Executive Briefing Document

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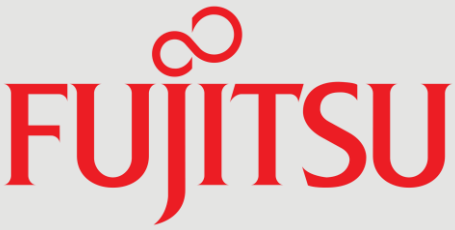


Desktop virtualization as an accelerator of digital transformation

Fast-track creation of a modern digital workspace

Freeform Dynamics, 2018

Introduction

Employee facing systems, including the desktop computing environment, have fallen behind in many organizations.

Digital transformation investments have, to date, focused mainly on customer facing initiatives, enabling new business opportunities and engagement models. Meanwhile, employee facing systems, including the desktop computing environment, have fallen behind in many organizations. In some organizations, this is now becoming a constraining factor in relation to broader business transformation agendas.

Today's workforce consists of many roles and occupations, and any of these can become less effective when access to modern tools and applications is lacking. But delivering a modern digital workspace while simultaneously transforming the business is no easy matter, so business and IT decision makers need to consider alternative approaches and delivery models, especially where the Windows desktop is concerned.

Key points

Today's workforce consists of many roles and occupations, and any of these can become less effective when access to modern tools and applications is lacking.

Fully managed, and even cloud-delivered desktop as a service options are now available for those who want it.

Digital transformation is less likely to succeed without digital workplace investment
Products, services, and rewarding customer experiences are designed, delivered and managed by employees, so organizations must do all they can to spark creativity and drive productivity by investing in the skills, tools, and environment of the workforce.

Workforce productivity, collaboration and innovation are drivers of business growth
The design goal of an end-user computing environment should be that of providing an easy-to-use, secure computing experience that can deliver the apps and data that the employee is likely to need, on any device that the employee is likely to use, from any location that the employee needs to be.

Desktop virtualization technologies can increase the adaptability of business and IT
The Windows desktop is still relevant for many high-value business activities and process scenarios, and the versatility and utility of this computing environment can be enhanced, augmented and optimized by using desktop virtualization solutions.

Today's virtual desktop experience is far superior to how it used to be
Market consolidation has resulted in a set of very capable offerings, making today's desktop virtualization projects much easier to implement, manage, and deploy thanks to pre-integrated products, mature IT services, and purpose-built appliances.

Corporate networks and IT infrastructure are ready for desktop virtualization
Business adoption of IP based telephony, video conferencing, and cloud computing models have led to modern networks with more bandwidth, less latency, and better quality of service management – all of which fit perfectly with desktop virtualization.

The virtual desktop infrastructure ecosystem has evolved and matured
Systems integrators, managed service providers, and IT infrastructure suppliers are now an integral element of the desktop virtualization ecosystem, especially where large enterprises are concerned. Optimized solutions meet a variety of industry and business needs, offering organizations a fast-track to the modern digital workspace.

What once seemed impossible is now perfectly doable
Desktop virtualization has evolved to meet the most demanding Windows desktop application workloads. Fully managed, and even cloud-delivered desktop as a service options are now available for those who want it, complete with the kind of service and support that few ever thought was possible.

The digital workspace imperative

Market competition and customer expectations are driving demand for increased levels of workforce adaptability and mobility.

At the employee level, most end-users want IT tools that are simple and easy-to-use. In addition, power users want more flexibility and capability from their end-using computing environment. From a business manager's perspective, market competition and customer expectations are driving demand for increased levels of workforce adaptability and mobility while maintaining the highest appropriate levels of security and compliance. And it goes without saying that budget holders would rather pay less, not more, for desktop provisioning and support.

The design goal of the modern digital workspace is to provide the employee with an easy-to-use, secure, cost-effective desktop experience that can deliver the apps and data that they are likely to need, on any device that they are likely to use, from any location that they need to be. This begs the question: Is there an alternative, low risk, cost-effective, fast-track route to the modern digital workspace?

Today's desktop virtualization solutions have, for the most part, overcome the limitations of previous products and solutions.

Desktop virtualization solutions clearly have a role to play here, but a recent survey of 220 IT professionals[1] suggests that knowledge of this market is likely to be somewhat out-of-date, especially where the choices and options relating to virtual desktop infrastructure (VDI), application virtualization, and service provision are concerned.

Based on your previous experience, perhaps gained from several years ago, you might think about the usability and functionality constraints of desktop virtualization, and have concerns about the cost and complexity from an implementation and ongoing management perspective. This is understandable. However, today's desktop virtualization solutions have, for the most part, overcome the limitations of previous products and solutions.

Why the Windows desktop matters

The versatility and adaptability of Windows-based PCs have always lent themselves to a range of different usage scenarios.

Mobile devices continue to offer significant transformative potential, but so too does the traditional PC in its various guises. It's easy to fixate on desktop and laptop computers, but workstations and slate/tablet devices are part of the Windows PC family too. For some organizations, wearable PCs, in the form of Microsoft HoloLens, are already extending the reach and range of Windows into the world of mixed reality.

