Extensible Security For X: Motivation and Design

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Summary

- Working towards an open source, trusted desktop.
- Need to have infrastructure for doing fine-grained access control in the X server.
- Hooks only – no specific policies.
- Local to server – no protocol changes.
- Branch development model.

What Is SELinux?

- Fine-grained Mandatory Access Control for Linux.
- Policy system based on Flask architecture.
  - Strong separation of security domains and roles.
  - Controls over process execution & resource access.
  - Diminish severity of program vulnerabilities.
- Kernel module; uses LSM security hooks.
- Some userspace changes.

SELinux Timeline

1985	LOCK (early Type Enforcement)
1990	
	DTMach / DTOS
1995	
	Utah Fluke / Flask
1999	2.2 Linux Kernel (patch)
2000	
2001	2.4 Linux Kernel (patch)
2002	LSM
2003	2.6 Linux Kernel (mainline)
Present	

SELinux Precursors

- LOCK
  - Early type enforcement.
- Distributed Trusted Mach (DTMach)
- Distributed Trusted OS (DTOS)
  - Improved design and implementation in Mach.
- Flux Advanced Security Kernel (Flask)
  - Flexible MAC architecture in the Flux OS.

SELinux Distributions

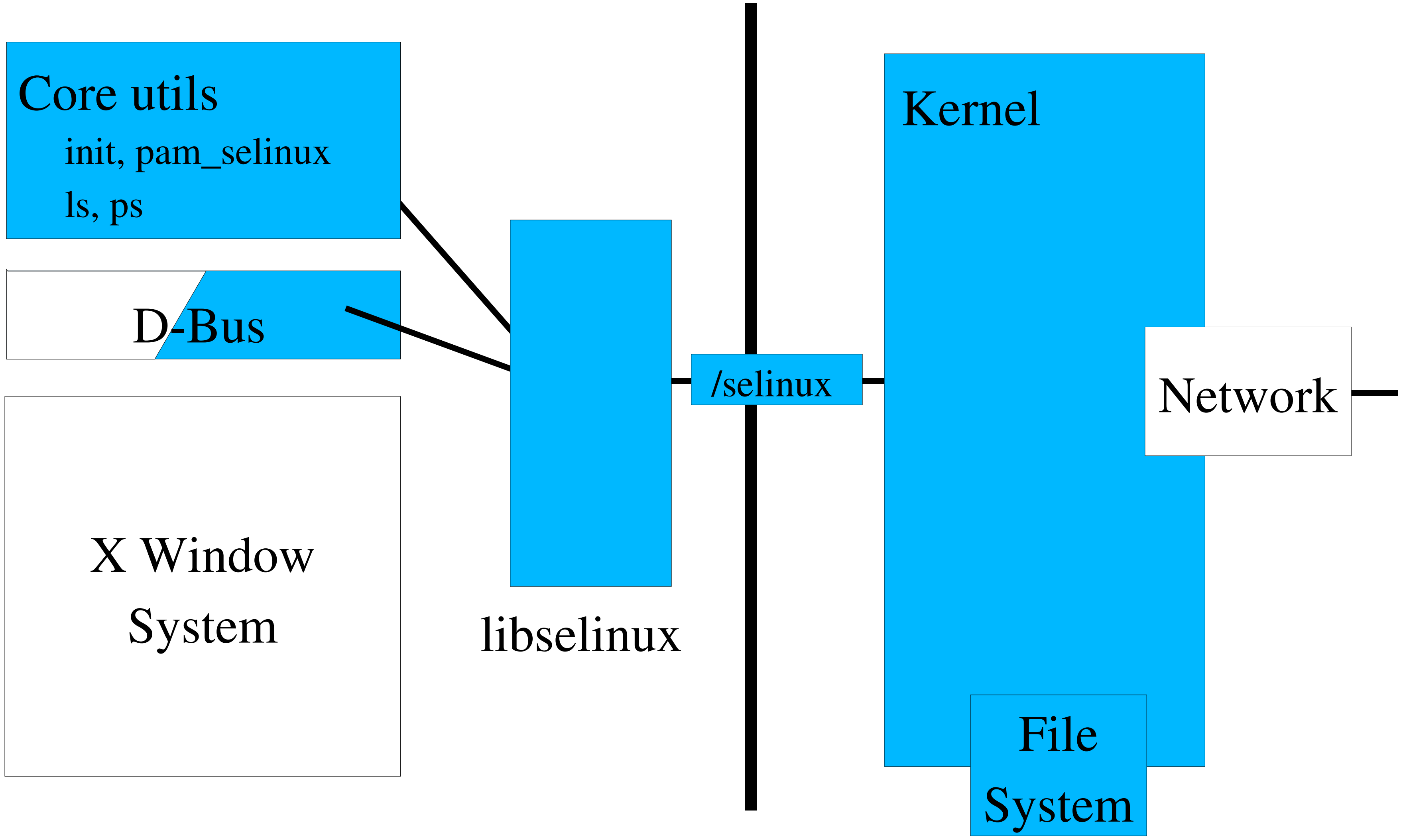
- Fedora Core 2
- Hardened Gentoo
- Debian (packages)
- SE-BSD (port)
- SE-Darwin (port)

