REPORT 2022

Video Streaming Performance

India

bolina vs HTTP/2 vs HTTP/3

codavel

Fast and Resilient Content Delivery for Mobile apps

01. Summary

Mobile video streaming is skyrocketing in the Indian market, one of the fastest-growing globally. But are current services and infrastructures capable of handling such growth while ensuring a superior user experience for everyone? In this report, you will find data showing how unstable and unpredictable wireless networks are in the Indian market, and how that impacts user experience and engagement. Finally, this report will also shed light on how Codavel can help mobile apps provide a consistently good user experience. In a nutshell, you will learn how Codavel decreases the number of session dropouts by 80%.

02. Challenge

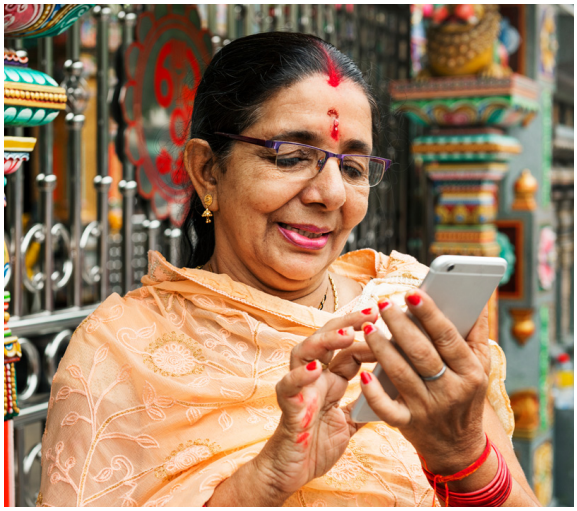
During the last decade, India has become a mobile-first nation, and one of the largest video streaming services consumers worldwide. However, user expectations and demands have also been intensifying, especially regarding the quality of the mobile experience (QoE) delivered. When expectations aren't met, uninstalling the app and trying another one is the usual path for Indian users, **contributing to increasing churn rates, and consequently, revenue losses.**

User experience degradation can happen due to several factors, but among the most frequent and highly complex to mitigate are the issues related to **wireless networks' speed, stability, and reliability** (usually caused by uncontrolled latency and packet loss).

By evaluating the data from the Telecom Regulatory Authority of India (T.R.A.I), it is clear the aforementioned problems are happening all across the country, creating wide variations in the quality of the experience delivered to tier 1, 2, 3 and 4 cities, highly dependent on which ISP (Internet Service Provider) is providing the service.

Even among tier 1 cities, as validated in this Tutela study - Only roughly 50% of the users achieved an **Excellent Consistent Quality Score**, which indicates the number of users that can successfully interact with more demanding apps like **HD video calls or 720p video streaming.** A clear issue is when the speed and the quality of a video or streaming are among the most important KPIs in user experience.

To validate this widespread instability's true impact on user experience, we set out a deeper analysis of key performance indicators for QoE in mobile apps based on real user data and look in detail at what is happening in each user session.



