



“egg” – A Stealth fine grained code analyzer

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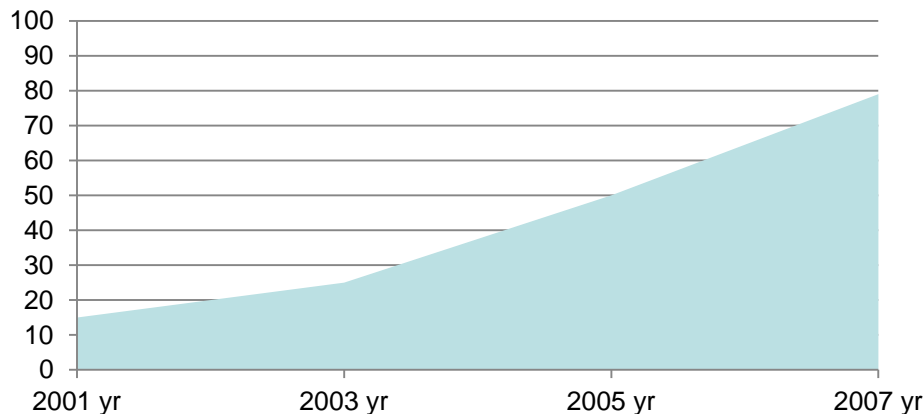
Agenda

- Background and problems
- Introduce “egg”
 - Demonstration its basic functions
- Implementation (Taint tracing approach in ring-0)
 - Demonstration of the taint tracing behavior
- Discuss a limitation of “egg”
- Conclusion



Too many malwares!

The percentage of packed malwares



80% of malwares were packed in 2007

- We can't manually analyze each malware.
- Automatic approaches have become more important.

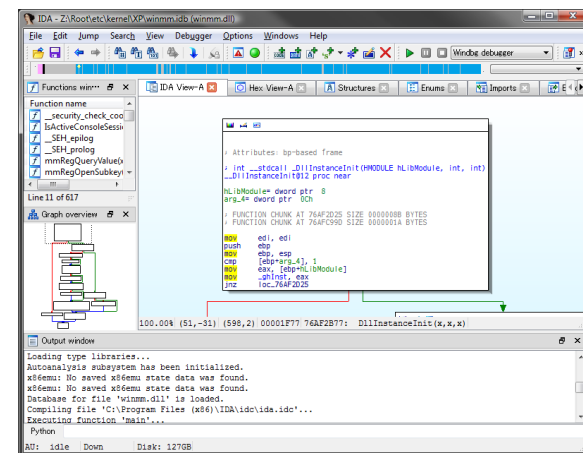
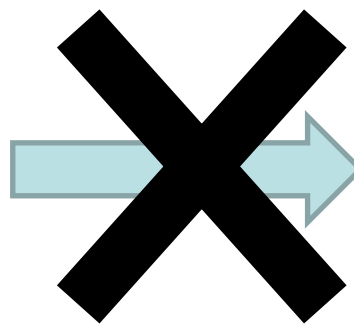
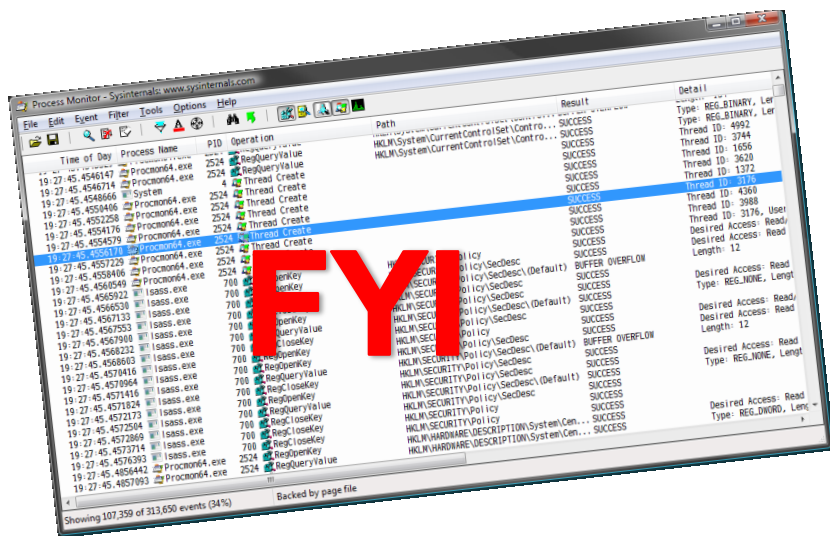
Source:

2001-2005 : McAfee Sage vol.1 issue 1

2007 : Panda Research (<http://research.pandasecurity.com/malwareformation-statistics/>)

Problems of traditional dynamic analyzers

- We can't get useful information for more intensive analysis.
- We can't analyze a kernel mode code.
- It's difficult to analyze a spreading malware over the process.



Innovative analyzers (based on VM environments)

- Innovative analyzers have already resolved the above problems 😊
 - Anubis
 - Ether
 - It's able to analyze a kernel mode code and perform an instruction level analysis.
 - BitBlaze and Renovo
 - Also these analyze a spreading malware automatically with approach called “taint tracing”.

- However these systems are detected by VM detection techniques 😞

Summary table of problems

Type of system	Traditional	Innovative (Based on virtual environments)
Getting useful information	Insufficient	Good
Analyzing a kernel mode code	Insufficient	Good
Analyzing a spreading malware.	Insufficient	Good
Not affected by VM detection techniques	Good	Insufficient

- I developed “egg” to try and resolve these problems.

What is egg?

- “egg” is a dynamic analyzer based on a Windows device driver.
- egg has following capabilities:
 1. It can obtain more detailed information.
 2. It can analyze a kernel mode code.
 3. It can automatically trace a spreading malware.
- Of course, It's not affected by VM detection techniques.
- Also most common anti-debug tech can't detect “egg”.

What kind of information does "egg" collect?

1. API arguments for IN, OUT (,INOUT), and return value

```
BOOL WINAPI ReadFile(  
    __in      HANDLE hFile,  
    __out     LPVOID lpBuffer,  
    __in      DWORD nNumberOfBytesToRead,  
    __out_opt LPDWORD lpNumberOfBytesRead,  
    __inout_opt LPOVERLAPPED lpOverlapped  
);
```


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```
call to kernel32.dll!ReadFile(  
  Arg 1 : 00000064 = File : ¥Device¥HarddiskVolume1¥WINDOWS¥(...),  
  Arg 3 : 00000800 (2048)  
)
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What kind of information does "egg" collect?

1. API arguments for IN, OUT (,INOUT), and return value

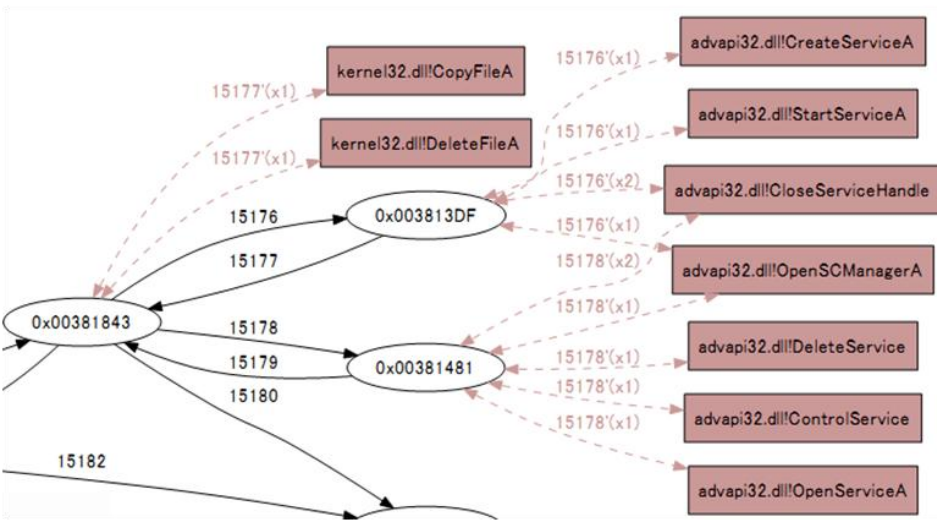
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call to kernel32.dll!ReadFile(  
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    Arg 3 : 00000800 (2048)  
)
```

