Standing on the shoulders of the Blue Monster:

Hardening Windows Applications

olleB
olle@toolcrypt.org

The Toolcrypt Group
www.toolcrypt.org

Agenda

- Introduction to Windows security model
- Windows security-related features
- Strategies for hardening Windows Apps
- Question time

Intro to Windows security model

- Security Identifiers
- Security Descriptors
- Access Control Lists
- Objects and Handles
- Tokens and Privileges

Intro to Windows security model

- Security Identifiers (SIDs)
  - Authority, *n* x Sub-Authority, Relative ID

Example: S-1-5-32-544

Revision	Authority	Sub Authority	RID
1	5	32	544
First	“NT”	Builtin	Administrators

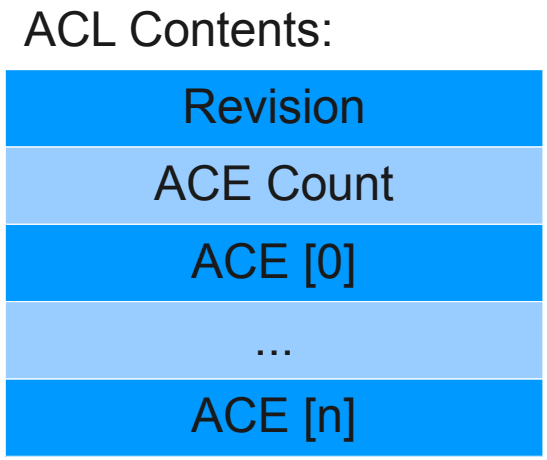
Intro to Windows security model

- Security Descriptors

SECURITY_DESCRIPTOR
Header (revision number and control flags)
Owner SID
Group SID (used for POSIX compatibility)
DACL (Discretionary Access Control List)
SACL (System Access Control List)

Intro to Windows security model

- Access Control Lists (ACLs)
  - Lists of Access Control Entries (ACEs)
    - DACLs list "access permissions"
    - SACLs list system info (auditing, etc.)



Intro to Windows security model

- Access Control Entries (ACEs)
  - Type and Flags determine meaning
  - Checked in order (first match, default deny)

ACE Contents:

Type (Allow, Deny, Audit, etc.)
Flags (inheritance, etc.)
Access Mask (e.g. GENERIC_READ)
Trustee SID

Intro to Windows security model

- Objects and Handles
  - Kernel Objects are ref-counted structs
    - Common header (with type, refcounts, etc.)
    - Contains Security Descriptor => “Securable Object”

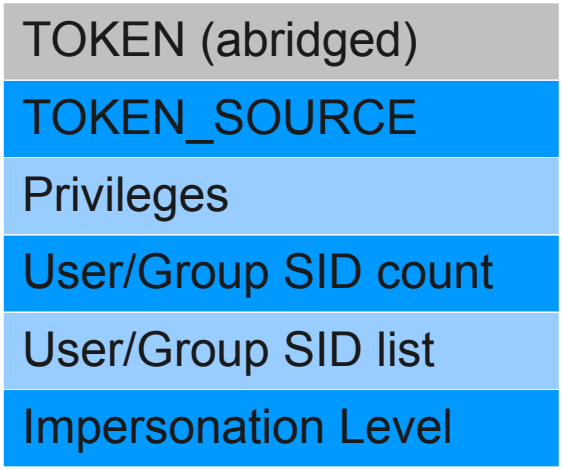
OBJECT_HEADER
Pointer Reference Count
Handle Reference Count
Type (Pointer to type object)
Misc. Flags and Control Structures
Security Descriptor

Intro to Windows security model

- Objects and Handles
  - Kernel ref by pointer, usermode by handle
  - Handles are kept per-process in kernel tables
  - Many different processes can have “open” handles to same Kernel Object
  - Handles closed by CloseHandle() or Exit()
  - Objects destroyed when refcounts reach 0

Intro to Windows security model

- Tokens and Privileges
  - An Access Token is a Securable Object
  - Describes security context of process (or thread)



Intro to Windows security model

- Tokens and Privileges
  - Processes get a “Primary Token” at creation
  - Process or thread can temporarily have different Token assigned by “Impersonation” (or delegation)
  - Privileges can be assigned to users / groups
  - Privileges stored in Token, must be “enabled”

Windows security-related features

- Restricted Tokens
- Desktop Objects and Window Stations
- Job Objects
- MIC / UAC / UIPI
- Memory protection
- Exploit mitigations

Windows security-related features

- Restricted Tokens
  - CreateRestrictedToken()
    - Remove Privileges from Token
    - Prevent SIDs from granting accesses
    - Restrict SID list to a certain subset
  - CreateProcessAsUser()
    - Normally requires SeTokenPrivilege
      - not with Restricted version of callers' Primary Token
      - which becomes the Primary Token of new process!

Windows security-related features

- Desktop Objects and Window Stations
  - Session => Window Station => Desktop
    - Winsta0 only interactive Window Station
    - Interactive Desktop selected by SwitchDesktop()
  - Processes assigned to a Window Station
  - Threads assigned to a Desktop
  - Desktop is container for UI objects
    - Windows, message queues, etc.

