CCIE Practice Lab: OSPF

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1. Configure the OSPF areas for your network as per the above diagram.
2. For MD5 authentication use `cisco` key.
3. Test your configuration that the correct neighbor relationships have been established. Ensure that you can ping each other’s LAN network.
ANSWER

**NOTE:** This is a trick to putting in the inverse-mask for the OSPF. If you do not know how to calculate the inverse-mask then just put in the normal mask and the router automatically puts the inverse mask in. For example:

```plaintext
Router ospf 100
    Network 137.1.45.0 255.255.255.192 area 0
```

The router would automatically convert this to:

```plaintext
Router ospf 100
    Network 137.1.45.0 0.0.0.63 area 0
```

**ROUTER1**

Interface loopback 0
- Ip address 11.11.11.11 255.255.255.0
- Ip ospf network point-to-point

Interface f0/0
- Ip address 137.1.13.1 255.255.255.248
- Ip ospf message-digest 1 md5 cisco

Interface s0/0
- Ip address 137.1.200.1 255.255.255.224
- Encapsulation frame-relay
- No frame-relay inverse-arp
- Frame-relay map ip 137.1.200.2 101 broadcast
- Ip ospf network point-to-point
- Ip ospf message-digest 1 md5 cisco

Router ospf 100
- Router-id 11.11.11.11
- Network 11.11.11.0 0.0.0.255 area 0
- Network 137.1.13.0 0.0.0.7 area 0
- Network 137.1.200.0 0.0.0.31 area 1
- Area 0 authentication message-digest
- Area 1 authentication message-digest
- Area 1 virtual-link 22.22.22.22 authentication message-digest
- Area 1 virtual-link 22.22.22.22 message-digest-key 1 md5 cisco

**ROUTER2**

Interface loopback 0
- Ip address 22.22.22.22 255.255.255.0
- Ip ospf network point-to-point

Interface e0/0
- Ip address 137.1.24.2 255.255.255.240
- Ip ospf message-digest 1 md5 cisco

Interface s0/0
- Ip address 137.1.200.2 255.255.255.224
Encapsulation frame-relay
No frame-relay inverse-arp
Frame-relay map ip 137.1.200.1 110 broadcast
Ip ospf network point-to-point
Ip ospf message-digest 1 md5 cisco

Router ospf 100
  Router-id 22.22.22.22
  Network 22.22.22.0 0.0.0.255 area 0
  Network 137.1.24.0 0.0.0.15 area 2
  Network 137.1.200.0 0.0.0.31 area 1
  Area 1 authentication message-digest
  Area 1 virtual-link 11.11.11.11 authentication message-digest
  Area 1 virtual-link 11.11.11.11 message-digest-key 1 md5 cisco
  Area 2 authentication message-digest
  Area 2 virtual-link 44.44.44.44 authentication message-digest
  Area 2 virtual-link 44.44.44.44 message-digest-key 1 md5 cisco

ROUTER3

Interface loopback 0
  Ip address 33.33.33.33 255.255.255.0
  Ip ospf network point-to-point

Interface f0/0
  Ip address 137.1.13.3 255.255.255.248
  Ip ospf message-digest 1 md5 cisco

Router ospf 100
  Router-id 33.33.33.33
  Network 33.33.33.0 0.0.0.255 area 0
  Network 137.1.13.0 0.0.0.7 area 0
  Area 0 authentication message-digest

ROUTER4

Interface loopback 0
  Ip address 44.44.44.44 255.255.255.0
  Ip ospf network point-to-point

Interface f0/0
  Ip address 137.1.24.4 255.255.255.240
  Ip ospf message-digest 1 md5 cisco

Interface f0/1
  Ip address 137.1.45.4 255.255.255.192
  Ip ospf message-digest 1 md5 cisco

Router ospf 100
  Router-id 44.44.44.44
  Network 44.44.44.0 0.0.0.255 area 2
  Network 137.1.24.0 0.0.0.15 area 2
  Network 137.1.45.0 0.0.0.63 area 3
  Area 2 authentication message-digest
  Area 2 virtual-link 22.22.22.22 authentication message-digest
  Area 2 virtual-link 22.22.22.22 message-digest-key 1 md5 cisco
  Area 3 authentication message-digest
### ROUTERS

