Thin Client Visualization and Remote Access

*Industrial and commercial companies are employing thin clients and other types of remote access to interface to private clouds.*

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Thin clients, cloud computing and remote access are three trending IT technologies finding traction in both the commercial and industrial sectors. Taken individually these technologies are compelling, and they become even more powerful when combined in a complimentary manner. Local or remote thin clients can remotely access PCs and controllers when connected over private industrial clouds to provide visualization and operator interface solutions.

Intelligent implementation of these technologies can allow plant management to enhance productivity, increase efficiency, and reduce total cost of ownership. These benefits are realized by providing improved access to data found in enterprise resource planning systems, manufacturing execution systems, and other applications.

Private industrial clouds facilitate the connections to commercial off-the-shelf (COTS) hardware which is typically located in a protected environment. COTS hardware is much less expensive than specialized hardware that would be required for a harsh or challenging environment. As AutomationWorld.com puts it, “it’s clear that the interaction and interoperability of consumer technology devices are going to be the big drivers of automation system advances in the near term.”

Operations personnel including technicians, operators, engineers, and executives routinely use human-machine interface (HMI) software, supervisory control and data acquisition (SCADA) software, and other PC-based applications. Interfacing with these software packages in a protected environment such as an office or a control room is accomplished via a number of established technologies such as PC-based Ethernet access, browser-based Internet access and other forms of remote access. The combination of PCs, networking technologies, and other connected devices is often referred to as a “private industrial cloud”.

Yet interface to these private industrial clouds by personnel in plant floor or process areas presents a significant challenge for user in industrial, manufacturing, and heavy commercial facilities because the interface hardware must be toughened to survive harsh environments.

Operator interface solutions that were commonly applied in protected environments, such as connecting a COTS PC to the cloud, are either unworkable or very expensive on the plant floor or other extreme process environment. While deploying an industrially-hardened PC is possible, it is often expensive to install, maintain, and update.

There is a better solution for many plant floor and process plant applications, in the form of thin clients connected via a cloud-based system to offer remote access. Thin client costs (both initially and over the entire life cycle) are lower than PCs, especially when the thin client is located in a difficult environment.

Private Industrial Clouds
The “cloud” is just one of many nebulous terms such as “big data” and the “Internet of Things” that swirl through the media today. These terms may seem to describe some entities or creations that interact or even overlap. In particular, the cloud seems to be the backbone of many other things. How exactly does the cloud impact us, and how does the cloud concept extend to the industrial arena?
In the simplest sense, a cloud can mean obtaining the services of one or more servers via a digital network. When we use an Internet-connected PC to access a search-engine application running on a remote server such as Google, we are using the cloud.

The Internet is a phenomenal execution of a cloud, but of course the Internet is a global implementation. If one were to construct a similar but smaller cloud within a single company, behind a corporate firewall, then that could be considered a private cloud (Figure 1).

Networks within industrial companies typically have distinct divisions. A “business” area may be provided for the front office, while a second area for the shop floor may be called “production”, “operations”, or “manufacturing”. The business network is generally administrated by an information technology (IT) group.

While the production network might include some common PCs, it will likely have specialized production machinery, process equipment, material handling systems, and testing devices. Therefore this network is often administrated by operations and maintenance personnel. If we restrict a cloud to the shop floor and the network-capable devices therein, then it is a private industrial cloud.

So, the cloud principles are the same, but the cloud scope can be focused on as small an area as desired. Whatever the size of the cloud, the resulting efficiencies have prompted Forbes to state that “using cloud-based systems to streamline key areas of their business, manufacturers are freeing up more time to invest in new products and selling more.” Industries that adopt clouds can realize a number of benefits, summarized in Table 1.

Table 1: Benefits of Clouds and Virtualization
1. More uptime
2. Hardware upgrades are simplified
3. Applications can be moved among PCs with no downtime
4. Greater application longevity
5. New instances can be created based on existing instances
6. Not as many PCs are required
7. Total footprint is reduced
8. Energy consumption is lower
9. Security is improved
10. Overall lower costs

Possibly the greatest benefit is a reduction in the number of PCs. This is because a key feature of any cloud is offloading functionality from local PCs, and consolidating it elsewhere on remote servers using an established IT technology called “virtualization”. With virtualization, multiple guest PC operating system instances are created as virtual machines (VMs), which are able to run concurrently in the hypervisor software environment of a single host server. Simply put, virtualization allows multiple operating systems and associated applications to run on a single PC.