The versatility and adaptability of Windows-based PCs have always lent themselves to a range of different usage scenarios and business functions. The challenge, however, is the cost-effective management of the different layers of the PC stack: hardware, operating system, applications, user data, and settings.

Windows 10 has probably secured the operating system's future for another decade.

The Microsoft Windows desktop paradigm has been with us for over 30 years, and is truly engrained within all industries. And while many organizations have embraced alternative desktop computing environments, either in part or in whole, it's almost impossible to escape the gravitational pull of Windows. However, as we shall see, there are several ways to use Windows without owning or using a physical PC.

The arrival of Windows 10, with its mobile-like management features and new capabilities, has probably secured the operating system's future for another decade at least. So, as client platforms move towards more of a services model, you may be thinking about your organization's end-user computing strategies, considering how best to deploy the traditional desktop and the business applications that run within it.

The virtual desktop alternative

It's important to recognize the many ways in which desktop virtualization can often handle existing and emerging needs/expectations more effectively and efficiently.

The familiar Windows-based desktop computing model is still relevant for dealing with many business scenarios and requirements. However, it's important to recognize the many ways in which desktop virtualization can often handle existing and emerging needs/expectations more effectively and efficiently, especially where these are time critical. When deployed appropriately to relevant users, top level benefits of desktop virtualization include:

- Increased flexibility, by enabling end-users to work almost anywhere and at any time, in a consistent, predictable, well-managed manner. Key to this is effective access to their applications and data regardless of device and form factor (workstation, desktop, laptop, tablet, etc.), with their personal 'preferences' as well as preferred 'look-and-feel' preserved wherever possible across devices.
- Enhanced business continuity, by minimizing the impact of malfunctioning equipment and applications, power and communication outages, natural disasters, and other disruptive events. Achieved by reducing the user's dependency on a specific work location and/or specific devices.
- Adherence to security and compliance policies, by centralizing desktop management, application execution, and data storage in ways that enhance visibility and control without degrading the end-user's experience.
- Reduced burden on IT staff, by enhancing their ability to maximize the quality of service to users through the simplification of application development, deployment and maintenance, and the efficiency gains that stem from a more centralized, more process-driven, and more consistent management approach.

Desktop virtualization consists of a range of techniques and approaches, underpinned by models and architectures.

In practical terms, desktop virtualization consists of a range of techniques and approaches, underpinned by models and architectures, aspects of which you may already be familiar with. We'll be describing these at a high level in the coming sections, and discussing how they can be combined to meet the needs of different types of user. If you need to get up to speed or refresh your memory at the next level of detail, you'll find further background and information in Appendix A.

Desktop virtualization options

Desktop virtualization is a general term used to describe a set of delivery models that enable the user to access a Windows-based desktop computing environment running on a remote server as though it were a local PC (additional application virtualization techniques extend these models in different ways). The user sits in front of a screen (or potentially stands if they're using a tablet device) and interacts with the keyboard and mouse (or touch screen), but the computer delivering the Windows desktop experience and/or associated applications is somewhere else.

Session-based virtualization and virtual desktop infrastructure are the two common desktop virtualization models in use today.

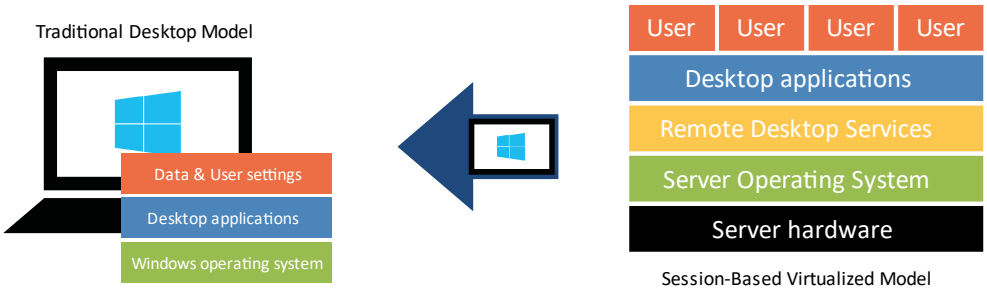
There are two primary Windows desktop virtualization models in common use today:

- Session-based virtualization uses the resources of a Windows Server host to provide a cost-effective multi-session environment for 'everyday' workloads.
- Virtual desktop infrastructure (VDI) uses the server's computer resources and Windows client operating system to provide users with a familiar, performant, and highly compatible desktop experience.

Sometimes referred to as 'Hosted Shared Desktop', session-based virtual desktops share the computing resources of the server, with discrete sessions managed by the server operating system keeping each user's activity separate from everyone else's. Using this model, the user's desktop experience is actually that of the server operating system (Windows Server). This approach (Figure 1) is optimized for high density user desktop sessions.

