NComputing

# Delivering transformative value to Enterprise VDI
# HDX System-on-Chip


*white paper*

## The problems

*"For many customers both the upfront total cost of acquisition (TCA) and the ongoing TCO end up being more expensive than simply using PCs"*

*The markets for both enterprise VDI and thin clients have plateaued. Customers understand the value proposition for desktop virtualization very well, but the economics of the solution have remained sketchy. While there has been accelerating progress in storage management and other areas related to cost of a VDI deployment, the price, complexity, and limited capability of endpoint devices has remained constant. Therefore, when a customer issues a tender or RFQ for a VDI deployment that includes thin client devices, there has been an immutable $300-$600 per seat price included – a price that rivals or exceeds that of some PC's. In many cases, customers simply choose PC's, even with all of its attendant costs.*

For many organizations, the benefits of thin clients are well established. These devices allow organizations to deploy an endpoint that limits use to a task at hand, minimizes security issues, and in theory is more easily managed than a PC. In fact, traditional thin client vendors have made this argument explicitly: lower long-term management costs theoretically lower the total cost of ownership (TCO). The reality is far from that. The vast majority of thin client devices are "stripped down" PC's running an embedded version of a desktop operating system. And those devices architected to provide a more secure environment are often hobbled by barely acceptable performance – especially when it comes to modern multi-media applications. And on top of these issues, thin clients still suffer from complex management solutions that counter any TCO savings. As a result, both the upfront total cost of acquisition (TCA) and the ongoing TCO end up being more expensive than simply using PCs.

But, even as organizations move toward BYOD (bring your own device) and mobility solutions, the demand for a high performance, highly secure and easily manageable thin client is accelerating. Without it, customers considering VDI need to consider not only the high cost of the device, but also the continuing high cost of IT staff and management. For a company like Citrix with a vision of allowing access to apps and data from anywhere from any device, there is both a challenge and opportunity: how best to break through the long-running price/performance and manageability barriers to deliver a purpose-built endpoint solution for HDX.

## Citrix and the HDX System-on-Chip (SoC) program

*"The Citrix premise is that the lower cost of the endpoint can help enterprise VDI reach the tipping point, dramatically accelerating adoption."*

At Synergy Barcelona in October 2011, Citrix CEO, Mark Templeton, presented an overview of a new program designed to stimulate dramatic new levels of innovation in the HDX market. The initiative is designed to enable an entirely new generation of devices to deliver high-definition virtual apps and desktops at an unprecedented low cost using HDX as the transport technology. By incorporating HDX directly into silicon – and not just as an add-on protocol accelerator – Citrix was looking to drive the ubiquity of virtual desktops and applications.

As Sumit Dhawan, group vice president and general manager, Receiver and Gateways group at Citrix said at the time: "Citrix continues to expand the power of virtual computing. The new HDX Ready System-on-Chip initiative is core to expanding ways for end users to access and use virtual apps and desktops with the highest levels of user experience on a whole new range of devices. By enabling our partners to deliver very low-cost endpoints from thin clients to network displays and tablets, we will continue to drive down the cost of virtual desktops to be the same or less than physical desktops."

To summarize the two goals, Citrix wants to enable non-traditional devices like network monitors, consumer set-top boxes, shop floor equipment, kiosks and hospital workstations-on-wheels to be able to display virtual apps and desktops directly, without the need for an a full PC at the endpoint. Second, Citrix wants to drive the cost of the endpoint devices under $100 without sacrificing performance or functionality. Their premise is that the lower cost of the endpoint can help enterprise VDI reach the tipping point, dramatically accelerating adoption. For NComputing, this initiative and our deep relationship with Citrix is a tremendous opportunity.

And among the vendors participating in the announcement and the on-going development, only NComputing brings the combination of a purpose-built System-on-Chip, innovative and secure device design, and scalable device management to the table.

## Why use a System-on-Chip to support virtual computing deployments?

*"Outlining the criteria will quickly show severe limitations and compromises and a difficulty of balancing multiple variables at the same time."*

*There are many choices available to build a thin client to support virtual computing deployments. Depending on the tradeoffs you are willing to consider between performance, cost, device dimensions, and power, some of these alternatives may suffice.*

The most common alternative chosen by vendors is a standard x86-based chip coupled with an embedded Microsoft OS.* Given the maturity of the Wintel platform and the Citrix Receiver on x86, this makes sense at first. But outlining the criteria will quickly show severe limitations and compromises and a difficulty of balancing multiple variables at the same time.

