Profiling Energy Consumption of DASH Video Streaming over 4G LTE Networks

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Profiling Energy Consumption of DASH Video Streaming over 4G LTE Networks

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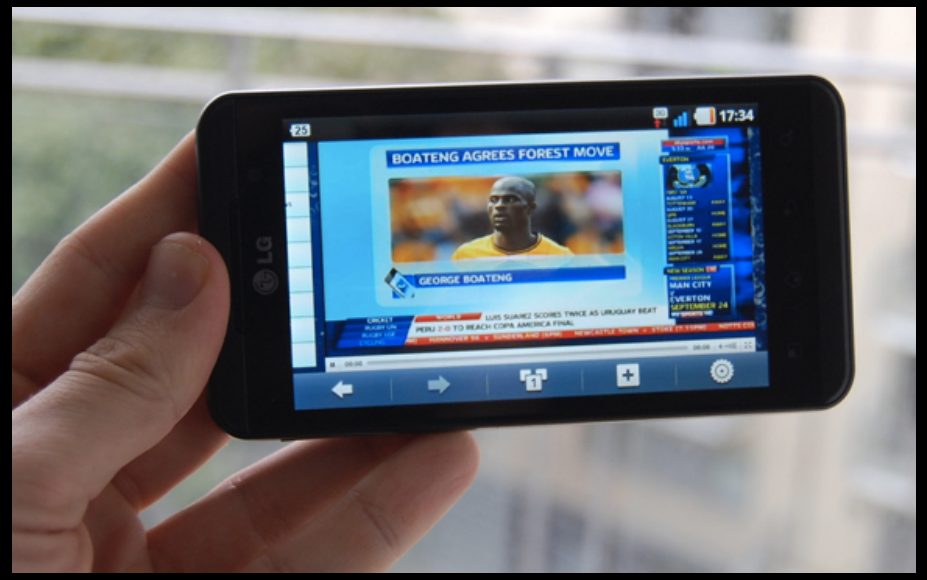
Video Consumption on Mobile Devices



YouTube vimeo NETFLIX

hulu Dailymotion iQIYI

> 80% traffic by 2019

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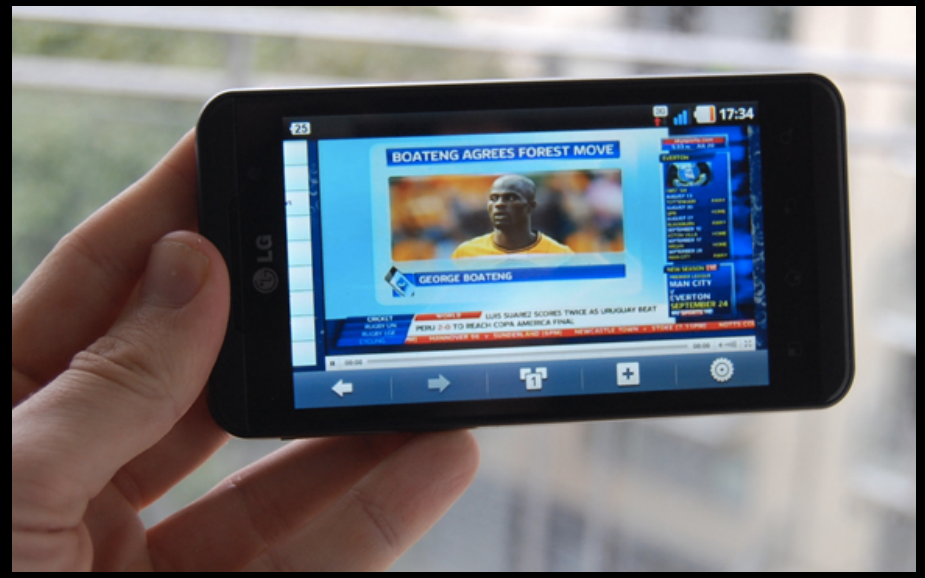
Video Streaming over 4G LTE Networks

