Interactive Video Streaming

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Admin

- HW6
  - Due Wednesday – both questions
- Final Exam
  - Monday, Dec. 7, 2014
    - 8:00am-9:50am
    - Plan on starting at 8:15am

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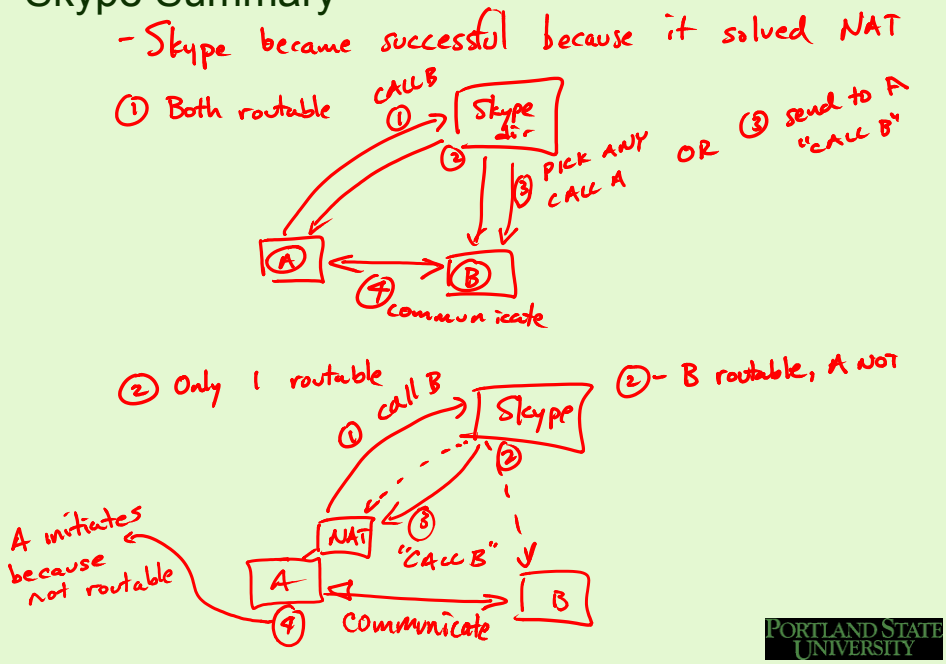
Skype Summary

- Skype became successful because it solved NAT



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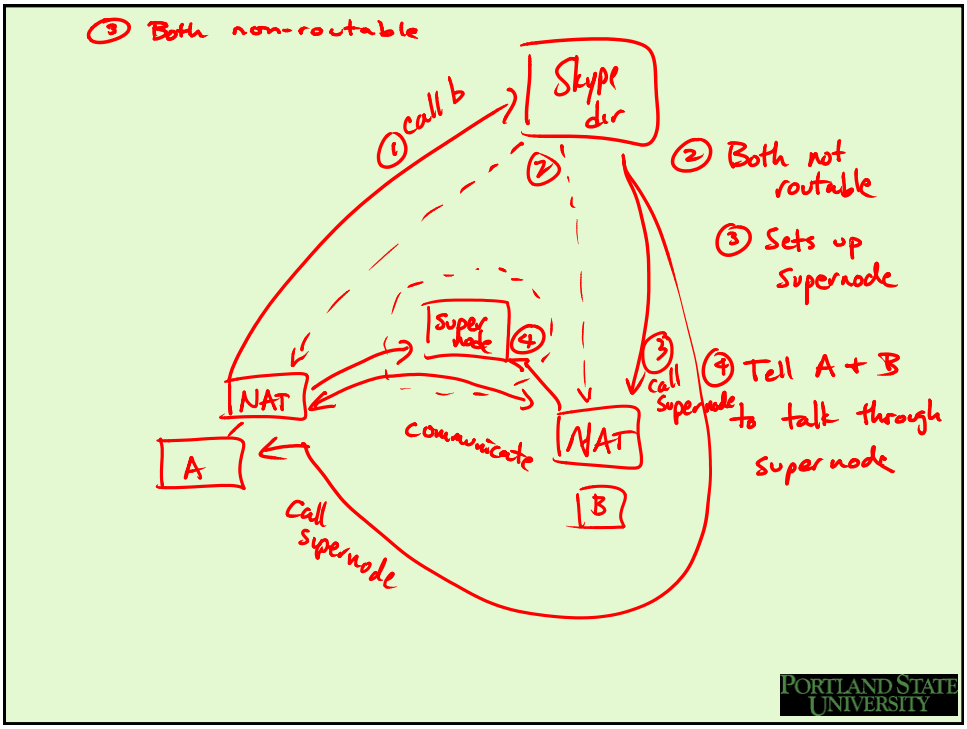

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Solving NAT / VPN with IETF

STUN / ICE / TURN

Session Traversal Utilities for NAT

RFC 7064 ← IETF DOC #

Interactive Connectivity Establishment

RFC 5245

Traversal using Relays around NAT

RFC 5766

SIP supports STUN/ICE/TURN

↑ Requires infrastructure in network

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STUN, ICE, TURN

STUN discover reachability of clients

- results in a list of possible candidates
- Needs a STUN server on other side of NAT
- STUN determines possible IP addresses: IPV4, IPV6, TURN, etc. addresses

