Technology Brief

L300 Pre-Deployment and Performance Guide

Introduction

NComputing's multi-user technology enables greatly expanded computing capabilities by allowing up to 30 users to simultaneously access a single PC. This multi-user desktop experience supports simultaneous users at lower costs in an easy to use, set-up and maintain environment that is eco-friendly. The result is a significantly lower cost of computing, on-going management and power usage that is many times better than a traditional networked PC model.

The L300 now elevates the multiuser multimedia experience to the next level by providing full screen streaming video support on huge screens with resolutions of up to 1920 x 1080.

Since most users only utilize a few percent of today's powerful PCs, NComputing leverages this power with small access terminals and proven software that enables a single PC or server to support up to 30 users at once. The goal in the multi-user environment is to maintain the performance of the host computer across many users; and as long as the host CPU, memory or LAN performance is not constrained, each access terminal should operate at a speed similar to the host.

In this document we will discuss best practices in deploying an L300 multi-user environment, including a review of two different hosts using our L300 product. With each host we will provide detailed insight into how these hosts support different productivity and multimedia workloads.

System Setup

Host System Requirements

Selecting a good host is important for the L300, if chosen correctly and the environment set up properly each L300 will have performance that is nearly that of the host PC. With the multimedia capabilities included in the L300, the host requirements can be more demanding then previous L-series products. As always the number of users, intended application suite and overall performance expectation will ultimately determine how powerful a computer must be in order to deliver the desired multi-user experience.

The table below gives recommended specifications for a vSpace host computer, based on number of users and the type of applications used. NComputing recommends you test your environment in advance of deployment to ensure it meets your expectations.

Note: It is not advised to use a notebook PC as the L300 host in day to day deployments. Notebooks use power-saving features and technologies different than a typical desktop PC thatmay cause power management and other incompatibilities.

Recommended Host Hardware Configuration (L300)						
Host Configurations		Number of Users*				
		1-3	4-7	8-10	10-20	20-30
Productivity Applications	CPU** (minimum or Equivalent)	Core™ 2	Core 2	Core 2	Core i5	Core i7
	Host Memory	2 GB	3 GB	3 GB	4 GB	4 GB
Multimedia Applications	CPU** (minimum or Equivalent)	Core 2	Core i5	Core i7	Core i7	Core i7
	Host Memory	2 GB	3 GB	3 GB	4 GB	4 GB

* For the L-Series access terminal, the maximum number of users is 30. The number of users a customer's installation will support depends upon the host's configuration and performance expectations of the customer. Performance results are highly dependent upon the individual host hardware, memory, video card, applications being used, OS and network conditions within any LAN/WAN. Host requirements will vary, please test your multi-user environment before deployment. This table is only a guideline; actual use may vary based on system utilization.

** CPU recommendations are Core2 generation of processor or equivalent

Client Configuration

The L300 set up screens are defined in the L300 User's Guide, and detail the processes and settings necessary for initial configuration of the L300 access device. These configurations are used to determine network connectivity, client login and display settings, and the high-availability "server roll-over" settings. It is recommended that you review this portion of the user guide thoroughly (see http://ncomputing.com/support/documentation.aspx)

Management Console

The vSpace management console is used to view and alter settings related to each access device and user session, as well as global settings which will affect every client connection. These management console features are described in detail within the L-series User Guide.

The L300 also features additional remote push & deployment capabilities like pushing firmware updates and rapid desktop deployment. These capabilities will be leveraged by future versions of the vSpace console.

LAN Configuration

Minimum network specifications for the L300 are relatively simple. For deployments of 10 to 12 L300 devices, a standard 10/100 Network Switch or Router can be used to direct traffic between the host computer and access devices. Multiple hops can be used as long as the L300's connection are not limited by the network. If 10 -12 or more L300 devices are connecting to a single vSpace host, the host's network interface card, as well as the network path upstream of the server must support gigabit traffic. Most network admins simply use a 1Gb backboned switch with enough 10/100 ports to support the number of connected access devices. (for example a 12, 24 or 36-port 10/100 switch with Gb uplink) and make a 1Gb connection to the host computer. This way every L-series device connects at 100 Mb/sec and even with the maximum of 30 users access the host simultaneously for bandwidth, each will have ~ 33 Mb/sec (1Gb/30) of bandwidth, much more than needed.

