ESCAPE

European Science Cluster of Astronomy & Particle physics ESFRI research Infrastructures

Event Driven Processing and Data Management

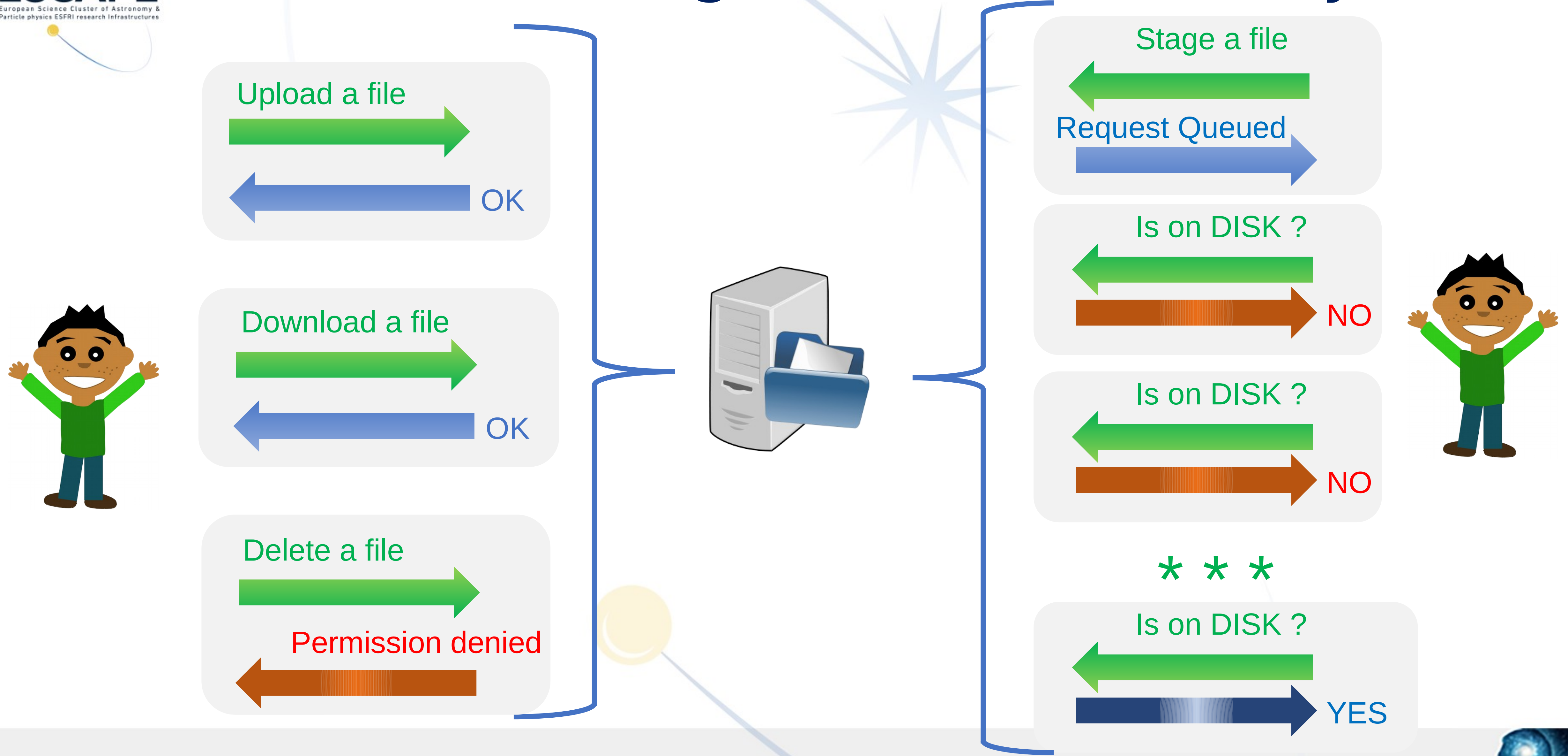
Paul Millar

Joint ESCAPE WP2/WP5 workshop

(with material donated by Marica Antonacci, Patrick Fuhrmann and Michael Schuh)

ESCAPE - The European Science Cluster of Astronomy & Particle Physics ESFRI Research Infrastructures has received funding from the European Union’s Horizon 2020 research and innovation programme under the Grant Agreement n° 824064.

How storage is used currently



Upload a file

OK

Download a file

OK

Delete a file

Permission denied

Stage a file

Request Queued

Is on DISK ?

NO

Is on DISK ?

NO

* * *

Is on DISK ?

YES

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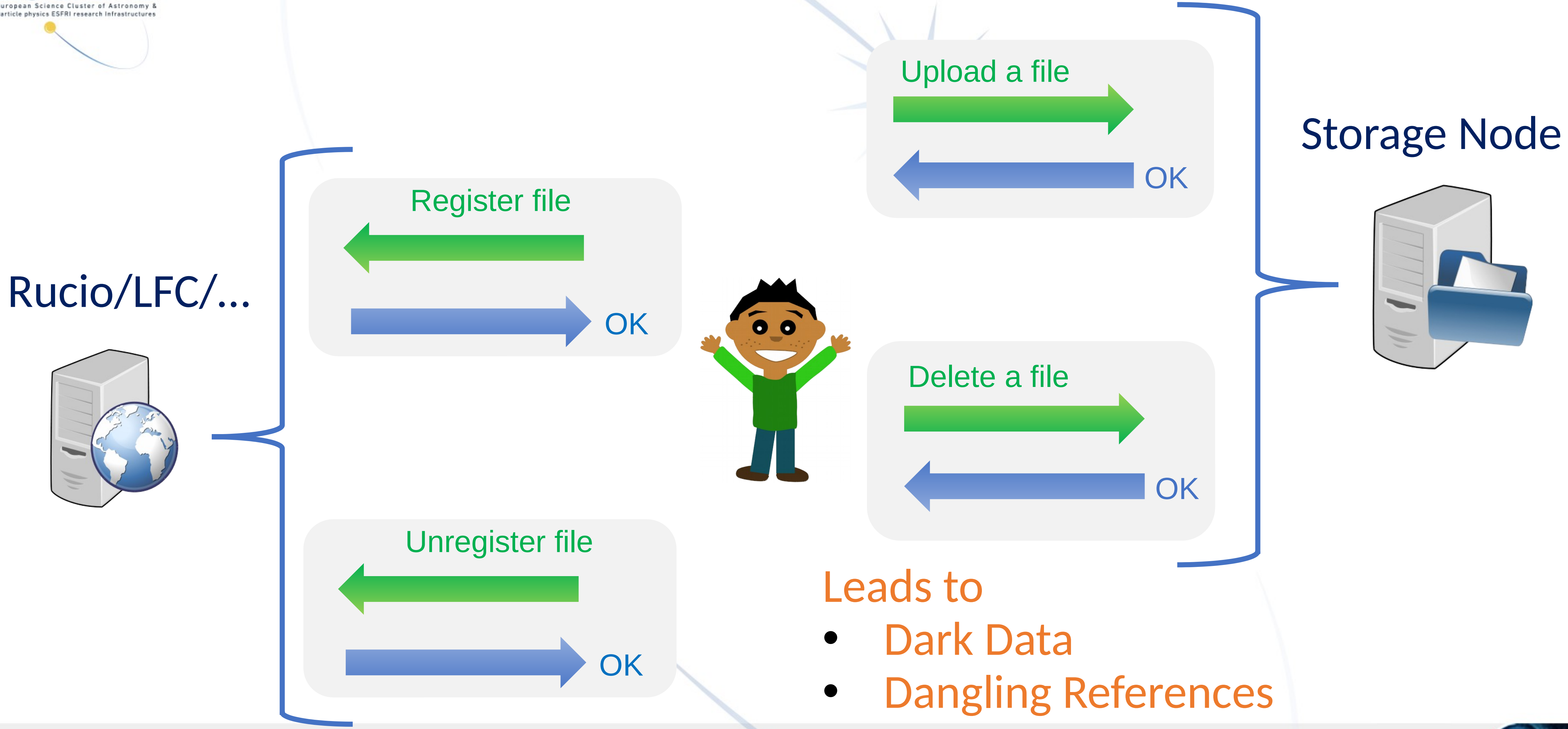
This may lead to problems…



Leads to

- Dark Data
- Dangling References

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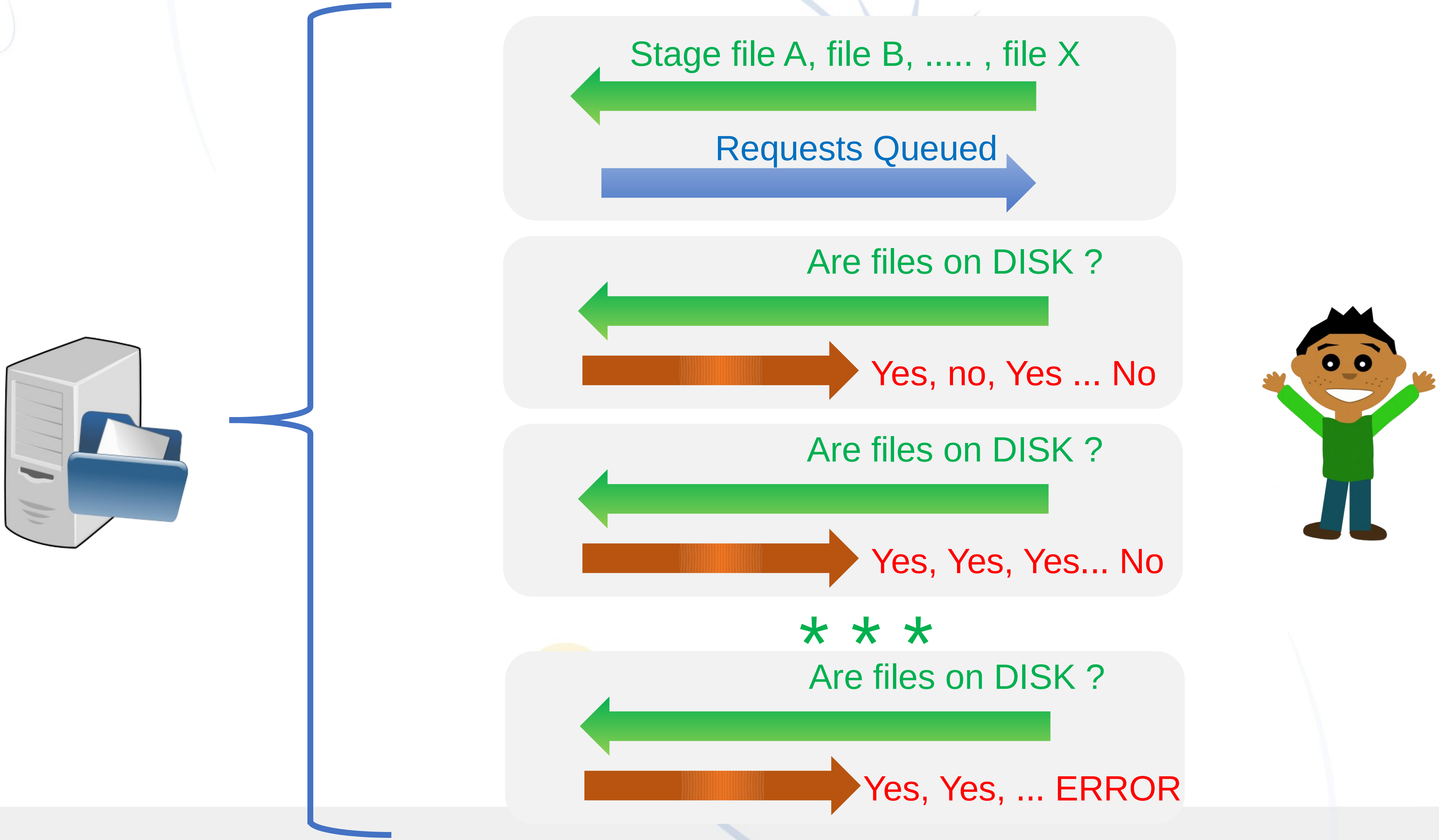
This may cause more problems



Stage file A, file B, ... , file X

Requests Queued

Are files on DISK ?

Yes, no, Yes ... No

Are files on DISK ?

