



Technical Report

FlexPod Select with Hadoop Technical Specifications

Karthikeyan Nagalingam, NetApp
Raghunath Nambiar, Cisco
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TABLE OF CONTENTS

1	Product Overview	3
1.1	Benefits of FlexPod Select for Hadoop	3
2	System Specifications	7
1.2	Hardware Requirements	7
3	System Specifications	8
4	Hadoop Master Rack and Expansion Rack Details	10
5	Software Versions	14
6	Support	14
7	Version History	15

LIST OF TABLES

Table 1)	Key benefits of FlexPod Select for Hadoop.....	3
Table 2)	System specifications for the Hadoop master rack configuration.....	8
Table 3)	System specifications for the Hadoop expansion rack configuration.....	9
Table 4)	Estimated environmental data for the master and expansion rack configurations.....	10
Table 5)	NetApp hardware.....	10
Table 6)	NetApp software licensing.....	11
Table 7)	Hadoop software licensing and support.....	11
Table 8)	NetApp support services.....	12
Table 9)	NetApp Professional Services.....	12
Table 10)	Cisco data node hardware and cables.....	12
Table 11)	Cisco networking hardware and cables.....	13
Table 12)	Cisco data node software requirements.....	13
Table 13)	Cisco data node and switching support services.....	14
Table 14)	Partner professional services.....	14
Table 15)	Software versions.....	14
Table 16)	Support contracts.....	15

LIST OF FIGURES

Figure 1)	Solution architecture with optional FAS.....	4
Figure 2)	Solution architecture with only E-Series storage controllers.....	5
Figure 3)	Cisco UCS 6296UP 96-port fabric interconnect.....	6
Figure 4)	Cisco UCS C220 M4 rack server (Small Form Factor Disk Drive model).....	7

1 Product Overview

FlexPod® Select with Hadoop is a reference architecture developed collaboratively between Cisco and NetApp. The solution offers a comprehensive analytic stack for big data that includes compute, storage, network connectivity, and enterprise Hadoop distribution with a full range of services to manage heavy workloads. The offer is a validated solution for enterprise Hadoop deployments with breakthroughs around Hadoop stability, operations, and storage efficiency. By integrating all the hardware and software components and using highly reliable products, businesses can meet their tight SLAs around data performance while reducing the risk of deploying Hadoop.

Lines of business are motivated by top-line business benefits to work on unsolvable or unaffordable problems involving machine-generated data, often combined with other traditional data sources. The lines of business exploit big data to derive competitive advantage, provide better customer experiences, and help make decisions faster. Big data can be used to prevent fraud, improve business logistics by correlating buyer behavior with inventory, correlate patient treatments to their cures, and improve homeland security and government intelligence. Big data also can cross-correlate huge datasets from credit card transactions, RFID scans, video surveillance, and many other sources.

To address these requirements, companies need analytical solutions that meet the following criteria:

- Provide resilient and reliable storage for Hadoop.
- Implement high-performance Hadoop clusters.
- Build on an open partner-based ecosystem.
- Allow efficient Hadoop clustering.
- Scale compute and storage independently and quickly as data volume grows.
- Are cost effective.

The FlexPod Select for Hadoop architecture is designed to address these challenges.

1.1 Benefits of FlexPod Select for Hadoop

FlexPod Select for Hadoop combines leading-edge technologies from Cisco and NetApp to deliver a solution that exceeds the requirements of emerging big data analytics. This architecture enables businesses to manage, process, and unlock the value of new and large volume data types that they generate. Designed for enterprises in data-intensive industries with business-critical SLAs, the solution offers presized storage, networking, and compute in a highly reliable, ready-to-deploy Apache Hadoop stack.

Table 1) Key benefits of FlexPod Select for Hadoop.

