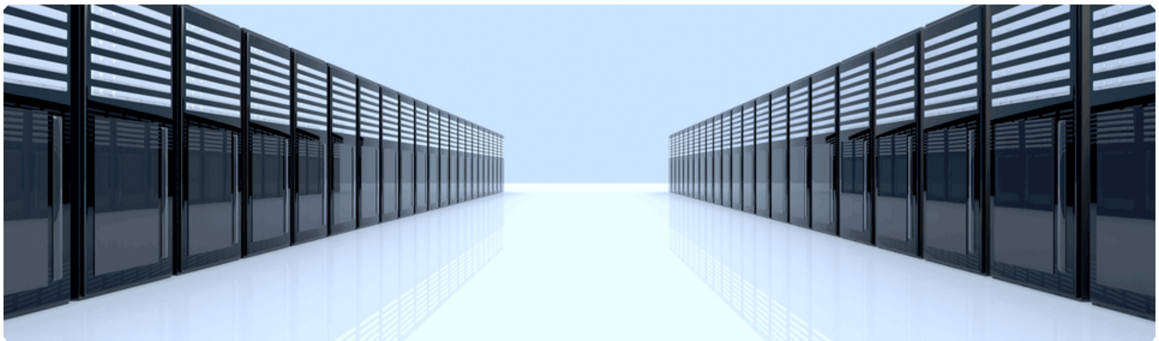
Cloud Desktop - White Paper



14 Quai du Mont-Blanc, 1201 Geneva - Switzerland
Korenlei 22 - 9000 Ghent - Belgium
Antwerpsesteenweg 19 - 9080 Lochristi - Belgium
Cinnah Caddesi 47 Sarayli Apt. 06680 - Ankara - Turkey

1. Table of Contents

1. Table of Contents 2
2. Introduction 3
3. Hosted VDI 4
    3.1. End-user experience 4
    3.2. Cost structure 5
4. Cloud Desktop 6
    4.1. End-user benefits 7
    4.2. Service provider benefits 9
5. Summary 10
6. References 10
7. List of abbreviations 10

2. Introduction

Desktop virtualization is a cloud service where the desktop and its applications are offered from a centralized infrastructure in the cloud. Desktop virtualization brings a number of advantages to the end-user.

Desktop virtualization creates the flexibility to use thin client devices. As desktops are virtualized, the workload runs in the cloud and the end-user device is freed up from CPU intensive tasks, opening up the possibility for light-weight end-user devices. Since desktop virtualization also makes the desktop independent of the OS, it is possible to run almost any service on any device, anywhere, which further increases flexibility and business agility.

Moving the desktop to the cloud improves security and control: a centralized environment allows easier updates and control than a fully distributed environment.

Another driver for desktop virtualization is the decrease in desktop cost. Cloud computing changes the IT cost model, and typically slashes upfront cost. Most cloud services are paid for on a subscription basis or on a pay-per-user model, where there is little or no upfront investment for the customer. Many of the cost savings enabled by the cloud stem from the centralized underlying infrastructure which is shared between applications and users. Virtualized desktops additionally promise to decrease the operational costs for maintaining an installed base of desktops compared to an onsite, distributed deployment. The decrease of computational power at end-user side allows for cheaper end-user devices and may also decrease overall power consumption.

Finally, desktop virtualization benefits from the general advantages of cloud computing such as elasticity of resources: IT capacity can be scaled up and down according to the customer's needs and this almost instantaneously.

So far, hosted VDI has been the most common technology model to set up a desktop virtualization solution. The next section explains why hosted VDI has not led to a large scale adoption of desktop virtualization. As an alternative to hosted VDI, this white paper introduces cloud desktop. Cloud desktop brings an integrated application and storage solution to the end-user, by leveraging the latest web technologies. It is a new way of delivering desktops that addresses many of the end-user and service provider concerns that hosted VDI failed to address. Cloud desktop is a browser-based desktop solution that provides a uniform interface for native web and traditional desktop applications.

3. Hosted VDI

Today, hosted VDI is the most common model for implementing desktop virtualization.
In the hosted VDI model, Linux and Windows virtual machines are hosted on servers in the cloud and are made accessible to users over a wide area network. Since hosted VDI relies on virtualization technology, it takes advantage of the technology benefits brought by virtualization.

