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2007-09-01

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International Common Criteria Conference (ICCC), Rome, Italy, September 2007

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# Assurance Considerations for a Highly Robust TOE

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*8<sup>th</sup> International Common Criteria Conference  
Rome, Italy  
September 25-27, 2007*



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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**

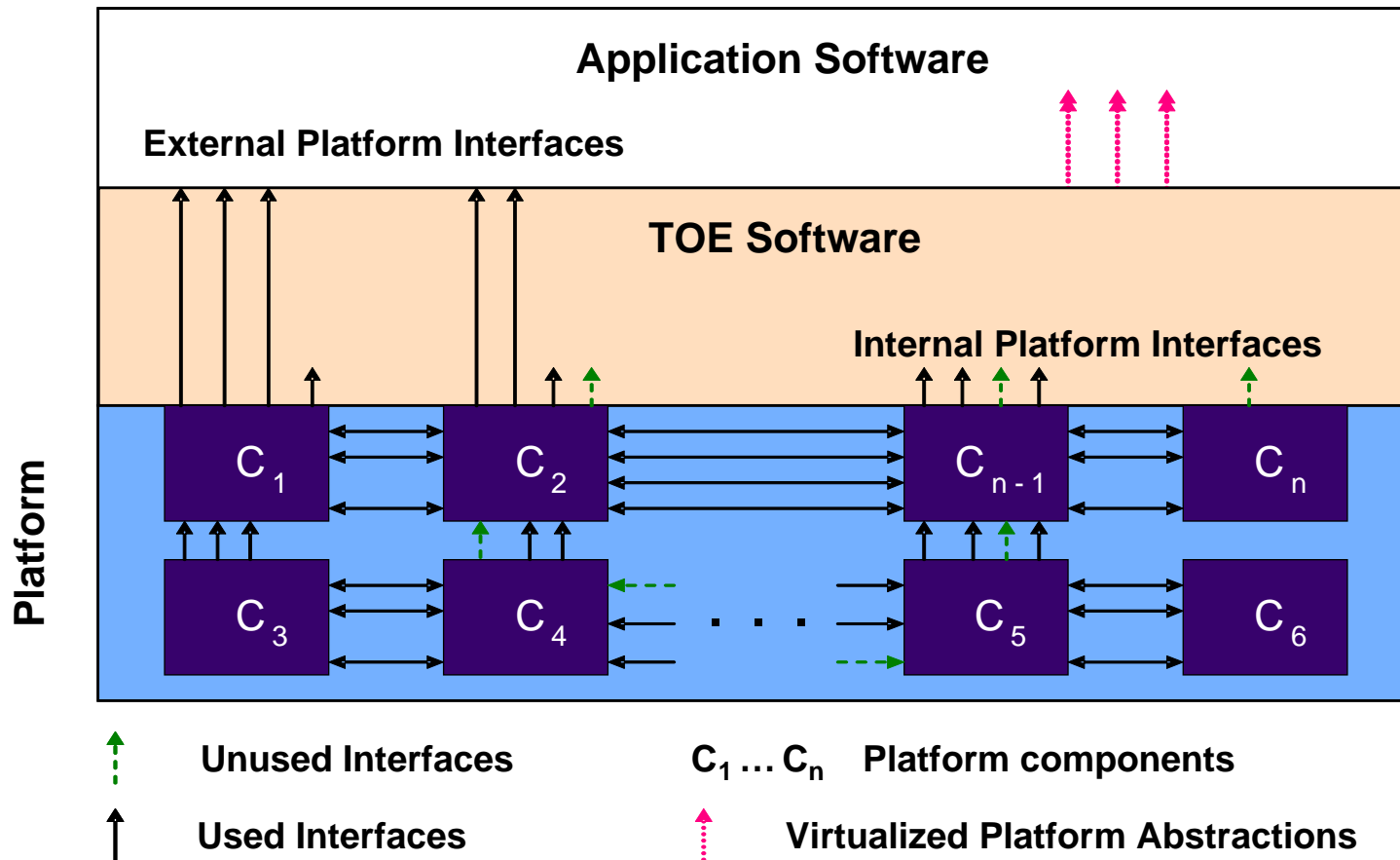


# Platform Concepts

- **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**

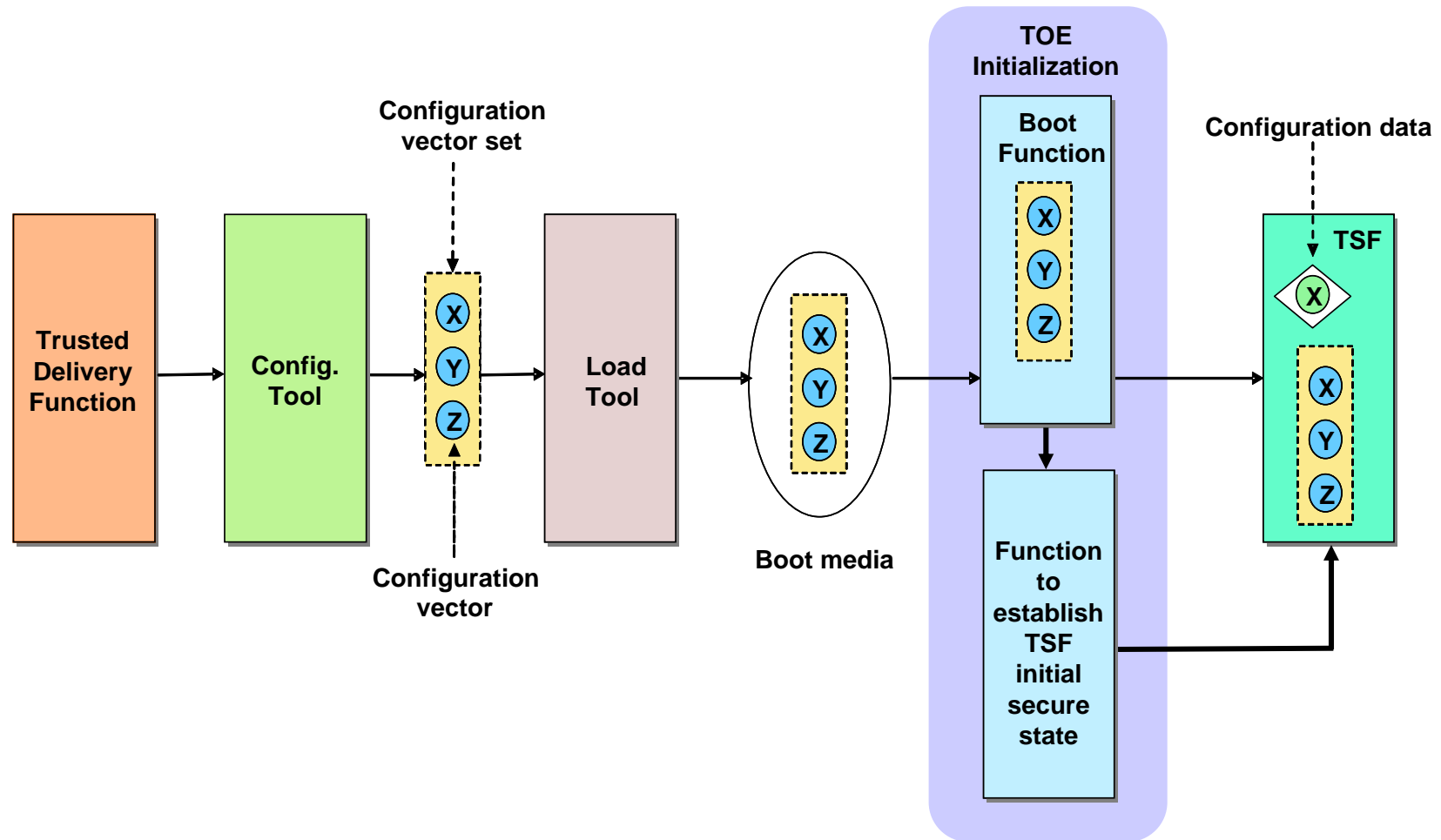


