CIVIL PROTECTION
DISASTER RISK REDUCTION
BIODIVERSITY

WRF-GO

workflow manager for meteo prediction and applications

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RESEARCH FOUNDATION
cima
OBSERVE TO PREDICT,
PREDICT TO PREVENT.

FONDAZIONE CIMA
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CENTRO INTERNAZIONALE IN MONITORAGGIO AMBIENTALE
INTERNATIONAL CENTRE ON ENVIRONMENTAL MONITORING

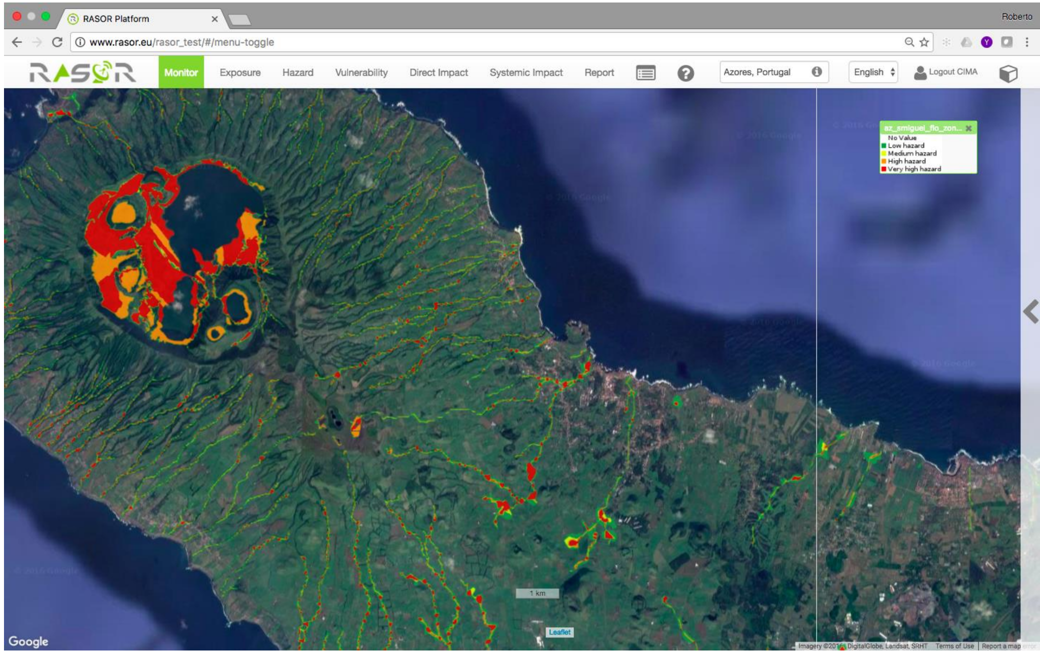
CIMA Fields of activities

- Hydro-met applications for Civil Protection
- Risk assessment
- Climate Change and DRR: Targeting Extremes
- EO assisted applications
- ICT Tools for research and services
- Liability, Responsibility & Governance in risk
- Capacity building and education from the international to the local dimension
- Marine Ecosystem Monitoring

Disaster Risk Reduction

Whenever there is a risk, we are asked to complement operational services:

- High-resolution downscaling (WRF)
- Model chains (meteo + hydro or wildfire models)
- Impact estimation (windstorm, floods, …)



