iRODS

Policy Composition

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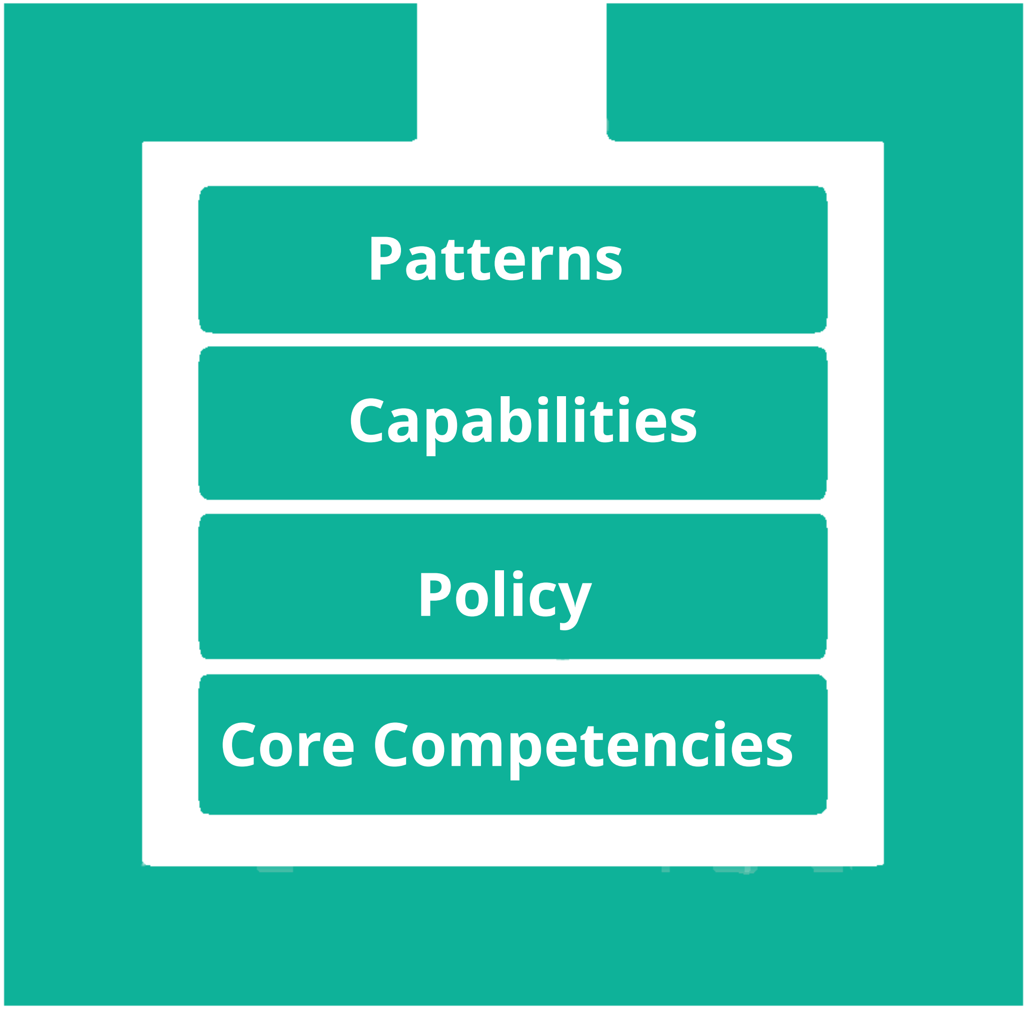
Motivation

- How can we help new users get started?
- How can we make policy reusable?
- How can we simplify policy development?
- How do we get from Policy to Capabilities?
- How can we provide a cook book of deployments?

The iRODS Technology Stack



Patterns

Capabilities

Policy

Core Competencies

What is Data Management

A Definition of Data Management

"The development, execution and supervision of plans, **policies**, programs, and **practices** that control, protect, deliver, and enhance the value of data and information assets."

Organizations need a **future-proof** solution to managing data and its surrounding infrastructure

What is Policy

A Definition of Policy

A set of ideas or a **plan** of what to do in **particular situations** that has been agreed to officially by a group of people...

So how does iRODS do this?

iRODS Policies

The reflection of real world data management decisions in computer actionable code.

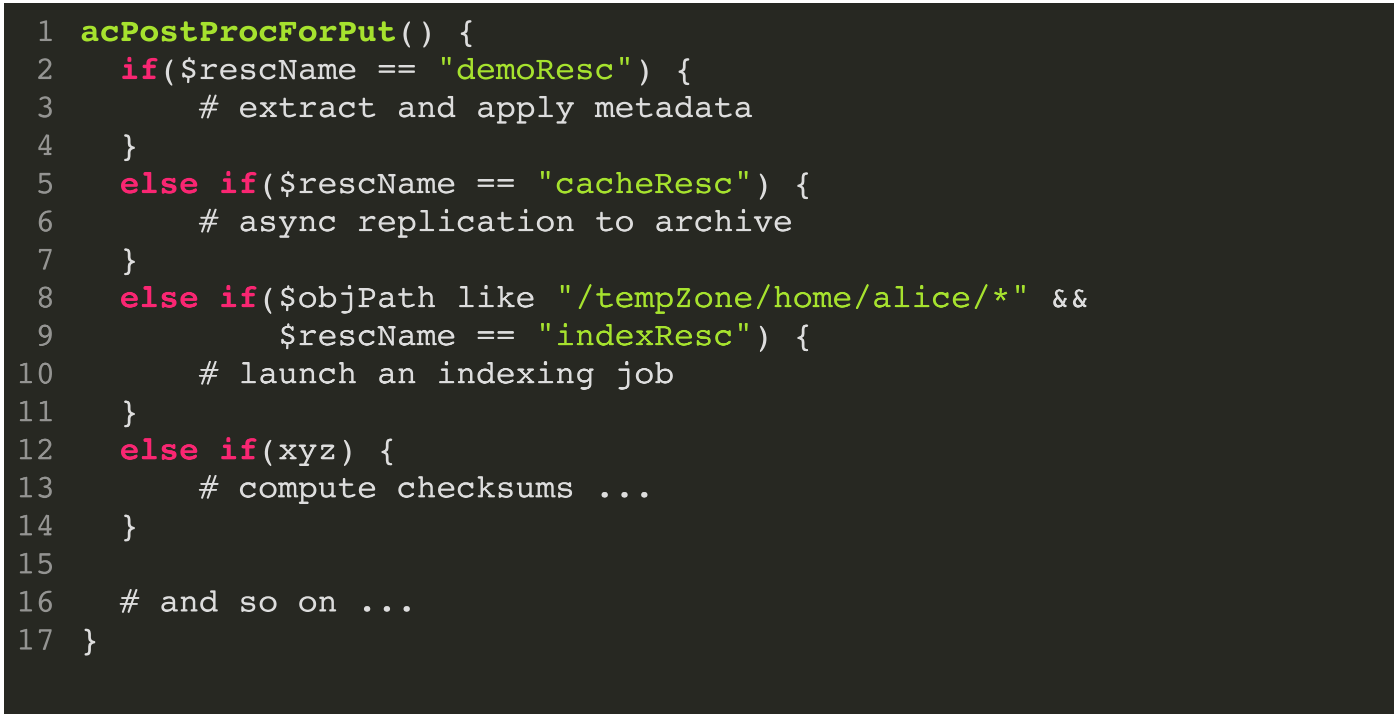
(a plan of what to do in particular situations)

Possible Policies

- Data Movement
- Data Verification
- Data Retention
- Data Replication
- Data Placement
- Checksum Validation
- Metadata Extraction
- Metadata Application
- Metadata Conformance
- Replica Verification
- Vault to Catalog Verification
- Catalog to Vault Verification
- …

The Original Approach

In /etc/irods/core.re ...



```
acPostProcForPut() {
  if($rescName == "demoResc") {
      # extract and apply metadata
  }
  else if($rescName == "cacheResc") {
      # async replication to archive
  }
  else if($objPath like "/tempZone/home/alice/*" &&
          $rescName == "indexResc") {
      # launch an indexing job
  }
  else if(xyz) {
      # compute checksums ...
  }

  # and so on ...
}
```

Our second approach

Expanding policy implementation across rule bases

For example: pep_data_obj_put_post(...)

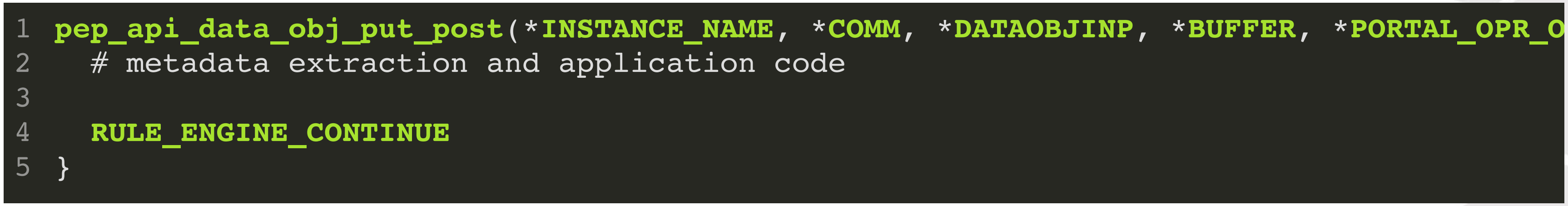
- Metadata extraction and application
- Asynchronous Replication
- Initiate Indexing
- Apply access time metadata
- Asynchronous checksum computation

Rather than one monolithic implementation, separate the implementations into individual rule bases, or plugins, and allow the rule(s) to fall through

Expanding policy across rule bases

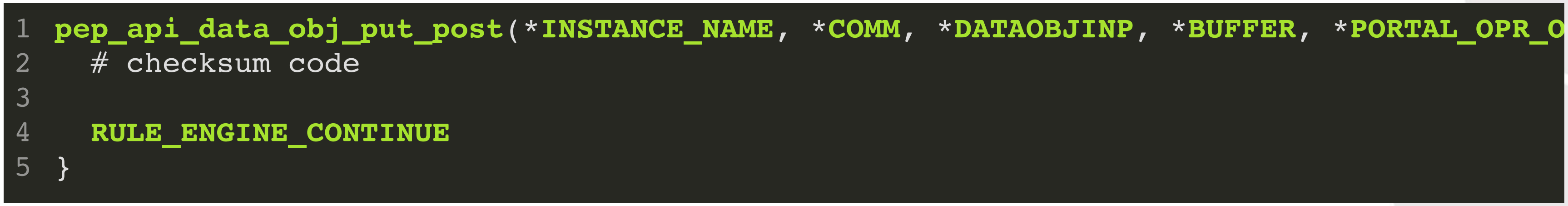
Separate the implementation into several rule bases:

/etc/irods/metadata.re



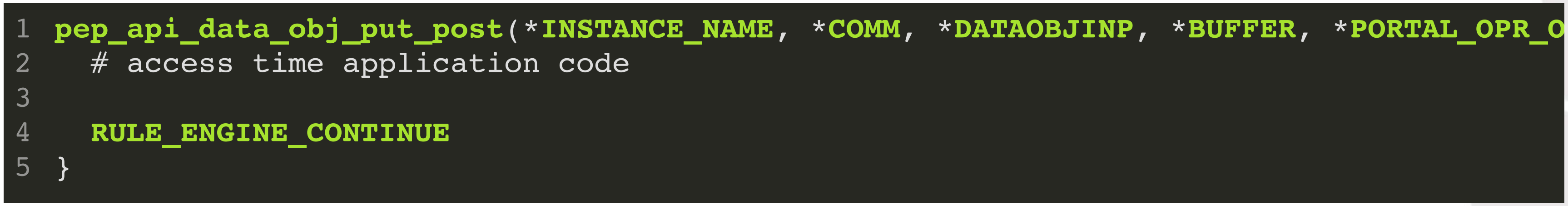
```
pep_api_data_obj_put_post(*INSTANCE_NAME, *COMM, *DATAOBJINP, *BUFFER, *PORTAL_OPR_O
  # metadata extraction and application code

  RULE_ENGINE_CONTINUE
}
```

/etc/irods/checksum.re



```
pep_api_data_obj_put_post(*INSTANCE_NAME, *COMM, *DATAOBJINP, *BUFFER, *PORTAL_OPR_O
  # checksum code

  RULE_ENGINE_CONTINUE
}
```

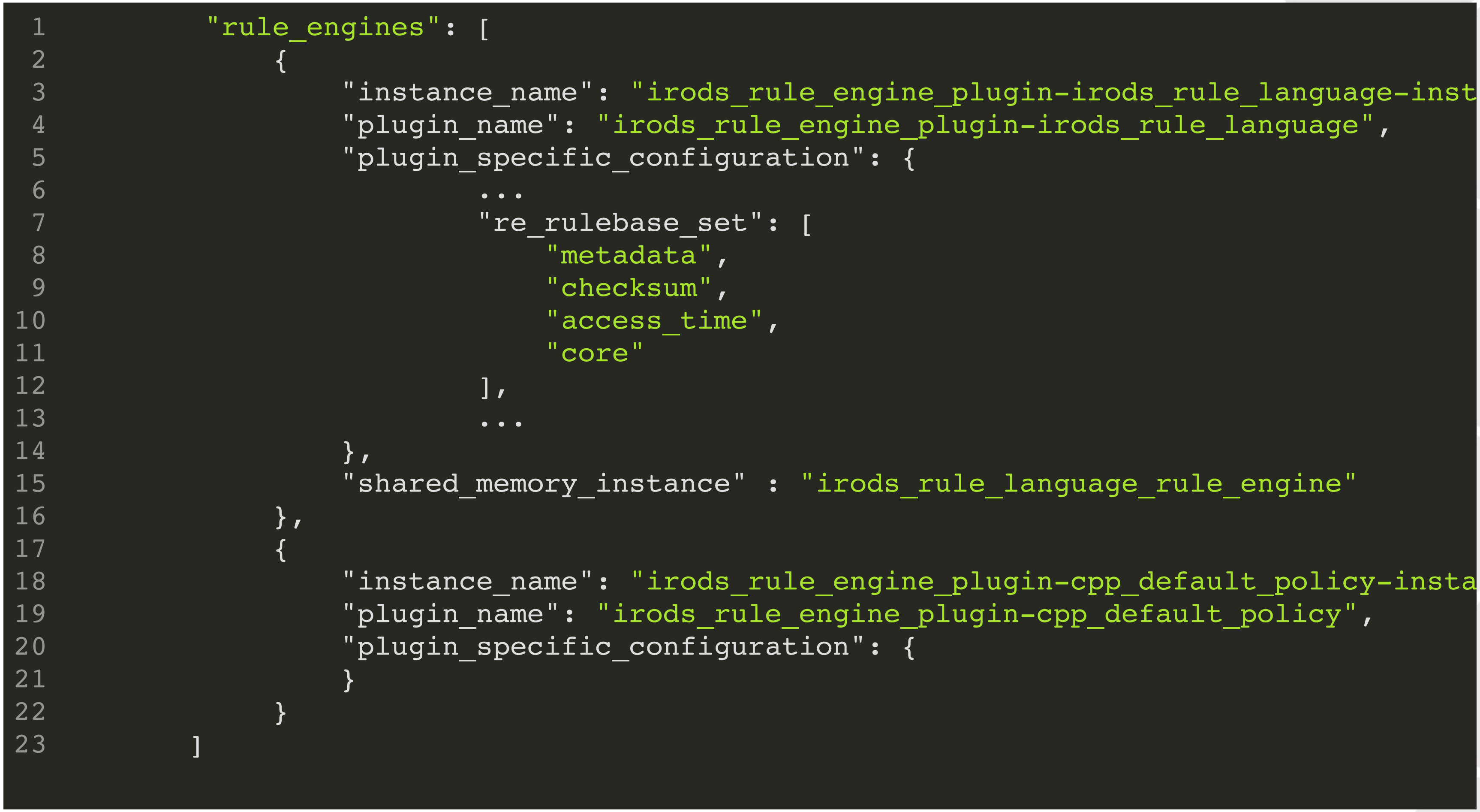
/etc/irods/access_time.re



```
pep_api_data_obj_put_post(*INSTANCE_NAME, *COMM, *DATAOBJINP, *BUFFER, *PORTAL_OPR_O
  # access time application code

  RULE_ENGINE_CONTINUE
}
```

