Migrating to a virtual environment

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Abstract
This paper provides a deep dive into the pros and cons of local, cloud, solid-state and linear tape-open storage solutions. It opens with John McKenna's account of the YES Network's digital transformation, and is followed by Jason Marshall's summary of modular to virtual technology migration. This paper details ratios on high-performance broadcast data systems, as well as power consumption and solution trade-offs. This paper aims to gain the reader's confidence in virtualising a media asset system as well as converting linear systems to packet-based media technologies including transcoding, Active Archive and future SMPTE 2110 solutions.

KEYWORDS: MAM, virtual, YES Network, LTO, cloud, transcode, Active Archive, VSAN

A DIGITAL HISTORY
Since its launch in March 2002, the YES Network has been the number 1 rated regional sports network in the USA. From its inception, YES has striven for the highest-quality picture and sound and to be at the leading-edge of broadcast technology. To this end, YES was constructed as an all-digital facility.
To manage its growing library, the network launched a digital archive project. Initially, the plan was to find a way to convert HD content into a file format that could be stored in a system so that producers and directors could easily find and retrieve selected plays to be integrated into classic game and other shoulder programmes. Avid had provided the YES editing systems from the outset, and the original five Avid editing systems were connected to an Avid Omega JBOD array for storage.

The network explored a number of media asset management (MAM) system vendors and mass storage systems. The criteria used to select project vendors were as follows:
(1) YES was happy with Avid as its editing platform, hence the complementary systems had to work seamlessly with Avid;
(2) due to limited resources for maintenance, sub-systems had to demonstrate a high level of reliability over the long term;

(3) those sub-systems needed the capacity to grow with the network and be able to migrate to emerging complementary new technologies without impact to other sub-systems and
(4) vendors would have to agree to work together with the YES Network and each other over the long term to guarantee the reliability of the entire MAM enterprise.
After several months of meetings followed by booth visits at the NAB Convention and site visits to observe the various systems in action, it was decided to solicit proposals from three vendors. Avid would be asked to provide the editing systems, online storage and proxy video storage; SGL was asked to provide the MAM Systems; and Spectra Logic was asked for a proposal to provide near-line storage and a linear tape-open (LTO) cassette-based library system.

All companies involved were invited to a project launch meeting with YES in the autumn of 2010, and the three vendors agreed to work with YES Engineering as a team to solve any issues that might arise as the disparate systems were integrated into a cohesive asset management and archive system. Construction of the system began in November 2010 and the system was declared in service in early December.
Moving the thousands of hours of content from DigiBeta and Beta-SR tapes into the new MAM system was far too daunting for the YES library staff to undertake. It was also necessary to ingest the legacy tape material quickly so that the producers could take full advantage of the new system. With this in mind, MediaKive was contracted to convert over 3,000 tapes into DNX-145HD format and store the content on hard drives. The hard drives were sent to Stamford and ingested directly into the system. This was accomplished in just a few weeks, and all of the YES HD games and all of the melt reels from the launch in 2002 were available before the New York Yankees' spring training began in 2011. In subsequent years, the content was migrated to LTFS tape format in order to make future transfers easier.

Additional SD tape content is ingested as requested by production, and, in time, all of the SD YES telecasts, along with many hours of legacy games supplied by the Yankees, will be stored in the archives and ready for almost immediate recall. Naturally, all Yankees games are ingested, while the Brooklyn Nets and New York City Football Club soccer games are also available to be ingested into the system at the direction of production.
The MAM system continues to evolve through planned virtualisation of many of the services as well as a planned upgrade to the storage library by upgrading to the latest LTO standard. In 2015, all of the legacy LTO-5 content was moved to LTO-6, and a 2019 project is planned to move the content to LTO-8. This will allow a quadrupling of the storage capacity and read/write speed of the library unit without adding additional cabinets.

LET THERE BE VIRTUALISATION

Back in the 1990s, I discovered an application that brought me back to my childhood: a Nintendo Entertainment System emulator, which I promptly installed on my Windows 98 operating system. I was able to download all of the games that I used to play as a child and save each game individually as a ROM file, before spending the better part of a month exploring this treasure trove of sentimentality. That was my introduction to the concept of virtualisation.