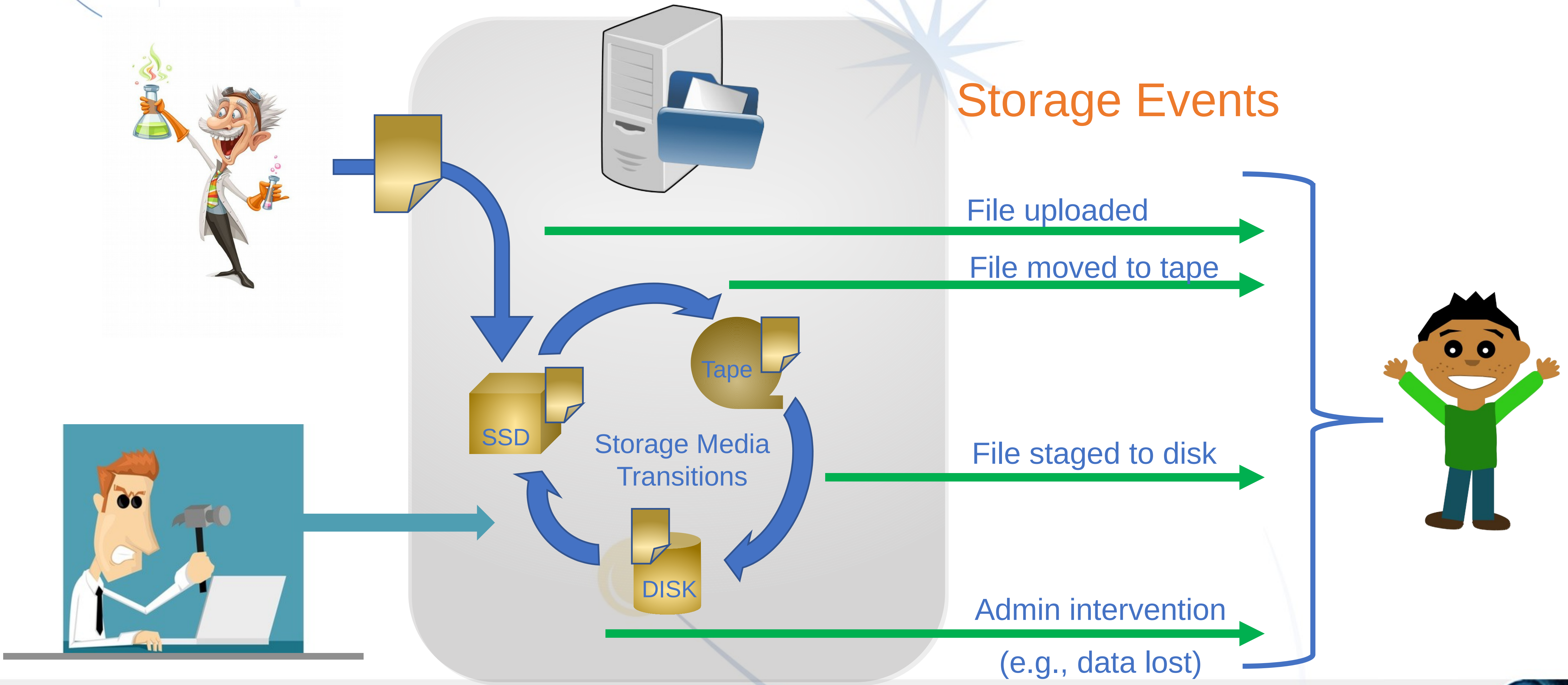
Yes, Yes, Yes... No

* * *

Are files on DISK ?

Yes, Yes, ... ERROR

New way of interacting: storage events



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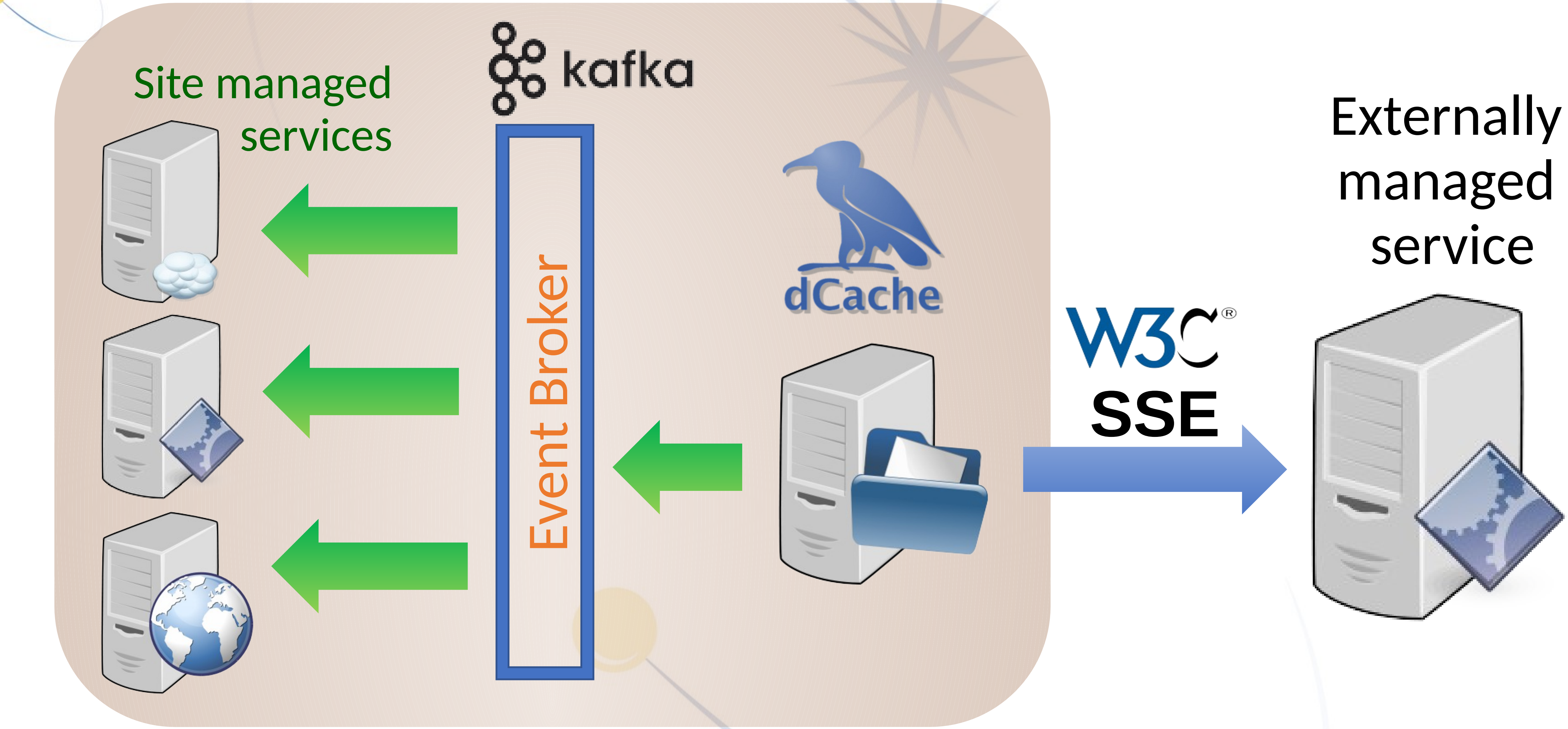
dCache implementation

dCache Storage Events: Kafka and SSE



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Cheat sheet: Kafka vs SSE

	kafka	W3C® SSE
Availability since...	dCache v4.1	dCache v5.0
Standard …	Software package	Protocol
What events does it see?	dCache billing events	inotify
Main benefit	Easy integration	Built-in security
“Catch-up” storage	Memory & disk	Memory-only (currently)
Target audience	Site-level integration	Events for users

Use-cases and demonstrators

Use-cases and demonstrators

INDIGO-Orchestrator

& automated data processing

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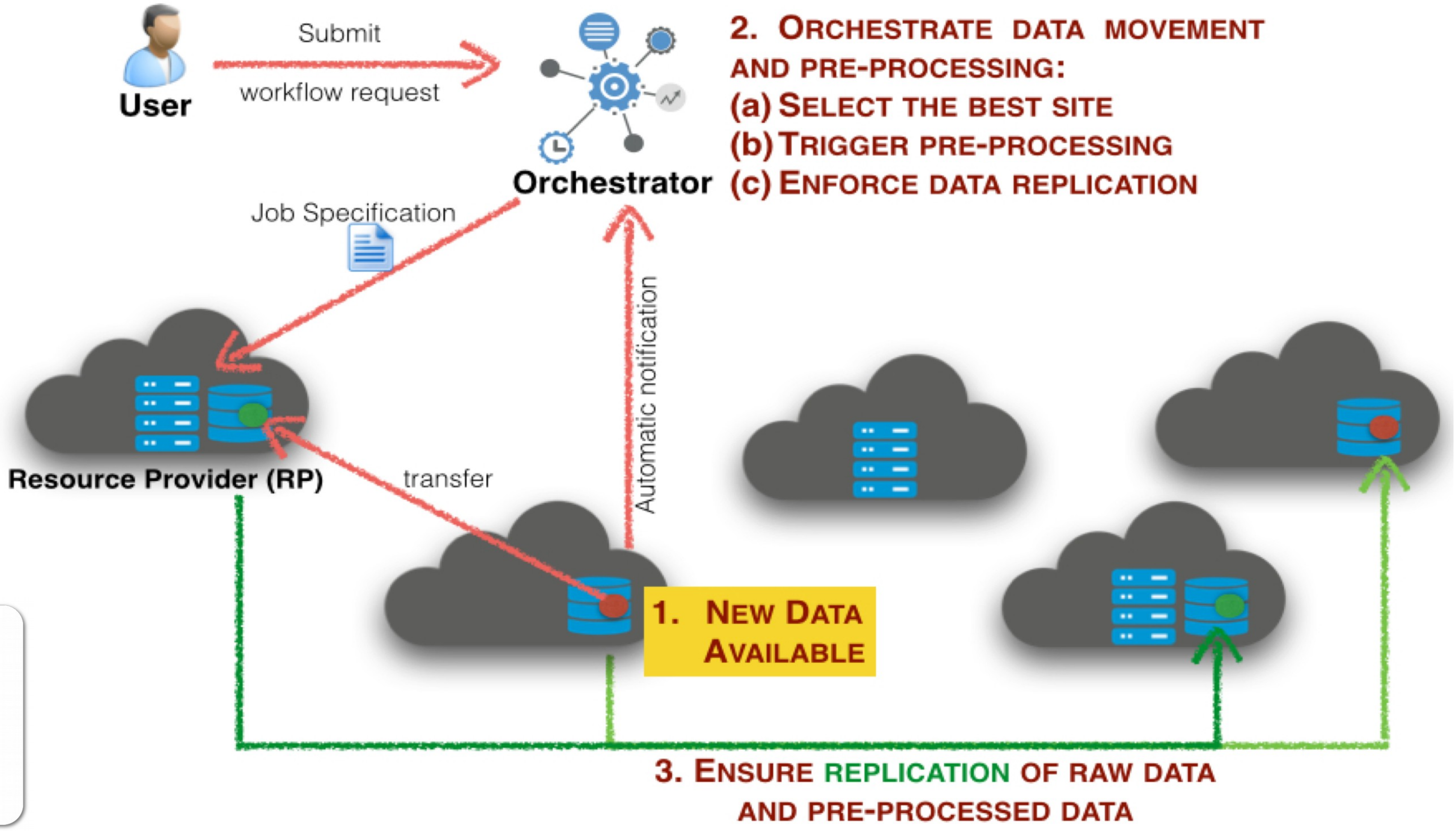
INDIGO Orchestrator (SSE)



2. Orchestrate data movement and pre-processing:
(a) Select the best site
(b) Trigger pre-processing
(c) Enforce data replication

1. New Data Available

3. Ensure replication of raw data and pre-processed data

Use-cases and demonstrators

EU-XFEL

Analysis and automation

pilot platform pilot

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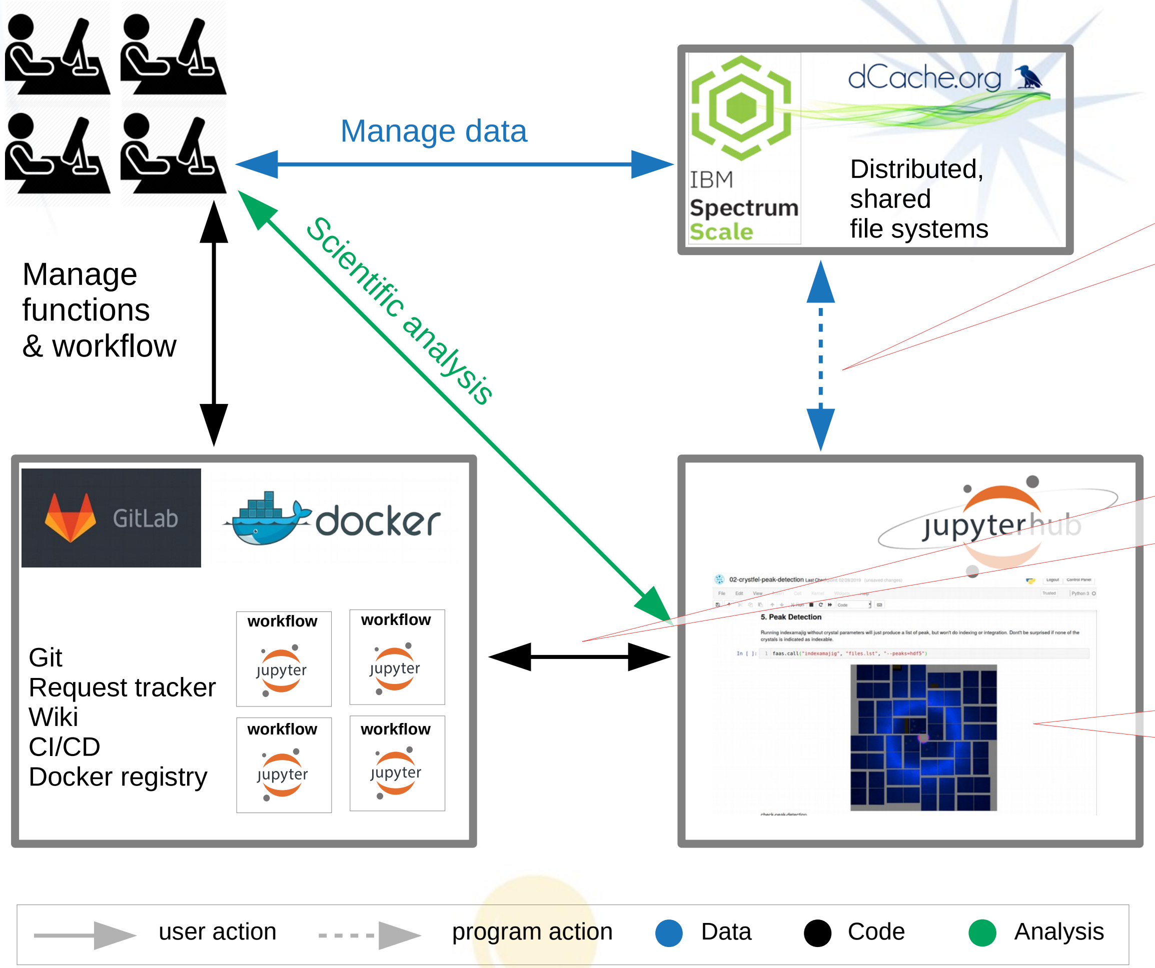
Jupyter Notebooks on HPC cluster



