

# 画像情報特論 (2)

## Advanced Image Information (2)

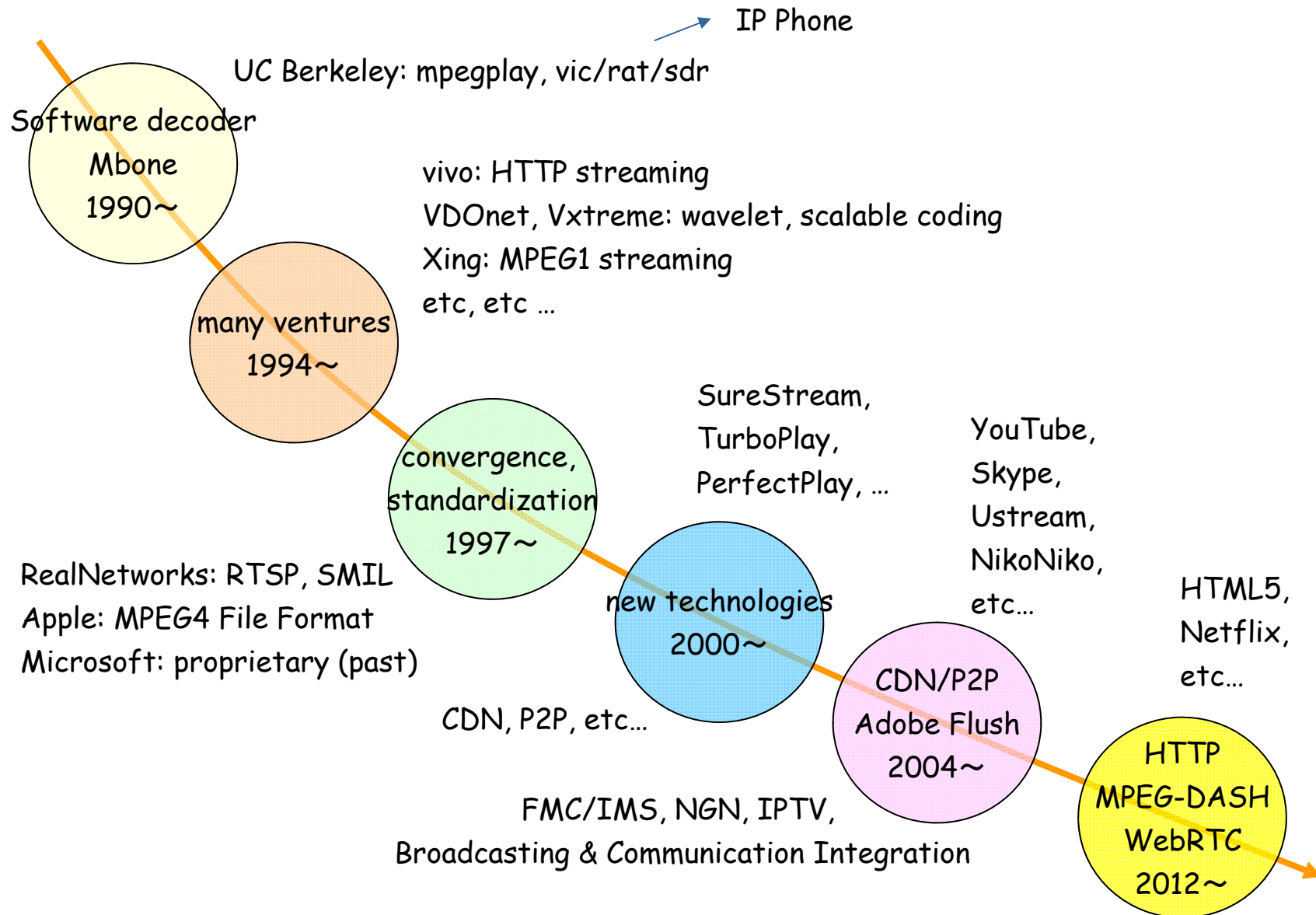
### Streaming Background

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# Background of Streaming

# History of Streaming



# (Old) Protocol Stack for Video Streaming

VoIP, IPTV and streaming shares almost common protocol stack

<b>application (L7)</b>	video (H.264 etc...)	audio	SDP	layout (HTML, SMIL)
<b>adaptation</b>	RTP / RTCP		RTSP, SIP, SAP*	HTTP
<b>transport (L4)</b>	UDP / TCP / DCCP		TCP / UDP / SCTP	
<b>network (L3)</b>	IP (IPv4, IPv6, IP-multicast)			
<b>datalink &amp; physical (L2 &amp; L1)</b>	actual networks (802.3 (ethernet), 802.11 (WiFi), etc)			

