Performance analysis and comparison of virtualization protocols, RDP and PCoIP

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Abstract: - This work deals with the possibilities of using terminal servers and virtualization technologies available on Microsoft platforms, VMware and Citrix, and mainly with comparing the communication protocols RDP and PCoIP underlying these technologies. The first part deals with the technical principles of virtualization and compares the benefits of individual technologies. The second part is practically oriented and deals with the design of a methodology for testing the performance of both RDP and PCoIP. Test methodology consists of identifying key factors that describe the behaviour of client stations, which are subsequently used for the selection and design of hardware architecture. The testing methodology is transformed into a scripting language and it is ready for automated testing. Past tests can be divided into groups - the server load performance, monitoring and mapping the data transmission time system response to user stimulus. On the client side thin and software clients are deployed. The performance characteristics of the RDP and PCoIP are monitored and compared.

Key-Words: - virtualization, protocol, RDP, PCoIP, analysis, comparison

1 Introduction

A distribution of desktop virtualization is currently one of the most recent trends in IT infrastructure consolidation. This is the next logical step that builds on the virtualization of servers and it delivers savings to the client side. With this rediscover paradigm, where the computational burden is largely transferred to the server, it is possible to minimize the performance of client devices. The most important consequence of such a slimming bark applied to the client device is a significant reduction of energy consumption. The equipment that has been deliberately deprived on power parameters is known as a thin client.

This technology uses in principle two different approaches. The first, known as VDI, is based on a separate autonomous systems. Operating system images are stored in a centralized shared repository. In this repository, mentioned image is virtualized and ready for client connections. Access software on the client side connects to the virtualized system on the server, whole data transfer from peripherals client is redirected to a remote system. This process is hidden from the user and the system creates the impression that it is running locally. The second approach uses a single operating system which appears as a host. With every client requirement to connect the host system creates isolated relation. From the perspective of the user, it is again a separate local system, but it is the same type as the host system and includes only those applications that are installed on the host. From the perspective of the host system, each session is running as another process, so it is not an autonomous system. This approach is known as Terminal Services TS [1],[2].

2 Analysis of the requirements for virtualization system

Deployment of desktop virtualization technology to the production environment is an essential step over the use of traditional PC and it is necessary to implement appropriate analysis of requirements, which will be placed on such system. Systems of distribution of remote areas are generally the most difficult to use RAM. Right after the system memory has high demands on the storage subsystem. It is necessary to provide redundancy for images and virtual systems, while minimizing access times to data. The primary task in the planning of natural resource virtualization server is to set the number of users who such a server will connect [3]. Each user represents a session that represents some amount of the allocated memory. This memory mode must be added to the sum of all memory consumed by user applications. The value of this calculation is multiplied by the number of users and gets demands on memory. Determination of processor performance is very subjective according to the deployment location. There are general recommendations for the implementation of desktop virtualization system, but these are only a recommendation. Therefore, the establishment of

appropriate stress tests are able to detect quantities of demands on the proposed virtualization environment.

Design of test methodology consists of the following points:

- Definition of monitored counter values
- Definition of requirements for virtualization architecture
- Definition of running client applications
- Selection of appropriate testing tools
- Evaluation of test results and their reflection in the design of physical resources.

Previous indicators can be summarized in a group designated as primary.

The secondary indicator can indicate the ability of the distribution protocol to adapt to the physical environment network and to deliver the expected result to the user in the expected time. One of the examples of the secondary parameter can be a response to a user's initiative in the WAN network.

2.1 Distribution Protocols

Current users are demanding and in case of the deployment of distributed desktops, they expect the same comfort, what a local system provides them. Manufacturers of virtualization tools realized this fact and started to implement the tools ensuring high user experience into their systems and protocols. These improvements provide the use of hardware on the thin client computing for graphics data.

Microsoft uses for Terminal Services RDP (Remote Desktop Protocol). The latest version of this protocol is labelled as RDP 7.The main benefit of this version is support for Aero desktop environment [5]. Another new feature is the support for System Direct 2D and 3D 10.1., recorded and playback HD video without losing synchronization between video and audio.

