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Research Report of Desktop Cloud Experience

iLab

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Desktop cloud service allows users to access virtual desktops deployed on the cloud through the network using terminals such as thin clients (TC), pads, laptops, and mobile phones.

In the cloud era, the main values of desktop cloud for users include centralized data management and control, high security, mobile office, and on-demand dynamic resource configuration. As one of the ways to access the cloud world, desktop cloud is changing the mode that people work.

After preliminarily experiencing the desktop cloud service provided by two vendors, Huawei iLab presented the following key findings:

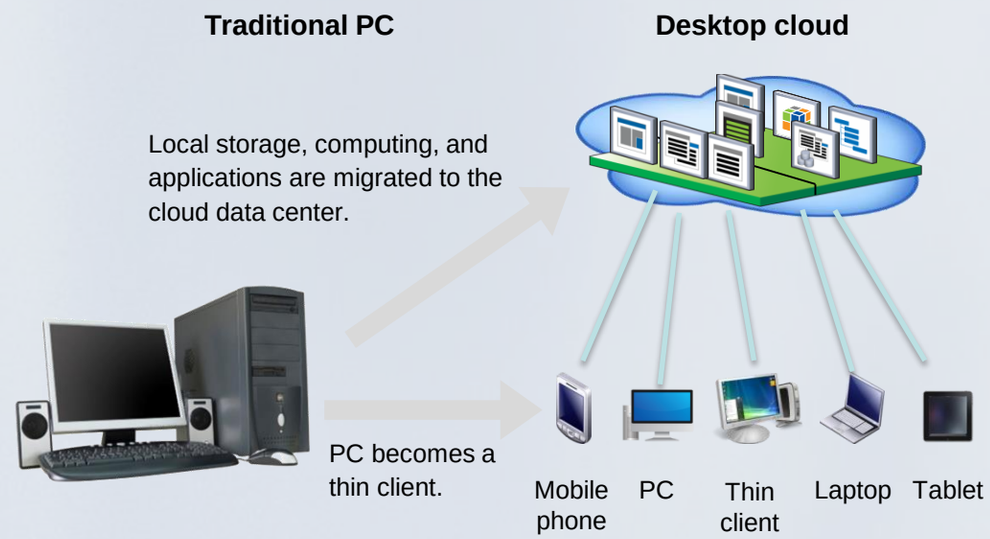
1. **There is a high network latency requirement to achieve quick login, smooth application of Microsoft PowerPoint (PPT), and clear voice communication of desktop cloud.**
   - **Proper experience with round trip time (RTT) less than 40 ms:** acceptable login speed (less than 10s); smooth response of PPT, clear images and no obvious delay; good voice experience with a high mean opinion score (MOS).
   - **Degraded performance with RTT up to 60 ms:** delay occurs in PPT page flipping; when the RTT increases to 100 ms, the login speed decreases to about 17.8s; when the RTT increases to 160 ms, there are obvious noises and delay in voice.
2. **Desktop cloud applied in office work requires no large traffic, but good experience requires a high bandwidth.**

   Superior experience requires over **10.5 Mbit/s** bandwidth to ensure quick login, smooth application of PPT, high-fidelity images, and good voice quality. Login delay occurs when the bandwidth is less than 5 Mbit/s. PPT response delay occurs when the bandwidth is less than 10.5 Mbit/s.
3. **Videos on desktop cloud require larger bandwidths compared with traditional playing modes. To improve the experience of desktop cloud videos, efforts must be made to improve both the video processing technology and bandwidth.**

   Playing a local 720p video on the desktop cloud requires a bandwidth of about **10 to 25 Mbit/s**. It requires only less than half of the bandwidth required on traditional terminals (about 4.8 Mbit/s) than that on the desktop cloud.
4. **If desktop cloud is deployed in households, a 25 Mbit/s bandwidth in the home broadband package must be reserved for desktop cloud.**

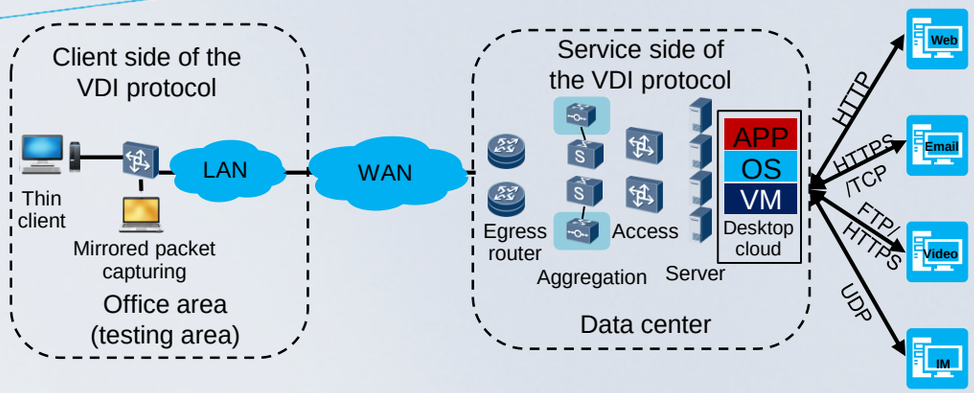
   In the future, a **100 Mbit/s** bandwidth will be required for home broadband to support multiple devices in a family: 37.5 Mbit/s for a single-screen 4K TV, 7.5 Mbit/s for a 1080p mobile phone, 7.5 Mbit/s for a single-screen tablet, and 10.5 to 25 Mbit/s for a single-screen desktop cloud.
5. **Although the traffic required by a single user is low, desktop cloud offices in enterprise campus require large bandwidths because of the high user concurrency.** A 10.5 Mbit/s bandwidth should be reserved per user for a pure office working environment and a 25 Mbit/s bandwidth should be reserved per user if video streaming is required.

