

Computer Networks

Course introduction, ubiquitous information
society and computer networks

College of Information Science and Engineering
Ritsumeikan University

Agenda

- About this course
- Uses of computer networks
- Types of computer networks
- Network technologies
- Policy, legal, and social issues
- Summary

General course info

- **Course name:** Computer Networks
- **Course format:** Classroom - Forest 101 (BCP Level 1-2) or Zoom (BCP Level 3-4)
 - if a student is unable to attend face-to-face classes due to special circumstances (e.g., cannot get a visa), application for eligibility of online class participation must be done through the office
- **Textbook:** Andrew Tanenbaum, Nick Feamster, David Wetherall: Computer Networks (Global edition, 6th edition)
- **Instructor:** Mate Kovacs (~ mahteh kovatch)
 - e-mail: kovacsm@fc.ritsumeai.ac.jp
 - consultations: by appointments
- **Teaching assistant:** Buriakov Daniil
- I will share the lecture slides via manaba-R

Grading criteria

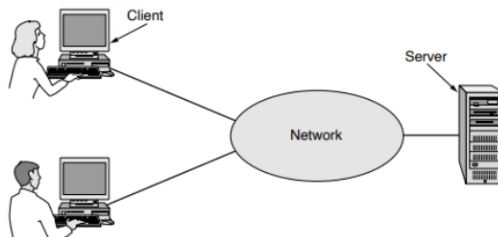
- Student course work will be evaluated based on the following:
 - final examination 60% (in case we are unable to conduct final examination, an in-class exam will be conducted during the last lecture on Week 15)
 - in-class short tests and an in-class review tests 40% (in case we are unable to conduct final examination, this becomes 100%)
- Students who miss more than 5 classes automatically receive an "F" mark

Concept of a computer network

- The demand for sophisticated information processing grows fast
- The concept of the "computer center" as a room with a computer where people bring their work for processing is obsolete
 - the old model is replaced by systems with a large number of separate but interconnected computers
- In simple terms **computer networks** are a collection of interconnected, autonomous computing devices
 - computers are interconnected if they can exchange information
 - transmission media can be copper wire, fiber optic cable, radio waves, etc.
 - example: the Internet

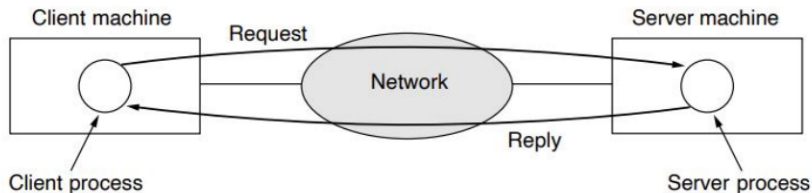
Client-server model (1)

- Online distribution has allowed the distribution of news to reach to broad and large audiences
- Online libraries and retail sites host digital versions of content
- Much information on the Internet is accessed using a **client-server model**
 - the client explicitly requests information from a server hosting that information, e.g. a web application



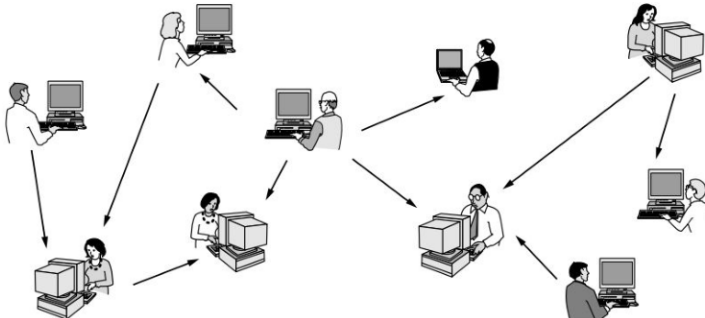
Client-server model (2)

- 1 The client is sending a message over the network to the server
- 2 Client waits for reply
- 3 Server performs the requested work: looks up the requested data and send back a reply



Peer-to-peer

- When accessing information **peer-to-peer** (p2p), individuals forming a loose group are communicating with others in the group
 - everybody can communicate with one or more people: no fixed division into clients and servers
 - typical examples are music and video sharing (e.g., torrent), email



Person-to-person communication

- **Instant messaging** and multi-person messaging services (e.g., Twitter), to enhance human-to-human communication
- **Social networks**, where the flow of information is driven by the relationships that people declare between each other (e.g., Facebook)
- A **wiki** is a collaborative site that members of a community edit (e.g., Wikipedia)

Electronic commerce

- Popularity of e-commerce for online shopping and to give access to financial institutions
 - e.g., buying on Amazon, paying bills online, transferring money, or online auctions (p2p)

Tag	Full name	Example
B2C	Business-to-consumer	Ordering books online
B2B	Business-to-business	Car manufacturer ordering tires from a supplier
G2C	Government-to-consumer	Government distributing tax forms electronically
C2C	Consumer-to-consumer	Auctioning second-hand products online
P2P	Peer-to-peer	Music or file sharing; Skype

