

IPv6 Basics

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.

<https://www.eve-ng.net/index.php/documentation/howtos/howto-add-aruba-cx-switch/>

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Lab Objective

This lab will provide hands on experience with IPv6 addressing, static routing and SLAAC.

Loopback, link local, unique local, global unicast, documentation addressing examples and route summarization are included as part of this lab to help understand these basics.

Lab Overview

This lab as shown in Figure 1 has the following different types of IPv6 addresses: loopback, link local, unique local, global unicast, documentation addressing.

Refer to <https://www.ripe.net/manage-ips-and-asns/ipv6/ipv6-address-types> for an explanation of the different address types.

It's recommended an IPv6 calculator such as http://www.gestioip.net/cgi-bin/subnet_calculator.cgi be used to help understand subnet summarization. User/device LAN subnets are standardized to subnets with /64 mask.

3001:101::/64 on Switch4 is considered a "Global Unicast Address" as it is part of the 2000::/3 range.

2001:db8:beef:X::/128 on Switch2 and Switch3 are considered part of the "Documentation" 2001:db8::/32 range and are "Loopbacks" as they have /128 subnet mask.

2001:db8:beef:111::/64 on Switch1 is considered part of the "Documentation" 2001:db8::/32 range

fd00:1:X::/127 between Switches are part of the "Unique Local" fc00::/7 range, as a best practice /64 are reserved for inter switch links but /127 are actually used, e.g. fd00:1:13::/64 is reserved for Switch1 to Switch3 link, but fd00:1:13::/127 is used as only 2 IPs are required on that link.

The objective of this lab is to:

- Provide IPv6 connectivity between the 2 hosts across the IPv6 network
- Implement static routes with summarized address to correctly provide network connectivity to the Loopbacks on Switch2 and Switch3 from the hosts

