Modeling the Effect of Seek and Pause on Server Load in Peer-Assisted VOD

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joint work with

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Brampton's study of World Cup 2006 VoD:

8.75 jumps / session

2.24 pauses / session

Costa's study of eLearning Video (2004):

28% of videos between **30-40** minutes have more than **10** interactive requests, **54**% of which are pauses.

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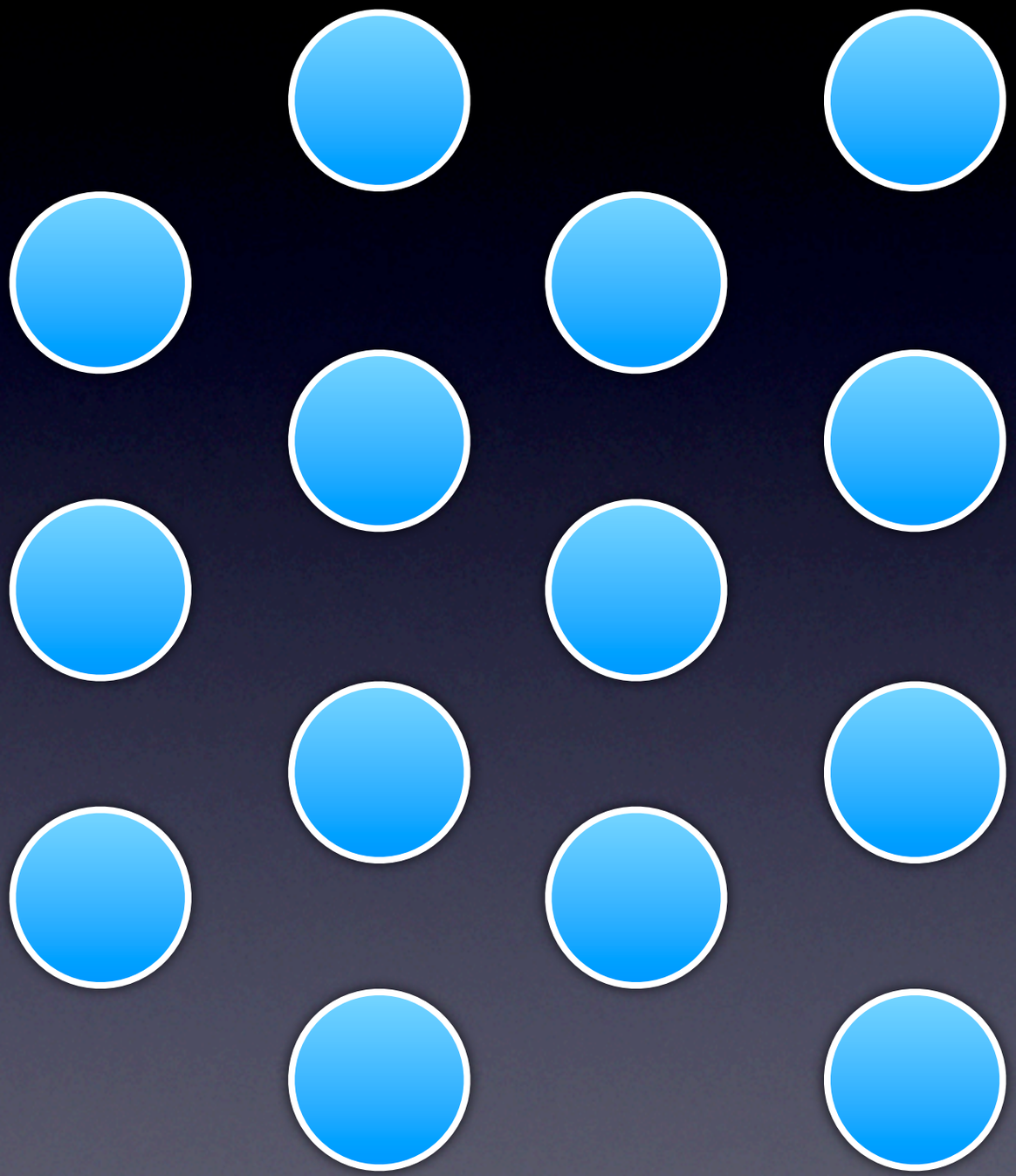
Peers



Server

- Peers may arrive at any time and watch the video from the beginning.
- Peers always download chunks in increasing time order after the playback point.
- Chunks are downloaded from other peers if possible, from server if not.

