GEORGIA TECH INFORMATION SECURITY CENTER

Safeguarding Digital Infomation Through Innovative Research and Education

Ether

Malware Analysis via Hardware Virtualization Extensions

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Agenda

- Motivation
  - The malware problem
- The Ether Framework
  - Transparency and transparent malware analysis
- Evaluation
  - Comparing Ether to current approaches
- Conclusion

The Malware Problem

- A centerpiece of current security threats
  - Botnets
  - Spam
  - Information Theft
  - Financial Fraud
- Real Criminals
  - Criminal infrastructure
  - Domain of organized crime

Malware Analysis

- There is a profound need to understand malware behavior
  - Forensics and Asset Remediation
  - C&C Detection
  - Threat Analysis
- Malware authors make analysis very challenging
  - Direct financial motivation

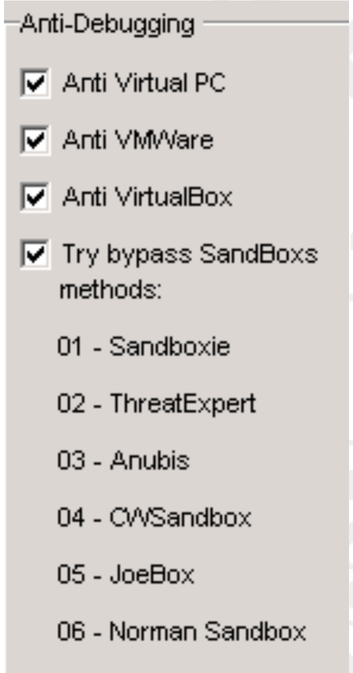
Two Types of Malware Analysis

- **Static Analysis**
  - **What a program would do**
  - **Complete view of program behavior**
  - **Requires accurate disassembly of x86 machine code**
  - **Often impossible to do in practice**
- **Dynamic Analysis**
  - **Shows what a program actually did when executed**
  - **Only gives a partial view of program behavior**
  - **Misses trigger based actions**
  - **How do you hide your analyzer?**

The Malware Uncertainty Principle

- An important practical problem
- Observer affecting the observed environment
- Robust and detailed analyzers are typically invasive
  - In-memory presence
  - Hooks
  - CPU Emulation
- Malware will refuse to run

The Malware Uncertainty Principle, Commercialized



Anti-Debugging

☑ Anti Virtual PC

☑ Anti VMWare

☑ Anti VirtualBox

☑ Try bypass SandBoxs methods:

01 - Sandboxie

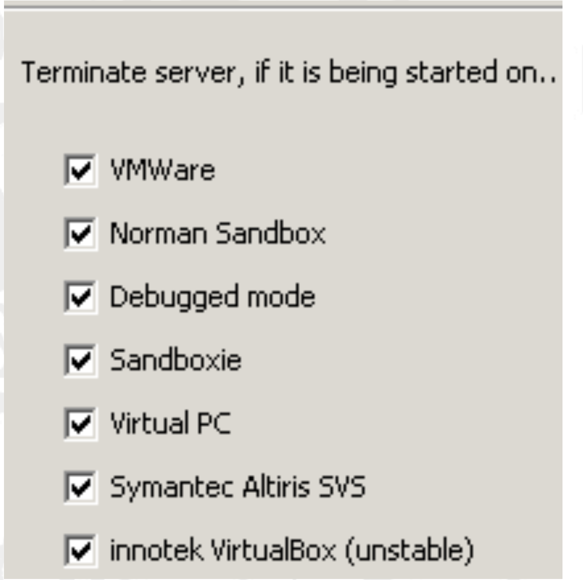
02 - ThreatExpert

03 - Anubis

04 - CWSandbox

05 - JoeBox

06 - Norman Sandbox



Terminate server, if it is being started on..

