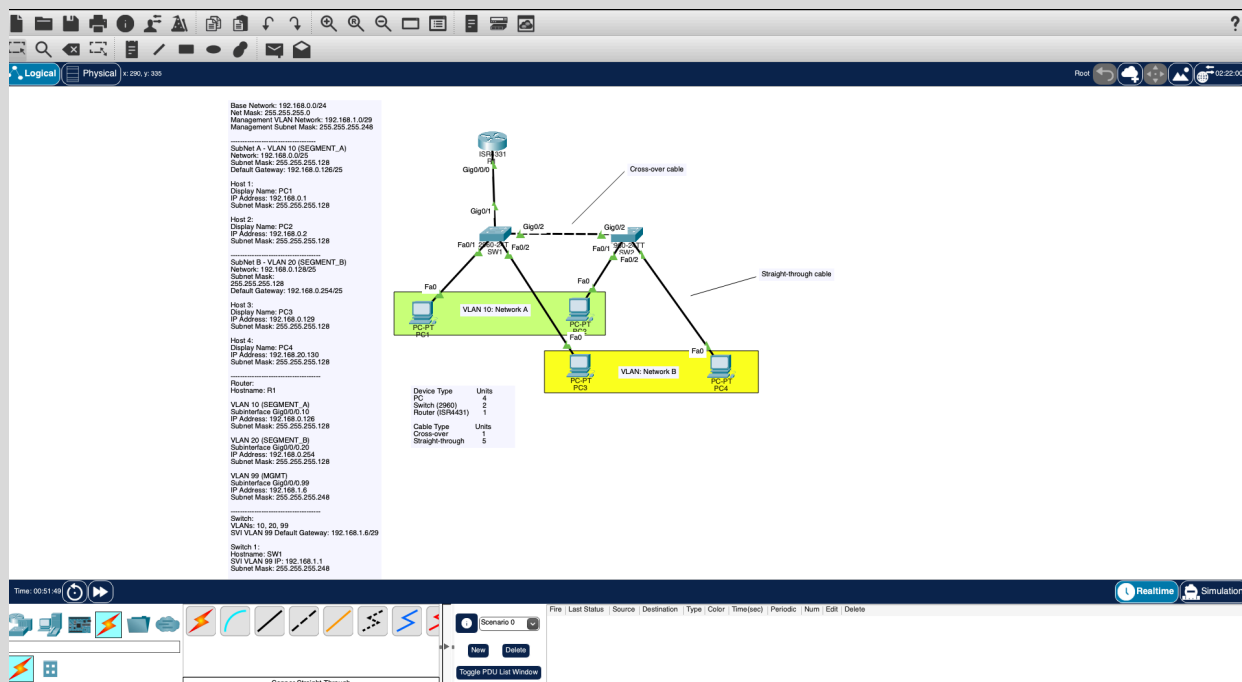


Lab 1: Subnetting, VLAN & Trunk Configuration, Router-on-a-Stick Inter-VLAN Routing, NTP, and Secure Device Access

This lab focuses on implementing foundational Layer 2 and Layer 3 networking concepts by configuring VLANs, trunking, and inter-VLAN routing using Router-on-a-Stick. The lab begins with initial device setup, including hostnames, clock configuration, and NTP synchronization, followed by VLAN creation and access port assignment on switches. Trunk links are configured using 802.1Q with a reassigned native VLAN to enhance security. Inter-VLAN communication is enabled by configuring router subinterfaces, each mapped to a specific VLAN and serving as the default gateway for hosts. Connectivity and functionality are verified through interface, VLAN, trunk, and end-to-end communication testing.

