Geo-location-aware Emulations for Performance Evaluation of Mobile Applications

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LiU EXPANDING REALITY

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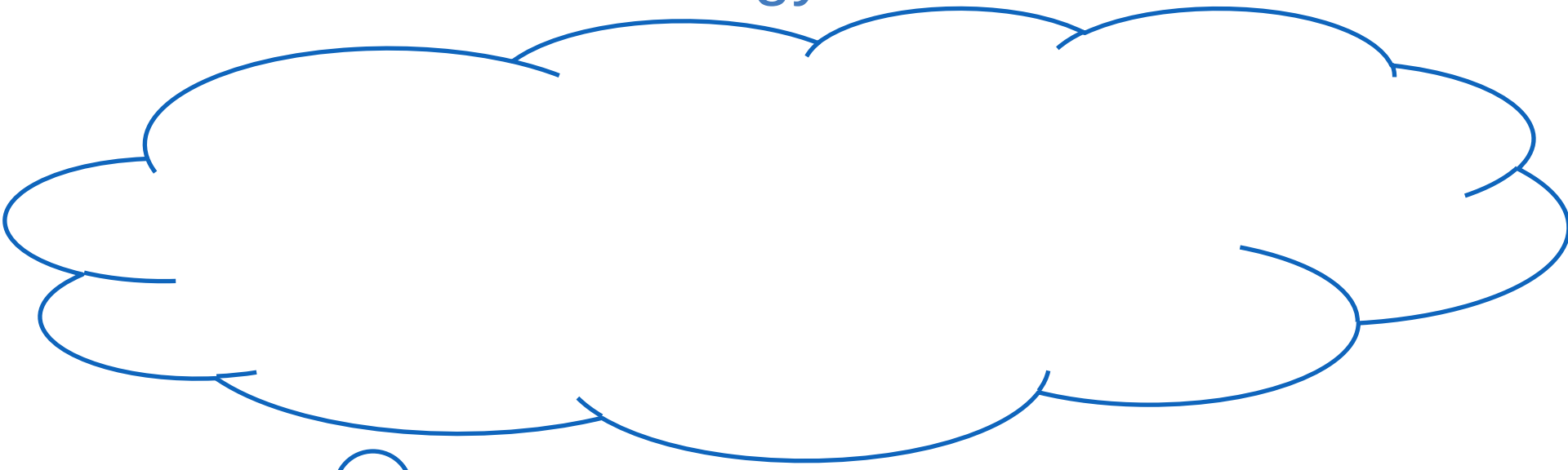
Customized service

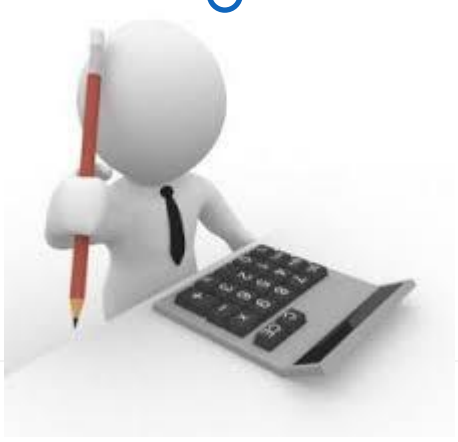
- Access to Internet everywhere
  - Wireless connectivity
- Increasingly mobile users
  - Smart phones and tablets
  - Connected (close to) all the time
- Powerful customized applications
  - Location-aware app
  - Customized services based on location

Evaluation methodology

- New emerging location-based services and applications for mobile users
- Many alternative implementations
- Need fair evaluation methodology

Evaluation methodology





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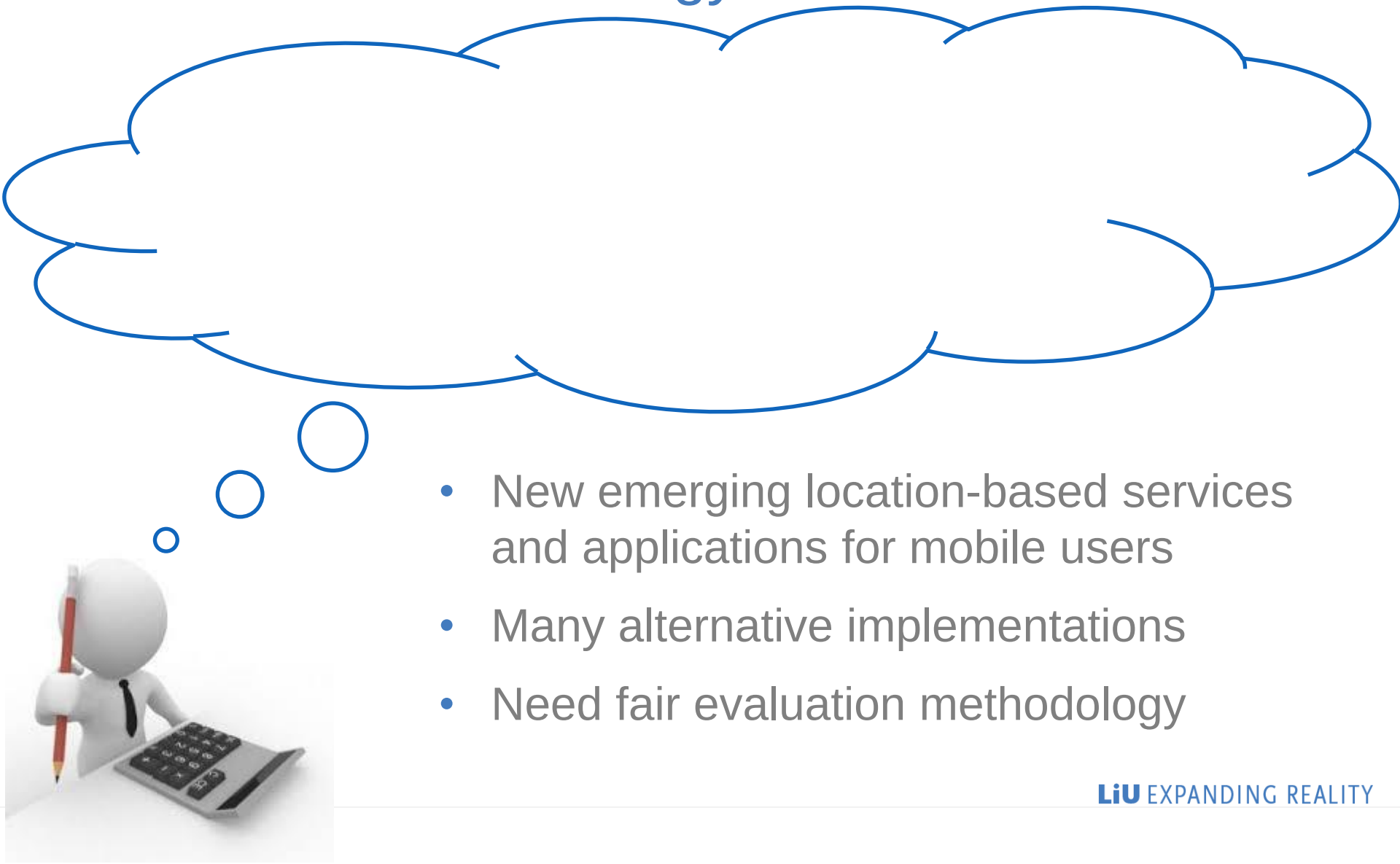

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Evaluation methodology

- Fair head-to-head comparisons …

  …. under realistic scenarios
- Repeatable experiments
- Quick and low price

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- Many alternative implementations
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Evaluation Methodology

Approach	Comment	Choice
Field tests		
Modeling Simulations		
Emulation		

Evaluation Methodology

Approach	Comment	Choice
Field tests	Expensive and does not allow repeatable experiments	✗
Modeling Simulations		
Emulation		

