

COMP5216 Assignment Project Exam Help

Week 07

Semester 2, 2020

<https://eduassistpro.github.io/>

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Outline

- Computation
 - Managing Computation tasks
 - Monitoring the load
 - Cloud computing support
- Energy Manage <https://eduassistpro.github.io/>
 - Energy consumption
 - Best practices for energy management
 - Platform supported energy management
- Towards battery less devices

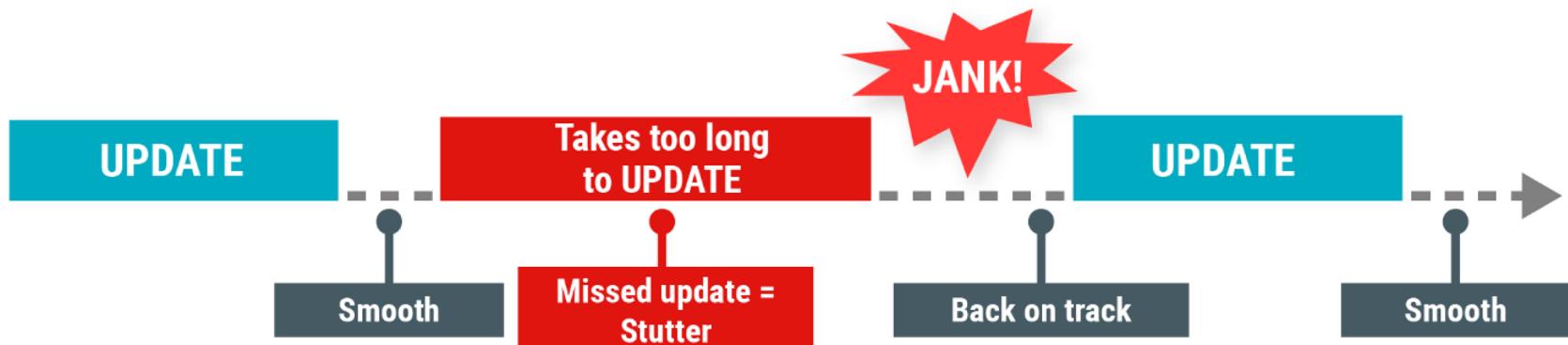
Computing Challenge

- Hardware updates screen every 16 milliseconds
- UI thread has 16ms to do all its work
- If it takes too long, app stutters or hangs

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Computing Challenge

- What are long running tasks ?
 - Downloading/Uploading files
 - Image processing, e.g. object detection
 - Loading data
 - Complex calculations

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- How to check wh ?
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Checking your frame rate

- What are long running tasks ?
 - Downloading/Uploading files
 - Image processing, e.g. object detection
 - Loading data
 - Complex calculations

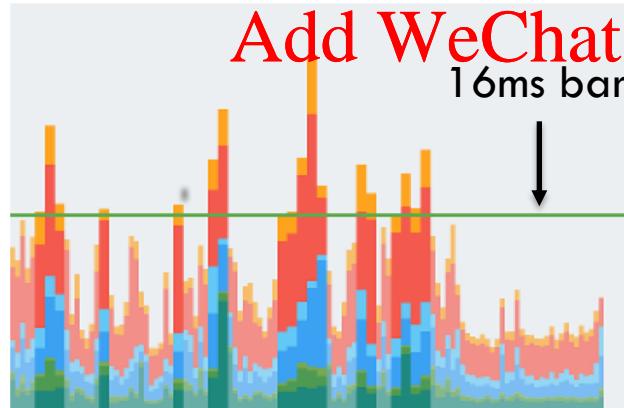
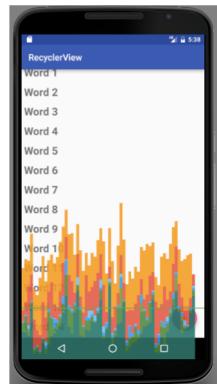
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- How to check wh ?
 - Settings > Developer options > Mo Add WeChat edu_assist_pro rendering > On screen as bars
 - How to find Developer options ?

