PROCESS

Use of the HPC Containers in the way towards exascale

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Motivation and objectives

The PROCESS project aims to:

- Pave the way towards exascale by providing scalable platform
- Enable deployment of services on heterogenous infrastructures
- Support different domains of science and business

Our objective is to:

- Build the Container based platform based on Singularity
- Integrate the HPC resources across multiple countries
- Provide effortless user experience via the WebUI

Project Use Cases

Health
- **Content-based search and classification**
- HAUTE ECOLE SPECIALISEE DE SUISSE OCCIDENTALE (CH)

Astronomy
- **Square Kilometre Array SKA**
- STICHTING NETHERLANDS ESCIENCE CENTER (NL)

Risk Management
- **Supporting innovation based on global disaster risk data**
- LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN (DE)

Airlines Operations
- **Ancillary pricing for airline revenue management**
- LUFTHANSA SYSTEMS GMBH & CO KG (DE)

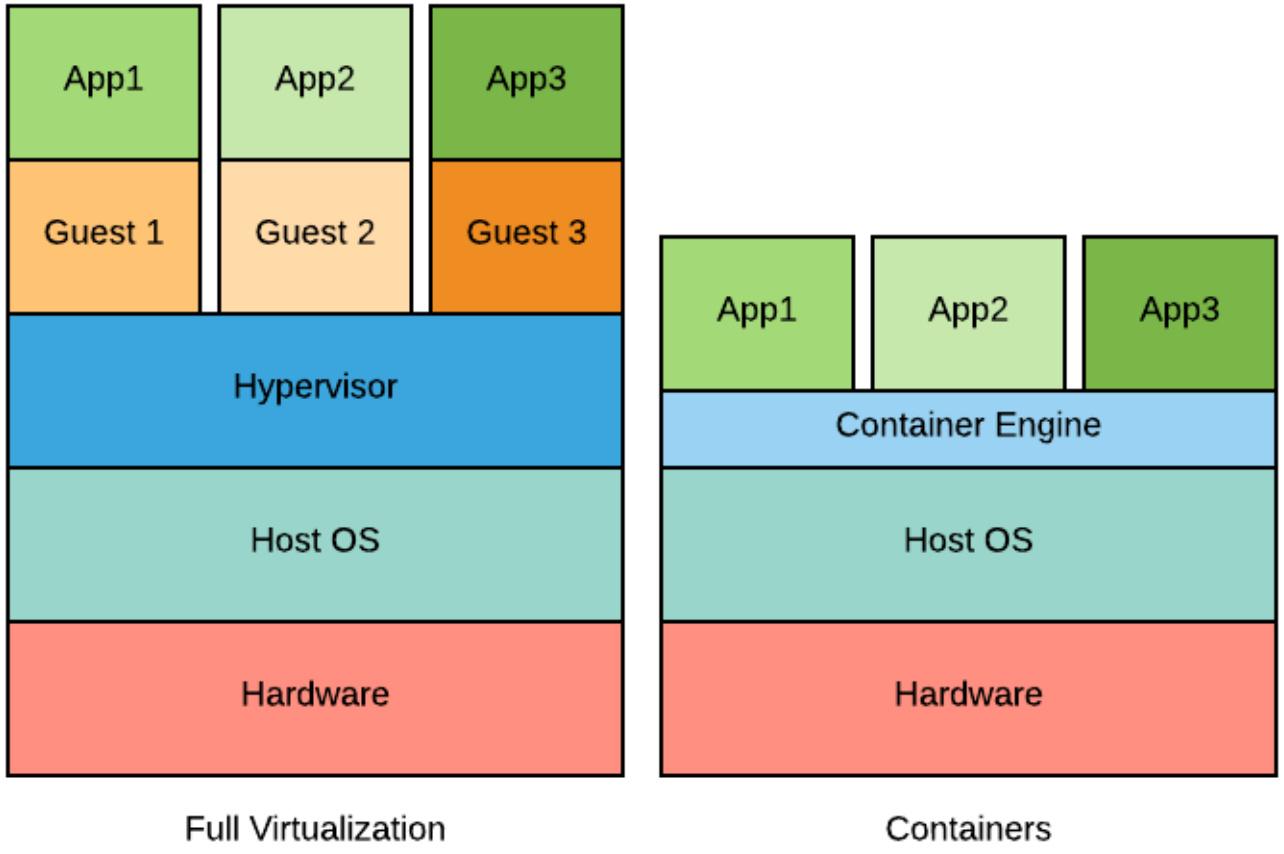
Agriculture
- **Agro-Copernicus**
- LUDWIG-MAXIMILIANS-UNIVERSITAET MUENCHEN (DE)

Road Towards Exascale

Rank	Site	System	Cores	Rmax (TFlop/s)	Rpeak (TFlop/s)	Power (kW)
1	DOE/SC/Oak Ridge National Laboratory United States	**Summit** - IBM Power System AC922, IBM POWER9 22C 3.07GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM	2,282,544	122,300.0	187,659.3	8,806
2	National Supercomputing Center in Wuxi China	**Sunway TaihuLight** - Sunway MPP, Sunway SW26010 260C 1.45GHz, Sunway NRCPC	10,649,600	93,014.6	125,435.9	15,371
3	DOE/NNSA/LLNL United States	**Sierra** - IBM Power System S922LC, IBM POWER9 22C 3.1GHz, NVIDIA Volta GV100, Dual-rail Mellanox EDR Infiniband IBM	1,572,480	71,610.0	119,193.6	
4	National Super Computer Center in Guangzhou China	**Tianhe-2A** - TH-IVB-FEP Cluster, Intel Xeon E5-2692v2 12C 2.2GHz, TH Express-2, Matrix-2000 NUDT	4,981,760	61,444.5	100,678.7	18,482
5	National Institute of Advanced Industrial Science and Technology (AIST) Japan	**AI Bridging Cloud Infrastructure (ABCI)** - PRIMERGY CX2550 M4, Xeon Gold 6148 20C 2.4GHz, NVIDIA Tesla V100 SXM2,	391,680	19,880.0	32,576.6	1,649

