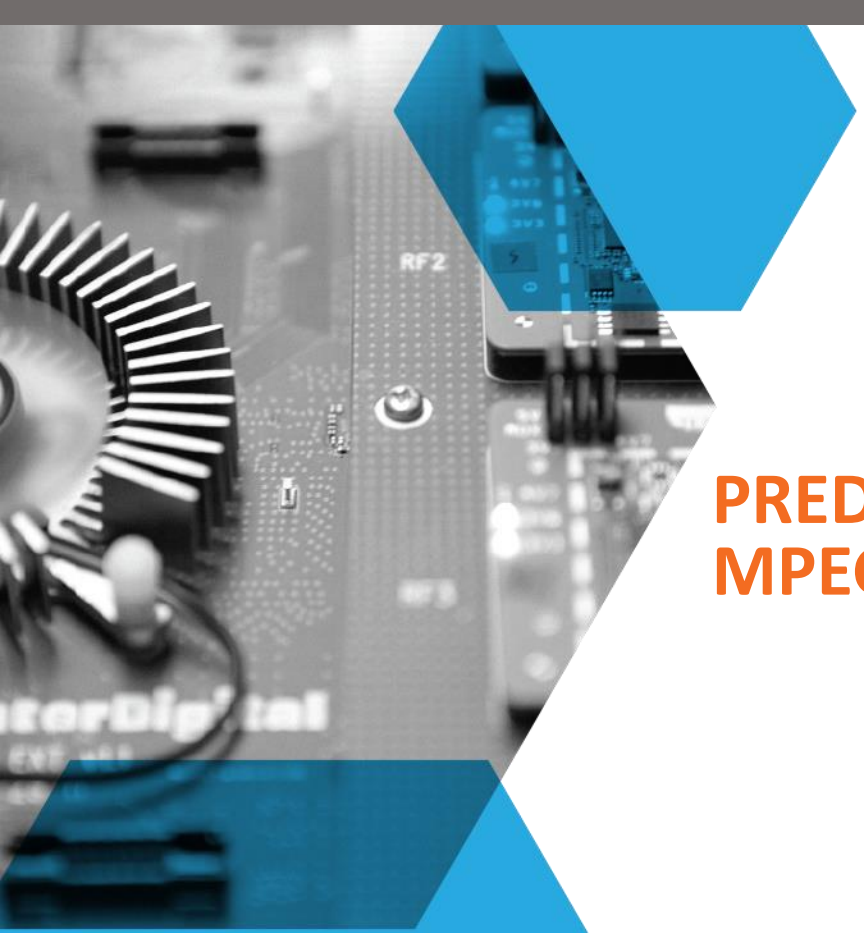


PREDICTIVE PREFETCHING FOR MPEG DASH OVER LTE NETWORKS

Tianyi Xu, **Liangping Ma**

INTERDIGITAL®

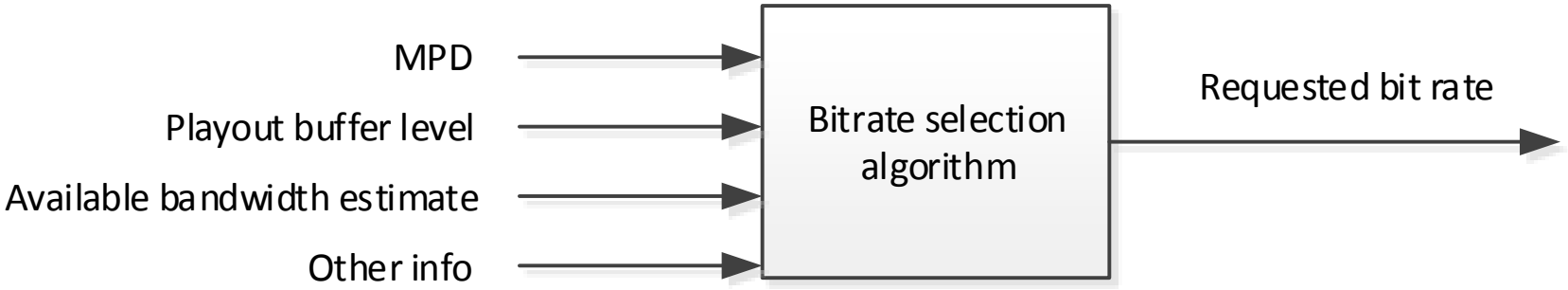
Creating the Living Network

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



