Moving FLASK to BSD Systems
SELinux Symposium 2006

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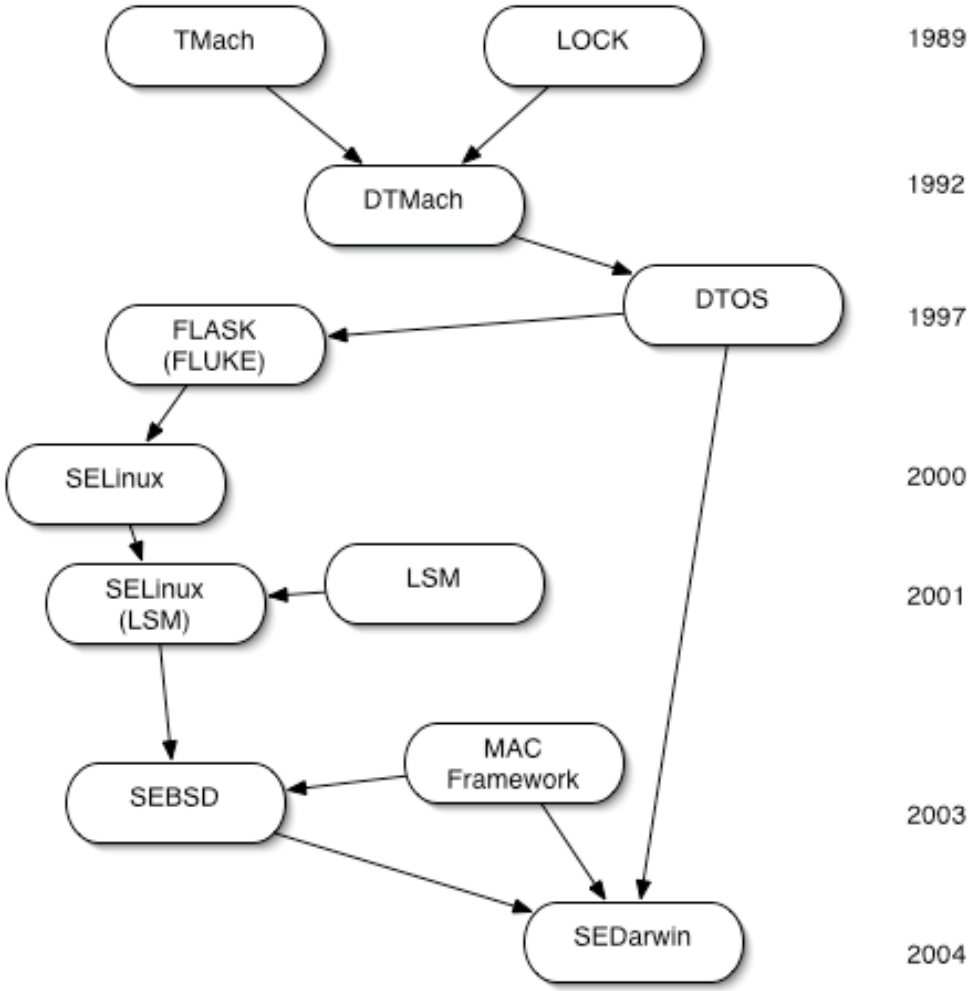
Overview

- **Security Frameworks**
- **A Brief History**
- **SELinux Inspired…**
  - Security Enhanced BSD
  - Security Enhanced Darwin

Security Frameworks

- **Traditional UNIX security isn't enough**
  - OS hardening
  - Mandatory protection
  - Flexible, manageable, scalable protection
- **Support required in the operating system for new security services**
  - Costs of locally maintaining security extensions are high
  - Framework offers extensibility so that policies may be enhanced without changing the base operating system
- **There does not appear to be one perfect security model or policy**
  - Sites may have different security/performance trade-offs
  - Sites may have special local requirements
  - Vendors unlikely to adopt a single policy
- **Bottom Line: Frameworks for Linux, FreeBSD, Darwin**

