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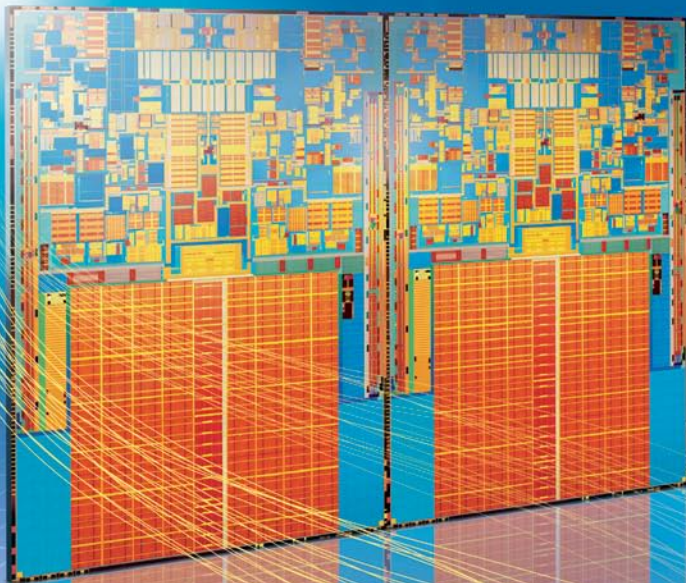
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Article Reprint

Streaming: Performance Gain or Server Drain?

Intel IT studies streaming operating system software and virtual hosted desktops to determine which compute model makes more efficient use of servers and network resources.