Though the model seems appealing, large commercial roll-out of hosted VDI has not taken place. The main reasons are that the hosted VDI model has shortcomings both in terms of end-user experience and in terms of cost structure.

3.1. End-user experience

Crucial to the commercial success of any application is the end-user experience. End-user experience is determined by a complex mix of ease-of-use, the quality and availability of applications, responsiveness of applications, a unique-value-proposition, pricing (value for money), etc. Unfortunately, hosted VDI has not been able to deliver an adequate response to these needs.

At the client side, hosted VDI solutions rely on remote desktop software known as RDP clients. A variety of RDP clients exist for a range of end-user devices. However, introducing client software brings its own problems of maintenance , upgrades and interoperability. Furthermore, the usage of different clients on different end-user devices may lead to an inconsistent user experience for different devices. Overall, hosted VDI is today still a very desktop-centric solution, while end-users expect to have the same application available on any device whether it is a desktop, a notebook or a tablet.

Traditional hosted VDI has suffered from bad performance for delivering multimedia because RDP is used as a single protocol to transport any type of content. In such an architecture, video is decoded at server side and sent over RDP as a succession of bitmap changes.
Various vendors have come up with solutions for video streaming. In some solutions, the video is no longer sent over RDP while others are using an enhanced version of RDP that supports multimedia redirection. In essence, the original compressed multimedia steam is sent over a separate channel and is decoded at client side by a media player to deliver good quality audio and video.
However, such an architecture does not provide a solution for video or audio conferencing, which will still suffer from latency. Therefore, in most configurations, voice (and video) conferencing is deployed as a native desktop application independent from the VDI solution, see figure 1.

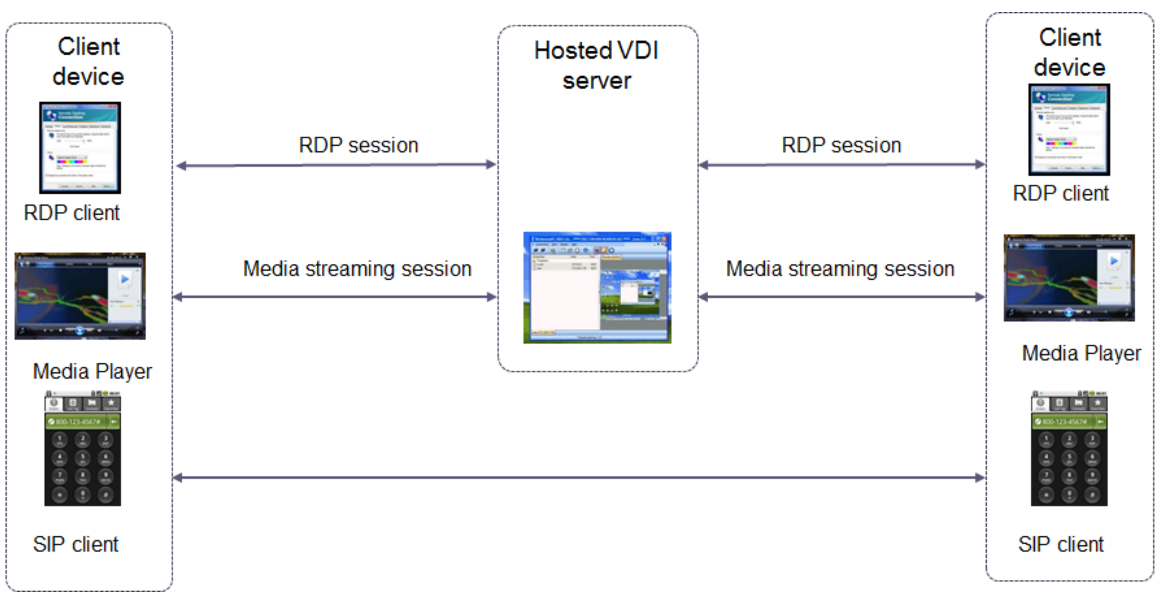


Figure 1. Delivering multimedia in a hosted VDI architecture.

