

# 画像情報特論 (1)

## Advanced Image Information (1)

### はじめに

## Class Overview

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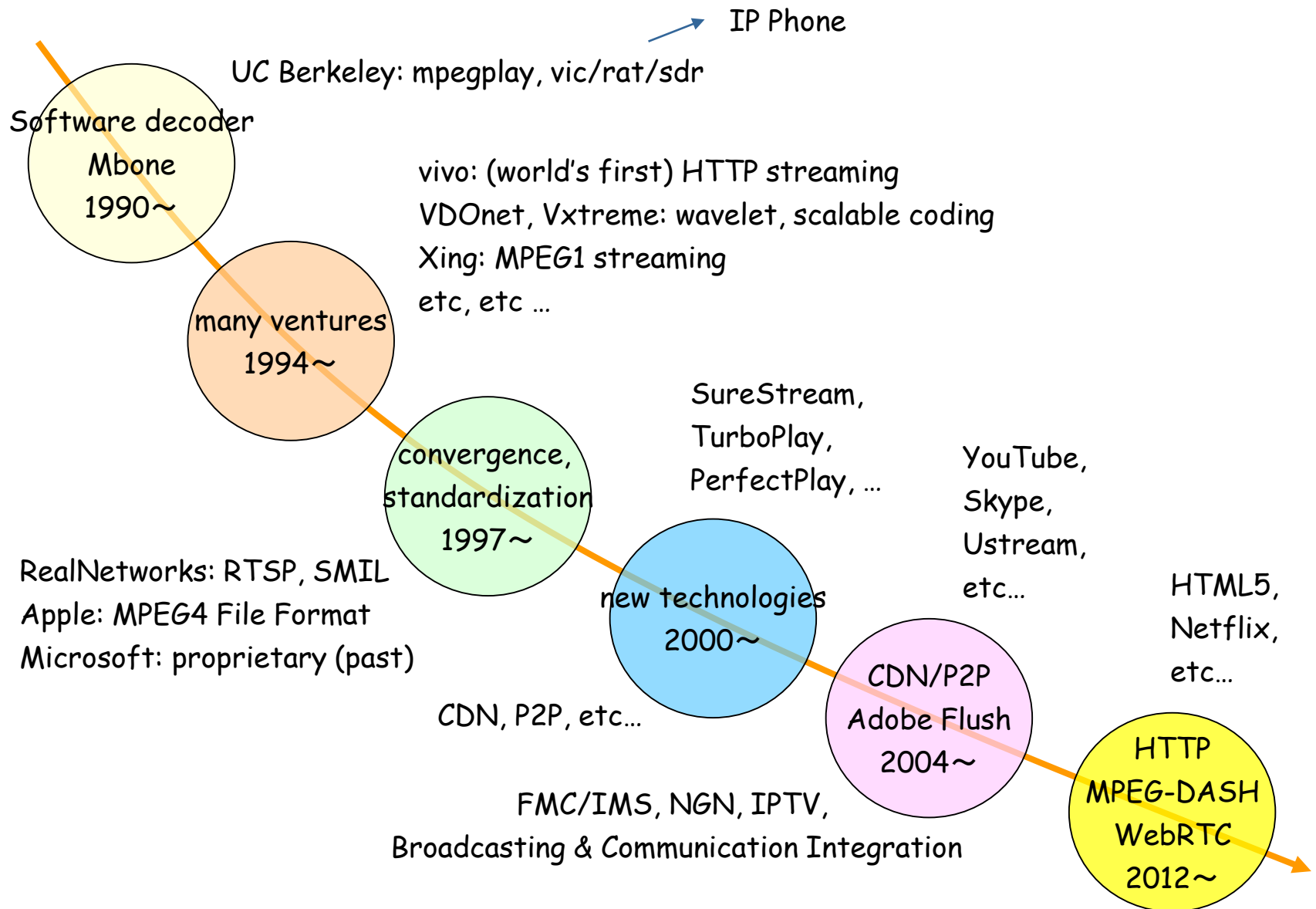
# This Year's Schedule

(tentative)