Network Topology:



Network Addressing Plan (Subnetting):

Overall Network:

| Parameter | Value |
|-------------------------|-----------------|
| Base Network | 192.168.0.0/24 |
| Subnet Mask | 255.255.255.0 |
| Management VLAN Network | 192.168.1.0/29 |
| Management Subnet Mask | 255.255.255.248 |

Subnet A – VLAN 10 (SEGMENT_A)

| <u>Parameter</u> | <u>Host 1 (PC1)</u> | <u>Host 2 (PC2)</u> |
|------------------|---------------------|---------------------|
| IP Address | 192.168.0.1 | 192.168.0.2 |
| Subnet Mask | 255.255.255.128 | 255.255.255.128 |
| Default Gateway | 192.168.0.126 | 192.168.0.126 |
| VLAN | 10 | 10 |
| Network | 192.168.0.0/25 | |

Subnet B – VLAN 20 (SEGMENT_B)

| <u>Parameter</u> | <u>Host 3 (PC3)</u> | <u>Host 4 (PC4)</u> |
|------------------|---------------------|---------------------|
| IP Address | 192.168.0.129 | 192.168.0.130 |
| Subnet Mask | 255.255.255.128 | 255.255.255.128 |
| Default Gateway | 192.168.0.254 | 192.168.0.254 |
| VLAN | 20 | 20 |
| Network | 192.168.0.128/25 | |

Router – R1

| <u>Interface</u> | <u>Subinterface</u> | <u>IP Address</u> | <u>Subnet Mask</u> | <u>VLAN / Purpose</u> |
|------------------|---------------------|-------------------|--------------------|-------------------------|
| Gig0/0/0 | .10 | 192.168.0.126 | 255.255.255.128 | VLAN 10 / SEGMENT_A DGW |
| Gig0/0/0 | .20 | 192.168.0.254 | 255.255.255.128 | VLAN 20 / SEGMENT_B DGW |
| Gig0/0/0 | .99 | 192.168.1.6 | 255.255.255.248 | VLAN 99 / MGMT DGW |

Switch 1 – SW1

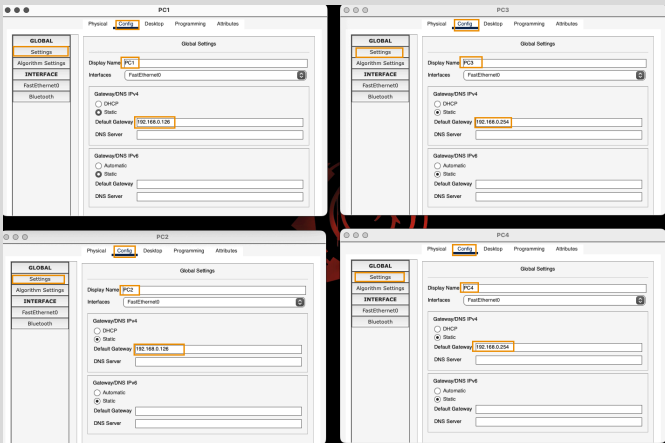
| <u>Parameter</u> | <u>Value</u> |
|------------------------|-----------------|
| Hostname | SW1 |
| VLANs | 10, 20, 99 |
| SVI VLAN 99 IP Address | 192.168.1.1 /29 |
| Default Gateway | 192.168.1.6 |

Switch 2 – SW2

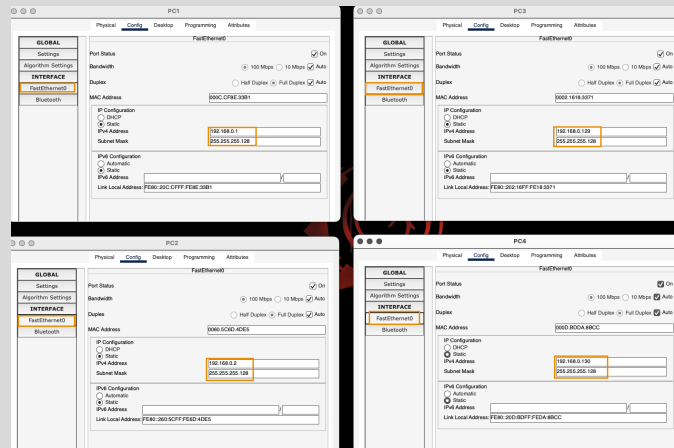
| <u>Parameter</u> | <u>Value</u> |
|------------------|-----------------|
| Hostname | SW2 |
| VLANs | 10, 20, 99 |
| SVI VLAN 99 IP | 192.168.1.2 /29 |
| Default Gateway | 192.168.1.6 |