Lab Network Layout

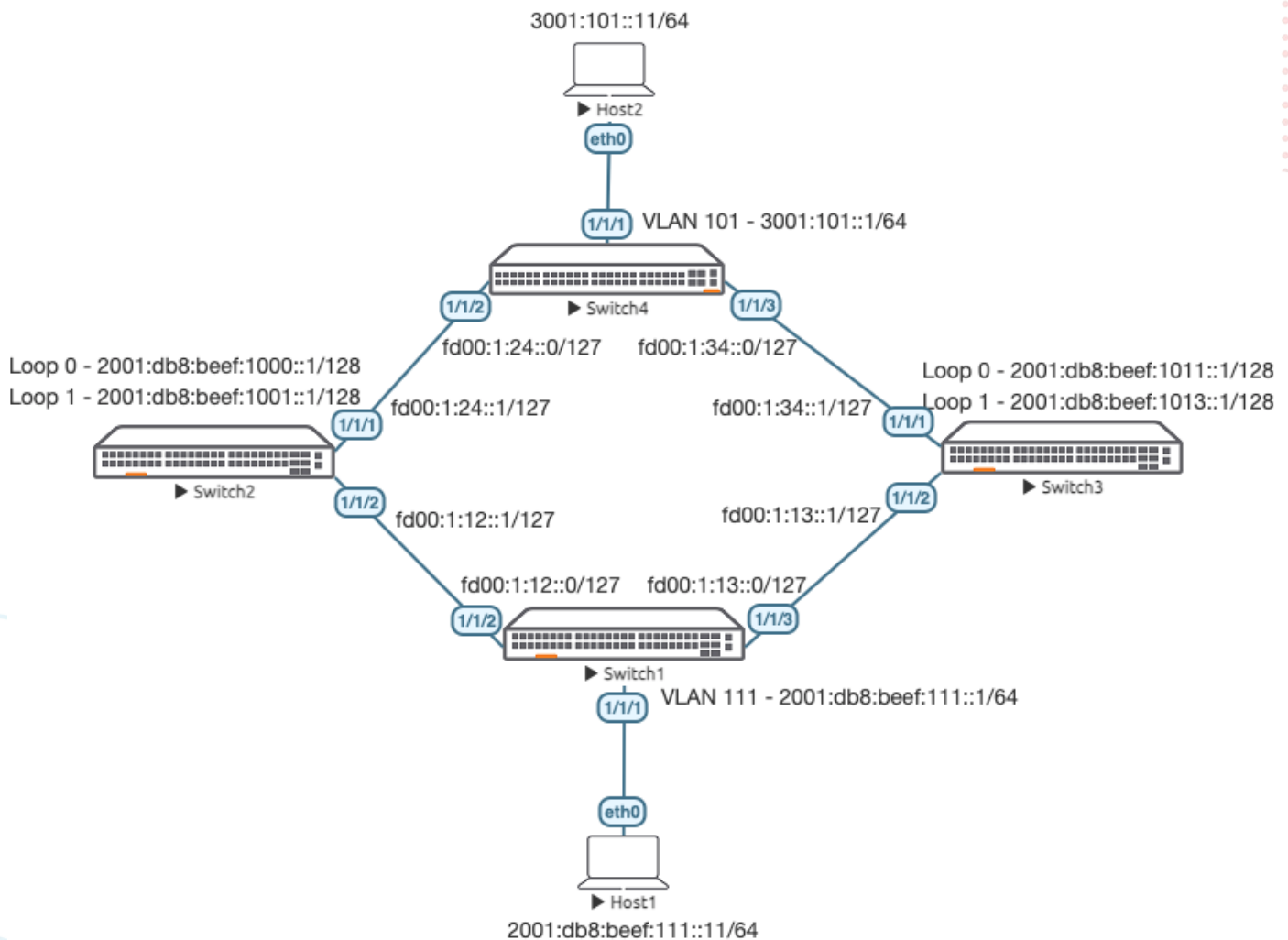


Figure 1. Lab topology and addresses

Lab Tasks

Task 1 – Lab setup

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

- Start all the devices, including hosts
- Open each switch console and log in with user “admin” and hit enter, so that no password is applied
- Set your desired password
- Change all hostnames as shown in the topology:
configure
hostname ...
- On all devices, bring up required ports:
int 1/1/1-1/1/6
no shutdown
use “exit” to go back a level

- Validate LLDP neighbors appear as expected on each switch
show lldp neighbor

Switch1

```
Switch1(config)# sh lld nei
```

```
LLDP Neighbor Information
=====
```

```
Total Neighbor Entries      : 2
Total Neighbor Entries Deleted : 0
Total Neighbor Entries Dropped : 0
Total Neighbor Entries Aged-Out : 0
```

LOCAL-PORT	CHASSIS-ID	PORT-ID	PORT-DESC	TTL	SYS-NAME
1/1/2	08:00:09:8a:14:fa	1/1/1	1/1/2	120	Switch2
1/1/3	08:00:09:12:8e:9e	1/1/2	1/1/2	120	Switch3

Task 2 – Configure IPv6 address and Interfaces

- Configure interfaces, IPs and required VLANs on these 4 switches

Switch1

```
Switch1(config-if)# int 1/1/2
Switch1(config-if)# ipv6 address fd00:1:12::0/127
Switch1(config-if)# int 1/1/3
Switch1(config-if)# ipv6 address fd00:1:13::0/127
! You can think of /127 IPv6 links as equivalent to /31 IPv4 links
! Main difference is:
! IPv4 normally requires you to take a /24 and chop it into multiple /31s for each link
! IPv6 best practice is to reserve a unique /64 for each link and just use /127 to support
! 2 IPs on that link
```

```
Switch1(config)# vlan 111
Switch1(config-vlan-111)# int vlan 111
Switch1(config-if-vlan)# ipv6 address 2001:db8:beef:111::1/64
! User/device LAN subnets are standardized to /64 mask
Switch1(config-if-vlan)# no ipv6 nd suppress-ra dnssl
Switch1(config-if-vlan)# no ipv6 nd suppress-ra rdns
! IPv6 Router Advertisements (RAs) are suppressed by default
! disable RA suppression so that IPv6 hosts are able to receive default gateway info
Switch1(config)# int 1/1/1
Switch1(config-if)# no routing
Switch1(config-if)# vlan access 111
```

Switch2

```
Switch2(config)# int 1/1/2
Switch2(config-if)# ipv6 address fd00:1:12::1/127
Switch2(config-if)# int 1/1/1
Switch2(config-if)# ipv6 address fd00:1:24::1/127
Switch2(config-if)# int lo 0
Switch2(config-loopback-if)# ipv6 address 2001:db8:beef:1000::1/128
Switch2(config-loopback-if)# int lo 1
Switch2(config-loopback-if)# ipv6 address 2001:db8:beef:1001::1/128
```