A few years later, I bought my first Mac. At the time, it was unable to use the Windows applications that were vital to my business. After a while, although, I began to accept the trade-offs. Eventually, however, Apple decided to abandon its proprietary Motorola-designed chips and instead go with a more universal hardware set, utilizing the industry-leading Intel chips in its home computers. To my mind, Apple had shaken hands with the devil. Indeed, even Apple joked that hell had frozen over. However, Apple's move opened up a more universal application platform that sent developers scurrying to write applications for this new and promising market share. Soon after came Boot Camp, which enabled a fully functioning Windows operating system to run on Apple hardware. This helped me understand that operating systems were simply a platform to write applications, and that operating systems themselves could be encapsulated into virtual files.

The early 2000s heralded the next generation of virtualisation in the form of the VMware Workstation. This form of virtualisation clearly laid out the possibilities and benefits for the future of virtualisation. Not only could one now virtualise a system of computing hardware (CPU and RAM) but a whole suite of products that, in the past, relied on specific hardware requirements. Most interestingly, one could virtualise networking hardware and its related protocols (ie TCP/IP). Multiple virtual machines could have different IP addresses while sharing a single physical network card and its throughput capabilities equally. It was now possible to 'spin up' lab environments in minutes. Before long, I had a fully functioning active directory, e-mail server, print server, Dynamic Host Configuration Protocol (DHCP) server and even a Domain Name System server all stored within a few virtual files on a single computer. It provided an otherworldly training ground for me to gain experience that would otherwise require full access to a company's server room.

THE GOOD: MINUS THE BAD AND THE UGLY

The physical benefits of virtualisation are often clear. Today, one can run an entire small business of separate servers and applications using the power of a single laptop. Imagine what one can run on today's massively dense server hardware.

A notable physical benefit of virtualization is hardware leverage. As previously mentioned, one can fit a lot more servers and applications on a lot less physical hardware than in years past. An intrinsic benefit could also be reduced power consumption. When migrating to a virtual environment, it is feasible to turn 80–100 physical servers into 5 or 10. Those new servers will likely consume a lot less power due to the advancements in the power efficiency of the underlying hardware.

Power consumption can also be automated in a virtual environment. For example, anyone who wants to shut down 80 per cent of their servers during off-peak hours can schedule and automate that task without any downtime. Another benefit is the physical space saving. Again, taking 100 rack units and turning them into 10 will open up more possibilities in a data centre, especially if that rack space is rented from a facility.

Data protection may not fall under the physical benefits but is a very good reason to migrate to virtual servers. One can back up virtual machines as a whole without the need to restore them back to specific hardware. One can also protect an entire data centre at an alternative site, or perhaps at the cloud provider's data centre.

For those who are new to virtual environments, some virtual benefits might not be immediately evident. Some of the most important are described herein. Add-on solutions can be tested without altering the current infrastructure. Proof-of-concept solutions are often delivered electronically as virtual appliances from a vendor, whereas in the past, there could be a lot of shipping expenses and commissioning by all stakeholders. With a virtual appliance, one can receive and deploy a solution and have it up and running in minutes. Parity of virtual machines can be spread across multiple disks. The same way that RAID protects the hard disk, RAIN parity protects virtual machine files.

It is worth remembering that these virtual machines, even if they happen to be extremely powerful transcode servers, are simply files with extensions. That virtual machine file can be written in a striped manner across multiple disks simply as if it were a .txt (text) file. In the event of physical server failing, the virtual machine will still be fully intact and continue running on different physical servers in the farm.

This leads into the next virtual benefit of high availability. High availability (HA) is the reason that software-only companies like VMware are so successful. One might describe HA as virtual redundancy. One's infrastructure could be designed so that if a virtual machine goes down, another virtual machine can take over right where it left off in lock-step. This is something that would have been unfathomable for engineers 15 years ago. Scalability is often unaccounted for when migrating to a virtual environment. If designed correctly, it will be possible to scale upward and outward. For example, if an application needs more CPU, one can easily migrate the virtual machine to a new physical server with a much higher CPU capability within the same virtual farm without losing communication to the network or its compute resources. Alternatively, one can create a duplicate of the potential environment in parallel to test workload before deploying it. Leveraging storage is another tremendous benefit which basically kicked off the virtual craze in the early 2000s.