- A peer leaves only when its playback is complete (can be relaxed).
- Download rate is larger than playback rate.

no assumption about :

overlay structure

content discovery protocol

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server load =
total download demand -
total upload supply

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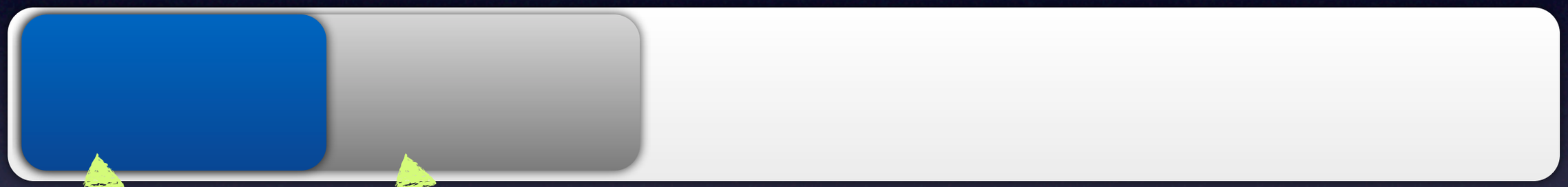
Total video length

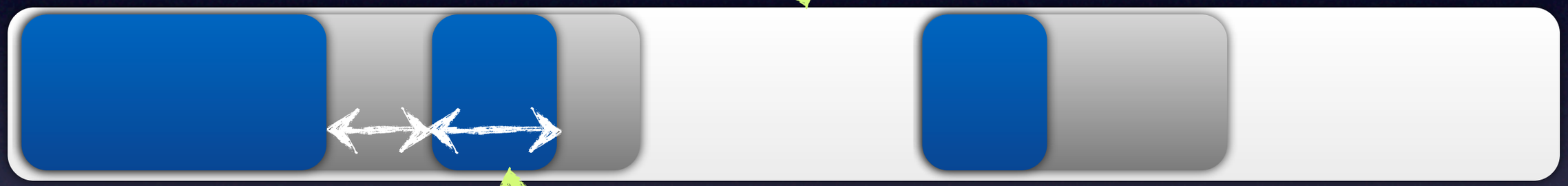


Downloaded

Played

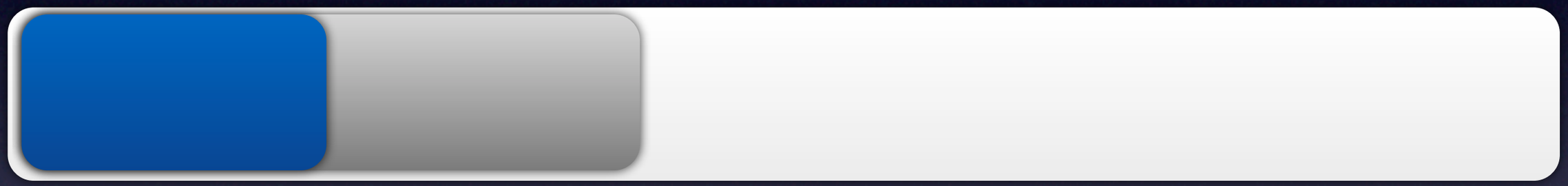

Seek

Gap



Inter-Seek Distance

Seek Length



Pause

Consider a sequence of pauses (P) and seeks (S)

SPPPSSPSPSSSPP

Consecutive pauses can be aggregated

SPSSPSPSSSP

Pause after the last seek
does not reduce gap size

SPSSPSPSSSQ

Does **seek** increase or decrease server load?

increase:
finish playback faster
leave earlier
contribute less

decrease:

creates gap
download less

Does **pause** increase or decrease server load?

decrease:

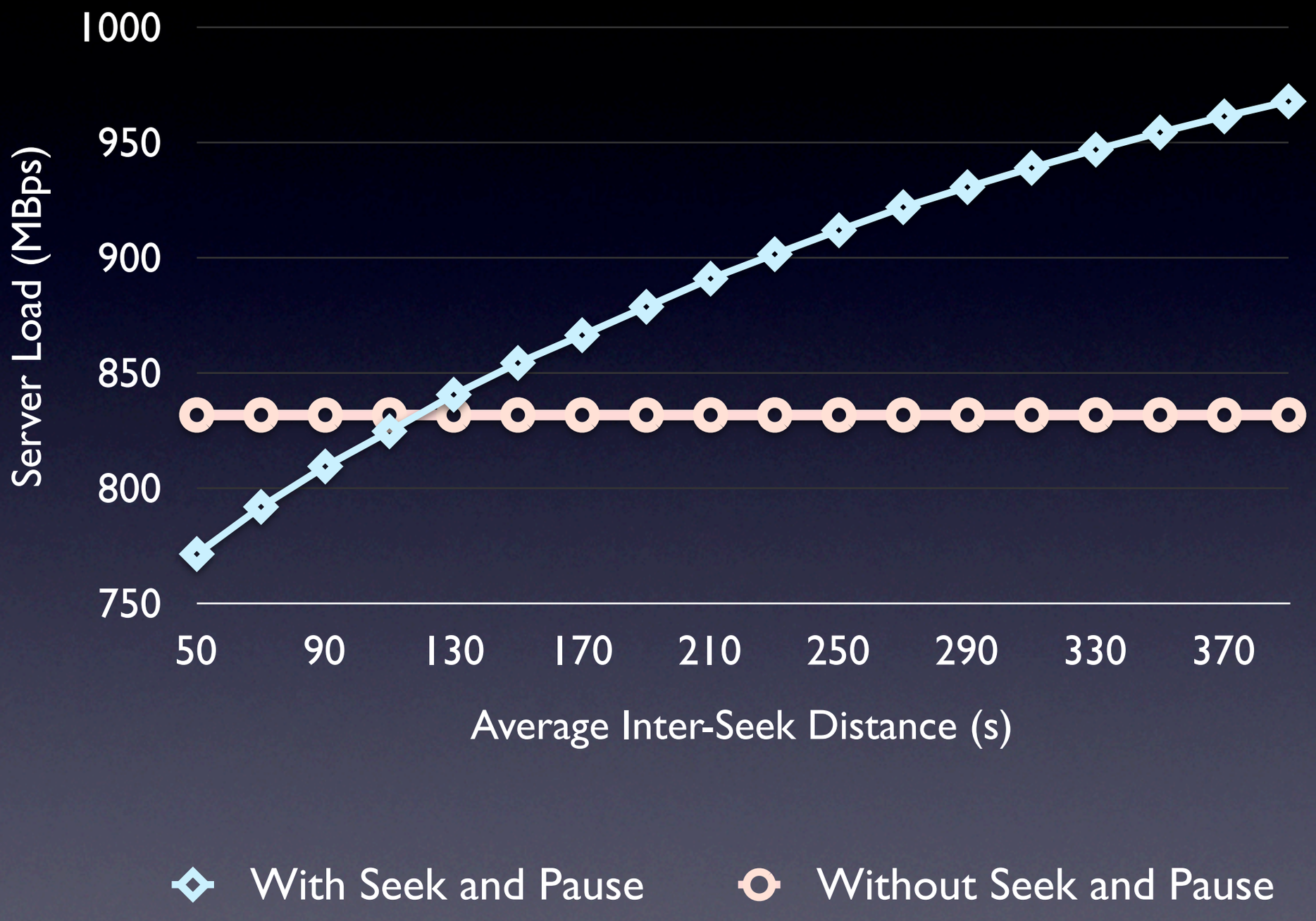
stay longer in system