Enterprise-Class Big Data Architecture	Accelerate Time to Value	Coexistence with Enterprise Applications
<ul style="list-style-type: none"> • Easy manageability, higher reliability, scalability, and performance • Fully redundant architecture • Lower cluster downtime • Faster recovery from drive failure through enterprise hardware RAID 5, RAID 6, and DDP to provide 99.999% reliability • Fewer copies of Hadoop data mean less storage to manage, 	<ul style="list-style-type: none"> • Reduced risk, better power and floor space footprint • Prevalidated, pretested reference architecture (Cisco Verified Design) • Presized, leading-edge storage, compute, networking with Hadoop (Cloudera Enterprise Core) • Higher performance with faster interconnects, lower latency, and less network congestion 	<ul style="list-style-type: none"> • Seamless data and management integration with enterprise applications and traditional FlexPod deployments • Global support and services • Open analytical stack for higher interoperability within infrastructure • Hadoop handles data well, in any kind of schema • Open solution with best-in-class

<p>resulting in higher storage efficiency and 33% less network traffic</p> <ul style="list-style-type: none"> • Dynamically add capacity as data grows, expand storage while the cluster runs • Multiprotocol support such as i-Band, FC, or iSCSI, 8:1 (NetApp® E-Series) SAS options 	<ul style="list-style-type: none"> • Well-established FlexPod channel • Independent scaling of compute and storage or scale together • With a decoupled design, both the compute and storage tier can be scaled independently and allocate more or less storage capacity to compute node • Nondisruptive data node replacement, no rebalancing or migration 	<p>components</p> <ul style="list-style-type: none"> • Proven at PB scale • Lower TCO, less rack space needed, lower power required (360TB in 4U) • Hardware-accelerated encryption without performance degradation • Service-level agreement with predicted performance
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This solution is prevalidated for enterprise Hadoop deployments built using Cisco 6296 fabric interconnects (connectivity and management), C220 M4 servers (compute), NetApp FAS2254 (optional), and NetApp E5600 series storage arrays. Following the highly successful FlexPod model of presized rack-level configurations, this solution will be available through the well-established FlexPod sales engagement and channel.

The architecture consists of a master rack and optionally up to four expansion racks in a single management domain, creating a complete self-contained Hadoop cluster. The master rack provides all the components required to run a 12-node Hadoop cluster. Each additional expansion rack provides 16 additional Hadoop cluster nodes. The solution has been tested and validated with major Hadoop distributions including those from Cloudera and Hortonworks.

Figure 1 depicts the solution architecture with optional FAS.

Figure 1) Solution architecture with optional FAS.

