Army Enterprise Thin Client Architecture Standardization for Army Small Computer Program (ASCP)

White Paper/Technical Overview

Army Enterprise Thin Client Architecture Standardization for Army Small Computer Program (ASCP)

Information Technology Enterprise Solutions – 2 Hardware
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1. Introduction

This White Paper is designed to support the Army Small Computer Program's (ASCP), Thin Client Architecture Standardization Program. Contained herein GTSI outline a solution based approach and subsequent methodologies around optimal thin client computing environment deployments to include hardware, software and resource requirements. GTSI is proposing an implementation methodology based on years of experience and adherence to industry proven best practices. Within this draft is outlined the approach, methodologies, materials needed to build a solution, and continued benefits of incorporating such a solution. Through our knowledge and experience this document will allow the Army an ease of use and secure application delivery mechanism while continuing to allow for secure, centralized administration of Army IT assets and tools.

1.1 Purpose

This document exists to provide architectural, materials, and project methodologies around thin-client deployments for the Department of the Army. Encapsulating the Army's requirements this document will cover thin client computing solutions around Microsoft terminal services and Citrix Presentation Server to include best practices, methodologies and scope.

1.2 Scope

GTSI is committed to providing the Army a robust and streamlined design and implementation solution around thin-client computing environments. The goal of the paper is to provide the Army with a secure, robust and an up-to-date computing environment capable of supporting external and internal user needs via thin-client architectures. By incorporating the latest technologies, both software and hardware, with proven methodologies for success the GTSI design will reduce the cost of procurement and operations thus resulting in optimal Return on Investment (ROI).

The Army currently utilizes a number of varying technologies but as per directive is standardizing on thin-client computing architectures unless it is deemed non-interoperable and therefore a traditional fat-client will be utilized. That stated, this paper demonstrates GTSI's capabilities around thin-client solutions design and implementations standards in this document and will provide recommendations as such. The scope around thin-client computing environment deployments will include:

- Research of current directory services, network and application environment;
- Gather and document business and technical requirements for thin-client needed solution;
- Review and understand current application environment, to include restricted access and needs;
- Create and document all necessary design requirements;
- Revise the directory services and security policy designs as needed;
- Incorporate a test laboratory environment will be used to test and validate load balancing and failover client / server environment;
- Test and validate the proposed technical solutions;

- Document test results and report on outcomes; and
- Document strategies and tactical steps needed to maintain, build, failover/failback and disaster recovery processes and procedures.

The end result will be that of a centralized thin-client solution capable of offering a reduction in administrative overhead, cost of operations, a quantified ROI and a reduced Total cost of Ownership (TCO).Our vision of a typical thin-client architecture is depicted below:

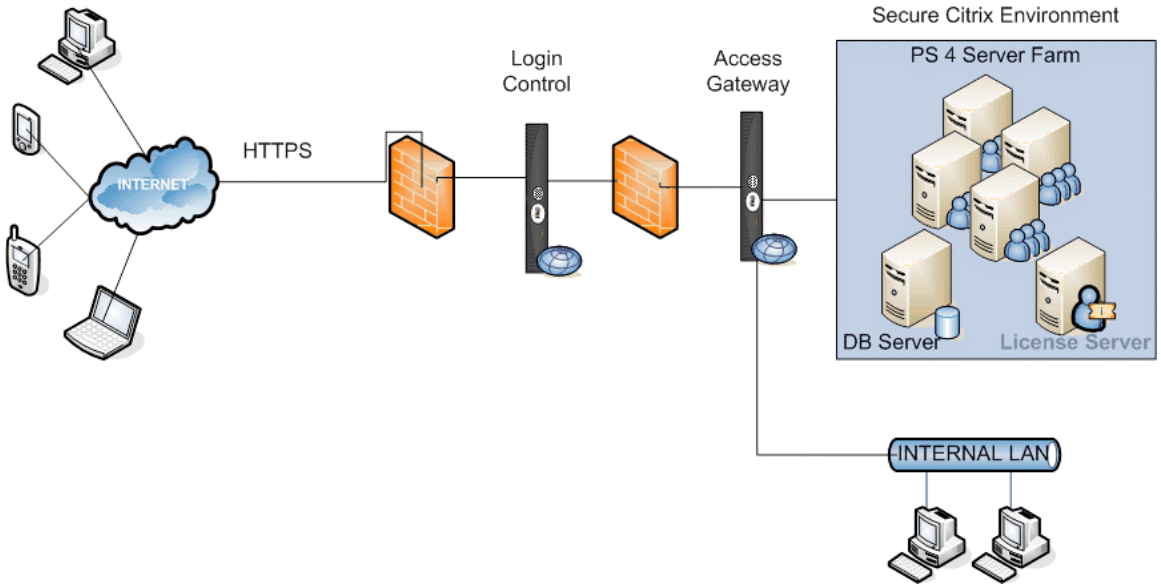

Figure 1: Depiction of Thin-Client Architecture

1.3 References

1. Memorandum, SAIS-IOM, Army Policy for use of the Army's Microsoft Enterprise License Agreement (ELA), 4 February 2004
2. NETCOM Technical Authority 2003-005c, Army Enterprise Desktop Standardization, 13 September 2006
3. Army Regulation (AR) 25-2, Information Assurance, 14 November 2003
4. DoD Directive 8500.1, Information Assurance, 24 October 2002
5. DoD Instruction 8500.2, Information Assurance (IA) Implementation, 6 February 2003
6. DoD 8570.01-M, Information Assurance Workforce Improvement Program, December 05
7. DoD Directive 8100.1, Global Grid (GIC) Overarching Policy, 19 September 2002
8. NSTISSI No. 7003, Protective Distribution Systems (PDS), 13 December 1996
9. Citrix Systems, Citrix Presentation Server 4.5 Overview, http://www.citrix.com

2. Background

For almost twenty years the Army, as well as all other government agencies, has made strategic decisions around server / client hardware and software architectures which pulled applications and user data away from the traditional mainframe systems of old to smaller '*fat-clients'* systems. This allowed for great processing power at the end-user level, lower cost of hardware and extended control. Now, in today's computing environments there exist a need to provide greater security controls over classified and unclassified data as well as to reduce cost of not only systems but administrative overhead and operations; enter thin-client computing environments.

