A First Look at Performance of TV Streaming Sticks

Ayon Chakraborty, Arani Bhattacharya, Santosh Ghosh, Samir R. Das

Stony Brook University
Smart TVs Increasingly Popular
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... and so are streaming sticks!
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Amazon Fire TV Stick vs. Chromecast vs. Roku Streaming Stick

By Christian de Looper, Jon Porter  July 07, 2017  HDTV

Which ultra-portable streaming device reigns supreme?
Lots of User Concerns

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Can't stream anything, unbearably slow internet

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Which ultra-portable streaming device reigns supreme?
Lots of User Concerns

Slow loading? (self.Roku)
submitted 3 days ago by jb_3333
4 comments share report

Can't stream anything, '
(self.Roku)
submitted 2 days ago by JonWood007
8 comments share report

Amazon Fire TV Stick vs. Chromecast vs. Roku Streaming Stick
By Christian de Looper, Jon Porter July 07, 2017 HDTV

Which ultra-portable streaming device reigns supreme?
Lots of User Concerns

Internet

Can't stream anything, help?
(submitted 2 days ago by Jon_3333)

Slow loading? (self.Roku)
submitted 3 days ago by jb_3333
4 comments share report

Amazon Fire TV Stick vs. Chromecast:
Roku Streaming Stick
By Christian de Looper, Jon Porter July 07, 2017 HDTV
Which ultra-portable streaming device reigns supreme?
Lots of User Concerns

Can't stream anything, internet is terrible.

Slow loading? (self.Roku)
submitted 3 days ago by jb_3333
4 comments share report

Slow connection speeds on chromecasts.
Which ultra-portable streaming device reigns supreme?
Lots of User Concerns

Fire TV Stick app is extremely slow, bordering on useless. Anyone else with this issue?
Lots of User Concerns

Internet speeds drop dramatically after ROKU plugged in. They’re bordering on slow, and my Fire TV is still working fine otherwise. Could it be the internet connection? (self.Roku)

Submitted 2 days ago by John Doe

Which ultra-portable streaming device reigns supreme? (self.Roku)
Quality of Experience Affected
Quality of Experience Affected

Startup Delay
Quality of Experience Affected

Startup Delay
Quality of Experience Affected

Startup Delay  Video Bitrate

Internet
Quality of Experience Affected

Startup Delay  Video Bitrate

Buffering
Quality of Experience Affected

Startup Delay  Video Bitrate
Buffering  Data Usage
Quality of Experience Affected

Internet

Startup Delay
Video Bitrate
Buffering
Data Usage

Impact Other Devices
Measuring the Quality of Experience Parameters

- Startup Delay
- Video Bitrate
- Buffering
- Data Usage
- Impact Other Devices

How can we measure parameters of different devices?
Getting Bitrate and Resolution Challenging

• Works only with Smart TVs -- Cannot log parameters

How can we measure parameters of different devices?
Getting Bitrate and Resolution

Challenging

How can we measure parameters of different devices?

- Works only with Smart TVs -- Cannot log parameters
- Encrypted traffic -- Intercepting traffic not useful
Adaptation Technique in Streaming Sticks

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  -- Cannot log parameters
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  -- Intercepting traffic not useful

Adaptation ONLY on client side
Replacing Internet channel by our server does not affect our results

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Adaptation ONLY on client side
Viewer can see the resolution and video bitrate.

Video frames watermarked with resolution and bitrate.
Viewer can see the resolution and video bitrate

Video frames watermarked with resolution and bitrate

800×600
375 Kbps
Measurement Setup
Measurement Setup

Watermark

800×600
375 Kbps

Wowza Video Server

5 watermarked video files of 10 minutes each
Measurement Setup

Watermark

800×600
375 Kbps

Control Bandwidth, Latency

Wowza Video Server

5 watermarked video files of 10 minutes each
Measurement Setup

- Video camera
- Watermark
- Control Bandwidth, Latency
- Wowza Video Server

- 800×600
- 375 Kbps

5 watermarked video files of 10 minutes each
Measurement Setup

- Video camera
  - 800×600 @375 Kbps
  - OCR on video frames

- Watermark

- Control Bandwidth, Latency

- Wowza Video Server
  - 5 watermarked video files of 10 minutes each
Measurement Setup

Video camera

OCR on video frames

Control Bandwidth, Latency

Wowza Video Server

5 watermarked video files of 10 minutes each

Log file

Watermark

Video camera

Bitrate, Resolution

1s: 800×600, 235K
2s: 720×480, 300K

………

Tc-netem

800×600
375 Kbps

800×600
2720×480
375 Kbps

1s: 800×600, 235K
2s: 720×480, 300K

………

Log file
Stick Performance Metrics
Stick Performance Metrics

• Streaming Performance
  – Average Bitrate
  – Video Startup Delay
  – Video Stalls
Stick Performance Metrics

• Streaming Performance
  – Average Bitrate
  – Video Startup Delay
  – Video Stalls

• Network Load
  – Data Wastage on Abandonment
  – Effect of Background Traffic
Roku provides the highest average bitrate.
Roku provides the highest average bitrate

Better Quality

Average Bitrate

Average Network Bandwidth

Roku most aggressive
Roku provides the highest average bitrate

Better Quality

Roku most aggressive

Chromecast targets an average bitrate
Increase in bitrate delays startup

![Graph showing startup delay vs. average network bandwidth for Chromecast, Roku stick, and Fire stick. The graph illustrates that higher network bandwidth reduces startup delay, indicating better quality experience.](image)
Increase in bitrate delays startup

- Startup Delay (secs)
  - Chromecast
  - Roku stick
  - Fire stick
- Average Network Bandwidth
- Average Bitrate

Better Quality
Chromecast has the lowest amount of buffering
Chromecast has the lowest amount of buffering.

Better Quality

Average Network Bandwidth
Roku prefetches data most aggressively

Better Quality
Roku prefetches data most aggressively.
Fire is most affected by background traffic

Better Quality

![Chart showing video bitrate (Kbps) for different devices under different background traffic types.](chart)

- Chromecast
- Roku stick
- Fire stick

Video Bitrate (Kbps)

- File-Download
- Video-Streaming

Background Traffic Type

Chromecast has the highest video bitrate under video-streaming, while Fire stick has the highest under file-download.
Fire is most affected by background traffic.

Better Quality

Chromecast and Roku gets much less affected.

Background Traffic Type

File-Download  Video-Streaming

Fire reduces its utilization the most.
User Concerns

Internet speeds drop dramatically after ROKU plugged in. Fire TV bordering on this issue!

Reddit post: 2 days ago by jb_3333

Google support thread: 26/15

Chromecast Help Forum

Slow connection speeds on chromecasts. by EdgarC Feb 10

Which ultra-portable streaming device reigns supreme?
Analysis of User Complaints Confirm Our Measurement Study
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Amazon has fewest complaints related to network, Roku has most.
Analysis of User Complaints Confirm Our Measurement Study

Amazon has fewest complaints related to network, Roku has most. Overall complaints about streaming are roughly similar.
Takeaways

• A systematic way of understanding the complaints of TV stick users

• We showed how streaming sticks prioritize different aspects of Quality of Experience:
  – Roku tries to fetch higher bitrates, loses on startup
  – Fire minimizes usage of network bandwidth

THANK YOU
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