Containers:
The Future of Virtualization & SDDC

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Containers: The Future of Virtualization & SDDC

This session will appeal to Data Center Managers, Development Managers, and those that are seeking a fundamental understanding of the future of virtualization and next generation software defined data centers both on-premise and in clouds. The session delves into the emergence of containers as the next generation of virtualization to run multiple applications without a hypervisor and as the light weight platform that will extend to software defined data centers (SDDC). Their rapid adoption by both startups and major IT vendors is a testament to their “Build and Configure once, run anywhere” portability between On-Premise DCs to Clouds. The session is targeted to bring a clear understanding of this key technology to developers as well as systems admins and cloud service providers.
IT Industry Roadmap (Source: © IMEX Research)

Big Data Analytics
Predictive, Cognitive Analytics-Unstructured/All Data
From Dashboards Visualization to Prediction Engines using Big Data.

Automation/SDDC
Automatically Config Srvcs to Meet VM/App SLAs
(Self-Discover/Configure, Self-Healing©IMEX, Centralized Control OnPrem or Cld

Cloudization
On-Premises > Private Clouds > Public Clouds
Cloud-Aware Infrast.In DCs., Cascade Apps migration to SPs/Public Clouds.

Virtualization–VMs & Containers
Pools Resources. Provisions & Monitors
Resources to optimize Delivery of various Business Services

Integration/Consolidation
Integrate Physical Infrast./Blades to meet CAPSIMS©IMEX
Cost, Availability, Performance, Scalability, Inter-operability, Manageability & Security

Standardization
Standard IT Infrastructure- Volume Economics HW/Syst SW
(Servers, Storage, Networking Devices, System Software (OS, MW & Data Mgmt. SW)
## Data Center IT Issues & Solutions

### Issue

| • VMs/Hypervisor treated all apps as same  
  ✓ Created Blender Effect  
  ✓ Poor Performance of some VMs | • Workload I/O Optimized Infrastructure  
  • Solid State/Flash for I/O intensive Apps (e.g. OLTP)  
  • Application segregated by Frequency of use into Hot/Warm/Cold Storage |
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<td>• Each Application is different and depending on its SLA/mission criticality needs in the Data Center or Cloud</td>
<td>• Must identify various Metrics to meet SLA needs such as Availability, Performance, Cost, Security etc. (e.g. Performance metrics - Latency vs Bandwidth)</td>
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| • Storage must meet 2 major criteria of  
  ✓ Data Protection  
  ✓ Storage Efficiency | • Implement technologies  
  ✓ RAID, Continuous Availability,  
  ✓ Compression, Encryption, |
| • Real-Time IT/Databases needed for both  
  ✓ On-line Transaction Processing to  
  ✓ Real-Time Deep Queries  
  ✓ Cloud Queries Exploding  
  ✓ VMs heavy due having to load 10-20 MB of OS from storage slowing queries | • Implement New technologies  
  ✓ RDBMS/Big Data/Virtualization VMs,  
  ✓ Columnar Compression  
  ✓ Use of Lightweight Containers with no Hypervisor or not having to load OS – witness Google containers using 7000 queries per second |

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Virtualization: Impact on IT Infrastructure

Virtualization led Workload Consolidation provided >20x Savings in RE, Pwr., HA

Virtualization: TCO

995 Pre-Virtualization (VZ) Servers → 78 VZ Servers

Multiple VMs create I/O Blender & Bottlenecks in Physical Servers sharing Memory

Virtualized Server Penetration

50% of all servers in 2011 growing to 85% by 2016

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Past, Present & Future of Virtualization

Legend: DE=Docker Engine; G-OS=Guest Operating System; HOST=Host Operating System; PI=Physical Infrastructure

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[Image of diagram showing Legacy Computing, Virtualization, and Containerization with labels and diagram for Docker Engine and Hypervisor]
Containers: In Perspective

Container = Hottest Trend in Data Center Innovation
Container = Opening next wave of optimization of computing power usage post VMs
Container = Lightweight OS Level Virtualization
Container = Runs Multiple Apps without a Hypervisor
Container = Build and Configure Once, Run Anywhere
Container = Key to Google Search Engine speeds
  Google - World’s largest Linux Containers User
  Google Search launches 7000 containers/sec
  Search App in Container launches in msec
State of Containers Industry

Containers: An open source app portability platform that packages app and its dependent component parts into a hardware isolated container

Containers provide a more efficient use of Resources:: Eliminates Hypervisor reducing virtualization overhead while still allowing separation and isolation of multiple tasks on one host without relying on a separate OS, saving huge amount of HW resources compared to bulky VMs which emulate physical servers complete with OS

Allows Easy Application Portability between different hosts within DCs, DC to DC/ DC to Cloud (Private, Public, Hybrid) / Cloud to Cloud

Rapidly gaining adoption: Over 15000 aps have been “containerized” and available on Docker Hub repositories, ready for server admins and cloud server providers to deploy both as free and paid options.

