Final Project Report

Topic : Enhancing Android Kernel Observability Using eBPF

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Chapter 1: Introduction

1.1 Introduction

The Android operating system, built upon the Linux kernel, is the most dominant mobile OS worldwide. Securing and optimizing such a complex system requires deep visibility into its kernel-level operations. Historically, achieving this visibility meant using Loadable Kernel Modules (LKMs), a method known to introduce significant stability and security risks. A flawed LKM could compromise or crash the entire system. The extended Berkeley Packet Filter (eBPF) introduces a revolutionary alternative. It allows small, sandboxed programs to be executed safely within the kernel's address space, triggered by specific events like system calls or network packets. An in-kernel verifier statically analyzes eBPF bytecode before loading, guaranteeing that it cannot harm the kernel. This enables live, dynamic instrumentation of a production system without the need for reboots or kernel recompilations, heralding a new era of system observability.

eBPF fundamentally changes the relationship between user-space applications and the kernel. It provides a safe, efficient, and flexible interface that allows developers to extend kernel capabilities at runtime. This is analogous to how JavaScript enabled dynamic, sandboxed applications in web browsers. Just as JavaScript brought interactivity to the web without compromising the user's machine, eBPF brings programmability to the kernel without compromising system stability.

1.2 Motivation

While eBPF is well-established in cloud and server environments for networking, security, and observability, its application to Android remains nascent. The motivation for this project stems from the immense potential eBPF holds for the Android ecosystem. For security analysts, eBPF offers a powerful tool to monitor system integrity and detect malware behavior at the most fundamental level, bypassing traditional user-space evasion techniques. For performance engineers, it provides a low-overhead method to profile applications and identify system bottlenecks that degrade the user experience, a critical concern for battery-powered mobile devices.

However, the Android platform presents unique challenges. Unlike a standard Linux server, a production Android device is a locked-down, resource-constrained environment that lacks the necessary development tools and kernel configurations for ad-hoc eBPF programming. This internship sought to bridge the gap between eBPF's potential and its practical implementation on the unique and security-hardened Android platform.

1.3 Objectives

The primary objectives of this internship were defined to address the challenges and explore the potential of eBPF on Android systematically:

1. **To establish a functional and reproducible development environment** for creating and deploying eBPF programs on a modern Android device. This includes compiling a custom kernel and setting up the necessary on-device toolchains.
2. **To master the use of both the BCC and libbpf/CO-RE toolchains** for writing eBPF applications, understanding their respective strengths and weaknesses in the context of Android.
3. **To implement a suite of observability tools** demonstrating key use cases: system call tracing for security monitoring, network activity monitoring for debugging, and system-wide performance profiling for optimization.
4. **To analyze the results and evaluate the security implications** of using eBPF on Android, providing concrete recommendations for its secure deployment and identifying potential avenues for malicious use.

1.4 Report Outline

This report is structured into five chapters to provide a comprehensive overview of the project.

- **Chapter 2** provides a detailed background on eBPF technology, reviewing its architecture, core components, and the development toolchains. It also surveys existing literature on eBPF security and its application on Android.
- **Chapter 3** details the project's problem statement, presents a flowchart of the overall methodology, and provides a detailed discussion of the algorithms and logic behind the implemented observability tools.
- **Chapter 4** describes the step-by-step implementation process, including the environment setup and tool development, and presents the results obtained from running the tools on the target Android device.

- **Chapter 5** concludes the report with a summary of the key findings, an evaluation of the project's success, and a discussion on the future trajectory of eBPF within the Android ecosystem.

Chapter 2: Background and Literature/Technology Review

2.1 The Evolution from cBPF to eBPF

The original Berkeley Packet Filter (cBPF, or "classic" BPF) was designed in the early 1990s with a singular purpose: to efficiently filter network packets in the kernel for tools like tcpdump. It used a simple, 32-bit, register-based virtual machine that could make basic decisions on packets, avoiding the costly overhead of copying every packet to user space.

The extended BPF (eBPF), introduced into the Linux kernel in 2014, represents a complete reimagining of this concept. It is a general-purpose execution engine that extends far beyond networking. The eBPF virtual machine features a 64-bit instruction set, ten general-purpose registers, a 512-byte stack, and access to a rich set of helper functions. This transformation turned a specialized packet filter into a versatile framework for safely programming the kernel, now used for advanced networking, observability, and security.

