

• Network Device

- End Device (Computer)
- Intermediary Device switch, Router (Network, Security, Internetwork)
- Network Media, ~~WLAN~~ WLAN, LAN, WAN (Copper, Fiber, Wireless)

• Network Diagram

- Logic ของเน็ตเวิร์ก ว่า device อะไรเชื่อมกับอะไร
- Physical ของเน็ตเวิร์กจริงๆ

• Network Topology

- โหนดรับส่งข้อมูล, bus, ring, token...

• Network Protocol

- กฎเกณฑ์หรือวิธีการที่เครื่องคอมพิวเตอร์ใช้สื่อสารกัน
- IP net address

• Network Size

- LAN ใช้งานภายใน admin ใช้นี้หรือว่าส่งข้อมูลภายใน
- WAN LAN

• Network Layer

- data - Application : DNS, DHCP, HTTP → encode appli data
- net - Session : UDP, TCP → dest & source process num (port)
- pack - Network : IP/NET, ICMP, OSPF, EIGRP → dest & source logic network (Network)
- frame - Data Link : Network Access : PPP, Ethernet, ATM → dest & source phy addr (data link)
- bit - Phy → timing & sync bit (phy)

• Network Media

- Unshielded Twisted Pair, 10/100/1000
- Coaxial cable, 10/100/1000

• Network Connection

Computer → Patch Cable → Patch Panel → Switch → ...

LAN 100Mbps Cat 5

• Protocol Interaction

othernet → IP → TCP → HTTP (www)

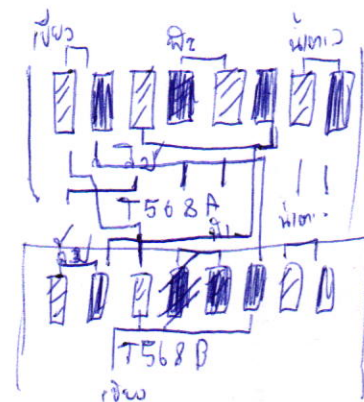
- Port

- 0-65535 well known - IANA
- 1024-49151 reg port
- 49152-65535 dyn port

IP Class	min	max	Range	not network	not host
A	8	24	0-127	126	16,777,216
B	16	16	128-191	16,384	65,535
C	24	18	192-223	2,093,182	254
multicast D	28	4	224-239	N/A	N/A

• MAC

- 48bit (4bit per hex) 12 hex
- ethernet MAC



private

- A 10.0.0./8
- B 172.16.0.0/12
- C 192.168.0.0/16

message delivery
 unicast | dest p, soup, soup, destip |
 broadcast | FF-FF, soup, soup,SS |
 multicast | " " " " | → sharp only

• Cisco IOS (Internetwork OS)

• Access by console port, telnet, ssh, aux port

• Mode

- user exec >
- privileged #
 - global-confiq - command, router
 - if (interface) (confiq-if) #
 - router
 - line

• Routing (routing information network) IOS

• Router & CPU, RAM, ROM, NVRAM, Flash Mem, Interface
 IOS confiq

1. Post → exe bootstrap loader (ROM)

2. load IOS (Flash) → 2nd → 3rd TFTP

3. load confiq → NVRAM -

4. console

• function - initialization, routing protocol

• Default Gateway (routing information network) → dest mac

Dynamic

- Routing Information Protocol - Map count.
- Open Shortest Path First (OSPF)
 - count bandwidth from source → dest
- Enhanced Interior Gateway Routing Protocol (EIGRP)
 - bandwidth, delay, load,

Admin Distance (AD)

- Connected 0
- Static 1
- EIGRP summary router 5
- external BGP 20
- Internal EIGRP 90
- OSPF 100
- RSTP no

