

IP Services and Basic Routing

Lecture 5

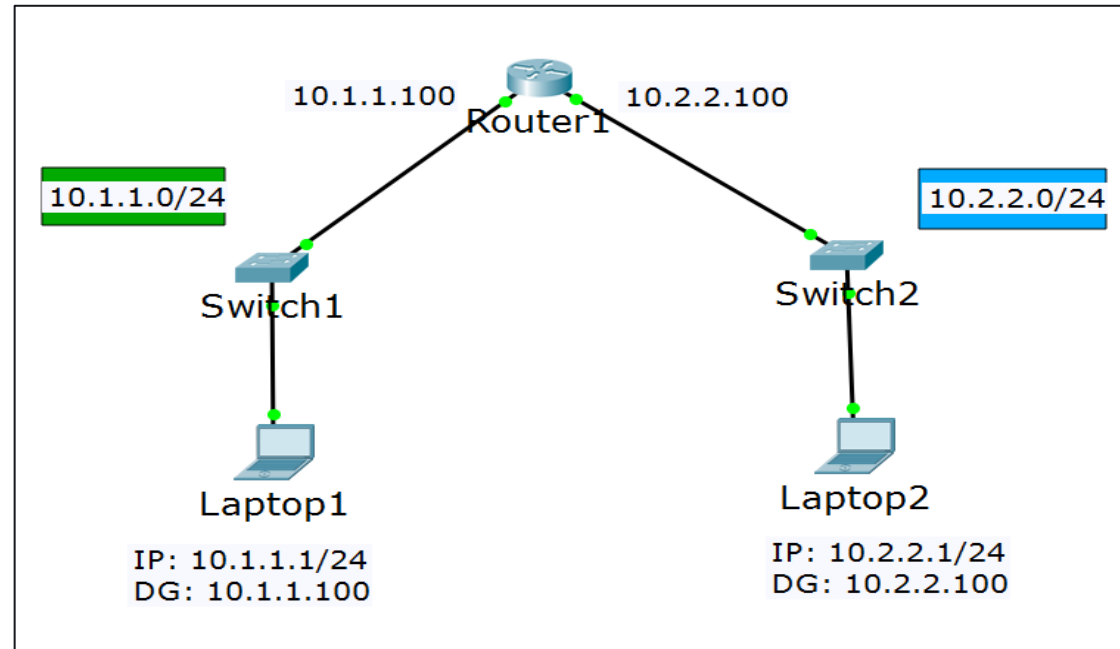


Table of Contents

1. IP services: DHCP and DNS
2. Introduction to routing
3. Direct routing
4. Inter-VLAN routing
5. Static routing



A background network diagram featuring a central dark blue circle. Surrounding it are several smaller, light gray circles connected by thin gray lines, forming a web-like structure. The text "IP services: DHCP and DNS" is centered in the lower half of the image.

IP services: DHCP and DNS

What is DHCP?

- DHCP: Dynamic Host Configuration Protocol
- Provides automatic distribution of IP addresses and other networking parameters such as:
 - Subnet mask
 - Default gateway
 - DNS servers
 - More...
- Industry standard

Why use DHCP?

- Reduces the administration efforts
- Easy to use from the clients
- Decreases the risk of IP address duplication
- Can provide additional network information
- DHCP fingerprinting

When NOT to use DHCP

- Static IP configurations may be preferred for:
 - Servers
 - Network devices (switches, routers, etc.)
 - Printers
 - Admin stations
- Very small networks may prefer not to use DHCP at all

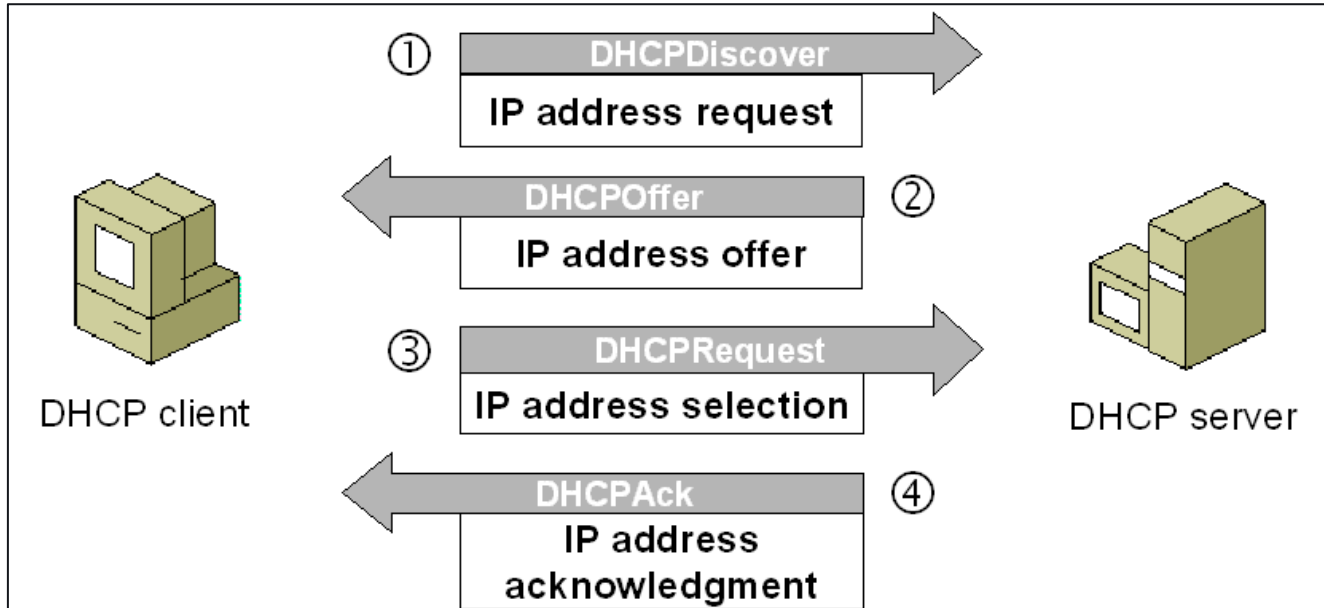
DHCP Reservations

- Alternative way to have “static” addresses with DHCP:
DHCP reservations
- The server gives the same IP address to the same client (MAC address) each time
- Examples:
 - Always assign 192.168.1.100 to 37-25-AE-6C-0C-7F
 - Always assign 192.168.1.200 to 41-AA-7E-21-31-54