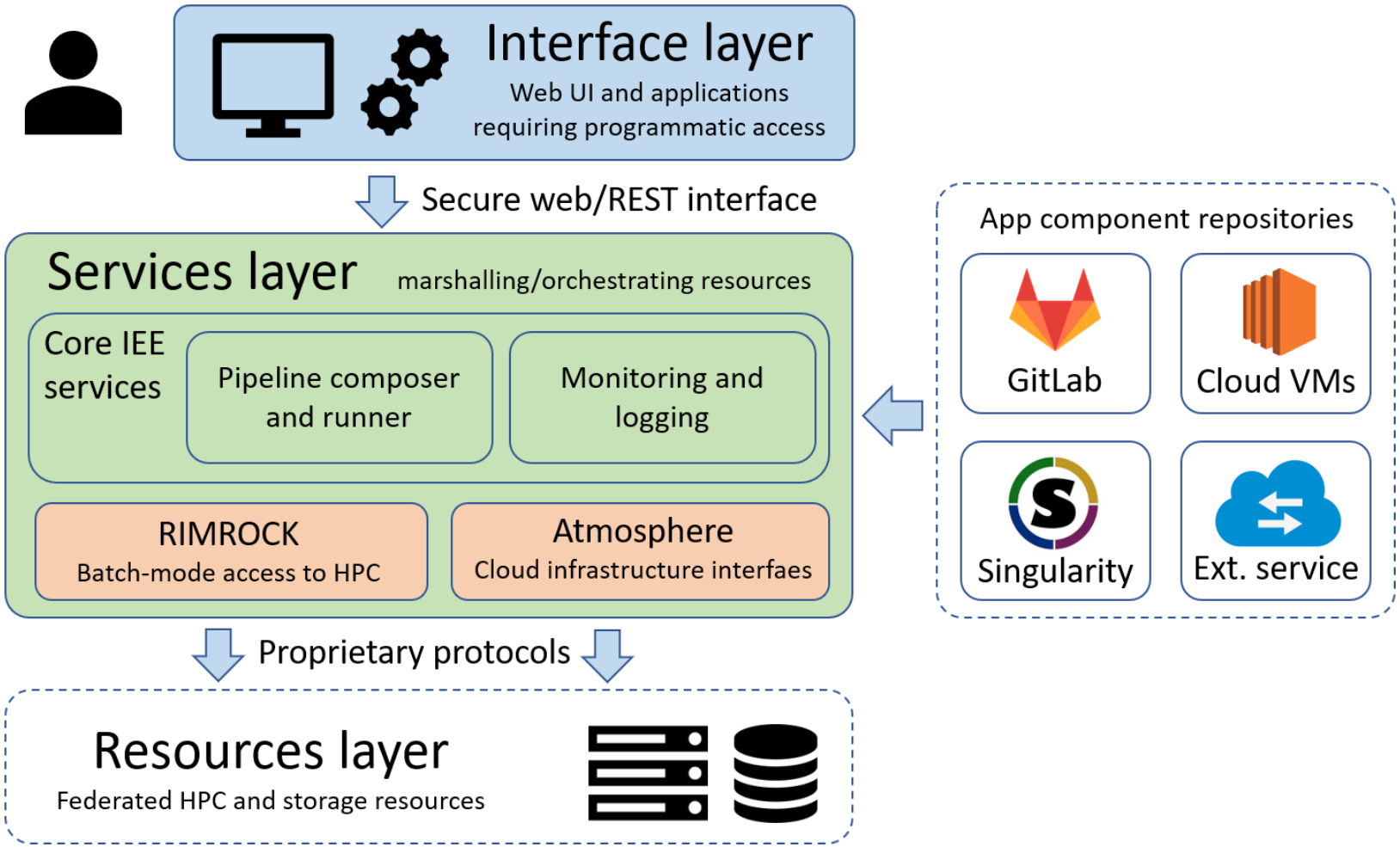
- No single HPC system capable of exceeding exaflop **for generic computations**
- Fastest known: < 0.2 Eflop/s
- 1-5 still way bellow 1 Eflop/s
- We may need to pool resources of multiple Centers
- Has been done for years but we want to:
  - Enable running single computation on multiple sites
  - Provide support for non-IT scientists to prepare/run codes on such massive scale

Why Singularity?



- Why container ?
  - Small footprint
  - Less overhead
  - Quick launch
  - Manageable images
- Why Singularity?
  - Built for the HPC
  - Integrated with SLURM
  - Unprivileged / secure
  - Support for MPI, GPU, …