Switch3

```
Switch3(config)# int 1/1/2
Switch3(config-if)# ipv6 add fd00:1:13::1/127
Switch3(config-if)# int 1/1/1
Switch3(config-if)# ipv6 add fd00:1:34::1/127
Switch3(config-if)# int lo 0
Switch3(config-loopback-if)# ipv6 address 2001:db8:beef:1011::1/128
Switch3(config-loopback-if)# int lo 1
Switch3(config-loopback-if)# ipv6 address 2001:db8:beef:1013::1/128
```

Switch4

```
Switch4(config)# int 1/1/2
Switch4(config-if)# ipv6 address fd00:1:24::0/127
Switch4(config-if)# int 1/1/3
Switch4(config-if)# ipv6 address fd00:1:34::0/127
Switch4(config-if)# vlan 101
Switch4(config-vlan-101)# int vlan 101
Switch4(config-if-vlan)# ipv6 address 3001:101::1/64
Switch4(config-if-vlan)# no ipv6 nd suppress-ra dnssl
Switch4(config-if-vlan)# no ipv6 nd suppress-ra rdns
! RAs are suppressed by default
! disable RA suppression so that IPv6 hosts are able to receive default gateway info
Switch4(config-if-vlan)# int 1/1/1
Switch4(config-if)# no routing
Switch4(config-if)# vlan access 101
```

Task 3 – Verify Directly Connected IPs/Neighbors

- On each switch, try to identify the different types of IPv6 addresses assigned
- Notice the link local address is based on MAC address of an interface,

e.g. 08:00:09:ee:11:82 -> fe80::800:901:8ee:1182/64

```
Switch4(config)# sh int 1/1/2
Interface 1/1/2 is up
  Admin state is up
  Link state: up
  Link transitions: 0
  Description:
  Hardware: Ethernet, MAC Address: 08:00:09:ee:11:82
```

```
Switch4(config)# sh ipv6 int 1/1/2
Interface 1/1/2 is up
  Admin state is up
  IPv6 address:
    fd00:1:24::/127 [VALID]
  IPv6 link-local address: fe80::800:901:8ee:1182/64 [VALID]
  IPv6 virtual address configured: none
  IPv6 multicast routing: disable
  IPv6 Forwarding feature: enabled
  IPv6 multicast groups locally joined:
    ff02::1 ff02::1:ffee:1182 ff02::1:ff00:0 ff02::2
  IPv6 multicast (S,G) entries joined: none
  IPv6 MTU 1500
  IPv6 unicast reverse path forwarding: none
  IPv6 load sharing: none
  L3 Counters: Rx Disabled, Tx Disabled
  Rx
    ucast: 0 packets, 0 bytes
    mcast: 0 packets, 0 bytes
  Tx
    ucast: 0 packets, 0 bytes
    mcast: 0 packets, 0 bytes
```

- Since IPv6 uses multicast instead of broadcast, identify the IPv6 multicast groups joined between switches, 1 of which is based on the link local address

e.g. fe80::800:901:8ee:1182/64 -> ff02::1:ffee:1182

- This link provides a good explanation of the notable IPv6 multicast addresses

https://en.wikipedia.org/wiki/Multicast_address#Notable_IPv6_multicast_addresses

- On a neighbor switch, try pinging to the directly connected IP in the same subnet, both global unicast and link local should work

```
Switch2(config)# ping6 fd00:1:24::0
PING fd00:1:24::0(fd00:1:24::) 100 data bytes
108 bytes from fd00:1:24::: icmp_seq=1 ttl=64 time=2.74 ms
108 bytes from fd00:1:24::: icmp_seq=2 ttl=64 time=2.33 ms
```

```
Switch2(config)# ping6 fe80::800:901:8ee:1182 source 1/1/1
PING fe80::800:901:8ee:1182(fe80::800:901:8ee:1182) from fe80::800:901:48a:14fa mls1p1: 100
data bytes
108 bytes from fe80::800:901:8ee:1182: icmp_seq=1 ttl=64 time=22.0 ms
108 bytes from fe80::800:901:8ee:1182: icmp_seq=2 ttl=64 time=1.64 ms
```

- You should also be able to view the ipv6 neighbor table

```
Switch2(config)# sh ipv6 neighbors
```

IPv6 Address	MAC	Port	Physical Port	State
fd00:1:24::	08:00:09:ee:11:82	1/1/1	1/1/1	reachable
fe80::800:901:8ee:1182	08:00:09:ee:11:82	1/1/1	1/1/1	reachable
Total Number Of IPv6 Neighbors Entries Listed- 2.				