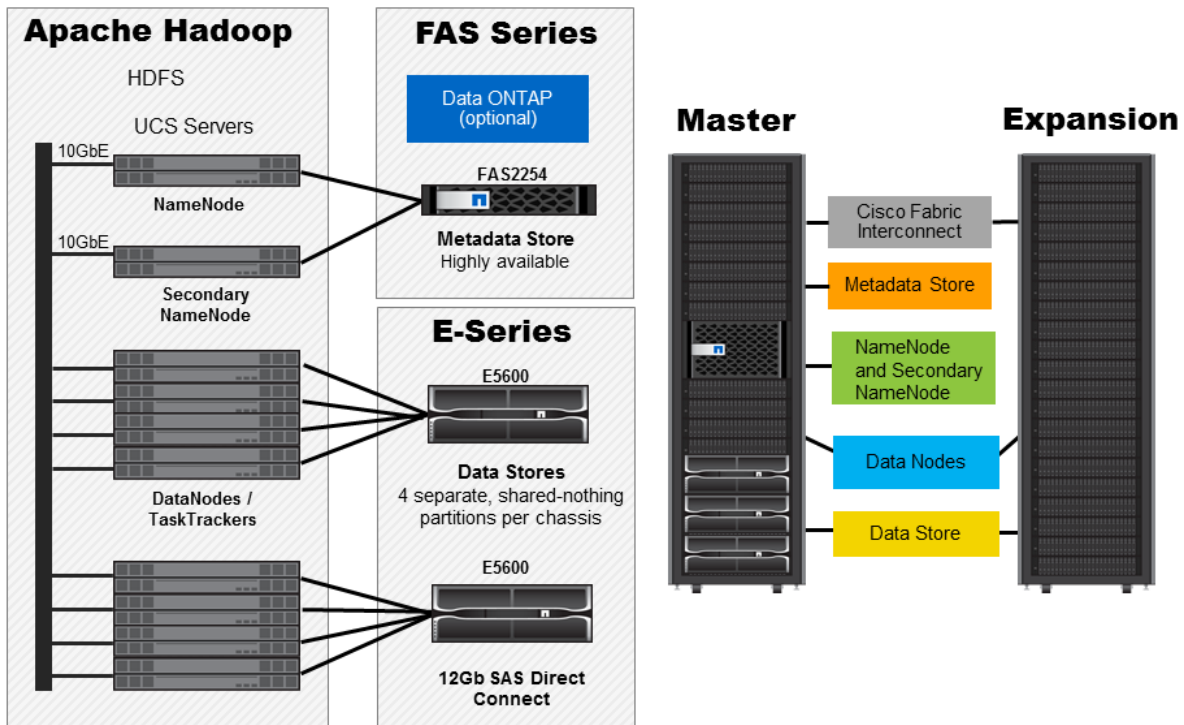
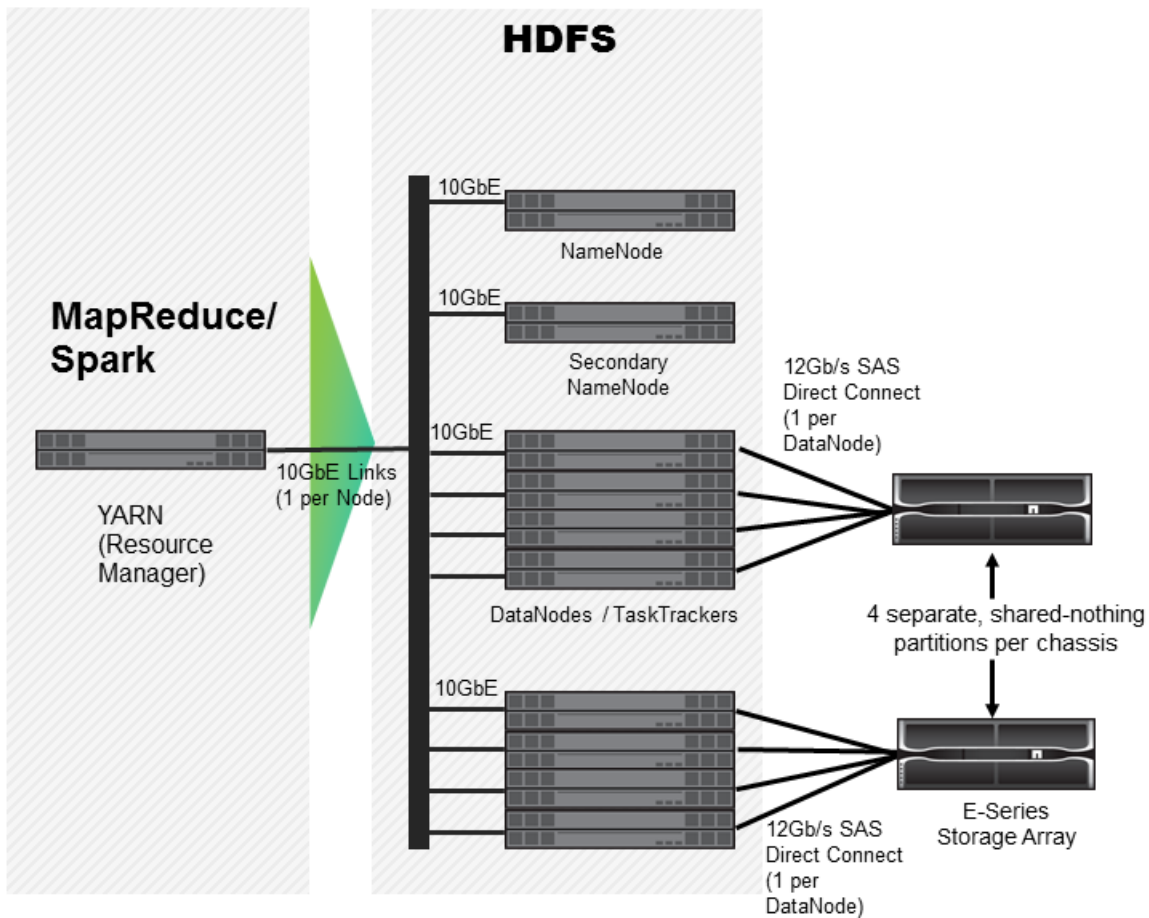


Figure 2) Solution architecture with only E-Series storage controllers.



NetApp E5600 Series

The NetApp E5600 is a hybrid storage system designed to meet the most demanding data-intensive applications and provide continuous access to data with 99.999% availability.¹ The E5600 is the latest system in the E-Series line, which offers zero-scheduled-downtime systems. The E5600 has redundant hot-swappable components, automated path failover, and online administration capabilities. The system provides proactive drive monitoring with a highly serviceable design and worldwide support from NetApp, with NetApp AutoSupport™ tracking options to enhance serviceability and prevent downtime.

