Reverse Engineering and the ANI Vulnerability

Alexander Sotirov
alex@sotirov.net

Introduction

- Security researcher at Determina
- Vulnerability analysis and reverse engineering Microsoft patches
- Exploit development experience
- Speaker at CanSecWest, REcon, SyScan and BlackHat
- Vista vulnerabilities

Exploit Demo

Part I

Reverse Engineering Microsoft Patches

Patch Statistics

- More than 500 bulletins since 1998
- Most updates fix multiple vulnerabilities
  - 5 vulnerabilites in the latest IE patch
- Fixed release schedule
  - second Tuesday of the month

Skeletons in Microsoft's Closet

- Security issues are often fixed silently
  - security researcher reports a vulnerability
  - Microsoft audits the affected code and discovers 5 related bugs
  - 6 bugs are fixed in the patch
  - security bulletin describes only the first bug
- Service packs silently fix bugs

Withholding information

- Security bulletins omit technical details:

There is a privilege elevation vulnerability in Windows 2000 caused by improper validation of system inputs. This vulnerability could allow a logged on user to take complete control of the system.

- Reverse engineering is the only way to really understand vulnerabilities

Patch Analysis

- The security industry relies on reverse engineering patches for:
  - attack vectors and packet signatures
  - vulnerability analysis
  - remote detection of the vulnerability
  - exploit development

Reverse Engineering Tools

- IDA Pro
  - great plugin API
- BinDiff
  - function level diffing of binaries
- PaiMei
  - allows tracing and visualization of execution paths, guides static analysis
- VMware
  - backwards debugging with multiple snapshots

Patch Analysis Demo

Part II

Exploitation

Protection Mechanisms in Vista

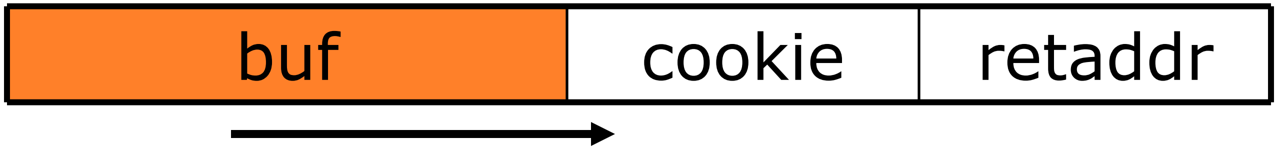
- /GS stack cookies
- Address Space Layout Randomization
- Data Execution Prevention

/GS stack cookies

```
static_cookie = rand();
void foo(char* input)
{
        int cookie = random_cookie;

        char buf[256];
        strcpy(buf, input);

        if (cookie != random_cookie)
              abort();
}
```



Bypassing /GS

- No need to bypass /GS for ANI exploit
- There is no stack cookie in our function:
  - /GS protects only functions with arrays
  - ANI header data is read into a structure

ASLR

- Address Space Layout Randomization
  - stack and heap addresses
  - base addresses of executables and libraries
- Blocks the use of jmp esp trampolines
  - we need a fixed location

Bypassing ASLR

- Find something that's not randomized
  - executables
  - ntdll.dll and kernel32.dll
- Write our shellcode at a known location
  - vulnerability specific
- Heap spraying
  - great for browser exploits

Heap spraying

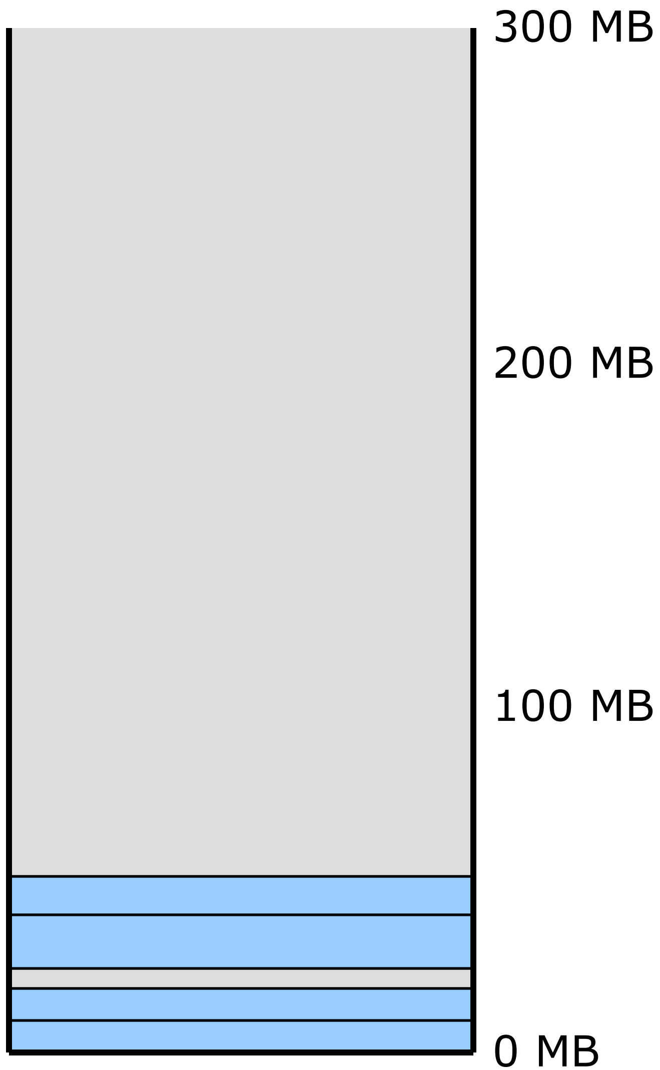
Used by most browser exploits since 2004

```
var x = new Array();

// Fill 200MB of memory with copies of the
// NOP slide and shellcode

for (var i = 0; i < 200; i++) {
    x[i] = nop + shellcode;
}
```

