

NASCIO Enterprise IT Management Initiatives

The State of Tennessee



The Virtual State of Tennessee

Executive Summary

The State of Tennessee made a strategic decision four years ago to consolidate our infrastructure environments. **“The Virtual State of Tennessee”**, is a phrase that has been coined to symbolize the state’s consolidation objectives by using virtualization as the core building block. Along the way, we learned many valuable lessons regarding the use of virtualization technology. Utilization of enterprise storage area networks, (SANS), and consolidated backups, in conjunction with virtualization techniques, has allowed the state to realize its financial and management goals.

Employing the vision of the Chief Information Officer, the state has invested in technology to provide the consolidation and virtualization to achieve these goals. At first, the consolidation model was somewhat unpopular among state agencies. However, once our customers experienced the benefits of lower costs, improved redundancy, and rapid service delivery, they quickly embraced the changes in technology. In fact, we now see increased demand from state agencies for virtual servers and enterprise SAN disk space to provide new and ever increasing services to our citizens. The last five years have seen financial benefits that include:

- \$9 Million hardware cost avoidance
- \$2.25 Million annual power and cooling cost avoidance

However, the benefits extend further than hard dollar benefits. Recently, the State of Tennessee experienced an unprecedented flood. In what is being referred to as a “500 year flood”, the downtown area of Nashville was besieged with floodwaters from the overflowing banks of the Cumberland River. One of the agencies that provide critical services to the state found their building flooded. This agency had not completed server consolidation and was in a position where production servers were at risk. Workers were granted escorted entrance to the flooding building to retrieve their production servers. These physical servers were delivered to the state’s data center to be provisioned in the virtual environment. The entire process took 7 man-hours from start to finish. In the midst of the state’s worst disaster, the streamlined process of the virtualized environment had a critical agency back in business.

Our experience has been extremely positive, and our consolidated environments have grown over seven hundred percent since the inception of this effort. We are now positioned to provide more cost effective and timely services to our customers, and provide the citizens of Tennessee improved and uninterrupted access to state resources needed for their daily lives.

Description of the business problem and solution

As IT operational issues become more complex and associated costs continue to rise, the State of Tennessee needed to find a way to minimize complexity and spending while maintaining the quality of services delivered to our citizens.

As Tennessee was in the beginning stages of server consolidation, a few key issues became apparent:

- Consolidation efforts were inefficient using the physical server model because the state's primary data center did not have enough floor space or power to accommodate the additional servers.
- During the initial phase of the consolidation effort, the primary data center was faced with approximately 150 physical servers from the agencies that were all unique. Each had their own backup tape and each had a different image. Management of these servers with existing staff was reaching critical mass.
- "Server sprawl", which is uncontrolled server growth that occurs in (agency) data centers, made our ability to maintain consolidated data backups and the capability to provide integrated disaster recovery solutions almost impossible in our current environment.

Upon analysis of the state's infrastructure environment, it became apparent that virtualization would be one solution to our problem. As an added benefit, we found a greener way to do business and are reducing our footprint in the environment. Virtualization is a server technique used to provide a complete simulation of the underlying hardware, allowing multiple virtual machines to run a mix of operating systems on one piece of physical hardware. This results in a system that allows all software normally run on physical machines to be run on the virtual machine. There are multiple forms of virtualization, including platform, resource, application, and desktop.

The advantages of server virtualization have allowed the State of Tennessee to reduce staffing costs, lower energy costs and harmful carbon dioxide emissions, and offer better Disaster Recovery (DR) options.

Maximum efficiency. Since virtualization is not hardware dependent, a move from one location to another is swift and painless. High availability is more easily maintained as well, with almost zero downtime realized for planned and unplanned outages. We have also found that our customers are pleased with the faster provisioning of a virtual server over the customary lag time needed to procure a physical piece of server hardware. For example, procuring and provisioning a physical server took approximately forty-five (45) days, while provisioning a virtual server takes less than five (5) days.

Based on our virtualization model, we have embraced both data disk de-duplication on disk drives and an enterprise backup solution for disaster recovery and business continuity. As our amount of data space increased on the enterprise SAN, we experienced difficulty in meeting our nightly backup windows. Prior to the new disk backup technology, backups began at 4:30 pm with a completion goal of 7:00 am. We often missed the window and at times could not complete the schedule before 9:00 am causing latency problems for our customers. We have been using the new disk backup technology for three years and have not missed the scheduling window once. This technology provided us both disk based backups that are de-duplicated with a minimum of 20:1 disk compression, and the ability to replicate this data to provide an offsite Disaster Recovery solution.