4/07	Class overview
4/14	Video Streaming (1) Streaming, TCP variants
4/21	Video Streaming (2) TFRC
4/28	Video Streaming (3) Wireless
5/12	Video Streaming (4) Upper Layer Protocols
5/19	Video Streaming (5) CDN & P2P
5/26	Video Streaming (6) MPEG-DASH & WebRTC
6/02	Video Compression (1) Video Compression Basics
6/09	Video Compression (2) H.264/AVC
6/16	Video Compression (3) H.265/HEVC
6/23	Image Processing (1) tbd
6/30	Image Processing (2) tbd
7/07	Image Processing (3) tbd
7/14	Self-study on CourseN@vi
TBD	Final report

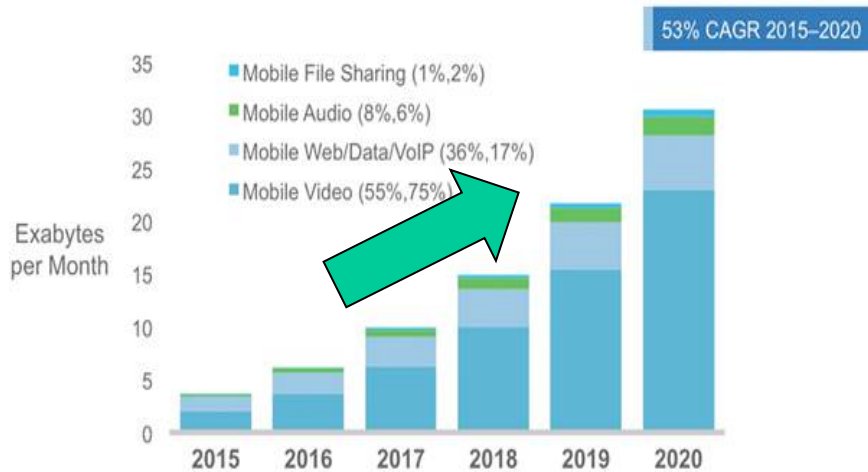
Self-study on CourseN@vi, once or twice

# History of Video Streaming



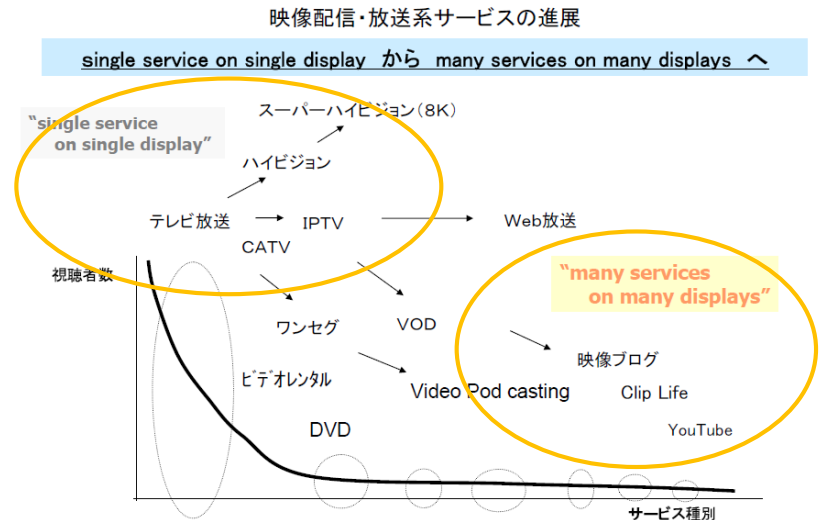
# Recent Trends

- Drastic Increase of Video Traffic
  - more than 70%
  - x10 until 2020



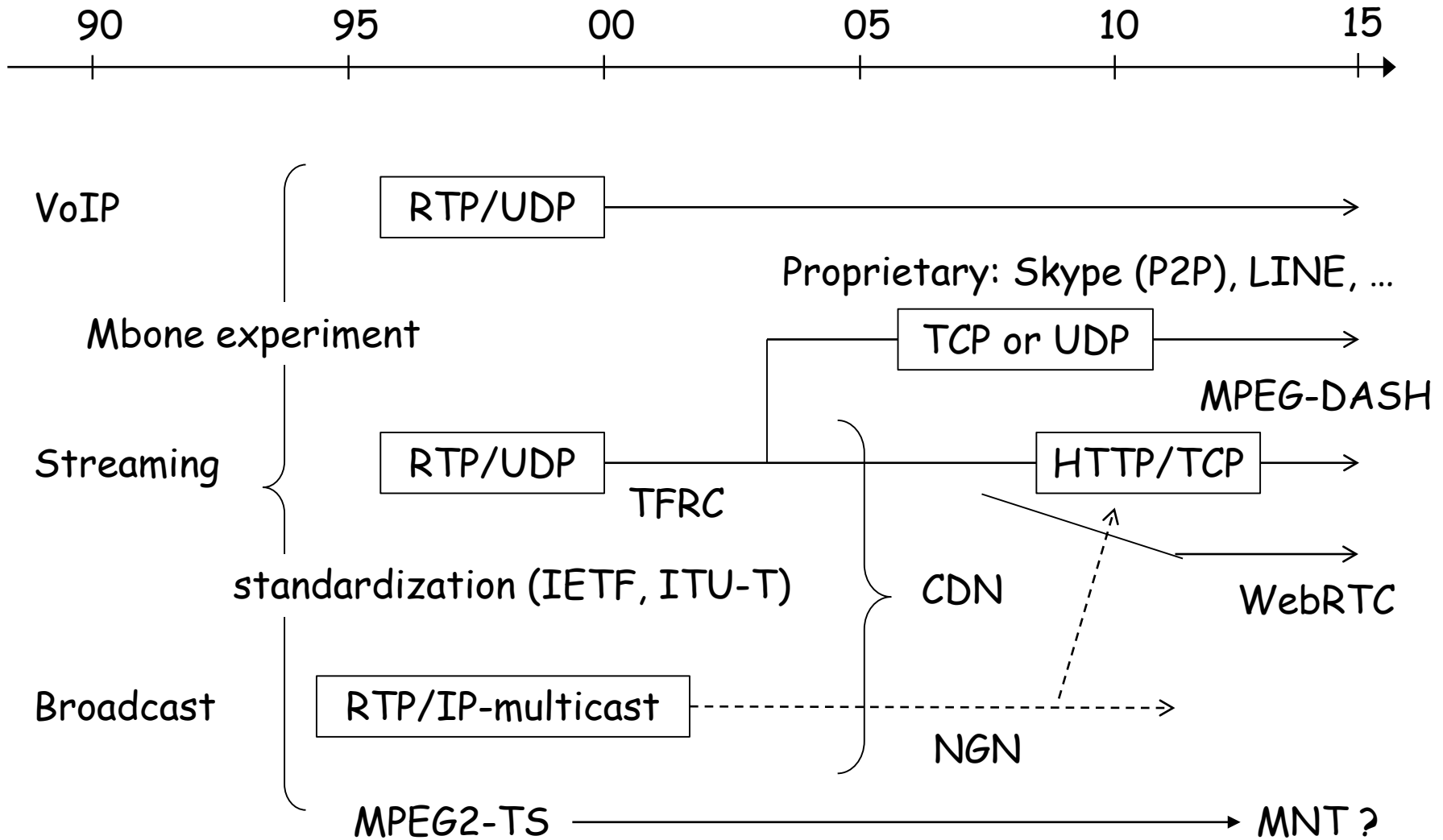
(Cisco VNI, 2016)

- Evolution of Various Video Services
  - higher resolution and personalization



(MIC Report, 2008)

