Needham Insights

Providing in-depth analysis of significant industry issues

"Game of Nodes"
Understanding Converged & Hyper-Converged Infrastructure

Change is coming to the data center, and we believe it will be converged and hyper-converged infrastructure (or HCI) solutions managed by software-defined architectures that will help bring it about. While thought leaders in the space, such as Nutanix, Simplivity, Scale Computing and Pivot3, are not yet public, we believe that EMC (EMC, Buy) and Super Micro Computer (SMCI, Buy) are two public ways for investors seeking to participate in this theme in the interim.

Watch this space… not everyone makes it to the next season of "Game of Nodes."
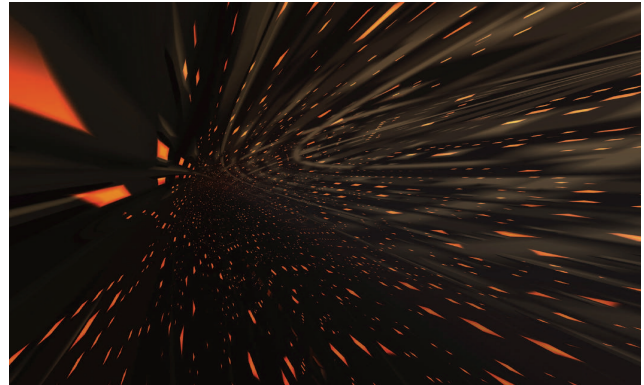
In our view, there are five important mega trends operating within the storage industry today: 1) the proliferation of hybrid and all-flash arrays and the replacement/consolidation of legacy platforms; 2) copy data reduction; 3) the evolution (return?) of the disaggregated rack; 4) converged infrastructure; and 5) hyper-converged infrastructure. In this report, we focus on the latter two themes and their impact on the broader space.

The overall market for converged and hyper-converged solutions—that for a pre-integrated combination of server, storage, compute and management software, including reference designs—is expected to grow at a 24% CAGR from 2014 to 2018, or from ~$8 billion to ~$19 billion, significantly faster growth than the broader IT market's recent 2-3%.

The converged infrastructure (and hyper-converged space) can be divided into Integrated Infrastructure Systems, Reference Architectures, and Integrated Stack. Gartner estimates the hyper-converged market should grow from low-single-digit percentages of the overall converged infrastructure market in 2015 to 30-35% by 2018, implying $6 billion-plus TAM. Yet with more than 75% of all converged infrastructure environments potentially addressable by HCI, this forecast could prove conservative.

Bottom line, we believe hyper-converged infrastructure, in particular, represents one of the most significant architectural changes to the storage and infrastructure world since the introduction of fibre channel as an interconnect for SANs in the 1990s. Until the leading private companies emerge on the public stage, we believe that EMC and Super Micro Computer are two public ways for investors seeking to play this theme.

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Background

Change is coming to the data center, and we believe it will be converged and hyper-converged infrastructure (or HCI) solutions managed by software-defined architectures that help bring it about. Just as hyperscale disrupted the IT spending landscape for large OEMs, these two themes have the potential to leave some players behind. Hyper-converged infrastructure, in particular, represents one of the most significant architectural changes to the storage and infrastructure world since the introduction of fibre channel as an interconnect for SANs in the 1990s, in our view. To a large extent, the underlying principles of the hyper-convergence movement build upon the lessons learned from the hyperscale data center leaders, extending the functionality of virtualization into storage and networking while leveraging off-the-shelf x86 components and intelligent software-defined capabilities.

While thought leaders in the space, such as Nutanix, Simplivity, Scale Computing and Pivot3, are not yet public, we believe that EMC and Super Micro Computer are two public ways for investors to play this theme in the interim. Watch this space… not everyone makes it to the next season of "Game of Nodes."

In our view, there are five important mega trends operating within the storage industry today: 1) the proliferation of hybrid and all-flash arrays, as well as the replacement/consolidation of legacy platforms; 2) copy data reduction; 3) the evolution (return?) of the disaggregated rack; 4) converged infrastructure; and 5) hyper-converged infrastructure. The focus of this report is on the latter two themes, and their impact on the broader space.

Spurred by the relentless growth in the digital universe, data center infrastructure technology continues to evolve at a blistering pace. New terminology used to describe these approaches is appearing just as quickly, often complicating understanding rather than illuminating the value of solutions. Through discussions with the buy side (and even some corporations), it is increasingly apparent that there is some confusion as to what exactly defines these next-generation architectures, the critical capabilities (and shortcomings) as well as the addressable markets for each, key players, and potential impact from broader adoption. First, let's revisit how the data center arrived at this point.

Defining the Problem

We believe data center infrastructure advancements have generally followed a "rubber-band" history, moving from consolidated to distributed and back multiple times. Initially, mainframe systems centralized storage and compute, with "clients" effectively operating as dumb terminals/mini computers within range of the mainframe. In this "1st Platform," as it is known, a relatively small number of users worked with thousands of applications.

Over time, advancements in cost-effective microprocessor technology and productivity software enabled client devices to have their own processing power locally (the client/server world). Improvements in PC capabilities, cost, internet connectivity and increase in the number of applications drove the user totals into the hundreds of millions. This is defined as the "2nd Platform," and some elements of many corporations continue to reside in this category. Ever-expanding data centers and the creation of "islands of storage"—not easily accessible by the broader network—were (and are) inherent flaws of this platform. To address the limitations of this approach, waves of public and private companies advanced storage, server and networking capabilities.

A key development was the implementation of fibre channel as an interconnect for storage area networks, which helped consolidate storage once again with high-performance equipment that could be accessed by the broader network. There are millions of existing legacy applications that cost billions of dollars to build and deploy, and are driving many businesses to this day still running on Platform 2.

Rapid fundamental improvements in processing capabilities (while shrinking packaging and power usage), storage capacity, and connectivity enabled broad availability first of notebooks and later of handsets and smartphones. This in turn drove further demands on the networks supplying these devices with applications and data. Specifically, the desire to have all data available whenever and wherever has broad implications for IT, increasing data center complexity and server sprawl, and requiring new architectures to cope with the now billions of users running millions of apps. Enter "Platform 3," defined by pervasive mobility, cloud, big data and social. The back-end powering this new world necessitates a more efficient, software-based way of scaling infrastructure, with virtualization being that remedy. Through virtualization, physical servers (and later storage and networking) were separated from logical versions of themselves, dividing up previously wasted processing power to create virtual compute/storage resources that could be moved where needed.

While the benefits of virtualization and the key attributes of the 3rd Platform are obvious to IT managers across industries, not all applications, infrastructures or even management teams are currently able or prepared for the cost of moving from Platform 2. For these instances, EMC often refers to "Platform 2.5," which is a hybrid model where certain applications are ported to next-generation architectures while background work remains on the legacy installed base.