The ever-increasing need to secure data, reduce TCO while at the same time increasing ROI has opened the door for thin-client computing environments. Thin-client architectures allow organizations to pull user data and application back into the data-center or server farm while still providing a cost effective and user friendly computing environment to organizational staff. More so, thin-client computing allows centralized administrative control and significant reduces the time needed to deploy, maintain and decommission applications and systems. The industry proven advantages for thin-client computing environments are seen in the following:

- Thin-client devices are less expensive than traditional *fat-clients* and have a considerably longer shelf life
- Thin-clients are engineered so that no data will actually reside on a thin-client device
- Reduces the cost and administration of licenses and applications
- All user data and applications are stored and maintained at the datacenter level
- Server class hardware is increasingly less expensive while at the same time extremely more powerful
- With advancements in network security, increased protection using data encryption and data delivery technologies via thin-client architectures and systems it is increasingly more difficult to maliciously access organizations data
- TCO is dramatically improved with centralized administrative models around thin-client architectures
- ROI is immediately recognized with thin-client architectures

Technology Focus: This document is focused on thin-client computing architectures with reference to two distinct, yet interoperable, technologies; Microsoft Windows Server 2003 R2 Terminal Services and Citrix Presentation Server 4.0 or higher. Both technologies are discussed at length in this reference document while at the same time pointing out advantages and disadvantages.

3. Discussion

3.1 Thin-Client Concept

Thin-client environments is best described as the housing of all data, applications, tools and the operating system in centralized locations datacenters (also called server farms or Area Processing Centers), thus utilizing terminal emulation to provide the end-user computing experience. This architecture allows for operational and security control from a centralized, easier and less costly managed locations thus elevating data loss, theft or corruption at the end-user level. In reality, the thin-client computing environment can best be conceptualized with the notion that organizational end-user computing has come full circle; pointing out that traditionally computing was performed via mainframes and dumb-terminal. As time and technology progressed, as well as significant cost savings, organizations started using fat-, or thick, clients; computers with operating systems, processors, memory and storage space. Again, as time progressed the advantages of thin-client computing with regard to cost, security and administrative overhead began to take hold and now, just like the Army, many organizations are standardizing on thin-client (or dumb terminal) computing infrastructures thus utilizing backend processing and storage components to house data and applications.

Conceptually thin-client computing completes the circle from mainframe processing, to individual PC based operations, back to a server based architecture but, with a great deal more advantages than mainframe usage. In today's computing environments thin-client architectures provide many advantages that far exceed the dumb terminals of old:

- Streaming desktops and applications
- Streaming video and audio
- Session sharing and monitoring
- Negating loss of data or corruption due to local system failures
- Compact but powerful terminals
- Localized peripheral sharing and access

There is a great deal of advantages to thin-client computing and this document will discuss these in detail.

3.2 Thin-Client Implementation Considerations

Workforce Acclimation: Without doubt one of the most significant 'hurdles' to overcome with thin-client integration is that of acclimating the end-user environment. With traditional workplace computing environments users are accustom to accesses and storing data locally, installing their own unique programs and sometimes unauthorized applications that have not been approved for security, and customizing their desktop environment as well as having local access to peripheral devices.

With thin-client environments many of these users standards are not available, as the point of thin-client computing is to regain control of data and applications in a secure, auditable and easily managed solution. For these reasons and many others it is essential to provide communication and end-user training to ensure a seamless transition as well as to 'sell' the benefits of such a solution.

Application exceptions: In many instances organizations utilize custom applications that are not engineered to exist and run effectively in a thin-client architecture. For these reasons it is necessary to realize that some applications will require either thin-client computing re-engineering or the use of fat-clients.

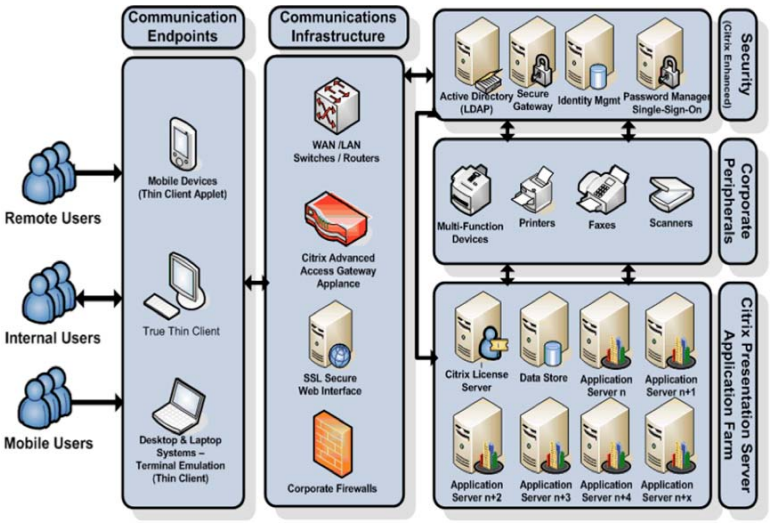

Figure 2: GTSI ITES-2H Thin Client Reference Architecture

Redundancy Planning: Because thin-client devices rely heavily on a number of separate but interoperable components like networks, servers, security and storage the need to plan for redundancy accelerates at every single-point of failure; i.e. dual switches/routers, dual NICs, clustered or failover / failback server and storage systems, etc. This should be accounted for and recommended in the planning and design phases.

