Application of the Flask Architecture to the X Window System Server

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Overview of Talk

- X Window System overview, security issues, and proposed solution.
- Userspace object managers: how they fit into the Flask architecture and SELinux implementation.
- Description of changes to libselinux, X server.
- Examples of SELinux policy for X applications.
- Conclusion

X Window System

- Graphical capability provided by a server process.
- Three important functions:
  - Provides window objects and methods for drawing graphics primitives.
  - Links mouse and keyboard input events to windows.
  - Supports inter-client communications (cut & paste, drag & drop).

X Security Problems

- Once connection to X server is allowed, SELinux has no further control over X operations.
- Objects are globally accessible: can read or draw into other windows, capture keyboard events, etc.
- Processes can exchange arbitrary data using window properties.
- Current solution is to deny connection entirely. This is too coarse-grained.

Traditional Text Console

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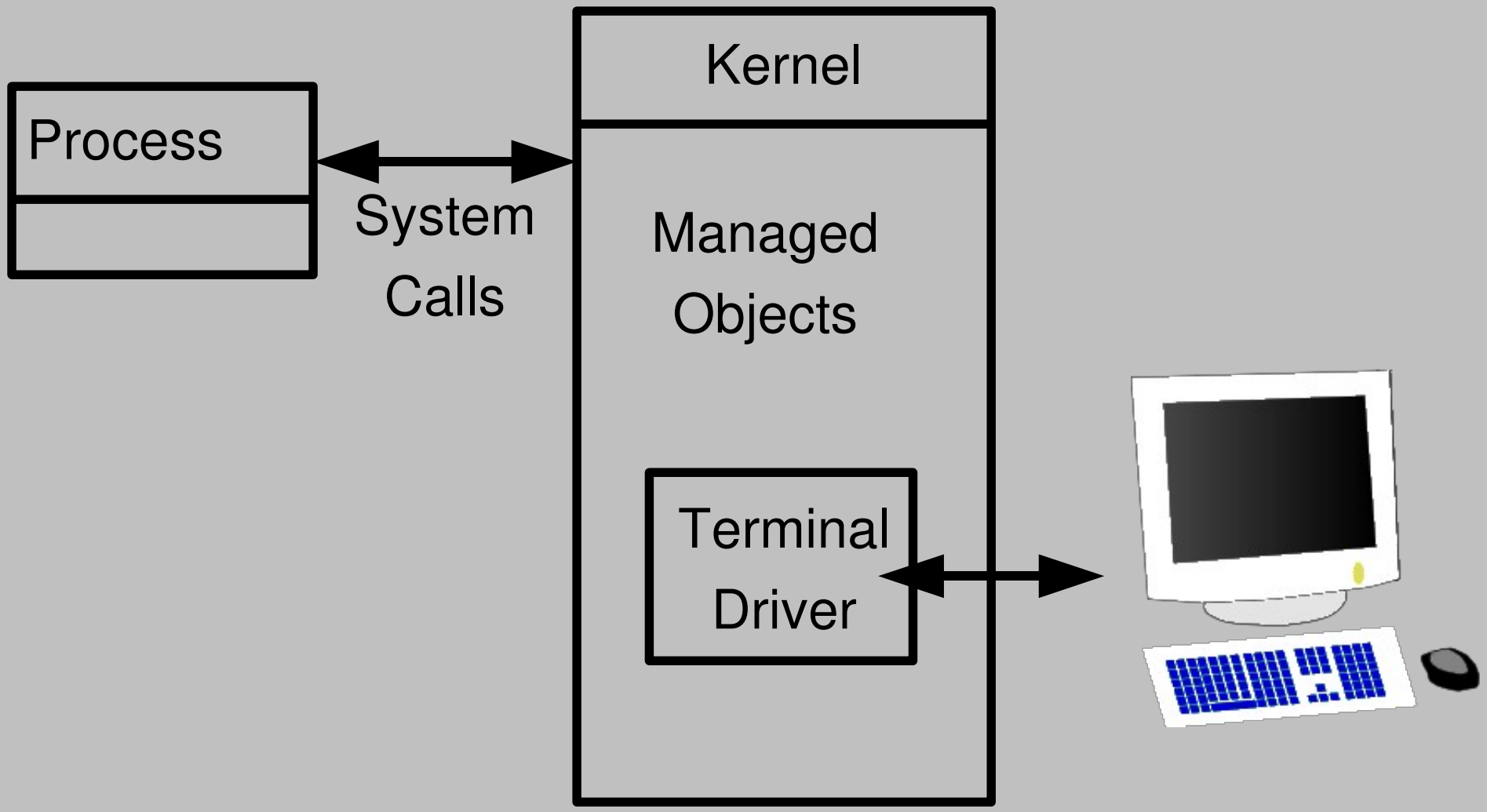

X Server Model

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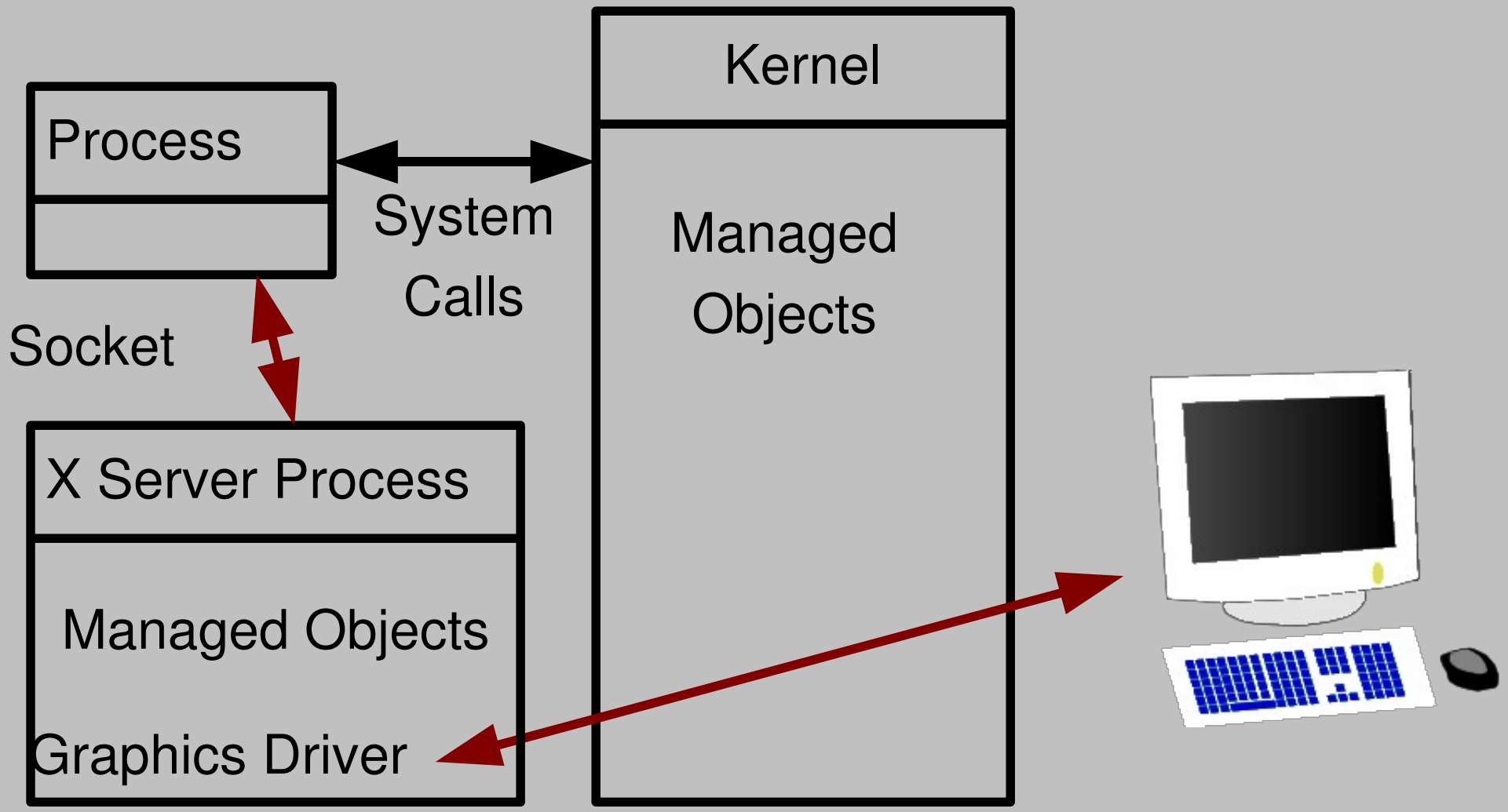