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Emulation	Relatively cheap, real hardware, but we still need methodology for repeatable location-based evaluation …	✓

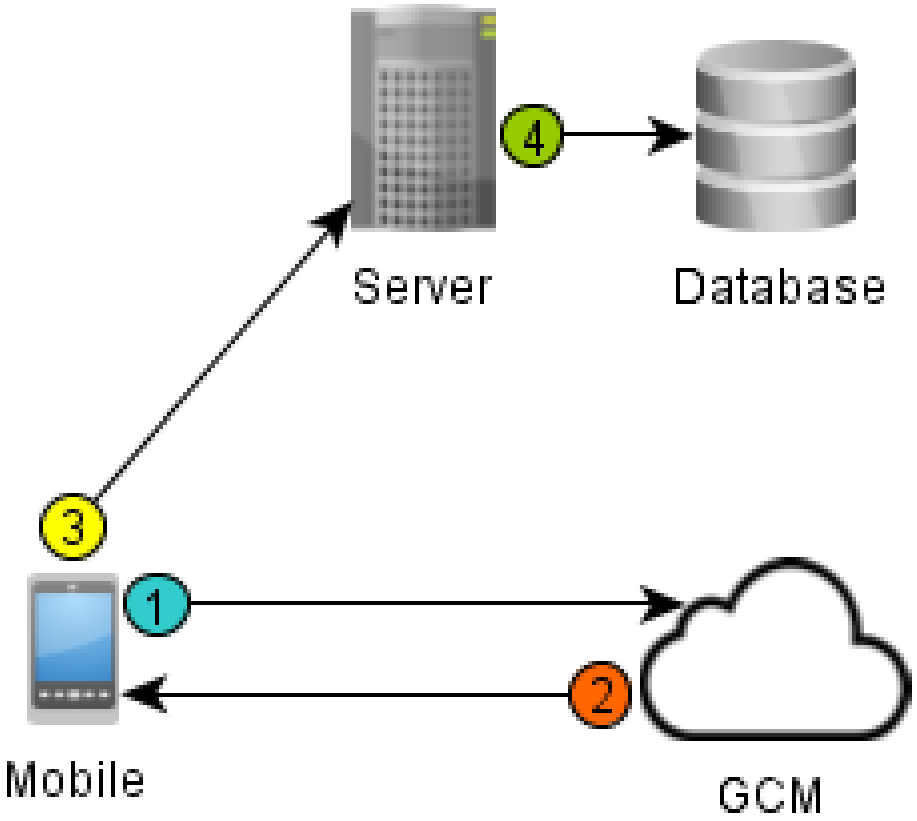
… develop simple methodology that allow …

- *Repeatable experiments: Allow head-to-head comparison*
- *Quick and low price: Can be done in-house*
- *Realistic scenarios: Use of real mobility patterns and network conditions*

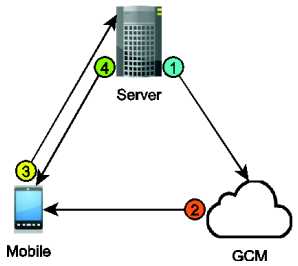
Example application

- Location-aware download scheduler based on notification service
  - Google Cloud Messaging (GCM)
- Mobile app
  - HTC wildfire with Android
  - Wi-Fi and location service (GPS and network)
- Application server
  - PHP + MySql
  - Notifications, network conditions

Example application

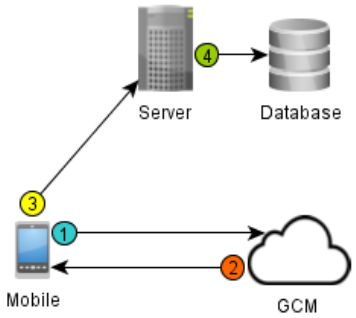


Registration



Notifications

Example application



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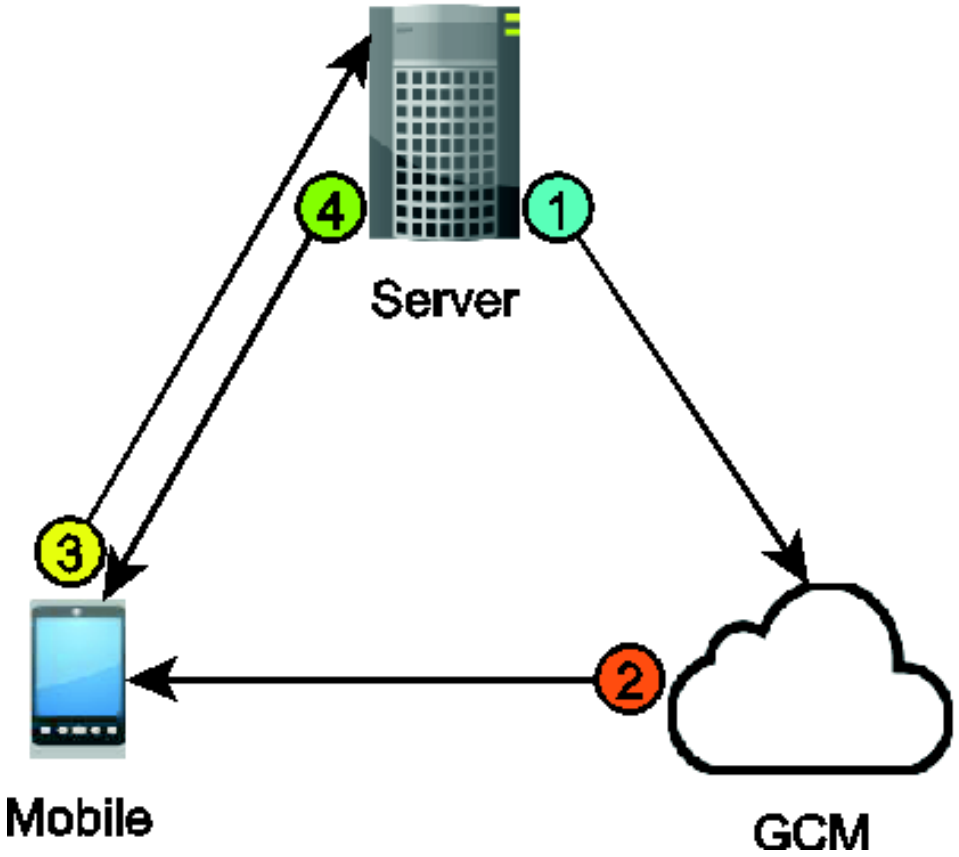

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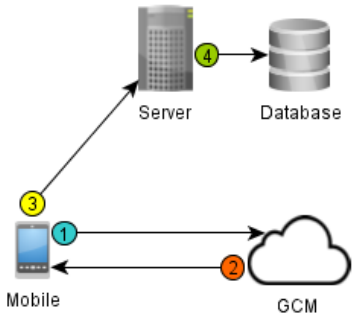

