# TCP/IP Introduction
# & Network Research @CSE

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# outline

- Internet
  - IP
  - TCP
- Network Research
  - Wireless Network
  - Social Network
  - Content-centric Network
  - Sensor Network, Internet of Things
  - Data Center Network
  - Video Delivery

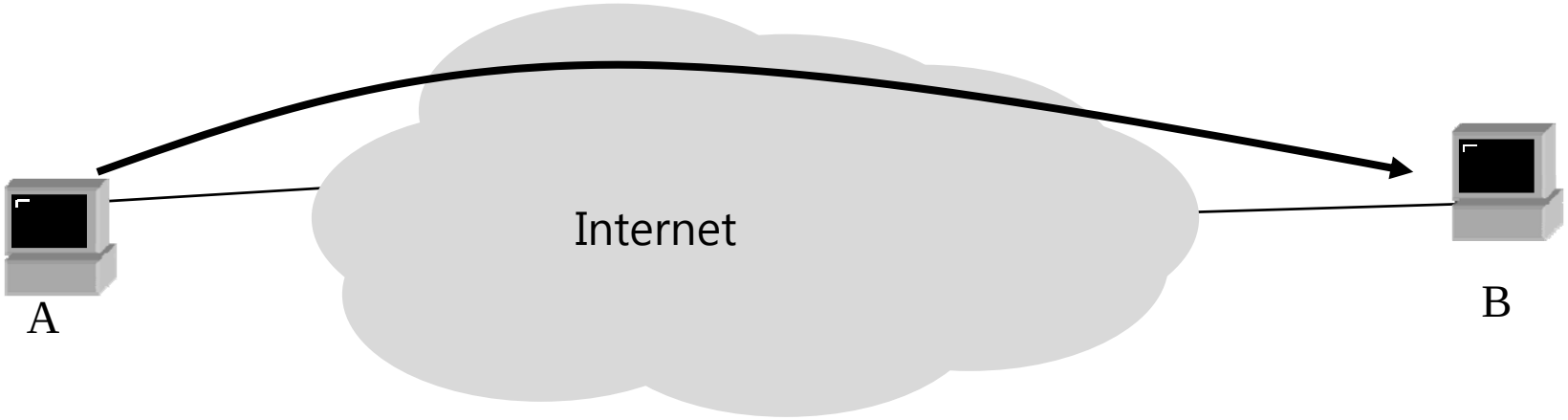
# Internet Protocol (IP)

- IP address is a 32 bit integer
  - Every host has a unique IP address
  - $2^{32} \approx 4$ billion
- Written as 4 octets/bytes in decimal format
  - E.g. 134.79.16.1, 127.0.0.1

- DNS: www.snu.ac.kr
  - 147.46.10.58

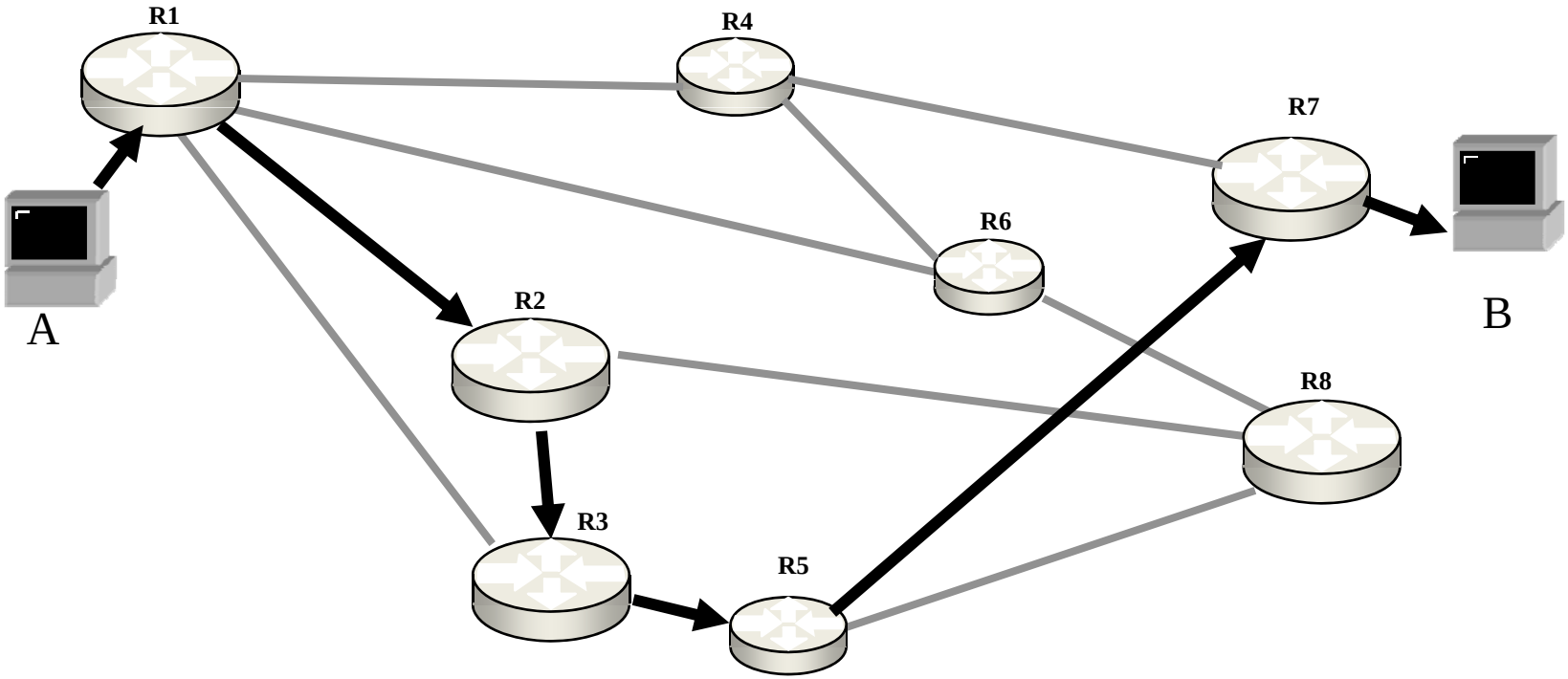
# IP performs routing

- How do packets get from A to B in the Internet?



