ชื่อ-สกุล วริยา สายสม กระดาษแผ่นที่ 1 รหัสนักศึกษา 68080202

for Staples

Chapter 1 Network Overview

- device - end device
  - intermediate device
  - media
- diagram - physical การเดินสาย
  - logical ตัวโล
- representation: end device, hub, switch (L2), router (L3), wireless, LAN (single admin area), WAN
- size - small home
  - small office / home office (remote)
  - medium to large
  - world wide (Internet)
- reliable - fault tolerance
  - scalability
  - security
  - quality of service

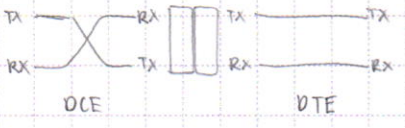
network engineer
- implement
- maintainance
- trouble shooting

	name system	host config	email	file transfer	web	PDU
Application	DNS	BOOTP, DHCP	SMTP, POP, IMAP	FTP, TFTP (to transfer via command)	HTTP	data
Transport	UDP	TCP				segment
Internet	IP	ip support	routing protocol			packet
	NAT	ICMP	OSPF	EIGRP		
Network access	ARP	PPP	Ethernet	Interface Driver		frame

ออกนอกวงจาก HDLC แต่ไม่ใช้ MAC

boardcast MAC address : FF-FF-FF-FF-FF-FF
* ที่ออกนอก network Dest. MAC เป็น default gateway
boardcast IP : 255.255.255.255

- network media 1,2×3,6
  - LAN - straight-trough A-A, B-B
  - crossover A-B
  - WAN



- rollover (สาย console)

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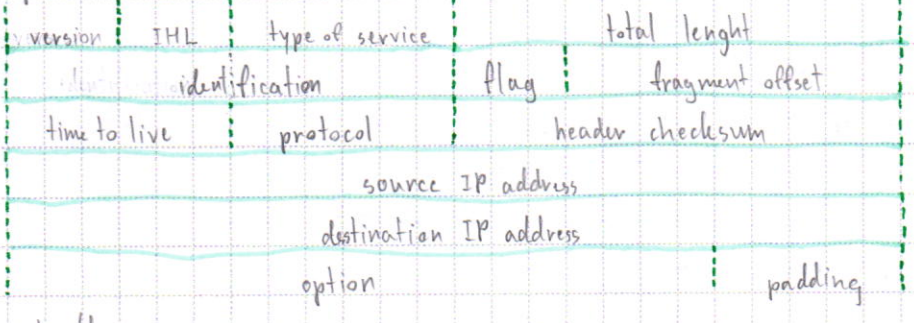
Chapter 2 Basic Router Configuration

- port address - well known
  - registered
  - dynamic / private
- logical address : IP address each node : unique ip (real, public ip)
  - class A (0), B (10), C (110), D (1110)
  - private addressing : 10.0.0.0/8 , 172.16.0.0/12, 192.168.0.0/16
  - IP packet header



8 bytes แรกมีไว้ organizationally unique identifier

- physical address
  - message delivery - unicast unique
    - multicast
    - boardcast DHCP & ARP

- CISCO IOS - operating system
  - purpose : CLI-based network program
  - function : security, routing, QoS, addressing managing resource, interface
  - mode : user EXEC (view), privileged EXEC, global config

shell UI
kernell
hardware

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Chapter 3 Static Routing & Dynamic Routing Protocol

Routing Concept

- function of router
  - best path
  - forwarding
    - process switching
    - fast switching
    - Cisco Express forwarding (CEF)
  - mechanism
- CPU : execute OS instruction
- RAM : routing table
- ROM : router bootstrap program
- NVRAM : startup config & IP address
- flash memory : operating system
- interface

- boot-up process
  - test hardware
  - locate & load CISCO IOS software
  - locate & load startup config & enter setup mode

POST → ROM
Bootstrap → ROM
Cisco IOS → Flash, TFTP server
config → NVRAM, TFTP server, console

- connect device
  - default gateway (need to connect other network)
  - IP on host : statically, dynamically (ต้องมีตัวแจก IP (DHCP))
- switching packet between network

packet arrives on interface → router search routing table for match → dest IP match subnet of
- directly (yes) → check ARP cache and forward
- (no) remote network (manually / dynamically) (yes) → encap & forward to next hop
- (no) default (yes) → encap & forward to next hop
- (no) drop