2.2 Core eBPF Architecture

The safety, performance, and flexibility of eBPF are built upon a sophisticated architecture comprising several key components.

2.2.1 The eBPF Virtual Machine

At its core, eBPF operates a lightweight, register-based virtual machine (VM) that executes eBPF bytecode within the kernel. Its RISC-like instruction set is designed to map closely to modern hardware architectures like ARM64, which is dominant in the mobile space. This design facilitates highly efficient execution once the bytecode is compiled.

2.2.2 The Verifier: A Guarantee of Safety

The most critical component of the eBPF architecture is the verifier. Before any eBPF program is loaded into the kernel, it undergoes a rigorous static analysis process. The verifier acts as a gatekeeper, ensuring that the program cannot harm the kernel. It does this by simulating every possible execution path of the program and enforcing a strict set of rules
:

- **Guaranteed Termination:** The verifier constructs a Directed Acyclic Graph (DAG) of the program's control flow to ensure it contains no unbounded loops. This guarantees the program will always run to completion and can never cause a kernel hang.
- **Memory Safety:** The verifier tracks the state of all registers and stack accesses to prohibit any out-of-bounds memory operations, null pointer dereferencing, or access to uninitialized variables.
- **Restricted Functionality:** eBPF programs cannot call arbitrary kernel functions. They are limited to a curated set of "helper functions" exposed by the kernel as a stable API, preventing them from accessing unstable or dangerous internal kernel code.
- **Finite Complexity:** The verifier imposes limits on the program's size and complexity to ensure the verification process itself can complete in a reasonable time.

If a program fails any of these checks, the kernel rejects it, shifting the risk from a potential system crash to a program failing to load.

2.2.3 Just-In-Time (JIT) Compilation

After a program successfully passes the verifier, its bytecode is translated into native machine code for the host CPU by a Just-in-Time (JIT) compiler. This means the eBPF program runs at near-native execution speed, imposing negligible performance overhead, which is critical for high-frequency events like system call tracing.

2.2.4 Event-Driven Execution and Hook Points

eBPF programs are event-driven; they lie dormant until a specific event occurs at a "hook point" to which they are attached. The versatility of eBPF comes from the wide variety of available hook points, including:

- **Kprobes/Kretprobes:** Dynamic instrumentation points that can be attached to the entry (kprobe) or return (kretprobe) of almost any kernel function.
- **Tracepoints:** Stable, static instrumentation points placed at logical locations in the kernel source code by developers. They are often preferred over kprobes for common events due to their stable API.
- **System Calls:** Hooks at the entry and exit points of any system call, providing deep visibility into user-space/kernel interactions.
- **Network Events:** Hooks in the networking stack, such as at the Traffic Control (TC) or eXpress Data Path (XDP) layers.

2.3 eBPF Maps and Helper Functions

To be useful, eBPF programs need to store state and communicate with user-space applications. The architecture provides two primary mechanisms for this :

- **eBPF Maps:** These are generic key-value data structures that reside in kernel memory and serve as the main bridge for data exchange. They come in various types, such as hash tables (

BPF_MAP_TYPE_HASH), arrays (BPF_MAP_TYPE_ARRAY), and high-performance event streaming buffers like BPF_MAP_TYPE_PERF_EVENT_ARRAY and BPF_MAP_TYPE_RINGBUF.

- **Helper Functions:** As mentioned, eBPF programs interact with the kernel through a stable API of helper functions. These helpers provide a safe, curated set of capabilities, such as getting the current process ID (

bpf_get_current_pid_tgid()), safely reading memory (bpf_probe_read_kernel()), and interacting with maps (bpf_map_lookup_elem()).

2.4 eBPF Development Toolchains

Two primary toolchains dominate the eBPF development landscape.

2.4.1 BCC (BPF Compiler Collection)

BCC is a toolkit designed for ease of use and rapid development, particularly for tracing. It provides front-ends in Python and Lua, embedding a C compiler (Clang/LLVM) to compile the eBPF C code at runtime.

- **Advantages:** Excellent for interactive exploration and rapid prototyping. It abstracts away many complexities and comes with a rich suite of pre-built tools.
- **Disadvantages:** Its primary drawback is the heavy runtime dependency on the entire LLVM/Clang toolchain, which must be present on the target machine. This makes it cumbersome for resource-constrained devices like those running Android.

