Thin Client Research

By

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Table of Contents

Figures

Tables

Abstract

The basic principles of thin clients have remained unchanged since their invention in 1993. A user uses a low power terminal client to connect to a server that computes the client's requests. One of the main advantages of thin clients is centralized management and security. For example applications and desktops are fully controlled by the administrator, which results in a more streamlined and secure environment.

Building a thin-client network is a complex task that can have many solutions; during the course of my research I found a solution that deals with the issues that are associated with thin clients. The license cost of thin clients and servers are expensive, and my goal was to find a balance between cost and performance. I have used proprietary and open source solutions in order to reduce cost.

Introduction

IT professionals who administer a large number of computers and users face many issues during the course of their workday. A major problem is the lack of standardization of user's personal computers throughout an organization. Users are not always running the same versions of software and they could be running a vulnerable version unknowingly. This results in unexpected errors and potential security holes. Keeping track of every user is a hard task, and mobile users are even harder to re-image because of their unpredictable locations. The inability to maintain computers at the same level of security makes security compliance nearly impossible. The difference in configuration makes troubleshooting hard and takes away resources from the IT department. Data security and control is also a major problem in thick-client environments. Administrators need to keep their sensitive information from being accessed and leaked by unauthorized individuals.

Problem Statement

One solution to the problem of desktop security and stability is desktop and application virtualization. Thin clients are one of the many solutions and are an alternative to full desktop computers. They operate on an extremely basic operating system in order to connect to the services that are hosted on a centralized location. A central point of management allows IT professionals to deploy applications and system updates to all of their users rapidly. A base image can be made for the virtual desktop, and applications can be deployed to the user's environment. The user do not have control over the machines' physical environments. By

prohibiting direct access to the computer's storage an administrator can prevent a wide variety of attacks that a malicious user could perform locally on a thick-client.

As great as thin-clients may be, one of the major issues with a thin client system is the cost. One of the largest costs in thin-client computing is licensing. The licenses are expensive, and the cost adds up with every device used to provide the service. The goal of this project is to reduce the cost of thin clients. My thin client will use cheaper hardware and open source systems in an attempt to reduce expenses. Traditional thin clients are rather expensive considering its simple hardware, whereas standard computers can provide a more affordable client alternative. Computers built on standards, like ATX connectors and interchangeable parts, provide administrators with a wide variety of choices when building and repairing. This client would not become obsolete, because it would run an open source Linux operating system. The concept of using open source software can be a major advantage when it comes to the longevity of a thin client, because software updates will not depend on the financial interest of a third party.

Linux was chosen because it will allow businesses to cut down on the cost of client licensing and can be customized to act as a thin client operating system. There are many VDI and terminal server solutions, but the one that I selected to complete my project does support Linux as a client OS. I believe that an IT department could reduce the amount of time they spend supporting and fixing desktops by switching to a centralized management solution. The ability to directly push updated applications to the application server would increase security by forcing all users to comply with the same level of security without taking any action. The user will not notice a difference until they log in after the update.

Another potential solution, aside from thin clients, is an advanced mass imaging solution with network file backup. In theory, you could refresh computers on a monthly basis, to make sure that everyone's computer has the same image, but this requires more interaction with the user's physical machine. This could require IT personnel to go from station to station, to verify that users have no local files, and to initiate the process.

Solution

My solution to the issue of thin client costs is to create a client built from standardized hardware that still maintains the power efficiency of traditional thin client systems. The reason why thin clients are expensive is because they are a niche product. Thin clients have not yet conquered the business desktop market, and probably will not until the advantages become clearer to administrators and accountants. Because of the low volume of sales, thin client costs more to produce, even though they contain less powerful hardware. In the past, desktop parts were not capable of achieving thin client-like power consumption, but this is not a problem anymore. Intel's new line of Atom processors can use as little as 0.65 watts to a maximum of 10 watts. Using this technology, I have built a client that uses a low power motherboard as its main platform. The CPU and GPU are all integrated onto the board in order to save money. Its basic components are still universal; just as the power supply, RAM, and hard drive are all based on the standard parts used, like any other computer.

