Hewlett Packard Enterprise

HPE Reference Architecture for Hadoop on HPE Elastic Platform for Big Data Analytics (EPA)

Deploying Hortonworks HDP with HPE Workload and Density Optimized (WDO) system

HORTONWORKS®

Reference Architecture

Contents

Executive summary

As organizations strive to identify and realize the value in Big Data, many now seek more agile and capable analytic systems. Some of the business drivers are to improve customer retention, increasing operational efficiencies, influence product development and quality, and to gain a competitive advantage.

While many have piloted Hadoop as a data repository for simple workloads, Hadoop is not just a storage platform for big data, as it also serves as the computational platform for business analytics. Hadoop is an ecosystem of several services rather than a single product, and is designed for storing and processing Petabytes of data in a linear scale-out model. Each service in the Hadoop ecosystem may use different technologies to ingest, store, process and visualize data.

As organizations look at accelerating their analytics workloads beyond traditional batch processing into real time event streaming and in-memory analytics, they realize that current architectures are not as flexible and do not perform well as a multi-tenant platform. This limitation leads to deploying separate clusters for each workload, and duplicating data across these clusters.

As data volumes grow, companies look at data tiering and archiving strategies in addition to workload consolidation on a shared enterprise platform for analytics.

The HPE Elastic Platform for Big Data Analytics (EPA), previously referred to as Big Data Reference Architecture (BDRA), is designed as a modular infrastructure foundation to address the need for a scalable multi-tenant platform, by enabling independent scaling of compute and storage through infrastructure building blocks that are optimized for density and workloads.

HPE supports two different deployment models under this platform:

- HPE Balanced and Density Optimized (BDO) system – Supports conventional Hadoop deployments that scale compute and storage together, with some flexibility in choice of memory, processor, and storage capacity. This is primarily based on the HPE ProLiant DL380 server platform, with density optimized variants using HPE Apollo 4200 and Apollo 4530 servers.
- HPE Workload and Density Optimized (WDO) system – Harnesses the power of faster Ethernet networks that enables a building block approach to independently scale compute and storage and lets you consolidate your data and workloads growing at different rates. The HPE WDO system is based on the HPE Apollo 4200 storage block and the HPE Apollo 2000 compute block, and combines them with Hadoop YARN's features for resource scheduling using containers and labels on the Hortonworks Data Platform to enable a scalable multi-tenant Hadoop platform.

Organizations that are already invested in balanced systems have the option of consolidating their existing deployments to a more elastic platform with the HPE Workload and Density Optimized system.

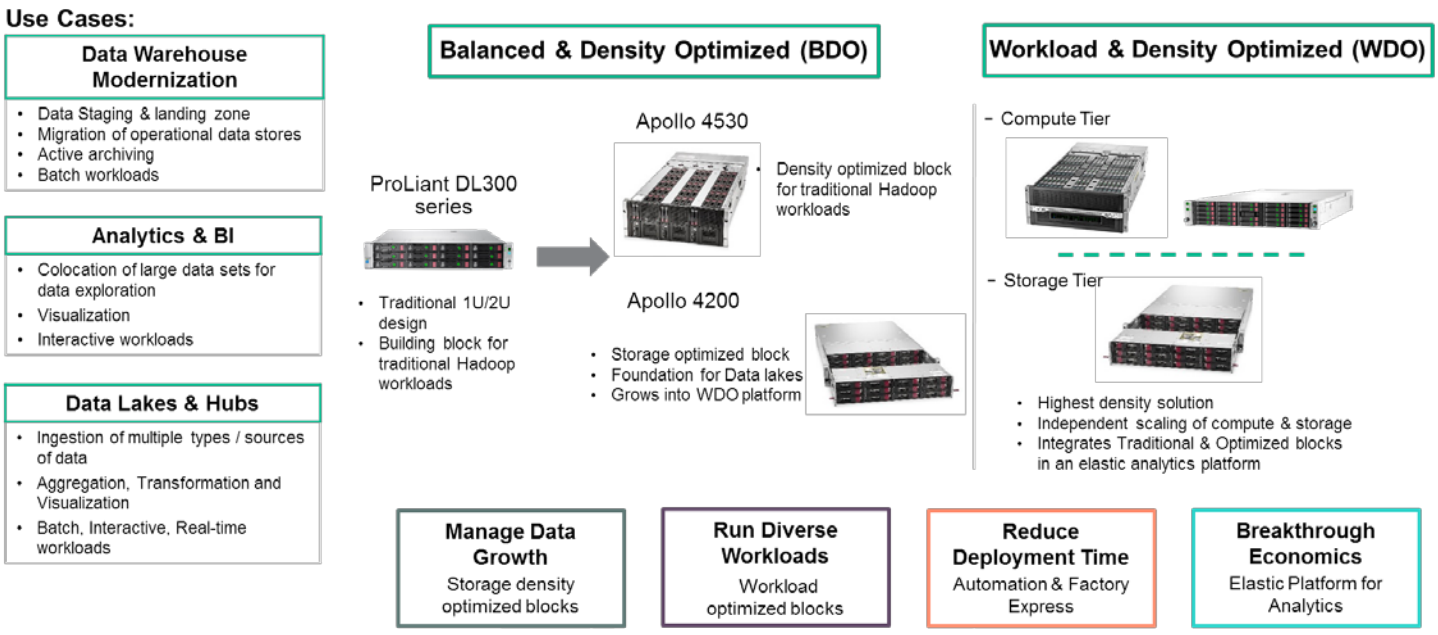

Figure 1. HPE Elastic Platform for Big Data Analytics

For more information about the HPE Elastic Platform for Big Data Analytics (EPA) and the benefits of separating compute and storage using modular building blocks, see the document at https://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=4AA6-8931ENW

Target audience: This paper is intended for decision makers, system and solution architects, system administrators and experienced users that are interested in reducing design time or simplifying the purchase of a big data architecture containing both HPE and Hortonworks components. An intermediate knowledge of Apache Hadoop and scale-out infrastructure is recommended.

Document purpose: This white paper describes a big data solution deploying the Hortonworks Data Platform (HDP) with the Hewlett Packard Enterprise Workload and Density Optimized system. The paper also describes the HPE Apollo 2000 compute system and the HPE Apollo 4200 storage nodes as key components of the solution. This solution provides recognizable benefits of using Hortonworks Data Platform (HDP) with the HPE WDO system. In addition to simplifying the procurement process, this paper also provides guidelines for configuring HDP once the system has been deployed.

Collaborative testing between Hewlett Packard Enterprise and Hortonworks engineering for this reference architecture was performed in May 2016.

Disclaimer: Products sold prior to the separation of Hewlett-Packard Company into Hewlett Packard Enterprise Company and HP Inc. on November 1, 2015 may have a product name and model number that differ from current models.

Solution overview

HPE Big Data solutions provide world class performance and availability, with integrated software, services, infrastructure, and management – all delivered as one tested configuration, described in more detail at hpe.com/info/hadoop. The HPE WDO system is a highly optimized configuration built using unique servers offered by HPE – the HPE Apollo 4200 Gen9 for the high density storage layer and the HPE Apollo 2000 system with HPE ProLiant XL170r nodes for the high density computational layer. The servers and components described below combine to offer an asymmetric Hadoop architecture designed and optimized for a variety of workloads.

- HPE Apollo 4200 Gen9 server offers revolutionary storage density in a 2U form factor. It provides this storage density leadership along with an unprecedented selection of processors to match for data intensive workloads. The HPE Apollo 4200 Gen9 server allows you to save valuable data center space through its unique density optimized 2U form factor which holds up to 28 LFF or 54 SFF hot plug drives.

- The HPE Apollo 2000 system offers a dense solution with up to four independent, hot-pluggable HPE ProLiant XL170r Gen9 server nodes in a standard 2U chassis. It delivers twice the compute density as 1U rack-mount servers with front hot-pluggable drives and rear serviceable nodes providing very cost effective configurations for various workloads.
- HPE ProLiant DL360 servers include two sockets using Intel® Xeon® E5-2600 v4 product family to provide the high performance required for management services for Hadoop cluster.

The HPE iLO management engine in the servers contains HPE Integrated Lights-Out 4 (iLO 4) and features a complete set of embedded management features for HPE Power/Cooling, Agentless Management, Active Health System, and Intelligent Provisioning which reduces node and cluster level administration for Hadoop.

This reference architecture is the result of a great deal of testing and optimization done by HPE engineers resulting in the right set of software, drivers, firmware and hardware to yield extremely high density and performance. This architecture is changing the economics of work distribution in big data. Simply deploying Hadoop onto a collection of traditional servers in an asymmetric fashion will not yield the kind of benefits that is seen with HPE WDO system. In order to simplify the build for customers, HPE provides the exact bill of materials in this document to allow a customer to purchase this complete solution. HPE recommends that customers purchase the option in which HPE Technical Services Consulting will install the prebuilt operating system images, verify all firmware and versions are correctly installed, and run a suite of tests that verify that the configuration is performing optimally. Once this has been done, the customer can perform a standard Hortonworks installation using the recommended guidelines in this document.

