Security – A Big Question for Big Data

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Keynote Lecture
IEEE BIgData 2013
Santa Clara, CA
October 9, 2013

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

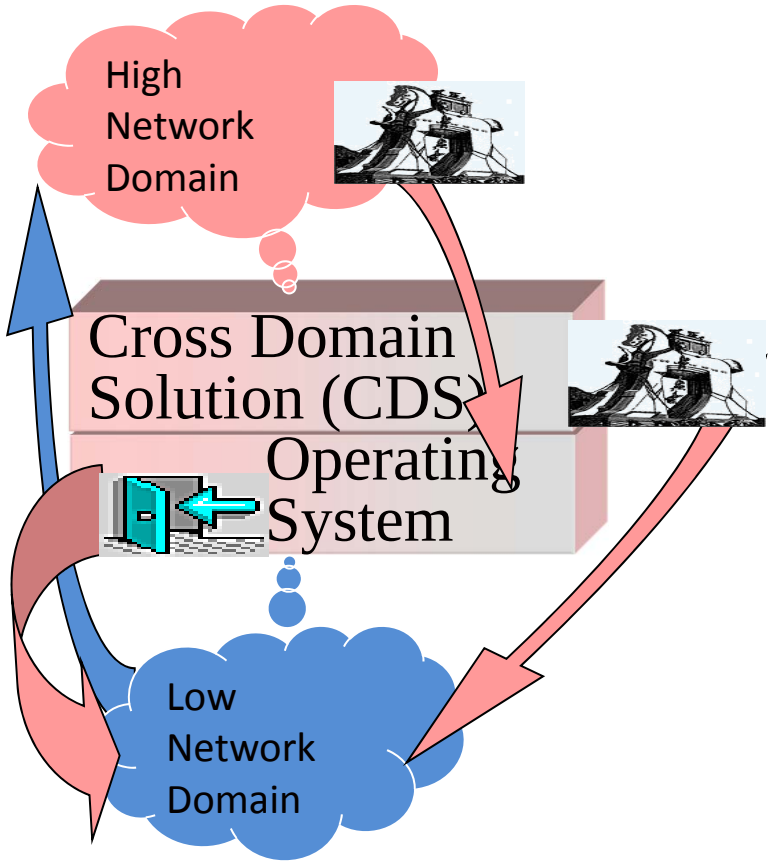
Reality

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



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

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  - Low cost, low risk to attacker, virtually undetectable
  - Highly effective, extensible, e.g., “two card loader”
- **Ineffective response: band-aid solutions**
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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."
    - – Hannaford Bros. Co., reported on eWeek.com, March 28, 2008
- 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 evaluatable
  - 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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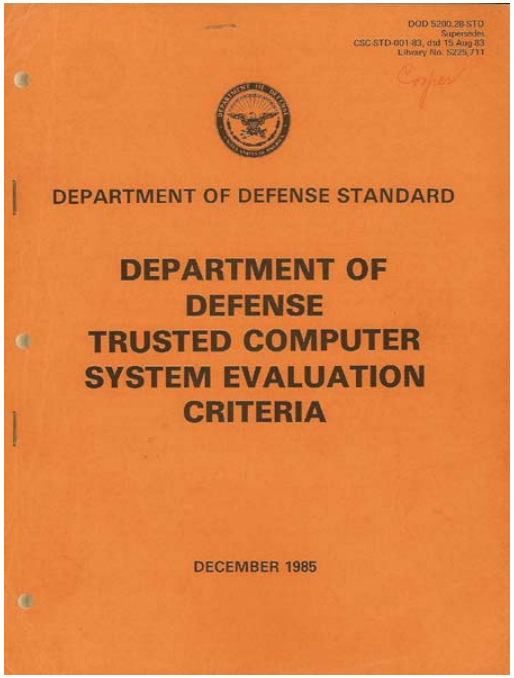
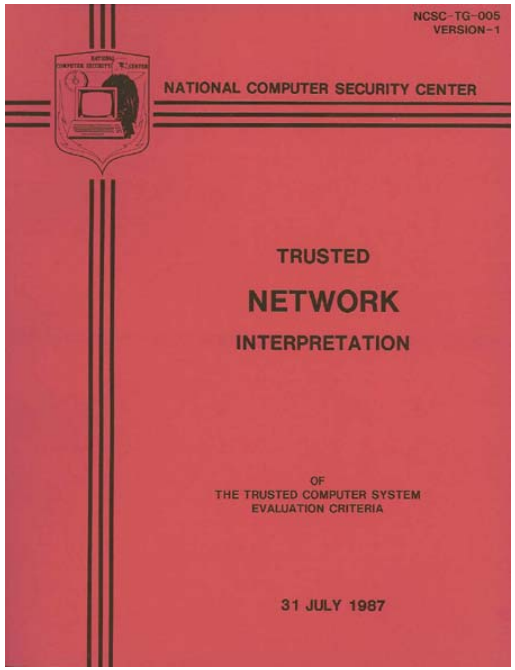
- Ineffective response: band-aid solutions
  - Current practice invites catastrophic big data impacts
  - Pixie dust of “secure” components gives false security
- **Opportunity: leverage verifiable protection**

