Aviso

Enabling notifications for meteorological workflows across HPC and Cloud data centres

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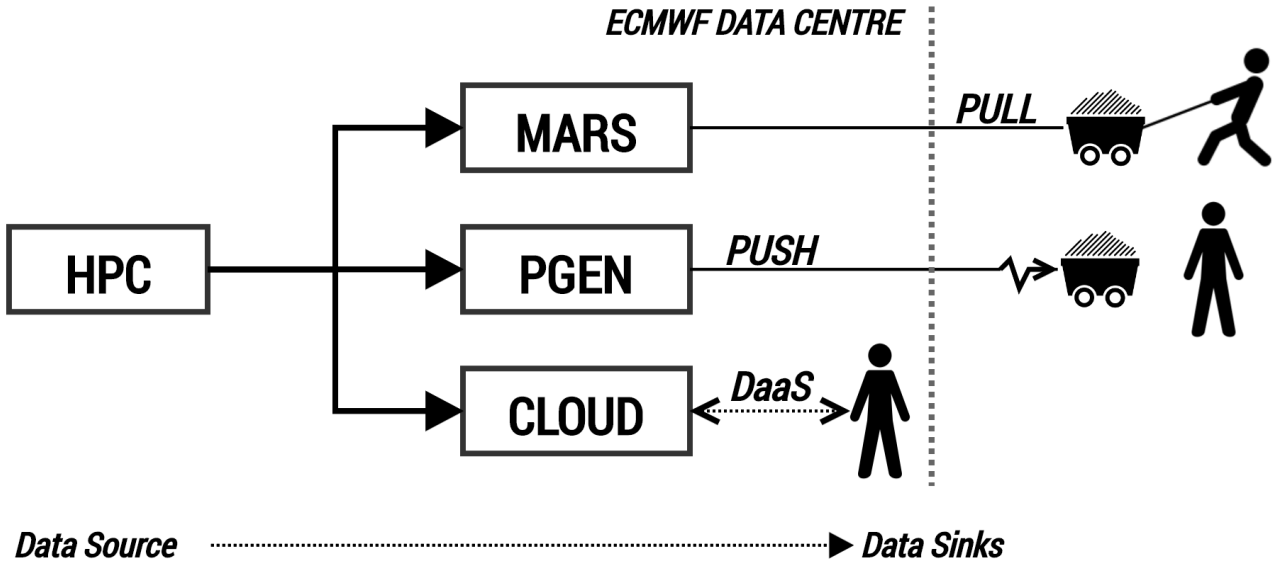
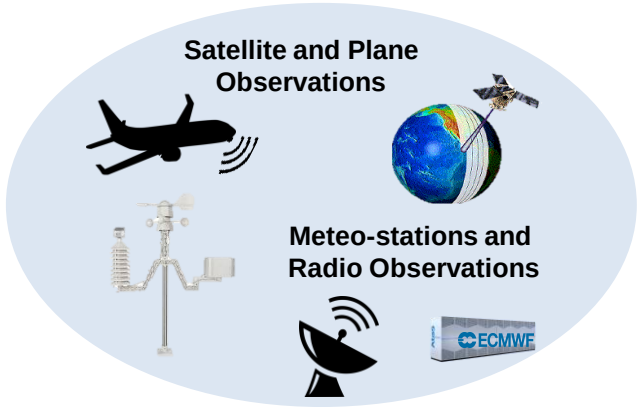
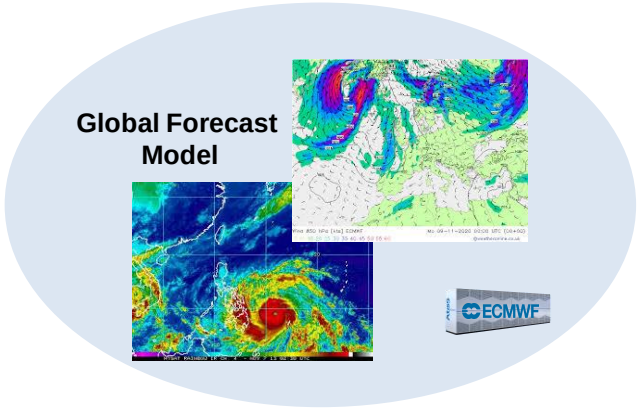
Cloud Data-as-a-Service

