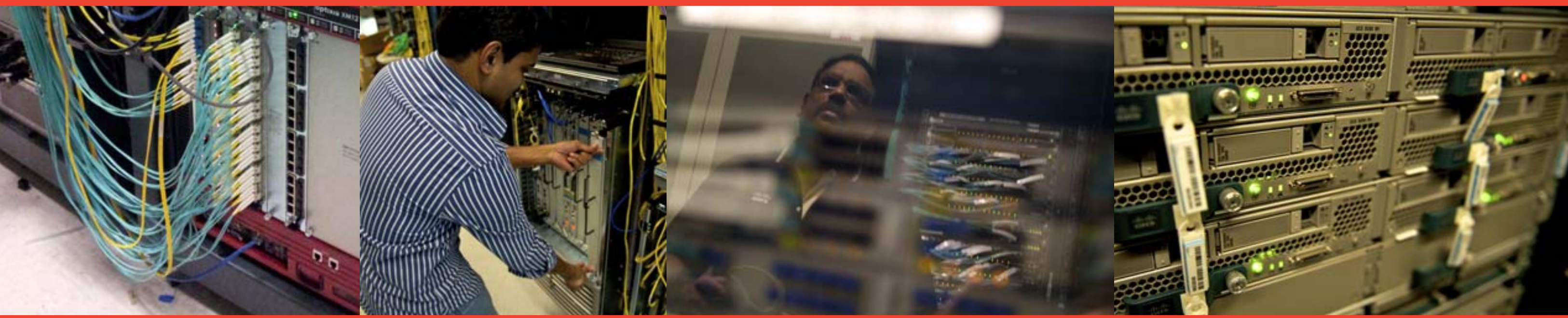

EANTC's Independent Test of Cisco's CloudVerse Architecture

Part 3: Cloud Applications & Services

Photos taken by Kim Ringeisen (Flying Monkey Photography)

Introduction from Light Reading

A few months ago, Cisco's Videoscape platform was about as much of a vague concept as the cloud itself. Ultimately, both concepts are meant to be far-reaching and comprehensive, giving service providers ways to serve more customers than ever, with fewer things to worry about.

Cisco does the best job of explaining Videoscape's attributes and how those attributes manifest themselves in the cloud. The key message is that Cisco wants to give service providers the tools to handle delivery of any kind of content to any kind of device, where and when subscribers demand it:

[Video can be found on LightReading.com http://www.lightreading.com/video.asp?doc_id=216268]

All the while, as service providers journey toward a network where any video format is being delivered to any device a consumer has, Cisco has acknowledged that there won't be one path that works for every provider, so flexibility is key:

[Video can be found on LightReading.comhttp://www.lightreading.com/video.asp?doc_id=209079]

In the context of this test, Part III of this CloudVerse deconstruction will give some of Videoscape's highlights, including the ability to control the mobile video experience in a way that helps service providers make the most money from their network investments. Also thrown in are two examples of cloud applications that have a specific enterprise tilt, putting many of the attributes of Cisco's Unified Data Center to the test.

Here is the full table of contents for this series of equipment and service tests and demo observations:

- Comprehensive Video Transcoding
- Multi-Format Video Delivery
- Cisco Mediasuite
- Adaptive Bit Rate Video Scalability
- Live Streaming Redundancy
- Transcoder Redundancy
- Mobile Video
- Conclusion: Cloud Applications & Services

Enjoy!

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About EANTC

EANTC is an independent test lab founded in 1991 and based in Berlin, Germany, conducting vendor-neutral proof of concept and acceptance tests for service providers, governments and large enterprises. EANTC has been testing data center solutions since the early 2000s for both online publications and interoperability and service providers.

EANTC's role in this program was to define the test topics in detail, communicate with Cisco, coordinate with the test equipment vendor (Ixia), and conduct the tests at the vendors' locations. EANTC engineers then extensively documented the results. Cisco submitted their products to a rigorous test in a controlled environment contractually defined. For this independent test, EANTC exclusively reported to Light Reading. Cisco test did not review the individual reports before their release. Cisco had a right to veto publication of the test results as a whole, but not to veto individual test cases.