- Data on shared file systems mounted on HPC host (NFS)
- uid, gid mapping

Sync git and Jupyter

- Mybinder
- Nbgitpuller
- git

Reproducibility

- Functions
- Results

Contact: eosc-pan-info@desy.de
Icons: flaticon.com (freepik/prettycon)

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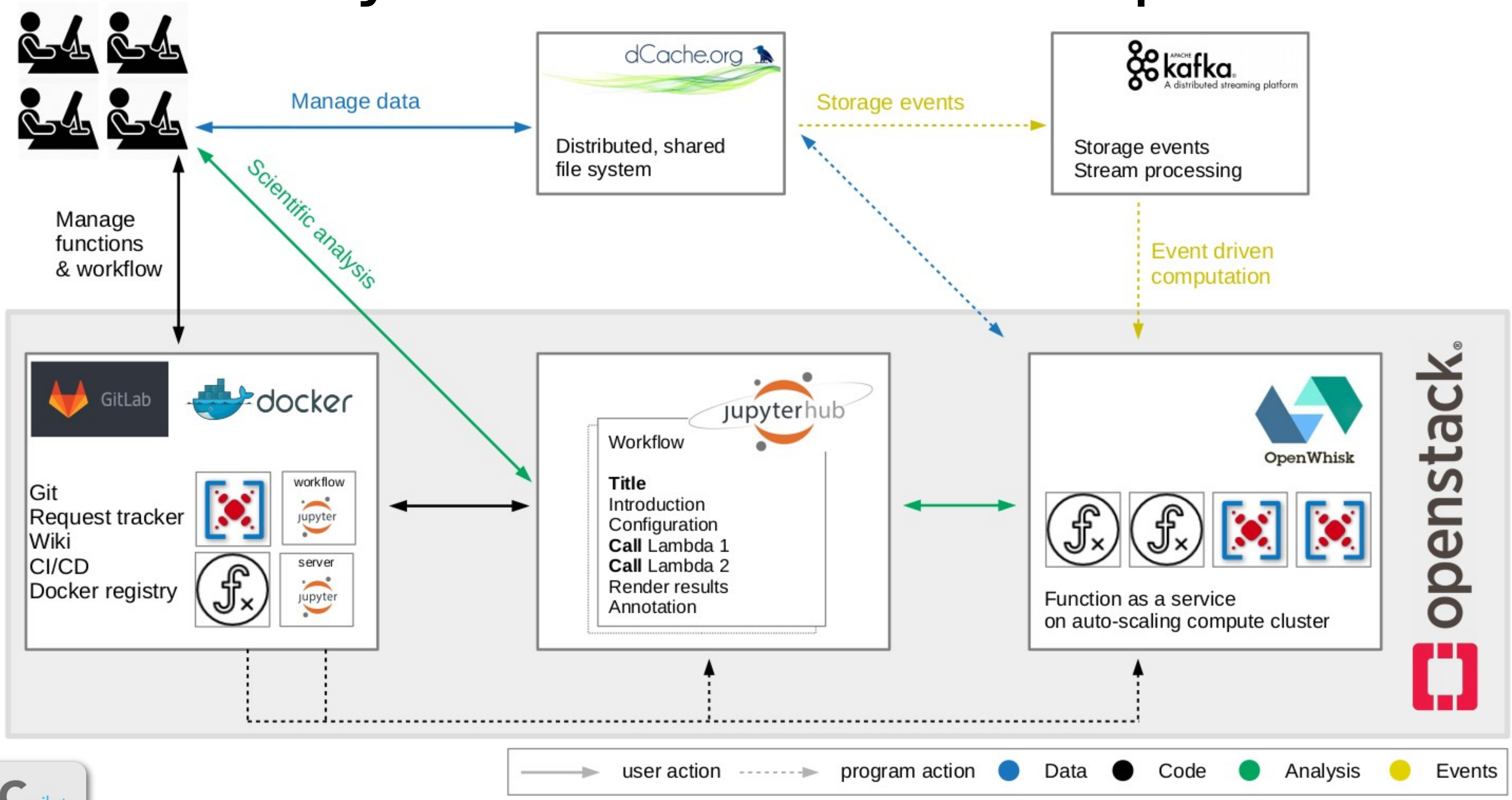
Analysis and automation platform



Manage data

Distributed, shared file system

Storage events

Storage events
Stream processing

Event driven computation

Manage functions & workflow

Scientific analysis

Git
Request tracker
Wiki
CI/CD
Docker registry

Workflow

Title
Introduction
Configuration
Call Lambda 1
Call Lambda 2
Render results
Annotation

Function as a service on auto-scaling compute cluster

→ user action ⇢ program action ● Data ● Code ● Analysis ● Events

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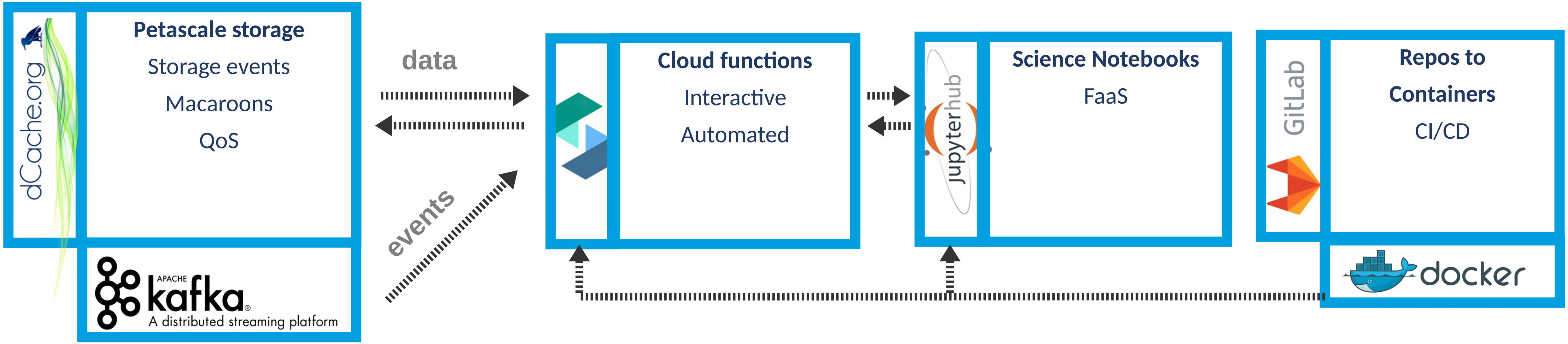
Analysis and automation platform

Single namespace in multi-clouds.

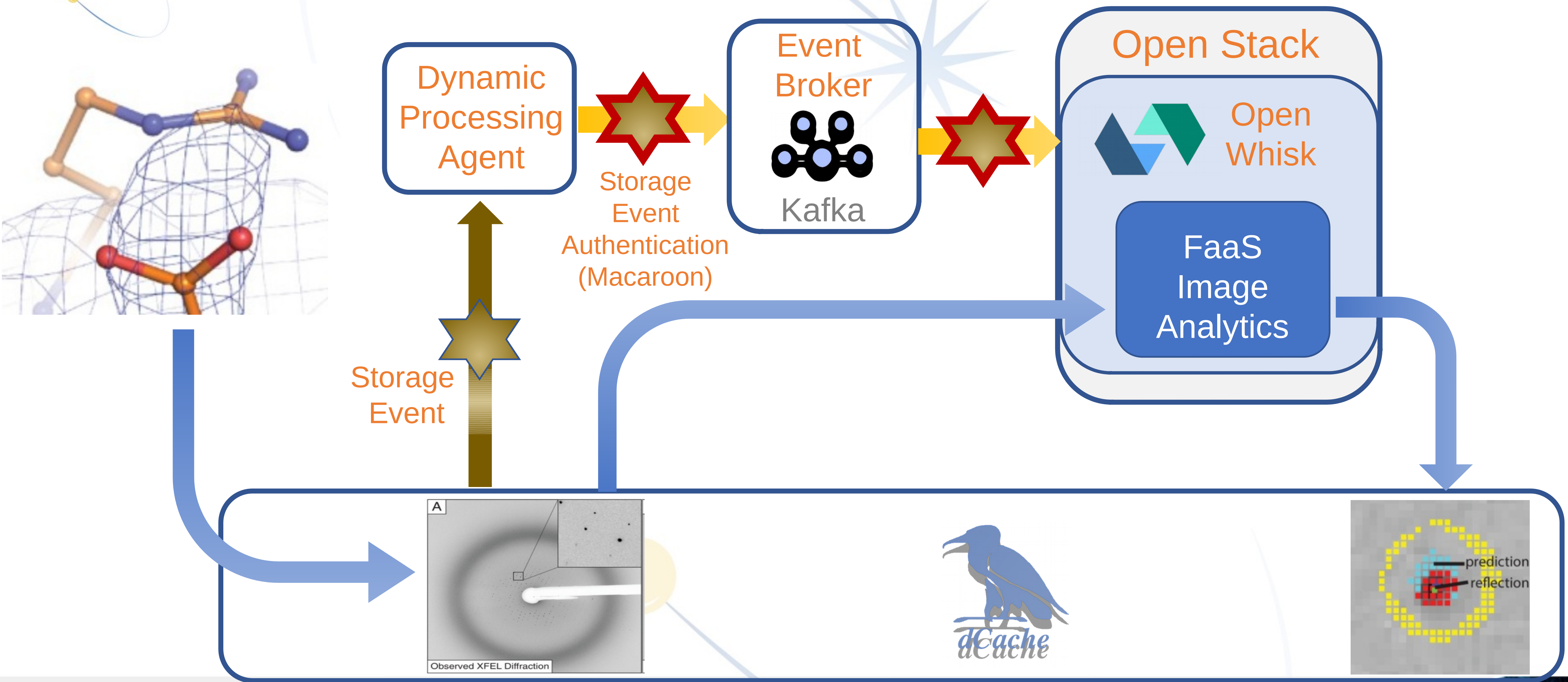
Function-as-a-Service in Science Notebooks and in automation.

Jupyter Notebooks in user-defined environments.

Just push code it builds, goes live and scales.



System/integration view



Dynamic Processing Agent

Storage Event Authentication (Macaroon)

Event Broker

Kafka

Open Stack

Open Whisk

FaaS Image Analytics

Storage Event

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Use-cases and demonstrators

EISCAT 3D

Automated replication pilot

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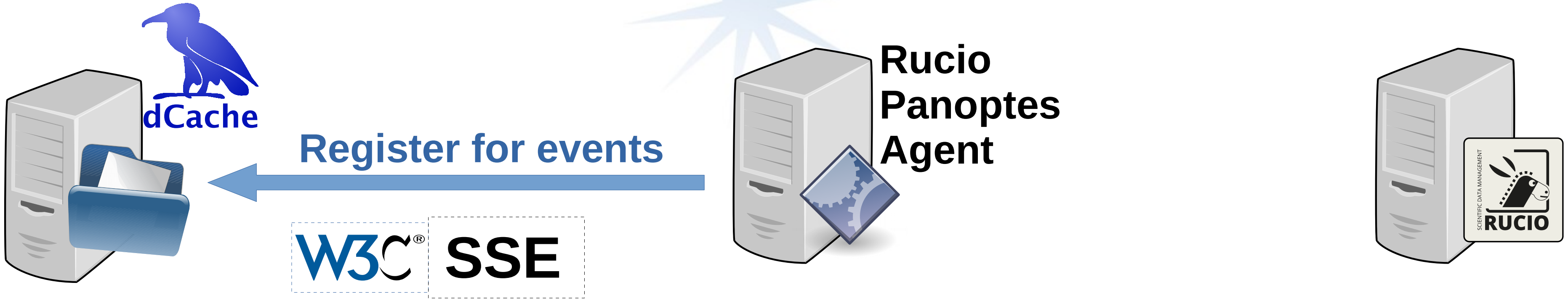
EISCAT_3D: automated replication



dCache

Register for events

W3C SSE

Rucio
Panoptes
Agent

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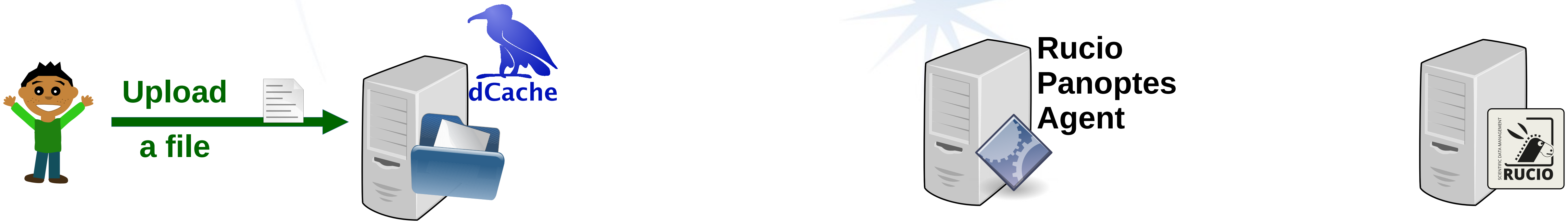
EISCAT_3D: automated replication