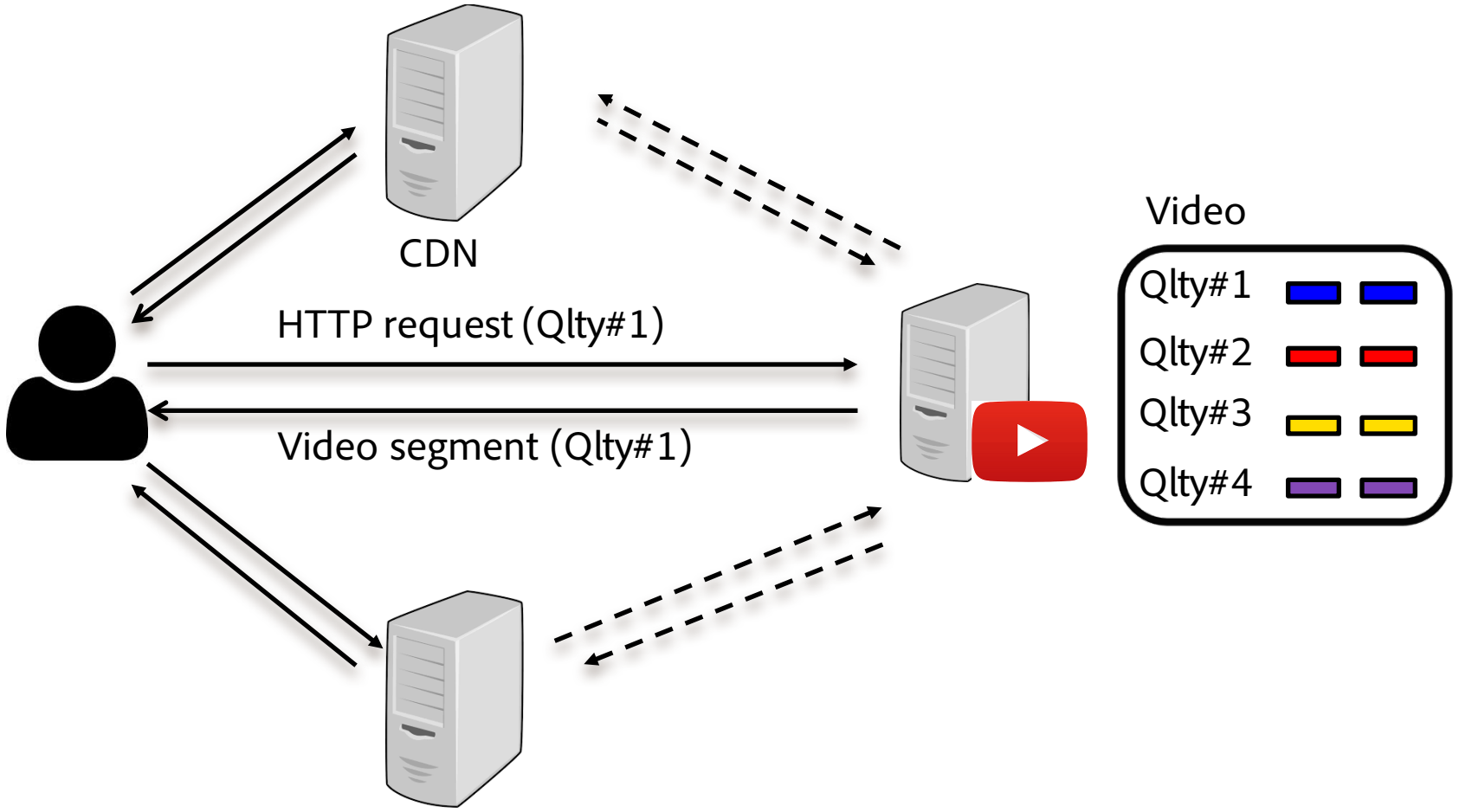


- 4G speed: >> 3G
  - Avg: 4~12 Mbps
  - Peak: 50Mbps
  - HD-video streaming

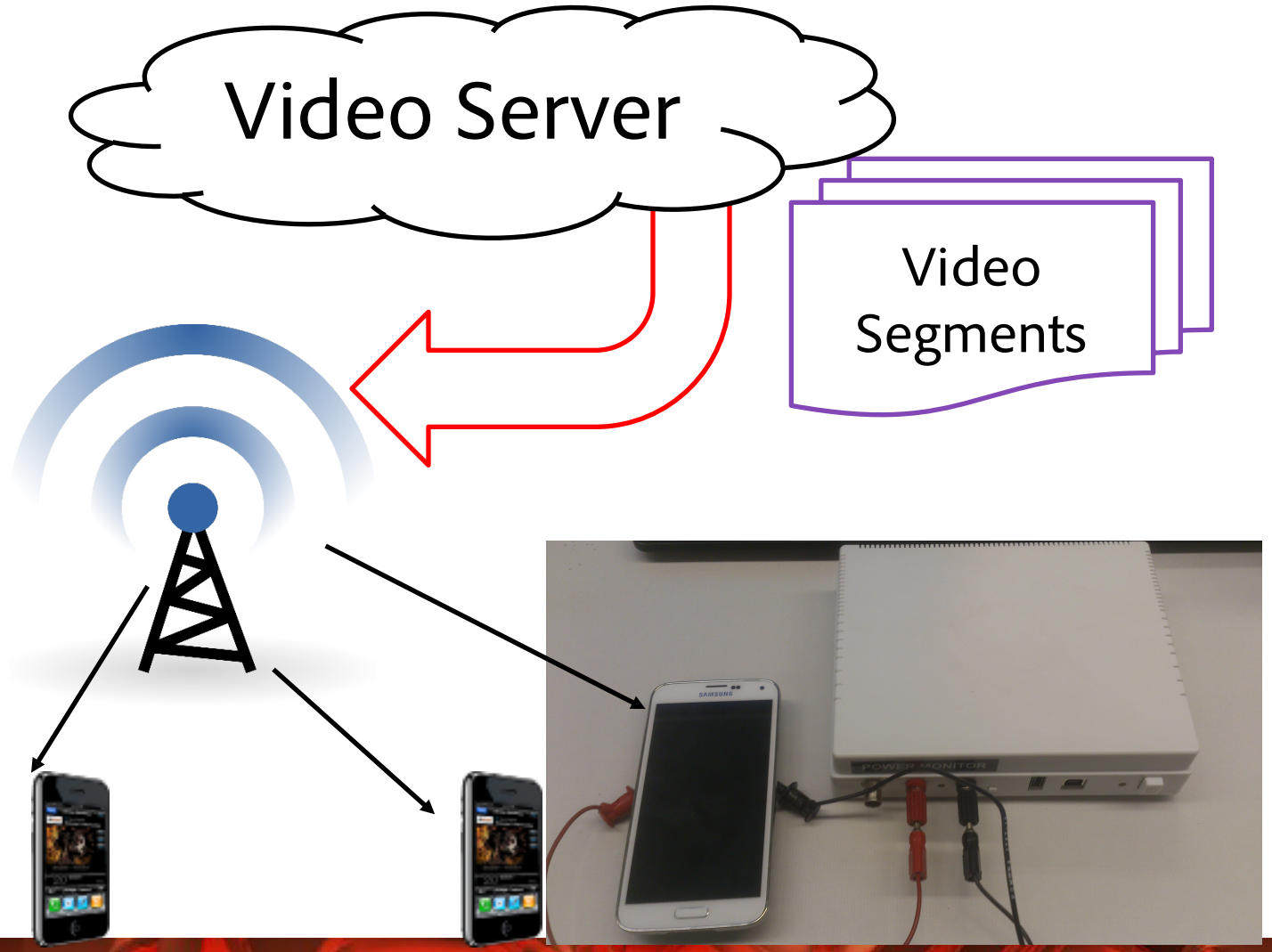
- Battery limit
  - Supports 3-5 hrs online video playing

