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Cisco Data Center Case Study

Cisco has historically developed networking equipment into data centers going back to the 1990's. Its foray into the data center market is recorded in the media back to the mid-1990's when the company partnered with two software vendors to encroach upon IBM's dominant position. The solution enabled customers with high-throughput connectivity to SNA (systems network architecture) applications through TCP/IP links and web browsers (1996). In the early 2000's Cisco expanded its data center networking offerings. In May 2000, Cisco Metro Series Metropolitan Area Network DWDM, was designed for large enterprise networks and used for data center interconnect and consolidation applications. The Cisco 1105 Hosting Solution Engine, announced in August 2001, was designed to manage e-commerce data center environments. In January 2003, Cisco introduced two content switching devices – Cisco GSS 4480 Global Site Selector and Cisco CSS 11501 Content Services Switch - to help their customers build virtual distributed data centers with increased efficient delivery of applications and improved network availability and performance during site failures. With this expertise, Cisco won a few high-profile data center deployments. For example, Korea Telecom selected Cisco in Dec 2001 for networking equipment in three Internet Data Centers (IDC) using Cisco 12016 Internet Routers and 7500 Series Routers. Additionally, as part of a national IP backbone solution for Cox Communications in January 2002, Cisco supported the regional and service data centers with its 7609 Internet Router and Catalyst 6509 and 6513 switches. And in October 2004, Cisco announced it would build a data center for Qatar Telecom, the largest in the country (2004).

Cisco's data center strategy reportedly began in 2002 by providing local area network storage, switches, and load balancers (2008). Cisco acquired storage switch maker Andiamo in 2002 and used the resulting storage area networking products for data centers. In the early-to-mid 2000's Cisco announced acquisitions and partnerships that would bolster its data center networking capabilities. In December 2004, it launched a new product line based on its Actona acquisition (announced June 2004). The File Engine Series used wide-area files services technology enabled companies to access network files in a remote data center as if they were local, reducing the need and cost of locally storing documents in each corporate site/branch (Reardon 2004). By 2004, Cisco teamed up with Intel to provide the switching capability (Catalyst 6500 Series) for 10GbE in the data center. Intel developed a 10-Gbps Ethernet adapter for servers. The Intel PRO/10GbE SR Server Adapter had interoperability with Cisco Catalyst 6500 Series Switches. Cisco and Intel worked on education and outreach programs to assist IT managers in migrating to 10-GbE networks (2004). In April 2005, Cisco announced its acquisition of Topspin, an intelligent server fabric switch maker that would strengthen Cisco with networking technology enabling its customers to build flexible, grid-like data centers. The next month (May 2005) Cisco publicized its intent to acquire FineGround Networks, a provider of network appliances that maximize infrastructure capacity in the data center while minimizing bandwidth usage. This would help Cisco provide application-acceleration for secure, optimized web-based applications. In August 2006,

Cisco announced an investment in Nuova Systems, Inc as part of its accelerated data center strategy. The \$50 million investment (with a possible increase of \$42 million in additional funding) gave Cisco an 80% ownership stake in this subsidiary (2006). In February 2007, Cisco agreed to acquire Reactivity, an XML gateway provider, for \$135 million in cash. The company's gateway technology that was used in data centers for applications communications where XML and Web standards were employed would be incorporated into Cisco's Application Control Engine, a module within the Catalyst 6500 Series switch (2007).

Some of the technologies developed from the acquisitions and partnerships accelerated key deployments across the world. In April 2006, Cisco announced a data replication solution for Finland-based Sanoma Data. Cisco provided MDS 9216i Fabric Switches for Fiber Channel over Internet Protocol (FCIP) functionality and its Catalyst 6500 series switches while HP deployed its EVA storage and Continuous Access replication software (2006). During 2006, Cisco made several deployments of its Data Center Network Architecture. Cisco's Wide Area File Services solution, which was part of its Application Networking Services product line, decreased data-access times for WAN users and improved data management, sharing, and security. The architecture was supported by Cisco MDS 9000 Multilayer Switches, Cisco PIX firewalls and Cisco Catalyst 6500 Series Switches (2006). By October 2006, Cisco deployed a storage area network (SAN) based on its MDS 9216i Multilayer Fabric Switches along with an end-to-end Cisco data center architecture. At Long Island University, for example, the data center architecture supported an existing Cisco IP network with over 300 Cisco switches and routers, along with some of its Unified Communications products.

