

F5 101 – Application Delivery Fundamentals

Part 1: Networking Basics

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Switching Concepts

Layer 1 – Physical

- Binary Transmission
- Defines the electrical, mechanical, procedural, and functional separation for activating and deactivating physical link
- Cable (Copper or Optical), Repeater, Hubs and Physical Ports

Layer 2 – Data Link

- Allows the upper layers to access the media using framing
- Defines how data is formatted for transmission and how access to the network is controlled
- Provides error detection
- Uses frame as transmission unit
- Ethernet Switch and Ethernet Bridge

Switching Concepts

Layer 2 technologies

- MAC address
- CAM and ARP Table
- Broadcast Domain
- VLANs
- 802.1Q (Tagged)
- Untagged
- Link Aggregation / Trunk

Switching Concepts

Address Resolution Protocol (ARP)

- communication protocol used for discovering MAC address, associated with a given IPv4 address.
- uses a simple message format containing one address resolution request or response.
- Send broadcast ARP message (destination FF:FF:FF:FF:FF:FF MAC address), which is accepted by all computers on the local network and request answer for a specific host.

Reverse Address Resolution Protocol (RARP)

- obtain IP addresses of other nodes from data link layer (Layer 2) addresses. It is primarily used in Frame Relay (DLCI), ATM other Wide Area Networks (WAN)
- client computer to request its Internet Protocol (IPv4) address from a computer network, when all it has available is its link layer or hardware address, such as a MAC address.
- client broadcasts the request and does not need prior knowledge of the network topology
- Obsolete and replaced by BOOTP, which was later superseded by the Dynamic Host Configuration Protocol (DHCP)

IP addressing and Subnetting

IP Address

- Unique identity of host in a network
- Part of Packet - Transmission unit in Layer 3 of the OSI Model – Network
- Consist of two parts:

Network ID:

- Identifies the network of which the IP is a part of
- Use by routers to maintain route information

Host ID:

- Identifies the individual host
- Assigned by organizations to individual devices

192 . 168 . 1 . 1 /24

Network

Host

IP addressing and Subnetting

Decimal and Binary

- Decimal represents numbers from 0 to 9
- Binary represents series of 0s and 1s

Binary	Decimal
0	0
1	1
10	2
11	3
100	4
101	5
110	6
111	7

Binary	Decimal
1000	8
1001	9
1010	10
1011	11
1100	12
1101	13
1110	14
1111	15

IP addressing and Subnetting

Decimal to Binary Conversion

Octet								
Base	2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
Value	128	64	32	16	8	4	2	1

192 . 168 . 1 . 1 / 24

11000000

10101000

128 + 64 = 192

128 + 32 + 8 = 168

IP addressing and Subnetting

Private IP address

IP Address Class	Private IP Address Range
A	10.0.0.0 to 10.255.255.255
B	172.16.0.0 to 172.31.255.255
C	192.168.0.0 to 192.168.255.255

Public IP address

IP Address Class	Public IP Address Range
A	1.0.0.0 to 9.255.255.255 11.0.0.0 to 126.255.255.255
B	128.0.0.0 to 172.15.255.255 172.32.0.0 to 191.255.255.255
C	192.0.0.0 to 192.167.255.255 192.169.0.0 to 223.255.255.255

IP addressing and Subnetting

Others

IP Address Class	IP Address Range
D (Multicast)	224.0.0.0 to 239.255.255.255
E (Reserved)	240.0.0.0 to 255.255.255.255

Specials

IP Address Class	Public IP Address Range
127.0.0.0	127.0.0.0 to 127.255.255.255 (Loopback Address)
255.255.255.255	255.255.255.255 (Global Broadcast)

IP addressing and Subnetting

IPv6

- 128 Bits with up to 3.4×10^{38} IP Addresses
- Address representation format X:X:X:X:X:X:X:X. X is 16-bit Hexadecimal aka field

2001:0DB3:00F1:0003:0000:0000:0000:0AB3

- In a field, leading Zeros are optional and be rewritten as:

2001:DB3:F1:3:0:0:0:AB3

- Successive fields of 0 are represented as "::". This only be used once per address:

2001:DB3:F1:3::AB3

Benefits

- Larger address space
- Simpler header
- Security and mobility
- Transition richness

