DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY TRAINING AND DOCTRINE COMMAND
950 JEFFERSON AVENUE
FORT EUSTIS, VIRGINIA 23604-5700

REPLY TO
ATTENTION OF

18 MAR 2014

ATIM-OP

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: United States Army Training and Doctrine Command (TRADOC) Thin Client Computing Deployment Guidance

1. References:

a. Memorandum, HQDA, CIO, 15 Nov 2010, subject: Army Thin Client Computing Guidance.

b. AR 25-1 (Army Information Technology), 25 June 2013.

2. The enclosed TRADOC Thin Client Implementation Guide provides TRADOC commanders planning guidance for deploying thin client virtual desktop capabilities. The guide encompasses the experience of multiple TRADOC agencies and provides essential planning factors when acquiring, deploying, and operating thin client technology.

3. When deployed properly, thin client technology provides commanders a reliable, efficient, and secure means of managing critical computing systems, applications, and data. Thin client technology also provides commanders a flexible computing option for executing remote access teleworking, life cycle management, disaster recovery, and insider and outsider cyber threat protection. In all cases, commanders must execute a thorough cost benefit analysis prior to deploying thin client technology.

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Encl

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Chief of Staff

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SUBJECT: United States Army Training and Doctrine Command (TRADOC) Thin Client Computing Deployment Guidance

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United States Army Training and Doctrine Command

(TRADOC)

Thin Client Implementation Guide

Version 1.0

(20 January 2014)

Table of Contents

1. Executive Summary

a. The purpose of this document is to provide Army leaders with guidance on key factors to consider when deploying Thin Client technology. Thin Client technology has been employed both in the industry and across parts of the Department of Defense (DoD) over the last 5 to 10 years. The United States Army Training and Doctrine Command (TRADOC) have employed Thin Client technology in various configurations over the past five years for both training and administrative (command and staff function) purposes in multiple commands and employs a mixture of both Thin Client and Zero Client technology. Both variants minimize computing power, storage, and applications housed locally on user desktops by centralizing these features on backend servers located in organization data centers, in effect making the user's terminal similar to dumb terminals used during the 1970's and 80's with IBM mainframe popularity.

b. Thin Client systems differ from Zero Client systems by the amount of computing power located at the user's desktop device. These devices have embedded operating systems in the user terminal which still require some technical management and systems maintenance on the desktop device. Zero Client implementations are very small footprint devices with no embedded operating system, processing, storage, or software on the desktop device. DoD and Army Information Technology (IT) strategies include implementing these technologies as a means of defending against insider and external cyber threats, deploying protected mobile computing capabilities, extending desktop/laptop life-cycles and reducing end-user desktop technician manpower requirements. TRADOC has implemented Thin or Zero Client technology across multiple Commands to include TRADOC Headquarters, CAC, ICOE, Aviation Center of Excellence, and USASMA, with varied results based on implementation and use.

c. TRADOC has garnered many lessons learned based on its various TRADOC implementations of thin client. The technology has fared well in homogeneous and standard client (user) environments such as training environments and on SIPRNET; however, in heterogeneous or mixed client production environments, such as headquarters and command and staff elements, results have varied with early implementations failing and later implementations becoming more improved and more reliable over time as the technology has matured and added investments have been made to upgrade infrastructure.

d. When employed properly, Thin Client technologies provide reliable, secure, and flexible computing environments. Key considerations that Commands must consider prior to any implementation include a 5-year investment strategy, significant upfront investment, robust network infrastructure, advanced technical skill expertise, remote access/telework requirements, effective strategic communications strategy, and leadership support. In all cases, a sound cost benefit analysis must be conducted prior to any thin client implementation.

2. Introduction

a. A Commander's mission requirements should help guide an organization's implemented computing environment solution. Coupled with higher headquarters IT strategy and other variables, mission requirements should help a Commander determine the optimal computing environment for the organization. The computing solution which has been implemented in some TRADOC commands and drawn increasing interest in recent years is Thin Client technology. TRADOC computing implementations have varied from pure traditional Client server/personal computer PC-based (thick client), to pure Thin Client-based to hybrid (mixed) solutions. As with most technologies, Thin Client technology has limitations that make it not a good fit for all organizations; however, when implemented and managed correctly, it can perform as well as (if not better than) its thick client counterpart – with the added benefits of better configuration management and stronger security against insider and outsider cyber threats.

b. This document provides Army leaders' guidance on essential factors to consider when deploying Thin Client technology. The information provided is based upon multiple TRADOC operational implementations, Headquarters Army level guidance, and analyses provided by the United States Army Information Systems Engineering Command (USAISEC).

3. Background

a. Thin Client technology has been employed in both industry and across parts of the Department of Defense over the last 5 to 10 years. The United States Army Training and Doctrine Command (TRADOC) has employed the technology in various configurations over the past five years for both training and administrative (command and staff function) purposes in multiple commands. TRADOC employs two variants of Thin Client technology – Thin Client and Zero Client. Both variants minimize computing power, storage, and applications housed locally on user desktops by centralizing these features on backend servers located in organization data centers.

b. Thin Client systems differ from Zero Client systems by the amount of computing power at the user's desktop device. These devices have embedded operating systems in the user terminal which still require some technical management and systems maintenance on the desktop device. Zero Client implementations are very small footprint devices with no embedded operating system, processing, storage, or software on the desktop device. DoD and Army IT strategies include implementing these technologies as a means of defending against insider and external cyber threats, deploying protected mobile computing capabilities, extending desktop/laptop life-cycles, and reducing end-user desktop technician manpower requirements.

