A Formalisation of an Access Control Framework

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Access Control

Perhaps most known are

- Unix-style access control systems (root super-user, setuid mechanism)

```
> ls -ld . * */*
drwxr-xr-x 1 alice staff    32768  Apr  2 2010 .
-rw----r-- 1 alice students 31359  Jul 24 2011 manual.txt
-rwsr--r-x 1 bob   students 141359 Jun  1 2013 microedit
dr--r-xr-x 1 bob   staff    32768  Jul 23 2011 src
-rw-r--r-- 1 bob   staff    81359  Feb 28 2012 src/code.c
```

Access Control

More fine-grained access control is provided by

- SELinux
  (security enhanced Linux devloped by the NSA;
  mandatory access control system)

- Role-Compatibility Model
  (developed by Amon Ott;
  main application in the Apache server)

Operations in the OS

using Paulson's inductive method a **state of the system** is a **trace**, a list of events (system calls):

$$[e_1, \ldots, e_2]$$

$$
\begin{array}{lll}
e ::= \mathit{CreateFile}\ p\ f & \mid \mathit{ReadFile}\ p\ f & \mid \mathit{Send}\ p\ i \\
\mid \mathit{WriteFile}\ p\ f & \mid \mathit{Execute}\ p\ f & \mid \mathit{Recv}\ p\ i \\
\mid \mathit{DeleteFile}\ p\ f & \mid \mathit{Clone}\ p\ p' & \mid \mathit{CreateIPC}\ p\ i \\
\mid \mathit{ChangeOwner}\ p\ u & \mid \mathit{ChangeRole}\ p\ r & \mid \mathit{DeleteIPC}\ p\ i \\
\mid \mathit{Kill}\ p\ p' & &
\end{array}
$$

Valid Traces

we need to restrict the traces to **valid traces**:

$$\frac{}{\mathit{valid}\ [\,]} \qquad \frac{\mathit{valid}\ s \quad \mathit{admissible}\ s\ e \quad \mathit{granted}\ s\ e}{\mathit{valid}\ (e::s)}$$

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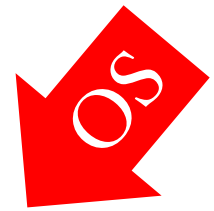

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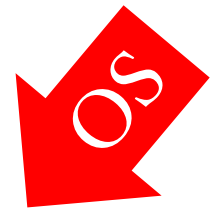

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$$\frac{p \in current\_procs\ s \qquad p' \notin current\_procs\ s}{admissible\ s\ (Clone\ p\ p')}$$