Interface loopback 0  
   Ip address 55.55.55.55  255.255.255.0  
   Ip ospf network point-to-point

Int f0/0  
   Ip address 137.1.45.5  255.255.255.192  
   Ip ospf message-digest 1 md5 cisco

Router ospf 100  
   Router-id 55.55.55.55  
   Network 55.55.55.0  0.0.0.255 area 3  
   Network 137.1.45.0  0.0.0.63 area 3  
   Area 3 authentication message-digest

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.22.22.22</td>
<td>0</td>
<td>FULL/</td>
<td>-</td>
<td>137.1.200.2</td>
<td>OSPF_VL0</td>
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<tr>
<td>33.33.33.33</td>
<td>1</td>
<td>FULL/DR</td>
<td>00:00:35</td>
<td>137.1.13.3</td>
<td>FastEthernet0/0</td>
</tr>
<tr>
<td>22.22.22.22</td>
<td>0</td>
<td>FULL/</td>
<td>00:00:34</td>
<td>137.1.200.2</td>
<td>Serial0/0</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Neighbor ID</th>
<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.11.11.11</td>
<td>0</td>
<td>FULL/</td>
<td>-</td>
<td>137.1.200.1</td>
<td>OSPF_VL0</td>
</tr>
<tr>
<td>11.11.11.11</td>
<td>0</td>
<td>FULL/</td>
<td>00:00:38</td>
<td>137.1.200.1</td>
<td>Serial0/0</td>
</tr>
<tr>
<td>44.44.44.44</td>
<td>1</td>
<td>FULL/DR</td>
<td>00:00:37</td>
<td>137.1.24.4</td>
<td>Ethernet0/0</td>
</tr>
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<tr>
<th>Neighbor ID</th>
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<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.11.11.11</td>
<td>1</td>
<td>FULL/BDR</td>
<td>00:00:33</td>
<td>137.1.13.1</td>
<td>FastEthernet0/0</td>
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<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>22.22.22.22</td>
<td>0</td>
<td>FULL/</td>
<td>-</td>
<td>137.1.24.2</td>
<td>OSPF_VL0</td>
</tr>
<tr>
<td>22.22.22.22</td>
<td>1</td>
<td>FULL/BDR</td>
<td>00:00:37</td>
<td>137.1.24.2</td>
<td>FastEthernet0/0</td>
</tr>
<tr>
<td>55.55.55.55</td>
<td>1</td>
<td>FULL/</td>
<td>00:00:36</td>
<td>137.1.45.5</td>
<td>FastEthernet0/1</td>
</tr>
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<table>
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<tr>
<th>Neighbor ID</th>
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<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.44.44.44</td>
<td>1</td>
<td>FULL/BDR</td>
<td>00:00:38</td>
<td>137.1.45.4</td>
<td>FastEthernet0/0</td>
</tr>
</tbody>
</table>

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<tr>
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<th>Pri</th>
<th>State</th>
<th>Dead Time</th>
<th>Address</th>
<th>Interface</th>
</tr>
</thead>
</table>

OSPF_VL1 is up, line protocol is up  
   Internet Address 0.0.0.0/0, Area 0  
   Process ID 100, Router ID 22.22.22.22, Network Type VIRTUAL_LINK, Cost: 10  
   Configured as demand circuit.  
   Run as demand circuit.  
   DoNotAge LSA allowed.  
   Transmit Delay is 1 sec, State POINT_TO_POINT,  
   Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5  
   oob-resync timeout 40  
   Hello due in 00:00:04  
   Index 3/5, flood queue length 0  
   Next 0x0(0)/0x0(0)  
   Last flood scan length is 1, maximum is 1  
   Last flood scan time is 0 msec, maximum is 0 msec  
   Neighbor Count is 1, Adjacent neighbor count is 1  

   Adjacent with neighbor 44.44.44.44 (Hello suppressed)
Suppress hello for 1 neighbor(s)
Message digest authentication enabled
Youngest key id is 1
OSPF_VL0 is up, line protocol is up

