Written by Thapanapong Rukkanchanunt

Updated by Prakarn Unachak

The Internet

Outline

- History of Internet
- Internet Properties
- TCP/IP
- IP Address
- Domain Name/URL
- Internet Infrastructure
- Server and Clients

The Internet

- The Internet is the computer network that connect computers throughout the world.

- https://www.youtube.com/watch?v=Dxcc6ycZ73M

- A computer network can be connected by:
  - copper or optical wire (wired network)
  - Through radio-like signal (wireless network)
  - or both

- https://www.youtube.com/watch?v=ZhEf7e4kopM

History of Internet

- ARPANET is the first project that tried to connect many different computer networks together

- The first connection happens in 1969 between University of California, Los Angeles and Stanford Research Institute

- In 1983, TCP/IP was invented and became a backbone the Internet

- In 1990, ARPANET underwent a big upgrade which later becomes the Internet

Internet Properties

- Each computer network will select a presentative called host to join the Internet

- All hosts must speak the same language, TCP/IP protocol.

- Different parts of the Internet are operated by different entities such as universities, governments, telephone companies

- No one owns (all of) the Internet

What does it mean to be on the Internet

- Run TCP/IP protocol
- Have an IP Address
- Can send IP packets to other computers on the Internet

TCP/IP Protocol

- IP or Internet Protocol moves data packets from one host to another. No connection stays so there is no guarantee of successful delivery
- TCP or Transmission Control Protocol establishes a reliable connection between two hosts. TCP can resend lost packets.
- Internet uses both protocols because both of them compliments each other
- https://www.youtube.com/watch?v=5o8CwafCxnU

Transmission Control Protocol (TCP)

- On Sender Side:
  - TCP breaks message into packets.
  - TCP then pass packets to IP, sending packets to the sender.
  - Wait for acknowledgement/resend message, resend packets as necessary.
- On Receiver Side:
  - TCP receive packets from IP.
  - If all packets are received, send acknowledgement message to sender, the reconstruct the message from packets.
  - If some packets are missing, send resend message.

Internet Protocol (IP)

- IP uses IP Address to relay packets across networks
- IP also decides which datagram (packet) path to take, this process is called **Routing.**

Data Flow of the Internet Protocol Suite
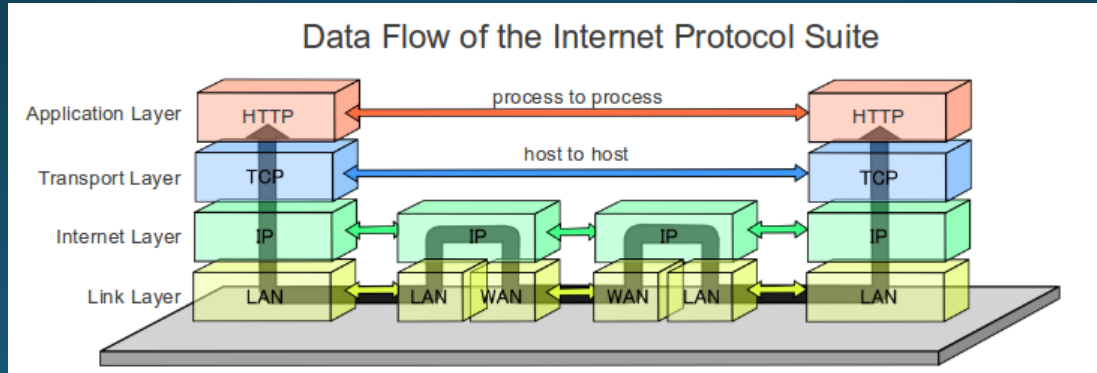
IP Address

- Each computer on the Internet must have unique IP Address

- IP Address consists of 4 numbers separated by dots. Each number ranges from 0 to 255