X Security Solution

- Fine-grained control over X objects.
  - Flask object classes and permissions describing them.
  - Enforcement logic able to enforce policy decisions.
  - SELinux policy and means for querying it.
- Other security goals specific to user interface:
  - Label displayed objects so that spoofing is prevented.
  - Trusted input stream, secure attention mechanism.

The Flask Security Architecture

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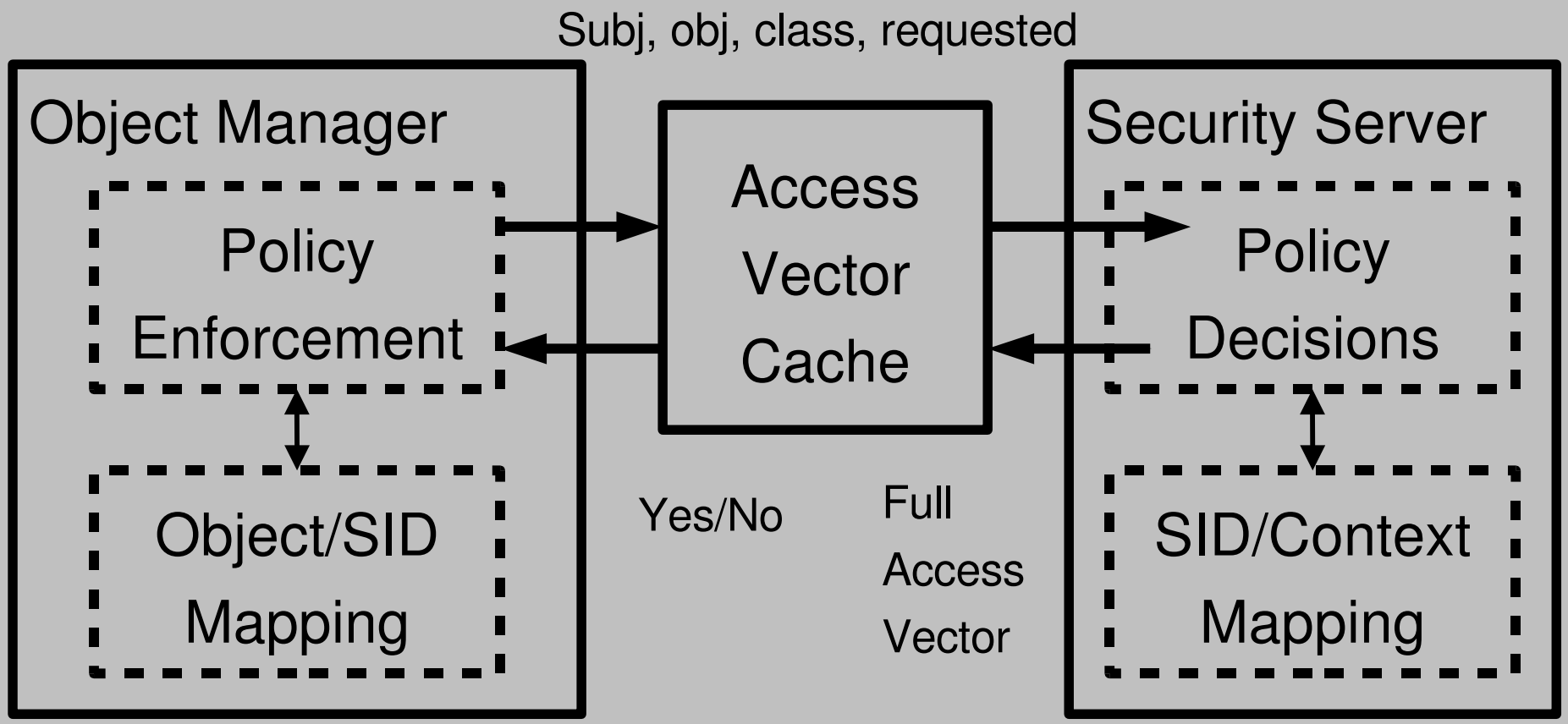

