Introduction to Data Communications

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What is Data Communications?

- When we communicate, we are sharing information
  - Local sharing. E.g. face to face communications
  - Remote sharing. E.g. over some distance
    - A side note: ‘tele’ means ‘far’ in Greek. Telecommunications: communicate of a large distance. Telephony, telegraphy, television, …
- Data
  - Refers to the information that is shared
  - Information/data comes in various forms: text, numbers, images, audio, video.
- Data Communications
  - Exchange of data between two devices via some transmission medium

- An effective data communications system depends on:
  - Delivery: the data must be delivered to the correct destination
  - Accuracy: the data received must be accurate representations of the data sent
  - Timeliness: the data should be delivered within a reasonable time

Today's Data Communications

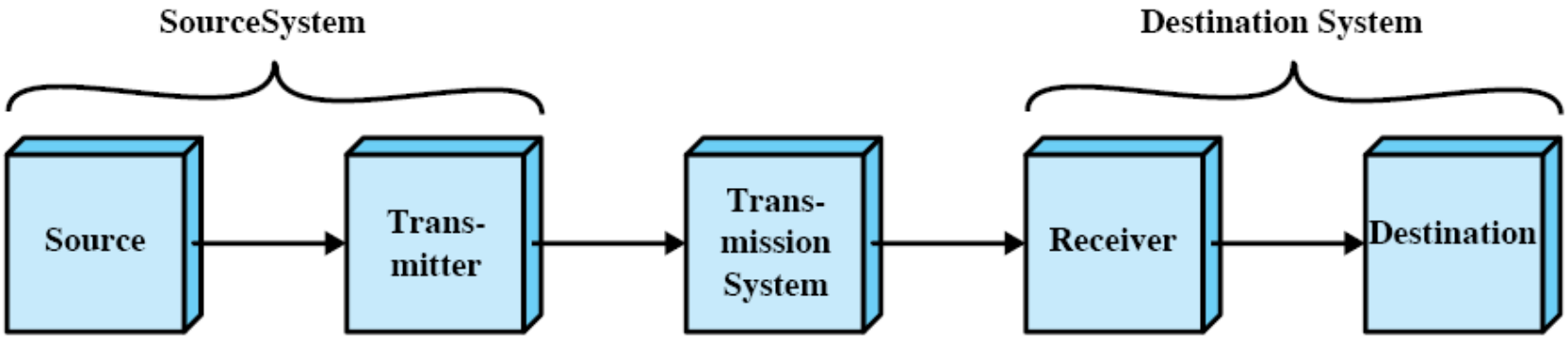
- Trends:
  - Traffic growth at a high and steady rate
    - Office automation, remote access, online transactions, …
  - Development of new services
    - New services require higher capacity; higher capacity enables new services
  - Advances in technology
    - Cheaper and faster computer and communication technologies
    - Intelligent voice and data services, e.g. giving different levels of service to different traffic
    - The Internet and Web provide businesses with new ways of reaching customers, suppliers partners, …
    - Mobility - people do not want to be restricted to desks/homes to access network services

Today's Data Communications

- Basic data communications theory and technology was started in 1850's. Developed through telephony based systems in 1900's, until digital communications and the Internet in 1970's.
- Some of the changes that have impacted on data communications are:
  - Emergence of high-speed LANs
    - LANs are now essential part of any organisation
    - High speed LANs are needed for use of data intensive applications (media, publishing, CAD, engineering, …)
  - Corporate Wide Area Networking
    - Organisations want to link their LANs together and allow employees and others remote access to their LAN
    - Increase amount of traffic sent on WANs
      - Used to be 80% internal (LAN), 20% external (WAN)
      - Now the external component is much more significant
  - Digital electronics
    - Consumer electronics moved to digital technologies
      - Digital cameras, CDs, DVDs, …
    - Desire to transfer this content over LANs, WANs and Internet
    - Networks must be faster to support this traffic

Simplified Communications Model

Fundamental purpose of communications system is the exchange of data between two parties



