LAB GUIDE

a Hewlett Packard Enterprise company

Deploying OSPFv2 Features

!!IMPORTANT!!

THIS GUIDE ASSUMES THAT THE AOS-CX OVA HAS BEEN INSTALLED AND WORKS IN GNS3 OR EVE-NG. PLEASE REFER TO GNS3/EVE-NG INITIAL SETUP LABS IF REQUIRED.

AT THIS TIME, EVE-NG DOES NOT SUPPORT EXPORTING/IMPORTING AOS-CX STARTUP-CONFIG. THE LAB USER SHOULD COPY/PASTE THE AOS-CX NODE CONFIGURATION FROM THE LAB GUIDE AS DESCRIBED IN THE LAB GUIDE IF REQUIRED.

TABLE OF CONTENTS

Lab Objective

The OSPF (Open Shortest Path Protocol) is one of the most popular routing protocols for IP Networks. It uses a link state routing (LSR) algorithm which is performed by every switch router mode in the network.

This lab should be considered as a basic OSPFv2 lab as an introduction to the configuration and operation of OSPF on Aruba CX switches.

This workshop introduces OSPF features relating to the use of virtual links and options for using encrypted password between ospf neighbors for authentication. Other configurations involve the use of the 'passive interface ' command and the 'default-information originate' command.

The list of features presented in this lab is a very small snapshot of the ospf features available within the CX software and a comprehensive view of all OSPF features available can be found in the documentation guides from the aruba support portal :

AOS-CX 10.07 IP Routing Guide 8400

AOS-CX 10.07 IP Routing Guide 8400 (HTML)

AOS-CX 10.07 IP Routing Guide 6300,6400,8320,8325,8360 Series

AOS-CX 10.07 IP Routing Guide 6300,6400,8320,8325,8360 Series (HTML)

At the end of the lab tasks, familiarity should be obtained on how to deploy the key features of virtual links and authentication commands, the default originate command and familiarity with additional ospf 'show and status' commands.

Lab Overview

This Lab is based on CX simulator release 10.07.

The lab comprises of configuring multiple areas within a single autonomous system. A virtual link is required to connect 'Area2 'to the backbone as Area 2 is directly connected to Area 1. On completion of the area link configuration , routing exchanges between ospf neighbors are propagated to and from area 2.

The second part of the lab comprises of encrypted authentication between ospf neighbors using configurations with a key-chain' and directly on the interface of each switch. The passive interface ' command and the 'default-information originate' command.

are introduced as separate task

Finally, series of useful 'show' commands are presented as a final task.

Lab Network Layout

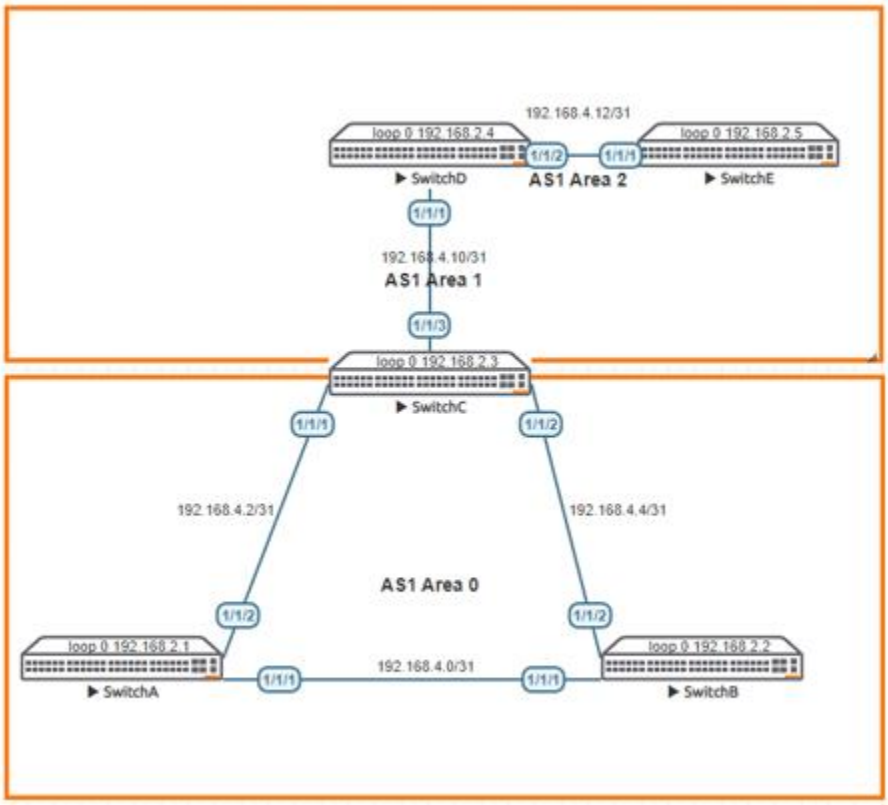


Figure 1 OSPF Area and IP addressing

Lab Tasks

Task 1 Lab Set-up

For this lab refer to Figure 1 for topology and IP address details.