Significant buy-in from both start-ups and large vendors: :
Repositories – Ubuntu, Redis, MySQL, mongo DB etc.
OS Vendors - Red Hat, SUSE, CoreOS, Boot2Docker - Mac & Windows …
Clouds – IBM, Amazon, Microsoft, Rackspace, Google, Intel etc.
Major Users - Paypal, eBay, Google, Spotify etc..

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Containers: Pros & Cons

Pros

• Containers pack more computing workloads onto a single server
• Launch capacity for new computing jobs in a split second vs minutes for VMs since no loading of OS from storage required
• Appealing to Virtualization Admins and Cloud Providers to maximize consolidation and improve resources efficiency in multi-tenant price-sensitive environments
• Developers able to rapidly move their applications from concept to production since no need to boot up an OS instance of Linux or Windows for every app run
• Efficiency driven from speed allows improvements in CapEx (Buy less HW) or OpEx (Build/Rent less DC space, Fewer people in operations/maintenance).
• Speed lets DCs respond quickly in case of a sudden spike in business activity (explosion in searches/queries or Black Friday promotion driven sales orders)

Cons

• Shared back-end Host OS failures can create system-wide outages
• Can’t provide a virtual instance of windows on a Linux Server
• Uneasy co-existence with VMs in the long haul
• Much as Containers give each app running on a server its own isolated environment to run, but those containers all share host servers’ OS With severe dependencies.
VMs vs. Containers

VMs

Every app, every copy of an app, and every slight modification of the app requires a new virtual server.

Containers

Original App
No OS to take up space, resources, or require restart

Copy of App
No OS, can share bins/libs

Modified App
Copy on write capabilities allow us to only save the diffs between Container A and Container A’
## VMs vs Containers Characteristics

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<th>Metric</th>
<th>VM</th>
<th>Containers</th>
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<td><strong>Infrastructure</strong></td>
<td>• 100s of VMs can be put on a single host server each running an application w its own Guest OS&lt;br&gt;• Strong Management systems available to deal with 100s of VMs per server</td>
<td>• Lightweight, require Less Memory space&lt;br&gt;• Fast Launch time&lt;br&gt;• 1000s of containers can be loaded onto a Host. Containerized apps share Host OS’s kernel to execute work&lt;br&gt;• Containers can become ultimate form of compute intensive low power, dense computing environment</td>
</tr>
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<td><strong>Performance</strong></td>
<td>• Slower than Containers since need to retrieve 10-20 GB of OS from storage per VM launch</td>
<td>• Fast creation without shackle of retrieving OS&lt;br&gt;• Workload in Containers use Host OS kernel&lt;br&gt;• Container can boot up in 0.5 seconds&lt;br&gt;• Activates code instantly to test or launch add’l ecommerce capacity</td>
</tr>
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<td><strong>Interoperability</strong></td>
<td>• Systems designs fully compatibility with existing operations of enterprise DCs</td>
<td>• Apps are formatted in a standard way to be placed in a container.&lt;br&gt;• Once in a container, each type of app moves around the network in same way</td>
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<td><strong>Maturity</strong></td>
<td>• Robust, Highly Developed&lt;br&gt;• Proven, even in mission critical workloads</td>
<td>• Less Mature&lt;br&gt;• Kinks not worked out yet&lt;br&gt;• Cos. Still working on a creative Management System</td>
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### VMs vs Containers Characteristics

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| **Security** | • Security of a dedicated OS  
• Harder Logical Boundaries  
• Hypervisor controlled dedicated pathway between App/Guest OS and Physical Infrastructure | • High security concerns  
• Containers share CPU, Memory, Disk in close proximity to each other  
• Containers talk to each other using shared memory - one container can steal neighbor’s data or spread its malicious code to neighbors |
| **Portability** | • Highly portable between systems running same hypervisor (such as ESX, Hyper-V, Xen or KVM) | • Highly portable but bound to a certain version of an OS.  
• An app inside a container can’t move to another host OS, only where there is copy of same OS w same version level |
| **Multi-tenancy** | • VM’s Guest OS can be different than physical host’s OS allowing different types of Apps (Technical on Mac vs Marketing on Windows) to run on same Physical Host | • Higher Level isolation with many apps running under the host OS and all containers sharing certain OS’s kernel and certain Libs  
• Proven barriers to keep containers colliding each other  
• Once in a container, each type of app moves around the network in the same way |
## VMs vs Containers Characteristics

