Virtual Utility

University of Auckland

Abstract:

In late 2004 the University of Auckland was drowning in servers, parched for storage and had spaghetti for a data center network. Faced with ever growing University demand, the need for disaster recovery and an impending data centre move in 2007, something had to give.

The infrastructure blinked first. The University embarked on a radical overhaul of its infrastructure virtualising networks, storage and computing platforms.

This paper outlines the drivers, the process, the thinking, the technologies and outcome of what has the look and feel of a utility services model; one that we hope will benefit the entire University.

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The Site

The University of Auckland is one of the oldest in New Zealand and has a traditional governance style, which is best described as federated. The University of Auckland is the equivalent of an Australian ‘Sandstone’ institution.

ITSS is the central IT service provider with a charter to provide shared services to the University, specifically those services that must be governed centrally as well as those services that faculties and service divisions cannot provide themselves. These services range from infrastructure through to applications development and end user support.

The usual tensions between faculty IT and central IT exist with focus on the cost of service provision combined with expectations of rapid delivery and flexibility to change.

The Problem

In the early part of the 21st century, ITSS had a problem; more precisely it had a myriad of problems, primarily with the rapidly increasing demands for servers, storage and technical support time.

Due to a silo based mentality, each application owner expected to have their own dedicated computing resources. Business cases of that period would typically specify several development and production servers and have a standby server thrown in just in case. The sizing of these servers would be based on how much the business case could justify and these servers were bought on a lease term of three years.

Storage requirements also snowballed. While ITSS had a quality SAN (IBM Shark) in place, the cost of SAN storage was prohibitive for most projects. SAN storage would also magically disappear as technical staff appropriated it for their essential activities.

Within the data centre the effects of this unrestrained model rapidly became apparent, with the data centre network becoming spaghetti due to the myriad of security, load balancing and VLAN requirements the different applications groups expected.

The ITSS data centre was old, built in nineteen seventies, and had limited environmental capability to cope with the additional space, power and cooling requirements demanded by the unrestrained server growth. At one stage a ban on further servers was put in place as the back up generator could not cope with the aggregate load.

Lastly and most importantly the usual OPEX constraints were in place, with ITSS unable to increase headcount to deal with raised demand. Technical staff were

preoccupied with manual management of physical hardware and a consequent feeding and watering of a myriad of environments.

In summary the model of dedicated infrastructure per application was unsustainable and seriously affecting ITSS ability to deliver its primary services let alone support faculty or future needs.

Staggering steps

Previous attempts to address these issues included

- the purchase of two Sun F15Ks to consolidate the primary ERP systems (Finance, Human Resources, Student Administration and Library);
- the improvement of the data centre power, air conditioning and generator capacity;
- the implementation of IBM blade centers with the objective of physical consolidation
- the provision of lower cost SAN arrays allowing a lower price point of storage

These initiatives while stabilizing the infrastructure environment, still did not address the unconstrained growth caused by the dedicated hardware per application model. Multiple SAN arrays, while offering better price options, raised the complexity of managing storage, placing more pressure on systems staff.

Even with the Sun F15K, individual system boards were dedicated to individual application components. And the organization culture was silo based where the concept of 'shared' resources was akin to blasphemy. This lead to the Sun F15K becoming fully populated but severely underutilized. To address this ITSS implemented a 'Right Sizing' project that moved some of the PeopleSoft 8.x components off of Sun F15K hardware onto Linux blades. A shared database space was created using the released resources.

The Blade Center approach reduced the overall space needs for the data centre but did not address the proliferation of servers. By 2004 ITSS had 350+ servers in its datacenter with more purchases anticipated. Also in 2004 servers started coming off their three year lease program, requiring the systems staff to replace them. With 350 servers purchased over three years, this averaged out at replacing 2 servers a week, for no corresponding business value, not to mention a high overtime bill. To add insult to a high workload, the average utilization for servers (including the F15Ks) was only 12%[1].

The leasing program was stopped as the lifespan of servers was found to be longer than the available lease periods. All new servers were to be purchased outright. This decision was controversial however as leasing had been introduced to guarantee refresh of the hardware stock. While solving the continuous

[1] This is not unusual for most computing sites, given recent increases in processing power.

replacement for no business value issue created by leasing, the alternative of establishing a growing pool of aging servers was an unattractive proposition.