Reducing the number of PCs by collapsing them onto a smaller number of compact servers located in a data center obviously reduces physical footprint, energy consumption, and initial procurement costs. Many times in an industrial environment space is at a premium, so the minimized space requirement can become a huge benefit. Servers consolidated into a computer room are also physically more secure than multiple PCs scattered throughout a facility.

A surprising benefit of combining multiple PCs into fewer servers is increased reliability and uptime. This is a non-intuitive result due to several features of virtualized systems operated in a cloud manner. First, the server hardware used is more robust than that of typical PCs, and usually includes redundant power supplies, hard drive storage configured as a redundant array of independent disks (RAID), and networking with multiple redundant paths.

The virtualization software can offer improved options such as high availability, where upon hardware failure the system can automatically restart affected VMs as necessary on different hardware. In fact, an even better level of reliability termed fault tolerance is possible where VMs are synchronized in pairs on different servers so that bump less continued operation is possible.

Additionally, virtualization provides a convenient means of starting, stopping, backing up, and restoring VMs, and for moving VMs among the pool of available hardware without downtime. Proven configurations can be deployed for future work, while improved configurations can be archived as images or snapshots. The assortment of virtualization tools and methods enables administrators to deploy new nodes, or restore problem systems, or even upgrade hardware and software far more quickly than could otherwise be possible. Uptime soars.

In particular, upgrades are an issue that technology administrators wrestle with. PC hardware updates every few years and operating systems undergo significant revisions at only a slightly slower pace. In fact, operating systems may require minor patching and upgrades monthly or even more frequently. An end user’s application may change often, or in the case of certain industrial applications, the configuration may be static for a decade or more.

At some point or another, users must decide whether to perform expensive upgrades or to maintain increasingly unsupported and obsolete operating systems. This is a problem largely solved by virtualization. Virtualization software is continually updated to operate on the latest hardware, while at the same time is designed to support many current and legacy operating systems. Therefore, a system
with a lifecycle initially conceived to be 5 to 7 years can actually benefit from an extended stable operation lifetime of 10, 15, or more years.

When looking at virtualization for the plant floor, Control Engineering has found that “Virtualization is a mature technology and has been used in enterprise environments and service provider data centers for many years. It has proven to save both time and money.”

The combination of cloud and virtualization technologies provides many benefits. However, establishing a way for operators to interface with these systems can be challenging, especially in the industrial and heavy commercial environments where they would be most advantageous. Fortunately, a technology called “thin clients” exists that provides an ideal solution.

Thin Client Advantages
Cloud-based and conventional computing systems require a means for personnel to interact with the remote PCs and controllers, both for visualization and operator interface. Connecting a user to a single remotely located PC would seem to be straightforward, but how can such an interface properly access a particular VM located within a server in the cloud? Furthermore, how can this interface provide a computing experience identical to that of sitting in front of the actual PC or server?

One option is called a “thick client”, which is a fully configured traditional PC device running a software client application. However while a thick client option may have certain applications, it basically requires providing and administrating yet another PC. This is moving away from simplicity and economy, and does not solve the problem of computing in a harsh environment as industrially hardened PCs are very expensive.

The better choice is a thin client. Thin clients offer just enough hardware and software to connect to a virtualized system, regardless of where it is located (Figure 2). Thin clients offer the user a video-display and keyboard/mouse or touchscreen interface as required. They are designed to connect to a VM that is remotely located on the cloud, and offer a “local desktop” type experience. Table 2 identifies a number of thin client advantages.

Figure 2 - Thin Clients often provide the best means to remotely access a private cloud from a harsh environment
Table 2: Advantages of Thin Clients over PCs

1. Reduced upfront cost
2. Lower total life cycle cost
3. Smaller footprint
4. Less heat generation
5. Easier to deploy in harsh environments
6. Software can be maintained at the host
7. Longer life cycle as software resident at the thin client is minimal
8. Greater security
9. Each thin client user can access multiple hosts

Cost is always a key consideration, and ruggedized and industrialized thin clients are much less expensive than a PC. But an even more substantial real cost advantage of thin clients over PCs is the lower total life cycle cost realized by administrators.

For example, thin clients may need firmware or software updates occasionally, but these are extremely minimal compared to those required by PCs. Thin clients often have no moving parts (not even fans), and therefore require no periodic maintenance. Therefore, ongoing labor savings is exceptional. Even if there is a failure, the simplicity of the device and the fact that software services are provided remotely in the cloud allows quick hardware change out with very minimal local effort.

