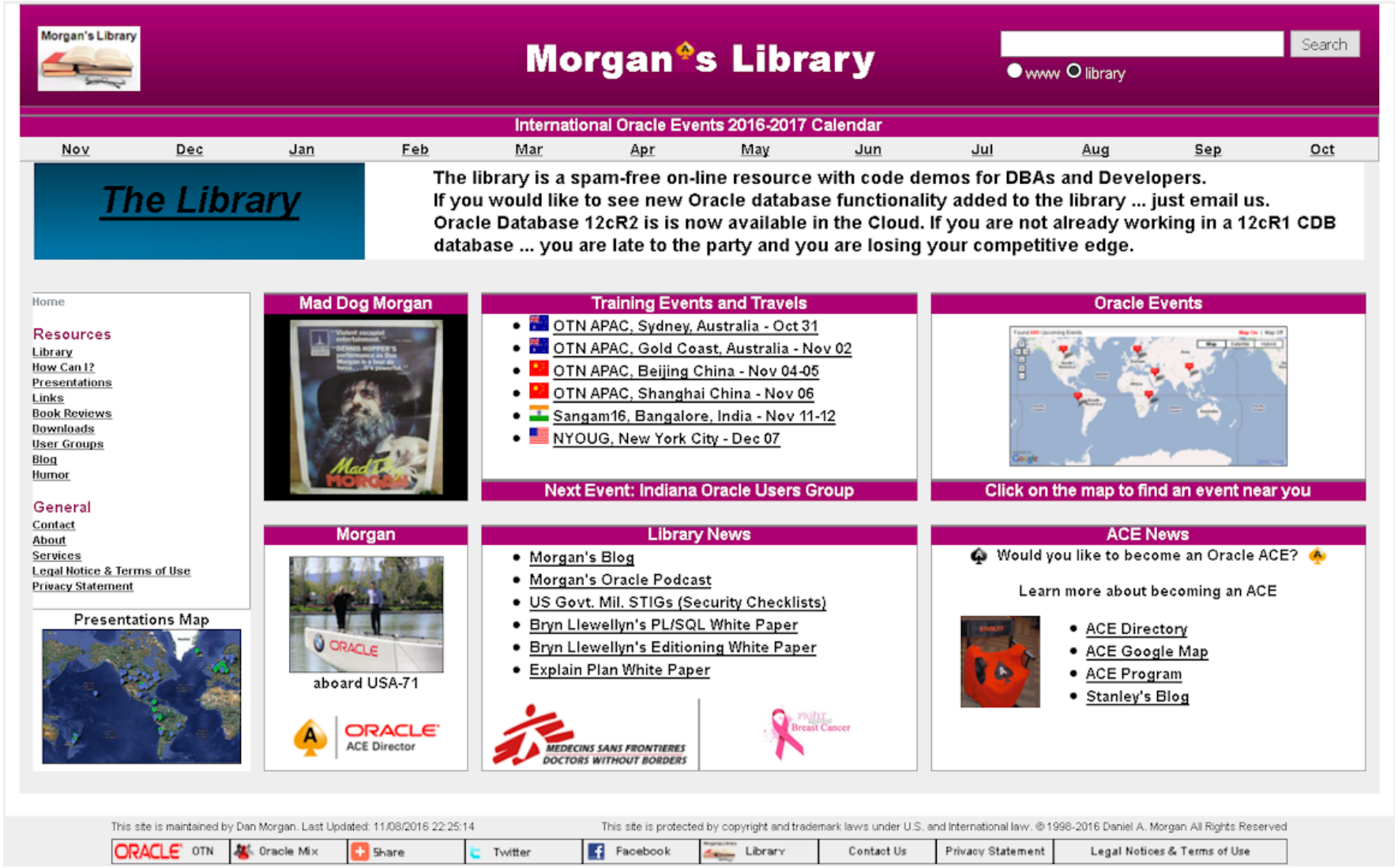
My Websites: Morgan's Library

- The Morgan behind www.morganslibrary.org



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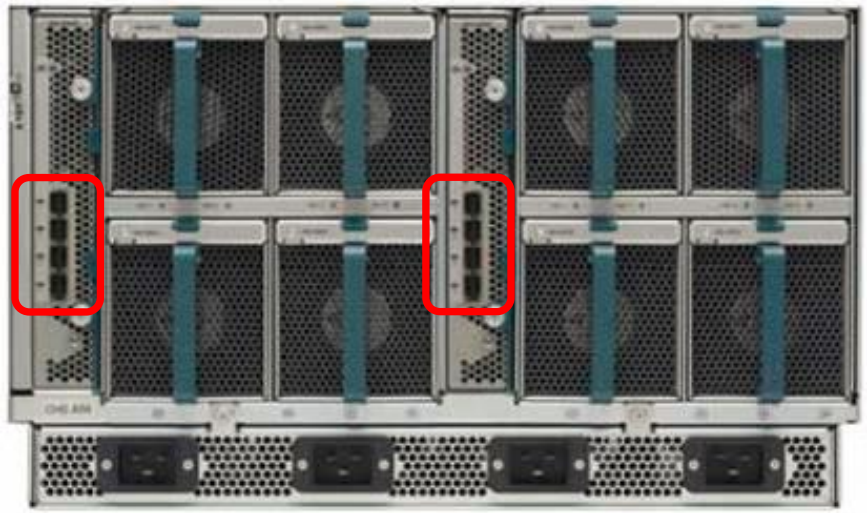
Let's Talk About Blades

- This may look like a lot of computing power ... it is

- But this does not look like a lot of dedicated NIC cards ... because it isn't
  - In even the least expensive "pizza box" servers there are more individually configurable NIC cards and far more redundancy to eliminate single points of failure
  - There is a lot more to networking than bandwidth



- What matters most to databases is a stable platform that can handle peak loads

What Our Customers Should Be Thinking

- If blade servers are such a great database technology ...
  - Why doesn't Oracle sell blade servers for databases?
  - Why doesn't Oracle use blade architecture in the Oracle Database Appliance (ODA)?
  - Why doesn't Oracle user blade architecture in the Exadata and SuperCluster?
  - Why isn't blade architecture used by IBM for their P Series servers?
  - Why isn't blade architecture used by IBM for their Z Series frames?
  - Why isn't blade architecture used by IBM for Netezza?
  - Or by Teradata?
  - Or by Fujitsu for their M series?
- The reason is that blade servers were designed for a very different purpose
  - They perform their design purpose very well
  - That purpose, however, has nothing to do with hosting databases
  - Using blade servers for databases is using the wrong tool for the job ... and the outcome is very often not a good one

What Oracle Support Says

RAC: Frequently Asked Questions (Doc ID 220970.1)

The following best practices should be followed:
The Cluster Interconnect VLAN must be on a non-routed IP subnet.

All Cluster Interconnect networks must be configured with non-routed IPs. The server-server communication should be single hop through the switch via the interconnect VLAN. There is no VLAN-VLAN communication.

Oracle recommends maintaining a 1:1 mapping of subnet to VLAN.

The most common VLAN deployments maintain a 1:1 mapping of subnet to VLAN. It is strongly recommended to avoid multi-subnet mapping to a single VLAN. Best practice recommends a single access VLAN port configured on the switch for the cluster interconnect VLAN. The server side network interface should have access to a single VLAN.

Troubleshooting gc block lost and Poor Network Performance in a RAC Environment (Doc ID 563566.1)

6. Interconnect LAN non-dedicated
Description: Shared public IP traffic and/or shared NAS IP traffic, configured on the interconnect LAN will result in degraded application performance, network congestion and, in extreme cases, global cache block loss.

The interconnect traffic should not be shared with public or NAS traffic.

Recommendation for the Real Application Cluster Interconnect and Jumbo Frames (Doc ID 341788.1)

Failing to properly set these parameters in all nodes of the Cluster and Switches can result in unpredictable errors as well as a degradation in performance.

Questions We As IT Professionals Need To Answer

- Why does deployment take so long and cost so much?
- Why are we spending so much on support?
- Why does patching so often break something new?
- Why do we spend so much time fighting fires?

