Assigning Responsibility for Deteriorations in Video Quality

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CONVIVA

SPARK SUMMIT 2017

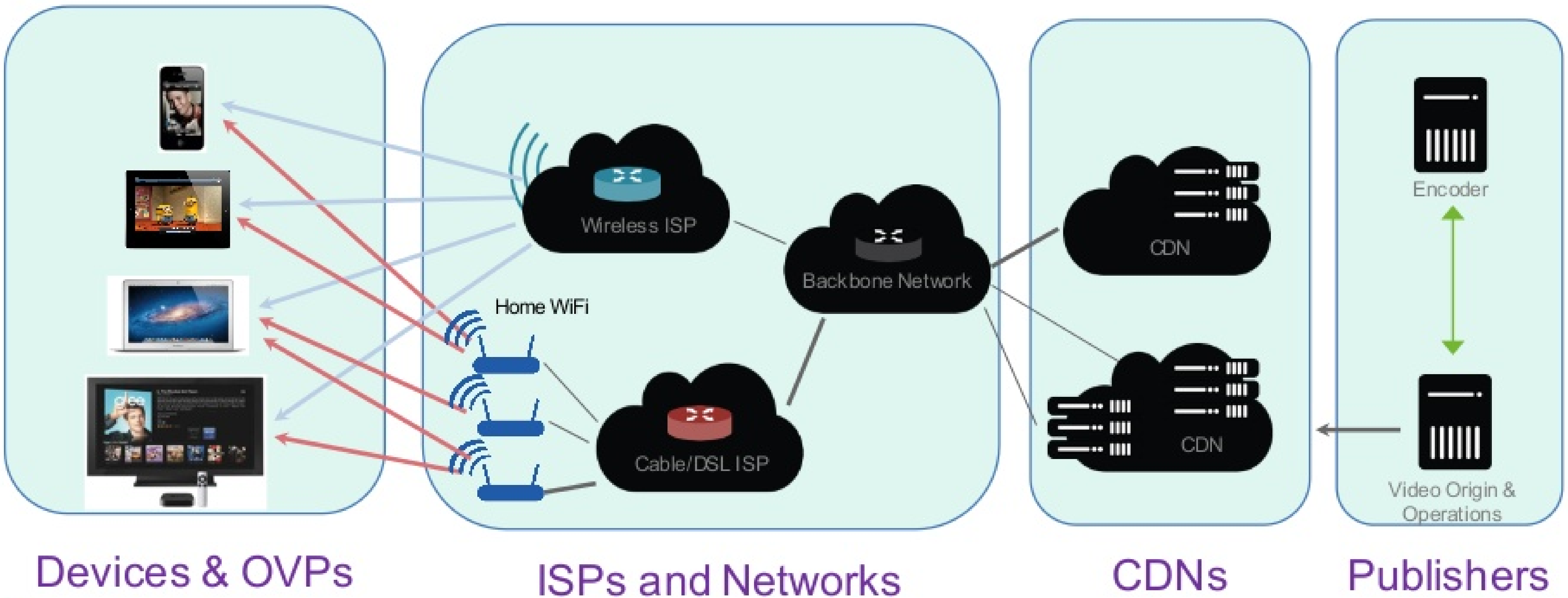
CONVIVA®

…is a video experience management platform that maximizes viewer engagement.

We provide quality metrics that give a comprehensive view into online video businesses.

Internet Video Streaming is Hard

Many parties, many paths, but no E2E owner



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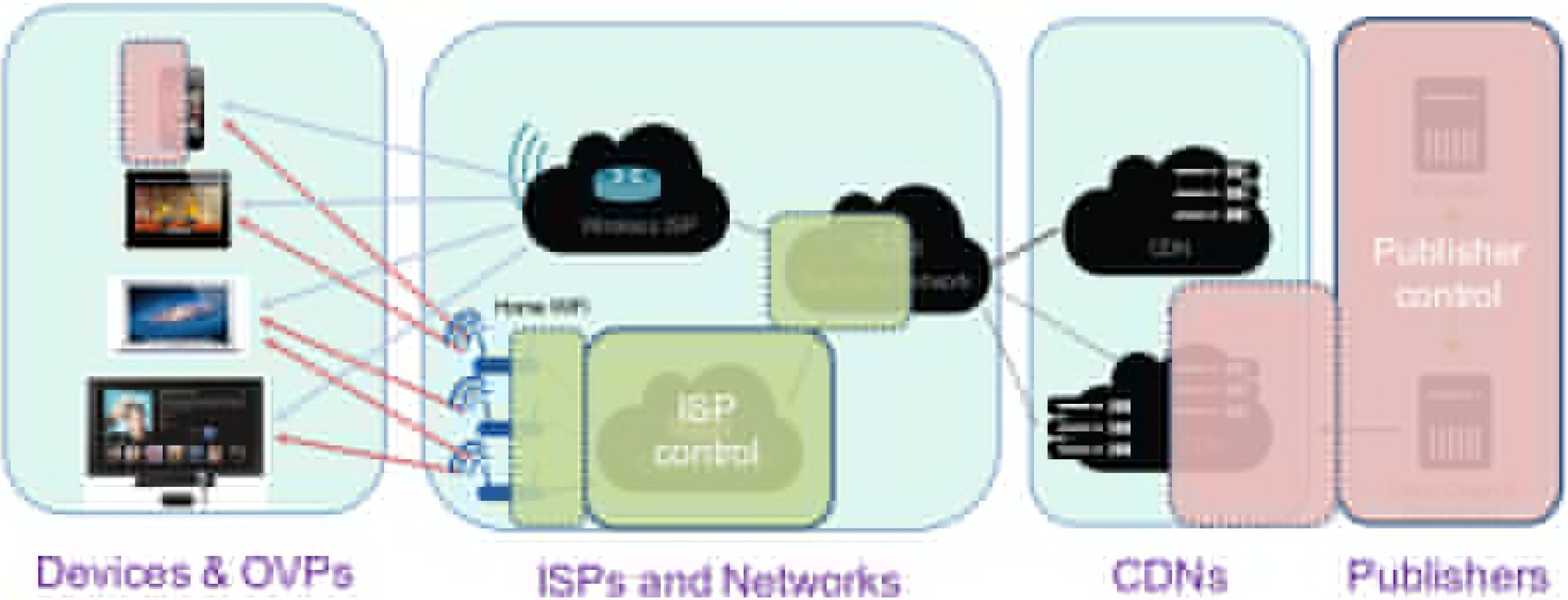
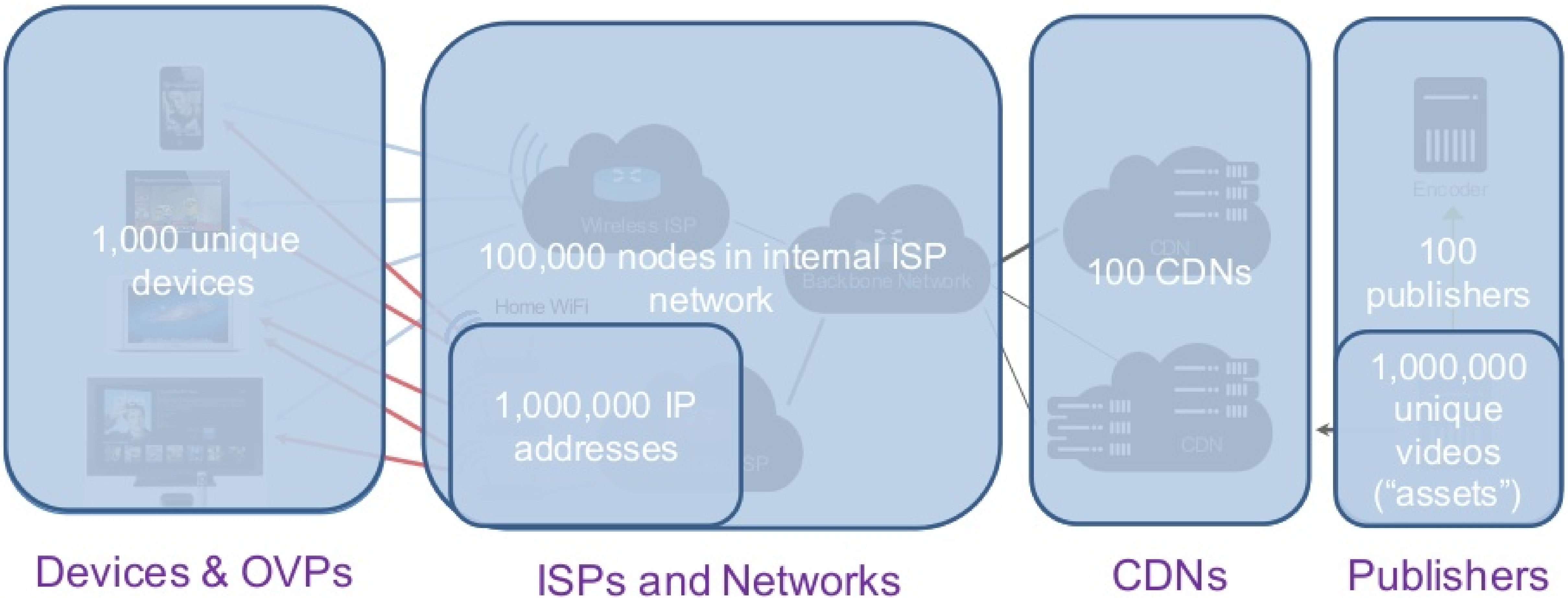