Test Parameters

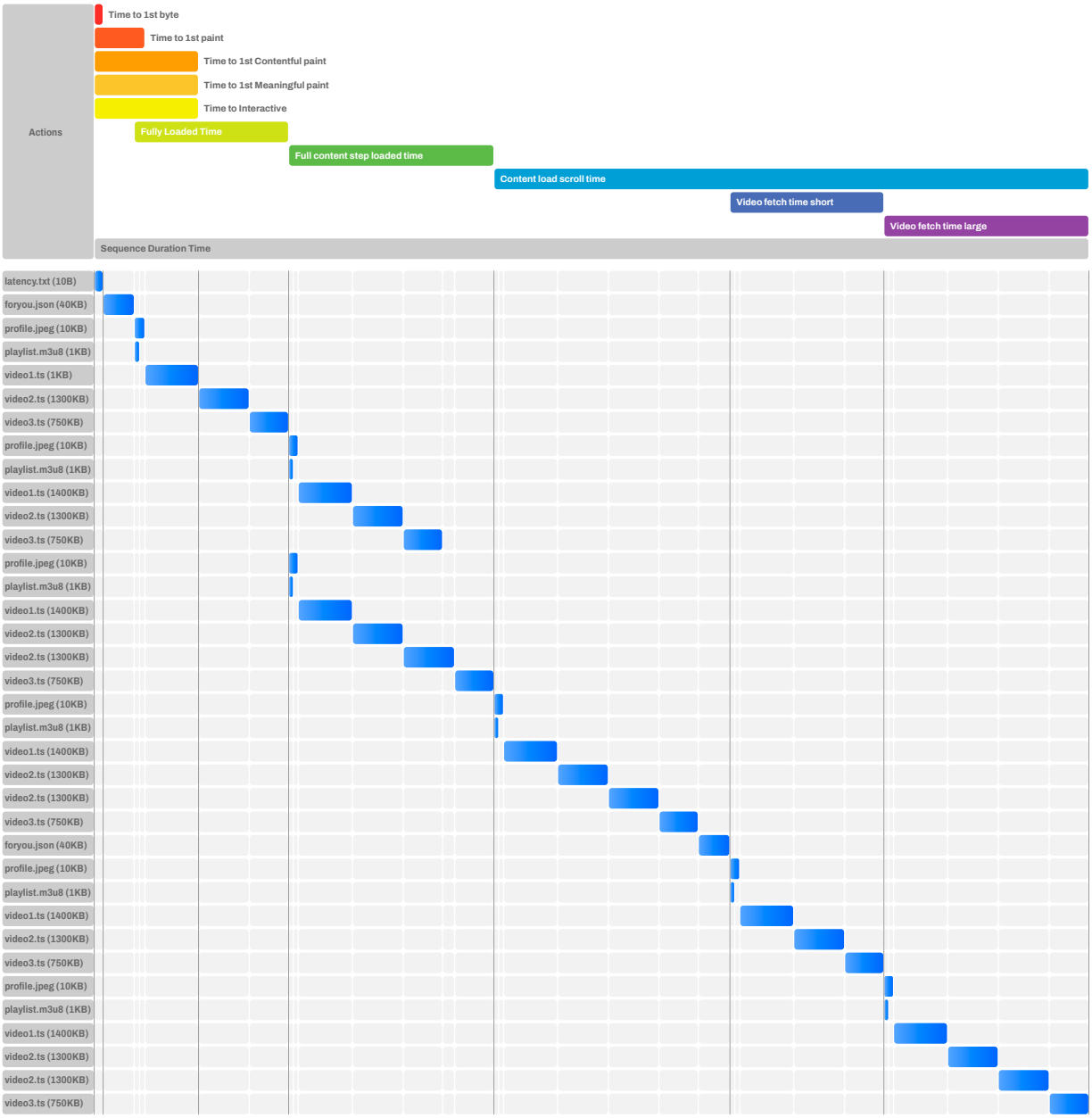
We conducted field tests to analyze the video streaming use-case by looking at the performance of an Indian short-video mobile application delivering content through three different solutions:

- A traditional CDN using HTTP2, the most used solution in the market
- A traditional CDN using HTTP3, the most recent version of HTTP, based on QUIC
- Codavel CDN with Bolina Protocol

The performance indicators under evaluation and the deployment specifications can be found in the following table.