☑ VMWare

☑ Norman Sandbox

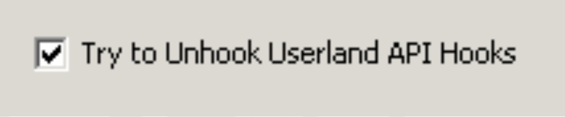
☑ Debugged mode

☑ Sandboxie

☑ Virtual PC

☑ Symantec Altiris SVS

☑ innotek VirtualBox (unstable)



☑ Try to Unhook Userland API Hooks

- **Dynamic analyzer detection is a standard malware feature**

Explaining the Malware Uncertainty Principle

- **Why such a high detection rate?**
- **Detection of In-Guest presence**
  - **PolyUnpack, CWSandbox**
- **Detection of Whole-System emulation**
  - **Anubis, Renovo**
- **Detection of API Emulation**
  - **Norman Sandbox**

Contributions

- **Transparency**
  - The theory
- **Ether: A transparent malware analysis platform**
  - The implementation
- **An externally reproducible evaluation of our results**
  - Source Code
  - Malware Samples

Solving the Malware Uncertainty Principle

- **An analyzer's aim should be *transparency.***
  - **Defining transparency**
- **The execution of the malware and the malware analyzer is governed by the principle of *non-interference.***

Transparency Requirements

- Higher Privilege
- No non-privileged side effects
- Same instruction execution semantics
- Identical exception handling
- Identical notion of time

Additional Analyzer Requirements

- Semantic information
  - Process names, system call arguments, etc.
- Coarse grained (system call level) tracing
  - Behavioral anti-virus
  - Malware Analysis Services
- Fine grained (instruction by instruction) tracing
  - Dynamic taint analysis
  - Automated unpacking
  - Multipath exploration

Fulfilling Transparency Requirements

- Debugging API
  - In-guest presence
  - Exception Handling
- Reduced Privilege Guests (VMWare, etc)
  - Non-privileged side effects
- Emulation (QEMU, Simics)
  - Instruction execution semantics