In July 2007, Cisco unveiled its Data Center 3.0 Strategy at its Cisco Networkers user conference. Its vFrame Data Center appliance would streamline the provisioning process for servers, networks, storage, and all other elements for online business applications. This strategy would better position Cisco for the data center through resource virtualization, as well as data center and server consolidation (Musich 2007). Cisco's vFrame Data Center interoperated with servers from IBM, HP, and Dell as well as storage platforms from IBM, HP, HDS, EMC, and NetApp (2007). Following the launch of Cisco's Data Center 3.0 strategy with the vFrame appliance at its core, Cisco acquired 1.6 percent ownership of VMWare to move beyond networking into virtualization solutions. The VMWare virtual machine engine - and particularly Vmotion - would support vFrame in providing virtualization solutions and security for the network. This VMware ownership stake starting pitting Cisco against competitors like Microsoft, IBM, and HP as they integrated leadership in network virtualization and server virtualization to enhance the data center offering (Musich 2007). In January 2008, Cisco introduced new solutions for its Data Center 3.0 strategy, including the Cisco Nexus 7000 Series (first switches designed specifically for data center requirements and scale to 15 Tbps); improvements to its Catalyst 6500 Series; a 16-port 10 Gigabit Ethernet Module assisting in the transition from Gigabit Ethernet to 10 Gigabit Ethernet; Cisco Catalyst Blade Switches for blade server (e.g., Dell's PowerEdge M1000e blade server enclosure); and Catalyst 4900M Series for data center rack-server aggregation (2008). The Nexus switches reportedly took four years, \$250 million in development costs, and contributions

from 500 engineers. It incorporated Cisco MDS storage equipment and IP routing knowledge from its 2004 acquisition of Procket Networks (Matsumoto 2008). A few months later (April 2008), Cisco announced its acquisition of Nuova Systems, a provider of next-generation products for the data center that developed the Cisco Nexus 5000 Series - a 10 Gigabit Ethernet "top-of-rack" switch with unified fabric capabilities through the support for multiple data center networking protocols and software intelligence.

In fiscal year 2009, Cisco made more headway into its data center strategy. In a July 2008 interview with John McCool, Cisco's vice president of data center, switching and security, unveiled Cisco's data center strategy entering the fiscal year 2009. The plan included promoting the virtualized data center through its new Nexus data center switch as well as its Catalyst 6500 Series Switches and utilizing the wide area applications support to consolidate services (Duffy 2008). Cisco's push in the data center market was evidenced by John Chambers' comments in October 2008 that he would grow its IT budget by 10 percent in 2009. In the meantime, Cisco faced increasing competition from other networking vendors, like Juniper and HP ProCurve, looking to move into virtualization. Juniper in early 2009 teamed up with IBM to deliver network connectivity for IBM's cloud computing offering (2009). To counter this competition, Cisco announced the Unified Computing System in March 2009 as part of its data center strategy, incorporating its Nexus series switches and server blades. In an effort to lower data center operational and capital costs, Cisco leveraged its Nexus switches, protocols like Fiber Channel over Ethernet (FCoE), and top-tier partners (2009). Cisco's UCS combined a UCS B-series blade server, VMware virtualization technology, a Cisco switch, and third-party tools combined in a single rackable system. The blade server put Cisco in more competition with some of its partners, including IBM and HP (Hamblen 2009). Cisco reportedly reached out to IBM and HP for partnerships in delivering its data center offering. Chambers remarked that Cisco was willing to do without its storage or server business had not IBM or HP entered a partnership with them (Matsumoto 2009). The next month (April 2009) Cisco announced its intent to acquire Tidal Software, integrating its intelligent application management and automation solutions into Cisco's data center strategy. By the end of fiscal 2009 (June 2009), Cisco launched a data center partner program and individual certification scheme for its Unified Computing Architecture. This Data Center Channel Solutions Program enabled its channels to sell standardized offerings from Cisco and its data center alliance partners. The two new individual certifications were Data Center Architect and Data Center Engineer (Cameron 2009).