Key Performance Indicators	Deployment Specifications
• Time to first byte • Time to 1st paint • Time to 1st Contentful Paint • Time to 1st Meaningful Paint • Time to Interactive • Fully Loaded Time • Full Content Step Loaded Time • Video Fetch Time Short • Video Fetch Time Large • Content Load Scroll Time • Sequence Duration Time	LOCATION - INDIA • Servers (for both Bolina, HTTP2, and HTTP3) placed in Mumbai, India • 588 user sessions per protocol • 21K requests per protocol

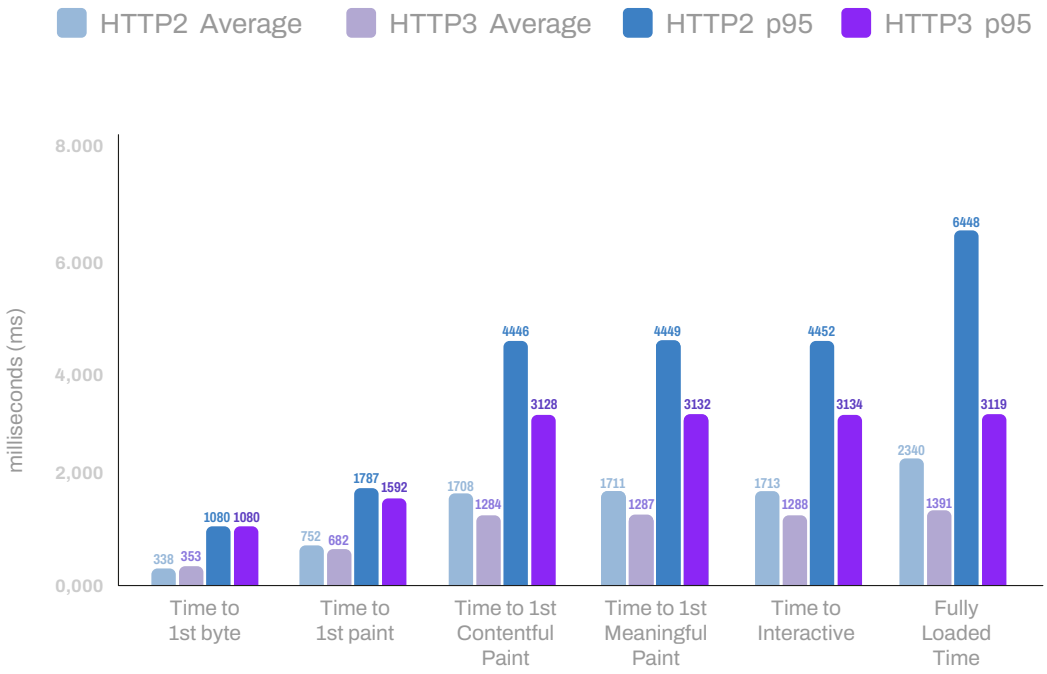
To better understand what these KPIs mean, consider the following image, that represents the behavioral sequence of the mobile app under analysis. Notice that the sequence under analysis assumes prefetching mechanisms to ensure continuous user interaction, a crucial best practice, and it does not have adaptive video quality delivery.



To shed some light on the KPIs, let us look at two examples. Time to Interactive (TTI) represents the time it takes from opening the app until actually starting to see a video. During this time, the app loads the initial setup and user information, the playlist file that points toward the video, and finally the first video segment. With respect to Fully Loaded Time, it represents the time it takes from the first request of the first video until this first video is fully played out.

Empirical Results

Let us focus on the first part of the sequence, i.e. until Fully Loaded Time. The results immediately show the existence of critical user experience issues.