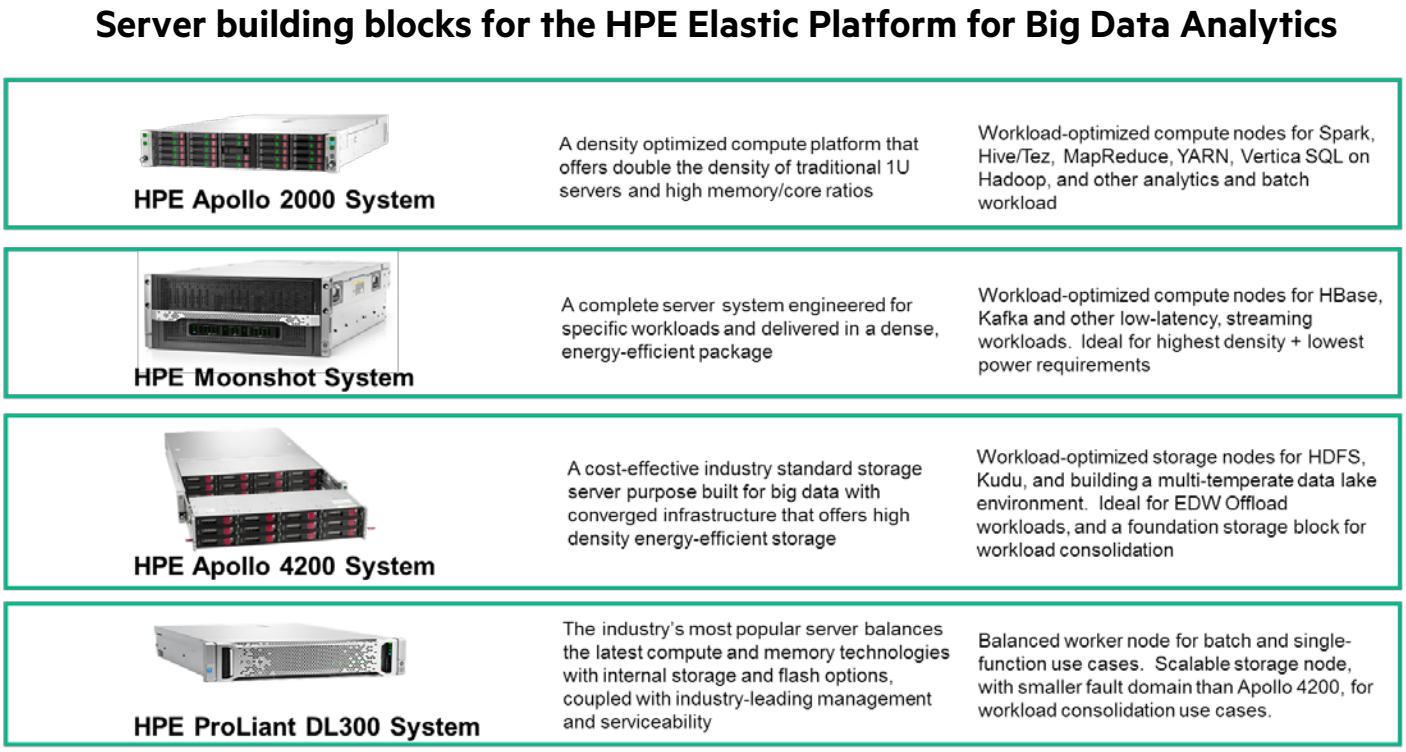

Figure 2. HPE Elastic Platform for Big Data Analytics building blocks

The HPE Workload and Density Optimized design is anchored by the following HPE technologies.

[1] Vertica is a trademark that is owned by Micro Focus International PLC or one of its affiliates. All third-party marks are property of their respective owners.

Storage nodes

HPE Apollo 4200 Gen9 servers make up the HDFS storage layer, providing a single repository for big data. The HPE Apollo 4200 Gen9 server offers the right mix between storage and compute performance in a 2U form factor. The 28 LFF disks have been adequately powered by 28 exclusive physical cores for the compute needs of HDFS. The storage controllers in the HPE Apollo 4200 support HPE Secure Encryption, a Smart Array controller-based data encryption solution that provides encryption for data at rest.

Compute nodes

HPE Apollo 2000 system nodes deliver a scalable, high-density layer for compute tasks and provide a framework for workload-optimization with four HPE ProLiant XL170r nodes on a single chassis.

The HPE Reference Architecture for Workload and Density Optimized system provides great flexibility in deploying your workloads and managing your data growth, by decoupling storage growth from compute through high-speed networking. This allows you to add compute or storage as needed without having to add both lock-step. The architecture preserves the performance and availability benefits achieved through rack locality, while eliminating the need for node locality by leveraging high-speed networks for I/O performance and intelligent placement of Hadoop services on servers optimized for running specific components Testing carried out by HPE indicates that most workloads respond almost linearly to additional compute resources.

YARN and Hadoop 2.0

One of the most significant benefits of YARN and Hadoop 2.0, is to separate processing from resource management. This enables a variety of new and familiar tools like Spark and SQL to identify data of value interactively and in real time, without being hampered by the often I/O intensive, high latency MapReduce framework.

Hortonworks Data Platform

HDP is a platform for multi-workload data processing. As shown in Figure 3, the platform can utilize a range of processing methods – from batch to interactive and real time – all supported by solutions for governance, integration, security, and operations. HDP integrates with and augments solutions like HPE WDO system, allowing you to maximize the value of big data. HDP enables Open Enterprise Hadoop, a full suite of essential Hadoop capabilities in the following functional areas: data management, data access, data governance and integration, security, and operations.

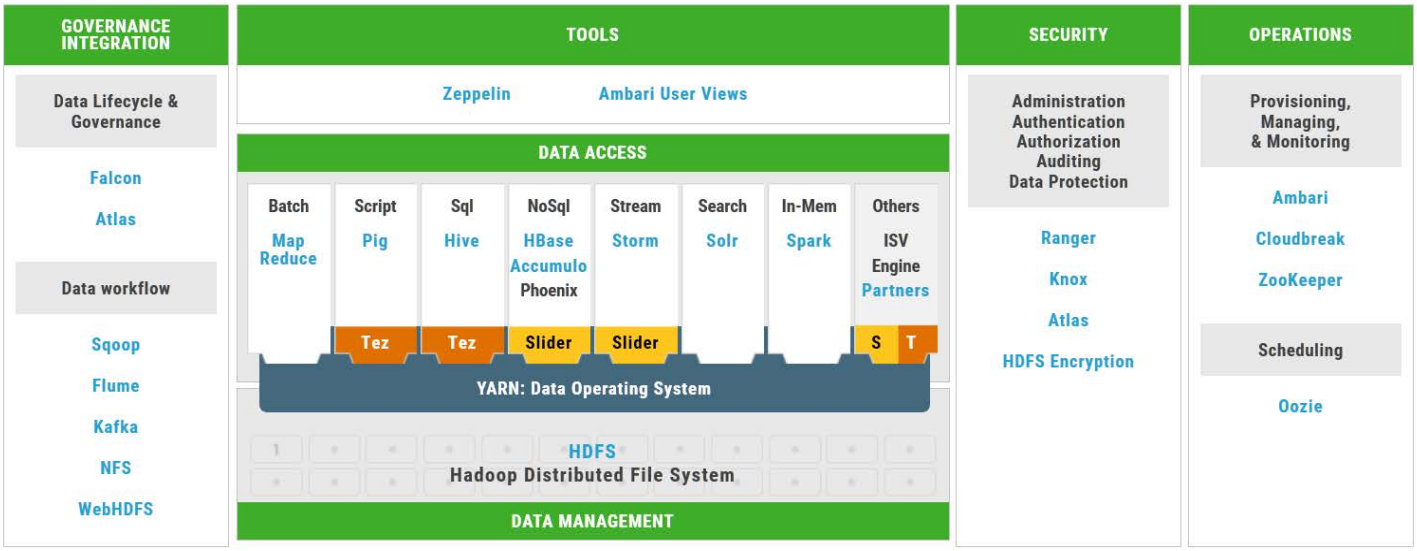

Figure 3. HDP blueprint for Enterprise Hadoop

Key highlights of HDP 2.4 include the following:

- Enhanced security
- Workload Management advancements
- Apache Hive improvements
- High-performance ETL via Pig and Tez
- Stream processing via Apache Storm and Apache Kafka

For more information on HDP, refer to hortonworks.com/hdp

Benefits of HPE Workload and Density Optimized system

The HPE Workload and Density Optimized system lets you consolidate your data and workloads and gives you the flexibility to scale compute and storage using modular building blocks of workload and density optimized servers for maximum performance and density.

