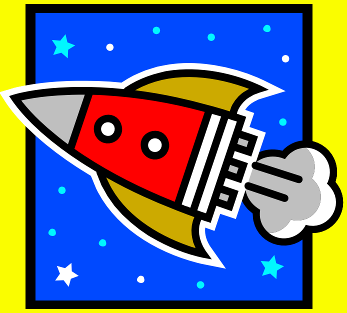
Mobile Code

CSH6 Chapter 17
"Mobile Code"
Robert Gezelter

Topics

- ➢ Introduction to Mobile Code
- ➢ Mobile Code from the Web
- ➢ Motivations and Goals
- ➢ Design and Implementation Errors



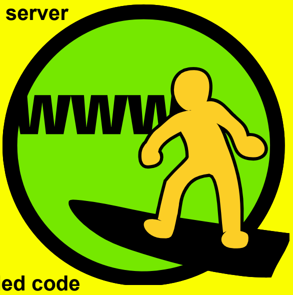
CSH6 Chapter 17
Mobile Code

Mobile Code Defined

- ➢ Instructions delivered to remote computer from outside an *enclave*
- ➢ *Enclave* is system under unitary control by single authority
- ➢ Dynamic execution (execution on demand)
- ➢ Fundamental problems
  - ❑ Mobile code may perform unauthorized functions
  - ❑ Growing spectrum of devices using mobile code
    - ✓ PDAs
    - ✓ Mobile phones
    - ✓ Tablets

Mobile Code from the WWW

- ➢ Definition
  - ❑ Executable code delivered by Web server
  - ❑ Or by e-mail
  - ❑ For execution on client computer
  - ❑ Not including HTML or XML
- ➢ Typical languages
  - ❑ ActiveX
  - ❑ Java
  - ❑ JavaScript
- ➢ Examples of problematic content
  - ❑ HTML-enabled e-mail with embedded code
  - ❑ Pop-ups in browsers
    - ✓ May access unexpected Web pages
    - ✓ Julie Amero, CT teacher, convicted of using classroom computer for inappropriate content due to popups

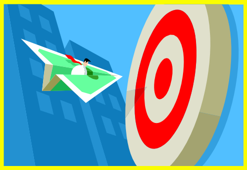


Effects of Mobile Code

- ➢ System / application crashes
  - ❑ Obvious effects include
    - ✓ Denial of service
    - ✓ Corruption (integrity problems)
- ➢ Covert effects more dangerous
  - ❑ Access to e-mail addresses → spam
  - ❑ Keyloggers
  - ❑ Rootkits
- ➢ Hephrati case in Israel (2005) showed how mobile code could be used for industrial espionage
  - ❑ Varda Raziel-Jacont & Amnon Jacont's MS for "L is for Lies" appeared on Internet sites
  - ❑ Former son-in-law Michael Hephrati responsible using implanted mobile code

Motivations & Goals

- ➢ Shift in motivations
  - ❑ Pranks → vengeful → vindictive → criminal
- ➢ Goals differ
  - ❑ Amusement
  - ❑ Blackmail
  - ❑ Corporate espionage
  - ❑ Financial fraud/theft
- ➢ Misappropriation of computer resources
  - ❑ Creation of botnets
  - ❑ Applications to DDoS & spam
  - ❑ Involvement in information warfare

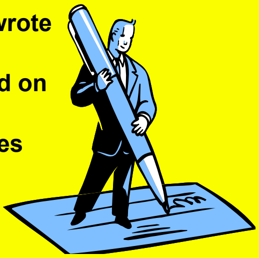


Design & Implementation Errors

- Range of errors
  - Simple design/coding errors cause mistakes in function
    - ✓Usually predictable
    - ✓Often noticeable
  - But mistakes in security architecture particularly serious
- Security architectures for mobile code may be flawed in
  - Creation of sandbox
  - Method of code authentication

Signed Code

- Principle (belief):
  - If you know and trust who wrote code it must be OK
  - Use digital signatures based on Public Key Cryptosystem
  - Apply ANSI X.509 Certificates
- But signing *bad* code doesn't remove the flaws
- Topics discussed below:
  - Authenticode
  - Limitations of Signed Code
  - Problems with ActiveX Security Model
  - Case Studies



Authenticode

- Microsoft method
  - Developers obtain digital certificate from Microsoft Certificate Authority (CA)
  - Sign their code with their private key
  - Users (systems) check validity of code at execution time using public key
- Components
  - PKI, X.509, CA
  - Control over private keys used to sign code
    - ✓Known as the Software Publishing Certificate
  - Valid method for verifying digital signatures
- No protection against bad code

Limitations of Signed Code

- All-or-nothing approach to trust
  - Signed items assumed to be perfect
  - No concept of partial trust
  - "Digital signature does not … provide any guarantee of benevolence or competence." – CERT/CC®
- Organizations signing their code must strictly control access to the signing key
  - But widespread practice in software development shops tolerates shared accounts and passwords
  - Serious question about value of signing code

Problems with ActiveX Security Model

- Importing and installing controls
  - Signing does not guarantee safety or trustworthiness
- Running controls
  - ActiveX control has no limitations on actions
  - Runs with same privileges as user
  - Typically users run as *root* on their Windows PCs
  - No basis for deciding whether particular control is safe or not in specific context
- Scripting concerns
  - Individual developers have no systematic method for evaluating safety of their code
  - No equivalent to a *sandbox* for testing