— Carsten Rossenhövel is Managing Director of the European Advanced Networking Test Center AG (EANTC) , an independent test lab in Berlin. EANTC offers vendor-neutral network test services for manufacturers, service providers, governments and large enterprises. Carsten heads EANTC's manufacturer testing and certification group and interoperability test events. He has over 20 years of experience in data networks and testing.

Jonathan Morin, EANTC, managed the project, worked with vendors and co-authored the article.

Comprehensive Video Transcoding

EXECUTIVE SUMMARY: Cisco's Transcode Manager was able to convert seven popular video formats to Apple's HTTP Live Streaming format without operator involvement.

At the 2011 International CES Cisco announced its vision for high-quality video distributed from any device to any device – from any format to any format. Cisco captured the vision under the brand name Videoscape, incorporated into a common software architecture. Cisco's Videoscape solution, according to Cisco, is designed to be a streamlined system, with easy management, automated processes and a level of flexibility dynamic enough to receive and deliver any kind of video content. The solution is aimed mostly at service providers looking to provide a consistent video experience across multiple platforms and devices.

We found the goals of Videoscape to be abstract, but interesting. What does Cisco actually mean when it says it wants to empower service providers to deliver any content to any device?

We started off with a use case that's known by many subscribers, and not only technical folks. It is a common goal these days for your IPTV provider to provide an Android or iPad app that allows you to catch up on TV shows you missed, maybe watch a game, or rent videos, all over a screen other than your TV. What's hidden behind this simple app is an array of requirements. The service provider has to make sure that the video content is actually watchable on your device. And just as several devices exist in the market, so do various video encoding formats, including newer TCP-based Adaptive Bit Rate (ABR) formats.

Apple devices, for example, favor Apple's HLS format; Microsoft products prefer the Microsoft Smooth Streaming format. The service provider has to take the source content, often in various encoding formats, and change the encoding to fit the format the subscriber end device can understand.

This was the first Videoscape issue we looked at: How does Videoscape ingest and transcode new content?

As in every test we first set our expectations for the results of the test. We expected the Cisco Transcode Manager (CTM) to automatically detect new content from content providers, transcode it to the video type

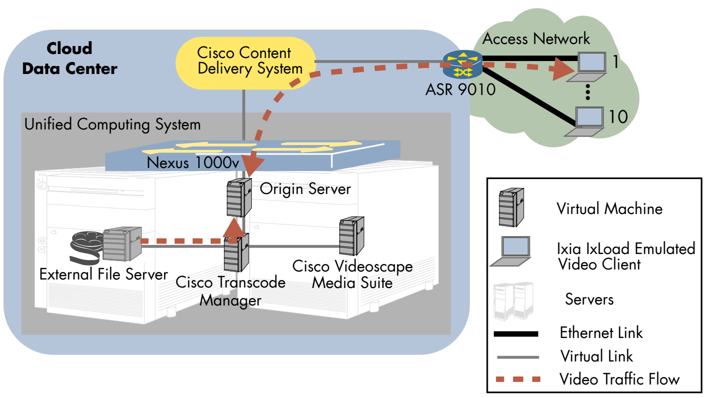

Figure 1: Cisco Transcode Manager Test Setup

of our choosing, and save it to our origin server, where it would be ready to be seen by customers. Since this was expected to work automatically, we expected that no configuration changes or further involvement from us during the test would be required.

In setting up for the test we did have to choose a type of video that we wanted to store in our origin server – the server that holds the content to be streamed to the subscriber. We chose between two of the newer streaming formats – Microsoft Smooth Streaming and Apple's HLS – going with the latter for this test. Once this was configured, we could start the test.

Our defined test procedure had just two steps. First, we put ourselves in the shoes of the content provider. We moved a set of files into the external file server just as a content provider like NBC or HBO would do. The video formats included the following file types, which we believe to be common: GXF, MXF, MPEG4, MPEG-TS, MPEG-PS, AVI, WMV and with PCM, AAC, AC3, MPEGv1 and WMA2 audio codecs and with AVC, MPEGv2, WMV3, Huffman, Cineform and ProRes video codecs.

Second, after allowing enough time for the CTM to transcode the files, we used Ixia's IxLoad to emulate users requesting the content we stored on the server, in HLS form.