This fundamentally changes the economics of the solution across scale, performance and cost efficiency to meet specific use case and workload needs.

Flexibility to scale
Scale compute and storage independently to build a hyperscale analytics platform.

The HPE WDO system provides you the flexibility to add modular building blocks that are optimized for each workload and lets you access the same pool of data for batch, interactive or real-time analytics.

Cluster consolidation
Multiple big data environments can directly access a shared pool of data.

As Hadoop adoption expands in the enterprise, it is typical to have multiple clusters running different workloads on a variety of technologies and Hadoop distributions, in both development and production environments, leading to challenges with data duplication and cluster sprawl.

The HPE WDO system allows you to consolidate your data, workloads and clusters on a shared centrally managed platform.

Maximum elasticity
Rapidly provision compute without affecting storage.

The HPE WDO system lets you build and scale your infrastructure in alignment with the different phases of your analytics implementation. For example, pilots use a smaller number of storage density optimized servers for data staging and MapReduce workloads, and as you add interactive workloads like SQL on Hadoop or scale your batch workloads, you can add high-latency compute nodes without having to add storage. A low-latency tier of density optimized servers with SSDs or NVMe Flash can be added to accelerate time series analysis of large datasets in real-time.

Breakthrough economics
The HPE WDO can provide better density, cost and power through workload optimized components than even HPE traditional symmetric Hadoop solutions.

When compared to our traditional solution using a rack of eighteen HPE ProLiant DL380 Gen9 systems, the balanced configuration of the HPE WDO system (i.e., nine HPE Apollo 2000 chassis and nine HPE Apollo 4200 Gen9 servers) offers 2.0x the compute density, 1.16x the storage density, and 1.33x the memory density within a single rack. These benefits extend to the hot and cold configurations due to the flexibility to scale compute or storage independently based on data access.

With storage and compute capacity growing at different rates for modern workloads, the HPE WDO system provides density optimized building blocks to target a variety of latency, capacity, and performance requirements.

Solution components

Figure 4 provides a basic conceptual diagram of the HPE WDO system.

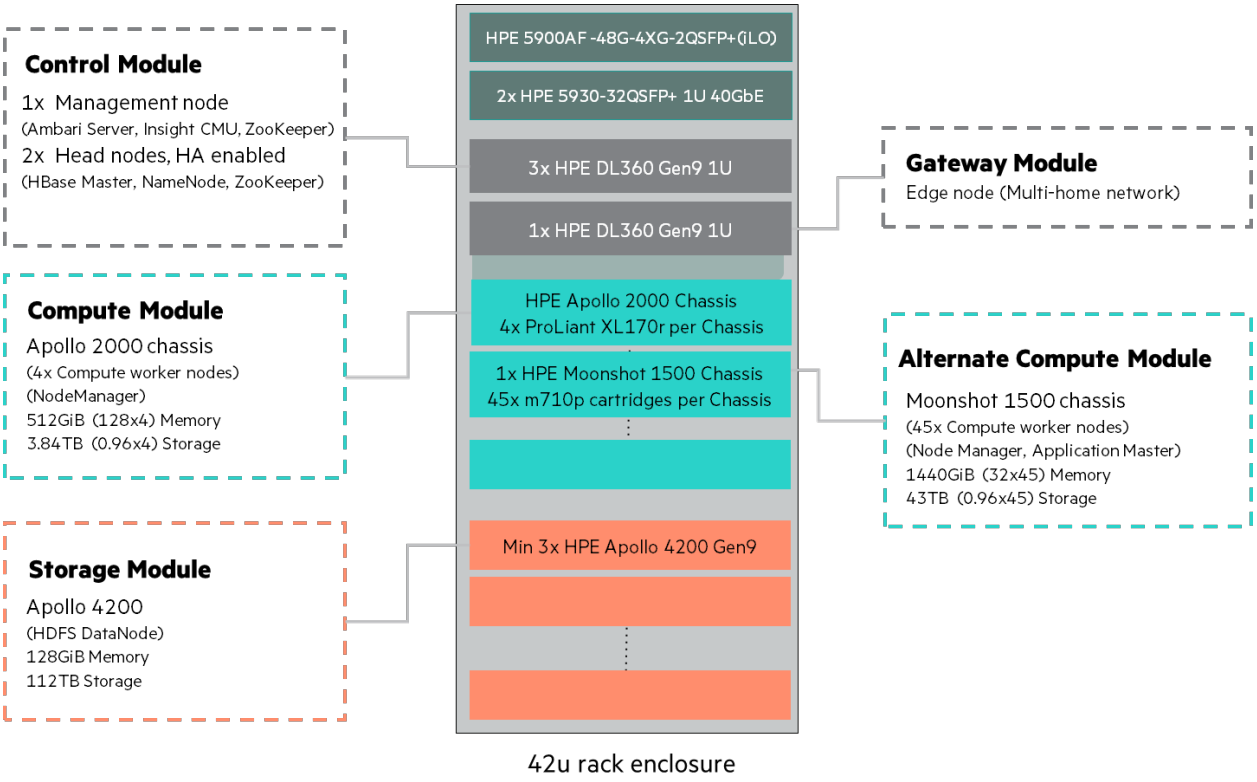

Figure 4. HPE WDO system conceptual diagram

For full BOM listings of products selected for the proof of concept, refer to the Appendix A: Bill of materials section of this white paper.

Reference architecture

Figure 5 shows a reference architecture for the HPE WDO system, with 12 worker nodes and 3 storage nodes housed in a single 42U rack.

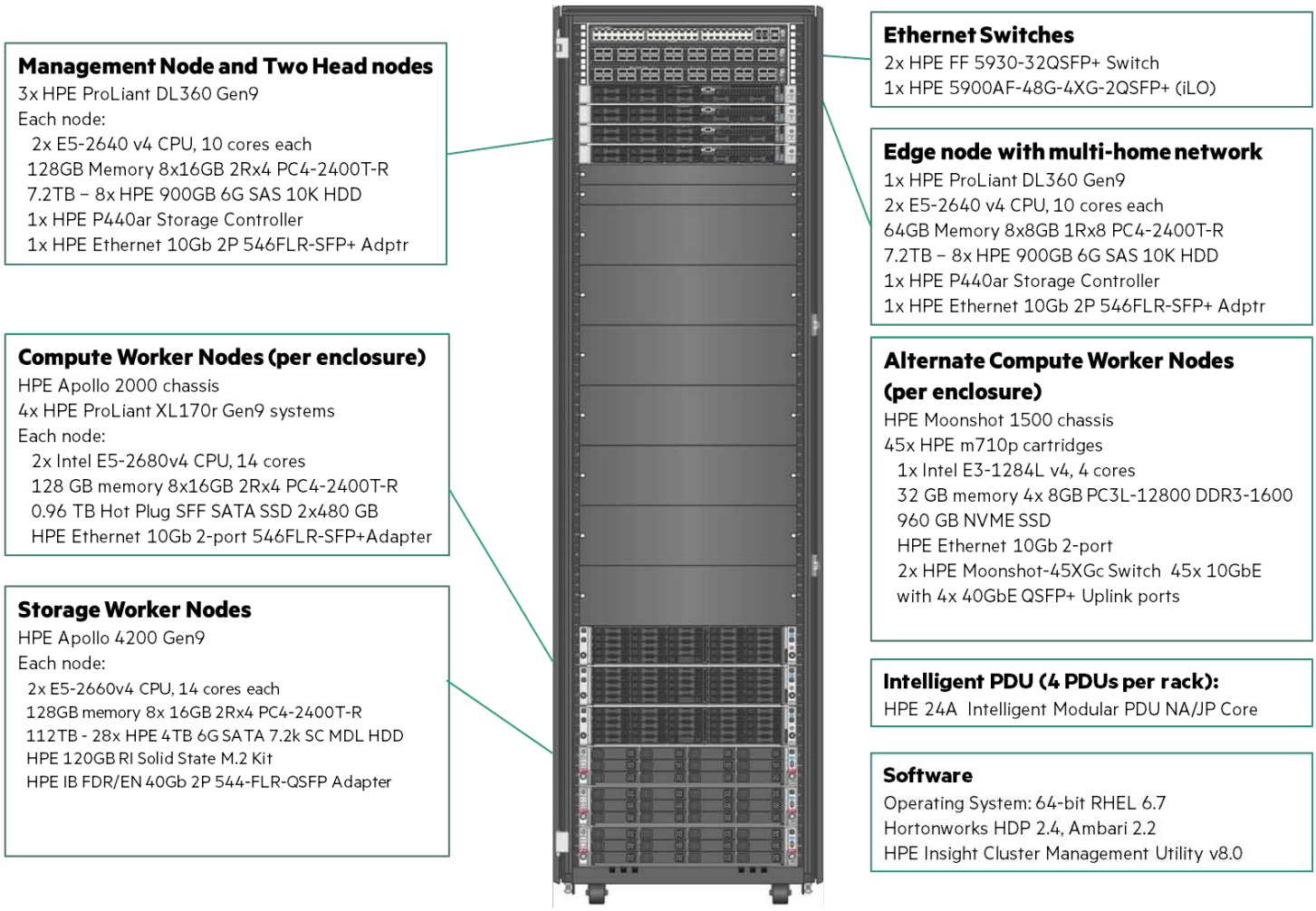

Figure 5. HPE WDO system reference architecture, with detailed lists of components

Best practice

HPE recommends starting with three HPE Apollo 4200 storage nodes, and adding in compute nodes consisting of HPE Apollo 2000 chassis each with 4x HPE ProLiant XL170r nodes with 128 GB of memory. For Hive/Tez installations, consider increasing the memory to 256 GB in the compute nodes.

