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Joint work with Mahbub Hassan, Salil Kanhere, Jun Yao and Garson Zhong

Outline

Why we need such dataset? (Example of use)

Our data collection campaigns

- Bandwidth measurement application
- Data format



Mobile Data Tsunami

Global Mobile Data Traffic Growth / Top-Line Global Mobile Data Traffic will Increase 10-Fold from 2014-2019



1 EB = 1000⁶ bytes = 10¹⁸ bytes = 1 000 000 000 000 000 000 B = 1000 petabytes = 1 million terabytes = 1 billion gigabytes.



Global Mobile Data Traffic Drivers



...... CISCO

Source: Cisco VNI Global Mobile Data Traffic Forecast, 2014-2019



Mobile Video Expected to Dominate



Figures in parentheses refer to 2014, 2019 traffic share. Source: Cisco VNI Mobile, 2015



what's the Problem?



Bandwidth Variability in Vehicular Environment

Mobile bandwidth fluctuates rapidly and significantly while in motion



Simple reactive techniques may not result in the best QoE for the users

J. Yao, S. Kanhere and M. Hassan, "*An Empirical Study of Bandwidth Predictability in Mobile Computing*", WiNTECH'08 (in ACM MOBICOM 2008), San Francisco, Sep 2008.



Our Solution





Environment Model





Higher QoE using Bandwidth Dataset

Comparing MDP vs. non-MDP-based DASH players



Comparison between MDP and non-MDP algorithms. MDP significantly outperforms non-MDP algorithm by achieving less DM for the same AQ. Testing trips: 66-71, (a) Big Buck Bunny, (b) Different video clips: 1- Elephant Dream, 2- Of Forest and Men, 2- The Swiss Account, 4- Valkaama

Bokani, A., Hassan, M., Kanhere, S. and Zhu, X., 2015. Optimizing HTTP-Based Adaptive Streaming in Vehicular Environment Using Markov Decision Process. *IEEE Transactions on Multimedia*, *17(12)*, *pp.2297-2309*.



Bandwidth Statistics



Bandwidth Measurement Application

A user friendly Android application:

Measure and store the downstream bandwidth characteristics

from any given network

by actively downloading a 1MB file from UNSW-CSE web server using the HTTP protocol







Bandwidth Measurement Campaigns

Using two Android smartphones to perform the bandwidth measurements for 3G and 4G simultaneously

Bandwidth measurements in different day and night times





Bandwidth Measurement Campaigns

Version 1 (3G - 2008)

Sampling rate: 10 Sec 71 traces (~30 minutes) 24 Km route, Sydney, Australia



Version 2 (3G \$ 4G - 2015)

Sampling rate: 10 & 15 Sec 72 traces (~15 minutes) 4.7 Km route, Sydney, Australia





Each sample is time and location stamped

- ~180 samples per trace for ~30min drive for each trip
- ~ 56,754 samples in total from all 71 traces/trips for 3 providers

| | time | latitude | longitude | bandwidth (Kbps) |
|---|-----------------------|------------|------------|------------------|
| 1 | 1186549400 | -33.919785 | 151.228913 | 1663.1440 |
| 2 | 1186549410 | -33.919635 | 151.227787 | 1964.7330 |
| 3 | 1186549420 | -33.91958 | 151.227322 | 2038.8659 |
| 4 | 1186549430 | -33.91958 | 151.227322 | 2011.2631 |
| 5 | 1186549440 | -33.91953 | 151.22692 | 1838.6578 |
| 6 | 1186549450 | -33.91905 | 151.226322 | 1208.2767 |

Example of 6 probes within a specific trip for Provider A



Bandwidth Dataset 2

sampling time, file size, download duration and time, geographical coordinates before and after file download, network operator's information and country name