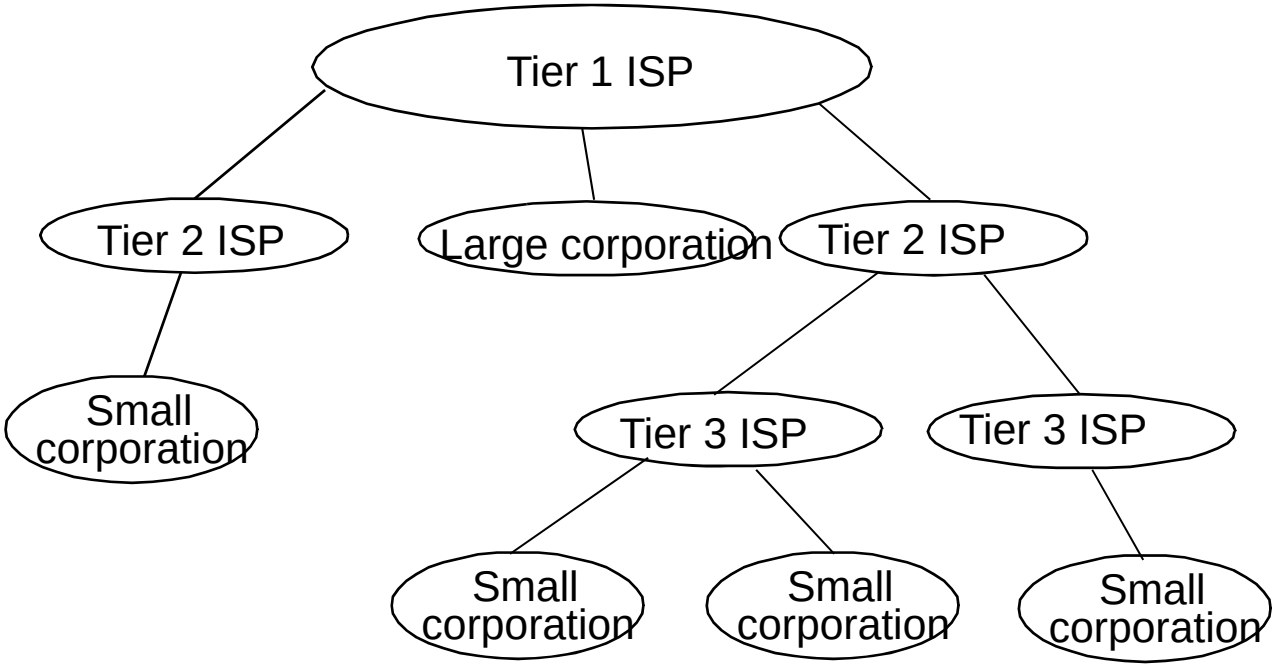
# A Simplified Example

- Connectionless forwarding
  - Each router (switch) makes a LOCAL decision to forward the packet towards B



# Internet structure

- Original Practice

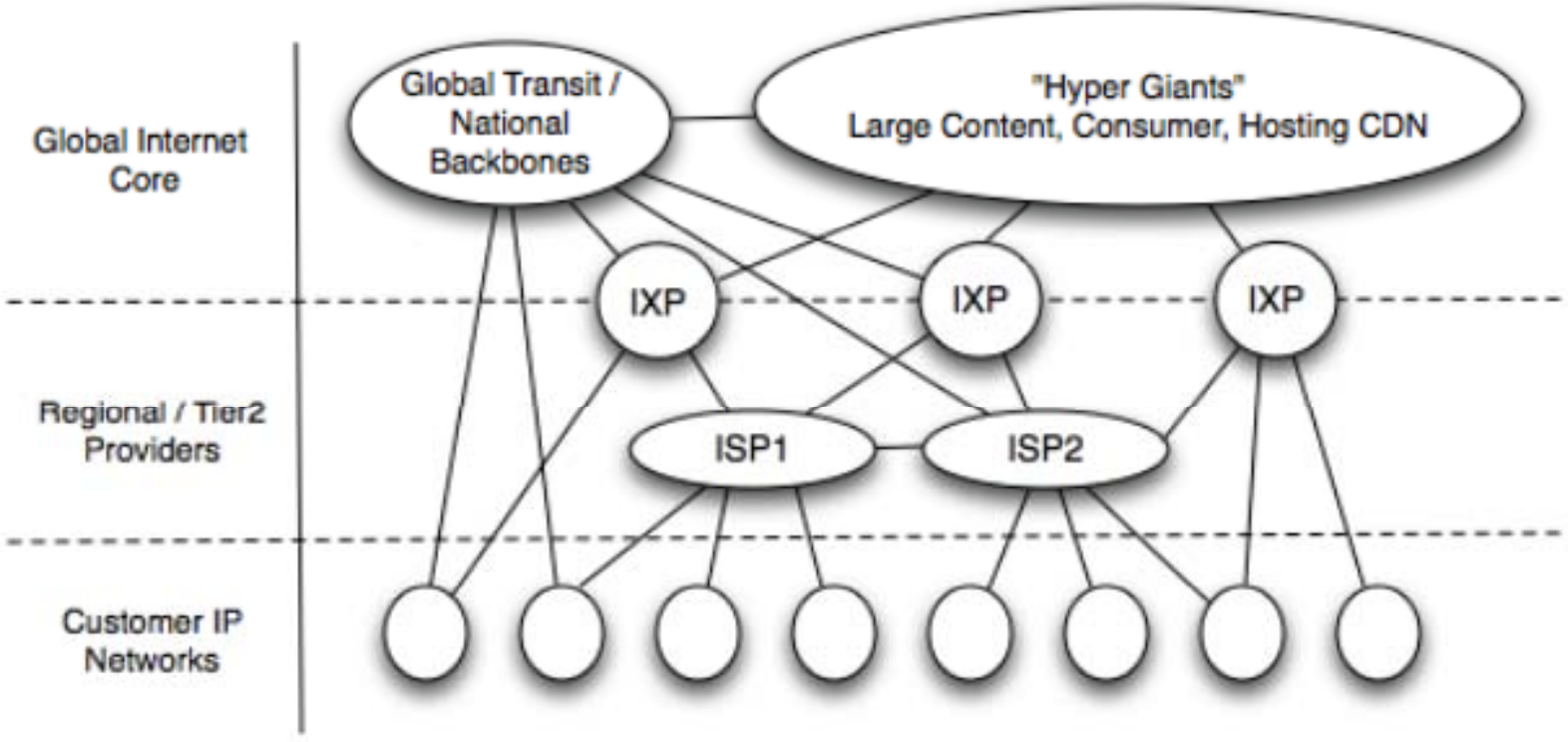



ISP: Internet Service Provider

# Internet structure

- The reality is…

Source: Arbor Networks




* Why peering and multi-homing?

IXP: Internet eXchange Point

# What IP provides to application

- Best effort service
  - it may lose packets
  - it may reorder packets
  - it may duplicate packets

# The Transport Layer

- Two transport layer protocols supported by the Internet:
  - Reliable:
    - Transport Control Protocol (TCP)
  - Unreliable
    - Unreliable Datagram Protocol (UDP)

# UDP

- UDP is an unreliable transport protocol
- UDP does not provide:
  - connection management
  - flow or error control
  - guaranteed in-order packet delivery
- UDP is almost a "null" transport layer