Expanding policy across rule bases

Within the Rule Engine Plugin Framework, order matters



```
 "rule_engines": [
     {
         "instance_name": "irods_rule_engine_plugin-irods_rule_language-inst
         "plugin_name": "irods_rule_engine_plugin-irods_rule_language",
         "plugin_specific_configuration": {
                 ...
                 "re_rulebase_set": [
                     "metadata",
                     "checksum",
                     "access_time",
                     "core"
                 ],
                 ...
         },
         "shared_memory_instance" : "irods_rule_language_rule_engine"
     },
     {
         "instance_name": "irods_rule_engine_plugin-cpp_default_policy-insta
         "plugin_name": "irods_rule_engine_plugin-cpp_default_policy",
         "plugin_specific_configuration": {
         }
     }
]
```

Policy Composition

Consider Policy as building blocks towards Capabilities

Follow proven software engineering principles:

Favor composition over monolithic implementations

Provide a common interface across policy implementations to allow transparent configuration

Initial work with Policy Composition

Consider Storage Tiering as a collection of policies:

- Data Access Time
- Identifying Violating Objects
- Data Replication
- Data Verification
- Data Retention

The First Implementation

Policies invoked by monolithic framework plugins and delegated by convention:

- irods_policy_access_time
- irods_policy_data_movement
- irods_policy_data_replication
- irods_policy_data_verification
- irods_policy_data_retention

Each policy may be implemented by any rule engine, or rule base to customize for future use cases or technologies

The New Approach

Continue to separate the concerns:

- When : Which policy enforcement points
- What : The policy to be invoked
- Why : What are the conditions necessary for invocation
- How : Synchronous or Asynchronous

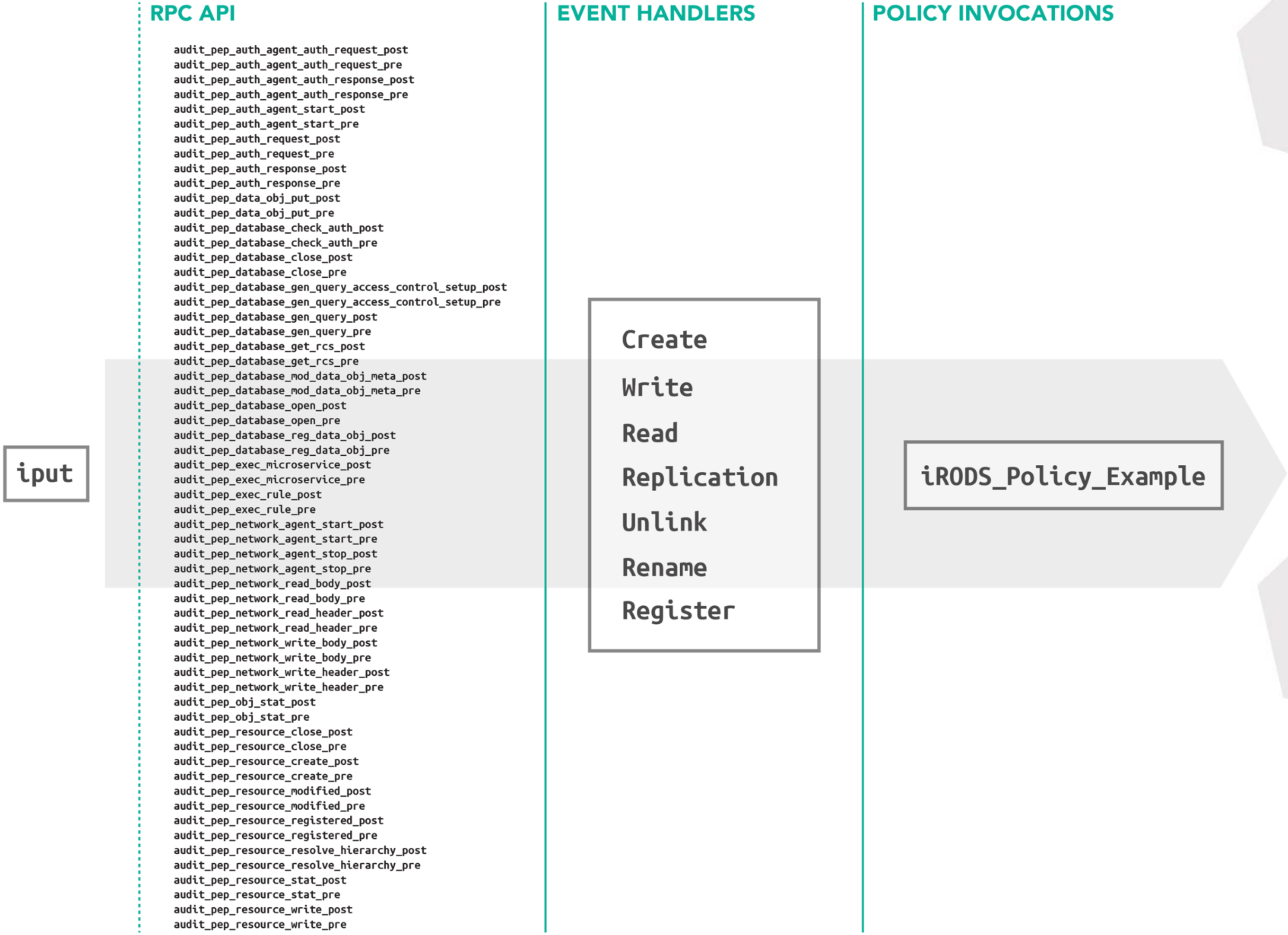
Write simple policy implementations

- Not tied to a Policy Enforcement Point
- Do one thing well
- How it is invoked is of no concern

Each policy may now be reused in a generic fashion, favoring configuration over code.

The When

When - Event Handlers



iput

RPC API

```
audit_pep_auth_agent_auth_request_post
audit_pep_auth_agent_auth_request_pre
audit_pep_auth_agent_auth_response_post
audit_pep_auth_agent_auth_response_pre
audit_pep_auth_agent_start_post
audit_pep_auth_agent_start_pre
audit_pep_auth_request_post
audit_pep_auth_request_pre
audit_pep_auth_response_post
audit_pep_auth_response_pre
audit_pep_data_obj_put_post
audit_pep_data_obj_put_pre
audit_pep_database_check_auth_post
audit_pep_database_check_auth_pre
audit_pep_database_close_post
audit_pep_database_close_pre
audit_pep_database_gen_query_access_control_setup_post
audit_pep_database_gen_query_access_control_setup_pre
audit_pep_database_gen_query_post
audit_pep_database_gen_query_pre
audit_pep_database_get_rcs_post
audit_pep_database_get_rcs_pre
audit_pep_database_mod_data_obj_meta_post
audit_pep_database_mod_data_obj_meta_pre
audit_pep_database_open_post
audit_pep_database_open_pre
audit_pep_database_reg_data_obj_post
audit_pep_database_reg_data_obj_pre
audit_pep_exec_microservice_post
audit_pep_exec_microservice_pre
audit_pep_exec_rule_post
audit_pep_exec_rule_pre
audit_pep_network_agent_start_post
audit_pep_network_agent_start_pre
audit_pep_network_agent_stop_post
audit_pep_network_agent_stop_pre
audit_pep_network_read_body_post
audit_pep_network_read_body_pre
audit_pep_network_read_header_post
audit_pep_network_read_header_pre
audit_pep_network_write_body_post
audit_pep_network_write_body_pre
audit_pep_network_write_header_post
audit_pep_network_write_header_pre
audit_pep_obj_stat_post
audit_pep_obj_stat_pre
audit_pep_resource_close_post
audit_pep_resource_close_pre
audit_pep_resource_create_post
audit_pep_resource_create_pre
audit_pep_resource_modified_post
audit_pep_resource_modified_pre
audit_pep_resource_registered_post
audit_pep_resource_registered_pre
audit_pep_resource_resolve_hierarchy_post
audit_pep_resource_resolve_hierarchy_pre
audit_pep_resource_stat_post
audit_pep_resource_stat_pre
audit_pep_resource_write_post
audit_pep_resource_write_pre
```

EVENT HANDLERS

Create
Write
Read
Replication
Unlink
Rename
Register

POLICY INVOCATIONS

iRODS_Policy_Example

When - The Event Handler

A Rule Engine Plugin for a specific Class of events

- Data Object
- Collection
- Metadata
- User
- Resource

The Events are specific to the class of the handler

The handler then invokes policy based on its configuration

When - event_handler-data_object_modified

A Rule Engine Plugin for data creation and modification events

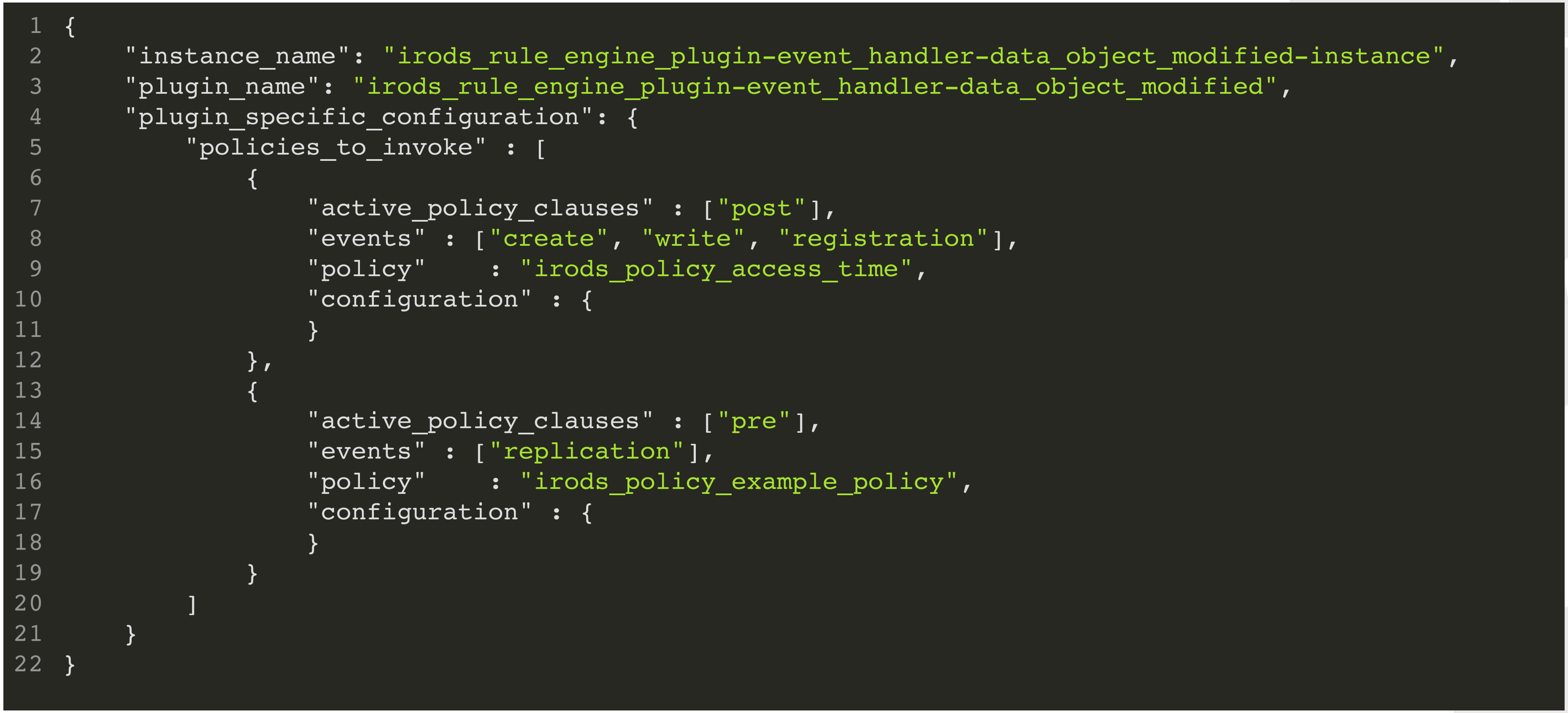
- Create
- Read
- Replication
- Unlink
- Rename
- …

Policy invocation is configured as an array of json objects for any given combination of events