The following nodes are used in the reference architecture shown in figure 5 for HPE WDO system.

Edge node

The HPE WDO system includes a multi-homed network server called Edge node. It acts as a gateway node between the cluster's private VLAN and the external routable network. Any application that requires both external network access and cluster-private-network can run on this server. When significant storage and network bandwidth are required, use more additional HPE ProLiant DL360 Gen9 servers as Edge nodes. Refer to Table 1 for software components for the Edge node.

Management and Head nodes

Three HPE ProLiant DL360 Gen9 servers are configured as Management/Head nodes. Refer to Table 2 for the suggested software components for the Management node, and Table 3 for the suggested software components for the Head nodes.

Management and Head nodes store important metadata information for the cluster and hence for greater data protection and performance a RAID configuration is suggested for data storage. RAID 1 is recommended for the OS and NameNode metadata. RAID 10 is recommended for Database data.

Compute nodes

The reference architecture shown in Figure 5 features three HPE Apollo 2000 chassis containing a total of 12 HPE ProLiant XL170r Gen9 hot-pluggable server nodes as shown in Figures 6 and 7.

Figure 6. HPE ProLiant XL170r Gen9

Figure 7. HPE Apollo 2000 chassis (rear and front)

The HPE Apollo 2000 system is a dense solution with four independent HPE ProLiant XL170r Gen9 hot-pluggable server nodes in a standard 2U chassis. Each HPE ProLiant XL170r Gen9 server node is serviced individually without impacting the operation of other nodes sharing the same chassis to provide increased server uptime. Each server node harnesses the performance of 2400 MHz memory (16 DIMM slots per node) and dual Intel Xeon E5-2600 v4 processors in a very efficient solution that shares both power and cooling infrastructure. Other features of the HPE ProLiant XL170r Gen9 server include:

- Support for high-performance memory (DDR4) and Intel Xeon E5-2600 v4 processor up to 22C, 145W
- Additional PCIe riser options for flexible and balanced I/O configurations
- FlexibleLOM feature for additional network expansion options
- Support for dual M.2 drives

For more information on HPE Apollo 2000 Chassis, visit
hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-apollo-r2000-chassis.7832023.html

For more information on the HPE ProLiant XL170r Gen9 server, visit
hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-proliant-xl170r-gen9-server.7799270.html

Each of these compute nodes typically runs YARN NodeManager.

Note

Alternate compute nodes: HPE ProLiant m710p server cartridges (Intel Xeon E3-1284L v4 2.9GHz-3.8GHz) housed on HPE Moonshot 1500 chassis provides users with an alternate choice of compute servers to use in the HPE WDO system for denser compute nodes. The HPE ProLiant m710p cartridges come with Intel's 4th Generation Broadwell chips. For BOM information, refer to Appendix B: Table B-4.

Storage nodes

There are three HPE Apollo 4200 Gen9 servers. Each server is configured with 28 LFF disks; each typically runs HDFS DataNode. The HPE Apollo 4200 Gen9 server is shown in Figure 8.

Figure 8. HPE Apollo 4200 Gen9 server

The HPE Apollo 4200 Gen9 server offers revolutionary storage density for data intensive workloads such as Apache Hive on Hadoop HDFS. The HPE Apollo 4200 allows you to save valuable data center space through its unique density optimized 2U form factor which holds up to 28 LFF disks and with capacity for up to 224 TB per server. It has the ability to grow your big data solutions with an infrastructure that is ready to scale. Another benefit is that the HPE Apollo 4200 fits easily into standard racks with a depth of 32-inches per server – no special racks are required.

For more detailed information, visit hpe.com/us/en/product-catalog/servers/proliant-servers/pip.hpe-apollo-4200-gen9-server.8261831.html

Key point

The storage controllers in the HPE Apollo 4200 and HPE ProLiant XL170r support HPE Secure Encryption. HPE Secure Encryption is an HPE Smart Array controller-based data encryption solution. It provides encryption for data at rest, an important component for complying with government regulations having data privacy requirements, such as HIPAA and Sarbanes-Oxley. This optional feature enhances the functionality of the storage controller in cases where encryption is a required feature of the solution.

Best practice

HPE recommends starting with a minimum of three HPE Apollo 4200 Gen9 servers as storage nodes, due to the default replication factor of 3 for the Hadoop Distributed File System (HDFS).

Power and cooling

When planning large clusters, it is important to properly manage power redundancy and distribution. To ensure servers and racks have adequate power redundancy, HPE recommends that each HPE Apollo 2000 chassis, each HPE Apollo 4200 Gen9 server, and each HPE ProLiant DL360 Gen9 server should have a backup power supply and each rack should have at least two Power Distribution Units (PDUs).

There is additional cost associated with procuring redundant power supplies; however, the need for redundancy is less critical in larger clusters where the inherent redundancy within HDP ensures there would be less impact in the event of a failure.

Best practice

For each chassis, HPE Apollo 2000, HPE Apollo 4200 Gen9, and HPE ProLiant DL360 Gen9 server, HPE recommends connecting each of the device's power supplies to a different PDU. Furthermore, PDUs should each be connected to a separate data center power line to protect the infrastructure from a line failure.

Distributing server power supply connections evenly to the PDUs while also distributing PDU connections evenly to data center power lines ensures an even power distribution in the data center and avoids overloading any single power line. When designing a cluster, check the maximum power and cooling that the data center can supply to each rack and ensure that the rack does not require more power and cooling than is available.

Networking

As shown in Figure 9, two IRF-bonded HPE FlexFabric 5930-32QSFP+ switches are specified in each rack for high performance and redundancy. Each provides six 40GbE uplinks that can be used to connect to the desired network or, in a multi-rack configuration, to another pair of HPE FlexFabric 5930-32QSFP+ switches that are used for aggregation. The other 22 ports are available for Hadoop nodes.

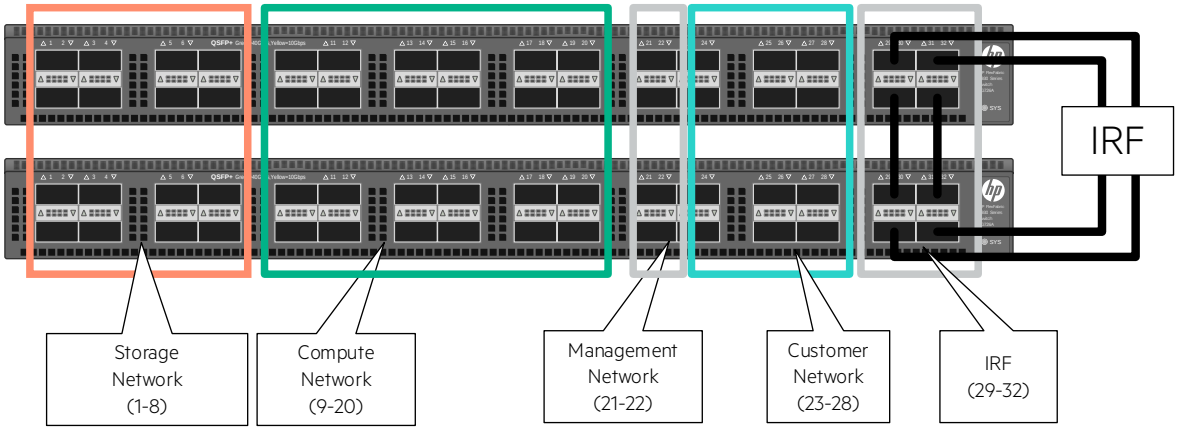

Figure 9. HPE FlexFabric 5930-32QSFP+ switch port allocation based upon node type

Note

IRF-bonding requires four 40GbE ports per switch, leaving six 40GbE ports on each switch for uplinks. QSFP+ 4x10G SFP+ DAC cables are used to connect compute and Management nodes to the QSFP+ ports on the HPE FlexFabric 5930 switches. Therefore a single QSFP+ port on the HPE FlexFabric 5930 switch handles 4 compute node connections.

iLO network

A single HPE FlexFabric 5900 switch is used exclusively to provide connectivity to HPE Integrated Lights-Out (iLO) management ports, which run at or below 1GbE. The iLO network is used for system provisioning and maintenance.