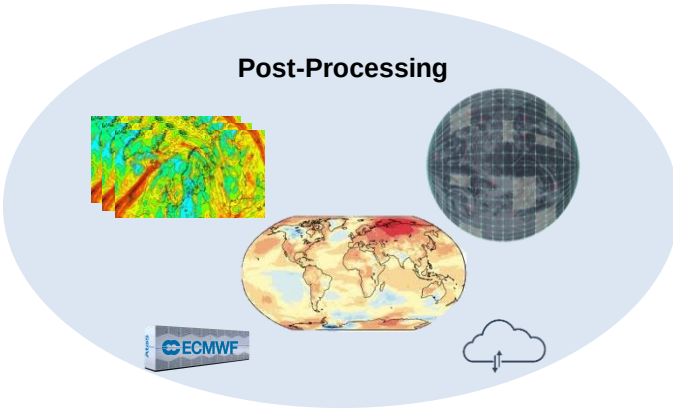
- Raw data output and disseminated products increasing in size
  - 5km ensemble ~1PiB of raw data in 1 hour
  - Transferring data out of the centre becoming prohibitive
  - Cloud data model: **bring the computing to the data**



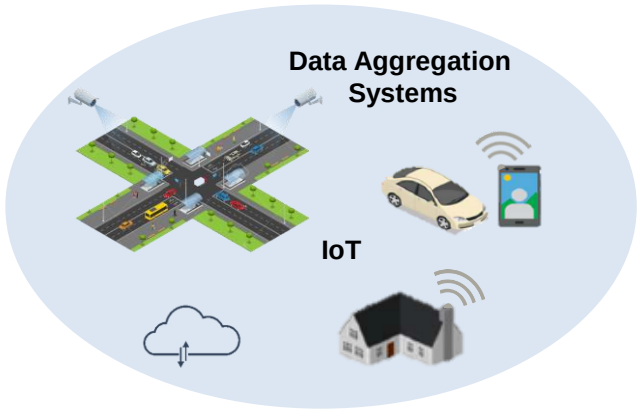
Enabling multi-domain workflows across data centres (HPC + Clouds)