IP addressing and Subnetting

Four types IPv6 Unicast

■ Global Unicast

publicly routable address and starts with 2000::/3 and assigned by IANA

■ Link Local Unicast

are akin to the private, non-routable addresses

starts with FE80::/10

■ Unique Local

joining two subnets does not cause address collisions

FC00::/7 prefix, 41-bit Global ID, 16-bit Subnet ID and 64-bit Interface ID

■ Special Address

Reserved Addresses such as:

::/128 for Unspecified Address

::/0 for Default Route

::1/128 for Loopback Address <https://t.me/learningnets>

IP addressing and Subnetting

IPv6 Multicast

- Packet sent only to the host/s who are member/s of the multicast group
- Routable

Reserved Multicast Address for Routing Protocols

- FF02::5 for OSPFv3
- FF02::6 for OSPFv3 Designated Routers
- FF02::9 for RIPng
- FF02::A for EIGRP

Anycast

- A single address assigned to multiple nodes
- Packet sent to anycast address is then delivered the first available node
- Same concept with anycast in IPv4

Routing Concepts

Layer 3 – Network

- Data Delivery
- Routes data packets
- Connectionless protocol
- Selects best path to deliver data
- Provides logical addressing and path selection
- Uses packet as its transmission protocol
- Two variants: IPv4 and IPv6

Routing Concepts

Network Devices

- Router
- L3/Multilayer Switch
- Firewall
- Host - PC/Server

Routing Technologies

- IP address and Subnetting
- Routing Table
- Routing Protocols – Static and Dynamic
- ICMP
- Time to Live (TTL)

Routing Concepts

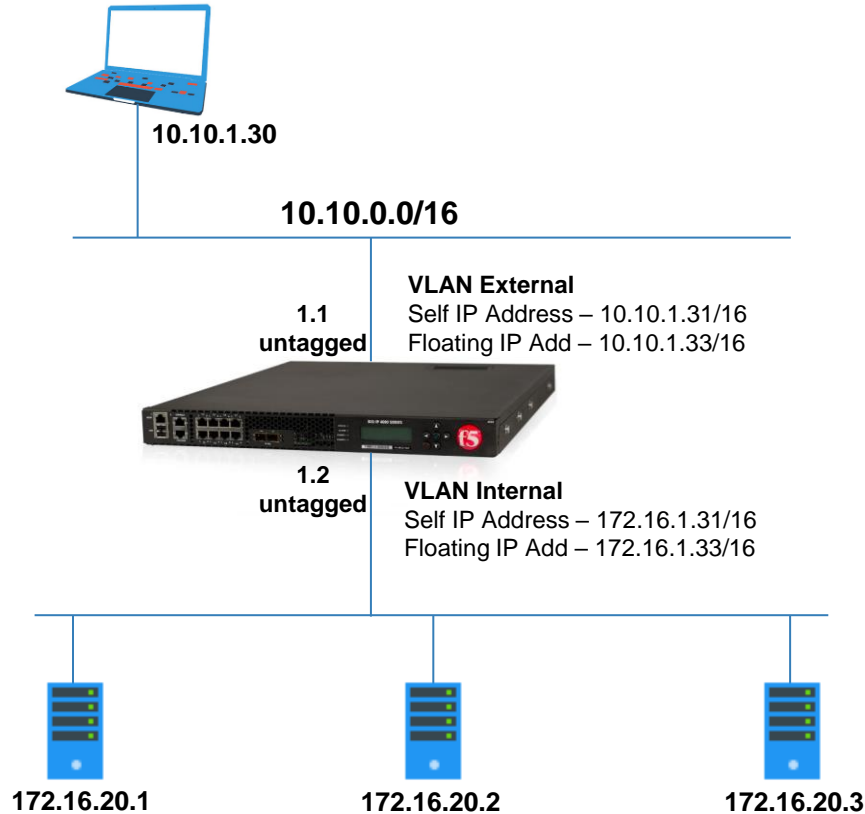
Static Routing

- Enters manually by the administrator
- Requires manual update and can be controlled precisely