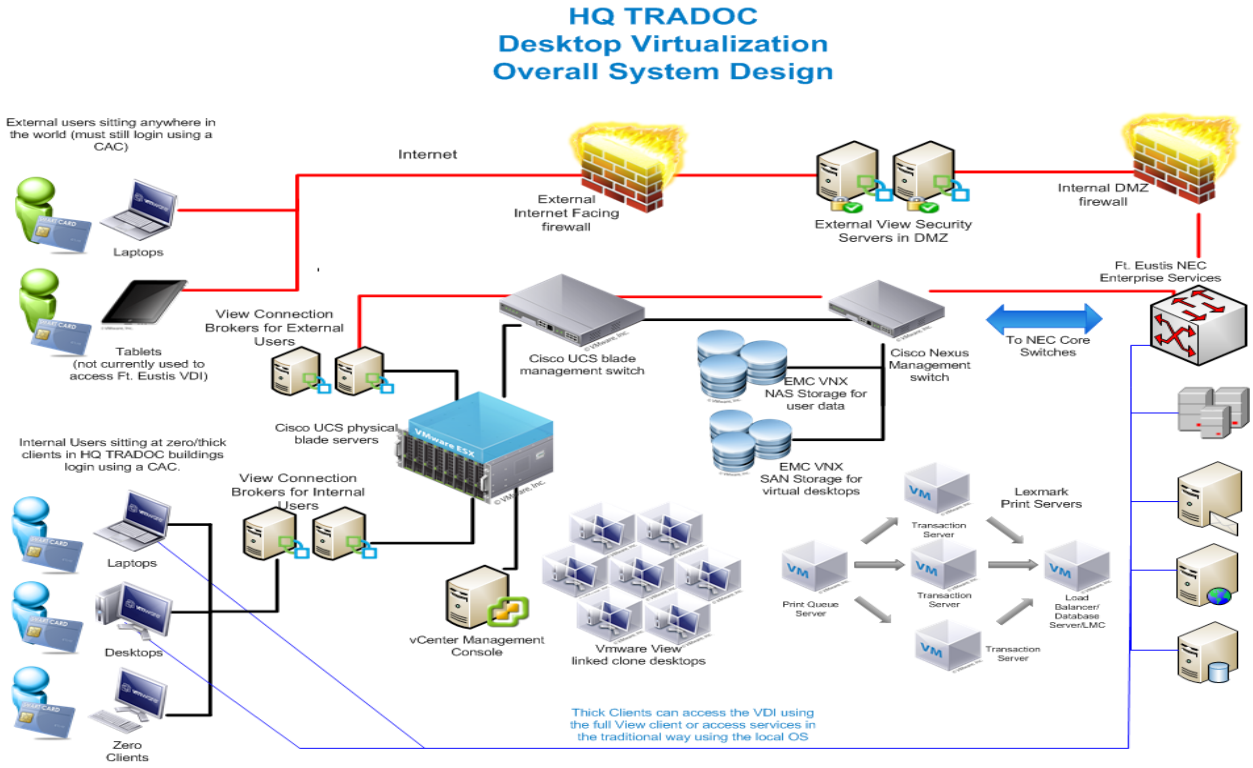
c. TRADOC has invested in Thin or Zero Client technology across multiple Commands to include TRADOC Headquarters, CAC, ICOE, Aviation Center of Excellence, and the United States Sergeants Major Academy. Experiences have varied based on implementation, use, and technical maturity. The information below provides Thin Client findings and lessons learned based on TRADOC's experiences.

4. TRADOC Deployments

a. TRADOC has implemented Thin Client technology on NIPRNET and SIPRNET in both training and operational headquarters and staff. Funding has come from a mixture of sources. Summarized below are the primary Thin Client implementations that have been deployed across multiple TRADOC organizations in different configurations on multiple installations.

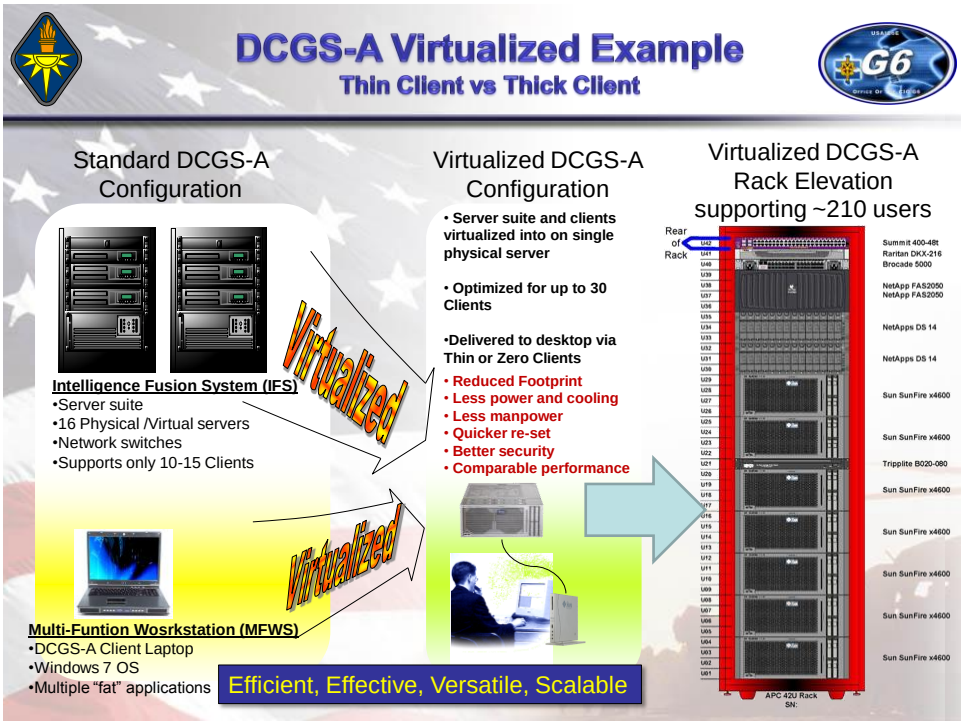
4.1 TRADOC Headquarters (Fort Eustis, VA)