More pressure was added, with the university determining disaster recovery capability for its core systems was a top priority combined with the building of and corresponding migration to a new data centre in mid 2007. The existing approach to infrastructure both of these targets looked unachievable.

Opportunity

Several factors came together that allowed ITSS to turn this situation around

Technology

The University of Auckland had been aware of virtualization technologies for some time, specifically VMWare on Intel. However this was viewed with suspicion (especially by the silo cultists) and only useful for development purposes.

This changed when the Computer Science Department[2] embraced VMWare enthusiastically, both because they saw it as a cool technology and because their budgets were slashed and they had no way of providing the same level of service without it.

This proved the technology worked and provided the confidence needed to make a radical change.

On the Sun front, the University upgraded its F15K's to E25K's in place in late 2004. While this made overall utilization worse, it freed up system boards from production use, enabling ITSS to start fully investigating Solaris 10.

For storage, SAN virtualization technologies had matured[3] in the marketplace providing other options for providing storage services.

Finance

The lease program had started in early 2000. This proved fortuitous as most servers were on a three year lease and those leases were coming due from 2004 onwards.

This enabled ITSS to aggregate the lease replacement budget into one capital case that proposed replacing dedicated servers with a VMWare farm.

[2] Computer Science provides Faculty IT services for the Faculty of Science
[3] Though not quite as ready as we would have liked

People

Several changes occurred within the senior management team. The new team was less suspicious of the shared approach enabling a consensus to be built, allowing a strategy to be formed and implemented.

Approach

There were several layers of problem to be resolved involving network, storage, computing platforms. Instead of attacking these separately an architectural approach was taken based on the following principles

- infrastructure should be shared wherever possible
- minimize the differences
- design for the university (not just ITSS)
- infrastructure should be a utility, priced and delivered accordingly

The Network

As with all University networks, the University of Auckland campus network is not that much safer than the Internet. This is a fact of life as Universities are designed to be open and our customers[4] walk our halls[5].

Defense in depth is the only way a University can properly approach security (Companies should be as well in truth). This entails having firewalls inside the network protecting those computing assets that need more security than the campus network[6]. However, having just one firewall protecting the data centre is not effective. This is primarily because of the diversity of servers and applications hosted in the data centre which historically has tended to create firewall rule sets that resemble Swiss cheese. (thereby weakening security with the volume and complexity of protocol filters).

To address this, ITSS implemented the service provider version of Checkpoint/1. This allowed several virtual firewalls to be created across separate VLAN's using a single hardware platform. These firewalls (including other separate firewalls) were managed from a single platform (Provider/1)

Implementing this design on top of the existing spaghetti data centre network was not practical however. Fortunately the need to consolidate servers provided an opportunity to use a green fields approach.

Storage

The ITS storage environment prior to virtualization was a fairly capable one. Mission critical storage was provided by an IBM Shark with less expensive storage provisioned through Fast-T SAN arrays.

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[4] Staff and Students

[5] Urban legend has it that one Computer Science Academic issued a 'Ping of Death' assignment to his students

[6] This is in addition to hardening individual systems

However all of this storage was provided via a complex fiber channel infrastructure leading to

- higher costs
- each server having to attach to each storage array
- complexity (how many layers of redundancy do you need)
- inflexibility for D/R and the 2007 data centre move

ITSS luckily had a strong and long running partnership with IBM combined with in-house expertise. IBM introduced ITSS to its SAN Volume controller (SVC) line of storage virtualization technology.