Verifiable Protection Mitigates Subversion

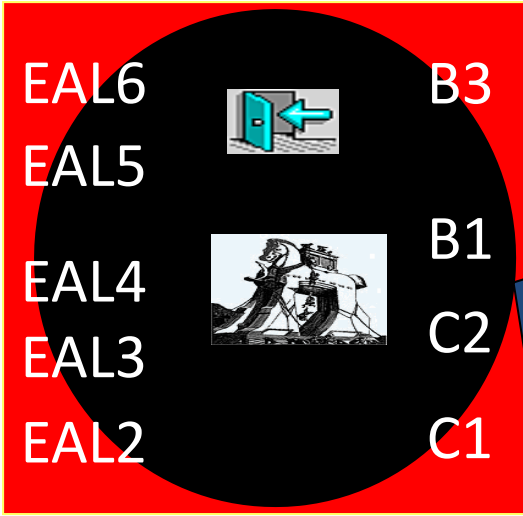
- **Mature, proven trusted systems *technology***
  - TCSEC/TNI need not be used as organizational utterance for policy





Can "Substantially Addresses" Subversion

Common Criteria	TCSEC	
EAL7 (Selected PP)	**A1**	**NO VULNERABILITIES**



UNKNOWN VULNERABILITIES

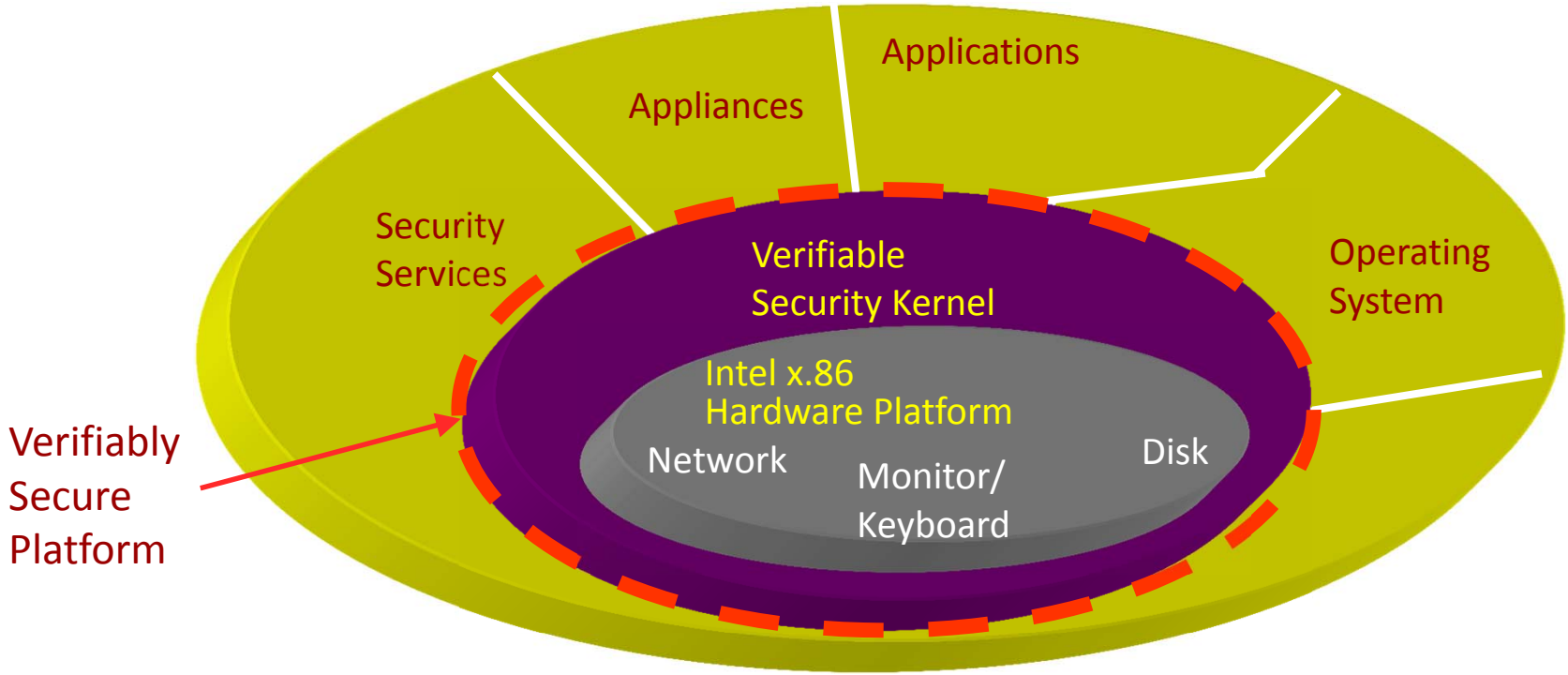
Beware of "No Man's Land"