Since we had planned to later test scalability, we emulated a small number of subscribers asking for the streams – at least two. In all cases the video was received on our Ixia emulated clients without any failed delivery. We also checked for errors and the need for TCP retransmissions (HLS is based on TCP, after all) and found none.

It is clear that Cisco has every interest in seeing video really taking off – the network will then have to grow to accommodate the video landscape needs and with that Cisco will ship more devices. It is also reassuring to see that Cisco's Videoscape is agnostic to file format and device types and is ready to support any format to any unmanaged device type delivery, though Cisco was not prepared to deliver the content to a set-top box. We could have spend a lot of time in the lab testing an almost endless matrix of file formats, but we feel that our confirmation that Cisco could convert seven popular file formats to the more recent Apple HLS format is a good starting point. It is also useful to know that the Videoscape platform really did "just work" without us having to do anything special to get the system to identify file types and play them out. We'll look later at some resiliency mechanisms of the CTM, but first onto a deeper look at the delivery system.

Multi-Format Video Delivery

EXECUTIVE SUMMARY: Multiple video formats were successfully delivered to multiple emulated users through a single infrastructure.

Continuing our test of Cisco's Videoscape architecture, we shifted our attention to the next logical component in the system. We already verified that the Cisco Transcode Manager (CTM) could take video files of various containers and transcode them to a single unified video type. Now we investigated if the system could deal with a common, yet demanding use case in which many prominent video types are streamed in parallel. Since some of the popular Adaptive Bit-Rate (ABR) formats include Apple's HTTP Live Streaming (HLS) and Microsoft's Smooth Streaming Format (SSF) we also verified Videoscape's ability to change the quality of the streams on the fly using up-shifting and down-shifting.

A service provider wishing to offer a TV Everywhere-type of service to subscribers must consider that the number of video codecs is really dependent on the subscriber's choice of viewing device. Some subscribers might enjoy peeping into their home channel when on the road for business and therefore using their business laptops. Other subscribers, even within the same household, might use an iPad to watch one show, while in another room the good old television will be used to watch another. In some markets, service providers also enable mobile subscribers with access to the same TV content over UMTS or LTE. So what's a service provider to do?

Cisco sees no reason not to support all codecs with a single system. We therefore actually played video files in each of the prominent file formats: Flash, Windows Media, Apple's HTTP Live Streaming (HLS) and Microsoft's Smooth Streaming Format (SSF). After stepping through each of these codecs and verifying, using Ixia's IxLoad, that the video was being received and in viewable quality, we switched gears and gave Apple's and Microsoft's formats a run for their money up-shifting and down-shifting the quality levels of the streams by changing the bit rates and resolutions of each stream.

After running through the test using Cisco's CDS-IS running on the CDE 220 as the streaming device, we repeated the same procedure with another streaming system. As an alternative to the CDE system, Cisco has incorporated similar functionality into their Integrated Service Module – a line card for their ASR 9000 series routers. For the purposes of this test, the line card replicates the same streaming functionality that we tested from the CDE 220 system. We streamed all four video types, and stepped through quality levels when playing HLS and SSF video. A graph below shows the change in bit rate observed by Ixia's IxLoad software as we stepped through the different quality levels.

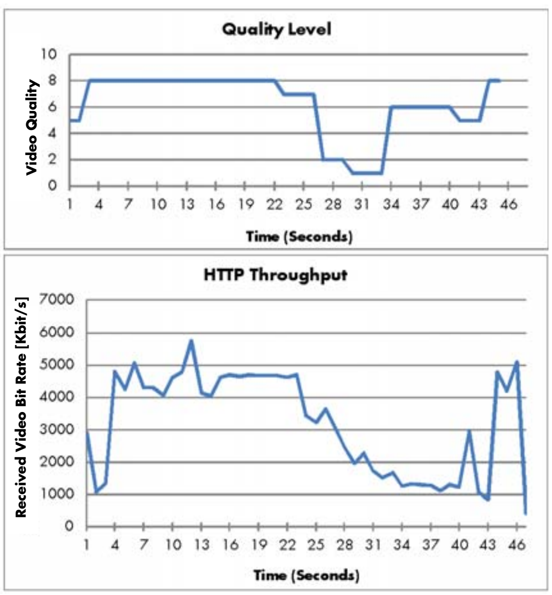

Figure 2: Stepping Through SSF Video Quality Levels

In essence this test served more as a sanity check than anything else. Once video is transcoded into different formats, delivering it was pretty much a given. Still, we wanted to go through the motions to be sure, and we also wanted check that the features that come with smooth streaming were functional. Cisco's CDE system and the ASR 9000 line card equivalent delivered Flash, WMV, HLS, and SSF based video to our emulated users. As a next step we asked: how does it scale? But first, we took a look at Cisco's Mediasuite – the intelligence behind the end-to-end solution.

