Active Data: Data Life Cycle Management Across Heterogeneous Systems and Infrastructures

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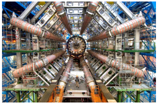
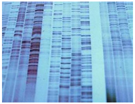
Big Data ...

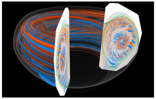
- Huge and growing volume of information originating from multiple sources.



Big Science



Instruments



Simulations

Internet

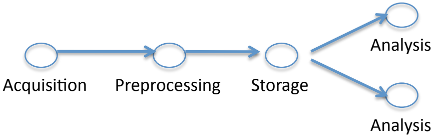
Open Data

- . . . or Big Bottlenecks ?
  - how to scale the infrastructure ?
    - end-to-end performance improvement, inter-system optimization.
  - how to improve productivity of data-intensive scientist ?
    - data-oriented programming language, data quality, improve automation and errors recovery

Data Life Cycle

Definition

Data Life Cycle (DLC) is the course of operational stages through which data pass from the time when they enter a set of systems to the time when they leave it.



Challenges :

- Expose high level view DLC across distributed systems and infrastructures
- Expose interactions between the infrastructure and the DLC (e.g failures)

Active Data

Active Data:

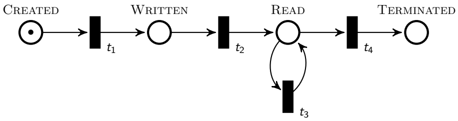
- Allow to reason about data sets handled by heterogeneous software and infrastructures.
- A **formal model** that captures the essential life cycle stages and properties: creation, deletion, faults, replication, error checking . . .
- **programming model** to develop easily data life cycle management applications.
- Allows legacy systems to expose their intrinsic data life cycle.

Active Data: Principles & Features

System programmers expose their system's internal data life cycle with a model based on Petri Nets.

A *Life Cycle Model* is made of

- **Places**: data states
- **Transitions** : data operations



Each token has a unique identifier, corresponding to the actual data item's.

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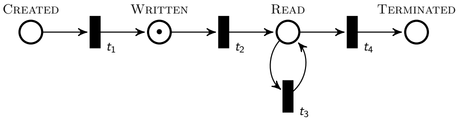

A transition is fired whenever a data state changes.

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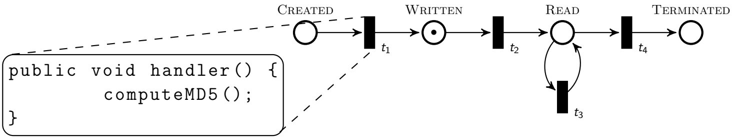
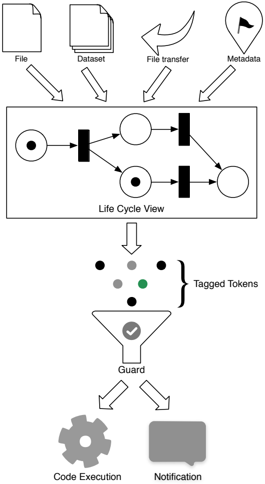


```
public void handler() {
        computeMD5();
}
```

Code may be plugged by clients to transitions.

It is executed whenever the transition is fired.

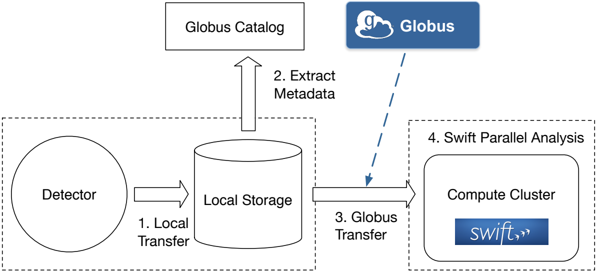
Active Data Framework



Framework features:

- Captures data events in legacy systems
- High-level *life cycle-centered* view of data
  - Single namespace for all the files, datasets and metadata
- Powerful filters based on **Data Tags**
  - Install *Taggers* on Transitions
  - *Guarded Transitions* : only executes on token which have specific tags.
- Publish/subscribe transitions
- Custom user reaction to data progress
  - Custom code execution
  - Custom notifications (twitter, email, gdoc, ifttt ...)

Use Case: Advanced Photon Source



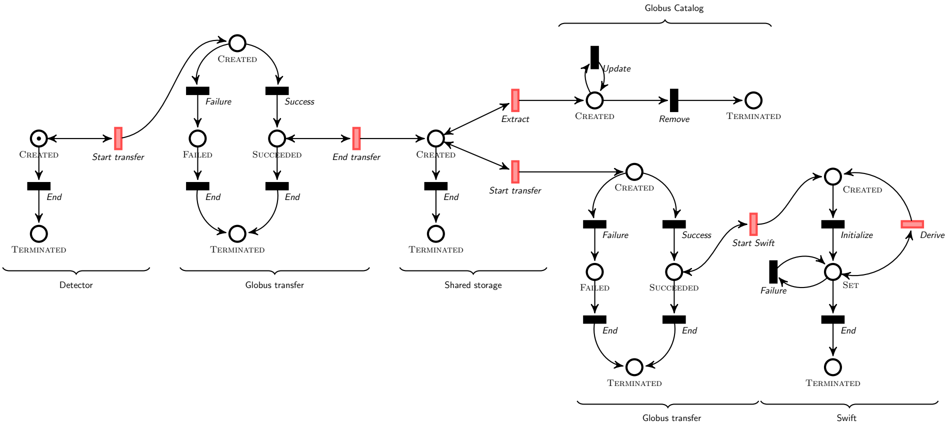
- 3 to 5 TB of data per week on this detector
- Raw data are pre-processed and registered in the Globus Catalog :
- Data are curated by several applications
- Data are shared amongst scientific user

Data Surveillance Framework

4 goals (that would otherwise require a lot of scripting and hacking):

- Monitoring Data Set Progress
- Better Automation
- Sharing & Notification
- Error Discovery & Recovery

APS Data Life Cycle Model



Data life cycle model composed of 6 systems.

Error Detection & Recovery

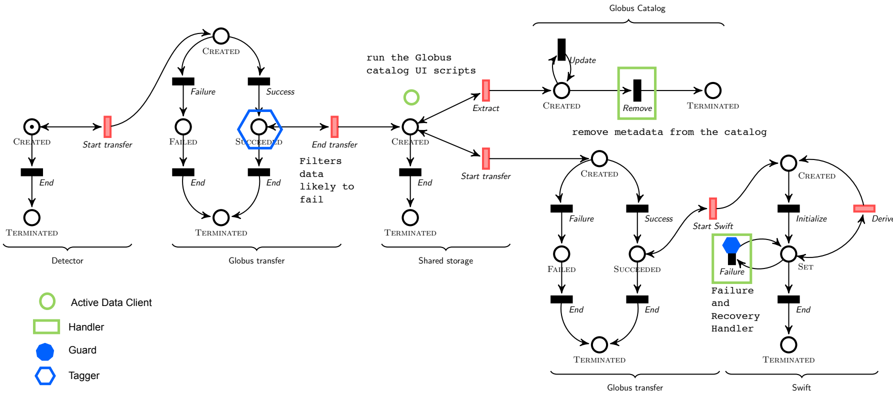
Example scenario

Recover from system-wide errors: faulty acquired files are detected only after Swift fails to process them.

In this situation, the user manually:

- Drops the whole dataset
- Removes any associated file and metadata
- Re-acquire the dataset using the same parameters

E.D.&R. implementation



run the Globus catalog UI scripts

remove metadata from the catalog

Filters data likely to fail

Failure and Recovery Handler

Handler Code

```
TransitionHandler handler = new TransitionHandler() {
   public void handler(Transition t, boolean isLocal, Token[] inTokens, Token[] outTokens) {
      // Get the dataset identifier
      LifeCycle lc = ad.getLifeCycle(inTokens[0]);
      datasetId = lc.getTokens("Shared storage.Created")[0].getUid();

      // Remove the dataset annotations from the catalog
      String url = "https://catalog.globus.org/dataset/" + datasetId;
      Runtime r = Runtime.getRuntime();
      Process p = r.exec("catalog_client.py remove " + url);
      p.waitFor();

      // Locally, remove the datasets
      String path = "~/aps/" + datasetId;
      FileUtils.deleteDirectory(new File(path));

      // Publish the "Detector.End"
      Token root = lc.getTokens("Detector.Created")[0];
      ad.publishTransition("Detector.End", lc);

      // Notify the user
      sendEmail("user@server.com", "APS - Corrupted dataset " + datasetId);
   }
};

HandlerGuard guard = new HandlerGuard () {
    public boolean accept ( Transition t , Token [] inTokens , Token [] outTokens ) {
       return input[0].hasTag("failure corrupted");
}}

ad.subscribeTo("Swift.Failure", handler, guard);
```

Conclusion

Active Data

- allows to expose Data Life Cycle across heterogeneous systems and infrastructures
- *transition-based* programming model for DLC management application
  - Monitoring, automation, error detection & recovery
  - X-systems optimizations: incremental computing, data staging, caching, throttling etc...

Perspectives :

- Use AD to deploy data management software stack on IaaS (Asma Ben Cheick, Heithem Abbes, Univ. Tunis)
- Big Data Apache stack X-optimization (H. He, CAS, Beijing)
- Volunteer & crowd computing (M. Moca, BBU, Romania)

Thank you!

Questions?