- path determination
  - best path : dynamic routing protocol use routing information protocol (hop count) RIP 120, open shortest path first (bandwidth) OSPF 110, EIGRP 90 ~ enhanced interior gateway routing protocol (bandwidth, delay, load, reliability)
  - load balancing
  - administrative distance (AD)
- routing table (connected route, remote route, next hop)
  - source : link local interface (interface configured), directly connected interface (interface active), static route (manually configured & interface active), dynamic routing protocol EIGRP or OSPF implemented (no shutdown)

learned by	dest. network	AD	metric cost	next hop address	outgoing
ไอคอน → D	10.1.1.0/24	[90 / 2170112]	via	209.165.200.226 (1 or 2)	00:00:05, Serial 0/0/0

- routing
  - static
    - standard command ที่ 1 : ip route network-address subnet-mask {ip-address | exit-intf}
    - default
    - summary รวมเน็ต 1 อัน
    - floating back up link
  - dynamic routing protocol
    - exterior BGP
    - interior RIP, OSPF, EIGRP, IS-IS (intermediate system-to-intermediate system)
      - classful ส่งแค่ class ไม่ส่ง subnet
      - classless inter-domain routing (Efficient!)
        - CIDR (summarized)
        - VLSM /24 → /27

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Chapter 4 Distance Vector Routing Protocol RIP v.1

Dynamic Routing Protocol
- function : dynamically share information, auto update routing table, determine best path (หน้าที่หลัก)
- purpose : discover remote network, maintaining, choosing best path
- component : algorithm & routing protocol message

→ exterior gateway - BGP (autonomous system เชื่อมต่อกัน)
→ interior gateway
- distance vector: RIP, IGRP → RIP v.2, OIGRP (distance & direction, periodic update, broadcast, entire table)
- link-state: OSPF, IS-IS (complete view)

convergence คือ เวลาที่ routing table ของ router ทุกตัว consistency!
metric คือ ค่าที่ใช้เลือกหา best path : RIP hop count, OSPF bandwidth, cost, delay, load, reliability, IGRP
load balancing คือ distribute packet among multiple same cost paths

to compare : time to convergence, scalability, resource usage, implementation & maintenance

Interior Gateway Protocol (IGP)
RIP periodic, EIGRP bounded, triggered, multi access random jitter

* distance vector routing protocol — slow convergence, maintenance, routing loop → count to infinity
  - setting a maximum
  - holddown timer
  - split horizon rule (invalid 180s, holddown 180s, flush 240s)
  - route poisoning
  - split h with poison reverse
  - IP & TTL ไม่ update ค่า TTL=0

- RIP v.1 • characteristic = classful, metric : hop count, unreachable > 15, broadcast update 30s
  • message format (transport layer)

0	7 8	15 16	23 24	31
command (1 - request, 2 - reply)	version	must be zero		
address family identifier (IP=2)		route tag v2	must be zero	
IP address (network address)				
must be zero		subnet mask v2		
must be zero		next hop v2		
metric				

route entry max of 25

basic config
router rip
network 192.168.1.0
network 10.0.0.0
→ show ip protocols
debug ip rip

administrative distance
• AD = 120

& boundary router

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verification & troubleshooting • passive interface command passive-interface fa0/1
auto summarization : classful → not support discontinuous network (same network)
• processing RIP update • same network : update subnet
• different network : update classful
(ลดขนาด : summarization)

default route ip route 0.0.0.0 0.0.0.0 s0/1/0 ต้องมี default-information originate

classless, multicast update, มี subnet mask, VLSM, included next hop

Chapter 5 RIP v2 Access Control List (message format)

	รับ	ส่ง
RIP v1	1, 2	2
RIP v2	2	2

RIP v2 • configuring : router rip \n version 2
• auto-summary ถ้าจะ no ต้องไม่ discontinuous

inbound / outbound logic acl ก่อน/หลัง ดู routing table

Access Control List (ACL) ทางออกเริ่มจาก seq, last statement = implicit deny
- standard ACL (1-99, 1300-1999) : check source หรือดู destination
- extended ACL (100-199, 2000-2699) : check source & destination หรือดู source, specific protocol

wildcard mask invert ของ subnet mask
0 : fixed bit all → host
1 : อะไรก็ได้ all → any