Entertainment

- Music, radio, TV programs over the Internet
 - complementing and replacing traditional mechanisms
- IP Television (IPTV) systems using the IP technology instead of cable TV
 - all of this can be moved between different devices and displays, speakers via a wireless network
 - interactive movies and series with alternative scenarios
- Multi-person and real-time simulation games
 - e.g., MMORPGs

The Internet of Things

- **Ubiquitous computing** entails computing that is embedded in everyday life
 - door and window sensors at homes, smart home sensors (e.g., for energy consumption), smart refrigerators
 - in simple terms, **IoT** (Internet of Things) is about connecting our electronic devices to the Internet
- **Ubiquitous information society:** "A term that describes an information environment in which computers exist in every nook and cranny in life and society so that people can access computers anytime, anywhere." (Hitachi)
- More and more consumer electronic devices are networked
 - e.g., devices can use power-line networks to send information through the house over the electrical wires

Broadband Access Networks

- Nowadays, one of the prevailing reasons to buy a PC is to get internet access
 - many consumer electronic devices come with embedded computers to access networks (mainly wireless)
- Internet access provides home users with *connectivity* to remote computers
 - the main benefit comes from connecting devices to other destinations than home at high speeds
 - Metcalfe's law (1993): value of a network is proportional to the square of the number of users (roughly the number of different possible connections)
- **Broadband access** is delivered to homes through copper, coaxial cable, or optical fiber

Mobile and Wireless Access Networks (1)

- Mobile computers (e.g., laptops, tablets, smartphones) are one of the fastest-growing segments of the computer industry
 - since physical connectivity with mobile devices can be a problem, there was always a lot of interest in wireless networks
 - cellular networks, wireless hotspots (802.11 standard) are popular
 - the rise of mobile and wireless networking has led to a revolution in ground transportation (e.g., Uber, Lyft)
- There are **fixed-wireless** and **mobile wireless** networks

Wireless	Mobile	Typical applications
No	No	Desktop computers in offices
No	Yes	A laptop computer used in a hotel room
Yes	No	Networks in unwired buildings
Yes	Yes	Store inventory with a handheld computer

Mobile and Wireless Access Networks (2)

- **Short Message Service** (SMS or text messaging) via cellular networks using a mobile phone was extremely popular before the wireless alternatives on smartphones (e.g., iPhone, Android devices)
- Mobile phones often know their locations using **GPS** (Global Positioning System)
- Photos and videos are often **geo-tagged** to record the location and annotate the media
- Mobile phones are used in **m-commerce** (mobile commerce) to authorize payments and other transactions
 - if equipped with **NFC** Near Field Communication, mobiles can interact with a nearby reader for payment

Content provider networks

- Many internet services are now served from the *cloud* or a **data-center network**
 - data center networks serve the growing demands of **cloud computing**, designed to move large amounts of data between servers in the data center and the rest of the Internet
- A **CDN** (Content Delivery Network) is a large collection of servers that are geo-distributed in a way that content is placed as close as possible to the users that are requesting it
 - many services use CDN need to deliver content to users fast all around the world (e.g., Google, Netflix)
 - historically, early data-center network designs were based on a simple tree topology that did not scale well

Transit and Enterprise networks

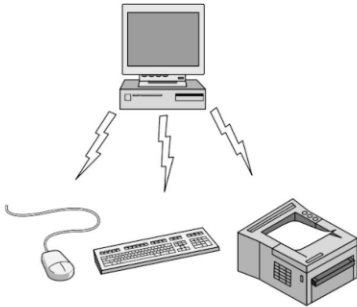
- Usually, content must traverse the Internet from the data center to the access network, and from there to the user device
- When the content provider and the **ISP** (Internet Service Provider) are not directly connected, they rely on a **transit network**
 - e.g., between ISPs and large content providers like Google or Netflix, but as the size of access networks and the content provider networks grow, it is more like a backup
- Many organizations have a common network which allows the employees to share data and resources, etc. (e.g., Excel tables, printers)
 - **VPNs** (Virtual Private Networks) are often used to connect individual networks at different sites into one logical network
- Other technologies like **VoIP** (Voice over IP), **desktop sharing**

PAN, LAN (1)

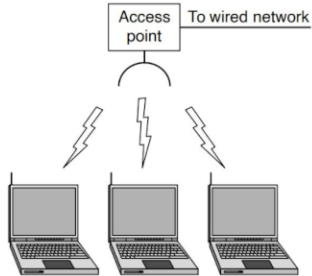
- **PANs** (Personal Area Networks) let devices communicate over the range of a person
 - e.g., a wireless network such as **Bluetooth** that connects a computer with its peripherals
- **LAN** (Local Area Network) is a private network that operates within and nearby a single building
 - In case of wireless LANs, each computer talks to an **AP** (Access Point), **wireless router**, or **base station**
 - the IEEE 802.11 standard running from 11 Mbps to 7 Gbps is called **WiFi**
 - the **Ethernet** (IEEE 802.3) is the most common wired LAN (generally faster, and lower latency)
 - when each computer connects to a **switch** with a point-to-point link, it is a **switched Ethernet** topology
 - a switch has multiple **ports**, each of which connect to one other device