The L300's full screen video playback capabilities generally use 4 to11 Mb/sec of network bandwidth, and the Remote USB transfer rates are up to 8 Mb/sec. But, it is NOT expected that all user will run streaming video and USB transfer at the same time (worse case bandwidth impact on the LAN); therefore provisioning each L300 for 8 to 10 Mb/sec of traffic should be fine; or 10 to 12 L300s per 100 Mb connection to the host.

If more L300 devices are connecting to a single vSpace host, the host's network interface card, as well as the network path upstream of the server must support gigabit traffic. Simply use a 1Gb backboned switch with enough 10/100 ports to support the number of connected access devices.

The table below shows bandwidth usage of the L300, during basic use, multimedia streaming, and while transferring data through the on-board USB ports. The L130 and L230 provide a baseline for the L300's increased efficiency.

	Typical Bandwidth Use (in Mbps)		
	L130	**L230**	**L300**
Basic Office Apps	0.3	0.3	0.3
Multimedia	15	15	4 to 11
USB Transfers	-	2	6 to 8
Recommended Provisioning*	**15**	**17**	**8 to 11**

***Only L300 devices are designed to perform multimedia streaming. Playing multimedia content on L130 and L230 devices, or with improper codec configuration, can result in increased network load. Please see http://www.ncomputing.com/mediareference for more information on multimedia compatibility.

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Remote USB 2.0

NComputing terminals use Remote USB support that provides transparent USB redirection. When USB devices are inserted into the L300, the USB communication is redirected from the L300 to the USB drivers that are resident on the host PC. The L300 features a full USB 2.0-compatible physical layer, allowing it to recognize and interface with a variety of USB devices.

Within a multiuser environment, the drivers for a given USB peripheral (connected to the L300) must be multiuser aware. Multiuser awareness allows multiple devices to be recognized and utilized by separate user sessions from a single host OS. If the USB driver and any accompanying USB applications are not multiuser aware then the USB device will not operate correctly on multiple L300s, if this occurs request the USB vendor adjust their software for multiuser environments.

Since NComputing's Remote USB 2.0 travels over Ethernet via UXP protocol, transfer speeds are subject to UXP protocol & network limitations. When using a USB memory stick the operating system must read the device's directory before it will mount the device for use. In most cases this process will take 15-25 seconds but it may be longer, depending on file directory size (determined by number of files and drive size).

At this time, Remote USB support does not include the use of instantaneous USB data commands, and therefore does not support the isochronous class of USB products.

Multimedia Support

Multimedia and the L300

The L300 will display full screen streaming video across multiple user sessions and is optimized to do so using NComputing's vSpace transcoding process. This process works transparently to stream video and support multimedia content in a terminal device well beyond what has been seen in thin client or multiuser computing before. Full screen streaming video with matched sound synchronism in the norm for vSpace and the L300.

vSpace Multimedia Transcoding and Numo

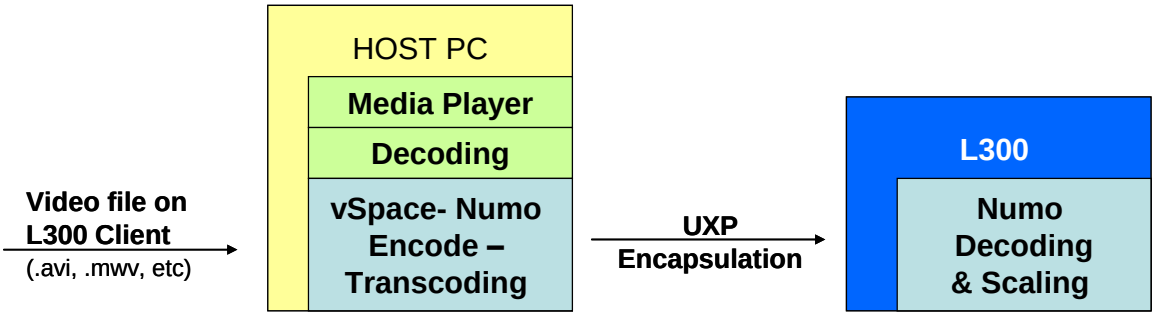
vSpace transcoding is designed to mimic the multimedia experience that the user would see on the host. vSpace uses has two optimized video pipeline implementations to achieve the performance:

1. Direct JPEG
    - Streaming content that is capable on host is captured by our device driver, compressed and passed over the wire to the Numo chip for decoding and scaling.
    - Direct JPEG has the capability to stream video content that the host is capable of streaming. This makes Direct JPEG a seamless method of delivering vSpace transcoding on the L300 without having configured the many video setting.
2. Directshow API
    - This method is similar to above but uses Microsoft's API that allows for another level of optimizations

Either method provides a great media streaming experience on the L300.

The Numo™ system-on-chip (SOC) in the L300 device and the vSpace-enabled host PC work closely together to balance video streaming workloads. The vSpace software for the L300 features a unique transcoding engine that can take most any media file format and transcode it for a low bandwidth transfer over the network to the L300 client which then decodes and scales locally. This efficient approach allows NComputing to offer low cost clients that can provide full-screen streaming video, up to display sizes of 1920 x 1080.

The vSpace transcoding process works as follows. A streaming video file (.mp4, .wmv, etc.) is activated from the L300 virtual desktop. The vSpace transcoding engine starts with the video that has been decoded by the host computer and media player (and optimized with Directshow) and then it encodes the data into a compressed video stream. This compressed video data is then sent over NComputing's UXP protocol to the L300 device. The Numo SOC in the L300 then decodes the data locally and scales it to fit the screen and window resolution set in the user's desktop. The diagram below illustrates this process:



A key advantage of the vSpace transcoding process is that the original video file's codec processing takes place on the host. This allows vSpace to work with a wide variety of codecs within the PC that may be updated from time to time. These multiple video formats using multiple codecs are then processed by the vSpace transcoding engine into a single compressed video stream that is decoded in dedicated hardware on the L300. This enables the L300 to deliver an exceptional level of performance at a low cost. The transcoding process for streaming video uses compression that removes data that will generally not be detectable by the end user. However, the standard display graphics for normal 2D applications are extended in a separate lossless process. This ensures the best possible user experience for all types of interaction with the desktop.

Another key advantage of this approach is that full screen scaling on the L300 does not impact the CPU utilization on the host since the Numo SOC's scalar capabilities handle this function locally.

The L300 virtual desktop accelerates most video formats through standard media players, such as Windows Media Player (which is included in all current Microsoft operating systems) or Media Player Classic (which is included in the vSpace installation).

By default, these media players only playback a limited number of media types with just a few preinstalled codecs (coder/decoder). Most host PCs do NOT come configured for a wide range of support for media types, so additional supported codecs can be added when setting up the host and configuring the NComputing vSpace installation. For an L300 to stream a given file the host must be able to stream it first. The vSpace acceleration method on the host system directs the output of the media playback to a compute-efficient transcoding engine that creates a low-bandwidth stream that is transmitted to the L300 device over the network. The L300 then decompresses and scales the video stream locally in hardware up to 1920x1080 resolution for optimal video quality and always with flawless sound synchronization.

NComputing video acceleration for up to full-screen resolution directly supports Windows Media Player 10 and 11 as well as Media Player Classic. Any other media player can be used for effective display of videos in windows that are at approximately 480x360 resolution or less where acceleration is not required. Some of these additional media players may also take advantage of the NComputing video acceleration capabilities when configured to use the Directshow API and the appropriate codecs --

check the online knowledge base or forum for community supported media player options.