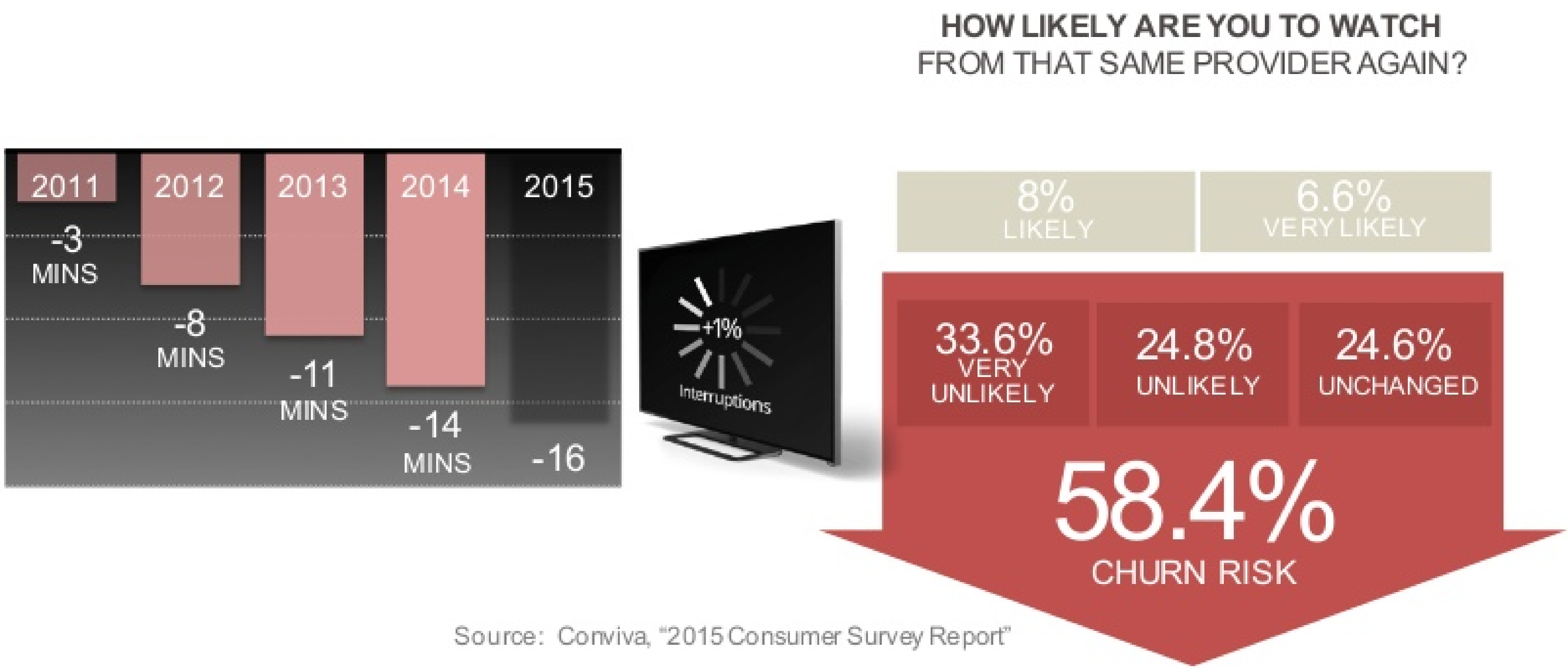
The ecosystem is big.



…in 10,000,000 video sessions from one week, at one US ISP

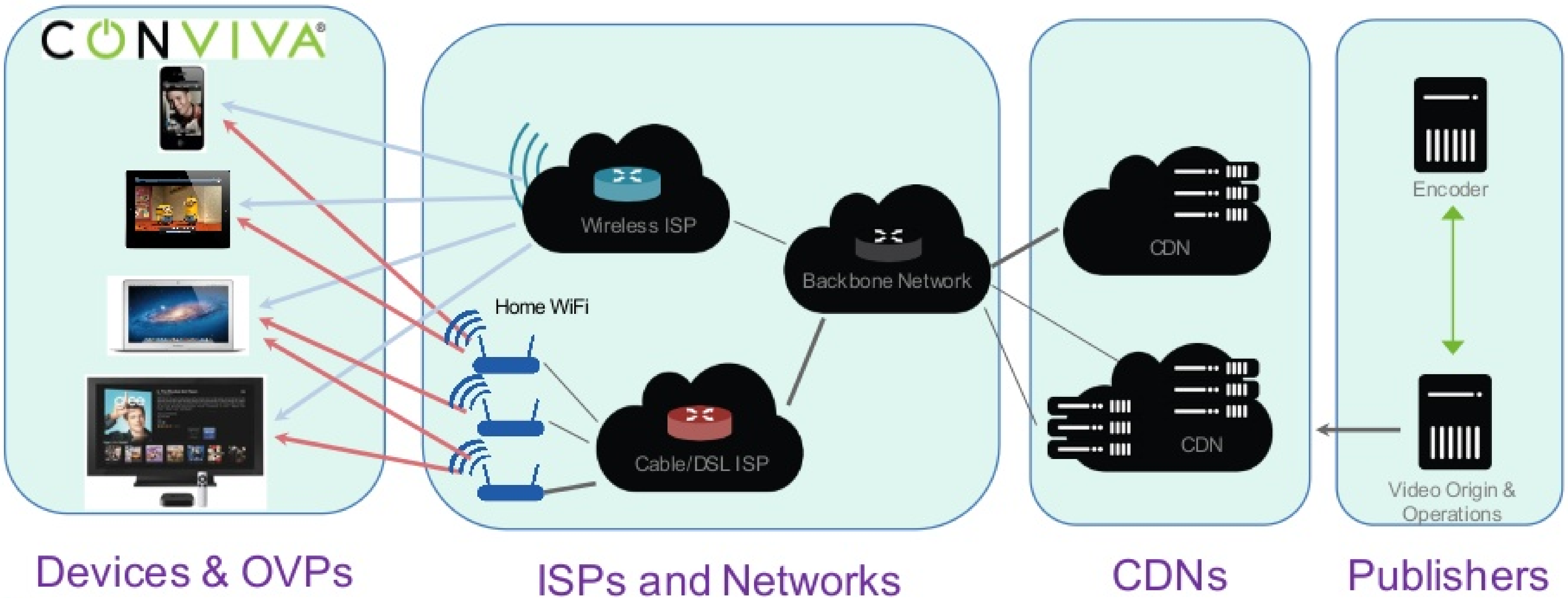
QoE is Critical to Engagement

For both video and advertisement businesses



Source: Conviva, "2015 Consumer Survey Report"

Viewers are expecting TV-like quality (or better)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Home WiFi
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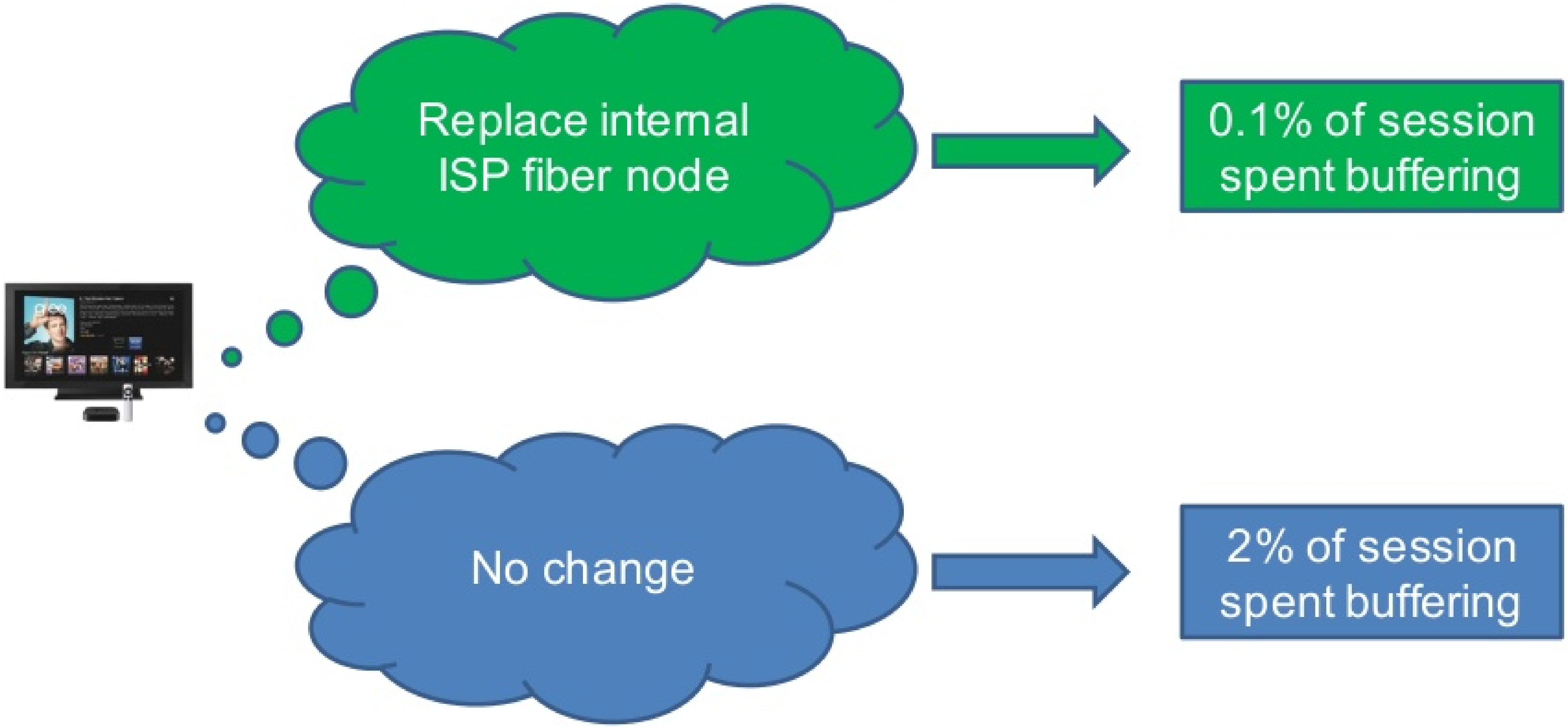
Cable/DSL ISP
CDN
CDN
Encoder
Video Origin & Operations
Devices & OVPs
ISPs and Networks
CDNs
Publishers