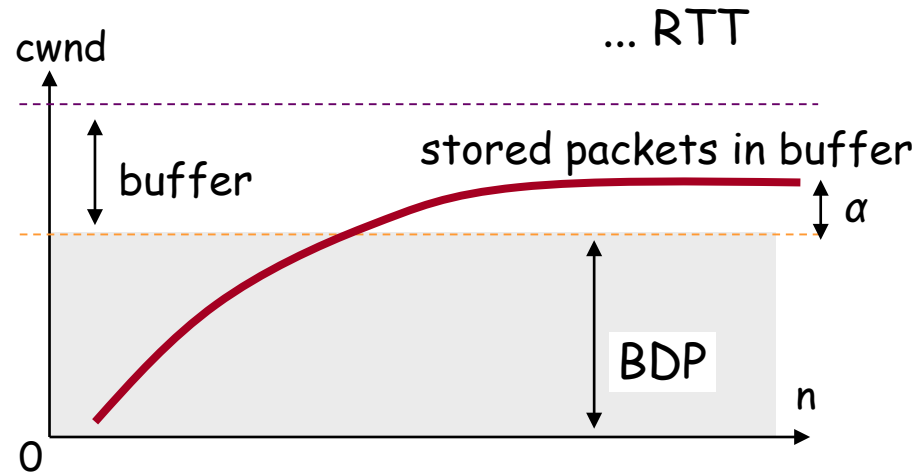
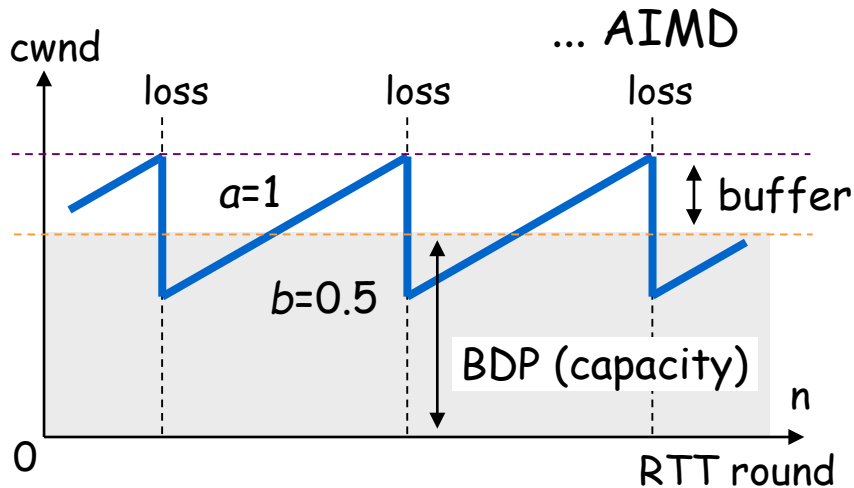
# Protocol Transition



# Video streaming (1) TCP/IP

## ■ Loss-driven

## ■ Delay-driven



TCP-Reno, High-Speed TCP,  
TCP-Westwood, CUBIC-TCP, ...

TCP-Vegas, FAST-TCP

BDP/Buffer relationship

small buffer  $\rightarrow$   $\times$  efficiency  
large buffer  $\rightarrow$   $\times$  delay