Task 4 – Configure Static Routes

- On Switch2 and Switch3, configure static routes towards the host subnets.

Switch2

```
Switch2(config)# ipv6 route 3001:101::/64 fd00:1:24::0
```

```
Switch2(config)# ipv6 route 2001:db8:beef:111::/64 fd00:1:12::0
```

Switch3

```
Switch3(config)# ipv6 route 3001:101::/64 fd00:1:34::0
```

```
Switch3(config)# ipv6 route 2001:db8:beef:111::/64 fd00:1:13::0
```

- On Switch1 and Switch4, configure remote host route and summary routes towards the loopbacks on Switch2 and Switch3.
- Using the IPv6 calculator,
 - loopbacks on Switch2 could be summarized as 2001:db8:beef:1000::/63 or 2001:db8:beef:1000::/62
 - loopbacks on Switch3 could be summarized as 2001:db8:beef:1010::/62 or 2001:db8:beef:1010::/61
 - Play around with the IPv6 calculator and utilize your preferred summarized route

Switch1

```
Switch1(config)# ipv6 route 2001:db8:beef:1000::/63 fd00:1:12::1
```

```
Switch1(config)# ipv6 route 2001:db8:beef:1010::/62 fd00:1:13::1
```

```
Switch1(config)# ipv6 route 3001:101::/64 fd00:1:12::1
```

```
Switch1(config)# ipv6 route 3001:101::/64 fd00:1:13::1
```

Switch4

```
Switch4(config)# ipv6 route 2001:db8:beef:1000::/63 fd00:1:24::1
```

```
Switch4(config)# ipv6 route 2001:db8:beef:1010::/62 fd00:1:34::1
```

```
Switch4(config)# ipv6 route 2001:db8:beef:111::/64 fd00:1:24::1
```

```
Switch4(config)# ipv6 route 2001:db8:beef:111::/64 fd00:1:34::1
```

- Verify routes appear in routing table as expected on the switches

```
Switch4(config)# sh ipv6 route
```

Displaying ipv6 routes selected for forwarding

'[x/y]' denotes [distance/metric]

```
2001:db8:beef:111::/64, vrf default
  via fd00:1:24::1, [1/0], static
  via fd00:1:34::1, [1/0], static
```

```
2001:db8:beef:1000::/63, vrf default
  via fd00:1:24::1, [1/0], static
```

```
2001:db8:beef:1010::/62, vrf default
```



```

        via fd00:1:34::1, [1/0], static
3001:101::/64, vrf default
        via vlan101, [0/0], connected
3001:101::1/128, vrf default
        via vlan101, [0/0], local
fd00:1:24::/127, vrf default
        via 1/1/2, [0/0], connected
fd00:1:24::/128, vrf default
        via 1/1/2, [0/0], local
fd00:1:34::/127, vrf default
        via 1/1/3, [0/0], connected
fd00:1:34::/128, vrf default
        via 1/1/3, [0/0], local

```

Task 5 – Configure Hosts

- Configure Host1 with your desired IP and auto default gateway (static IPv6 default gateway does not work in VPCS)

```

VPCS> ip 2001:db8:beef:111::11/64 auto
PC1 : 2001:db8:beef:111::11/64

```

- Verify Host1 has your desired IP and router info from RA

```
VPCS> sh ipv6
```

```

NAME           : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6805/64
GLOBAL SCOPE    : 2001:db8:beef:111::11/64
DNS             :
ROUTER LINK-LAYER : 08:00:09:16:7b:7e
MAC             : 00:50:79:66:68:05
LPORT          : 20000
RHOST:PORT      : 127.0.0.1:30000
MTU:            : 1500

```

- Configure Host2 with your desired IP and auto default gateway (static IPv6 default gateway does not work in VPCS)

```

VPCS> ip 3001:101::11/64 auto
PC1 : 3001:101::11/64

```

- Verify Host2 has your desired IP and router info from RA

```
VPCS> sh ipv6
```

```

NAME           : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6807/64
GLOBAL SCOPE    : 3001:101::11/64
DNS             :
ROUTER LINK-LAYER : 08:00:09:ee:11:82
MAC             : 00:50:79:66:68:07
LPORT          : 20000
RHOST:PORT      : 127.0.0.1:30000
MTU:            : 1500