- Start all the devices, including host and client
- Open each switch console and log in with user “admin” and no password
- Change all hostnames as shown in the topology:

```
hostname …
```

- On all devices, bring up required ports:

```
int 1/1/1-1/1/3
  no shutdown
```

- Validate LLDP neighbors appear as expected on each switch

```
show lldp neighbor
```

Task 2–Configure loopback 0 interfaces on Switch A-E

Configure loopback addressing on loopback 0 on each switch

Loopback0 ip addressing

Switch A ip address 192.168.2.1
Switch B ip address 192.168.2.2
Switch C ip address 192.168.2.3
Switch D ip address 192.168.2.4
Switch E ip address 192.168.2.5

Example Switch B

```
SwitchB# conf t

SwitchB(config)# interface loopback 0
SwitchB(config-loopback-if)# ip address 192.168.2.2/32
```

End of Task2

Task 3 - Configure OSPF for Switches A, B, C, D & E

The following tasks will be completed in task3 to configure OSPF on switches A,B, C, D & E

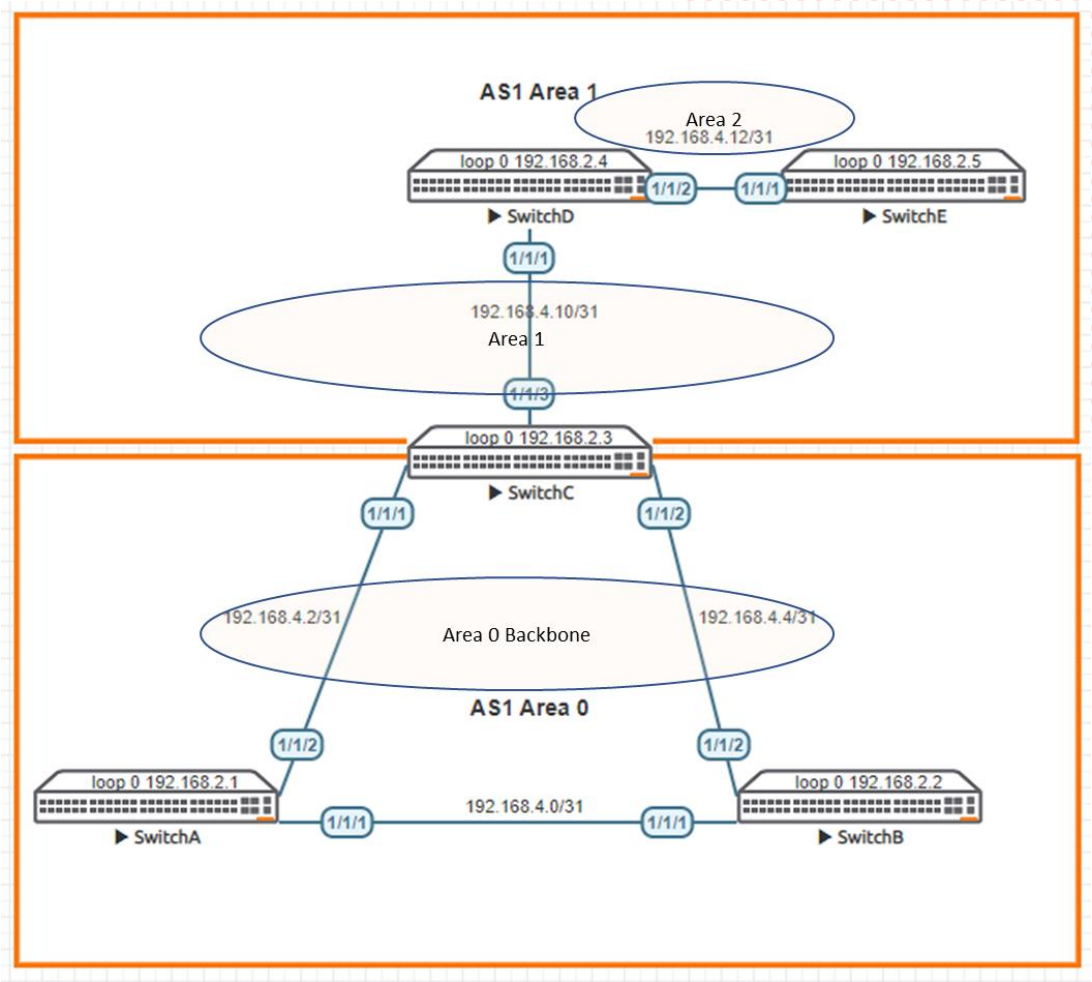
On each switch A, B,C

- Configure a OSPF routing process with appropriate areas and assign a router-id which will be ‘loopback0’
- Configure appropriate switch interfaces with OSPF enabled and ensure connectivity is established
- Ensure neighbor adjacencies are formed between each switch rtr
- Review inter-area and intra-area routes in the ospf routing table
- Review the OSPF Cost of specific routes (Switch A)

Task 3.1 Configure OSPF routing

- Configure OSPF routing on Switch A, B, C ,D & E and assign a router-id with loopback 0
- Configure IP ospf interfaces

At the end of this section , the logical ospf topology will be:-



Configure Switches A to E with their appropriate configurations. OSPF routing area configurations are presented with their full notation but can be abbreviated; as in `area 0.0.0.0` to `area 0` and `area 0.0.0.1` to `area 1`

SwitchA area 0

```
router ospf 1
    router-id 192.168.2.1
    area 0.0.0.0

interface 1/1/1
    ip address 192.168.4.0/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point

interface 1/1/2
    ip address 192.168.4.2/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point

interface loopback 0
    ip ospf 1 area 0.0.0.0
```

SwitchB area 0

```
router ospf 1
    router-id 192.168.2.2
    area 0.0.0.0

interface 1/1/1
    ip address 192.168.4.1/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point

interface 1/1/2
    ip address 192.168.4.4/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point


interface loopback 0
        ip ospf 1 area 0.0.0.0
```

SwitchC Area0 & Area 1 - ABR

```
router ospf 1
    router-id 192.168.2.3
    area 0.0.0.0
    area 0.0.0.1
interface 1/1/1
    ip address 192.168.4.3/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point


interface 1/1/2
    ip address 192.168.4.5/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point

interface 1/1/3
    ip address 192.168.4.10/31
    ip ospf 1 area 0.0.0.1
    ip ospf network point-to-point


interface loopback 0
    ip ospf 1 area 0.0.0.0
```

SwitchD Area 1

```
router ospf 1
    router-id 192.168.2.4
    area 0.0.0.1

interface 1/1/1
    ip address 192.168.4.11/31
    ip ospf 1 area 0.0.0.1
    ip ospf network point-to-point


interface 1/1/2
    ip address 192.168.4.12/31
    ip ospf 1 area 0.0.0.1
```

```
    ip ospf network point-to-point


interface loopback 0
    ip ospf 1 area 0.0.0.1
```

SwitchE Area 2

```
router ospf 1
    router-id 192.168.2.5
    area 0.0.0.1

interface 1/1/1
    ip address 192.168.4.13/31
    ip ospf 1 area 0.0.0.2
    ip ospf network point-to-point


interface loopback 0
    ip ospf 1 area 0.0.0.2
```

Task 3.2 display OSPF routes

Note relating to OSPF areas

OSPF rules state that each non-backbone area cannot learn routes from another non-backbone area (if not forming a direct adjacency neighbor).

