

Android Power Management: Current and Future Trends

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Projet : « Smart 4G Tablet »

ARCHOS

gemalto
security to be free



wysips
what you see is photovoltaic surface



LPCIM : Laboratoire de Physique des
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LES PÔLES DE  COMPÉTITIVITÉ



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- Introduction
- Android power management architecture
- Present research on power consumption & management
- Survey on power saving Android apps
- Future directions
- Privacy & security concerns
- Conclusion

Introduction

- Smart device features that consume power
 - CPU, Wi-Fi, GPS, colorful bright display, 3G, auto sync, Bluetooth etc.
 - third party advertisements shown in free Android apps
- Many power saving apps written
 - control Wi-Fi, 2G and 3G connections, brightness level, CPU frequency, GPS etc.

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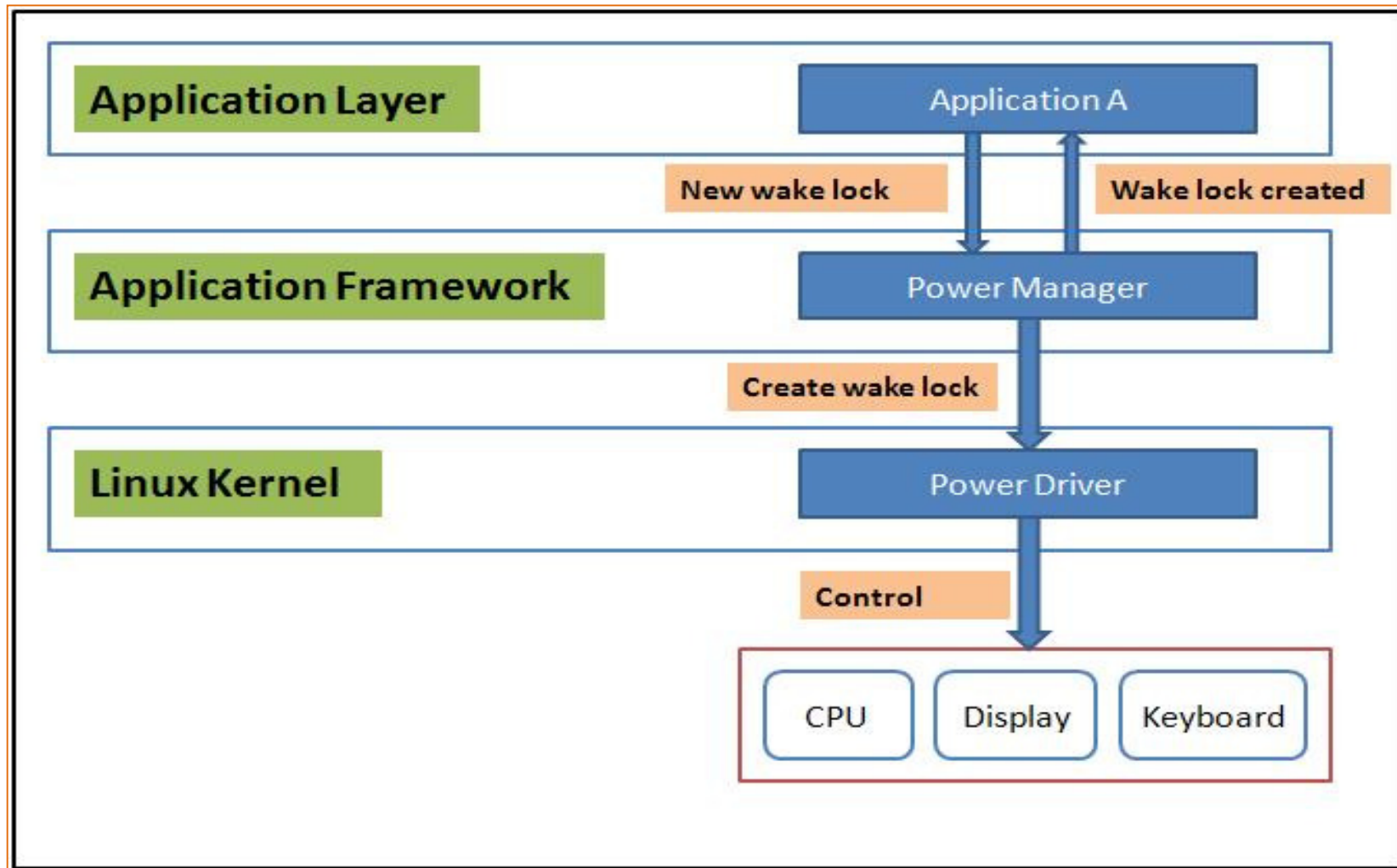
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Android Power Management