Planning and design: The most important aspect to any integration project is that of planning and design, even more so in thin-client computing environments. Because the end-user interaction with a thin-client terminal is based on the streaming of data there exist a great many points of failure that need to be addressed and accounted for in these types of environments. The most fundamental points that require strict planning and design are:

- User to Application mapping: What users or groups get what applications? This is not only important to a seamless transition but to also understand user provisioning.
- Single Points of Failure: Thin-client terminals rely heavily on working network components; i.e. switches and routers, server and storage resiliency
- Thin-client Configuration: The user experience and the ability to function correctly will depend on the necessary and appropriate configuration aspects to provide optimal computing needs.

Software licensing: Software licensing is an important consideration especially when determining whether to utilize strictly a Microsoft Terminal Services thin-client environment or to utilize a Citrix Presentation Server solution. The current Army Microsoft Enterprise Application agreement allows for the use of Terminal Services CALs, or TSCALs, whereas if Citrix is utilized there will be an additional expense. This will also be a consideration in the planning and design phase of any thin-client integration.

4. Requirements

4.1 Operational Requirements

4.1.1.1 Thin-Client Terminal Configuration

Thin-client computing environment device requirements will be configured according to current and projected Army standards to include, but not limited to:

- Logoff / Lock terminal after X minutes of inactivity
- 'Blank Screen' after X minutes of inactivity with password / CAC PKI interface re-activation requirement
- Lowest power-save settings possible for chosen units
- Exceptions will be discovered during planning & design phases of individual integration projects

4.1.1.2 Server, Storage, Network Configurations & COOP

As stated earlier in this document a prominent concern with regard to high-availability with thin-client terminals is the infrastructure that supports the end-user computing environment. The requirements for optimal availability of the thin-client terminals are as follows:

Server: Servers should be configured for failover / failback either via load-balancing or clustering (when available). Servers should also avail of multiple NICs that are load balanced with static IPs

Storage: Storage solutions should be configured to utilize SCSI and Fiber technologies while at the same time avail of optimal LUN distribution. Storage should also be configured to utilize optimal RAID levels

Network: Use of redundant switching and routing configurations is a must to ensure that no single point of failure exist within the network infrastructure and communication to terminals

Backup / Restore: Backup and restore procedures should be in place, tested for operability and optimized using the latest technologies such as cloning and snap. Offsite storage of backup media is a must and restore SLA should be optimized and tested at regular intervals.

COOP: Continuity of Operations is the most important fundamental need in IT environments today. Thin-client computing environments are no exception when planning for disaster recovery when procuring systems for such architecutures the additional need for alternate server, storage and thin-client devices is essential. Simply put, COOP environments with respect to thin-client computing models should be zoned (if using Citrix) or mirrored (duplicated) if using terminal services in alternate geographical locations.

4.2 Software Requirements

Requirements for 1 – 500 Users

Thin-Client Architectures require robust software utilization for optimal performance. Organization IT administrators and planners should plan for software utilization using one terminal server or Citrix server for every 50-100 users. The below table describes the necessary operating platforms needed for seamless thin-client architecture integration.

Table 1: Software Requirements for 1 - 500 Users Recommendations

Software Requirements for 1 – 500 Users	
Software	Description
Terminal Server	Microsoft Windows Server 2003 R2 64x with SP2 with Terminal Services and licensing server installed (must have appropriate TSCALs)
Citrix Presentation Server	Citrix Presentation Server 4.5 Standard Editions or Above

Client Software	Windows XP (Shell), CN or Above with latest Service Pack, Must support RDP 5.0 or higher and ICA protocols
Database (Citrix)	SQL 2005, Oracle 8i or above or IBM DB2

Requirements for 500+ Users

Thin-client architectures are completely scalable meaning that for each organization IT administrators and planners should plan for software utilization scaling one terminal server or Citrix server for every 50-100 users. The number of terminal servers or Citrix servers needed for 500+ Users are determined by increasing the number of servers so that a multiple of the 50-100 users per server is maintained. The above noted software should scale in this manner.

4.3 Hardware Requirements

Hardware: Servers
All servers for consideration of any thin-client project should be 64bit bus architecture with appropriate RAM, hard drives, system storage (SCSI Compliant), NICs (dual or quad based) and HBA's (dual or quad). The following table gives the minimum requirements needed to supply a successful thin-client architecture deployment for server-class systems:

4.3.1.1 Server Hardware for 1 – 500 Users

Table 2: Server Hardware for 1 - 500 Users Recommendations

Server-Class Hardware Requirements for 1 – 500	
Server Type	Description
Terminal Server	Dual, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's / or Dual iSCSI Initiators / TOE Cards
Citrix Presentation Server	Dual, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's

Citrix Database Server	Single / Dual, Dual-Core 64x 2.0 GHz+ Processor with 1MB bus; 2GB+ RAM, Dual 73.5GB+ HDDs, Dual 10/100/1000 NICs, HBA optional depending on storage utilization
Citrix Licensing Server	Single Dual-Core 2. .0 GHz+ Processor with 1MB bus; 2GB+ RAM, Dual 73.5GB+ HDDs, Dual 10/100/1000 NICs, HBA optional depending on storage utilization

4.3.1.2 Server Hardware for 500+ Users

Table 3: Server Hardware for 500 Users or More

Server-Class Hardware Requirements for 1 – 500	
Server Type	Description
Terminal Server	Dual or Quad, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's
Citrix Presentation Server	Dual or Quad, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's
Citrix Database Server	Dual or Quad, Dual-Core 64x 2.0 GHz+ Processor with 1MB bus; 2GB+ RAM, Dual 73.5GB+ HDDs, Dual 10/100/1000 NICs, HBA optional depending on storage utilization
Citrix Licensing Server	Dual, Dual-Core 2. .0 GHz+ Processor with 1MB bus; 2GB+ RAM, Dual 73.5GB+ HDDs, Dual 10/100/1000 NICs, HBA optional depending on storage utilization