Area 2 from Switch E connects directly to Switch D in area 2. Switch D & E exchange routing information (for area 2) as a neighbor adjacency has been formed.

On switch D, show the ip ospf route table with the 'sh ip ospf route' command

```
192.168.2.5/32     (i) area: 0.0.0.2
    via 192.168.4.13 interface 1/1/2, cost 100 distance 110
```

Switch E will only have ospf routes learnt that are resident within area 2 which will be the directly connected transit subnet between switch D & C of 192.168.4.12/31

Host route 192.168.2.5/32 from loopback 0 on switch E is present on Switch D but the route will not be present on Switches A, B, & C as the ospf area topology breaks the ospf topology rules.

To enable our routes to propagate throughout our network including to and from Switch E in Area2, a virtual link 'tunnel' will be configured between Switch D and Switch C. This will be covered in the next section.

End of task 3

Task4 – Creating a Virtual Ospf Link

In this task, a virtual link will be configured traversing area 1 between Switch C and Switch D. This will allow area 2 to virtually connect to area 0 and exchange routing information, even though area 2 does not have a direct connectivity to area 0 through Switch D.

- Virtual links are only valid traversing a full ospf area (stub areas cannot be used.) In this example, a virtual link between Switch C & Switch D will be created across 'area 1'.
- Router-id's must be used for each virtual ink connection.
- A virtual link cannot be created across area 0 (backbone area)

Task 4.1 Virtual links between Switch D and Switch C across area 1

On Switch C, create a virtual link to Switch D ospf router-d 192.168.2.4

```
SwitchC(config)# router ospf 1
SwitchC(config-ospf-1)# area 0.0.0.1 virtual-link 192.168.2.4
```

On Switch D, create a virtual link to Switch C ospf router-id 192.168.2.3

```
SwitchD(config)# router ospf 1
SwitchD(config-ospf-1)# area 0.0.0.1 virtual-link 192.168.2.3
```

On Switches A, B & C run the following command to confirm that Switch D host route is now advertised throughout the network.

```
sh ip ospf route 192.168.2.5/32
```

On switch E, display the ip ospf routes. Switch E should now have a routing table reflecting all routes learnt between areas.

```
SwitchE# sh ip ospf route
Codes: i - Intra-area route, I - Inter-area route
       E1 - External type-1, E2 - External type-2

OSPF Process ID 1 VRF default, Routing Table
--------------------------------------------

Total Number of Routes : 8

192.168.2.1/32     (I)
     via 192.168.4.12 interface 1/1/1, cost 100 distance 110
192.168.2.2/32     (I)
     via 192.168.4.12 interface 1/1/1, cost 300 distance 110
192.168.2.3/32     (I)
     via 192.168.4.12 interface 1/1/1, cost 200 distance 110
192.168.4.0/31     (I)
     via 192.168.4.12 interface 1/1/1, cost 400 distance 110
192.168.4.2/31     (I)
```

```
     via 192.168.4.12 interface 1/1/1, cost 300 distance 110
192.168.4.4/31     (I)
     via 192.168.4.12 interface 1/1/1, cost 300 distance 110
192.168.4.10/31    (I)
     via 192.168.4.12 interface 1/1/1, cost 200 distance 110
192.168.4.12/31    (i) area: 0.0.0.2
     directly attached to interface 1/1/1, cost 100 distance 110
```

From Switch E , ping loopback 0 addresses of Switch A & B, 192.168.2.1 & 192.168.2.2 respectively, to ensure connectivity across the ospf area.

On Switch A or Switch B, run the following command:-

```
SwitchA# sh ip ospf border-routers
VRF : default                          Process : 1
Internal Routing Table
---------------------------------------------------

Codes: i - Intra-area route, I - Inter-area route

           Router-ID   Cost  Type              Area     SPF           Nexthop
     Interface
 i       192.168.2.3    100   ABR           0.0.0.0      26       192.168.4.3
         1/1/2
 i       192.168.2.4    200   ABR           0.0.0.0      26       192.168.4.3
         1/1/2
```

Switch C & Switch D are operating as Area Border routers. Area 0 is extended to switch D, `router-id 192.168.2.4`, to support the connectivity of Area 2 to the backbone Area 0.

End of lab task 4

Task 5 Authentication

OSPF Neighbors can authenticate with each other using an encrypted password. From software release CX 10.07, additional cryptography support is provided in addition to the existing MD5 algorithm. In CX release 10.07, cryptography support is provided for the following authentication/Digests:-

Authentication/Digest Lengths

- MD5 = 16 bytes
- SHA-1 = 20 bytes
- SHA-256 = 32 bytes
- SHA-384 = 48 bytes
- SHA-512 = 64 bytes

When it comes to speed and less security, MD5 maybe the best fit.

If security is the most important factor, select a hash algorithm from the SHA suite, example SHA-256,SHA-384, SHA-512'. SHA-256 seems like a good balance between speed and security.

In the authentication examples, the sha-256 crypto algorithm is used. If using a CX simulator release prior to 10.7, only the MD5 authentication crypto method is available.

Task 5.1 OSPF Authentication – Interface

In this task, will configure authentication between all ospf neighbors and including the virtual link 'tunnel' between Switch C and Switch D.