- Power driver addition to Linux kernel.
- Wake Locks
 - It prevents the system from entering suspend or other low-power states.
 - Android apps are required to request CPU resources with wake locks.

Wake Lock	CPU	Screen	Keyboard
PATIAL_WAKE_LOCK	On	Off	Off
SCREEN_DIM_WAKE_LOCK	On	Dim	Off
SCREEN_BRIGHT_WAKE_LOCK	On	Bright	Off
FULL_WAKE_LOCK	On	Bright	Bright

Android PM Architecture



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Power consumption of connectivity features

- Reducing power dissipation in Wi-Fi, 3G/4G, GPS
- Location Based Apps (LBA)
 - Social networking, weather, traffic, ad etc.
 - Adaptive location sensing framework

Context Aware PM

- Employs several monitoring system to extract contexts (CABMAN)
 - Location
 - Battery
 - Process
 - Call
- Can predict the next charging opportunity

Power Model Generation

- PowerBooster technique & PowerTutor app is introduced in [1].
- Monitoring & recording battery consumption.
- Each hardware element has several states and power consumption depends on the states.
- Power consumption is correlated with the hardware elements of the smartphones.

Other Approaches on PM

- Analysis using smartphone usage pattern
 - An Android app 'battery logger' is used to collect usage pattern and send it to a server.
- Internal energy consumption of apps
- Human Battery Interaction