Quality impact

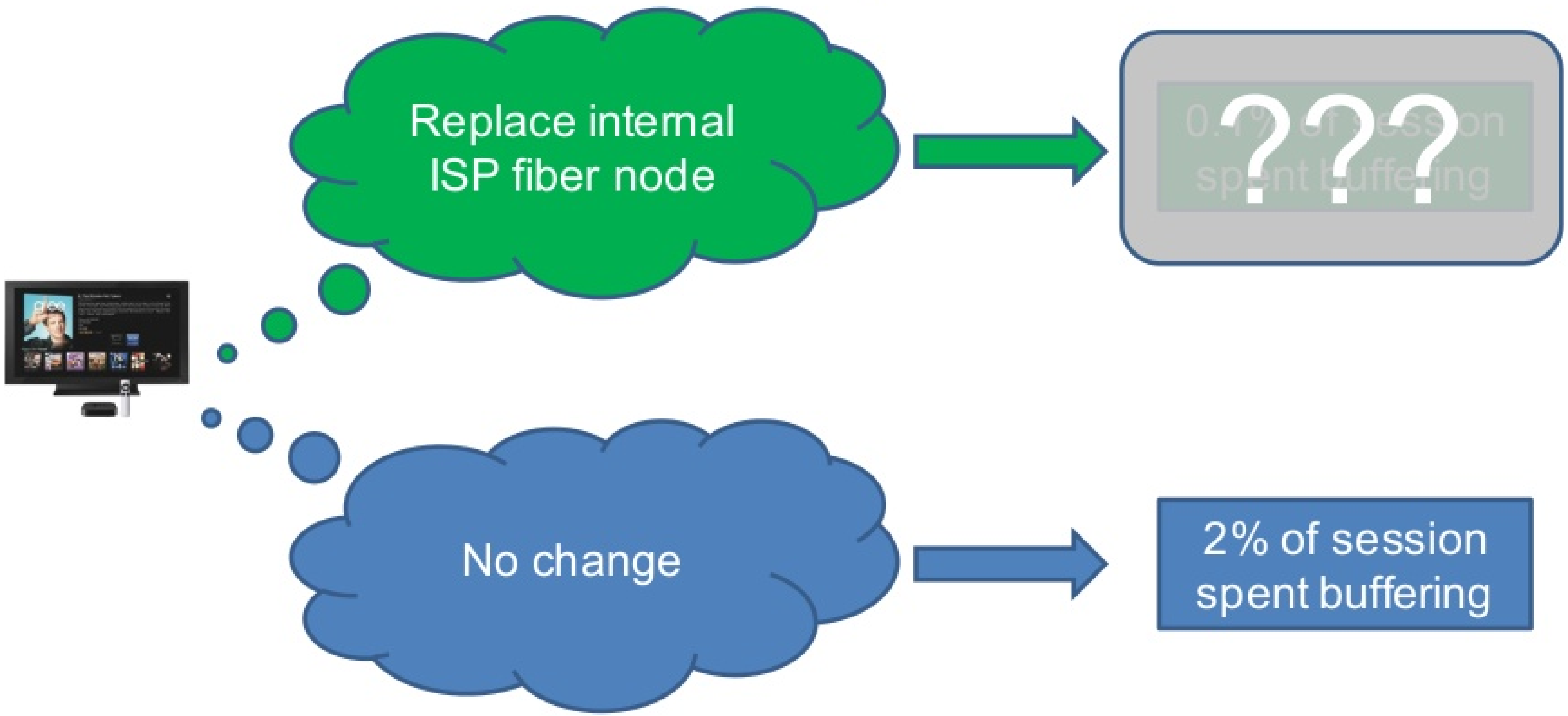


Quality impact

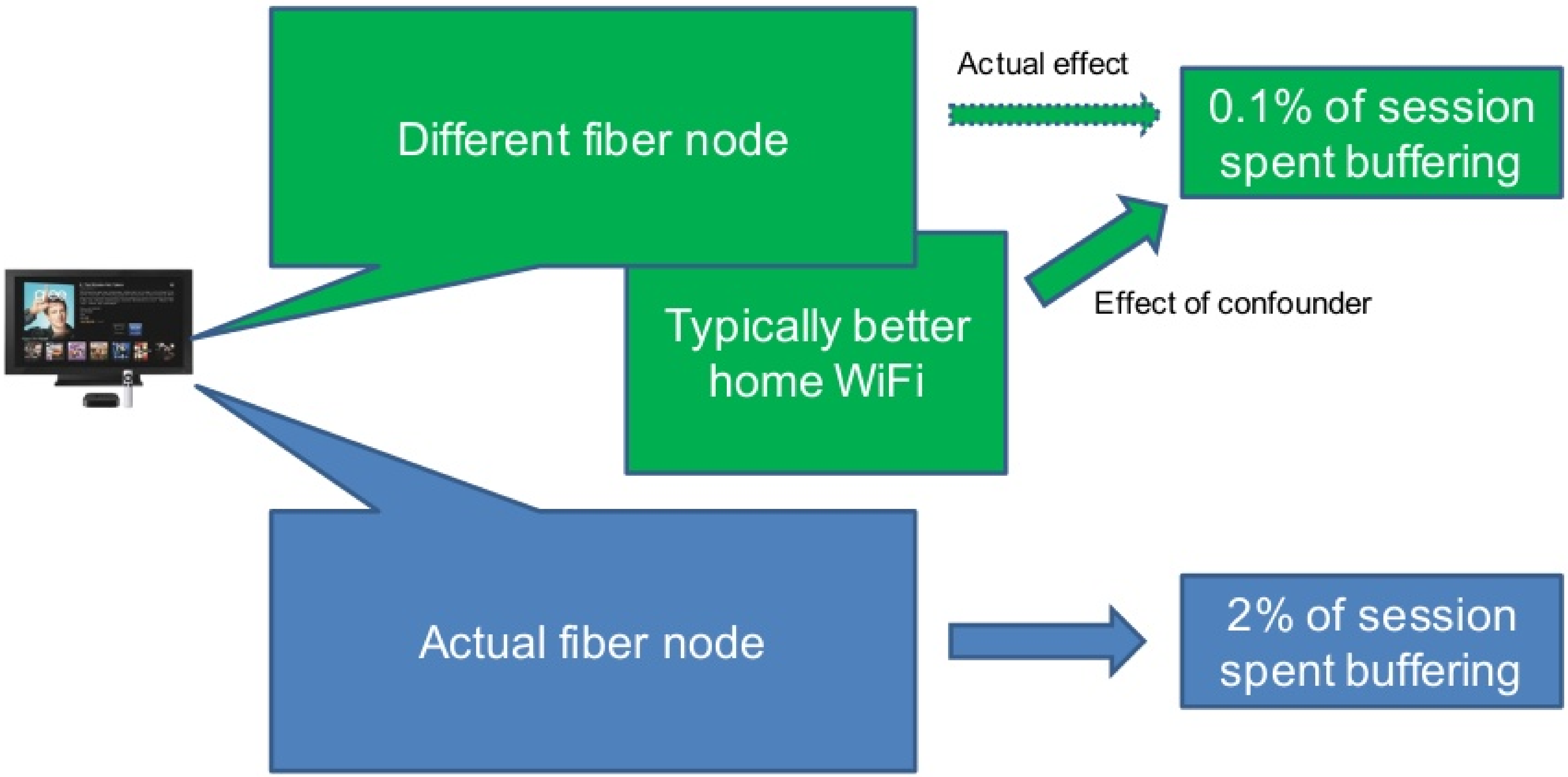
Quality impact of this fiber node on this session = 2% of session spent buffering - 0.1% of session spent buffering

Quality impact of this fiber node = $\sum$ [Quality impact of this fiber node on session 1, session 2, session 3]

