SECURITY IMPROVEMENTS IN WINDOWS VISTA

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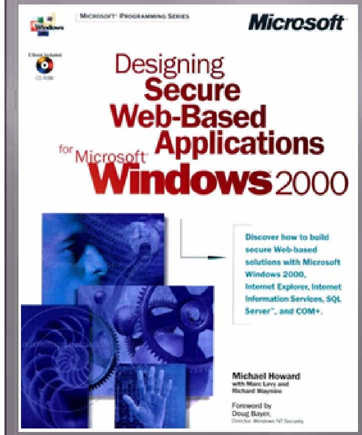
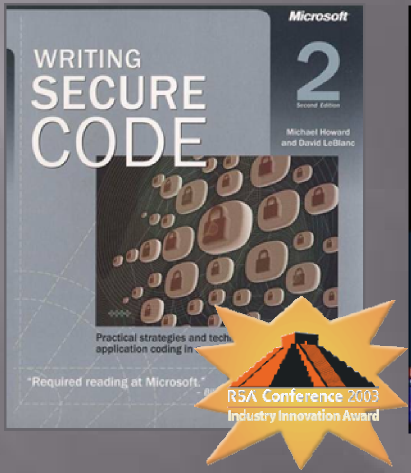
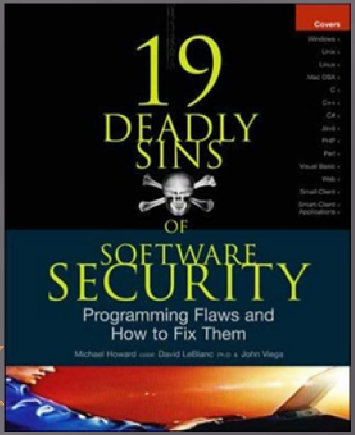
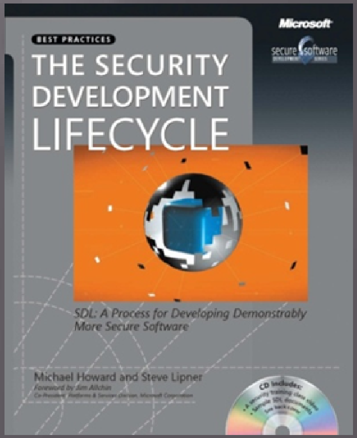
Who is this Guy?

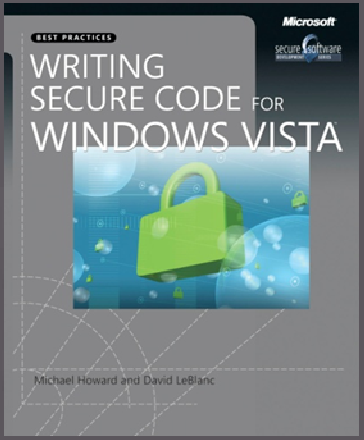
- Microsoft employee for >15 years
- Always in security
- Editor for IEEE Security & Privacy
- A pragmatist!


Microsoft Programming Series
Microsoft
Designing Secure Web-Based Applications for Microsoft Windows 2000
Michael Howard


Microsoft
Writing Secure Code
2
Michael Howard and David LeBlanc
"Required reading at Microsoft."
RSA Conference 2003 Industry Innovation Award


19 Deadly Sins of Software Security
Programming Flaws and How to Fix Them
Michael Howard, David LeBlanc, John Viega


Best Practices
Microsoft
The Security Development Lifecycle
SDL: A Process for Developing Demonstrably More Secure Software
Michael Howard and Steve Lipner


Best Practices
Microsoft
Writing Secure Code for Windows Vista
Michael Howard and David LeBlanc