The E5600 handles a wide range of application workloads ranging from big data analytics, database, and high-IOPs and bandwidth-intensive streaming applications to a mixture of workloads in a high-performance storage consolidation point.

The E5600 storage system also provides optimal performance efficiency with high bandwidth and IOPS levels while minimizing complexity, power, and space requirements, which is ideal for capacity-intensive application environments. In addition, the intuitive interface makes installation and maintenance simple.

¹ <http://www.netapp.com/in/media/ds-3643.pdf>

The E5600 delivers consistent performance, data integrity, and security that enable:

- Efficient scaling
- Reduced footprint
- Intuitive management
- Protection of data at rest
- Effective data replication and disaster recovery

NetApp FAS Series

The FAS storage controller is optional with this solution because Hadoop NameNode protection is built in with Hadoop 2.x. However, the FAS storage controller can be used for network booting of the Hadoop cluster servers and for enabling in-place analytics with NetApp NFS Connector for Hadoop.

Cisco UCS 6200 Series

Fabric interconnects establish a single point of connectivity and management for the entire system. They provide high-bandwidth, low-latency connectivity for servers, with integrated, unified management for all connected devices provided by Cisco UCS Manager. Deployed in redundant pairs, Cisco fabric interconnects offer the full active-active redundancy, performance, and exceptional scalability needed to support the large number of nodes that are typical in clusters serving big data applications. Cisco UCS Manager enables rapid and consistent server configuration using service profiles, automating ongoing system maintenance activities such as firmware updates across the entire cluster as a single operation. Cisco UCS Manager also offers advanced monitoring with options to raise alarms and send notifications about the health of the entire cluster.

Figure 3) Cisco UCS 6296UP 96-port fabric interconnect.



Cisco UCS C-Series Rack Mount Servers

Cisco UCS C-Series rack mount C220 M4 rack servers (Small Form Factor Disk Drive model) are enterprise-class systems that support a wide range of computing, I/O, and storage-capacity demands in compact designs. Cisco UCS C-Series rack mount servers are based on the Intel Xeon E5-2600 v3 product family and 12Gbps SAS throughput, delivering significant performance and efficiency gains over the previous generation of servers. The servers use dual Intel Xeon processor E5-2600 v3 series CPUs and support up to 768GB of main memory (128 or 256GB is typical for big data applications). The servers also provide a range of disk drive and SSD options and 2 x 1 Gigabit Ethernet embedded LAN-on-motherboard (LOM) ports. Cisco UCS virtual interface cards 1227 (VICs), designed for the M4 generation of Cisco UCS C-Series rack servers, are optimized for high-bandwidth and low-latency cluster connectivity, with support for up to 256 virtual devices that are configured on demand through Cisco UCS Manager.

Figure 4) Cisco UCS C220 M4 rack server (Small Form Factor Disk Drive model).



2 System Specifications

1.2 Hardware Requirements

The FlexPod Select with Hadoop reference architecture includes the following hardware and software components.

Servers

Cisco UCS C220 M4 Servers

- 2 Intel Xeon processor E5-2680 v3 CPUs
- 256GB RAM (supports up to 768GB of RAM with 24 DIMM slots for memory-intensive applications)
- 2 x 600GB 10K SAS HDD
- Cisco 12Gbps SAS modular RAID controller with 2GB flash-based write cache
- Cisco UCS VIC 1227 2 10GE SFP+
- 2 PCI Express Gen 3 slots and 2 1GE LAN interfaces on the motherboard
- Cisco 12G SAS HBA with 8 external ports

Storage

- NetApp E5660 data storage subsystem
- NetApp FAS2254 NAS storage system (optional)