Unifies the POSIX and Object behaviors into a single place to configure policy

When - event_handler-data_object_modified

Example : Synchronous Invocation



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-instance",
    "plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
    "plugin_specific_configuration": {
        "policies_to_invoke" : [
            {
                "active_policy_clauses" : ["post"],
                "events" : ["create", "write", "registration"],
                "policy"    : "irods_policy_access_time",
                "configuration" : {
                }
            },
            {
                "active_policy_clauses" : ["pre"],
                "events" : ["replication"],
                "policy"    : "irods_policy_example_policy",
                "configuration" : {
                }
            }
        ]
    }
}
```

Note that order still matters if more than one policy is configured for a given event

The What

What - Simple policy implementations

Basic policies that are leveraged across many deployments and capabilities:

- irods_policy_access_time
- irods_policy_query_processor
- irods_policy_data_movement
- irods_policy_data_replication
- irods_policy_data_verification
- irods_policy_data_retention

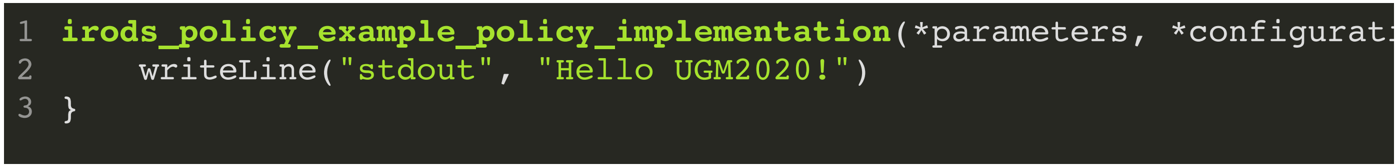
The library will continue to grow, with a cookbook of usages

What - Simple policy implementations

Standardized serialized JSON string interface :

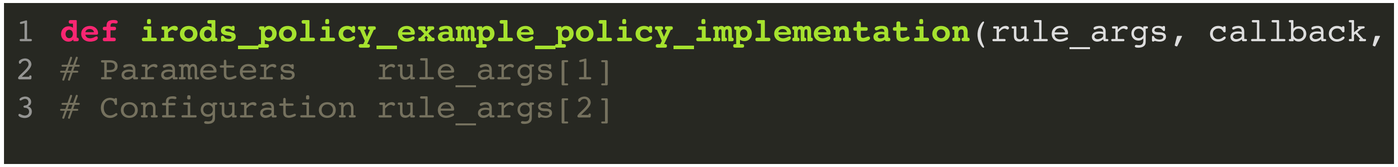
parameters, and configuration

iRODS Rule Language



```
irods_policy_example_policy_implementation(*parameters, *configurat
    writeLine("stdout", "Hello UGM2020!")
}
```

Python Rule Language



```
def irods_policy_example_policy_implementation(rule_args, callback,
# Parameters    rule_args[1]
# Configuration rule_args[2]
```

Policy can also be implemented as fast and light C++ rule engine plugins termed Policy Engines

What - Simple policy implementations

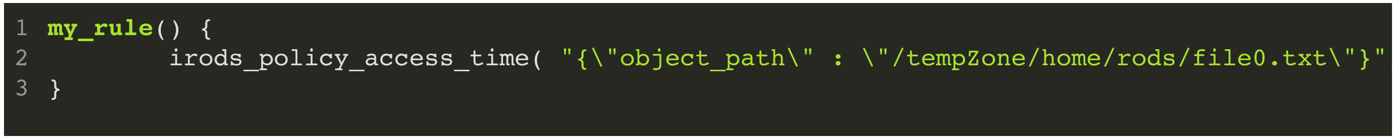
Policy may be invoked using one of three different conventions:

- Direct Invocation : a JSON object
- Query Processor : array of query results in a JSON object
- Event Handler   : a JSON object

Each invocation convention defines its interface by contract

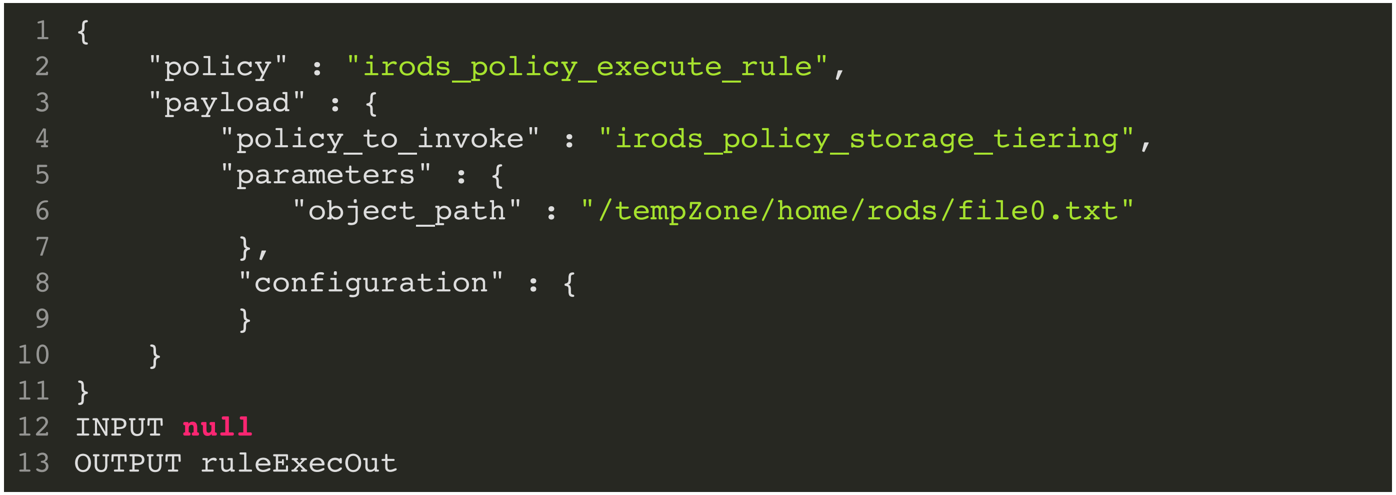
What - Direct Invocation

Parameters passed as serialized JSON strings



```
my_rule() {
        irods_policy_access_time( "{\"object_path\" : \"/tempZone/home/rods/file0.txt\"}"
}
```

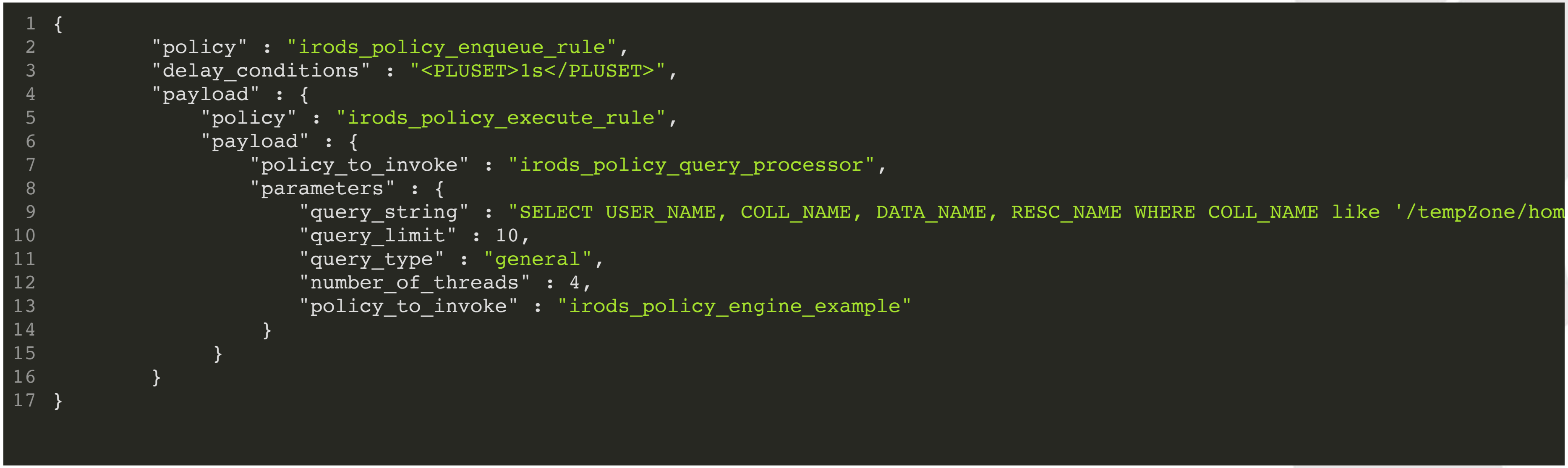
Directly invoked policy via irule



```
{
    "policy" : "irods_policy_execute_rule",
    "payload" : {
        "policy_to_invoke" : "irods_policy_storage_tiering",
        "parameters" : {
            "object_path" : "/tempZone/home/rods/file0.txt"
         },
         "configuration" : {
         }
    }
}
INPUT null
OUTPUT ruleExecOut
```

What - Query Processor Invocation

Serializes results to JSON array and passed to the policy via the parameter object as "query_results"

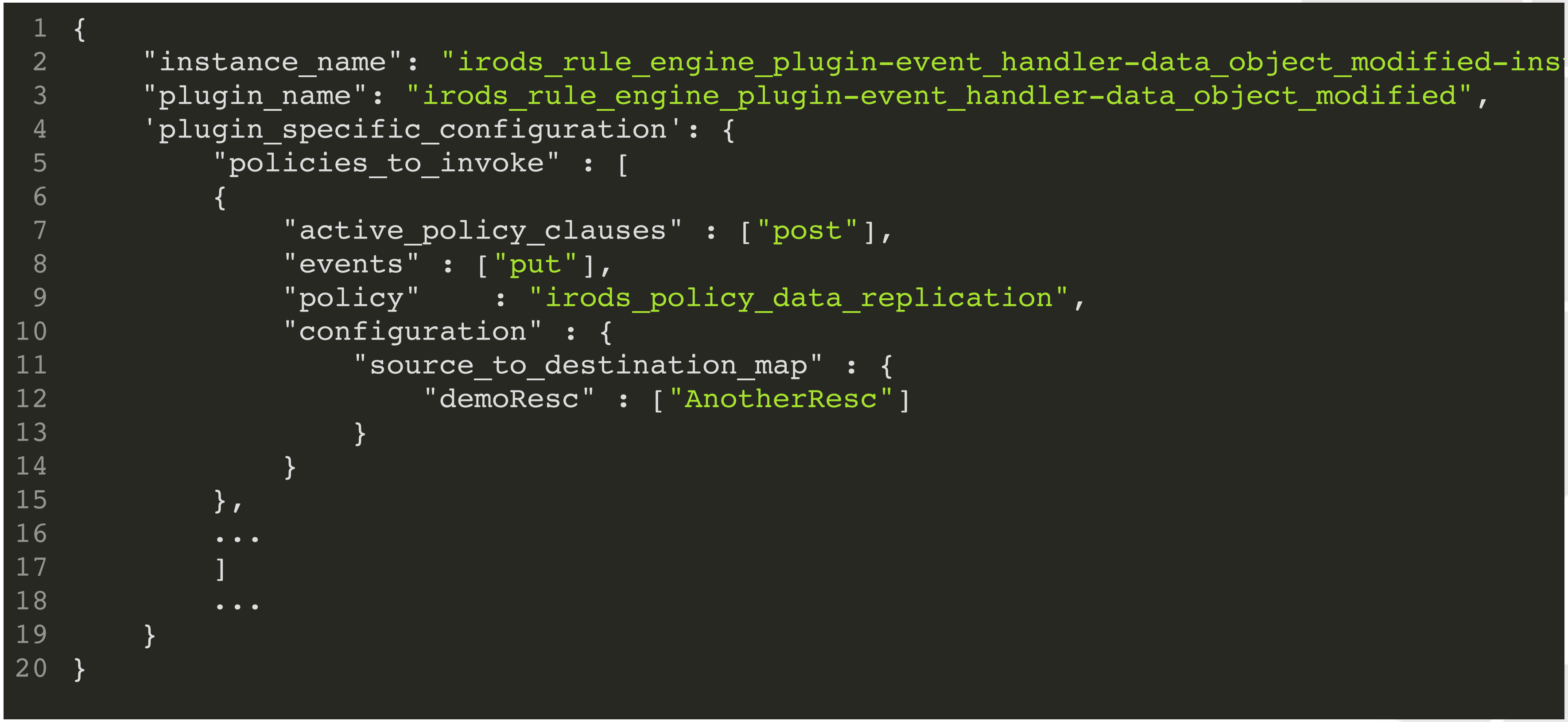


```
{
        "policy" : "irods_policy_enqueue_rule",
        "delay_conditions" : "<PLUSET>1s</PLUSET>",
        "payload" : {
            "policy" : "irods_policy_execute_rule",
            "payload" : {
                "policy_to_invoke" : "irods_policy_query_processor",
                "parameters" : {
                    "query_string" : "SELECT USER_NAME, COLL_NAME, DATA_NAME, RESC_NAME WHERE COLL_NAME like '/tempZone/hom
                    "query_limit" : 10,
                    "query_type" : "general",
                    "number_of_threads" : 4,
                    "policy_to_invoke" : "irods_policy_engine_example"
                 }
             }
        }
}
```

For example the invoked policy would receive a row like:

"query_results" : ['rods', '/tempZone/home/rods', 'file0.txt', 'demoResc']

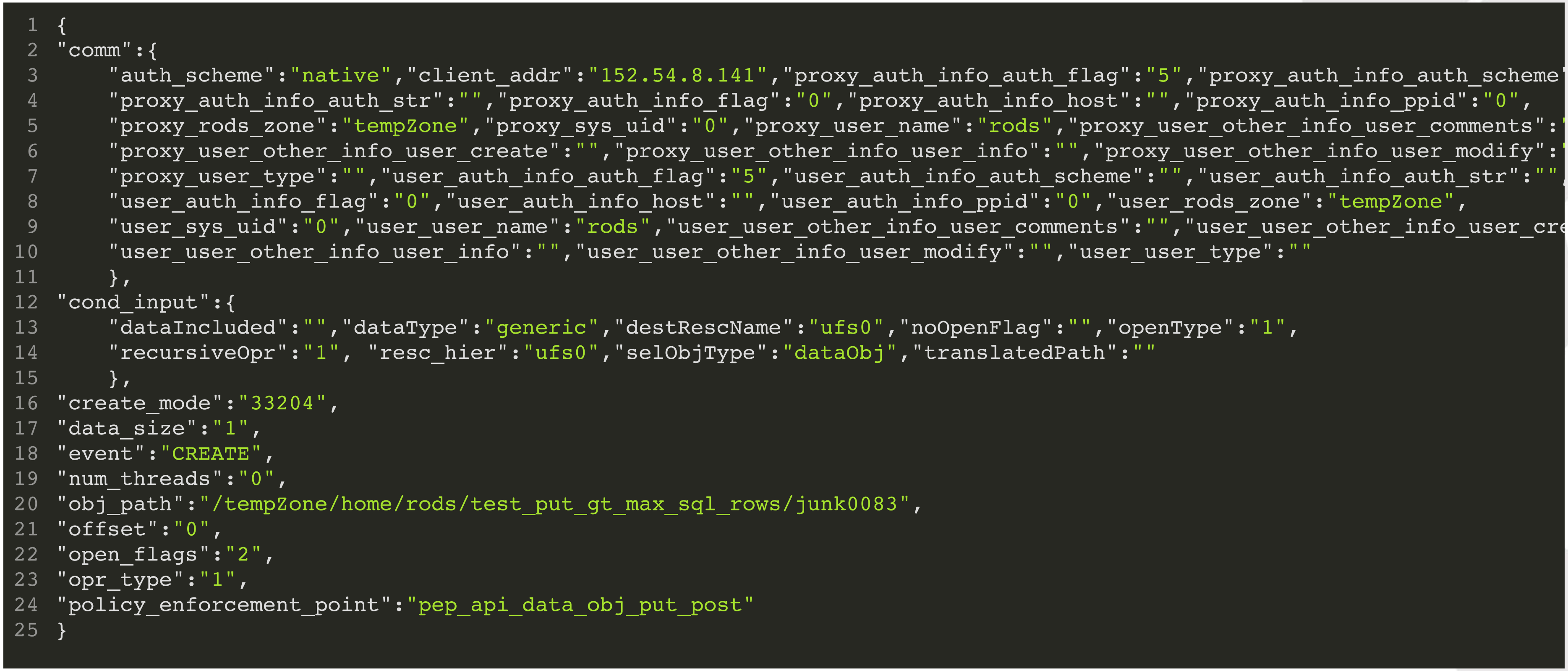
What - Event Handler Invocation



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-ins
    "plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
    'plugin_specific_configuration': {
        "policies_to_invoke" : [
        {
            "active_policy_clauses" : ["post"],
            "events" : ["put"],
            "policy"    : "irods_policy_data_replication",
            "configuration" : {
                "source_to_destination_map" : {
                    "demoResc" : ["AnotherResc"]
                }
            }
        },
        ...
        ]
        ...
    }
}
```