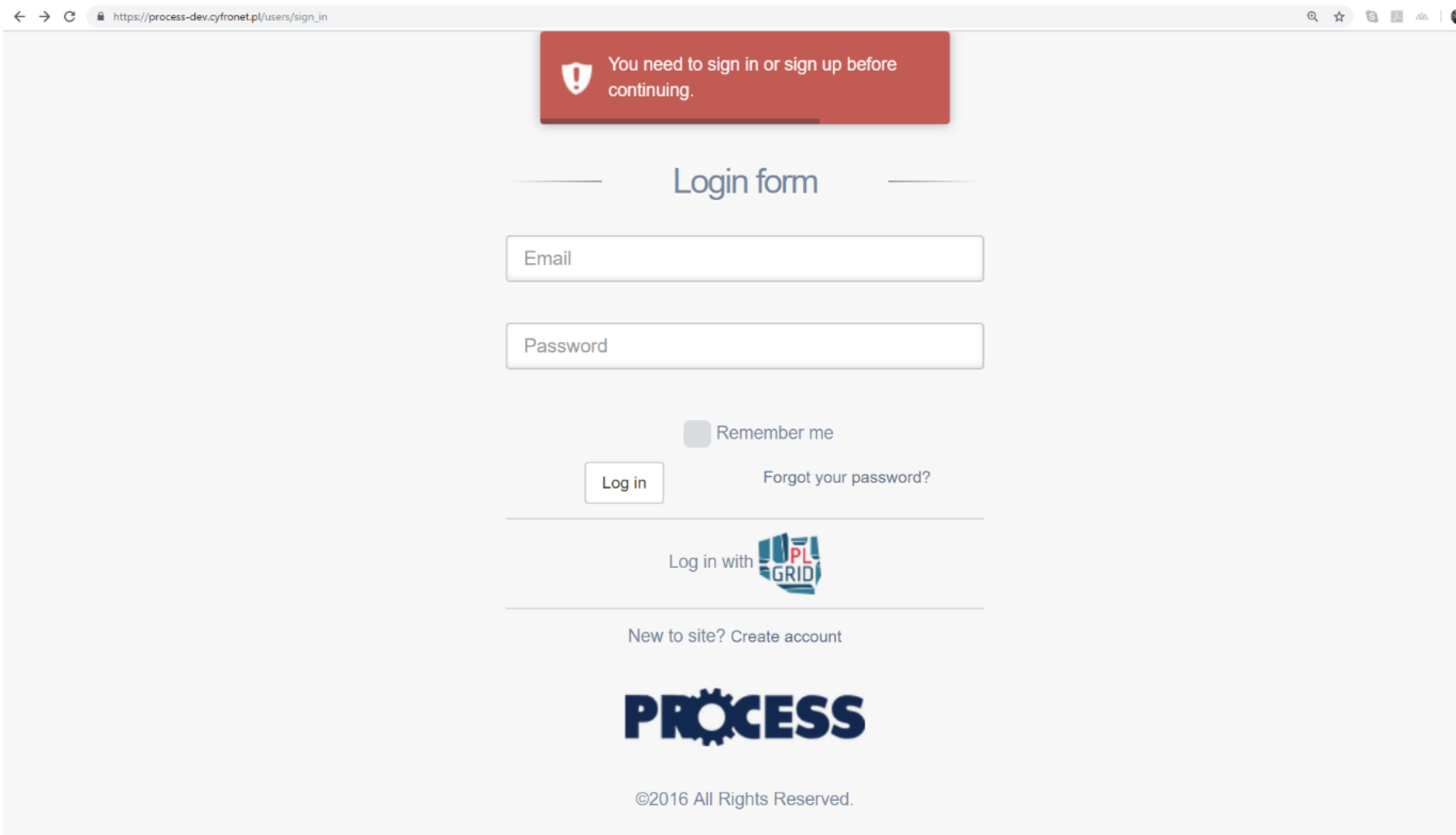
PROCESS Platform Architecture



- User accesses WebUI
- Service layer is used to:
  - select inputs
  - choose code version
  - prepare and run computations
- Computations are scheduled on the HPC via RIMROCK
- Computations may be in form of classical scripts or Singularity (new)