1. Differences Between Desktop Cloud and Traditional PCs

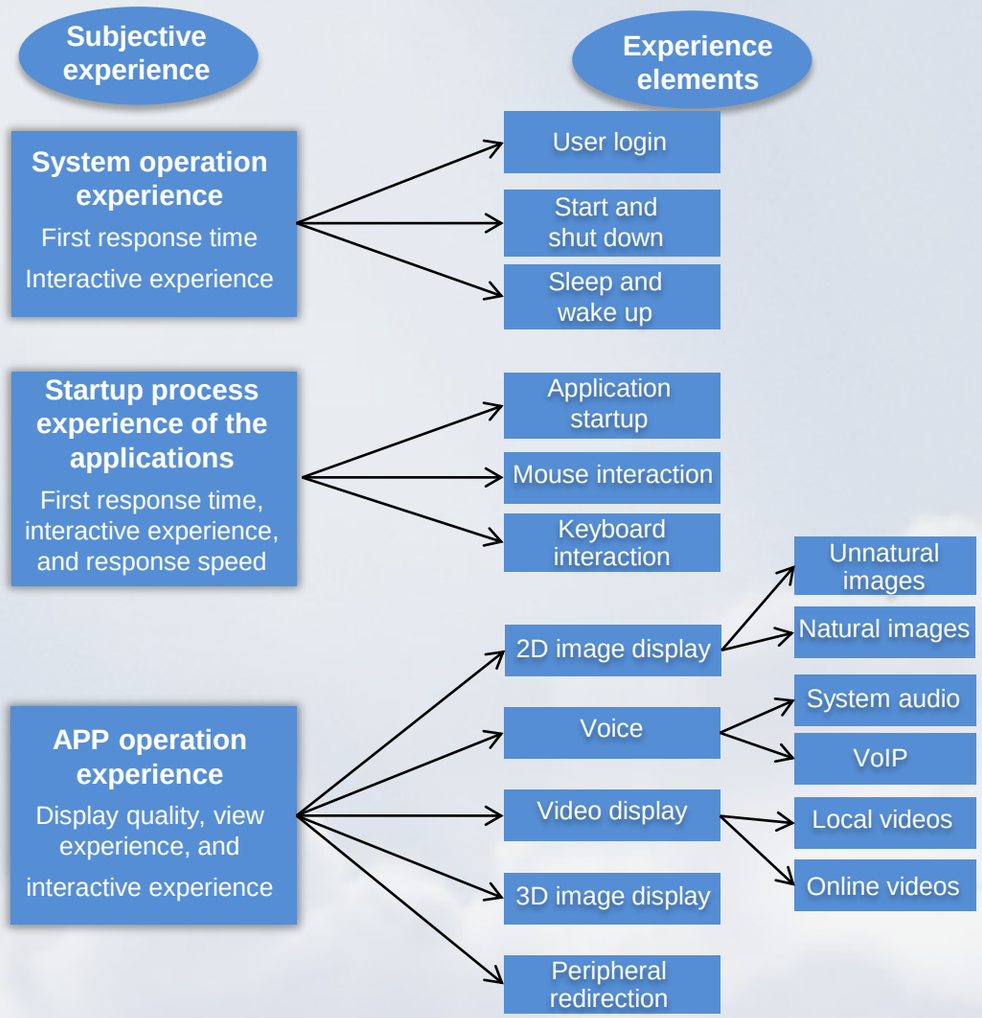


2. Desktop Cloud System

Users transmit commands to the desktop cloud virtual machine (VM) through the network using a mouse and keyboard. After the response, desktop cloud VM encapsulates application data through VDI protocol, transmits it to the client through the network and displays it on the client screen. Desktop cloud server is deployed in the data center.