What - Event Handler Invocation

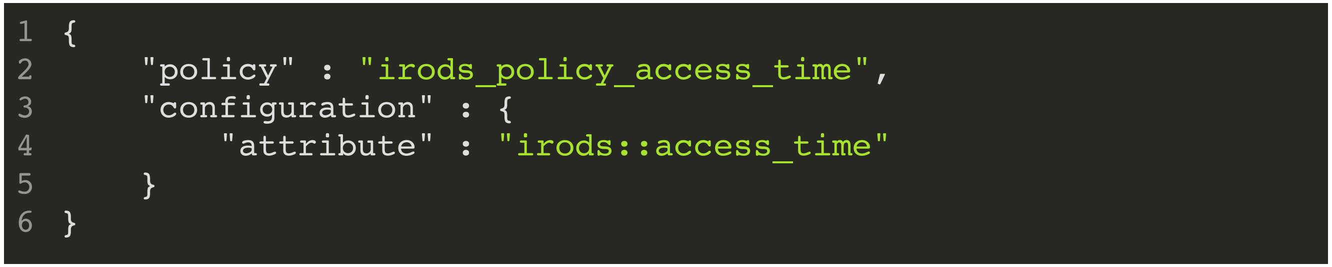
Serializes dataObjInp_t and rsComm_t to the Parameter object



```
{
"comm":{
    "auth_scheme":"native","client_addr":"152.54.8.141","proxy_auth_info_auth_flag":"5","proxy_auth_info_auth_scheme"
    "proxy_auth_info_auth_str":"","proxy_auth_info_flag":"0","proxy_auth_info_host":"","proxy_auth_info_ppid":"0",
    "proxy_rods_zone":"tempZone","proxy_sys_uid":"0","proxy_user_name":"rods","proxy_user_other_info_user_comments":"
    "proxy_user_other_info_user_create":"","proxy_user_other_info_user_info":"","proxy_user_other_info_user_modify":"
    "proxy_user_type":"","user_auth_info_auth_flag":"5","user_auth_info_auth_scheme":"","user_auth_info_auth_str":"",
    "user_auth_info_flag":"0","user_auth_info_host":"","user_auth_info_ppid":"0","user_rods_zone":"tempZone",
    "user_sys_uid":"0","user_user_name":"rods","user_user_other_info_user_comments":"","user_user_other_info_user_cre
    "user_user_other_info_user_info":"","user_user_other_info_user_modify":"","user_user_type":""
    },
"cond_input":{
    "dataIncluded":"","dataType":"generic","destRescName":"ufs0","noOpenFlag":"","openType":"1",
    "recursiveOpr":"1", "resc_hier":"ufs0","selObjType":"dataObj","translatedPath":""
    },
"create_mode":"33204",
"data_size":"1",
"event":"CREATE",
"num_threads":"0",
"obj_path":"/tempZone/home/rods/test_put_gt_max_sql_rows/junk0083",
"offset":"0",
"open_flags":"2",
"opr_type":"1",
"policy_enforcement_point":"pep_api_data_obj_put_post"
}
```

What - Configuration

Any additional static context passed into the policy



```
{
    "policy" : "irods_policy_access_time",
    "configuration" : {
        "attribute" : "irods::access_time"
    }
}
```

May be "plugin_specific_configuration" from a rule engine plugin or "configuration" from within the event framework

May hold additional policy which to be subsequently invoked, e.g. the Query Processor

The Why

Why - Policy Conditionals

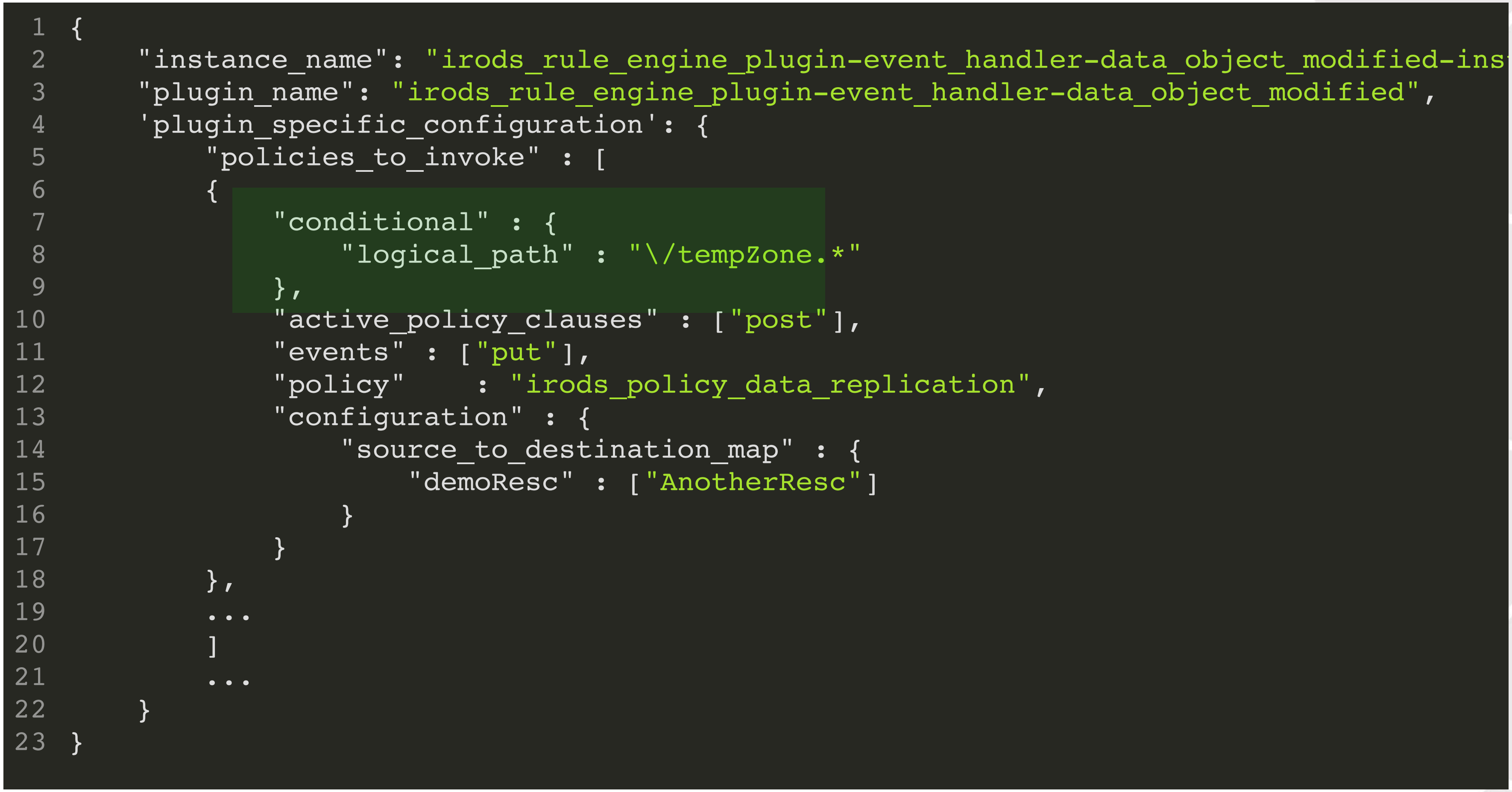
Each invoked policy may set a conditional around each noun within the system which gates the invocation

- Data Object
- Collection
- Metadata
- User
- Resource

Leverages boost::regex to match any combination of logical_path, metadata, resource name, or user name

Why - Policy Conditionals

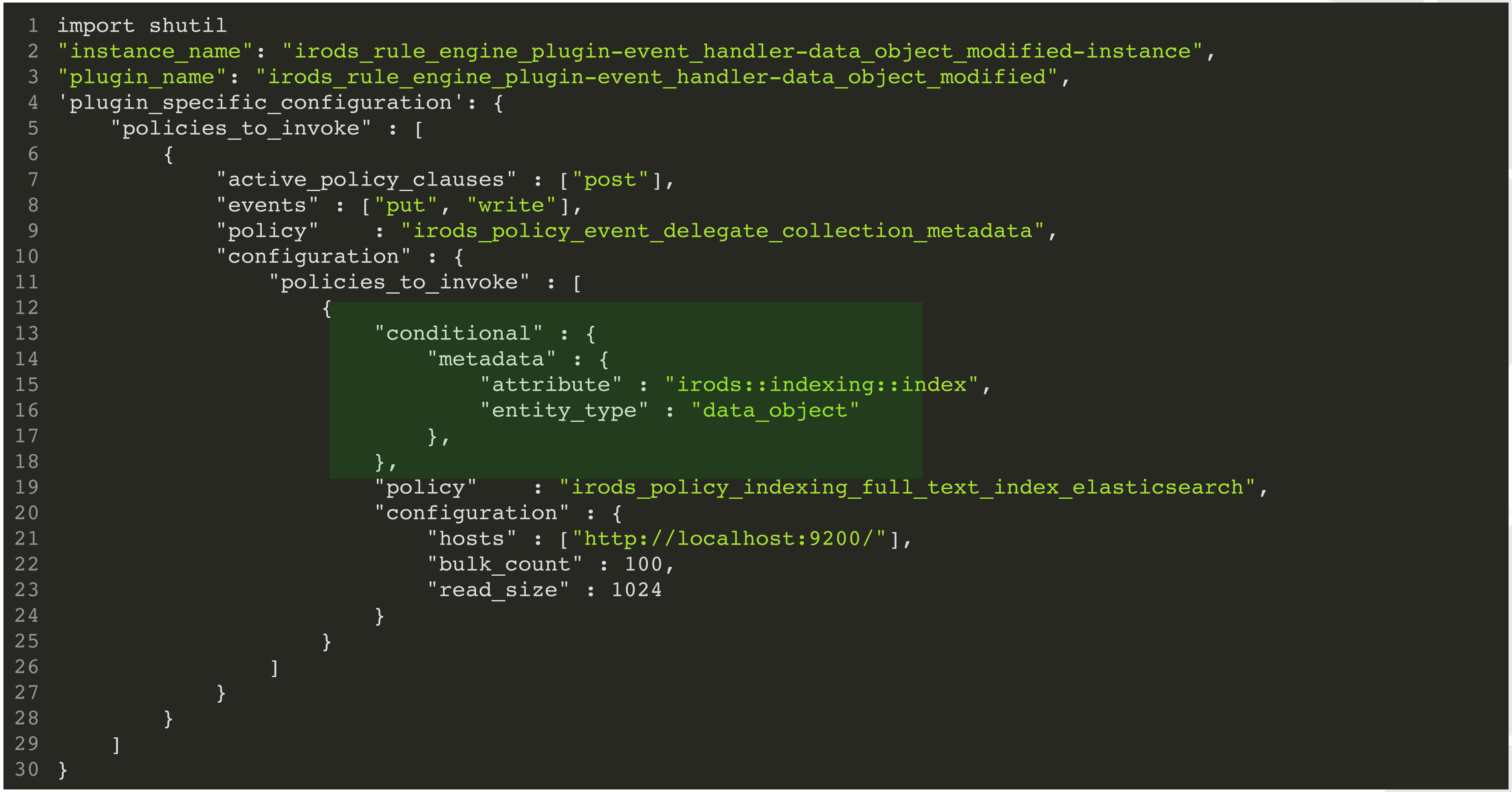
Matching a logical path for replication policy invocation



