

The Combination of Real-Time Data, HPC, and Interactive Visualization in the VESTEC project

Max Kontak

DLR German Aerospace Center, Cologne, Germany



DLR

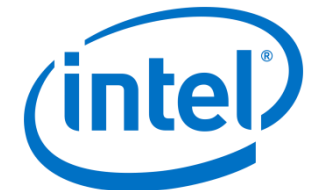
Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center



The VESTEC project has received funding from the European Union's Horizon 2020 Programme for research, technological development and demonstration under grant agreement n° 800904

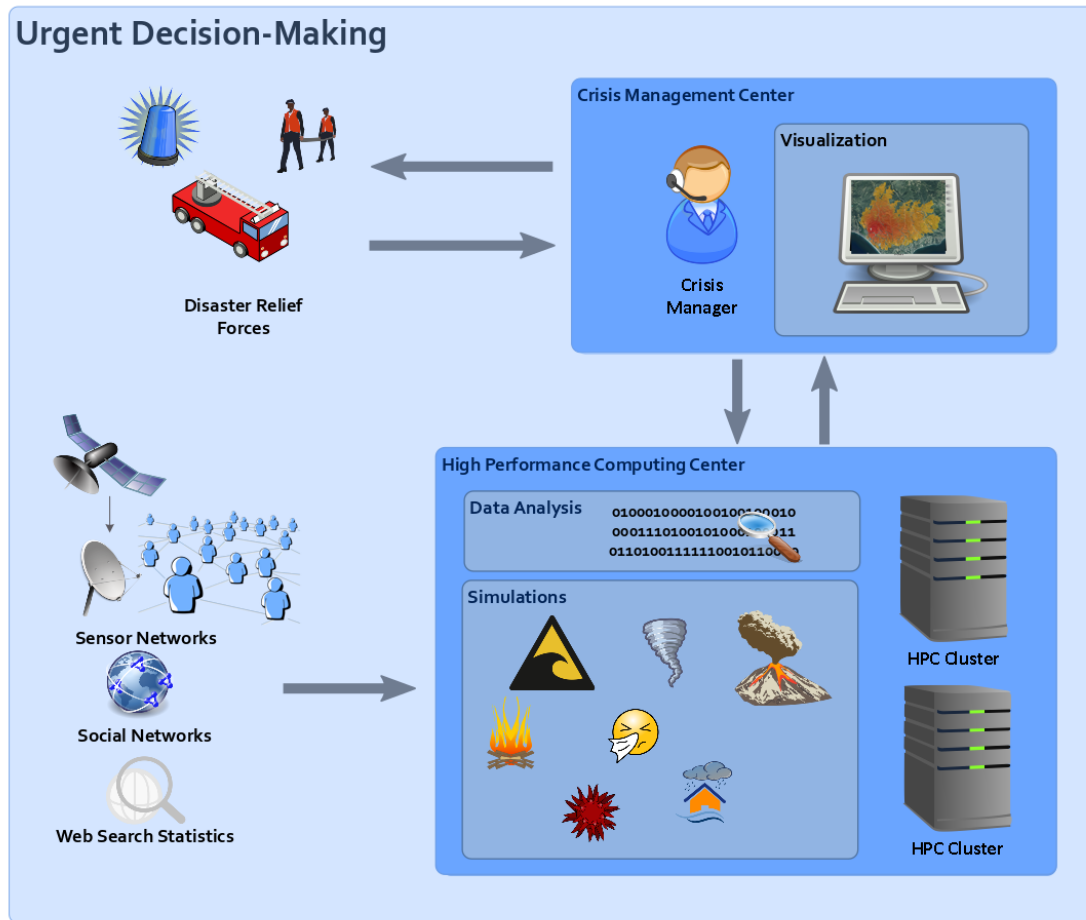
The VESTEC Consortium

- DLR German Aerospace Center (Coordinator)
- The University of Edinburgh
- Sorbonne Université
- KTH Stockholm
- Kitware SAS
- Intel Deutschland GmbH
- Fondazione Bruno Kessler
- Université Paul Sabatier Toulouse
- Tecnosylva SL

