Metadata and Archiving at Scale

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Open Source Data Management

Data Centric. Metadata Driven.

Provides insurance against your changing infrastructure:

- edge devices (sequencers, satellites, supercomputers, etc.)
- storage
- compute
- networking
- authentication
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."

Most organizations are still managing their assets with a collection of small scripts, tribal knowledge, vigilance, and hope.

Organizations, instead, need a future-proof solution to managing data and its surrounding infrastructure.
Why Data Management Matters

DATA LIFECYCLE

Data
- Protect Collection
- Data Grid
- Data Processing Pipeline
- Digital Library
- Reference Collection
- Federation

State
- Private
- Shared
- Analyzed
- Published
- Preserved
- Sustained

Policy
- Local Policy
- Distribution Policy
- Service Policy
- Description Policy
- Representation Policy
- Re-purposing Policy

iRODS virtualizes the stages of the data lifecycle through policy evolution

As data matures and reaches a broader community, data management policy must also evolve to meet these additional requirements.
The Data Lifecycle begins at Data Generation

When data management is involved from the point of data generation, a system can address other hard problems:

- Data Harmonization
- Data Movement
- Data Integrity
- Geographic Distribution
- Network Capacity
- Network Reliability
- Variety of Data Sources
- Variety of Data Formats
A Small Matter of Policy

Two Simplified Assertions for Today:

- **Metadata**
  - Annotations that mean something:
    - to people
    - to programs

- **Archive**
  - Copies or replicas in a safe/cheaper place
  - Discoverable
  -Retrievable when appropriate

Both can be handled abstractly through configuration and policy.

Automatic, policy-based solutions are resilient to future changes in technology.
iRODS Core Competencies

The underlying technology categorized into four areas
iRODS Policy Examples

- Data Routing
- Data Movement
- Data Verification
- Data Synchronization
- Data Transformation
- Metadata Capture
- Metadata Application
- Metadata Verification
iRODS Capabilities

Automated Ingest

Auditing

Indexing

Data Integrity

Storage Tiering

Provenance

Publishing

Compliance
Deployment Patterns

Data to Compute

- Unified Namespace
  - Data Sources
  - Your Organization
  - HPC

Compute to Data

- Unified Namespace
  - Client Compute Requests
  - Your Organization
  - Federate Securely

Filesystem Synchronization

- Sync Policy
  - Amazon Web Services
  - Microsoft Azure
  - Google Cloud Storage
  - Federate Securely
  - Other Organization
The Data Management Model

iRODS provides eight packaged capabilities, each of which can be selectively deployed and configured.

These capabilities represent the most common use cases as identified by community participation and reporting.

The flexibility provided by this model allows an organization to address its immediate use cases.

Additional capabilities may be deployed as any new requirements arise.

A pattern represents a combination of iRODS capabilities and data management policy consistent across multiple organizations. Three common patterns of iRODS deployment have been observed within the community:
Automated Ingest - Landing Zone

Data may be automatically ingested from a number of sources which do not speak the iRODS protocol (microscopes, telescopes, sequencers, etc.). These sources could feed a single landing zone or an array of landing zones - this is a design decision for the iRODS administrator.

The iRODS Rule Engine Framework can watch the landing zone(s) and execute the appropriate policy when there is new data to ingest. The policy could include quality assessment criteria, format conversion, checksum creation and/or verification, metadata extraction and annotation, automated collection creation, and logging.

Upon success, the ingest policy could place a replica of the data and any newly created data products into long term storage as well as move the original landing zone data aside (to prevent the next run from picking it up).

If the ingest process fails for some reason, the landing zone data could be moved aside to a different location and notification can be sent to another process or human for further assessment.

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

Periodically a scanning job is added to the queue which generates jobs to register or ingest data.

Metadata is extracted and applied once the objects are registered in the catalog.

Extract file metadata from known file formats.

Add any custom metadata.

Calculate and store data object checksum.

The data gets registered or ingested into iRODS.
Storage Tiering

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.

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.

YOUR ORGANIZATION

DATA SOURCES

Tier 0 (FAST)

Tier 1 (INTERMEDIATE)

Tier 2 (SLOW)

FEDERATE SECURELY

OTHER ORGANIZATION

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

- Automatic, policy-based solutions are more future-proof as technology continues to change

- Having a programmatic interface (to the iRODS Rule Engine, via Policy Enforcement Points) means action(s) can be taken on your data based on the metadata:
  - Ingest
  - Metadata Extraction
  - Data Verification
  - Storage Tiering
  - Indexing
  - Publication
  - Auditing / Reporting

- Metadata templates allow for validation and verification
  - Match your domain-specific vocabulary and taxonomies
  - Reference outside standards
  - Prove compliance with required formats
  - Publish to make data discoverable
Ongoing and Upcoming Work

- Cacheless S3
- NFSRODS / CIFSRODS
- RDMA (RoCE) integration
iRODS Open Source Code
https://github.com/irops

iRODS Overview and Diagrams
https://irods.org/documentation

iRODS Software Documentation
https://docs.irods.org

iRODS Training Materials and Presentations
https://slides.com/irops

iRODS User Group Meeting
https://irods.org/ugm2019
Thank you.

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