Userspace Object Manager Concept

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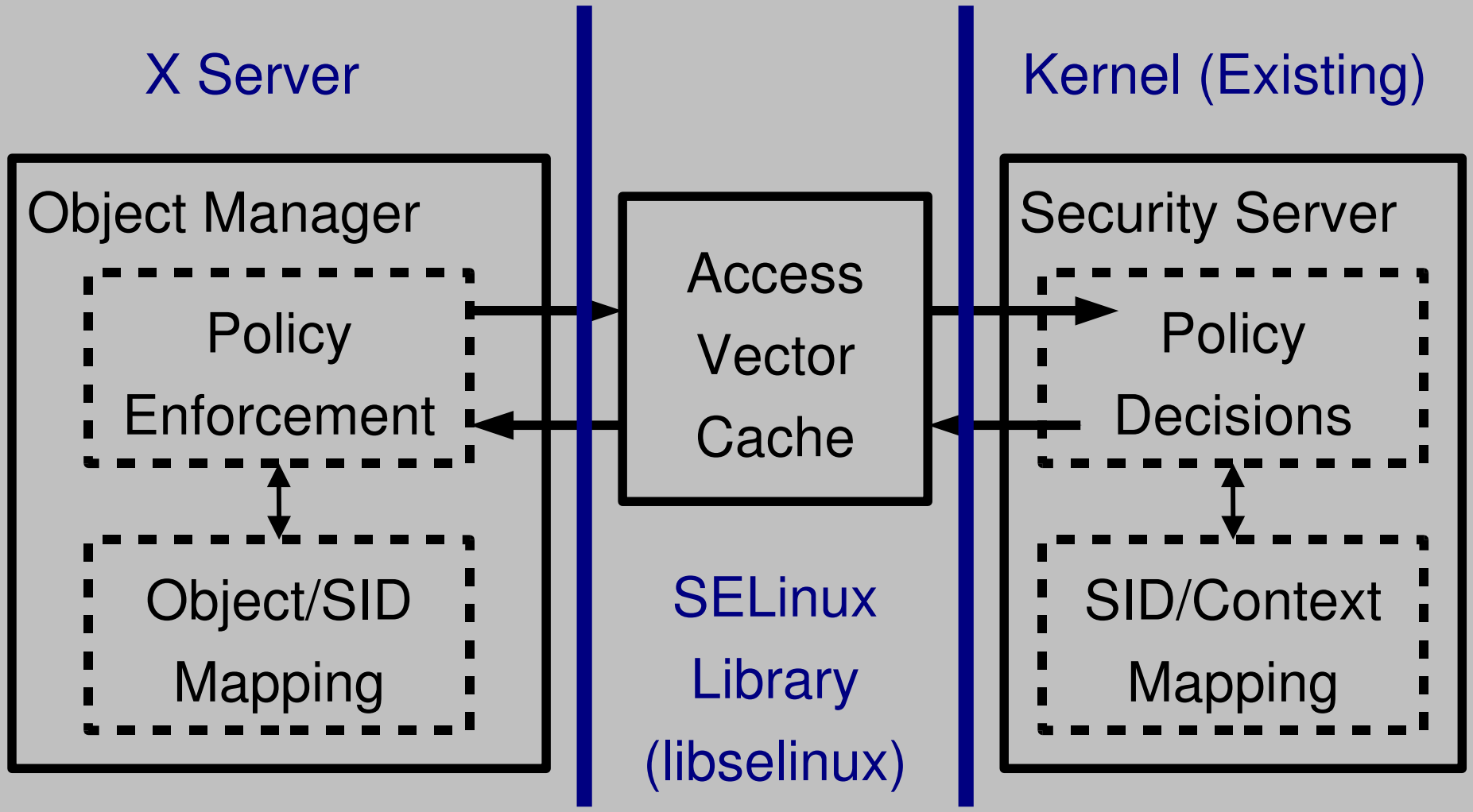

