A Component-Based Approach to Improving the Modularity of OSCAR

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Introduction

- Overview
- Motivation
- Component Architecture (OCA)
- Implementation
- Future Work
- Conclusion

What does OSCAR do?

- Wizard based cluster software installation
  - Operating system
  - Cluster environment
- Automatically configures cluster components
- Increases consistency among cluster builds
- Reduces time to build / install a cluster
- Reduces need for expertise

Overview

- Cluster installation and management toolkit
  - add/del cluster node
  - add/del cluster software
- Comprised of,
  - graphical wizard
  - libraries & scripts (glue/guts)
  - installation/validation tests
  - oscar packages
    - *core:* SIS, C3, Env-Switcher/Modules, ODA
    - *included:* PVM, Torque, LAM/MPI, ...
- OSCAR "users" get **all** of this! – good/bad?

OSCAR Score Sheet

Good/Bad depends on type of "user"

a) end-user

b) developer or "re-user"

Good

- Many Linux distributions
- Extensible Meta-Packages
  - Decouples applications from core infrastructure
  - Leveraged by "spin-offs"
    - HA-OSCAR, SSS-OSCAR, SSI-OSCAR

Bad

- Maintain/Add distributions
- Initial implementation had RPM bias
  - Meta-packages
  - Libraries/Scripts
- Modification to *core* infrastructure is too difficult

How bad is it?

- End-users
  - Ok, not concerned with *core* anyway
  - Bad, indirectly effected by slow release cycles
- Developers / Re-users
  - Ok, some restructuring for non-RPM
  - Ok, not <u>all</u> concerned with changing core
  - Bad, monolithic design slows innovation
  - Bad, tightly coupled core limits "spin-offs"

<u>Example</u>: Add a new Linux distribution

- Must touch several areas to make changes
- Testing is impacted because changes throughout

New Class of Users

- The "re-users" are major motivation for changes to the *core* infrastructure
  - A need to replace pieces of the system, as is done via extensible meta-package system
  - A need to allow alternate approaches to OSCAR
  - Alternate approaches based on many factors: technical, political or investigative

<u>Example</u>: Replace C3 tool with an alternate approach

- A new more scalable C3 (investigative/technical)
- A custom tool built "in house" (political/technical)
- A tool for a unique environment [no-TCP] (technical)

Prior Improvements

- Previous efforts addressed select areas
  - PackMan/DepMan
    - Native package manager abstraction
  - Database
    - Centralize access and revised data schema
  - Improve “config.xml”
    - Less RPM bias and modify for better XML validation

- Not address more fundamental problems
  - Monolithic design
  - Tightly coupled infrastructure (core)

Component Architecture

- OSCAR Component Architecture (OCA)
  - Effort to improve modularity within OSCAR
  - Based on component technology
  - Influenced by Open MPI component design*

- Modularity
  - Isolate functionality
  - Improve potential for reuse

- Customization
  - Adapt to new needs (static)

** Members of the Open MPI project are involved in OSCAR, so it was inevitable. :-)*

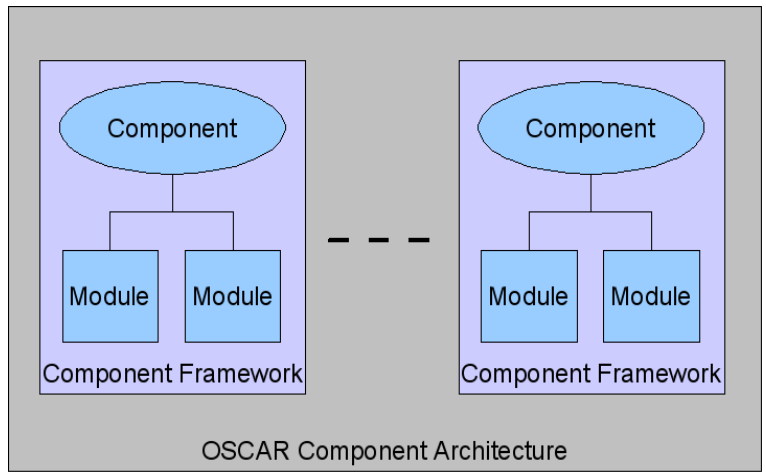
OCA Structure

Architecture

- Manage frameworks
- Provides basic support

Framework

- Manage a functional unit
- Liason for rest of system
- Defines the semantics/contract



Component

- General abstraction for a unit

Module

- Concrete implementation for a unit

Component/Module analogous to OOP class/object

OCA Advantages

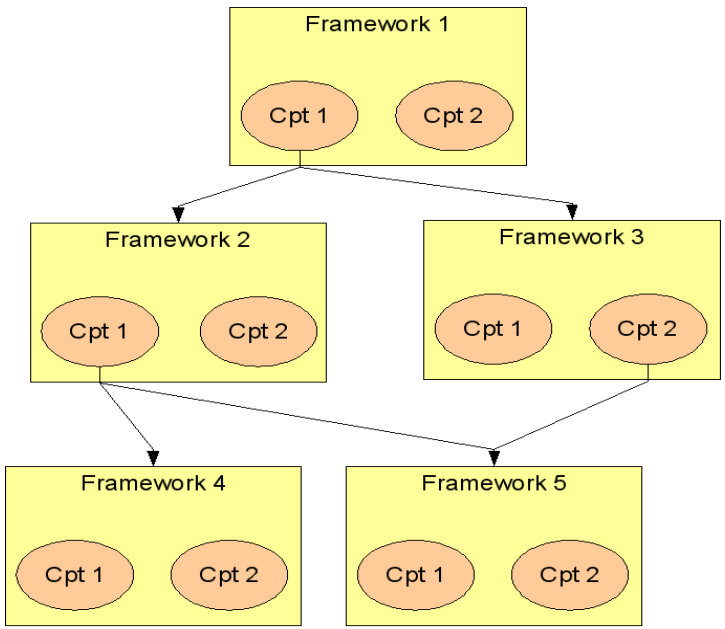
- Modularity
  - Begin breaking monolithic design into pieces, which helps reduce the tight coupling
- Organization / Structure
  - Developers know where to find/change things
- Extensibility
  - Add alternate approaches (components)
  - Add new approaches (frameworks)
- Reuse
  - The “spin-offs” can better customize without having to effectively fork for their needs

