NSA Security-Enhanced Linux (SELinux)

http://www.nsa.gov/selinux

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What is SELinux?

- Flexible Mandatory Access Control (MAC) for Linux.
- Configurable policy engine supporting:
  - Type Enforcement (TE), Role-Based Access Control (RBAC)
  - Optionally Multi-Level Security (MLS)
- Ability to enforce confidentiality and integrity guarantees.
- Ability to confine flawed and malicious applications.
- Ability to enforce assured pipelines.

SELinux: Key Properties

- Complete mediation
  - Control over all processes, objects, operations.
- Control based on all security-relevant information.
  - Properties of the actual process and object, not just its name.
- Configurable support for meeting application security requirements transparently.
  - Assured pipelines.
- Infrastructure for security-aware applications.
  - A secure system requires more than just a secure OS.

SELinux: Background

- Originated from NSA R&D.
- First public release by NSA in Dec 2000.
- Large and growing user and developer community.
- First packaged externally for Debian.
- Integrated into Hardened Gentoo.
- Integrated into mainline Linux 2.6 in Aug 2003.
- Included and enabled in Red Hat distributions.
  - Fedora Core 3, 4, and 5; Red Hat Enterprise Linux 4

Recent Advances in SELinux

- Improved integration with audit subsystem.
- Enhanced network packet labeling and control.
- Enhanced filesystem labeling support.
- Key management controls.
- Improved base policy.
- Loadable policy modules.
- Policy management infrastructure and tools.
- Improved and new policy development tools.

Improved Audit Integration

- Extended syscall audit records with security contexts.
- Enabled filtering based on security contexts.
- Added auditing of SELinux specific events.
- Enabled audit of netlink capability checks.
- Some parts included in Linux 2.6.17, further support added for 2.6.18.

Network Labeling: IPSEC/xfrm

- Implicit packet labeling via IPSEC/xfrm.
- Security context stored in xfrm policy rules and states.
- Authorize socket's use of policy based on context.
- Build SAs with context of policy.
- Included in Linux 2.6.16.
- TCP SO_PEERSEC support, UDP SCM_SECURITY support added in Linux 2.6.17.

Network Control: SECMARK

- Motivation: Existing SELinux network controls very limited in expressiveness and coverage.
- Solution: Separate labeling from enforcement.
  - Use iptables to select and label packets.
  - Use SELinux to enforce policy based on those labels.
- SECMARK and CONNSECMARK targets added.
- http://james-morris.livejournal.com/11010.html
- For 2.6.18.

Network Labeling: MLS enhancements

- Granular IPSEC associations
  - Allow a single xfrm poilcy rule to cover a MLS range.
  - Instantiate individual SAs for individual levels within the range.
- Flow labeling outside of socket context
  - Label based on origin when no socket involved (e.g. forward)
- Label socket IPSEC policy from socket.
- Label TCP child sockets from peer.
- In progress, see redhat-lspp and netdev lists.

Network Labeling: NetLabel

- Explicit packet labeling via IP option.
- Motivation: Compatibility with other trusted OSes.
  - Also avoids requiring use of iPSEC for labeling.
  - Also enables packet filtering based on the explicit labels.
- Presently limited to CIPSO, MLS labels.
- Code and info at http://free.linux.hp.com/~pmoore/projects/linux_cipso/

Filesystem Labeling

- Jffs2 xattr support (for 2.6.18)
- Improvements to mount context options (for 2.6.18)
- Atomic labeling of new files (2.6.14)
- VFS fallback for security xattrs (2.6.14)
- Canonicalization of getxattr results (2.6.15)

Key Management Controls

- Added security labeling of keys upon creation.
- Added basic permission checks on key operations.
- Added keycreate support to specify key labels.
- Randomized key serial number generation.
- Filtered /proc/keys output.
- For 2.6.18.

Reference Policy

- Improved base policy for SELinux, replaces old example policy.
- Strong modularity with explicit interfaces.
- Inline documentation.
- Ability to build policy variants from single source base.
- Deployed as the base policy in Fedora Core 5.
- http://oss.tresys.com

Loadable Policy Modules

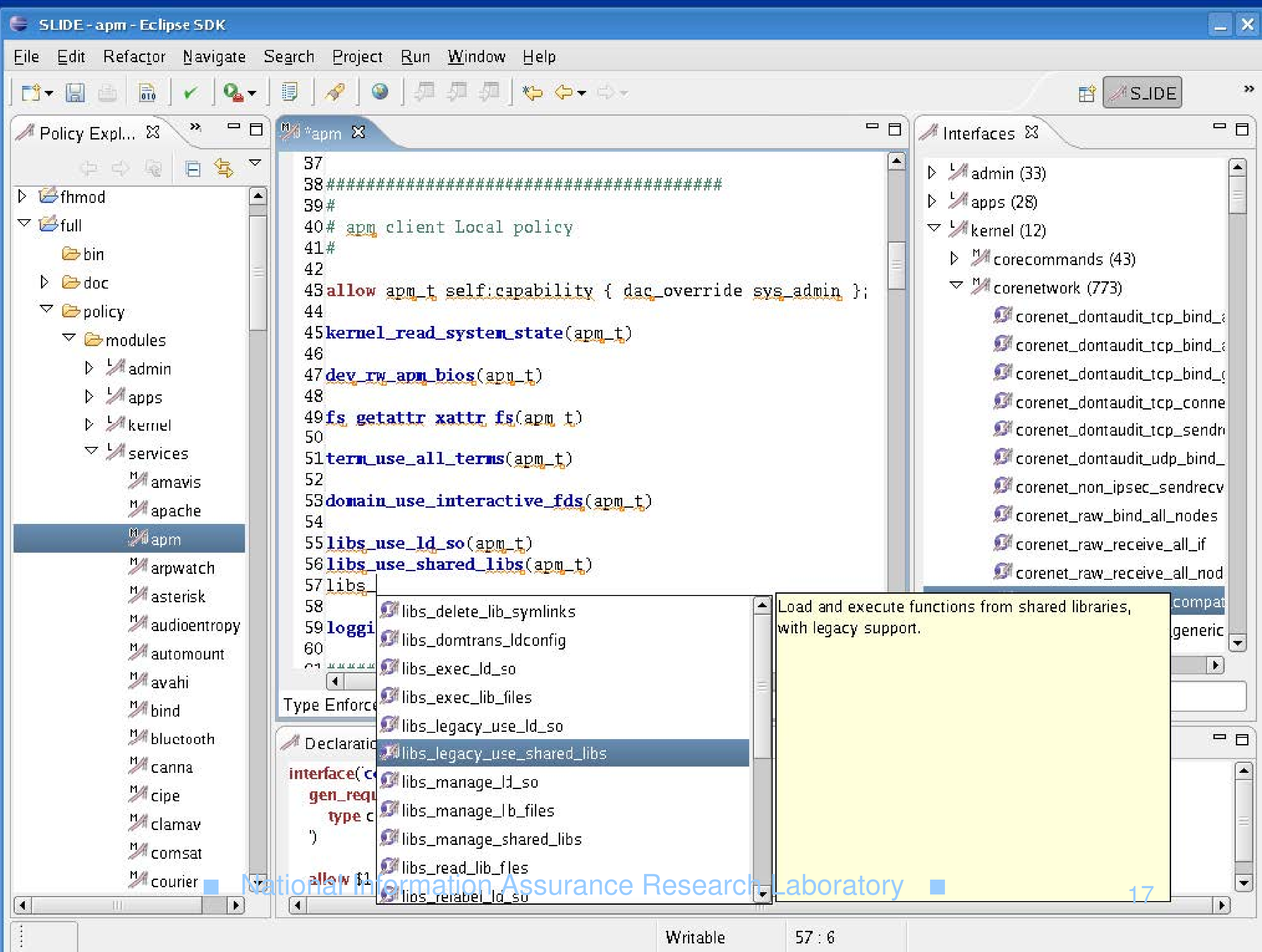
- Ability to build and package policy modules separately.
- Avoids need for policy sources for local customizations.
- Enables third party policy and decomposition of distro policy.
- Initially deployed in Fedora Core 5.
- Ongoing work to migrate policy into individual packages for Fedora Core 6.

Policy Management

- Standard library for applications to use to manipulate policy (libsemanage).
- Designed to support multiple back-ends transparently.
  - Initial support for direct manipulation of policy store.
  - Work in progress for policy management server daemon.
- Used by policy management tools.
  - Semodule, semanage, setsebool

Policy Development Tools

- SLIDE, http://oss.tresys.com
  - Integrated Development Environment for policy
  - Eclipse plugin, integrates with reference policy
- SEEdit, http://seedit.sourceforge.net
  - Policy editor with simplified policy language, GUI
- Polgen, http://www.mitre.org/tech/selinux
  - Policy generation tool based on pattern recognition
- SETools, http://www.tresys.com/selinux
  - Policy analysis tools



```
##########################################
#
# apm client Local policy
#

allow apm_t self:capability { dac_override sys_admin };

kernel_read_system_state(apm_t)

dev_rw_apm_bios(apm_t)

fs_getattr_xattr_fs(apm_t)

term_use_all_terms(apm_t)

domain_use_interactive_fds(apm_t)

libs_use_ld_so(apm_t)
libs_use_shared_libs(apm_t)
libs_

loggi
```

```
interface(`c
	gen_requ
		type c
	')

	allow $1
```

Load and execute functions from shared libraries, with legacy support.

Next Steps

- Securing the desktop
  - Reviving the XACE/XSELinux implementation, upstreaming it.
  - Labeled windowing.
  - Addressing other desktop infrastructure components.
  - Ensuring that user applications function properly in a secured environment.
- Improved useability
  - New troubleshooting tool
  - Continued improvements to policy tools

Next Steps (Cont)

- Policy Management
  - Completing the policy management server daemon and the libsemanage backend support.
  - Extending management to collections of SELinux hosts, including support for local variations and policy splitting.
  - Reconciling differences in policies between SELinux systems.
- Improvements to policy modules
  - Language support for interfaces
  - Integration with package management

Next Steps (Cont)

- Integration with SE-Xen
    - Flask architecture in Xen hypervisor.
    - Support for Xen object managers, like XenStore.
    - Policy management for Xen policy (shared toolchain).
    - Coordination with guest policies.
- NFS integration
    - Extending NFSv4 to support process and file security attributes.
    - Ensuring correct enforcement on client and server.

Credits

- HP (audit, MLS, NetLabel)
- IBM (audit, MLS, IPSEC labeling)
- MITRE (Polgen)
- NEC (SMP scalability, jffs2 xattr, embedded)
- Red Hat (audit, fs labeling, SECMARK, semanage)
- Tresys Technology (refpolicy, modules, semanage, policy server, SLIDE, SETools)
- Trusted Computer Solutions (audit, MLS, IPSEC labeling)
- And the entire SELinux community...

Resources

- SELinux News http://selinuxnews.org
- Sourceforge project http://selinux.sourceforge.net
- SELinux Symposium http://selinux-symposium.org
- NSA SELinux site http://www.nsa.gov/selinux
- Tresys Technology site http://oss.tresys.com

End of Presentation