Checking your frame rate

- Settings > Developer options > Monitoring section > Profile GPU rendering > On screen as bars
- How to find Developer options ?
 - Hidden by default

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bar represents one frame

dering

the bar, the longer it

takes to render

- The horizontal green line represents 16 milliseconds.
- **Each frame needs to stay below this line → 60 frames/s**

Visualize GPU overdraw

- Settings > Developer options > Hardware accelerated rendering > Debug GPU Overdraw > overdraw areas

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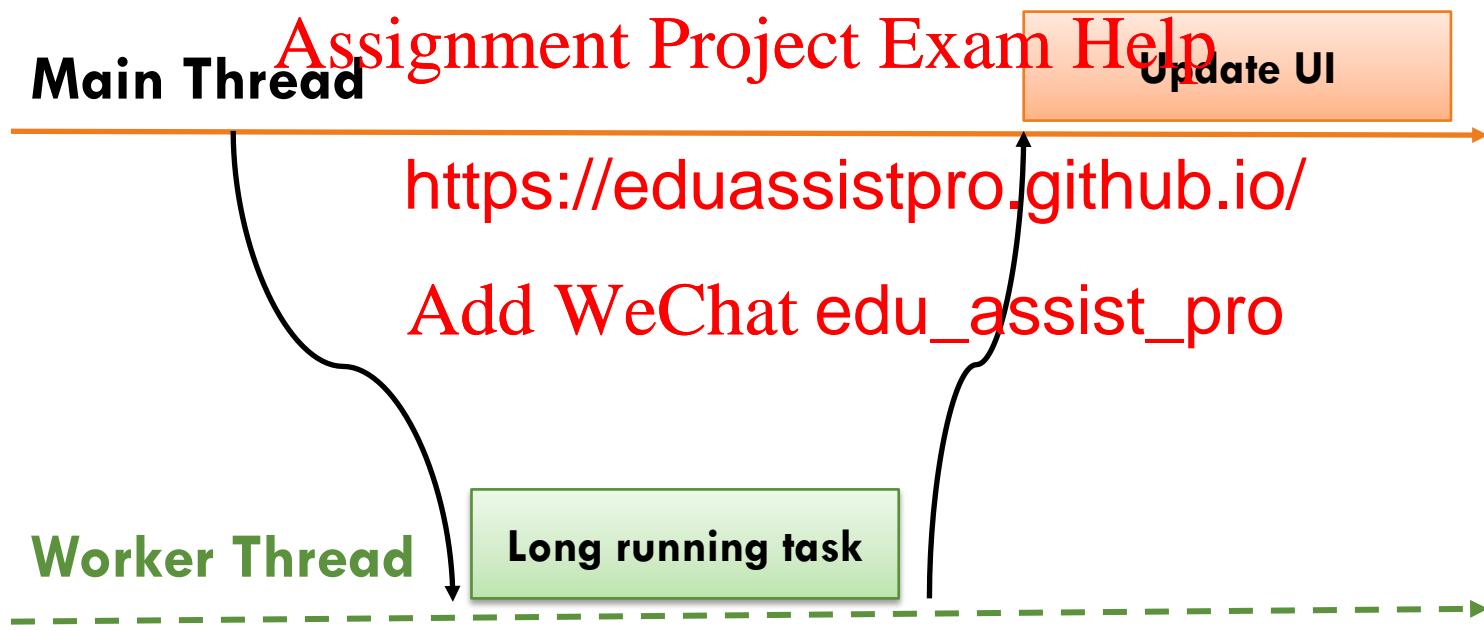
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- How to reduce overdraw ?
 - Removing unwanted backgrounds in layouts.
 - Flattening the view hierarchy.
 - Reducing transparency.
 - <https://developer.android.com/topic/performance/rendering/overdraw>

Best Practice Computing

1. Complete tasks in less than 16ms
2. Move non-UI tasks to background thread



- In Android
 - AsyncTask, The Loader Framework, Services

Best Practice Computing

1. Complete tasks in less than 16ms
2. Move non-UI tasks to background thread
3. Offload to a location with enough resources

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- **Mobile Computation** <https://eduassistpro.github.io/> to connect their application to backend cloud storage using
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What is Mobile Cloud Computing ?

