Virtualization for Manufacturing Industries
Agenda

Overview & Drivers

Virtualization for Engineers

Virtualization for Production

Virtualization & Rockwell

Licensing Considerations
Virtualization Adoption, by Industry

Server virtualization adoption, by industry. (Percent of respondents)

- Using server virtualization in a production environment
- Using server virtualization, but in a test environment only
- Have not yet deployed server virtualization, but plan to
- Have not deployed and have no current plans to

<table>
<thead>
<tr>
<th>Industry</th>
<th>Using in Production</th>
<th>Using in Test</th>
<th>Plan to Deploy</th>
<th>Not Deployed</th>
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Virtual Machine Deployment Projection

VM Cross Over

Source: IDC
ANSI/ISA 95 Functional Hierarchy

Level 4
Business Planning and Logistics Systems

Level 3
Manufacturing Operations and Control Systems

Level 2
Data Collection, Operator and Batch Control Systems

Level 1
Equipment Control Systems

Level 0
I/O and Sensors

Business Process Information Network
Operations Information Network
Automation Network

Continuous/ Batch Manufacturing
Discrete Manufacturing
What is Virtualization?

- Traditionally the OS and its applications were tightly coupled to the hardware they were installed on.
- Virtualization breaks the link between operating system and physical hardware.
- This allows the ability to change hardware without replacing the OS or applications.
- Additionally multiple instances of an OS with independent applications can now run on the same hardware.
Considerations for Manufacturing

Virtualization is widely adopted by IT and growing in Manufacturing
Manufacturing has some unique Considerations and Opportunities

- Long ICS upgrade cycles vs. short IT upgrade cycles
- Space, power, cooling and management limitations
- Management of operator and engineering workstations
- Management of multiple incompatible software versions
- Higher downtime costs

Address with Virtualization Value Propositions

- System longevity with HW/SW abstraction
- Server consolidation
- Centralized server management and deployment
- Centralized workstation management and deployment
- Improve reliability with management and recovery features
Increased Application Longevity

- Typical computer refresh cycle is 3-5 years
- Typical Industrial control system refresh is 15 to 20 years
- Computer replacements typically require software upgrades which are expensive and difficult
- Virtual hardware exposed to the guest OS does not change when physical hardware is replaced
- Each virtual hardware version is supported for three major releases of vSphere
### VMware vSphere: Most Comprehensive OS Support

**MS Hyper-V R2 with SP1**
- Windows Server 2003 (32/64)
- Windows Server 2008 (32/64)
- Windows Home Server 2011
- Windows Storage Server 2008 R2
- Windows Small Business Server 2011
- Windows 7 (32/64)
- Windows Vista (32/64)
- Windows XP (32/64)
- RHel 5 (32/64)
- RHel 6 (32/64)
- SLES 10 (32/64)
- SLES 11 (32/64)
- CentOS 5 (32/64)
- CentOS 6 (32/64)

**Total: 25**

**Citrix XenServer 6**
- Windows Server 2003 (32/64)
- Windows Server 2008 (32/64)
- Windows 7 (32/64)
- Windows Vista
- Windows XP
- RHEL 4
- RHEL 5 (32/64)
- RHEL 6 (32/64)
- SLES 9
- SLES10 (32/64)
- SLES11 (32/64)
- Debian Lenny 5
- Debian Squeeze 6 (32/64)
- CentOS 4
- CentOS 5 (32/64)
- Oracle OEL 5 (32/64)
- Oracle Linux 6 (32/64)
- Ubuntu 10 (32/64)

**Total: 30**

**VMware vSphere 5**
- MS-DOS 6.22
- Windows 3.1
- Windows 95
- Windows 98
- Windows NT
- Windows Preinstallation 2 (32/64)
- Windows XP (32/64)
- Windows Vista (32/64)
- Windows 7 (32/64)
- Windows 2000
- WinServer 2003 (32/64)
- WinServer 2008 (32/64)
- RHEL 2.1
- RHEL 3 (32/64)
- RHEL 4 (32/64)
- RHEL 5 (32/64)
- RHEL 6 (32/64)
- SLES 8
- SLES 9 (32/64)
- SLES 10 (32/64)
- SLES 11 (32/64)
- Debian 4 (32/64)
- Debian 5 (32/64)
- Debian 6 (32/64)
- CentOS 4 (32/64)
- CentOS 5 (32/64)
- CentOS 6 (32/64)
- Oracle OEL 4 (32/64)
- Oracle OEL 5 (32/64)
- Oracle Linux 6 (32/64)
- Asianux 3 (32/64)
- Asianux 4 (32/64)
- Ubuntu 7 (32/64)
- Ubuntu 8 (32/64)
- Ubuntu 9 (32/64)
- Ubuntu 10 (32/64)
- Ubuntu 11 (32/64)
- FreeBSD 6 (32/64)
- FreeBSD 7 (32/64)
- FreeBSD 8 (32/64)
- Solaris 8
- Solaris 9
- Solaris 10 (32/64)
- OS/2 Warp 4
- NetWare 5
- NetWare 6
- eComStation 1
- eComStation 2
- SCO UnixWare 7
- SCO OpenServer 5
- Mac OS X 10 (32/64)

