Mobilyzer: An Open Platform for Controllable Mobile Network Measurement

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*Based on the authors’ slides
Mobile apps are increasingly popular

- Mobile platforms is the dominant mode for data access
- Mobile network performance suffers from performance and reliability problems.
We need measurements

- When YouTube hangs, is it
  - A slow device?
  - Weak signal?
  - Contention for bandwidth?
  - ISP shaping?
  - Load on network?
  - Bad server?

- A lack of visibility

- Key challenge: Need extensive network measurements to perform root cause analysis
Strawman: There’s an app for that

• Unscalable
• Inconsistent and inflexible
• Uncoordinated
Mobilyzer: Multiple Apps, One Library

[Diagram of various icons related to speed tests and data analysis]
Mobilyzer overview

- An app library
- A local measurement scheduler
- A cloud-based global manager
Measurement Library and API

- API for issuing/controlling measurements and gathering the results
  - With less than 10 LoC
- Measurements supported

A set of measurement primitives:
  » Executable in sequence or parallel
  » Predictable in data and energy
Measurement Library and API

- Supports three type of measurements
  - Primitive (Basic):
    - DNS lookups, ping, traceroute, HTTP GET, TCP throughput, and UDP burst
  - Complex:
    - RRC timer inference, Video QoE, and Page load time
  - Composed:
    - Sequential and Parallel
Composed Tasks: simple diagnosis task
Triggered traceroute for high ping RTT destinations

```
run ping
if
  ping.rtt>100ms &
  rssi>50 &
  nettype==LTE
then
  run traceroute
```
Local Measurement Scheduler

- One task is executed at a time
- Supports task priority
- Eliminates redundant tasks
- Enforces user specified resource constraints
- Uses /proc to check background traffic and discard impacted measurements
Local Measurement Scheduler

Ping measurements are significantly affected by cross traffic.
Global Manager

1. Data collection
2. Measurement task scheduling
3. Fairness enforcement
4. Availability prediction
Global Manager Use Example

- Dynamic scheduling to differentiate between location, internet, and server side problems.
Security and Privacy

- **DDos**
- **Limit targeted measurements**
- **Resource Drain**
- **Subverting the control channel**
- **Subverting the controller**
- **HTTPS**
- **Google Account Authentication**

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- **Privacy**
  - ✓ Require explicit user consent
  - ✓ All user information are stripped from the data

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All user information are stripped from the data
Evaluation of Mobilyzer Overhead

<table>
<thead>
<tr>
<th>Overhead Item</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduling delay</td>
<td>~20ms</td>
</tr>
<tr>
<td>Consumed energy</td>
<td>5% (with a 250 MB monthly measurement quota)</td>
</tr>
<tr>
<td>Data cap enforcement error</td>
<td>6%</td>
</tr>
</tbody>
</table>
Web Browsing Measurement Support

- Crowd-sourced measurements of mobile web page performance:
  - PLT (Page Load Time) and PIT (Page Interactive Time)
    - Navigation Timing API (W3C standard)
  - Network vs. computation time
    - Combining resource timing data with Wprof [1] based dependency graphs for PLT analysis

Page Load Time Measurement

- Mobile CPUs can be a significant bottleneck

By doubling the CPU frequency, computation time is reduced by half.
Video QoE Measurement

- Crowd-sourced measurements of video QoE in mobile:
  - Rebuffering
  - Video bit rate

- Compare Capacity Based Adaptive (CBA) with Buffer Based Adaptive (BBA)[1] streaming algorithms

Video QoE Measurement

- BBA algorithm outperforms CBA

Higher bitrate for BBA

Lower rebuffering rate for BBA
Incentive for Adoption

• “Bring your own app” deployment model
• Researchers
  – Access to resources based on contribution
• App developers
  – Reduced operational cost
  – Reduced coding/debugging effort
• Device owners
  – Verify carrier SLAs
  – Compare with data from other devices
Summary

- Mobilyzer: a mobile network measurement platform that provides
  - Easy-to-use API for flexible measurement
  - Network isolation
  - Dynamic scheduling based on global view
The next app comes from you

- Mobilyzer is open source
- Apps currently using Mobilyzer:
  - Mobiperf
  - MySpeedTest
  - MCoverage (alpha)
  - You?
- Data is anonymized and publicly accessible online
  - [http://mobilyzer-project.mobi](http://mobilyzer-project.mobi)
  - [info@mobilyzer-project.mobi](mailto:info@mobilyzer-project.mobi)