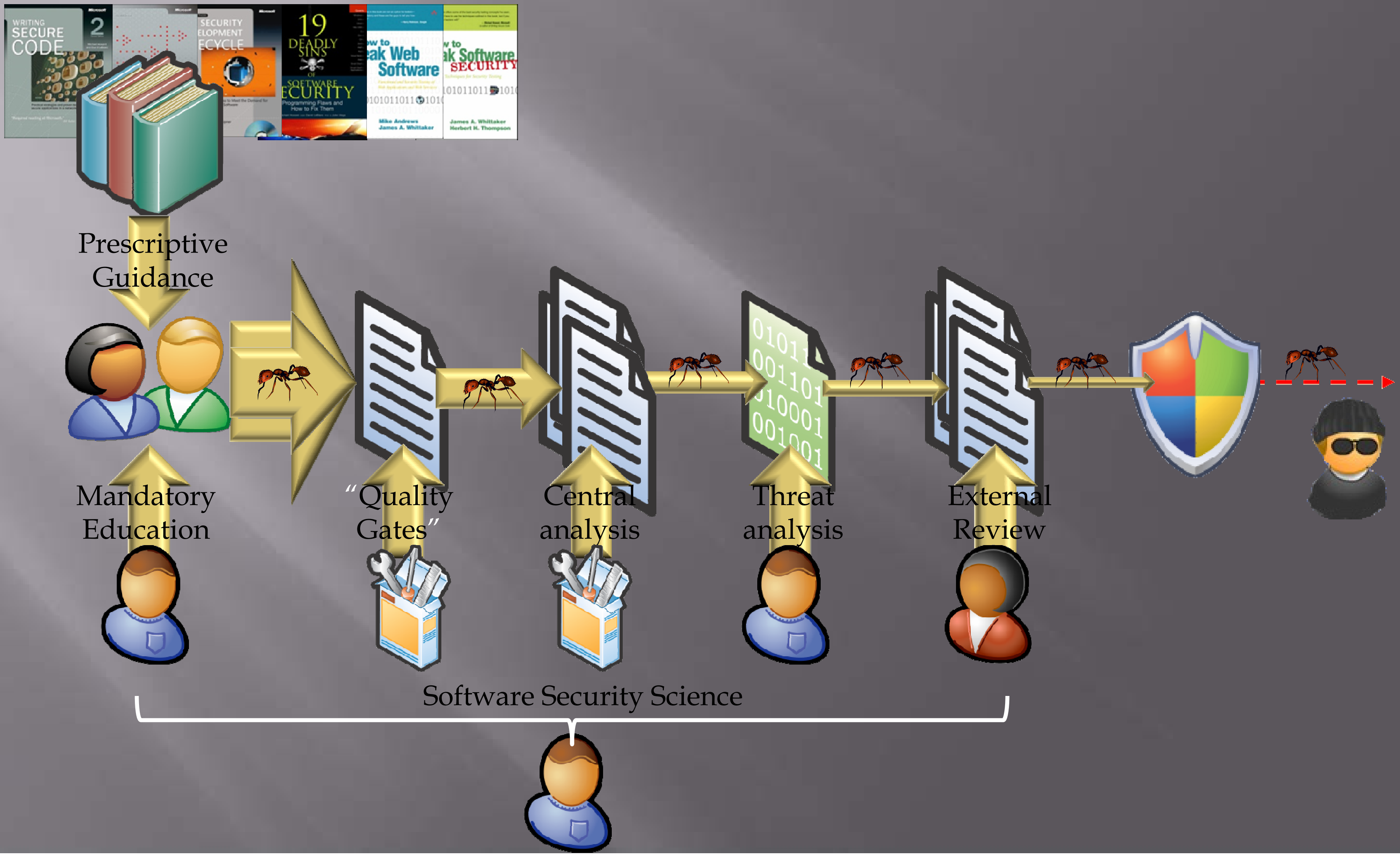
Agenda

- Core Design Assumptions
- Security Development (SDL) Process security contributions
- Isolation
- Service Hardening
- Memory defenses

Core Design Assumptions

- Code is never perfect
- Designs are never perfect
- Remember, security is “Man vs. Man”
  - Security is a never-ending arms race
  - You can never be “done” with security
- Individual protections may fail
  - Windows Vista includes numerous, layered defenses
  - All enabled by default
  - Each protection raises the bar
- But, we must protect customers

High Level Windows Vista Engineering Process


Prescriptive Guidance
Mandatory Education
"Quality Gates"
Central analysis
Threat analysis
External Review
Software Security Science
WRITING SECURE CODE 2
SECURITY DEVELOPMENT LIFECYCLE
19 DEADLY SINS OF SOFTWARE SECURITY
How to Break Web Software
How to Break Software Security

SDL In Action For Windows Vista

- Weak Crypto banned in new code
  - No use of MD4, MD5 or SHA1.
  - No use of RC4.
  - No symmetric keys smaller than 128 bits allowed.
  - No RSA keys smaller than 1024 bits allowed.
- Threat Modeling
  - Training and tools provided to engineering teams
  - 1,400+ Threat models developed for Windows Vista
  - Security team reviewed models