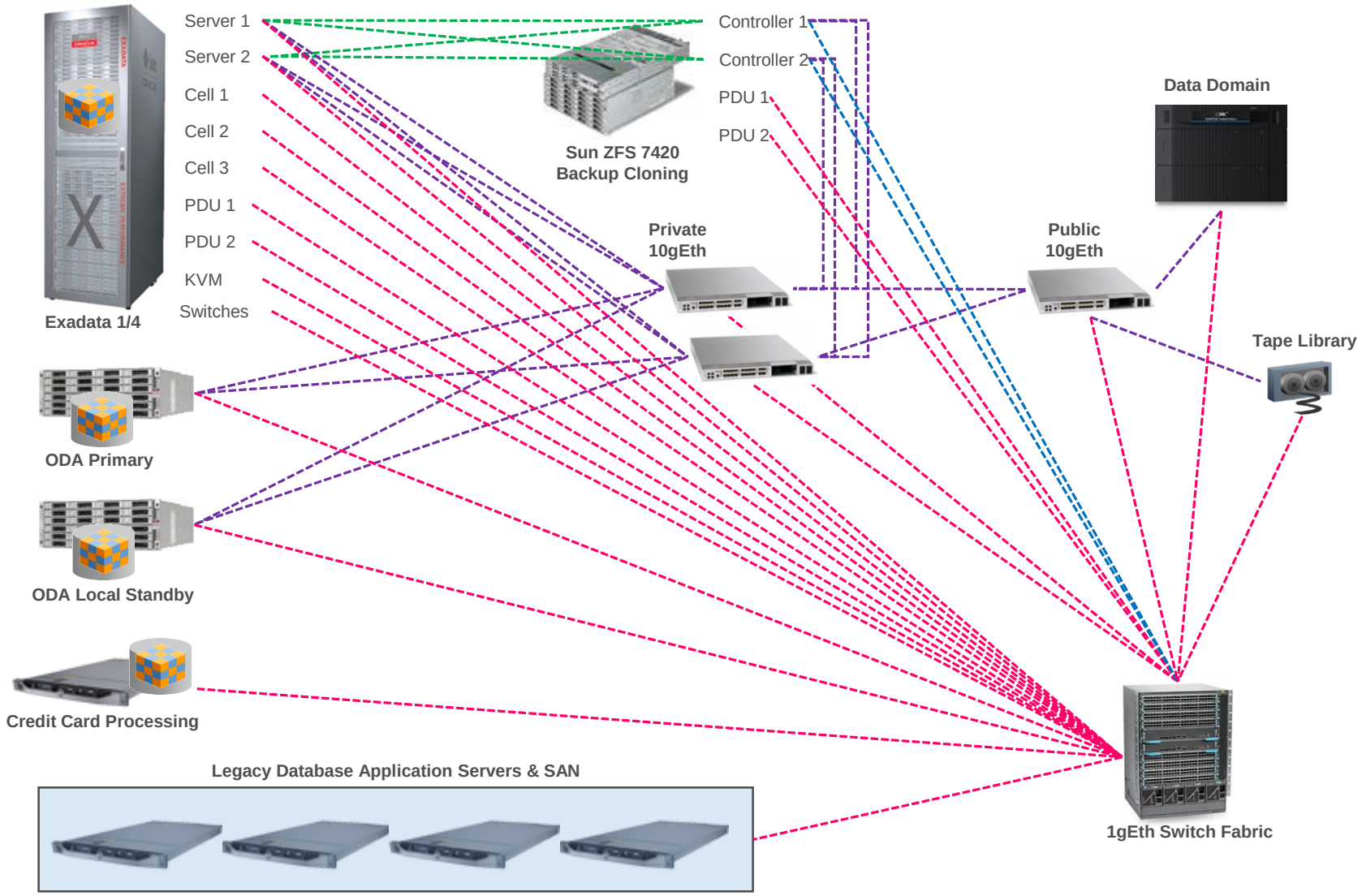
IT When We Describe It To Our Family and Friends

lindsay lohan

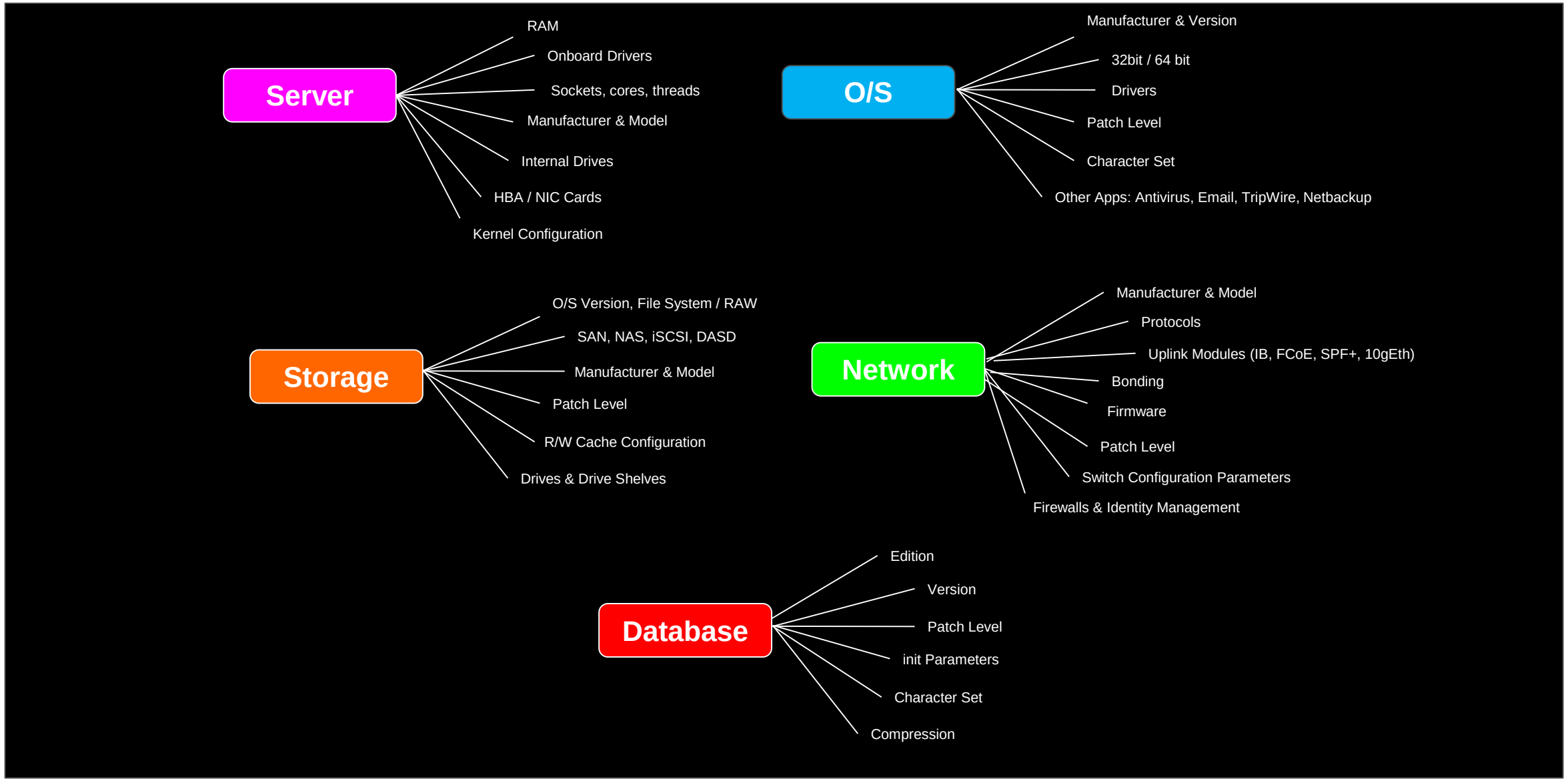
IT Infrastructure Meets a Single Point of Failure

