COllaborative Measurement of Internet QUALity

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COMIQUAL

Internet Society

Lebanon case

- Small country: 10k sqkm, 4M inhabitants
- NRI 2012 rank 95
- 1 incumbent public operator (monopoly MoT)
- 2 state-owned mobile operators (duopoly)
  - Alfa: managed by Orascom
  - Touch: managed by Zain
  - More than 1.8M smartphones registered
  - 3G less than 2 years old, now start of data 4G-LTE commercial phase
  - Stress on the network !!
- Politics.. No transparency..
- #Ontornet #FlipTheSwitch #OpenTheTap #UnleashTheBandwidth campaign

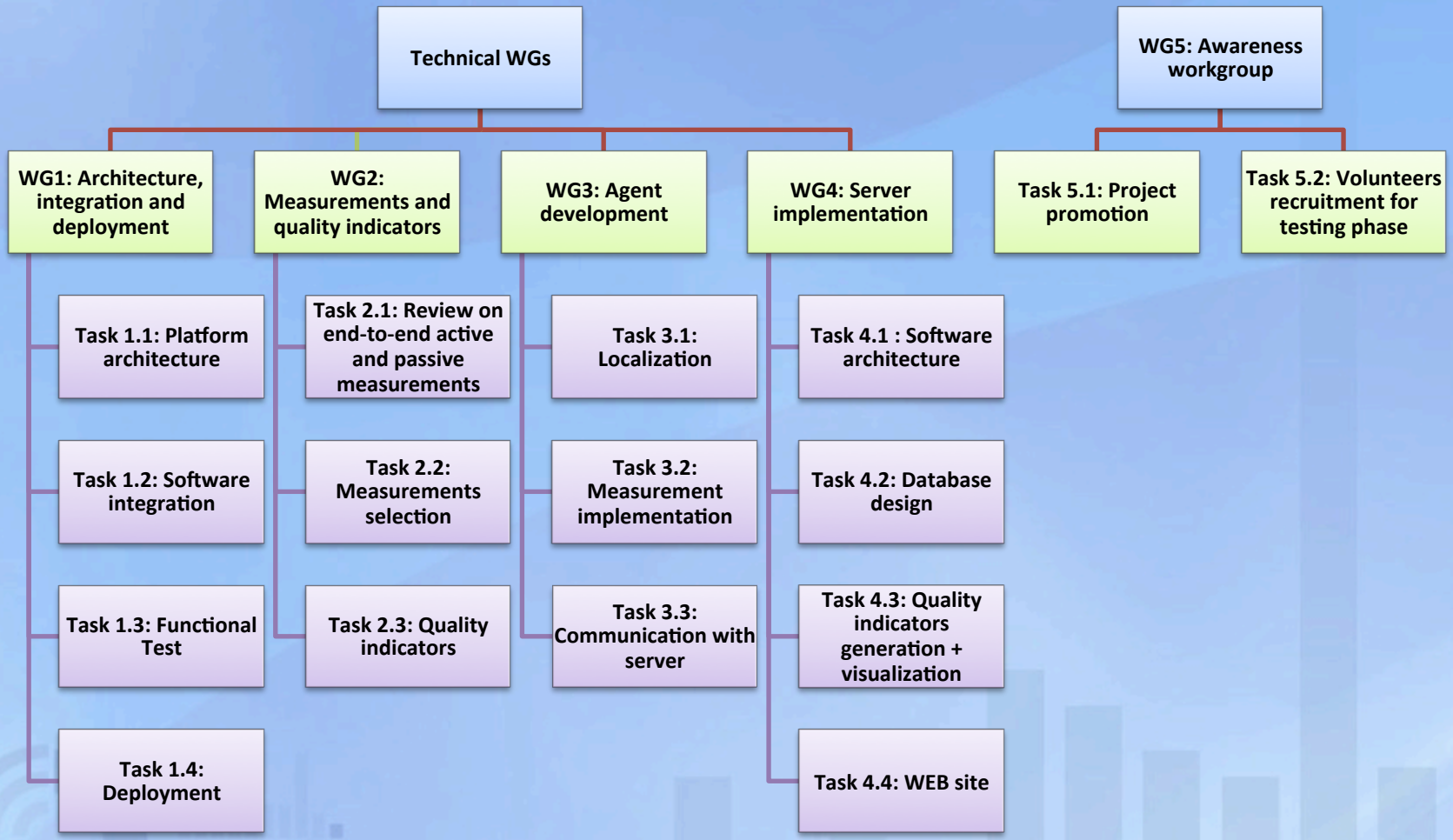
Objectives

- Build a collaborative, independent and transparent observatory that quantitatively assesses the Internet Quality in Lebanon from the user's perspective
- Conceive systematical methodologies and developing tools for characterizing network performance directly from end users
  - Measurements will be periodically performed by agents installed as applications at the users'
  - A central server will aggregate all the measurements statistics, generate quality indicators (QIs) for each location and ISP/Mobile operator, and publish the QIs using user friendly visualization techniques

Benefits

- Smartphone customers want to know the cellular network performance in order to choose carriers (and maybe devices) to use
- Mobile network operators and ISPs care about cellular network performance to ensure the quality of service
- 6 months after project started
  - Lots of positive traction & welcome
    - Touch, ISOC, Setelia (Nemo), Beirut IXP, MoMo Beirut
  - 5 Work Groups formed & active

