android Bootcamp 2016

New App Lifecycle for Encryption

January 21, 2015

Agenda

- File-based Encryption
- Integration with Android
- User Data Layout Changes
- App Lifecycle Changes

File-based Encryption

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Why encrypt?

- Protect our users against extraction of data from lost/stolen/appropriated devices
- To avoid more subtle physical attacks, critical data must be encrypted with user’s credentials

Full disk encryption

- Meets requirement that data be encrypted at rest
- Credential requirement is a challenge:
    - Only one user per device can be protected properly
    - That user must log in before anything works
    - Does not lend itself to a great user experience
- No obvious way of solving any of these issues with full disk encryption

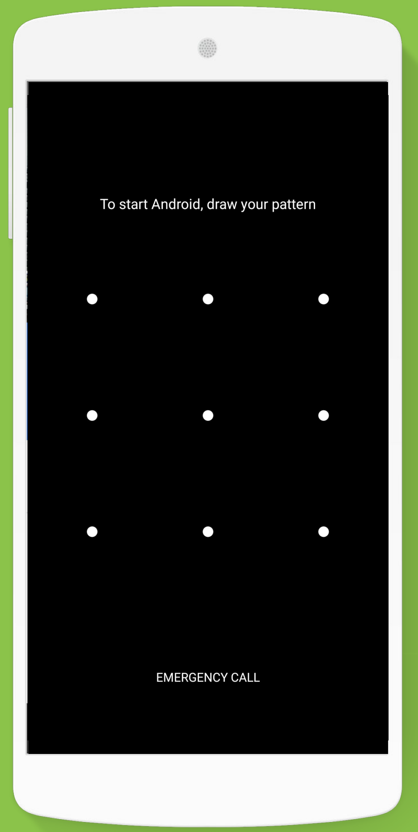
File-based encryption

- Added to `ext4` by Michael Halcrow and Theodore T'so
  - Encrypts file contents with AES-256 in XTS mode
  - File names are also encrypted
  - Policy is applied to a folder and all subfolders
- Performance is slightly better on average than full disk encryption
- Backported to Linux 3.18 common kernel (and Linux 3.10 kernels for testing)
- `f2fs` encryption is also available

Integration with Android

Motivation

- Alarm clock never goes off
- Incoming calls/SMS are forgotten
- Only a handful of built-in “core” apps, no third-party accessibility services
- Wi-Fi configuration is missing
- Bluetooth pairing data is missing



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Storage areas

Device encrypted (DE)

Files encrypted with a key that is only available after a device has performed a successful verified boot.

There is a single **DE_{sys}** key for the system, and a separate **DE_n** key for each user to support fast wipe.

Credential encrypted (CE)

Files encrypted with a key that is entangled with user credentials, such as PIN, pattern, or password. Only available after a user has presented their credentials.

There is a separate **CE_n** key for each user.

Not encrypted (NE)

Files not encrypted at all, which should be extremely rare. OTA update files are one example.

User Data Layout Changes

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Layout goals

Apps

- Default app storage must be **CE_n** to keep legacy apps secure
- Apps can access a new **DE_n** storage area

Media

- Internal shared storage must be **CE_n**

System

- Default system storage can be **DE_{sys}** to make migration easier
- System can access new **CE_n** and **DE_n** storage areas to better protect data

Typical layout

DE_{sys}	`/data/system`
DE_0	`/data/system_de/0`
CE_0	`/data/system_ce/0`
CE_0	`/data/user/0`
DE_0	`/data/user_de/0`

CE_0	`/data/media/0`
DE_{sys}	`/data/misc`
DE_0	`/data/misc_de/0`
CE_0	`/data/misc_ce/0`
NE	`/data/misc_ne`

System storage

- System internals persist a lot of data!
  - By default it's probably stored in **DE_{sys}**
  - Look for data that is strongly associated with a user, and migrate to either **DE_n** or **CE_n**, depending on when it's needed

- **You** are responsible for auditing all data stored by your device
  - Consider unexpected data sources, such as temporary camera files

- So how do you decide if data should be **DE** or **CE**?