DHCP Components

- Server
 - DHCP scope - range of addresses (pool), lease time, reservations, etc.
 - Uses port UDP 67
- Client
 - Must be configured to use DHCP
 - Uses port UDP 68
- (Relay agent)
 - Used to serve multiple (V)LANs with a single DHCP server

The DHCP Process



- “DORA”
 - Discover
 - Offer
 - Request
 - Acknowledge

All messages use broadcast (IPv4)

DHCP Relay

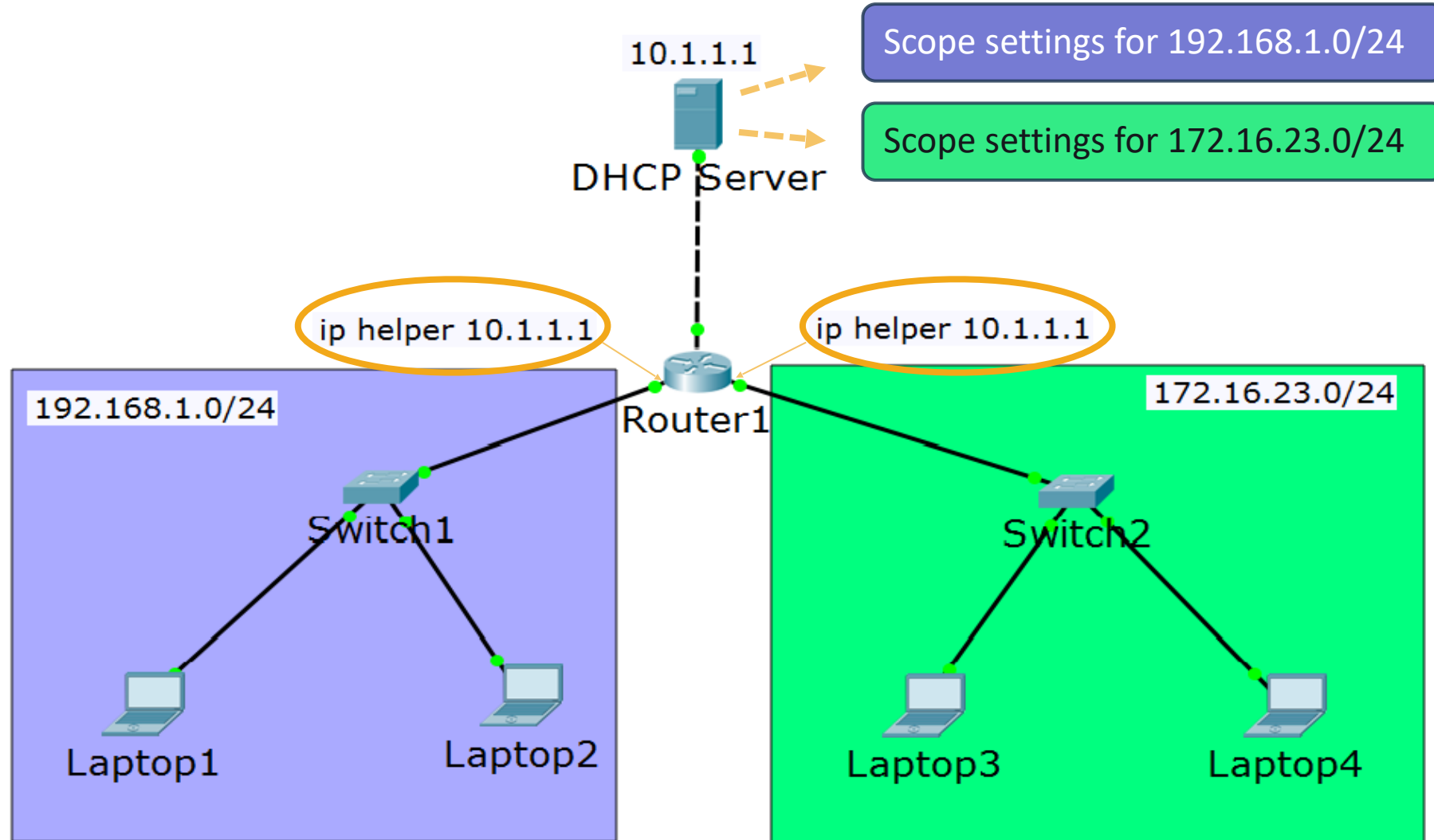
Two facts about the DHCP operation and the (V)LANs:

1. DHCP uses broadcast and this is limited to a single (V)LAN
2. Multiple (V)LANs = multiple broadcast domains

So how to use DHCP in multiple (V)LANs?

- Two options to serve clients from multiple broadcast domains:
 - Use a separate DHCP server in each (V)LAN
 - Use DHCP relay

DHCP Relay (2)



DNS Introduction

- DNS: Domain Name System
- DNS Usage:
 - To translate names to IP addresses
 - To translate IP addresses to names
 - To find a particular service in the network

*DNS will be discussed in more details in the advanced course

DNS “A” Records

- One of the most commonly used records in DNS
- Matches a hostname (or FQDN) to an IP address
- Examples:
 - pc1 -> 192.168.1.1
 - pc2 -> 192.168.1.2
 - server -> 192.168.1.100
 - www.abv.bg -> 194.153.145.104

*FQDN = Fully Qualified Domain Name

DNS: Client-to-Server Communication

- The clients need to know the address of their DNS server(s)
- It can be either:
 - Statically configured
- OR
- Dynamically received from a DHCP server
- DNS uses server port 53 (both UDP and TCP)

A background network diagram featuring a central dark blue circle. Surrounding it are several smaller, light gray circles connected by thin gray lines, forming a web-like structure. The text "Introduction to routing" is centered in the lower half of the image.