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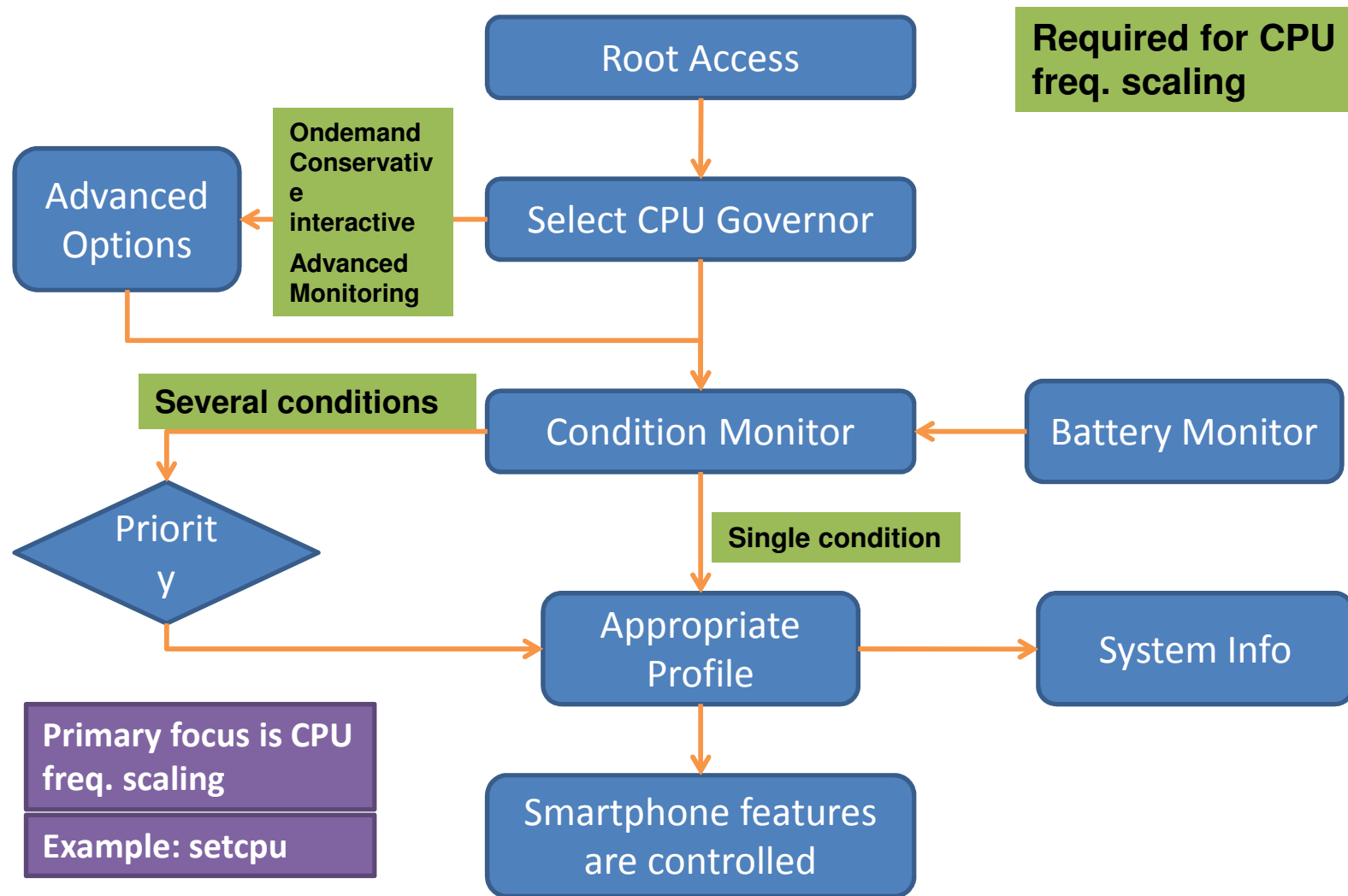
Approach for power saving

Primary Approach	Secondary Approach	App Example
CPU frequency scaling	Toggling other features	Setcpu, cputuner
Control smartphone features	CPU frequency optimization	Juice defencder, extended control and more