In the case of Headquarters, TRADOC, an upfront Thin Client infrastructure investment was made as part of its Base Realignment Closure (BRAC) funding whereas in the case of other TRADOC subordinate commands, upfront investments were taken out of hide using a combination of Other Procurement, Army (OPA) and Operation and Maintenance (OMA) funds. The Headquarters backend infrastructure consists of Cisco servers running VMWare software with an EMC Storage Area Networks (SAN). The end user devices are ClearCube "Zero Client" devices. Currently, there are approximately 150 users on NIPRNET and 360 users on SIPRNET.



4.2 ICOE (Fort Huachuca, AZ)

The ICOE is the earliest and largest adopter of Thin/Zero Client technology in TRADOC, beginning use of the technology in early 2000. Their Thin/Zero Client implementation has evolved significantly over the past 14 years. Current backend infrastructure consists of a combination of SunFire, Cisco, IBM, and Nutanix servers running VMWare View software and NetApp SAN arrays for both unclassified and classified operations. The end user devices are a combination of Wyse P20/P25 Zero Client devices and SunRay 1/1G, SunRay 2/2FS, and SunRay 3 Thin Client devices. Thin client is used primarily in training classrooms and for select SIPR, JWICS, and NSANET Office automation supporting approximately 9500 seats across approximately 300 classrooms and office locations. The ICOE solution was resourced from mission funds. Depicted below is an example of how ICOE has been able to leverage the advantages of Thin Client technology to support their training.



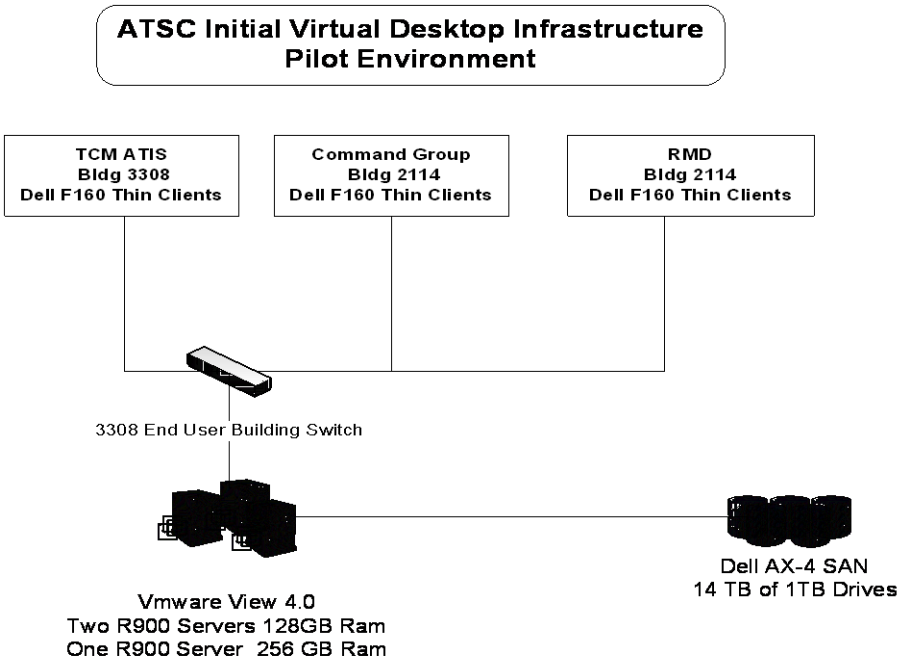
4.3 CAC (Fort Leavenworth, KS)