2.5.2 libbpf and CO-RE (Compile Once - Run Everywhere)

libbpf is a C library, maintained as part of the Linux kernel source, that represents the modern, production-oriented approach to building eBPF applications. The workflow involves pre-compiling the eBPF C code into a standard object file. The user-space application links against libbpf to load this object file. This model is tightly integrated with CO-RE, which uses BPF Type Format (BTF) debugging information embedded in the kernel to perform runtime relocations. This allows a single compiled eBPF binary to adapt to minor variations across different kernel versions, solving a major portability problem.

- **Advantages:** Produces small, self-contained, and efficient binaries with no runtime dependency on a compiler, making it ideal for production and embedded systems.
- **Disadvantages:** The development process is more involved than with BCC, and it relies on newer kernels having BTF support enabled, which is not always a given on Android.

2.6 eBPF in the Context of Android Security

The application of eBPF to Android security is an emerging field of research. The academic paper "BPFroid" presented a novel dynamic analysis framework for Android that uses eBPF to monitor events across the entire software stack, from kernel functions to the Java API framework. The key insight of BPFroid is that by hooking events in the kernel, malware is unable to trivially bypass the monitoring. This work established a strong precedent for using eBPF for robust, real-time malware detection on Android.

Conversely, the security community has also recognized the potential for eBPF to be abused. Research into eBPF-based rootkits has demonstrated that an attacker who gains root privileges can use eBPF to create sophisticated, hard-to-detect malware. These rootkits can hide files and processes, intercept network traffic, and make malicious processes unkillable by hooking and manipulating kernel functions and system calls. This dual-use nature makes a thorough understanding of eBPF's security posture essential.

Chapter 3: Problem Statement and Methodology

3.1 Problem Statement

The core problem this project addresses is the significant challenge of applying dynamic, ad-hoc eBPF-based observability to a standard Android environment. Production Android devices are locked down and lack the kernel headers, compilers, and other development tools required for on-device eBPF development. Furthermore, the Android ecosystem's use of the Bionic C library, its unique boot process, and security hardening create an environment that is fundamentally different from a standard Linux distribution where eBPF tooling is mature.