Introduction to routing

Switching vs Routing

- Switches:
 - Use Layer 2 information (MAC addresses)
 - Forwarding decisions based on the MAC address tables
 - Not scalable for big networks
- Routers:
 - Use Layer 3 information (IP addresses)
 - Forwarding decisions based on the routing tables
 - Scalable for large networks

What is required for routing?

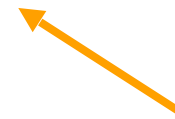
- If a destination IP address is **not local**, the sending device consults its **routing table**
- The routing table has entries which describe:
 - Which is the destination network?
 - How to reach it?
- Example:

192.168.1.0/24 via 10.1.1.1

Destination network



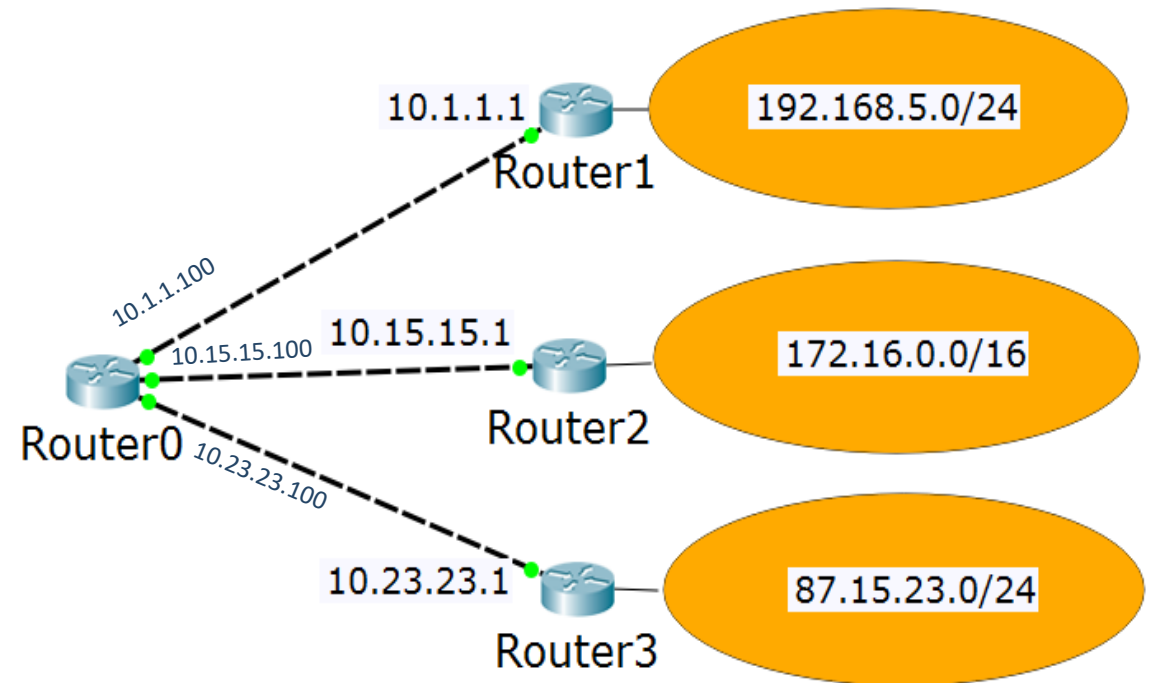
How to reach it



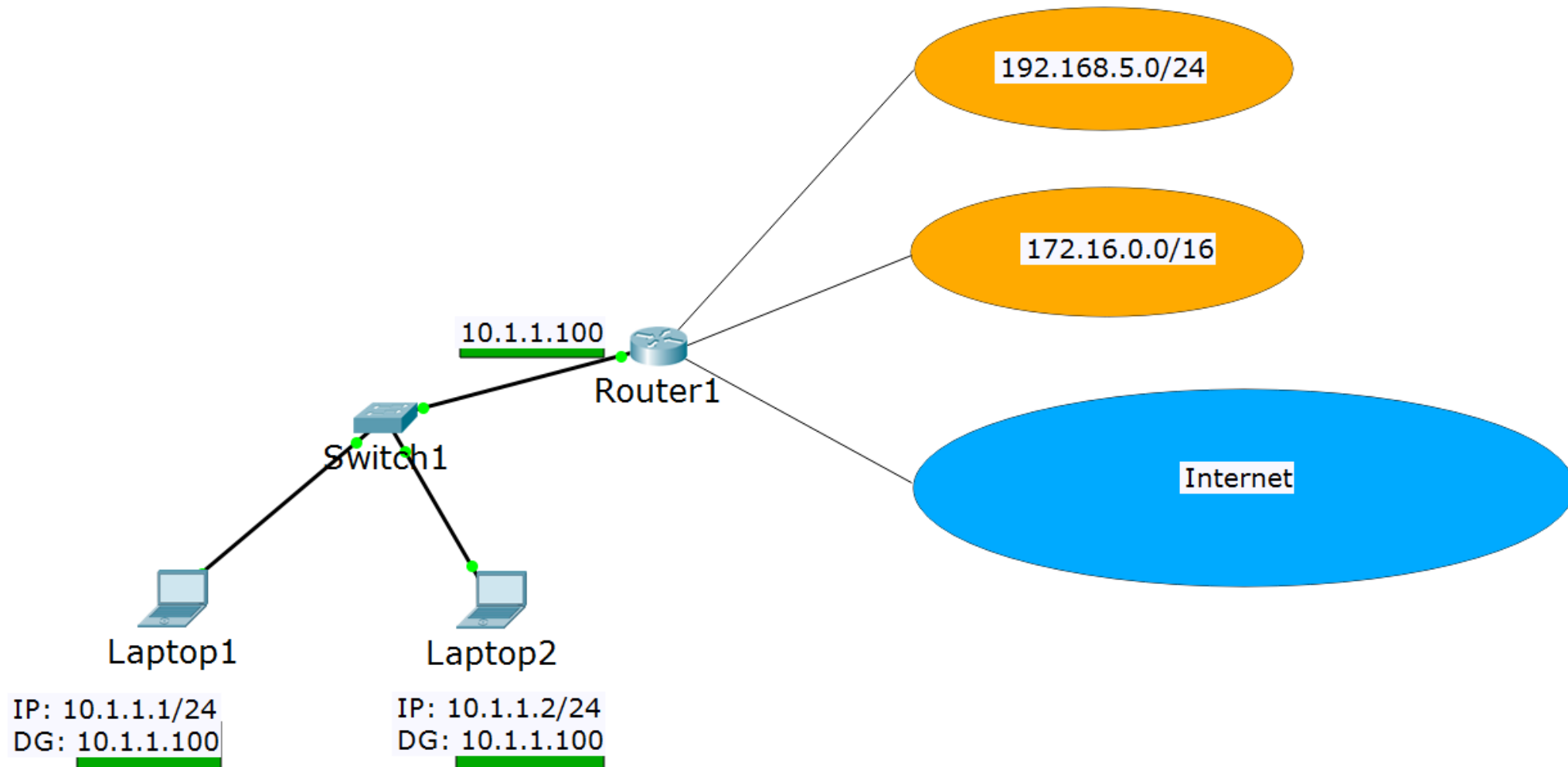
The Routing Table

My routing table:

192.168.5.0/24 via 10.1.1.1
172.16.0.0/16 via 10.15.15.1
87.15.23.0/24 via 10.23.23.1
10.1.1.0/24 is local
10.15.15.0/24 is local
10.23.23.0/24 is local



Default Gateway



Default Gateway (2)

My routing table:

192.168.5.0/24 is local

10.1.1.0/24 is local

172.16.0.0/16 via 10.1.1.2

87.15.23.0/24 via 10.1.1.2

10.15.15.0/24 via 10.1.1.2

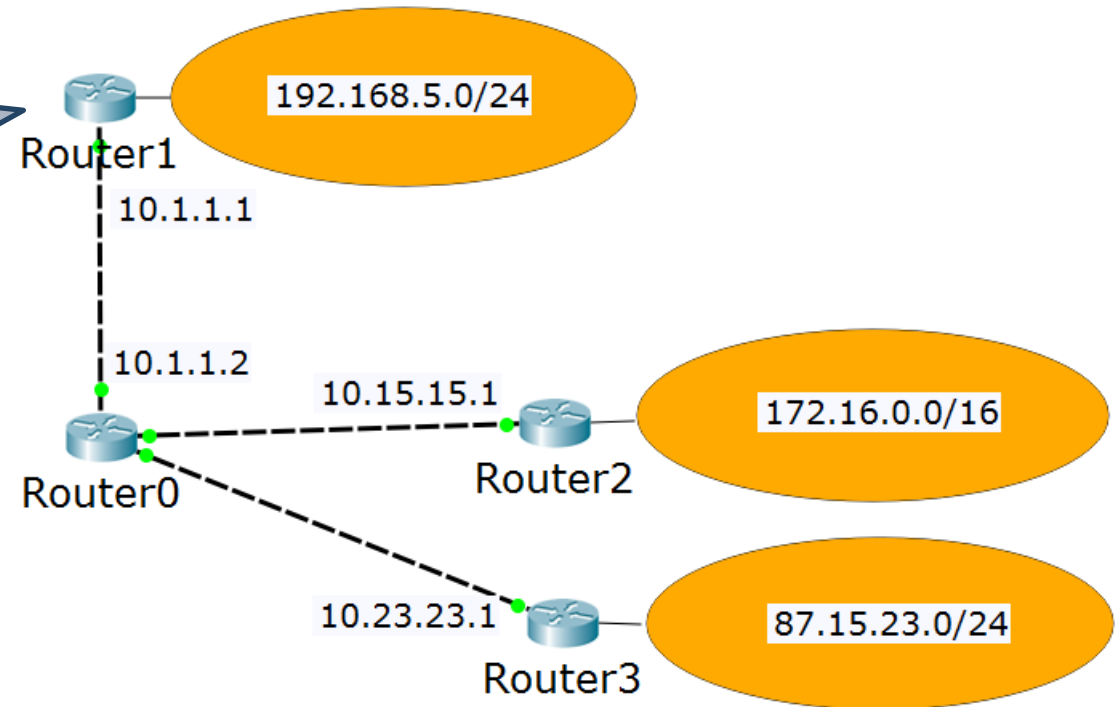
10.23.23.0/24 via 10.1.1.2

OR ↕

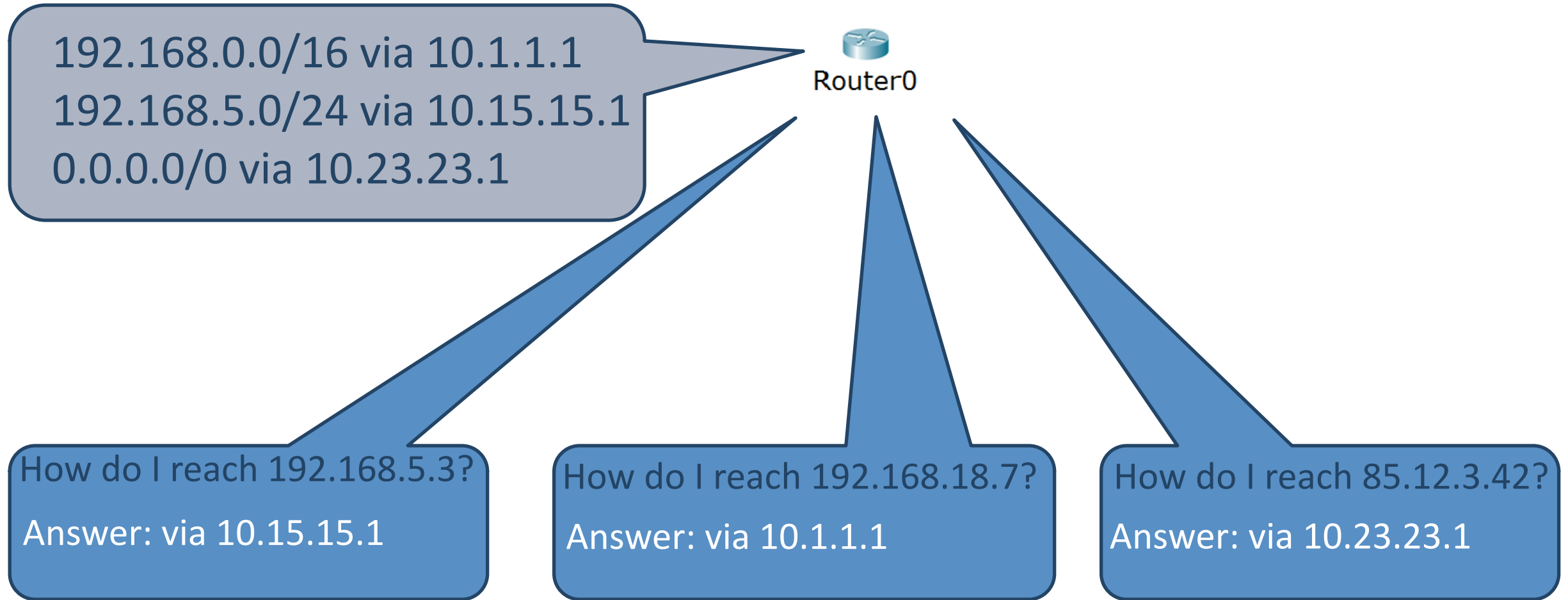
192.168.5.0/24 is local

10.1.1.0/24 is local

0.0.0.0/0 via 10.1.1.2 (default gateway)



