

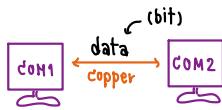
+

NETWORK



Module 1 : Networking Today

Networks Affect Our Lives



bit: Binary Digital / 8 bit = 1 Byte "2⁸"

data communication

Signal: ទូរន័សការសំដែង

Media: សំណុលានិងអាជ្ញាក់ទីនៅប្រឈម
ធម្មតាសំណុលានិងអាជ្ញាក់ខ្លាំងខ្លាំង

ex. កញ្ចប់ > លំនៅ > ការពារ

សំណុលានិងរាជក្ខុង

ធម្មតាសំណុលានិងខ្លាំង Fiber Optic

+ រាជក្ខុង+ទេរ៉ា+ពាក្យល់អំពួយ
(ជំនួយ WiFi, radio)

Network Component

- Host Roles -

Server ————— Client

client នឹងចាំបាច់ទិន្នន័យ server នៃខ្លួន!

server នឹង provide នៃខ្លួន

- Peer to Peer -

device can be server and client

device នឹង send request ទៅការប្រើប្រាស់ client

សំបុត្រ នឹងទិន្នន័យ client ទិន្នន័យ server នៃខ្លួន

និង network នៃខ្លួន + Lower cost + Less complex

+ Easy to set up + used to simple task
(-slower performance)

- End Devices -

គុណភាពខ្លួនការស៊ូតាត់

- Intermediary Network Devices -

ផែនអ្នករដ្ឋនៃម៉ោងសំណុលានិង (ម៉ោងការ)

ex switches, wireless, router, firewalls

ដើម្បីផ្តល់ព័ត៌មាន + និងផ្តល់នូវ + នៅ

ការ retransmit, detect error, maintain information

- Network Media

Metal wires, Glass or Plastic fiber, Wireless
copper fiber optic

Network Representations & Topologies

► NIC: Network Interface Card នឹងប្រឡងសំណុលានិង

• Physical Port

• Interface

► Topologies

↳ Physical: Hardware for programmer

↳ Logical: Software for user

Intranet: Only

Extranet: Collab

The Internet: World wide

I បាន់ - Small Home

- SOHO: small office/Home office

- Median to Large ex. university

- World wide ex. global

II LANS, WANS: ទូរសព្ទ គន្លឹមគណន៍

LANS: Local Area Network

WANS: Wide Area Network

ex. LANS in Silpakorn សាលាអ៊ីនហ៊ុន

WANS → Silpakorn សាលាអ៊ីនហ៊ុន + ពេទ្យបុរី + សំរាប់ពេទ្យ

LANS+WANS → "Internet"

ឯសោុរ្យ

Internet Connections



ISP: Internet Service Provider

Converged network: data, voice, video

one link including

Reliable Networks

► Fault Tolerance: ចងការបែបងារដែលនឹងទទួលបានការងារដូចតាមតែងតាំង

↳ Packet-switched network

↳ Circuit-switched network

► Scalability

► QoS (Quality of Service)

► Security

Network Architecture

Network Trends

- **BYOD Bring Your Own Device**: allows users to access information and communicate
 - **Collaboration**
 - **Cloud computing**: allow us to store personal files or backup our data on servers over the internet.

4 Type Cloud

- Public cloud
 - Private cloud
 - Hybrid cloud ⇒ custom + public
 - Custom cloud ⇒ can be private/public

• Smart Home

- Powerline Network: allow device connect to a LAN with cable or wireless
 - Wireless Internet Service Provider "WISP" is an ISP that connects subscribers to designated access points or hotspots

Network Security

- Security Threats -

Internal threat : lost or stolen device
accident by employee

External threat : Virus, identity theft

-Security Solution-

- + Anti Virus & antispyware
 - + Fire wall filtering
 - dedicated fire wall system
 - ACL : Access control lists
 - IPS : Intrusion prevention system
 - VPN : Virtual private network

Module 5: Number System

IPv4 : 98ba9 Binary $\frac{8\text{ bit}}{} \cdot \frac{8\text{ bit}}{} \cdot \frac{8\text{ bit}}{} \cdot \frac{8\text{ bit}}{}$ 32 bit

Module 3: Protocols & Models

Protocols [Function, Format, Rules]

+Software
+Hardware] ทำงาหะประสาหกน์ดี

Type

- Network Communication
 - Network Security การยืนยันตัวตน
 - Routing select best path
 - Service Discovery detect, check services

Function : ผู้ที่ต้องเชื่อมต่อ กันอย่างไรให้ได้

- I. Addressing : identifies sender, receiver (ผู้ส่ง, ผู้รับ)
- II. Reliability : guaranteed delivery (รับประกันว่าได้ / ไม่ได้)
- III. Flow Control : Ensures data flows, efficient data (ความเร็วในการส่งข้อมูล / ขนาด data)
- IV. Sequencing : Ordering data
- V. Error Detection : check error
- VI. Application Interface : Process to Process communication Between network Applications