Of course, not all companies are traditional Fortune 500 enterprises running staid corporate applications, all with linear growth in compute, storage and networking requirements accessed by fairly stable or predictable end-user counts. Web 2.0 companies, such as Google, Facebook, Amazon and other hyperscale infrastructure players, were forced to blaze their own trail (away from branded proprietary OEMs) to develop a new approach to IT scaling that enabled hundreds of millions of simultaneous users, unpredictable requests and unforgiving demands on speed and accessibility. Rather than taking the "belt and suspenders" approach of traditional branded IT vendors, these pioneers created redundancy via software and the networking of unprecedented numbers of low cost, commodity servers and storage (often assembled internally or via ODMs). The driving force behind our two topics—converged and hyper-converged infrastructure—emerged from all of these trends.

To understand where converged, hyper-converged and other solutions fit within the overall IT spending landscape, innovative all-flash array vendor SolidFire has an excellent graphic of where next-generation architectures fit within the larger infrastructure continuum. Obviously, some solutions can play in multiple areas, but we believe converged and hyper-converged appears accurately reflected, addressing from SMB/startups right through to large enterprise. Similarly, hyperscale customers largely prefer software on commodity hardware, but in some cases need best-of-breed appliances. Finally, SMB/startups can increasingly seek out as-a-service cloud solutions, hyper-converged and converged solutions.

The Infrastructure Consumption Continuum — Figure 1
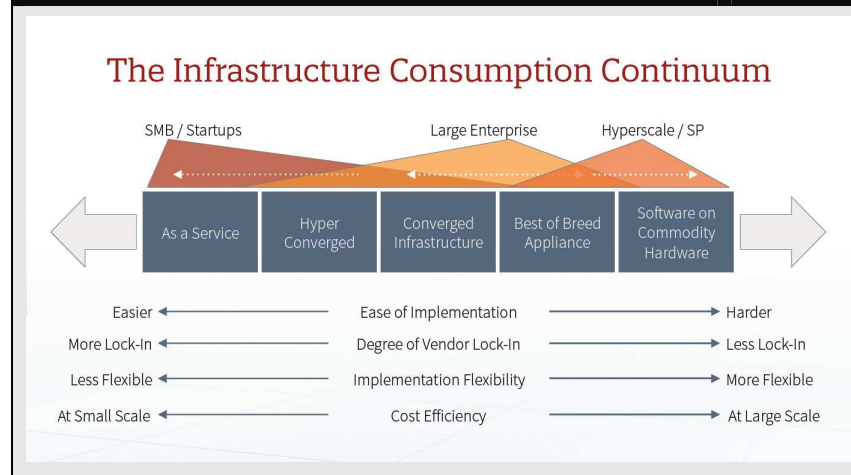
Source: SolidFire, Needham & Company, LLC.

Converged Infrastructure: What Is It?

In our view, Converged Infrastructure is essentially the combination of discrete storage, server and networking infrastructure, often sold with provisioning software to assist in the management of the solution. From a high level, we believe there are three variants on this approach.

1) Dedicated Appliance: Combined server, storage and networking hardware with specific application software and sold as an appliance. These types of solutions include Oracle Exadata, IBM PureApplication, and various products from Teradata, among others. We would also add that these systems are primarily not intended to handle workloads outside of their targeted application and tend to be extremely expensive.


Example of Oracle's Exadata Solution — Figure 2

Source: Company websites.

2) "Best of Breed" Reference Architectures. To ease the purchasing decisions for data center buyers, leading OEMs coordinate with the various storage, server and networking vendors to provide a documented series of options *they suggest* to address different workloads. These reference architectures still require the end-user to purchase the various underlying components and management software (or enlist capable solutions architects like Datalink) and integrate them into a consolidated unit. An example of a leading reference architecture would include EMC VSPEX.

3) "Best of Breed" Converged Infrastructure. We draw a distinction between the open-ended nature of reference architectures and the delivery of a specific SKU as an integrated converged infrastructure solution. In the latter, vendors (seeking greater wallet share) incorporate their own solution with the products of key strategic partners into an integrated system, managed and provisioned by a single pane of software, and often sold by the various participants as a specific set of SKUs. The customer is generally not afforded the opportunity to make many modifications to the underlying components beyond a small set of options, and if a greater level of tailoring is required, the customer is instead likely pushed toward reference architecture alternatives.

Although Cisco—with its UCS server/networking converged system in 2009—was one of the earliest proponents of combining solutions (but not storage), examples of these converged systems with storage as well would include VCE (once a joint venture between VMware, Cisco and EMC, now majority owned by EMC combining EMC storage, x86 servers and primarily Cisco networking gear, as well as VMware virtualization software), NetApp's FlexPod, Nimble Storage's SmartStack, and PureStorage's FlashStack, among many others. In fact, virtually every storage company in our coverage has or will have some type of relationship with server, networking and virtualization players to deliver a converged infrastructure solution by 2016.

| Reference Architecture Examples | Figure 3 |
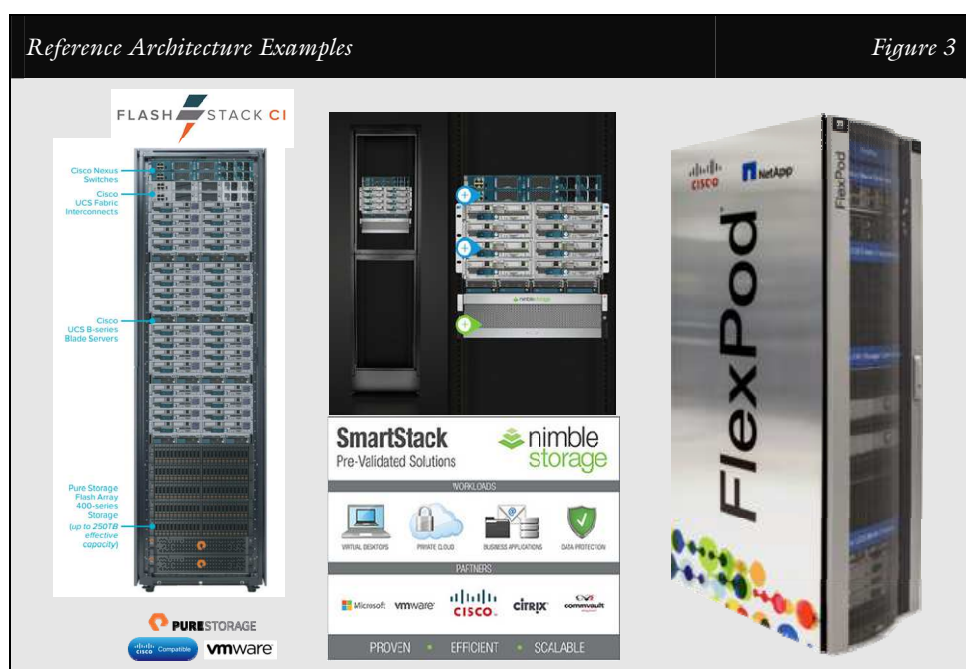
Source: Company websites.

