Cost-Effective Deployment of High-Quality Video Processing for Broadcast Using Off-the-Shelf Technology

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This white paper outlines the trends driving the need for high-quality video transcoding and encoding and offers an alternative to conventional host media processing (HMP). Using a PCI Express video accelerator and embedded broadcast video processing firmware, this approach offers dramatically improved performance, taking up less space, consuming less power and costing less. Furthermore, it shows how you can achieve that level of flexibility in a server-based environment. Specific application examples demonstrate the performance and cost virtues of this approach.

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The Evolution of Movie Night

It's Tuesday night, the kids are asleep and all you want to do is watch your favorite movie or recorded show… and it's buffering. Who do you yell at? Is it the cable provider, the movie streaming service or the Internet provider's fault?

Whichever one did not accelerate their network to allow everyone a perfect viewing experience at that given time. Video distribution used to dictate when people watched TV and that concept has been turned on its head. Viewers are in charge of everything now and service providers are scrambling to keep up with demand.

The Network Shift to Accommodate Consumers

Consumers are changing how video is consumed. Smart devices are pervasive, transitioning traditional TV bundled consumption to an on-demand experience on multi-screen devices. In order to keep up with the need for efficient delivery of high-definition (1080p today and 4K in the future) streams, the network must provide scalable density and capacity to support growing user demand.

This exponential growth in video streaming subscribers is forcing a change in the way we build out the broadcast network infrastructure. With the broadcast video market undergoing this intense transformation, broadcast distribution equipment must rise to the challenge.

Innovation is the key to accommodate the sharp rise of video traffic and its need to support multiple types of devices using less bandwidth, constraining proprietary systems currently in place.

These systems were built for a level of video traffic that is a fraction of what has now become a full-scale invasion on the network's capability to support video.

What is the service provider (MSO or ISP) to do?

Add more systems on top of old systems until they physically reach the clouds (not the "cloud")?

Not an option.

Instead, the approach defined here invites you to optimize your existing systems to think faster and look to off-the-shelf solutions for more scalability so you can focus on your own value add.

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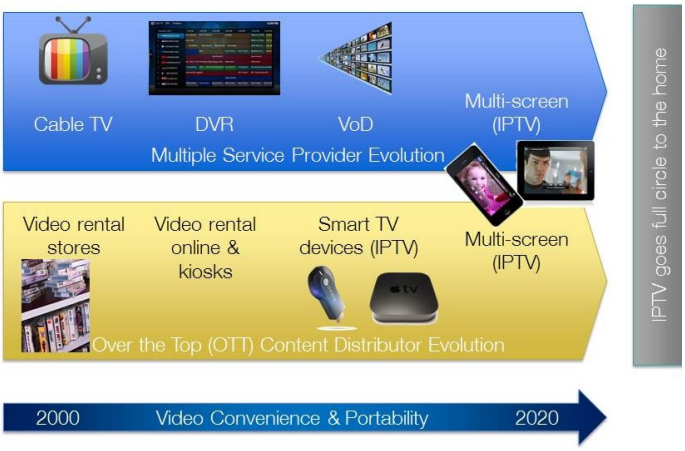
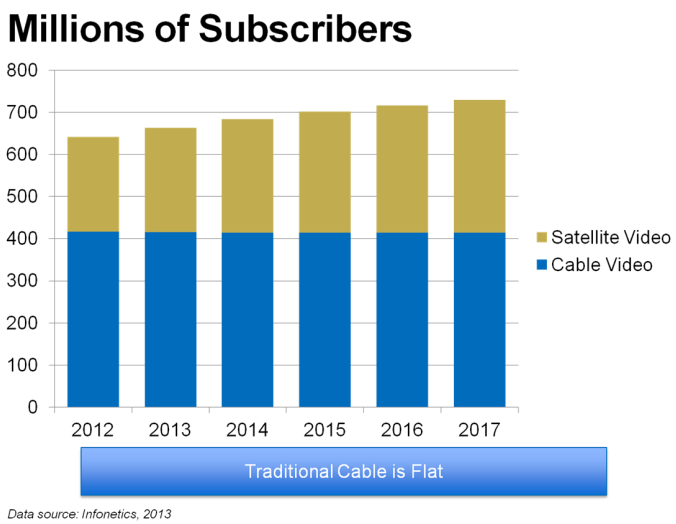


