Thin Client

Thin Client, Client Virtualization, and Virtual Desktop Infrastructure (VDI)[1] have reached a pivotal point with an exponential ramp of interest. A successful deployment of any Thin Client implementation requires a strong, proven methodology for the design and implementation process. A mature, thorough methodology and assessment effort will effectively characterize the operating environment. The two primary elements for establishing the technical architecture requirements for any Thin Client deployment are thorough measurements of the Input/Output Per Second (IOPS) of the existing architecture elements, and the segments by which the user community are characterized. Below are the basic principles of those user characterizations and Figure 1 further defines the user segment characterizations.

User segments are essentially characterized into four (4) categories:

1. **Task Workers** — A task worker is defined as a user that interacts with a minimal set of applications. These users generally utilize just one text-based application at any point of time. The user generally has only one or two applications open at a time. Such users have limited requirements of printing and USB access. The majority of work produced is keystrokes.
2. **Productivity Workers** — A productivity worker uses a fairly broad application set. This user has multiple applications running at any given point in time and leaves certain applications, such as Microsoft Outlook, Microsoft Excel, Microsoft PowerPoint and Internet Explorer, open for their entire login session.
3. **Knowledge Workers** — A knowledge worker, also known as a Smart User, uses a broad application set. They interact with the desktop throughout the entire work day. Applications for this user typically demand higher resource utilization. These users will run multiple applications and, expediently and efficiently switch between those applications using keyboard shortcuts and will therefore demand a higher level of IOPS throughput.
4. **Performance Workers** — A Desktop Power User, Performance User, or Designer typically has requirements for high-end graphics, may be running Windows and Linux, and using resource intensive applications such as satellite imaging, and will therefore demand a higher level of IOPS throughput and graphics performance.

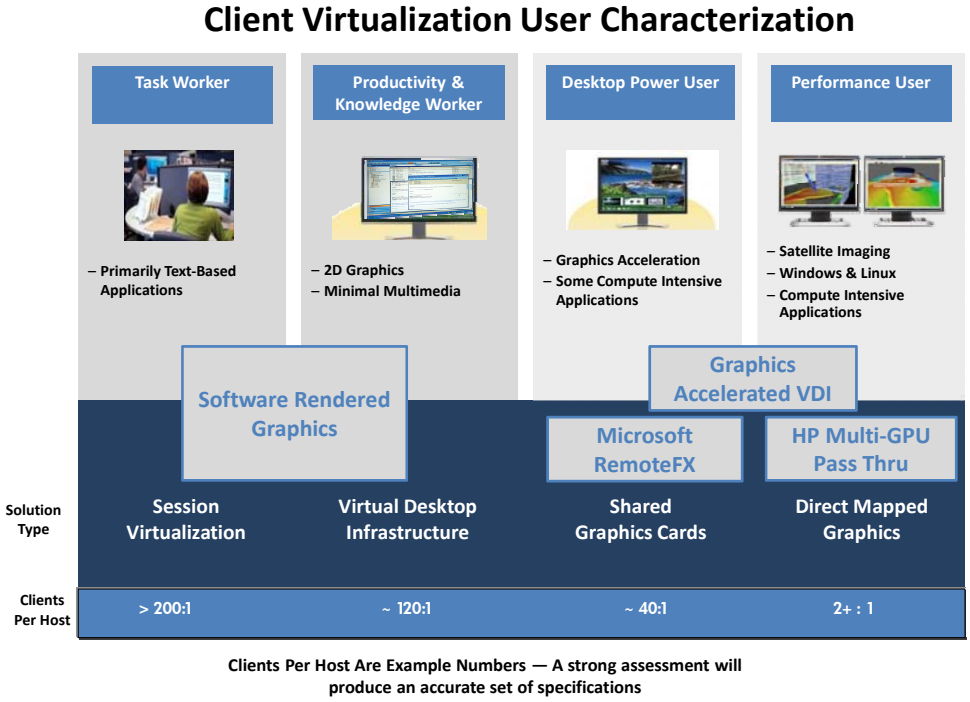


Figure 1 - User Characterization

Essentially, there is no typical Thin Client configuration. However, a clear, concise analysis of the entire operating environment will enable a predictable, effective Thin Client design and subsequent deployment. This is referred to as a Client Virtualization Methodology. The methodology must be applicable to any size implementation. Primarily, user segments and IOPS are the key factors and there are many other variables to be considered but it has been proven again

[1] The terms "Thin Client", "Client Virtualization", and "Virtual Desktop Infrastructure (VDI)" are used interchangeably in this section of the document. However, it's noted that the term Thin Client typically refers to the desktop end-point and VDI refers to the Thin Client and the infrastructure which supports the Thin Client.

and again, that moving forward with a strong, thought-out process will enable a predictable Thin Client deployment and will effectively facilitate any scale up and/or scale-out progression.
The requirements will inevitably vary from the each deployment because each mission introduces greatly different user, application, storage, compute, and network access considerations. Again, a proven, end-to-end Methodology which provides all the required data points will provide the foundation for a successful design and subsequent deployment.

Each step of Hewlett-Packard's (HP's) proven Methodology is illustrated in Figure 2 and articulated below.

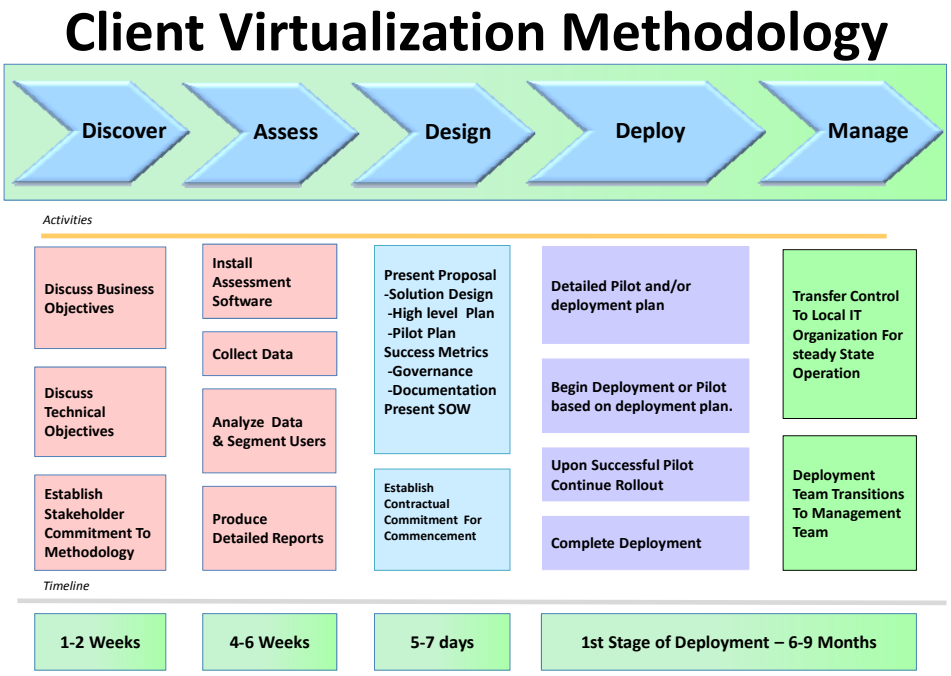


Figure 2 - Client Virtualization Methodology

1. **Discover**
   a. **Objectives**
      i. Agree upon the business justification parameters which typically are, but are not limited to:
         1. The required capital investment
         2. Costs to effectively complete the virtualization vs. the costs of the current state
         3. Estimated reduced operating costs related to end user productivity gains and IT support gains
         4. An estimated Return on Investment (ROI)
         5. The number of users
      ii. Define the target values for the business justification parameters
      iii. Ensure stakeholders are in agreement and know how to support the methodology
   b. **Solution**
      i. For each individual deployment, determine answers to these questions:
         1. What are the top five strategic business goals for the next two years?
         2. What are the top five strategic IT goals for the next two years?
         3. What is the total annual IT budget? What portion is operating budget versus strategic budget?
         4. What is the end-user computing budget and what portion of the budget is labor related?
         5. How many full-time employees are part of the end-user support organization?
         6. How many full-time employees are employed directly with the organization compared to those which are contractors?
         7. If contractor, what is the annual cost of the contract and when does the contract expire?
         8. Is the direction of virtual desktop to provide enhanced secure mobile computing and Bring Your Own Device (BYOD)?
         9. How many total devices does IT support and what percentage is targeted for BYOD?

10. Does BYOD policy provide no reimbursement, partial, or full reimbursement for the end-point device? If partial or full, what is the stipend amount?
11. For the targeted BYOD mobile use cases, what is the current cost of physical and end-point devices purchased by IT?
12. What are the expected business implications by virtualizing the client? Has the quantified financial impact been established?
13. Are there current use cases for client virtualization?
14. Is there a specific use case targeted, and is there a clear "go live" date committed by IT to the business for that use case?

2. Assess

a. Objectives

i. Implement a comprehensive trend analysis to discover, assess, and determine each component to be included in the Virtualization Client deployment.
ii. Collect strategic data points over 30 +/- days. The longer the better due to variations attributed, but not limited to:
    1. Job scheduling
    2. Seasonal processing requirements
    3. Personnel scheduling
    4. Strategic applications
    5. Storage and compute requirements
iii. Collect data points for a comprehensive measurement of the effect on each element in the infrastructure
iv. Evaluate the applications as candidates for virtualization
v. Define the applications that may challenge the virtualization effort
vi. Establish the baseline measurement for capacity planning and sizing exercises
vii. Evaluate user segment characterizations based on actual, real-time usage
viii. Evaluate a target set of users and their characterizations for the pilot phase
ix. Establish the impact of the project to the organization.

b. Solution

i. HP leverages institutional knowledge, industry experience, and internal testing to design and build Client Virtualization Reference Architectures (CVRAs) which provide a baseline/blueprint for end-to-end solutions that have been fully tested, validated, and optimized for client virtualization. The HP CVRAs facilitate a faster time-to-production, and quicker time-to-desktop transformation.
ii. HP also leverages SysTrack assessment software which is specially designed to gather data from emerging Thin Client environments and/or provide ongoing monitoring and analysis of existing implementations. Together the CVRAs and SysTrack assessment combine to deliver a powerful set of tools from which to design successful client virtualization projects; blueprints forming a baseline from which to work from and the environmental data necessary to correctly analyze and scope any thin client environment. Below are examples of the data points extrapolated from the highly comprehensive SysTrack Software.

iii. Workloads

Figure 3 shows an example of the number of modeled systems that are active across the enterprise in a typical week. This graph is intended for use in modeling desktop systems. More specifically, it shows the number of concurrent users with active sessions.

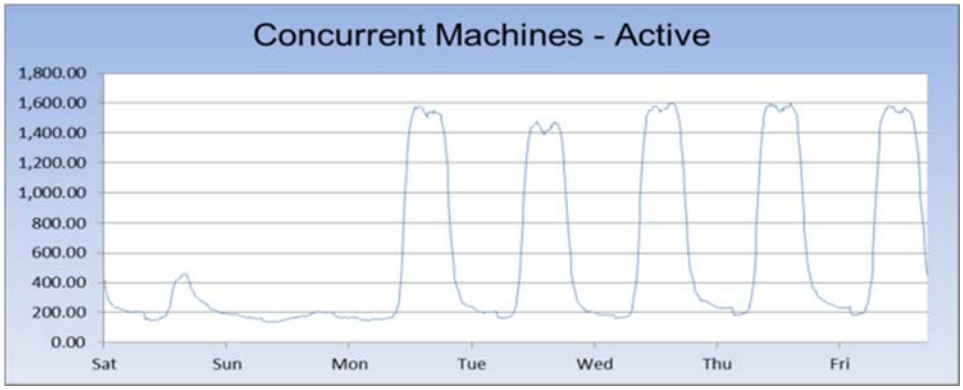


Figure 3 - Concurrent Active Machines

iv. User Applications And System Applications

Figure 4 identifies CPU, Memory, and Disk I/O consumers to enable configuration for maximum performance and end user experience while reducing the capital expenditure required for the VDI infrastructure. On the server side, this enables planning for Hypervisor specifications and scalability accordingly. This information is used to right-size the infrastructure to the load and to enable proactive reduction of unforeseen performance bottlenecks.

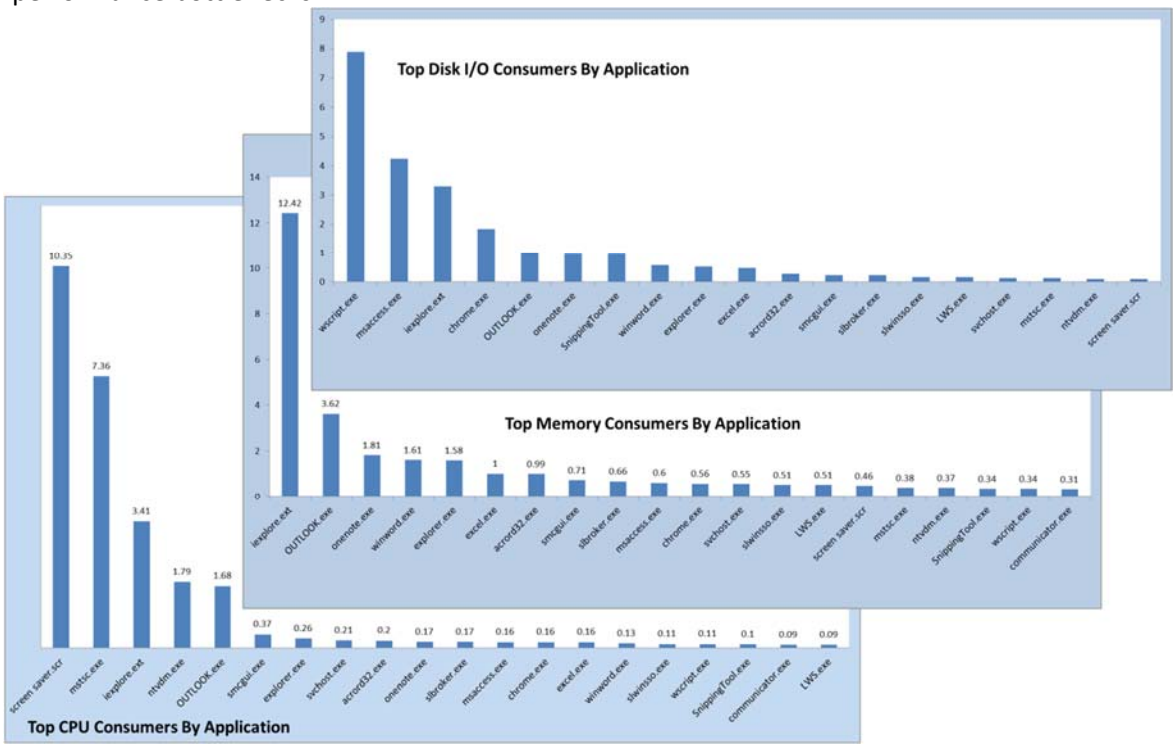


Figure 4 - User Applications

v. Hypervisors And Resource Utilization

Figure 5 is an example Assessment Report showing the quantity of necessary Hypervisors[2] to support the current scope of established VDI candidates. Calculations emphasize maximize end-user experience, peak usage intervals, and any unusual usage scenarios.

[2] Hypervisor Based Upon Two (2) 6-Core, 2.4GHz Processors, 96GB Memory, SAN, 10GB/e Network

Virtualization Report

Hypervisor Specifications[2]	Required Hypervisors	Configured Growth	Confidence Level	Consolidation Ratio
87,967 MIPS 192 GB Memory SAN/NFS I/O 2 Gb/s Network 20% Growth Rate	76	20%	87%	49:1

Predicted Enterprise Demand	Average	Minimum	Maximum
CPU (MIPS)	1,133,927	447,758	2,993,857
Memory (GB)	4,582,838	2,098,289	9,454,112
Disk IOPS	58,191	22,987	161,860
Network I/O (Mb/s)	192.61	26.3	948.5

Figure 5 – Assessment Phase Virtualization Report

vi. Target Desktop Users and Desktop/Thin Client Candidates

Figure 6 shows an example report of the physical systems that were identified for potential virtualization and provides indication of the scope. The test-period ran between 30 and 60 days, was conducted on 2,182 systems, 101 systems were not selected for virtualization due to economics and 72 machines were determined they could be deprecated.

Candidate Population

Candidates	Quantity
Total Potential	2182
Candidates Not Configured For VMP	131
Number Of Systems Which Actually Collected Data	2051
Number Of Candidates Not Recommended For Virtualization	101
Candidates Recommended For Deprecation	72
Candidates Chosen To Model	1878

Figure 6 - Potential Physical Systems for Virtualization

vii. A comprehensive, quantifiable return on investment (ROI) and total cost of ownership (TCO) report

Error! Reference source not found. Figure 7 and Figure 8 show an example report with data derived directly from the assessment phase of the methodology. The information is used to validate/justify (better word) the business aspect of the project. In other words, see? It's beneficial to move forward because here are concrete data, establishing the business justification, and identifying the goals for the project.

OPEX: Productivity Assumptions In ROI Model				
Productivity Lost Due To	**SysTrack Observed**		**Post Virtualization**	
	Minutes Per Month	Dollars Per Year (Weighted)	From Setup	Dollars Per Year
CPU	398,040	$1,393,140.00	80.00%	$278,628.00
Memory	3,960	$6,930.00	90.00%	$693.00
Disk	938,790	$4,928,647.50	10.00%	$4,435,782.75
Network	11,880	$20,790.00	95.00%	$1,039.50
Latency	2,640	$9,240.00	50.00%	$4,620.00
Application / Session Startup	0	$0.00	50.00%	$0.00
Virtual Memory	0	$0.00	50.00%	$0.00
Virtual Machine	0	$0.00	0.00%	$0.00
Software Installation	0	$0.00	95.00%	$0.00
Software Updates	0	$0.00	95.00%	$0.00
System Event	35,970	$188,842.50	40.00%	$113,305.50
System Fault	30	$210.00	95.00%	$10.50
Hardware Conflict / Failure	0	$0.00	100.00%	$0.00
	$1,391,310.00	$6,547,800.00		$4,834,079.25

