# Tutorial: Network Layer

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### IPv4 addressing

- A network has the IP Prefix: **145.10.34.0/24** 
  - **Network IP address:** 145.10.34.0
  - **Broadcast IP address:** 145.10.34.255
  - **IP range:** 145.10.34.1 145.10.34.254

#### Dotted-Decimal notation



# Dynamic Host Configuration Protocol (DHCP)

- The computer dynamically obtains an IP address from the server of the network when connected to the network
  - can renew the lease for an address in use
  - o allows the reuse of addresses
  - support also for mobile users connected to the network



### **DHCP** Client-Server



#### **BGP** Basics

- The Internet connects thousands of Autonomous Systems (ASes) operated by different institutions, such as Internet Service Providers (ISPs), companies, and universities
- ASes interconnect via dedicated links and public network access points, and exchange reachability information using the Border Gateway Protocol (BGP)
- BGP is an interdomain routing protocol that allows ASes to apply local policies for selecting routes and propagating routing information, without revealing their policies or internal topology to others.



#### **BGP** basics

- The Internet topology is shaped according to business relationships
  - ASes connect only if they have a business relationship
  - BGP is a "follow the money" protocol
- 2 main business relationships today:
  - customer/provider
  - peer/peer

#### Customer/Provider Relationship

- <u>Customer/provider</u>: A customer pays its provider for connectivity to the rest of the Internet
- The amount paid is based on peak usage



# Peer to Peer Relationship

 <u>Peer/peer</u>: Peers agree to exchange traffic between their respective customers free of charge



### Gao-Rexford guidelines

- Many ASes may have conflicting BGP policies that lead to route divergence
- Gao-Rexford guidelines ensure route convergence even under changes in the topology and routing policies
  - Prefixes received from a customers are advertised to customers, peers and providers
  - Prefixes received from a peer are advertised to customers only
  - Prefixes received from a providers are advertised to customers only
  - Customers are preferred over peers and providers, and peers are preferred over providers

# Example Subnetting

- A network with an IP Prefix 223.1.17.0/24
  - Separate the network in two subnets:
    - subnet1: 127 IPs
    - subnet2: 127 IPs

### Solution

Αρχικά το prefix 223.1.17.0/24 σε δυαδική μορφή ισούται με

11011111 .		0000001 .		00010001 .		00000000		
223	Ĩ.	1	8	17	ų.	0		

To /24 μας επιτρέπει να διαχειριστούμε 2<sup>8</sup>-2 = 256 - 2 ΙΡ διευθύνσεις (εξαιρούνται οι διευθύνσεις .0 και .255, όπως αναφέρθηκε και στο μάθημα).

#### Solution

Το πρώτο Υποδίκτυο

Από	11011111		0000001	•	00010001	27	00000001
	223		1		17		1
Εως	11011111		0000001		00010001	13	01111110
	223		1	353	17		126
Ή αλλιώς	το Υποδίκτυο 1 θα	έχει μο	ρφή 223.1.17.0/	25.			
Αντίστοιχα	α, το Υποδίκτυο 2						
Από	11011111		0000001		00010001	×.	10000001
	223		1		17		129
Εως	11011111	a.	0000001		00010001	13	<b>1</b> 1111110
	223		1	200	17		254
Δηλαδή, τ	ο Υποδίκτυο 2 θα έ	χει τη μ	ιορφή 223.1.17.1	28/25.			

## Router Configuration

- routing tables are created and used by routers to forward packets from their local networks to other networks
- a router cannot create a routing table or forward any packets
  - $\circ$  until it has been configured
- Assume a topology with routers and hosts
- Examples of configurations:
  - assign IP address to all interfaces
  - define the BGP neighbors (the links between the routers)
  - OSFP configuration
  - iBGP, eBGP sessions

# **Configuration Examples**

- Host
  - Assign an IP address and subnet to one of the interfaces available on the host
    - > ip address add 111.0.222.3/24 dev R1
- Router
  - assign an IP address to a router's interface
    - >router# conf t
    - >router(config)# interface INTERFACENAME
    - >router(config-if)# ip address 1.0.0.1/24

## Router Configuration

• Available commands:

clear	Reset functions
configure	Configuration from vty interface
exit	Exit current mode and down to previous mode
no	Negate a command or set its defaults
ping	Send echo messages
quit	Exit current mode and down to previous mode
show	Show running system information
traceroute	Trace route to destination
write	Write running configuration to memory, network, or terminal

### BGP configuration

RouterA# show ip b	qp						
BGP table version	is 14, local rout	ter ID is 17:	2.31.11	.1			
Status codes: s su	ppressed, d dampe	ed, h history	v, * val	lid, > 1	best, :	i -	
internal, r RIB-fa	ilure, S Stale			1990 B	() () () () () () () () () () () () () (		
Origin codes: i -	IGP, e - EGP, ? ·	- incomplete					
Network	Next Hop	Metric	LocPrf	Weight	Path		
*> 10.1.0.0/24	0.0.0.0	0		32768	i		
* i	10.1.0.2	0	100	0	i		
*> 10.1.1.0/24	0.0.0.0	0		32768	i		
*>i10.1.2.0/24	10.1.0.2	0	100	0	i		
*> 10.97.97.0/24	172.31.1.3			0	64998	64997	i
*	172.31.11.4			0	64999	64997	i
* i	172.31.11.4	0	100	0	64999	64997	i
*> 10.254.0.0/24	172.31.1.3	0		0	64998	i	
*	172.31.11.4			0	64999	64998	i
* i	172.31.1.3	0	100	0	64998	i	
r> 172.31.1.0/24	172.31.1.3	0		0	64998	i	
r	172.31.11.4			0	64999	64998	i
ri	172.31.1.3	0	100	0	64998	i	
*> 172.31.2.0/24	172.31.1.3	0		0	64998	i	
<output omitted=""></output>							

- Next hop: The IP address of the first router interface in AS-PATH
- Metric: A value of the MED<sup>[1]</sup> attribute, preferred links with the lowest metric
- Local Preference: It can be set by a router in order to influence the best path choices of all its iBGP peers
- **Path**: The ASes that the packet passes through to reach the destination

[1] The BGP multiple exit discriminator (MED) only propagated to adjacent autonomous systems (ASes). The purpose of MED is to influence how other ASs enter your AS to reach a certain prefix.