- Source - Device that generates data to be transmitted, e.g. telephone, PC
- Transmitter - Converts data from source into transmittable signals
  - E.g. Modem takes bits (0's and 1's) and converts into analog signal)
- Transmission System - Carries data from source to destination
  - Maybe a single physical line or complex set of networks
- Receiver - Converts received signal into data; dual of transmitter
- Destination - Takes incoming data (dual of source)

Communications Tasks

Communications model makes it look easy!
But many tasks must be performed …

Transmission system utilization	Addressing
Interfacing	Routing
Signal generation	Recovery
Synchronization	Message formatting
Exchange management	Security
Error detection and correction	Network management
Flow control	

Communications Tasks

- **Transmission system utilization** - need to make efficient use of transmission facilities typically shared among a number of communicating devices
- a device must **interface** with the transmission system
- once an interface is established, **signal generation** is required for communication
- there must be **synchronization** between transmitter and receiver, to determine when a signal begins to arrive and when it ends
- there is a variety of requirements for communication between two parties that might be collected under the term **exchange management**
- **Error detection and correction** are required in circumstances where errors cannot be tolerated
- **Flow control** is required to assure that the source does not overwhelm the destination by sending data faster than they can be processed and absorbed
- **addressing** and **routing**, so a source system can indicate the identity of the intended destination, and can choose a specific route through this network
- **Recovery** allows an interrupted transaction to resume activity at the point of interruption or to condition prior to the beginning of the exchange
- **Message formatting** has to do with an agreement between two parties as to the form of the data to be exchanged or transmitted
- Frequently need to provide some measure of **security** in a data communications system
- **Network management** capabilities are needed to configure the system, monitor its status, react to failures and overloads, and plan intelligently for future growth

Communication Systems

- Two important parts of a communication system are:
  - Transmission Medium
    - The physical technique for getting information from transmitter to receiver
  - Networking
    - Communications between two entities is not sufficient for many tasks
    - Many different transmission systems can be utilised to form a communications network
      - Allowing any user on the network to communicate with any other users, independent of medium and technology they use
- An example communications network is the Internet
- Terminology:
  - An internet (lowercase ‘i’): a set of interconnected networks
  - The Internet (uppercase ‘I’): a specific internet, the one we use everyday, which uses the Internet Protocol (IP)