Cisco Mediasuite

EXECUTIVE SUMMARY: Cisco's Mediasuite streamlined the processes and workflows required throughout the various Videoscape tests.

As part of our method of breaking down the different components of Cisco's Videoscape architecture and testing them one by one, we have so far not mentioned one component: Mediasuite.

As Cisco described the roles of Mediasuite, we began to consider it as the centralized brain, or at least the coordinator, of the Videoscape architecture. It is through the Mediasuite software and user interface that administrators can configure the content workflows – where it is coming from, how it should get transcoded and how it is presented to the customer. During our transcoding test of Cisco's Cisco Transcode Manager (CTM), we verified that the solution automatically detected the presence of new content from content providers. In fact, this function was performed by Mediasuite, which then alerted the CTM and made a transcoding order. (See Comprehensive Video Transcoding.)

Figure 3: Mediasuite Administrative User Interface

Mediasuite also captures the metadata of the video file, and posts it to a user portal. We sat down and poked through some of the portal options. We opened a couple of browser windows (Firefox and Internet Explorer) on our laptops and loaded the Mediasuite portal. After logging in, we saw the series of video files that we were working with thus far, in thumbnails, and we were able to play them. We've included a screen shot.

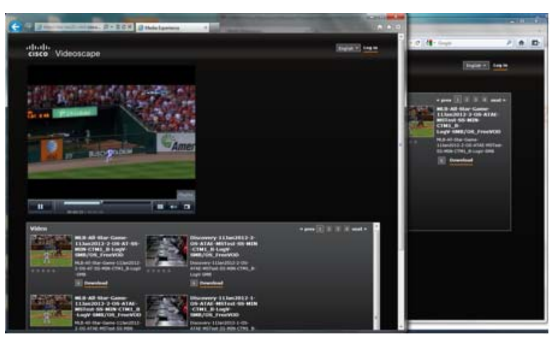

Figure 4: Videoscape User Portal

Finally, we also saw that Mediasuite manages encryption and entitlements. We asked Cisco to transcode a video we were not able to see. After moving on to another test, and coming back to our portal, we noticed an icon with a lock on it. Indeed, we couldn't play it. We went and took a look at the administrative portal where Cisco gave us the rights to see the encrypted video – to allow us to obtain the key – after which we could play it.

In summary, Cisco demonstrated what Mediasuite's user portal and administrative interface look like and how they were used to build the workflows in our Videoscape tests.

Adaptive Bit Rate Video Scalability

EXECUTIVE SUMMARY: Cisco's Content Delivery System (CDS) - Internet Streamer (CDS-IS) scales to 12,002 concurrent video streams, delivering a maximum of 39.497Gbit/s of HLS formatted video traffic.

Video is arguably the most demanding network application. Cisco's Videoscape aims to work as a video delivery solution for any application, with a strong focus on residential users. But residential users tend to come in large numbers, so what does this mean for service providers who want to deploy Videoscape at scale? How much equipment will be required for how many users?

Another consideration for a service provider offering video is that Video on Demand (VoD) services have different requirements from live video. Clients can load potentially vast amounts of data before playing the video, and in many cases can seek forward through the video, having access to any segment.

For VoD services, Cisco's Content Delivery System (CDS) - Internet Streamer (CDS-IS) is designed to deliver the streamed content, and also to cache content locally nearby the customer. Of course, not all content will always be cached, so delivery of content that is sitting in the data center is also important.

