**Mobilyzer**: Mobile Measurement Library Support for Principled Mobile QoE Characterization

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Mobile apps are increasingly popular

- Dominant mode for data access is **mobile**
- Mobile **networks** suffer from *performance* and *reliability* problems

[Images of Facebook and Youtube with error messages: Facebook: no Internet connection, Youtube: rebuffering]
We need measurements

- When YouTube hangs, is it
  - A slow device?
  - Weak signal?
  - Contention for bandwidth?
  - ISP traffic shaping?
  - Load on network?
  - Bad server?
- There is a lack of visibility
- **Key challenge:** Need extensive network measurements to support root cause analysis.
Strawman: There's an app for that

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

Mobilyzer library
Balancing Safety and Flexibility

- Measurements supported
  - Executable in sequence or parallel
  - Predictable in data and energy

- API: issue measurements, collect results
  - Fewer than 10 LoC to invoke the API
Flexibility Through Task Composition

Composed Tasks: simple diagnosis task
Trigger \texttt{traceroute} probing for high ping RTT destinations

\begin{verbatim}
run ping
if ping.rtt > median_rtt+std_rtt
    && signal_strength == strong
then
    run traceroute
\end{verbatim}

Sequential Task

\begin{itemize}
\item Task 1
    \begin{itemize}
    \item ping
    \end{itemize}
\item pre-cond
\item Task 2
    \begin{itemize}
    \item traceroute
    \end{itemize}
\end{itemize}
Coordinating Across Devices

1. Measurement task scheduling
2. Data collection
3. Resources management
Coordination Enables Diagnosis

Dynamic measurement scheduling: location, Internet, and/or server problems?
Context Aware Measurements

• Trigger measurements only when necessary, using device context.
  – Use case: performance impact of *handovers* between cells

![Graph showing overhead and accuracy comparison between threshold-based and periodic measurement methods.](image-url)
Context Aware Measurements

• Schedule measurements based on device context.
  – Use case: censorship measurements
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

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

Who is using *Mobilyzer*?

- Mobiperf
- MySpeedTest (Princeton)
  - Censorship measurements
  - Performance measurements
- MCoverage (University of Michigan ITS)
  - Understanding WiFi/Cellular coverage in Campus
- You?
Future Plans for Improvement

• Extending the set of primitive and complex measurements:
  – IPv6 Experiments
  – D2D Connectivity and Performance
  – Network Policy Inference
  – CDN Measurements

• Providing a query based interface
  – Converting the query to measurement tasks that can be scheduled on the devices
  – Predicting performance from historical data
Feedback from Community

• *Mobilyzer* is open source
• Data is anonymized and publicly accessible online
  
  http://mobilyzer-project.mobi
  info@mobilyzer-project.mobi

• More details: