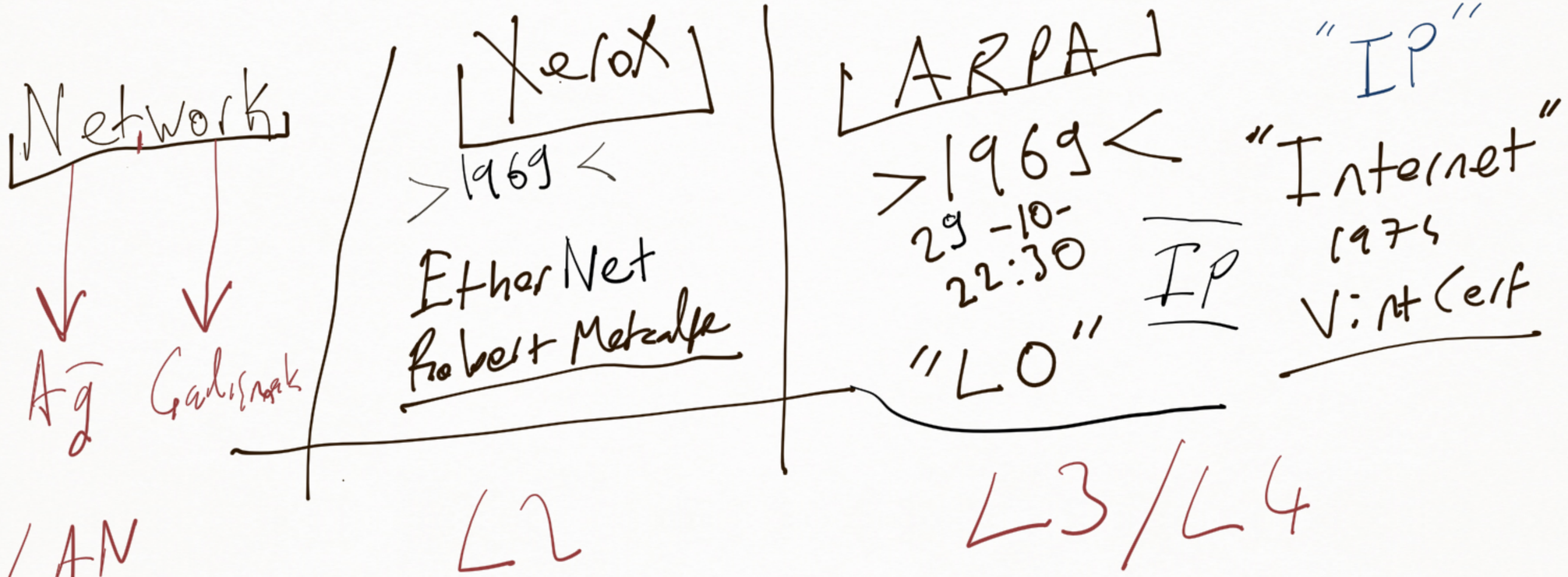
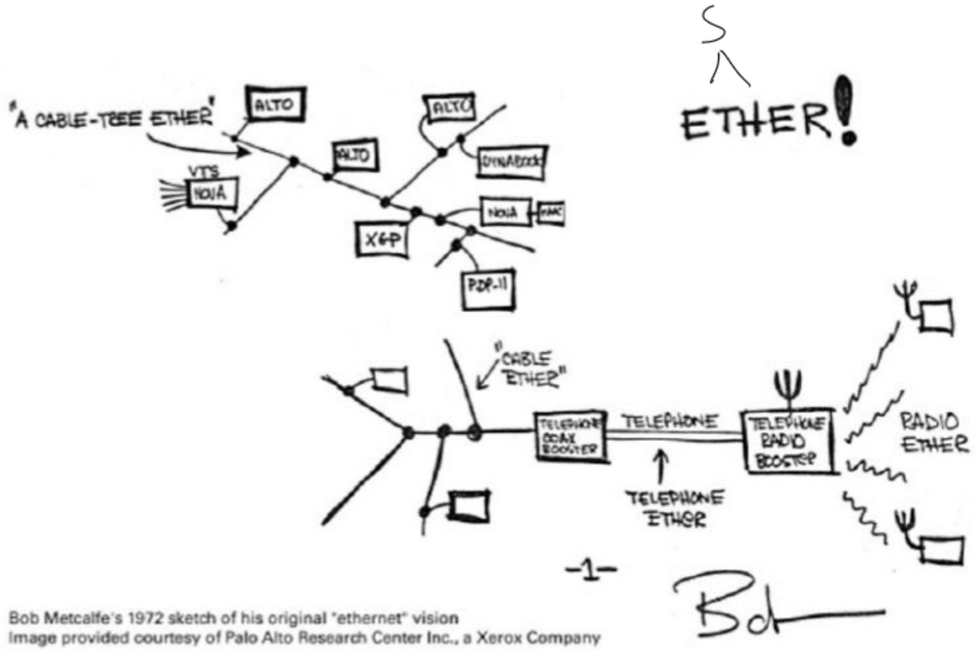
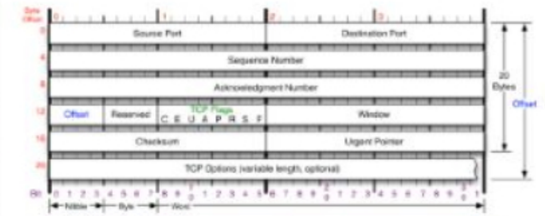
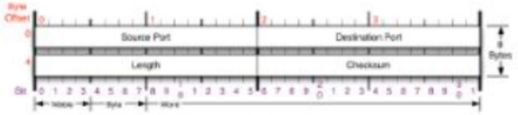
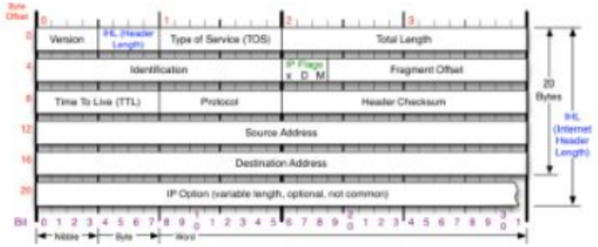

Network
Xerox
1969
EtherNet
Robert Metcalfe
ARPA
1969
29-10-
22:30
"LO"
IP
"IP"
"Internet"
1974
Vint Cerf
Ag
Gadisnak
LAN
WAN
L2
L3/L4



Bob Metcalfe's 1972 sketch of his original "ethernet" vision
Image provided courtesy of Palo Alto Research Center Inc., a Xerox Company







TCP Flags

C E U A P R S F
Congestion Window
C 0x80 Reduced (CWR)
E 0x40 ECN Echo (ECE)
U 0x20 Urgent
A 0x10 Ack
P 0x08 Push
R 0x04 Reset
S 0x02 Syn
F 0x01 Fin

Congestion Notification

ECN (Explicit Congestion Notification). See RFC 3168 for full details, valid states below.

TCP Options

0 End of Options List
1 No Operation (NOP, Pad)
2 Maximum segment size
3 Window Scale
4 Selective ACK ok
8 Timestamp

Checksum

Checksum of entire TCP segment and pseudo header (parts of IP header)

Offset

Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.

RFC 793

Please refer to RFC 793 for the complete Transmission Control Protocol (TCP) Specification.

Checksum

Checksum of entire UDP segment and pseudo header (parts of IP header)

RFC 768

Please refer to RFC 768 for the complete User Datagram Protocol (UDP) Specification.

Version

Version of IP Protocol. 4 and 6 are valid. This diagram represents version 4 structure only.

Header Length

Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.

Protocol

IP Protocol ID. Including (but not limited to):

1 ICMP	17 UDP	57 SKIP	
2 IGMP	47 GRE	88 EIGRP	
6 TCP	50 ESP	89 OSPF	
9 IGRP	51 AH	115 L2TP	

Total Length

Total length of IP datagram, or IP fragment if fragmented. Measured in Bytes.

Fragment Offset

Fragment offset from start of IP datagram. Measured in 8 byte (2 words, 64 bits) increments. If IP datagram is fragmented, fragment size (Total Length) must be a multiple of 8 bytes.

Header Checksum

Checksum of entire IP header

IP Flags

x D M

x 0x80 reserved (evil bit)
D 0x40 Do Not Fragment
M 0x20 More Fragments follow

RFC 791

Please refer to RFC 791 for the complete Internet Protocol (IP) Specification.

Vint Cerf the "fathers of the Internet"
TCP/IP inventor

Mat = 100mt
Min = 64B CSMA/CD

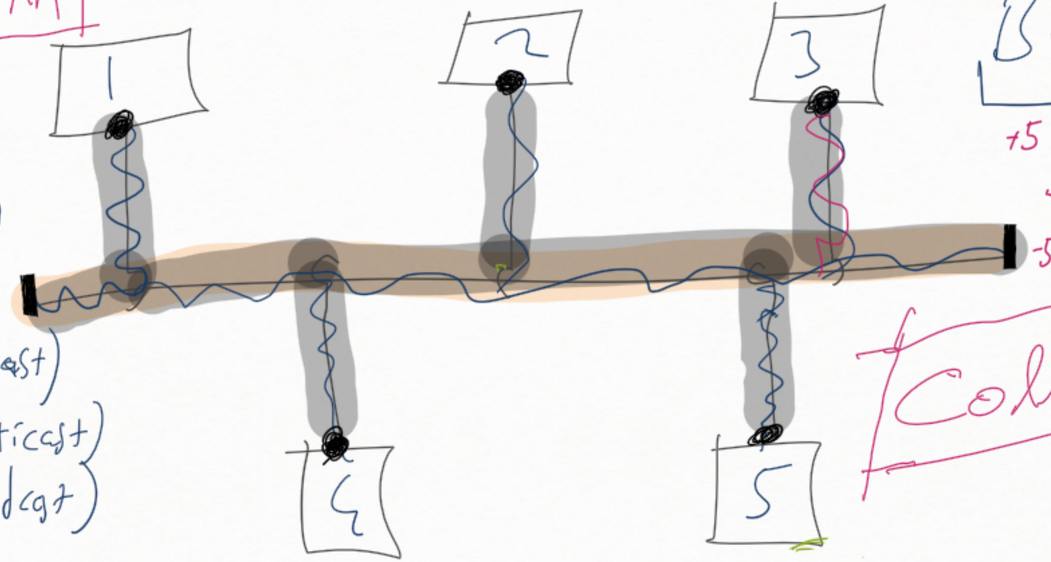
JAM

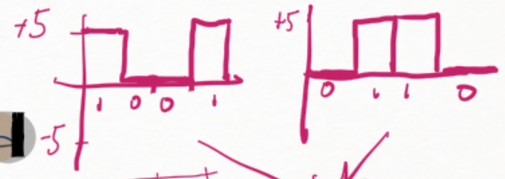
flooding Shared Media
MultiAccess

Ether-Net

MAC
Media Access Control

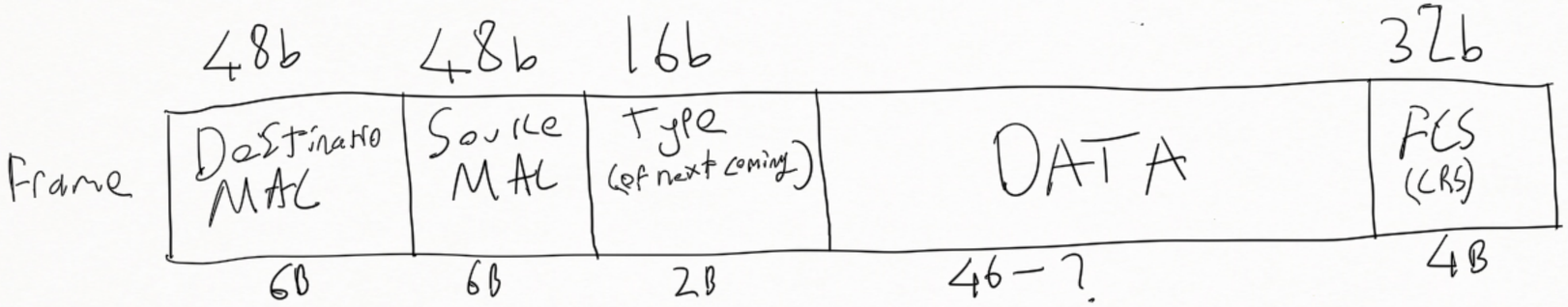
Best Effort

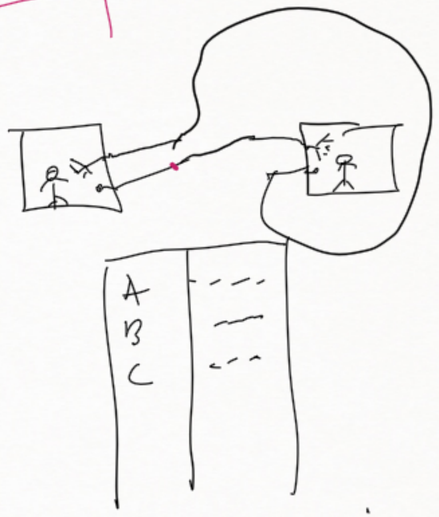




Collission

00:AB:CD:01:09:1A (Unicast)
01:00:5E:00:00:0A (Multicast)
ff:ff:ff:ff:ff:ff (Broadcast)





MTU = 1500B

Alto-Alto Network

1972 — Ethernet I Xerox 2.94 Mbps

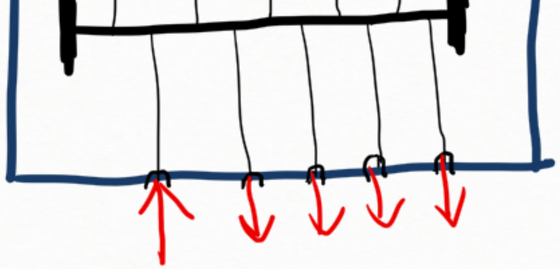
1980 — Digital Intel Xerox (DIX, Ethernet II)

Ethernet Frame Structure

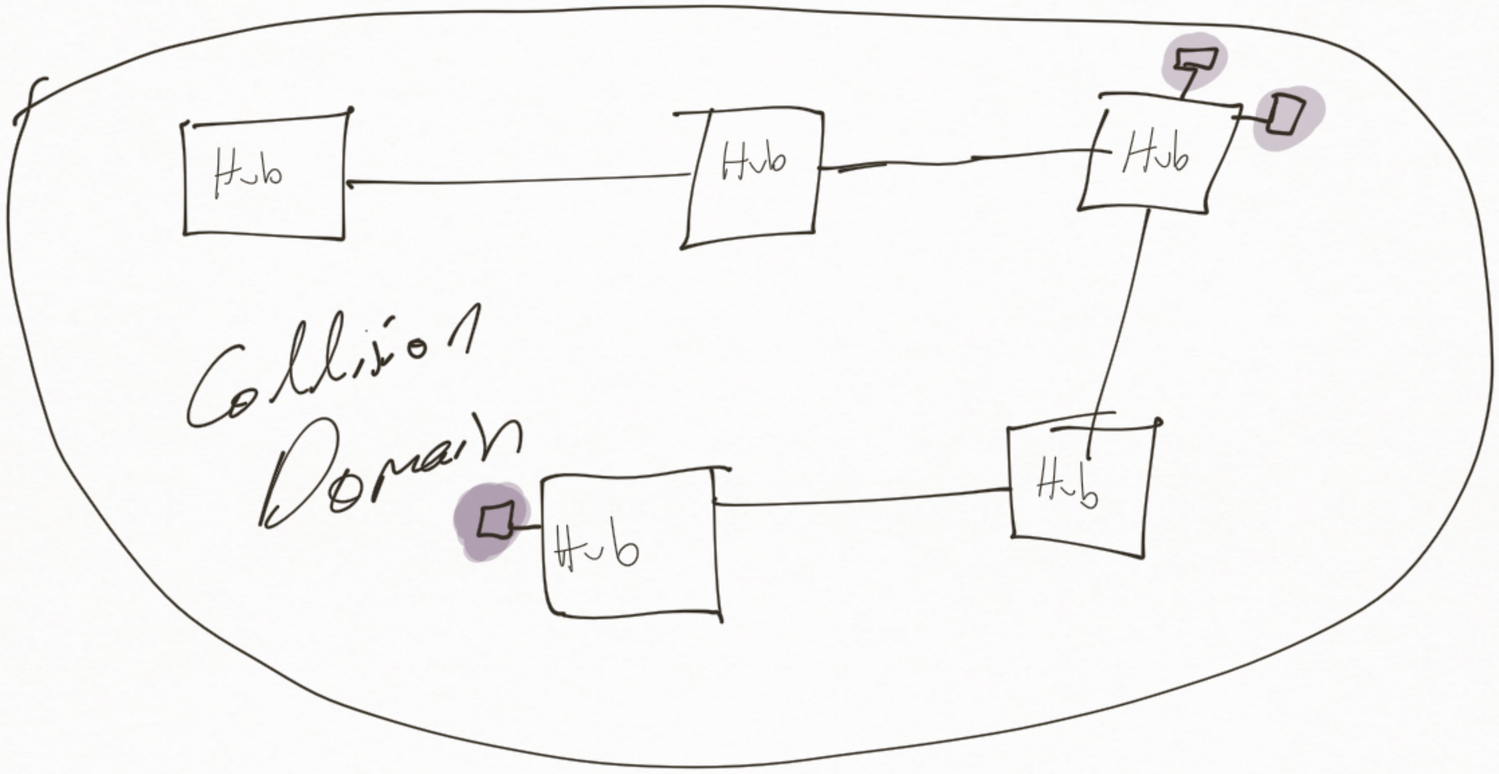
Typical Ethernet Frame					
8 bytes	6	6	2	46-1500	4
Preamble	Destination Address	Source Address	Type	Data	FCS

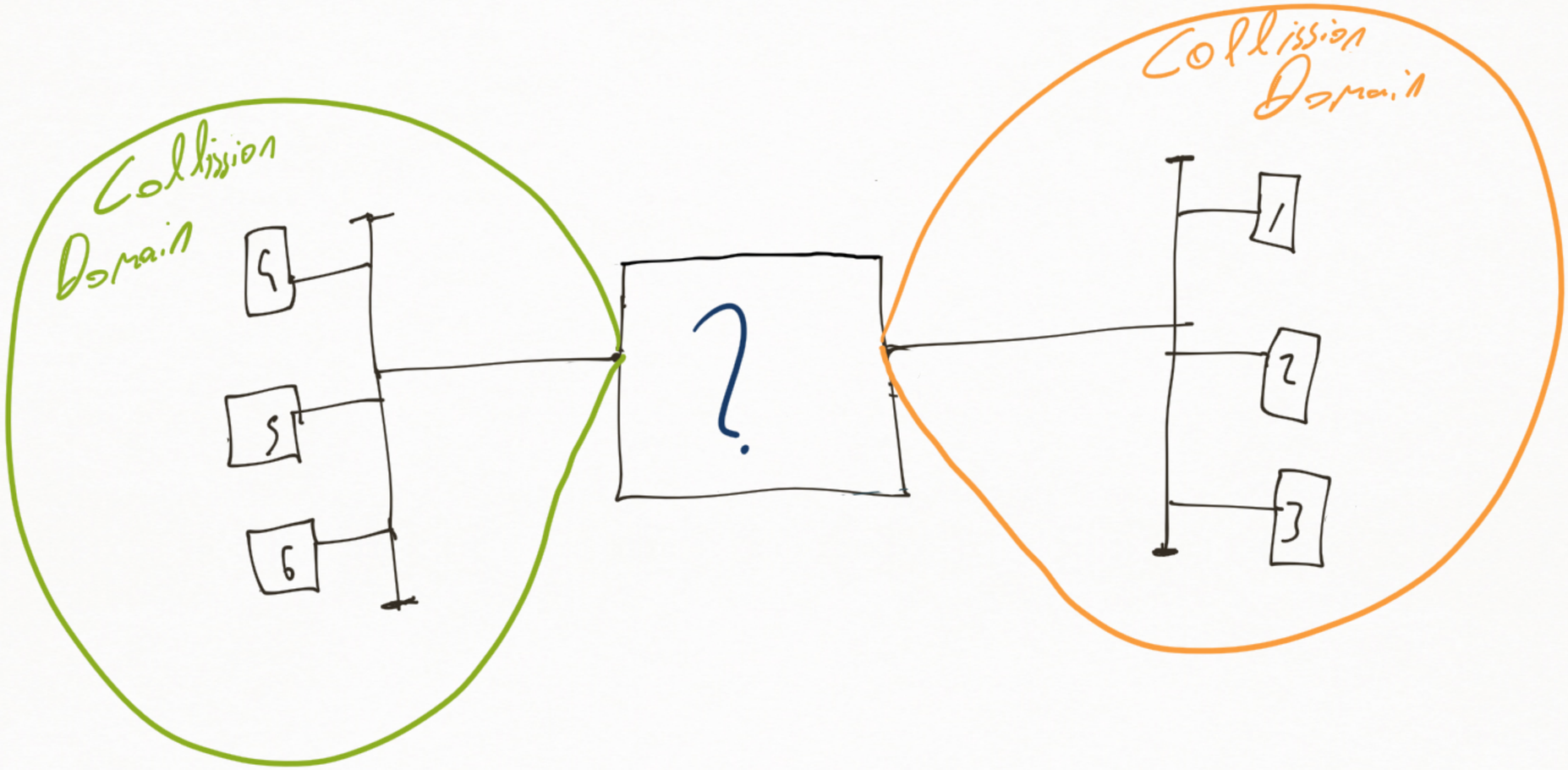
- FCS = frame check sequence
- Field length is stated in bytes.

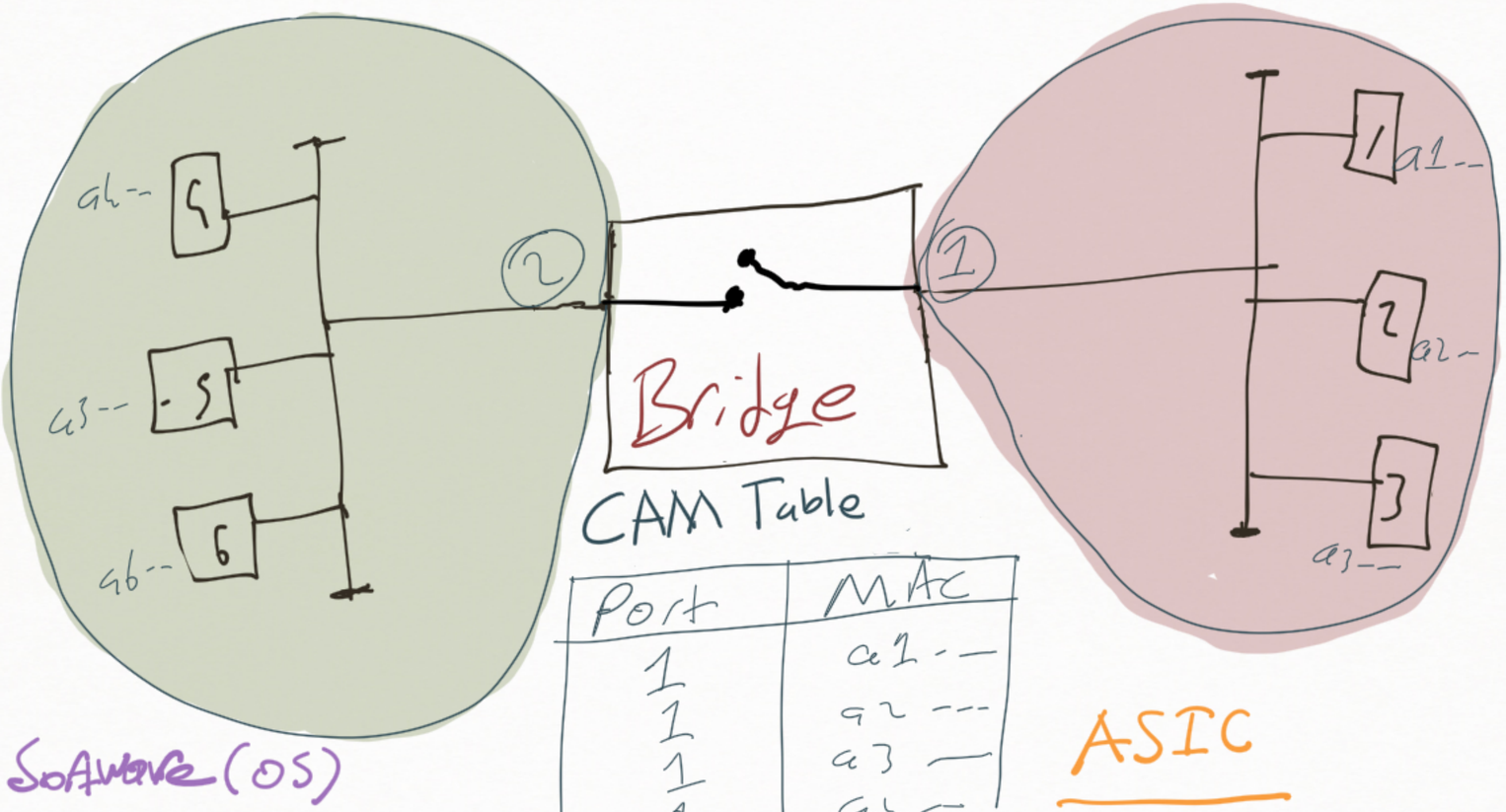
1485 - IEEE 802.3

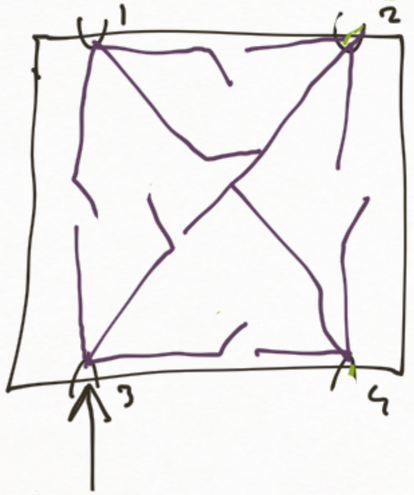



HUB
HEWLETT PACKARD
28691A
EtherTwist Hub/8
1 2 3 4 5 6 7 8
1 2 3 4
5 6 7 8
Fault
Power
Col
Act
Twisted-Pair Ports