Single Security Server, Multiple Object Managers

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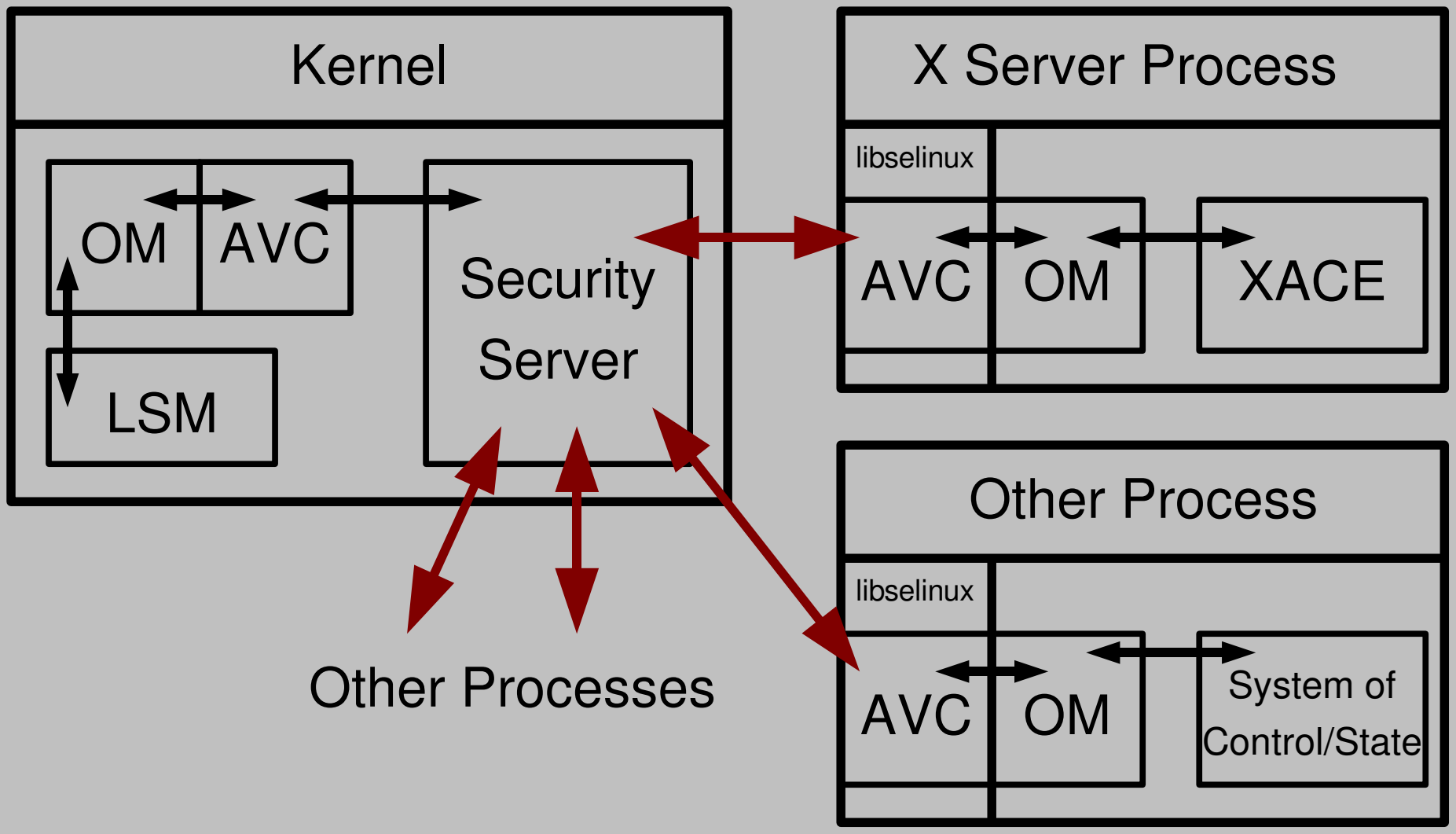

