

**Chapter 1**

- : NW
  - Network Device
    - End D : PC, Printer, Laptop
    - Intermedia NW D : switch, Router
    - NW media : Hub, AC
      - fiber optic, UTP, coax, RJ-45
  - Nw protocol - protocol - ทำให้เรา → commu
    - Ads
      - Physical (Mac - data link)
      - Logical (IP - NW)
    - special (Port - Transport)
  - Nw type - LAN : small & single admin
  - WAN
    - Fault tolerance - ถ้าตัวนึงเสีย ตัวอื่นยังใช้งานได้
    - Scalability - scale easy
    - Security - Limit Access จำกัดผู้เข้าถึง
    - QoS - ให้คุณภาพบริการที่ต้องการ
      - switches - Crossover (SW-Hub, Router, PC)
      - others - straight

**Chapter 2**

- IPv4 → Class → Unique
- |               | NW Host |         |       |                 |
|---------------|---------|---------|-------|-----------------|
| A : N.H.H.H   | 0       | 0-127   | 128   | 16.8M 255       |
| B : N.N.H.H   | 10      | 128-191 | 16.4K | 65.5K 255.255   |
| C : N.N.N.H   | 110     | 192-223 | 2.1M  | 254 255.255.255 |
| D : Multicast | 1110    | 224-239 | n/a   | n/a             |
- MAC Ads → Phy Ads : identify source/dest

Unicast - only 1

Broadcast - All

Cisco IOS

Access - Console [after login], telnet, ssh, Aux port

Mode → User Mode → enable config terminal

→ Privilege mode → Global Config : (config) → line

structure

- Prompt cmd space keyword / argument

- Method - Get hostname &gt; Limiting Access &gt; Ads device &gt; Verifying, Connect

**Chapter 3**

: static / Dynamic Protocol

• Routing → ③ ไป ① บน Routing table

• Routing → choose best path

+ encapsulation header ไม่ต้องใส่

NW Design ← Diagram vs topology

↓ ไม่สามารถ NW

ต้องการให้เป็น

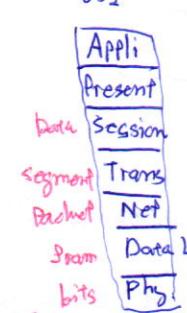
กันหมด NW

- ต้องการจะเป็น  
bus, ring, star

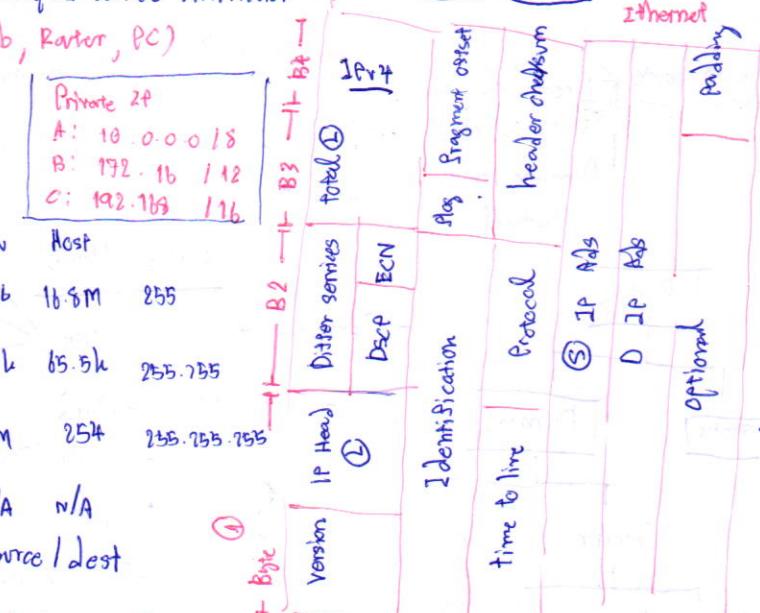
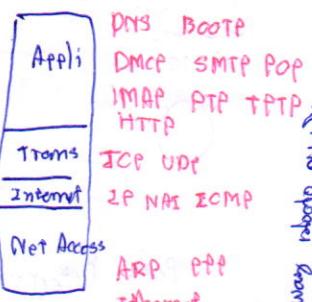
1. Phys Dia - ขนาดเล็ก, จำกัดวง

