Virtualization Reduces the Cost of Supporting Open Industrial Control Systems
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Virtualization, a technology which has been used in the data centers of the world, is delivering proven savings to the IT industry. This whitepaper will discuss how virtualization technology can be applied to open industrial control systems to reduce their lifecycle cost and improve manageability.

Introduction

In today's tough economic climate, end users are trying to reduce their operating costs in any way that they can while maintaining plant safety and production levels. At the same time, companies are coping with less staff and having to bring new projects online faster and for less cost than ever before. For existing projects and systems, end users need to:

- Reduce hardware and operating system (OS) changes
- Improve computer platform resource utilization
- Make the system easier to maintain

Virtualization has matured as a technology from a performance and reliability perspective and is ready to solve the above challenges facing the industrial control industry.

What is Virtualization?

The term virtualization refers to: the separation of hardware or software requests from the actual physical hardware or operating system resources that are responsible for their completion.

Put another way, virtualization places a buffer or Abstraction Layer between the component making the request (the requestor) and the one responsible for completing it. This prevents the requestor from having to know exactly how to complete the request on a given piece of hardware or operating system. So, at a high level, virtualization then provides:

- The ability for multiple requestors to simultaneously make "virtual" hardware and software requests in total isolation from one another
- The insulation of the requestor from changes to underlying hardware or operating system

This definition of virtualization is high level and not specific to any type of hardware or software. In reality, there are many different types of virtualization depending upon the physical hardware or peripherals that are being virtualized. Two of these types will be covered in this whitepaper:

- **Platform Virtualization**
  - The decoupling of an operating system from the underlying hardware upon which it relies
- **Application Virtualization**
  - The decoupling of an application from the underlying operating system
Platform Virtualization

The Decoupling of the Operating System from the Hardware

In a traditional deployment, the operating system is sitting directly on top of the hardware and is coupled to it. In this conventional setup, the operating system is interfacing directly with the underlying hardware and creates the following limitations:

- Only a single operating system can be used per physical machine.
- Hardware suppliers generally only support the most current operating systems on their platforms. This can make it difficult to source hardware that supports older operating systems in the event of a platform failure. It can also make periodical hardware refresh programs difficult.
- The software and hardware are tightly coupled making it very difficult to move an operating system and its applications from one machine to another. This also can’t be achieved without shutting down that machine, which normally results in some disruption to plant operations.
- Running multiple applications especially from different vendors can often cause conflict within the operating system. Users are forced to manage a proliferation of physical machines to avoid this issue.
- Resources tend to be underutilized. It is very difficult to size a physical machine according to the resources an application requires and those resource demands can change over time. Even if it were possible to size a physical machine according to the exact needs of the application load, it wouldn’t be desirable from a maintenance perspective to have the hardware specification of each machine being different from one another. The desire to standardize in order to make maintenance and procurement easier, further compounds resource underutilization.
Virtualization adds a buffer between the operating system (or systems as there can now be more than one) and the underlying hardware, called the hypervisor.

Adding a hypervisor delivers the following benefits over a traditional, physically deployed system:

- Multiple operating systems can be used at the same time on a given physical machine maximizing the use of a physical machines resources
- Resources allocated to each operating system can be controlled and any faults isolated to that virtual machine
- Ability to run older operating systems on hardware platforms not normally capable of running them
- Deploy pre-built virtual machines to any physical machine
- Operating system and application combinations (virtual machines) can be moved around to different physical machines (that can be of a different model or manufacturer) without requiring any reinstallation or operational downtime.
- Allows multiple applications to be run on the same physical machine without conflict

In short, the benefits of platform virtualization can be summarized as providing:

- Hardware independence
- Hardware consolidation and
- Improved manageability
Application Virtualization

The Decoupling of the Application from the Operating System

In much the same way as an operating system tightly couples itself to a piece of hardware, applications if conventionally deployed tightly couple themselves with an operating system. This creates the following limitations:

- All applications need to interact with the one registry and file system. This creates the potential for application conflicts.
- Applications make Application Programming Interface (API) calls to a common set of operating system files called DLLs or Dynamic Link Libraries. Issues can be encountered when applications require different versions of these libraries. This is sometimes called “DLL hell” in the industry.
- Applications need to be installed locally on each machine in order to be coupled to the operating system.
- Applications read and write directly to the OS opening up the possibility for an application to adversely impact OS operations.
To solve these problems, an insulating layer is added between the operating system and the application. This is very similar conceptually to adding the hypervisor between the hardware and the OS in platform virtualization.

The Virtual OS prevents the application from having to make its calls directly against the OS and thereby provides the following benefits:

- Time spent installing applications is reduced and reliability improved. This is achieved through applications being preinstalled in a “capsule” that contains everything they need.
- Eliminates “DLL hell” through each “capsule” containing all of the DLLs that it requires.
- Applications can be executed from a central location allowing updates to be rolled out in a far more cost-effective manner.
- “Dirty applications” can be fenced off from the “clean system” to ensure that core applications, critical to control, can be isolated from other “value-add” applications.