In terms of value proposition, these integrated/converged solutions offer the promise of faster time to deployment and (per our checks) simplified support from the selling vendor, and can be less expensive for end users vs. buying each individual component and integrating on their own, among other benefits. Additionally, we note that unlike hyper-converged solutions, the discrete underlying components could be "split" from the converged solution and used individually with vendor software.
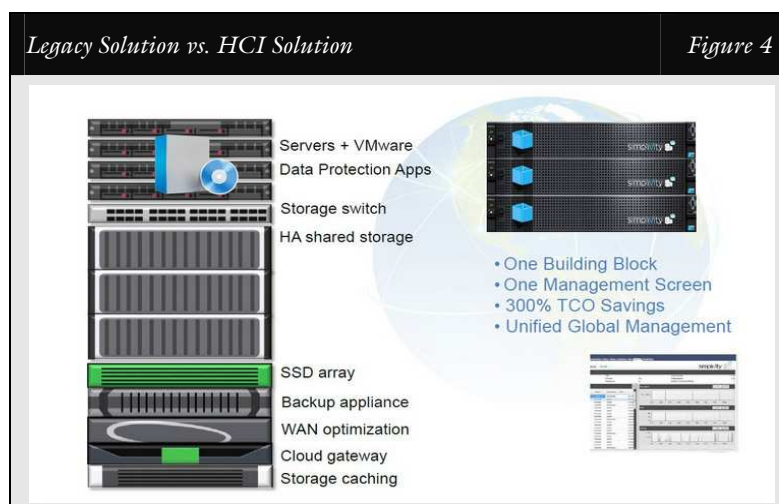
Limitations?

Some of the downsides or limitations often associated with converged infrastructure solutions include:
- Can be simplistically viewed as merely offering an easier buying process vs. anything truly innovative (i.e., a value meal vs. buying a burger, fries and drink individually).
- In general, the underlying systems that are included in the converged solution are chosen by the vendors themselves, not the customer.
- The complexities inherent in managing and scaling a multivendor data center are largely just as present as in a standard purchase.
- Management software, while capable from some vendors, still requires IT staff experience with the respective vendor software.
- Sizing the solution for a workload can be challenging if the customer has certain elements that will increase at a rate greater than overall requirements (i.e., storage or memory), which could invite scaling or management complexities and vendor lock-in.

What Is Hyper-Converged Infrastructure?

As a software-defined, node-based, fabric architecture, resources within a hyper-converged infrastructure solution are entirely consolidated within one box (or node) and then presented to a hypervisor for management of the entire fabric. Storage comes from each server node rather than an external controller-based storage device (found in stand-alone systems or in converged architectures). This storage can be all HDD, SSD, PCIe or any ratio of each. But it is important to note that hyper-converged is an infrastructure consolidation play, not just another way of sharing storage without the use of a SAN. HCI can just as easily be viewed as a scalable consumption model for data center infrastructure as some cloud alternatives.

From an architecture standpoint, nodes are linked today via 10Gb ethernet (not FC) into clusters to create a true virtual computing platform pooling all resources with virtual global management, automation and data protection services. Vendors within HCI have some unique flavors to create the virtual computing platform, such as Simplivity, which has a proprietary PCIe card within each of its servers to deliver its functionality, while other vendors such as Maxta provide a software-only offering that aims to allow any certified hardware to be selected by the customer to build an HCI solution. Common among all vendors is the goal of accelerated deployment of new systems and lowered ongoing management costs. Below is an example from major hyper-converged vendor Simplivity of what a traditional system would look like and the technologies involved vs. the ease of deployment found through using building blocks of a hyper-converged solution (numbers reference TCO savings found through Simplivity). Note that the placement of the Simplivity solution is intentional relative to what is displaced vs. the legacy solution in a hyper-converged world.

Legacy Solution vs. HCI Solution — *Figure 4*

Servers + VMware
Data Protection Apps
Storage switch
HA shared storage
- One Building Block
- One Management Screen
- 300% TCO Savings
- Unified Global Management
SSD array
Backup appliance
WAN optimization
Cloud gateway
Storage caching

Source: Simplivity.

In the past, server technology was not powerful enough to run applications and provide storage functionality, nor was the software management capable of delivering the features IT was accustomed to from storage arrays. In our view, these technological limitations no longer exist (or certainly are not prohibitive). We believe hyper-converged infrastructure (HCI) delivers on the promise of the software-defined data center by creating a pool of intelligently shared storage, processing power and networking resources across a cluster of virtualized servers, ending the drawbacks in designing and implementing HCI.

Industry checks suggest that mid-range enterprises are beginning to embrace HCI due to the lower upfront costs, modular scalability, simplified maintenance, and opportunities for automation.

To further contrast some of the key attributes of traditional converged infrastructure from that of HCI, we include the following information in Figure 5 from a February 2015 Gartner report on the subject.

Additional Differentiation Characteristics Between Traditional & HCI		*Figure 5*
Component	**Traditional Converged Infrastructure**	**Hyperconverged Infrastructure**
Server	Proprietary, hardware-managed	Flexible
Computer	Scale-up, large memory capacity, flash memory	Basic nodes, ODM or OEM-provided
Network	Data center with high performance and bandwidth	Simple, multinode
Storage	Tiered storage area network (SAN)	Software-defined storage
Management Software	Vertical stacks	Horizontal compute, storage and global file system
Scalability	Scale-up, using primarily proprietary components	Scale-out, using mostly commodity components, including storage
Workload Support	Core enterprise	The Nexus of Forces (social, mobile, cloud and information)
Integration	Hardware-defined, vendor defined	Software-defined, hypervisor-integrated
Architecture	Vertical	Horizontal

Source: Gartner.

What Are the Benefits?

Put simply, the benefits are numerous and growing. As mentioned above, HCI promises faster time to deployment, greater operational efficiencies and significantly lower IT-related costs (headcount, expertise, etc.). Fractional consumption and node-by-node scale-out approaches, proven in the crucible of hyperscale environments, are compelling on a TCO savings basis (for example, Simplivity quotes a 3x lower TCO).

While it can be easy to dismiss the opex savings as something difficult to quantify in the real world, our research continues to show a widening gap between the growth in data, the complexities of data center architectures, and the availability of knowledgeable IT personnel on those architectures. A simple-to-deploy, simple-to-use approach that scales as needed is very appealing to customers, particularly SMB and mid-market enterprise (although Nutanix has seen considerable traction right through into multinational enterprise accounts). We believe the move to a generalist IT staff will prove essential to continuing data center innovation in the 21st century.

What Are the Drawbacks?

