Persistent Data-Only Malware

Function Hooks Without Code

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Outline

Protection Mechanisms

Motivation & Background

Protection Mechanisms

- $W \oplus X$

Motivation & Background

▸ Problem

Protection Mechanisms

- $W \oplus X$
- Signed Driver Loading

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- Code Integrity Checking

Motivation & Background

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Protection Mechanisms

- $W \oplus X$
- Signed Driver Loading
- Secure Boot
- Code Integrity Checking

$\Rightarrow$ **It is getting more and more difficult to introduce malicious code into the system.**

Data-only Malware

Motivation & Background

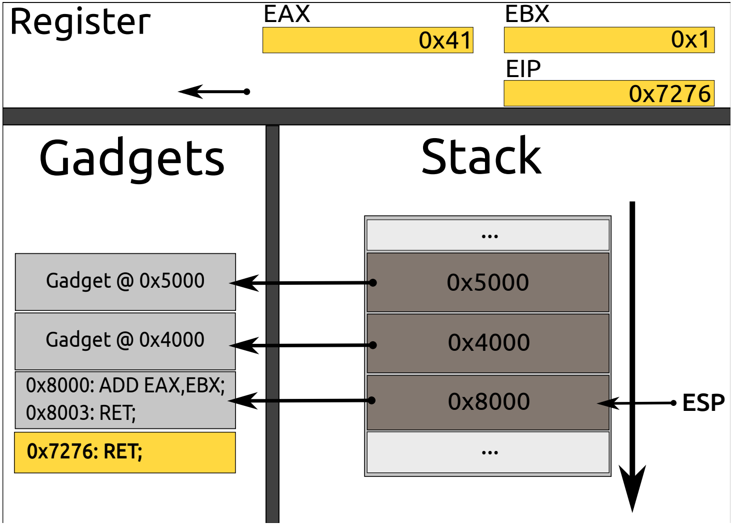
▸ Solution

Data-only Malware

Hund et. al [1]: Return-oriented Rootkits (2009)

Motivation & Background

▸ Return-oriented Programming (ROP)



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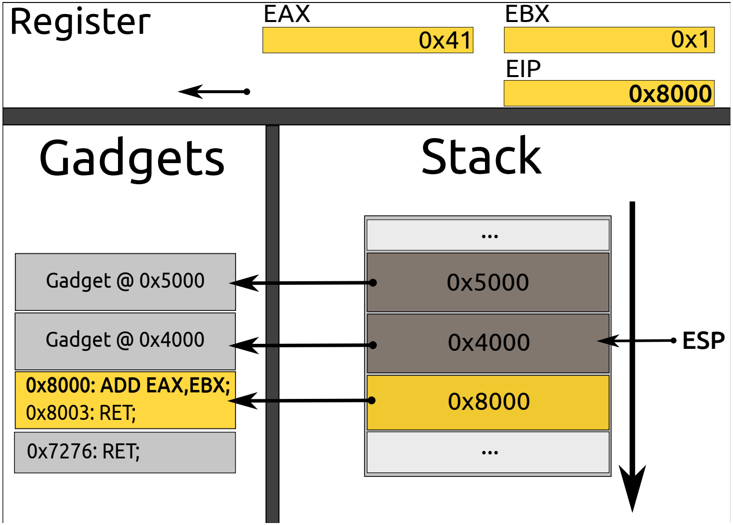

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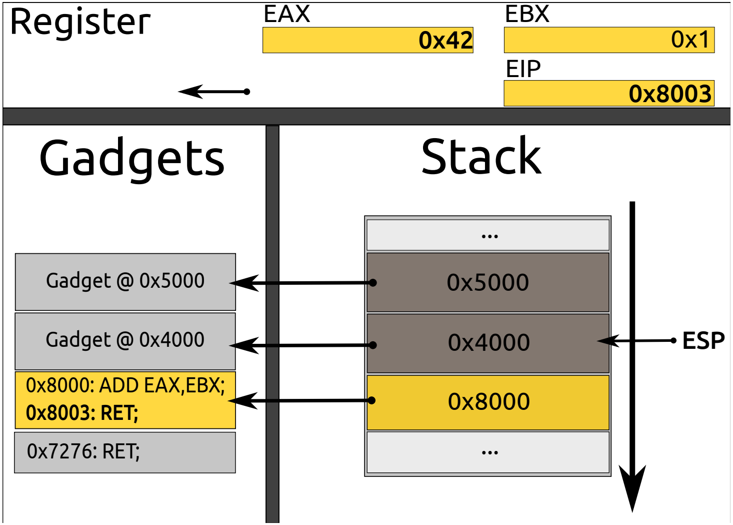

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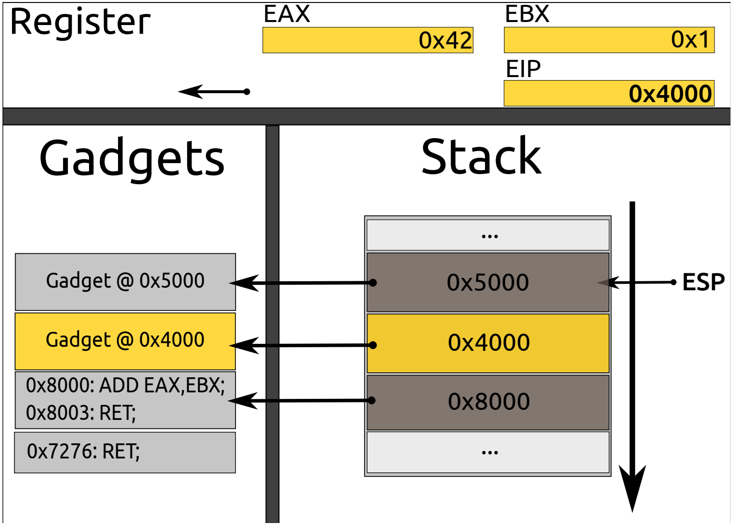

Data-only Malware

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Data-only Malware

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- “One-Shot-Attacks”

Data-only Malware

Hund et. al [1]: Return-oriented Rootkits (2009)

- "One-Shot-Attacks"
- **Triggered** by attacker

Motivation & Background

- Cannot **intercept events** within the system

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▸ Persistence

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- Usually accomplished with **hooks**

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Persistence?

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Persistent data-only malware

▸ Challenges

1. Finding a suitable **location** for the **persistent** control structure

Persistent data-only malware

▸ Finding a suitable location for the persistent control structure

- Control structure must be **exclusively** owned by the malware

Persistent data-only malware

▸ Finding a suitable location for the persistent control structure

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  ⇒ Create **new** memory region (e.g. kmalloc)

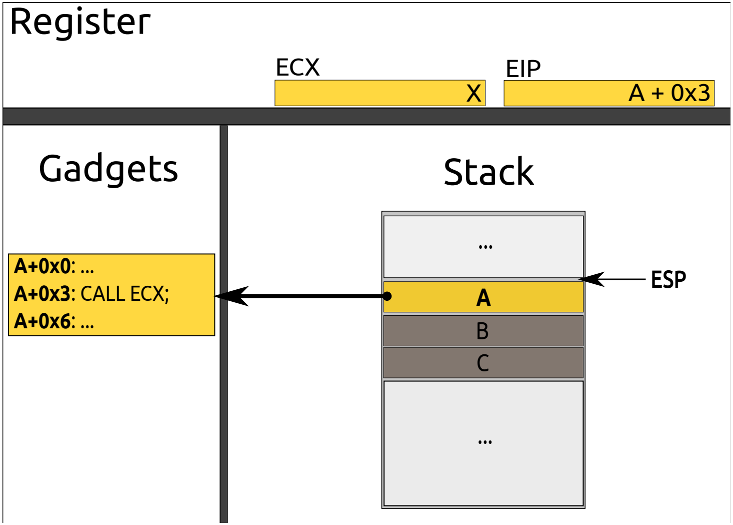
Persistent data-only malware

▸ Challenges

1. Finding a suitable **location** for the **persistent** control structure
2. Protecting against **overwrites**

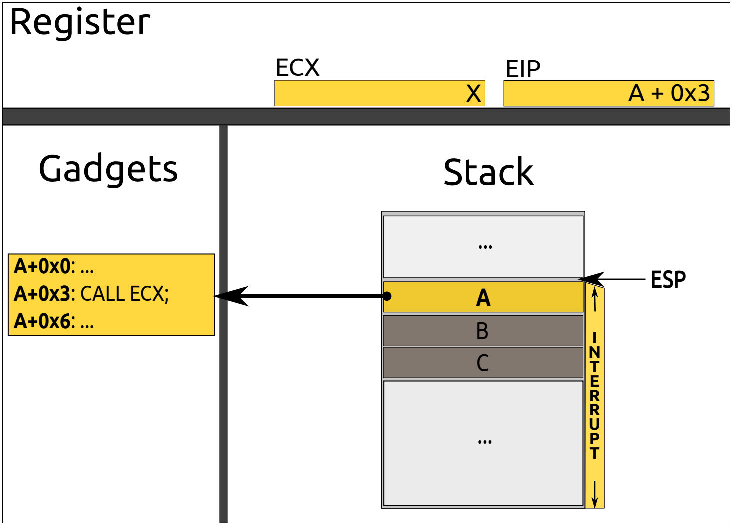
Persistent data-only malware

▸ Protecting against overwrites



Persistent data-only malware

▸ Protecting against overwrites



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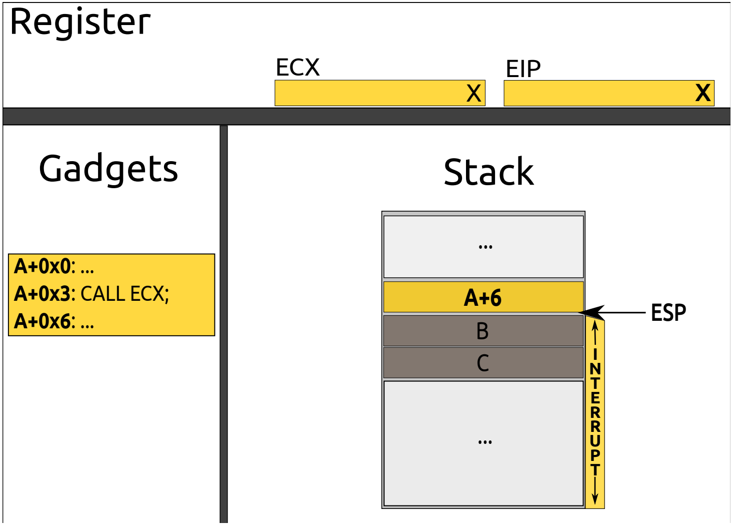

Persistent data-only malware

▸ Protecting against overwrites

Two types of overwrites:

- **Interrupt-induced** overwrites

Persistent data-only malware

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Persistent data-only malware

▸ Protecting against overwrites

Two types of overwrites:

- **Interrupt-induced** overwrites
  - *Disable* interrupts
  - No *external* function calls
- **Self-induced** overwrites
  - *Carefully* design persistent chain

Persistent data-only malware

1. Finding a suitable **location** for the **persistent** control structure
2. Protecting against **overwrites**
3. **Resuming** the original control flow

Persistent data-only malware

▸ Resuming the original control flow

- Registers must be saved **before use**

Persistent data-only malware

- Resuming the original control flow

- Registers must be saved **before use**
- Control flow most be **restored** after execution

Persistent data-only malware

▸ Challenges

1. Finding a suitable **location** for the **persistent** control structure
2. Protecting against **overwrites**
3. **Resuming** the original control flow
4. **Activating** the *persistent* control structure

Persistent data-only malware

▸ Activating the persistent control structure

- *Control structures* **somewhere** in memory

Persistent data-only malware

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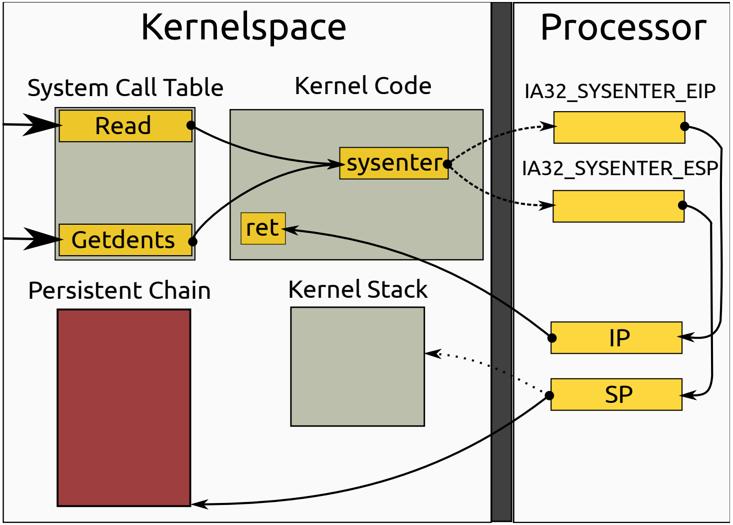
Solution

sysenter

Persistent data-only malware

- Activating the persistent control structure



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Proof of Concept

Victim	Ubuntu 64-bit Server (Kernel 3.8) with secure boot (UEFI)

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Hooks	sys_read, sys_getdents
Functionality	Key logging, process hiding, file hiding

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- **Persistent** data-only malware is possible

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POC code available on our website

http://www.sec.in.tum.de/persistent-data-only-malware/

Bibliography I

Ralf Hund, Thorsten Holz, and Felix C. Freiling.
Return-oriented rootkits: Bypassing kernel code integrity protection mechanisms.
In *Proceedings of 18th USENIX Security Symposium*, 2009.