contribute more

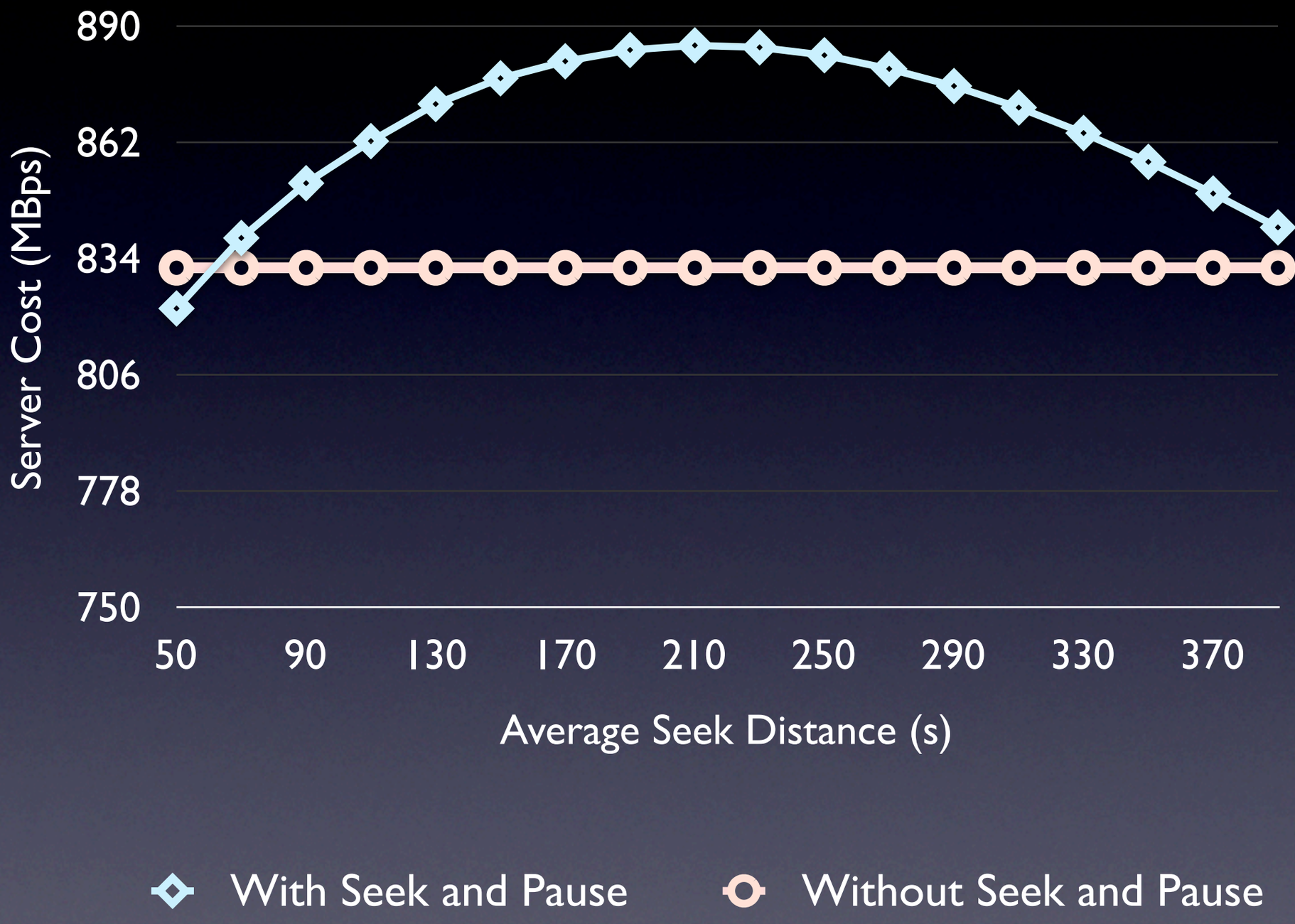
increase:

download chunks that might be skipped later

Effects of Seek and Pause



Effects of Seek and Pause



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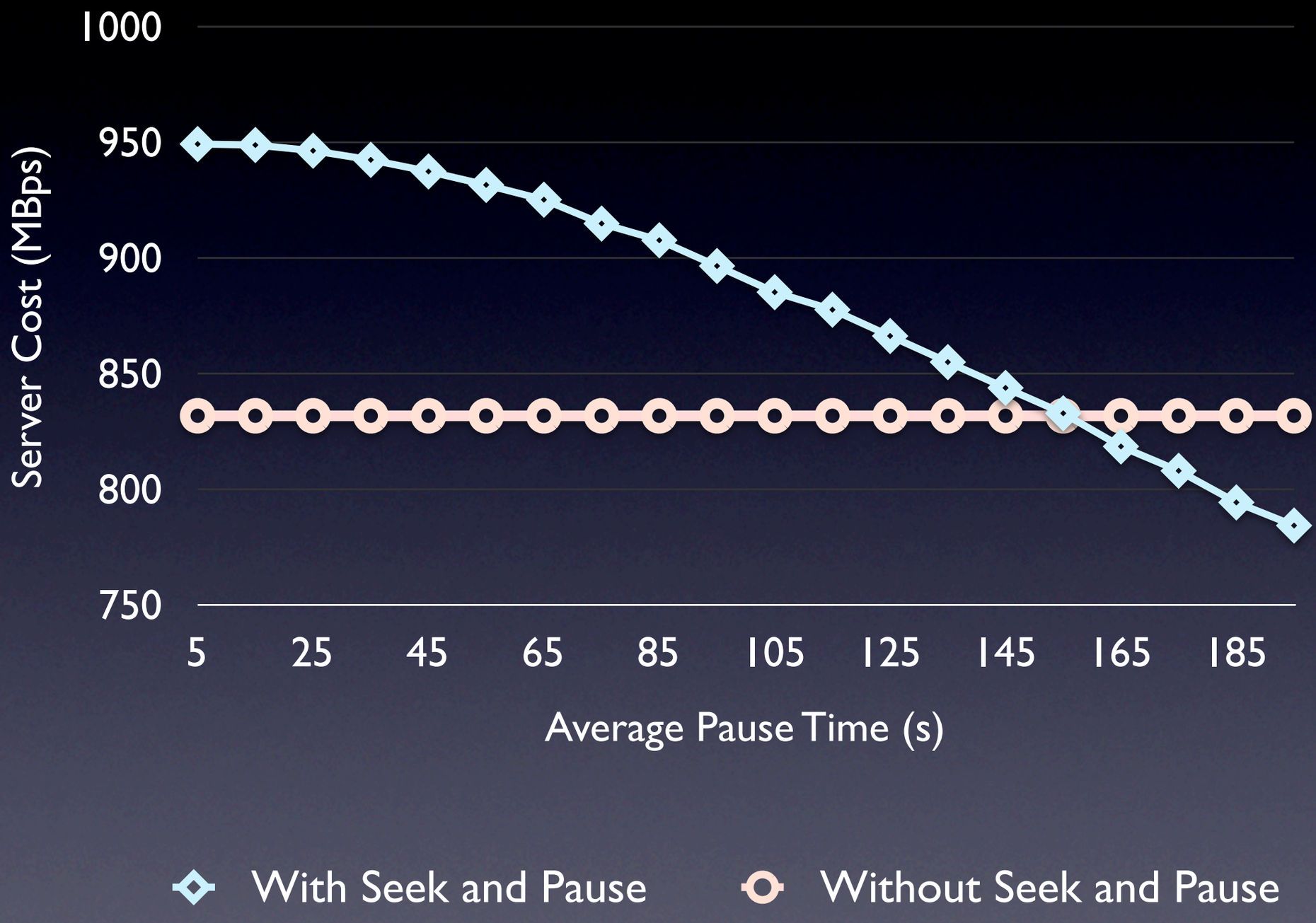

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How big are the gaps?

Average playback rate

Average download rate

$$G = \max\{ v(I+L) - D(I+P),\ 0 \}$$

Average gap size per seek

Average seek length

Average pause time

$$G = \max\{ v(I+L) - D(I+P),\ 0 \}$$

Average interseek distance

"demand"

"supply"

$$G = \max\{\, v(I+L) - D(I+P),\ 0 \,\}$$

How much data is downloaded by a peer?

Average num of seeks per peer

$$z = vT_y - NG$$

video length

average amount of data downloaded by a peer

How long does a peer stay in the system?

Average pause time
after last seek

$$T_s = T_v - NL + NP + Q$$

Total pause time

$$T_s = T_v - NL + NP + Q$$

Total watching time

how many peers?

arrival rate

$$m = \lambda T_s$$

Total bandwidth demand?

$$\frac{Z}{T_s}\dot{m}$$

Total bandwidth supply?

