Consolidation Assessment Final Report

Town of Marshfield

January 18, 2010

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Section 1 – Executive Overview

Town of Marshfield engaged GovConnection to conduct a server consolidation analysis to help determine how a server consolidation would benefit Town of Marshfield and to evaluate a selected server consolidation scenario. GovConnection has been using VMware Capacity Planner to automate the collection of inventory, performance and utilization data since December 7, 2009. Data was collected on 14 servers specified by Town of Marshfield for review and analysis during the installation. The performance data was collated and analyzed.

GovConnection developed this assessment to establish and define both the technical and financial baseline workload that exists for the identified 14 servers. This report provides inventory and performance data for these servers.

The list of 14 servers in the Town of Marshfield domain was reviewed by Town of Marshfield to verify that all servers in their data environment were consolidation candidates. Using the workload of these consolidation candidates as an input to a capacity model, several consolidation scenarios were built and then compared against the existing costs. Upon review of these possible scenarios, Town of Marshfield can then determine the feasibility of any of these as potential consolidation projects.

Also included with this report is a separate document that compares the Total Cost of Ownership (TCO) of the new consolidated environment against maintaining and growing the existing environment. This report provides all the detailed calculations behind the three-year cost saving estimates. It demonstrates how Town of Marshfield can realize dramatic savings in server hardware, storage, network, data center power and cooling, real estate space, and disaster recovery by implementing VMware solutions. The report also outlines the initial investment required to purchase VMware software, receive professional training, and to assess and deploy a virtual infrastructure.

Based upon consolidating the 14 identified servers, implementing VMware products provides a projected IT capital savings of $145,156 and operating savings of $143,002 over five years.

Section 2 – Collection Results Inventory

Capacity Planner found 15 systems on all domains at Town of Marshfield. Only 14 of these servers were inventoried to be included in this consolidation study.

Inventoried / Monitored Systems by Week
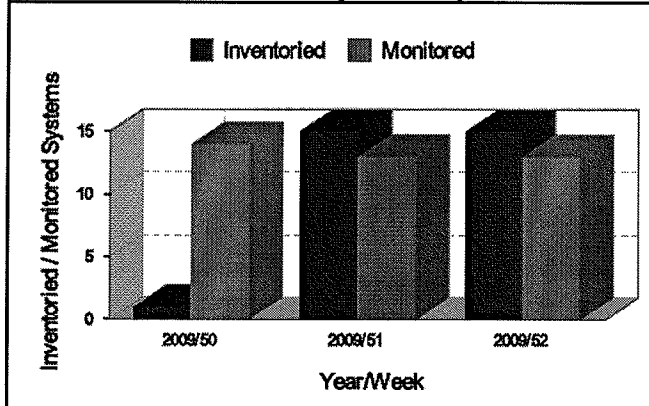
Consolidatable Systems
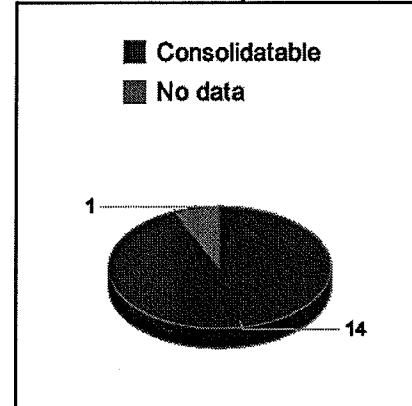
Name	System Population	Number	Reason for Exclusion
A	All discovered systems	15	N/A
B	No data,		• VMware Capacity Planner unable to connect to system
C	Invalid data		• VMware Capacity Planner identified questionable anomalies (e.g. CPU speed reporting as 3MHz)
D	Incomplete data	(1)	• VMware Capacity Planner did not obtain a complete sampling of data across the entire sampling period
E	Total Systems Analyzed	14	
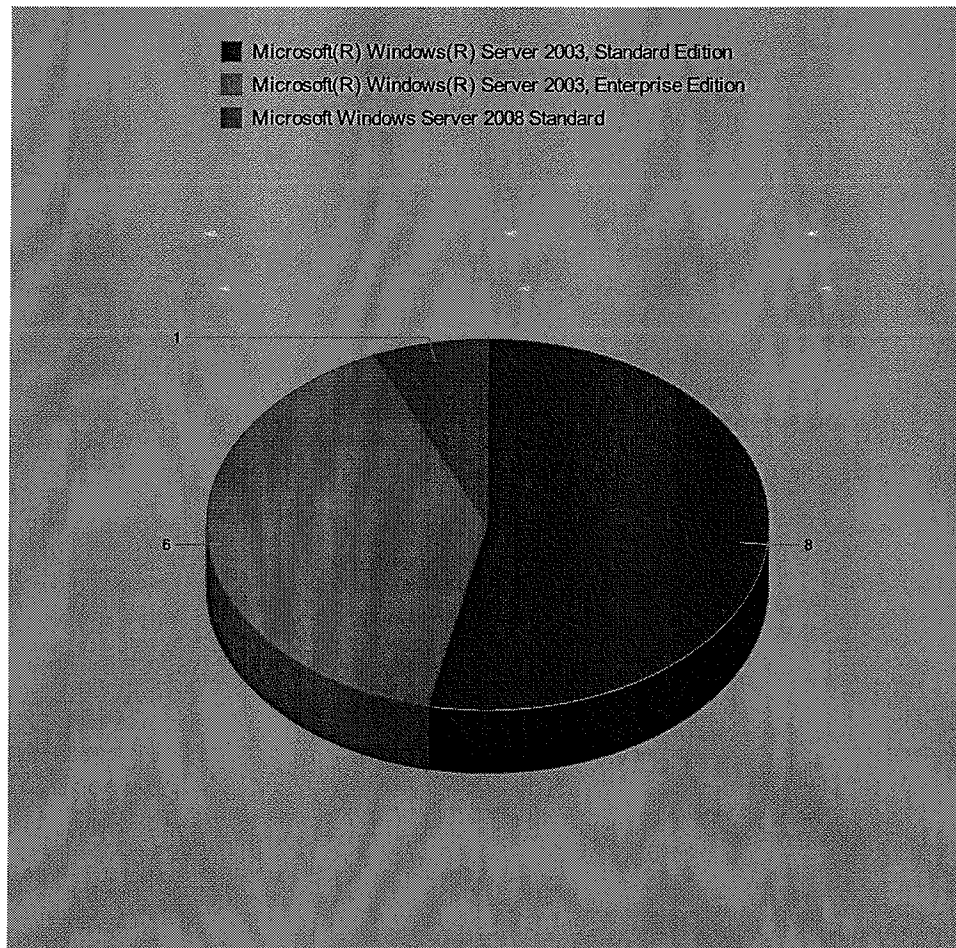
Figure 1: System OS Distribution