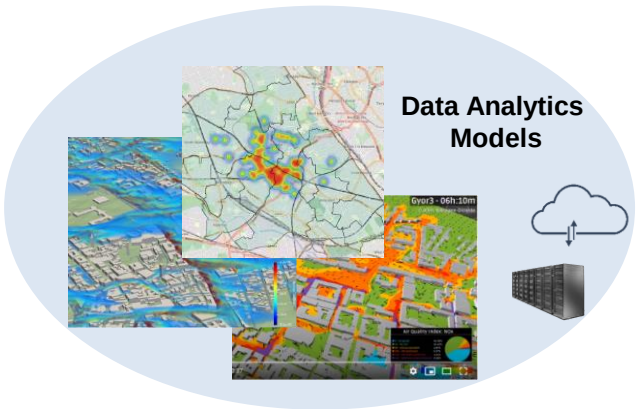


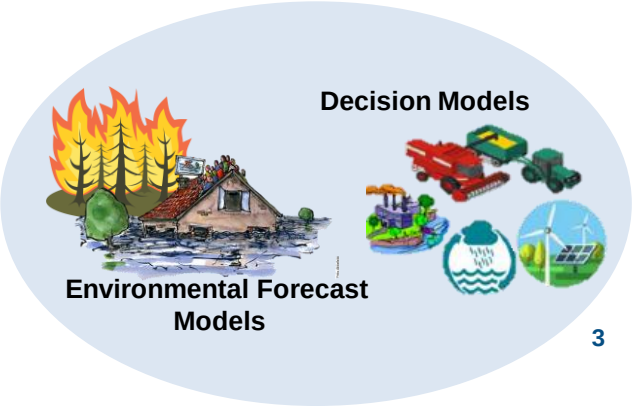




Model – To – Model
Notification of data availability is crucial



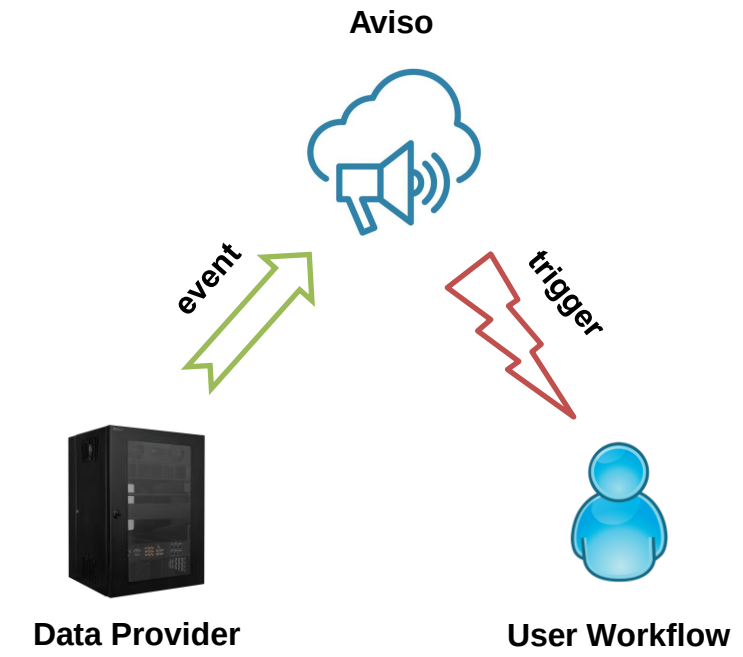




Aviso – Aims

Aviso is a software developed at ECMWF with the aim of:

- Notifying for **data availability**
- Meant for **automated systems**
- Support **When** <this> **… Do** <that> …