- **Mobile Computing + Cloud Computing**
 - Provides mobile application developers a way to connect their application to backend cloud storage and processing
- **“Anything-as-a-Service” Assignment Project Exam Help**
 - Software-as-a-
 - Platform-as-a-S <https://eduassistpro.github.io/>
 - Infrastructure-as-a-Service
 - Mobile Backend-as-a-Service [Add WeChat edu_assist_pro](#)
- Multiple monetization models
 - Pay per use
 - Subscriptions
- Private vs Public cloud resources

<https://www.back4app.com>

Mobile Cloud Computing

- Why ?
 - Limited resources on mobile devices
 - Battery, Computation, Network, etc.
 - Abstract away complexities of app development
 - E.g. Google Play Services
 - Minimize launching and managing own infrastructure
 - Enable enter <https://eduassistpro.github.io/> a capital expenditure
 - Focus more on fr ackend functions
 - Integration of multiple developers, a
 - To enable data sharing
 - For permanent storage, backup
 - Easy app analytics
 - Security
- Examples from current popular apps ?

Examples

- Apple Siri
 - Speech recognition → Too complex for a mobile device
- Dropbox, Google Drive, Apple iCloud
 - Unlimited storage → Not enough storage on mobile devices
- Google Play Loca<https://eduassistpro.github.io/>
 - Hide complexity from the app devel
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- Single Sign-on Authentication
 - Focus more on the front-end development
- Social Networking
 - Data storage and sharing, Push notifications

MBaaS Providers

- Not a comprehensive list
 - Literally every company has a MBaaS Cloud Service

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Firebase

- Google MaaS Solution
 - Not only for Android
 - Most Features supports     
- Offer a number of features
 - Build better app
 - Improve app q <https://eduassistpro.github.io/>
 - Grow your business
- Click Tools >Firebase to open the Assistant window
 - Tutorial 4

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Firebase

- Firebase ML - <https://firebase.google.com/docs/ml>
 - Still a beta version
 - APIs that work either in the cloud or on the device
 - Convenient APIs use deep learning capabilities
 - For both iOS and Android
 - Text recognition <https://eduassistpro.github.io/>
 - Face detection
 - Barcode reading [Add WeChat edu_assist_pro](#)
 - Label images
 - Landmark recognition
- Firebase Cloud Messaging - <https://firebase.google.com/docs/cloud-messaging/>
 - FCM provides a **single, persistent connection** to the cloud
 - All apps needing real-time messaging can share this connection

ML Tool kit

- ML Tool Kit – <https://developers.google.com/ml-kit>
 - Released on Jun 2020

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Natural Language APIs

Natural language processing APIs to identify and translate between 58 languages and provide reply suggestions.



Language ID

Determine the language of a string of text with only a few words.

[Get started](#)



On-device translation

Translate text between 58 languages, entirely on device.

[Get started](#)



Smart Reply

Generate reply suggestions in text conversations.

[Get started](#)

ML Tool kit

- ML Tool Kit – [https://developers.google.com/ml-kit">
– Released on Jun 2020](https://developers.google.com/ml-kit)
- Samples:
<https://github.com/AssignmentProject/ExamHelp/master/android/vision-quickstart>
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Battery consumption

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Battery consumption

- **Screen & CPU**

- Foreground vs Background
- Activity vs Services
- Sleep vs Active

- **Input modalities**

- Type, Talk or S

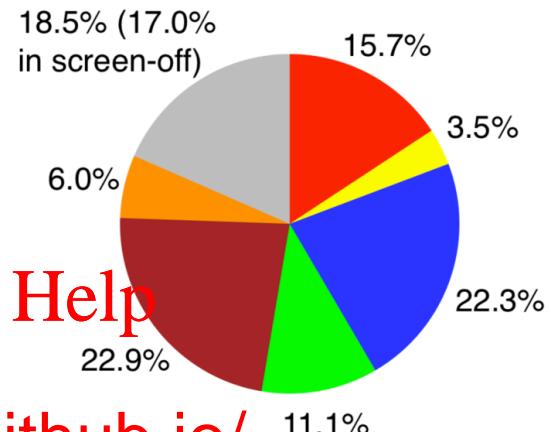
- **Sensing**

- Location (GPS vs Network)
- Activity monitoring sensors - Accelerometer, Magnetometer, etc.
- Camera

- **Network interface**

- Cellular>WiFi>Bluetooth in general
- Communication protocol, e.g. HTTPS vs HTTP, content refresh rate

Screen & CPU



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- Move the app to ~~Add WeChat~~ ~~Background~~, if ~~edu_assist_pro~~ ~~action~~ is not required.
 - Activity vs Services in Android
- Good programming practices
 - Efficient algorithms
 - Reduce disk access frequency
- Figure Reference: Chen, Xiaomeng, et al. "Smartphone Background Activities in the Wild: Origin, Energy Drain, and Optimization." Proceedings of the 21st Annual International Conference on Mobile Computing and Networking. ACM, 2015.

