

Lab 01: Campus Core Hub and Spoke

Cisco Packet Tracer Lab Guide

Building a clean campus core with one core multilayer switch and three building access switches

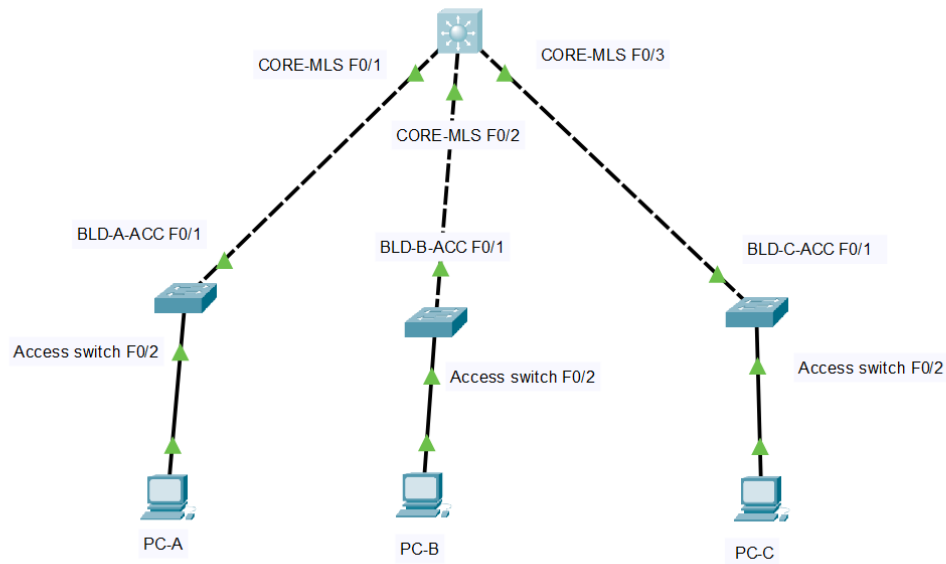


Figure 1. Packet Tracer target topology for Lab 01

Lab level	Foundation
Estimated time	45 to 60 minutes
Main topic	Campus core infrastructure design and hub-and-spoke access design
Packet Tracer devices	1 multilayer switch, 3 access switches, 3 PCs
Main skill	Create clean building spokes, assign one VLAN per building, enable inter-building routing at the core

Design decision for this lab

This first lab uses access uplinks between CORE-MLS and each building switch because each building carries one user VLAN only. This keeps the first lab simple and helps students understand the hub-and-spoke model. Later VLAN labs should use trunk uplinks when one building carries multiple VLANs.

1. Lab Description

In this lab, you build a simple campus hub-and-spoke network. The CORE-MLS device acts as the central hub. Each building access switch acts as a spoke. Each building has one user subnet and one connected PC. The core multilayer switch provides the default gateway for all buildings and routes traffic between the building subnets.

The design teaches a key campus rule: every building should connect back to a central core instead of chaining buildings together. This reduces troubleshooting time, keeps the path short, and helps the network grow in a controlled way.

