CESGA
GALICIA SUPERCOMPUTING CENTER

Galicia Supercomputing Center

Javier Cacheiro, PhD.
Big Data Team Leader @ CESGA

Galicia Supercomputing Center (CESGA)

- Founded in **1993**
- Placed in **Santiago de Compostela, Galicia, Spain**
- Board of Trustees composed of members from **Xunta de Galicia (Regional Government)** and **CSIC (the Spanish National Research Council)**
- **Mision**: contribute to the advance of science and technology via research and application of high performance computing and communications
- CESGA offered supercomputing services to more than **1400 researchers** in 2023
- CESGA colaborates in research projects with other institutions
    - Participated in more than **200 projects (mostly European!) since the begining**

CESGA Staff

Around 50 people in total (and **growing**!)

Technical staff: Physicists, Computer Scientists, Telecommunicaction engineers, Matematicians, etc.

Most departments **do research** and/or **support researchers**

CESGA
GALICIA SUPERCOMPUTING CENTER

CESGA in Spain and Europe

- CESGA belongs to the **Spanish Supercomputing Network (RES)**
  - Composed of 14 Supercomputing centers
- CESGA is a **Singular Scientific Technical Infrastructure (ICTS)** in Spain, integrated in RES
- **Second largest Supercomputing center in Spain** (only after BSC)
  - **Finisterrae III** has a peak performance of **4,36 PetaFLOPS**
- Most of the projects in which CESGA participates are **European projects**
- **CESGA** leads the **Galician Quantum Technology Hub**
  - Quantum computing, communications and sensors
  - Galician colaborative effort
- CESGA has **one of the first quantum computers in South Europe**

History of CESGA's Supercomputers

CESGA
GALICIA SUPERCOMPUTING CENTER

FinisTerrae III: 2022

714 processors of 32 cores each (**22.848 cores** in total)

157 GPU accelerators (mainly nvidia A100)

126 TB of agregated memory

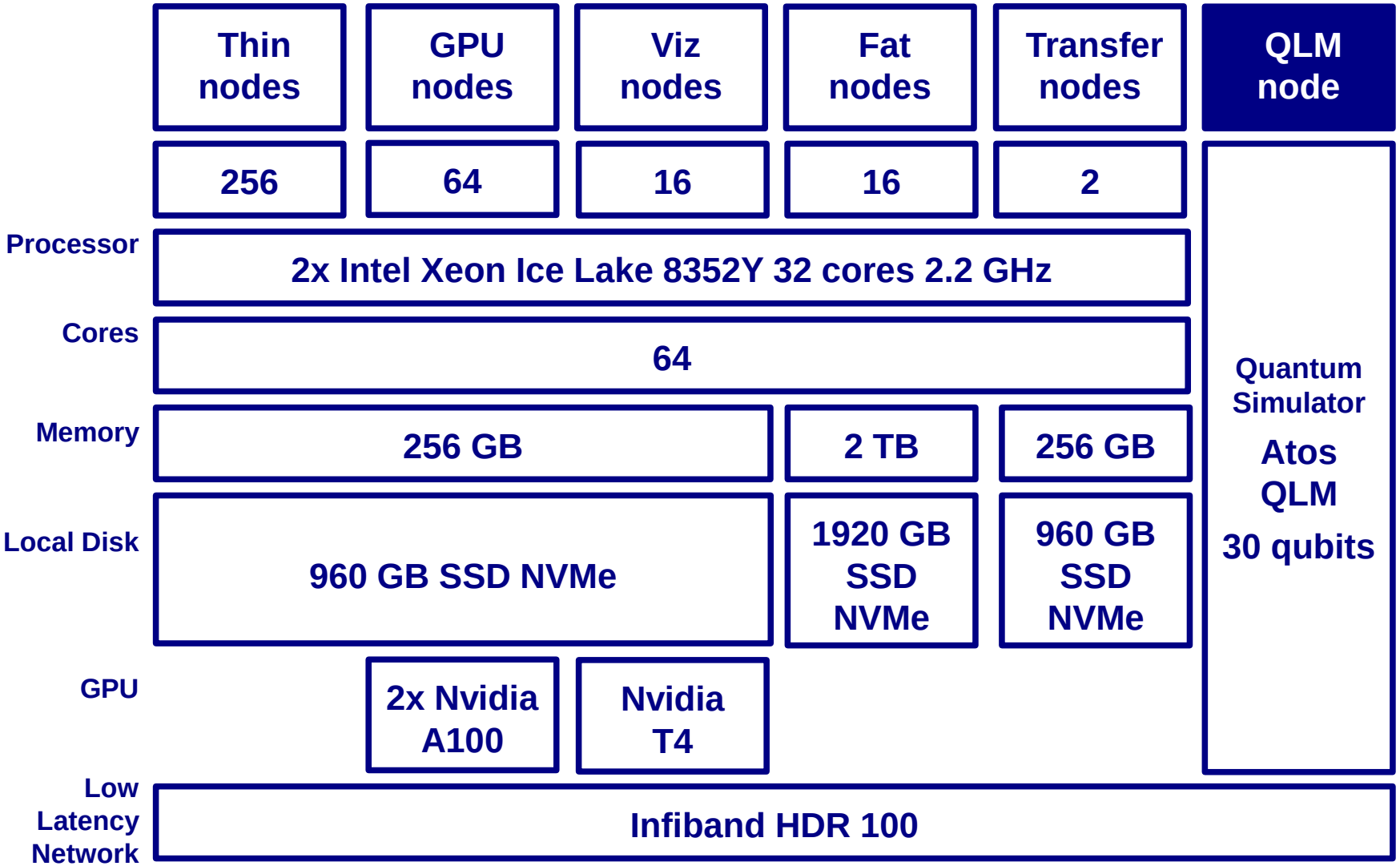
359 TB of storage in high performance SSD disks

Infiniband HDR 100 network

30 qubits simulator of a quantum computer

Peak performance: **4,36 PetaFLOPS**

FinisTerrae III



+ additional multi GPU nodes

CESGA
GALICIA SUPERCOMPUTING CENTER

Storage Systems

- NAS NetApp Cabinet: **3.3PB**
- High Performance Lustre-based Storage system: **1PB**
- High Capacity Lustre-based Storage system: **3PB**
- Tape Library: **25 PB**
- Ceph: **3PB**
- **Aggregated Storage: >35 PB !!**

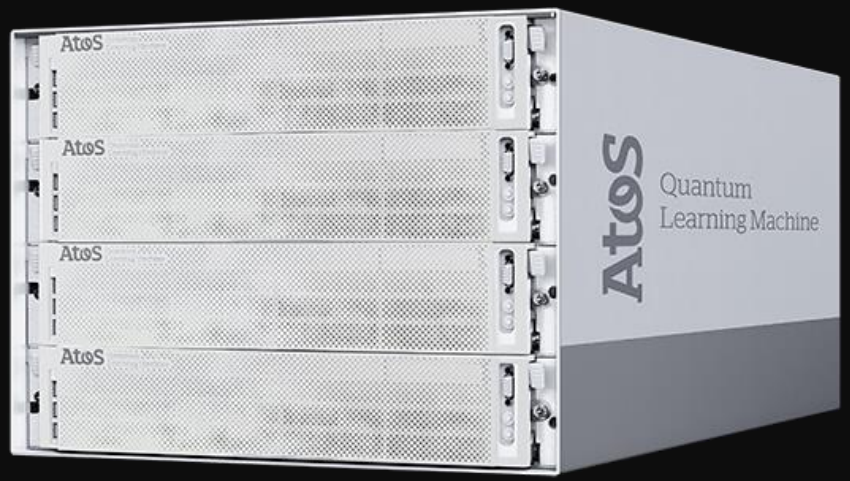
Quantum Random Number Generator (QRNG)

- **Quantum Random Number Generator (QRNG)** from the company **QSIDE**
- We are **building a better interface** to give an easier access to the QRNG
- **Users can already access it!**

Quantum Computer Emulators

- Quantum Learning Machine (**QLM) de 30 qubits** (ATOS)
  - CESGA researchers reached **38 qubit simulations**
- **Qulacs A64FX Quantum Simulator 32 qubits (Fujitsu)**
- **Other emulators on FT3** (Qiskit aer, projectQ, YAO, etc.)