Even shrinking PC form factors cannot approach the small footprint of thin clients. With all core software applications and processing occurring at the VM host server in the cloud, relatively little local processor power is required. The resulting device is thin and low powered, generating very little heat and requiring no air flow. The form factor is ideally suited for a small wall mounted enclosure, a kiosk, or a console.

These features also contribute to the ability of many thin clients to be installed in harsh environments. The devices are commonly available in IP-rated or NEMA-rated configurations for wet areas, and with touchscreens so that keyboards and external pointing devices are not needed. Their solid-state nature means that installations on vibrating machinery or even vehicles are possible. Other more advanced thin client configurations offer a degree of protection from extreme temperatures, dirt or other contaminants, electromagnetic noise, and intensive wash-down or sanitization protocols.

Various styles of thin clients are a good fit not only in tough industrial environments, but also in other challenging locations such as warehousing, retail establishments, and medical facilities. Being that they are specialized hardware that must connect into an infrastructure to operate, they are much less attractive targets for thieves. Also, since all application software and associated data are centralized elsewhere on the cloud servers, thin clients present a much better security solution than traditional PCs.

The fact that cloud servers and clients are physically decoupled leads to numerous efficiencies. IT personnel have much less need to visit the shop floor, and can instead concentrate their efforts on the server room. All application software is installed, operated, and maintained on the server hosts—meaning that upgrades and changes can be administrated there regardless of how many thin clients are connected and where they are actually located.

Additional functional benefits are realized by designing an infrastructure of virtualized PCs operating on cloud-based servers and accessed by thin clients. Each thin client is capable of being configured to access as few or as many VMs as required, based on user logon and assigned privileges. An operator
can check the status of the process, a maintenance technician can troubleshoot devices, and a supervisor can view the MES reports.

The thin client is effectively leveraged to serve in a multitude of roles. Not only that, but new functionality is possible. A single user can log on and off thin clients as they move through a facility and their personal "session" will effectively follow them.

As the web site *TechRadar* says, “Thin clients can remove much of the cost associated with traditional desktops – something that's highly attractive to any business.”

It is obvious that thin clients coupled with cloud-based virtualization represent an obvious and powerful advantage for many industries, but how difficult is it to achieve this architecture?

**Thin Client Implementation Details**

If thin clients required esoteric host software and hardware, they would not be quite so attractive. Fortunately, there are native and third-party options to facilitate remote access. One powerful and flexible option for centralized thin client management is ACP’s ThinManager product, which coordinates the connection of thin client sessions with associated terminal server hosts.

ThinManager allows all the resources of a given computer (physical or virtual) to be remotely accessed over the network by another system via a thin client session. The thin client’s interface activities including keyboard strokes, mouse movements, and touchscreen operations are directed to the host VM on the cloud. Thin clients can be fixed or mobile devices, with varying screen sizes and functionality depending on specific application requirements (Figure 3).

![Figure 3 - Microsoft's RDP protocol provides built-in remote access functionality for thin clients](image-url)
The VM graphic output and sound feedback are presented on the thin client. The processing power, operating system, and executing application only exist on the host but are represented to the thin client as if it and the host PC were one system.

Even more advanced capabilities are available with ThinManager. The software allows thin client sessions to connect to the terminal servers with the lightest loads, effectively load balancing the system. Furthermore, thin client sessions can be automatically directed to failover to alternate terminal server(s) in the event of a primary terminal server failure.

Thin client sessions can even be “shadowed” by administrators, so that the remote activity can be monitored. In fact, the thin client can be completely and remotely administered, rebooted, enabled or disabled through the use of ThinManager.

One of the key enabling technologies when using ThinManager and thin clients is everyday COTS Ethernet communications infrastructure. Standard copper CATx cabling and switches are more than adequate for the networking load, and runs longer than 100m can use fiber optic media converters to extend the connection to great distances. ThinManager allows redundancy options for multiple Ethernet connections, and also supports IP cameras.

For common HMI and SCADA applications many of the images are mostly static and therefore don’t consume much bandwidth, making simple Ethernet connectivity very suitable for commercial and industrial installations. If extensive pictures and videos are being displayed then the network will typically require more bandwidth.