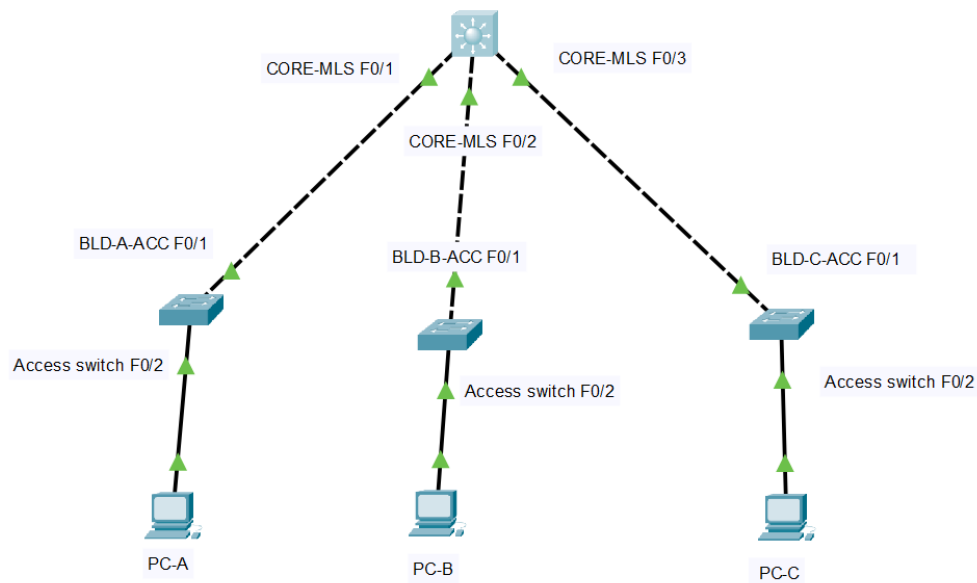
2. Why Students Are Doing This Lab

- To understand why the campus core is the hub in a hub-and-spoke design.
- To avoid daisy chaining buildings or switches across the campus.
- To create one clean Layer 2 access spoke per building.
- To configure VLAN-based segmentation, with routing performed at the core.
- To verify end-to-end reachability between building subnets.
- To learn when an access uplink is acceptable and when a trunk uplink is needed.

Instructor message

Access uplinks are acceptable here because each building has one VLAN only. A trunk becomes the right choice when a building carries several VLANs such as Staff, Students, Voice, CCTV, and Management. A routed Layer 3 uplink becomes the best design when each building has a Layer 3 distribution switch.

3. Target Topology



3.1 Devices

Device name	Packet Tracer device	Role	Purpose
CORE-MLS	3560 Multilayer Switch	Campus core	Gateway and inter-VLAN routing for all building spokes
BLD-A-ACC	2960 Switch	Building A access	Access layer for PC-A
BLD-B-ACC	2960 Switch	Building B access	Access layer for PC-B
BLD-C-ACC	2960 Switch	Building C access	Access layer for PC-C
PC-A	PC	Building A user	End-host test station
PC-B	PC	Building B user	End-host test station
PC-C	PC	Building C user	End-host test station

3.2 Cable Map

Link	From device	From port	To device	To port
1	CORE-MLS	Fa0/1	BLD-A-ACC	Fa0/1
2	CORE-MLS	Fa0/2	BLD-B-ACC	Fa0/1
3	CORE-MLS	Fa0/3	BLD-C-ACC	Fa0/1
4	BLD-A-ACC	Fa0/2	PC-A	FastEthernet0
5	BLD-B-ACC	Fa0/2	PC-B	FastEthernet0
6	BLD-C-ACC	Fa0/2	PC-C	FastEthernet0

3.3 VLAN and Addressing Plan

Building	VLAN	VLAN name	Subnet	Core gateway	PC address
Building A	10	BLD_A_USERS	192.168.10.0/24	192.168.10.1	PC-A 192.168.10.10/24
Building B	20	BLD_B_USERS	192.168.20.0/24	192.168.20.1	PC-B 192.168.20.10/24
Building C	30	BLD_C_USERS	192.168.30.0/24	192.168.30.1	PC-C 192.168.30.10/24
Switch	Management VLAN interface		Management IP	Default gateway	
BLD-A-ACC	VLAN 10		192.168.10.2/24	192.168.10.1	
BLD-B-ACC	VLAN 20		192.168.20.2/24	192.168.20.1	
BLD-C-ACC	VLAN 30		192.168.30.2/24	192.168.30.1	

4. Build Steps

Step 1: Place and rename devices

- Place one multilayer switch and rename it CORE-MLS.
- Place three access switches and rename them BLD-A-ACC, BLD-B-ACC, and BLD-C-ACC.
- Place three PCs and rename them PC-A, PC-B, and PC-C.
- Cable the devices according to the cable map.

