



Making Video Streams QUIC'er

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Introduction

[Exec Summary, not presented]

The QUIC Protocol is the next generation of transport for the Internet and is on track to become ubiquitous on end-user platforms and within all server-side workflows. Unlike prior standard technologies, which are struggling to innovate due to compatibility issues with existing infrastructure, QUIC operates on top of UDP in the application layer and that brings flexibility to deploy new features in rapid iterations. QUIC excels at providing a great innovation platform for experimentation in ways not possible with other protocols and Akamai's leadership in QUIC protocol R&D and deployment at scale for video workflows allows to tune it for best performance.



We are all on a journey. [pause] A journey that leads to better video streaming experience.

Let me tell you a bit about the history of innovating the Internet transport protocols.



The transmission control protocol, mostly known as TCP or TCP/IP, has been invented over 40 years ago.



Over the years, it has been evolving steadily.
And it became the #1 transport protocol on the Internet.



But it also started to ossify.

Ossification is a process of becoming rigid, like a bone.

For TCP, this means that any innovation in the protocol became very hard. Changes are taking years or sometimes decades to get deployed.

This is because of compatibility with the huge amount of Internet infrastructure out there which relies on the very details of the protocol. This includes all routers, end user devices and servers.



There are still great improvements to TCP, especially in the congestion control area. That's possible because it mostly requires changes to be applied only in servers.



In response to these challenges with slow innovation of TCP, companies like Akamai and Google, but many others as well, started experimenting with proprietary protocols build on top of UDP.

UDP is a very basic protocol. It only provides the bare minimum functionality and is suitable for new protocols to be built on top of it.

It is well supported by all infrastructure on the Internet.

Protocols on top of UDP can be implemented in applications so it allows for rapid deployment of new versions.

Full encryption and authentication can be used to protect against ossification and tampering by middleboxes. These protections are not possible to be applied for TCP.

The experiments with UDP protocols evolved into an effort to bring in the engineering community and openly collaborate on a single protocol framework on top of UDP.





An Internet Engineering Task Force working group has been established to specify a protocol called QUIC.

QUIC stands for Quick UDP Internet Connections.

By end of this year we are likely to see the first QUIC Internet standard published.

Why care about protocol innovation?

Akamai's QUIC Beta program result in 2017:

 Fewer Rebuffers	 Faster Startup	 Higher Bitrates	 Higher Throughput
24%	9%	Up To: 25% more 4K, 23% more HD viewers	12.5%
Reduction	Median Improvement		Average Increase

“Shortly after shifting traffic to Media Acceleration, Vimeo observed higher quality video experiences for our viewers; most notably a marked increase in playbacks at HD quality”

Naren Venkataraman, Vice President, Engineering, Vimeo

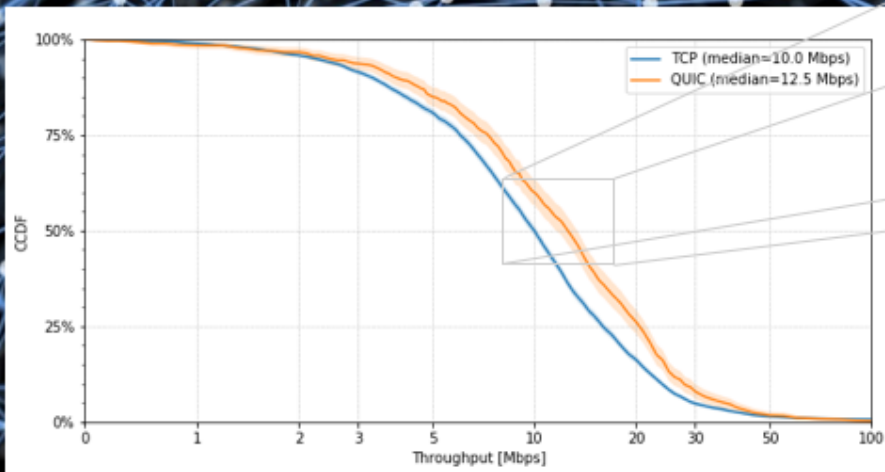
Now you know about the history but why shall we care about the innovations in transport protocols? How is it relevant to video experience?

Let me show you a sample data point. Last year Vimeo opted in to use QUIC protocol on Akamai's network. They immediately saw improvements in all relevant video metrics.

There were significantly fewer rebuffers, faster startup times, higher bitrates and throughput.

Protocol Performance Comparison

via Throughput Complementary Cumulative Distribution Function (CCDF)



⇒ 25% higher throughput for median viewer

We've been tuning the protocol and are commonly seeing results like this.

This measurement is from a recent soccer event.

An excellent 25% throughput improvement for median viewer was achieved.

To explain the CCDF graph briefly:

Blue line shows TCP throughput. Orange line is for QUIC.