lindsay lohan

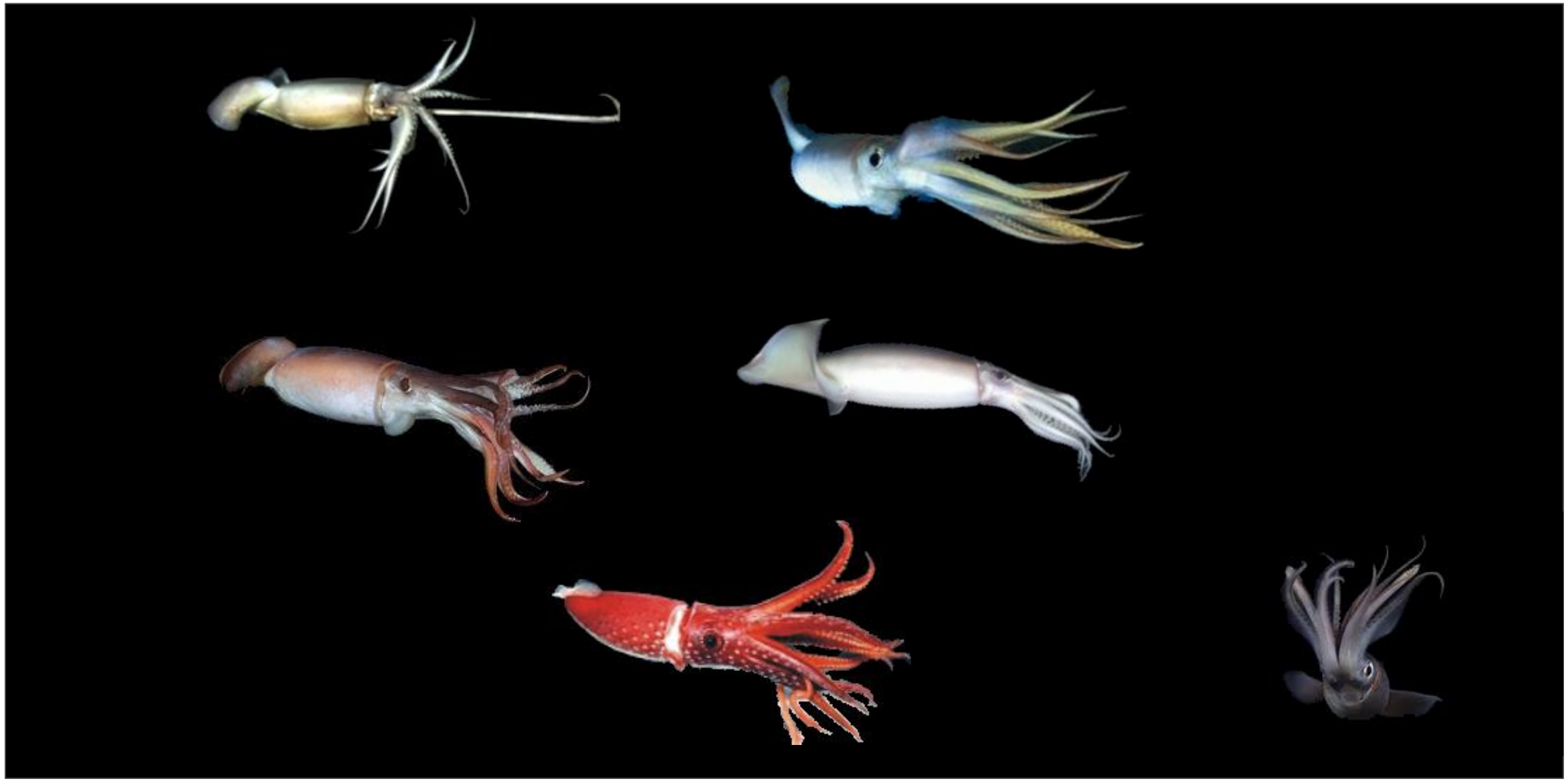
Puzzle Pieces



Static Puzzle Pieces



Animated Puzzle Pieces

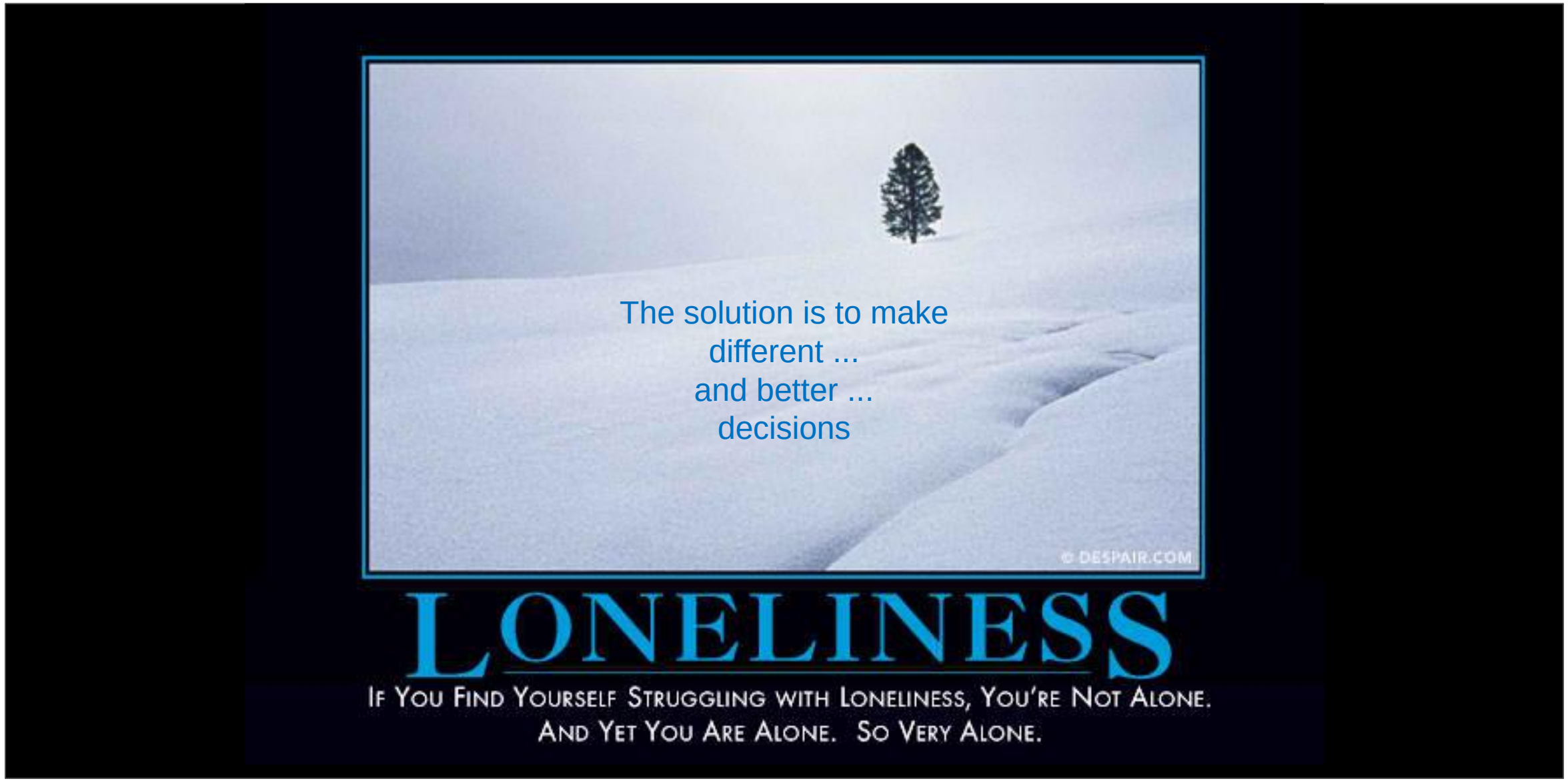


Embracing A Barrel of Squid

The Truth About Puzzle Pieces

- The decisions we've made in the past guarantee that
  - No one has ever built a RAC cluster with your specific configuration
  - No one has ever applied operating system and firmware patches to your configuration
  - No one has ever patched your specific configuration
  - Oracle has never tested and certified your specific configuration
  - No one in support can exactly duplicate your specific environment

Loneliness


The solution is to make
different ...
and better ...
decisions
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LONELINESS
If You Find Yourself Struggling with Loneliness, You're Not Alone.
And Yet You Are Alone. So Very Alone.