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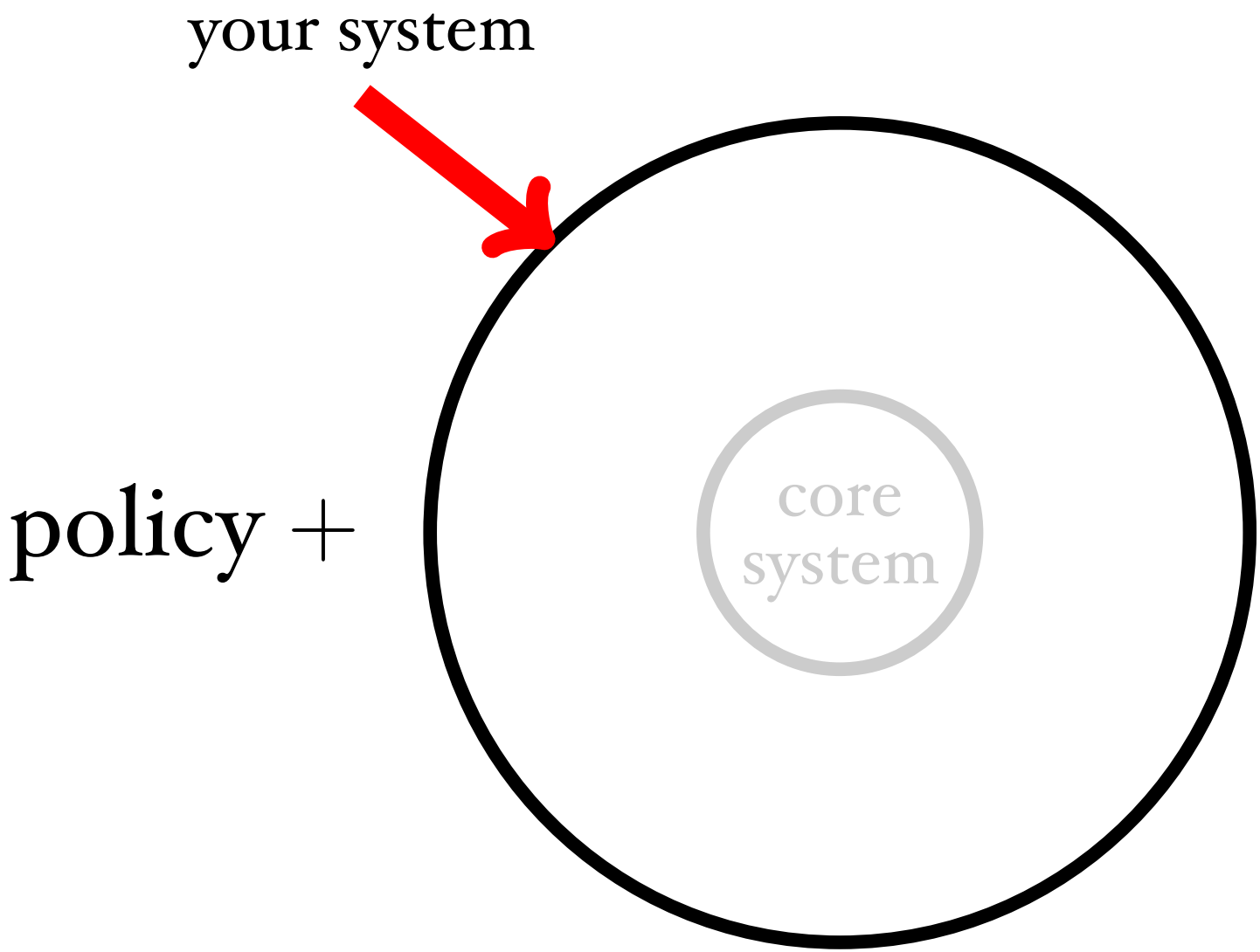
RC

$$\frac{is\_current\_role\ s\ p\ r \quad is\_file\_type\ s\ f\ t \quad (r,\ t,\ Execute) \in permissions}{granted\ s\ (Execute\ p\ f)}$$

Design of AC-Policies

"what you specify is what you get but not necessarily what you want..."

