Analysis and Comparison of Energy Efficiency of Android Device for Indoor / Outdoor Localization

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Abstract- *In the present day, there is prevalent exploit of mobile submissions that capture pro of the setting of user. Trendy conventions of position data take account of geotagging happening in social media arena, driver assistance and course-plotting, and uncertainty in close by locality of awareness. Conversely, the middling user turns out to be incapable to comprehend the lofty energy outlay of exercising location services in particular GPS or can never put together smart verdicts a propos at what time to make possible or immobilize location utilities - for instance, whilst inside an enclosure. Accordingly, a apparatus that preserve the resolution finalizing by in lieu of user can drastically get better a Smartphone's battery living.*

Keywords-Android Location Services Framework, Indoor/Outdoor Detection Service, FusedLocationProvider API, indoor / semi-indoor / outdoor, GPS, Network Localization, Energy Efficiency of Android Device

I. INTRODUCTION

The current scenario of technological expansions mainly in the segment of smart phones have given a real time flourish to the demand for localization so the applications may run more effectively than ever. Societal utilities depending on these data have its usage in geotagging, weather reporting or other similar applications. But no electronic gadgets can work without an energy supply and so the case of smart phones. We all know that recent expansions in smart phone requirement also showed the excessive complaints on the battery consumption. Though with the availability of power banks many came over the issue, still it remains as a negative aspect.

Learning about the matter, experts have unveiled the fact that localization aspects draw much battery leading to quicker drainage of power source. GPS or WIFI based methods made use of for attaining fine tuning of locations, indoor / outdoor determination techniques are queued up to meet the matter. It is necessary to model equilibrium between expediency and functionality of the gadget to limit the diminishing battery life.

Accustomed approach in localization includes various methods which take care of position of the user - whether indoor or outdoor. Contemporary smart phones classically bid two focal approaches of resolving the spot of consumer - either GPS at more expense of battery life or with network dependent resolutions with comparatively lesser. Much more sophisticated output is offered with GPS usage but only applicable when the user is outdoors while network utilities give a broader outcome when indoors. Lesser energy is used by the network relying approaches which will save much expensive battery life. In order to switch between the techniques of localization, smart phones will have to recognize whether the phone is used while the person is inside a building or under sky. This is the scenario where the work has to be done - battery drainage should be tackled to extended level for a person who is more prone to outside premises than staying back indoors. If GPS is used for locating the position quicker will be the exhaustion of energy reserved. So while traversing through the requirement arena, exactness and energy swapping turn out to be the centre of deliberation. For a typical consumer, there are may not be higher curiosity or thoughts towards such matters, but from a point of inspection of an advanced user or the smart phone makers these are matters for crucial consideration. Outlay of money is much lesser important when bearing in mind the convenience and energy adequacy of the doodad.

The slogan of android developing wings has come up as to pick nattily among the more energy outflow side location identification to lesser energy expenses relying on functional necessities or further perspective. Nevertheless, developers become unable to constantly envisage at what time to animatedly toggle involving schemes. In supplementary occasions, locality information sent by the network supported manner will not be adequately precise for apposite functionality of a number of applications as in case of navigation and direction findings. During such situations, the GPS will automatically be invoked not considering of milieu or framework. This will result in depletion of power in conditions where the GPS is engaged or erroneous, such as in enclosed settings or city ravines.

It is fact that a user can turn on or off the services like GPS or WIFI or Data Network, but it affects the whole

applications which depend on these while a developer can take care of individual utilities on the centre of obligation form time to time. Hence, a means to facilitate in formulating assessment a propos location services supported on framework and in addition impinge on every mounted location-based application will upshot in noteworthy energy funds.

II. PROPOSED SYSTEM

Separately from the obtainable arrangements, the proposed system pioneers a swapped indoor localization structure. Adapt the Fused Location Provider API to dynamically lever between the GPS and an indoor-based location supplier relying on indoor/outdoor grade. Then the energy burning up is gauged by scrutinizing the battery charge devoted by available assortment of sensors in getting hold of the setting.

Features of the system are:

- Improvising localization and energy competence of smart phone utilities
- Energy proficient indoor/outdoor identification on smart phones
- Investigating on battery charge data by means of fused location provider

In the upcoming sections of the paper, similar works, supportive information to the schema, analysis of available methods of localization, system implementation, discussions on obtained yield and finishing arguments are depicted.