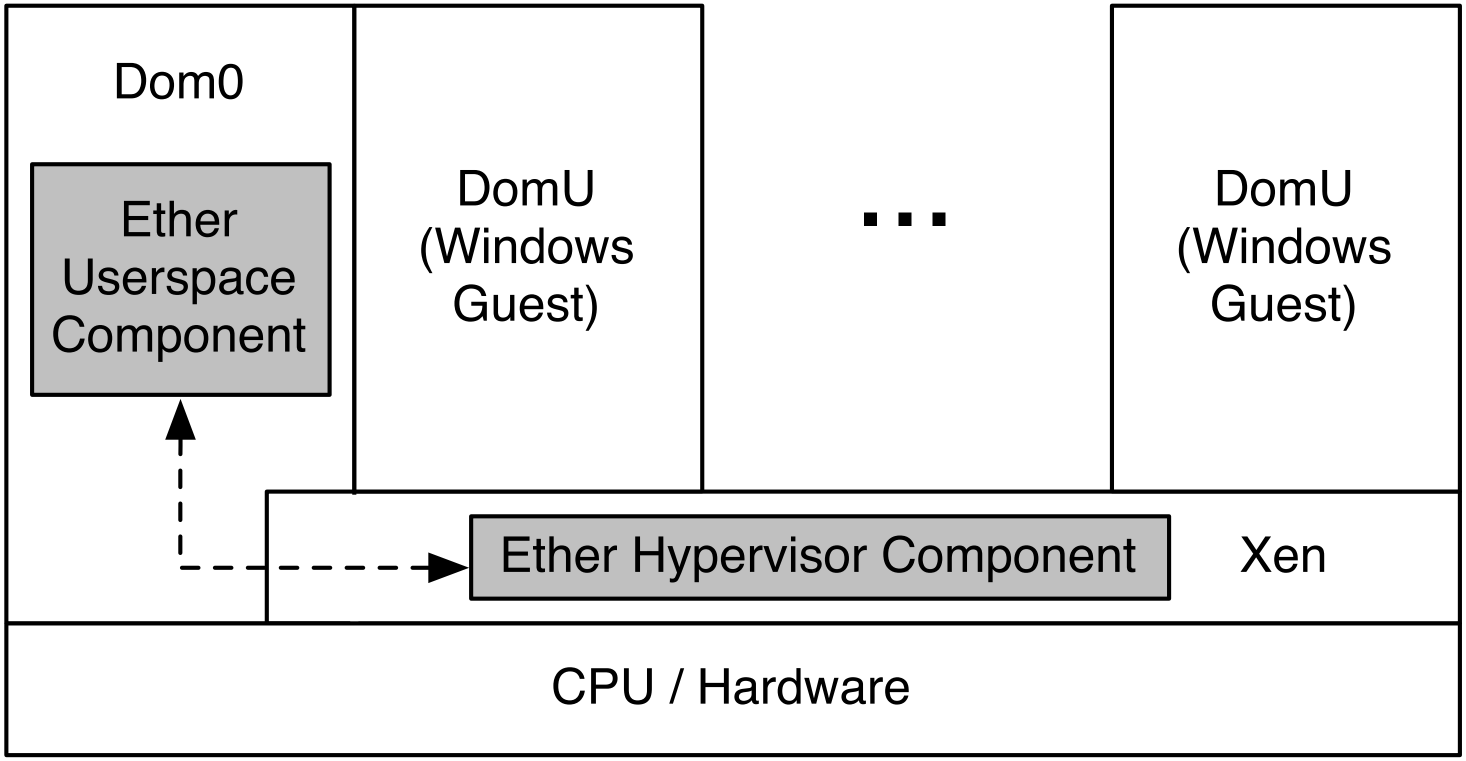
Fulfilling Transparency Requirements

- Idea: Use hardware assisted virtualization
- Provides several attractive transparency features
  - External
  - Capable
  - Equivalent
- Poses complex analysis challenges
  - Different goals

Challenges

- A transparent yet functional malware analyzer
- Use features of Intel VT in novel ways to achieve:
  - Guest memory analysis
  - Coarse grained tracing
  - Fine grained tracing
- Maintaining transparency

The Ether Framework



Detecting Ether

- **Detecting Intel VT**
  - **Increasingly irrelevant**
  - **Not the same**
- **Timing attacks**
  - **Network-based clock sources**
  - **Nothing we can really do**
- **Memory Hierarchy Attacks**
  - **Use AMD…**

