On Energy Security of Smartphones

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Smartphone Energy Modeling

Energy energy modeling on each app:

- Breakdown the power consumption by every component and build energy models.
- A well designed battery interface to visualize energy consumption.
- High frequency and high accuracy.
- Existing energy malware is not hard to detect under the energy accounting and battery interface.

❑ However, existing energy modeling could be easily evaded!

Attacking vectors

❖ Wakelock- & Screen-based Attack Vector.

Screen energy profiling:

1. Take screen as an independent module.
2. Allocates screen energy to foreground app.

Problem: both mechanisms give malicious apps the possibility to deceive energy accounting.

Change the screen configuration in background.

Attacking vectors

❖ IPC-based Attack Vector.

- Bob uses the Message app to film a 30s video.
- A small camera window is embedded in the Message. All occur in the Message.
- It is reasonable to expect: **the Message should be accounted for the energy consumption.**

❖ Measured by Android official app.

- Message only consumes **a quite small portion** of energy.
- The energy **drained by video filming** is assigned to **the Camera**.

- ❑ The Message sends an Intent to request the Camera app.
- ❑ It is the Camera app that actually records the video.

Problem: existing energy accounting modules overlook IPC.

Energy Collateral Attacks

❑ Attacks.

- **#1** Hijack components belonging to other apps.
- **#2** When malware is launched by user, malware open other apps concurrently and make them run in background.
- **#3** Bind to services without unbinding.
- **#4** Interrupt attacked apps to background.
- **#5** Drain energy through changing screen configuration (such as escalating the brightness).
- **#6** Acquire screen wakelock without releasing to keep screen on.
- **Multi- & Hybrid Attack.**
 - Multi attack on one app.
 - Energy attack chains.

Attack Scenarios.

- DoS attack.
- Mislead a user's attention to an innocent app.
- Unlike traditional attacks, target at reducing battery.
- Launch accompanying with traditional attacks.

Defense

❖ Architecture of E-Android

- **Extension of Android framework.**
 - Record all events potentially invoke an energy collateral attack.
 - Record the user ID of both apps as well as the type of the operation.
- **Enhanced energy accounting module.**
 - Calculate energy consumption with consideration of collateral effects
- **Revised battery interface.**
 - Inform users of all information related to energy consumption.
 - Provide a detailed inventory specifying contribution of all attack related apps

Experiments

- ❖ (a) Open the Message app 30s and then use it to take a 30s short video (Similar to the malware attack #1).
- ❖ (b) Use the Contacts to open the Message, then films a 30s video (Energy attack chain).
- ❖ (c) Malware binds the victim's service and forces the service to **run continuously after the attacked app attempts to stop the service.**
- ❖ (d) Interrupt the foreground app to background by detecting the quit dialog, using SurfaceLinger.
- ❖ (e) Malware enhances brightness from service.
- ❖ (f) Malware does not release screen wakelock.

❑ All those attacks could successfully bypass the supervision of the Android battery interface.

❑ E-Android can **detect all these attacks.**