SAPIENZA
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BlueTracer: a Robust API Tracer for Evasive Malware

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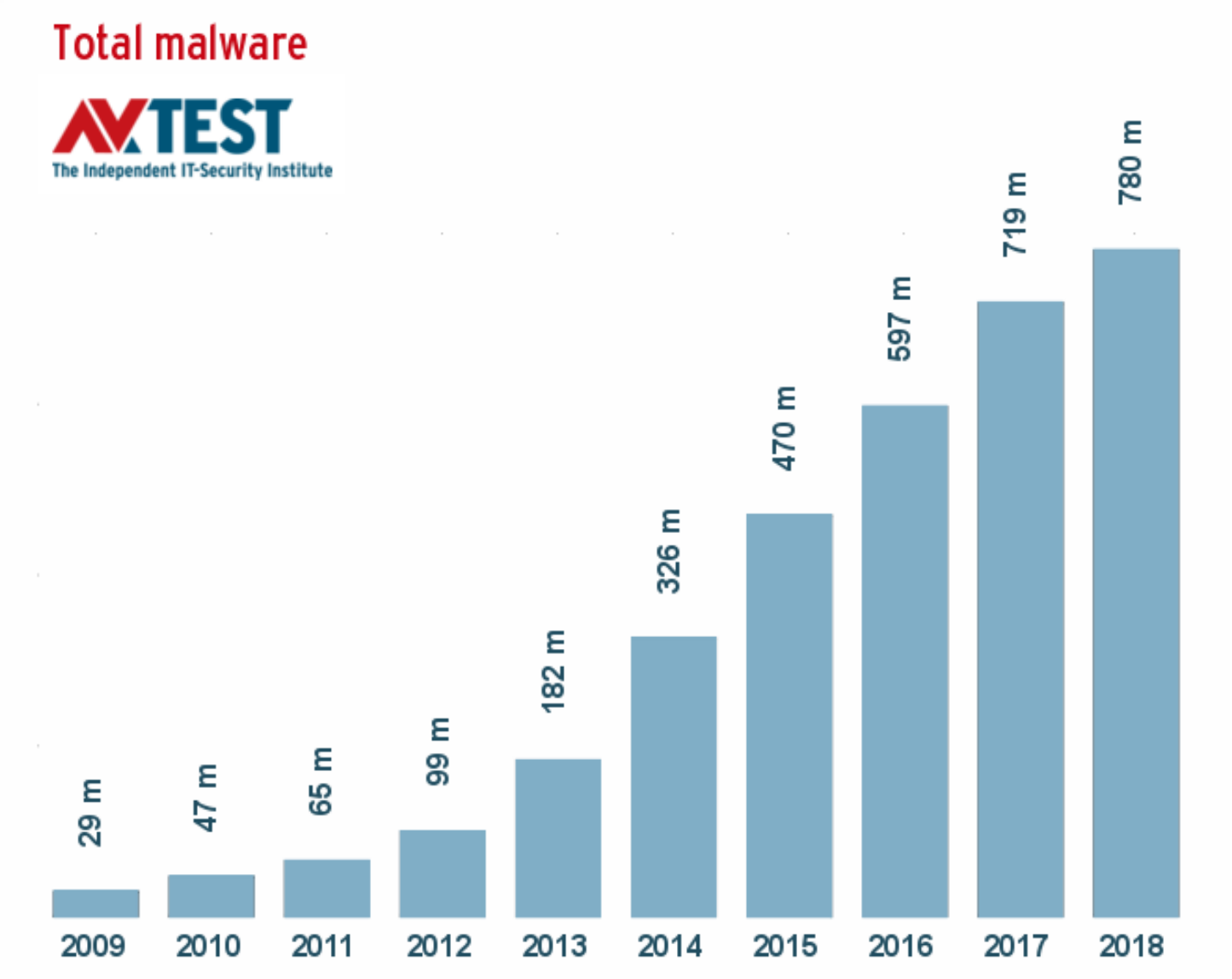
Malware: an increasingly significant problem



Malware Analysis

Two main types:

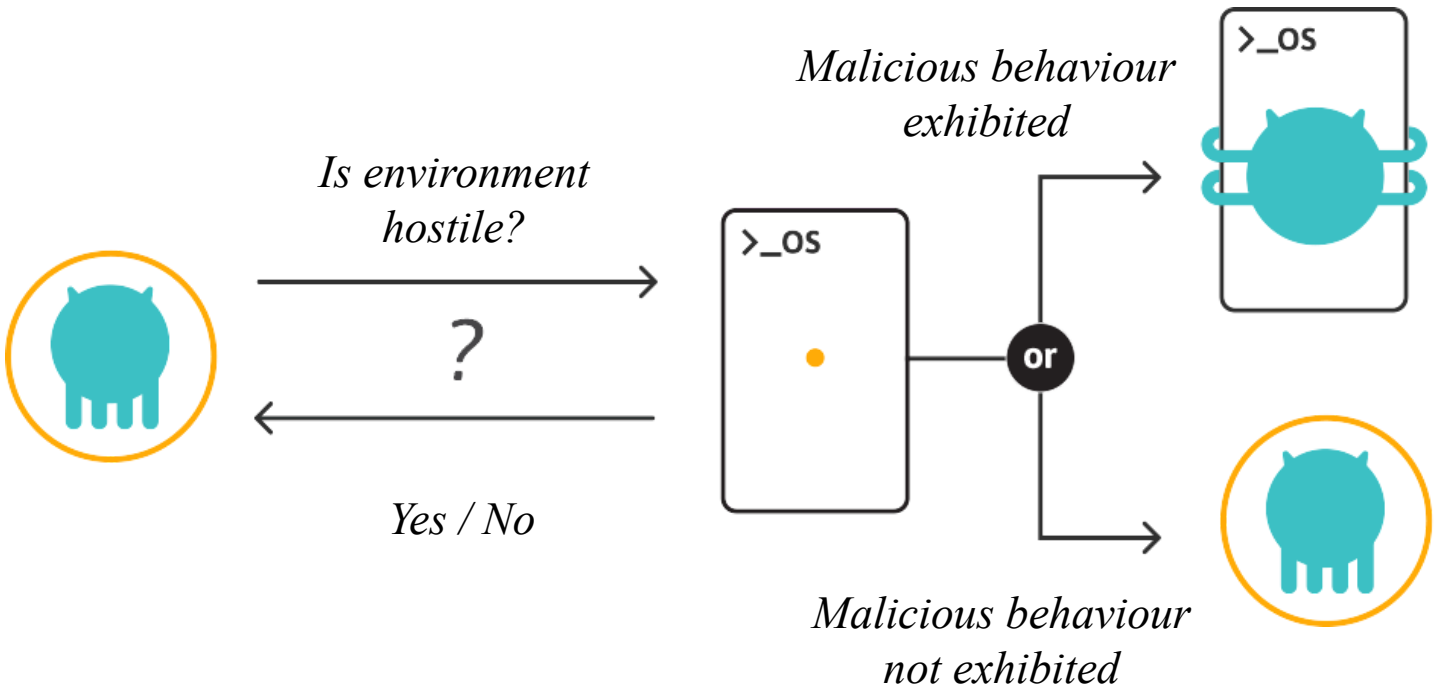
- **Static Analysis:**
  involves the inspection of the different data and code sections of a binary
- **Dynamic Analysis:**
  the malware sample is executed and the actions it performs on the environment are observed

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

The threat posed by evasive malware

Evasive malware

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



Function call monitoring

Functions can abstract implementation details providing a semantically richer representation of some functionality.

Example:

The abstractions embodied by **system calls** and **library calls** can be used to grasp the visible behavior of a malicious sample

Implementation of function call monitoring

API Hooking

The interception of function calls provided by dynamically linked libraries (DLLs)

Three broad categories:

- Binary Rewriting
  - Call Redirection
  - Function Rewriting
- Virtual Machine Introspection (VMI)
- **Dynamic Binary Instrumentation (DBI)**

Dynamic Binary Instrumentation (DBI)

A dynamic binary analysis technique in which the behaviour of an application is inspected at run-time, without the need of recompiling it, via the injection of analysis code.