ทางออก firewall ใน network

• guideline for ACL creation : 3 Ps - one per protocol
- one per direction
- one per interface

• config standard IPv4 ACL : access-list เลข deny | permit | remark (comment) "source" source address wildcard
- applying : เข้า interface ip access-group เลข in | out

securing VTY port with standard : (config-line)# access-class เลข in [vrf-also] | out

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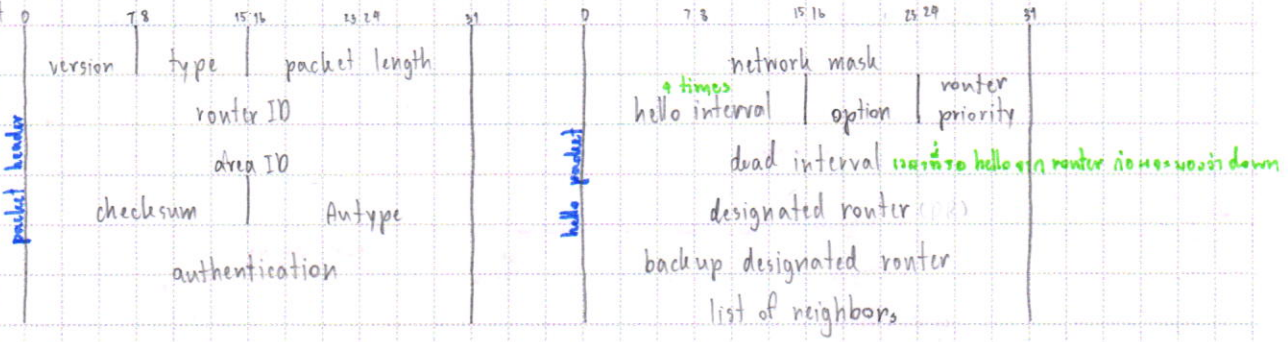
• extended ACL filter on source addr., destination addr., protocol, port number
access-list เลข deny | permit | remark protocol source [wildcard] [operator operand] [port number] (สร้างการเชื่อมต่อ)
destination [wildcard] [operator] [port] [established]

debug ip packet เลข

Chapter 6 OSPF & DHCP

Link-State Routing Protocol - complete map of network topology
- link & link-state - use link-state information or link-state packet (LSP) ⊕ send only changes
- say hello - work best on hierarchical (⊕ multi area) large networks, fast convergence (⊕) crucial, admin good knowledge
- building LSP - dijkstra's algorithm calculate best path (SPF)
- flooding & building database (⊖ bw) (⊖ processing)
- building SPF tree & routing table (⊖ memory)

OSPF : AD=110
- data structure → database : adjacency (neighbor), link-state (topology), forwarding (routing table)
- message format



type - 1 hello every 10s multiaccess & point-to-point network
- 2 database description (DBD)
- 3 link-state request (LSR)
- 4 link-state update (LSU) contain 1 or more LSAs (contain route info) → type
- 5 link-state acknowledgment (LSAck)

1 router LSAs
2 network LSAs
3,4 summary LSAs
5 autonomous system external LSAs
6 multicast OSPF LSAs
7 defined for not-so-stubby areas
8 external attributes LSA for BGP
9,10,11 opaque LSAs

- operation: down state → init state → two-way state → exstrat state → exchange state → loading state → full state
  - create adjacency w/ neighbor
  - exchange routing info
  - calculate best path
  - reach convergence
  - process while attempting to reach convergena
- configuring single area - router ospf process-id (between 1-65535 & locally unique) ≠ clear ip ospf process
  - router-id 1.1.1.1
  - network network-address wildcard area area-id (0)
- cost = reference BW (10^8 bps) / interface BW : auto-cost reference-bandwidth BW-mbps
  in interface : bandwidth ? Kbps or ip ospf cost ___

redistribute ? (permit/deny) bgp, connected, ospf, eigrp, static, rip, metric

DHCP dynamic host configuration protocol : automatic IP addressing to client
- manual allocation admin assign
- automatic allocation auto assign permanently
- ★ dynamic allocation dynamically assign, lease in period