Working groups (WG) and tasks



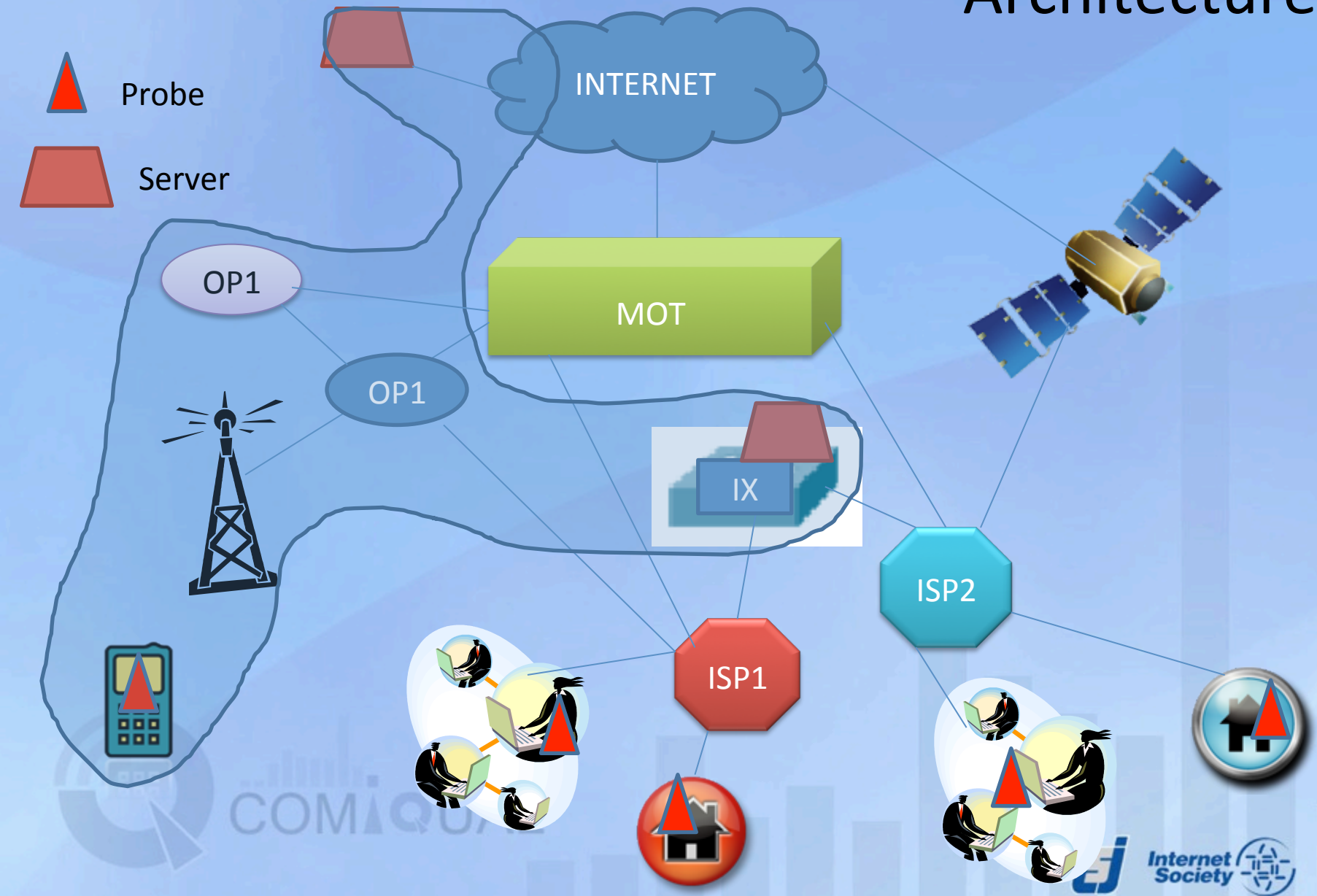
Related Works & Rationale

- RIPE NCC Atlas : hardware probes (costly)
- Grenouille, C'MON: focus on fixed access
- OpenSignal, Portolan, Sensorly, Mobiperf, Netradar, Speedtest
  - Only measure predefined metrics
  - More geared towards active measurements & understanding network applications performance on smartphones
- Opted for a Mobile-based solution to support
  - Both active & passive measurements
  - OpenData access under Creative Commons license
  - Modular and expandable to integrate easily new metrics/ measurements
  - Local (as well as international) traffic measurements via Beirut IXP
  - "Low-cost" (software) solution