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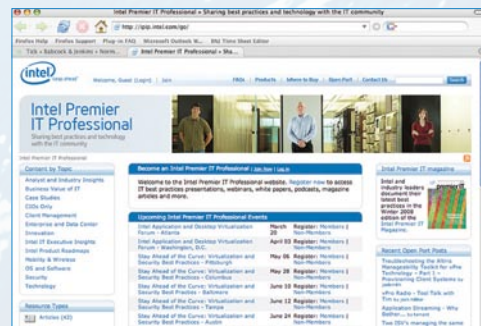
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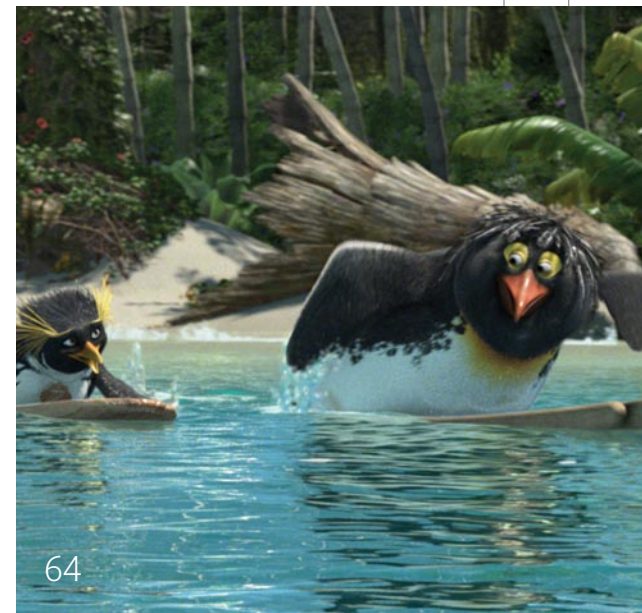
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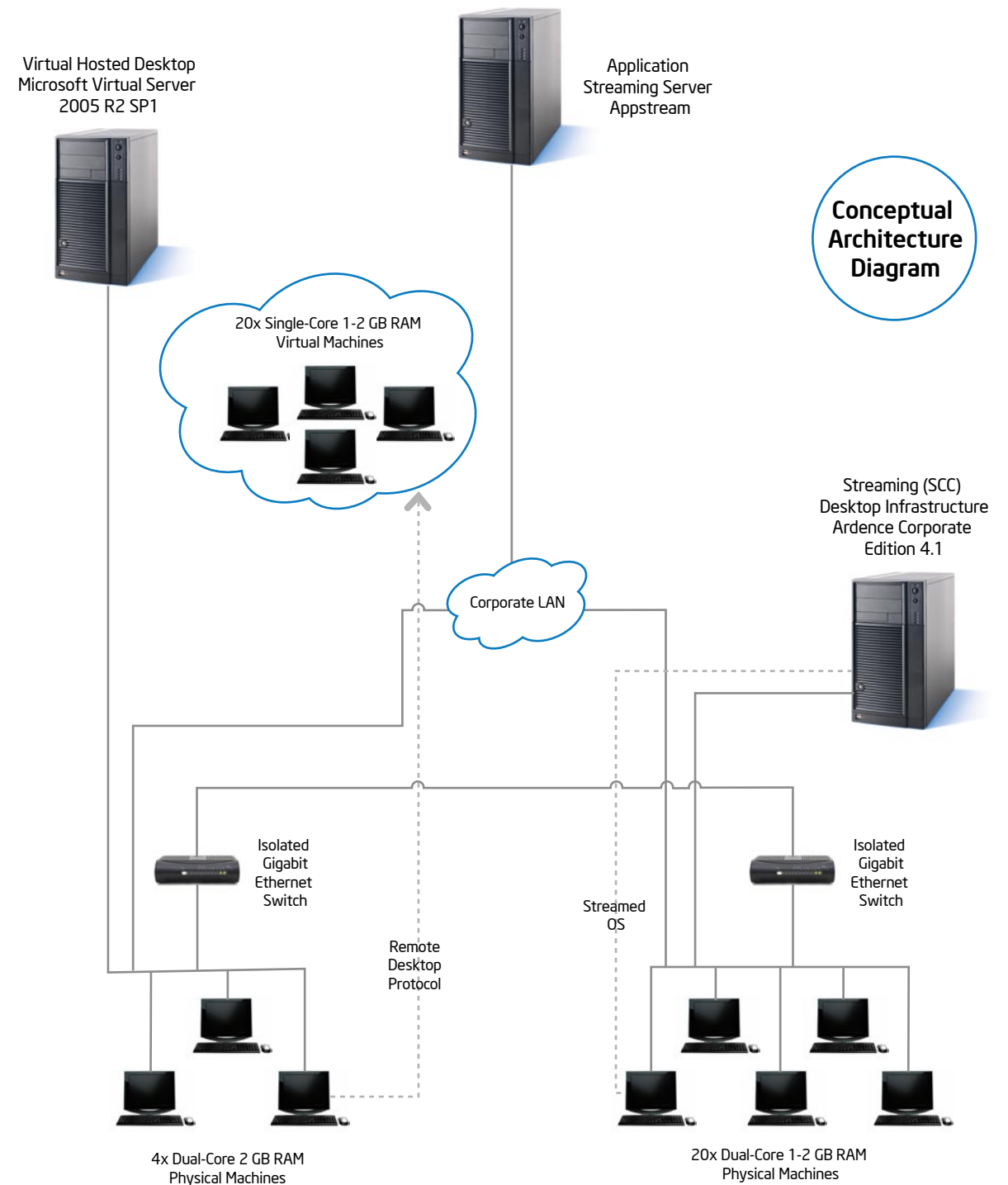
Performance
gain
or server
drain?

IN THE QUEST TO optimize IT resources, enterprises use various computing models. Recently, Intel IT put two computing models to the test: streaming operating system software to hardware client platforms, and virtual hosted desktop, which relies on remote processing on a virtualized server. In a benchmarking study, we set out to determine which model makes more efficient use of servers and the network.

To simulate a realistic workload based on standard office applications, we designed and executed an application script. Using identical server, network, and client configurations for both computing models minimized any hardware-related performance differences. We compared two scenarios—when clients ran natively installed or embedded applications, and when applications were streamed to clients—to assess the impact on the server and network.