Towards the beginning of Fiscal 2010 (July 2009), Cisco announced new data center capabilities to make storage area networks more secure, resilient, and less costly and complex. Its MDS 9000 family of Multilayer Directors would enable faster data traffic over distance, secure data traveling outside the data center, speed disaster recovery and data backup, and manage large scale storage-area networks (2009). In November 2009, HP acquired 3Com, incorporating its routing and network switching technology - along with 3Com's TippingPoint intrusion prevention products - into a more competitive position in the data center market. 3Com's network technologies would complement

HP's ProCurve offerings to challenge Cisco's converged data center infrastructure (2009). However, in March 2010, Cisco's CRS-3 router was launched with a potential capacity of 322 Tbps. Cisco's foresight that cloud computing, social media, and mobility would require more powerful networks motivated the design of this new router. The company viewed more capacity at the core as an opportunity to 'support the public cloud through more powerful data centers, benefiting from its Nexus and UCS platforms' (2010). The next month (April 2010) Cisco announced enhancements and additions to its Data Center 3.0 strategy, including: second-generation Unified Computing System, with a high performance computing architecture (50 percent more processor cores, 300 percent greater application performance, and 400 percent more standard memory footprint) in a single energy-efficient system; and expanded Nexus portfolio (Nexus 2248 and 2232 fabric extenders) delivering 10-Gigabit Ethernet to the data center (2010). Analysts reported that Cisco wanted to move beyond its networking and virtualization offerings in the data center to address virtually every facet of data center IT, bringing it more into competition with Dell, HP, and IBM – incumbents in data center servers (Duffy 2010). By the end of Fiscal 2010 (July 2010), Cisco, VMware, and NetApp announced the first industry certified Fiber Channel over Ethernet (FCoE) solution for VMware-virtual environments, reducing the number of cables and devices needed to virtualize, consolidate, and automate data centers (2010). During fiscal 2010, Cisco's data center products increased year-over-year by approximately \$249 million, with the UCS products accounting for an increase in \$181 million and the storage area networking products having an additional \$68 million (primarily from higher sales of the Cisco MDS 9000 product line) (Cisco 10-K, 2011, p. 55).

During Fiscal 2011, Cisco made more additions to its data center offerings. In September 2010, it introduced the Unified Network Services to deliver network services across any form factor and in any environment. The company made enhancements to its Unified Fabric and Unified Computing for increased cost-effectiveness, simplicity, and deployment flexibility. Unified Network Services, Unified Computing and Unified Fabric would form part of the Cisco Data Center Business Advantage, improving agility and efficiency of traditional and virtualized data centers. At the end of March 2011, NetApp announced it was one of the first storage vendors supporting director-class multi-hop Fiber Channel over Ethernet (FCoE) with Cisco data center switches (2011). And QLogic Corporation stated that it fully optimized its 3rd generation 10GbE converged networking adapter (EGCNA) with the Cisco Data Center Fabric (2011). Along with these partnerships, Cisco updated its Data Center Business Advantage portfolio in March 2011 as well. Key changes include: Cisco Nexus 7000 and Nexus 5000 Series updates (e.g., Cisco Nexus 5548UP and Nexus 5596); new low-latency 10Gigabit Ethernet switches with its Cisco Nexus 3000 series switch; additions to its fabric extension portfolio; director-class, multi-hop FCoE for the Nexus 7000 data center switch platform as well as the MDS 9500 storage switching platform; a new Data Center Network Manager (DCNM) for managing converged data center networks; and Cisco NX-OS data center operating system with added support for multi-hop Fibre Channel over Ethernet (2011). The next month (April 2011), Cisco built its Allen, Texas-based green data center, showcasing Cisco's data center solutions with green approaches to cooling and power along with an environment-friendly facility design (2011). In May 2011, Cisco launched

its Containerized Data Center - a portable data center (40 by 8 feet or 20 by 8 feet) suitable for transport on ships and trucks, containing all necessary servers, networking, and storage equipment. First announced in March 2010, this modular portable data center solution moved Cisco into a market that IBM, Oracle (former Sun Microsystems), HP, Dell-Microsoft, and SGI had been involved in for the past 7-8 years (2011). More enhancements to its data center strategy were announced in July 2011, including: innovations within its Unified Computing System (expanded networking capabilities and VMware vCenter); optimizing cloud and video application performance with innovations to its WAAS product line; and Cisco IronPort Email Security (2011). According to Synergy Research Group, for the first half of calendar year 2011, Cisco was fourth place in cloud equipment sales with 10.44 percent market share. The other top vendors included HP (1st) with 19.87 percent; IBM (2nd) with 17.98 percent; Dell (3rd) with 14.73 percent; and Oracle (5th) with 5.22 percent. Cisco continued to be the dominant networking infrastructure supplier for cloud deployments with a market share approaching 50 percent. On the other hand, for virtualized computing systems, HP and IBM represented over 50 percent market share combined while Dell, NetApp, and HP comprised 50 percent of the storage opportunity (2011). For Fiscal 2011, Cisco's data center products grew 44% year-over-year (\$491 million increase). Its UCS products grew 273% in sales (\$496 million increase) while its storage sales grew 9% (\$43 million, primarily due to MDS 9000 product line) (Cisco 10-k, 2011, p. 39, 54).