Also from an application perspective, hosted VDI has not been able to deliver the same user experience as a native desktop. First, most hosted VDIs are offered with a fixed set of applications, and it is not easy to add applications in a dynamic way. End-users have become accustomed to on-demand installation of new software (e.g. app store model for mobile devices) and are expecting the same from a desktop virtualization solution. Secondly, many new applications are delivered natively through a browser by leveraging new technologies such as Javascript. While technically feasible to deliver these applications through a hosted VDI solution, it adds another level of indirection which adds no value.
Finally, by design, hosted VDIs can only offer applications supported by one specific OS, i.e. for a Windows-based hosted VDI, users are limited to applications supported by Windows only.

Today's end user IT experience is complex and fragmented. Files are dispersed between local media and cloud storage solutions such as e.g. Dropbox or Sugarsync. Some applications are delivered through the cloud, while others are installed locally on the desktop. Furthermore, there is a lack of integration between applications and storage. In addition, most users have multiple devices. Sharing content between devices or between users is not straightforward. Hosted VDI solutions fail to deliver an adequate answer to these end-users needs.

Many early hosted VDI solutions have suffered from bad performance. Limited-scale user trial results were used as a basis to dimension the infrastructure for the VDI deployment. However, as will be explained in the next section, dimensioning a hosted VDI solution is far from trivial. In particular, the storage dimensioning is cumbersome. Hosted VDI solutions create a high number of IOPS that may peak at times. Under-dimensioning storage leads to a disappointing end-user VDI performance perception.

3.2. Cost structure

One of the appealing features of cloud solutions is that they allow turning CAPEX into OPEX and allow reducing the total-cost-of-ownership of the IT infrastructure.

Hosted VDI reduces the computational load on end-user devices. Consequently, hardware requirements for these devices can be relaxed, resulting in cheaper devices that potentially also consume less power.
From an administration and day-to-day maintenance perspective, it is easier (and more secure) to update a central infrastructure than a myriad of end-user devices.

However, the TCO reduction and the return-on-investment (ROI) of a hosted VDI deployment may not be as straightforward as it seems at first sight. Licensing costs and investment in back-end infrastructure are important factors to take into consideration.

Deploying hosted virtual desktops requires that compute, networking and storage infrastructure are appropriately dimensioned. It turns out that virtual desktops exhibit a traffic patterns that is particularly harsh for SAN storage in terms of IO pattern and IOPS requirements:

- Virtual desktops are very write intensive, with a read/write ratio of 50/50 up to 20/80 in steady state.
- Boot storms can occur when many people boot their virtual desktop at the same time, e.g. at the start of working hours, which mandates dimensioning the storage according to peak load. Most of IOPS in the boot phase are reads.
- Login storms can occur when many people try to login to their virtual desktop at the same time, again typical at the start of working hours. Most of the IOPS are reads, with reported read/write ratios of 80/20 or 90/10, and the number of write IOPS being the double of that observed in steady state.
- Application first runs happen after people logged on, and have a typical read/write pattern of 50/50. After applications have started, the reads typically go down by a factor of 5, while the amount of writes stay the same, resulting in a read/write ratio of about 20/80.

In summary, VDI applications are write intensive. An average desktop will generate ten IOPS in steady state, of which eight are write IOPS and two are read IOPS. Additionally, boot and login storms generate spikes in read operations. These spikes heavily depend on the concurrency when people boot/log in to the VDI, and hence are somewhat harder to dimension. If storage is not properly dimensioned to cope with this traffic pattern, the end-user experience will be poor and customers will perceive the VDI service as slow and unresponsive.

When data is written to a traditional RAID5 SAN system, data is first read from the affected blocks, the changed data is overwritten, the new parity is calculated and the blocks are then written back. The result is that a write IO is many times slower than a read IO on a RAID5 system. Reported values for 15,000 RPM disks are 150-160 read IOPS while write IOPS are closer to the 35-45 range. The problem can partially be solved through RAID1 mirroring, at the expense of 50% storage overhead. With RAID1, the number of read IOPS remains approximately the same, while the write IOPS increases to roughly half the number of read IOPS.