Input Modalities

- Talk (Speech to Text), Type (Soft Key) and Swipe

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CHARACTERISTICS OF DIFFERENT INPUT MODALITIES

Input Accuracy Convenience Privacy Speed Modes					Energy Consumption <i>Short long</i>	
SK	Highest	Low	High	Fast	Lowest	Low
STT	Lowest	High	Low	Fastest	High	Lowest
Swype	Medium	High	High	Slower	Low	High

Reference: Jiang, Fangzhou, et al. "When to type, talk, or Swype: Characterizing energy consumption of mobile input modalities." Pervasive Computing and Communications (PerCom), 2015 IEEE International Conference on. IEEE, 2015.

Sensing

- Sensor API are primarily used;
 - Identifying sensors and sensor capabilities
 - Monitor sensor events

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- **Identify Sensor**
 - getResolution() for <https://eduassistpro.github.io/>
 - getMaximumRange() for maximum measurement
 - getPower() for sensor's power requirement
 - getVendor() and getVersion() to optimize for different sensors or different versions of sensor
 - getMinDelay() to determine maximum rate at which sensor can acquire data

Sensor Delays

- Rely on the lowest possible sampling rate
 - Higher the sampling rate, higher the energy consumption

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Kolamunna, H. D., Thilakarathna, K., Perino, D., Makaroff, D., & Seneviratne, A. (2018). Seamless Resources Sharing in Wearable Networks by Application Function Virtualization. *IEEE Transactions on Mobile Computing*.

Networking Radio/Chipset on mobile devices

- Not always ON
- Becomes ACTIVE, only when it is required to transfer data
- After a transfer, stays ON for some time
- Eventually, **Assignment Project Exam Help** goes back to SLEEP

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3G State machine.

LTE State machine.

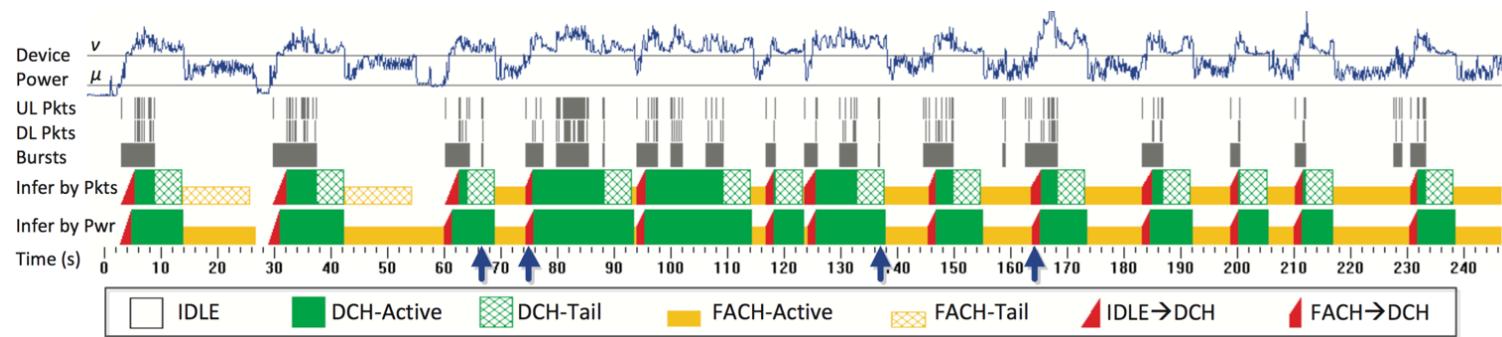
[1]. Qian, Feng, et al. "Profiling resource usage for mobile applications: a cross-layer approach". Proceedings of the 9th international conference on Mobile systems, applications, and services. ACM, 2011.