Cluster isolation and access configuration

It is important to isolate the Hadoop cluster so that external network traffic does not affect the performance of the cluster. In addition, isolation allows the Hadoop cluster to be managed independently from its users, ensuring that the cluster administrator is the only person able to make changes to the cluster configuration.

Thus, HPE recommends deploying ResourceManager, NameNode, and Worker nodes on their own private Hadoop cluster subnet.

Key point

Once a Hadoop cluster is isolated, the users still need a way to access the cluster and submit jobs to it. To achieve this, HPE recommends multi-homing the Management node so that it can participate in both the Hadoop cluster subnet and a subnet belonging to users.

Ambari is a web application that runs on the Management node, allowing users to manage and configure the Hadoop cluster and view the status of jobs without being on the same subnet – provided that the Management node is multi-homed. Furthermore, this approach allows users to shell into the Management node and run Apache Pig or Apache Hive command line interfaces and submit jobs to the cluster in that way.

Staging data

After the Hadoop cluster has been isolated on its own private network, you must determine how to access HDFS in order to ingest data. The HDFS client must be able to reach every Hadoop DataNode in the cluster in order to stream blocks of data on to the HDFS.

The HPE WDO system provides the following options for staging data:

- **Using the Management node** – The already multi-homed Management node can be used to stage data. HPE recommends configuring this server with eight disks to provide a sufficient amount of disk capacity to provide a staging area for ingesting data into the Hadoop cluster from another subnet.
- **Using an Edge node** – The already multi-homed Edge node can be used to stage data. HPE recommends configuring this server with eight disks to provide a sufficient amount of disk capacity to provide a staging area for ingesting data into the Hadoop cluster from another subnet.
- **Using the Top of Rack switches** – Alternately, you can make use of open ports in the ToR switches. The HPE WDO system is designed such that if both NICs on each storage node are used, eight ports are used on each HPE Apollo 2000 chassis (two NICs on each node), and two NICs are used on each Management node, the remaining 40GbE ports on the ToR switches can be used by multi-homed systems outside the Hadoop cluster to move data into the cluster.
- **Using WebHDFS** – WebHDFS provides HTTP access to securely read and write data to and from HDFS. For more information on WebHDFS, refer to http://docs.hortonworks.com/HDPDocuments/HDP2/HDP-2.4.2/bk_hdfs_admin_tools/content/ch11.html

Capacity and sizing

Expanding the base configuration

As needed, compute and/or storage nodes can be added to an HPE WDO system. The reference architecture, shown in Figure 5, with three HPE Apollo 2000 chassis and three HPE Apollo 4200 Gen9 storage nodes can expand, depending on the requirements, to a variety of combinations of compute and storage nodes in a single rack, ranging from hot (with a large number of compute nodes and minimal storage) to cold (with a large number of storage nodes and minimal compute).

Multi-rack configuration

The single-rack HPE WDO system is designed to perform well as a standalone solution but also form the basis of a much larger multi-rack solution, as shown in Figure 10. When moving from a single-rack to a multi-rack solution, you simply add racks without having to change any components within the base rack.

A multi-rack solution assumes the base rack is already in place and extends its scalability. For example, the base rack already provides sufficient management services for a large scale-out system.

Note

There is no need for an aggregation switch when there are only two racks in the configuration. The existing HPE FlexFabric 5930 switches in the racks can be used to network between the two base racks. Figure 10 shows the network connection, using an additional aggregation switch, when a third rack (expansion rack) gets added to the base racks. For simplicity, the figure depicts only one of the base racks and the third expansion rack. The other base rack connects to the aggregation switch in the same way as shown in the figure.

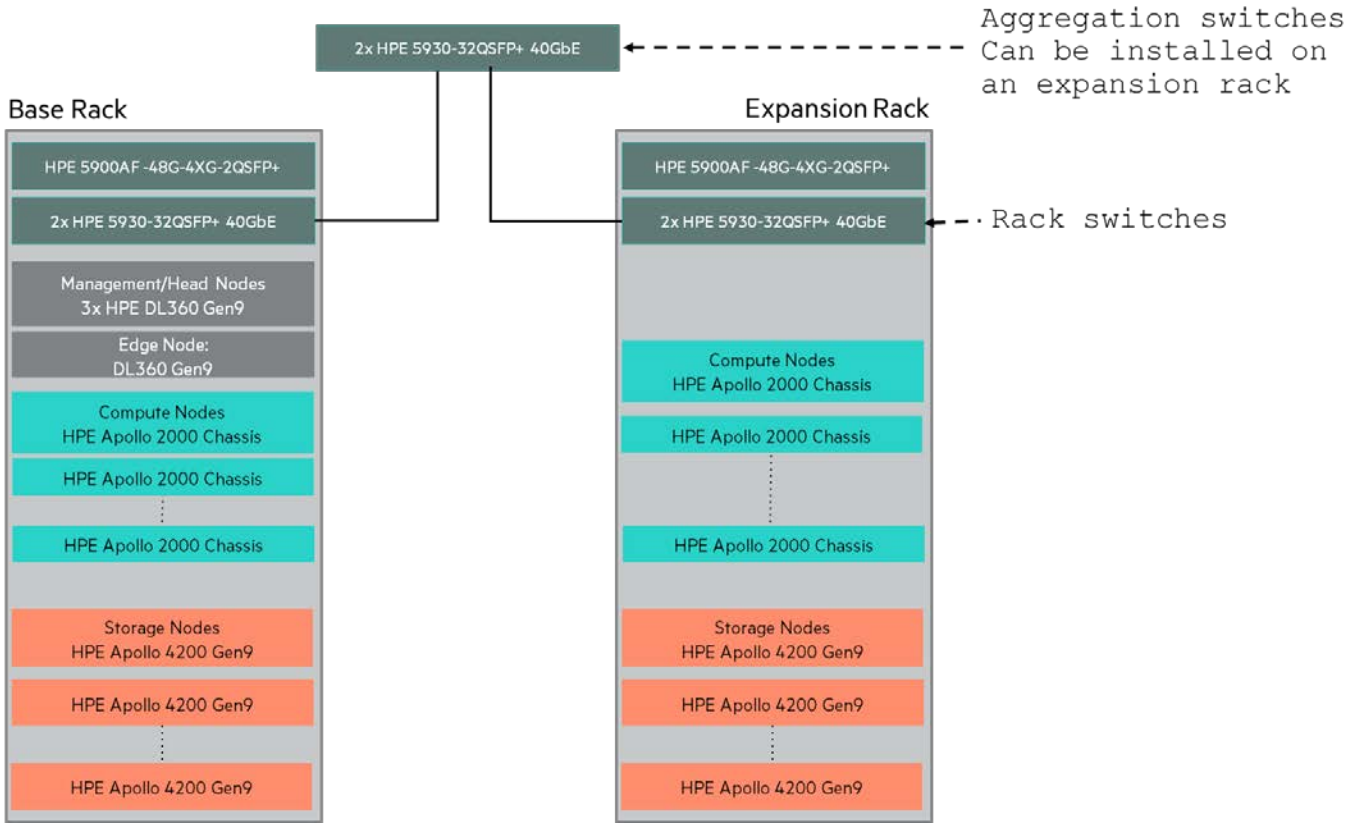

Figure 10. Multi-rack HPE WDO system, extending the capabilities of a single rack

Note

Much of the architecture for the multi-rack solution is based on previous iterations of Hadoop testing, and is provided here as a general guideline for designing multi-rack Hadoop clusters.

Extending networking in a multi-rack configuration

For performance and redundancy, two HPE FlexFabric 5930-32QSFP+ ToR switches are specified per expansion rack. The HPE FlexFabric 5930-32QSFP+ switch includes up to six 40GbE uplinks that can be used to connect these switches to the desired network via a pair of HPE FlexFabric 5930-32QSFP+ aggregation switches.

Guidelines for calculating storage needs

Hadoop cluster storage sizing requires careful planning, based on the identification of current and future storage and compute needs. The following are general considerations for data inventory:

- Sources of data
- Frequency of data
- Raw storage
- Processed HDFS storage
- Replication factor
- Default compression turned on
- Space for intermediate files

It makes sense to identify storage requirements for the short-, medium-, and long-term. To calculate your storage needs, determine the number of TB of data needed per day, week, month, and year; and then add the ingestion rates of all data sources.

