Virtualizing FactoryTalk® View Site Edition Architecture at Pepsi Bottling Plants

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Overview

- Pepsi and the Need for Virtualization
  - Why did we virtualize the traditional FactoryTalk View Site Edition architecture?

- Key Design Decisions
  - Compliance with Rockwell Automation’s recommended architecture
  - Hardware consolidation
  - Cost
  - Logistics
Overview

- Features and Benefits
  - Architecture simplicity
  - Reliability
  - Availability
  - Redundancy
  - Maintainability
  - Hardware/Software independence (long-term support of legacy applications)
Overview

- Features and Benefits (Continued)
  - Standardization across Pepsi’s enterprise
  - Cost
    - Lower life-cycle cost
    - Lower support cost
Pepsi and the Need for Virtualization

- Why did we virtualize the FactoryTalk View Site Edition Architecture?

- Pepsi’s Self-Manufacturing Initiative
  - Gives Pepsi the ability to make plastic bottles in cold-fill bottling plants
  - Saves cost of trucking finished plastic bottles into bottling plants
  - Twenty-two U.S. bottling plants completed by Design Group across seven phases starting in 2008
  - Last eleven plants implemented using FactoryTalk View Site Edition on a virtualized architecture
    - Application ported from competitor’s platform
Pepsi and the Need for Virtualization

- Pepsi Orlando Plant First in System to be Virtualized
  - Scope of Self-Manufacturing Project
    - Design Group Responsible for syrup cut-off system to minimize syrup and bottle waste
    - Two Blowmolder Lines
      - 2 FactoryTalk View Site Edition HMI Servers
      - 15 HMI Clients (Thin Clients)
    - Data Storage (Microsoft SQL) and Reporting (Microsoft SQL Reporting Services)
      - Product/Recipe management – Data storage and reporting
      - Preform lot numbers – Data storage and reporting
      - Utility usage (Energy, Water, and Air) – Data storage and reporting
Pepsi Orlando Plant First in System to be Virtualized

Scope of Project (Continued)

- Remote Support via Pepsi’s Secure Vendor Access (SVA)
- Future Expansion
  - Performance monitoring and OEE (FactoryTalk Metrics)
  - Asset management (FactoryTalk AssetCentre)
Key Design Decisions

- Compliance with Rockwell’s Recommended Architecture
  - Reference Rockwell Automation’s Knowledge Base Article 32549 - FactoryTalk View Site Edition Distributed System Design Considerations
    https://rockwellautomation.custhelp.com/app/answers/detail/a_id/32549
  - Infrastructure and Topology Design Considerations
    - First plant in Orlando consisted of:
      Two packaging lines
      Single supervisory PLC per line communicating to multiple machines
      15 HMI Clients (all thin clients)
      No more than 1,000 (on-scan) tags per data server per line
    - Traditional, non-virtualized layout initially considered
Traditional Rockwell Architecture

- Domain Controller
- HMI Server Data Server Line 1
- HMI Server Data Server Line 2
- Terminal Server
- SQL Database Server

Managed Ethernet Switch for Control System Network – HMI / Control Communications

- FactoryTalk Directory Server
- FactoryTalk Clients
- 15 Clients

- Managed Ethernet Switch for Control System Network – HMI / Control Communications

- ControlLogix
- Flex
Traditional Rockwell Architecture

- Traditional Rockwell Architecture Requires:
  - 6 physical servers (No redundancy)
  - 8 physical servers (With redundancy)

- Prospect of deploying a large number of physical servers in 2011 at ten plants forced us to consider alternatives. All servers needed to be configured in St. Louis and shipped to site.
Key Design Decisions

- Hardware Consolidation
  - Question: How could Rockwell’s recommended architecture be implemented while minimizing the amount of hardware required?
  - Answer: Virtualization! By virtualizing Rockwell’s recommended architecture, the number of servers could be reduced down to two. Less hardware means fewer points of failure and decreased chance of lost production time.
Virtualized Rockwell Architecture

Virtual Servers
1. Domain Controller
2. FactoryTalk Directory Server
3. FactoryTalk View SE Server
4. Terminal Server
5. SQL Database Server
6. vCenter VM Management Server

Managed Ethernet Switch for Control System Network – HMI / Control Communications