The Rule of the Longest Match

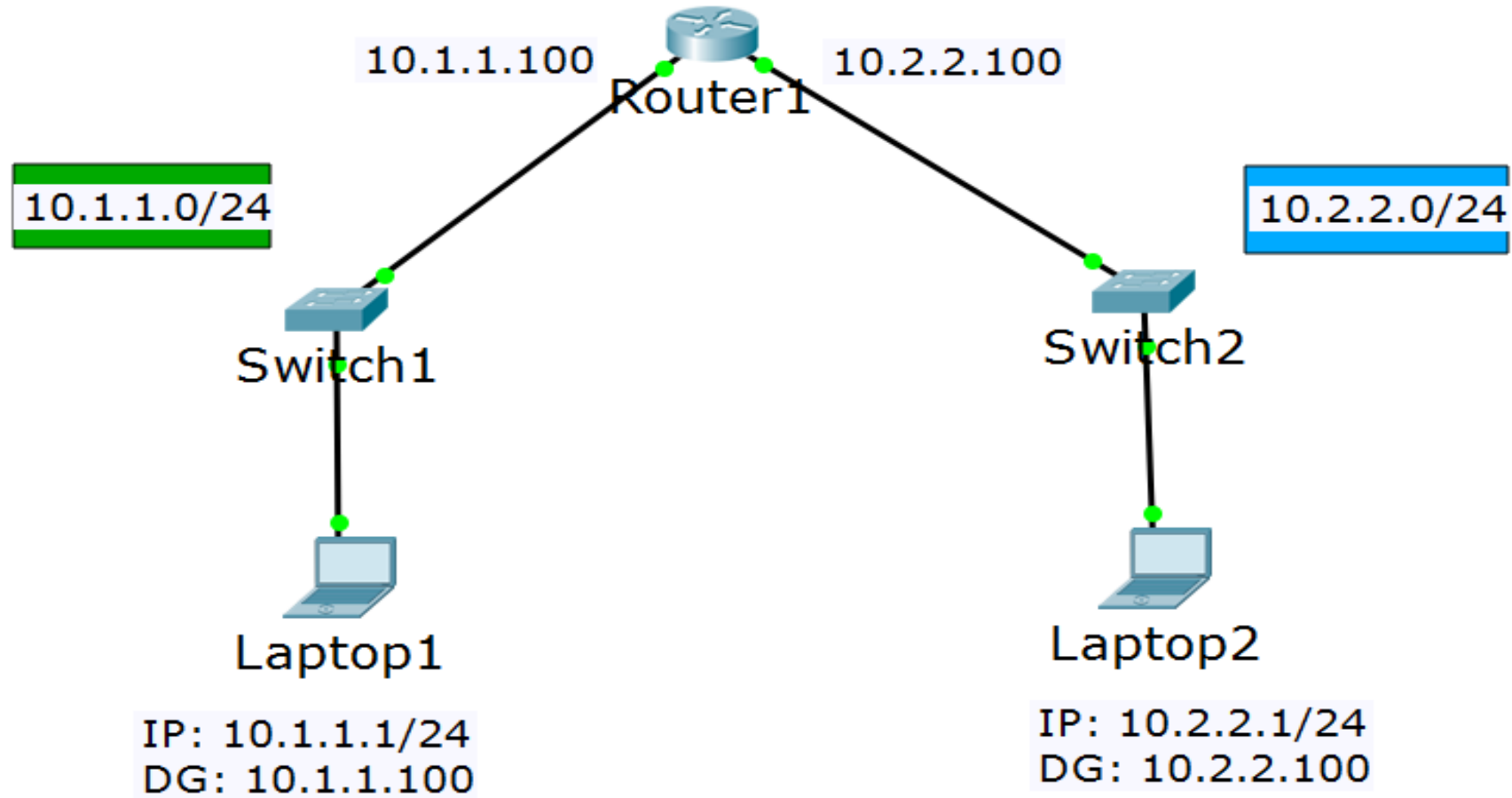




Direct routing

The image features a network diagram with a central dark blue circle. Surrounding this central node are several smaller, light gray circles connected by thin gray lines. The connections form a complex web, with some nodes having multiple links. The text "Direct routing" is positioned below the central node in a bold, dark blue font.