Step 2: Configure the CORE-MLS

CORE-MLS full configuration

```
enable
configure terminal
hostname CORE-MLS
no ip domain-lookup
ip domain-name campus.local

service password-encryption

enable secret Enable@123

username admin privilege 15 secret Campus@123

banner motd #UNAUTHORIZED ACCESS IS PROHIBITED#

line console 0
password Console@123
login
logging synchronous
exec-timeout 5 0
exit

line vty 0 15
login local
transport input ssh
exec-timeout 10 0
exit
```

```
crypto key generate rsa general-keys
1024
ip ssh version 2
ip ssh time-out 60
ip ssh authentication-retries 3
ip routing

vlan 10
  name BLD_A_USERS
vlan 20
  name BLD_B_USERS
vlan 30
  name BLD_C_USERS
exit

interface vlan 10
  description Gateway for Building A users
  ip address 192.168.10.1 255.255.255.0
  no shutdown
exit

interface vlan 20
  description Gateway for Building B users
  ip address 192.168.20.1 255.255.255.0
  no shutdown
exit

interface vlan 30
  description Gateway for Building C users
  ip address 192.168.30.1 255.255.255.0
  no shutdown
exit

interface fastEthernet0/1
  description Spoke link to BLD-A-ACC Fa0/1
  switchport trunk encapsulation dot1q
  switchport mode trunk
  switchport trunk allowed vlan 10,20,30
  no shutdown
exit

interface fastEthernet0/2
  description Spoke link to BLD-B-ACC Fa0/1
  switchport trunk encapsulation dot1q
  switchport mode trunk
  switchport trunk allowed vlan 10,20,30
  no shutdown
exit

interface fastEthernet0/3
  description Spoke link to BLD-C-ACC Fa0/1
  switchport trunk encapsulation dot1q
  switchport mode trunk
  switchport trunk allowed vlan 10,20,30
  no shutdown
exit

spanning-tree mode rapid-pvst
spanning-tree vlan 10,20,30 root primary
end
write memory
```

Important

Do not enable PortFast on Fa0/1, Fa0/2, or Fa0/3 of CORE-MLS because these ports connect to other switches. PortFast belongs on end-device ports only.

Step 3: Configure Building A access switch

BLD-A-ACC full configuration

```
enable
configure terminal
hostname BLD-A-ACC
no ip domain-lookup
ip domain-name campus.local
service password-encryption

enable secret Enable@123
username admin privilege 15 secret Campus@123

banner motd #UNAUTHORIZED ACCESS IS PROHIBITED#

line console 0
password Console@123
login
logging synchronous
exec-timeout 5 0
exit

line vty 0 15
login local
transport input ssh
exec-timeout 10 0
exit

crypto key generate rsa general-keys
1024
ip ssh version 2
ip ssh time-out 60
ip ssh authentication-retries 3

vlan 10
 name BLD_A_USERS
exit

interface fastEthernet0/1
 description Uplink to CORE-MLS Fa0/1
 switchport mode trunk
 switchport trunk allowed vlan 10
 no shutdown
exit

interface fastEthernet0/2
 description PC-A access port
 switchport mode access
 switchport access vlan 10
 spanning-tree portfast
 no shutdown
exit

interface vlan 10
 description Management interface for Building A access switch
 ip address 192.168.10.2 255.255.255.0
```

```
no shutdown
exit

ip default-gateway 192.168.10.1
spanning-tree mode rapid-pvst
end
write memory
```

Step 4: Configure Building B access switch

BLD-B-ACC full configuration

```
enable
configure terminal
hostname BLD-B-ACC
no ip domain-lookup
ip domain-name campus.local
service password-encryption

enable secret Enable@123
username admin privilege 15 secret Campus@123

banner motd #UNAUTHORIZED ACCESS IS PROHIBITED#

line console 0
password Console@123
login
logging synchronous
exec-timeout 5 0
exit

line vty 0 15
login local
transport input ssh
exec-timeout 10 0
exit

crypto key generate rsa general-keys
1024
ip ssh version 2
ip ssh time-out 60
ip ssh authentication-retries 3
vlan 20
 name BLD_B_USERS
exit

interface fastEthernet0/1
 description Uplink to CORE-MLS Fa0/2
 switchport mode trunk
 switchport trunk allowed vlan 20
 no shutdown
exit

interface fastEthernet0/2
 description PC-B access port
 switchport mode access
 switchport access vlan 20
 spanning-tree portfast
 no shutdown
exit

interface vlan 20
 description Management interface for Building B access switch
```

```
ip address 192.168.20.2 255.255.255.0
no shutdown
exit

ip default-gateway 192.168.20.1
spanning-tree mode rapid-pvst
end
write memory
```