Quality impact



Confounding factors



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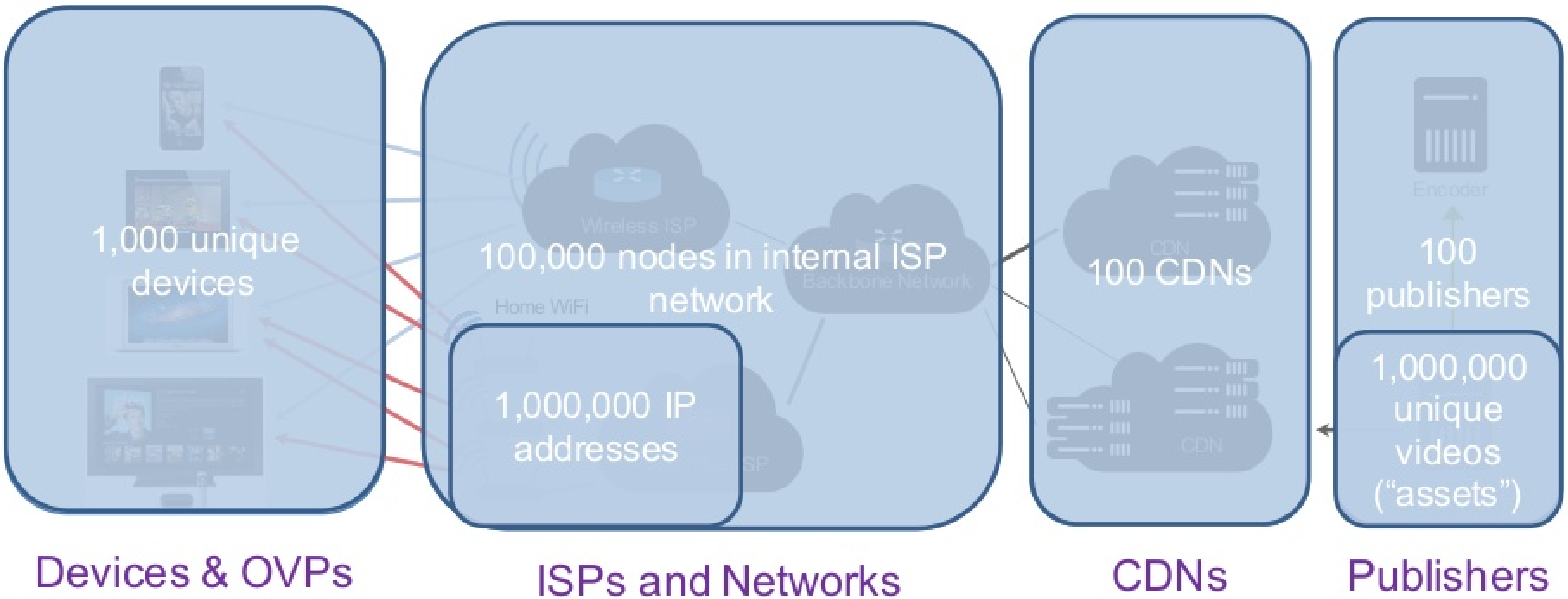
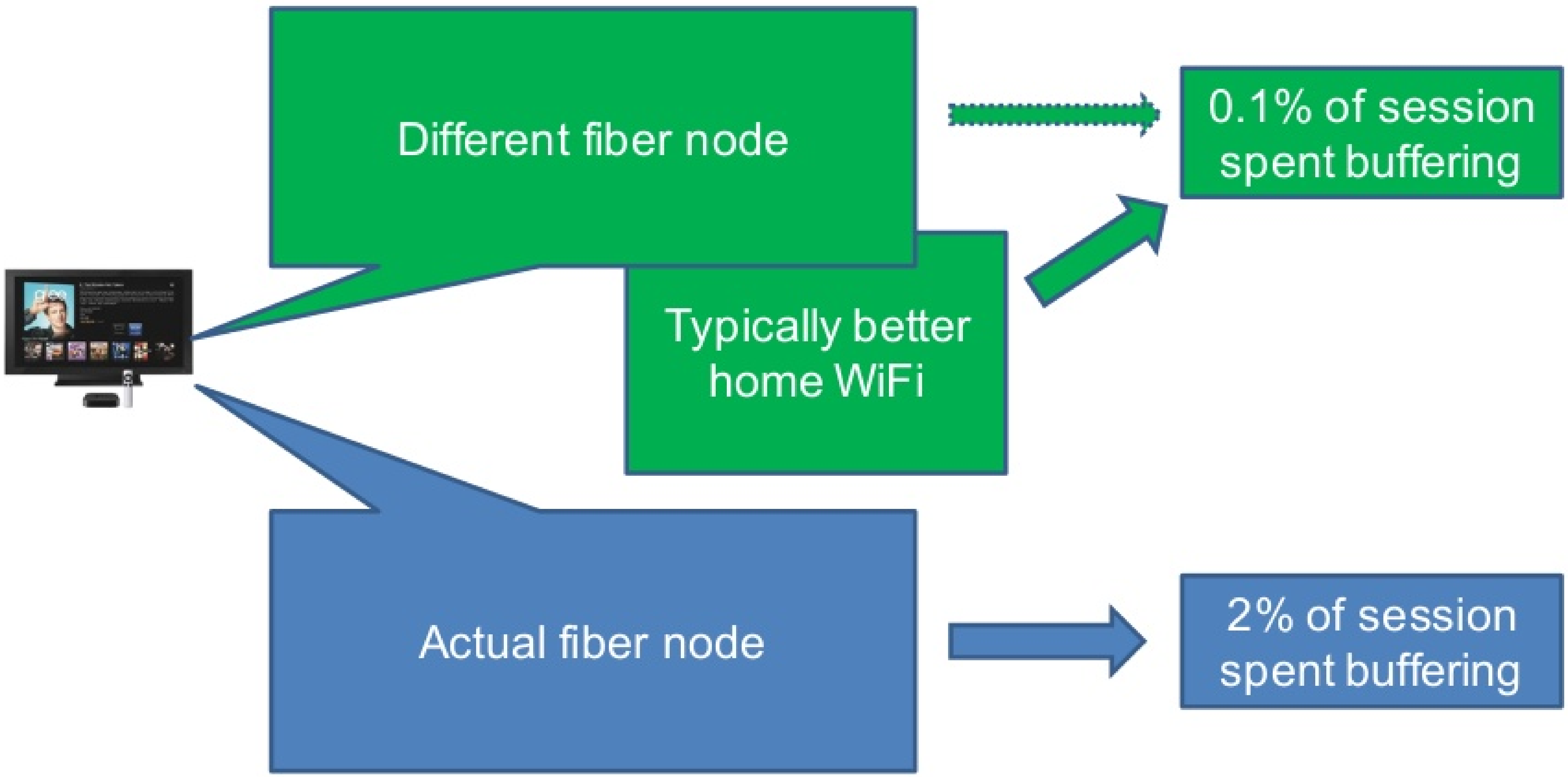
Many potentially-important factors

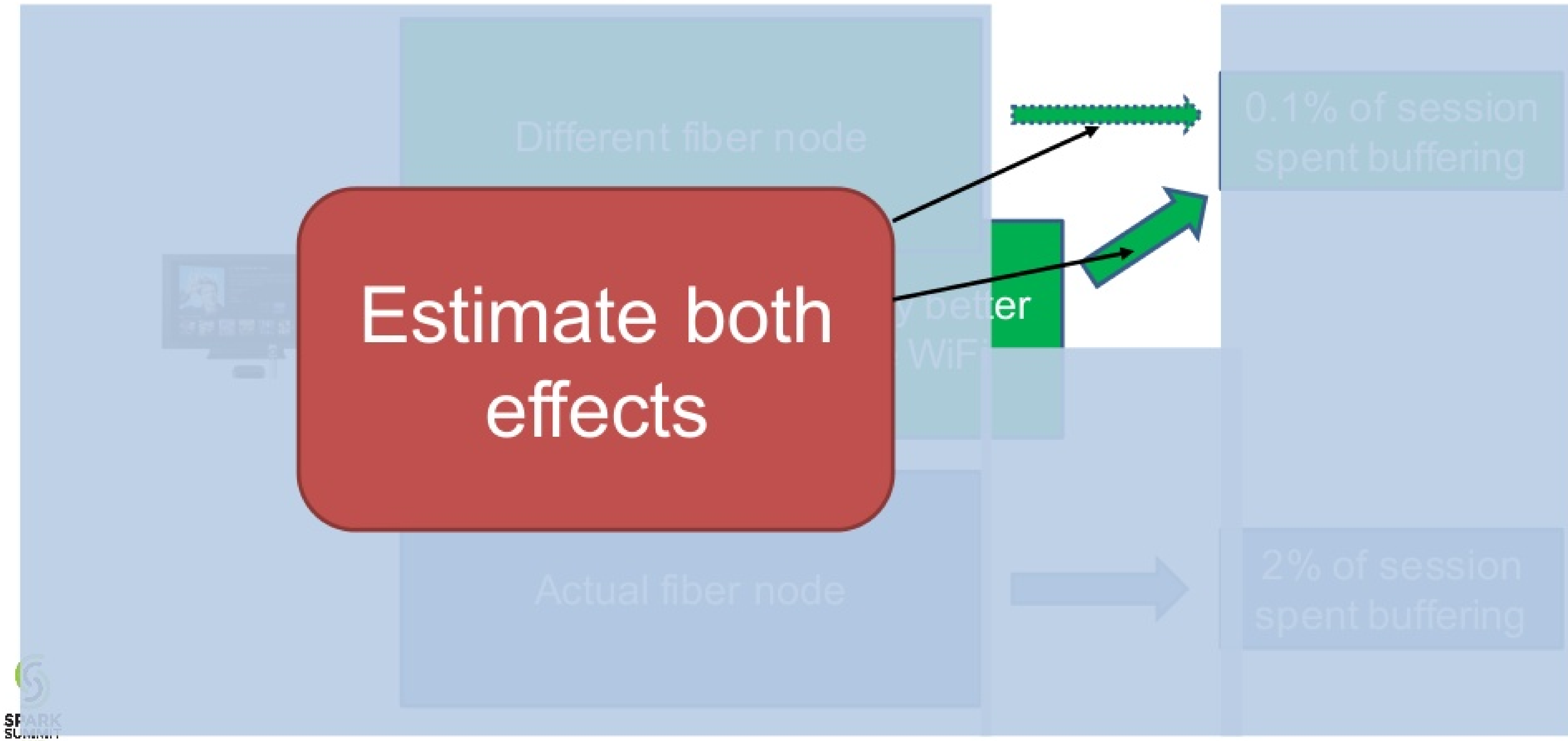
…and confounding factors!