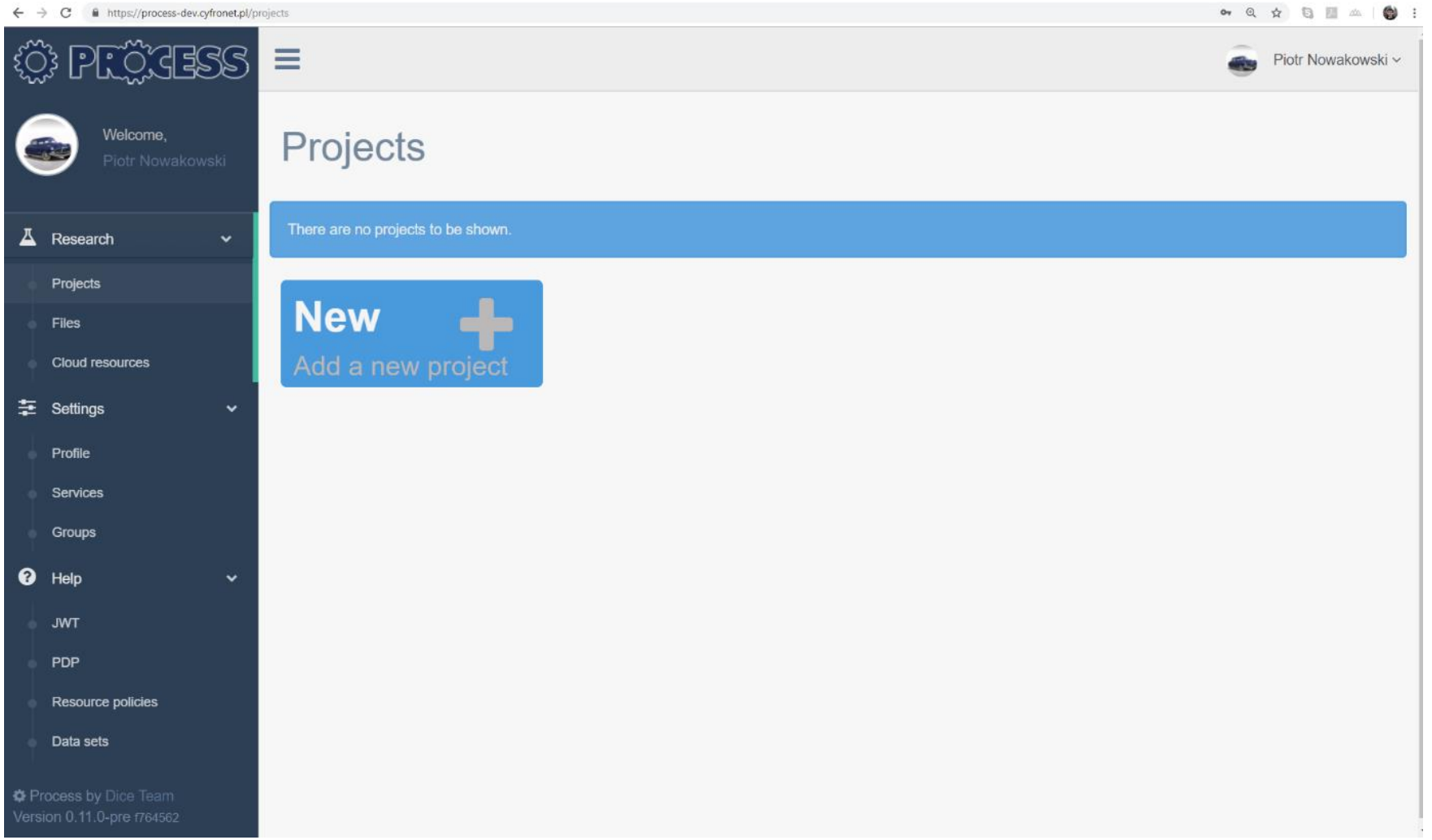
Singularity Step (1/5)