Another important consideration is data retention – both size and duration. Which data must you keep? For how long?

In addition, consider maximum fill-rate and file system format space requirements on hard drives when estimating storage size.

Configuration guidance

The instructions provided below assume that the Hadoop cluster has already been created on an HPE WDO system. They are intended to assist in optimizing the setup for the various HDP services on this reference architecture.

Setting up HDP

The following sections describe the placement of the various Hadoop components on the different node types.

Edge node components

Each Edge node acts as a gateway between the cluster's private network and external network. Users outside the cluster's private network may access the Edge node to access cluster resources, and hence it is recommended to install various Client Gateways on the Edge node.

Table 1. Edge node basic software components

Software	Description
Red Hat® Enterprise Linux® (RHEL) 6.7	Recommended Operating System
Oracle JDK 1.7.0_75	Java Development Kit
Gateway Services	Hadoop Client Services (HDFS, YARN, MapReduce, HBase, and others)

Management node components

The Management node runs the various components that are used to maintain and configure the rest of the cluster.

Table 2. Management node base software components

Software	Description
Red Hat Enterprise Linux 6.7	Recommended operating system
Oracle Java Development Kit	JDK
Ambari Server	Hortonworks HDP management
Hadoop Client components	Used to initiate the various Hadoop jobs (if dual purposing the Management node as an Edge node)
NameNode Quorum JournalNode	Quorum based Journaling for NameNode HA
ZooKeeper	Hadoop consensus management utility
Insight CMU	Cluster Management Utility

Head node components

The Head nodes run the Hadoop master components of the Hadoop cluster.

Table 3. Head node base software components

Software	Description
Red Hat Enterprise Linux 6.7	Recommended operating system
Oracle Java Development Kit	JDK
Ambari Agent	Hortonworks HDP management
NameNode	HDFS name node Service
Quorum JournalNode	Quorum based Journaling for NameNode HA
SNameNode	Secondary HDFS NameNode service
ResourceManager	YARN resource management service
HiveServer2	Apache Hive server
Hive Metastore	Stores metadata for Hive tables and partitions
MySQL Server	Database
WebHcat Server	Web API for HCatalog and related Hadoop components
ZooKeeper	Hadoop consensus management utility

Compute node components

Compute nodes run the working components of the Hadoop cluster.

Table 4. Compute node base software components

Software	Description
Red Hat Enterprise Linux 6.7	Recommended operating system
Oracle Java Development Kit	JDK
Ambari Agent	Hortonworks HDP management
NodeManager	NodeManager process for MR2/YARN

Storage node components

Storage nodes run the DataNode components of the Hadoop cluster.

Table 5. Storage node base software components

Software	Description
Red Hat Enterprise Linux 6.7	Recommended operating system
Oracle Java Development it	JDK
Ambari Agent	Hortonworks HDP management
DataNode	DataNode process for HDFS

Implementing a proof-of-concept

As a matter of best practice for all deployments, HPE recommends implementing a proof-of-concept using a test environment that matches as closely as possible the planned production environment. In this way, appropriate performance and scalability characterizations can be obtained. For help with a proof-of-concept, contact an HPE Services representative (hpe.com/us/en/services/consulting.html) or your HPE partner.

Summary

HPE Workload and Density Optimized system is a modern, flexible architecture for big data solutions that improves overall access to information and time-to-solution, while providing the inherent flexibility to support the rapidly changing requirements of big data applications. The HPE WDO system leverages HPE's innovative big data building blocks of servers, storage, and networking, along with integrated management software and bundled support.

The combination of HDP 2.4 running Hive with Tez on YARN on HPE WDO system provides the ideal blend of speed, flexibility, scalability and optimization of operations needed by today's enterprises: a high performance data warehouse infrastructure built on top of Hadoop that provides data summarization, query and analysis, supports analysis of large datasets stored in HDFS, and provides a SQL-like interface

HPE WDO system and HDP allow an organization to derive new business insights from big data by providing a platform to store, manage, and process data at scale. However, the design, procurement and deployment of a Hadoop cluster can be both complex and time consuming. Thus, this white paper outlined reference architectures for heterogeneous clusters of varying sizes with HDP 2.4 running Hive on Tez on HPE infrastructure and management software. Guidelines for optimizing HDP software settings were provided.

Appendix A: Bill of materials

The BOMs outlined in the following tables below are based on the HPE WDO system single-rack reference architecture with the following key components:

- One Management node
- Two Head nodes
- One Edge node
- Twelve compute nodes (refer to Appendix B – Alternate compute node components)
- Three storage nodes (refer to Appendix C – Alternate storage node components)
- Two ToR switches
- One HPE iLO switch
- Hortonworks Data Platform (HDP 2.4 was tested)

Note

Part numbers are at time of testing and subject to change. The bill of materials does not include complete support options or other rack and power requirements. If you have questions regarding ordering, please consult with your HPE Reseller or HPE Sales Representative for more details. hpe.com/us/en/services/consulting.html

---

Edge node, Management node, and Head nodes

Important

Table A-1 provides a BOM for one HPE ProLiant DL360 Gen9 server. The reference architecture features one Edge node, one Management node and two Head nodes, requiring a total of three HPE ProLiant DL360 Gen9 servers.

Table A-1. BOM for a single HPE ProLiant DL360 Gen9 server

Note that the BOM between Management/Head nodes and Edge nodes differs only in memory.

Qty	Part Number	Description
1	755258-B21	HPE DL360 Gen9 8SFF CTO Server
1	818176-L21	HPE DL360 Gen9 E5-2640v4 FIO Kit
1	818176-B21	HPE DL360 Gen9 E5-2640v4 Kit
8	836220-B21	HPE 16GB 2Rx4 PC4-2400T-R Kit (Management/Head nodes)
8	805347-B21	HPE 8GB 1Rx8 PC4-2400T-R Kit (Edge nodes)
8	652589-B21	HPE 900GB 6G SAS 10K 2.5in SC ENT HDD
1	749974-B21	HPE Smart Array P440ar/2G FIO Controller
1	779799-B21	HPE Ethernet 10Gb 2P 546FLR-SFP+ Adptr
1	734807-B21	HPE 1U SFF Easy Install Rail Kit
2	720478-B21	HPE 500W FS Plat Ht Plg Pwr Supply Kit
1	764646-B21	HPE DL360 Gen9 Serial Cable
1	764636-B21	HPE DL360 Gen9 SFF Sys Insght Dsply Kit
2	AF595A	HPE 3.0M, Blue, CAT6 STP, Cable Data

Compute nodes

Note

Table A-2 provides a BOM for one HPE Apollo 2000 chassis with four HPE ProLiant XL170r servers. The reference architecture features three HPE Apollo chassis with a total of 12 HPE ProLiant XL170r servers. (See Appendix B for the BOM for alternate components for compute nodes.)

Table A-2. BOM for a single HPE Apollo 2000 with four HPE ProLiant XL170r servers

Qty	Part Number	Description
1	798153-B21	HPE Apollo r2600 24SFF CTO Chassis
2	800059-B21	HPE Apollo 2000 FAN-module Kit
4	798155-B21	HPE ProLiant XL170r Gen9 CTO Svr
4	850314-L21	HPE XL1x0r Gen9 E5-2680v4 FIO Kit
4	850314-B21	HPE XL1x0r Gen9 E5-2680v4 Kit
32	836220-B21	HPE 16GB 2Rx4 PC4-2400T-R Kit
4	779799-B21	HPE Ethernet 10Gb 2-port 546FLR-SFP+ Adapter
8	832414-B21	HPE 480GB 6Gb SATA 2.5in MU-2 SC SSD
4	798178-B21	HPE XL1x0r Gen9 LP PCIex16 L Riser Kit
4	798180-B21	HPE XL170r FLOM x8 R Riser Kit
4	798192-B21	HPE XL170r/190r Dedicated NIC IM Board Kit
4	800060-B21	HPE XL170r Mini-SAS B140 Cbl Kit
2	720620-B21	HPE 1400W FS Plat Pl Ht Plg Pwr Spply Kit
1	740713-B21	HPE t2500 Strap Shipping Bracket
1	611428-B21	HPE DL2000 Hardware Rail Kit
8	AF595A	HPE 3.0M, Blue, CAT6 STP, Cable Data
2	JG330A	HPE X240 QSFP+ 4x10G SFP+ 3m DAC Cable (2 per 798153-B21)

Storage nodes

Important

Table A-3 provides a BOM for one HPE Apollo 4200 Gen9 server. The reference architecture features three HPE Apollo 4200 Gen9 servers. (See Appendix C for the BOM for alternate components for storage nodes.)