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-ins
    "plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
    'plugin_specific_configuration': {
        "policies_to_invoke" : [
        {
            "conditional" : {
                "logical_path" : "\/tempZone.*"
            },
            "active_policy_clauses" : ["post"],
            "events" : ["put"],
            "policy"    : "irods_policy_data_replication",
            "configuration" : {
                "source_to_destination_map" : {
                    "demoResc" : ["AnotherResc"]
                }
            }
        },
        ...
        ]
        ...
    }
}
```

Why - Policy Conditionals

Matching metadata for indexing policy invocation



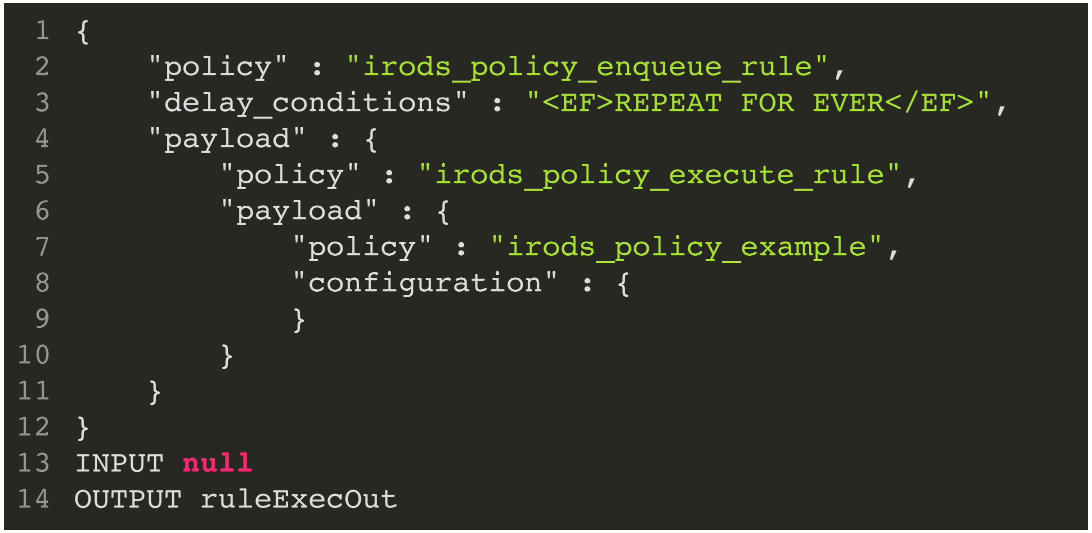
```
import shutil
"instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-instance",
"plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
'plugin_specific_configuration': {
    "policies_to_invoke" : [
        {
            "active_policy_clauses" : ["post"],
            "events" : ["put", "write"],
            "policy"    : "irods_policy_event_delegate_collection_metadata",
            "configuration" : {
                "policies_to_invoke" : [
                    {
                        "conditional" : {
                            "metadata" : {
                                "attribute" : "irods::indexing::index",
                                "entity_type" : "data_object"
                            },
                        },
                        "policy"    : "irods_policy_indexing_full_text_index_elasticsearch",
                        "configuration" : {
                            "hosts" : ["http://localhost:9200/"],
                            "bulk_count" : 100,
                            "read_size" : 1024
                        }
                    }
                ]
            }
        }
    ]
}
```

The How

How - Asynchronous Execution

The cpp_default rule engine plugin in 4.2.8 will now support two new policies:

- irods_policy_enqueue_rule
- irods_policy_execute_rule

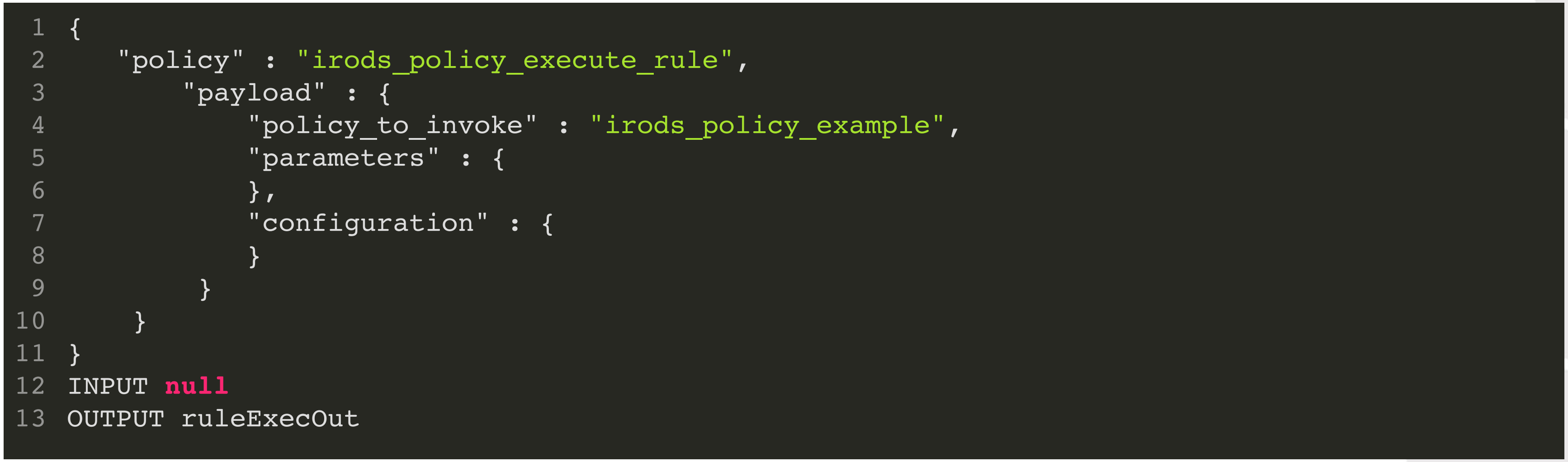


```
{
    "policy" : "irods_policy_enqueue_rule",
    "delay_conditions" : "<EF>REPEAT FOR EVER</EF>",
    "payload" : {
        "policy" : "irods_policy_execute_rule",
        "payload" : {
            "policy" : "irods_policy_example",
            "configuration" : {
            }
        }
    }
}
INPUT null
OUTPUT ruleExecOut
```

The enqueue rule policy will push a job onto the delayed execution queue. The "payload" object holds the rule which is to be executed.

How - Direct Execution

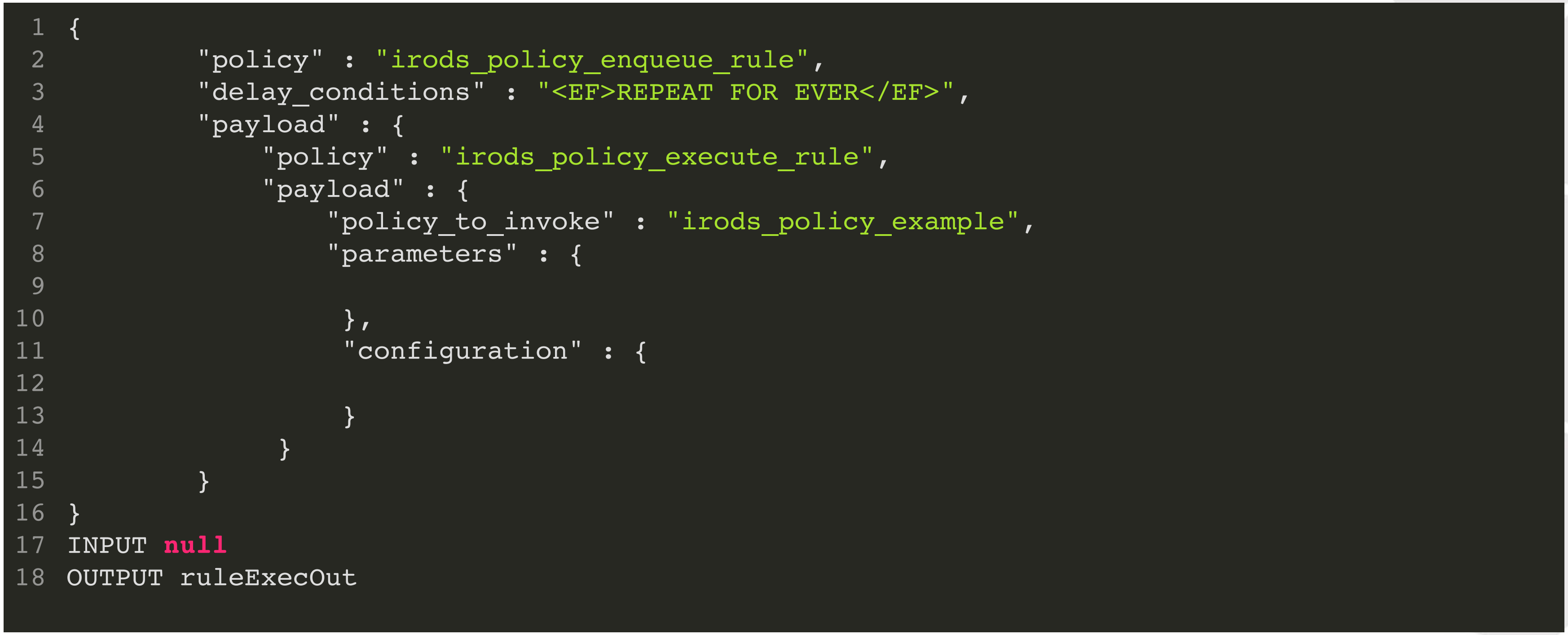
The execute rule policy will invoke a policy engine either from the delayed execute queue or as a direct invocation



```
{
    "policy" : "irods_policy_execute_rule",
        "payload" : {
            "policy_to_invoke" : "irods_policy_example",
            "parameters" : {
            },
            "configuration" : {
            }
        }
    }
}
INPUT null
OUTPUT ruleExecOut
```

How - Asynchronous Execution

Sample Delayed Rule for Asynchronous Execution by the cpp default rule engine



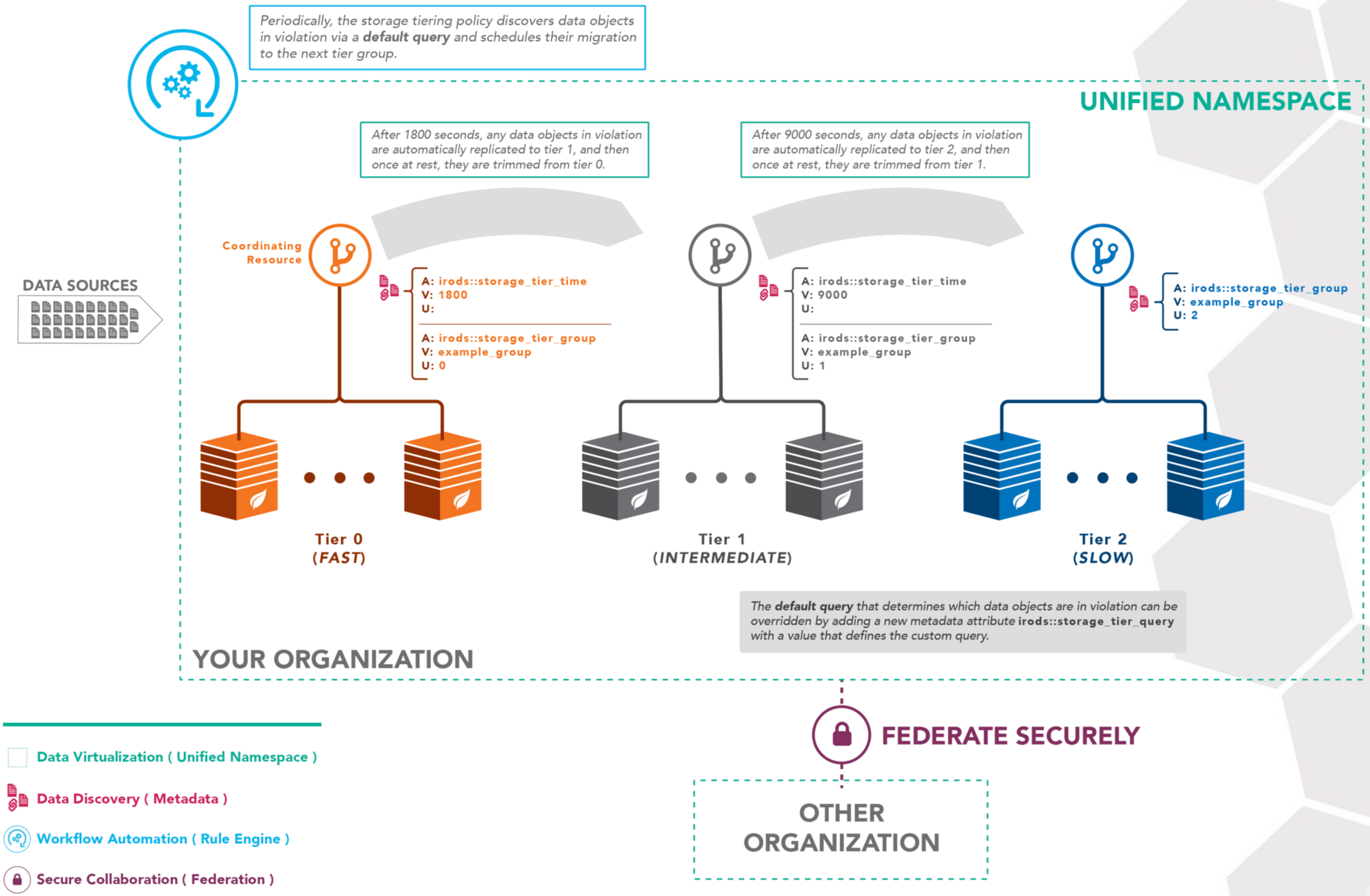
```
{
        "policy" : "irods_policy_enqueue_rule",
        "delay_conditions" : "<EF>REPEAT FOR EVER</EF>",
        "payload" : {
            "policy" : "irods_policy_execute_rule",
            "payload" : {
                "policy_to_invoke" : "irods_policy_example",
                "parameters" : {

                 },
                 "configuration" : {

                 }
             }
        }
}
INPUT null
OUTPUT ruleExecOut
```

We no longer need to pay the penalty of instantiating an interpreted language

Policy Composed Capabilities

Storage Tiering Overview

iRODS



Periodically, the storage tiering policy discovers data objects in violation via a ***default query*** *and schedules their migration to the next tier group.*

After 1800 seconds, any data objects in violation are automatically replicated to tier 1, and then once at rest, they are trimmed from tier 0.

After 9000 seconds, any data objects in violation are automatically replicated to tier 2, and then once at rest, they are trimmed from tier 1.