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  - **Oracle Cloud Machine (OCM)**
- Infrastructure as Code (IaC)

Oracle Database Appliance (ODA)

- Buy an ODA if
  - Looking for an Oracle engineered platform optimized for the Oracle Database and RAC
  - Looking for ease of deployment
  - Looking for ease of patching
  - Looking for database infrastructure exactly identical to that which Oracle Support has in inventory

Version	CPU/Sever Node	Memory/Server Node	Storage	Cluster Interconnect
X6-2S	one 10-core 2.2GHz Xeon® E5-2630 v4 processors	128 GB of main memory, expandable to 384 GB	6.4 TB of high-bandwidth NVMe flash for data storage and offer the option to double the raw storage capacity to 12.8 TB of NVMe flash.	10GBase-T and 10GbE SFP+ network connectivity No fusion interconnect
X6-2M	Two 10-core 2.2GHz Xeon® E5-2630 v4 processors	256 GB of main memory, expandable up to 768 GB	6.4 TB of high-bandwidth NVMe flash for data storage and offer the option to double the raw storage capacity to 12.8 TB of NVMe flash.	10GBase-T and 10GbE SFP+ network connectivity No fusion interconnect
X6-2 HA	Two 10-core 2.2 GHz Intel Xeon® E5-2630 v4 processors	256 GB per Eight x 32 GB	The storage shelf in the base system is half populated with ten solid-state drives (SSDs) for data storage, totaling 12 TB of raw storage capacity. The storage shelf in the base system also includes four 200 GB high endurance SSDs for database redo logs to improve performance and reliability.	two InfiBand ports or 10gEth

Exadata (Exa)

- Buy an Exadata if
  - Looking for an Oracle engineered platform optimized for the Oracle Database and RAC
  - Looking for maximum performance
  - Looking for Hybrid Columnar Compression
  - Looking for sharding support
  - Looking for database infrastructure exactly identical to that which Oracle Support has in inventory

Not Just Another Intel Box

- At a superficial level Exadata is
  - Just another Intel box
  - Just another converged architecture with Infiniband and Direct Attached Storage
  - Just buy the components and you can build one yourself
- No really: In fact no one except Oracle can build an Exadata
- Because what makes an Exadata is 10% hardware and 90% software
- The "secret sauce" is the storage cell software

Build it yourself

Engineered for a Purpose

The Infrastructure Components

- Storage Nodes
  - An Oracle engineered number of compute nodes match up with an Oracle engineered amount of networking, and is married to an Oracle engineered number of compute nodes
  - The storage layer is not dumb disk ... each storage cell is running two Intel E5-2640 V4, 10-core, 2.2GHz processors with four integrated DDR4 memory controllers per processor with its own operating system and its own application software

KEY FEATURES

- Up to 836 CPU cores and 28.5TB memory per rack for database processing
- Up to 360 CPU cores per rack dedicated to SQL processing in storage
- From 2 to 19 Database Servers per rack
- From 3 to 18 Storage Servers per rack
- Up to 460 TB of flash capacity (raw) per rack
- Up to 1.7 PB of disk capacity (raw) per rack
- Hybrid Columnar Compression often delivers 10X-15X compression ratios
- 40 Gb/second (QDR) InfiniBand Network
- Complete redundancy for high availability

- Networking
  - Slot 3 contains a dedicated InfiniBand (IB) host channel adapter (HCA) card
  - Four 10GBASE-T Gigabit Ethernet (10GbE) RJ-45 ports

The Secret Sauce

- Everyone has heard of these
  - Flash
  - Hybrid Columnar Compression
  - Smart Scan
  - Storage Indexing
- But what is really important is what is not often discussed
- All Oracle databases, for that matter all SQL Server, Informix, Sybase, DB2, MySQL, ... databases, return 8K blocks from storage to main memory for processing ... it is the compute server's cpu that parses the block to obtain the rows and columns required
- On an Exadata the storage cell software uses the storage cell processors to preprocess 8K blocks and only ships the required rows and columns to the compute server vastly reducing I/O as well as the amount of RAC and EE licensing required to perform a unit of work

Exadata Cloud Machine (ExaCM)

- Buy an Exadata Cloud Machine if you want all of the capabilities of an Exadata, and all of the advantages of an Exadata in the Oracle Cloud, but need to have the machine in your data center

Private Cloud Appliance (PCA)

- Buy a PCA if
  - Looking for an Oracle engineered platform optimized Oracle software
  - Looking for a virtualized platform on a monthly payment
  - Full support for Trusted Partitions providing license containment for all Oracle products
  - Supports multiple flavors of Linux, Solaris, and Windows
  - Supports FibreChannel HBA and NAS storage connectivity
  - Can be expanded from 2 to 25 physical servers
  - Does not support Oracle Public Cloud PaaS services
  - Looking for database infrastructure exactly identical to that which Oracle Support has in inventory

Oracle Cloud Machine (OCM)

- Brings the Oracle Cloud to your data center behind your firewall
  - IaaS
  - PaaS
- Workloads are completely portable between on-premise and off-premise clouds
- Primary benefits
  - Highly Optimized
  - DevOps Integration – Hooks in IaaS to implement DevOps by integrating configuration management tools like CFEngine, Chef, and Puppet
  - Exclusive Pre-Built Content – Automated cookbooks, VM templates, provisioning, multi-tier architecture, scale out and scale in for applications with automated migration of between on-premises and cloud
  - Fully Integrated with OEM Cloud Control – Single pane of glass for managing and monitoring all aspects of Oracle from application to disk – middleware, applications, VMs, and hardware
- Subscription-based pricing

OCM Cloud Services

OCM Services	Description
Application Container Cloud Services	Easily and quickly deploy your Java SE and Node.js™ applications to the Oracle Cloud Platform.
Database Cloud Service	Consolidate and manage databases as cloud services. Accelerate analytical performance while achieving new levels of efficiency, security and availability
Integration Cloud Service	Simplify integration and maximize the value of your investments in SaaS, PaaS and on-premises applications through a simple and powerful integration platform in the cloud
Java Cloud Service	A subscription-based service that provides a complete Oracle WebLogic clustered deployment including load balancing
Messaging Cloud Service	Enables communication between software components by sending and receiving messages via a single messaging API to achieve a dynamic, automated business workflow environment
SOA Cloud Service	A comprehensive, standards-based software suite to build, deploy and manage integration following the concepts of service-oriented architecture (SOA)

OCM: Oracle Provided Services

OCM Services	Description
Backup and Restoration	Regularly scheduled backups of the Oracle Cloud Machine infrastructure
Change Management	Maintains the integrity of the Cloud Machine environment in a proactive manner by governing all change requests and maintenance records
Cloud Administration	Manage and maintain the Cloud Machine IaaS resources and PaaS infrastructure
Incident Management and Resolution	ITIL-based processes and technological expertise for system administration and incident resolution
Installation and Configuration	Comprehensive, standard system hardware installation including site audit, installation and configuration, hardware, network and operating system functionality validation
Monitoring	Predictive monitoring provides 24x7 proactive system monitoring; these services help ensure uptime and deliver increased service levels via proactive notification of potential issues, enabling staff to focus on core business activities
Oracle Cloud Support	Management of product support Service Requests (SR) for hardware and software components of the Oracle Cloud Machine
Patching	Periodic deployment of patches to proactively keep your business-critical infrastructure up to date
Upgrades	Management of on-boarding of new Cloud Services and enhancements to existing services

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- **Infrastructure as Code (IaC)**

In Enterprise Computing Only Two Things Matter

QoS

TCO

In Enterprise Computing Only Two Things Matter

- **QoS** ... Quality of Service is a simple way of saying a solution is
  - Stabile
  - Secure
  - Scalable
  - Addresses a business need
- **TCO** ... Total Cost of Ownership is a simple way of saying enterprise computing solutions must
  - Not negatively impact the cost or ability to deliver products and services
- Many separate factors contribute to each of these from staffing to complexity ... but ultimately what matters can be summed up in these two acronyms
- At Meta7 we are in the business of solving business problems through the application of technologies that achieve both goals simultaneously