Table A-3. BOM for a single HPE Apollo 4200 Gen9 server

Qty	Part Number	Description
1	808027-B21	HPE Apollo 4200 Gen9 24LFF CTO Svr
1	830736-L21	HPE Apollo 4200 Gen9 E5-2660v4 FIO Kit
1	830736-B21	HPE Apollo 4200 Gen9 E5-2660v4 Kit
8	836220-B21	HPE 16GB 2Rx4 PC4-2400T-R Kit
1	806563-B21	HPE Apollo 4200 Gen9 LFF Rear HDD Cage Kit
28	797265-B21	HPE 4TB 6G SATA 7.2k 3.5in MDL LP HDD
1	813546-B21	HPE SAS Controller Mode for Rear Storage
1	764285-B21	HPE IB FDR/EN 40Gb 2P 544_FLR-QSFP Adapter
2	720479-B21	HPE 800W FS Plat Hot Plug Power Supply Kit
1	806565-B21	HPE Apollo 4200 Gen9 IM Card Kit
1	788028-B21	HPE 120GB RI Solid State M.2 Kit
1	806562-B21	HPE Apollo 4200 Gen9 Redundant Fan Kit
1	822731-B21	HPE 2U Shelf-Mount Adjustable Rail Kit
2	JG327A	HPE X240 40G QSFP+ QSFP+ 3m DAC Cable
2	AF595A	HPE 3.0M, Blue, CAT6 STP, Cable Data

Networking

Table A-4 provides a BOM for two ToR switches and one iLO switch, as featured in the reference architecture.

Table A-4. BOM for two HPE FlexFabric 5930 switches (ToR) and one HPE FlexFabric 5900 switch (HPE iLO)

Qty	Part Number	Description
2	JG726A	HPE FF 5930-32QSFP+ Switch
4	JG553A	HPE X712 Bck(pwr)-Frt(prt) HV Fan Tray
4	JC680A	HPE A58x0AF 650W AC Power Supply
1	JG510A	HPE 5900AF-48G-4XG-2QSFP+ Switch
2	JC680A	HPE A58x0AF 650W AC Power Supply
2	JC682A	HPE 58x0AF Bck(pwr)-Frt(ports) Fan Tray
2	JG329A	HPE X240 QSFP+ 4x10G SFP+ 1m DAC Cable
4	JG326A	HPE X240 40G QSFP+ QSFP+ 1m DAC Cable

Other hardware

Important

Quantities listed in Table A-5 are based on the reference architecture with three switches, 12 compute nodes, and three storage nodes.

Table A-5. BOM for a single rack with four PDUs

Qty	Part Number	Description
1	BW904A	HPE 42U 600x1075mm Enterprise Shock Rack
1	BW946A	HPE 42U Location Discovery Kit
1	BW930A	HPE Air Flow Optimization Kit
1	TK817A	HPE CS Rack Side Panel 1075mm Kit
1	TK816A	HPE CS Rack Light Kit
1	TK815A	HPE CS Rack Door Branding Kit
1	BW891A	HPE Rack Grounding Kit
4	AF520A	HPE Intelligent Mod PDU 24a Na/Jpn Core
6	AF547A	HPE 5xC13 Intlgnt PDU Ext Bars G2 Kit
2	C7536A	HPE Ethernet 14ft CAT5e RJ45 M/M Cable

Recommended service components

Table A-6 provides a BOM for three recommended service components for Factory Express Build, TS Consulting and HPE WDO system.

Table A-6. Recommended service components

Qty	Part Number	Description
--	HA454A1	HPE Factory Express Level 4 Service (recommended)
1	H8E04A1	HPE Hadoop Custom Consulting Service (recommended)
1	P6L57A	HPE Big Data Reference Architecture

Software options

Important

Quantities listed in Table A-7 may vary. Quantities below are based on a rack with three Management/Head nodes, 12 HPE ProLiant XL170r compute nodes and three HPE Apollo 4200 storage nodes.

Table A-7. BOM for software options

Qty	Part Number	Description
18	E6U59ABE	HPE iLO Adv incl 1yr TS U E-LTU
18	QL803BAE	HPE Insight CMU 1yr 24x7 Flex E-LTU
18	G3J29AAE	RHEL Svr 2 Sckt/2 Gst 1yr 9x5 E-LTU
3	C9A82AAE	HPE Secure Encryption per Server Entitlement

Hortonworks software

Important

Table A-8 provides the BOM for the Hortonworks license and support. One Hortonworks license covers a single HPE Apollo 2000 chassis of compute nodes.

For the Moonshot compute node option, one license covers up to 15 HPE ProLiant m710p server cartridges. Therefore, three of these licenses will cover a fully populated Moonshot 1500 chassis. While HPE is a certified reseller of Hortonworks software subscriptions, all application support (level-one through level-three) is provided by Hortonworks.

Table A-8. BOM for Hortonworks software

Qty	Part Number	Description
--	F5Z52A	Hortonworks Data Platform Enterprise 4 Nodes or 50TB Raw Storage 1 year 24x7 Support LTU

Appendix B: Alternate compute node components

This appendix provides BOMs for alternate processors, memory, and disk drives for the HPE ProLiant XL170r servers used as compute nodes, and also includes the BOM for the optional HPE Moonshot cartridge nodes.

Table B-1. BOM Alternate processors – HPE Apollo 2000 – HPE ProLiant XL170r

Qty	Part Number	Description
1	850306-L21	HPE XL1x0r Gen9 E5-2650v4 (12C,2.2 GHz) FIO Kit
1	850306-B21	HPE XL1x0r Gen9 E5-2650v4 Kit
1	850300-L21	HPE XL1x0r Gen9 E5-2640v4 (10C, 2.4 GHz) FIO Kit
1	850300-B21	HPE XL1x0r Gen9 E5-2640v4 Kit
1	850290-L21	HPE XL1x0r Gen9 E5-2620v4 (8C, 2.1 GHz) FIO Kit
1	850290-B21	HPE XL1x0r Gen9 E5-2620v4 Kit
1	793028-L21	HPE XL1x0r Gen9 E5-2680v3 FIO Kit (12C, 2.5 GHz)
1	793028-B21	HPE XL1x0r Gen9 E5-2680v3 Kit
1	793024-L21	HPE XL1x0r Gen9 E5-2660v3 FIO Kit (10C, 2.6 GHz)
1	793024-B21	HPE XL1x0r Gen9 E5-2660v3 Kit
1	793020-L21	HPE XL1x0r Gen9 E5-2640v3 FIO Kit (8C, 2.6 GHz)
1	793020-B21	HPE XL1x0r Gen9 E5-2640v3 Kit

Table B-2. Alternate memory – HPE Apollo 2000 – HPE ProLiant XL170r

Qty per node	Part Number	Description
8/16	805351-B21	HPE 32GB 2Rx4 PC4-2400T-R Kit
8/16	728629-B21	HPE 32GB 2Rx4 PC4-2133P-R Kit
8/16	726719-B21	HPE 16GB 2Rx4 PC4-2133P-R Kit
16	759934-B21	HPE 8GB 2Rx8 PC4-2133P-R Kit

Table B-3. Alternate disk drives – HPE Apollo 2000 – HPE ProLiant XL170r

Qty per Node	Part Number	Description
2/4/6	804625-B21	HPE 800GB 6G SATA MU-2 SFF SC SSD
2/4/6	817011-B21	HPE 1.92TB 6G SATA MU-3 SFF SC SSD
2/4/6	757339-B21	HPE 1.6TB 6G SATA VE 2.5in SC EV SSD
1	798190-B21	HPE XL1x0r Gen9 NGFF Riser w/ 2x64G Drive (Optional for Operating System)

Table B-4. BOM for a single HPE Moonshot chassis with 45 HPE ProLiant m710p server cartridges

Qty	Part Number	Description
1	755371-B21	HPE Moonshot 1500 Chassis
4	684532-B21	HPE 1500W Ht Plg Pwr Supply Kit
2	704654-B21	HPE Moonshot-45XGc Switch Kit
2	704652-B21	HPE Moonshot 4QSFP Uplink Kit
45	808915-B21	HPE ProLiant m710p Server Cartridge
45	827245-B21	HPE 960GB M.2 22110 PCI-E-PLP SSD
1	681254-B21	HPE 4.3U Rail Kit
1	681260-B21	HPE 0.66U Spacer Blank Kit
6	JG327A	HPE X240 40G QSFP+ QSFP+ 3m DAC Cable
1	JG326A	HPE X240 40G QSFP+ QSFP+ 1m DAC Cable
3	AF595A	HPE 3.0M, Blue, CAT6 STP, Cable Data

Appendix C: Alternate storage node components

This appendix provides BOMs for alternate processors, memory, and disk drives for the HPE Apollo 4200 servers used as storage nodes.