```
A: irods::storage_tier_time
V: 1800
U:

A: irods::storage_tier_group
V: example_group
U: 0
```

```
A: irods::storage_tier_time
V: 9000
U:

A: irods::storage_tier_group
V: example_group
U: 1
```

```
A: irods::storage_tier_group
V: example_group
U: 2
```

The ***default query*** *that determines which data objects are in violation can be overridden by adding a new metadata attribute* **irods::storage_tier_query** *with a value that defines the custom query.*

Data Virtualization (Unified Namespace)

Data Discovery (Metadata)

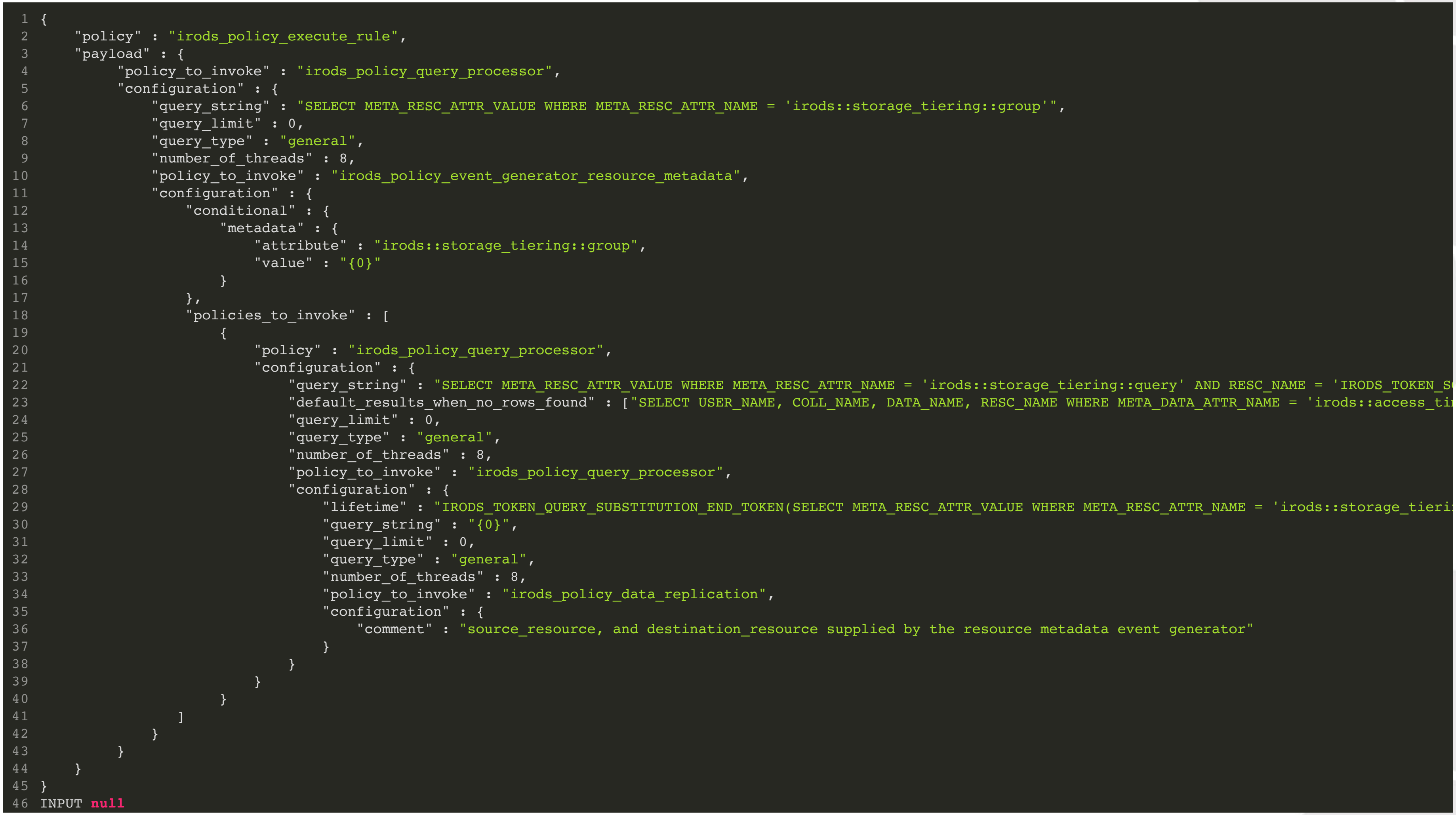
Workflow Automation (Rule Engine)

Secure Collaboration (Federation)

Policy Composed Storage Tiering

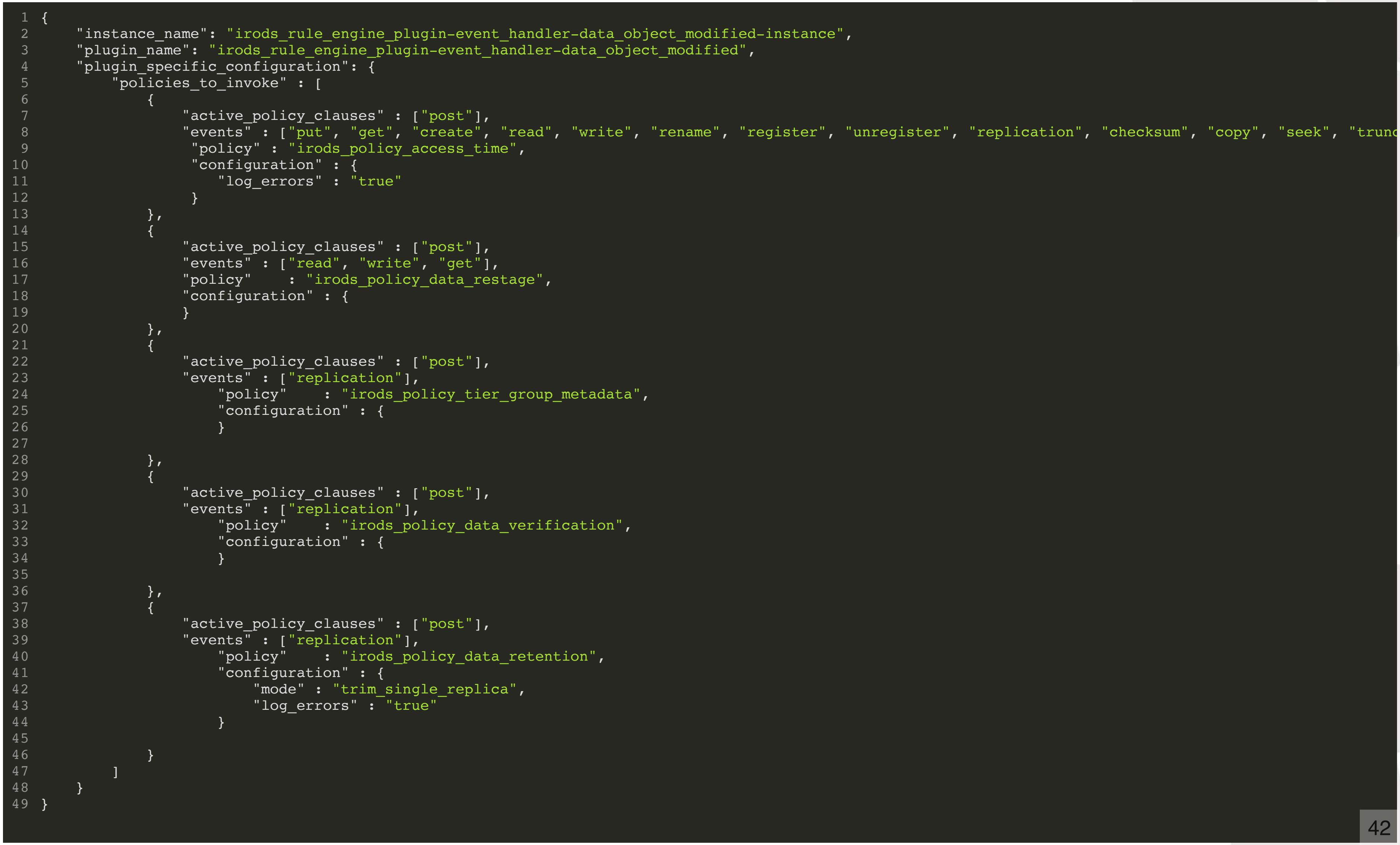
- Asynchronous Discovery
- Asynchronous Replication
- Synchronous Retention
- Resource associated metadata
- Identified by 'tiering groups'

Asynchronous Replication



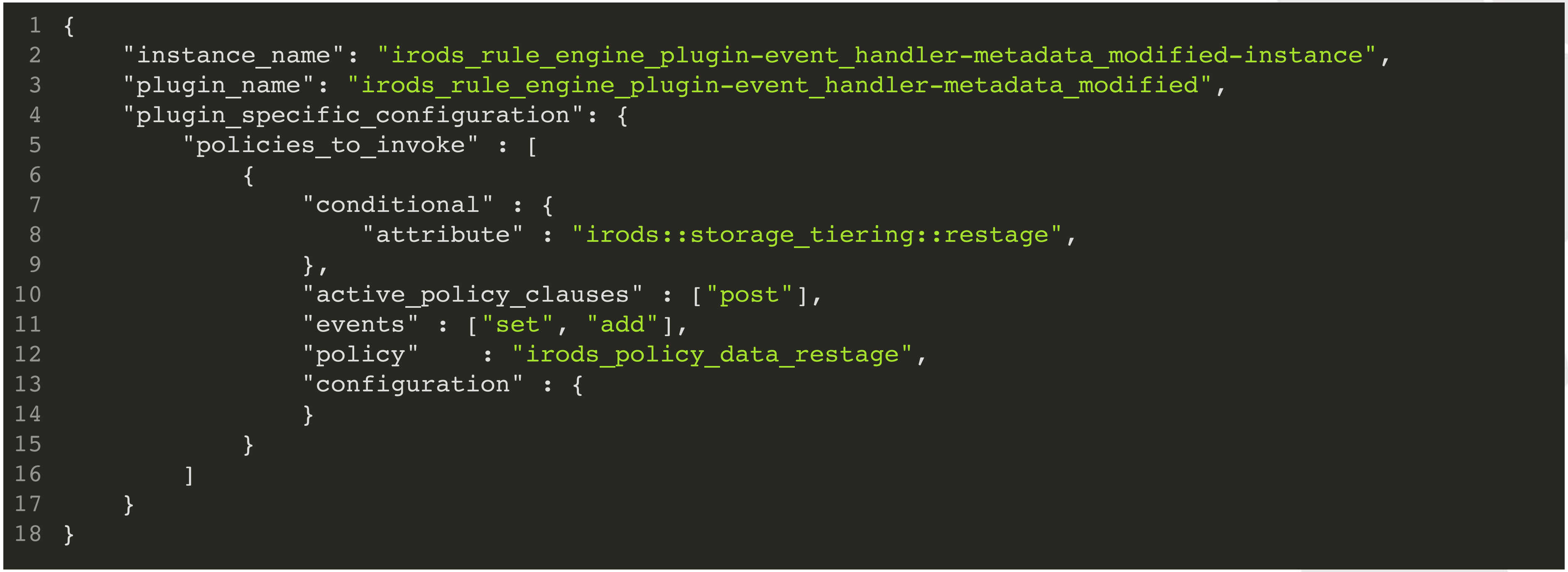
```
{
    "policy" : "irods_policy_execute_rule",
    "payload" : {
        "policy_to_invoke" : "irods_policy_query_processor",
        "configuration" : {
            "query_string" : "SELECT META_RESC_ATTR_VALUE WHERE META_RESC_ATTR_NAME = 'irods::storage_tiering::group'",
            "query_limit" : 0,
            "query_type" : "general",
            "number_of_threads" : 8,
            "policy_to_invoke" : "irods_policy_event_generator_resource_metadata",
            "configuration" : {
                "conditional" : {
                    "metadata" : {
                        "attribute" : "irods::storage_tiering::group",
                        "value" : "{0}"
                    }
                },
                "policies_to_invoke" : [
                    {
                        "policy" : "irods_policy_query_processor",
                        "configuration" : {
                            "query_string" : "SELECT META_RESC_ATTR_VALUE WHERE META_RESC_ATTR_NAME = 'irods::storage_tiering::query' AND RESC_NAME = 'IRODS_TOKEN_S
                            "default_results_when_no_rows_found" : ["SELECT USER_NAME, COLL_NAME, DATA_NAME, RESC_NAME WHERE META_DATA_ATTR_NAME = 'irods::access_ti
                            "query_limit" : 0,
                            "query_type" : "general",
                            "number_of_threads" : 8,
                            "policy_to_invoke" : "irods_policy_query_processor",
                            "configuration" : {
                                "lifetime" : "IRODS_TOKEN_QUERY_SUBSTITUTION_END_TOKEN(SELECT META_RESC_ATTR_VALUE WHERE META_RESC_ATTR_NAME = 'irods::storage_tieri
                                "query_string" : "{0}",
                                "query_limit" : 0,
                                "query_type" : "general",
                                "number_of_threads" : 8,
                                "policy_to_invoke" : "irods_policy_data_replication",
                                "configuration" : {
                                    "comment" : "source_resource, and destination_resource supplied by the resource metadata event generator"
                                }
                            }
                        }
                    }
                ]
            }
        }
    }
}
INPUT null
```

Synchronous Configuration for Storage Tiering



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-instance",
    "plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
    "plugin_specific_configuration": {
        "policies_to_invoke" : [
            {
                "active_policy_clauses" : ["post"],
                "events" : ["put", "get", "create", "read", "write", "rename", "register", "unregister", "replication", "checksum", "copy", "seek", "trunc
                 "policy" : "irods_policy_access_time",
                 "configuration" : {
                    "log_errors" : "true"
                 }
            },
            {
                "active_policy_clauses" : ["post"],
                "events" : ["read", "write", "get"],
                "policy"    : "irods_policy_data_restage",
                "configuration" : {
                }
            },
            {
                "active_policy_clauses" : ["post"],
                "events" : ["replication"],
                    "policy"    : "irods_policy_tier_group_metadata",
                    "configuration" : {
                    }

            },
            {
                "active_policy_clauses" : ["post"],
                "events" : ["replication"],
                    "policy"    : "irods_policy_data_verification",
                    "configuration" : {
                    }

            },
            {
                "active_policy_clauses" : ["post"],
                "events" : ["replication"],
                    "policy"    : "irods_policy_data_retention",
                    "configuration" : {
                        "mode" : "trim_single_replica",
                        "log_errors" : "true"
                    }

            }
        ]
    }
}
```

