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SIMATC PCS 7

PCS 7 Virtualization

Application Example
Warranty and Liability

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Preface

Objective of this application
This document provides an overview over the PCS 7 virtualization. Typical configurations on virtualized servers are displayed and measured performance data is represented.

Core topics of this application
The following main points are discussed in this application:
- Display of typical configurations
- Display of performance data in the various configurations
- Monitoring the performance of all guest systems

Validity
This document is valid for PCS 7 V7.1 as of SP2.
Please notice the product information „SIMATIC PCS 7 OS Software Client V7.1 + SP2 and higher released for use in virtual operating environments“:
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1 Automation Task

1.1 Overview

Introduction

Virtualization of servers is already of high importance in information technology. In automation technology the advantages of virtualization shall also be reached.

Description of the automation problem

- Typical configurations of PCS 7 systems shall be virtualized.
- What is the required infrastructure for virtualizing PCS 7 systems?
- What needs to be observed for PCS 7 in virtual operating environments?

1.2 Virtualization requirements

The requirements for virtualized computers are identical to those for real computers. During runtime no difference to real computers shall be noticeable.
2 Automation Solution

2.1 What is virtualization?

2.1.1 Definition

Virtualization

Virtualization refers to the runnable mapping of one or several computers on a real computer.

On a real computer a special software runs which provides one or several virtual computers parallel. The virtual computers can be started and stopped independent of each other. Even after a failure only the respective virtual computer is affected.

Layout for virtualization

Figure 2-1

A physical PC provides its hardware to several virtualized systems.
Differences between server-based and client-based virtualization

![Diagram showing differences between server-based and client-based virtualization]

- **Client-based Virtualization**
  - Operation directly at the PC via graphics card and monitor.

- **Server-based Virtualization**
  - No direct operation. Operation e.g. via one or several RDP clients.

---

**Figure 2-2**
2.1.2 Advantages of the virtualization

Reducing the hardware costs
- Reduced HW costs through consolidating several physical computers. (The cost reduction results from a better hardware utilization.)
- On the client side more cost-efficient hardware is possible.
- Expanded application areas: SIMATIC ThinClient solutions (PC, Panel, mobile PDA).

Reducing the time expenses for service and maintenance
- Shorter times for updates and backups since these are executed from a central place
- Reduced maintenance cost and time through central administration.
- Server configuration by means of remote management tools.

Increased safety
- Increased safety through remote access and centralized rights management.
- Virtually no possible attacks for thin clients, central protection at the virtual server.

Increased availability
Exchange of hardware at the virtual server is possible during runtime.¹

Increased flexibility
- Additional clients can be added on demand simply by starting a further VMware session.
- Additional clients for “special tasks” can simply run in the background:
  - RDP²/VNC³-solutions for remote or mobile accesses
  - Provision of “substitute computers” as virtual systems, e.g. during maintenance of a system a substitute system can be used instead.

¹ When using the respective virtualization hardware.
² Windows Remote Desktop protocol: There is a number of possible clients for various operating systems of for mobile devices. (the “server” is located in the Windows operating system.)
³ Virtual Network Computing: alternative option for remote control of operating systems. (a server is required on the operating system. Viewing requires a client (available for various operating systems or for mobile devices).
2.2 Requirements

Virtualization infrastructure based on VMware vSphere 4

- Minimum a ESX Server V4.1
- Minimum a vSphere Client V4.1
- If necessary vCenter Server V4.1
3 Configuration

3.1 Configuration of the host systems

**ATTENTION**

The user/administrator must ensure that sufficient system resources are available on host and VMs.

**Optimal operation of ESXi server and VMWare**

Further information on the optimal operation is available on the support internet pages of VMWare under the following link:

http://www.vmware.com/support

**Enabled hardware for VMware**

The following internet address contains a summary of the hardware validated and enabled by VMWare:

http://www.vmware.com/resources/compatibility/search.php

3.2 Configuration of the guest systems

<table>
<thead>
<tr>
<th>Properties</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of logic CPU cores</td>
<td>ES, OS server: minimum 2</td>
</tr>
<tr>
<td></td>
<td>OS client: minimum 1</td>
</tr>
<tr>
<td>Virtual network modules</td>
<td>As many network cards must be configured as would be the case for real OS stations. A redundant OS server would have 3 virtual network cards.</td>
</tr>
<tr>
<td>Separation of networks</td>
<td>We recommend separating terminal, system and redundancy bus.</td>
</tr>
<tr>
<td>CPU load</td>
<td>The CPU load of the assigned logic CPU cores must not exceed 70% to 80%.</td>
</tr>
<tr>
<td></td>
<td><strong>Note</strong></td>
</tr>
<tr>
<td></td>
<td>When archiving large data volumes a respective reserve is required (high I/O load). This load is given at a capacity of 70%-80%.</td>
</tr>
<tr>
<td>VMware Tools</td>
<td>Current VMware tools must be installed on the guest computers. This yields a better performance.</td>
</tr>
<tr>
<td>Hard disk storage management</td>
<td>Do not use dynamic storage management. The size of the hard disk file adjusts dynamically to the used capacity.</td>
</tr>
<tr>
<td>Operating states</td>
<td>Suspend/Resume of the VMs, as well as VMware options (e.g. vMotion) are not supported. The VMs must be treated like real OS stations.</td>
</tr>
</tbody>
</table>
SIMATIC software and operating system

- As of PCS 7 V7.1 SP2
- Windows operating system (depending on the application, as described in the PCS 7 readme file)
  - Windows 2003 Server SP2 or Windows Server 2003 R2
  - Windows XP SP3

Note

- For HW configuration (CPU, main memory) of the VMs with PCS 7 installation, the requirements in the readme file can be used as a guidance.
  These are available on the DVD SIMATIC PCS 7 V7.1 SP2 or under the following link:
- The “Ressource Allocation” of the VMs can be kept on the default settings.

3.3 Configuration examples

3.3.1 Configuration of the hosts

Note

It is recommended to also use network adapters dedicated in the host for the terminal bus and the plant bus.

HP Blade System “C7000 Enclosure G2”

In HP Enclosure two blades are plugged on which one each ESX server is running. Both ESXi servers form a cluster.

Table 3-2

<table>
<thead>
<tr>
<th>Component</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Work memory (total)</td>
<td>192 GB</td>
</tr>
<tr>
<td>Hard disks</td>
<td>3 TB (RAID 5 + Global Spare via SAN)</td>
</tr>
<tr>
<td>Network cards</td>
<td>2 x 2 HP VC flags 10 ENET modules 1GB (for management network, terminal, system and redundancy bus)</td>
</tr>
<tr>
<td>Processor</td>
<td>Intel Xeon Core i7 L5520, 2,27GHz</td>
</tr>
<tr>
<td>Number of blades</td>
<td>2</td>
</tr>
<tr>
<td>CPUs per blade</td>
<td>2</td>
</tr>
<tr>
<td>Cores per CPU</td>
<td>4</td>
</tr>
<tr>
<td>Total number of cores</td>
<td>16</td>
</tr>
<tr>
<td>RAM per blade</td>
<td>96 GB</td>
</tr>
</tbody>
</table>

Further information on the used HP Blade system is available in the following link:
3 Configuration

3.3 Configuration examples

**Fujitsu Primergy “RX 300 S6”**

Table 3-3

<table>
<thead>
<tr>
<th>Component</th>
<th>Property</th>
</tr>
</thead>
<tbody>
<tr>
<td>Processor</td>
<td>12 Cores (Intel Xeon CPU 5650 2.67GHz)</td>
</tr>
<tr>
<td>RAM</td>
<td>24 GB</td>
</tr>
<tr>
<td>Hard disks</td>
<td>6x 600GB SATA (local)</td>
</tr>
</tbody>
</table>

Further information on the used Fujitsu Primergy system is available in the following link:


**3.3.2 Configuration of the VMs**

**ES**

Table 3-4

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAM</td>
<td>2048 MB</td>
</tr>
<tr>
<td>CPUs</td>
<td>2</td>
</tr>
<tr>
<td>Graphics card</td>
<td>32 MB</td>
</tr>
<tr>
<td>Hard disk 1</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Hard disk 2</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Network adapter 1</td>
<td>Terminal bus</td>
</tr>
<tr>
<td>Network adapter 2</td>
<td>Plant bus</td>
</tr>
</tbody>
</table>

