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Beyond Entitlements for Cloud Native

Scalable Responsibility Management with Spring Boot and Open Policy Agent

Chandra Guntur

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Bank of New York Mellon

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About :: Chandra Guntur

- Technologist in the financial services industry since 2003 and is programming with Java since 1998.
- Chandra Guntur is a **Director** and **Sr. Principal Architect** in Java Platform Engineering, BNY Mellon.
- BNY Mellon representative in the **Java Community Process** (JCP) **Executive Committee**.
- Java Champion
- **JUG Leader**, at **NYJavaSIG** (New York Java Special Interest Group) and **NJ Java SIG**.
- Speaker at: **Oracle CodeOne**, **Oracle CodeNY**, **QCon NY**, **Devnexus, DawsCon** and **GIDS India**.

Agenda

- Responsibility Management
  - Scenarios
  - Common (existing) solutions for both Data and Logic
  - A Right Solution - described and visualized
- Architecture
  - Technology choices
  - Federated model
  - Distributed model
  - Comparison
- A Sample Policy in action
- IDE Productivity tool

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Responsibility Management for the Enterprise

Background and existing solutions

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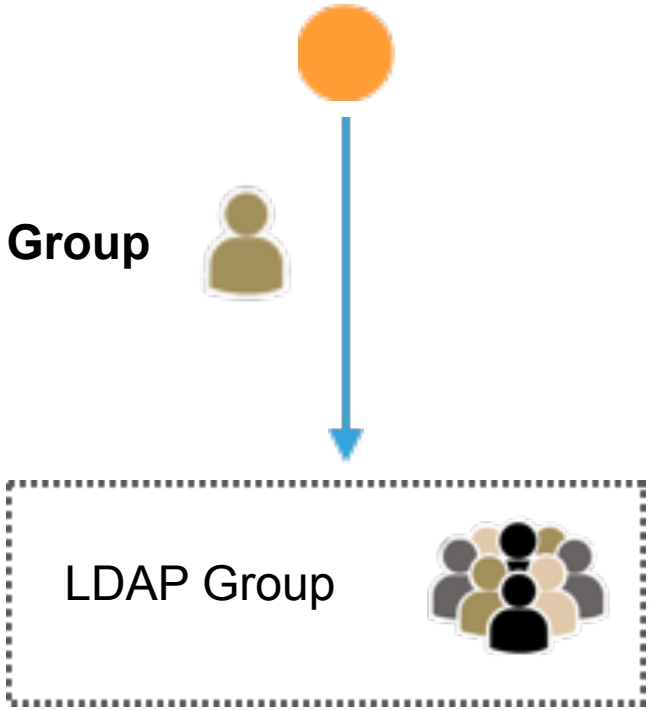
Responsibility Management System

Scenarios

Why Responsibility Management – Scenario 1

- Service A needs to know if a user is a member of an enterprise **LDAP Group**
  - Access may be granted based on membership.
  - Access may be denied based on membership.
  - Access may be granted based on lack of membership.
  - Access may be denied based on lack of membership.



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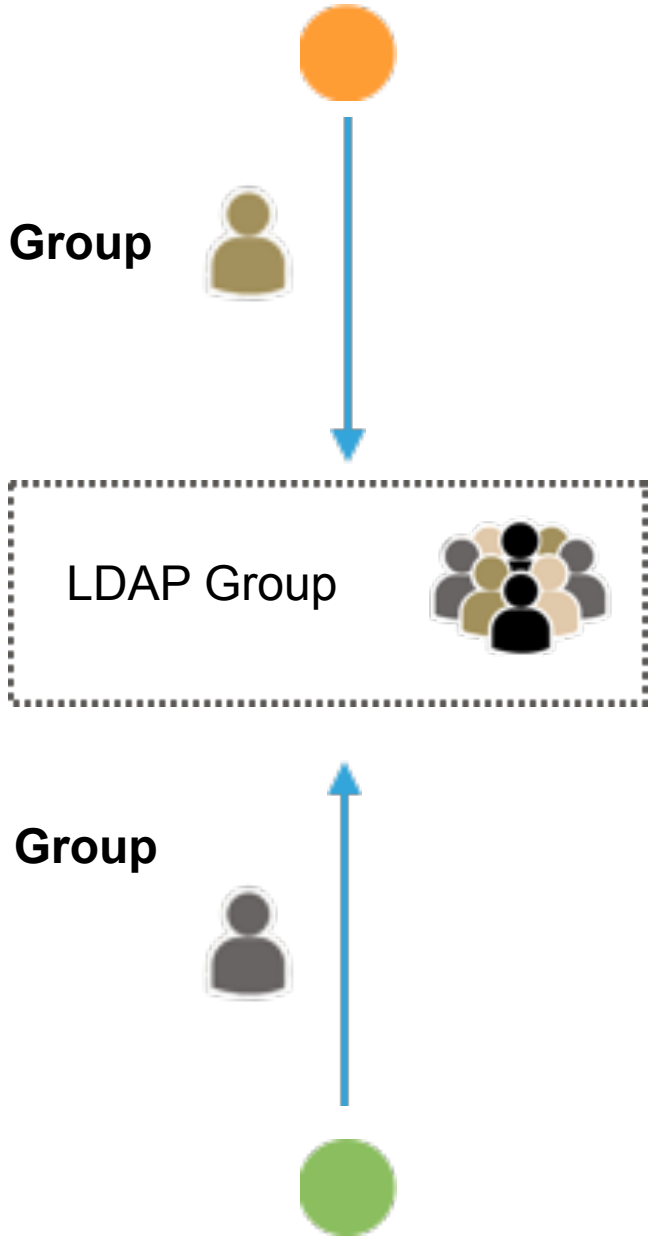
Then …

- Service B needs to know if a user is a member of an enterprise **LDAP Group**



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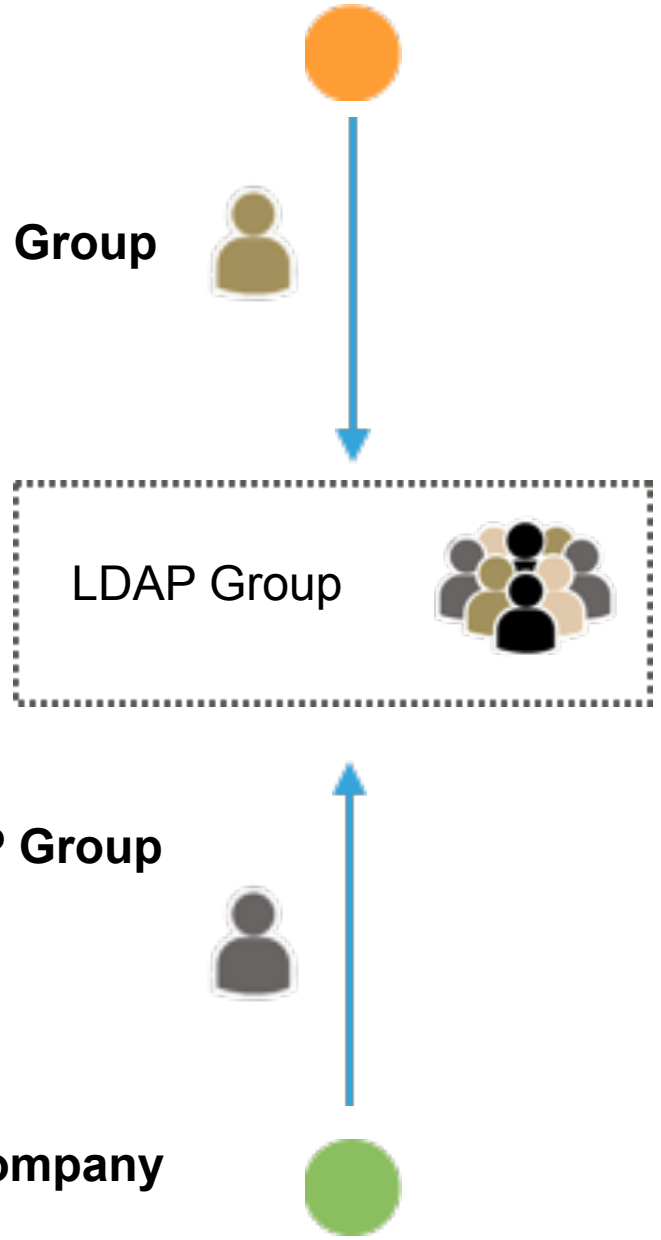


Then …

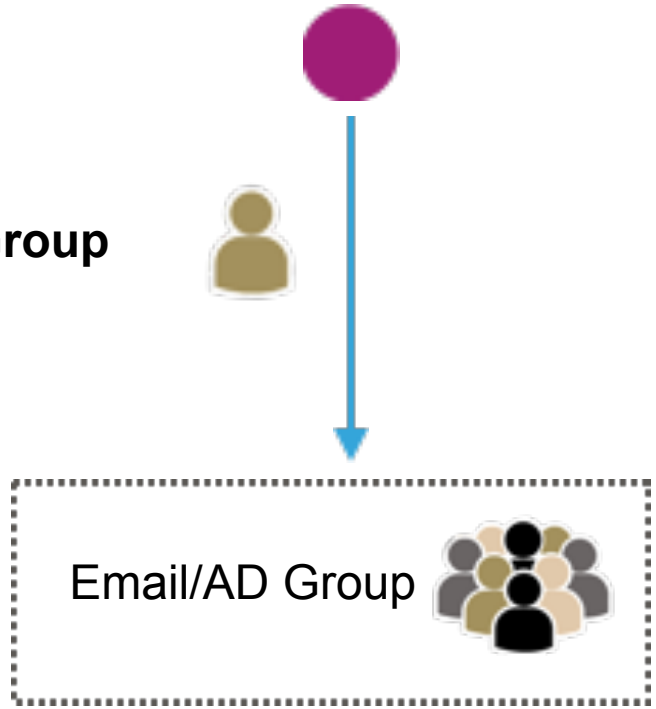
- Service B needs to know if a user is a member of an enterprise **LDAP Group**

Questions

- How about Service/Application C, D or E ?
- Who manages people who **move/leave/join the department/org/company** (Movers/Leavers/Joiners)

Why Responsibility Management – Scenario 2

- Service M needs to know if a user is a member of an enterprise **AD Group**
  - Access may be granted based on membership.
  - Access may be denied based on membership.
  - Access may be granted based on lack of membership.
  - Access may be denied based on lack of membership.



Why Responsibility Management – Scenario 2

- Service M needs to know if a user is a member of an enterprise **AD Group**
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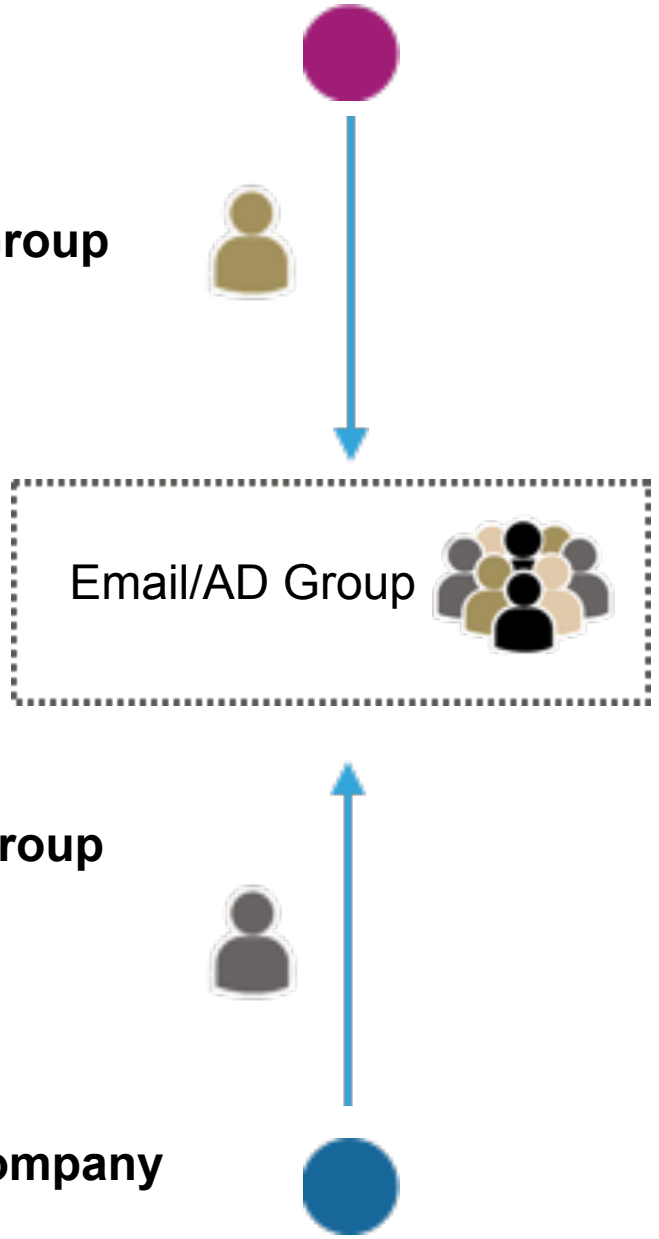


Then …

- Service N needs to know if a user is a member of an enterprise **AD Group**

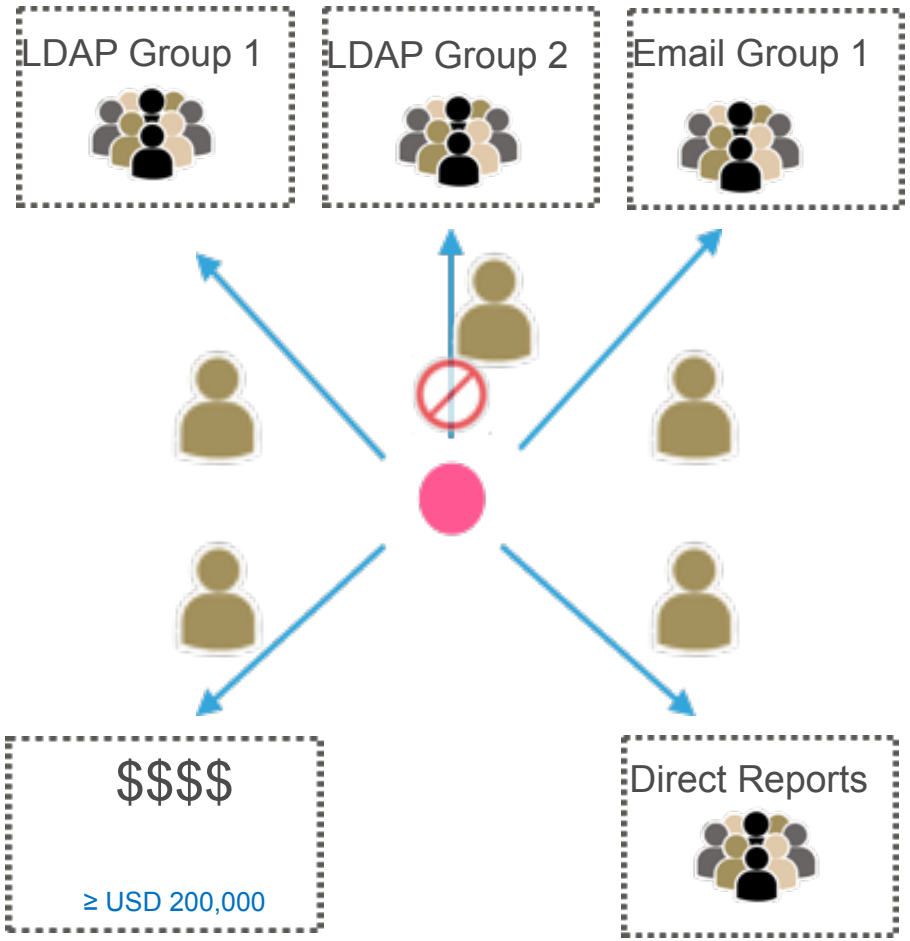
Questions

- How about Service/Application O, P or Q with different groups?
- Who manages people who **move/leave/join the department/org/company** (Movers/Leavers/Joiners)

Why Responsibility Management – Scenario 3

More complex evaluations occur as well.

Service X needs to check if all of the below are true for a user:

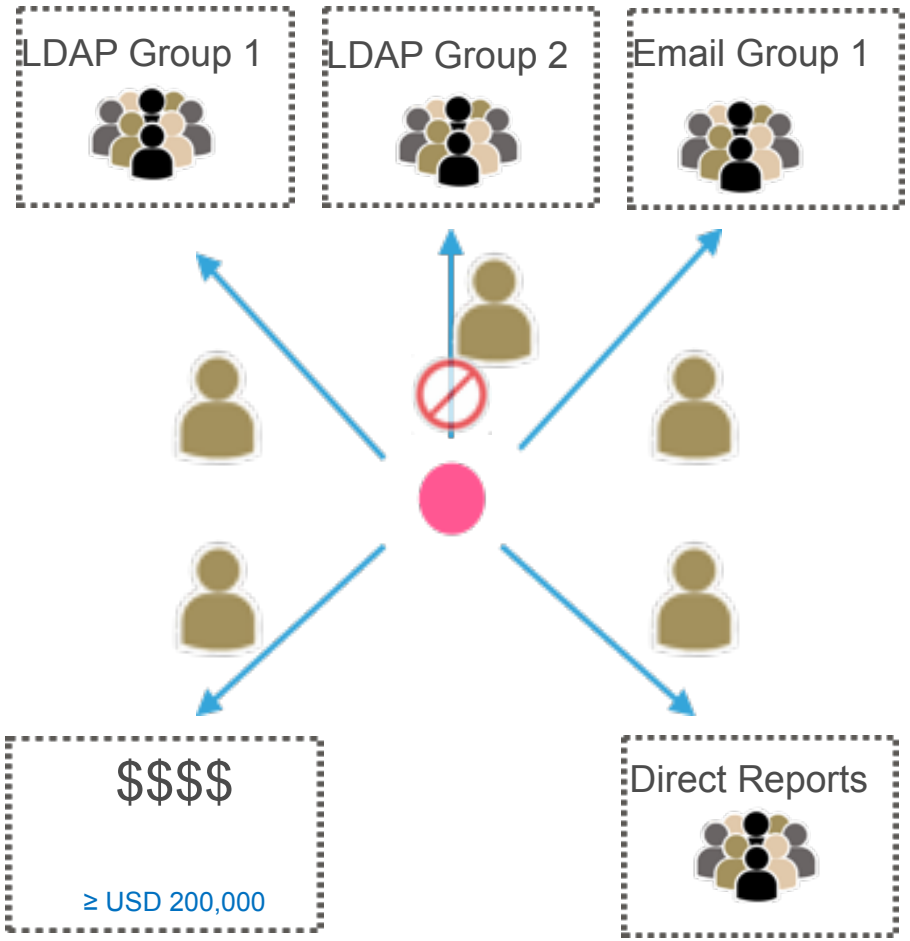


Why Responsibility Management – Scenario 3

More complex evaluations occur as well.