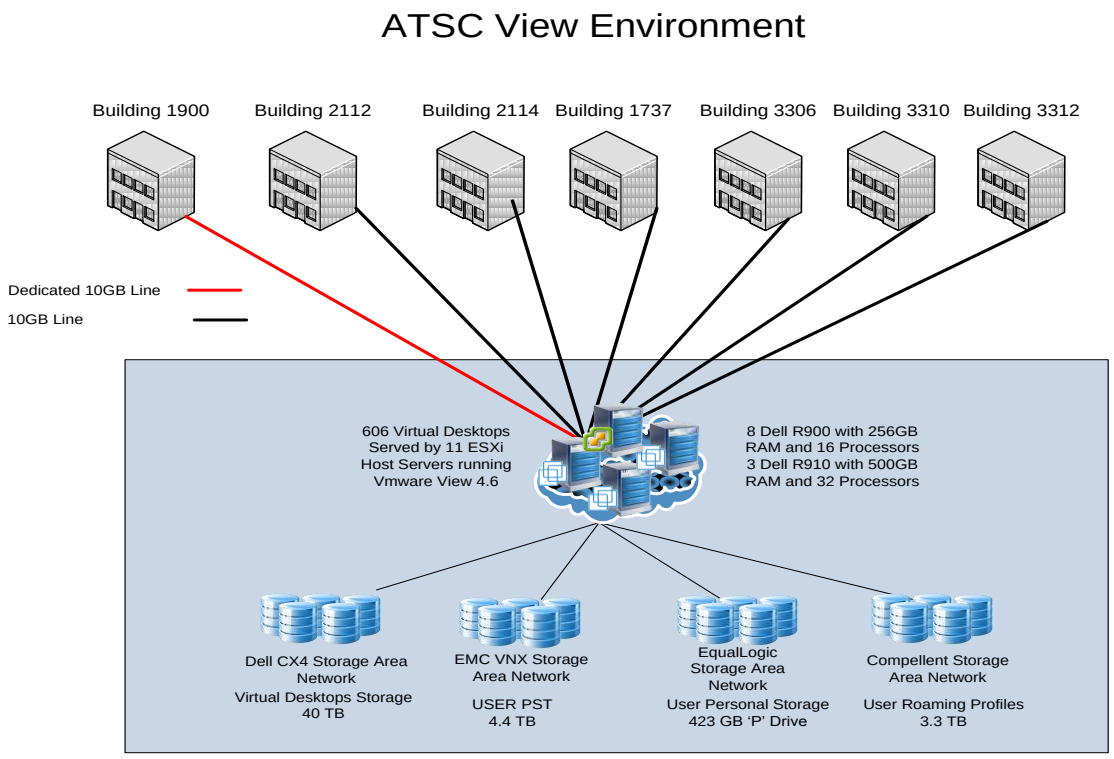
The CAC headquarters was one of the early adopters of Thin Client technology; implementing the technology when it was less mature and required skilled expertise was not as readily available. They do not currently have an operational Thin Client environment. Over the last six years, several attempts were made to install different variations of thin client infrastructure but none functioned adequately enough to declare

success. Additionally, a cost benefit assessment performed by USAISEC for the command ultimately assessed that the cost to CAC outweighed the benefit of further implementation.

4.4 Army Training Support Center/ATSC (Fort Eustis, VA)

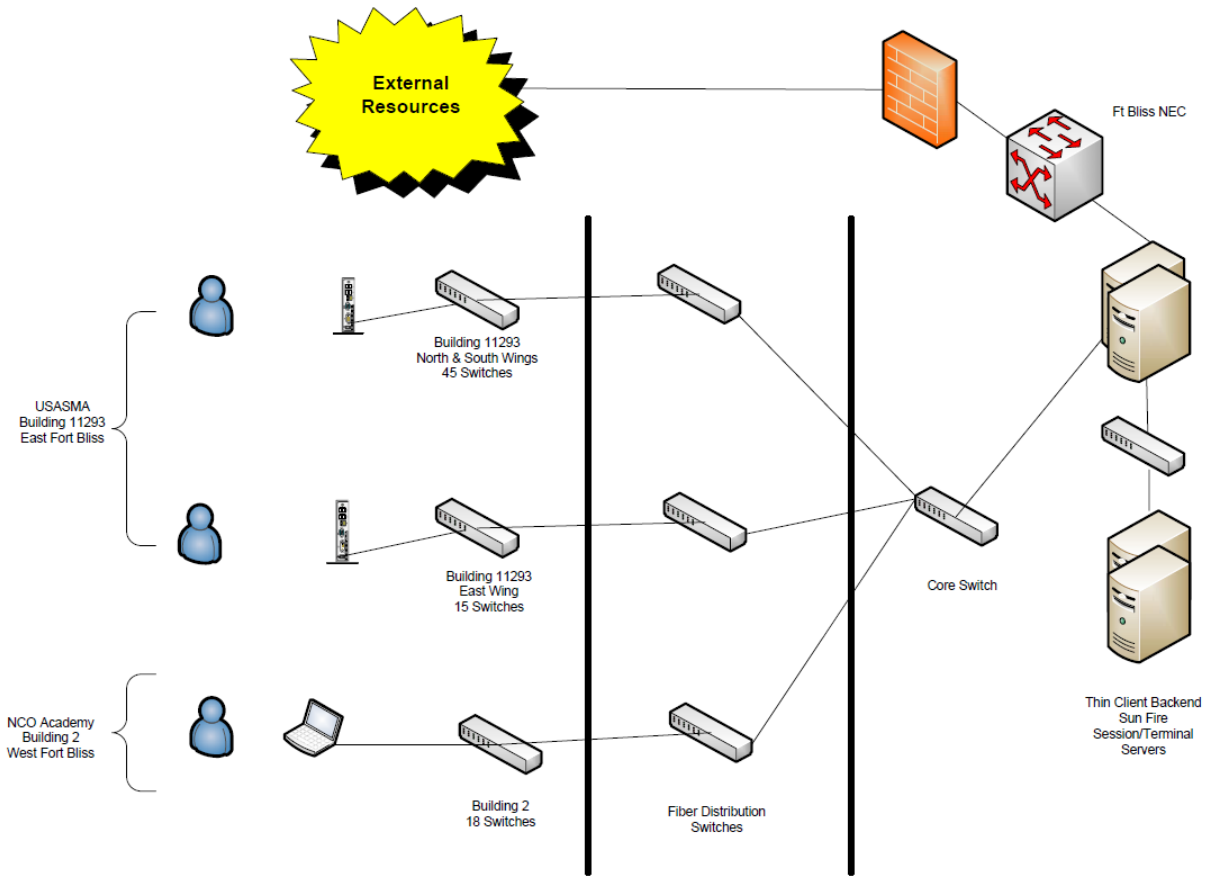
The backend infrastructure of ATSC's thin client environment consists of Dell servers running VMWare software with Dell CX4, EMC VNX, EqualLogic, and Compellent SANs. The end user devices are Dell F160 Zero Client devices. The ATSC solution has approximately 550 users who largely perform standard command and staff functions. The solution was resourced solely from mission funds. It is an unclassified system. ATSC began their deployment with a 3-month pilot in 2009 consisting of 60 users.