DASH: Dynamic Adaptive Streaming over HTTP

- Resolution, segment length, buffer size

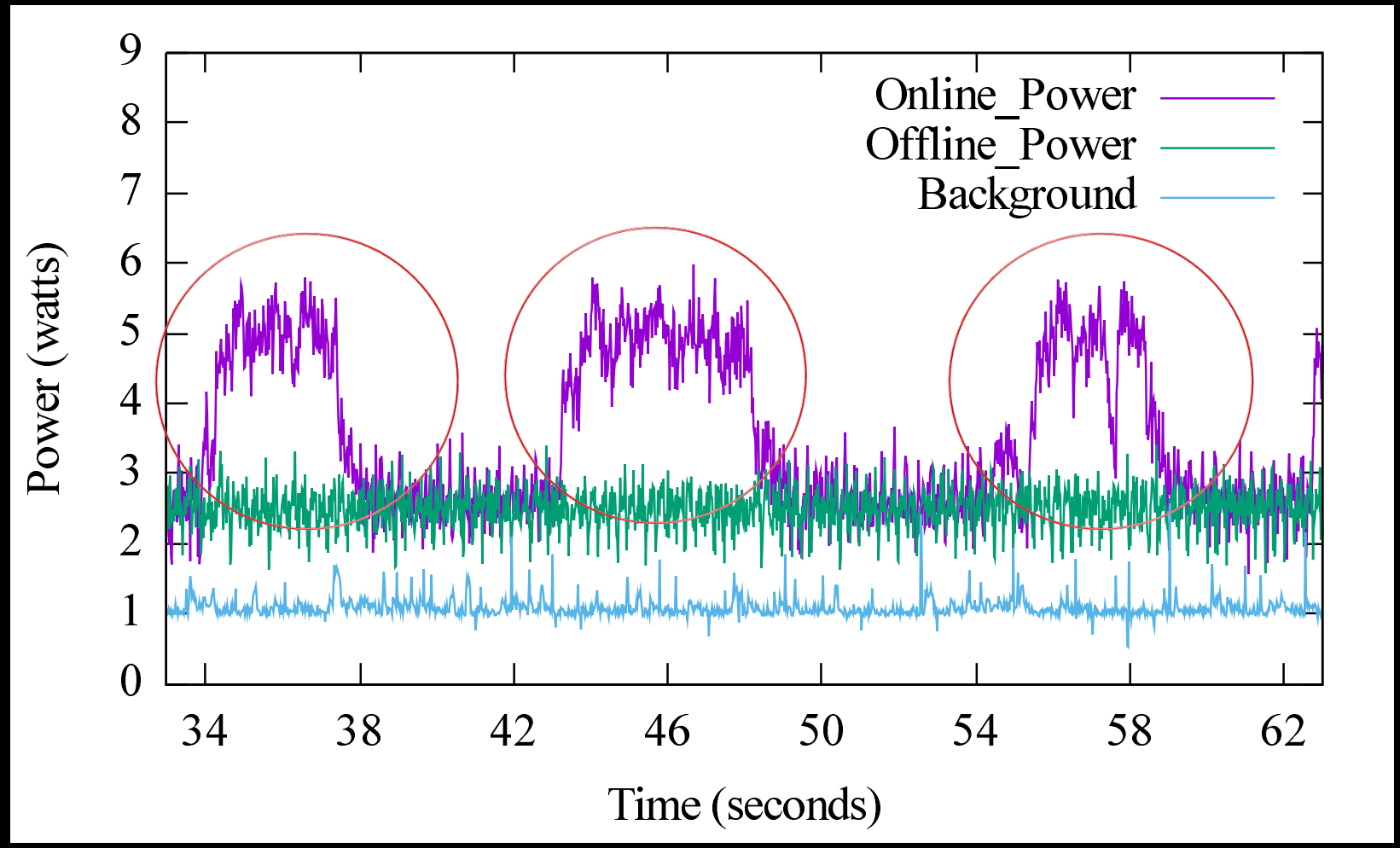


Measurement Methodology



- Open source streaming testbed
  - Server: Jetty
  - Player: Dash.js
  - Segmenting: MP4Box
- 4G LTE networks: T-Mobile and AT&T
- Power monitor: Monsoon
- Sample video: timer

Coarse-Grained Profiling



- Online vs Offline (no network activities)
- Background power (basic: screen, CPU, memory etc)

Testing Settings

- Video Quality (Resolution)
  - 360p, 720p, 1080p
- Segment Length
  - 2sec, 3sec, 4sec
- Buffer Size
  - 30sec, 45sec, 60sec

Profile

1

Resolution

2

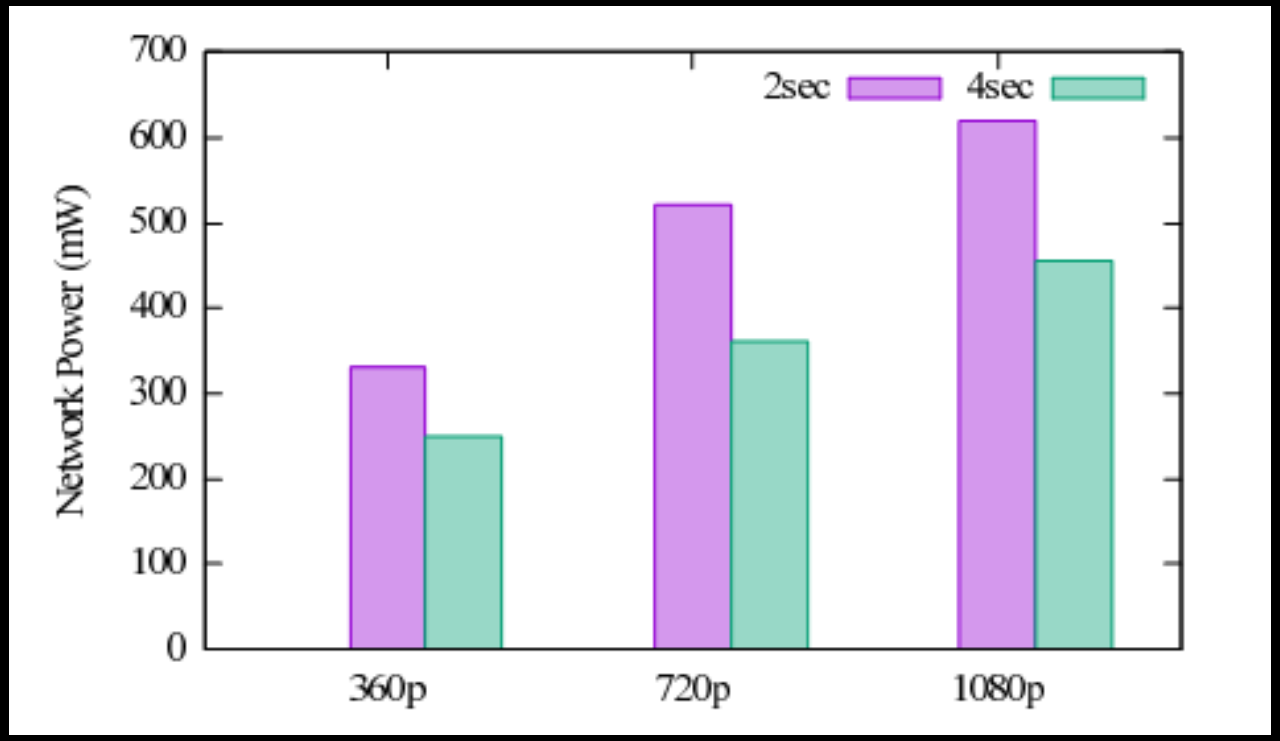
Segment Length

3

Buffer Size

Video Resolution

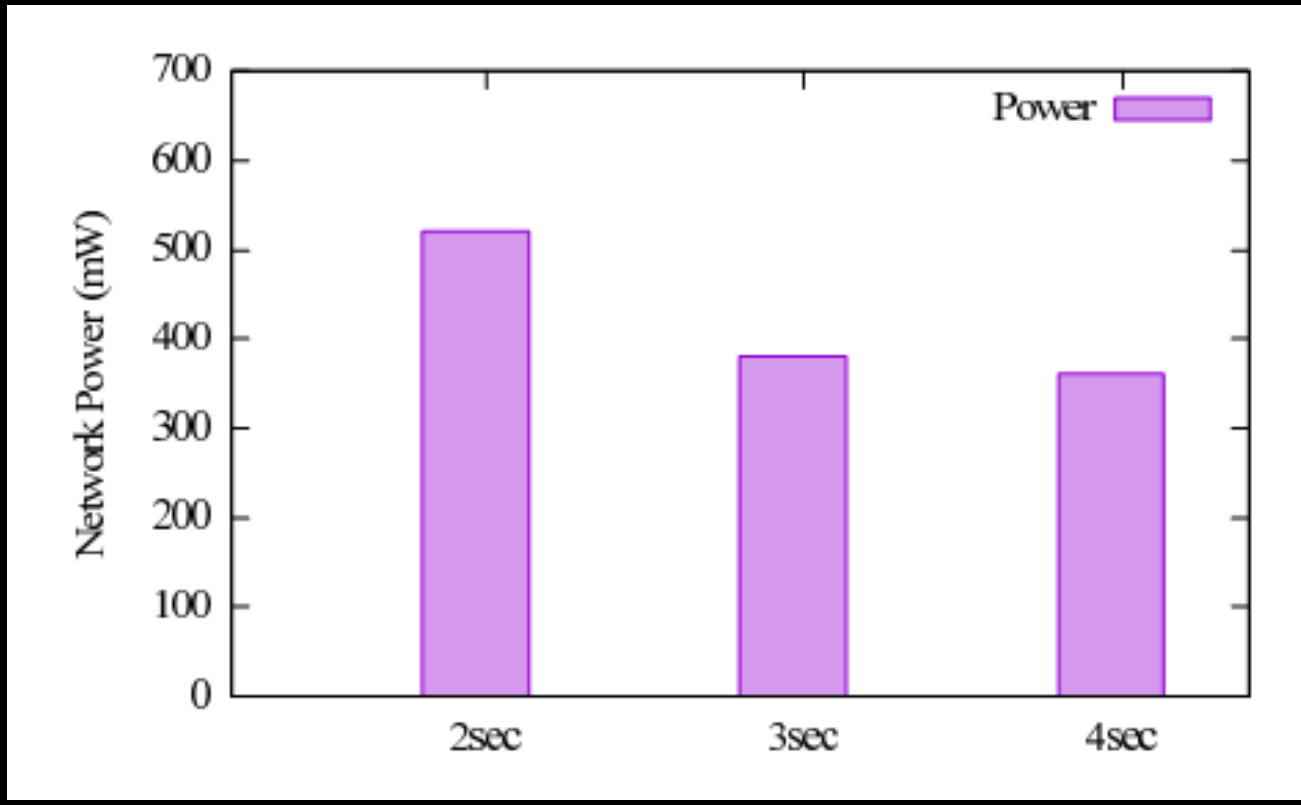
- Settings
  - Resolutions: 360p, 720p, 1080p
  - Segment length: 2s, 4s
- higher res consumes more power
  - 360p: 331mW
  - 1080p: 619mW (187%)



