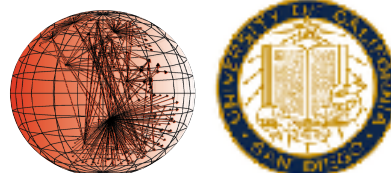


QUINCE: a gamified crowdsourcing QoE assessment framework.

**Bradley Huffaker
CAIDA / UC San Diego**

Work partially supported by NTT

Broadband Performance and QoE June 2018





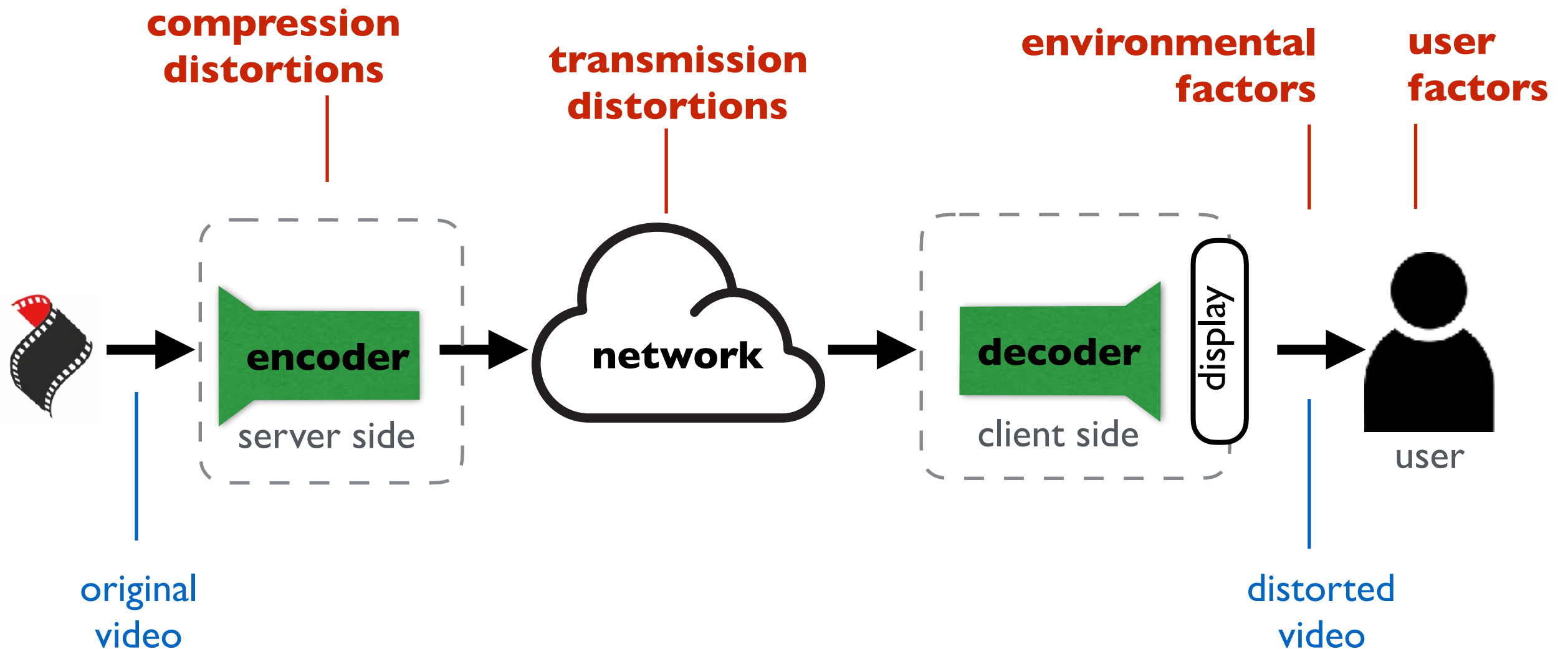
Quality of Experience

Quality of Experience (QoE) is the degree of delight or annoyance of the user of an application or service. It results from fulfillment of their expectations with respect to the utility and or enjoyment of the application or service in light of the user's personality and current state.[†]

