

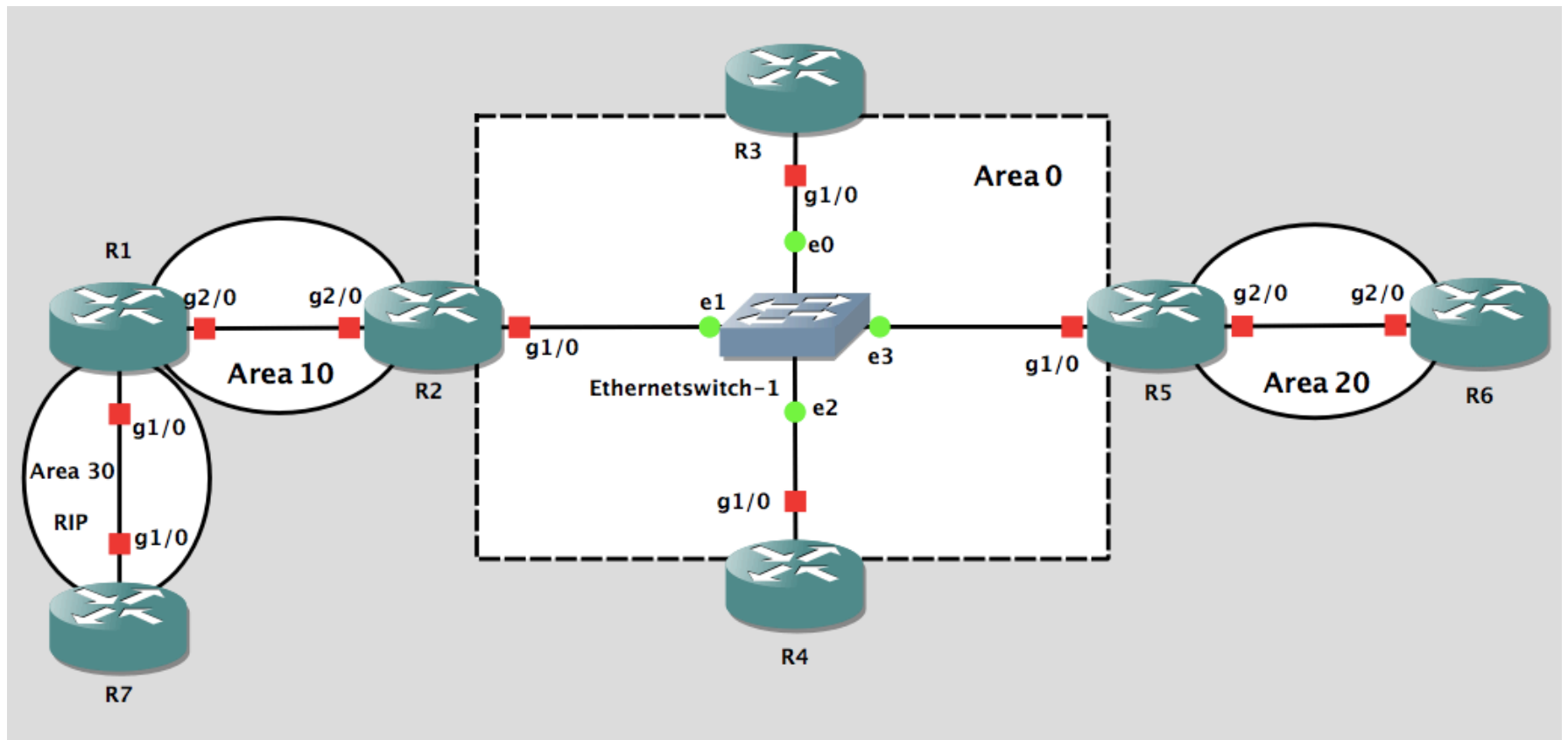
OSPF

Lab Activity



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Topology



IP Plan

- OSPF Region (R1 – R7)
 - Loopback 10: 10.10.10.X/32
 - Peering: 100.100.XY.X(Y)/24
 - OSPF Router ID: X.X.X.X
 - OSPF Process ID: 1
 - R2, R3, R4 and R5
 - Interface IP: 100.100.100.X/24
- RIP Region (R7)
 - Loopback 10: 20.20.20.10/32
 - Loopback 20: 20.20.20.20/32