**OS server**

Table 3-5

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAM</td>
<td>3072 MB</td>
</tr>
<tr>
<td>CPUs</td>
<td>2</td>
</tr>
<tr>
<td>Graphics card</td>
<td>32 MB</td>
</tr>
<tr>
<td>Hard disk 1</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Hard disk 2</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Network adapter 1</td>
<td>Terminal bus</td>
</tr>
<tr>
<td>Network adapter 2</td>
<td>Plant bus</td>
</tr>
<tr>
<td>Network adapter 2</td>
<td>Redundancy</td>
</tr>
</tbody>
</table>
3 Configuration

3.3 Configuration examples

OS client

Table 3-6

<table>
<thead>
<tr>
<th>Hardware</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAM</td>
<td>1024 MB</td>
</tr>
<tr>
<td>CPUs</td>
<td>2</td>
</tr>
<tr>
<td>Graphics card</td>
<td>32 MB</td>
</tr>
<tr>
<td>Hard disk 1</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Hard disk 2</td>
<td>Virtual hard disk, not dynamic</td>
</tr>
<tr>
<td>Network adapter 1</td>
<td>Terminal bus</td>
</tr>
</tbody>
</table>

3.3.3 Configuration 1:

- 1x virtual ES
- 1x real OS server
- 4x virtual OS clients

Figure 3-1
3.3.4 Configuration 2

- 1x virtual ES
- 1x virtual OS server on ESXi server 1
- 4x virtual OS clients on ESXi server 1 and 2

Figure 3-2

![Diagram of Configuration 2]
3.3.5 Configuration 3

- 1x virtual ES
- 1x virtual red. OS server pair
- Nx virtual OS clients on ESXi server 1 and 2
- real CAS
- real OS client

Figure 3-3
4 User Scenarios

Download target systems

Table 4-1

<table>
<thead>
<tr>
<th></th>
<th>Real ES downloads</th>
<th>Virtual ES downloads</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real AS</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Real OS server</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Real OS client</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Virtual OS server</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Virtual OS Client</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

Process mode

Table 4-2

<table>
<thead>
<tr>
<th></th>
<th>Virtual OS client visualizes data of a real OS server</th>
<th>Virtual OS client visualizes data of a virtual OS server</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating I/O fields</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Operating faceplates</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Displaying and acknowledging messages</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>Displaying trends</td>
<td>OK</td>
<td>OK</td>
</tr>
<tr>
<td>SFV</td>
<td>OK</td>
<td>OK</td>
</tr>
</tbody>
</table>

PCS 7 Web Server, OpenPCS 7, DataMonitor

Table 4-3

<table>
<thead>
<tr>
<th></th>
<th>Local access to</th>
<th>Remote access to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual PCS 7 OS server</td>
<td>OK with PCS 7 Web Client</td>
<td>OK with PCS 7 Web Client</td>
</tr>
<tr>
<td>Virtual OS client with OpenPCS 7</td>
<td>OK with Matrikon OPC Explorer</td>
<td>OK with Matrikon OPC Explorer</td>
</tr>
<tr>
<td>Virtual DataMonitor server</td>
<td>OK with DataMonitor client</td>
<td>OK with DataMonitor client</td>
</tr>
<tr>
<td>Virtual terminal server</td>
<td>N/A</td>
<td>OK with RDP</td>
</tr>
</tbody>
</table>
5 Notes / Restrictions

Note

WPF controls in VMware
WinCC offers the option of using WPF controls for visualization. This option does not work on virtualized systems.

(See also http://support.automation.siemens.com/WW/view/en/43101218)

SIMATIC shell

If the server client communication occurs across network boundaries, the SIMATIC shell must be configured accordingly. This is independent of the virtualization.

Figure 5-1
**Standard gateway**

If the communication at the plant bus occurs across network boundaries, the routes at the plant bus must be known. The only option to realize this is to configure a router for the plant bus in NetPro and a standard gateway for the plant bus in Windows.

**Creating new VMs from templates**

In vSphere client the templates must not contain any PCS 7 installation, since after creating new VMs with other computer names the SQL database must be adjusted.