Work Group 1

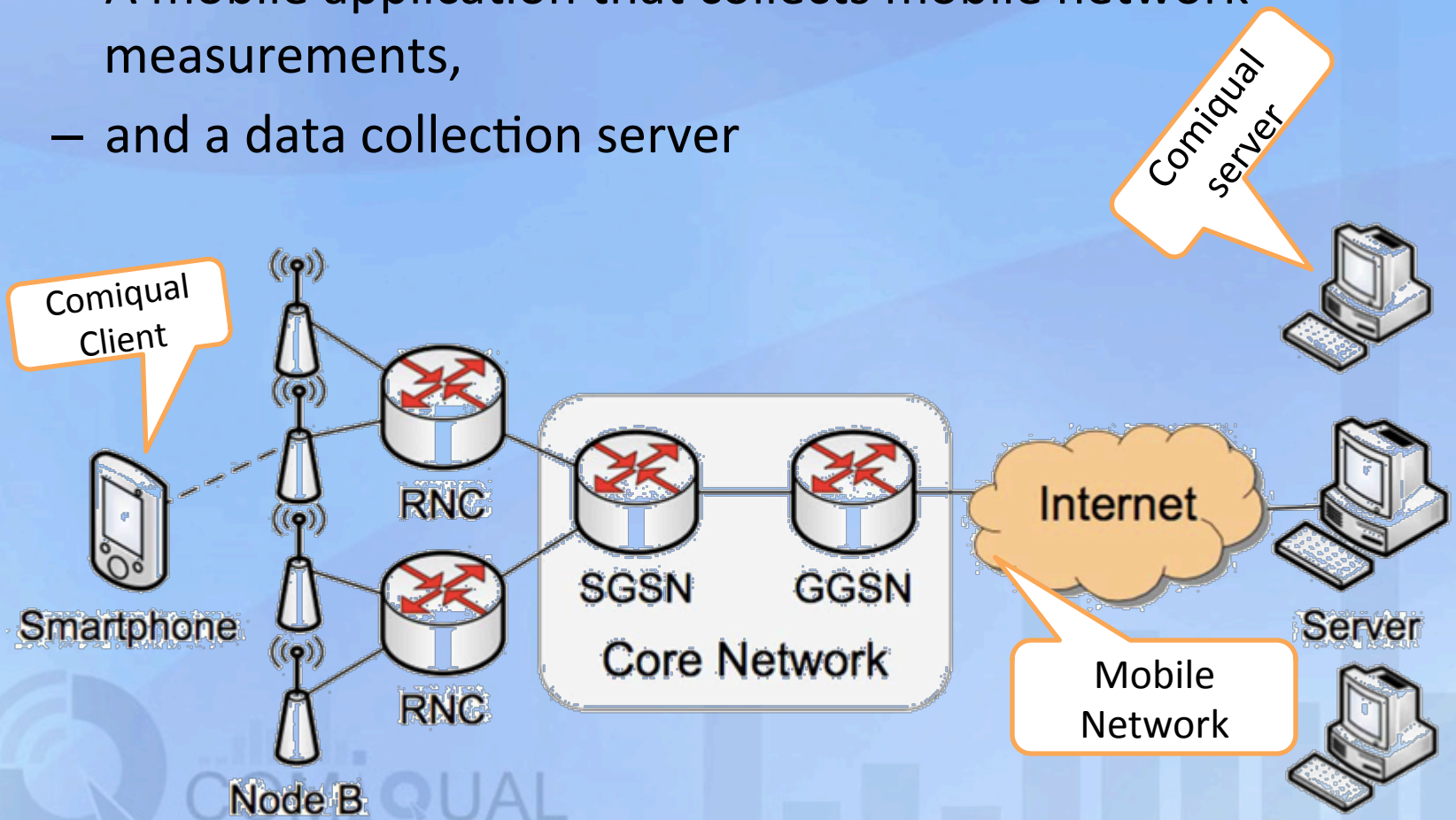
Architecture, Integration, Deployment

Architecture

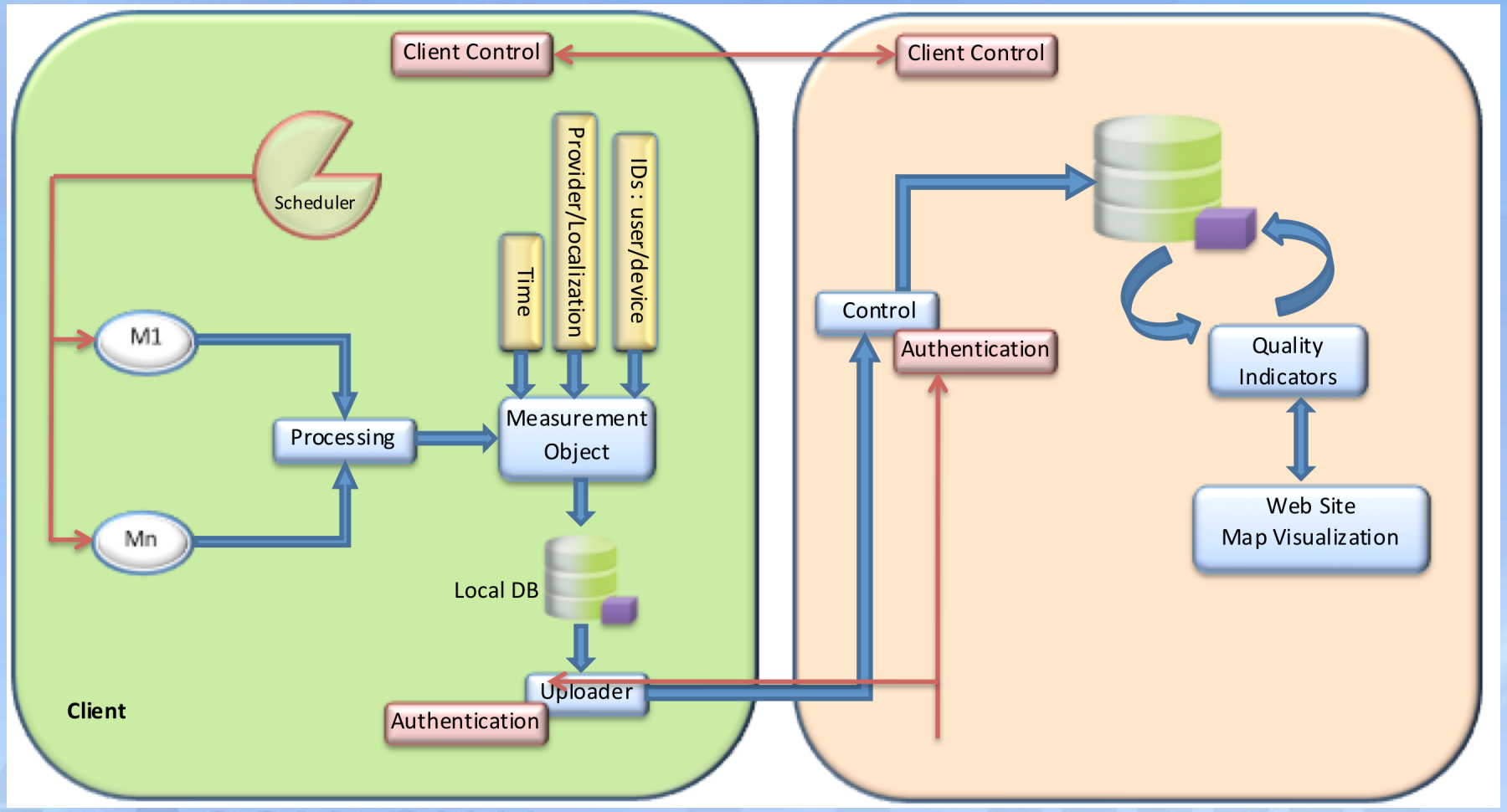


Deployment

- Comiqual consists of:
  - A mobile application that collects mobile network measurements,
  - and a data collection server



Software Functional Blocks



Work Group 2

Measurements & QI

Test drive

- 3G/LTEs dongles from 2 mobile operators
- 4 different regions: Ain el Mraisseh, Hamra, Hazmieh, Ghazir (2 in capital Beirut, 1 in suburb, 1 urban area)
- Time of Day: 9-10am, 3-4pm, 10-11pm

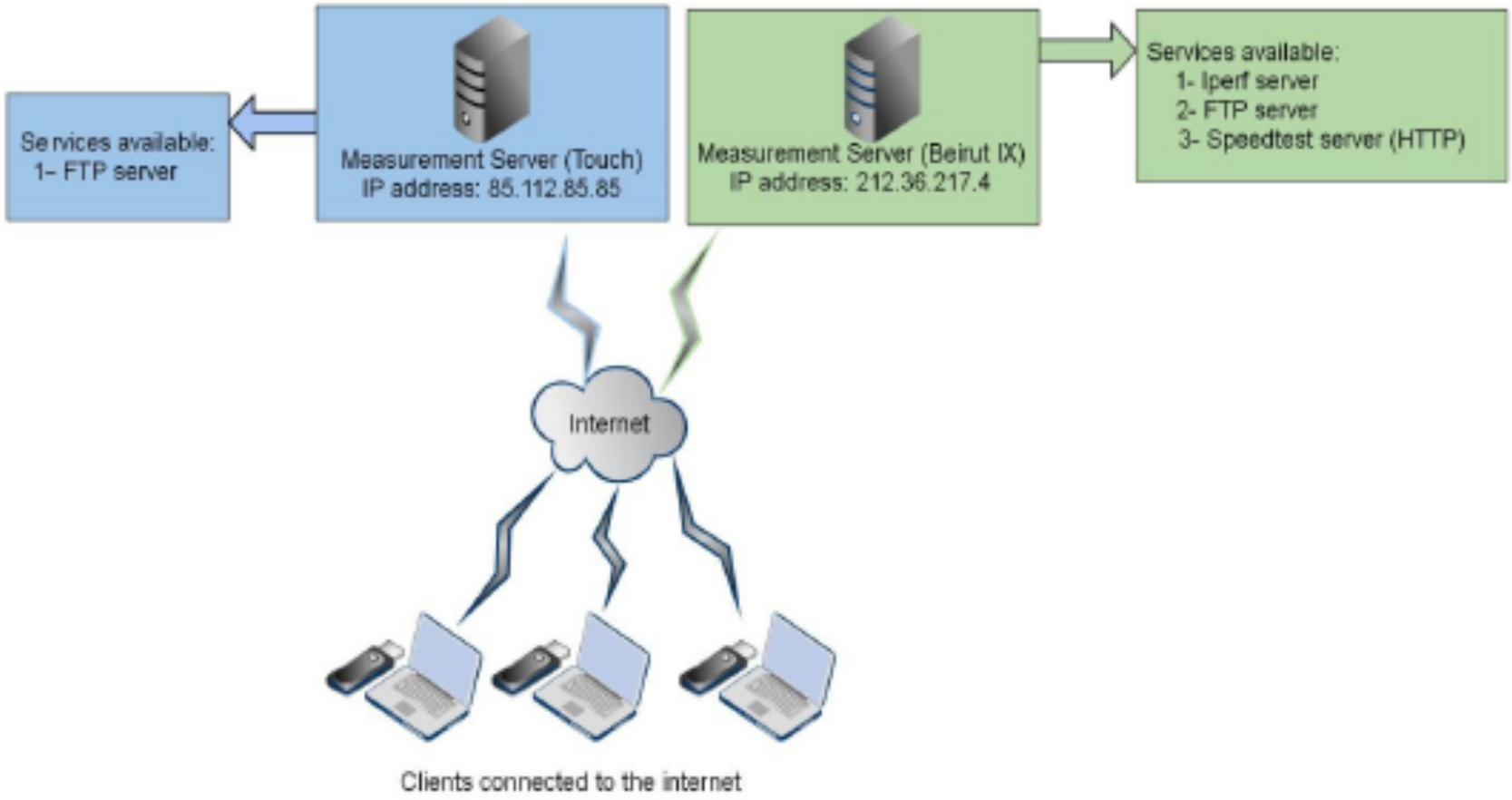
Lebanese TRA QoS parameters

Table 1 Target levels for QoS and network performance for wireless broadband data services

Wireless Broadband Data Services (≥ 2048 bit/s)	
QoS/Network Performance Parameter	**Target Level**
Service Availability	≥ 99.00%
Supply Time for Connection	95% completed on agreed day
Customer Fault Rate per leased line	1.25 failures per 100 customers per month
Fault Repair Time	95% within 24 hours
Ratio of Packet Loss	≤ 5% Packet Loss
Round trip Delay	≤ 95 milliseconds (ms.) for national reference < 250 milliseconds (ms) for International reference
Jitter	< 50 milliseconds

http://www.tra.gov.lb/Key-Performance-Indicators

Testbed


Services available:
1- FTP server
Measurement Server (Touch)
IP address: 85.112.85.85
Measurement Server (Beirut IX)
IP address: 212.36.217.4
Services available:
1- Iperf server
2- FTP server
3- Speedtest server (HTTP)
Internet
Clients connected to the internet