Task 0: Troubleshooting Basics

Verifying OSPF

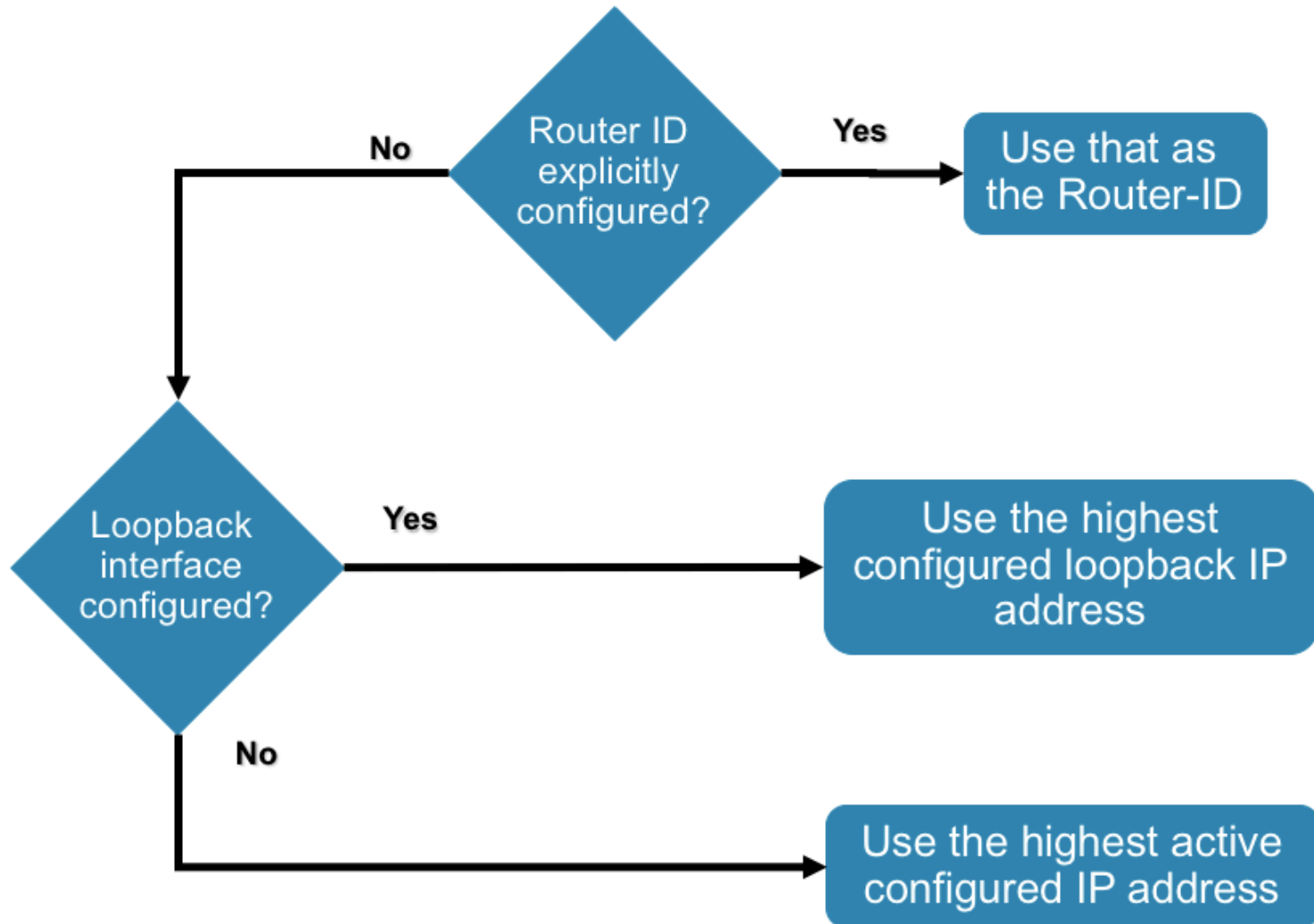
Command	Description
show ip protocols	Displays OSPF process ID, router ID, networks router is advertising & administrative distance
show ip ospf neighbors	Displays OSPF neighbor relationships.
show ip route	Displays the routing table.
show ip ospf interface	Displays hello interval and dead interval
show ip ospf	Displays OSPF process ID, router ID, OSPF area information & the last time SPF algorithm calculated