Figure 1

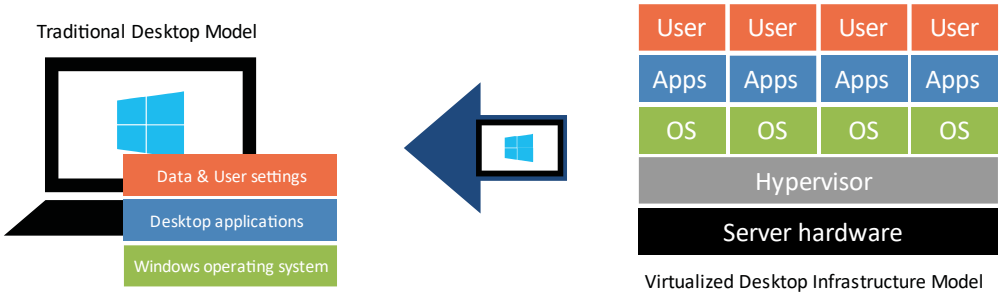
Session-based desktop virtualization model



Sometimes referred to as 'Hosted Virtual Desktop' VDI is also delivered by datacenter (or cloud) resident servers, storage and other platform components to create, execute and manage tens, hundreds, or even thousands of virtual desktops (Figure 2).

Figure 2

Virtual desktop infrastructure model



Using hypervisor technology, VDI essentially hosts 'virtual machines' that mimic desktop PC hardware, presenting the Windows operating system to the user with what appears to be dedicated system resources, such as processors, RAM, and storage. VDI comes in two 'flavors':

- **Non-persistent VDI (sometimes called Pooled VDI)** builds on the notion that a Windows-based PC is at its best when it's brand new, unfettered by multiple software patches and updates. So, why not provide the user with a new, virtual computer every time they request one, obliterating it when it's virtually "switched off"? And because it's a virtual PC running a standard version of the Windows operating system, application compatibility issues are minimized. This model is optimized for highly standardized environments and employee roles.
- **Persistent VDI** is almost identical to non-persistent VDI, with the difference being that every user's desktop environment is booted from a separate virtual machine image. This provides more user flexibility, as each Windows desktop can be uniquely configured and tailored by the user (subject to policy). This model is optimized for individual users and diverse end-user computing environments.

When done well, a Windows desktop computing environment delivered using virtualization technologies should be almost indistinguishable from that of a traditional desktop or laptop PC.

When done well, a Windows desktop computing environment delivered using virtualization technologies should be almost indistinguishable from that of a traditional desktop or laptop PC. Indeed, the aim of desktop virtualization should be to provide a better computing experience for the end user and, by association, the business, including the IT department of course.

Desktops, whether physical or virtual, only exist so the user can run the applications they need.

Appendix B includes additional detail relating to virtualization models, but let's not forget that desktops, whether physical or virtual, only exist so the user can run the applications they need.

Application installation and access options

Within the desktop virtualization environments described above, you can install and manage a variety of applications. Applications can be installed in the familiar manner following operating system deployment or they can be preinstalled as part of a standard virtual machine image to form a foundation for a pool of users with similar core requirements.

Direct installation in either environment will, by definition, make an application available to any user in the relevant pool served by that image, so this is something that would normally be controlled by IT.

Where persistent VDI is used (or the Windows client operating system is running as a locally hosted virtual machine), different mixes of applications may be installed on each virtual Windows machine by either IT or the user (depending on permissions).

Where persistent VDI is used, different mixes of applications may be installed on each virtual Windows machine by either IT or the user.

As with traditional PCs, applications often become woven into the local operating environment when they are directly installed, sharing things like runtime libraries (DLLs), registry settings and other local resources, so the usual caveats apply regarding application conflicts.

Beyond these more familiar installation and execution options, some of the most significant developments in the world of desktop virtualization in recent years have been in 'application virtualization'. The two most common means of application virtualization are:

- Remote application execution: As the name suggests, in this model the application executes on a remote server, which may be different from the one hosting the virtualized computer environment. The application may appear to be running natively on the target desktop (which may be physical or virtual), but it's not, it's just presenting the remote user interface and interacting with keyboard and mouse.
- Virtual application streaming: Using this model, individual applications are bundled-up with the resources and settings they need to operate (library modules, specific registry entries, and so on), then deployed (even 'streamed' on demand) from a central server in the form of a self-contained package to the target PC (which may be physical or based on any kind of virtualized Windows desktop deployment model). From there, they execute as if they were directly installed, but do so in their own protected, virtualized environment.

Appendix C provides more detail about application virtualization mechanisms.

User experience virtualization

Personalization is an important part of the end-user computing experience.

Personalization is an important part of the end-user computing experience, however, with the advent of Windows desktop virtualization, and use of multiple devices by a single user becoming more popular, traditional approaches to managing user settings and data (often referred to as 'state'), are often no longer adequate.

If you've not looked at desktop virtualization in a while, then user virtualization is probably the area where you'll see the most advancement.

If you've not looked at desktop virtualization in a while, then user virtualization is probably the area where you'll see the most advancement, addressing many of the issues associated with roaming profiles and the overall user experience. User virtualization can work across any mix of Windows-based desktops that support the facility, whether they are physical, virtual or even temporary, such as a hot-desk PC.

User virtualization ensures that the workforce has a consistent experience regardless of which type of Windows desktop environment they're using, be it a physical desktop, virtual desktop, or virtualized application. Taken one step further, user virtualization can provide employees with a consistent experience across a range of devices, not just Windows-based computers.