2. Logical Dia - ขนาด NW อยู่  
ใน IP test connection

OSI

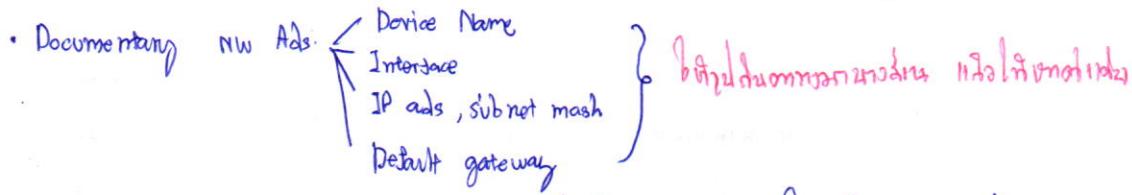


TCP/IP

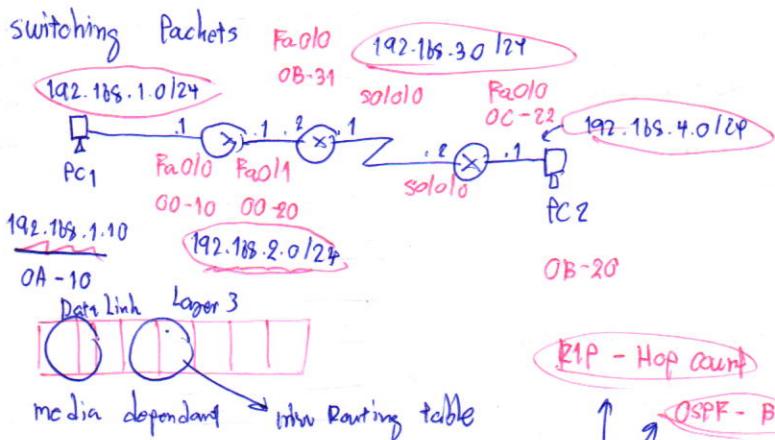


1. Broadcast frame
2. Fast
  - Switching
  - Forwarding
3. CDP - lookup, trigger

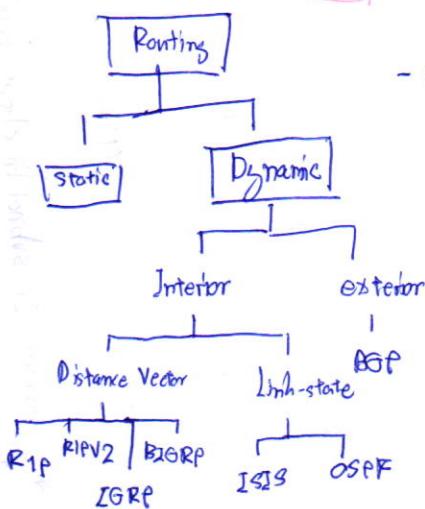
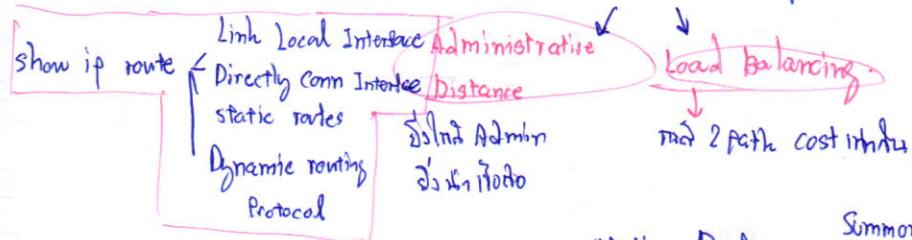




- Enable IP : 1. statically → Manual - Hosts/Ip, subnet in Internet profile  
Identify NW resource, NW config
- 2. Dynamically : Auto - via DHCP distributions



- Path Determination : cost-metric → *Distanzmautriktion*



static Route Summarize group routing entries

Create & backup route with sub NW summarization

- Connected to specific NW

- Type 1.) standard

- do cmd summarization

2.) Default

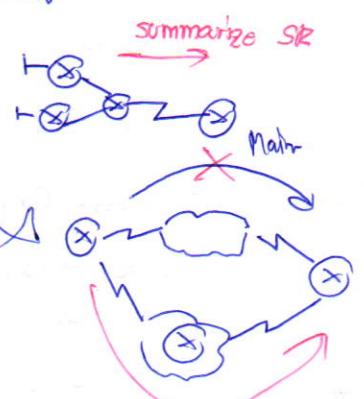
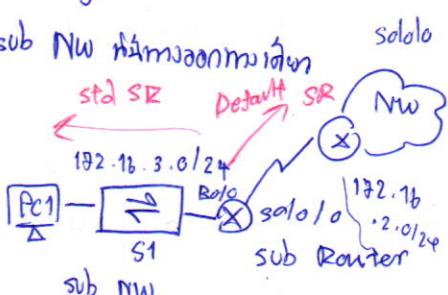
- do Router sum

3.) Summary

- entry summarization

4.) Floating

- do route and Backup link into link when failure



#### • Network Adsing

► classful Routing - one class number

► classless Routing - do subnet Adver

for Staples

### Distance Vector Routing Protocol

- 
- Function
    - nfb Info min
    - update  $\oplus$  table on topology change
    - find best path to destination