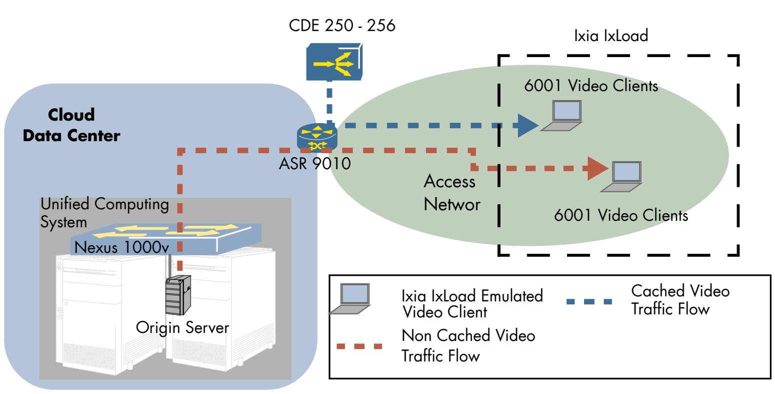

Figure 5: Adaptive Bit Rate Video Scalability Test Setup

We set out to verify Cisco's claims that a single Cisco CDE could scale to 40Gbit/s across four 10Gbit/s Ethernet interfaces using HLS format Video on Demand (VoD) traffic.

Since HLS is based on TCP, it is up to the user to request the segments of the video they need next, and can simply use TCP retransmissions if it is not received.

We scaled as high as we could while still observing consistent video delivery with no or very few TCP retries. We ran 12,002 video streams to 12,002 unique subscribers (each receiving an average of 3Mbit/s stream) for 72 minutes and only observed 16 TCP retries. Half of these 12,002 videos were cached locally already on the CDE 250-2S6 system, which sat close to the Ixia IxLoad emulated clients, the other half had to be retrieved from the origin server. We should also note that the emulated clients were configured with TCP "Delayed ACK" enabled -- a feature in the TCP stack which consolidates multiple TCP ACK messages into a single IP packet, reducing the number of outgoing packets which simply acknowledge that traffic is received. Not having to process as many incoming IP messages from the customer, the CDE 250-2S6 was able to scale as high as it did.

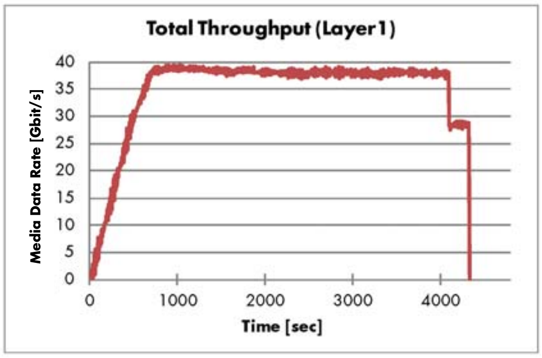

Figure 6: Total Throughput

Network planners in charge of budgeting for the rollout of more advanced video services need to understand not only how systems operate, but how they scale. We were able to verify that Cisco could support over 37Gbit/s of HTTP Live Streaming traffic to more than 12,000 clients simultaneously, reaching a maximum of 39.497Gbit/s of Ethernet traffic when measured at Layer 1, all through a single Cisco CDE 250-2S6 device.

These service engine devices are designed to be placed close to the customer site, and that's a good amount of video traffic for a single site. We focused on ABR video delivery, but with reason. Cisco sees adaptive bit rate smooth streaming formats (SSF and HLS) as the future of video delivery, predicting that flash and windows media based video will soon no longer be the norm. After this test, it seems that they are well equipped for this shift.

Live Streaming Redundancy

EXECUTIVE SUMMARY: Cisco's Media Processor transcoded a live IPTV feed to HLS and SSF formats and provided multiple encoders for users to switch to when one failed.

You'll notice that our tests so far have focused on video on demand (VoD) services, but as much as Web video has picked up, live video services are not likely to be replaced soon. Traditional television or IPTV are examples of live video – the content arrives at a certain time to all viewers screens. Supporting live video is of course part of Cisco's strategy of providing any video to any unmanaged client, and the list of clients includes iPads, windows laptops and Android tablets.

Cisco claimed that its Cisco Media Processor (CMP) could encode a live IPTV stream to both HTTP Live Streaming (HLS) and Smooth Streaming Formats (SSF). In addition, Cisco ensured us that the solution supports the inherent redundancy mechanisms built into both streaming formats.