The solution that I designed is meant for commercial and business environments. It was designed to be durable and easy to maintain, so it could be used in a normal office environment,

or even the harsh environment of a steel plant. The backend of my thin client network was created on a Citrix environment. XenDesktop in itself is not cheap, but it is also one of the oldest and well-known thin client server solutions. One of the considerations during my research was the long-term support of a potential choice. I found solutions that were more affordable, but those solutions were made by companies that offered little to no support, or had just started in the virtualization industry. When investing into an information technology solution it is important to think about the long-term goal and stability of a project. If the consumer is required to hire an expert to deploy and maintain a complicated server; it could cost more in man hours than to pay for a more expensive license. If a software vendor goes bankrupt, then there will be no one to support its infrastructure.

Network and Server Design

My initial choice for the hypervisor was VMware ESXi. ESXi was an attractive option, because it is an industry standard and I am very familiar with it. However, I eventually switched to Citrix XenServer. XenServer was chosen because of its price and prebuilt compatibility with XenDesktop and Citrix's other products. While attempting to use ESXi, I ran into a variety of problems. One problem was the requirement to purchase and install vCenter; the other problem was the need to purchase an SSL certificate. Both of these requirements added to the overall cost of my project. Thus, I settled for XenServer and it worked without any additional purchases or configuration. Due to budget issues, I used the equipment I borrowed free of charge. The specs for my "server" were an i7 Mac Mini with 16GB of RAM. In a production environment, I would

recommend buying several servers that are designed for virtualization in order to cluster them to create a more professional and failover design.

The XenDesktop and XenApp server is actually hosted on real server hardware. My Citrix server is running in a Windows Server 2012 virtual machine hosted by an ESXi server. The hardware specs for that machine were 16 cores, 64GB of RAM, and a fiber storage solution.

The theoretical network design and the actual design that was used to demonstrate this project were very different. My thin client backend was built on UC's network, and not the sandbox. Since I do not have any control over the UC network, I had to make some adaptations. In a real environment, I would isolate the thin clients from the network connected to the Internet. This serves two functions: it prevents hackers from directly accessing the thin client hardware; further, it forces the user to go through the XenApp or XenDesktop service. This allows administrators to have more control over the network's traffic and what users are capable of doing based on their credentials. The sessions that the users access, can be restricted to what applications they can run and even to which network they are allowed to connect. This can be a great tool to prevent data theft by employees. Isolating a user based on who they are can stop hackers from gaining access to the whole network if they manage to infect a machine.