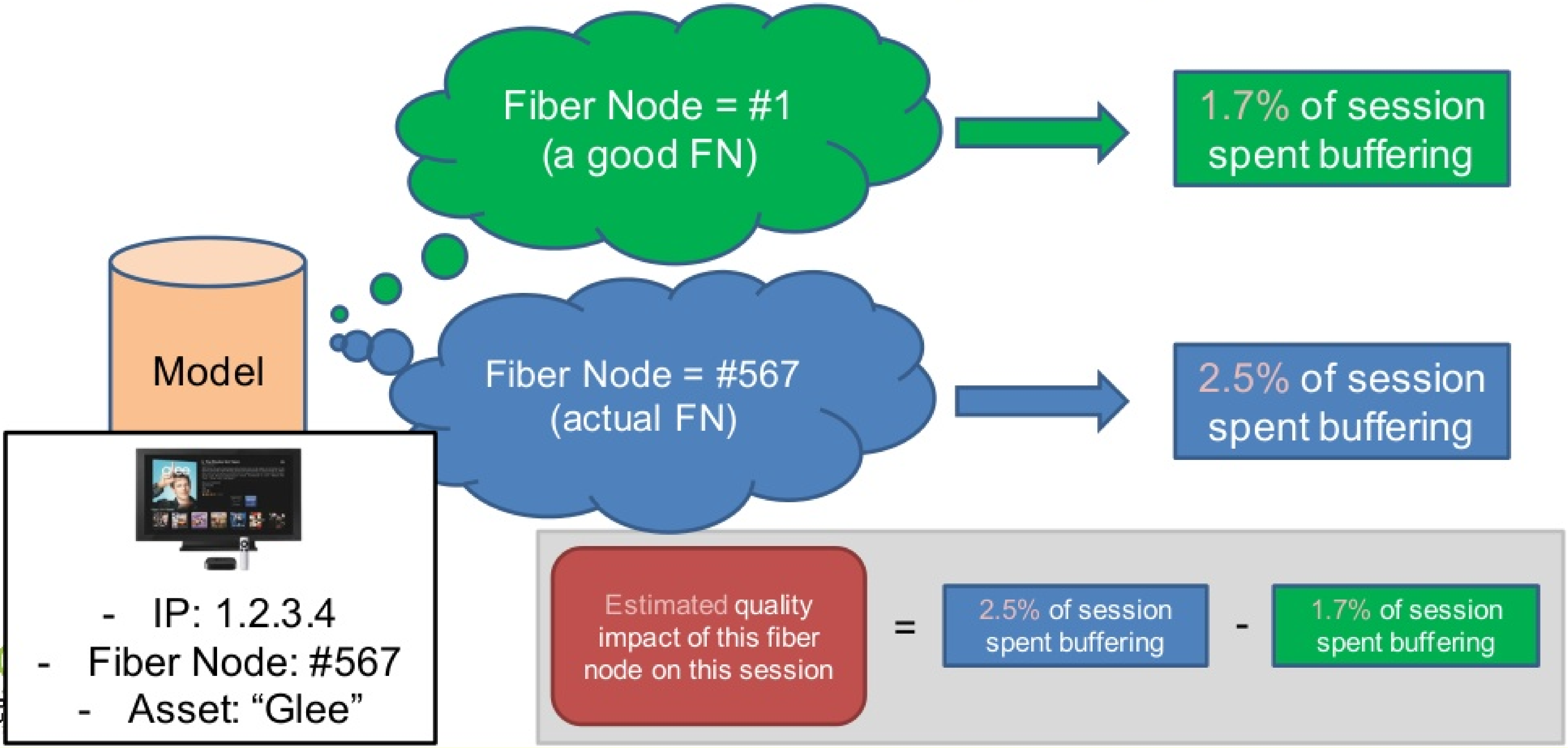
Fixing confounding



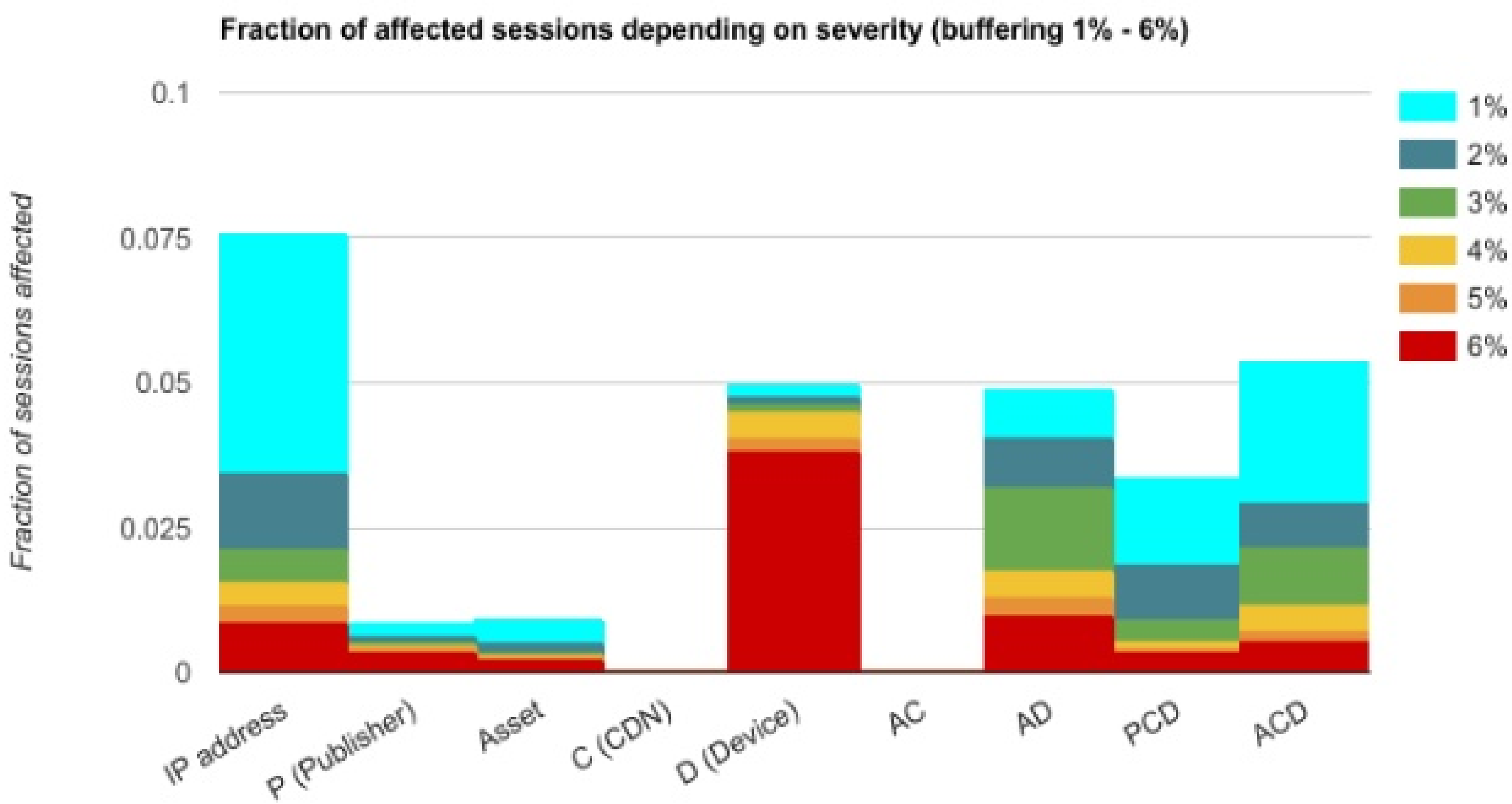
Fixing confounding



Estimating quality impact



Devices produce short buffering