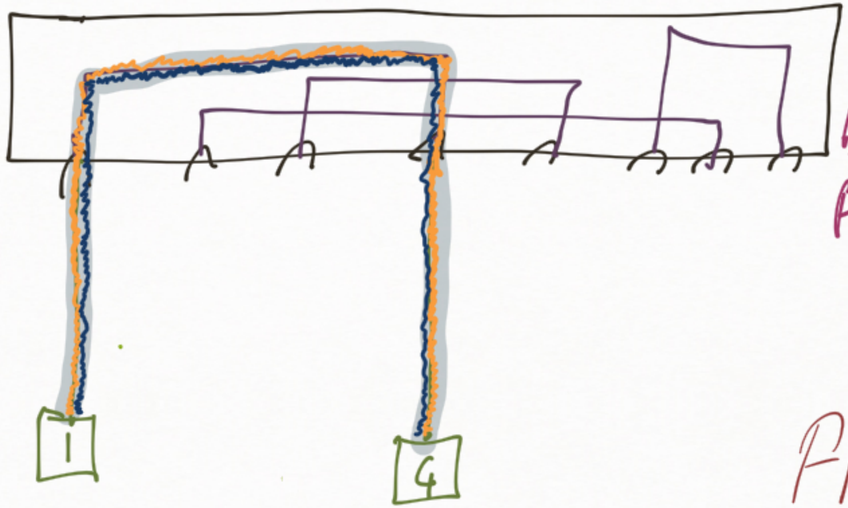

Hub
Hub
Hub
Collision
Domain
Hub
Hub


Collision
Domain
4
5
6
?
Collision
Domain
1
2
3


Bridge
CAM Table
Port
MAC
ASIC
Software (OS)
L1 to L2 mapping



Full Duplex + Switch



~~Simplex~~

Half duplex =

full duplex ≡

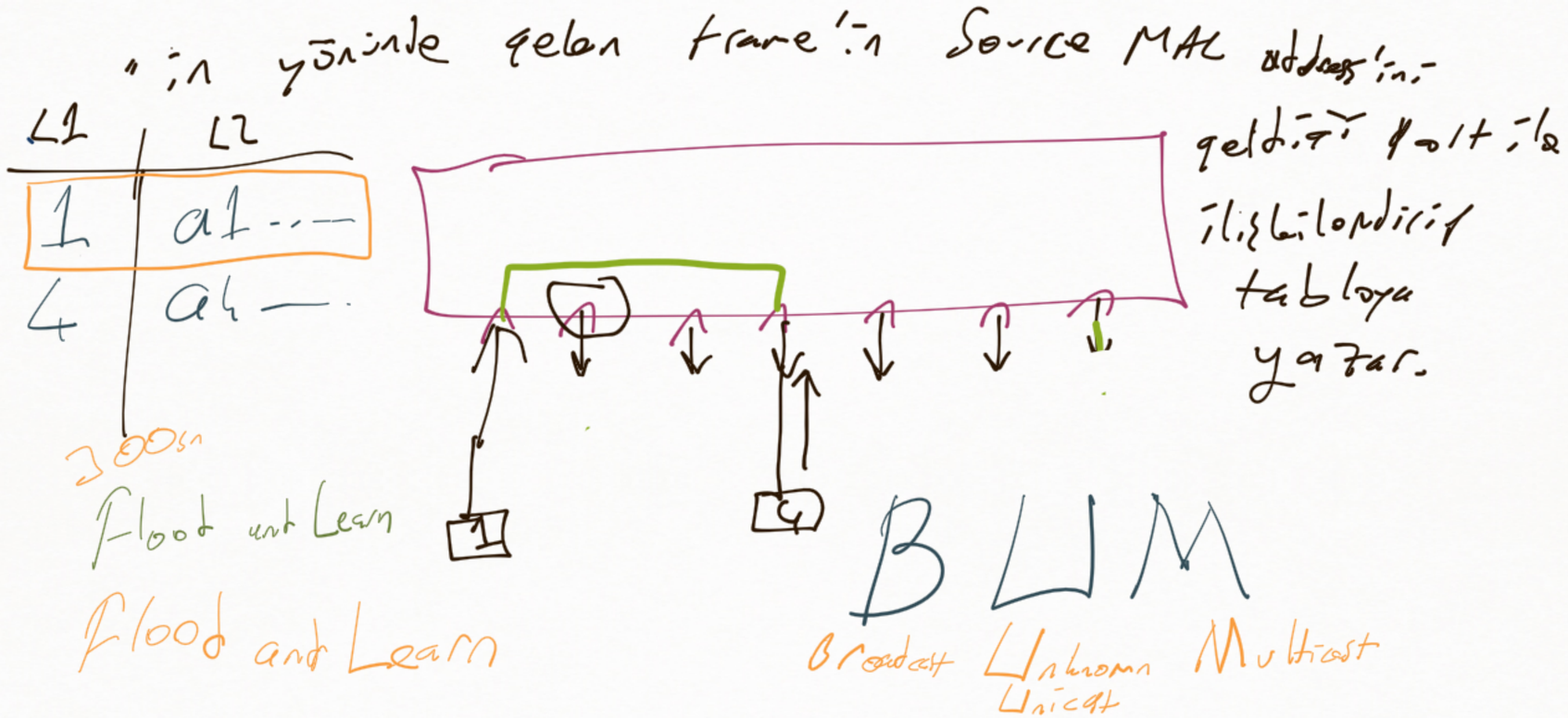
First Switch

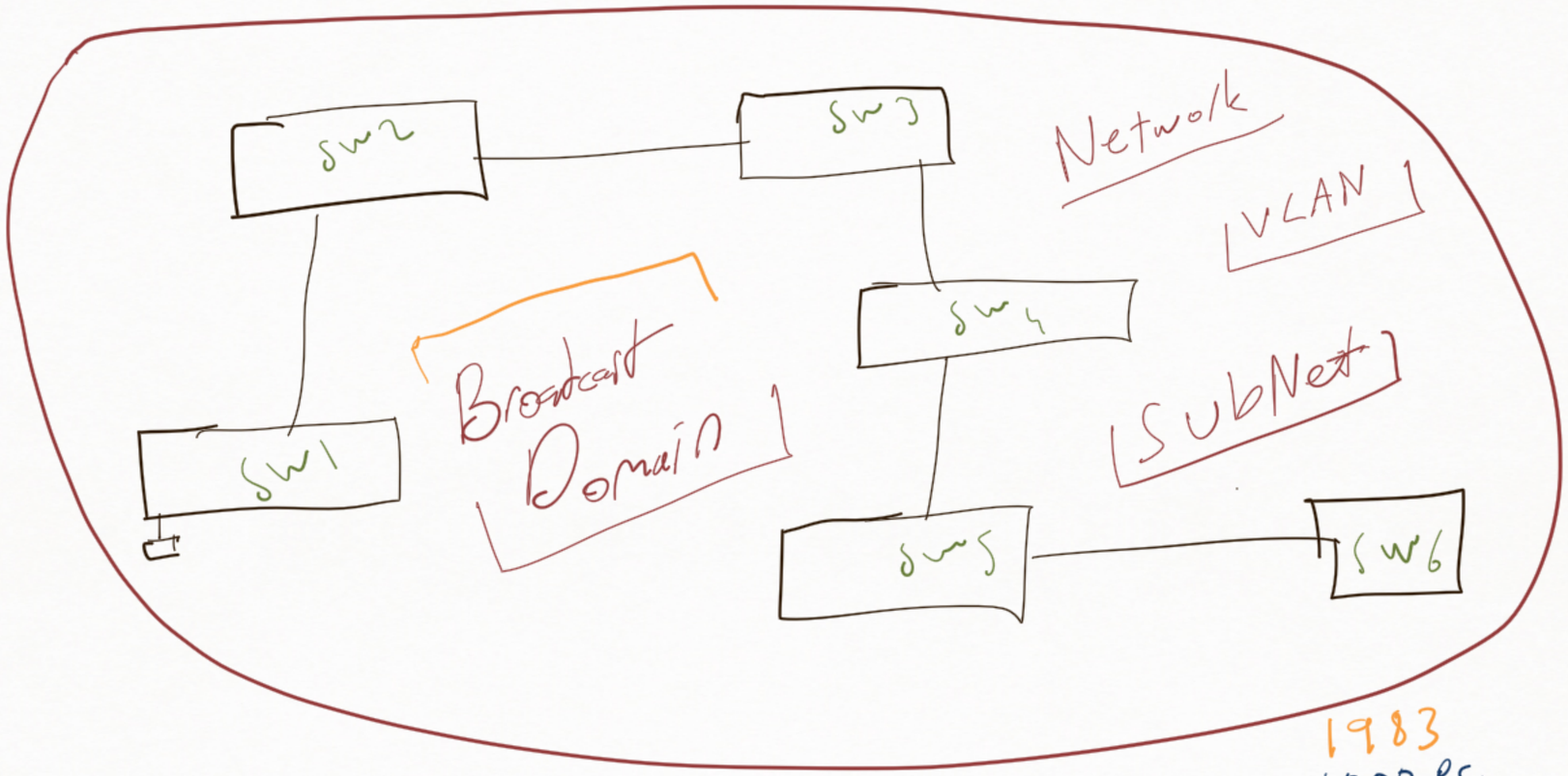
Emma Nutt (1860–1915) became the world's first Switch
on 1 September 1878 when she started working for
the Edwin Holmes Telephone Despatch Company in Boston, Massachusetts, USA.
Emma was hired by Alexander Graham Bell.
She was paid a salary of $10 per month for a 54 hour week.

A few hours after Emma started working, her sister, Stella Nutt,
became the world's second Switch, also making the pair the first two Switches in history.

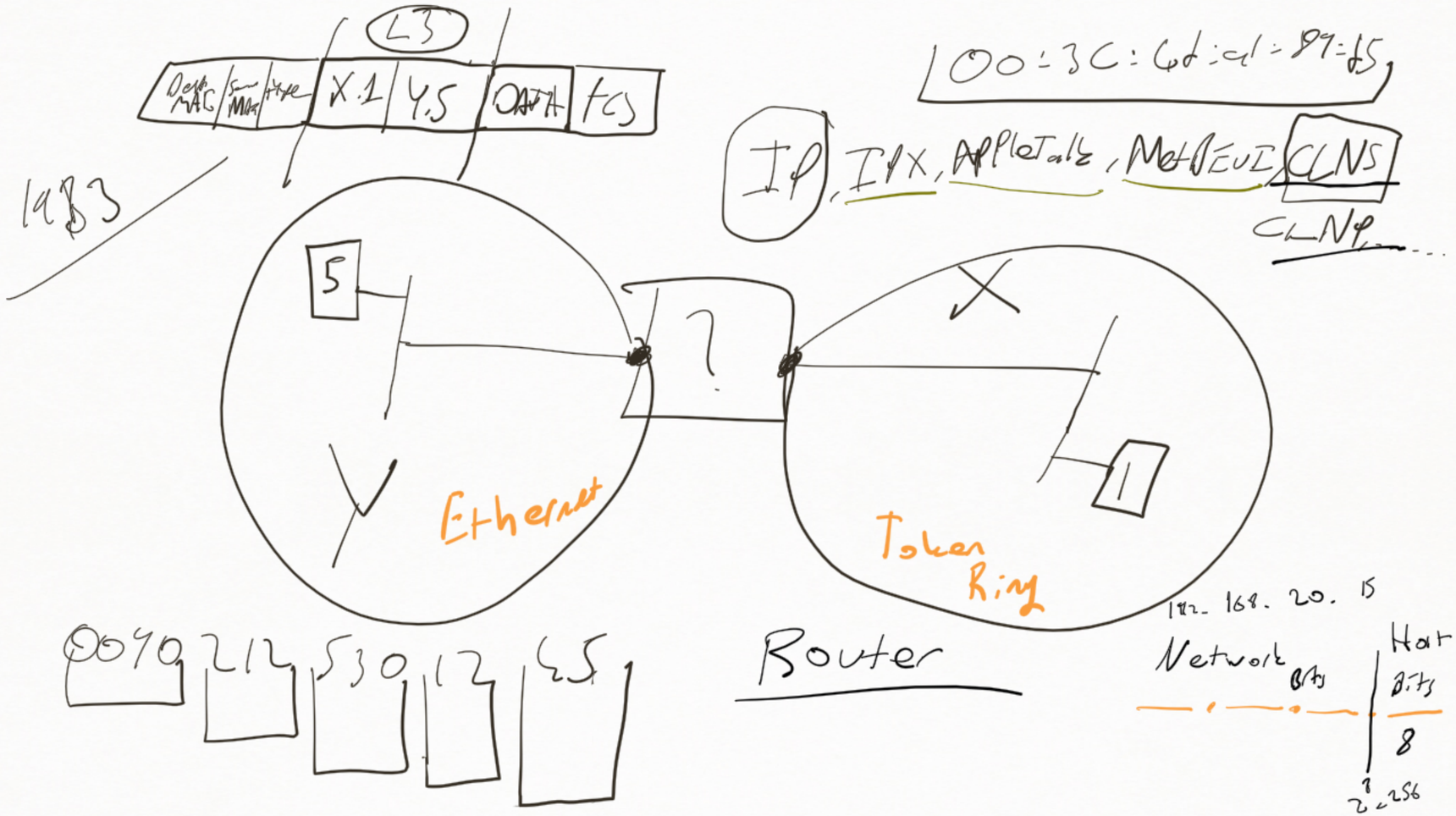
NOT: To be an operator, a woman had to be unmarried [clarification needed] and between the ages of seventeen and twenty-six. She had to look prim and proper, and have arms long enough to reach the top of the tall telephone switchboard. Like many other American businesses at the turn of the century, telephone companies discriminated against people from certain ethnic groups and races. For instance, African-American and Jewish women were not allowed to become operators.

A large Bell System international switchboard in 1943


'in yönünde gelen frame'in Source MAC address'ini
L1
L2
1
a1
4
a4
geldiği portla ilişkilendirip tabloya yazar.
Flood and Learn
BUM
Broadcast
Unknown Unicast
Multicast

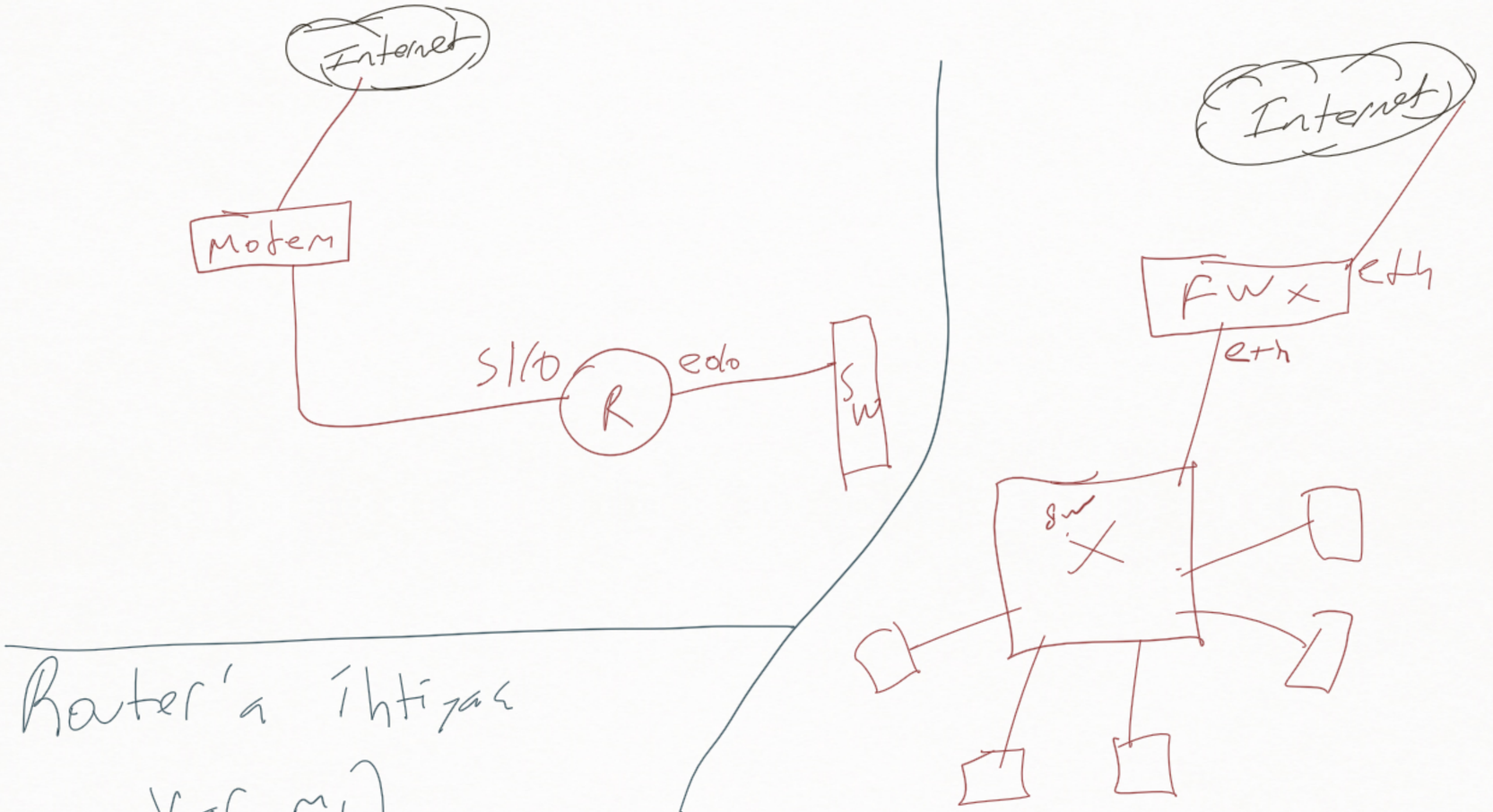


1983
1000 PCs
20 x 52port Full Duplex
Switch


L3
X.1
Y.5
DATA
FCS
1483
5
7
X
Y
1
Ethernet
Token Ring
Router
00:3C:6d:cd:89:45
IP, IPX, AppleTalk, NetBEUI, CLNS
CLNP
0090 27C 530 12 E5
192. 168. 20. 15
Network Bits
Host Bits
8
2^8 = 256

Routing table

192.168.1.0/24	eth0
192.168.2.0/24	eth1


Internet
Modem
S1/0
R
e0/0
SW
Router'a ihtiyac
var mi?
Internet
FW x
eth
eth
SW
X

HUB = "1" adet Collision domain "1" adet broadcast Domain.

Bridge = "2" adet Collision domain "1" adet broadcast Domain.

Switch = "n" adet Collision domain "1" adet broadcast domain.

Router = "x" adet Collision domain "x" adet broadcast domain.

n = port

x = interface

(1) In the early 1960s a computer scientist named J. C. R. Licklider had a vision for an **"Intergalactic Computer Network."**

(1a) Licklider shared the concept with some **colleagues working for the US Government, before leaving to work elsewhere.**

(2) The first message on ARPANET was sent from UCLA to Stanford on October 29th, 1969.

(2a) The message was 'lo' because the Stanford computer crashed after receiving two letters.

(3) 1974: VINTON G. CERF AND ROBERT E. KAHN **publish** ***A Protocol for Packet Network Intercommunication.***

(4) ARPANET officially switched from its prior standard **to the new Internet protocol suite on January 1st, 1983.**

Protocol | Standard

Arpa

Microsoft

Apple

IBM

Novell

DEC

Xerox

1980,

Internetworking Protocol Suites

- TCP/IP (US Defense Dept, UNIX, etc.) ilk 74
- OSI (ISO) Son 85
- XNS (Xerox, Ungermann-Bass)
- SNA/APPC (IBM)
- ATP (Apple)
- NetBEUI (Microsoft)
- IPX/SPX (Novell)

DECNET

OSI Model and Real Protocols

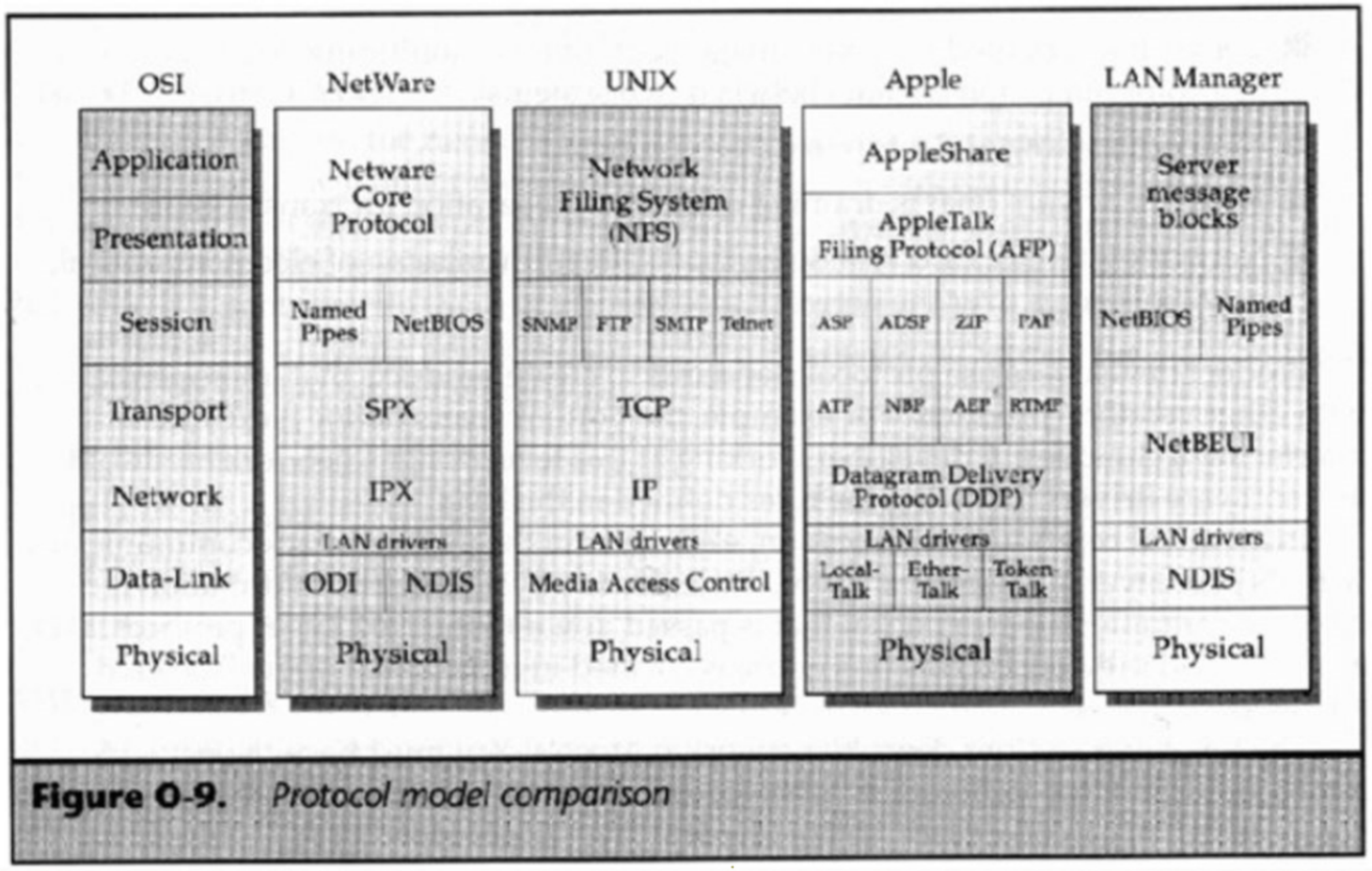
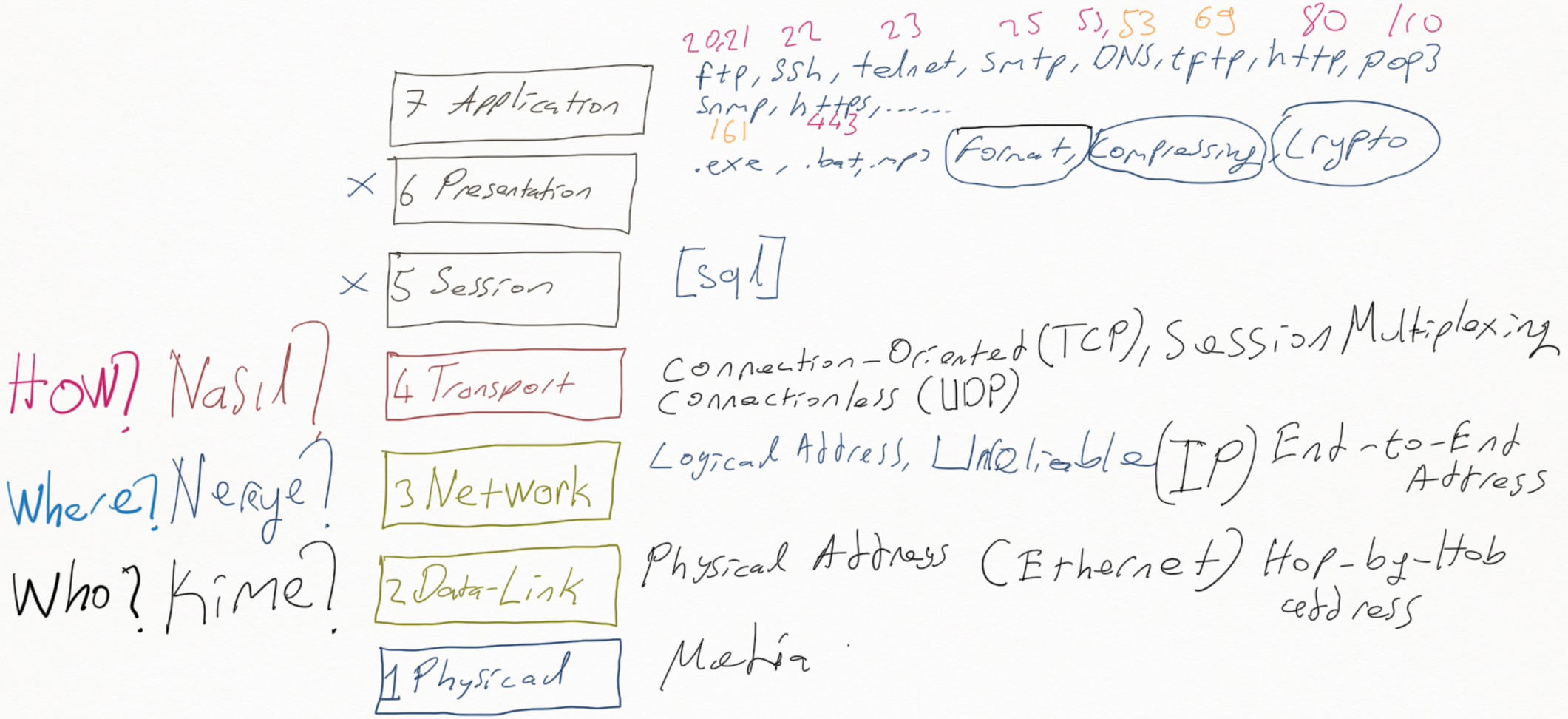


Figure 0-9. *Protocol model comparison*


20,21 22 23 25 53,53 69 80 110
ftp, SSh, telnet, smtp, DNS, tftp, http, pop3
snmp, https, ...
161 443
.exe, .bat, .mp3
Format, Compressing, Crypto
7 Application
6 Presentation
5 Session
[sql]
How? Nasıl?
4 Transport
Connection-Oriented (TCP), Session Multiplexing
Connectionless (UDP)
Where? Nereye?
3 Network
Logical Address, Unreliable (IP) End-to-End Address
Who? Kime?
2 Data-Link
Physical Address (Ethernet) Hop-by-Hop address
1 Physical
Media

