画像情報特論 (2)
Advanced Image Information (2)
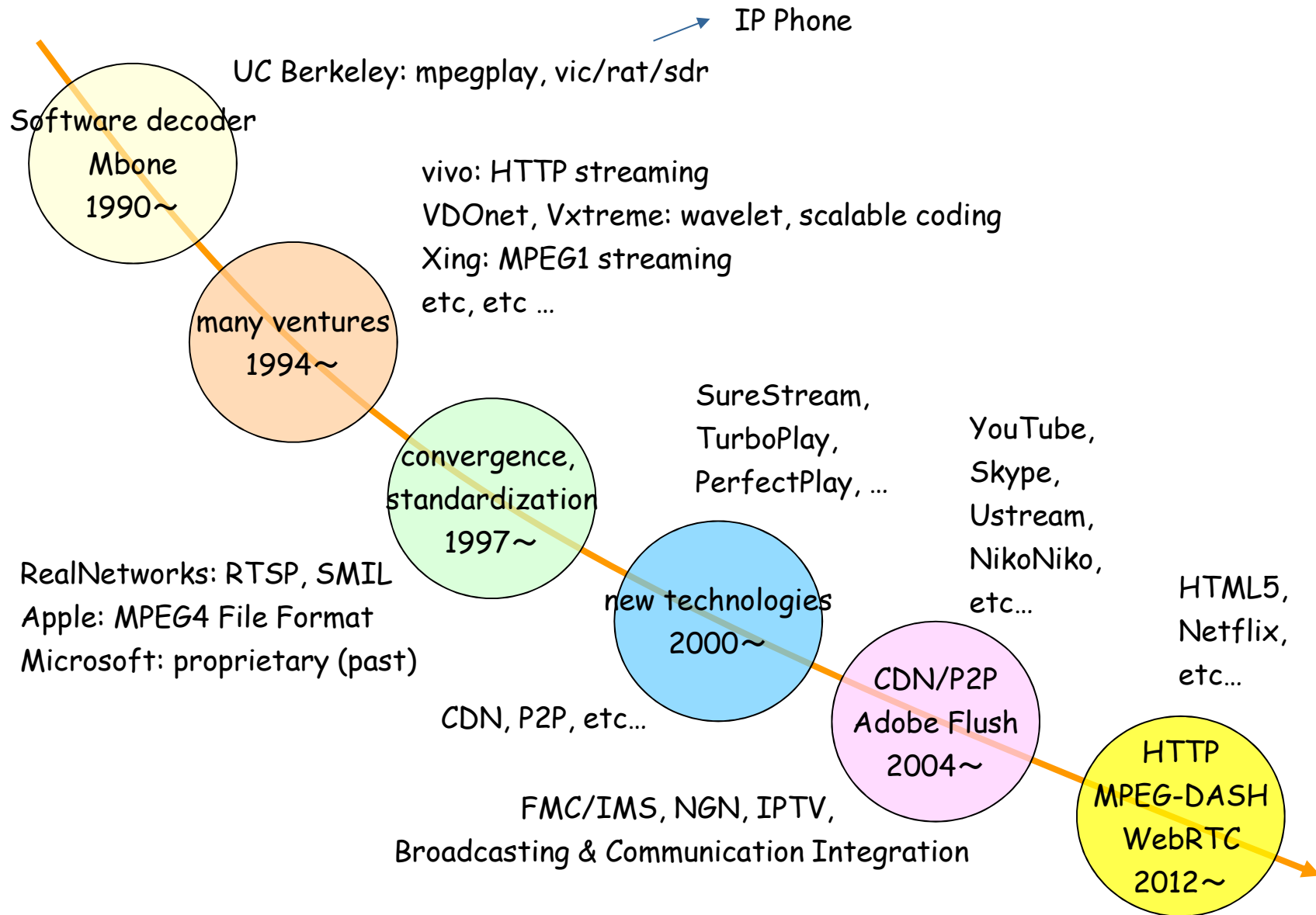
Streaming Background