SDL in Action for Windows Vista

- Mandatory Use of Compiler Security Options
  - /GS flag (runtime stack BO detection)
  - /SAFESEH (runtime exception checking)
  - /NXCOMPAT (NX support)
  - /DYNAMICBASE (ASLR support)
  - /ROBUST switch for MIDL compiler
- Safe Libraries Developed
  - 120+ Banned functions
  - IntSafe (C safe integer arithmetic library)
  - SafeInt (C++ safe integer arithmetic template class)
  - Secure CRT (C runtime replacements for strcpy, strncpy etc)
  - StrSafe (C runtime replacements for strcpy, strncpy etc)

    strcpy, strcpyA, strcpyW, wcscpy, _tcscpy, _mbscpy, StrCpy, StrCpyA, StrCpyW, lstrcpy, lstrcpyA, lstrcpyW, _tccpy, _mbccpy strcat, strcatA, strcatW, wcscat, _tcscat, _mbscat, StrCat, StrCatA, StrCatW, lstrcat, lstrcatA, lstrcatW, StrCatBuff, StrCatBuffA, StrCatBuffW, StrCatChainW, _tccat, _mbccat, strncpy, wcsncpy, _tcsncpy, _mbsncpy, _mbsnbcpy, StrCpyN, StrCpyNA, StrCpyNW, StrNCpy, strcpynA, StrNCpyA, StrNCpyW, lstrcpyn, lstrcpynA, lstrcpynW strncat, wcsncat, _tcsncat, _mbsncat, _mbsnbcat, StrCatN, StrCatNA, StrCatNW, StrNCat, StrNCatA, StrNCatW, lstrncat, lstrcatnA, lstrcatnW, lstrcatn CharToOem, CharToOemA, CharToOemW, OemToChar, OemToCharA, OemToCharW, CharToOemBuffA, CharToOemBuffW alloca, _alloca wnsprintf, wnsprintfA, wnsprintfW, sprintfW, sprintfA, wsprintf, wsprintfW, wsprintfA, sprintf, swprintf, _stprintf, _snwprintf, _snprintf, _sntprintf, wvsprintf, wvsprintfA, wvsprintfW, vsprintf, _vstprintf, vswprintf, _vsnprintf, _vsnwprintf, _vsntprintf, wvnsprintf, wvnsprintfA, wvnsprintfW strtok, _tcstok, wcstok, _mbstok makepath, _tmakepath, _makepath, _wmakepath, _splitpath, _tsplitpath, _wsplitpath scanf, wscanf, _tscanf, sscanf, swscanf, _stscanf, snscanf, snwscanf, _sntscanf _itoa, _itow, _i64toa, _i64tow, _ui64toa, _ui64tot, _ui64tow, _ultoa, _ultot, _ultow gets, _getts, _gettws IsBadWritePtr, IsBadHugeWritePtr, IsBadReadPtr, IsBadHugeReadPtr, IsBadCodePtr, IsBadStringPtr strlen, wcslen, _mbslen, _mbstrlen, StrLen, lstrlen

Tool Utilization in SDL

- *TOOLS ARE NOT A PANACEA*
- PREfast – Static code analysis (used by /analyze)
- FxCop – Static analysis of managed code and assemblies
- Standard Annotation Language (SAL)
  - Majority of C Runtime library has been annotated
  - Windows SDK functions have been annotated

Sidebar: What's SAL?

- Tools can only find "so much" without more contextual information
- SAL helps bridge the gap by providing interface contract information to the tools
- SAL leads to dramatically improved static analysis
  - More bugs
  - Less noise
- The process of adding annotations can find bugs!
- The concept is not new: think IDL
- Included in Visual Studio 2005

Example Annotation

Joined at the hip

```
void FillString(
        char* buf,
        size_t cchBuf,
        char ch) {

  for (size_t i = 0; i < cchBuf; i++) {
    buf[i] = ch;
  }
}
```

Example Annotation

```
void FillString(
        __out_bcount(cchBuf) char* buf,
        size_t cchBuf,
        char ch) {

  for (size_t i = 0; i < cchBuf; i++) {
    buf[i] = ch;
  }
}
```

More Extensive Security Testing

- Identify and fuzz all file formats consumed by the operating system
  - Minimum 100,000 malformed files per parser
  - Fuzz many networking protocols, including RPC
- Internal Penetration Testing
- External Penetration testing (thanks to):
  - Code Blau Security Concepts
  - Cybertrust
  - iSec Partners
  - IOActive
  - Matasano
  - Password Consultancy
  - Net-square
  - NGS
  - n.runs
  - Security Innovation