Service X needs to check if all of the below are true for a user:

- is member of LDAP Group 1

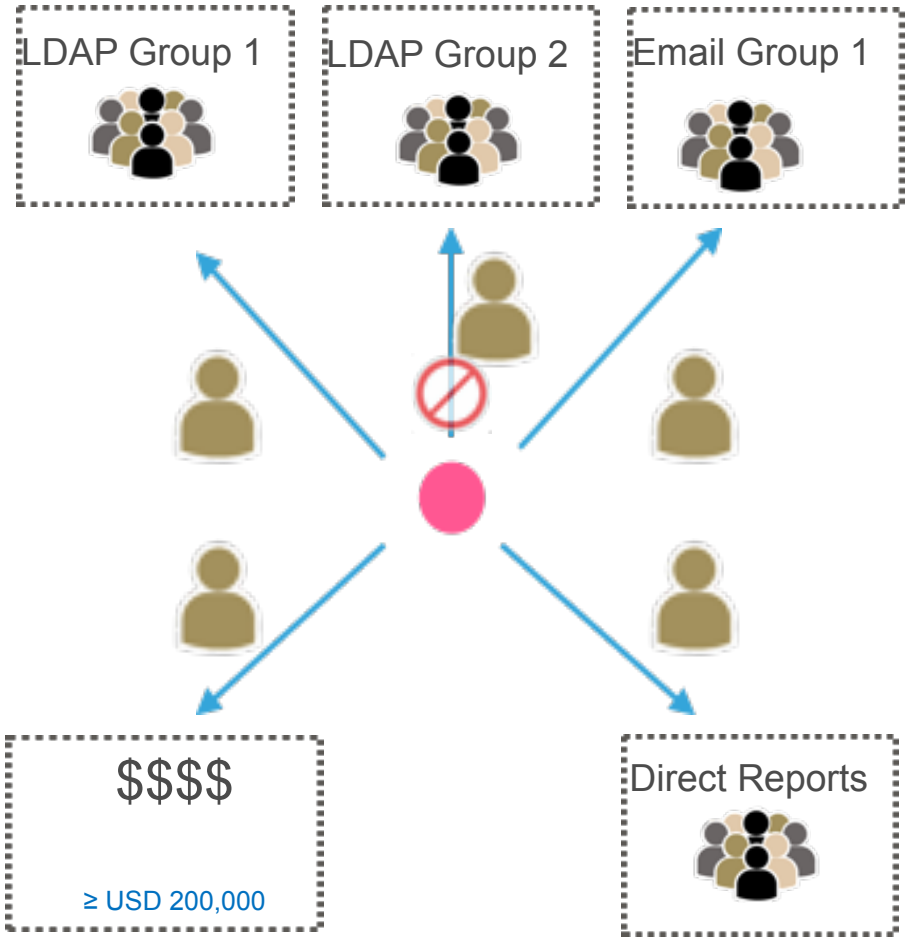


Why Responsibility Management – Scenario 3

More complex evaluations occur as well.

Service X needs to check if all of the below are true for a user:

- is member of LDAP Group 1
- is **not** member of LDAP Group 2



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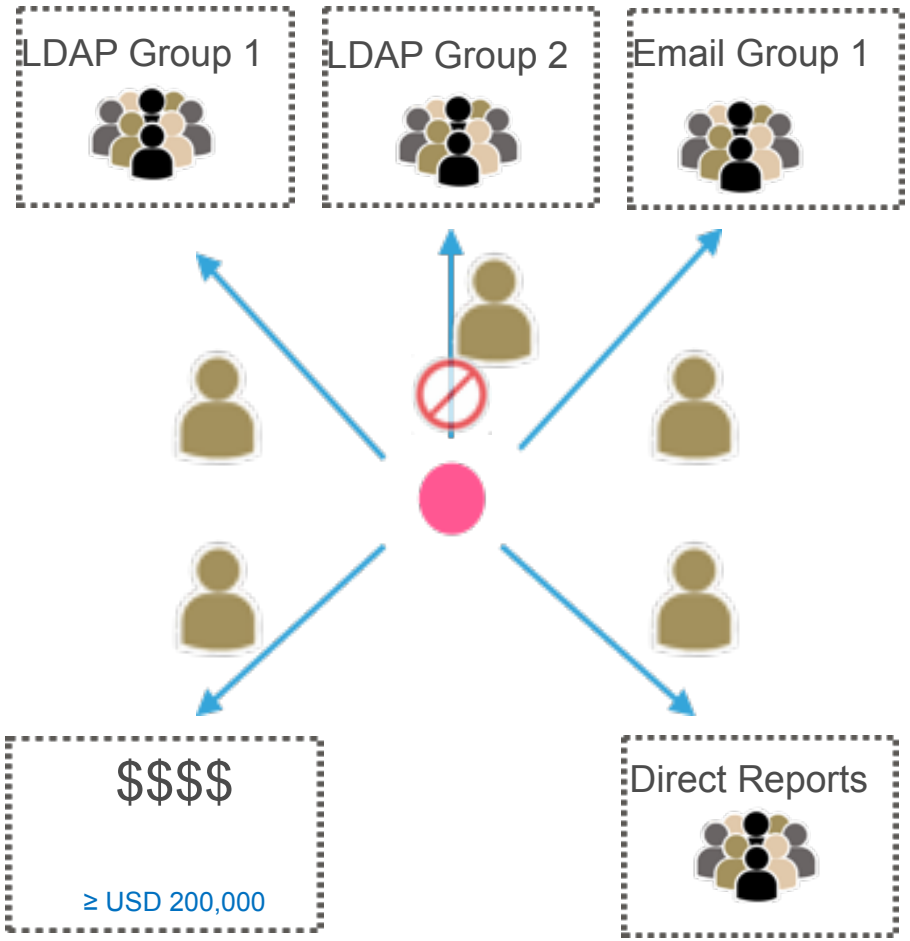
Service X needs to check if all of the below are true for a user:

- is member of LDAP Group 1
- is **not** member of LDAP Group 2
- is member of Email Group 1

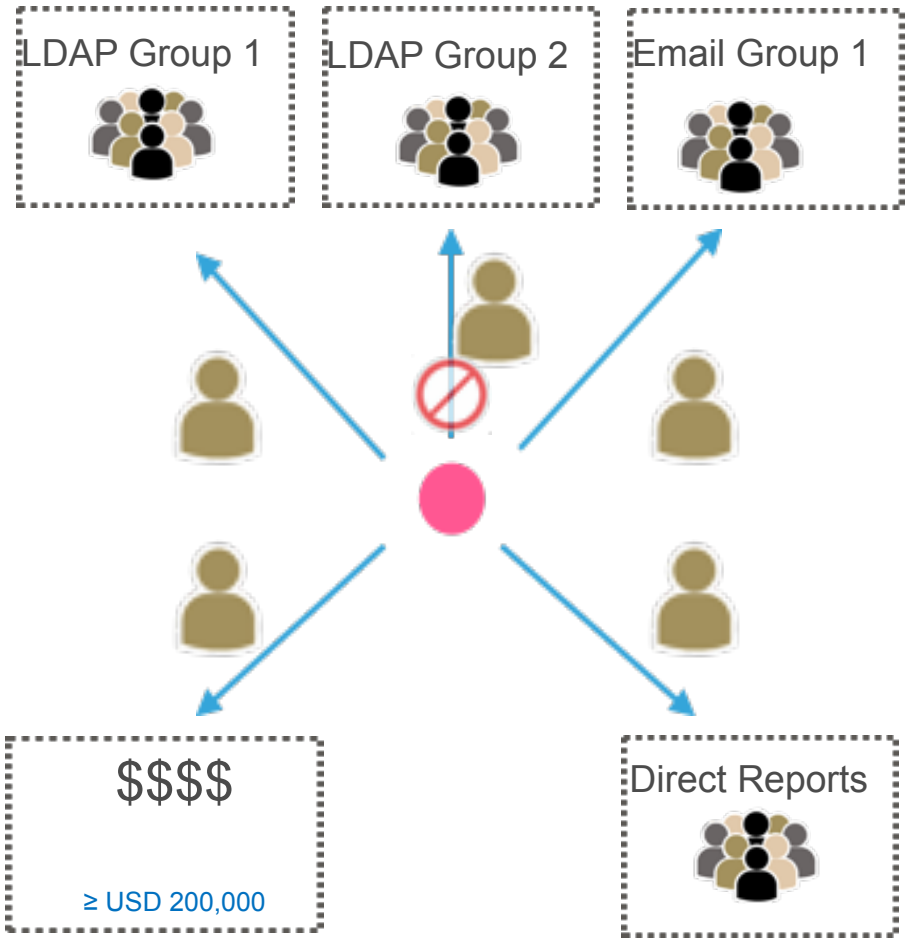


Why Responsibility Management – Scenario 3

More complex evaluations occur as well.

Service X needs to check if all of the below are true for a user:

- is member of LDAP Group 1
- is **not** member of LDAP Group 2
- is member of Email Group 1
- is allowed procurement amount USD 200,000

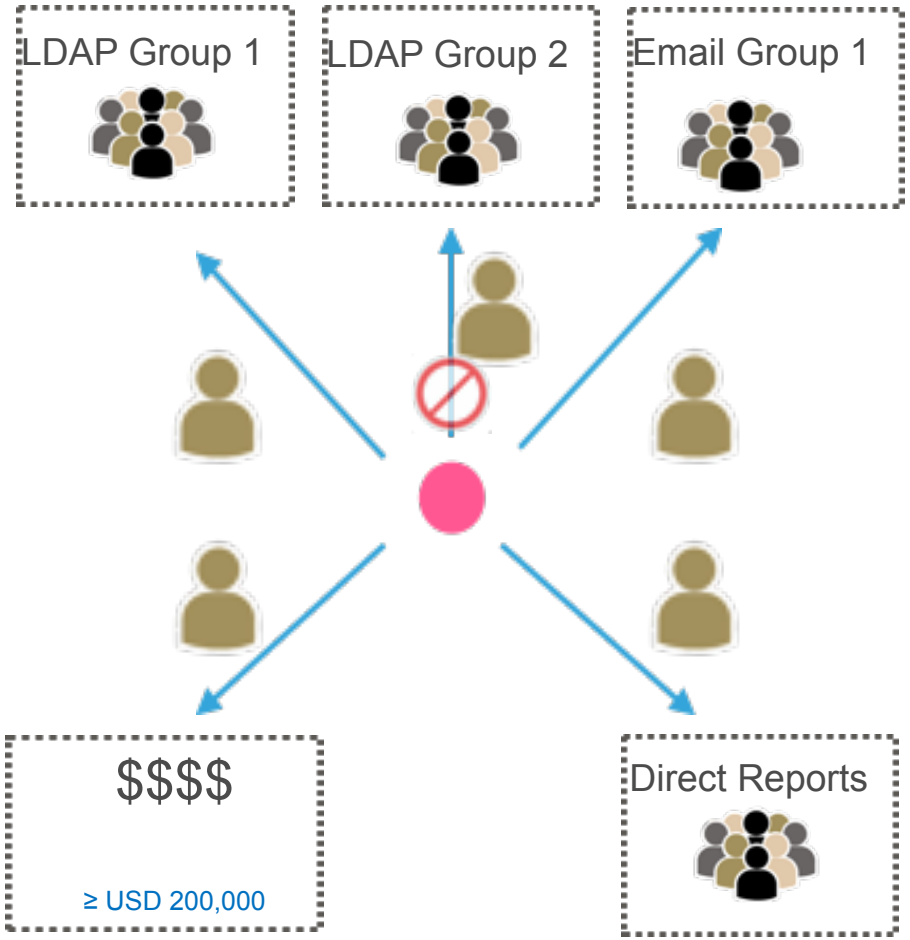


Why Responsibility Management – Scenario 3

More complex evaluations occur as well.

Service X needs to check if all of the below are true for a user:

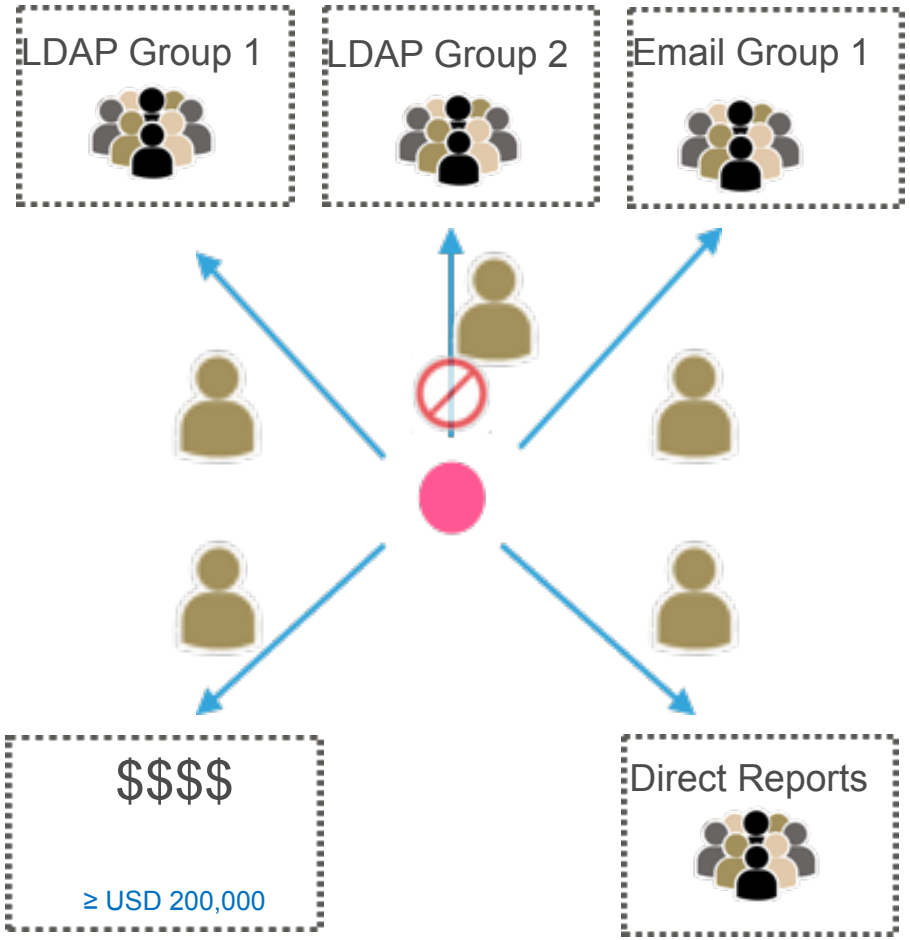
- is member of LDAP Group 1
- is **not** member of LDAP Group 2
- is member of Email Group 1
- is allowed procurement amount USD 200,000
- has at least two direct reports



Why Responsibility Management – Scenario 3 - Continued

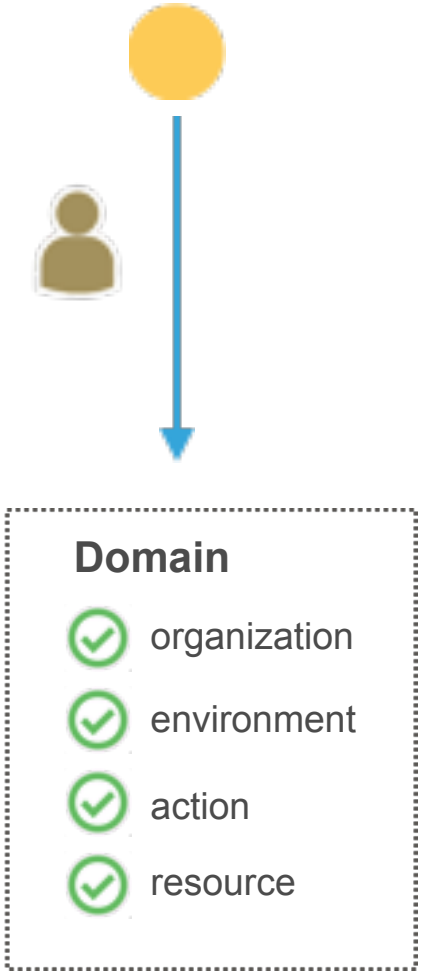
Questions

- What if each request is for different sets of groups and/or amounts?
- What if other services have similar functional constraints with different values?
- Where are such “policies” maintained?
  Are they auditable?
  Follow **SDLC** and **Config Management**?
- Who manages Mover/Leaver/Joiner logic?

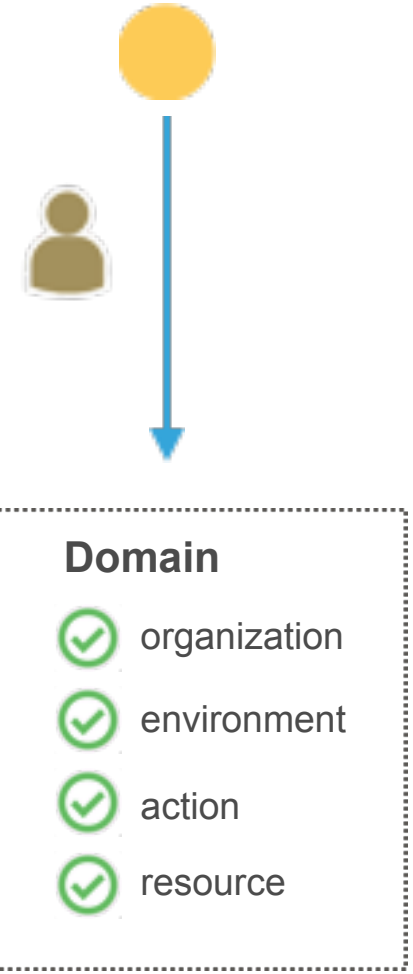


Why Responsibility Management – Scenario 4

Service Y needs to check responsibility privileges for a user/subject:



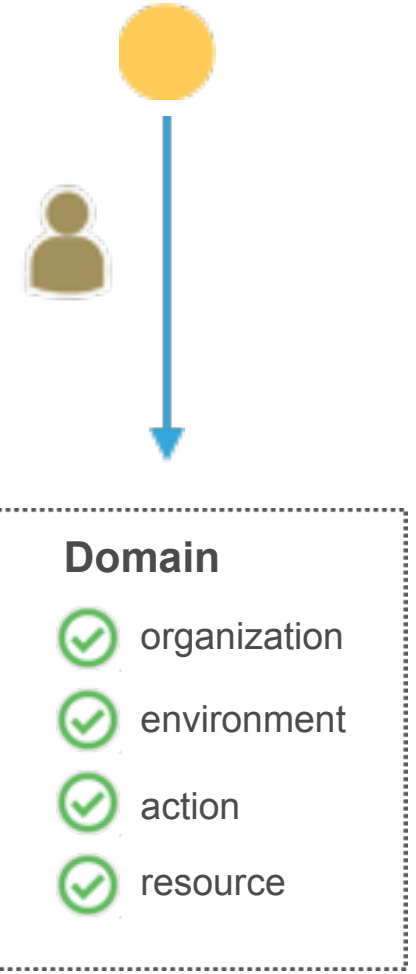
Why Responsibility Management – Scenario 4



Service Y needs to check responsibility privileges for a user/subject:

- in a given **domain** (Infra or Shared - service or tool)

Why Responsibility Management – Scenario 4



Service Y needs to check responsibility privileges for a user/subject:

- in a given **domain** (Infra or Shared - service or tool)
- for a given **cost code identifier** or org. business unit ($)

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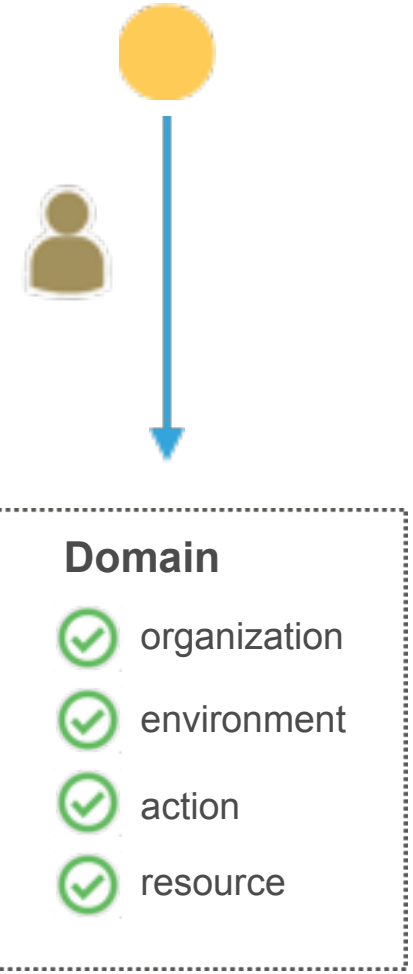

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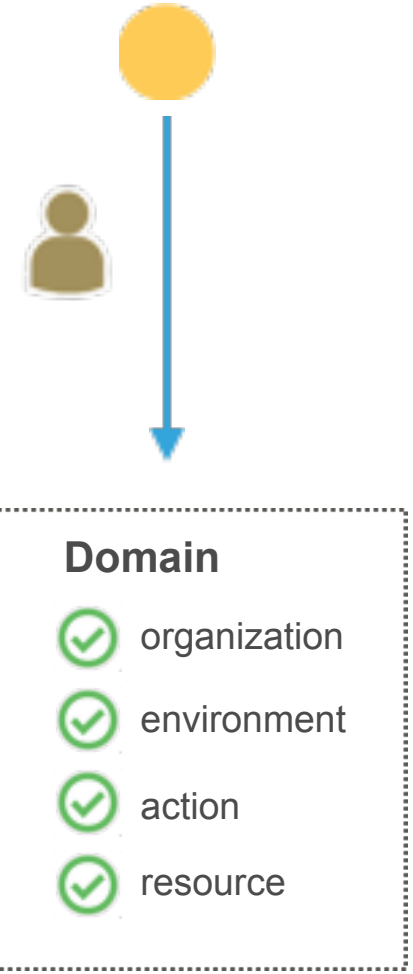

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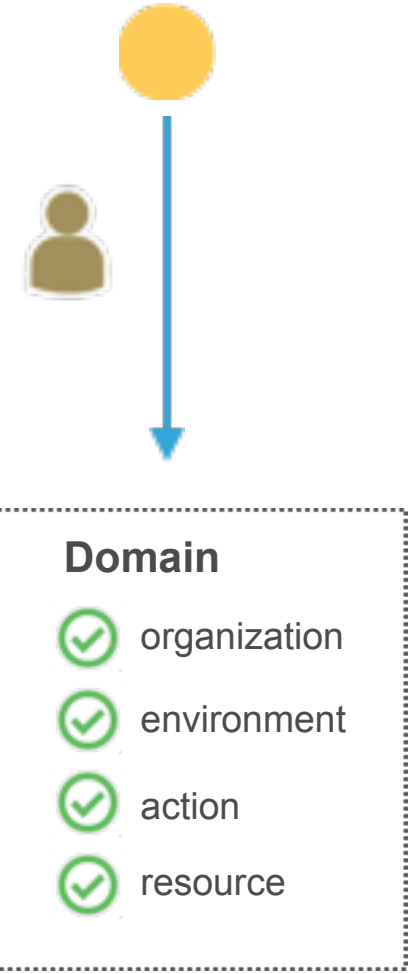
- for a given **action** (e.g. EDIT, DELETE, CREATE …)
- for a given **resource** (e.g. org.databases.prod.instance1.schema1)

Why Responsibility Management – Scenario 4 - Continued



Questions

- What if each request is for different sets of values for the given domain?
- What if other services have similar functional constraints with different values?
- Who manages **Role-Responsibility** per domain and **User-Role** Mappings?
- Who manages Mover/Leaver/Joiner logic ?

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Common Solutions

Responsibility Management – Common Solutions – For Data

DATA - Reference or Static Data for evaluation

- **LDAP/Active directory** queried by the application/service via **direct connections**.
- **User approver/manager** is queried via **proprietary corporate directory services**.
- **Role-Responsibility mappings** usually stored in **local persistence**, **proprietary systems**.
- **User-Role mappings** usually stored in any of: **local persistence**, **proprietary systems**.

Responsibility Management – Common Solutions – For Functions

LOGIC - Calculations / Functions (Policies)

- Complex functions/calculations were **coded into the application/service**.
- Newer applications/services may separate such as an **independent [micro]service**.
- Some applications/services utilize **embedded rule engines** such as Drools.
- Some applications/services utilize **proprietary entitlement systems** for evaluations.

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A solution to manage dynamic privileges and entitlements

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A Right Solution

Responsibility Management System (RMS) – The Right Solution

A Responsibility Management System that:

- federates the calls to LDAP, Active Directory, and other services as **integrated services**
- provides appropriate **mapping of roles and responsibilities**, per domain
- provides for **user to role mapping, per organization per domain**
- provides **proper SDLC and audit mechanism** for policies per domain, to author and deploy

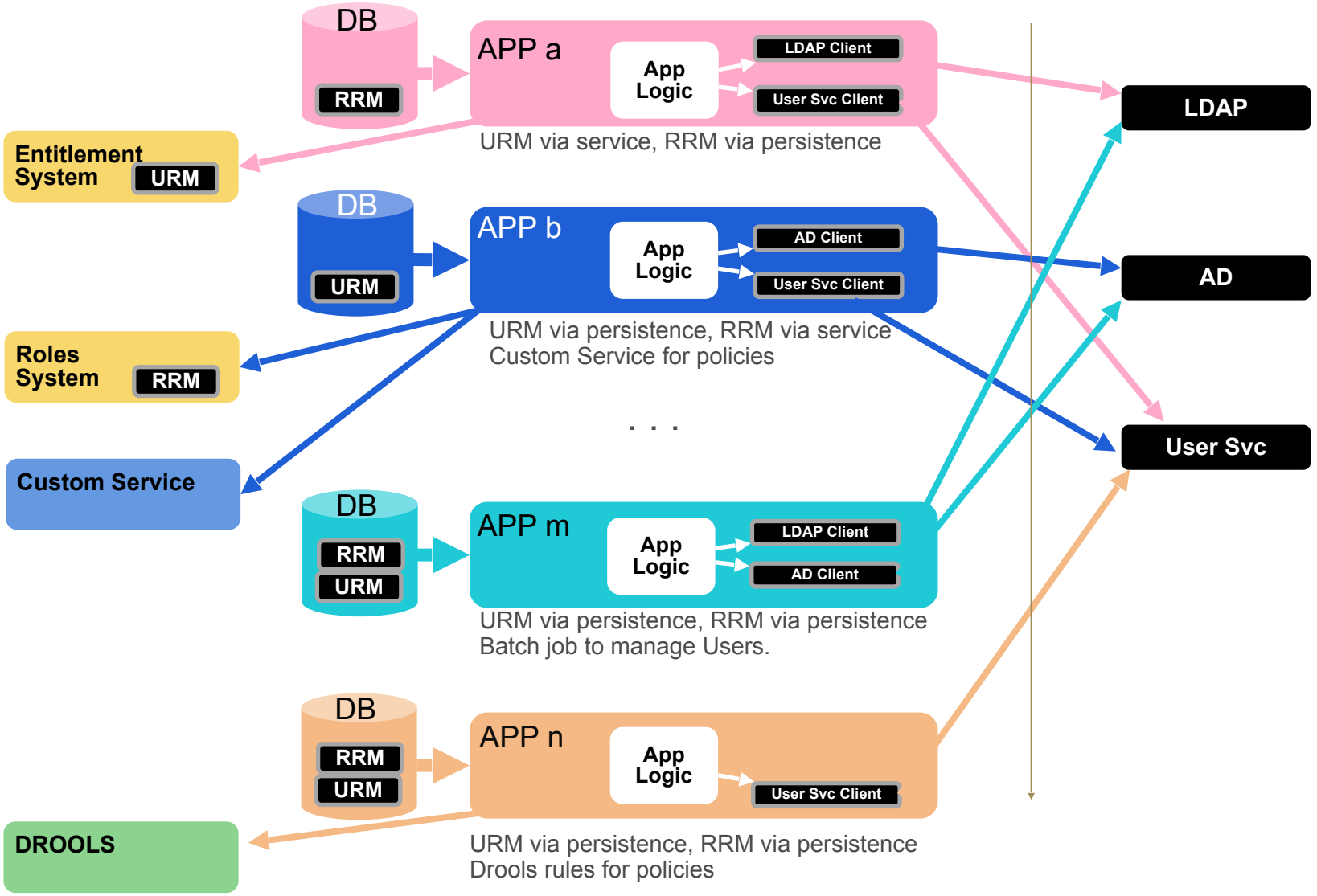
. . .

Responsibility Management System (RMS) – The Right Solution - Continued

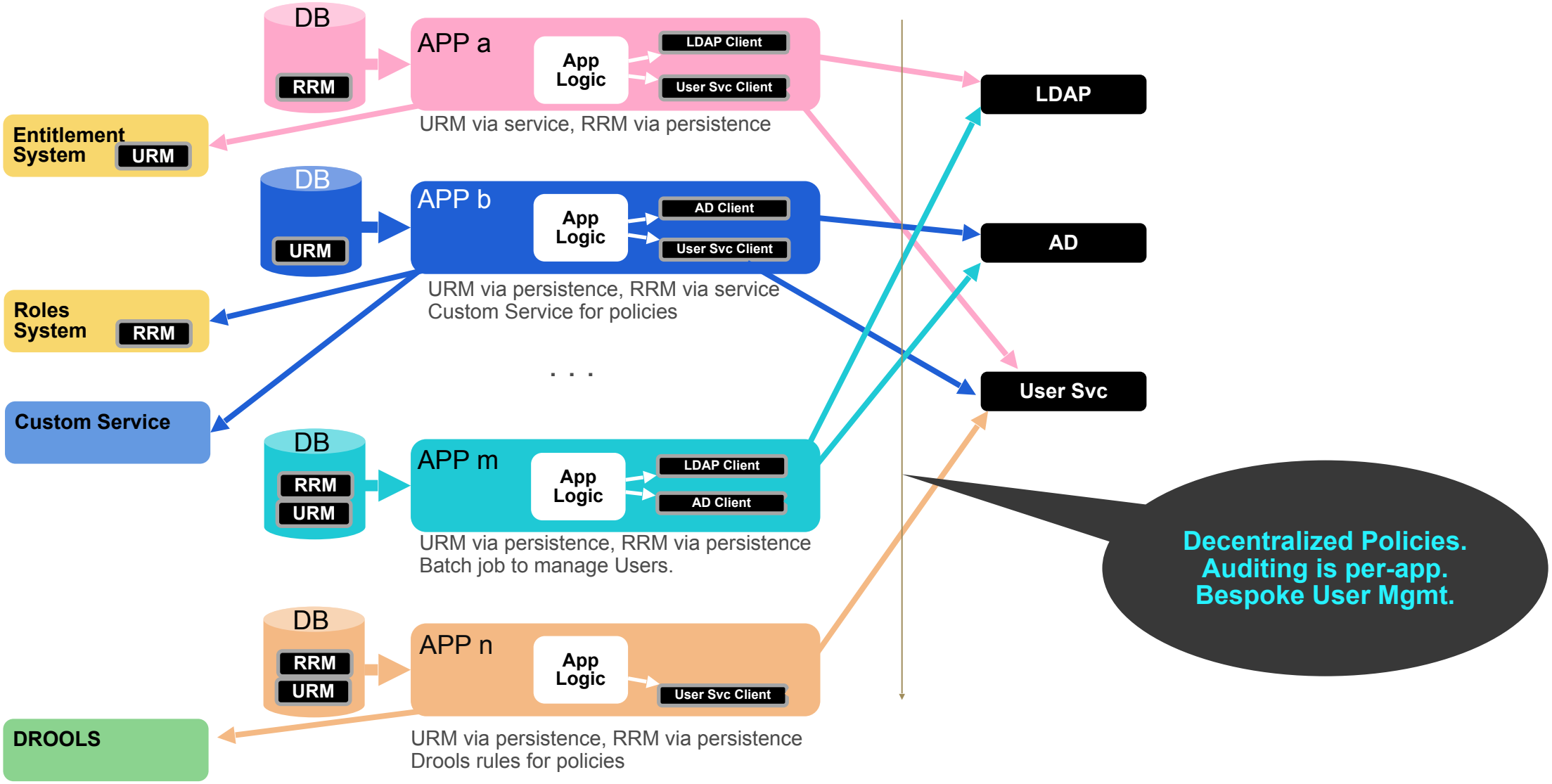
A Responsibility Management System that:

- provides a **policy engine** to evaluate complex calculations/functions using:
  - data provided as inputs by service-consumer
  - data queried from integrated services
  - policies provided by the domains
- caters to **applying a mover/leaver/joiner logic** to all controlled datasets
- provides **horizontal scaling** and thus, **high availability** for varying request volumes

Before RMS



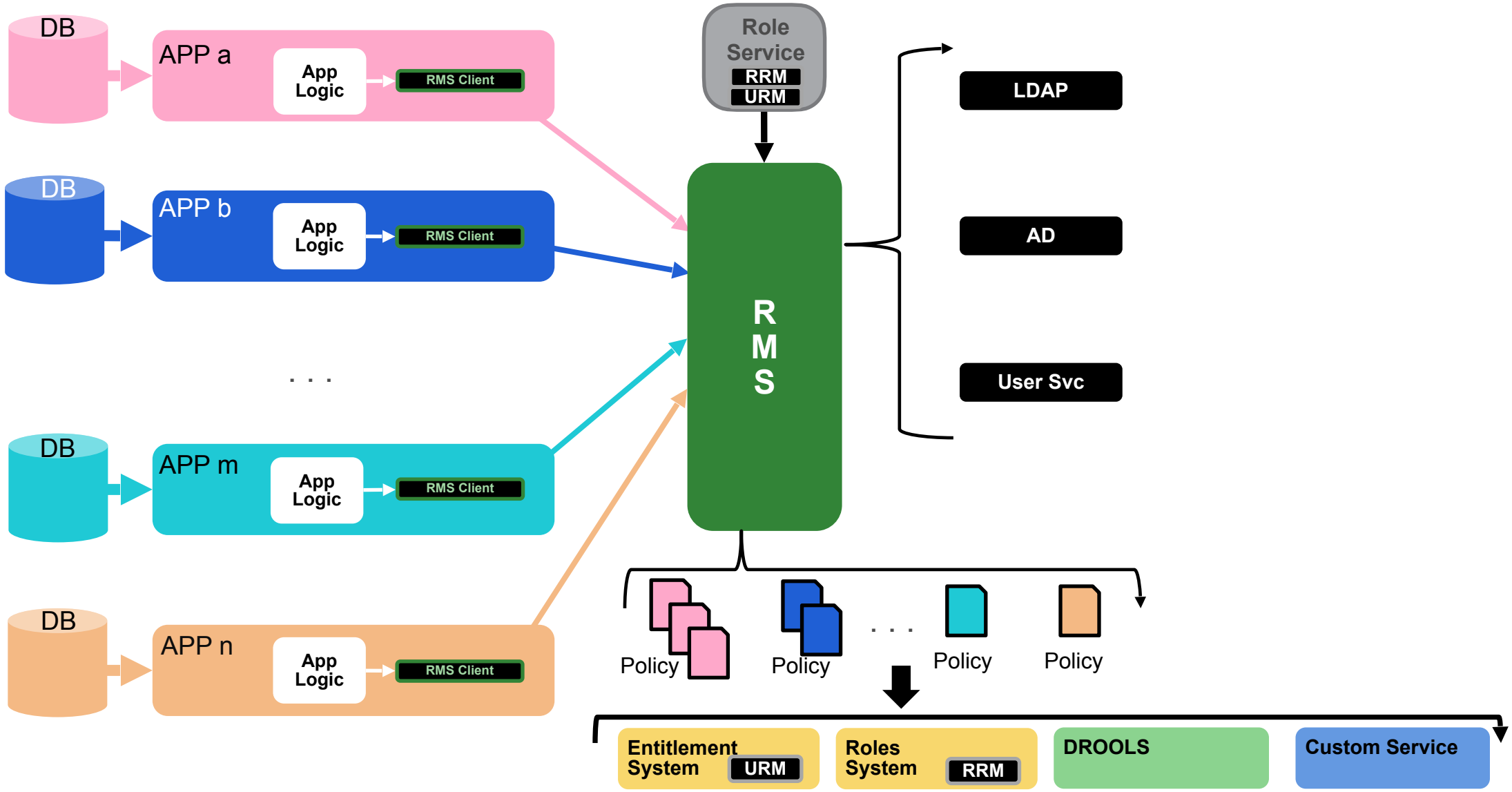
Before RMS



Post-RMS visualized

RRM Role Responsibility Mapping

URM User Role Mapping



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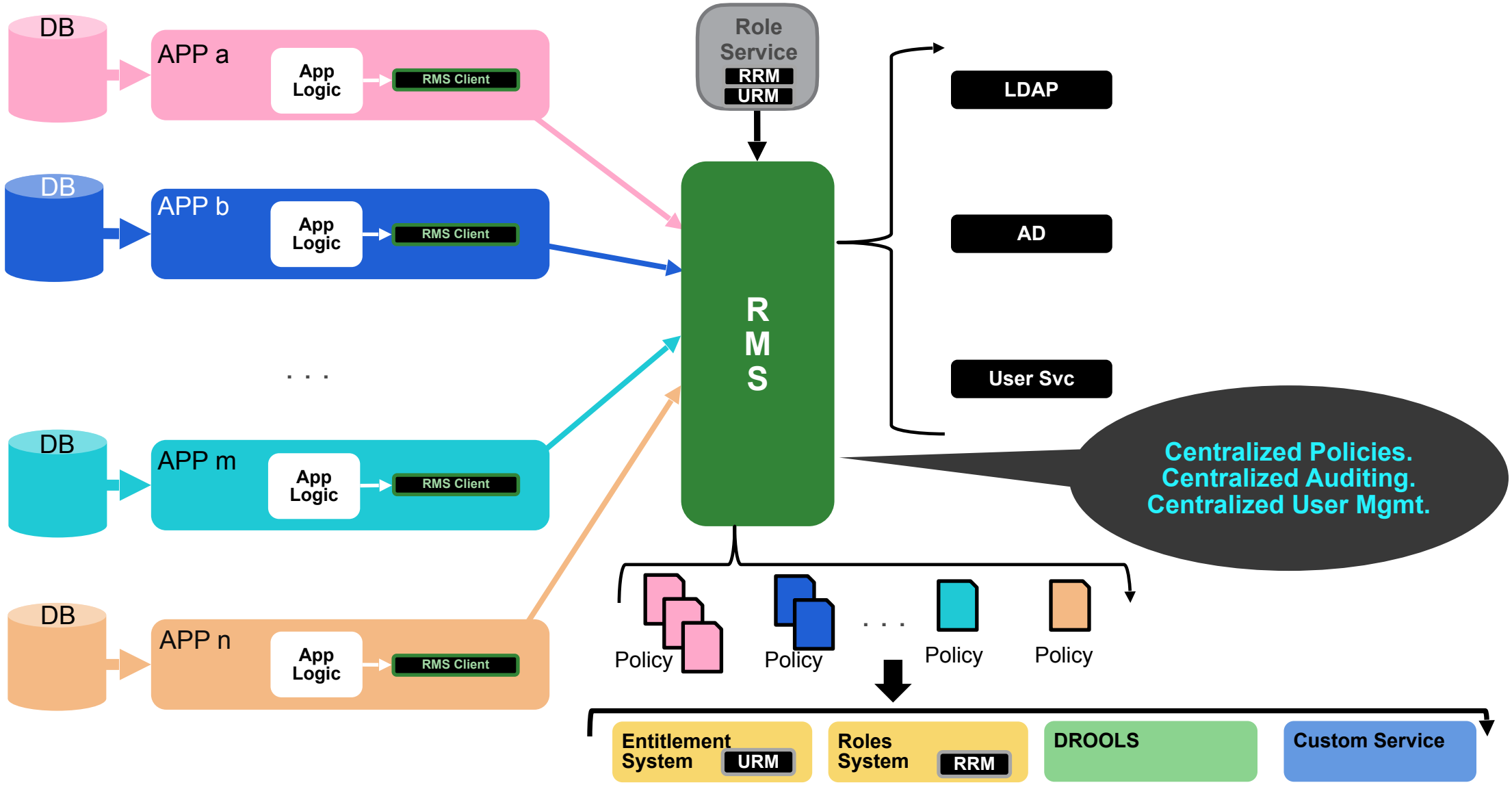

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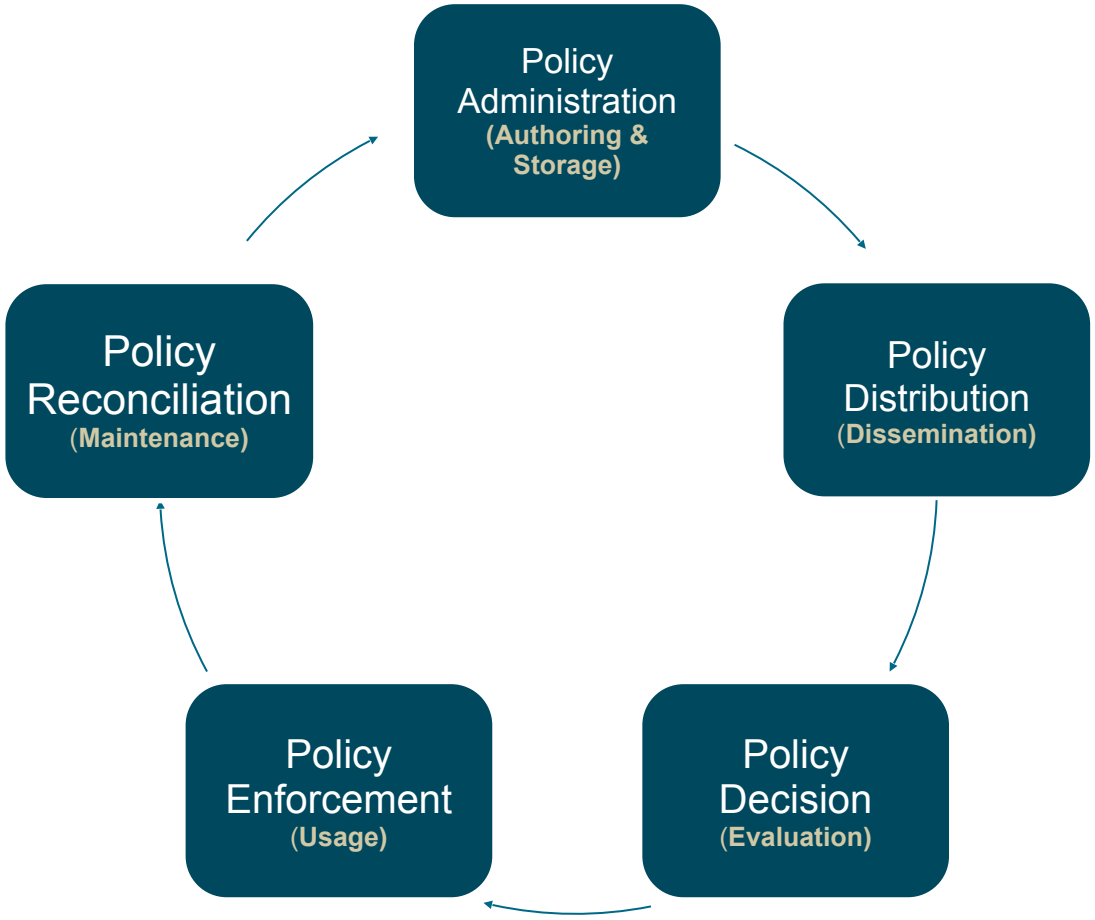
Architecting the Responsibility Management System

A platform solution for Responsibility Management

Responsibility Management - Policy Lifecycle

Responsibility Management is performed via policies

Policies have a lifecycle



More detailed flow: Appendix

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Technology Choices

Technology choices for building the Responsibility Management System

Payload format: HOCON: Use case

A Case for using **H**uman-**O**ptimized **C**onfiguration **O**bject **N**otation

- Intent is to expose query-only operations.
- Policy decisions should be queried (non-mutating), thus logically GET operations.

☐ GET operations do not support a request body.

☐ GET operations may be exposed to character limits, large content not possible.

☑ POST operations allow for a request body but do not support meaningful caching.

☐ JSON and individual query parameters are quite verbose.

☑ HOCON * trims the parameter verbosity by a significant amount.

https://github.com/lightbend/config/blob/master/HOCON.md

Payload format: HOCON: Benefits

Benefits of using **H**uman-**O**ptimized **C**onfiguration **O**bject **N**otation

HOCON (see link below)

- syntax is quite simple and has low ambiguity.
- is a superset of JSON. JSON is parsed properly by HOCON parsers.
- allows the use of comments.
- allows multi-line strings.
- allows for includes and substitutions (next slide has more on this).
- has built-in durations (5d or 100ms)

https://github.com/lightbend/config/blob/master/HOCON.md

Payload format: HOCON: Features

Human-**O**ptimized **C**onfiguration **O**bject **N**otation - using *includes* and *substitutions*

generic.conf

```
{x: 10, y: ${x}, z: 5s}
```

my.conf

```
{a : { include "generic.conf" } }
```

Substitution

Inclusion

a.x = 10

a.y = 10

a.z = 5s

https://github.com/lightbend/config/blob/master/HOCON.md

Payload format: HOCON: Comparing to JSON

Human-**O**ptimized **C**onfiguration **O**bject **N**otation - sample comparisons to JSON

Sample JSON

```
foo : {
  bar : {
    baz: myvalue
  }
}
employee: {
  firstname: ”Jane"
  lastname: ”Doe"
  nested: {
    loginTimeoutInMilliSeconds: 5000
  }
  fullname: “Jane Doe”
}
standard-policy: {
  developer: "yes"
  operator: false
}
```

Sample HOCON

```
foo.bar.baz: myvalue
        ----    Or    ----
foo { bar { baz: myvalue}}
employee {
  firstname: ”Jane"
  lastname: ”Doe"
  nested {
    loginTimeout: 5s
  }
  fullname: ${employee.firstname} ${employee.lastname}
}
standard-policy {
  developer: "yes"
  operator: false
}
```

Java Collections Library: Eclipse Collections

Key highlights

Eclipse Collections (see link below)

- Rich, concise and readable APIs.
- Clear mutable and immutable hierarchies for collection types.
- Memory efficient containers.
- Optimized eager APIs instead of Java Collection Framework's lazy APIs.
- Improved code readability.
- Ease of learning thanks to several Code Katas.

https://www.eclipse.org/collections/

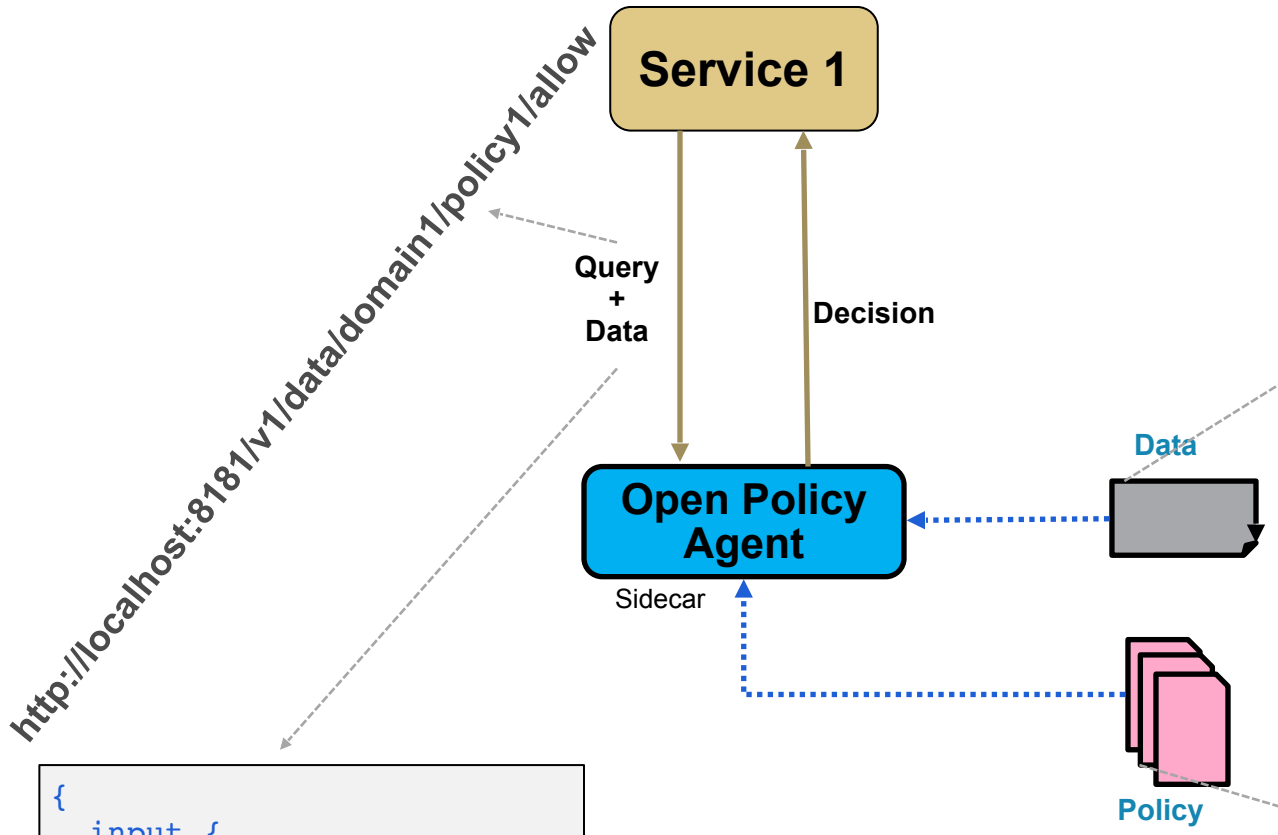
Policy Engine: Open Policy Agent

Key highlights

- Open Policy Agent (OPA) (see link below) is an open source general purpose policy engine.
- Uses “rego” (inspired by Datalog) as a declarative native query language.
- Policies are written as rulesets (similar to functions).
- Policies can be queried as RESTful POST operations.
- Data and policy publishing is via RESTful PUT operations.
- Can be launched as a **library** for a **service**, an **independent daemon** or **sidecar**.
- Decision in RMS was to use OPA as a **sidecar**.

https://www.openpolicyagent.org/

Open Policy Agent: Usage Pattern



Reference Data (available from Policy Information Point)

```
[
  {
    "name": "bucket1",
    "clients": [
      {
        "name": ”client1",
        "access": ["READ”, “WRITE”]
      },
      {
        "name": ”client2",
        "access": ["WRITE"]
      }
    ]
  },
  {
    "name": "bucket2",
    "clients": [
      {
        "name": ”client1",
        "access": [”READ"]
      }
    ]
  }
]
```

data.json

```
{
  input {
    bucket: "bucket2",
    client: ”client1",
    access: "READ"
  }
}
```

Query Payload (Inputs from invoker per request)

policy.rego

```
package domain1.policy1

import data.domain1.policy1.buckets

default allow = false

allow {
     buckets[i].name == input.bucket
     buckets[i].clients[j].name == input.client
     buckets[i].clients[j].access[k] == input.access
}
```

Policy Logic (available from Policy Distribution Point)

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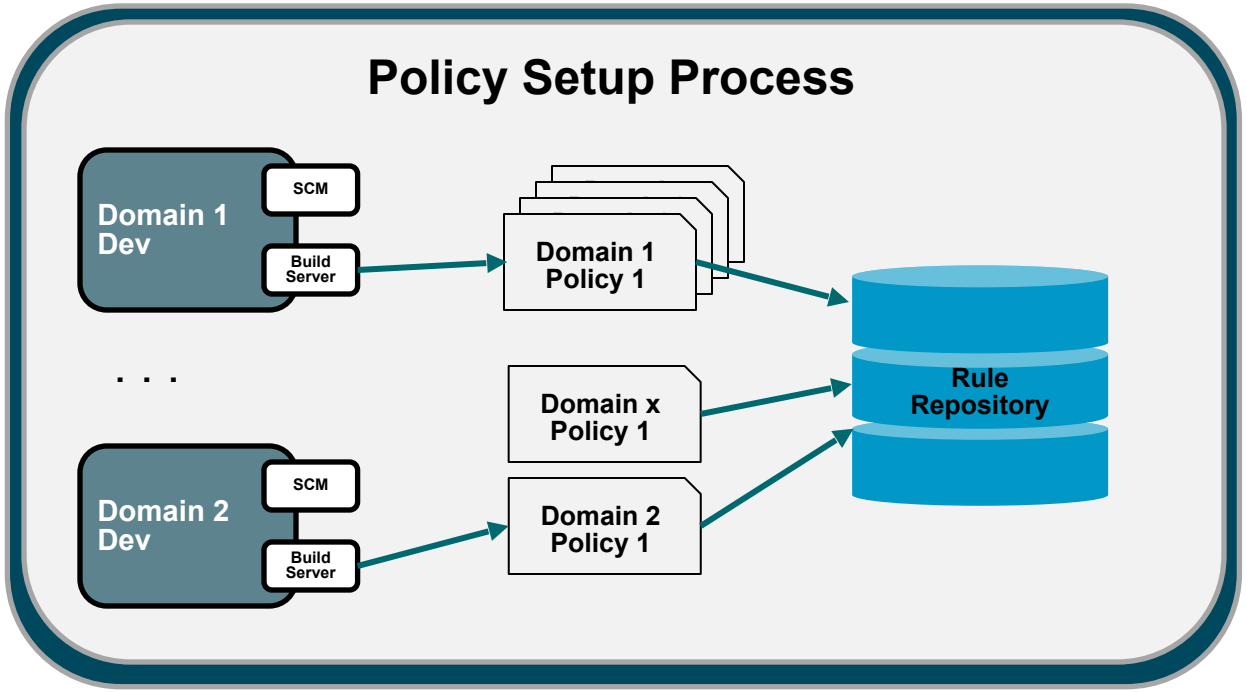
Responsibility Management System

Architecture (Version 1)

A ***Federated*** Responsibility Management Service

RMS Architecture - Version 1: Federated

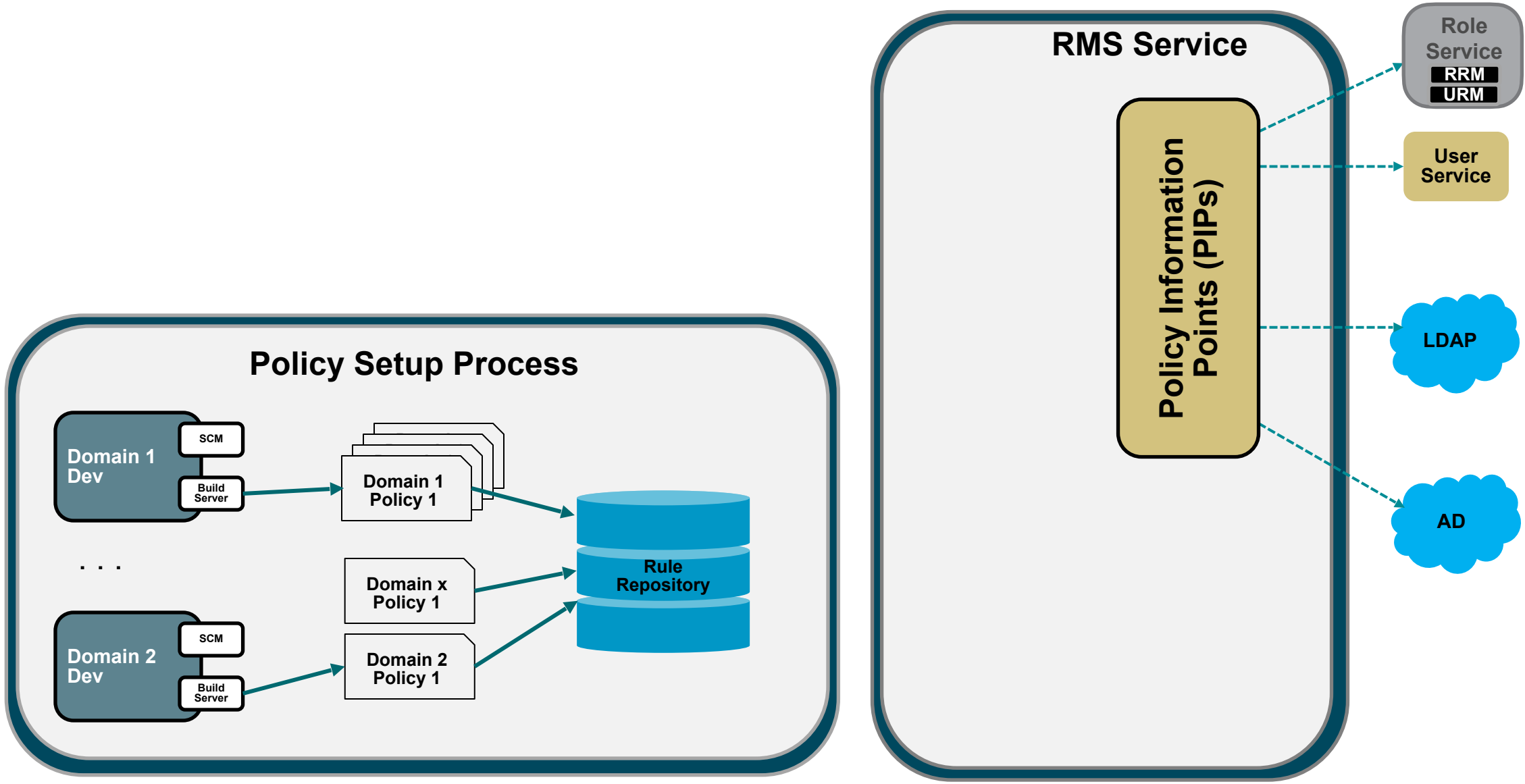
RRM	Role Responsibility Mapping
URM	User Role Mapping



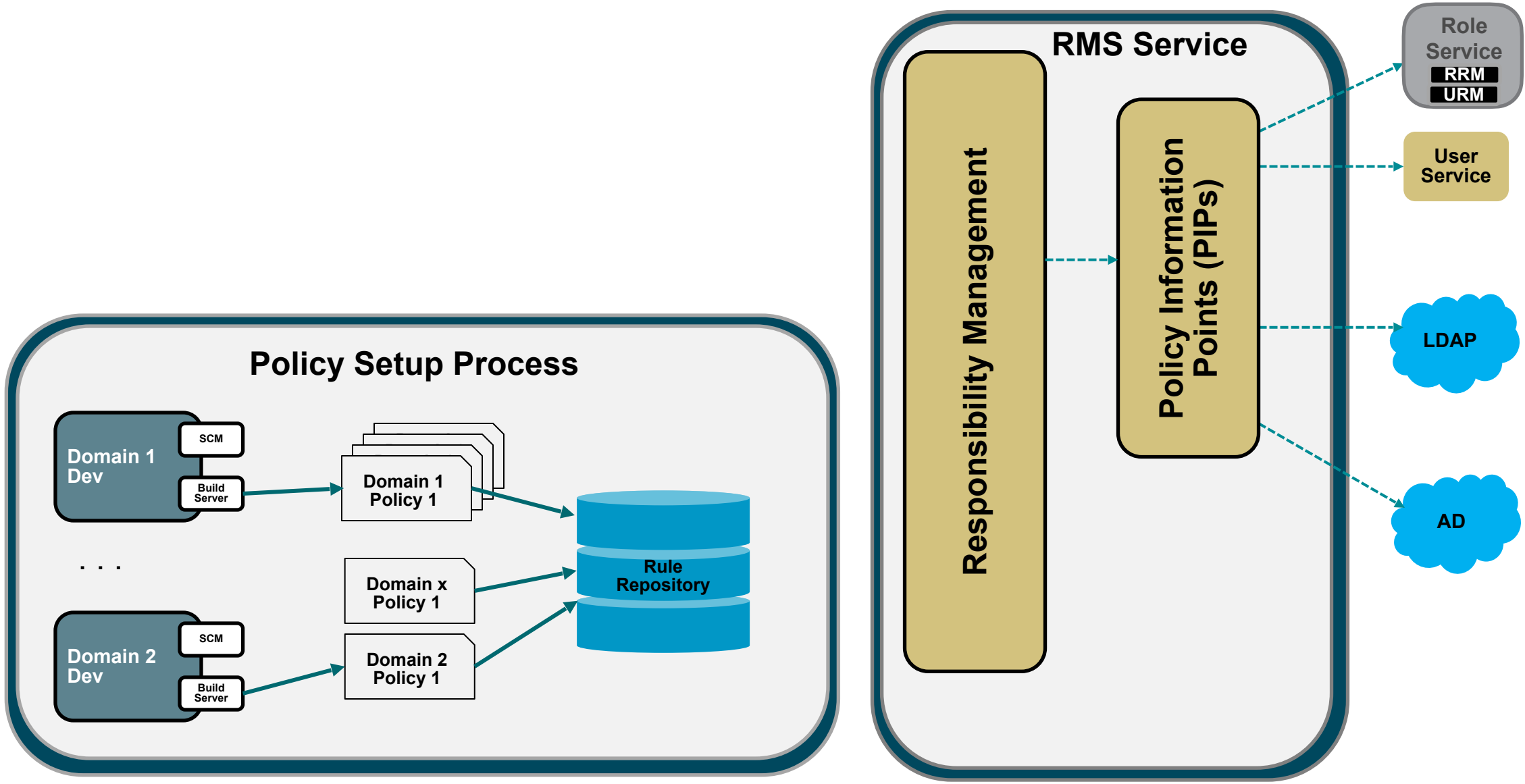
RMS Architecture - Version 1: Federated

RRM Role Responsibility Mapping

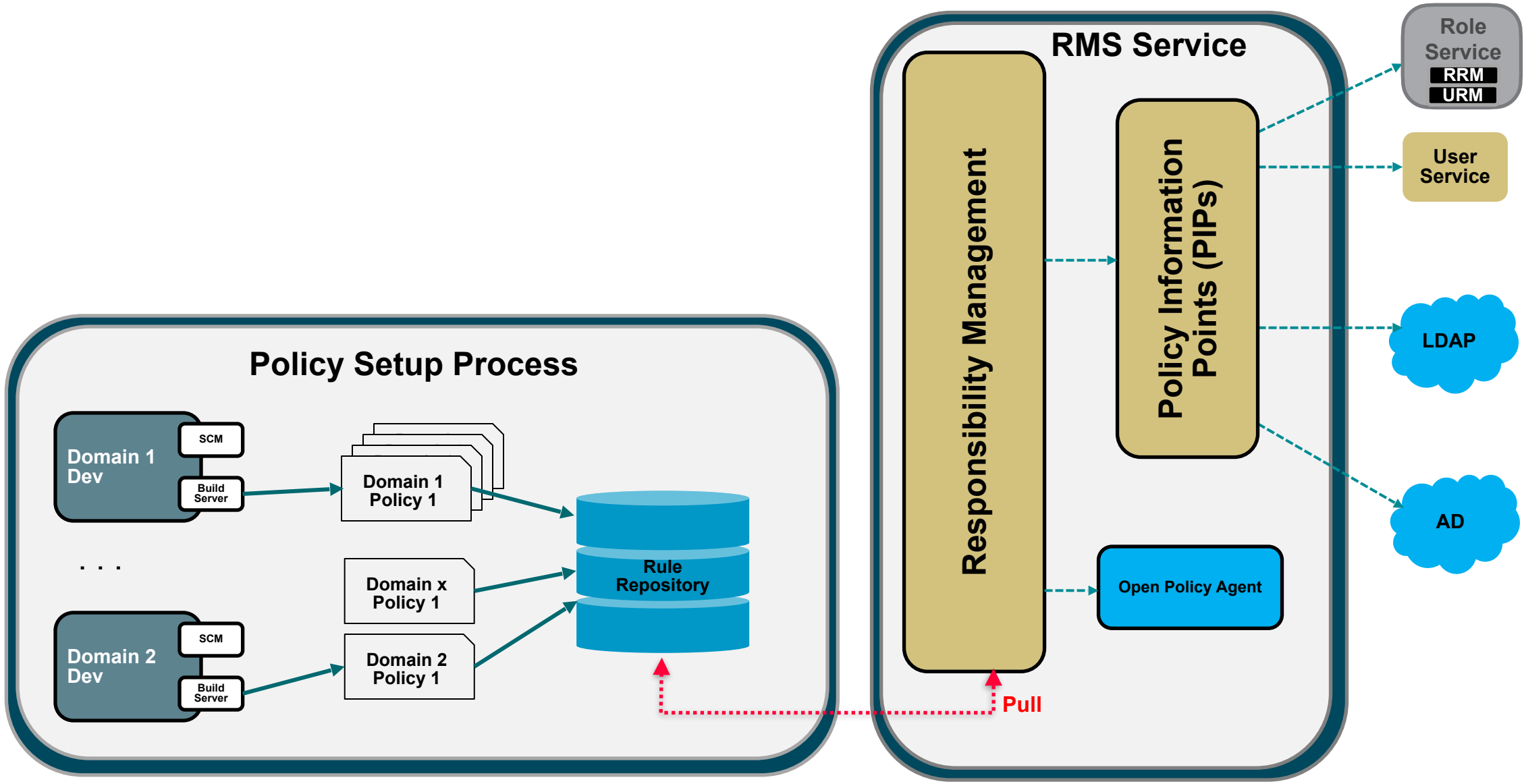
URM User Role Mapping



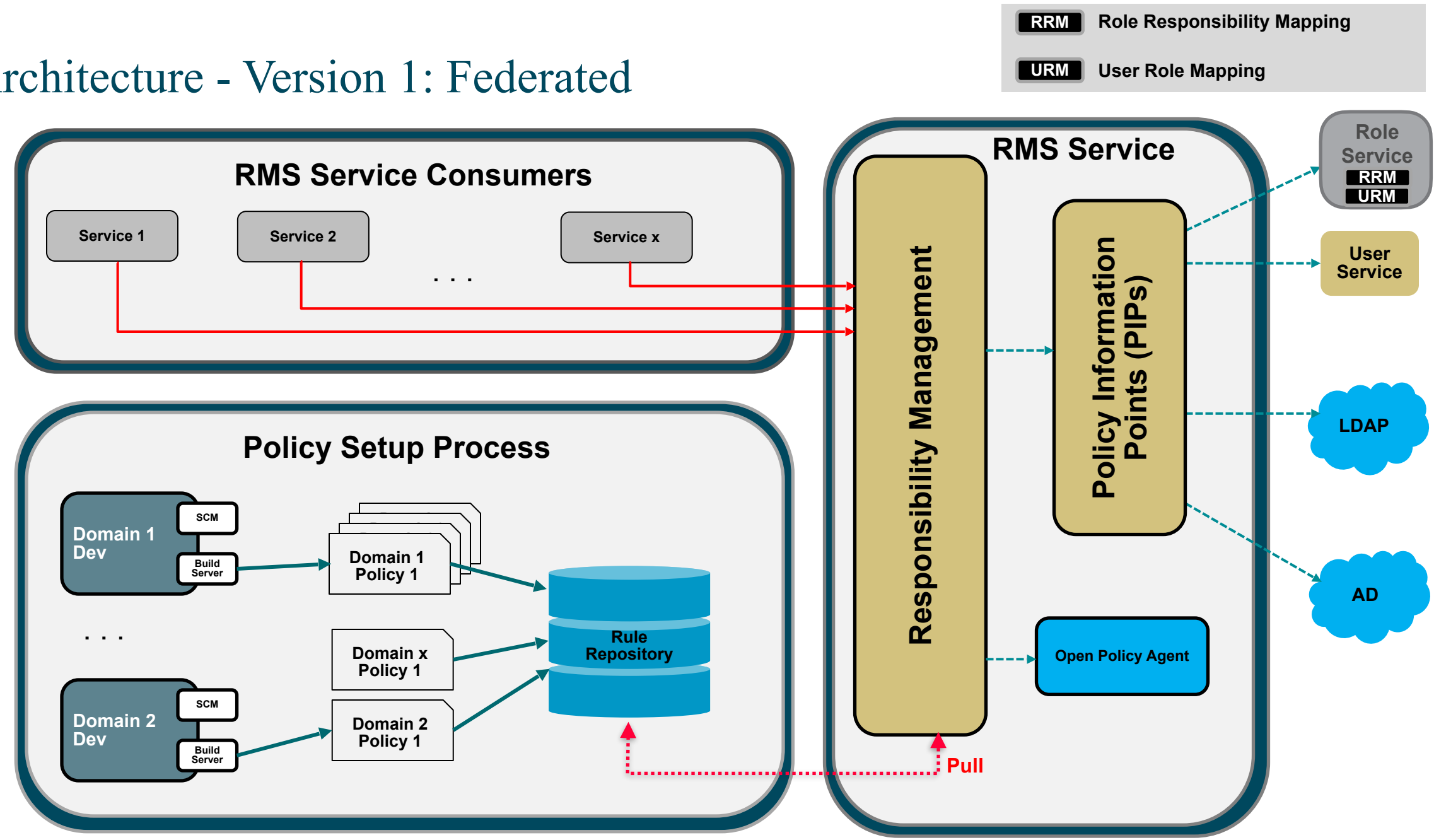
RMS Architecture - Version 1: Federated



RMS Architecture - Version 1: Federated



RMS Architecture - Version 1: Federated



Federated Architecture: Issues Faced

Key issues

- Segregation and information-barrier needs **implied more work**.
- A rogue policy script could lead to **loss of service for all domains**.
- RM Service **became the gatekeeper for testing and coverage**.
- RM Service **had to establish a release-train model** to pick up new policies.
- Out-of-band policy changes lead to **intermittent service-unavailability**.
- **Observation**: Policy changes were more frequent when a new domain onboards.

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Responsibility Management System

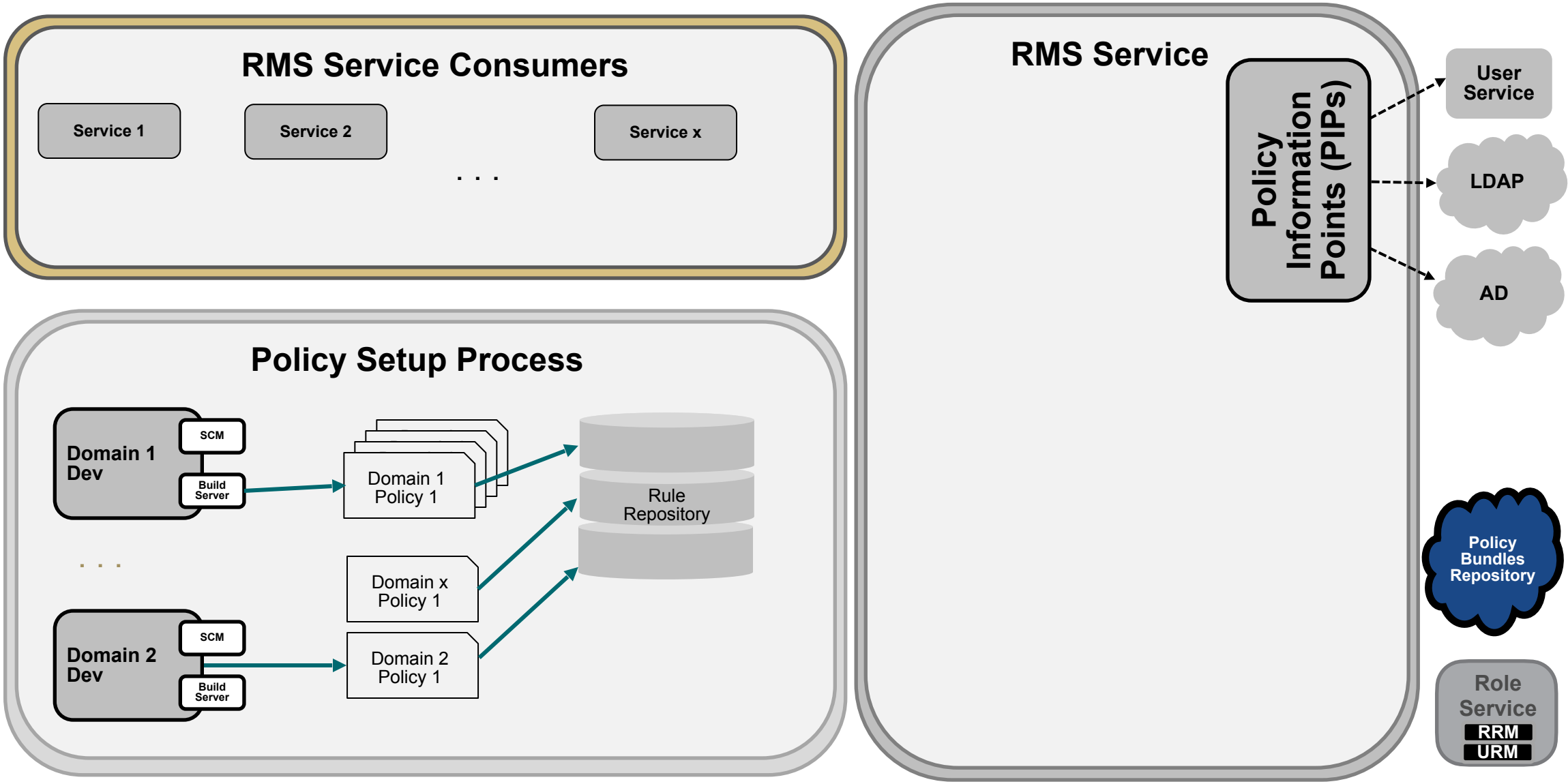
Architecture (Version 2)

A ***Distributed*** Responsibility Management Service

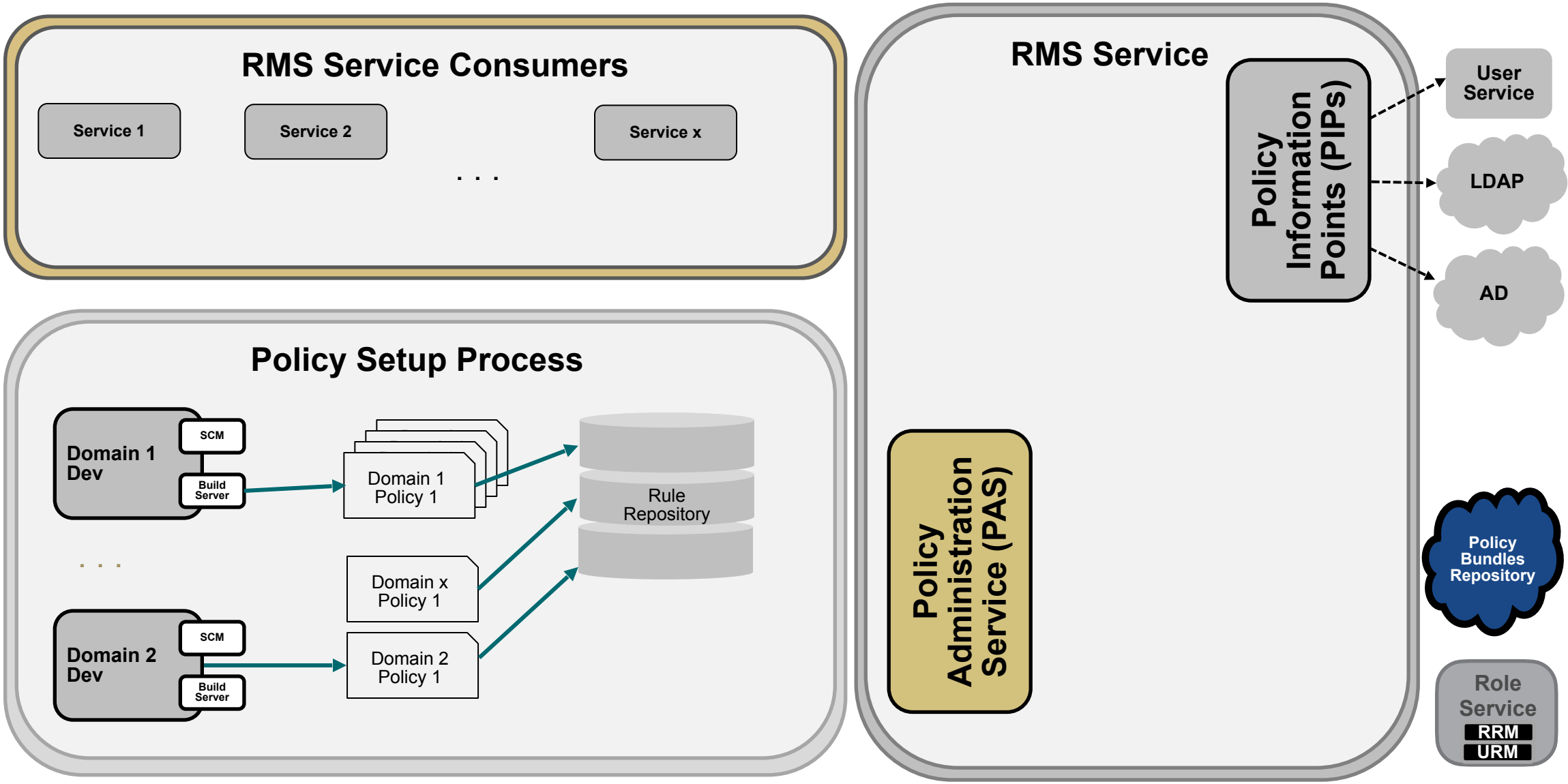
RMS Architecture - Version 2: Distributed