Segment Length

- Settings
  - Resolutions: 720p
  - Segment length: 2s, 3s, 4s

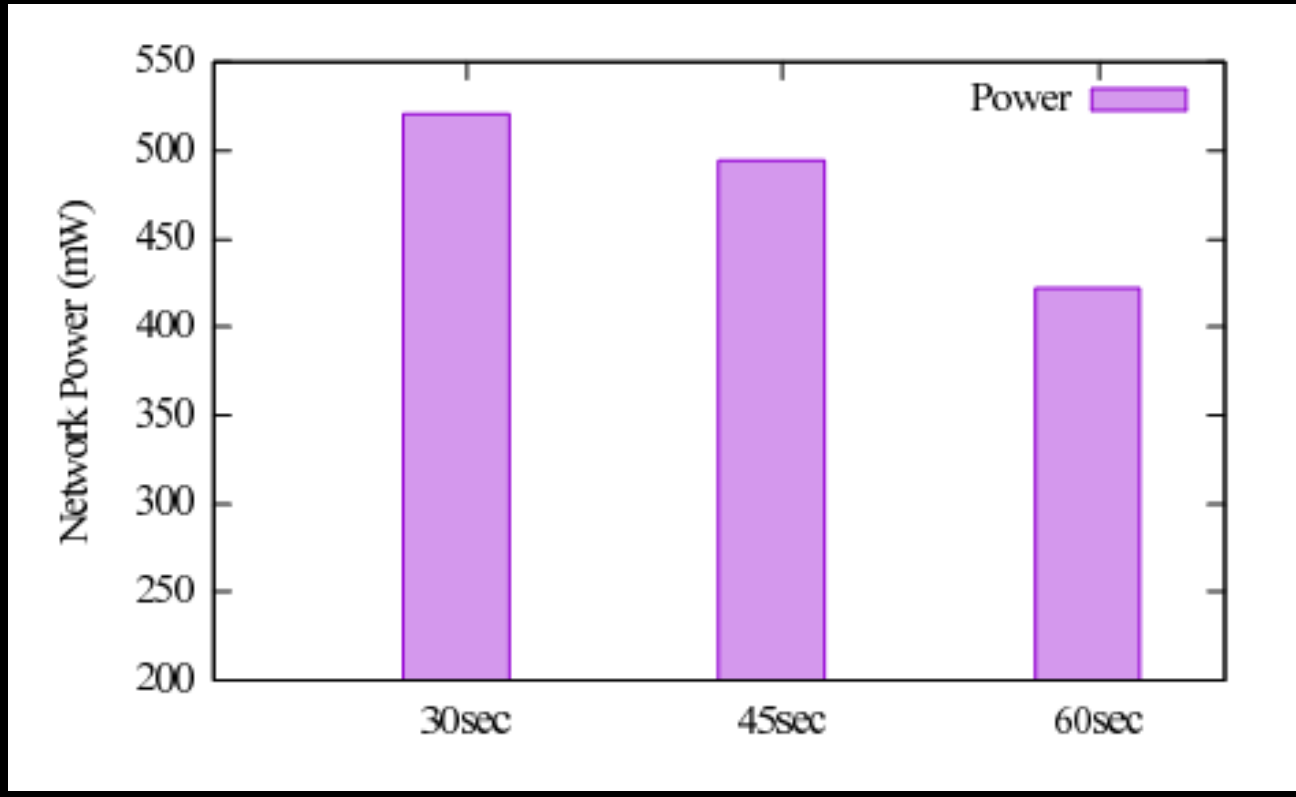
- Larger segment length consumes less power
  - 2s: 521mw
  - 4s: 361mw (69.3%)