- Current version of IP is IPv4 Address

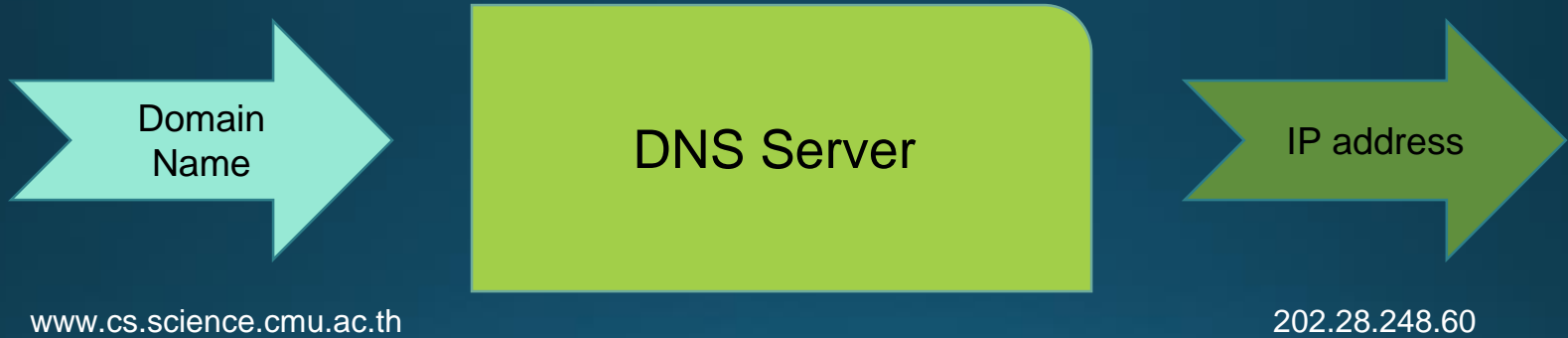- For example, 202.28.249.7 is an IP address for www.cmu.ac.th

Future IP Address

- Internet users start to reach billion active users but IP Address is limited
    - IP Address that begins with 18 is IP Address of computers at MIT but MIT doesn't have enough computers to use all those IP Address

- One solution is to increase the size of IP Address

- IPv6 Address are currently being developed and tested along side IPv4 Address. In the near future, IPv4 Address will be retired. (just like when phone number changes form 9 digits to 10 digits)

- Example: IPv6 address for www.cmu.ac.th is 2001:3C8:5007::98

Domain Name

- IP Address is hard to memorize. For example, if we want to access Facebook, we have to type its IP Address of 69.63.176.13

- Domain Name is invented to cover IP Address so we can only need to type www.facebook.com instead of 69.63.176.13

- Web Browser will connect to Domain Name Server (DNS) to translate www.facebook.com to 69.63.176.13

- https://www.youtube.com/watch?v=5o8CwafCxnU

DNS Server

Domain Name → DNS Server → IP address

www.cs.science.cmu.ac.th

202.28.248.60

Reading Domain Name

- To read a domain name, we start from the **rightmost** part of the domain name, or Top Level Domain (TLD)

- 3-letter (or more) TLD usually indicates Type of the entity (commercial, governmental organization, etc.)

- 2-letter TLD usually indicates where the domain is registered (China, Thailand, Myanmar, etc.)

- More information at
  - https://en.wikipedia.org/wiki/List_of_Internet_top-level_domains

Examples of TLD

TLD	Intended Use (Original)
.com	Commercial
.net	Network Infrastructure
.org	Organization
.gov	Government (US)
.edu	Educational Organization
.mil	Military (US)
.int	International Organization (Treaty)
.biz	Business
.info	Informational Site

TLD	Country
.cm	Cameroon
.cn	China
.mm	Myanmar
.mn	Mongolia
.th	Thailand
.tv	Tuvalu
.uk	United Kingdom
.us	United States
.vn	Vietnam

Reading Domain Name (cont.)

- After the TLD, the next level domain can be:
  - Type of entity (if the TLD is country code)
  - Name of the entity (if the TLD is type of entity)
- The domain will get more specific the lower (right) level it gets.
- The leftmost characters indicate <u>service</u> the entity provides.
  - For example, *www* is web service.
- Example domain name: www.cs.science.cmu.ac.th

Uniform Resource Locator (URL)

- To get to a specific item (webpage, file, etc) on the Internet, we need a URL, or web address.

- An example of URL (basic version):

  http://www.cs.science.cmu.ac.th/course/201110/doku.php

  (1)   (2)   (3)   (4)

- A URL consists of:
  1. Protocol
  2. Domain Name
  3. Path
  4. Item Name

Internet Infrastructure (First Layer)

- Each computer or computer network will connect to Internet Service Provider (ISP) such as TOT, 3BB, True, AIS Fiber

- Because ISP needs to provide service to customers all over the country, it has multiple connections in many provinces called Point of Presence (POP)