Hence the VDI read/write pattern with a high emphasis on writes is less than an ideal match for classical SAN storage.

As a practical example, assume 64 virtual desktops on a 2-socket, multi-core server with on average 10 IOPS per virtual desktop. That amounts to 640 IOPS per server. With an assumed traffic pattern of read/writes 20/80, this amounts to 128 reads and 512 writes. In a RAID5 configuration that supports 160 read IOPS and 45 write IOPS per disk, this amounts to (128/160) + (512/45) = 13 disks. Or stated differently, every disk supports on average ~5 virtual desktops. For more information on the storage challenges of VDI deployments, please consult the excellent white paper “VDI and storage: deep impact” by Herco van Brug (1).

In summary, sustainable write IOPS is the limiting factor in dimensioning the SAN for steady-state. Additionally, the SAN needs to cope well with occasional high peaks of read IOPS at the start of working hours. As a result, the overall investment in SAN storage is an important consideration for any hosted VDI deployment and may severely impact any TCO calculation.

4. Cloud Desktop

The previous sections have explained the merits of desktop virtualization and the fundamental shortcomings of hosted VDI that have hindered wide scale roll-out of desktop virtualization solutions. This section introduces cloud desktop, a disruptive solution to bring applications to the end-user that addresses the pain points of hosted VDI solutions, both from an end-user experience as well as from a cost structure perspective. Cloud desktop does this by leveraging the latest web technologies.

Cloud desktop integrates applications with file storage and provides a desktop from within a browser, see Figure 2.

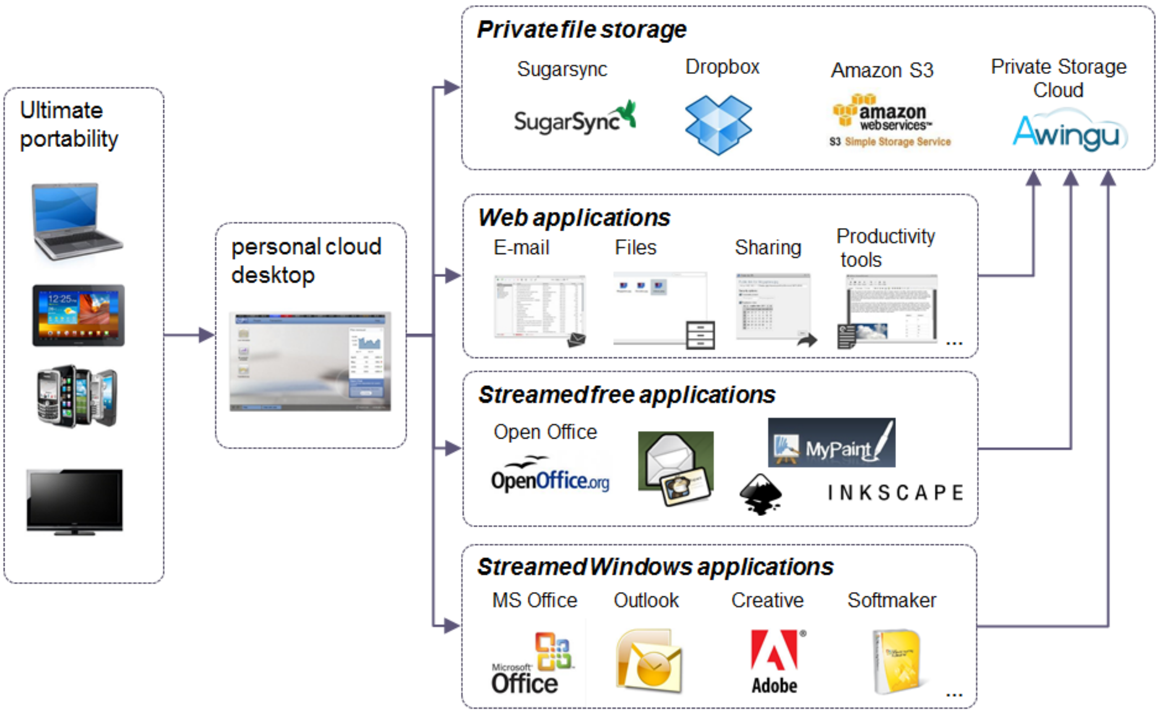


Figure 2. Cloud desktop concept.