Bandwidth utilization

Average upload bandwidth

$$S + \alpha m U$$

Server load

$$mz/T_s = S + \alpha mU$$

Estimate S given:

α, λ, D, U

N, I, L, P, Q

v, T_v

Extensions:
backward seek
start-up delay
random departure
quantitative model

1. Backward Seek

Behave just like pause

2. Start-up Delay

Long pause in the beginning

3. Random Departure

Affect z and T_s

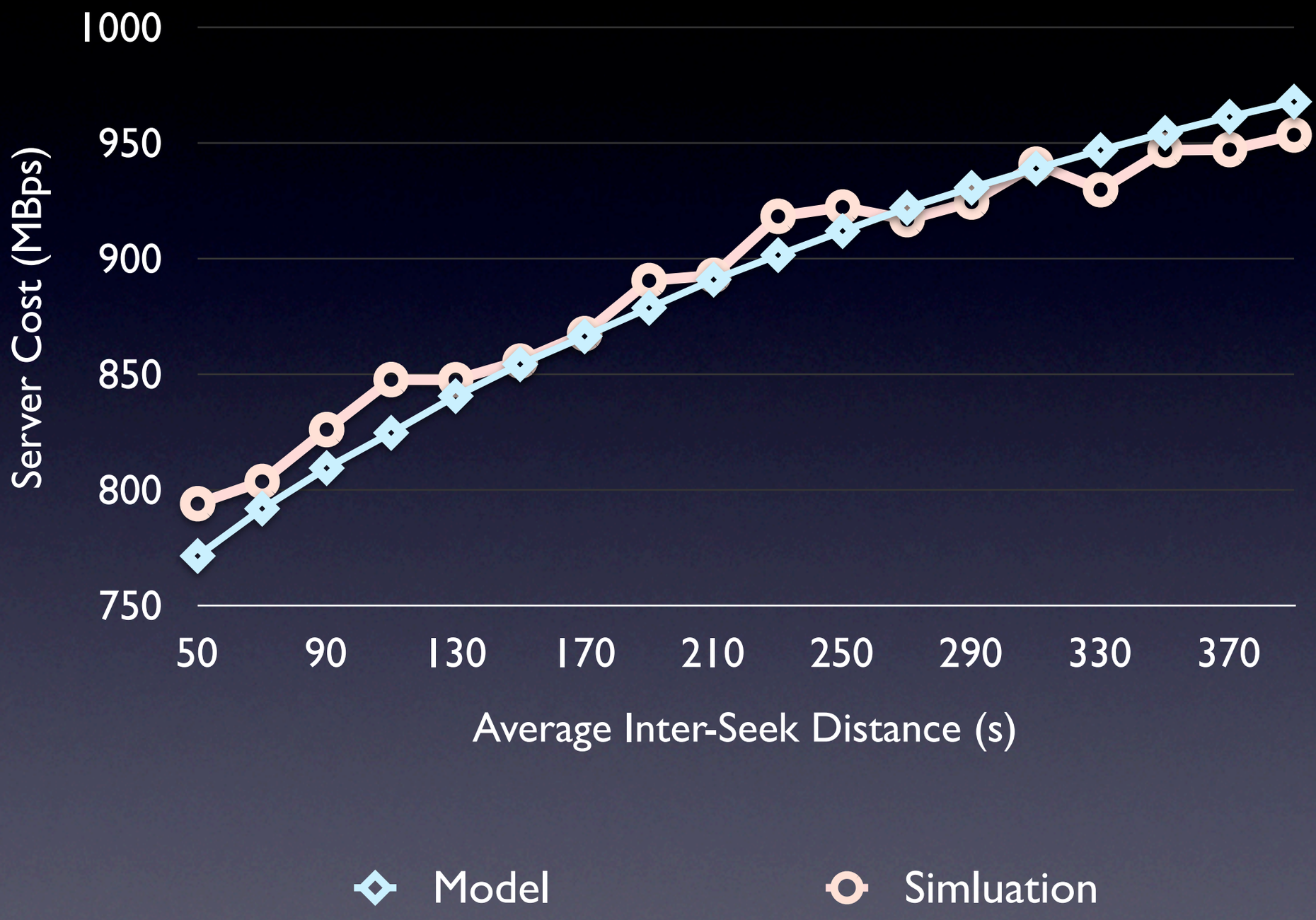
4. More accurate model

(G is not in closed form)