[†]Kjell Brunnstrom, et. al. "Qualinet White Paper on Definitions of Quality of Experience", from fifth Qualinet meeting. (2013)

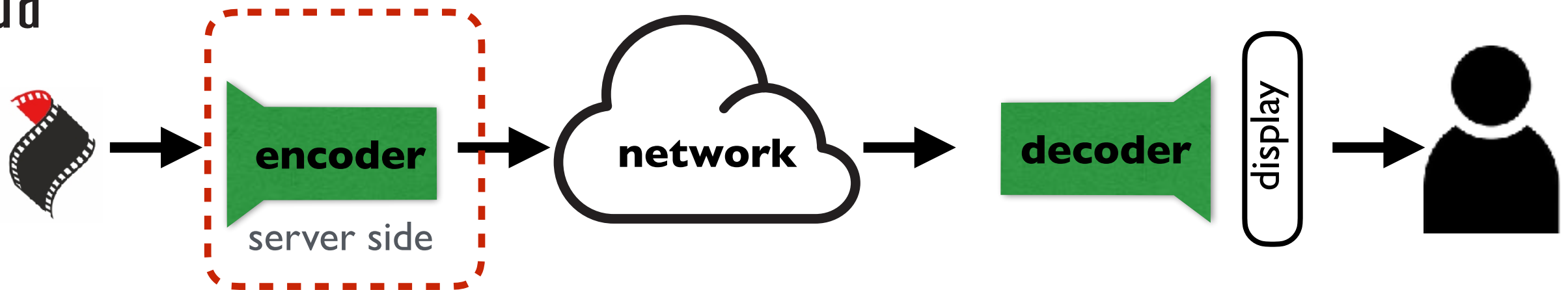


influences on experience





compress factors

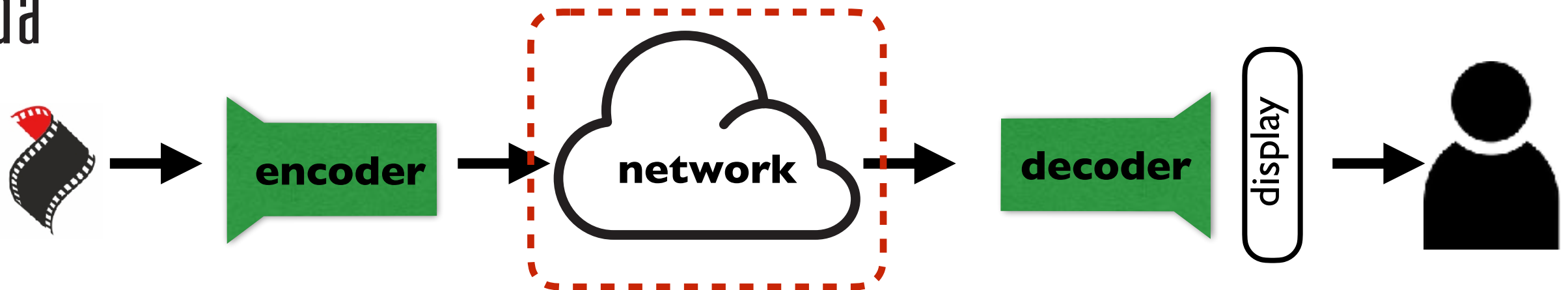


- **frame rate:** frequency image is redrawn
 - humans can perceive 10-12 frames per second
- **bit rate:** rate at which data is transmitted
 - more complex scenes require more data
- **temporal and spatial features of the video**
 - different temporal and spatial features are easier for humans to perceive.