Switch A – Switch B Authentication

On either Switch A or Switch B, use the '`sho ip ospf interface 1/1/1`' command.

Example output below from Switch A.

```
SwitchA# sh ip ospf interface 1/1/1

Codes: DR - Designated router  BDR - Backup Designated router


Interface 1/1/1 is up, line protocol is up

-----------------------------------------


VRF             : default                       Process             : 1

IP Address      : 192.168.4.0/31                Area                : 0.0.0.0


Status          : up                            Network Type        : Point-to-point
```

```
Hello Interval  : 10  sec                    Dead Interval       : 40  sec
Transit Delay   : 1   sec                    Retransmit Interval : 5   sec
Authentication  : No                         Link Speed          : 1000Mbps
Cost Configured : NA                         Cost Calculated     : 100
State/Type      : Point-to-point             Router Priority     : n/a
DR              : No                         BDR                 : No
Link LSAs       : 0                          Checksum Sum        : 0
BFD             : Disabled
```

Enter the following configuration on **Switch A**

```
SwitchA(config)# interface 1/1/1
SwitchA(config-if)# ip ospf authentication hmac-sha-256
SwitchA(config-if)# ip ospf sha-key 1 sha plaintext aruba
```

Note: at this point the ospf neighbor adjacency will be 'down' between Switch A and Switch B.

```
SwitchA# sh ip ospf neighbors
VRF : default                            Process : 1
================================================

Total Number of Neighbors : 1

Neighbor ID      Priority  State             Nbr Address       Interface
------------------------------------------------------------------------------
192.168.2.3      n/a       FULL              192.168.4.3        1/1/2
```

Repeat the configuration on Switch B

And then run the 'sh ip ospf neighbor' & 'sh ip ospf interface 1/1/1' commands.

```
SwitchA# sh ip ospf neighbors
VRF : default                            Process : 1
================================================

Total Number of Neighbors : 2

Neighbor ID      Priority  State             Nbr Address       Interface
------------------------------------------------------------------------------
```

```
192.168.2.2      n/a       FULL              192.168.4.1       1/1/1

192.168.2.3      n/a       FULL              192.168.4.3       1/1/2
SwitchA# sh ip ospf interface 1/1/1
Codes: DR - Designated router  BDR - Backup Designated router

Interface 1/1/1 is up, line protocol is up
-------------------------------------------

VRF             : default                       Process             : 1
IP Address      : 192.168.4.0/31                Area                : 0.0.0.0

Status          : up                            Network Type        : Point-to-point

Hello Interval  : 10  sec                       Dead Interval       : 40  sec
Transit Delay   : 1   sec                       Retransmit Interval : 5   sec
Authentication  : SHA-256                       Link Speed          : 1000Mbps
Cost Configured : NA                            Cost Calculated     : 100
State/Type      : Point-to-point                Router Priority     : n/a
DR              : No                            BDR                 : No
Link LSAs       : 0                             Checksum Sum        : 0
BFD             : Disabled
```

Task 5.2 Authentication between Switch B & Switch C using the keychain

Using the keychain option is a more flexible way to manage key string passwords whereby a key string password can be changed in a central location on the switch.

Enter the following configuration on **Switch B**

SwitchB(config)# keychain sha256

SwitchB(config-keychain)# key 1

SwitchB(config-keychain-key)# key-string plaintext aruba

SwitchB(config-keychain-key)# cryptographic-algorithm hmac-sha-256

SwitchB(config-keychain-key)# exit

SwitchB(config-keychain)# interface 1/1/2

SwitchB(config-if)# ip ospf authentication keychain

SwitchB(config-if)# ip ospf keychain sha256

Repeat the configuration on Switch C with interface 1/1/2

And then run the 'sh ip ospf neighbor' & 'sh ip ospf interface x/x/x' commands on either Switch B or Switch C.

```
SwitchC# sh ip ospf neighbors
VRF : default                          Process : 1
================================================

Total Number of Neighbors : 3
Neighbor ID      Priority  State             Nbr Address       Interface
-------------------------------------------------------------------------
192.168.2.1      n/a       FULL              192.168.4.2        1/1/1

192.168.2.2      n/a       FULL              192.168.4.4        1/1/2

192.168.2.4      n/a       FULL              192.168.4.11       1/1/3

SwitchC# sh ip ospf interface 1/1/2
Codes: DR - Designated router  BDR - Backup Designated router

Interface 1/1/2 is up, line protocol is up
------------------------------------------
VRF             : default                       Process             : 1
IP Address      : 192.168.4.5/31                Area                : 0.0.0.0

Status          : up                            Network Type        : Point-to-point

Hello Interval  : 10  sec                       Dead Interval       : 40  sec
Transit Delay   : 1   sec                       Retransmit Interval : 5   sec
Authentication  : Keychain sha256               Link Speed          : 1000Mbps
Cost Configured : NA                            Cost Calculated     : 100
State/Type      : Point-to-point                Router Priority     : n/a
DR              : No                            BDR                 : No
Link LSAs       : 0                             Checksum Sum        : 0
BFD             : Disabled
```

Task 5.3 Authentication between Switch C and Switch A using Keychain and interface authentication commands

The keychain configuration can be used at one end of the link and the interface authentication commands can be used at the other end of the link to form an ospf neighbor adjacency using encrypted password authentication.

In this example, Switch C will use the keychain configuration and Switch A will use authentication configuration on the interface.