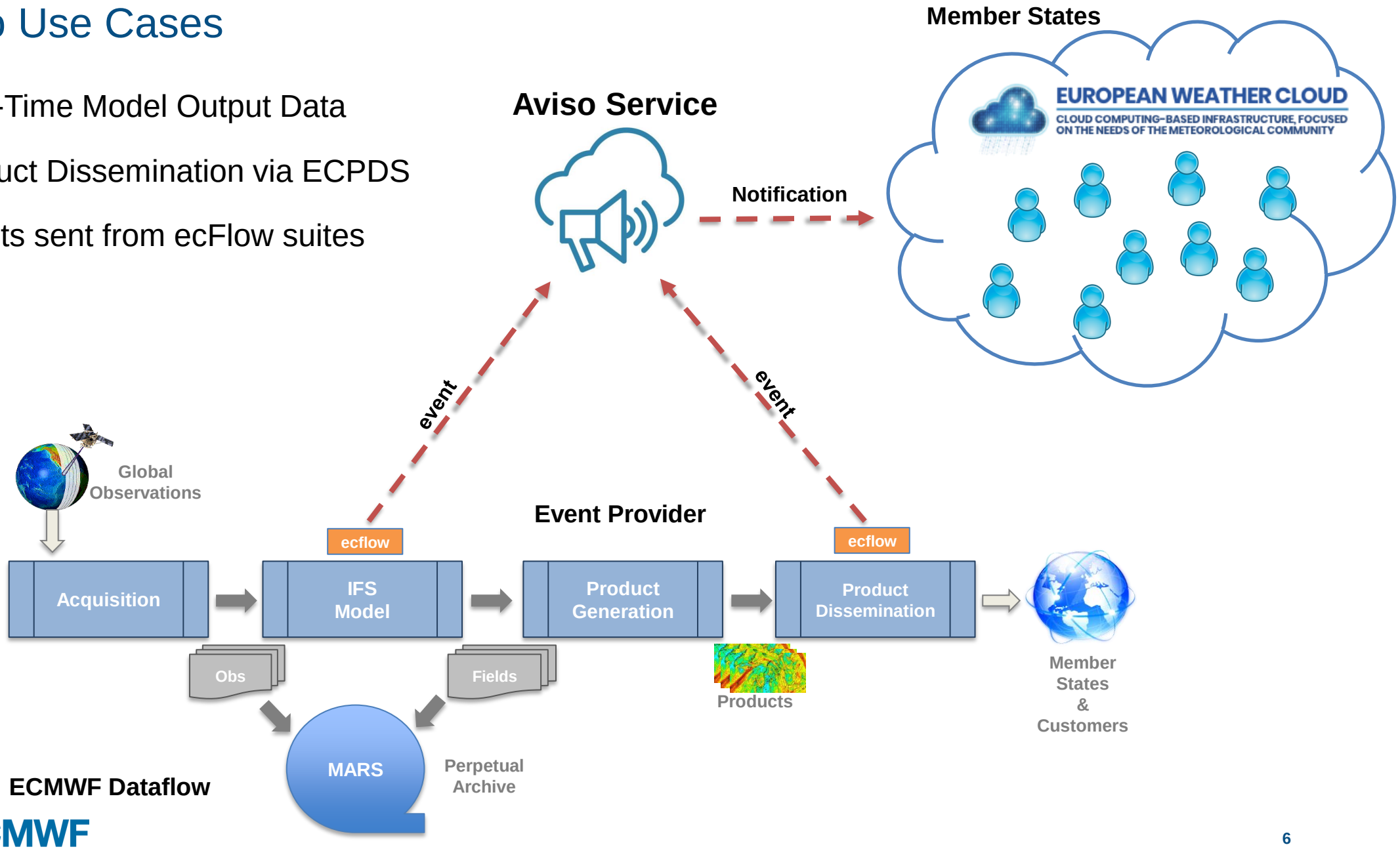


Aviso – Rationale

- **Domain-Specific** notification system:
  - Speaks **Meteorological** language (MARS DSL)
    - Understand our metadata
    - Richer experience for the user
  - **Protocol Agnostic:**
    - We can develop interfaces for MQTT, AMQP, RabbitMQ, Kafka, **CloudEvents**, etc..
- **Persistent State:**
  - Consistency
  - Transactionality
  - Reliability (notification history)
- Leverage on modern **Cloud technologies**:
  - Highly-available, high-throughput
  - Scalable & Distributed
  - Lightweight client

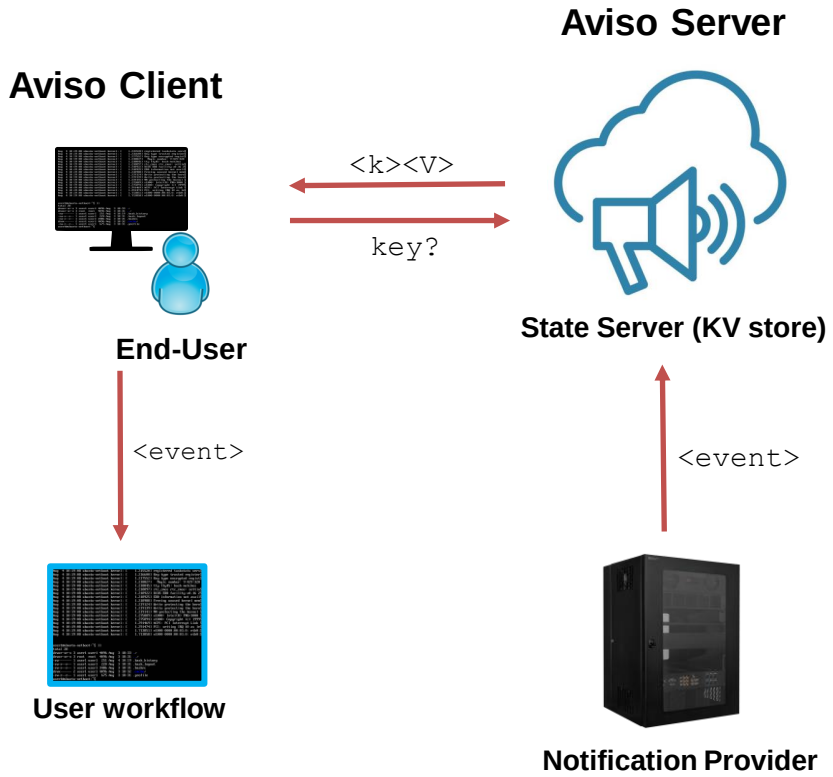
Aviso Use Cases

- Real-Time Model Output Data
- Product Dissemination via ECPDS
- Events sent from ecFlow suites



General Workflow

- Server: Microservices architecture based on a Key-Value Store
- Client: CLI application or Python API
- Users:
  - End-Users
  - Notification Providers
- Workflow:
  1. End-User subscribes to an event and programs the trigger.
  2. Aviso client polls for changes.
  3. A notification provider submits a notification.
  4. The subscriber is notified with a new event.
  5. The event triggers user's workflow.