Cloud desktop does not require any specific client to be installed on the end-user device, a browser that supports the latest HTML5 standard is sufficient. This simplifies roll-out, improves the portability across a range of devices and ensures the consistency of the service experience across those devices.
Cloud desktop provides access to a wide variety of applications through a browser: native Web applications, free open source applications and traditional desktop software. All these applications are accessed in the same way from the browser canvas.
Cloud desktop also provides the end-user with a file manager that gives access to multiple storage back-ends (e.g. Dropbox, Amazon S3, Awingu Private Storage Cloud) and this through one interface. At the same time, the cloud desktop application back-end infrastructure, integrates with the locally deployed storage solution (e.g. Awingu's Private Storage Cloud).

The Cloud desktop concept is flexible in the sense that it has the capability to dynamically add new applications to a particular cloud desktop from an app store. Cloud desktop can integrate with app stores through a well-defined API used for the provisioning of new applications.

Secondly, cloud desktop allows to flexibly on-board new applications: i.e. it provides the capability to extend the application catalogue with new applications.

Figure 3 provides a high-level view of the cloud desktop architecture.

The Cloud Desktop solution is based on HTML5 and Websockets technology. Applications that run in the Cloud Desktop are either native Javascript applications which run on the client side and Webapp server back-end, or Windows /and or Linux based applications that run on application servers in the back-end. The latter applications are streamed towards a broker and then tunnelled over Websockets to the end clients (via the web server).

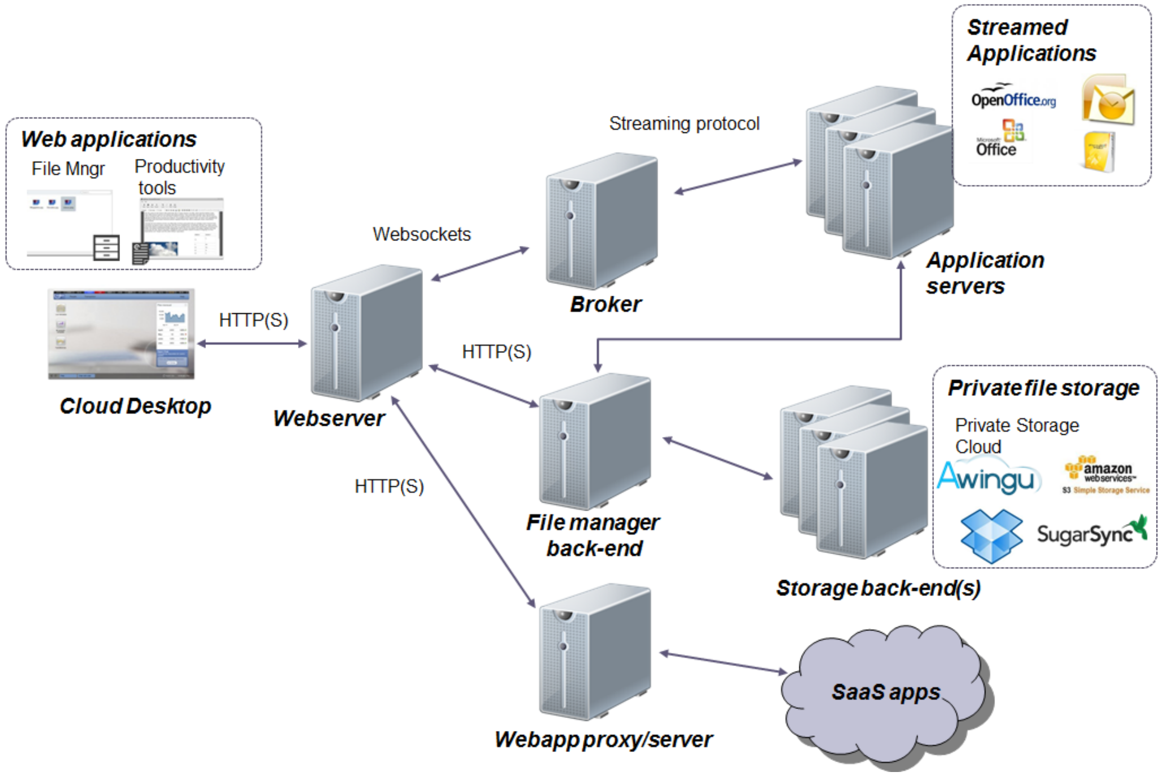


Figure 3. Cloud desktop architecture.