CESGA
GALICIA SUPERCOMPUTING CENTER



Quantum Computer

- Already installed at CESGA
- **32 superconducting qubits,**
- **The Quantum Computer in a public institution with more qubits in South Europe**

Applications

https://www.cesga.es/infraestructuras/aplicaciones/

Bioinformatics

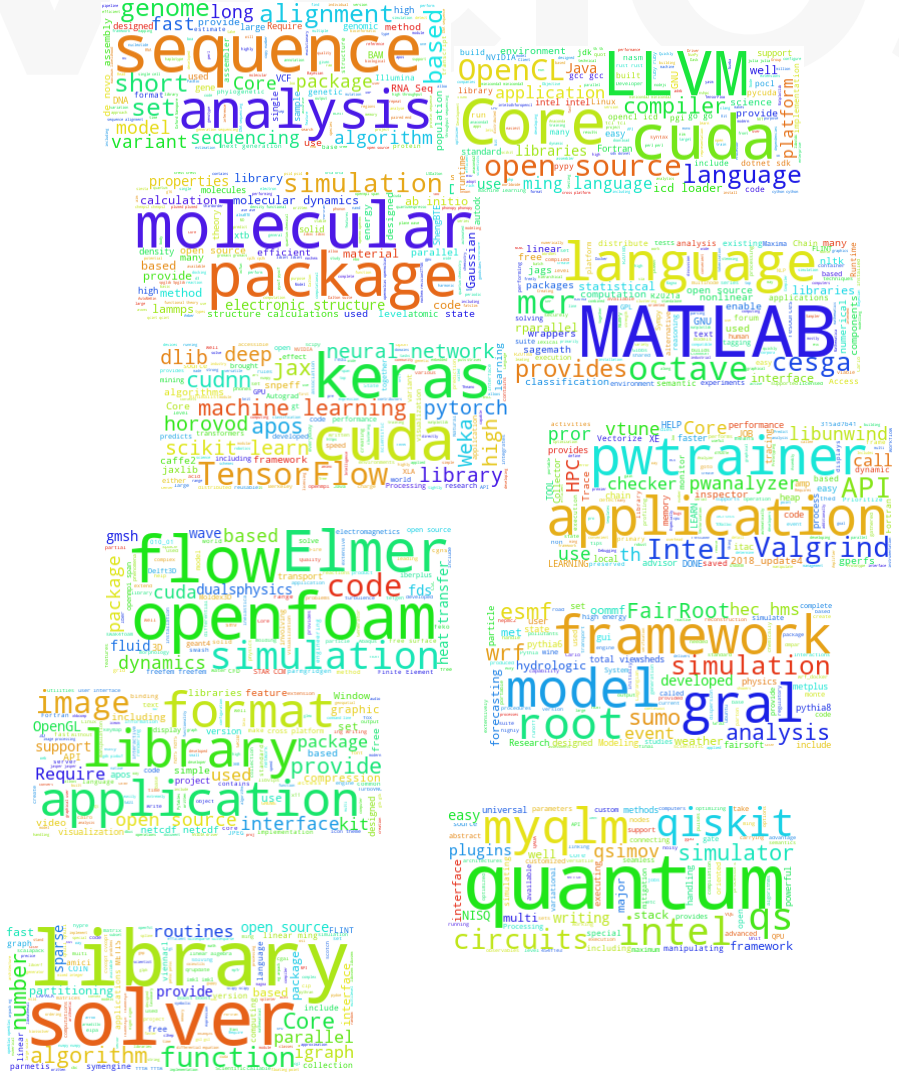
Chemistry and Materials

Machine Learning

Multiphysics and CFD

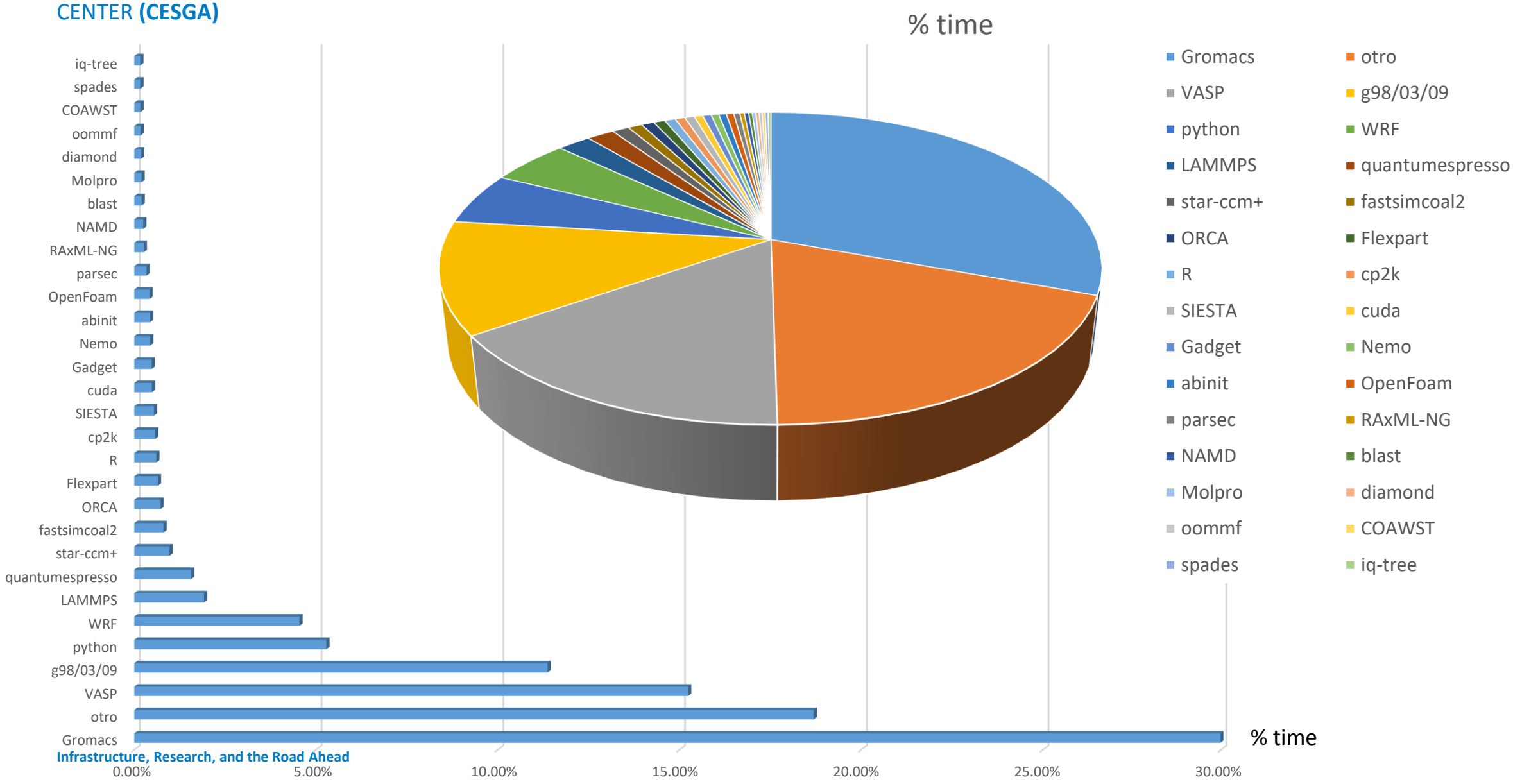
Visualization and data formats

And many others …

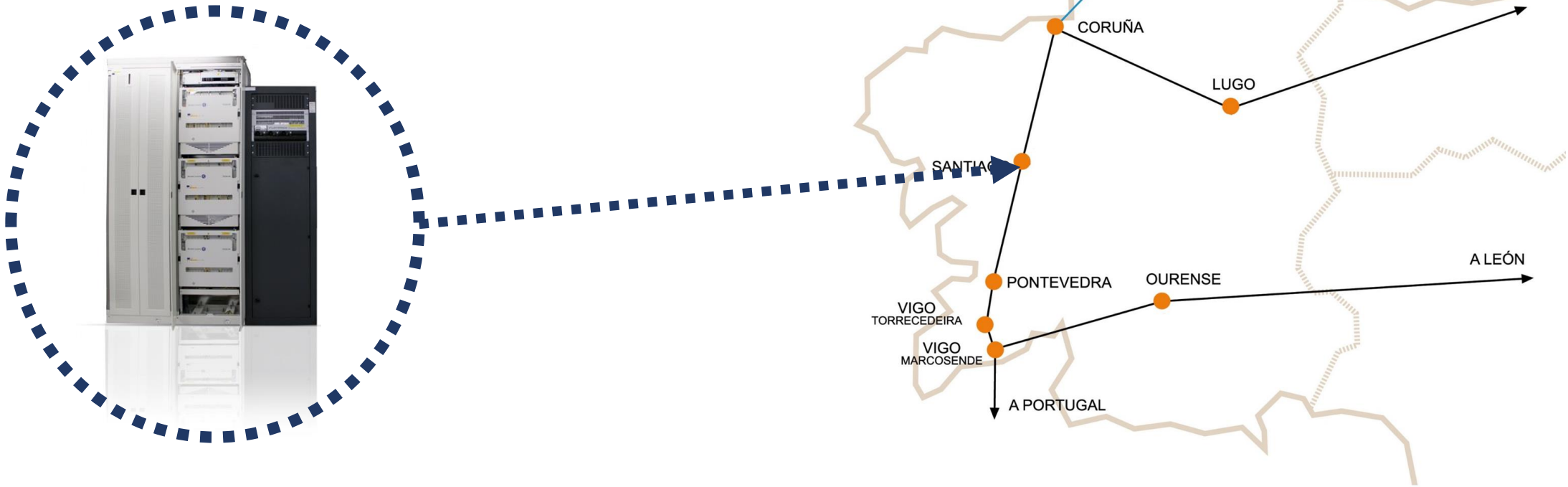


Usage per Application

GALICIA **SUPERCOMPUTING CENTER (CESGA)**



Galicia Science and Technology Network (RECETGA)



Connected Centers

Universities

UNIVERSIDADE DA CORUÑA

USC UNIVERSIDADE DE SANTIAGO DE COMPOSTELA

UniversidadeVigo

CSIC

IIM Instituto de Investigaciones Marinas de Vigo

IIAG

incipit Instituto de Ciencias del Patrimonio

CSIC

XUNTA

E.S.O.