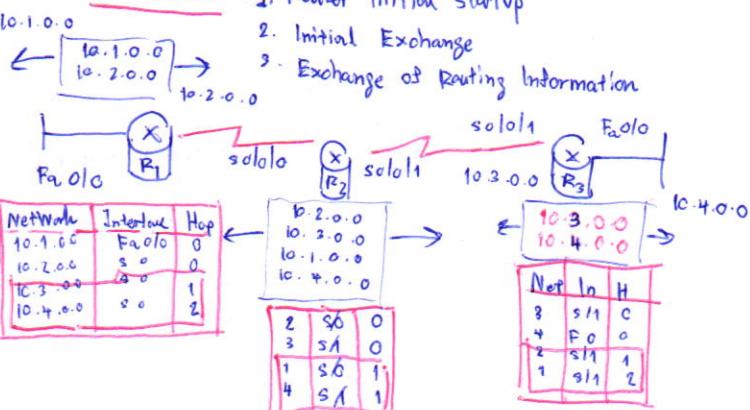
- Components
  - Algorithm, Routing Protocol Message
- Interior gateway Protocol

- Distance Vector
  - distance & direction
  - incomplete topology
  - Periodic update
- Link state
  - complete NW topology
  - not periodic update

- Convergence
  - state of NW immediately after down  $\rightarrow$  ต้อง update routing table ที่ router ที่สูญเสีย
  - router ผู้ให้บริการ information ที่ NW ที่สูญเสียไปลงที่哪儿
  - metric - metric (how much) des NW ที่ best path < Hop count - RIP
  - Load Balancing - ลองมาหัด ms 2 math Cost หรือ ห้าม NW ไม่ต้อง > 1 path
  - Administrative Distance - ต้อง protocol ที่ add ที่ Routing มาก

- Distance Vector
  - router ที่ Distance Vector / direction
  - characteristic - periodic update, neighbors, broadcast update, entire routing table

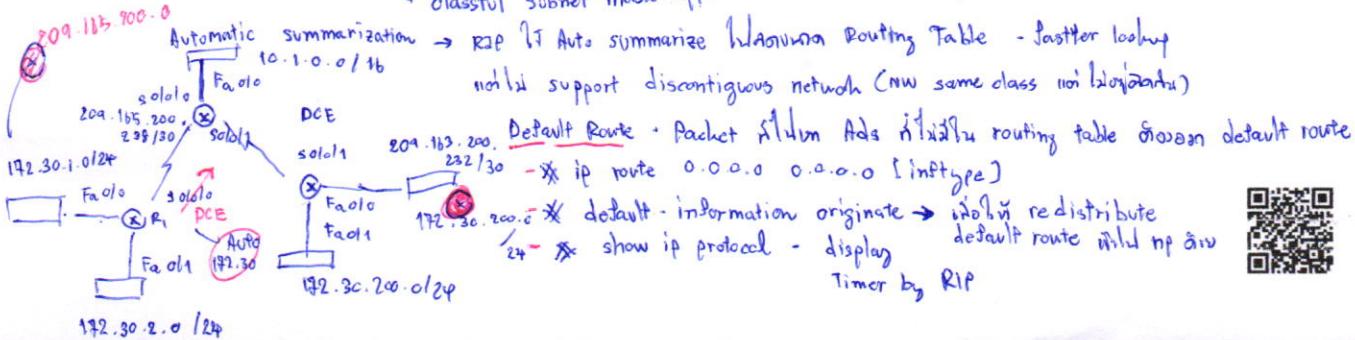
- NW Discover
  - 1. Router Initial startup



- RIP1** Characteristic
- classful, distance vector  $\rightarrow$  Not send subnet mask
  - metric as hop count
  - hop count > 15  $\rightarrow$  Unreachable
  - broadcast every 30s
  - can Auto Summarize

- Rule ① Routing update in Interface received on some NW
- subnet mask applied to the NW on the routing update

- ② if difference NW
- classful subnet mask applied to the NW in Routing update



- Purpose
  - remote NW

- maintain up-to-date
- find best path
- minimize bandwidth consumption

### Classifying $\oplus$ protocol

- Classful
  - 256 class ที่ต้อง Update ทุก class
  - ที่สูญ NW ที่ Mask ที่ต้อง routing
  - ที่สูญ subnet Mask ที่ต้อง update
- classless
  - ที่สูญ VLSM ที่ต้อง Mask ที่ต้อง classless class

in AD	Connected static	0
EIGRP	1	
BGP	20	
Int EIGRP	90	
OSPF	100	
RIP	110	
IS-IS	120	
Ext EIGRP	115	
Int BGP	170	
	200	

### Periodic Time Update

- RIP update Timer

Default : 30s

Invalid : 180s (ถ้าต้อง R ไม่ถูก)

Holddown : 180s (ถ้าต้องเดินทาง invalid นั้น)

Flush : 240s (ต้องตั้งไว้ 240s)