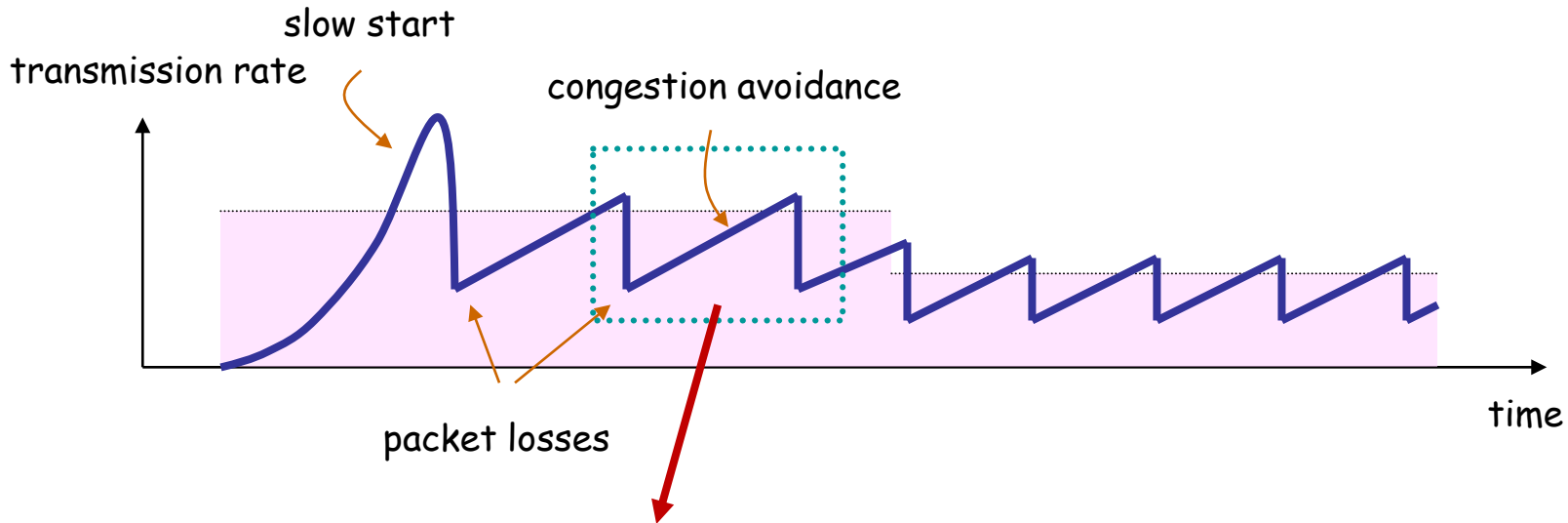
Unfairness by loss-driven TCP

$\times$  friendliness

BDP: Bandwidth-Delay Product

# Video streaming (2) TFRC

## ■ TFRC



Modeling of steady-state  
TCP behaviors

$$R = \frac{1}{RTT} \sqrt{\frac{3}{2p}}$$

p: packet loss rate

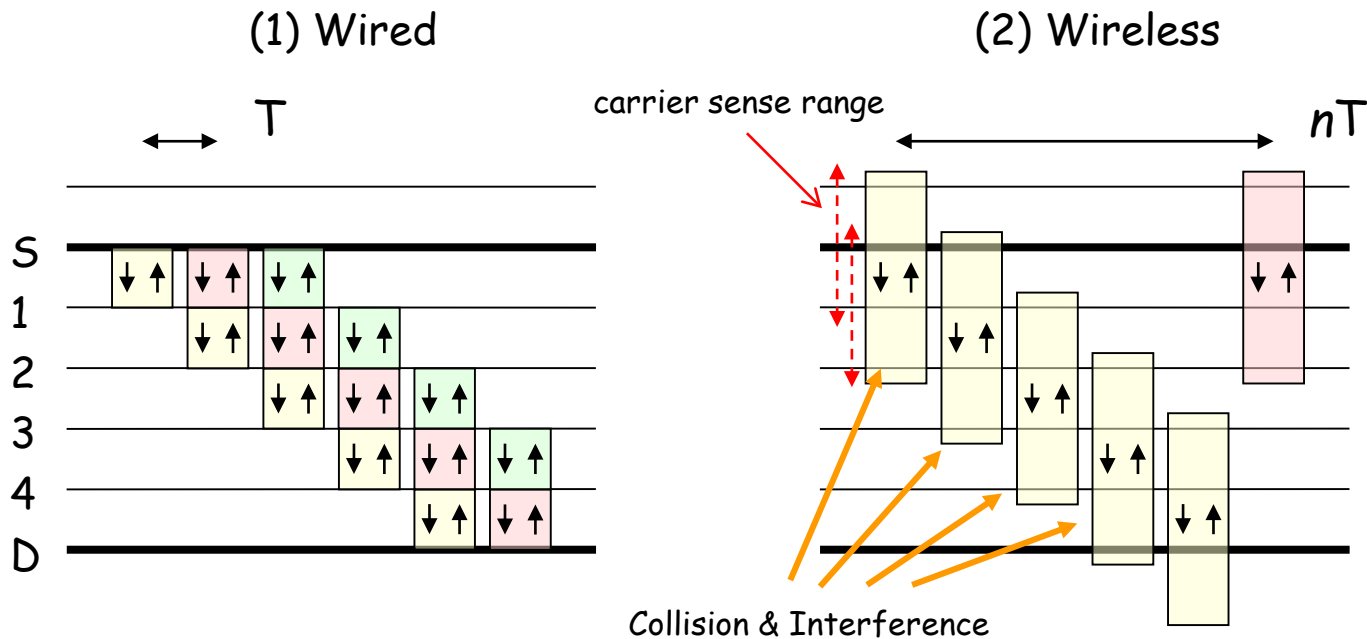
BDP/Buffer relationship

small buffer → × efficiency  
large buffer → × delay



# Video streaming (3) Wireless

## ■ Single-Channel Multi-hop Network



Channel Efficiency = 1

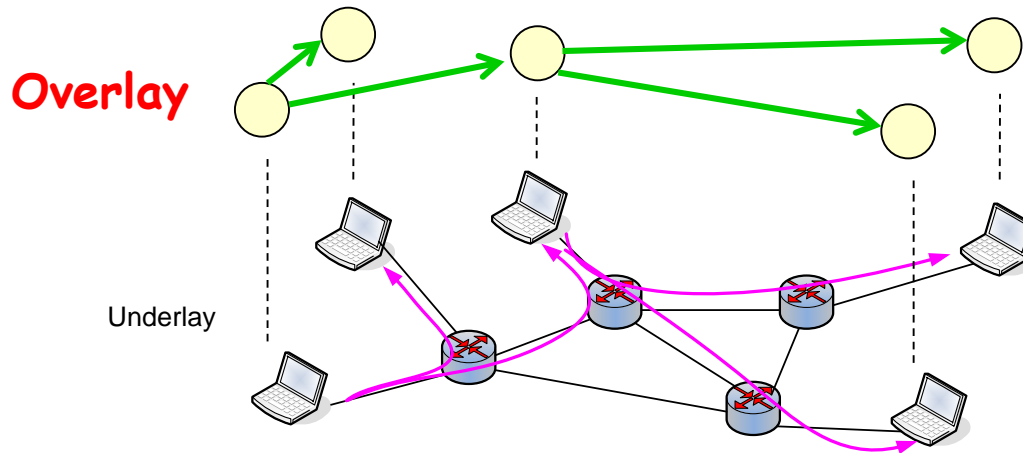


Channel Efficiency =  $1/n$   
( $n$  : # of multi-hops)

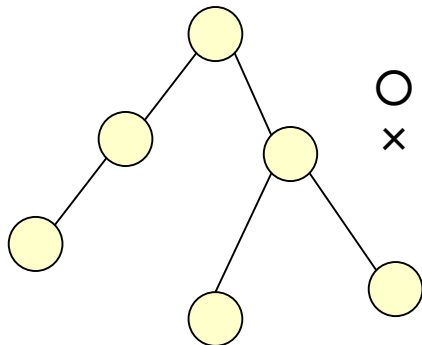