Secundary Schools

Public Entities

CEIDA Centro de Extensión Universitaria e Divulgación Ambiental de Galicia

CIAR

FEUGA Fundación Empresa-Universidad Galicia

EUROPEAN FISHERIES CONTROL AGENCY

VIGO, CORUÑA
SANTIAGO

IEO

CENTRO OCEANOGRÁFICO DE VIGO

CENTRO OCEANOGRÁFICO DE CORUÑA

Health Sector

Complexo Hospitalario Universitario de Santiago de Compostela

RTD Centers

CTC centro tecnolóxico da carne

CIS CENTRO DE INNOVACIÓN E SERVIZOS DE GALICIA

intecmar

ANFACO

tecnópole

cetmar

Others

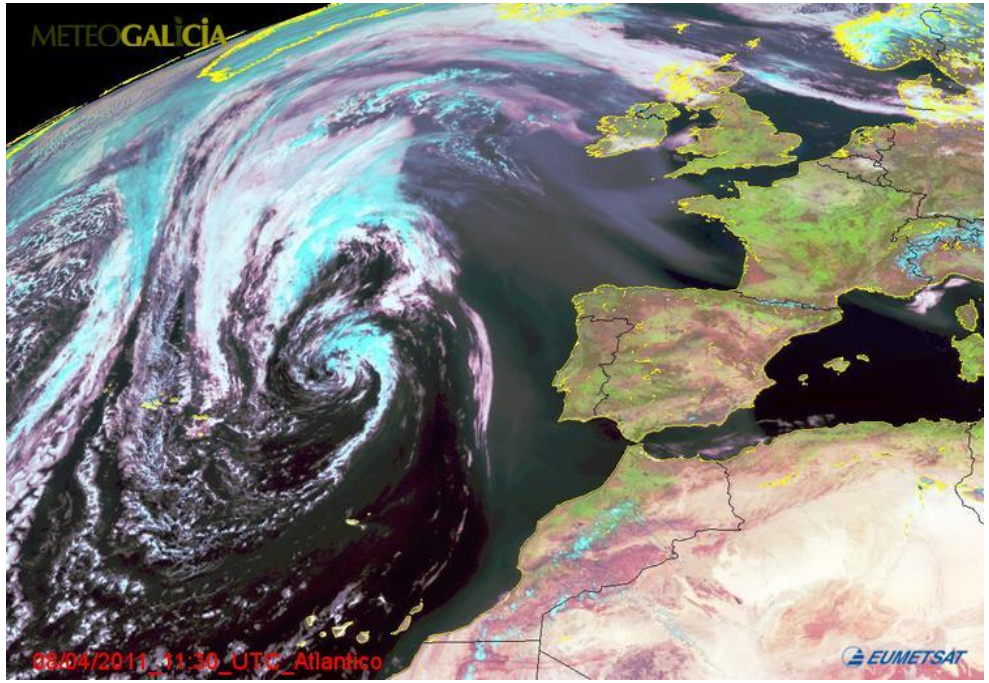
Project Agreements
ICTS

Featured Use Cases

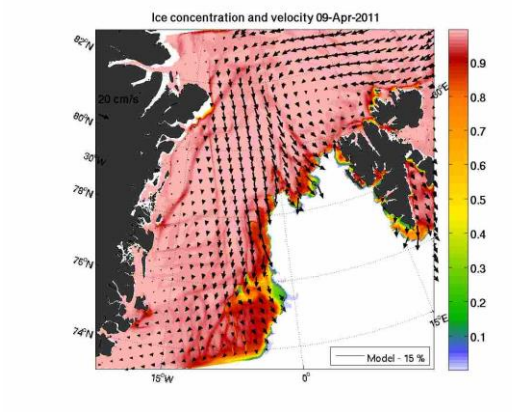
CESGA
GALICIA SUPERCOMPUTING CENTER

Galician Weather Forecasting Service

meteogalicia

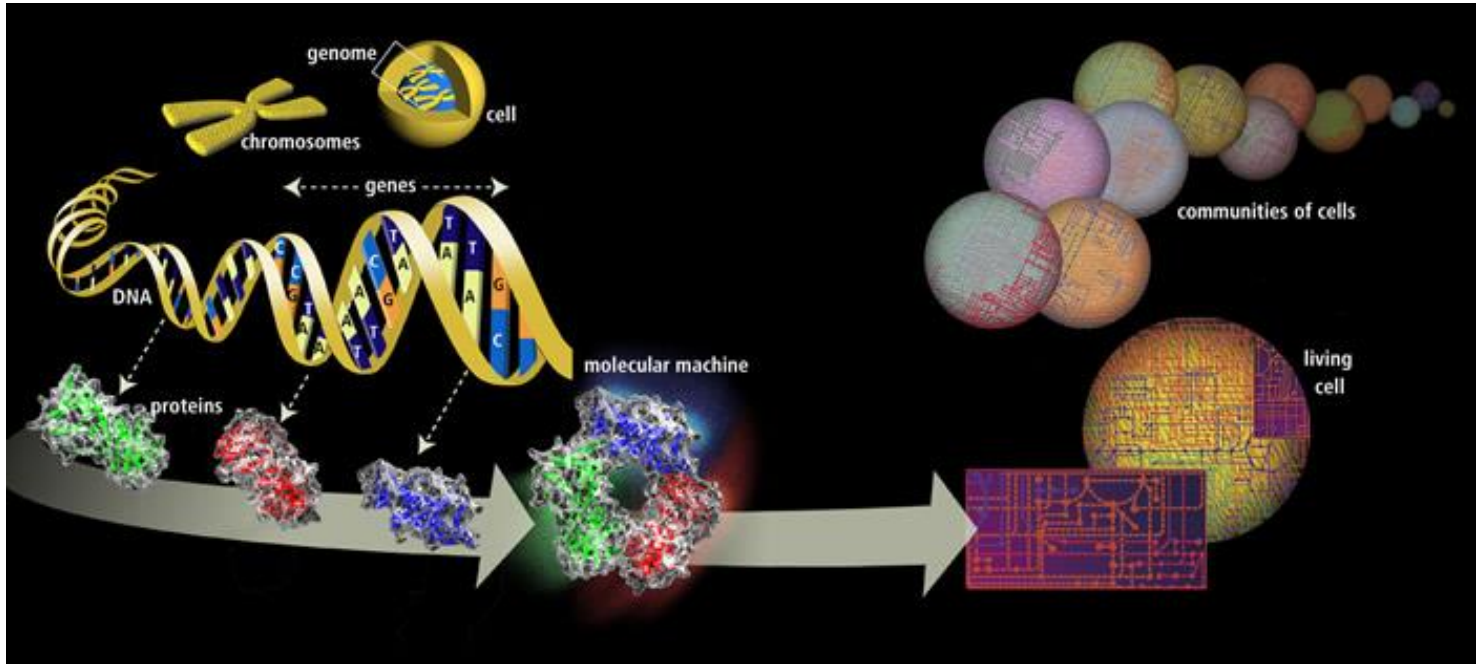


Ocean Forecasting Service (European IBI Area)



Galician Public Health Administration

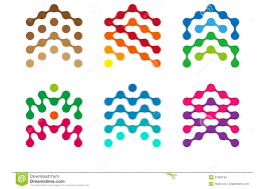
- **Fundación Galega de Medicina Xenómica**
- **Genomic analisys**
- **Lead by Ángel Carracedo**



Research Lines

Research lines

- HPC & Big Data
- Applied Machine Learning / Deep Learning
- Quantum Computing
- Quantum communications
- E-learning technologies
- Geographical information Systems



info@cesga.gal

Big Data
Data Science

Anomaly Detection


CIENCIAS
MARIÑAS
GALICIA


宇宙
uchuu

The Road Ahead

New Infrastructures CESGA 2026

- Budget: **47,4 M€ (+taxes)**

- Deadline: **June 2026**

- **4 Projects:**
  - **Supercomputer:** **15,5 M€**
  - **Quantum Computer:** **15 M€**
  - **Storage:** **6,5 M€**
  - **Datacenter:** **10,4 M€**

- **The projects include budget for hiring new staff**

We are hiring!

