



A Note on High Robustness Requirements for Separation Kernels

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- Problem Definition
- Separation Kernel and PP Description
- High Robustness PP Issues
 - Least Privilege
 - Dynamic Reconfiguration
- CC v3.0 Transition Issues
- Summary

- Need for U.S. Government Protection Profile for Separation Kernels in Environments Requiring High Robustness (SKPP)
 - Various products forthcoming
 - High Robustness - uncharted Common Criteria territory
- Preliminary Analysis: Protection Profile (PP) requires
 - CC-oriented description of TOE abstractions
 - Extensions to several Common Criteria requirements
 - Extrapolation from existing guidance and examples
 - E.g., US scheme medium robustness CIM
 - Medium Robustness MLS OS PP draft

- Separation Kernel (Rushby, 1981, etc.)
- Manages computing and communication resources
 - Self-protecting
- Creates abstractions of resources for export at SK interface
- SK Partitions resources into policy equivalence classes*
- Controlled separation of equivalence classes
 - No interaction between classes unless explicitly allowed

** These equivalence classes are sometimes also called “partitions”*

- Taxonomy of SK runtime resources
 - Internal
 - Used for implementation of kernel
 - Exported
 - Subjects
 - Programs, asynchronous devices, etc.
 - All other
 - Memory, files, devices, buffers, volumes etc.
 - “objects”

- Limited functionality expected
 - E.g., embedded systems
- No runtime user interface
 - No user identification and authentication
- Static runtime configuration of security policy and resource allocation
 - Specified in “TSF configuration data”
 - Exceptions allowed for exigencies
- Support privileged subjects
 - Limit access to privileged interfaces
- Support trusted delivery, trusted recovery
- Export or store audit records
 - At least one is required

- EAL6
- + Formal Security Policy Model
- TOE Components
 - TSF
 - Software
 - Hardware base
 - Initialization mechanism
 - Configuration mechanism
 - Delivery and recovery mechanisms

- Principle of least privilege (PoLP)
 - All-or-nothing security cannot be high robustness
- Dynamic configuration
 - On-the-fly security policy changes may be intractable to analyze with respect to the separation of equivalence classes (e.g., Harrison et al, 1976)
- Hardware as part of the TSF
 - A classic third-party assurance composition problem

- PoLP (reviewed in Saltzer, Schroeder, 1975)
 - Mechanisms should have no more privilege than what is necessary to perform the actions for which they were designed
- PoLP Applied to SKPP
 - TSF must have capability to restrict subjects'...
 - access to privileged operations
 - access to resources within a partition
 - TSF must be structured to restrict privileges of internal modules/functions

- Use Case:
 - TSF supports multiple heterogeneous subjects in a partition
 - TSF must discern between those subjects for the purpose of information flow control
- **FDP_ACC:**
 - *TSF may allow an operation of a subject on an exported resource only if:*
 - *Partition-to-Partition flow rule explicitly authorizes operation*
 - *Subject-to-Resource flow rule explicitly authorizes operation*

Least Privilege in ADV_ARC/ADV_INT

- PoLP advantages for design and internal structure
 - Affords simplicity to implementation
 - Coupled with layering and minimization, increases confidence in analysis of TSF correctness
- **ADV_ARC: requires justification that TSF design achieves PoLP**
- **ADV_INT: requires PoLP to be applied to all TSF modules/functions**

- FDP_ACC allows certain PoLP “exceptions”
 - Configurations where subject-resource interaction is “policy-equivalent” to that of their partition
 - Interaction between single-subject and single-resource partitions
 - *Only one subject in subject’s partition*
 - *Only one exported resource in resource’s partition*
 - Homogeneous functionality of subjects in a partition
 - *All subjects in subject’s partition require same operation on all exported resources in resource’s partition*

- Static Configuration SK
 - Initial configuration data determines runtime behavior
 - All resource allocations
 - Time - e.g., CPU time slices
 - Space - e.g., per-partition memory regions
 - All allowed information flows
 - Ideal for embedded systems and security research
 - Simple design and implementation
 - Evaluatable size
 - Provides fundamental security service: separation
 - Building block for more complex systems
 - *Assurance issue with configuration-data based policy mechanism:*
 - *Ensure resulting security policy reflects the organization's intent*

- Problem scenario
 - Failure of a peripheral device in a mission critical application, or
 - Overriding environmental security conditions
- Desirable for TOE to be able to change its configuration
- SKPP allows TOE to change resource allocations and policy rules during runtime
 - Several problems

Dynamic Configuration Problems

- Continuity of security across a policy transition
 - Undefined security during transition?
 - Undefined combinations of policies after transition?
- Arbitrary changes are hard to understand w.r.t. policy
 - Formal models often have static attributes because of this
- Approach:
 - Limit how policy may change
 - Four hierarchical modes of change defined

1. Off-line transitions and pre-loaded configurations
 - Allows complete removal of previous security state
 - Allows pre-analysis of subsequent security policies
 - Triggered by privileged subject or offline actions
 - *Assurance issue: TSF must ensure*
 - *Only authorized subject may request configuration change*
 - *TOE fully and properly executes the change request*
2. On-line transitions and pre-loaded, configurations
 - Allows dynamic change of configuration
 - *Additional assurance issue: TSF must continuously maintain secure state*
 - *Before, during and after the configuration change*

3. On-line transitions and limited configuration changes

- Changes limited by static rules enforced by TSF
- *Additional assurance issue:*
 - *Ensure ad hoc policy change requests are consistent with organization's policy intents*

4. On-line transitions and arbitrary configuration changes

- *Additional assurance issue:*
 - *TOE vendor must provide convincing definition of “secure transition” in SFP model*

- Options 3 and 4 are beyond the scope of the SKPP
 - Will require an ST- rather than PP-based evaluation



Details of SKPP functional and assurance requirements for dynamic configuration are ST-specific

- SKPP
 - Developed to be conformant to CC V2.2
- CC V3.0 significantly different
- FDP_ACC simpler than FDP_IFF/IFC
- Challenges include
 - Hardware assurance undefined
 - Non-user Security Attributes
 - Covert Channel Analysis by developer

- SKPP requires binding of security attributes to exported resource when resource is created
- Two-step process: registration and initialization
 - **FIA_URE:** *TSF must store attributes of exported resources in identified internal resources*
 - e.g., kernel structures
 - **FIA_ISA:** *TSF must bind (those) attributes to corresponding exported resources when resource is created*

- High Robustness Requires
 - PoLP
 - Control of Dynamic Re-Configuration
- Common Criteria Version 3.0 transition
 - Most SK requirements fit into existing families
 - A few new explicit requirements required to cover scope of TOE

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Questions?

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