```

Task 6 – Final Validation

- Ensure unicast connectivity works between hosts and towards loopbacks

From Host1

VPCS> ping 3001:101::11

3001:101::11 icmp6_seq=1 ttl=58 time=3.079 ms

3001:101::11 icmp6_seq=2 ttl=58 time=3.136 ms

PCS> ping 2001:db8:beef:1000::1

2001:db8:beef:1000::1 icmp6_seq=1 ttl=63 time=3.287 ms

2001:db8:beef:1000::1 icmp6_seq=2 ttl=63 time=1.670 ms

VPCS> ping 2001:db8:beef:1001::1

2001:db8:beef:1001::1 icmp6_seq=1 ttl=63 time=1.952 ms

VPCS> ping 2001:db8:beef:1011::1

2001:db8:beef:1011::1 icmp6_seq=1 ttl=63 time=8.230 ms

VPCS> ping 2001:db8:beef:1013::1

2001:db8:beef:1013::1 icmp6_seq=1 ttl=63 time=4.478 ms

2001:db8:beef:1013::1 icmp6_seq=2 ttl=63 time=1.871 ms

VPCS> trace 3001:101::11

trace to 3001:101::11, 64 hops max

1 2001:db8:beef:111::1 1.586 ms 0.657 ms 0.547 ms

2 fd00:1:13::1 1.438 ms 1.117 ms 1.875 ms

3 fd00:1:24:: 2.537 ms 2.076 ms 1.780 ms

4 3001:101::11 2.244 ms 2.664 ms 2.192 ms

VPCS> trace 2001:db8:beef:1000::1

trace to 2001:db8:beef:1000::1, 64 hops max

1 2001:db8:beef:111::1 1.230 ms 0.494 ms 0.458 ms

2 2001:db8:beef:1000::1 1.552 ms 1.062 ms 1.148 ms

Task 7 – SLAAC

- You can also validate Stateless Address Autoconfiguration (SLAAC) IP assignment on your VPCS host by using

```
VPCS> clear ipv6
IPv6 address/mask and router link-layer address cleared
```

```
VPCS> sh ipv6
```

```
NAME           : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6805/64
GLOBAL SCOPE    :
DNS             :
ROUTER LINK-LAYER :
MAC             : 00:50:79:66:68:05
LPORT          : 20000
RHOST:PORT      : 127.0.0.1:30000
MTU             : 1500
```

```
VPCS> ip auto auto
GLOBAL SCOPE    : 2001:db8:beef:111:2050:79ff:fe66:6805/64
ROUTER LINK-LAYER : 08:00:09:16:7b:7e
```

```
VPCS> sh ipv6
```

```
NAME           : VPCS[1]
LINK-LOCAL SCOPE : fe80::250:79ff:fe66:6805/64
GLOBAL SCOPE    : 2001:db8:beef:111:2050:79ff:fe66:6805/64
DNS             :
ROUTER LINK-LAYER : 08:00:09:16:7b:7e
MAC             : 00:50:79:66:68:05
LPORT          : 20000
RHOST:PORT      : 127.0.0.1:30000
MTU             : 1500
```

Appendix – Complete Configurations

- If you face issues during your lab, you can verify your configs with the configs listed in this section
- If configs are the same, try powering off/powering on the switches to reboot them

Switch1

```
Switch1# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.06.0110
!export-password: default
hostname Switch1
user admin group administrators password ciphertext
AQBapdfPVQnAOnvhV/vgVIykFHLBBrx+BGnS0i4ee/4fqWixYgAAAL7+19mOdfj9uX2jftvu3T/Bk7UXtnXGqLaC9ETw6Ga
ww9BbjTOJEdqAQp5wlrNcJyGL+dHH/ynJPXE9pjt7avGJPivh
qYnmz0jzROTVdT815990GeAn00nedcWFyiPqBtXe
led locator on
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
!
!
!
ssh server vrf mgmt
vlan 1,111
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1
    no shutdown
    no routing
    vlan access 111
interface 1/1/2
    no shutdown
    ipv6 address fd00:1:12::/127
interface 1/1/3
    no shutdown
    ipv6 address fd00:1:13::/127
interface 1/1/4
    no shutdown
interface 1/1/5
    no shutdown
interface 1/1/6
    no shutdown
interface vlan 111
    ipv6 address 2001:db8:beef:111::1/64
    no ipv6 nd suppress-ra dnssl
    no ipv6 nd suppress-ra rdns
ipv6 route 2001:db8:beef:1000::/63 fd00:1:12::1
ipv6 route 2001:db8:beef:1010::/62 fd00:1:13::1
ipv6 route 3001:101::/64 fd00:1:12::1
ipv6 route 3001:101::/64 fd00:1:13::1
!
!
!
!
https-server vrf mgmt
```