1. • **SIGN-IN**
2. • DASHBOARD
3. • CREATE PROJECT
4. • CREATE PIPELINE
5. • RUN COMPUTATION



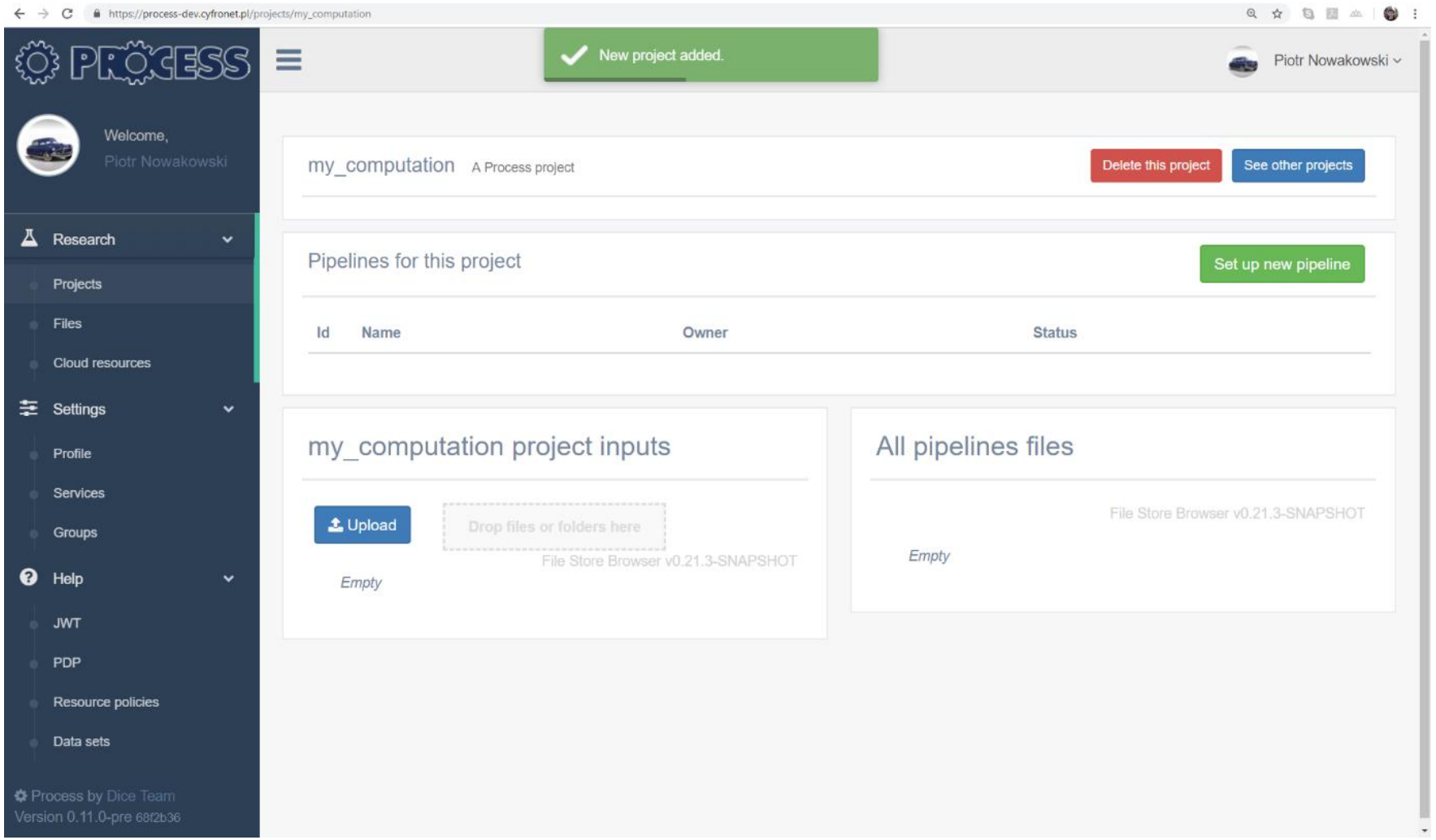
Singularity Step (2/5)