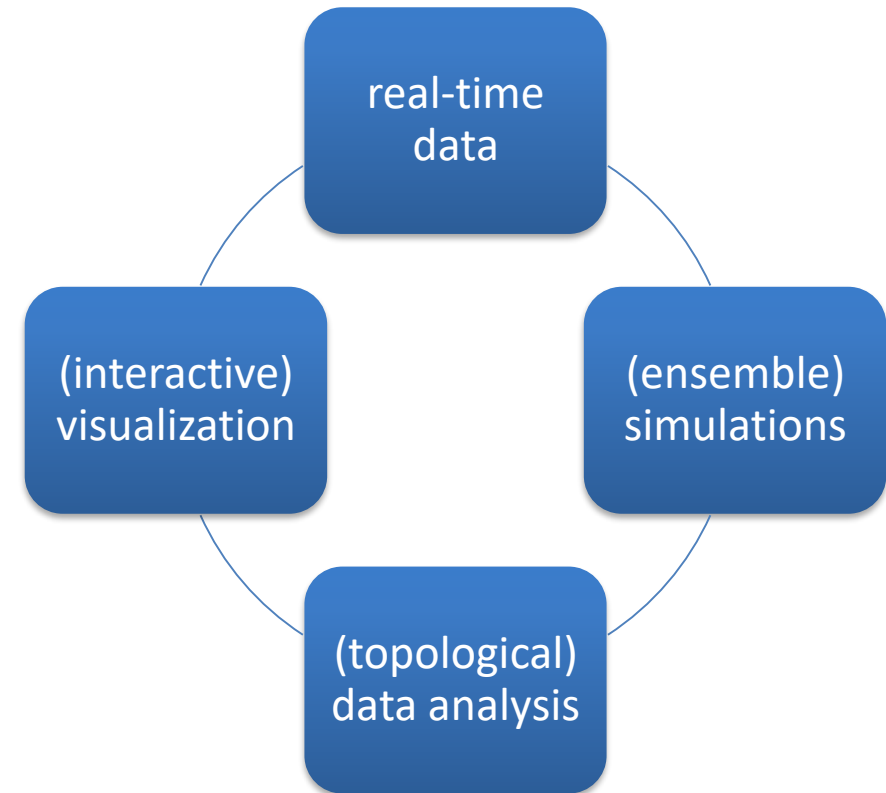


Visual Exploration and Sampling Toolkit for Extreme Computing (VESTEC)

The Vision

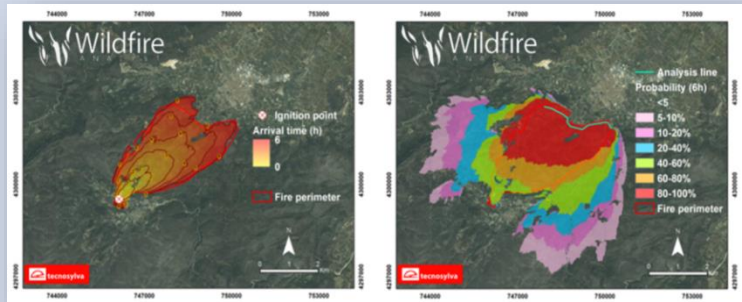


support
urgent decision-making (UDM)
with a generic software architecture incorporating