- Bound update : EIGRP

- Triggered  $\rightarrow$  information ใหม่ update แรก

- Random jitter  $\rightarrow$  multiple Access

② 192.168.8.0/24 [120/2] via 192.168.2.2, 00:00:23, 5/0



Automatic summarization  $\rightarrow$  RIP ที่ Auto summarize หลังจาก Routing Table - faster lookup

support discontiguous network (NW same class ไม่ติดต่อ)

Default Route + Packet filter Ads ที่ต้อง routing table ฝ่ายละ default route

ip route 0.0.0.0 0.0.0.0 [intf-type]

\* default-information originate  $\rightarrow$  นำออก redistribute default route ที่ต้อง config

\* show ip protocol - display default route ที่ต้อง config

Timer by RIP



RIPv2	RIPv1		Similar (IGP)
<ul style="list-style-type: none"> <li>- classful - update 1 hop Address</li> <li>- 1 hop support Discontiguous subnet</li> <li>- 1 hop support VLSM (in case) + C2DR</li> <li>- 1 hop, subnet mask routing update</li> <li>- update 1 hop broadcast</li> </ul> <p>BW = <math>10^8</math></p>	<ul style="list-style-type: none"> <li>- classless - update many subnet</li> <li>- Next hop ads for update</li> <li>- update many multicast</li> <li>- Authentication</li> <li>- support VLSM + Route Summarization</li> <li>+ Auto summary</li> <li>- Auto boundary - major class NW</li> </ul>		<ul style="list-style-type: none"> <li>- int routing loop detection timer</li> <li>- If split horizon via poison reverse</li> <li>- triggered update</li> <li>- max hop count = 15</li> </ul>

Default Route: ip route 0.0.0.0 0.0.0.0 [loopback] N

## Dynamic Host Configuration Protocol

- find IP Address → subnet Mask / Default Gateway / DNS (client & server)
- Protocol ↑
- method
  1. Manual Allocation - Set in CTRL Panel / cmd
  2. Automatic Allocation - Fix IP Information
  3. Dynamic Allocation - from IP pool & from DHCP server
    1. DHCP Discover - client to request 1st to DHCP server → Broadcast
    2. DHCP OFFER - server to Assigned IP Address to client → Unicast
    3. DHCP REQUEST → Accept IP Address from Server → Broadcast [no detail]
    4. DHCP ACK → 2. Ack from client → unicast

## Configure DHCP v4 server

- \* ip dhcp excluded-address 192.168.10.1 192.168.10.9 → ip range reserved
- \* ip dhcp pool LAN-Pool-1 192.168.10.2-54 → Default Gateway
- \* network 192.168.10.0 255.255.255.0
- \* default-router 192.168.10.1
- \* dns-server 192.168.11.5
- \* domain-name ex.com } optional
- \* and

mask subnet		
/21	255.255.255.254	- Not Valid
/30		852
/25		198
/24	- 255.255.255.0	
/23		... .252.0
/8	255.0.0.0	

## Subnet Planning \* for NW address IP host range / SubNet

- \* Network 161.246.6.0 /23
  - ip Ads 161.246.6.0
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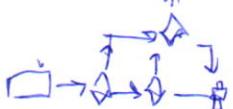
## Access control list

### → main wildcard Mask

1. 192.168.1.65, 67, 69, 127

Sol  
• 65 : 0100 0001  
• 67 : 0100 0001  
• 127 : 0111 1111  
    01 xx xx 1  
    0011 1110

Ans | 192.168.1.65 0.0.0.62 |



A. wildcard Mask

- Invert of subnet Mask

→ 192.168.1.0 255.255.255.0

WC: 192.168.1.0 0.0.0.255

② 192.168.64.x - 192.168.191.x

(x is odd) - 0 or 2 units

Sol  
192.168.01000000.x  
192.168.01000001.x  
192.168.01111111.x

192.168.64.1 0.0.63.254 → ①

192.168.10000000.x  
192.168.10111111.x

192.168.128.1 0.0.63.254 → ②

ชื่อ-สกุล นายจตุรัส ใจดี

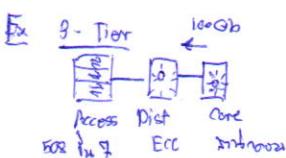
กระดาษแผ่นที่ 4 รหัสนักศึกษา

for Staples

## Basic switch Network

- LAN Design - based on Admin and policy
  - Borderless switch nw design
    - Hierarchical - sub
    - Modularity - management
    - Resilience
    - Flexibility

	Port secure	Vlan	Fal/gig	PoE	Link Aggregation	Gos	Major 3 Support
Access	✓	✓	✓	✓	✓	✓	-
Distribution	ACL	-	10Gig	-	✓	✓	✓
Core	-	-	10Gig	-	✓	✓	✓