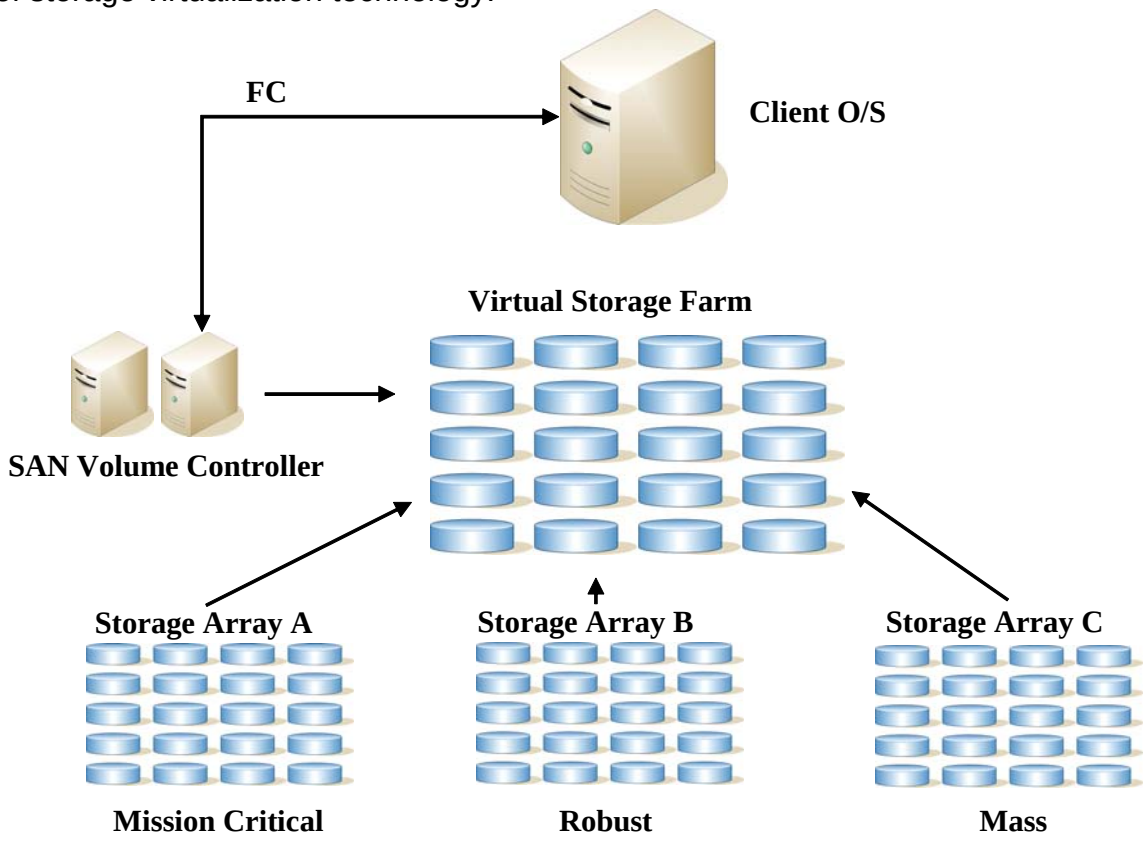


Figure 1 - Storage Virtualization

This technology offered IT'S the opportunity to

- have one standard set of server drivers that allowed each server to see all storage offered by the SVC
- The ability to replicate data between locations independent of storage arrays
- The ability to keep the price of new storage to market levels (i.e. minimal lock in)

Again the timing of lease replacement for the IBM Shark storage allowed ITSS to create an amalgamated business case for a storage solution based around three

IBM DS4800 SAN arrays managed by two SVCs situated across the two data centers.

This design allowed for ITSS to replicate data between data centers independent of storage type[7]. This capability was exactly what ITSS needed to accomplish its D/R goals and be able to migrate between data centers without taking the Universities central IT systems down.

Computing Platforms

Intel[8]

ITSS embraced the VMWare technology wholeheartedly. There were concerns about production level performance, but the architectural principle adopted was to scale out. To enable this ITSS purchased 15 IBM366 four-way Intel servers. Ten of these servers were placed at our city data centre for production use with the remaining five placed at our backup data centre (for development).

The design of the VMWare farm[9] was straightforward. All servers were implemented the same and could all see the same storage and network VLANs. This approach is critical to enabling migration of virtual servers seamlessly (VMotion), with no user downtime, across the farm.

This environment was set up in a green field manner and then a P2V (Physical to Virtual) tool was used to migrate existing services.

Not all servers were migrated to this platform. High I/O or CPU bound servers were left on their on dedicated hardware (e.g. medium to large scale SQLServer databases)

For D/R, the virtual server images are replicated via SVC to the secondary data centre.