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Background of Streaming

History of Streaming

IP Phone

UC Berkeley: mpegplay, vic/rat/sdr

Software decoder
Mbone
1990~

vivo: HTTP streaming
VDOnet, Vxtreme: wavelet, scalable coding
Xing: MPEG1 streaming
etc, etc …

many ventures
1994~

SureStream,
TurboPlay,
PerfectPlay, …

YouTube,
Skype,
Ustream,
NikoNiko,
etc…

convergence,
standardization
1997~

RealNetworks: RTSP, SMIL
Apple: MPEG4 File Format
Microsoft: proprietary (past)

HTML5,
Netflix,
etc…

new technologies
2000~

CDN/P2P
Adobe Flush
2004~

CDN, P2P, etc…

HTTP
MPEG-DASH
WebRTC
2012~

FMC/IMS, NGN, IPTV,
Broadcasting & Communication Integration

(Old) Protocol Stack for Video Streaming

VoIP, IPTV and streaming shares almost common protocol stack

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

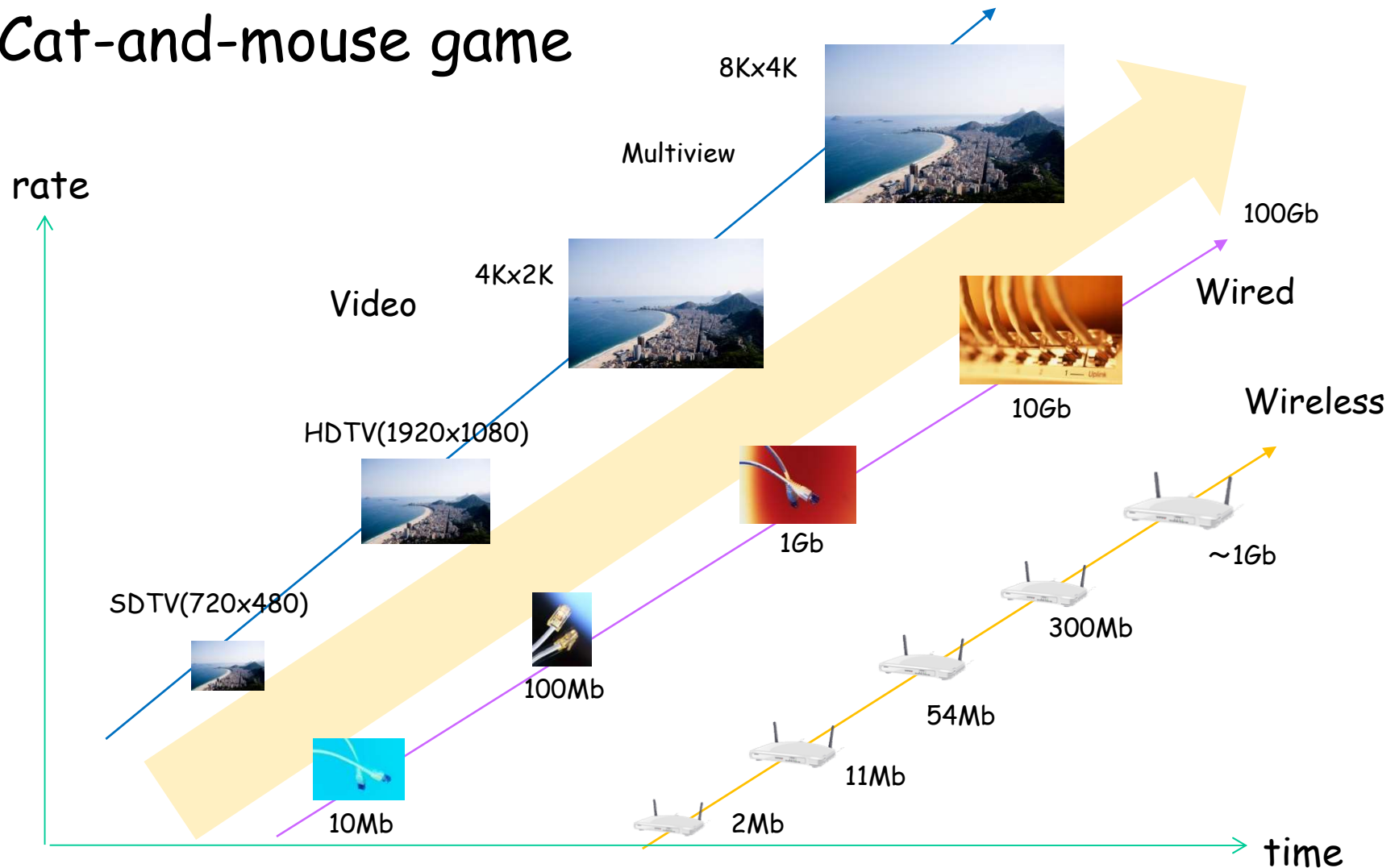* SAP: delivered by IP-multicast for program advertisement