```
returned from kernel32.dll!ReadFile(  
    Arg 2 : 0012F184 - 0012F983 is dumped as ¥(...)¥(...)ReadFile_Arg02.bin  
    ) => 00000001 (1)
```

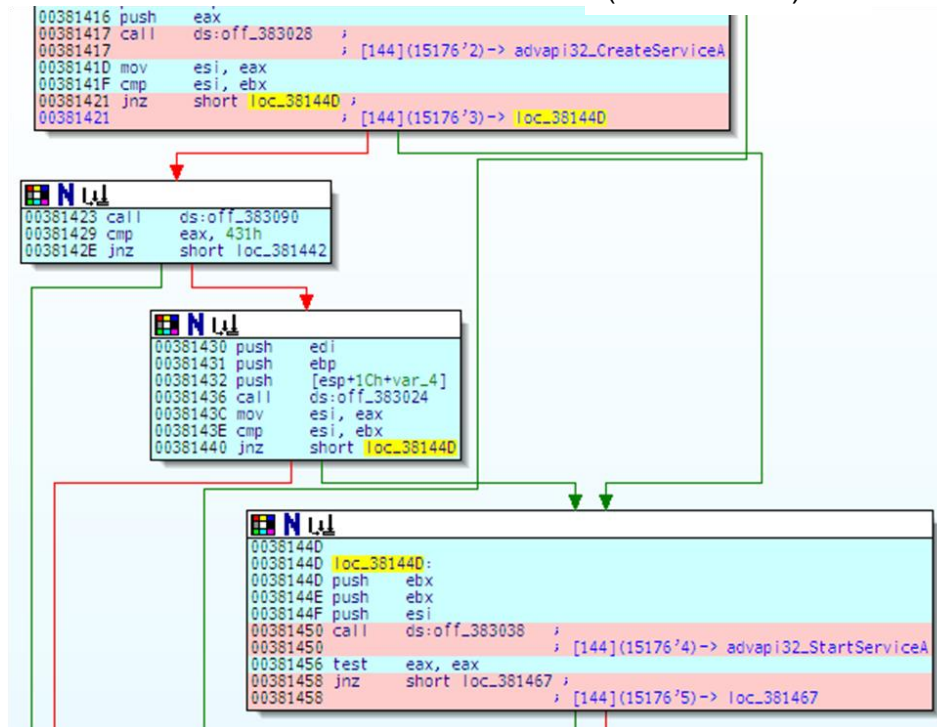
What kind of information does "egg" collect?

2. Callgraph
3. Branch information



Callgraph
(made with Graphviz)

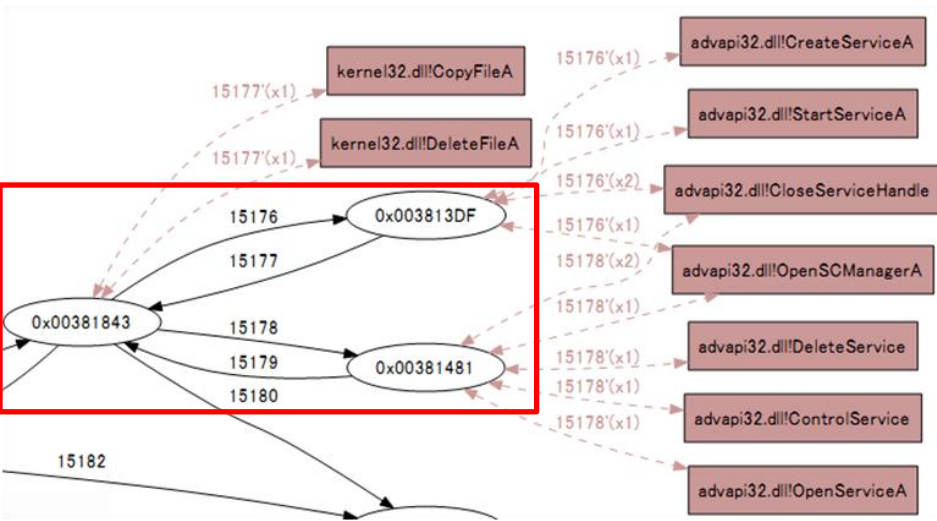
Branch Info
(with IDA Pro)





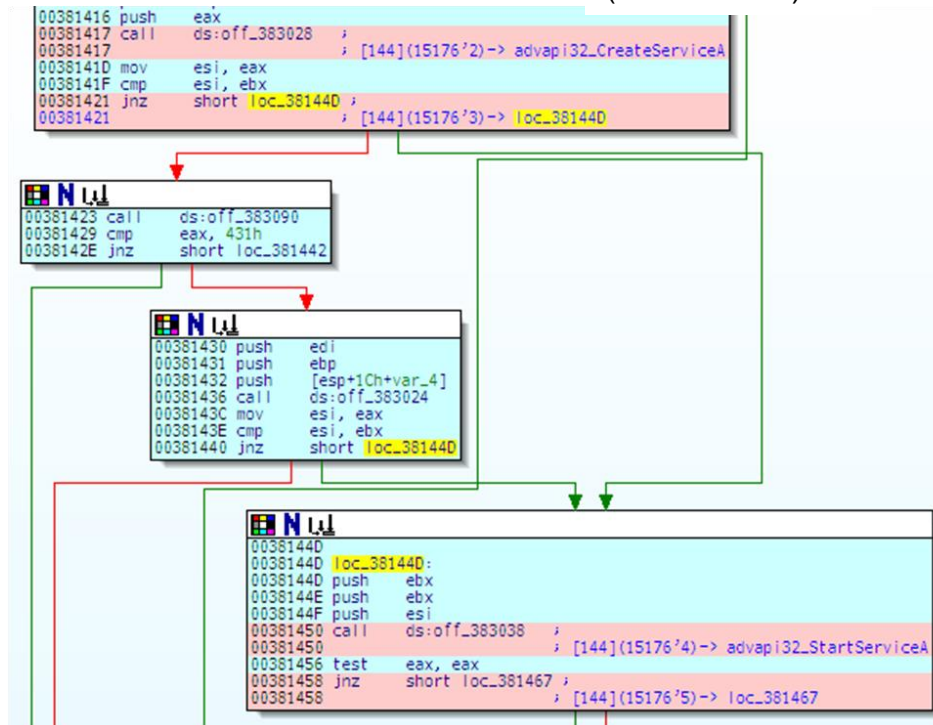
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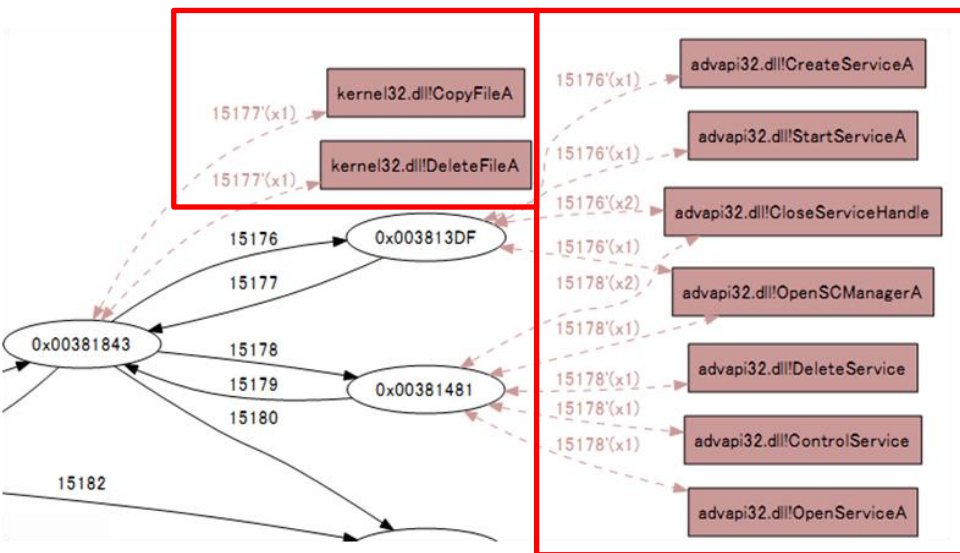
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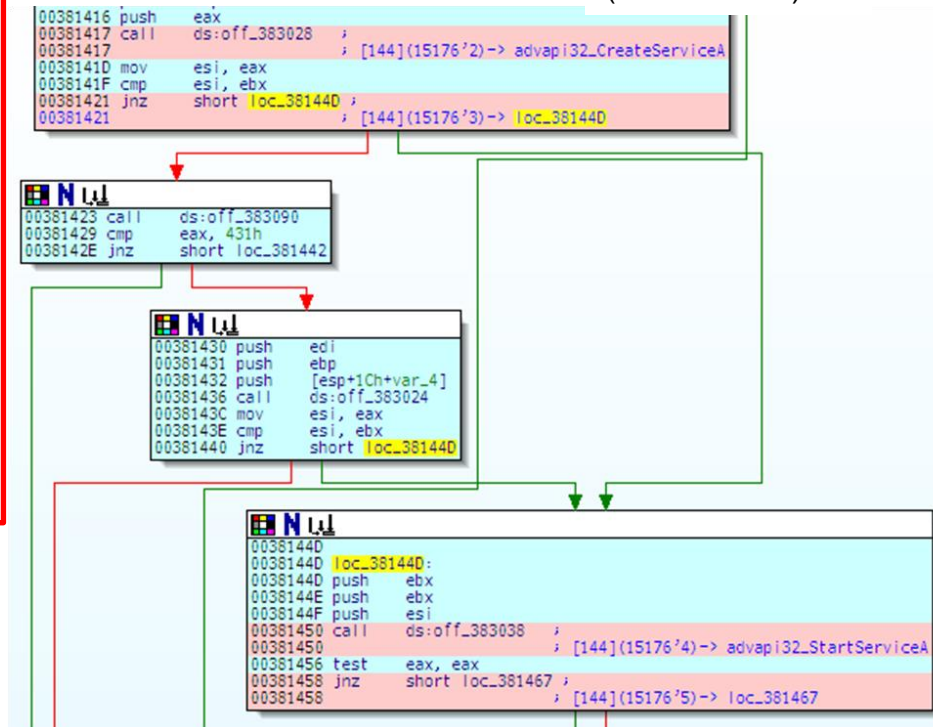