Transmission Medium

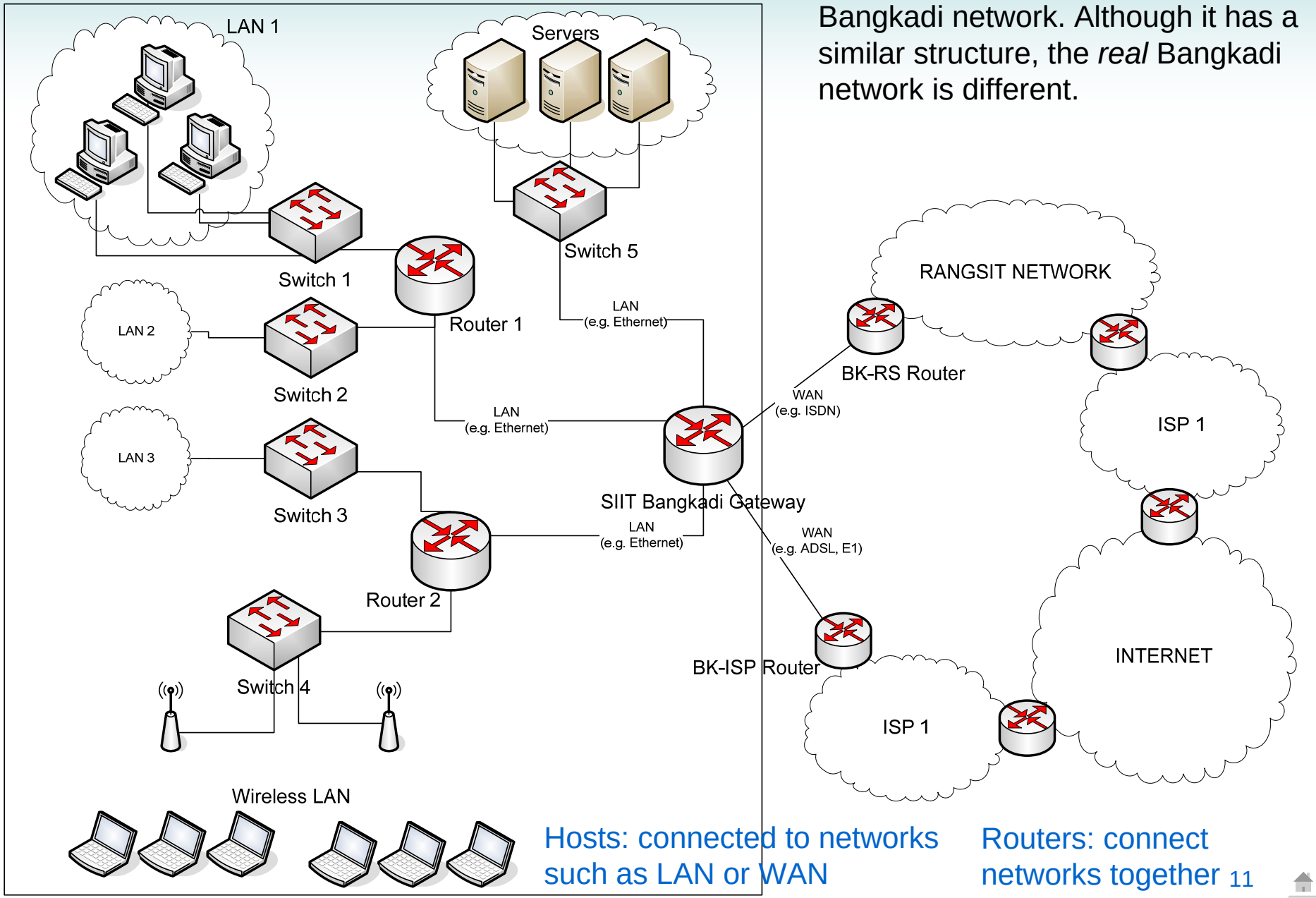
- Transmission line is building block of a communications facility
  - The “link” between a transmitter and receiver
    - (It may not be a physical link, e.g. in the case of wireless)
- What medium should be used for the link?
  - It often depends on who owns the link and the amount of traffic to carry
    - E.g. A link for internal use, the choose is entirely up to business (e.g. end-user, company). Long-distance links between cities and countries are controlled by other companies, telecommunication companies like TOT, CAT
- Many different technologies to choose from:
  - Copper
  - Fiber optic
  - Wireless
- Although fiber optics provide very large capacity, transmission costs still high
  - Hence interest in efficiency improvements

Networking

- Growth of number and power of computers is driving need for interconnection
  - Users want to be able to communicate with any other user
- Need communication software (e.g. Internet protocols) as well as communication network technologies
- Rapid integration of voice, data, image and video technologies
- Two broad categories of communications networks:
  - Wide Area Network (WAN)
    - Cover large geographical area (cities, countries)
    - Operated by carriers
  - Local Area Network (LAN)
    - Cover buildings, homes and small campuses
    - Usually owned and operated by organization that owns end devices
    - High end-user data rates than WAN
- An internet interconnects different WANs and LANs

SIIT BANGKADI LOCAL AREA NETWORK

This is a fictional example of the SIIT Bangkadi network. Although it has a similar structure, the *real* Bangkadi network is different.