Interfaces

- Interfaces
  - The heart of a component-based system
  - Define the contracts, which govern usage
- Framework Interfaces
  - Expose high-level generic access to users
  - Encode the policy
    - selection patterns: *one-of-many* / *many-of-many*
  - Ex: open(), execute()
- Component Interfaces
  - Provide a standard for (internal) framework interactions
  - Hides the appliability logic behind interface
    - component determines if suitable for use by framework

Framework Hierarchies

- Frameworks are associated with a specific task
  - The underlying components actually do the work
- Frameworks can be linked together to perform more complex tasks
- Increased level of abstraction



Implementation

- Written in Perl and organized as as a collection of modules
- Frameworks create a module and directory to house components
- Components determine applicability and if so they successfully “open”

```
$OSCAR_HOME/lib/OSCAR/
                      |
                      |--> Debugger.pm
                      |--> OCA.pm
                      |--> OCA/
                             |--> Framework1.pm
                             |--> Framework1/
                             |      |--> Component1.pm
                             |      |-->     ...
                             |      |--> Component{N}.pm
                             |
                             |-->     ...
                             |
                             |--> Framework{N}.pm
                             |--> Framework{N}/
                                    |--> Component1.pm
                                    |-->     ...
                                    |--> Component{N}.pm
```

Basic Usage

1. User "opens" a Framework.
   Framework open()
   → Component1 open()
   → Component2 open()
   ...
   → Component*N* open()

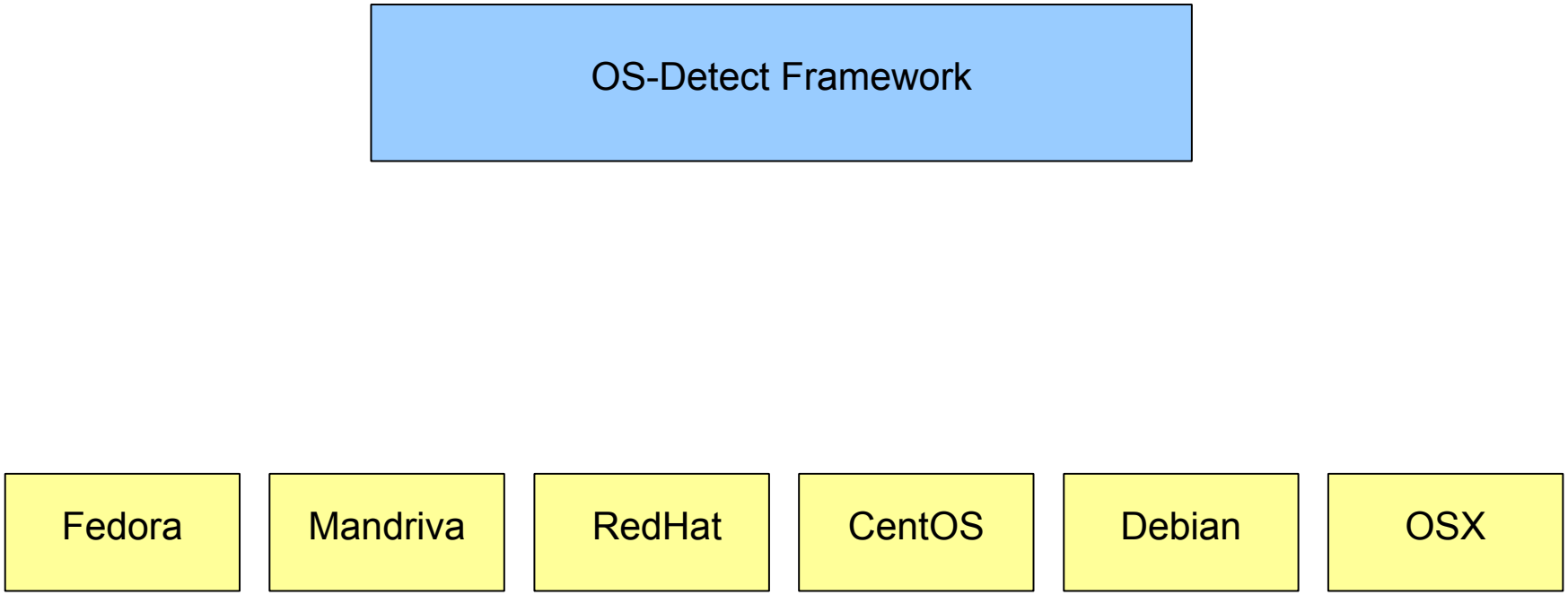
2. Framework selects (policy) from "applicable" components (those that successfully opened).