Network Diagram

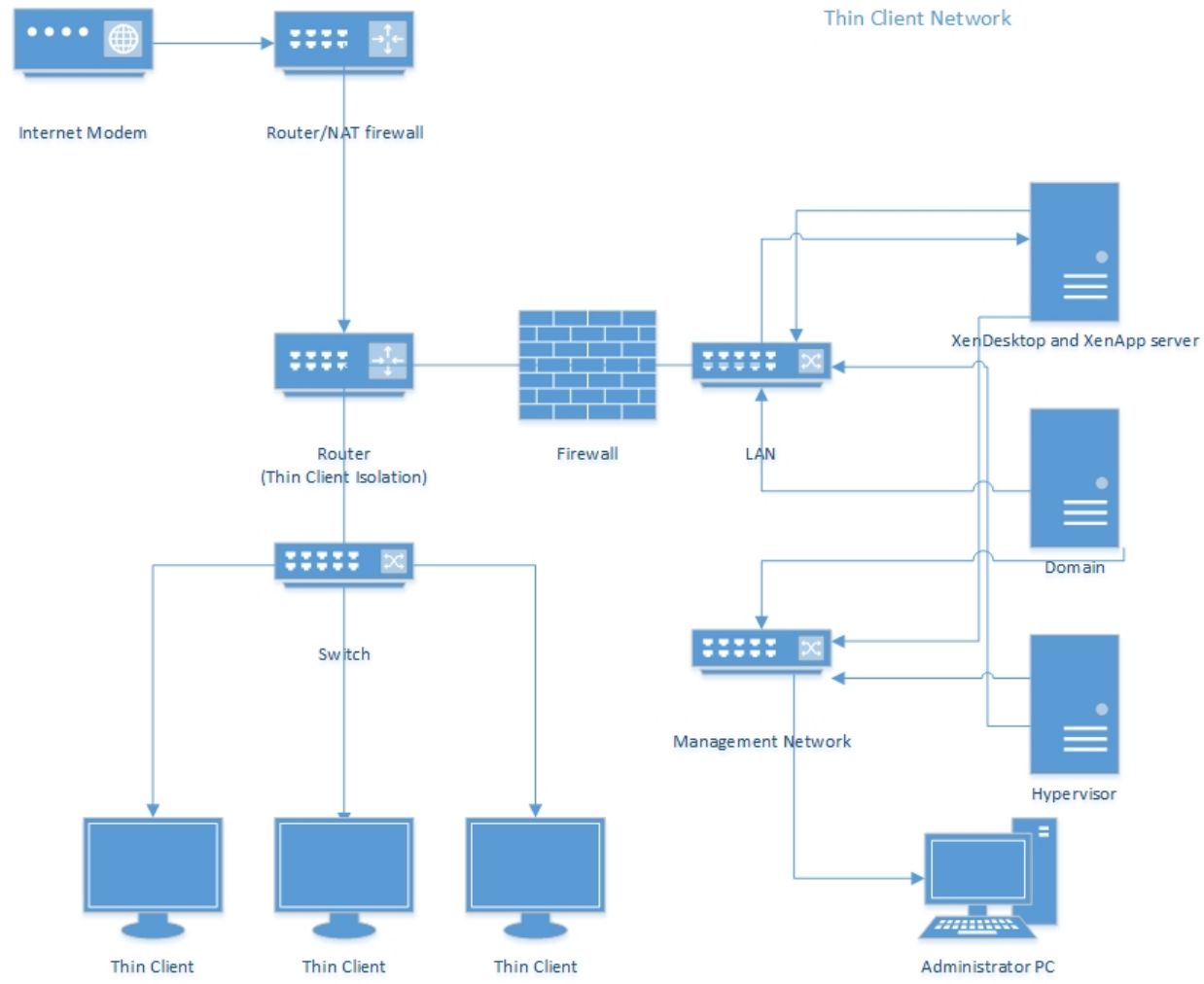


Figure 1: Network Design

Physical Design of Client

The prototype for this project was built with a minimalist design in mind. The computer case serves two functions: it holds the computer components, and it acts as a monitor stand. The structure is made out of steel sheet metal, which is then assembled into a computer mount. This

allowed me to create something compact. This metal work would have to be contracted out by a manufacturer. Even though the cost of material is low, an IT professional cannot be expected to buy heavy machinery to complete this task.

Client Prototype Method

For this prototype, I used 16 gauge hot roll steel, which is thicker than the metal used to make cars and light trucks. While this material is extremely sturdy, it is not very malleable. When the sheet was purchased, the dimensions were 24 by 36 inches. I used a hydraulic metal shear to cut the sheet into smaller sections, which were then bent into shape using a metal brake. The bent parts were then welded, bolted, or riveted into place to make a permanent bond between the components. Next, I proceeded to cut an existing ITX back plate and attached it within the frame of the commuter case. I could have drilled the metal mounts directly into the frame itself, but that would have required precision drilling and specific tools to thread the holes.

Figure 2: Thin Client Design

While reading this, it is quickly understood that it would consume too much time and energy to create these inside an organization. This is why this part of the project would have to be done by a manufacturer. Sheet metal work and construction are not the job of an IT professional. My goal would be to mass produce these cases. These computer cases might interest people outside of the thin client industry, as they can be used in a wide variety of environments. The standardizations of an "all-in-one" computer mount could directly compete with traditional thin clients and all-in-one computers that use nonstandard parts. The mass production of parts that could be used in both thin and thick clients could reduce the overall cost of manufacturing.