SELinux Research Agenda

- Security architecture research
- Kernel prototype code
- Kernel production code
- Userspace enhancements

  → – Local GUI security
- Labeled networking
- Network-wide policy

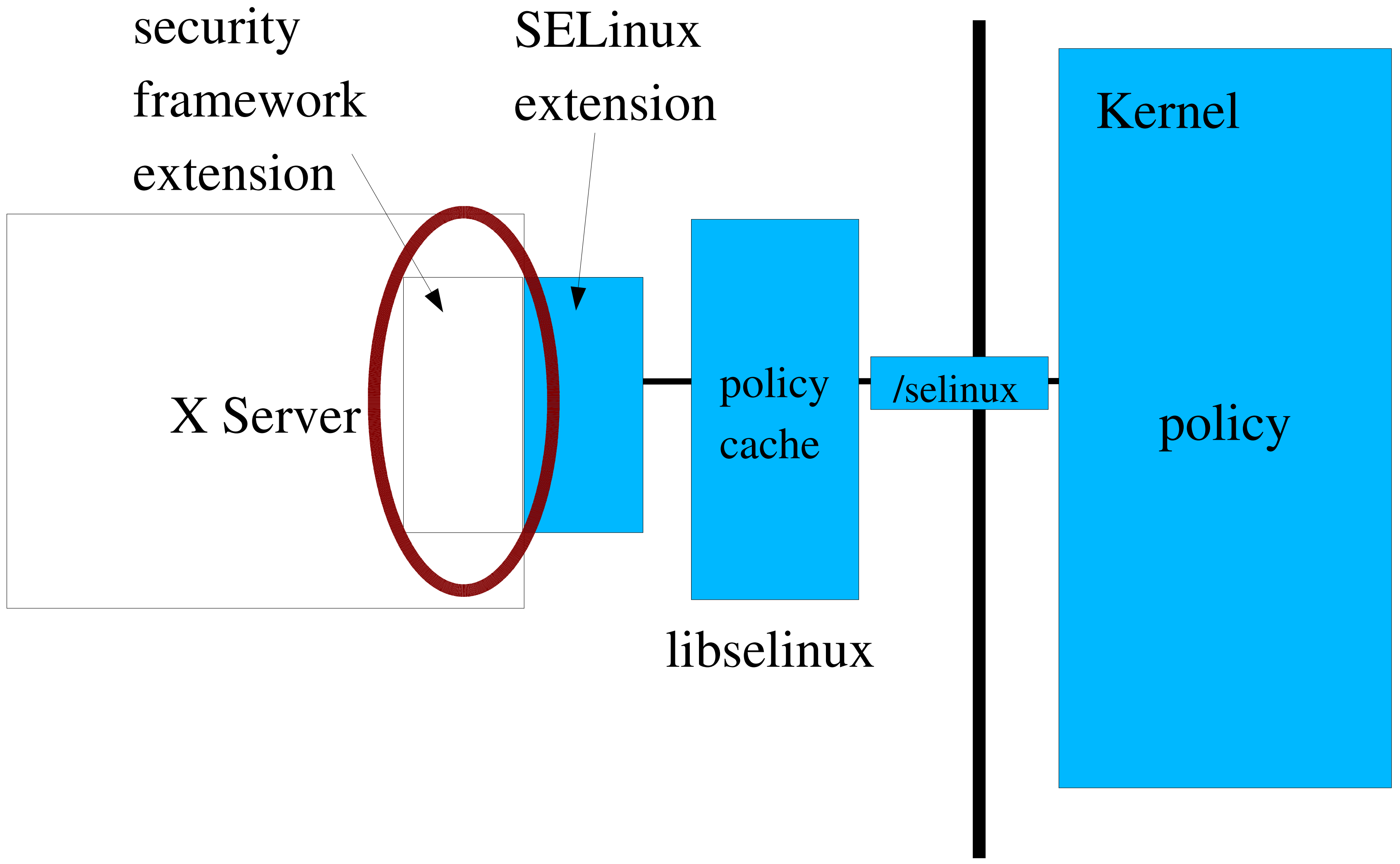
Current State of SELinux



GUI Security

- GUI security is the last piece of the complete SELinux desktop system.
- X Window System operations should be policy-controlled.
- Need to write policy for the X Window System and have the X server enforce it.
- Generalize: make it easy to write access control extensions for the X server.