**Total: 85**

Data collected Mar 1, 2012
Server Consolidation

• Many physical servers
  - Under utilized
  - Requiring maintenance
  - Generating heat
  - Consuming energy

• Fewer physical servers
  – More efficiently utilized
  – Easier to maintenance
  – Generating less heat
  – Consuming less energy
Agenda

Overview & Drivers

Virtualization for Engineers

Virtualization for Production

Virtualization & Rockwell

Licensing Considerations
Hosted (aka Desktop) Virtualization

Hypervisor runs as an application on another OS such as Linux or Windows

Advantages:
• Low cost
• Self administered
• Independent of IT management and controls
VMware Player Overview

- Free solution built on the same hypervisor technology as VMware Workstation
- Allows basic creation, modification and use of one or more virtual machines
- Similar in functionality to Windows Virtual PC and Windows XP mode for Windows 7

Aimed at end users that need multiple OS or software versions with limited IT support.
VMware Workstation Overview

- Easily and quickly build and run multiple VM’s
- Snapshot capabilities to allow rapid recovery from botched upgrades or destructive tests
- Basic server functions, for sharing VM’s with a team of engineers
- Integration with VMware vSphere

Aimed at developers and engineers that need to build a multi-tiered application in a test environment, then seamlessly migrate to a production server cluster.
Workstation vs. Player

**Workstation**
- Support for VM groups
- Basic VM sharing / serving support
- Integration with VMware vSphere
- Snapshots – create restore points for destructive tests

**Player**
- Free – for *noncommercial* use
- Basic virtual machine creation and management
- Common hypervisor technology with Workstation
Agenda

- Overview & Drivers
- Virtualization for Engineers
- **Virtualization for Production**
- Virtualization & Rockwell
- Licensing Considerations
Server (aka Bare Metal) Virtualization

Hypervisor replaces host operating system and manages host hardware and resources

Advantages:
- Reduced host maintenance
- Improved host reliability
- Reduced security surface area
- Data center level vendor support
VMware vSphere Overview

- Combines multiple servers and storage units into a pool of resources that can be divided between applications
- Provides central management for servers and their applications
- Advanced high availability and disaster recovery features

Intended to provide a highly available, always on back end for server applications and desktops. Can segment hardware into multiple priority groups allowing development testing and production to share the same hardware.
Centralized management (servers)

- Monitor all host servers and virtual machines
- Deploy new VM’s from template
- Attached to the console session to manage installed applications
- Shutdown / reset problem VM’s
- (optional) Backup and restore virtual machines with integrated addons
Manageability: vMotion

- Migrate a running VM from one physical server to another
Manageability: DRS

- Management server monitors host load and virtual machine placement vs. defined rules.
- Either suggests or automatically executes vMotion operations

![Diagram showing resource pool and virtual machines in VMware ESXi environments with management server monitoring host load and virtual machine placement.]
DRS Live Demo
Reliability: High Availability

- Hosts monitor each other and their virtual machines for failure.
- Failed virtual machines automatically restarted where resources are available.
HA Live Demo
Reliability: VMware Fault Tolerance

- Virtual machines execute simultaneously on two physical servers
- Bumpless failover in the event of a HARDWARE failure
Increasing Uptime and Availability

**Local Site**
- vSphere High Availability
- vSphere Fault Tolerance
- vMotion and Storage vMotion

**Data Protection**
- vSphere Data Recovery
- Storage APIs for Data Protection

**Failover Site**
- vCenter Site Recovery Manager
- Includes vSphere Replication

**Disaster Recovery**

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VMware View Overview

- Central management for both engineering and operations clients
- Rapid deployment of new desktops and updates
- Run virtual machines on production server cluster, or on engineering laptop
- Client can run on a range of devices from desktops to tablets
- End user focuses on using the applications rather than managing his virtual machine library

Aimed at systems that could benefit from centralized management
Extend server virtualization benefits to clients:

- Software independence from hardware
- Lower Administration and Support Costs
- Rapid Desktop Deployment
- Leverage VM Availability Features
- Centralized disaster recovery
- Integrated Secure Remote Access
- Offline Mode
Centralized management (clients)