The benchmark findings were as follows:

- **SERVER** Server utilization was significantly lower for streaming than virtual hosted desktop. For 20 clients, server utilization was 44 percent lower for streaming than virtual hosted desktop in our test configuration. Compute-intensive and multimedia applications caused high server utilization in virtual hosted desktop. Streaming applications to the virtual hosted desktop had better performance than embedded applications running on the virtual hosted desktop. Application streaming improved virtual hosted desktop server utilization by 15 percent.
- **NETWORK** Network utilization was consistently low for virtual hosted desktop. For 20



An Intel IT study evaluates streaming and virtual hosted desktop compute models. Intel's conclusion: Both are efficient, but deployment depends on workloads.

Executive Summary

Intel IT studies streaming operating system software and virtual hosted desktops to determine which compute model makes more efficient use of servers and network resources.

clients, the virtual hosted desktop network-sent metric was less than 5 Mbps compared to 15 Mbps for streaming. At boot time, streaming briefly consumed the network. However, streaming became more efficient as the OS and applications were cached locally.

- **EFFICIENCY** Virtual hosted desktop was more efficient for workloads with low screen refresh. Streaming was more efficient for a wider variety of applications, including graphics, multimedia, flash animation, and real-time collaboration.

Supporting Network-Based Services on Demand

As networks become more robust, one trend is to enable centralized, network-based services that are provided on demand. Streamed client computing and virtual hosted desktop can support such services.

With streaming, the server delivers the operating system and/or applications over the network for temporary, local execution by clients. OS streaming involves creating and storing a disk image on a server and loading it on the client via the network at boot time. In application streaming, the server stores strategically packaged client applications and distributes them to the clients as users access the application. When a user invokes an application, the server sends the first application execution block to the client, and sends additional blocks in the background. Streamed applications can execute within a virtual machine (VM) on a client or server.

With virtual hosted desktop, the client desktop environment runs within a VM on a server. The server distributes the user interface to the client hardware using remote desktop protocol (RDP). All processing occurs within the VMs.

We designed the benchmark study to simulate back-end utilization under a typical user workload, including standard office suite applications and a video playing concurrently in a media player. We captured server and network metrics as the load was scaled from one to 20 simultaneous clients. We evaluated several software delivery configurations:

- **STREAMED OS WITH EMBEDDED APPLICATIONS:** We created an image of office applications traditionally installed on the OS. The server streamed the image to diskless clients.
- **STREAMED OS WITH STREAMED APPLICATIONS:** We created an OS image. At boot, the server streamed the OS to diskless clients. As the client accessed these applications, the server streamed the necessary software on demand. Applications were run in virtual containers.
- **VIRTUAL HOSTED DESKTOP WITH EMBEDDED APPLICATIONS:** For each client, we created a VM on the server that ran the OS with installed applications. The server distributed the user interface using RDP.

- **VIRTUAL HOSTED DESKTOP WITH STREAMED APPLICATIONS:** For each client, we created a VM on the server that ran the OS. We packaged the suite of applications and streamed them to the client VM on demand. The user interface was distributed to the clients using RDP.

- **OS RUNNING LOCALLY WITH EMBEDDED APPLICATIONS:** We configured traditional clients with the OS and office applications installed locally on the client hard disk.

- **OS RUNNING LOCALLY WITH STREAMED APPLICATIONS:** We configured basic clients with only the OS installed locally. Applications were packaged and streamed to the clients, and were run locally in virtual containers.

Benchmarking took place in the Intel IT lab environment. All software delivery configurations used the same server, client, and network hardware. For streaming tests, the script we created executed as follows:

1. Start script—20-second pauses between steps.
2. Open Microsoft Windows Media Player* and start playback of a 12 MB, 15-minute video; move the task to the background.
3. Open Microsoft Word*; type 1.5 pages of text; copy and paste twice; save; close Word.
4. Open Adobe Acrobat Reader*; open Word document; copy and paste twice; insert two pictures into Word document; save; close Word; close Acrobat Reader.
5. Open Adobe Photoshop*; open 1 MB jpg; apply artistic transformations to jpg; close without saving.
6. Open Microsoft Excel* document, copy and paste multiple times to Word using Paste Special (metafile format for graphs) and other options; type paragraph of text; insert picture from file; save Word document; close Word; save Excel document; close Excel.
7. Open Microsoft PowerPoint*; create a single slide with two text blocks and four resized pictures from file; save document; close PowerPoint.
8. Close Windows Media Player; end script.
9. The tests executed the script incrementally, from one to 20 simultaneous clients. For multiple clients, the scripts launched 15 seconds apart to stagger the workload.