OS : operation system

Hardware คือบุคคลอุปกรณ์ computer ในการทำงาน

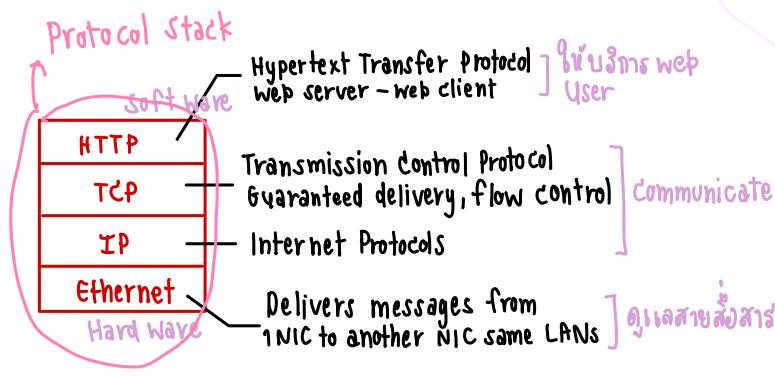
Software run on "OS"

process ระนาบเครื่องคอมพิวเตอร์ "Protocols" → TCP/IP

process เครื่องคอมพิวเตอร์ "OS"

Protocol Interaction

: network use



Protocol Suites : High layers — Lower layers

-Evolution-

ปัจจุบันนี้

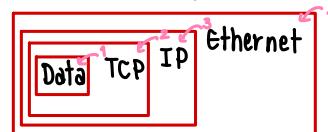
Internet Protocol Suite or TCP/IP "IETF"
OSI ref. from ISO & ITU แห่งระบบเดียวกัน

ในอดีต

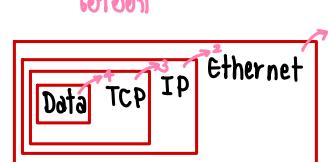
AppleTalk : proprietary by Apple Inc. protocol ตัวเอง
Novell Netware : proprietary by Novell Inc. ตัวเองเดียวกัน
IP → IPv4 address ผู้ที่คงพอเดิม IPv6