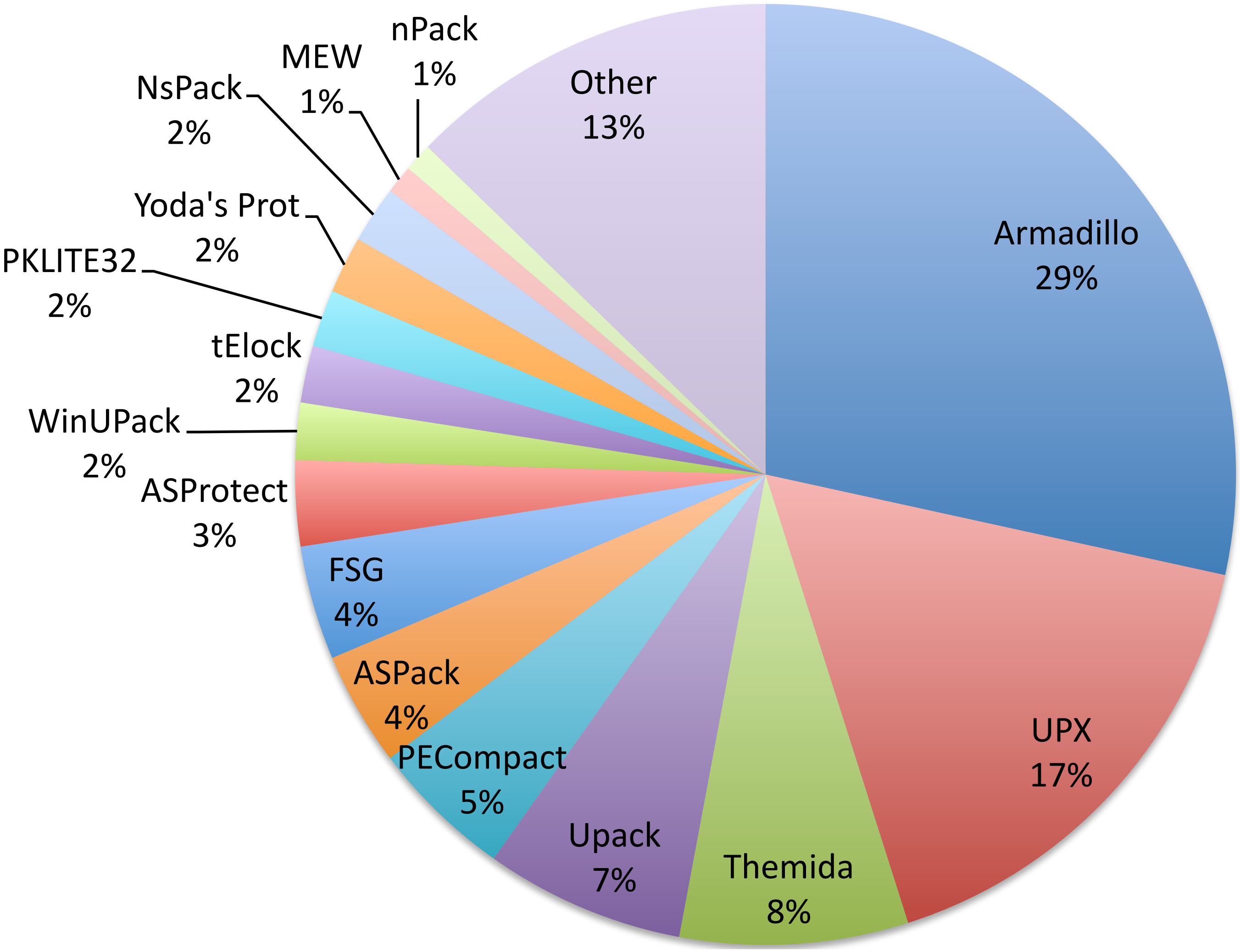
About EtherTrace

- An implementation of a coarse grained tracer using the Ether framework
- Traces the Windows equivalent of system calls (Native API)
  - Concept extends to other OSes
- Information Provided:
  - Call name
  - Typed arguments
  - Return values
  - Context (Process ID, Thread ID)