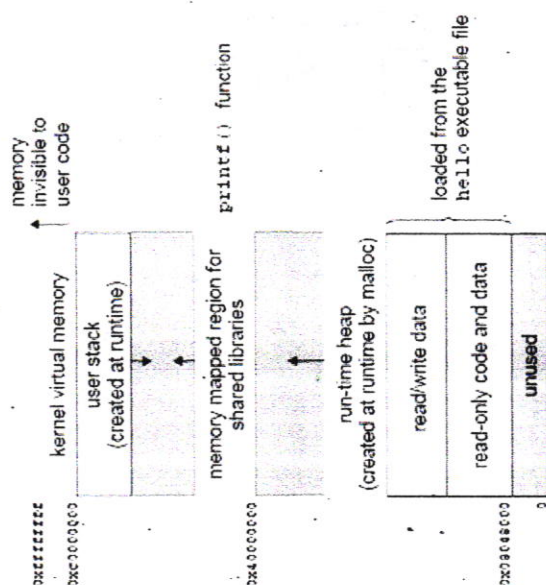


Figure 1.13: Linux process virtual address space.

for Staples

* Dynamic Routing Protocol

- * ทำหน้าที่ share info ระหว่าง 2 point, auto update routing table, find best path
- * ประมวลผล algorithms โดยใช้ routing protocol msg

Dynamic Routing Protocol

Interior Gateway Protocol

Exterior Gateway Protocol

Distance Vector Routing Protocol

Link Vector Routing Protocol

RIP V1 (120) → R1, R2 → R3 (100) → R4 (90)

RIP V2 (120)

Link State Routing Protocol → hop

OSPF (110) → bandwidth

IS-IS (115)

* Classify Routing Protocol

- 2 subnet, 128 subnet
- ตัวอย่างในกรณีนี้คือ RIP, OSPF, fast: EIGRP, OSPF

* Routing Protocol Metrics

- Hop, Bandwidth, Cost, delay, load, Reliability → Metric
- Load Balancing - สามารถเลือกเส้นทางได้