These days, storage environments have become a lot more simplified in terms of the flavour of storage architecture one can choose. In the early days of virtualisation, the choice was between fibre channel and Internet Small Computer Systems Interface (ISCSI) storage networks. For those without the budget to support an isolated storage fabric, network file system (NFS) storage was an option. In other words, there would be one set of switches for the server network and another set of segmented switches for the storage. Engineers would need to choose between fibre channel, ISCSI or NFS storage networks, and often weigh the trade-offs.

The advent of 10 Gbps ethernet made the NFS option an even more viable storage architecture because it does not need to be segmented and can be added onto existing networking infrastructure without any major compromises. More recently, VMware has even virtualised the complexities of storage networks with the advent of Virtual SAN (VSAN). One no longer needs to choose between ISCSI, fibre channel or NFS. Instead, one can pack all or some storage within the physical servers themselves to share among each other, keeping the parity in line and opening up a whole world of new benefits. One major benefit is solid-state storage, which can be quite expensive and difficult to manage when otherwise externalised into a SAN array. VSAN can internalise that solid-state storage directly into the physical servers, making it possible to run all of one's virtual machines on solid-state drives, with the ability for those machines to communicate without the network traffic ever leaving the hard drive. Another major benefit in the migration of a media archive management system is the fact that one can now transcode with virtual machines on all or some solid-state drives, while keeping the initial protection of those machines and vastly increasing disk read/write speeds. This lands at the core of a modern virtualised environment, as transcode is very difficult to manage offsite and often needs scale out according to demands.

Transactional databases no longer need separate RAID 1 arrays and can write at almost 100 times the speed of spinning HDD drives. Those databases can be pinned to solid-state storage or even scheduled to migrate onto or off solid-state storage during peak activity, much like one can with power consumption. During transcode testing at YES, disk writes on spinning disks have been increased from 50 MB per second over the network all the way up to 5,000 MB per second on enterprise-level solid-state disks. In the production environment, a 20-fold increase in transcode speeds was observed. This kind of thing will make many media managers' jobs a lot easier and more efficient.

Snapshot technology on virtual machines is another great virtual feature. Consider the following scenario: You have a server which is a virtual machine that requires a major software upgrade. The maintenance window is short, and the implications of the upgrade are unclear because the users (and perhaps the infosec team) have not yet tested or vetted it. Virtual snapshot technology makes it possible to take a snapshot of the machine as it was before the upgrade. Assuming all goes well with the upgrade, one can join that snapshot with the delta data (anything written after the snapshot). If the upgrade causes adverse effects for any reason, instead of joining the delta data, one can simply delete it and roll back to the machine exactly how it was before the upgrade attempt. These are just some examples of the versatility of a virtual environment. It will take knowledge of virtualization along with some engineering creativity and experimentation to gain the most out of a virtual environment. In general, MAM Systems have been reluctant to migrate to virtual environments. Only recently have MAM solution vendors jumped on board to support their products in a virtual setting. The advancements in virtualisation are allowing vendors and clients to explore a long list of potential benefits.

VINYL MIGHT BE COMING BACK, BUT TAPE NEVER REALLY LEFT

It would be remiss not to mention LTO tape as a valuable storage option for virtual environments. At the heart of every MAM is an active archive. These days, there is a lot of talk about using cloud as a cold but active archive, because it is possible to decrease the management of all the archival data and let one of the major cloud providers handle that work instead. LTO tape, however, not only offers great cost efficiency per byte and air-gap security to defend against ransomware attacks, but can also be added easily into virtual server farms.

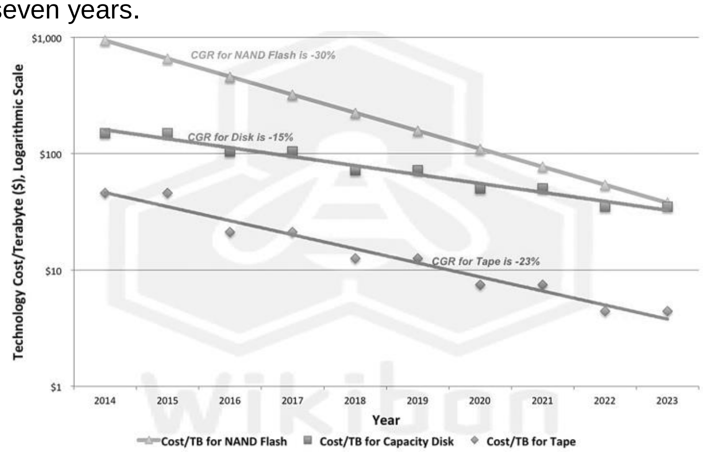
In the early days of virtualisation, fibre channel was the fashionable storage option. It required a host bus adapter card in each server. Those adapters were fully supported by most virtual solutions. As things progressed, it was no longer necessary to use fibre channel for enterprise-level disk storage. Different options for directly connected fibre channel solutions are still viable, including LTO tape drives. Because fibre channel was an early adoption of virtualisation, those fibre channel fabrics and all of the inherent fundamentals are still supported. That means it is easy to weave a fibre channel switch with multiple LTO fibre-attached tape drives and libraries into a virtual farm without compromising the virtual infrastructure.