The majority of systems at T O M are 2 Core CPU systems; 53.33% are 2 Core processor machines with a detailed breakdown as follows:
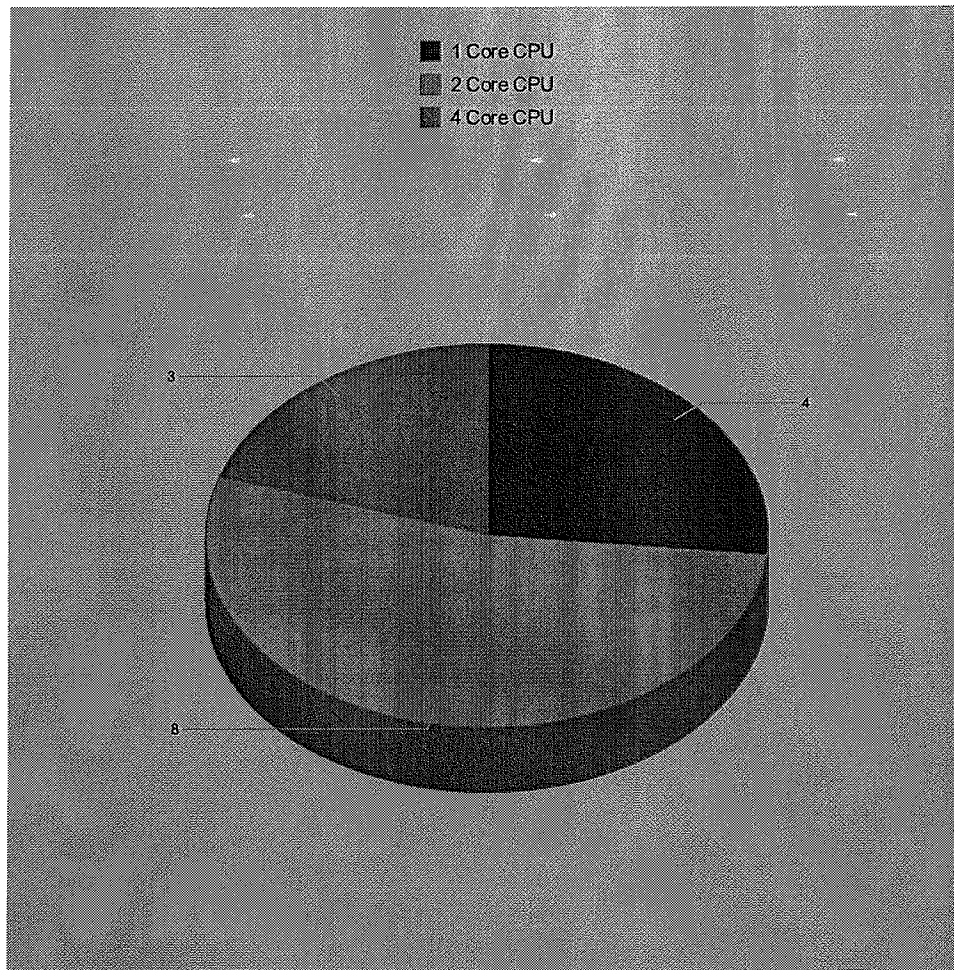
Figure 2: CPU Core Count Summary

Type of System	Number of Systems	Percentage of Total
2 Core CPU	8	53 %
1 Core CPU	4	27 %
4 Core CPU	3	20 %
TOTAL	15	100%

Table 3: CPU Core Count

Section 5 –Consolidation Scenarios

Consolidation Processing Overview

After collecting performance and inventory data, information can be correlated to generate consolidation recommendations from the Capacity Planner Dashboard. These recommendations are manually initiated by a Capacity Planner Administrator and can be executed on the entire monitored group of systems or only on a specific group of systems.