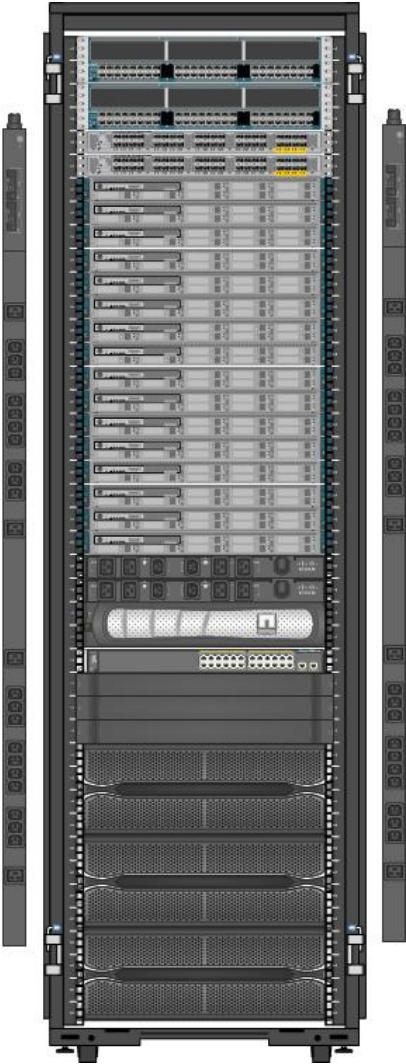
Network

- Cisco UCS 6296UP fabric interconnect
- Cisco Catalyst 2960S

3 System Specifications

Table 2 lists the components of the master rack.

Table 2) System specifications for the Hadoop master rack configuration.

Component	Details	Master Rack
Cisco R42610 rack	Industry-standard 42U rack	
Cisco RP208-30-U-1	Single-phase PDU with 2 C13 connectors and 4 C19 connectors (2 per rack)	
Cisco RP208-30-U-2	Single-phase PDU 20 C13 connectors and 4 C19 connectors (2 per rack)	
Networking Components		
Cisco UCS 6296UP fabric interconnect	96-port 10Gb fabric interconnect switch (2 per cluster of up to 160 servers)	
Cisco Catalyst 2960S	Layer 2 Ethernet switch (1 per cluster)	
Hadoop Management Components		
FAS2554A-001-R6 (optional and future use for NFS Connector)	Entry-level NAS with 6 x 1TB drives for NameNode metadata protection (optional and future use for NFS Connector)	
Cisco UCS C220 M4 Server 1	DNS server	
Cisco UCS C220 M4 Server 2	NameNode server	
Cisco UCS C220 M4 Server 3	Secondary NameNode server	
Cisco UCS C220 M4 Server 4	ResourceManager	
Configuration of Cisco UCS C220 M4 Servers 1–4	2 x Intel Xeon E5-2680v3 @ 2.50GHz, 256GB memory, Cisco UCS VIC 1227, 2 x 600GB 6Gb SAS 10K RPM SFF HDD, Cisco 12G SAS modular RAID controller with 2GB cache	
Data Nodes		
Cisco UCS C220 M4 5–16	Data nodes	
Configuration of Cisco UCS C220 M4 Servers 5–16	2 x Intel Xeon E5-2680v3 2.50GHz, 256GB memory, Cisco UCS VIC 1227, 2 x 600GB 6Gb SAS 10K RPM SFF HDD, Cisco 12G SAS modular RAID controller with 2GB cache, Cisco 12G SAS HBA with 8 external ports	

Component	Details	Master Rack
Storage Arrays		
E5660	6 x E5600A, 12GB controllers 3 x DE6600 4U/60-drive enclosures 180 x 6TB 7.2K disk drives	

Table 3 lists the components of the expansion rack.

Table 3) System specifications for the Hadoop expansion rack configuration.