A vendor can build a product to deliver optimized HDX functionality without an SoC. But with an SoC at its core, a vendor can deliver a solution that optimizes across all of the key functions required for an enterprise-class offering: performance, dimensions, power, and cost.


- **Performance:**
  Which type of implementation is going to offer the highest performance within a given class? The implementation should take into account the ability to perform hardware acceleration versus general-purpose processing on a CPU. The implementation should also deliver key future functionality like H.264 upstream and downstream.

* Some may consider choosing full fledged Linux running on x86. While Linux itself is free, embedded Linux is often a specialized product and may require separate licensing and a reliance on a particular variant. Most x86-based solutions are therefore built on an embedded Windows OS.

- **Cost:**
  which type of implementation will deliver not only a low cost platform but also an appropriate cost for the final device? Choosing an x86 or old-style SoC may seem safe, but the right equation is around price for the given functionality required in deployment. To create an end-user device at a breakthrough price point, cost issues need to be incorporated into the design from the start.

- **Power:** which kind of implementation will deliver the lowest power required for implementation? As an alternative to PC's, thin clients can and should deliver dramatically lower power usage than the typical 60-150 watts/hour. However, the choices made at design will limit later flexibility. For example, an x86 solution will use the CPU for heavy lifting task like video compression/decompression creating more heat and power draw along with introducing more cost and risk due to increasing the number of components on the board. Moreover, a power hungry x86 CPU is responsible for not only processing but also all housekeeping and dispatch across the system meaning more power, heat, and often requiring a more expensive and capable processor than what would be necessary if embedded specific hardware functions are dedicated to specific stuff .

- **Security:** which implementation can most easily meet the high standards for security expected within most enterprise environments? With an SoC, many of the functions performed in software can be embedded in the hardware itself. And with an independently developed firmware approach rather than a full fledged embedded OS, there is much less attack surface available. Moreover, the amount of external security and management software needed to protect a Wintel device becomes material to an organization.

- **Supportability:** which type of device will be more supportable within a customer environment? A vendor ought to build management into its devices and considers this from the beginning. While this criterion is not black and white, there is a clear priority to optimize the number of vendors and to identify key areas in the SoC offering providing this value. As an example, an x86-based device will by nature have more components. It is important to assess how well can a device vendor control or manage the entire delivery stack.

These are a complex set of interrelated requirements. The only solution that can optimize across all of these dimensions simultaneously is a purpose-built System-on-Chip. Any other solution will be slower, use more power, be bigger, and certainly more expensive.

The goal is to optimize across 4 or more dimensions at the same time, producing an end product that delivers the best HDX experience and performance in a small form factor, using minimal power, and at the lowest possible cost. There are powerful things that you can do in custom, integrated SoC-based device that are impossible otherwise:

- **Maximally optimize the delivery of the HDX protocol**
  Most x86 thin clients handle decoding the HDX protocol in software. By using a purpose-built SoC, you have the ability to introduce specific targeted HDX-specific acceleration, like hardware encryption and decryption and hardware compression and decompression. These are very CPU-intensive and to do this otherwise would take a much larger and more expensive processor and device (akin to a PC). In addition, an SoC can now have an integrated media engine (including scaling, color space conversion, and standard codecs) deployed in hardware and highly optimized for HDX.

