Google

Kernel Runtime Security Instrumentation

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Motivation

Our context

- Fleet of corporate Linux machines.
- Security monitoring and policies.
- Dynamic and scalable.

Example of signals

- A process that deletes its own executable.
- A Kernel module that loads and "hides" itself.
- "Suspicious" environment variables.

Example of mitigations

- Prevent known vulnerable binaries from running.
- Dynamic whitelist of known Kernel modules.
- Chain signals into a configurable MAC policy.

Current security landscape

Signals

Audit

Perf

Logs system's behaviour

Mitigation

SELinux, Apparmor

seccomp

Affects system's behaviour

Adding a new signal

Signals

Audit

Perf

Update Audit (user/kernel) to log environment variables

Mitigation

SELinux, Apparmor

seccomp

Adding a new mitigation

Signals

Audit

Perf

Mitigation

SELinux, Apparmor

seccomp

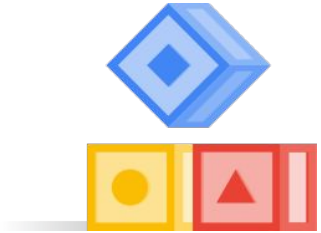
Update the mitigation logic for a malicious actor with a known **LD_PRELOAD signature**

Introducing KRSI

LSM (Linux Security Module)

- **Basis of SELinux**, AppArmor etc...
  - Years of research and verification.
- Various hooks for system security **behaviours**.
  - Higher level than syscalls.
- Return value **allows or denies an operation**.
  - MAC (Mandatory Access Control)

BPF (Berkeley Packet Filter)



- **Bytecode** JIT-ed into the kernel.
- **Dynamically loaded** with libbpf.
- Can be **written in C.**
- **Statically verified** (eg: read-only memory).
- Can **exchange data** with a userspace program.

BPF + LSM = KRSI

- Allows **BPF programs attachment to LSM hooks**.
- Dynamic **MAC and Audit policies** written in C.
- PATCHv3 **on LKML**

Usage example

Step 1: Hook into an appropriate LSM hook

```
SEC("lsm/file_mprotect")
int BPF_PROG(mprotect_example, struct vm_area_struct *vma,
             unsigned long reqprot, unsigned long prot)
{



        return 0;
}
```

Step 2: Use eBPF helpers

```
SEC("lsm/file_mprotect")
int BPF_PROG(mprotect_example, struct vm_area_struct *vma,
             unsigned long reqprot, unsigned long prot)
{
        __u32 pid = bpf_get_current_pid_tgid();


        return 0;
}
```

Step 3: Access structure fields with BTF

```
struct vm_area_struct {
        unsigned long vm_start;
} __attribute__((preserve_access_index));

SEC("lsm/file_mprotect")
int BPF_PROG(mprotect_example, struct vm_area_struct *vma,
             unsigned long reqprot, unsigned long prot)
{
        __u32 pid = bpf_get_current_pid_tgid();
        unsigned long vm_start = vma->vm_start;

        return 0;
}
```

Step 4: Share variables with userspace

```
int mprotect_count = 0;

struct vm_area_struct {
        unsigned long vm_start, vm_end;
} __attribute__((preserve_access_index));

SEC("lsm/file_mprotect")
int BPF_PROG(mprotect_example, struct vm_area_struct *vma,
             unsigned long reqprot, unsigned long prot)
{
        __u32 pid = bpf_get_current_pid_tgid();
        int vm_start = vma->vm_start;
        mprotect_count ++;
        return 0;
}
```

Step 5: Allow or deny an operation

```
int mprotect_count = 0;

struct vm_area_struct {
        unsigned long vm_start, vm_end;
} __attribute__((preserve_access_index));

SEC("lsm/file_mprotect")
int BPF_PROG(mprotect_example, struct vm_area_struct *vma,
             unsigned long reqprot, unsigned long prot)
{
        __u32 pid = bpf_get_current_pid_tgid();
        int vm_start = vma->vm_start;
        mprotect_count ++;
        return (mprotect_count > 100) ? -EPERM : 0;
}
```

What will you build next?

Thank You

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