Testing Policies



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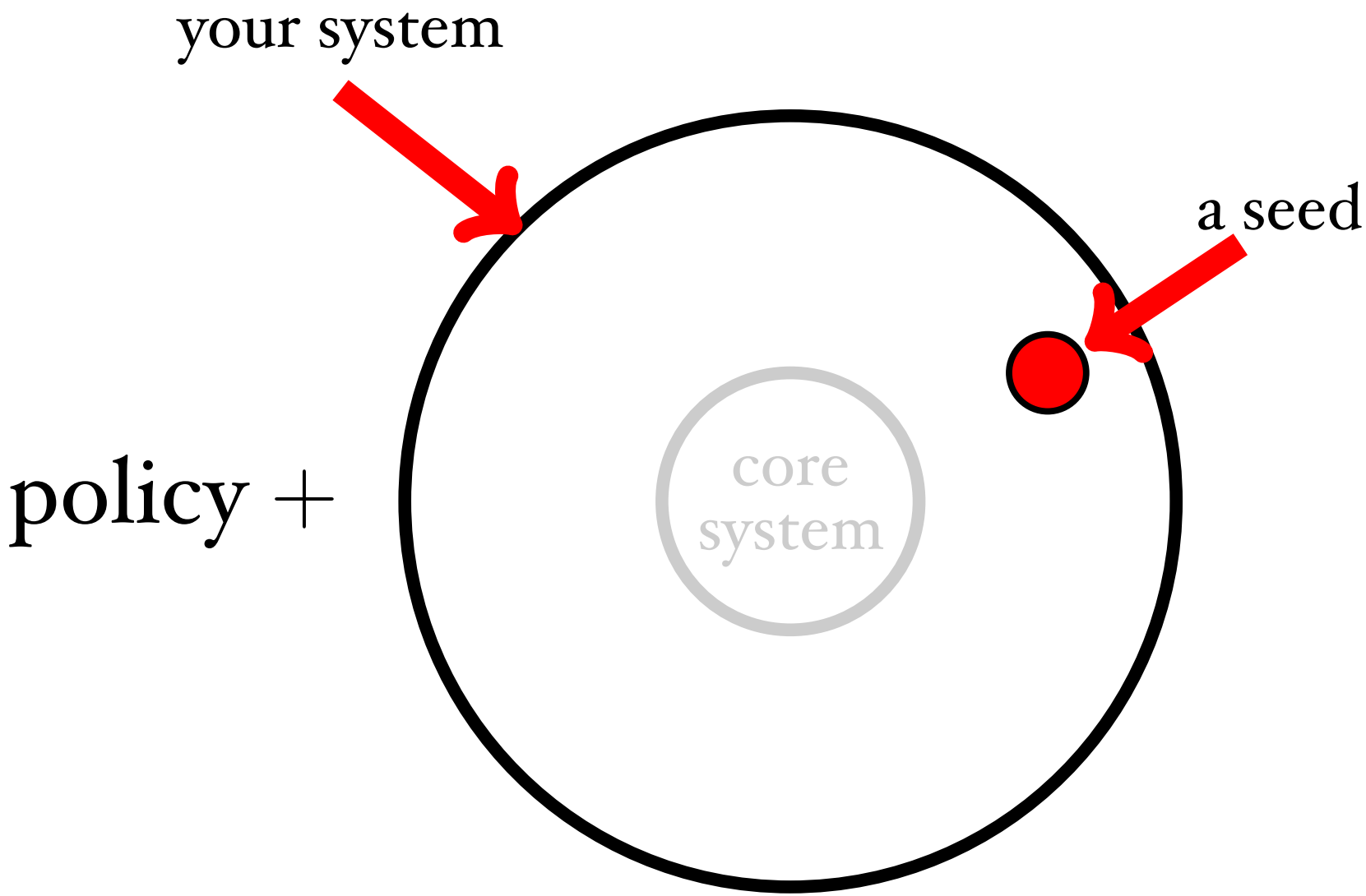

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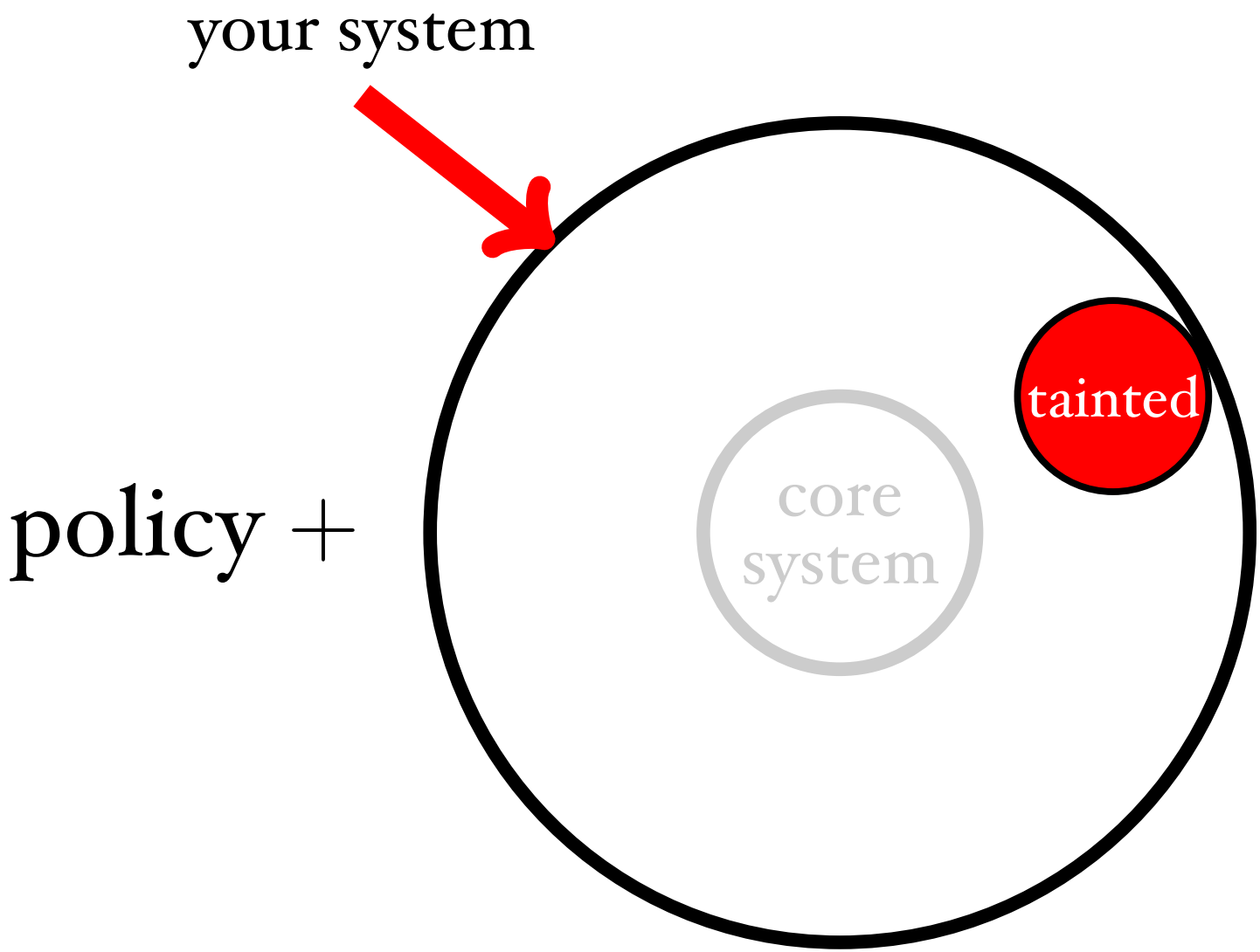

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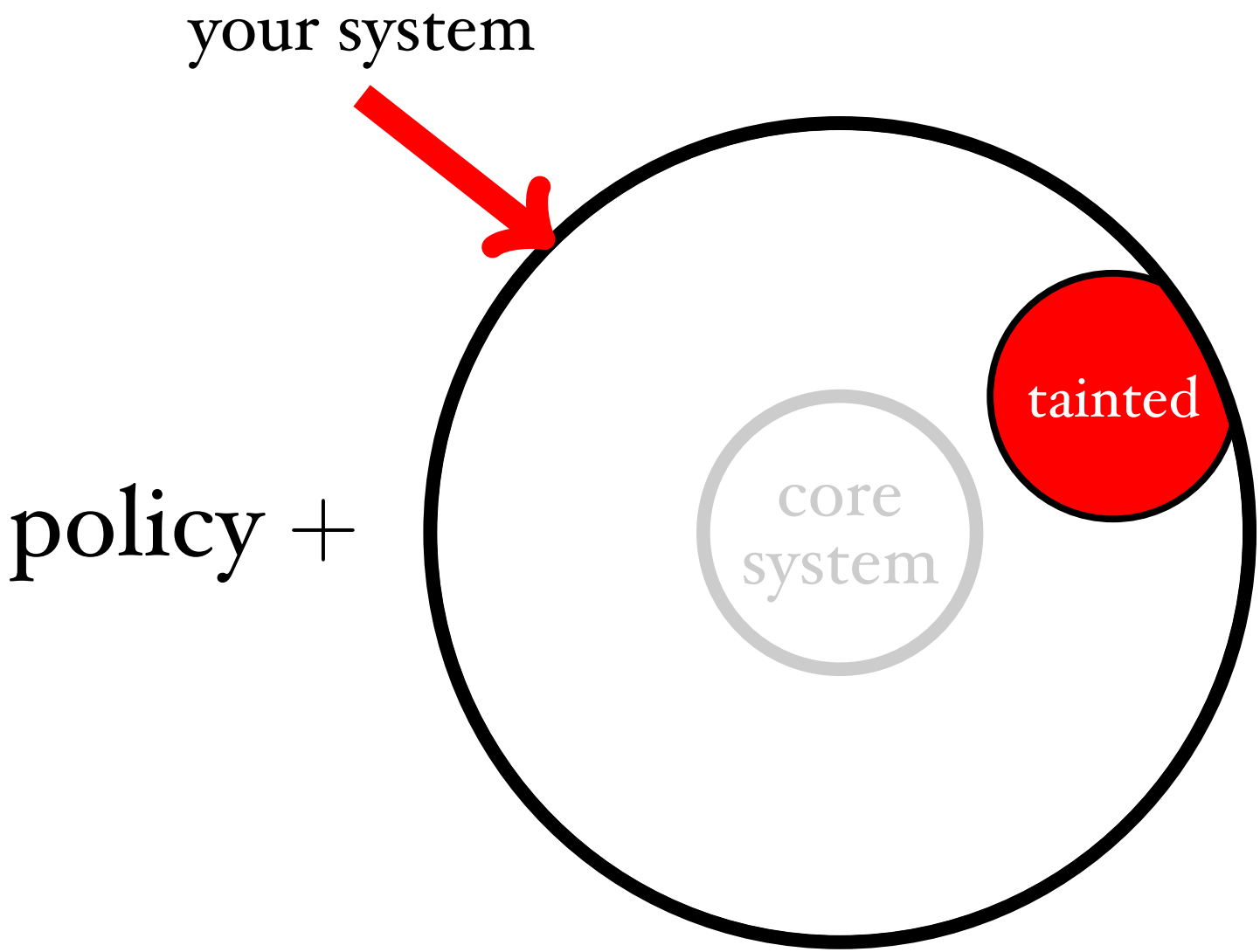