Implementation Dates

- Initial deployment of server virtualization, Fall 2006.
- Virtualization enhancements (references in submission described as “newer virtualization technologies”), August 2009.
- Enterprise SAN, Spring 2005.
- Disk backup technology, (references in submission described as “new disk backup technology”), Fall 2007.

Savings. The new disk backup technology has played a role in the drastic reduction of tape storage from 150,000 tapes to fewer than 2,500 tapes. The combination of tape cost and tape storage vendor costs have saved \$250,000 annually. Consequently, this job is performed by 1 FTE instead of 3FTEs that were previously used to pull tapes and send tapes offsite.

The current VMware environment houses over 680 virtual guest servers running on 65 host servers, (actual physical server hardware), in the State’s Data Center. This would equate to 650+ physical servers that would require rack space, electricity, and air cooling in the Data Center. The State of Tennessee’s IT organizations are committed to Governor Phil Bredesen’s pro-active conservation initiatives, and virtualization has become one strategy that is already giving us green IT paybacks.

Virtualization has been employed in the state environment for well over three years. We have seen our virtual server numbers increase from 100 in Year One to well over 650 servers presently. We have provided cost-effective solutions to our customers through:

- Increased services
- Less staff
- No increase in costs to agencies

Significance to the improvement of the operation of government

We have found that virtualization provides excellent uptime solutions for mission critical Agency applications. The use of newer virtualization technologies allow virtual servers to automatically migrate to another host server in the farm, based on predefined settings determined by a perceived hardware failure or crossing a threshold percentage of resource usage on a server. This means that if a physical server fails, the customer continues to work and does not realize that a problem occurred. Also, if host physical server resources become fully utilized, the tool will automatically migrate the virtual server to another physical host server without the customer being aware. This feature is directly comparable to clustering of physical servers in providing customers constant access to their servers.

Server provisioning has become a straightforward process. Provisioning physical servers required a minimum forty five day lead time. Now we can provision a virtual server to our customers in five business days or less. The impact of this rapid deployment has been fully utilized by our customers to react more rapidly to the business requirements of our citizens.

Standardization. Another benefit that virtualization has allowed us to provide is more uniform server configurations and settings that reduce the amount of server administration time required to manage the servers. By having duplicate server templates, we can ensure that our servers are configured in a standard fashion thus meeting all state policies and procedures. Similarly, due to reduction in physical server hardware our System Administrators can administer more servers than they could previously. Our server to System Administrator ratio has tripled in four years. This allows the state to support large numbers of servers without having to increase staff.

Disaster Recovery capabilities are being realized for virtual servers as well. The newer virtualization technologies allow the replication of virtual servers and their associated data to occur at both the primary data center and Disaster Recovery locations. This allows the state agencies to continue to conduct business operations in the event of some type of disaster that would cause the primary Data Center to become nonfunctional. Recent events in Nashville with flooding, provides clarity on why disaster recovery is such a critical business requirement. Also with this type of tool, the amount of downtime experienced by the customer can be greatly reduced for routine maintenance and software patching by switching the customer from the primary to the secondary site during these maintenance outages.

When the first enterprise SAN was placed in production at the state Data Center, we were not sure how performance would be impacted and the reliability that it would provide our customers. We were pleased to discover that the enterprise SAN actually improved performance over server hard disks and provided a much more redundant and reliable storage vehicle than server hard disks. In the four years since SANS were introduced into our environment, we have not had any downtime related to SAN failure that impacted our customers. Truly, we have experienced the five/nines of uptime, which is an industry standard used for benchmarking server availability, that service

providers strive to achieve. The use of SANS also allows us to provide nearly real time Disaster Recovery solutions to minimize customer impact. SAN software has the capability to replicate data from one location to another location, allowing applications to be brought on line rapidly in case of disaster and other unplanned events.

A building block of our virtualization and consolidation initiatives is the use of enterprise SANS to house all of the virtual server configurations and application data on which our customers depend. Prior to the use of a virtual solution, our customers used physical server hard disks in raid configurations for redundancy requirements and had self contained tape backup solutions maintained on their servers. Based on drive technology, our customers experienced downtime due to hard disk failures that in some cases exceeded the built-in protection provided. Data backups were done in a decentralized manner which introduced the possibility of human error in replacing tapes and backup routines. In a “perfect storm” scenario, a customer could lose multiple hard disks and have a problem with a tape restore that would result in data loss. This caused productivity issues and, in some cases, impacted the citizens of Tennessee.