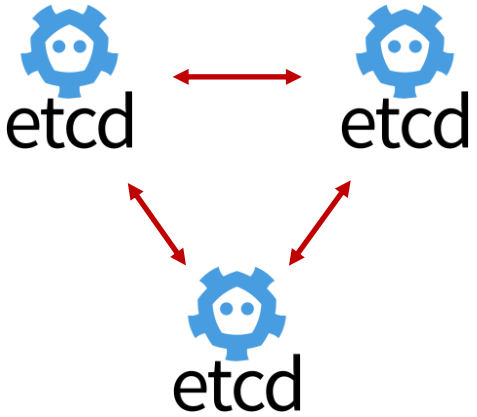


Key : Product's metadata
Value : Product's location

Aviso Server – Under the hood

etcd cluster

- Strongly consistent, distributed key-value store
- Leader election based on the Raft consensus algorithm
- Gracefully tolerates machine failure and network partition
- Provides gRPC and RESTful interfaces
- Benchmarked at 10,000s of writes per second
- Adopters:
  - kubernetes uses it as service discovery, storing cluster state and configuration
  - openstack. has it as configuration storage and distributed locking
  - CoreDNS uses it as optional backend
  - ROOK uses it as orchestration engine
  - M3 (metric platform for Prometheus) uses it for rule storage



Benchmark for a 3-size cluster

N. keys	N. clients	Write QPS	Latency x req.
100,000	1000	50,100	20 ms

Aviso Client - Command Line Interface

- Listen to events and program a trigger

```
aviso listen my_listener.yaml
```

my_listener.yaml

```
listeners:
  - event: dissemination
    request:
      destination: FOO
      stream: enfo
      step: [1,2,3]
    triggers:
      - type: command
        command: my_script.sh
        environment:
          STEP: ${request.step}
```

- Listen to a specific time interval in the past

```
aviso listen --from 2020-10-20T00:00:00.0Z --to 2020-10-21T00:00:00.0Z
```

- Test with local user-defined notifications

```
aviso notify event=mars,class=od,date=20190810,domain=g,expver=1,step=1,stream=enfo,time=0 --test
```

Aviso Client as a Python API

Aviso Client can be used as a Python API. Below an example:

1

2

3

4

```
from pyaviso import NotificationManager
from ecmwfapi import ECMWFService

# define function to be called
def do_something(notification):
    mars_server = ECMWFService("mars")
    request = notification["request"]
    request.update({
        "type": "fc",
        "levtype": "sfc",
        "param": 167.128})
    mars_server.execute(request, "my_data.grib")

# define the trigger
trigger = {"type": "function", "function": do_something}

# create an event listener request that uses that trigger
request = {"stream": "enfo", "date": 20190810, "time": 0}
listeners = {"listeners": [{"event": "mars", "request": request, "triggers": [trigger]}]}


# run it
aviso = NotificationManager()
aviso.listen(listeners=listeners)
```

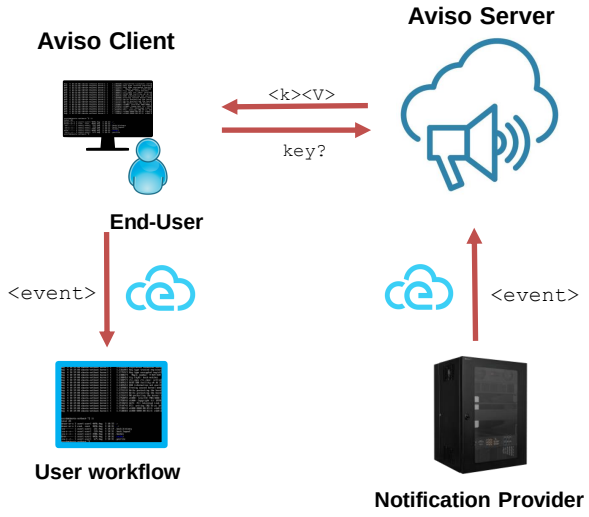
CloudEvents

CloudEvents is a specification seeking to describe event data in a common way

- **Consistency** – Reuse event handling logic for different event source
- **Accessibility** – SDKs for Go, JavaScript, Java, C#, Ruby, and Python to build common libraries, tooling, and infrastructure for delivering event data across environments.
- **Portability** - Interoperability among different cloud platforms. Implemented by most cloud vendors.

```
{
   "specversion" : "1.0",
   "type" : "aviso",
   "source" : "https://...",
   "id" :  "0c02fdc5-148c-43b5-b2fa-cb1f590369ff",
   "datacontenttype": "application/json",
   "data": {
      "event": "mars",
      "request": {…},
      "location": "…"
    }
}
```