Initial Endpoints (PC1, PC2, PC3, & PC4) Setup:

- Configure Display Name & Default Gateway



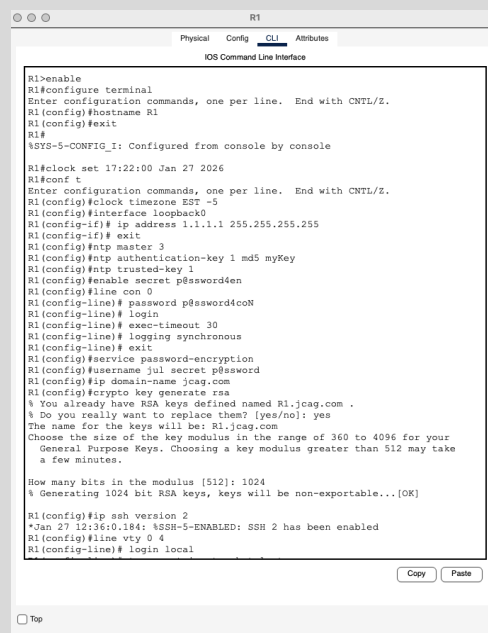
- Configure IP Address & Subnet Mask



Initial Router & Switches Setup

- Configure hostnames
- Set system clock
- Configure NTP for time synchronization
- Secure device access (console & VTY)
- Save configurations

Router Configuration:



Would you like to enter the initial configuration dialog? [yes/no]: no

! Enter privileged EXEC mode
enable

! Enter global configuration mode
configure terminal

! Set hostname
hostname R1

! Set system clock and timezone

```

exit
clock set 17:22:00 Jan 27 2026      → configure on privilege exec mode
conf t
clock timezone EST -5              → configure on global config mode
! Configure loopback 0 interface (for NTP source)
interface loopback0
    ip address 1.1.1.1 255.255.255.255
    exit
! Configure NTP master with authentication
ntp master 3                      → optional stratum number
ntp authentication-key 1 md5 myKey
ntp trusted-key 1
! Set enable secret with script (Type 9)      → not an option for ISR4331 Router
enable algorithm-type script secret p@ssword4en
! Set enable secret with MD5 (Type 5)
enable secret p@ssword4en
! Configure console access (set password, standby time, sync with log output)
line con 0
    password p@ssword4coN
    login
    exec-timeout 30
    logging synchronous
    exit
! Encrypt all existing and future plain-text passwords (Type 7)
service password-encryption
! Create local username and secret for login (Type 5)
username jul secret p@ssword
! Configure domain name for crypto keys (needed for SSH)
ip domain-name jcag.com
! Generate RSA keys for SSH
crypto key generate rsa
! When prompted, choose default [512]      → enter 1024 bits (at least 768 bits size for SSH v2)
! Force SSH version 2
ip ssh version 2
! Configure VTY lines (set VTY line for up to 5 simultaneous users, login to use local DB for user &
password, transport input SSH only (no Telnet or AUX), standby time, sync to log output)
line vty 0 4
    login local
    transport input ssh
    exec-timeout 30
    logging synchronous
    exit
! Save configuration
do write memory