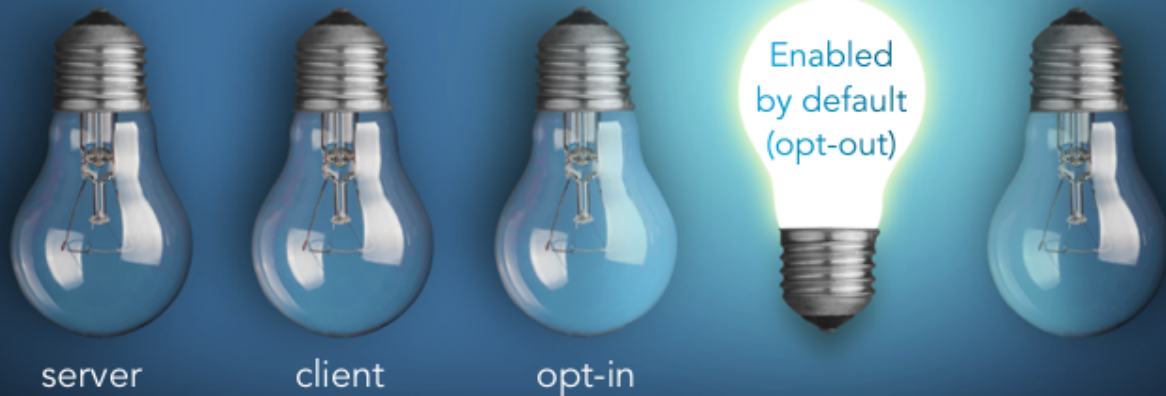
Each point represents how many percent of viewers were able to achieve that speed or higher. Note the logarithmic scale of the X axis.

To the right on the graph means faster, higher on the graph means more users.

The horizontal distance between the blue and orange lines shows the improvement in speed and vertical distance indicates the difference in the number of viewers capable of reaching certain video bitrate.

Shading around lines shows statistical error bounds.

How to get faster adoption for the innovation?



So we have a good way to innovate the protocol with QUIC, but how do we get people to adopt it and enjoy the benefits?

For the protocol to work you need both the server and the client to support the new protocol and to select to use it.

The Chrome browser supports QUIC on the client side.
Akamai supports QUIC on server side.

QUIC has been nicely designed to allow being enabled seamlessly for existing video workflows without any changes needed in the video formats or players.
We've had QUIC available for customers since 2016, allowing them to opt-in to use it.
We've now moved to a more scalable approach. That is to enable the new protocol by default for everyone and allow opting out.

How does QUIC make streaming QUIC'er?

- Low-latency secure connections
 - Usual TCP+TLS (i.e. HTTPS) session takes 3-4 RTTs
 - About half of QUIC connections use 0-RTT, others 1-RTT
- More efficient loss recovery
- Multiplexing without head-of-line blocking
- Connection Migration

...measure impact of each feature and protocol setting ⇒ apply selectively

So, how does QUIC make the streaming work better?

There are many features of the protocol that contribute to this but let me highlight some: With usual TCP&TLS session which forms HTTPS streaming, there has to be 3 or 4 exchanges of information back and forth between the client and the server, before the video request is made. With QUIC there's none needed, assuming the client communicated with the server previously. The first packet from the client already contains the video request, and the first packet from the server already contains the video content. Or in case the client hasn't communicated with the server before, it only takes one roundtrip between the client and server. This reduces latency greatly. TCP has similar features available with new version of TLS, TLS-1.3, and TCP Fast Open feature but its deployment is complicated.

The 0-RTT (zero round trip time) connection establishment for returning connections applies to about 50% of connections in our experience.

QUIC also uses more efficient loss recovery – due to more information being provided about the lost packets and timing.

QUIC allows Multiplexing without head-of-line blocking. {explain only if time allows - One packet lost => all requests affected}

Connection Migration {explain, wifi<->cellular}

Most important feature of all is that with QUIC it is easy to measure the impact of each feature and apply them selectively.

At Akamai we choose the right protocol and protocol settings for each user to achieve best performance.



QUIC is on track to becoming ubiquitous in the coming years.

Once standardized our expectation is that it'll be supported by all devices, platforms, browsers and will take over from TCP as the main video distribution protocol.

It is already estimated to be about 7% of the current Internet traffic.

In future we can also expect DNS to run securely and more efficiently with privacy guarantees over QUIC.

Similarly, there are experiments under way for using QUIC for WebRTC, which is used by some low-latency streaming solutions.



I'd like to finish where I started today. We are all on a journey of improving video streaming experience.

If there's one thing to remember from my presentation, I'd like it to be that the QUIC protocol is a major change in transport and it is available to help you achieve better streaming performance today.

Unless you are using it already or have a strategy to start using it soon, I'd use my favorite quote from an Akamai co-founder Danny Lewin, "You are behind!" ☺

Thanks for your attention.

Thanks a lot also to the organizers for having me here today.

I'll be happy to answer a few questions now.