Figure 7 - OPEX ROI Model

OPEX: IT Support Assumptions In ROI Model						
Desktop / Laptop + Thin Client	**Desktop / Laptop Current**			**Thin Client Projected**		
Operational Expenses	Industry Default	Override	Value Used	From Setup	Savings	Cost
Administration (Adds and Changes)	$10.80		$10.80	65.00%	$7.02	$3.78
Hardware Configuration and Reconfiguration	$25.52		$25.52	86.70%	$22.13	$3.39
Hardware Deployment	$6.87		$6.87	76.70%	$5.27	$1.60
OS And Software Deployment	$118.79		$118.79	95.00%	$112.85	$5.94
OS and Application Management	$31.42		$31.42	95.00%	$29.85	$1.57
Backup, Archiving, And Revovery	$6.87		$6.87	50.00%	$3.44	$3.44
Service Desk (Tier 0/1)	$234.63		$234.63	50.00%	$117.32	$117.32
Security Management	$29.45		$29.45	55.00%	$16.20	$13.25
IT Administration	$14.73		$14.73	55.00%	$8.10	$6.63
	$479.08		$479.08		$322.16	$156.92
Solution Servers (Brioker, Cluster Manager)	**Desktop / Laptop Current**			**Thin Client Projected**		
Operational Expenses	Industry Default	Override	Value Used	From Setup	Savings	Cost
Administration (Adds and Changes)	$25.00		$25.00	65.00%	$16.25	$8.75
Hardware Configuration and Reconfiguration	$50.00		$50.00	86.70%	$43.35	$6.65
Hardware Deployment	$50.00		$50.00	76.70%	$38.35	$11.65
OS And Software Deployment	$150.00		$150.00	95.00%	$142.50	$7.50
OS and Application Management	$150.00		$150.00	95.00%	$142.50	$7.50
Backup, Archiving, And Revovery	$100.00		$100.00	50.00%	$50.00	$50.00
Service Desk (Tier 0/1)	$0.00		$0.00	50.00%	$0.00	$0.00
Security Management	$50.00		$50.00	55.00%	$27.50	$22.50
IT Administration	$250.00		$250.00	55.00%	$137.50	$112.50
	$825.00		$825.00		$597.95	$227.05
Network	**Desktop / Laptop Current**			**Thin Client Projected**		
Operational Expenses	Industry Default	Override	Value Used	From Setup	Savings	Cost
Administration (Adds and Changes)	$10.00		$25.00	65.00%	$6.50	$3.50
Hardware Configuration and Reconfiguration	$50.00		$50.00	86.70%	$43.35	$6.65
Hardware Deployment	$50.00		$50.00	76.70%	$38.35	$11.65
OS And Software Deployment	$100.00		$150.00	95.00%	$95.00	$5.00
OS and Application Management	$25.00		$150.00	95.00%	$23.75	$1.25
Backup, Archiving, And Revovery	$50.00		$100.00	50.00%	$25.00	$25.00
Service Desk (Tier 0/1)	$0.00		$0.00	50.00%	$0.00	$0.00
Security Management	$100.00		$50.00	55.00%	$55.00	$45.00
IT Administration	$150.00		$250.00	55.00%	$82.50	$67.50
	$535.00		$825.00		$369.45	$165.55
SAN	**Desktop / Laptop Current**			**Thin Client Projected**		
Operational Expenses	Industry Default	Override	Value Used	From Setup	Savings	Cost
Administration (Adds and Changes)	$750.00		$25.00	65.00%	$487.50	$262.50
Hardware Configuration and Reconfiguration	$2,000.00		$50.00	86.70%	$1,734.00	$266.00
Hardware Deployment	$3,000.00		$50.00	76.70%	$2,301.00	$699.00
OS And Software Deployment	$250.00		$150.00	95.00%	$237.50	$12.50
OS and Application Management	$250.00		$150.00	95.00%	$237.50	$12.50
Backup, Archiving, And Revovery	$500.00		$100.00	50.00%	$250.00	$250.00
Service Desk (Tier 0/1)	$250.00		$0.00	50.00%	$125.00	$125.00
Security Management	$2,000.00		$50.00	55.00%	$1,100.00	$900.00
IT Administration	$1,000.00		$250.00	55.00%	$550.00	$450.00
	$10,000.00		$825.00		$7,022.50	$2,977.50

Figure 8 - Comprehensive Savings Analysis

viii. Progression / Milestones

Figure 9 shows an example of the measurable milestones for the deployment which will facilitate a comprehensive, educated go/no go decision process and progression timeline.

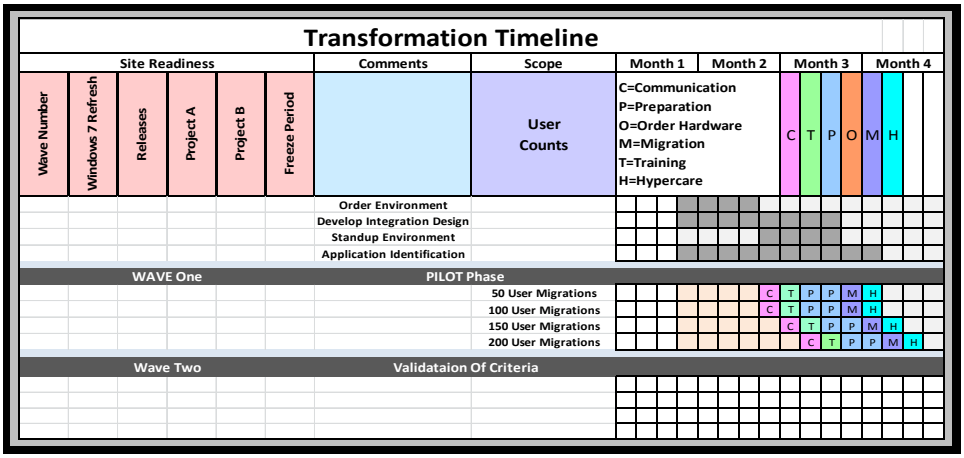


Figure 9 - Measurable Milestones

3. Design

a. Objectives

i. Build the design to the precise operating environment
ii. Align the design with the business and technical objectives
iii. Develop a proposal with complete details of the overall effort to include the:
    1. Server, Storage, and Networking Architecture
    2. Software
        a. Which applications can be thinned, delivered or streamed efficiently
        b. Licensing and Procurement
iv. Prepare the candidate pilot users
v. Eliminate potential for over-design and expensive over-provisioning
vi. Stakeholder agreement for the acceptance criteria
vii. Agree upon the final architecture and operating environment

b. Solution

i. Establish the Virtualization Candidate Profile
ii. Use actual data to create an explicit hardware architecture
iii. Construct and socialize target architecture

4. Deploy

a. Objectives

i. Prepare detailed pilot/deployment plan
ii. Align with the User Community and the IT organization for the pilot/deployment
iii. Prepare users and IT personnel
iv. Establish the baseline for a smooth transition to the target operating environment
v. Migrate the system into production
vi. Re-calibrate the migration plan

b. Solution

i. Validate the:
    1. Overall Design
    2. Lessons learned from the assessment phase
    3. Success Criteria
    4. Scalability
ii. Align the virtualization project to the engineering effort

5. Manage

a. Objectives

i. Ensure effective control of operating environment transfer
ii. Ensure training, documentation and overall knowledge transfer
    1. Streamlining application delivery and thinning applications are examples of new concepts to be embraced by IT personnel
iii. Ensure ROI is recognized

b. Solution

i. Infrastructure management changes slightly; train IT personnel for prominent image management
ii. Debrief the implementation; cycle back with questionnaire. Address any deficiencies to ensure ongoing success.
iii. Produce audit reports to demonstrate anticipated and actual ROI and TCO

6. Proposed Thin Client Configurations[3]

HP maintains that a truly effective implementation requires a detailed analysis. For the purposes of this document, Hewlett-Packard will utilize example information to produce a configuration for <500 users and a configuration for >500 users. The data utilized in this exercise does not reflect actual data and should not be used as a guide or baseline for any real-world implementation. Figure 10 shows a combined diagram of two proposed configurations for 100 users and 3150 users. This figure is for example purposes only

i. See Figure 10 for an example configuration for greater than 500 users — 3150 Users
   1. This solution will support the following:
      a. Task Worker – 13 iops/user = ~1500 users
      b. Productivity worker – 20 iops/user = ~1000 users
      c. Knowledge Worker – 30 iops/user = ~650 users
ii. See Figure 10 for an example configuration for less than 500 users — 100 Users
   1. This solution will support the following:
      a. Task Worker – 13 iops/user = ~65 users
      b. Productivity worker – 20 iops/user = ~25 users
      c. Knowledge Worker – 30 iops/user = ~10 users