Citrix is implemented extension of HDX (High Definition User Experience) in its distribution ICA protocol. This extension implements more effective bandwidth utilization for graphic data transmitting. Examples can be MediaStream HDX technology for Flash, which allows the streaming Flash video in its native compressed form. Video output is computed from the received data on the client side. HDX extension is able to dynamically adjust the bit rate according to the state transmission lines, which makes them suited for distribution of virtual desktops as trans-LAN (Local Area Network) and WAN (Wide Area Network).

VMware, of course, does not remain a party and in cooperation with Teradici created a new protocol called PC-over-IP. This technology can automatically identify the user's local device (for example, whether it is a thin client or projector) and accordingly is able to choose the optimal method of data delivery. Another criterion used to optimize the transmission is the status of data lines, which adapts the data transmission. PC-over-IP achieves excellent results in transmission of graphics and multimedia data, but it should be noted that to fully exploit the capabilities of this technology is necessary to have a hardware support Teradici technology.

3 Selected tests and testing procedures

The following text discusses the test performed with the RDP and PCoIP protocols that are mostly used in virtualization environment. For these tests was used both software and hardware implementations of thin client.

3.1 Performed Test

During preparing of the test methodology the tests were divided into two groups to be able to cover both primary and secondary parameters. The first group of tests is intended to analyze primary parameters including monitoring the usage of memory and computer CPU time, depending on the scenario, which defines user's performance. The term “user’s performance” may represents the number of simultaneously running applications, used bit colour depth of desktop, visual styles setting, etc.

Tests of the secondary group are divided into two types. The first type monitors bandwidth consumption depending on used protocol (RDP, PCoIP), session settings and user activity. The second type of test analyzes the operation system response to user command depending on physical parameters of the network, session setting, used protocol (RDP, PCoIP) and user activities.

Results of tests generated for one user under the above categories may be multiplied by the expected number of users working in a virtualized environment to obtain the physical parameters of virtualization server. This approach is not suitable for extreme situations that may arise, for instance the mass of users to log on virtualization server in a short time. Simulation of such a situation provides the scalability problem, which is not included among the tests because of its large extensiveness.

3.2 Created scenarios

Depending on the type and number of simultaneously running applications different physical resources

especially CPU and memory are used. For the analysis of the use of physical resources is necessary to define requirements of users working in a virtualized environment. From the view of group of user requirements it is appropriate to isolate the scenarios that significantly differ in consumption of physical parameters and can help to more accurately detect limitation in the design of virtualized infrastructure. For this analysis, two scenarios were developed representing users with low and high system requirements.

Created scenarios are displayed in the form of flow chart.

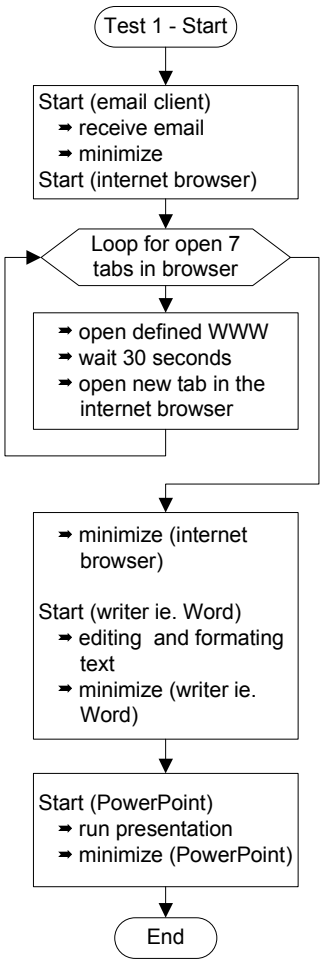

Fig.1 – Test Sequence 1

Scenarios are designed to simulate the most common user activity on the computer. In a more detailed look at a scenario, it is possible to identify the blocks that fall into the categories of Text, PDF, Web, Presentations. This subcategories exclusion is particularly important for such type of test, which is monitoring the size of consumed bandwidth depending on the specific activities and the distinction is not important to the whole scenario. There are significant differences in the data stream for activities falling within the category of Text or Presentations.