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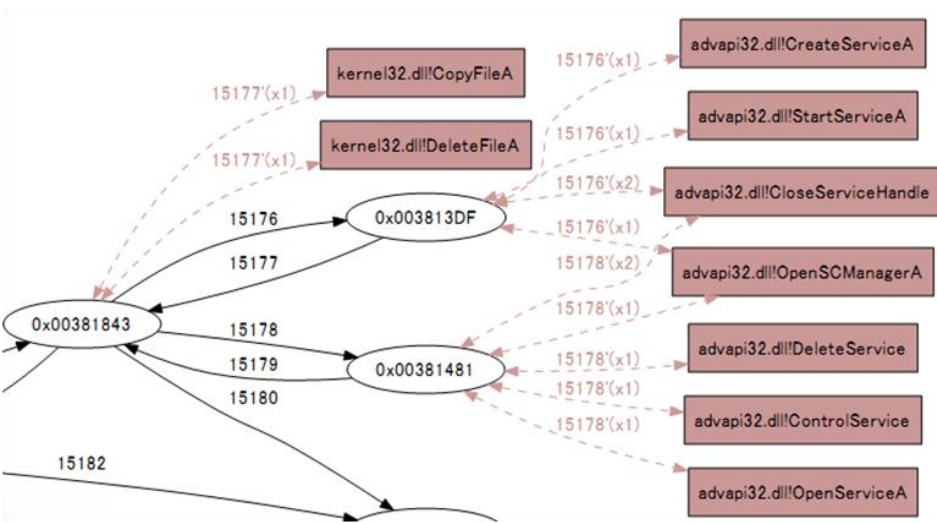
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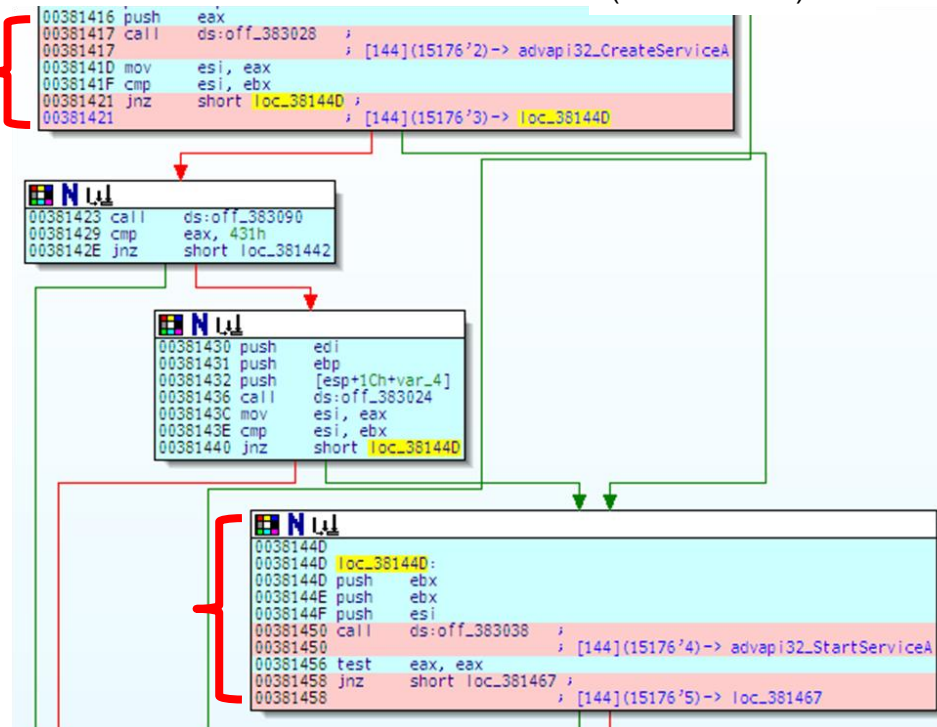
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Branch Info
(with IDA Pro)





Demonstration of basic functions(movie)

- Analyzing sample.exe.
- Sample.exe overwrites original beep driver (beep.sys).
- Then restarts beep service to install this driver in the kernel.
- “egg” analyzes sample.exe and the modified beep driver.



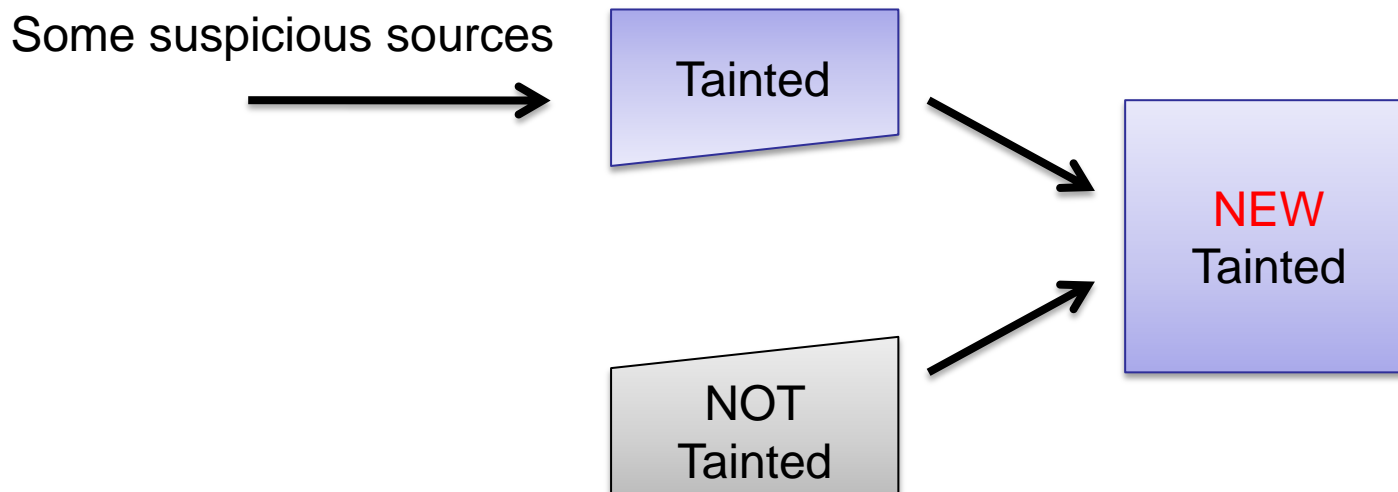
Implementation of the fine-grained code analysis

- Based on the page protection and the trap flag.
- Published by the paper “Stealth Breakpoints”.