# TCP

- TCP provides the end-to-end reliable connection that IP alone cannot support

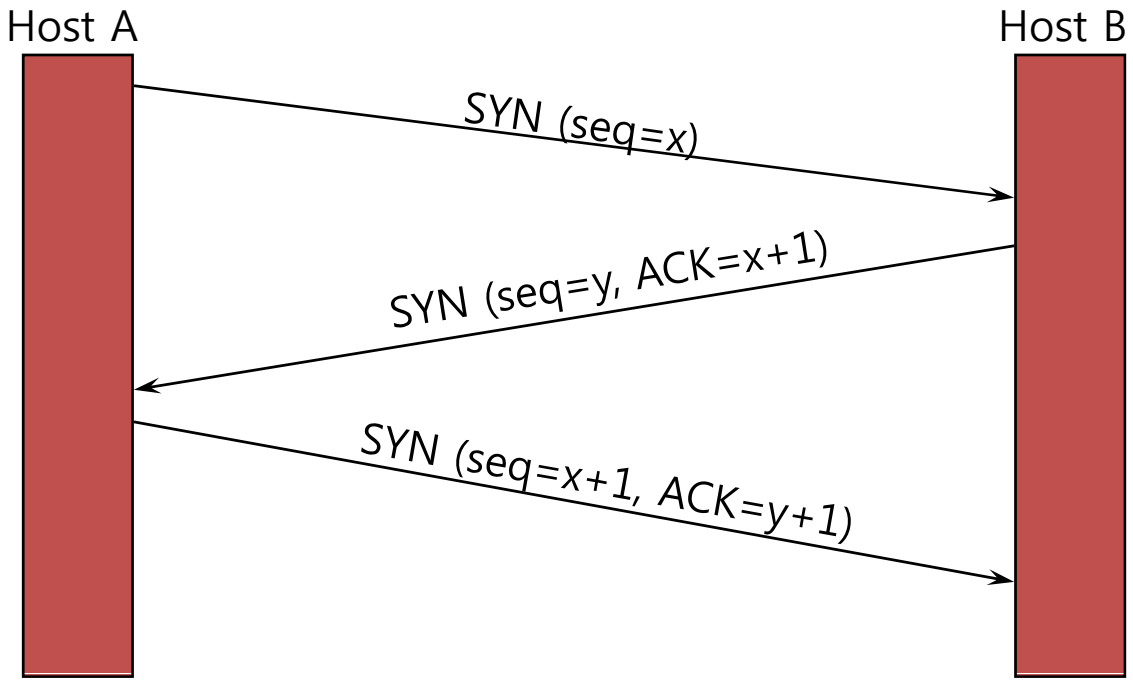
- The protocol
  - Frame format
  - Connection management
  - Retransmission
  - Flow control
  - Congestion control

# Reliability: error detection and recovery

- A packet may be:
  - corrupted
  - completely lost
- TCP is based on explicit acknowledgements (ACK)
- When a data packet is received, the receiver generates an ACK packet