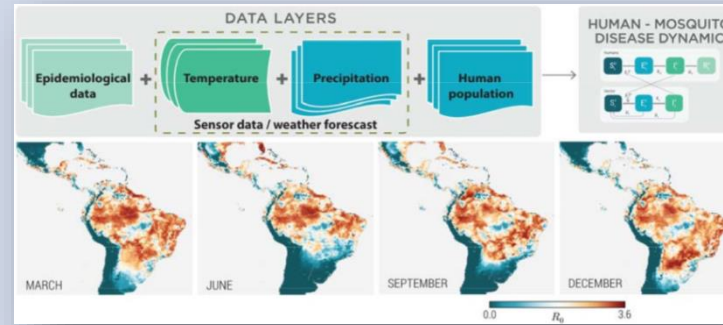


Three Pilot Applications for Urgent Decision-Making

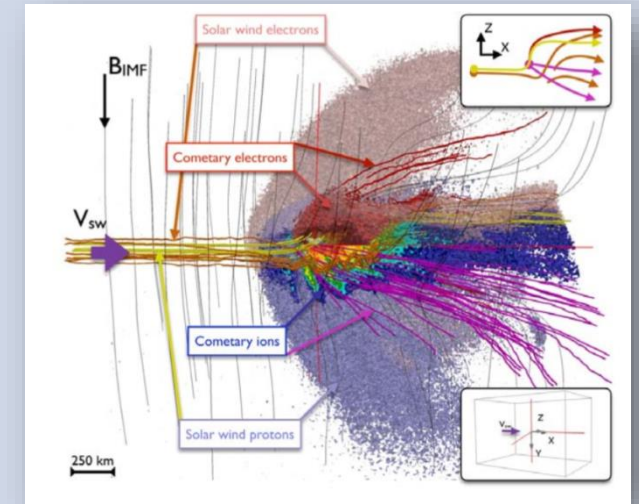
Wildfire Forecasting



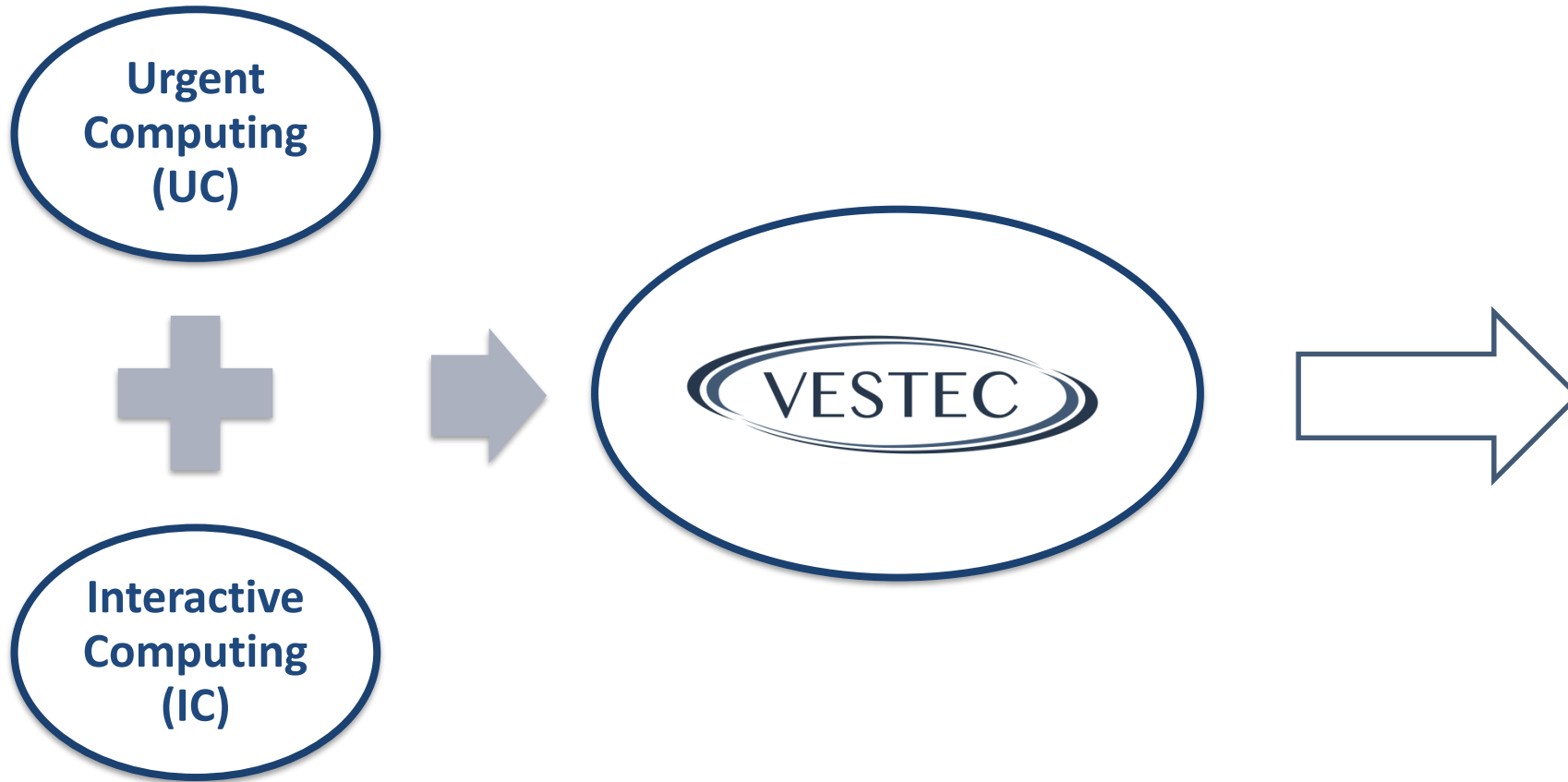
Spread of Mosquito-borne Diseases



Space Weather Forecasting



VESTEC – A Combination of HPC Computing Paradigms



We inherit both the
opportunities
and the
challenges
of UC and IC

A Challenge for Both Urgent and Interactive Computing: Batch Schedulers

- Effectively **all** HPC systems schedule jobs by using a batch queue (e.g., SLURM, PBS, etc.)

→ Jobs might wait in the queue for an **unbounded amount of time**

- Obstacle for Urgent Computing:

results may not arrive in time (e.g., before a disastrous event)

- Obstacle for Interactive Computing:

users do not want to wait for their interaction (at least, it is impractical)