Enter the following configuration on **Switch A**

```
SwitchA(config)# interface 1/1/2
SwitchA(config-if)# ip ospf authentication hmac-sha-256
SwitchA(config-if)# ip ospf sha-key 1 sha plaintext aruba
```

Enter the following configuration on **Switch C**

```
SwitchC(config)# interface 1/1/1
SwitchC(config-if)# ip ospf authentication keychain
SwitchC(config-if)# ip ospf keychain sha256
```

And then run the ‘`sh ip ospf neighbor`’ & ‘`sh ip ospf interface x/x/x`’ commands on either Switch A or Switch C.

```
SwitchC# sh ip ospf neighbors
VRF : default                          Process : 1
=================================================

Total Number of Neighbors : 3

Neighbor ID      Priority  State             Nbr Address       Interface
-------------------------------------------------------------------------
192.168.2.1      n/a       FULL              192.168.4.2        1/1/1

192.168.2.2      n/a       FULL              192.168.4.4        1/1/2

192.168.2.4      n/a       FULL              192.168.4.11       1/1/3

SwitchC# sh ip ospf interface 1/1/2
Codes: DR - Designated router  BDR - Backup Designated router
```

```
Interface 1/1/2 is up, line protocol is up
------------------------------------------

VRF             : default                       Process           : 1
IP Address      : 192.168.4.5/31                Area              : 0.0.0.0

Status          : up                            Network Type      : Point-to-point

Hello Interval  : 10  sec                       Dead Interval     : 40  sec
Transit Delay   : 1   sec                       Retransmit Interval : 5   sec
Authentication  : Keychain sha256               Link Speed        : 1000Mbps
Cost Configured : NA                            Cost Calculated   : 100
State/Type      : Point-to-point                Router Priority   : n/a
DR              : No                            BDR               : No
Link LSAs       : 0                             Checksum Sum      : 0
BFD             : Disabled
```

Task 5.4 Authentication with virtual-link configuration

Authentication is also available over the virtual link(s) either using the key chain configuration method or providing the authentication configuration directly within the virtual link configuration as if configuring a physical interface.

In this example , the authentication configuration is configured directly within the virtual link configuration on both Switch C and Switch D.

Run the following command on either Switch D or Switch to confirm the current authentication status of the virtual-link

```
SwitchD# sh ip ospf virtual-links
Virtual link to router 192.168.2.3 is up
----------------------------------------

VRF                 : default                   Process             : 1
Transit Area        : 0.0.0.1                   Authentication      : No
Hello Interval      : 10                        Dead Interval       : 40
Transit Delay       : 1                         Retransmit Interval : 5
Number of Link LSAs : 0                         Checksum Sum        : 0
```

Enter the following configuration on **Switch D**

```
SwitchD(config)# router ospf 1
SwitchD(config-ospf-1)# area 0.0.0.1 virtual-link 192.168.2.3
SwitchD(config-router-vlink)# authentication hmac-sha-256
SwitchD(config-router-vlink)# sha-key 1 sha plaintext aruba
```

Repeat the configuration on **Switch C**

```
SwitchC(config)# router ospf 1
SwitchC(config-ospf-1)# area 0.0.0.1 virtual-link 192.168.2.4
SwitchC(config-router-vlink)# authentication hmac-sha-256
SwitchC(config-router-vlink)# sha-key 1 sha plaintext aruba
```

On Switch C & D, run the following command to confirm the new authentication status of the virtual link

```
SwitchC# sh ip ospf virtual-links
Virtual link to router 192.168.2.4 is up
----------------------------------------

VRF                 : default                    Process             : 1
Transit Area        : 0.0.0.1                    Authentication      : sha256
Hello Interval      : 10                         Dead Interval       : 40
Transit Delay       : 1                          Retransmit Interval : 5
Number of Link LSAs : 0                          Checksum Sum        : 0
Number of State Changes : 10
```

The following attributes are required when configuring authentication to ensure a successful neighbor adjacency. This applies to the commands if applied directly under an interface or using the keychain or in a combination at either end of the link..

1. The authenticating algorithm must match at either end of the link, as in '`hmac-sha-256`' for example.
2. The key number must match at either end of the link, as in '`sha-key 1`' under interface or '`key 1`' if using the key chain.
3. The authentication password match at either end of the link , as in '`ip opsf sha-key 1 sha plaintext aruba`' under interface or '`key-string plaintext aruba`' if using the key chain for example.

End of Task 5

Task 6 Passive interface

Passive interface

The use of the passive interface for OSPF tells the interface to disable route processing for that interface. There are two methods to deploy a passive ospf interface, either in the ospf global context:-

Global OSPF context example

```
SwitchA(config)# router ospf 1
SwitchA(config-ospf-1)# passive interface default
```

And disabled on a per interface as a desired:-

```
SwitchA(config)# interface 1/1/2
SwitchA(config-if)# no ip ospf passive
```

The option to use the default global setting (`no passive interface default`) and the interface command to set specific interfaces as 'passive' as desired . This is the method that will be used in task 6.1

Task 6.1 Passive Interface

The passive interface can be enabled on a per interface as desired.

On Switch A display ospf neighbors

```
SwitchA# sh ip ospf neighbors
VRF : default                          Process : 1
==================================================

Total Number of Neighbors : 2

Neighbor ID      Priority  State             Nbr Address       Interface
------------------------------------------------------------------------
192.168.2.2      n/a       FULL              192.168.4.1        1/1/1

192.168.2.3      n/a       FULL              192.168.4.3        1/1/2
```

On Switch A enter the no ip ospf passive command under interface 1/1/1

```
SwitchA(config)# interface 1/1/1
```

```
SwitchA(config-if)# ip ospf passive
```

Repeat the `sh ip ospf neighbor` command on Switch A.

Switch A will no longer have an ospf neighbor on interface 1/1/1 to neighbor 192.168.2.2. All routing processes will be disable on that interface.