Commercial services

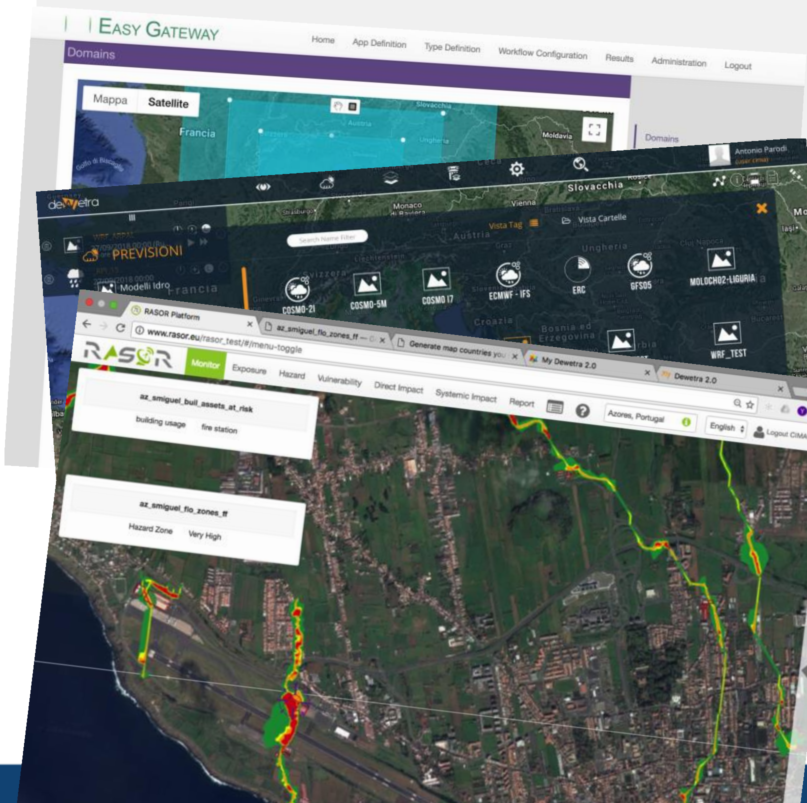
Forecast of energy production (wind turbines, photovoltaic)

- Following day
- Hourly updates

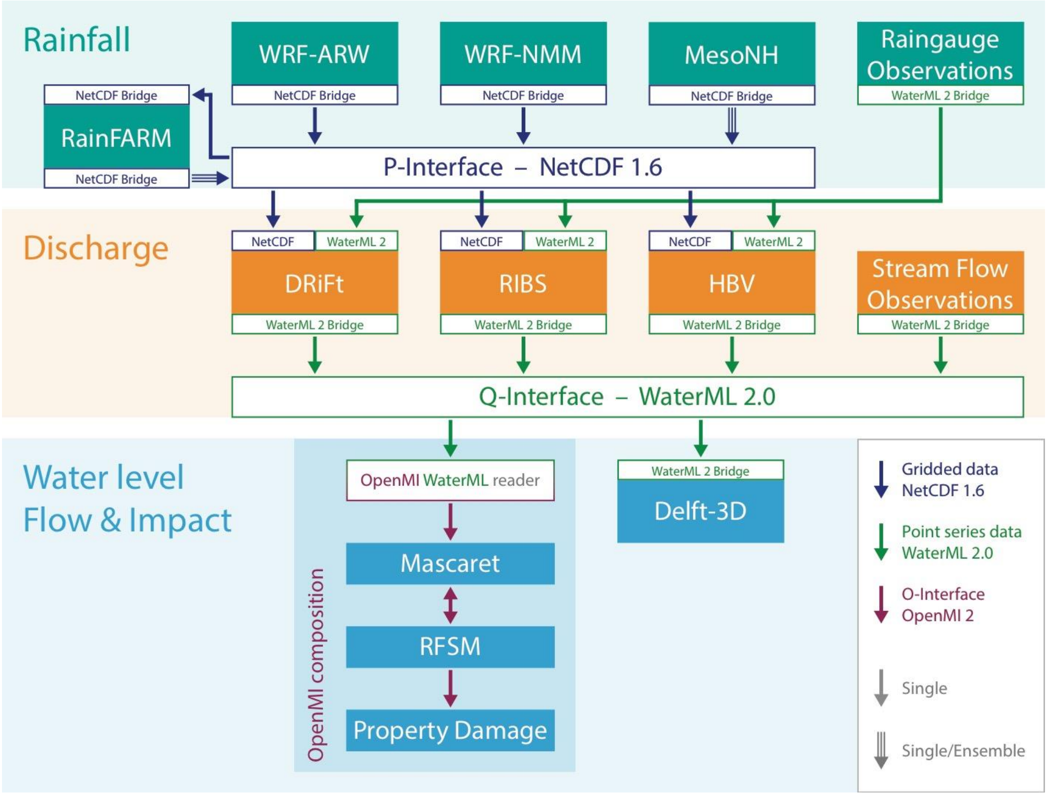
Insurance (floods, hail)