RRM Role Responsibility Mapping

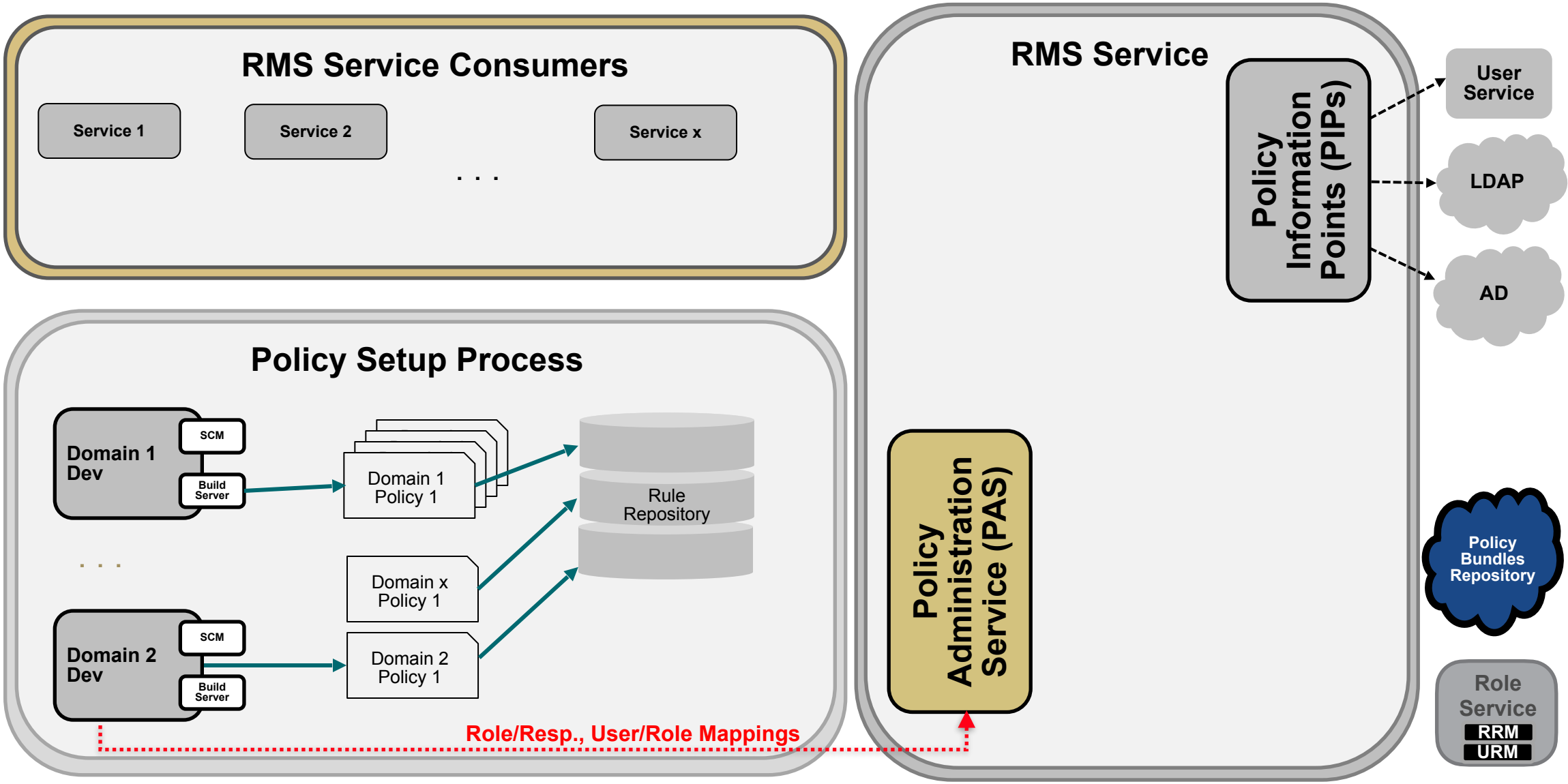
URM User Role Mapping



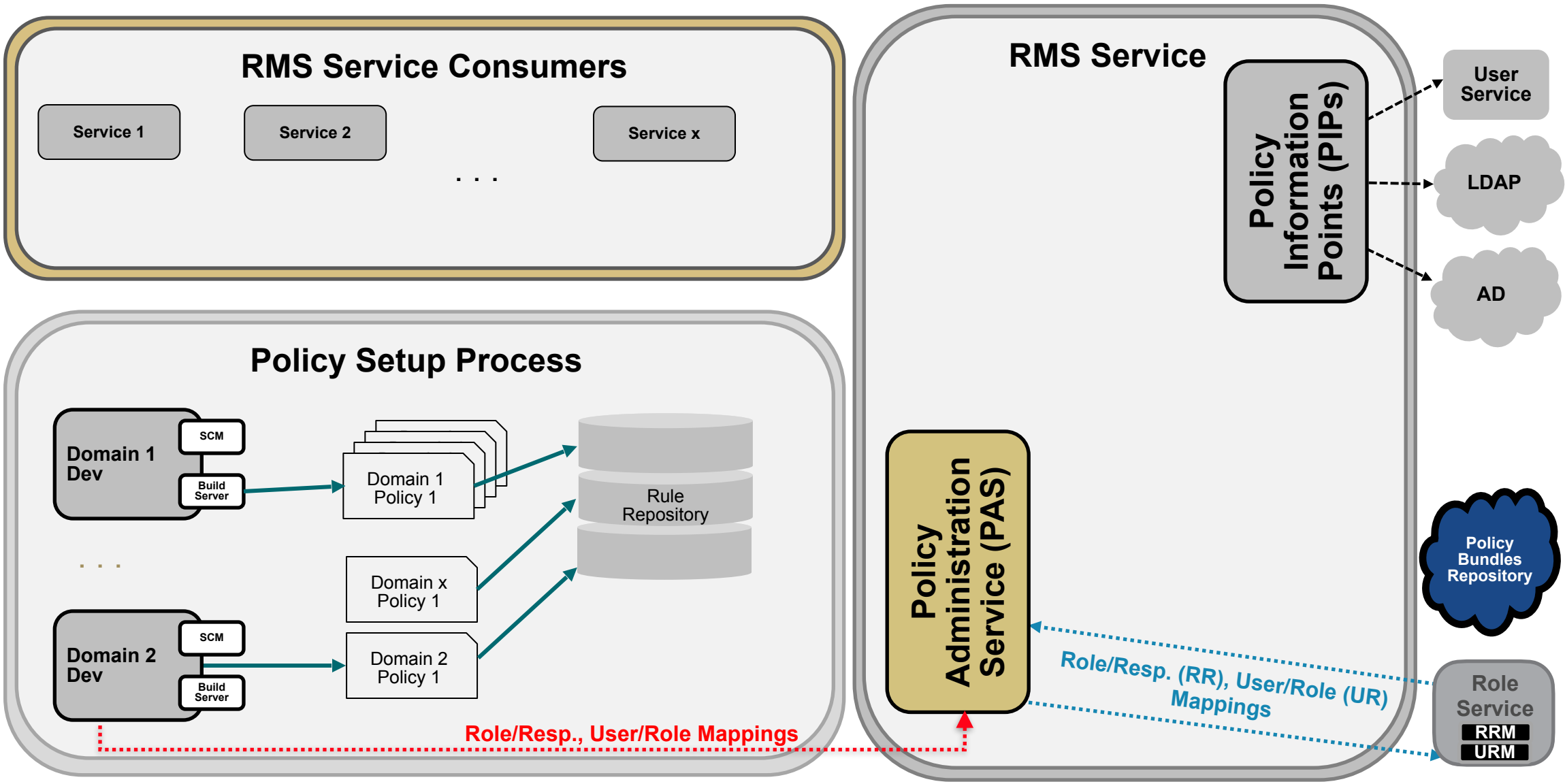
RMS Architecture - Version 2: Distributed



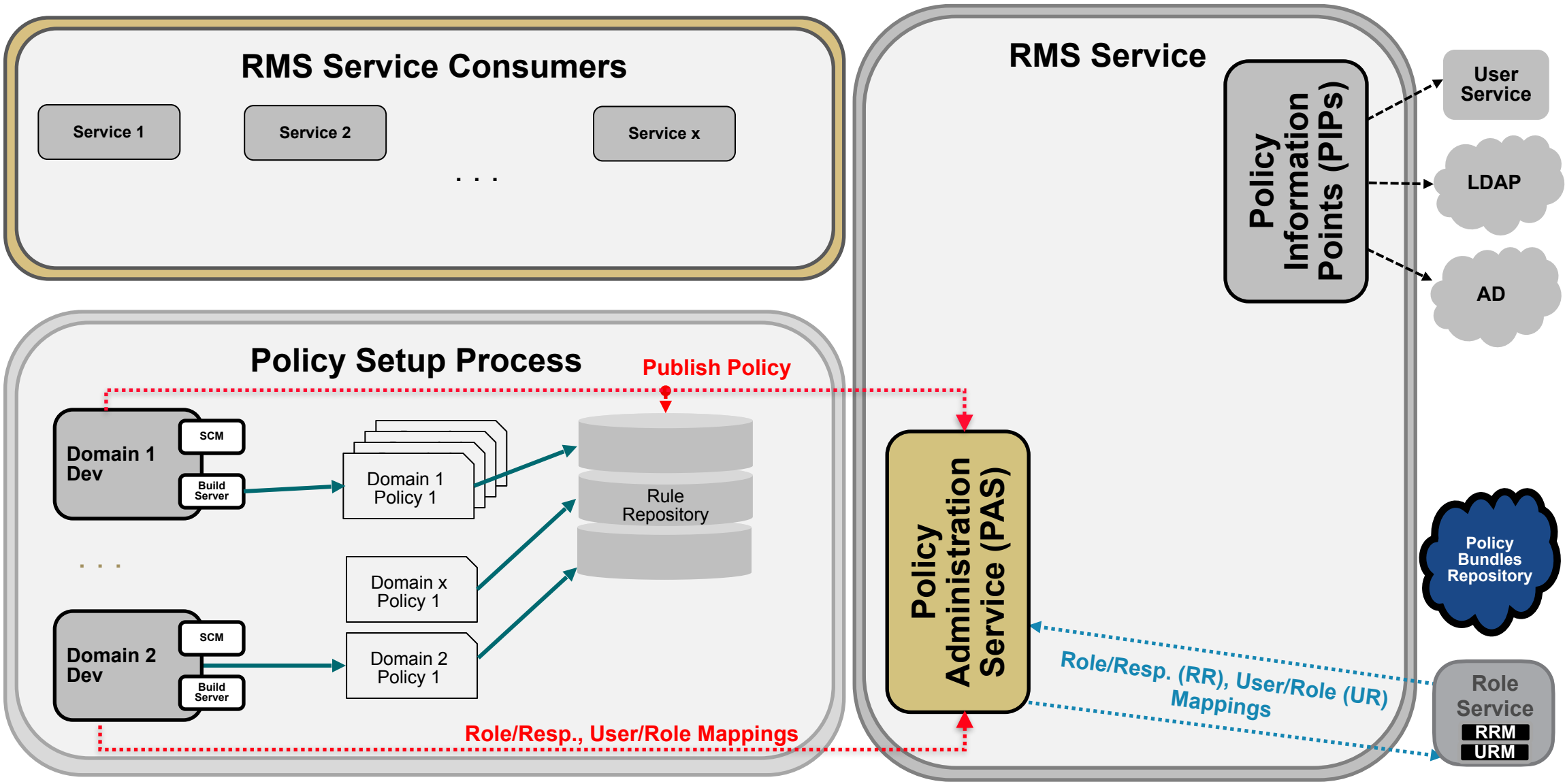
RMS Architecture - Version 2: Distributed



RMS Architecture - Version 2: Distributed



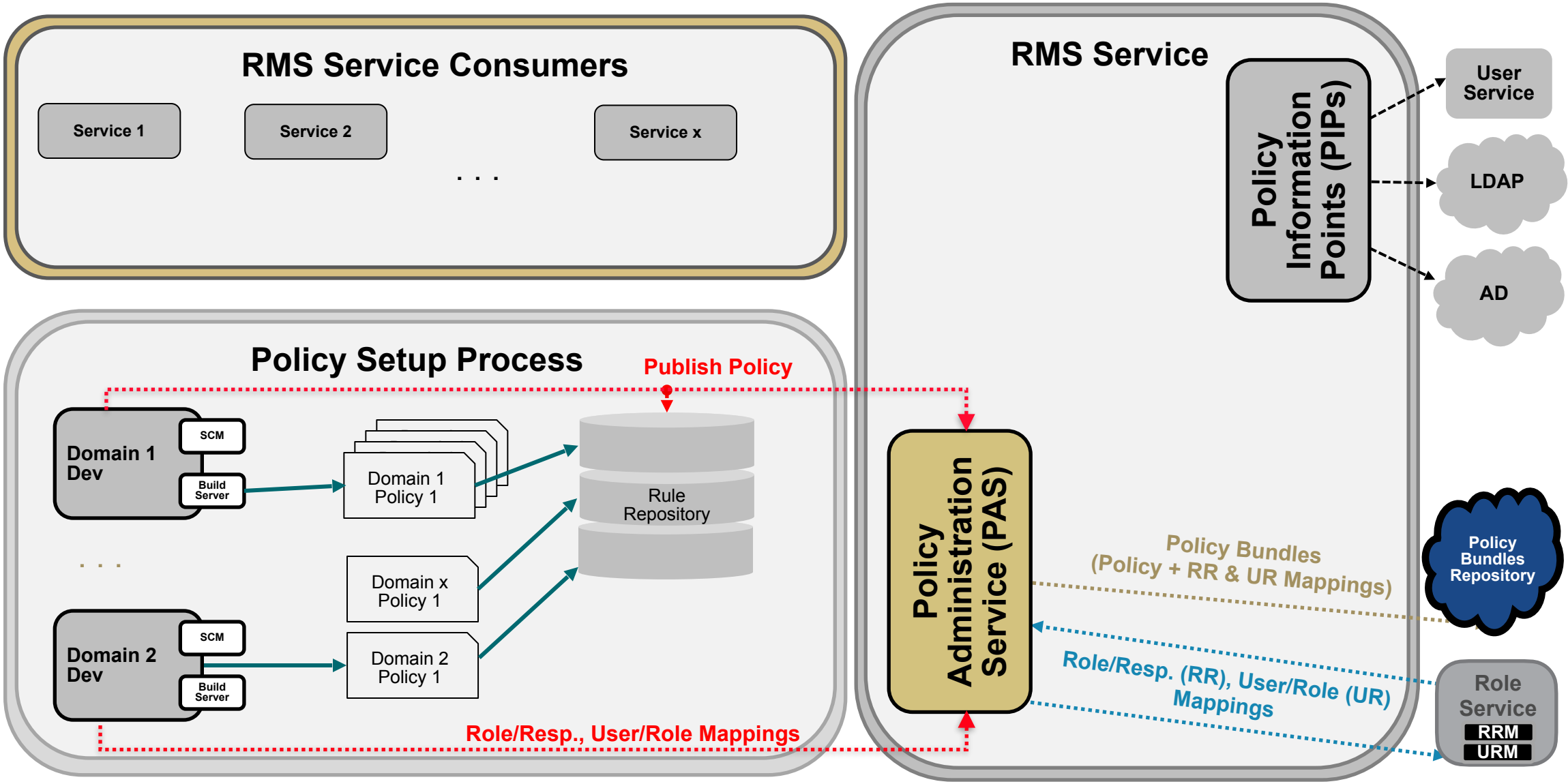
RMS Architecture - Version 2: Distributed



RMS Architecture - Version 2: Distributed

RRM Role Responsibility Mapping

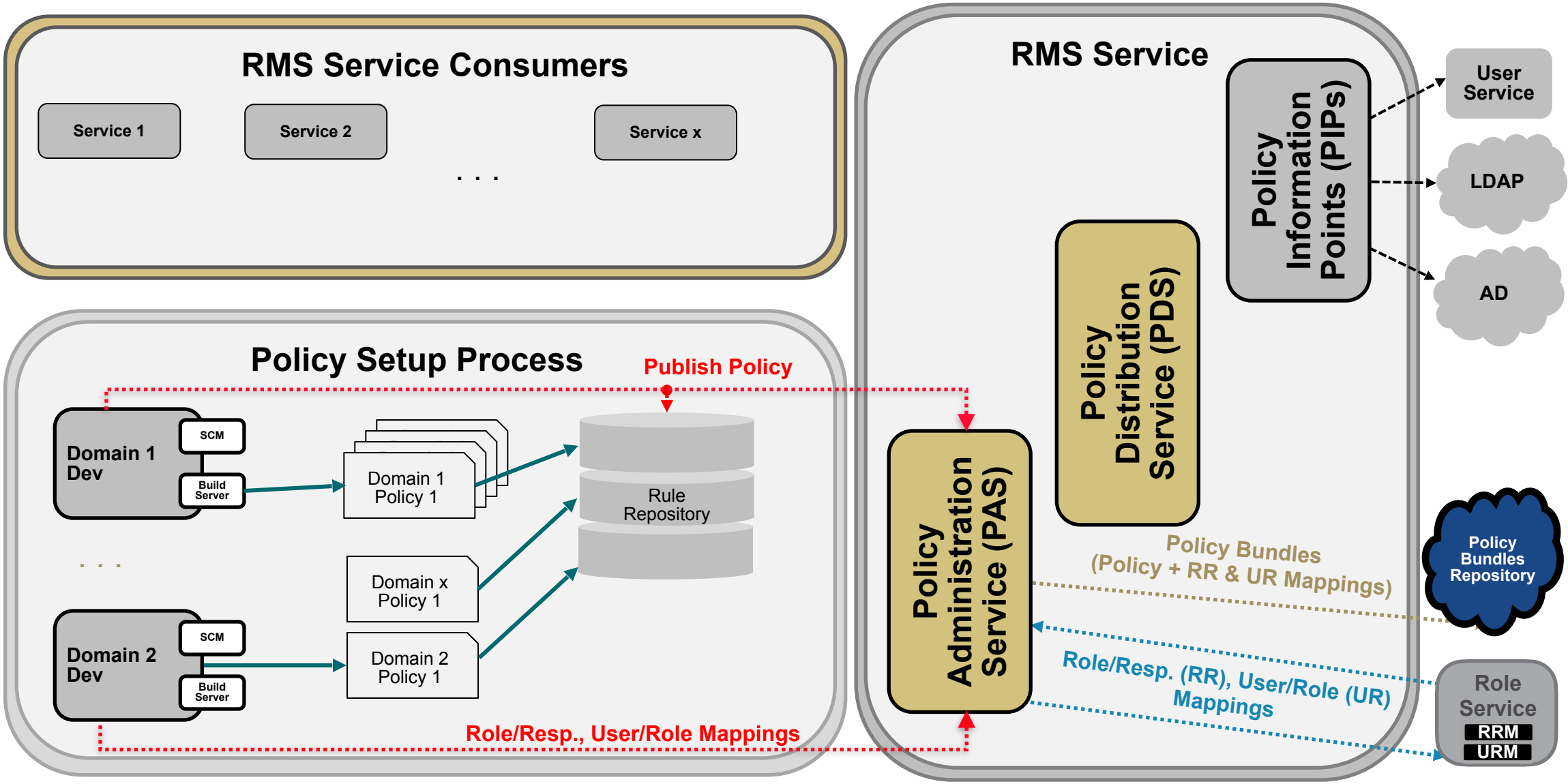
URM User Role Mapping



RMS Architecture - Version 2: Distributed

RRM Role Responsibility Mapping

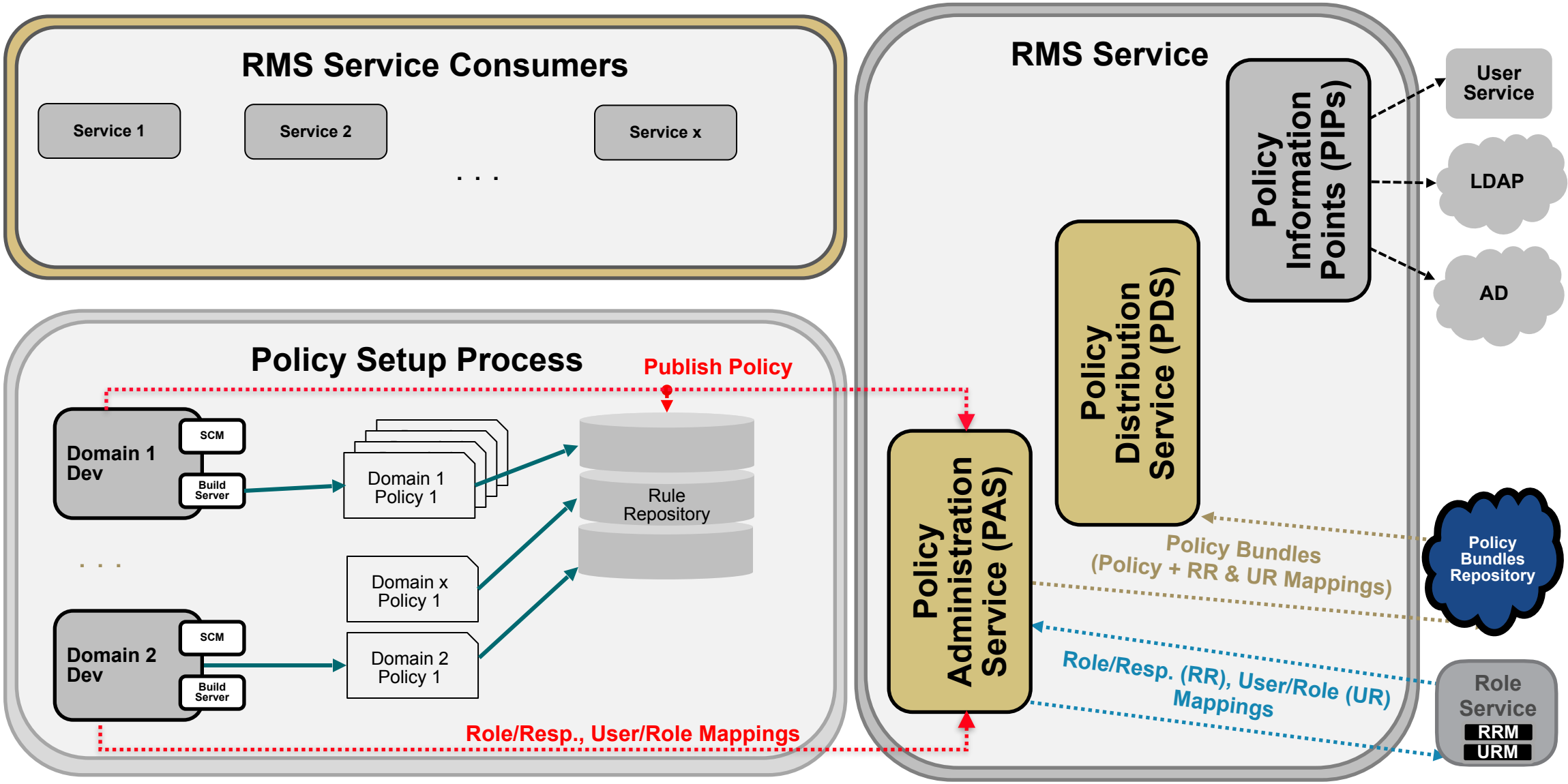
URM User Role Mapping



RMS Architecture - Version 2: Distributed

RRM Role Responsibility Mapping

URM User Role Mapping



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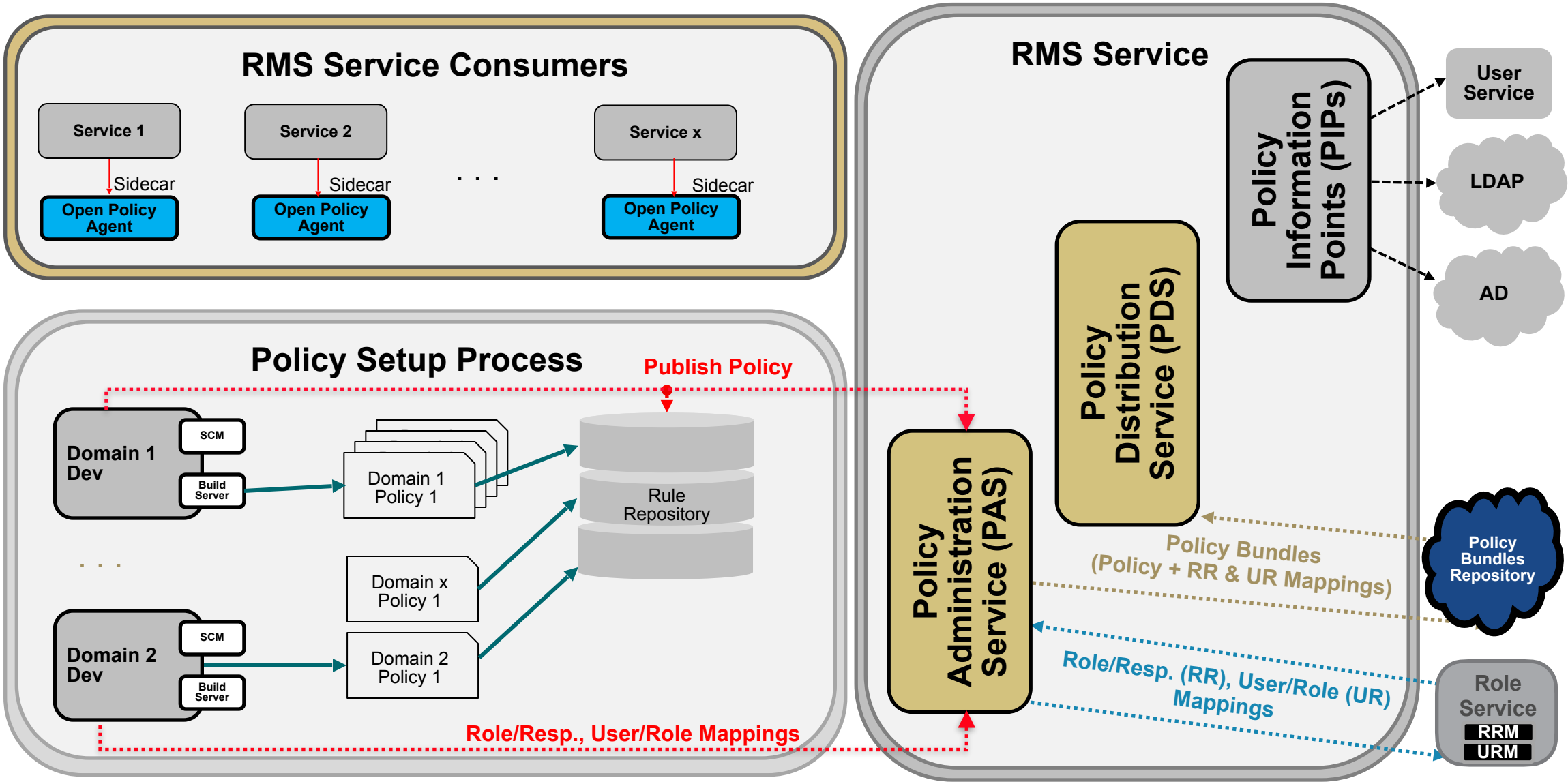
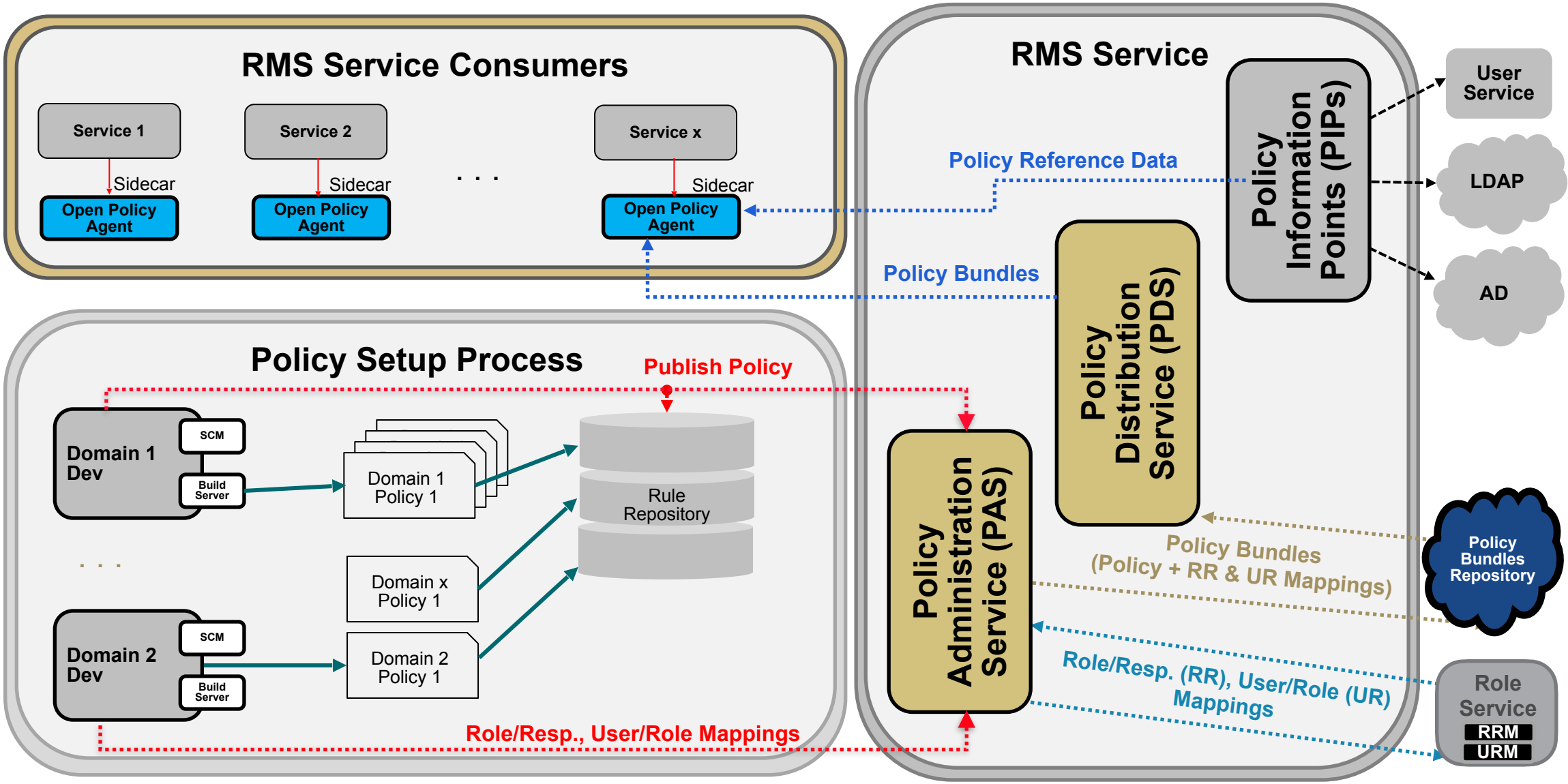
RMS Architecture - Version 2: Distributed



RMS Architecture - Version 2: Distributed

RRM Role Responsibility Mapping

URM User Role Mapping



Benefits of a Distributed Policy Management Architecture

Comparing Version 1 (federated single policy engine) with Version 2 (distributed policy engines)

	V1 Federated Policy Engine	V2 Distributed Policy Engine
Segregation and Information Barriers	Requires **additional work**	Is implicit, **no additional work**
Impact of a rogue policy script	Outage for **all domains**	Outage **only for the specific domain**
Gatekeeping for testing and coverage	Requires **RMS** to be the gatekeeper	Requires **domain** to be the gatekeeper
Strategy for new and updated policies	**Needed a Release Train model**	**A domain can push policies on-demand**
Impact of ad-hoc policy changes	RMS Downtime for **all domains**	RMS Downtime for **the changed domain**
Implicit RBAC Support	-	**Available**

Policy Bundles Repository

Policy bundles repository stored enriched policy archives.

Enriched policy bundles are archives that contain:

- Policy file(s), **specific to the domain**.
- Policy static data, **specific to the domain**.
- Standard RMS OPA policy rego files **common across all domains**.

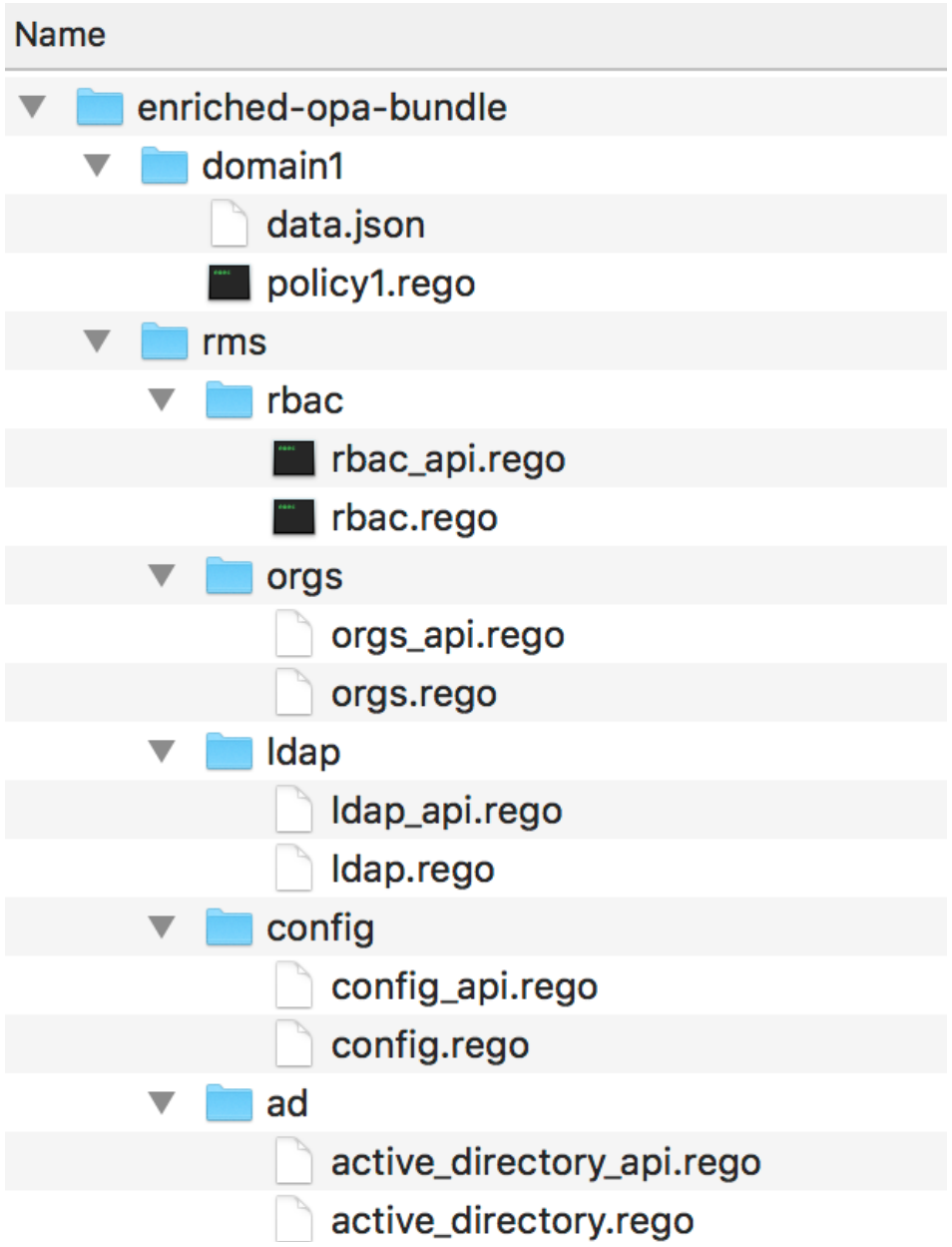
Policy Bundles Repository

Folder structure in policy bundles repository :

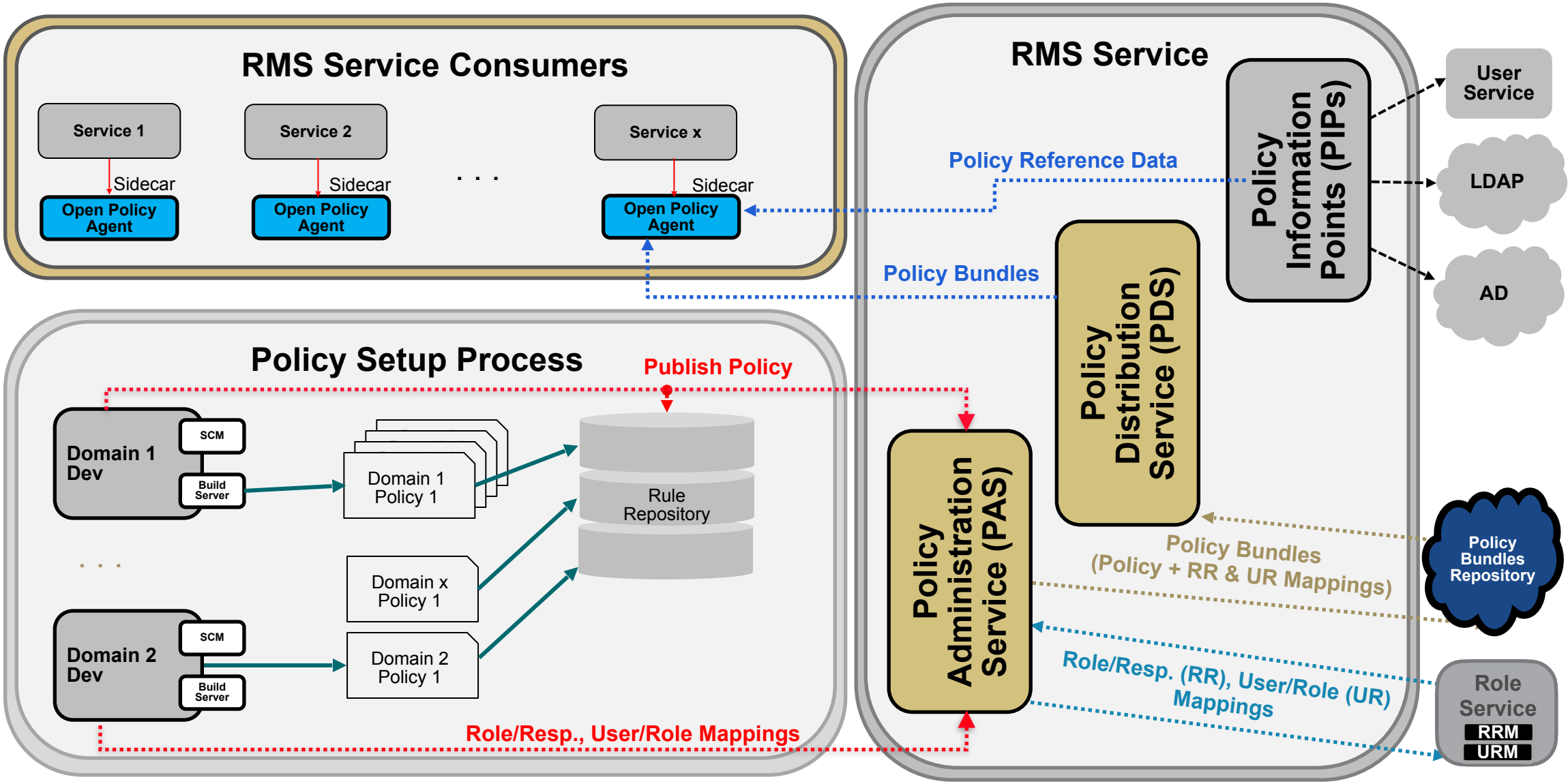
- **<domain>**
  - **<policy>**
    - **<version>**
      - **<policy bundles>**

Example:

- domain1
  - policy1
    - 1.0.0
      - enriched-opa-bundle.tar.gz



RMS Architecture - Version 2: Distributed



Policy Agent: Setup

- Open Policy Agent (the executable)
- Open Policy Agent – Configuration
- Open Policy Agent – Dockerfile command

Policy Agent: Setup: Configuration Files

OPA Configuration file (located at **${configPath}**)

```
services:
  - name: domainPolicies
    url: policyDistributionServiceUrl/
    allow_insecure_tls: true
bundle:
  name: policyDomain/policyName/policyVersion
  service: domainPolicies
  polling:
    min_delay_seconds: minDelaySeconds
    max_delay_seconds: maxDelaySeconds
```

Policy Agent: Setup: Dockerfile Commands

OPA launch command (used in the Dockerfile)

```
exec ./opa run --server --log-level=debug –c ${configPath}
```

RBAC Policy Library

```
package rbac

user_has_responsibility(userId, action, resource) {
  role := roles[_]

  responsibility := role.responsibilities[_]
  does_resource_match(resource, responsibility)

  responsibility.actions[_] = action

  is_user_a_member(userId, role)
}

is_user_a_member(userId, role) {

  ...
}
```

rbac.rego

Application Policy

```
package application1

default allow = false

allow {
    data.rbac.user_has_responsibility(
              input.userid, input.action,
              input.service)
}
```

policy.rego

Sample Role Data Excerpts

```
{
  "name": "App User",
  "responsibilities": [
    {
      "resource":
        "service.1",
      "actions": [
        "provision"
      ]
    },
    {
      "resource":
        "service.2",
      "actions": [
        "provision"
      ]
    }
  ],
  "members": [
    "EVERYONE"
  ]
}
```

data1.json

```
{
  "name": "App Admin",
  "responsibilities": [
    {
      "resource":
         "regexp:service\\..*",
      "actions": [
        "create",
        "update",
        "delete",
        "view"
      ]
    }
  ],
  "members": [
    "org:abc"
  ]
}
```

data2.json

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IDE Productivity

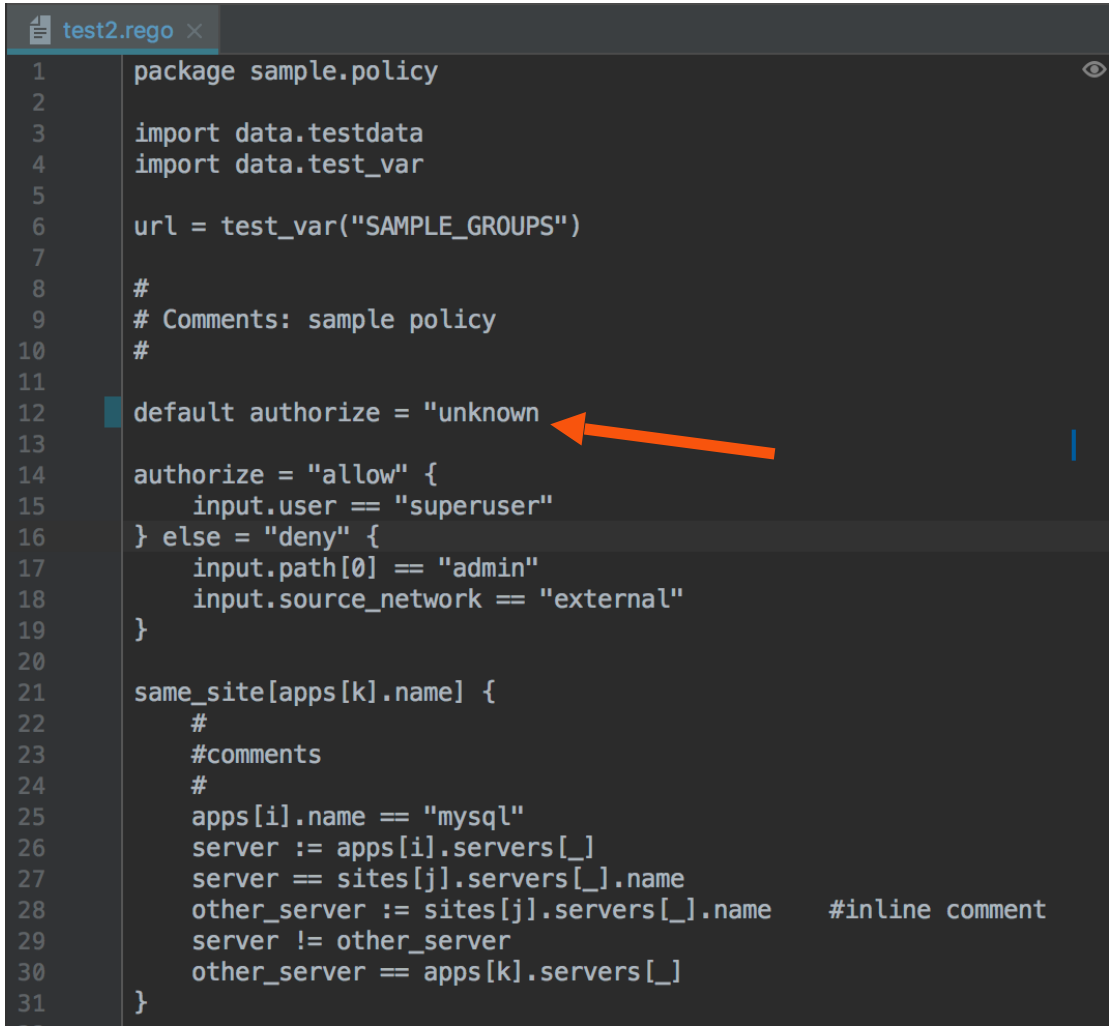
An IDE plugin tool for the Open Policy Agent file authoring