- View status of current clients
- Reset problem clients
- Provision new systems
- Rapidly deploy tested patches or software updates
- Entitle or revoke user access

VMware View VDM can also be used to manage access to Microsoft Terminal Services
VMware View vs. Workstation

**VMware View**
- Production Environments
- Centralized management
- Composer functionality for rapid patch and update deployment
- Securely provision environments for contractors and vendors
- Thin client support
  - Execution occurs in the data center not at the client endpoint
- Offline mode support
  - Allows disconnect use of desktop for traveling users

**Workstation**
- Development for SI/Engineers
- Decentralized management
- Lower hardware costs for small deployments
- Broader OS support
Typical Hardware Architecture

In the data center
- Storage Array (iSCSI, FC, NFS)
- 2-5 Physical Servers
- Redundant Gigabit Switches

In the office and on the shop floor
- legacy desktops
- ruggedized laptops
- solid state thin clients
- Tablets (iPad / Android)
Server Considerations

- CPU
  - 2 CPU sockets with 4-8 cores each
  - Consolidation Ratios of 8 – 20 VM’s per Server

- Memory
  - 32-128GB physical RAM per server
  - Suggested initial allocations
    - Operator Workstations: 2 GB
    - Engineer Workstation: 4 GB
    - HMI/Historian Server: 4 GB
  - Monitor actual memory usage and adjust allocations up or down depending on actual application usage

- Number of Servers
  - For redundant systems, 3 physical servers is a suggested minimum, allowing for full application redundancy during infrastructure maintenance periods.
Storage Considerations

- **Storage Options**
  - Fibre Channel
  - NAS
  - iSCSI
  - Direct Attached SAS
  - Virtualized SAN

- **Selection Factors**
  - Capacity / Price / Performance
  - Disk types (SCSI, ATA, FC, SATA)
  - Access Time; IOPS; Sustained Transfer Rate
  - Reliability (MTBF)

*Virtual machine performance is highly dependent on I/O throughput of the storage array*
Virtualization requires additional networks to manage and isolate information traffic

- VM Network(s)
  - Ie./ Assembly Line 1 VLAN, Assembly Line 2 VLAN, DMZ
- Management / vMotion
- Storage Network (If applicable)
- Fault Tolerant Network

So how many NIC’s do I need on my server?

- 2 per traffic type.
  - For a system with iSCSI, Fault Tolerance and a DMZ: 10

- Gigabit Switches are required, 10GbE switches may be used
- Networks should be isolated by VLAN’s
- The NICs connected to the Servers act as Trunks into your vSwitches
Agenda

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Licensing Considerations
FactoryTalk System Example

Active Directory  FactoryTalk Directory  Primary HMI  Secondary HMI

Asset Centre  Historian  VantagePoint  Batch

Engineering Workstations

Operator Workstations
FactoryTalk System Example

Active Directory  FactoryTalk Directory  Primary HMI  Secondary HMI

Asset Centre  Historian  VantagePoint  Batch

Engineering Workstations

Operator Workstations
Rockwell Virtualization Progression

November 2009 – “RA Products Supported with VMware”

- RSLinx Classic & Enterprise
- FactoryTalk AssetCentre
- FactoryTalk Vantage Point
- FactoryTalk Production Centre
- FactoryTalk Historian SE & Classic
- Emonitor

Official statement of support: RA Knowledgebase Article 42682
Rockwell Automation and VMware

- **Solution Provider**
  - Combine Rockwell’s industry expertise with VMware technology to provide design, plan and deployment services for VMware based virtual infrastructure.

- **Technology Alliance Partner**
  - Allow Rockwell Automation to directly leverage the VMware resources needed to deliver enhanced value to shared customers.
Rockwell Virtualization Progression

November 2010 – “RA Announces VMware Ready Software”

FactoryTalk®
INTEGRATED PRODUCTION & PERFORMANCE SUITE

RSLinx Classic
RSLinx Enterprise
RSLogix 5000
FactoryTalk View SE
FactoryTalk View Studio
FactoryTalk Batch
FactoryTalk AssetCentre
FactoryTalk Vantage Point
FactoryTalk Historian SE
FactoryTalk Talk Gateway
FY 2011 – Network and Security Services Group expands consultant services to Virtualized Systems

- Capacity Planner
- Infrastructure Design
- Hardware Procurement
- System Validation
- And much more…
Rockwell Virtualization Progression

2009

2010

2011

2012

FY2012 - Virtual Appliance Development

...with Virtual Appliances

- System Elements as standard products – Reduced validation Costs!
- Pre-installed & Pre-configured – Reduced Engineering Costs!
- Hardware Independent – Increased Product Lifecycle!