2.1 Android Location Services Framework

Conventionally, Android application developers are capable of calling for location details from the operating system by overtly denoting a location donor characteristically any the GPS or the network-based giver and presenting instance and aloofness necessities. LocationManager instances take delivery of location desires from applications and advance them to the coupled LocationManagerService. The service administers location vertices requirements and holds communiqué with the location contributors of the Smartphone explicitly GPS and network. The indigenous and core services are mislaid for minimalism.

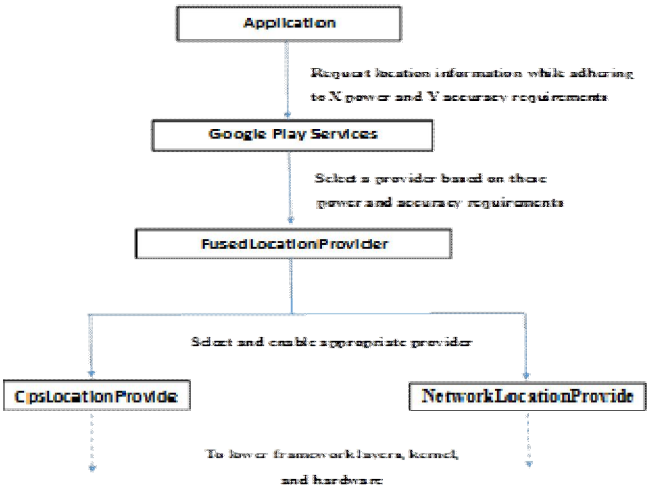

Figure 1:Simplified View of Requesting the Fused Provider

In accumulation to overtly designation a location source to exploit, developers can draw on the more recent FusedLocationProvider API, supplied within the packing of Google Play Services, which is a readymade company offered annals to entrée Google-explicit services including Google Maps, Drive, Wallet, etc. Google Play Services is set up on for the most part Android doodads and as well at the present consists of the network-based location contributor, as the network donor settles on location of a user stopping at a network demand to servers of Google.

The mechanism of execution of FusedLocationProvder API takes care that as an alternative to unambiguously designating a location supplier, applications merely convey their precision and supremacy rations to the FusedLocationProvider. This will robotically revisit the nearly all apposite location ideas derived from the causal location bringers. By making use of this API, there are benefits in generalization and pensiveness of the progression on behalf of the developer and perks up location precision and power burning up. The figure depicted below exemplifies the progression of building a location request by means of the fused provider.

2. 2 Indoor/Outdoor Detection Service

The blueprint of my resolution takes account of the realization of the indoor/outdoor exposure service anticipated in [1] as a factual scheme service in the Android operating system. I preferred their organization for a multiplicity of basis. Major number of works I have gone through during the course of search for a good base, I came across the idea that a fair majority considered that the preliminary condition of the Android gadget is indoor. There has not been much delve into,

in particular not for Smartphone, on the vibrant discovery of enclosed vs. open-air surroundings. Furthermore, the recognition service anticipated in [1] also publicized their coordination as a "generic service," entailing it was transferable to supplementary layout for instance an operating system service. To end with, their archetype system was fulfilled for Android doodads and made application of sensors which are universally accessible on the largest part of Android phones. Consequently, to the most excellent of our acquaintance, it was the unsurpassed aspirant scheme to make the most of in my solution blueprint.

In petite, their coordination brings into play the tagged on five hardware gears to settle on if a Smartphone is in one of three probable conditions - "indoor", "semi-outdoor", or "outdoor":

- Accelerometer - step-detection to activate the indoor/outdoor revealing
- Cellular radio - discrepancy of close at hand RSS of the cell tower in excess of time
- Light sensor - quantifies ecological brilliance; recognition supported on time-of-day
- Magnetometer - appraises ebbs and flows in the restricted magnetic field
- Proximity sensor - recognize whether phone is set aside in pocket; accustomed to corroborate light sensor comprehension

Depending on the user's mobility, the unruffled data in addition to the contemporary condition is summated to keep informed the indoor/outdoor grade. This archetype structure was modelled the same as an Android application, except the possessions of the modus operandi consent to it to be put into action as a factual method service devoid of upshots on the detection accurateness.

III. SYSTEM DESIGN AND IMPLEMENTATION

In this division of paper, the authentic carrying out segment is made clear to furnish a vindication on factual system makeup; the blueprint of the schema is included here followed by the realization result explanation.