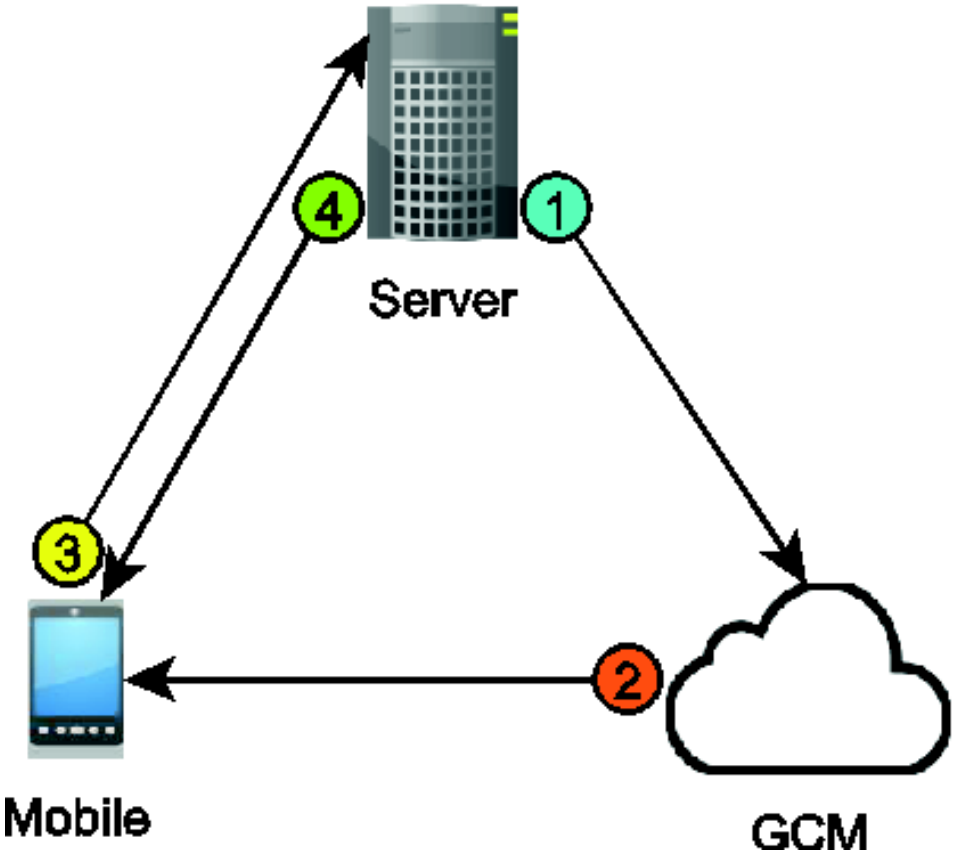

1. The server sends a notification to GCM
2. GCM notifies the mobile that an update is available
3. The mobile requests the update
4. The server sends the update

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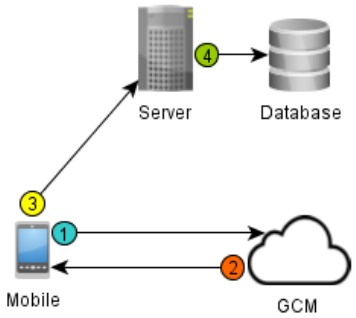

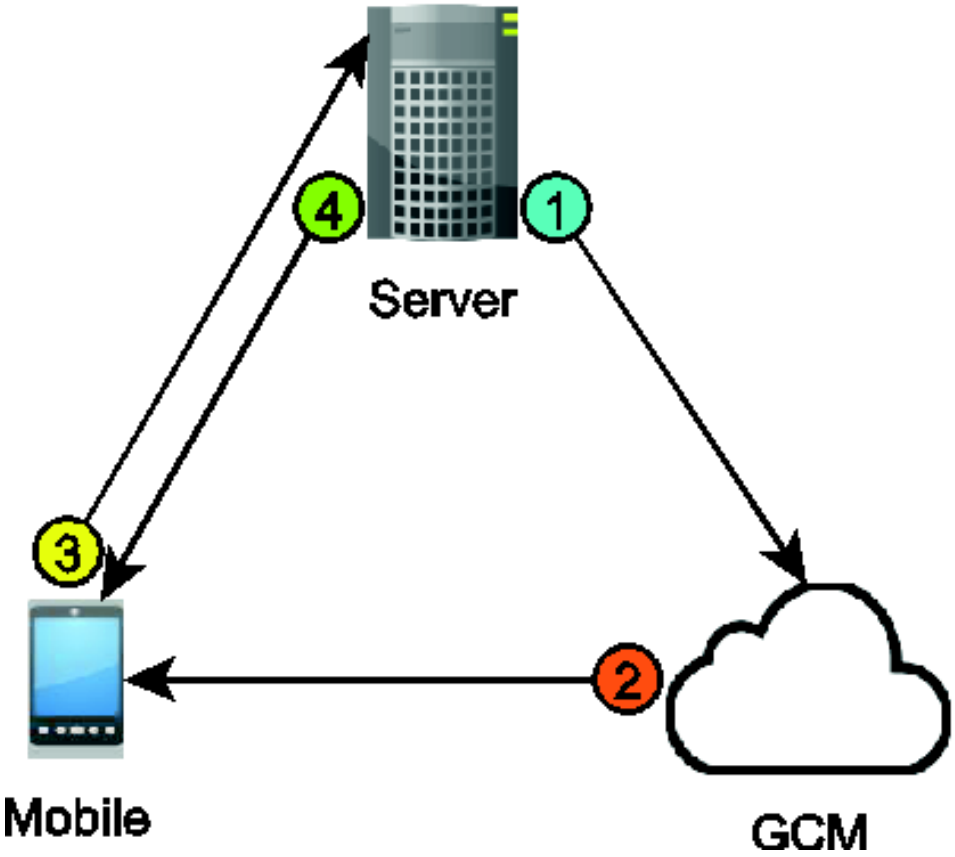

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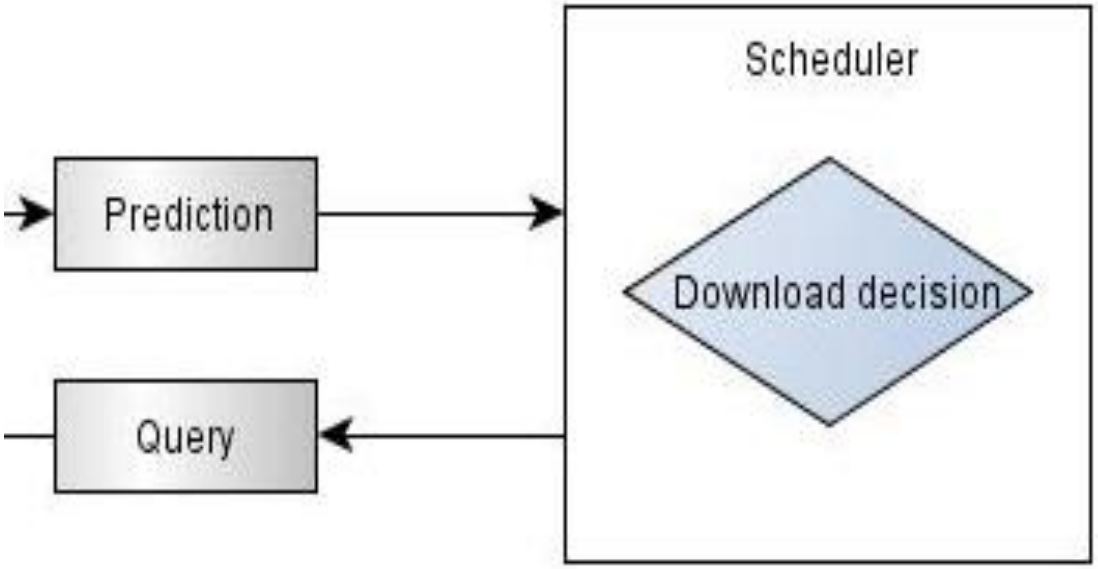
GeoSmart Scheduler