Upload

a file

dCache

Rucio
Panoptes
Agent

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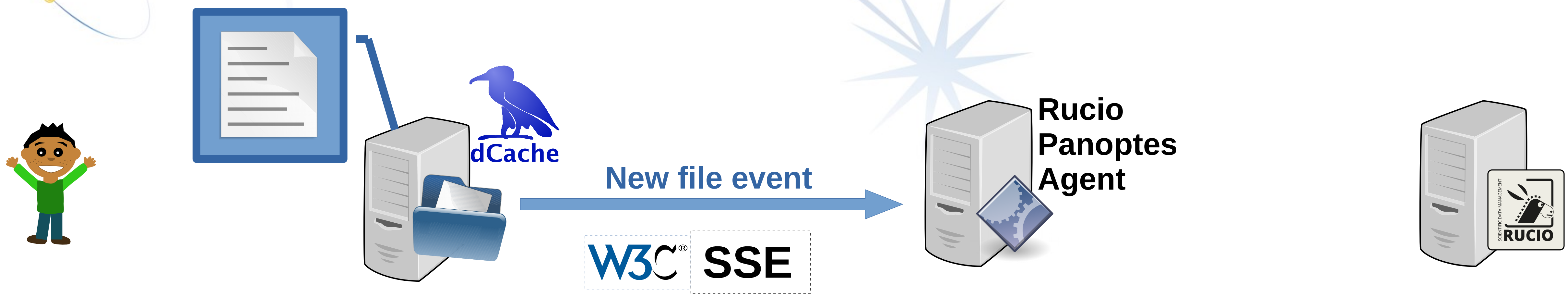
EISCAT_3D: automated replication



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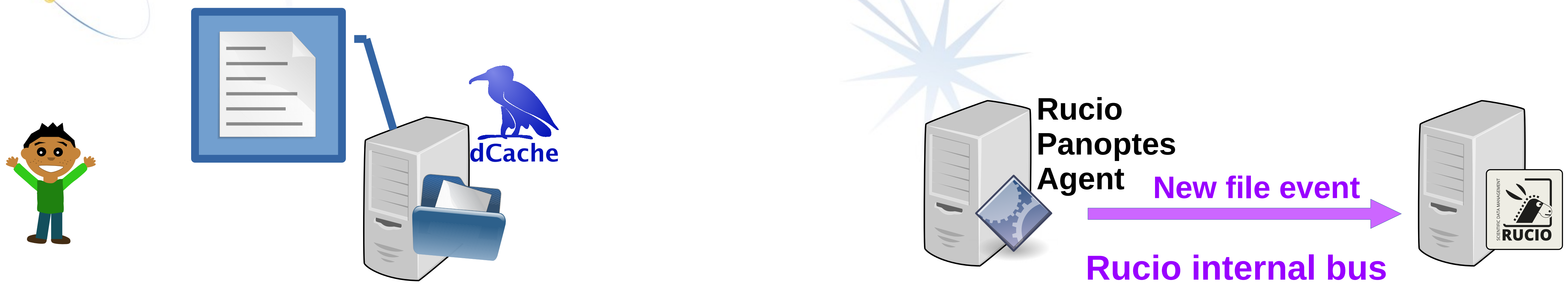
EISCAT_3D: automated replication



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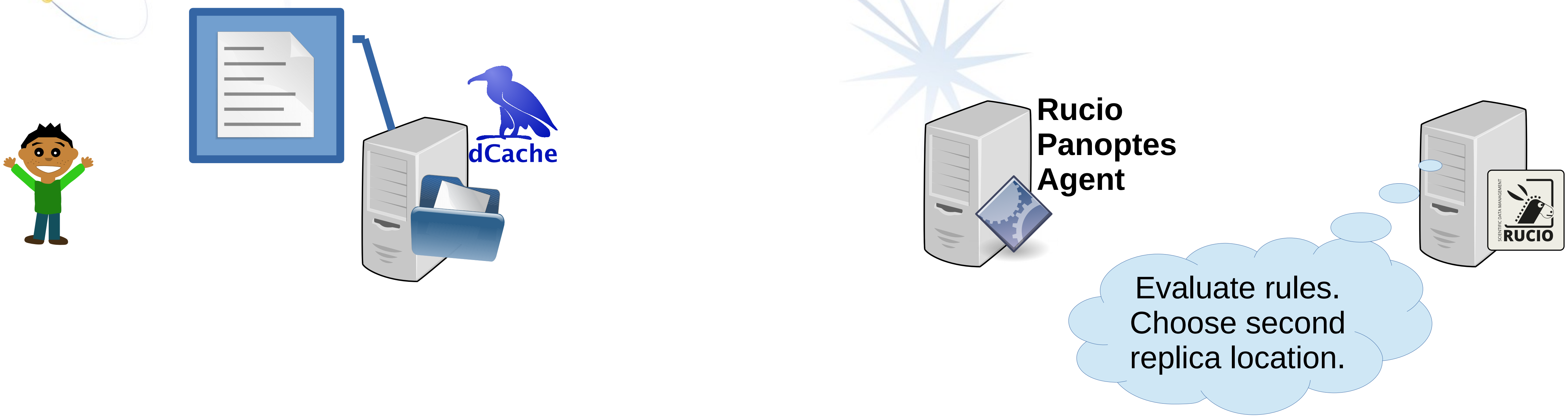
EISCAT_3D: automated replication



Rucio
Panoptes
Agent

Evaluate rules.
Choose second
replica location.

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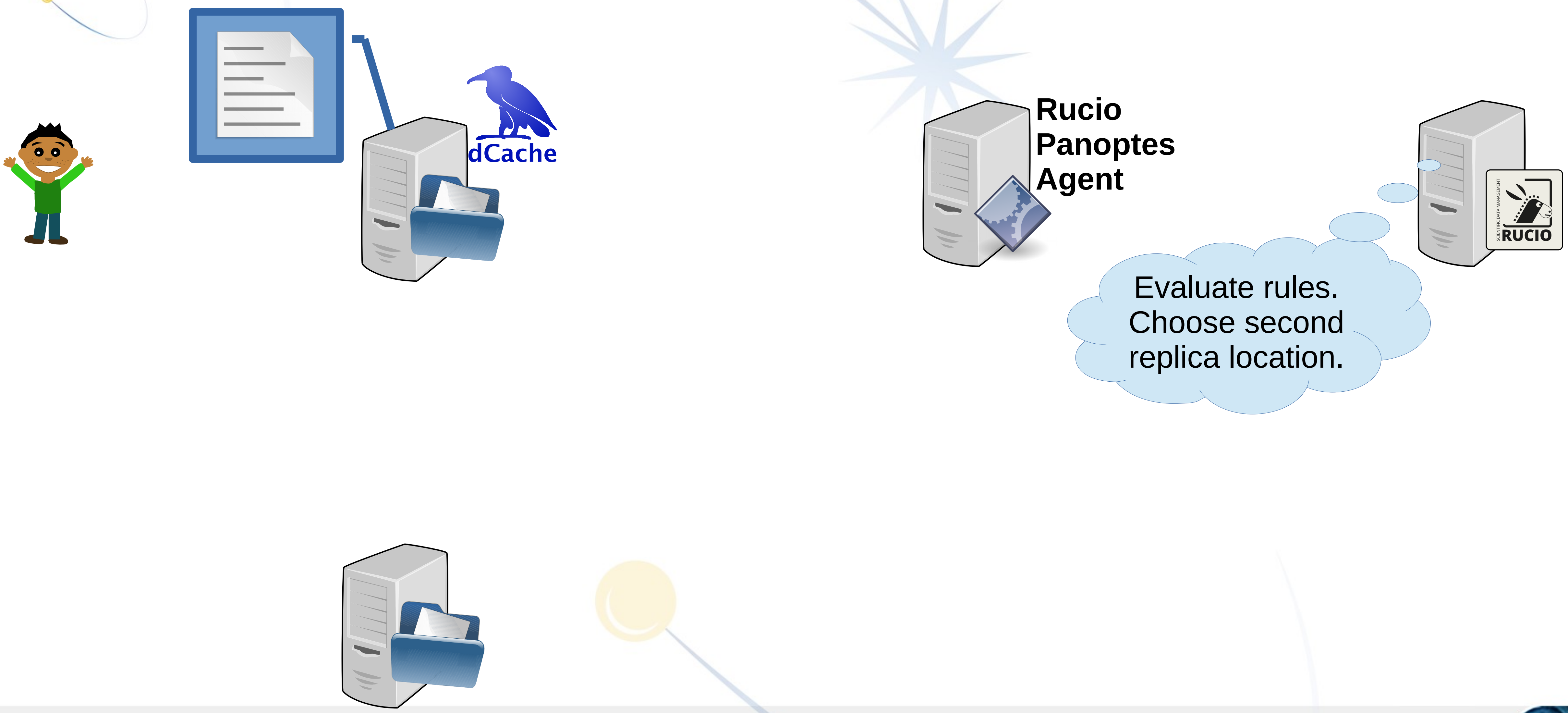
EISCAT_3D: automated replication



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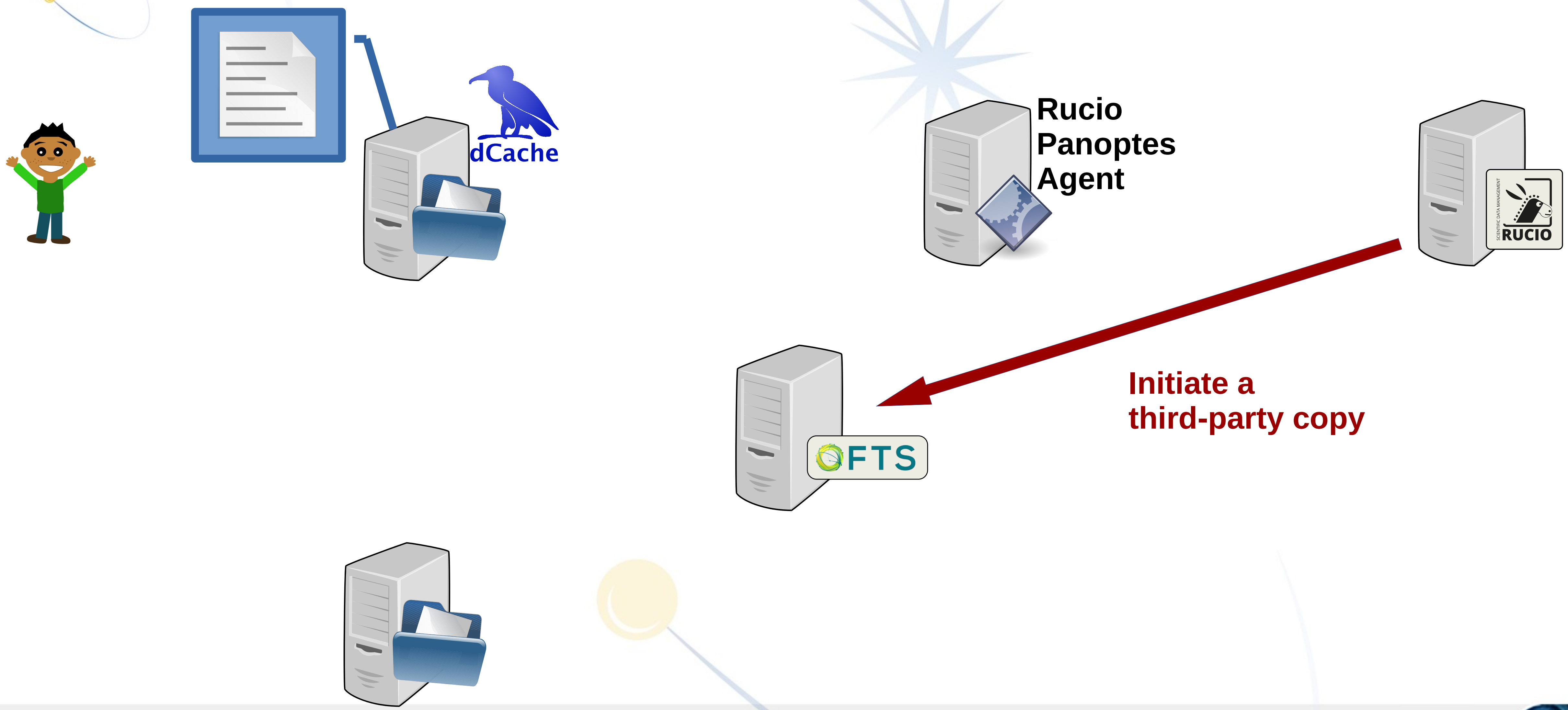
EISCAT_3D: automated replication