Clear OSPF

- To clear all routes from the IP routing table, use:
 - **Router# clear ip route ***
- To clear a specific route from the IP routing table, use:
 - **Router# clear ip route *prefix***
- To clear all OSPF processes on the router, use:
 - **Router# clear ospf process ***
- To clear a specific OSPF processes on the router, use:
 - **Router# clear ospf process *process_id***

Task 1: Router-ID

Router-ID Selection Process



Task 1: Router-ID

R2 (config) #router ospf 1

*Dec 15 12:51:42.667: %OSPF-4-NORTRID:
OSPF process 1 cannot pick a router-id.
Please configure manually or bring up
an interface with an ip address.

Ops... OSPF process
can not run without
a router-id

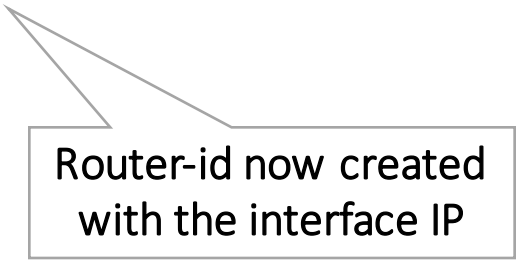
Router-id can be configured
manually or automatically (with
the IP Address of UP interface)

Task 1: Router-ID

```
R2 (config) #interface Gi2/0
R2 (config-if) #ip address 100.100.12.2 255.255.255.0
R2 (config-if) #no shut
R2 (config-if) #exit
R2 (config) #router ospf 1
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 100.100.12.2
```



Router-id now created
with the interface IP

Task 1: Router-ID

```
R2 (config) #interface Gi2/0
```

```
R2 (config-if) #shutdown
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 100.100.12.2
```

Once selected, Router-id remains the same even if the interface is DOWN

```
R2 (config) #interface Gi1/0
```

```
R2 (config-if) #ip address 100.100.100.2 255.255.255.0
```

```
R2 (config-if) #no shut
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 100.100.12.2
```

Once selected, Router-id remains the same even if new interface has higher IP

```
R2#clear ip ospf process 1
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 100.100.23.2
```

Router-id gets updated once the OSPF process (or the router) restarts

Task 1: Router-ID

```
R2 (config)#interface Loopback10
```

```
R2 (config-if)#ip address 10.10.10.2 255.255.255.255
```

```
R2#clear ip ospf process 1
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 10.10.10.2
```

```
R2 (config)#router ospf 1
```

```
R2 (config-router)#router-id 2.2.2.2
```

Highest loopback IP address becomes Router-id even if UP interfaces have higher IP

```
R2#clear ip ospf process 1
```

```
R2#show ip ospf
```

```
Routing Process "ospf 1" with ID 2.2.2.2
```

Manually configured Router-id supersedes all other rules

Task 2: Interface and OSPF Config

Example: R5

```
R4 (config) #interface loopback10
R4 (config-if) #ip address 10.10.10.5 255.255.255.255
R4 (config-if) #ip ospf 1 area 0
R4 (config-if) #exit
R4 (config) #interface Gi1/0
R4 (config-if) #ip address 100.100.100.5 255.255.255.0
R4 (config-if) #no shutdown
R4 (config-if) #ip ospf 1 area 0
R4 (config-if) #exit
R4 (config) #interface Gi2/0
R4 (config-if) #ip address 100.100.56.5 255.255.255.0
R4 (config-if) #no shutdown
R4 (config-if) #ip ospf 1 area 20
R4 (config-if) #exit
R4 (config) #router ospf 1
R4 (config-router) #router-id 2.2.2.2
```

