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
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
General Separation Kernel Characteristics

- 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
Principle of Least Privilege (PoLP)

• 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
SK Configuration

• 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
    • Evaluable 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
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
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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