POP

LAN
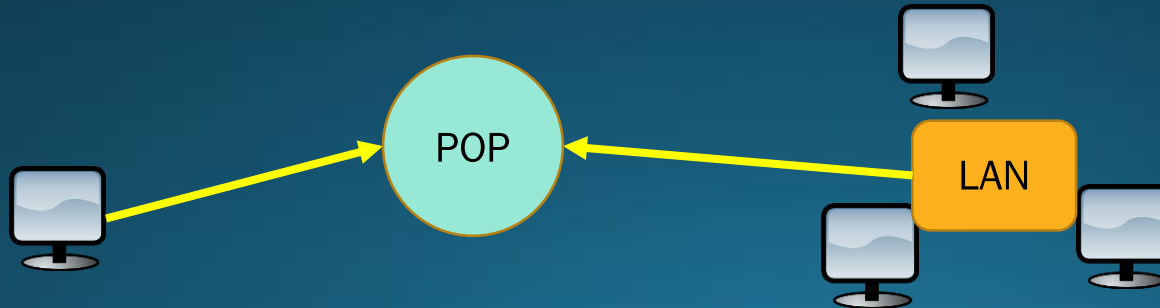
Internet Infrastructure (Second Layer)

- Each POP connects to bigger connection points called Network Access Points (NAPs)

- NAPs has no owners because it accepts all connection from POP in different ISP
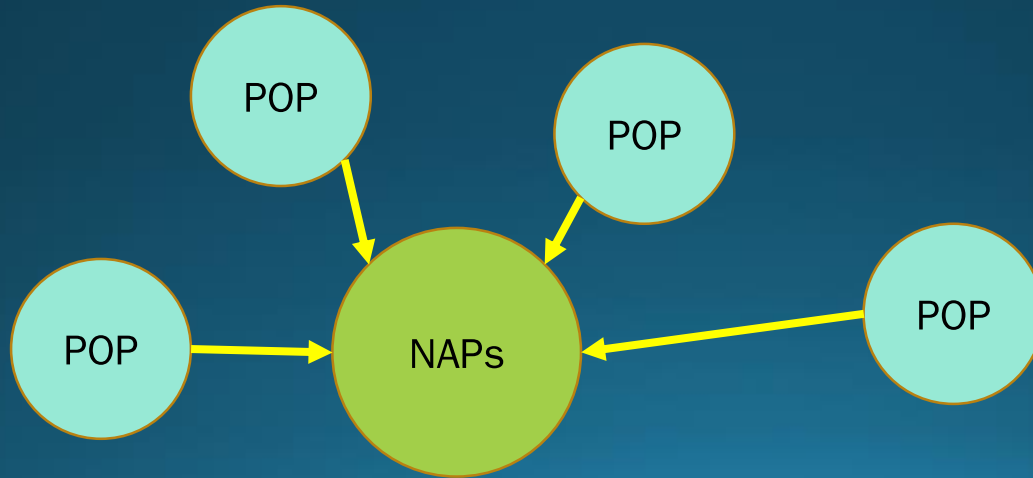
Internet Infrastructure (Final Layer)

- NAPs from different countries communicate via wired and wireless. We call this communication the Internet!!!

NAPs

Internet

NAPs

NAPs
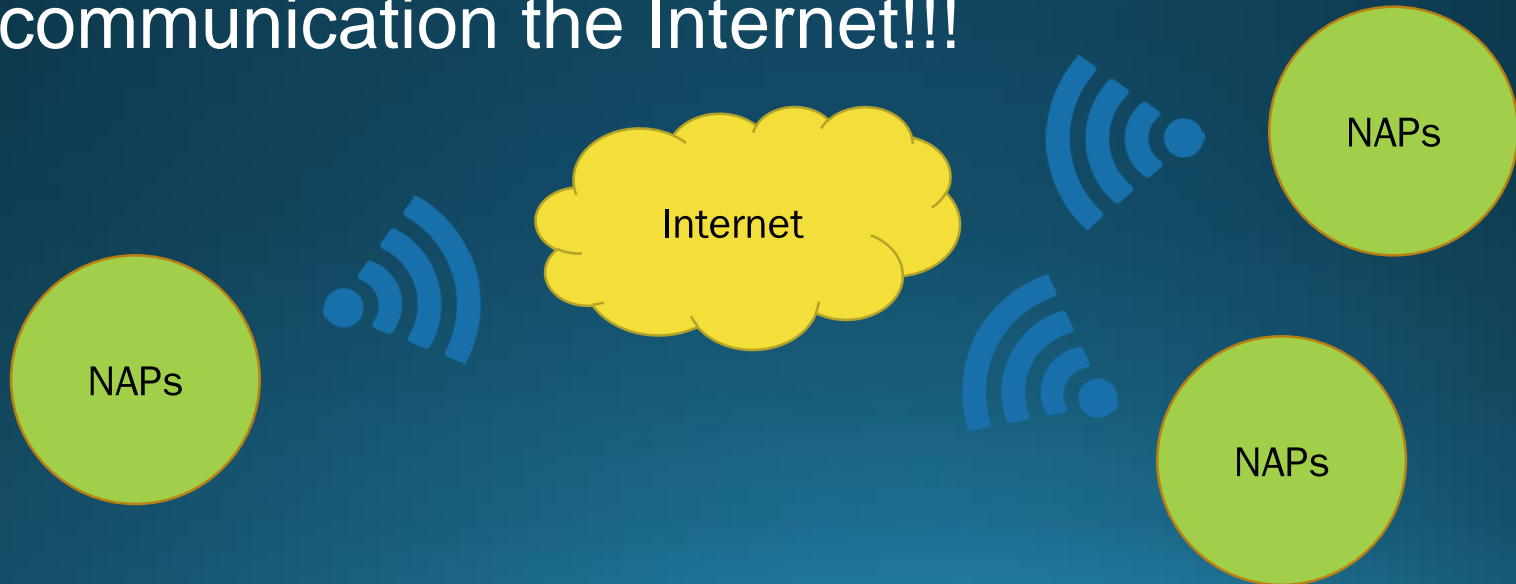
Examples of Connection: Wire Connections