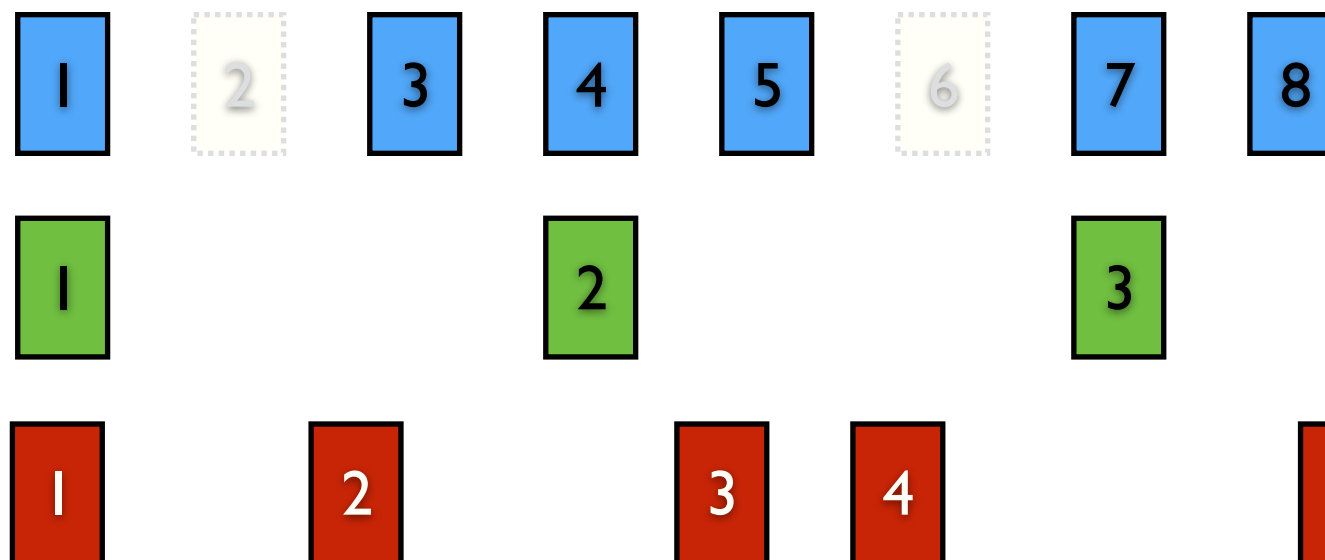




network distortions

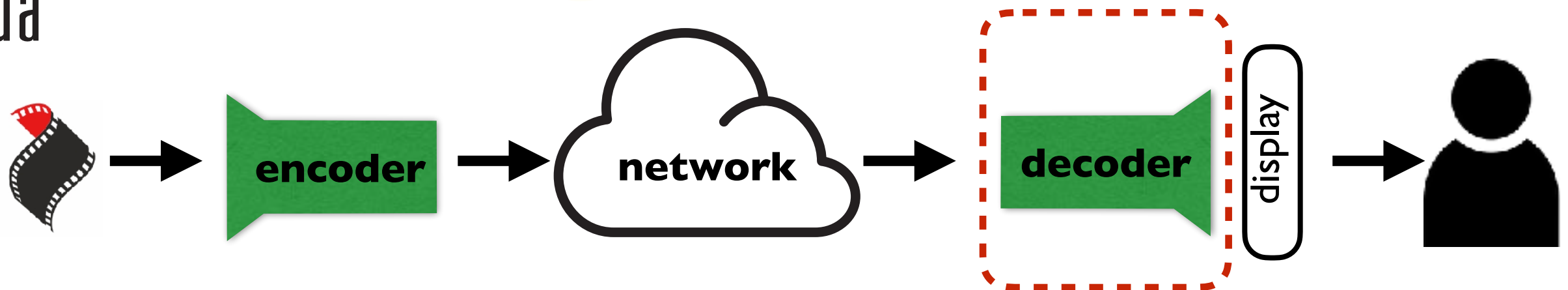


- **packet loss**: rate at which packets are lost in the network
- **delay**: time it takes for packet to cross the network
- **jitter**: variance in packet delays