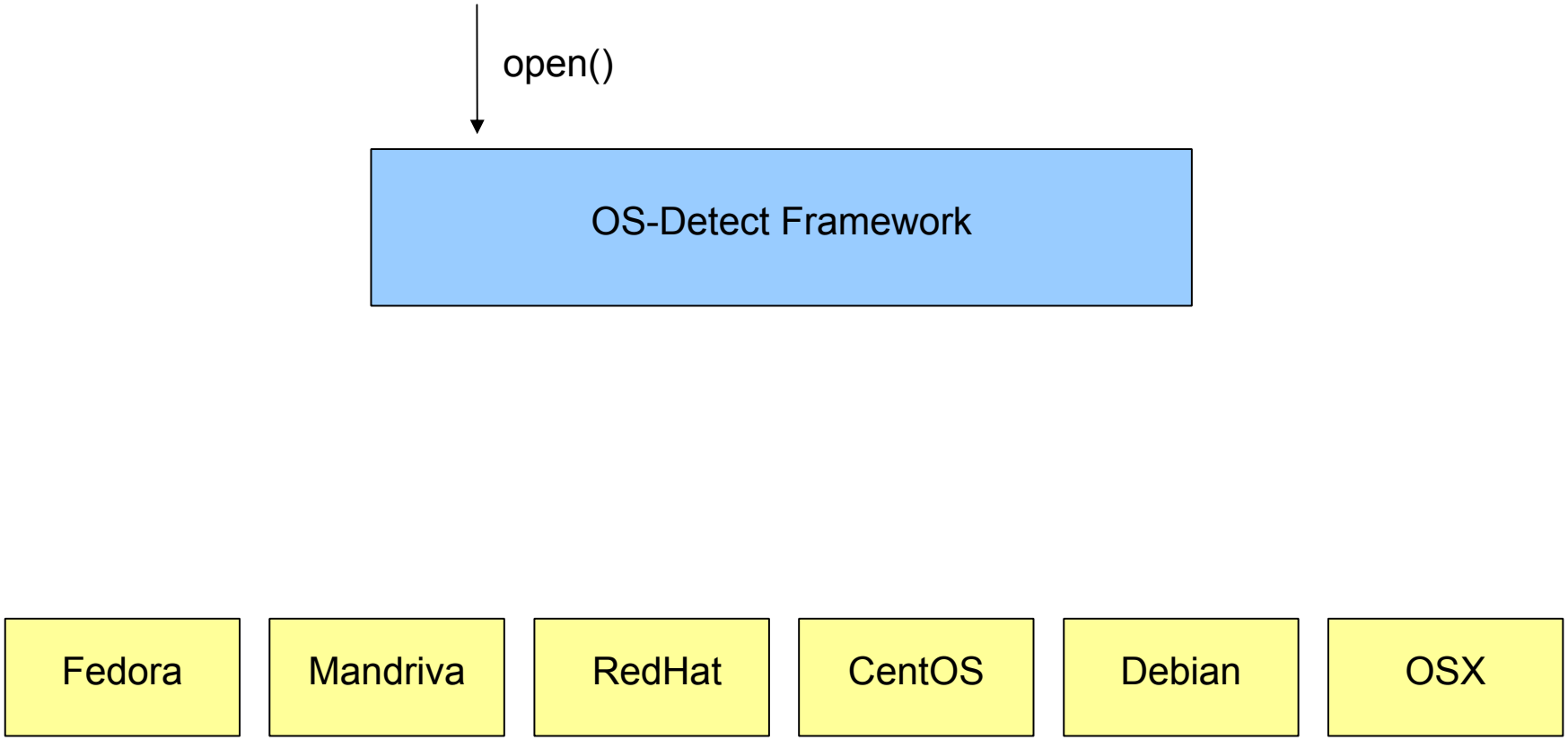
3. Framework returns handle for component to user

Framework: OS_Detect

- First framework – very simple
- Mechanism for platform identification
  - Simplify support for new distros & CPU types
- Components are the “supported” platforms
- Selection pattern is one-of-many
  - Only one platform (component) should be applicable*
- Provides the platform data via Perl hash
  - Ex. os=>'linux', arch=>'i386', distro=>'centos', etc.

* ignoring virtualization


OS-Detect Framework
Fedora
Mandriva
RedHat
CentOS
Debian
OSX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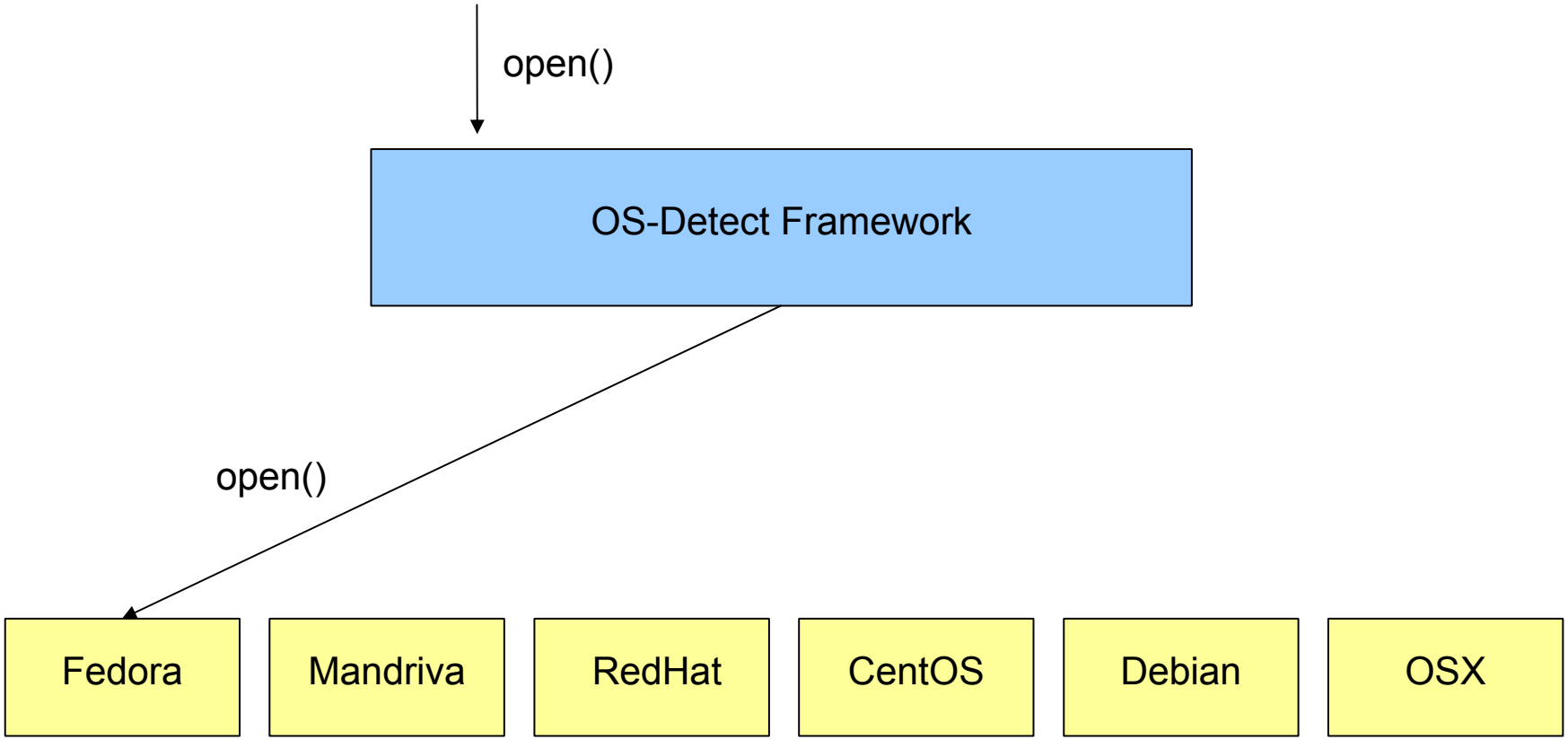
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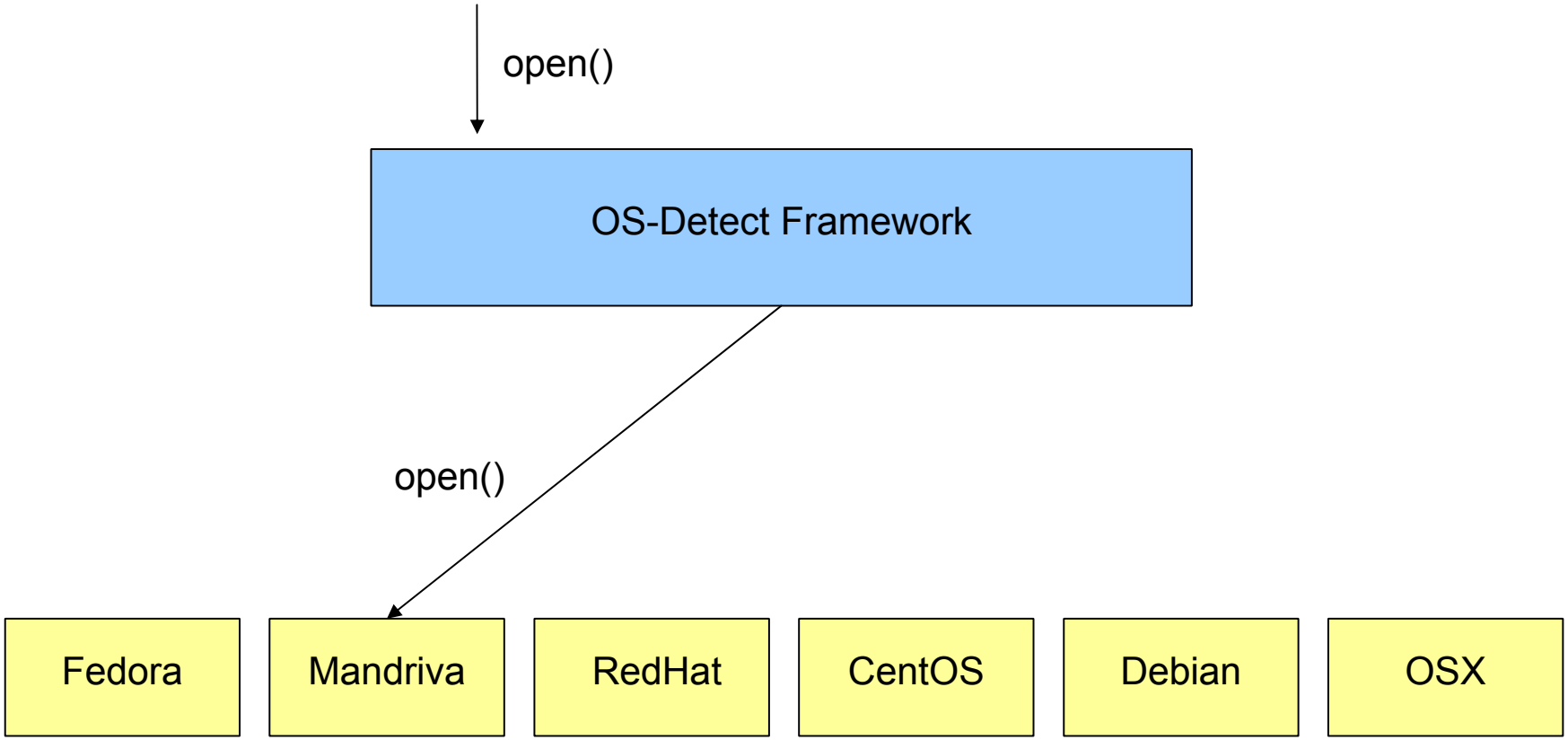
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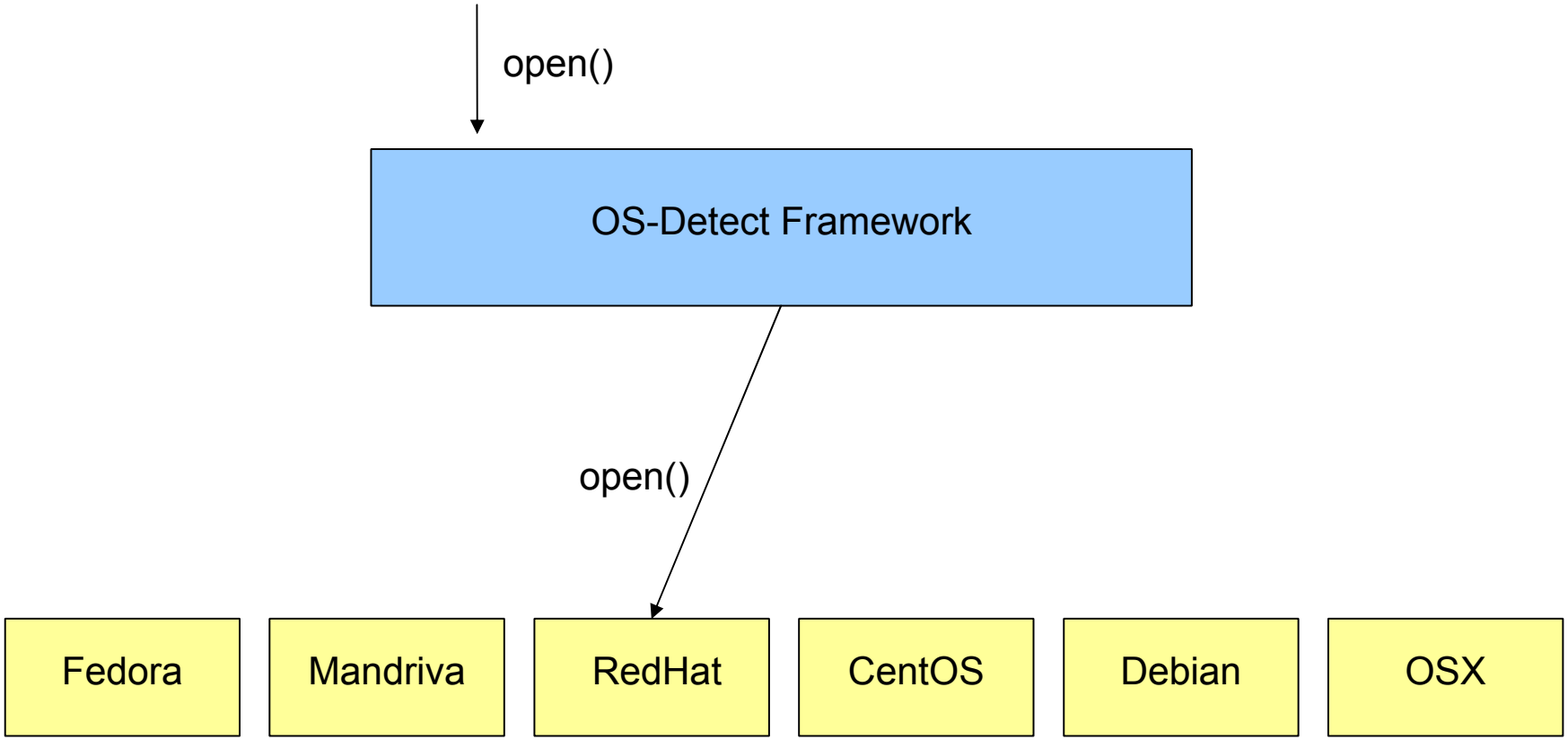
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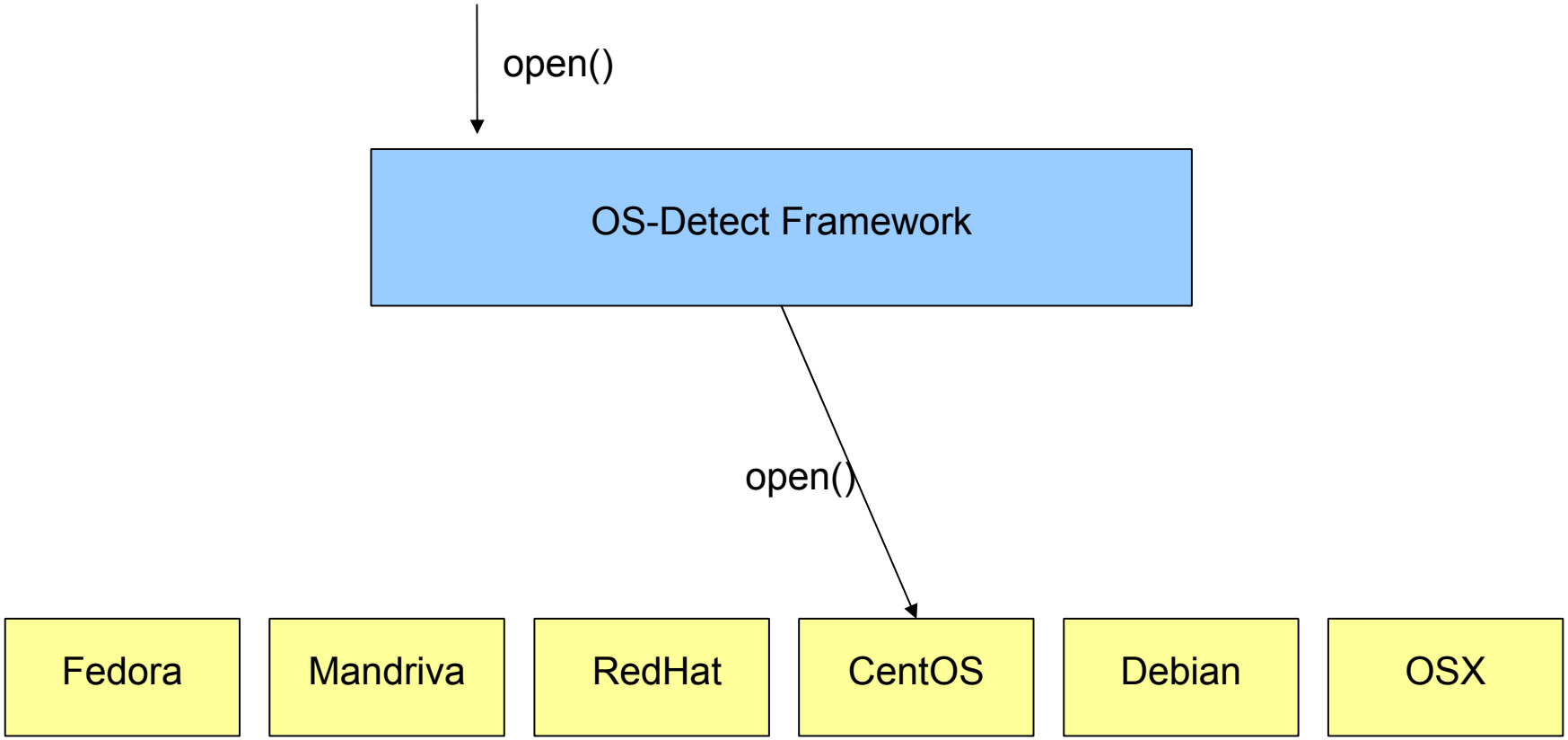
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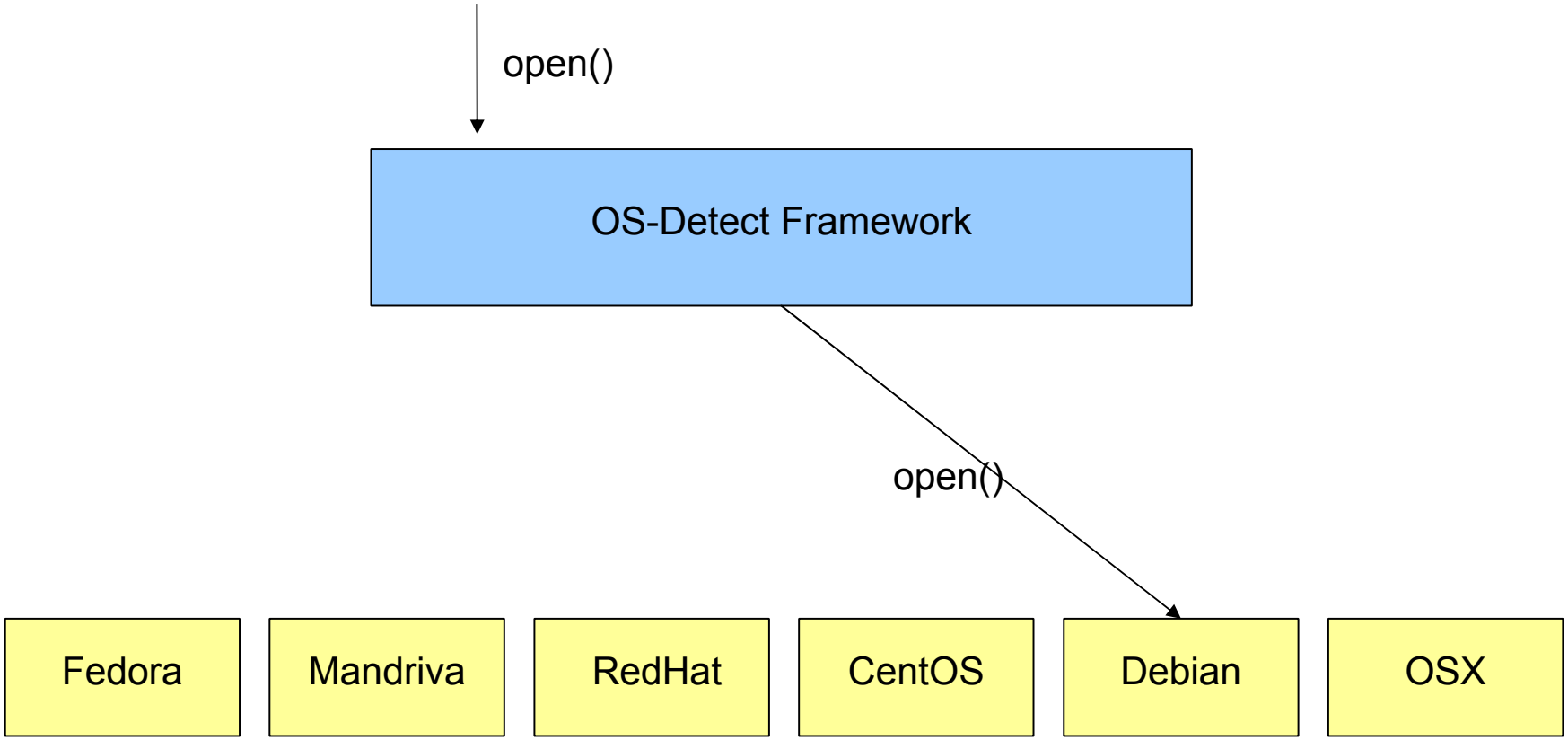
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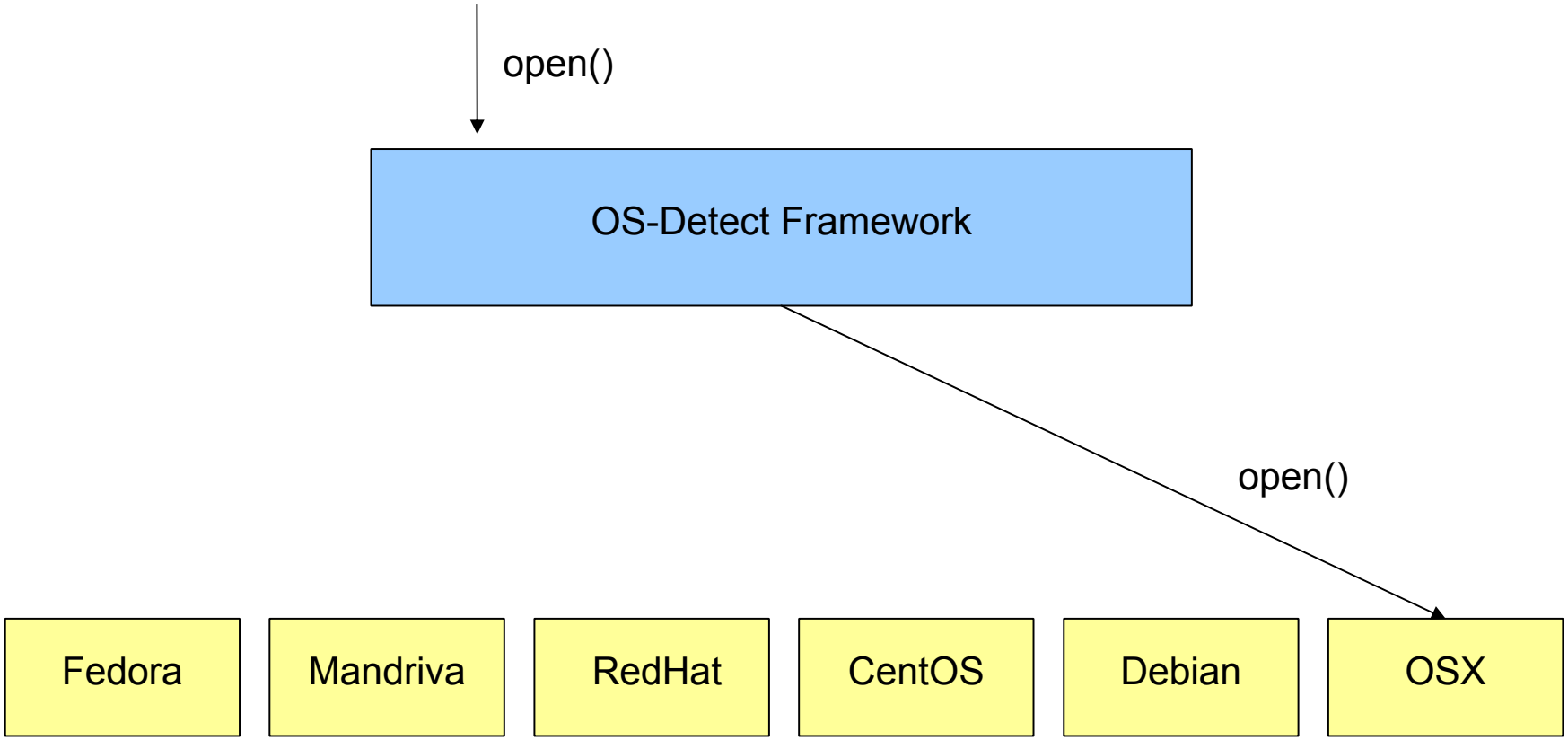
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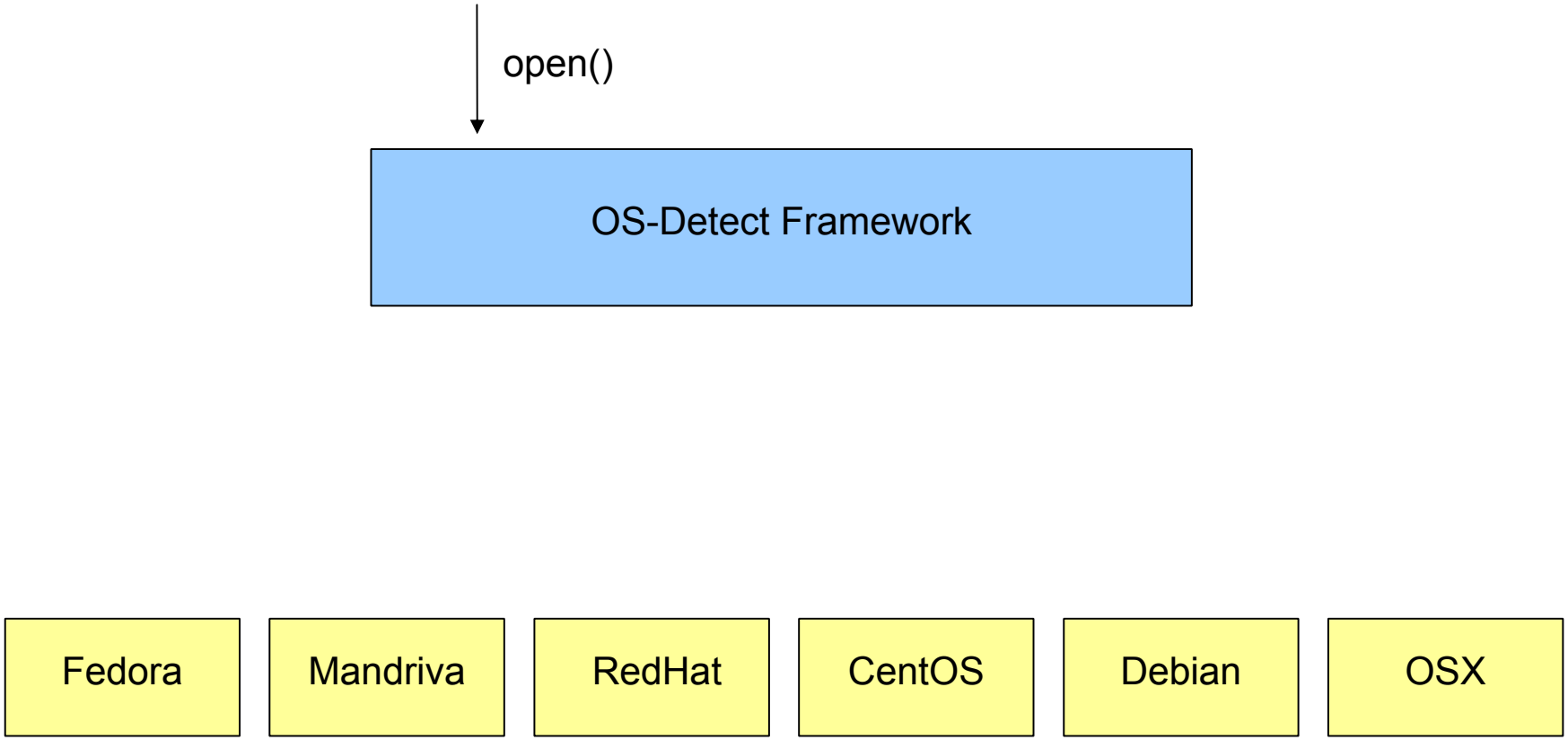
Selection pattern: *one-of-many*