\* SAP: delivered by IP-multicast for program advertisement

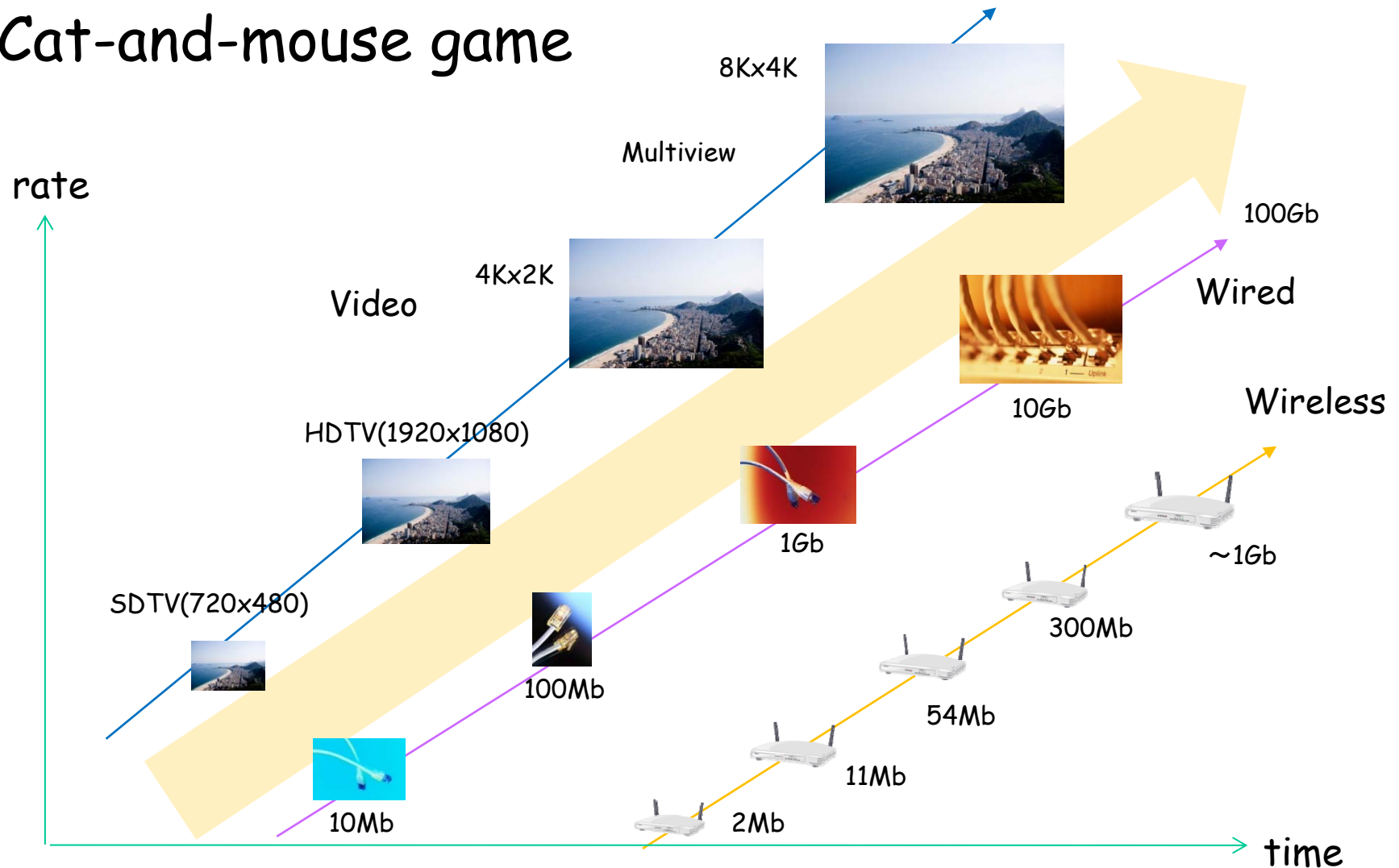
# Protocol Stack for HTTP Video Streaming