-- Design and Proof-of-concept Implementation

Performance Network Map + Smart Scheduler



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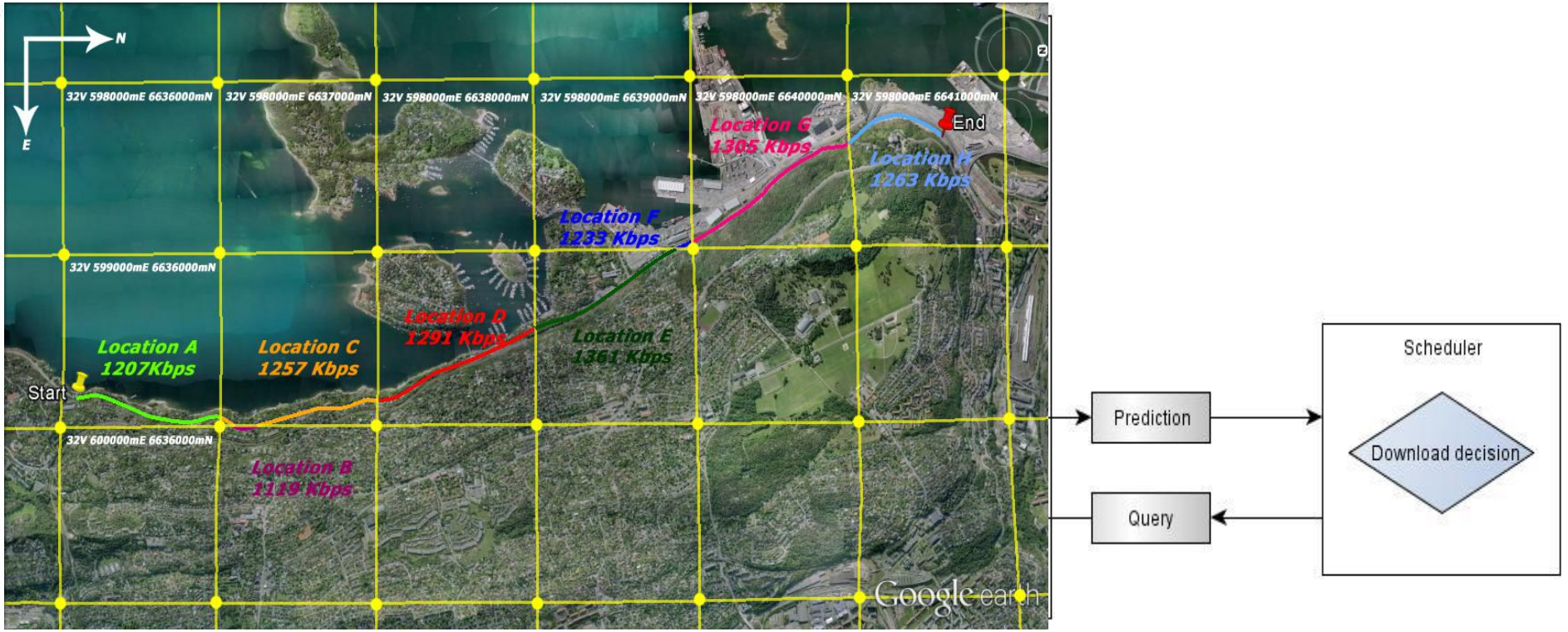


Performance Network Map

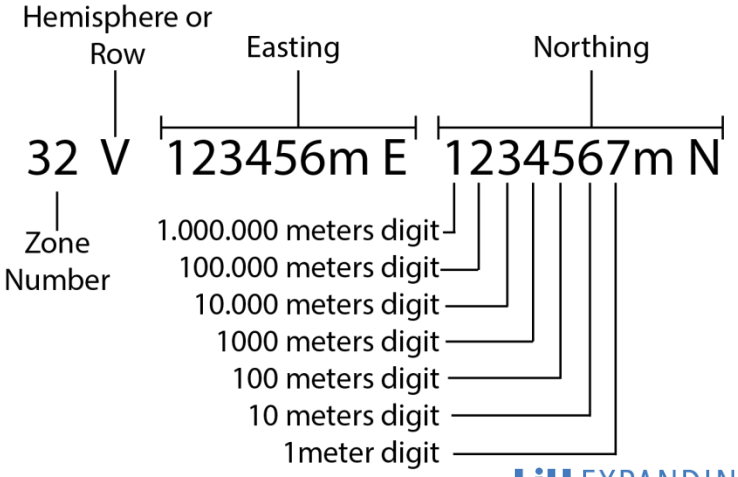
Throughput-location pairs

- HTTP throughput prediction

1. Passively measure throughput when data is downloaded
2. Update prediction using EWMA

- UTM location:

1. Obtain location in latitude/longitude when data is downloaded
2. Convert location to UTM coordinates



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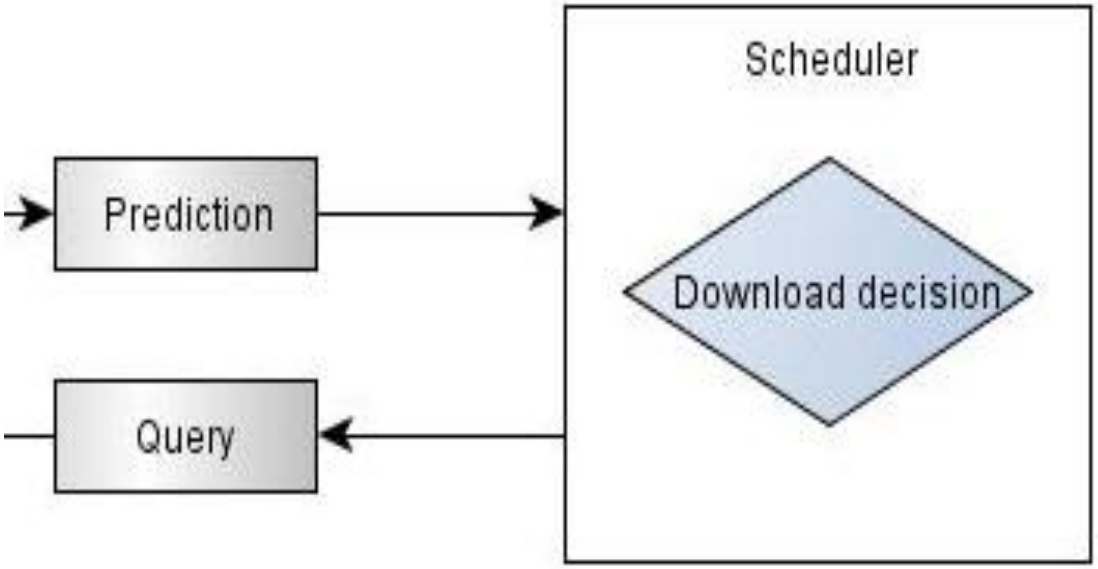
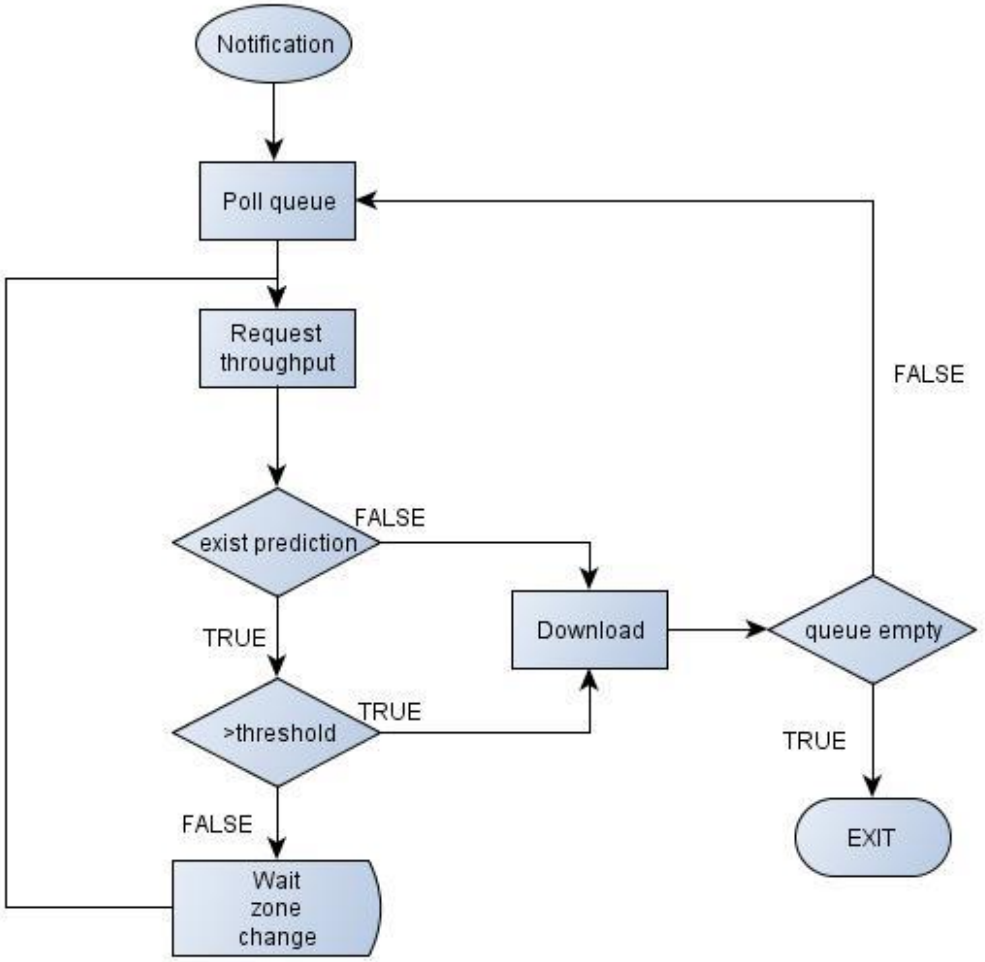