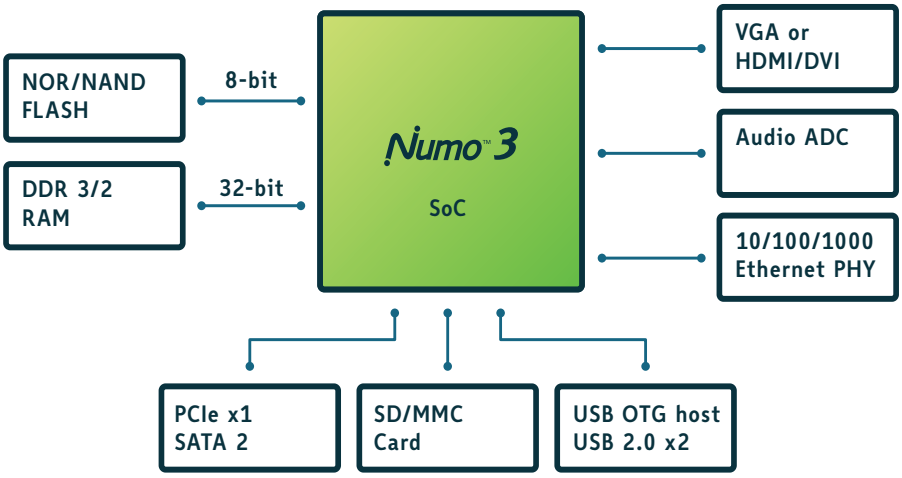
- **Manage power utilization at a highly granular level**
  Once an SoC is an option, optimizing for low power draw becomes easier. First, ARM-based chips use dramatically less power than x86, with 5:1 or even 10:1 reductions routine. Second, architecting to turn various parts of the SoC on and off further reduces to power envelope. In addition, isolating tasks to specific blocks and focusing the CPU on housekeeping tasks creates further efficiencies. This aspect delivers very low standby power use and enables easy power on. Third, making the right decisions about single vs. dual-core makes parsing out tasks across the SoC more granular. A 1Ghz single-core SoC will always have a given draw; a dual-core SoC may be able to run at lower frequencies or even switch-off a core in some situations with great savings in power. Overall, the challenge is to manage MIPS per milliwatt as tasks are distributed across the SoC and the device as a whole. Having these types of "use what you need" options in an SoC means low power usage without compromise.

- **Optimize the entire solution stack from the silicon up**
  As a device manufacture, the ability to control the design and implementation of the SoC delivers a seamless solution stack. A vendor building an integrated solution around the HDX protocol can make decisions about not only the best way to implement a given function, but it can place functionality at the appropriate layers of the stack and optimize at each layer. This drives extreme efficiency, improved reliability, and a better supportability. With all aspects of the solution at hand, including the silicon, firmware, device, and even management software, an integrated vendor has the ability to understand and to identify solutions much more quickly.

## The Numo™ 3 System-on-Chip

To power these next-generation HDX ready devices, NComputing invested to create its third-generation SoC. The Numo 3 device is based on an ARM Cortex A9 Dual-Core processor and includes accelerators for TCP/IP packet processing and cryptographic encryption in hardware– ensuring maximum network security with minimal network impact. A powerful set of codecs is also integrated, offloading the central processor from CPU-intensive video processing functions. For rendering HDX streams on the client side, Numo™ 3 is capable of decoding in-coming H.263, H.264, MPEG2/MPEG4, JPEG, VC1 (used for WMV) and Sorenson Spark streams of up to 1080p Full HD resolution. These advanced video features enable support for a wide range of multimedia content – while optimizing the use of host and network resources.

With support for Citrix HDX in firmware and hardware, Numo™ 3 delivers extremely high performance, graphics resolution up to 1920x1080 at 60Hz, and a variety of external ports needed to support appropriate peripheral devices and configurations required by enterprise customers. Moreover, the Numo™ 3 SoC is designed to operate with extremely low power draw, allowing the device to meet increasingly stringent regulations for energy consumption. By incorporating a broad set of pertinent functions into an efficient SoC design, NComputing is able to dramatically simplify device designs to ensure high quality and performance.



## Numo™ 3 versus other SoC approaches

*"The Numo™ architecture includes a Cryptographic Security Processor, giving Numo™ 3-based devices an edge."*

When introduced at Synergy Barcelona in October 2011, NComputing was one of only two System-on-Chip vendors. As of May 2011, other vendors are recognizing the opportunity and a number of alternatives are being developed or conceived. That said, NComputing brings a number of substantive advantages to the market, advantages that play out in higher performing, more secure, and more flexible solutions.

- **Third-generation technology**
  Unlike other manufacturers, Numo™ 3 is now third-generation technology. Over the past 2+ years, NComputing has shipped nearly one million devices powered by the Numo™ and Numo™ 2 SoCs. This volume has driven costs down quickly and produced an extremely high quality and purpose-built chip for powering the next generation of thin clients. With a proven hardware, ASIC, firmware, and software engineering team in-house, NComputing is in a position to leverage its direct experience to accelerate value to customers.