Thresholds control consolidation by setting the maximum combination of loads which servers must not exceed in order to generate a successful consolidation. Capacity Planner collects many performance metrics and uses them to determine if there is a statistical fit. If the combination of loads exceeds any of these metrics, no consolidation recommendation is made.

Capacity Planner uses the peak load values when considering consolidation, not the weekly average. As statistics are received, they are evaluated to determine in what hour of the day the peak load occurs. The peak load is determined by evaluating load for a minimum of three weeks. The hour with the consistently highest load will be deemed the peak load hour and its average value becomes the peak load for the server. Each server has its own peak load hour and peak load value.

The following list of parameters is used for consolidation:

- CPU Utilization %
- CPU Queue
- Disk Busy %
- Disk Queue
- RAM Utilization %
- Page File Utilization %
- Pages/Sec
- Server Bytes/Sec

Additionally, servers are checked for conformance to minimum standards of MHz value. These values as well as the consolidation thresholds are defined by the Capacity Planner Administrator. Any systems that do not meet these minimum standards are considered obsolete.

Phantom servers are provided to run "what-if-analysis." Phantom servers are servers that do not currently exist in the environment. Through the use of performance projections, phantom servers can demonstrate projected server consolidation results and allow for the impact analysis of potential future hardware configurations and purchases within the environment.

After discussions with Town of Marshfield, it was determined that we should use the Dell PowerEdge R710 as the target or phantom server.

The standard threshold limits are as follows and are considered to be Capacity Planner best practices.

Threshold Parameter	Threshold Value	Comments
Prime Time Start	7:00	
Prime Time End	18:00	
CPU Utilization Max	50.0%	
Queue per CPU	4.0	
Pages/Sec Max	4000.0	Raised from default of 200.
RAM Utilization Max %	90.0%	Often referred to as RAM load
Page File Utilization Max %	70.0%	
Disk MB per Sec	50	
File System Cache (MB)	546	This threshold is not considered for VM workloads
Disk I/O Trans/sec	1,000	

Table 6: Consolidation Thresholds

Scenario

A scenario compares the current environment to the proposed technology architecture. This scenario serves as a high-level guide for server consolidation.

Server Consolidation Scenarios

Two scenarios were compiled using the data collected over the course of the assessment. A moderate hardware profile and an aggressive hardware profile were run against a Dell PowerEdge R710 Server as a possible target for virtualization.

Scenario 1: The moderate hardware profile uses 2 quad core 2.53 GHZ Intel CPU's with 32 GB of memory. This showed that the 15 physical servers could be virtualized on to 2 ESX host servers for a consolidation ratio of 85%. With 2 exceptions DCR1 and 10.70.70 which did not properly report CPU information.

Scenario 2: The aggressive hardware profile uses 2 quad core 2.53 GHZ Intel CPU's with 48 GB of memory. This showed that the 15 physical servers could be virtualized on to 2 ESX host for a consolidation ratio of 85%. With 2 exceptions DCR1 and 10.70.70 which did not properly report CPU information.

GovConnection recommends using the aggressive hardware profile as your hardware model going forward as it will give you more headroom to accommodate new virtual machines as your environment expands

The capacity planner tool will make server consolidation recommendations based solely on the data, such as CPU utilization, memory utilization, and disk utilization. In that sense, capacity planner

generates an idealized outcome of the greatest consolidation possible. However, true business conditions often dictate different results, such as critical database servers remaining as standalone servers because sharing resources for such critical applications could be imprudent. These considerations are why in any contemplated server consolidation plan, it is critical to adopt a strategy of replicate, validate, and implement for key application servers. This strategy will be covered in somewhat more detail in the recommendations section of this document, but suffice to say that the number of servers that the capacity planner tool indicates can be consolidated is a goal and not a guaranteed outcome. Business intelligence must factor into the decision making.

VMware Virtual Infrastructure

VMware ESX Server is high-end virtual machine software for partitioning and consolidating Intel x86 architecture computer systems in the most demanding environments. It allows an enterprise to treat one such computer as a collection of independently managed virtual machines. The virtual machines created are isolated from each other, secure, and portable. It is a cost-effective, highly scalable virtual machine platform with advanced resource management controls, which allow IT administrators to guarantee services levels across the enterprise.

By running directly on the hardware, VMware ESX Server provides fine-grained resource controls that adapt to the needs of mission-critical applications. The resource management capabilities of VMware ESX Server allow limits to be placed on the CPU, networking, memory, and disk I/O for each virtual machine.

VirtualCenter uniquely leverages virtual computing, storage, and networking to improve data center management and reduce cost.

VMotion allows dynamic changes without impacting users, thus providing rapid reconfiguration and optimization of resources across the virtual infrastructure.

Distributed Resource Scheduler helps improve resource allocation across all hosts and resource pools. DRS collects and monitors resource usage for all hosts and virtual machines in a cluster and gives recommendations for migration for both initial placement (power up) and load balancing using VMotion.

High Availability protects against host failure. In the event of a server failure, affected virtual machines are automatically restarted on other physical servers that have spare capacity within the cluster

Storage VMotion allows the live migration of virtual machine disks from one shared storage location to another with no disruption or downtime to application users.

Update Manager manages patches/updates for physical ESX Servers as well as guest operating systems, enforcing compliance and securing IT infrastructure.
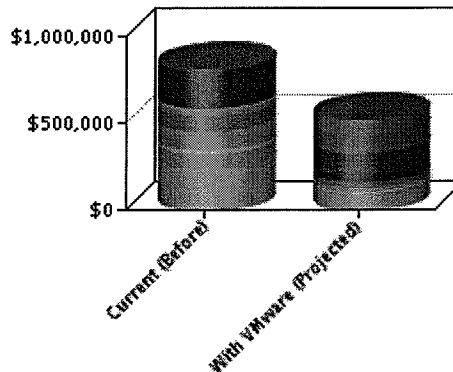
Section 7 – Return on Investment Analysis

Town of Marshfield will analyze technology investments as they would any other business investment; therefore, the best path for demonstrating that a project is worthwhile is to show a positive return on investment (ROI).

This section summarizes the financial metrics determined in this analysis. Please see the separate TCO analysis report for full details.

For Town of Marshfield, this analysis compares the total cost of ownership (TCO) of the current datacenter before virtualization, and after implementation of the proposed VMware solution.

How VMware achieves these benefits:	
Datacenter servers before virtualization:	15
Servers after virtualization:	2
Consolidation ratio:	7.5:1
Improve annual IT productivity equivalent to hiring N additional resources:	0.53 FTEs
Reduce annual energy consumption:	7.7 kWatts
Reduce annual carbon emissions:	45 tons
Datacenter space savings:	37.6 sq. feet
Decommission unused, expired and unauthorized VMs:	1 to 0 VMs
Improve provisioning and update labor productivity, saving:	30 person hours/yr

- Achieve an ROI of 151% from a 5 year total investment of $191,237 in VMware datacenter solution, and projected IT capital savings of $145,156, and operating savings of $143,002.

- Town of Marshfield is expected to achieve a net present value savings over 5 years of $191,403, an internal rate of return of 87% and a payback of 13 months.

- Datacenter Server Hardware
- Software License Cost Avoidance
- Datacenter Server Storage
- Datacenter Server Networking
- Datacenter Server Power and Cooling Consumption
- Datacenter Server Space
- Datacenter Server Provisioning

- Datacenter Server Performance Management (AppSpeed)
- Network Change and Configuration Management
- Datacenter Server Administration
- Datacenter Server Unplanned Downtime (Indirect)
- VMware Software Licensing   • VMware SnS
- Additional Software Licensing Costs (if any)

- VMware Design, Plan and Deployment Labor and Services
- VMware Training

Figure 6: Five Year TCO Comparison for VMware

Please note that the TCO analysis uses a conservative consolidation estimate. Based on the information provided, the projected number of new servers is two. Capacity Planner scenario results are two. Capacity Planner provides more specific information about the consolidation possible based on actual current server performance.

The TCO analysis uses many assumptions, industry averages, and average customer data in its calculations. Additional information on these assumptions and costs can be provided if desired.

Town of Marshfield should continue to build a multiyear strategy for server virtualization. Metrics on overall server expenses should be measured and tracked. Technology offerings should be evaluated at least annually for possible deployment, first in pilot projects and then broadly—based on results; but always with rapid return on investment and future flexibility in mind. Server consolidation projects should be pursued within the context of continual change in virtualization offerings every year. A consolidation project that takes more than two years to deploy or achieve a return on investment should be considered very carefully. A server consolidation project that inhibits further use of evolving virtualization technology should be avoided. Every time a server needs to be refreshed or upgraded, Town of Marshfield should consider how to leverage server virtualization technologies as a part of the refresh. Also Town of Marshfield should understand the virtualization offerings and strategies of their server vendors, and make that a part of their server selection process.

Section 8 – Recommendations/Implementation Plan

Virtualization Methodology

GovConnection recommends that its customers follow a methodology plan specifically tailored to virtualization when planning to deploy a virtual environment. The methodology consists of Assess, Design, Implement, and Manage.
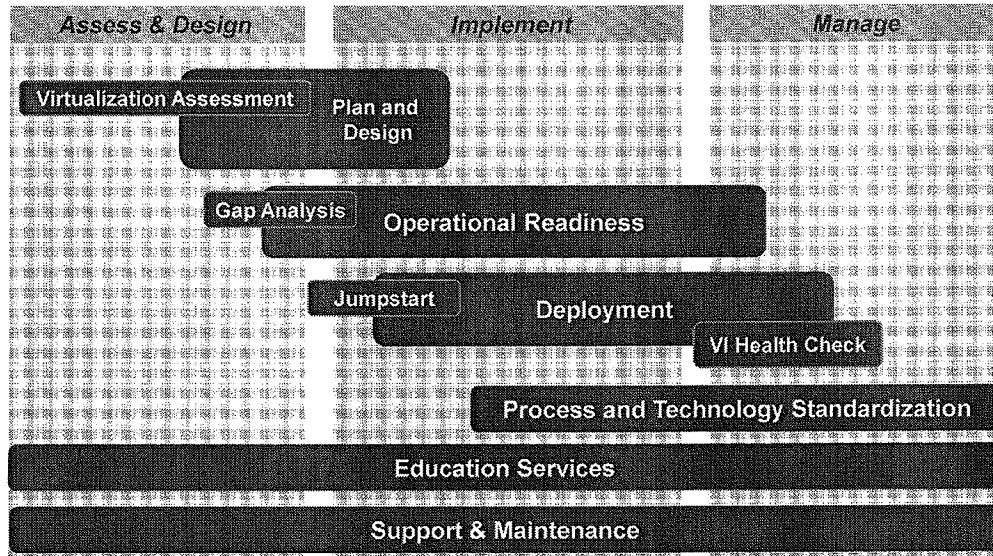
Assess & Design

This first step of this methodology is to "Plan and Design" a virtual environment. Town of Marshfield has taken the first step to plan and design its virtual environment with this assessment. This step is important because the analysis lets you identify your current environment, recognize reusable resources, and gives you the technical and financial information to prepare for the next phase— Implement.

Implement

During the Implement phase of Virtualization Methodology, Town of Marshfield refines the initial plan developed in the Assess & Design phase and prepares for its organization for operational changes. During this phase, a company may perform a Gap Analysis to determine operational readiness. A company may also decide a Jumpstart Service would benefit its employees.

Gap Analysis
As a precursor to implementation, a company may choose to perform a strategic or operational gap analysis to compare its actual server performance with its potential server performance. The gap analysis identifies where the company is at now and identifies where the company needs to be. Identifying these two elements is a business discussion often directly related to the company's mission or annual goals. The gap analysis documents the variance between actual capacity and business requirements; it helps the company discover which areas could be improved. It can also be used to justify the capital expenditure of a new investment.

Jumpstart
In any new server consolidation, the first hurdle to clear is that of getting the staff familiar and experienced with virtualization. Combining the best advantages of classroom training (quick transfer of knowledge) with the best advantages of self-study (real world application knowledge versus controlled lab environments); VMware ESX Server and vCenter Jumpstarts are the best way to educate staff in their own datacenter on their own hardware.

The concept behind the Jumpstart is to have a VMware Certified Professional work with Town of Marshfield IT to show them how to implement ESX Server and vCenter using actual Town of Marshfield servers.

Manage

Once Town of Marshfield has implemented a virtual environment, it will have the challenge of maintaining and managing that new environment. Town of Marshfield will need to review and standardize processes for this technology. A Virtualization Health Check may be in order to confirm that Town of Marshfield is utilizing this new technology to its upmost potential.

Virtualization Health Check
A virtualization health check is a technical analysis of the Town of Marshfield's production VMware Virtual Infrastructure environment. During this analysis, Town of Marshfield IT Server, Storage, and Network IT staff engage in an onsite best practices workshop regarding production VM Virtual Infrastructure environments. The result of the health check is a report regarding the current state of the VMware Virtual Infrastructure environment with actionable recommendations for improvement.

Town of Marshfield's Recommended Implementation Plan

Production Environment Recommendation

Capacity Planner shows the maximum consolidation scenarios possible given the resource thresholds set. The scenarios provide valuable information regarding the relationships between processor, memory, storage, and network utilization.

Given the number of consolidation candidates and the output of Capacity Planner, GovConnection would recommend utilizing 3 Dell Powedge R710 servers.

After the servers are deployed, in the event of a single server failure, the workload could be migrated onto the remaining 2 servers. The entire workload of the Town of Marshfield environment could be virtualized onto 2 servers. However, with this scenario, a single server failure could cause a resource constraint on the remaining servers, and possibly resulting in some virtual machines failing to migrate successfully.

Recommended Implementation Methodology

When production consolidation takes place, GovConnection recommends that this be done using the following methodology:

1. Identify and consolidate easiest systems first (e.g. DHCP, DNS, File Servers, Print Servers, Active Directory servers). Later, other servers can be considered (small SQL servers).
2. Replicate critical servers onto target servers and test outside of production before actually running production through virtualized servers.
3. Once the performance has been verified, the server can be moved into production.
4. Particularly with production servers, the goal should not be to implement several at once, but rather to consolidate only a few at a time, verify performance, and then target additional servers.
5. Business intelligence must be applied to all potential server consolidation targets. For example, if the load on a particular server is expected to grow substantially over a period of time, it may not be appropriate to consolidate that server until it reaches stability.
6. Constantly reevaluate performance of servers that have been consolidated.