PC, Server

7 Application

× 6 Presentation

× 5 Session

FW

4 Transport

Router, L3sw

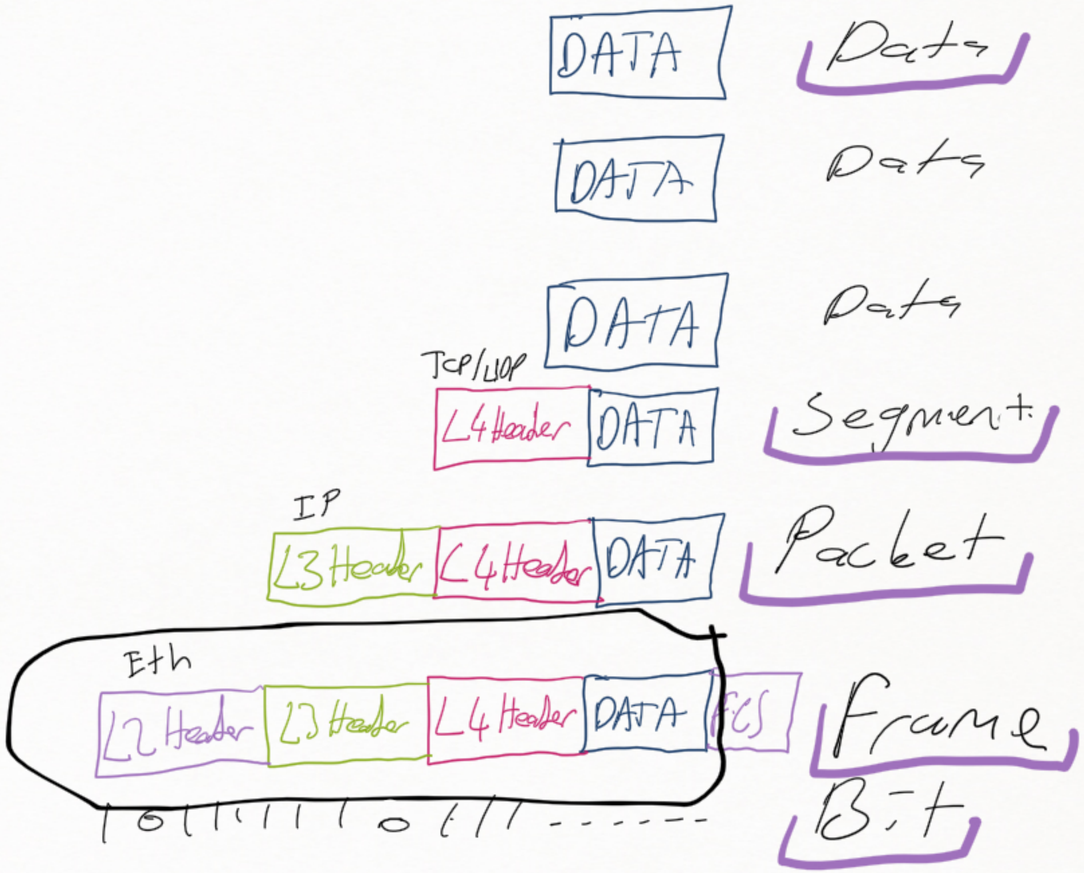
3 Network

Bridge, Switch

2 Data-Link

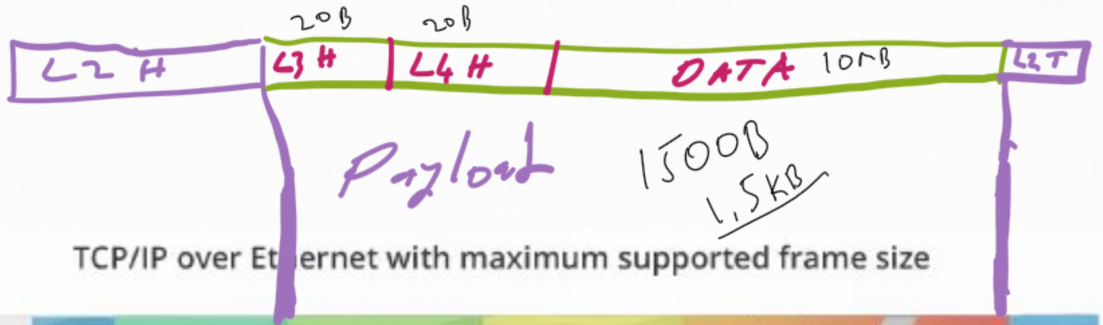
Cable, Hub, Modem

1 Physical

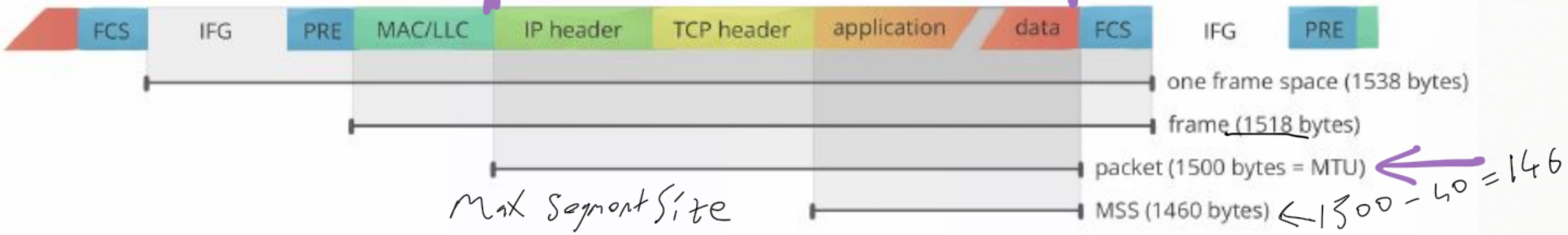


MTU = 1500

MSS = 1460



TCP/IP over Ethernet with maximum supported frame size



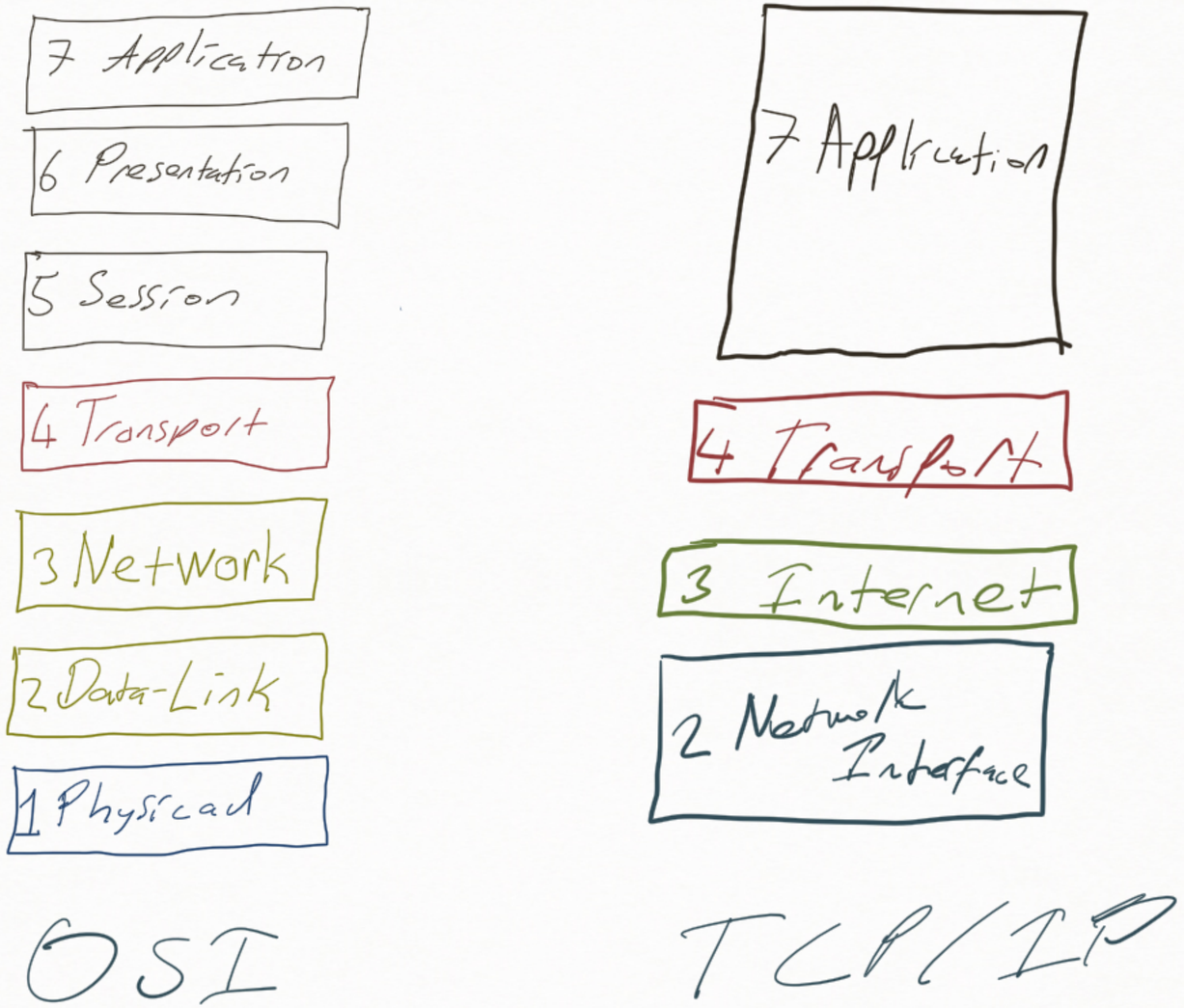
OSI layer	content	description	bits	bytes
n/a	IFG	inter-frame gap	96	12
1 (physical)	PRE	preamble (clocking)	64	8
2 (data link)	MAC/LLC	media access control	112	14
3 (network)	IP header	n/a	160	20
4 (transport)	TCP header	n/a	160	20
5 (session), 6 (presentation), 7 (application)	application data	may contain other layers	11680	1460
1 (physical)	FCS	frame check sequence	32	4

10 MB

$\frac{10.000kB}{1,460kB} = 6849$

6849 (1460B) + 460B

6850 tane Segment


7 Application
6 Presentation
5 Session
4 Transport
3 Network
2 Data-Link
1 Physical
OSI
7 Application
4 Transport
3 Internet
2 Network Interface
TCP/IP

ISO OSI

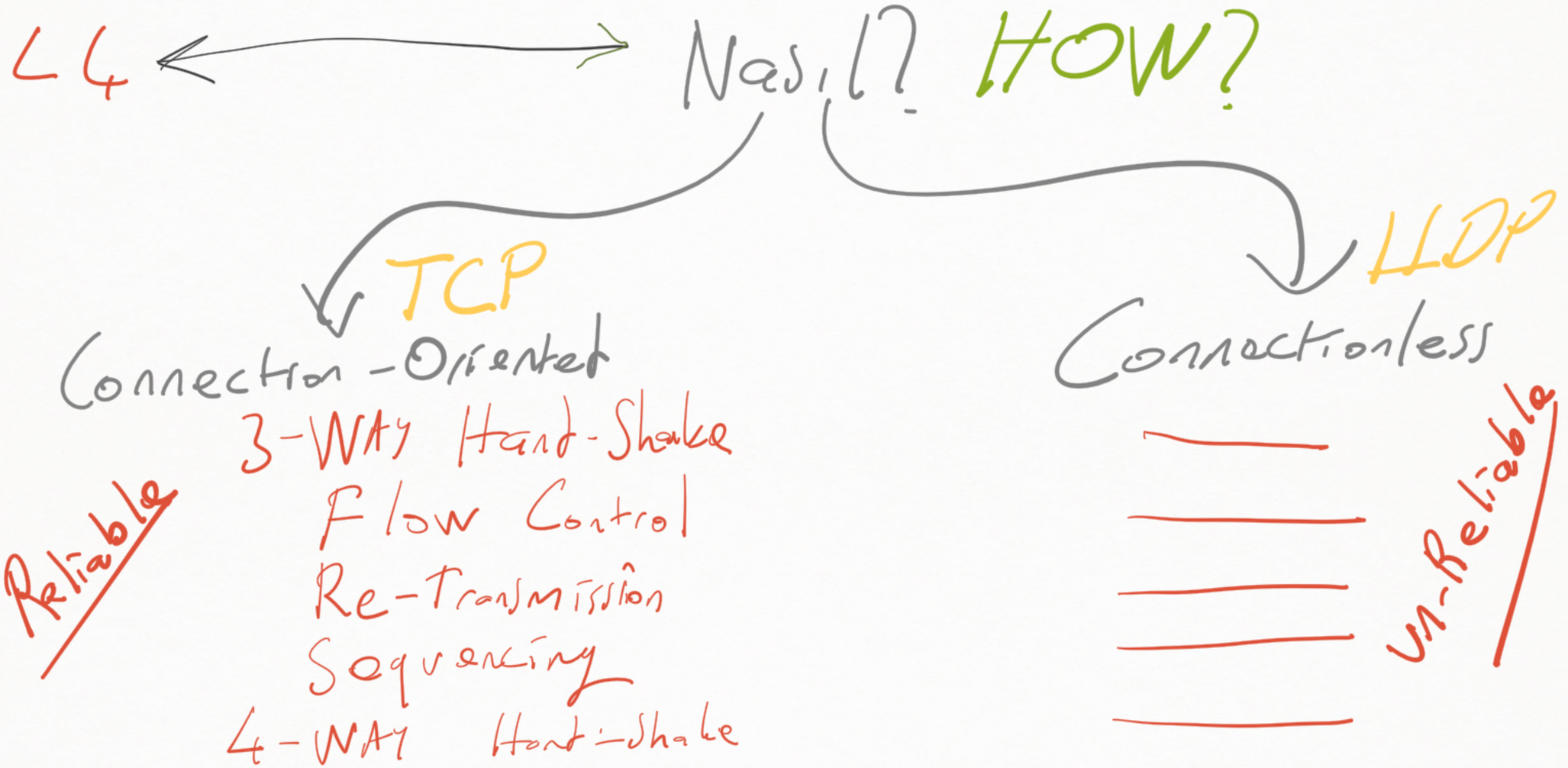
L1 ANSI, EIA/TIA, ITU

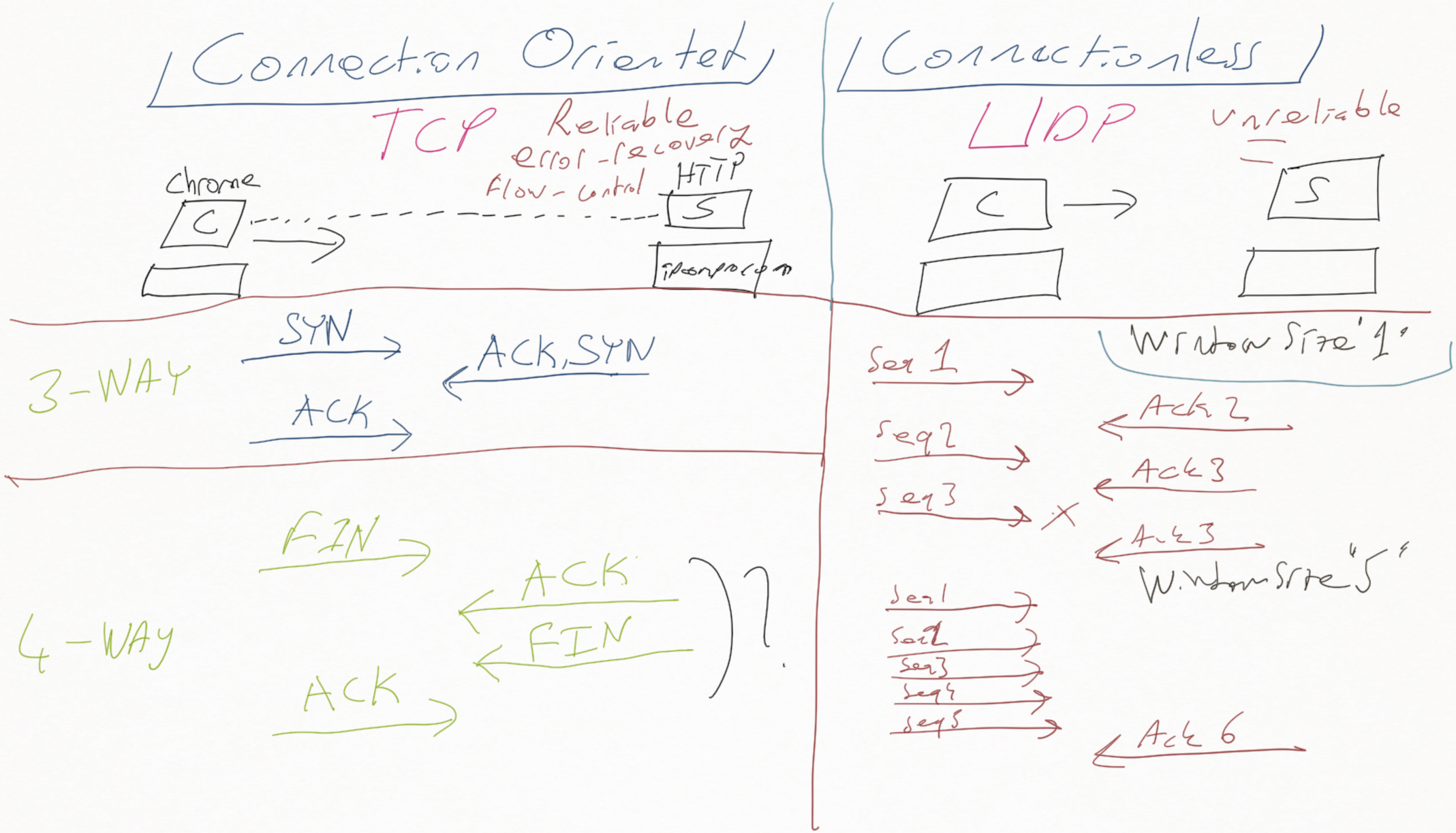
L2 IEEE 802.xxx

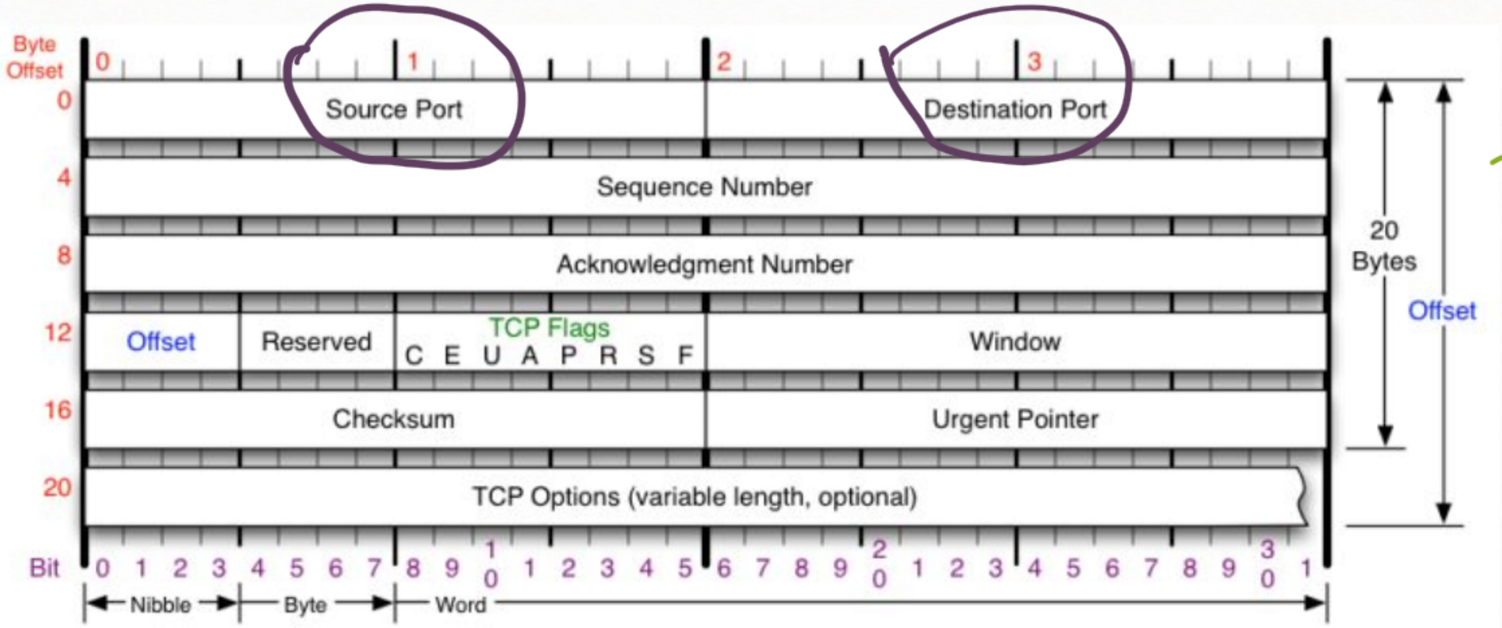
L3/L4 IETF RFCs

IANA IPv4, IPv6, AS Number

ICANN Domain


L4
Nasıl? HOW?
TCP
Connection-Oriented
3-WAY Hand-Shake
Flow Control
Re-Transmission
Sequencing
4-WAY Hand-Shake
Reliable
LLDP
Connectionless
UN-Reliable


Connection Oriented
TCP
Reliable
error-recovery
Flow-control
Chrome
C
HTTP
S
Transport
3-WAY
SYN
ACK, SYN
ACK
4-WAY
FIN
ACK
FIN
ACK
Connectionless
UDP
Unreliable
C
S
Window Size "1"
Seq 1
Ack 2
seq 2
Ack 3
seq 3
X
Ack 3
Window Size "5"
Seq 1
Seq 2
Seq 3
Seq 4
Seq 5
Ack 6



16
2 = 65536

TCP Flags

C E U A P R S F

Congestion Window
C 0x80 Reduced (CWR)
E 0x40 ECN Echo (ECE)
U 0x20 Urgent
A 0x10 Ack
P 0x08 Push
R 0x04 Reset
S 0x02 Syn
F 0x01 Fin

Congestion Notification

ECN (Explicit Congestion Notification). See RFC 3168 for full details, valid states below.

Packet State	DSB	ECN bits
Syn	0 0	1 1
Syn-Ack	0 0	0 1
Ack	0 1	0 0
No Congestion	0 1	0 0
No Congestion	1 0	0 0
Congestion	1 1	0 0
Receiver Response	1 1	0 1
Sender Response	1 1	1 1

TCP Options

0 End of Options List
1 No Operation (NOP, Pad)
2 Maximum segment size
3 Window Scale
4 Selective ACK ok
8 Timestamp

Checksum

Checksum of entire TCP segment and pseudo header (parts of IP header)

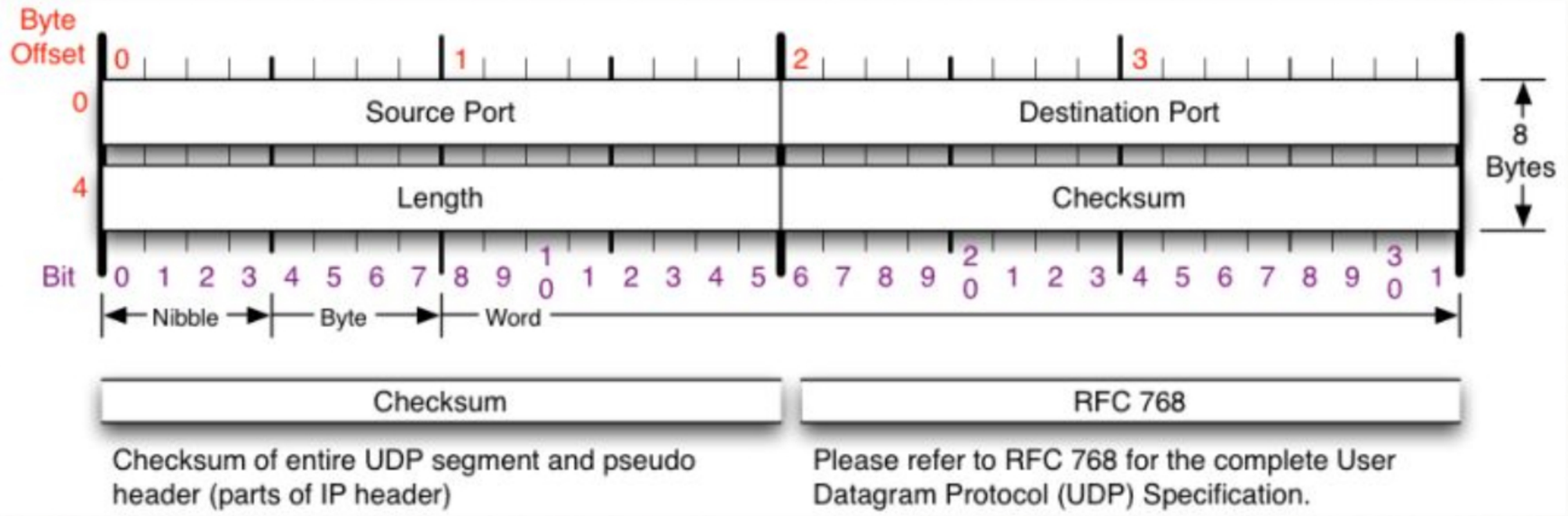
Offset

Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.

RFC 793

Please refer to RFC 793 for the complete Transmission Control Protocol (TCP) Specification.