Switch2

```
Switch2# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.06.0110
!export-password: default
hostname Switch2
user admin group administrators password ciphertext
AQBapaaZw8WLBuEKR150MKy8VI8jkhZIDzaj20jmBg27lPhqYgAAAG/rJZtDb2A0vBMvT7MLibfHBGHACU8qTZWR+19ZzlQ
zEXciI4S9SAvrRQxBnf6oRWNSOj8wJ0PB3zbVnjsO9o16kJRzI
aFxFLyhKsHHJsiFGa/wuhCszpu78/kNrLn7gLsojR
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
    ipv6 address fd00:1:24::1/127
interface 1/1/2
    no shutdown
    ipv6 address fd00:1:12::1/127
interface 1/1/3
    no shutdown
interface 1/1/4
    no shutdown
interface 1/1/5
    no shutdown
interface 1/1/6
    no shutdown
interface loopback 0
    ipv6 address 2001:db8:beef:1000::1/128
interface loopback 1
    ipv6 address 2001:db8:beef:1001::1/128
ipv6 route 2001:db8:beef:111::/64 fd00:1:12::
ipv6 route 3001:101::/64 fd00:1:24::
!
!
!
!
!
https-server vrf mgmt
```

Switch3

```
Switch3# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.06.0110
!export-password: default
hostname Switch3
user admin group administrators password ciphertext
AQBapTSCOBwIL9rRJKZoV4/j4z20j/WuGdmbsngCol52hiZgYgAAAFz33XxqudO8JlPg/UxqociPs340D30yuu8mXTrBqdH
mQVF0d2sMKQTr45gpZLIYrfMzsB4/ejqvJnbRwlJUNORupfRK
UzefIw3SHJRiQ/LrzYlv4QpSy49EhtjwVpWqmjqA
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
    ipv6 address fd00:1:34::1/127
interface 1/1/2
    no shutdown
    ipv6 address fd00:1:13::1/127
interface 1/1/3
    no shutdown
interface 1/1/4
    no shutdown
interface 1/1/5
    no shutdown
interface 1/1/6
    no shutdown
interface loopback 0
    ipv6 address 2001:db8:beef:1011::1/128
interface loopback 1
    ipv6 address 2001:db8:beef:1013::1/128
ipv6 route 2001:db8:beef:111::/64 fd00:1:13::
ipv6 route 3001:101::/64 fd00:1:34::
!
!
!
!
!
https-server vrf mgmt

```

Switch4

```

Switch4# sh run
Current configuration:
!
!Version ArubaOS-CX Virtual.10.06.0110
!export-password: default
hostname Switch4
user admin group administrators password ciphertext
AQBapefBfrpuJXlmMYp2l1lloxaKjgqwNtX20//I87ecSnCqGYgAAAKQmsWvOa9sYAiZx6Gvisg7lbc0PC35idAsNrMYezrd
b9WRTk7X7LcvGbul7z3yIxYPS9+5G/ntqMhcWsrVA8RVTELC/
lehdOjkLzZLyE6ZzP4onoj7lAgUQJWp4+/uH1QDT
led locator on
ntp server pool.ntp.org minpoll 4 maxpoll 4 iburst
ntp enable
!
!
!
!
ssh server vrf mgmt
vlan 1,101
interface mgmt
    no shutdown
    ip dhcp
interface 1/1/1

```

```
no shutdown
no routing
vlan access 101
interface 1/1/2
no shutdown
ipv6 address fd00:1:24::/127
interface 1/1/3
no shutdown
ipv6 address fd00:1:34::/127
interface 1/1/4
no shutdown
interface 1/1/5
no shutdown
interface 1/1/6
no shutdown
interface vlan 101
ipv6 address 3001:101::1/64
no ipv6 nd suppress-ra dnssl
no ipv6 nd suppress-ra rdns
ipv6 route 2001:db8:beef:111::/64 fd00:1:24::1
ipv6 route 2001:db8:beef:111::/64 fd00:1:34::1
ipv6 route 2001:db8:beef:1000::/63 fd00:1:24::1
ipv6 route 2001:db8:beef:1010::/62 fd00:1:34::1
!
!
!
!
!
https-server vrf mgmt
```



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