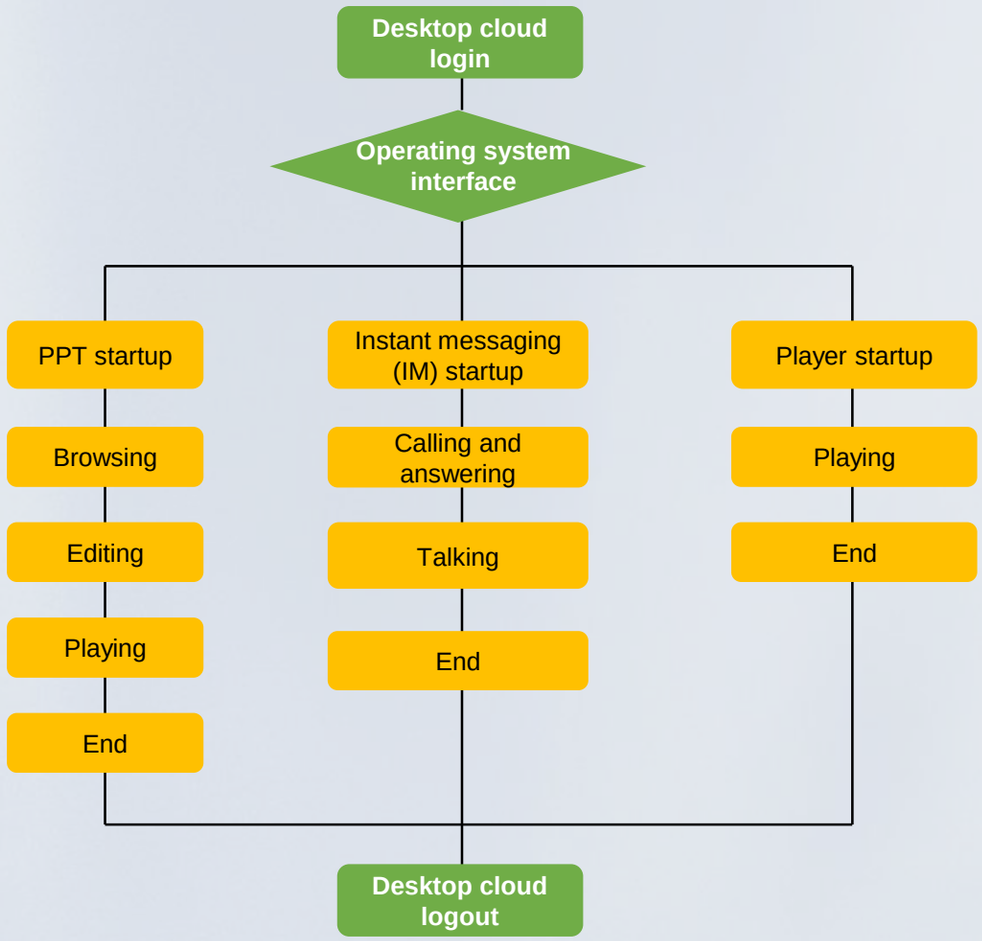


3. Experience Elements of Desktop Cloud Services



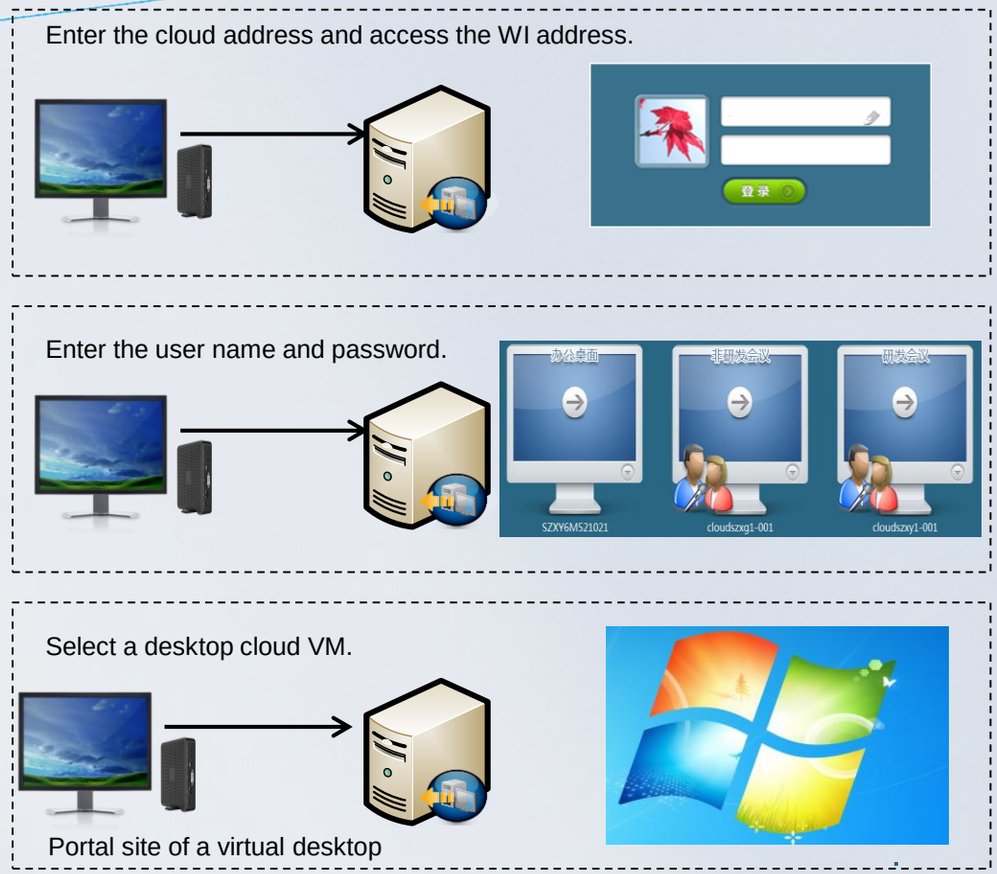
4. Interactive Process Analysis of Typical Desktop Cloud Scenarios

The preliminary experience this time involves user login, PPT application, voice communication, and video experience. These four scenarios can best represent the keyboard and mouse interaction technology, graphics display technology, voice processing technology, and video display technology of the desktop cloud protocol.



4.1 Desktop Cloud Login

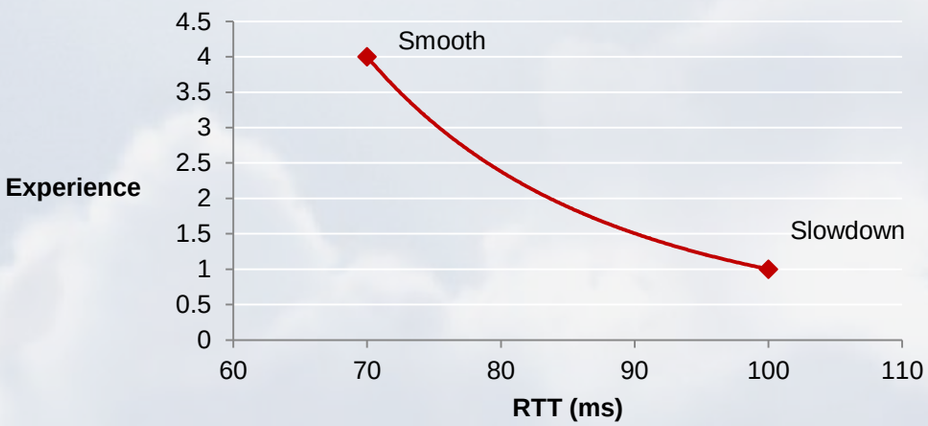
Log in to a desktop cloud is actually the login to a desktop cloud VM at the remote end of the network. The login process is displayed on the TC terminal through a network extension.