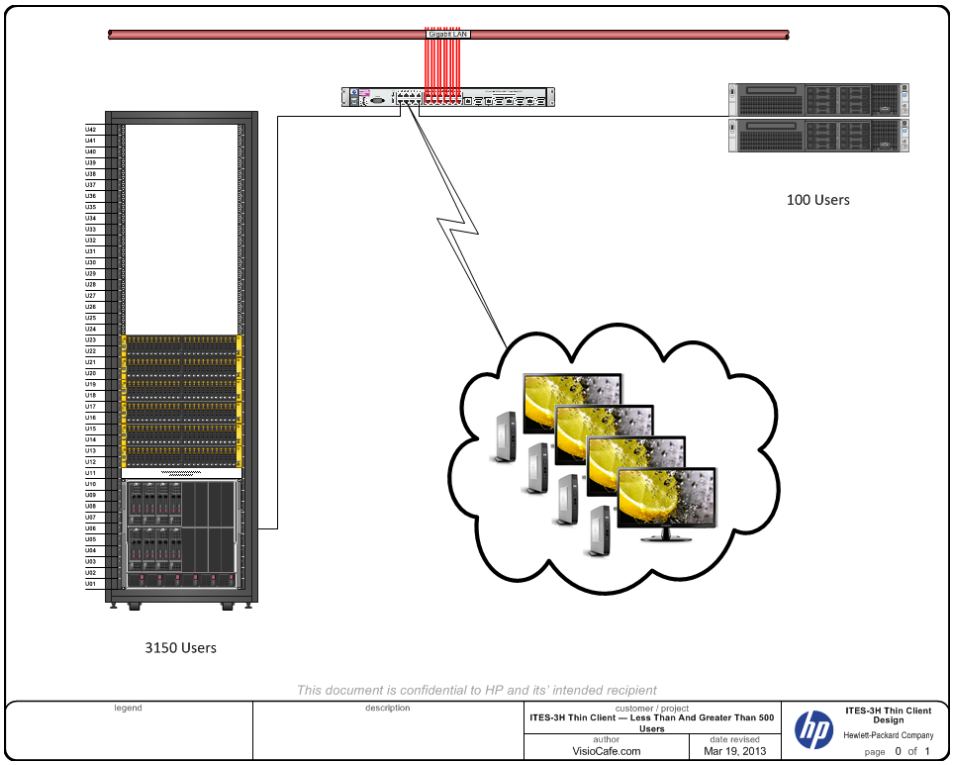


Figure 10 - 3150 User And 100 User Thin Client Diagram

[3] Proposed Thin Client Configurations are for example purposes only and are not intended for real-world use.

iii. Bills Of Material For Proposed Thin Client Configurations

1. Figure 11 shows the Bill Of Materials for the proposed Thin Client Configuration — 3150 Users

Thin Client Configuration — Greater Than 500 Users

Quantity	Catalog Identification	Description
		Enterprise Level Storage System
1	QR485A	HP 3PAR StoreServ 7400 4-N Storage Base
8	QR490A	HP M6710 2.5in 2U SAS Drive Enclosure
192	QR494A	HP M6710 450GB 6G SAS 10K 2.5in HDD
1	QR516A	HP 3PAR 7000 Service Processor
8	QK734A	HP Premier Flex LC/LC OM4 2f 5m Cbl
		Additional Array Drive - 450 GB
144	QR494A	HP M6710 450GB 6G SAS 10K 2.5in HDD
		Additional Array Drive - 300 GB
32	652564-B21	HP 300GB 6G SAS 10K 2.5in SC ENT HDD
		Blade Server
14	641016-B21	HP BL460c Gen8 10Gb FLB CTO Blade
14	662063-L21	HP BL460c Gen8 E5-2680 FIO Kit
14	662063-B21	HP BL460c Gen8 E5-2680 Kit
224	672631-B21	HP 16GB 2Rx4 PC3-12800R-11 Kit
14	684212-B21	HP FlexFabric 10Gb 2P 554FLB FIO Adptr
14	647590-B21	HP FlexFabric 10Gb 2P 554M Adptr
2	641016-B21	HP BL460c Gen8 10Gb FLB CTO Blade
2	662063-L21	HP BL460c Gen8 E5-2680 FIO Kit
2	662063-B21	HP BL460c Gen8 E5-2680 Kit
32	672631-B21	HP 16GB 2Rx4 PC3-12800R-11 Kit
		Blade System Chassis
1	507019-B21	HP BLc7000 CTO 3 IN LCD ROHS Encl
2	684212-B21	HP FlexFabric 10Gb 2P 554FLB FIO Adptr
2	647590-B21	HP FlexFabric 10Gb 2P 554M Adptr
2	QK763A	HP 1.2TB MLC IO Accelerator for Blade Sy
2	571956-B21	HP BLc VC FlexFabric 10Gb/24-port Opt
2	638526-B21	HP BLc VC Flex-10/10D Module Opt
4	AJ716B	HP 8Gb Short Wave B-Series SFP+ 1 Pack
8	455883-B21	HP BLc 10Gb SR SFP+ Opt
1	517521-B22	HP 6X 2400W Plat Ht Plg FIO Pwr Sply Kit
1	456204-B21	HP BLc7000 DDR2 Encl Mgmt Option
1	413379-B21	HP BLc7000 1 PH FIO Power Module Opt
1	517520-B21	HP BLc 6X Active Cool 200 FIO Fan Opt
1	433718-B21	HP BLc7000 10K Rack Ship Brkt Opt Kit
		48" Equipment Cabinet
1	BW908A	HP 642 1200mm Shock Intelligent Rack
1	BW946A	HP 42U Location Discovery Kit
1	BW932A	HP 600mm Black Rack Stabilizer Kit
1	BW930A	HP Air Flow Optimization Kit
1	BW909A	HP 42U 1200mm Side Panel Kit
2	AF916A	HP 3PH 48A NA/JP Pwr Monitoring PDU
4	AF500A	HP 2, 7X C-13 Stk Intl Modular PDU
2	A0K04A	HP 1.37m 10A C13-C14 Gray Jpr Cord
2	142257-006	HP 10A IEC320 C14-C13 4.5ft US PDU Cable
		Thin Client Terminals
3150	H2P19AA#ABA	HP t510 Thin Client
		Installation and Support
2	H1K92A3 7G3	HP Proliant DL38x(p) HW Support
2	HA113A1 5A6	300 Series HW Installation SVC
2	H1K92A3 4YD	HP IC ML-DL-BL SW Sup
2	H1K92A3 QBL	HP VSA SW LTU SW Supp
		Software
1	BC795A	HP 3PAR 7400 Reporting Suite LTU
1	BC773A	HP 3PAR 7400 OS Suite Base LTU
168	BC774A	HP 3PAR 7400 OS Suite Drive LTU
1	BC785A	HP 3PAR 7400 Dynamic Opt Base LTU
168	BC786A	HP 3PAR 7400 Dynamic Opt Drive LTU
2	TA688BAE	HP StoreVirtual VSA SW E-LTU