Without commenting on the specifics, some of the technological (and political) drawbacks/headwinds that we see to broader HCI adoption include:

- Not regarded by some as highly available, scalable storage. In fact, it is not even storage to some in the storage world.
- As a distributed file system lacking hardware-based RAID, the inclusion of data protection services (such as rebuild reserves) eats into available capacity.
- Some level of vendor lock-in occurs as the solution is aggregated into one box by the vendor.
- Requirements for compute, storage or networking may not scale linearly, leading to over-provisioning of some of these resources.
- Capex savings are limited as all of the TCO appears in opex.
- The leaders in the space are all small start-ups vs. large OEMs with well-established channels and professional services organizations.
- Unlike in converged infrastructure, hyper-converged solutions (other than EVO:RAIL) do not include the hypervisor license, as the end customer is responsible for handling the software keys. Vendors will provide support and instructions on upgrades/patches, but the actual implementation falls on the customer.

Needham's Take

We view HCI as much bigger than just a storage alternative to traditional solutions—we view it as a true infrastructure consolidation play. HCI is server virtualization taken to its next logical step to include storage and (over time) even networking in a unified architecture. Few in IT believed that hyperscale players could meet the unprecedented data demands of their businesses on commodity, off-the-shelf hardware that they assembled themselves either, yet few today could deny their success in their environments. Today's HCI solutions are capable. Take Nutanix, for example, which provides all of the mainstream functionality expected in a typical VNX solution (such as snapshots, thin-provisioning, in-line or post process compression, replication for disaster recovery, synchronous mirroring, etc.). In our opinion, even if there are some elements of data protection services or certain workloads that need further development to properly address, the groundwork has been unmistakably laid and can be built upon.

Key End Markets

The addressable markets for converged infrastructure, in our view, are essentially all traditional end markets for data center infrastructure. The only change to the end markets for converged is the way the buyer purchases the solution, not the components of the solution. They give up individual component choice for the ease of buying and a guarantee that it will work out of the box.

For hyper-converged, the end market opportunity seems to depend on whom you ask. For traditional storage and system OEMs, the message to date has been that hyper-converged is only applicable in low-end environments that have predictable workloads, have only a few vectors of growth (e.g., more compute needed over time but storage stable, or vice versa), VDI, new Platform 3 applications that are not currently sitting on infrastructure, disaster recovery/backup/replication use cases, or branch office locations with limited IT staff.

We believe this is a dated (and likely self-serving) viewpoint, and to this list we would add video/imaging, business continuity, data center consolidation, an alternative to the cloud, and general IT workload environments. Furthermore, while many next-generation technologies routinely get their faster performance applied to VDI (being the perennial domain of suboptimal performance and poor user experience), the market has mercifully moved beyond VDI into more enterprise-grade environments with production data.

Market Overview

The overall market for converged and hyper-converged solutions—that for a pre-integrated combination of server, storage, compute and management software, including reference designs—is expected to grow at a 24% CAGR from 2014 to 2018, from ~$8 billion to ~$19 billion. This represents significantly faster growth than the broader IT market, which has been struggling to grow more than 2-3% per year in recent years. Gartner further estimates that roughly three quarters of the data center hardware market is expected to be addressable by some type of converged infrastructure by 2018.

While exact definitions and clear lines of demarcation between the various "flavors" of converged remain somewhat elusive given the early stages in this trend, Gartner divides the market into the following three segments: Integrated Infrastructure Systems, Reference Architectures, and Integrated Stack. As of the publishing of this report, Gartner has not explicitly broken out hyper-converged in a clean category of its own. Nevertheless, some Gartner studies have suggested that the market should be growing from the low-single-digit percentages of the overall converged infrastructure market in 2015 to 30-35% by 2018 (implying more than a $6 billion TAM).

Integrated Infrastructure Systems: Integrate Compute, Storage, Networking and Software, providing shared compute resources (examples include VCE Vblock, Dell's Active Systems, IBM's PureFlex).

Reference Architectures: "Menu" of various Compute, Storage, Networking combinations (often from different vendors) for end user/end user's channel partner to choose from based on needs (examples include FlexPod – partnership between NTAP and CSCO; VSPEX – partnership between EMC and CSCO; and UCP Select – Hitachi Data Systems and CSCO).

Integrated Stack: Server, storage, networking hardware combined to be an appliance, or appliance-like, and typically intended for a limited set of applications (examples include Oracle's Exadata, HP's AppSystem, or IBM's PureApplication).

While Reference Architectures comprises the majority of spending in the converged/hyper-converged market at 40%/$3.2 billion in 2014, spending is expected to shift toward the Integrated Infrastructure Systems sub-segment over the next few years, taking share mostly from the Integrated Stack category but also from Reference Architectures (see Figures 6 and 7).

Integrated Systems Market Proportions, 2014-18E (Includes Hyper-converged)   *Figure 6*
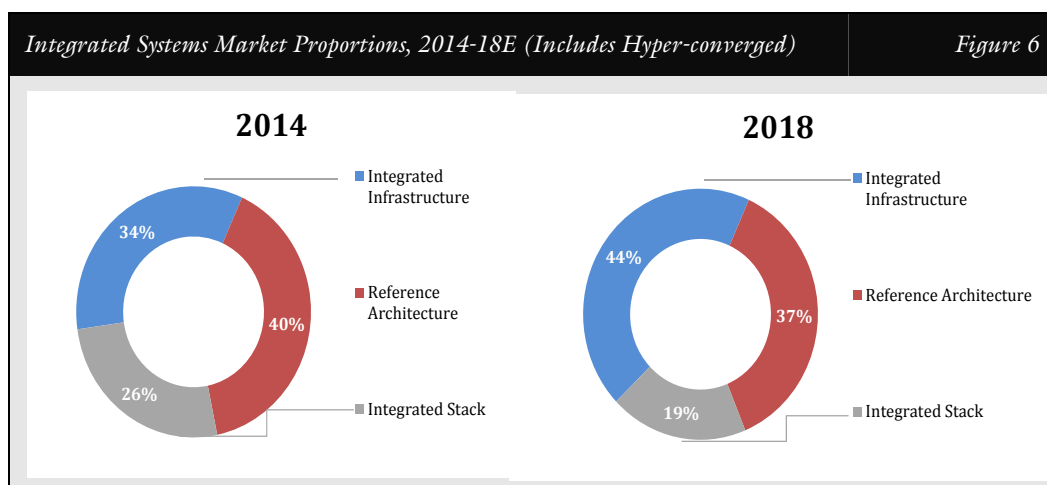
Source: Gartner, Needham & Company, LLC.