The following table shows many of the popular media formats that are supported by the L300 video acceleration feature using Windows Media Player 10 and 11 or Media Player Classic with appropriate codecs installed. A reference of common industry codec's can be found at www.ncomputing.com/mediareference.

Media formats accelerated by L300 virtual desktop in Windows Media Player 10 and 11 or Media Player Classic

Media type	File extension	Example supported codecs*
QuickTime™	.mov	h.264
Audio Video Interleave	.avi	MJPEG, DivX®, Xvid (MPEG-4)
Windows Media Video	.wmv **	Windows Media 9 +
DVD	.vob **	MPEG-2
Matroska	.mkv	h.264
M4V	.m4v	h.264
MP4	.mp4	MPEG-4
MPG	.mpg	MPEG1-MPEG-2
Flash™ Video	.flv **	h.264

*Not a complete list. Refer to full listing of enabled codecs provided with your codec pack
** Supported with Media Player Classic only

Optimizing for DirectShow

As mentioned Direct JPEG has the capability to stream video content that the host is capable of streaming. This makes Direct JPEG a seamless method of delivering vSpace transcoding on the L300 without having configured the many video setting. But Directshow does offer some added performance benefits and using it will maximize the number of streams that can be obtained from a single host, therefore we have provided what are mostly industry standard steps to configure Directshow properly.

Microsoft's market leading Directshow API or by using NComputing Microsoft's Directshow API is the world's most popular video playback API is therefore the most widely supported. Maximum performance can be achieved with a standard install but to support a wider range of video file types the administrator or user should:

- Choose a video player that supports the Directshow API and configure it for Directshow (Windows Media Player and Media Player Classic are installed by default)
- Download the proper codecs for any video files they wish to play and enable them for the player. Also setting the MIME type to the appropriate player will make sure the association to the correct player is made
- For playing .avi files, apply a filter to determine the true file encoder used.

Some video players that support Microsoft's API do not do so by default and configuration may be needed. Proper setup of filters and codecs can assist in making this process simpler. The process mentioned in the previous and next section will ensue that the maximum performance of the L300 can be achieved across a wide range of video types.

Players that do not support Directshow or Direct JPEG should be avoided as streaming files that are greater than ~480 x 360 will result in dropped frames, an overall reduction in video quality and greater network bandwidth use.

Players, Codecs, and Filters

Windows Media Player is installed by default with any Microsoft OS and our vSpace installer now includes Media Player Classic; therefore both players will be installed by default.

Download the proper codecs to support the video files types that are desired and enable them for the player. A reference of common industry codec's can be found at www.ncomputing.com/mediareference, but others can be used.

Optimally a filter may be needed to determine the true file type of a .avi file. The instructions for one such filter, Matroska, are described in the L300 User's Guide. Also setting the mine type to the appropriate player will make sure the association to the correct player is made.

As NComputing determines the optimal settings for players and/or Codec's we will post them as Knowledge Base articles.

Browser-based video acceleration

In addition to the media types supported above in stand-alone media players, the L300 also supports acceleration of browser-based embedded video including Flash video. Unlike stand-alone media players with discreet graphics output, the graphics output of browser-based video is combined with the other web page content. vSpace software detects when embedded video is being played in a browser and then directs the output of that video to the vSpace transcoding engine which creates a low-bandwidth stream that is transmitted to the L300 device over the network. The L300 then decompresses and scales the video stream in hardware up to full screen resolutions for optimal video quality.

Users will find that video on popular websites such as YouTube™ will display full-motion content up to 480p that can scale to full-screen at 1920x1080 resolution. During this process the display might show a very brief blue window where the streaming content is going to play, this is part of vSpace setting up for the transcoding process.

Browser-based animation optimization

Flash animations are optimized through vSpace and default rendering in the L300. The native rendering of desktop application content by vSpace assures that users get fast updates, smooth scrolling, and synchronized audio. The hardware-optimized performance of the L300 gives users a great multimedia experience.

