An Efficient and Privacy-Aware Method for Revealing Network Covert Channels

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Covert Channels

- **Stegomalware** uses information hiding to:
  - Elude well-known detection techniques
  - Orchestrate an attack
  - Exfiltrate sensitive data
  - …
- **Covert channels** mainly exploit:
  - Host resources (CPU, memory usage, etc.)
  - Traffic (HTTP, DNS, etc.)
- Challenges:
  - Unknown a priori
  - Threat-dependent
  - Scalability
  - Privacy

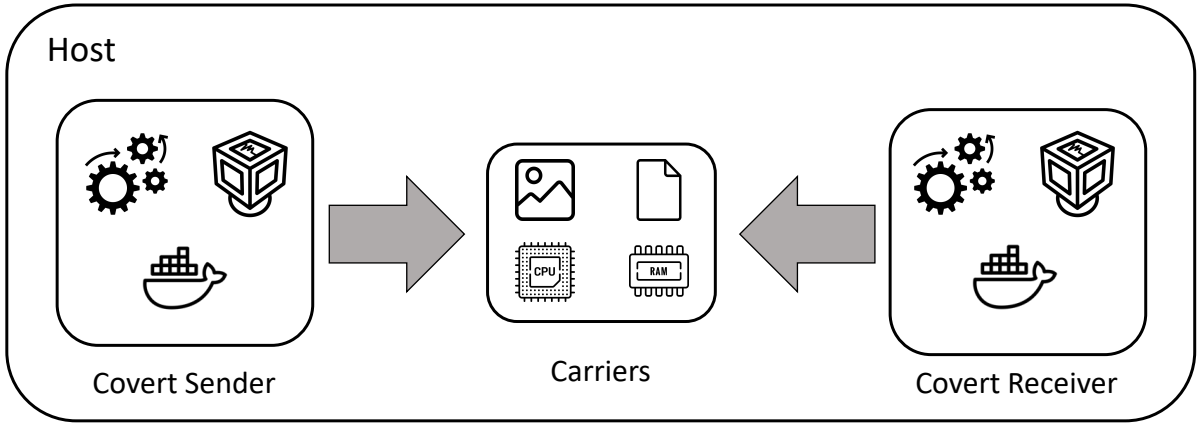


Figure 1. Local covert channel.