Both protocols specify a bit of automatic client intervention in a network failure scenario. The protocols are both based on HTTP. When a video source, in our case an encoder providing a specific quality level, fails, the HTTP requests will start go unanswered. Luckily, the client can request an alternative video quality level that came in the manifest file received when it originally requested.

Since the stream is live, the assumption is that all encoders are playing the same content at the same time so switching to a new source should not be a problem to the viewer. If the second encoder is ready, the request to the second URL will be successful and the video feed will continue.

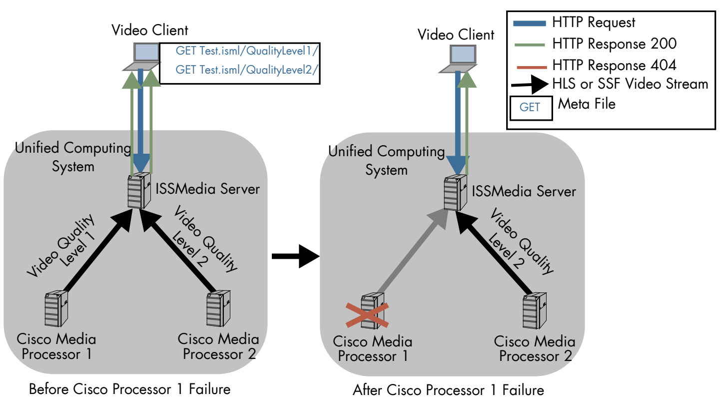

Figure 7: Live Streaming Redundancy Test Procedure

In order to test the solution's ability to switch to an alternate video source, we had to use real clients simply because the emulated clients could not switch to a different source automatically. This also meant that we could not measure the outage duration since real clients are concerned with displaying the video and not measuring failure duration.

We performed the test twice – once using an iPad to view HLS video, and once using a Windows laptop running Silverlight to view SSF video. The video source was fed into the UCS 6140 and 5100 – where two UCS blades each had Cisco's CMP software installed.

Client requests were directed to an origin server with knowledge of the various streams. In each case we established a video stream, watched it for a bit, and then removed one source through the origin server user interface. This caused the next HTTP requests to fail – the origin server returned 404 messages. Upon receiving the 404, the client requested a second URL and second quality level as known from the original manifest file. In the case of SSF, the protocol does not allow multiple URLs to send video with the same quality level, so our backup CMP sent video at a different bit rate. Once the new request came in, the origin server directed the second CMP, which was already receiving and encoding traffic, to send that traffic to the client. We verified this visually, and in the case of SSF we took a packet capture as well. In the iPad case, we noticed no visual effects, and in the case of SSF it was only a minor blip

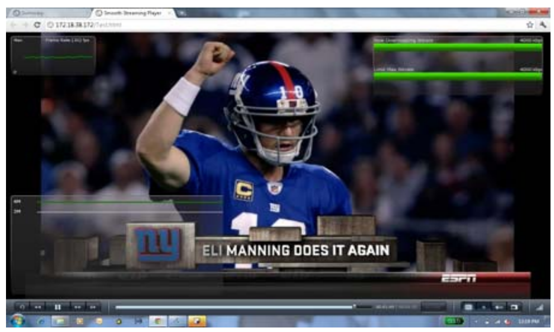

Figure 8: SSF Video Screen Shot

For us, there were a few takeaways from this test. First, Cisco could encode incoming video into the new HTTP ABR formats that Cisco considers to be the future: HLS and SSF. Second, Cisco's live encoders could run directly on UCS blades so an appliance is not needed. Finally, the solution supports the redundancy mechanisms as the formats describe, ensuring that a failure in one encoder will not leave users without service.

VoD Transcoder Redundancy

EXECUTIVE SUMMARY: Cisco’s virtual machine-based Transcode Manager recovered transcoding jobs from a virtual machine failure.

Transcoding video from one format to another is an intensive task for a CPU. Each video frame needs to be analyzed and reformatted. Even if you transcode a two-hour movie video with a low frame rate (like 25 frames per second), there are still 180,000 frames to crunch through. Cisco's transcoder solution, Cisco Transcode Manager (CTM), which we previously tested, answers this problem by offloading processes to multiple virtual machines that can share the load of transcoding tasks. Since the work is shared by virtual machines (running on Cisco's UCS of course) we were interested in the not so rare situation in which a virtual machine fails.