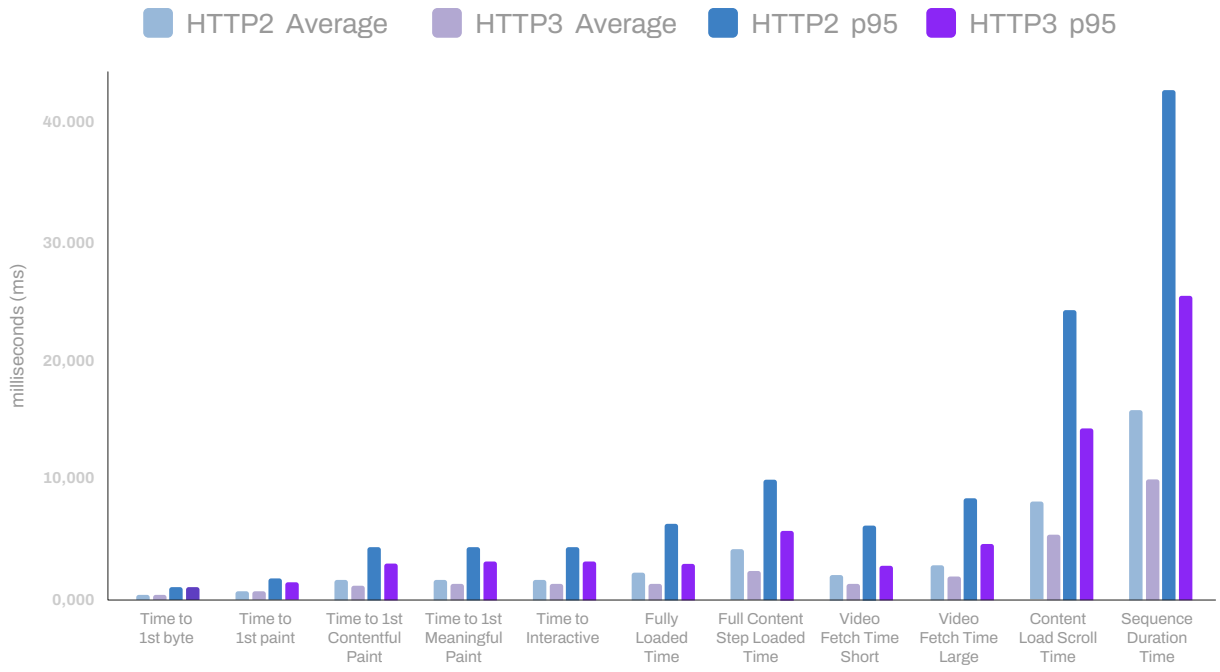
The first clear observation is that, although there is still small availability of HTTP3 end-points and it is still complex to deploy it, HTTP3 clearly outperformed HTTP2. For example, **HTTP3 reduces Time to Interactive by 25% on average.**

Apart from the significant disparity between the average experience and the tail-end experience (in this case, viewed through the 95th-percentile), which is similar for both protocols, we can see that the average TTI is above 1 second. In other words, it takes more than 1 second for the user to start a video, on average. When we look at 95th-percentile, the time to start a video jumps to more than 4 seconds in HTTP2 and more than 3 seconds with HTTP3.

This is very concerning because users start abandoning a video that takes more than 2 seconds to load, considering Akamai's report as the benchmark. And for each additional second, the abandonment rate is expected to increase by 5.8%. With this in mind, from our empirical results and based on Akamai benchmark, we should expect, when using the market trend HTTP2, **8.1% of the sessions to be abandoned** before the first action of the app: watching the first video. **Even if we resort to the latest HTTP3, 5.8% of the sessions are dropped.**

2 SECONDS **5.8% DROP OFF FOR EACH ADDITIONAL SECOND**

If we consider Snapchat's more recent data, which is more tuned to short video applications, like the one under analysis in this report, the scenario is even more dramatic. According to Snapchat, their entire user base abandons a session if the video takes more than 2 seconds to start. Using this Snapchat benchmark, our empirical results show that a **staggering 22% of user sessions are abandoned even before watching the first video when using HTTP2, and 11% for HTTP3.**