4.3.1.3 Storage Hardware

Table 4: Storage Hardware Recommendations

Server-Class Hardware Requirements for 1 – 500	
Storage Type	Description
SAN	Dual, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's / or Dual iSCSI Initiators / TOE Cards
NAS	Dual, Dual-Core 64Bit 2.5 GHz+ Processor with 2MB Bus; 8GB+ RAM, Dual 73.5GB HDDs (Mirrored), Quad 10/100/1000 NICs and Dual HBA's
DAS	Single / Dual, Dual-Core 64x 2.0 GHz+ Processor with 1MB bus; 2GB+ RAM, Dual 73.5GB+ HDDs, Dual 10/100/1000 NICs, HBA optional depending on storage utilization

4.3.1.4 Client Hardware (Thin-Client)

Table 5: Thin-Client Hardware Requirements for 1 – 500 Recommendations

Thin-Client Hardware Requirements for 1 – 500	
Server Type	Description
Thin-Client	2.0 GHz with 256 MB Flash, 256 MB RAM, 10/100/1000 MB or better NIC
Keyboard & Mouse	USB (Preferred) or PS2
Monitor	17"+ Flat Screen
USB Ports	4+ USB Ports

CAC Card Reader	Smart Card Reader and current DoD CAC Middleware
Thin-Client Manager	Vendor Specific interface

4.4 Information Assurance Requirements

1. National Information Assurance (IA) Policy (NSTISSP #11. http://niap.nist.gov/cc-scheme/nstissp_11_revised_factsheet.pdf
2. National Information Assurance Acquisition Policy, 6 August 2002. https://ascp.monmouth.army.mil/scp/downloads/standardspolicy_files/NSTISSP_Guidance.pdf
3. Guide to Information Technology Security Services NIST Special Publication 800-35, October 2003. http://csrc.nist.gov/publications/nistpubs/800-35/NIST-SP800-35.pdf
4. Guide to Selecting Information Technology Security Products NIST Special Publication 800-36, October 2003. http://csrc.nist.gov/publications/nistpubs/800-36/NIST-SP800-36.pdf
5. Guide for Secrity Certification and Accrediatation of Federal Information Systems Specia Publication 800-37, Mary 2004. http;//csrc.nist.gov/publications/nistpubs/800-27/SP800-37-final.pdf
6. Recommended Security Controls for Federal Information Systems, February 2005. http://csrc.nist.gov/publications/nistpubs/800-53/SP800-53.pdf
7. Security Requirements per DoD Information Technology Security Certifications and Accreditation Process (DITSCAP) outlined in DoD 8510.1-M
8. National Industrial Security Program Operational Manual (NISPOM)
9. Industrial Security Regulation DOD 5220.22-5.2

5. Recommendations

5.1 Technical

Thin-client computing environments allow for all applications, data and server processing to be handled on the backend, or the datacenter/server farm, of an organizations IT environment thus providing for dramatically reduced TCO and a quantifiable ROI. Because this type of architecture relies heavily on network resources and optimal server-class hardware, as opposed to locally processed application and resources, it is recommended that environments within the Army with less than 100 users utilize a Microsoft Terminal Server thin-client computing environment and any environment with more than 100 users to utilize a Citrix Presentation Server solution.

5.1.1.1 Terminal Server Utilization

As noted earlier, environments within the Army that maintain a user base of 100 users or less should utilize a Microsoft Terminal Server solution. This solution will allow for optimal thin-client computing while at the same time providing for lower cost and administrative overhead. Because this solution is not enhanced for server-farm utilization, load balancing and speed-streaming of applications, and performance degradation will be experience when utilizing this solution with more than 100 users and a dramatic increase in administrative overhead will quickly become apparent.

5.1.1.2 Citrix Server Utilization

Citrix Presentation Server provides for small to enterprise-wide thin-client computing solutions by meshing a number of technologies that not only extend terminal services but allows for more in-depth failover, streaming, security, applications and systems monitoring, and access control. For the purposes of Army thin-client integrations it is recommended that any environment with more than 100 users that a Citrix solution be put in place to compliment the thin-client architecture and allow for ease-of-administration as well as to provide a better end-user computing experience. Citrix allows for 'Access Anywhere' application delivery solution from almost any device and operating system. Below is an overview of the latest Citrix servers offerings.

5.1.1.2.1 Citrix Presentation Server 4.5 Overview

Presentation Server now offers an end-to-end system for application delivery for all Windows applications. As always, Presentation Server offers the value of best TCO, security and performance.

Despite the '.5'of the 4.5 version number, this is a major upgrade. It completes the "application delivery system" with significant updates and enhancements to the base product as well as several significant new technologies. These innovations introduced in version 4.5 enable Presentation Server to become the foundation of a strategic approach to application delivery.

Presentation Server 4.5: New Technologies

Figure 3: Presentation Server 4.5 Technologies

Application Streaming - By adding streaming to the existing application virtualization capabilities, Presentation Server provides a flexible system that can dynamically select the best application delivery method for the user, the application, the device or the network. You can stream applications to mobile users who often work offline, and, for maximum control and security, virtualize applications that access confidential data.

Isolation 2.0 - Isolation 2.0 increases the performance of isolated applications and extends compatibility to more Windows-based applications. It provides core technology for Application Streaming, Application Isolation Environments and the Application Hub.

App Hub - Application Hub centrally stores application profiles where they can be delivered using virtualization, streaming, or both. Application Streaming takes these profiles and delivers them directly to end users or to Presentation Server. This enables IT to rapidly provision applications to entire Presentation Server farms without system conflicts and lengthy, costly regression testing.

Application Performance Monitoring - One of the most-desired features in the new version is Application Performance Monitoring, which provides visibility into the user experience. Powered by Citrix EdgeSight, this feature enables IT to quickly pinpoint and troubleshoot server, network and application programming issues that impact the user experience.

Smart Access - The Security of app delivery is a vital component of the system, which is why we include SmartAccess in the Platinum Edition of Presentation Server. It provides a single, secure point of entry to applications with an industry-leading universal SSL VPN solution. Powered by the Citrix Access Gateway, the new secure gateway solution provides secure remote access with SmartAccess™ granular access control policies and integrated endpoint analysis.

