Assurance Considerations for a Highly Robust TOE

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### Report Documentation Page

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### DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

### SUPPLEMENTARY NOTES

8th International Common Criteria Conference (ICCC), Rome, Italy, 25-27 Sep 2007

### ABSTRACT

### SUBJECT TERMS

### SECURITY CLASSIFICATION OF:

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### LIMITATION OF ABSTRACT

Same as Report (SAR)

### NUMBER OF PAGES

32

### NAME OF RESPONSIBLE PERSON

unclassified
Discussion Topics

• TOE overview
  – Separation Kernel (SK)
  – Separation Kernel Protection Profile (SKPP)
• Assurance issues for High Robustness
  – Platform Assurance
  – Trusted Initialization
  – Trusted Recovery
• SKPP extended requirements
• Conclusion and plans
Separation Kernel

- Introduced by Rushby (1981)
- Simpler than traditional security kernels
- Primary functional properties
  - Separate system resources into security policy equivalence classes, i.e., partitions
  - Control information flows between and within partitions
- Configuration data establishes
  - Binding of resources to partitions
  - Policy rules for information flow control
- No support for MAC labels but can be configured to control information flows in a manner consistent with a MLS policy
Least Privilege Separation Kernel

• Refinement of separation kernel
• Apply Principle of Least Privilege to further restrict access to resources
  – Basic SK: homogeneous resource-access requirements
    • Same access authorizations for all subjects in a partition
  – Least Privilege SK: heterogeneous resource-access requirements
    • Separate access authorizations for different subjects in a partition
High Robustness

• Robustness – US scheme only
  – Metric for TOE’s protection ability
  – Degrees of robustness: Basic, Medium, High
    • Assurance level
    • Strength of security functions

• Robustness requirement for a TOE
  – Based on value of data and threats in operational environment

• High robustness
  – Provides most stringent protection
  – Can counter sophisticated, well-funded attacks
  – Suitable to protect high value data
Separation Kernel Protection Profile

- **U.S. Government Protection Profile for Separation Kernels in Environments Requiring High Robustness**
  - Validated in July 2007 (Version 1.03, 29 June 2007)
- **Based on Common Criteria Version 2.3**
- **Assurance requirements**
  - Combination of CC-defined components for EAL6 and EAL7
  - Two types of explicitly stated components
    - Modifications of existing CC requirements
    - New requirements

→ No EAL claim due to these extensions
Security Concepts in SKPP

• **Enforcement of Partition Information Flow Policy**
  - Partition Abstraction, Least Privilege Abstraction

• **TOE configuration change**
  - Four models: offline, static, constrained, unconstrained

• **Establishment of initial secure state**
  - Achieved through different degrees of assurance levied on non-TSF components
    • Delivery mechanisms
    • Configuration data generation capability
    • TOE loader
    • Initialization mechanisms

• **Trusted recovery**
• **Platform assurance**
Assurance Issues for High Robustness

Platform Assurance
Trusted Initialization
Trusted Recovery
Platform Assurance Issues

- High robustness requires hardware-supported domain separation and self-protection mechanisms
- No CC-defined requirements for hardware assurance
- Difficult to produce assurance evidence for hardware at same level of detail as software
- Need an assurance framework
  - To assess security properties of hardware mechanisms based on their interfaces to software
  - To establish trust in security-relevant hardware mechanisms
  - To address hardware obsolescence during and after TOE evaluation

→ New Class APT -- Platform Assurance
Platform Concepts

- **Platform** = hardware + associated firmware
- **Platform component**
  - Independently procurable, mass-produced, non-specialized
- **TOE platform** = one or more platform components
  - Defined by ST author
- **Platform definition can vary based on intended usage of the TOE**
  - Very restrictive: require a specific component type with exact properties
  - Less restrictive: allow variations in properties of a specific component type
  - More open: allow use of different component types with defined assembly rules
- **Platform interface**
  - Internal: accessible only to TOE components
  - External: accessible to both TOE components and entities outside the TOE
Hardware/Software Relationships