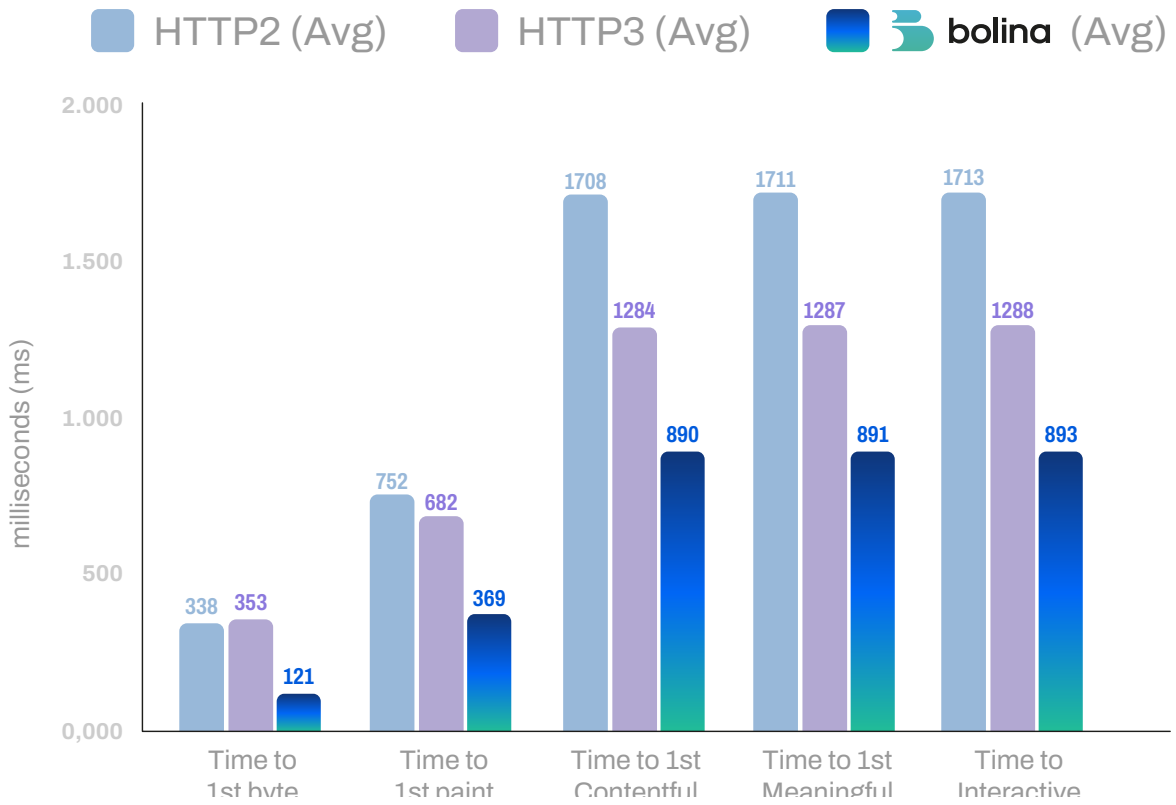
The results for the entire sequence are depicted above. As aforementioned, there is a massive variation in terms of user experience. For example, the 95th-percentile for the overall sequence duration is more than twice as large as the average value. This clearly manifests the volatile and unpredictable network connections, as discussed at the beginning of this report.

03. Solution

Codavel's team has devoted more than 15 years of R&D to be able to help mobile apps to become resilient to the wireless links instability that leads to the unpredictable user experience we have seen before. This is why we have built the only CDN entirely focused on delivering content to mobile applications.