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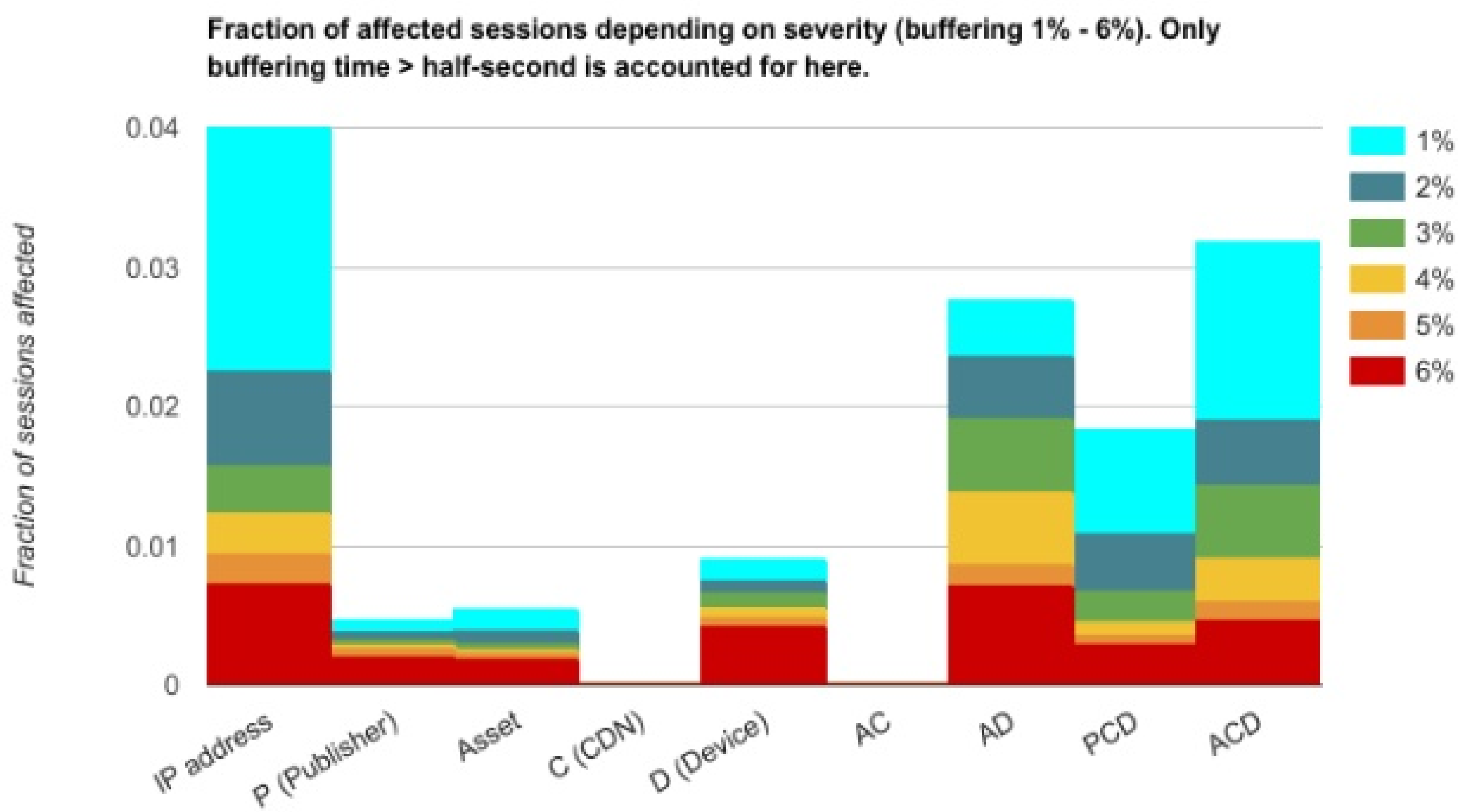
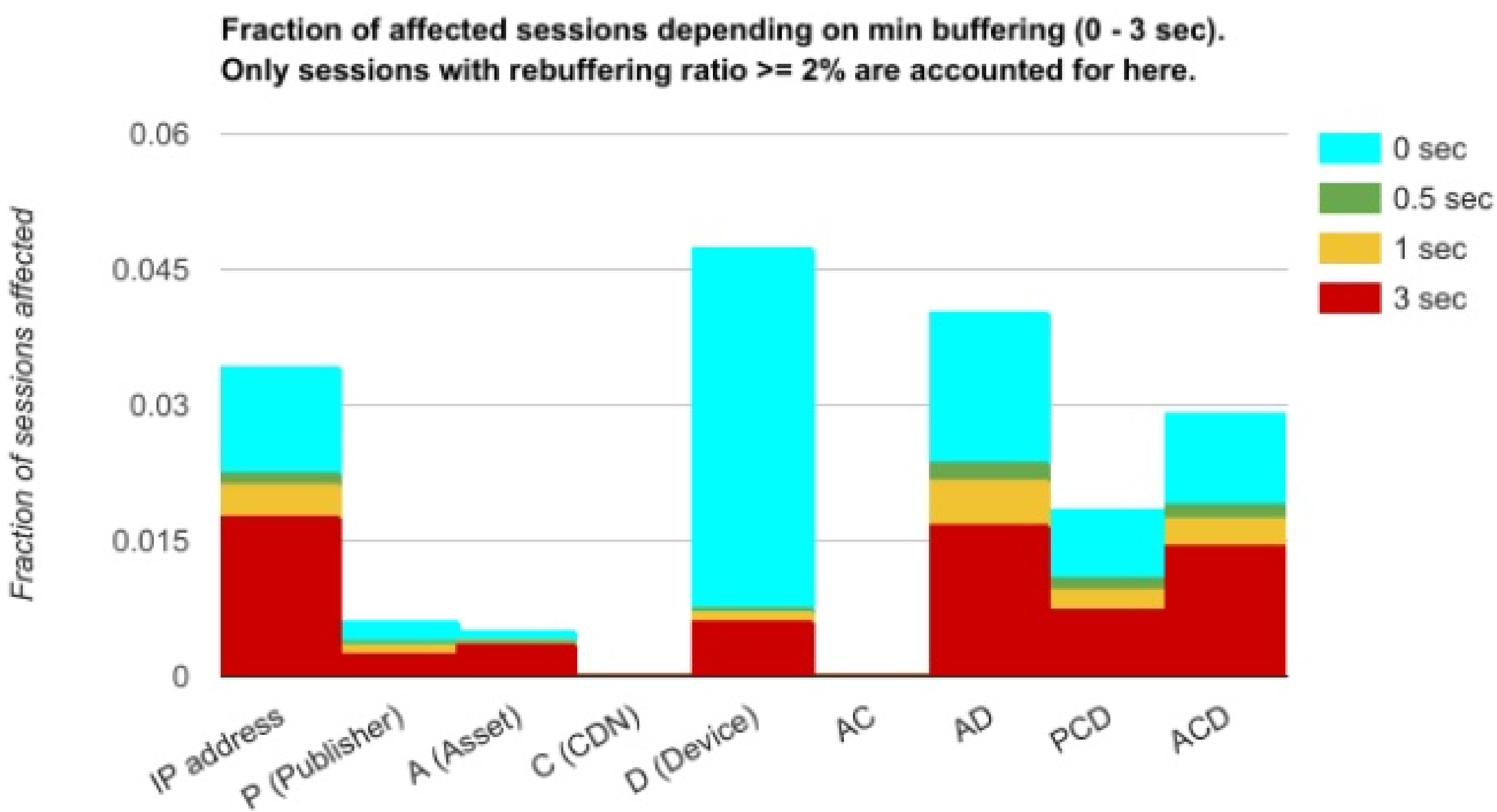
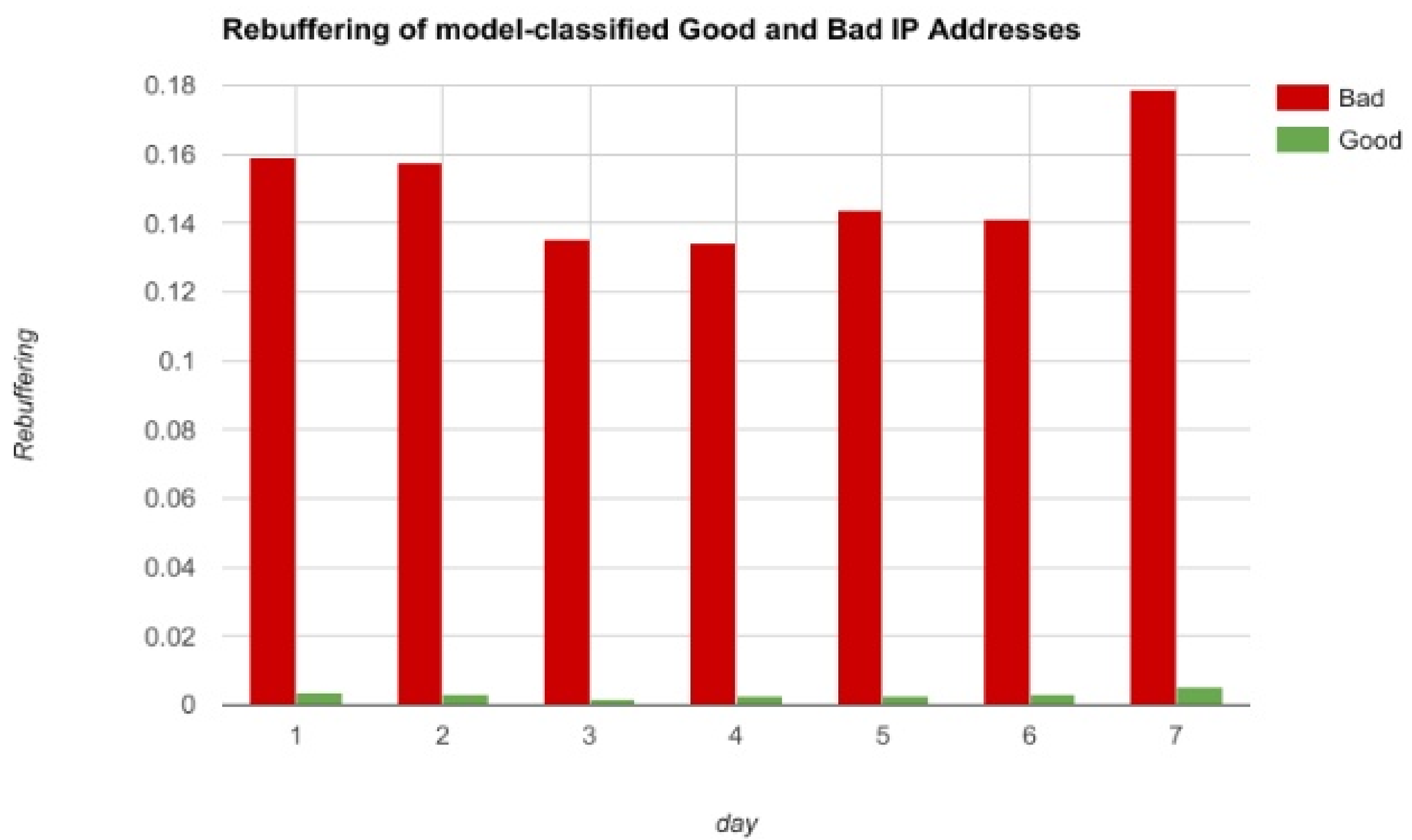
Devices produce short buffering