Direct routing



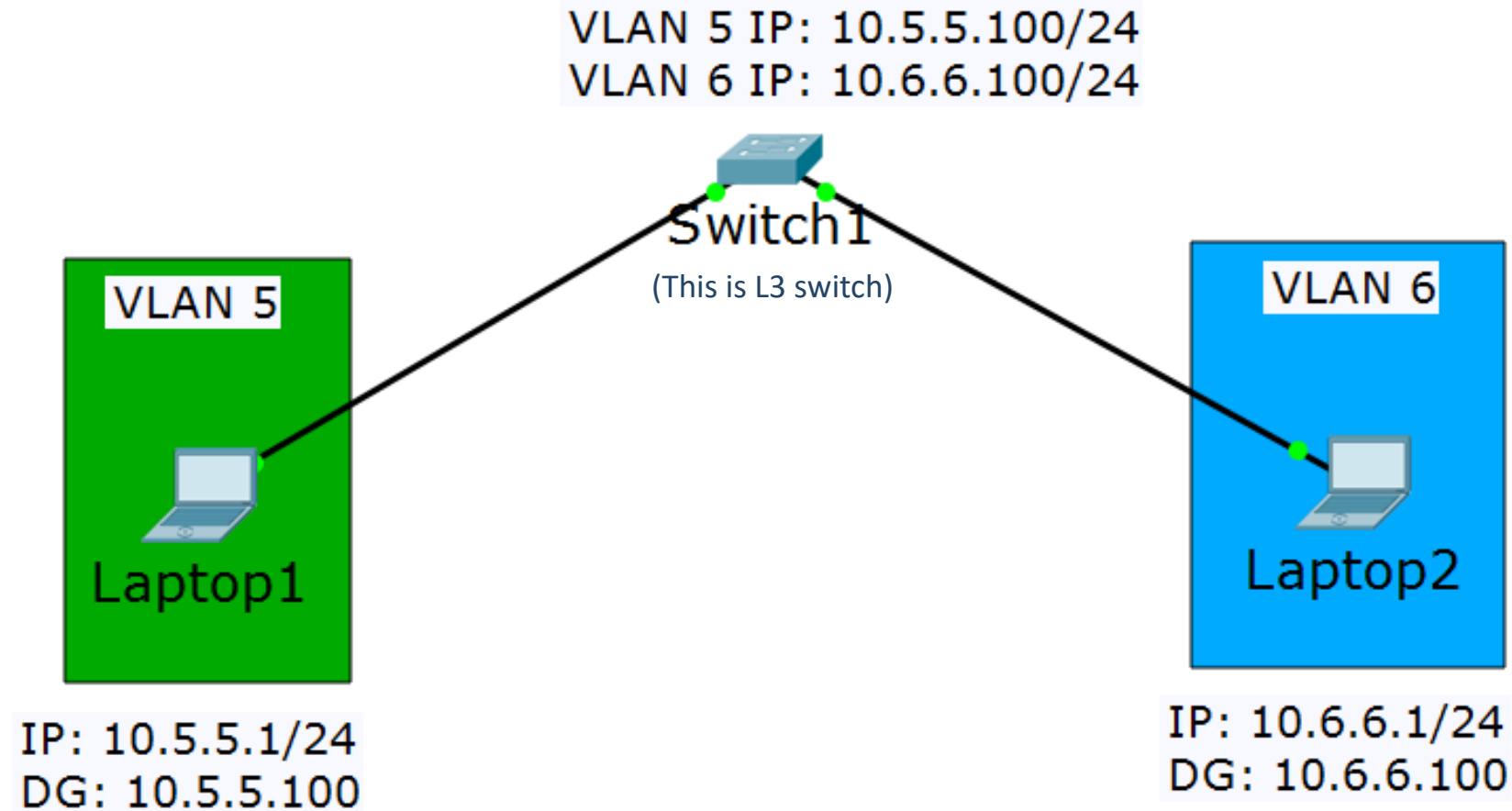


Inter-VLAN routing

How to Route Between VLANs

- To route between two or more VLANs, a Layer 3 device is required (Router or L3 switch)
- Inter-VLAN routing can be done with either
 - The same switch which holds the VLANs (if it is L3)
 - External L3 switch
 - External router
- Only IP addresses (one per VLAN) and no other static or dynamic routing configuration is required

