Dell | Apache Hadoop Solution

Dell | Cloudera Solution Deployment Guide v2.0

A Dell Deployment Guide

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Overview

Summary

The Deployment Guide for the Dell™ | Cloudera™ Hadoop™ Solution describes the steps to install the solution on a predefined hardware and network configuration as specified in the "Dell | Cloudera Solution Reference Architecture v2.0" document. It covers the steps required to prepare hardware platforms for the deployment of Cloudera Manager or Cloudera Hadoop (CDH). For deployment of Cloudera Manager, use the *Dell | Cloudera Apache Hadoop Solution User Guide*.

Abbreviations

Abbreviation	Definition
BMC	Baseboard management controller
CDH	Cloudera Distribution for Hadoop
DMBS	Database management system
EDW	Enterprise data warehouse
EoR	End-of-row switch/router
HDFS	Hadoop File System
IPMI	Intelligent Platform Management Interface
NIC	Network interface card
LOM	Local area Network on Motherboard
OS	Operating system
ToR	Top-of-rack switch/router

Table 1: Dell | Cloudera Hadoop Solution Software Locations

Daemon	Primary Location	Secondary Location
JobTracker	Master Name Node	
TaskTracker	HA Filer Node	
NameNode	Master Name Node	Secondary Name Node
Operating System Provisioning	Admin Node	
Chef	Admin Node	
Yum Repositories	Admin Node	
Cloudera Management Suite	Edge Node(x)	
Zookeeper	Slave Node(x)	
HMaster	Master Name Node	
RegionServer	Slave Node(x)	
Crowbar Admin	Admin Node	

Table 2: Dell | Cloudera Solution Support Matrix

RA Version	OS Version	Hadoop Version	Available Support
2.0	Red Hat Enterprise Linux 6.2	Cloudera Manager 3.7	Dell Hardware support Cloudera Hadoop support Red Hat Linux support
2.0	CentOS 6.2	Cloudera Distribution including Apache Hadoop Cloudera Enterprise	Dell Hardware support

High-level Network Architecture

Network Overview

The Dell | Cloudera solution implements at a minimum three distinct, separate VLANs:

- **Hadoop Cluster Production LAN** —connects the compute node NICs into the fabric used for sharing data and distributing work tasks among compute nodes
- **Hadoop Cluster Management LAN**—connects all the iDRAC/BMCs in the cluster nodes
- **Hadoop Cluster Edge LAN**—connects the cluster to the outside world

All servers in a Hadoop cluster are tied together using TCP/IP networks. These networks form a data interconnect across which individual servers pass data back and forth, return query results, and load/unload data. These networks are also used for management.

The Admin Node manages all the cluster nodes. It assigns the other nodes IP addresses; PXE boots them, configures them, and provides them the necessary software for their roles. To provide these services, the Admin Node runs Crowbar, Chef, DHCP, TFTP, NTP, and other services, and this must be the only DHCP server visible to the compute and storage nodes. Details follow:

- **DHCP server**—assigns and manages IPs for the compute and storage nodes
- **NTP server** (Network Time Protocol server)—makes sure all nodes are keeping the same clock
- **TFTP server**—PXE boots compute and storage nodes with a Linux kernel; the TFTP server services any PXE boot request it receives with its default options.
- **DNS server**—manages the name resolution for the nodes and can be configured to provide external name forwarding.

Due to the nature of the different software used, the network is set up as flat as possible using a dedicated BMC port and bonded LOMs. If Crowbar is used to deploy the cluster, it manages all networks, and comes out

of the box preconfigured to allow the initial configuration to come up quickly by predefining the admin, public, and BMC networks.

The Crowbar network configuration can be customized to better map to site-specific networking needs and conventions. These changes include adding additional vLANs, changing vLAN mappings, and teaming NICs.

Dell | Cloudera Solution Hardware Configuration

Table 3: Edge Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device PERC H710 LUN 0
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
	C-State	Disable
PERC H710 BIOS	RAID	Enabled
	LUN 0	Disk 0-5 RAID 10
	Boot Order	LUN 0

Table 4: Master and Standby Name Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device PERC H710 LUN 0
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
	C-State	Disable
PERC H710 BIOS	RAID	Enabled
	LUN 0	Disk 0-5 RAID 10
	Boot Order	LUN 0

Table 5: Slave Node Hardware Configuration

Component	Setting	Parameter
BIOS	Boot Order	LOM 1 PXE Internal Boot Device
	PXE Boot LOM 1	Enable
	PXE Boot LOM 2	Disable
	C-State	Disable
PERC H710 Controller BIOS	RAID	Enabled
	LUN0 LUN1 . LUN23	Disk0 RAID0 Disk1 RAID0 . Disk23 RAID0
	Boot Order	Disk 0 Disk 1

Table 6: Network Top of Rack Configuration

Setting	Parameter	Ports
Spanning-Tree	Enable	ALL
Port-Fast	Enable	ALL
Flow-Control	Enable	ALL

Dell | Cloudera Solution Network Configuration

Table 7: IP Scheme

A	B	C	D	Use
First POD				
172	16	0/22		Rack Number
			1-42	Slave Node[XX] bond0, by Rack Unit
		4/22		Rack Number (1xx)
			200-242	Slave Node [XX] BMC, by Rack Unit
172	16	3	1-19	Master Node[XX]
		3	20-30	Slave Node[XX]
		3	41-50	Edge Node[XX]
172	16	7	1-19	Master Node[XX]
		7	20-30	Master Node[XX]
		7	41-50	Edge Node[XX]

- All Master Nodes will be addressed in the first Pod only. Additional Pods will not contain additional Master Nodes.
- Master Nodes running Zookeeper-related services will be distributed among Pods for larger deployments. Please consult with your Dell sales team when designing your solution.

Dell | Cloudera Solution Network Interconnects

The network cabling within the Dell | Cloudera Solution is described in the following table:

Table 8: Dell | Cloudera Solution Network Cabling

Component	NICs to Switch Port				
	LOM1	*LOM2*	LOM3	LOM4	BMC
Admin Node					
Name Nodes				N/A	
Filer Node					
Data Node(s)			N/A	N/A	
Edge Node(s)					

Legend	
	Cluster Production LAN
	Cluster Management LAN
	Cluster Edge LAN

Rack Configuration

Configuring the Force 10 Network Solution

Single Rack Configuration

Using 1G nodes the Dell Force10 recommends using S60 ToR switches in the rack. Each rack could have a maximum of 20 servers. Each rack has two ToR S60 switches that are stacked and this stack connects to the two S4810 switches. The S60 stack offers a single switch view to the servers. Each Slave Node has 2 data 1GbE NIC ports. It forms a LAG of 2 ports with 1 port on each switch in the stack, thereby offering high availability and redundancy.

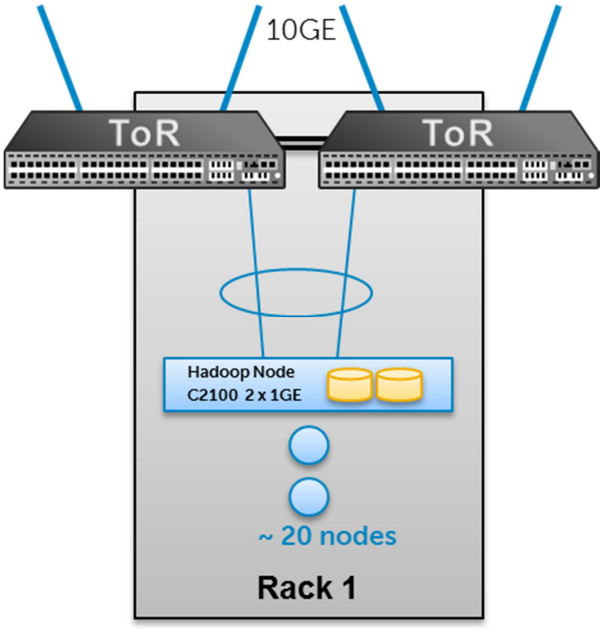

Figure 1: Single Rack View

Use the switch configuration guide (manual) for the initial configurations. Examples of these are: enabling the interfaces ('no shut'), configuration of IPs on the management interfaces, enabling ssh (telnet is enabled by default), and authorization details.