Cost of Prototype

The prices shown below are based on retail prices. If the thin client prototype were built commercially, the cost per unit would be reduced by wholesale discounts. The cost of manufacturing is not included. Manufacturing costs could differ depending on how and where the units are built. In order to reduce costs, the final product would most likely use plastic instead of steel.

Part	Model	Price
Motherboard	ECS CDC-I/D2550	$69.99
RAM 2GB	KVR13S9S6/2	$17.99
Power Supply	RAIDMAX RX-380K 380W	$16.99
HDD	Seagate SATA2 250GB	$29.95
Sheet metal	16 gauge steel	$15.00

Table 1: Thin Client Cost

User Profile

The users will interact with a simple interface that will require little to no training on their part. Initially, the users will need to learn how to start their remote sessions, but once the sessions start, they will be greeted with the same Windows interface they are used to. An administrator will also use a familiar Windows Server interface to control their network using Citrix Studio, which is a well-designed interface that makes administration much more intuitive.

Use Case Diagram

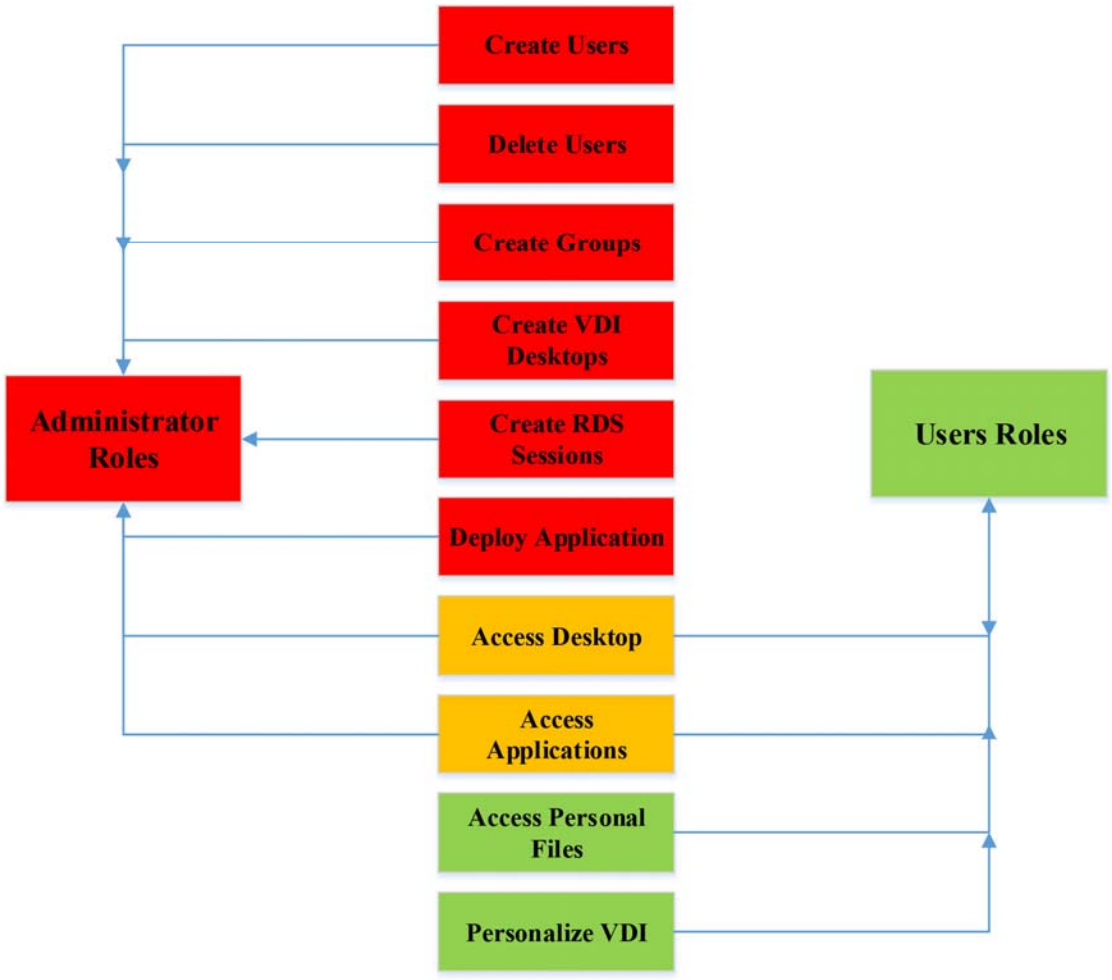


Figure 3: Use Case Diagram

Budget

The budget for a thin client project will vary depending on a variety of variables. Vendors may provide discounts, depending on the size and the type of the organization. Large volume and education clients are usually given discounts on licenses and hardware. Software licensing is a complex process that should be discussed with a vendor's licensing department. The size of a deployment and its level of redundancy will affect the cost of a project.

This is an estimate for a retail-priced small thin-client network for a hundred users:

	Price USD	Units	Total	Comment
XenServer 6.5 Enterprise	$1,525	2	$3050	The Enterprise version is only needed for accelerated graphics and other features. A free version is available.
XenDesktop Entreprise	$159.96	100	$15996	Retail Price.
Windows Server 2012 R2 Standard	$882	2	$1764	One license is used for the Citrix server, and one is for the remote desktop service instance.
User CAL(only used for XenApp and RDS)	$109	75	$8175	Number of units will vary whenever RDS or VDI is selected.
VDI license	$100	25	$2500	Number of units will vary whenever RDS or VDI is selected.
HP ProLiant ML350	$10,255	2	$20510	Two servers will be used for redundancy.
Networking Equipment	$4,000	n/a	$4000	Various networking equipment (switches, firewalls, routers).
Grand Total			$55,995	For a 100 user