A Short History of Enterprise Computing (1:3)

- In the 1960s databases were flat files on mainframes; application interfaces were dumb terminals; reports were green bar
  - Our customers paid for computing by the tick of the cpu clock

- In the 1980s mainframes with flat files were replaced with client-server computing with relational databases such as Informix, Sybase, and Oracle
  - The database resided on a UNIX server; applications resided on user's desktops; reports came from local printers on standard paper
  - Our customers paid for computing by the number of cpu cores
- In the 2000s client-server was replaced with n-tier architecture with separate database, application, and web servers
  - Databases continued to reside on a UNIX server; applications resided in the data center and were delivered to web browsers
  - Our customers continued to pay for computing by the number of cpu cores
- Beginning in the 2010s it became apparent we were drowning with too much complexity, too little security, and far too much cost

A Short History of Enterprise Computing (2:3)

- In the 2010s it became apparent to industry leaders that the evolution from mainframe to client-server to n-tier had led us to endlessly increasing costs and complexity, and to issues impacting stability, security, and scalability
- And that the exact same problem exists that drove mainframes and COBOL to near extinction: **IT is not responsive to the needs of the business**
- Thus the DevOps and the "Cloud" architecture were born based on the best of breed from previous architectures and new concepts such as Infrastructure as Code (IaC)
  - Stability, often referred to as "high availability" is improved by infrastructure and software that eliminate single points of failure
  - Security is improved by deploying "best practices" too expensive for most enterprises to deploy for themselves
  - Scalability is improved through using IaC to manage a large pool of resources while controlling costs so that we only pay for what we use

A Short History of Enterprise Computing (3:3)

- But the most important benefits from "the Cloud" have nothing to do with "the Cloud"
- Just-in-time (JIT) is an inventory strategy companies first began employing in the 1980s to increase efficiency and decrease waste by receiving goods only as they are needed in the production process, thereby reducing inventory costs
- The most important benefit derived from "the Cloud" is the realization that "Just In Time" provisioning can be applied to IT
  - Purchase only what you need
  - Just before you need it

What is Infrastructure as Code (IaC)?

- Infrastructure as Code is the process of managing and provisioning computer data centers through machine-readable definition files, rather than physical hardware configuration or interactive configuration tools
- Both physical equipment such as bare-metal servers and virtual machines and associated configuration resources are called "infrastructure"
- The concept of IaC is one of using code to design, implement, and deploy application infrastructure with known software best practices
- The ability to treat infrastructure as code allows for a cycle of development, pre-production testing and deployment after quality checks that has been behind the success of essentially all technology-based projects from the Hubble Space Telescope to the mobile phone system

The IaC Business Case

- The value of Infrastructure as Code can be broken down into three, measurable categories
  - Cost (reduction)
    - Cost reduction aims at helping not only the enterprise financially but also in terms of people and effort, meaning that by removing the manual component, people are able to refocus their efforts towards other enterprise tasks
  - Speed (faster execution)
    - Infrastructure automation enables speed through faster execution when configuring your infrastructure and aims at providing visibility to help other teams across the enterprise work quickly and more efficiently
  - Risk (remove errors and security violations)
    - Automation removes the risk associated with human error, like manual misconfiguration; removing this can decrease downtime and increase reliability
    - IaC, by definition, increases the organization's maturity providing built-in Change Management and a single version of truth

Traditional Database Deployment (1:4)

1. Identify resource requirements
   - Storage requirements
   - Network requirements
   - Server capabilities
   - Security requirements
   - High Availability Requirements (DR, SLA, RTO, RPO)
2. Provision infrastructure
   - IP addresses
   - Appropriate quantities of Tier 1 (and Tier 2 storage)
   - Rack space
   - Operating system licenses
   - Database licenses
   - Other licenses
3. Download software for installation

Traditional Database Deployment (2:4)

4. Wait while
   - Storage is provisioned
   - Holes are punched in the firewall
   - Infrastructure is racked and stacked
   - Operating systems are misconfigured
5. Install software in the Oracle Home(s)
   - Multiplex the control file
   - Multiplex the redo logs
   - Configure sqlnet, listener, and tnsnames .ora files
   - Configure spfile parameters
   - Configure auditing
6. Go to support.oracle.com and
   - Research the one-off patches that need to be applied
   - Download the patches
7. Apply each patch sequentially

Traditional Database Deployment (3:4)

8. Install the OEM Agent and configure credentials
9. FTP everything to the DR site and repeat steps 2, 4, 5, 7 and 8
10. Register the database with the RMAN repository

Traditional Database Deployment (4:4)

- You may be Ok if
  - It isn't a RAC cluster
  - GoldenGate or other Data Integration products are not in use
  - The current SAN has sufficient capacity and can be expanded to hold storage for the next 3-5 years
  - The current VLANs are not overprovisioned so that you are getting only a fraction of the 10gEth you need
  - The initial requirements, as gathered, are reasonably accurate
  - The system either does not grow or has a growth rate within the expected range
  - Your system architects, System Admins, Network Admins, and Storage Admins regularly read the Oracle docs, read Oracle books and blogs, attend user group conferences, and are aware of the many issues that exist when deploying on blade servers and generic converged infrastructure solutions
  - Nothing else is provisioned in the data center as a shared service that starts utilizing your database's portion of the resources