PASS
Process Automation System Server

OWS
Operator Workstation

EWS
Engineering Workstation

AS Batch
Application Server – Batch Management

AS Information
Application Server – Process Information

AS Asset Centre
Application Server – Asset Centre

Virtual Appliances

Plant Asset Management

Process Information

Process Automation System Servers

Plant Enet

Batch Management

Engineering Workstation

Operator Workstations

Process Control Enet

Plant Enet

OS

vApp

OS

vApp

OS

vApp

OS

vApp

OS

vApp

OS

vApp

OS

vApp

OS

vApp

OS

PASS

Process Automation System Server

OWS
Operator Workstation

EWS
Engineering Workstation

AS Batch
Application Server – Batch Management

AS Information
Application Server – Process Information

AS Asset Centre
Application Server – Asset Centre

Plant Enet

Batch Management

Engineering Workstation

Operator Workstations

Process Automation System Servers

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Windows 7 XP Mode support

FactoryTalk View Studio for FactoryTalk View Enterprise v6.00
FactoryTalk View Studio for Machine Edition v6.00
RSView32 Works v7.50
FactoryTalk Activation Manager v3.30
FactoryTalk Services Platform (FTSP) – v2.30
RSLinx Enterprise v5.30
RSLinx Classic v2.57
PanelBuilder32 v3.82

Official statement of support: RA Knowledgebase Article 341918
Network & Security Services: Lifecycle Approach to Services and Support

Because Infrastructure Matters
ASSESS
• Assess the current state of the security program, design, policy
• Assess the current state of the network design, implementation
• Assess the current state of a manufacturing data center

DESIGN/PLAN
• Design and plan a network infrastructure
• Design and plan security program, policy, infrastructure, business continuity plan
• Design and plan a virtual infrastructure

IMPLEMENT
• Installation, procurement and configuration of a network
• Implementation of a security program, infrastructure design, policy training
• Installation, procurement and configurations of a virtual infrastructure

AUDIT
• Audit current architecture compared to governing body (ODVA, IEEE, ANSI/ TIA)
• Audit security program compared to governing body (NERC CIP, ISA -99, NIST 800-53, NIST 800-82

MANAGE/MONITOR
• Manage, maintain and monitor uptime and issues on the network and SANs environment
• Managed Security Services (Incident response, disaster recovery, monitoring)
Agenda

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Licensing Considerations
FactoryTalk Activation Considerations

Activation server can be virtualized in a production environment or run on the host for a development machine. FactoryTalk Activation is fully supported in a virtual environment.

Considerations for a virtualized activation server:

- MAC addresses on virtual network adapters can change, use disk serial number as host ID instead.
- Use concurrent activations centralized on an activation server for easy management.

*Virtualization does not change Rockwell Software licensing*
VMware Licensing

For Development
- VMware Player is free for noncommercial use
- VMware Workstation is a retail and download product

For Production
- VMware vSphere and VMware View are sold through resellers and hardware OEMs
- VMware View is sold by concurrent user and is available either stand alone or as an add-on for vSphere
- VMware vSphere is sold in 3 editions with different functionality enabled

For more information see vmware.com
## vSphere Edition Comparison

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<th>Essentials</th>
<th>Essentials Plus</th>
<th>Standard</th>
<th>Enterprise</th>
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<tbody>
<tr>
<td>Physical CPU</td>
<td>3 servers, 2 proc.</td>
<td>3 servers, 2 proc.</td>
<td>8 proc. starter kit</td>
<td>6 proc. starter kit</td>
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<td>vRAM Entitlement</td>
<td>32GB (192GB total)</td>
<td>32GB (192GB total)</td>
<td>32GB / CPU license</td>
<td>64GB / CPU license</td>
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<td>Scalable</td>
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<td>✗</td>
<td>✔</td>
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<td>✔</td>
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<td>✔</td>
</tr>
</tbody>
</table>

Microsoft Licensing for Virtualization

For Engineers

- Windows 7 Professional entitles 1 virtual instance of Windows XP, Vista or 7 run on the licensed computer.
- Server OS licenses for development can be acquired as part of an MSDN subscription.

For Production Environment

- Servers:
  - Each host must be entitled for the virtual machine “high water mark”
  - Standard = 1 VM, Datacenter = unlimited VM’s
- Desktops:
  - Client device requires Windows Software Assurance, Intune or Virtual Desktop Access license
  - License entitles use of up to 4 vm's in the datacenter and/or 4 vm’s run locally
  - License entitles primary user to “roam” to other devices such as tablets

**Microsoft Windows licenses are tied to hardware not VMs**
Questions?