Few results: May-June 2013

Percentage of packets compliant to TRA indicators

Table 4 comparison of our measurement results with the TRA regulations

	Alfa 3g	Touch 3g	Alfa LTE	Touch LTE
Ratio of packet loss	95%	30%	35%	40%
Jitter	30%	100%	100%	100%
Roundtrip Delay National Reference	15%	10%	100%	100%
Roundtrip Delay International Reference	90%	90%	100%	100%

TCP Window issues on 4G

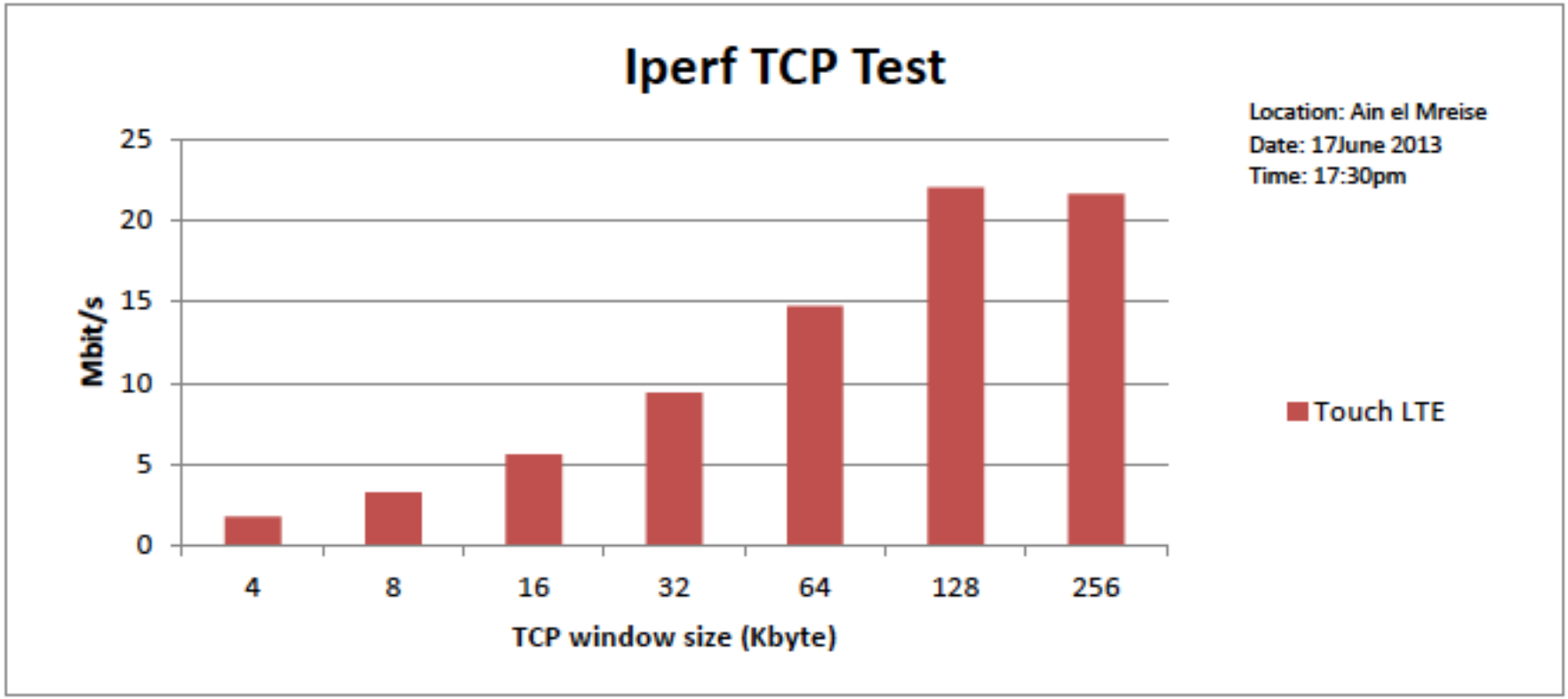


Figure 11 TCP throughput with various window sizes

Out-of-order packets

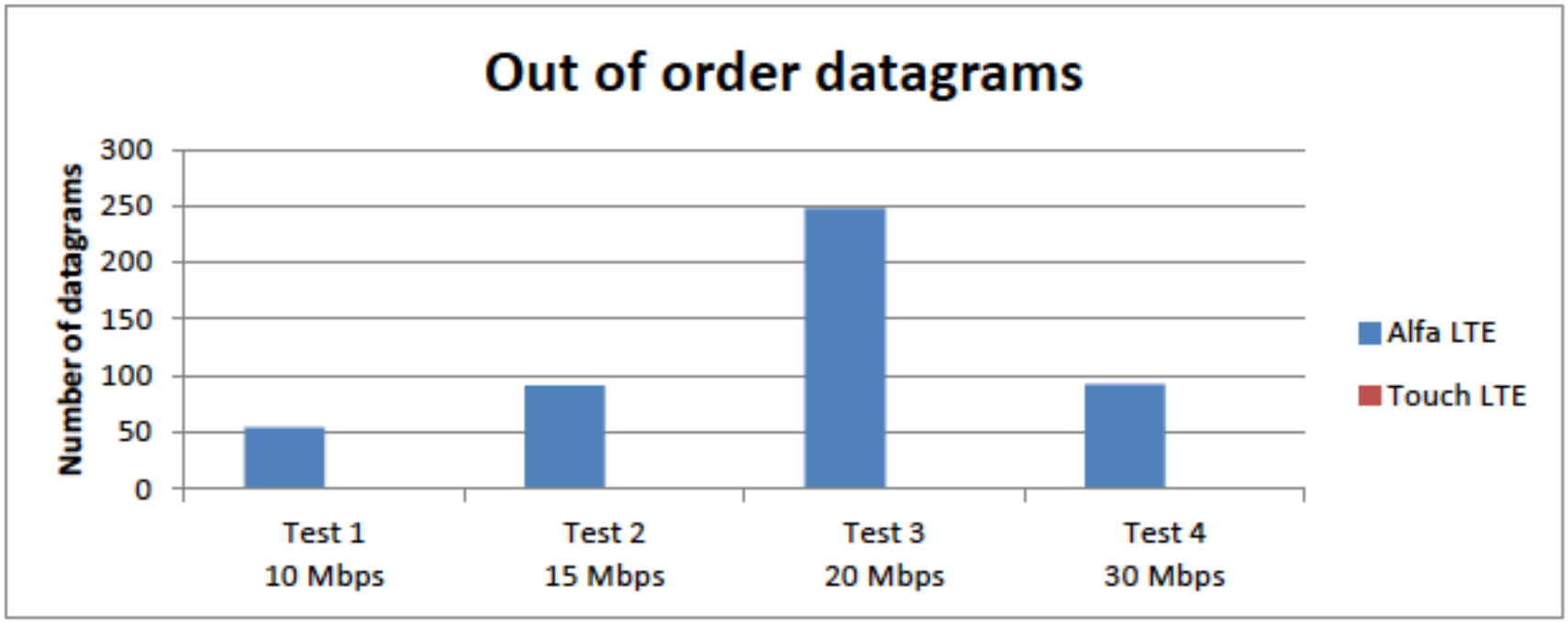


Figure 27 Comparison between Alfa and Touch LTE UDP out of order datagrams in Hamra location

QI for QoS/QoE

- Key challenge now is defining a set of QIs and scenarios based on technology used
- Reflections with stakeholders