Server Utilization Results

Server processor utilization was very efficient for streaming. For OS streaming, cold test runs (OS and applications are accessed for the first time) with embedded applications used 1.2 percent of the server processor to run 20 clients. Utilization for warm runs (OS and applications are already memory resident in the client) improved to 0.5 percent for the same 20 clients.

Summary of Study Results

Model	Percent Server Processor Utilization (20 Clients)	Network Utilization (20 Clients)	Single Server Scaling (Est. Max. Clients)	Caveats
Virtual Hosted Desktop/Embedded App	45	0.5 Mbps per client	35 Clients	No multimedia or compute-intensive
Virtual Hosted Desktop/Streamed App	45	0.5 Mbps per client	55 Clients	No multimedia or compute-intensive
Stream OS/Embedded App	1	5 Mbps per client	150 Clients	Reboot Caution
Stream OS/Streamed App	1	0.8 Mbps per client	150+ Clients	Reboot Caution

Application streaming had comparable performance to embedded applications. About 1 percent of the processor is used for 20 clients. However, less than 1 percent of the processor was used for cold runs, and almost 1.2 percent was used for warm runs.

For virtual hosted desktop tests, we modified the task script in order to enable its execution, eliminating steps 2 and 5. The high rate of screen refresh with the video and Photoshop displays caused high server utilization, interfering with all VMs on the server. We concluded that RDP was responsible for the behavior, so any application with a multimedia component would react similarly. This includes unified communications applications, Web 2.0 applications with flash animation, and dynamic screen savers. In a production deployment it would be necessary to provide graphic acceleration or to limit the use of these applications.

Even excluding two of the tasks from the test script, the virtual hosted desktop model had much higher server utilization than streaming. Processor utilization increased significantly when the number of VMs exceeded the number of cores on the server, and 20 clients used 45 percent of the processor. When we streamed applications to VMs, server processor utilization dramatically improved; 20 clients used 25 percent of the processor.

Network Utilization Results

Network traffic for OS streaming consumed the entire 1 Gbps network for 35 seconds when simultaneously rebooting 20 clients. OS streaming uses all available bandwidth at reboot time, slowing network operations and creating a utilization spike. One way to mitigate network limitations is to stagger any required rebooting for a widespread OS refresh or patch.

Over time, traffic decreased with OS streaming. With embedded applications and 20 clients, cold runs generated 40 Mbps, while warm runs sent 1 Mbps. Streaming the applications lessened the load on the network to 15 Mbps cold and 1 Mbps warm sent for 20 clients. In both scenarios, network received was 15 Mbps for cold and warm runs on 20 clients. In fact, streamed applications used slightly more network than locally installed applications in clients with a hard disk that ran the OS locally.

Network traffic for virtual hosted desktop was consistent for both embedded and streamed applications; 20 clients generated 5 Mbps for network sent and 1 Mbps for network received. There was a slight reduction in network traffic when applications were streamed.

Conclusion

Our study indicates that each computing model is efficient for certain workloads, but special considerations are required when designing around a particular model. Virtual hosted desktop offers excellent performance for some workloads, allowing infrastructures to run as much as 20 times thinner. However, virtual hosted desktop places a substantial load on the server, with up to 45 percent utilization for 20 clients. Scaled up for more than 20 clients, we would expect to tap server processor resources before we exhaust our network capacity. Consequently, system design for virtual hosted desktop is extremely important in order to prevent overloading the server.

With very low server disk and processor utilization, streaming is a very efficient model. Over time, streaming performs efficiently on the network, comparable to locally installed OS and applications. However, during a massive reboot of clients, the network can be temporarily consumed as the OS is simultaneously downloaded to many clients. It's important to design the network and client-reboot strategies to mitigate slow startup times.

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MORE INFORMATION For complete study details, read the white paper at www.intel.com/it.

JOIN IN Catherine Spence's blog conversation on streaming technology at communities.intel.com.