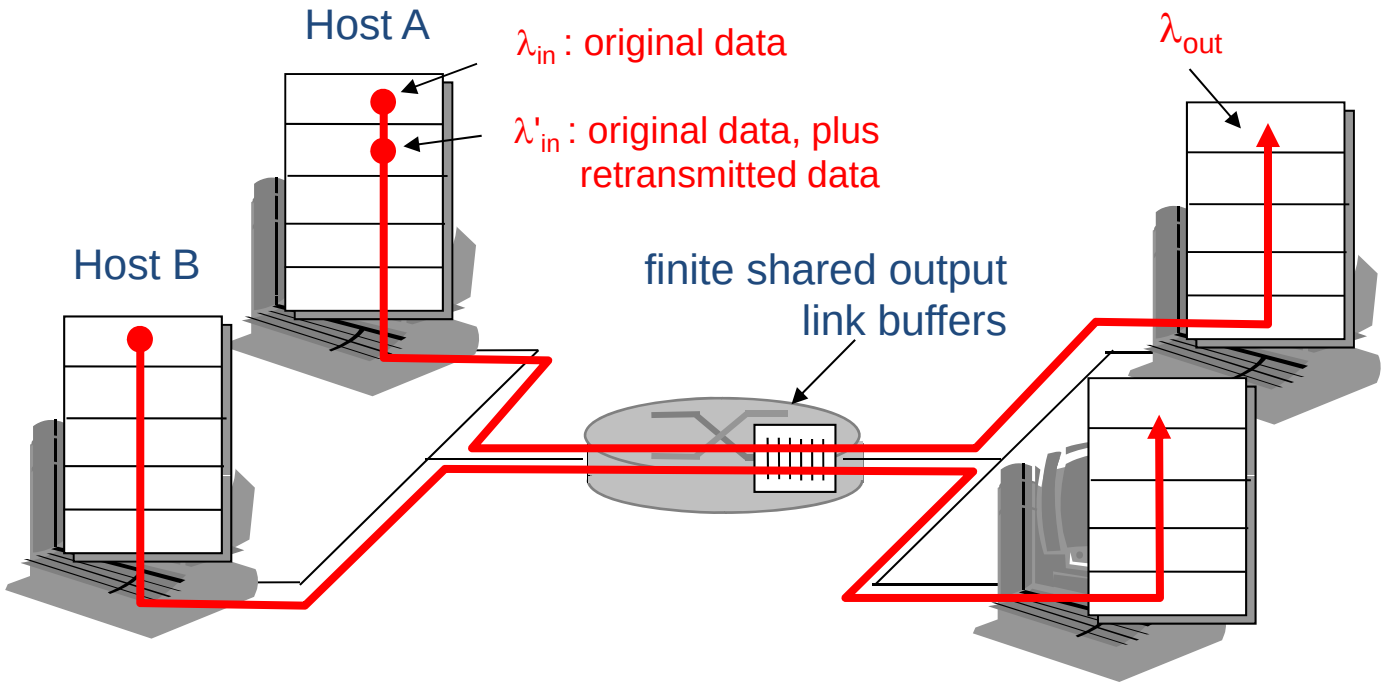
# TCP Connection Establishment

- Three-way Handshake



# Bottleneck Bandwidth

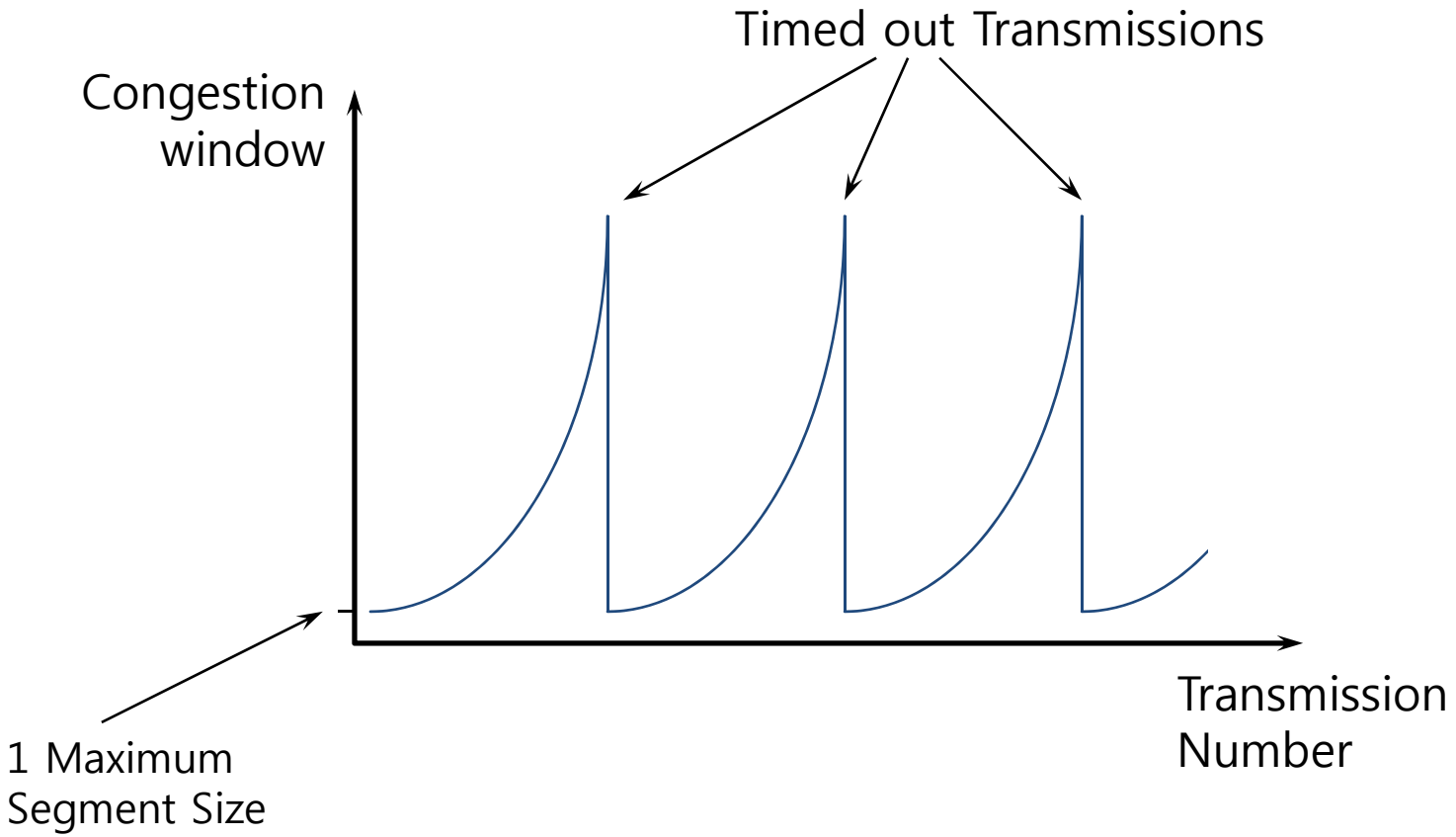
- one router, *finite* buffers
- sender retransmission of lost packet



# TCP Congestion Control

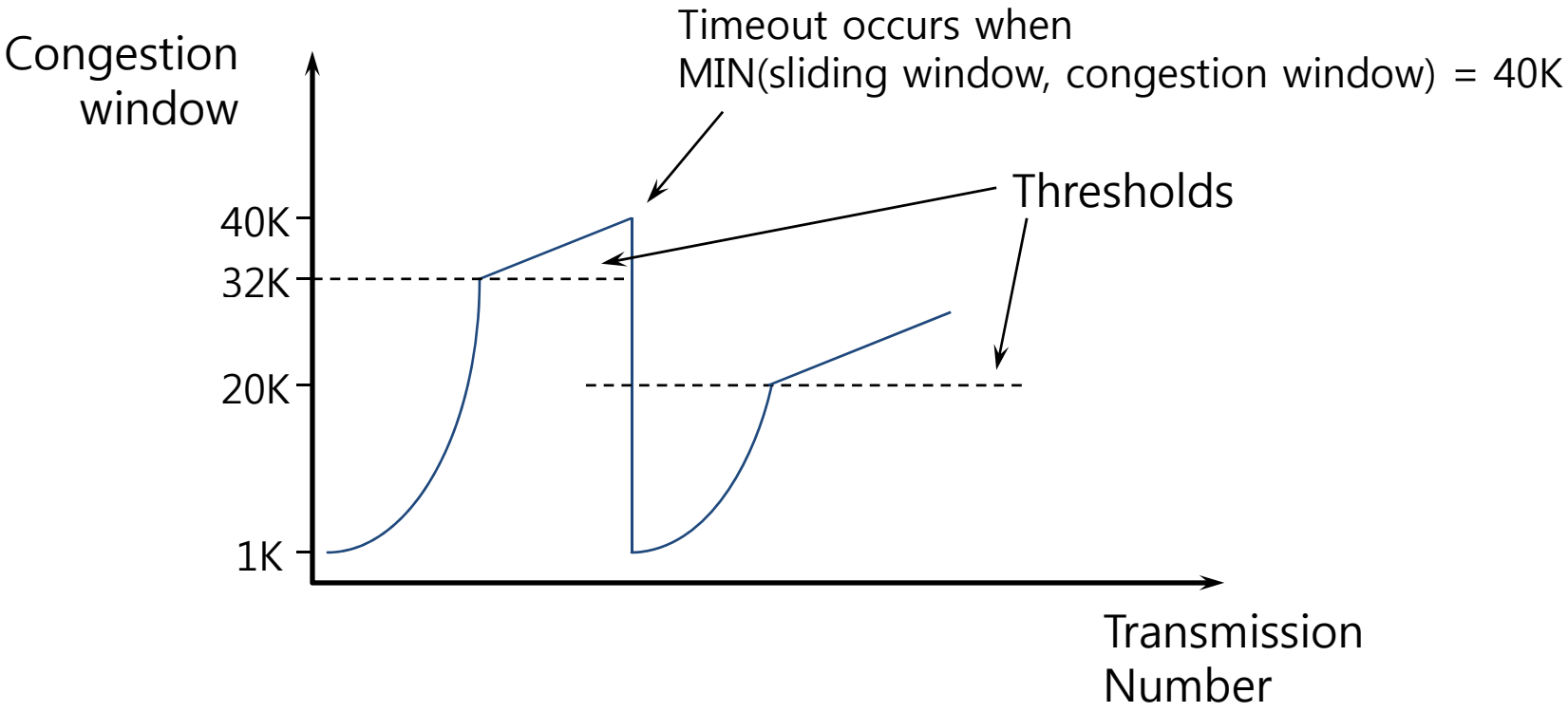
- Goal: achieve self-clocking state
  - Even if don't know bandwidth of bottleneck
  - Bottleneck may change over time
- Two phases to keep bottleneck busy:
  - Slow-start ramps up to the bottleneck limit
    - Packet loss signals we passed bandwidth of bottleneck
  - Congestion Avoidance tries to maintain self clocking mode once established