VMware Host Server #1
VMware Host Server #2

Storage Array

FactoryTalk Clients
15 Clients

ControlLogix
Flex

Firewall
Key Design Decisions

- **Cost:**
  - Initially 40 – 50% more expensive for virtualized architecture using two hosts, one storage array, and VMware ESXi vs. fully redundant architecture with eight individual Windows based servers. Depending on hardware used, break-even occurs when virtualizing approximately twelve physical servers.
  - Justified to Pepsi on the basis of lower life-cycle costs and future expandability
    - No additional hardware needed to add future virtual servers for:
      - FactoryTalk Metrics (OEE / Performance / Downtime Tracking)
      - FactoryTalk AssetCentre
    - **No downtime required** to configure future virtual servers
    - Building “infrastructure” for Pepsi
Key Design Decisions

- Logistics:
  - Ten Pepsi Self-Manufacturing plants (12 packaging lines) completed in 2011
    - 64 physical servers required with traditional architecture
      - 16 servers at two dual-line plants (2 plants x 8 servers / plant)
      - 48 servers at eight single-line plants (8 plants x 6 servers / plant)
    - 20 physical servers required with virtualized architecture
  - Leveraged VMware tools (VMware Converter) to copy virtual servers from first set of hardware to other sites
    - Saved time configuring individual servers
    - Ensured consistency between sites
    - Removed need for repeated installations of application software
Features and Benefits – Simplicity

- Architecture Simplicity
  - Two servers and a storage array
    - Two Dell R710 Host Servers
      - VMware ESXi (embedded) O/S
        - vMotion – Live VM migration between hosts
        - High Availability – Automatic VM failover
  - 24 GB memory each
  - No on-board storage
  - 4 network ports – Connection to storage array
  - 1 management network port
  - Dual power supplies
Features and Benefits – Simplicity

- Architecture Simplicity
  - Two servers and a storage array
    - One Dell PowerVault MD3200i Storage Array
      - Dual RAID controllers
        - 4 iSCSI ports each
        - 1 management port each
      - Five 300 GB drives
        - One hot-swappable
        - RAID 10 – Mirrored and striped
        - About 560 GB usable storage
  - Dual power supplies
Features and Benefits – Simplicity

- **Architecture Simplicity**
  - **Additional Hardware**
    - One Cisco 2960s managed switch
    - Dual uninterruptable power supplies
      - Approximately 40 minutes of backup per UPS
    - 15 Advantech UNO-2053GL Thin Clients
      - Managed with ThinManager
    - Additional virtual servers can be added without buying new hardware.
Features and Benefits – Simplicity

Dell PowerEdge R710 Host Server
Single CPU with 4 Cores
24 GB Memory

Cisco 2960s 48-Port Gigabit Switch

20 Ports Used

4 Ethernet + 1 Management Port

Dell PowerVault
MD3200i Storage Array
Five 300 GB Hard Disks
RAID 10 Configuration

Dell PowerEdge R710 Host Server
Single CPU with 4 Cores
24 GB Memory
Features and Benefits – Reliability

- Reliability
  - Dell server class hardware used. No hardware failures at eleven sites since initial installation in early 2011.
    - Estimated MTBF for the host servers is 79,000 hours
    - Estimated MTBCF for the storage array is 5,464,000 hours (the MTBCF takes into account system redundancy)
  - Storage array configured for RAID 10 (mirrored and striped)
    - Chose RAID 10 instead of RAID 5 because it offers lowest level of risk. Two drives can fail with RAID 10. Only one drive can fail with RAID 5 before data loss.
Features and Benefits – Availability

- Availability
  - Failover protection – Virtual servers automatically failover from one host server to the other if one host fails.
    - VMware’s High Availability (HA) required with vCenter Server
  - Through vCenter Server, the virtual servers are configured to automatically “power on” in Rockwell’s recommended sequence:
    1. Domain controller
    2. vCenter
    3. FactoryTalk Directory Server
    4. FactoryTalk HMI Server(s)
    5. SQL Server
    6. Terminal Server
Features and Benefits – Redundancy

- Redundancy
  - Can simultaneously lose:
    - One host server
    - One RAID controller
    - Two hard drives
    - One power supply in any device
    - One UPS
  - and still operate without impacting production.
Features and Benefits – Maintainability