4.5 USASMA (Fort Bliss, TX)

The USASMA backend infrastructure consists of Sun Servers running Solaris 10 software and SunRay edge devices for the users. The Thin Client environment supports all of the Sergeant Majors courses (resident and non-resident), two digital training rooms, and three staff and faculty development classrooms. The solution was resourced solely from mission funds. It is an unclassified system.



5. Deployment and Implementation Considerations

In 2010**,** the Army Chief Information Officer (CIO)/G-6 office issued guidance recommending commanders execute a Thin Client mission analysis, conduct a sound cost-benefit analysis, review authoritative Thin Client technical documentation, and clearly define stakeholder roles and responsibilities to support decisionmaking related to implementing Thin Client technology. This assessment is consistent with TRADOC's findings. In particular, Commanders should evaluate their IT spending plans for traditional personal computer (PC) workstation and server replacements, and procurements in order to ensure life-cycle technology replacement investments adequately support initial deployment requirements of Thin Client infrastructure and devices. Based on TRADOC's experience, other essential considerations are highlighted below.

5.1 Funding

a. Funding is typically a top consideration in most organizations when deploying Thin Client technology. Funding considerations include:

- The Funding Requirement (above baseline service vs. baseline service)
- The Source of Funding (mission funded or other)
- The Type of Funding Appropriation (OMA, OPA, RDT&E)

b. Without the support of a validated requirement and approved programmed funding at either the Department of the Army, major headquarters, or subordinate command level, commands may find it difficult to invest the resources required to implement Thin Client technology. Thin Client technology is currently considered an "above-baseline" IT service capability since it is not one of the standard C4IM services provided by NETCOM. As a result, commands must fund Thin Client implementations using mission funds. This must be an essential planning factor. As of the writing of this guidance document, the Department of the Army CIO/G-6 office removed all Program Objective Memorandum (POM) requirements for Enterprise Thin Client, but is investigating the possibility of adding Thin Client to all new building construction as part of the normal Military construction (MILCON) information technology tails. Until there is Army-level support for Program Managed-fielded Thin Client, commands must continue to implement and operate out of mission funds.

c. The contract funding appropriation category is another key area of consideration for Thin Client. To reduce the likelihood of Anti-Deficiency Act violations, Commanders must carefully assess which category of funding appropriation (Operation and Maintenance - OPA, Army, Other Procurement, Army – OPA, or Research, Development, Test, and Evaluation - RDT&E) they will apply toward contracting Thin Client implementations as this has been an area in the past where some have encountered problems. In accordance with DFAS Manual 37-100, Thin Client implementations that exceed $250,000 in total cost, OPA funds must be used for initial purchase. Clearly defining what constitutes the "total Thin Client system" is an extremely important factor in determining which funding appropriation category an organization is authorized to apply against its Thin Client investment. This must also be taken into account as commands execute recurring life-cycle replacements. In Thin Client environments, the "system" will normally consist of all infrastructure from the backend server environment to the user terminal, typically resulting in a requirement for OPA dollars. With traditional thick client environments, the "system" can be segregated into server, network, and user terminal buys, thereby making it easier to expend OMA funds vice OPA. It is essential that leaders take this into account prior to executing thin client contracts. Failure to do so can result in Anti-Deficiency Act violations. Leaders must take necessary actions to obtain OPA funding for thin client implementations where required.

5.2 Site Analysis and Engineering

Thin client implementations must be well designed from the early stages and designed with growth, scalability, and redundancy in mind. An improperly engineered Thin Client architecture can result in poor performance and reliability such as choppy streaming media and audio, slow application response or network failures. The core computing infrastructure is the key to success (network, servers, storage). An in-depth facility/site survey should be conducted during the design phase to ensure sufficient

resources are available to support the architecture, including server room physical space, power, and cooling. Executing this phase correctly will prove essential to introducing a positive user experience. In all cases across TRADOC implementations, additional infrastructure was added after implementation in order to improve system performance and user experiences. The Site Analysis and Engineering design team should consist of at minimum server, network, and storage subject matter experts.

5.3 Development and Testing

a. Prior to deploying Thin Client technology, Commands should establish a developmental solution in the actual environment before implementing the production solution and migrating users. The TRADOC G-6 office recommends at minimum 3 months development and testing prior to going to production. Although the TRADOC headquarters solution was stood-up in the contractor's lab environment prior to deployment, the contractor's lab doesn't capture all the nuances of operating on the operational DoD network.

b. There have been instances in the past where an organization has used different models (types) of end users devices in their Thin Client implementation. System Administrators should save models from each type of Thin Client implementation to run compatibility tests against to ensure compatibility before deployment. Although few issues arise from different models, keeping unique models to a minimum helps keep the workload to a minimum.