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<td>Process ID 100, Router ID 22.22.22.22, Network Type VIRTUAL_LINK, Cost: 64</td>
</tr>
<tr>
<td>Configured as demand circuit.</td>
</tr>
<tr>
<td>Run as demand circuit.</td>
</tr>
<tr>
<td>DoNotAge LSA allowed.</td>
</tr>
<tr>
<td>Transmit Delay is 1 sec, State POINT_TO_POINT,</td>
</tr>
<tr>
<td>Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5</td>
</tr>
<tr>
<td>oob-resync timeout 40</td>
</tr>
<tr>
<td>Hello due in 00:00:09</td>
</tr>
<tr>
<td>Index 2/4, flood queue length 0</td>
</tr>
<tr>
<td>Next 0x0(0)/0x0(0)</td>
</tr>
<tr>
<td>Last flood scan length is 1, maximum is 4</td>
</tr>
<tr>
<td>Last flood scan time is 0 msec, maximum is 4 msec</td>
</tr>
<tr>
<td>Neighbor Count is 1, Adjacent neighbor count is 1</td>
</tr>
</tbody>
</table>

Adjacent with neighbor 11.11.11.11 (Hello suppressed)
Suppress hello for 1 neighbor(s)
Message digest authentication enabled
Youngest key id is 1
Loopback0 is up, line protocol is up

<table>
<thead>
<tr>
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<td>Process ID 100, Router ID 22.22.22.22, Network Type POINT_TO_POINT, Cost: 1</td>
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<tr>
<td>Transmit Delay is 1 sec, State POINT_TO_POINT,</td>
</tr>
<tr>
<td>Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5</td>
</tr>
<tr>
<td>oob-resync timeout 40</td>
</tr>
<tr>
<td>Hello due in 00:00:02</td>
</tr>
<tr>
<td>Index 1/1, flood queue length 0</td>
</tr>
<tr>
<td>Next 0x0(0)/0x0(0)</td>
</tr>
<tr>
<td>Last flood scan length is 0, maximum is 0</td>
</tr>
<tr>
<td>Last flood scan time is 0 msec, maximum is 0 msec</td>
</tr>
<tr>
<td>Neighbor Count is 0, Adjacent neighbor count is 0</td>
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Suppress hello for 0 neighbor(s)
Serial0/0 is up, line protocol is up

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<th>Internet Address 137.1.200.2/27, Area 1</th>
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<td>Process ID 100, Router ID 22.22.22.22, Network Type POINT_TO_POINT, Cost: 64</td>
</tr>
<tr>
<td>Transmit Delay is 1 sec, State POINT_TO_POINT,</td>
</tr>
<tr>
<td>Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5</td>
</tr>
<tr>
<td>oob-resync timeout 40</td>
</tr>
<tr>
<td>Hello due in 00:00:02</td>
</tr>
<tr>
<td>Index 1/3, flood queue length 0</td>
</tr>
<tr>
<td>Next 0x0(0)/0x0(0)</td>
</tr>
<tr>
<td>Last flood scan length is 1, maximum is 1</td>
</tr>
<tr>
<td>Last flood scan time is 4 msec, maximum is 4 msec</td>
</tr>
<tr>
<td>Neighbor Count is 1, Adjacent neighbor count is 1</td>
</tr>
</tbody>
</table>

Adjacent with neighbor 11.11.11.11
Suppress hello for 0 neighbor(s)
Message digest authentication enabled
Youngest key id is 1
Ethernet0/0 is up, line protocol is up