Benchmarking

Introduction

NComputing's L300 ethernet access devices are intended to replace desktop PCs in a variety of applications and environments, but how do they measure up in terms of performance? This section draws from a large body of benchmarking and performance data to help illustrate what IT administrators can expect when deploying NComputing technology.

All testing and benchmarks in this section were done on two separate host PCs, each representing different price points and capabilities within the desktop PC market, to help show the versatility and efficiency of NComputing's desktop virtualization. See the table below for detailed specifications on each host PC.

	Host A	Host B
PC Grade	Mid-range desktop	High-end desktop
Estimated Cost	$399	$899
CPU	Core 2 Duo (2.66GHz)	Core i7 (2.67GHz)
Memory	3GB DDR2	4GB DDR3
Network Card	Gigabit	Gigabit
Operating System	Windows Server 2003	Windows Server 2003
vSpace Software	v4.09.002	v4.09.002

Internet Performance

Normal PC network performance rules apply to the host PC, and the most common limit is the connection bandwidth to your Internet service provider. Internet bandwidth is a shared resource for all users, whether using individual PCs or using a shared environment. Therefore there is no difference in connecting 30 PCs or 30 L-series to your internet provider.

Productivity Testing

In order to measure performance of productivity software on L300 devices, we used OfficeBench, a free test script designed to evaluate desktop performance using Microsoft Office (Word, Excel, PowerPoint, and Internet Explorer). It uses the Office COM interfaces to drive the tests with different application in Microsoft Office suite through a series of scripted tasks simulating knowledge workers. It then measures the time each application takes to complete its test sequence.

In our tests, we run OfficeBench directly from the host, as well as from the L300 devices. We also compare running one L300 session to five simultaneous L300 sessions. To simulate knowledge workers in real life, we configured a 2-second delay between each scripted action. Even with this delay, this benchmark runs through a series of operations that opens, enters and calculates, manipulates, saves and prints files at a pace that is much faster than any human would do in a normal working environment.

The results showed that regardless of whether the test was run on the host or an L300 device, it took nearly the same amount of time (about 400 seconds) to finish. Furthermore, it made no difference if we ran one instance or 5 instances simultaneously; the same amount of time was taken. The results are shown below, and demonstrate that the L300 devices do not lag, hang, or introduce any form of delay to the user experience, ultimately delivering performance that is equivalent to a dedicated PC.

Host A				
	Time (in sec)	CPU (in %)	Memory (in MB)	Network (in Mbps)
Idle	N/A	0.03	157	0.01
Host only	396.4	4.5	254	0.3
1 Session	409.7	4.3	294	0.3
5 Sessions	409.5	19.4	804	1.3

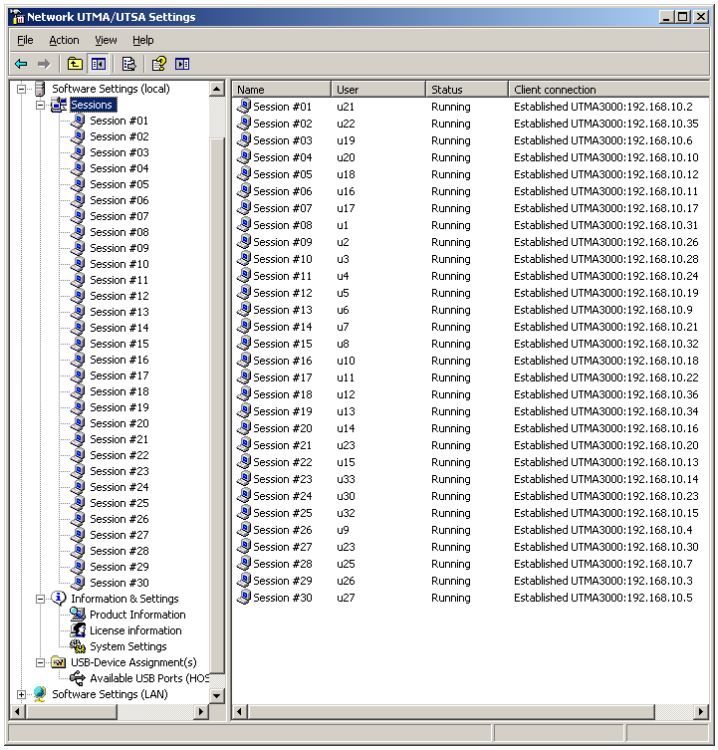
Host B				
	Time (in sec)	CPU (in %)	Memory (in MB)	Network (in Mbps)
Idle	N/A	0.15	167	0.01
Host only	391.8	0.7	257	0.01
1 Session	396	1	299	0.23
5 Sessions	395	4.8	833	1.4