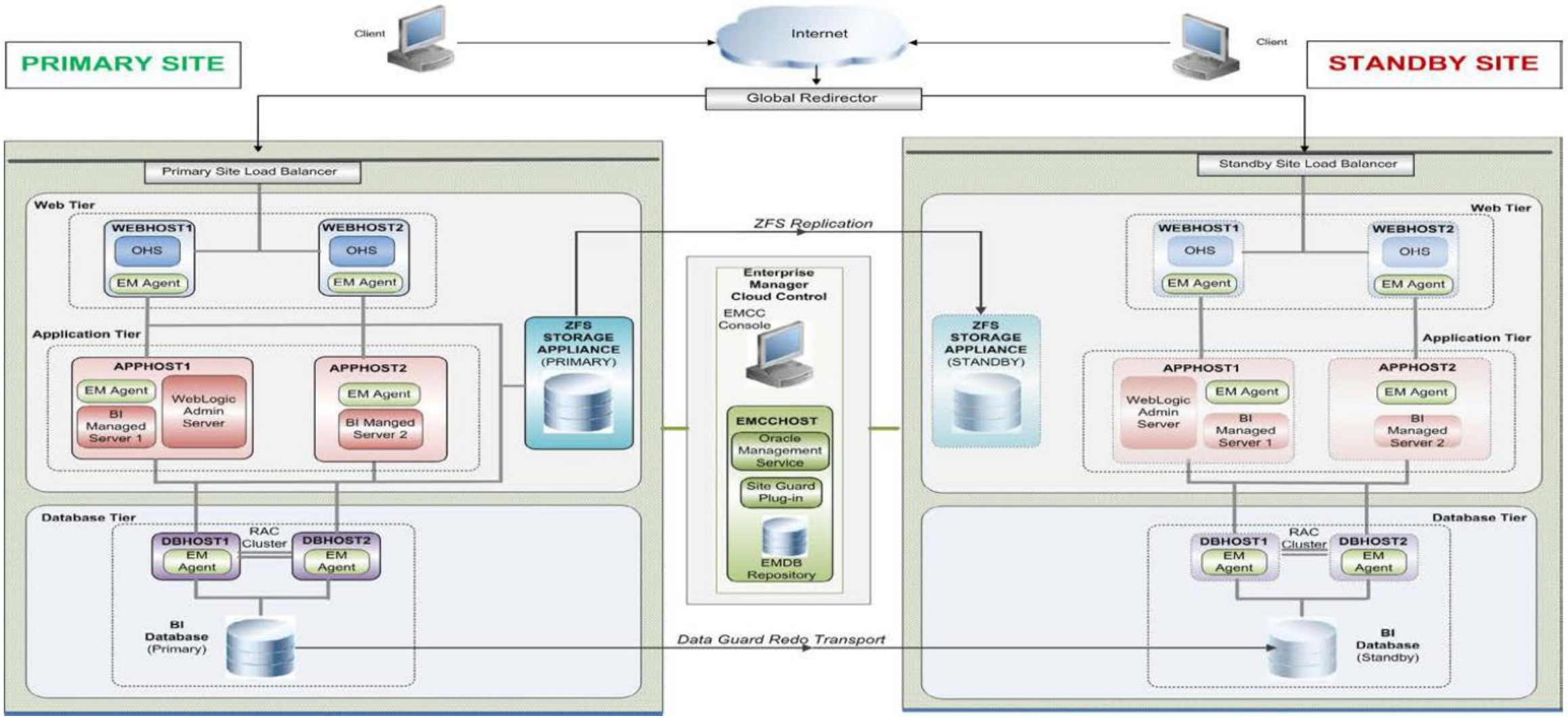
IaC Database Deployment

1. Identify resource requirements
   - Storage requirements
   - Network requirements
   - Server capabilities
   - Security requirements
   - High Availability Requirements (DR, SLA, RTO, RPO)
2. Write what definition of what you want to deploy in an IaC configuration file
3. Execute the configuration

Site Guard (1:3)

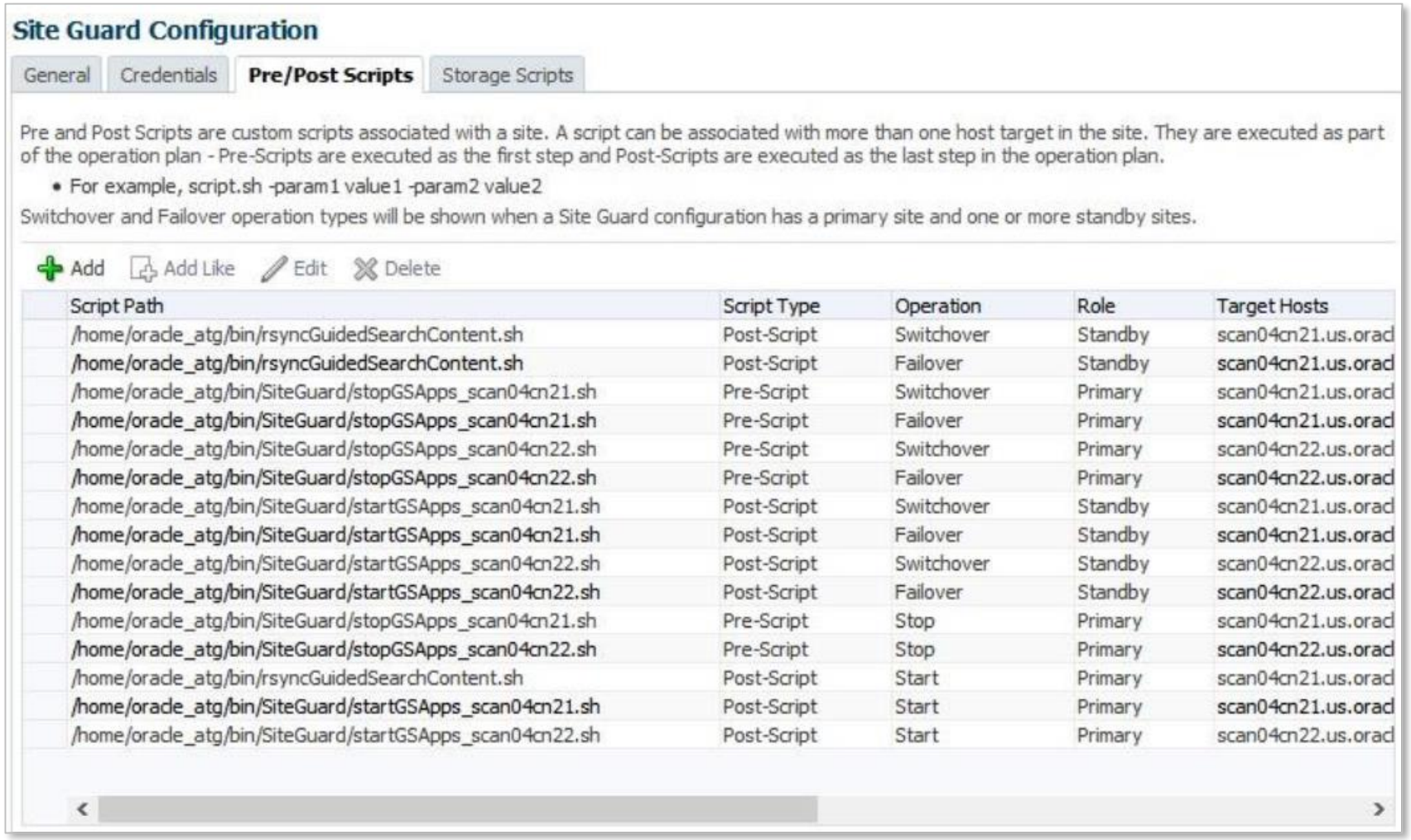
- Available as an OEM Plug-In
- End-to-end Disaster Recovery automation orchestrating coordination and automation of switchover and failover between data centers
- Achieves graceful site level role transitions
- Extensible to integrate with 3rd party infrastructure components
- Reduces the possibility of human errors

Site Guard (2:3)



Site Guard (3:3)

- Sample Site Guard script



Script Path	Script Type	Operation	Role	Target Hosts
/home/oracle_atg/bin/rsyncGuidedSearchContent.sh	Post-Script	Switchover	Standby	scan04cn21.us.orac
/home/oracle_atg/bin/rsyncGuidedSearchContent.sh	Post-Script	Failover	Standby	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn21.sh	Pre-Script	Switchover	Primary	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn21.sh	Pre-Script	Failover	Primary	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn22.sh	Pre-Script	Switchover	Primary	scan04cn22.us.orac
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn22.sh	Pre-Script	Failover	Primary	scan04cn22.us.orac
/home/oracle_atg/bin/SiteGuard/startGSApps_scan04cn21.sh	Post-Script	Switchover	Standby	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/startGSApps_scan04cn21.sh	Post-Script	Failover	Standby	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/startGSApps_scan04cn22.sh	Post-Script	Switchover	Standby	scan04cn22.us.orac
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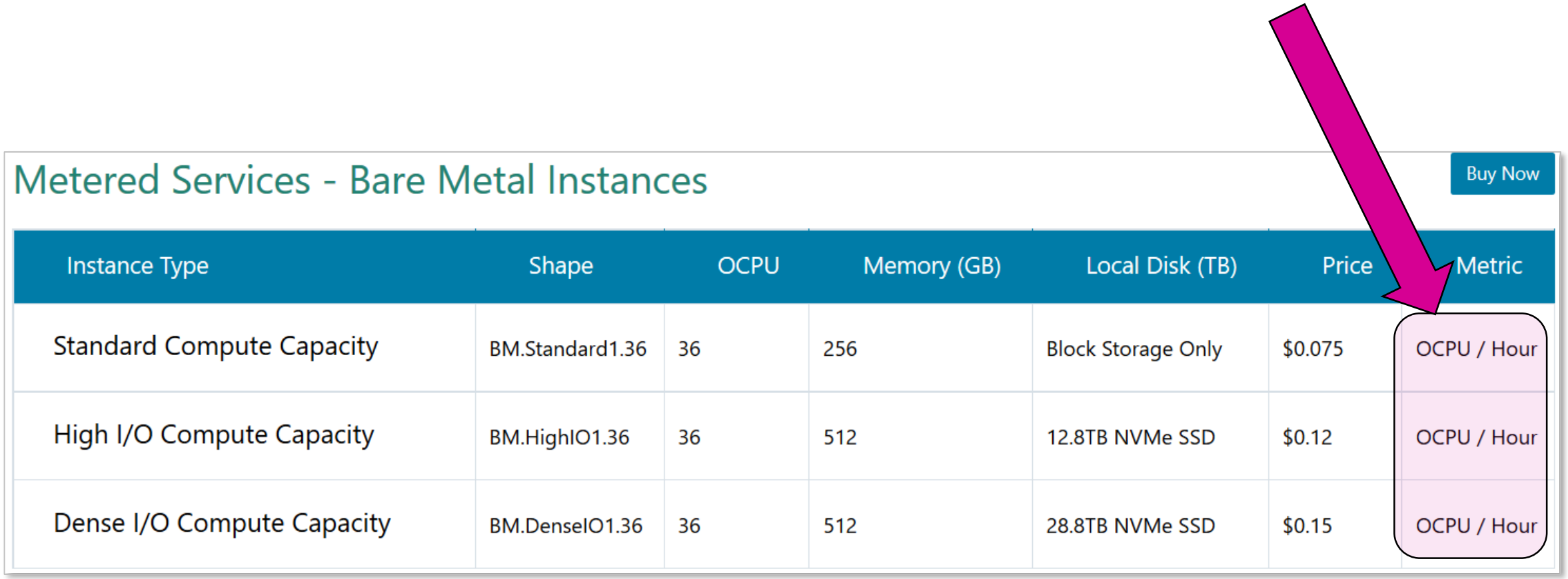
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn21.sh	Pre-Script	Stop	Primary	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/stopGSApps_scan04cn22.sh	Pre-Script	Stop	Primary	scan04cn22.us.orac
/home/oracle_atg/bin/rsyncGuidedSearchContent.sh	Post-Script	Start	Primary	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/startGSApps_scan04cn21.sh	Post-Script	Start	Primary	scan04cn21.us.orac
/home/oracle_atg/bin/SiteGuard/startGSApps_scan04cn22.sh	Post-Script	Start	Primary	scan04cn22.us.orac