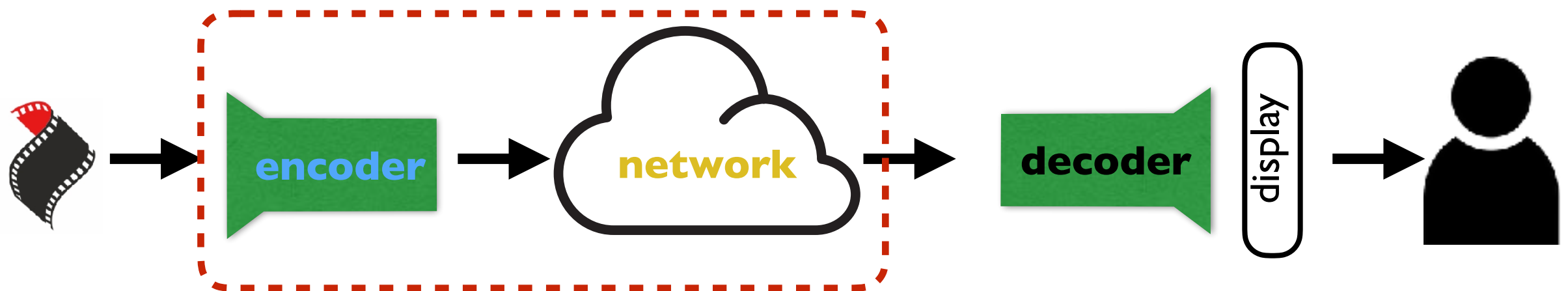
decoding factors



- **buffering**: delay before the video is displayed
- **rebuffering**: delay after the decoder starts displaying video
 - frequency of rebuffering
 - length of time required
- **degrading**: decoder pulls lower quality video in response to network loss/delay



video distortions



The end result of information lost from **compression** and **transmission** is visual artifacts in the video.

These decrease the user's *quality of experience*.

examples of artifacts



basic pattern: normally found in textures



blocking: encoding block boundaries are visible



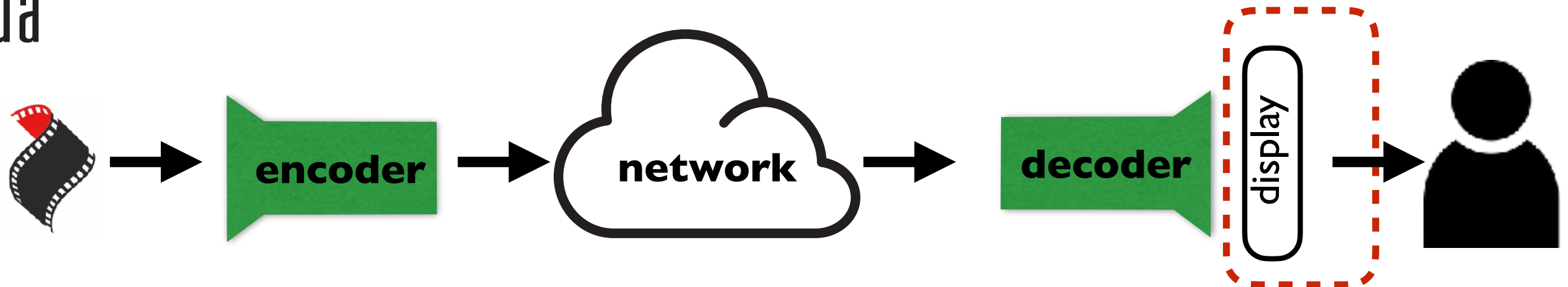
blurring: loss of spatial information and sharp edges



staircase: blocking on straight or curved edges



environmental factors



- **ambient light**

- experience of color and contrast affected by ambient light

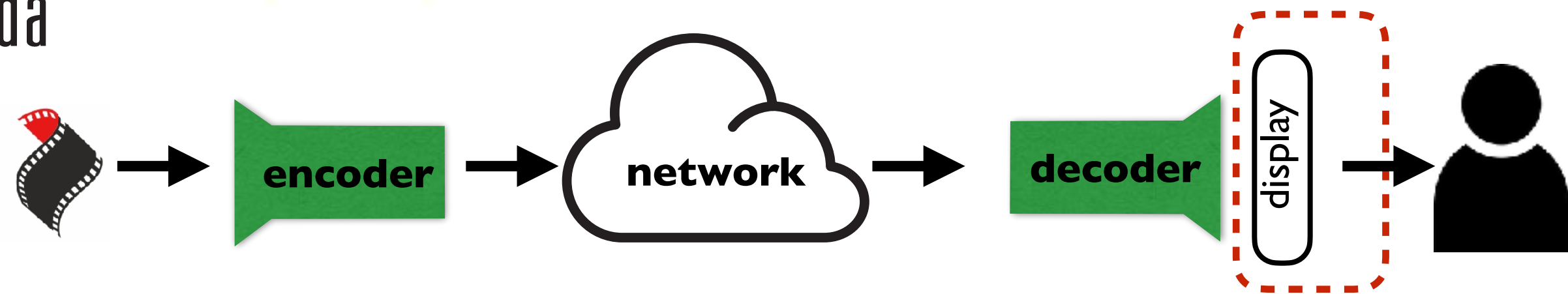
- **display device**




- larger display requires more information
- different expectations, viewing ratio



display devices used

caida



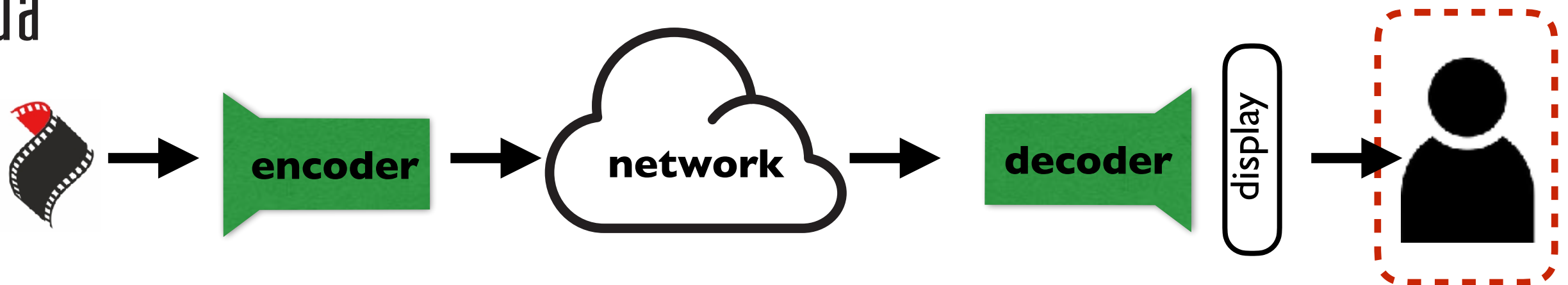
	 mobile		 desktop	 TV
	cellphone	tablet		
Youtube ²⁰¹⁷	70%		30%	-
Netflix ²⁰¹⁸	10%	5%	15%	70%

self reported “views”