When the RTT is less than 70 ms, the login duration is shorter than 10s, and such a speed is acceptable during the experience.

When the RTT increases to 100 ms, the login duration increases to about 17.8s and the subjective experience starts to degrade.

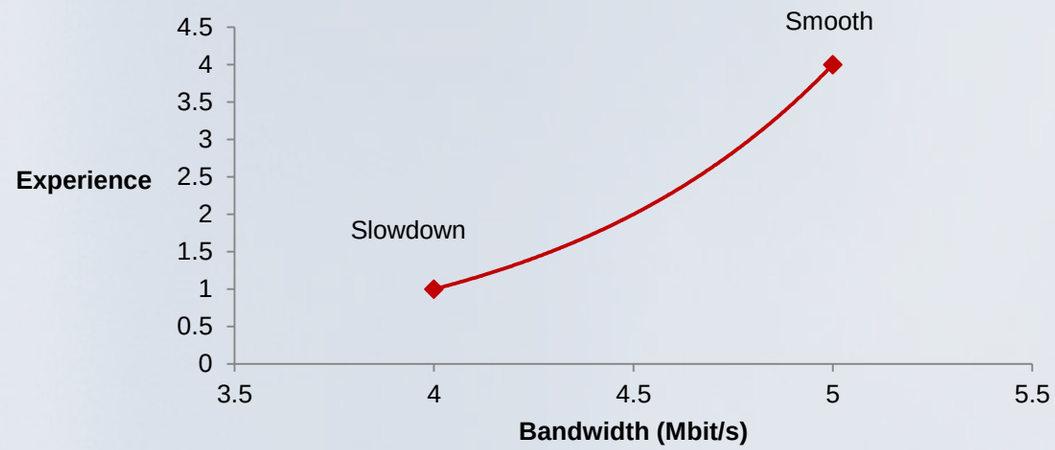
The relationship between login experience and RTT

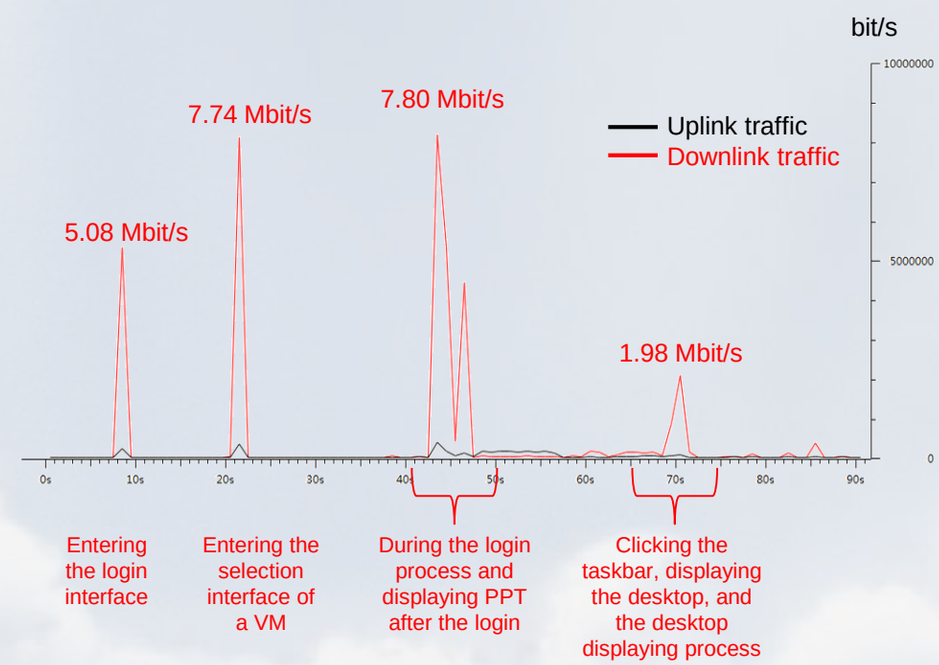


Traffic models during the login process:

- The interaction traffic is about 3.9 MB for the entire login process. The peak bandwidth is required when the Windows main interface is displayed. At this time, the rate is 7.8 Mbit/s and the traffic required by mouse interaction is about 0.01 MB.
- When the bandwidth is less than 5 Mbit/s, the login time obviously increases and a black screen occurs during the login process.