Note: Each chart represents the same total market, highlighting its respective parts

| INTEGRATED INFRASTRUCTURE SYSTEMS | REFERENCE ARCHITECTURES | INTEGRATED STACK |
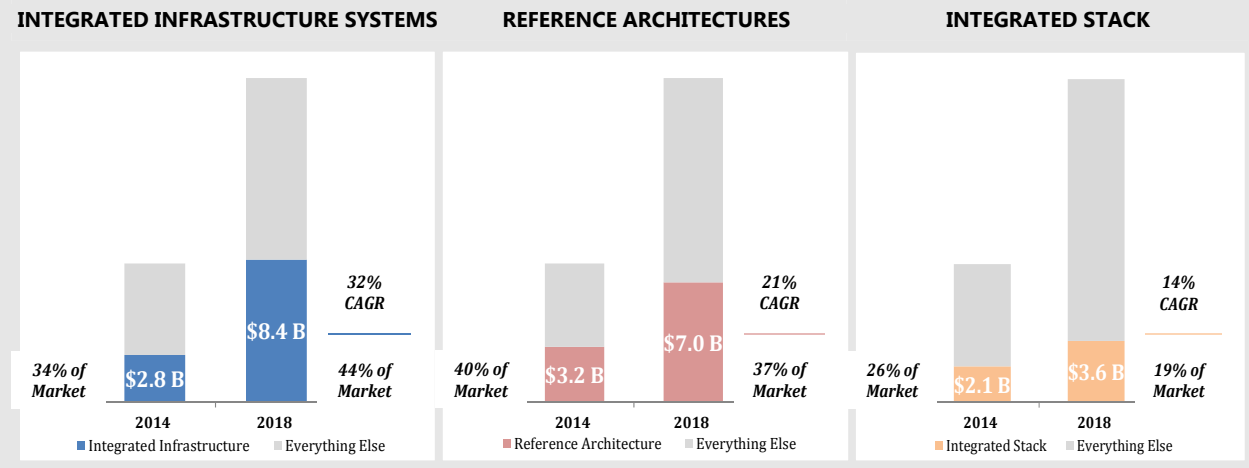
Source: Gartner, Needham & Company, LLC.

The main message from Figure 7 is that all of these markets are growing, and growing faster than traditional IT or even storage (both of which have been in the low-single-digit range in recent years), as these next-generation architectures take share from traditional stand-alone approaches.

Integrated Infrastructure is expected to be the fastest-growing segment, with a 32% CAGR from 2014 to 2018, going from $2.8 billion to $8.4 billion, or 34% of spending to 44%.

Reference Architectures is expected to grow at a 21% CAGR from 2014 to 2018, going from $3.2 billion to $7.0 billion, although it is expected to decline slightly as a percent of total spend, going from 40% to 37% in the same time period.

Integrated Stack growth is expected to be somewhat slower, with a 14% CAGR from 2014 to 2018, going from $2.1 billion to $3.6 billion, declining more sharply as a portion of spend, from 26% to 19%.

Worthy of note is that spending on these categories is expected to come mainly from new workloads (rather than replacement spending on existing workloads), though with a roughly $300 billion data center hardware installed base, greater than expected replacement spend would likely cause upside to growth estimates.

Needham's Take

When we take all of the market share data and the company commentary into account, we believe that the market is likely to shift more dramatically to converged and hyper-converged than industry analysts currently estimate. Driven by the more generalist IT staffs at companies and the need for flexible, cost-effective, scalable solutions, traditional sales motions seem antiquated. Figure 8 is entirely our own conceptual thinking on how the solutions might break down for data center deployments, rather than an exact revenue forecast.

| How the Solutions Might Break Down for Data Center Deployments | Figure 8 |

Converged/ Hyperconverged

50%

10% — Very high end / Largely legacy applications / Performance-focused / Moving to all-flash

15% — Hyperscale / Software-only, build-their-own

15% — Low end/mid-range / Simple channel solutions (even cloud) will work

10% — SOHO remote office / Small/simple requirements

Source: Needham & Company, LLC.

We note that while half of the market could go converged and hyper-converged, we expect many of the next-generation players to actively participate either through relationships with players like Cisco, Datalink, or other solutions providers to offer easier solution sales instead of merely discrete products. Some innovative players may go even further and adapt the new architectures to incorporate hyper-converged functionality (something we encourage).

What Are the Traditional OEMs Doing In This Space?

EMC Corp. (EMC, Buy)/VMware (VMW, Hold)

Never one to protect sacred cows within its business lines, we believe that no public storage OEM has been more aggressive in driving and innovating in the HCI world than EMC. From its reference architecture VSPEX to its dedicated converged infrastructure group VCE (now virtually wholly owned) to its ScaleIO acquisition (generally positioned farther upmarket than virtual SANs and can be installed on clusters of non-virtual or non-VMware servers) and finally to its version of VMware's EVO:RAIL program called VSPEX Blue, EMC takes many bites from the CI and HCI apples.

VCE has been largely a success for EMC, and now with it almost wholly owned, they can diversify the solutions embedded within it (such as using non-Cisco networking). The VCE group is estimated at ~$2 billion in sales and continues to grow, with more than 1,500 customers running more than 2,000 Vblocks to date. Revenues in the most recent quarter increased 30% year over year, above their own internal expectations, with 50-70% of this revenue coming from existing customers.

We are most interested in the adoption rate of VSPEX Blue, which may take time to evolve and differentiate beyond some software management and functionality provided by EMC's suite of offerings and EMC's well-known professional services team. To date, our conversations with the company largely places VSPEX Blue as a solution pitched for SMB branch office, greenfield applications, for new applications designed for an HCI environment, or for VDI.

Nevertheless, the message is clear that EMC is focused on hyper-converged architectures. Its recent EMC World event in Las Vegas spent considerable time discussing their solutions in the area as well as the launching of VxRack (shipping in 3Q15), intended to bring hyper-convergence into the hyperscale world.

The new hyper-converged solution builds upon VMware's VSAN and combines it with EMC's ScaleIO to give it the ability to scale into hyperscale environments. We view the solution, which can start at just 4 nodes and scale up to more than 1,000, as a credible first step to move hyper-convergence into larger deployments (which ironically stands in contrast to EMC's historical stance that the technology is intended for smaller installations). Of course, all solutions have downside, and for VxRack some industry observers have noted that it only supports VSphere and KVM at launch (and not Microsoft Hyper-V).

Bottom line, we believe EMC has done a good job driving converged infrastructure into the mainstream even at the expense of its traditional stand-alone VMAX and VNX solutions, and we expect the company to push VCE and VSPEX Blue and VxRack in the same way.

NetApp, Inc. (NTAP, Buy)
On paper, NetApp has always been unique among the large storage IT players as being proof of how enterprise-grade software can be placed on essentially commodity hardware to great effect. As evidence, their Data ONTAP operating system may be the most prominent data storage operating system in the world (as EMC supports more than a dozen different operating systems from all of its acquisitions).

In converged infrastructure, NTAP has been successful with its FlexPod solution in conjunction with Cisco. In fact, as the EMC-Cisco relationship has publicly soured, NTAP has been more than happy to be the shoulder to cry on. One would expect that such a company would also be at the forefront of the HCI movement, and one would be wrong.