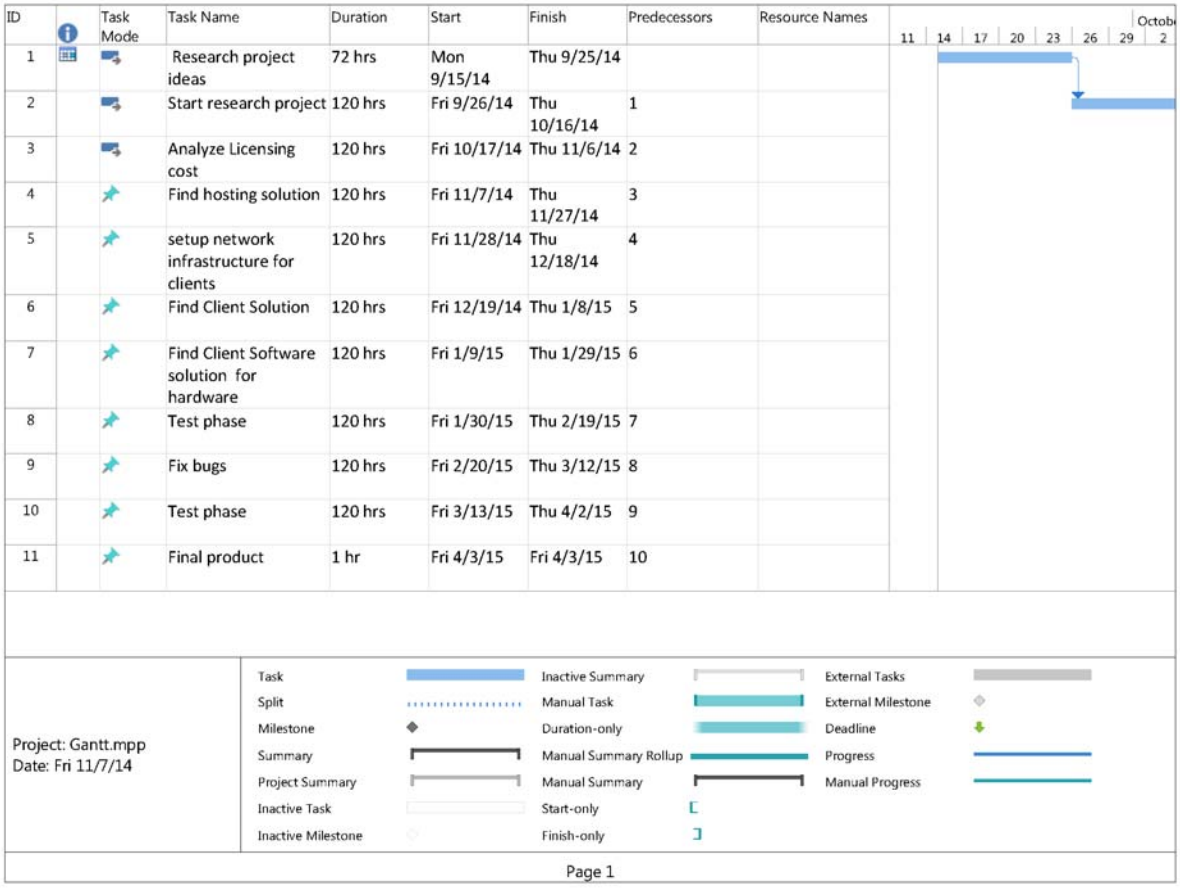
Table 2: Backend cost

Some institutions will receive significant discounts on these retail prices. Additionally, Microsoft VDI licenses fees may be waived by Microsoft when under the Software Assurance program. The grand total estimate above is for a small thin client solution for a hundred users.