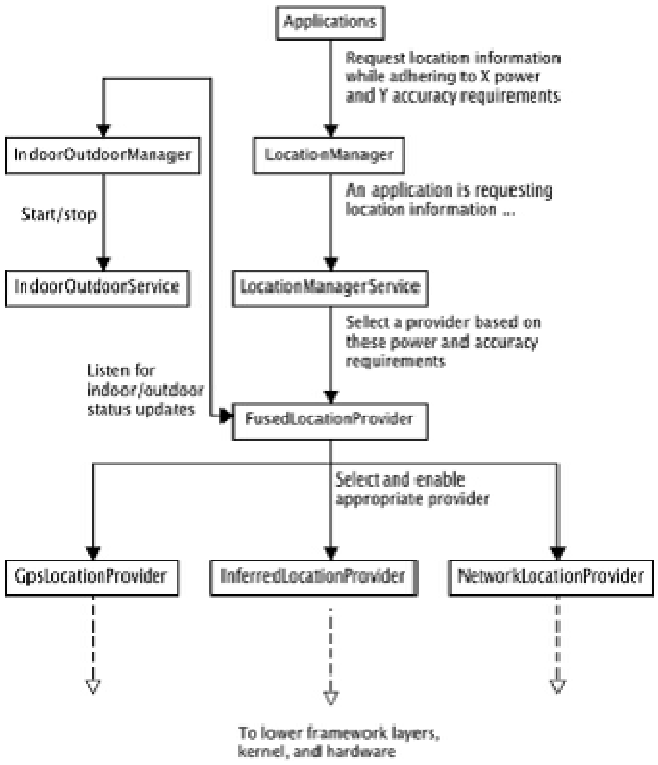

Figure 2: Simplified View of Modification in Fused Location Provider Framework

3.1 System Requirements

The nominal provision that the modelled scheme demands for proper running with planned functionalities of indoor-outdoor identification to meet the battery efficacy target in localization of Smartphone is been explained here in this quarter of paper.

3.1.1 Hardware Requirements

- Device : Smart phone
- Processor : Dual core processor
- RAM : 2 GB
- Memory : 4 GB

3.1.2 Software Requirements

- Operating system : Android v6+
- Tools : Android Studio
- Front End : XML
- Back End : Java
- Database : SQLite

3.2 Module Description

3.2.1 Location Manager

Location Manager requests take delivery of location needs from functions and promote them to the allied Location Manager Service. The service administers location detail requirements and knobs communiqué with the location providers namely GPS and network of the scheme; the indigenous and kernel offerings are mislaid for unfussiness.
Features

1. Multiple Location Sources

There is manifold contributor from which position is got hold of GPS, WI-FI and Cell-ID and the entire schema show a discrepancy immeasurably in exactness, power expenditure and momentum.

2. Unreliable Accuracy

Locality inference imminent from diverse bringer might be appreciably not as much of truthful as the evaluation upcoming from a grown-up giver.

3. User Movement

As the non-stationery characteristic of the user can contribute to the shifting of his position many times and hence it had to be invigorated on every reasonable interval.

3.2.2 Fused Location Provider

The FusedLocationProvder API put it efforts far from just unambiguously delegating a location bringer, submissions basically set free their precision and authority necessities to the FusedLocationProvider, which after that involuntarily revisits the a good number of apposite location statics derived from the principal location suppliers. By means of this API I was capable of abridging and summarizing the progression for the coder in addition to getting location exactness and clout burning up better.

3.2.3 Indoor Outdoor Identifier

This part categorize the status of the device as indoor, outdoor or semi-indoor and make available data on the subject of the location founded on diverse sensor comprehensions akin to magnetic field, light uncovering, proximity sensor, accelerometer and as well in progress instance.

The realization of the indoor/outdoor uncovering service anticipated as a spot on coordination overhaul in the Android operating structure. The coordination exercises the going behind five hardware apparatus to settle on if a Smartphone is in single of three promising status - indoors, semi-outdoors, or outdoors:

3.2.3.1 Accelerometer

An accelerometer is a piece of equipment that procedures apt speeding up is unlike the schema as synchronizing acceleration tempo of revolutionize of swiftness. For instance, an accelerometer not working on the exterior of the Earth will quantify quickening by reason of Earth's enormity, directly increasing through clarity of $g \approx 9.81\ m/s^2$. By dissimilarity, accelerometers in at no force plummet, descending in the direction of the midpoint of the Earth at a pace of in relation to $9.81\ m/s^2$, will gauge zero. By and large, Accelerometer utilize for quantifying apparatus going round the alignment (x, y, z,) and Android Sensor scaffold make available schemes like getRotationmatrix() and getOrientationmatrix() the apparatus rotary motion comparative to position on every axis; obviously it appraises the linear acceleration and orientation comparative to gravity.