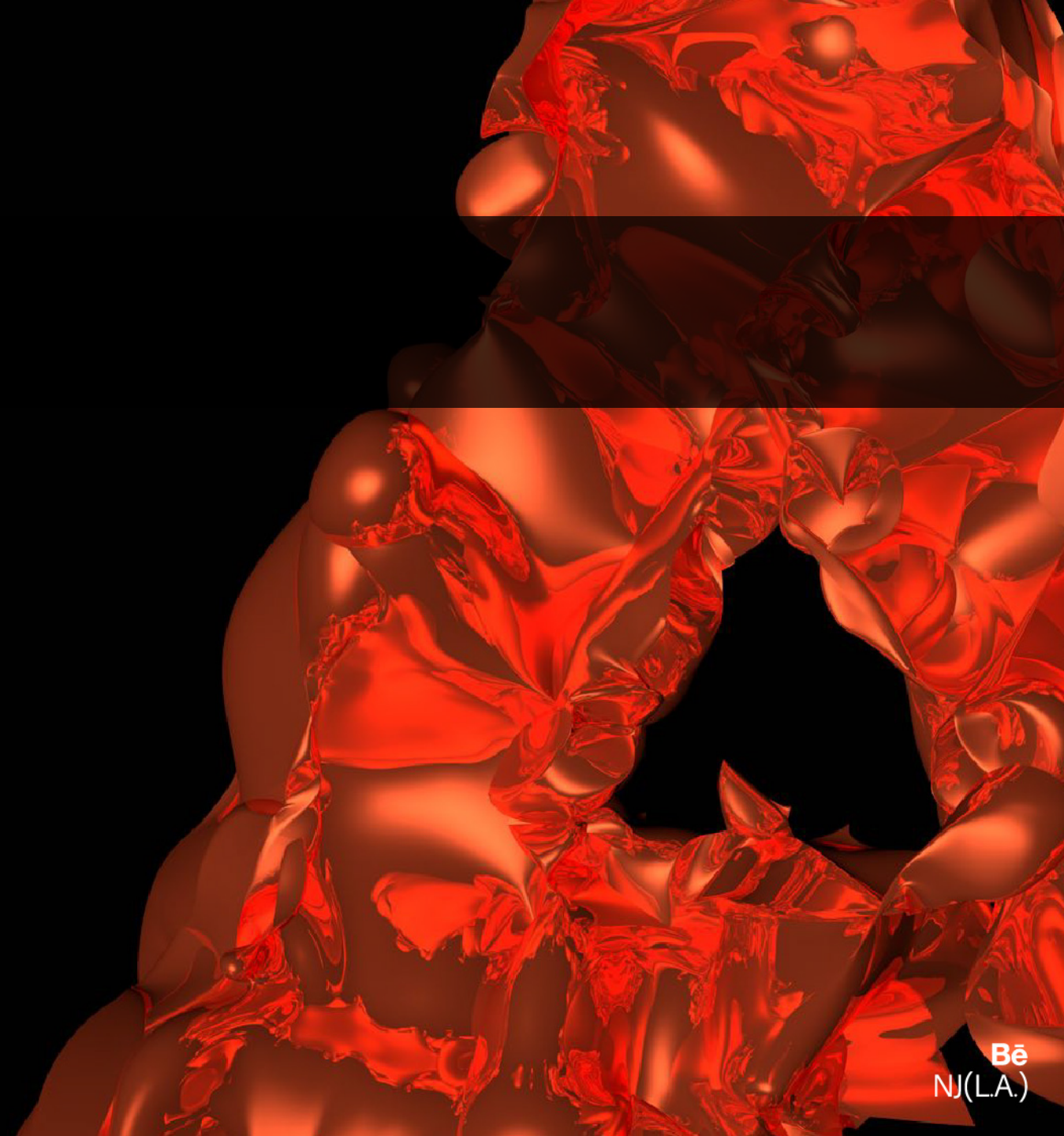
Buffer Size

- Settings
  - Resolutions: 720p
  - Buffer: 30s, 45s, 60s

- Larger buffer size consumes less power
  - 30s: 521mw
  - 60s: 422mw (81%)



Signal strength?



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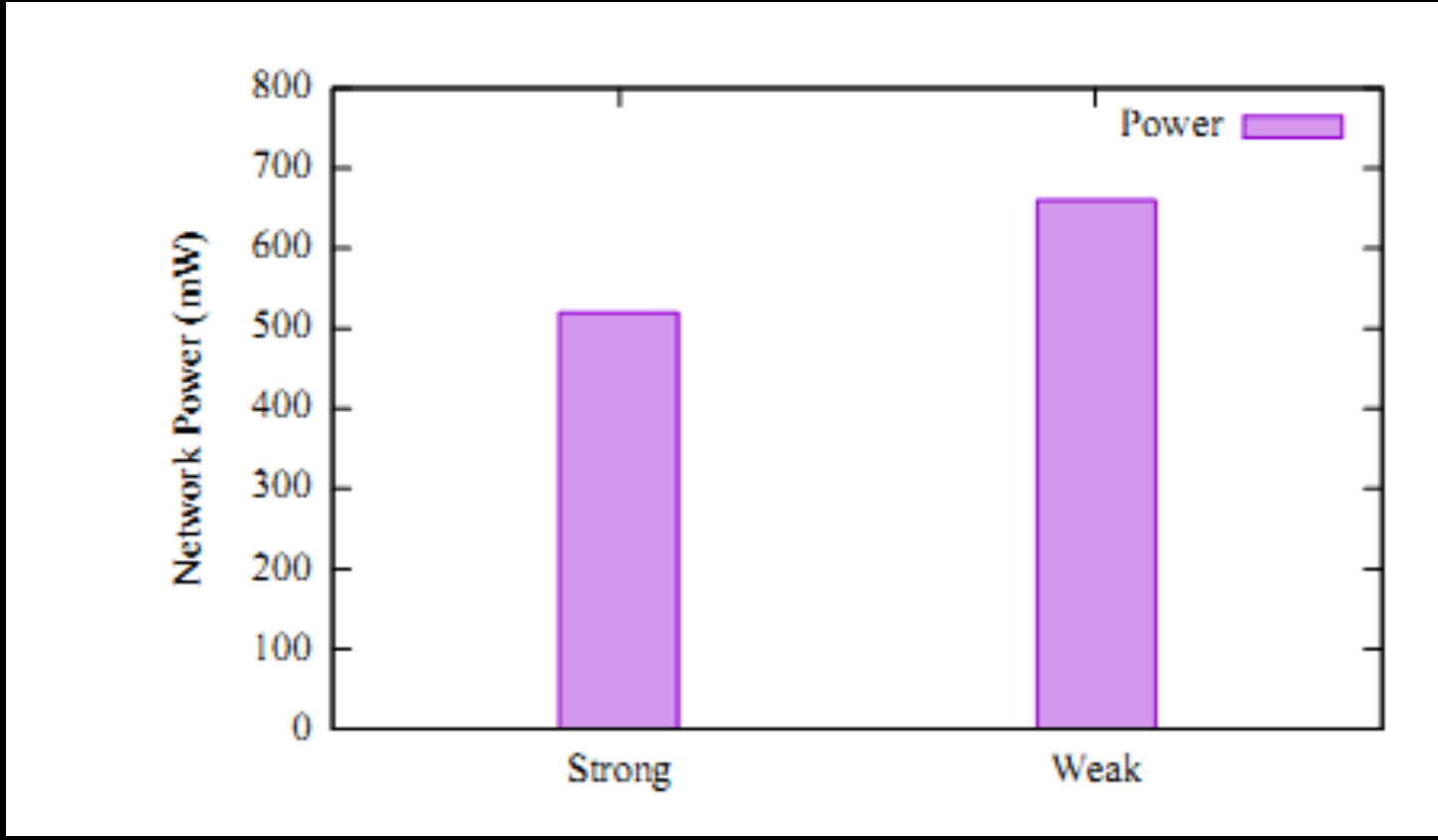
LTE Signal Strength (Speed)