[2]. Huang, Junxian, et al. "A close examination of performance and power characteristics of 4G LTE networks". Proceedings of the 10th international conference on Mobile systems, applications, and services. ACM, 2012.

LTE Network Power Usage

- Power consumption of LTE data communication

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High Power
Medium Power
Low Power
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Network Power Usage

LTE vs 3G vs WiFi

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- In general, LTE>3G>WiFi.
 - Dependent on the network conditions, e.g. available bandwidth, signal strength, interference, etc.

Balasubramanian, Niranjan, Aruna Balasubramanian, and Arun Venkataramani. "Energy consumption in mobile phones: a measurement study and implications for network applications." Proceedings of the 9th ACM SIGCOMM conference on Internet measurement conference. ACM, 2009.

Privacy and Security

- Energy cost of secure protocols is not negligible.
 - More data due to adding noise, encryption, channel coding, etc.
 - Extra communication due to key exchanges

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- Security is important in today's mobile world.
 - It is worth the cost of energy

H. Kolamunna, J. Chauhan, K. Thilakarathna, D. Perino, D. Makaroff and A. Seneviratne, "Are Wearables Ready for Secure and Direct Internet Communication?", ACM GetMobile: Mobile Computing and Communications, vol. 21, no. 3, pp. 5-10, Sep 2017.

Best Practices for Energy Management

- “Lazy First” design strategy

1. Reduce Assignment Project Exam Help

- Can we cache data before downloading? <https://eduassistpro.github.io/>

2. Defer Add WeChat edu_assist_pro

- Can we wait until the device is charging ?

3. Batch

- Can we batch downloads together?

Best Practices for Energy Management

- **Reduce**
 - Upload/Download only necessary data [Week 5]
 - Reduce – Caching [Week 5]
 - Compressing [Week 5]
- **Defer** <https://eduassistpro.github.io/>
 - Offloading (reactive/predictive) to smart networks [Week 5]
- **Batch**
 - Reduce the frequency of communication
 - Use an exponential back-off pattern when you sync or poll to extend the time between subsequent polls

Best Practices for Energy Management

- Batch transfers and connections
 - E.g. analytics information should batched together and queued to be bundled with another download or upload
 - In Android, JobScheduler API or Firebase JobDispatcher

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Example Question

You have decided to develop your own ads library to reduce device energy consumption. To properly configure the relevant parameters, you first conducted an experiment to measure the energy consumption of an Android phone when downloading an image of 100KB using the 3G (UMTS) Cellular network. The obtained average energy profile is in the Figure. Note that it takes 4 seconds to download a 100KB file and the idle energy consumption is 10 mJ per seconds as shown in the Figure.

Q1. Consider a scenario displayed during a 2.5 minutes time frame an ad library refresh ads at every 30 seconds Add WeChat <https://eduassistpro.github.io/> Calculate the energy consumption of the app (i
Note: assume each ad is of size 100KB.

Q2. Calculate the amount of energy that can be saved, if your ad library fetch all 5 ads at the same time.

Best Practices for Energy Management

- Avoid polling server to see whether there is an update
 - Let the server push data to the app only when there is an update
 - Firebase Cloud Messaging (FCM) implements lightweight mechanism to transmit data.

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- Measure the per

g Network Profiler

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- Best programming practices

- <https://developer.att.com/video-optimizer/docs/best-practices>

Best Practices for Energy Management

Android Platform Battery Management

1. Doze

- Deferring background CPU and network activity for apps when the device is unused for long periods of time
- If the device is **unplugged** and **stationary for a period of time**, with the **screen off**, the device enters Doze mode.
- After that, system

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<https://developer.android.com/training/monitoring-device-state/doze-standby>

Best Practices for Energy Management

Android Platform Battery Management

- Doze restrictions
 - Network access is suspended, including WiFi scans
 - Does not allow JobScheduler, SyncAdapters
 - Ignores wake locks.
 - Standard Alarms will not go off.