To date, NTAP has been timid addressing hyper-converged infrastructure (at least in their actions, in our view). Although the company has announced support for EVO:RAIL where they attach a FAS filer to the back end, this solution received mostly head scratches in our industry checks. Some of this reluctance to be more aggressive may be tied to the initial target markets for these first versions of EVO:RAIL and hyper-converged in general (namely SMB to mid-market enterprise). However, some players are making waves in the enterprise, such as Nutanix. To be a player in the coming HCI world, we believe NTAP will need to either acquire (unlikely in their "not invented here" world view) or find a way to port ONTAP into more of an HCI solution. Arguing for a complete rewriting of ONTAP for this environment might prove problematic and potentially analogous to the less-than-stellar Project Mars all-flash array efforts (FlashRay has hardly been able to dent the growth of AFA players such as Pure Storage or SolidFire; the project head is now employed by Pure, and the effort now reports underneath the ONTAP group).

Hewlett-Packard (HPQ, Hold)
Hewlett-Packard has an entirely different approach to the hyper-convergence movement. At least from a marketing perspective, HP had been vocal early on about converged infrastructure. This, of course, was self-serving to some degree as their strong position in servers didn't seem to translate into high storage attach rates. If a combined solution could be packaged, then they would gain customer wallet share. Compared with many of their other divisions, converged infrastructure continues to do well at HP, increasing 21% year over year in the most recent quarter (though we note it appears to be slowing). Yet, hyper-convergence is an entirely separate beast, differentiated by even more commoditized hardware managed by a software-defined OS. In October 2008, HP acquired Lefthand Networks. Ultimately, Lefthand's virtual SAN storage appliance became known as HP StoreVirtual. In our checks, HP has not been able to drive significant traction within the StoreVirtual line, which may be more an issue of internal channel conflict vs. limitations of the solution. That said, it is hyper-converged but only storage and server, not networking.

As is typical of large IT companies, HP has publicly hedged by supporting VMware's EVO:RAIL initiative as well as continuing to sell its converged solutions. Which begs the question: When HCI is the best solution to pitch, do you lead with HP StoreVirtual or EVO:RAIL? Once HP's complicated conscious uncoupling with the PC business is complete, we hope that HP revisits the HCI area and perhaps makes an acquisition in the space to bolster their capabilities in this critical area.

Dell (Private)

As one of the earliest proponents of commodity infrastructures disrupting the proprietary hegemony of the titans of IT, one would think Dell would be well positioned in the HCI world. However, with limited R&D dollars to execute on the extensive software intelligence required to bring a solution to market, Dell has largely partnered instead. To date, Dell is part of the EVO:RAIL program under VMware, where customers can build EVO:RAIL solutions utilizing Dell servers and networking. More interestingly, Dell announced on June 24, 2014 a partnership with HCI leader Nutanix. Under the agreement, Dell OEMs the Virtual Computing Platform and Prism UI from Nutanix and installs it on PowerEdge servers to offer the XC Web Scale Appliance. Initially, Dell offered in the fall of 2014 five versions of the solution with fixed configurations depending on the environment requirements (e.g., VDI or remote branch office). Over the next few years, we believe this arrangement alone could represent a couple hundred million in revenue to Dell.

Select Private Company Descriptions

Nutanix

Nutanix was founded in 2009 and is based in San Jose, CA. Its core technology, its distributed file system, was heavily influenced by the success of the hyperscale market (web-scale IT). This file system handles all data protection services, data reduction techniques, system resilience, and tiering while eliminating the bottlenecks found in traditional IT by increasing performance and capacity as nodes are added. Architecturally, Nutanix's appliances consolidate the compute and storage tiers into a single integrated solution that can scale linearly as needed. In many respects, Nutanix (and the HCI space, in general) bring cloud economics into the enterprise data center, enabling a "pay-as-you-grow" model, saving on upfront capex dollars but also on ongoing opex through ease of deployment and management.

Initially, a Nutanix deployment begins as a cluster of three nodes, but can scale linearly from that point one node at a time (and the cluster remains up during the expansion). Through its Prism control plane, Nutanix handles analytics and monitoring as well as infrastructure management. Unlike most HCI solutions, Nutanix supports all three major hypervisors (VMware ESXi, Microsoft's Hyper-V and KVM). To date, the company has seen broad adoption across major market sectors, including financial services, healthcare, retail, public/education, manufacturing, technology and energy (with Fortune 500 logos in each).

Nutanix offers various flavors of its appliances depending on the end-user requirements, including the flagship NX-3000 line; a low-end NX-1000; storage-heavy NX-6000; a graphics-intensive version in the NX-7000; and the NX-8000, a highly flexible platform and the first one that is configure to order and can support all tier-1 enterprise workloads (e.g., SQL, Exchange, SAP); and an all-flash NX-9000 appliance. We expect a broadening of these systems to address the various workloads their expanding sales reach is encountering. To that end, in June 2014, Nutanix signed an OEM agreement with Dell, where the Nutanix Distributed File System is offered in the XC Series of Web Scale appliances. We expect that Dell will actively market this XC Series more than the EVO:RAIL product they also support, as it should come at a lower ASP than most EVO:RAIL solutions.

On May 12, Nutanix announced that it was providing access to its software stack to the developer community. Nutanix Community Edition will be available in beta on June 8th and is free of charge to developers and tech enthusiasts (just not intended for production environments).

According to various industry analysts, Nutanix currently leads the HCI market with over 50% market share, but given the early stages of the space, we expect that figure to move around considerably over time. The company is led by a seasoned management team, including Founder and CEO Dheeraj Pandey (from Oracle and Aster Data) and CFO Duston Williams (formerly of Infinera, Gigamon, Maxtor and Western Digital). Nutanix has successfully raised more than $315 million in funding.

Simplivity

Founded in 2009 and based in Westborough, MA, Simplivity has quickly become one of the fastest-growing companies in New England. The company is led by well-known industry veteran Doron Kempel (former CEO and founder of backup appliance vendor Diligent and an EMC executive).

Simplivity's solution, the OmniCube, began shipping in general availability in April 2013. The appliance features Dell commodity servers powered by Simplivity's proprietary OmniStack software, which provides Enterprise features such as in-line de-dupe and compression of all data (including backup VM copies), as well as simplified replication. While these types of features normally "eat up" CPU cycles, the company has decided to incorporate a proprietary PCIe card with an FPGA that handles most of the "heavy lifting" of the storage efficiency features (although we believe that a pure software version is possible if the company chose to offer it). The company sells its software on a stand-alone basis or as part of a reference architecture relationship with Cisco using its switches and UCS servers. Initially, customers are generally small/mid-size enterprise (some SMB), service providers, and even hyperscale customers (Amazon and others, according to 451 Research) in the U.S., Europe, APAC and Latin America. While the company has an internal sales team, Simplivity's intention is to be 100% indirect, working with channel partners to generate leads, sales and implement deployments. To date, Simplivity has raised $276 million in funding (most recent D round in March 2015 at more than a $1 billion valuation).