# Video streaming (4) CDN, P2P & Cloud

## ■ Overlay networks

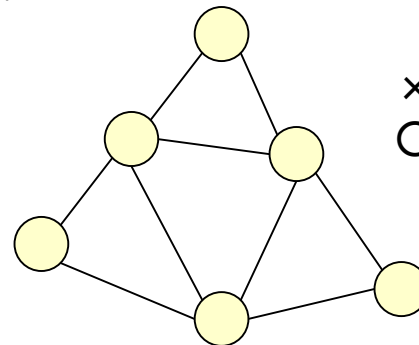


## ■ tree



○ complexity  
× robustness

## ■ mesh



× complexity  
○ robustness

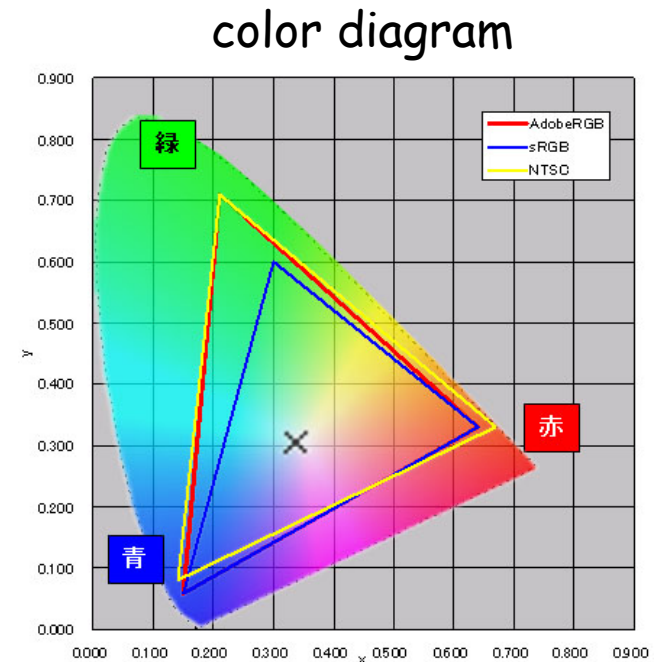
# Video Compression: H.265 & Beyond

## ■ H.265/HEVC

- HEVC: High Efficiency Video Coding
- NGVC: Next Generation Video Coding

## ■ Other topics

- Higher resolution
  - spatial: U-HDTV
  - temporal: 10,000 frames
- Gamut expansion
- High dynamic range
- 3D / freeviewpoint



# Handouts

- Check handouts on CourseN@vi.
- (in April) check class web page
  - <http://www.katto.comm.waseda.ac.jp/~katto/Class/>