Cloud desktop encapsulates different storage back-ends, making it transparent to the end user where files actually reside. Files of the end-user can either be in Awingu's Private Storage cloud, Dropbox, Amazon S3 or a local file system. The cloud desktop comes with a file manager that provides the same representation of the files and directories in the cloud desktop, independent of the actual storage back-end. The interaction between applications and the local storage back-end is mediated through the same file manager back-end.

4.1. End-user benefits

The cloud desktop imposes minimum requirements on the end-user device and there is no need to install software beyond the browser itself. This makes the cloud desktop available on a range of end-user devices without interoperability problems or client software upgradeability/maintenance issues.

Furthermore, any device that can run a recent browser is suited, independent of its OS. Hence cloud desktop provides ultimate portability of applications across devices and ensures a consistent user experience across those devices. With cloud desktop, desktop virtualization is no longer a PC-only experience but it enables the same applications across PC, notebooks, tablets, mobile devices and even some TVs. In this respect, cloud desktop can be considered a technology enabler for a BYOD (bring-your-own-device) policy where private devices are used in a work environment: corporate applications and data are securely stored in the cloud and accessed through a browser from the end-user device.

Since cloud desktop leverages HTTP, all standard web security mechanisms apply, making cloud desktop a secure solution based on field-proven technology and avoiding any ad-hoc security implementation.

Cloud desktop streams traditional Windows applications from a streaming server. However, video is streamed from a separate video streaming server, directly to the browser, leveraging HTML5 video capturing and embedded video codecs. While Flash technology has a similar value proposition, Flash is generally considered as a technology that will lose support in favor of HTML5.
For VoIP and video conferencing, it is still an option to leverage native client SW or a browser plugin. Alternatively, browser-to-browser communication leveraging HTML5 audio and video capabilities can be used without (Flash) plugins, see figure 4.