- We can run analysis codes for each instruction execution.
- It can apply to both a kernel and user modes, and even works transparently in the user mode code.

Stealth Breakpoints
<http://www.acsac.org/2005/abstracts/72.html>

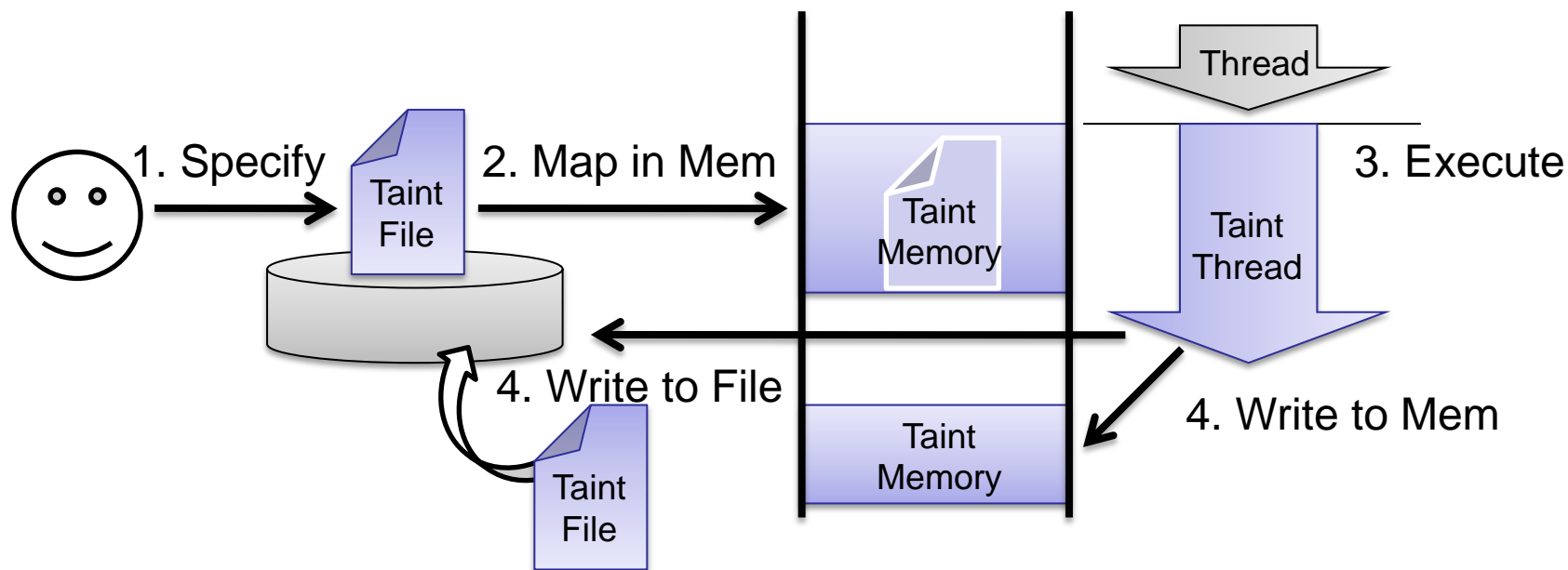
What is taint tracing?

- It can automatically trace suspicious elements.
- A suspicious element is marked as tainted.
- A taint automatically influences new elements that used tainted elements.



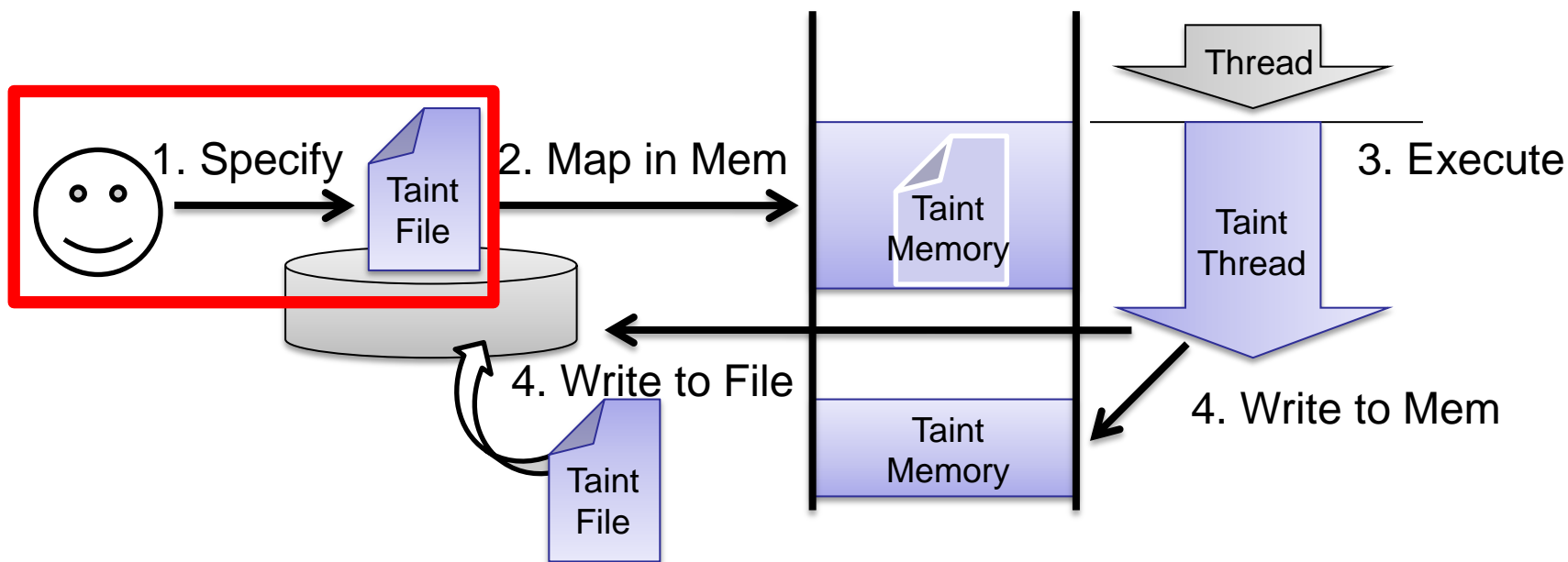
An overview of taint tracing approach of “egg”

- egg takes a novel approach to implement the taint tracing.