GovConnection recommends virtualizing the Town of Marshfield domain in planned phases beginning with the least CPU intensive servers up to the heaviest utilized servers.

Virtualization of existing physical servers should take place during non-critical business hours to ensure the least amount of disruption of normal day-to-day business requirements.

Included in Appendix C is a spreadsheet which contains a list of servers for Town of Marshfield sorted by server phases.

> Phase 1 – Blue: Servers with CPU Utilizations under 5% or CPU speeds under 1 GHZ (7).
>
> Phase II – Green: Servers with CPU Utilizations over 5% but less than 30% (6).
>
> Phase III – Red: Servers with CPU Utilizations greater than 30% (0).

Phase I would consist of servers with CPU utilizations under 5% or CPU speeds 1GHZ or below. These servers can be migrated to a virtual infrastructure by enabling fast, reliable, and non-disruptive conversions utilizing VMware's Converter software. After deployment, validate utilization performance of Phase I virtual machines.

Phase II contains servers that are somewhere in between the Phase I and Phase III servers. Their CPU utilization numbers are within the normal figures to make them virtualization candidates. After deployment, validate utilization performance of Phase II virtual machines.

Phase III servers contain CPU utilizations higher than those reported in Phases I and II. These servers have higher than average CPU utilization and might not be ideal candidates for virtualization. These servers should be further investigated and carefully evaluated before converting into the virtualization environment.

Once physical servers are converted into a virtual environment, the hardware can be either re-deployed in a VMware VI3 test environment, disaster recovery, or disposed of through GovConnection's lifecycle management program.

Any SAN storage space used with decommissioned physical servers can be reclaimed for either present day or future virtualization requirements.

Appendix E – TCO Report

The following Total Cost of Ownership/Return on Investment document is produced by VMware using a conservative consolidation estimate. If Town of Marshfield chooses to consolidate more aggressively, Town of Marshfield will see a greater total cost of ownership and return on investment. Likewise, if Town of Marshfield chooses to consolidate less aggressively, Town of Marshfield will see a lesser total cost of ownership and return on investment.

Infrastructure Optimization Solutions

For Town of Marshfield, this analysis compares the total cost of ownership (TCO) of the current datacenter before virtualization, and after implementation of the proposed VMware solution.

How VMware achieves these benefits:	
Datacenter servers before virtualization:	15
Servers after virtualization:	2
Consolidation ratio:	7.5:1
Improve annual IT productivity equivalent to hiring N additional resources:	0.53 FTEs
Reduce annual energy consumption:	7.7 kWatts
Reduce annual carbon emissions:	45 tons
Datacenter space savings:	37.6 sq. feet
Decommission unused, expired and unauthorized VMs:	1 to 0 VMs
Improve provisioning and update labor productivity, saving:	30 person hours/yr

• Achieve an ROI of 151% from a 5 year total investment of $191,237 in VMware datacenter solution, and projected IT capital savings of $145,156, and operating savings of $143,002.

• Town of Marshfield is expected to achieve a net present value savings over 5 years of $191,403, an internal rate of return of 87% and a payback of 13 months.

| Cumulative 5 Year TCO Comparison (Before - After)	Current (Before)	With VMware (After)	Difference ($ and % savings)		Exclude?
Cost Opportunity and Benefits for vSphere					
IT Capital Costs and Savings					
Datacenter Server Hardware	$235,783	$84,982	$150,801	64.0%	
Software License Cost Avoidance	$91,486	$12,198	$79,288	86.7%	
Datacenter Server Storage	$0	$0	$0	0.0%	
Datacenter Server Networking	$24,415	$8,138	$16,277	66.7%	
Total Capital Costs and Savings	$351,684	$105,318	$246,366	70.1%	
IT Operating Costs and Savings					
Datacenter Server Power and Cooling Consumption	$107,441	$25,509	$81,932	76.3%	
Datacenter Server Space	$88,387	$17,223	$71,164	80.5%	
Datacenter Server Provisioning	$33,162	$2,485	$30,677	92.5%	
Datacenter Server Performance Management (AppSpeed)	$2,220	$886	$1,334	60.1%	
Network Change and Configuration Management	$8,287	$6,423	$1,864	22.5%	
Datacenter Server Administration	$217,500	$171,707	$45,793	21.1%	
Datacenter Server Unplanned Downtime (Indirect)	$6,170	$5,905	$265	4.3%	
Total Operating Costs and Savings	$463,167	$230,138	$233,029	50.3%	

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Investment Required				
IT Capital Investment				
vSphere Software Licenses	$0	$101,210	($101,210)	0.0%
IT Operating Investment				
vSphere Support and Subscription	$0	$78,495	($78,495)	0.0%
Additional Software Licensing Costs (if any)	$0	$0	$0	0.0%
vSphere Design, Plan and Deployment Services and Internal Labor	$0	$11,532	($11,532)	0.0%
vSphere Training	$0	$0	$0	0.0%
Total Operating Investments	$0	$90,027	($90,027)	0.0%
Total IT Capital Costs and Savings	$351,684	$206,528	$145,156	41.3%
Total Operating Costs and Savings	$463,167	$320,165	$143,002	30.9%
Total TCO and TCO Savings (5 year)	$814,851	$526,693	$288,158	35.4%