We expected that the CTM would offload transcoding tasks to multiple VMs, and if one VM had an error, its tasks would be failed over to another VM. We started this demonstration by moving five movie files to a folder we positioned as the external file server from a content provider. Just as before, Mediasuite automatically detected the new files and directed CTM to transcode them. CTM split this task across its three virtual machines – two were tasked to transcode two movies, and the third VM was tasked to transcode the fifth movie.

We wanted to see that a failure would not mean that the completed tasks from a VM would need to be done again, only the incomplete tasks, so we waited. After Transcoder 1 finished its first job (process ID 419) and had started working on its second job (process ID 417) we went to vCenter and virtually pulled the plug; we shut down Transcoder 1 VM. In seconds, we saw that Encoder 3 had a new task – process ID 417. Once it completed, we saw that all five movie files were sitting on the origin server as expected.

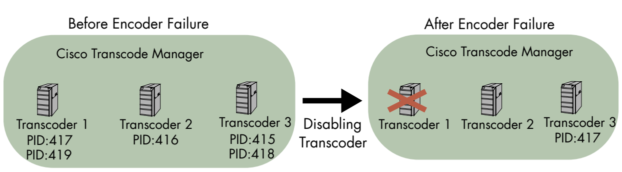

Figure 9: Transcoder Redundancy Test Procedure

So what does it mean? Well, using UCS to encode video files, across multiple virtual machines, is a smart way to get parallel tasks working efficiently. We verified that when a virtual machine stops, the workflow – even when in the middle of an encoding process – will not be affected. To some, it may be a question of whether using virtual machines is a benefit at all, depending on the performance requirements, but we believe this solution is certainly dynamic and allows for flexibility and easier management of tasks

Mobile Video

EXECUTIVE SUMMARY: Cisco demonstrated its Mobile Video Gateway's ability to optimize video bit Rates and pace the amount of video sent to mobile clients.

Mobile subscribers expect the same capabilities in their LTE- or UMTS-connected laptops, tablets and smartphones as they see in their DSL or cable connections, and service providers need to deliver a balance of network speed and quality of service. Cisco is not generally expected to limit itself to landline connectivity so we were not surprised when they asked us to shift our attention a solution focused on video over mobile networks. We should note these features were demonstrated to us – we did not perform rigorous tests, but poked around with the intent of reporting what we observed.

Cisco brought us to one of its mobile environment test labs – a separate test setup than the one we were at so far. Cisco created a demonstration setup that showed a Long Term Evolution network – all functions collapsed into one Cisco ASR 5000: Serving Gateway (S-GW), Packet Gateway (P-GW) and Mobility Management Entity (MME). The eNodeBs were emulated in software in an additional server. The focus of the demonstration setup was to share with us Cisco's vision for mobile video usage using Cisco's Content Adaption Engine (CAE, also running on the UCS system).

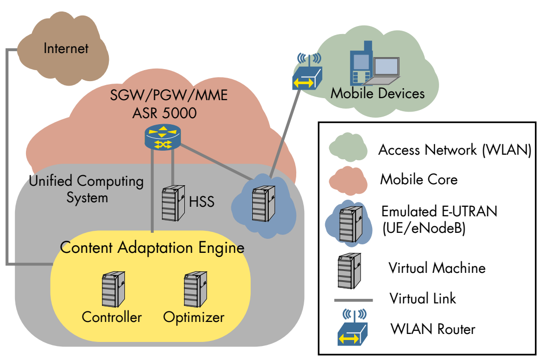

Figure 10: Mobile Video Test Setup

Cisco started with what it calls mobile video "optimization." The idea is that while mobile subscribers may request HD video, HD video might be unnecessary for the subscribers' small screens and therefore will be a waste of bandwidth. According to Cisco, the ASR 5000 in our setup would detect the type of client, and would instruct the CAE to optimize the video bit rate to the mobile device as it is being streamed from the Internet.