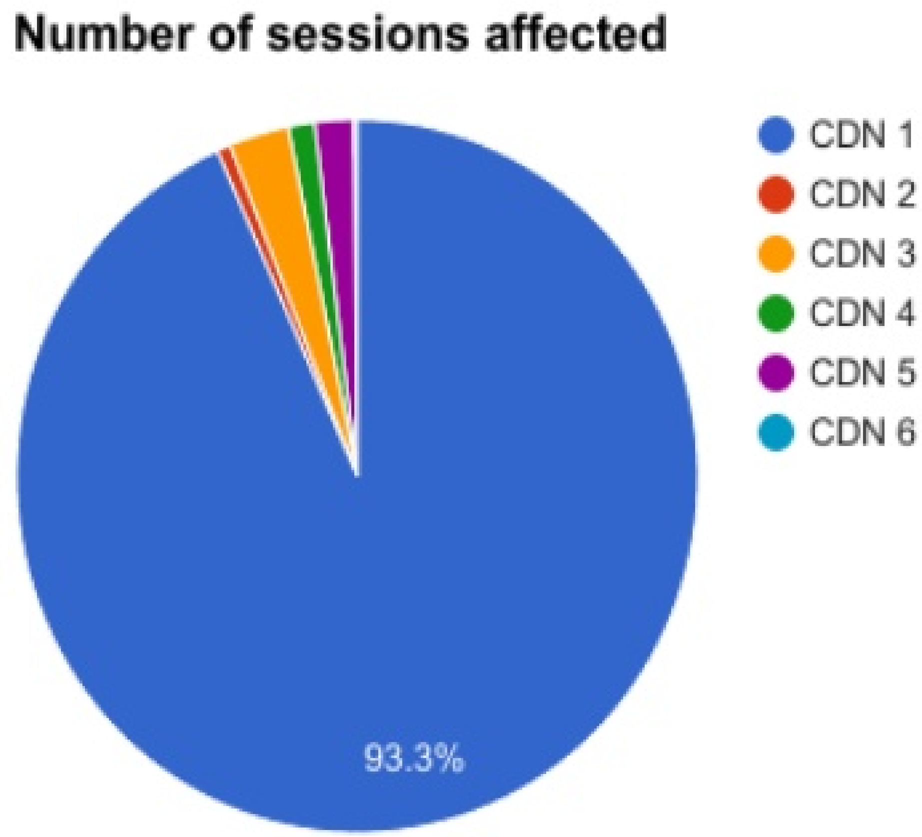
Device-level issues are responsible for most short buffering episodes



Good and bad IP addresses



From worst PCD, typical week:



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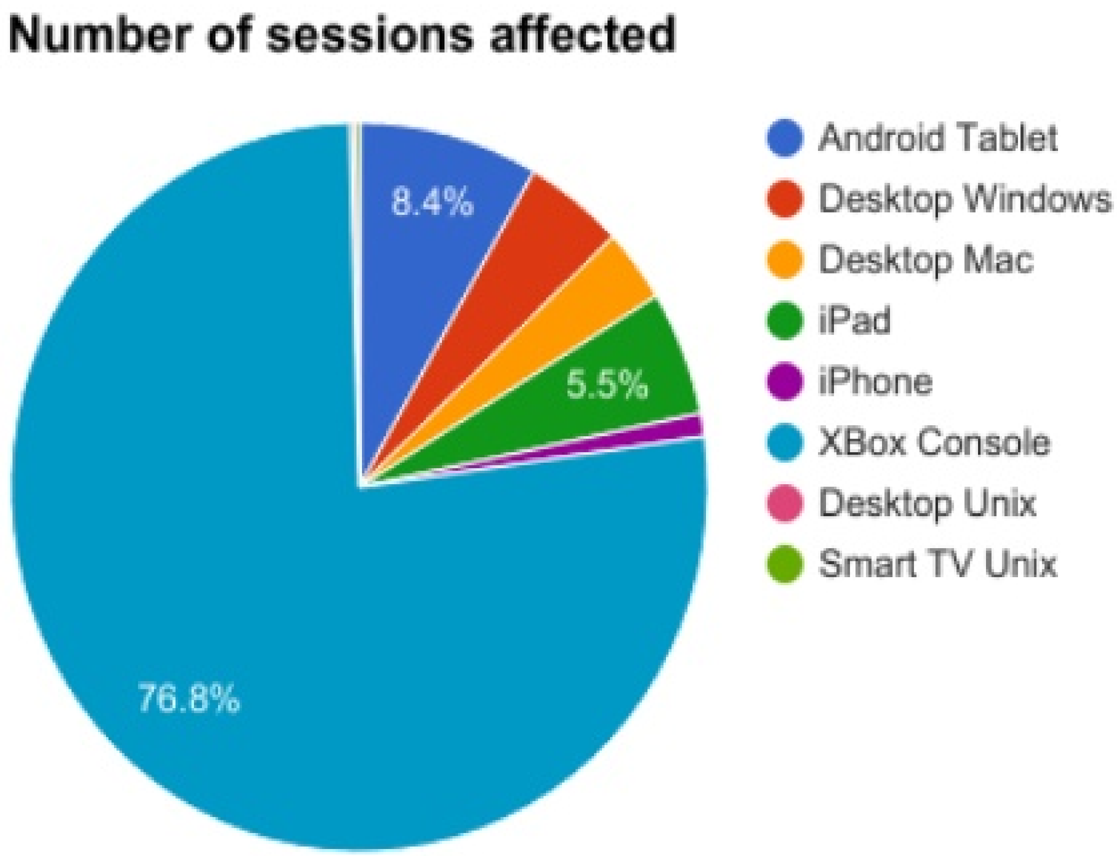
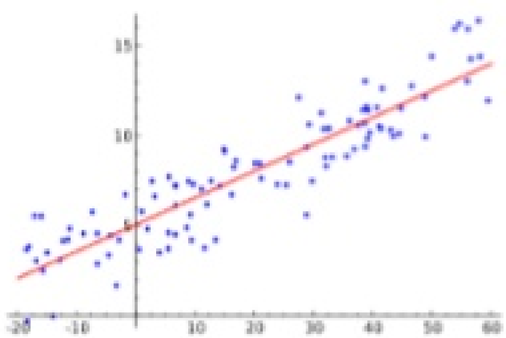


Worst assets, typical week:

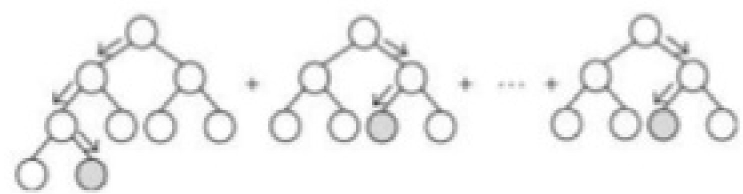
Only 6 really bad assets responsible for strong deterioration of their sessions regardless of other factors.

Of these, 4 are sport programs and 2 are obscure regularly scheduled foreign programs.