***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)

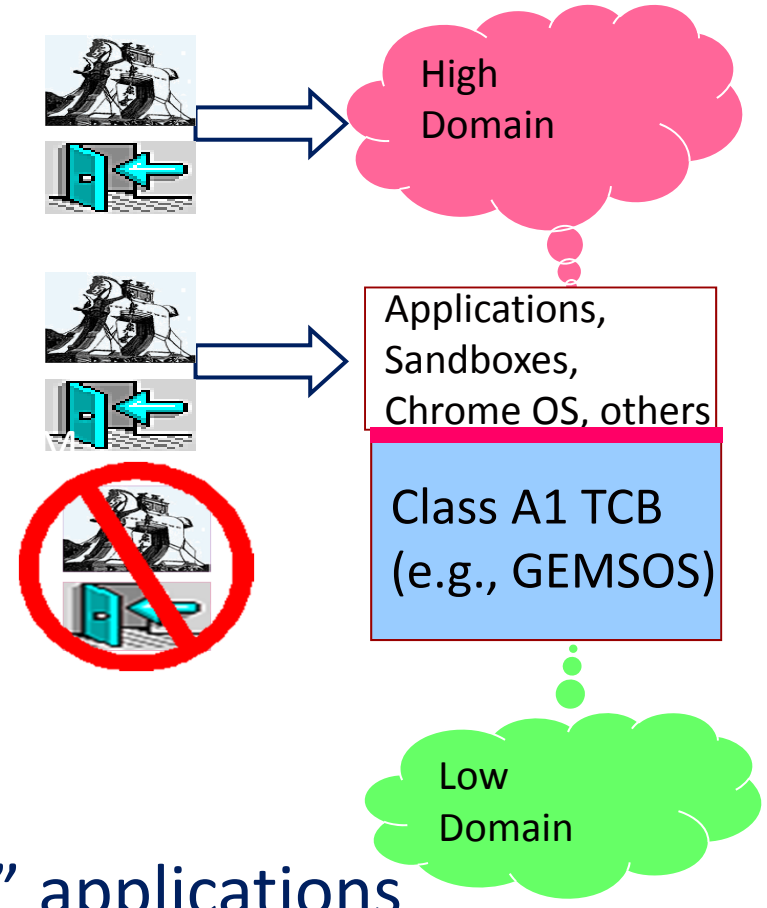


Class A1 enables secure system

Plant trap door or Trojan horse

Impossible to find or fix

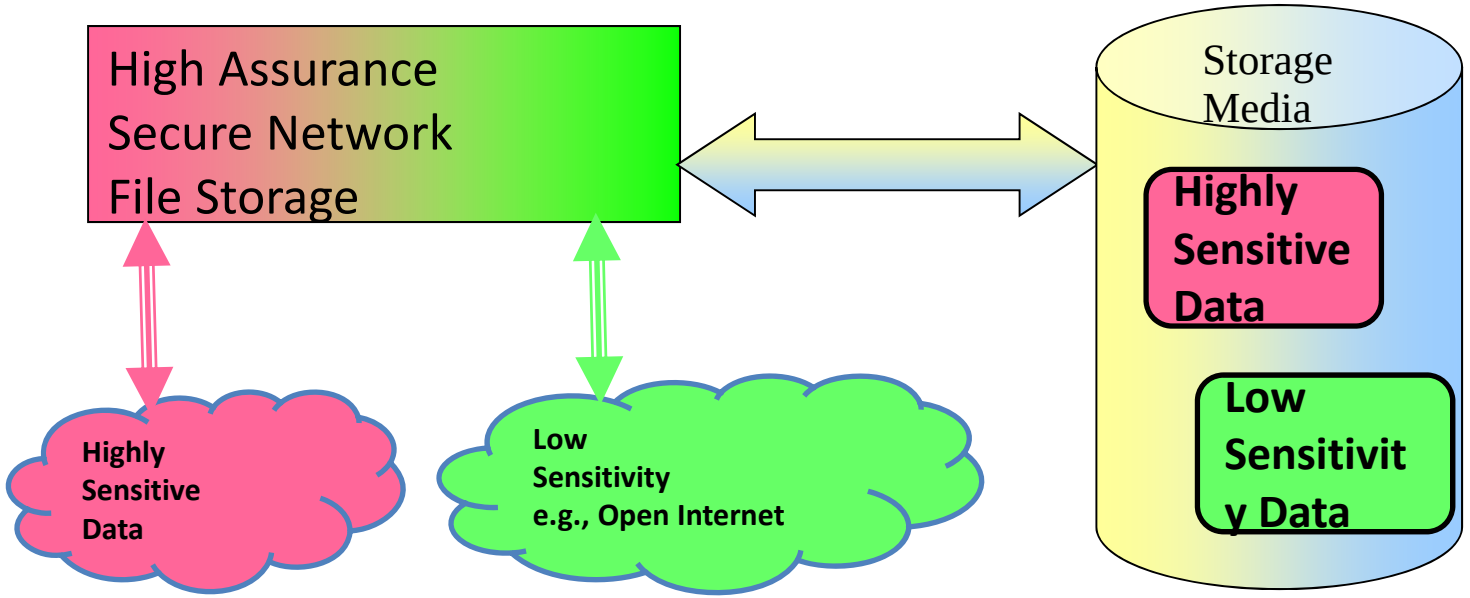
Protects data *despite* apps



Class A1 doesn't assume "secure" applications