Over-the-Top is on the Rise

Online TV and video has been forecasted to generate $35 billion by 2018 (Digital TV Research, 2013). Multiple factors are putting a strain on the network for efficient delivery of video. Video is now consumed on multiple devices (multi-screen) and in different formats, which means an increasing demand for dynamically transcoded video (as opposed to pre-transcoded video stored in multiple formats) in order to support more content.

Consumers' demand for Over-the-Top (OTT) and on-demand video (multi-screen) is rising faster than traditional (linear) broadcast video, yet both types are demanding higher-definition quality. *Infonetics* predicts the OTT market for CDN video equipment will grow at 19.7% while traditional cable video (analog & digital) subscriber market is saturated maintaining a relatively flat 2% CAGR.

These Pay TV service providers cannot just depend on video on demand (VoD) revenues – their business model is shifting to mobile distribution through multiscreen distribution to compete with growing OTT consumer options. This will result in even more CDN buildout to accommodate this influx of video competition in the network.



Data source: Infonetics, 2013

Service providers all want to monetize content – this includes multiple system operators like Comcast, Internet Service Providers and content distributors like Netflix or Apple.

These are the OTT players competing and collaborating for the profit made from streaming video. Primary video distributors, such as Comcast, are providing pay movie services that will compete with Netflix by procuring exclusive rights to popular movies (http://www.cnet.com/news/could-comcast-be-netflixs-new-competitor/).

For a premium, OTT Content Providers could have their own freeway to distribute video more efficiently and theoretically pass on those premium costs to the consumer. Carrier giants and cable providers are acquiring competition & potential partners, effectively merging the effort to monetize from OTT content (http://blog.idate.fr/comcast-time-warner-netflix-verizon-redrawing-americas-tv-landscape/).

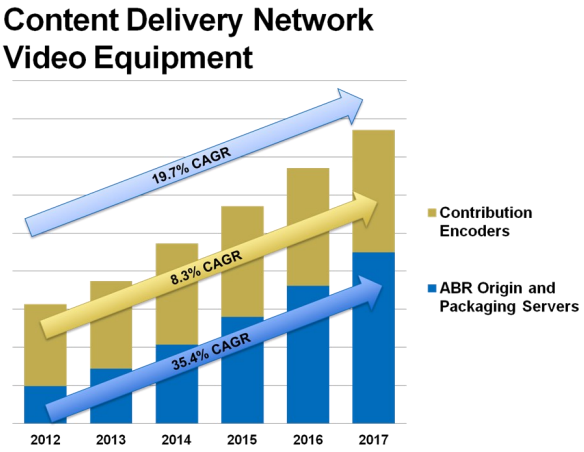
Pay TV service providers are being forced to transform their business model to stay in the game and compete with OTT content providers such as Netflix and Apple.

Getting their content on mobile devices and transitioning their VoD from the cable box to the internet is table stakes to compete with subscription based services online. Global VoD revenues will be 74% OTT by 2017 (IDATE, 2013).

How are Pay TV providers supposed to survive?

Their only hope is building out multiscreen video distribution networks, so consumers have the option to use their digital cable accounts on mobile devices. The days of cable TV may have reached its peak, but the Pay TV service providers will endure through multiscreen networks.

For legacy-based business models, multiscreen has facilitated "the transition to IP based video delivery, which is more efficient and provides an opportunity for interactivity and portability they never had before" (Infonetics, 2014).



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A recent survey reveals that "during the first half of 2013, time spent watching video on tablets increased by a massive 59%, with the share of video viewing on phones increasing 41%. Taken together, mobile and tablet video viewing have increased by a factor of ten in the past two years, now accounting for 13% of all online video" (Light Reading, 2014) http://www.lightreading.com/agile-digital-business/accelerating-telco-revenue-growth-with-ott-and-multi-screen-services/d/d-id/707680.