5.4 Technical Skill Requirements

Thin Client technology requires expanded technical skill sets for system administration. The TRADOC headquarters pilot quickly showed the critical need for competent technical support with the proper skill sets to support a virtualized client environment. These skill sets must include knowledge of virtual desktop infrastructure administration, application management and virtualization, and storage management.

5.5 Infrastructure Requirements

An organization's customer perception and user experience with Thin Client will be heavily dependent upon the quality of its infrastructure, in particular the implementation of its virtual clients, servers, and SAN virtual infrastructure. It is critical that these elements and infrastructure scalability be designed and engineered properly up front. TRADOC has found the VMWare Virtual Desktop Infrastructure (VDI) solution to be a reliable virtual Thin Client environment solution. Key infrastructure considerations are highlighted below.

5.5.1 Network Implementation

One of the most important planning considerations in implementing Thin Client technology is the network. The network in itself represents a "single point of failure" vulnerability in Thin Client implementations. If the network fails, so do the virtually connected user sessions – similar to what would happen if the IBM mainframe crashed when mainframes were prominent in the past. However, if implemented and managed properly, the risk of such failure can be significantly minimized and be commensurate with that of Thick Client environments. In all cases, a reliable operational network is essential for Thin Client deployments. If the network fails, users will be unable to continue performing basic stand-alone tasks (word processing, e-mail, etc.) at their individual workstations. In contrast, with thick client environments, it may be possible to still perform stand-alone system tasks – depending upon where the application and data being worked is hosted. Thick Client systems; however, are more susceptible to experiencing irrecoverable data issues when a system crashes at the user end. Ultimately, planning considerations must account for maintaining robust redundant network and server backend infrastructure as this will greatly enhance performance. This must be taken into account when considering the Thin Client investment.

5.5.2 Server Implementation

Careful planning is required for server-side scalability as each additional Thin Client and application will be a drain on the overall system (i.e., computing power and storage capability). As a result, a well designed backend system with sufficient processing power and storage is critical. This element alone will make or break the user acceptance of VDI client implementation. Careful planning and consideration must be put into the design of the back end systems support of any VDI.

5.5.3 Virtual Storage Area Network

a. With no internal hard disk or other storage capability, Thin Client end-user terminal devices do not provide storage for user data; data is stored on shared network drives. Organizations and users that currently rely on thick client system hard drives for data storage will be expected to migrate data to centralized storage devices to provide this function. Proper planning and design of the storage environment is just as vitally important as the backend infrastructure planning/configuration.

b. During the ATSC pilot, the initial data storage configuration did not affect performance or indicate any issues; however, during expansion, indications of system latency began to appear. Problems continued to increase as more users were added, creating periods of near system shutdown. The final diagnosis of this issue was determined to be data store design. As configured, the data stores were unable to handle the increase in number and volume of user E-mail Personal Storage Table

(PST) files. PST files act as individual databases within the virtual environment. Some individual user PST files were as large as 14 Gigabytes (GB). Other users had multiple PSTs files - some in excess of ten. These substantial PSTs negatively impacted system performance as they were being accessed by the users through Microsoft.

c. Outlook. A partial solution involved initiating an educational/technical campaign to have users perform file maintenance, reduce large PST file sizes, limit PST files to 2 GB in individual size and have no more than four active PST files connected to Outlook at once. Additionally, redesign of the storage backend area was made to separate user files, Desktop images, and PST files. This storage separation along with proper file management techniques greatly improved system performance. The redesign ensured user's files were separated from the virtual machines, thus enabling quick recovery of users systems without lost of user data, unlike on standard PCs.

5.5.4 Virtual Client (Desktop) Implementation

It is critical to devise the desktop user view environment around the essentials of what the user base needs to perform its mission. Desktop clients should be built by minimizing the number of different desktop configurations, ensuring that all desktops are based off a default approved Army Gold Master (AGM) Image and set up in image group pools. This strategy permits quicker system maintenance and updates. It is important to the greatest extent possible that unique applications such as Microsoft Visio and Project get added to an individual user desktop profile as application virtualization solutions or "ThinApp" VMWare application virtualization solution. A ThinApp is an application that has been packaged into a self-contained windows executable file which can be run from any windows computer without the need to install the application on that computer. ThinApp applications can be run from virtually any file system - no installation is required. This will allow a reduction in the number of licenses required and an increase in the ability to share as needed between users when not in use.

5.6 Peripherals

Peripherals commonly available on Thick Clients (i.e., DVDs, CD-ROMs, digital scanners, etc.) must be provided separately as standalone units with a more limited access. For example, at TRADOC Headquarters, a Thick Client NIPRNET kiosk was placed in selective locations to provide users access to these peripheral devices, if required.