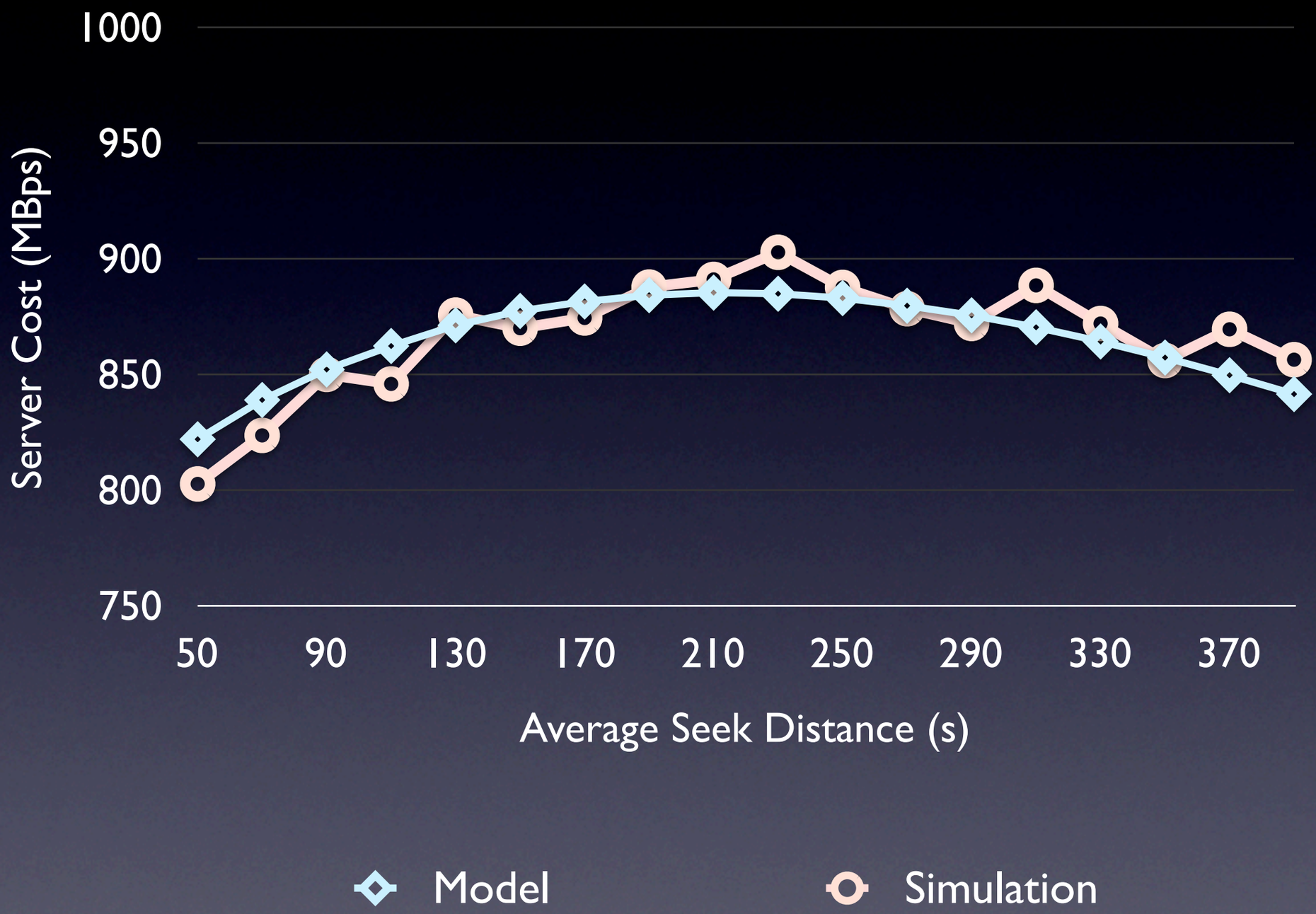
How accurate is our model?