Key Market Shifts

In summary, the following shifts are happening in the broadcast distribution network:

- Pay TV providers are transitioning their business model to IP delivered multi-screen video.
- Service providers are seeking to monetize their networks for OTT providers, so that video can be delivered more efficiently and with less latency to differentiate their offerings.
- OTT Content providers, Multiple System Operators (MSOs) and Internet Service Providers (ISPs) are both collaborating and competing for business.
- As the network for broadcast video completes its evolution to IP, standard servers are ubiquitous and preferred by MSOs and ISPs for video processing platforms, however today's servers are not ideal platforms for the scalable and efficient delivery of video with increasing density and processing burden.

As video consumption is on the rise, a key concern is scalability. How will the data centers of the future scale to meet the growing demand for video? Furthermore, how will broadcast equipment vendors offer solutions that meet the need for higher-density, lower-bandwidth and high-quality video features serving both traditional cable markets as well as the rising multiscreen market?

Choosing the right software platform can make the delivery of video content, from camera to the screen, far more efficient by reducing the necessary file formats. This would allow operators to more quickly build out CDNs for OTT by consolidating multi-format streams.

Typical Applications in the Broadcast Equipment Market

Looking specifically at the task of broadcast OEMs, let's explore two typical applications concerned with high-quality video processing.

Production Playout Server Transcoding

A good example of high-quality broadcast production equipment is the playout server and its role in transcoding video content. The purpose of this server is to broadcast television programs to the networks, so they can deliver them to audience. To accomplish this task, the server takes in uncompressed high quality video through SDI inputs or compressed video though ASI or Gigabit Ethernet ports. Once manipulated (ad insertion, etc), the video is transcoded into the appropriate format and distributed across the network.

With the rise of video content played on mobile devices (ie. tablets, smart phones, etc.), broadcast OEMs are now being tasked to provide both main screen and multi-screen content from these servers. This extra workload equates to an increase in system resources (storage, CPU utilization, etc.) and a decrease in the total number of programs being sent due to shared output bandwidth. The challenge then becomes how to maintain or increase the number of programs sent without purchasing another server or sacrificing video quality.

Primary Distribution Headend Transcoder

The purpose of the primary distribution head end is to distribute high quality video content from the national to local cable head ends.

In general, these servers are 1U and 2U systems with high density channel outputs. A single high density transcoder can output anywhere from 4 to 24 channels of video content.

Today's distribution servers must now support both linear (traditional cable) and multi-screen transcoding while trying to maintain the same level of high video quality over the same bandwidth. To combat this situation, broadcast OEMs are developing or using chipsets or software with efficient high quality video compression techniques and algorithms.

Specifically for developers using x86 based solutions and host media processing, this means having to potentially await the next chipset to get the hardware acceleration needed or use 3rd party CPU-intensive software-based solutions to meet the performance and high-quality requirements demanded by this application.

Possible Solutions

Architecturally, supporting high-quality multi-screen transcoding can be accomplished in two different ways:

- An internal software solution, adding functionality to an existing broadcast appliance, or to a standard server
- An internal high-quality broadcast video accelerator, offering hardware-accelerated transcoding for both linear and multiscreen transcoding

The first option, an internal software solution, uses host media processing (HMP) software that makes use of internal processing resources. While it enables broadcast video functions to be supported on standard servers with no special hardware, it does not offer the level of scalability in terms of video quality versus channel density, power and footprint needed, because it requires several servers to accomplish the task, consuming the host CPU resources of multiple servers.

This leads to the burden of unpredictable capital equipment costs and high deployment costs such as power, cooling and real estate. In addition, today's X86-based software implementations generally struggle with high-quality features such as motion estimation, mode decisions and CABAC (context-adaptive binary arithmetic encoding), which is a lossless compression technique used in H.264/AVC and H.265/HEVC video encoding).

The Solution

Now let's explore the third option. Unlike a pure software approach, hardware-accelerated transcoding relies upon specific hardware and may not be as easy to deploy.

However, if that hardware-accelerated transcoding capability can be offered in an off the shelf format that is usable by industry standard servers, it brings the best of

both worlds in terms of ease of adoption and the most efficient performance: shrinking the network footprint required while simultaneously growing capacity.

Introducing SharpCaster™

Artesyn's SharpCaster™ broadcast video accelerator delivers the highest-density solution with no compromise in video quality for the most demanding broadcast application requirements.

As a standard-off-the-shelf high-density PCI Express add-on card, the SharpCaster accelerator is designed for 1U and 2U off-the-shelf server platforms, so it can be broadly deployed to meet the needs of different applications.

The SharpCaster accelerator employs the design of the Magnum D7Pro broadcast system-on-a-chip solution which delivers industry leading video quality and channel densities with software application libraries specifically designed to meet the most challenging requirements for each application in the contribution, production and distribution broadcast market segments.

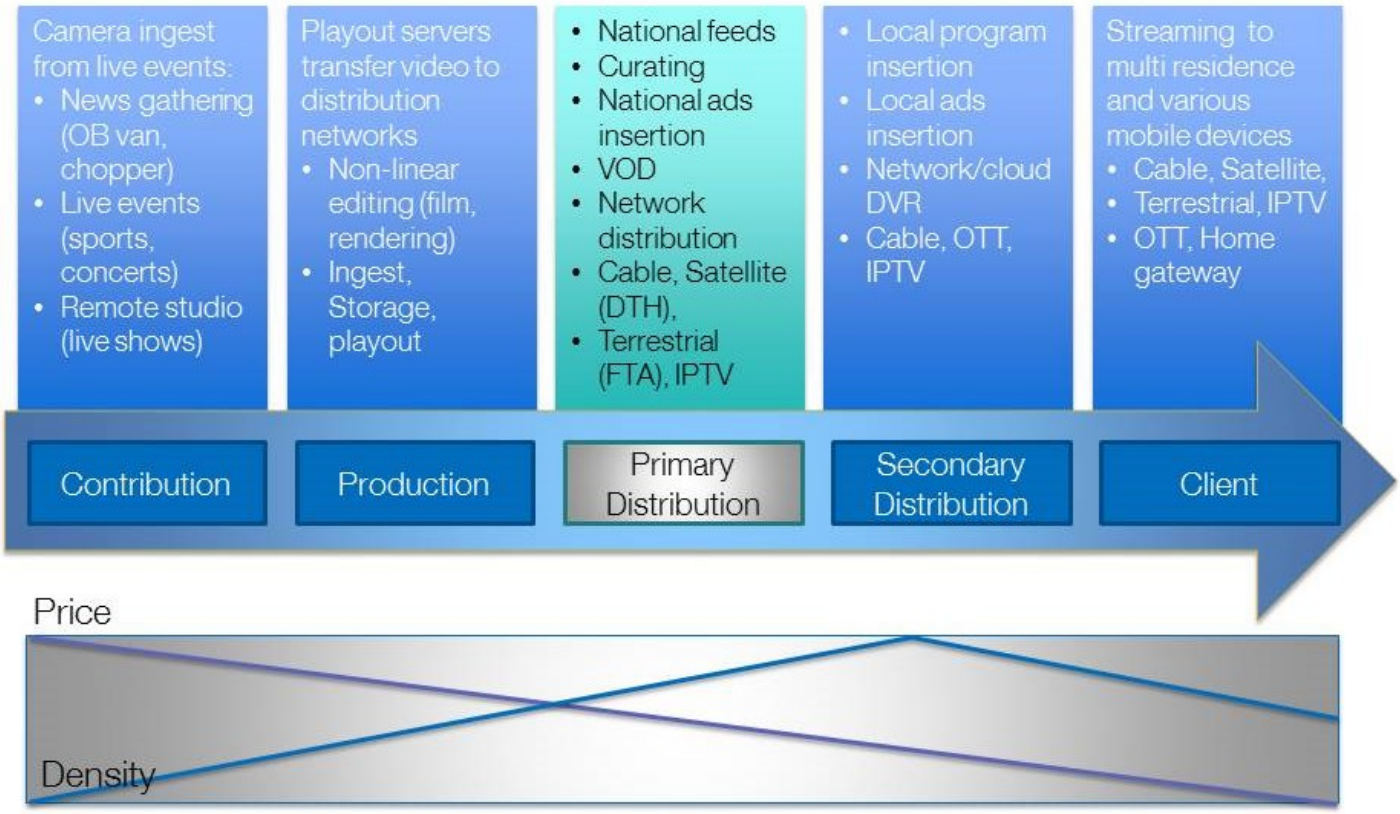
Broadcast Application Spectrum