The benefits of application virtualization can be summarized as providing:

- Application isolation
- Improved compatibility
- Reduced upgrade and installation times
The Static Industrial Control System of Today

Today’s typical control systems include a number of operator consoles along with servers that support console operations and other ancillary plant operations.

In this traditional architecture, each application typically has its own server. This helps guarantee performance and limits any interoperability issues. It can also be done for scope of loss reasons. The downsides to this approach are:

- Underutilized servers
- High maintenance costs (every server added has a maintenance overhead)
- Higher running costs, power, cooling etc.
- Long lead times to add capacity
- Failed nodes generally require like for like replacement
- Very static, inflexible architecture - each physical node has only one purpose

Operators are required to interact with different applications from potentially different vendors on the one physical Operator Console. Having multiple machines to provide application separation isn’t practical from both a cost an operations perspective. Therefore customers are forced to add these applications all on the one physical machine with the downsides being:

- Potential for “value-add” applications to interfere with ones required for critical control
- Need to perform integration testing which then needs to be repeated when upgrading components
- Support issues with vendors
The Flexible, Dynamic Industrial Control System of Tomorrow

Tomorrow’s fully virtualized control system will provide far more agile, cost effective industrial control environment. Let’s analyze how the virtualized control system will help with the three key problems mentioned at the beginning of this whitepaper.

- Reduce hardware and OS change
- Improve resource utilization
- Make the system easier to maintain

Reduce Hardware and OS Change

In the virtualized control system of tomorrow, end users will be able to continue to use their existing hardware as long as it is able to provide the minimum performance levels that an application requires of the virtual machine. This will reduce plant upgrade costs.

End users will be able to stay on the same operating systems for longer as the ability to run an operating system on a physical piece of hardware is no longer dependent upon the underlying hardware but on what the hypervisor supports. This will allow plants to update their hardware without having to change the operating system or applications, ensuring that they have the most reliable and performant hardware for their new and old applications.

Improve Resource Utilization

With a virtualized control system, an end user will be able to provision a new virtual machine to support an OS/application combination onto an existing server as long as there are sufficient resources available to meet the minimum requirements of that application. This can be done knowing that performance and isolation characteristics similar to when the application had its own dedicated box can be
achieved. This reduces maintenance costs and where resources are available, new nodes to be added without the purchase of additional hardware.

Using application virtualization, an end user will be able to install new applications onto operator consoles confident that there will be no interoperability issues with other applications. This increases the utilization of those consoles and reduces the amount of time required for integration testing. Application virtualization isn’t only for operator consoles though; it has a place with servers as well. With just platform virtualization, the number of operating systems that you need to support remains the same. Using application virtualization on a server provides the potential to reduce the number of operating systems required by allowing multiple applications to safely coexist on the server. This results in less cost for the operating systems and reduced patching and maintenance efforts.

**Make the System Easier to Maintain**

**Rapidly deploy new control system nodes**

When plant expansions or upgrades occur that require adding new nodes to the control system, this can be accomplished without adding new hardware (assuming sufficient available resources) and without having to perform fresh OS and application installations. Existing Virtual Machines (templates) that have been installed with an OS, had the control system application installed and configured for site needs can be used. This saves valuable installation and configuration time and ensures a more reliable and repeatable result.

**Upgrading and replace hardware without reinstallation and loss of view**

End users can replace or upgrade physical machines without requiring OS reinstallation or without any disruption to the operation of the virtual machine. This allows hardware and performance issues to be addressed with less time and less plant disruption than is possible with traditional deployments.

**Improved disaster recovery techniques**

Most virtualization vendors provide a number of advanced functions such as “snapshots” of a systems activity that make it easy to install patches and rollback to known points if issues are encountered.

**Upgrade operator applications easily**

An end user can push a new application (or upgrade an existing one) out to operator consoles without requiring time consuming installations to be performed on each node.
Where to From Here?

So, if these benefits sound appealing, where is a good place to start applying virtualization in your plant? Great news is that this can be done gradually. End users can start small, building the company’s confidence in virtualization technology and processes and then grow from there. Here are some suggestions for easy places to start:

**Off-Process Development**

Off-process development systems are by their nature non-critical, making them a great place to start applying virtualization while providing new levels of flexibility and utilization of your off-process development system.

**Non-Critical Ancillary Nodes**

Where supported by the vendor, begin to virtualize non-critical ancillary nodes e.g. Web Access portals, Active Directory Servers, OPC Servers, etc.

**Business Domain Interface Software**

Virtualization is being widely applied today in the IT domain. So, industrial control applications that are used to interface with the IT domain are more exposed to this technology because the systems that they connect to are normally virtualized.

For More Information

For more information about virtualization, visit our website at www.honeywell.com/ps or contact your Honeywell account manager.

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