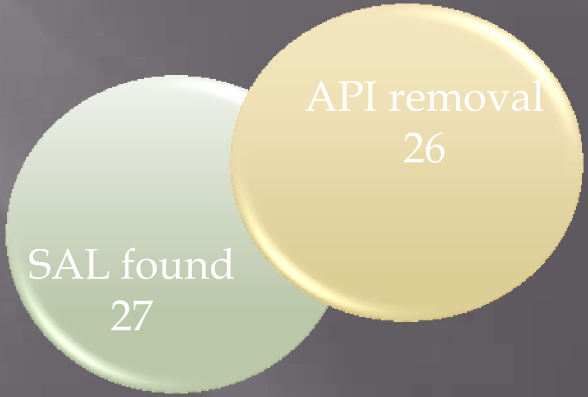
Some Early Results
Security Bulletins that do not affect Windows Vista

- MS06-078 Windows Media Player
  - Banned API removal (wcsncat)
- MS06-069 Flash 6
  - Installed by default in Windows XP, not shipped with Windows Vista
- MS06-066 NetWare Client
  - Installed by default in prior OS's, removed in Windows Vista
- MS06-055 VML
  - Found through fuzzing
- MS06-050 Windows Hyperlink Object Library
  - Found and fixed because of SAL
- MS07-004 VML
  - Integer overflow calling **`::new`** caught by compiled code