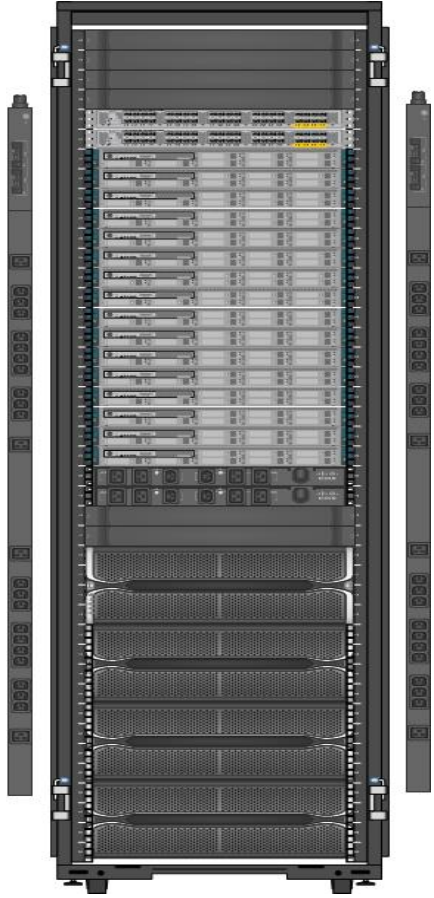
Component	Details	Expansion Rack
Cisco R42610 rack	Industry-standard 42U rack	
Cisco RP208-30-U-1	Single-phase PDU with 2 C13 connectors and 4 C19 connectors (2 per rack)	
Cisco RP208-30-U-2	Single-phase PDU 20 C13 connectors and 4 C19 connectors (2 per rack)	
Data Node Servers		
Cisco UCS C220 M4 Servers	Data nodes (16 per expansion rack)	
Configuration of Cisco UCS C220 M4 Servers	2 x Intel Xeon E5-2680v3 2.50GHz, 256GB memory, Cisco UCS VIC 1227, 2 x 600GB 6Gb SAS 10K RPM SFF HDD, Cisco 12G SAS modular RAID controller with 2GB cache, Cisco 12G SAS HBA with 8 external ports	
Storage Arrays		
E5660	8 x E5600A, 12GB controllers 4 x DE6600 4U/60-drive enclosures 240 x 6TB 7.2K disk drives	

Table 4 lists estimated environmental data for the master and expansion rack configurations.

Table 4) Estimated environmental data for the master and expansion rack configurations.

Equipment	Master Rack					Expansion Rack				
	Rack Units (RUs)	Max/ Typical Watts	Max/ Typical BTU/hr	Weight	Qty	RUs	Max/ Typical Watts	Max/ Typical BTU/hr	Weight	Qty
R42610 rack	42	N/A	N/A	354lb 161kg	1	42	N/A	N/A	N/A	0
Cisco UCS 6296UP	2	950/750	3,163	50lb 22.67 kg	2	N/A	N/A	N/A	N/A	0
Cisco Catalyst 2960S	1	131/84	740/447	9.5lb 4.30kg	1	N/A	N/A	N/A	N/A	0
Cisco UCS C220 M4 Server	1	496/299	1,693/ 1,020	37lb 16.78 kg	16	1	496/299	1,693/ 1,020	37lb 16.78kg	16
RP208-30-U-1	0				2	0				2
RP208-30-U-2	1				2	1				2
NetApp FAS2554 (optional)	2	423/257	1,444/ 878	62.9lb 28.5kg	1	N/A	N/A	N/A	N/A	0
NetApp E5660	4	1,001/ 793	3,415/ 2,707	236.2 lb 107.1 kg	3	4	1,001/973	3,415/ 2,707	236.2lb 107.1kg	4
Total	37	14,756/ 9,812	50,622/ 35,333	1497lb 678.8 kg		34	13,524/ 8,806	46,292/ 30,532	1,557lb 705.9kg	

4 Hadoop Master Rack and Expansion Rack Details

Table 5 through Table 13 provide detailed part number information for a master rack and one expansion rack.

Table 5) NetApp hardware.

Part Number	Part Description	Master Qty.	Qty. per Expansion
NetApp E-Series Components			
E5600-SYS-R6	E5600, SYS, -R6	3	4
E5600A-12GB-R6-C	E5600A,12GB Controller, No HIC,-C	6	8
E-X5680A-R6-C	Enclosure,4U-60,DE6600,Empty,2PSU,-C	3	4
X-56015-00-R6-C	HIC,E5600,12Gb SAS,4-ports,-C	6	8

Part Number	Part Description	Master Qty.	Qty. per Expansion
E-X4064A-R6-C	Disk Drive,6TB,7.2k,Non-FDE,DE6600,-C	180	240
X-48619-00-R6-C	Battery,E5400,E5500,E5600,-C	6	8
DOC-E-SERIES-4U-SYS-C	Install Documents,System,DE6600,-C	3	4
X-50613-00-R6-C	Power Cord, In Cabinet,2m,C14-C19,DE6600,-C	3	4
SES-SYSTEM	Support Edge Services Attach PN	3	4
X-M102061-R6	40U Rack,Empty,L6-30,Domestic	3	4
SW-ESERIES-SANTRICITY	SW, E-Series, SANtricity	3	4
OS-SANTRICITY-CAP1-0P-C	OS Enable,Per-0.1TB, SANtricity,Cap-Stor,0P,-C	3	4
SVC-A2-NBR-Y	HW Support, Standard2 Replace,NBD,y	3	4
SW-SSP-A2-NBR-Y	SW Subs,Standard2 Replace,NBD,y	3	4
CS-OS-SUPPORT-SANTRICITY	OS Support Entitlement, SANtricity	3	4

Table 6 lists NetApp software licensing.