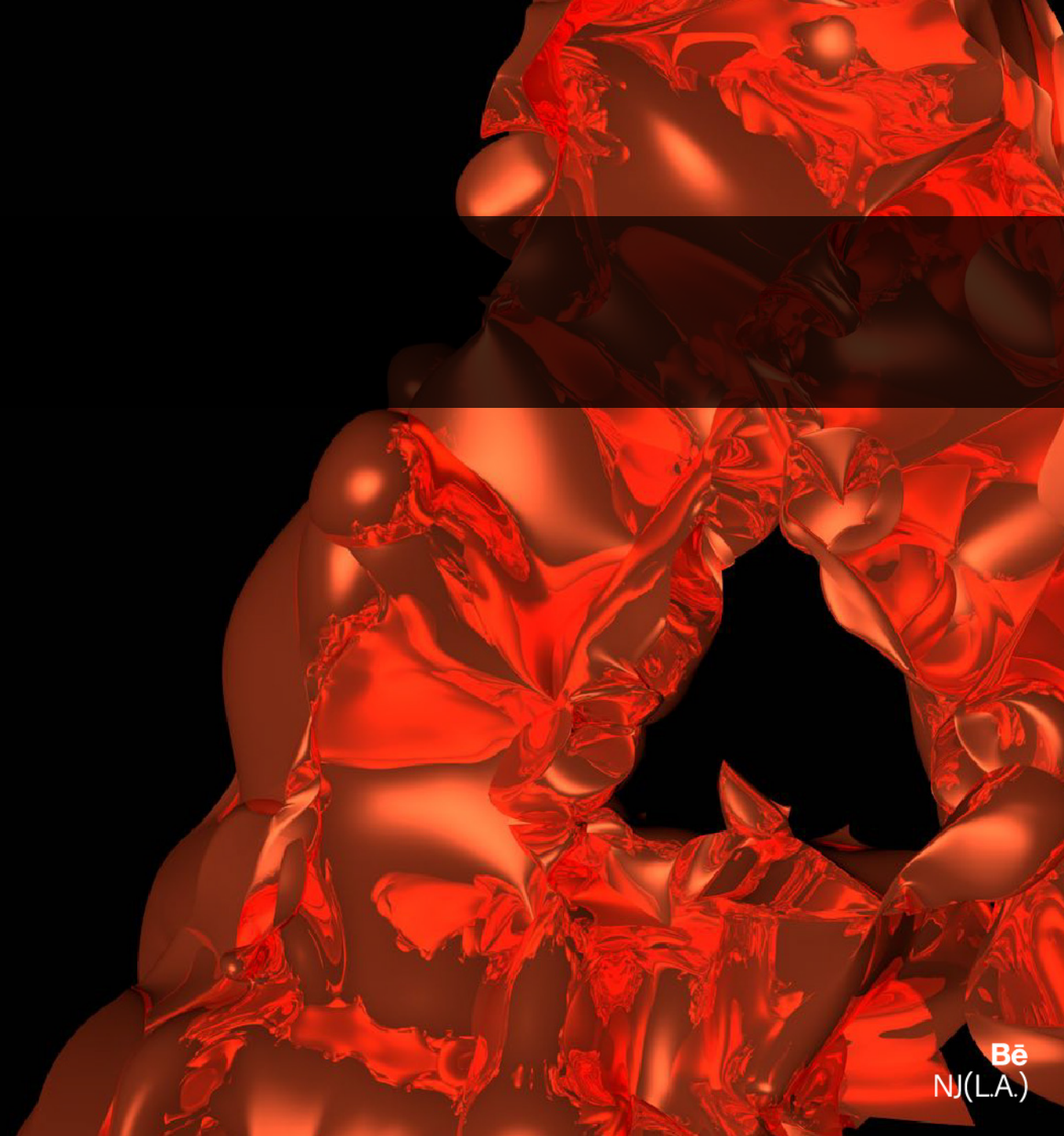
- Settings
  - Resolutions: 720p
  - Strong: 8-20Mbps
  - Weak: 3-3.8Mbps

- Faster LTE speeds consumes less power.



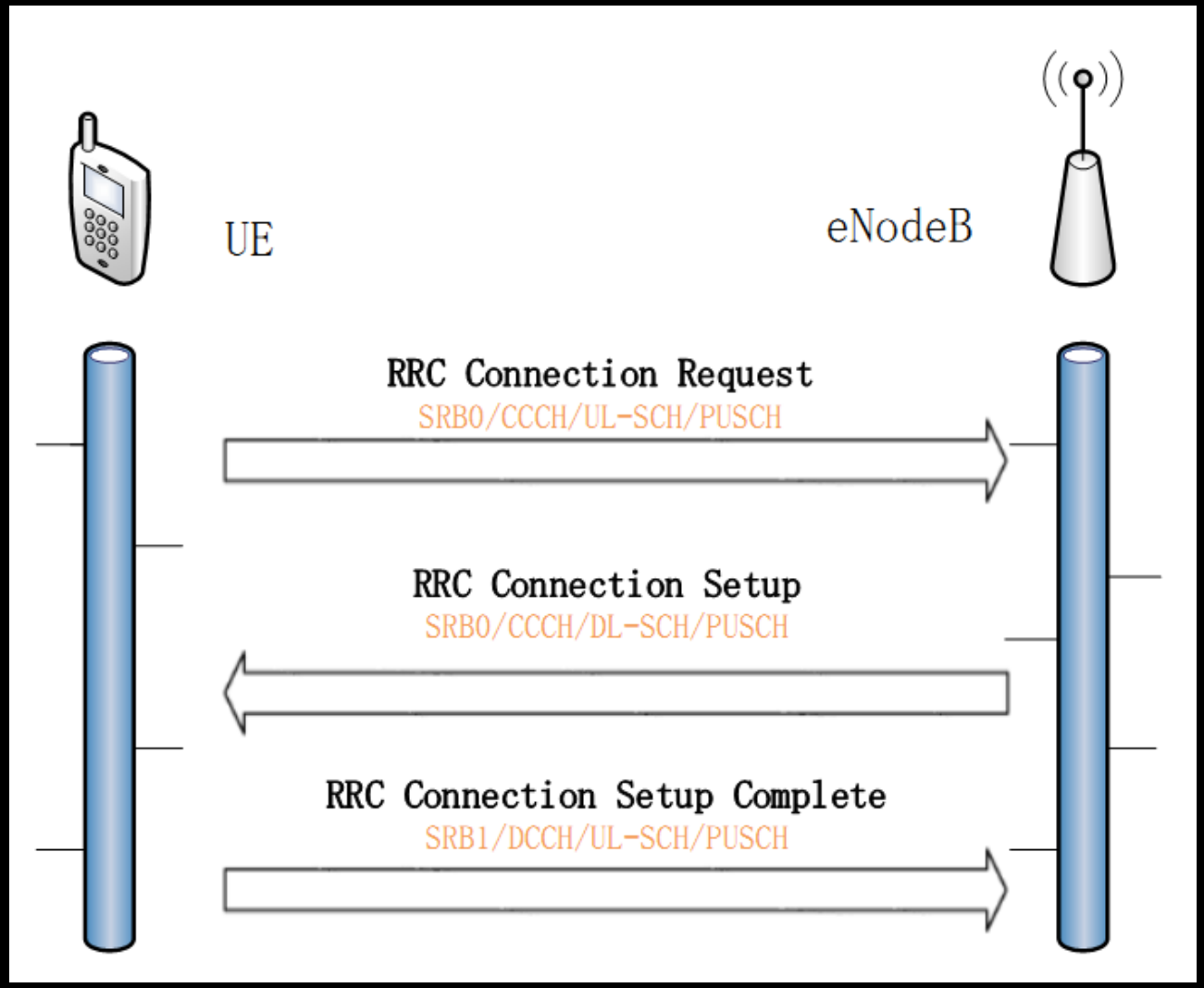
Analysis and potential savings

RRC (radio resource allocation)



