Security – A Big Question for Big Data

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Implications of Current State of IT Security

• Current security implications intensified by big data

• Significance of witted adversary
  – Subversion uncommonly impactful and intractable
  – “Existential” national threat – “pre-9/11 moment”

• Reactive “arms race” that cannot work – ever!!
  – Decades of surveillance and patch failure indicate

• In contrast, proven power of principled response
  – Verifiable protection dramatically mitigates subversion
  – A real paradigm shift: no security patches in years of use
Implications of Big Data Key Aspects

• **Security impact of big data defining emphases (5 Vs)**
  – Volume
  – Velocity
  – Variety
  – Value
  – Veracity

• **The key aspects increase challenge for security**
  – Science and foundations
  – Infrastructure
  – Management
  – Searching and mining
  – Applications.
Outline of Big Data Security Speech

• Hard problem: software subversion
  
• Ineffective response: band-aid solutions
  
• Opportunity: leverage verifiable protection
Vulnerable to Trojan Horse Attack

• Hidden functionality in big data apps & “solutions”
  – Adversary usually outsider (stranger to victim)
  – Can be surreptitiously distributed

• Big data application user is unwitting agent
  – Requires victim (user) to execute application
  – Constrained by system security controls on victim
  – Exploitation undetected & controlled by remote design

• Big data cloud paradigm opens vast opportunity
  – Testing & review to detect is futile and delusional
  – Stegonography and such defy perimeter detection
  – Little mitigation in apps & most security solutions
Trap Door Platform Subversion

• Malicious code in platform running big data apps
  – Software, e.g., operating system, drivers, tools
  – Hardware/firmware, e.g., BIOS in PROM
  – Artifice can be embedded any time during lifecycle
  – Adversary chooses time of activation
• Can be remotely activated/deactivated
  – Unique “key” or trigger known only to attacker
  – Needs no (even unwitting) victim use or cooperation
• Efficacy and Effectiveness Demonstrated
  – Exploitable by malicious applications, e.g., Trojans
  – Long-term, high potential future benefit to adversary
  – Testing not at all a practical way to detect
  – Even open source cannot be counted on
Big Data Security Network Reality

Determined competent adversary understands

Reality

of current CDS:

Trojan horse planted: Substantial high data leakage to low domain

Malicious software gives low attacker access to data

Trap door planted: Low has repeated undetectable access to high information for years or decades

High Network Domain

Cross Domain Solution (CDS) Operating System

Low Network Domain
NPS Linux Trap Door Demo

- Navel Postgraduate School thesis*
- Major Linux distribution
- Network File Server (NFS) subversion
  - Trap door activated with trigger known to attacker
  - Unrestricted access to all NFS files
  - Attacker need not be legitimate user of the system
  - Less than a dozen lines injected into source
- Triggered by attacker over the Internet
  - Representative of platforms in big data context
- Only defense: don’t connect to big data network

*March 2002 Thesis by Emory A. Anderson, III
Summary of Subversion Process

• Step #1 – infrastructure subversion
  – Integral to installed software, e.g. trap door
  – Added to software suite during lifecycle, e.g., viruses
  – Big attraction: easy to avoid being apprehended
    • Perpetrator not present at time of attack

• Step #2 – execution of artifice software
  – Can activate by unique “key” or trigger
  – NPS demo, 12 lines of code (LOC) subverts Linux NFS

• Step #3 – (optional) “two card loader”
  – Bootstrap small toehold for diverse customized attacks
  – NPS demo with 6 LOC to subvert XP and then IPSEC

• Step #4 – access unauthorized domain data
  – Information flow between big data sources
Outline of Big Data Security Speech

• Hard problem: software subversion
  – Low cost, low risk to attacker, virtually undetectable
  – Highly effective, extensible, e.g., “two card loader”

• Ineffective response: band-aid solutions

• Opportunity: leverage verifiable protection
Common Practice Misaligned with Threat