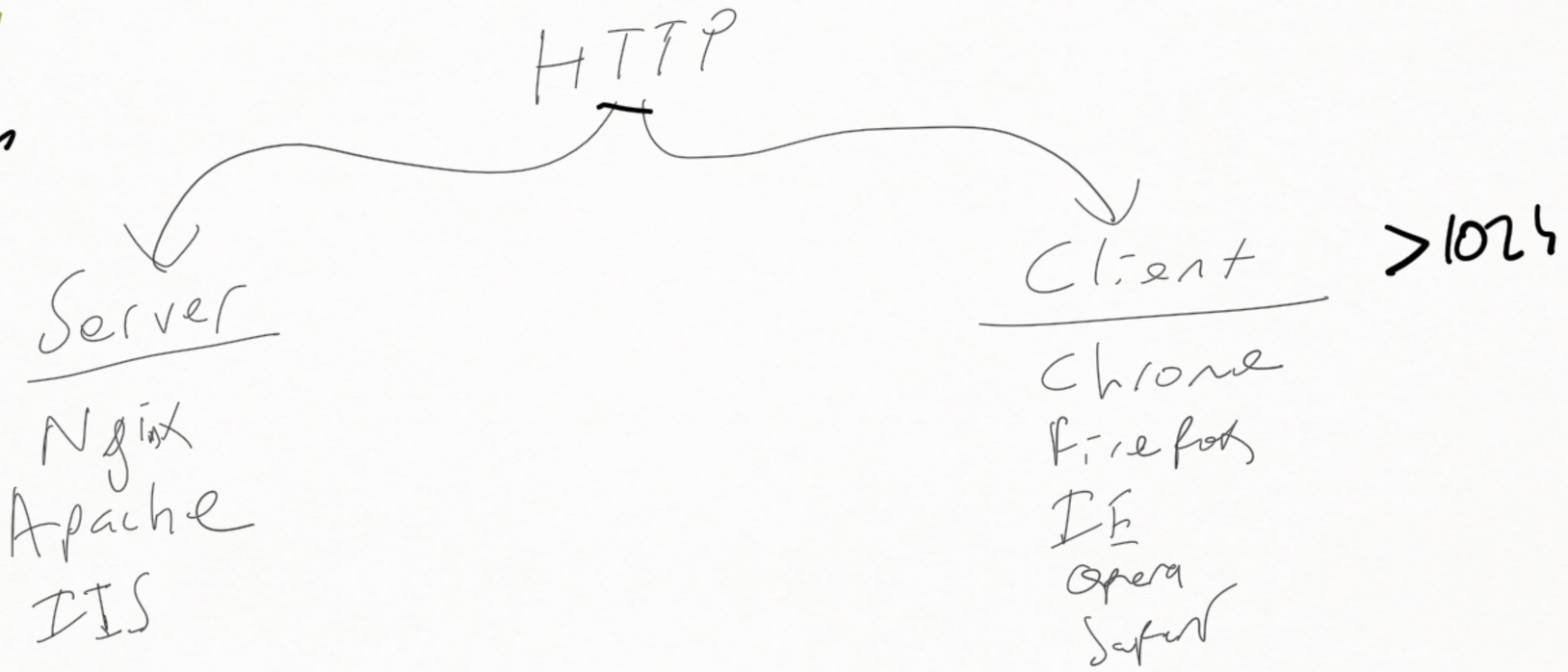
Voice Video



Real-time Stream

[1-1024]
Well-known

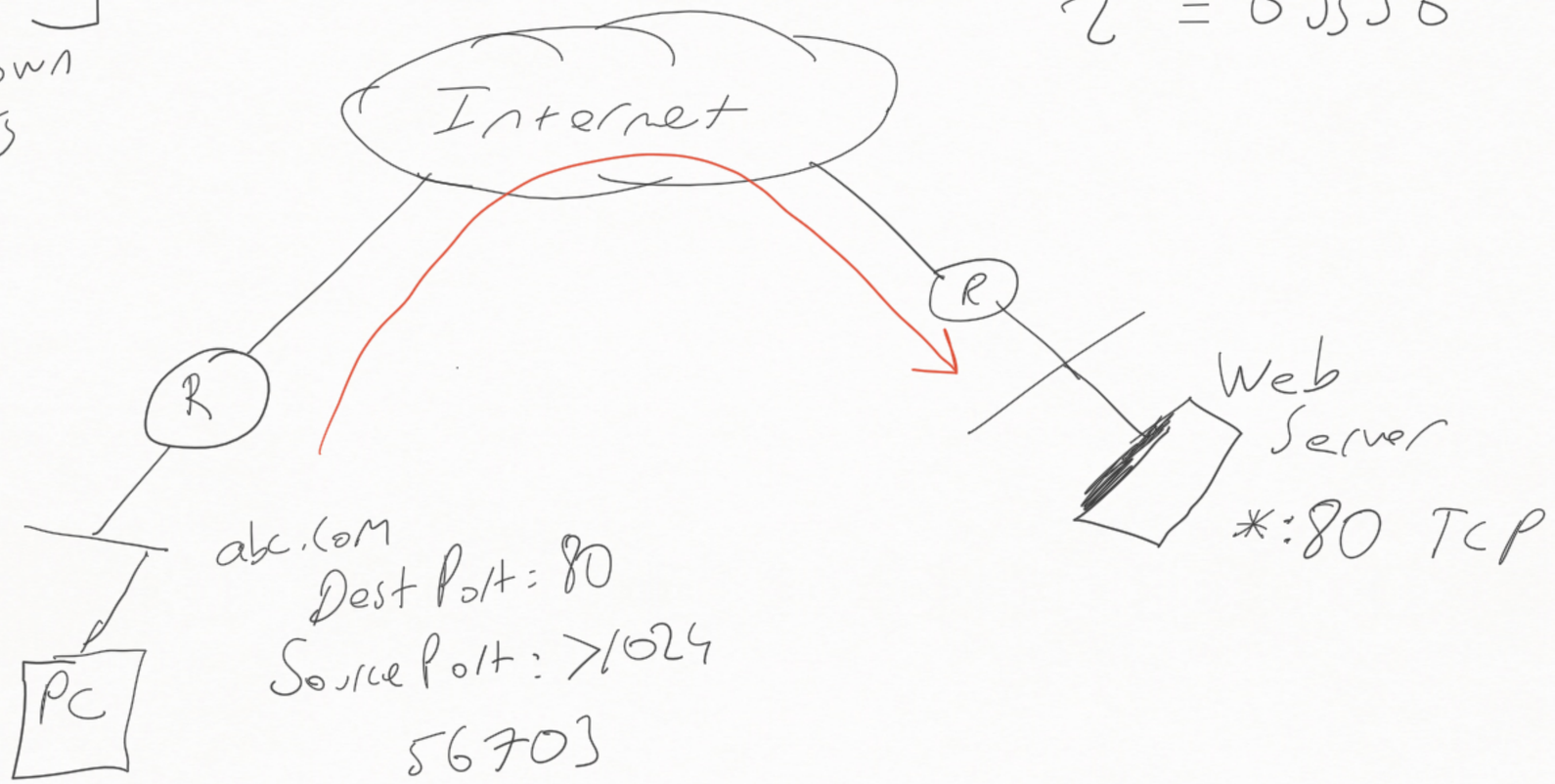
(TCP 80)

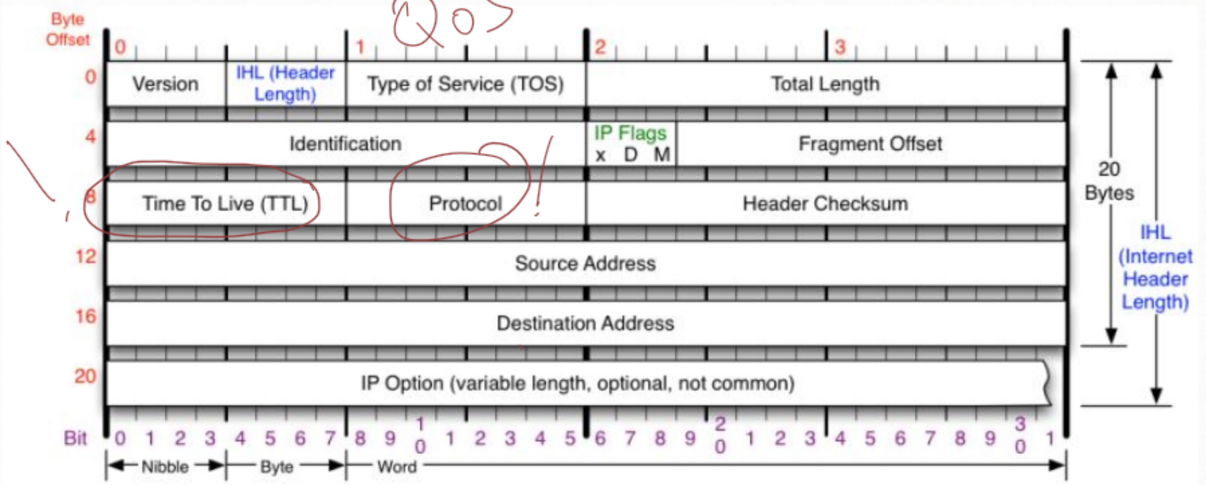


>1024

[0 - 1024]
Well-known ports

$2^{16} = 65536$





Version

Version of IP Protocol. 4 and 6 are valid. This diagram represents version 4 structure only.

Header Length

Number of 32-bit words in TCP header, minimum value of 5. Multiply by 4 to get byte count.

Protocol

IP Protocol ID. Including (but not limited to):

1 ICMP	17 UDP	57 SKIP
2 IGMP	47 GRE	88 EIGRP
6 TCP	50 ESP	89 OSPF
9 IGRP	51 AH	115 L2TP

Total Length

Total length of IP datagram, or IP fragment if fragmented. Measured in Bytes.

Fragment Offset

Fragment offset from start of IP datagram. Measured in 8 byte (2 words, 64 bits) increments. If IP datagram is fragmented, fragment size (Total Length) must be a multiple of 8 bytes.

Header Checksum

Checksum of entire IP header

IP Flags

x D M

x 0x80 reserved (evil bit)
D 0x40 Do Not Fragment
M 0x20 More Fragments follow

RFC 791

Please refer to RFC 791 for the complete Internet Protocol (IP) Specification.

Ethernet II

IEEE 802.3

EtherType values for some notable protocols[8]

EtherType	Protocol
0x0800	Internet Protocol version 4 (IPv4)
0x0806	Address Resolution Protocol (ARP)
0x0842	Wake-on-LAN[7]
0x22F3	IETF TRILL Protocol
0x6003	DECnet Phase IV
0x8035	Reverse Address Resolution Protocol
0x809B	AppleTalk (Ethertalk)
0x80F3	AppleTalk Address Resolution Protocol (AARP)
0x8100	VLAN-tagged frame (IEEE 802.1Q) and Shortest Path Bridging IEEE 802.1aq[9]
0x8137	IPX
0x8204	QNX Qnet
0x86DD	Internet Protocol Version 6 (IPv6)
0x8808	Ethernet flow control
0x8819	CobraNet
0x8847	MPLS unicast
0x8848	MPLS multicast
0x8863	PPPoE Discovery Stage
0x8864	PPPoE Session Stage
0x8870	Jumbo Frames (proposed)[2][3]
0x887B	HomePlug 1.0 MME
0x888E	EAP over LAN (IEEE 802.1X)
0x8892	PROFINET Protocol
0x889A	HyperSCSI (SCSI over Ethernet)
0x88A2	ATA over Ethernet
0x88A4	EtherCAT Protocol
0x88A8	Provider Bridging (IEEE 802.1ad) & Shortest Path Bridging IEEE 802.1aq[9]
0x88AB	Ethernet Powerlink[citation needed]
0x88CC	Link Layer Discovery Protocol (LLDP)
0x88CD	SERCOS III
0x88E1	HomePlug AV MME[citation needed]
0x88E3	Media Redundancy Protocol (IEC62439-2)
0x88E5	MAC security (IEEE 802.1AE)
0x88E7	Provider Backbone Bridges (PBB) (IEEE 802.1ah)
0x88F7	Precision Time Protocol (PTP) over Ethernet (IEEE 1588)
0x88FB	Parallel Redundancy Protocol (PRP)
0x8902	IEEE 802.1ag Connectivity Fault Management (CFM) Protocol / ITU-T Recommendation Y.1731 (OAM)
0x8906	Fibre Channel over Ethernet (FCoE)
0x8914	FCoE Initialization Protocol
0x8915	RDMA over Converged Ethernet (RoCE)
0x891D	TTEthernet Protocol Control Frame (TTE)
0x892F	High-availability Seamless Redundancy (HSR)
0x9000	Ethernet Configuration Testing Protocol[10]

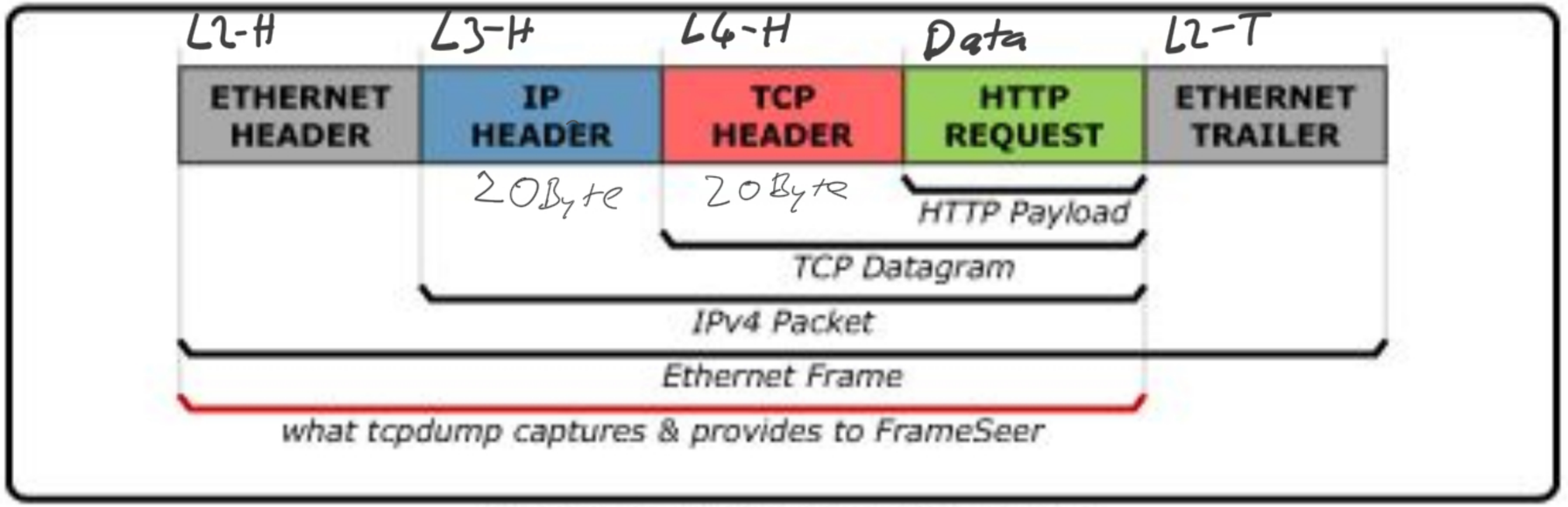
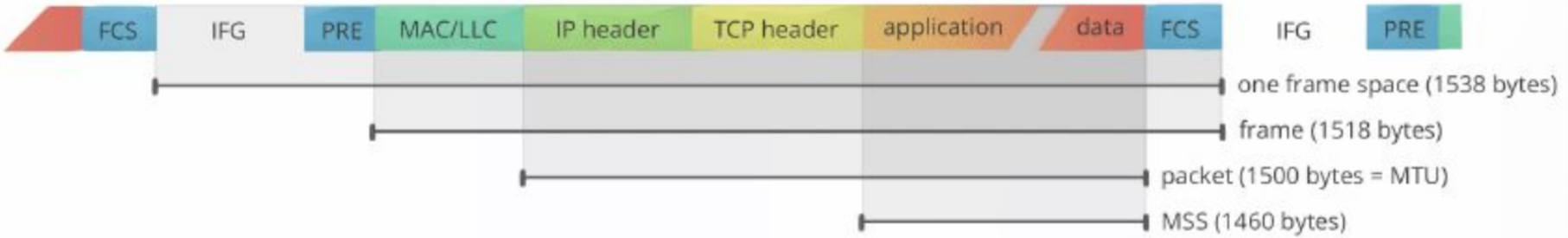


Figure 2 — Ethernet Frame Format

TCP/IP over Ethernet with maximum supported frame size

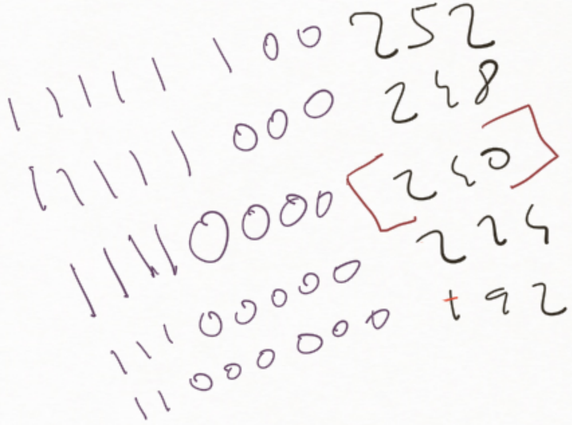


OSI layer	content	description	bits	bytes
n/a	IFG	inter-frame gap	96	12
1 (physical)	PRE	preamble (clocking)	64	8
2 (data link)	MAC/LLC	media access control	112	14
3 (network)	IP header	n/a	160	20
4 (transport)	TCP header	n/a	160	20
5 (session), 6 (presentation), 7 (application)	application data	may contain other layers	11680	1460
1 (physical)	FCS	frame check sequence	32	4

bin = [00000000 - 11111111]

dec = [000 - 255]

Hex = [00 - ff]



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

IP Address

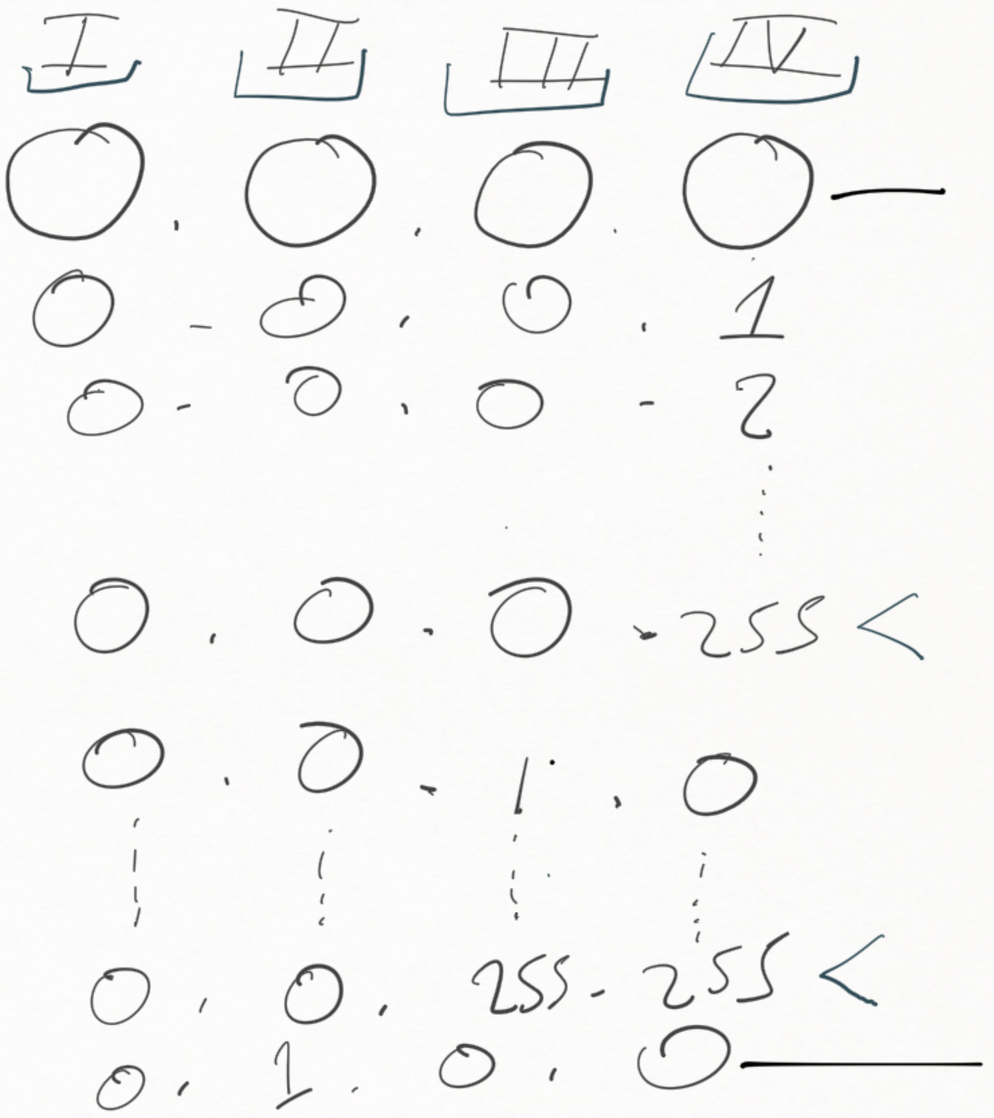
32-bit

0.0.0.0 > 255.255.255.255

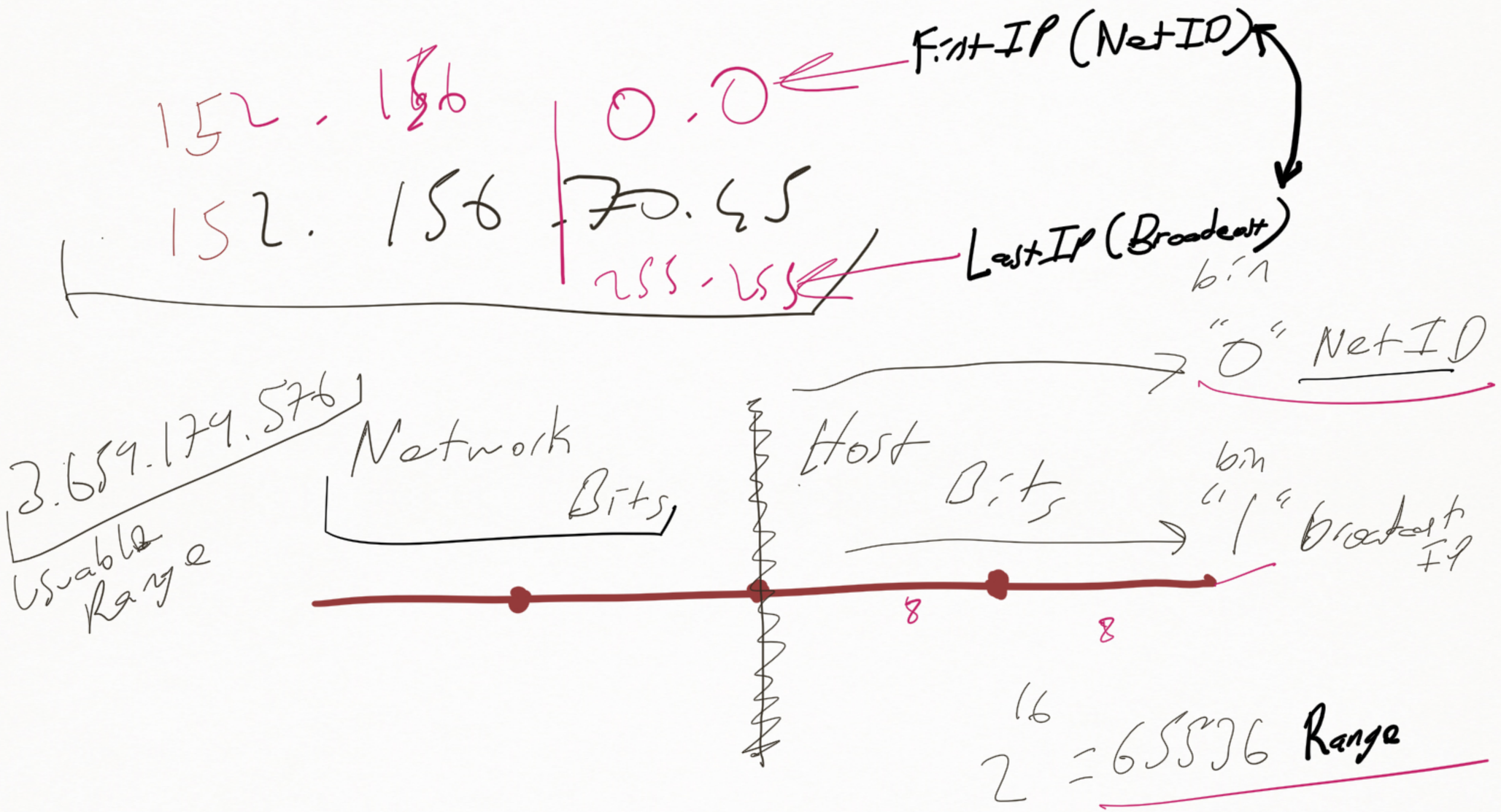
> 255.255.255.255

~ 4,294 Milyar

Lebar Kenal Komputer



88.26.35.30


152.156.0.0
First IP (NetID)
152.156.255.255
Last IP (Broadcast)
bit
"0" NetID
3.659.179.576
Usable Range
Network Bits
Host Bits
bin "1" Broadcast IP
8
8
$2^{16} = 65536$ Range

Classful

A - Class 1-126 Network Bits -8- | Host Bits -24-

16777216

88.26.45.33

88.0.0.0

88.255.255.255

B - Class 128-191 Network bits -16- | Host Bits -16-

65536

156.48.195.13

156.48.0.0

156.48.255.255

C - Class 192-223 Network bits -24- | Host bits -8-

~254

212.26.30.8

212.26.30.0

212.26.30.255

D-Class 224.0.0.0 ┐
Multicast 239.255.255.255 ┘

F-Class 240.0.0.0
Experimental 255.255.255.255

Network Bits | Host Bits $2^8 = 256$

192.168.16.68. 256-2=254

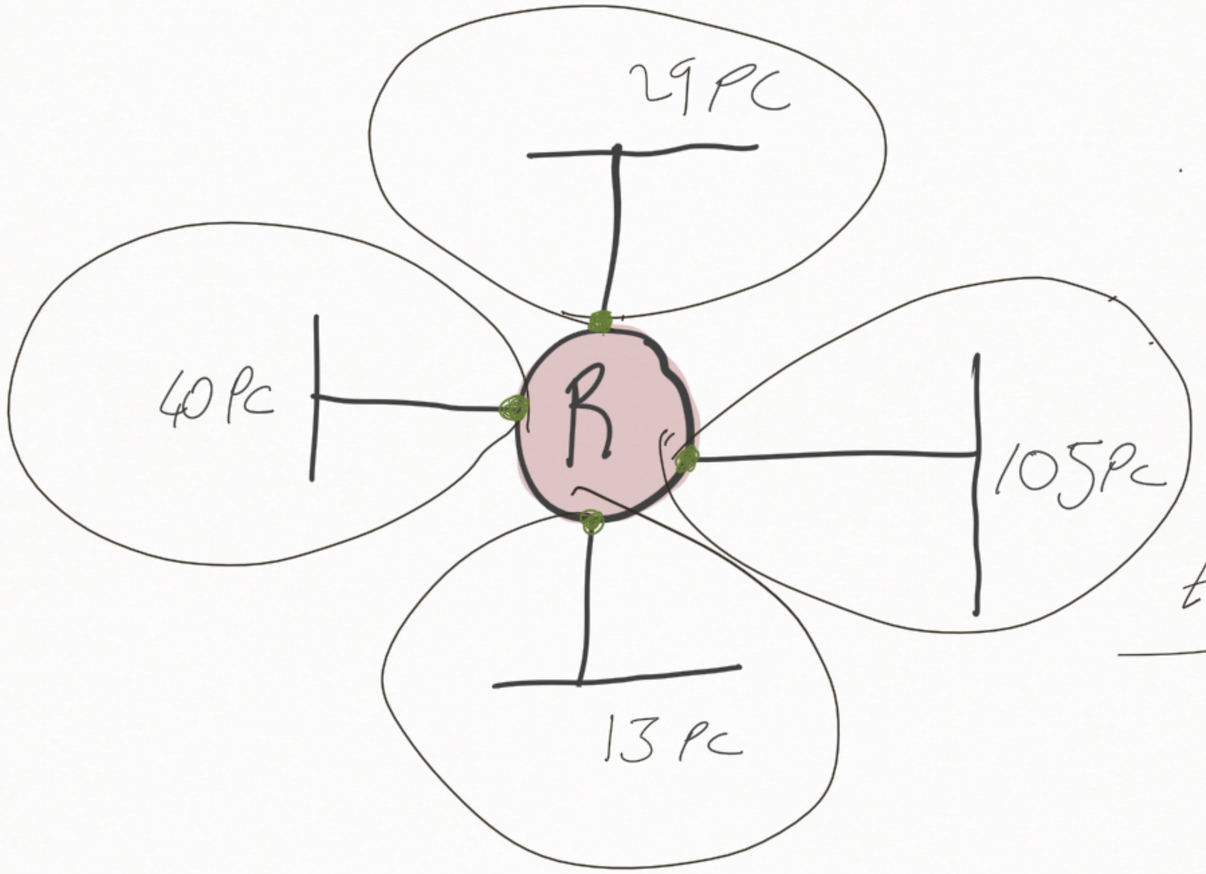
-8-

192.168.16.0 .1< Net ID (first)

192.168.16.255 .254< Broadcast IP (last)