Step 5: Configure Building C access switch

BLD-C-ACC full configuration

```
enable
configure terminal
hostname BLD-C-ACC
no ip domain-lookup
ip domain-name campus.local
service password-encryption

enable secret Enable@123
username admin privilege 15 secret Campus@123

banner motd #UNAUTHORIZED ACCESS IS PROHIBITED#

line console 0
password Console@123
login
logging synchronous
exec-timeout 5 0
exit

line vty 0 15
login local
transport input ssh
exec-timeout 10 0
exit

crypto key generate rsa general-keys
1024
ip ssh version 2
ip ssh time-out 60
ip ssh authentication-retries 3

vlan 30
name BLD_C_USERS
exit

interface fastEthernet0/1
description Uplink to CORE-MLS Fa0/3
switchport mode trunk
switchport trunk allowed vlan 30
no shutdown
exit

interface fastEthernet0/2
description PC-C access port
switchport mode access
```

```
switchport access vlan 30
spanning-tree portfast
no shutdown
exit

interface vlan 30
description Management interface for Building C access switch
ip address 192.168.30.2 255.255.255.0
no shutdown
exit

ip default-gateway 192.168.30.1
spanning-tree mode rapid-pvst
end
write memory
```

Step 6: Configure PC addressing

Open each PC, go to Desktop, then IP Configuration. Enter the following values.

PC	IP address	Subnet mask	Default gateway
PC-A	192.168.10.10	255.255.255.0	192.168.10.1
PC-B	192.168.20.10	255.255.255.0	192.168.20.1
PC-C	192.168.30.10	255.255.255.0	192.168.30.1

5. Verification Guide

Run each check after configuration. The lab is complete only when all required tests pass.

Check	Device	Command or test	Expected result
VLANs exist	CORE-MLS	show vlan brief	VLANs 10, 20, and 30 exist. Fa0/1 is in VLAN 10, Fa0/2 is in VLAN 20, Fa0/3 is in VLAN 30.
SVIs are active	CORE-MLS	show ip interface brief	Vlan10, Vlan20, and Vlan30 show up/up.
Routing is enabled	CORE-MLS	show ip route	Connected routes for 192.168.10.0/24, 192.168.20.0/24, and 192.168.30.0/24 appear.
Building switch VLAN	BLD-A-ACC	show vlan brief	Fa0/1 and Fa0/2 are in VLAN 10.
Building switch VLAN	BLD-B-ACC	show vlan brief	Fa0/1 and Fa0/2 are in VLAN 20.
Building switch VLAN	BLD-C-ACC	show vlan brief	Fa0/1 and Fa0/2 are in VLAN 30.
Access uplink mode	All switches	show interfaces fa0/1 switchport	Operational mode shows static access. Access VLAN matches the building VLAN.
Local gateway reachability	Each PC	ping default gateway	PC-A pings 192.168.10.1, PC-B pings 192.168.20.1, PC-C pings 192.168.30.1.
Inter-building reachability	PC-A	ping 192.168.20.10 and ping 192.168.30.10	Both pings succeed.
Switch management reachability	CORE-MLS	ping 192.168.10.2, 192.168.20.2, 192.168.30.2	All access switch management IPs respond.