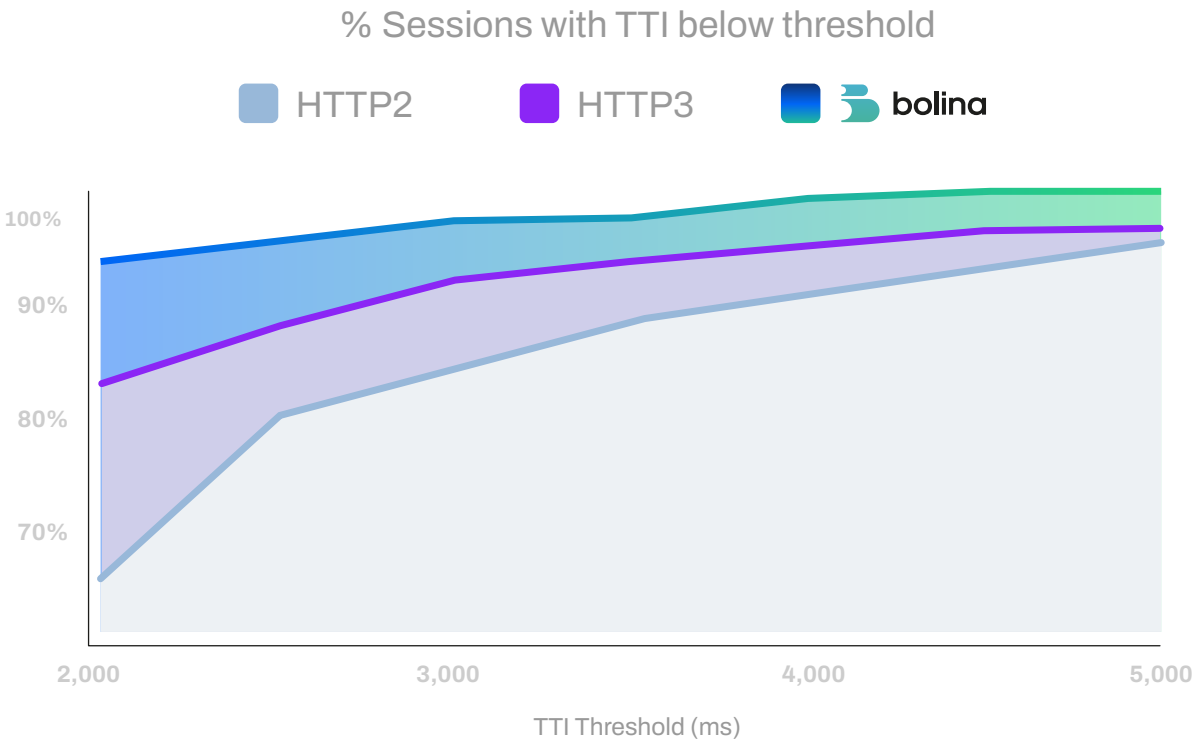
Codavel CDN is built on top of our own content delivery protocol, Bolina. Bolina was developed with network coding techniques and exhaustively tested to be resilient against latency and packet loss, protecting the user experience from degradation, regardless of the quality of the network connection. This means the desired experience is what is being delivered to the users without the unpredictability of the link quality.

Keeping the same testing environment and parameters, we tested the same sequence of requests, using Codavel Mobile CDN, with all traffic served through Bolina Protocol. The results show the clear impact of Bolina on user experience on all the KPIs.



On average, **Bolina reduces the time it takes for the user to start seeing the first video (TTI) by more than 48% when compared to HTTP2, and by more than 31% compared to HTTP3.**

Recalling the Akamai benchmark mentioned above, the time it takes for a video to start (here, TTI) is of paramount importance for users to stick to a mobile application. By significantly reducing TTI, Bolina also brings a tremendous reduction in the number of user sessions that get an unbearable experience.