- 7 positions for Data Spaces (DataLife)
- 4 positions for Quantum Computing (Quantum Spain)
- 2 positions for FFPLUS project
- Much more positions coming in the next years!
- More info: https://www.cesga.es/en/employment/

GALICIA **SUPERCOMPUTING**
CENTER **(CESGA)**

A iniciativa do Polo de Tecnoloxías Cuánticas de Galicia conta con financiamento de:

Fondos REACT EU

AXENCIA GALEGA DE INNOVACIÓN

UNIÓN EUROPEA

Xacobeo 21·22

CESGA
Centro de Supercomputación de Galicia

Despregamento dunha infraestrutura baseada en tecnoloxías cuánticas da información que permita impulsar a I+D+i en Galicia.

Apoiar a transición cara a unha economía dixital.

Operación financiada pola Unión Europea, a través do FONDO EUROPEO DE DESENVOLVEMENTO REXIONAL (FEDER), como parte da resposta da Unión á pandemia da COVID-19.

PROGRAMA OPERATIVO
FEDER GALICIA
2014-2020

Unha maneira de facer Europa

GALICIA **SUPERCOMPUTING**
CENTER **(CESGA)**

Fondos do Plan de Recuperación, Transformación e Resiliencia

Apoiado economicamente polo Ministerio de Asuntos Económicos e Transformación Dixital do Goberno de España a través da convocatoria do proxecto QUANTUM ENIA - proxecto Quantum España, e pola Unión Europea a través do Plan de Recuperación, Transformación e Resiliencia – NextGenerationEU no marco da Axenda España Dixital 2025.

GALICIA **SUPERCOMPUTING**
CENTER **(CESGA)**

Plan Complementario de Comunicaciones Cuánticas:

Fondos Next Generation EU (MRR)

This work was supported by MICIN with funding from the European Union NextGenerationEU (PRTR-C17.I1) and with own funding from the Galician Regional Government through the "Planes Complementarios de I+D+I con las Comunidades Autónomas" in Quantum Communication.

Fondos propios da Xunta de Galicia a través da Axencia Galega de Innovación

Subvencionado pola Axencia Galega de Innovación.

GALICIA **SUPERCOMPUTING**
CENTER **(CESGA)**

Fondos do Programa Marco de Investigación H2020

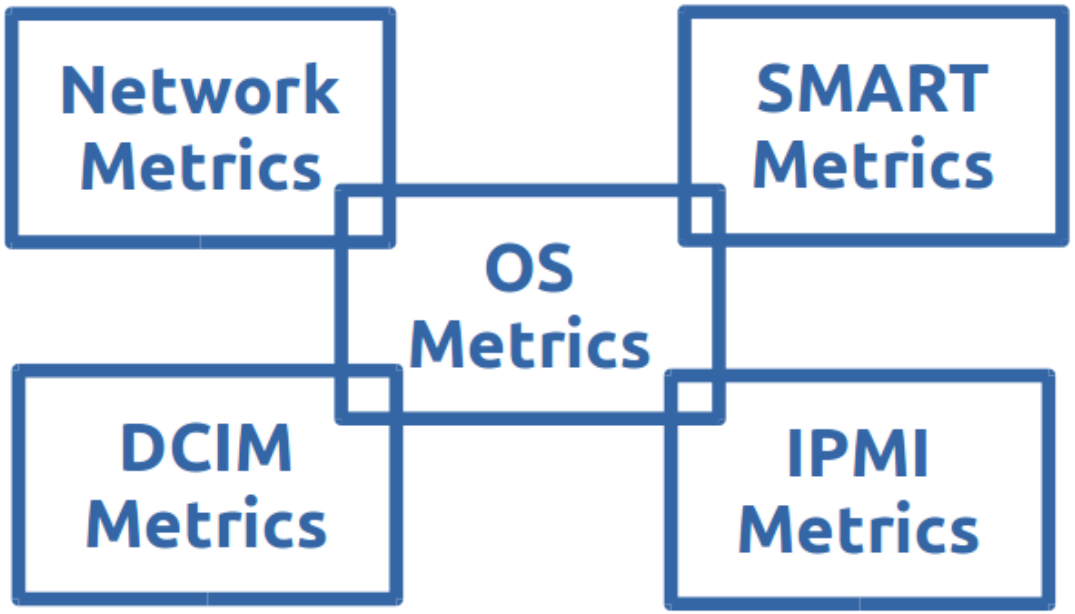
Este proxecto recibiu financiamento do programa de investigación e innovación Horizonte 2020 da Unión Europea en virtude do acordo de subvención n.º 951821.

ADDITIONAL MATERIAL

galicia XUNTA DE GALICIA
GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS
Unión Europea Fondo Europeo de Desarrollo Regional "Una manera de hacer Europa"

Anomaly Detection

galicia XUNTA DE GALICIA
GOBIERNO DE ESPAÑA MINISTERIO DE ECONOMÍA Y COMPETITIVIDAD CSIC CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS
Unión Europea Fondo Europeo de Desarrollo Regional "Una manera de hacer Europa"