Task 3: Virtual Link

Task 3: Virtual Link

- Check routing table of R1, R2 and R7

R7#sh ip route

```
Gateway of last resort is not set
      100.0.0.0/24 is subnetted, 1 subnets
C       100.100.17.0 is directly connected, GigabitEthernet1/0
      10.0.0.0/32 is subnetted, 1 subnets
C       10.10.10.7 is directly connected, Loopback10
```

R1#show ip ospf neighbors

Neighbor ID	Pri	State	Dead Time	Address	Interface
2.2.2.2	1	FULL/DR	00:00:34	100.100.12.2	Gi2/0

Task 3: Virtual Link

- Configure Virtual-link between R1 and R2

```
R1 (config-router)#area 10 virtual-link 2.2.2.2
```

- Check routing table of R1, R2 and R7 again

```
show ip route ospf
```

```
show ip ospf neighbors
```

- Ping R6 from R7

Task 3: Virtual Link

```
R1#sh ip ospf virtual-links
```

```
Virtual Link OSPF_VL0 to router 2.2.2.2 is up  
  Run as demand circuit  
  DoNotAge LSA allowed.  
  Transit area 10, via interface GigabitEthernet2/0,  
Cost of using 1  
  Transmit Delay is 1 sec, State POINT_TO_POINT,  
  Timer intervals configured, Hello 10, Dead 40,  
Wait 40, Retransmit 5
```

Task 4: OSPF Timers

Task 4: OSPF Timers

```
R4#sh ip ospf 1 interface gi1/0
```

```
GigabitEthernet1/0 is up, line protocol is up
  Internet Address 100.100.100.4/24, Area 0
  Process ID 1, Router ID 4.4.4.4, Network Type BROADCAST, Cost: 1
  Enabled by interface config, including secondary ip addresses
  Transmit Delay is 1 sec, State DR, Priority 1
  Designated Router (ID) 4.4.4.4, Interface address 100.100.100.4
  Backup Designated router (ID) 3.3.3.3, Interface address
  100.100.100.3
  Timer intervals configured, Hello 10, Dead 40, Wait 40,
  Retransmit 5
    oob-resync timeout 40
    Hello due in 00:00:02
```

```
<output omitted fro brevity>
```

Task 4: OSPF Timers

- Check the timers from R5 and R6

```
sh ip ospf 1 interface gi2/0
```

- Turn on debug in R6

```
debug ip ospf hello
```

- Configure hello and dead interval in R5 and R6.

Neighbor won't be established with different timers.

```
interface Gi0/2
```

```
ip ospf hello-interval 5
```

```
ip ospf dead-interval 15
```

- Check the timers from R5 and R6 again
- Analyze the debug messages in R6

Task 5: DR/BDR Selection

The Election of DR/BDR

1. All neighbors with a priority > 0 are listed.
2. The router with highest priority is elected DR.
If there is a tie, the highest router IDs are used.
3. If there is no DR, the BDR is promoted as DR.
4. The neighbor with the next highest priority is elected BDR.

Task 5: DR/BDR Election

- Shutdown Gi1/0 of R2 – R5

```
interface Gi1/0  
shutdown
```

- Turn on debug in R4

```
R4#debug ip ospf adj
```

- Turn on Gi1/0 of R3 and R4

- Check DR and BDR from R3

```
R3#show ip ospf neighbors
```

- Analyze debug message in R4

Task 5: DR/BDR Election

- Turn off Debug in R4
R4#undebug all
- Turn on Gi1/0 of R5
- Check DR and BDR
 - Any change?
- Shutdown Gi1/0 of DR and check DR/BDR again
 - Any change?
- Turn on Gi1/0 of DR and check DR/BDR again
 - Any change now?