Dynamic Routing

- Dynamic routes automatically adjusts when topology changes
- Router learns routes by exchanging routing updates
 - Routing Information Protocol (RIP) – UDP 520
 - Enhanced Interior Gateway Routing Protocol (EIGRP) – IP 88
 - Open Shortest Path First (OSPF) – IP 89
 - Intermediate System to Intermediate System (IS-IS) – L2 / CLNP
 - Border Gateway Protocol (BGP) – TCP 179

Configuring ADC Networking



Transport Layer

Layer 4 Transport

- End-to-end connections
- Handles transportation issues between hosts
- Ensures data transport reliability
- Establishes, maintains, and terminates virtual circuits
- Provide reliability through fault detection and recovery
- Uses segment as its transmission protocol

Transport Layer

Layer 4 Technologies

- TCP and UDP
- TCP Three-Way Handshake
- TCP Flags
- Retransmission
- Flow Control
- Windowing/Sliding Windows

Transport Layer

TCP vs UDP

- TCP is connection-oriented protocol, UDP is connectionless
- TCP does error checking and UDP doesn't
- TCP is reliable while UDP is unreliable
- TCP does ordering and sequencing while UDP sends packet in any order
- TCP is slower than UDP as it has to establish connection, error-check etc

TCP

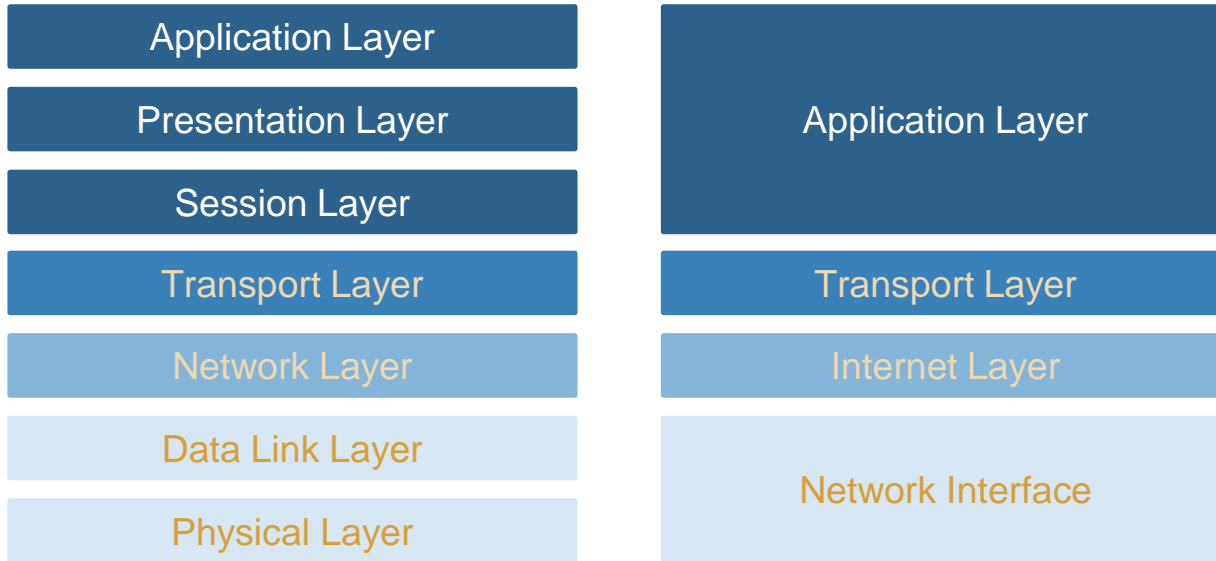
- HTTP and HTTPS (80/443)
- Telnet and SSH (23/22)
- FTP (20/21)
- SMTP, IMAP/POP (25/143/110)

UDP

- DNS (53)
- BOOTP/DHCP (67,68)
- TFTP (69)
- SNMP (161)

Transport Layer

OSI Model vs TCP/IP Model



Transport Layer

Lower Layers of OSI Model

Transport Layer

establishing a communication session between two applications and delivering data
responsible for end-to-end communication over a network

Segmenting data for manageability and reassembling segmented data

TCP - connection-oriented communication, reliability, flow control, window sizing.