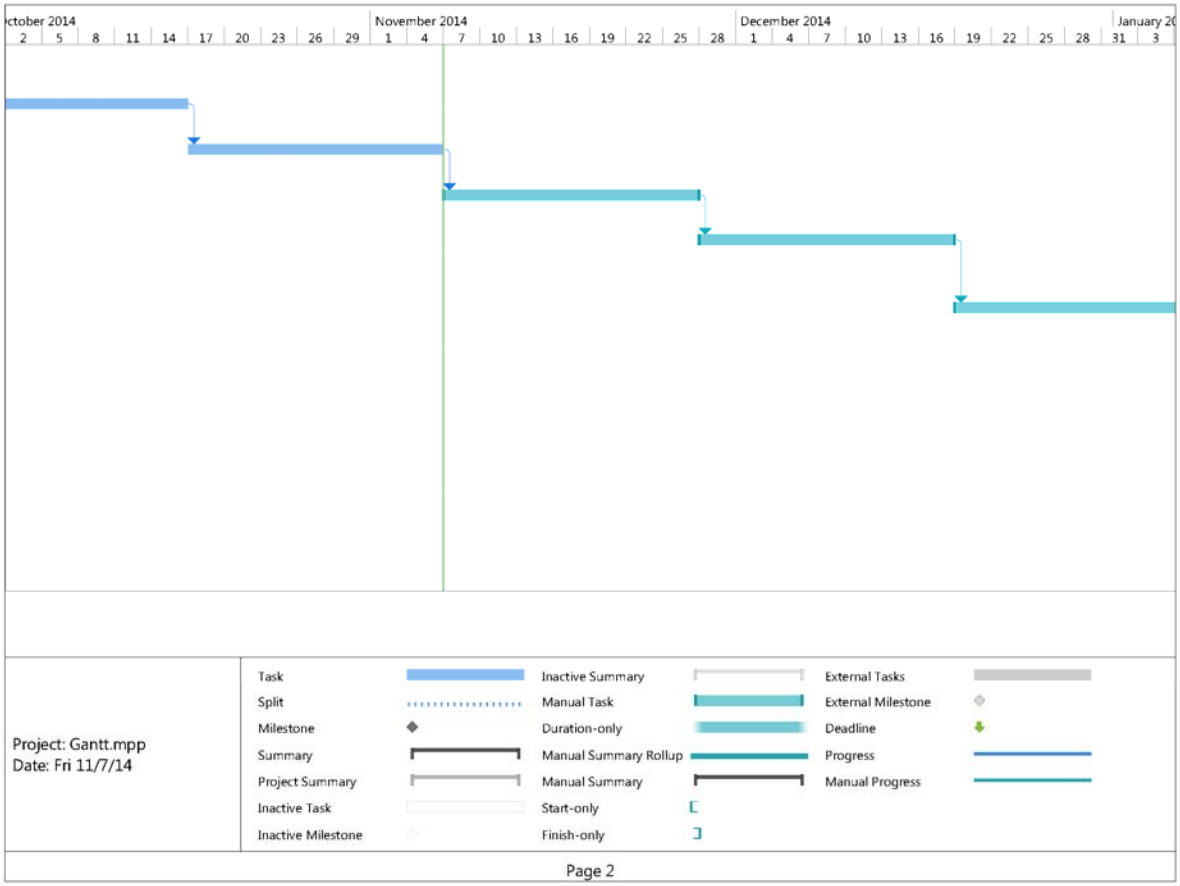
Technical Challenges and Limitations

Though thin-client solutions are great tools for administrators, they are not perfect. Some graphic-intensive applications do not run properly in a virtual environment because they are either not compatible with vGPU, or they need access to direct hardware. In some instances, applications simply refuse to virtualize because the software developers used DRM, which is incompatible with thin-client environments. It is also important to realize that thin-clients connected across the internet will need enough bandwidth to create a desktop-like experience. This requirement also applies to local area networks. This issue requires an user to analyze their current network's capabilities, which could in some instances lead to necessary upgrades.

Gantt Charts



ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		Research project ideas	72 hrs	Mon 9/15/14	Thu 9/25/14		
2		Start research project	120 hrs	Fri 9/26/14	Thu 10/16/14	1	
3		Analyze Licensing cost	120 hrs	Fri 10/17/14	Thu 11/6/14	2	
4		Find hosting solution	120 hrs	Fri 11/7/14	Thu 11/27/14	3	
5		setup network infrastructure for clients	120 hrs	Fri 11/28/14	Thu 12/18/14	4	
6		Find Client Solution	120 hrs	Fri 12/19/14	Thu 1/8/15	5	
7		Find Client Software solution for hardware	120 hrs	Fri 1/9/15	Thu 1/29/15	6	
8		Test phase	120 hrs	Fri 1/30/15	Thu 2/19/15	7	
9		Fix bugs	120 hrs	Fri 2/20/15	Thu 3/12/15	8	
10		Test phase	120 hrs	Fri 3/13/15	Thu 4/2/15	9	
11		Final product	1 hr	Fri 4/3/15	Fri 4/3/15	10	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November 2014
December 2014
January 20
2 5 8 11 14 17 20 23 26 29 1 4 7 10 13 16 19 22 25 28 1 4 7 10 13 16 19 22 25 28 31 3
Project: Gantt.mpp
Date: Fri 11/7/14
Task
Split
Milestone
Summary
Project Summary
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
External Tasks
External Milestone
Deadline
Progress
Manual Progress
Page 2