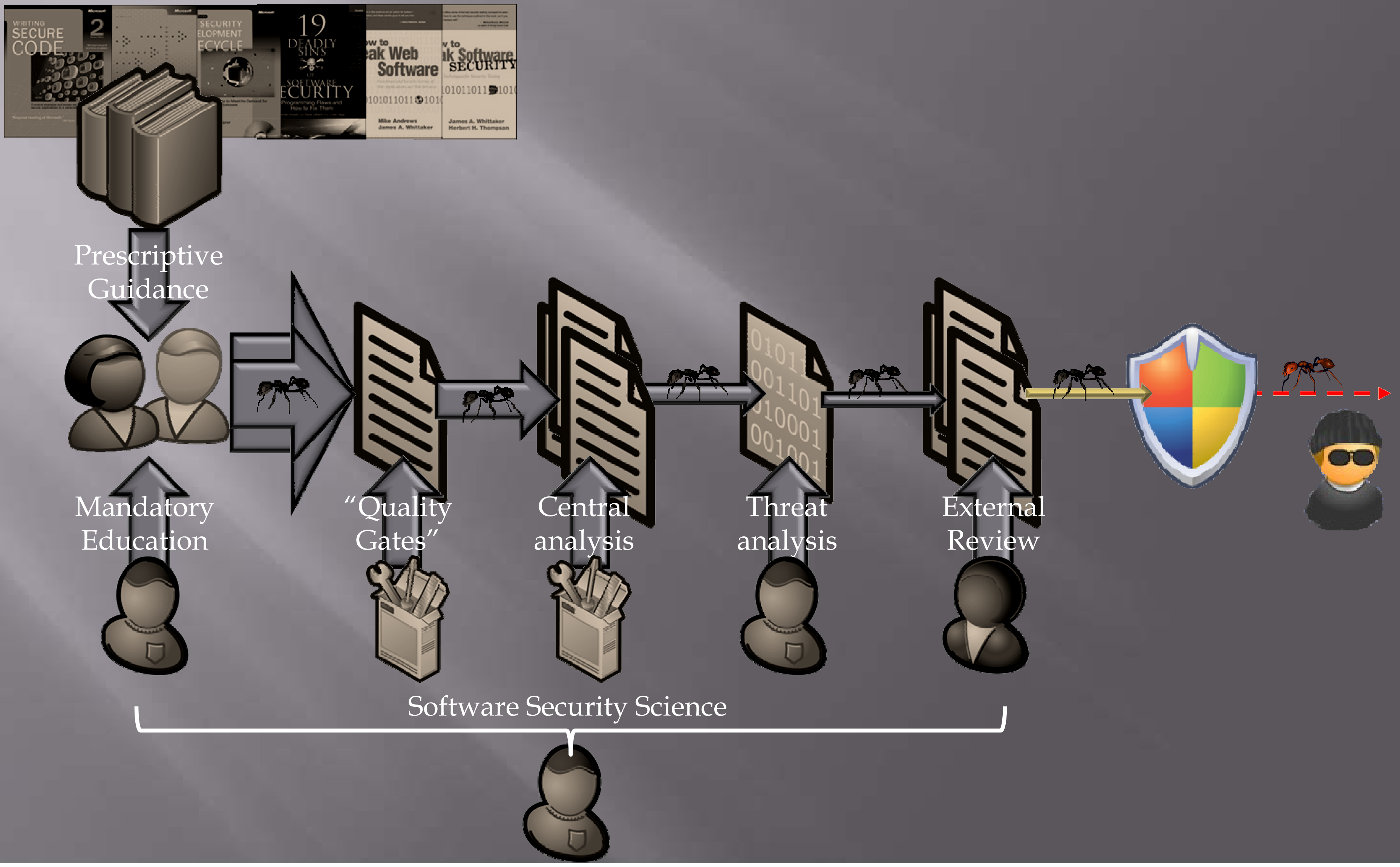
Some Early Results

Interesting figures

- Analysis of 63 buffer-related security bugs that affect Windows XP, Windows Server 2003 or Windows 2000
  - but not Windows Vista
- 82% removed through SDL process
  - 27 (43%) found through use of SAL
  - 26 (41%) removed through banned API removal



Windows Vista Engineering Process (from 35,000ft!)



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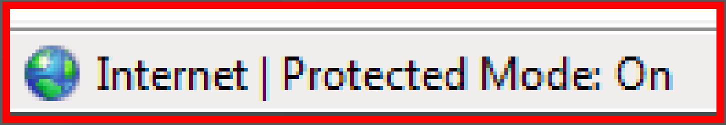
Isolation

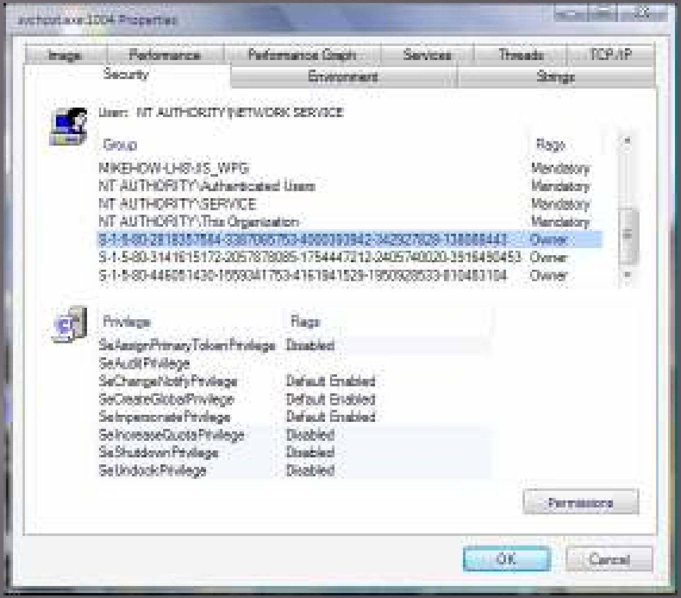
- UAC: Users are no longer admins by default
  - Even an admin is not an admin
- Integrity levels help contain damage
  - IE7 runs in low integrity (by default)
    - Protected Mode
  - Most parts of the operating system are medium integrity
  - Restricts "Write-Up"
  - Helps defend integrity of the operating system


Internet | Protected Mode: On

DEMO: Integrity Levels

Service Hardening

- Many existing services moved out of SYSTEM
- Describe the privileges you need
- Per-service identity (SID)
  - Protect objects for just that service
  - S-1-5-80-xxxx
- Stricter service restart policy
- Restrict network behavior
  - Eg: foo.exe can only open port TCP/123 inbound
    - |Action=Allow|Dir=In|LPORT=123|Protocol=17|App=%SystemRoot%\foo.exe



User: NT AUTHORITY\NETWORK SERVICE

Group	Flags
MIKEHOW-LH8\IIS_WPG	Mandatory
NT AUTHORITY\Authenticated Users	Mandatory
NT AUTHORITY\SERVICE	Mandatory
NT AUTHORITY\This Organization	Mandatory
S-1-5-80-2818357584-3387065753-4000393942-342927828-138088443	Owner
S-1-5-80-3141615172-2057878085-1754447212-2405740020-3916490453	Owner
S-1-5-80-446051430-1559341753-4161941529-1950928533-810483104	Owner

Privilege	Flags
SeAssignPrimaryTokenPrivilege	Disabled
SeAuditPrivilege	
SeChangeNotifyPrivilege	Default Enabled
SeCreateGlobalPrivilege	Default Enabled
SeImpersonatePrivilege	Default Enabled
SeIncreaseQuotaPrivilege	Disabled
SeShutdownPrivilege	Disabled
SeUndockPrivilege	Disabled