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<td><strong>Architecture</strong></td>
<td>• VMs package files that can move from one host to another over internal networks or internet</td>
<td>• Built in layers and accessed independently.- a code change affecting one layer can be executed without touching other layers, making changes less dangerous vs. monolithic architecture in which an error can stall whole application</td>
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<td>• Built in layers and accessed independently.- a code change affecting one layer can be executed without touching other layers, making changes less dangerous vs. monolithic architecture in which an error can stall whole application</td>
<td>• Google/Kubernetes for Docker Manages multi-containers adoptable by enterprises running clusters of containers for large apps across multiple computers.</td>
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<td><strong>Adoption &amp; Futures</strong></td>
<td>• Highly Developed and adopted in 50-60% of all large IT shops</td>
<td>• Google’s efforts to get container in Linux kernel &amp; Docker making its creation &amp; movements in open source helped developers rally around them as a standard, avoiding proliferations</td>
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<td>• Robust, proven, even in mission critical workloads</td>
<td>• Docker formatting engine now a standard with lots of tools/workflows</td>
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<td>• Multiple offerings by several vendors</td>
<td>• Support from Linux startups and large companies (IBM, MS, RH, Docker, Google etc.)</td>
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<td>• Being adopted as the foundation in next generation DCs and Clouds via Software Defined Data Centers SDDC – SDC/SDS/SDN</td>
<td>• IBM Docker Hub Enterprise with Middleware allowing developers install preformatted dockerized containers in their own DCs and invoke the services through a link.</td>
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Containers Lightweight Operation

App A
Bins/Libs
Base Container Image

Container Mod A'

App Δ

Push

Docker Container Image Registry

App A''
Bins/Libs
Docker Engine

Host is now running A''

App A
Bins/Libs
Docker Engine

Host running A wants to upgrade to A''. Requests upgrade. Gets only diffs.
Containers: Future of Virtualization & SDDC

Docker Ecosystem

Community
460+ Contributors
250+ Meetups on Docker
2.75M Downloads
6700 Projects on GitHub

Support
Enterprise Support
Robust Documentation
Implement, Integration, Training

Partners
rockspace hosting
IBM
openstack
Atlassian
redhat
amazon web services
ubuntu
Microsoft Azure
Chef
SALTSTACK
puppet labs

Users
ebay
RelateIQ
Spotify
mailgun
GILT
New Relic
auto.com
Groupon
OpenTable
Google Cloud Platform

Docker Platform
Docker Engine
Docker Hub
Build, Ship, and Run

Content
Official Repos & 14K+ Dockerized Apps

Content
redis
NGINX
Java
Ruby
MySQL
Rails
PostgreSQL
WordPress
node
mongoDB

Communities

Network of Partners

Official Repos & 14K+ Dockerized Apps

2.75M Downloads
6700 Projects on GitHub

250+ Meetups on Docker
Docker: Open Source Platform

Any App
+ 14K apps
+ 6K projects

API

Docker Engine
open source software at the heart of the Docker platform

Docker Hub Enterprise
cloud-based platform services for distributed applications

API

Any infrastructure
• Physical
• Virtual cloud
Docker: Engine

- Stable core
- All major Linux platforms and distributions
- Execution engine plug-ins: LXC, libcontainer
- Filesystem plug-ins: AUFS, BTRFS, device mapper
- Host networking, link hostnames
- boot2docker: Mac OS X and Windows
- Support for SELinux and AppArmor
- TLS auth, systemd slices, release hashes
Distributed Applications

- API Endpoint
- Background Workers
- Data
- Queue
- Web Frontend
- Data
- Analytics DB
- User DB

- Contributor's Laptop
- Development VM
- Production Servers
- QA Server
- Disaster Recovery
- Production Cluster
- Customer Data Center
- Public Cloud

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Official Repositories

- DBs, Web servers, OSes and more
- Free on Docker Hub Registry
- Optimized and tuned for Docker
- Maintained and supported
- Publisher program
Container Deployment Infrastructure

Integration Tests

Revision Control

Platforms

Docker Hub

Revision Control

Integration Tests

Platforms

Docker Hub

Revision Control

Integration Tests

Platforms

Docker Hub
Open Source Community

- 6K+ pull requests
- 12K+ stars
- 6.7K+ projects
- 8.5K+ commits
- 2.75M+ downloads
- 460+ contributors
- 14K+ dockerized
- 250+ meetups
- 90+ cities
- 30+ countries
Containers – In Perspective

- Containers extending virtualization to next generation computing bringing in speed with thousands of containers launch able within seconds on same hardware lowering CapEx and OpEx for enterprises and cloud service providers.
- Several start-ups and all major IT vendors endorsing it.
- Allows developers to quickly create, ready-to-run "containerized" applications and enterprises to offer preconfigured, ready to run infrastructure apps to VARs and System Integrators to add industry vertical apps.
- Makes managing and deploying applications much easier.
The SNIA Education Committee thanks the following Individuals for their contributions to this Tutorial.

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