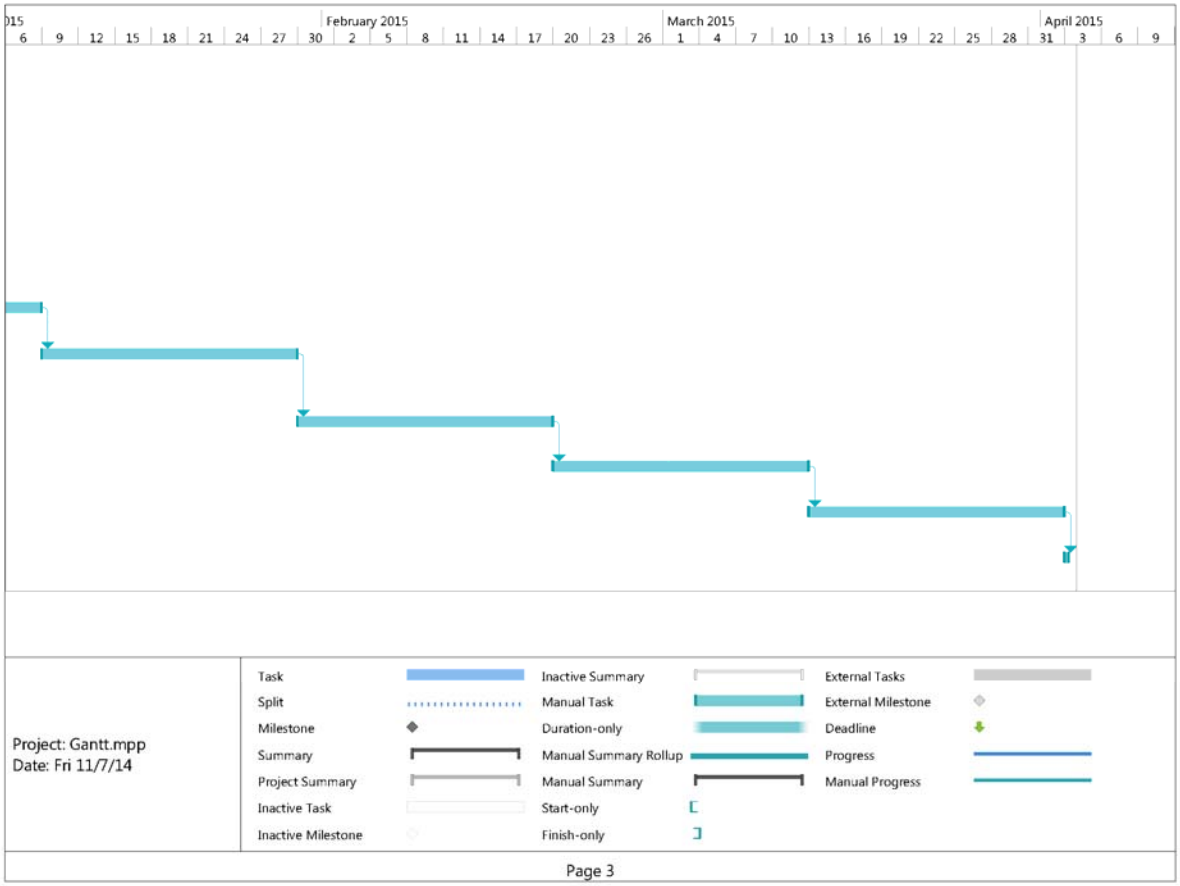

Figure 4: Timeline

Testing

The function of this project will be tested manually by creating an administrator and an user account to verify that the tasks are indeed possible. In a production environment, administrators log in as both themselves and as test users to check for potential issues on a daily basis. The IT department should also allow their users to provide negative feedback when an issue arises.

Test	Role	Result
Create User	Admin	Positive
Delete User	Admin	Positive
Create Group	Admin	Positive
Create VDI Desktop for Users	Admin	Positive
Create Terminal service pools	Admin	Positive
Deploy Application to users	Admin	Positive
Set application to specific groups	Admin	Positive
Access VDI Desktop	User	Positive
Access TS Desktop	User	Positive
Access Personal Files	User	Positive
Personal VDI Session	User	Positive

Table 3: Test Results

Conclusion

While thin-clients are great solutions for administrators, they are often expensive. The licensing and hardware costs can be prohibitive. However, with the use of open source software and more affordable hardware, thin-clients can quickly become an attractive option to many administrators. The centralized management of thin clients provides a simplified process of client management and security. With the use of Linux and standardized hardware, I was able to create a more affordable client that can be used, updated, and customized by organizations. The implementation of thin clients can increase compliance and security, which results in a safer and more productive workplace.

Work Cited

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