Mr. Bunny's Guide to ActiveX

by

Carlton Egremont III

Case Studies (1)

- Internet Exploder (1996)
  - Fred McLain wrote demonstrate
  - ActiveX control to illustrate excessive control of systems
  - Shut down user's computer (with permission of user!)
- Chaos Computer Club Demo (1997)
  - ActiveX control subverted Quicken accounting package
  - Made Quicken create transfer order for money
  - Filmed demonstration for German television

Case Studies (2)

- VeriSign Issues Certificates to Imposters (2001)
  - ❑Class 3 Digital Certificates for signing ActiveX controls
  - ❑Issued to someone impersonating MS employee
  - ❑Allowed signing code as if it came from MS
- Problems
  - ❑No Certificate Revocation List (CRL)
  - ❑Would need to verify date of every MS certificate to identity fraudulent issued ones
- Caution to avoid overreacting
  - ❑1st error discovered in >500,000 issued certificates

Restricted Operating Environments

- At simplest level, users should not execute code that affects entire system – restricted to their own processes
  - ❑Process is unique instance of execution of particular code by specific user on particular machine at specific instant
- Concept of *privileges* determines what a process can accomplish
  - ❑Supervisory or root privileges allow full access
- Restricted operating environment
  - ❑Developed since earliest multi-user systems
    - ✓MULTICS, OS/360, UNIX…
  - ❑See *CSH6* Chapter 24, Operating System Security
  - ❑*Sandbox* is an example of restricted operating environment

Java

- Programming language developed by Sun Microsystems
  - ❑Platform independence
  - ❑Typically used in Web browser
- Includes virtual machine (JVM)
  - ❑Plus Java Run Time Environment
- Code known as *applets*
  - ❑May be signed
  - ❑Restricted access to system resources
    - ✓Known as the Java sandbox
- But bugs have allowed Java applets to leave sandbox on occasion

Asymmetric & Transitive Trust

- *Asymmetry* in power can cause opportunity for mass infection
  - ❑E.g., large customer can force small suppliers to conform to its standards
  - ❑Force use of unsafe mobile code
  - ❑Can resist damage by enforcing principle of *least privilege* in execution of all code
- *Transitive* trust results from assumption that trusted sites must have trustworthy code
  - ❑Essential to enforce tight security on all mobile code regardless of source
  - ❑ActiveX security model thus fundamentally flawed because it relies solely on transitive trust

Misappropriation & Subversion

- Mobile code targets have changed
  - ❑From individual target machines
  - ❑To entire populations of targets
- John Schiefer ("acidstorm")
  - ❑Caught by *Bot Roast II,* FBI operation against botnet operators in 2007
  - ❑250,000 systems infected with spybots for capture of userID and passwords
    - ✓Used to subvert PayPal & other accounts
  - ❑150,000 systems infected to support Dutch criminal Internet advertising company
  - ❑Pled guilty
  - ❑Sentenced to 4 years in US federal prison

Multidimensional Threat

- Signing code leaves other issues
  - ❑Integrity of signing process
  - ❑Integrity of the PKI
  - ❑Safety or validity of code not addressed
- Individual controls or applets may function correctly BUT
  - ❑Interactions that were not or could not be tested may cause failures
  - ❑E.g., attempts to use same Windows registry key in conflicting ways
  - ❑Complexity of operating environment may preclude provable safety

Client Responsibilities (1)

- ➢ Fundamental issue: Browser running mobile code may allow change to persistent state of operating system
- ➢ Use nonprivileged account wherever possible when browsing Web
  - ❑Windows XP SP2 offers Data Execution Prevention™ (DEP)
    - ✓Monitors use of memory to restrict access to protected areas
  - ❑Windows 7
    - ✓Stronger partition between administrator privileges and normal user mode
    - ✓AppLocker™ allows admin control over allowable execution of code

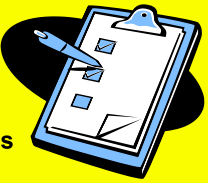
Client Responsibilities (2)

- ➢ Virtual Machine (VM) technology
  - ❑Significant potential for security improvement
  - ❑Can instantiate a desktop for specific purpose
  - ❑Complete isolation from rest of system
- ➢ Expendable WWW browser
  - ❑Run on VM desktop
  - ❑Delete when finished
  - ❑Bad effects of harmful code could be
    - ✓Isolated
    - ✓Evanescent

Server Responsibilities

- ➢ Avoid use of active code for trivial purposes
- ➢ Minimize use of ActiveX in favor of Java, JavaScript and other less dangerous tools
  - ❑E.g., for shopping carts, changing appearance of screen
  - ❑But updating Windows client will likely required ActiveX
- ➢ Apply standards of secure programming to all mobile code
  - ❑See *CSH6* Chapter 38, “Writing Secure Code”

Recommendations for Mobile Code Security



- ➢ Client systems
  - ❑Bar acceptance of unsigned controls and applets
  - ❑Restrict use of ActiveX
  - ❑Restrict acceptance of pop-ups
- ➢ Developers
  - ❑Follow good software engineering practices
  - ❑Grant minimum necessary privileges & access
  - ❑Use defensive programming
  - ❑Limit privileged access
  - ❑Ensure integrity of code-signing process
  - ❑Protect signing keys against compromise

Now go and study