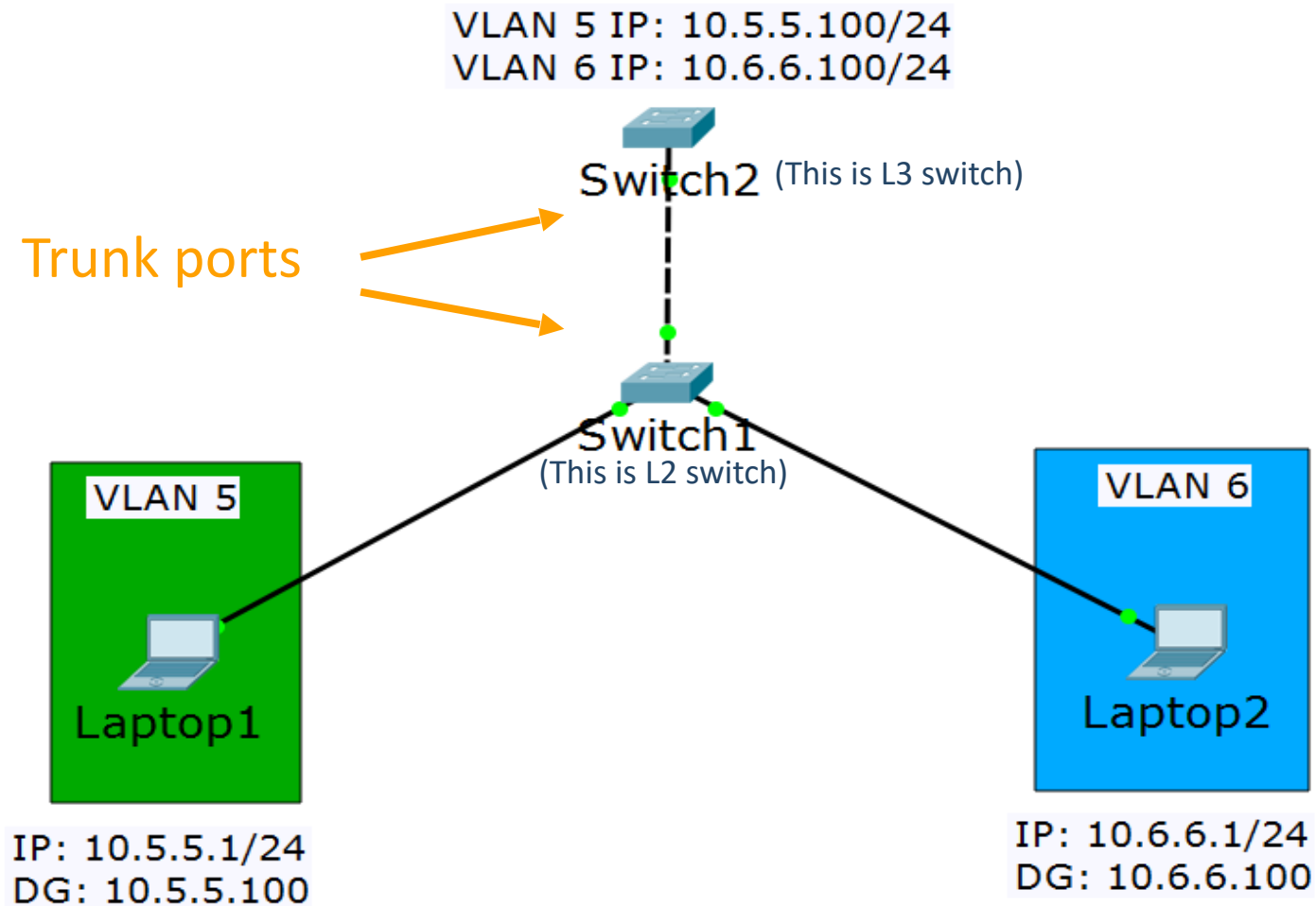
Inter-VLAN Routing Using the Same Switch



Inter-VLAN Routing Using the Same Switch (2)

- The switch must have L3 functionality
- Configurations required:
 - One IP address per VLAN
 - Default gateway on the end devices

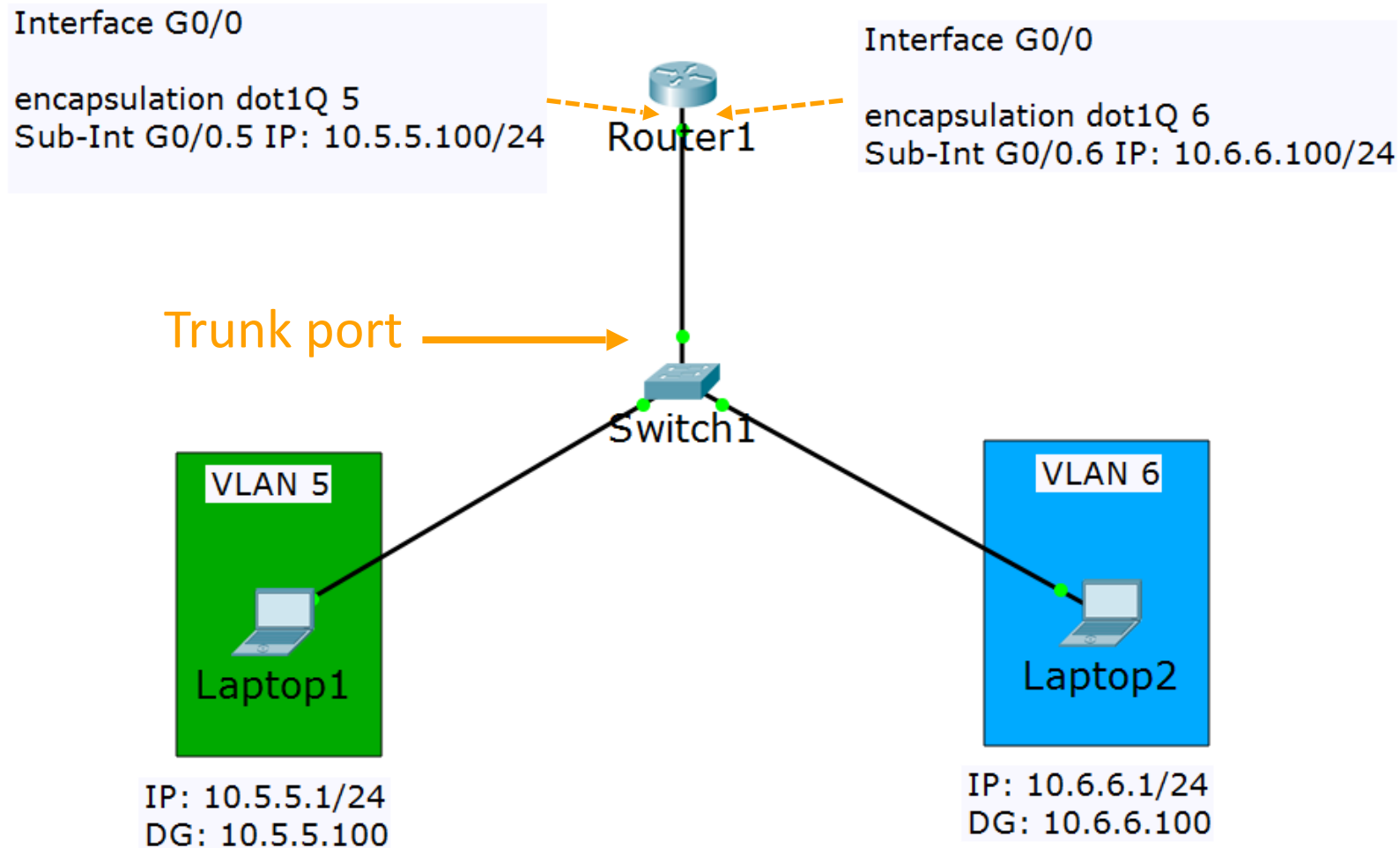
Inter-VLAN Routing Using External Switch