The relationship between login experience and bandwidth

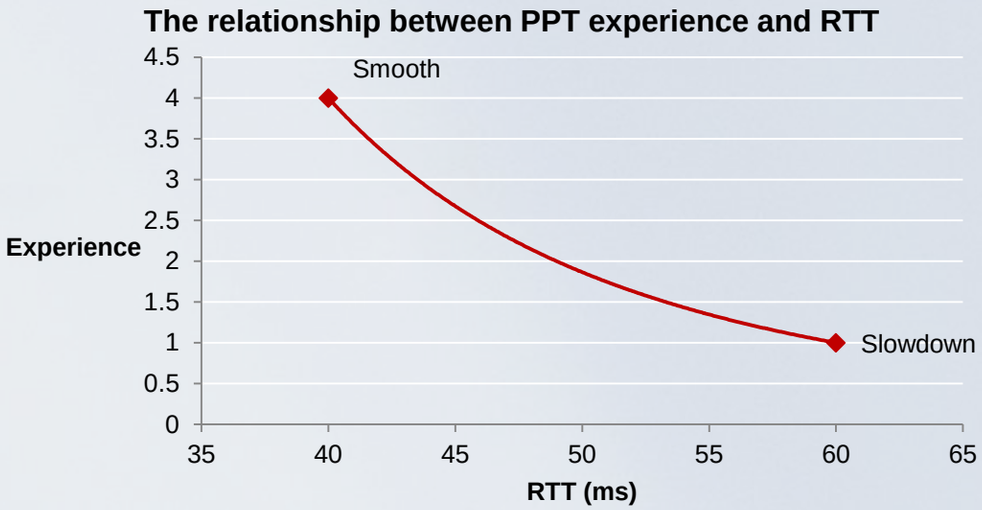




4.2 PPT Application in Desktop Cloud

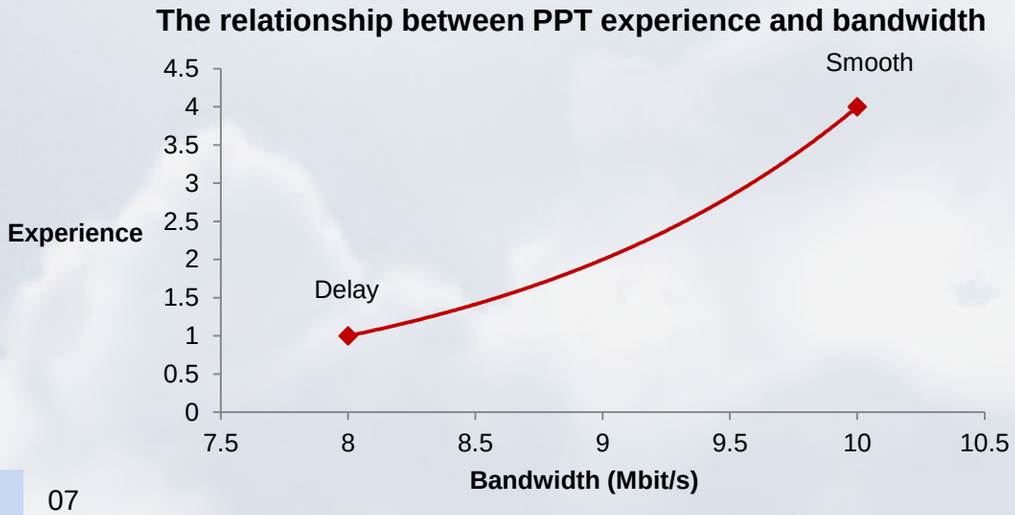
PPT is opened in the desktop cloud VM and then projected to the client through desktop transmission protocol.

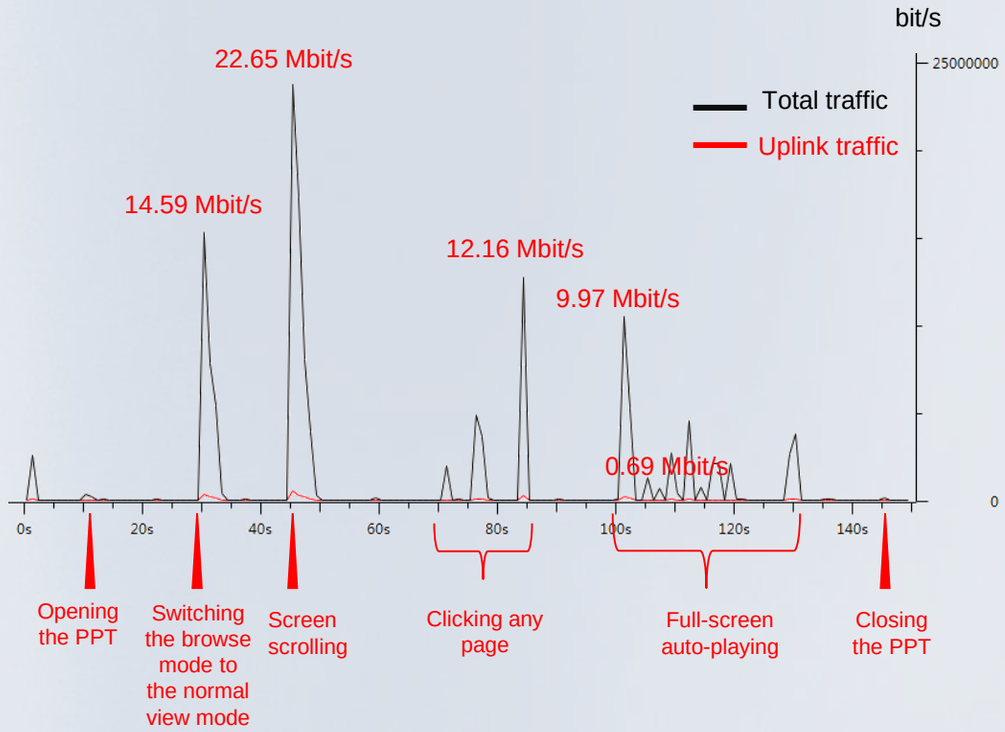
- When the RTT is less than 40 ms, the images are clear, there is no sense of delay, and the page flipping responses within 1s.
- When the RTT increases to 60 ms, the page flipping response takes about 3s with a sense of delay.



Traffic models during the PPT processing:

- The peak occurs at the moment of a page refresh with the value from 0.69 Mbit/s to 22.65 Mbit/s, and the actual value varies with the complexity of the PPT contents.
- When the bandwidth is less than 10.5 Mbit/s, obvious delay occurs during the PPT page flipping and user experience degrades.



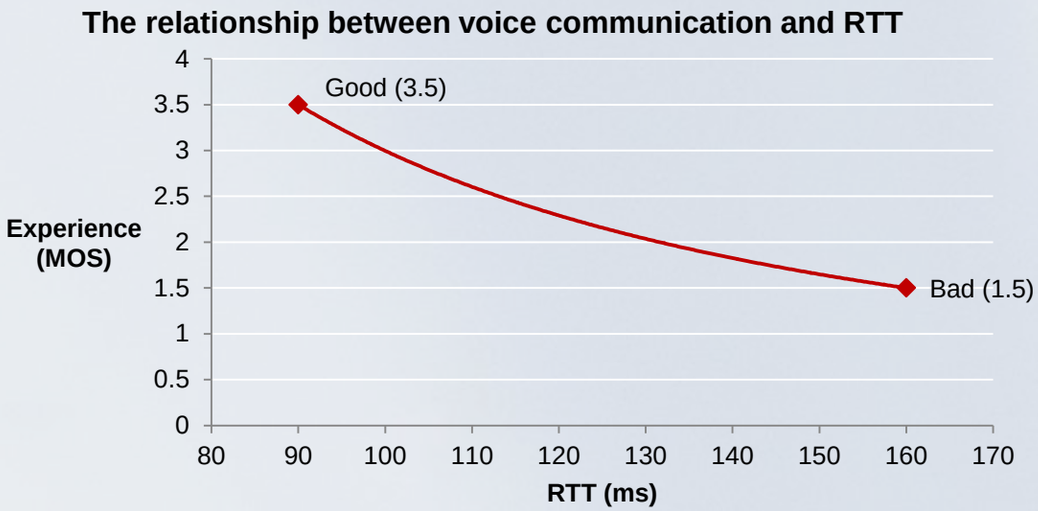


4.3 Voice Communication in Desktop Cloud

The evaluation is made with reference to the ITU-T perceptual evaluation of speech quality (PESQ).

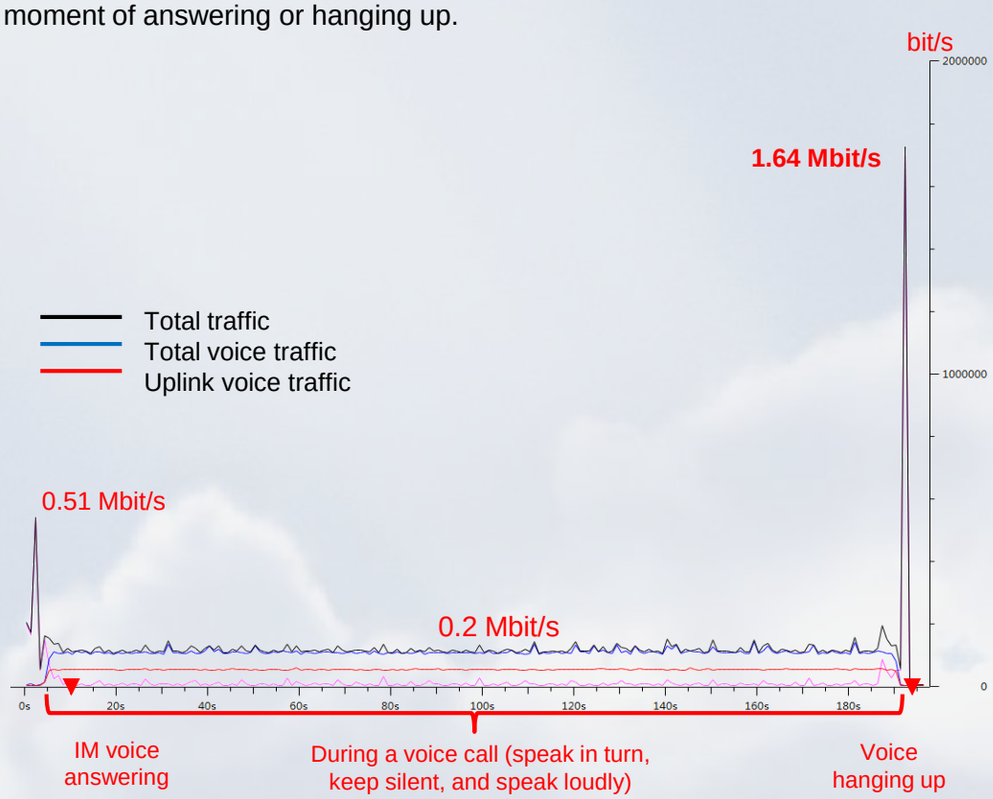
Level	MOS Value	Customer Satisfaction
Excellent	4.0–5.0	Very good, with clear voices
Good	3.5–4.0	Fairly clear voices, but with a little noise
Medium	3.0–3.5	Not so good, but can still communicate
Inferior	1.5–3.0	Bearable, but cannot hear clearly
Bad	0–1.5	Very bad, and cannot hear

For a 3-minute voice call between two users, the relationship between voice quality and network latency is shown in the figure below.



Traffic characteristics of voice communication:

Voice communication consumes a little traffic: the uplink traffic is about 1.3 MB; and the downlink traffic is about 1.6 MB. The peak rate occurs at the moment of answering or hanging up.



4.4 Processing Mechanism of Desktop Cloud Videos Results in Larger Bandwidth Requirements

Desktop cloud video decoding involves two key technologies: server-side decoding and client-side decoding (multimedia redirection). Server-side decoding takes video images as parts of desktop images and projects them to the client through the VDI protocol. The following sections analyze the network bandwidth requirements of server-side decoding.