- **Purpose-built for HDX**
  Unlike other System-on-Chip vendors and vendors retrofitting older processors, Numo™ 3 is purpose-built to support HDX and HDX alone. Supporting additional protocols and vendor infrastructure may sound appealing, but in practice it introduces a variety of risks. Instead, NComputing takes a fully purpose-built approach to working with Citrix and HDX. This approach dramatically simplifies development, improves supportability, and eases and minimizes upgrades for any devices built on Numo™. It leads to higher quality and fewer moving pieces both at initial production and in field deployments. Simply put, NComputing and our customers can stay focused on HDX and its evolution rather than juggling changes in other protocols and the necessary updates and corrections in endpoint firmware.

- **Optimized for high performance**
  Currently only the Numo™ 3 is architected for HDX with a dual-core processor, the ARM Cortex A9. Unlike other SoC implementations, this gives the Numo™ 3 tremendous headroom to deliver higher performance as the underlying software takes better advantage of parallelism. The Numo™ architecture also incorporates a real-time 1920x1080 HD encoder, hardware-based JPEG acceleration, hardware scaling, hardware video post-processing and a wide set of dedicated hardware codecs, allowing the Numo ™ SoC to deliver higher throughput for end-user tasks while offloading video and graphics processing. Finally and perhaps most importantly, the Numo™ architecture includes a Cryptographic Security Processor. In enterprise environments where SSL and secure session communication is a must, Numo™ 3-based devices will have an edge. This combination of performance-related features ensures that an organization's infrastructure is used as efficiently as possible while delivering an exceptional HDX user experience on Numo™ 3-based devices. Finally, NComputing's deep experience in optimizing silicon and firmware for efficiency and performance are a critical differentiator that results in the best possible multimedia and application experience for end-users.

*"NComputing has provided this breakthrough security capability as standard functionality within the Numo™3 SoC."*

- **Architected to meet the highest security standards**
  As mentioned above, the Numo™ architecture incorporates dedicated SSL processing, offloading the central processor from these routine cryptographic tasks. The crypto engine can encode all HDX traffic (uplinks and downlinks, including the USB traffic), without CPU intervention on the device itself. This provides equivalent functionality to having an encryption card on a server at orders of magnitude less cost. Even more important for many customers, Numo™ 3 incorporates a highly secure and high performance random number generator to generate keys in the SoC itself – a method that requires physical access and extraordinary hacking skills to break. This NComputing approach is in line with requirements in the most secure environments. The alternative for other SoC-based thin clients is to either create an interminable delay while gathering enough data to create a truly random key or use a pseudo random generator like "urandom," considered wholly insecure by most modern security organizations. NComputing has provided this breakthrough security capability as standard functionality within the Numo™ 3 SoC.

- **Firmware architected and integrated from Day 1**
  The NComputing chip and firmware design teams work together closely from the beginning of the development process. This collaboration ensures that functionality and device drivers are implemented in the most appropriate and efficient way, whether in silicon, firmware, or a combination of the two. The NComputing firmware also includes an embedded management agent, allowing the endpoint devices to be remotely managed and upgraded without requiring access to the physical device. This well-conceived remote management capability is a huge advantage for customers looking to deploy lower-cost devices at scale.

- **Strongly future-proofed**
  NComputing is strongly aligned with Citrix and its engineering teams. This collaboration ensures that the entire technology stack delivers the highest performance with high levels of simplicity and affordability. To ensure this, there are additional capabilities delivered in the Numo™ 3 SoC that will pay off in the near future: (1) Numo™ 3 includes a dedicated 3D graphics accelerator that will more completely deliver a heightened HDX experience as the Citrix Receiver supports this capability. While not needed for many applications, 3D graphics are becoming more mainstream, even in more traditional enterprise applications; (2) Numo™ 3 uniquely incorporates H.264 encoding and decoding both downstream and upstream. This capability sets the stage for a low-cost video conferencing offering to supplement the high performance H.264 capability already in silicon.

- **Only integrated manufacturer**
  NComputing is the only vendor providing the entire endpoint stack in partnership with Citrix. All firmware – except for the Citrix Receiver – and the devices we architect is done in alignment with the work done on the Numo™ SoC itself. This deep integration and collaboration delivers great synergy. The endpoint devices are purpose-built to take advantage of the specific SoC architecture and when an issue arises, either during development or in deployment, customers have a single vendor that can address the situation. Coupled with our deep relationship with the Citrix engineering team, the Numo™ platform gives NComputing an important leg up.

There are also a number of areas where NComputing and the Numo™ 3 SoC are at parity with the characteristics provided by alternative vendors.

- **HDX Ready Certification**
  We expect all of the vendors participating in the HDX SoC program to reach either Citrix Ready or HDX Ready certification. As that program evolves, we may see Citrix begin to clarify performance and functionality standards to help customers make clearer distinctions between endpoint devices.

- **Very low power utilization**
  Simply by moving to a System-on-Chip architecture, vendors will be able to deliver endpoint devices that use dramatically lower amounts of energy. We believe NComputing will be among the leaders, using less than 5 watts in use and less than 0.5 watts at rest.

Overall, the Numo™ 3 System-on-Chip provides NComputing and Citrix with a broad set of advantages over alternative SoC offerings. Moreover, we expect to see increasing advantages in quality, time-to-market, and time-to-problem resolution as the Numo™ 3-based N-series family of devices gain acceptance and volume in the market. NComputing is proud to be a charter member of the Citrix HDX SoC Initiative and looks forward to providing customers with the very best HDX experience, without compromise, and at a most affordable price point.

## NComputing background

NComputing has a long history of developing end-to-end desktop virtualization solutions based on its unique vSpace™ Server technology and is a world leader in building purpose-built SoC-based devices For customers in the mid-market, SMB, and education space, the ability to deliver up to 100 independent user sessions on a single server via a complete end-to-end solution is an unparalleled benefit. More than 50,000 customers have deployed nearly 4 million NComputing virtual desktop seats around the globe. But for enterprise desktop virtualization, long served by Citrix and others, the server-side requirements for the enterprise are more comprehensive and complex. The opportunity for NComputing, then, is to leverage its revolutionary Numo™ SoC technology and target it to help revolutionize the market for enterprise thin clients. By working with Citrix and innovating in silicon, in the devices themselves, and in software, NComputing developed its 3rd generation SoC and a new product line capable of driving 100% of the HDX experience at one-third the cost of existing solutions.

## Appendix 1: Numo™ 3 vs. TI DM8148 Feature Set

| FEATURE | NUMO™ 3 | TMS320_DM8148 |
|---|---|---|
| CPU | Cortex A9 (dual, SMP) | Cortex A8 (single) |
| CPU FREQ | 600, 800 MHz | up to 1GHz |
| CPU MIPS | 4000 | 2000 |
| DSP | Not required for HDX (codecs in hardware) | Yes (required) |
| SSL CRYPTO ENGINE HW | Yes | No |
| VIDEO OUT | 1 (2 under investigation) | 2 |
| 3D ENGINE | Yes, 16 MTS | Yes, up to 14 MTS |
| VIDEO INPUT PORT | One digital video (raw camera) | One 24 bit HD capture port or two 2 bit SD plus one raw camera input port |
| MEMORY | up to 2GB DDR2/3 | up to 2GB DDR2/3 |
| DEVICE CONFIG FOR MAX $/PERF. | 4 x DD3-1066 MHz | 8 x DDR3-800 |
| ETHERNET | One: 10/100/1000 | Two: 10/100/1000 |
| NAND FLASH | Up to 512 MB | Up to 512 MB |
| SD/MMC/SDIO | Yes | Yes |
| I2C/I2S | Yes, Multichannel | Yes, Multichannel |
| ANALOG TO DIGITAL CONVERTER | One, 8 analog inputs | No |
| PCIE/SATA/USB 2.0 | x1 / x1 / 3 ports | x1 / x1 / 2 ports |
| POWER | <2W | 3W |
| COST | <$20 | <$30 |

## Appendix 2: Numo™ 3 vs. TI TMS320, Common PC Multimedia Formats

| FEATURE | NUMO™ 3 | TMS320_DM8148 |
|---|---|---|
| H264 ENCODER FOR WEBCAM | Yes | Yes |
| H263 | Yes | No |
| H264 | Yes | Yes |
| MPEG 1,2,4 | Yes | Yes |
| VC1 | Yes | Yes |
| SORENSON SPARK | Yes | No |
| JPEG | Yes | Yes |
| MJPEG | Yes | Yes |
| VMW9 | Yes | ? |
| REAL VIDEO 8 | Yes | No |
| REAL VIDEO 9,10 | Yes | Yes |
| DIVIX 3,4,5,6 | Yes | No |
| ON2 VP6,7 | Yes | Yes |
| ON2 VP8 | Yes | No |

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