Application Software

External Platform Interfaces

TOE Software

Internal Platform Interfaces

Platform

C1 … Cn Platform components

Unused Interfaces

Used Interfaces

Virtualized Platform Abstractions
Trusted Initialization Issues

- CC Version 2.x defines no requirements for TOE initialization
  - Rely on administrative actions to ensure proper TOE initialization
- Intended usage of SK requires autonomous TOE initialization
- TSF cannot initialize itself
  - Formal model assumes TSF starts in an initial secure state
- Need a robust mechanism to
  - Establish execution environment for the TSF
  - Bring the TSF to an initial secure state defined by configuration data
- Generation and loading of configuration data need commensurable assurance
SKPP Approach to TOE Initialization

- Correct TOE initialization is achieved through a trust chain of non-TSF functions
  - Delivery
  - Configuration data generation
  - TOE loading
  - Initialization

- Require use of standardized cryptographic algorithms for trusted delivery
  - American National Standards Institute (ANSI)
  - National Institute Standards and Technology (NIST)

- Apply different developmental assurance measures to other initialization-related functions
  → New assurance ADV families
TOE Components

- Trusted Delivery Function
- Configuration vector set
- Load Tool
- Boot media
- Function to establish TSF initial secure state
- Configuration data
- TOE Initialization

Diagram depicts the flow of components, including:
- Trusted Delivery Function
- Config Tool
- Load Tool
- Boot media
- Configuration vector

The diagram illustrates the process of setting up a secure environment.

Trust Delivery Function

Config Tool

Load Tool

Function to establish TSF initial secure state

TOE Initialization

Configuration data

Boot media

TSF
Trusted Recovery Issues

• CC requirements emphasize ways to handle failures and discontinuities
  – Manual versus automated

• CC is vague about presence of recovery functions while in maintenance mode
  – “In the maintenance mode, normal operation might be impossible or severely restricted, as otherwise insecure situations might occur.”

• Verification of robustness of recovery mechanisms is difficult
  – Failures/discontinuities have no formal properties
SKPP Approach to Trusted Recovery

• Focus on protecting the TSF against further compromise during a recovery
• Extend FPT_RCV to require the TSF to attempt recovery to a secure state upon detection of an insecure state
• Expand definition of maintenance mode
  – “A contiguous period during an execution session when operational mode functions are restricted, or recovery functions are available that are not available during operational mode, or both.”
• Clarify intended use of maintenance mode
  – Enable the TOE to return to a secure state
  – Prevent the TOE from entering an insecure state
Maintenance Mode & Secure State

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SKPP Extended Requirements
Platform Assurance (APT)

- New assurance class with five families
  - Platform Definition (APT_PDF)
  - Platform Specification (APT_PSP)
  - Platform Conformance Testing (APT_PCT)
  - Platform Security Testing (APT_PST)
  - Platform Vulnerability Assessment (APT_PVA)
- Focus on specifications instead of identifications of components
- Replace a subset of ADV, ATE and AVA requirements for COTS components
  - Specialized components by TOE developer must meet all ADV, ATE and AVA requirements defined for software
- ACM, ADO_DEL and ALC requirements only apply to specialized components
  - Information about CM, delivery, development security are not generally available for COTS components
- Does not address physical protection and anti-tampering issues
Platform Definition (APT_PDF)

- Require Platform Definition Document (PDD) to support component-specific security analysis against SFRs
- PDD can include vendor documentation if they meet content requirements
- PDD include
  - Component types and assembly rules
  - Identification of component interface specifications for all interfaces
  - Security analysis on how each component type interacts with the TOE
  - Precise references to component interfaces so that specifications can be obtained by third-party
Platform Specification (APT_PSP)

• Require complete specifications of platform component interfaces
  – External interface
  – Internal interface
  – Unused interface

• Specifications include
  – Invocation methods, parameters, expected results, error conditions
  – Arguments that all interfaces are included in specifications

• Support functional analysis and vulnerability assessment of the TOE
Platform Conformance Testing (APT_PCT)

• Require functional testing to ensure platform components identified in PDD operate as expected
  – Vendor-provided tests may be used to satisfy this requirement

• Require exercising all security features that are relied upon by the TSF
  – Testing is performed through TSF interfaces
  – Tests are to be developed by TOE developer
Platform Security Testing (APT_PST)

- **Require comprehensive security testing**
  - Verify correct operations of all external and internal platform interfaces

- **Tests to be performed at the component interface level**
  - Different than tests in APT_PCT which are at TSF interface level