- In case of egg, “Elements” are Files, Virtual memory and Threads.

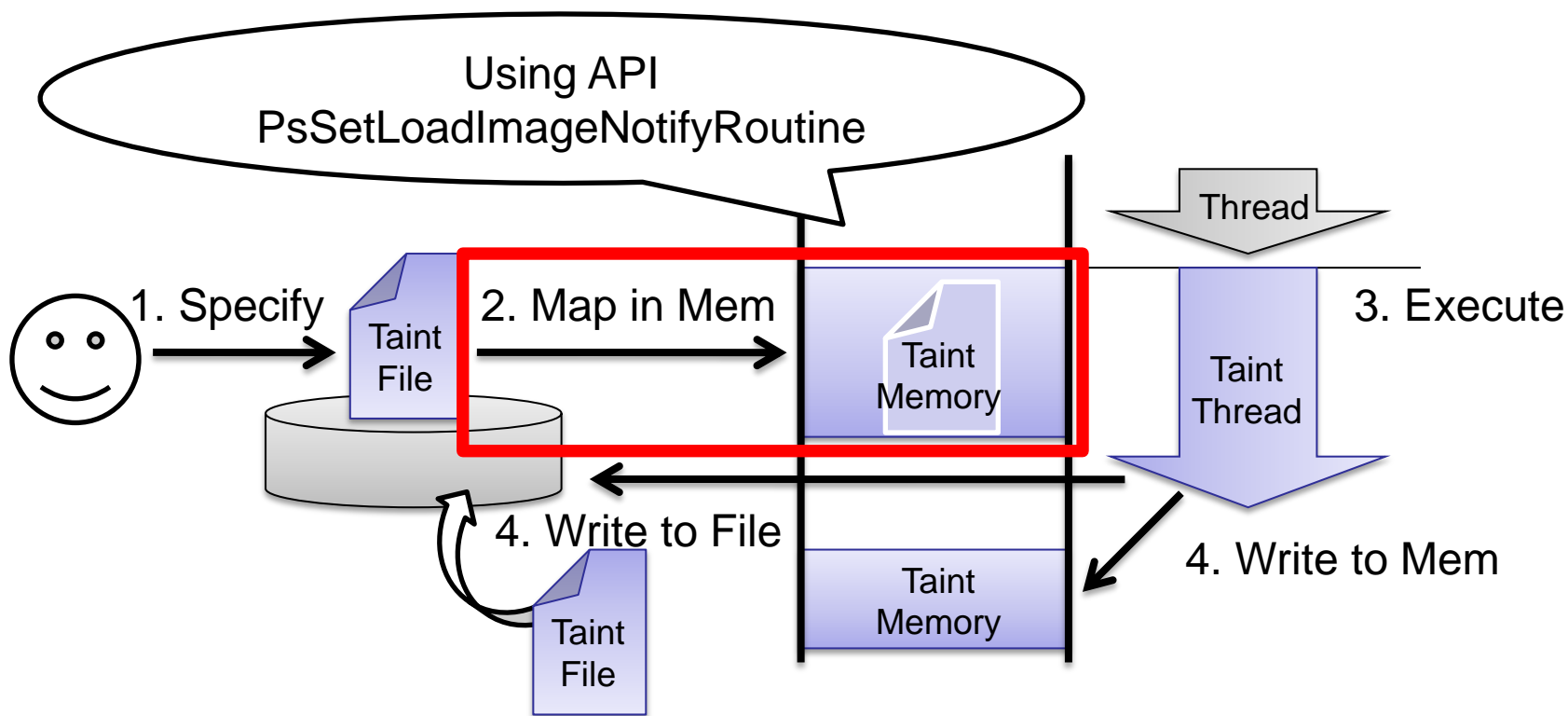


An overview of taint tracing approach of “egg”

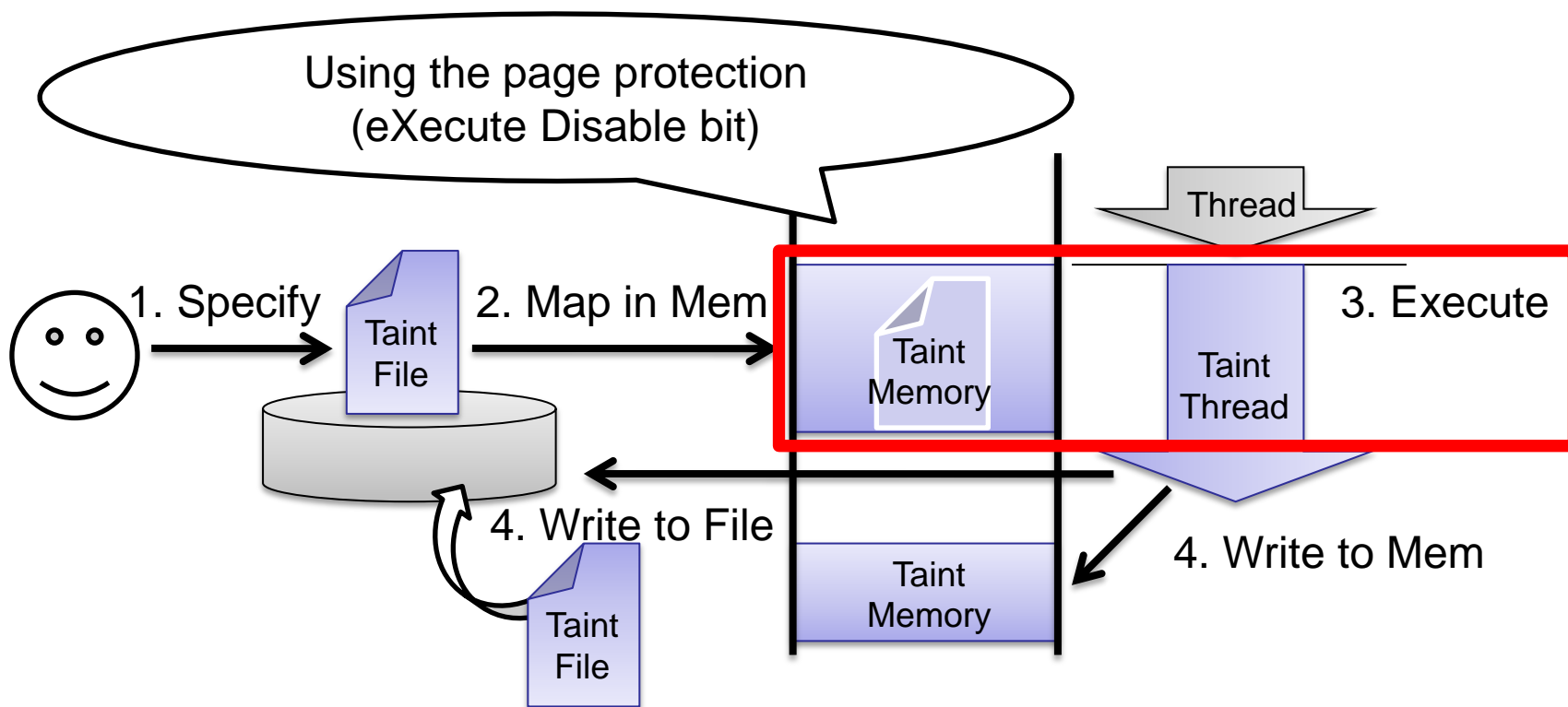
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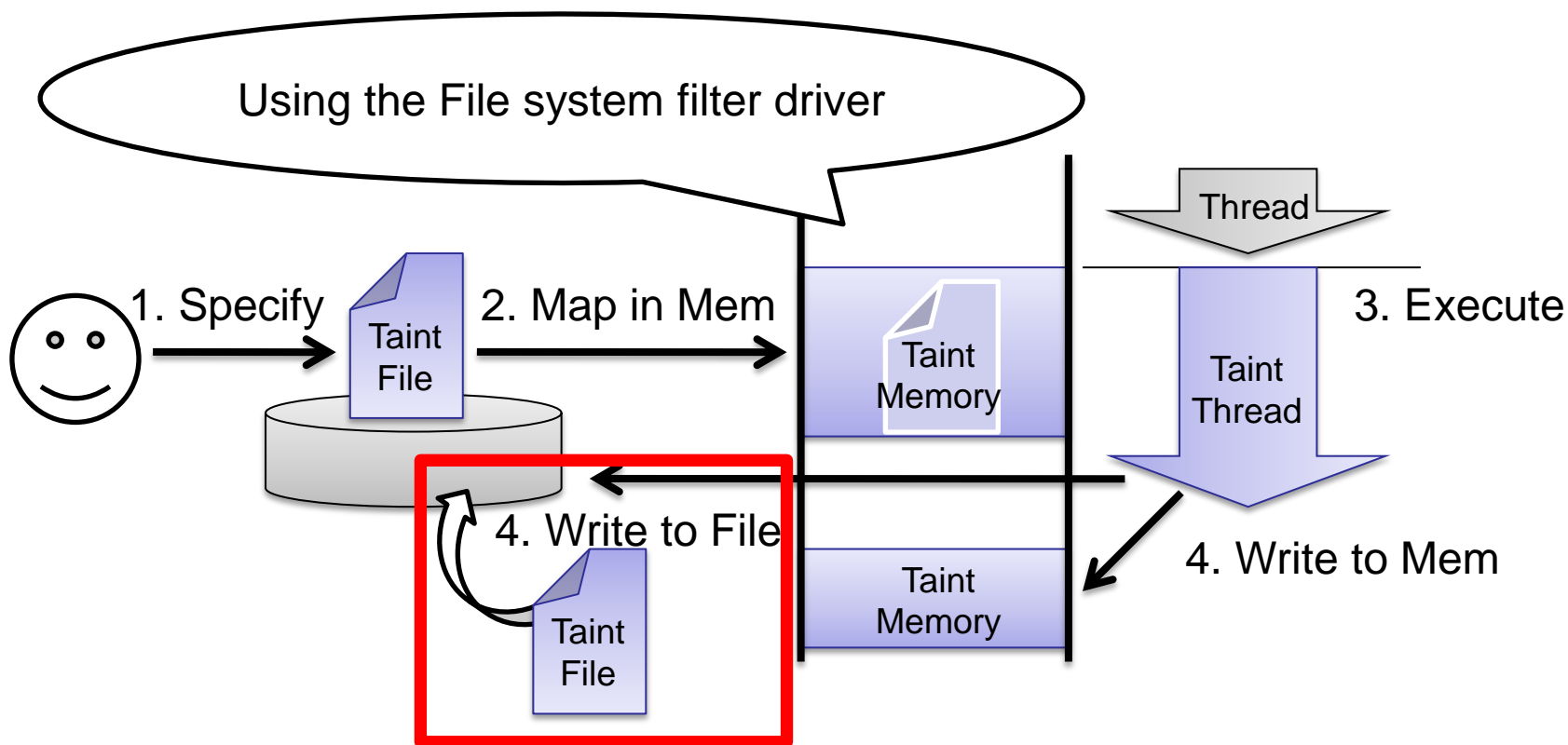
Implementation of taint tracing in ring-0



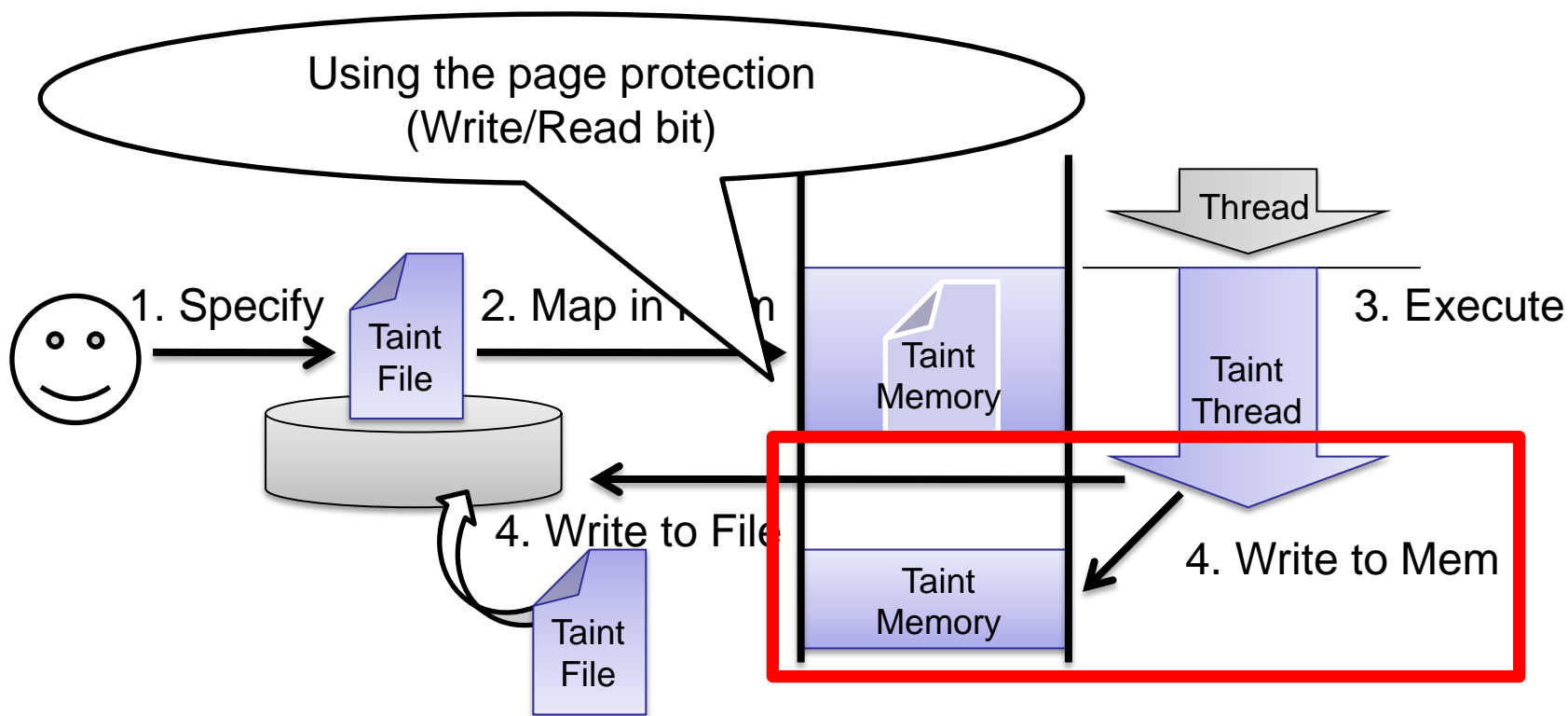
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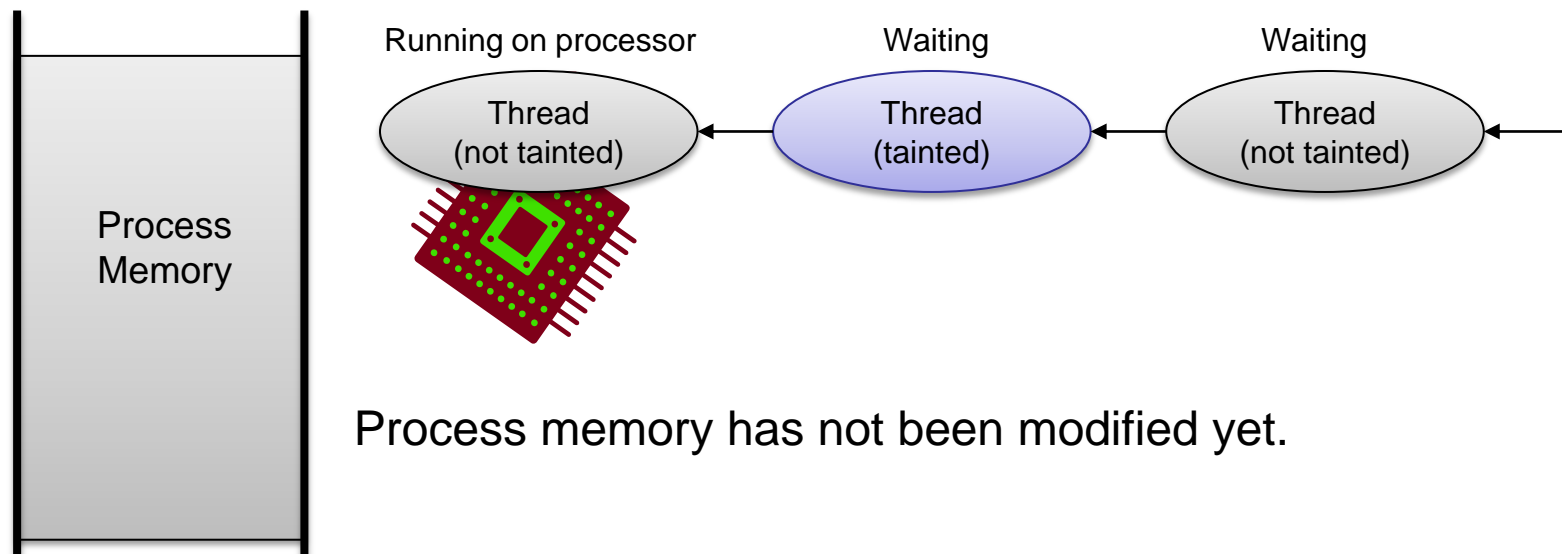


Implementation of taint tracing in ring-0



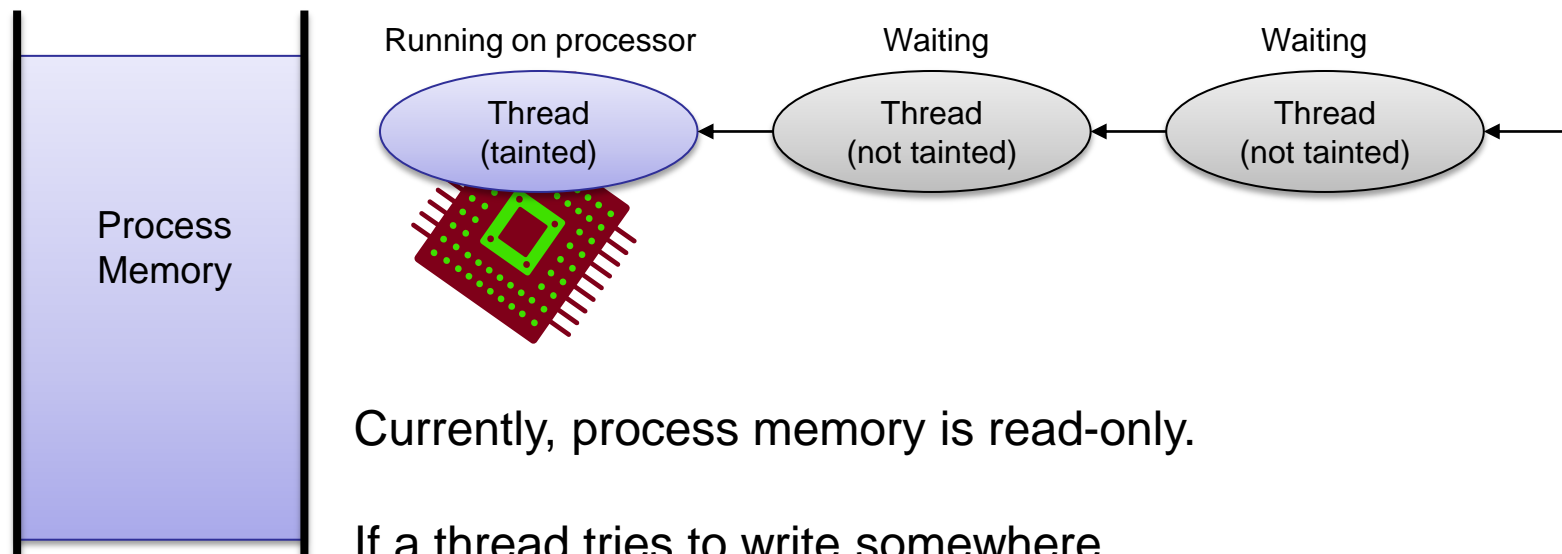
Implementation of taint tracing in ring-0

- For thread safety, egg hooks thread switching function (called SwapContext).