Task 5: DR/BDR Election

- Turn off Gi1/0 of R2 – R5
- Configure priority
 - Make R4 as DR, R3 as BDR and R5 as DROTHER
- ```
R5(config)#interface gi1/0
```

```
R5(config-if)#ip ospf priority <value>
```
- Turn on Gi1/0 of R2 – R5 and check DR/BDR
  - Any reflection?
- Restart Ethernetswitch-1 and check DR/BDR again
  - Any change?

## Task 6: DR/BDR in Point-to-Point Link

# Task 6: DR/BDR in Point-to-Point Link

- Turn on debug in R6

```
R6#debug ip ospf adj
```

- Configure network type point-to-point in R5 and R6

```
interface GigabitEthernet2/0
```

```
ip ospf network point-to-point
```

- Has the adjacency been reset?

# Task 6: DR/BDR in Point-to-Point Link

- Check neighbors
  - Any change in DR/BDR election?

**R5#sh ip ospf neighbors**

| Neighbor ID | Pri | State   | Dead Time | Address      | Interface |
|-------------|-----|---------|-----------|--------------|-----------|
| 6.6.6.6     | 0   | FULL/ - | -         | 100.100.23.3 | Gi2/0     |

- Analyze the debug message

# Task 7: OSPF Authentication

# Task 7: OSPF Authentication

- Three types of message:
  1. Type 0: No authentication
  2. Type 1: Plaintext password
  3. Type 2: MD5 password

# Task 7: OSPF Authentication

- Turn on debug in R6  
`R6#debug ip ospf adj`
- Configure plaintext authentication in R5 and **no authentication in R6**
  - Check debug message
- Configure **different** plaintext authentication between R5 and R6
  - Check debug message
- Configure MD5 authentication between R5 and R6
  - Configure **two different MD5 password** in R6
  - Check debug message



# Example: R5

## MD5 Authentication:

```
interface GigabitEthernet2/0
 ip ospf authentication message-digest
 ip ospf message-digest-key 1 md5 ospflab
```

## Plaintext Authentication:

```
interface GigabitEthernet2/0
 ip ospf authentication
 ip ospf authentication-key ospflab
```

## Task 8: Passive Interface

# Task 8: Passive Interface

- Router stops exchanging “OSPF Hello” through passive interfaces
  - No OSPF neighbor is established through passive interface
- Router does not include network addresses of passive interfaces in LSU
  - OSPF speaking routers can't learn the network address via OSPF
  - OSPF speaking routers can't see the network address in their routing table via OSPF

# Task 8: Passive Interface

- Configure passive interface in R1
  - Without 'default'
  - With 'default'
- Check R1's loopback 10 from R4
  - Make loopback 10 passive
  - Check R1's loopback 10 from R4 again
  - Anything different?
- Revert back to the previous configuration

# Example: R1

```
router ospf 1
 passive-interface gi1/0
```

Or:

```
router ospf 1
 passive-interface default
 no passive-interface gi2/0
```

## Task 9: OSPF Metric (Cost)

# Task 9: OSPF Metric (Cost)

| Interface Type           | $10^8/\text{bps} = \text{Cost}$    |
|--------------------------|------------------------------------|
| Fast Ethernet and faster | $10^8/100,000,000 \text{ bps} = 1$ |
| Ethernet                 | $10^8/10,000,000 \text{ bps} = 10$ |
| E1                       | $10^8/2,048,000 \text{ bps} = 48$  |
| T1                       | $10^8/1,544,000 \text{ bps} = 64$  |
| 128 kbps                 | $10^8/128,000 \text{ bps} = 781$   |
| 64 kbps                  | $10^8/64,000 \text{ bps} = 1562$   |
| 56 kbps                  | $10^8/56,000 \text{ bps} = 1785$   |

- The ref-bw parameter is the reference bandwidth in Mbps
  - The range is from 1 to 4,294,967; **The default is 100.**
- Use this command if interfaces are faster than 100 Mbps.
  - The command must be configured on all OSPF routers to ensure accurate route calculations.