Table C-1. BOM for alternate processors – HPE Apollo 4200

Qty	Part Number	Description
1	830728-L21	HPE Apollo 4200 Gen9 E5-2640v4 (10C, 2.4GHz) FIO Kit
1	830728-B21	HPE Apollo 4200 Gen9 E5-2640v4 Kit
1	830734-L21	HPE Apollo 4200 Gen9 E5-2650v4 (12C, 2.2GHz) FIO Kit
1	830734-B21	HPE Apollo 4200 Gen9 E5-2650v4 Kit
1	821791-L21	HPE Apollo 4200 Gen9 E5-2697v3 FIO Kit (14C, 2.6GHz)
1	821791-B21	HPE Apollo 4200 Gen9 E5-2697v3 Kit
1	803311-L21	HPE Apollo 4200 Gen9 E5-2660v3 FIO Kit (10C 2.6 GHz)
1	803311-B21	HPE Apollo 4200 Gen9 E5-2660v3 Kit
1	803314-L21	HPE Apollo 4200 Gen9 E5-2680v3 FIO Kit (12C, 2.5 GHz)
1	803314-B21	HPE Apollo 4200 Gen9 E5-2680v3 Kit
1	803308-L21	HPE Apollo 4200 Gen9 E5-2640v3 FIO Kit (8C, 2.6 GHz)
1	803308-B21	HPE Apollo 4200 Gen9 E5-2640v3 Kit

Table C-2. Alternate memory – HPE Apollo 4200

Qty per node	Part Number	Description
8/16	805351-B21	HPE 32GB 2Rx4 PC4-2400T-R Kit
8/16	728629-B21	HPE 32GB 2Rx4 PC4-2133P-R Kit
8/16	726717-B21	HPE 4GB 1Rx8 PC4-2133P-R Kit
8/16	726719-B21	HPE 16GB 2Rx4 PC4-2133P-R Kit
8/16	759934-B21	HPE 8GB 2Rx8 PC4-2133P-R Kit

Table C-3. Alternate disk drives – HPE Apollo 4200

Qty per Node	Part Number	Description
Up to 28	797269-B21	HPE 6TB 6G SATA 7.2K 3.5in LP MDL HDD
Up to 28	797271-B21	HPE 3TB 6G SATA 7.2k 3.5in MDL LP HDD
Up to 28	805334-B21	HPE 8TB 6G SATA 7.2k 3.5in MDL LP HDD

Appendix D: HPE value added services and support

In order to help you jump-start your Hadoop solution development, HPE offers a range of big data services, which are outlined in this appendix.

Factory Express Services

Factory-integration services are available for customers seeking a streamlined deployment experience. With the purchase of Factory Express services, your Hadoop cluster will arrive racked and cabled, with software installed and configured per an agreed-upon custom statement of work, for the easiest deployment possible. You should contact HPE Technical Services for more information and for assistance with a quote.

Technical Services Consulting – Reference Architecture Implementation Service for Hadoop (Hortonworks)

With HPE Reference Architecture Implementation Service for Hadoop, HPE can install, configure, deploy, and test a Hadoop cluster that is based on HPE WDO system. Experienced consultants implement all the details of the original Hadoop design: naming, hardware, networking, software, administration, backup, disaster recovery, and operating procedures. Where options exist, or the best choice is not clear, HPE works with you to configure the environment to meet your goals and needs. HPE also conducts an acceptance test to validate that the system is operating to your satisfaction.

Technical Services Consulting – Big Data Services

HPE Big Data Services can help you reshape your IT infrastructure to corral increasing volumes of data – from e-mails, social media, and website downloads – and convert them into beneficial information. These services encompass strategy, design, implementation, protection, and compliance. Delivery is in the following three steps:

1. **Architecture strategy:** HPE defines the functionalities and capabilities needed to align your IT with your big data initiatives. Through transformation workshops and roadmap services, you'll learn to capture, consolidate, manage and protect business-aligned information, including structured, semi-structured, and unstructured data.
2. **System infrastructure:** HPE designs and implements a high-performance, integrated platform to support a strategic architecture for big data. Choose from design and implementation services, reference architecture implementations, and integration services. Your flexible, scalable infrastructure will support big data variety, consolidation, analysis, share, and search on HPE platforms.
3. **Data protection:** Ensure the availability, security, and compliance of your big data systems. HPE can help you safeguard your data and achieve regulatory compliance and lifecycle protection across your big data landscape, while also enhancing your approach to backup and business continuity.

For additional information, visit hpe.com/us/en/services/consulting/big-data.html

HPE Support options

HPE offers a variety of support levels to meet your needs. More information is provided below.

HPE Support Plus 24

HPE can provide integrated onsite hardware/software support services, available 24x7x365, including access to HPE technical resources, four-hour response onsite hardware support and software updates.

HPE Proactive Care

HPE Proactive Care provides all of the benefits of proactive monitoring and reporting, along with rapid reactive support through HPE's expert reactive support specialists. You can customize your reactive support level by selecting either six-hour call-to-repair or 24x7 with four-hour onsite response.

HPE Proactive Care helps prevent problems, resolve problems faster, and improve productivity. Through analysis, reports, and update recommendations, you are able to identify and address IT problems before they can cause performance issues or outages.

HPE Proactive Care with the HPE Personalized Support Option

Adding the Personalized Support Option for HPE Proactive Care is highly recommended. This option builds on the benefits of HPE Proactive Care Service, providing you an assigned Account Support Manager who knows your environment and can deliver support planning, regular reviews, and technical and operational advice specific to your environment.

HPE Proactive Select

To address your ongoing/changing needs, HPE recommends adding Proactive Select credits to provide tailored support options from a wide menu of services that can help you optimize the capacity, performance, and management of your environment. These credits may also be used for assistance in implementing solution updates. As your needs change over time, you have the flexibility to choose the services best suited to address your current challenges.

HPE Datacenter Care

HPE Datacenter Care provides a more personalized, customized approach for large, complex environments, providing a single solution for reactive, proactive, and multi-vendor support needs. You may also choose the Defective Media Retention (DMR) option.

Other offerings

HPE highly recommends HPE Education Services (customer training and education) and additional Technical Services, as well as in-depth installation or implementation services when needed. HPE Analytics & Data Management services provide a range of Business Intelligence (BI) modernization services and include advisory and platform services to implement and manage Hadoop solutions.

More information

For additional information, visit:

- HPE Education Services: http://h10076.www1.hpe.com/ww/en/training/portfolio/bigdata.html
- HPE Technology Consulting Services: hpe.com/us/en/services/consulting/big-data.html
- HPE Services: hpe.com/services

Resources and additional links

Hortonworks: hortonworks.com

Hortonworks partner site: hortonworks.com/partner/hpe

Hortonworks HDP 2.4: http://docs.hortonworks.com/HDPDocuments/HDP2/HDP-2.4.0/bk_Sys_Admin_Guides/content/index.html

HPE Solutions for Apache Hadoop: hpe.com/us/en/solutions/big-data.html

HPE Insight Cluster Management Utility (Insight CMU): hpe.com/info/cmu

HPE FlexFabric 5930 switch series:
hpe.com/us/en/product-catalog/networking/networking-switches/pip.hpe-flexfabric-5930-32qsfpplus-switch.6373316.html

HPE ProLiant servers: hpe.com/info/proliant

HPE Apollo systems: hpe.com/info/apollo

QuickSpecs for HPE Apollo 2000 system: http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=c04542552

QuickSpecs for HPE ProLiant XL170r Gen9 server: http://h20195.www2.hpe.com/V2/GetDocument.aspx?docname=c04545616

HPE Moonshot system: hpe.com/info/moonshot

HPE Software: hpe.com/software

HPE Networking: hpe.com/networking

HPE Integrated Lights-Out (HPE iLO): hpe.com/info/ilo

HPE Product Bulletin (QuickSpecs): hpe.com/info/qs

HPE Services: hpe.com/services

HPE Support and Drivers: hpe.com/support

To help us improve our documents, please provide feedback at hpe.com/contact/feedback.

About Hortonworks

Hortonworks develops, distributes and supports the only 100% open source Apache Hadoop data platform. Our team comprises the largest contingent of builders and architects within the Hadoop ecosystem who represent and lead the broader enterprise requirements within these communities. The Hortonworks Data Platform provides an open platform that deeply integrates with existing IT investments and upon which enterprises can build and deploy Hadoop-based applications. Hortonworks has deep relationships with the key strategic data center partners that enable our customers to unlock the broadest opportunities from Hadoop. For more information, visit hortonworks.com

Sign up for updates

4AA5-6136ENW, May 2018, Rev. 7

Hewlett Packard Enterprise