There may be some challenges to get it to work the way you want it to, but the fact that it does not require a protocol redesign or pass-through technologies to make it work is a major luxury. While one cannot discount all the advancements and options that cloud providers can offer, LTO remains a major solution for large media archives. Given the large size of some media, with some contiguous files reaching in the range of 500 GB to 1 TB, it is worth crunching the numbers over a three-to five-year span. It is common to find LTO tape to be a lot more beneficial than moving all huge volumes of data into the cloud.

During a recent cloud discovery project, someone asked, ‘What if we need to change format or resolution of all of our media assets in order to keep them viable as a whole?’ My answer was that this would require the entire archive to be brought back from the cloud in order to transcode the assets. Such a scenario might make the budget operator responsible for operational expenditure reach for the Alka Seltzer. Some providers may offer other solutions to mitigate those costs, but the fact remains that one gains a lot more control and versatility when one has full access to one’s data, hardware and networking. One can also anticipate costs more easily because everything has been paid for already.

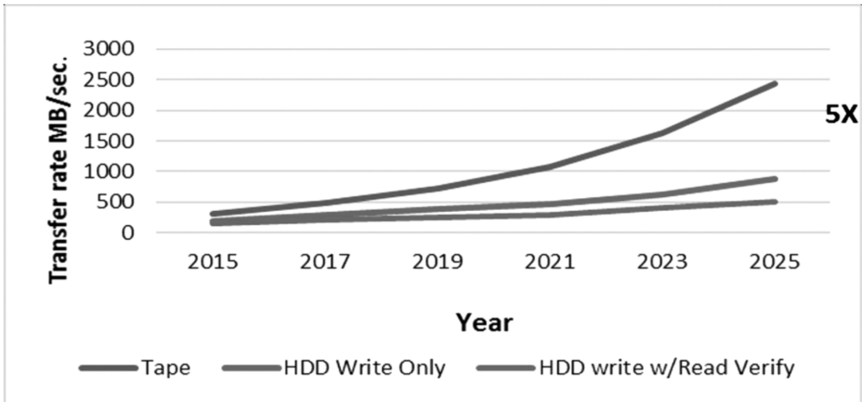
Depending on how much data must be kept readily accessible, it may be worth looking at the cloud as a tertiary option for a cold archive. Indeed, this seems be the general consensus when speaking to media managers on the subject. To be sure, there are many arguments, but speed and accessibility are crucial to any MAM system, and when it comes to storing and retrieving media, such speed and accessibility is not available among cloud providers. Figure 1 predicts the cost per terabyte over a ten-year period.

An important issue to consider is restore time obligation. Not only will cost be a factor, but the speed at which LTO-8 (which is currently shipping) can write is likely a lot faster than an Internet connection to a cloud provider. That is not taking into account latency for a whole host of reasons, such as firewall security. LTO-8 will write at about 360 MB per second; a cloud provider, meanwhile, would require a 3 Gbps Internet connection as well as a long list of routing and security measures, to match that speed. To quantify that, an hour-long media asset in the popular XDCAM 50 format would take roughly 27 minutes to restore via cloud with a 100Mbps Internet connection. An LTO-8 drive can do the same restore in 56 seconds. We are not yet at the point to compare solid-state with LTO, although Figure 2 illustrates the roadmap of transfer rates between spinning disk and LTO over the previous three years and the next seven years.



Source: © Wikibon 2014, from Numerous Sources including Analysts, Consultants, IBM & Oracle.