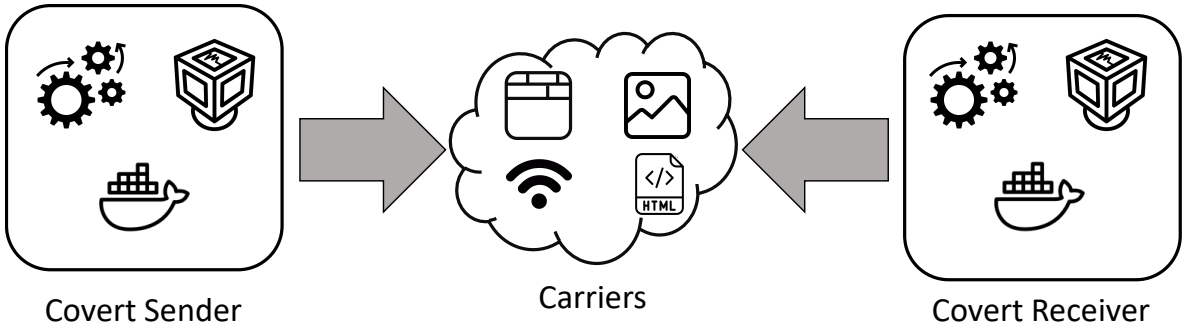
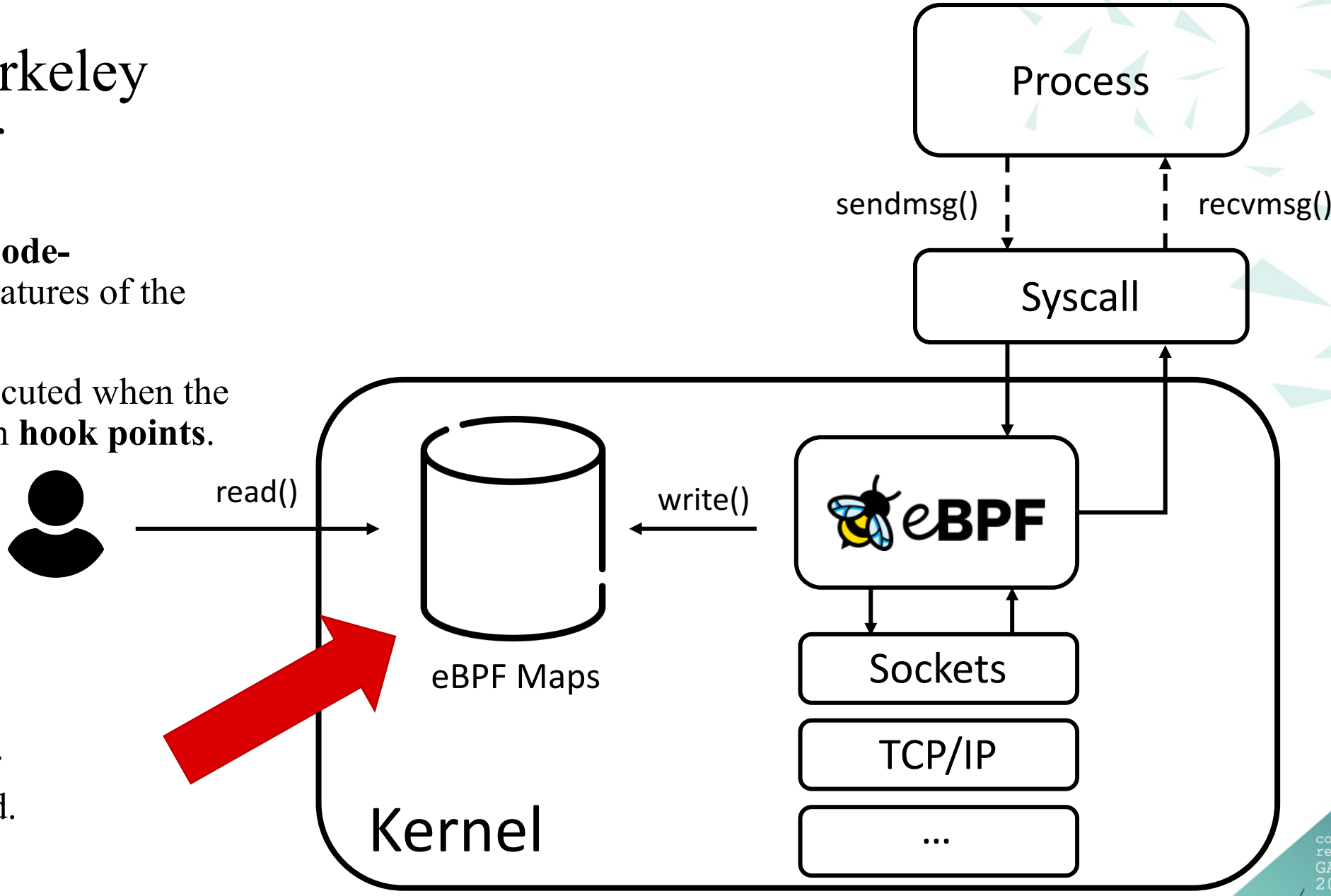


Figure 2. Network covert channel.

extended Berkeley Packet Filter

- eBPF leverages **code-augmentation** features of the Linux kernel.
- Programs are executed when the kernel hits certain **hook points**.



- Privacy-aware.
- Easily extensible.
- Memory bounded.

Figure 3. eBPF overview.

Data Collection for Network Covert Channels

- Organization of the eBPF map: the whole range of values of a field is split into B equally-spaced **bins**. Each bin has a corresponding **counter**.