Initiate a third-party copy

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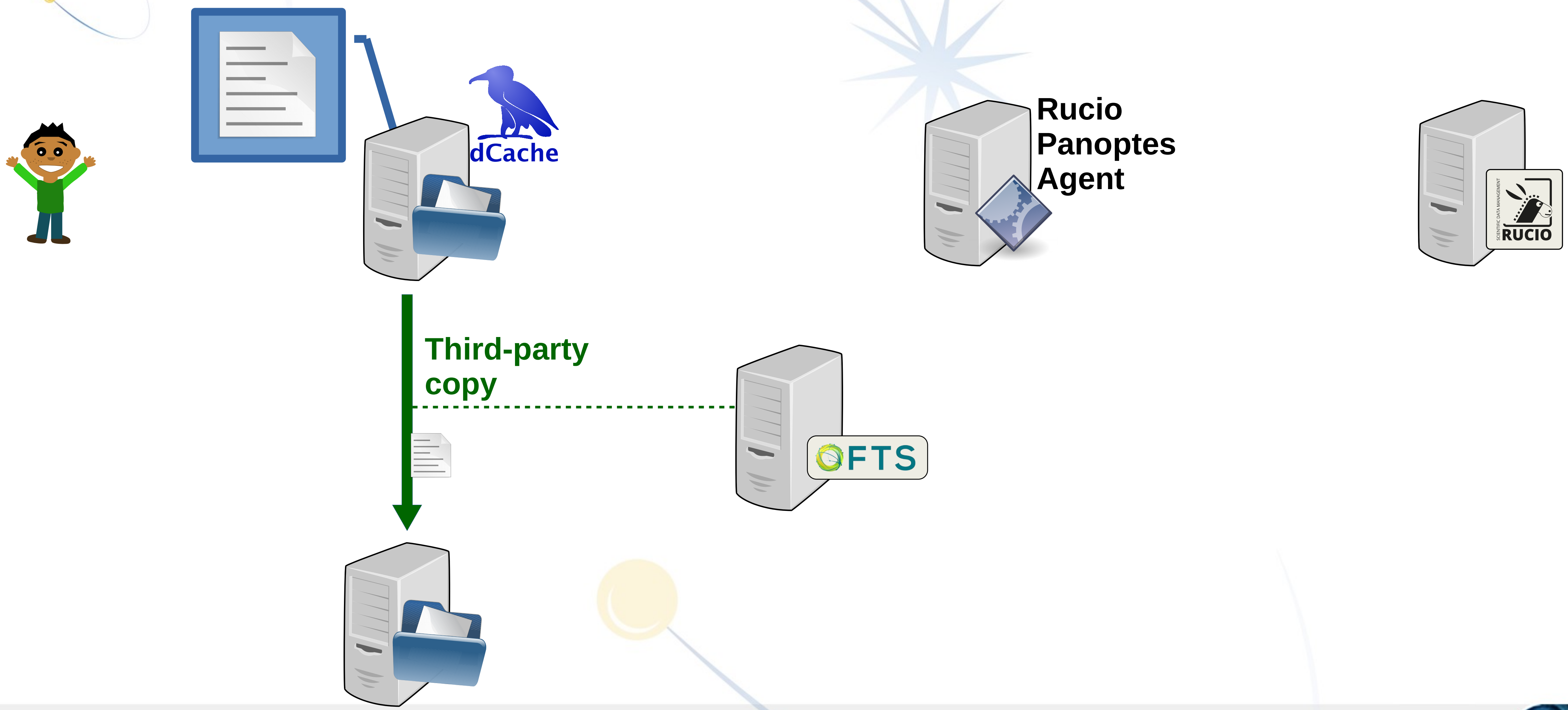
EISCAT_3D: automated replication



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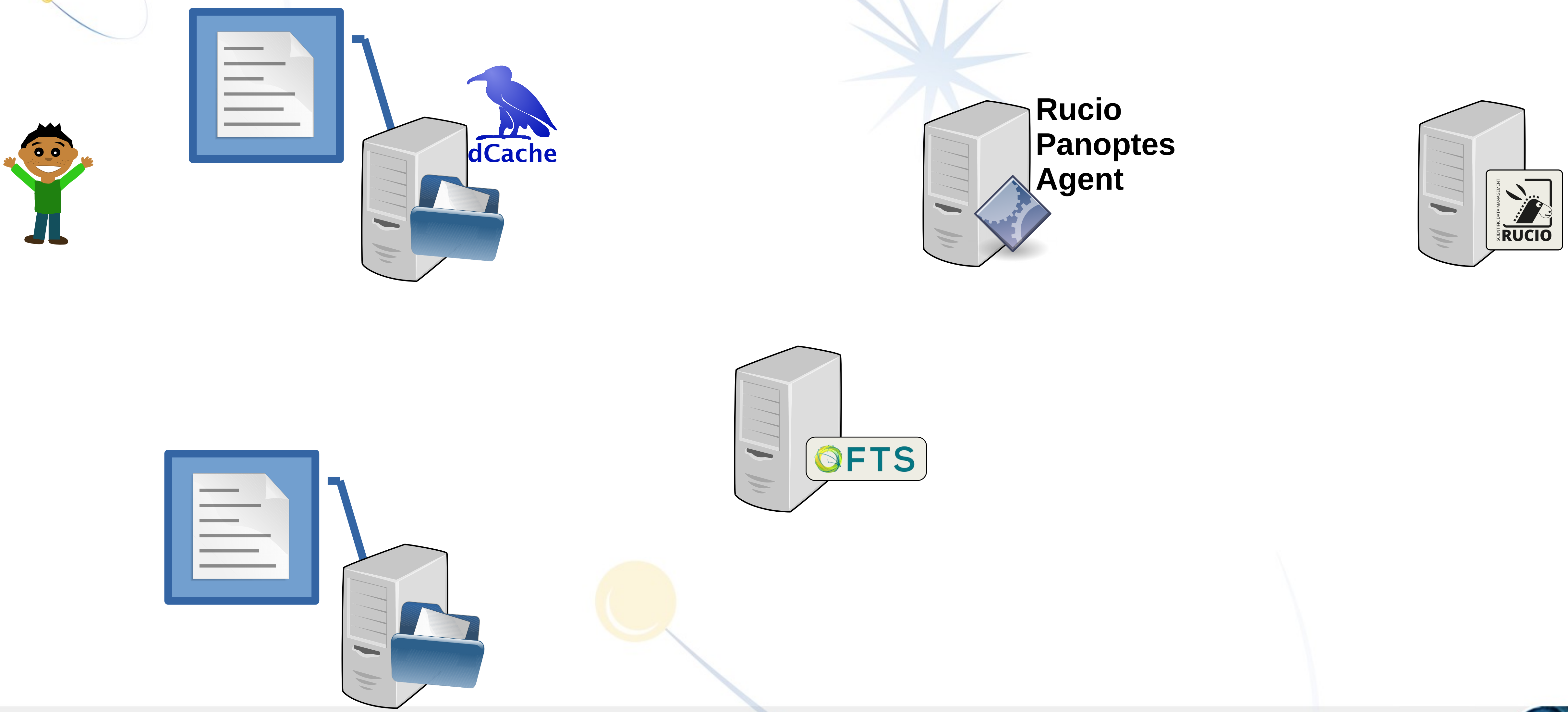

Rucio
Panoptes
Agent

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Use-cases and demonstrators

Fermilab & WLCG

Increased tape staging efficiency

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Increased tape staging efficiency

- One of the closely correlated metric for tape inefficiency is **remount count**: loading same tape two (or more) times in close succession.

  Load tape once. Read all relevant data. Move on.

- To reduce likelihood, the tape system should be given (ideally) **all pending requests**.

  This allows the tape system to reorder requests.

- **Problem**: polling overhead from repeatedly checking status.
- **Solution**: storage events to discover when files have been staged
  - Allow clients to request all files (almost without limit).
  - Low latency: jobs/transfers may start as soon as file is available.

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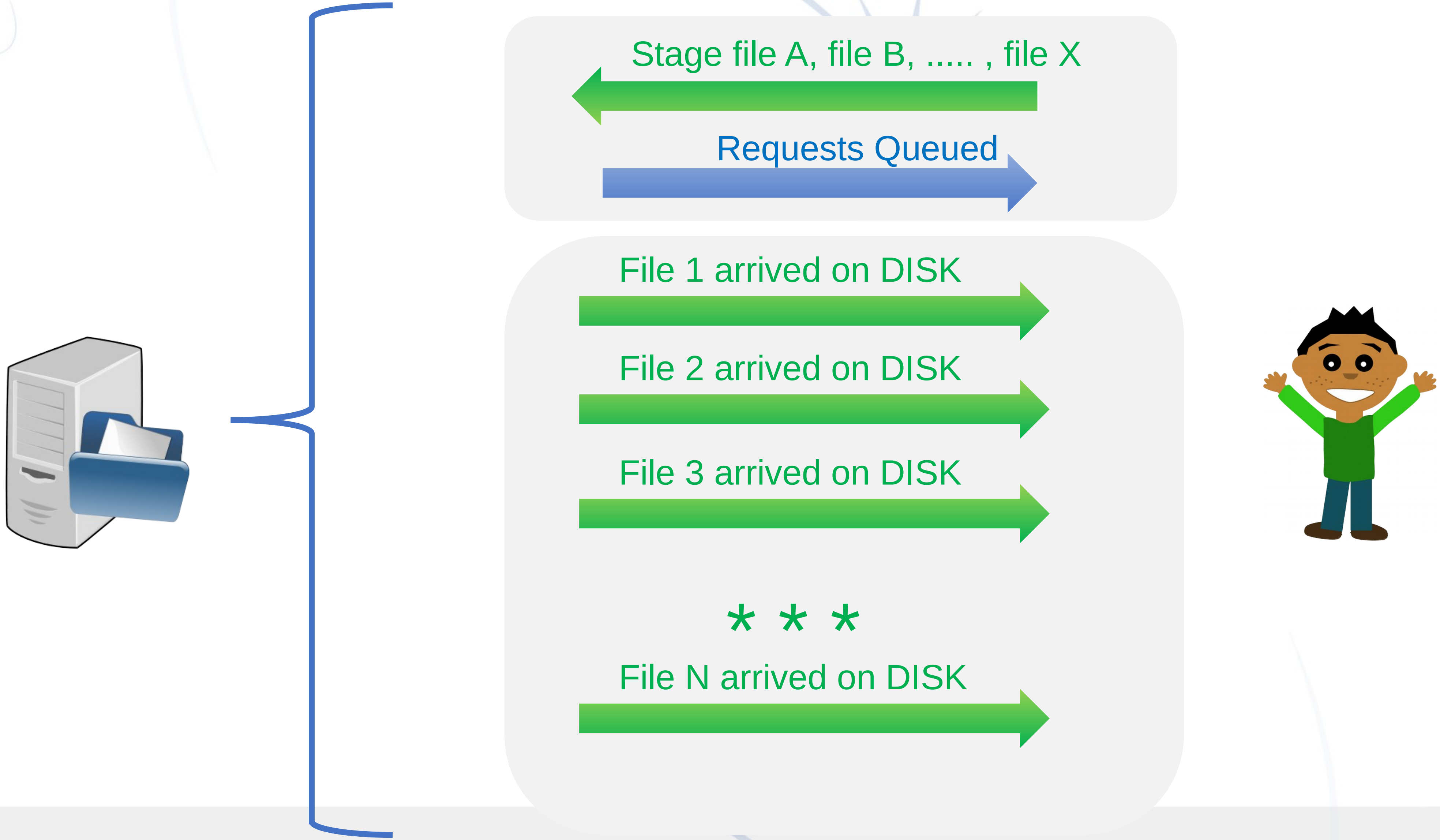
Increased tape staging efficiency



Stage file A, file B, ... , file X

Requests Queued

File 1 arrived on DISK

File 2 arrived on DISK

File 3 arrived on DISK

* * *

File N arrived on DISK

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Use-cases and demonstrators

Handling data-loss:
Automated data-replica recovery

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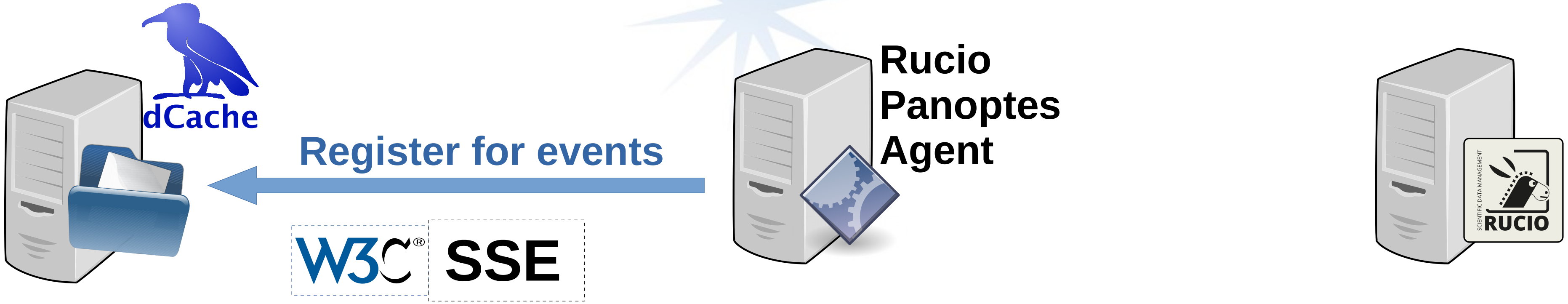
Automatic data-replica recovery



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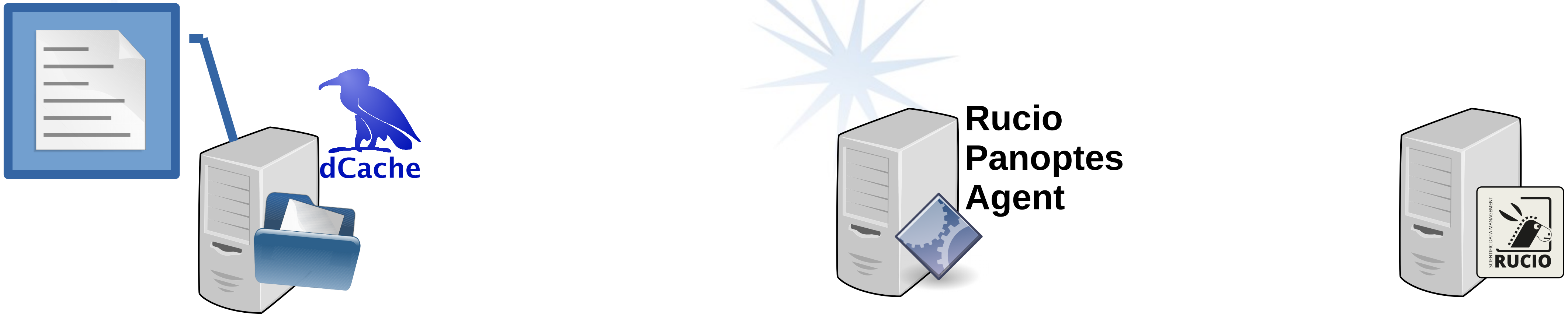
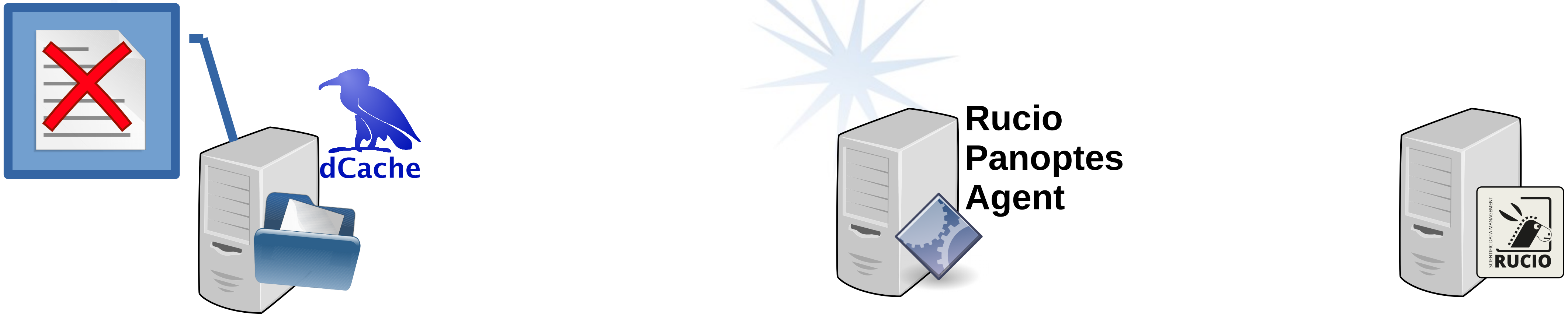
Automatic data-replica recovery

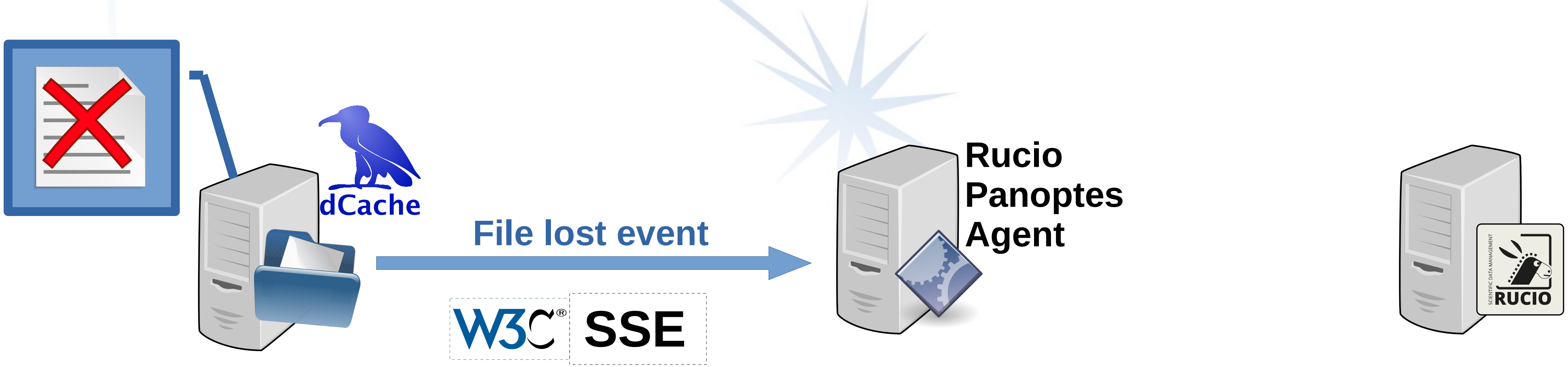


Rucio
Panoptes
Agent

Automatic data-replica recovery



Automatic data-replica recovery



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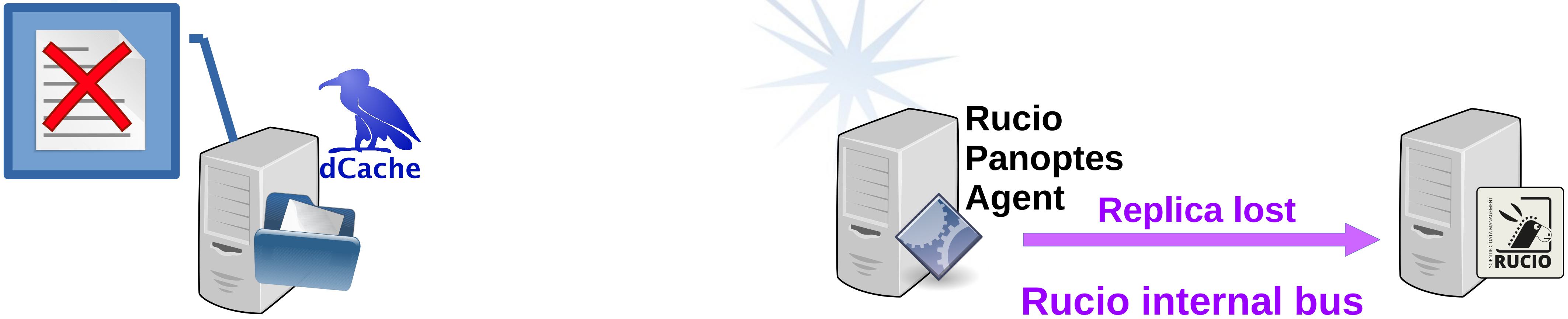
Automatic data-replica recovery



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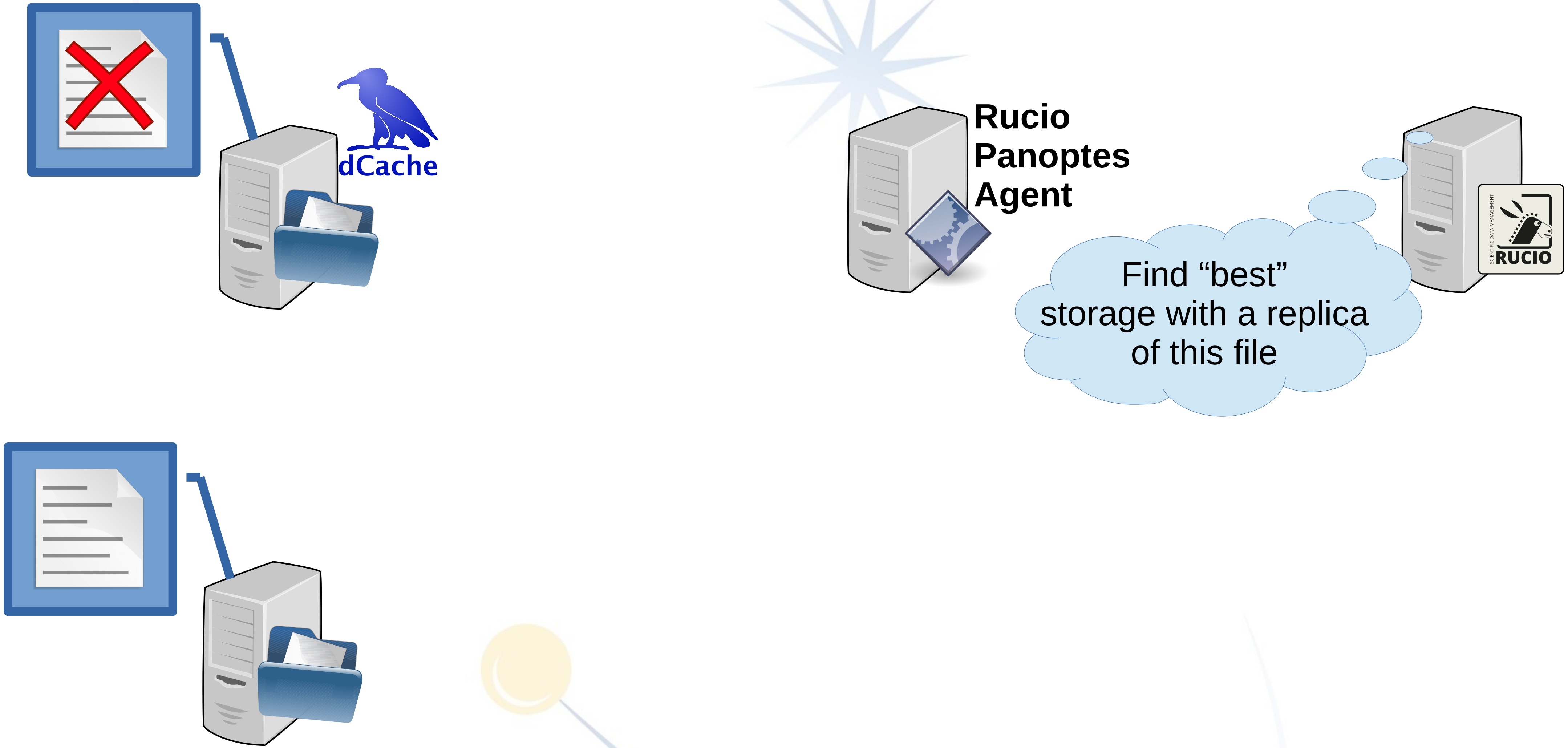
Automatic data-replica recovery



Find “best” storage with a replica of this file

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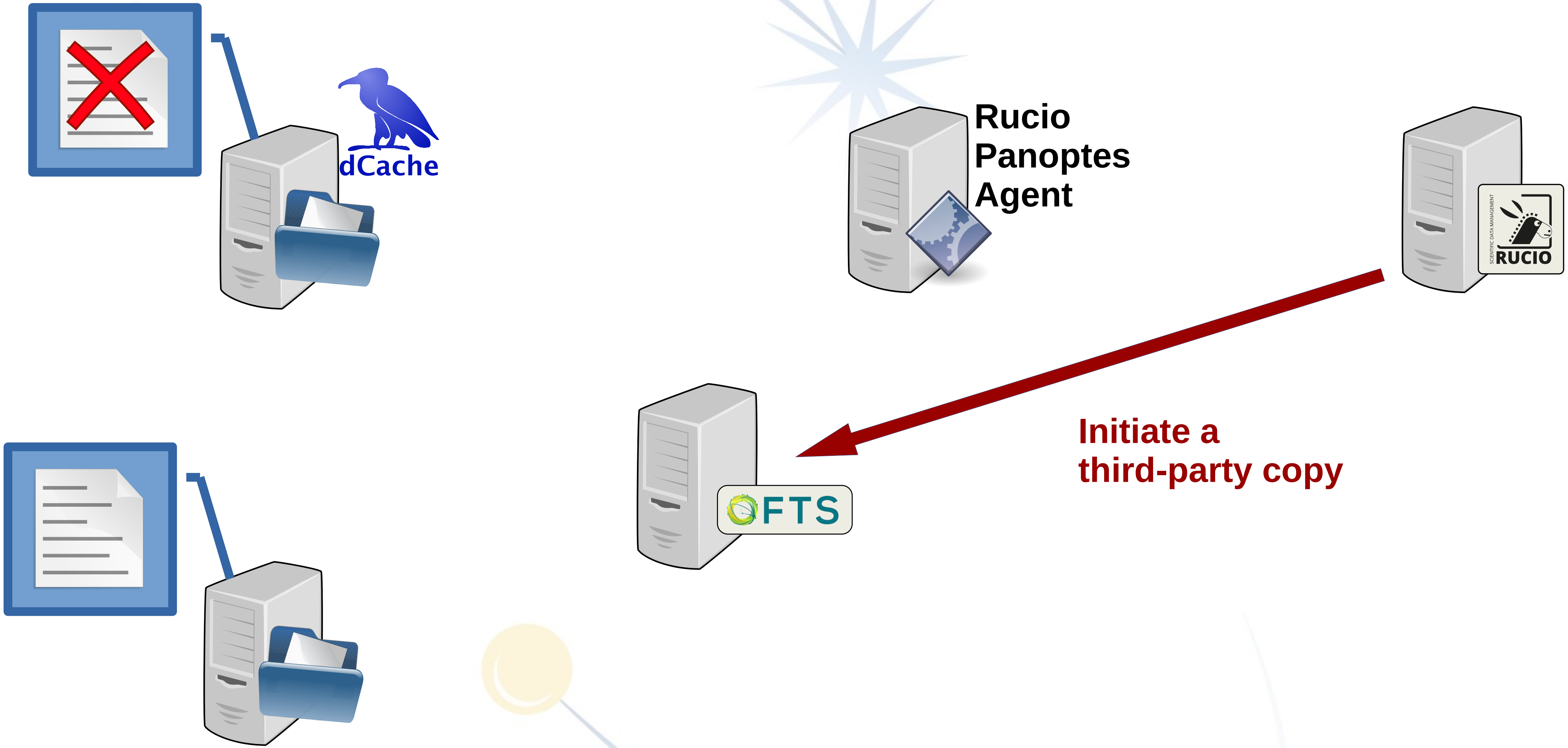
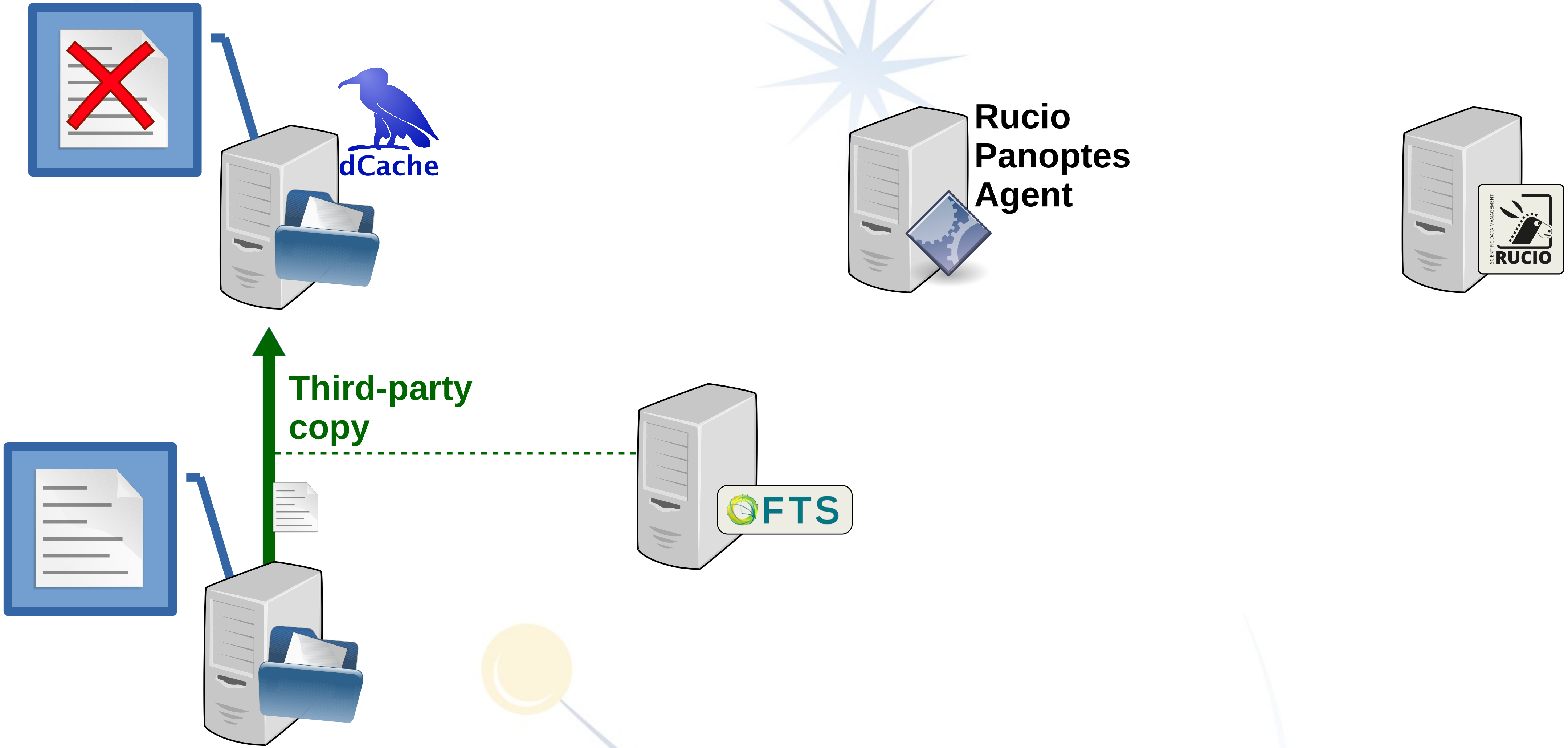
Automatic data-replica recovery



Initiate a
third-party copy

Automatic data-replica recovery



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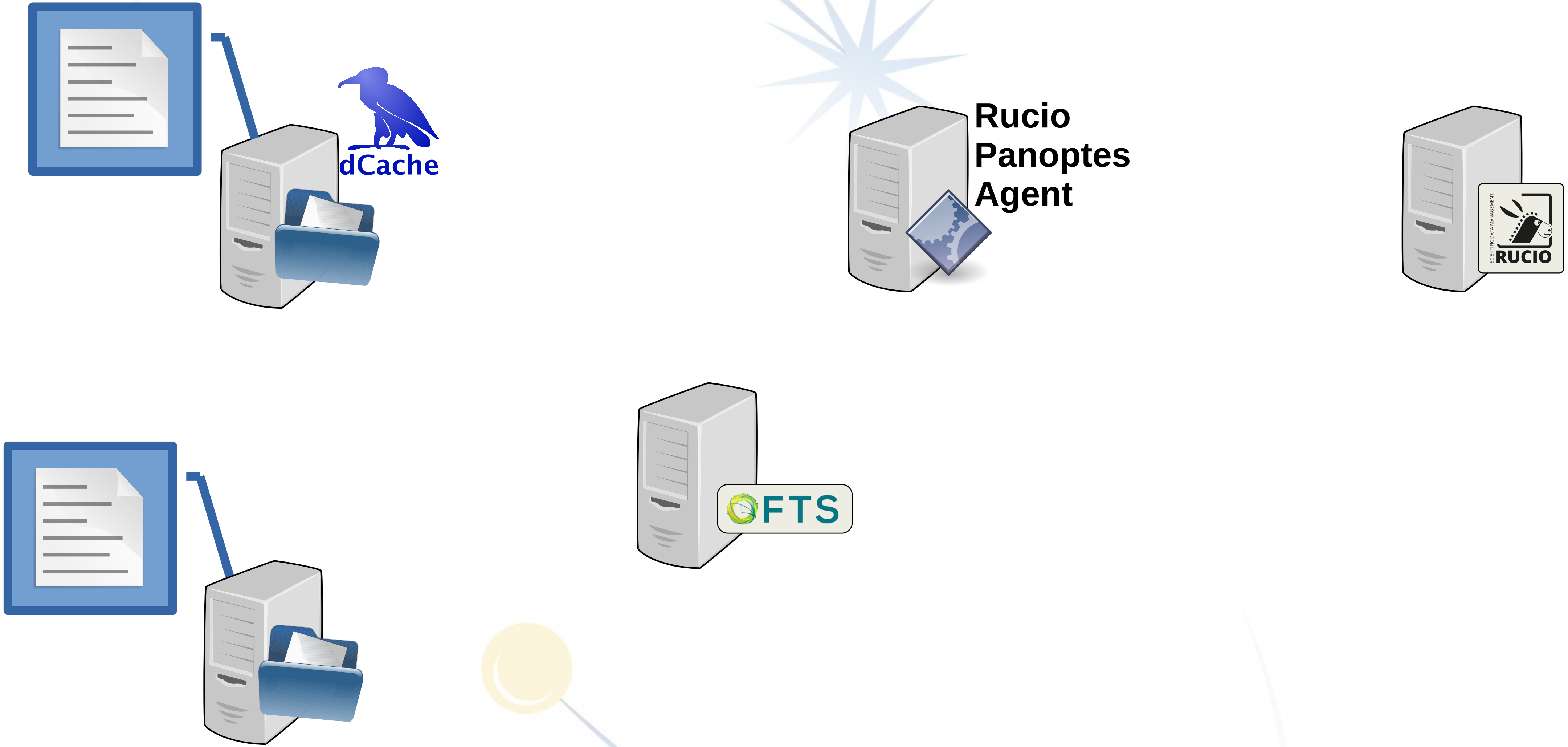
Automatic data-replica recovery



Thanks for listening!

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Bonus material

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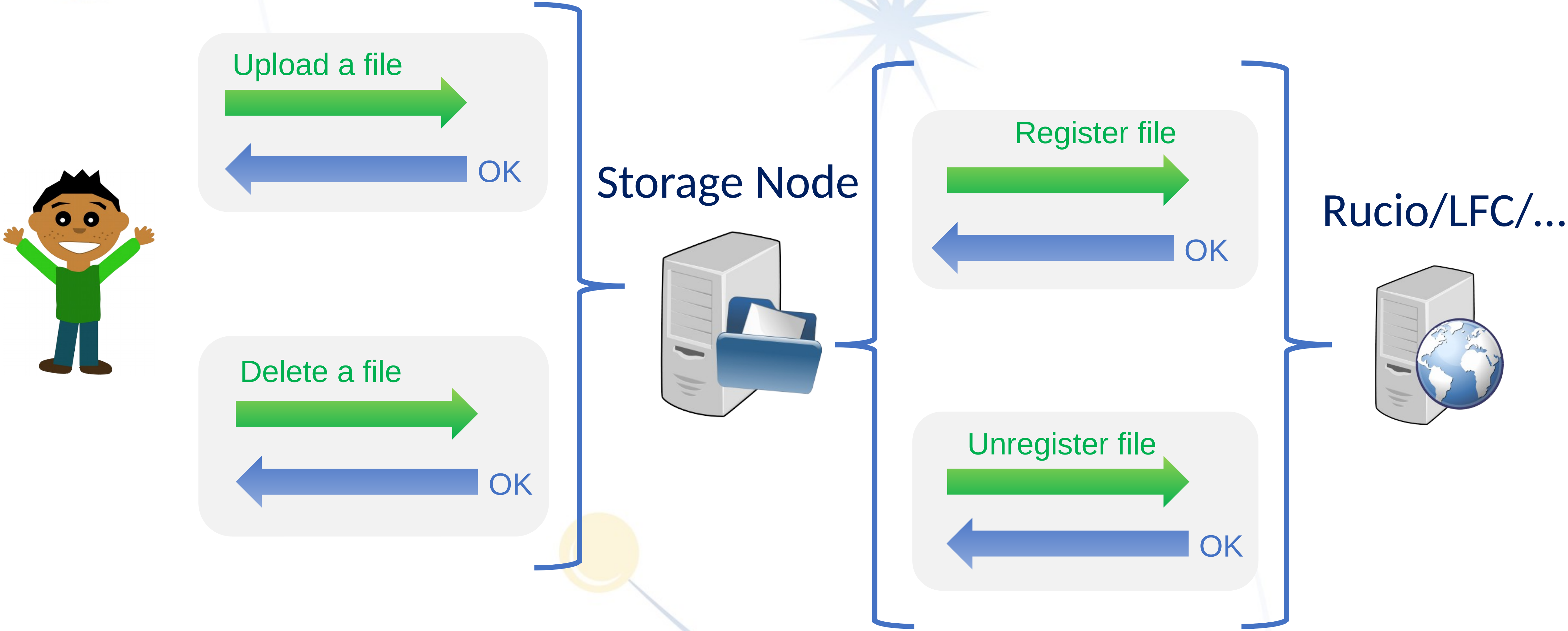
New solutions to old problems