Work Group 3

Agent development

Based on Mobiperf – Mlab Model

Mobile Users

Run Tests

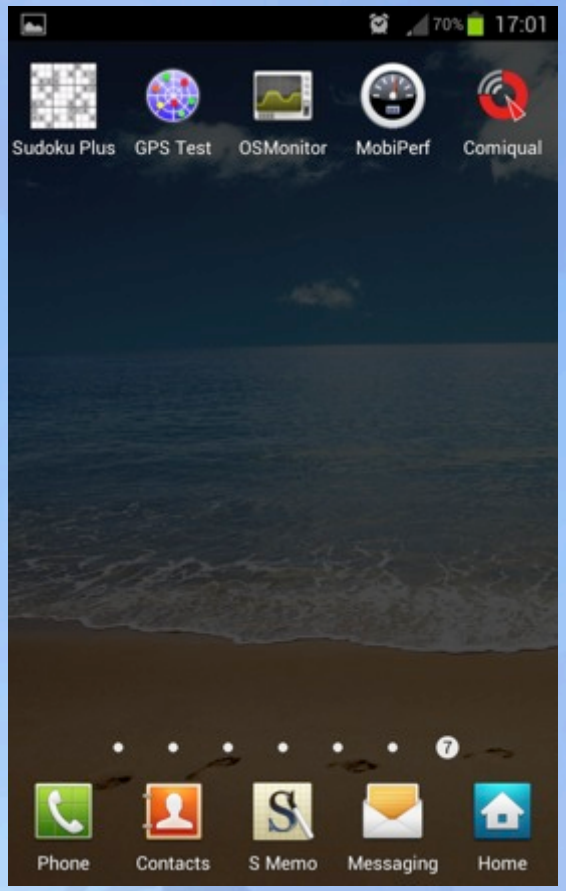
Send Measurement Data

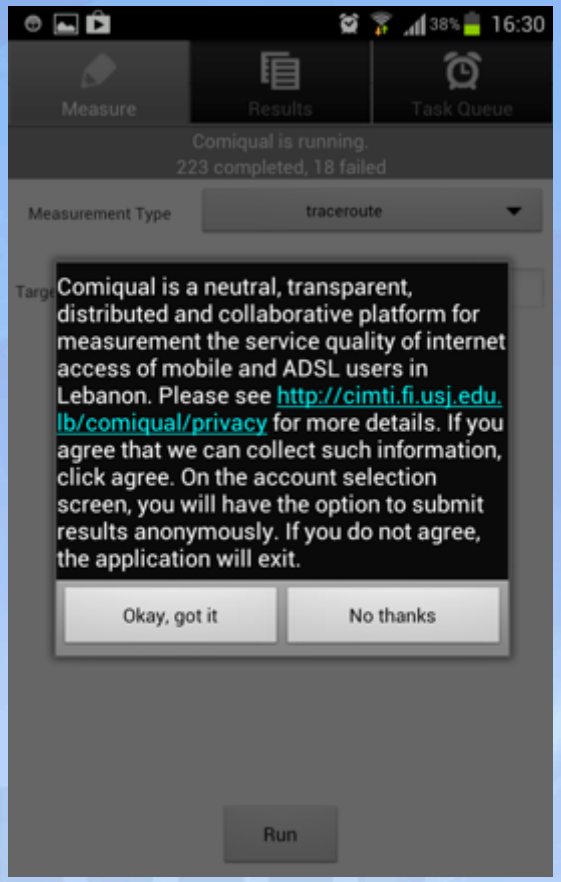
Return Intuitive Results

Customization of Mobiperf Client & Server

- Rewrote Main Module to allow the usage of the last version of Google App Engine (1.8.5 instead of 1.4)
- Rewrote measurement modules (ping, traceroute, …)
- Modified Checkin and Postmeasurement modules to get and save new information (GPS, Radio technology, Telephony Network Class, Telephony Network Technology, more details on cell info…)
- Added the retrieval of the ISP name from the client IP address, using whois service
- Added an authentication handler based on:
  - Username and password defined locally on server
  - Oauth2.0 authentication
  - OpenID authentication

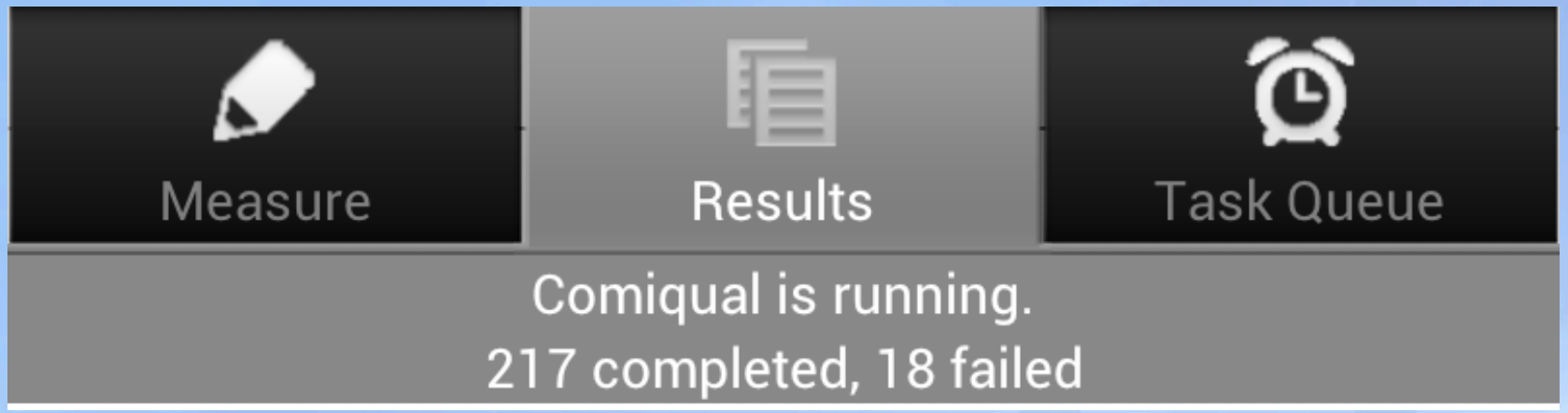
Mobile App:
Icon, SplashScreen and Consent Dialog



