CIS 610: Advanced Topics in Systems Security Assurance

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Problem

• Suppose you go to some trouble to build a system to satisfy the reference monitor concept
  ‣ How would you evaluate that your system correctly satisfies that concept?

Way to Go!
Practical Problem

- Commercial systems are not designed to satisfy the reference monitor concept
  - Can we do something to encourage improvement?
  - Can we layout a path that could result in a commercial system that satisfies the concept?
Assurance

- A set of evaluations aiming to show that a system provides a correct security function
- Motivated by work on security kernels
  - (1) Implement a specific security policy
  - (2) Design a verifiable protection behavior of the system as a whole
  - (3) Implementation must be shown to be faithful to the system’s design
- Develop distinct sets of requirements to be fulfilled for such an approach
Formal Assurance

• Throughout the 1970’s and 1980’s researchers examined methods to prove security properties

• Peter Neumann: *Provably Secure Operation System*
  ‣ Formal design and proofs of security (1976)

• Padilla and Benzel: Evaluation of *SCOMP*
  ‣ First “assured” system (1985)

  ‣ Completely Validated Software (ICSE 1989)
  ‣ Integrating into Development Process (IEEE Soft 1990)
Formal Assurance

• Throughout the 1970’s and 1980’s researchers examined methods to prove security properties

• Feiertag, Levitt, Robinson: Proving Multilevel Security of a System Design (SOSP 1977)

What Do We Want To Know?

- Complete Mediation
  - Each structure member access to a security-sensitive object must be mediated (*domination*)
  - Find objects that enable an information flow between subjects
  - Mediation must authorize all dominated operations (*AND of all accesses*)
  - Can we compute all operations that are dominated?
  - Thus, uncommon accesses may require additional mediation (*consistent across code*)
  - Is a set of accesses embodied in an operation elsewhere? (mediated differently)
What Do We Want To

- **Tamperproofing**
  - Start with known, good code and data (*integrity verification*)
  - Each information flow to kernel or TCB must be from trusted entity (*Biba integrity*) OR
  - Each information flow from an untrusted entity to kernel or TCB must be filtered (*attack surface*)
  - Filters must be acceptable (*type safety, FSA, legal sequence of interfaces, ...*)
What Do We Want To

• Verification
  ‣ Code must correctly implement security-sensitive function
    (security function: build queries, execute queries, etc)
  ‣ Policy must correctly describe data security requirements – all
    authorized information flows (tamperproofing and user/app data)

• Design
  ‣ Validate these in design

• Implementation
  ‣ Verify mapping to implementation (what if no design?)
Assurance Criteria

• First proposal
  ‣ Nibaldi proposed first criteria in 1979
  ‣ “Laboratory Evaluations”

• Eventually led to Rainbow Series of TCSEC

• Criteria goals
  ‣ Security policy
  ‣ Mechanisms contributing to effective enforcement of policy
  ‣ Assurance that mechanisms are functioning
Rainbow Series

- Trusted Computer Systems Evaluation Criteria
- From 1983-1999
  - A variety of documents to help build secure systems
  - Password Management
  - Audit
  - Configuration Management
- Orange Book (1985)
  - Defined 6 classes of security systems
    - Function that the class provides
    - Requirements for verifying that implementation met the class
  - Requirements fall into a number of categories
    - Access control mechanism/policy
    - Authentication
    - Audit
Orange Book Classes

• C1 and C2
  – Discretionary protection
    • Authentication, audit for discretionary access
    • Testing and documentation
  – C2 is the most common class for commercial products

• B1, B2, and B3
  – Labeled security protection:
    • Multi-level security (Bell-LaPadula)
    • More testing and more documentation
  – B1: MLS on some objects; B2: MLS on all
    • B2 also introduces covert channel protections and config mgmt
  – B3 more software engineering documentation

• A1: Verified protection
  – Requires correspondence between code and formal model
Common Criteria

- Started 1993 by US, Canada, and European Countries
- Attempt to identify a set of common criteria to evaluate information security
  - A set of evaluation techniques used to vet technologies
  - ... and tell which ones were good and bad (more or less).
  - This allows consumers of goods and services to know if the security advertised is as good as is claimed
    - Based on some specified evaluation criteria
Common Criteria

- Separate
  - Protection Profile
  - Assurance Level

  Protection Profile

  Security Target

- This is really just the set of requirements for the class of products of this type (e.g., firewalls)
- This is the definition of what and how the TOE (target of evaluation) meets a set of security requirements

EAL1 ... EAL7
EAL Levels

- EAL1: Functionally Tested
  - Breathing
- EAL2: Structurally Tested
  - High-level design
- EAL3: Methodically Tested and Checked
  - High-level design motivates testing
- EAL4: Methodically Designed, Tested, and Reviewed
  - Low-level design and vulnerability analysis
- EAL5: Semi-formally Designed and Tested
  - Rigorous development using (semi-)formal models
- EAL6: Semi-formally Verified Design and Tested
  - Low-level design
- EAL7: Formally Verified Design and Tested
Common Criteria in Practice

• Linux is assured to:
  – EAL4 for Controlled Access Protection Profile
    • Discretionary access control with a low-level system design
• With LSM and SELinux (MLS)
  – EAL4 for Labeled Security Protection Profile
  – Done September 6, 2006
• Challenges
  – Upstream all code
    • Assure a mainline Linux kernel
  – Enable applications
    • E.g., Polymorphic file system
  – Package into distribution
    • That RedHat can deliver
• **Solaris 10 with Trusted Extensions (MLS)**
  ‣ Has been assured to EAL4+ for
  ‣ LSPP, CAPP, and RBAC
  ‣ Original Solaris was a C2 system, but is now EAL4 for CAPP and RBAC

• **Windows Server 2003 and XP are EAL4 (for CAPP)**
  ‣ Windows 7 also aims for EAL4
Assurance Results

• Is Assurance achieving its goals?
  ‣ Proving a system is “secure”
  ‣ Encouraging the development of more secure systems

• Should we try something else?
  ‣ What?
  ‣ Can anything be automated?
  ‣ On code?