Protocol Stack for HTTP Video Streaming

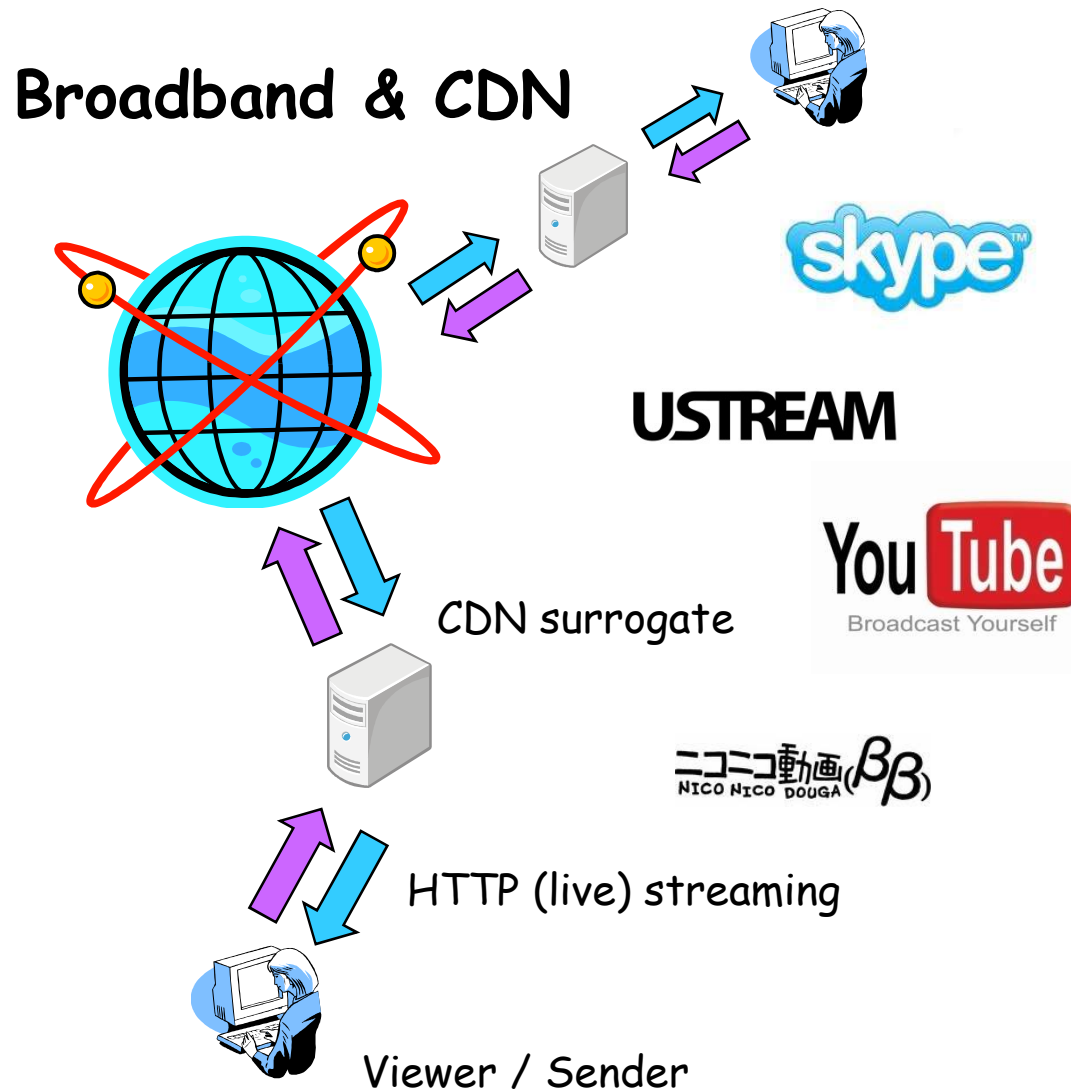VoIP, IPTV and streaming shares almost common protocol stack