Keeping track of where user documents, files and folders are stored can be hard in a multi-device environment, especially where enterprise mobility initiatives are linked to digital transformation programs. Data protection, business continuity, and disaster recovery are also likely to be front-of-mind when you think about the management of end-user data, especially if General Data Protection Regulation (GDPR) is within your remit. In all these areas, user data virtualization can be a powerful technology.

Keeping track of where user documents, files and folders are stored can be hard in a multi-device environment, especially where enterprise mobility initiatives are linked to digital transformation programs.

End-user data virtualization is a central component of many digital workspace initiatives, with vendors such as Microsoft (Microsoft 365), VMware (Horizon Suite, Workspace ONE), Citrix (Citrix Workspace), and others all competing in this space. Each vendor has a different starting position when it comes to provisioning the digital workspace, but they are all trying to provide a solution that enables the user to work with native apps and data beyond the confines of a single device.

Enterprise file sync and share products can enhance desktop virtualization initiatives in some scenarios and, as they are almost de rigueur these days, these offerings may also be considered to form part of an enterprise mobility management solution.

We've added a few more details to Appendix D, including commentary relating to the crossover between desktop virtualization and enterprise mobility management strategies.

From concepts to real-world solutions

So far, we've described desktop virtualization solutions in a 'logical' sense, focusing on key concepts and functionality rather than specific enabling products. Getting from here to real-world solutions that deliver the kind of benefits we have discussed has historically been challenging, expensive and risky.

That was then…

If you've been involved with VDI before, you may have lingering memories of how easy it used to be to underestimate requirements for storage capacity, throughput, network bandwidth and other server-side resources.

If you've been involved with VDI before, you may have lingering memories of how easy it used to be to underestimate requirements for storage capacity, throughput, network bandwidth and other server-side resources. Even if you sized the system appropriately for run-rate loads, you could still be caught out by 'boot storms', with some critical element of the system bottlenecking in the first 15 mins as most of your users arrived at their desks and attempted to log in at the same time.

If you were lucky, you identified the need to over-provision capacity before you went live, so while the system cost a lot more than was originally envisaged, at least it delivered a reasonable experience to users. If you were not so lucky, the problems surfaced post-implementation, leaving you grappling with the political problems of

unhappy users, while trying to find the necessary, but unbudgeted time and money, to remediate issues and repair reputations.

…this is now

Systems still need to be designed, sized and built with the right resources configured in the right way to deal with your requirements, but several factors make this much more straightforward than it used to be.

Developments over recent years have all but done away with such issues. Of course, systems still need to be designed, sized and built with the right resources configured in the right way to deal with your requirements, but several factors make this much more straightforward than it used to be:

- VDI software platforms have evolved and matured to allow the use of physical system resources, such as compute, memory, storage and networking, to be managed and optimized dynamically and automatically. Whether it's just-in-time allocation of RAM to a virtual machine, using a single image to boot many non-persistent desktops, or smart use of bandwidth between the client and server to provide a good experience, today's VDI platforms are inherently much more efficient and tolerant of demand spikes and fluctuations than their predecessors. This makes them cheaper and easier to implement, manage and support, and capable of delivering a consistently good user experience as conditions and usage patterns fluctuate and evolve.

The hardware you need to underpin your VDI environment is now considered 'normal' rather than exceptional.

- Physical infrastructure itself is now far less of a constraint. For example, the norm for networks has shifted independently of VDI requirements. In response to adoption of IP based voice and video, a growing dependency on cloud computing, and a more general escalation in data transport and storage demands, modern networks tend to have more bandwidth, less latency, and better quality of service management than they used to. The same can be said of storage, where mainstream acceptance of flash technologies[2] has translated to much higher performance at an affordable cost. 'Bang-per-buck' in relation to computing power has been trending similarly. The hardware you need to underpin your VDI environment is now considered 'normal' rather than exceptional.

- Experience and best practice has been harvested from many mainstream deployments of desktop virtualization projects, both large and small. It's now rare to have to size, build and configure a solution from first principles. All serious vendors and integrators have blueprints or reference architectures that allow a specification to be generated based on a relatively simple set of parameters – number and type of desktops, user and application mix, and so on. Even if you do want an integrator to take care of the design and build, the number of consulting days required to stand up a fully working VDI environment is now much lower.

You can acquire VDI solutions as self-contained appliances, with the whole stack – hardware, software and management tools – pre-integrated and supported as a single solution.

- Procurement and delivery options that further streamline implementation, operation, and ongoing management of growth and enhancement are now offered by some vendors. As an example, you can acquire VDI solutions as self-contained appliances, with the whole stack – hardware, software and management tools – pre-integrated and supported as a single solution. Modular, standards-based designs and 'pay-as-you-grow' commercial terms allow you to start small then scale quickly, smoothly and efficiently as you add more users and desktops into the system.

Picking up on this last point, an ability to support growth and expansion elegantly and cost effectively leads us to the question of how you select and prioritize different

groups of users so you can phase adoption appropriately and make sure needs are properly met. This brings us to the topic of user profiling and segmentation.