- **Maintainability**
  - **Zero downtime** required to maintain servers.
  - Can migrate virtual servers from one host to the other **without affecting production**. VMware’s vMotion required.
  - Hardware is modular and easily serviceable.
  - Purchased Dell’s mission critical support package
    - 4 hour, 24/7 on site service with emergency dispatch, 3 years
    - Purchased Dell’s hardware limited warranty
      - On site service, initial year
      - Extended year
  - **One connection to virtual server** for remote troubleshooting.
    - Can remotely connect to vCenter VM and troubleshoot all VMs
Features and Benefits – Independence

- Hardware/Software Independence
  - Legacy applications never need to be upgraded and can run indefinitely by upgrading hardware.
  - Old applications running on old hardware on obsolete operating systems (Windows NT 3.51 or Windows 2000, for example) can be virtualized and run on new hardware.
  - No longer tied to software upgrade cycle.
  - Host hardware becomes irrelevant.
Features and Benefits – Standardization

- Standardization Across Pepsi’s Enterprise
  - Makes it very easy to standardize systems because virtual servers can be reused (after relicensing)
  - First ten of the eleven Pepsi sites are all based on the same set of virtual server templates created for Orlando.
    - First ten sites
      - FactoryTalk View Site Edition v6.0
      - Three virtual servers run Windows Server 2008 SP2 32-bit
      - Three virtual servers run Windows Server 2008 R2 64-bit
    - Eleventh site
      - FactoryTalk View Site Edition to v6.1
      - All virtual servers running Windows Server 2008 R2 64-bit
Features and Benefits – Cost

- Lower Life-Cycle Cost
  - Longevity of applications results in lower upgrade costs. Normal upgrade cycles can be extended because hardware incompatibility is no longer an issue since virtual servers are always compatible with applications.
  - Scalable with no additional hardware costs. Virtual servers can be added as needed – only operating system licensing costs required.

- Lower Support Cost
  - Less hardware = Fewer failures = Lower support cost
Benefits to Pepsi

- Ease of Support
  - Ability to establish a corporate-wide support model because of standardization

- Architecture Consolidation
  - Fewer hardware components
  - More consistent
  - Easier to maintain
  - Expandable
Benefits to Pepsi

- **Standardization**
  - Instrumental in helping Pepsi (BIS) standardize their VMware solution

- **Convergent Strategy**
  - Accelerated through partnering with Design Group
vMotion Demonstration

- VMware’s vMotion

- Migrate running virtual machines from one host server to another with no disruption or downtime.

- Demonstration video was recorded of a migration of the FactoryTalk View Site Edition HMI server at Pepsi's Urbandale, Iowa plant. The HMI server was migrated from host server #1 to host server #2 in about a minute and a half WITHOUT ANY IMPACT TO PRODUCTION. Video was recorded remotely from St. Louis.
What is a Cluster?

A cluster is a group of hosts. When you add a host to a cluster, the host's resources become part of the cluster's resources. The cluster manages the resources of all hosts within it.

Clusters enable the VMware High Availability (HA) and VMware Distributed Resource Scheduler (DRS) solutions.

Basic Tasks

- Add a host
- Create new virtual machine
Keys to Success

- Leveraged internal IT department capabilities. Barry-Wehmiller has extensive how-to knowledge related to VMware, storage arrays, and networks that proved invaluable during the set-up and configuration of the first site’s hardware and software.

- Encouraged by Pepsi to implement the best long-term solution. Pepsi is a very technology-forward looking company that recognized the value of virtualization.

- Worked with Dell and VMware experts early in the design stage to develop a robust and workable solution.

- Willingness to innovate.
Lessons Learned

- Match Server Horsepower to Actual Needs
  - Could have used lower horsepower host servers to reduce initial cost. Architecture may be more robust than necessary for the application.

- Establish Naming Conventions Early
  - Should have used generic virtual server naming convention rather than naming servers uniquely for each site. This would have made it easier to copy virtual servers from site to site.

- Consider Disaster Recovery Plan
  - Could have implemented an enterprise level disaster recovery system that backs up the virtual servers to a centralized Pepsi server.
Rockwell Automation’s recommended architecture for FactoryTalk View Site Edition was successfully virtualized in eleven Pepsi bottling plants using VMware and provides many benefits to Pepsi including a system that is simple, reliable, redundant, maintainable, and standardized with lower life-cycle and support costs.