Figure 11 - Thin Client Configuration 3150 Users

2. Figure 12 shows the Bill Of Materials for the proposed Thin Client Configuration — 100 users

Thin Client Configuration — Less Than 500 Users

Quantity	Catalog Identification	Description
		Enterprise Level Storage System
		Additional Array Drive - 450 GB
		Additional Array Drive - 300 GB
		Rack Mounted Server
2	653200-B21	HP DL380p Gen8 8-SFF CTO Server
2	662228-L21	HP DL380p Gen8 E5-2680 FIO Kit
2	662228-B21	HP DL380p Gen8 E5-2680 Kit
32	672631-B21	HP 16GB 2Rx4 PC3-12800R-11 Kit
8	652564-B21	HP 300GB 6G SAS 10K 2.5in SC ENT HDD
2	652235-B21	HP 12.7mm SATA DVD RW Jb Kit
2	647594-B21	HP Ethernet 1Gb 4-port 331T Adapter
2	684208-B21	HP Ethernet 1GbE 4P 331FLR FIO Adptr
2	631681-B21	HP 2GB FBWC for P-Series Smart Array
2	666988-B21	HP 2U Security Bezel Kit
2	663478-B21	HP 2U SFF BB Rail Gen8 Kit
2	673644-B21	HP 785GB MLC G2 PCIe IO Accelerator
4	656363-B21	HP 750W CS Plat PL Ht Plg Pwr Supply Kit
		Blade System Chassis
1	507019-B21	HP BLc7000 CTO 3 IN LCD ROHS Encl
2	684212-B21	HP FlexFabric 10Gb 2P 554FLB FIO Adptr
2	647590-B21	HP FlexFabric 10Gb 2P 554M Adptr
2	QK763A	HP 1.2TB MLC IO Accelerator for Blade Sy
2	571956-B21	HP BLc VC FlexFabric 10Gb/24-port Opt
2	638526-B21	HP BLc VC Flex-10/10D Module Opt
4	AJ716B	HP 8Gb Short Wave B-Series SFP+ 1 Pack
8	455883-B21	HP BLc 10Gb SR SFP+ Opt
1	517521-B22	HP 6X 2400W Plat Ht Plg FIO Pwr Sply Kit
1	456204-B21	HP BLc7000 DDR2 Encl Mgmt Option
1	413379-B21	HP BLc7000 1 PH FIO Power Module Opt
1	517520-B21	HP BLc 6X Active Cool 200 FIO Fan Opt
1	433718-B21	HP BLc7000 10K Rack Ship Brkt Opt Kit
		48" Equipment Cabinet
1	BW908A	HP 642 1200mm Shock Intelligent Rack
1	BW946A	HP 42U Location Discovery Kit
1	BW932A	HP 600mm Black Rack Stabilizer Kit
1	BW930A	HP Air Flow Optimization Kit
1	BW909A	HP 42U 1200mm Side Panel Kit
2	AF916A	HP 3PH 48A NA/JP Pwr Monitoring PDU
4	AF500A	HP 2, 7X C-13 Stk Intl Modular PDU
2	A0K04A	HP 1.37m 10A C13-C14 Gray Jpr Cord
2	142257-006	HP 10A IEC320 C14-C13 4.5ft US PDU Cable
		Thin Client Terminals
350	H2P19AA#ABA	HP t510 Thin Client
		Installation and Support
2	H1K92A3 7G3	HP Proliant DL38x(p) HW Support
2	HA113A1 5A6	300 Series HW Installation SVC
2	H1K92A3 4YD	HP IC ML-DL-BL SW Sup
2	H1K92A3 QBL	HP VSA SW LTU SW Supp
		Software
1	BD692AAE	VMw View Prm Bndl 100Pk 3yr E-LTU
2	TA688BAE	HP StoreVirtual VSA SW E-LTU
2	TC278AAE	HP Insight Control ML/DL/BL Bundle E-LTU
1	H1K92A3 63E	VMw View Prm Bndl 100Pk 3yr SW

Figure 12 - Thin Client Configuration 100 Users

1. *Identify the resources and timeline to facilitate the development and maintenance of the proposed Thin Client configurations;*

The amount of resources and time to allocate to any VDI implementation will vary based upon the scope. Upon completion of the assessment and pilot phases, an accurate roadmap of the overall engineering effort is evident and easily produced. Again, the architecture is based many variables but primarily on total average IOPS for each of the user classifications and will primarily drive the solution. The end point (user count) will also play a role in determining the hypervisor, server, storage, and network hardware architecture to support the effort. In almost every case, required personnel are as follows, but not limited to:

a. **Resources**
   i. Project Lead — Engage with the project lead, such as someone who manages the desktop environment.
   ii. Project Manager — Oversight and management for the deployment
      1. Site preparation
      2. Solution implementation
      3. The migration Test Plans for applications and users
      4. Acceptance criteria
      5. Transfer of ownership from deployment to operations.
   iii. VDI Subject Matter Expert (SME) — Discuss technical objectives with the VDI Solution Engineer or VDI Solution Architect and the customer VDI SME.
   iv. Stakeholders — Officials with the vested interest in the implementation
   v. Management Principal(s) with decision making authority
   vi. Operations principal(s) with decision authority from all applicable organizations
   vii. Administrative principal(s) with decision authority from all applicable organizations

b. **Time Line**
   i. **Discover** — 1 - 2 Weeks
      a. Establish and agree upon the business objectives
      b. Ensure the technical objectives are completely identified and agreed upon
      c. Gain agreement and commitment from stakeholders; a virtual environment migration requires strong stakeholder commitment along with their support and promotion within the organization
   ii. Assess — 4 - 6 Weeks
      a. SysTrack installation and data collection commencement
      b. Extrapolate reports and present findings
      c. Establish User Segment and pilot participants
      d. Develop Statement Of Work (SOW) and Project Plan
      e. Obtain agreement and commitment to move forward
   iii. Design — 5 - 7 Days
      a. Develop, Present and Socialize the:
         i. Solution Design
         ii. High-Level Plan
         iii. Pilot Plan
         iv. Deployment Plan
         v. Success and Acceptance Criteria
         vi. Stakeholder Mission Statement for the commitment to the project
         vii. Documentation, SOW, and Pricing
         viii. Formal agreement to move forward
   iv. Deploy / Manage — 6 - 9 Months
      a. Deploy
         i. Execute the pilot
         ii. Refine the plan based on results from the Pilot
         iii. Obtain agreement and commitment on any adjustments
         iv. Commencement - Execute the Deployment Plan
         v. Daily/Weekly meetings for agreement on momentum
         vi. Adjust plan accordingly and establish agreement and commitment for any changes

vii. Follow Project Plan to completion of Deployment Phase
viii. Develop Migration Test Plans for Applications and Users
ix. Develop Functionality and Operational Acceptance Test Plans

b. Manage
i. Transfer full control to IT personnel
ii. Oversee progression into Steady State
iii. Transfer of ownership from deployment to operations
iv. Ensure Knowledge Transfer
v. Execute Migration Test Plans for Applications and Users
vi. Execute Acceptance Test Plans