Understand the workforce to succeed with VDI

The best way of analyzing desktop virtualization requirements is through a user profiling exercise.

The best way of analyzing desktop virtualization requirements is through a user profiling exercise. The aim is to build a picture of which applications are being used, how, and by whom. Next, identify groups or segments with the same or similar requirements.

We've added some hints and tips in Appendix E to help you get started, but as an example you might end up with a list of user segments that look something like this:

- Managers and executives
- General administration staff
- Finance and accounting staff
- Sales and marketing professionals
- Customer services representatives
- Engineers and technicians

Where the workforce is more complex, or where a lot of 'exceptions' to normal requirements exist, it can sometimes be better to segment users based on key characteristics (Table 1):

Table 1

Example segments based on user characteristics and behavior

User type	Characteristics
Task/process worker	Works from a fixed location, always connected to the LAN, often through a hot-desk terminal (e.g. in a call center), limited set of applications (e.g. CRM or ERP access).
Admin worker (regulated)	Works from a fixed location, always connected to the LAN via a dedicated workstation, fixed set of applications, but often working with sensitive data or on highly regulated activities.
Admin worker (normal)	Works from a fixed location, always connected to the LAN via a dedicated workstation, fixed set of applications, but not involved with particularly sensitive or highly regulated data.
Office-based professional	Usually desk-based, well connected, one or two devices, more variable or demanding application requirements.
Roaming professional	Works from different locations, intermittent or variable connectivity, multiple devices, variable or demanding app requirements.
Home office worker	Works from a fixed desk at home, reasonably well connected over broadband, single device, fixed set of applications.
Engineer/creative professional	High demands in terms of graphics usage and overall computer performance.
Contractor/BYOD	High degree of autonomy, flexibility and mobility and potentially has access to commercially sensitive business information.

Please note that the purpose of Table 1 is to show how requirements can vary between groups – it is not intended to be exhaustive.

Profiling exercises aren't as onerous as you might imagine, as you can focus initially on a subset of users in a specific department and use automated discovery tools that interrogate machines over the network to speed up data gathering.

Specific needs, in terms of the required application mix are important here, as are constraints and considerations related to performance, access and security. In practice, profiling exercises aren't as onerous as you might imagine, as you can focus initially on a subset of users in a specific department and use automated discovery tools that interrogate machines over the network to speed up data gathering.

Mapping is all about identifying the most appropriate option, or blend of options, for each category of user to get the balance right between cost, performance, security, flexibility and control.

If you work through all of the needs and practicalities, and bear in mind the economics (e.g. use the less costly session-based model rather than VDI for users with fixed application needs and modest performance requirements), then you may end up with a mapping that looks something like this for OS deployment options (Table 2):

Table 2

Example mapping of deployment options to user types

	Centralized ⟷ Localized				
	Session-based virtualization	Non-persistent VDI	Persistent VDI	Blended local/virtual apps	OS & Apps fully local
Task/process worker	✓	ⓘ	⚠	✗	✗
Admin worker (regulated)	ⓘ	✓	ⓘ	✗	✗
Admin worker (normal)	ⓘ	✓	ⓘ	⚠	✗
Office-based professional	ⓘ	ⓘ	✓	ⓘ	ⓘ
Roaming professional	ⓘ	ⓘ	ⓘ	✓	ⓘ
Home office worker	ⓘ	ⓘ	ⓘ	✓	ⓘ
Engineer/creative professional	✗	ⓘ	ⓘ	✓	ⓘ
Contractor/BYOD	ⓘ	ⓘ	ⓘ	✓	⚠

✓ Preferred/primary option

ⓘ An option, depending on practicalities

⚠ Generally, only for exceptional needs

✗ Generally, not appropriate

With this kind of objective approach, you will be able to find the right balance between flexibility, control and cost efficiency for each type of user within your organization.

Whichever way you go about your profiling, it's important to identify all applications currently installed, exactly as you would in preparation for a traditional desktop migration project. Categorize applications according to their importance, and if rationalization or consolidation is appropriate, do this before getting into any virtualization activity.

A digital workspace checklist

Finding the "right approach" to desktop virtualization can be accelerated when business and IT decision-makers engage with experts in the field.

Finding the "right approach" to desktop virtualization can be accelerated when business and IT decision-makers engage with experts in the field. A range of system integrators, technology providers, and system outsourcers have developed tried-and-tested blueprints that reduce the cost and complexity of desktop virtualization projects, including full end-to-end service offerings that span every aspect of digital workspace strategy, from initial workplace assessment right the way through to Desktop-as-a-Service (DaaS) if that's what you're looking for.

If you're an IT manager you'll probably be inclined to advocate the use of modern technology, however, business managers are also recognizing that having a progressive end-user computing strategy is a key enabler of digital transformation, supportive of employee engagement, and a driver of enterprise productivity.