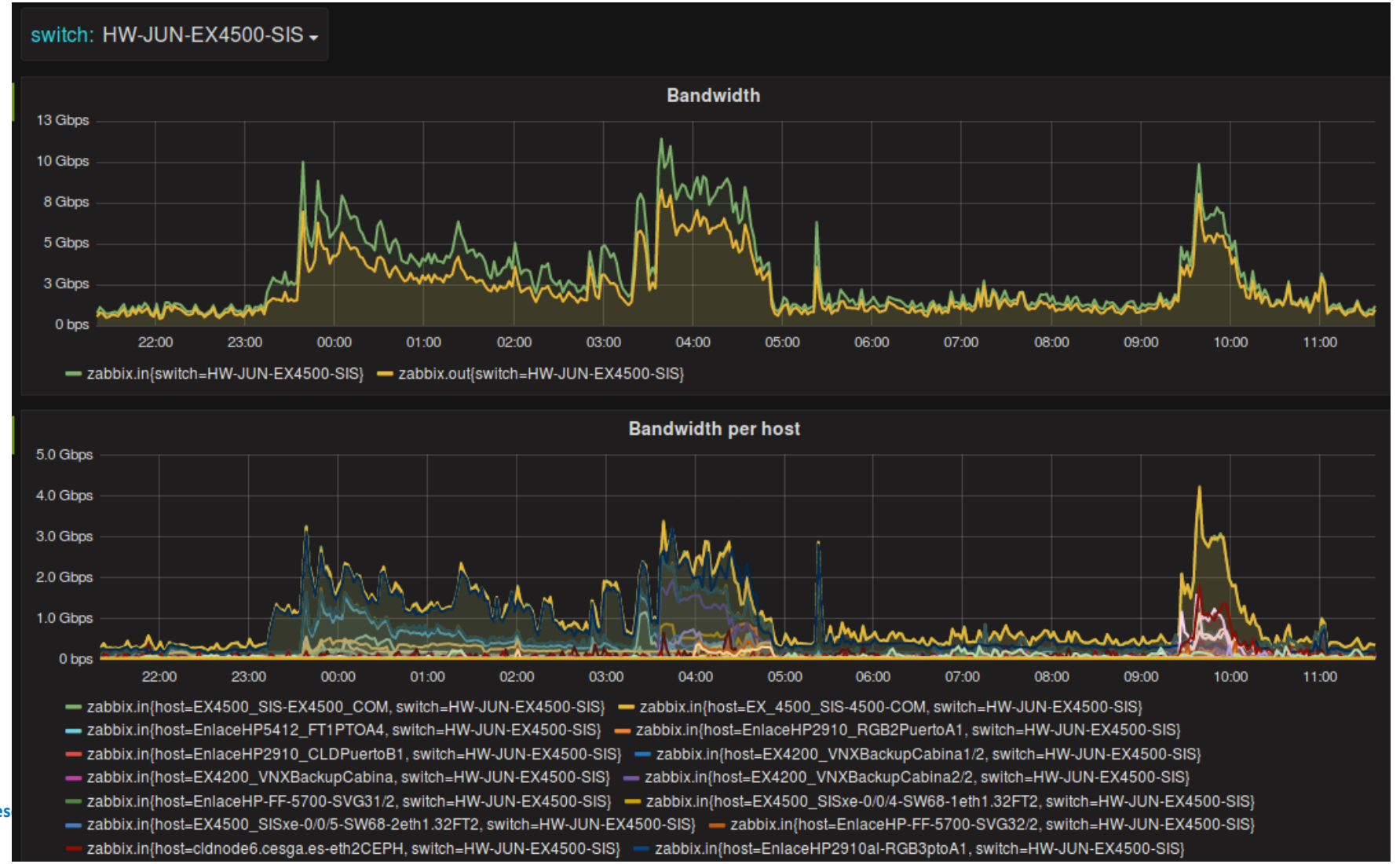

Network Metrics
SMART Metrics
OS Metrics
DCIM Metrics
IPMI Metrics


OS
Logs
Network
Logs
SLURM
Accounting
OS
Accounting

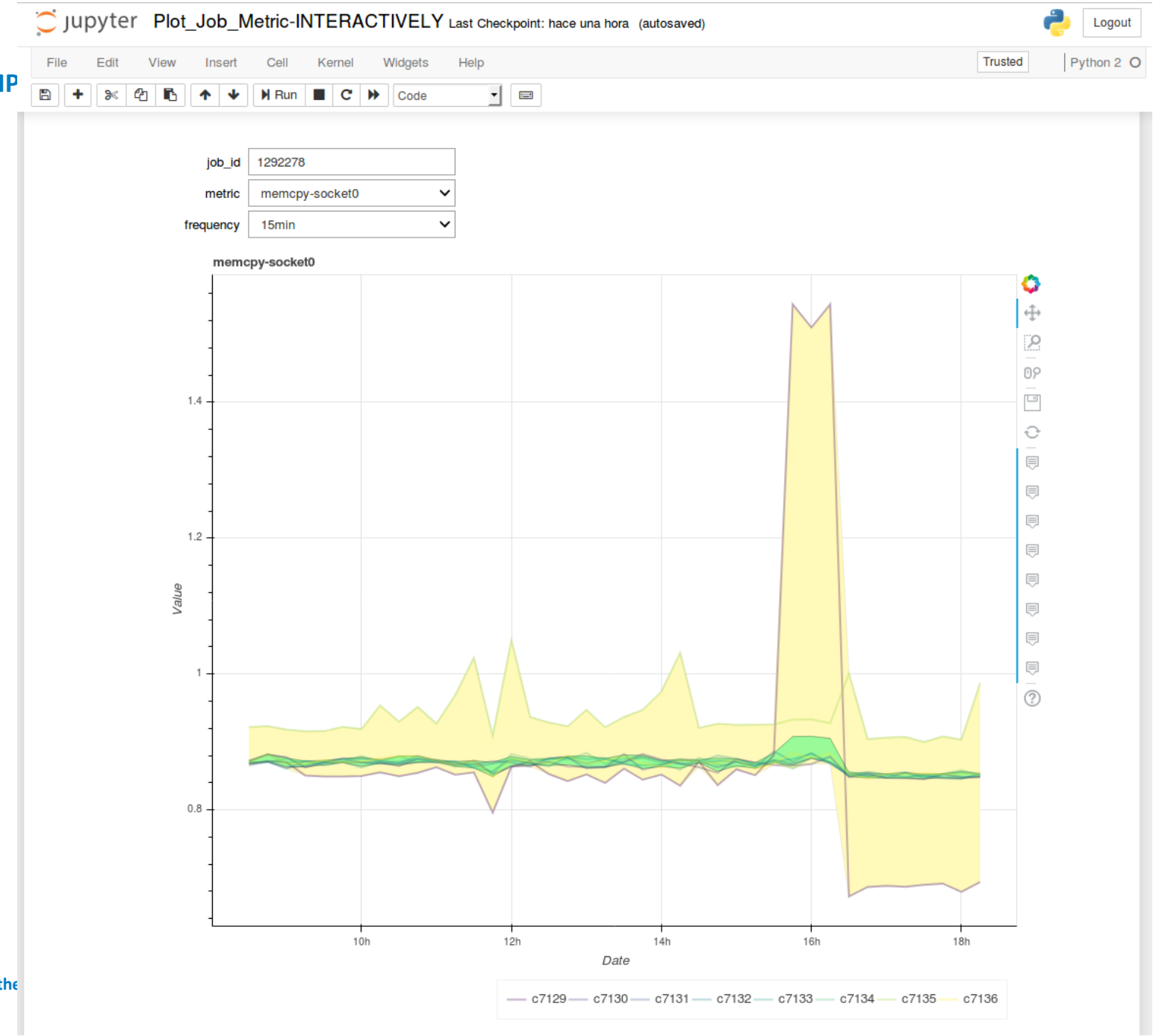
33487 metrics

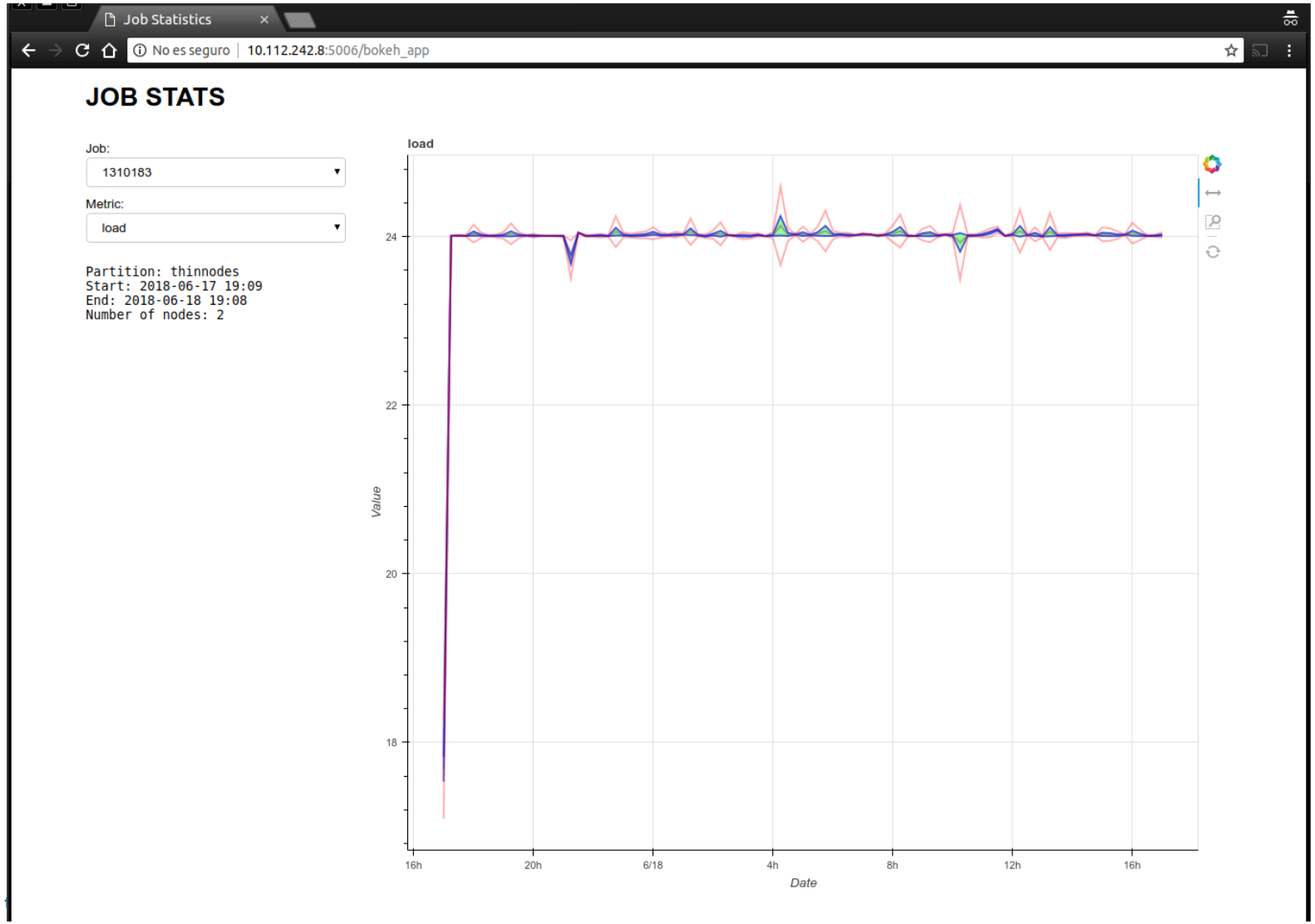
10 Million time series


Datacenter Power (KW)
200
150
100
50
0
14:00
16:00
18:00
20:00
22:00
00:00
02:00
04:00
06:00
08:00
10:00
12:00
Cuadro CPD5
Cuadro CPD7
Cuadro CPD8
Cuadro CPD9
Cuadro CPD1
Cuadro CPD3
Cuadro CPD2
Cuadro CPD4
Cuadro CPD6
Chiller 1 Power (KW)
150
100
50
0
16:00
20:00
00:00
04:00
08:00
12:00
Power (KW)
Chiller 1 Temperatures (ºC)
30
25
20
15
10
16:00
20:00
00:00
04:00
08:00
12:00
in
out
evaporator
ambient
Chiller 2 Power (KW)
150
100
50
0
16:00
20:00
00:00
04:00
08:00
12:00
Power (KW)
Chiller 2 Temperatures (ºC)
30
25
20
15
10
16:00
20:00
00:00
04:00
08:00
12:00
in
out
evaporator
ambient