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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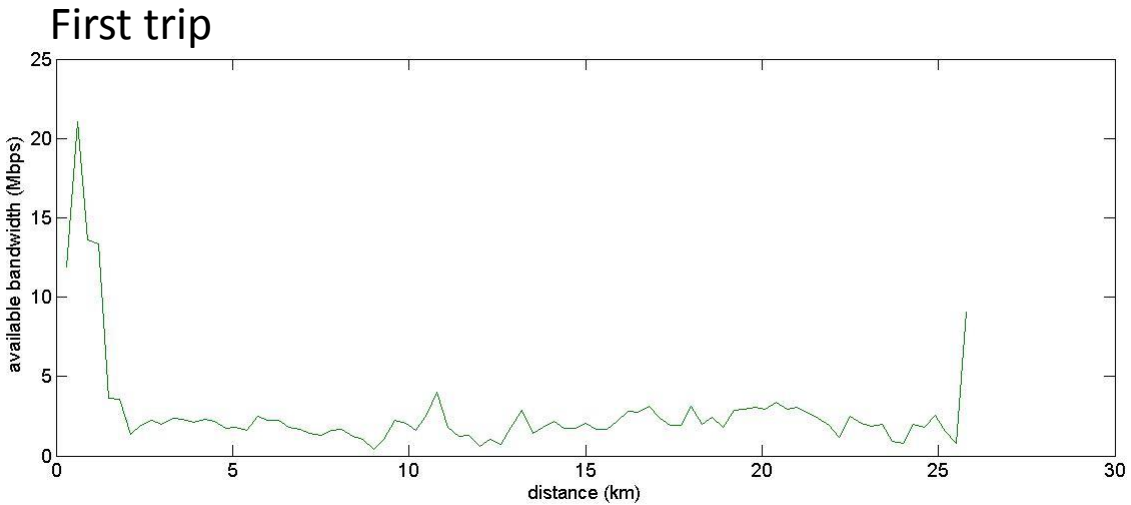
Motivation

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



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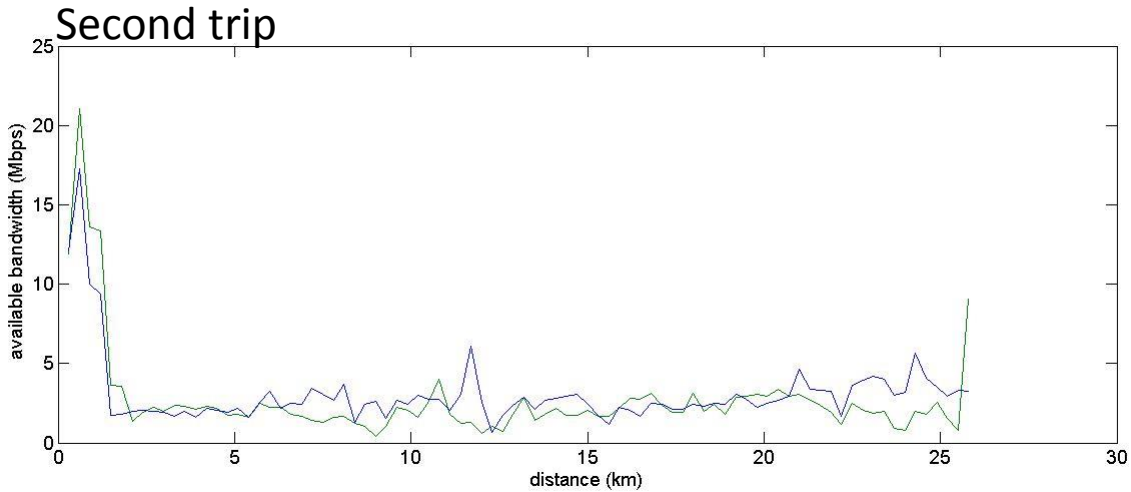