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

Networks and Multimedia

- Cat-and-mouse game

Wired Networks
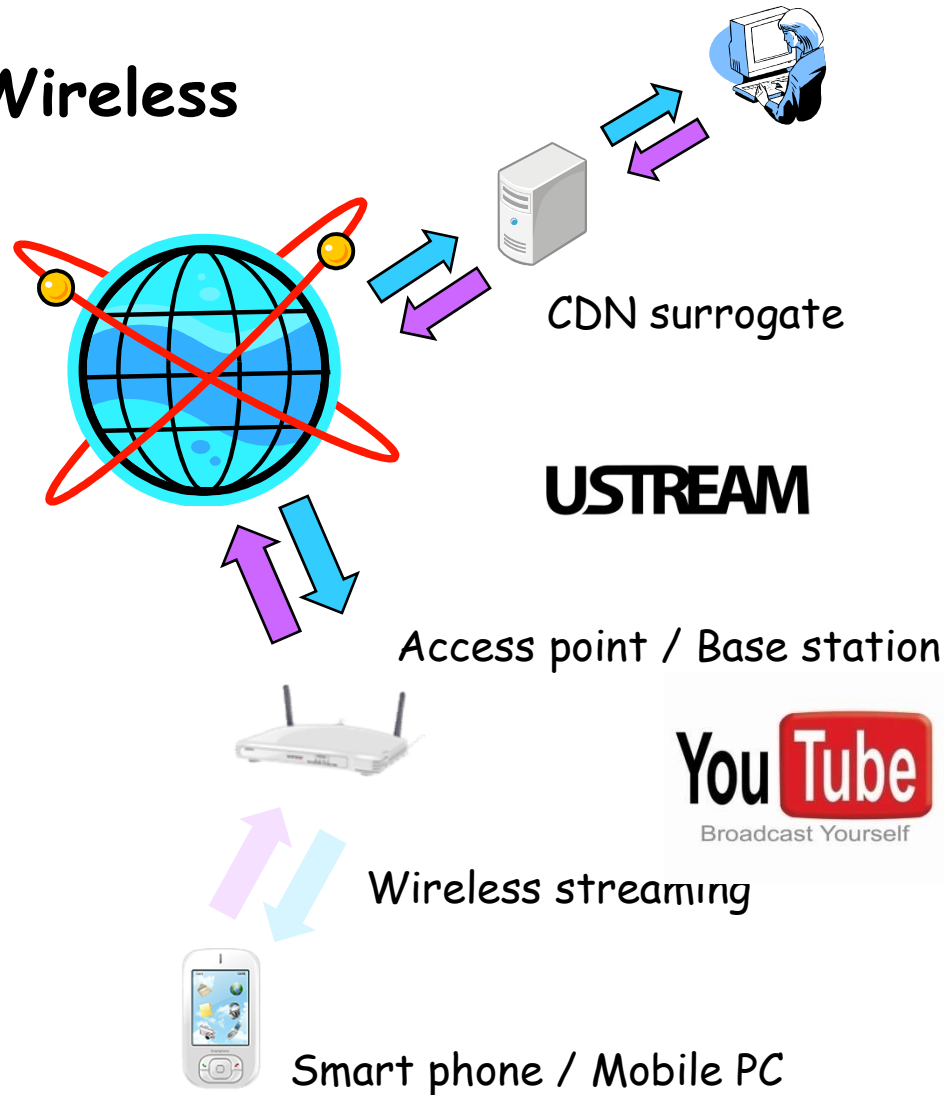
Broadband & CDN

RTP/UDP & RTSP & TFRC

→ HTTP/TCP streaming

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

One-way (on-demand / live)

Bi-directional (interactive)