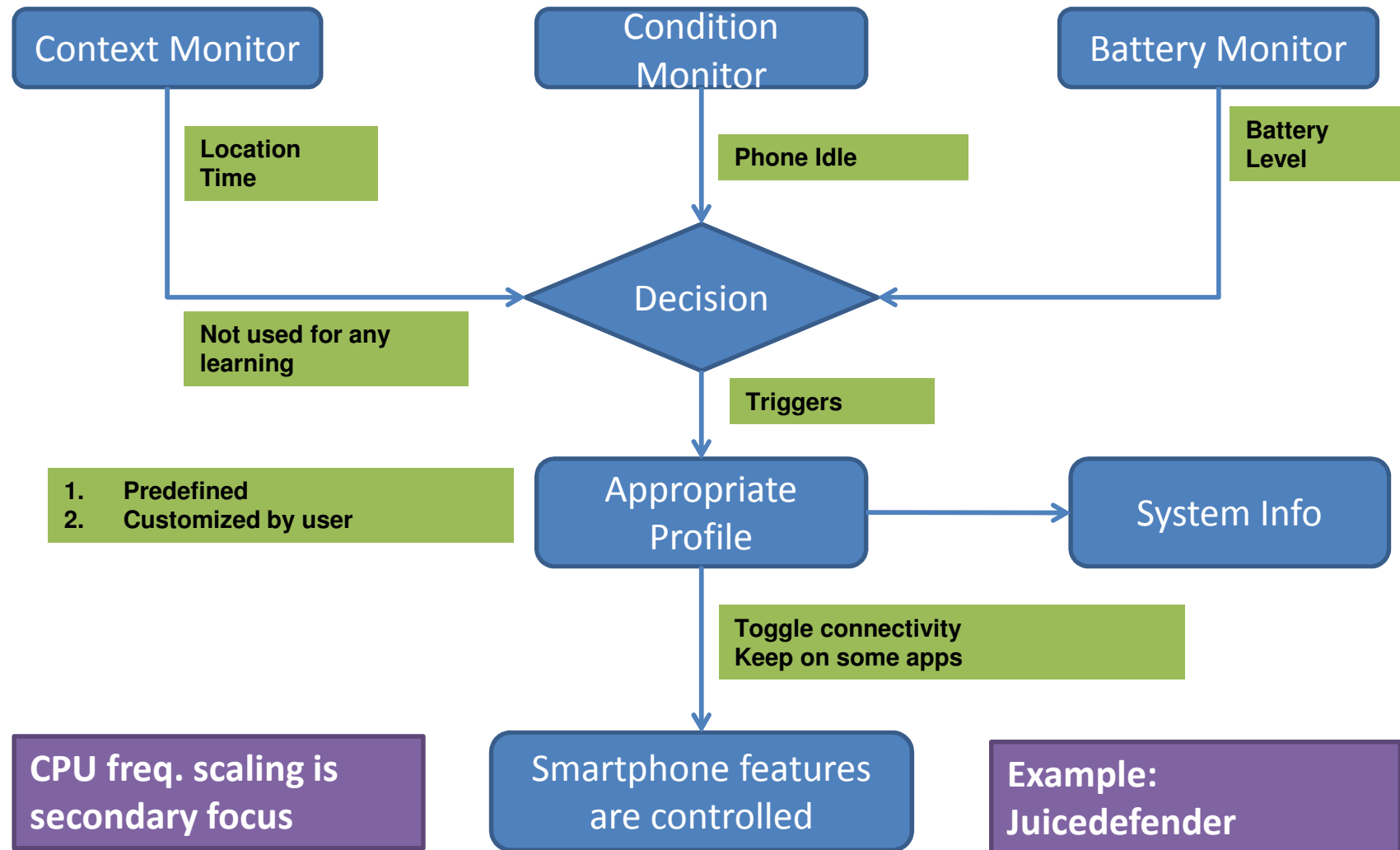
Increasing power efficiency

- Toggle control on Wi-Fi, Bluetooth, GPS, auto sync, airplane mode, auto screen lock, USB mass storage, screen-always-on, torch, 2G, 3G, 4G/Wimax (if present) and mobile data (APN).
- Change brightness level of display.
- Volume and vibration control.
- Alter screen timeout value.
- Scheduling – night, weekend, peak.
- Setting Wi-Fi timeout.
- Setting dark home screen wallpaper for OLED display.

Overall Architecture for CPU frequency scaling approaches



Overall Architecture for Control Smartphone Features Approaches



Limitations of studied apps

- Static profiling (one customizable profile)
 - Not customized for specific user
- “Controlling” – not intelligent
- Requirement for root access
 - For CPU freq. scaling
- No focus on power consumption pattern (except power tutor)
- Context information is not used for any learning purpose
- Do not focus on learning the power consumption pattern of users.
- In-app advertising: waste of energy