Multimedia Testing

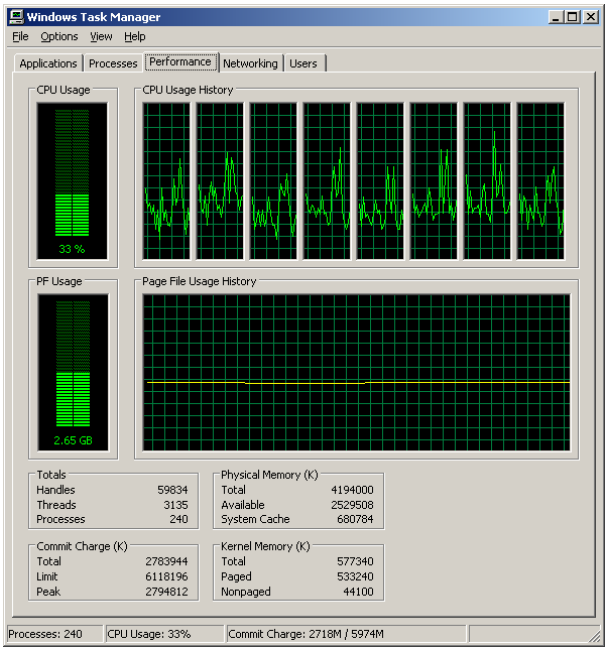
Beyond demonstrating the L300's ability to perform alongside desktop PCs in the office, we want to show the L300 in a more media-rich environment.

To do this, we chose to launch 30 user sessions, each playing a video clip at full screen. We used Host B from above and successfully played a 240x360 mpg file on every connected L300, scaled to a full-screen size of 1920x1080 via Windows Media Player.

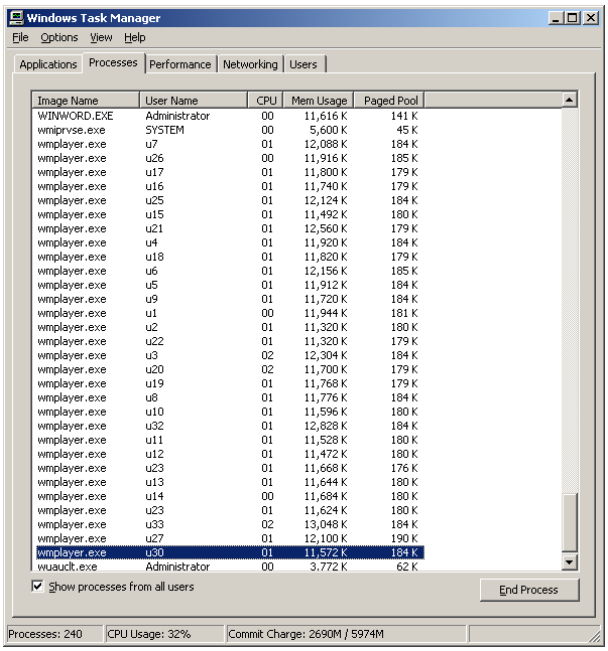
This image is from our vSpace Console and shows the 30 individual user sessions running.



The task manager was running with processing capability to spare at ~33% processor utilization and the available memory was still over 1.3 GB.



This task manager image shows the 30 instances of Windows Media Player, each assigned to a separate client session.