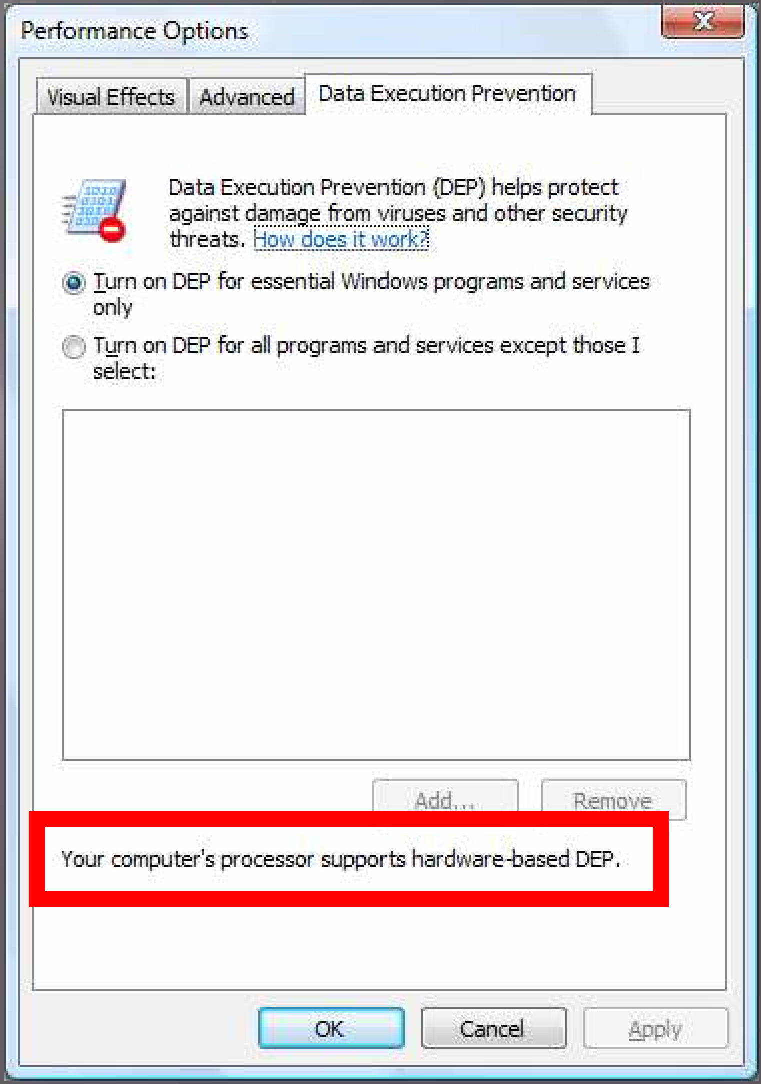
Memory Defenses

- Stack BO detection (aka /GS, enabled by default)
  - Detects many stack-based overruns at runtime
  - Re-arranges the stack so buffers are in higher memory (helps protect variables)
  - Moves various arguments to lower memory
- Exception handler protection (aka /SAFESEH, enabled by default)
  - Exception addresses are verified at runtime

Memory defenses

- Data Execution Prevention (aka NX/XD, enabled by default*)
  - Harder to execute data
- In Windows Vista, DEP cannot be disabled once turned on for a process

*Most CPUs today support DEP, but make sure it's enabled in the BIOS



Data Execution Prevention (DEP) helps protect against damage from viruses and other security threats. How does it work?