88.26.30.0/24

254



187 pc

191 usable

tiketm = 199

FLSM

88.26.30

/24 {
- /26 → 64
- /26 → 64
- /26 → 64
- /26 → 64

Borrowing Bits 2

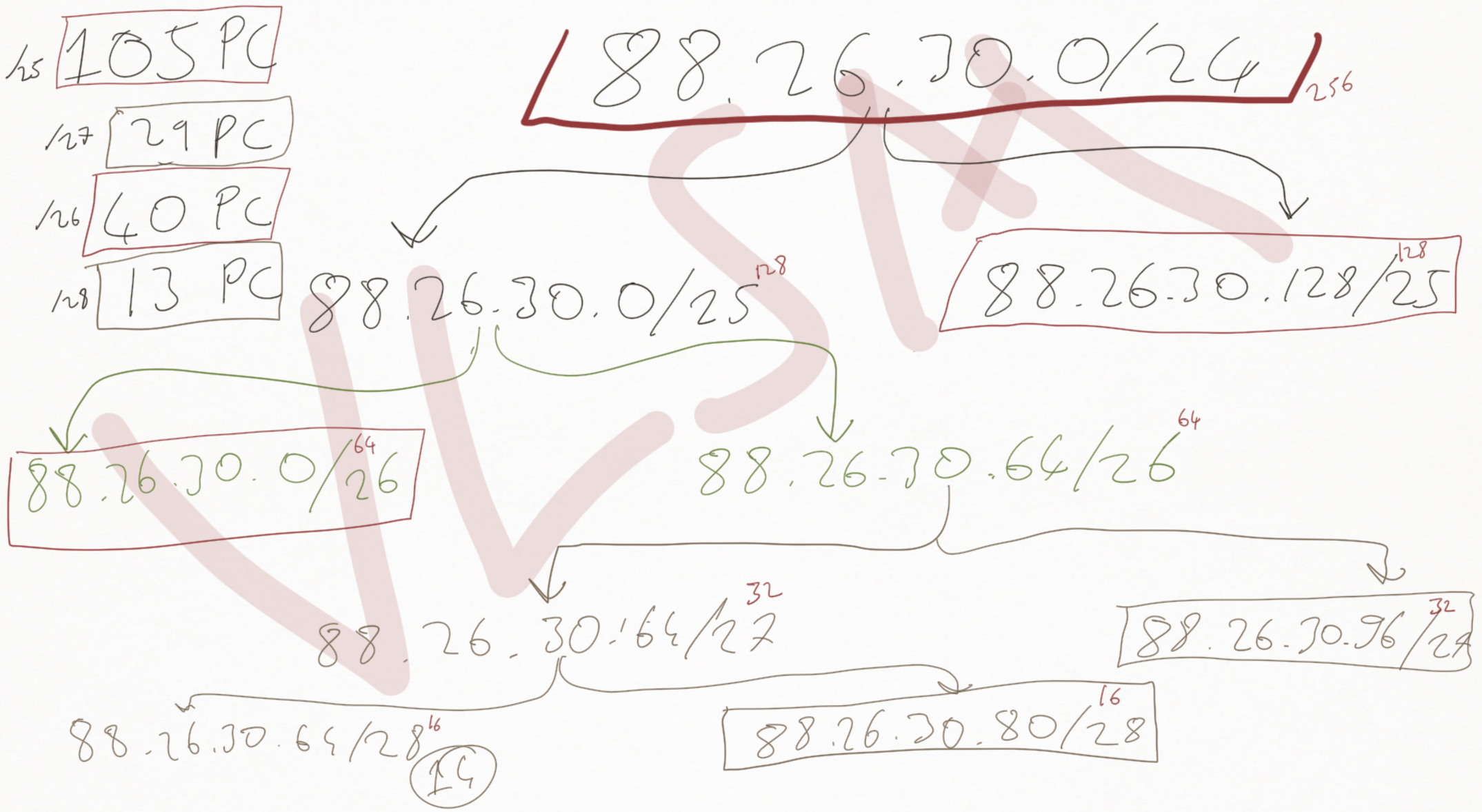
$2^2 = 2 = 4$

} 88.26.30.0/26

} 88.26.30.64/26

} 88.26.30.128/26

} 88.26.30.192/26


/25 105 PC
/27 29 PC
/26 40 PC
/28 13 PC
88.26.30.0/24
256
88.26.30.0/25
128
88.26.30.128/25
128
88.26.30.0/26
64
88.26.30.64/26
64
88.26.30.64/27
32
88.26.30.96/27
32
88.26.30.64/28
16
IG
88.26.30.80/28
16

Address block	Present use
0.0.0.0/8	"This" network[5] 0.0.0.0 → 0.255.255.255
10.0.0.0/8	Private-use networks[6]
100.64.0.0/10	Carrier-grade NAT[7]
127.0.0.0/8	Loopback[5]
127.0.53.53	Name collision occurrence (listing in server logs denotes a collision in DNS.)[8]
169.254.0.0/16	Link local[9] ✓
172.16.0.0/12	Private-use networks[6]
192.0.0.0/24	IETF protocol assignments[10]
192.0.2.0/24	TEST-NET-1[11]
192.168.0.0/16	Private-use networks[6]
198.18.0.0/15	Network interconnect device benchmark testing[12]
198.51.100.0/24	TEST-NET-2[11]
203.0.113.0/24	TEST-NET-3[11]
224.0.0.0/4	Multicast[13]
240.0.0.0/4	Reserved for future use[5]
255.255.255.255/32	Limited broadcast[14][15]

Public

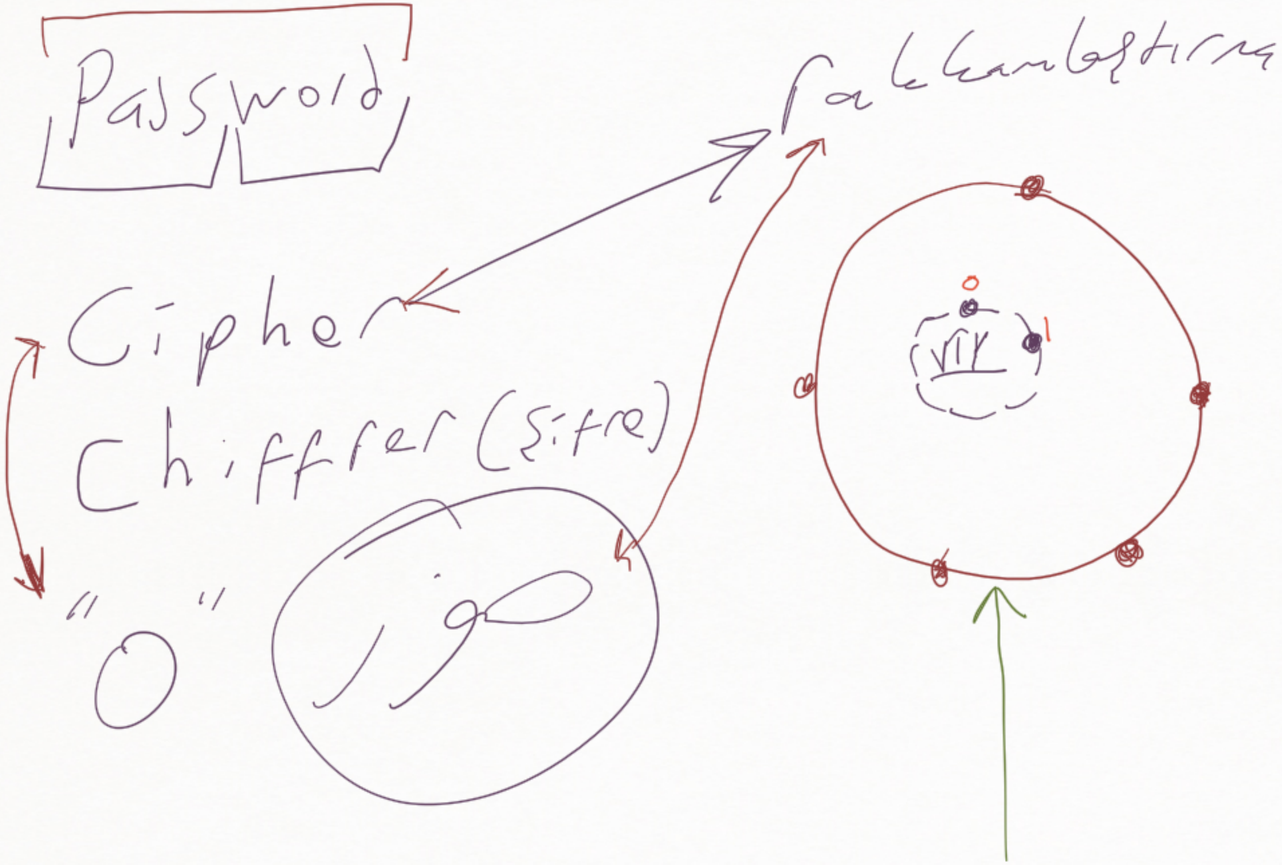
3,659,377,464

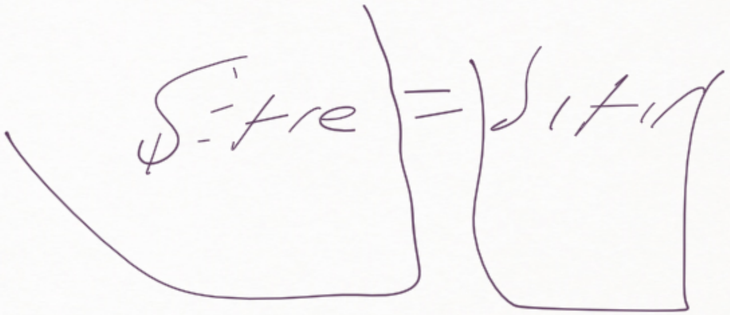
Effective Usable IP range

1-) Console
2-) Telnet/SSH
3-) HTTP/HTTPS
4-) SNMP
5-) SDN

Parola

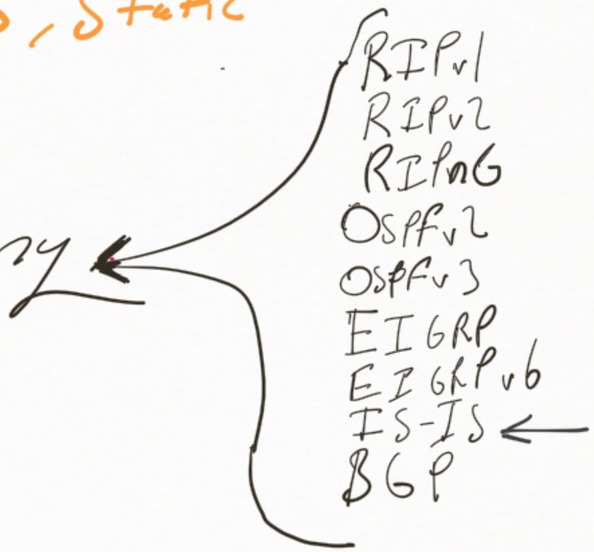
Password



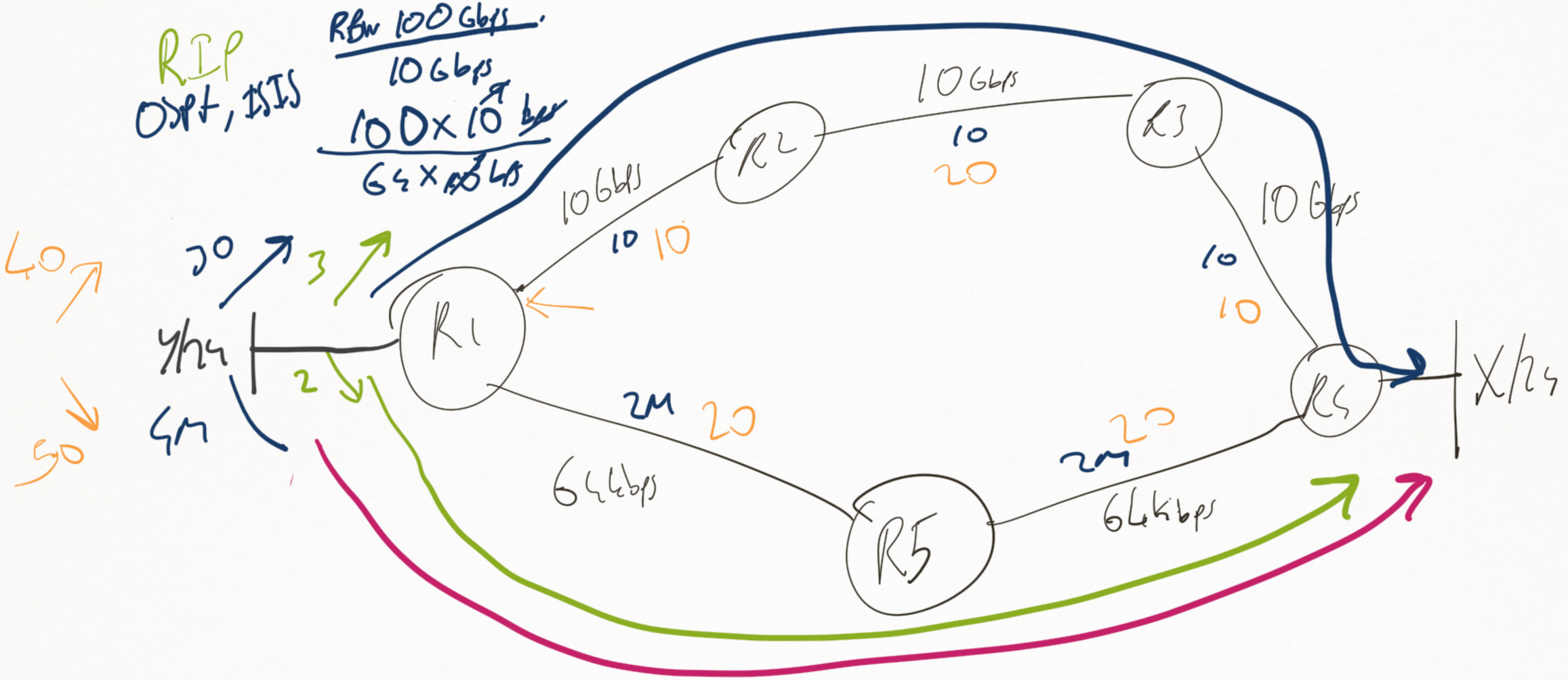


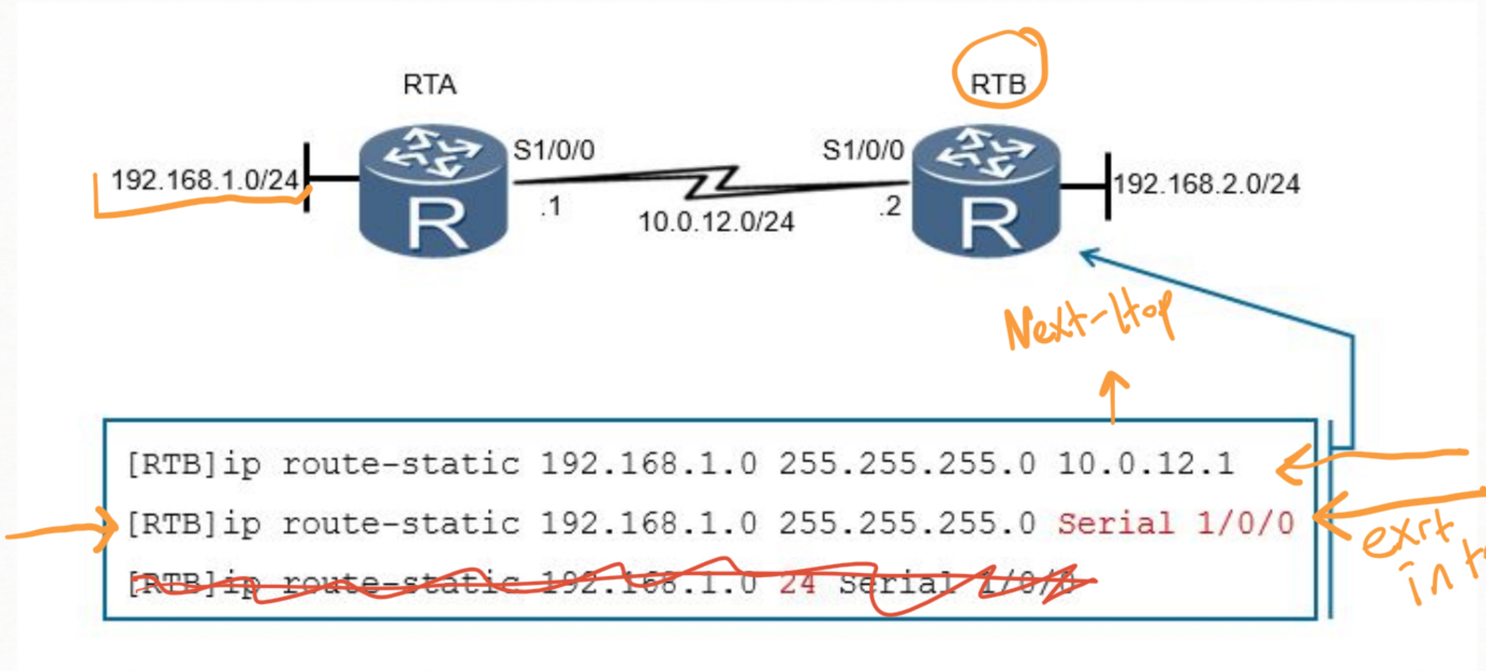
Routing Table

- Directly Connected C, L, Direct
- Static Route S, Static
- Dynamic Routing



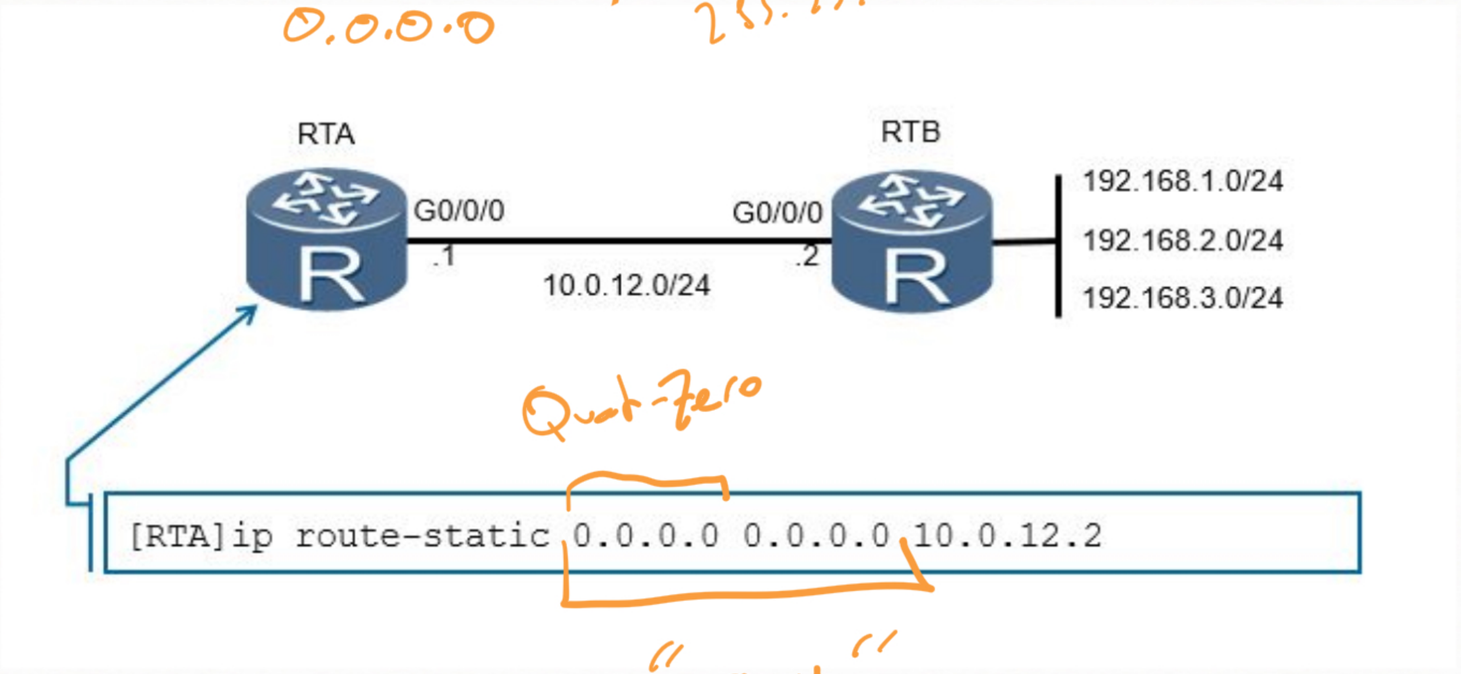
1- longest Prefix Match
2- Administrator Distance
3- Metric
4- Load balance


RIP
OSPF, ISIS
Rbw 100 Gbps
10 Gbps
10 Gbps
10
20
10 Gbps
10 10
10
10
2M 20
64kbps
2M 20
64kbps
R1
R2
R3
R4
R5
40
30
3
2
50


RTA
RTB
192.168.1.0/24
S1/0/0
.1
10.0.12.0/24
S1/0/0
.2
192.168.2.0/24
Next-Hop
[RTB]ip route-static 192.168.1.0 255.255.255.0 10.0.12.1
[RTB]ip route-static 192.168.1.0 255.255.255.0 Serial 1/0/0
[RTB]ip route-static 192.168.1.0 24 Serial 1/0/0
exit interface

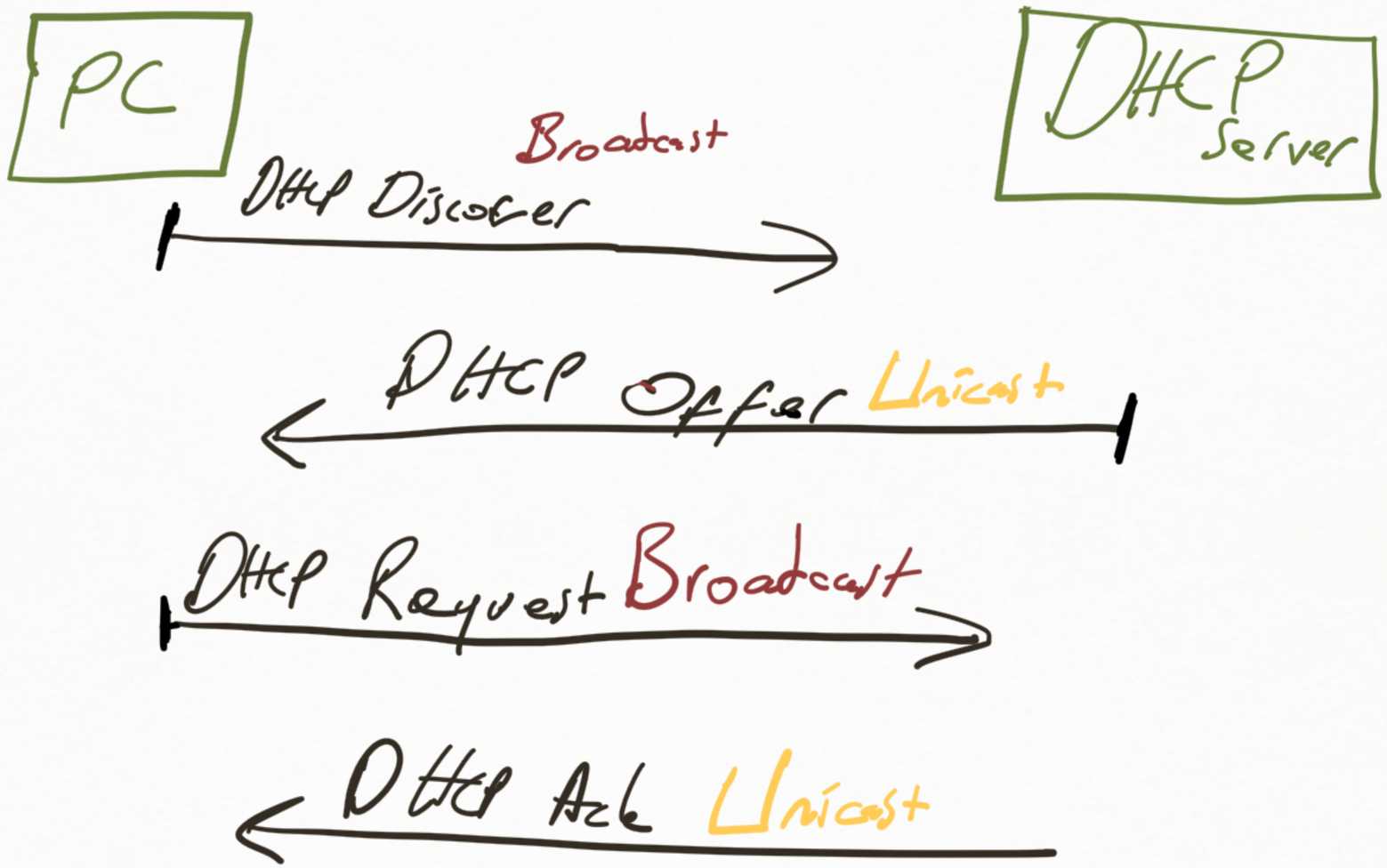
any ≠ all

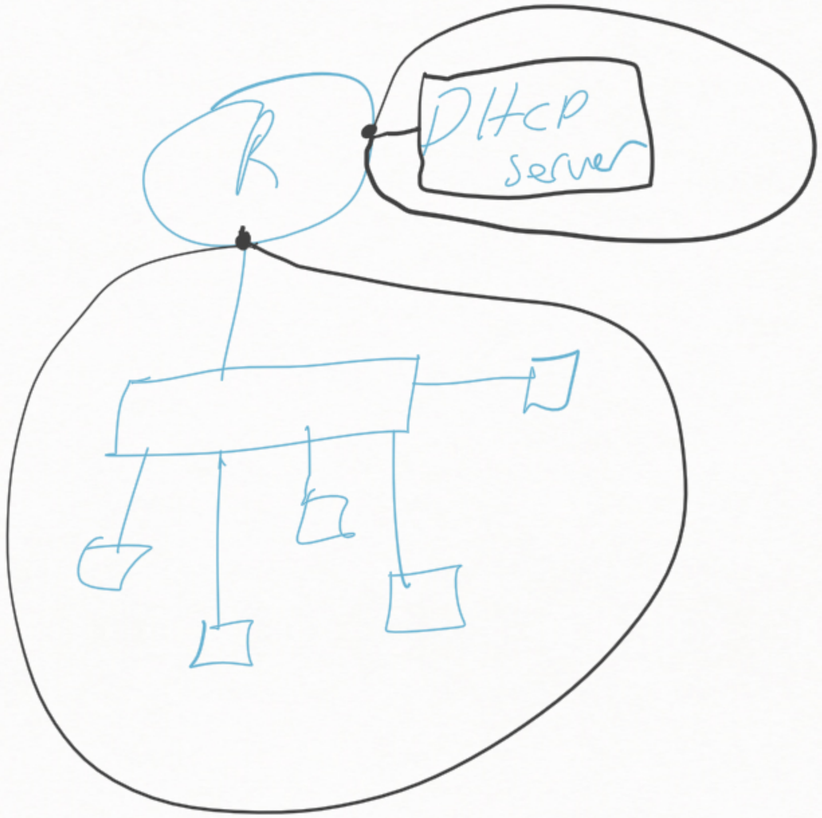
0.0.0.0 255.255.255.255

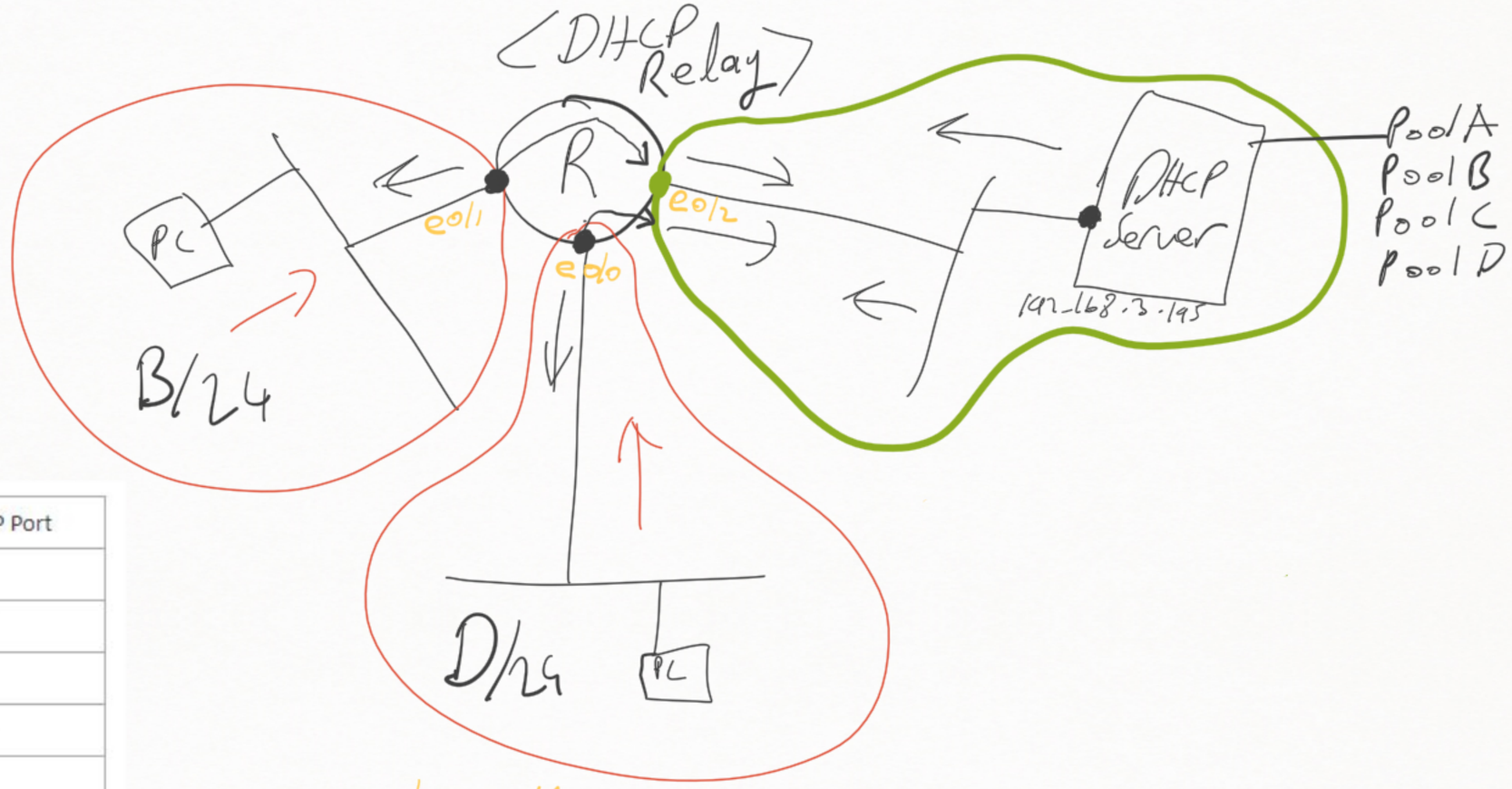


Quad-zero

"any"