1. • **SIGN-IN**
2. • **DASHBOARD**
3. • CREATE PROJECT
4. • CREATE PIPELINE
5. • RUN COMPUTATION



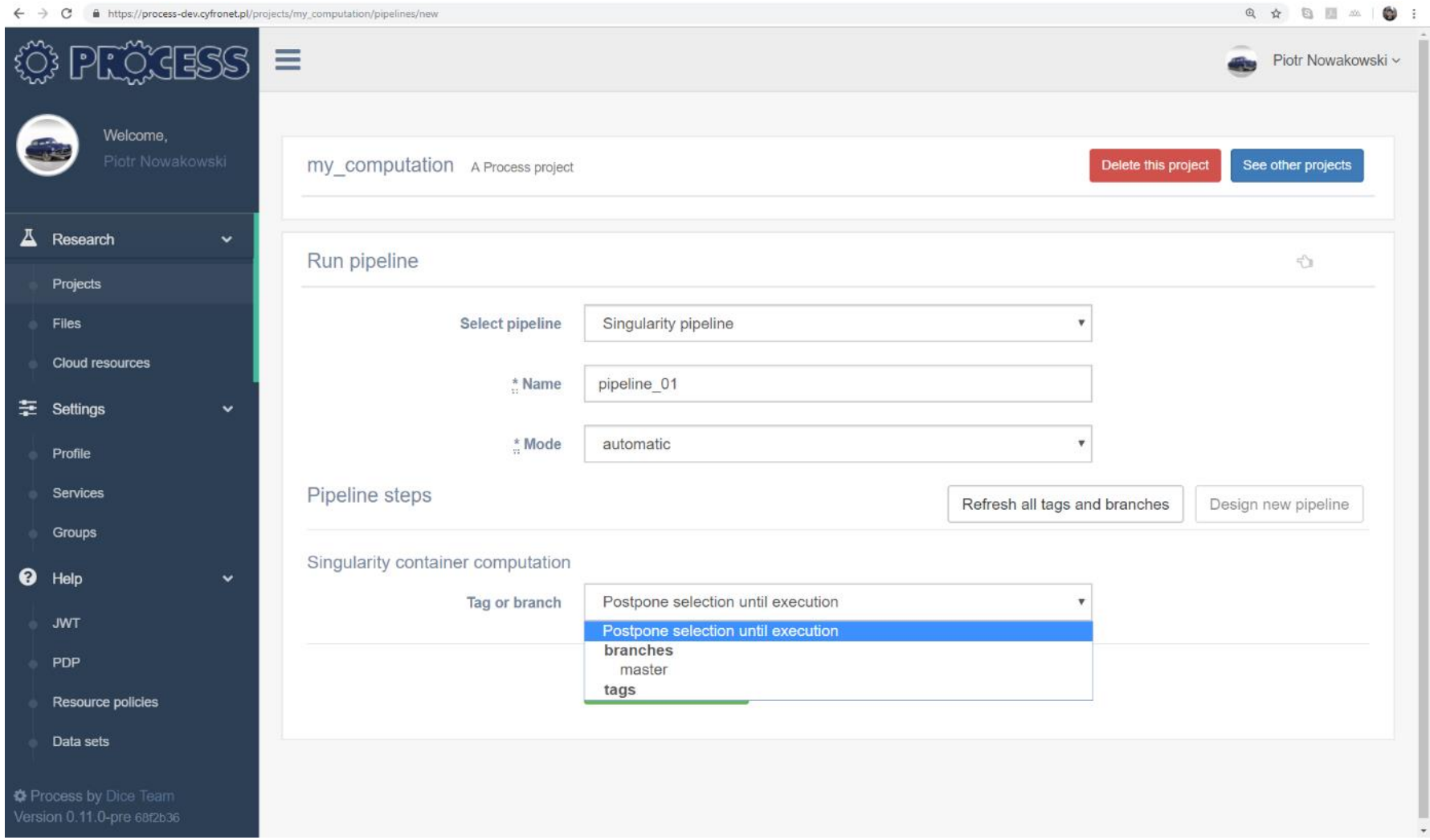
Singularity Step (3/5)