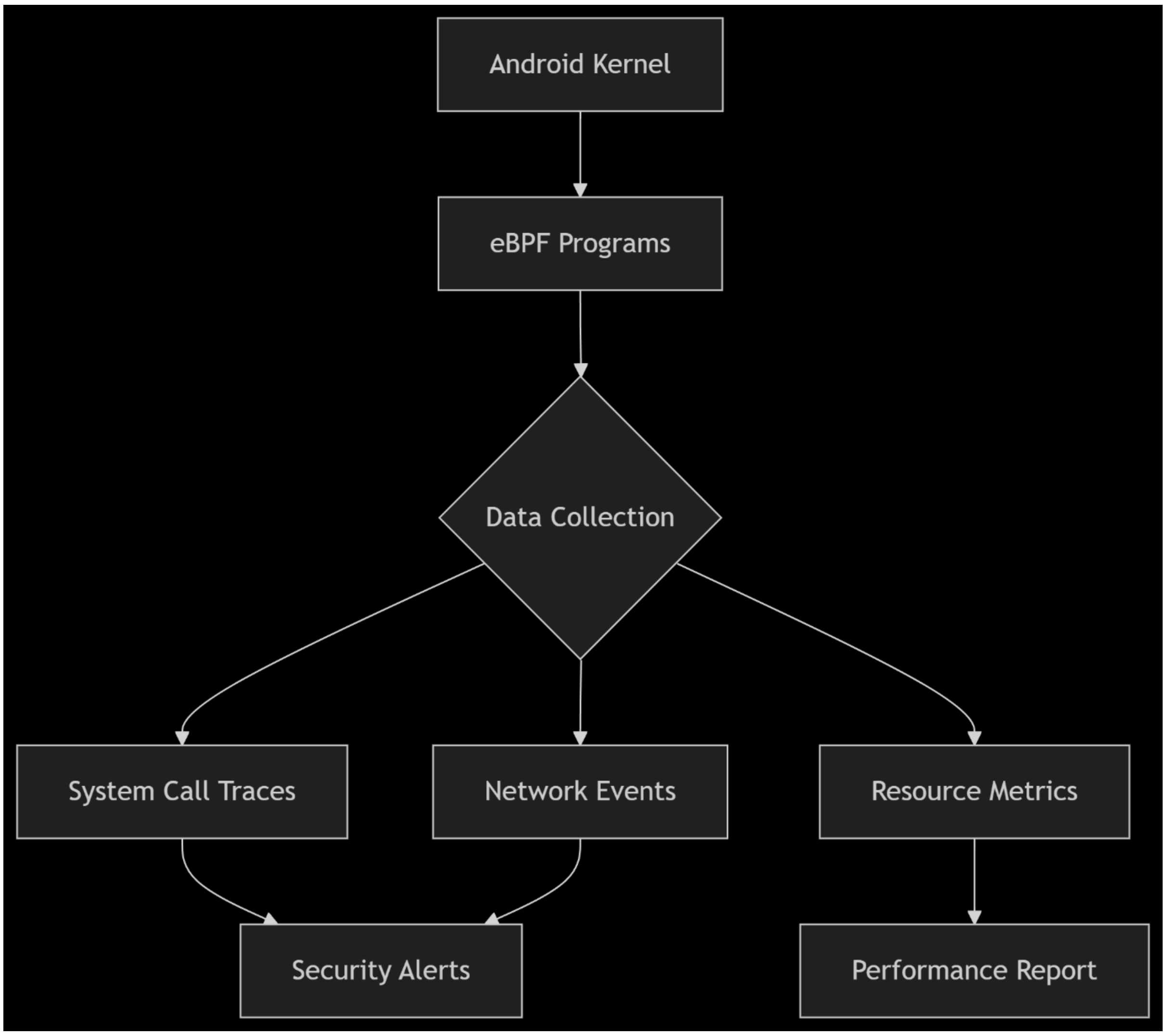
The official use of eBPF for features like network traffic monitoring follows a static, platform-integrated model where programs are compiled as part of the Android Open Source Project (AOSP) and loaded at boot by a system daemon. This approach is unsuitable for the dynamic analysis, debugging, and security research that this internship aims to explore.

Therefore, the problem is to devise and document a complete methodology to overcome these limitations, enabling the creation and execution of sophisticated eBPF tracing tools on a typical Android device for security and performance analysis.

3.2 Flowchart of the Work

The methodology followed a structured, multi-stage process, designed to systematically build the required environment and then leverage it for practical tool development. This workflow is visualized in Figure 3.1.

Figure 3.1: Workflow for eBPF Development on Android



This flowchart illustrates the critical path from obtaining the source code to analyzing the data produced by the custom eBPF tools. Each step is a prerequisite for the next, highlighting the foundational importance of preparing the kernel and the on-device environment correctly.

3.3 Detailed Discussion of Algorithm(s) Used

The three observability tools developed for this project each employ a distinct algorithm tailored to its specific goal, leveraging different eBPF features.

3.3.1 Algorithm for execsnoop: System Call Tracing

This tool's purpose is to trace all new process executions by monitoring the execve system call. The algorithm prioritizes stability and performance by using tracepoints and the modern libbpf/CO-RE toolchain.

1. **Hook Point Selection:** The stable kernel tracepoint tracepoint/syscalls/sys_enter_execve is chosen as the hook. Tracepoints are part of the kernel's stable ABI, making them more portable across kernel versions than kprobes.
2. **Kernel-Space Logic:**
   - An eBPF program is defined and attached to the selected tracepoint using the SEC("tp/syscalls/sys_enter_execve") macro.
   - When the tracepoint is hit, the program executes. It calls the bpf_get_current_pid_tgid() helper to retrieve the 64-bit value containing the Process ID (PID) and Thread Group ID (TGID).
   - It then uses the bpf_probe_read_user_str() helper to safely copy the filename argument of the execve call from the user-space memory of the calling process into a buffer in the eBPF program's stack.
   - A custom C struct is populated with the PID, TGID, and the captured filename.
   - The populated struct is sent to user space using a BPF_MAP_TYPE_RINGBUF map. This map type is chosen for its high performance, lockless design, and efficient handling of variable-sized data, making it superior to older perf buffer mechanisms for high-volume event streams. The

bpf_ringbuf_reserve() and bpf_ringbuf_submit() helpers are used for this purpose.