Stacking S60s

The following configuration helps stack the two s60s together within the rack. This configuration assumes the stacking module in both s60s is in module 0 (IO-facing side) and the 10G uplink module is in slot 1 (power supply and fan side).

Connect port 49 on module 0 (IO side from the left) to port 49 of the second S60 and similarly connect port 50 on both switches. The stack is automatically detected and formed without a user configuration. Using the CLI command 'show system brief' verify that the stacking module is detected by the S60.

When you are adding units to a stack, you can either:

- Allow FTOS to automatically assign the new unit a position in the stack, or
- Manually determine each unit's position in the stack by configuring each unit to correspond with the stack before connecting it.

Three configurable system variables affect how a new unit joins a stack: priority, stack number, and provision.

After the new unit loads, it synchronizes its running and startup configurations with the stack.

```
TOR-Rack1#stack-unit renumber
TOR-Rack1(conf)# stack-unit priority <higher priority determines primary role>
```

After connecting the switches together run the following command to check the status of the stack.

```
TOR-Rack1#show system brief

Stack MAC : 00:01:e8:d5:ef:81

-- Stack Info --

Unit    UnitType   Status   ReqTyp   CurTyp   Version   Ports
------------------------------------------------------------------------
0       Standby    online    S60     S60     8.3.3.7    52
1       Management online    S60     S60     8.3.3.7    52
```

Uplinking the S60s

The following configuration helps create configurations for the uplink of the stack. This configuration assumes the 10G uplink module is in slot 1 (power supply and fan side). The uplink ports are going to be numbered 0/51,0/52 and 1/51,1/52 respectively. All four 10G interfaces would part of a single LAG or port-channel. The following illustrates that.

```
# Put the user ports in the switchport mode
TOR-Rack1(config)# interface range gigabitethernet 0/1 - 47
TOR-Rack1(config-if-range-gi-0/1-47)# no shutdown
TOR-Rack1(config-if-range-gi-0/1-47)#switchport
TOR-Rack1(config-if-range-gi-0/1-47)#end

# Repeat the same for ports on the second unit
TOR-Rack1(config)# interface range gigabitethernet 1/1 - 47
<snip>…

# Create port-channel of the 4 10G ports.The example below shows it for 1 port.
# Repeat the same configs for other 10G ports 0/52,1/51 and 1/52.

TOR-Rack1(conf)#interface Gigabitethernet 0/51
TOR-Rack1(conf-if-gi-3/15)#no shutdown
TOR-Rack1(conf-if-gi-3/15)#port-channel-protocol lacp
TOR-Rack1(conf-if-gi-3/15-lacp)#port-channel 1 mode active

# Change the defaults on the port-channel that gets created automatically
# From the above commands.

TOR-Rack1(conf)#interface port-channel 1
TOR-Rack1(conf-if-po-1)#no shutdown
TOR-Rack1(conf-if-po-1)#switchport

# Add the Data ports 0 through 30 and the port-channel 1 to vlan 100

TOR-Rack1#config
TOR-Rack1 (conf)#int vlan 100
TOR-Rack1 (conf-if-vlan)#tagged po 1
TOR-Rack1 (conf-if-vlan)#untagged gi 0/0-21
TOR-Rack1 (conf-if-vlan)#untagged gi 1/0-21
TOR-Rack1 (conf-if-vlan)#show conf
!
interface Vlan 100
no ip address
tagged Port-channel 1
untagged gi 0/0-21
untagged gi 1/0-21
```

```
TOR-Rack1#config
TOR-Rack1 (conf)#int vlan 300
TOR-Rack1 (conf-if-vlan)#tagged po 1
TOR-Rack1 (conf-if-vlan)#untagged gi 0/29-41
TOR-Rack1 (conf-if-vlan)#show conf
!
interface Vlan 300
no ip address
tagged Port-channel 1
untagged gi 0/29-41
```

So far the configuration is sufficient to link the nodes to the ToR switches, Stacking the ToR and uplinks from ToR.

The uplink port-channel links are all active and forward traffic to the aggregate switches. Each *flow*, a unique combination of a source and adestination, gets hashed internally and gets load-balanced across the port-channel.

Server Gateway

The nodes in a rack have a single virtual IP as their gateway for routing purposes. The VRRP protocol runs on the aggregation S4810s. It does not need any configuration on the ToR. The VRRP master owns the virtual IP and does the routing but the combination of VLT and VRRP makes it certain that backup also routes or switches the traffic if it has a path in its forwarding table. This is an active-active brained capability where routing is independent of which switch owns the virtual IP.

Management Network

The BMC ports from all the nodes connect to the same ToR switches as the data ports. However the management VLAN is separate from the data VLAN. Ports 0 to 30 on the ToR are reserved for data connections and 31 to 48 are configured for management network. This is achieved by creating a separate VLAN on the the ToR and adding all the management ports as part of that VLAN.

```
TOR-Rack1(conf)#int vlan 300
TOR-Rack1(conf-if-vlan)#tagged po 1
TOR-Rack1(conf-if-vlan)#untagged gi 0/31-47
TOR-Rack1(conf-if-vlan)#untagged gi 1/31-47
```

Multi-Rack Configuration

Once the single rack is deployed from the server and network perspective we can take a look at the multi-rack view and then move on to configure the aggregation switches that connect the racks together. This section shows the S4810 aggregating the clusters together to enable inter-rack traffic as well as the management network. As we saw there are two separate VLANs for data and management; all port-channels on S4810 and ToR are tagged in these two VLANs.

The following table shows the network inventory details in a full cluster of 3 racks.

Table 9: 60 Node Network

Total Racks	3 (15-20 nodes per rack)
Top of Rack Switch	6 S60 (2 per rack)
Pod-interconnect Switch	2 S4810
Server	2RU R720/R720xd
Over-subscription at ToR	1:1
Modules in Each ToR	1x 12-2port Stacking, 1x 10G -2 port uplink