The Traditional Database Purchasing Algorithm

- Determine the largest resource requirement you anticipate having over the following 12-60 months
  - Add a percentage to that requirement to provide a safety margin
- Purchase infrastructure and licensing capable of meeting that peak load requirement
- Pay for that infrastructure, licensing, and associated support cost 7 x 24 x 365
- If your requirement decreases you are stuck with what you purchased
- If your requirements increase use a forklift to move it out into the parking lot and purchase more
  - more expensive infrastructure
  - more storage
  - more servers
  - more licenses
  - more support

The Metered Services Purchasing Algorithm

- Purchase, each hour precisely what you need for that hour
- If your requirement decreases purchase less lowering your cost of operations
- If your requirements increase purchase more in accordance with your need

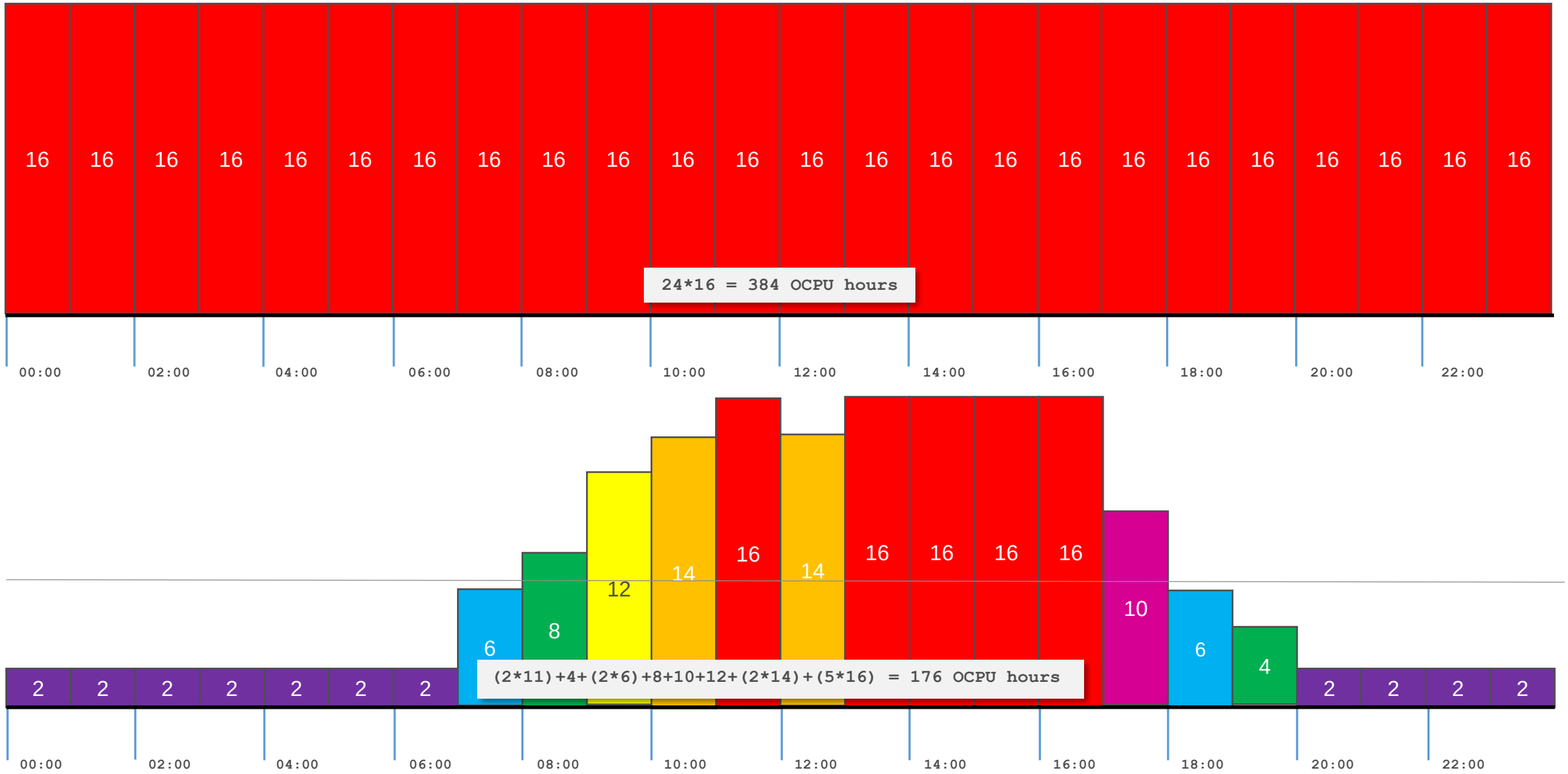


Metered Services - Bare Metal Instances

Buy Now

Instance Type	Shape	OCPU	Memory (GB)	Local Disk (TB)	Price	Metric
Standard Compute Capacity	BM.Standard1.36	36	256	Block Storage Only	$0.075	OCPU / Hour
High I/O Compute Capacity	BM.HighIO1.36	36	512	12.8TB NVMe SSD	$0.12	OCPU / Hour
Dense I/O Compute Capacity	BM.DenseIO1.36	36	512	28.8TB NVMe SSD	$0.15	OCPU / Hour

Fixed vs. IaC (1:2)



Fixed vs. IaC (2:2)

- The following is based on Oracle's published cost of $0.15 Per OCPU per hour for an 8,760 hour year (365 x24) based on a 7 day week

IaaS CPU cores	Cost/OCPU/hour	OCPU hrs/year	Annual Cost
Fixed 16	0.15	140,160	$21,024
Dynamic: Managed	0.15	64,240	$ 9,636

- Calculated on a 5 day business week not paying for maximum capabilities on Saturdays and Sundays

IaaS CPU cores	Cost/OCPU/hour	OCPU hrs/year	Annual Cost
Fixed 16	0.15	140,160	$21,024
Dynamic: Managed	0.15	50,752	$ 7,613

- Dynamic Management brings in addition to providing all of its other benefits provides an annual Cloud deployment saving of between 54% and 64%

DBaaS with IaC vs. x86

- DL580 pricing is based on the fully discounted price of all components over 3 years and an Oracle EE license discount of 35%
- Cloud pricing is based on Oracle's published list price for DBaaS of $6.72 Per OCPU per hour after applying a 15% discount ($5.71/ocpu hr) over 3 years
- Both are based upon bare metal installation and 20 TB of usable storage

Compute Node	Server Cost	Storage	Server Support	O/S Support	DB Support	FTEs	DC	TCO (3 yrs)
HP DL580 16 core	$58,100	$30,000	$2,176	$2400	$163,020	$60,000	$1,736	$317,432
DBaaS 16 ocpu	$289,794	$13,000	included	included	included	$8,000	included	$310,794

- Add to the HP DL580 solution all costs associated with
  - Security including firewalls
  - Network infrastructure including switches and routers, and load balancers
  - Insurance
  - Taxes
- With the HP DL580 if you need 20 cpu cores ... buy another server + licenses
- With the IaC solution if you need 20 cpu cores ... you bring it online in 60sec.