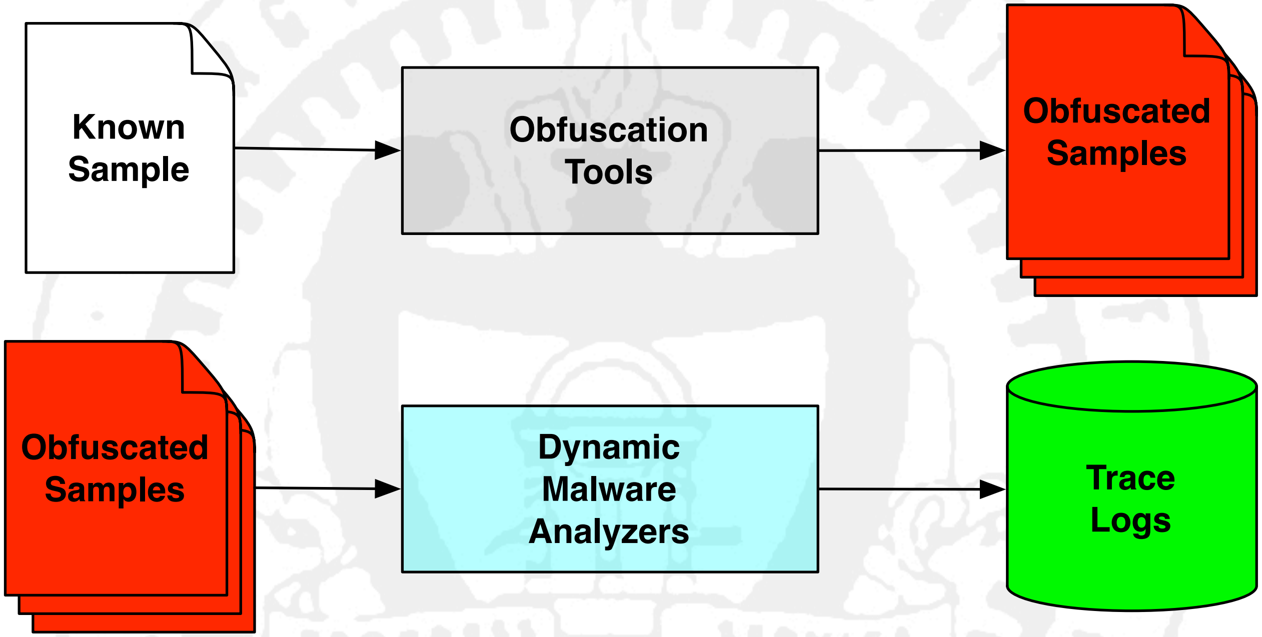
About EtherUnpack

- Precision universal automated unpacker
- Uses instruction-by-instruction tracing (fine grained tracing) to detect unpack execute behavior
- If code written is later executed, unpack-execution occurred
  - First proposed in Renovo
- Able to handle multiple packing layers
- Dumps unpacked memory images to disk