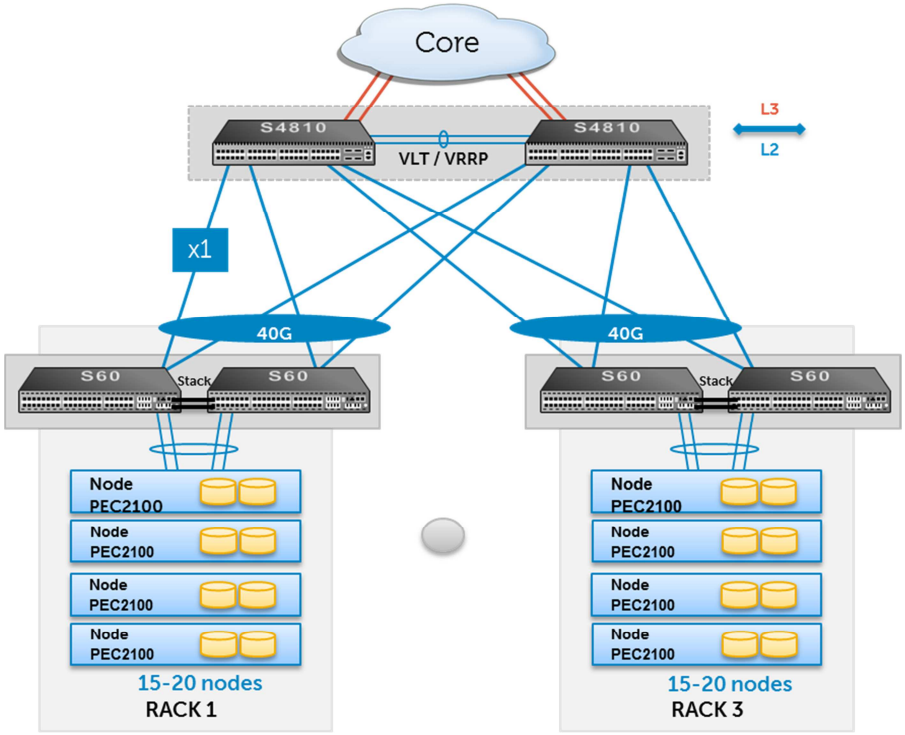

Figure 2: Multi-Rack View

VRRP on S4810

The following configuration shows a sample VRRP configuration on the S4810s. This configuration is created on the VLAN interfaces of the S4810. Since there is only a single VLAN 100 in the cluster of three racks, a single instance of this configuration is needed.

```
Force10_VLTpeer1(conf)#int vlan 100
Force10_VLTpeer1(conf-if-gi-1/1)#vrrp-group 100
Force10_VLTpeer1(conf-if-gi-1/1-vrid-111)#virtual-address 10.10.10.1
#One or more these virtual IP addresses can be configured, which can be used
#as the unique gateway per rack or cluster.
Force10_VLTpeer1(conf-if-gi-1/1-vrid-111)# priority 125
# Priority from 1-255 can be used to determine which switch owns the VIP and
becomes the VRRP master.

# Repeat the same configuration on the second VLT peer, except for a different
priority.
```

VLT on S4810

The second part of configuration involves the pod-interconnect switches that run VLT with each other.

Figure 3: S4810 VLT interconnect

With the following steps we will configure VLT on the pair of S4810s that interconnect the racks. To configure virtual link trunking, you must create a VLT domain, configure a backup link and interconnect trunk, and connect the peer switches in a VLT domain to an attached access device (switch or server). But first RSTP should be configured, as a best practice, on the S4810 as well as the S60s.

```
Force10_VLTpeer1(conf)#protocol spanning-tree rstp
Force10_VLTpeer1(conf-rstp)#no disable
Force10_VLTpeer1(conf-rstp)#bridge-priority 4096

#Repeat the same on VLTPeer2 with a different bridge priority to make it the
root.

Force10_VLTpeer2(conf-rstp)#bridge-priority 0
```

The next figure shows a sample configuration on VLT. The VLT works over a primary link and a backup link. Therefore this configuration consists of configuring the IP connectivity details of each switch. In addition each port-channel to the layer-2 switch, S60 stack in this case, gets a configuration specifying the port-channel that acts as the ICL link. In absence of a direct path to the destination the ICL link would carry the traffic to the peer. The backup link is only for heartbeat status of the peer; no data traffic flows over it.

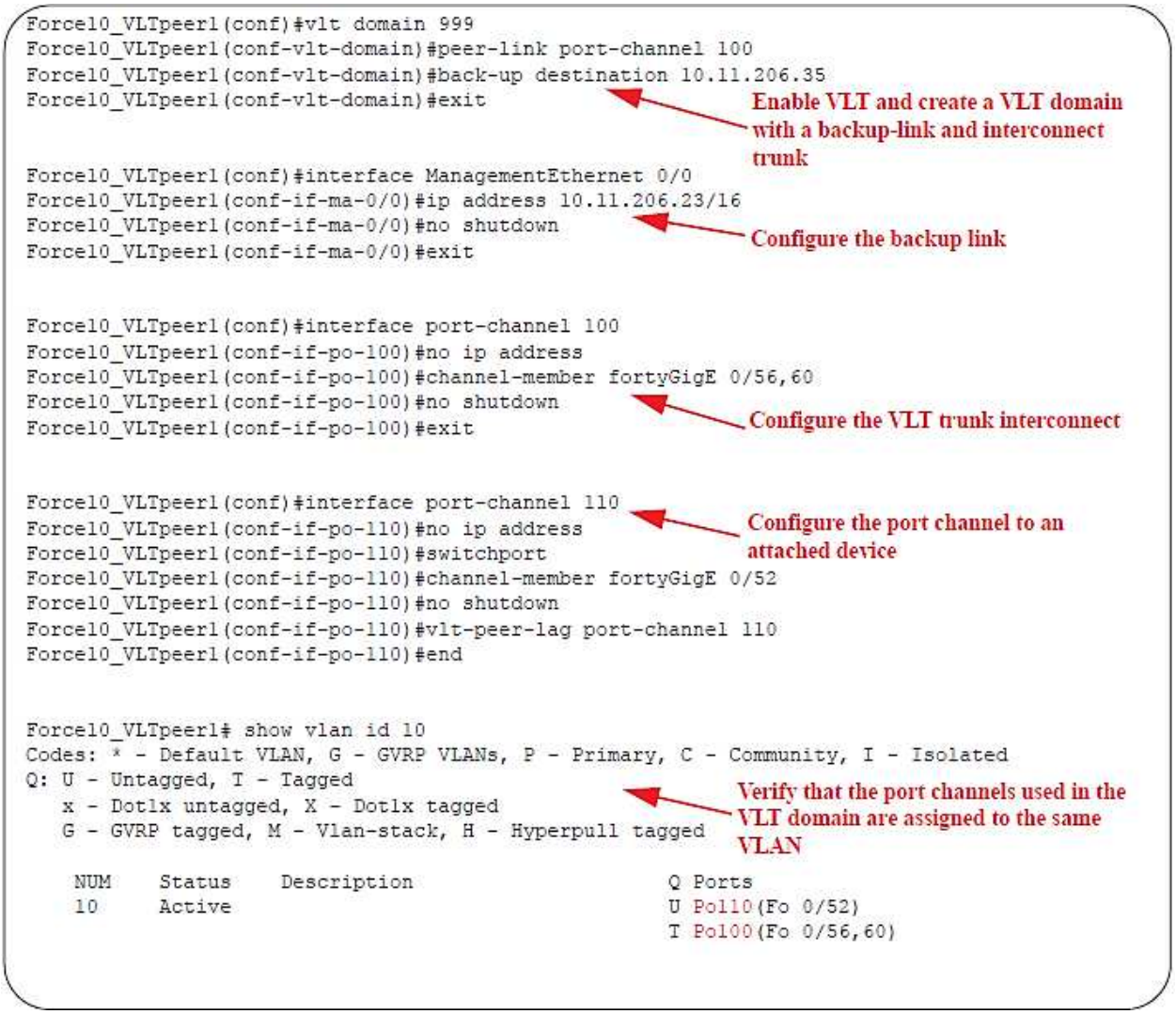

Figure 4: VLT Configuration on peer1

Configuring the Force10 S60 switch

1. Use a serial communication hyperterminal (e.g. Minicom) to configure the switch. The following are the instructions for using Mincom:
   # minicom –s
   - Serial port settings: /dev/ttyUSB0, 9600,n,8,1
   - Modem and Dialing:
     - Delete init, dial and hangup lines
   - Save settings as dfl