Over the next fiscal year (2012), Cisco would enhance its technology offerings as well as market share in data centers. Cisco's CloudVerse framework was introduced in December 2011, enabling organizations to build, manage, and connect public, private, and hybrid clouds. This framework combined the Unified Data Center, Cloud Applications and Services, as well as the Cloud Intelligent Network (2011). Cisco ended the year strong, with Cisco "essentially tied" with HP and IBM in the North American market in 4Q11 (calendar year) according to Synergy Research Group (2012). In January 2012, Cisco reached a milestone of 10,000 customers for its UCS product line (see figures below). In February 2012, Dell announced a data center and enterprise architecture, competing with Cisco. With its Virtual Network Architecture (VNA) that automates and orchestrates virtualized data center applications (based on Force10Networks switches), Dell challenged IBM and HP in an architecture similar to Cisco's offering. Bolstering its own position, Cisco announced its acquisition of Lightwire in February 2012, a provider of optical interconnect technology for high-speed networking, allowing Cisco to offer its data center (and service provider) customers cost-effective, high-speed networks. Cisco ended fiscal 2012 announcing its acquisition of Virtuata, integrating its capabilities for securing virtual machine information (in cloud and data center environments) for more consistent and enhanced virtual machine security. For fiscal 2012, Cisco's UCS servers, networking, and software was up 87% Year-over-Year in their third year, according to fiscal, quarterly reports (2012).

In the current fiscal year (2013), Cisco launched the Cloud Firewall in September 2012 - its Adaptive Security Appliance 1000V - to address security in the modern data center (2012). Cisco announced its intent to acquire vCider in October 2012 for its virtual network overlay technology, making data center infrastructure more secure. More

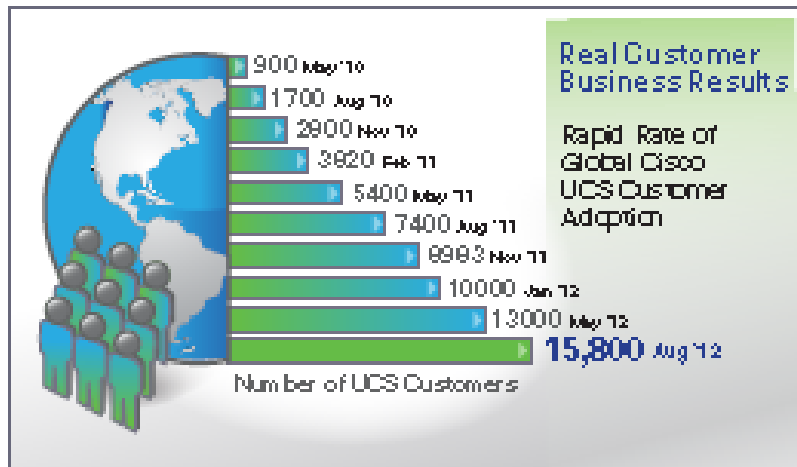
recently, Cisco publicized the acquisition of Cloupia in November 2012, integrating Cloupia's automation software to efficiently accelerate migration from physical to cloud environments (Ohnesorge 2012).

Cisco leveraged experience of connectivity (routing and networking equipment, e.g., Catalyst 6500) in the data center to get into storage (area networking) and then move into (blade) server market, providing a unified computing, virtualization platform. Meanwhile, its competitors - server giants like Dell, IBM, and HP - entered into networking for the data center. Cisco momentarily lost business with their competitors (in networking) - e.g., HP ripped out internal Cisco network, replacing it with 3COM/ProCurve hybrid. Dell tied more closely with Brocade for SAN to fill out its data center offerings while IBM allied with Juniper for QFabric data center and cloud fabric switches.¹ Ultimately, Cisco's foray into data centers deepened its enterprise offerings, going beyond networking to virtualization and cloud computing for their installed customer base.