- Simulating a P2P VoD system based on centralized tracker ($\alpha = 1$)
- Poisson arrival (1/s) with random departure
- Pause time, inter-seek distance, seek length follow log normal distribution
- Watch 2-hour long movie at 500 kbps
- Simulate for 12000 seconds

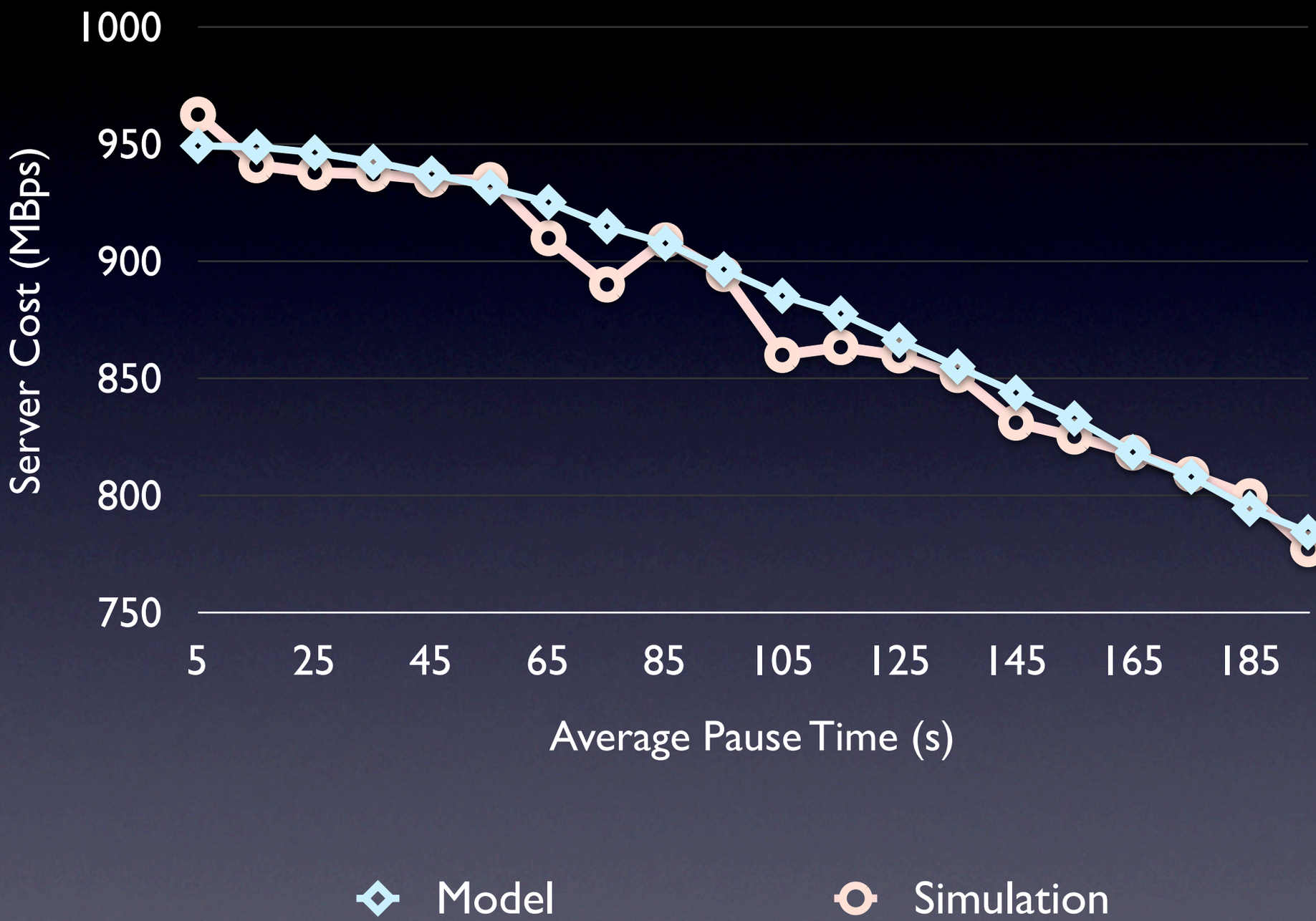
Accuracy of Model



Accuracy of Model



Effects of Seek and Pause



Server cost decreases when:

very long pauses
very short/long seek distance
short inter-seek distance

Application of Our Model

better server provisioning

reduce server cost by modifying interaction behavior

Open Questions

Verification with real P2P VoD data?

More accurate closed-form model?

Thank You for Listening

comments?
questions?