3.2.3.2 Cellular radio

Cell phones exploit radio waves to correspond; Radio waves transfer digitized accent or facts in the outward appearance of fluctuating electric and magnetic fields, called the electromagnetic field; the tempo of vacillation is called frequency. Radio waves clutch the details from the conversing end and pass through in atmosphere at the alacrity of light.
Cell phones enclose as a minimum single radio antenna with the purpose of put on the air or take delivery of radio signals. An antenna translates a stimulating signal to the radio wave spreader as well as vice versa beneficiary. A quantity of cell phones makes use of one antenna as the spreader and recipient whereas contemporaries, such as the iPhone 5, have numerous putting on the air or in receipt of antennas; a cellular phone or some other apparatus that are capable of getting attached to a cellular radio will be submitted as a Mobile station.

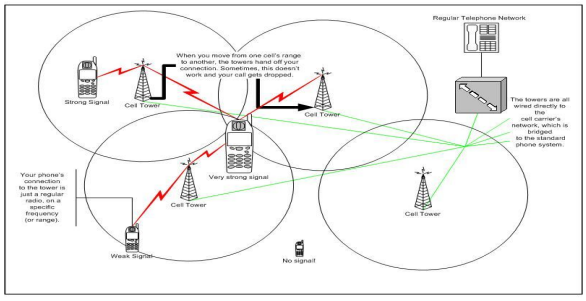

Figure 3: Working of the Technology

3.2.3.3 Light sensor

These sensors are exercised to keep an eye on virtual ambient clamminess, luminance, ambient strain, and ambient heat in close proximity to an Android-powered apparatus. Amid the omission of the light feeler, the ambient illumination sensor fiddles with the brilliance of gadget display in proportion to the peripheral surroundings. In the intervening time, the propinquity sensor becomes aware of transformations in aloofness connecting stuffs and phone. Such as, it consents to the panel of the Smartphone to breather throughout a call for the reason that the phone is positioned subsequently to ear.

It gauges the vividness of the ambient beam, the phones software draws on this statistics to fiddle with the puts on shows lustre involuntarily, whilst the ambient glow is copious, the brilliance of the screen impelled up, and once it is sinister the output gadget is muted behind; Lux Units is the SI entity for appraising the data.

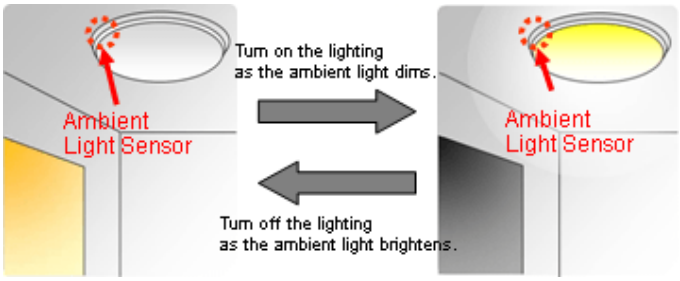

Figure 4: Working of the Ambient Light Sensor

3.2.3.4 Magnetometer

Magnetometer is decisive for becoming aware of the point of reference of the apparatus comparative to the Earth's magnetic north; entity that corresponds to the assessment is micro Tesla units (µT).

Figure 5: Magnetometer Working in a Phone

It is computing mechanism au fait with evaluating the potency and conceivably the bearing of magnetic fields; the track is qualified route, it complies with the match up classification.