Single Sign-on (Powered by Citrix Password Manager) - While the SmartAccess addresses secure access to applications and other IT resources, single sign-on addresses the user experience and security of actually logging on to those applications. Users need to remember how to logon to many applications, each with their own rules and policies. They either forget their passwords, causing a help desk call, or worse, they write them down and leave them exposed, causing a security risk. Centralizing password management with Single Sign-on keeps credentials stored securely in the system, rather than written on pieces of paper or some other exposed location. It also makes it easier for authorized users to access applications which increase user adoption of new applications.

Health Assistant - Once you have your applications delivered and secured, you need to maintain the system so it is resilient, reliable and consistently available. Health Assistant makes it easier to manage Presentation Server farms and reduces need for human intervention – reducing administration costs. Health Assistant monitors the Presentation Server environment, reporting any failures when they happen and automatically takes action to recover from the failure, such as load balancing to another server, restarting a critical service, rebooting the server, or simply alerting the administrator.

SpeedScreen Progressive Display - SpeedScreen Progressive Display dramatically improves the performance and usability by applying heavy compression while graphics are being moved or manipulated, then return to full resolution detail when the motion stops. This makes it easier for users to work with graphics, without sacrificing clarity of the image when it is at rest. This dramatically reduces the amount of bandwidth required to send graphics display over networks – by up to 20X (as tested by Citrix with a medical Picture Archiving and Communication Systems (PACS) application), or a 95% reduction in bandwidth utilization.

X64 Platform Support - Presentation server x64 support means more users per server – thus fewer servers. This reduces recurring data center costs such as space requirements, electrical and cooling. This also helps IT support their company's "Green" initiative. X64 lowers the costs of provisioning, maintaining and managing servers. Finally, because Presentation Server delivers both 32-bit and 64-bit applications it eases IT's migration to the 64-bit platform.

Windows Vista Support - With Presentation Server Client 10.0 for Vista, users can move to Vista, continue to use their current virtualized or streamed applications, and IT can continue to support the same application set. This helps to bridge the gap between operating systems and make the transition go much smoother.

	Advanced Edition	Enterprise Edition	Platinum Edition
Application Virtualization Enhancements 100+ new and upgraded features	●	●	●
SpeedScreen Progressive Display	●	●	●
x64 support	●	●	●
Application Streaming		●	●
Application Hub		●	●
Isolation 2.0		●	●
Health Assistant		●	●
Performance Monitoring			●
SmartAccess			●
Single Sign-On			●

Figure 4: CSP Editions Comparison Chart

5.2 Thin-Client Baseline Configurations

Servers: Servers, blade or xU, should be racked, secured and configured for optimal performance based on the recommendations in this document. Also as per this document; because the configured thin-client computing environments recommended deployment methodologies servers should allow for scalability while at the same time be configured for optimal user access. Server should also be maintained at the highest security and patching levels possible as per Army standard operating procedures.

Storage: Storage, either local storage for smaller environments or attached, i.e. SAN, NAS, etc. for larger environments, should be configured at RAID levels of 0, 1, 5 or 10 and should be partitioned allowing for growth and 'hot-swappable' removal and replacement of drives. Attached storage components should be configured for redundancy at all times to eliminate any single point of failure. Hard drives spindles RPM rates should be 10,000 or above and should allow for a minimum of 73.5 GB of raw storage but should not exceed 300 GB as this will detiriate optimal IOPS (Input/Output per second)

Clients: Thin-client devices should be configured as per this document to allow for optimal security and end-user experience. The chosen thin-client devices should take advantage of vendor-specific management interfaces that will scale to match the organizations number of clients needed in both arena's of number of clients and architecture. Also, any ports on the thin-client device not in use should be disabled.

Backups: Backup processes and procedures should take into account operating systems system-state, applications and data. Backup intervals should align with Army best practices and should take into account disaster recovery architectures, off-site storage and COOP procedures.

UNIX / Linux Environment Considerations: For Army organizations / environments where the primary operating system utilized for both server and client hardware is either UNIX or Linux, or both, special considerations for thin-client devices and application delivery should be considered. See Appendix B of this document for further details.

6. GTSI Integration Methodologies

6.1 Understanding of Project Requirements

Project Requirements

This section of the proposal is intended to identify and document the key business requirements that are driving the project forward and defining its scope. The overall success of the project will be evaluated on its ability to meet the stated Goals and Objectives, and its delivery against the identified success criteria.

6.1.1.1 Project Objectives

The following items are assumed to be Army's business objectives for a typical project:

- Implement a pristine thin-client solution
- Provide a pilot, or test, solution around the thin-client integration
- Test failover / load balancing features of solution

- Provide end users direct and remote access to needed applications and tools via thin-client environment
- Maintain access to mission critical and workflow applications

6.1.1.2 Success Criteria

- The following elements will be used to measure the success of this project
- Execution of the project with minimal impact to production services and end-user experience
- Completion of pristine thin-client architecture solution
- Completion of publishing or hosting application configuration
- Provide optimal application / desktop access solution via various access methods

6.1.1.3 Deliverables

The following deliverables are assumed to be in line with Army objectives either during the course of or at the conclusion of the Project:

- Discovery documentation
- Project Plan
- Active Directory Policy review documentation
- Group Policy Design (Citrix & Terminal Services) document
- Thin-client Design documentation
- Implementation Plan
- Lab Architecture document
- Lab Test Plan
- Lab Test Results documentation
- As-built network documentation
- Server build documentation
- Project sign-off sheet by phase

6.2 Critical Assumptions

The Scope of Work proposed in this document is based on the following Critical Assumptions. If any of the following assumptions are revealed to be incorrect or inaccurate during the course of the project, the Scope of Work may be impacted, in which case a change order will be issued to account for the additional Scope requirements.