- operation

Server	Client
DHCPoffer →	← DHCPdiscover
DHCPack →	← DHCPrequest

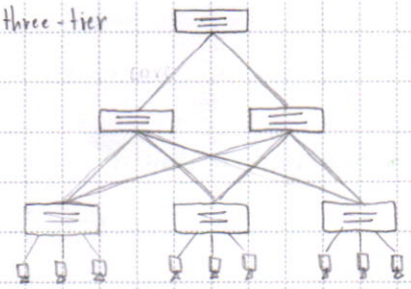
- configuring : ip dhcp excluded-address 192.168.10.1 192.168.10.9
  ip dhcp pool name
  network network-address subnet-mask
  default-router default-gateway
  dns-server ___ } optional
  domain-name ___ }

≠ no service dhcp <disable>

Chapter 7 Basic Switch Address Resolution Protocol

LAN Design in borderless switched network architecture that allow organization to connect everyone

- three-tier



core layer : very high forwarding rate, redundant

distribution layer : high forwarding rate, redundant, ACL (backup หากอัน ระยะทาง)

access layer : port security, VLANs, Fa/G, power over ethernet (optional)

all of layer can link aggregation, quality of service (QoS)

- consideration
  - cost
  - port speed
  - port density
  - frame buffer
  - power
  - scalability
  - reliability
- wiring building
  - function : enterprise server & workgroup server (MDF) (nearest IDF)
  - collision detection
  - segmentation split collision domain
  - broadcast domain ควรขนาดเล็ก เพื่อลด traffic

MDF : main distribution facility
IDF : intermediate distribution facility
VCC : vertical cross-connect
HCC : horizontal cross-connect (เชื่อมกับ access ผ่าน patch panel)

Switch Environment

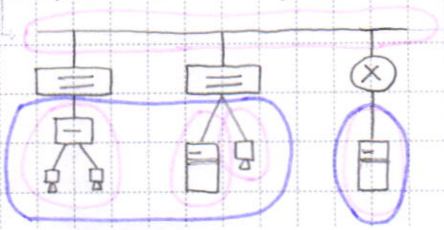
- operation
  - learning learn MAC address (source) ใน frame เพื่อสร้าง MAC/CAM table (content address memory)
  - aging reset aging ของ MAC address ใน table เมื่อ clear ไม่ใช้ memory เดิม
  - flooding ส่งออกทุก port ถ้าเป็น broadcast, multicast, unknown unicast (ไม่มีใน table)
  - forwarding ส่งออกตาม MAC table
  - filtering filtering frame ที่อยู่ port เดียวกัน
- transparent bridge process

receive frame
↓
learn source address or refresh aging timer
↓
destination เป็น broadcast, multicast, unknown unicast ? yes → flood packet
↓ no
source และ destination อยู่ใน interface เดียวกัน ? yes → filter packet
↓ no
forwarding unicast to correct port

- method frame forwarding
  - store-and-forward switching
    - check for error
    - automatic buffering
  - cut-through switching ~ 10 ms (mode)
    - fast-forwarding ~ 12 Bytes
    - fragment-free ~ 64 Bytes (CSMA/CD)

frame ยาวสูงสุด ~ 1500 Bytes

- collision domain : segment where devices must compete to communicate
  - all ports of a hub belong to the same collision domain
  - every port of a switch is a collision domain on its own (break to smaller)
- broadcast domain : extend of the network where a broadcast frame can be heard
  - all ports of a switch belong to same broadcast domain (ส่งออกทุก port)