Three Possible Solutions

A dedicated machine for UDM

machine would be idling most of the time

a large HPC system is expensive to buy and maintain

one system might not be enough in case of a disaster

Special job priorities for UDM jobs

other jobs need to be cancelled

HPC resource owners are bound by SLAs

other users would need to be rewarded if their jobs are cancelled

Federating UDM jobs over multiple machines

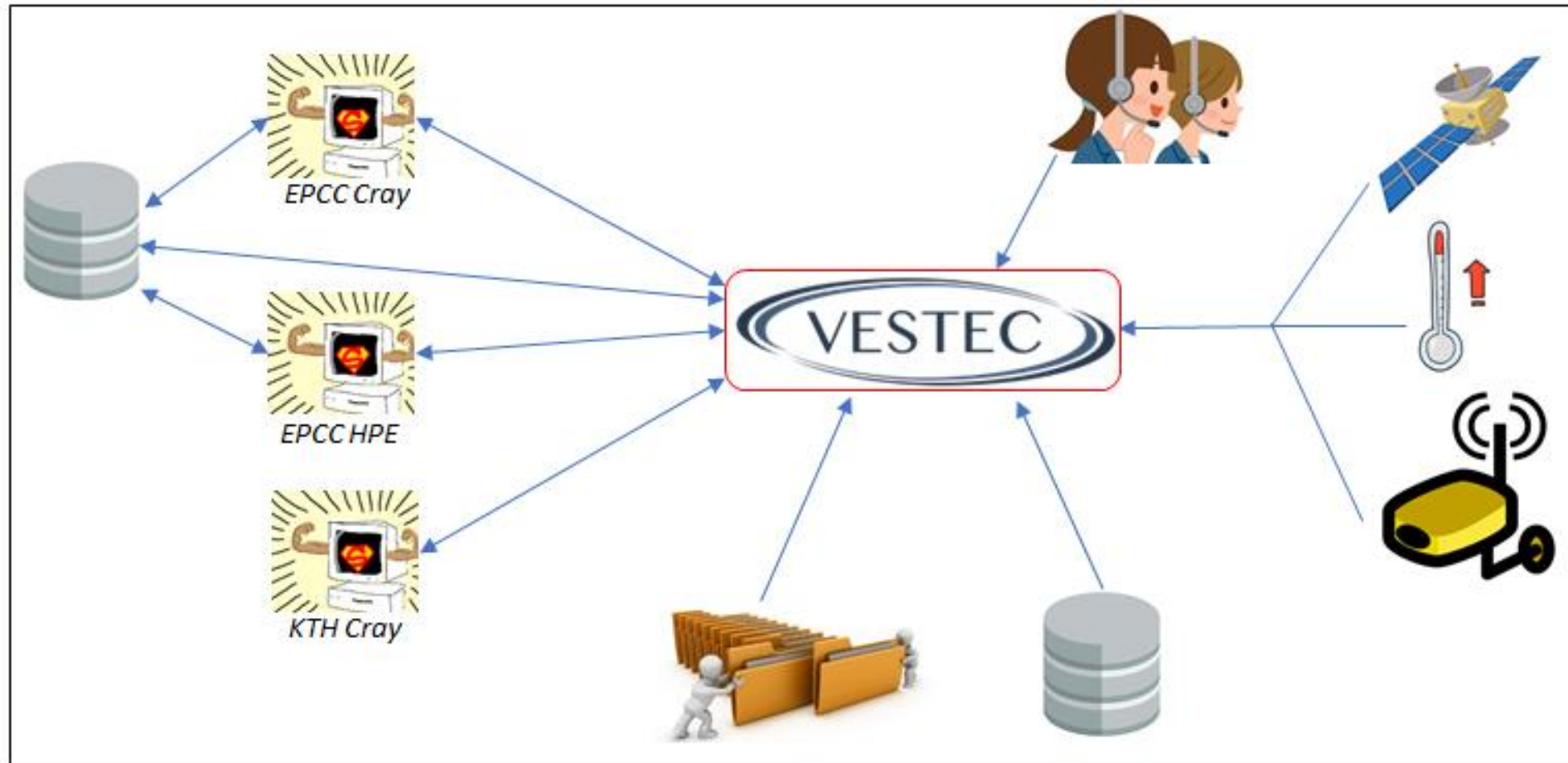
jobs still wait in queues

probability of running in time is much higher

no policy changes needed → works with current systems

We don't expect that policies change in the short and medium term → We decided for the federator strategy

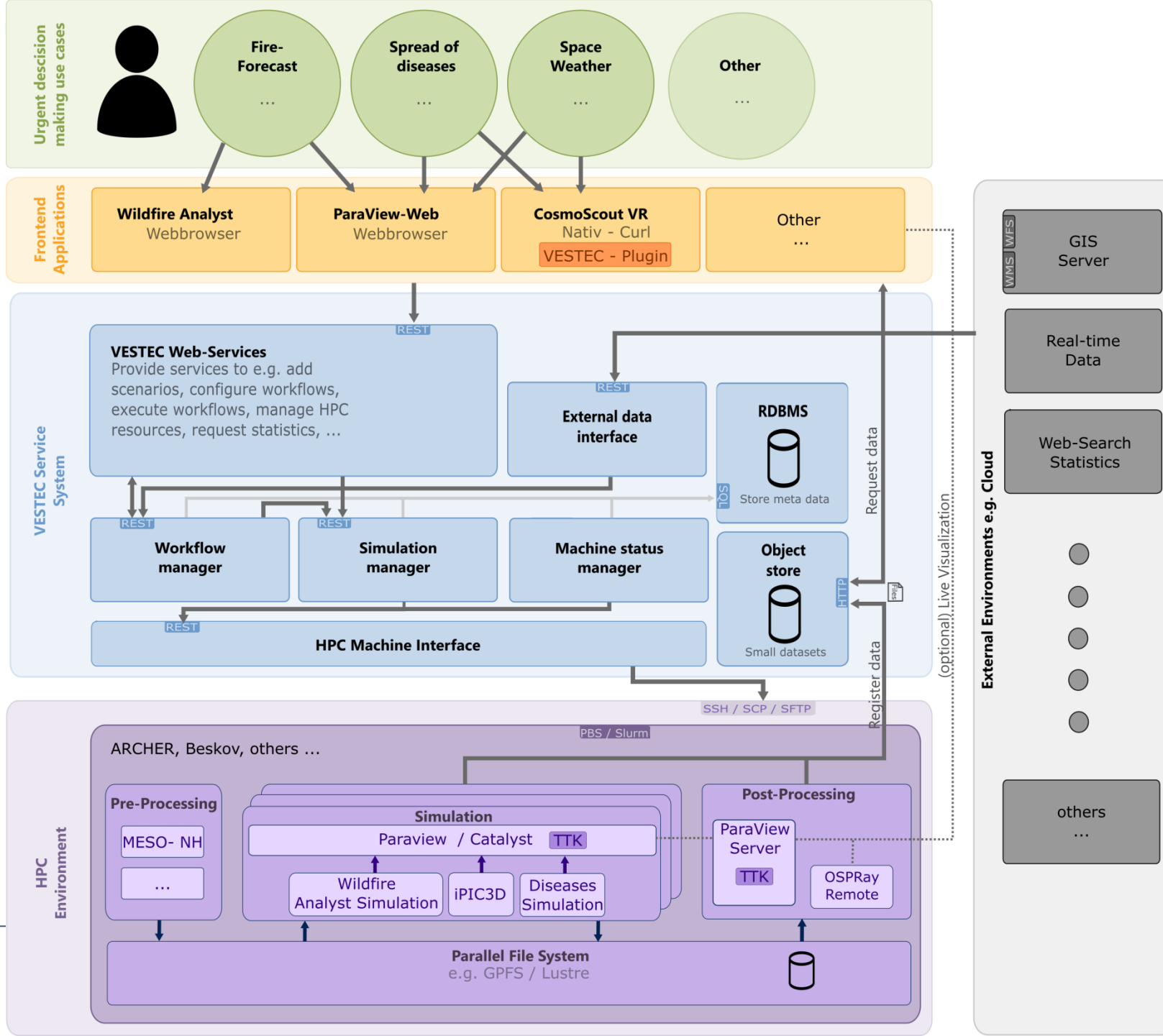
The VESTEC Approach: Federate over Multiple Machines