Network Layer

packet forwarding including routing through intermediate routers

network layer flow control, error control, packet sequence control, fragmentation, ICMP, TTL

Logical Address, Logical Path, IP Address, Subnet/Network, Netmask, Multicast, Anycast

Routing Protocols – Dynamic and Static

Data Link Layer

Encapsulation/Decapsulation of network layer data packets into frames

transform a raw transmission facility into a line of undetected transmission errors to the network layer

802.1Q, VLANs, Trunk/LACP, ARP, MAC Address

Physical Layer

Electrical and Mechanical

BITS / Binary Transmission

Port - Duplex and Speed

<https://t.me/learningnets>
Cable and Module- SFP+, Copper and Optical

Network Address Translation

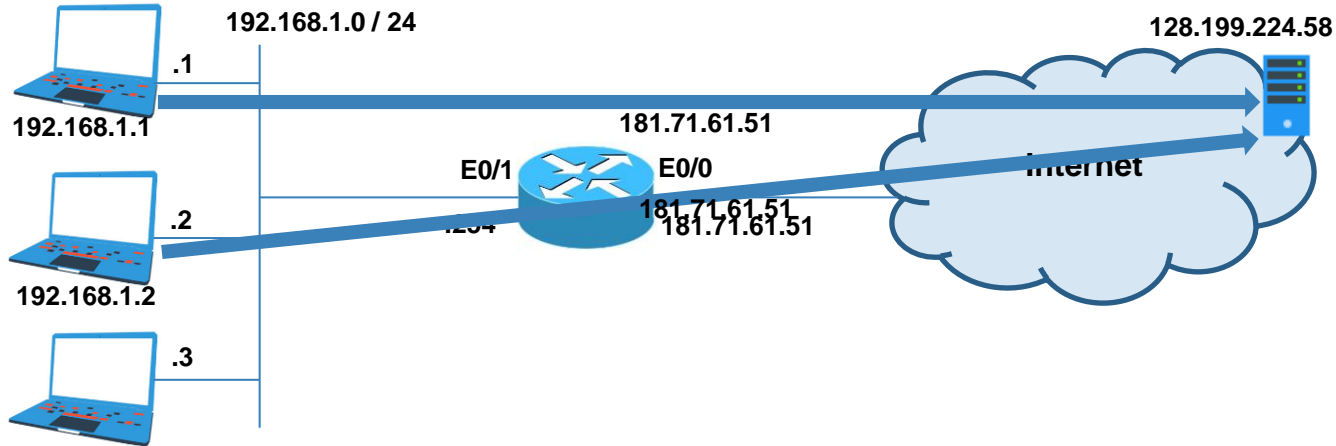
NAT

- Allow private users to access public network by sharing one or more public IP addresses
- Allow one or multiple devices to access the Internet

Types of NAT

- One-to-one address mapping
- Many-to-many (pool) address mapping
- Many-to-one address mapping

Network Address Translation



Inside Local	Inside Global	Outside Global
192.168.1.1:1516	181.71.61.51:1516	128.199.224.58:80
192.168.1.2:1517	181.71.61.51:1517	128.199.224.58:80

Dynamic Host Configuration Protocol

Static IP address assignment

- Manually configuration of IP address per network adapter
- Time consuming and prone to errors
- Extremely rare in a wireless environment

DHCP IP address assignment

- Centralize IP address allocation
- Assign IP addresses automatically in accordance with VLAN settings
- DHCP relay agent forward DHCP request/replies between clients and servers when they are not on the same subnet / broadcast domain

Dynamic Host Configuration Protocol



IP Address 172.16.1.1
Netmask 255.255.255.0
Gateway 172.16.1.254
Lease time 86400s (1 Day)
DNS 172.16.1.254

DHCP Options	
1	Subnet mask
3	Router / Gateway
51	IP Address lease time
6	DNS Server

DHCP Message Type	
1	DHCPDISCOVER
2	DHCPOFFER
3	DHCPREQUEST
4	DHCPDECLINE
5	DHCPACK

Part 1 Wrap Up

Part 1: Networking Basics

- Switching Concepts
- IP addressing and Subnetting
- Routing Concepts
- Configuring ADC Networking
- Transport Layer Concepts
- Network Address Translation (NAT)
- Dynamic Host Configuration Protocol (DHCP)