Inter-VLAN Routing Using External Switch (2)

- The external switch must have L3 functionality
- Configurations required:
 - Trunk ports for the switch-to-switch connection
 - One IP address per VLAN on the external switch
 - Default gateway on the end devices

Inter-VLAN Routing Using External Router



Inter-VLAN Routing Using External Router (3)

- Known as “Router on a stick” or “One-armed router”
- Configurations required:
 - Trunk port on the switch
 - Sub-interfaces on the router (with “encapsulation dot1Q *vlan*”)
 - One IP address per sub-interface
 - Default gateway on the end devices

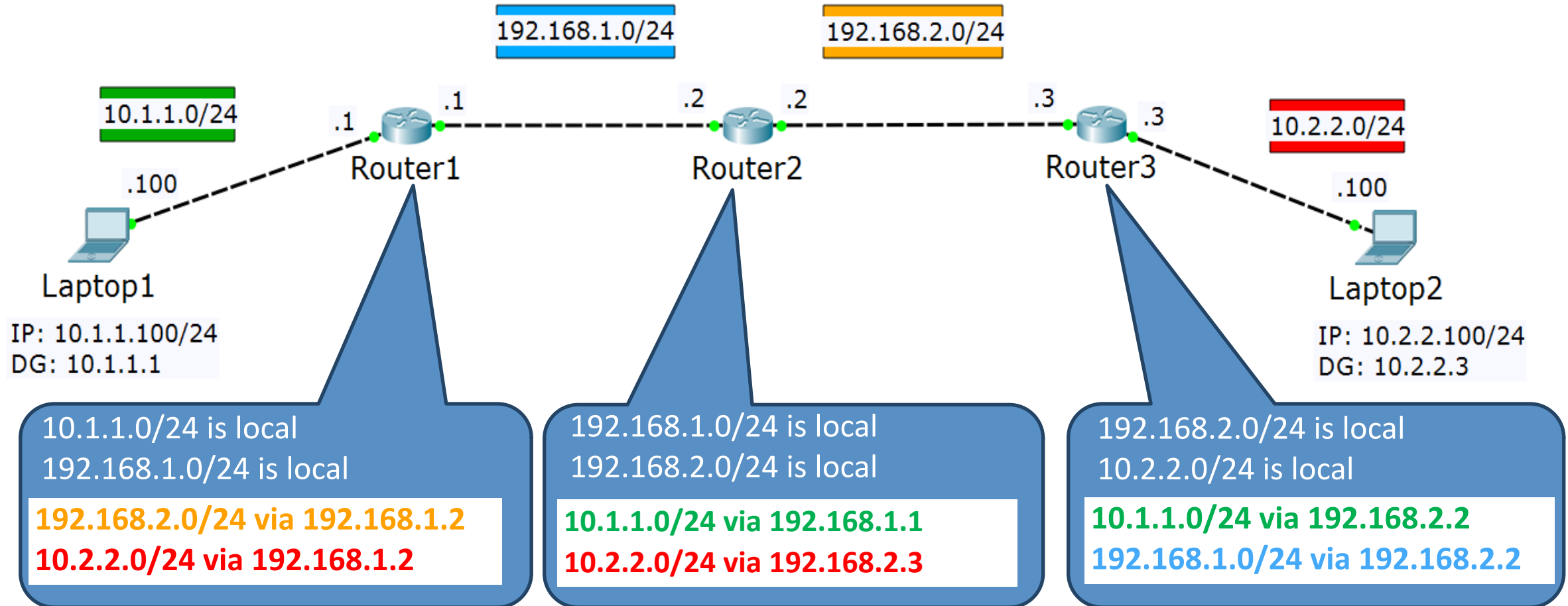


Static routing

Direct vs indirect Routing

- Directly connected networks (or VLANs) does not require static or dynamic routing configuration
- To reach remote networks, entries in the routing tables must be added – this is known as **indirect routing**
- The routing table can be updated
 - Statically (manual configuration)
 - Dynamically (requires routing protocol like OSPF)

Static Routes





Demonstration

Summary

1. IP services: DHCP and DNS
2. Introduction to routing
3. Direct routing
4. Inter-VLAN routing
5. Static routing