1. • **SIGN-IN**
2. • **DASHBOARD**
3. • **CREATE PROJECT**
4. • CREATE PIPELINE
5. • RUN COMPUTATION



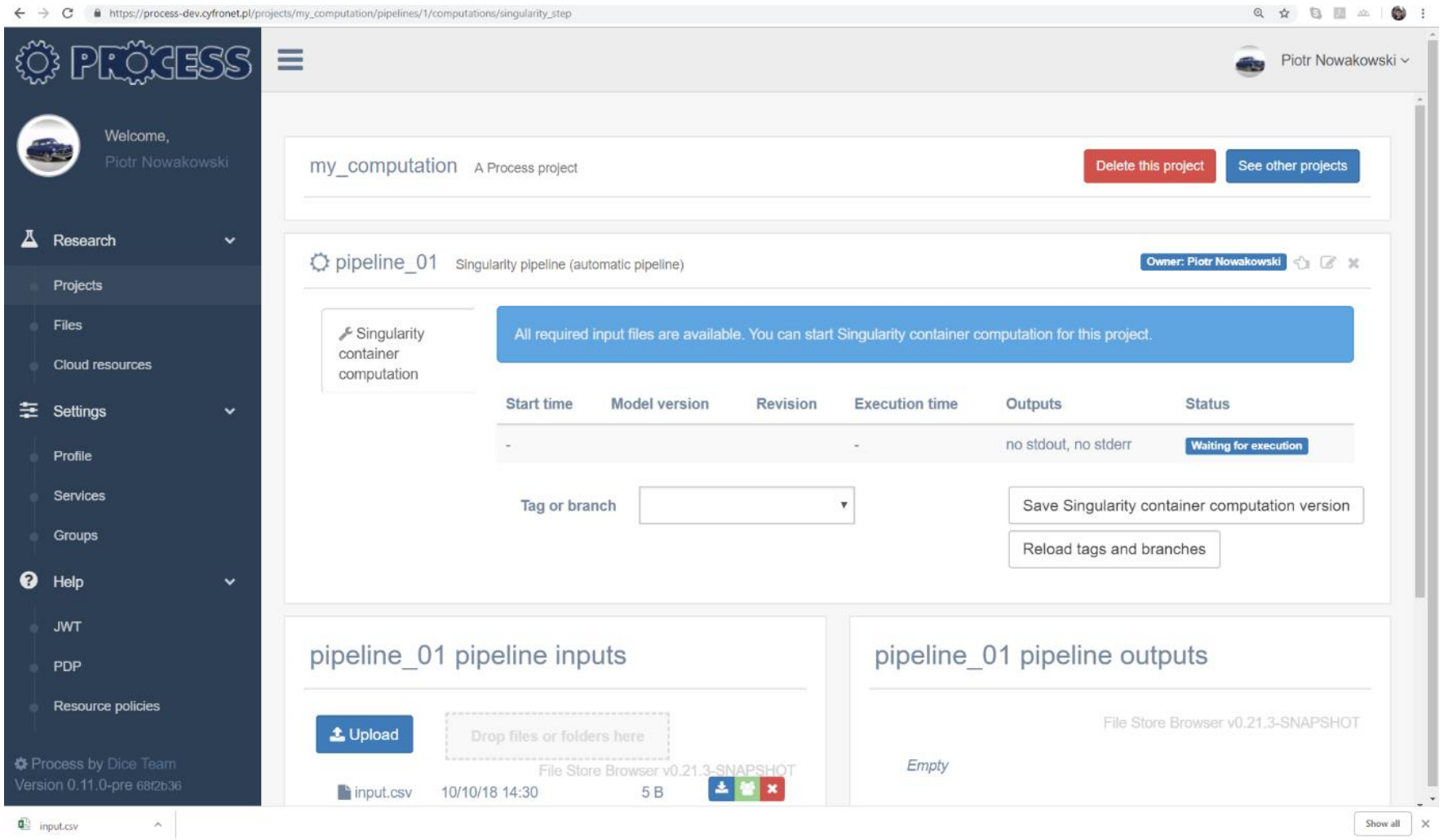
Singularity Step (4/5)

1. • **SIGN-IN**
2. • **DASHBOARD**
3. • **CREATE PROJECT**
4. • **CREATE PIPELINE**
5. • RUN COMPUTATION



Singularity Step (5/5)

1. • **SIGN-IN**
2. • **DASHBOARD**
3. • **CREATE PROJECT**
4. • **CREATE PIPELINE**
5. • **RUN COMPUTATION**



Conclusions and Further Plans

- Conclusions:
  - New type of the pipeline step based on the Singularity containers was created for the Interactive Execution Environment
  - It enables execution of user provided applications on the HPC
  - Tested on the HPC system at Cyfronet (CPU and GPU)

- Future plans:
  - Extending solution for other Clusters in PROCESS (in Germany, Slovakia and the Netherlands)
  - Enable running same computation on multiple sites
  - Handle site-to-site communication
  - Add support for the private and public clouds

See more at our sites

http://dice.cyfronet.pl

http://www.process-project.eu

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