PC
DHCP Server
Broadcast
DHCP Discover
DHCP Offer
Unicast
DHCP Request
Broadcast
DHCP Ack
Unicast

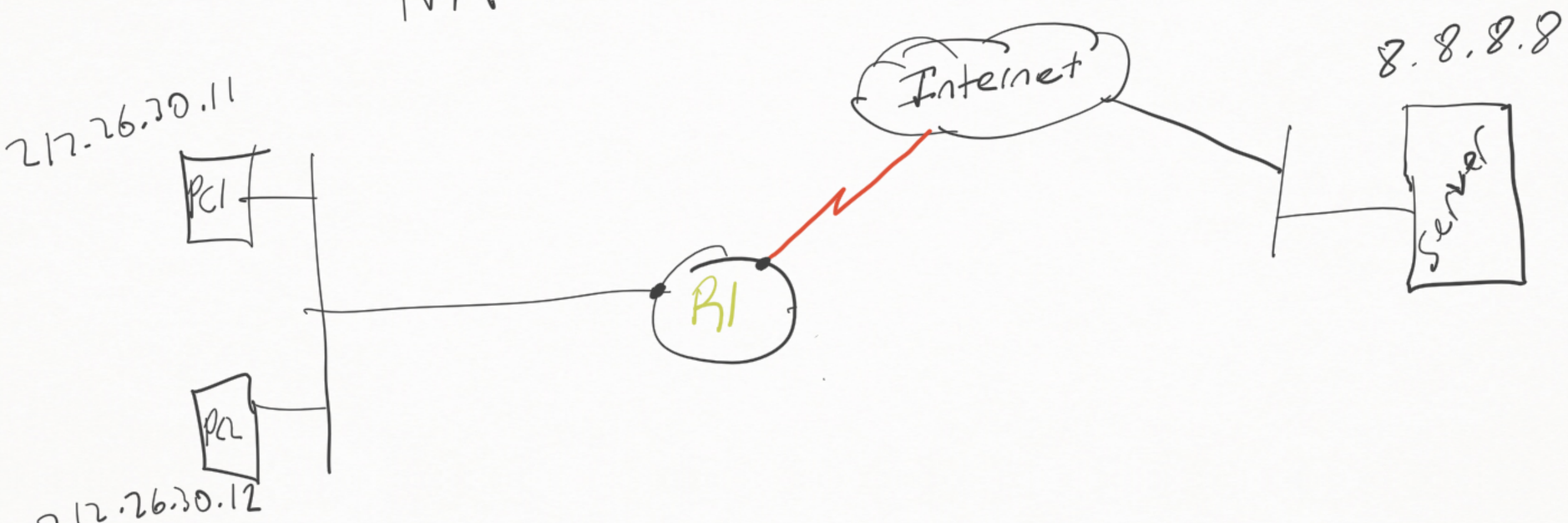

R
DHCP
server



Protocol	UDP Port
Time	37
TACACS	49
DNS	53
BOOTP/DHCP Server	67
BOOTP/DHCP Client	68
TFTP	69
NetBIOS name service	137
NetBIOS datagram service	138
IEN-116 name service	42

int e0/0, e0/1
> ip helper-address 192.168.3.195

NAT - Network Address Translation

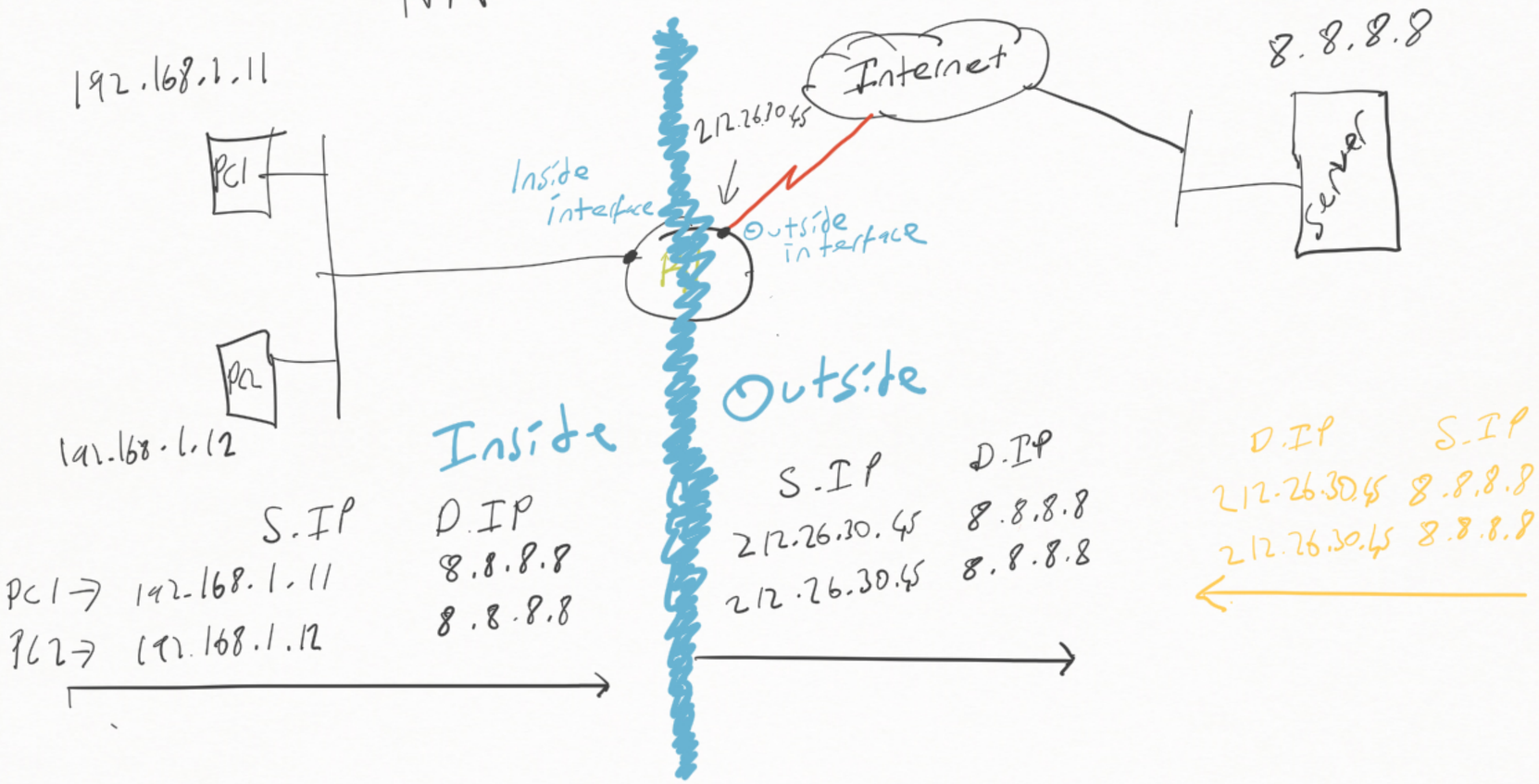


10.0.0.0/8

172.16.0.0/12 — Private IP Blocks — 172.31.255.255

192.168.0.0/16 — 192.168.255.255

NAT - Network Address Translation

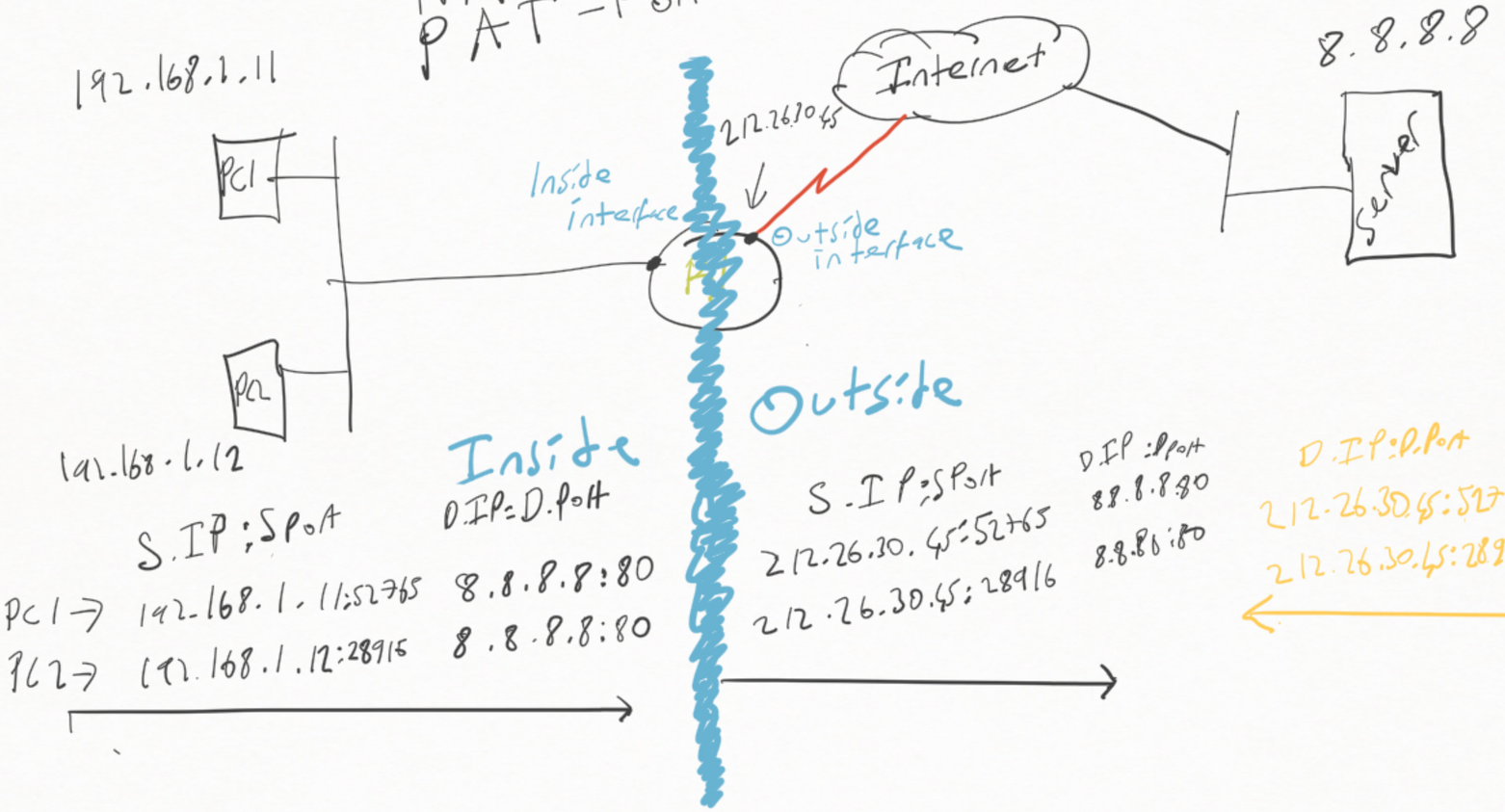


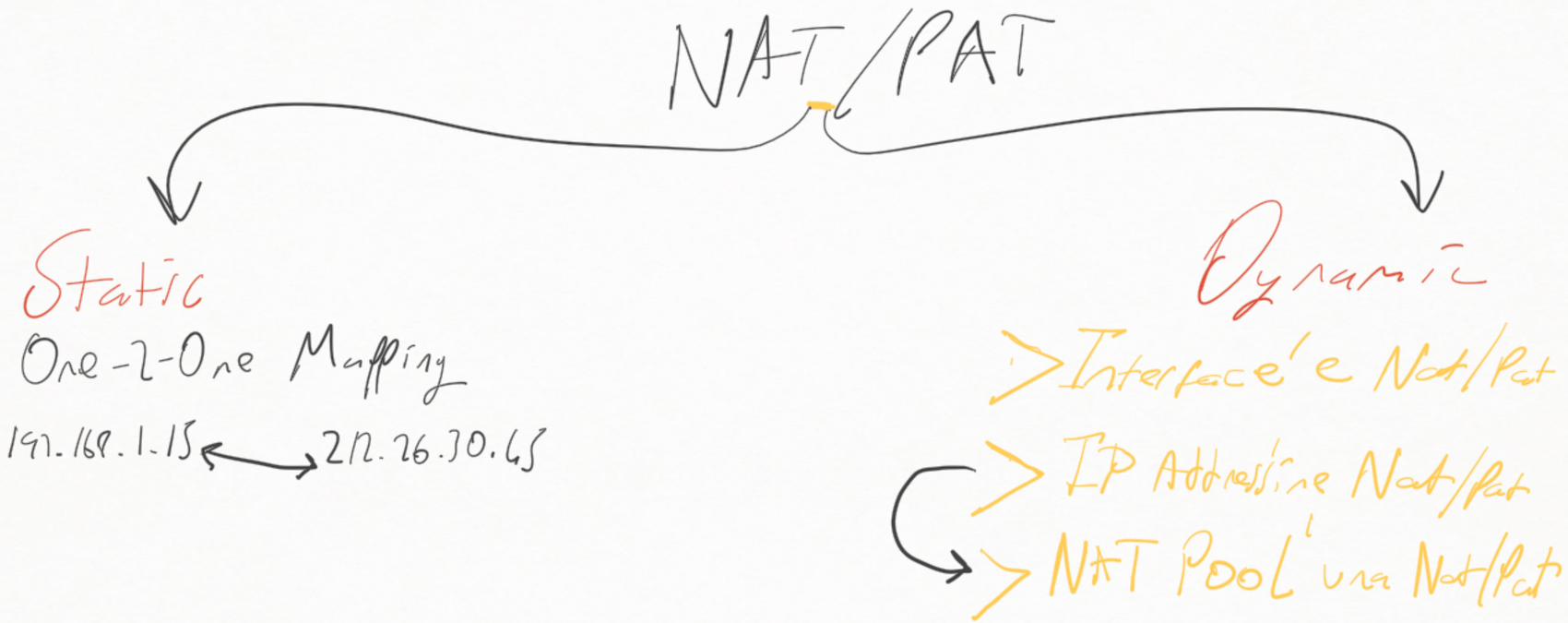
	S.IP	D.IP
PC1 →	192.168.1.11	8.8.8.8
PC2 →	192.168.1.12	8.8.8.8

S.IP	D.IP
212.26.30.45	8.8.8.8
212.26.30.45	8.8.8.8

D.IP	S.IP
212.26.30.45	8.8.8.8
212.26.30.45	8.8.8.8

NAT - Network Address Translation
PAT - Port Address Translation




NAT/PAT
Static
One-2-One Mapping
192.168.1.15 ⟷ 212.26.30.65
Dynamic
> Interface'e Nat/Pat
> IP Addressine Nat/Pat
> NAT Pool'una Nat/Pat

Static NAT → Hangi interface(Inside) (1) Hangi Interface(Outside) (2)
NAT (3) komutu.

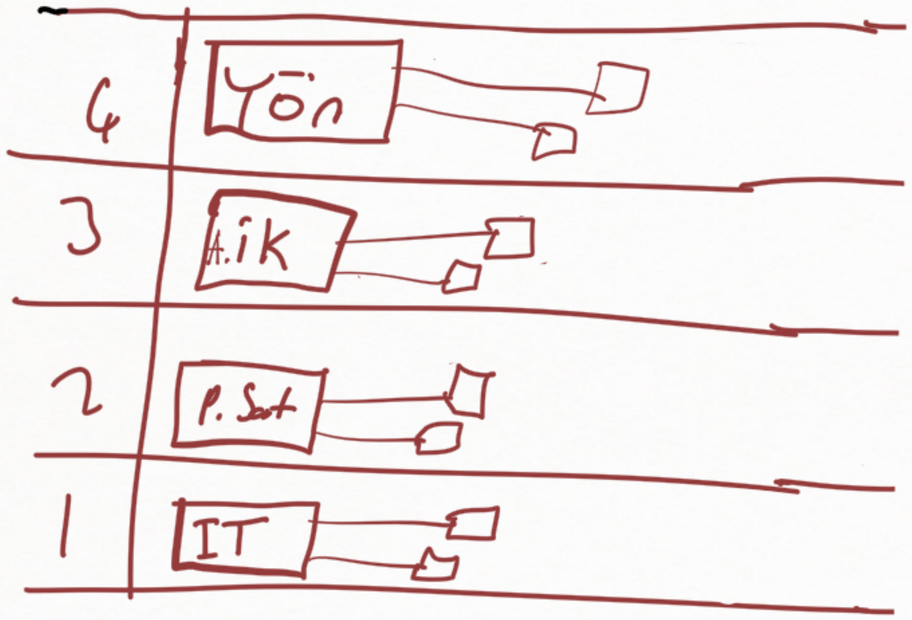
Dynamic NAT

Interface → Hangi Int (1) Inside) Hangi Int (2) Outside) Natlanacakları yakalayan ACL. (3)
NAT/PAT (4) komutu.

IP → Hangi Int (1) Inside) Hangi Int (2) Outside) Natlanacakları yakalayan ACL (3)
NAT/PAT (4) komut.

Pool → Hangi Int (1) Inside) Hangi Int (2) Outside) Natlanacakları yakalayan ACL (3)
Nat POOL. (4) NAT/PAT (5) komutu

VLANs vs LANs

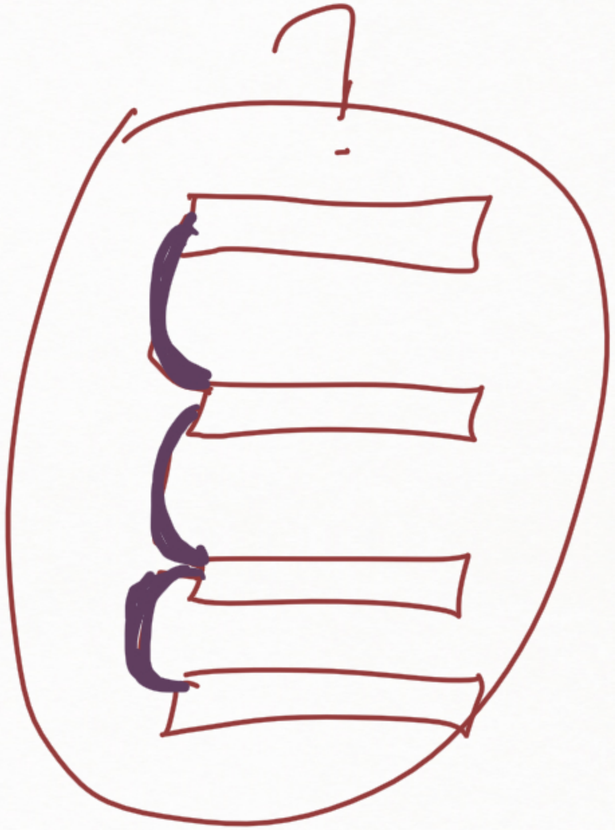


- Network
- Switch
- LAN
- Broadcast Domain

VLANs vs LANs

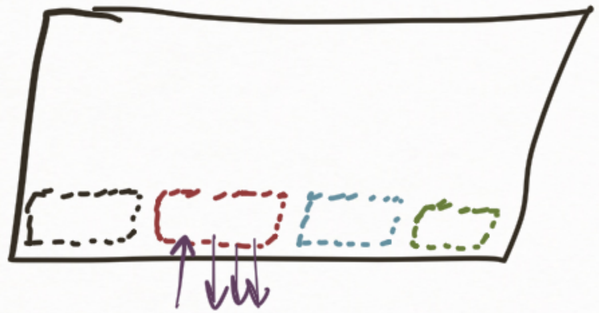
4	Yön	ik	S	IT
3	ik	S	Y	IT
2	P. Sat	TL	Y	IT
1	IT	TL	S	Y