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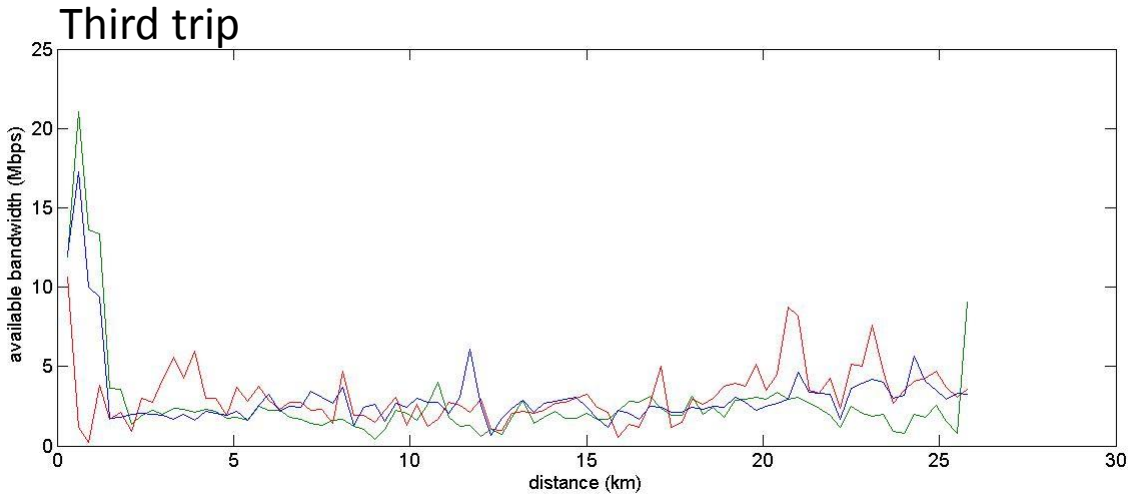

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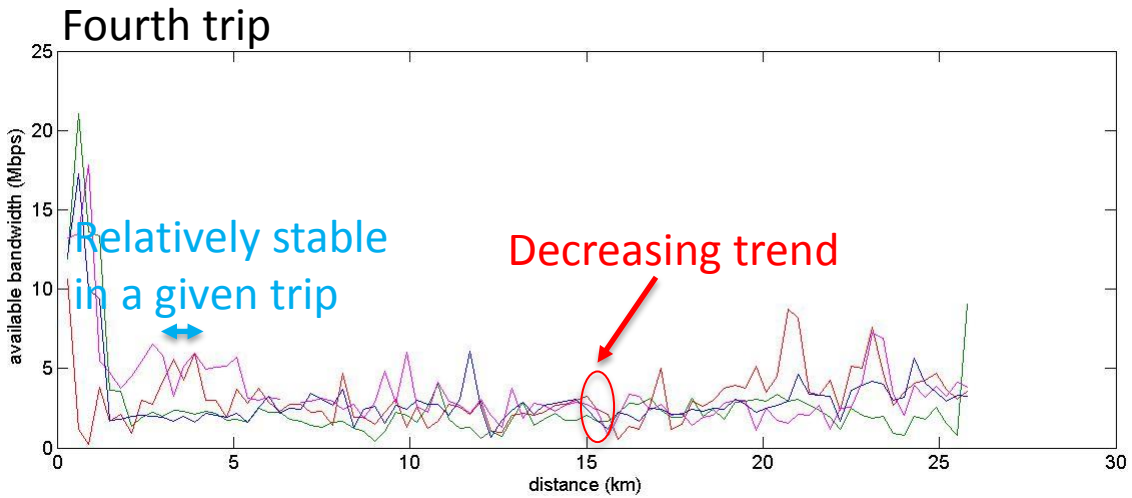