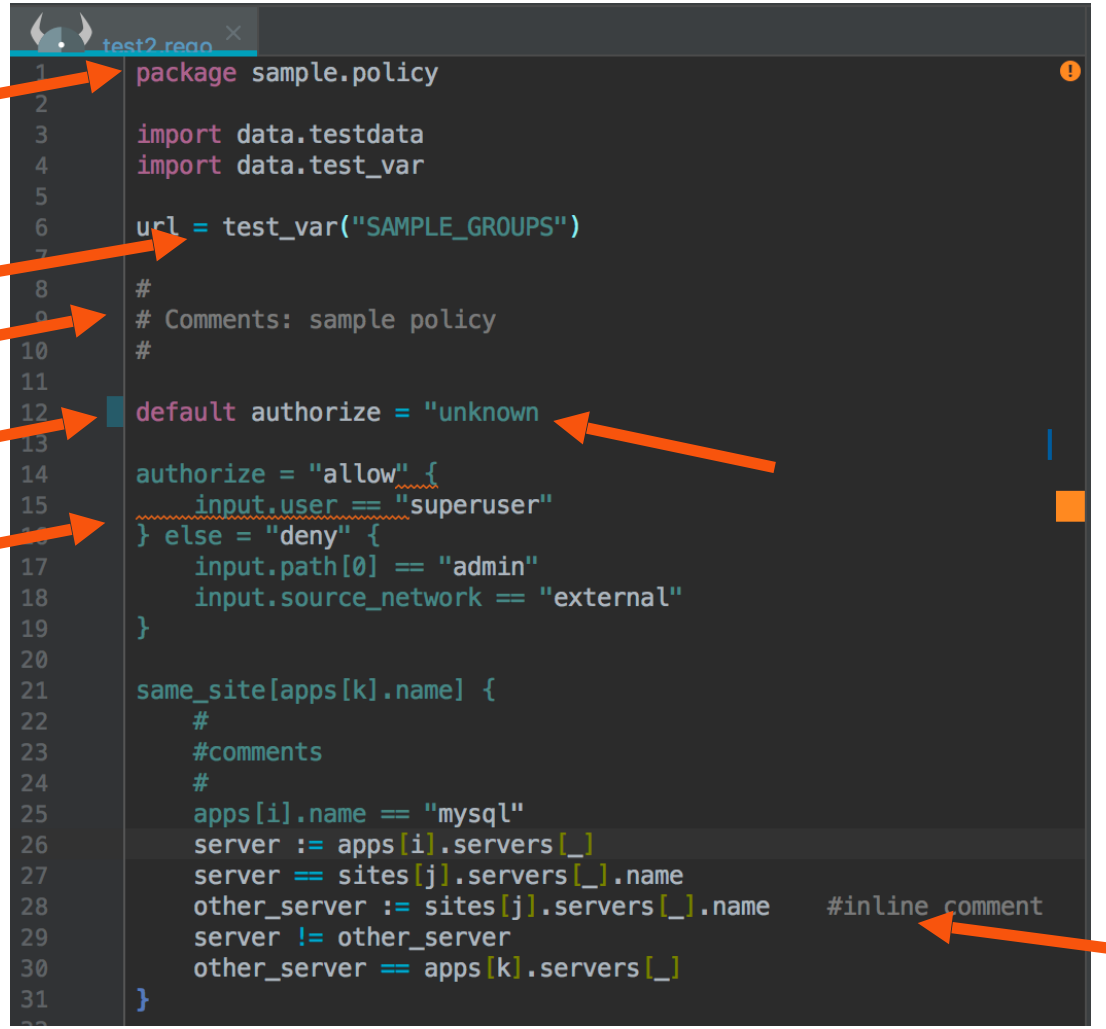
Open Policy Agent: IntelliJ Plugin

- OPA IntelliJ Plugin is *functional* work-in-progress policy editor.
- The editor parses and validates OPA policy.
- Relies on the OPA language reference linked * below.
- Can be customized for editor color schemes in IntelliJ.
- Work continues on indentation, run configurations and variable tracking.

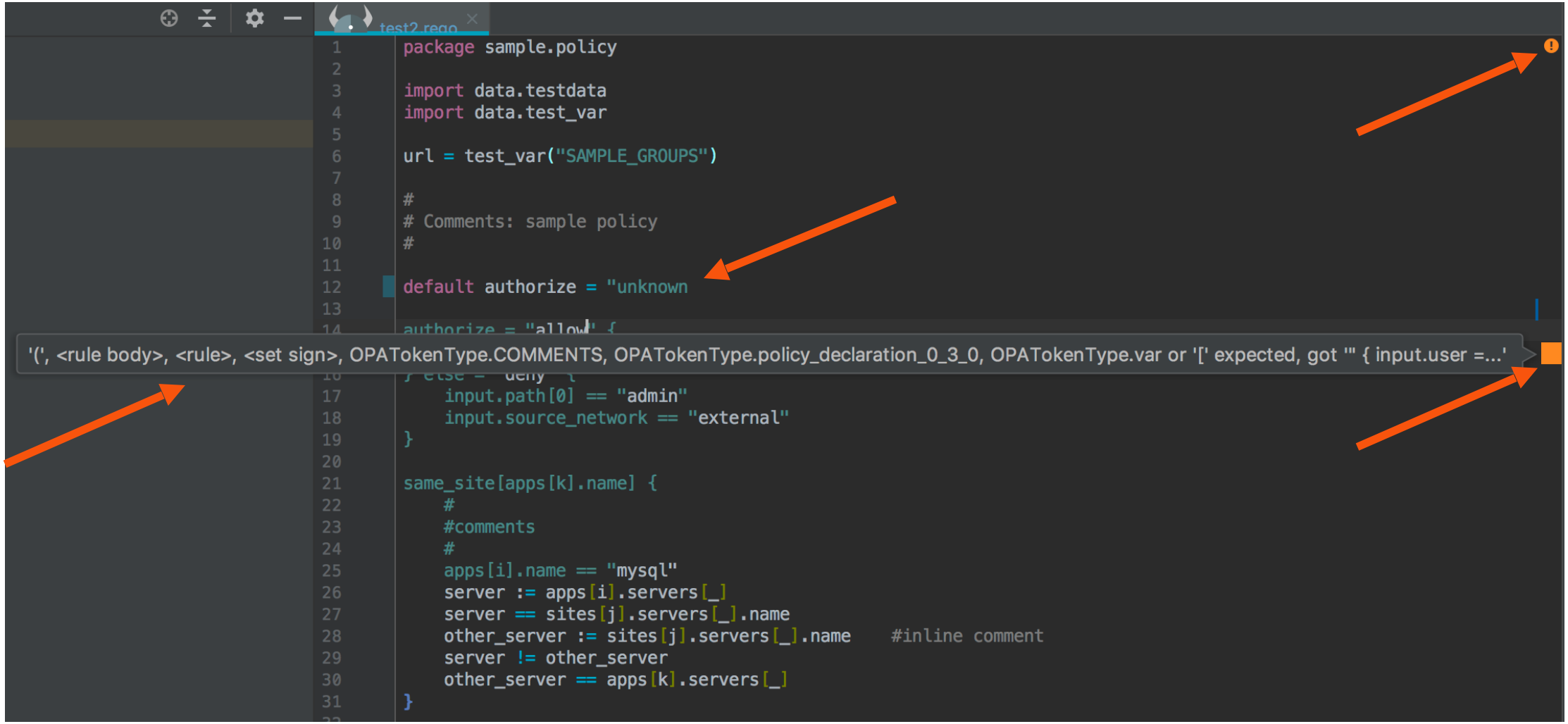
https://www.openpolicyagent.org/docs/latest/language-reference/

Open Policy Agent: IntelliJ Plugin: Before and After

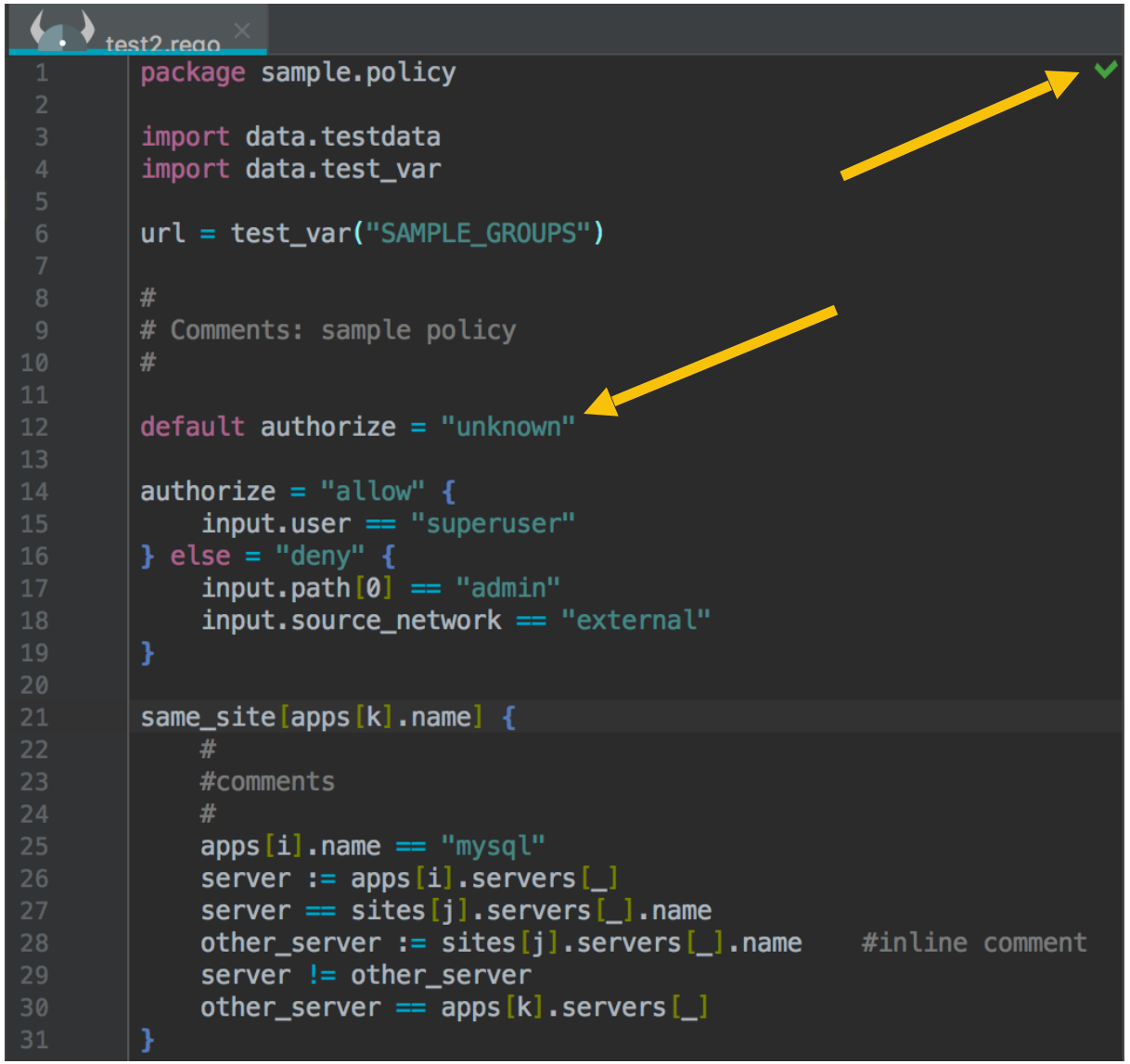




Open Policy Agent: IntelliJ Plugin: Syntax Validation



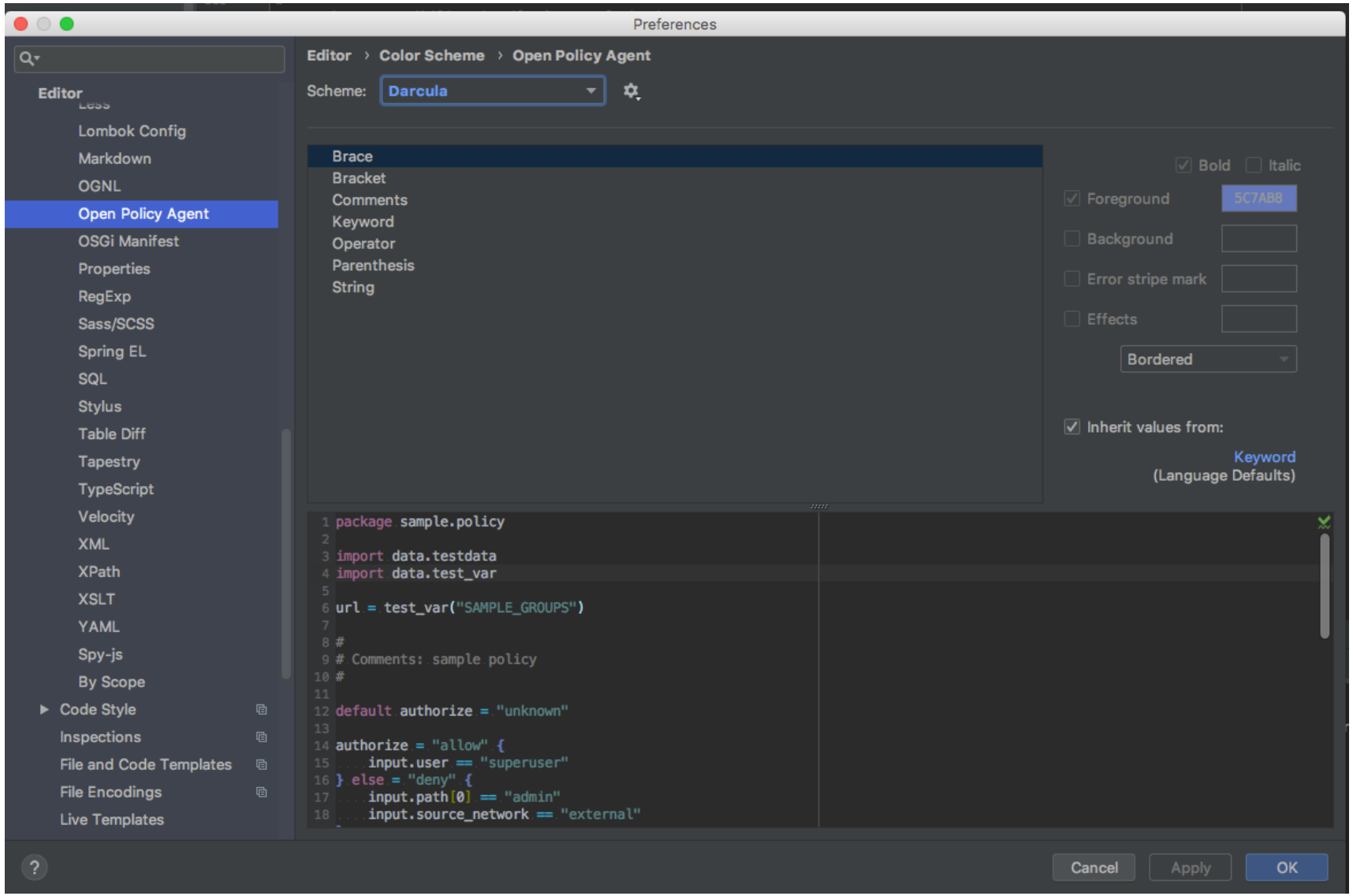
Open Policy Agent: IntelliJ Plugin: Syntax Validation - Continued



Open Policy Agent: IntelliJ Plugin: Settings

Select

- Preferences
  - Editor
    - > Color Scheme
      - Open Policy Agent



Summary

- Responsibility Management as a Service can resolve issues on several fronts.
- Choice of a payload format (HOCON over JSON or XML) can help control verbosity.
- Choice of architecture (federated versus distributed) can help determine resilience.
- Distributed policy engines can alleviate back-pressure and volume demands.
- Distributed policy engines can reduce outages and maintenance-related downtimes.
- Creating a policy editor plugin can help boost productivity.

Links

- HOCON

  https://github.com/lightbend/config/blob/master/HOCON.md

- Eclipse Collections

  https://www.eclipse.org/collections/

- Open Policy Agent

  https://www.openpolicyagent.org/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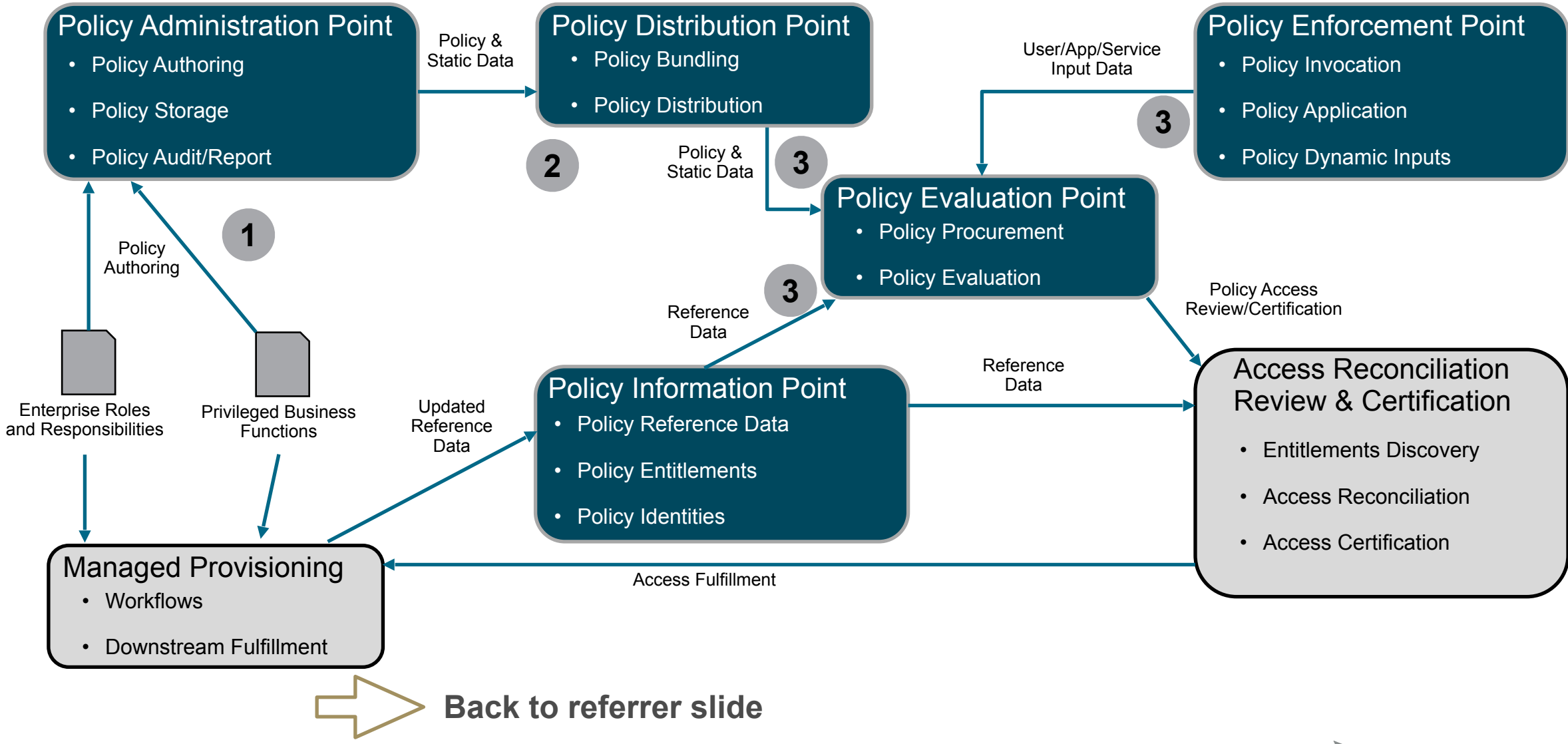
Appendix: Responsibility Management Cycle



Back to referrer slide