   # minicom

force10> enable

configure

interface range gigabitethernet 0/0 - 46

no ip address

switchport

spanning-tree rstp edge-port

no shutdown

exit

interface range gigabiethernet 1/0 – 46

no ip address

switchport

spanning-tree rstp edge-port

no shutdown

exit

Int vlan 100

description Production

no ip address

untagged gigbitethernet 0/0-30

untagged gigabitethernet 1/0-30

no shutdown

exit

int vlan 300

description BMC

no ip address

untagged GigabitEthernet 0/31-39

no shutdown

exit

Dell | Cloudera Solution Deployment Process Overview

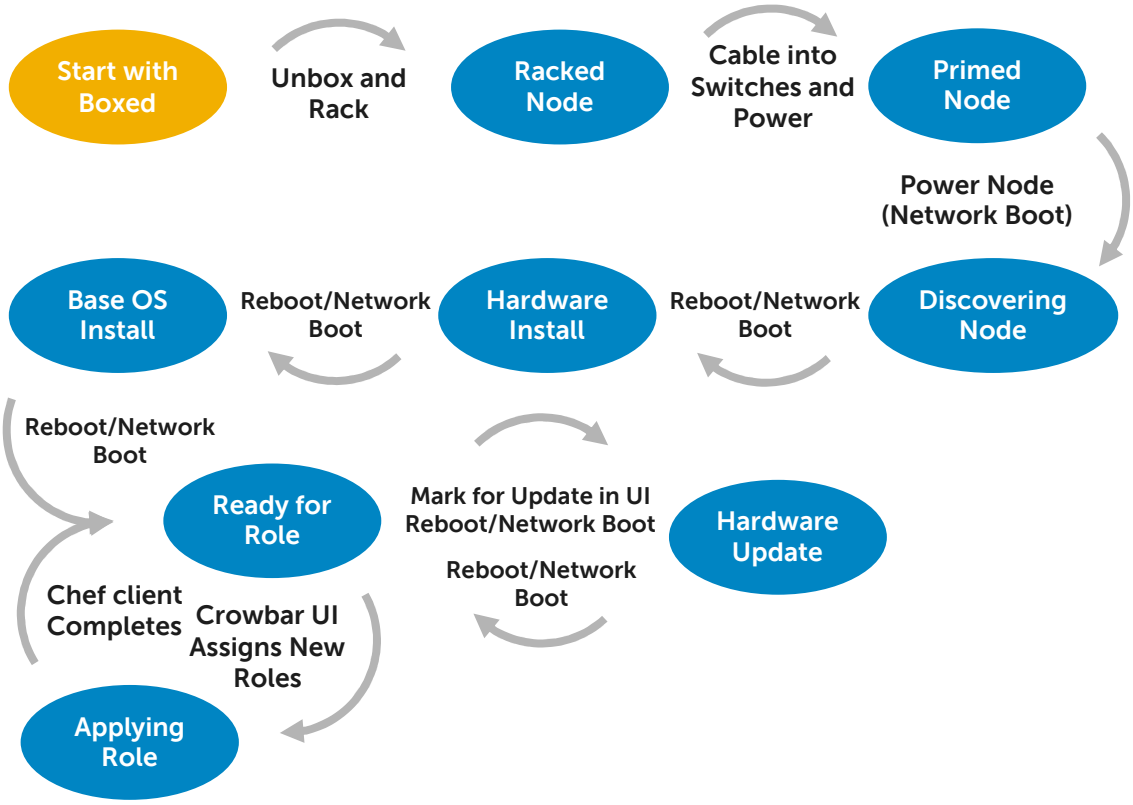

Figure 5: Dell | Cloudera Solution Deployment Process Overview

Dell | Cloudera Solution Automated Software Installation

Admin Node Installation

To use Crowbar, you must first install an Admin Node. Installing the Admin Node requires installing the base operating system, optionally customizing the Crowbar configuration, and installing Crowbar itself.

The following is required to bootstrap the Admin Node by PXE booting:

1. The user is required to make the physical arrangements to connect a VM to the network in such a way that the Admin Node (when there is one) can PXE boot from it. A network crossover cable may be required.
2. All BIOS and RAID configuration for the Crowbar Admin Node will need to be completed manually, prior to the installation from the Crowbar ISO image.
3. A VM image provides an initial TFTP/DHCP/Boot server. A VMware Player (free download from VMware) is required to execute it.

In preparation for running VMware Player on a particular machine, please make sure that:

- Support for Intel VT is enabled in BIOS
- There is only one NIC enabled (turn off the wireless NIC if there is one and leave only the wired NIC enabled)

Procedure:

1. Install VMware Player on a laptop.
2. Open the VMware machine configuration distributed with Crowbar. (e.g Crowbar_Installer-1.3.tgz)
3. Edit the machine settings (see figures that follow) and ensure that:
    - The CD/DVD drive is mounting the Crowbar ISO distribution
    - The Network adapter is configured to use Bridged Networking
4. Obtain the ISO of Crowbar (from your Dell Account Representative) and configure VMware Player to mount it as a DVD in the VM.
5. Plug the crossover cable into eth0 of the server and your network port on the laptop.
6. Start the WMware Player and configure it to use the network port.
7. Power on the Admin Node, and ensure that:
    - It is set up to boot from the hard disk for subsequent boots
    - The first boot is a network boot

The machine will obtain its image from the VMware Player VM and start the installation process.