SELinux/X architecture



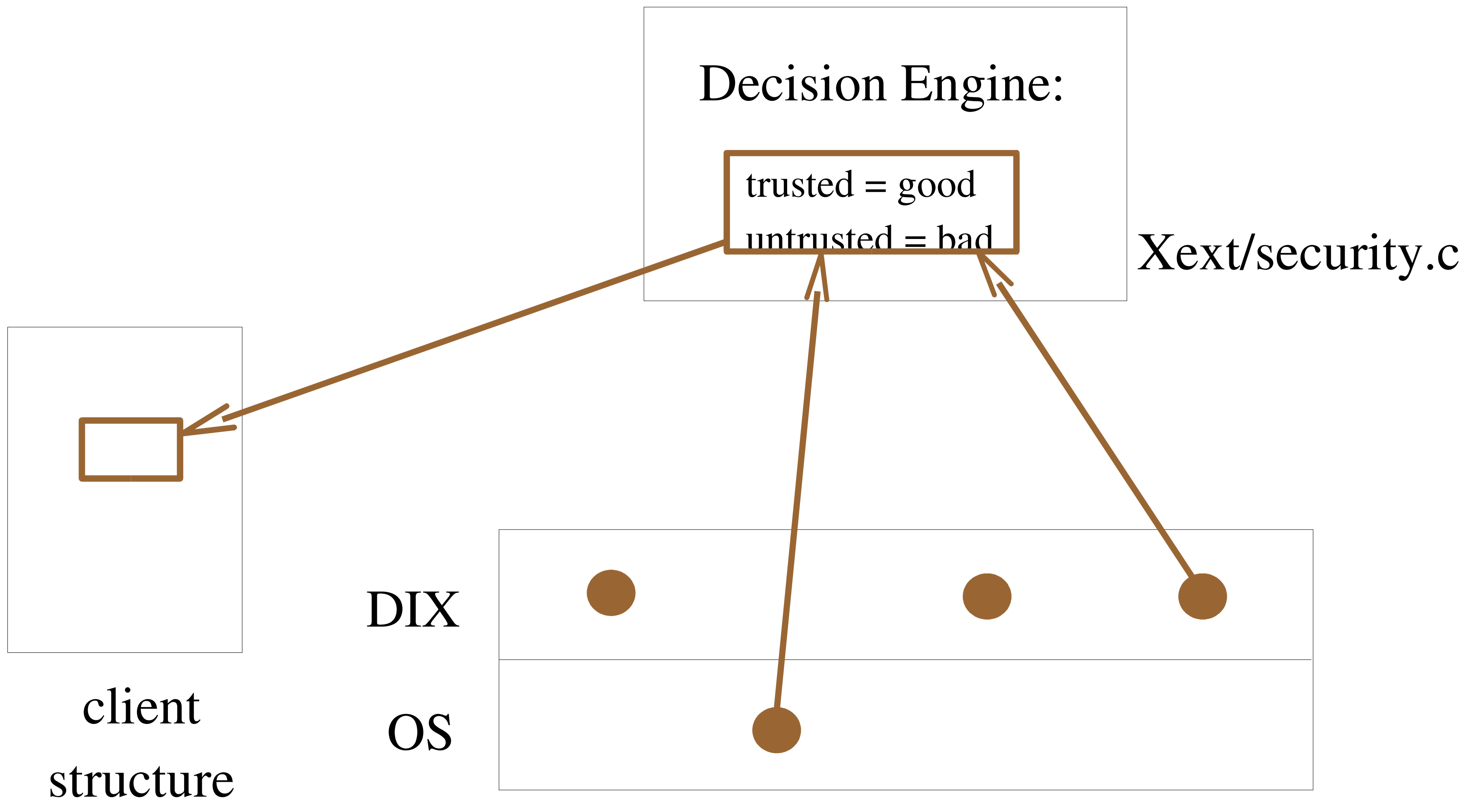
X Security and the Network

- SELinux is currently a local system.
- SELinux does not have labeled networking or network authentication.
- X Window System big problem is client authentication over the network.
- Local security engine, new auth solution can be independent; complementary.

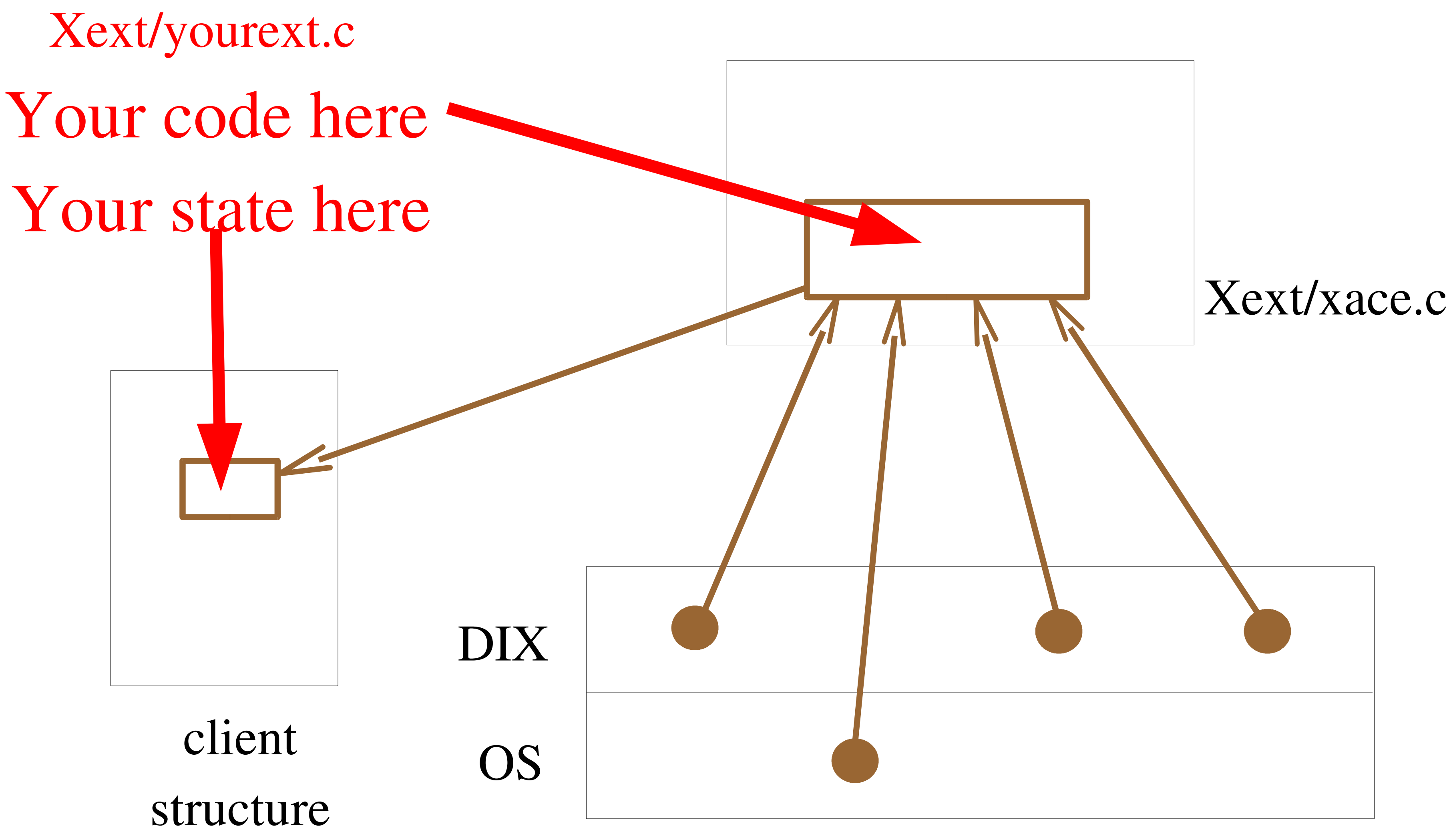
Goals for Security Framework

- Based on existing work.
- Easily extensible.
- Non-intrusive: based on callbacks, not local code.
- Works at dispatch (DIX) layer to avoid performance issues.
- Provides framework for arbitrary decision-making (access control) extensions.

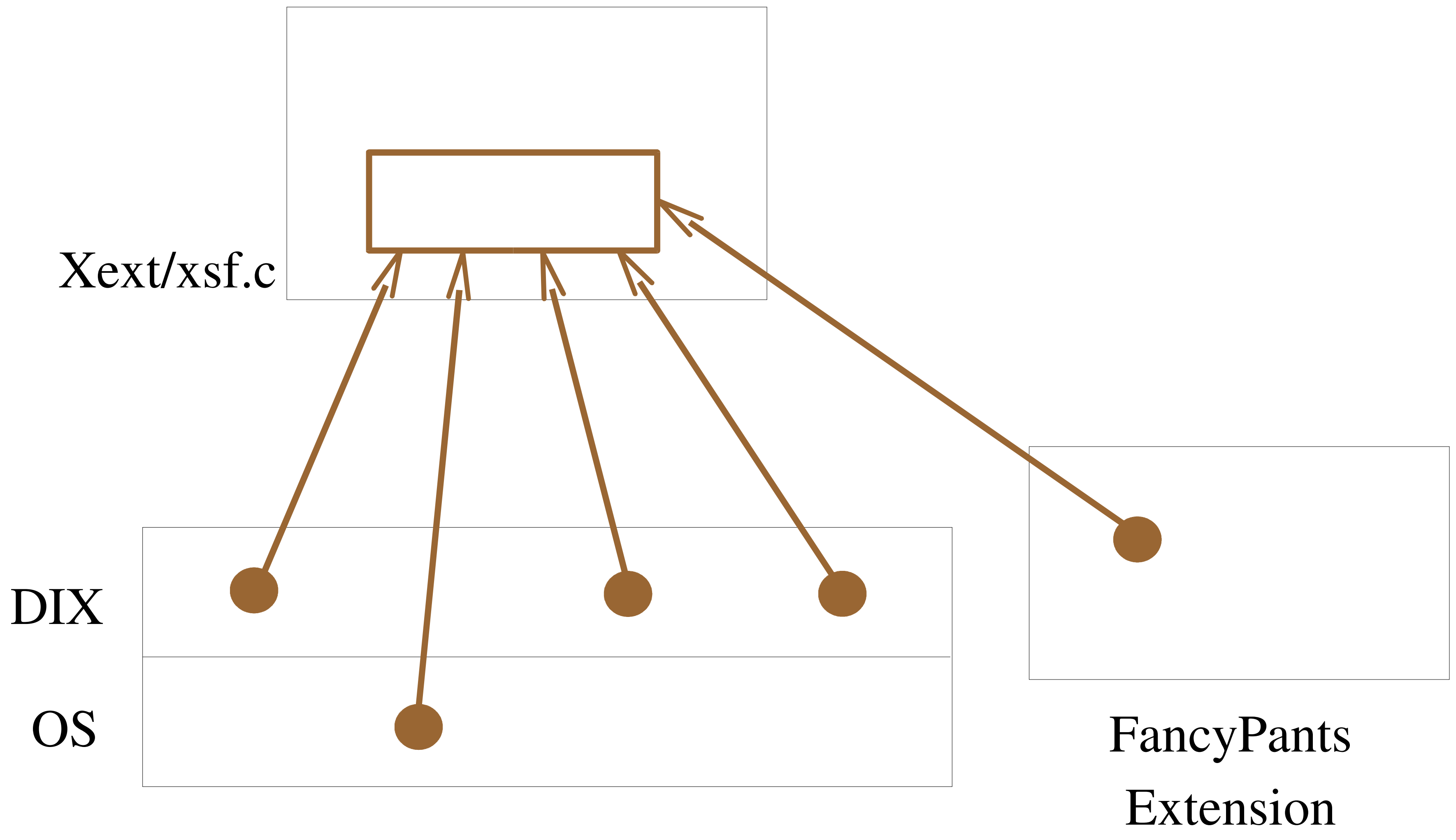
Current XC-Security Extension



Generalized Security Extension



Easily Extensible



Non-Intrusive

- At decision point, only need to pass parameters to a hook function and check the result.
- Actual security code is in the callback functions.
- Separates security code from the core code.
- Whole framework is compile-time option.

Code Examples

```
ProcDoSomething(...)
{
   rval = SecurityLookupIDByType
(client,
           MyResType, stuff->id,
           SecurityReadAccess);
   if (!rval) return BadSomething;
   DoNiftyStuff();
}
```

```
ProcDoSomething(...)
{
#ifdef XACE
   if (!SecurityHook
(XACE_FOO_ACCESS,
                 client, whatever))
      return BadSomething;
```

Sample Hooks

CORE_DISPATCH

EXT_DISPATCH

- Replace XC-Security shadow dispatcher.

RESOURCE_ACCESS

DEVICE_ACCESS

PROPERTY_ACCESS

- Replace SecurityCheck*Access() functions.

MAP_ACCESS

BACKGRND_ACCESS

- Replace untrusted child & background “None” checks.

Performance Issues

- Keep hooks at the DIX layer.
- O(1) hook calls per protocol request.
- Make decision before starting graphics operation.

Provides General Framework

- Arbitrary new extensions can be written to use the framework's interface.
  - Provide own state for server objects and own callback functions.
- No client-side work necessary (except for proper error handling).

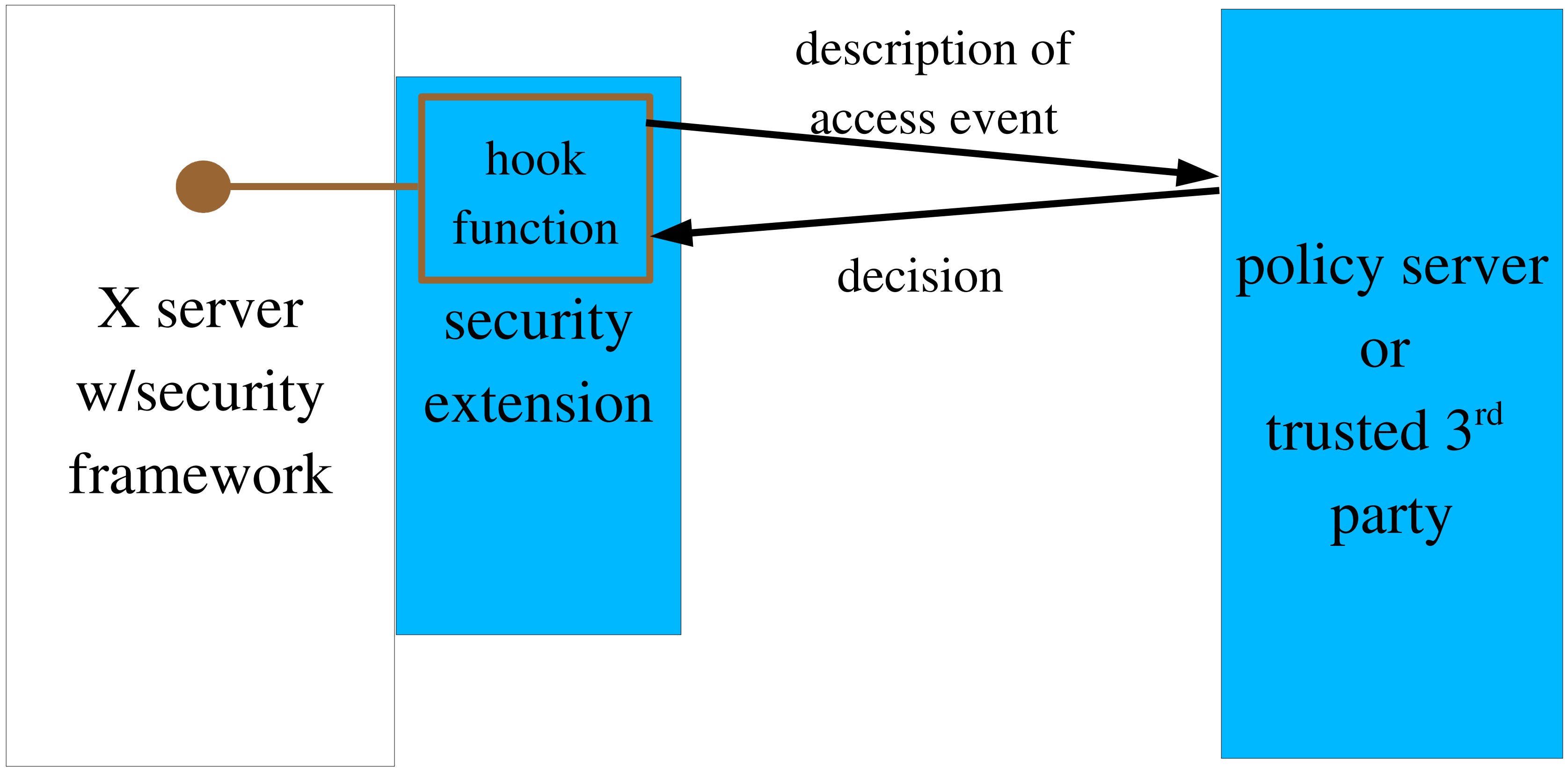
How to make Security Decisions?

- Need information about the connected client.
- Obtain once - store as client state.
- Can get:
  - From the local system.
  - From the system security policy.
  - From the authentication mechanism.

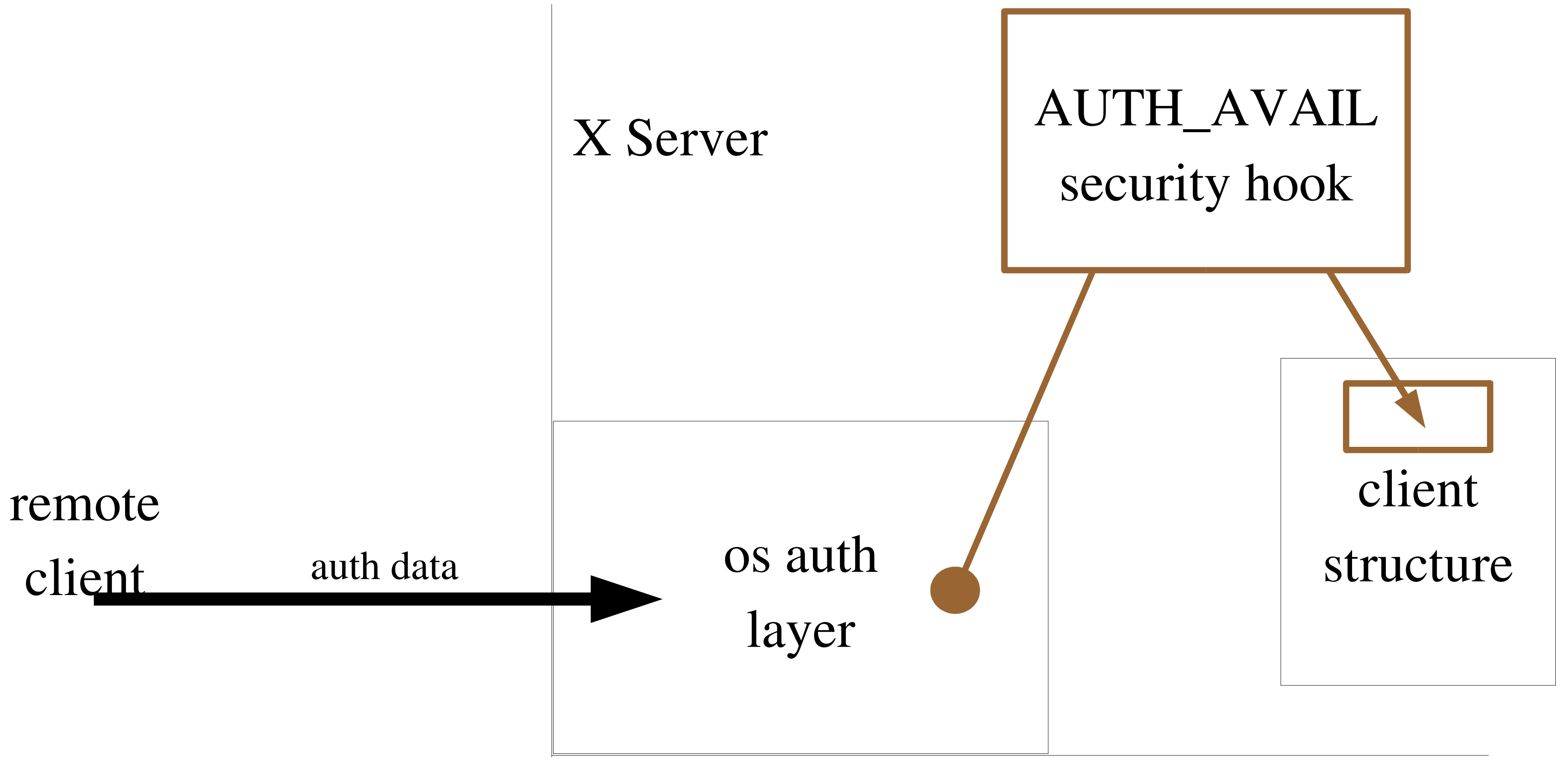
Local System

$$\begin{tikzcd}
& & & & \text{UID} & \\
& & & \text{getpeercred} \arrow[ur] \arrow[r] \arrow[dr] & \text{GID} & \\
\text{ClientPtr} \arrow[r, bend left] & \text{osPriv} \arrow[r, bend left] & \text{fd} \arrow[uur] \arrow[dr] & & \text{PID} \arrow[r] & \text{/proc} \\
& & & \text{getpeercon} \arrow[r] & \text{security context} &
\end{tikzcd}$$

Local Security Policy


description of access event
hook function
decision
X server w/security framework
security extension
policy server or trusted 3rd party

Authentication Protocol



Authentication Protocol, cont'd.

- Opportunity to combine power of the security framework with new, secure authentication methods.
- Design protocol, then write security extension to do fine-grained access control.
- At connect time, pass auth data to a security hook.
- Callbacks on that hook can set client state based on the auth data

Other Security Issues

- Trusted window labeling
  - Pass some String label to window manager on request.
  - Define a standard way to do this (new extension).
  - Or, use a Property on the window (that other clients can't mess with).

In Closing

- Flexible MAC on the open-source desktop is within reach.
- Generalized security engine, as described, will benefit SELinux project and others.
- Combine with better authentication for full solution.

Contact Information

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