for Staples

* Distance Routing Protocol

- 3-4-5-6-7-8-9-10-11-12-13-14-15-16-17-18-19-20-21-22-23-24-25-26-27-28-29-30-31-32-33-34-35-36-37-38-39-40-41-42-43-44-45-46-47-48-49-50-51-52-53-54-55-56-57-58-59-60-61-62-63-64-65-66-67-68-69-70-71-72-73-74-75-76-77-78-79-80-81-82-83-84-85-86-87-88-89-90-91-92-93-94-95-96-97-98-99-100-101-102-103-104-105-106-107-108-109-110-111-112-113-114-115-116-117-118-119-120-121-122-123-124-125-126-127-128-129-130-131-132-133-134-135-136-137-138-139-140-141-142-143-144-145-146-147-148-149-150-151-152-153-154-155-156-157-158-159-160-161-162-163-164-165-166-167-168-169-170-171-172-173-174-175-176-177-178-179-180-181-182-183-184-185-186-187-188-189-190-191-192-193-194-195-196-197-198-199-200-201-202-203-204-205-206-207-208-209-210-211-212-213-214-215-216-217-218-219-220-221-222-223-224-225-226-227-228-229-230-231-232-233-234-235-236-237-238-239-240-241-242-243-244-245-246-247-248-249-250-251-252-253-254-255-256-257-258-259-260-261-262-263-264-265-266-267-268-269-270-271-272-273-274-275-276-277-278-279-280-281-282-283-284-285-286-287-288-289-290-291-292-293-294-295-296-297-298-299-300-301-302-303-304-305-306-307-308-309-310-311-312-313-314-315-316-317-318-319-320-321-322-323-324-325-326-327-328-329-330-331-332-333-334-335-336-337-338-339-340-341-342-343-344-345-346-347-348-349-350-351-352-353-354-355-356-357-358-359-360-361-362-363-364-365-366-367-368-369-370-371-372-373-374-375-376-377-378-379-380-381-382-383-384-385-386-387-388-389-390-391-392-393-394-395-396-397-398-399-400-401-402-403-404-405-406-407-408-409-410-411-412-413-414-415-416-417-418-419-420-421-422-423-424-425-426-427-428-429-430-431-432-433-434-435-436-437-438-439-440-441-442-443-444-445-446-447-448-449-450-451-452-453-454-455-456-457-458-459-460-461-462-463-464-465-466-467-468-469-470-471-472-473-474-475-476-477-478-479-480-481-482-483-484-485-486-487-488-489-490-491-492-493-494-495-496-497-498-499-500-501-502-503-504-505-506-507-508-509-510-511-512-513-514-515-516-517-518-519-520-521-522-523-524-525-526-527-528-529-530-531-532-533-534-535-536-537-538-539-540-541-542-543-544-545-546-547-548-549-550-551-552-553-554-555-556-557-558-559-560-561-562-563-564-565-566-567-568-569-570-571-572-573-574-575-576-577-578-579-580-581-582-583-584-585-586-587-588-589-590-591-592-593-594-595-596-597-598-599-600-601-602-603-604-605-606-607-608-609-610-611-612-613-614-615-616-617-618-619-620-621-622-623-624-625-626-627-628-629-630-631-632-633-634-635-636-637-638-639-640-641-642-643-644-645-646-647-648-649-650-651-652-653-654-655-656-657-658-659-660-661-662-663-664-665-666-667-668-669-670-671-672-673-674-675-676-677-678-679-680-681-682-683-684-685-686-687-688-689-690-691-692-693-694-695-696-697-698-699-700-701-702-703-704-705-706-707-708-709-710-711-712-713-714-715-716-717-718-719-720-721-722-723-724-725-726-727-728-729-730-731-732-733-734-735-736-737-738-739-740-741-742-743-744-745-746-747-748-749-750-751-752-753-754-755-756-757-758-759-760-761-762-763-764-765-766-767-768-769-770-771-772-773-774-775-776-777-778-779-780-781-782-783-784-785-786-787-788-789-790-791-792-793-794-795-796-797-798-799-800-801-802-803-804-805-806-807-808-809-810-811-812-813-814-815-816-817-818-819-820-821-822-823-824-825-826-827-828-829-830-831-832-833-834-835-836-837-838-839-840-841-842-843-844-845-846-847-848-849-850-851-852-853-854-855-856-857-858-859-860-861-862-863-864-865-866-867-868-869-870-871-872-873-874-875-876-877-878-879-880-881-882-883-884-885-886-887-888-889-890-891-892-893-894-895-896-897-898-899-900-901-902-903-904-905-906-907-908-909-910-911-912-913-914-915-916-917-918-919-920-921-922-923-924-925-926-927-928-929-930-931-932-933-934-935-936-937-938-939-940-941-942-943-944-945-946-947-948-949-950-951-952-953-954-955-956-957-958-959-960-961-962-963-964-965-966-967-968-969-970-971-972-973-974-975-976-977-978-979-980-981-982-983-984-985-986-987-988-989-990-991-992-993-994-995-996-997-998-999-1000

* Routing Loop

- ปัญหาที่เกิด = routing loop set max hop ด้วย (7 hop)

* RIPv1 (admin = 120) (UDP port 520)

- 1 hop count, ได้ 15 hop, อัปเดตทุก 30 s.

RIP msg format | command 1. req 2. reply (8bit) 0-3
| version 1. v.1 2. v.2 (4) 2-15 } header
| must be zero 16-31

Router Entry { address family (2) (0-15) | must be zero (16-31)
| ip addr (0-31)
| must be zero (0-31) → v2 → subnet
| " (0-31) → next hop
| metric (hop) (0-31)

- RIPv1 not send subnet in routing update | summary RIPv1 subnet major network
- RIPv1 possible interface sending broadcast

for Staples



* RIPv2 / support VLSM

- classless, next hop address update, multicast, authen
- prevents RIPv1 from preventing routing loop times, split horizon, max hop^s 15
- RIPv2 Limit: loopback, null interfaces, No CIPB support