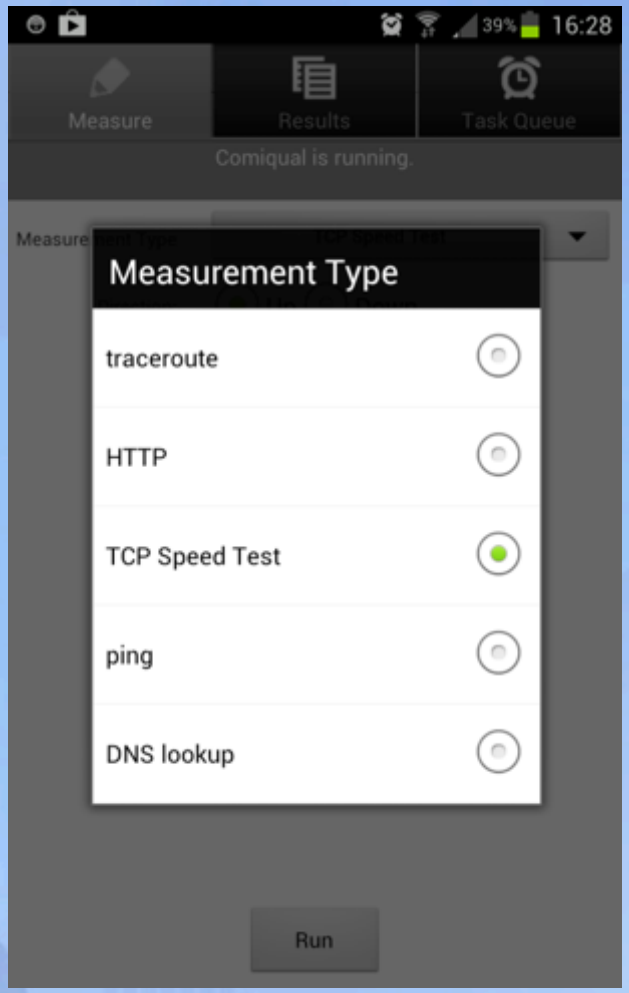


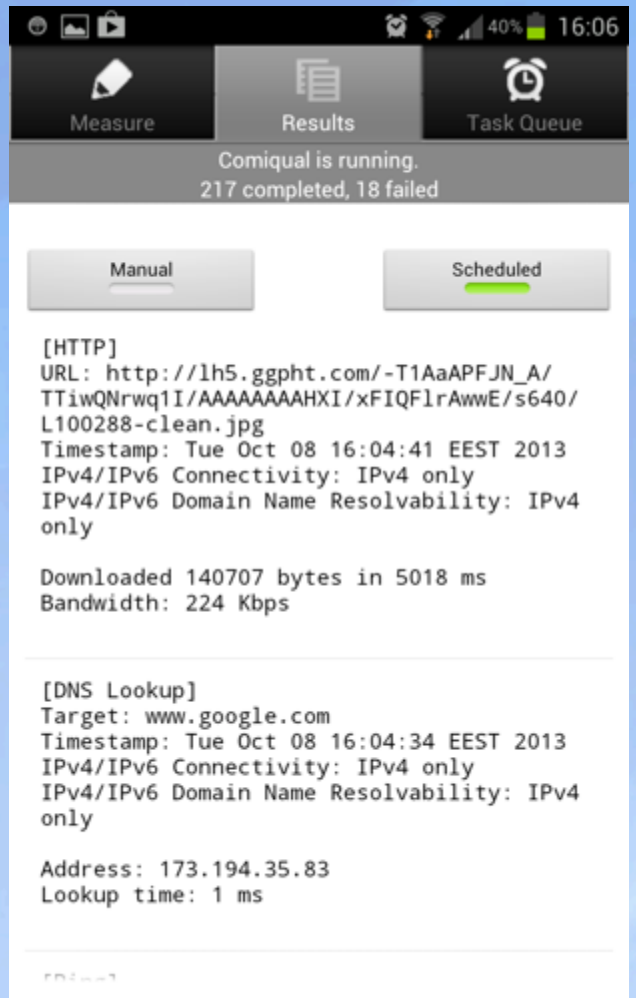
Mobile App: Main Screen

- Three TABS:
  - Measure: manual tasks
  - Results: Display manual or scheduled tasks
  - Task Queue: Scheduled tasks