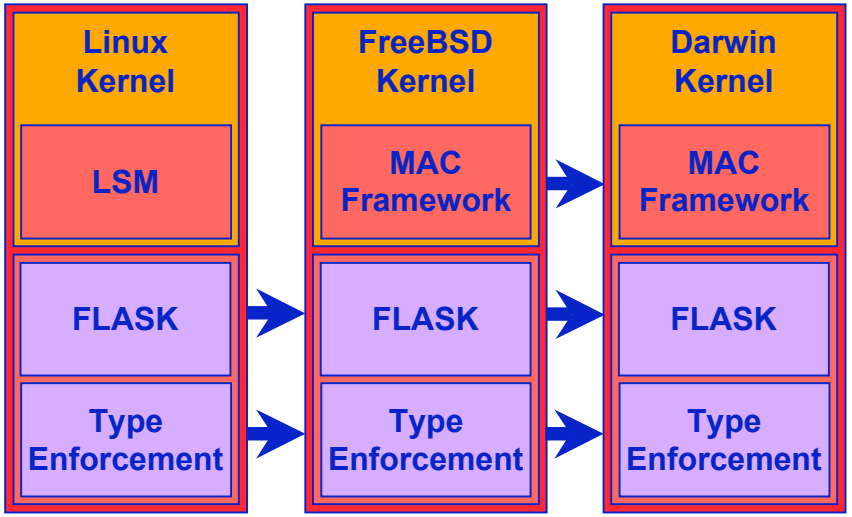
How We Got Here…



Focus and Reuse

- **Don't "reinvent" security**
  - Learn from the past
  - The research is often decades old
  - A good design is durable, doesn't require constant change
  - FLASK hasn't changed much recently, what's that mean?
- **Leverage existing technology, focus on "new" issues**
  - Focus on improving operating system security
  - Spend the time to get Frameworks correct
  - Work with vendor for acceptance
  - Develop rule sets that work
  - Develop effective tools to manage policy
- **Do innovate**
  - Don't stop thinking!
  - Don't squash new ideas
  - Re-factor old ideas