Remove the ip ospf passive command on interface 1/1/1

```
SwitchA(config)# interface 1/1/1
```

```
SwitchA(config-if)# no ip ospf passive
```

The neighbor adjacency will be formed for neighbor 192.168.2.2 on interface 1/1/1

End of Task 6

TASK 7 Default-information originate

The default-information originate configures ospf to advertise the default route (0.0.0.0/0) to its neighbors. There are two options:-

default-information originate

```
SwitchA# conf t
SwitchA(config)# router ospf 1
SwitchA(config-ospf-1)# default-information originate
```

This option will advertise the default route (0.0.0.0/0) if present in the router

default-information originate always

```
SwitchA# conf t
SwitchA(config)# router ospf 1
SwitchA(config-ospf-1)# default-information originate always
```

This option will advertise the default route (0.0.0.0/0) regardless if the route is present in the router

Task 7.1 'default-Information originate always' command

In this task, the `default originate always` configuration will be configured on Switch A. The route table will be observed to see how the default route propagates through out the network.

On Switch A, configure the default-information originate always command under the ospf 1 context.

```
SwitchA# conf t
SwitchA(config)# router ospf 1
SwitchA(config-ospf-1)# default-information originate always
```

On the remaining switches B,C,D & E, run the `sh ip ospf route` command

Extract from Switch B & C route table

Switch B

```
0.0.0.0/0          (E2)
     via 192.168.4.0 interface 1/1/1, cost 25 distance 110
```

Switch C

```
0.0.0.0/0          (E2)
     via 192.168.4.2 interface 1/1/1, cost 25 distance 110
```

All switches will now receive the default route of 0.0.0.0/0 generated by Switch A.

Task 7.2 'default-information originate' command

On Switch A, replace the `default-information originate always` config and add the `default-information originate` command

```
SwitchA(config)# router ospf 1
SwitchA(config-ospf-1)# no default-information originate always
SwitchA(config-ospf-1)# default-information originate
```

On the remaining switches B,C,D & E, run the `sh ip ospf route` command

All remaining switches no longer have the default route of 0.0.0.0/0 in the routing table as Switch A does not have the default route in the route table.

The next step is to add a default route to the routing table to get Switch A to re-advertise the default route .There is not an appropriate interface to use for default routes as it is an isolated lab, so the interface on Switch B 192.168.4.1 is selected to illustrate the default route re-advertisement

On Switch A , enter the following command

```
SwitchA(config)# ip route 0.0.0.0/0 192.168.4.1
```

This is identifying interface 192.168.4.1 (on Switch B) as the default route from Switch A for all unknown ip routes. Switch A will re-advertise the default static route into ospd.

On the remaining switches, run the sh ip ospf route command and note the default advertisement and the interface that it is being advertised from.

Switch B

```
0.0.0.0/0          (E2)
     via 192.168.4.0 interface 1/1/1, cost 1 distance 110
```

Switch C

```
SwitchA(config)# ip route 0.0.0.0/0 192.168.4.1
```

Switch D

```
0.0.0.0/0          (E2)
     via 192.168.4.10 interface 1/1/1, cost 1 distance 110
```

Switch E

```
0.0.0.0/0          (E2)
     via 192.168.4.12 interface 1/1/1, cost 1 distance 110
```

End of Task 7

TASK 8 –show commands

In this section there is a summary of some of the more common ospf commands that can be used. There are multiple options on some commands, which can be highlighted using the '?' as in:-

```
SwitchC# sh ip ospf ?
  [<1-63>]         Specify the OSPF Process ID
  all-vrfs         All VRFs.
  border-routers   Display OSPF border router information
  interface        Display OSPF interface information
  lsdb             Display OSPF link state database information
  neighbors        Display OSPF neighbor information
  routes           Display OSPF routing table
  statistics       Display OSPF statistics
  virtual-links    Display OSPF virtual links information
  vrf              VRF Instance.
  <cr>
```

A snapshot of the key command cli string is provided as examples.

sh ip ospf border-routers

Displays the OSPF routing table entries for Area Border Router (ABR) and Autonomous System Border Router (ASBR).

```
SwitchA# sh ip ospf border-routers
VRF : default                          Process : 1
Internal Routing Table
-------------------------------------------------

Codes: i - Intra-area route, I - Inter-area route

           Router-ID   Cost  Type              Area      SPF           Nexthop
     Interface
 i       192.168.2.3    100   ABR           0.0.0.0      83       192.168.4.3
         1/1/2
 i       192.168.2.4    200   ABR           0.0.0.0      83       192.168.4.3
         1/1/2
```

sh ip ospf

Displays general OSPF, area, state, and configuration information.

```
SwitchC# sh ip ospf
VRF : default                          Process  : 1
```

```
--------------------------------------------------

RouterID           : 192.168.2.3         OSPFv2                 : Enabled
BFD                : Disabled            SPF Start Interval     : 200   ms
SPF Hold Interval  : 1000  ms            SPF Max Wait Interval  : 5000  ms
LSA Start Time     : 5000  ms            LSA Hold Time          : 0     ms
LSA Max Wait Time  : 0     ms            LSA Arrival            : 1000  ms
External LSAs      : 0                   Checksum Sum           : 0
ECMP               : 4                   Reference Bandwidth    : 100000 Mbps
Area Border        : true                AS Border              : false
GR Status          : Enabled             GR Interval            : 120
GR State           : inactive            GR Exit Status         : none
GR Helper          : Disabled            GR Strict LSA Check    : Disabled
GR Ignore Lost I/F : Disabled
Summary address:

Area      Total     Active
------------------------------
Normal     2         2
Stub       0         0
NSSA       0         0

Area  : 0.0.0.0
----------------
Area Type              : Normal        Status               : Active
Total Interfaces       : 3             Active Interfaces    : 3
Passive Interfaces     : 0             Loopback Interfaces  : 1
SPF Calculation Count  : 96
Area ranges     :
Number of LSAs         : 9             Checksum Sum         : 279047
Area  : 0.0.0.1
----------------
Area Type              : Normal        Status               : Active
Total Interfaces       : 1             Active Interfaces    : 1
Passive Interfaces     : 0             Loopback Interfaces  : 0
SPF Calculation Count  : 96
Area ranges     :

Number of LSAs         : 9             Checksum Sum         : 279047

Area  : 0.0.0.1

----------------

Area Type              : Normal        Status               : Active

Total Interfaces       : 1             Active Interfaces    : 1

Passive Interfaces     : 0             Loopback Interfaces  : 0

SPF Calculation Count  : 96

Area ranges     :

    ip-prefix 10.10.10.200/32, inter-area, advertise

    ip-prefix 10.10.20.200/32, inter-area, advertise

Number of LSAs         : 19            Checksum Sum         : 571478
```