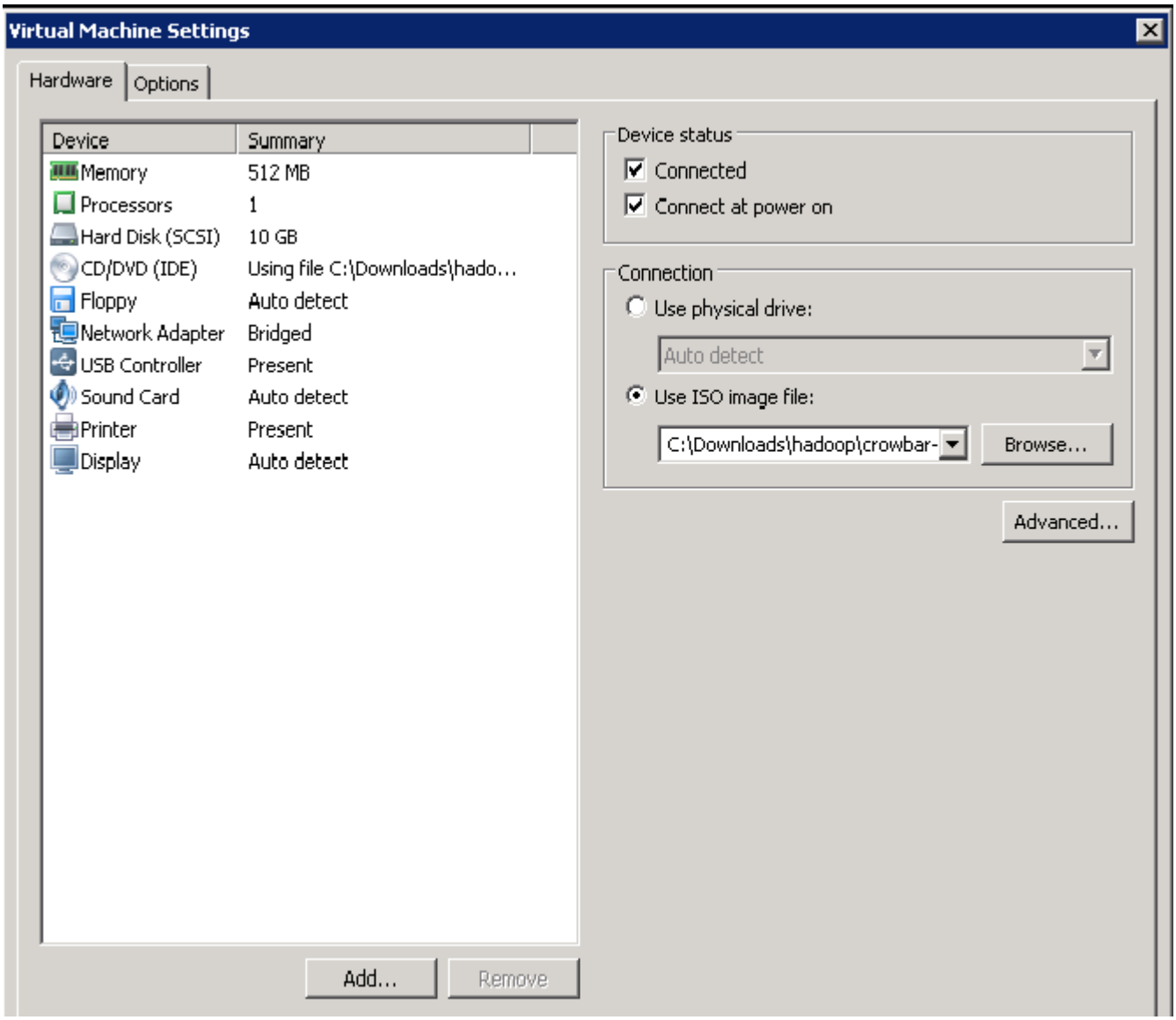

Figure 6: VMware Player Configuration for DVD

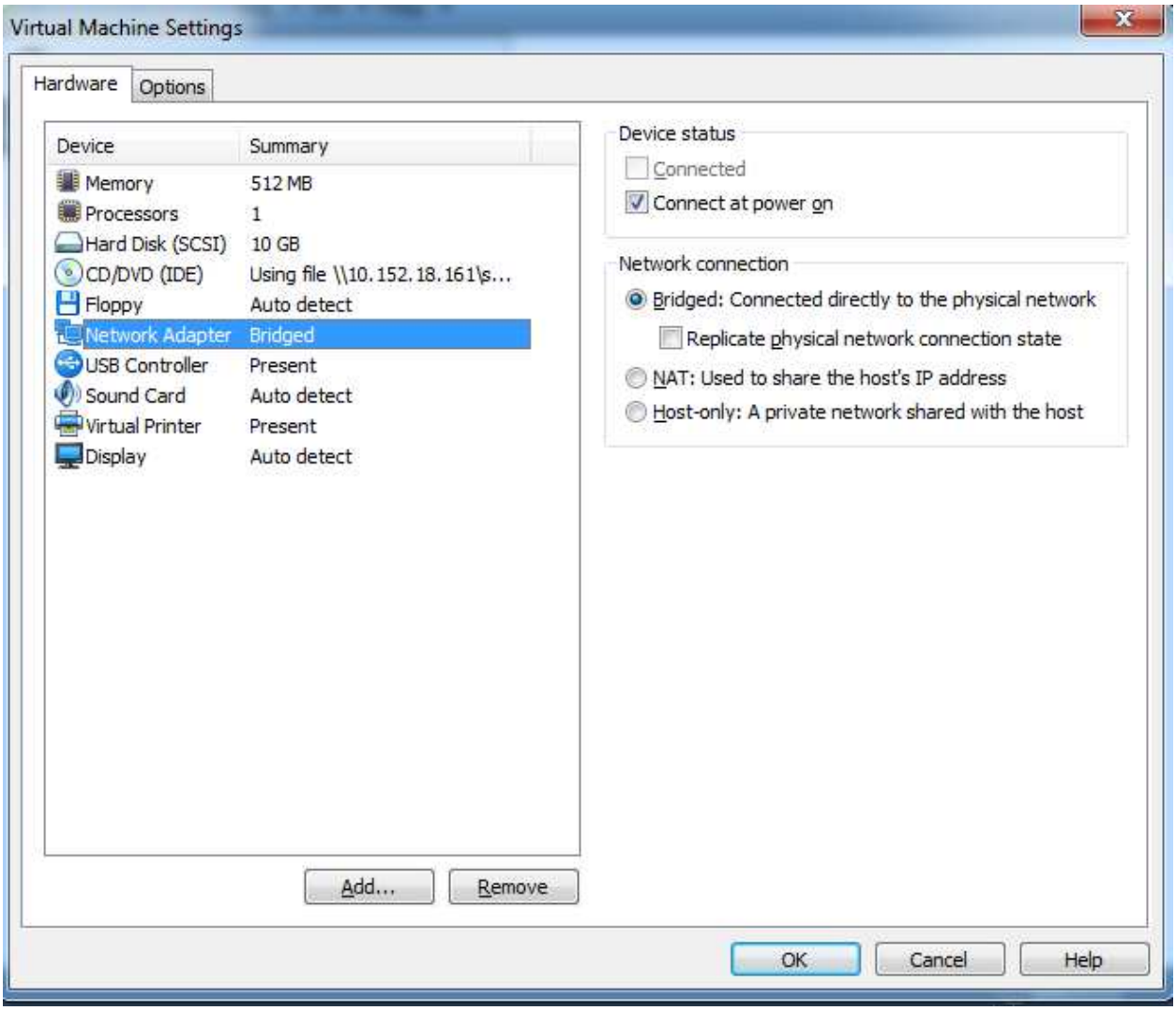

Figure 7: VMware Player Configuration for Network Adapter

Installing Crowbar

The image installed in the previous steps includes all the required Crowbar components. Before actually installing Crowbar, there is the opportunity to customize the installation to fit into the deployment environment. The steps below assume default configuration.

To install Crowbar:

- Log onto the Admin Node. The default username is root, password: crowbar.
- If necessary edit the file /opt/dell/chef/data_bags/crowbar/ bc-template-network.json to customize the network information for the deployment. A detailed description of how to edit the network json can be found in the next section.
- **The networks cannot be reconfigured once the system is installed**.
- cd /tftpboot/redhat_dvd/extra
- ./install admin.your.cluster.fqdn
  where admin.your.cluster.fqdn is the fully qualified domain name of the admin machine, for example admin.dell.com

This will install Crowbar.

Note: Because there are many dependencies some transient errors might be visible on the console. This is expected

Editing the Network JSON

The JSON is located at /opt/dell/chef/data_bags/crowbar/bc-template-network.json. The file should be edited before the install command is run to create your Admin Node.

The information you will need:

1. VLAN ID for each of the VLAN's used by crowbar.
2. Network subnet for each VLAN
3. Netmask for each VLAN
4. Gateway for the public network and possibly the BMC ranges

The following is a section from the JSON:

Example network (admin)

```
"admin": {
"vlan": 100,
"use_vlan": false,
"add_bridge": false,
"subnet": "192.168.124.0",
"netmask": "255.255.255.0",
"broadcast": "192.168.124.255",
"ranges": {
"admin"
{ "start": "192.168.124.10", "end": "192.168.124.11" },
"dhcp"
{ "start": "192.168.124.21", "end": "192.168.124.80" },
"host"
{ "start": "192.168.124.81", "end": "192.168.124.160" },
"switch"
{ "start": "192.168.124.241", "end": "192.168.124.250" }
}
}
```

Note: The biggest error for many users is putting a comma at the end of the last statement or value within a JSON.

Other networks are specified in the same manner. The default file contains a public network, an admin network, a BMC VLAN and a BMC network.

Network configuration options are:

Name	Default	Description
mode	single	A string value of either single, dual or team. This specifies the default network interface construction model.
teaming	map	A map of values specific to teaming
networks	map	A map of networks that this barclamp should manage

The system provides the following default networks:

Name	Usage	Notes
admin	Private network for node to node communication	A router, if wanted, is external to the system; this network must be owned by the Crowbar system to run DHCP on it.
bmc	Private network for BMC communication	This can be made the same as the admin network by using the ranges to limit what IP goes where; a router, if wanted, is external to the system.
bmc_vlan	Private network for admin nodes on the BMC network	This must be the same as the BMC network and have the same VLAN. This will be used to generate a VLAN tagged interface on the Admin Nodes that can access the BMC LAN.
public	Public network for crowbar and other components	A router, if wanted, is external to the system.

Each network has the following parameters:

Name	Default	Description
vlan	Integer	This is the VLAN to use on the switch and interfaces for this network.
use_vlan	true	A value of "true" indicates that the VLAN should be applied to the interface. A value of "false" assumes that the node will receive untagged traffic for this network.
add_bridge	false	This indicates whether the network should have a bridge built on top of it. The bridge will be br.
subnet	IP Address	The subnet for this network
netmask	Netmask	The netmask for this network
router	IP Address	The default router for this network
broadcast	IP Address	The default broadcast address for this network
ranges	map	Contains a map of strings to start and stop values for the network; this allows for sub-ranges with the network for specific uses, e.g. dhcp, admin, BMC, hosts.