```

Switch Configuration:



```
SW1>enable
SW1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
SW1(config)#hostname SW1
SW1(config)#ntp server 1.1.1.1
SW1(config)#ntp authentication-key 1 md5 myKey
SW1(config)#ntp trusted-key 1
SW1(config)#enable secret p@ssword4en
SW1(config)#line con 0
SW1(config-line)# password p@ssword4coN
SW1(config-line)# login
SW1(config-line)# exec-timeout 30
SW1(config-line)# logging synchronous
SW1(config-line)# exit
SW1(config)#service password-encryption
SW1(config)#username jul secret p@ssword4ssH
SW1(config)#ip domain-name jcag.com
SW1(config)#crypto key generate rsa
The name for the keys will be: SW1.jcag.com
Choose the size of the key modulus in the range of 360 to 4096 for your
General Purpose Keys. Choosing a key modulus greater than 512 may take
a few minutes.
How many bits in the modulus [512]: 1024
% Generating 1024 bit RSA keys, keys will be non-exportable...[OK]

SW1(config)#ip ssh version 2
*Mar 2 18:42:46.637: %SSH-5-ENABLED: SSH 1.99 has been enabled
SW1(config)#line vty 0 4
SW1(config-line)# login local
SW1(config-line)# transport input ssh
SW1(config-line)# exec-timeout 30
SW1(config-line)# logging synchronous
SW1(config-line)# exit
SW1(config)#do write memory
Building configuration...
[OK]
```

! Enter privileged EXEC mode

enable

! Enter global configuration mode

configure terminal

! Set hostname

hostname SW1

→ run hostname SW2 for Switch 2

! Configure NTP server with authentication

ntp server 1.1.1.1

ntp authentication-key 1 md5 myKey

ntp trusted-key 1

! Set enable secret with scrypt (Type 9 hash) → not an option for Layer 2 Switches

enable algorithm-type scrypt secret p@ssword4en

! Set enable secret with MD5 (Type 5)

enable secret p@ssword4en

! Configure console access

line con 0

password p@ssword4coN

login

exec-timeout 30

logging synchronous

exit

! Encrypt all plain-text passwords (service password-encryption)

service password-encryption

! Create local user for SSH login (Type 5 secret)

username jul secret p@ssword4ssH

! Configure domain name for crypto keys (needed for SSH)

ip domain-name jcag.com

! Generate RSA keys for SSH

crypto key generate rsa

! When prompted, choose default [512]

→ enter 1024 bits (at least 768 bits size for SSH v2)

! Force SSH version 2

ip ssh version 2

→ failed to enable on L2 Switch (2960), 1.99 enabled

! Configure VTY lines (set VTY line for up to 5 simultaneous users, login to use local DB for user & password, transport input SSH only (no Telnet or AUX), standby time, sync to log output)

```
line vty 0 4
  login local
  transport input ssh
  exec-timeout 30
  logging synchronous
  exit
```

! Save configuration

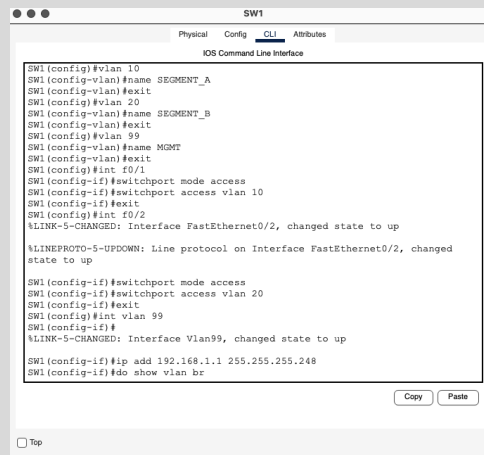
```
do write memory
```

! Configure Switch 2 (change input entry accordingly)

Switching (Layer 2)

- Create VLANs
- Assign access ports to VLANs
- Verify VLAN membership
- Configure management VLAN