Modeling video quality



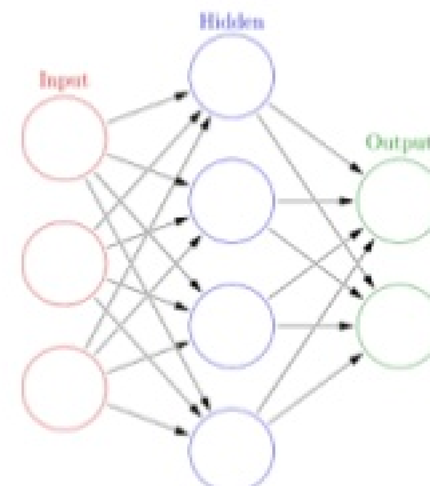
GLMs



random forests

boosted trees

Today's results



neural networks

Model for rebuffering ratio

Response: Rebuffering ratio (R)

(buffering time / (buffering time + playing time))

Categorical features:

IP address (I)
Fiber Node (N)
Service Group (S)
Publisher (P)
Asset (A)
CDN (C)
Device (D)
Live / VoD

More features:

Time, day of week, asset length.

Time or no time?

Time is strongest or one of strongest features.

Big game, popular show – many sessions suffer, regardless of IP and device or even CDN.

Time makes model more precise.
But: time steals effect from big nodes such as Asset and Publisher.

Similar question: Bitrate or no bitrate?

Model versions, practical issues

Preference: Spark cluster of 10-30 nodes, each node 4-8 cores and 30GB memory. Hopefully 1-3 hours to process 1-3 weeks of data of big ISP, whole US.

Nodes as embedded features. Boosted trees on Spark. Whole US. Learn from 1-3 weeks, apply to last week.

Nodes as one-hot encoding. Random forest on Spark. Each geographical area is processed separately.

Model versions, practical issues

Nodes as a trainable embedding first layer. Neural network on single Spark node with Tensorflow. Each geographical area separately.

Embedding size is same for all kinds of nodes.

Embedding size is ~ log of node's dictionary size.

One or two hidden layers above the embedding layer.

Adagrad or any other Ada-like optimizer performs better than no-Ada.

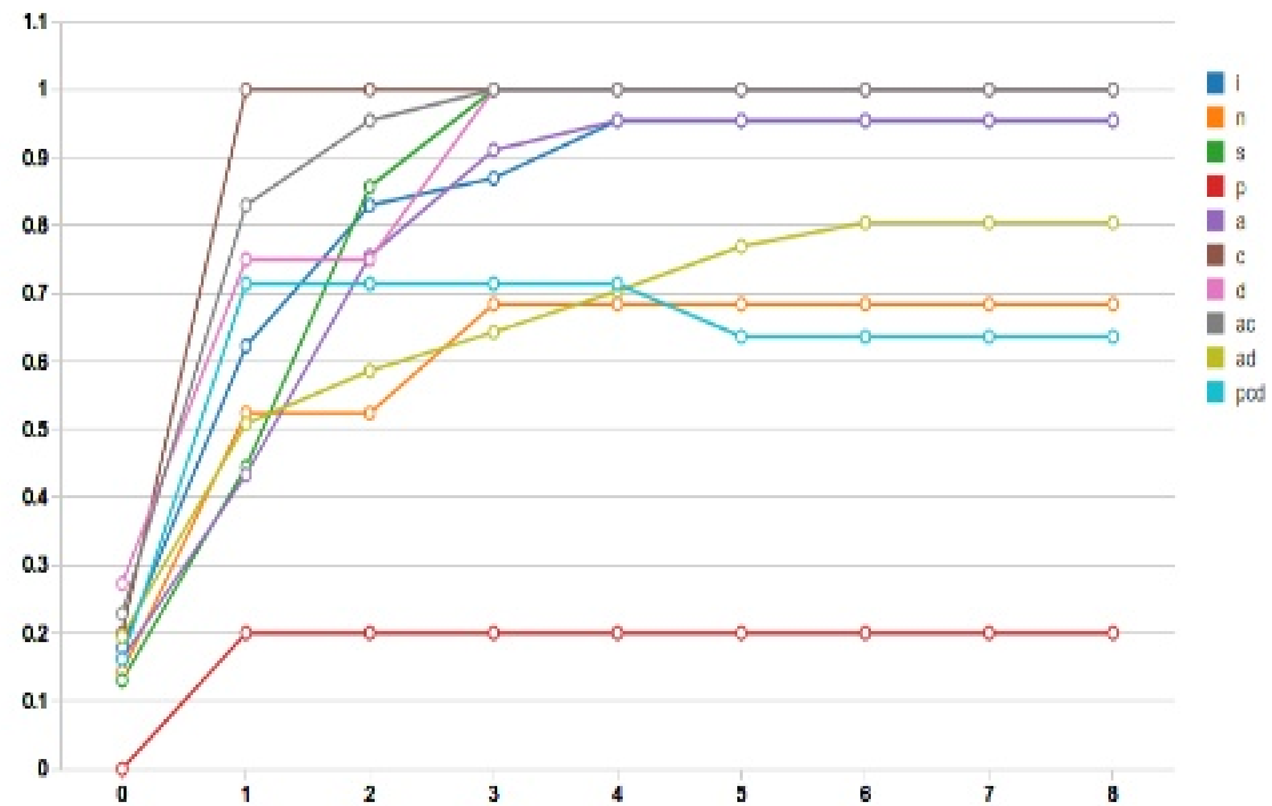
Slow improvements beyond fast mediocre accuracy.

Finding a "good" node

Effect of a node = Model(real features) - Model(features with good node)

In case of trainable embedding – iterative finding of good nodes:

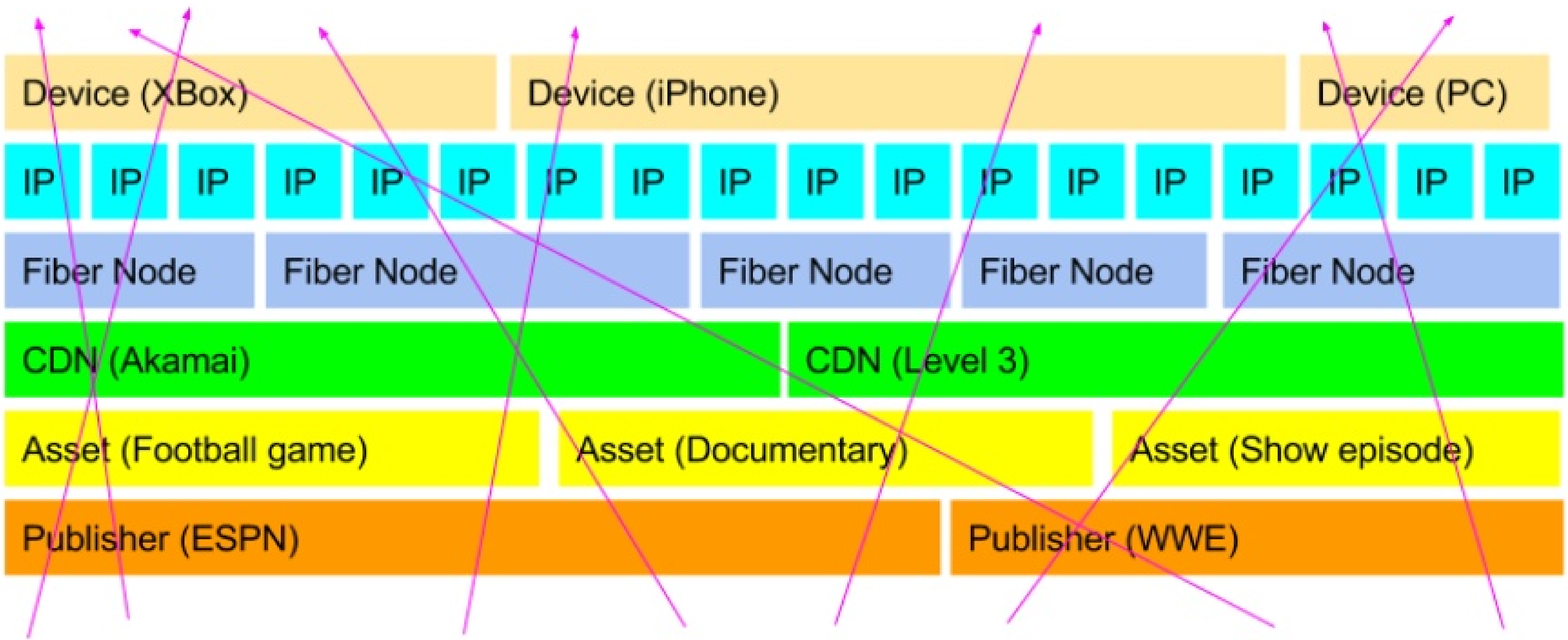
good = nodes with lowest avg label
while set of good nodes is changing:
  for each session:
    Effect = Model(real) - Model(good)
  good = nodes with lowest avg effect



Overlap of set of good nodes with the set from previous iteration - typically stabilizes in 2-3 iterations.

Sessions are affected by ...

Video sessions. Each has buffering >=0, from all involved nodes.



If effect is linear, this would be like ART in 3D tomography

Thanks to Spark and Databricks for making it easy for us

Thank You.

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