GeoSmart Scheduler

Basic implementation

- *FIFO Notifications queue using*
- *Threshold based on average path throughput*



Evaluation and results

TRACE-BASED EMULATION EVALUATION

Trace-driven emulation

- *Client location and bandwidth conditions*
  - *Traces obtained from dataset of real measurements*
    - *E.g., commuter traces: bus, ferry, car, train, etc.*
    - *(i) Timestamp, (ii) Latitude/longitude, and (iii) bandwidth*
  - *Location mocking using Android API features*
    - *Create test location service*
  - *Network conditions emulated with Dummynet*

- Server-driven workload
  - Traces collected using Twitter API
    - E.g., rate of 3 to 12 notifications per minute
    - (i) time stamp and (ii) unique ID

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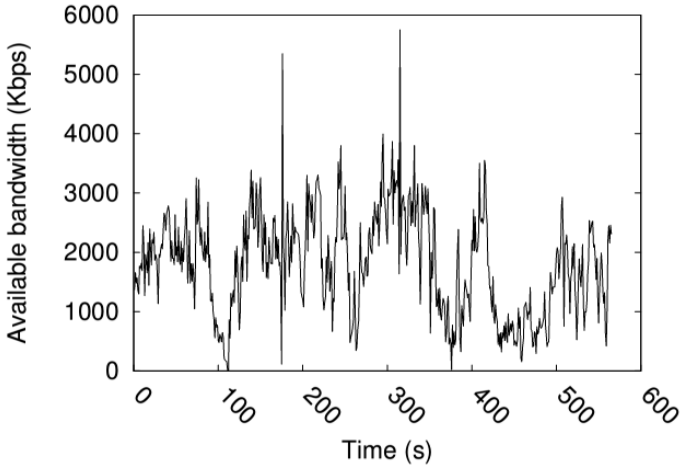
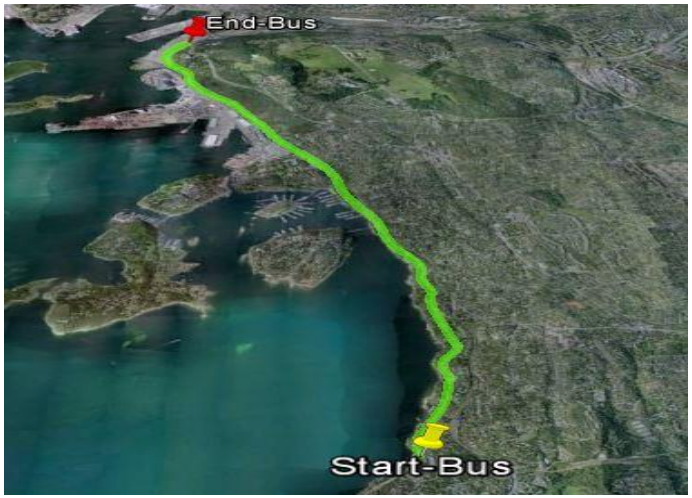
Bandwidth, location, and and workload traces

Bus scenario





H. Riiser, P. Vigmostad, C. Griwodz, and P. Halvorsen, "Commute path bandwidth traces from 3g networks: Analysis and applications," in Proc. ACM MMSys, Feb/Mar. 2013.

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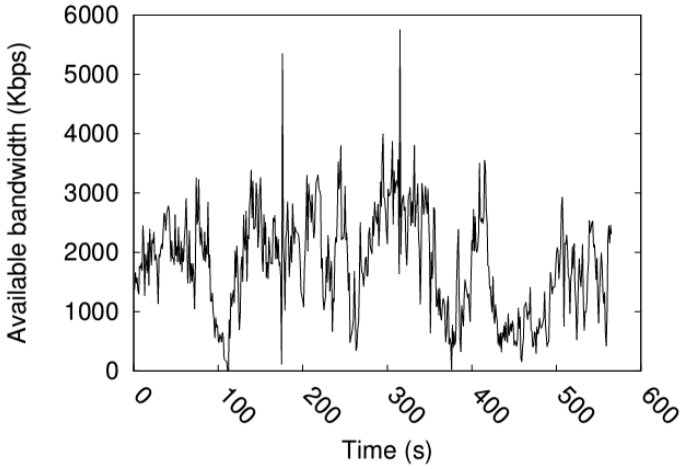
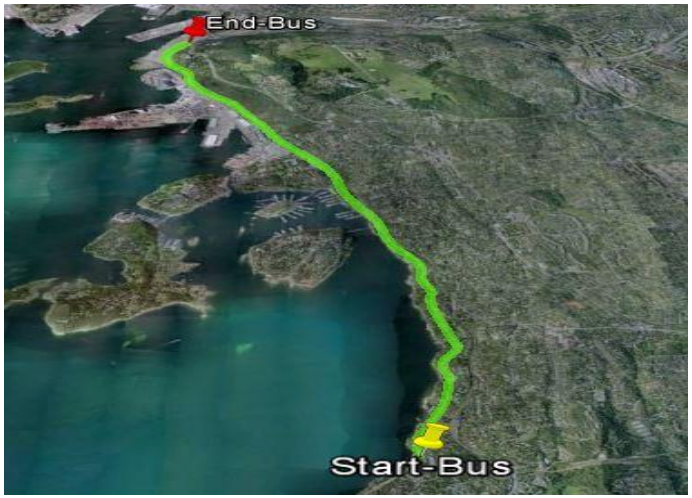
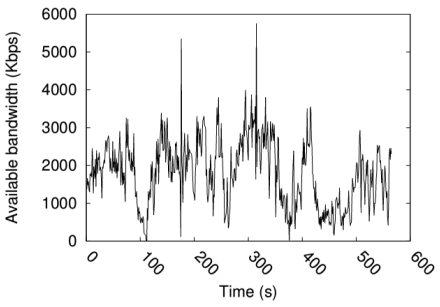
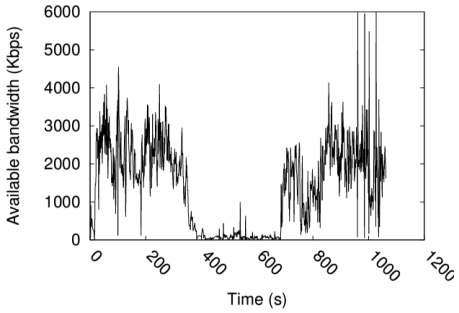