- Maximize LAN bandwidth
    - Placement of servers
    - Collision detection issues
    - Segmentation issues
    - Broadcast domain issues
  - Access [Core - SBS]
    - Point-to-point Modem
    - Bridging and Group Routing
    - Multilayer Bridges
    - Domain Issues

## Switch Operations

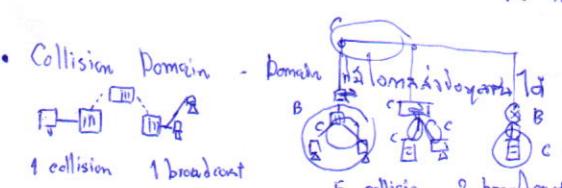
for Staples

1. learning - If switch doesn't see port in table, it does learn mac address frame with switch
  2. Aging - If switch learn the table entry for a long time, it will drop it after no port No. has Mac address → source mac  
for frame from source Mac address
  3. Flooding - If switch doesn't know port for source Mac address, it drops it. It then broadcasts to all ports and learns them
  4. Forwarding - According to SW filter table information, source Mac address is known
  5. Filtering - If frame source address is in the filter table, it is forwarded to the correct port

\* Transparent Bridge Process

  - Flood packet
  - ↑ yes
  - ↑ no
  - Receive frame → Learn source → BC, MC, Unknow UC → Source / Dest some Inf → Forward unicast to correct port
  - \* Forwarding methods - store-and-forward → if no CRC error then store forward

→ 1. Unknown Unicast  
→ 2. Broadcast MAC  
→ 3. Multicast MAC



## Basic switch Configuration

- IP information (address, subnet, gateway)
    - Config terminal
    - interface vlan 99
    - ip address 172.17.99.11 255.255.255.0
    - no shutdown
    - exit
    - ip default-gateway 172.17.99.1
  - Duplex communication → Config from TELNET
    - interface fastethernet 0/0
    - duplex full
    - speed 100
    - media auto
    - end
    - show mac-address

- security remote Access → SSH opr
- line vir 015 (datas No sh)
- transport input ssh
- login local

Violent

Mode	Forward traffic	Send syslog	Display error	Increase violation	sticky mac signature
strict	x	x	x	x	sudden port
restrict	x	✓	x	✓	
shutdown	x	x	x	✓	x x
Default	Port security: disable maximum: 1 Violation: shutdown				✓

• implement for  
var level

---

match level  
with

3-Tier : Core - Distribution - Access  
 2-Tier : Collapsed - Access  
 (Core + distribution)  
single Tier & missing Overlapped functionality

redundant component - ✓ ✓

- POE : power Ethernet infrastructure
- Fa|Gig : BW & support Link Aggregation - 722 Link BW increasing
- Redundant - 3302 switch 3rd.

The diagram illustrates a network architecture across three layers:

- Access Layer:** Represented by a box labeled "Access". It connects to a "CAT5 UTP" hub, which further connects to "H" (Host) and "S" (Switch) ports.
- Core Layer:** Represented by a box labeled "WAN" (Wide Area Network). It contains a "MDP" (Main Distribution Point) and a "VCO" (Virtual Cross Connect). The MDP is connected to the "S" port of the Access layer via an "Opticfiber" (Optical fiber) and to the VCO via a "Forward rate switch". The VCO is connected to the "H" port of the Access layer via another "Opticfiber" and to an "IDF" (Intermediate Distribution Facility).
- Distribution Layer:** Represented by a box labeled "IDF". It contains a "DF" (Distribution Facility) and a "Horizontal cross-connect". The DF is connected to the "H" port of the Core layer via an "Opticfiber" and to the "S" port of the Access layer via another "Opticfiber". The Horizontal cross-connect is also connected to the "S" port of the Access layer.

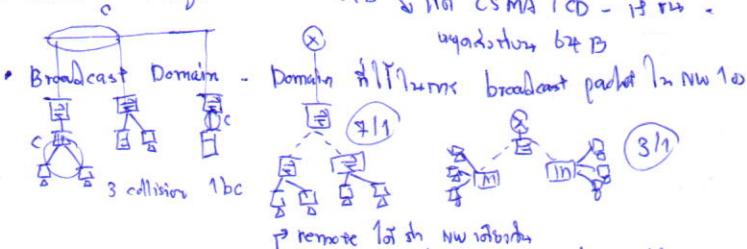
Annotations in the diagram include:

- "Main Distribution Facility" pointing to the MDP in the Core layer.
- "Forward rate switch" pointing to the connection between the MDP and the VCO.
- "Vertical cross-connect" pointing to the connection between the VCO and the Access layer.
- "Horizontal cross-connect" pointing to the connection between the IDF and the Access layer.
- "Intermediate Distribution Facility" pointing to the DF in the Distribution layer.
- "Distribution" pointing to the DF in the Distribution layer.