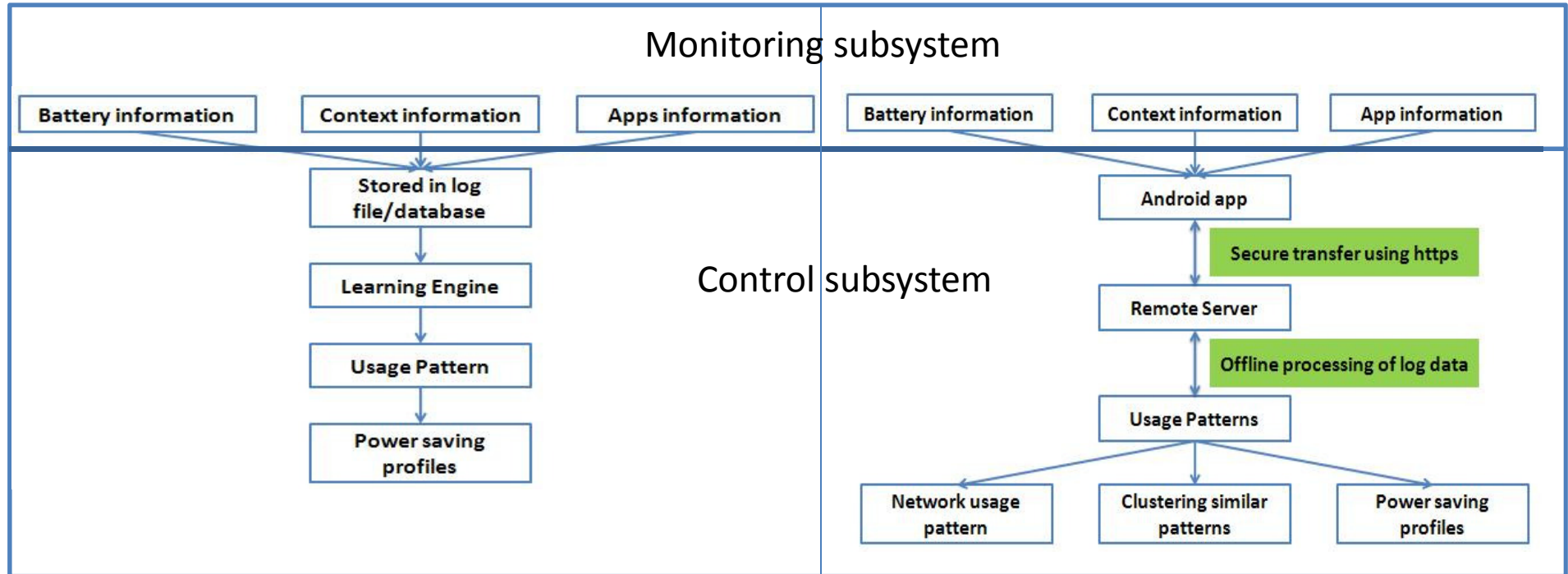
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Apps for Power Management

- Monitoring subsystem
 - Extracts several information like location, date & time, battery discharge behavior, apps running [usage pattern]
 - Controlling subsystem
 - Control smartphone/tablet features based on usage pattern
- Two types of architectures
 - Client server
 - Learning engine

Overall System Architecture



Learning engine

Client server

Advantages of Client Server Architecture

- Generation of smartphone usage pattern
- The context in which most power is spent
- Clustering similar usage pattern at the server
 - Derive power saving profiles based on clusters
- Evolution of clusters
- Network usage pattern
 - Useful for service providers
- But threat to privacy

Advantages of Learning Engine

- Intelligent learning engine
- Usage pattern and power saving profile are generated locally
- No threat on private data
- But network usage pattern could not be known

Other Avenues

- Adding a photovoltaic cell to generate additional power
 - WYSIPS has introduced this
- Adaptive display
 - Shorten the display screen when battery level falls below a predefined threshold

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Privacy Concerns

- Today's smart devices contain user sensitive information.
- Usage pattern is mutually exclusive.
- Collecting usage logs to interpret usage pattern raises the issue of privacy.
- Generation of usage pattern must be privacy aware