Obfuscation Tool Distribution

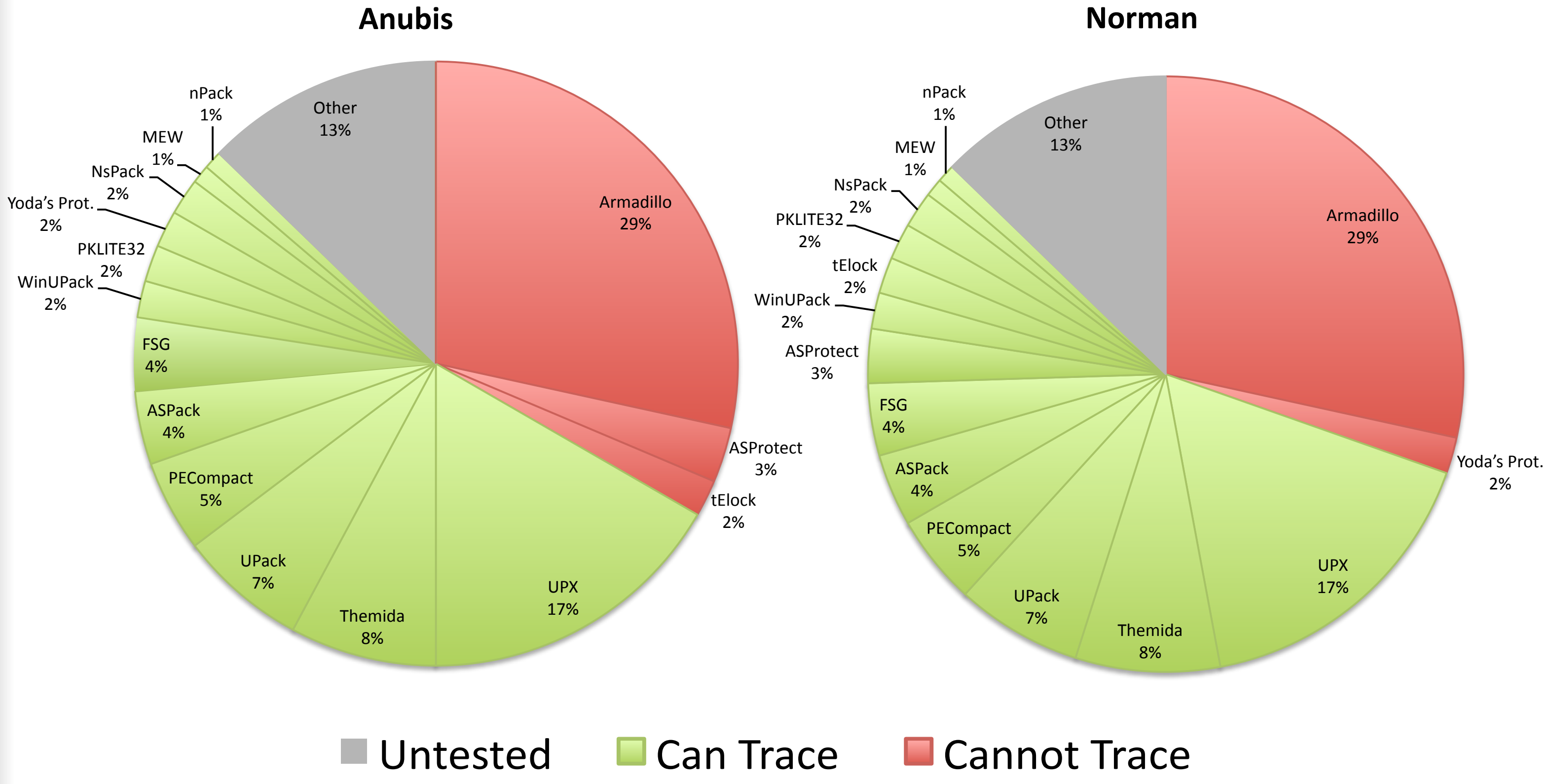


Evaluation: EtherTrace



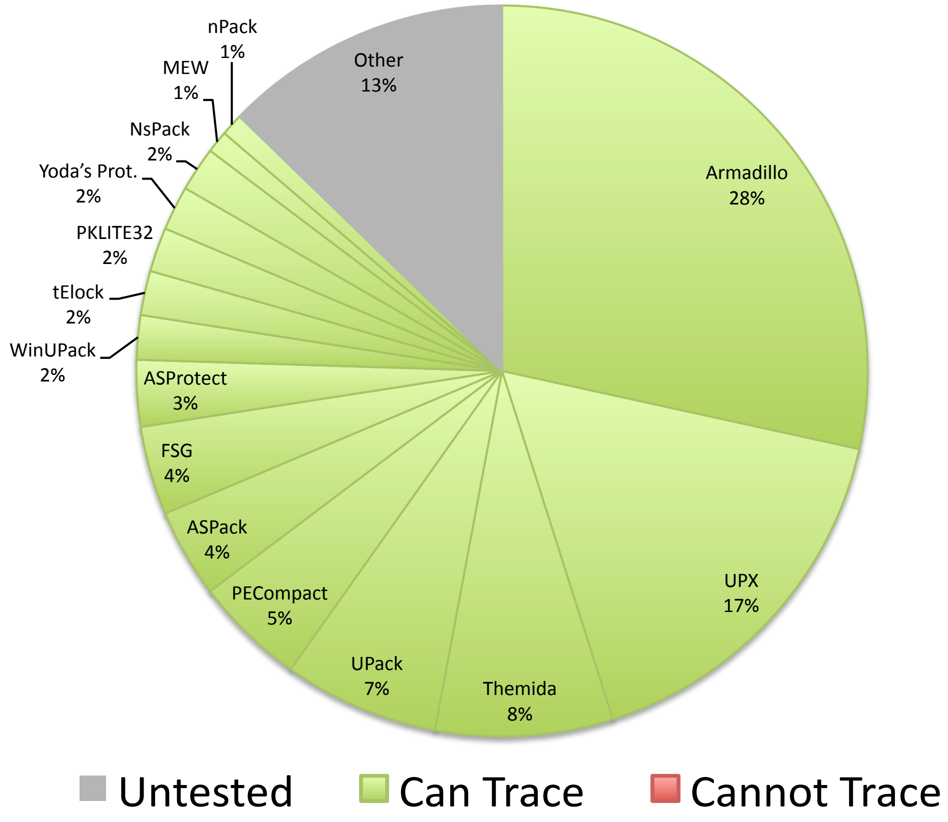
- Examine trace logs for expected actions
  - File
  - Registry