- That a pristine thin-client architecture environment will be created and all users, unless deemed inappropriate, will utilize this solution
- All applications published or hosted in this environment will need minimal configuration; any application needing additional configuration to exist in a thin-client environment will require additional engineering time
- That a high-availability solution will be implemented consisting of redundant systems, shared storage and load balanced thin-client environments
- That sufficient network, hardware and software is available for this project

- That access to work areas, systems and key IT staff will be made available in a timely manner throughout the duration of this project

6.3 GTSI Phased Approach to Projects

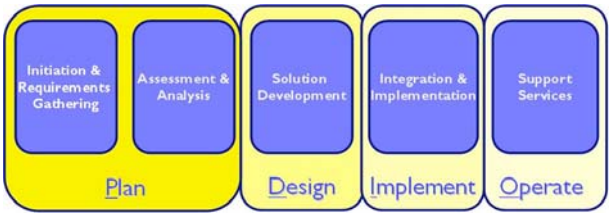

Figure 5: GTSI PDIO Methodology

GTSI takes a phased approach to each project we engage in. Collaborating years of experience and industry proven methodologies, GTSI follows a strict Plan, Design, Implement and Operate (PDIO) methodology structure. This helps us to manage the project lifecycle and mitigate potential risks through the course of the project. Each of our technology implementation projects includes the following project phases:

1. **Planning Phase:**
    a. **Vision & Scope:** The first phase of the project is where we establish our baseline of information and set the stage for success. This phase includes any network discovery and documentation that needs to be completed, definition of project roles & responsibilities, and the development of a high-level project plan to move forward with.
2. **Design Phase:**
    a. **Design & Planning:** After completing our initial discovery, we engage in a thorough Design & Planning phase. This includes our technology design sessions, where we engage with your team in a bi-directional dialogue that educates your staff while informing us of details particular to your environment that will be critical to the projects success. We complete draft design documentation based on the outcome of these sessions, and develop a more detailed project plan to move forward with.
    b. **Testing & Validation:** We consider thorough lab testing and validation of a proposed design to be a vital step toward the success of any project. During this phase we explore any unknown factors with the design or implementation plan, and validate (or invalidate) any critical assumptions that we have made in our planning. We then incorporate our lessons learned from the lab into our design documentation and implementation plan, and are ready to move forward with implementation.
    c. **Proof of Concept:** We feel it is necessary that before beginning the implementation phase that we conduct a pilot rollout to a select group of “friendly” users, to “prove” the design in a live environment. Adjusting as necessary based on feedback from the pilot group, we are then ready to rollout to the production environment at large

3. **Implementation Phase:**

    a. **Implementation:** After successful completion of the previous phases we now begin a successive rollout of the technologies and methodologies solidified in proof of concept. Where appropriate, we will coordinate Administrative or End-User training with the rollout schedule to maximize the impact of these training sessions.

    b. **Documentation & Knowledge Transfer:** In accordance with our philosophy of maximizing our potential for success by empowering your team to manage the technology we deploy, we bring focus to documentation and knowledge transfer once the implementation is complete. During this phase we complete any knowledge transfer with the administrative staff that was not completed during the planning, lab & implementation phases, and update the network documentation to reflect the current as-built state.

4. **Operate Phase:**

    a. **Post Implementation & Support:** The Post-Implementation & Support phase gives us the opportunity to identify and resolve any open issues, and identify any additional needs moving forward that we may be able to support. We conduct a project quality and success assessment, and complete the final project sign-off as well as define next steps, if any, to provide ongoing support.

6.4 Example Project Outline for 100 – 500 Users

This outline is intended to provide an overview of the Major Tasks, Objectives, and Deliverables specific to the scope of this particular Citrix project. This is not intended to serve as a project plan or exhaustive list of the tasks to be performed during the course of the project, but rather to define the operational goals and deliverables for each phase of the project. Below you will see the needed high-level steps that will ensure project success.

6.5 Phase I: Planning

Vision & Scope

6.5.1.1 Major Tasks & Objectives

- Project Kick-Off
- Definition of Roles & Responsibilities
- Identification of Key Milestones & Target Delivery Dates
- Develop High Level Project Plan
- Identify Risk Associated With Project
- Technical Discovery & Documentation
- Schedule & Perform Analysis Interviews
- Process Review & Analysis
- Technical Review & Analysis

6.5.1.2 Deliverables

- High-Level Project Plan (Outline Level)

- Project Contact Sheet
- Network Discovery Documentation
- Process Discovery Documentation
- Technical Discovery Documentation
- Systems Discovery Documentation
- Project Phase sign-off

6.6 Phase II: Design

Design & Planning

6.6.1.1 Major Tasks & Objectives

- Analysis of Review Findings
- Storage Design
- Thin-client Design Session
- Conceptual Design
- Architecture Design
- Implementation Design
- Operational Processes Design
- Proof of Concept Design & Planning Session
- Implementation Design & Planning Session

6.6.1.2 Deliverables

- Findings Review Documentation (Final)
- Requirements & Assumptions Documentation
- Storage Design Document (draft)
- Thin-client Server Design Document (draft)
- Network access Design Document (draft)
- Proof of Concept Design (draft)
- Implementation Plan (draft)
- Hardware requirements checklist
- Software requirements checklist
- Project Phase sign-off

Testing & Validation

6.6.1.3 Major Tasks & Objectives

- Lab Architecture design session
- Document Lab Architecture
- Setup of Lab environment
- Develop & Document Lab Test Plan
- Execution of Lab Test Plan

- Documentation of Lab Test Results
- Update thin-client Server Strategy Design documentation
- Update Proof of Concept Design documentation
- Update Implementation Design documentation

6.6.1.4 Deliverables

- Lab Architecture documentation
- Lab Test Plan (checklist)
- Lab Test Results
- Hardware Build complete
- Software Procurement needed
- Access Strategy Design documentation (updated)
- Proof of Concept Design documentation (updated)
- Project Plan (updated)
- Implementation Plan (updated)
- Project Phase sign-off