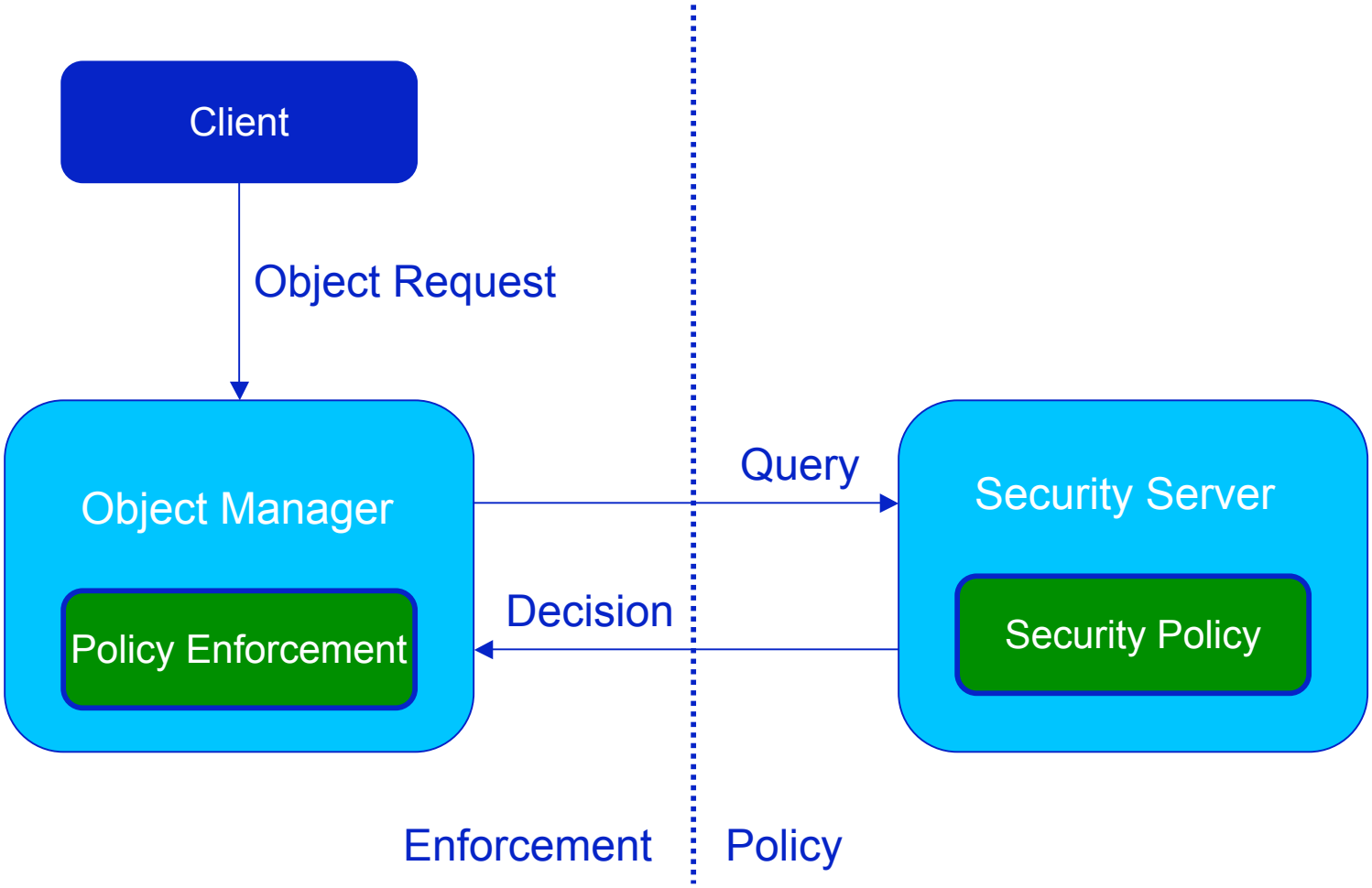
Strategy



- Use MAC Framework to isolate policy from enforcement
- Build on Darwin's source code and structural similarities to FreeBSD
- Port MAC Framework from FreeBSD
- Port FLASK components from SELinux
- Expand scope for Darwin-specific functionality (Mach IPC)
- Minimize Vendor diffs (OS & SELinux)
- Leverage existing policy & tools

Strong, useful security without sacrificing features, performance, or utility.

FLASK Architecture



FreeBSD and Mac OS X

- **Two related operating systems**
  - FreeBSD - Server-class network operating system
    - » Appropriate for embedded devices, network appliances, storage appliances, web services, firewalls, etc.
    - » Already had FLASK components ported from SELinux
    - » Already has MAC Framework
  - Mac OS X - Workstation-class operating system
    - » Desktop environment, MS office suite, Adobe tools, etc.
    - » Provides application and GUI components necessary for widespread adoption
- **Open Source availability (Darwin)**
- **Shared BSD code heritage (user space and kernel)**
- **Audit support**
- **We understood FreeBSD, Mac OS X was new to us!**

Mac OS X

- **Mac OS X is Apple's next generation operating system**
  - Builds on elements of Mach, NeXTStep, FreeBSD, and Mac OS 9, as well as other open source elements such as KDE
  - Continues Apple's tradition of user interface innovation
  - Potential for a larger user base (desktop users with application suites, programs people are familiar with)
- **Security**
  - UNIX security model as base
  - Mach Ports from NeXTStep for user space to represent privilege and capability
  - Rich application layer services: SecurityServer, SecurityFramework, SecurityAgent, CDSA crypto framework
  - Blend of Unix and Mach offers challenges
- **Mach IPC used extensively, must be considered**
  - Thousands of Mach messages per second!

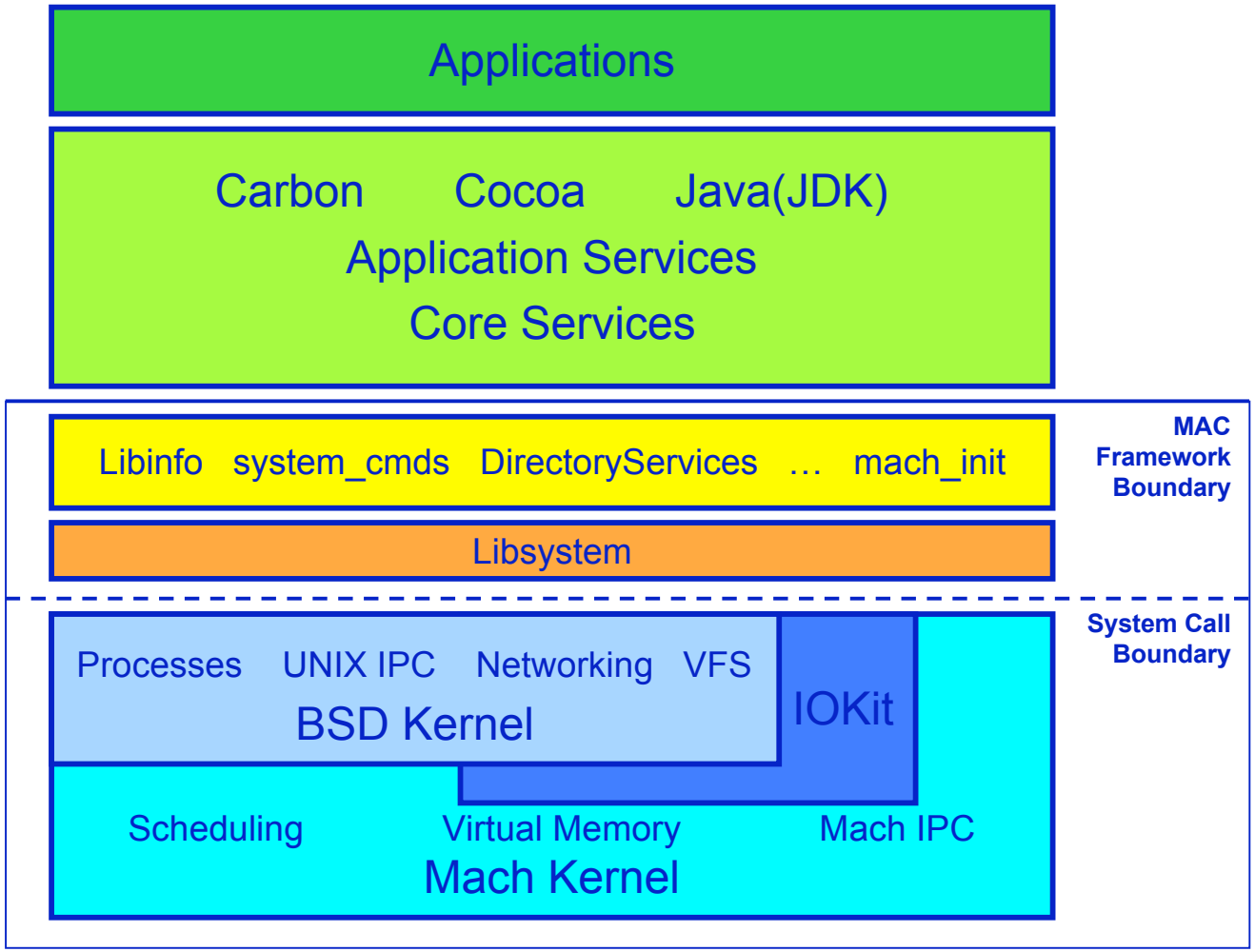
Mac OS X System Architecture

Applications

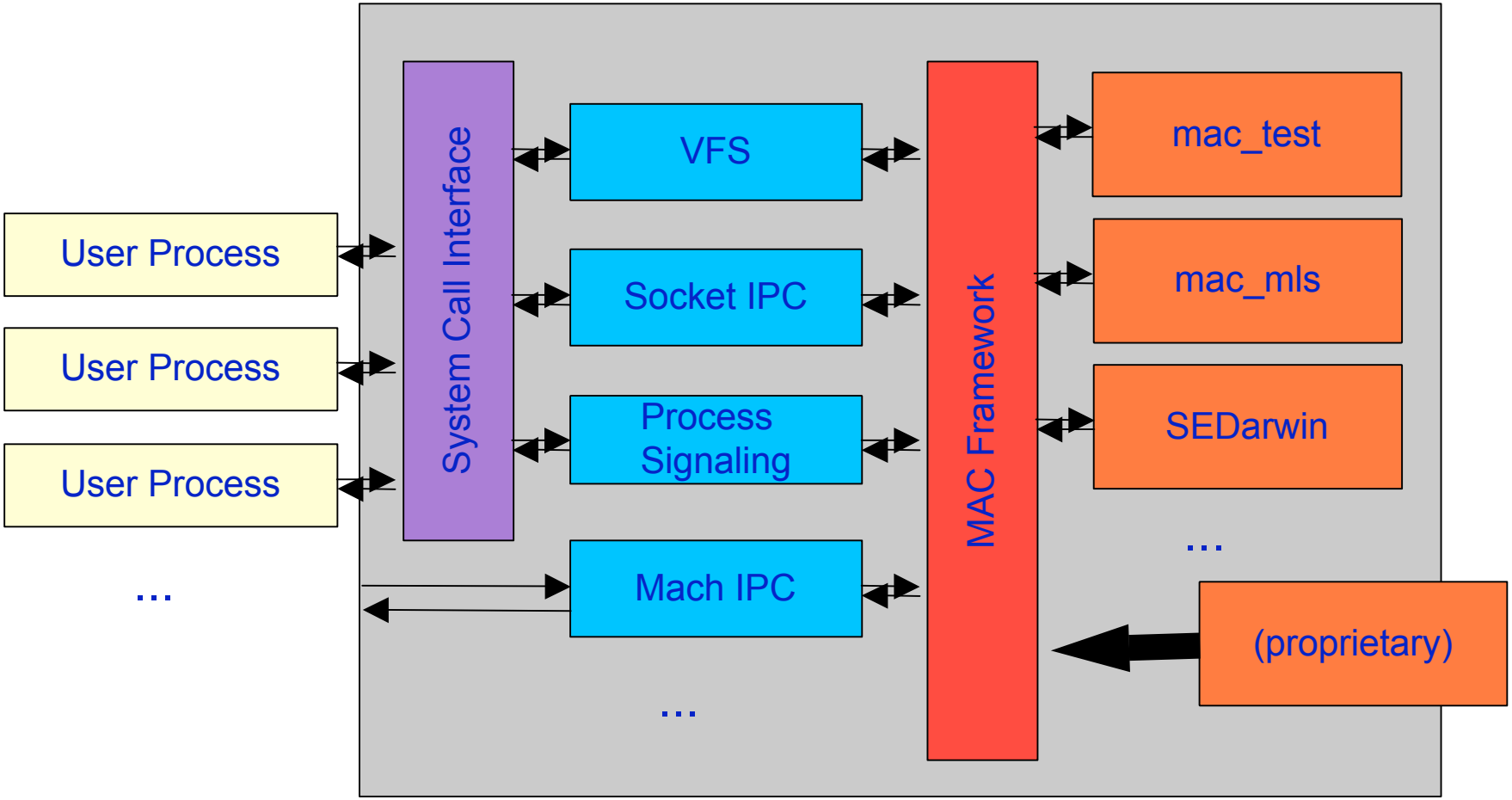
Closed source frameworks and daemons

Open source libraries and daemons

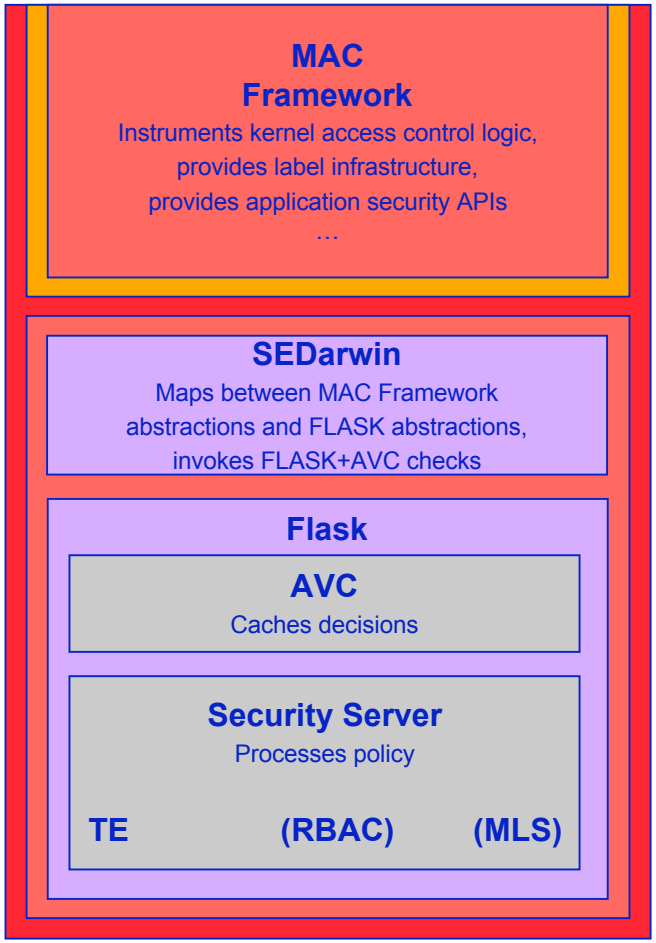
XNU Kernel



MAC Framework Big Picture



SEBSD/SEDarwin Policy Module



- **Policy module wraps FLASK and TE implementations**
  - FLASK provides access control abstractions
  - Access Control Vector Cache (AVC) caches policy decisions
  - TE/RBAC/MLS engine stores and implements file-backed policy
- **User space components from SELinux**
- **Kernel components ported easily**
  - “normal” issues with allocators, locking primitives, logging, printf, audit, etc.

LSM v. MAC Framework

- **Linux, FreeBSD, Darwin similar in operation, very different implementations**
- **Parallel in construction**
  - modular policies, registration based callbacks
- **Linux**
  - Widespread use
  - Requirements for vendor (Linus) adoption was critical
  - Lightweight Framework, less invasive
- **FreeBSD**
  - MAC Framework provides more label manipulation and management calls
  - Module composition from the start
  - Vendor buy-in allowed more significant changes
- **When SELinux moved from invasive kernel patches to an LSM module, we benefited**
- **Future focus is to avoid divergence**

Unique to Darwin

- **Rich (GUI) applications, desktop integration**
  - Provides motivation to use the system
  - Provides more challenges due to complexity
  - Inter-application messaging is ubiquitous
- **IOKit (another discussion entirely)**
- **Mach IPC**
  - Critical to secure
  - Performance/efficiency concerns
  - Didn’t have to start from scratch
  - Explore DTOS protections for Mach IPC

Darwin Complexity

- **Three separate system boundaries (IOKit, Mach, BSD) and each one must be adequately secured!**
- **Mach isn't implemented as a microkernel, there is a blending of the lines between BSD and Mach services**
  - BSD is in the kernel address space, not user
  - Threads and the scheduler are Mach constructs while processes are a BSD construct
  - Even worse, virtual memory is shared amongst all three kernel subsystems
- **History showed that the complexity of the Mach microkernel led from DTOS to FLASK**
  - Yet here were are trying to secure Mach IPC again…
  - It's no less complex than it was

FLASK Extensions to Support Mach Messaging

- **Add Support for Mach IPC**
  - send, make_send, copy_send, move_recv, hold_send, hold_recv, etc.
- **Binary policy format is unchanged**
- **Add name based checks / generic access checks**
  - Fine grained control for user space services
  - For security aware applications / servers
  - Mach messages are opaque in kernel
  - User space must do some mediation

