SAPIENZA
UNIVERSITÀ DI ROMA

BlueTracer: a Robust API Tracer for Evasive Malware

Simone Nicchi

Thesis Advisor: Prof. Camil Demetrescu
Thesis Co-Advisors: Dr. Daniele Cono D'Elia, Dr. Emilio Coppa

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Malware Analysis

Malware is an ever-growing threat

- **Static Analysis:**
  involves the inspection of the different data and code sections of a binary
- **Dynamic Analysis:**
  a malware sample is executed and the actions it performs on the environment are observed

Dynamic analysis strongly favoured as it allows us to dodge most code obfuscations and deal with a large number of samples

Function call monitoring

- Functions can abstract implementation details providing a semantically richer representation of some functionality
- The abstractions embodied by **system calls** and **library functions** can be used to grasp the visible behavior of a malicious sample

Example:

```
RegCreateKey("...\CurrentVersion\Run\monitor")
CreateDirectory("C:\Windows\utils")
CreateFile("C\Windows\utils\GFypmMVqJQOEQqy.exe")
```

Problem 1: limited logging capabilities

Available API tracing tools have **limited logging capabilities**

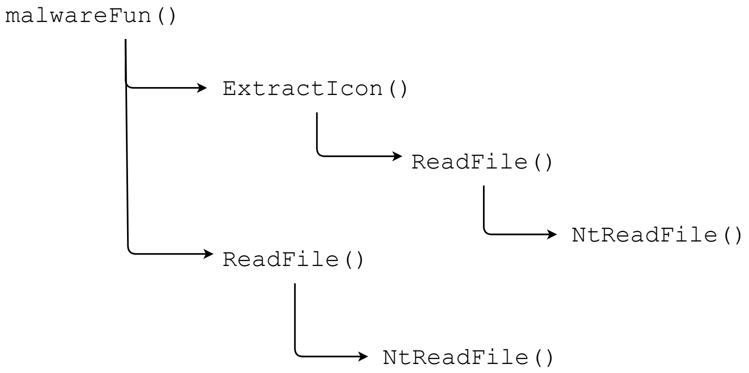
```
record_before(libcall_name, arg1)
retval = libcall(arg1, &arg2)
record_after(retval, *arg2)
```

- Access to function calls information is required
  - Prototype (number of arguments, data types, input/output)
- **Challenge:** heterogeneity of Windows libraries used in malware and lack of well-structured documentation for their prototypes

Problem 2: logging only calls made by sample

It is hard to distinguish the calls made directly by the sample from the ones made within libraries

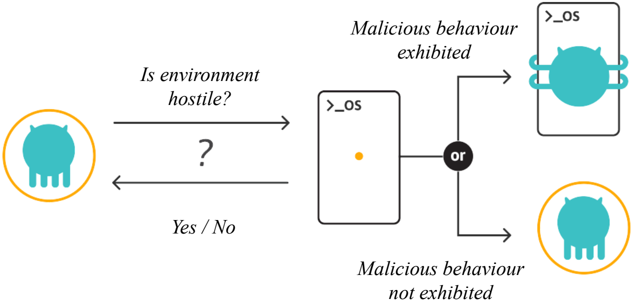
- Resulting logs are large and contain irrelevant information



Problem 3: evasive malware

Evasive malware

Malware that conceals its harmful behaviour when detecting a hostile environment, such as a well-known sandbox solution


Is environment hostile?
?
Yes / No
>_os
or
Malicious behaviour exhibited
>_os
Malicious behaviour not exhibited

Current tracing tools are **easily detectable** and are not coupled with mechanisms to hide their presence

BlueTracer: accurate API logging

BlueTracer is a robust library and system call tracer for Windows programs specialized in evasive malware based on Intel Pin

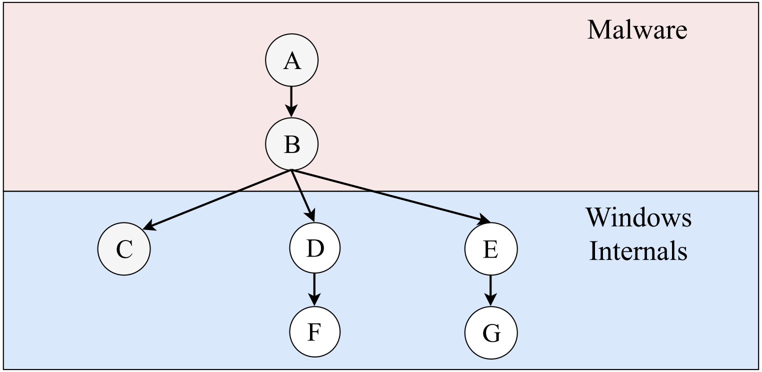
The tool possesses a remarkable logging power:

- Integration of rich, reliable external sources of function prototypes information
  (**Dr. Memory** and **CISCO PyREBox**)
- Stealthy tracing of input parameters, output buffers and return values of all system calls and of over 17,000 library calls
- Logging of asynchronous events

BlueTracer: focussed tracing of the sample's actions

Only calls made directly by the sample are recorded through the use of context-sensitive introspection

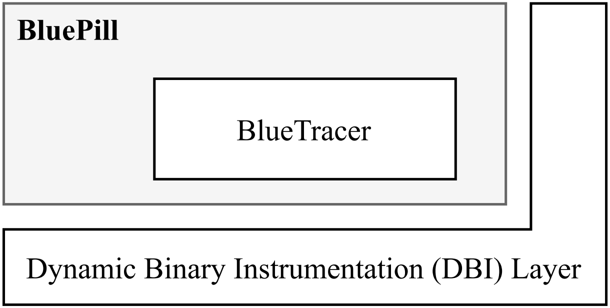
- Stack pointer and return address analysis



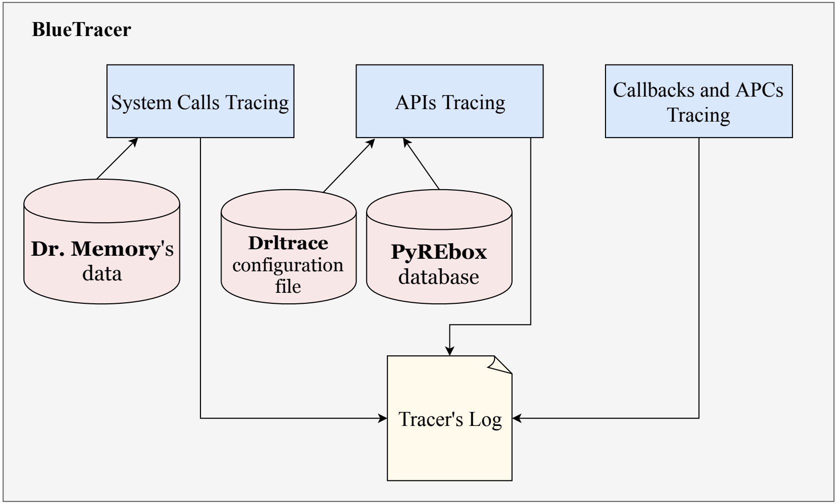
BlueTracer: robust against evasive malware

Solution to the detection problem:

- Seamless integration with the **BluePill** stealthy execution framework



Architecture of BlueTracer

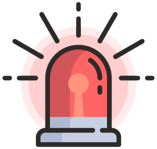


Validation (1): Al-Khaser

Al-Khaser is an open-source application which performs checks popular in malware samples spotted in the wild to determine if they are being executed in an analysis environment.

Many implemented techniques:

- **Anti-Debugging**
- **Timing-based**
- **Human Interaction Detection**
- **Anti-Virtualization**
- **Detection of Analysis Tools**



BlueTracer:

- remained undetected thanks to its integration with BluePill
- managed to track all arguments used to trigger evasion

Validation (2) with highly evasive malware samples

Five highly evasive samples collected by Joe Security:

ID	MD5	Name
1	0af4ef5069f47a371a0caf22ae2006a6	*banker*
2	9437eabf2fe5d32101e3fbf9f6027880	*dropper*
3	cbdda646a20d95f078393506ecdc0796	*trojan*
4	cfdd16225e67471f5ef54cab9b3a5558	Olympic
5	ef694b89ad7addb9a16bb6f26f1efaf7	Malicious CCleaner

Manual validation of all relevant actions performed by each sample:

- Check if logs are congruous with Joe Security reports

The logs collected by BlueTracer reveal behaviors consistent with the analysis reports authored by Joe Security

Example of tracked malevolent action

Tracing a particular action of a malware instance allows to understand in detail what the sample's intentions are

Example: dropping a malicious executable

```
[PID: 1116] kernel32.dll!CopyFileA
arg 0:   C:\Users\Simuset\Desktop\sample1.exe
         (name=lpExistingFileName, type=char*, size=0x1)
arg 1:   C:\Windows\system32\†\ffpb6966.exe
         (name=lpNewFileName, type=char*, size=0x1)
arg 2:   0x0
         (name=bFailIfExists, type=(long/int), size=0x4)
retval: 0x1
         (name=Return value, type=(long/int), size=0x4)
```

Conclusions

Contribution:

Design and implementation of **BlueTracer**, a robust library and system call tracer for Windows programs specialized in evasive malware.

Future Developments:

- Automatic methodology for large-scale evaluation
- Improvement of logging capabilities
- Log filtering and aggregation techniques

Thank you for your attention!