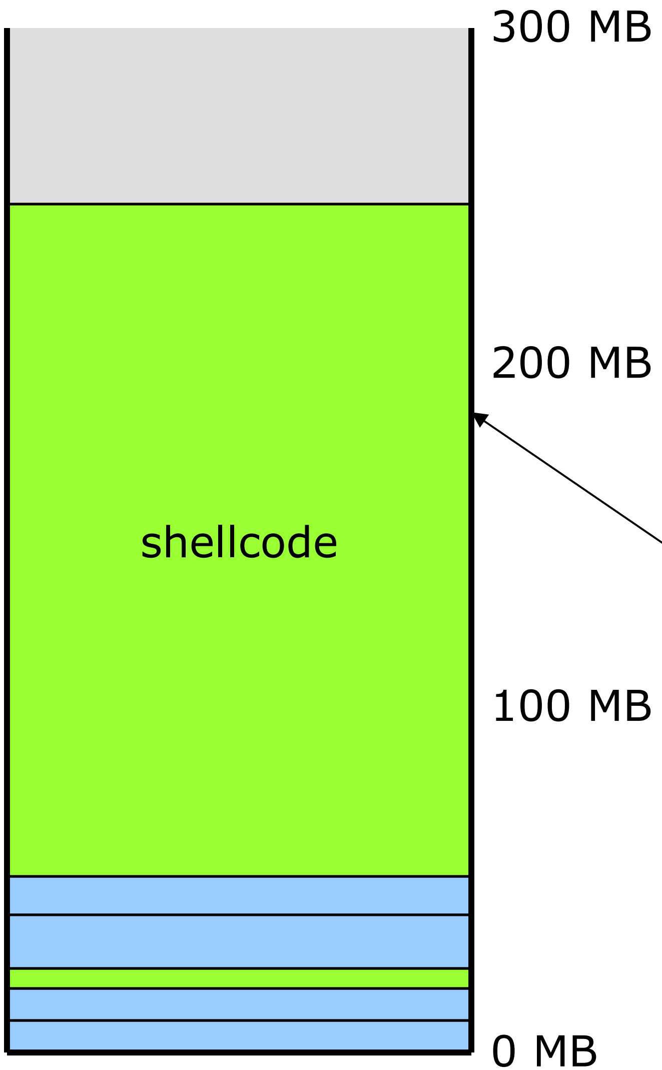
Normal heap layout



used memory: 🟦

free memory: ⬜

After heap spraying



used memory: 🟦

free memory: ⬜

shellcode: 🟩

Any address around 200MB is likely to contain shellcode.

Data Execution Prevention

- CPU support for non-executable data
  - x86 architecture did not support it
  - introduced by AMD and Intel in 2004
- Prevents code injection
- Opt-in on Windows
  - IE not protected by default even on Vista

Bypassing DEP

- Return-into-libc attacks

  system("/bin/sh")

- Disabling DEP
  - jump to code in ntdll.dll that disables DEP
- VirtualProtect
  - change the protection of the heap to allow execution

Bypassing DEP

- ASLR is supposed to stop DEP bypasses
- LoadAniIcon function has an exception handler that catches access violations
- Send multiple ANI files
    - guess the address of ntdll.dll (only 256 locations)
    - disable DEP and execute shellcode

Part III

Secure Development

Security from the ground up

- Use the right language and platform
  - Java and Python eliminate buffer overflows
  - PHP encourages insecure programming
  - C++ is a bad choice in almost any case

Designing secure software

- Isolate components along trust boundaries
  - authenticated / non-authenticated
  - root / non-privileged user
  - user data / trusted data
- Narrow, well defined interfaces
- Validate all data that crosses a trust boundary

Know when to give up

- Some things are just really bad ideas
  - ActiveX
  - Google Desktop Search web integration
  - PHP register_globals setting
- Adding security on top of an existing insecure system
  - Windows and Oracle legacy codebases
  - WordPress vs. MediaWiki

Exploit mitigation

- All software has bugs
- Assume that all software you write will ship with critical security vulnerabilities
- Make exploitation harder
  - /GS cookies and ASLR are great examples
  - SSH privilege separation
  - Avoid single sign-on for web services

Microsoft vs. RedHat vs. Apple

	Vista	XP SP2	2000	RHEL	Open BSD	OSX
ASLR						
Executable Randomization	🟩	🟥	🟥	🟩	🟩	🟥
Library Randomization	🟩	🟥	🟥	🟩	🟩	🟥
Stack Randomization	🟩	🟥	🟥	🟩	🟩	🟥
Heap Randomization	🟩	🟥	🟥	🟩	🟩	🟥
Stack Protection						
Stack Cookies	🟩	🟩	🟥	🟩	🟩	🟥
Variable Reordering	🟩	🟩	🟥	🟩	🟩	🟥
Non-executable	🟩	🟩	🟥	🟩	🟩	🟩
Heap Protection						
Heap Metadata Protection	🟩	🟩	🟥	🟩		🟥
Non-executable	🟩	🟩	🟥	🟩	🟩	🟩

Questions?

alex@sotirov.net