switch: HW-JUN-EX4500-SIS
Bandwidth
13 Gbps
10 Gbps
8 Gbps
5 Gbps
3 Gbps
0 bps
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
zabbix.in{switch=HW-JUN-EX4500-SIS}
zabbix.out{switch=HW-JUN-EX4500-SIS}
Bandwidth per host
5.0 Gbps
4.0 Gbps
3.0 Gbps
2.0 Gbps
1.0 Gbps
0 bps
22:00
23:00
00:00
01:00
02:00
03:00
04:00
05:00
06:00
07:00
08:00
09:00
10:00
11:00
zabbix.in{host=EX4500_SIS-EX4500_COM, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX_4500_SIS-4500-COM, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP5412_FT1PTOA4, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP2910_RGB2PuertoA1, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP2910_CLDPuertoB1, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX4200_VNXBackupCabina1/2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX4200_VNXBackupCabina, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX4200_VNXBackupCabina2/2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP-FF-5700-SVG31/2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX4500_SISxe-0/0/4-SW68-1eth1.32FT2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EX4500_SISxe-0/0/5-SW68-2eth1.32FT2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP-FF-5700-SVG32/2, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=cldnode6.cesga.es-eth2CEPH, switch=HW-JUN-EX4500-SIS}
zabbix.in{host=EnlaceHP2910al-RGB3ptoA1, switch=HW-JUN-EX4500-SIS}

GALICIA **SUPERCOMP**
CENTER **(CESGA)**



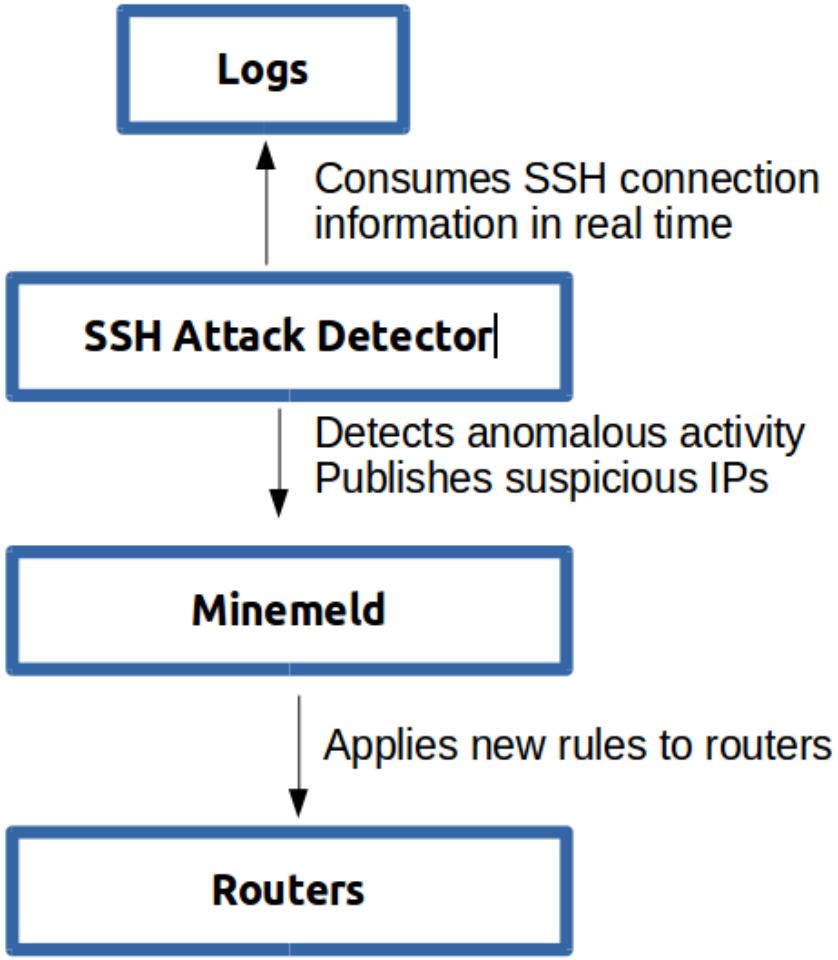

Job Statistics
No es seguro | 10.112.242.8:5006/bokeh_app
JOB STATS
Job:
1310183
Metric:
load
Partition: thinnodes
Start: 2018-06-17 19:09
End: 2018-06-18 19:08
Number of nodes: 2
load
24
22
20
18
Value
16h
20h
6/18
4h
8h
12h
16h
Date

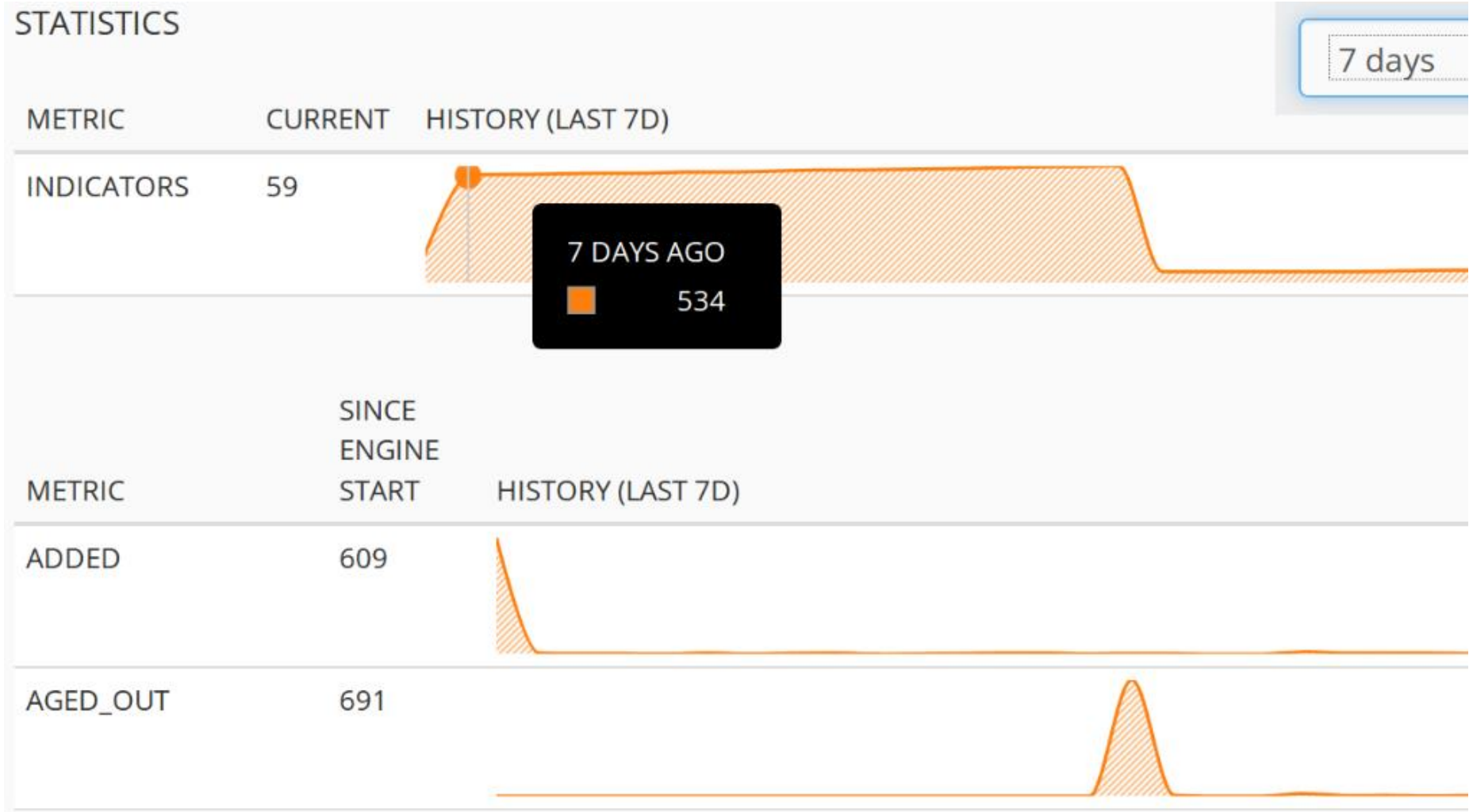
SSH Attack Detection

Problem: Daily our public servers are scanned and attacked

Detection: Correlate real-time SSH connection information to detect attacks

Objective: Automatically update router configuration to stop the attacks


Logs
Consumes SSH connection information in real time
SSH Attack Detector
Detects anomalous activity
Publishes suspicious IPs
Minemeld
Applies new rules to routers
Routers

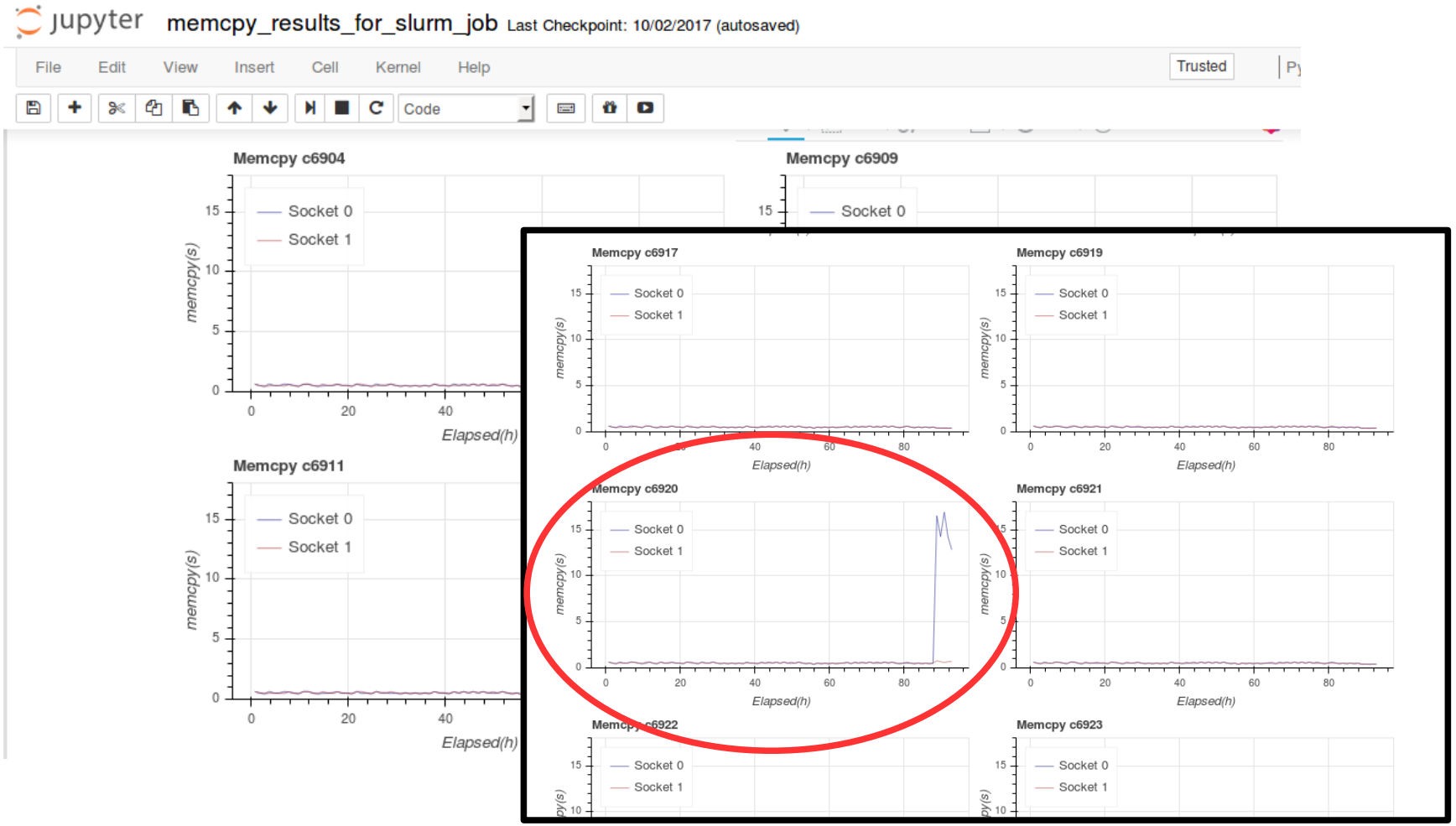

STATISTICS
7 days
METRIC
CURRENT
HISTORY (LAST 7D)
INDICATORS
59
7 DAYS AGO
534
METRIC
SINCE ENGINE START
HISTORY (LAST 7D)
ADDED
609
AGED_OUT
691

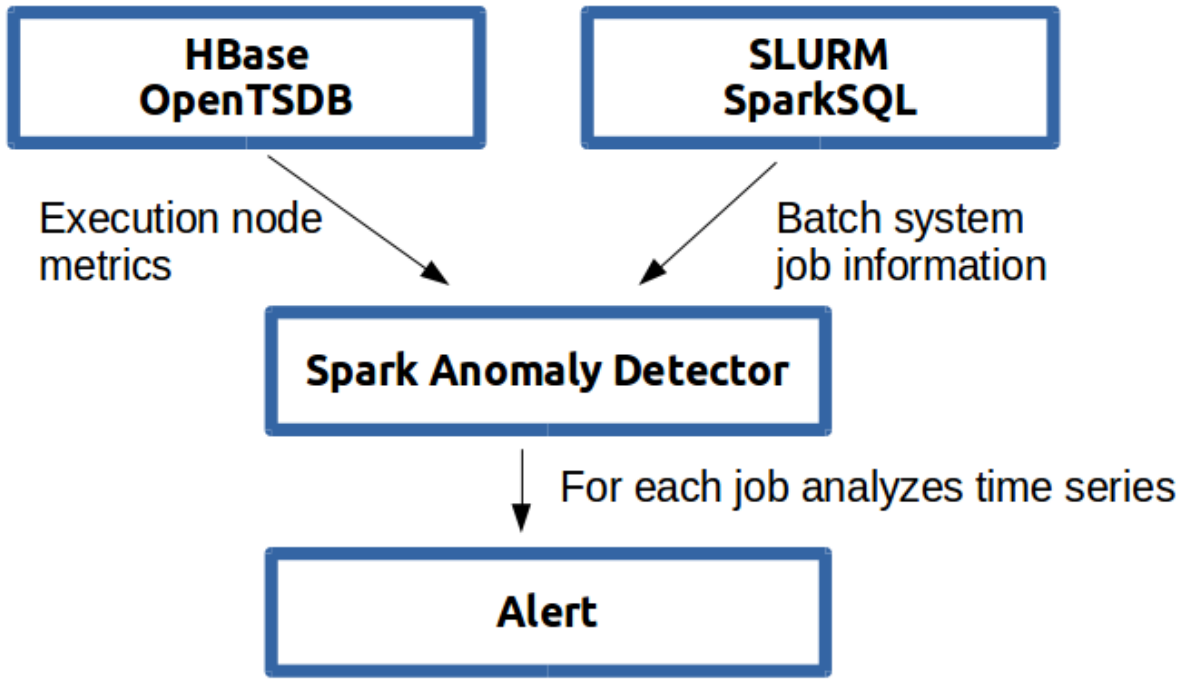
Server Anomalous Performance

Problem: Parallel jobs are cancelled because some of the nodes have poor performance. Computation is lost.

Detection: Analyze & visualize server metrics to spot the anomalous node

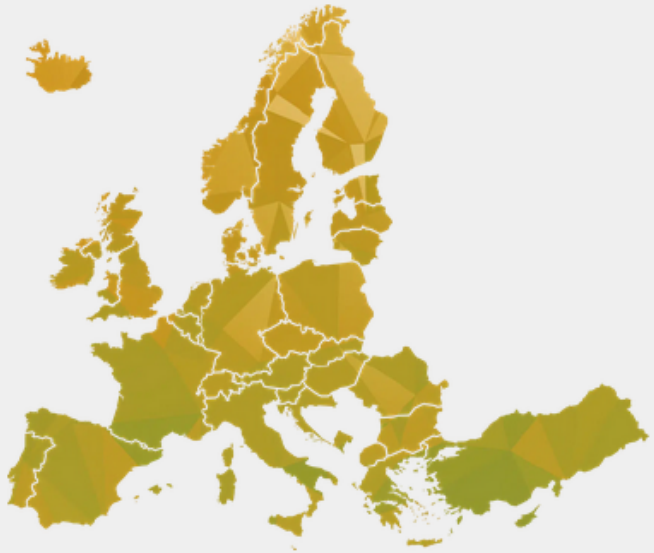
Objective: Automatically detect low performance nodes


jupyter
memcpy_results_for_slurm_job
Last Checkpoint: 10/02/2017 (autosaved)
File
Edit
View
Insert
Cell
Kernel
Help
Trusted
Code
Memcpy c6904
Memcpy c6909
Memcpy c6911
Memcpy c6917
Memcpy c6919
Memcpy c6920
Memcpy c6921
Memcpy c6922
Memcpy c6923
Socket 0
Socket 1
memcpy(s)
Elapsed(h)


HBase
OpenTSDB
SLURM
SparkSQL
Execution node
metrics
Batch system
job information
Spark Anomaly Detector
For each job analyzes time series
Alert

Relevant Projects

EuroCC – National Competence Centres



The National Competence Centres (NCCs) are the **central points of contact** for HPC and related technologies in their country.

