HMI & Virtualization in Process Automation

Virtualization

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PEPPERL+FUCHS

Virtualization is a technology that stems from the information technology (IT) industry and has become more and more popular in process automation. Virtualization promises to ease software management while reducing costs. This trend also has an impact on the human machine interaction (HMI) in such systems. Especially in combination with thin client technology, virtualization provides an easier and cost-efficient way to control process automation systems even in the harshest industrial environments.

In this technical white paper series, *HMI & VIRTUALIZATION IN PROCESS AUTOMATION*, we give an overview on virtualization in process automation and describe how Pepperl+Fuchs' thin client technology fits into virtualized systems.

In this technical white paper No. 1, we give a closer look on virtualization technology. We focus on the back end and show how virtualization works and what benefits virtualization offers in process automation.

Technical white paper No. 2 describes thin clients, how they work, what their general advantages are, and which role they play in a virtualized process automation system.

In technical white paper No. 3, we present the P+F remote monitors which are industrial thin client solutions that help to save time and money during installation and operation and offer broader/more functionalities than other technologies.

Dr. Marc Seißler,
Product Portfolio Manager

What is virtualization?

Virtualization is a technology that is strongly driven by the information technology industry and has become more and more popular in process automation. In process automation, virtualization mainly affects the process engineering departments that manage the process application software.
In traditional process automation systems, multiple, powerful PCs, called workstations, are used to host process applications like process control, alarm and asset management, historian data, etc. One disadvantage of the workstation-based infrastructures is that applications and operation systems (OS) are tied to the workstation hardware.

The idea of virtualization is to break up the strong coupling between application software, OS, and hardware. Virtualization allows you to run multiple OSs and applications concurrently, but segregated from each other, on one physical host hardware.

Depending on the number of system components that are virtualized, different terminologies are used:

- **Server Virtualization**: Multiple servers and their OSs (e.g., Windows 2012 R2) are consolidated on one or a few host servers. This is, for example, a common way to run a separate backup server or a test server on which new configurations can be evaluated.
- **Desktop Virtualization / Virtual Desktop Infrastructure (VDI)**: VDI is one of the newer virtualization trends where many complete desktop OSs (e.g., Windows 7) with their applications are hosted on one host server. This is, for example, used to consolidate multiple workstations with different applications on one centralized host server. (See Figure 1.)
- **Application Virtualization**: A set of applications is encapsulated in sandboxes and hosted on a server. The operators can access these applications from their local machines while the applications run on the server. This setup is quite common in setups where users need access to a pool of centrally managed applications.

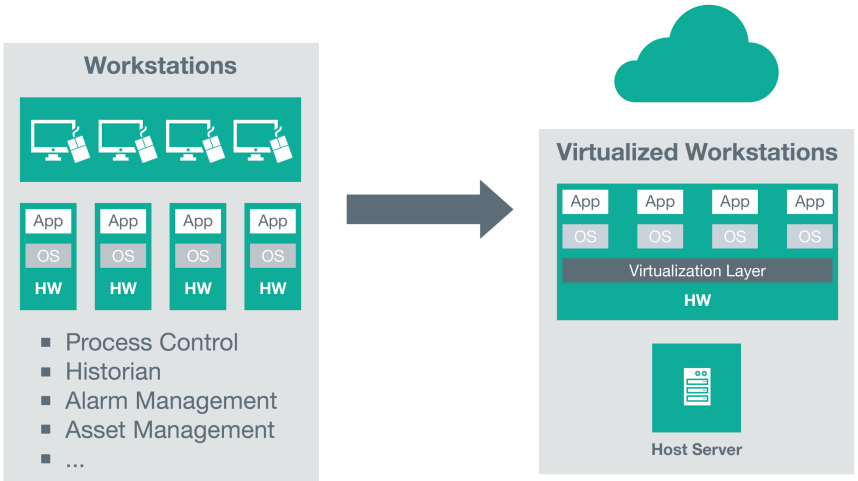

Figure 1: Virtualizing multiple workstations on one host server

In process automation, all three virtualization types can be seen; however, server virtualization and VDI seem to be the most prominent setups today. For manufacturing execution systems (MES) applications, virtualization is the most popular choice of virtualization technology.

Especially in server virtualization and VDI, an additional software layer on the host server enables the virtualization and separation of the hardware and the guest operating system and applications. This software, called a hypervisor, intercepts all operations of the guest OSs and the host server hardware. Each guest OS runs in its own virtual machine (VM) that is a pure software container, which provides a virtual hardware interface and gives the guest OS and applications the impression that they run natively on their own hardware. Each VM has an interface to the hypervisor that controls the physical hardware and assigns the resources concurrently to the VMs. (See Figure 2.)