Pivot3, Inc.

Unlike many start-ups addressing the HCI market, Pivot3 has a long history in the IT world. It was founded in 2002, has over 1,600 customers (over 20 of which have purchased at least $1 million in systems from Pivot3) with more than 13,000 appliances shipped to date. It has a presence across many regions of the globe, including North America, Europe, the Middle East, APAC and Latin America. Initially, the company was known primarily in the video surveillance world with a Big Data/Analytics application, which requires intense amounts of computing and storage resources (especially those uses cases where analytics are required while recording is underway). Pivot3 has customers in most end market verticals, including government, entertainment, security, technology/telecom, transportation, etc. sold through specialized integrators, as well as Arrow and Ingram Micro. Its systems are built on Dell servers, and support VMware hypervisor environments.

Today, Pivot3 aims to economically deliver enterprise-grade, homogenous, reliable and scalable pools of storage and compute power that can be used by any application in the network. Its patented Scalar Erasure Coding and vSTAC OS are the keys to their product differentiation, as they allow a truly reliable global hyper-converged infrastructure that creates merged pools of RAM cache, SSD storage, HDD storage and IOPs across appliances. It is that ability to access resources outside the specific appliance hosting the VM that defines the term "global." The solution is also highly fault-tolerant as a result, mitigating the need for data backup and expensive replicated disaster recovery solutions (costly in terms of hardware and expert IT staff). Pivot3 supports Veeam, Commvault and Zerto running on a VM for all DR services.

Finally, one of the key defining characteristics of the Pivot3 solutions is the vSTAC OS hyper-converged infrastructure software operating system, which in contrast to the traditional approach of writing to the disk through a hypervisor has direct disk access (the company claims a 30-40% performance improvement as a result). Erasure Coding technology helps maintain data resiliency in the face of even a high number of drive failures (a capability even Google references in its own internal data center work).

In terms of the data path, Pivot3 takes the incoming data first into flash and protects the data system-wide across the storage. The solution can be scaled one at a time vs. some competing solutions (such as EVO:RAIL) that require as many as 4 node cluster additions. This allows Pivot3 to stack and scale appliances linearly, with cluster-aware appliances that automatically recognize the presence of additional resources in the hyper-converged pool.

Each additional node increases the bandwidth for the whole network, with each appliance having access to all of the controllers in the cluster. This ability to have IOPS available to the collective allows a heavy workload on one server to be allocated resources from other nodes. We also note that this "rebalancing" of resources to compute/storage needs happens automatically, preventing hot spots and islands of stranded resources. This dynamic also helps Pivot3 claim higher storage efficiency than competing HCI solutions. In Pivot3's view, these "replication-based" competitors offer reduced available storage capacity when accounting for the significant resources dedicated to ensure high-availability against drive failures plus reserve capacity.

Pivot3, based in Austin, TX, is led by Chairman and CEO Ron Nash. The company recently raised $45 million in funding.

Other Private Companies of Interest

Maxta, Inc.
Founded in 2009 and headquartered in Sunnyvale, CA, Maxta's solution is available as a standalone software-defined storage product (allowing users to hyper-converge on their own servers) or through the channel as part of a number of pre-validated appliance configurations loaded with Maxta's software. Currently offering support for VMware and KVM (with "ability to support Hyper-V"), the company plans to offer support for Docker containers in the near future. Finally, Maxta also has a partnership with Cisco Systems.

StorMagic
Founded in 2006 and headquartered in Mountain View, CA, StorMagic is a hyper-converged software provider targeting companies/enterprises with business-critical aps "at the edge" of multi-site infrastructure (i.e., in a branch office). Its SvSAN technology takes existing direct-attached storage (internal or external) and aggregates it for the hypervisor as a virtual SAN, with synchronous mirroring between nodes allowing for high availability to prevent downtime for those business-critical applications.

Atlantis
Atlantis' offerings include its recently-announced HyperScale appliance as well as software products Atlantis USX and ILIO. Atlantis HyperScale is an all-flash appliance that aims to be cheaper (50-90%, the company claims) than other hyper-converged solutions. USX is a software-defined storage product that allows for pooling of multiple forms of storage (SAN, NAS, Flash, RAM, DAS, Public Cloud), facilitating the consolidation of existing (and in the case of DAS and Public cloud, cheaper) forms of storage while simultaneously increasing performance. The product also includes Atlantis' HyperDup Content-Aware Data Services, which accelerates IO and increases storage efficiency with features like inline dedupe and others. Atlantis ILIO is a software product that aims to improve the way virtual desktops/applications use storage, leveraging the HyperDup Content-Aware Data Services while using server RAM for either primary storage or a separate storage tier to improve performance and efficiency.

Nimboxx, Inc.
Founded in 2012 and headquartered in Austin, TX, Nimboxx is a web-scale hyper-converged hardware and software vendor for companies of all sizes. Its NIMBOXX-AU-110 platform is a hyper-converged solution to help mid-size organizations move from legacy solutions to more integrated and simplistic solutions, combining legacy and agile IT. The company now offers the first single vendor virtual desktop interface and hyper-converged infrastructure (VDI + HCI) appliance using technology acquired from VERDE VDI, called NIMBOXX VERDE VDI Appliance (VE-100). It can be sold as a bundled solution or as a standalone product and can host 100 VDI sessions.

DataCore Software
Founded in 1998 and headquartered in Ft. Lauderdale, FL, DataCore Software is a leader in software-defined storage offering storage virtualization and virtual SAN solutions. The storage virtualization software allows for scalable data storage architectures for increased performance and scalability at a lower cost. The company's SANsymphony-V software runs on commodity servers and combines storage capacity into a shared pool of data with real-time communication and self-directed technology to reduce downtime and increase efficiency over manual processes. The company uses an indirect channel model including a network of distributors and resellers for the distribution of their solutions.

Scale Computing
Scale Computing is a hyper-converged appliance provider headquartered in Indianapolis, IN. The company's HC3 family of appliances is targeted largely at the SMB (though the portfolio was recently expanded with a higher-end offering). The appliances are powered by the bare-metal KVM hypervisor and the company's HyperCore software layer. A core building block of HyperCore is the company's SCRIBE (Scale Computing Reliable Independent Block Engine) software that combines all block storage resources into one pool of shared storage that interfaces directly with the hypervisor.

Stratoscale
Stratoscale was founded in 1993 and is headquartered in Herzeliya, Israel. The company offers a hyper-converged, all software-based operating system targeting enterprise data centers of all sizes, which allows companies to select their own hardware. The autonomous platform allocates assets, both physical and virtual in actual time adding efficiencies to the data center. Stratoscale's architecture supports OpenStack and Docker.

