NetMap - Network Performance Measurements

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ABSTRACT

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We introduce a platform for measuring wireless Internet access performance across the world's cellular and WiFi networks. Our platform consists of a library for collecting network performance measurements on Android devices, a pipeline for storing and processing the performance measurements, and tools and sample code for accelerating the development of location-based mobile games that contribute peformance measurements to our project. We plan to develop one such game, and release it for free on the Android market. Players pay for the by game by implicitly allowing us to use their phone to measure network performance. We also opened up and documented our platform, hoping to influence other (more talented) game developers to build games on top of our platform.

2. INTRODUCTION

Recent years have seen an immense growth in the number of wireless devices in use. Functionality of these devices has similarly evolved as one can find a mobile application for just about any task. In turn, the need for efficient and widespread wireless network coverage is at a high. However, today, customers are often susceptible to poor network coverage over both WiFi and cellular networks. Application developers find it difficult to understand how to optimize their application performance for different devices over wireless networks. Researchers struggle to find data to test potential improvements in wireless network and device performance. This arises from a lack of information about the behavior and performance of wireless networks for different devices, locations, and times.

In this paper, we propose NetMap, a novel system which crowd-sources performance data collection for wireless (802.11 and cellular) networks. Our main contributions are a measurement collection library/API designed for games as well as a packaging mechanism to collect performance data in a mobile device game. We developed a scheme which aligns incentives so game players collect measurements while playing. That is, we tie measurement collection at real-world locations with movement and action in the mobile device game.

Our measurement library is specifically designed for mobile device games. We targeted the Android platform as it gave us the best compromise between reachable population, for widespread measurements from a large customer base, and engineering cost as android is open-source and provides a substantial measurement library. To enhance our ability to collect performance measurements, we used the Network Diagnostic Tool (NDT) which provides an API to collect many additional metrics using their client program and distributed servers.

Game development is straightforward, as designers are not required to know how our measurements are collected, processed, stored, etc. Game designers simply must use functions in our API to collect the requested data. Ideally, the provided measurement library would be called upon when a game player moves (reflecting movement in real-life and consequently movement in-game). Measurement collection can thus be widespread as users provide measurements from various locations while playing their mobile device game.

Users of these mobile games are aware that they will be collecting information on network connectivity that will be used for research purposes. However, beyond providing permission, gameplay is the users sole focus, as no additional effort must be expended to gather, store, or analyze the network performance measurements.

Targeted results of using NetMap and a mobile device game are a collection of various network performance statistics such as bandwidth, latency, average round-trip-time, etc., user statistics such as phone models and battery, and a comprehensive map of how different wireless networks behave across various regions. From these results, researchers and game developers can infer cellular network and WiFi performance for different areas, devices, and times. Additionally, this will provide a reliable and concrete source of information for researchers to use in developing improvements for wireless and mobile device connectivity.

3. RELATED WORK

Network Diagnostic Tool (NDT) [1] collects performance data over wireless links using a client/server architecture. The server consists of a webserver and an analysis engine. The client communicates with this enhanced server to perform diagnostic tests including web page request and the

server collects the resulting measurements and attempts to identify the cause of performance issues. The primary goal of ndt is to identify network performance issues, which occur close to users (eg. incorrectly set TCP buffers). The server locations are all known (clients connect to one of the closest servers) and servers collect data making it easier to measure certain statistics such as one-way latency.

Dasu [4] is a measurement platform for the Internet's edge. Dasu can support broadband characterization as well as internet measurement experiements. They design Dasu for the edge of the Internet so measurements reflect end users' views of the services they are using. Dasu also does not use dedicated infrastructures for experimentation. Instead, they use an incentive model to make sure it is widely adopted at the edge of the Internet. Dasu has a distributed set of clients and a set of management services. Clients perform measurements and the management services configure clients, perform administration of experiments, and handle data collection. Dasu provides a programming interface that is flexible to run many kinds of tests (when-then model where condition dictates type of test).

MIST (mobile internet services test), a distributed platform for measuring cellular network performance of users with hopes of aiding mobile application developers. MIST is a mobile app connected to server back-end. Communication between the mobile application on the user's device and the servers are performed to measure characeteristics of the cellular networks, including latency, jitter, throughput, etc. The database at the server saves the measurement data along with mobile device info/configuration from the test. Perk is that MIST can be deployed on top of mobile devices (don't have to change cell network infrastructure). App first collects info about mobile device, service provider, and test location. Mobile app connects to closest server to get most accurate measurements. Then app sends packets of set byte-size to analyze uplink and downlink latency, throughput, and timeouts. Difference from ours is that MIST is an app designed to get such measurements for mobile app developers (we wrap measurement collection in a game so it is not specifically used for this purpose).

Balachandran et al. [2] capture a workload at a large conference and analyze it to understand user behavior and network performance. They collect a continuous trace of SNMP data from all APs in the conference main room as well as a tcpdump trace of network-level headers of packets going through switch which all APs connected to. This provided aggregate packet level statistics of all traffic passing through these APs at the link, network and transport layers. Also, they obtained information about the users associated with the APs such as their MAC addresses, SNR, and effective throughput. They inferred the number of distinct wireless users by counting the number of distinct MAC addresses in packets passing through the APs present. The primary goal was to analyze user behavior in terms of mobility, application popularity, data rates, etc. In terms of network performance, they measure the aggregate offered load for each of the APs and observe the bursty behavior. They also measure packet errors by using the SNMP trace where APs count the total number of packets transmitted and received, and the number of packets in error (account for inbound packets that could not be delivered to higher layer and outbound packets that cant be transmitted due to channel).

VISUM [3] is a framework for wireless network monitoring that uses set of agents within network (scales better than centralized) to monitor network devices and store info at repositories. VISUM also visualizes the data into real-time statistical graphs and interactive network topology maps. They target single-hop wireless networks. Thus, VISUM relies on a distributed architecture (agents at different locations) to monitor large scale wireless networks. Agents collect measurement info from network devices using SNMP and store the data in a centralized repository (data stored per device using device OID).

4. DESIGN OVERVIEW

5. REFERENCES

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