# TCP Slow Start *(cont'd)*



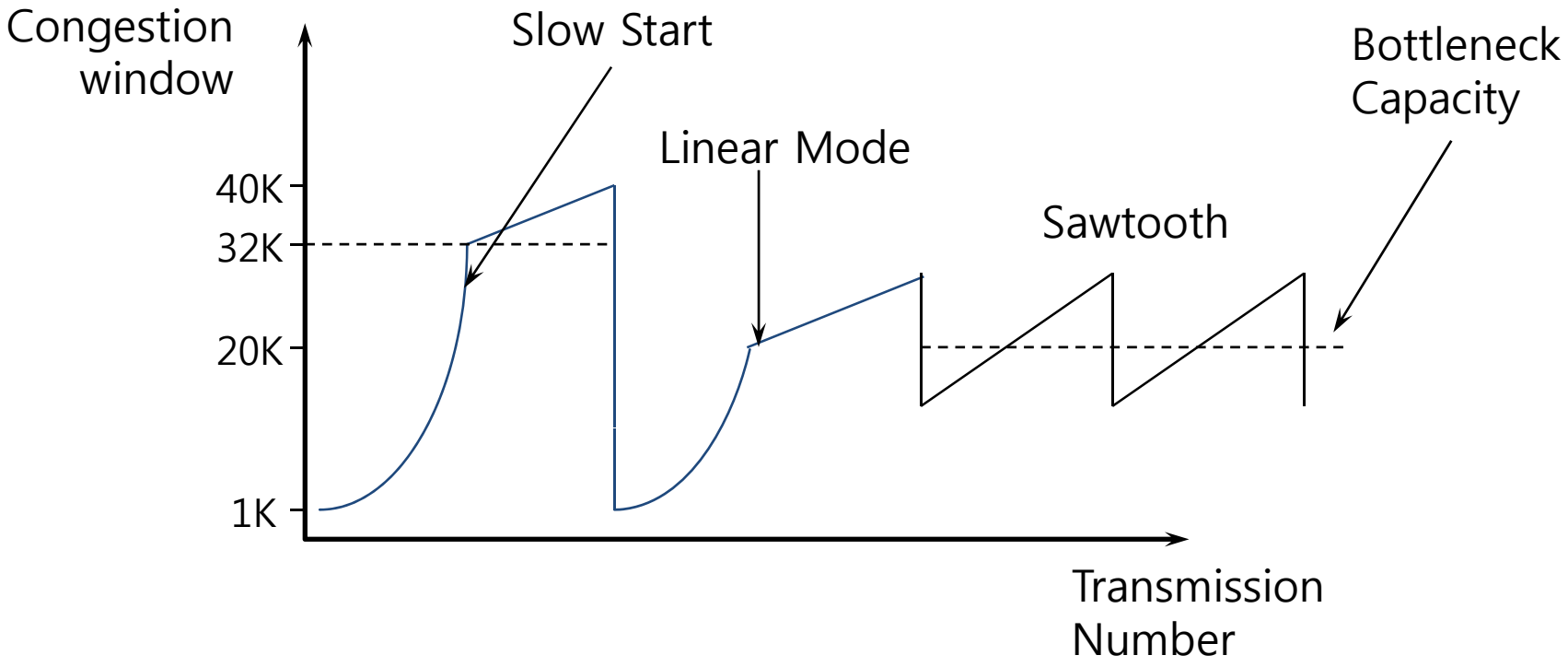
# TCP Linear Increase Threshold Phase

Example: Maximum segment size = 1K
Assume SSthresh=32K

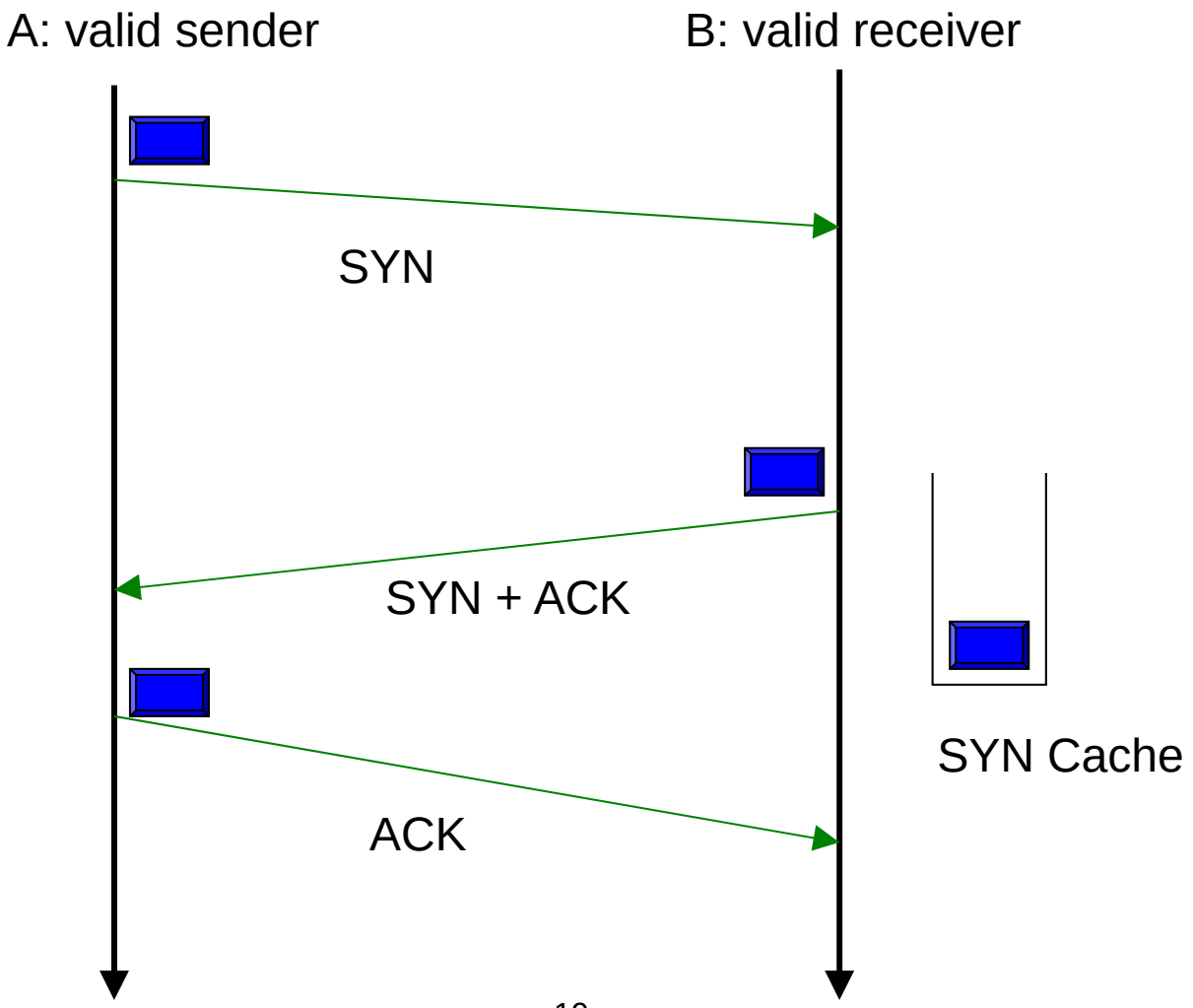


# Resulting TCP Sawtooth

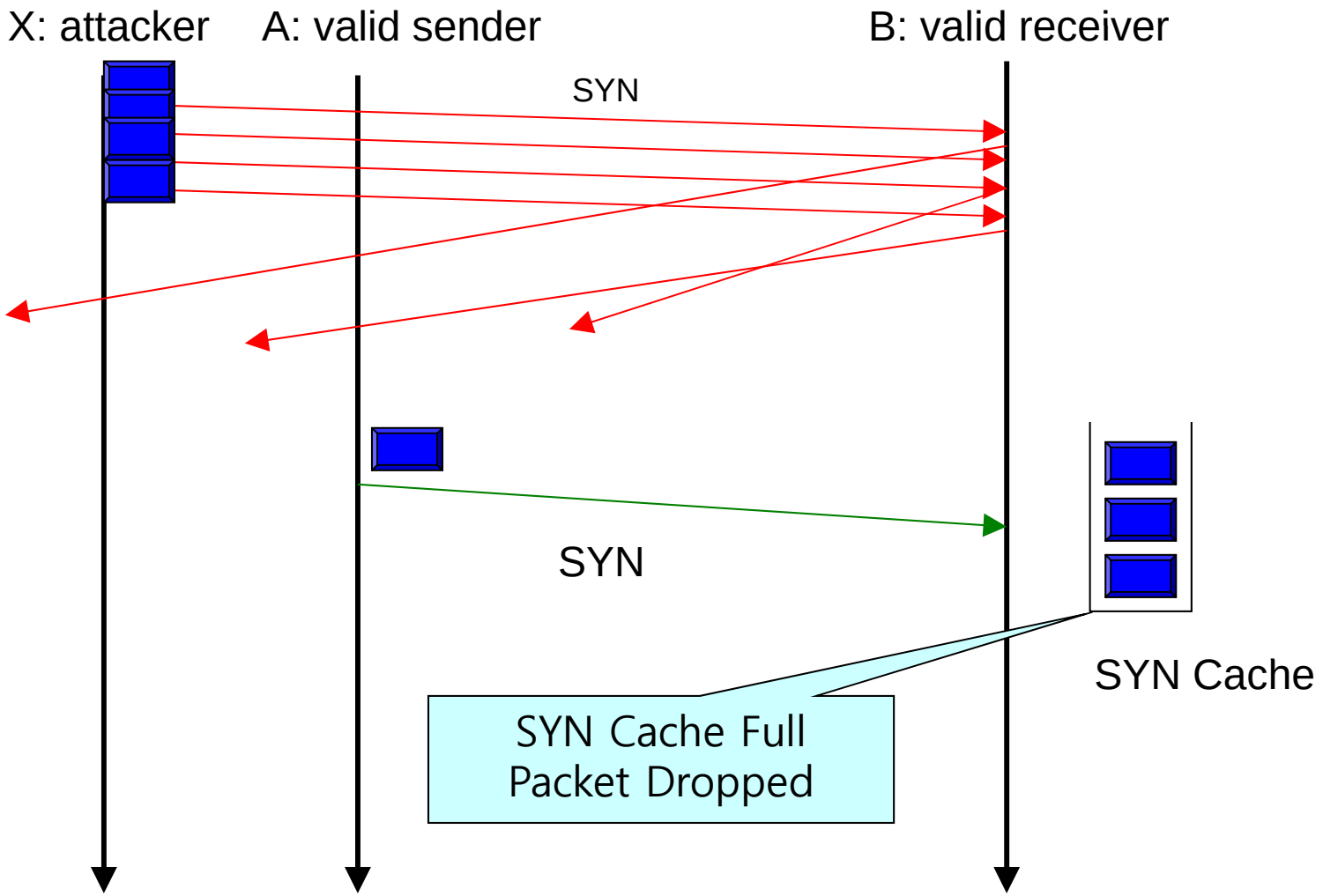
In steady state, window oscillates around the bottleneck's capacity
(I.e. number of outstanding bytes in transit)