5.7 Applications

a. Some applications are not well suited for Thin Client technology. Standard applications such as word processing, e-mail, etc. generally work well with Thin Client technologies; however, customized applications, which may have been developed specifically to support a unique mission function such as finance or logistics, must be closely analyzed and tested since they may require unique application interface and data requirements. Thin Client issues may occur more with customized applications vice standard applications such as Microsoft Office products. Because of this, there may be requirements in an organization that dictate who receives a Thin Client system and who does not solely based on the uniqueness of the application environment as some applications may not run well remotely on servers or via virtual desktops. Unique examples include imagery exploitation, full-motion video, gaming, and 3D/HD graphics that require onboard hardware acceleration. This may foster the need for hybrid implementations vice pure Thin Client implementations, or as an alternative, include 3D hardware graphics acceleration as part of the backend design, taking advantage of new technologies available to do this. Consideration must be taken to cost, as these enhancements will increase the cost of the overall system.

b. Organization “power users” may require Thick Client systems for legacy applications that are not compatible with a particular Thin Client implementation; although, in a server-based computing environment, enterprise standard services, supplied to a Thin Client, may also be delivered to a Thick Client on the same network. In both cases, the analysis, design, and implementation teams must execute a thorough applications analysis and execute thorough testing before determining whether or not to virtualize (or thin-app) a specific application. A sound back-out plan must also be planned in the event it is determined that an application ultimately doesn’t work well with Thin Client after full implementation.

5.8 User Migration

a. Extremely careful planning and consideration must be given toward determining who in the organization Thin Client should be deployed to. Individuals considered VIPs, senior leaders, their immediate staffs and personnel working unique functions or working in high-throughput no-fail environments are not likely good candidates. A thorough user survey is essential up front. Reserve implementation for general purpose users whose operations are not critical to the organization and who do not depend upon customized applications to execute their daily mission.

b. Document and thoroughly vet the physical migration procedures from Thick to Thin client. Ensure the procedures capture all the capabilities a user had prior to migration and once the migration is complete the user has the same capabilities. This will prevent piecemeal migration and in effect provide a more productive one-stop-shop.

5.9 Remote Access and Teleworking

As Thin Client technology has continued to mature, an added capability has been support for remote access and teleworking. When implemented correctly, Thin Client solutions can provide a powerful, more efficient remote access/teleworking capability than virtual private networking (VPN) remote access solutions. Organizations should plan for this capability up front during the analysis process. The initial implementation of Thin Client at Headquarters, TRADOC did not have a remote access solution simply because the technology was not readily available nor very mature at the time. As a result, the continued migration of Thick Client users to Thin Client was temporarily paused. A subsequent contract was eventually awarded providing a remote solution using security servers and VMWare View software. Remote access for frequent travelers and teleworkers is now fully operational and is designed to support 25 percent of the headquarters at any given time. A powerful benefit of the Thin Client remote access capability is that it enables the user to access his or her personal office desktop environment from remote or travel locations away from the office.

5.10 Operational Environment

Optimal operational environments for Thin Client technology are environments with consistent and standard end-user application configurations (common work tasks, standard desktop applications, etc.). Standard classroom training environments running standard applications would be an example of an optimal environment. For example, in training environments such as ICOE and USASMA, where the user desktop configurations are consistent classroom environments, Thin Client encountered fewer obstacles. Also, in a low density user population (500) yet fairly standardized production environment such as ATSC, Thin Client has also fared well. In contrast, environments where there are many different types of customized applications or which require processor or graphics intense applications (such as higher end software development tools) or above normal network demand, performance will likely be mixed. For example, in Headquarters, TRADOC where there is a mixture of higher demand customized user applications in addition to standard applications, the experience is more varied, thus calling for a hybrid mixed Thin Client/Thick Client environment. In Headquarters, TRADOC, once adequate infrastructure was put in place, technicians gained more experience and better tactics, techniques, and procedures were implemented, the experience improved. In training environments with more consistent desktop configurations, Thin Client becomes a more obvious fit.

6. Costs vs. Benefits

a. As referenced in Army CIO/G-6 guidance published in 2010, Thin Client technology benefits include the following:

- Reduced touch labor and administration costs

- Reduced risk of physical data compromise
- Reduced life-cycle costs
- Reduced software license management
- Reduced power consumption

Thin Client limitations include:

- Less computing power
- Single point of failure without a continuity of operations plan
- Application/peripheral limitations
- Specialized expertise

b. TRADOC's Thin Client analysis showed consistent benefits and limitations with the above. TRADOC would also add remote access as an additional benefit, but list costs as a disadvantage with Thin Client implementations. TRADOC's experience indicates that it is very difficult to measure cost as a clear benefit of Thin Client. While the front end user terminals will be cheaper than Thick Client terminals, the cost of the extensive backend infrastructure may make the dollar investment in these environments 20-40 percent higher than traditional pure Thick Client environments. This can result in making a difficult business case for some leaders.

c. Ultimately each command must seriously weigh both pros and cons relative to their specific mission, customer base and resourcing ability. The USAISEC Cost Benefit Analysis prepared for the CAC acknowledged that the benefits of a Thin Client implementation should not be measured in terms of upfront investment dollars alone. The study states "recent SIPRNet security spillages have resulted in tremendous damage to the United States; but, it is impossible to quantify the cost of these types of spillages." The cost of the required backend server requirements, redundant network infrastructure, and advanced skill sets required to manage the systems could alone eliminate Thin Client as an option if solely viewed in terms of upfront investment. This investment should be but one of the criteria. Other criteria considerations should include:

- Mission need
- Life-cycle costs
- Desktop technician cost

- Security environment
- Data/Network Security impact
- User function profile (VIPs, High-production, Graphics Artists, etc.)

d. Given above, the TRADOC G-6 office recommends commands go into any Thin Client implementation with at a minimum 5-year life-cycle strategy in mind in contrast to a typical 2 to 3 year life-cycle strategy of a Thick Client environment.