Our tools

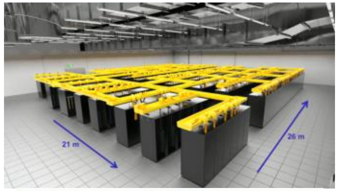
- Multi-model ensemble to target extreme events
- Model chains (meteo-hydro/wildfire/energy-impact)
- Web interface to configure experiments & trigger execution
- myDewetra for situation awareness and decision support
- Rasor to assess the impact of extreme events



Model chains (from DRIHM project)



HPC



HTC

Cloud

Sample workload

Meteo downscaling

- fetching boundary conditions + pre-processing (36 cores, 20’)
- 48h WRF at 1.5km at national level (1500-1800 cores, 3 hours) (180 GB of output files - uncompressed NetCDF)
- UPP post-processing + delivery (3 GB compressed GRIB2)

A smaller case

- 48 WRF at 2km at regional level (200-300 cores, 2 hours)

Hydro models, Impact assessments, … (tens of cores, minutes)

Computing resources

Reserved resources:

- 50 nodes (1800 cores) on CINECA Tier-1 HPC system (WRF 1.5km)
- In-house small cluster ~300 skylake cores (WRFDA 2km)
- AWS reserved VMs for operational services (flood, wildfire)

Resources on demand:

- Grants on SuperMUC & Cineca Tier-0 HPC system
- AWS on-demand clusters (c5 instances)

How to fit ? 1/2

Beside pure computation, there are time consuming tasks:

Fetching boundary condition, preprocessing, post-processing, data transfer.

Files represent a timeframe: we adopts event-based programming / streaming programming to reduce latencies

We use a messaging system to notify the workflow manager and to trigger events.

How to fit ? 2/2

Are reserved resources available ? We use them!