Table 6) NetApp software licensing.

Part Number	Service Description	Master Qty.	Qty. per Expansion
SW-2220-ONTAP8-P	SW, Data ONTAP Essentials, 2220-P	1	0
SW-NFS-C	SW, NFS, -C	1	0
SW-CIFS-C	SW, CIFS, -C	1	0
SW-FCP-C	SW, FCP, -C	1	0
SW-ISCSI-C	SW, iSCSI, -C	1	0

Table 7 provides information about Hadoop software licensing and support.

Table 7) Hadoop software licensing and support.

Part Number	Service Description	Master Qty.	Qty. per Expansion
Select either Cloudera Enterprise management software and support or Hortonworks support.			
SW-HORTONWKS-SERVICE-12	Hortonworks 24/7 support for 12 months	14	16
SW-CLOUDERA-HADOOP-24x7	Cloudera Enterprise management software with 12 months of 24/7 support and product guarantee	4	4

Table 8 provides information about NetApp support services.

Table 8) NetApp support services.

Part Number	Service Description	Master Qty.	Qty. per Expansion
CS-O2-4HR VA	SupportEdge Premium 4hr onsite, VA; E5460: 36 months	3	4

Table 9 provides information about NetApp Professional Services.

Table 9) NetApp Professional Services.

Part Number	Service Description
PS-SOW-E-HADOOP-POD	Storage configuration and Hadoop installation and configuration, custom

Table 10 provides information about Cisco data node hardware² and cables.

Table 10) Cisco data node hardware and cables.

Part Number	Part Description	Master Qty.	Qty. per Expansion
RACK-UCS2	Cisco R42610 standard rack w/side panels	1	1
RACK-BLANK-001	Filler panels (qty 12) 1U plastic toolless	1	1
RP208-30-1P-U-1	Cisco RP208-30-U-1 Single Phase PDU 2x C13 4x C19	2	2
RP208-30-1P-U-2	Cisco RP208-30-U-2 Single Phase PDU 20x C13 4x C19	2	2
UCSC-C220-M4S	UCS C220 M4 SFF w/o CPU, mem, HD, PCIe, PSU, rail kit	16	16
UCS-CPU-E52680D	2.50 GHz E5-2680 v3/120W 12C/30MB Cache/DDR4 2133MHz	32	32
UCS-MR-1X162RU-A	16GB DDR4-2133-MHz RDIMM/PC4-17000/dual rank/x4/1.2v	256	256
A03-D600GA2	600GB 6Gb SAS 10K RPM SFF HDD/hot plug/drive sled mounted	32	32
CAB-N5K6A-NA	Power Cord, 200/240V 6A North America	32	32
UCSC-PSU1-770W	770W AC hot-plug power supply for 1U C-Series Rack Server	32	32

² Cisco base rack components are available in a single SKU bundle: UCS-EZ-DB-NOSH.

Part Number	Part Description	Master Qty.	Qty. per Expansion
UCSC-MRAID12G	Cisco 12G SAS modular RAID controller	16	16
UCSC-SAS9300-8E	Cisco 12G SAS HBA with 8 external ports	12	16
UCSC-MLOM-CSC-02	Cisco UCS VIC1227 VIC MLOM - Dual Port 10Gb SFP+	16	16
N20-BBLKD	UCS 2.5 inch HDD blanking panel	96	96
UCSC-HS-C220M4	Heat sink for UCS C220 M4 rack servers	32	32
UCSC-RAILB-M4	Ball Bearing Rail Kit for C220 M4 and C240 M4 rack servers	16	16
LSI CBL-SFF8088 SAS-20M	2M External Mini SAS SFF-8088 (26-pin 4x) to Mini-SAS SFF-8088 (26-pin 4x) Cables	12	16
C3050-05BLU	CCX CAT5e patch cable, 5Ft, blue	8	8

Table 11 provides information about Cisco networking hardware and cables.

Table 11) Cisco networking hardware and cables.