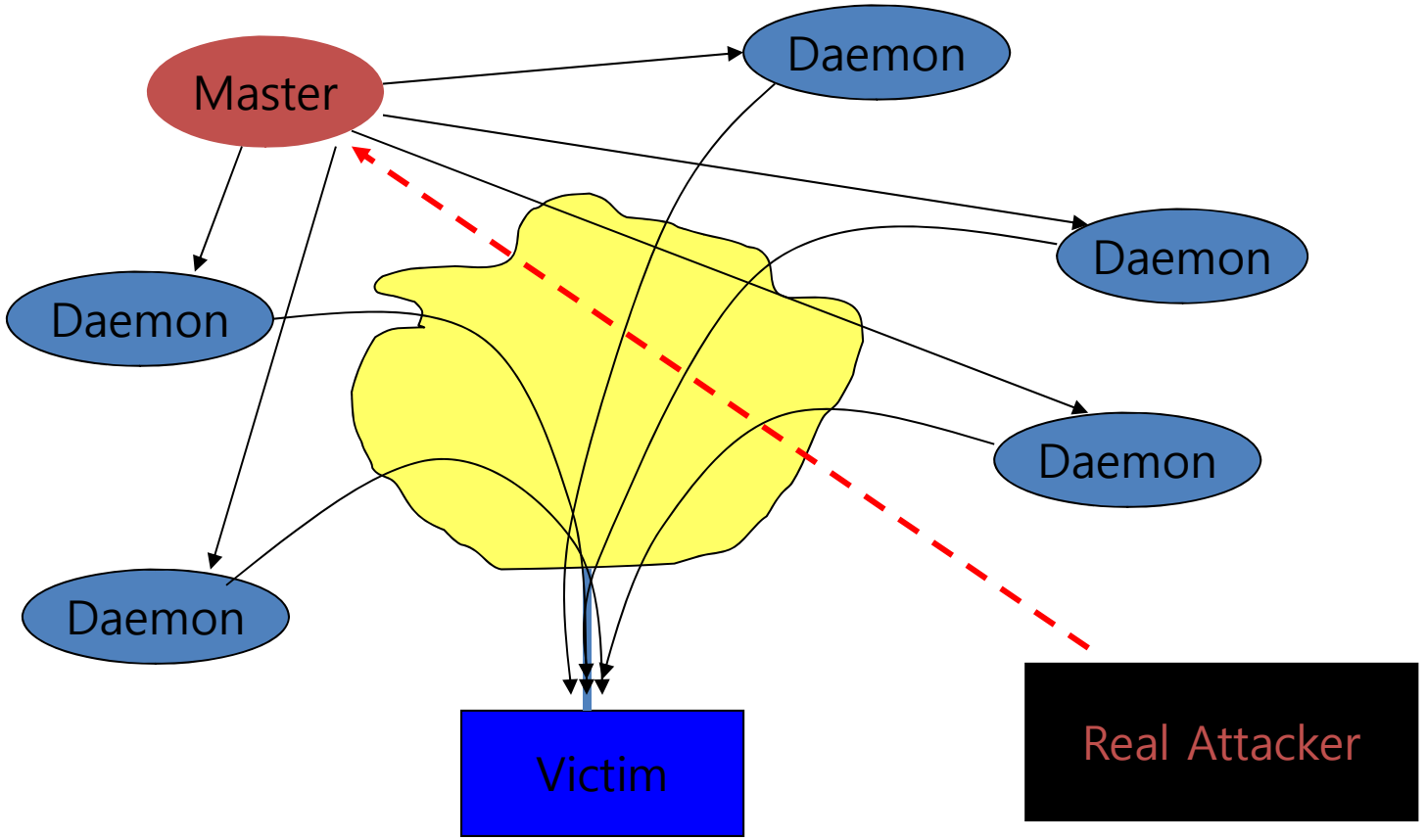
# Denial of Service (DoS) attack



# DOS attack!

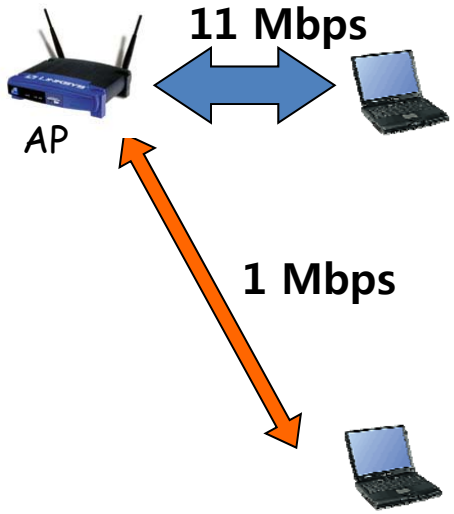

X: attacker
A: valid sender
B: valid receiver
SYN
SYN
SYN Cache
SYN Cache Full
Packet Dropped

# Distributed DOS (DDOS) attack!

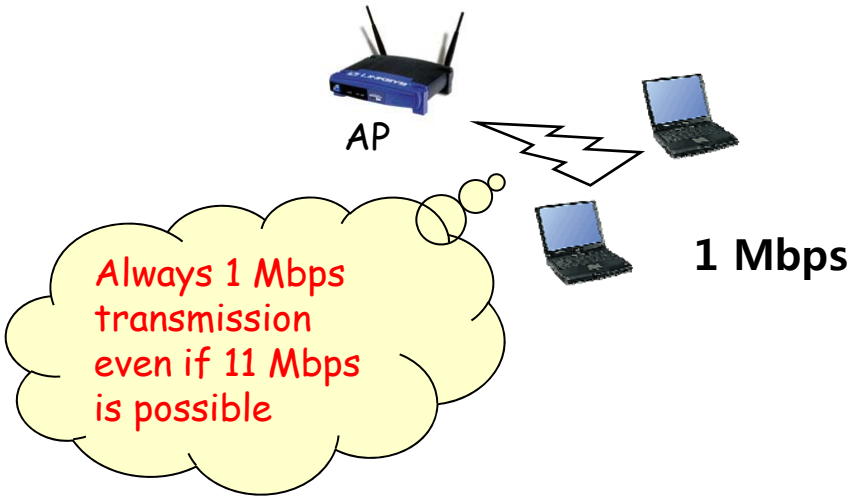


# Multicasting problems

- Open-Loop Transmission (No feedback such as ACK)
  - Fixed/Low Tx Rate → Efficiency issue
    - Other STAs' performance is degraded
      → Similar to Performance Anomaly Problem




**Unicast** (Rate Adaptation)




**Multicast** (No Rate Adaptation)

## ❖SCONE Lab

- Social and Computer Network Lab
- (소셜정보망 연구실)
- Professor : 김종권 (Chong-Kwon Kim)
- http:://popeye.snu.ac.kr

## ❖Members

- Ph. D Course: **7**
- MS Course: **3**
- Alumni:  Ph. D(18), MS(55)

## ❖Research Areas

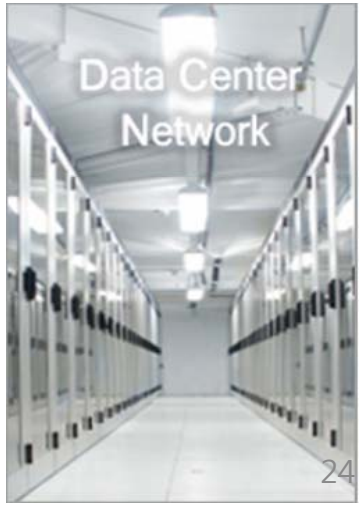
- Wireless Networking
- Data Center Networks
- Social Networks
- Network Security

## ❖ Wireless Networking

- IEEE 802.11 (Wi-Fi) PHY/MAC Layer Protocols
- Multiple-Input Multiple-Output (MIMO) Communicati
- ZigBee, Bluetooth, LTE (4G)
- Smartphone-based Indoor Localization


## ❖ Data Center Networks

- Flow Load Balancing
- DCN traffic analysis
- DCN Routing and scheduling



## ❖ Social Networks

- Information Diffusion and Cascades
- Influence Maximization
- Recommender system with social relation


## ❖ Network Security

- Distributed Denial of Service (DDoS)
- Social Network Threats
- Internet Traffic Classification & Measurements

# 이동 컴퓨팅 및 통신 연구실

## Mobile Computing and Communications Lab.

**이동 컴퓨팅 및 통신 연구실**은 유비쿼터스 통신 환경을 위한 차세대 핵심 기술인 이동 컴퓨팅 기술 및 무선 네트워킹 기술에 관한 연구를 진행하고 있습니다.

### **지도 교수**: 전화숙 교수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- 이메일 : wsjeon@snu.ac.kr

- 학력 :
  - 서울대학교 공과대학 컴퓨터공학과 학사 ,1983
  - 서울대학교 공과대학 컴퓨터공학과 석사, 1985
  - 서울대학교 공과대학 컴퓨터공학과 박사, 1989

### 구성원

- 박사후 과정: 1
- 박사 과정: 3
- 석사 과정: 4

❖ 졸업생: 박사 3명, 석사: 22 명

### 연구 분야

- Cognitive Radio
- Radio Resource Management
- Green Communication
- Relay-based Communication
- Wireless Mesh Network
- Network Performance Evaluation

### 현재 진행 중인 프로젝트

- 중첩 Super-WiFi/LTE 셀룰라 네트워크에서 통합 무선자원관리 기법 설계 (한국연구재단, 2012.5.1 ~ 2015.4.30)
- 기지국/단말 협력 (Cooperative) 무선 전송 기술 (ITRC, 2008.6.1 ~ 2013.12.31)
- 헬스 갤럭시 (Health Galaxy)를 위한 핵심 기반 기술 개발 (삼성전자, 2012.9.24 ~ 2013.9.23)