Broadcast video applications have specific requirements according to where they fall in the overall network application spectrum. One requirement they all share is maintaining high quality while being converted into multiple viewing formats. Note how as we move across the spectrum from the original video capture at its highest-quality, to video distributed to enterprises and end-users density increases and quality decreases:

As a complete solution, the SharpCaster accelerator offers full support for the Magnum Pro API libraries, and Artesyn has packaged implementations for linear transcoding, multiscreen transcoding and encoding enable flexibility across different applications. The SharpCaster accelerator supports both native SDI/ASI inputs as well as transport stream access across the SharpCaster card's PCIe interface, which allows broadcast OEMs to focus on delivering innovative software features in a standard server platform without compromising video quality, density and power.

As mentioned earlier, today's X86-based software implementations generally struggle with high-quality features such as motion estimation, mode decisions and CABAC.

In addition to that, a whole slew of proprietary algorithms are required for real-life video coding, and those algorithms require significant processing cycles, making it impractical to achieve the same video quality and channel density results on general purpose hardware.



Some of these required functions are:

- fade detection
- flash detection
- skin tone detection
- noise filtering
- pre-deblocking

The SharpCaster technique employes Magnum field-proven and widely deployed ProAPI software to implement these key features.

SharpCaster High-quality Broadcast Features Supported:

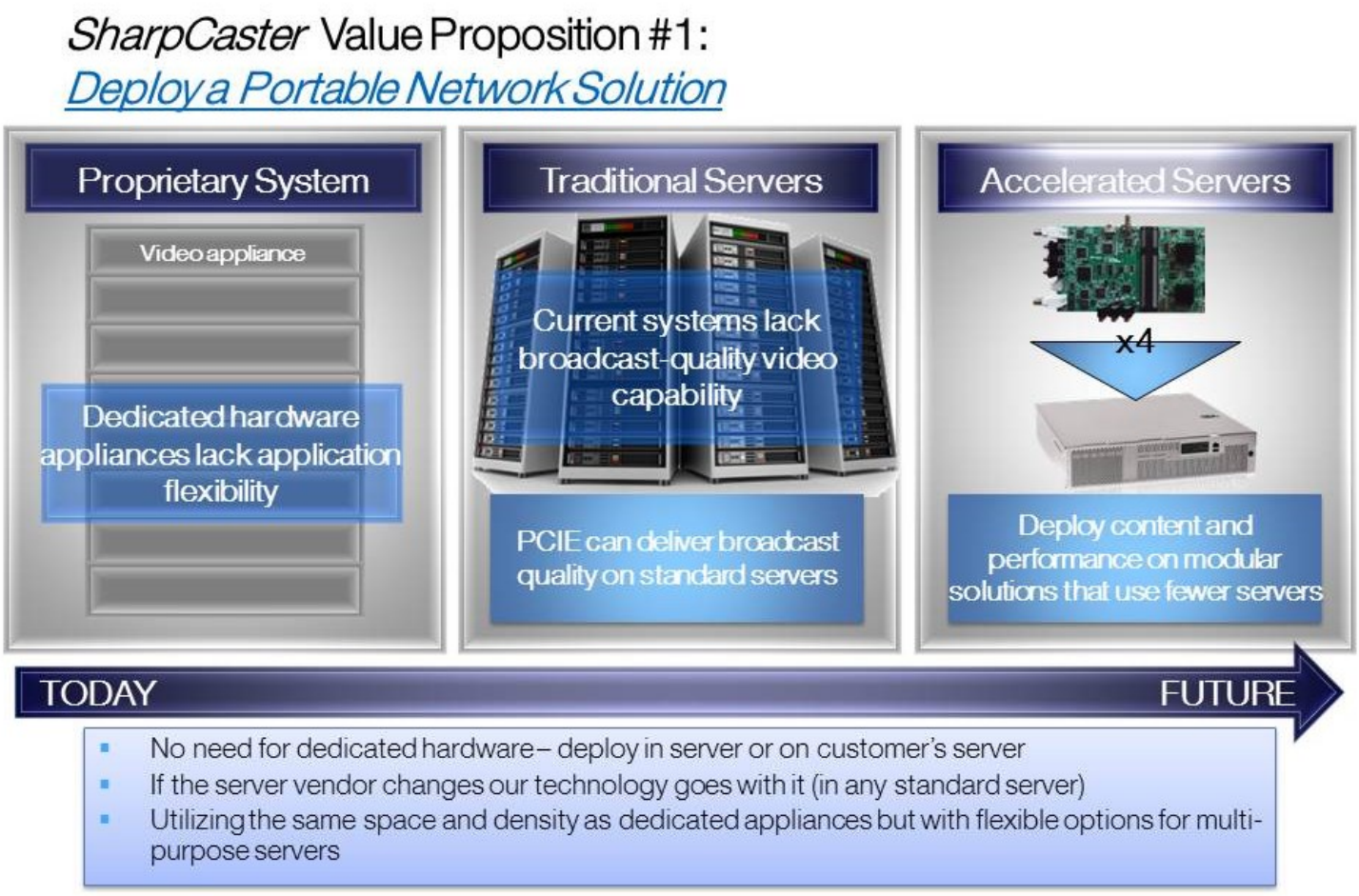
- Motion Estimation Features:
  - Hierarchical motion estimation with large search ranges
  - All available mode decisions
  - Up to 80 Mbps CABAC
- Real-life Video Coding Features:
  - Fade detection
  - Flash detection
  - Skin tone detection
  - Noise filtering
  - Pre-deblocking
- Support for both Linear (cable) and Multiscreen formats
- MPEG-2 and H.264 encoding and transcoding
- IDR, PTS and GoP aligned ABR support
- Interlaced to progressive conversion
- SD to HD up-scaling and HD to SD downscaling
- Aspect ratio conversion
- Logo insertion and graphics overlay with animation and fade-in/out support
- Statistical multiplexing support
- Multi-channel Dolby Digital Pro, AAC-LC, HE-AAC and MPEG-1 Layer II audio support
- MPEG-2 transport stream support over PCIe
- Hardware Options:
  - Optional SDI/ASI input interfaces via DIN connectors
  - Scalable processor density with options for 2-4 Magnum devices per card

Advantages of this Approach

Deploying a Portable Solution

The first benefit of this approach is deployment flexibility. With no need for dedicated hardware the SharpCaster accelerator option can be deployed on the broadcast equipment vendor's own hardware or on the MSO or ISP's own server, which may already exist.

Furthermore, if that server changes over time this solution is portable and can go from one environment to the next, offering the same efficient and high-quality



performance and functionality from one generation to the next, or one server vendor to another.

Deploying this type of high-quality video encoding and transcoding on a hardware-accelerated expansion card offers the ultimate benefit of server reuse, with far fewer servers needed versus host-media processing which requires multiple servers and doesn't scale cost-effectively as the network needs to scale up to handle more density, content and formats to server the growing customer base.

Ease of Adoption

The second benefit of this approach delivers ease of adoption for broadcast developers, which is essentially the opportunity cost of not reinventing the wheel and the significant offset of development expense and time to market.