Triage examples

DE

- Wi-Fi credentials, Bluetooth pairing data
- Alarm clock details
- Wallpaper, active ringtones

CE

- Account auth tokens/passwords
- Contacts, calendar, SMS history, call log
- Location/browsing history
- Recent tasks, screenshots

System APIs

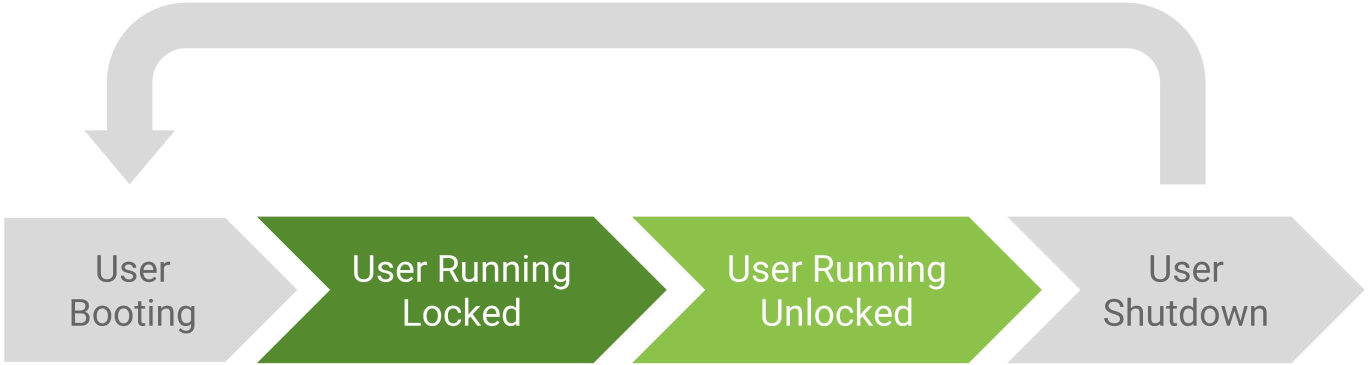
- Inside the system server, paths can be constructed using:
  - `Environment.getUserSystemDirectory(int userId)` **DE_{sys}**
  - `Environment.getUserSystemDeviceEncryptedDirectory(int userId)` **DE_n**
  - `Environment.getUserSystemCredentialEncryptedDirectory(int userId)` **CE_n**
  - `Environment.getMiscNotEncryptedDirectory()` **NE**

App APIs

- By default, Context points at **CE_n** storage, but you can obtain a Context that redirects all file operations to **DE_n** storage:
  - `Context.createDeviceEncryptedStorageContext()`

- System apps can change their default Context to point at **DE_n** storage, and then use a similar method to get back to **CE_n** storage:
  - `<application android:forceDeviceEncrypted=”true”>`
  - `Context.createCredentialEncryptedStorageContext()`
  - **Extreme care** must be used with this flag; all data stored by the app must be audited, and this is only designed to make migration easier

App Lifecycle Changes



- When running locked, only **DE_{sys}** and **DE_n** storage are available
    - Only apps that are *encryption aware* can be run safely
- When running unlocked, **DE_{sys}**, **DE_n**, and **CE_n** storage are available
    - All apps can be run safely
    - User must go through full shutdown to eject **CE_n** keys

Encryption aware apps

- Apps can explicitly mark components as being *encryption aware*, which signals that they can safely run while **CE_n** is unavailable.
  - Includes activities, services, receivers, providers
  - `<receiver ... android:encryptionAware=”true”>`

- All `PackageManager` queries are filtered based on the user state:
  - When locked, **only** encryption aware components are matched
  - When unlocked, **both** encryption aware and unaware components are matched
  - Flags can be used to override this matching behavior when needed

App APIs

- New `UserManager.isUserUnlocked()` API to detect current state
- When user enters locked state:
  - New `LOCKED_BOOT_COMPLETED` broadcast is sent
- When user enters unlocked state:
  - Components started while locked are left running without being killed
  - Existing `BOOT_COMPLETED` broadcast is sent
  - New `USER_UNLOCKED` foreground broadcast is sent
  - Encryption unaware providers are started in already running apps

Common Questions

What if my device doesn’t support file-based encryption?

Devices without file-based encryption support will still need to provide the various filesystem paths described earlier, even if they’re all backed by a single encryption key. These devices can immediately transition from the “running locked” to “running unlocked” state when starting users. Together these ensure we give developers a consistent experience through broadcasts and storage APIs.

THANK YOU