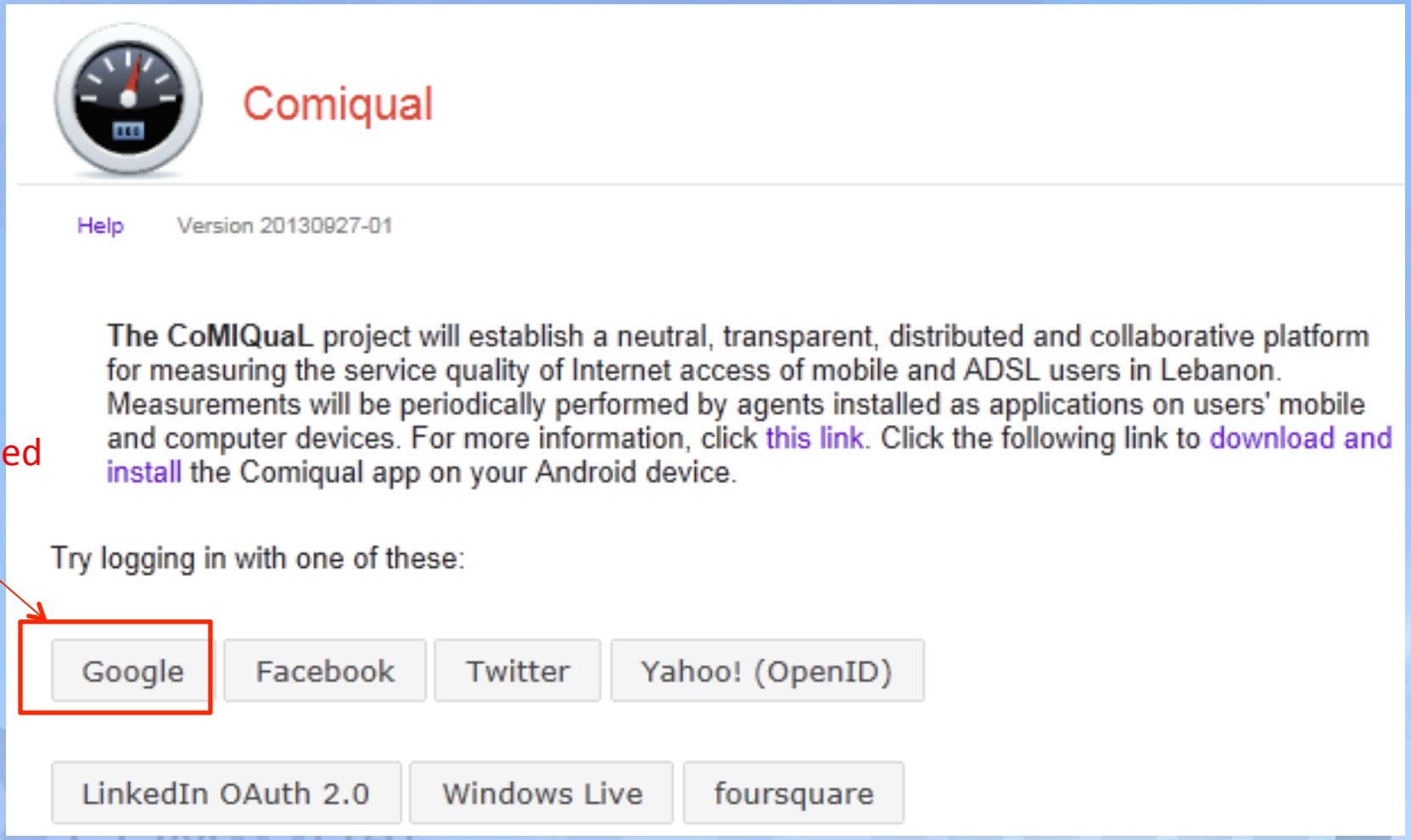


Mobile App: Tasks & Results





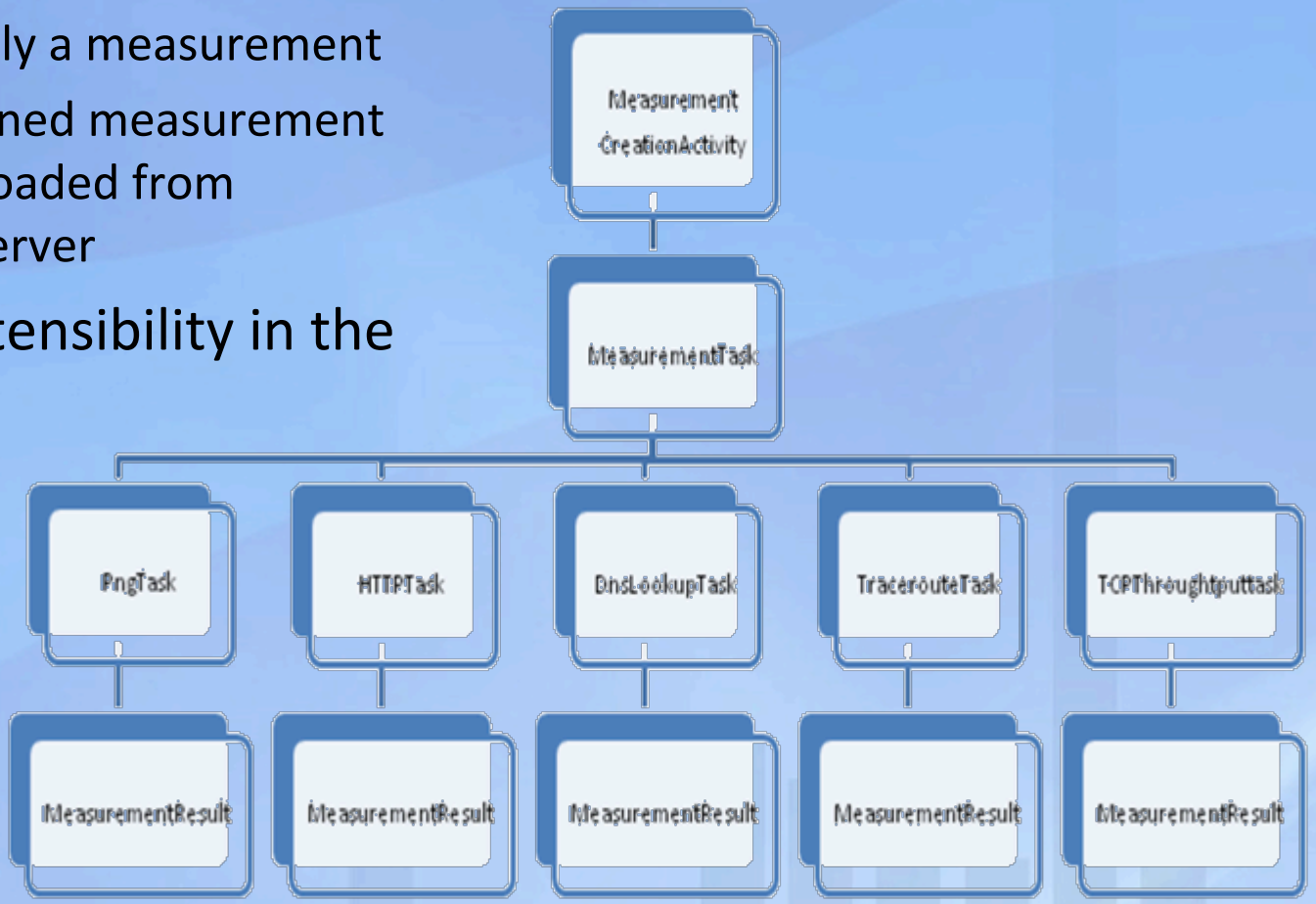
New Authentication modules



Implemented

Measurements Classes

- Two types of execution
  - perform manually a measurement
  - perform predefined measurement schedule downloaded from measurement server
- Modularity & extensibility in the architecture



Passive Measurements

- Tests underwent
  - Client-side: Shark Android app
  - Server-side: Wireshark (GUI), Tshark & Captcp (CLI)
    - RTT, TCP throughput & Tseq
- To do: integrate with existing architecture

Work Group 4

Server implementation

Server-side

- Customized MobiPerf server
  - Crunch measurements
  - SQL database
  - Configure tests scripts/scenarios/schedules for the mobiles
- Visualization techniques
  - Adaptation module with measurement server
- OpenData

Check In

- Used by devices to periodically check in with the service.
- It sends device information and receives measurement schedule
- Measurement schedule is a list of JSON objects representing task descriptors for the measurements that the device should perform

Device Information Example

Manufacturer: **Samsung**

Id: **352167050333444**

Model: **GT-N7000**

OS: **“INCREMENTAL:JPLPD, RELEASE:4.0.3 SDK_INT:15”**

Is Battery Charging: **false** Battery **Level:95**

Location_type: **GPS**

Location: **{longitude:35.563813542651 44,latitude:33.8658934766225}**

Network Type: **Mobile**

Radio Technology: **GSM**

Carrier: **Alfa**

Telephony Network Class: **3G** Telephony Network Type: **HSPA+**

Cell Info: **"LAC:3104,CID:207321,MCC:415,MNC:01,RSSI:99"**

DNS Resolvability: **IPv4 only**

IP Connectivity: **IPv4 only**

Measurement Schedule Example

Type	Interval (sec)	Params	
ping	600	target:	mlab1.hnd01.measurement-lab.org
tcpthroughput	86400	duration_period_sec data_limit_mb_down: target: data_limit_mb_up: dir_up:	16 10 mlab 5 TRUE
traceroute	3600	target:	mia04s05-in-f18.1e100.net
http	3600	url:	www.google.com
traceroute	600	target:	mlab1.ord01.measurement-lab.org
dns_lookup	3600	target:	mlab1.sea01.measurement-lab.org
http	86400	url:	http://lh5.ggpht.com/-T1AaAPFJN_A/TTiwQNrwq1I/AAAAAAAAHXI/xFIQFlrAwwE/s640/L100288-clean.jpg
dns_lookup	3600	target:	www.google.com
tcpthroughput	86400	duration_period_sec: data_limit_mb_down: target: data_limit_mb_up: dir_up:	16 10 mlab 5 FALSE
ping	600	target:	mlab1.lhr01.measurement-lab.org
ping	600	target:	www.google.com
traceroute	3600	target:	dfw06s07-in-f20.1e100.net
http	600	url:	m.youtube.com