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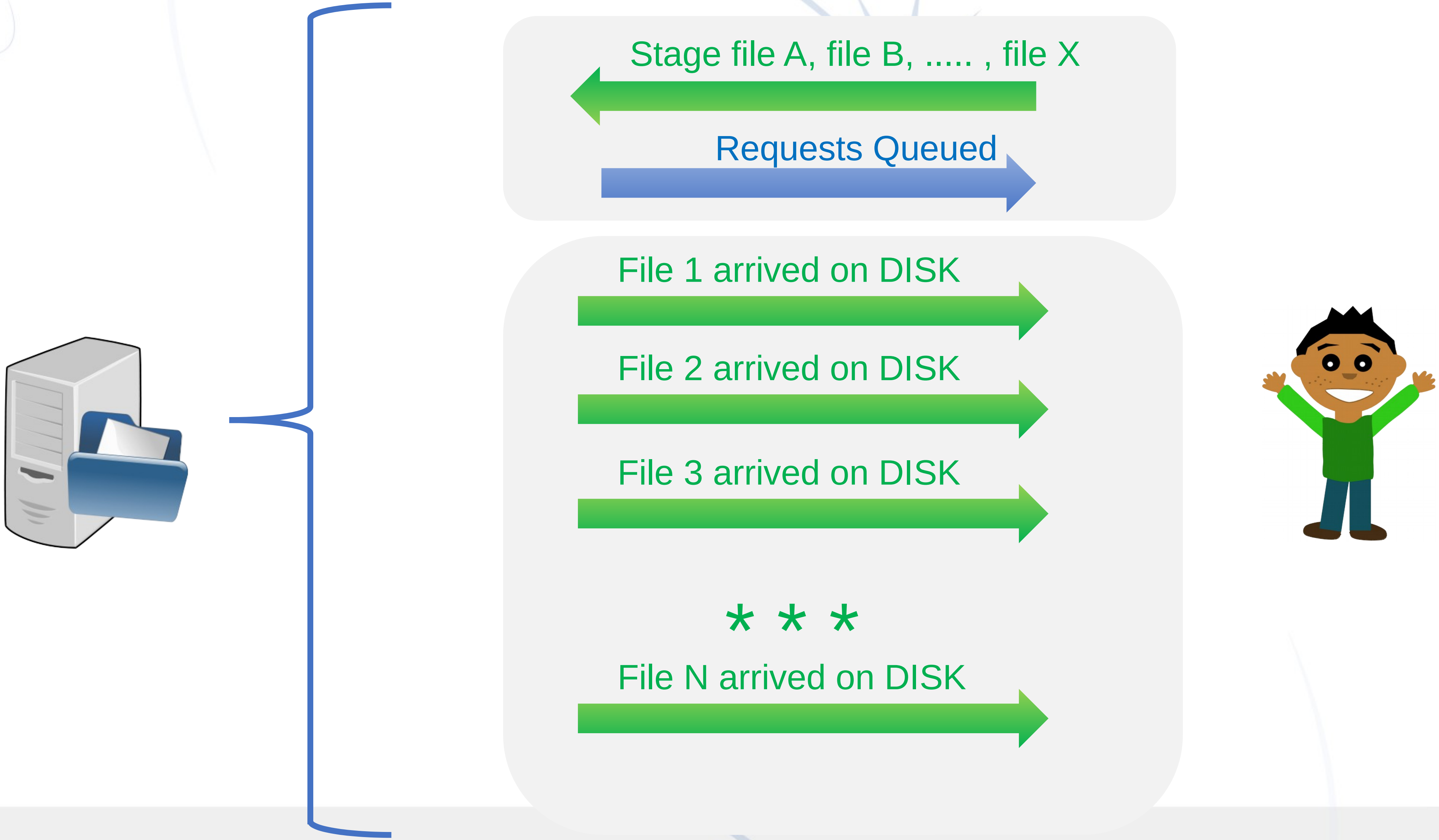
New solutions to old problems



Stage file A, file B, ... , file X

Requests Queued

File 1 arrived on DISK

File 2 arrived on DISK

File 3 arrived on DISK

* * *

File N arrived on DISK

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Comparison: events in industry…

Amazon Lambda

Image Thumbnail Creation

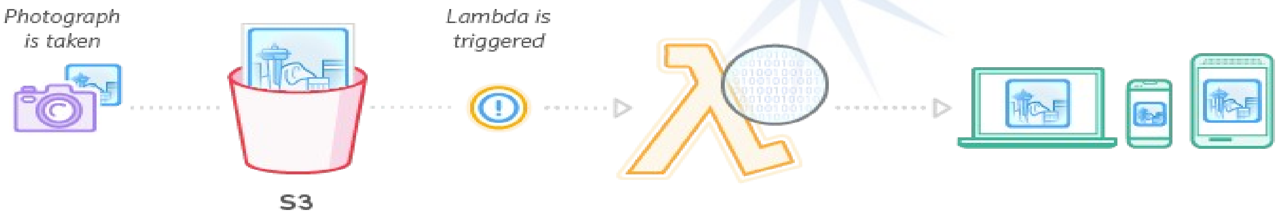
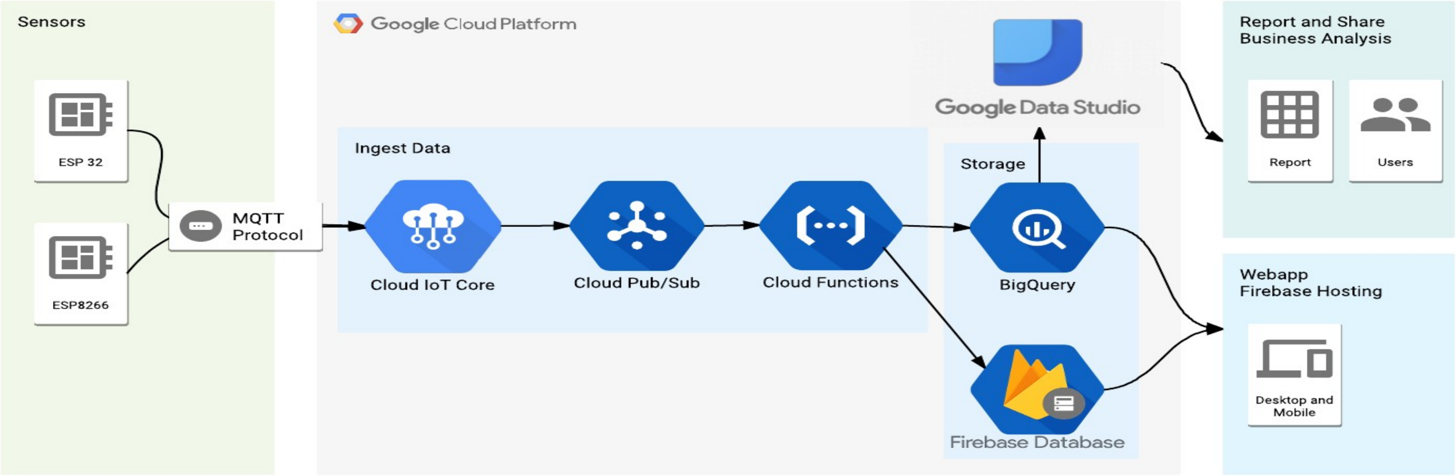


Photo is uploaded into S3 bucket

Lambda runs image resizing code to generate Web, mobile and tablet sizes

Google Cloud Platform



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Comparison: events in Open-Source

STORM

Apache Storm is a distributed stream processing computation framework written predominantly in the Clojure programming language.

Spark

OpenWhisk

APACHE kafka®
A distributed streaming platform

samza

Samza allows you to build stateful applications that process data in real-time from multiple sources including Apache Kafka.

APACHE nifi

Apache NiFi is a software project from the Apache Software Foundation designed to automate the flow of data between software systems.

Kubeless

Kubeless is a Kubernetes-native serverless framework that lets you deploy small bits of code (functions) without having to worry about the underlying infrastructure.

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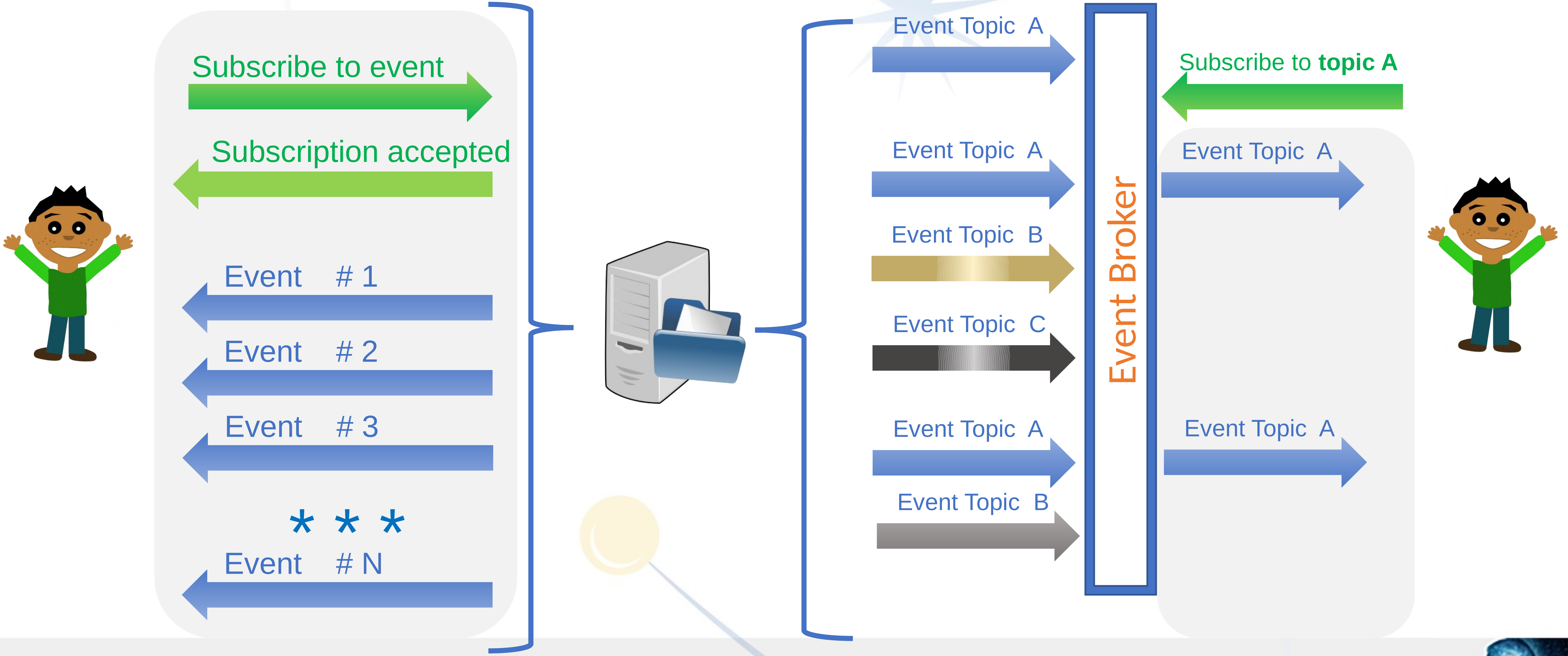
New way of interacting: storage events

Direct event delivery

Brokered event delivery



Subscribe to event

Subscription accepted

Event # 1

Event # 2

Event # 3

* * *

Event # N

Event Topic A

Event Topic A

Event Topic B

Event Topic C

Event Topic A

Event Topic B

Event Broker

Subscribe to **topic A**

Event Topic A

Event Topic A

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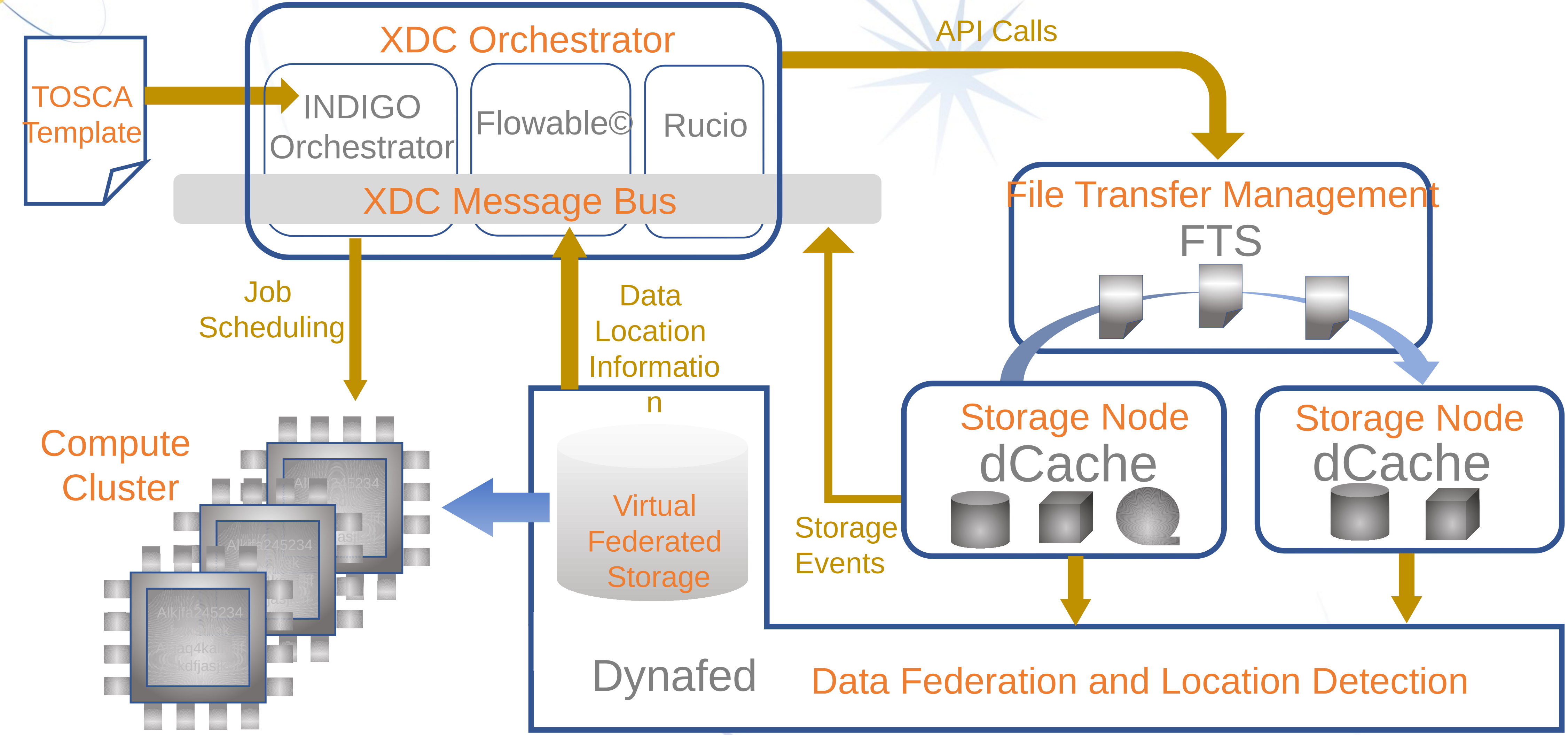
Full XDC Layout using Storage Events



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