Oracle Cloud IaC Code Sample (1:2)

```
  sshKeys.#: "" => "1"
  sshKeys.0: "" => "ATS-cluster-ssh"
  vcable:    "" => "<computed>"
opc_compute_instance.web_nodes.0: Creating...
  imageList: "" => "/Compute-a430291/DRAUBA@forsythe.com/Ubuntu.16.04-LTS.amd64.20170307.1"
  ip:        "" => "<computed>"
  label:     "" => "WEB1"
  name:      "" => "WEB1"
  opcId:     "" => "<computed>"
  shape:     "" => "oc3"
  sshKeys.#: "" => "1"
  sshKeys.0: "" => "ATS-cluster-ssh"
  vcable:    "" => "<computed>"
opc_compute_security_ip_list.open-internet: Creation complete (ID: open-internet)
opc_compute_security_list.ATS-cluster: Creation complete (ID: ATS-cluster)
opc_compute_ip_reservation.web_node_reservations.1: Creation complete (ID: 0edc423b-...fd4311f1)
opc_compute_ip_reservation.web_node_reservations.0: Creation complete (ID: 7a72ecf7-...3b0c8701)
opc_compute_security_list.allow-ssh: Creation complete (ID: allow-ssh)
opc_compute_security_rule.allow-ssh: Creating...
  action:           "" => "permit"
  application:      "" => "/oracle/public/ssh"
  destination_list: "" => "seclist:allow-ssh"
  disabled:         "" => "false"
  name:             "" => "allow-ssh"
  source_list:      "" => "seciplist:open-internet"
opc_compute_security_rule.allow-ssh: Creation complete (ID: allow-ssh)
opc_compute_instance.web_nodes.1: Still creating... (10s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (10s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (20s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (20s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (30s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (30s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (40s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (40s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (50s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (50s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (1m0s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (1m0s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (1m10s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (1m10s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (1m20s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (1m20s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (1m30s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (1m30s elapsed)
opc_compute_instance.web_nodes.1: Still creating... (1m40s elapsed)
opc_compute_instance.web_nodes.0: Still creating... (1m40s elapsed)
opc_compute_instance.web_nodes.1: Creation complete (ID: WEB2)
opc_compute_instance.web_nodes.0: Still creating... (1m50s elapsed)
```

Oracle Cloud IaC Code Sample (2:2)

```
null_resource.install-consul (remote-exec): Reading package lists... 0%
null_resource.install-consul (remote-exec): Reading package lists... 100%
null_resource.install-consul (remote-exec): Reading package lists... Done
null_resource.install-consul (remote-exec): Building dependency tree... 0%
null_resource.install-consul (remote-exec): Building dependency tree... 0%
null_resource.install-consul (remote-exec): Building dependency tree... 50%
null_resource.install-consul (remote-exec): Building dependency tree... 50%
null_resource.install-consul (remote-exec): Building dependency tree
null_resource.install-consul (remote-exec): Reading state information... 0%
null_resource.install-consul (remote-exec): Reading state information... 7%
null_resource.install-consul (remote-exec): Reading state information... Done
null_resource.install-consul (remote-exec): curl is already the newest version (7.47.0-1ubuntu2.2).
null_resource.install-consul (remote-exec): 0 upgraded, 0 newly installed, 0 to remove and 23 not upgraded.
null_resource.install-consul (remote-exec): Fetching Consul...
null_resource.install-consul (remote-exec):   % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
null_resource.install-consul (remote-exec):                                 Dload  Upload   Total   Spent    Left  Speed
null_resource.install-consul (remote-exec):   0     0    0     0    0     0      0      0 --:--:-- --:--:-- --:--:--     0
null_resource.install-consul (remote-exec):   0 8559k    0 29473    0     0  33309      0  0:04:23 --:--:--  0:04:23 33302
null_resource.install-consul: Still creating... (1m0s elapsed)
null_resource.install-consul (remote-exec):  28 8559k   28 2463k    0     0  1310k      0  0:00:06  0:00:01  0:00:05 1310k
null_resource.install-consul (remote-exec):  88 8559k   88 7615k    0     0  2645k      0  0:00:03  0:00:02  0:00:01 2645k
null_resource.install-consul (remote-exec): 100 8559k  100 8559k    0     0  2803k      0  0:00:03  0:00:03 --:--:-- 2804k
null_resource.install-consul (remote-exec): Installing Consul...
null_resource.install-consul (remote-exec): Installing Systemd service...
null_resource.install-consul (remote-exec): Starting Consul...
null_resource.install-consul (remote-exec): using systemctl
null_resource.install-consul (remote-exec): Created symlink from /etc/systemd/system/multi-user.target.wants/consul.service to /etc/systemd/system/consul.service.
null_resource.install-consul (remote-exec): # Generated by iptables-save v1.6.0 on Fri Apr  7 15:49:47 2017
null_resource.install-consul (remote-exec): *filter
null_resource.install-consul (remote-exec): :INPUT ACCEPT [4:388]
null_resource.install-consul (remote-exec): :FORWARD ACCEPT [0:0]
null_resource.install-consul (remote-exec): :OUTPUT ACCEPT [4:356]
null_resource.install-consul (remote-exec): -A INPUT -p tcp -m tcp --dport 8400 -j ACCEPT
null_resource.install-consul (remote-exec): -A INPUT -p tcp -m tcp --dport 8302 -j ACCEPT
null_resource.install-consul (remote-exec): -A INPUT -p tcp -m tcp --dport 8301 -j ACCEPT
null_resource.install-consul (remote-exec): -A INPUT -p tcp -m tcp --dport 8300 -j ACCEPT
null_resource.install-consul (remote-exec): COMMIT
null_resource.install-consul (remote-exec): # Completed on Fri Apr  7 15:49:47 2017
null_resource.install-consul: Creation complete (ID: 3750839304722881756)

Apply complete! Resources: 18 added, 0 changed, 0 destroyed.

The state of your infrastructure has been saved to the path
below. This state is required to modify and destroy your
infrastructure, so keep it safe. To inspect the complete state
use the `terraform show` command.
```

TCO Summary

- Unlike the unrealized promises you have heard for years ... the TCO savings are measurable
  - Finance
    - CapEx becomes OpEx
    - Move your IT to Just In Time (JIT) procurement and provisioning
    - Purchase only what you need only when you need it
    - All data center costs reduced to 0
    - Cost of asset insurance reduced to 0
    - State and local taxes on assets reduced to 0
    - Budgeting becomes more predictable
    - If something breaks it is not your problem
  - FTEs
    - Network administration resources required 0
    - Storage administration resources required 0
    - System administration resources required reduced by more than 65%
    - Database administration resources refocused on QoS

QoS Summary

- Stability and reliability enhanced because applications run on infrastructure designed and deployed by Oracle's architects
- Security enhanced because application run in data centers built, certified and operated in compliance with the strictest DOD regulations
  - DBAs and IT professionals have time to concentrate on what is important to the business
- Scalability enhanced because the pool of assets, network bandwidth, storage, memory, and cpu can be immediately, and flexibly, expanded to meet essentially any requirement
- Performance enhanced by more frequent tech refreshes
- Consistent on-demand creation of Dev, Test, and Production environments

In Enterprise Computing Only Two Things Matter

QoS

TCO

Thank You For Your Time

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