- Goals:
  - It guarantees privacy
  - It can be adapted to many protocols
  - Larger fields can be mapped into a smaller space

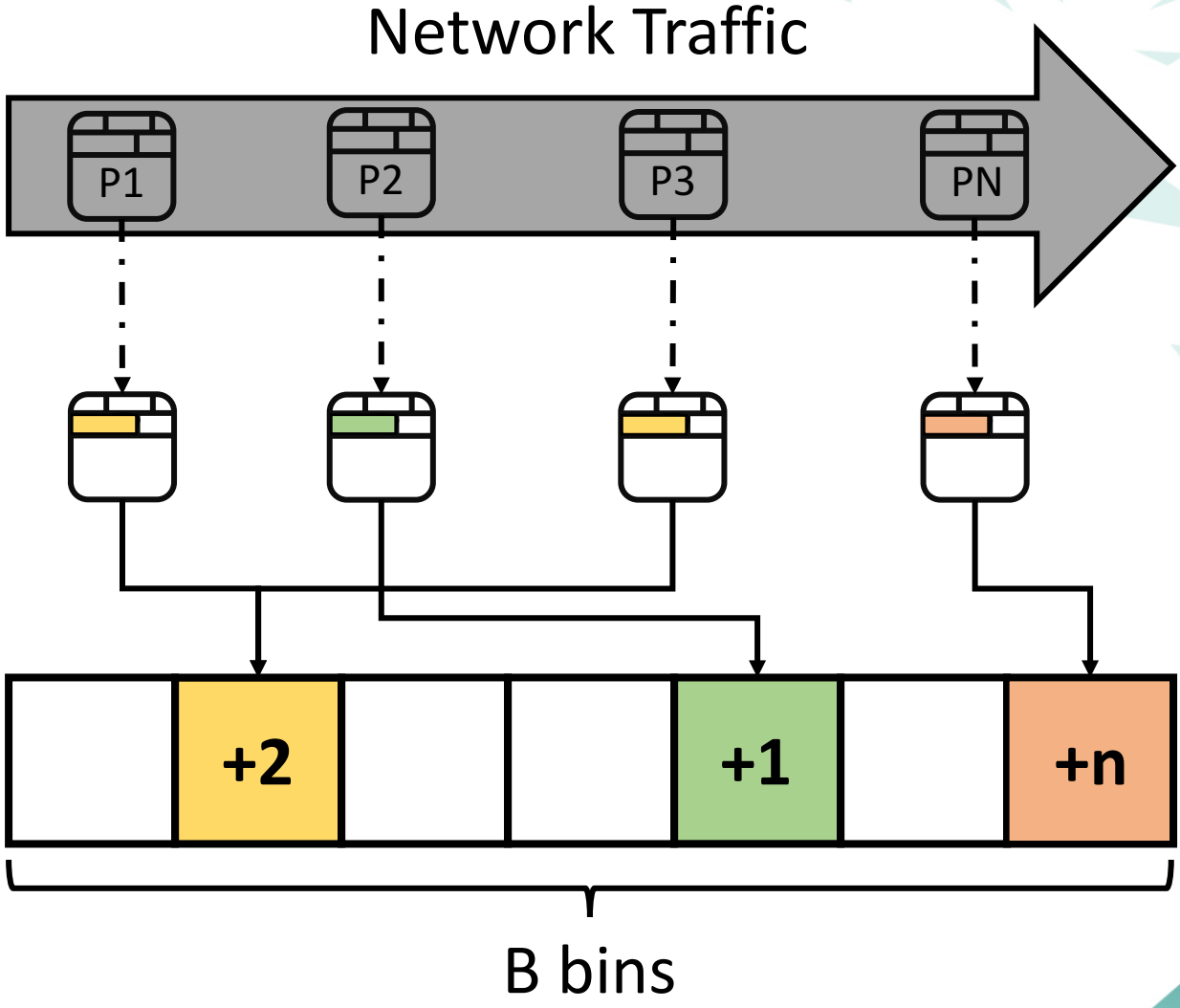


Figure 4. eBPF map organization.

Metrics and Detection

- Reveal of covert channels, by producing:
  - “new” metrics
  - a “pictorial” status of the network traffic (e.g., heatmaps)

- Example detection - IPv6 use case:
  - Comparison between an estimate of active IPv6 flows and third-party measurements
  - Temporal evolution of heatmaps

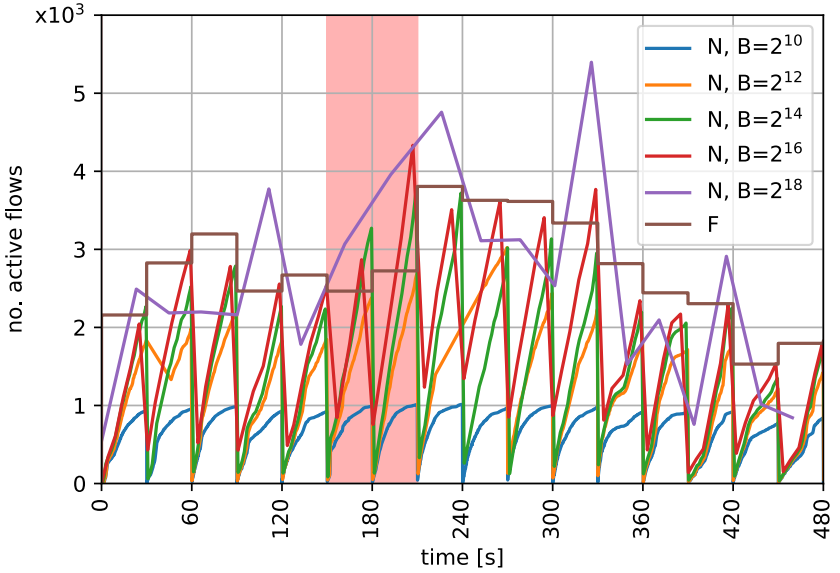


Figure 5. eBPF measurement example.

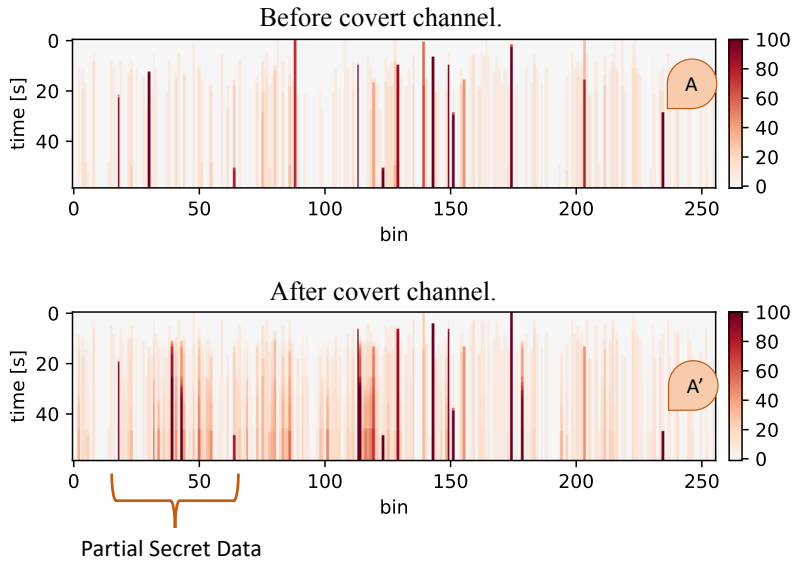


Figure 6. Temporal evolution of the bins.

Conclusions

- Covert channels can target both host resources and network packets.
- eBPF guarantees the visibility on the entire host.
- Our framework ensures:
  - Privacy-awareness
  - Efficiency
  - Extensibility and scalability
- Current research goals:
  - Comparison with other security tools
  - Use of the eBPF framework to deal with other threats