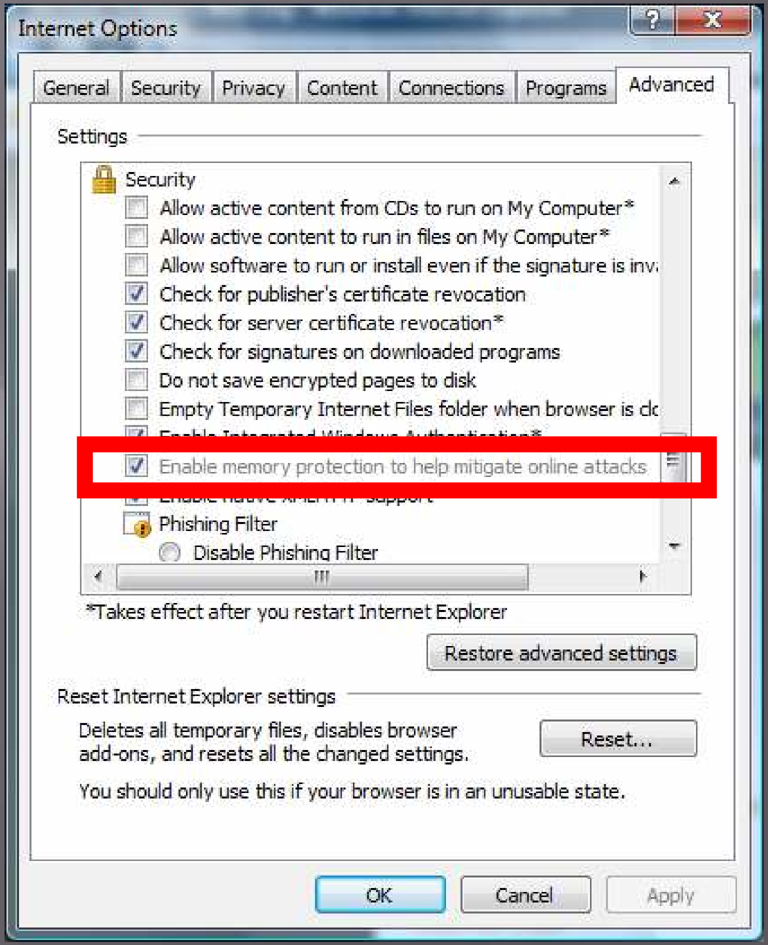
[✓ Turn on DEP for essential Windows programs and services only]

Turn on DEP for all programs and services except those I select:

Your computer's processor supports hardware-based DEP.

Sidebar: Memory defenses and IE7

- By default IE7 does not enable DEP/NX :(
  - Because too many controls break
  - Many controls use just-in-time compilation
  - They try to run data
  - Fix is to use VirtualProtect(…, PAGE_EXECUTE_READ,…)
- We **<u>will</u>** enable DEP/NX in a future release of IE



Internet Options

General | Security | Privacy | Content | Connections | Programs | Advanced

Settings

Security
- [ ] Allow active content from CDs to run on My Computer*
- [ ] Allow active content to run in files on My Computer*
- [ ] Allow software to run or install even if the signature is inv
- [✓] Check for publisher's certificate revocation
- [✓] Check for server certificate revocation*
- [✓] Check for signatures on downloaded programs
- [ ] Do not save encrypted pages to disk
- [ ] Empty Temporary Internet Files folder when browser is cl
- [✓] Enable Integrated Windows Authentication*
- [✓] Enable memory protection to help mitigate online attacks
- [✓] Enable native XMLHTTP support

Phishing Filter
- ( ) Disable Phishing Filter

*Takes effect after you restart Internet Explorer

Restore advanced settings

Reset Internet Explorer settings

Deletes all temporary files, disables browser add-ons, and resets all the changed settings.

Reset...

You should only use this if your browser is in an unusable state.

OK | Cancel | Apply

Memory Defenses

- Heap defenses (all enabled by default)
  - Lookasides gone
  - Arrays of free lists gone
  - Early detection of errors due to block header integrity check
    - ENTRY->Flink->Blink == ENTRY->Blink->Flink == ENTRY
  - Heap terminate on corruption
- Integer overflow calling **`operator::new`** automatically detected at runtime (by default)