TCP/IP communication

Encapsulating server→client



Decapsulating client→server



Standards Organization

OPEN STANDARD ของ NETWORK

IEEE

IETF → IP Address
IANA → Domain name
TCP/UDP port number

ICANN: IPv4, IPv6

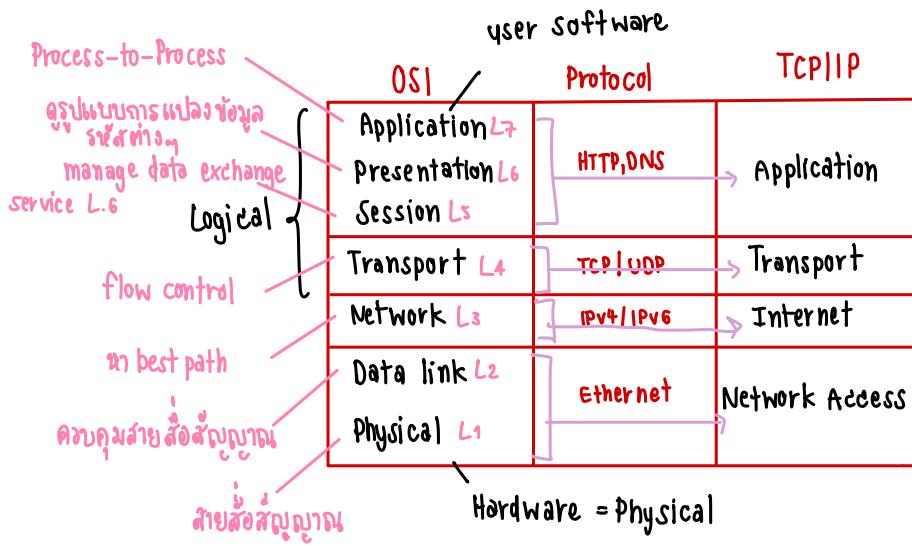
ITU: ร่างกฎหมาย

INTERNET STANDARD

ISO/IEC สมุด Internet สถาบัน

IAB
IETF งาน
IRTF วิจัย, พัฒนา

Reference Models



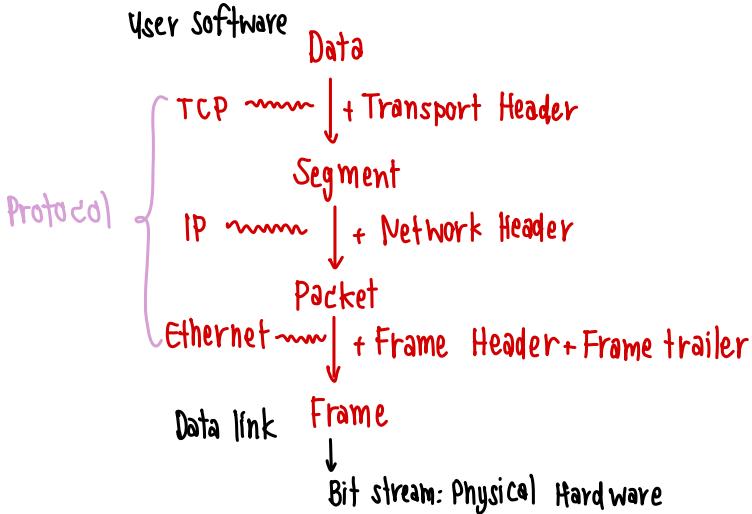
Data Encapsulation

- Segmenting Message:** ทำให้เข้ามูลเล็กลง
好处: Load ภายนอก ค่าบุญเบร์สั้นยิ่งๆ และรวมทั่วโลก
- Benefits → Increase speed
→ Increase efficiency ย่อชั้นบุญลดเวลา

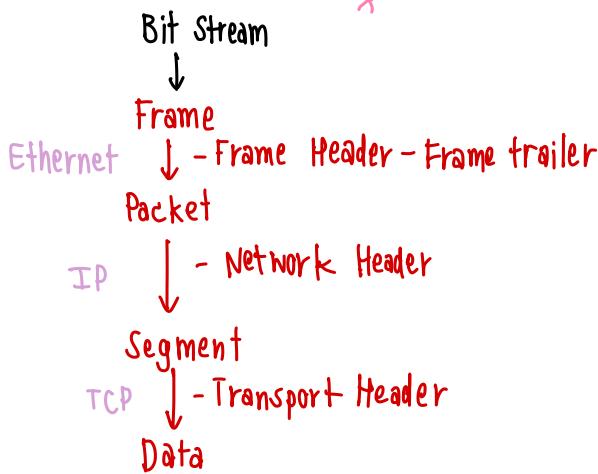
- Sequencing:** ทำให้ปรับแต่งลำดับให้มีที่ปลายทาง by Protocol TCP

Protocol Data Units

Encap



Decap



Data Address

Address Source and destination

Network Layer: Logical Address "IP Address" แบ่ง network portion เดียวสำหรับ Host ต่อตัวเดียวเท่านั้น
network area: portion Host ที่ไม่ใช่

ex. PC1 192.168.1.110 → Host อยู่ใน
FTP Server 192.168.1.9 → Host อยู่ใน
Network portion เดียวเท่านั้น

IPv4
Network | Host = 32 bit

IPv6
Network | Host = 128 bit

Data link: Mac address from NIC ex. IME of phone
"IEEE"

Module 4: Physical Layer

- L7 Application
- L6 Presentation
- L5 Session
- L4 Transport
- L3 Network
- L2 Data link
- L1 Physical

Logical Link Control (LLC)
Media Access Control (MAC)

L1 Physical : ឧច្ចាស់ Hard ware ឬ NIC នឹងចំណាំ network
IEEE, ANSI, ITU-T, EIA-TIA, ISO (Protocol ethernet)

Component → Hardware device, media, connector
សាយសម្រួល្យានទាំងអស់, wireless

Encoding → លើសត្រាងបាននូវការដោយអាមេរិក
volt សង "1" volt ជាបី "0"

Signaling → "1" "0" represented on
the physical medium
ex. fiber-optic cable

wave FM, AM, PM, Digital Signal

Band width → គោលនៅ | គោលការងារឱ្យលើសម្រួល្យាន

bps, Kbps, Mbps, Gbps, Tbps
ដំឡូង 10³ 10⁶ 10⁹ 10¹²

Latency នៅលើ (រវាងការ delay) កំសែរ data ទុកដាន → ពុលិ៍

Throughput ភាពខ្លួន (ក្នុងរាល់ទៅលើទំនាក់ទំនង)
band width នូវ throughput នូវូន

Goodput subset នូវ throughput

Goodput < Throughput តាមទី

Copper Cabling សាយកម្មបេកសែរ

Copper cabling : គោលការងារទាំងអស់, តម្លៃក្នុងតម្លៃ

ផ្តល់ព័ត៌មាន
I. ចំណែកលើកស្រួល
II. ផែតាមពេរក

Type

- ① UTP: Unshielded Twisted-Pair: មុកស្រួល, ឲ្យធ្វើការ
| ដៃសម្រាប់ RJ-45
- ② STP: Shielded Twisted-Pair: shield ដើម្បីការរករាយ, ឱ្យង់
- ③ Coaxial cable: ឲ្យធ្វើការក. នៅក្នុង

