

Ripples in the Gene Pool

Creating Genetic Mutations to Survive
the Vulnerability Window

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Standard Disclaimer

The views expressed in this presentation are my own and do not necessarily reflect the official policy or position of my employer

Background

- Ideas born from CTF
 - Often no source code available
 - Stopping service not an option
 - Patch needs to survive < 3 days
- Techniques discussed using x86 examples
 - Easily adapted to other platforms

The Software Monoculture

➤ From Geer et al.

- A monoculture of networked computers is a convenient and susceptible reservoir of platforms from which to launch attacks; these attacks can and do cascade.
- This susceptibility cannot be mitigated without addressing the issue of that monoculture.

The Vulnerability Window

- Time of discovery to patch availability
- Two components
 - Discovery to disclosure
 - Hardest to pin down
 - Requires a cooperative discoverer
 - Effectively no defensive capability
 - Disclosure to patch availability
 - Defense via mitigation
 - Must be shorter than disclosure to automated exploit window or all hell breaks loose

Third Party Patching

- Discoverer provided patch
 - Rarely seen
- Independent researcher provided patch
 - Follows disclosure, precedes vendor patch
 - Also rare
 - Ifak's WMF hotfix
 - eEye's IE patch
 - Controversial

Responsible Disclosure 😊

- I don't care if you disclose or not
- I don't care if you coordinate with a vendor or not
- IF you do choose to disclose please do all the grandmothers in the world a favor and publish ways to mitigate

What Mutations Are

- Simple changes to a binary to alter runtime characteristics sufficiently enough to foil automated exploitation attempts
 - Often easier than a proper fix
- Security Through Obscurity

What Mutations Aren't

- Not un-exploitable
- Not a long term solution

Assumptions

- Automated exploits are generally built for specific target layouts
- Automated attackers simply move on to new targets when they do not achieve expected results

Binary Patching

- A bit of a black art
- Proper fixes generally require additional space
 - Compilers are usually concerned with size and don't generally leave to much free space
 - May require extensive editing of file headers
- May require functions not originally imported

Simple Mutations

➤ Stack Mutations

- Alter stack layout to something unexpected
- Simplest to perform

➤ Heap mutations

- Alter heap layout

➤ Format String Mutations

- Add extra parameter

➤ Uninitialized Stack Variables

- Alter stack layout to move variable

Stack Mutations

- Grab more stack space
- Typical function prologues

```
push    ebp
mov     ebp, esp
sub     esp, 34h    ; one byte constant
```

```
push    ebp
mov     ebp, esp
sub     esp, 414h  ; four byte constant
```

Stack Mutations (cont)

- After grabbing more stack space frame pointer offsets may need adjusting
 - esp based frames
 - No adjustment required for local variable offsets
 - Adjust all function argument offsets
 - ebp based frames
 - Adjust all local variable offsets
 - No adjustment needed for function arguments

Stack Mutation Example

```
-00000410 var_410      dd ?
-0000040C var_40C      dd ?
-00000408 var_408      dd ?
-00000404 var_404      dd ?
-00000400 var_400      dd ?
-000003FC var_3FC      dd ?
-000003F8 var_3F8      db 1016 dup(?)
+00000000 s           db 4 dup(?)
+00000004 r           db 4 dup(?)
+00000008 arg_0       dd ?
```

```
push    ebp
mov     ebp, esp
sub     esp, 414h      ; claim extra 1024
lea    edx, [ebp+var_3F8]
```

Stack Mutation Example (cont)

```
-00000810 var_810      dd ?      ; former var_410
-0000080C var_80C      dd ?      ; former var_40C
-00000808 var_808      dd ?      ; former var_408
-00000804 var_804      dd ?      ; former var_404
-00000800 var_800      dd ?      ; former var_400
-000007FC var_7FC      dd ?      ; former var_3FC
-000007F8 var_7F8      db 1016 dup(?) ; former var_3F8
    ; 1024 bytes of padding here
+00000000 s              db 4 dup(?)
+00000004 r              db 4 dup(?)
+00000008 arg_0          dd ?
```

```
push    ebp
mov     ebp, esp
sub     esp, 814h      ; NOTE CHANGE HERE
lea     edx, [ebp+var_7F8] ; AND HERE
```


Stack Mutation Example (cont)

```
-00000810 var_810      db 1016 dup(?)  ; former var_3F8
-00000410 var_410      dd ?           ; In this case no other
-0000040C var_40C      dd ?           ; variable offsets need
-00000408 var_408      dd ?           ; to be changed
-00000404 var_404      dd ?
-00000400 var_400      dd ?
-000003FC var_3FC      dd ?
      ; 1016 bytes of padding here
+00000000 s           db 4 dup(?)
+00000004 r           db 4 dup(?)
+00000008 arg_0       dd ?
```

```
push    ebp
mov     ebp, esp
sub     esp, 814h      ; NOTE CHANGE HERE
lea    edx, [ebp+var_810] ; AND HERE
```

Stack Mutations (cont)

➤ Variations

- Add padding to all functions, especially main
 - The effect is poor man's stack randomization
- Reorder local variables
 - Place additional locals between buffers and saved return address
 - Poor man's canaries

Heap Mutations

- Allocations made using
 - Fixed size chunks for known size structs/arrays
 - Computed size chunks based on expected size of structs or array
- Mutation is made to increase requested size

Heap Mutation Example

➤ Simple static size mutation

- Trades increased memory use for improved(?) security

```
push    16  
call    _malloc
```

- becomes

```
push    64  
call    _malloc
```

Heap Mutation Example

- Computed size mutations
 - More difficult
 - Need to create space to adjust computed size upward
 - Need a gap of 5 or more bytes to insert an add instruction

Format String Mutations

- This is a more standard patch
- Usually need to push a valid format string
- Create space for extra push
 - At least 5 bytes required
- Create format string in binary
 - Overwrite some unimportant string like usage
- Modify post return stack adjustment

Uninitialized Stack Variable Mutations

- Two options here
 - Create space to add initialization code
 - Adjust stack offsets to move variable to a less predictable location

Demonstrations



Questions?

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shoutz & greetz to the Sk3wl kr3w, Kenshoto, and all the Shmoo

References

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