- Therefore egg can notice a thread switching.



Implementation of taint tracing in ring-0

- When taint thread becomes active, egg changes every process memory to read-only.

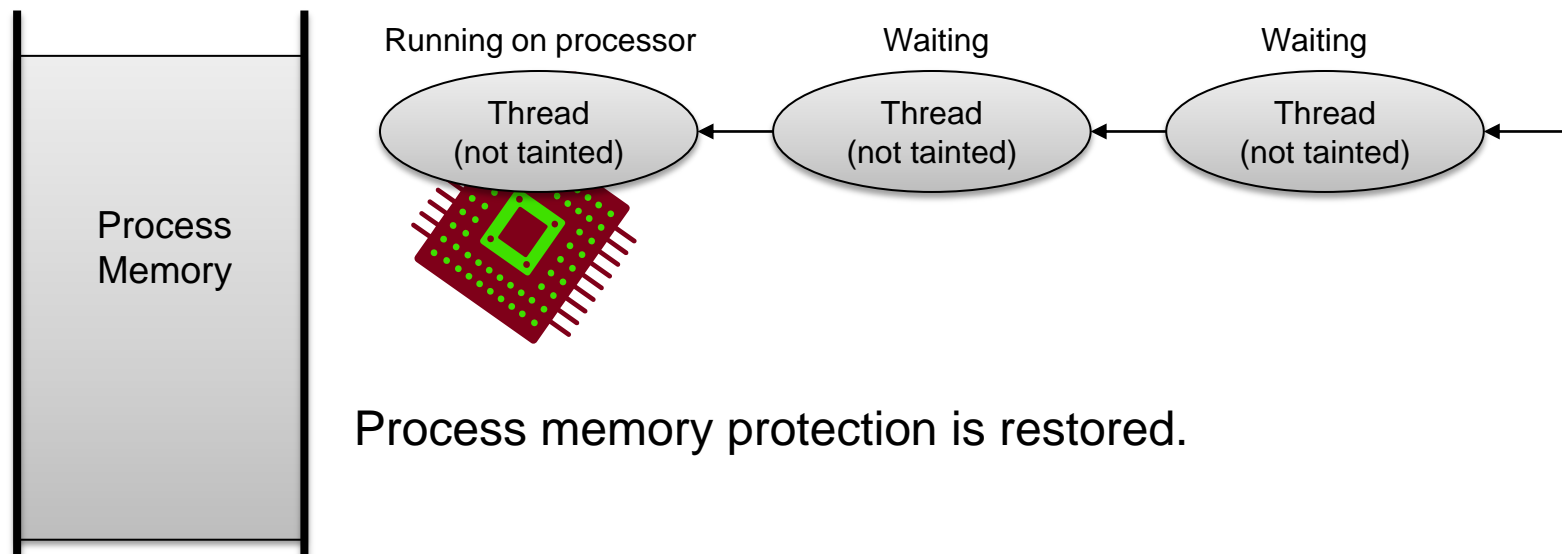


Currently, process memory is read-only.

If a thread tries to write somewhere, the processor causes an exception. egg catches this exception as taint event.

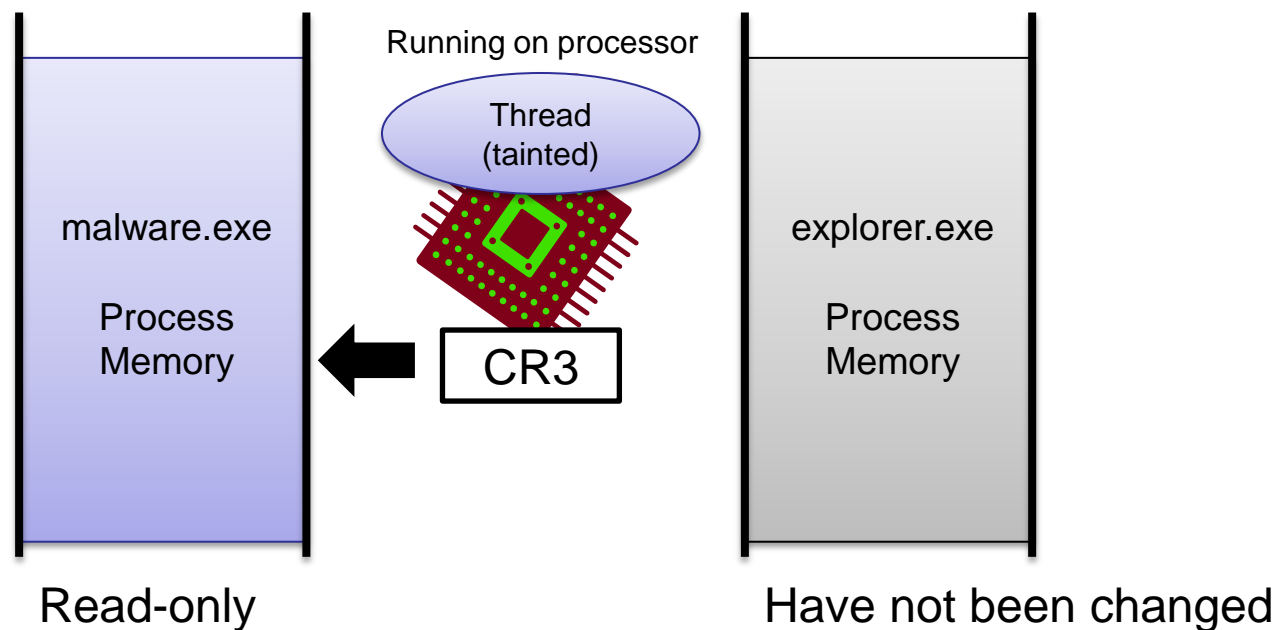
Implementation of taint tracing in ring-0

- When taint thread becomes inactive, egg restores every page protection.



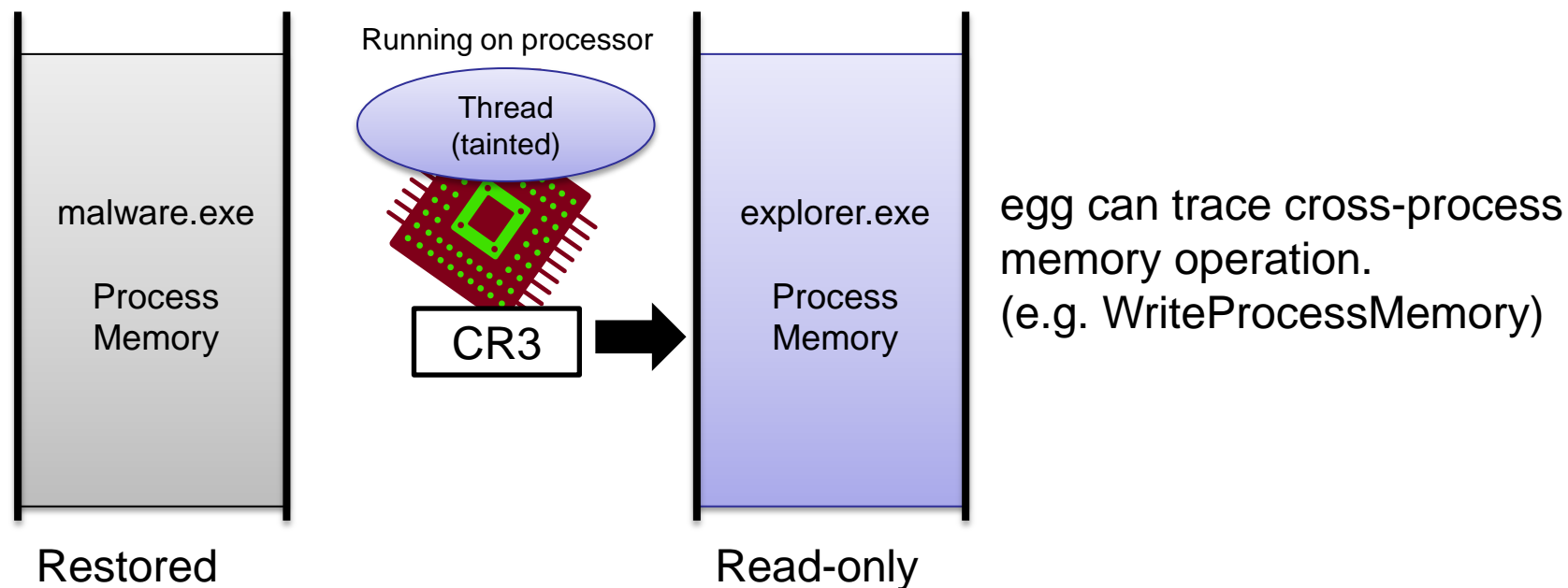
Tracking the cross-process memory operation

- To trace cross-process memory operation, egg hooks context switching function (called KiSwapProcess).
- Therefore egg can notice cross-process memory operation.



Tracking the cross-process memory operation

- When taint thread is running on other process memory, its process memory will be changed to read-only.





Demonstration of the taint tracing function(movie)

- The sample is the thread injection code.
- Sample malware called “injector.exe” injects to notepad.exe with VirtualAllocEx, WriteProcessMemory and CreateRemoteThread.
- Injected thread calls AllocConsole and WriteConsole in infinite loop.
- egg will trace the injected thread.

Problem of same privilege

- egg has limitation against kernel mode code.
 - egg is visible and breakable from kernel mode malware.
- This limitation is result of trade off for avoiding detection by the VM detection.



Conclusion

Type of system	egg	Traditional	Innovative
Getting useful information	Good	Insufficient	Good
Analyzing a kernel mode code	Better	Insufficient	Good
Analyzing a spreading malware.	Good	Insufficient	Good
Not affected by VM detection techniques	Good	Good	Insufficient

- We can save time by using egg.
- In the future, I will try to improve its stability and usability.

Thank you!



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