# Task 9: OSPF Metric (Cost)

- Check the OSPF cost of R5's Gi2/0
- Change OSPF Cost in R5
  - Set auto-cost reference BW to 10000 (Mbps)
    - Check the OSPF table in R5
    - Any difference?
  - Set Gi2/0 with BW 10000 (Kbps)
    - Check the OSPF table in R5
    - Any difference?
  - Set Gi2/0 with cost 15
    - Check the OSPF table in R5
    - Any difference?
- Revert back to the previous configuration



# Example: R5

```
router ospf 1
```

```
 auto-cost reference-bandwidth 10000
```

Or:

```
int gi2/0
```

```
 bandwidth 10000
```

Or:

```
int gi2/0
```

```
 ip ospf cost 15
```

# Task 9: OSPF Metric (Cost)

- Verification

```
show ip route ospf
```

```
show ip ospf 1 int <interface_id>
```

```
show int <interface_id>
```

# Task 10: External Route Redistribution

# Task 10: External Route Redistribution

- Configure RIP in R1 and R7
  - Network
  - Version
  - No auto-summary
- Check RIP Routes
  - show ip route
  - show ip rip database
- Redistribute RIP into OSPF in R1
  - With and without subnet
  - With and without metric
  - With and without metric-type
  - With metric-type and metric

# Example: R7

```
interface Loopback10
 ip address 20.20.20.10 255.255.255.255
interface Loopback20
 ip address 20.20.20.20 255.255.255.255
interface GigabitEthernet1/0
 ip address 100.100.17.7 255.255.255.0

router rip
 version 2
 network 20.20.20.10
 network 20.20.20.20
 network 100.100.17.0
 no auto-summary
```

# Example: R1

```
router ospf 1
 redistribute rip subnets
```

```
router rip
 redistribute ospf 1 metric 2
```

# Task 11: Default Route

# Task 11: Default Route

- Configure default information in R1
  - Without 'always' option
  - With 'always' option
  - With metric value
- Check routing table of R6 for both option
- **Remove the configuration** and return to the previous configuration



# Example: R1

```
router ospf 1
 default-information originate [always]
```

```
ip route 0.0.0.0 0.0.0.0 null 0
router ospf 1
 default-information originate
```

# Task 12: Inter-area Route Summarization

# Task 12: Inter-area Route Summarization

- Check routing table of R1
- Configure summary route in R2
  - Range 10.10.10.0 for area 0
- Re-check routing table of R1
  - Any change?
- Remove the configuration

# Example: R2

```
router ospf 1
 area 0 range 10.10.10.0 255.255.255.0
```

# Task 13: External Route Summarization

# Task 13: External Route Summarization

- Check external routes from R6's routing table
- Check OSPF database of R1 for type-5 and 7 LSA
- Configure route summarization in R1
  - For RIP routes
- Re-check external routes from R6's routing table
- Check the routing table of R1 for null route
- Re-check OSPF database of R1 for type-5 and 7 LSA
- Remove the configuration

# Example: R1

```
router ospf 1
 summary-address 20.20.20.0 255.255.255.0
```

## Task 14: Stub and Totally Stub Area



# Task 14: Stub and Totally Stub Area

- Configure area 20 as stub
- Check the routing table
- Check OSPF database from R5 and R6
  - Any LSA type 4 or 5?
- Configure area 20 as totally stub
- Check routing table
- Re-check OSPF database from R5 and R6
  - Any change?

# Example: R5

Stub area:

```
router ospf 1
 area 20 stub
```

Totally stub area:

```
router ospf 1
 area 20 stub no-summary
```

## Task 15: NSSA and Totally NSSA Area

# Task 15: NSSA and Totally NSSA Area

- Configure area 10 as NSSA
- Check the routing table from R1, R2 and R5
- Check OSPF database from R1, R2 and R5
  - Check LSA type-7, 5,4 and 3
- Configure area 10 as totally NSSA
- Check routing table from R1, R2 and R5
- Re-check ospf database R1, R2 and R5
  - Any change?

# Example: R1

## NSSA:

```
router ospf 1
 area 10 nssa default-information-originate
```

## Totally NSSA:

```
router ospf 1
 area 10 nssa no-summary
```

# Question?