2. *Describe the engineering efforts required to implement and migrate Thin Client solutions over the life of the contract*

a. Discover
i. Resources – The IT organization should be prepared to provide the following resources for Desktop, Server, Storage, Networking
ii. Estimated Timeline
iii. Current Challenges
iv. Projected Challenges

b. Assess
i. Implementation ideas
ii. User Type Segmentation

c. Design
i. Image Creation and Management
ii. Migration efforts

d. Deploy
i. Pilot
ii. Roll-Out
iii. Control Transfer

e. Manage
i. Replica Management
ii. Security Posture
iii. Replica Management
iv. User Management

f. Support
i. Desktop Support
ii. Server Support
iii. Storage Support
iv. Networking Support

3. *Describe its understanding of the impact of Thin Client solutions and how the proposed solutions will reflect the evolution of product offerings during the life of the contract.*

Thin Client implementations or migration to a Client Virtualization infrastructure affects every part of the organization. Users, applications, servers, storage, networking, power, cooling, IT personnel, processes and procedures will experience some level of impact.

a. Impact
i. Flexible Desktop Delivery
1. Anywhere, anytime, any device, secure mobility

ii. Increased Data Security And Compliance
1. Keep desktops, data, and applications in the data center

iii. Easy And Efficient Management
1. Maintain the desktops without business interruption

iv. Cost Containment
1. A comprehensive CAPEX ROI model will be provided for each Thin Client deployment
2. A comprehensive productivity model for OPEX ROI will be provided for each Thin Client deployment. See Figure 7 for an example.

3. A Comprehensive, quantifiable cost analysis report on IT support costs will be provided as part of each Thin Client deployment. See Figure 8 for an example.
4. A Comprehensive, quantifiable return on investment (ROI) and total cost of ownership (TCO) report for the worker community will be provided as part of each Thin Client deployment. See Figure 13 for an example report.

2,500 Task Workers TCO & ROI analysis			
	Current State	Virtualized	Comments
Capital Cost Comparison			
Capital Cost Per Desktop (1.650 Total)	$874,500	$660,000	$530 Current Desktop Cost And $400 Thin Client Assumed
Capital Cost Per Laptop (850 Total)	$850,000	$340,000	$1,000 Current Laptop Cost And $400 Thin Client Assumed
Solution Block (2,500 Total Users)	N/A	$1,750,000	Includes: Virtualization Software, Servers, Networking, Storage, Deployment Services, Hardware & Software Support
Unused Client Software	$1,850,000	$0	Observed As Unused $10 Per Unused Licenses Assumed Amortized Over 3 Years
Total 3-Year CAPEX	$3,574,500	$2,750,000	**-$824,500** less (-23%)
Operating Cost Comparison			
End User Productivity Lost Per Year	$6,540,000	$4,834,000 **+$1,706,000** Gain (+26%)	23,188 Hours Lost Per Machine Observed Current State 17,159 Hours Lost Per Machine Estimated Virtualized $35 Per Hour Labor Rate Assumed
IT Support Costs Per Year	$1,200,000	$446,000 **+$754,000** (+63%)	Industry Standard Support Costs Used
Power & Cooling Per Year	$89,000	$68,000 **+21,000** (+24%)	$ .0975 Per kWh Assumed
Data Center Footprint	N/A	60u	
Total 3-Year OPEX	$23,487,000	$16,044,000	**+$5,118,000** End User Productivity Gain **+$2,325,000** IT Operational Savings
Total 3-Year Return On Investment	N/A	**+$4,693,000**	Capital Costs – Operating Savings / Gains = ROI

Figure 13 - Task Worker TCO & ROI Analysis

5. Depending upon the scale of the Thin Client implementation the organization may achieve up to an 80% reduction in endpoint maintenance costs.
6. A typical software upgrade can take one week for 30, or more desktops. Moving to virtualized desktops the same upgrade will take only part of a day. This typically equates to an 80% reduction in maintenance costs for this activity.
7. Move to less individual desktops and printers management to a more server-centric management methodology. Up to 80% of the current IT staff can now focus their time and attention to strategic activity.
8. A new desktop can cost more than $1,250—or $3,750. By virtualizing with a Virtual Desktop Infrastructure, there is a potential cost savings of $2,500 per desktop over the life of the ITES-3H contract.

v. Scalability

1. Increased scalable opportunities
2. Establish platform advancements toward tablet use
3. Servers do not have to exist at smaller sites

vi. Usability

1. Users can sign on to a system and run needed applications. Users can move to the next computer that is convenient, access via CAC, and up comes their desktop, just the way they left it at the previous system.
2. 65% increase in end-user productivity

vii. IT Personnel

1. The IT staff is now able to manage at the server level, with greater degrees of functionality.
2. 80% saved in IT travel and maintenance time per week
3. 80% saved weekly in IT staff time through centralized server management
4. Power and cooling
    a. Thin clients reduce power usage by up to 75 percent compared to thick clients
5. Reduced IT staff efforts of administering and maintaining an altered desktop
6. Increased IT resources available for new projects due to streamlined client maintenance

viii. **Maintenance**

1. Because they don't have hard disks—the part of a system most likely to fail—I can replace them every seven to eight years instead of four to five years
2. HP Virtual Desktop Infrastructure will help them become more efficient, freeing staff time to learn the technology to a greater depth while working on more strategic projects."
3. Thin clients can be configured, patched, and maintained in about 50 percent less time.
4. Easier patch and revision management
5. Faster more efficient backup methods
6. Centralizing Management

ix. **Support**

1. The support staff will be available for strategic projects because there is a potential of 60% cost reduction for desktop support
2. Personnel can focus more on server management and less on desktop management
3. End point deployment faster and more standardized.
4. Faster Operating System and application deployment
5. Faster more efficient recovery methods
6. Reduced system faults and fewer hardware conflicts
7. can deploy new features, functions, and use cases quickly to the global pool, in a way that doesn't disrupt users."
8. Automatic software installation

x. **Security**

1. Security management
2. Enhanced information security due to data stored centrally vs. on endpoints
3. Security is enhanced because all applications and data are stored in the data center rather than on the endpoints.