Solaris 10

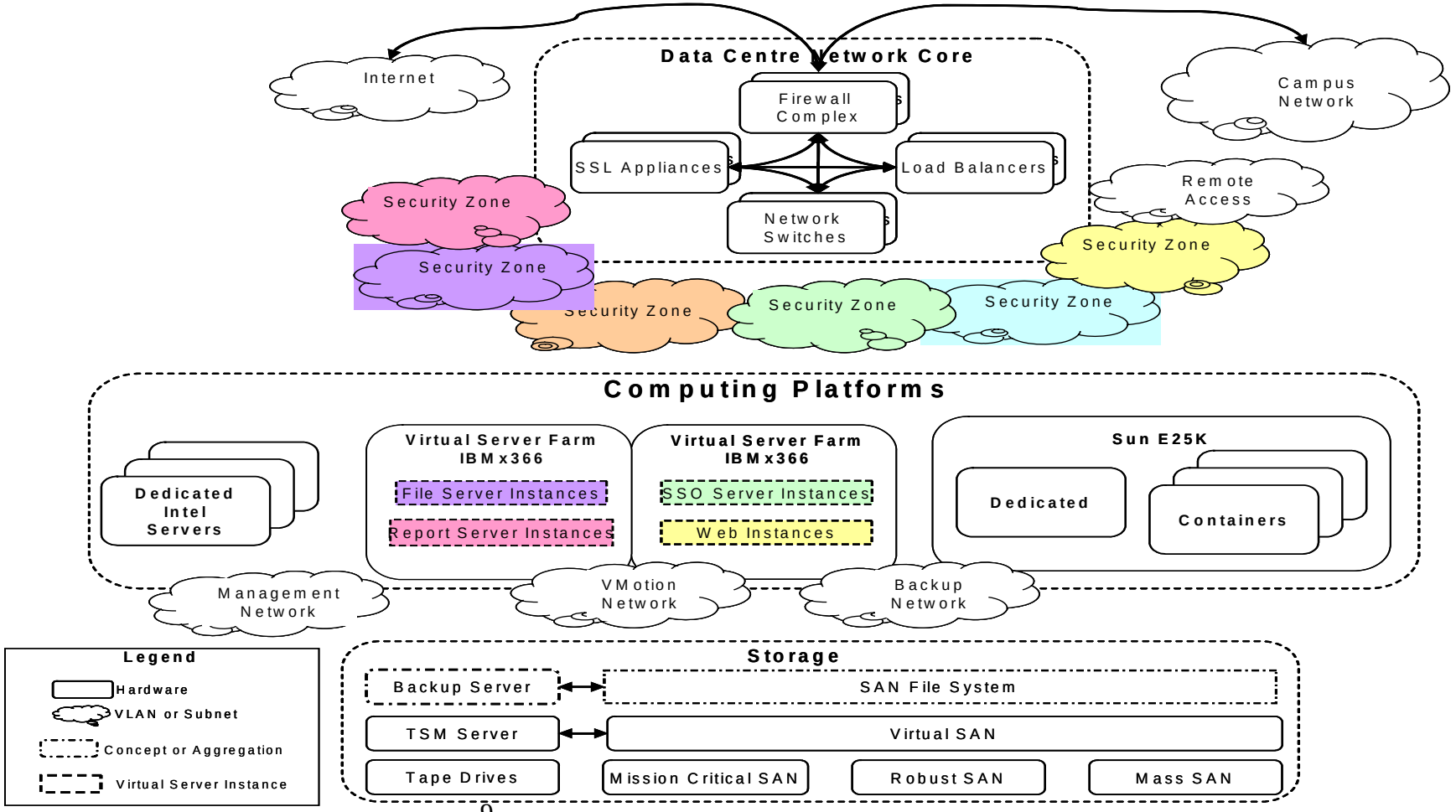
A similar approach was taken with Solaris 10 to enable virtualization. The primary design was to have two Solaris 10 domains set up per E25K. Each domain [10] would see storage and network identically allowing the migration of virtual instances between them (although not seamlessly as downtime is required)

[7] Note: Synchronous replication requires storage of similar performance characteristics to avoid increasing latency
[8] Some of the latest AMD servers are more than able to run VMWare
[9] This project won our provider (Computerland now Geni) a reseller award from IBM New Zealand
[10] A domain is one or more E25K system boards consisting of eight CPU cores and 16GB memory

Summary

These three combined approaches allowed ITSS to reposition its entire infrastructure from a dedicated, manpower expensive, unable to be scaled to one that is shared, enables disaster recovery and prepares for the data centre move. Staff, while still busy, are now able focus their efforts across the infrastructure.