To further demonstrate the L300's multimedia capabilities, we tested seven additional videos, across a range of sizes and file types. With each of these videos, we continued adding instances until the host's CPU peaked, or the 30-user session limit was reached. In every case, playback on the L300 device was clean, stable, and free of tearing or artifacts.

Videos Tested		
Name	**Size**	**Filetype**
Video A	352 x 240	.mpg
Video B	640 x 360	.mov
Video C	640 x 480	.wmv
Video D	720 x 480	.avi
Video E	720 x 480	.wmv
Video F	1280 x 720	.mp4
Youtube 1	360p	.swf (Flash)
Youtube 2	480p	.swf (Flash)

Again, these results demonstrate that each L300 is fully capable of handling media-heavy environments at full screen display to 1920 x 1080.

These tests have demonstrated that, regardless of the number connected to the host, each L300 has the capability to stream full screen, real-time video with full sound synchronization: no small accomplishment for a stateless access terminal. Furthermore, it shows that the L300 device is not a performance limiter in multimedia playback, and in further testing it will be demonstrated that the host PC's configuration becomes central to taking advantage of the L300's performance capabilities.

Video transcoding varies greatly depending upon the format and size of the media being played (as well as the player used), and is a CPU-intensive process. When considering a system for media-heavy deployments, it is wise to choose a powerful CPU such as Intel's Core i7 or an equivalent processor. It is also important to make sure that there is sufficient memory and at least 4GB of RAM is recommended for most environments. Please refer to our host configuration guide for more information on recommended specifications.

Vertical Market Use-Cases

To help provide customers with meaningful and practical benchmarking data, NComputing has performed a series of tests, each representing a vertical market in which our product has been implemented. These scenarios give a picture of use-cases, and are designed to help with pre-sales questions and aid in choosing an appropriate host PC.

Manufacturing

The L-series is ideal for manufacturing environments as harsh chemicals, air particulates, and other environment factors make the manufacturing floor a graveyard for standard desktop PCs, but have no effect on NComputing's zero-client access devices.

In a typical manufacturing environment, the production manager needs to display job assignment data to many users over a large production floor. Each user runs a basic set of applications, including an HTML or PDF viewer to view job data, a basic Messenger for internal communication, and the Microsoft Office suite for reporting purposes. We simulated this environment by connecting 25 L300 access devices to Host A. On each L300, we logged into Windows and then ran two of the above applications.

Under this load, Host A showed an average CPU utilization of 14.2% and Memory utilization of 2.9 GB.

Office

An office environment is often quite basic in terms of applications, typically limited to MS Office, a web browser, an internal messenger, and sometimes a database or data-entry program. This, combined with high user-density, makes office environments prime candidates for NComputing implementation. To simulate such an environment, we connected 20 L300 devices to Host A and ran a separate copy of MS Word, MS Excel, Internet Explorer, and Adobe Reader on every session. On top of this, five of the sessions ran script-driven stress-tests, each of which simulated heavy user activity.

Under this load, Host A showed an average CPU utilization of 37.2% and Memory utilization of 3.1 GB.

Classroom

Classrooms and school computer labs are both excellent locations for NComputing product to be implemented. Typically, classrooms will come with a standard selection of applications, including MS Office, a web browser, and a media player. Often, they will also include testing programs, typing tutors, and other educational applications. To simulate this use-case, we connected 20 L300 devices to Host B, and launched a blend of office applications (5 instances under normal use, and 5 instances script-driven), Youtube videos (5 instances, 360p), and local multimedia files (5 instances, 640x368).

Under this load, Host B showed an average CPU utilization of 21.1% and Memory utilization of 2.8 GB.

Internet Café

Internet cafés vary greatly in their purpose and applications, though many simply provide their customers a web browser and printing capabilities. For this use-case, we connected 20 L300s to Host B and launched Internet Explorer on each. For ten of the sessions, Youtube was launched to stream 480p Flash videos.

