

Lab 5: Multi-area OSPF

Or: When one area just isn't enough

What You Will Do:

Working in pairs, combine your skills & knowledge to:

1. Configure multi-area OSPF for IPv4, the key to making OSPF more efficient and scalable
2. Confirm full end-to-end network reachability.
3. Capture and examine output from show commands which reveal the state of the network, especially the LSDBs and router states.

Things that you will need to know or learn:

1. How to set up single-area OSPF (from previous lab)

What you need to submit and when:

1. Complete the pre-lab quiz on BrightSpace, **before** the start of your lab period.
2. Complete the in-lab part of the exercise (see below), **before** the end of your lab period.
3. Complete post-lab exercise and quiz on BrightSpace, **before** your next lab.

Required Equipment:

- A laptop and/or a USB memory stick to save results for post-lab questions
- **Hard-cover lab notebook**, for reference during **SBA** at the end of the course.

In-Lab Marks:

[1 mark] Proof of multi-area OSPF (Task 5 completed) with suitable "show" command(s)

[1 mark] Full end-to-end connectivity throughout your entire network.

The pre-lab is worth **30%**, the in-lab is worth **35%**, and the post-lab is worth **35%** of this lab, even though the number of points may differ between two parts.

References and Resources:

- Slide deck on multi-area OSPF networks, posted on course site
- Multi-area OSPF (free chapter) <https://www.ciscopress.com/articles/article.asp?p=2738303>
- Packet Tracer ver 8 (available from NetAcad)

Command List

```
router ospf {pID}                (Repeat)
router-ID {rID}
auto-cost reference-bandwidth
default-information originate

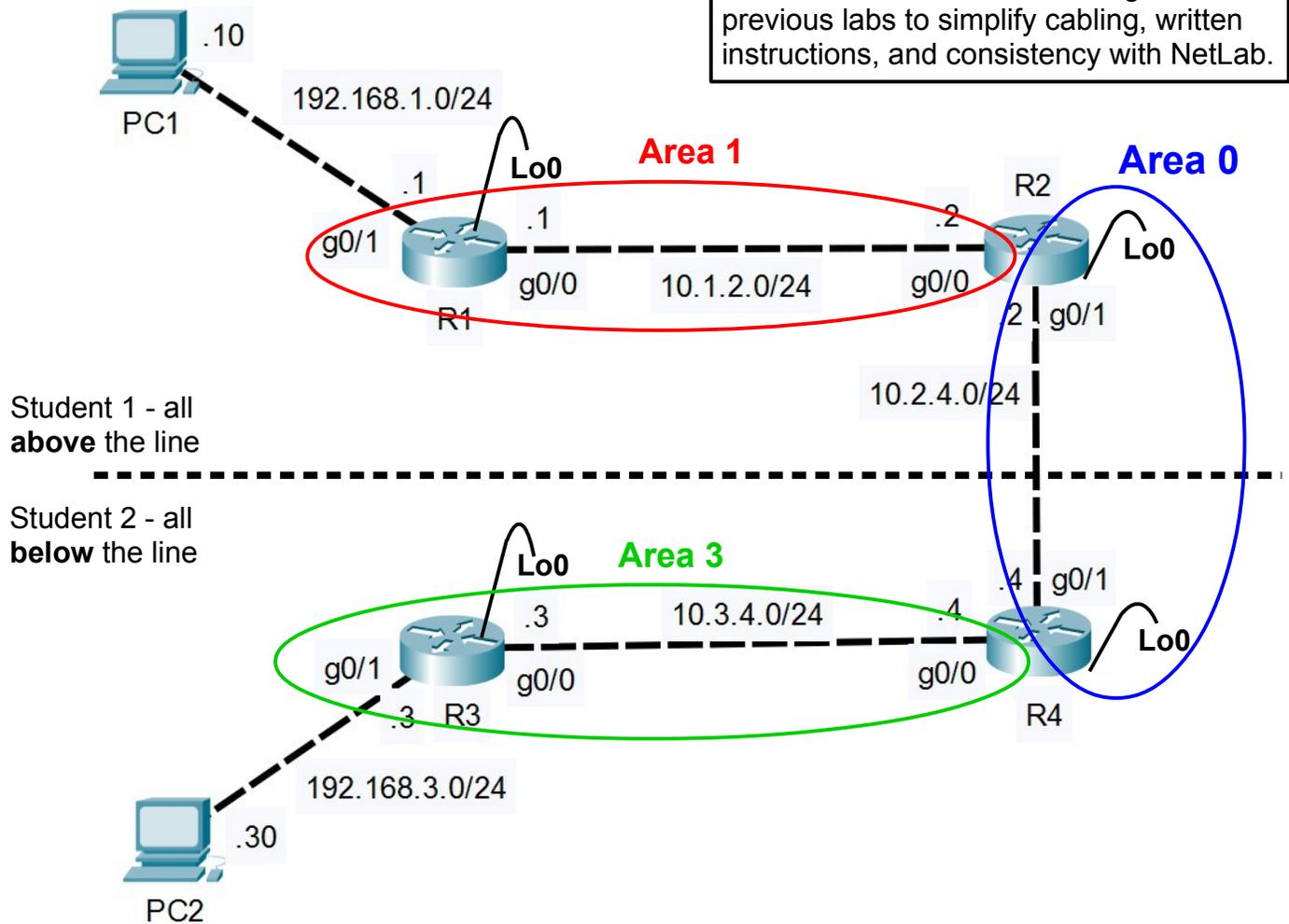
ip ospf {pID} area {X}           (Repeat)
ip ospf network point-to-point

show ip route [ospf]             (Repeat)
show ip protocols                 (Repeat)
show ip ospf [...possibly with options...]
show ip ospf interface [brief]   (Repeat)
show ip ospf neighbor [detail]   (Repeat)
show ip ospf database            (Repeat)
```