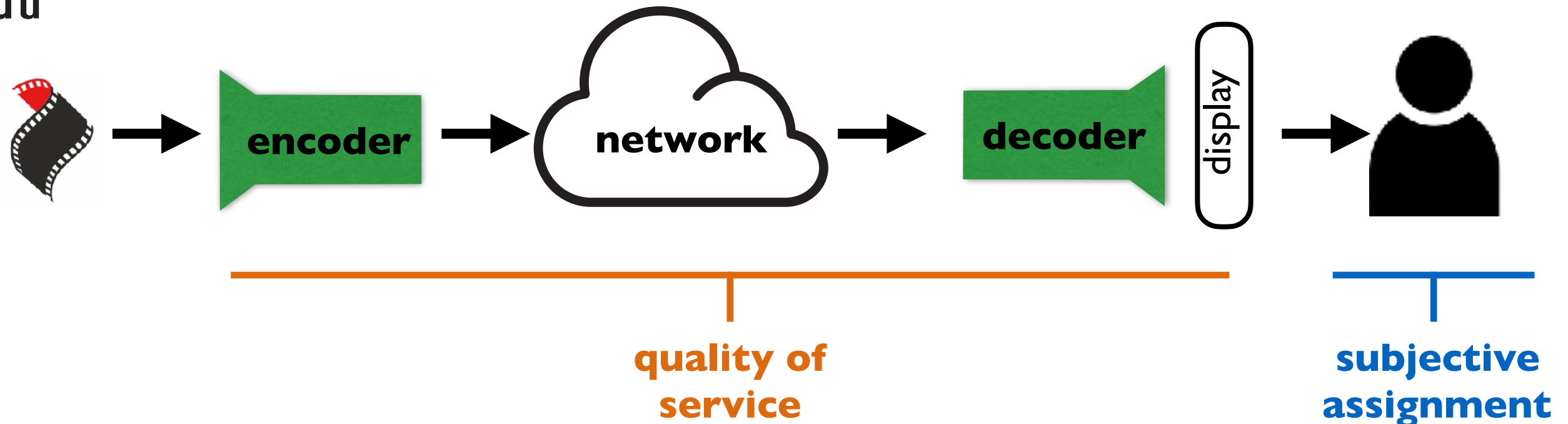


user factors



- **video popularity:** more forgiving of popular content
- **video length:** more forgiving of longer videos
- **video type:** live vs on demand, sports vs anime

measurements



- **Quality of Service (QoS)** — objective —
 - direct measurements of network, device, codecs, application behavior
- **Quality of Experience (QoE)** — subjective —
 - measured by asking users or inferred from behavior
- **Challenge**
 - discover correlations that allow inference of QoE from QoS metrics



types of experiments

- **laboratory:** from volunteers in a laboratory
 - ITU Recommendation (ITU-R BT. 500-11)
- **crowdsourcing:** from volunteers on real Internet
- **indirect:** QoE inferred from user engagement
 - the length and frequency viewer watched video

	control	number of users	client software	QoE collected
laboratory	high	low	yes	yes
crowdsourcing	middle	middle	yes	yes
indirect	low	high	no	no

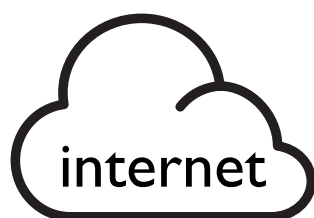
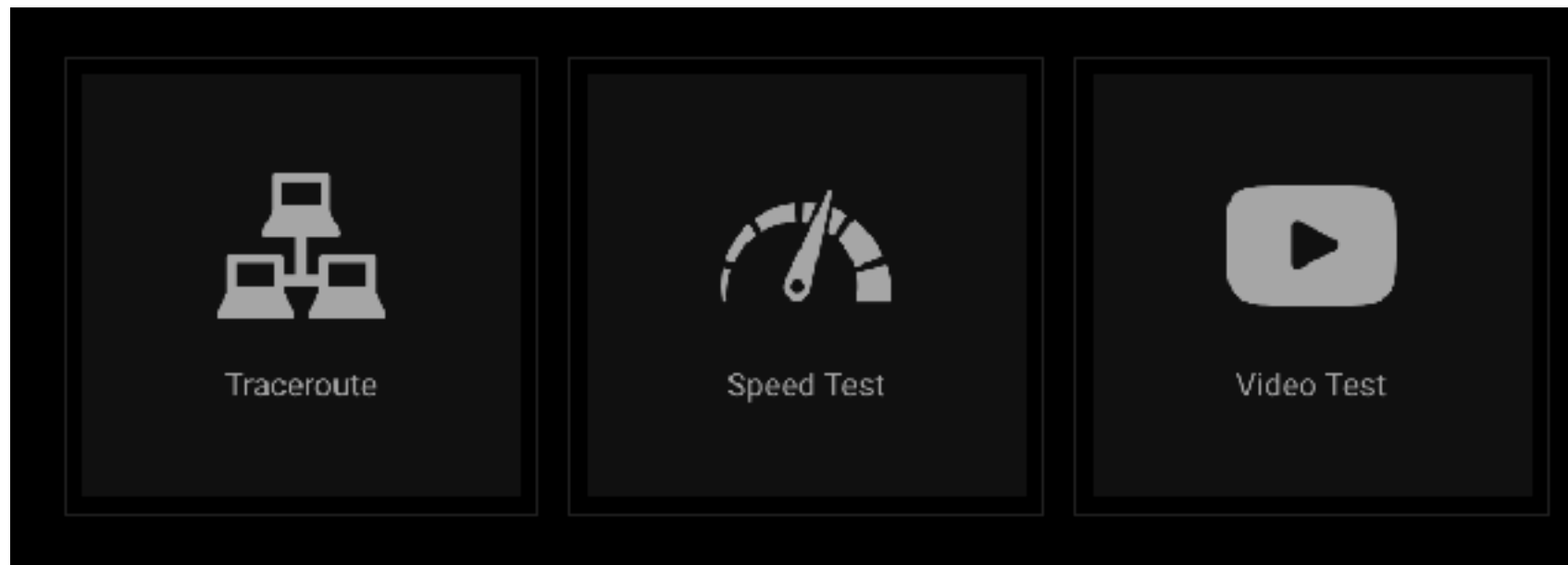