Under this load, Host B showed an average CPU utilization of 20% and Memory utilization of 2.7 GB.

Employee Training

As part of employee training courses, lengthy instructional videos will need to be viewed by each trainee. For periods when training is not needed, these PCs are either repurposed, or simply left to sit until they are needed again, so why not replace them with a zero client? To test NComputing's L300 device as a solution for this environment, 20 access devices were connected, and each launched a 640 x 480 video.

Under this load, Host B showed an average CPU utilization of 74.3% and Memory utilization of 2.5 GB.

Digital Signage

Digital signage is burgeoning market for advertisement and information sharing. Although no regular user interaction is expected, High Definition multimedia streaming is a must. We pushed the L300 to its limits and streamed 8 simultaneous videos, each at 720p HD resolution. The video quality was superb, with no tearing or artifacts, and sound was fully-synchronized.

Under this load, Host B showed an average CPU utilization of 75% and Memory utilization of 1.1 GB.

Use-Case Summary

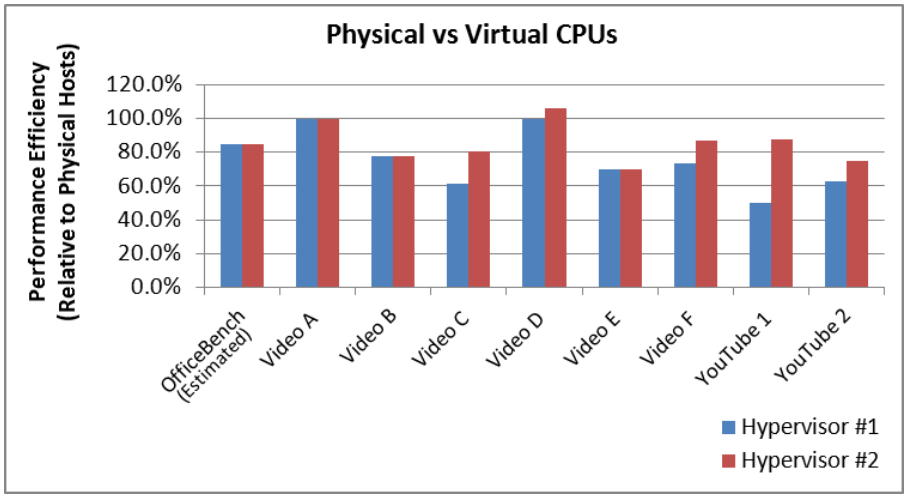
The following matrix provides a quick summary for each multi-user environment detailed above. These tests have shown that NComputing's desktop virtualization is versatile enough to thrive in a variety of environments and application loads, and so efficient that it can do so while powered by a typical desktop PC.

	Host	Sessions	CPU Load	Memory Load
Manufacturing	A	25	14.2%	2.9 GB
Office	A	20	37.2%	3.1 GB
Classroom	B	20	21.1%	2.8GB
Internet Café	B	20	20.0%	2.7 GB
Employee Training	B	20	74.3%	2.5 GB
Digital Signage	B	8	75.0%	1.1 GB

Virtualized vSpace Hosts

Virtual machine technology is becoming more and more popular as a means to consolidate server roles, reduce down-time, and ensure high availability for all business-critical server functions. NComputing's L-series desktop virtualization benefits from these same factors for our host, therefore we benchmarked a set of virtual hosts in addition to our physical ones.

We ran the benchmarks listed above with two separate industry leaders in VM technology, and then compared the results to our physical hosts. From these test we get an idea as to the added overhead within a fully-virtualized host environment and see that the VM's add on average about 20-30% of overhead. Therefore when deploying virtual hosts we recommend that the multiuser environment account for this.



Summary

In this L300 Deployment Guide, we have provided best practices for deployment, shown how application performance of the L300 matches that of a desktop PC, and demonstrated that the multimedia capabilities of the L300 are limited only by the power of its host PC. It is our hope that this information will help you fully understand the L300, appreciate its capabilities and limitations, and deploy it in your environment with confidence.