sh ip ospf interface x/x/x

```
SwitchC# sh ip ospf interface 1/1/1
Codes: DR - Designated router  BDR - Backup Designated router

Interface 1/1/1 is up, line protocol is up
------------------------------------------

VRF            : default                       Process            : 1
IP Address     : 192.168.4.3/31                Area               : 0.0.0.0
```

```
Status          : up                            Network Type        : Point-to-point
Hello Interval  : 10  sec                       Dead Interval       : 40  sec
Transit Delay   : 1   sec                       Retransmit Interval : 5   sec
Authentication  : Keychain sha256               Link Speed          : 1000Mbps
Cost Configured : NA                            Cost Calculated     : 100
State/Type      : Point-to-point                Router Priority     : n/a
DR              : No                            BDR                 : No
Link LSAs       : 0                             Checksum Sum        : 0
BFD             : Disabled
```

sh ip ospf routes

Displays OSPF routing table information.

```
SwitchC# sh ip ospf routes
Codes: i - Intra-area route, I - Inter-area route
       E1 - External type-1, E2 - External type-2

OSPF Process ID 1 VRF default, Routing Table
---------------------------------------------

Total Number of Routes : 10

192.168.2.1/32     (i) area: 0.0.0.0
     via 192.168.4.2 interface 1/1/1, cost 100 distance 110
192.168.2.1/32     (i) area: 0.0.0.0
     via 192.168.4.11 interface 1/1/3, cost 100 distance 110
192.168.2.2/32     (i) area: 0.0.0.0
     via 192.168.4.4 interface 1/1/2, cost 100 distance 110
192.168.2.5/32     (I)
     via 192.168.4.11 interface 1/1/3, cost 200 distance 110
192.168.4.0/31     (i) area: 0.0.0.0
     via 192.168.4.2 interface 1/1/1, cost 200 distance 110
192.168.4.0/31     (i) area: 0.0.0.0
     via 192.168.4.4 interface 1/1/2, cost 200 distance 110
192.168.4.2/31     (i) area: 0.0.0.0
     directly attached to interface 1/1/1, cost 100 distance 110
192.168.4.4/31     (i) area: 0.0.0.0
 -- MORE --, next page: Space, next line: Enter, quit: q
```

sh ip ospf statistics

```
SwitchC# sh ip ospf statistics
OSPF Process ID 1 VRF default, Statistics (cleared 3 days ago)
---------------------------------------------------------------

Unknown Interface Drops         : 0
Unknown Virtual Interface Drops : 0
Bad Instance ID Drops           : 0
Bad IP Header Length Drops      : 0
Wrong OSPF Version Drops        : 0
Bad Source IP Drops             : 0
Resource Failure Drops          : 0
Bad Header Length Drops         : 0
Total Drops                     : 0
```

sh ip ospf virtual-links

```
SwitchC# sh ip ospf virtual-links
Virtual link to router 192.168.2.4 is up
----------------------------------------

VRF                 : default                   Process             : 1
Transit Area        : 0.0.0.1                   Authentication      : sha256
Hello Interval      : 10                        Dead Interval       : 40
Transit Delay       : 1                         Retransmit Interval : 5
Number of Link LSAs : 0                         Checksum Sum        : 0
Number of State Changes : 10
```

sh ip ospf neighbors

```
SwitchC# sh ip ospf neighbors
VRF : default                          Process : 1
================================================

Total Number of Neighbors : 3

Neighbor ID      Priority  State             Nbr Address      Interface
-------------------------------------------------------------------------
192.168.2.1      n/a       FULL              192.168.4.2       1/1/1

192.168.2.2      n/a       FULL              192.168.4.4       1/1/2

192.168.2.4      n/a       FULL              192.168.4.11      1/1/3
```

End of Task 8 and Lab

Appendix – Complete Configurations

Switch A

SwitchA# sh runn

```
Current configuration:
!
!Version ArubaOS-CX Virtual.10.07.0004
!export-password: default
hostname SwitchA
user admin group administrators password ciphertext AQBapUIjq5yzV2PXlvinBNH3jHolHScphhas
TIqFhY98FUJiYgAAAPSjj/wY2BG5dUHQLQ4BA/40bY5dAJgSzMudwESxaqHTfW7NK17bl1HRW2PrjBNNkpWRax5P
0RtODX5Uj6lZZy6SJBypBXn2uGsKIItI9no7wgzDp5+PMHBZR1z68Y7FUZMU
led locator on
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
ssh server vrf mgmt
vlan 1
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    ip address 192.168.4.0/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip ospf authentication hmac-sha-256
    ip ospf sha-key 1 sha ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQA
AAIouj7OC
interface 1/1/2
    no shutdown
    ip address 192.168.4.2/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
```

```
    ip ospf authentication hmac-sha-256
    ip ospf sha-key 1 sha ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQA
AAIouj7OC
interface 1/1/3
    no shutdown
interface loopback 0
    ip address 192.168.2.1/32
    ip ospf 1 area 0.0.0.0
ip route 0.0.0.0/0 192.168.4.1
!
router ospf 1
    router-id 192.168.2.1
    default-information originate
    area 0.0.0.0
```