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

Problems:

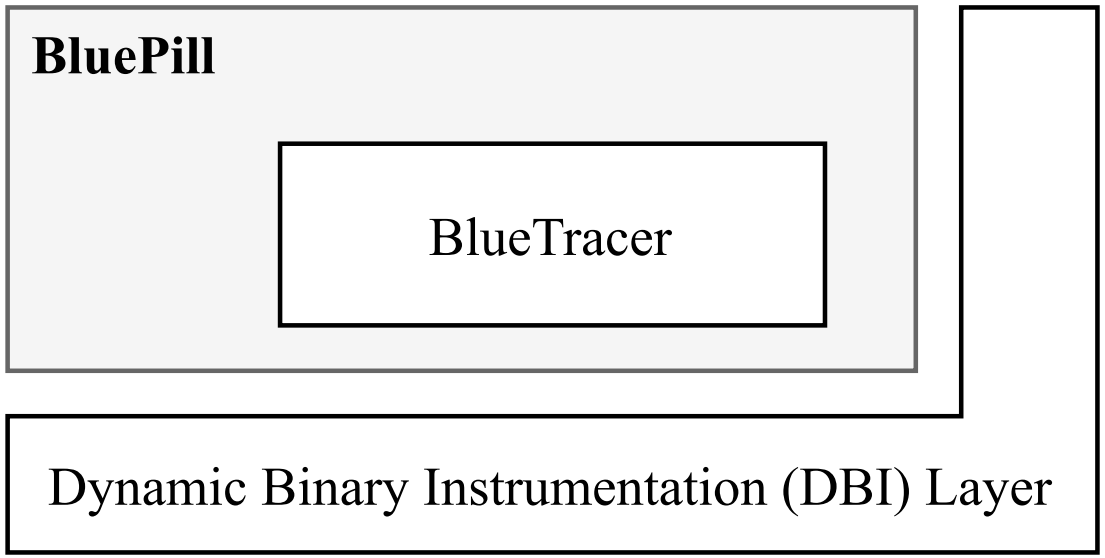
1. Existing products have limited logging capabilites
2. API hooking techniques in literature are not coupled with mechanisms to hide their presence from evasive malware

Our solution: BlueTracer

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

Building blocks:

- Based on the **Intel Pin** DBI framework
- Integrated with the **BluePill** stealthy execution framework