VoIP, IPTV and streaming shares almost common protocol stack

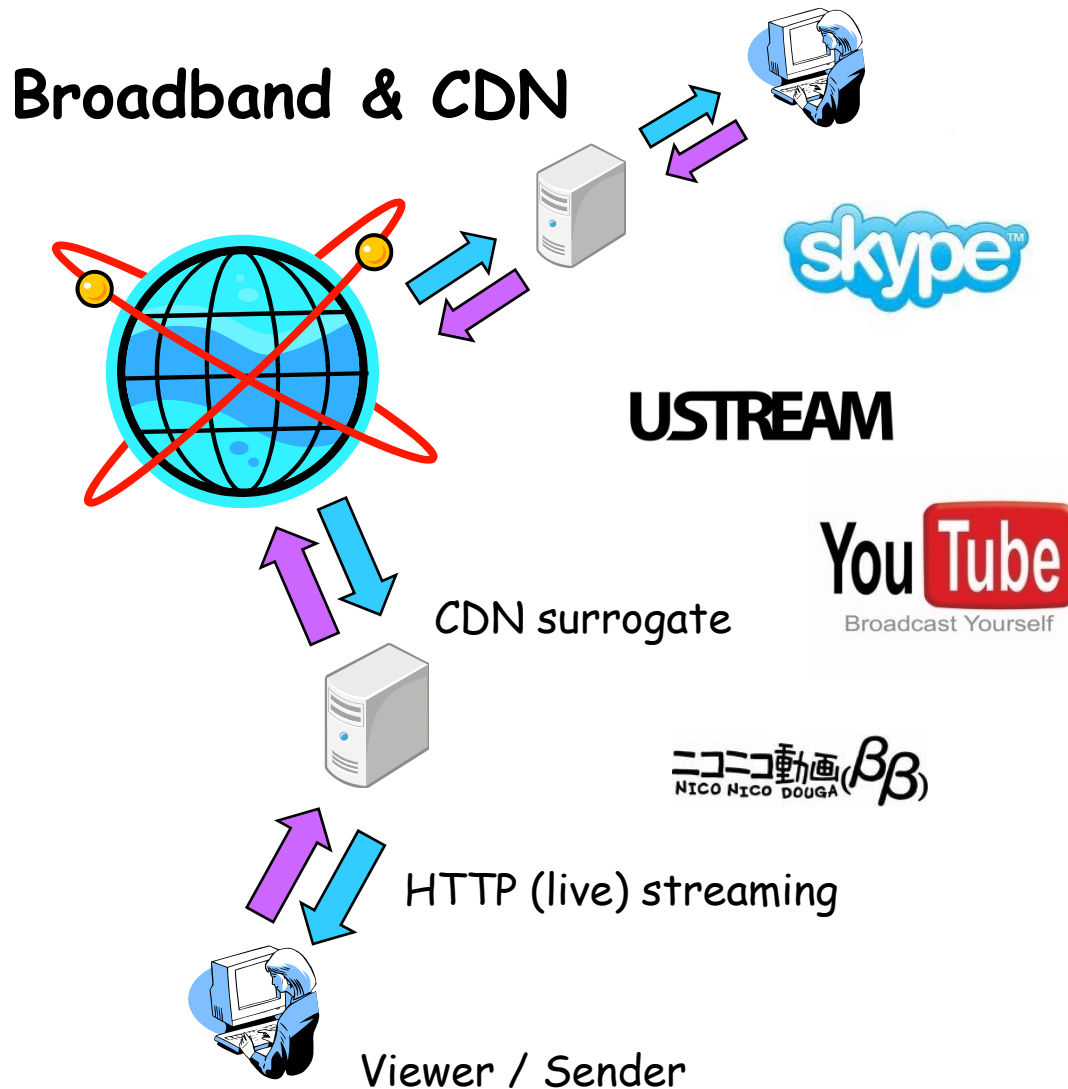
<b>application (L7)</b>	video (H.264 etc...)	audio	MPD (MPEG-DASH)	layout (HTML)
<b>adaptation</b>	HTTP			
<b>transport (L4)</b>	TCP			
<b>network (L3)</b>	IP (IPv4, IPv6)			
<b>datalink &amp; physical (L2 &amp; L1)</b>	actual networks (802.3 (ethernet), 802.11 (WiFi), etc)			

# Networks and Multimedia

- Cat-and-mouse game



# Wired Networks



RTP/UDP & RTSP & TFRC

→ HTTP/TCP streaming

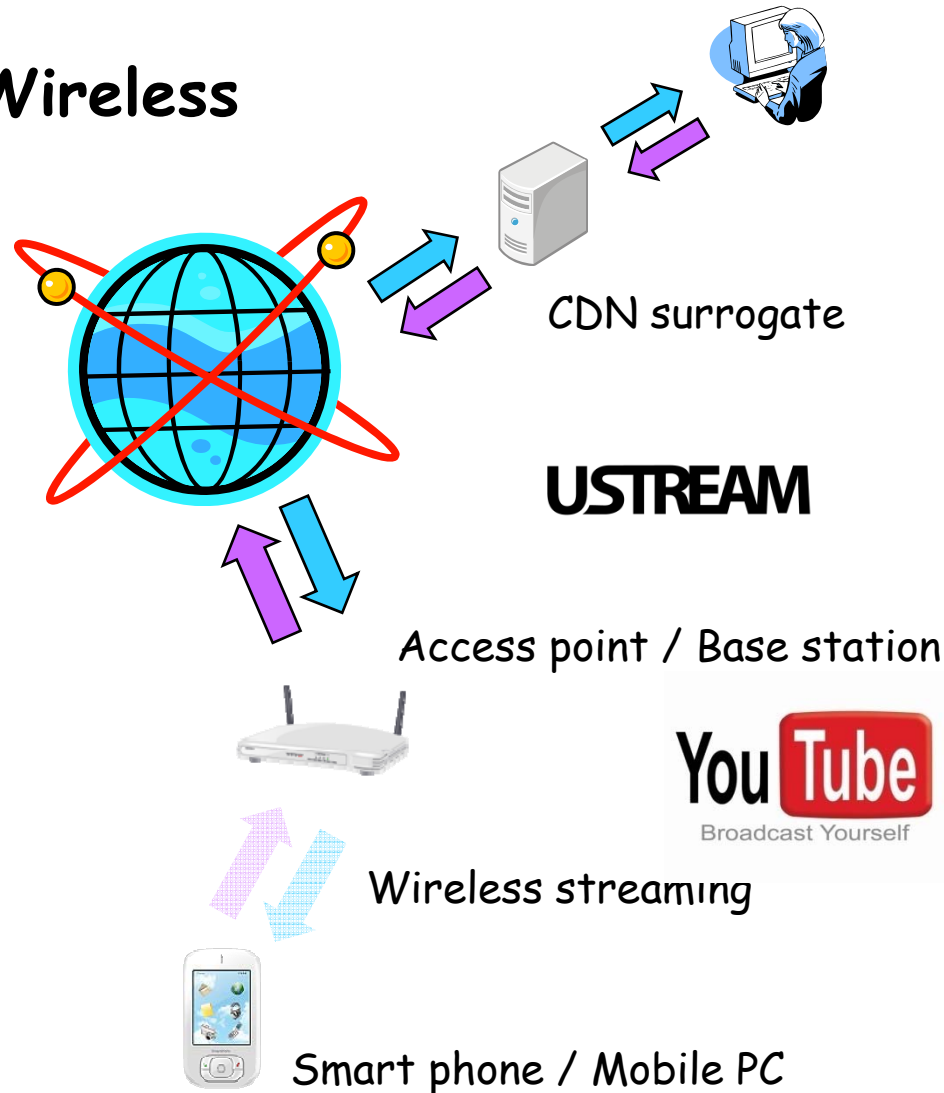
- Broadband
- CDN (Akamai, Lime Networks)
- Firewall (port 80)
- ...

One-way (on-demand / live)

Bi-directional (interactive)

# Wireless Networks

Wireless



Wireless specific problems

- WiFi: IEEE 802.11 n/ac/ax
- Cellular: 3G, 4G(LTE), 5G
- WiMAX: IEEE 802.16
- Home Networks: DLNA
- (Satellite)
- ...