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2. App Standby <https://eduassistpro.github.io/>

- If the user does not touch the app for a period of time
- No current foreground processes
- No notifications
- Not a system admin app, Android moves the app to Standby mode
- For list of all restrictions of Doze and App Standby
 - <https://developer.android.com/topic/performance/power/power-details>

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Best Practices for Energy Management

Android Platform Battery Management

3. App Standby Buckets

The system dynamically assigns each app to a priority bucket

- Active: App is currently being used or was very recently used
- Working set: App is in regular use
- Frequent: App is used ^{day}
- Rare: App is not

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Best Practices for Energy Management

Android Platform Battery Management

- Restrictions**

- <https://developer.android.com/topic/performance/power/power-details>**

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Best Practices for Energy Management

Android Platform Battery Management

- **Make sure your app functions well under Doze & App Standby modes**
 - If you need to set alarms that fire while in Doze, use setAndAllowWhileIdle() or setExactAndAllowWhileIdle().
 - Use ~~Fireba~~~~Assignment Project Exam Help~~
~~https://eduassistpro.github.io/~~
~~Add WeChat edu_assist_pro~~
 - FCM is optimized for standby idle modes by means of high-priority wake locks, then returns the device to services and partial the idle state.
- Partial exemption from restrictions
 - Users can manually configure the list of exempted apps in **Settings > Battery > Battery Optimization**
 - REQUEST_IGNORE_BATTERY_OPTIMIZATIONS permission can trigger a system dialog without user setting it manually

Best Practices for Energy Management

Android Platform Battery Management

Best practices to manage App Standby Bucket

- Do not try to manipulate the system into putting your app into one bucket or another.
- If an app does not have a launcher activity, it might never be promoted to the active bucket.
- If the app's notifications (including high-priority FCM message) aren't actionable, users will ignore them, which may affect the app's promotion to the active bucket by the system.
- You should be sure to correctly manage the packages assigned to various buckets to make sure the app behaves properly.
- You should test your app fully in **Doze** and **App Standby**
 - Forcing the system into Doze mode by running the following command:
\$ adb shell dumpsys deviceidle force-idle
 - Forcing the app into App Standby mode by running the following commands:
\$ adb shell dumpsys battery unplug
\$ adb shell am set-inactive <packageName> true

Profile battery usage in Android

- **Batterystats** – a tool in Android framework
- **Battery Historian** – visualize data collected from Batterystats

1. Install Battery Historian

- <https://github.com/google/battery-historian>
- Using Docker
 - Install [Docker](#). <https://eduassistpro.github.io/>
 - Choose a port num
 - `docker -- run -p<port>:9999 qcr.io/andr 9999`
- For Linux and Mac OS X:
 - Historian will be available at <http://localhost:<port>>.
- For Windows:
 - You may have to [enable Virtualization in your BIOS](#).
 - Find the IP address of docket.
 - Historian will be available at <http://<ip address>:<port>>.

Profile battery usage in Android

- Collect data with BatteryStats
- Using Android Debug Bridge (ADB)
 - <https://developer.android.com/studio/command-line/adb>
- Follow this walkthrough -
 - <https://develop>
 - <https://eduassistpro.github.io/>
 - <https://battery-historian>

Profile battery usage in Android

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1 Add more metrics

2 More info including
the color legend

3 More info of the
metric at that
particular time

Towards battery less devices

- Ambient energy harvesting
 - Radiant – Light, Radio frequencies
 - Kinetic – Vibrations, human motion
 - Thermal – Temperature
 - Chemical – Metabolic reactions
- Using body heat <https://eduassistpro.github.io/wearables>
 - PowerWatch [Add WeChat edu_assist_pro](https://www.powerwatch.com)
 - <https://www.powerwatch.com>
- Kinetic energy harvesting shoes
 - <https://newatlas.com/energy-harvesting-shoes/41796/>
- Kumara Kahatapitiya, Chamod Weerasinghe, Jinal Jayawardhana, Hiranya Kuruppu, Kanchana Thilakarathna, and Dileeka Dias. 2018. Low-power step counting paired with electromagnetic energy harvesting for wearables. In Proceedings of the 2018 ACM International Symposium on Wearable Computers (ISWC '18)



What's Next ?

- Next week
 - Mobile computing beyond smartphones
- Homework 2 is due next week ! Assignment Project Exam Help
- Guest/Industry L <https://eduassistpro.github.io/>
 - Cross-Platform
 - Glenn Stephens Add Microsoft WeChat edu_assist_pro
- Project proposal marks will be made available soon !
 - If you want feedback about your proposal, please talk to me !