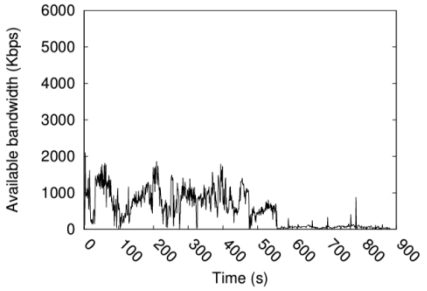




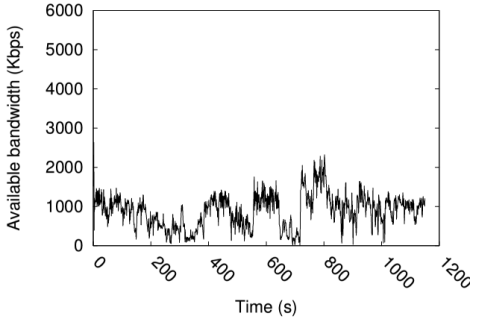
(a) Bus



(b) Ferry



(c) Metro



(d) Tram

Bandwidth, location, and and workload traces

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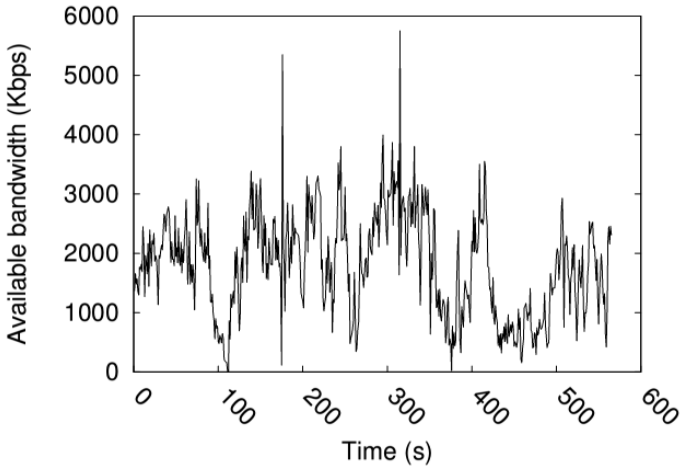
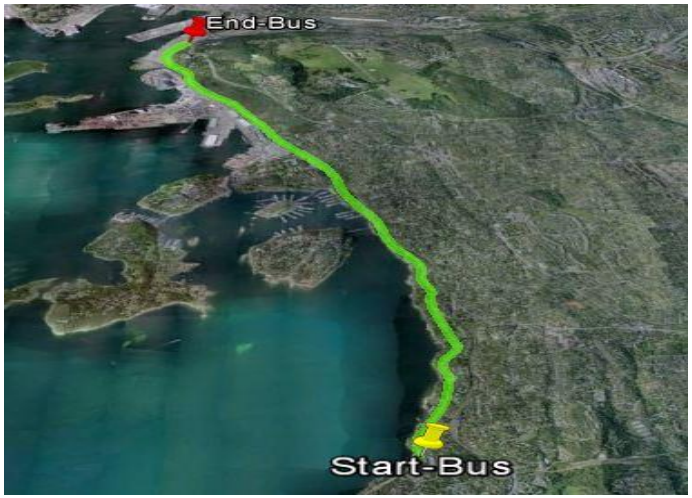
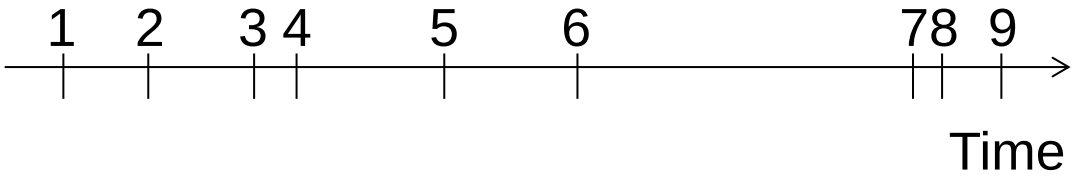




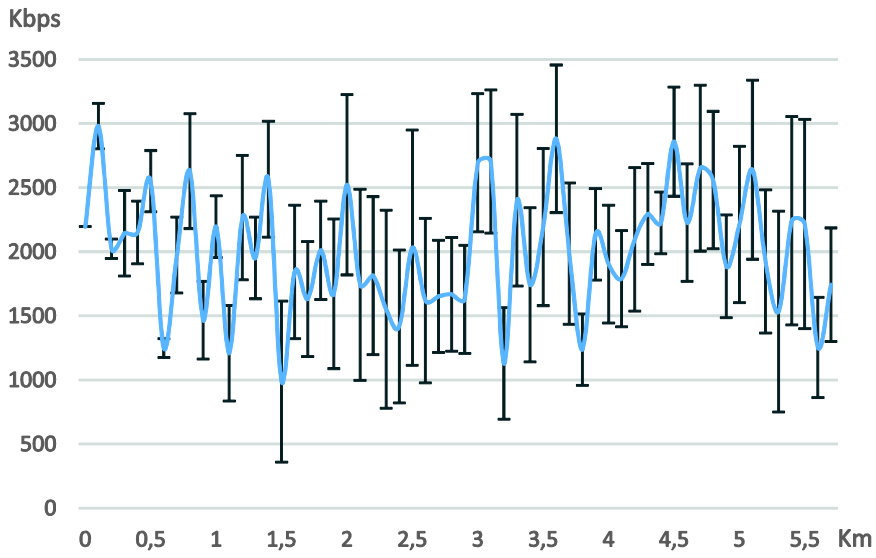
Notification traces …

#topicX

#topicY



Naive download speeds



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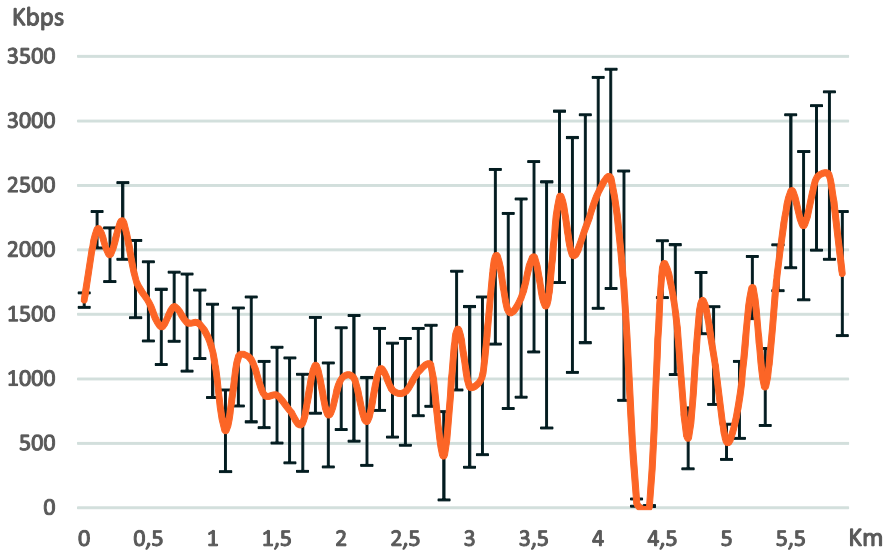
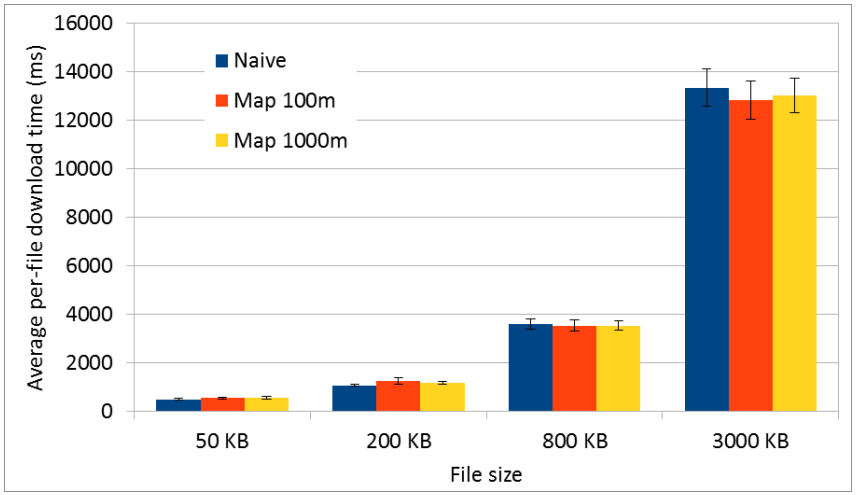