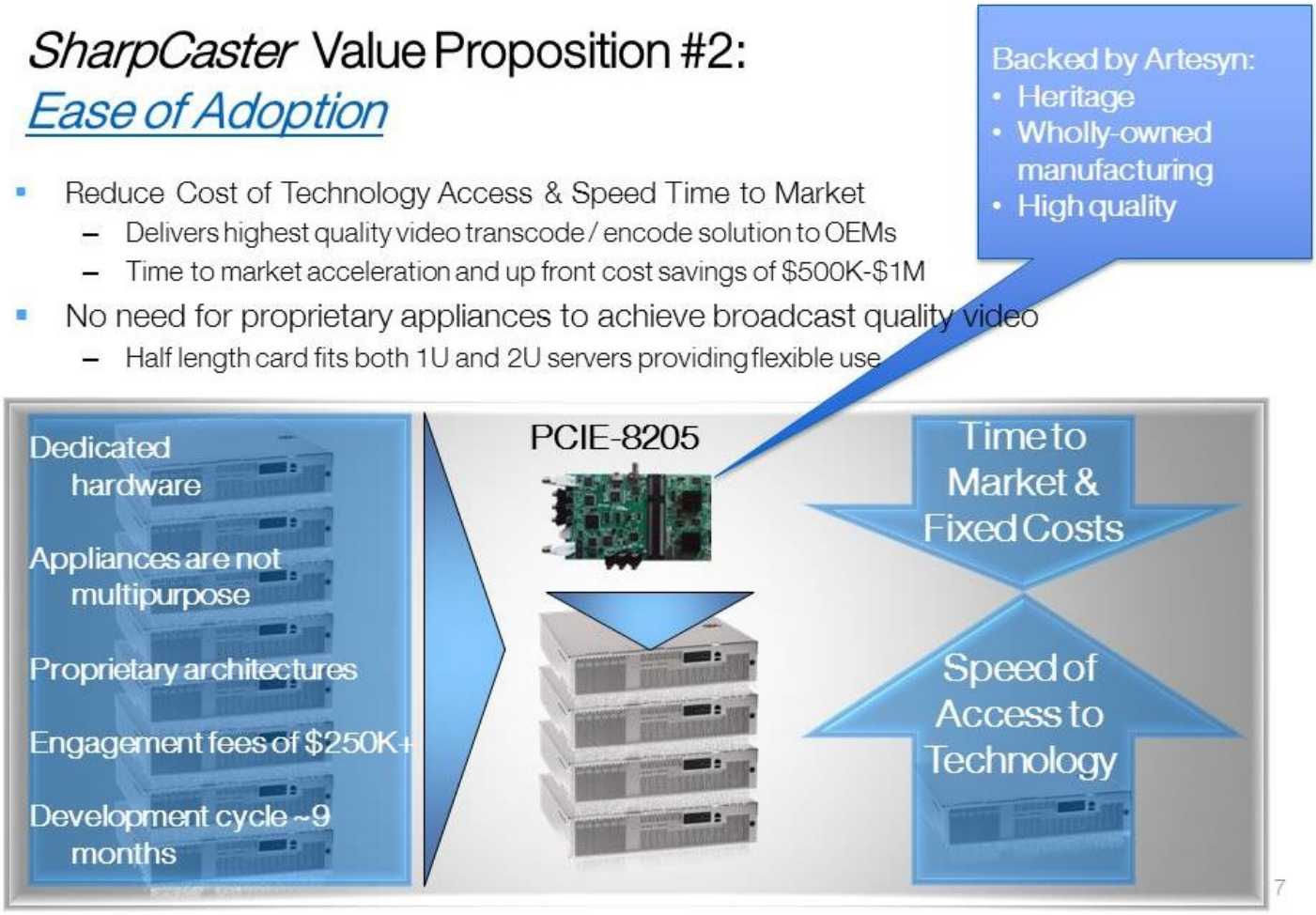
Developing solutions in-house for this level of high-quality video transcoding and encoding capability typically requires system on a chip, FPGA or DSP development.