e. In the Headquarters, TRADOC implementation, the many hours once required to physically touch systems to apply, correct, or update user PCs security patches have been reduced down to only Kiosk, test, and other standalone PCs. VDI devices are updated remotely and mostly in pools at one time. It has also reduced hours for migration from versions of software to new versions through image management allowing multiples to be done at same time rather than individually. As an example, when converting from Vista to Windows 7, it normally would have taken a 4-month phased-in period to convert all 500+ user PCs to the new Operating System. This process would take users offline for a period of time and users would be required to complete a pre-conversion process affecting their data files. With VDI, all was recomposed and the entire process completed over the weekend. Over 500 users logged off their VDI Client on a Friday and returned on Monday to a new operating system without any further actions on their part. Life Cycle of desktops/VDI devices have been extended as well. Normally with physical PCs, the headquarters would have already gone through nearly two replacement cycles of Desktops. Additionally, the cost of Zero Clients is half the cost of standard PCs. It should also be noted that Thin Client implementations are also less prone to device driver peculiarities and operating system patch differences than are their thick client counterparts.

f. In CAC's final implementation, after considering all factors (and incurring some performance issues), CAC ultimately determined that Thin Client was not worth the investment for their environment from both a cost and performance perspective. The USAISEC study states "the increased mission benefit of operational security did not out way [outweigh] the negative return on investment (ROI) as seen in this 5-year life-cycle cost benefits analysis." USASMA, ATSC, and ICOE on the other hand have had success with their Thin Client environments.

7. Recommendations

The following is a summary of key recommendations that must be considered prior to implementing Thin Client technologies within any Command:

- Execute a thorough cost-benefit analysis. Include key stakeholders to include the Command G-6, Information Management Officers, supporting NEC/ NETCOM personnel, system and network engineers, user representation, required contract personnel.

- Develop a thorough strategic/command communications and training and education plan.

- Determine acceptable candidates through surveys and personal interviews. Reserve implementation for general purpose users whose operations are not critical to the organization and who do not depend upon customized applications to execute their daily mission.

- Weigh the requirement for higher cost specialized skill personnel against the cost for lower cost touch labor personnel.

- Plan for a robust (and potentially more expensive) backend server and network environment.

- Develop a sound Continuity of Operations Plan (COOP).

- Assess the security environment and information/network cyber security needs of the organization.

- Assess higher level strategic planning and funding guidance for programming and budgeting purposes.

- Plan for scalability of the network, server, and user terminal footprint.

- Conduct a thorough applications analysis. Plan for extensive applications testing of standard and customized applications.

- Determine which configuration best suits the organization – pure Thin Client, pure Thick Client, or hybrid.

8. Conclusion

a. Through an extensive series of surveys, operational implementations, in-person interviews, site visits, and personal experiences, the TRADOC G-6 office has garnered many lessons learned pertaining to Thin Client technology. Overall, TRADOC's experience has netted mixed results with the overall Thin Client experience being more positive than negative. In all cases, Commands encountered less than positive results with their initial infrastructure implementations as the infrastructure was either insufficient or not optimally configured to the particular work environment. In all cases,

significant upfront cost and funding ability was a key factor. The technology has fared well in consistent homogeneous client-station environments such as training environments and on SIPRNET; however, in production environments, such as headquarters and command and staff elements, results have varied with earlier implementations failing and later implementations becoming more improved and more reliable over time as the technology has matured and added investments have been made to upgrade infrastructure.

b. The implementation of Thin Client architecture is consistent with Department of the Army strategic objectives for reducing of overall IT operating costs while strengthening overall DoD network security posture. When deployed and resourced properly, Thin Client technologies provide reliable, secure, and flexible computing environments that perform just as well as many thick client environments, depending upon the operational environment. From a resourcing perspective, Army CIO/G-6 efforts to validate Thin Client as a SIPRNET requirement and gain funding approval should weigh into Command implementation plans. In all cases, it is essential that Commands execute a sound cost benefit analysis and execute a well thought-out strategic communications plan to gain leadership buy-in. Without doing so, implementing Thin Client technology would be high risk. Thin Client implementations can provide a reliable work environment and flexible telework capability while providing a much stronger defense against insider and outsider cyber security threats.

9. Appendices

A. Document Contact Organization

B. Acronyms and Abbreviations

C. References

Appendix A

Document Contact Organization

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Appendix B

Acronyms and Abbreviations

AGM	**Army Gold Master**
ATSC	**Army Training Support Center**
AVCOE	**Aviation Center of Excellence**
BRAC	**Base Realignment Closure**
CAC	**Combined Arms Center**
CD-ROM	**Compact Disk Read Only Memory**
COOP	**Continuity of Operations Plan**
DVD	**Digital Video Disks**
ICOE	**Intelligence Center of Excellence**
OMA	**Operation and Maintenance, Army**
OPA	**Other Procurement, Army**
NETCOM	**Network Enterprise Technology Command**
NIPRNET	**Non-Classified Internet Protocol Router Network**
PST	**Personal Storage Table**
RDT&E	**Research, Development, Test & Evaluation**
SAN	**Storage Area Network**
SIPRNET	**Secret Internet Protocol Router Network**
USAISEC	**United States Army Information Systems Engineering Command**
USASMA	**United States Army Sergeants Major Academy**
VDI	**Virtual Desktop Infrastructure**

Appendix C

References

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