Project Status

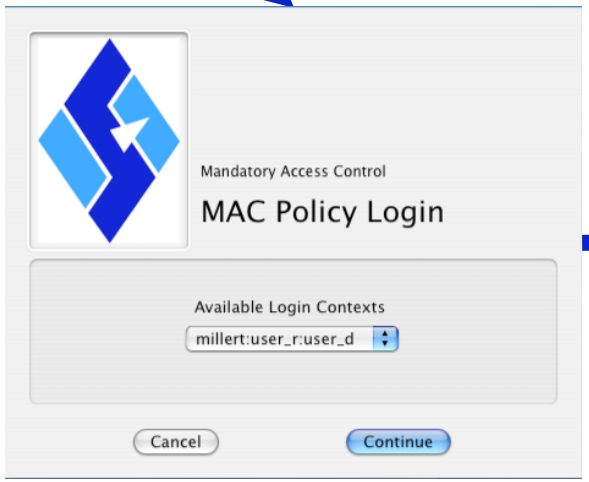
- SEBSD module for FreeBSD 5.1 and up
- SEDarwin module for Mac OS X “Panther” (10.3.8)
- Simple sample policy for Mac OS X
- BSD coverage is fairly complete for both
- Support for Network protections undeveloped
- Mach subsystem coverage is still experimental

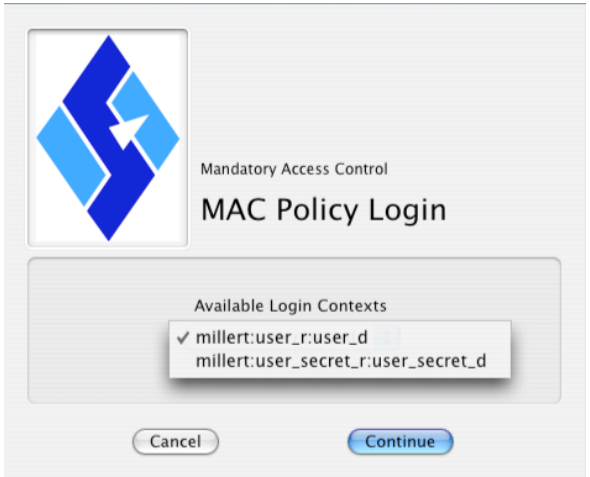
Future Directions

- MAC Framework is supported on Mac OS X “Tiger” (10.4.5) but SEDarwin isn’t yet
- More complete support for Mach IPC
- Update FLASK components to current version
- Implement network access controls (Framework already does)
- Develop new policy/rules
- OpenDarwin integration

Login

Mac OS X
Todd Miller's Computer
Name: millert
Password:
Sleep
Restart
Shut Down
Log In


Mandatory Access Control
MAC Policy Login
Available Login Contexts
millert:user_r:user_d
Cancel
Continue


Mandatory Access Control
MAC Policy Login
Available Login Contexts
millert:user_r:user_d
millert:user_secret_r:user_secret_d
Cancel
Continue

SEDarwin: For More Information

- **Email:**
  - <Christopher.Vance at SPARTA.com>
  - TrustedBSD Mailing lists
    http://lists.freebsd.org/mailman/listinfo/trustedbsd-discuss
- **Web:**
  - http://sedarwin.org/
  - http://trustedbsd.org/

End.

Learning From History

- **You learn each step of the way**
  - Domain and Type Enforcement (DTE) on BSD/OS
  - Wrappers (System call interception)
  - Linux Security Modules
  - Security Enhanced Linux
  - TrustedBSD MAC Framework on FreeBSD
  - Security-Enhanced BSD
  - BSM-based Audit on Mac OS X (CAPP/EAL3)
  - TrustedBSD MAC Framework on Darwin
  - Mac OS X DCID 6/3 system
  - Security Enhanced Darwin
- **What's Next?**