CDN surrogate

HTTP (live) streaming

Viewer / Sender

Wireless Networks

Wireless

CDN surrogate

USTREAM

Access point / Base station

You Tube
Broadcast Yourself

Wireless streaming

Smart phone / Mobile PC

Wireless specific problems

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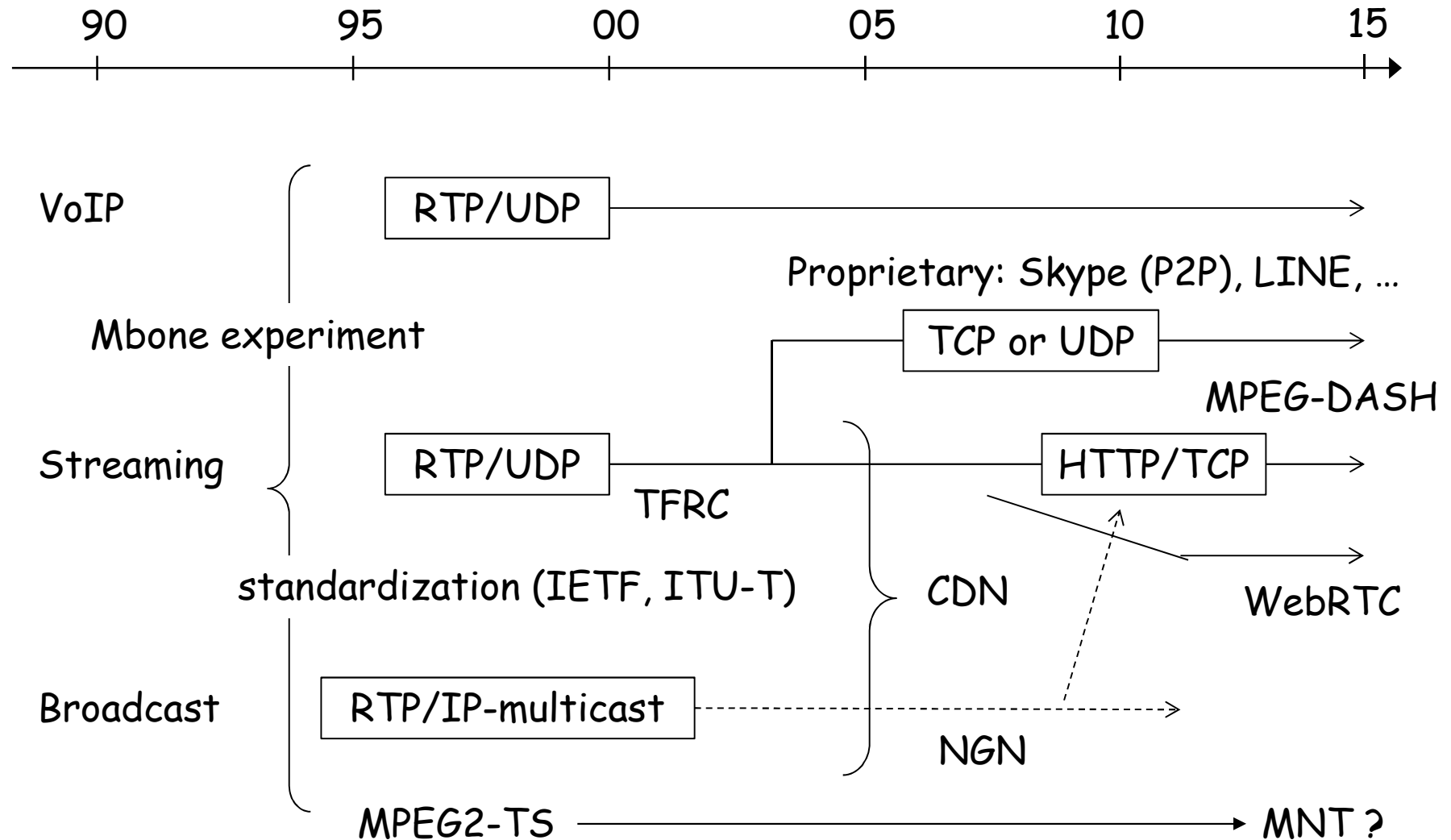- Home Networks: DLNA
- (Satellite)
- ...

- **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/