The range map has a string key that is the name and map defining the range.

Name	Type	Description
start	IP Address	First address in the range, inclusive
end	IP Address	Last address in the range, inclusive

JSON Configuration by Section

1. Attributes

    a. Startup delay set to 30 seconds to allow spanning tree to settle down
    b. Mode — This sets whether to build up single NICs or bonded NICs; options are single, teamed
    c. teaming — Sets the mode of the teaming: in this case 6

2. Interface Maps — To set up the interface map for figuring out and defining eth0, eth1, eth2 on particular hardware models.

    a. Pattern — Pattern of the hardware model/type
    b. Bus order — Order to start enumerating; enumeration begins at eth0, eth1, eth2, eth3. If a bus is not defined, it will be enumerated at the end in the order in which it was presented.
    c. Conduit Maps — Determine what network gets mapped to which interface based on what role; pattern this matched to the attribute variable, the NIC type and role

        i. mode (single, team)
        ii. NIC type 1g or 10g
        iii. role — mastername, crowbar-config-default

3. Conduit or Network Lists to use:

    a. conduit name (prod, mgmt, admin)

        i. if_list — what interfaces to use
        ii. team_mode — how to team when needed

    b. repeat for other conduits

4. Networks — Define the network, IP ranges, available scopes, etc.

    d. Name of Network (admin, mgmt, prod)
    e. Conduit — Name of conduit used in step 4
    f. vLan — VLAN to use
    g. add_bridge — Whether to use bridging protocol or VLAN tagging
    h. subnet — The IP subnet
    i. netmask — Subnet netmask
    j. broadcast — Broadcast IP
    k. ranges — The IP ranges in the subnet broken down by usage; admin, host, dhcp, are all possible examples.

Special Note: The following Networks are required: B, bmc_lan and admin. Admin must have ranges set to the dhcp, admin, and host.

JSON Example

```
"admin": {
"conduit": "prod",
"vlan": 100,
"use_vlan": false,
"add_bridge": false,
"subnet": "172.16.2.0",
"netmask": "255.255.254.0",
"broadcast": "172.16.3.255",
"ranges": {
"host": { "start": "172.16.2.21", "end": "172.16.2.254" },
"dhcp": { "start": "172.16.3.1", "end": "172.16.3.240" },
"admin" : {"start": "172.16.2.18", "end": "172.16.2.20" }
```

Below is trimmed down version of the json

```
{
"id": "bc-template-network",
"description": "Instantiates network interfaces on the crowbar managed systems. Also
manages the address pool",
"attributes": {
"network": {
"start_up_delay": 30,
"mode": "team",
"teaming": {
"mode": 6
},
"interface_map": [
{
"pattern": "PowerEdge R610",
"bus_order": [
"/0/100/1",
"/0/100/3"
]
{
"pattern": "product",
"bus_order": [
"/0/100/1",
"/0/100/2"
]
}
],
"conduit_map": [
{
"pattern": "team/.*/crowbar-config-default",
"conduit_list": {
"prod": {
"if_list": [ "1g1", "1g2", "1g3" ],
"team_mode": 6
},
"mgmt": {
```

```
"if_list": [ "1g4" ]
}
}
},
{
"pattern": ".*/.*/.*",
"conduit_list": {
"prod": {
"if_list": [ "1g1" ]
},
"admin": {
"if_list": [ "1g1" ]
},
"external": {
"if_list": [ "1g1" ]
}
}
}
],
"networks": {
"bmc": {
"conduit": "bmc",
"vlan": 300,
"use_vlan": true,
"add_bridge": true,
"subnet": "172.16.0.0",
"netmask": "255.255.255.0",
"broadcast": "172.16.0.255",
"router": "172.16.0.1",
"ranges": {
"router": { "start": "172.16.0.1", "end": "172.16.0.10" },
"host": { "start": "172.16.0.50", "end": "172.16.2.254" }
}
},
"storage": {
"conduit": "intf1",
"vlan": 200,
"use_vlan": true,
"add_bridge": false,
"subnet": "192.168.125.0",
"netmask": "255.255.255.0",
"broadcast": "192.168.125.255",
"ranges": {
"host": { "start": "192.168.125.10", "end": "192.168.125.239" }
}
},
"bmc_vlan": {
"conduit": "mgmt",
"vlan": 300,
"use_vlan": true,
"add_bridge": true,
"subnet": "172.16.0.0",
"netmask": "255.255.255.0",
"broadcast": "172.16.0.255",
"router": "172.16.0.1",
"ranges": {
"host": { "start": "172.16.0.21", "end": "172.16.2.50" }
}
},
"admin": {
"conduit": "prod",
"vlan": 100,
"use_vlan": false,
"add_bridge": false,
"subnet": "172.16.2.0",
"netmask": "255.255.254.0",
```

```
"broadcast": "172.16.3.255",
"ranges": {
"host": { "start": "172.16.2.21", "end": "172.16.2.254" },
"dhcp": { "start": "172.16.3.1", "end": "172.16.3.240" },
"admin" : {"start": "172.16.2.18", "end": "172.16.2.20" }
}
}
}
}
},
"deployment": {
"network": {
"crowbar-revision": 0,
"elements": {},
"element_order": [
[ "network" ]
],
"config": {
"environment": "network-base-config",
"mode": "full",
"transitions": true,
"transition_list": [ "discovered" ]
}
}
}
}
```

How to Add a Public IP to a Node

From a command prompt on the Admin Node, you can execute the following:

- crowbar network allocate_ip default <machine name> public host

To validate address, you can run:

- crowbar machines show <machine name>

You should then have your system set up with a public IP. From the admin section above, you could do "admin switch" instead of "public host", and the IP allocated will be from the switch range of the admin network.

To edit the DNS or NTP time server, please modify the DNS and NTP Barclamps.

Configuring the Network for External Connectivity

1. Choose the JSON that matches your environment best:

   ```
   a. /opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json
   b. /tftpboot/redhat_dvd/extra/config/network-hadoop-noteam-admin.json
   c. /tftpboot/redhat_dvd/extra/config/network-hadoop-team-admin.json
   ```

2. Backup the old file:

   ```
   opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json
   ```

3. Copy the file you want to use, to:

   ```
   opt/dell/barclamps/network/chef/data_bags/crowbar/bc-network-template.json
   ```
   (this will overwrite the existing one.)

4. Using your favorite editor edit that file:

a. Change the section of the public IP ranges to match your network

```
"public": {
       "conduit"
       "public",
       "vlan"
       500,
       "use_vlan"
       false,
       "add_bridge"
       false,
       "subnet"
       "192.168.1.0",
       "netmask"
       "255.255.255.0",
       "broadcast"
       "192.168.1.255",
       "router"
       "192.168.1.1",
       "ranges" {
              "host" {
                     "start": "192.168.1.10",
                     "end": "192.168.1.25"
                     }
       }
},
```

b. Change the netmask,broadcast, router and ranges

c. Verify the file and save it.

5. Run the Install command

6. If you need to deploy the external network to the Admin Node continue or go to step 12

7. Before starting any Slave Nodes

8. Connect to the Admin Node at 172.16.2.18 (unless you change the IP ranges of the Admin net) via ssh. A table of services and default credentials can be found in the next section.

9. Execute from the root command prompt:

```
a. crowbar network allocate_ip default "admin node FQDN" public host
b. "chef-client"
c. /etc/init.d/chef-server-webui restart
```

10. From the Crowbar GUI modify the DNS and NTP barclamps to use the external server and apply them

11. From a command line you can do an ntpq -p

```
a. [root@admin config]# ntpq -p
b. remote refid st t when poll reach delay offset jitter
c. ==============================================================================
d. *172.26.1.50 132.163.4.103 2 u 40 64 377 0.287 -0.433 0.169
```

12. When the "*" shows up the NTP server is now synced with your server and your server is now ready for the slaves to come online

Verifying Master Node State

When the Admin Node finishes installation, it will remain at a shell prompt. At this point, all Crowbar services have started. Consult the table below to access these services.