3.2.3.5 Proximity sensor

A proximity sensor is a feeler equipped for becoming aware of the existence of close by stuffs exclusive of several corporeal communiqué. A proximity antenna over and over again emanates an electromagnetic field or a ray of electromagnetic emission infrared, such as, and rummages around for alterations in the pitch or revisiting indication.xxc

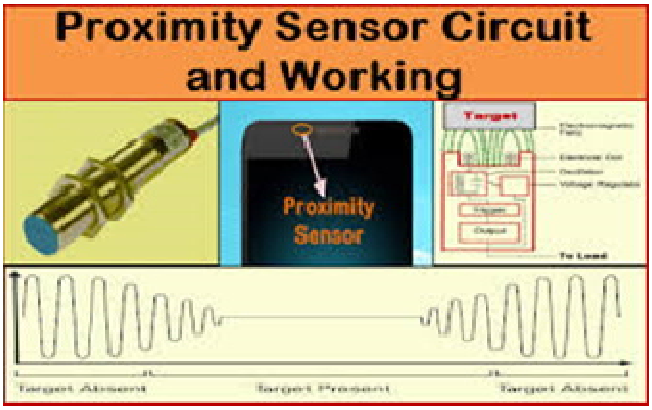

Figure 6: Proximity Sensor Working

Mobile phones make use of IR-based proximity identifier to perceive the incidence of a human ear; this sagacity is prepared for two rationales:

- trim down display power using up by off-ramping the LCD taillight
- for putting out of action the stroke-display to steer clear of chance pat by the cheek.

Proximity recognizing gadget senses the existence of metallic things. Their functioning attitude is derived from a twirl and elevated frequency oscillator that craft a field in the slam backdrop of identifying facade. The accessibility of metallic occurrence while the sensor is at action will compose a discrepancy in oscillation amplitude and for this to be met, a threshold circuit is been formulated.

3.2.4 Indoor Location Provider

This section of the system is employed to make available location particulars of the device under scrutiny when it is within an enclosure or partially sheltered.

3.2.5 Outdoor Location Provider

Outdoor Location Provider part is accustomed to realize outdoor position aspects of the widget; moreover it is applied when getting hold of semi-indoor scene and pull together perfect setting data from GPS location donor and network position bringer.

3.2.6 Performance Analyzer

Performance Analyzer scrutinizes the competence of battery along with exactness niceties of the coordination in keeping with the location made available.

3.3 Experiments

The working out on the modules extended the battery life up to an 80% which is been shown in the screenshots displayed below.

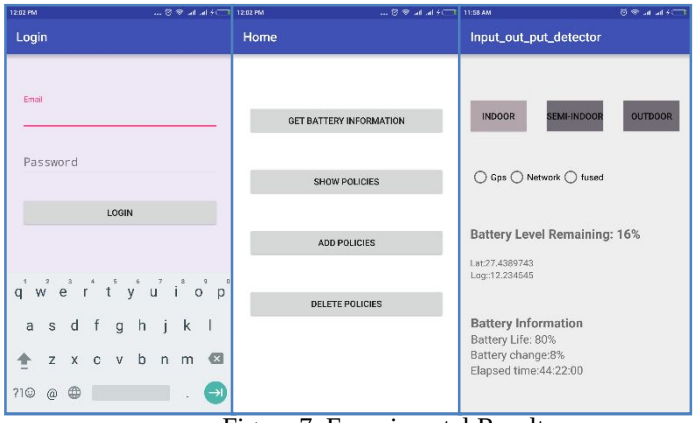

Figure 7: Experimental Results

IV. CONCLUSION AND FUTURE WORK

Although

In this exertion, I have in point of fact opened a breakdown of ideas linked to exhausting of energy from the Smartphone batteries owing to its usage of GPS/Network assistance for getting hold of the sight of its existence. I had to develop a proposal for limiting the taxing of backed up energy while employing localization approaches in Android schema thereby modelling a modification to achieve “indoor / semi-indoor / outdoor” encroachment. FusedLocationProvider API has been utilized with extensive adjustments to pull off the indispensable upshot in savings of battery verve; trial ending turned out to be much effective in terms of the demanded period of unmitigated usage of power accessibility in battery.

Prospect exertion will be capable of coming across into supplementary energy proficient customs to agree on “indoor / semi-indoor / outdoor” perspective and putting into operation further truthful indoor localization schema on the Smartphone podium and as well making offered augmenting guiding principles for safekeeping.