Evaluation: EtherTrace



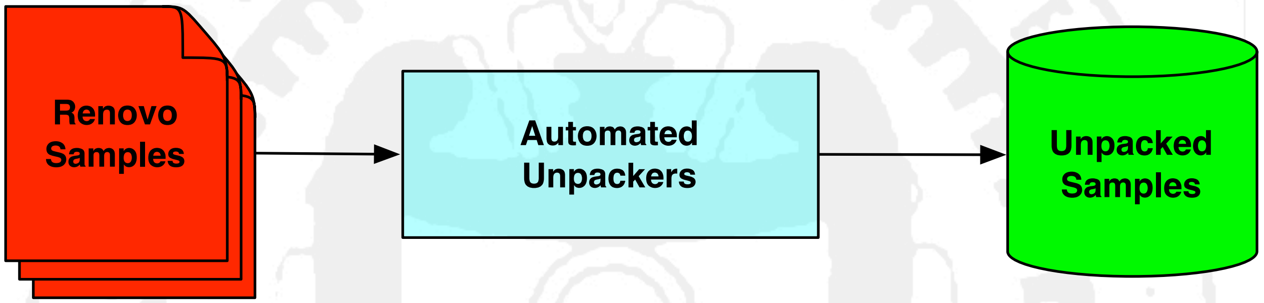
- **Obfuscation tools traced ranked by popularity**