Handwritten notes at the bottom:

1. port & mac add 1 manuf not 1 Mac | 1 port works

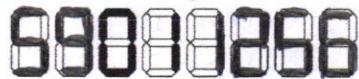
- 1. Unknow Unicast mac
- 2. Broadcast MAC
- 3. Multicast mac



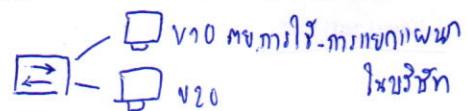
→ remote IoT sh NW ဂေါ်များ

mac 84 102000  
↑  
[mac - 84] 102000

- Addr Resolution Protocol
- Map IP to MAC Address via ARP cache (MAC address table)
  - Command: arp -a shows ARP cache Ex: 10.10.0.3 : 00-0d-56-09-9b-d1
  - ARP Request - ping (dest) request -> timeout
  - ARP Reply - Ping reply
- LAN Redundancy ensures no Design is Redundant
- Problem 1. Mac database instability - mac table does learning loop
  - Problem 2. Broadcast storm - from multiple sources to switch
  - Problem 3. Multi frame trans - multiple Dest for frame not on SW fabric frame info
- Spanning Tree protocol !! no Redundancy in NW → block non port in SW mesh
- Only one logical path - block port for maintaining topology
  - Bridge protocol Data Unit (BPDU) maintains port status for loop
  - Port Role
    - ① Root bridge - designation "1 RB/NW"
    - finds own position relative to root → in BPDU includes
      - own Bridge ID: 2 bytes
        - Priority → lower Mac priority
        - MAC Addr - Minimum SPT
      - Cost from > Root
    - ② Root port - 1 RP / Non RB
      - this port is the closest to root port of 1st
    - ③ Designated port - 1 DSN / segment (two LAN interfaces - non root port)
    - ④ Non-Designated Port - 1 block port forward
    - ⑤ Alternative / Backup port
- Spanning Tree Algo
- Cost (ing "Bridge ID")
  - Bridge Sender including "source Port ID" in BPDU
- SPT Characteristic
- | Protocol             | Standard     | Resource needed | Convergence | Tree calculation |
|----------------------|--------------|-----------------|-------------|------------------|
| STP                  | 802.1D       | Low             | slow        | All VLANs        |
| RSTP                 | Cisco        | H               | S           | Per VLANs        |
| <del>Rapid STP</del> | 802.1W       | Med             | Fast        | All VLANs        |
| Rapid PVST+          | Cisco        | Very High       | Fast        | Per VLANs        |
| MSTP                 | 802.1S Cisco | med or H        | F           | Per Instance     |
- Config
- S1 (Config) \* Spanning-tree VLAN 1 root primary
- 
- secondary
- \* sh spanning-tree active.
- V2AN 1 priority 24576
- PVST + Load Balancing: spans across VLAN
  - Spanning-tree VLAN 10 priority 4096
  - Rapid PVST+: supports RSTP on per-VLAN basis
  - int [int\_id] mode rapid ~~switch~~-port
    - ↳ link-type point-to-point
  - Troubleshooting
    - Tracert hangs
    - remove redundant when failure
    - Problem
      1. Default gateway limitation
      2. Redundancy
      3. Failure
- \* Initiates local ARP cache miss
- Route Lookup Hierachy - IP lookup → individual
- Ultimate Route - next hop
  - L1: NW Route, Supernet Route, Default Route
  - L2: Parent Route [Group in L1 Route]
- L1 Route
- 
- Next-hop IP Addr and/or exit interface
- Best Match
- L1 ult
    - forward
  - L1 parent
    - examine child routes (subnet)
  - L2 child
    - forward
  - Not match in L2
    - search in supernet / default (R)
  - Not Match any
    - drop
- First-Hop Redundancy Protocol

chapter 9 VLANs & Inter VLAN

- VLANs (Virtual LAN) - เครือข่ายที่อยู่บน Physical เติบโต成 แบ่ง成 logical group
  - แต่ละ VLAN เป็น broadcast domain ของ IP Subnet ที่เดียวกัน
  - ต้องมี switch ต่อเข้ากัน ไม่สามารถ VLAN ต่างๆ ที่เดียวกัน

Benefits

- Improve Security
- Reduce Cost - ลดต้นทุนของการซื้อ switch จำนวนมาก [Up to NW Topo Scale]
- Better Performance
- Smaller Broadcast Domain
- Efficiency
- Management Efficiency

Trunk

- ใช้ switch ที่ VLAN เดียว ก็สามารถส่ง data ระหว่าง switch หลายตัวได้
- การแท็ก Tagging - ตรวจสอบ VLAN ไหนใน Link ใดๆ
- config as trunk ที่ port ต้องมาใน range ของ VLAN
- switch flood เฉพาะ VLAN ที่ trunk ที่ broadcast flood all

TrunkNative VLANAssignmentSummaryInter VLANChapter 10

- VTP - จัดการ VLAN ที่ต้องการ ที่จะยังคง อยู่ใน domain เดียวกัน
- ใช้งานกับ Cisco Switch เท่านั้น

- Benefit
- consistently maintain VLAN access a common admin domain
  - VTP is running and has certain default already config

operation จัดการ VLAN และ trunk ต่างๆ

- Parameter VTP config revision no. - 8 bit
- switch จะทำงานตาม domain ที่ VTP config
- 3 mode - serves
 

client	✓	✓	✓
transparent	✓	✗	✗
	✗	✓	✓

source VTP msg Listen to VTP msg Create and remember VLAN.