xi. **Evolution**

HP is on its seventh generation of VDI Reference Architectures. These have developed based on delivering predictable performance and scalability. A VDI users' performance is dependent on a tightly integrated solution and our focus is cost-effectively optimizing the solution, focusing on remove the next bottle necks to performance. We believe we have the most tightly integrated cost effective tiered storage solution. We are now also leading the industry with Graphics Enabled VDI which addresses the needs of both the Desktop Power User and the Performance User. We are bringing to market the industry's broadest range of virtualized graphics and the highest GPU density. We will be supporting VMware, Citrus and Microsoft graphics enabled VDI solutions.

xii. **Impact**

HP maintains an industry leadership role with regard to hardware, software, converged infrastructure, reference architecture designs. HP's Research and Development (R&D) organizations are continually fed performance testing data to further support our technological roadmaps. HP continues to evolve and drive technological standards for best of breed, predictable and scalable business technology solutions.

The United States Department of Defense (DoD) is a highly strategic customer of Hewlett-Packard and has been as long as HP has been in business. HP continually encourages input from our customers and has historically encouraged the United States Government to help influence emerging technological products and DoD standards for those products.

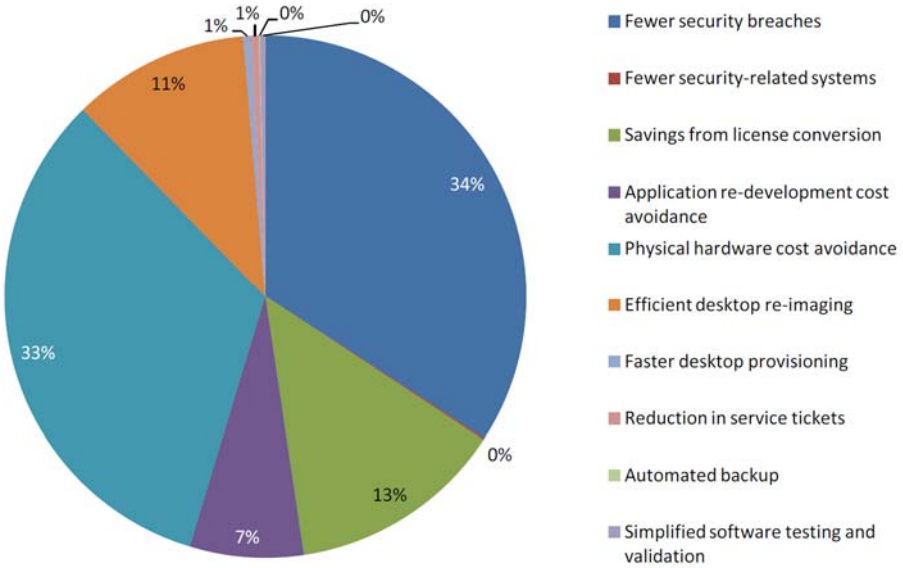
xiii. **High-Level Benefit Summary**

In almost any Thin Client migration the following benefits can be recognized

1. Lower IT administration
2. Positive contribution to continuity of operations plans
3. Easier hardware failure management
4. Easier to sustain a more secure environment
5. Multilevel security compliance is feasibly achievable
6. Ease of use
7. Faster start-up
8. Lower hardware costs
9. More value of lesser-cost hardware

10. Increased reliability
11. More simplistic hardware upgrade path
12. Smarter allocation of software licensing
13. Less energy consumption
14. Lower heat output and lesser footprint
15. Less ambient noise
16. More effective network bandwidth utilization
17. Operable in Hostile Environments
18. Thin Client hardware is a less a less desirable target for theft

xiv. **Three-Year Risk Adjusted Benefits**[4]



Summary

A standard methodology is applicable to any Thin Client implementation. The principles set forth in HP's Client Virtualization methodology are applicable to a configuration for <500 users and a configuration for >500 users. Experienced personnel, plus a proven methodology, add up to a successful project that aligns the business objectives with the technical objectives. Hewlett-Packard's Client Virtualization Methodology will enable a cost-effective, expedient Thin Client deployment.

[4] Source: Forrester Research, Inc.

Backup Information

See Figure 14 for an illustration of Hewlett-Packard's Current Architecture Landscape.

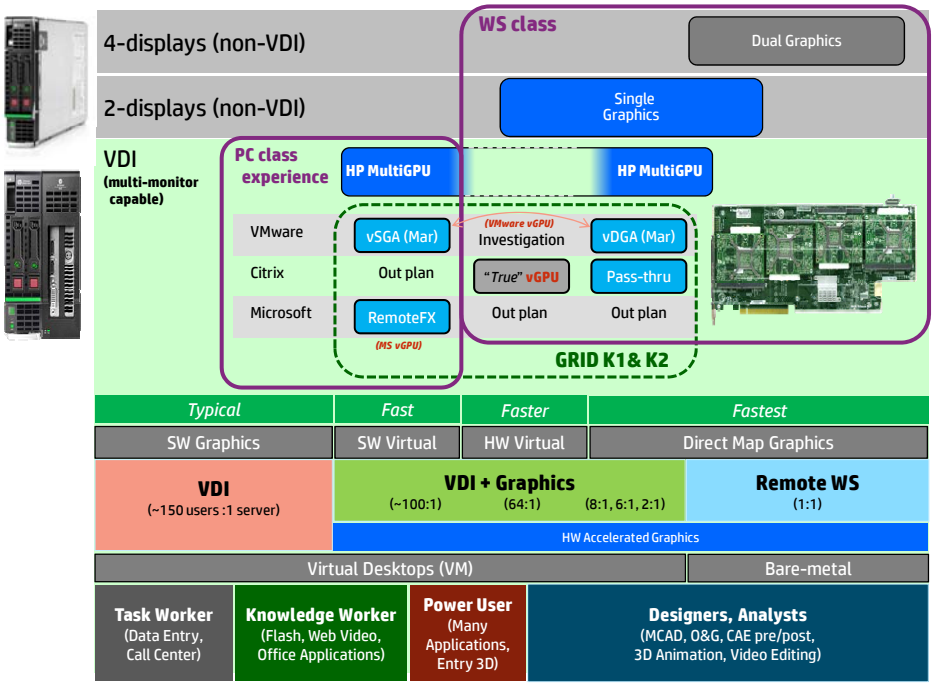


Figure 14 - HP Generation 8 Graphics Server Landscape