Ferry scenario

Sample file size 100KB

GeoSmart Scheduler Results

- Example measure: Average download time
  - Three (3) alternative approaches (or grid sizes)
  - Four (4) alternative file sizes



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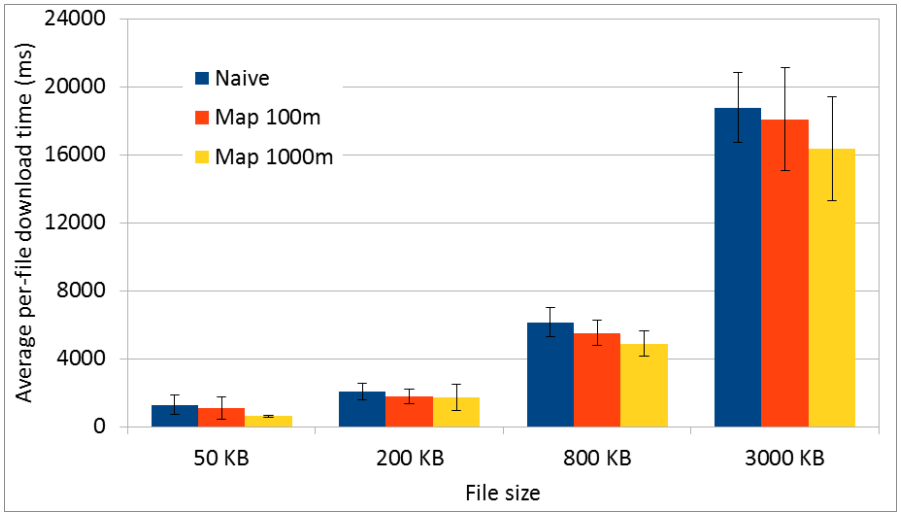

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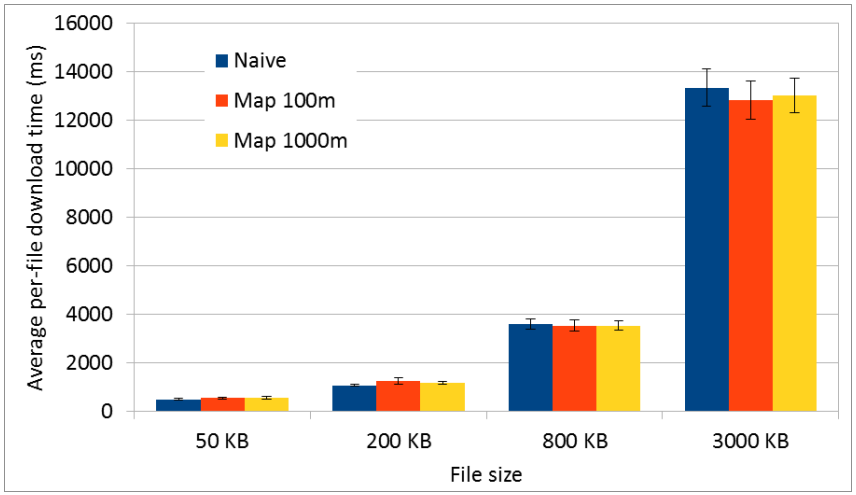

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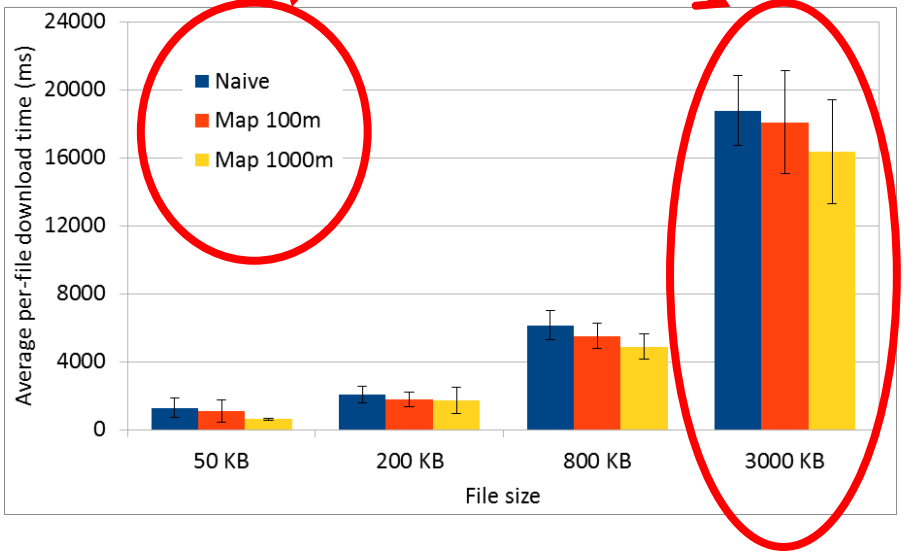

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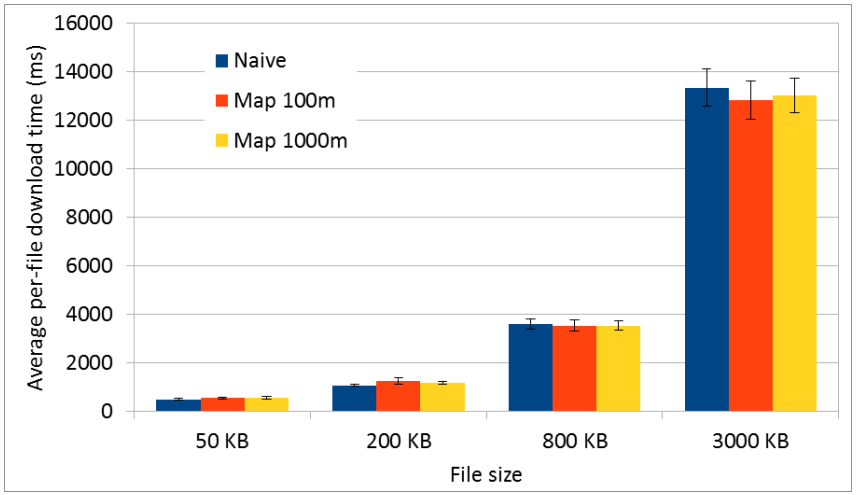