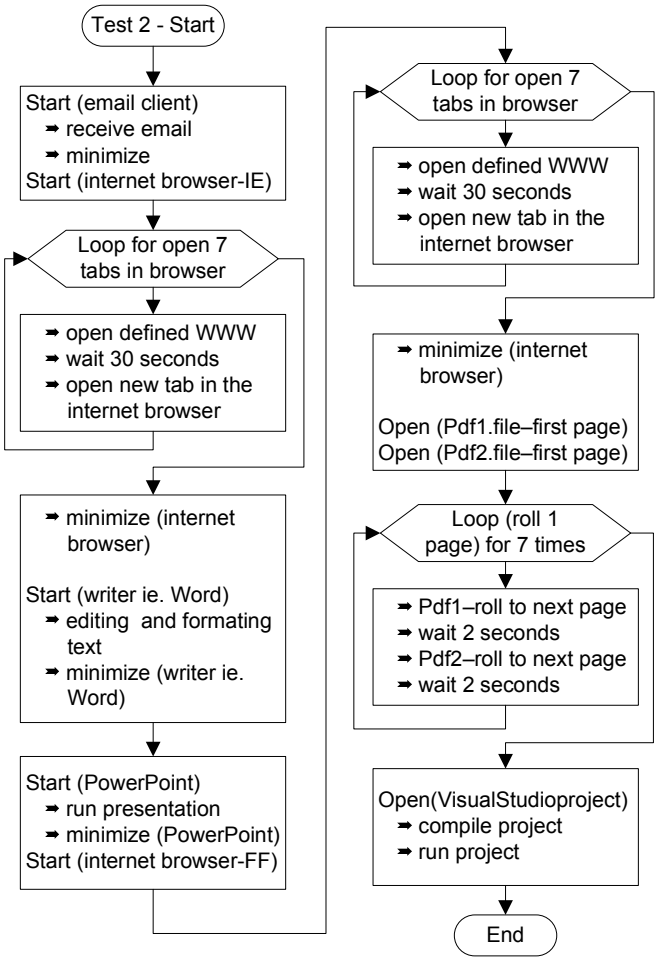

Fig.2 – Test Sequence 2

Due to large number of configurable options for the RDP protocol, not all of these options are changed, but the created presets are used.
These presets correspond to the defined quality transmission lines and always provide the appropriate user settings for the quality of the transmission lines. Created presets and their options are shown in the Table 1.

PCoIP protocol in comparison with the RDP protocol offers significantly less parameters for the session setting. The absence of more detailed options settings can be attributed to the adaptive character of the protocol PCoIP. PCoIP protocol should be able to adapt to the physical condition of the line and offers the user maximum comfort comparable to the work on local system / desktop. For this reason, in the tests are defined only two groups of user settings. The first group is named as MIN and represents the minimum requirements and the second group is named as MAX

and represents the maximum requirements (see Figure 6).

Table 1: Parameter settings

Parameters	Preset 1	Preset 2	Preset 3
Desktop background	×	×	✓
Font smoothing	×	×	✓
Desktop composition	×	×	✓
Show window content while dragging	×	×	✓
Menu and window animation	×	×	✓
Themes	×	✓	✓
Bitmap caching	✓	✓	✓
Transmission line speed	56 kbps	256 kbps	LAN

3.2 Results

The first type of tests (see Figure 3) monitors a memory consumption during the establishment of terminal session using protocol RDP 7.0, depending on the parameters setting (see Table 1) of user sessions. The establishment of terminal session is considered the state when the user has successfully logged into the system and the desktop is displayed to the user.

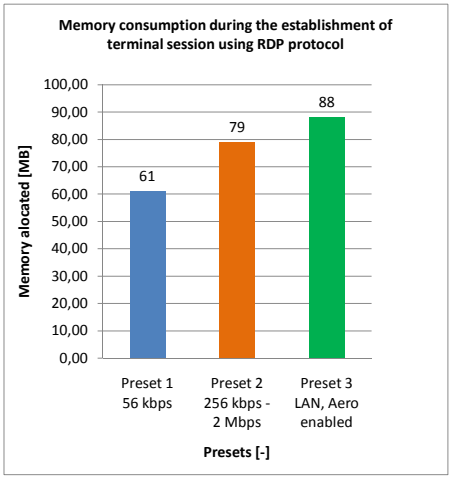

Fig.3 – Memory consumption during establishment pf terminal session using RDP

For parameters setting of Preset no.1 was consumed memory 61 MB. In the case of Preset no.2, where the parameters setting corresponds to the line speed of 256 kbps, increased memory is consumed by 18.82%. The increasing was mainly due to the use of visual styles. Activation of all the settings in Preset no.3 caused the value of consumed memory increased by 45.00% compared to the value of memory consumed in Preset no.1. In this case, the increase was caused by the use of Aero environment.