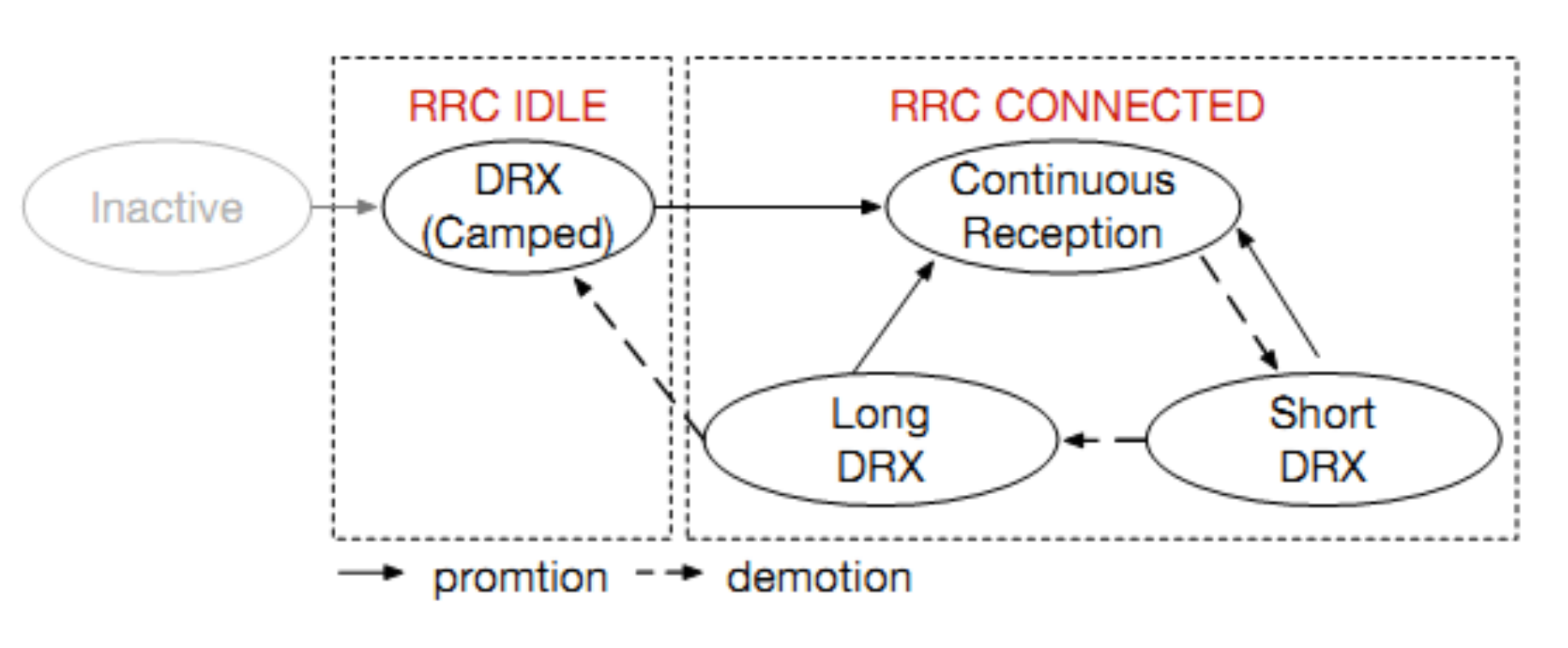
RRC connection

1. UE sends a RRC connection request to eNodeB
2. eNodeB responds UE with a RRC connection message
3. Finally the UE proceeds to complete the procedure by send a RRC Connection Complete message