- **Test documentation include**
  - Procedures and expected results
  - Argument that test coverage is complete
Platform Vulnerability Assessment (APT_PVA)

- Performed as part of TOE vulnerability analysis
- Assessment is at platform interface level
  - All external platform interfaces
  - All internal platform interfaces used by the TOE
- Complement AVA_VLA requirements
  - Systematic search for vulnerabilities
  - Disposition of identified vulnerabilities
  - Justification that analysis is complete
  - Independent vulnerability analysis by NSA
  - Independent penetration testing by NSA
Trusted Initialization (ADV_INI)

- **New family in Class ADV**
- **Levy both functional and assurance requirements on initialization function**
  - Initialization has both testable behaviors and development process
  - SFR paradigm is not applicable to non-TSF components
- **Functional responsibilities of initialization function**
  - Establish the TSF in an initial secure state
  - Verify integrity of TSF code and data during initialization
  - Handle failures during initialization
  - Provide self-protection during initialization
  - No arbitrary interaction with the TSF after initialization
- **Require cooperation from TSF to prevent rogue initialization function**
  - Extended SFR requires secure state confirmation by TSF prior to TSP enforcement (FPT_ESS_EXP)
Development Assurance for Initialization

- **Architecture assurance**
  - Self-protection against tampering from other TOE components
  - No interaction with TSF operations after initialization

- **Functional specification**
  - Similar to ADV_FSP requirements for TSF
  - Describe each initialization interface
    - Purpose, method of use, parameters, operations, exceptions, error messages and effects

- **Design documentation**
  - One level of specification, i.e., not as rigorous as ADV_HLD and ADV_LLD for TSF
  - Require modular composition of components
  - Module characterization is based on relevancy to secure state establishment (SSE)
    - SSE-related, SSE-unrelated

- **Test documentation**
  - Test plan, test procedures, expected results, actual results
Configuration Tool Design (ADV_CTD)

- Configuration vector(s) define the initial secure state
  - Corrupted vector could result in unintended TSF operations
- Need robust Configuration Tool to generate and validate configuration vector(s)
- ADV_CTD levies both functional and assurance requirements on Configuration Tool
- Configuration Tool capabilities
  - Generate human-readable form of configuration vectors with clear semantics to allow validation of intended TOE configuration
  - Preserve semantics of data during conversion between human-readable and machine-readable forms of configuration vectors
  - Apply cryptographic seal(s) on generated configuration vector(s)
- Design documentation
  - Explain how to verify correctness and accuracy of generated configuration vector(s)
  - Same level of abstraction and detail required by ADV_HLD
Load Tool Design (ADV_LTD)

- **Similar to ADV_CTD**
  - Include both functional and assurance requirements
- **TOE loading function needs to be robust**
  - Part of the chain of trust to establish initial secure state
  - Must maintain integrity of TOE software and configuration vector(s)
- **Load Tool capabilities**
  - Convert TOE software and configuration vector(s) into a TOE-usable form
  - Preserve integrity of code and data during conversion
- **Design documentation**
  - Explain the conversion process
  - Same level of abstraction and detail required by ADV_HLD
Trusted Recovery (FPT_RCV)

- Extend base FPT_RCV.2 component
- TSF must attempt recovery to a secure state upon detection of being in an insecure state
  - After completion of TOE initialization
  - During execution session
- TSF must attempt to halt if unable to complete recovery action
  - Transition to maintenance mode may be an acceptable action for certain TOEs
- ST enumerates pair-wise recovery conditions and associated actions
  - Recovery is implementation-specific
- Require assurance evidence that secure state results from the identified action
  - TSF design specifications
  - Administrative guidance documentation
  - Test analysis documentation
Conclusion and plans

• Assurance considerations for high robustness not sufficient as addressed in CC Version 2.3
  – Platform assurance, trusted initialization, trusted recovery
• SKPP explicitly defined SFRs and SARs to address these issues for a separation kernel TOE type
• Most of these extended requirements are applicable to other high assurance TOE types
• Next step for this PP development team
  – Development of another high robustness PP for a more complex TOE
    • Leverage SKPP experience to shorten PP engineering time
  – Challenge is to articulate high robustness requirements in CC Version 3.1 context
Acknowledgements

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Questions and Contacts

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