* RIPv2

- Cisco default RIPv1

* Access Control List

- standard dot, link, network, extra segment allowed
- deny if else if deny
 - standard ACLs, check source address
 - Extended ACLs, " " and dest address
- number (1-99), (1300-1999) std
(100-199) Extended
- wildcard Mask $\text{den} \sim \text{var subnet}$
 - ex 1.1 192.168.1.0 ip
 - 0.0.255.255 wildcard } and op
 - 192.168.1.0 result
 - ↳ old num ip
- block std network addresses incoming traffic and ip address
- ext " " outgoing port and port
- command \rightarrow access-list <num> <deny/permit> <ip/host>

for Staples

* Link-State Routing Protocol

- ทำให้ง่าย network topology, create topology map and set best path to all dest.
- OSPF std. routing, IS-IS - pop for provider network
- use Dijkstra's

- state 1. ทำ router สร้าง table network, ip, type network, cost and neighbors.

↳ Link & Link-State

2. Say Hello - บอกเพื่อน router ที่อยู่ใกล้ network

3. Build the Link-State Packet ทำคือคือคือคือคือ link จาก A → B cost ใน link

4. Flooding LSP & Build database คือ ปล่อยทุกตัว แล้วเก็บเข้า database

5. Build SPF Tree & [building table คำนวณหาเส้นทางไป dest ให้ได้ minimum cost]

- area 5²

* OSPF v.2 (ip4) v.3 (ip6) (cost 110) หรือ RIP (120)

- backbone (area 0) (คือคือคือคือคือ 2 area)

- cost - hello time 229.0.0.5 | multicast ever 10s, non-broadcast ever 30s

- operation - down-state - say hello → B (multicast)

- init-state - ack hello → A (unicast)

- two-way state - แล้ว list neighbor (ip: network type)

- ex start state - send all

- exchange state - $\beta \xrightarrow{\text{info}} A, A \xrightarrow{\text{link}} B, A \xrightarrow{\text{info}} B, B \xrightarrow{\text{link}} A$ $\frac{n(n-1)}{2}$ session

- loading state - $A \xrightarrow{\text{need}} B, B \xrightarrow{\text{entry ip}} A, A \xrightarrow{\text{link}} B$ 497.

- ospf cost | cost = ref bandwidth / interface bandwidth

default	10 ⁸	serial (1.544 Mbps)	(12) Kbps, 60 Kbps
fast ether	100	100 Mbps	cost 10
diga	1000	1 Gbps	1
10 giga	10000	10 Gbps	1

* PMCP (Dynamic Host Config Protocol)

- non subnet, default gateway, DNS server

- 211111 manual allocation, automatic and dynamic accept all-u

- communication ① client $\xrightarrow{\text{req}}$ dns ② dns $\xrightarrow{\text{ip}}$ client ③ client $\xrightarrow{\text{ack}}$ dns ④ dns $\xrightarrow{\text{ack}}$ client

- do MAC: FF:FF:FF:FF:FF:FF, IP SRC: 0.0.0.0, IP DEST: 255.255.255.255 | port 67

for Staples

for Staples



* Slide 3 Again

* Router Concept

- respond to user network
- have own OS [IOS], mem and storage { NVRAM: hold config, Flash: IOS }
- boot → post [ROM] → bootstrap load [ROM] → load OS [Flash] or load in internet
[TFTP] → load config [NVRAM] or load ftp [TFTP] → run boot [Console]
- routing → determines routing network, interface
→ set best path → forward package
- config basic → host, clock rate (serial) interface, ip

* Router Table have interfaces static routing, direct connect.