Part Number	Part Description	Master Qty.	Qty. per Expansion
UCS-FI-6296UP-UPG	UCS 6296UP 2RU Fabric Int/No PSU/48 UP/ 18p LIC	2	0
UCS-PSU-6296UP-AC	UCS 6296UP power supply/100-240VAC	4	0
UCS-L-6200-10G-C	2rd Gen FI License to connect C-direct only	0	16
WS-C2960S-48FPS-L	Cisco Catalyst 2960S 48 GigE PoE 740W, 4 x SFP LAN Base	1	0
SFP-H10GB-CU3M	10GBASE-CU SFP+ Cable 3 Meter	16	24
SFP-H10GB-CU2M	10GBASE-CU SFP+ Cable 2 Meter	20	24
SFP-H10GB-CU1M	10GBASE-CU SFP+ Cable 1 Meter	18	0

Table 12 provides information about Cisco data node software requirements.

Table 12) Cisco data node software requirements.

Part Number	Part Description	Total Needed
N/A	Cloudera's Distribution including Apache Hadoop (CDH) 4.x	Installed on all servers, except for DNS
N/A	Hortonworks Distribution of Apache Hadoop (HDP) 1.x	Installed on all servers, except for DNS
RHEL-2S-1G-3A	Rhel/2 Socket/1 Guest/3Yr Svcs required; version 6.2 for x86_64	Installed on all servers

Table 13 provides information about Cisco data node and switching support services.

Table 13) Cisco data node and switching support services.

Part Number	Service Description	Master Qty.	Qty. per Expansion
CON-SNTP-C220M4S	SMARTNET 24X7X4 UCS C220 M4 SFF w/o CPU, mem, HD	48	48
CON-UCW3-RPDUX	UC PLUS 24X7X4 Cisco RP208-30-U-X single phase PDU 2x	12	12
CON-SNTP-FI6296UP	SMARTNET 24X7X4 UCS 6296UP 2RU fabric interconnect/2 PSU/2	2	0
CON-SNT3-2960S4FS	SMARTNET 3YR 8X5XNBD CAT2960S Stk48 GigE PoE 740W, 4xSFP Base	1	0
CON-ISV1-RH2S1G3A	ISV 24X7 RHEL/2 Socket/1 Guest List Price 3Y	16	16

Table 14 provides information about partner professional services.

Table 14) Partner professional services.

Professional Service Description
Master rack integration: On-site installation and configuration services (including travel expenses)
Expansion rack integration: On-site installation and configuration services (including travel expenses)

5 Software Versions

Table 15 lists the software versions validated in the FlexPod Select solutions.

Table 15) Software versions.

Software	Version
NetApp E-Series controller firmware	08.20.12..00
NetApp SANtricity® software	11.20
Red Hat Enterprise Linux	RHEL 6.7 (upgrade) or RHEL 7.1 (new installation)
Cloudera CDH 5.x	5.5.2
Hortonworks HDP 2.x	2.3.4

6 Support

The solution components should be covered by a validated support contract with each vendor, as listed in Table 16, as required. The solution provides Unified Support across all vendors, leveraging existing best practices for case escalation and transfer to support customer needs.

Table 16 lists the support contracts.

Table 16) Support contracts.

Company	Support Contract	Contact
NetApp	SupportEdge Premium for NetApp Systems	http://support.netapp.com/
Cisco	Networking: SMARTnet 24x7x4	http://www.cisco.com/cisco/web/support/index.html
Red Hat	Red Hat Enterprise Linux Server Premium	http://www.redhat.com/support/
LSI	LSI hardware support	http://www.lsi.com/support/Pages/download-search.aspx
Cloudera	Cloudera 24/7 support for 12 months	http://www.cloudera.com/content/support/en/home.html
Hortonworks	Hortonworks 24/7 support for 12 months	http://hortonworks.com/hadoop-support/#portal

7 Version History

Version	Date	Document Version History
Version 1.0	August 2013	Initial release
Version 1.1	August 2013	LSI SAS HBA firmware/BIOS update
Version 2	April 2016	Update with Cisco UCS C220 M4 and NetApp E5600

Refer to the [Interoperability Matrix Tool \(IMT\)](#) on the NetApp Support site to validate that the exact product and feature versions described in this document are supported for your specific environment. The NetApp IMT defines the product components and versions that can be used to construct configurations that are supported by NetApp. Specific results depend on each customer's installation in accordance with published specifications.

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