The next test (see Figure 4) is focused on the system memory requirements, depending on the user scenarios. By the selection of Preset no.3 the value of consumed memory was higher by 55.80 % for the chosen scenario of user with low system requirements (see Figure 1, Test Sequence 1) compared with the value of Preset no.1. In the case of the selection of scenario of user with high system requirements (see Figure 2, Test Sequence 2) the consumed memory increased by 26%. These values point to the fact that in the case of using more memory by the chosen scenario is to reduce the impact of user settings to memory consumption.

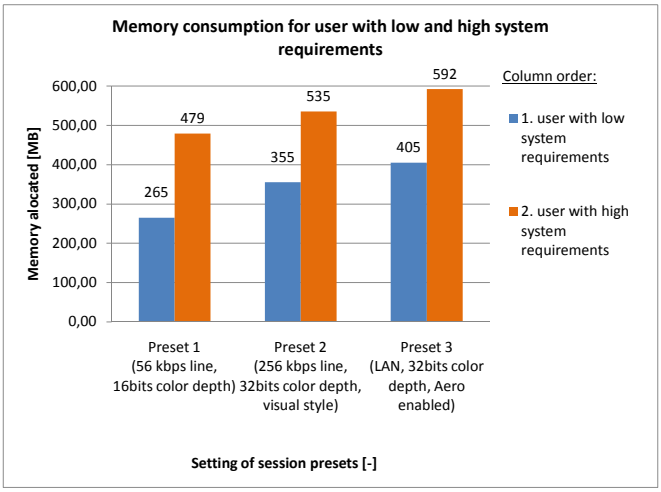

Fig.4 – Memory consumption for users with low and high system requirements

Bandwidth consumption of RDP 7.0 compared with bandwidth consumption of PCoIP brought interesting results which shows that the protocol PCoIP used for its activity significantly more of bandwidth than the protocol RDP. For comparison the values obtained for the Preset No.1 and selected scenario Test Sequence 1 (part "text") PCoIP protocol used 4.32 times more bandwidth than RDP.

Specific measured values are 2.15 kbps for RDP and 9.27 kbps for PCoIP. This trend was similar for the other test scenarios (see Figure 5 and Figure 6). PCoIP protocol is designed as an adaptive protocol, and because of this feature could be a disadvantage in this test. Adaptive protocol is adapting to state of lines and trying to use the most of its potential for maximizing user requirements. If this happens at network with low load (low traffic), there may be situations where the protocol will use more network bandwidth than necessary.