Configuration สามารถ manage VLAN via trunk, ไม่ว่า Domain

จะ 2 mode, VLAN db config

Verify - show vte status

- VTP Pruning - an bandwidth ที่ต้องการของ trunk
- ↳ an traffic

- Default - disable

- no config

(VLAN db) - vte pruning

(Conf t) - int (int\_if)

- switchport trunk pruning VLAN remove VLANid



## NAT - Network Address Translation

- translates IP address IP an route the private IP to public
- NAT → retains IP or route pub net private

Characteristic - Terminology - Inside NW : device has private IP

- Outside NW : No warranty

- Type of address
  - 1. Inside Local Address
  - 2. Inside Global Address
  - 3. Outside Local
  - 4. Outside Global

### Type of NAT

#### static NAT

- Map private IP to put into fixed IP
- Server in inside can access from outside
- SSH 터미널  
Inside local → In Global

$$192.168.10.10 \rightarrow 209.165.200.226$$

#### Dynamic NAT

- Public can map multi-IP to private
- Map by one-to-many, run by one-to-one
- inside-local → In Global
- $192.168.10.12 \rightarrow 209.165.200.226-230$
- PAT - Port Address translation
  - map IP-port number IP-IP 헤더에 번호를 넣어줌
  - map multiple private IPv4 to single pub IPv4
  - dynamic NAT overload

verify NAT : show ip nat  
translation  
statistics

to-end (③)

## Benefit and disadvantage

- Benefit
  - conserve the legally registered address scheme
  - and flexible IP numbering for pub NW
  - for many devices, no internal NW address
  - Nat security

## disadvantage ↑

- Downgrade Performance end-to-end function
- End-to-End IP traceability lost
- IP tunneling implementation
- Initiating TCP connection

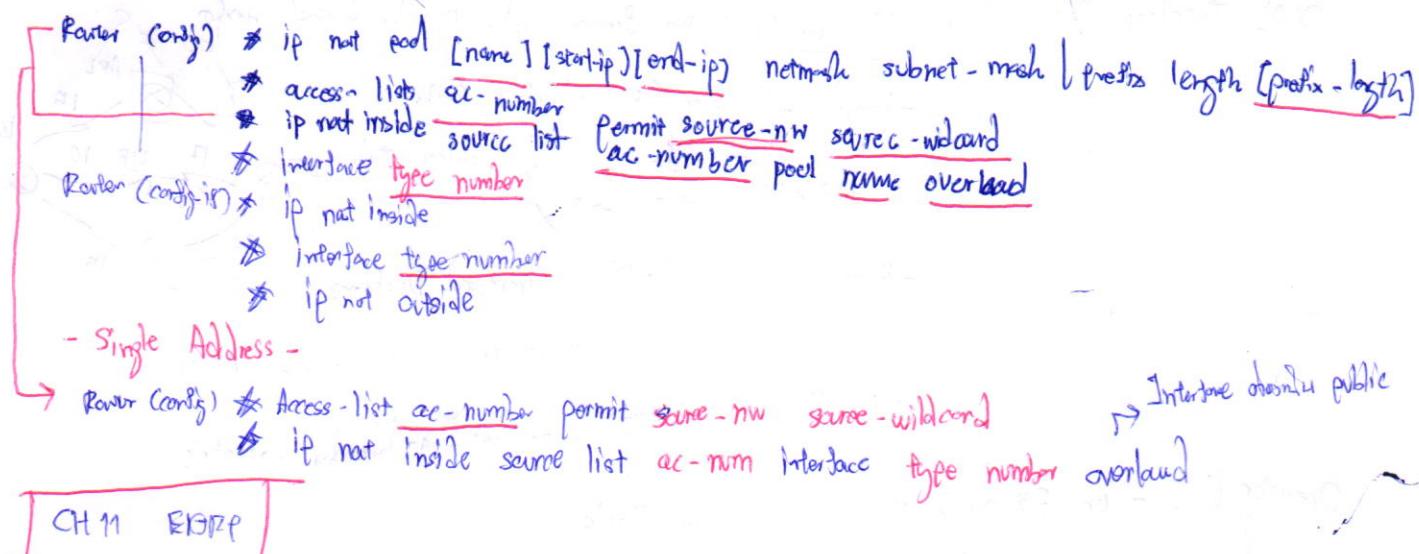
## Config - Static NAT

- ```
(conf +) ip nat inside source static  
    int (int type) → inside int  
    ip not inside  
    exit  
    int (type) → outside int  
    ip nat outside
```