3. **User-space Logic:**
    - A C application uses the libbpf library and an auto-generated skeleton header (.skel.h) to load and attach the eBPF program.
    - It sets up a ring buffer manager using ring_buffer__new(), providing a callback function to handle incoming data.
    - The application enters a polling loop (ring_buffer__poll()), which efficiently waits for events from the kernel. When data arrives, the callback function is invoked, which casts the raw data to the shared C struct and prints the formatted output to the console.

3.3.2 Algorithm for tcpstates: Network Activity Monitoring

This tool's purpose is to trace the duration of TCP connections, demonstrating stateful tracking. The algorithm uses the BCC/Python toolchain for rapid development and kprobes for dynamic instrumentation.

1. **Hook Point Selection:** Kprobes are attached to the kernel functions tcp_v4_connect and tcp_close to mark the start and end of a connection's lifecycle.
2. **Kernel-Space Logic:**
    - A BPF_HASH map, named start, is defined. This map is used to store the initial timestamp when a connection is initiated. The key for this map is the kernel's struct sock * pointer, which serves as a unique identifier for the socket during its lifetime.
    - When the tcp_v4_connect kprobe fires, the program retrieves the current struct sock * pointer and the current nanosecond timestamp via bpf_ktime_get_ns(). It then stores the timestamp in the start hash map, using the socket pointer as the key.
    - When the tcp_close kprobe fires, it retrieves the corresponding socket pointer and looks it up in the start map.
    - If an entry is found, it calculates the connection duration by subtracting the stored start time from the current time.
    - It populates a data structure with the PID, command name, IP addresses, ports, and the calculated duration.

   - The data is sent to user space via a BPF_PERF_OUTPUT channel, the standard data transfer mechanism in BCC.
   - Finally, the entry is deleted from the hash map to clean up state.
3. **User-space Logic (Python):**
   - The Python script defines the eBPF C code as a multi-line string and instantiates the BPF object from the bcc library.
   - It defines a Python ctypes.Structure that mirrors the C data struct to correctly parse the incoming data.
   - It opens the perf buffer using b["events"].open_perf_buffer(callback_function) and enters a polling loop with b.perf_buffer_poll().

3.3.3 Algorithm for On-CPU Profiler

This tool performs system-wide CPU profiling by sampling stack traces at a fixed frequency. It uses the high-performance libbpf/CO-RE framework.

1. **Hook Point Selection:** The program is of type BPF_PROG_TYPE_PERF_EVENT. It is not attached to a specific function but to a periodic sampling event (PERF_COUNT_SW_CPU_CLOCK) created by the user-space application for each CPU core.
2. **Kernel-Space Logic:**
   - Two specialized eBPF maps are used: a BPF_MAP_TYPE_STACK_TRACE map to store unique stack traces, and a BPF_MAP_TYPE_HASH map to count the frequency of each trace.
   - When triggered by the perf event (e.g., at 99 Hz), the eBPF program executes.
   - It calls the bpf_get_stackid() helper twice: once for the kernel stack and once for the user-space stack (using the BPF_F_USER_STACK flag). This helper efficiently walks the stack and returns an integer ID for the trace, with the kernel handling deduplication and storage in the

stack_traces map.

   - The program then uses the returned stack ID as a key to look up and increment a counter in the counts hash map. This in-kernel aggregation is extremely efficient.

3. **User-space Logic:**
    - The C application iterates through all online CPUs. For each CPU, it calls the perf_event_open() syscall to create a sampling event that will trigger the eBPF program.
    - It attaches the eBPF program to each of these perf event file descriptors.
    - The application sleeps for a specified duration (e.g., 10 seconds) while the kernel program collects data.
    - After collection, the user-space program iterates through the counts and stack_traces maps.
    - For each stack trace, it performs symbolization, converting the raw instruction pointer addresses into human-readable function names.
    - The final output is printed in the "folded stack" format, which is the standard input for Brendan Gregg's Flame Graph generation scripts.