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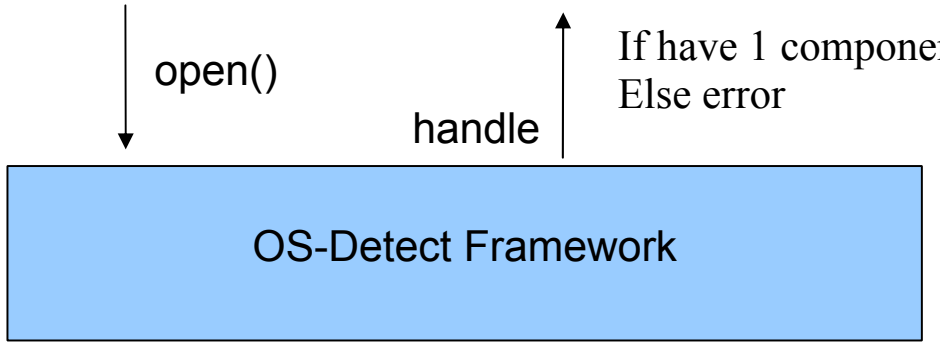
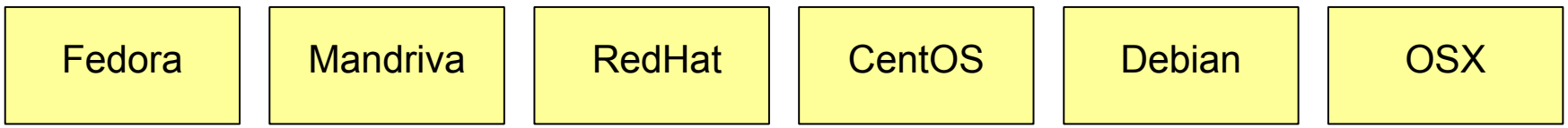


If have 1 component, return handle
Else error



Future Work

- Begin breaking core facilities into frameworks and components
- Adjust current implementation to a more object-oriented approach
- Improve testing and diagnostics of OCA

Summary

- OSCAR “users” (re-users) have increased
- The core infrastructure is tightly coupled due to a monolithic design
- Use a component-based approach to improve modularity/customization – OCA
- First framework OS_Detect provides canonical source for supported platform data

Questions?

OSCAR Homepage

http://oscar.openclustergroup.org/

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