- Remote Network Entries

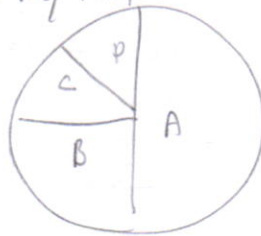
[P | dest net/24 | [cost admin/metric] | next hop ip | amount time | interface dest]
link local [L], directly connect [C]

* Static Routing

- set next-hop interface in my router

* Classful Addr

- A	0	0.0
- B	10	128.0
- C	110	192.0
- mul	1110	224.0
- reserv	11110	240.0



* CIDR

- into network over subnet

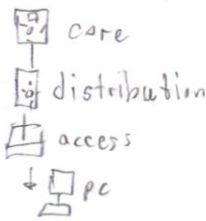
* VLSM

for Staples Basic Switch & ARP

* LAN Design

- Borderless switch 3-Tier

- โครงสร้าง core → dist → access



access:

- VLAN
- port security
- QoS
- link aggregation
- PoE

distribution, Core (Very High forward rate)

- Layer 3 support
- redundant components
- ACL

* Switch Op

- learning, Aging, Flooding, Forwarding, Filtering

Local switch จะรับ frame → learn source address table → ตรวจสอบ dest address broadcast, multicast, unicast unknown (flood package) → อยู่ interface ที่รับ (filter package) → forward package to correct port.

- port table

DESC port	port
cc-cc-cc-cc	port 1
	...
	n

- Broadcast Domain

- switch จะ forward to all port

- ถ้ามี interface switch เป็น broadcast กับ switch อื่น

* Switch Boot

- POST → run boot loader → boot loader run low-level op → boot loader load flash → run IOS

* Preparing for Basic Switch Manager

- duplex communication (duplex full, speed 100)
- auto mdix (duplex auto, speed auto)

for Staples

* Remote

- use secure shell on unix base ใช้ telnet ไป port 22 (telnet 23)

* Switch Port Security

- static (support port-security mac-address cc-cc-cc)
- dynamic (" " sticky + manual ไม่ใช้)
- violation mode (protect, restrict: send syslog, increases port counter, shutdown, increases count, and shutdown port)

* ARP

- ตรวจสอบ frame ที่ source ip, source mac แล้ว sw แล้ว broadcast

- ตรวจสอบแล้ว จะ reply mac address และ source mac table จะ forward port ที่

* IPv4 (Classless Inter Domain Routing)

- Variable length subnet Masking (คือจะ host + 2 ตัว 72 แล้ว 2ⁿ use)

ex. 161.245.6.0/28 จะใช้ 512 IP address 112 คือ 16 slot ใน 112 ใช้ 64

* Low Redundancy

- Issue Layer 1: - Mac database instability
- Broadcast storm
- multiple frame transmission

* Spanning Tree Protocol

- Root Bridge
- Port Cost ไป 802.1D BPDUs

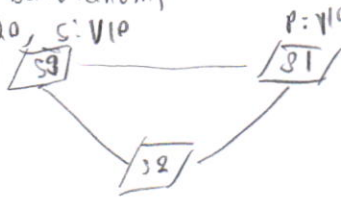
link	Revised IEEE	Previous IEEE
10Gb	2	1
1Gb	4	1
100Mb	14	10
10Mb	100	100

for Staples



STP config
 spanning-tree VLAN 1 (root primary) priority 29576

- load balancing
 P: 20, S: V10



S3: V20 → primary
 V10 → second
 S1: V10 → pri-
 V20 → second

VLAN

- on Layer 2, logical partition, ដើម្បី កាត់បន្ថយ broadcast ផ្ទាល់, ការ security, ងាយ គ្រប់គ្រង
- trunk mode ដើម្បី ភ្ជាប់ VLAN ពី ១ ទៅ ១០០ (SW ↔ SW)
- កាត់បន្ថយ broadcast ការងារ ក្នុង VLAN តែម្នាក់ឯង
- ជៀសវាង 802.1Q STC 100 → STC 100/20
- access mode គឺជា mode ឯង