Switch Configuration:



```
SW1 (config)#vlan 10
SW1 (config-vlan)#name SEGMENT_A
SW1 (config-vlan)#exit
SW1 (config)#vlan 20
SW1 (config-vlan)#name SEGMENT_B
SW1 (config-vlan)#exit
SW1 (config)#vlan 99
SW1 (config-vlan)#name MGMT
SW1 (config-vlan)#exit
SW1 (config)#int f0/1
SW1 (config-if)#switchport mode access
SW1 (config-if)#switchport access vlan 10
SW1 (config-if)#exit
SW1 (config)#int f0/2
%LINK-5-CHANGED: Interface FastEthernet0/2, changed state to up
%LINEPROTO-5-UPDOWN: Line protocol on Interface FastEthernet0/2, changed
state to up
SW1 (config-if)#switchport mode access
SW1 (config-if)#switchport access vlan 20
SW1 (config-if)#exit
SW1 (config)#int vlan 99
SW1 (config-if)#
%LINK-5-CHANGED: Interface Vlan99, changed state to up
SW1 (config-if)#ip add 192.168.1.1 255.255.255.248
SW1 (config-if)#do show vlan br
```

! VLAN Creation

```
vlan 10
  name SEGMENT_A
  exit
vlan 20
  name SEGMENT_B
  exit
vlan 99
  name MGMT
  exit
```

! Assign VLANs to Access Ports

```
interface fastEthernet 0/1
  switchport mode access
  switchport access vlan 10
  exit
interface fastEthernet 0/2
  switchport mode access
  switchport access vlan 20
  exit
```

! Configure Management VLAN SVI

```
interface vlan 99
```

```
ip address 192.168.1.1 255.255.255.248 → change IP to 192.168.1.2 for SW2
no shutdown
exit
```

! Verify VLANs

```
do show vlan brief
```

! Verify Interfaces IP Addressing & Status

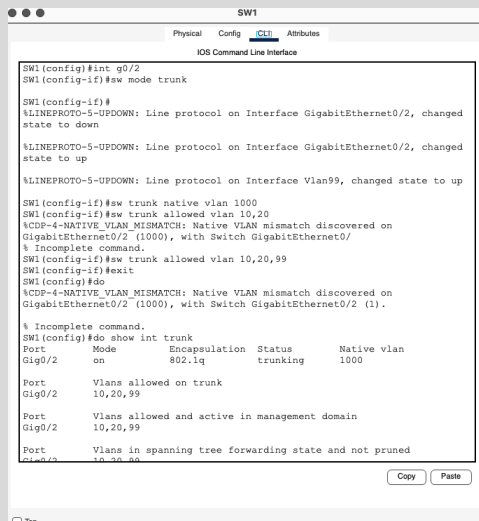
```
do show ip interface brief
```

! Configure SW2 (change input entry accordingly)

Trunking

- Configure 802.1Q trunk links
- Reassign native VLAN (non-default VLAN)
- Allow required VLANs on trunks
- Verify trunk status

Switches Configuration:



```
SW1
Physical Config CLI Attributes
IOS Command Line Interface

SW1(config)#int g0/2
SW1(config-if)#sw mode trunk

SW1(config-if)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed
state to down

%LINEPROTO-5-UPDOWN: Line protocol on Interface GigabitEthernet0/2, changed
state to up

%LINEPROTO-5-UPDOWN: Line protocol on Interface Vlan99, changed state to up

SW1(config-if)#sw trunk native vlan 1000
SW1(config-if)#sw trunk allowed vlan 10,20
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet0/2 (1000), with Switch GigabitEthernet0/
% Incomplete command.
SW1(config-if)#sw trunk allowed vlan 10,20,99
SW1(config-if)#exit
SW1(config)#do
%CDP-4-NATIVE_VLAN_MISMATCH: Native VLAN mismatch discovered on
GigabitEthernet0/2 (1000), with Switch GigabitEthernet0/2 (1).
% Incomplete command.
SW1(config)#do show int trunk
Port      Mode      Encapsulation  Status      Native vlan
Gig0/2    on        802.1q         trunking    1000

Port      Vlans allowed on trunk
Gig0/2    10,20,99

Port      Vlans allowed and active in management domain
Gig0/2    10,20,99

Port      Vlans in spanning tree forwarding state and not pruned
Gig0/2    10,20,99
```

! Configure Trunk on SW1

```
interface gigabitEthernet0/2
switchport mode trunk
switchport trunk native vlan 1000
switchport trunk allowed vlan 10,20,99
exit
```