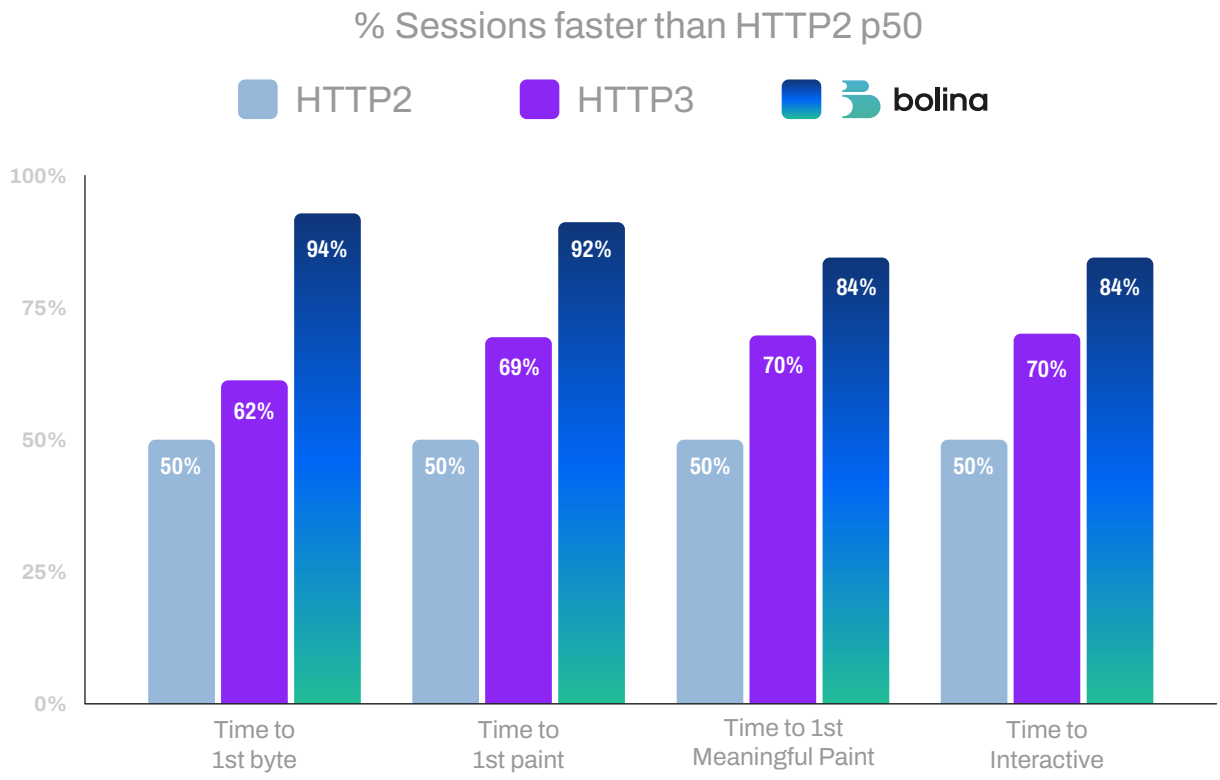


As we can see in the above plot, with Bolina, you get 96% of user sessions below 2 seconds of TTI compared to 78% when using HTTP2 and 89% when using QUIC. Let's take Akamai's data that says that, after 2 seconds, every additional second that it takes to load a video leads to an additional 5.8% of dropouts. Based on the previous assumption, **Bolina reduces the number of dropouts by a staggering 80% versus HTTP2, and by 72% compared to HTTP3.**

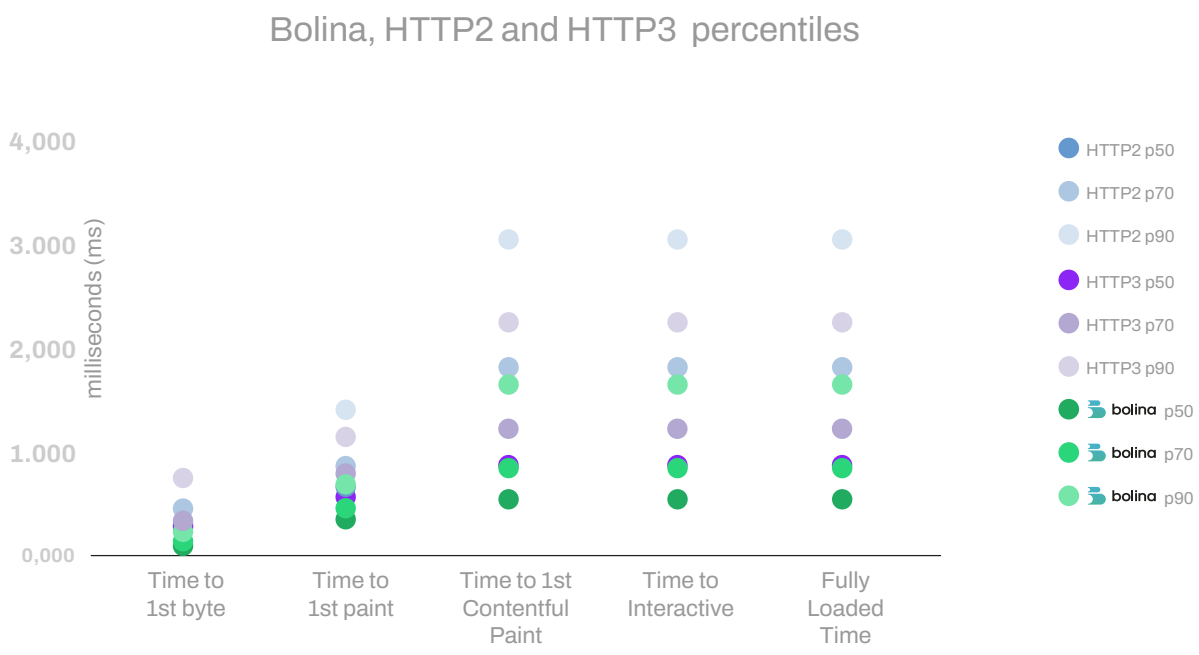
Sessions dropouts due to time to start video *(estimates)*