- Copper wire
  - Carry data as electromagnetic signal
  - Example: telephone wire, LAN cable, coaxial cable for bale TV/modem
- Optical Fiber Cable (or Fiber Optics)
  - Carry optical (light) signal
  - Usually faster but more expensive than copper wire
  - Example: Fiber internet
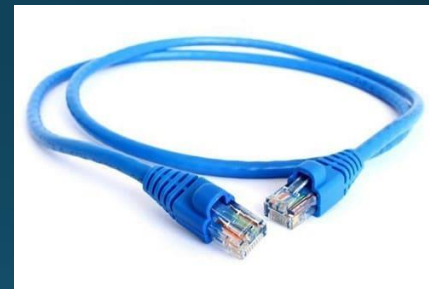
Examples of Connection: Wireless Connections

- (Possibly) quicker, cheaper to set up over long distance than wired connection, but slower and prone to noise

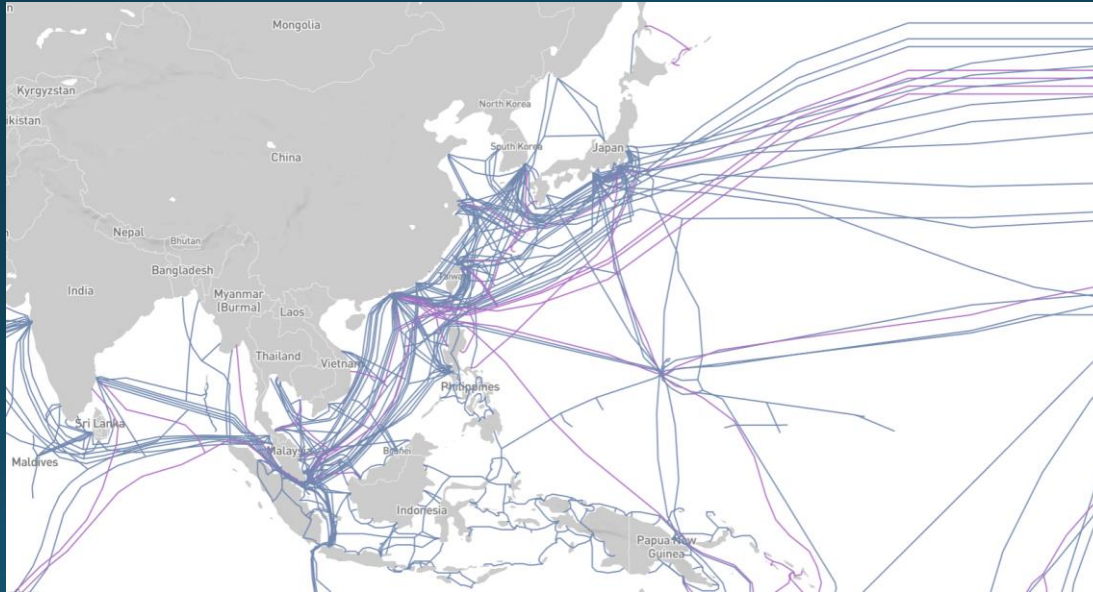- Example: Satellite, Ad-hoc Regional Wireless Network