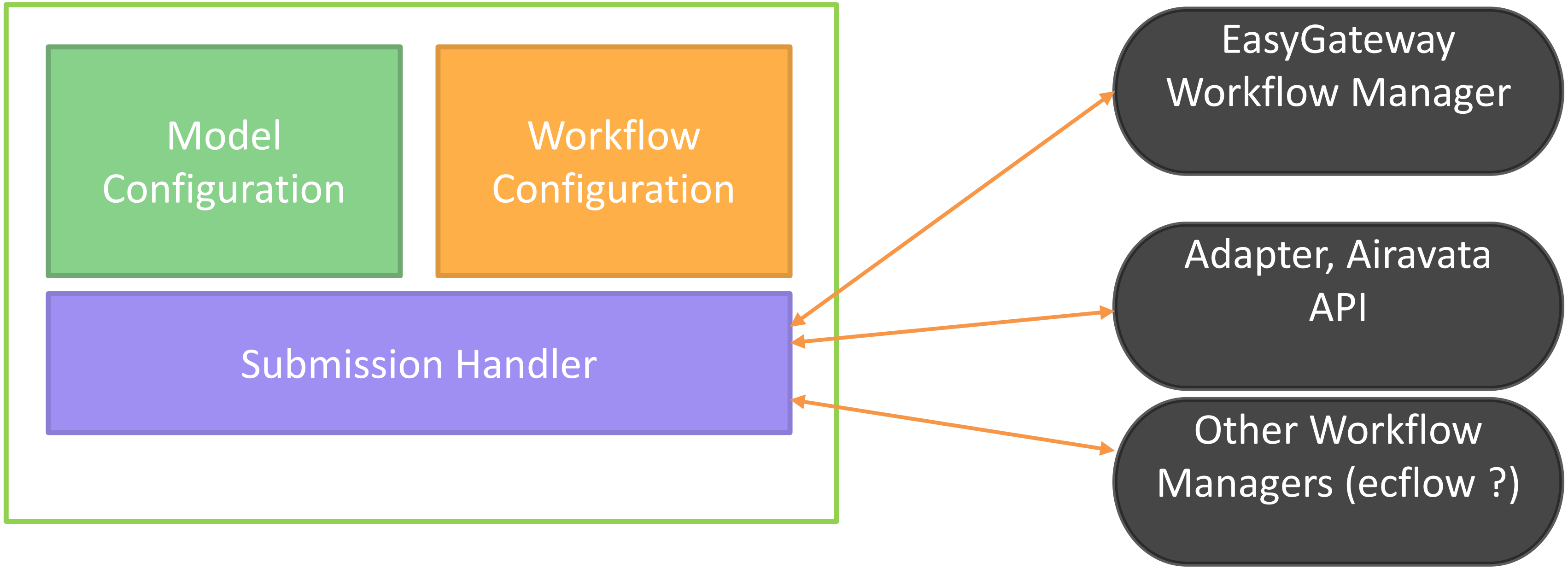
otherwise

Best-effort HPC resources may impose long queues

We submit on multiple resources, if one starts the computation (within a deadline) we exploit it and free the other resources.

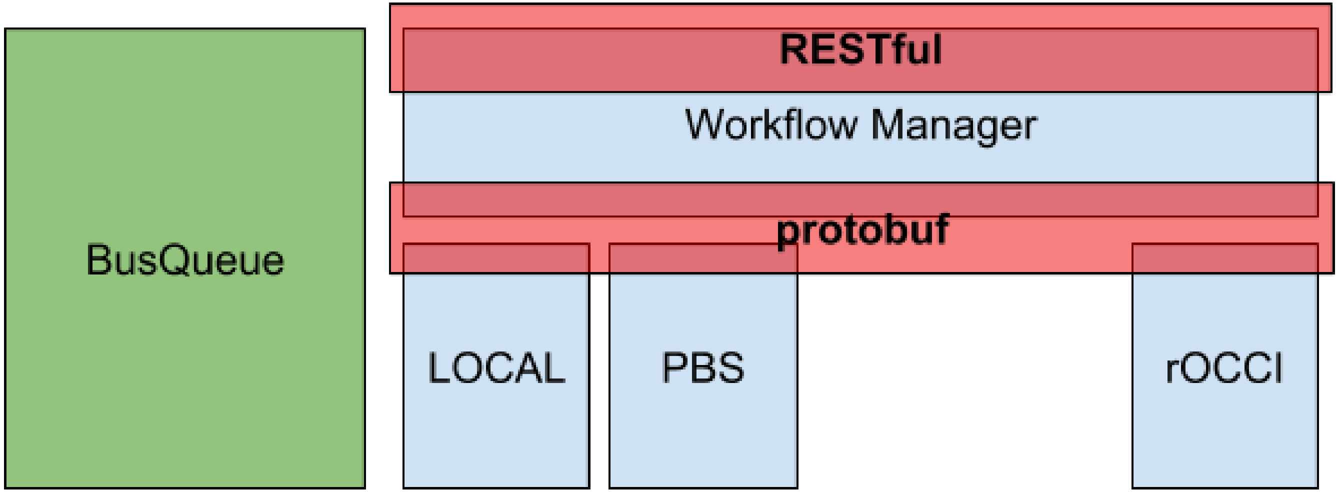
If none succeed in time, the task is executed on a virtual cluster on AWS

How it works


Model Configuration
Workflow Configuration
Submission Handler
EasyGateway Workflow Manager
Adapter, Airavata API
Other Workflow Managers (ecflow ?)