**Communication with the AS**

Since no SIMATIC CPs (e.g. CP1623) can be operated in an ESX server, communication with the AS is only possible with TCP/IP via BCE. The following restrictions apply:

- A highly available S7 connection with an H station is not working since “S7-REDCONNECT” is necessary for this.
- A maximum of 8 connections is possible.

**Licensing**

When using VMs it must be ensured, that a correct licensing of all software components is guaranteed, e.g. Microsoft and PCS 7.

**Creating VMs**

When an infrastructure for virtualization exists (ESX server, vCenter server and vSphere client) there are several options for creating new VMs:

- Complete new generation of VMs within a vSphere clients
- Creating new VMs from templates within a vSphere client
- Transferring real machines via VMware converter in VMs (consolidation)
- Exporting VMs in the vSphere client in OVF templates and importing VMs from OVF templates

**Using OVF templates**

When OVF templates exist as data, the can be used for the following purposes, for example:

- Transferring VMs to another host
- Archiving exported VMs to external media

**VMware Features**

- Suspend/Resume the VMs, especially of redundant servers, creates problems and must therefore not be used.
- Snapshots should not be used.
- vMotion, DRS, FT were not explicitly tested.
Remote Desktop Protocol (RDP)

The VMs can be operated via an opened Remote Desktop connection.

**Note**
Remote Desktop must only be used via "mstsc /console" or "mstsc /admin".

Diagnosis with VMware vSphere Client

It is recommended, using the vSphere client, to regularly monitor the resources of the hosts and guest systems, such as:

- Main memory load
- Operating state
- CPU load
- Hard disk
- Network load
CPU load of the guest systems
For the following actions the processor load increases to almost 100%, independent of whether it is a real machine or a VM.

- Web Navigator > Web View Publisher
- Web Navigator > Export of configuration data

This also increases the load of the hypervisor. If this status is pending for a longer time, the host generates an error message. After termination this message disappears automatically. The tasks are executed without error.
6 Glossary

Guest
Is a virtualized computer executed within a host (equal to VM).

Host
Refers to the real hardware on which the ESX or ESXi runs, and which provides its resources to the VMs.
The computers running within the host are referred to as guest or VMs.

Hyper threading
A technology for better processing of commands for the processor. One process core therefore appears as 2 process cores.

Virtual hardware
Real resources are not provided to the VMs directly, but they are virtualized for joint usage.
Such jointly used hardware can be network cards, process cores or hard disks.
These can be used proportionally and jointly by all VMs.

Virtual processor core
A processor core provided to the VM.

Virtual Machine (VM)
See Guest

Virtual network
A network provided to the VM by the host. Enables communication options of several VM within this network.

VMware
A company and manufacturer for virtualization software.

VMware ESX and ESXi
VMware ESX server or VMware ESXi server are the central component of VMware vSphere. They correspond to a hypervisor type 1.

VMware vCenter Server
Part of VMware vSphere and serves for central management of the virtual infrastructure.

VMware vSphere
A product palette of VMware for virtualization on the basis of hypervisor type 1.

VMware vSphere client
Component of VMware vSphere and enables the access to the vCenter server or ESX server, which makes it the tool for managing the virtual infrastructure.
VMware workstation

A type 2 hypervisor and serves creating and managing virtual systems on an already existing operating system.
7 Links & Literature

7.1 Further literature

This list is by no means complete and only presents a selection of related references.

Table 7-1

<table>
<thead>
<tr>
<th>Topic</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>/1/ VMware vSphere</td>
<td>VMware vSphere 4 „Das umfassende Handbuch“ (The comprehensive manual)</td>
</tr>
<tr>
<td></td>
<td>Galileo Computing</td>
</tr>
<tr>
<td></td>
<td>Galileo Press 2010</td>
</tr>
<tr>
<td></td>
<td>ISBN 978-3-8362-1450-6</td>
</tr>
</tbody>
</table>

7.2 Internet links

The following list is by no means complete and only presents a selection of related sources.

Table 7-2

<table>
<thead>
<tr>
<th>Article</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td>/2/ Siemens I IA/OT Customer Support</td>
<td><a href="http://support.automation.siemens.com">http://support.automation.siemens.com</a></td>
</tr>
</tbody>
</table>
## 8 History

Table 8-1

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Revisions</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>10/2011</td>
<td>First issue</td>
</tr>
</tbody>
</table>