| Ρ | 4G | DEV | DEV V | | | | | 🕸 Core 🕀 | Analytics 📫 F | Push 🌞 Settin | gs 🤝 Docs |
|----------|-------------|-----|-----------------|------------------|---------|------------------|-----------|---------------|---------------|----------------|--------------|
| = | | | | | | | | | | | |
| Role 0 | | | ObjectId String | dateTime String | dlDurat | dlRate Number | dlSize Nu | endLat Number | endLon Number | lat Number | lon Number |
| 👥 User 0 | | | zbVrxysBy9 | 25/03/2015 4:28: | 4.678 | 1751.17571611799 | 8388608 | -33.90053715 | 151.21260207 | -33.90053715 | 151.21260207 |
| B\ | NData 5.68K | | puQW27iMie | 25/03/2015 4:28: | 6.447 | 1270.66852799751 | 8388608 | -33.90028676 | 151.21115862 | -33.90028676 | 151.21115862 |
| | | | V0t49QdUb6 | 25/03/2015 4:28: | 3.352 | 2443.91408114558 | 8388608 | -33.90031307 | 151.21019493 | -33.90031307 | 151.21019493 |
| | + Add Class | | 1ahaTg4bmR | 25/03/2015 4:29: | 4.31 | 1900.69605568445 | 8388608 | -33.90076942 | 151.20940256 | -33.90076942 | 151.20940256 |
| \sim | | | 17SPUØMbbH | 25/03/2015 4:29: | 3.283 | 2495.27870849832 | 8388608 | -33.90055439 | 151.20843894 | -33.90055439 | 151.20843894 |
| | | | swdL0pCFvv | 25/03/2015 4:29: | 4.099 | 1998.53622834837 | 8388608 | -33.90042723 | 151.20722048 | -33.90042723 | 151.20722048 |
| Ð | Cloud Code | | YRSKGD9Rzx | 25/03/2015 4:29: | 1.637 | 5004.27611484422 | 8388608 | -33.90036591 | 151.20689125 | -33.90036591 | 151.20689125 |
| | | | Hq3JWKM3tw | 25/03/2015 4:29: | 3.688 | 2221.25813449023 | 8388608 | -33.90033033 | 151.20685722 | -33.90033033 | 151.20685722 |
| - K | VVEDNOOKS | | WK1hBZ4fnp | 25/03/2015 4:29: | 3.715 | 2205.11440107671 | 8388608 | -33.90024975 | 151.20643127 | -33.90024975 | 151.20643127 |
| Ģ | Jobs | | 6eilHyaTXX | 25/03/2015 4:30: | 3.524 | 2324.63110102156 | 8388608 | -33.90027294 | 151.2064814 | -33.90027294 | 151.2064814 |
| | | | zzH08fNnmj | 25/03/2015 4:30: | 6.618 | 1237.83620429132 | 8388608 | -33.90027294 | 151.2064814 | -33.90027294 | 151.2064814 |
| ÷ | Logs | | JBb0R8jXmi | 25/03/2015 4:30: | 8.752 | 936.014625228519 | 8388608 | -33.9004978 | 151.2052956 | -33.9004978 | 151.2052956 |
| ¢ | Config | | TvYaeuuUDv | 25/03/2015 4:30: | 3.678 | 2227.29744426318 | 8388608 | -33.90075069 | 151.20431568 | -33.90075069 | 151.20431568 |
| | | | GcrIxbr9S8 | 25/03/2015 4:30: | 4.064 | 2015.74803149606 | 8388608 | -33.90097693 | 151.20356331 | -33.90097693 | 151.20356331 |
| ţ↓ | API Console | | aC77cDVjLq | 25/03/2015 4:30: | 3.861 | 2121.73012173012 | 8388608 | -33.9009854 | 151.20350849 | -33.9009854 | 151.20350849 |
| | | | f8WivUcLhr | 25/03/2015 4:31: | 3.001 | 2729.75674775075 | 8388608 | -33.9009854 | 151.20350849 | -33.9009854 | 151.20350849 |
| | | | nGGaWSejKU | 25/03/2015 4:31: | 3.037 | 2697.39874876522 | 8388608 | -33.90098287 | 151.20344811 | -33.90098287 | 151.20344811 |
| | | | vX0daYbhmt | 25/03/2015 4:31: | 3.618 | 2264.23438363736 | 8388608 | -33.90093569 | 151.2034579 | -33.90093569 | 151.2034579 |
| | | | aSqYpLRx5h | 25/03/2015 4:31: | 2.506 | 3268.95450917797 | 8388608 | -33.90093569 | 151.2034579 | -33.90093569 | 151.2034579 |
| | | | 4HXhHPtjw7 | 25/03/2015 4:31: | 3.78 | 2167.19576719576 | 8388608 | -33.90093569 | 151.2034579 | -33.90093569 | 151.2034579 |



Thank You

Any Questions?

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