This approach also allows a utility model for scaling the infrastructure. Each new piece of hardware added to the farm supports all applications on that farm.



Learned Experience

ITSS had two years to complete the strategy outlined above. In that time we have achieved and exceeded our original goals with the culmination being a successful Disaster Recovery test in late 2006.

It was not all plain sailing however with several major issues that needed to be overcome.

Management and sustainability

The virtualization platform proved to be too successful as people saw how easy it was now to create new servers (less than an hour). The farm rapidly became overloaded before appropriate control measures were put in place. The most important management requirement is to ensure that all instances are paid for and that financial mechanisms are in place to purchase farm infrastructure in advance of demand.

Monitoring and Training

Technical staff in the modern age are not trained to tune shared environments (except perhaps large scale UNIX administrators). ITSS had sophisticated monitoring in place and technical staff assumed that this would be sufficient. This was incorrect as monitoring in a virtual environment requires monitor the farm itself and not inside individual virtual instances.

Training is critical to successfully implementing a virtualized environment. Technical staff must relearn some of their system performance concepts.

Specifically, tuning must be aimed at ‘good enough’ performance, not absolute fastest performance. In 2007 ITSS will implement Compuware’s Vantage product allowing agentless performance monitoring. This will establish a real baseline for web application performance that can be linked back to service levels for application performance.

On all platforms, technical staff have to remember to be careful stealing cycles for large scale administrative jobs (e.g. DBA batch unload/loads). In a shared environment large scale jobs can unduly affect the overall performance. Technicians have to become more attuned to the new environment. This takes time (as well as dented egos)

Certification

When an integral environment is put together, not all of the pieces are necessarily ready at the same time. ITSS ran into this specifically with the IBM SVC. This caused a fair amount of rework. There is no specific answer to this problem other than to be patient and ensure your vendor/partner is honest with its delivery schedules.

Some products will never be certified for new environments. The older PeopleSoft suites (7.6) will never be certified and the only way forward is to upgrade. Due to this it is essential that a pragmatic approach is taken (i.e. virtual plus dedicated)

P2V (physical to virtual) issues

Ensure that two processor images are completely rebuilt as Microsoft Windows Server does not allow a two CPU image to be reverted back to one CPU. The rule is to scale out instead of up. Therefore web servers that need two CPU physical servers may need two or three virtual instances.

Many physical windows servers run multiple components (web, application server, database, LDAP server). Make sure these are separated out into their own virtual instances. (The database server may need to stay on it's own hardware dependent on scale

Implementation, Co-ordination and partnership

ITSS formed cross function teams including vendors to implement this shared infrastructure. This was vital due to time pressure. Vendor involvement is critical. It's no longer a drop and run situation as many customers are hard pressed to maintain a workforce capable of dealing with all of the old stuff as well as adapting and implementing the new. The ITSS experience was that technicians were happy when they saw the benefit (especially VMWare). However much of this technology is non-trivial to get the base design and implementation right. This requires a combination of vendor and customer skill sets to get right.

Establish success criteria early in the project

Some of ITSS success criteria were

- Delivery of a new server within one day
- Reduction in number of physical moves and changes
- Ability to D/R services within a morning
- Ability to add storage on demand
- Reduced O/T hours
- Happier Staff

Future

Virtualization has been a success at the University of Auckland. ITSS is now looking to consolidate and improve its ability to offer services to the entire University using this infrastructure approach.

The utility model for computing is becoming a reality. The future of quad or greater multi-core processors, autonomic virtualized computing environments combined with greater disk densities, implies a future where administrative IT for Universities will be able to be housed on a single rack.

This implies that University IT organizations will need to change.

This challenge will be educating existing workforces from a per box application and server management mentality to one of service provision, where applications get the appropriate level of infrastructure resources they require at the time they require it.