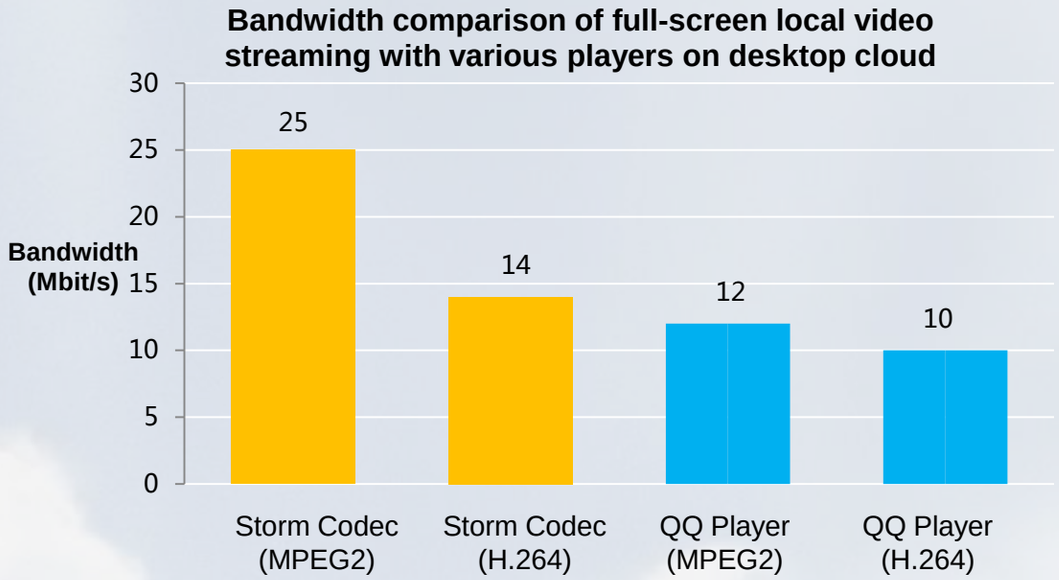
The video source resolution, content complexity, and content change per frame will affect the bandwidth requirement from the server to the client. The tested bandwidth data is related to the selected video source.

4.4.1 High Demand for Bandwidth When Streaming Both Local and Online Videos on Desktop Cloud

(1) Different from traditional PCs, desktop cloud requires traffic for playing local videos.

Local video streaming with various players on desktop cloud (resolution: 1280x720, bit rate: 1.9 Mbit/s):

- The desktop cloud client consumes higher bandwidth while adopting MPEG2 coding than adopting the H.264 coding.
- Using a traditional way to play a 720p video will require about 4.8 Mbit/s bandwidth, whereas using desktop cloud will require 10 to 25 Mbit/s bandwidth, which is more than twice of that in the traditional way.



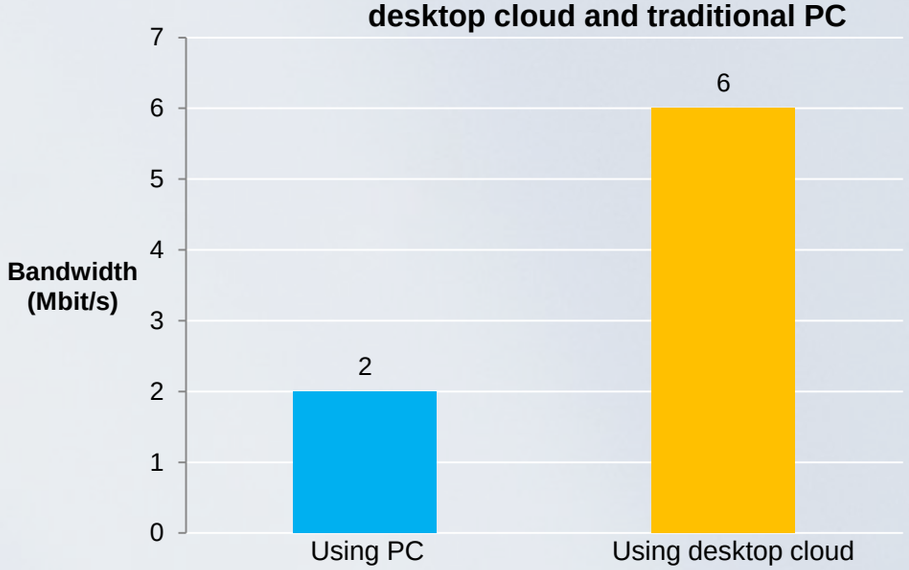
Local video resolution: 1280x720, bit rate: 1.9 Mbit/s
Display resolution: 1920x1080

(2) Different from traditional PCs, desktop cloud also requires higher bandwidth for online videos.

Resolution: 736x414, bit rate: 0.9 Mbit/s:

Using a traditional way to play the online video requires about 2 Mbit/s bandwidth, while using desktop cloud requires about 6 Mbit/s bandwidth, which is about 3 times of that in the traditional way.

Bandwidth comparison of full-screen online video streaming with desktop cloud and traditional PC



Online videos: 736x414 resolution and 0.9 Mbit/s bit rate
Display resolution: 1920x1080

(3) Why is a higher bandwidth required for playing videos on desktop cloud?

No B-frame encoding

Desktop cloud has a higher requirement for real-time transmission than the traditional way when playing videos. Desktop cloud cannot respond to users' operations immediately because the B-frame encoding needs an extra 30 ms.

VDI protocol policy

- Quality/Bandwidth comes first.
- Average bandwidth results in average quality, and the lowest quality results in peak bandwidth.

H.264 encoding parameters

- The ultra-fast mode has the features of simple compression encoding and low CPU consumption.
- The VM density and real-time processing are ensured.