QUINCE is CAIDA's gamified crowdsourcing QoE and Internet assessment framework.

crowdtrace.caida.org

	control	number of users	client software	QoE collected
laboratory	high	low	yes	yes
crowdsourcing	middle	middle	yes	yes
indirect	low	high	no	no

- **limited user engagement/trust**
 - run measurements with existing software
- **limited user technical knowledge**
 - simple step-by-step instructions
- **browser javascript restrictions**
 - can't obtain data from same-origin
 - can't perform traceroute

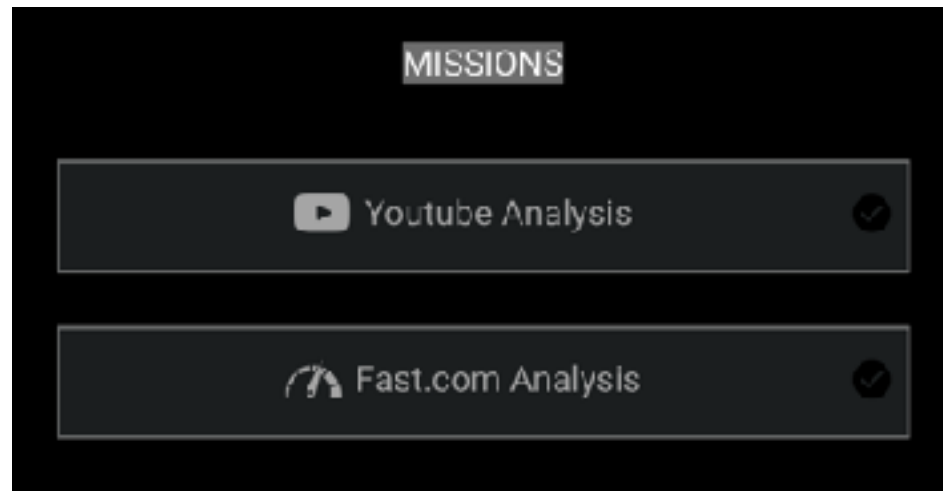


- **topology (Traceroute)**
- **bandwidth (Speed Test)**



user

- **QoE (Video Test)**



collect CDN information

users are diverted to different video caches based on their geographic and network locations

- **Youtube:** collects CDN server location from the source page of a YouTube video page
- **fast.com (Netflix):** collects the location and bandwidth to selected Netflix server



Conclusions

- **QoE influences:**

- information lost in encoding and transmission
- user demographics and viewing environment

- **QUINCE** (crowdtrace.caida.org)

- collects data through crowdsourcing
- metrics collected:
 - topological (traceroute & CDN locations)
 - bandwidth
 - Quality of Experience (QoE)