Expected Total TCO Savings from VMware	Year 1	Year 2	Year 3	Year 4	Year 5	Total
IT Capital Cost Savings						
Datacenter Server Hardware	$24,701	$27,171	$29,888	$32,877	$36,164	$150,801
Software License Cost Avoidance	$12,987	$14,286	$15,714	$17,286	$19,015	$79,288
Datacenter Server Storage	$0	$0	$0	$0	$0	$0
Datacenter Server Networking	$2,666	$2,933	$3,226	$3,549	$3,903	$16,277
Total Capital Cost Savings	$40,354	$44,390	$48,828	$53,712	$59,082	$246,366
IT Operating Cost Savings						
Datacenter Server Power and Cooling Consumption	$13,398	$14,463	$16,362	$17,621	$20,088	$81,932
Datacenter Server Space	$11,656	$12,822	$14,104	$15,515	$17,067	$71,164
Datacenter Server Provisioning	$4,604	$5,267	$6,026	$6,894	$7,886	$30,677
Datacenter Server Performance Management (AppSpeed)	$200	$229	$262	$300	$343	$1,334
Datacenter Server Administration	$6,873	$7,863	$8,995	$10,290	$11,772	$45,793
Datacenter Server Unplanned Downtime (Indirect)	$53	$53	$53	$53	$53	$265
Total Operating Cost Savings	$37,064	$41,017	$46,168	$51,092	$57,688	$233,029
Total Benefits	$77,418	$85,407	$94,996	$104,804	$116,770	$479,395

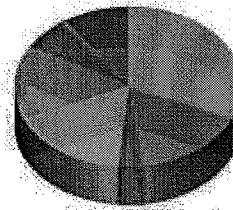| Expected Investment in VMware Solution	Initial / Year 1	Year 2	Year 3	Year 4	Year 5	Total
IT Capital Costs						
vSphere Software Licenses	$57,505	$5,751	$6,326	$12,651	$18,977	$101,210
IT Operating Costs						
vSphere Support and Subscription	$12,076	$13,284	$14,612	$17,269	$21,254	$78,495
Additional Software Licensing Costs (if any)	$0	$0	$0	$0	$0	$0
vSphere Design, Plan and Deployment Services and	$11,532	$0	$0	$0	$0	$11,532

Internal Labor						
vSphere Training	$0	$0	$0	$0	$0	$0
Total IT Operating Costs	$23,608	$13,284	$14,612	$17,269	$21,254	$90,027
Total Costs	$81,113	$19,035	$20,938	$29,920	$40,231	$191,237
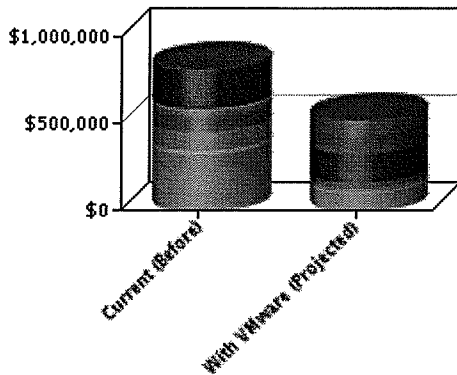
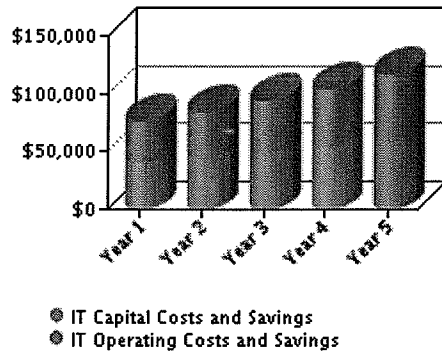**5 Year TCO Comparison**   **Expected 5 Year Benefits**

● Datacenter Server Hardware
● Software License Cost Avoidance
● Datacenter Server Storage
○ Datacenter Server Networking
● Datacenter Server Power and Cooling Consumption
● Datacenter Server Space
● Datacenter Server Provisioning

● Datacenter Server Performance Management
(AppSpeed)
● Network Change and Configuration Management
● Datacenter Server Administration
● Datacenter Server Unplanned Downtime (Indirect)
● VMware Software Licensing   ● VMware SnS
● Additional Software Licensing Costs (if any)

● VMware Design, Plan and Deployment Labor and
Services
● VMware Training

▣ Datacenter Server Hardware (31.5%) [$150,801]
▣ Software License Cost Avoidance (16.5%) [$79,288]
▣ Datacenter Server Networking (3.4%) [$16,277]

▣ Datacenter Server Power and Cooling Consumption
(17.1%) [$81,932]
▣ Datacenter Server Space (14.8%) [$71,164]
▣ Datacenter Server Provisioning (6.4%) [$30,677]

▣ Datacenter Server Performance Management
(AppSpeed) (0.3%) [$1,334]
▣ Network Change and Configuration Management (0.4%)
[$1,864]
▣ Datacenter Server Administration (9.6%) [$45,793]

▣ Datacenter Server Unplanned Downtime (Indirect)
(0.1%) [$265]

Savings over Five Years

- IT Capital Costs and Savings
- IT Operating Costs and Savings

Server Virtualization

- Number of servers
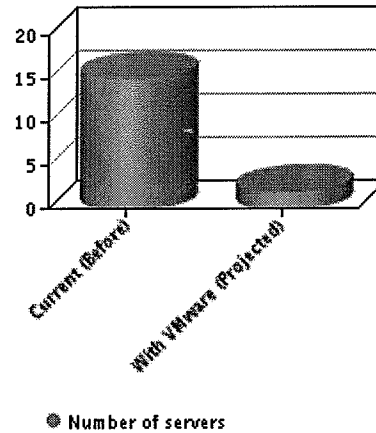
Appendix A: Profile and Common Assumptions

Organization Name: Town of marshfield

Industry: Regional / State / Local Government

Location: United States

State / Region: Massachusetts

Business Objectives for Virtualization

Reduce IT Costs
(√) Improve existing hardware utilization to reduce costs
(√) Reduce software license requirements
(√) Leverage scarce IT resources to manage more
(√) Reduce energy costs and drive Green IT initiatives
( ) Improve management of virtual infrastructure

Drive Business Improvements
(√) Better adapt to business changes
(√) Deliver services on demand
(√) Improve availability of applications
( ) Better secure data and infrastructure from risks

Scope
IT functions to analyze:
(√) Datacenter Virtualization and Management
( ) Application Development and Release Management
( ) Enterprise Desktop Management and Control

For what length of time would you like this analysis to be calculated?   Five Year

	Original Default	Value Used in Analysis
Discount Rates		
Discount rate (used for net present value (NPV) calculations)	11.0%	11.0%
The adjustment for any soft (indirect) benefits (percentage of these benefits to include in the analysis)	10.0%	10.0%

	Original Default	Value Used in Analysis
Salaries		
Fully burdened labor rate for IT administration and support staff (per hour)	$41.30	$41.30
Fully burdened labor rate for IT system provisioning staff (per hour)	$44.44	$44.44
Fully burdened labor costs for DR planning and recovery management (per hour)	$44.44	$44.44
Fully burdened rate of development per hour for bug reproduction	$47.57	$47.57
Fully burdened rate of development per hour for customer support engineer	$41.30	$41.30
Average uplift for overtime pay (if any)	1.50	1.50
Average annual increase in salaries and burdened labor costs (such as taxes and healthcare) anticipated over next 5 years	4.0%	4.0%

	Original Default	Value Used in Analysis
Facilities		
Hours per year the datacenter operates	8,766	8,766
Average price of electricity (cost per kWatt hour)	$0.1586	$0.1586
Measurement systems to calculate Datacenter space calculations		Square Feet

	Original Default	Value Used in Analysis
Carbon Emissions		
Average CO2 emission per kWh of Electrical Power (in lbs)	1.330	1.330

Average metric tons of CO2 emissions produced per automobile per year	5.46	5.46
Metric tons of CO2 emissions produced powering an average home per year	9.31	9.31
Mature trees it takes to sequester one metric ton of CO2 emissions in a year	920.43	920.43

Appendix B: Datacenter Solutions

Questionnaire

Current (Before) Datacenter Infrastructure

Total number of physical servers in the datacenter:	15
Total number of servers already hosting / supporting virtualized workloads:	0
Total number of virtualized workloads these servers are supporting:	0
Current number of servers you would like to virtualize (datacenter) and analyze as part of this proposal:	14

Details for the datacenter servers you intend to virtualize:

Current Datacenter Server Hardware Profile	Number of CPUs per Server	Number of Cores per CPU	Number of Datacenter Servers
1 CPU	1 CPU	Single Core	4
2 CPU	2 CPU	Single Core	8
4 CPU	4 CPU	Dual Core	3
8 CPU	8 CPU	Quad Core	0
16 CPU	16 CPU	Quad Core	0
32 CPU	32 CPU	Quad Core	0
Total			15

Will you be virtualizing your DR environment as well as your production datacenter environment?   No

Detailed Assumptions

Recommended VMware Solution(s)

(√)   **VMware vSphere**

Edition of vSphere to be implemented: Enterprise Plus
vSphere options implementing / including in analysis:

(√)	VMware vCenter Update Manager
(√)	VMware VMotion
(√)	VMware Storage VMotion
(√)	VMware Distributed Resource Scheduler (DRS)
(√)	VMware High Availability (HA)
(√)	vStorage Thin Provisioning
(√)	VMware Distributed Power Management (DPM)
(√)	VMware Fault Tolerance (FT)
(√)	VMware VDS and Host Profiles
(√)	VMware vCenter AppSpeed
(√)	VMware vCenter Server Heartbeat
(√)	VMware vCenter Chargeback
(√)	Cisco Nexus 1000V

(√)   **VMware vCenter Lifecycle Manager**

Datacenter Default Assumptions

Original Default   Value Used in Analysis

Datacenter Server Profile (Before)