Service	URL	Credentials
SSH	root@192.168.124.10	crowbar
Crowbar UI	http://192.168.124.10:3000/	crowbar / crowbar
Nagios	http://192.168.124.10/nagios3	nagiosadmin / password
Ganglia	http://192.168.124.10/ganglia	nagiosadmin / password
Chef UI	http://192.168.124.10:4040/	admin / password

Logging into the UI requires acceptance of the EULA. It can be found on the dashboard under EULA, and in in Appendix A of this document.

Slave Node Installation

Nodes other than the Admin Nodes are installed when they are first powered up. A sequence boot phase is executed (rebooting multiple times) which culminates in deploying a minimal OS image installed on the local drive. Part of the basic installation includes "hooking" the nodes into the infrastructure services—NTP, DNS, Nagios, and Ganglia.

Once known to Crowbar, the node can be managed; it can be powered on and off, rebooted, and components can be installed on it.

Functional components are installed on nodes by including them in one or more barclamps' proposals. For example, when a proposal names a Master name node , the relevant packages, services, and configuration are deployed to that node when the proposal is committed.

The next section describes details for installing the different components.

Installing components

The general workflow to install any component is the same:

1. Obtain a default proposal which includes the parameters for the component and a mapping of nodes to the roles they are assigned.
2. Edit the proposal to match the desired configuration.
3. Upload the proposal to Crowbar.
4. Commit the proposal.

All these activities are achieved by using the Crowbar command line tool or the Web-based UI. The sections that follow use the command line tool: /opt/dell/bin/crowbar.

In the sections that follow, this tool is referred to as "Crowbar."

General Installation Process

Set CROWBAR Parameter

Before any of the following command lines may be used, the CROWBAR_KEY environment variable must be primed with the ssh key so they may connect.

On the admin node, use this command: `export CROWBAR_KEY=crowbar:crowbar`
On all other nodes, use this: `export CROWBAR_KEY=$(`cat /etc/crowbar.install.key`)`

Obtain a proposal

Crowbar can inspect the current known nodes and provide a proposal that best utilizes the available systems for the component being installed. To obtain and inspect this proposed configuration:

```
/opt/dell/bin/crowbar <component> proposal create <name>
/opt/dell/bin/crowbar <area> proposal show <name> > <local_file_name>
```

Where:

- `<area>` — The area for which the proposal is made; e.g. Clouderamanager, Pig.
- `<name>` — The name assigned to this proposal. This name should be unique for the component; i.e. if two hadoop clusters are being installed, the proposals for each should have unique names.
- `<local_file_name>` — Any file name into which the proposal will be written

Update a proposal

The local file created above can be inspected and modified. The most common changes are:

- Change default passwords and other barclamp parameters (e.g. swift replica count).
- Change assignment of machines to roles.

Once edits are completed, Crowbar must be updated. To update Crowbar with a modified proposal, execute:

```
/opt/dell/bin/crowbar <area> proposal –-file=<local_file_name> edit <name>
```

Where the parameters in this command are exactly as mentioned above, Crowbar will validate the proposal for syntax and basic sanity rules as part of this process.

Committing a proposal

Once the proposal content is satisfactory, the barclamp instance can be activated. To achieve that, execute:

```
/opt/dell/bin/crowbar <area> proposal commit <name>
```

This might take a few moments, as Crowbar is deploying the required software to the machines mentioned in the proposal.

Modifying an active configuration

When committing a proposal that was previously committed, Crowbar compares the new configuration to the currently active state and applies the deltas.

To force Crowbar to reapply a proposal, the active state needs to be deleted:

```
/opt/dell/bin/crowbar <area> delete <name>
```

Installing Cloudera Manager

Cloudera Manager is installed as part of the Apache Hadoop barclamp. To install it, refer to the Dell | Cloudera Apache Hadoop Solution User Guide.

Hadoop Ecosystem Components

Some ecosystem components are installed via Cloudera Manager (HUE, Oozie,Hbase and Zookeeper). The *Dell | Cloudera Apache Hadoop Solution User Guide* shows how these services are installed or added to a Hadoop cluster. Pig, Sqoop and Hive have to be installed via Crowbar barclamps.

Table 10: Hadoop Ecosystem Components

Component	Master Node	Slave Node	Edge Node	Utilize From	Administer From
Pig	X	X	X	Edge Node	Edge Node
Hive		X	X	Edge Node	Edge Node
Sqoop			X	Edge Node	Edge Node

Note: "X" designates server location for the appropriate package binaries to be installed.

Dell | Cloudera Solution Software Configuration

Dell | Cloudera Solution Configuration Parameters Recommended Values

The following properties can be found in the Services → Configuration menu in the Cloudera Manager administrator's console. These values were validated by Cloudera and are considered to be optimal for installations that follow the Dell | Cloudera Solution Reference Architecture.

Table 11: hdfs

Property	Description	Value
dfs.block.size	Lower value offers parallelism	134217728 (128Mb)
dfs.name.dir	Determines where on the local file system the NameNode should store the name table(fsimage). For redundancy, enter a comma-delimited list of directories to replicate the name table in all of the directories. Typical values are /data/N/dfs/nn for N=1..3. For maximum resiliency, one of the directories should be on an NFS mount.	/dfs/nn
dfs.datanode.handler.count	Number of handlers dedicated to serve data block requests in Hadoop Slave Nodes	16 (Start 2 x CORE_COUNT in each SlaveNode)
dfs.namenode.handler.count	More Master Node server threads to handle RPCs from large number of Slave Nodes	Start with 10, increase large clusters (Higher count will drive higher CPU, RAM, and network utilization)
dfs.namenode.du.reserved	The amount of space on each storage volume that HDFS should not use, in bytes	10M
dfs.replication	Data replication factor; default is 3	3 (default)

fs.trash.interval	Time interval between HDFS space reclaiming	1440 (minutes)
dfs.permissions		true (default)
dfs.datanode.handler.count		8
dfs.data.dir	Comma-delimited list of directories on the local file system where the DataNode stores HDFS block data. Typical values are /data/N/dfs/dn for N = 1, 2, 3... These directories should be mounted using the noatime option and the disks should be configured using JBOD. RAID is not recommended.	/dfs/dn

Table 12: mapred

Property	Description	Value
mapred.child.java.opts	Larger heap-size for child JVMs of maps/reduces.	-Xmx1024M
mapred.job.tracker	Hostname or IP address and port of the JobTracker	namenode:8021
mapred.job.tracker.handler.count	More JobTracker server threads to handle RPCs from large number of TaskTrackers	Start with 32, increase large clusters (Higher count will drive higher CPU, RAM and Network utilization)
mapred.reduce.tasks	The number of Reduce tasks per job	Set to a prime close to the number of available hosts
mapred.local.dir	List of directories on the local filesystem where a TaskTracker stores intermediate data files. To spread disk I/O, enter a comma-separated list of directories on different devices. Directories that do not exist are ignored. Typical values are /data/N/mapred/local for N = 1, 2, 3...	/mapred/local
mapred.tasktracker.map.tasks.maximum	Maximum number of map tasks to run on the node	2 + (2/3) * number of cores per node
mapred.tasktracker.reduce.tasks.maximum	Maximum number of reduce tasks to run per node	2 + (1/3) * number of cores per node
mapred.child.ulimit		2097152
mapred.map.tasks.speculative.execution		FALSE
mapred.reduce.tasks.speculative.execution		FALSE
mapred.job.reuse.jvm.num.tasks		1