Evaluation: EtherTrace



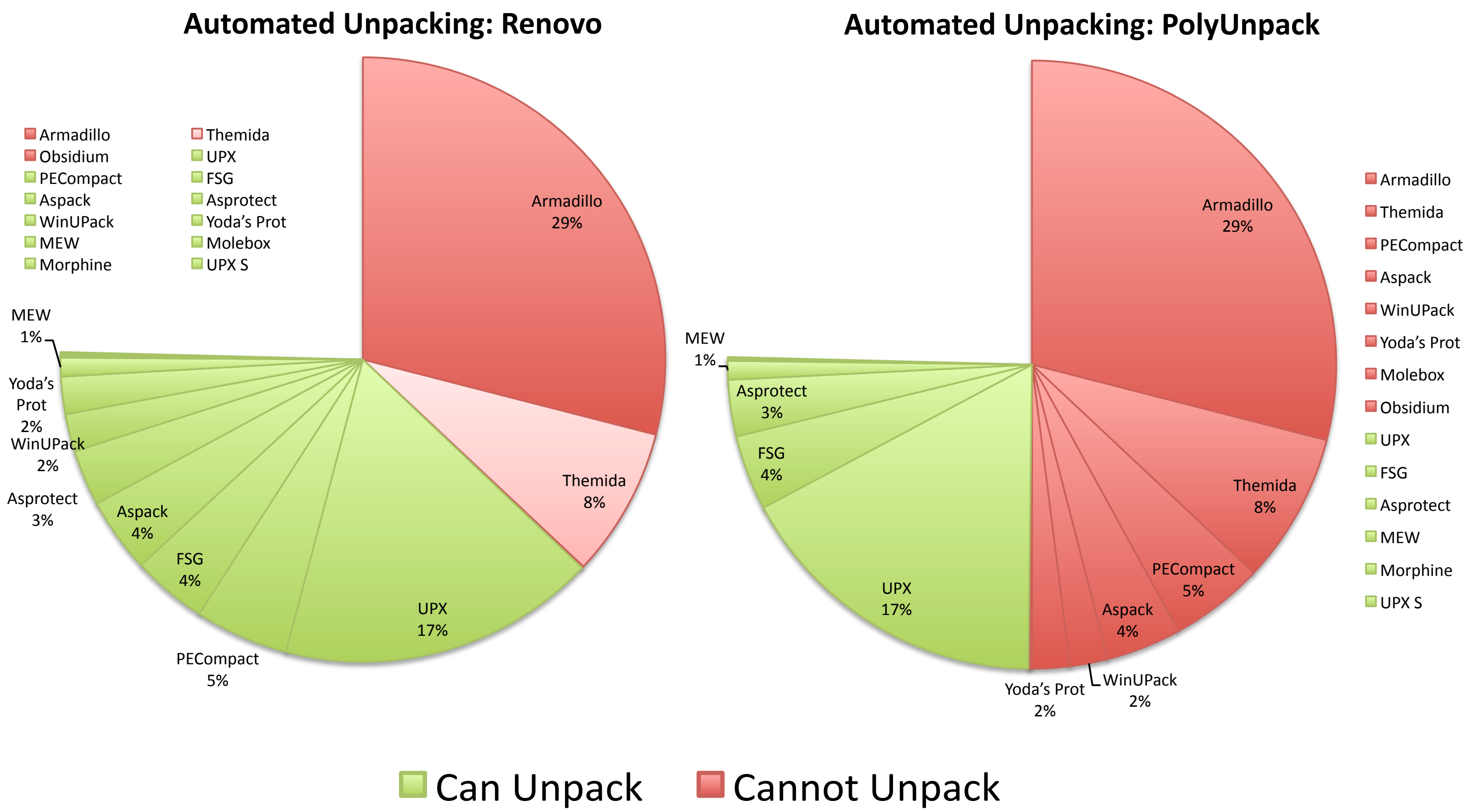
- **Ether is more transparent**

Evaluation: EtherUnpack



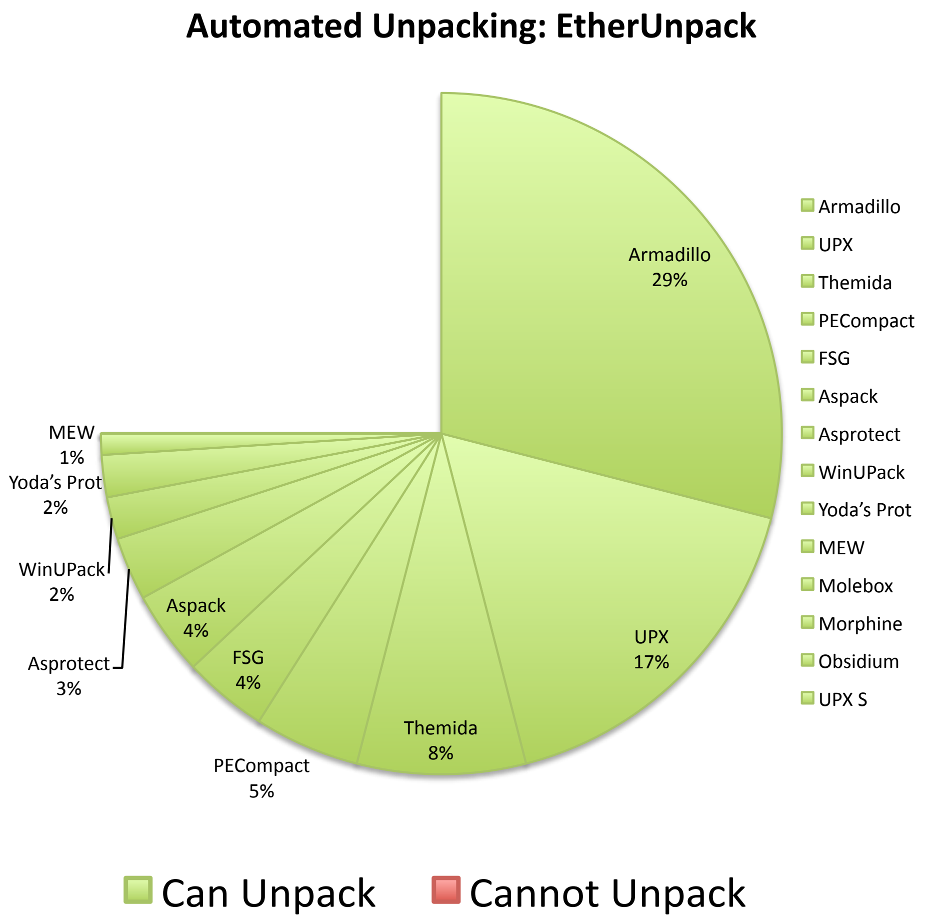
- Looked for a 32 byte string present in the original code section
- Not a random string
  - Avoid API calls
  - Not at entry point
  - On code path

Evaluation: EtherUnpack



- **Obfuscation tools unpacked ranked by popularity**

Evaluation: EtherUnpack



- **Ether is more transparent**

Conclusion

- An inadequacy of current tools
- Theoretically, we can do better
- Ether is an implementation of a different approach
- Evaluation confirms Ether is more transparent

Questions?

Source code and samples available at:

http://ether.gtisc.gatech.edu