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

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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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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

<table>
<thead>
<tr>
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... 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

Registration

Notifications
Example application

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
Example application

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2. GCM notifies the mobile that an update is available
3. The mobile requests the update [**geoSmart Scheduler**]
4. The server sends the update
GeoSmart Scheduler

-- Design and Proof-of-concept Implementation

Performance Network Map + Smart Scheduler
GeoSmart Scheduler
-- Design and Proof-of-concept Implementation

Performance Network Map + Smart Scheduler
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
GeoSmart Scheduler

-- Design and Proof-of-concept Implementation

Performance Network Map + Smart Scheduler
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
Trace-driven emulation

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Bandwidth, location, and workload traces

Bus scenario

Bandwidth, location, and workload traces

Bus scenario

(a) Bus
(b) Ferry
(c) Metro
(d) Tram
Bandwidth, location, and workload traces

Bus scenario

Notification traces …

#topicX

#topicY
Naive download speeds

Bus scenario

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

Bus scenario

Ferry scenario
GeoSmart Scheduler Results

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Bus scenario

Ferry scenario
GeoSmart Scheduler Results

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

Bus scenario

Ferry scenario
GeoSmart Scheduler Results

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

Bus scenario

Ferry scenario
Conclusions

• Our emulation framework provides fair-head-to-head protocol/service comparisons
  • 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