PREDICTIVE PREFETCHING FOR MPEG DASH OVER LTE NETWORKS

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Outline

• Introduction
• Motivation
• Our solution
• Experimental results
• Conclusion
Introduction

• DASH client selects the best bit rate for future video segments by
  - Estimating the available bandwidth/throughput
  - Looking up the MPD
  - Checking the playout buffer level

![Diagram showing bitrate selection algorithm]
Introduction

• In wireless networks, the available bandwidth may fluctuate severely due to
  • Shadowing, fading
    - e.g. a user onboard a train going through a tunnel
  • Difference in cell load
    - e.g., move from a lightly loaded cell to a heavily loaded cell
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Motivation

• Regularity in user’s mobility results in regularity in available bandwidth
  • e.g., Commute to work everyday: same route, almost same time

![Graph showing available bandwidth vs distance for the first trip](image-url)
Motivation

• Regularity in user’s mobility results in regularity in available bandwidth
  • e.g., Commute to work everyday: same route, almost same time

Second trip
Motivation

- Regularity in user’s mobility results in regularity in available bandwidth
  - e.g., Commute to work everyday: same route, almost same time
Motivation

• Regularity in user’s mobility results in regularity in available bandwidth
  • e.g., Commute to work everyday: same route, almost same time

![Graph showing available bandwidth](image)
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Our Solution

• System Architecture

What we do

7: Measure Available Bandwidth

8: Predict Available Bandwidth and speed - using data from past trips and the current trip

9: bit rate selection
Our Solution

- Predict available bandwidth at future locations
  - Using a Kalman filter on the data seen so far in the current trip
    - The state transition matrix is learnt using historical data (previous trips)
- Predict the speed at future locations
- Select the best bit rate
  - Avoid rebuffering
  - Maximize bit rate
Our Solution

• Select the bit rate $BR$ for the next $M$ route segments
  • If the current buffer size $BS \leq BS_{low}$, then select the lowest bitrate in MPD
  • Otherwise, we apply the condition of no rebuffering

\[
\sum_{k=1}^{m} T_{i,k} \leq BS + \frac{\sum_{k=1}^{m} D_{i,k}}{BR}
\]

for $1 \leq m \leq M$

Expected travel time in segment $k$

\[
D_{i,k} = \hat{B}_{i,k} T_{i,k} = \frac{\hat{B}_{i,k} L}{V_{i,k}}
\]

Predicted available bandwidth

Length of a route segment

Predicted speed

to get an upper bound on $BR$, and then select the largest in MPD
Our Solution

- Putting everything together

Algorithm 1 Given the predicted speeds $\hat{V}_{i,m}$ and the predicted bandwidth $\hat{B}_{i,m}$ for $1 \leq m \leq M$, and the current buffer size $BS$, determine the upper bound for the video bit rate to avoid rebuffering, and choose the bit rate to maximize the video quality.

1. IF $BS > BS_{low}$
2. Initialize $BR_{max} = \infty$;
3. FOR $m = 1$ to $M$
4. $T_{i,m} = \frac{1}{V_{i,m}}, D_{i,m} = \hat{B}_{i,m} T_{i,m}$
5. IF $\sum_{k=1}^{m} T_{i,k} > BS$
6. temp = $\frac{\sum_{k=1}^{m} D_{i,k}}{\sum_{k=1}^{m} T_{i,k} - BS}$ (See (16))
7. IF temp < $BR_{max}$
8. $BR_{max} = temp$;
9. END IF
10. END IF
11. END FOR
12. Select the maximum bit rate from the available bit rates in the MPD that is not greater than $BR_{max}$;
13. ELSE Select the minimum bit rate from the MPD;
14. END IF
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Experimental Results

- Implemented the DASH client on a Galaxy tablet
- Tested on two routes: CA 56, Mira Mesa Blvd.
Experimental Results

• Compared to Thang’s algorithm, our solution offers
  • More stable bit rate
  • Higher average bit rate

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The CDFs of the video bit rates
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Conclusion

• Proposed a novel bit rate selection algorithm for DASH
  • leveraged the regularity in user’s mobility to better predict the available bandwidth
  • Took into account the available bandwidth and speed in selecting the video bit rate

• Implemented the scheme in a mobile device, tested on a real LTE network
  • Showed significant performance improvement

More details of the work are in: Tianyi Xu, Liangping Ma, “Predictive prefetching for mpeg dash over LTE networks”, submitted to ICIP 2015.
Thank you!