! Verification

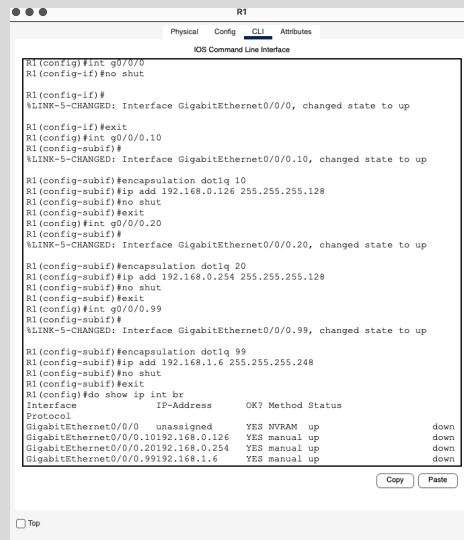
```
do show interfaces trunk
```

! Configure Switch 2

Inter-VLAN Routing

- Configure Router-on-a-Stick (ROAS)
- Create router subinterfaces
- Assign VLAN tags to subinterfaces
- Configure default gateways for hosts
- Verify inter-VLAN connectivity

Router Configuration:



```
R1
R1(config)#int g0/0/0
R1(config-if)#no shut
R1(config-if)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0, changed state to up
R1(config-if)#exit
R1(config)#int g0/0/0.10
R1(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.10, changed state to up
R1(config-subif)#encapsulation dot1q 10
R1(config-subif)#ip add 192.168.0.126 255.255.255.128
R1(config-subif)#no shut
R1(config-subif)#exit
R1(config)#int g0/0/0.20
R1(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.20, changed state to up
R1(config-subif)#encapsulation dot1q 20
R1(config-subif)#ip add 192.168.0.254 255.255.255.128
R1(config-subif)#no shut
R1(config-subif)#exit
R1(config)#int g0/0/0.99
R1(config-subif)#
%LINK-5-CHANGED: Interface GigabitEthernet0/0/0.99, changed state to up
R1(config-subif)#encapsulation dot1q 99
R1(config-subif)#ip add 192.168.1.6 255.255.255.248
R1(config-subif)#no shut
R1(config-subif)#exit
R1(config)#do show ip int br
Interface      IP-Address      OK? Method Status
Protocol
GigabitEthernet0/0/0    unassigned      YES NVRAM  up
GigabitEthernet0/0/0.10 192.168.0.126   YES manual up
GigabitEthernet0/0/0.20 192.168.0.254   YES manual up
GigabitEthernet0/0/0.99 192.168.1.6     YES manual up
```

! Enable physical interface

```
interface GigabitEthernet0/0/0
  no shutdown
  exit
```

! Configure subinterface for VLAN 10

```
interface GigabitEthernet0/0/0.10
  encapsulation dot1q 10
  ip address 192.168.0.126 255.255.255.128
  no shutdown
  exit
```

! Configure subinterface for VLAN 20

```
interface GigabitEthernet0/0/0.20
  encapsulation dot1q 20
  ip address 192.168.0.254 255.255.255.128
  no shutdown
  exit
```

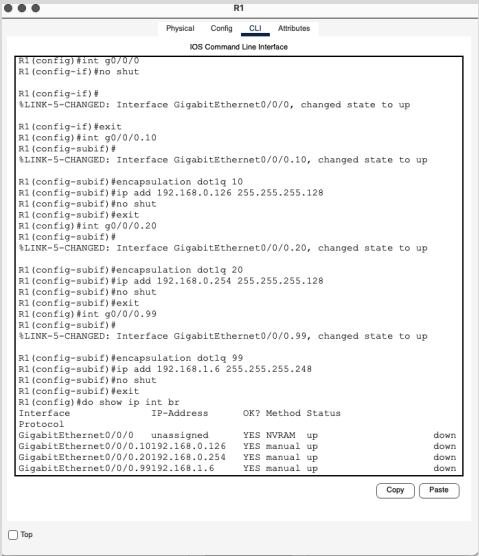
! Configure subinterface for VLAN 99 (Management)

```
interface GigabitEthernet0/0/0.99
  encapsulation dot1q 99
  ip address 192.168.1.6 255.255.255.248
  no shutdown
  exit
```