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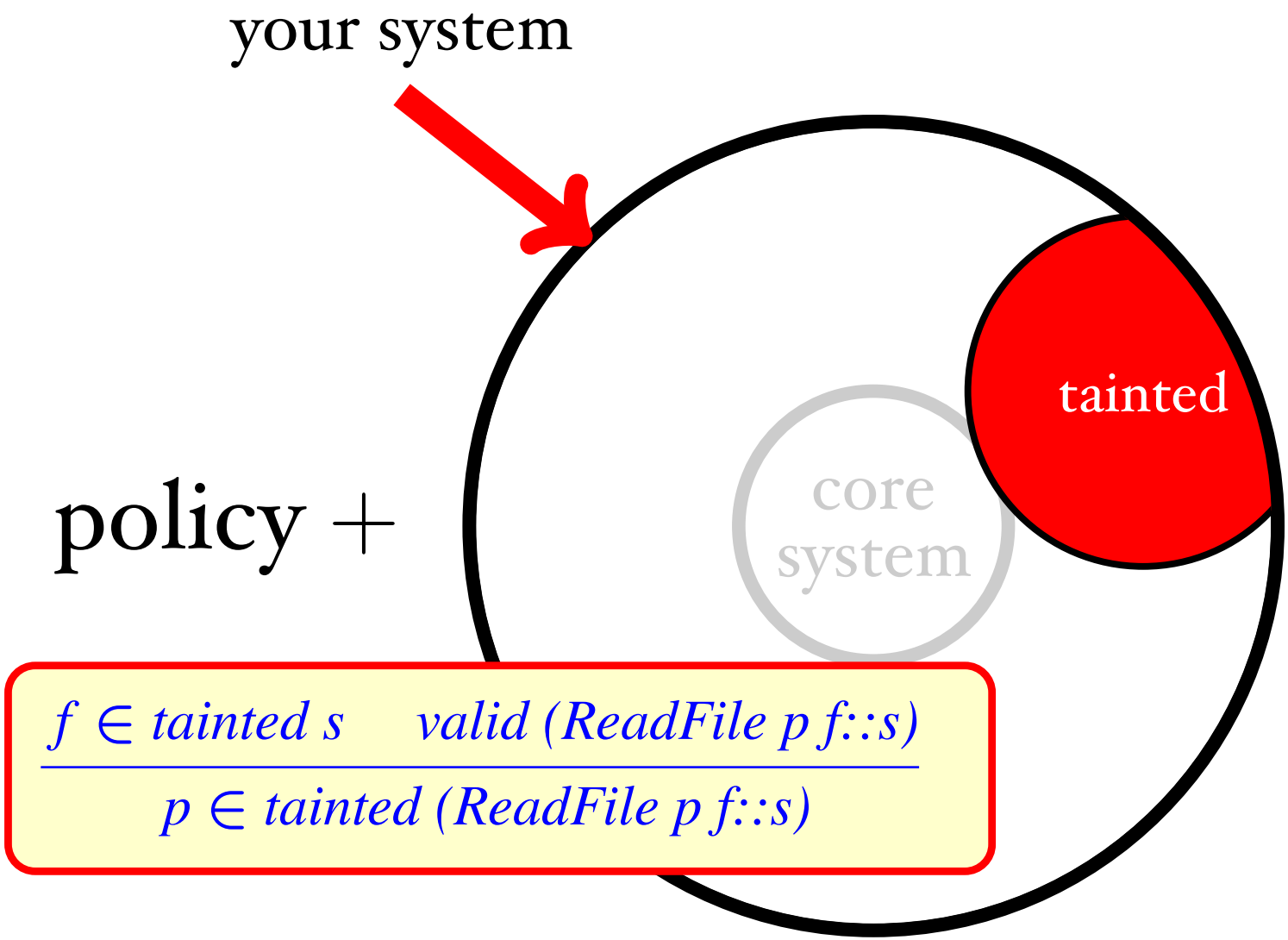

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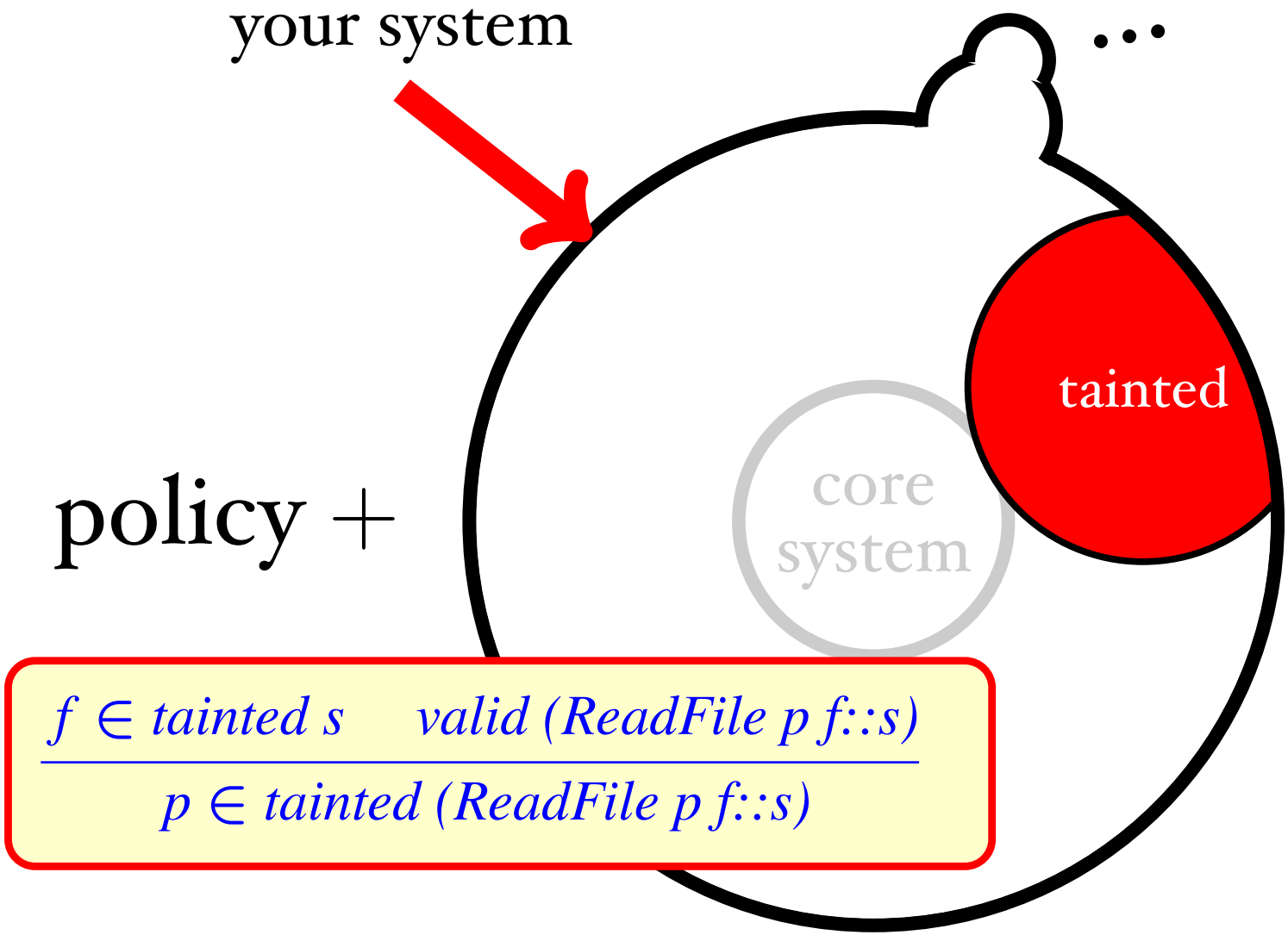

A Sound and Complete Test

- working purely in the *dynamic world* does not work – infinite state space
- working purely on *static* policies also does not work – because of over approximation
  - suppose a tainted file has type *bin* and
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  - but if there is no process with role *r* and it will never been created, then the file actually does not spread
- our solution: take a middle ground and record precisely the information of the initial state, but be less precise about every newly created object.

Results about our Test

- we can show that the objects (files, processes, ...) we need to consider are only finite (at some point it does not matter if we create another *bin*-file)

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Thm (Completeness)
If an object is taintable and *undeletable**, then our test will find out that it is taintable.

* an object is *undeleteable* if it exists in the initial state, but there exists no valid state in which it could have been deleted

Why the Restriction?

- assume a process with *ID* is tainted but gets killed by another process
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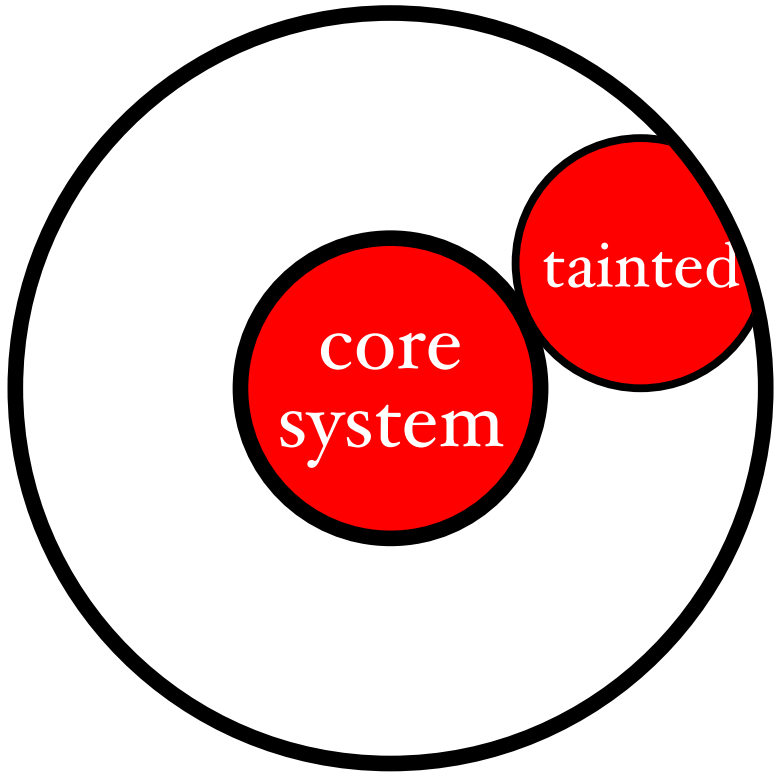
Is this a serious restriction? We think not ...

Core System

Admins usually ask whether their policy is strong enough to protect their core system?



core system files are typically undeletable

Conclusion

- we considered Role-Compatibility Model for the Apache Server

  13 events, 13 rules for OS admisibility, 14 rules for RC-granting, 10 rules for tainted

- we can scale this to SELinux

  more fine-grainded OS events (inodes, hard-links, shared memory, ...)

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- hard sell to Ott (who designed the RC-model)
- hard sell to the community working on access control (beyond *good science*)