UTP cabling 4 pairs

4 គ្រឿង 8 ល៉ែន ធម៌លេខ្ទីកំពុង twist pair

គោលនៅក្នុងរាល់ហេតុ ឬ cross talk

STANDARD for UTP

by TIA/EIA-568

♥ Fiber Optic ការប្រកាសតំបន់, ជួយឱ្យការងារ copper

- SMF: Single-Mode Fiber

+ small core
+ expensive lasers
+ Long-distance

- MMF: Multi-Mode Fiber

+ large core
+ less expensive LEDs នៃការងារដែលបានការងារ

+ Type Enterprise Network

| Fiber to the Home FTTH
| Long-Haul Network city, country
| Submarine Cable Network transoceanic distance

Fiber Optic តីកវា UTP cabling

♥ Wireless Media

WLAN ធនធាន ឲ្យការងារបានការងារ

• WiFi "IEEE 802.11"

• Bluetooth "IEEE 802.15"

• WiMAX "IEEE 802.16"

• Zigbee "IEEE 802.15.4" IoT

internet of thing និង bandwidth បានការងារ

WLAN - Wireless LAN

| Wireless Access Point(AP)

ព័ត៌មានទំនាក់ទំនង

| Wireless NIC Adapter គ្រឿងកំនើងទំនាក់ទំនង



រាយទំនាក់ទំនង
ឧបតាមមេរូ



RJ-45 Connector



RJ-45 Socket

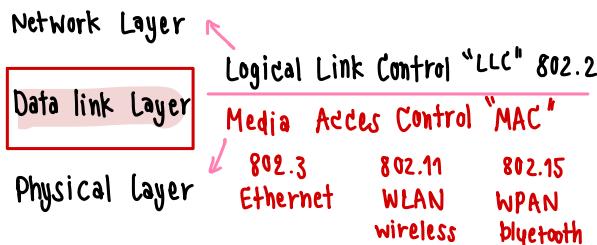
UTP cabling : Straight through → Host-device

Cross over → Host-Switch,
Hub-Hub, Switch-Switch, Router-Router

Module 6 : Data link Hub

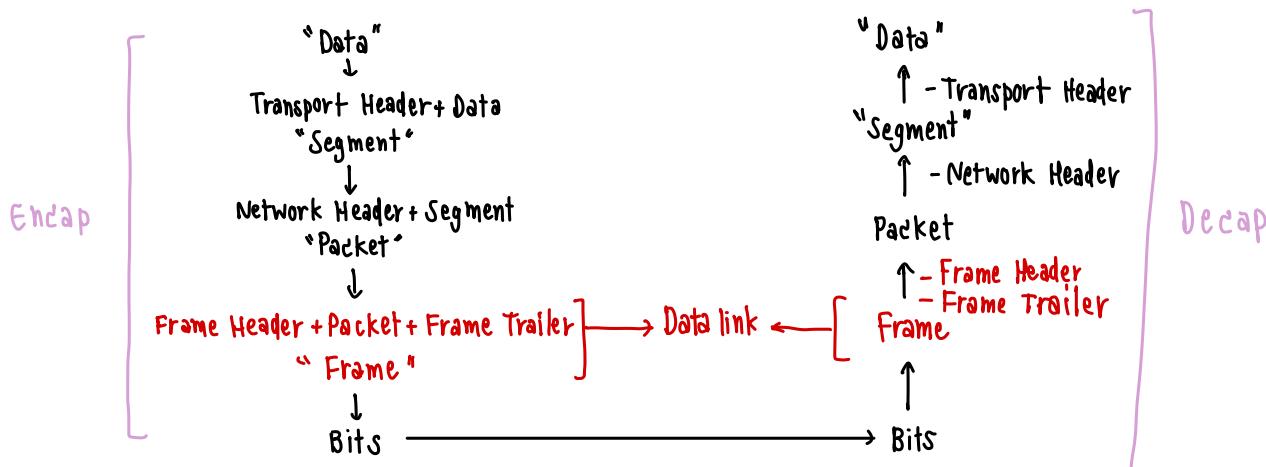
- L7 Application
- L6 Presentation
- L5 Session
- L4 Transport
- L3 Network
- L2 Data link : Protocols Ethernet
- L1 Physical

" IEEE 802 " LAN/MAN



Heart Data link Layer Standards

- IEEE 802
- ITU
- ISO
- ANSI



ມີເອງໃນ Network ເຄີຍຈຳນວດຕາຮັດໄລຍະ / ດ້ວຍ Network ກົບທີ່ຢູ່ຂອງໂທ ໃຫ້ router ຄອງຮ່ວຍ
Protocol for network layer