As you think about this topic, and to avoid getting bogged-down in the technology, it might be helpful to reflect on the following digital workspace checklist:

- Does it promote productivity, collaboration, and business innovation?
- Can it adapt to suit an expanding range of employee workstyles?
- Does it enhance the employee experience and augment their abilities?
- Does it scale to meet the dimensions of large enterprises, such as identities, occupations, devices, applications, and data?
- Does it preserve the confidentiality, integrity, and availability of corporate data and information?
- Does it maintain the highest appropriate levels of governance and compliance?
- Does it move the digital workplace and the business forward in a well-implemented, well-supported, always up-to-date manner?

Bringing it all together

The Windows desktop user interface is still the primary means of access to business applications.

Although the end-user computing environment has been enhanced and extended with mobile phone and tablet computers, the Windows desktop user interface is still the primary means of access to business applications, productivity tools, and information systems for hundreds of millions of employees.

Modernizing the desktop computing environment can, in many cases, be a good way of enhancing business performance and employee engagement, both of which ultimately contribute to increased customer satisfaction and business success.

The way in which the desktop performs and adapts has a big impact on user productivity and operational efficacy.

Conversely, allowing your digital workplace infrastructure to drift out-of-date can lead to escalating costs and risks, both of which are more likely to impact customers and business performance in a negative way.

Viewed holistically, the way in which the desktop performs and adapts has a big impact on user productivity and operational efficacy. These highly visible factors also influence the perception of how well IT is being managed overall, and thus its contribution to the business.

By de-coupling legacy applications from the underlying operating system, organizations can explore the business potential of new and different operating system versions, devices and peripherals.

The Windows operating system continues to offer new opportunities for innovation and disruption, especially if you take Windows 10 into account. However, adopting this new offering, even on a minor scale, can be challenging, as it can immediately double the workload from a testing perspective for IT departments. This is where virtualization presents its value to the business. By de-coupling legacy applications from the underlying operating system, organizations can explore the business potential of new and different operating system versions, devices and peripherals.

As you think about the business value of desktop virtualization, including the ways in which it can help transform the implementation, management and maintenance of your end-user computing environment, consider how this technology might also enhance or augment broader trends and developments within the business, such as enterprise mobility and workforce flexibility initiatives, service-centric delivery models, and the adoption of hybrid IT architectures.

Virtual desktops and VDI have come a long way since their introduction. The performance and storage problems that plagued early implementations are now mostly a thing of the past, replaced by more capable hardware systems and software stacks that have been designed and pre-integrated to meet particular needs.

Virtual desktops and VDI have come a long way since their introduction.

A decade or so ago, there were only one or two choices for desktop virtualization, whereas today there are multiple choices across the board, ranging from foundational elements, such as optimized hardware and software stacks, right the way through to application and persona management.

Just as virtual desktop technology has advanced over the years, so too has end-user expectation. This means that a virtual desktop environment has to outperform the alternative, and by this we don't mean the 5-year-old PCs sat in the accounts department, we mean the shiny new kit that was deployed less than six months ago.

What once seemed impossible is now eminently doable.

Desktop virtualization capabilities have evolved to the point where, with careful selection, rich multimedia applications and sophisticated CAD solutions can be delivered by a virtual desktop solution. What once seemed impossible is now eminently doable. And the evolution continues, with fully managed, and even cloud-delivered desktop as a service now an option for those who want it, complete with the kind of service and support that few ever thought was possible.

References and further reading

The following documents are available for download from the Freeform Dynamics website (www.freeformdynamics.com).

1. Thin Client Devices Revisited
2. The Enterprise Flash Imperative
3. Application Platforms Matter

Appendices

Appendix A: What is desktop virtualization?

Many readers will be aware of virtualization in the context of 'x86' servers, where it has been used as the basis for consolidating server estates, streamlining operations, increasing flexibility, and moving applications to the cloud. In fact, this 'flavor' of virtualization first entered the mainstream market in 1999 as a power user's tool, providing developers and IT administrators with a more convenient way to develop and support multiple different desktop operating system configurations.

An enabling component of virtual desktop infrastructure (VDI) is the 'hypervisor', which allows multiple 'virtual PCs' – historically known as virtual machines (VMs) – to run on a single physical computer, breaking the traditional tight coupling between computer hardware (memory, processor, and storage) and PC operating system software.

In the traditional desktop computing model, the computer hardware runs the Windows operating system upon which applications are executed. Users interact with these applications via a keyboard and mouse, and the user interface is presented on a screen.

By introducing desktop virtualization into this mix, and using remote desktop protocols to enable input/output over the network, we break the bindings between physical hardware, operating systems, applications, displays, keyboard, and other input/output peripherals.

This means that some or all the software components – operating system and applications – can be instantiated on a remote server, while giving the impression that Windows is running on a local device, receiving input from the user's keyboard and mouse and displaying output on the user's screen.

The latest generation of desktop virtualization solutions allows these elements (and more) to be mixed and matched, according to what's required. Desktop virtualization enables the Windows desktop and its applications to be delivered to the user in several different ways, perhaps depending on their location, their physical device, their network connection, and even the time of day. This is usually determined by a mix of policies, solution constraints, and user preferences.

Fortunately, it's not necessary to work through all these options from first principles, as several desktop virtualization deployment models have emerged to cater for frequently occurring requirements and objectives.