PAN, LAN (2)

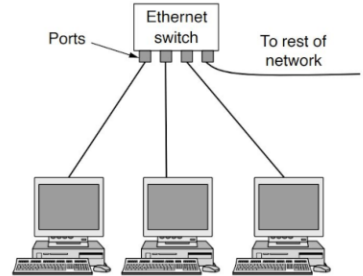
PAN



802.11 WiFi

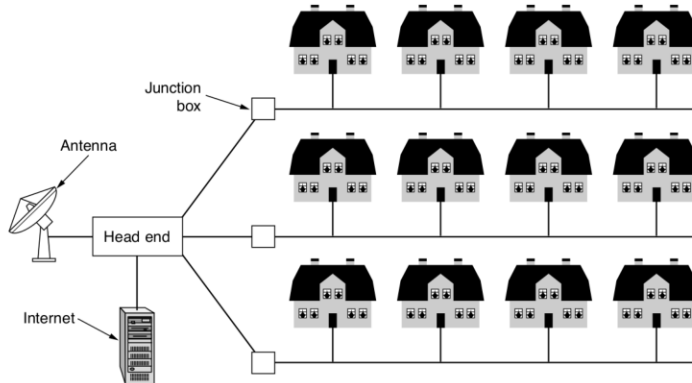


Switched Ethernet



MAN

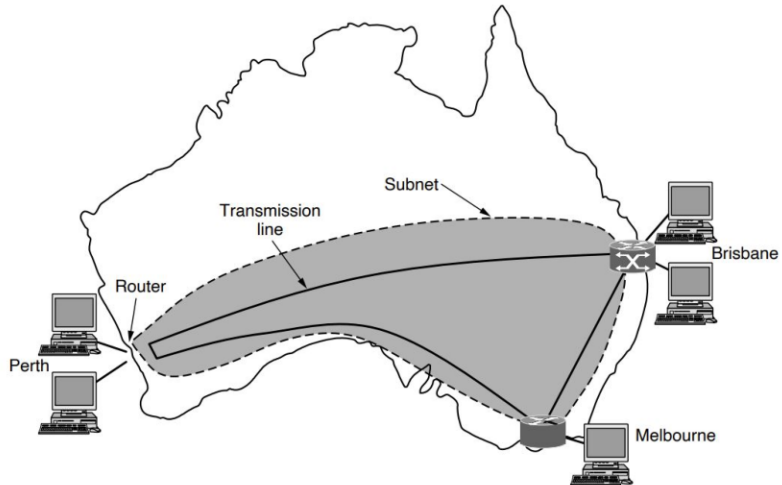
- In a **MAN** (Metropolitan Area Network), both television signals and the Internet are being fed into the centralized cable head-end for subsequent distribution to people's homes



WAN (1)

- A **WAN** (Wide Area Network) spans a large geographical area
 - e.g., a WAN that connects multiple offices of the same company where computers, **hosts** are running applications
 - the rest of the network that connects these hosts are the **subnet**
- Most companies use **switches** to connect multiple **transmission lines**
 - when data arrive on an incoming line, the switch (most commonly called a **router**) chose an outgoing line to forward it
- How the network makes a decision which path to use is called a **routing algorithm**
- How each router makes the decision where to send the information is called a **forwarding algorithm**

WAN (2)



Internetworks

- **Internetwork** is a collection of interconnected networks
 - can be described as a WAN network
- An **internet** is the interconnection of distinct, independently operated networks
 - connecting a LAN and a WAN or connecting two LANs
 - a **gateway device** makes a connection between two or more networks

Policy issues in the ubiquitous information society

- Online speech and user-generated content
- DMCA takedown notices
- Security aspects
 - **DDoS** (Distributed Denial of Service) attack where many machines on the network send traffic towards the victim machine, in attempt to exhaust its resources
 - **spam emails** and **phishing**
- Privacy aspects
 - **cookies** a **location privacy**
- Net neutrality
 - ISPs should provide equal quality of service to a given type of application traffic, regardless of who is sending that content
 - no blocking, no throttling, no paid prioritization, transparency

W1 Summary

- Much information on the Internet is accessed using a client-server model
- In peer-to-peer communication, individuals forming a loose group are communicating with others in the group
- IoT is about connecting our electronic devices to the Internet
- Broadband access is delivered to homes through copper, coaxial, or optical
- There are fixed-wireless and mobile wireless networks
- LAN is a private network that operates within and nearby a single building
 - the IEEE 802.11 standard is called WiFi
 - the Ethernet (IEEE 802.3) is the most common wired LAN
 - a switch has multiple ports, each of which connect to one other device
- A WAN spans a large geographical area with hosts connected by the subnet
- There are policy, legal, and social issues involving computer networks

W2 topic

- Network architecture
 - the Internet architecture, network protocols and services, reference models