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<thead>
<tr>
<th>Internet Address 137.1.24.2/28, Area 2</th>
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<tr>
<td>Process ID 100, Router ID 22.22.22.22, Network Type BROADCAST, Cost: 10</td>
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<tr>
<td>Transmit Delay is 1 sec, State BDR, Priority 1</td>
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<tr>
<td>Designated Router (ID) 44.44.44.44, Interface address 137.1.24.4</td>
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<tr>
<td>Backup Designated router (ID) 22.22.22.22, Interface address 137.1.24.2</td>
</tr>
<tr>
<td>Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5</td>
</tr>
<tr>
<td>oob-resync timeout 40</td>
</tr>
<tr>
<td>Hello due in 00:00:03</td>
</tr>
<tr>
<td>Index 1/2, flood queue length 0</td>
</tr>
<tr>
<td>Next 0x0(0)/0x0(0)</td>
</tr>
<tr>
<td>Last flood scan length is 1, maximum is 1</td>
</tr>
<tr>
<td>Last flood scan time is 0 msec, maximum is 4 msec</td>
</tr>
<tr>
<td>Neighbor Count is 1, Adjacent neighbor count is 1</td>
</tr>
</tbody>
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Adjacent with neighbor 44.44.44.44 (Designated Router)
Suppress hello for 0 neighbor(s)
Message digest authentication enabled
Youngest key id is 1
router4# sh ip ospf int
OSPF_VL0 is up, line protocol is up
Internet Address 0.0.0.0/0, Area 0
Process ID 100, Router ID 44.44.44.44, Network Type VIRTUAL_LINK, Cost: 1
Configured as demand circuit.
DoNotAge LSA allowed.
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:02
Index 1/3, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 1
Last flood scan time is 0 msec, maximum is 0 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 22.22.22.22 (Hello suppressed)
Message digest authentication enabled
Youngest key id is 1

FastEthernet0/0 is up, line protocol is up
Internet Address 137.1.24.4/28, Area 2
Process ID 100, Router ID 44.44.44.44, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State DR, Priority 1
Designated Router (ID) 44.44.44.44, Interface address 137.1.24.4
Backup Designated router (ID) 22.22.22.22, Interface address 137.1.24.2
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:06
Index 2/2, flood queue length 0
Next 0x0(0)/0x0(0)
Last flood scan length is 1, maximum is 3
Last flood scan time is 0 msec, maximum is 4 msec
Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 22.22.22.22 (Backup Designated Router)
Suppress hello for 0 neighbor(s)
Message digest authentication enabled
Youngest key id is 1

Loopback0 is up, line protocol is up
Internet Address 44.44.44.24/24, Area 2
Process ID 100, Router ID 44.44.44.44, Network Type POINT_TO_POINT, Cost: 1
Transmit Delay is 1 sec, State POINT_TO_POINT,
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Index 1/1, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 0, maximum is 0
  Last flood scan time is 0 msec, maximum is 0 msec
  Neighbor Count is 0, Adjacent neighbor count is 0
  Suppress hello for 0 neighbor(s)
Message digest authentication enabled
No key configured, using default key id 0

FastEthernet0/1 is up, line protocol is up
Internet Address 137.1.45.4/28, Area 3
Process ID 100, Router ID 44.44.44.44, Network Type BROADCAST, Cost: 1
Transmit Delay is 1 sec, State BDR, Priority 1
Designated Router (ID) 55.55.55.55, Interface address 137.1.45.5
Backup Designated router (ID) 44.44.44.44, Interface address 137.1.45.4
Timer intervals configured, Hello 10, Dead 40, Wait 40, Retransmit 5
  oob-resync timeout 40
  Hello due in 00:00:05
  Index 1/4, flood queue length 0
  Next 0x0(0)/0x0(0)
  Last flood scan length is 1, maximum is 3
  Last flood scan time is 4 msec, maximum is 4 msec
  Neighbor Count is 1, Adjacent neighbor count is 1
  Adjacent with neighbor 55.55.55.55 (Designated Router)
Suppress hello for 0 neighbor(s)
Message digest authentication enabled
Youngest key id is 1

router5# sh ip route
Codes: C - connected, S - static, R - RIP, M - mobile, B - BGP


D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
E1 - OSPF external type 1, E2 - OSPF external type 2
i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, ia - IS-IS inter area
* - candidate default, U - per-user static route, o - ODR
P - periodic downloaded static route

Gateway of last resort is not set

137.1.0.0/16 is variably subnetted, 4 subnets, 4 masks
O IA  137.1.200.0/27 [110/66] via 137.1.45.4, 00:06:17, FastEthernet0/0
O IA  137.1.13.0/29 [110/67] via 137.1.45.4, 00:04:47, FastEthernet0/0
O IA  137.1.24.0/28 [110/2] via 137.1.45.4, 00:06:17, FastEthernet0/0
C  137.1.45.0/26 is directly connected, FastEthernet0/0
33.0.0.0/24 is subnetted, 1 subnets
O IA  33.33.33.0 [110/68] via 137.1.45.4, 00:04:43, FastEthernet0/0
55.0.0.0/24 is subnetted, 1 subnets
C  55.55.55.0 is directly connected, Loopback0
22.0.0.0/24 is subnetted, 1 subnets
O IA  22.22.22.0 [110/3] via 137.1.45.4, 00:06:18, FastEthernet0/0
11.0.0.0/24 is subnetted, 1 subnets
O IA  11.11.11.0 [110/67] via 137.1.45.4, 00:06:18, FastEthernet0/0
44.0.0.0/24 is subnetted, 1 subnets
O IA  44.44.44.0 [110/2] via 137.1.45.4, 00:06:19, FastEthernet0/0