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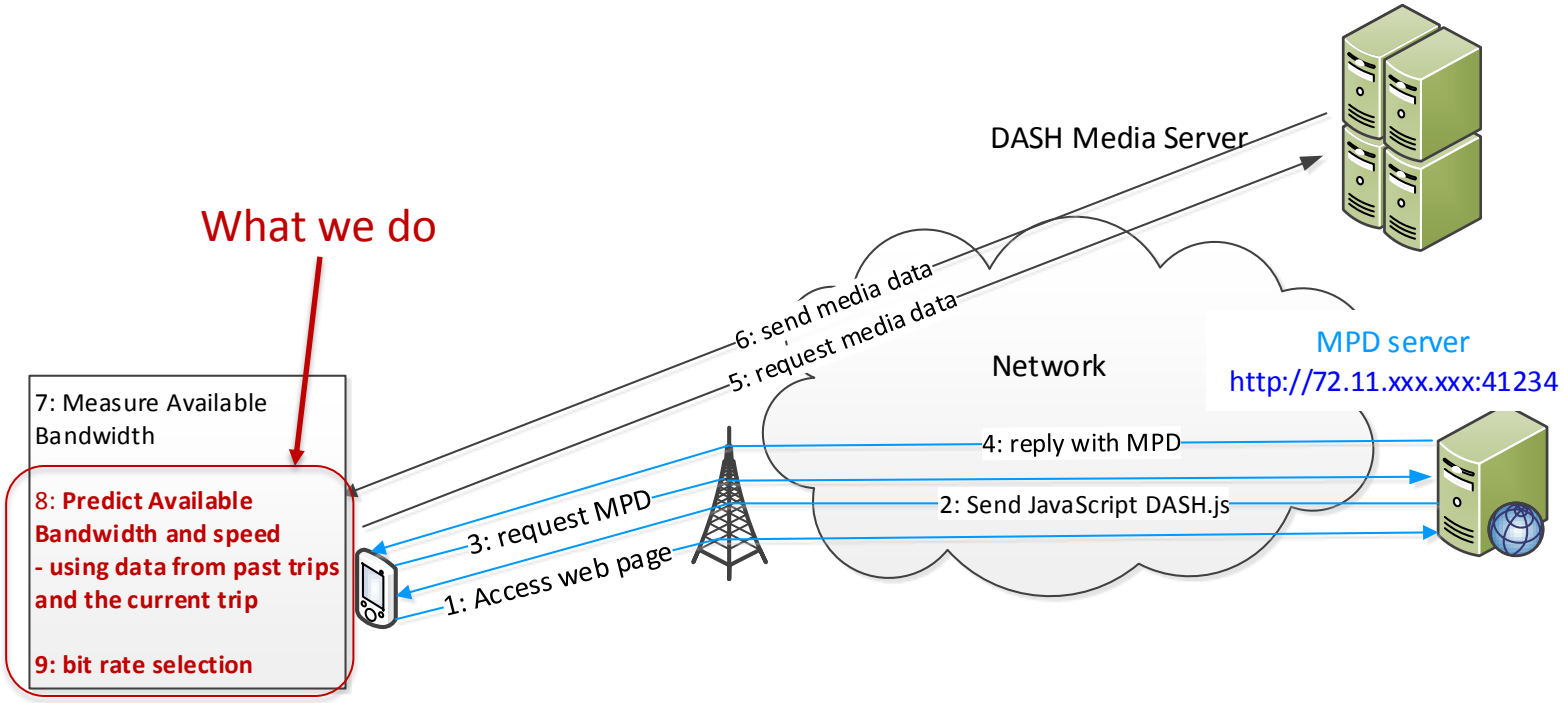
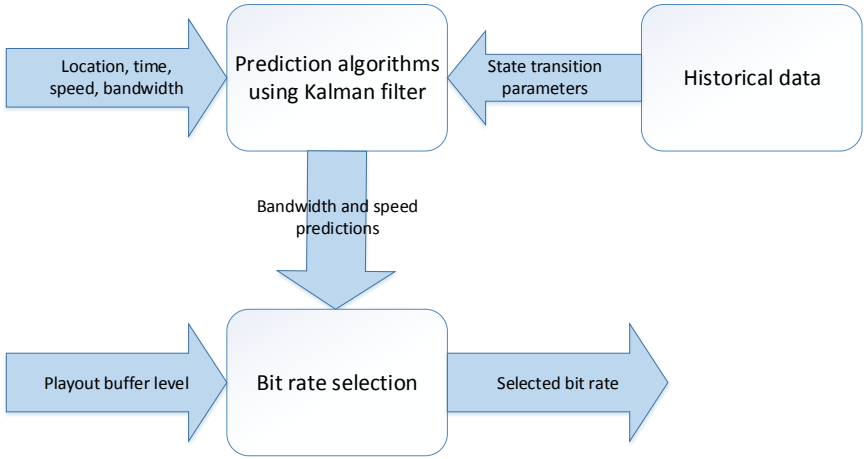
Our Solution