5.1 Required show commands

CORE-MLS verification commands

```
show vlan brief
show ip interface brief
show ip route
show interfaces fastEthernet0/1 switchport
show interfaces fastEthernet0/2 switchport
show interfaces fastEthernet0/3 switchport
show spanning-tree vlan 10
show spanning-tree vlan 20
show spanning-tree vlan 30
show running-config interface vlan 10
show running-config interface vlan 20
show running-config interface vlan 30
```

Access switch verification commands

```
show vlan brief
show ip interface brief
show interfaces fastEthernet0/1 switchport
show interfaces fastEthernet0/2 switchport
show spanning-tree
show running-config interface fastEthernet0/1
show running-config interface fastEthernet0/2
show running-config interface vlan 10
```

5.2 Required ping tests

Source	Destination	Expected result
PC-A	192.168.10.1	Success
PC-B	192.168.20.1	Success
PC-C	192.168.30.1	Success
PC-A	192.168.20.10	Success
PC-A	192.168.30.10	Success
PC-B	192.168.30.10	Success
CORE-MLS	192.168.10.2	Success
CORE-MLS	192.168.20.2	Success
CORE-MLS	192.168.30.2	Success

6. Troubleshooting Guide

Problem	Likely cause	Command to check	Fix
PC cannot ping its gateway	PC IP, mask, or gateway is wrong	PC Desktop > IP Configuration	Correct the PC addressing.
PC cannot ping another building	ip routing is missing on CORE-MLS	show running-config include ip routing	On CORE-MLS, enter ip routing.
Core SVI is down/down	No active port exists in that VLAN	show vlan brief and show ip interface brief	Check cable, access VLAN assignment, and no shutdown.
Access switch management IP cannot be pinged	Wrong SVI VLAN or missing default gateway	show ip interface brief and show running-config include default-gateway	Assign management SVI to the building VLAN and set ip default-gateway.
Fa0/1 is in wrong VLAN	Uplink assigned to wrong access VLAN	show interfaces fa0/1 switchport	Set switchport access vlan 10, 20, or 30 as required.
Links stay amber for a short time	STP is listening and learning	show spanning-tree	Wait for convergence. Do not use PortFast on switch-to-switch links.

7. Student Reflection Questions

1. Why does this design reduce the number of network devices in the traffic path?
2. Why should buildings connect back to the core instead of connecting through each other?
3. Why does this lab use access uplinks instead of trunk uplinks?
4. When would a trunk uplink become required?
5. What happens if ip routing is removed from CORE-MLS?
6. Why should PortFast not be enabled on the switch-to-switch uplinks?

8. Completion and Evidence Checklist

No.	Evidence item	How to capture it	Done
1	Final Packet Tracer topology with all links green	Screenshot of full topology	☐
2	CORE-MLS VLAN table	Screenshot or copied output of show vlan brief	☐
3	CORE-MLS SVI status	Screenshot or copied output of show ip interface brief	☐
4	CORE-MLS routing table	Screenshot or copied output of show ip route	☐
5	Each access switch VLAN table	Screenshot or copied output from BLD-A-ACC, BLD-B-ACC, BLD-C-ACC	☐
6	Fa0/1 uplink mode verified	Output of show interfaces fa0/1 switchport on each switch	☐
7	PC addressing configured correctly	Screenshot of PC-A, PC-B, and PC-C IP Configuration windows	☐
8	PC-A ping to PC-B and PC-C works	Screenshot of successful pings	☐
9	Access switch management ping works	CORE-MLS ping to 192.168.10.2, 192.168.20.2, 192.168.30.2	☐
10	Configurations saved	Output of write memory on all switches	☐

9. Facilitator Sign-Off

Skill area	Max score	Score	Comments
Topology built cleanly and labelled correctly	20		
Core VLANs and SVIs configured correctly	20		
Building access switch configuration correct	20		
PC addressing and gateway configuration correct	15		
Verification evidence complete	15		
Student explains access link vs trunk link decision	10		
Total	100		

Facilitator name: _____

Date: _____ Signature: _____

Next lab direction

After this lab passes, continue to Lab 02. Lab 02 should introduce multiple VLANs inside buildings, trunk uplinks, Rapid PVST, native VLAN hardening, allowed VLAN pruning, PortFast, BPDU Guard, and basic Layer 2 protection.