Windows security-related features

- Job Objects
  - Container for processes
    - Processes can be associated to Job Object
    - Processes created inherit Job Object association
  - Imposes limits on associated processes
    - Memory / CPU usage limits
    - Prohibit access to SwitchDesktop()
    - Prohibit access to UI objects (e.g. clipboard)
    - Prohibit access to sensitive APIs

Windows security-related features

- MIC – Mandatory Integrity Control
  - "Mandatory Label" new ACE in SACL
    - RID in SID of ACE defines "Integrity Level"
    - ACE attributes define a policy
      - NoWriteUp, NoReadUp, NoExecuteUp
  - Label defaulted if not explicitly present
    - Objects default to "Medium" and NoWriteUp
    - Processes to "Medium" and NoWriteUp / NoReadUp
  - Anyone with WRITE_OWNER can set lower IL
    - Need SeRelabelPrivilege to set higher IL than own

Windows security-related features

- UAC – User Account Control
  - Admin users run as Standard by default
  - "Elevation" required to use Admin rights
  - Privilege separation by "Linked Tokens"
  - New service "AppInfo" controls Elevation
  - Apps request Admin rights using Manifest

Windows security-related features

- UIPI – User Interface Privilege Isolation
  - Blocks windows messages between windows of processes with differing Integrity Level
  - "Message Filter" is list of allowed messages
  - ChangeWindowsMessageFilter()
    - Processes at or below "Low" IL cannot use

Windows security-related features

- Memory protection
  - Hardware can enforce access permissions on “pages” of virtual memory space
  - Permission bits in PTE => R / W / X
  - VirtualProtect(), VirtualAlloc()

Windows security-related features

- Exploit mitigations
  - Stack overwrite protection
  - Heap overwrite protection
  - Safe SEH, SEH Overwrite Protection
  - Data Execution Prevention
  - Adress Space Layout Randomization

Windows security-related features

- Exploit mitigations
  - Stack overwrite protection (or "/GS")
    - Inserts "cookie" value into stack frame
      - Check integrity of cookie before returning
      - Protects return address and stack variables
    - Default compiler option since VS 2003

Windows security-related features

- Exploit mitigations
  - Heap overwrite protection
    - Check forward / back links when unlinking lists
      - In all Windows versions since XP SP2
    - XORing / checksumming to “detect” overwrites
      - Since XP SP3, increasing protection in Vista
      - HeapSetInformation(HeapEnableTerminationOnCorruption)
    - *Don't use third-party dynamic memory managers!*

Windows security-related features

- Exploit mitigations
  - Safe SEH
    - Linker inserts table of known exception handlers
    - "/SAFESEH" option available since VS 2003
  - SEH Overwrite Protection (SEHOP)
    - Checks integrity of exception handler chain
    - Available since Vista SP1, Server 2008
    - Disabled by default on client systems

Windows security-related features

- Exploit mitigations
  - Data Execution Prevention (DEP)
    - Makes stack and heap non-executable by default
    - Modes: OptIn/OpOut/AlwaysOn/AlwaysOff
    - SetProcessDEPPolicy() or "/NXCOMPAT"
  - Address Space Layout Randomization (ASLR)
    - Complement to DEP prevents simple bypasses
    - Available in Vista and later, for supporting modules
    - Link all modules with "/DYNAMICBASE" to enable

Strategies for hardening Windows Apps

- Standing on Microsoft's shoulders
- Securing your application boundaries
- Partitioning your application code
- Wrapping the onion (in tin foil)

Strategies for hardening Windows Apps

- Standing on Microsoft's shoulders
  - Use exploit mitigations
    - always build with latest version of toolchain
  - Read and adopt from the SDL
    - Architecture review and Threat Modelling
    - Secure coding guidelines! (Musts and Don'ts)
  - Use safe libraries and templates
    - SafeInt / intsafe.h
    - Banned APIs / Secure Template Overload

Strategies for hardening Windows Apps

- Securing your application boundaries
  - Architect using modular components
  - Make sure components aren't too large
  - Identify interfaces to other components
    - Data flows
    - Execution flow
  - Apply safe default DACLs on resources

Strategies for hardening Windows Apps

- Partitioning your application code
  - Sandbox parsers and data processing
    - Reduces complexity required in core code
    - Verify syntax and semantics of simplified input
  - Examine each app component
    - Make sure interfaces are simple and clear
    - Apply the principle of least privilege
    - Redesign if complex or requires too many privs

"Practical Windows Sandboxing" - David LeBlanc http://blogs.msdn.com/b/david_leblanc/archive/2007/07.aspx

Strategies for hardening Windows Apps

- Wrapping the onion (in tin foil)
  - No “Silver Bullets” or “Magic Fairy Dust”
    - Goal: Raising the costs of the attacker!
  - Build security controls in layers
    - Overlapping controls build resilience
  - Each component is “autonomous”
    - Responsible for its own security
    - Assumes nothing of input, validates

Summary

- Build security in using overlapping checks
- Architect components and review them
- Divide your application into partitions
- Use Windows features to raise the bar
- Adopt what parts of the SDL make sense

Questions?

Corrections?

Additions?

Thank You for listening!

http://www.toolcrypt.org/

mailto:olle@toolcrypt.org

follow @toolcrypt on twitter