4.4.2 Comparison of Network Bandwidths for Video Streaming with Mainstream Desktop Cloud Protocols

Desktop Cloud Protocol	Requirement of Network Bandwidth
ICA/HDX	Fairly low
PCoIP	High
HDP	Fairly low
RDP/RemoteFX	High
SRAP	Medium
SPICE	Medium

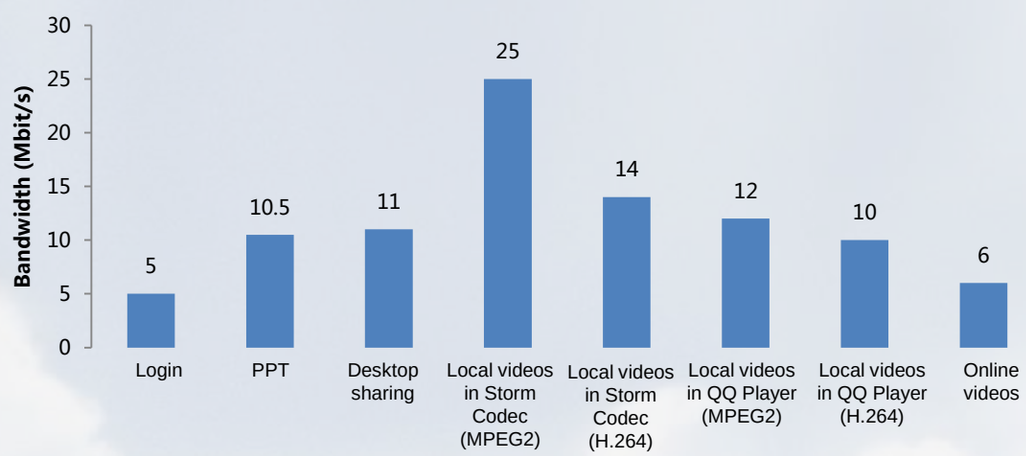
Source of part of the data: *H3C focus: desktop connection protocol parsing*

4.4.3 Suggestions for Improving Video Experience through Desktop Cloud Technologies

- Improve video encoding performance on the client.
- Optimize the H.264 encoding parameters of the current desktop cloud.
- Use the H.265 encoding technology to replace H.264.
- Standardize redirection APIs for client-side decoding.

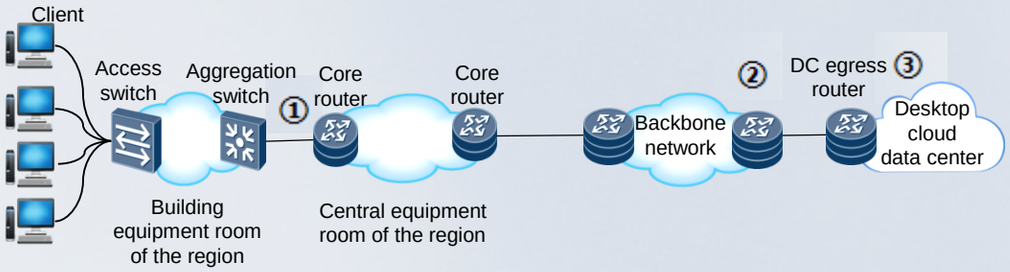
4.5 Bandwidth Requirement for Good Desktop Cloud Experience

Bandwidth requirement of good user experience on desktop cloud



Local videos: 1280x720 resolution and1.9 Mbit/s bit rate
Online videos: 736x414 resolution and 0.9 Mbit/s bit rate

5. Desktop Cloud Service Requirements on Campus Networks



The above figure shows a large enterprise user sharing a desktop cloud data center. According to the assessment data, it can be inferred that in order to provide good user experience, the desktop cloud should:

1. **The link bandwidth between the aggregation switch and core router should be above 20 Gbit/s.** If there are 500 desktop cloud users working or watching standard definition (SD) videos at the same time, the average link bandwidth should be 10–25 Mbit/s and the port rate should be 5–20 GE or higher to ensure good user experience. If high-definition (HD) videos are to be watched, or working or data backups are involved in the future, the link bandwidth should be at least 20 Gbit/s.
2. **It is advised that the egress rate of the data center network is over 100GE.** If the data center (DC) is planned for 10,000 desktop cloud users to work or watch SD videos at the same time, the per-user link bandwidth should be 10–25 Mbit/s and the DC egress rate should reach 100GE to ensure good user experience.
3. **The network adapter rate of the desktop cloud server should be at least 10GE.** If there are 25 users connecting to the desktop cloud server, the per-user bandwidth should be 10–25 Mbit/s to ensure good user experience. If they are working or watching 720p videos at the same time, the network adapter rate should be greater than 625 Mbit/s (25 x 25 Mbit/s). If users watch 4K videos in the future, the egress rate should be no lower than 10GE.

6. Desktop Cloud Brings Bright Future to Home Broadband

1. **Desktop cloud brings value-added broadband packages to hundreds and thousands of households.**

   Desktop cloud walks into home offices, and together with mobile phones and TVs, the bandwidth required by the multi-screen video streaming is about 100 Mbit/s.
2. **The thin client-integrated ONUs or STBs will be available in hundreds and thousands of households.**
3. **Thin clients with the Wi-Fi function will make the desktop cloud more flexible and convenient in enterprise offices or households.**

Appendixes:

1. Experience site: XXX campus in Shenzhen
2. Desktop cloud conditions for the evaluation:

Client Parameter			**Desktop Cloud System Parameter**			
CPU Clock Speed	Memory Specification	Storage	System	CPU Clock Speed	Memory Specification	Storage
2.41 GHz	1.87 GB	7.37 GB	Windows (64-bit)	2.60 GHz	7.99 GB	280 GB

3. Video sources for the evaluation are as follows:

Video Source	File Length (Minute)	File Size (MB)	Bit Rate (Mbit/s)	Resolution	Frame Rate (fps)
splitin4k-720p.mp4	3	42	1.9	1280x720	24
Online video	3.77	27.4	0.9	736x414	25