Heart Topologies

▪ **Physical topology "Hard ware"**

▪ **Logical topology "Soft ware"** ວາງເຊື່ອນຕົກກຳ IP Address

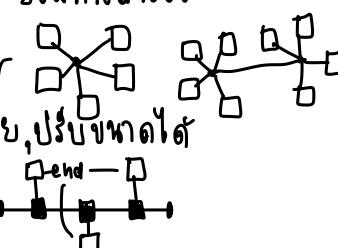
▪ **WAN topology** ▪ Point to Point : simple ex router-router ພົບ 1 ຕັ້ງກິນນັດ Router 1 — Network — Router 2
Physical directly connect two nodes.

▪ Hub and spoke : star topology ex hub-router
ກຳ Hub ຜົບຊະໜັດ

▪ Mesh : high available ex ຖຸກ node ເຊື່ອມດິຈິກັນ 1 node ພົບ
ງານມີກາງສົງລອງ

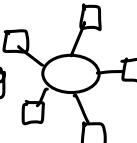
▪ **LAN topology** ▪ star and extend star

ຕົດຕັ້ງບໍ່ໄຍ, ແກ້ປໍລູາບໍ່ໄຍ, ປັບປຸງທາງໄຕ



▪ Bus ເຊື່ອນກິນແນວ

▪ Ring : can respective neighbors to form a ring



Half-duplex communication

- ສ່ວນໄດ້ຢ່າງເຕື່ອງ
 - ອີບໄດ້ຢ່າງເຕື່ອງ
- Used on WLANs Bus Ethernet Bus

Full-duplex communication

- ສ່ວນໄດ້ຢ່າງໄປ້ພຽນກຳນົດ

Used on Switch

Access control Methods

- Contention-Based Access -

* CSMA/CD - detect collision

"Ethernet Network" IEEE 802.3

- Half duplex mode
- Multiple device send at the same time
- ໜ້າຍ device ສ່ວນບໍ່ມີຜວຮນກັນຮັບໃນຮ່ານກົນ
- ສ່ວນໄດ້ຢ່າງ but ເກີດ collision ການຮຽນກົນ
- ຫຼອງນະບຸດທັງໝາດ \rightarrow ພົກເປົ້າ random time
- ໜ້າຍຄາລາລົບມາສ່ວນສໍລູນລູາລາດໃໝ່

CSMA/CA

"Wireless LANs" IEEE 802.11

- Half duplex mode

- ສຳກັບອອກແລກການສ່ວນ signal ເພື່ອໄວ້ໃຊ້ຮ່ານກົນ

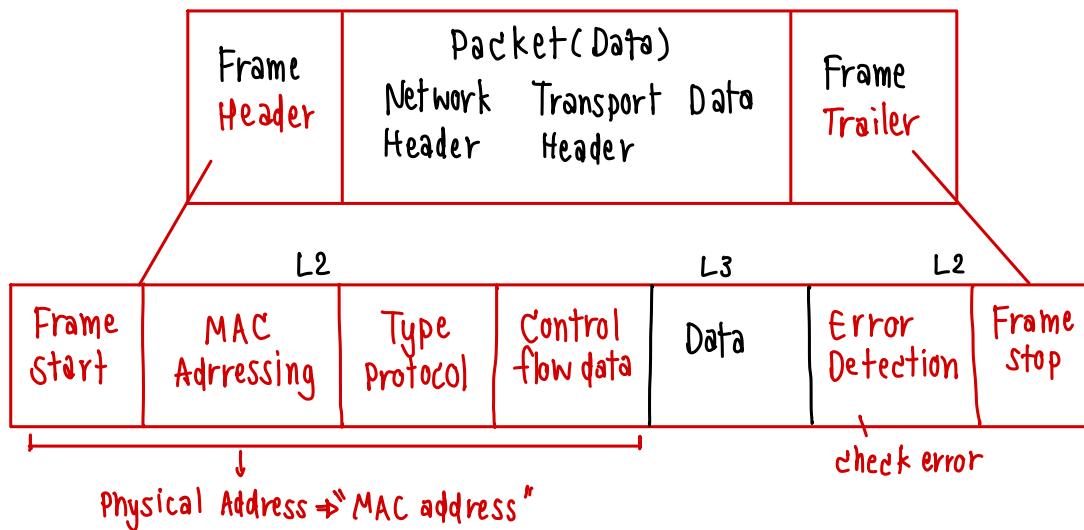
- Controlled access -

ຄວບຄຸນການເນັດຖິງ ຂຶ້ວລາສ່ວນ/ເນົາຄົງຂອ້ມງວລເປັນ ຂອງ ສ່ວນໂລງ

ຕັ້ງສິດທິນີ້ສ່ວນ \rightarrow ສ່ວນໄດ້

ຍັງມີສິດທິນີ້ສ່ວນ \rightarrow ດອດຕົ້ນ \rightarrow ດົງຄົວ = ໄດ້ສິດທິນີ້ \rightarrow ສ່ວນໄດ້] Token Ring & ARCNET

