The Android Linux Kernel (Part 3):
Android Kernel Extensions

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Learning Objectives in this Part of the Lesson

1. Recognize the two types of storage supported by Android Linux
2. Understand Android Linux’s local & remote communication mechanisms
3. Know how Android Linux’s processes & threads mediate access to one or more processor cores
4. Recognize extensions that Android Linux adds to the GNU Linux kernel
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   - Manage memory & power effectively on mobile devices
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4. Recognize extensions that Android Linux adds to the GNU Linux kernel, e.g.
   - Manage memory & power effectively on mobile devices
   - Accelerate performance for local inter-process communication (IPC)
Android Linux Extensions: Memory Management
• The Android Linux kernel manages primary storage efficiently for memory-constrained mobile devices
• GNU Linux kernel shields programmers from primary storage constraints
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- Linux’s virtual memory manager allows applications to access an address space larger than RAM
- Swapping is used to automatically exchange the contents of primary storage with secondary storage

See stackoverflow.com/a/4420560/3312330
• The Android Linux virtual memory manager behaves differently than GNU Linux
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- e.g., to conserve power Android Linux doesn’t provide swap space for RAM.

See developer.android.com/training/articles/memory.html#Android
The Android Linux virtual memory manager behaves a bit differently than GNU Linux.

- e.g., to conserve power Android Linux doesn’t provide swap space for RAM.

RAM modified by an app is not written automatically out to swap space.

See stackoverflow.com/a/17478535/3312330
Android Linux defines a “low memory killer” extension.
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- Terminates app components when available RAM falls below a given threshold

See [www.programering.com/a/MjNzADMwATE.html](http://www.programering.com/a/MjNzADMwATE.html)
App developers must know Android Linux kernel storage extensions.
• App developers must know Android Linux kernel storage extensions, e.g.
• Properly implement Activity & Service lifecycle methods

See www.vogella.com/tutorials/AndroidLifeCycle/article.html
App developers must know Android Linux kernel storage extensions, e.g.

- Properly implement Activity & Service lifecycle methods
  - e.g., cleanup dynamically allocated resources in the onPause(), onStop(), & onDestroy() methods

See www.vogella.com/tutorials/AndroidLifeCycle/article.html
App developers must know Android Linux kernel storage extensions, e.g.

- Properly implement Activity & Service lifecycle methods
- Apply common Android idioms for managing app RAM

See developer.android.com/training/articles/memory.html
App developers must know Android Linux kernel storage extensions, e.g.

- Properly implement Activity & Service lifecycle methods
- Apply common Android idioms for managing app RAM
- e.g., use long-running services sparingly & reduce size of Android package kits (APKs)

See developer.android.com/topic/performance/reduce-apk-size.html
App developers must know Android Linux kernel storage extensions, e.g.

- Properly implement Activity & Service lifecycle methods
- Apply common Android idioms for managing app RAM
- Apply common Android tools for managing app RAM

See developer.android.com/topic/performance/memory.html#AnalyzeRam
App developers must know Android Linux kernel storage extensions, e.g.

- Properly implement Activity & Service lifecycle methods

- Apply common Android idioms for managing app RAM

- Apply common Android tools for managing app RAM
  - e.g., Android Studio tools

See developer.android.com/studio/profile/investigate-ram.html
Android’s anonymous shared memory (ashmem) kernel extension allows multiple processes to share memory.
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  • e.g., the Binder framework uses ashmem to optimize transfer of “blobs” by avoiding data copying
ashmem is targeted for mobile devices with limited RAM
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Shared memory regions can be discarded when RAM runs low

See notjustburritos.tumblr.com/post/21442138796/an-introduction-to-android-shared-memory
- ashmem is targeted for mobile devices with limited RAM, e.g.
  - Shared memory regions can be discarded when RAM runs low
  - Memory allocated by ashmem is released when the process that creates it exits

See notjustburritos.tumblr.com/post/21442138796/an-introduction-to-android-shared-memory
Android Linux Extensions: Power Management
Android Linux provides kernel extensions & specialized device drivers tailored for the needs of mobile apps & services.
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  • e.g., mobile devices require kernel-level power management capabilities

See developer.android.com/training/monitoring-device-state
Android Linux Extensions: Power Management

- Android Linux provides kernel extensions & specialized device drivers tailored for the needs of mobile apps & services
  - e.g., mobile devices require kernel-level power management capabilities
  - Common problems include keeping the screen on too long or running the CPU for extended periods of time
Android Linux Extensions: Power Management

- Android Linux’s PowerManagement kernel extensions control when a device sleeps & wakes

See elinux.org/Android_Power_Management
• Android Linux’s PowerManagement kernel extensions control when a device sleeps & wakes

• Android middleware manages app power consumption via these kernel extensions
Android Linux Extensions: Power Management

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- Android middleware manages app power consumption via these kernel extensions
  - e.g., the PowerManager system service provides wake locks to apps that can’t sleep when they are idle

See [developer.android.com/training/scheduling/wakelock.html](https://developer.android.com/training/scheduling/wakelock.html)
Examples include Google Maps navigation.

Android Linux Extensions: Power Management

- Android Linux’s PowerManagement kernel extensions control when a device sleeps & wakes
- Android middleware manages app power consumption via these kernel extensions
- e.g., the PowerManager system service provides wake locks to apps that can’t sleep when they are idle
Android Linux Extensions: Local Inter-Process Communication
The TCP/IP protocol stack is designed for remote communication.
The TCP/IP protocol stack is designed for remote communication. e.g., handles network congestion via “slow start” & exponential back-off algorithms. See en.wikipedia.org/wiki/TCP_congestion_control.
TCP/IP incurs gratuitous overhead when used for IPC between processes on a mobile device

- e.g., unnecessary checksums & code that handles network congestion

See bhavin.directi.com/unix-domain-sockets-vs-tcp(sockets)
Android’s Binder driver is optimized for IPC on the same device.
Android’s Binder driver is optimized for IPC on the same device

- e.g. AIDL is used to invoke “remote” calls

See developer.android.com/guide/components/aidl.html
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Binder driver is written in C/C++ & runs in the kernel to enhance performance
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- e.g. AIDL is used to invoke “remote” calls

Binder driver collaborates with higher-layer Binder framework written in Java
Android’s Binder driver is optimized for IPC on the same device.

- e.g. AIDL is used to invoke “remote” calls.

These layers of software simplify/optimise object-oriented local IPC.
End of the Android Linux Kernel (Part 3): Android Kernel Extensions