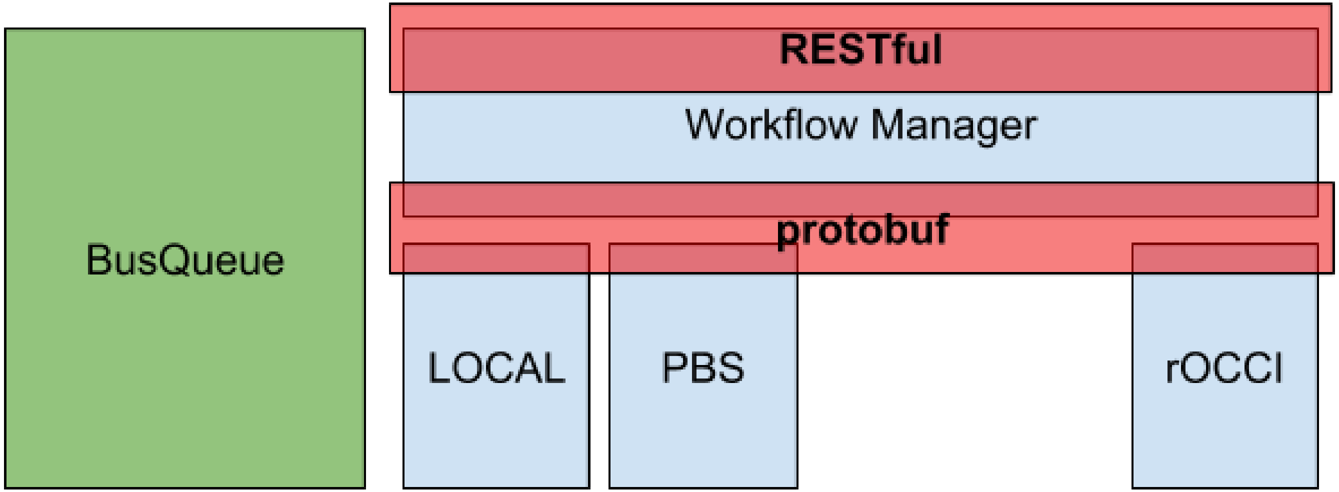
Workflow manager

- The main component – it handles all workflow submission request.
- It exposes a RESTful API for the workflow submission, monitoring and administration.
- Submission to resources is performed using Resource Specific Modules (RSM)



Resource Specific Modules

- A RSM performs a single job submission, monitoring and administration on a specific resource.
- WM - RMS communication protocol is based on protobuf.
- Real-time messages are sent to a Pub-Sub messaging system (BusQueue)



WM - RSM communication

The WM can:

- Request the submission of a job
- Request the termination of a job
- Publish on the BusQueue change of state of a Workflow
- Consume the BusQueue to detect:
  a change in the state of a job
  other notifications from the RSM

WM - RSM communication

The RMS must:

- Return OK/FAIL when a new job is submitted (i.e.: missing parameters)
- Publish on the BusQueue change of state of a Job
- Consume the BusQueue for job termination notification (i.e. no polling!)

The RMS can:

- Publish on the BusQueue specific events (an output file has been written)
- Publish on the BusQueue in near real-time log/stdout/stderr

A few technical choices

Workflow Manager & Resource Specific Modules

developed in go – good for concurrency, low memory footprint

BusQueue is NATS, a zero-configuration, fast and lightweight messaging system

Web portal for workflow configuration & execution
developed in TypeScript + Angular + node.js

Deployed on AWS (t2.micro can manage hundreds workflows/day)

Pros & cons

- Fast & lightweight
- Handles restart/failures
- Easy to extend
- Easy to connect to other workflow managers

- To battle-test
- Limited credential management (ssh public keys)
- No accounting

Future directions

Support data streaming:

- model send output to streaming pipeline
- next model in the workflow receives data from the pipeline
- models are loosely coupled

File-based IO is no longer required
We can have asynchronous IO by sinking to a file the data coming from the pipeline

Thanks!

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