Inter VLAN

- ភ្ជាប់ រវាង VLAN ពី ១ ទៅ ១០០ តាមរយៈ Layer 3 (router, SW L3) ដើម្បី routing
- router មាន sub interface

VTP (VLAN Trunking Protocol)

- Cisco បង្កើត
- ដើម្បី ងាយ គ្រប់គ្រង config ក្នុង គ្រប់ switch ដែល ភ្ជាប់ គ្នា

mode

- server បង្កើត
- client copy ↑
- transparent បង្កើត បញ្ជូន ទៅ គេ ប៉ុន្តែ មិន យក ទៅ ប្រើ ទេ
- ក្នុង ១ ប្រព័ន្ធ ត្រូវ មាន ១ server តែម្នាក់ឯង ដើម្បី គ្រប់គ្រង គ្រប់ switch ដទៃ
- ឬ show vtp counter ដើម្បី គណនា ចំនួន ការ ប្រែប្រួល



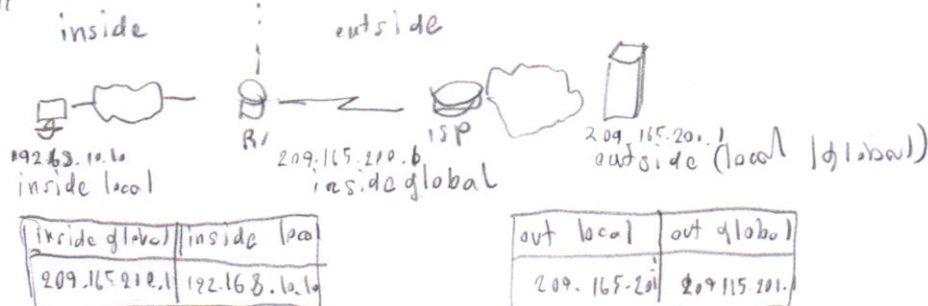
for Staples

7 Network Address Translation

♀ Private PV4.

- a. A 10.0.0.0 - 10.255.255.255 | 10.0.0.0 / 8
b. B 172.16.0.0 - 172.31.255.255 | 172.16.0.0 / 12
c. C 192.168.0.0 - 192.168.255.255 | 192.168.0.0 / 16

type 4:



- static / dynamic

static config not

- ① ip not inside source A/Aic <src> <dest>
- ② int s/p/o → ip not inside
- ③ ↗ ↓ outside

* dyn nat

- ① ip nat pool <name> <start ip> <end ip>
- ② access-list <num> permit <src-wildcard>
- ③ ip nat inside source list <acl-num> pool <pool-name>
- ④ in ip nat (inside & outside)

* day n pot in unzu naat nat to ③ in overload shing

~~A~~ B C D E

Distance Vector linkState

Clotrfu) MIP 1689

Classers R1V2 B10BP 05PFv2

- large, multi protocol (IPv4, v6 & legacy)

- support authentication

* Package 5 Type

- ① Hello for discovery & maintenance ; \rightarrow broadcast ack
- ② Update neighbor topology & advertise unicast \rightarrow broadcast ack
 \downarrow routing information
- ③ Ack
- ④ Query & reply use by DUAL (therefore require ack) & unicast

for Staples



#config

#router eigrp <proc-id>

network <ip-network> ex. 172.16.0.0 a=172.16.0.0 / 24, / 30

router-id <router-ip>

#eigrp operation



① R1 say hello R2 (to all EIGRP interface)

② R2 receive hello, add R1 to neighbor table, send update all router, send hello to R1

③ R1

#Metric default

$$\text{metric} = \left[\underset{(K1)}{\text{bandwidth}} \times \underset{(K1)}{\text{bandwidth}} + \underset{(K3)}{\text{delay}} \right] \times 256$$

bw bandwidth interface

$$\text{metric} = [\text{bandwidth} + \text{delay}] \times 256$$

delay (usec)

Gig	10
fast	100
10M	1000
64K	20,000