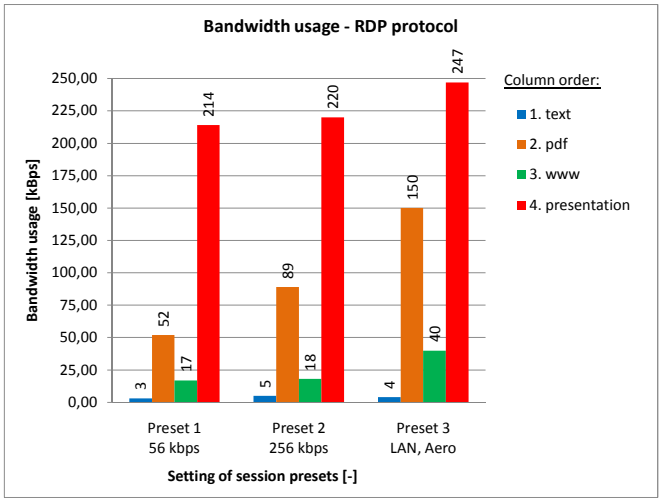

Fig.5 – Bandwidth usage – RDP

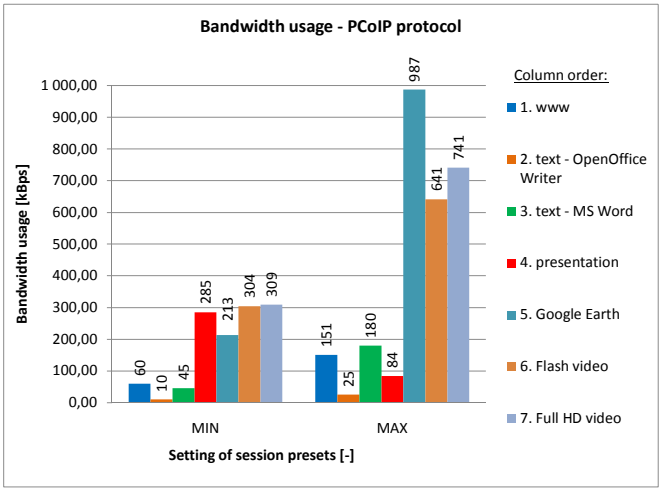

Fig.6 – Bandwidth usage – PCoIP

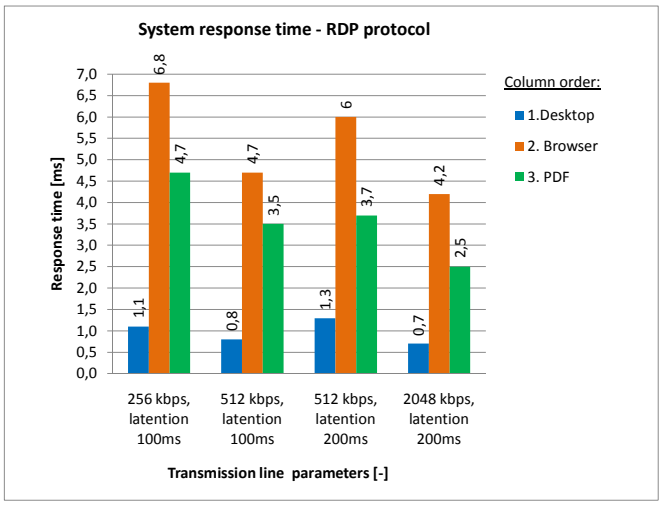

Fig.7 – System response time - RDP

Figures 7 and Figure 8 show the system response time to user request, depending on the quality parameters of transmission lines. In this test the response time was much better for protocol PCoIP only selected scenarios "Desktop" gave worse results than the protocol RDP. It was not too difficult a rendering operation and therefore in the case of RDP, the most data could be stored in the cache, where could be loaded more quickly and without limitation caused by the setting of transmission lines.

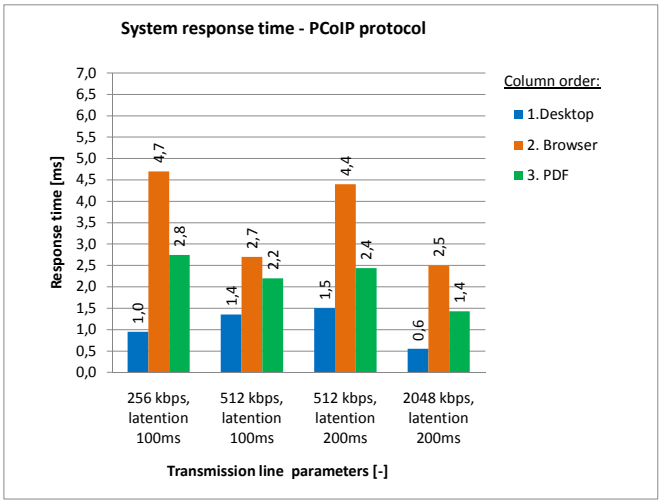

Fig.8 – System response time - PCoIP

4 Conclusion

Creating a test methodology consists of the definition of monitored parameters. Based on these parameters were developed tests monitoring the server load, bandwidth consumption, depending on the transport protocol, the reaction time elapsing between the user's request and reactions of the system, the ability of a server to process user requests for utilization of critical hardware resources.

After a testing methodology different test scenarios to define user behavior and hence the server load that causes are following. For the realization of test scenarios was necessary to select appropriate automated testing tools. In this work, we used primarily the programs Wintask and Remote Desktop Load Simulation Tools. Wintask allows interactive user record business, which is then converted into a scripting language like Visual Basic. Load Remote Desktop Simulation Tools is a toolset designed specifically for stress testing the Microsoft Remote Desktop Services.

The above tests were used to compare the performance characteristics and RDP protocols PCoIP that are used by VMware View and Microsoft Remote Desktop Services. The test results showed that the protocol PCoIP has much faster response system while passing through the WAN than RDP. Based on theoretical and practical knowledge, we prepared two case studies on the deployment of virtualization technology into production environments.

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