Secure Big Data Cloud Storage

- Operates like standard file storage
- BUT, verifiable security for big data



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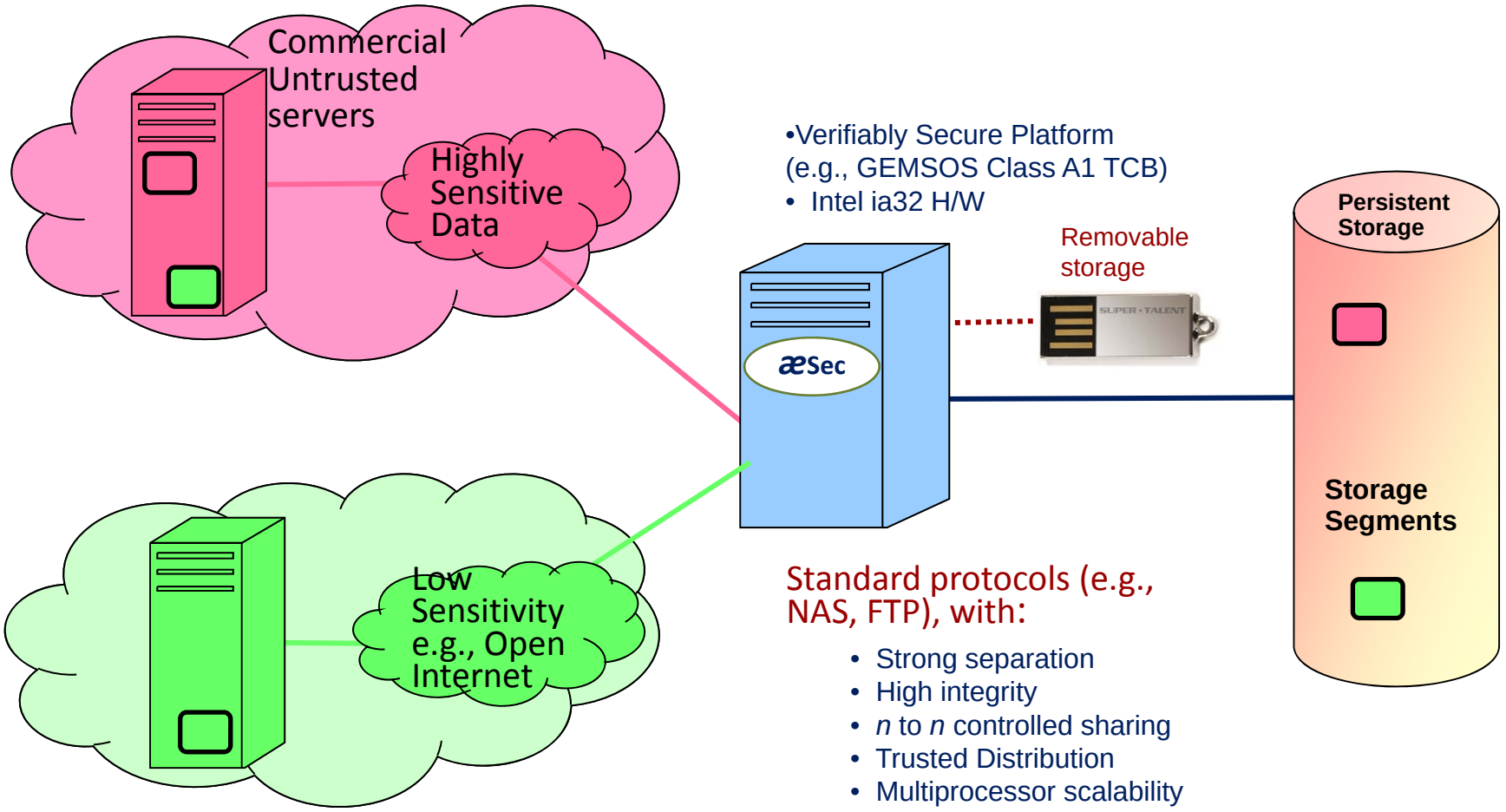

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- Opportunity: leverage verifiable protection
  - Innovative application designs to exploit TCB
    - Preserve much of existing software
    - Apply supportive hardware, e.g., segmentation, rings, TPM
  - Demo starting with sound security, adding functionality
  - 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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