REFERENCES

[1] Capurso, Nicholas, Song, Tianyi, Cheng, Wei, Yu, Jiguo, and Cheng, Xiuzhen (2016) An Android-based Mechanism for Energy Efficient Localization depending on Indoor / Outdoor Context, DOI 10.1109/JIOT.2016.2553100

[2] Zhou, Pengfei, Zheng, Yuanqing, Li, Zhenjiang, Li, Mo, and Shen, Guobin (2012) “IODetector: A Generic Service for Indoor Outdoor Detection”, Proceedings of the 10th ACM Conference on Embedded Network Sensor Systems, SenSys’12, Toronto, ON, Canada, pp. 113–126

[3] Roy, Nirupam, Wang, He, Choudhury, and Roy Romit, (2014) “I am a Smartphone and I can Tell my User’s Walking Direction”, Proceedings of the 12th Annual International Conference on Mobile Systems, Applications, and Services, MobiSys’14, Bretton Woods, New Hampshire, USA, pp. 329–342

[4] Nath, Suman (2012) Ace: “Exploiting correlation for energy-efficient and continuous context sensing”, Proceedings of the 10th International Conference on Mobile Systems, Applications, and Services, MobiSys ’12, New York, NY, USA, pp. 29–42

[5] You, Chuang-Wen, Montes-de-Oca, Martha, Bao, J. Thomas, Lane, D. Nicholas, Cardone, Giuseppe, Torresani, Lorenzo, and Campbell, T. Andrew (2012) “CarSafe: A Driver Safety App that Detects Dangerous Driving Behavior using Dual-Cameras on Smartphones”, Proceedings of the 2012 ACM Conference on Ubiquitous Computing, UbiComp12, Pittsburgh, USA, pp. 671–672

[6] Zhang, Lei, Liu, Jiangchuan, Jiang, Hongbo, and Guan, Yong (2013) “SensTrack: Energy-Efficient Location Tracking With Smartphone Sensors”, Sensors Journal, IEEE, vol. 13, no. 10, pp. 3775–3784

[7] Kjærgaard, Mikkel Baun, Langdal, Jakob, Godsk, Torben, and Toftkjær, Thomas (2009) “Entracked: Energy-efficient robust position tracking for mobile devices”, Proceedings of the 7th International Conference on Mobile Systems, Applications, and Services, MobiSys ’09, New York, NY, USA, pp. 221–234.

[8] Zhuang, Zhenyun, Kim, Kyu-Han, and Singh, Jatinder Pal (2010) “Improving Energy Efficiency of Location Sensing on Smartphones”, Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services, MobiSys’10, San Francisco, California, USA, pp. 315–330

[9] Subbu, Kalyan Pathapati, Gozick, Brandon, and Dantu, Ram (2013) “Locateme: Magnetic-fields based indoor localization using smartphones,” ACM Trans. Intell. Syst. Technol., vol. 4, no. 4, pp. 73:1–73:27

[10] Xie, Hongwei, Gu, Tao, Tao, Xianping, Ye, Haibo, and Lv, Jian (2014) “Maloc: A practical magnetic fingerprinting approach to indoor localization using smartphones,” Proceedings of the 2014 ACM International Joint Conference on Pervasive and Ubiquitous Computing, UbiComp ’14, New York, NY, USA, pp. 243–253

[11] Chintalapudi, Krishna, Iyer, Anand Padmanabha, and Padmanabhan, N. Venkata, (2010) "Indoor Localization Without the Pain", Proceedings of the Sixteenth Annual International Conference on Mobile Computing and Networking, MobiCom'10, Chicago, Illinois, USA, pp. 173–184

[12] Kumar, Swarun, Gil, Stephanie, Katabi, Dina and Rus, Daniela (2014) "Accurate Indoor Localization With Zero Start-up Cost", Proceedings of the 20th Annual International Conference on Mobile Computing and Networking, MobiCom'14, Maui, Hawaii, USA, pp. 483–494

[13] Enck, William, Gilbert, Peter, and Chun, Byung-Gon (2010) "TaintDroid: An Information-Flow Tracking System for Realtime Privacy Monitoring on Smartphones", Proceedings of the 9th USENIX Conference on Operating Systems Design and Implementation, OSDI'10. Berkeley, CA, USA, pp. 1–6

[14] Yan, Yin, Cosgrove, Shaun, Anand, Varun, Kulkarni, Amit, Konduri, Sree Harsha, Ko, Y. Steven and Ziarek, Lukasz (2014) "Real-time android with rtdroid", Proceedings of the 12th Annual International Conference on Mobile Systems, Applications, and Services, MobiSys'14, Bretton Woods, New Hampshire, USA, pp. 273–286