N.B. 7 of 11 commands are repeats from previous lab work, so only 4 new commands.

Topology and Addressing Diagram

Note: some interfaces re-arranged from previous labs to simplify cabling, written instructions, and consistency with NetLab.



Device	Interface	Address	Gateway
R1 (student 1) LHS rack (odd # pods): R1, or R3, or R5	G0/0, G0/1	As per topology	(None needed since OSPF will distribute info of all subnets!)
	Lo0 – Loopback 0	10.10.10.1/32	
R2 (student 1) RHS rack (even #pods): R1, or R3, or R5	Gi0/0, G0/1	As per topology	(None needed since OSPF will distribute info of all subnets!)
	Lo0 – Loopback 0	10.10.10.2/32	
PC1 (student 1)	Realtek NIC	192.168.1.10/24	?
R3 (student 2) LHS rack (odd # pods): R2, or R4, or R6)	G0/0, G0/1	As per topology	(None needed since OSPF will distribute info of all subnets!)
	Lo0 – Loopback 0	10.10.10.3/32	
R4 (student 2) RHS rack (even #pods): R2, or R4, or R6)	Gi0/0, G0/1	As per topology	(None needed since OSPF will distribute info of all subnets!)
	Lo0 – Loopback 0	10.10.10.4/32	
PC2 (student 2)	Realtek NIC	192.168.3.30/24	?

Task 1: Cable the Network

Cable the devices as shown in the diagram above, to create the required network topology.

Task 2: Configure basic *settings for PCs*

Working in parallel with your partner, determine the correct gateway address for each PC. Configure the necessary IP settings: address, mask, and gateway.

Task 3: Configure your two Routers with the essentials

Still working in parallel with your partner, your two routers need to be configured with the four essential categories of basic config. This is a repeat from previous labs. Hopefully the benefit of backing up, then copying & pasting configs is coming through loud and clear!!

Remember to verify connectivity between your PC and associated router. A successful ping from the PC to the router's loopback is rock-solid confirmation of full connectivity between PC + router.

Telnet or SSH from your PC to its associated router, so that you can move the console cable to the right-side router. Like previous labs, you'll want to have the benefit of side-by-side simultaneous windows to both routers.

Task 4: Configure an OSPF Internal Router

We'll begin with configuring OSPF on just the left-side router (attached to your PC). Prior to joining it the right-side router as a neighbour (next task), it behaves as a simple, single-area router. That means we can use it as a reference setup for comparison with a multi-area scenario.