16 Switch
4 LAN
4 Network
4 Broadcast Domain



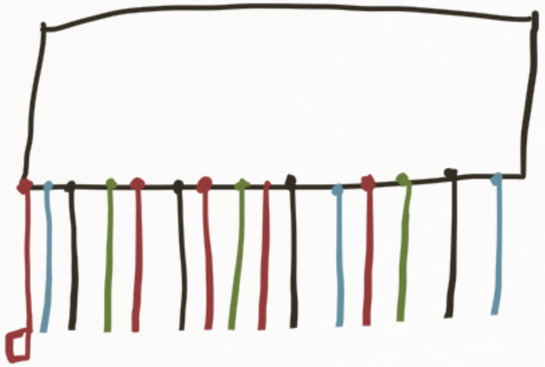
Virtual-LAN

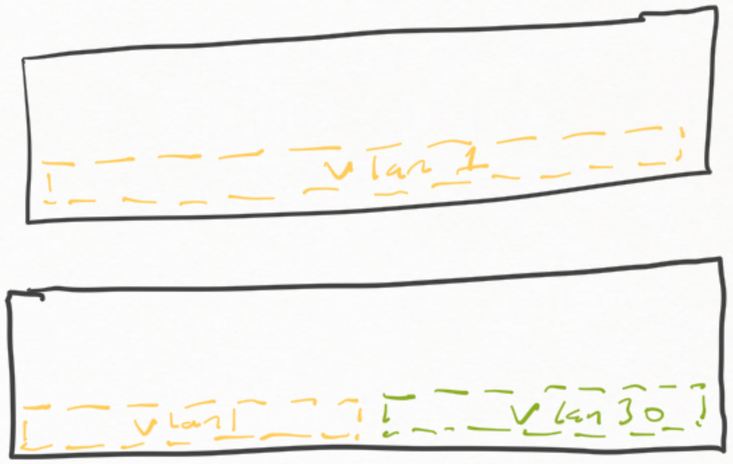
> Vlan10
> Vlan20
> Vlan30
> Vlan40



Vlan 30

MAC	Port	Vlan



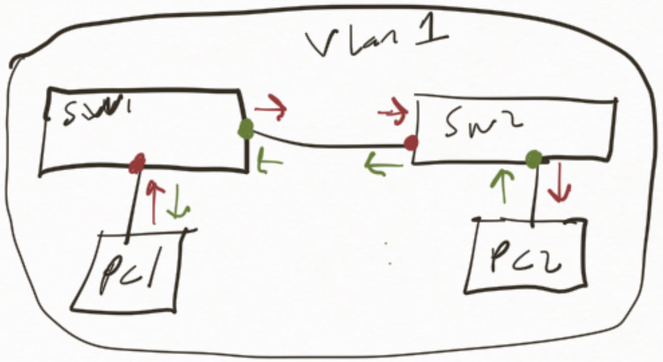


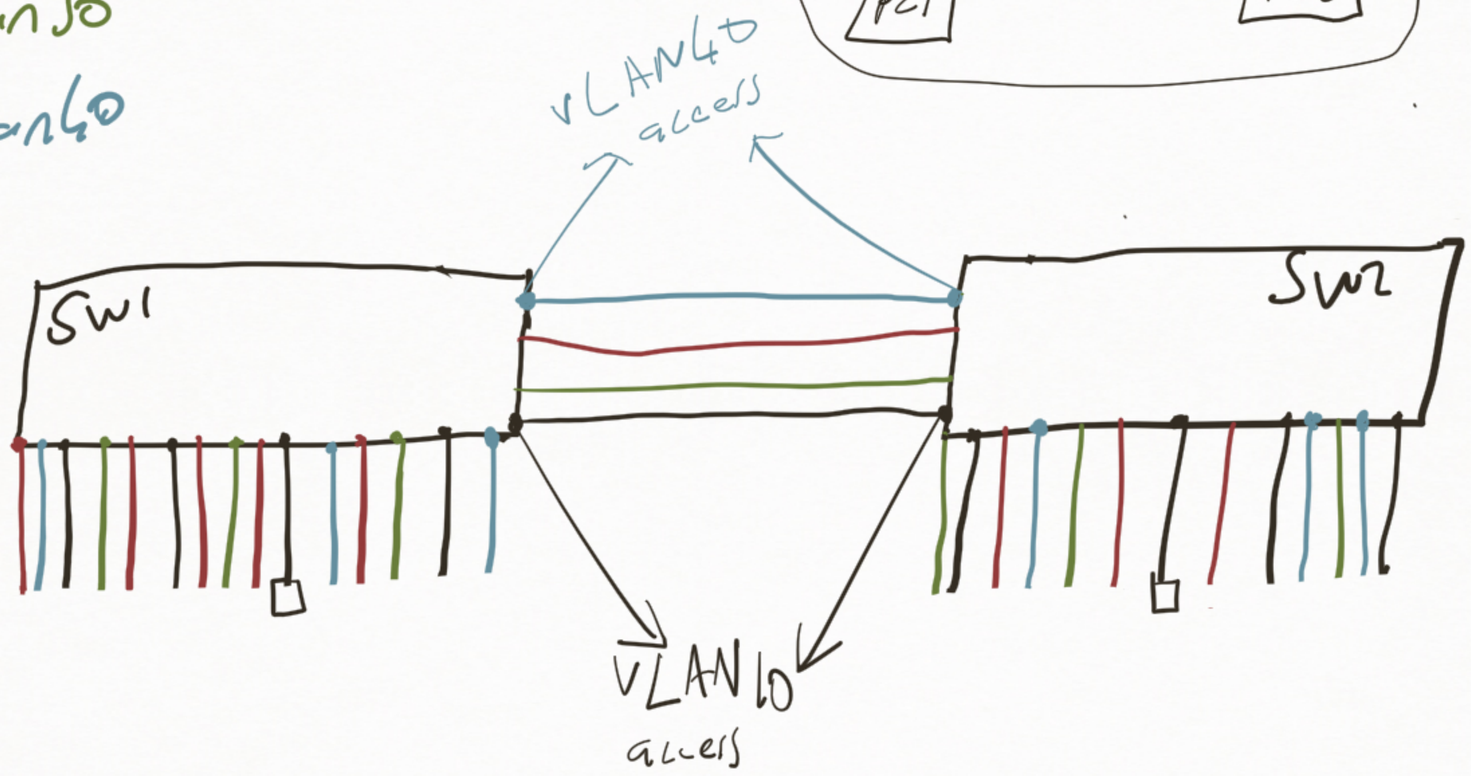
Vlan10

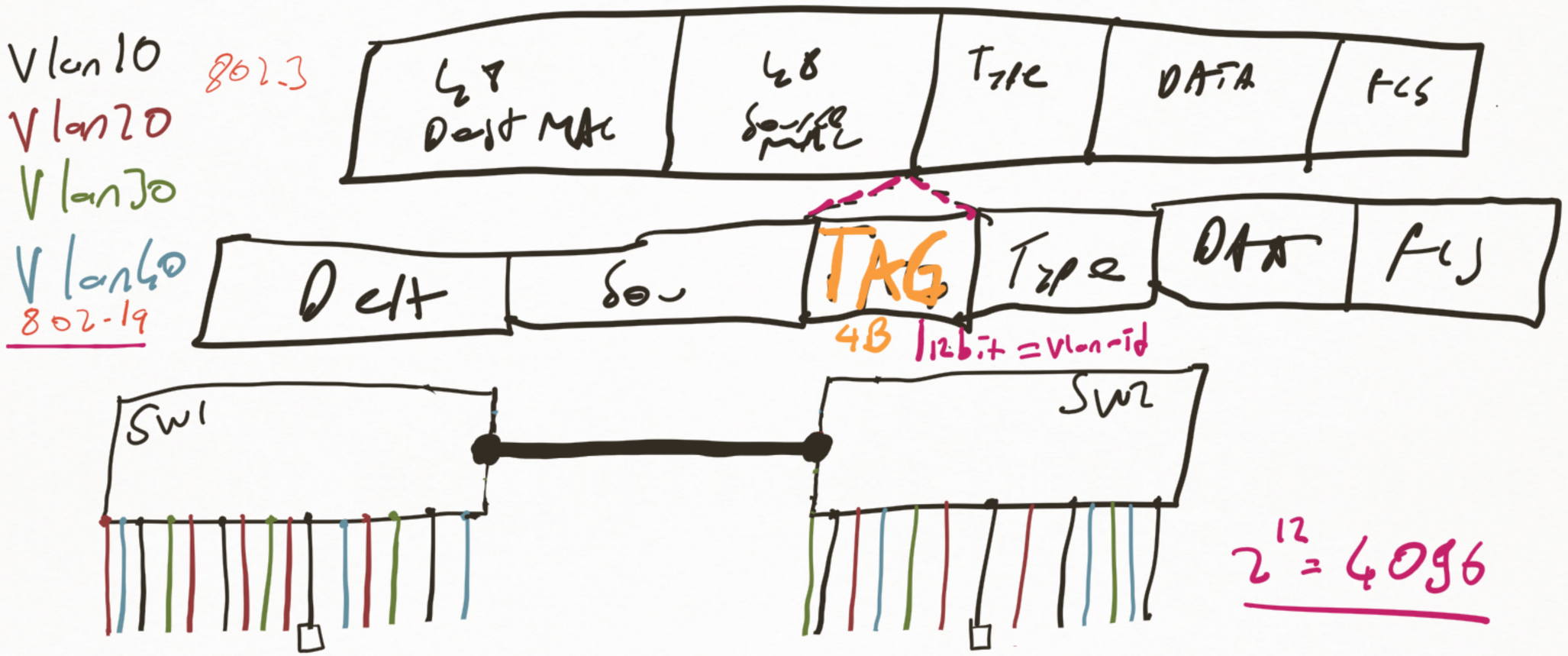
Vlan20

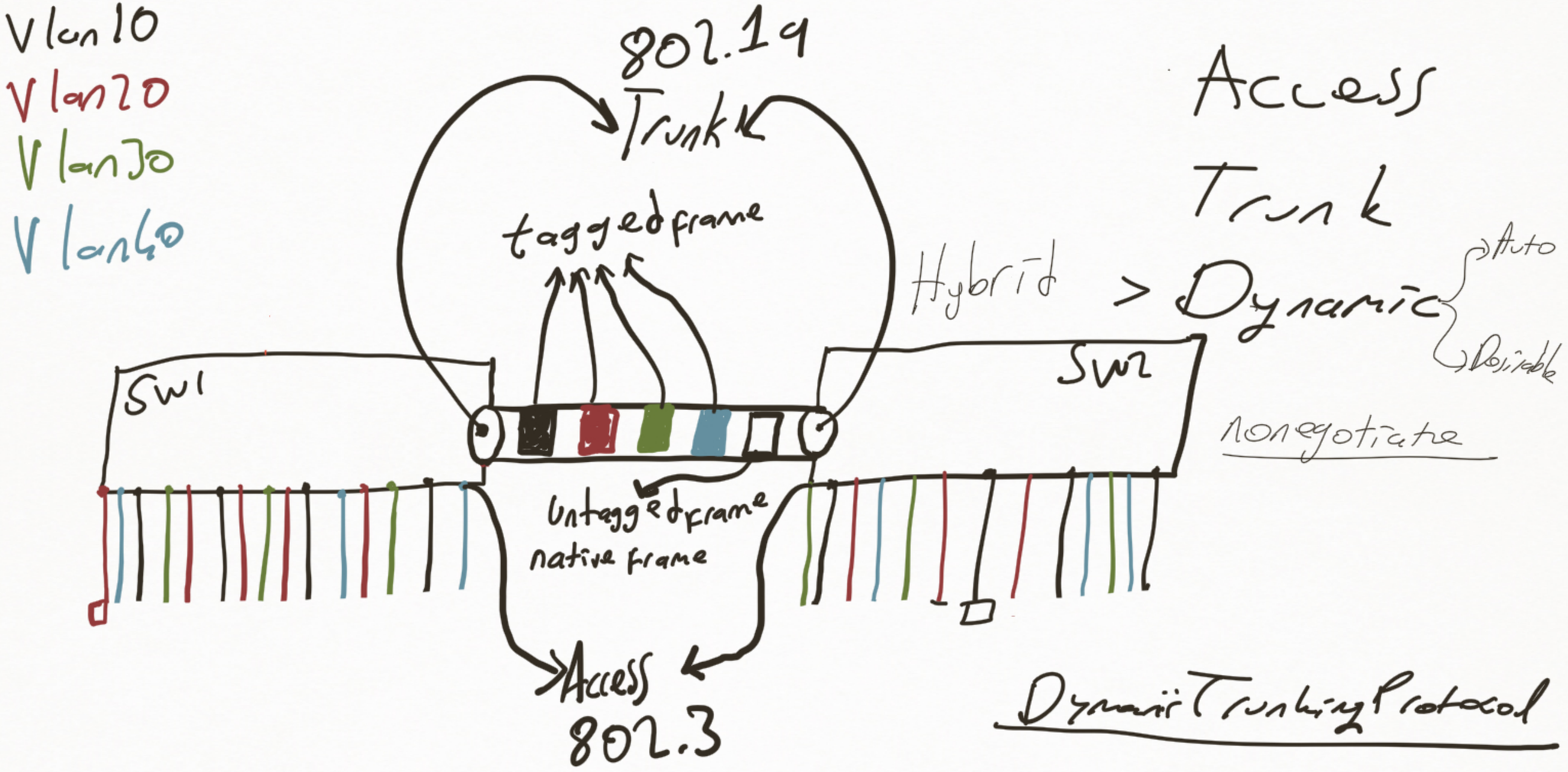
Vlan30

Vlan40






Vlan10
Vlan20
Vlan30
Vlan40
802-1q
802.3
6B
Dest MAC
6B
Source
Type
DATA
FCS
Dest
Sou
TAG
Type
Data
FCS
4B
12bit = Vlan-id
SW1
SW2
2^12 = 4096

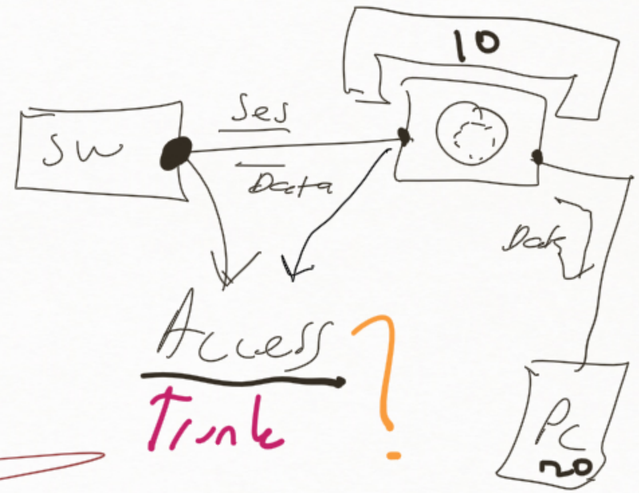

Vlan10
Vlan20
Vlan30
Vlan40
802.1q
Trunk
tagged frame
Hybrid
Access
Trunk
> Dynamic
Auto
Desirable
SW1
SW2
nonegotiate
Untagged frame
native frame
Access
802.3
Dynamic Trunking Protocol

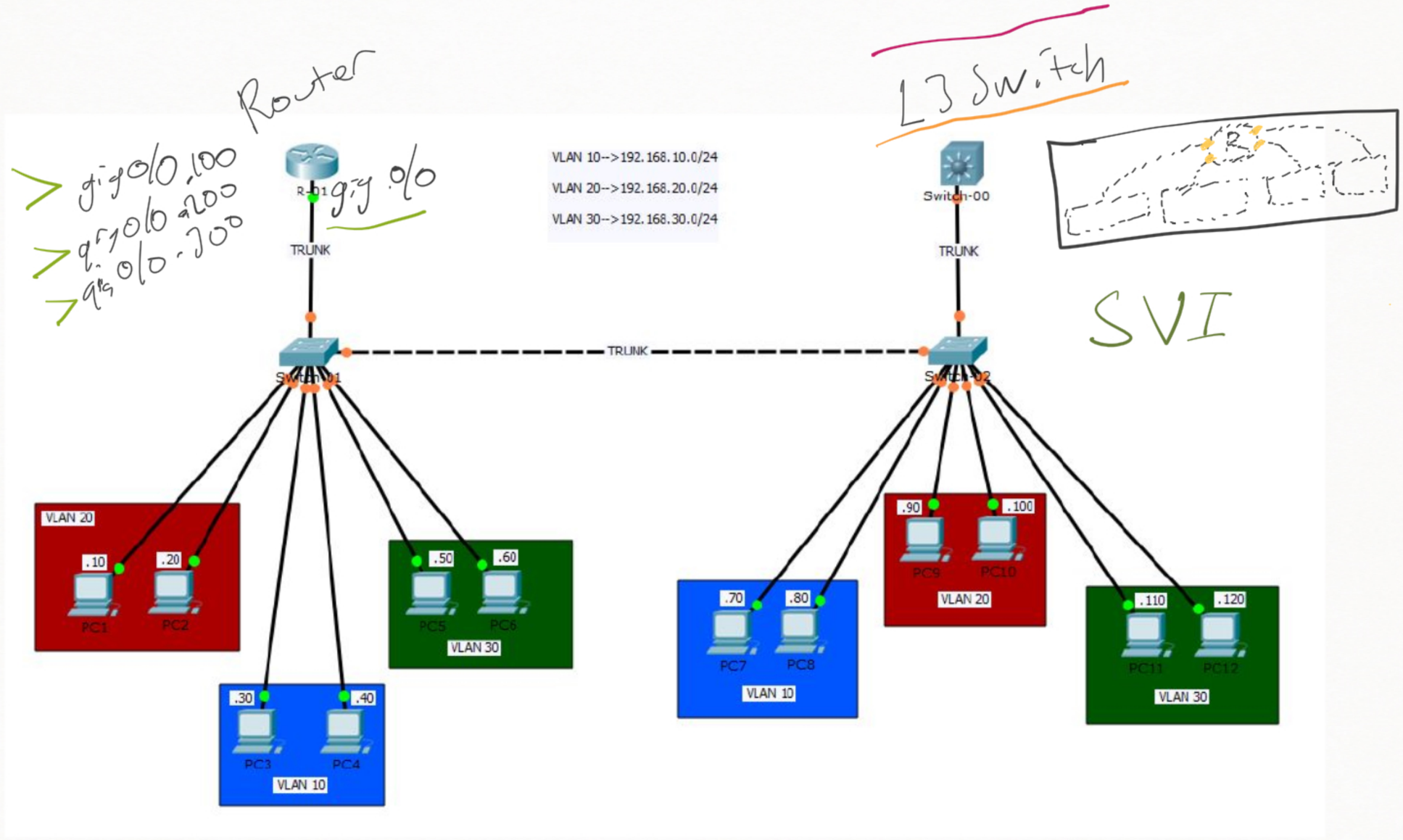
[switchport trunk encap dot1q
switchport mode trunk]

VoIP

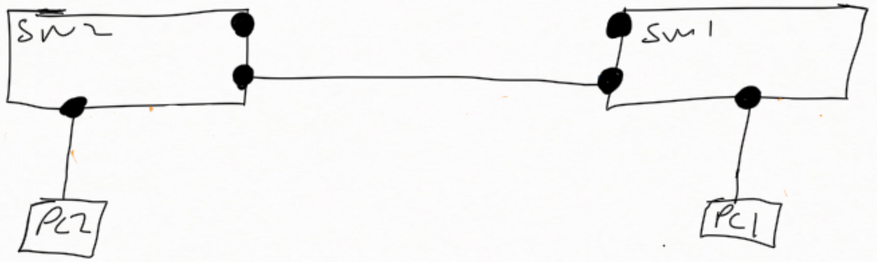
trunk (1)

hang-Vlan allowed (2)

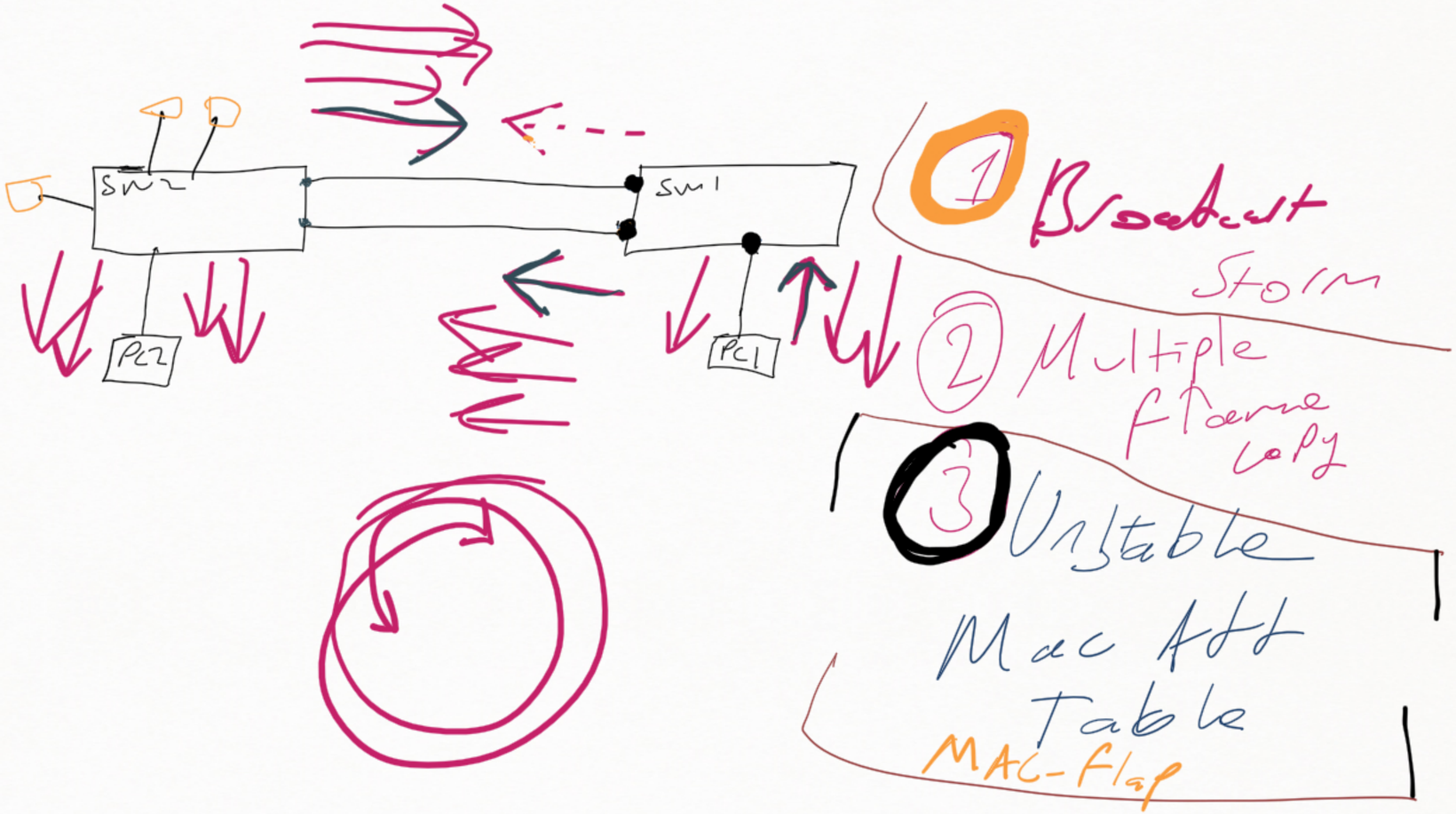



Router
L3 Switch
SVI
gig0/0.100
gig0/0.200
gig0/0.300
gig 0/0
VLAN 10-->192.168.10.0/24
VLAN 20-->192.168.20.0/24
VLAN 30-->192.168.30.0/24
TRUNK
TRUNK
TRUNK
Switch-00
VLAN 20
.10
.20
PC1
PC2
.50
.60
PC5
PC6
VLAN 30
.30
.40
PC3
PC4
VLAN 10
.70
.80
PC7
PC8
VLAN 10
.90
.100
PC9
PC10
VLAN 20
.110
.120
PC11
PC12
VLAN 30

Redundant



Redundant

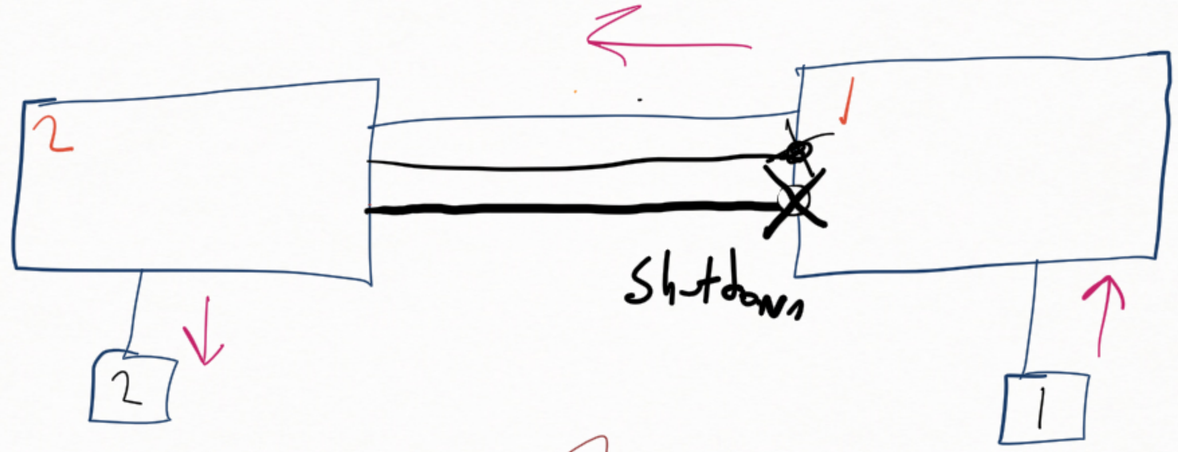

SW2
SW1
PC2
PC1
1
Broadcast
Storm
2
Multiple
frame
copy
3
Unstable
Mac Add
Table
MAC-Flap

Switch'lerin MAC Address Tablosunu Doldurmadı=?

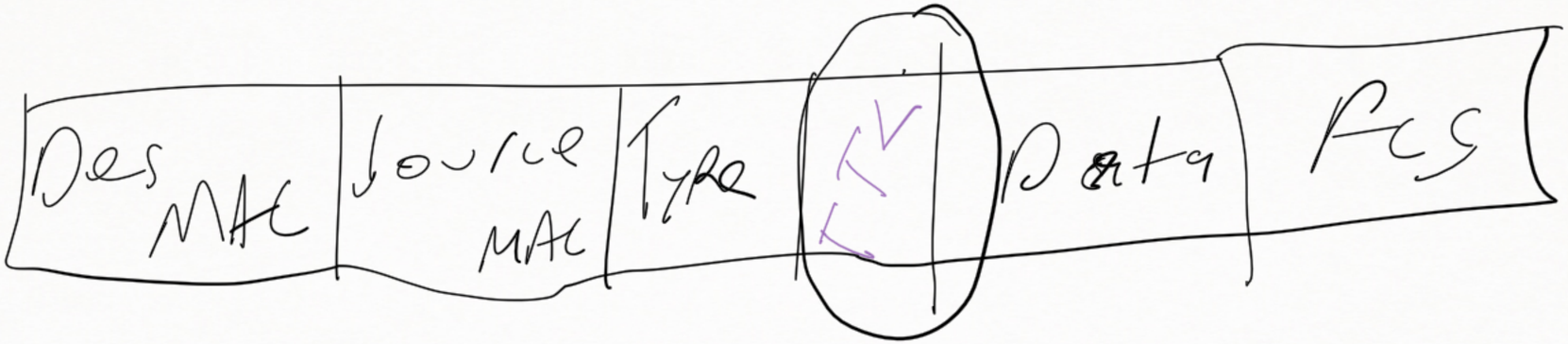
Flood and learn

"in" yönünde gelen frame'lerin Source MAC Address'lerini geldikleri portla eşleştirip tabloya yazarlar.

Yeterli değil!!!



?



Radia Joy Perlman (born January 1, 1951) is a software designer and network engineer. She is most famous for her invention of the spanning-tree protocol (STP). She is currently employed by EMC Corporation.

1984

The **Spanning Tree Protocol (STP)** is a network protocol that builds a logical loop-free topology for Ethernet networks.

The basic function of STP is to prevent bridge loops and the broadcast radiation that results from them.

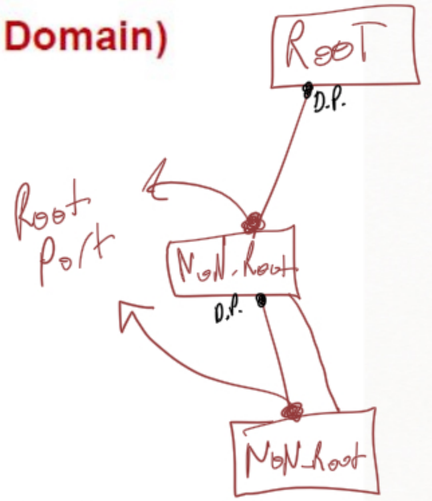
Spanning tree also allows a network design to include spare (redundant) links to provide automatic backup paths if an active link fails, without the danger of bridge loops, or the need for manual enabling or disabling of these backup links.

Spanning-Tree Golden Rules

1) **Root Bridge election for the whole NETWORK (per Broadcast Domain)**

There is exactly one Root Bridge for each Spanning Tree instance.

1. Lowest Bridge ID (Bridge Priority + MAC Address)



2) **Root Port election on each NoN-Root Bridge**

Each (NoN-Root) bridge has exactly one Root Port, which represents the best path to the Root Bridge.

1. Lowest Path Cost to Root
2. Lowest Sender Bridge ID
3. Lowest Sender Port ID (Port Priority + Port#)
4. Lowest Local Port ID (Port Priority + Port#)

3) **Designated Port election on each Segment**

There is exactly one Designated Port giving access to each LAN Segment.

1. Lowest Path Cost to Root
2. Lowest Bridge ID (Bridge Priority + MAC Address)

4) **All ports which are neither Root Ports nor Designated Ports are put into a Blocking state**

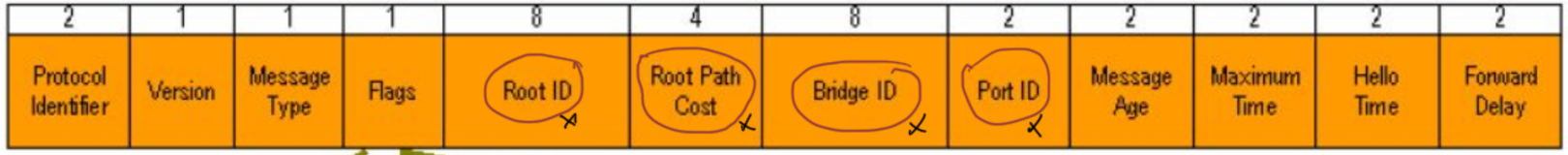
Non-Designated Port

BPDUs are not transmitted but are received, and no user traffic passes. These represent redundant links. Port role elections may be recalculated at any time.

With 802.1W, blocked ports are each given an Alternate port (Root port stand-in) or Backup port (Designated port stand-in) role, to pre-stage a more rapid failover.