These are relatively easy to understand, and the best way of appreciating what fits where is to consider each of the three important layers in turn – the desktop operating system, the applications that run on it, and the settings and data accessed by those applications.

Appendix B: Desktop virtualization models

Session-based virtualization

In the days before personal computers, users would typically access interactive applications running on a central/remote computer via a 'dumb' terminal, i.e. a simple keyboard and screen with no local compute or storage capabilities. Microsoft introduced this model of session-based computing to the mainstream Windows market in the late 1990s through a technology licensing agreement with Citrix. In short, the technology turned Windows Server into a multi-user system, enabling several concurrent users to remotely access interactive desktop applications.

Remote Desktop Services (known as Terminal Services in Windows Server 2008 and earlier) enables multiple users to establish a remote desktop session on a computer – the 'terminal server' – running the Windows Server operating system. The terminal server's computing resources are dynamically shared across discrete user sessions, thereby keeping each user's activity separate from everyone else's.

Using this model, which is sometimes referred to as 'Hosted Shared Desktop', the Windows desktop user experience is actually that of the server operating system (Windows Server), so application compatibility issues have to be carefully managed. This is typically addressed through application virtualization.

Due to the very nature of end-user computing, which is often ad hoc and generally that of the computer waiting for input from the end-user, session-based virtualization can provide a very cost-effective Windows desktop environment for a variety of everyday workloads. While Microsoft provides all of the primary elements to implement session-based virtualization, IT departments often supplement this environment with third-party products and tools to address their needs.

Looking at the client side of the equation, the device can be 'thin' in terms of computer processor, memory and RAM. This is because the device only needs to handle keyboard and mouse input and user interface display output (plus a network connection). Indeed 'zero clients' can contain just a network port and graphics card. Software-based thin clients are also popular and, being relatively lightweight, can run on low-spec, low-cost hardware. Aging PC equipment can also be given an extended period of life by using a remote desktop client application.

Non-persistent/Pooled VDI

The non-persistent VDI approach builds on the notion that a Windows-based PC is at its best when it's brand new, unfettered by multiple software patches and updates. So why not provide the user with a new, virtual computer every time they request one, obliterating it when it's virtually "switched off"? And because it's a virtual PC running a standard version of the Windows operating system (not a session on a multi-user Windows Server system), application compatibility issues are minimal.

Using this model, which is sometimes referred to as 'Hosted Virtual Desktop', requires more CPU, RAM and storage resources than the session-based virtualization approach mentioned earlier, but resources are only consumed while the VM is running. Modern systems allow on-demand memory allocation, so VMs only take control of what they need when they need it. User files, documents, and settings are, of course, stored on a separate file server or persistent storage device.

With this model, users with the same or similar computing requirements are grouped into 'pools', and their virtualized Windows computer is instantiated from the same 'master image', sometimes referred to as a 'golden image'. For obvious reasons, this model is sometimes referred to as 'Pooled VDI'. Where requirements vary significantly between distinct pools of users, a separate master image is created for each pool. Applications, such as productivity tools, can be encapsulated within the master image or layered on top by using application virtualization techniques.

As with session-based virtualization, end-users access their Windows desktop environment using proprietary thin-client devices or the software equivalent. Ecosystems built around Microsoft, Citrix, and VMware VDI technologies can be used to enhance and extend the core vendor offerings.

Persistent VDI

From a runtime execution perspective, the persistent VDI model is almost identical to the one we've just been discussing, in that each user has a virtual machine running the Windows operating system using the server's resources. The difference, however, is that every user's desktop environment is booted from a separate virtual machine image. This provides more user flexibility, as each Windows desktop can be uniquely configured and tailored by the user (subject to policy). However, with each user's image being stored separately on disk, a lot more storage is required to implement this model, and management overhead is likely to be higher as every virtual machine needs to be patched and updated just like a physical PC.

Persistent VDI (also referred to as 'Hosted Virtual Desktop') feels very familiar to the IT professional and end-user, as many aspects relating to the management and use of persistent virtual PCs are identical to that of physical PCs. IT departments that have gained years of experience managing physical PCs can apply their knowledge and know-how with very little modification. However, as with the non-persistent VDI model, transformation comes from the way that applications are deployed and managed.

Hosted Central Desktop

If centralization is demanded for power users with high performance requirements, then a 'Hosted Central Desktop' can be provisioned using dedicated workstation hardware in the datacenter. This hardware is often referred to as a 'Blade Server'.

Local Virtual Desktop

For mobile users who are frequently on the move, 'disconnected' usage is an essential requirement. With the 'Local Virtual Desktop', a virtual desktop image runs on a laptop using hypervisor technology and/or vendor software running on the host operating system (which could be Windows, macOS, or Linux). When the user connects to the corporate network, local data changes are automatically synchronized with the datacenter, and system updates and patches applied to the local virtual desktop. This model is informally used by many macOS users to run Windows applications and to corporate IT governance requirements.

Local Streamed Desktop

Local Streamed Desktop is a niche model, sometimes used in education, whereby entire desktop images are streamed to stateless PCs on which applications execute.