Switch B

```
SwitchB# sh runn
Current configuration:
!
!Version ArubaOS-CX Virtual.10.07.0004
!export-password: default
hostname SwitchB
user admin group administrators password ciphertext AQBapdU8DwDDuaT2OQXmQI6nMCTgg++q9zJF
he1RNAnaw4jfYgAAAP0EBAJbehQEaN9HFpOD64JUovBnIdPpXiVHuY17n1bdeathUHZdDy6EWe/wnQp+eyt4OJmS
I1eXZnUSzQ7xgHRCamuKslISZ/yWQAdWmPR7ayU88SqwWnuEPeNgK5xqb4ND
led locator on
keychain sha256
    key 1
        key-string ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQAAAIouj7
OC
        cryptographic-algorithm hmac-sha-256
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
!
!
```

```
!
!
!
ssh server vrf mgmt
vlan 1
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
   no shutdown
    ip address 192.168.4.1/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip ospf authentication hmac-sha-256
    ip ospf sha-key 1 sha ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQA
AAIouj7OC
interface 1/1/2
    no shutdown
    ip address 192.168.4.4/31
    ip ospf 1 area 0.0.0.0
    ip ospf network point-to-point
    ip ospf authentication keychain
    ip ospf keychain sha256
interface 1/1/3
    no shutdown
interface loopback 0
    ip address 192.168.2.2/32
    ip ospf 1 area 0.0.0.0
!
router ospf 1
    router-id 192.168.2.2
    area 0.0.0.0
```

Switch C

```
hostname SwitchC
user admin group administrators password ciphertext
```

```
AQBapfpGQNq62D++2BPOzWxgKegH8d6KK3SfliX0dRj8CecnYgAAAEiCQm3zivWzZ/l5ppG7kqWWa2aEMQK45iMxQfw4gg90g/qCgvb1+X7bv4Nvqakx
N9elSnOolA/B0t++NiwhFjdu

f03MqV5SKpVVXeIRXQ1Wb/HXk+2Jcd3Xz5f7uRwBXZdn

led locator on

keychain sha256

    key 1

        key-string ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQAAAIouj7OC

        cryptographic-algorithm hmac-sha-256

ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst

ntp enable

!

ssh server vrf mgmt

vlan 1

interface mgmt

    no shutdown

    ip dhcp

interface 1/1/1

    no shutdown

    ip address 192.168.4.3/31

    ip ospf 1 area 0.0.0.0

    ip ospf network point-to-point

    ip ospf authentication keychain

    ip ospf keychain sha256

interface 1/1/2

    no shutdown

    ip address 192.168.4.5/31

    ip ospf 1 area 0.0.0.0

    ip ospf network point-to-point

    ip ospf authentication keychain

    ip ospf keychain sha256

interface 1/1/3

    no shutdown

    ip address 192.168.4.10/31

    ip ospf 1 area 0.0.0.1

    ip ospf network point-to-point

interface loopback 0
```

```
    ip address 192.168.2.3/32
    ip ospf 1 area 0.0.0.0
!
router ospf 1
    router-id 192.168.2.3
    area 0.0.0.0
    area 0.0.0.1
    area 0.0.0.1 virtual-link 192.168.2.4
        authentication hmac-sha-256
        sha-key 1 sha ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQAAAIouj7OC
        exit
```

SwitchD

```
Current configuration:
!
!Version ArubaOS-CX Virtual.10.07.0004
!export-password: default
hostname SwitchD
user admin group administrators password ciphertext AQBapZ+cA9wXpQyfL58emkn8n/UirFMRWZB8
4hqkYsYzf73bYgAAABfU+dCAQmVJqR49gOGOwBKi70Ef7za5H4+ghgYy0NvJKAKzvfvhVhAjnXIbbUgtGGfMwaf5
4lBqh3SBXxFBk10u1Gd1pGhIAmp1n7zKQdFglLUHyEuPIcg/iHbQZ0vrnJeS
led locator on
keychain keychain
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
ssh server vrf mgmt
vlan 1,100,200
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    ip address 192.168.4.11/31
    ip ospf 1 area 0.0.0.1
    ip ospf network point-to-point
interface 1/1/2
```

```
    no shutdown
    ip address 192.168.4.12/31
    ip ospf 1 area 0.0.0.2
    ip ospf network point-to-point
interface 1/1/3
    no shutdown
interface loopback 0
    ip address 192.168.2.1/32
    ip ospf 1 area 0.0.0.1
!
router ospf 1
    router-id 192.168.2.4
    area 0.0.0.1
    area 0.0.0.1 virtual-link 192.168.2.3
        authentication hmac-sha-256
        sha-key 1 sha ciphertext AQBapUbZyuMyDkoDN0zeQbI8qY0p5vpa77xnpPQEngEkpWjWBQAAAIo
uj7OC
        exit
    area 0.0.0.2
```

SwitchE

```
Current configuration:
!
!Version ArubaOS-CX Virtual.10.07.0004
!export-password: default
hostname SwitchE
user admin group administrators password ciphertext AQBapVww/GYlxzz+hMHOX/elpFyCgHj0aJaY
AYjOi8T9GtQfYgAAABf+91qnBPzkPjIJNfAbWIKALfeq9y1Z1EormgD+Ukt4faM2kCCmxryIPBPl5G1lF58Pwew8
ojGvsiIndmtHuQYRXL7Esy8g60DR3zGXUAdVb1hVx4jQrrlyeBLfkldchBmK
led locator on
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
ssh server vrf mgmt
vlan 1
interface mgmt
```

```
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    ip address 192.168.4.13/31
    ip ospf 1 area 0.0.0.2
    ip ospf network point-to-point
interface 1/1/2
    no shutdown
interface 1/1/3
    no shutdown
interface loopback 0
    ip address 192.168.2.5/32
    ip ospf 1 area 0.0.0.2
!
router ospf 1
    router-id 192.168.2.5
    area 0.0.0.2
```

END OF DOCUMENT

a Hewlett Packard Enterprise company

www.arubanetworks.com

3333 Scott Blvd. Santa Clara, CA 95054
1.844.472.2782 | T: 1.408.227.4500 | FAX: 1.408.227.4550 | info@arubanetworks.com