CloudEvents in Aviso



CloudEvents as Aviso notifications

Notification Provider

Aviso Server

Key :ec/diss/foo/E1/od/g/1/enfo/20190810/0/1
Value :s3://storage.ecmwf.europeanweather.cloud/ecpds/E3S1

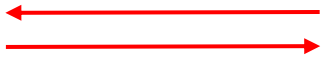
POST *https://aviso.ecmwf.*

```
{
  "type" : "aviso",
  "specversion" : "1.0",
  "source" : "/ecpds/emos",
  "id" : "0c02fdc5-148c-43b5-b2fa-cb1f590369ff",
  "datacontenttype" : "application/json",
  "data" : {
    "event" : "dissemination",
    "request" : {
      "destination" : "FOO",
      "target": "E1",
      "class": "od",
      "date" : "20190810",
      "domain" : "g",
      "expver" : "1",
      "step" : "1",
      "stream" : "enfo",
      "time" : "0" },
    "location":"s3://storage.ecmwf.europeanweather.cloud/ecpds/E3S1"
  }
}
```

CloudEvents as Aviso notifications

```
listeners:
  - event: dissemination
    request:
      destination: FOO
    triggers:
        - type: post
          protocol:
            type: cloudevents
            url: https://my.endpoint.com/
```

Aviso Server



Aviso Client

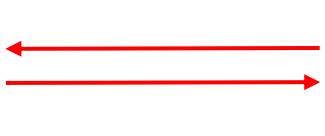
Key :ec/diss/foo/E1/od/g/1/enfo/20190810/0/1
Value :s3://storage.ecmwf.europeanweather.cloud/ecpds/E3S1

Request Key Prefix : ec/diss/foo

CloudEvents as Aviso notifications

```
listeners:
  - event: dissemination
    request:
      destination: FOO
    triggers:
        - type: post
          protocol:
            type: cloudevents
            url: https://my.endpoint.com/
```

Aviso Server



Aviso Client

End-User Endpoint

Key :ec/diss/foo/E1/od/g/1/enfo/20190810/0/1
Value :s3://storage.ecmwf.europeanweather.cloud/ecpds/E3S1

CloudEvents used as:

- protocol from notifiers to the server
- protocol from server to clients

POST *https://my.endpoint.com/*

```
{
  "type" : "aviso",
  "specversion" : "1.0",
  "source" : "https://aviso.ecmwf.int
  "id" : "6e364719-4880-49e9-adaf-c2f3334f771d",
  "datacontenttype" : "application/json",
  "data" : {
    "event" : "dissemination",
    "request" : {
      "destination" : "FOO",
      "target": "E1",
      "class": "od",
      "date" : "20190810",
      "domain" : "g",
      "expver" : "1",
      "step" : "1",
      "stream" : "enfo",
      "time" : "0" },
   "location":"s3://storage.ecmwf.europeanweather.cloud/ecpds/E3S1"
  }
}
```

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Conclusions

- Aviso is a scalable notification system designed for high-throughput
- Automatic triggering of user-defined workflows
- ECMWF data availability of real-time forecast data or derived products
- CloudEvents compliant notifications for interoperability across clouds

Current status

- Aviso Service is currently pre-operational and open to users of the European Weather Cloud
- **> 300K** notifications a day among real-time and product dissemination
- First users: Met Norway and FMI

Beta version released on https://github.com/ecmwf/aviso and **PyPI**

Current Projects

ECMWF internal development

- Aviso: a scalable notification system for ECMWF data availability
- Polytope: a distributed API for data access and manipulation

European projects

- LEXIS - Complex weather and climate workflows over 3 HPCs and 2 Cloud systems
- HiDALGO - On-demand data access for Global Challenges applications over multiple HPC sites

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European Commission

These projects have received funding from the European Union's Horizon 2020 research and innovation programme under grant agreements No 825532 and 824115.