Memory Defenses

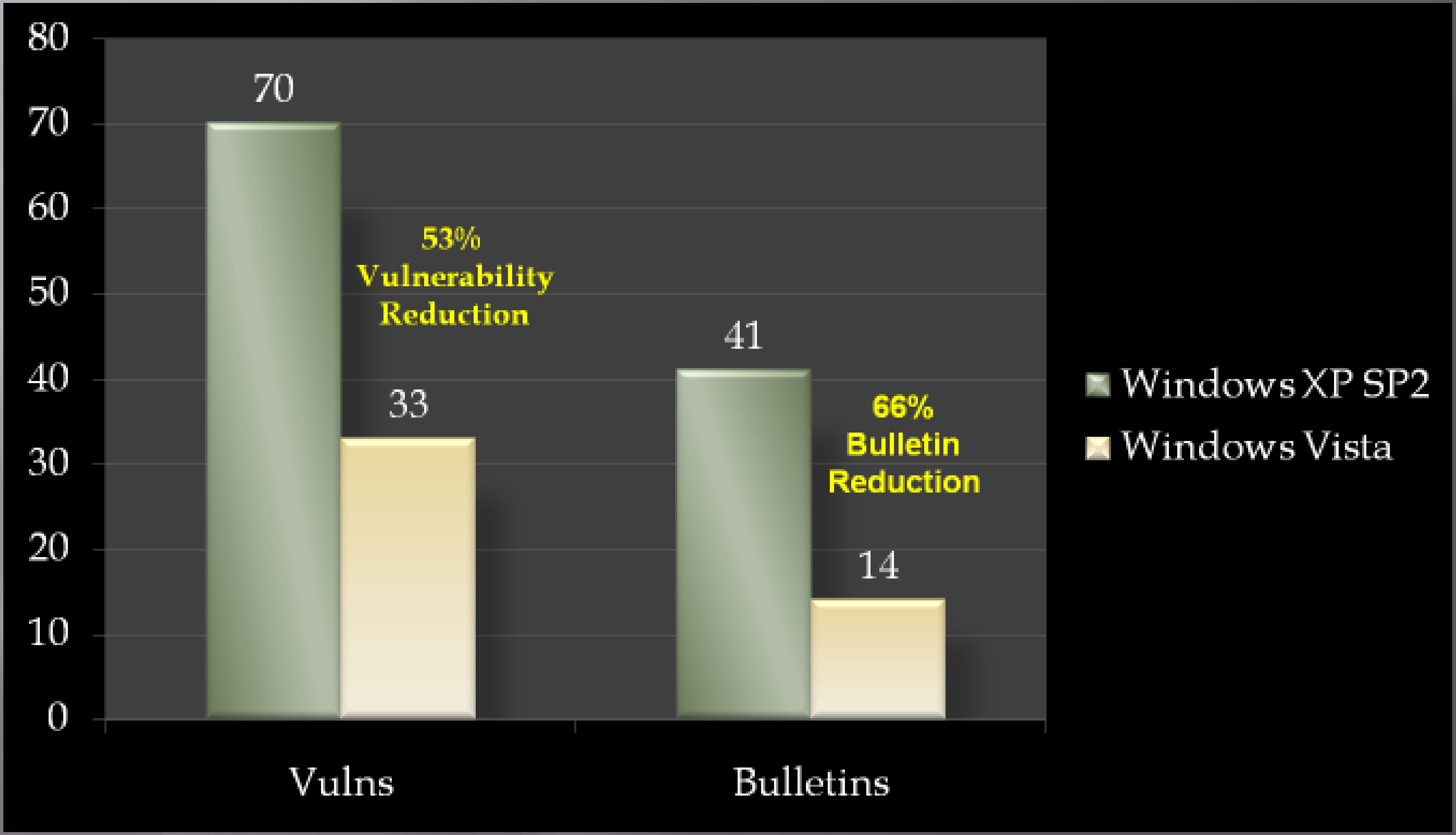
- Image randomization (ASLR)
  - System images are loaded randomly into 1 of 256 ‘slots’
  - Changes on each boot
  - **To be effective ASLR requires DEP**
  - Enabled by default
  - Link with /DYNAMICBASE for non-system images
- Stack is randomized for each new thread (by default)
- Heap is randomized (by default)
- Long-lived pointers are encoded and decoded
  - A successful pointer overwrite must survive the decoding process (XOR with a random number)

DEMO: Memory Defenses

Why the DNS Zero-Day Did not Exploit Windows “Longhorn” Server beta 2

- The coding vulnerability was in the code
- The attacker had to:
  - Get passed the firewall
  - Bypass /GS
  - Bypass SafeSEH
  - Bypass NX
  - Bypass ASLR
  - Bypass stack randomization
  - Bypass service hardening
- And the attacker has only two attempts
  - Because of service restart policy

Windows Vista Vulnerability Reduction to Date



Software Security Science

- Security is "Man vs. Man"
- We must continue to innovate
- We must continue to learn more about attackers
  - And how to thwart them
- We perform root-cause analysis of each security bug
- We analyze bugs from around the industry
- We work closely with security researchers
- Feeds back into the SDL twice a year

Call to Action

- Process
  - Evaluate the SDL (it works!)
  - Build threat models
  - Utilize all available tools (eg; compiler, /analyze, SAL etc)
  - Perform fuzz testing
  - Hire expert pentest help
- Engineering
  - Remove banned APIs
  - Compile with /GS
  - Link with /NXCOMPAT, /SAFESEH and /DYNAMICBASE

How to Break Web Software
Functional and Security Testing of Web Applications and Web Services
Mike Andr
James A.
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THE SECURITY DEVELOPMENT LIFECYCLE
SDL: A Process to Meet the De
More Secure Software
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Questions?