Proof of Concept

6.6.1.5 Major Tasks & Objectives

- Selection of Server/Application Base
- Communication
- Identification of Key Milestones & Target Delivery Dates
- Develop & Document POC Plan
- Execution of POC Plan
- Documentation of POC Results

6.6.1.6 Deliverables

- POC Project Plan
- POC Design documentation
- POC Results documentation
- Update Project Plan
- Project Phase sign-off

6.7 Phase III: Implementation

6.7.1.1 Major Tasks & Objectives

- Build storage Infrastructure
- Build thin-client (client) Infrastructure
- Integrate storage architecture
- Build thin-client server infrastructure as per Proof of Concept
- Publish / Host Applications

- Implement design fundamentals policies
- Integrate solution
- Upgrade/rebuild/deploy servers as needed
- Configure network services, secure gateway
- Configure storage
- Migrate Servers/Applications (if needed)

6.7.1.2 Deliverables

- Completion of storage Infrastructure
- Completion of thin-client (client) infrastructure integration Implementation
- Completion of thin-client server Build / Deploy
- Completion of network Integration
- Completion of physical server decommissioning
- Completion of COOP / DR solutions Integration (if any)
- Completion of Backup Implementation
- Updated Project Plan
- Project Phase sign-off

Documentation & Knowledge Transfer

6.7.1.3 Major Tasks & Objectives

- Complete as-built Network Documentation
- Complete system build sheets
- Complete Administrative Notes, as appropriate
- Deliver & Review documentation w/ Client IT Team
- Conduct Knowledge Transfer w/ Client IT Team

6.7.1.4 Deliverables

As-built Network Documentation, including:

- Design documentation (final)
- Administrative solutions Design documentation (final)
- System build sheets
- Updated Project Plan
- Project Phase sign-off

6.8 Phase IV: Operate

6.8.1.1 Major Tasks & Objectives

- Verification of Deliverables against Project Scope
- Evaluation against Success Criteria
- Identification & resolution of any open issues
- Identification of additional needs or requests

- Project wrap-up meeting

6.8.1.2 Deliverables

- Next Steps for Support
- Final Project Sign-off

6.9 Projected Project Timeline

The table below provides a proposed schedule for this project by phase. This table is not intended as a final project plan or fixed schedule for this project, but is rather intended to provide guidance and some initial structure to the project as it is initiated. A more detailed project plan and timeline will be completed at the initiation of the project.

Table 6: Project Timeline

Project Phase	Projected Duration
Phase I: Planning	**5 Days (Total)**
Vision & Scope	5 Days
Phase II: Design	**15 Days (Total)**
Design & Planning	5 Days
Testing & Validation	5 Days
Proof of Concept	5 Days
Phase III: Implementation	**7 Days (Total)**
Implementation	4 Days
Documentation & Knowledge Transfer	3 Days
Phase IV: Operate	**TBD**
Post Implementation & Support	TBD

7. Staffing Requirements

This section is included to provide clients with an understanding of the expectations of internal staff to participate in the proposed project. Success and timely execution of projects often hinge on the ability of the internal staff to work with the project team and participate in the execution of the project. We make a best effort to estimate these commitment levels in terms of time, however, these requirements can vary based on a number of potential factors.

Table 7: Staffing Requirements

Staff Member	Roles	Commitment Expectation
<Army Resource>	IT Director/Manager	10% or 4 hours/week: • Participate in Design & Planning sessions • Review & Approve deliverables • Issue escalation & conflict resolution • Budget approval
<Army Resource>	Windows System Administrator	25% or 10-12 hours/week during the systems builds portion of the project: • Participate in Design & Planning sessions • Review & Approve deliverables • Participate in critical application assessment, OS activities • Participate in knowledge transfer sessions
<Army Resource>	Citrix Administrator	50% or 20-24 hours/week during all Citrix related implementation aspects of the project: • Participate in Design & Planning sessions • Review & Approve deliverables • Participate in critical Citrix activities • Assist in application migration procedures • Participate in knowledge transfer sessions

8. Scope Responsibilities

CLIENT agrees to assume responsibilities for the following elements of the project:

- Participate in Design & Planning sessions
- Review and approve deliverables
- Participate in critical upgrade & migration activities
- Coordinate communications with user community
- Order required hardware and software resources

Appendix A. Abbreviations and Terms

Table 8: Acronym and Abbreviations

Acronym /Abbreviation	Description
ACE	Access Control Entry
ACL	Access Control List
AD	Active Directory
ADC	Active Directory Connector
API	Application Programming Interface
BB	BlackBerry
BCV	Business Continuity Volume
BES	BlackBerry Enterprise Server
BH	Bridgehead
CA	Connection Agreement or Certificate Authority
CCU	Citrix Concurrent User (license)
CPS	Citrix Presentation Server
DC	Domain Controller
DFR	Dedicated Forest Root
DHCP	Dynamic Host Control Protocol
DL	Distribution List
DNS	Domain Name System or Domain Name Service
E12	Exchange 2007
E2K3	Exchange 2003
E2K7	Exchange 2007
EA	Enterprise Administrator
ECC	Error Correction Code
EGS	Exchange Storage Group

Acronym /Abbreviation	Description
EU	Europe
EVS	Exchange Virtual Server
GAL	Global Address List
GB	Gigabytes
GC	Global Catalog
GPO	Group Policy Object
HBA	Host Bus Adapters
HTTP	HyperText Transfer Protocol
I/O	Input/Output
IIS	Internet Information Services
ILM	Information Lifecycle Management
ROI	Return on Investment
RTM	Release To Market
TCO	Total Cost of Ownership
TLM	Technology Lifecycle Management
TS	Terminal Services
TSCAL	Terminal Services Computer Access License
TTM	Time to Market
UCC	Unified Communications & Collaboration
WINS	Windows Internet Naming Service

Appendix B. UNIX/Linux Thin Client Considerations

Thin Client Supporting UNIX and Linux Environments
In addition, GTSI provides Army thin client solutions supporting users within Unix and Linux environments. GTIS uses its OEM partner, Sun Microsystems, as a vendor to provide such a solution.