Source: http://www.electricalelibrary.com

Source: https://loon.com/

22
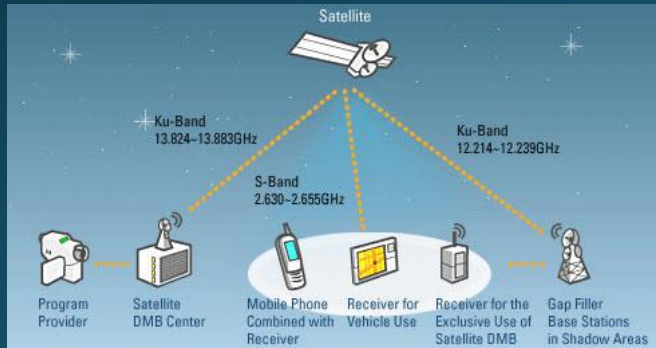
Map of Undersea Cables

- It is better (quality and overall cost) to set up wired connections for most frequently used route.


Source: https://live.infrapedia.com/

Wireless Connection: Cellular Networks

- Also called Wide-area Wireless Access
- For mobile phone (2G, 3G, 4G networks)
- Devices (phones) connect wirelessly to the network via cellular towers
- When you move, the phone will switch from one cellular tower to another automatically
- There are a few of them in the university too! Can you find one?

A cell tower (source: wikipedia)

An Example of Cellular Network

Cellular Network

Source: http://www.rfwireless-world.com
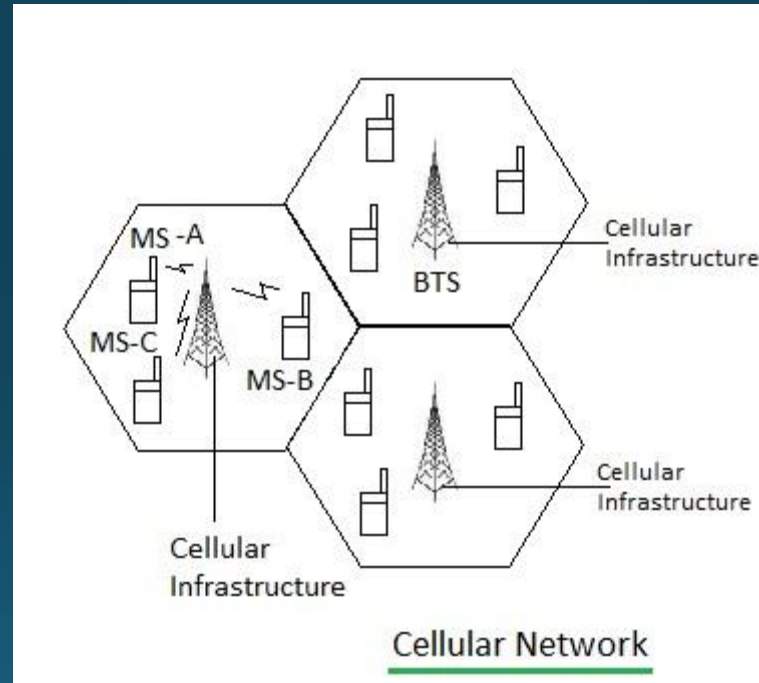
Wireless Connection: Wireless LAN

- Usually used indoor, connecting users to networks wirelessly, via wireless router.

- The router itself is usually connected to the network through wired connection.

- Short range.

Internet Servers and Clients

- Every component in the internet acts as server or client or both

- Servers are service providers for other computers such as Web servers, e-mail servers, FTP servers, etc.

- Clients are users of those services

- Usually, services on the Internet use <u>client-server</u> model, one provides service, the other uses that service.

- But a service can use peer-to-peer model, where everyone involved provide and use the service at the same time. Example: bittorent file-sharing

How Big is The Internet?

- TCP/IP is the most crucial part of the Internet because we can connect to people in different networks without hassle. If you want to be on the internet, you must obey TCP/IP.

- No one controls the (entire) Internet so we feel "freedom" on the Internet

- (As of 2017) There are over 3.5 billions users and 45 billions registered websites. Technology that involves the Internet takes a huge leap in development in the past 10 years.

How Fast is Your Internet Connection?

- There are two ways to measure internet connection speed: Bandwidth and Latency (Lag).
- Bandwidth
    - Amount of data that can be transfer during a second
    - Usually measure in (kilo, mega)bytes/second
    - Affect how long it takes to download a file
- Latency
    - Measure delay (seconds)
    - Time it takes for data to reach you
    - Affect real-time communication/ online gaming

1 Minute in 2019

- 1,000,000 Facebook logins
- 4.5 million YouTube views
- 3.8 million Google searches
- 46,200 Instagram posts

Image Source: Visual Capitalist