Chapter 4: Implementation and Results

4.1 Implementation Environment

The practical implementation of this project required a carefully constructed environment to overcome the inherent limitations of a standard Android system for dynamic eBPF development. The target device was a **Pixel 6 Android Virtual Device (AVD)** running Android 13, chosen for its ease of kernel flashing and guaranteed root access.

4.1.1 Custom Android Kernel Compilation

The stock Android kernel does not ship with all the necessary configuration options enabled for advanced eBPF tracing. Therefore, building a custom kernel was a mandatory first step.

1. **Source Download:** The Android Common Kernel (ACK) source for the appropriate device was downloaded using the repo tool.
2. **Configuration:** The kernel's .config file was modified to enable all required eBPF features. This is the most critical step, as missing flags are a common source of failure.

Table 4.1: Key Kernel Configurations Enabled for eBPF

CONFIG Flag	Rationale
$CONFIG_BPF_SYSCALL=y$	Enables the core $bpf()$ syscall, the entry point for all eBPF operations.
$CONFIG_KPROBES=y$	Enables the kernel probes framework for dynamic instrumentation.
$CONFIG_FTRACE_SYSCALLS=y$	Enables stable raw_syscalls:* tracepoints for syscall monitoring.
$CONFIG_DEBUG_INFO_BTF=y$	Embeds BPF Type Format (BTF) data into the kernel, a prerequisite for CO-RE.
$CONFIG_BPF_JIT=y$	Enables the Just-In-Time compiler for significantly improved performance.
$CONFIG_CGROUP_BPF=y$	Required for attaching eBPF programs to cgroups, used by Android's native traffic monitoring.

3. **Build and Flash:** The kernel was cross-compiled using the AOSP toolchain, and the resulting image was flashed to the running AVD using adb.

4.1.2 Debian Chroot Environment

To overcome the limitations of Android's user space (e.g., Bionic C library, lack of development tools), a chroot environment providing a complete Debian-based system was established. The **eadb** (eBPF Android Debug Bridge) tool was used to automate this process.

1. **Assets Push:** The eadb assets and a pre-built Debian root filesystem were pushed to the device via adb.
2. **Unpack and Run:** An adb shell was used to run the eadb scripts, which unpacked the filesystem and entered the chroot environment.
3. **Toolchain Installation:** Within the eadb shell, apt was used to install the necessary build dependencies, including clang, llvm, python3-dev, and libelf-dev. Finally, the BCC and libbpf-bootstrap repositories were cloned and built from source.

4.2 Implementation of Observability Tools

With the environment fully prepared, the three observability tools were developed and compiled directly on the Android device within the chroot.

4.2.1 execsnoop Implementation

This tool was built using the libbpf-bootstrap skeleton, which provides a template for CO-RE applications. The kernel-space program (

execsnoop.bpf.c) defined the tracepoint logic and the ring buffer map. The user-space program (execsnoop.c) handled loading the eBPF object and polling for events. A Makefile was created to automate the compilation process, including the generation of the vmlinux.h header from the kernel's BTF information and the creation of the BPF skeleton header.

4.2.2 tcpstates Implementation

This tool was implemented as a single Python script (tcpstates.py) using the BCC toolchain. The eBPF C code was embedded as a multi-line string within the Python script. The script used BCC's high-level abstractions to attach kprobes, define maps, and open a perf buffer for receiving data, significantly simplifying the development process compared to the

libbpf approach.

4.2.3 On-CPU Profiler Implementation

Similar to execsnoop, the profiler was built using the libbpf/CO-RE framework for maximum performance and efficiency. The kernel-space program (

profiler.bpf.c) was designed to be extremely lightweight, relying on the bpf_get_stackid helper to perform the heavy lifting of stack walking. The user-space program (profiler.c) was more complex, responsible for setting up the perf_event_open syscall for each CPU, managing the eBPF program's lifecycle, and, crucially, post-processing the collected stack data to resolve addresses into human-readable symbols for the final flame graph output.

4.3 Results and Analysis

All three tools were successfully executed with root privileges inside the eadb shell on the Android device.

4.3.1 Result of execsnoop

The tool produced real-time output, successfully capturing process execution events as they occurred.

```
#./execsnoop

COMMAND         PID     TID

sh              12345   12345
```

```
ls             12348   12348

pm              12351   12351

logcat          12355   12355
```

Analysis: The output validates the successful attachment to the execve tracepoint and the correct functioning of the libbpf-to-ring-buffer data pipeline. This tool provides a foundational capability for security monitoring, allowing an analyst to see every new binary executed on the system, which is critical for detecting the initial stages of a compromise.