Gridstore
Founded in 2009, Gridstore has made its foray into the hyper-converged infrastructure market by leveraging its existing expertise in specialized storage systems. The company's hyper-converged offerings include all-flash and hybrid 2U appliances powered by Gridstore's proprietary Server-Side Virtual Controller Technology, as well as separate all-flash and hybrid storage nodes. One of the company's main points of differentiation is its ability to optimize/prioritize I/O by VM, which the company claims alleviates the "I/O blender effect" that often causes bottlenecks at the storage controller in less-granular environments. While initially catering largely to the Microsoft installed base (Windows Server, Hyper-V), the company plans to introduce some VMware support this year.

Conclusion

Change is coming to the data center, and we believe it will be converged and hyper-converged infrastructure (or HCI) solutions managed by software-defined architectures that help bring it about. Just as hyperscale disrupted the IT spending landscape for large OEMs, these two themes have the potential to leave some players behind. Hyper-converged infrastructure, in particular, represents one of the most significant architectural changes to the storage and infrastructure world since the introduction of fibre channel as an interconnect for SANs in the 1990s, in our view. To a large extent, the underlying principles of the hyper-convergence movement build upon the lessons learned from the hyperscale data center leaders, extending the functionality of virtualization into storage and networking while leveraging off-the-shelf x86 components and intelligent software-defined capabilities.

Investment Recommendation & Risks

While thought leaders in the space, such as Nutanix, Simplivity, Scale Computing and Pivot3, are not yet public, we believe that EMC and Super Micro Computing are two public ways for investors to play this theme in the interim. Watch this space… not everyone makes it to the next season of "Game of Nodes."

Potential Positive Derivatives
EMC Corp. (EMC)
For public investors, we think of EMC as representing the Visa of storage… everywhere you want to be. While the legacy high-end VMAX and mid-range VNX lines may not be performing to historical standards, EMC's approach of covering all aspects of the market either organically or through acquisition positions them well for the next-generation data center. EMC addresses converged storage through its VSPEX reference design, the VCE converged appliance, and by participating in its majority-owned VMW EVO:RAIL initiative (EMC's own product called VSPEX Blue). EMC also has its ScaleIO solution, which is the basis for its recently announced VxRack hyper-converged solution for large-scale data center deployments. As almost a hedge on which storage technology is most likely to be adopted, in our view, EMC represents the comparatively lower-risk way of participating in these seismic shifts.

Super Micro Computer (SMCI)
Super Micro Computer is a major player in the server/storage market as the underlying solutions partner for many of the leading players today, including Nimble and Nutanix. Super Micro is also a participating server vendor under EVO:RAIL. Storage, as a percentage of total revenues, increased to 20% in the March quarter, up from 14% in the preceding period, in part thanks to strong growth at these players.

Neutral Derivatives
Cisco Systems (CSCO)
Cisco, with its UCS appliance (converging networking and servers into an appliance) has been an early proponent of converged infrastructures. It has also been prolific in signing up partnerships with every major vendor that might want to sell into enterprise accounts. Even in VCE, where their ownership has been reduced to 10%, the company is still the networking solution of choice even if alternative vendors are now being explored as an expanded line card. However, in hyper-converged Cisco finds itself potentially impacted. Of course, as the leader in networking, Cisco is partnered with just about everyone, including leading HCI player Simplivity and software-only player Maxta (as well as reportedly having an investment in Stratoscale). However, true HCI taken to its full logical conclusion requires commodity hardware throughout, including networking. For these environments, one could see a software-defined networking solution such as VMW's NSX offering. But in general, Cisco has earned a seat at the table in most situations, in our view, despite this commoditization risk, and it will be interesting to see what play (if any) Cisco makes to be more directly involved.

Datalink (DTLK)
Datalink is one of the largest data center solutions architects in North America. It was at the forefront of the reference architecture movement as one of the few players with the industry expertise to implement these complex, multivendor solutions with best-of-breed gear. Further expansion of converged infrastructure (or even reference) would be a positive for Datalink. However, the company may have less impact if the market flips to a majority of hyper-converged solutions, as the amount of IT expertise required in selling an appliance (where all the hard work is already complete) is far less than in a converged solution (and even less so than reference). Datalink does offer solutions from players such as Simplivity and Nutanix, but they are dwarfed by the business generated from traditional vendors like EMC, CSCO, HDS and NTAP, and even emerging players Pure Storage and Nimble.

Potential Negative Derivatives
Large OEMs
To some degree, with the exception of EMC (which is particularly adept at cannibalizing its own solutions), all of the major storage and system OEMs have a vested interest in maintaining the status quo for shipping stand-alone solutions or reference architectures. Converged solutions offer an opportunity to gain greater wallet share of customer spend but also a discount relative to what the total cost of the underlying solutions would have been if sold individually. Hyper-converged, and its commoditization of all underlying hardware while being run in a software-defined way, is potentially disruptive. Most players, such as HPQ, HDS, DELL, IBM, etc. have some type of solution for HCI but their commitment levels vary and the ultimate success of their sales channels remains to be seen.

NetApp (NTAP)
While NTAP is the second-largest storage vendors after EMC and has a large presence in the converged space with its Cisco relationship and their combined FlexPod offering, we are concerned by the lack of compelling solutions for hyper-converged. To date, we believe the company has focused primarily on supporting EVO:RAIL with a FAS filer attached. This solution is poised to be launched shortly, but much like EVO:RAIL in general, we are unclear how successfully marketed it will be. If NTAP follows the path of protectionism, pushing its standalone solutions first, and FlexPod second, the company may find itself increasingly marginalized in the new era. For the moment, we maintain our Buy rating on valuation reasons alone, but are cognizant of this existential threat.

Fibre Channel Components
It appears that hyper-converged architectures, and their focus on server-centric storage, reduce if not eliminate the need for fibre channel interconnects in the data center, potentially negatively impacting component players. That said, many companies in this space have already migrated to provide other areas of data center solutions and are no longer as reliant on the declining Fibre Channel market.

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Datalink	DTLK	9.63	Buy	B, G
EMC	EMC	26.52	Buy	B, D, J
Facebook	FB	78.44	Buy	B, G
Gigamon	GIMO	29.48	Buy	B
Google	GOOG	529.62	Buy	B, G
Hewlett-Packard	HPQ	33.30	Hold	B
Ingram Micro	IM	26.53	Buy	B
NetApp	NTAP	35.30	Buy	B, G
Nimble Storage	NMBL	24.94	Strong Buy	B
Super Micro Computer	SMCI	32.00	Buy	B, F1, G, H
VMware	VMW	87.59	Hold	B
Western Digital	WDC	95.96	Strong Buy	B, C, D, G, J

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