The point is that while a lot of vendors are pushing towards cloud, and perhaps even some financial departments are doing the same, LTO is in fact alive and kicking. Its roadmap for the future advancement is very promising when one actually crunches the numbers. LTO is on pace to expand exponentially in the coming generations, whereas growth for solid-state drives 2D Nand and 3D Nand have a lot more challenges to stay cost-competitive byte for byte. Currently, one can fit a massive 12 TB of uncompressed raw data onto a single LTO cartridge.



Source: TSC State of the Tape Industry Memo 2016

THE PROVERBIAL NEXT STEPS
Taking into consideration all that has been discussed previously, migrating to a virtual environment is definitely a time-consuming task that should be consulted by a virtual expert. It is definitely worth speaking with virtual solution vendors, who will be able to assist in calculating a capacity plan.
The most important factor to take into consideration when migrating to a virtual environment is capacity planning. It is essential to carefully calculate the capacity of disk I/O (read/write), disk space, the amount of simultaneous threads that the servers will require (IOPS), network requests and CPU utilisation.

For networking, it is important to consider the highest resolution assets that will be accessed, and multiply that by the maximum potential streams of that high-resolution video. More MAM and production asset management solutions are turning towards low-resolution proxy files, which can help considerably when planning network capacity. High-resolution video streaming can reach up to 1 Gbps per stream, while lo-res proxy streams are minimal and can be less than 1 Mbps per stream. Network requests can be quite large and should not be overlooked, even if using 10 Gbps ethernet.

For storage, it is essential to determine the total capacity of data required, as well as the speed at which the data must be read and written. As previously mentioned, there will be the option of networked or Virtual SAN storage. If choosing to leverage VSAN, it is well worth spending the extra money to buy enterprise-level SSD drives. Spinning disks are inexpensive and can provide much needed space for a lot less money. A mix of both is a good idea.

CPU requirements for MAM can be a lot more intensive mostly when it comes to transcoding. Transcoding definitely takes up a lot of CPU in a virtual environment. One can segment a single CPU into multiple virtual CPUs, which will make it possible to load balance transcodes across multiple servers. It is also possible to reserve CPU capacity for high-priority transcode machines. At present, CPU is often the least challenging hardware component to deploy when designing virtual architecture. New technologies such as artificial intelligence are challenging CPU roadmaps. This is a good thing; however, for basic MAM architectures, it is possible to select the CPU and capacity based on the specific solution's requirements.

Memory has become a lot more reasonably priced over the past years, and likely will not be too much of a challenge. That said, having more always helps. One can always overcommit or undercommit if necessary. Indexed searches are something to consider when planning a design. Indexed searching makes searching a lot faster (think of the autofill when searching with Google) but reserves a lot of RAM. This is because it stores its searchable results directly to a database. If planning to use indexing, take the vendor's RAM requirements and leave room for growth.

When migrating from a physical to a virtual environment, the best way to do it is in parallel. Stand up the new virtual equipment with an uplink to the old equipment. In this way, when the time comes to cut over, everything is in place and all that is required is to flip a couple of switches, transfer some databases and re-address the servers. It is important to have MAM vendor support during the migration. A lot of solutions have inherent issues in migrating, even when migrating within a physical environment. If everything is stood up prior, it can be fully tested before migrating.
Every solution can be virtualised, although not every solution should be virtualised. The elevator explanation would be: if it has video inputs or outputs, it might be worth waiting for the vendor to virtualize the solution instead of being overzealous and doing it yourself. Many vendors in the video business have finally embraced virtualisation and are leveraging the benefits to their advantage. Any server that does not have a video input or output device is a fine candidate to virtualise and should definitely be considered. In other words, if the solution relies on network communication, CPU, memory and storage, there is no reason why it should not be virtual.

The flexibility, scalability and portability that virtualising an infrastructure lends are invaluable. Data protection, disaster recovery and machine backups can justify a virtual migration without even taking performance into consideration. Virtual SAN will take compute and transcode operations to the next generation. Now is the time for broadcast data centres to fully embrace the virtualisation of high-performance infrastructures. With the ratification of SMPTE 2110, data packet-based technology is finally being trusted in broadcast plants. There are sure to be a growing number of solutions in which having a scalable virtual infrastructure will provide the option of bolting on and testing that solution seamlessly.