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CENTER FOR INFORMATION SYSTEMS SECURITY STUDIES AND RESEARCH

Assurance Considerations for a Highly Robust TOE

Thuy D. Nguyen, Cynthia E. Irvine, Timothy E. Levin
Department of Computer Science
Naval Postgraduate School

Michael McEvilly
The MITRE Corporation

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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**



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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**

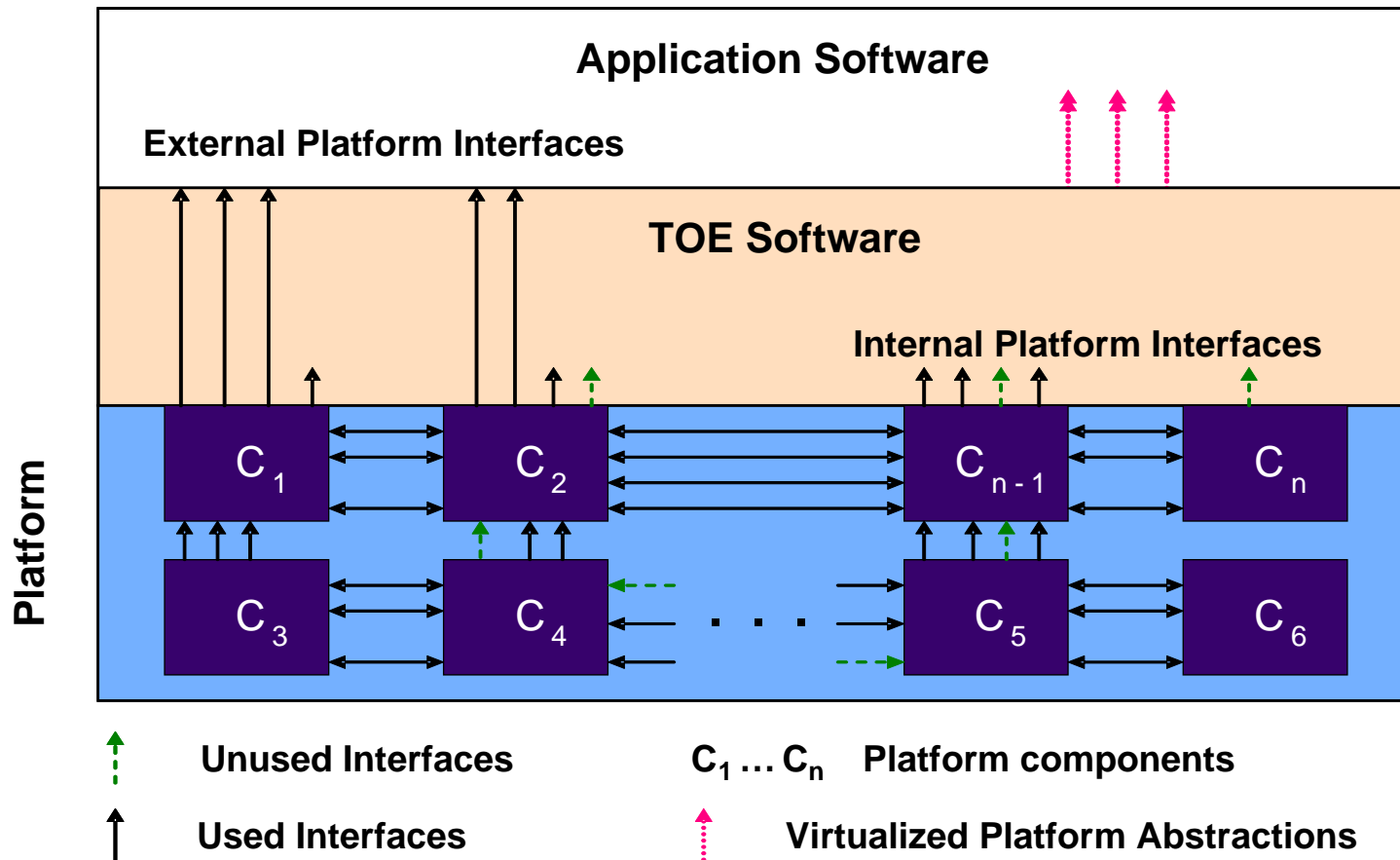


Platform Concepts

- **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





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**

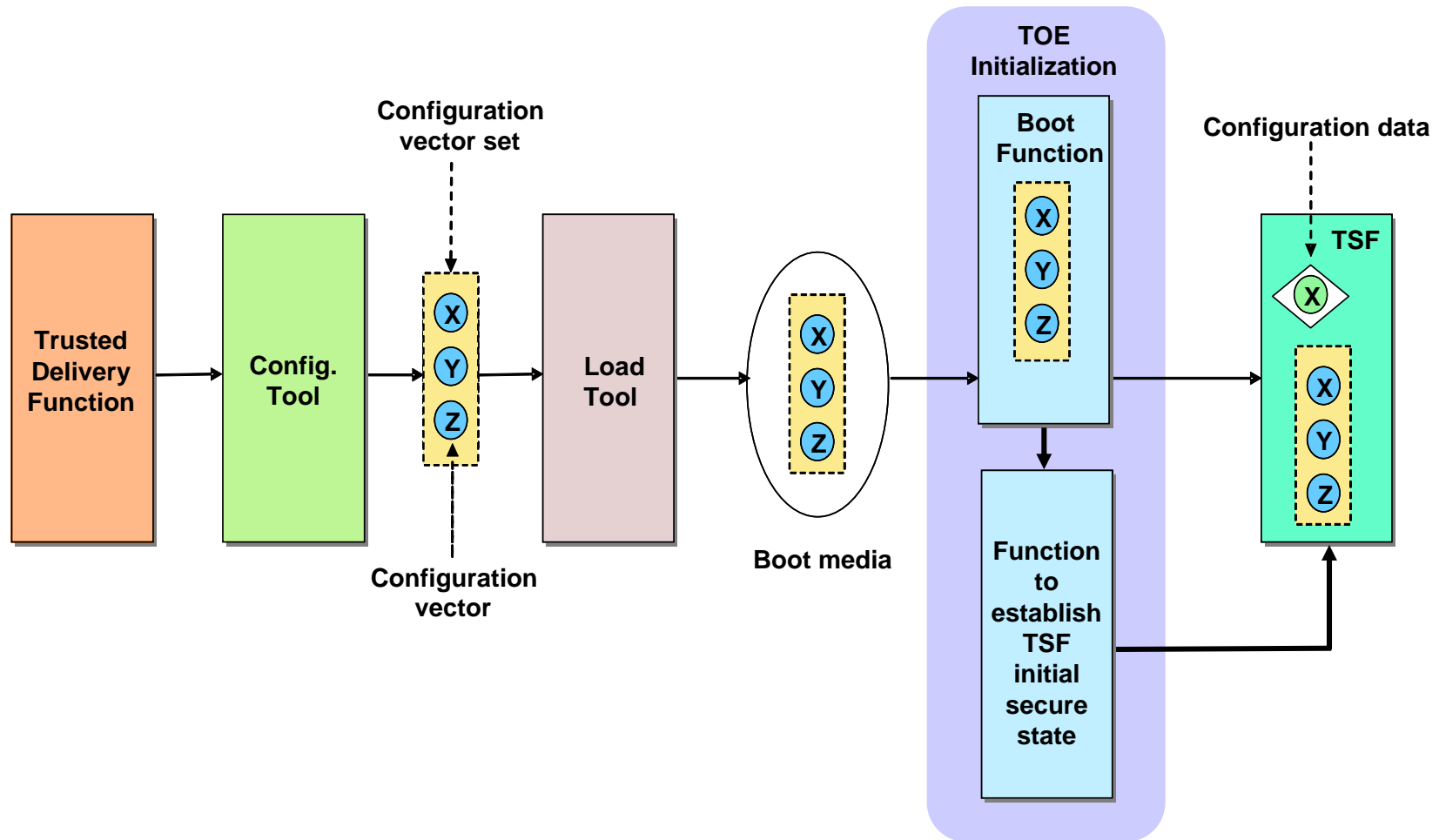


SKPP Approach to TOE Initialization

- **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 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

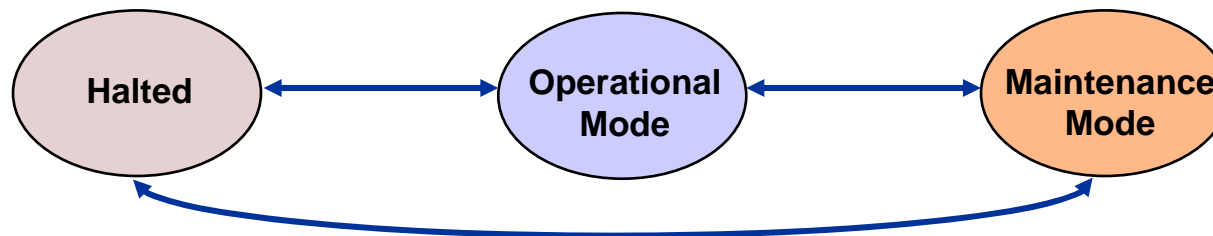


SKPP Approach to Trusted Recovery

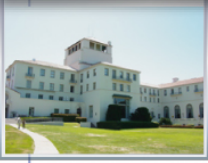
- Focus on protecting the TSF against further compromise during a recovery
- Extend FPT_RCV to require the TSF to attempt recovery to a secure state upon detection of an insecure state
- Expand definition of maintenance mode
 - “A contiguous period during an execution session when operational mode functions 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



	STATE		Secure (S)	Insecure (I)
	MODE			
Execution Session	Operational (O)	O\S	O\I	
	Maintenance (M)	M\S	M\I	
Halted (H)		H\S	n/a	



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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



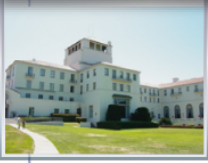
Trusted Recovery (FPT_RCV)

- **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



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Questions and Contacts

Thuy D. Nguyen

**Department of Computer Science
Naval Postgraduate School
Monterey, California, USA**

tdnguyen@nps.edu