We used an iPhone, iPad, HTC Android phone and a couple laptops, to start requesting various YouTube videos from the Internet connection the CAE had. When we requested standard YouTube videos, everything seemed normal. We watched. We laughed. We cried. We then cried a bit more when we switched the YouTube video to HD quality. Why the tears? After requesting HD video, the bit rate indeed went down, but this was also subjectively visible as a user. The Cisco team made the point that in the case of network congestion, using lower bit rates at scale will reduce loss and actually improve user experience, as is done dynamically in ABR video.

There was also a watermark over the video – a test feature enabled to demonstrate that the solution was actively editing the video stream. According to Cisco the optimization of video bit rate was being done by the CAE. After the initial show we activated all mobile devices and streamed different videos to observe a decrease in video bandwidth, and hence video quality, after the HD video was requested. Cisco explained that the quality difference for this demonstration was exaggerated – just to make the point.

The second feature we looked at had a similar motivation: save bandwidth that is otherwise wasted by unnecessary video transmission. In this case it was done by slowing down the amount of video being loaded when streaming. Cisco argues that most of the time users close their Web videos before they have completed, sometimes deciding they're not interested after watching for just 10 seconds.

Cisco's ASR 5000 therefore has a "pacing" feature. Users can see this for themselves. On YouTube, Vimeo, Flash-based video venues, the consumer's screen displays one shade of gray across the top bar as the upcoming video is downloaded and buffered, and another shade of gray to indicate the upcoming video that has not yet been downloaded.

Cisco began to demonstrate this by watching videos with us, then enabling the pacing feature and watching them again. At first, the pacing feature was not obvious to the human eye, since YouTube seems to have its own pacing algorithm. Cisco reconfigured the setup to show two clients running in parallel - both using the mobile video setup, but each going through different Access Point Name (APN) in the ASR 5000. One APN enabled the pacing function, and one did not. The difference became more obvious. A photo, albeit a blurry one, is shown below:

Figure 11: Video Pacing

These features will certainly require some careful configuration and processor resources. Depending on the operator's use case and network needs, the additional configuration may be worth it. In particularly dense regions these features could be a key to reducing operators' traffic load; however, in these regions the Cisco solution must also scale, something that we hope to test soon.

Conclusion: Cloud Applications & Services

Over the last few years service providers entered the business of delivering video content over their networks. The video headend and the systems installed all through the network are usually an adventure in integration. Every component would typically come from a different vendor which meant that after the system was working every issue would potentially lead to finger pointing between vendors with the service provider stuck in the middle. As if that weren't enough, when trying to introduce new platforms to consumers, a service provider would find himself in the middle of complicated compatibility risk.

"Cloud infrastructure is the foundation for future telco business models, but innovative cloud applications and services are where carrier cloud providers will make money," says Heavy Reading analyst Caroline Chappell. "This test demonstrates the potential of Cisco's vision for cloud-based video delivery and the power of video-enabling the carrier cloud."

For this series of tests, we only focused on specific elements of Cisco's Videoscape platform. But from our experience in testing for various service providers no stone should be left unturned in qualifying an IPTV/VoD system for going live. Issues can come up from the content acquisition system to the set-top box. For IPTV systems (i.e. live streaming), the baseline has been set by the cable and satellite networks. Viewers expect a quality on-par with these networks.

Having said all that, the elements of Videoscape we observed could be vital pieces to that overall video delivery system, depending on a service provider's specific needs. In this report we:

- Were assured of Mediasuite's ability to automate workflows from transcoding to publishing
- Verified that both Cisco's Media Processor and Transcode Manager could recover from failure
- Observed Cisco's demonstration of their mobile video features and saw some interesting tools to lower video bit rates to save bandwidth and keep certain sections of videos from loading when not necessary
- Saw that a single Content Delivery System could deliver just about 40Gbit/s of HLS Video on Demand content to 12,002 subscribers

Cisco's goal for its Videoscape solution is to help the vendor climb out of the hole he managed to dig himself into and let Cisco deal with the system while the service provider focuses on the network.

To show that the various parts work, and are future-proof and resilient, Cisco invited us to peek into its Videoscape system. Since the focus of the test was the data center, we did not test the performance or scalability of the various elements of Videoscape, but rather observed and verified its place and function within the data center. We feel this report serves as a good starting point for understanding and testing

Cisco's Videoscape architecture. The next step will be to see how service providers will really use it, and we look forward to building tests for those use cases.

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