4.3.2 Result of tcpstates

When network activity was generated (e.g., by opening a web browser), the tool logged the TCP connection details.

```
# python3 tcpstates.py

COMMAND         PID     S-IP        D-IP         PORTS       MS

chrome          15678   192.168.1.10 142.250.191.100 45012 -> 443   120.45

netd            1234    192.168.1.10 8.8.8.8        53421 -> 53    5.12
```

Analysis: This result demonstrates the power of BCC for rapid development and the effectiveness of using kprobes for stateful tracing. By tracking the start and end of connections, the tool provides valuable data for network debugging and for identifying applications making unexpected or potentially malicious outbound connections.

4.3.3 Result of On-CPU Profiler

The profiler was run for 10 seconds, generating a folded_stacks.txt file. This file was then processed on a host machine using Brendan Gregg's flamegraph.pl script to produce an SVG image.

Figure 4.1: Sample Flame Graph of System-Wide CPU Usage

Analysis: The flame graph provides an intuitive and powerful visualization of system-wide CPU consumption. The width of each function block on the graph is proportional to the percentage of total CPU time it consumed. This allows for at-a-glance identification of performance hotspots, whether in user-space applications or deep within the kernel. This result confirms that eBPF can be used for sophisticated, low-overhead performance profiling on Android, a capability previously difficult to achieve.

4.4 GitHub Link for All Code Created

All source code, Makefiles, build scripts, and detailed instructions developed during this internship are available for review and reproduction at the following public GitHub repository: (https://github.com/AAYUSH-MEEL/MNIT-cybersecurity-internship)

Chapter 5: Conclusion

5.1 Conclusion

This internship project has unequivocally demonstrated that eBPF is a viable and powerful technology for enhancing observability on the Android platform. It provides a safe and performant way to gain deep, real-time insights into the kernel that were previously unattainable without significant risk or overhead. The successful development of tools for tracing system calls, network activity, and CPU performance validates its practical utility for developers, performance engineers, and security researchers.

The project successfully met all its objectives. A complete, end-to-end methodology for compiling a custom kernel, establishing a dynamic development environment, and deploying sophisticated eBPF-based tools was developed and validated. The work confirmed that both the BCC and libbpf/CO-RE toolchains can be made to work on Android, each with distinct trade-offs. BCC excels at rapid prototyping, while libbpf/CO-RE provides a path toward creating efficient, portable, production-ready tools.

Furthermore, the security analysis highlighted the dual-use nature of eBPF. The observability it grants is a cornerstone of modern defensive security, enabling the creation of behavioral baselines and the detection of anomalies. However, this same power can be co-opted by attackers to create stealthy and resilient rootkits. The hardening recommendations provided offer a clear path for mitigating these risks.

5.2 Future Work

The primary obstacle to the widespread adoption of dynamic eBPF on Android is the complex, manual setup process. The most critical area for future work lies not in developing more eBPF tools, but in advocating for better platform-level support from Google.

The single most impactful improvement would be the **default inclusion of BPF Type Format (BTF) data in official Android Generic Kernel Image (GKI) releases**. This would enable true "Compile Once - Run Everywhere" (CO-RE) applications, abstracting away kernel version differences and eliminating the need for on-device compilers and kernel headers. This change would democratize eBPF development for Android, paving the way for a rich ecosystem of third-party performance and security tools that could be installed and run as easily as any standard application.

With improved platform support, future research could explore more advanced eBPF use cases on Android, such as:

- **eBPF-LSM:** Using the Linux Security Module hooks to create dynamic, programmable security policies that can adapt to new threats at runtime.
- **XDP Networking:** Leveraging the eXpress Data Path for ultra-low-latency networking applications, particularly relevant for future 5G and Wi-Fi standards.
- **On-Device EDR:** Building sophisticated, low-overhead Endpoint Detection and Response (EDR) agents that provide deep kernel visibility for enterprise and high-security environments.

In conclusion, this project serves as a comprehensive exploration of eBPF's current capabilities on Android and provides a clear vision of its transformative potential for the future of mobile computing.

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