Appendix C: Application virtualization

Streamed and remote applications appear to the computer user as if they're natively installed, being able to interact with the desktop, with one another, and with software that has been directly installed via cut, copy, paste, dynamic links, etc. They can also make use of resources available to the Windows desktop computing environment, including printers, storage, network drives, and so on.

The two things that matter the most when considering application deployment options are:

a) where the application executes
b) where the application looks for settings, shared libraries and other resources

It's important to understand how the type of installation impacts these (Table 3).

Table 3

Application deployment models

Model	Application executes on	Location of settings and resources
Direct installation	User's physical or virtual desktop	User's physical or virtual desktop
Virtual applications	User's physical or virtual desktop	Within the application deployment package
Remote applications	Independent server, separate to desktop	Remote server environment

As a reminder, any or all of these application models can be used in conjunction with any type of physical or virtual Windows desktop environment, and can even be combined with each other to meet specific needs.

To illustrate how this can work in practice, consider, for example, a word processor directly installed onto the desktop, an image processing tool streamed as a virtual application, and a business intelligence tool running remotely. Each of these would be launched in the same way by the user, i.e. from the Windows Start menu, desktop icon, or taskbar.

The user may then generate a chart in the business intelligence tool, copy it to the clipboard, then launch or task-switch to the image processing tool, where it's pasted for enhancement. Once the user is happy with the chart, they copy it to the clipboard again, switch to the word processor, and paste it into their monthly report. Three different application deployment models, all working together seamlessly, regardless of whether the user's desktop environment is physical, session-based or VDI-based.

Appendix D: User experience virtualization

A stand-alone computer usually stores the user's documents, desktop items, application preferences, and desktop appearance on the local computer in two distinct sections, consisting of one portion that could roam plus an additional temporary portion containing items such as the web browser cache. The Windows Registry is similarly divided to support user roaming. There are System and Local Machine hives that stay on the local computer, plus a separate user component designed to be able to roam with the user profile.

All current Windows operating systems support roaming profiles, but profile copying at login and logout can be slow due to the large amounts of data involved and the way these are handled. This is because as a profile ages it accumulates hundreds to thousands of cookies, favorites, and 'Recent Items'. To address this issue, Microsoft developed User Experience Virtualization (UE-V) as an alternative to roaming profiles.

Preferences and settings, what we refer to as the 'user state', are captured through this model and can be used to manage the configuration of natively installed software, streamed virtual applications, or remote applications. Using synchronization, user experience virtualization can provide a personalized management overlay across the whole physical and virtual desktop landscape.

For desktop virtualization to work well, users should not have to modify their desktop or application usage behavior. This means accommodating a desktop filled with files and folders rather than using Windows Group Policy to force files to network drives of other file storage locations. One option is to use Group Policy settings to redirect the 'Documents' folder and other 'local' folders, including the desktop, to a network share. The result is the same as forcing the user to use a network drive, but they don't have to think about it as such.

Synchronization is used when a user, working away from their normal place of work or 'on-the-road', needs to access their files and documents while they are disconnected from the corporate network. Files from the main folder, i.e. the network drive, are cached locally, then any changes made to either the master location or local store are synchronized when the device is next online.

Enterprise file sync and share solutions – such as those offered by Box, Dropbox, Citrix, VMware, and Microsoft – can also be used to enhance the virtualized desktop experience, providing access to documents and files on a variety of devices. With the arrival of Windows 10 Version 1709, users can now benefit from OneDrive Files On-Demand, whereby documents and files are only downloaded to the virtual machine when they are required.

Enterprise mobility management (EMM) solutions also enhance an organization's ability to secure and manage the mobile devices used by their employees. EMM solutions were initially aimed at smartphone and tablet devices, but this then extended to accommodate traditional PCs. The core components of EMM include: Mobile Device Management (MDM), Mobile Application Management (MAM), mobile security, and mobile content management.

The overlap between vendor desktop virtualization and EMM solutions has grown in significance over the last couple of years, resulting in a set of vendor solutions that fit well together, addressing the full gamut of entire end-user computing scenarios.

Appendix E: Desktop virtualization requirements gathering

As part of the requirements analysis, you might want to think about emerging and future needs of the workforce, such as better support for flexible or mobile working, support for the safe and cost-effective use of personal equipment, or laying the foundations for new collaborative or mobile productivity applications.

With all this in mind, questions to consider when analyzing needs and grouping users include:

- Which applications are important today?
- Which applications are likely to become important in the future?
- Are the application needs relatively static or likely to change on a frequent or continuous basis?
- What is the level of need for applications that are particularly demanding in terms of compute power or graphics capability?
- What is the mix of devices likely to be used?
- Will the use of personal equipment be supported?
- How much need exists for applications to be installed, configured or managed by users as opposed to by the IT department?
- What are the requirements for operating over slow or less reliable networks, or even running applications in disconnected mode?
- Are there any special security concerns?
- Are there any compliance obligations?

User segmentation can be time consuming, and organizations often spend a lot of effort defining employee types, roles and occupations, but general patterns usually emerge pretty quickly.

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