Note that while thin clients can be implemented over the regular facility network, it may be prudent to provide a dedicated network for the private industrial cloud. The reason is to obtain the highest level of network performance, as well as an added level of security due to segregation. Even if thin clients will share the facility network, there are IT tools such as virtual local area networks implemented on smart switches that can be configured to route traffic and provide a degree of isolation.

While the combination of ThinManager and thin clients is a powerful remote access software technology for harsh environments, there are other options and ways to leverage remote access technology in more forgiving locations.

Browser-Based Remote Access
Internet browser usage is commonplace in today’s world, so it makes sense that browser-based technology has made inroads into remote access. Browsers are now available not just on PCs, but also on smartphones, tablets, and similar mobile devices (Figure 4). Therefore, if a user has a PC or a controller application that natively serves web pages, it is possible to connect to this application via any browser-capable device. In addition to PCs and controllers, other components such as Ethernet switches, analyzers and instruments are often provided with web server capability.
Browser-based interfaces represent an open type of remote access as software with very specific interface capabilities can expose the output in a browser format. One example would be a specialized HMI/SCADA software application that must communicate to industrial controls and provide a graphical window into the operation. HMI packages are available that can be implemented on a protected PC and can then serve up graphics, alarms, and even video to distributed browser devices.

This type of solution can be useful in diverse vertical markets including building automation, petrochemical, water treatment, irrigation, and remote oilfield sites. HMIs are available offering varying levels of features as called for by particular industries.

*InTech* summarizes it this way, "With cloud-based SCADA, all of the computing power, storage, and redundancy required for remote access is provided by the cloud providers’ servers. This makes every user a remote user, with no additional effort required by the end user after establishing a connection from the local SCADA system to the cloud." ²

However, browser-based connections cannot usually help with detailed administration of embedded computers and controllers. Fortunately there is another class of remote access software tailored specifically for remote management of these resources.

**Remote Administration**

A remote administration application is typically installed on a PC, and then connected via a private cloud to a variety of embedded computers and controllers. All of the embedded hardware must be configured to allow remote administration access to system level functions, therefore most remote administration systems consist of a local PC-based software application connected to remote embedded computers and controllers, all from the same vendor.
This type of a remote administration solution enables IT and other personnel to inspect system-level conditions of embedded devices such as temperatures and voltages, and to receive automatic alarms if trouble occurs. Embedded devices be turned on and off, and backups and restorations can be performed. Most of these capabilities are of the type that day-to-day users should not even have access to, and are instead system-level IT responsibilities.

Remote administration software allows IT personnel to have a similar level of control and access to remote embedded devices than that enjoyed with internal networks of PCs (Figure 5). IT personnel are used to using these types of administration tools to monitor and maintain corporate PC networks, and therefore can rapidly implement remote administration systems for embedded devices.

The key is that IT personnel can remotely extend their reach throughout an organization and improve their effectiveness. A single PC can act as the gateway for IT personnel to maintain a host of remote embedded devices, improving system maintainability and uptime.

Conclusion
Businesses strive daily to improve operations, increase efficiency, and reduce costs. Using COTS hardware and software solutions offers obvious savings. Thin clients and remote access over private industrial clouds represent three complimentary COTS technologies that are even more powerful when used together. This technology triplet is an excellent fit for numerous commercial and industrial facilities, and offers other benefits.

A back-end solution of PC virtualization technology provides improved reliability, minimized space and power requirements, and maximized lifecycles. Combining this with a front-end thin client solution offers a window into the system that is less expensive over the life cycle than dedicated PCs offering a similar experience.

Thin clients offer other advantages over PCs, such as low-cost installation in harsh environments and minimal required management. New functionality is possible, such as configuring the thin client to
access many different virtual PCs, or allowing a user’s session to follow them across many different thin clients.

Standard COTS networking technologies and protocols such as Ethernet and ACP ThinManager are employed to create a private industrial cloud and to enable thin client remote access. Thin clients are readily available and the IT configurations are well understood. Users can size their private industrial cloud as large or as small as needed to meet the needs of their operation.

Where thin clients are not the best fit, often in non-industrial environments, there are other options such as web-browser based remote access and applications accessed via PCs and other browser-capable devices.

Furthermore, specialized remote administration software can enable an IT staff to maintain all of the embedded computers and controllers in a private cloud at a very detailed and low level, far more efficiently than performing all the work in person on the target equipment.

The bottom line is that these technologies may represent the best system design option for a variety of commercial and industrial applications.

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