Table 13: Default Parameters

Property	Description	Value
SCAN_IPC_CACHE_LIMIT	Number of rows cached in search engine for each scanner next call over the wire. It reduces the network round	100

	trip by 300 times caching 300 rows in each trip.	
LOCAL_JOB_HANDLER_COUNT	Number of parallel queries executed at one go. Query requests above than this limit gets queued up.	30

Table 14: Default Parameters

Property	Description	Value
java.net.preferIPv4Stack		true
JAVA_HOME		
HADOOP_*_OPTS		-Xmx2048m

Table 15: /etc/fstab

Property	Description	Value
File system mount options		data=writeback,nodiratime, noatime

Table 16: hdfs (core-site)

Property	Description	Value
io.file.buffer.size	The size of buffer for use in sequence files. The size of this buffer should probably be a multiple of hardware page size (4096 on Intel x86), and it determines how much data is buffered during read and write operations.	65536 (64Kb)
fs.default.name	The name of the default files system. A URI whose scheme and authority determine the file system implementation.	hdfs://namenode:8020
fs.checkpoint.dir	Comma-separated list of directories on the local file system of the Secondary Master Node where its checkpoint images are stored	TBD
io.sort.factor		80
lo.sort.mb		512

Table 17: /etc/security/limits.conf

Property	Description	Value
mapred – nofile		32768
hdfs – nofile		32768
hbase – nofile		32768

Dell | Cloudera Solution Monitoring and Alerting

Table 18: Components Monitored by Hadoop Monitoring Console

Service Type	Resource	Warning	Critical	Nodes to Monitor	Tool
Disk	HDFS_DISK_[00-10]	60	90	SlaveNode[]	Nagios
SWAP	SWAP	60	90	SlaveNode[]	Nagios
		60	90	Master Node[]	Nagios
		60	90	EdgeNode[]	Nagios
Ping_Node_From_Admin		DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
		DELAY	NO RESPONSE	EdgeNode[]	Nagios
NIC Bonding		DELAY	1 NIC in Bond	SlaveNode[]	Nagios
		DELAY	1 NIC in Bond	Master Node[]	Nagios
		DELAY	1 NIC in Bond	EdgeNode[]	Nagios
DNS_From_Node		DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
		DELAY	NO RESPONSE	EdgeNode[]	Nagios
DNS_About_Node		DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
		DELAY	NO RESPONSE	EdgeNode[]	Nagios
JobTracker_Daemon		DELAY	DAEMON NOT RUNNING	Master Node[]	Nagios
TaskTracker_Daemon		DELAY	DAEMON NOT RUNNING	SlaveNode[]	Nagios
SlaveNode_Daemon		DELAY	DAEMON NOT RUNNING	SlaveNode[]	Nagios
Master Node_Daemon		DELAY	DAEMON NOT RUNNING	Master Node[]	Nagios
SecondaryMaster Node		DELAY	DAEMON NOT RUNNING	Master Node[]	Nagios
SSH		DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
Zombie_Processes		5	10	SlaveNode[]	Nagios
		5	10	Master Node[]	Nagios
		5	10	EdgeNode[]	Nagios
CPU_Load		80	90	SlaveNode[]	Nagios
		80	90	Master Node[]	Nagios
		80	90	EdgeNode[]	Nagios
Zookeeper_Client		DELAY	DAEMON NOT RUNNING	SlaveNode[]	Nagios
Zookeeper_Server		DELAY	DAEMON NOT RUNNING	Master Node[]	Nagios

JobTracker_Submit_Job		DELAY	NO RESPONSE	Master Node[]	Nagios
Chef_Daemon		DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
		DELAY	NO RESPONSE	EdgeNode[]	Nagios
Disk	MAPRED_DIR	60	90	SlaveNode[]	Nagios
		60	90	Master Node[]	Nagios
		60	90	EdgeNode[]	Nagios
Memory_Capacity_Used	System Memory	80	90	SlaveNode[]	Nagios
		80	90	Master Node[]	Nagios
		80	90	EdgeNode[]	Nagios
Disk	HDFS01_Capacity	60	90	Master Node[]	Nagios
CPU_Utilizion				SlaveNode[]	Ganglia
				Master Node[]	Ganglia
				EdgeNode[]	Ganglia
Memory_Utilization				SlaveNode[]	Ganglia
				Master Node[]	Ganglia
				EdgeNode[]	Ganglia
NIG_LAG_Utilization				SlaveNode[]	Ganglia
				Master Node[]	Ganglia
				EdgeNode[]	Ganglia
CPU Temp		As defined by SDR (Sensor Data Record)	As defined by SDR	SlaveNode[]	Nagios
		As defined by SDR	PENDING	Master Node[]	Nagios
		As defined by SDR	As defined by SDR	EdgeNode[]	Nagios
Power Supplies		As defined by SDR	As defined by SDR	Master Node[]	Nagios
		As defined by SDR	As defined by SDR	Edge Node[]	Nagios
Master Node _NFS_Mount		DELAY	MOUNT MISSING	Master Node[]	Nagios
Hbase		DELAY	SELECT FAILED	EdgeNode[]	Nagios
		DELAY	INSERT FAILED	EdgeNode[]	Nagios
Hive		DELAY	SELECT FAILED	EdgeNode[]	Nagios
		DELAY	INSERT FAILED	EdgeNode[]	Nagios
Ping_From_Admin	IPMI Interface	DELAY	NO RESPONSE	SlaveNode[]	Nagios
		DELAY	NO RESPONSE	Master Node[]	Nagios
		DELAY	NO RESPONSE	EdgeNode[]	Nagios

Appendix A: The Dell End User License Agreement

DELL END USER LICENSE AGREEMENT Ver. 1.3
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Les parties ont demandé que cette convention ainsi que tous les documents qui s'y rattachent soient rédigés en anglais.

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20. **No Waiver.** No waiver of breach or failure to exercise any option, right, or privilege under the terms of this EULA on any occasion shall be construed to be a waiver of a subsequent breach or right to exercise any option, right, or privilege.

21. **Force Majeure.** Dell shall not be responsible for any delay or failure in performance of any part of this EULA to the extent that such delay or failure is caused by fire, flood, explosion, war, embargo, government requirement, civil, or military authority, act of God, act or omission of carriers, failure of the Internet or other similar causes beyond its control.

22. **No Assignment.** Except as set forth herein, you may not assign or transfer your interests, rights or obligations under this EULA by written agreement, merger, consolidation, operation of law or otherwise, without the prior written consent of an authorized executive officer of Dell. Any attempt to assign this EULA by you without such prior written consent from Dell shall be null and void.

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One Dell Way, Round Rock, Texas 78682

Last rev. 021812

Supplemental Terms and Conditions:

References

Ghemawat, S. Gobioff, H. and Leung, S.-T. The Google File System. Proceedings of the 19th ACM Symposium on Operating Systems Principles. pp 29--43. Bolton Landing, NY, USA. 2003. © 2003, ACM.

Borthakur, Dhruba. The Hadoop Distributed File System: Architecture and Design**. © 2007, The Apache Software Foundation.**

Hadoop DFS User Guide**. © 2007, The Apache Software Foundation.**

HDFS: Permissions User and Administrator Guide**. © 2007, The Apache Software Foundation.**

HDFS API Javadoc **© 2008, The Apache Software Foundation.**

HDFS source code

Pig – http://developer.yahoo.com/hadoop/tutorial/pigtutorial.html

Pig – http://pig.apache.org/docs/r0.6.0/setup.html

Zookeeper – http://zookeeper.apache.org/doc/r3.2.2/zookeeperOver.html

Zookeeper – https://ccp.cloudera.com/display/CDHDOC/ZooKeeper+Installation

Zookeeper – http://archive.cloudera.com/cdh/3/zookeeper/zookeeperAdmin.html#sc_zkMulitServerSetup

Nagios – http://www.nagios.org/

Ganglia – http://ganglia.sourceforge.net/

Additional information can be obtained at www.dell.com/hadoop or by e-mailing hadoop@dell.com.

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