- System Architecture



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

$$\Sigma_{k=1}^{m} T_{i,k} \leq BS + \frac{\Sigma_{k=1}^{m} D_{i,k}}{BR} \qquad \text{for } 1 \leq m \leq M$$

Expected travel time in segment k

$$D_{i,k} = \hat{B}_{i,k} T_{i,k} = \frac{\hat{B}_{i,k}}{\hat{V}_{i,k}} L.$$

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.

IF $BS > BS_{low}$
  Initialize $BR_{max} = \infty$;
  FOR $m = 1$ to M
    $T_{i,m} = \frac{L}{\hat{V}_{i,m}}, D_{i,m} = \hat{B}_{i,m} T_{i,m}$
    IF $\Sigma_{k=1}^{m} T_{i,k} > BS$
      $temp = \frac{\Sigma_{k=1}^{m} D_{i,k}}{\Sigma_{k=1}^{m} T_{i,k} - BS}$;(See (16))
      IF $temp < BR_{max}$
        $BR_{max} = temp$;
      END IF
    END IF
  END FOR
  Select the maximum bit rate from the available bit rates in the MPD that is not greater than BR_{max};
ELSE Select the minimum bit rate from the MPD;
END IF

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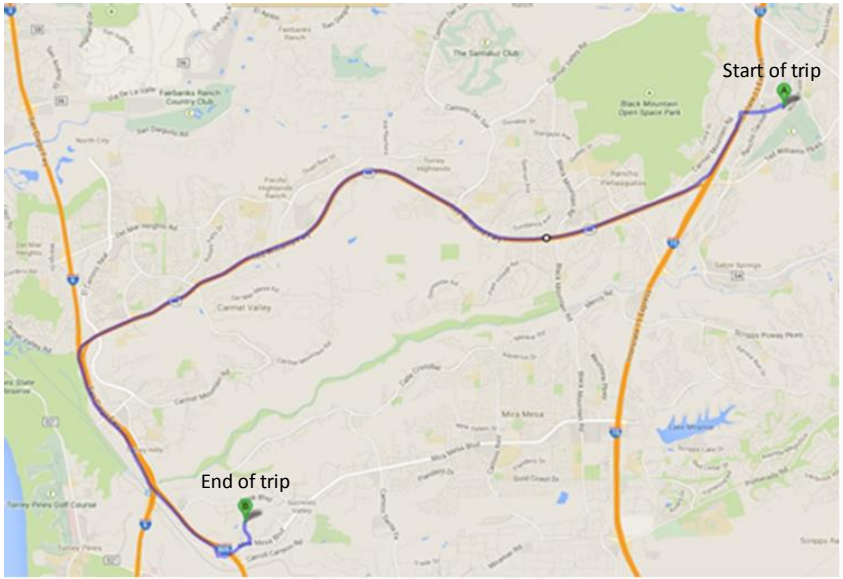
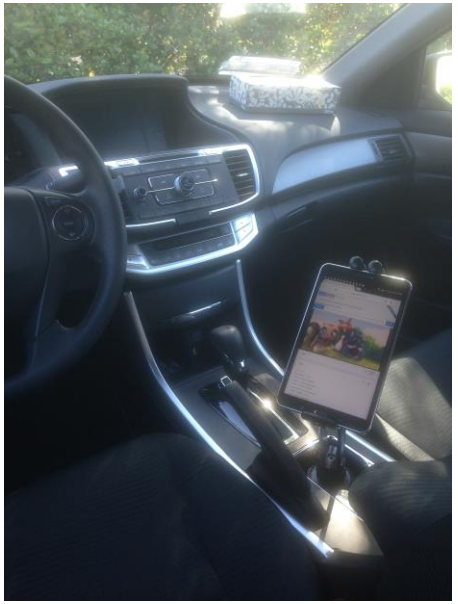
Experimental Results