SELinux Library Work

- Ported AVC code from kernel to libselinux.
- Uses selinuxfs to retrieve decisions from kernel security server.
- NETLINK support for asynchronous notification of policy reloads, invalidation.
- Provides `avc_has_perm` function for simple yes/no answers.

Enforcement Logic

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- Need to interrupt normal flow of execution and pass control to enforcement code.
- Chose the LSM model – generic security hooks.
- 1996 “Security” Extension, D. P. Wiggins (X Consortium) served as basis.
- Hooks allow interception of arriving protocol requests, resource lookups, and at other points.
- X Access Control Extension (XACE) accepted in X11R7.2.

State Storage

- Need to store SID's with objects.
- Again, chose general mechanism rather than adding specific structure fields.
- DevPrivates allows driver writers to store extra data, works well for security too!
- Work is ongoing to extend this to additional server structures.

XSELinux Flask Module

- Ties everything together.
- Uses XACE to intercept incoming requests.
- Formulates permission requests and obtains decisions using `avc_has_perm`().
- Enforces decision by returning BadAccess errors to connected client.
  - Need improved Xlib error handling to manage this.

Policy Examples

- Allow an app to draw into its own windows:
  ```
  allow app_t self:drawable draw;
  ```
- Allow a window manager to reparent windows:
  ```
  allow wm_t app_t:window chstack;
  ```
- Allow an app to use advanced graphics:
  ```
  allow app_t
  accelgraphics_xext_t:xextension use;
  ```
- Basic strict and unconfined policies in Refpolicy.

Window Labeling

- Make SID's available for reading by clients.
- Example: use a window property to store context of window object, and allow windowmgr to read:

```
allow wm_t app_t:seclabel_xprop_t:property read;
```

- Windowmgr can then display context to user.
- Provide X protocol allowing SELinux-aware clients to relabel their objects.

Development Timeline

- XACE accepted to X.org server 1.2.
  - Further work on XACE/DevPrivates is in progress.
- XSELinux Flask module available on a branch.
- Target for merging to trunk is X.org server 1.4
- Whether target is met depends on speed of work and X release schedule.

How to Get Started

- Example policy available in refpolicy.
  - 'xwindows_object_manager' tunable must be enabled.
- X Server source code available for download.
  - XACE-SELINUX branch of xserver git repository.
  - “ModularDevelopersGuide” explains how to compile.
- RPM's for Fedora, other distros?
  - Upstream package repos must track 1.4 development.

Contact Information

- Eamon Walsh, ewalsh@tycho.nsa.gov
- The X.Org Foundation:
  http://xorg.freedesktop.org/wiki/
- Kilpatrick et. al. X analysis paper:
  http://www.nsa.gov/selinux/info/docs.cfm
- XACE Documentation:
  http://gitweb.freedesktop.org/?p=xorg/doc/xorg-docs.git;a=tree
  - Browse to sgml/security