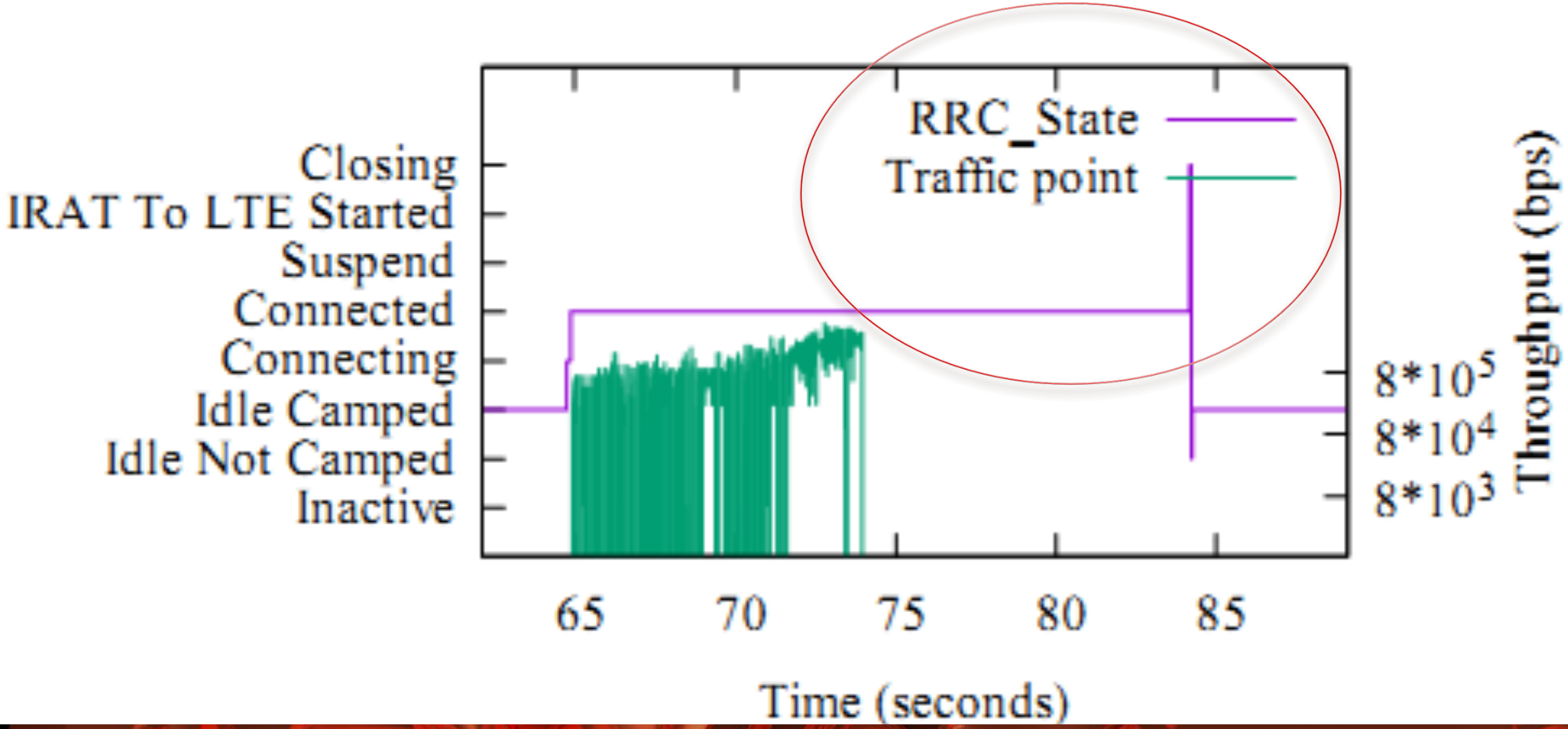


RRC State Transition over 4G LTE

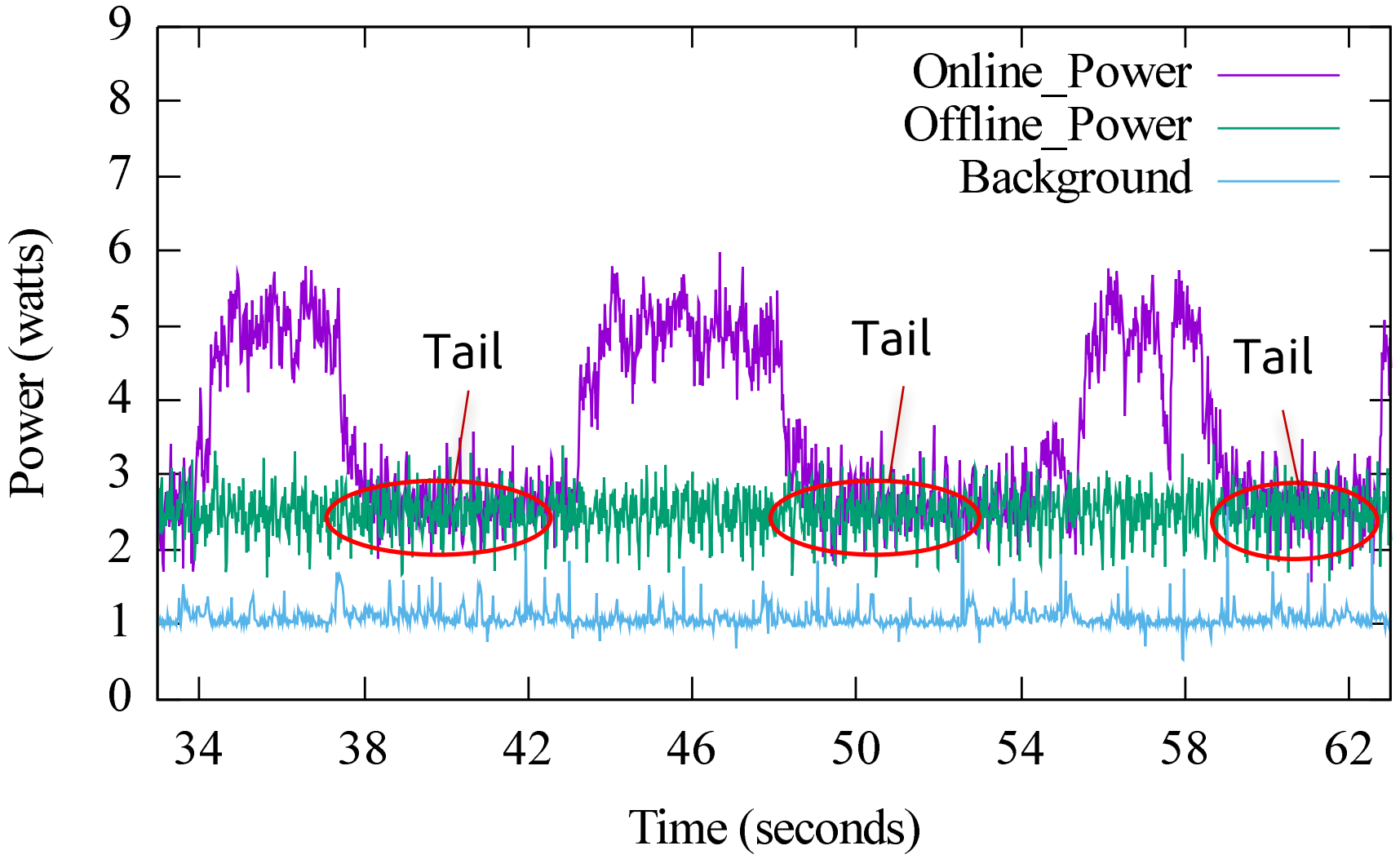
- RRC: Radio Resource Control
  - States: Idle (low power) and connected (high power)
  - Procedures: promotion and demotion



RRC Tail: No transmission but at high power



RRC tails in power traces



Potential Saving

- Larger segment length
  - Segment Length: 2s

    Segment Length: 4s:

    Saving: 30.7% (97.8J in the example)

- Larger buffers
  - Buffer Size: 30s

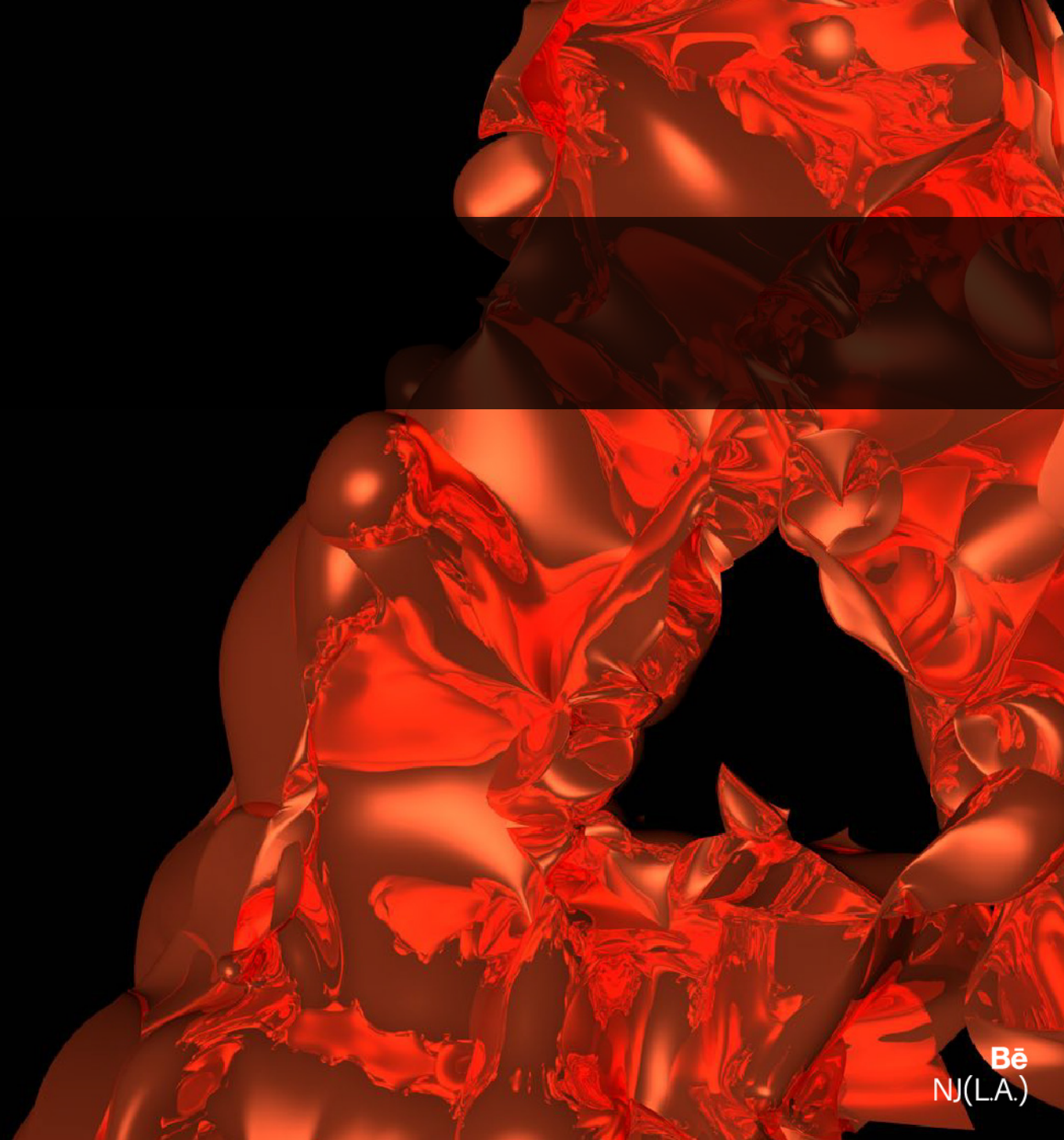
    Buffer Size: 60s

    Saving: 19%

Summary

- Profiled impact factors of video streaming network energy consumption
  - resolution
  - segment length
  - buffer size
  - Network condition
- RRC tail: energy wastes
  - Consistent with prior findings
- 30%+ potential saving (theoretically)
- Future work: energy-efficient network-aware video streaming

Questions ?



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