A key requirement for the newer virtualization technologies is the use of SAN technology to replicate the needed virtual server and application data information to perform the failover to the alternate Data Center site. Based on our Disaster Recovery strategy, the enterprise SAN is a key part of planned service offerings to our customers to minimize downtime and negative citizen impact.

Another building block of our virtualization and consolidation initiatives is our consolidated backup environment. We now regularly meet our backup window to complete data backups. With the newer virtualization appliances, we are realizing an exponential increase in our ability to backup critical application data for our customers. Four years ago prior to server consolidation, we were backing up about four or five terabytes of data on a nightly basis. Now, after server consolidation we are backing up sixty terabytes on a nightly basis and over five hundred terabytes on weekends. Using the traditional tape method for backups, we would not have had the capacity to perform these backups. This technology allows us to restore backups faster than with conventional tape restores, due to the speed of disks over tape drives. We have significantly reduced the amount of tape server units and actual backup tapes due to the use of the disk based backup solution. Again, this reduces the amount of staff resources required to support the tape devices and handle the large number of physical tapes required to perform data backups.

Disaster Recovery. We have experienced some additional benefits of our newer virtualization appliances as well. Previously, when a Disaster Recovery test was declared, all of the backup tapes needed for the data restoration had to be transported to the Disaster Recovery site. This required the use of a state vehicle for a week, and a minimum of two state resources to drive the tapes to the site and back. This is not required now because any data needed for Disaster Recovery tests is replicated and available for use by the onsite System Administrators. Another advantage of the newer virtualization equipment is the capability of state System Administrators to connect to the Disaster Recovery site and maintain basic services including operating system patches and upgrades, troubleshooting of equipment as needed, and the ability

to restore any data item needed for a customer test that is being scheduled. This greatly reduces the cost of manpower resources needed to maintain and perform Disaster Recovery tests for customers. It also makes the organization more productive and efficient by not having staff out of pocket for periods of time performing Disaster Recovery testing. The customer and the state receive benefits in both cost and resource utilization directly related to the use of newer virtualization appliances.

Benefits

When the State first reviewed the concept of a virtualization and consolidation strategy, we were very skeptical about the theory of under-utilized physical servers. VMware, Inc., a global leader in virtualization, provided us with statistics stating that physical servers only use about five to six percent of the resources available to them at any given point in time, which means that about 95% of the energy costs to operate that machine are wasted. The theory behind newer virtualization products is to fully utilize the server hardware resources by placing multiple guest servers on a physical host server to use all available resources to full capacity. We were pleasantly surprised that, in fact, we did have servers that met this under utilization criteria and were good candidates for virtualization. This strategy allows us to save physical space in the Data Center, as well as power, cooling costs, network connections, server racks, and storage connections. VMware's analysis¹ of our environment shows us that by virtualizing 680 physical servers, we are saving over \$2.25 million annually in energy costs and over six million pounds of carbon dioxide emissions, which is the equivalent of planting 13,600 trees or taking 1,020 cars off the highway.

The State of Tennessee currently outsources DR of critical Agency applications to a third party, vendor-housed location. Looking ahead, we have created the infrastructure building blocks to support our new initiatives such as the State's new Data Center. When the facility comes online, the ability to provide State Agencies with a wide range of DR solutions through virtualization will greatly enhance current service offerings. Based on the economies of scale that server consolidation would provide at both of the State Data Center sites, costs of DR services will be ultimately reduced at the State of Tennessee. And again, the State will be able to realize considerable cost savings in server hardware, energy, and indirect labor services as a result of the virtual implementation.

The State of Tennessee has fully embraced virtualization and consolidation as a means of reducing complexity, staffing and utility costs, while maintaining and even improving the level of quality services we can offer to our customers and citizens. The state has realized a cost savings of between eight and ten million dollars in current and reoccurring costs that were previously being expended. We consistently meet our Service Level Agreements for server uptime and minimal downtime with this green solution, which will hopefully assist in ensuring maximum Earth uptime for future generations.

¹VMware Total Cost of Ownership calculator can be found at www.vmware.com/solutions/green/calculator.html