HTTP 2	HTTP 3	bolina
8.06%	5.83%	1.61%

These results show that by using Bolina as the protocol for delivering content, Codavel CDN significantly improves user experience, but it does not end there. These results also show that, most importantly, Bolina is capable of "healing" (or saving!) user sessions that previously had a painful user experience. This becomes even more evident when we look at how many Bolina sessions were faster than the median behavior of HTTP2, depicted in the plot below.



A total of 84% of the user sessions with Bolina started playing the video faster than the median behavior of the HTTP2 sessions. That represents **a nominal 34% increase in sessions that started the video faster than the median HTTP2 session** and 14% more than HTTP3.



Last but not least, **Bolina is not only faster than HTTP2 and HTTP3,** but it is also capable of providing **a more consistent user experience**, as depicted in the above plot that compares the different percentiles for the protocols analyzed.

For example, notice that the **70th-percentile for TTI with Bolina is below the median for HTTP2 and HTTP3.**
Furthermore, for the same KPI, the **90th-percentile for Bolina is below the 70th-percentile for HTTP2 and HTTP3.** This phenomenon is seen across **all the KPIs considered.**

04. Final Highlights

Previous to this report, we were already aware of some of the challenges Indian mobile apps face every day just because of how unstable and unpredictable wireless networks can be across the country. But only after our first partners in India we realized how impactful such events can be on performance and business, hence the origin of this report.

As key takeaways, we would like to highlight:

- The instability of wireless networks leads to a very unstable user experience. Considering Snapchat's user data as a benchmark, our data shows that a staggering **22% of user sessions are abandoned** even before watching the first video when using HTTP2.

- From pressing the app start icon to being able to watch a fully loaded video, users waiting time was **reduced by 48%** when using Bolina, **lowering the probability of initial user drop-off by 80%**, if you are using HTTP2 today. For HTTP3, Bolina **reduces this KPI by 31%, leading to 72% less user drop-off.**

- Assuming Akamai's 2 seconds benchmark, serving traffic through **Bolina brings 71% of the users under this threshold**, compared with only 78% for HTTP2.

- **84% of the user sessions with Bolina started playing the video faster** than the median behavior of the HTTP2 sessions, **meaning 34% of the users with unbearable experiences were able to "leave the tail"** and re-gain usability and quality.

- There are still a lot of challenges to uncover when it comes to video streaming in the Indian market. In particular, our next steps will be to further segment this analysis, to analyze the differences in user experience for cities in different tiers. The data in this report already shed some light on the impact of network quality on user experience, but we believe there are a lot of users that are suffering from bad user experience in Tier 2, 3, or 4 cities, which for mobile apps means there is a huge amount of users to be unlocked.

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