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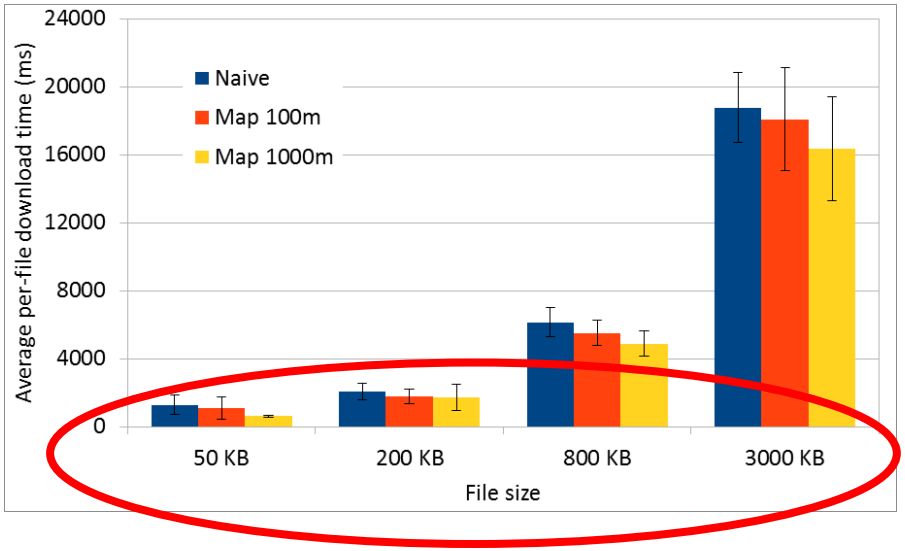

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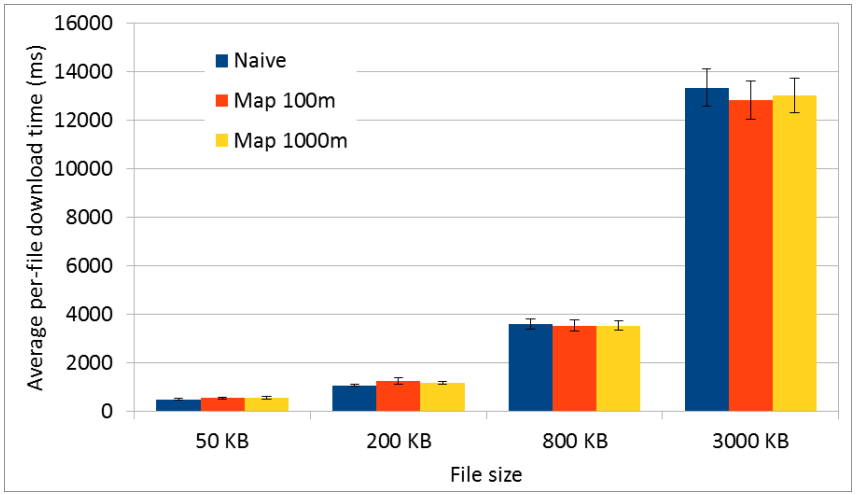
GeoSmart Scheduler Results

- Relatively small improvements (e.g, 10-20%)



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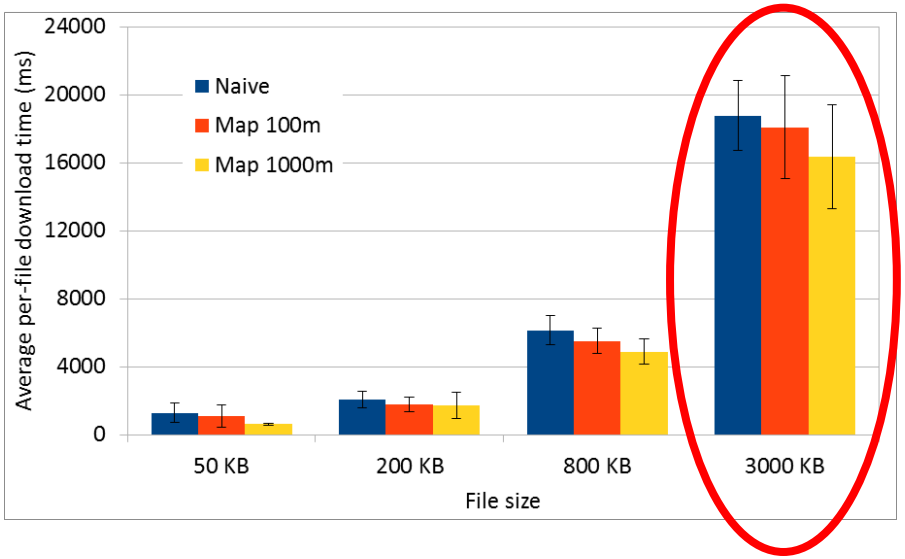

Ferry scenario

GeoSmart Scheduler Results

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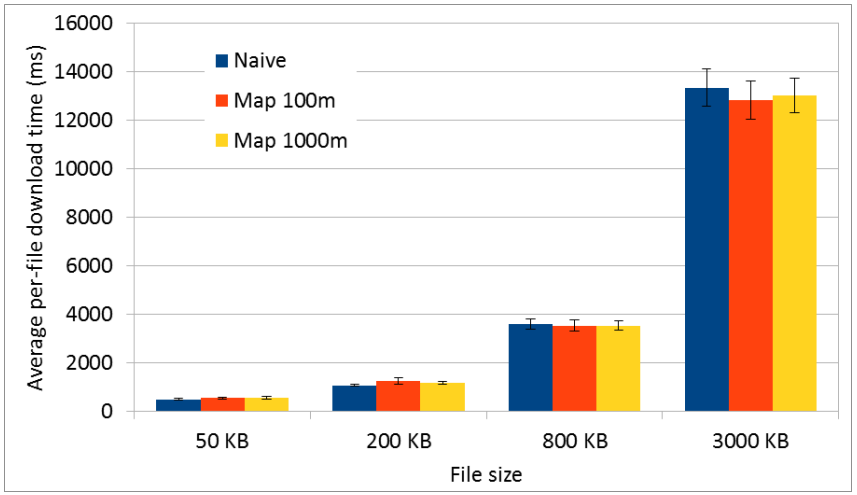
- Better improvements in scenarios with significant location differences in network performance



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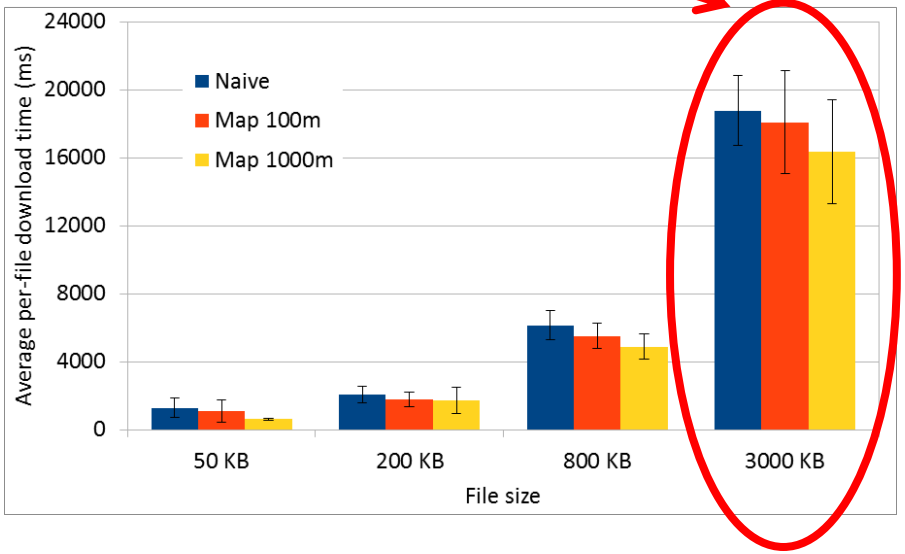

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Conclusions

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  - Real hardware and realistic mobile scenarios
  - Repeatable experiments
  - Relatively low cost
- Regards to our proof-of-concept implementation
  - GeoSmart scheduler perform better in scenarios with significant location differences in network performance
  - Limited accuracy of EWMA estimator for HTTP throughput
  - Choose correct resolution is important
- Future work will consider
  - Higher order stochastic models for estimation, adaptive map resolution (e.g., based on speed of user) with richer information (e.g., based on network data technology)

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Software: *www.ida.liu.se/~nikca/papers/wons14.html*

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