***Hidden Rule**: All ports in Root Bridge will become Designated Ports.*

802.1D and 802.1W BPDU Format



IEEE 802.1D

7	6	5	4	3	2	1	0

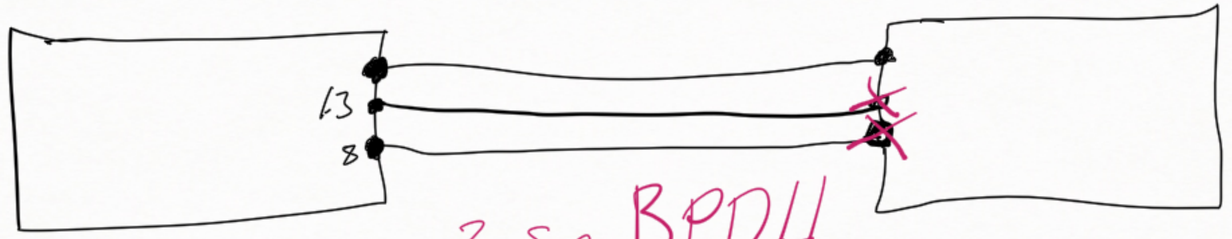
Bit	Function
7	Topology Change (TC)
6	Unused
5	Unused
4	Unused
3	Unused
2	Unused
1	Unused
0	Topology Change Ack (TCA)

IEEE 802.1w

7	6	5	4	3	2	1	0

Bit	Function
7	Toplogy Change (TC)
6	Proposal
5	**Port Role**: 00 – Uknown 01 – Alternate Port 10 – Root Port 11 – Designated Port
4	
3	Learning
2	Forwarding
1	Agreement
0	Topology Change Ack (TCA)

Spanning Tree



2 sn BPDU

13
+15
28

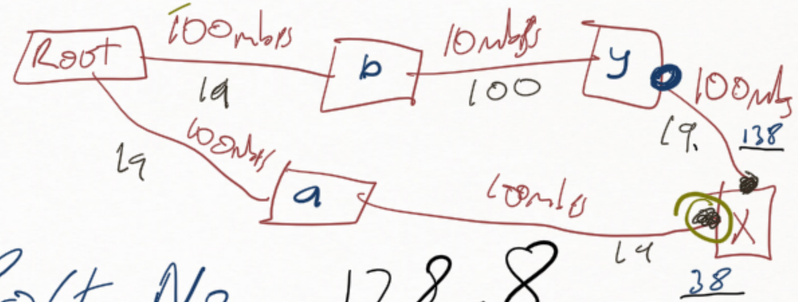
13
⊕15
1315

① Bridge ID = Bridge Priority ⊕ MAC ADDRESS
[32768]
<0-65536>
×4096

32768 a8:b1:d6:05:19:74

② ROOT BridgeID =

③ Cost ⇒ 1000 = 4
100 = 19 (cost)
10 = 100 (cost)



④ PortID = Port Priority ⊕ Port No
[128]
<0-255>
×16
8

128.8
128.13

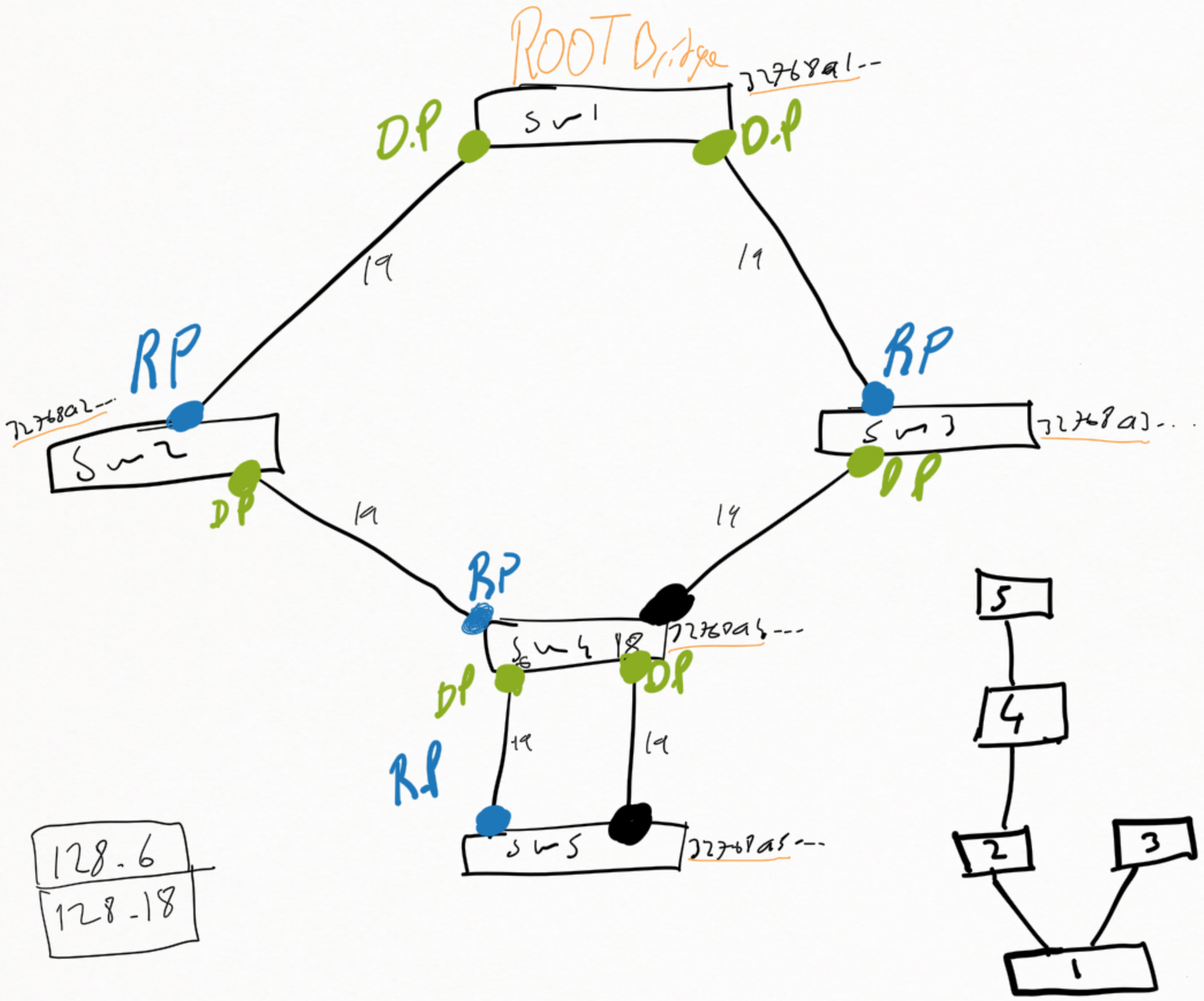
Yeni

802.1t

Port Speed	Recommended Value	Recommended Range	Available Range
£ 100 kbps	200000000	20000000 to 200000000	1 to 200000000
1 Mbps	20000000	2000000 to 200000000	1 to 200000000
10 Mbps	2000000	200000 to 20000000	1 to 200000000
100 Mbps	200000	20000 to 2000000	1 to 200000000
1 Gbps	20000	2000 to 200000	1 to 200000000
10 Gbps	2000	200 to 20000	1 to 200000000

eski

Link Speed(Bandwidth)	Port Cost
10 mbps	100
100 bmps	19
1 gbps	4
10 gbps	2



Root Bridge Elec.

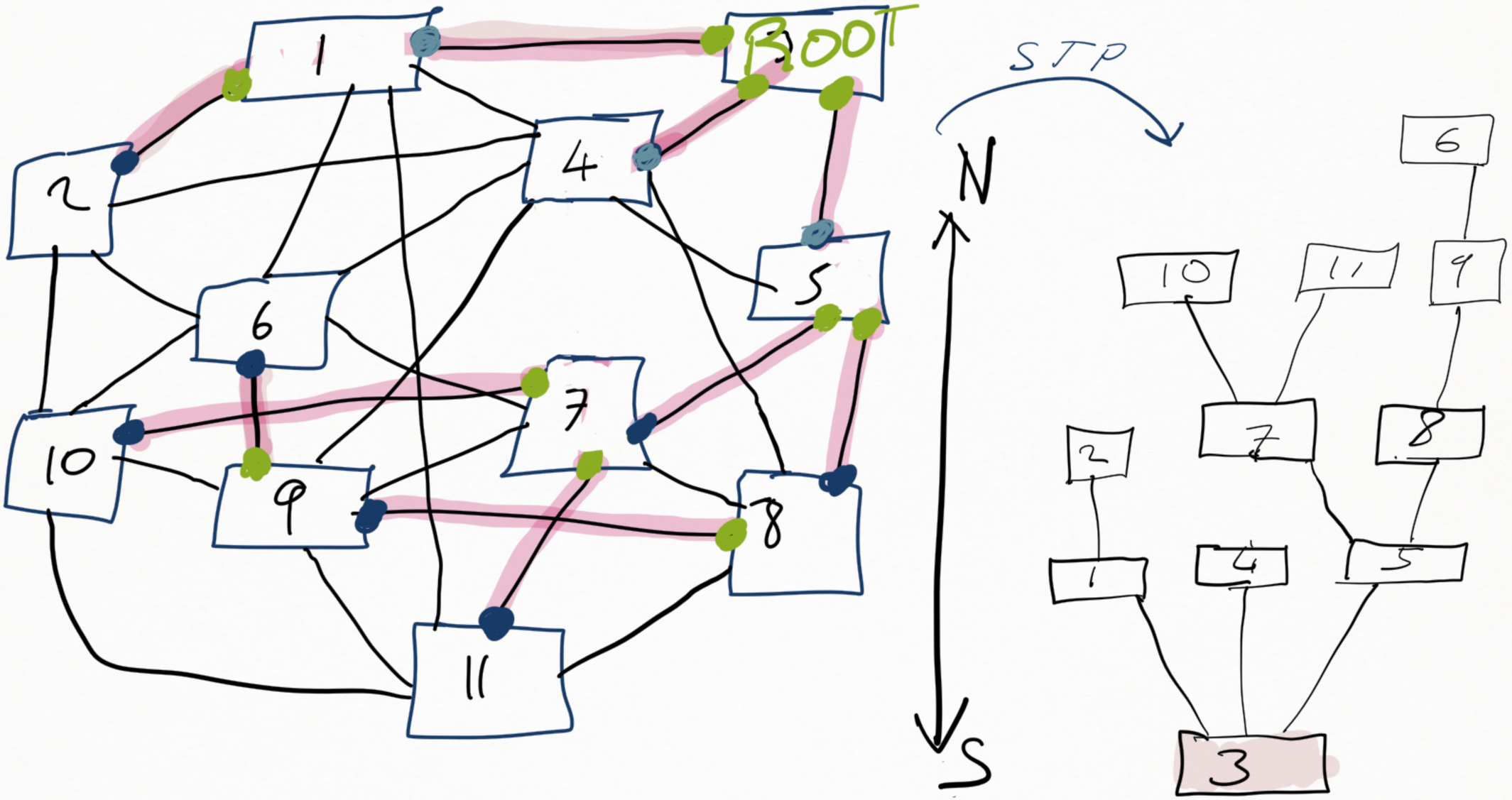
① Lowest Bridge ID

Root Port Elec.

① Lowest Cost to ROOT
② Lowest Sender Bridge ID
③ Lowest Sender Port ID
④ Lowest Local Port ID

Designated Port Elec

① Lowest Cost to Root


1
BOOT
2
4
5
6
7
10
9
8
11
STP
N
S
6
10
11
9
2
7
8
1
4
5
3

802.1D – STP
802.1W – RSTP

ROOT Bridge ✓

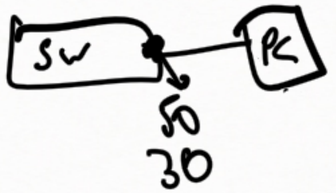
NoN_ROOT Bridge ✓

> Disable
> Listening (20sn)
> Learning (15s)
> Forwarding/Blocking (15sn)

[50 + 30]

Port roller:-	States
ROOT Port	FW
Designated Port	FW
NoN_Designated Port	BLCK
> Alternate (RP)	BLCK
> Backup (DP)	BLCK

Spanning-tree port-fast edge-port



802.1D State	802.1w State	Default Port Operational Status	Port in Active Topology?	Port Learning MAC Addresses?
Disabled	Discarding	Enabled	No	No
Blocking	Discarding	Enabled	No	No
Listening	Discarding	Enabled	Yes	No
Learning	Learning	Enabled	Yes	Yes
Forwarding	Forwarding	Enabled	Yes	Yes

20sn

15sn

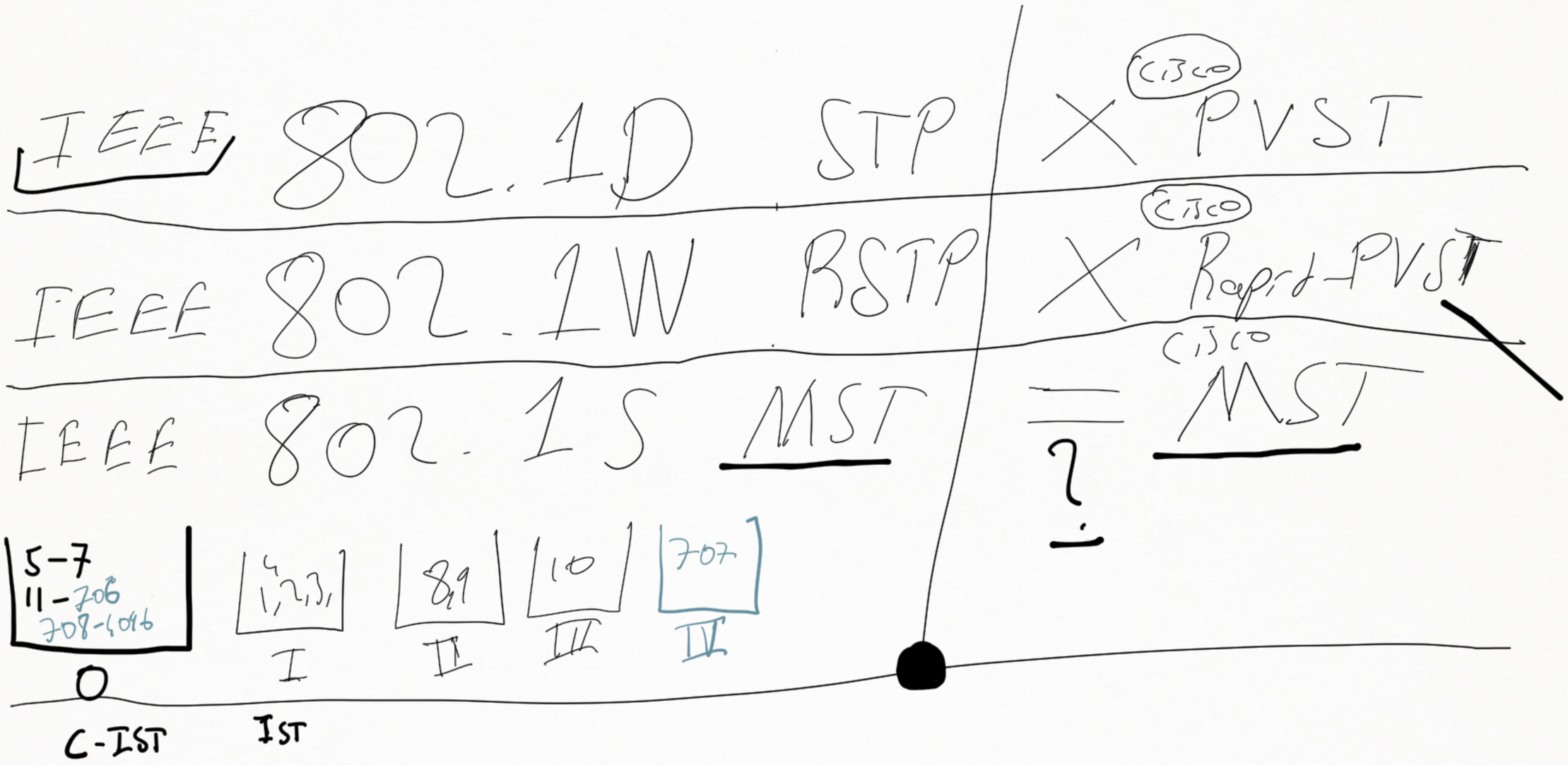
15sn

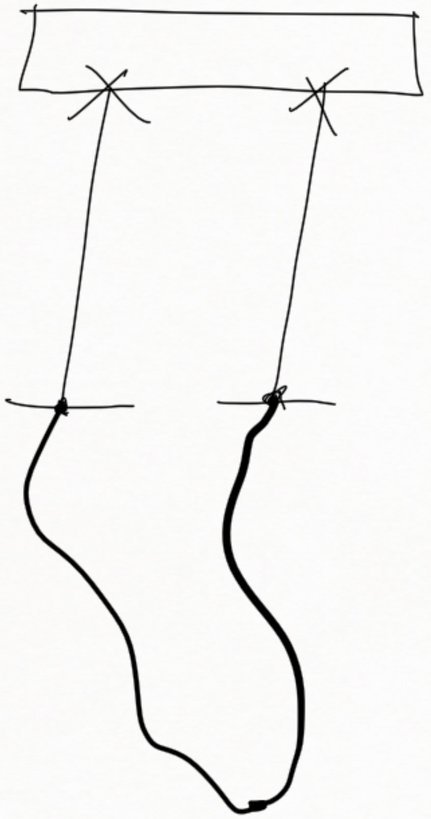
15

15

50 saniye

30 saniye


IEEE 802.1D STP
X PVST
Cisco
IEEE 802.1W RSTP
X Rapid-PVST
Cisco
IEEE 802.1S MST
MST
Cisco
?
5-7
11-706
708-4096
1,2,3,
8,9
10
707
I
II
III
IV
0
C-IST
IST



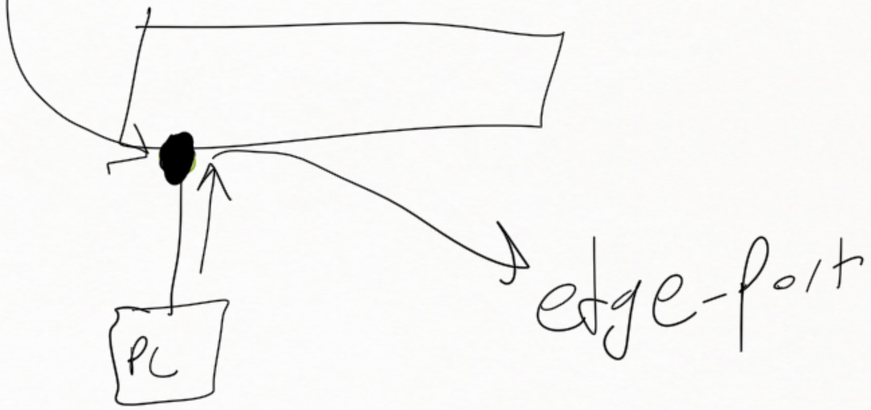
Loop Protection ✓

Loop Guard ✓

UDLD

BPDU Guard

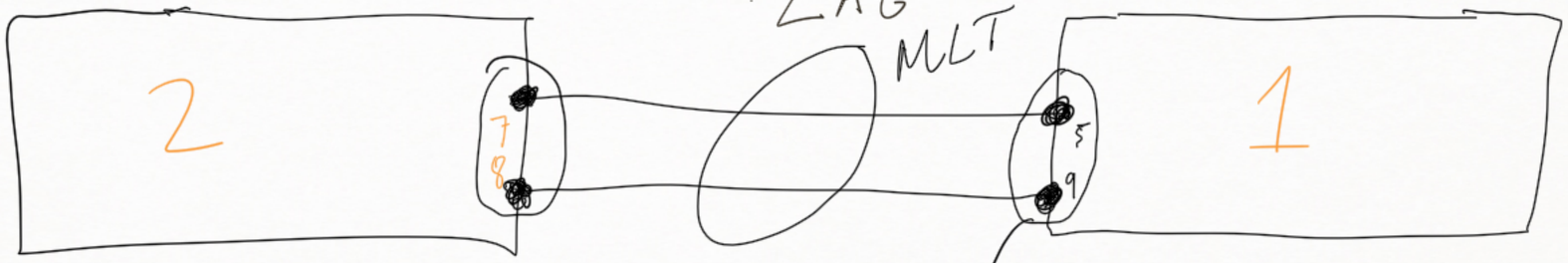
BPDU filter



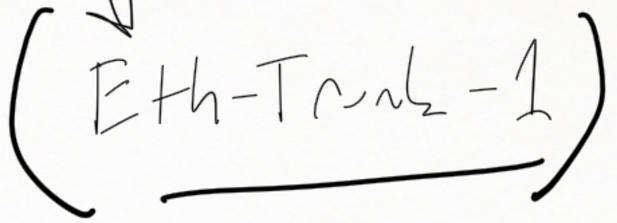
STP vs ?

bundle
NiC-Teaming
Bound
Ether-Channel
port-channel
Eth-Trunk
LAG
MLT

Mode "ON"



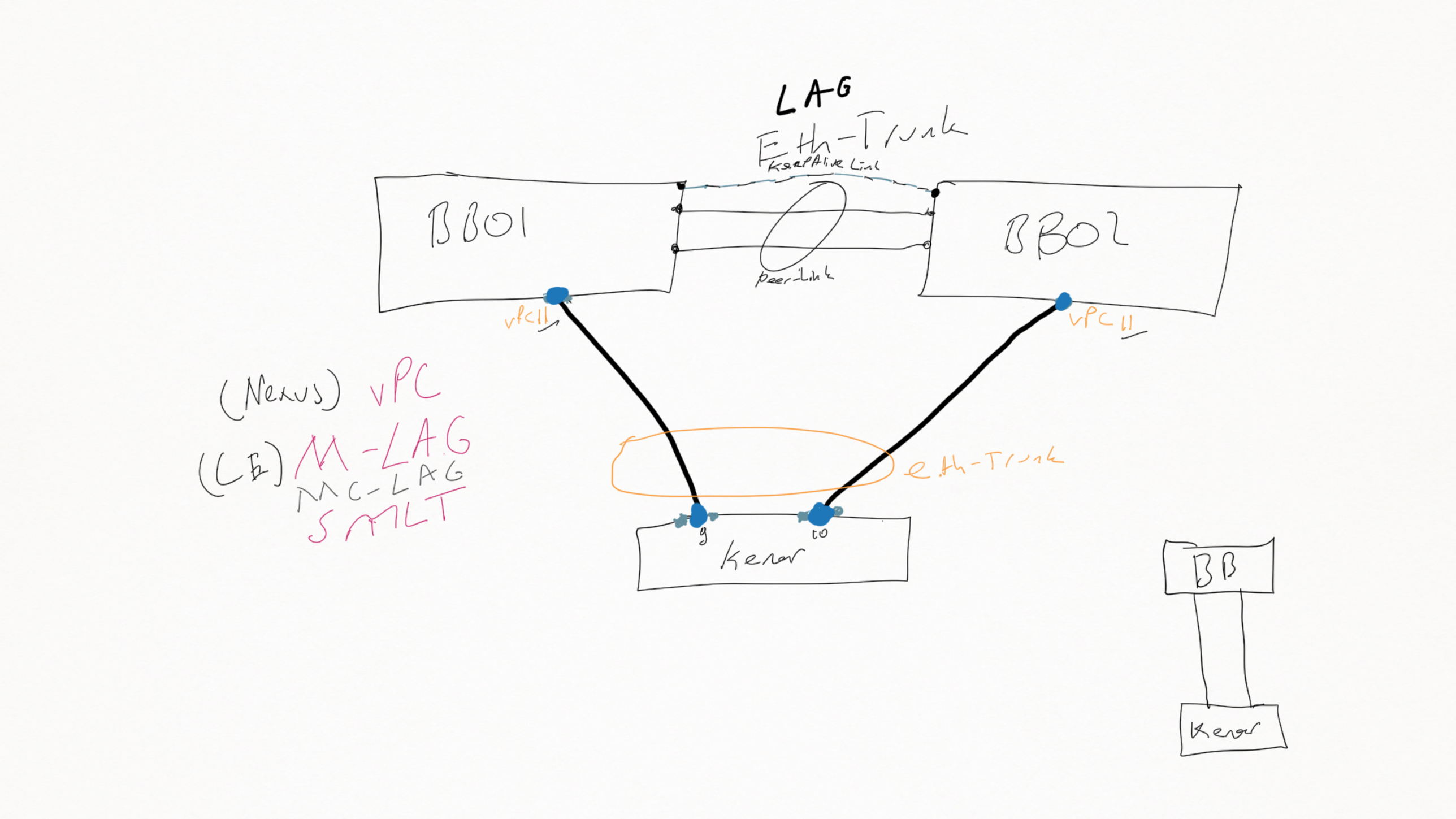
5 ve 9 port

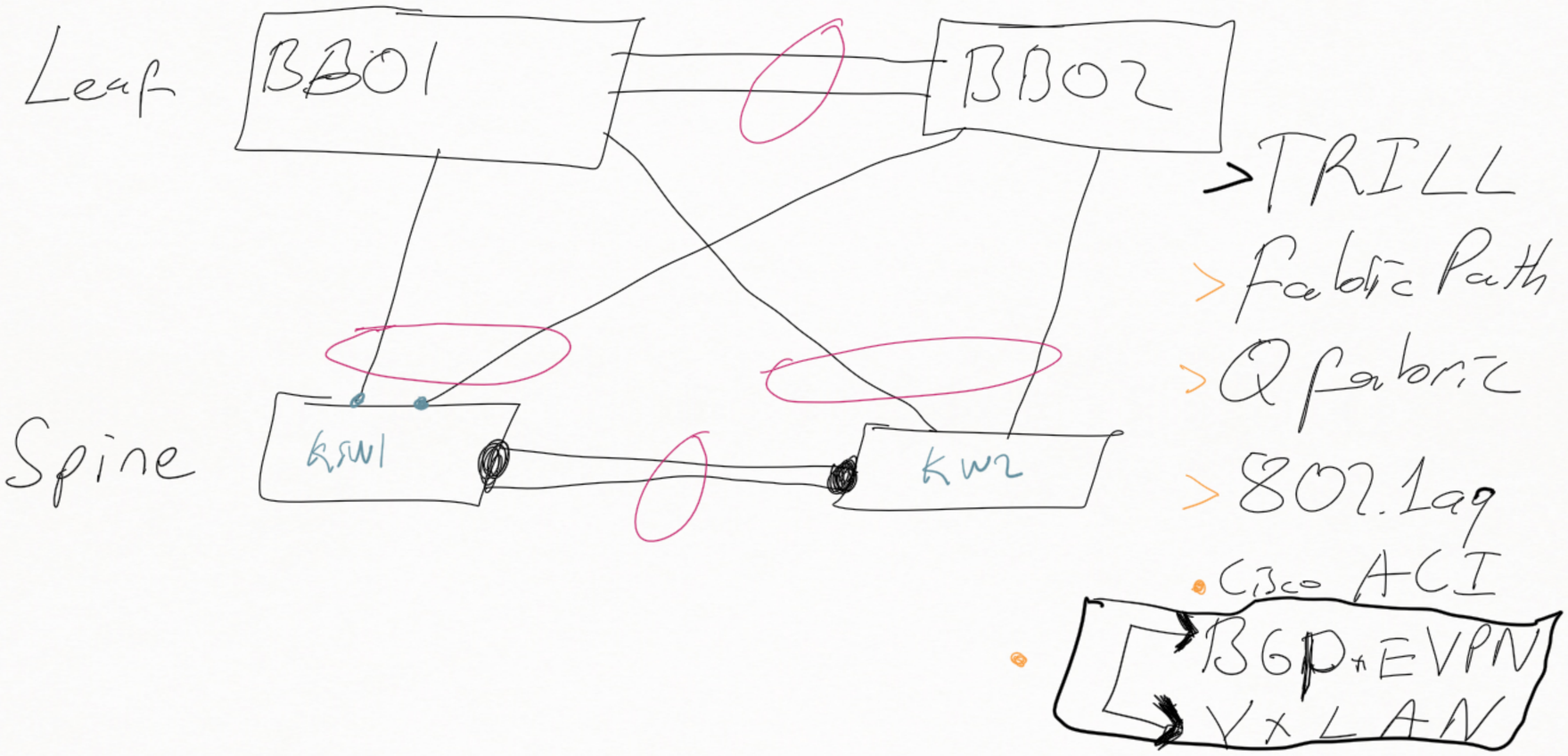


Control Protocols

MAX-Bundle
-8-

Vendor	Implementation Name
Arista	MLAG
ADVA	MC-LAG
Aruba (formerly HP ProCurve)	Distributed Trunking under Intelligent Resilient Framework switch clustering technology
Avaya	Distributed Split Multi-Link Trunking
Brocade	Multi-Chassis Trunking
Ciena	MC-LAG
Cisco Catalyst 6500 - VSS	Multichassis Etherchannel (MEC)
Cisco Catalyst 3750 (and similar)	Cross-Stack EtherChannel
Cisco Catalyst 9000	StackWise Virtual
Cisco Nexus	Virtual PortChannel (vPC), where a PortChannel is a regular LAG
Cisco IOS-XR	mLACP
Cumulus Networks	MLAG (formerly CLAG)
Dell Networking (formerly Force10 Networks, formerly nCore)	DNOS6.x Virtual Port Channel (vPC) or Virtual Link Trunking
EdgeCore Networks	MLAG
Extreme Networks	MLAG
Ericsson	MC-LAG (Multi Chassis Link Aggregation Group)
Fortinet	MC-LAG (Multi Chassis Link Aggregation Group)
HPE/Aruba	Distributed trunking
Lenovo Networking (formerly IBM)	vLAG
Mellanox	MLAG
NEC	MC-LAG (Openflow to traditional network)
Nocsys	MLAG
Nokia (Formerly Alcatel-Lucent)	MC-LAG
Nortel	Split multi-link trunking
Nuage Networks / Nokia	MC-LAG ; including MCS (Multi-chassis Sync)
Juniper	MC-LAG
Plexxi	MLAG
H3C	Distributed Resilient Network Interconnect
ZTE	MC-LAG
Huawei	M-LAG
NETGEAR	MLAG


LAG
Eth-Trunk
KeepAlive Link
BBO1
BBO2
peer-link
vPC 11
vPC 11
(Nexus) vPC
(LB) M-LAG
MC-LAG
SMLT
eth-Trunk
g
to
Kevor
BB
Kevor


Leaf
BB01
BB02
Spine
KSW1
KW2
> TRILL
> FabricPath
> Q fabric
> 802.1aq
• Cisco ACI
BGP+EVPN
VxLAN