5 collision domain
2 broadcast domain

locate & load default IOS into memory & hand control over to IOS

- basic switch configuration — boot environment variable, top-bottom search executable flash file system, init interface via config NVRAM
  - switch boot sequence : POST → run boot loader software → do low-lvl CPU initialization → init flash filesystem
  - preparing for basic switch management
  - configure switch port - duplex communication full & half
    - auto-MDIX ทำงานกับ physical ได้ทั้งคู่
- security remote access : secure shell (SSH) port 22 strong encryption feature
  - config - เปลี่ยน hostname
    - ip domain-name ____
    - crypto key generate rsa
    - username admin password ccna
    - line vty 0 15
    - transport input ssh
    - login local

show ip ssh or show ssh

- switch port security
  - operation : secure MAC address type
    - static manually config switchport port-security mac-address MAC
    - dynamic dynamically learn & store switchport port-security mac-address sticky
    - sticky dynamically learn & manually config then store & add to running config

interface configuration

  - violation mode
    - MAC table เต็ม แล้วมีอีกเครื่องพยายามเข้ามา
    - addr. learned on one secure interface is seen on another in same VLAN

mode	forward	send syslog	counter	shutdown port	
Protect	x	x	x	x	
Restrict	x	✓	✓	x	
Shutdown	x	x	✓	✓	default

Address Resolution Protocol (ARP) mapping IP to MAC address

IPv4 subnetting

- Classless Inter-Domain Routing (CIDR)
  - fixed length 192.168.1.0/24 ⟶ /27 3 bit หน่วงไว้ 8 ห้อง
  - variable length แบ่งตามจำนวนที่ใช้จริง

	RIPv1	RIPv2	IGRP	EIGRP
convergence	slow	slow	slow	fast
scalability	S	S	S	L
VLSM	x	✓	x	✓
resource usage	low	low	low	medium
implementing & maintenance	simple	simple	simple	complex

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Chapter 8 : LAN Redundancy : Spanning Tree Protocol

Issues : MAC database instability , broadcast storm , multiple frame transmission (unknown unicast)

Spanning Tree Protocol logically blocking paths that cause a loop ~ bridge protocol data unit (BPDU)

- 1 root bridge per network
- 1 root port per non-root bridge
- 1 designated port per segment

→ Operation ① Root Bridge ดูจาก bridge ID ที่น้อยที่สุด BID = priority, MAC address

② Path Cost ค่าเท่ากันดู sender → port number

- port ที่ cost ไป RB น้อยสุด = Root Port
- ใน segment หนึ่ง designated port
- ที่เหลือ block

⊕ extended system ID สำหรับการทำ load (vlan)

First-Hop Redundancy Protocol : layer 3

- default gateway limitation (IP, MAC)
- router redundancy : forwarding , virtual , standby

ex Hot Standby Router Protocol (HSRP)
Virtual Router Redundancy Protocol (VRRP)
Gateway Load Balancing Protocol (GLBP)
ICMP Router Discovery Protocol (IRDP)

varieties!

protocol	resource needed	convergence	tree calculation
STP	low	slow	all vlans
PVST+	high	slow	per vlan
RSTP (ไม่มี edge port, มี alternate port)	medium	fast	all vlans
Rapid PVST+	very high	fast	per vlan
MSTP (เชื่อม switch point-to-point)	medium high	fast	per instance

improve security, reduced cost, better performance, smaller broadcast domain, IT efficiency , management efficiency

Chapter 9 : Vlans & Inter Vlan

logical partition of layer 2 network

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★ trunk tagging 802.1q (IEEE) เวลาจะ vlan ไหน (vlan tags)

- native VLAN คือไม่มีการ tag คือ untag ใน trunk เร็วกว่า แต่ไม่ secure!

range - normal 1-1005 ใน flash (ISO) (vlan.dat)
- extended 1006-4096 ใน NVRAM (running-configs)

Inter Vlan Routing ~ subinterface on router

vlan trunking protocol

Chapter 10 : VTP & NAT ~ network address translation การแปลง private & public IP

VTP : messaging protocol to manage vlan on single domain & encapsulation IEEE 802.1q

- server : create, modify, delete
- client : listen & process changes คือสั่งอย่าง
- transparent : ทำงานเหมือนอันนี้ ไม่รับ domain แต่สั่งอันนี้ได้ (forward ignore info)

★ VTP Pruning : manage ใน traffic ไม่ให้ unnecessary flooding เช่น broadcast, multicast, unicast packet

NAT ใช้กับ stub network (มีทางออกทางเดียว)

- address - inside local (private)
  - inside global (real IP)
  - outside local } เหมือนกัน
  - outside global }
- type - static : one-to-one mapping
  - dynamic : pool of public address , first-come first-served
- port address translation NAT (PAT) : one-to-many

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