Context-keyed Payload Encoding

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Payload Encoders

Encoder:

Encodes the payload prior to exploit packaging
 Prepends a decoder stub to the original payload
 Decoder stub:
 Prepended to original payload
 Executes first on the target
 Responsible for decoding the original payload
 Executes the original payload once decoded

Why are they used?

Evade detection of common payloads

- Solution Filtering of traffic containing the likes of:
 - ☆ exec of /bin/sh or other shells
 - \mathbb{Z} adduser commands
 - ☆ interaction with /etc/passwd
 - ⊠etc...

Encoder Examples

Metasploit (x86):

- Manumeric Mixed-cased
- Market Alpha2 Unicode Mixed-cased
- ☆ Avoid UTF-8 and tolower()
- Polymorphic XOR Additive Feedback (Shikata Ga Nai)









The Problem

Inherent expected functionality: The decoder stub must be able to decode the payload Existing payload encoders either: 🖾 Don't use a key at all We use a key that is statically included in the decoder stub Observer can capture the payload and easily decode it for analysis All encoding methods I've found suffer from this problem

How can this improve?

Always use a keyed encoder
 Don't include the key in the decoder stub!

But then how does the decoder get the key?











Context-keyed Payload Encoding

Definitions

Contextual Keying - The process of key selection from context information that is either known or predictable about the target.

- Context-key The key value resulting from the contextual keying process.
- Context-address The address at which the context-key will be found on the target.
- Memory Map A file containing chunks of static data and their location addresses as will be found within an application upon execution.

Context-keyed Encoder

Encoder

Encodes the payload prior to exploit packaging using the context-key

Prepends the decoder stub to the original payload

Decoder stub:

Prepended to original payload

- Executes first on the target
- \mathbb{R} Responsible for:

Solution: Second Second

☑ Decoding the original payload

Executes the original payload once decoded

Usable Context

"There are known knowns; there are things we know that we know. We also know there are known unknowns; that is to say, we know there are some things we do not know. But there are also unknown unknowns; the ones we don't know we don't know." -- Donald Rumsfeld

Context: Static Application Data Easy to profile if an attacker can reproduce: X Application's operating environment Execution of the target application Also easy if the attacker has access to the application executable or linked libraries Context-key can be chosen from static values found in the process's memory Can use known locations of static values such as: **Environment variables** Static strings The application's executable instructions (.text)

Profiling an Application

Create an application memory map from one or more of the following methods:

- Repeatedly poll a running process's memory, eliminating the locations of changing data
- Parse an application executable or dynamically-linked library's .text data and locations where it will be mapped in memory





smem-map

- **Example** Linux application
- Relies on /proc/<pid>/maps for memory locations
- Will also do an exhaustive search of all memory
- Relies on /proc/<pid>/mem for access to memory
- Repeatedly polls the memory locations
- Eliminates data that changes
- Smem-map <pid> <output.map>
- Results in a memory map of a process's static data in memory
- http://sourceforge.net/projects/smem-map/

msfpescan

Metasploit Framework tool

Targets Portable Executable formatted files

 Parses files for sections with data which will be loaded into memory such as .text
 msfpescan --context-map <outdir> <files>
 Results in a memory map of an executable or library's static data in memory

Attp://www.metasploit.com

Memory Map

File contains data structures for each chunk of data:

🕾 8-bit: Data Type

32-bit: Chunk base address

🕾 32-bit: Chunk size (in octets)

Size: Chunk Data

O10Editor Template Available: With smem-map package from SourceForge http://druid.caughq.org/src/

Context: Event Data

Transient data may also be used as long as it persists long enough for the decoder stub to access it

- Applications that you are exploiting generally accept input somehow
- Data sent prior to or with the exploit may end up in a known location

Context: Temporal Data

Skape introduced the concept of temporal addresses

 \mathbb{Z} Location in memory that holds timer data:

- System time
- 🖾 Uptime

Contents originally used as viable return instructions for exploitation

Suffers from some restrictions:

 Window during which you can actually send the exploit
 Data is called directly as instructions, may be marked nonexecutable

Context: Temporal Data

When used as a context-key there are fewer constraints:

Data must not change during use of it as a context-key
 Data remains viable provided:

☑ It's used within it's update time window

When used as an encoding key it doesn't produce bad payload byte values

Must be able to predict the value of the temporal data

- Frequently changing data is not useful as a contextkey
- Some timers are large enough that parts of them change infrequently

Temporal Data Case Study Windows NT+ SystemTime is: An 8 (12) byte timer **22** 100 nanosecond resolution Epoch of January 1st, 1961 Mapped into every process at a known location as part of the SharedUserData region of memory







Windows SystemTime

Byte Indices update frequency:

- ☑ 0 = < 1 second

- 🖾 3 = 1 second
- ☑ 4 = 429 secs (7 mins 9 secs)
- ☆ 5 = 109951 secs (1 day 6 hours 32 mins 31 secs)
- 326 = 28147497 secs (325 days 18 hours 44 mins 57 secs)
- Given the desired length of the key, the window of opportunity can be quite large
- The smaller the desired length of the key, the less exact the prediction of the target's system time needs to be

Context-key Selection

Using memory map static chunks as data source:

- Select sequential data at any address that is large enough to use as a context-key
- Check that the result of encoding the payload using that key does not violate any byte value restrictions
- Check that the context-address does not violate any byte value restrictions
- If everything is good, note the context-key's value and context-address

Encoding/Decoding with Context Encoder gets the context-key value and produces an encoded payload as usual Decoder stub gets the context-address and is prepended to the encoded payload When the decoder stub executes, it: Retrieves the context-key from the context-address ⊠ Decodes as usual.







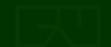
Proof of Concept

Metasploit's Shikata Ga Nai

Updated to optionally use context-keys instead of randomly generated

Series From MSF Console:

(regular exploit & payload commands)
set ENCODER x86/shikata_ga_nai
set EnableContextEncoding 1
set ContextInformationFile application.map
exploit





ms04-007 vs. XP-SP0

Create Memory Map

Solution Strategy and Strate

Metasploit:

use exploit/windows/smb/ms04-007-killbill
set PAYLOAD windows/shell_bind_tcp
set ENCODER x86/shikata_ga_nai
set EnableContextEncoding 1
set ContextInformationFile Isass.exe.map
exploit

Conclusions