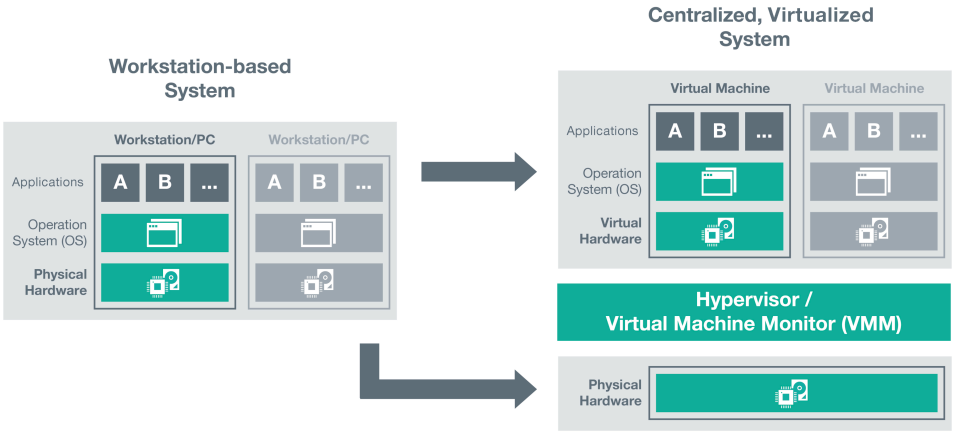

Figure 2: Virtualization hardware architecture

In other words, a hypervisor provides an abstraction layer that insulates the VMs from the host hardware and from each other.

In fact, a key feature of virtualization is that VMs are completely isolated from each other for operational purposes, although they can communicate with each other over normal Ethernet and data storage channels. This isolation is one major difference from standard server OSs, where multiple applications share the same OS. Running multiple applications on one OS increases, for example, the risk of conflicts between different applications since they rely on the same OS resources.

The most popular hypervisors, which implement this principle, are VMWare ESXi, Citrix XenServer, and Microsoft Hyper-V 2008/2012.
However, hypervisors are usually only one small component in a virtualized system since virtualized environments demand additional management tools. The most popular virtualization software solutions today are VMWare Horizon, Citrix XenDesktop, and Microsoft Remote Desktop Services (RDS) that also contain management suites.

Benefits

Virtualization offers several benefits. Besides centralized management and cost reduction due to less HW devices, which are the main drivers of this technology trend, there are other aspects that are appealing for the process automation industry as well.

Centralized management

One of the main benefits of virtualization is centralized management of the servers and its OS and application software. Since all applications run on only a few host servers, managing these systems becomes much easier. On the hardware side, only a very limited set of hardware components needs to be maintained. On the software side, the main benefit is that powerful tools are available that enable the managing of multiple virtual machines. Some features are, for example, duplication of VMs based on master images that allows the easy deployment of software updates among multiple VMs at once.

Reduced hardware costs

Most importantly, the conversion of many physical computers (workstations and servers) into virtual machines that run on few physical host servers allows optimizing the use of available hardware resources. The host hardware can used be more efficiently, and the hardware can be dynamically assigned to the VMs, depending on their performance demands.

Higher application flexibility

The centralized management of virtualized automation systems simplifies the roll out of new applications and among existing systems. New software revisions need to be installed on only one master VM and then can be duplicated. Virtualization brings another benefit, since new applications can be tested offline in a separate test VM that runs isolated from the VMs that are used online in production. When all applications are tested, the test VM can be easily deployed with one click, making the applications available to the users.

Increased uptime

Process automation systems must run reliably not just for cost reasons, but also to protect against equipment damage or even personnel injury. As in traditional server infrastructures, virtualized systems make it easy to set up redundant servers to increase the system robustness. For example, multiple physical host servers can be configured as a pool of resources, with VMs deployed throughout the pool based on the servers' workload and availability. If one of the physical host servers fails, the VMs can be automatically moved to an alternative physical host server.

Furthermore, administrators can balance server loads in this manner, either locally or remotely, and equipment can be freed up for repair. All of this can be accomplished with minimal or zero downtime.

This cannot be achieved with a traditional server infrastructure, where the operating systems are strongly coupled to their physical server hardware.

Increased application longevity

Many industries struggle with the life cycle of their computing hardware and software. Eventually, users are faced with performing costly hardware and OS upgrades and revisions, or running the risk of sticking with unsupported and obsolete components and systems.

However, the virtualization system providers constantly update their virtualization software to run on the latest hardware and to support a wide variety of guest OSs. Savings can be substantial as virtualization enables users to reliably keep their legacy software running for many more years, even though it is virtually deployed on newer hardware. Existing hardware with sufficient computing power can also be used for new application deployments.

Conclusion

Virtualization is a technological trend that stems from the IT industry and has become more and more popular in process automation industry. The core principle of this technology is to consolidate computing hardware (e.g., PCs or servers) by hosting them on one or a few centralized host servers, which use a hypervisor to run these systems independently in virtual machines.

Consolidation of workstations, servers, and applications onto less computing hardware is just the beginning. There is less hardware to purchase, fewer systems to manage, and reduced power consumption due to better utilization of the hardware. More important, in many industrial applications, reliability can be greatly improved compared to a distributed infrastructure with dedicated workstations.

Virtualization provides other gains that simply can't be realized with traditional, PC-based infrastructures. Configurations can be pretested and debugged in a sandboxed configuration. Application or even OS upgrades and migrations can be carried out in a controlled manner with little or no loss of operation. Software life cycles can be extended by years.

With virtualization on the back end, client devices are needed that enable the users to access the virtual machines on the host server. Keyboard-video-mouse (KVM) extender-based systems are no longer an option since the VMs don't provide a physical PC interface that allows connection to a monitor.
For virtual environments, thin clients are the best technology to access VMs. Thin clients are small computing devices that use standard Ethernet technology and communication protocols to access virtual machines.

In technical white paper No. 2 of our series, *VIRTUALIZATION IN PROCESS AUTOMATION*, we take a closer look at thin-client technology and explain how thin clients work and why they are one of the best solutions to provide users access to process control and information in harsh industrial environments.