Warp + RUSH + QUICR

base draft

draft-1curyler-warp-02
Media Encoding

Frame: I → P → P → P → I → P → P → ...

Deltas

Time: 0 1 2 3 4 5 6 7
Media Encoding

Frame

I → B → P → B → P → I → B → P → ...

Annoying

time 0 1 2 3 4 5 6 7
Media Encoding

Frame

I B B B B P I P S ...

WTF

time 0 1 2 3 4 5 6 7
Media Encoding

Frame

I B B B B P | I P S ...

GoP | GoP

time 0 1 2 3 4 5 6 7
Goals

1. respect encoding over network
2. minimize latency during congestion
3. use QUIC
TCP  RTMP  HLS/DASH

Frame:

I  B  P  B  P  I  B  P ...

how to serialize?

time:

0 1 2 3 4 5 6 7
TCP

RTMP

HLS/DASH

Frame

I ← P ← B ← P ← B ← I ← P ← B ...

decode order

time

0 2 1 4 3 5 7 6
TCP

RTMP

HLS/DASH

Congestion

Frame: I → P → B → P → B → I → P → B ... What to queue?

Time: 0 2 1 4 3 5 7 6
TCP

RTMP

HLS/DASH

Frame: I → P → B → P

Congestion Control

Time: 0 2 1 4 3 5 7 6 9 8

+ Latency
Rule 1

Don't introduce dependencies
RTP

Frame IBPBPBIBPB...

MTU fragments

time 0 1 2 3 4 5 6 7
RTP

congestion

Frame: IBPBPBIBP...

what to drop?

time 0 1 2 3 4 5 6 7
RTP

Frame: [Diagram showing a sequence of symbols with some red 'x' marks and green checks]

Best Case:

Time: [Diagram showing a sequence of symbols with red 'x' marks and green checks]

...
RTP

Frame

Worst case 😞

time ✓ ✗ ✗ ✗ ✗ ✗ ✗ ✗ ✗ ✗
Rule 2

don't drop partial frames

* slices
RUSH

Congestion

Frame

IBPBPPIBP...

what to reset?

time 0 1 2 3 4 5 6 7
RUSH

Frame

IBXBp...?

worst case:)

time

0xxx

xxxxx
RUSH + QUICR

Frame

IBBPBPIBP...

dependencies on the wire

time 0 1 2 3 4 5 6 7
Rule 3

don't drop dependencies

drop leaf nodes first
Warp

Frame

I → P → B → P → B → I → P → B → …

QUIC Stream per GoP

0 2 1 4 3 5 7 6
Warp

Frame order time

new > old

I P B P B | I P B B ...

2 1 4 3 5 7 6
Warp

congestion

Frame order time

I P B P B I P B ...

0 2 1 4 3 5 7 6

what to prioritize?
Warp

Frame order
time

I ← P ← B | I ← P ← B

Congestion control

Starve
Warp

Frame order

I ← P ← B ← P ← B

congestion

I ← P ← B ← P ← B

Skip queue

time

5 7 6 9 8 0 2 1 4 3
Why Warp?

- Variable latency
- Relay support
Warp  Receive Buffer

Video

Audio

1 2

low  Live
Recap

exact same delivery

low: +2 latency, -3 video, -1 audio
mid: +4 latency, -2 video
high: +6 latency
archive: +N latency
Warp + RUSH + QUICR

draft-Icurley-warp-02

1. any number of frames per stream = "segment"

2. delivery order and/or dependencies on wire
Warp + RUSH + QUICR

Frame

many options

I  P  P  B  B  I  P  ...
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Frame:

2I ← P ← B ← P ← B

1I ← P ← B...

time:

0 2 1 4 3 5 7 6
Warp + RUSH + QUICR

Frame

Time: 0 1 2 3 4 5 6 7

2I ← P ← P 1I ← P ...
$Warp + RUSH + QUICR^*$

**Diagram:**
- **Frames:** 2I $\rightarrow$ P $\rightarrow$ P $\rightarrow$ 1I $\rightarrow$ P $\rightarrow$ ...
- **Time:** 0 1 2 3 4 5 6 7
- **Boxes:**
  - 4B
  - 5B
  - 3B

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Warp + RUSH + QUICR

Frame

4I 5P 6P 1I 2P ...

time

0 1 2 3 4 5 6 7
What's next?
What's next?

Names r hard

Segments or layers
or fragments
or chunks

WARP or RUSH or MOQ
or ?
What's next?

- Wire format
- CON support
- Media stuff
- Adoption?
Contributors

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and you!
Thanks
if someone asks...
Warp + RUSH + QUICR* + SVC

4K: 5 I P P P P

1080p: 3 I P P P P

360p: 1 I P P P P

layers!