## Dynamic NAT

- ```
(conf +) ip nat pool name start-ip end-ip  
    network subnet ! prefix-length pre-length  
    access-list number permit source-NW  
        source-wildcard  
    ip nat inside source list number (access-list)  
        pool name  
    int (type)  
    ip net inside  
    int (type)  
    ip net outside
```

## Configuring PAT - a.k.a NAT overloading



### CH 11 EIGRP

#### EIGRP - Enhanced IGRP บริหาร OSPF

##### - Feature

- \* DUAL < Dual routing algo
- \* Establishing Neighbor Adjacencies < Directly connected routers
- \* reliable transport protocol < Dual delivery packets
- \* Partial & Bounded Update < Triggered when Path / metric change
- \* Load Balancing → cost minimized BW

##### Default

$l_1(BW) = 1$   
 $l_2(Load) = 0$   
 $l_3(Delay) = 1$   
 $l_4(Reliability) = 0$   
 $l_5 = C_R$

##### EPM (Protocol-Dependent Modules)

↳ maintain neighbor & topology table  
 Computing metric using DUAL  
 Implementing DUAL & routing table  
 Performing filtering and ACL  
 w/ other routing protocol

Support many protocol others

Neighbor Table : Next-Hop Router → Interface

Topology Table : Des 1 → Successor

Routing Table : Des 1 → 2 → Feasible Successor Successor

##### - by RTP Layer 3 packet : Update, Query, Reply, Hello, Ack

→ Hello : msg @ Intf → Intf Topology  
 Update : msg @ Intf Topology  
 Ack : information w/ des  
 Query : update info down  
 Reply : no query info

##### Config

##### - Autonomous system (AS) - Group of AS information [16 bits : 65535]

- Managing route in AS only

##### - Config : Router(config)

Router eigrp As \* Not Auto system

but process ID of routing domain

\* network net mask interface type number [default]

\* Possible - Interface type number [default]

(admin OSPF 1 or 2 + cumulative)

Verify : show ip eigrp neighbor

##### Metric

- weight cost bandwidth

BW : BW จำกัดวงจร

Policy : Cumulative interface delay - ต่อเนื่อง

- Reliability, Load

- Config : Router (config-router) & metric weight for  $l_1, l_2, l_3, l_4$

- BW : Router (config-if) & bandwidth kilobits bw value

- Policy : 80% min bandwidth packet bandwidth Source



## Metric calculating

- BW ( $10,000,000 / \text{BW}$ )  $\rightarrow (BW + Delay) \times 256 = \text{"metric"}$
- Delay (sum of Delay / 10)

## DUAL Topology Table - Term

- Successor (S): iden forward link to neighbor if cost Haven

- Feasible Successor (FS) - Backup Paths

$\left[ \begin{array}{l} \text{2x10} \\ \text{1x10} \end{array} \right] \text{Advertised Distance} \leq \text{Actual Distance} \rightarrow \text{Successor}$

- Reported Distance (RD) - Advertised Distance

- in report from Neighbor Router

- Feasible Distance (FD) - the Cost to a Link  $\rightarrow$  metric

## Operator

- in FS dual topology Table

- Sockit Up date in Routing

$192.168.1.0/24 [90 / 3012096] \text{ via } 192.168.10.10$   
00:12:32, Serial 0/0/1

$\downarrow FD$

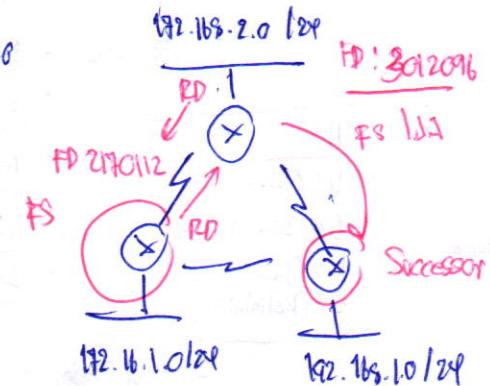
$\downarrow S$

## - Verify

: show ip eigrp topology

then Display or show (Cost/RD)

- Only Successor  $\rightarrow$  If  $\oplus$  table
- Passive state  $\rightarrow$  stable state & available for use
- Active state  $\rightarrow$  recomputed by DUAL



- Successor fail, no FSs

PtAL  $\rightarrow$  active state, active query

if neighbor for a new Successor

- Special Commands

- Redis (OSPF - static) -- classless redistribute connected subnets

- Redistribute (OSPF - RIP)

Router RIP

redis ospf process-id metric metric-no

router OSPF

redis rip subnets

- rip + static

default-information originate