• **Wireless issues**

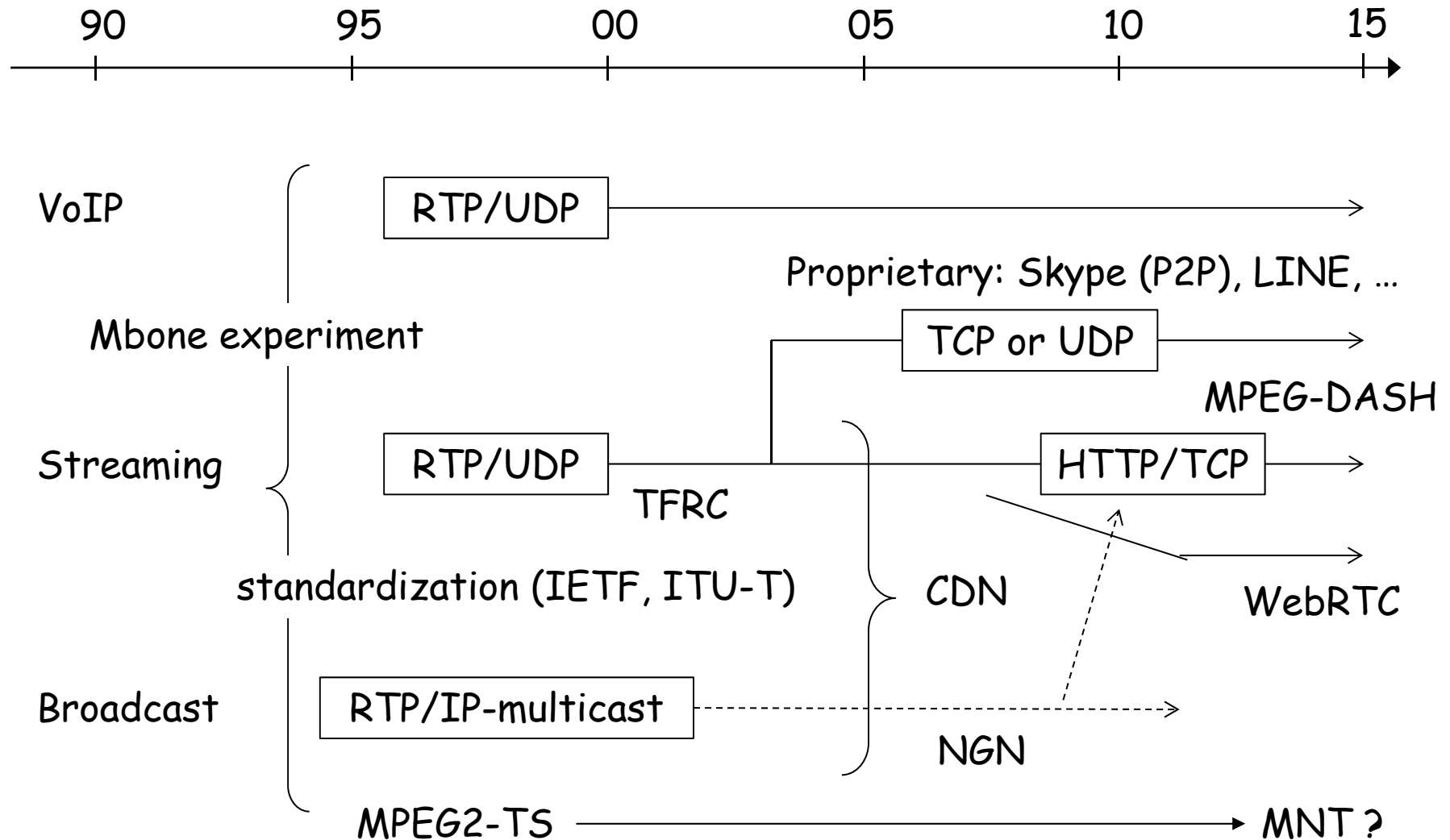
random errors, collisions,  
interference, delay increase

• **Multi-hop issues**

severe interference, lower  
throughput and higher delay



# Protocol Transition



# Overview

- TCP versions
- TCP over wireless
- TFRC (TCP friendly rate control)
- (simulators)
- CDN & P2P
- Upper layer protocols
- CDN and P2P
- MPEG-DASH, WebRTC

# Supplement

- On CourseN@vi
  - "Internet Video: The 2011 Perspective," IWQoS 2011.  
<http://www.ieee-iwqos.org/2011/keynote.html>
  - "Internet Video: Past, Present, and Future," SIGCOMM 2013 Tutorial.  
<http://conferences.sigcomm.org/sigcomm/2013/ttliv.php>
  - "Optimizing QoE in Large-Scale Video Networks," Packet Video 2013 (YouTube).
  - "Double, Double, Toil and Trouble, Bandwidth Grows and Congestion Bubbles," Packet Video 2013 (Akamai).  
<http://pv2013.itec.aau.at/workshop-program/>