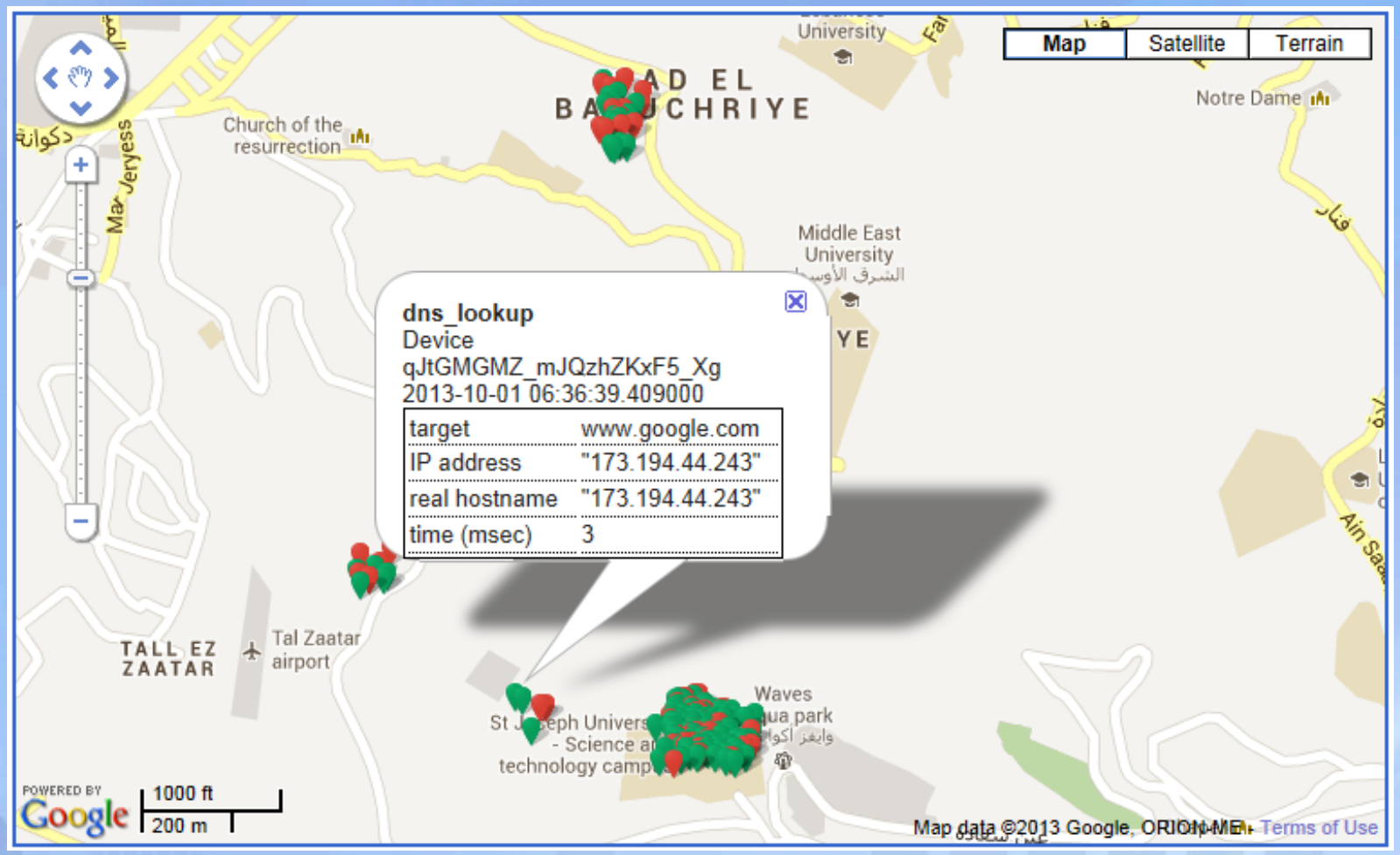
Postmeasurement

- Used by the device to post a set of measurement results to the service.
- **Input**: JSON representation of a list of Measurement objects, with embedded DeviceProperties.
- **Output**: A JSON-encoded representation of whether the post was successful
- The next slide shows an example of “Downlink measurement result” in JSON format:

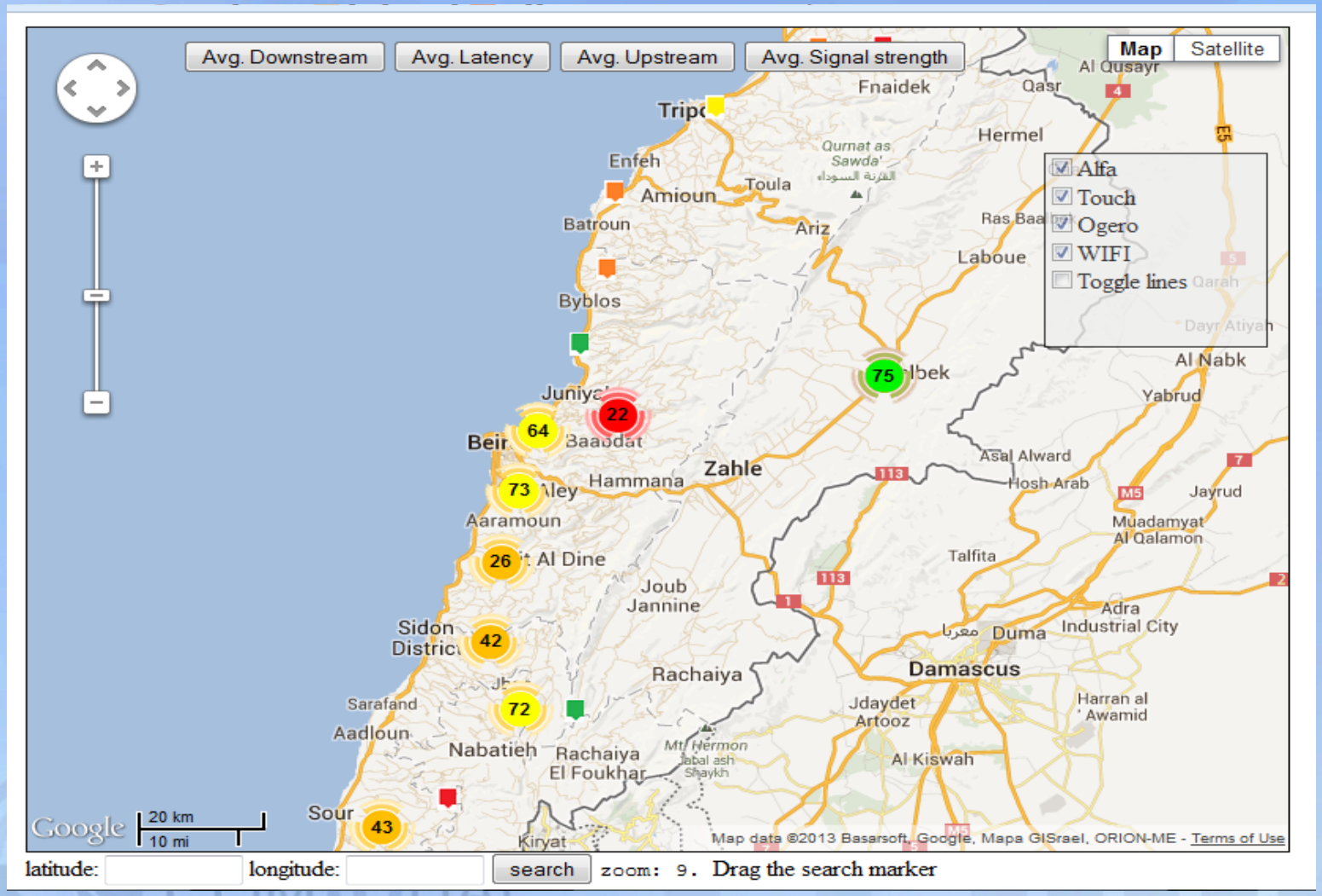
Measurement Result Example


```
{
    "device_id": "333165550333444 ",
    "properties":{
        "manufacturer":"samsung","app_version":"v1.0", "battery_level":66,"rssi":99,"is_battery_charging":true,
        "device_id":"333165550333444 ","os_version":"INCREMENTAL:JPLPD, RELEASE:4.0.3, SDK_INT:15",
        "carrier":"Alfa","radio_technology":"GSM","cell_info":"LAC:3104,CID:207321,RSSI:99,MCC:415,MNC:01",
        "network_type":"WIFI", "location":{"longitude":35.5639601,"latitude":33.8657119},"location_type":"network",
        "dn_resolvability":"IPv4 only","ip_connectivity":"IPv4 only", "timestamp":1373452061025000
    },

    "parameters":{
        "target":"1.michigan.mlab1.ath02.measurement-lab.org","pkt_size_up_bytes":1357, tcp_timeout_sec":30.0,
        "duration_period_sec":15.0, "sample_period_sec":1.0,"slow_start_period_sec":5.0,
        "data_limit_mb_up":5.0, "data_limit_mb_down":10.0, "dir_up":false,"type":"tcpthroughput",
        "end_time":"2013-07-11T10:27:16.672Z", "start_time":"2013-07-10T10:27:16.672Z","key":null,"parameters":null,
        "priority":-2147483648,"interval_sec":5.0,"count":1
    },

    "values":{
        "server_version":"1.0","data_limit_exceeded":"false","duration":"20.891",
        "tcp_speed_results":"[
            858.8184494602551,861.4324853228962,863.8164435946462,1127.5658914728683,1147.6875,1284.5623762
            376238,1325.3753475440221,1357.5,1359.6746765249538,1440.9089128305582,1461.9499036608863,1508.2
            750491159136,1717.3333333333333,1826.0492610837439,1975.018587360595
        ]"
    },

    "type":"tcpthroughput",
    "timestamp":1373452061038000,
    "success":true
}
```

Visualization



WebGoogleMapsClustering



Conclusion

- Positive so far ☺
- What's next
  - Integration of different blocks
  - Defining relevant QIs & associated tests/scenarios
- Issues
  - Overloading cells
  - Back-end scalability & Data storage
  - Large-scale user adoption
    - 100s or 1000s ?
    - Privacy
    - Incentives ?
      - special data packages, local app stores, passive measurements
- Transparency & OpenData
- Available for scientific community

THANK YOU

Q&A?

Feedback ?

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