A Note on High Robustness Requirements for Separation Kernels

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Presentation Overview

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

• 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”
Specific SK Characteristics

- 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
Evaluation Target

• EAL6
• + Formal Security Policy Model

• TOE Components
  – TSF
    • Software
    • Hardware base
  – Initialization mechanism
  – Configuration mechanism
  – Delivery and recovery mechanisms
SKPP High Robustness Issues

• 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*
• 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
Dynamically Configurable SK

- 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
SKPP Dynamic Configuration Options

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 Transition to CC V3.0

• 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
Summary

• 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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