>Data link frame

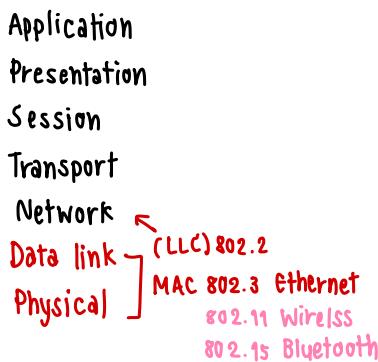


- LAN & WAN Frames -

- Ethernet 802.3] LANS
- 802.11 Wireless] LANS
- Point to Point (PPP)
- High-Level Data Link Control (HDLC)] WANS
- Frame-Relay

Module 7: Ethernet Switching

Ethernet Frames (protocol in Layer 1, 2)



Ethernet LANs និង Switch នៅក្នុងផែន

Switch → Full Duplex CSMA/CA (Layer 2)



Ethernet Frame Fields

min size 64 bytes

ចាត់មួយការៗ 64 byte "runt frame" និងទៅនឹង discard ក្នុង

max size 1518 bytes

ចាត់មួយការៗ 1518 bytes "jumbo" "baby giant frame"

ហាព switch នាមទៅអាចបញ្ចូនបាន jumbo Frame បាន និង Fast Ethernet ex. 100 mbps, 1000 mbps

Ethernet MAC Address

- MAC Address & Hexadecimal -

6 Byte ដែលគឺជាថុទិន្នន័យ \rightarrow 6 ពីរ \rightarrow 12 នៅ

'IEEE ពេនដូរគុណកម្មរោល' 48 bit បែងចែន

OUI \rightarrow 24 bit នៅក្នុង IEEE ដែលត្រូវការណា

ផែនក្នុង NIC ដើម្បី 2²⁴ បែបបុរាណការណា

Vendor Assigned \rightarrow 24 bit នៅក្នុង

ex. 1F 2B 3A | 4D 7F 5C
24bit OUI 24bit

• MAC Sublayer "IEEE 802.3"

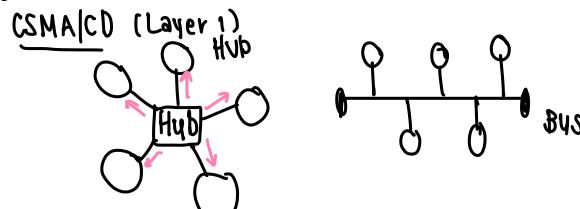
I. Ethernet Frame ខ្លួនឯងគុណបំបាត់ Ethernet frame

II. Ethernet Addressing - MAC Address

តិច Physical Address នៃក្នុង NIC

III. Ethernet Error detection - trailer នូវការចាយខាងក្រោម frame] Tailer

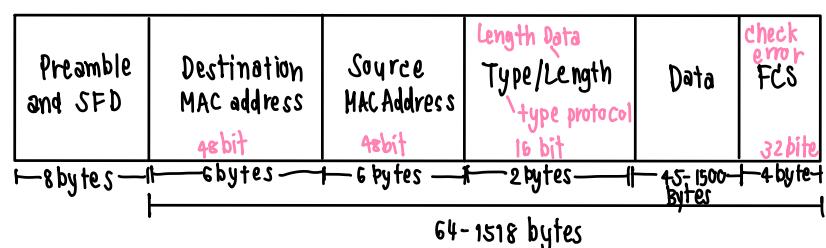
• Legacy Ethernet និង Bus / Hub Half Duplex



ក្នុង signal មានកែវតែសំណើ និងការងារការងារ random time

អាកាសនៃវិនិន័យ និងការងារ

Shared Media
ឱ្យសាយស្អែកបានរំលែកការងារ



- FRAME Processing -

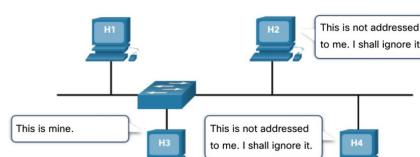
MAC Addressing គូរបង្រួចក្នុង Frame

តាន់នៃការដោរនឹងតែតូច ដោយការប្រើប្រាស់

H3
ម៉ាក្រា
H1
ម៉ាក្រា

Destination Address	Source Address	Data
CC:CC:CC:CC:CC:CC	AA:AA:AA:AA:AA:AA	Encapsulated data