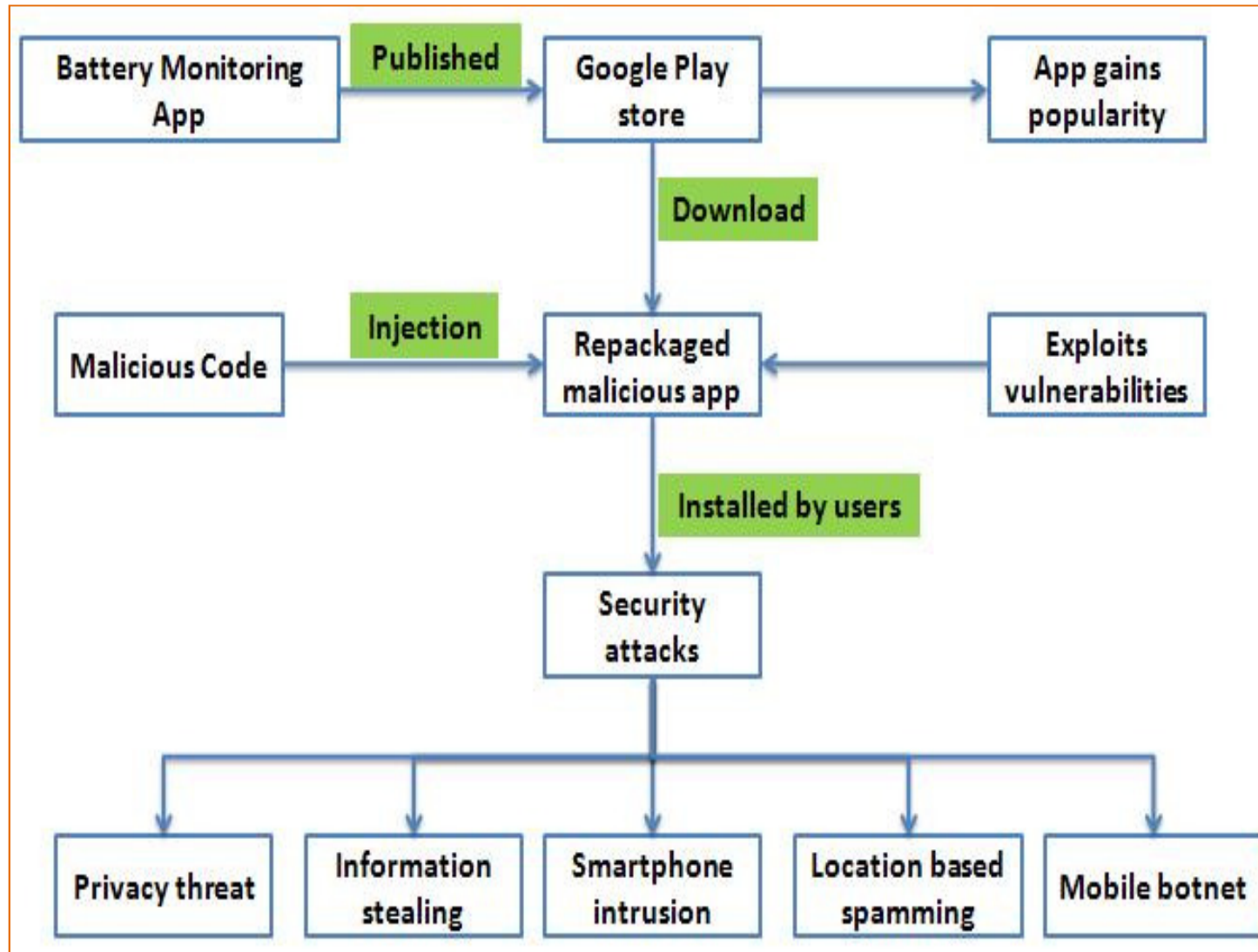
Privacy Concerns

- Raw usage data → User behavior
- App stores info in a log file → another app could access it and send to other remote server
- Location information → 3rd party ad and Location privacy is compromised
- Some app with similar approach could also collect
 - MAC address of Android device
 - IP address
 - Account credentials
 - Phone number

Solutions

- Store monitoring info in a secure database instead of writing into a file.
- Encrypt the collected information.
- The app randomly decides when to send the database dump to the remote server.
- Database dump is sent over a secure connection.
- The user should be given some control over how much usage information is to be sent to the remote server.
- The remote server must employ some privacy preserving data mining algorithm to generate the usage patterns.
- Such patterns should never be revealed to any third party.

Repackaging Attack



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Conclusions

- Highlighting the need of efficient power management for Android devices
- Different research directions are discussed.
- Survey on power saving apps
- Future direction on power management
- Privacy threats & repackaging attack



Thank you