BlueTracer: challenges and features

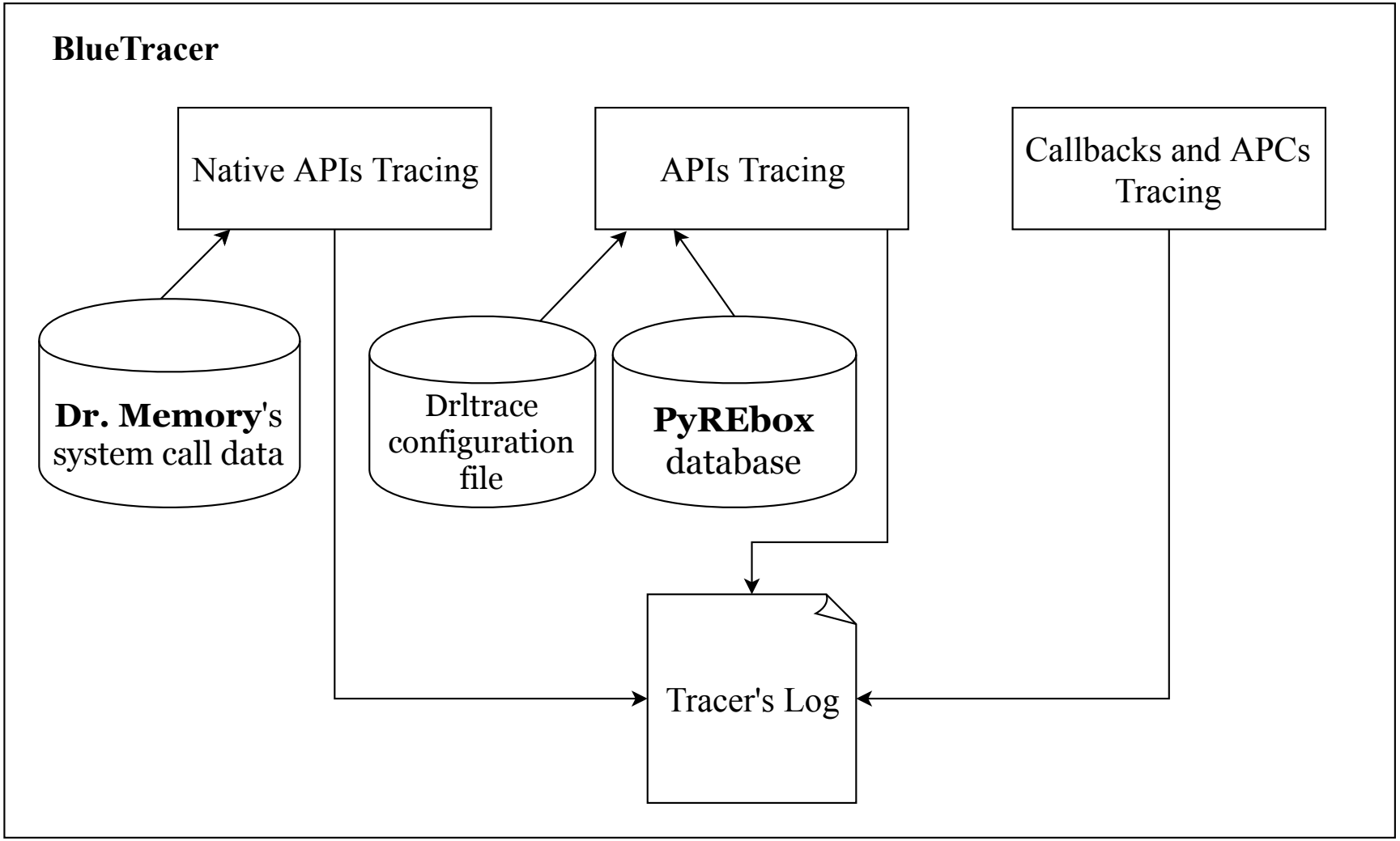
Implementation challenges:

- Heterogeneity of Windows libraries used in malware and the lack of well-structured documentation for their prototypes
  - → Integration of reliable external sources (**Dr. Memory** and **CISCO PyREBox**)
- Making best use of Intel Pin's capabilities with respect to run-time CPU and memory costs
- Addressing some inherent limitations of Intel Pin

Key features:

- Undetected tracing of input parameters, output buffers and return values of over 17 000 system calls and library calls
- Logging of asynchronous events
- Resolution of named constants

BlueTracer's architecture

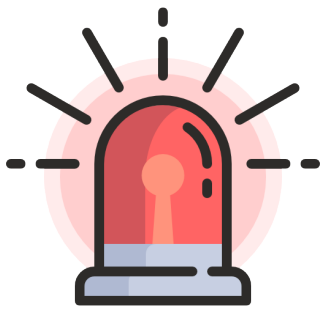


Evaluation with Al-Khaser

Al-Khaser is an open-source application which performs common checks employed by malware families to determine if they are being executed in an analysis environment.

Checks divided in categories:

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



BlueTracer:

- remained undetected thanks to its integration with BluePill
- managed to track all the checks

Example of tracked evasion check

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

Example: file system artifacts can be checked in order to uncover the presence of a virtualized environment.

```
~~3160~~ 24980 KERNELBASE.dll!GetFileAttributesW
24980   arg 0: C:Windows\system32\drivers\VBoxMouse.sys
 (name=lpFileName, type=wchar_t*, size=0x2)
24980     executed KERNELBASE.dll!GetFileAttributesW =>
24980   retval: 0xffffffff (name=Return value, type=DWORD, size=0x4)
```

Evaluation with evasive malware samples

Five highly evasive samples collected by Joe Security:

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

Evaluation was done manually and is a time-consuming process:

- Check if logs are congruous with Joe Security reports
- Process Monitor as ground truth for system activity

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

Conclusions

Contribution:

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

Future Developments:

- Adoption of an automatic methodology for large-scale evaluation
- Improvement of logging capabilities
- Usage of log filtering techniques

Thank you for your attention!