Configure: Repeat the OSPF config process from last lab. Key points to remember:

- Be kind to us humans: use a consistent process ID throughout. Use "5" since this is Lab5.
- Explicitly set the router ID to match the loopback IP address. (new)
- Use the correct area when including interfaces: **area 1** for the top / **area 3** for the bottom.
- Remember lessons learned last week: don't forget to include the loopback interface!

and two more new items for this lab:

- Configure the reference bandwidth to accurately calculate costs for speeds up to 1 Tbps*.
- Configure all interfaces in OSPF as point-to-point.

Verify:

- Confirm (prove!) that OSPF is running and all the interfaces are in OSPF: **show ip protocols**
Hunt in the output to find 4 key items: process ID, router ID, # of areas (1), list(s) of interfaces.
- Compare the interface info from a more specific command: **show ip ospf interface brief**
Read through the output to find 4 key items: process ID, area #, cost, and neighbours (Nbrs)
- Grab a copy of the routing table, for comparison after there's neighbour(s): **show ip route**

Capture and **save** the output of all commands for later reference.

* Some might argue this value should be higher, into the multi-Terabit range:

<https://www.infinera.com/press-release/zayo-group-worlds-longest-800g-optical-wave-supported-by-infinera>

Task 5: Configure a Backbone Router

The *right-side* router is both a backbone router and an ABR. (Be sure you know why!) Configuring it is almost an exact repeat of the previous task, except for which areas to which the interfaces are attached.

Configure:

- Configure OSPF (e.g. like you did in the previous task)
- For the moment, **leave G0/1 shutdown** so that top and bottom halves remain separated. (You'll enable the G0/1 interfaces for end-to-end connectivity in Task 7.)
- Be mindful of the areas for the interfaces: G0/0 = **area 1 or 3**; G0/1 + loopback = **area 0**
- Don't forget the reference bandwidth and make all interfaces point-to-point

For troubleshooting, it makes sense to start by confirming that all interfaces including loopbacks are up/up, and then directly connected interfaces of neighbours are reachable via ping.

Verify:

– Grab (and save!) some output now that there's neighbours and compare with the previous task:
Left side router (R1/R3) – routing table; ip protocols; LSDB
Right side router (R2/R4) – routing table; ip protocols; LSDB

Q: Does the *new* output from the right-side routers give any indication that they are ABRs??
Hint: check the lines in *show ip protocols* carefully!

Take a few minutes to digest and hopefully understand the LSDB for the right side router (R2/R4). Of any single output, understanding that one is the most significant accomplishment!

CHECK POINT: Point out proof from the output of either command that multi-area OSPF exists.

Task 6: Configure a Default Route

Most networks at the enterprise scale or smaller need a default route. In this task, you'll use two additional commands to add a default route to the right-side router (in area 0). Then you'll verify that it shows up in the routing table and LSDB of the left-side route.

Configure:

- Add a "dummy" (or *blackhole*) default route to loopback 0 on the right-side router (R2, R4) (see the pre-lab quiz, or section 2.5 of the Wk03 slide deck on configuring OSPF)
- Add the command so that the router shares the newly installed default route.

Verify:

– Grab (and save!) the (a) routing table and (b) LSDB for both the left and right-side routers.

Q: Can you identify: the new default route and new LSA(s)? What LSA *type* is the default route?

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Task 7: Join the Networks for End-to-End Connectivity

For full end-to-end connectivity, all that's required is to ensure that G0/1 on both routers (the vertical interfaces) are added into OSPF in area 0 and enabled (no shut).

Configure:

- Ensure the G0/1 interfaces are added in OSPF as point-to-point links.
Q: What command (issued in previous tasks!) confirms this?
- Enable the interfaces on both routers, then wait a dozen secs or so for convergence.

Verify:

– Grab (and save!) the (a) routing table and (b) LSDB for all four routers.
What changes are you expecting to see?

CHECK POINT: Have a CMD window open showing full end-to-end connectivity between PCs.

Task 8: Backups and Clearing the equipment

You'll want/need a backup of the config for all four routers for the post-lab. Make backups of your two routers, then exchange configs with your lab partner.

Be sure your equipment is cleared of all config before de-cabling and powering down.

show startup-config If the startup-exists, then: **erase startup-config**

Good work in lab today!