router5# sh ip ospf database

OSPF Router with ID (55.55.55) (Process ID 100)

Router Link States (Area 3)

<table>
<thead>
<tr>
<th>Link ID</th>
<th>ADV Router</th>
<th>Age</th>
<th>Seq#</th>
<th>Checksum</th>
<th>Link count</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.44.44.44</td>
<td>44.44.44.44</td>
<td>418</td>
<td>0x80000006</td>
<td>0x00D37F</td>
<td>1</td>
</tr>
<tr>
<td>55.55.55.55</td>
<td>55.55.55.55</td>
<td>416</td>
<td>0x80000005</td>
<td>0x09F94B</td>
<td>2</td>
</tr>
</tbody>
</table>

Net Link States (Area 3)

<table>
<thead>
<tr>
<th>Link ID</th>
<th>ADV Router</th>
<th>Age</th>
<th>Seq#</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>137.1.45.5</td>
<td>55.55.55.55</td>
<td>418</td>
<td>0x80000001</td>
<td>0x0076DB</td>
</tr>
</tbody>
</table>

Summary Net Link States (Area 3)

<table>
<thead>
<tr>
<th>Link ID</th>
<th>ADV Router</th>
<th>Age</th>
<th>Seq#</th>
<th>Checksum</th>
</tr>
</thead>
<tbody>
<tr>
<td>11.11.1.0</td>
<td>44.44.44.44</td>
<td>470</td>
<td>0x80000001</td>
<td>0x0065C3</td>
</tr>
<tr>
<td>22.22.22.0</td>
<td>44.44.44.44</td>
<td>470</td>
<td>0x80000001</td>
<td>0x0055F2</td>
</tr>
<tr>
<td>33.33.33.0</td>
<td>44.44.44.44</td>
<td>313</td>
<td>0x80000001</td>
<td>0x005491</td>
</tr>
<tr>
<td>44.44.44.0</td>
<td>44.44.44.44</td>
<td>495</td>
<td>0x80000001</td>
<td>0x0030D6</td>
</tr>
<tr>
<td>137.1.13.0</td>
<td>44.44.44.44</td>
<td>317</td>
<td>0x80000003</td>
<td>0x002D8A</td>
</tr>
<tr>
<td>137.1.24.0</td>
<td>44.44.44.44</td>
<td>495</td>
<td>0x80000001</td>
<td>0x00PAF3</td>
</tr>
<tr>
<td>137.1.200.0</td>
<td>44.44.44.44</td>
<td>470</td>
<td>0x80000001</td>
<td>0x008591</td>
</tr>
</tbody>
</table>

router5# trace 33.33.33.33

Type escape sequence to abort.
Tracing the route to 33.33.33.33

1 137.1.45.4 4 msec 0 msec 0 msec
2 137.1.24.2 4 msec 4 msec 0 msec
3 137.1.200.1 28 msec 28 msec 28 msec
4 137.1.13.3 28 msec * 28 msec

router3# ping 55.55.55.55

Type escape sequence to abort.
Sending 5, 100-byte ICMP Echos to 55.55.55.55, timeout is 2 seconds:
!!!!!
Success rate is 100 percent (5/5), round-trip min/avg/max = 56/57/64 ms

P1Switch# show vlan

<table>
<thead>
<tr>
<th>VLAN Name</th>
<th>Status</th>
<th>Ports</th>
</tr>
</thead>
</table>
2  VLAN0002  active  Fa0/7, Fa0/10  
3  VLAN0003  active  Fa0/2, Fa0/6  
4  VLAN0004  active  Fa0/8, Fa0/21  

<output truncated...>