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
    - Ilfak’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 too 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

  

  

- infectionvectors.com, “Just In Time: Microsoft’s Time to Exploit”
  
  http://www.infectionvectors.com/vectorspaces.htm#jit