¹ <http://www.networkworld.com/news/2011/102511-tech-argument-cisco-hp-ibm-dell-252359.html?page=2>

In Just Three Years

Demand for Data Center innovation has vaulted the Cisco Unified Computing System (UCS) to the top-tier of the fast-growing segment of the x86 Server Market.



x86 Blade Server Market Q2 2012 Vendor Shares

Worldwide

	Q2Q'09	Q2Q'12	Difference
Cisco	1.2%	15.2%	+14.0%
Dell	8.2%	8.9%	+0.7%
Fujitsu	3.2%	1.4%	-1.8%
HP	50.3%	50.1%	-0.2%
Hitech Ltd	1.4%	1.3%	0.0%
IBM	22.1%	15.4%	-6.7%
NEC	2.0%	3.0%	+1.0%
Oracle	2.6%	1.2%	-1.4%

North America

	Q2Q'09	Q2Q'12	Difference
Cisco	2.4%	21.9%	+19.5%
Dell	2.1%	2.3%	+0.1%
HP	47.5%	52.4%	+4.9%
IBM	34.3%	11.1%	-23.2%
Oracle	3.6%	1.4%	-2.2%

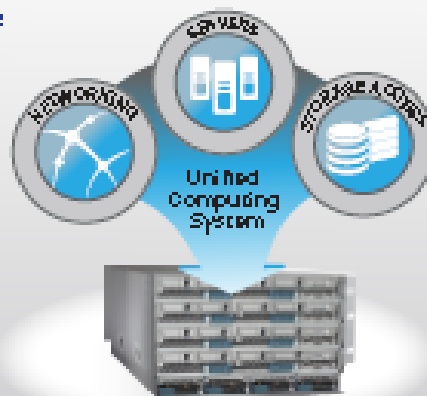
Source: IDC Worldwide Quarterly Server Tracker, August 2012, Revenue Share

x86 Blades far outpace overall server growth

Data Center Growth by Segment

0.9%	8.2%
All Servers	x86 Blades

Source: Server GAGR, 2011-15, IDC Q112 Server Forecasts, End-user Spend

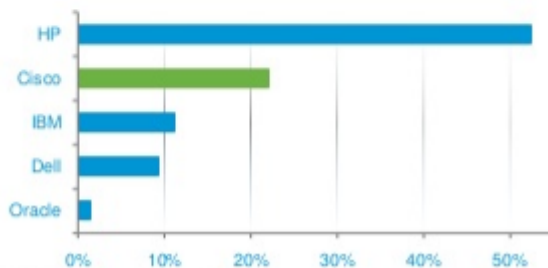
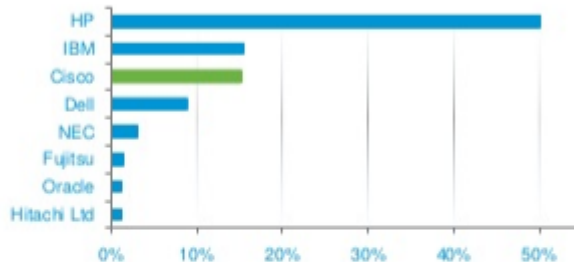


Cisco UCS Leadership and Momentum

- In Q4FY12 Data Center Revenue increased 90% year over year and 42% quarter over quarter
- In Q4FY12, UCS bookings increased 58%, year over year
- As of Q4FY12 Cisco UCS achieved an annualized run rate of over 1.6 billion dollars
- As of August 2012, there are over 15,800 unique UCS customers
- More than half of all Fortune 500 customers have invested in UCS
- 347 customers have booked over one million in UCS product and 813 have booked over \$500,000
- Over 2600 Channel Partners are actively selling UCS and over 1200 UCS specialized partners in the channel worldwide
- 64 World Record Performance Benchmarks to date

Customers Have Spoken

X86 Server Blade Market Share, Q2CY12¹



Source: ¹ IDC Worldwide Quarterly Server Tracker, Q2 2012, August, 2012, Revenue Share

² IDC Q1 CY12 Server Forecaster, Based on x86 Blade Revenue

- UCS momentum is fueled by game-changing innovation; Cisco is quickly passing established players¹
- x86 Blade servers are growing over twice as fast as the overall x86 computing market²

UCS After Only Three Years

- Maintained #2 in N. America (21.9%) and #2 in the US (22.2%)¹
- Maintained #3 worldwide in x86 Blades with 15.2%, just behind IBM's 15.4%¹

Source: <http://www.slideshare.net/Ciscodatacenter/cisco-ucs-momentum-2012-15051108>

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