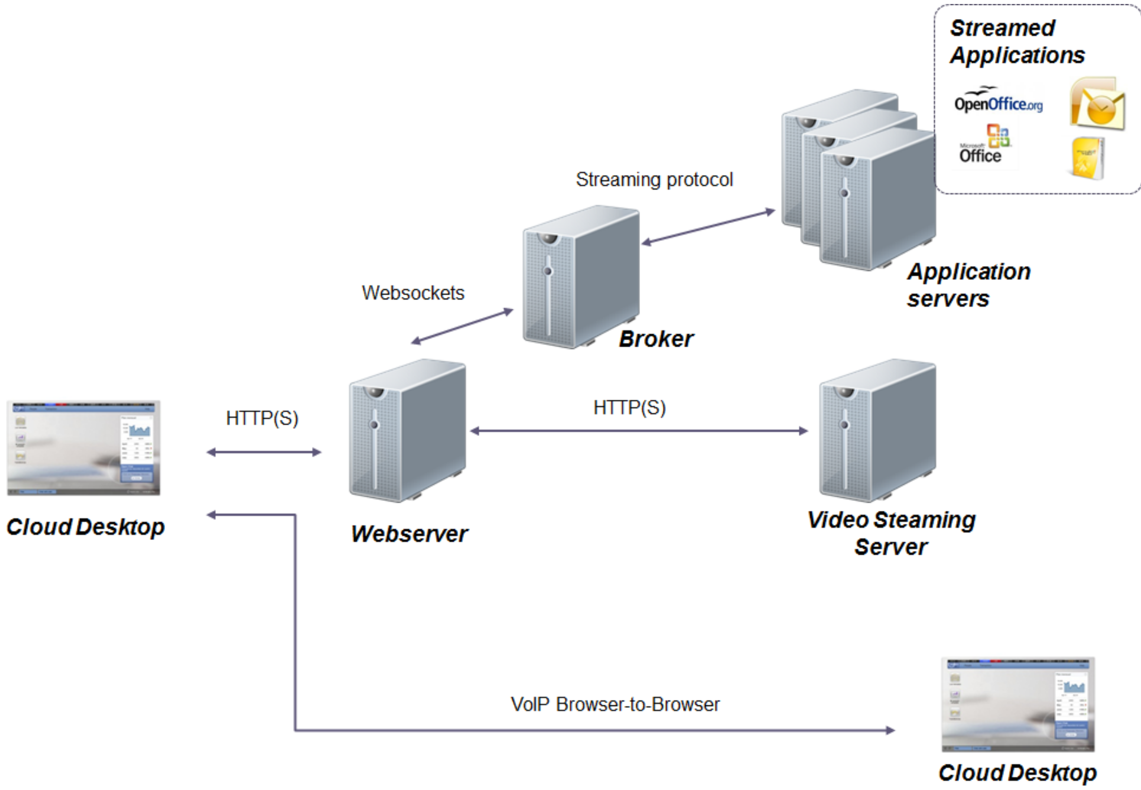


Figure 4. Cloud desktop multimedia delivery architecture.

The cloud desktop provides a unified framework to deliver all applications whether these are native web applications or traditional Windows/Linux applications. All these applications are delivered through the browser. The cloud desktop back-end is interoperable with both Linux and Windows servers, and hence applications available from both OS's can be delivered to the same user on the same cloud desktop at the same time. For enterprises, cloud desktop also provides a means to allow remote access to applications while avoiding to put these applications onto the Internet.

End-users no longer accept a desktop with a fixed set of applications that cannot be tuned to their needs. The cloud desktop easily integrates with an app store that can instantly provision new applications on a cloud desktop. Customers pay only for the applications they effectively use.

As argued before, today's end user experience is fragmented across applications and storage, and there is no solution that integrates storage and applications very well. Cloud desktop comes to rescue. Cloud desktop provides a unified interface to browse files on various cloud storage back-ends. Furthermore, the applications seamlessly integrate with storage.

Finally, the back-end infrastructure of a cloud desktop is simpler than that of a hosted VDI solution. It will require less hardware and does not suffer from the same storage performance (IOPS) problems as hosted VDI. This will improve the end-user experience in terms of responsiveness of the solution.

All the above benefits clarify why cloud desktop is so appealing and disruptive compared to hosted VDI. In addition, cloud desktop obviously also brings all the other advantages of a centralized infrastructure compared to an onsite desktop deployment. Since the whole cloud desktop infrastructure is in the cloud, it is more easily kept up-to-date. End-users and their system admins are freed of maintenance tasks and the whole infrastructure is more secure and robust than an onsite desktop deployment. A cloud based storage system provides a higher degree of data durability and protection than most onsite solution can provide.

In summary, the cloud desktop solves the shortcomings of hosted VDI in terms of end-user experience. In addition, it provides a framework that unifies the fragmented user experience across devices, applications and storage. The advantages of cloud desktop versus hosted VDI are summarized in Table 1.

	hosted VDI	Cloud Desktop
Client SW lifecycle mngt cost	medium to high	zero
Device portability	medium	high
consistent user experience across devices	medium	excellent
same user experience for web and desktop apps	no	yes
provide Windows and Linux apps to same desktop	no	yes
integrates applications with storage	no	yes
audio and video quality	poor	good
easy to add new apps to existing desktop	no	yes
leverages secure web technology (HTTPS)	no	yes
simple and cost-efficient back-end infratructure	no	yes
allows for disruptive pricing model	no	yes

Table 1. Comparison of hosted VDI vs Cloud Desktop.

Cloud desktop is an attractive value proposition not only to end-users, but also the service providers. This is the topic of the next section.

4.2. Service provider benefits

Cloud desktop has the potential to create a new revenue stream for service providers, and allows them to enter a currently unaddressed market segment. With the migration to cloud, there is a shift of IT expenditure (both hardware and software) from onsite to offsite and this is happening both in the residential and the corporate market. Cloud desktop creates an opportunity for service providers to take a share of that market and capture revenues previously appropriated by traditional hardware and software suppliers.