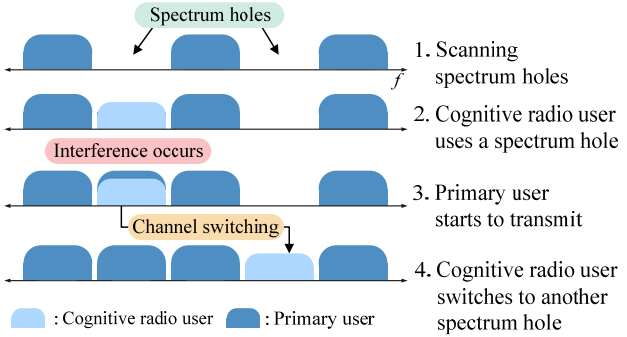
# 이동 컴퓨팅 및 통신 연구실 - 주요 연구 주제

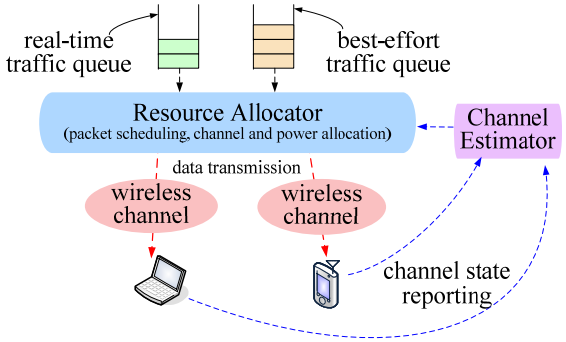
Homepage: http://mccl.snu.ac.kr

## 인지 라디오 (CR: Cognitive Radio)

: 주파수 스펙트럼 환경을 측정하고 측정된 정보를 기반으로 파악된 빈 주파수 스펙트럼을 이용하여 통신하는 기술

- 선순위 사용자를 효율적으로 검출하는 스펙트럼 센싱 기법 연구
- 다중 채널 CR ad-hoc 네트워크를 위한 무선 접속 기술 연구 및 라우팅 알고리즘 개발



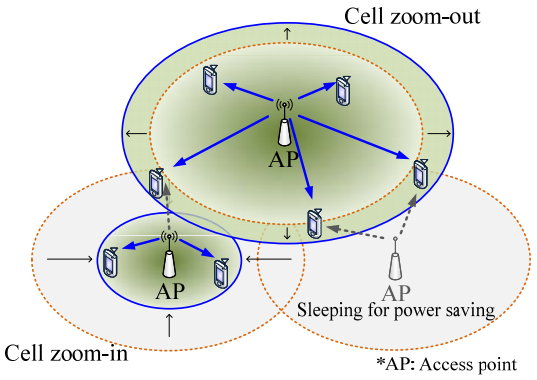

## 무선 자원 관리

- 멀티미디어 트래픽의 서비스 품질을 보장하면서 셀 처리량을 최대화 하기 위한 주파수 및 전력 할당 기법 연구
- 이종 (heterogeneous) 네트워크에서의 종단간 서비스 품질을 보장하고 시스템 성능을 최적화하는 자원 할당 알고리즘 개발

## 그린 커뮤니케이션 (Green Communication)

: $CO_2$ 절감을 위해 에너지 효율을 고려하는 무선 통신 및 네트워크 기술

- 이종 네트워크에서 에너지 효율적인 무선 자원 할당 알고리즘 개발
- 트래픽 상황에 따른 셀 최적화 기술 연구



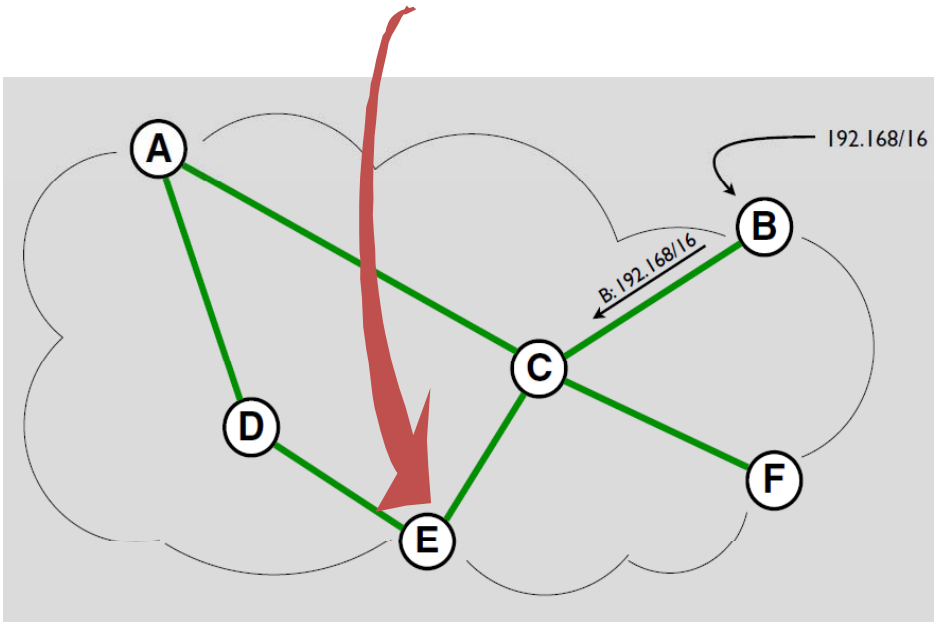
# Multimedia and Mobile communications Laboratory (MMLAB)

- mmlab.snu.ac.kr
- Members
  - Yanghee Choi, Taekyoung Kwon
  - 10 PhD students, 10 MS students
- Research Areas
  - Content-centric Networking (CCN)
  - Mobile/Wireless Networking
  - Adaptive Video Delivery
  - P2P Networking

# IP networking vs. CCN

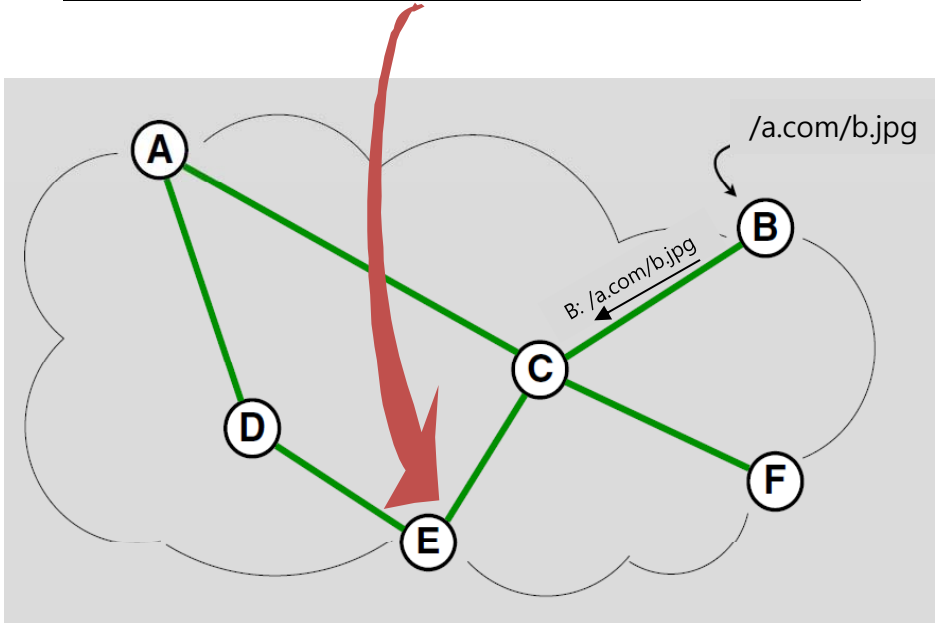
- Network prefix

| Destination | Next Hop |
|---|---|
| 192.168.0.0/16 | Router C |




- Content name

| Content Name | Next Hop |
|---|---|
| /a.com/b.jpg | Router C |



# Q & A