Metadata Driven Restage for Storage Tiering



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-metadata_modified-instance",
    "plugin_name": "irods_rule_engine_plugin-event_handler-metadata_modified",
    "plugin_specific_configuration": {
        "policies_to_invoke" : [
            {
                "conditional" : {
                    "attribute" : "irods::storage_tiering::restage",
                },
                "active_policy_clauses" : ["post"],
                "events" : ["set", "add"],
                "policy"    : "irods_policy_data_restage",
                "configuration" : {
                }
            }
        ]
    }
}
```

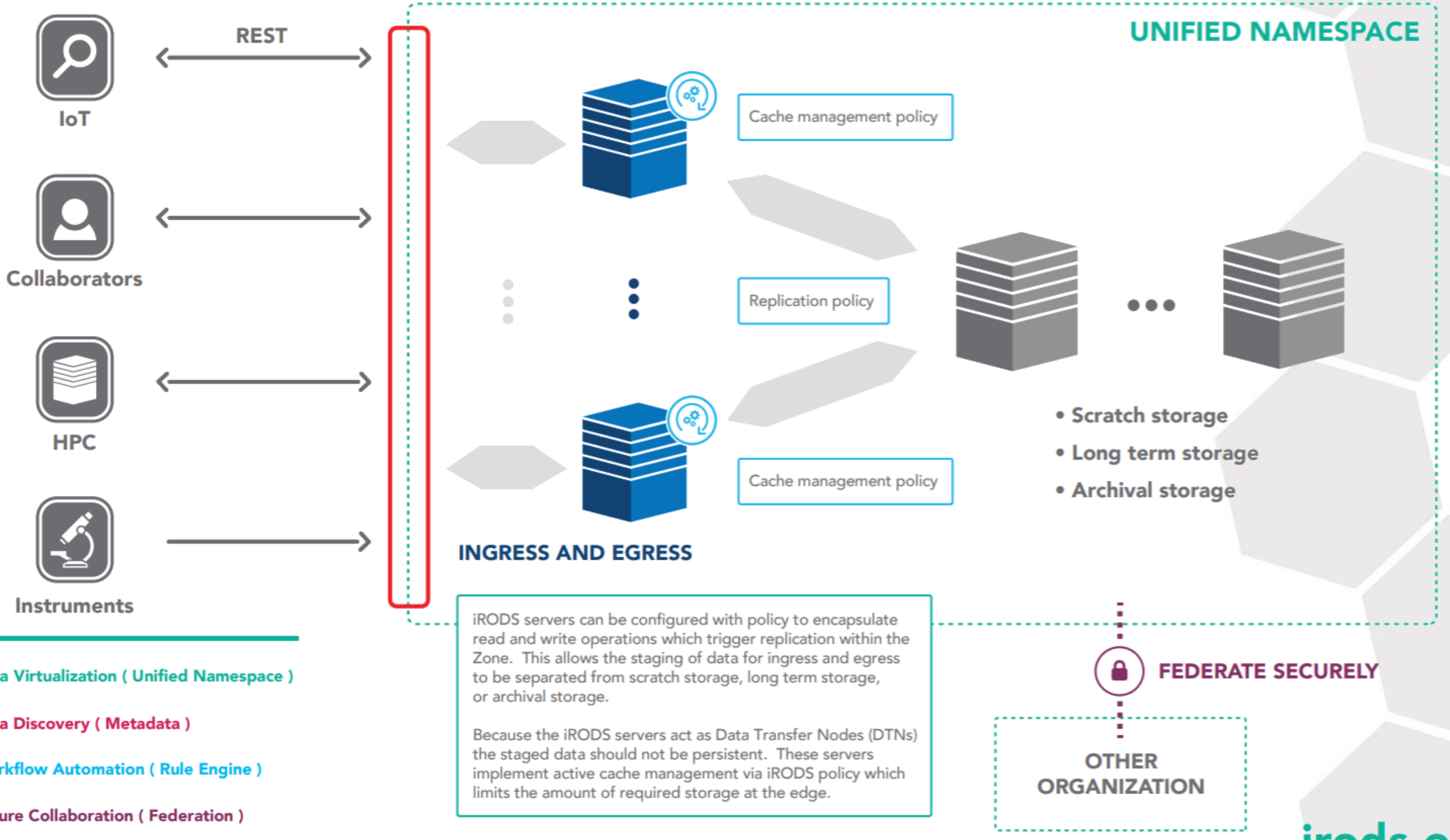
Data Transfer Nodes Pattern

iRODS

Moving large datasets across organizational boundaries remains a challenge due to the requirement of exposing high performance hardware to the public network. Data Transfer Nodes (DTNs) provide a secure location for ingress and egress of data while avoiding the performance impact of an organizational firewall.

In the following deployment pattern, iRODS satisfies the requirements of a Science DMZ while also providing automated data management.

> “The Science DMZ is a portion of the network, built at or near the campus or laboratory's local network perimeter that is designed such that the equipment, configuration, and security policies are optimized for high-performance scientific applications rather than for general-purpose business systems or 'enterprise' computing.
>
> —ESnet



iRODS servers can be configured with policy to encapsulate read and write operations which trigger replication within the Zone. This allows the staging of data for ingress and egress to be separated from scratch storage, long term storage, or archival storage.

Because the iRODS servers act as Data Transfer Nodes (DTNs) the staged data should not be persistent. These servers implement active cache management via iRODS policy which limits the amount of required storage at the edge.

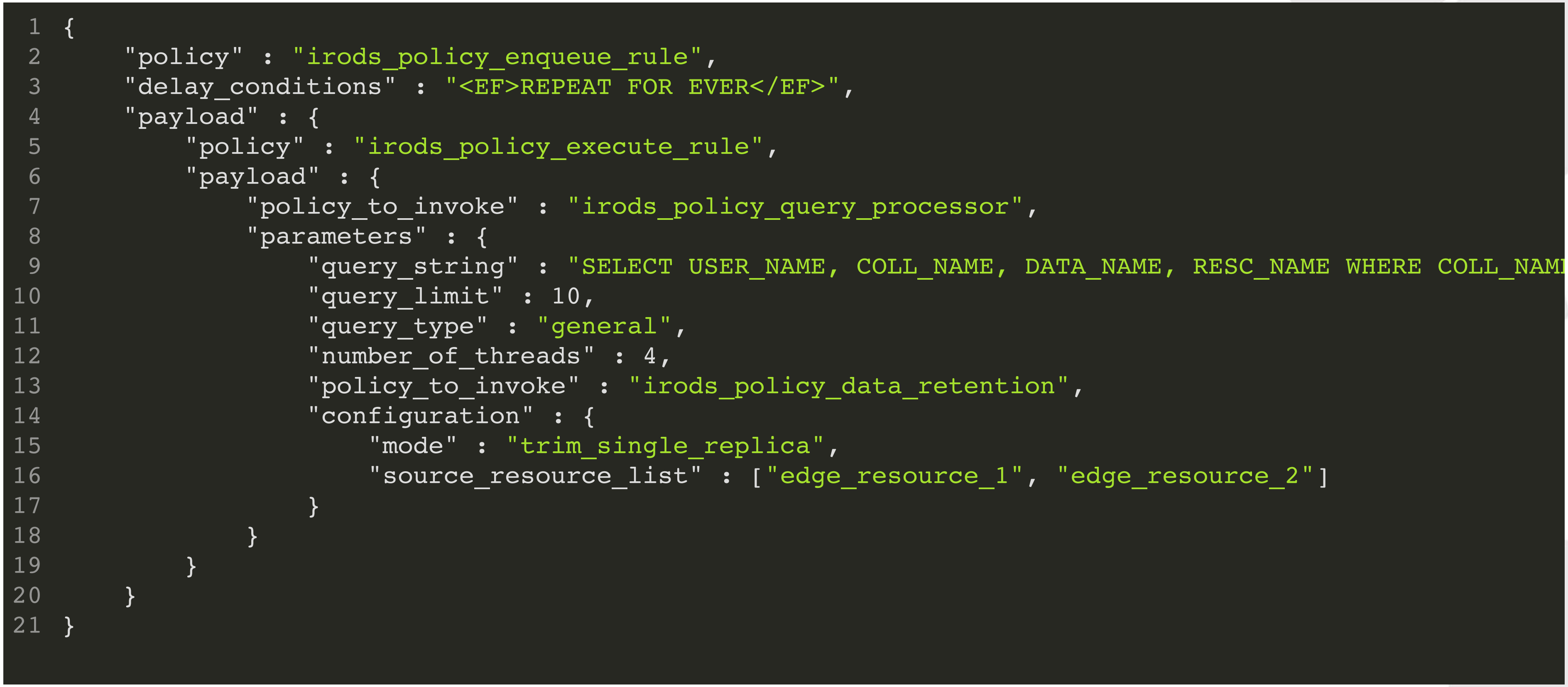
- Data Virtualization (Unified Namespace)
- Data Discovery (Metadata)
- Workflow Automation (Rule Engine)
- Secure Collaboration (Federation)

Policy Composed Data Transfer Node

- Asynchronous Discovery
- Asynchronous Retention
- Synchronous Replication
- Resource associated metadata
- Identified by 'replication groups'

Policy Composed Data Transfer Node

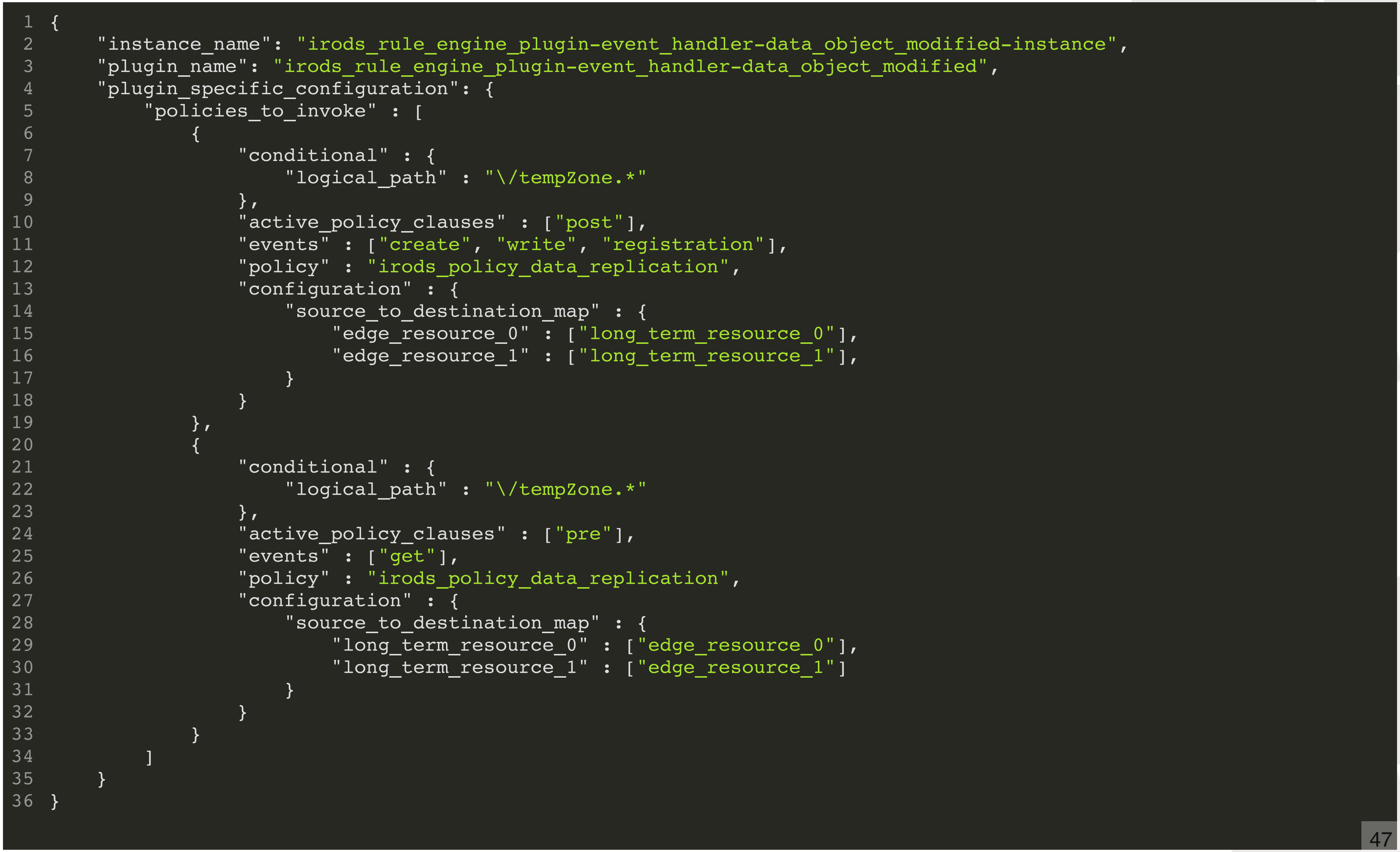
Asynchronous Retention on Edge Resources



```
{
    "policy" : "irods_policy_enqueue_rule",
    "delay_conditions" : "<EF>REPEAT FOR EVER</EF>",
    "payload" : {
        "policy" : "irods_policy_execute_rule",
        "payload" : {
            "policy_to_invoke" : "irods_policy_query_processor",
            "parameters" : {
                "query_string" : "SELECT USER_NAME, COLL_NAME, DATA_NAME, RESC_NAME WHERE COLL_NAM
                "query_limit" : 10,
                "query_type" : "general",
                "number_of_threads" : 4,
                "policy_to_invoke" : "irods_policy_data_retention",
                "configuration" : {
                    "mode" : "trim_single_replica",
                    "source_resource_list" : ["edge_resource_1", "edge_resource_2"]
                }
            }
        }
    }
}
```

Policy Composed Data Transfer Node

Synchronous Replication