! Verify interfaces

```
do show ip interface brief
```


SW1 Configuration:



```

! Configure Trunk on SW1
interface gigabitEthernet0/2
  switchport mode trunk
  switchport trunk native vlan 1000
  switchport trunk allowed vlan 10,20,99
exit

! Verification
do show interfaces trunk

```

Verification & Testing

- Verify configurations (VLANs, trunking, and interfaces)
- Test end-to-end connectivity using ping
- Validate routing between VLANs

| Category | Command | Notes / What It Shows |
|---------------------|---------------------------|---|
| Interface & IP | show ip interface brief | Displays IP addresses, interface status (up/down), and protocol status. |
| Routing/Inter-VLAN | show running-config | Confirm subinterfaces, VLAN encapsulation, and IP assignments. |
| VLANs | ping <destination_IP> | Verify inter-VLAN routing is working. |
| SVI/Mgmt VLAN | show vlan brief | Displays VLAN IDs, names, status, and assigned ports. |
| | show ip interface brief | Shows SVI IP address, status, and protocol. |
| Trunking | ping <SVI_IP> | Confirms switch management connectivity to router. |
| | show interfaces trunk | Displays trunk status, encapsulation, native VLAN, and allowed VLANs. |
| | show interfaces <int> sw | Shows mode (access/trunk), native VLAN, and operational details. |
| CDP/Neigh Discovery | show cdp neighbors | Displays connected Cisco devices, local interface, remote device, and capabilities. |
| | show cdp neighbors detail | Displays IP addresses of neighbors and more detailed info. |
| NTP | show ntp associations | Displays NTP associations and stratum info. |
| | `show running-config` | include ntp` |

| | | |
|----------------------|-------------------------|---|
| Device Security | `show running-config` | include username` |
| | `show running-config` | include enable` |
| | `show running-config` | section line vty` |
| General Verification | show startup-config | Confirms configuration was written to NVRAM. |
| | ping <neighbor_IP> | Confirms connectivity to switches, PCs, or other routers. |
| | ping <PC_in_other_VLAN> | Verifies that Router-on-a-Stick routing is working. |

Successful Pings from PC1 (VLAN 10):

192.168.0.2 (PC2: VLAN 10)
192.168.0.129 (PC3: VLAN 20)
192.168.0.130 (PC\$: VLAN 20)

Successful SSH from PC1 to R1:

ssh -l jul 192.168.1.6
password: p@ssword

The screenshot shows a PC1 desktop with a window titled 'PC1' containing a 'Command Prompt' application. The window has tabs for 'Physical', 'Config', 'Desktop' (selected), 'Programming', and 'Attributes'. The Command Prompt displays the following text:

```

Reply from 192.168.0.2: bytes=32 time=2ms TTL=128
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128
Reply from 192.168.0.2: bytes=32 time<1ms TTL=128

Ping statistics for 192.168.0.2:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 2ms, Average = 0ms

C:\>cls
Invalid Command.

C:\>ping 192.168.0.129

Pinging 192.168.0.129 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127
Reply from 192.168.0.129: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.0.129:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ping 192.168.0.130

Pinging 192.168.0.130 with 32 bytes of data:

Request timed out.
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127
Reply from 192.168.0.130: bytes=32 time<1ms TTL=127

Ping statistics for 192.168.0.130:
    Packets: Sent = 4, Received = 3, Lost = 1 (25% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 0ms, Maximum = 0ms, Average = 0ms

C:\>ssh 192.168.0.126 -l jul 192.168.1.6
Invalid Command.

C:\>ssh -l jul 192.168.1.6

Password:

R1>!
```

At the bottom left of the window, there is a 'Top' button.