## SKPP Approach to TOE Initialization

- **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

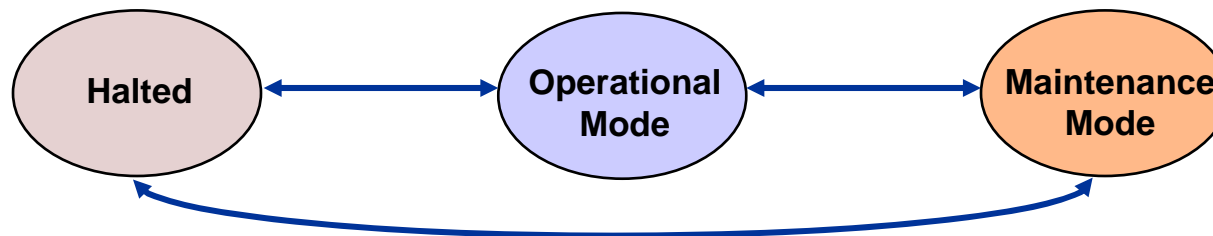


## SKPP Approach to Trusted Recovery

- 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\I	O\I	
	Maintenance (M)	M\I	M\I	
Halted (H)		H\I	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





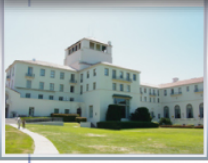
## Trusted Recovery (FPT\_RCV)

- **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



# Acknowledgements

**The authors would like to express their appreciation to the NSA SKPP management team and Olin Sibert, without whom this work could not have been completed.**



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