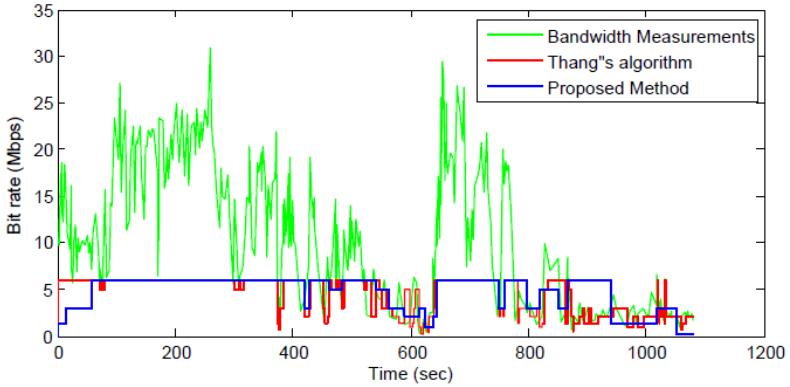
- Implemented the DASH client on a Galaxy tablet
- Tested on two routes: CA 56, Mira Mesa Blvd.



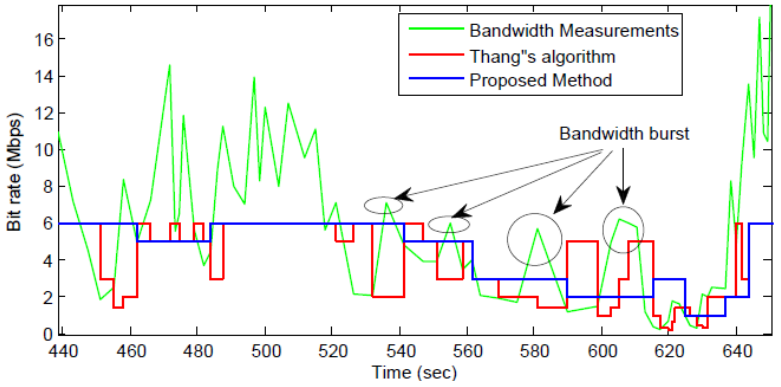


Experimental Results

- Compared to Thang's algorithm, our solution offers
  - More stable bit rate
  - Higher average bit rate



(a) Video bit rates for the whole trip



(b) Video bit rates from 450 sec to 650 sec

Thang's algorithm: T. Thang, Q. Ho, J. Kang, and A. Pham, "Adaptive streaming of audiovisual content using MPEG DASH," IEEE Transactions on Consumer Electronics, vol. 58, no.1, pp. 78-85, Feb., 2012.

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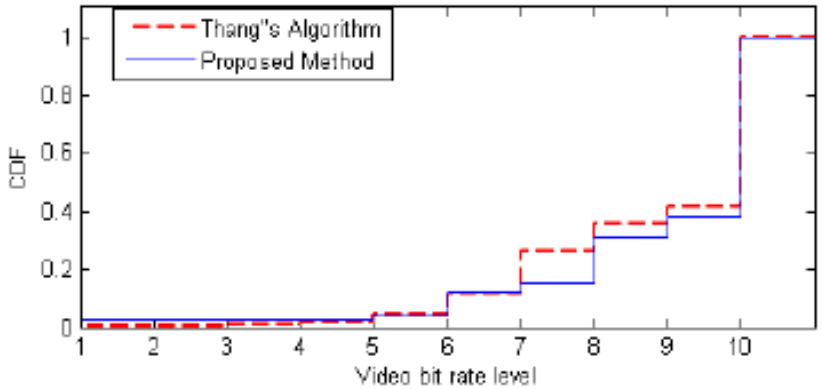

The CDFs of the video bit rates

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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!