Frame Addressing

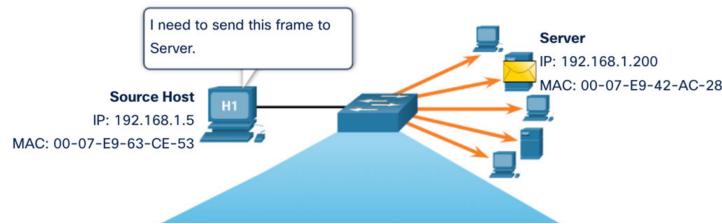


H1 សង្ឃឹមថា ពីរក្នុង device នៅក្នុង Address
CC:CC:CC:CC:CC:CC មួយ?

-Unicast-

1 ផ្លូវ : 1 គ្រឿង

IPv4 : នៅ ARP រាយការ MAC Address តាម IP
នៅលើមោងទីសំណើនៅ Destination
IPv6 : នៅ ND ការណើដែលខ្សោយ ARP

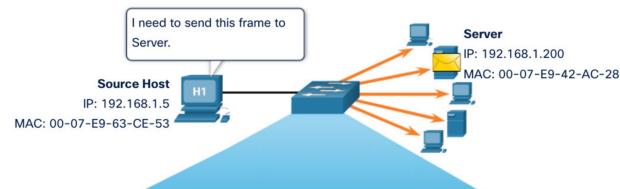


-Broadcast-

1 to All

destination MAC Address ទាំងអស់

"FF-FF-FF-FF-FF-FF"

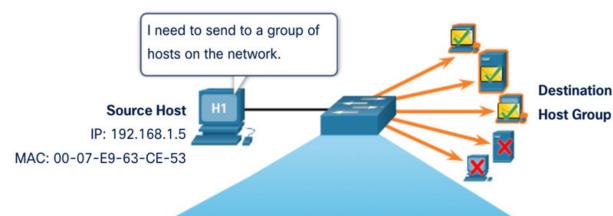


-Multicast-

1 to Many

destination MAC Address ទីផ្សារ

"01-00-5E- - - - -"



MAC Address Table

Switch នៅ MAC Address Table (Layer 2)

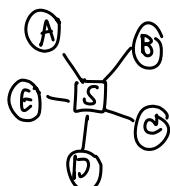
I Learning

រៀបចំពួន computer ដោយថែរក្សាទុកដៃពលនៃ port

ជាអារាន empty ក្នុងផ្ទុកផែិក

ex. port 1 - AA
port 2 - BB

ធម្មតាត្រូវការសំណើនៅ "Unicast"



II Forward

ex. switch ត្រូវការសំណើច នៅពីរក្នុងម៉ោង

port ឯណ៍ នៅពីរក្នុងម៉ោង "Broadcast"

ធម្មតាត្រូវការសំណើច នៅពីរក្នុងម៉ោង ត្រូវការសំណើច នៅពីរក្នុងម៉ោង "Unicast"

Filtering Frames

តាមរយៈ filter Mac Address ឬ
រាយការណ៍លើក្នុងម៉ោងប្រាប់

Switch Speeds & Forwarding Methods Autonegotiation

Full Duplex បុត destination ម៉ោង half ក្នុងម៉ោង half បុត

I Store & Forward ក្នុងម៉ោងក្នុង store ឱ្យកំណត់នៅលើគោរគោរយ Forward
Filtering, Check error

II Cut-through ឱ្យកំណត់នៅលើ Forward ឡើង

Fast Forward រួមទៅសំណើច

Fragment Free រួមទៅសំណើច

Memory Buffering On Switch

• Port-Based memory នៅ port នឹងកំណត់ destination នៅលើខ្លួន

• Shared memory រួមរាយការសំណើច

Duplex & Speed Setting

• Full duplex - Both ends.

• Half duplex - Only one end.

Autonegotiation: check destination and change duplex
switch

Note: គ្រាមពេលវេលា ទូទៅ Full duplex នៅក្នុង Gigabit Ethernet

Auto-MDIX

ការនៅក្នុងម៉ោងនៅលើ device ឱ្យក្នុង cable → cross over or straight-through cable

Note: Hub-switch នៅ cross over

Module 8 : Network Layer Router

Internet layer of TCP/IP Model

L3 Network Layer : Protocol IPv4 / IPv6

+ IP Addressing, Logical Addressing

+ Encap → Segment packet frame

+ Routing → provide best path

+ Decap → frame > packet - Header + Segment

IP Encapsulation Layer 7 → Layer 2

Segment = Data + Transport Header
(IP Header)

layer 3 ก็จะ router ต่อต่อเรื่อยๆ จนถึงปลายทาง

IP addressing ห้ามเปลี่ยน

IP source to destination

: NAT will change addressing:

● Connectionless : ฉะส่งก็ส่งเลย

: ยังคงท่องผ่านไปอยู่ มีช่วงกั้นๆ แต่ส่วนที่ส่งเลย
ส่งนึงนึง, ชั่วโมงนึง, ไม่บอกล่วงหน้า

สำคัญ connection-oriented ต้องมี protocol

จาก Layer 4 มาช่วย

● Best Effort การทำงานของ IP

ไม่ garant หรือต้องส่งสำเร็จ

✗ Media Independent

♥ How a Host Routes

- Host Forwarding Decision -

◦ Packet สร้างจาก source

◦ Host can sent packet to

◦ itself - 127.0.0.1 (IPv4) :: (IPv6)

◦ Local Host - same LAN (network เดียวกัน)

◦ Remote Host - ภายนอก network ต้อง router

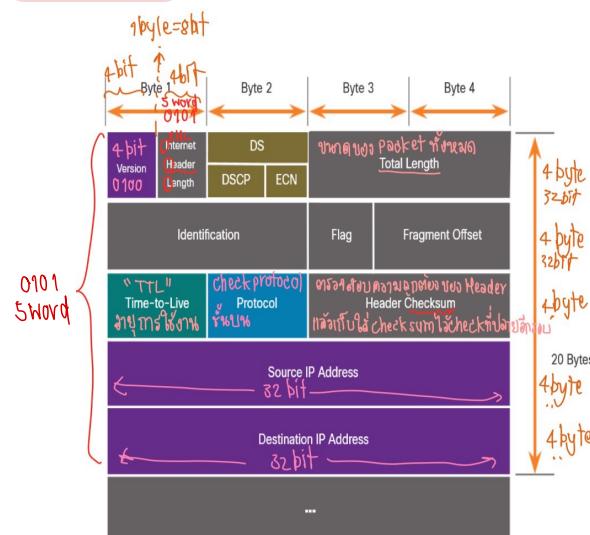
- Default Gateway -

◦ Router or Layer 3 switch

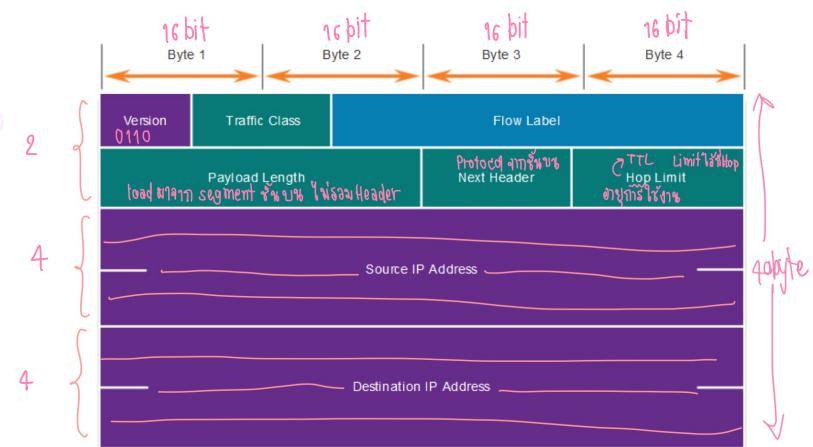
ต้องมี default gateway

(กรณีที่ packet อยู่นอก network)

♥ IPv4 Packet = Header Network + Segment



♥ IPv6 Packet = Header Network + Segment Fixed to Byte



TTL | Hop Limit กำหนดเวลาการใช้งานของ Packet

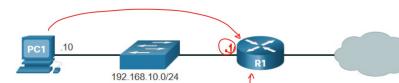
ช่องทางการเดินทางของ Network

- A Host Routes to the Default Gateway -

◦ Host จะส่งไปทาง default gateway

◦ All device on the LAN need DGW

- Host Routing Tables -



IPv4 Routing Table for PC1

IPv4 Route Table					
Active Router:		Network Destination:		Gateway:	Interface:
Network:	Mask:	Network:	Mask:	Gateway:	Interface:
0.0.0.0	0.0.0.0	192.168.10.0	255.255.255.0	192.168.10.1	25
127.0.0.0	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0	306
127.0.0.1	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	306
127.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	306
192.168.10.0	255.255.255.0	255.255.255.0	255.255.255.0	255.255.255.0	281
192.168.10.1	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	281
192.168.10.255	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	281
224.0.0.0	240.0.0.0	224.0.0.0	240.0.0.0	224.0.0.0	306
224.0.0.1	240.0.0.1	224.0.0.1	240.0.0.1	224.0.0.1	306
255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	306
255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	255.255.255.255	281