Cloud desktop complements IaaS and StaaS service offerings and in fact increases their usage. Since cloud desktop integrates with a storage solution, cloud desktop will drive storage consumption and hence increases the ARPU both for consumed storage space as well as consumed network bandwidth. Since cloud desktop is so captive from a user experience perspective, it is also a more sticky service than IaaS or StaaS and hence reduces the risks and costs associated with customer churn.

Virtually any application can be offered in a cloud desktop, native web applications, Linux applications and Windows applications. Since cloud desktop is interoperable with both commercial and open source software, it also opens the opportunity to shift power from classical SW vendors to alternatives. Additionally, cloud desktops are more future-proof than hosted VDI, as they form the bridge between traditional desktop software and new cloud SaaS applications. Cloud desktops allow for a gradual migration and shift from desktop applications to native web applications.

As explained before, cloud desktops are a natural fit to an app store model where additional apps are paid for on a pay-per-use model, common to SaaS applications. This offers customized desktops to end-users and generates additional revenues for service providers.

Cloud desktops also offer the opportunity to bring legacy applications to the cloud, for which no native cloud alternative exists. Those legacy applications are ported onto the cloud infrastructure and then made available to end-users via the cloud desktop. This again opens up a market segment of many niche applications that are out-of-reach for current cloud offerings. Key in this respect is the ease with which applications can be on-boarded and added to the application catalogue. These legacy applications may be very specific to a sector or geographical region, and service providers having knowledge of the local market may leverage this as an advantage over the more global players. From an end-user perspective, it takes away a barrier to adopt cloud solutions, as the very same application that today is offered on the desktop, can be offered through the cloud desktop.

As noted before, traditional hosted VDI suffers from a high back-end infrastructure cost, both from a SW licensing and hardware infrastructure perspective. On top of that, client software needs to be installed and maintained, including troubleshooting any potential interoperability problems. On the client side, cloud desktop only requires a browser that supports the latest HTML standards, so that cost is eliminated.
Also on the back-end side, cloud desktop provides a more cost efficient solution than hosted VDI.
From a software licensing perspective, the cost of a cloud desktop solution is determined by the expected concurrent usage of applications, not the concurrent usage of desktops. As soon as an end-user closes an application, that session becomes available for another customer to use. Secondly, cloud desktop provides a way to introduce alternatives to traditional onsite software solutions, which have a more appealing cost structure. This not only applies to applications themselves but also to the underlying OS.

From a hardware perspective, cloud desktop does not suffer the same storage performance problems as hosted VDI: there are no such problems as boot and logon storms. Cloud desktop provides an open API based integration into cloud storage, and the overall infrastructure is much easier to setup and dimension. This leads to a lower infrastructure cost compared to hosted VDI.

Since the cost structure of cloud desktop is so different, it also allows operators to come to market with a disruptive pricing model, with several variants of cloud desktop offerings in a tiered pricing structure.

5. Summary

This white paper has introduced cloud desktop: a new way to bring end-users an integrated application and storage solution, through a browser. The white paper has explained how cloud desktop is different from classic hosted VDI and why this leads to a better end-user experience and a lower total-cost of ownership. Moreover, the cloud desktop is future proof solution addressing the needs of today's and tomorrow's users: it is multi-device, integrates storage and applications and seamlessly bridges between legacy desktop software and native cloud applications.

6. References

(1) Herco van Brug "VDI and Storage: deep impact", September 2011, http://www.tdeig.ch/kvm/VDI/VDI_Storage.pdf

7. List of abbreviations

ARPU
BYOD
CAPEX
IOPS
OPEX
OS
RAID
RDP
RPM
ROI
SaaS
SAN
TCO
VDI

Average Revenue Per User
Bring-Your-Own-Device
Capital Expenditure
Input/Output operations per second
Operational Expenditure
Operating System
Redundant Array of Independent Disks
Remote Desktop Protocol
Rotations Per Minute
Return-on-Investment
Software-as-a-Service
Storage-Area-Network
Total-Cost-of-Ownership
Virtual Desktop Infrastructure