Host-media processing technologies will not offer the level of quality needed to effectively serve these applications. The investment associated with these technologies is high up-front, with NRE and up-front licensing costs typically ranging from $250,000 to $500,000 to support the features required. On top of the initial costs, there are incremental in-house cost burdens for R&D to develop boards or systems, and the time-to-market required to deploy the technology.

The SharpCaster approach offers ease of adoption by eliminating significant up-front expense, as the technology is now available in an off-the-shelf format. Also, time to market can be accelerated by building upon a hardware and software-ready solution, versus developing everything in-house.

Server platforms are now preferred over proprietary architectures, and with the technology now available in a server form factor, it does not make sense to re-create the wheel.

In other words developers need to ask themselves if there is meaningful differentiation left in hardware development, and is the time to market offset worth it.



What Are the Cost Implications of this Approach?

Coming back to our options for how to deploy high-quality video, let's look at HMP and hardware-accelerated resources like SharpCaster to compare capital and operational expenses, to ultimately measure the total cost of ownership of each approach.

Looking at the video processing engine itself, there are clear advantages in terms of power consumption, operational costs and capital equipment costs associated with the Magnum D7Pro technology implemented in the SharpCaster card.

		Artesyn SharpCaster Solution	Leading Software Solution
Density	Blades per bundle	1.5	1.0
	Blades per 350 channel system	525	350
	SharpCaster blades per RU	16	
	X86 blades per chassis (10RU)		16
	RU for 350 channels system	33	220
Power	X86 Blade (W)		80
	SharpCaster blade (W) based on 4xD7 per	56	
	Host server (W)	160	416
	Total solution power (W)	12,604	37,152
TCO	hours/year (hours/year)	8,760	8,760
	Life (years)	5	5
	Energy unit cost (per KW/h)	$0.10	$0.10
	Power usage effectiveness (PUE)	2.5	2.5
Total OPEX		$138,011	$406,814

On a system-level we can expect to see the advantages in terms of a 1:3 OPEX savings and potentially $500K CAPEX savings for development costs.

That is savings that can be applied to other parts of your business, improving your value-add and end customer experience.

The software based solution requires 220 rack units to achieve 350 channels, whereas the SharpCaster solution only requires 33 rack units.

This is 85% less space required for equal density! That saved space translates into less than 1/3 of operating dollars required to run the SharpCaster systems with equal performance.

Server Tested

Artesyn plans to test and verify the interoperability of its SharpCaster card in multiple server environments from leading vendors.

A Better Solution

With the rise of smart devices and the increased bandwidth available in the network, video is becoming more pervasive. However, broadcast equipment will need to evolve to rise to the challenge of transcoding and preserving high-quality in today's network.

Scaling up to higher densities and preserving quality can be accomplished more efficiently through hardware -based acceleration with the SharpCaster approach, enabling broadcast OEMs to use available server technology, but provision for transcoding and encoding capabilities in a cost-effective way that uses less power, footprint and processing resources to accomplish the task.

The choice is clear - with the fastest, most cost-effective solution now available in a server option, the opportunity cost of implementing a software-based solution is the inability to scale, and ultimately becoming less competitive in the growing entertainment distribution market.

About Artesyn Embedded Technologies

Artesyn Embedded Technologies is a global leader in the design and manufacture of highly reliable embedded computing solutions for a wide range of industries including communications, military, aerospace and industrial automation.

Building on the acquired heritage of industry leaders such as Motorola Computer Group and Force Computers, Artesyn is a recognized leading provider of advanced network computing solutions ranging from application-ready platforms, single board computers, enclosures, blades and modules to enabling software and professional services.

For more than 40 years, customers have trusted Artesyn to help them accelerate time-to-market, reduce risk and shift development efforts to the deployment of new, value-add features and services that build market share.

Artesyn has over 20,000 employees worldwide across nine engineering centers of excellence, five world-class manufacturing facilities, and global sales and support offices.

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