Sun has been one of the leaders in enterprise computing solutions for more than 20 years. Over the past several years, one of Sun's innovations has been the Sun Ray Virtual Client Infrastructure, which includes Sun Ray Desktop Units and Sun Ray Server Software Solution. The Sun Ray Desktop Units (DTUs) are ultra thin client appliances, providing low power consumption and stateless operation. The Sun Ray Server Software provides and manages flexible virtual desktop sessions, which are accessed by the Sun Ray Desktop Units.

The Sun Ray Server Software provides user authentication and encryption between server and thin clients, as well as session management. This reduces complexity and administration and enhances security. Sun Solaris Unix and Linux environments are made easily accessible, to the Sun Ray DTUs, since the Sun Ray Server software is available for both OS platforms. Sun Ray Desktop Manager and Sun Ray Connector for Windows are optional components that provide additional functionality, at no additional cost. Some of the additional features of the Sun Server Software are as follows.

- Multiple Topologies Support – Dedicated LAN, Shared LAN, and WAN deployments are supported.
- Load-Balancing – Sessions can be evenly distributed amongst multiple Sun Ray Servers, allow the creation of server farms for highly available user sessions.
- Centralization – Desktop Resources and Applications are centrally managed at the server tier.
- Platform Independence – Sun Ray Clients can link to other OS Platforms through the use of third-party software solutions, such as Citrix Presentation Suite and Sun Secure Global Desktop (formally Tarantella) software.
- Controlled Access Mode – Sun Ray Clients can be configured to launch and restart applications, in addition to restricting and controlling applications users can access.

The Sun Ray DTUs are low power zero-administration ultra thin clients. The entry-level model utilizes as low as 4watts of nominal power consumption. Another model can support multiple displays and 100FX network connectivity. The third model as an all-in-one Sun Ray DTU and 17" LCD Display, thus taking up less desktop real estate. So other features are as follows

- Session Mobility – Users can access their sessions instantly from any "Hot-Desk-enabled" Sun Ray Client in the server group.
- Zero-Administration – Firmware is updated from the Sun Ray Servers.
- Smart Card Reader – PC/SC Muscle Smartcard API can be used by Solaris or Windows for Smart Cad communication.
- USB and Mass Storage Devices support via LibUSB API under Solaris OS.
- SNMP Monitor Support

The typical Sun Ray environments have the following minimum requirements:

- Sun Ray Server Software
- Sun SPARC or x86-based servers
- Sun Ray Virtual Client Licenses
- Sun Solaris OS
- For Linux environments with reduced complexity, Red Hat AS3, SuSE SLES8, and JDS rev2
- Sun Ray Virtual Client DTUs

The following are sample Sun Ray Virtual Client configurations:

Software Requirements for 1 – 500 and 500+ Users	
Software	**Description**
Sun Ray Server 4 Software	Sun Ray Server Software Media Kit: Includes the Sun Ray Server Software 3.1, Sun Desktop Manager, and Sun Ray Connector for Windows
Sun Ray Virtual Client Perpetual RTU License	Sun Ray Client per User Licenses
Server-Class Hardware Requirements for 1 – 500 Solaris Users	
Server Type	**Description**
Sun Ray Primary Server	Sun Fire V490 4-CPU Dual-Core 2.1GHz US IV+ Processors with 16GB RAM, 2 x 146GB FC-AL Hard Drives, Quad Gigabit Ethernet Card, dual Single-Port FC HBAs
Recommended Sizing	One server configuration per 100 users, with a minimum of two servers for high-availability/load-balancing
Server-Class Hardware Requirements for 1 – 500 Linux Users	
Server Type	**Description**
Sun Ray Primary Server	Sun Fire X4600 8-CPU Dual-Core 2.8GHz AMD Opteron X64 Processors with 32GB RAM, 2 x 146GB SAS Hard Drives, Quad Gigabit Ethernet ports, dual Single-Port FC PCIe HBAs
Recommended Sizing	One server configuration per 150 users, with a minimum of two servers for high-availability/load-balancing

Server-Class Hardware Requirements for 500+ Solaris Users	
Server Type	**Description**
Sun Ray Primary Server	Sun Fire V490 4-CPU Dual-Core 2.1GHz US IV+ Processors with 16GB RAM, 2 x 146GB FC-AL HardDrives, Quad Gigabit Ethernet Card, dual Single-Port FC HBAs
Recommended Sizing	One server configuration per 100 users, with a minimum of five servers for high-availability/load-balancing to support the minimum 500 users
Server-Class Hardware Requirements for 500+ Linux Users	
Server Type	**Description**
Sun Ray Primary Server	Sun Fire X4600 8-CPU Dual-Core 2.8GHz AMD Opteron X64 Processors with 32GB RAM, 2 x 146GB SAS Hard Drives, Quad Gigabit Ethernet ports, dual Single-Port FC PCIe HBAs
Recommended Sizing	One server configuration per 150 users, with a minimum of four servers for high-availability/load-balancing to support the minimum 500 users

GTSI Corp. is the first information technology solutions provider offering a Technology Lifecycle Management (TLM) approach to IT infrastructure solutions delivered through industry-leading professional and financial services. GTSI employs a proactive, strategic methodology that streamlines technology lifecycle management, from initial assessment to acquisition, implementation, refresh, and disposal. TLM allows government agencies to implement solutions of national and local significance quickly and cost-effectively. GTSI's certified engineers and project managers leverage strategic partnerships with technology innovators. These experts use proven, repeatable processes to design, deploy, manage, and support simple to complex solutions, to meet governments' current and future requirements and business objectives. GTSI is headquartered in Northern Virginia, outside of Washington, D.C.

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