Hosts: connected to networks such as LAN or WAN

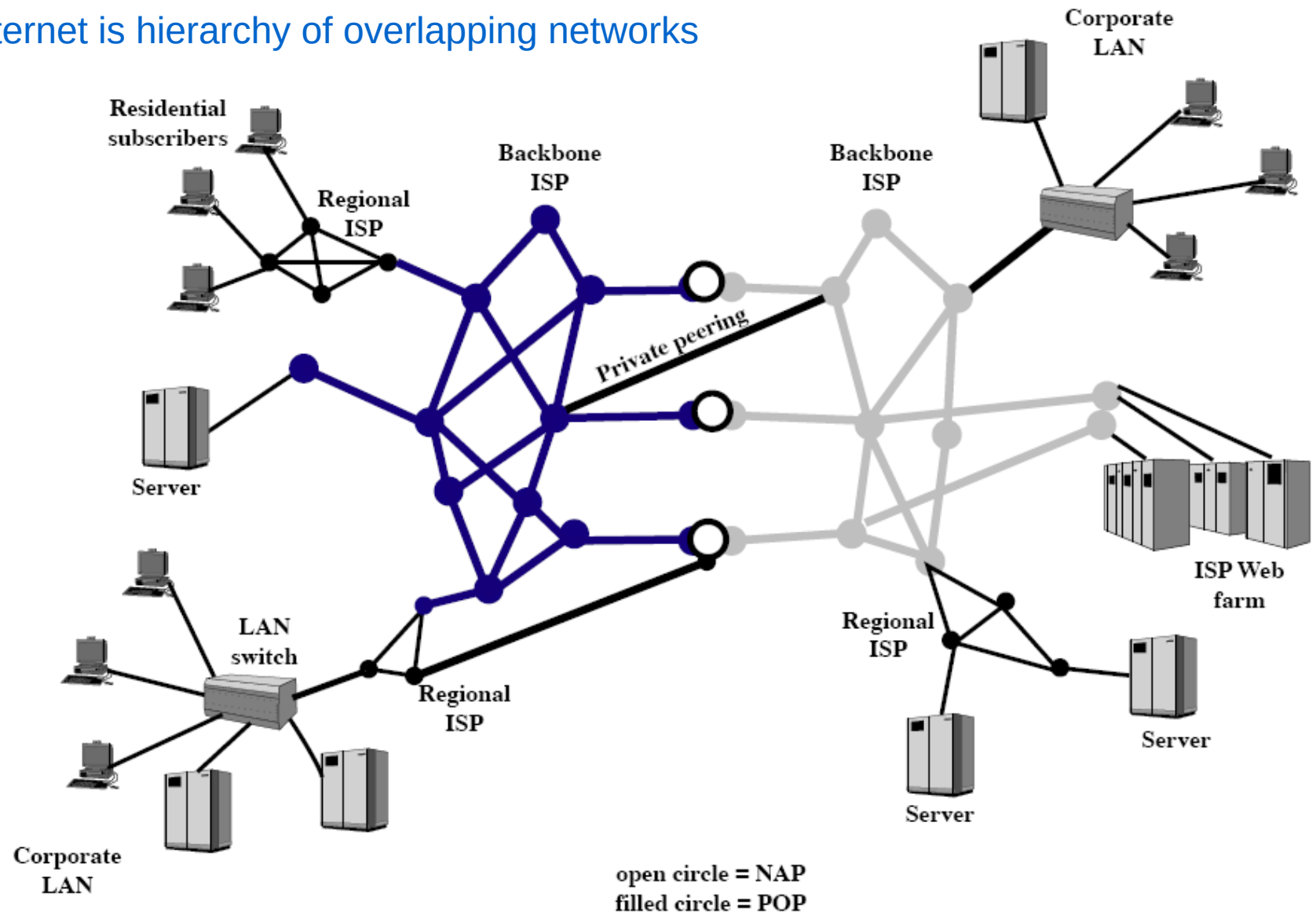
Routers: connect networks together

The Internet

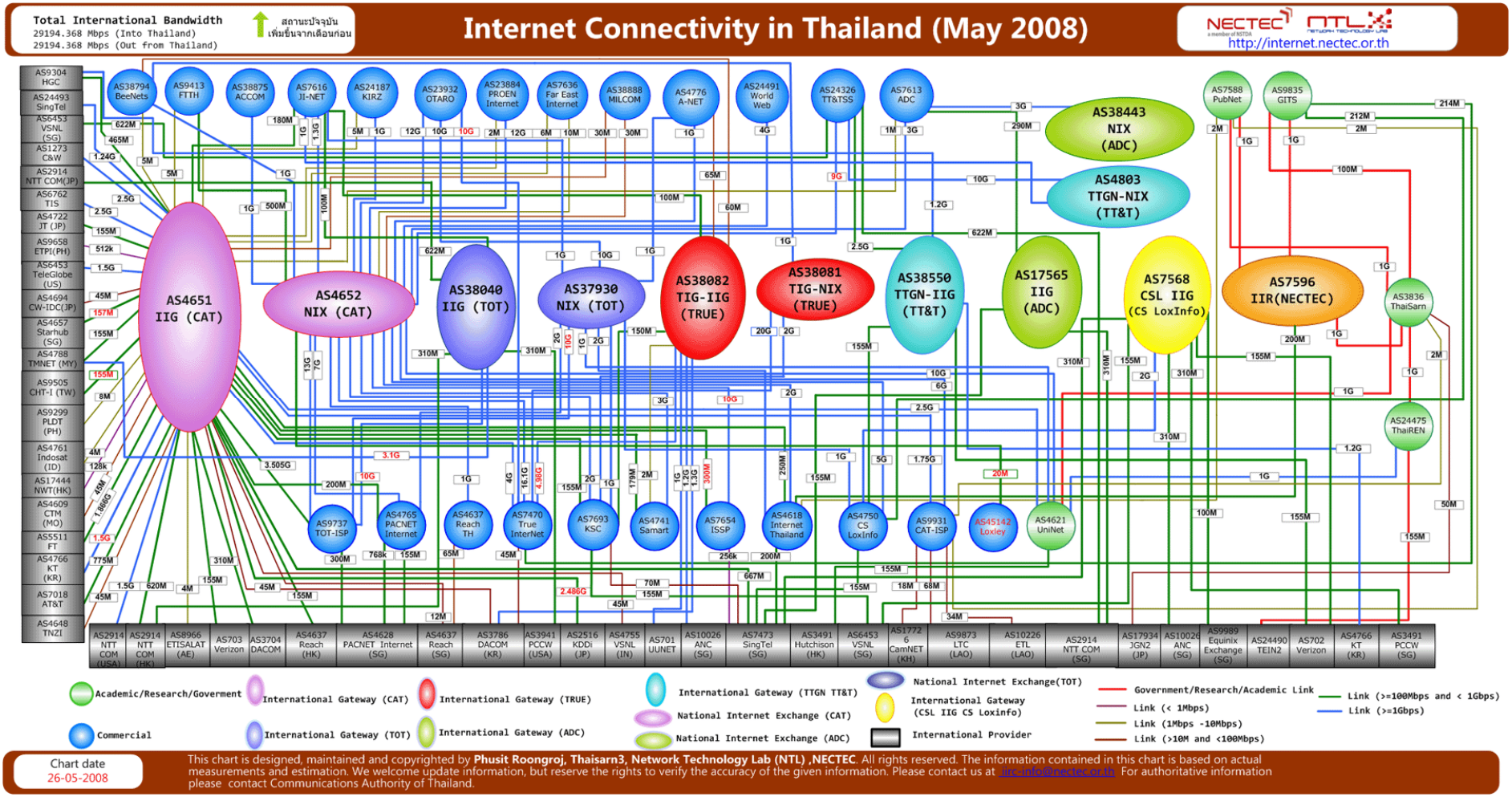
- The Internet evolved from a US Department of Defence research network: ARPANET, developed in 1969
  - Used packet switching technology
    - Same technology was also applied to packet radio and satellite communication used by US DoD
  - Development and standardization of the Internet suite of protocols: TCP/IP
- What is the Internet?
  - Collection of networks connected together using common software: Internet Protocol (IP)
  - Although network technologies differ, any computer can communicate with any other computer (providing they are using IP)

Internet Architecture

Internet is hierarchy of overlapping networks



Thailand Internet Map



NECTEC Thai Internet Map

- Graphical map of Internet exchanges and gateways in Thailand
  - Latest map available from http://iir.ngi.nectec.or.th/
- International Internet Gateways (IIG)
  - Connect networks within Thailand to ISPs in other countries
  - Six commercial IIG: CAT, TOT, True, TT&T, ADC, CSL Loxinfo
  - Total capacity to/from Thailand: 29Gb/s
- National Internet Exchanges (NIX)
  - Connect ISPs within Thailand
  - Five NIX: CAT, TOT, ADC, True, TT&T
  - More than 20 different registered ISPs within Thailand
- Academic and Research Networks
  - NECTEC, UniNet, ThaiSarn, …