**OPERATING SYSTEMS**



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**REPORT**

1. **Introduction:**

Operating systems (OS) form the backbone of modern computing by managing hardware resources and providing services to software applications. This report compares Android, a dominant mobile operating system, with macOS, Apple's desktop/laptop OS. The comparison will delve into key operating system concepts, including process management, memory management, file systems, security, and scheduling, providing insights into their architectural and functional differences.

1. **Process Management:**

**Android:**

Android, built on the Linux kernel, employs a unique approach to process management. Applications run in isolated processes, each with a unique user ID to enhance security. The Dalvik Virtual Machine (DVM), replaced by Android Runtime (ART) in newer versions, optimizes application execution. Processes are managed through techniques like Zygote, which preloads resources for faster app startup, and the kernel schedules tasks using priority-based algorithms.

**macOS:**

macOS leverages a preemptive multitasking environment to manage processes. The XNU kernel integrates Mach and BSD elements, providing robust inter-process communication (IPC) through message-passing mechanisms. Process scheduling in macOS relies on a hybrid model, blending priority-based scheduling with real-time capabilities, ensuring responsiveness and efficient resource allocation.

1. **Memory Management:**

**Android:**

Android employs a layered memory management system. The Linux kernel handles low-level memory allocation and deallocation, while ART manages higher-level memory optimization. Key features include:

* **Low Memory Killer (LMK):**

Frees memory by terminating low-priority processes during resource scarcity.

* **Shared Memory:**

Facilitates efficient IPC among applications.

**macOS:**

macOS features advanced memory management techniques:

* **Virtual Memory:**

Each application gets a separate address space, ensuring stability and security.

* **Memory Compression:**

Reduces physical memory usage by compressing inactive data.

* **Dynamic Memory Allocation:**

Optimizes resource usage by reallocating memory based on process needs.

1. **File System**

**Android:**

Android supports file systems like ext4 and F2FS, optimized for flash storage. SQLite databases manage structured application data, while the Media Store API organizes media files. Android’s file access model enforces application sandboxing, restricting direct access to other apps’ data.

**macOS**: macOS transitioned from HFS+ to APFS, offering:

* **Space Sharing:**

Dynamically allocates storage across multiple volumes.

* **Snapshots:**

Provides point-in-time backups for data recovery.

* **Encryption:**

Ensures data security at rest and in transit.

The file system also supports seamless integration with networked storage.

1. **Security:**

**Android:** Android's security model is multi-layered:

* **Permissions System:**

Regulates app access to sensitive resources.

* **Encryption:**

Implements full-disk encryption and secure boot processes.

* **SELinux:**

Enforces mandatory access control policies.

**macOS**:

* **System Integrity Protection(SIP):** Restricts modifications to critical system files.
* **Keychain:** Enforces mandatory access control policies.App Sandbox:
* **App Sandbox:** Isolates applications to limit potential damage from malware.

1. **Scheduling:**

**Android:**

The Linux kernel’s Completely Fair Scheduler (CFS) underpins Android’s scheduling. It ensures fair CPU time distribution among processes, while real-time scheduling mechanisms prioritize time-sensitive tasks like audio playback.

**macOS:**

macOS’s scheduling integrates CFS with real-time capabilities to handle diverse workloads. The kernel prioritizes user-interactive processes, ensuring smooth performance during multitasking.

1. **Creative Analog:** Android and macOS can be compared to cities:

**Android:** is like a sprawling metropolis, offering vast customization options and flexibility, akin to diverse neighborhoods catering to varied lifestyles.

**macOS:** resembles a meticulously planned city, where design and integration provide a seamless, cohesive experience.

1. **Insights and Observations:** Android’s open architecture and flexibility make it ideal for diverse hardware platforms, while macOS’s closed ecosystem ensures optimized performance and security. Developers must navigate these trade-offs when designing applications.
2. **Conclusion:** Understanding the differences between Android and macOS highlights their unique approaches to addressing user needs and hardware constraints. This comparison underscores the importance of tailoring OS design to specific use cases, balancing flexibility, performance, and security.

**References:**

1. "Android System Architecture," **GeeksforGeeks.**
2. "An Overview of Android Operating System and Its Security Features," **DocsLib.**
3. "Architecture of macOS," **Wikipedia.**
4. "Kernel Architecture Overview," **Apple Developer Library.**