```
{
    "instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-instance",
    "plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
    "plugin_specific_configuration": {
        "policies_to_invoke" : [
            {
                "conditional" : {
                    "logical_path" : "\/tempZone.*"
                },
                "active_policy_clauses" : ["post"],
                "events" : ["create", "write", "registration"],
                "policy" : "irods_policy_data_replication",
                "configuration" : {
                    "source_to_destination_map" : {
                        "edge_resource_0" : ["long_term_resource_0"],
                        "edge_resource_1" : ["long_term_resource_1"],
                    }
                }
            },
            {
                "conditional" : {
                    "logical_path" : "\/tempZone.*"
                },
                "active_policy_clauses" : ["pre"],
                "events" : ["get"],
                "policy" : "irods_policy_data_replication",
                "configuration" : {
                    "source_to_destination_map" : {
                        "long_term_resource_0" : ["edge_resource_0"],
                        "long_term_resource_1" : ["edge_resource_1"]
                    }
                }
            }
        ]
    }
}
```

Indexing Capability

iRODS

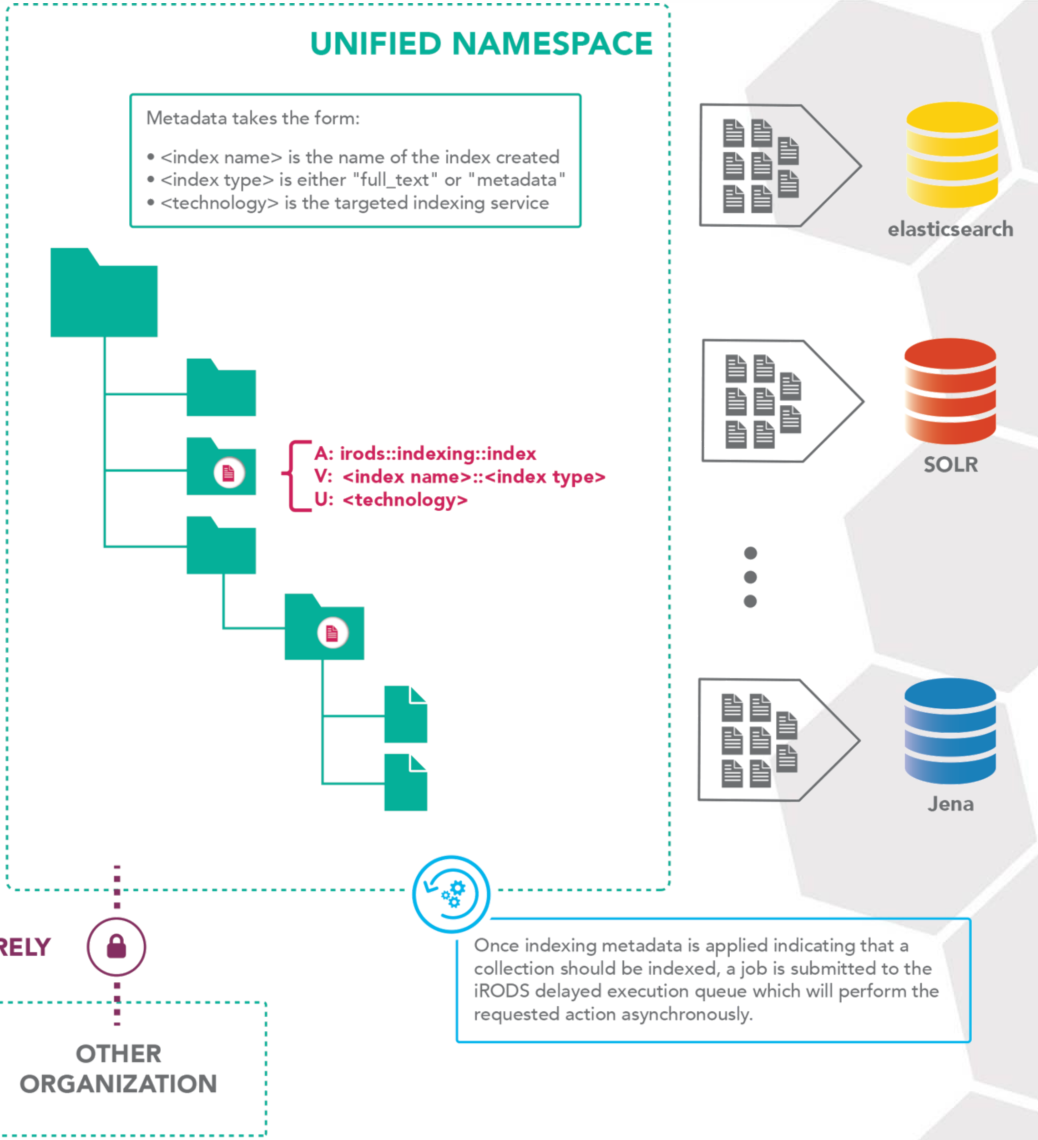
The iRODS Indexing Capability provides a policy framework around both full text and metadata indexing for the purposes of enhanced data discovery.

Logical collections are annotated with metadata which indicates that any data objects or nested collections of data objects should be indexed given a particular indexing technology, index type, and index name.

From the configured metadata, the framework composes a rule name and then delegates to the policy implementation through the rule engine.

A new indexing technology can be supported via a rule base or policy engine which provides policy implementations of the form:

- irods_policy_indexing_object_index_<technology>
- irods_policy_indexing_object_purge_<technology>
- irods_policy_indexing_metadata_index_<technology>
- irods_policy_indexing_metadata_purge_<technology>



UNIFIED NAMESPACE

Metadata takes the form:

- <index name> is the name of the index created
- <index type> is either "full_text" or "metadata"
- <technology> is the targeted indexing service

A: irods::indexing::index
V: <index name>::<index type>
U: <technology>

FEDERATE SECURELY

OTHER ORGANIZATION

Once indexing metadata is applied indicating that a collection should be indexed, a job is submitted to the iRODS delayed execution queue which will perform the requested action asynchronously.

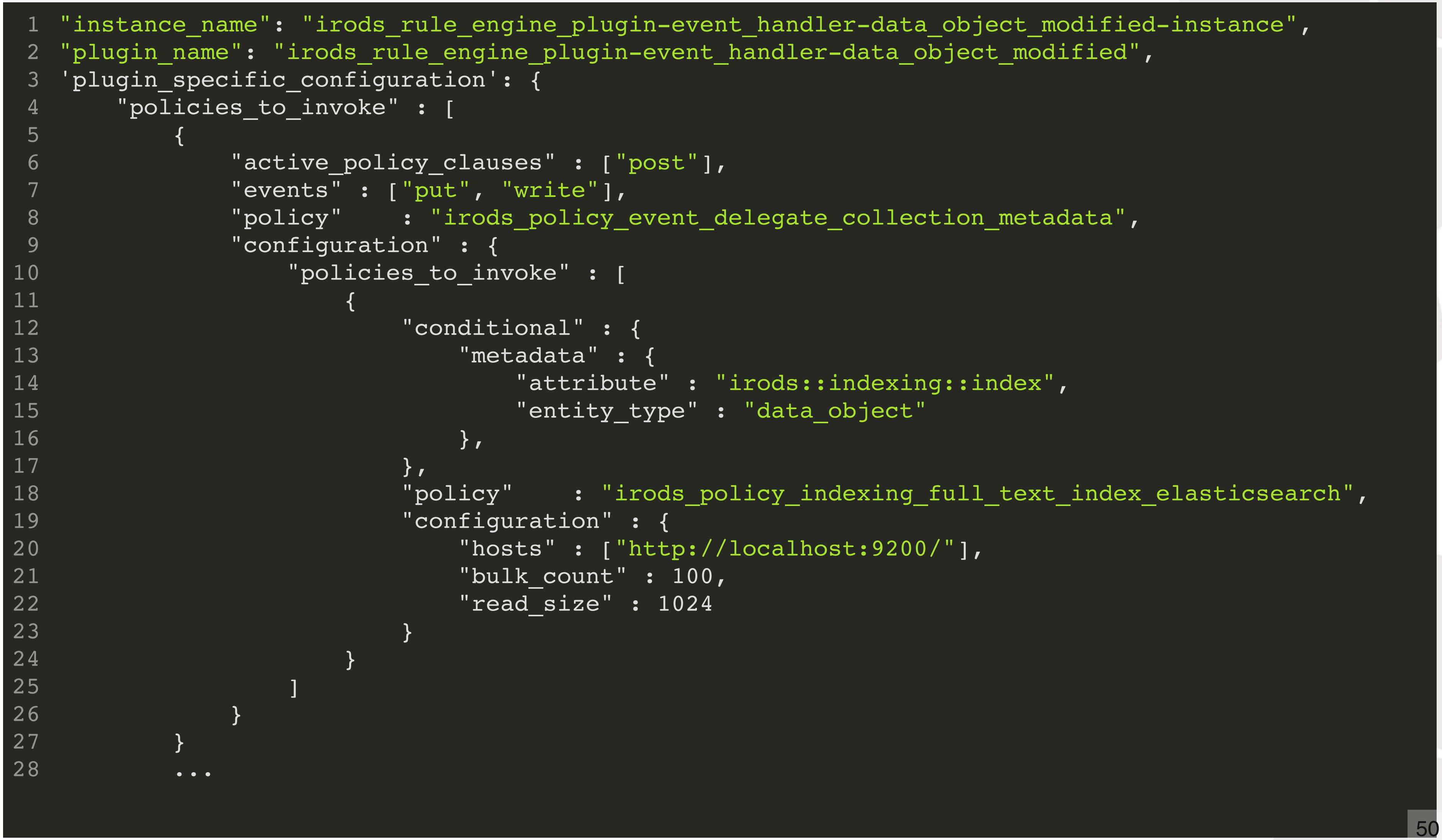
- ⬚ Data Virtualization (Unified Namespace)
- Data Discovery (Metadata)
- Workflow Automation (Rule Engine)
- Secure Collaboration (Federation)

Policy Composed Indexing

Implemented as individual Policy Engines

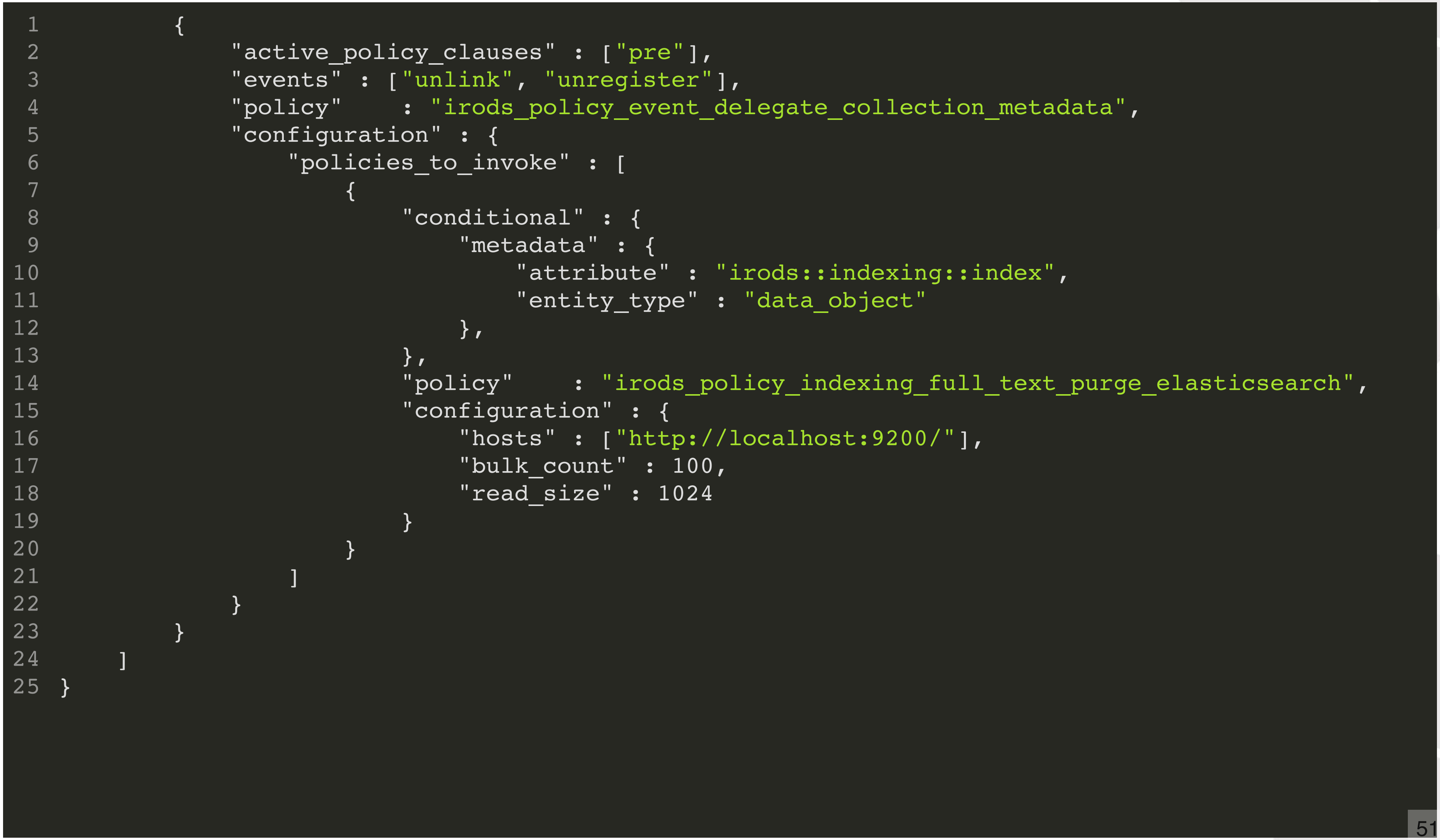
- irods_policy_indexing_full_text_index_elasticsearch
- irods_policy_indexing_full_text_purge_elasticsearch
- irods_policy_indexing_metadata_index_elasticsearch
- irods_policy_indexing_metadata_purge_elasticsearch

Synchronously configured full text indexing



```
"instance_name": "irods_rule_engine_plugin-event_handler-data_object_modified-instance",
"plugin_name": "irods_rule_engine_plugin-event_handler-data_object_modified",
'plugin_specific_configuration': {
    "policies_to_invoke" : [
        {
            "active_policy_clauses" : ["post"],
            "events" : ["put", "write"],
            "policy"    : "irods_policy_event_delegate_collection_metadata",
            "configuration" : {
                "policies_to_invoke" : [
                    {
                        "conditional" : {
                            "metadata" : {
                                "attribute" : "irods::indexing::index",
                                "entity_type" : "data_object"
                            },
                        },
                        "policy"    : "irods_policy_indexing_full_text_index_elasticsearch",
                        "configuration" : {
                            "hosts" : ["http://localhost:9200/"],
                            "bulk_count" : 100,
                            "read_size" : 1024
                        }
                    }
                ]
            }
        }
        ...
```

Synchronously configured full text purge



```
        {
            "active_policy_clauses" : ["pre"],
            "events" : ["unlink", "unregister"],
            "policy"    : "irods_policy_event_delegate_collection_metadata",
            "configuration" : {
                "policies_to_invoke" : [
                    {
                        "conditional" : {
                            "metadata" : {
                                "attribute" : "irods::indexing::index",
                                "entity_type" : "data_object"
                            },
                        },
                        "policy"    : "irods_policy_indexing_full_text_purge_elasticsearch",
                        "configuration" : {
                            "hosts" : ["http://localhost:9200/"],
                            "bulk_count" : 100,
                            "read_size" : 1024
                        }
                    }
                ]
            }
        }
    ]
}
```

Summary - Configuration not Code

- Capabilities become recipes which are easily configured
- A Policy GUI is now a possibility with the manipulation of server side JSON
- Continue to build a library of supported policy engines, driven by the community
- Data Integrity Capability will now be a collection of policy engines

Questions?