- Internet is notorious for abysmal security
  - Failures of firewalls, intrusion detection, web servers
  - Strong crypto, VPN and PKI on foundations of sand
- Operating systems are soft underbelly
  - Demonstrated by Argus “Pit Bull” lost challenge
  - Open to planned attack – trap doors & Trojan horses
  - Pervasive source of liability in Internet components
- No business recourse for platform failures
  - Exposed data, crypto keys and forged certificates
  - Security not objectively measured for insurance
  - Billions in opportunity costs – need web efficiencies
  - Insecurity has doomed numerous “solutions”
- Big data environment intensifies these challenges
Impact Indications and Warning

• Vendor downloadable product subverted
  “Cracker gained user-level access to modify the download file. . . . you pray never happens, but it did.”
  – WordPress, reported on wordpress.org, March 2, 2007

• SW subversion steals credit/debit card data
  “an ‘illicit and unauthorized computer program’ was secretly installed at every one of its 300-plus stores.”

• IC recognition that subversion is likely
  “shocked if tools and capabilities and techniques have not been left in U.S. computer systems,”
  – Admiral Mike McConnell, Recent DNI, CBS 60 Minutes, Jun 10, 2010

• Russian spies use stenography in espionage
  “more than 100 text files embedded in steganographic
Flaws in System Solutions Missed

• False security from isolated components

• Customers cannot responsibly judge flaws
  – Lack “approved” **system** security evaluation criteria
  – Unskilled in assessing methods to address subversion

• Only a verifiably secure CDS is evaluable
  – On verifiable trusted computing base (TCB) platform
  – Last coherent codification in TCSEC “Class A1”
  – **System** security must be designed in, not bolted on
  – Includes composition of “partitions” and “subsets”
Future of Security Band-aids

Current Destination
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• Hard problem: software subversion
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• Ineffective response: band-aid solutions
  – Current practice invites catastrophic big data impacts
  – Pixie dust of “secure” components gives false security

• **Opportunity: leverage verifiable protection**
• Mature, proven trusted systems technology
  – TCSEC/TNI need not be used as organizational utterance for policy
Can “Substantially Addresses” Subversion

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<th>Common Criteria</th>
<th>TCSEC</th>
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<tr>
<td>EAL7 (Selected PP)</td>
<td>A1</td>
<td>NO VULNERABILITIES</td>
</tr>
<tr>
<td>EAL6</td>
<td>B3</td>
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</tr>
<tr>
<td>EAL2</td>
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</tbody>
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Only Class A1/EAL7 excludes malicious software
Proven Solution: Security Kernel

The only way we know . . . to build highly secure software systems of any practical interest is the kernel approach.”

-- ARPA Review Group, 1970s (Butler Lampson, Draper Prize recipient)
Class A1 enables secure system

- Plant trap door or Trojan horse
- Impossible to find or fix
- Protects data *despite* apps

Class A1 TCB (e.g., GEMSOS)

Class A1 doesn’t assume “secure” applications
Secure Big Data Cloud Storage

- Operates like standard file storage
- BUT, verifiable security for big data
Secure Big Data Cloud Storage

• Verifiably Secure Platform (e.g., GEMSOS Class A1 TCB)
  • Intel ia32 H/W

Standard protocols (e.g., NAS, FTP), with:
  • Strong separation
  • High integrity
  • \( n \) to \( n \) controlled sharing
  • Trusted Distribution
  • Multiprocessor scalability

Commercial Untrusted servers

Highly Sensitive Data

Low Sensitivity e.g., Open Internet

Removable storage

Persistant Storage

Storage Segments

USC Viterbi
School of Engineering

University of Southern California
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• Opportunity: leverage verifiable protection
  – Innovative application designs to exploit TCB
    • Preserve much of existing software
    • Apply supportive hardware, e.g., segmentation, rings, TPM
  – Demo starting with sound security, adding functionality
  – Help users validate product hypothesis to vendors
Impact Summary for Big Data

• Computation for massive amounts of data
  – Complex analytics and database operations
  – Remotely from the data owner’s enterprise
  – Access to data from multiple and diverse domains

• Limitations of security best practices well-known

• Big data increases opportunity for attackers
  – Insert malicious software in apps and operating systems

• Pivotal choice for big data
  – Use rich set of proven concepts for verifiable protection
  – Risk massive disasters that discredit big data approach

• Need good education and reference implementation
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