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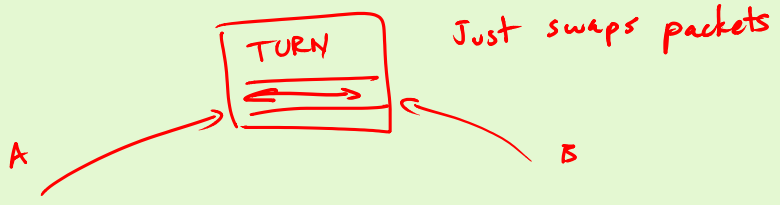
STUN, ICE, TURN

ICE - Takes STUN results and determines best one to use

Tries each addresses + picks best

Great for mobility

TURN - Internet relay server



Just swaps packets

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The Next Chapter

May 2011 Microsoft bought Skype $8.5 Billion

May 2011 Google releases open source project for browser-based RT communications known as WebRTC

Google Hangout infrastructure

Standardizing WebRTC - or browser-to-browser communication

W3C - browser API standardization

IETF - protocols

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Google implementation based libjingle

On2 technologies for video acquired by Google in 2010

Google Hangout built on On2 tech WebM or VP8

IETF ongoing work

Working on standardizing protocols

Mandatory to implement codecs?

Audio - G.711, Ogg Orbit

Video - MPEG-4 = legally encumbered

VP8 = "open source"

NetVC - IETF began effort to do video codec

Thor / Daala

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Stored Video Streaming

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Stored Video Delivery

A different kind of ballpark:

- Data has already been captured & stored
- Need to ensure "just in time" delivery
- Buffering may be a concern
- Initial delay is your friend (or enemy)

Best-effort delivery
- less constrained than interactive

Guaranteed delivery
- over ATM networks
- completely analyze data ahead of time
  - can be very deterministic

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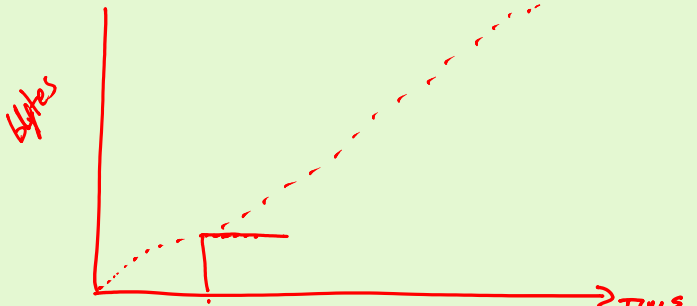
Model

$frame_i$ = size of i^{th} frame



At frame i all bytes from first frame to i^{th} need be delivered

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In Class…

3 5 2 4 5 8 3 2 2 10 3 5 2 4 3

3 ✓ x^{-2}

4 $\sqrt{}^{+1}$ ✓ $\sqrt{}^{+2}$ $\sqrt{}^{+2}$ $\sqrt{}^{+1}$ x^{-3}

5 +2 +2 +5 +6 +6 +3 +5 +8 +11 +6 . . . . . -> ✓

Average => 4.07

2 2 2 2 2 2 2 4 1 1 2 $\frac{61}{15}$ 2

16 1 1 1 1 1

14 1's

Determining Minimum Rate

2 2 2 2 2 2 4 1 1 2 2 2 2 2 .

Average rate = 2

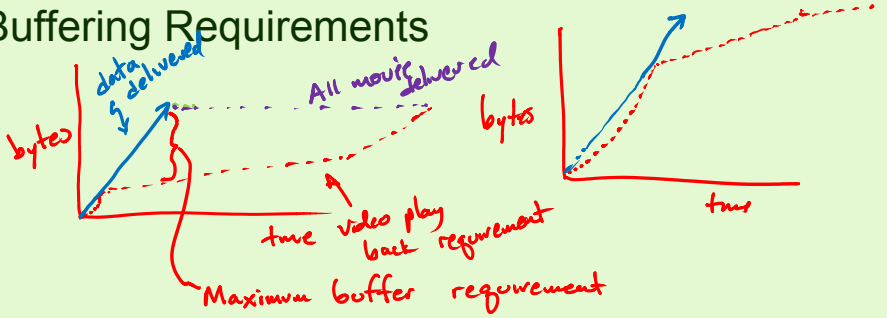
But won't work if playback begins immediately

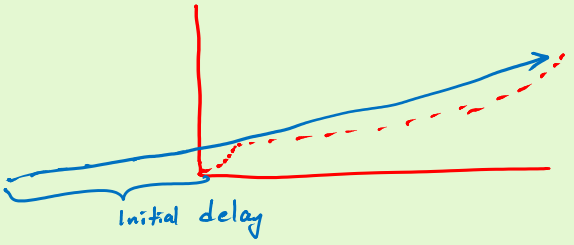
At any frame i, how much data had to have been delivered?

$$\max_{0 \le i \le N} \frac{\sum_{j=0}^{i} \text{frame\_size}_j}{i}$$

average rate from $0 \rightarrow i$

Buffering Requirements





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Prefetching

Add prefetching

8 2 2 2

Σ 8 10 12 14

rate 8 $\frac{10}{2}=5$ 4 3.5

max. rate calculation

$$\max_{0 \le i \le N} \left(\frac{\sum_{j=1}^{i} \text{frame\_size}_j}{j} \right)$$

3 frames prefetch

2 2 2 2

w/ prefetching

$$\max_{0 \le i \le N} \left(\frac{\sum_{j=1}^{i} \text{frame\_size}_j}{j + \text{prefetch frames}} \right)$$

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