Their missions are to:

- Develop and display a comprehensive and transparent map of **HPC competences and institutions** in their country
- Act as a **gateway for industry and academia** to providers with suitable expertise or relevant projects, may that be national or international
- Collect **HPC training offers** in their country and display them in a central place together with international training offers collected by other NCCs
- Foster the **industrial uptake of HPC**

2025

EUROCC2

NCC Spain

30 Aniversario CESGA GALICIA SUPERCOMPUTING CENTER

BSC Barcelona Supercomputing Center Centro Nacional de Supercomputación

bifi Instituto Universitario de Investigación Biocomputación y Física de Sistemas Complejos Universidad Zaragoza

SCAYLE SUPERCOMPUTACIÓN CASTILLA Y LEÓN

UC UNIVERSIDAD DE CANTABRIA

The FF4EuroHPC Project

FF4HPC: HPC Innovation for European SMEs
Funded under the H2020-JTI-EuroHPC-2019-2 Call
Started 1.9.2020; 36 months duration
Coordinator:

Other Partners:

The NEASQC Project

- NExt ApplicationS of Quantum Computing
- A 4-year project starting 1st September 2020
- A multidisciplinary consortium of 12 companies and research labs
- Funded by Horizon 2020 programme
  - under the complementary call of the Quantum Technology Flagship
  - 4.67 M€

Boosting practical applications of quantum computing in the NISQ era

Atos
AstraZeneca
CESGA
Centro de Supercomputación de Galicia
EDF
HQS QUANTUM SIMULATIONS
HSBC
ICHEC
Universiteit Leiden
TILDE
TotalEnergies
UNIVERSIDADE DA CORUÑA
UNIVERSITÉ DE LORRAINE

GALICIA **SUPERCOMPUTING** CENTER **(CESGA)**

Spanish plan on Quantum Communications. Galicia Track

CESGA GALICIA SUPERCOMPUTING CENTER

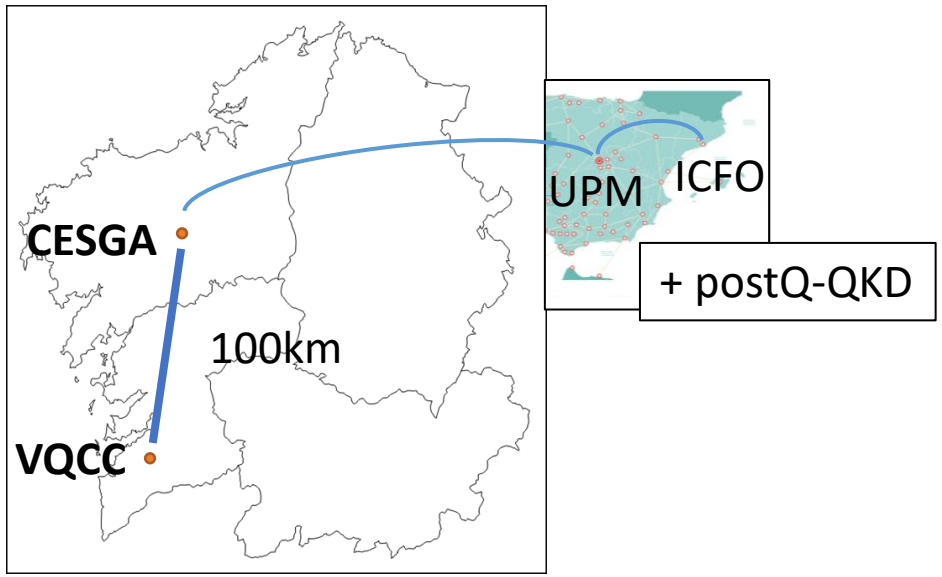
- **Goals:**
  1. **Set up a QKD link Santiago-Vigo: more tan 100kms**

     Current status:
     - Fibers VQCC-CESGA: up for tender
     - QKD equipment: preparing tender

  2. **Demostrate minimum 2 use-case demos**

     Currently exploring:
     i. Mixis QKD+5G to control drones (with GRADIANT)
     ii. Transnational QKD+post-quantum link

Single long link



Financiado por la Unión Europea NextGenerationEU
AXENCIA GALEGA DE INNOVACIÓN
GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN
Plan de Recuperación, Transformación y Resiliencia

GALICIA **SUPERCOMPUTING CENTER (CESGA)**

Quantum Spain

The definitive boost to the quantum computing ecosystem in Spain

- Quantum Spain aims to promote and finance a **competitive and complete quantum computing infrastructure** in Spain.

We are 13 RES nodes+ 14 Universities and research centers

- Quantum Spain is an initiative promoted by the **Ministry of Economy through the Secretary of State for Digitization and Artificial Intelligence** and financed with the Recovery Funds.
- Budget: **€22 million**
- Execution: **01/01/22 – 31/12/25**

Objectives:
Acquisition and installation of a quantum computer based on superconducting qubits technology.
Create a remote access system in the cloud to allow industry and the public sector to experiment with new quantum algorithms.
Develop useful quantum algorithms, applicable to real problems. These algorithms will emphasize the development of “Quantum Machine Learning”, in deep connection with advances in Artificial Intelligence (AI).

SINFONIA project

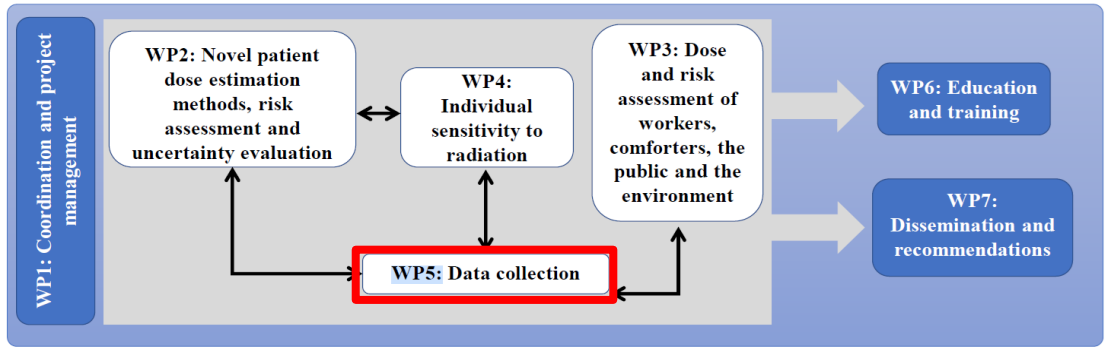
Radiation risk appraisal for detrimental effects from medical exposure during management of patients with lymphoma or brain tumour.

4 years: 2020/09/01 to 2024/08/31

14 centers, 8 countries: AT, BE, CH, DE, ES, GR, PL, SE

Funding: Total 5.999.997,5 € - **CESGA: 387.405,5 €**

The main objective is to develop **novel methodologies and tools** that will provide a comprehensive **risk appraisal for detrimental effects of radiation exposure** on **patients, workers, carers** and **comforters,** the **public** and the **environment** during the management of patients suspected or diagnosed with **lymphoma and brain tumours**.



CESGA leads WP5:

Development and operation of a platform for dose, imaging and non-imaging data.

Development of techniques for storing, searching and retrieving patient information from the research repositories.

SINFONIA

This project has received funding from the Euratom research and training programme 2019-2020 under grant agreement No 945196

IA techniques for a predictive control system successfully applied in MDF manufacturing: from sensoring to ML-based control systems, bridging through expert knowledge.

CESGA
Centro de Supercomputación de Galicia

FINANCIERA MADERERA FINSA
FINSA
soluciones en madera


CIENCIAS
MARIÑAS
GALICIA

CIENCIAS MARIÑAS GALICIA

GALICIAN MARINE SCIENCES PROGRAM

The protection and sustainable **management of marine ecosystem services** is the main challenge of the Galician Marine Sciences Program through three main lines of action:

- **Observation and monitoring** of the marine environment and the coast.
- **Sustainable, smart and precision** aquaculture.
- **Innovation, knowledge and opportunities** to adapt to change in the marine economy.

Financiado por la Unión Europea
NextGenerationEU
FEMP-FEMPA

GOBIERNO DE ESPAÑA | MINISTERIO DE CIENCIA E INNOVACIÓN | Plan de Recuperación, Transformación y Resiliencia | XUNTA DE GALICIA

GALICIA **SUPERCOMPUTING** CENTER **(CESGA)**