Additional Challenges

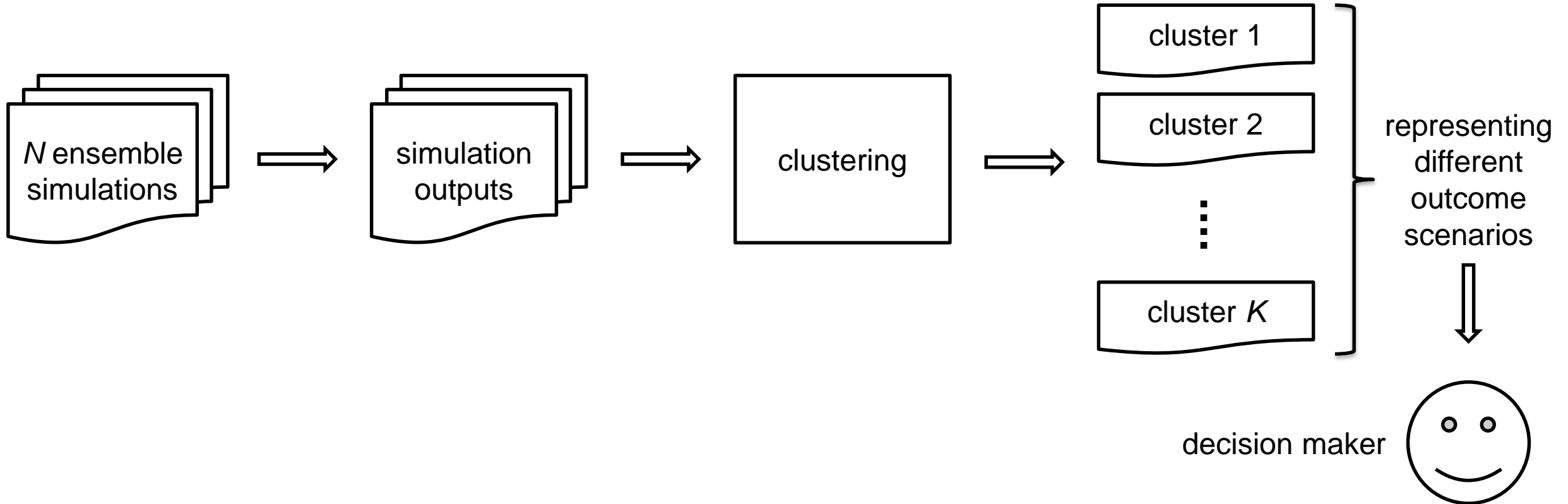
- Interactivity may require access to ports on the compute nodes, which is often not allowed for security reasons
- We must not DDoS an HPC machine!
- Simulation codes produce a high amount of data
→ we use in-situ topological data analysis for feature extraction
- The decision maker is not an HPC or even computing expert
→ the VESTEC system should work automatically in the background
- Different applications need different workflows, different codes have different interfaces
→ the VESTEC system should be designed as general as possible

VESTEC Architecture



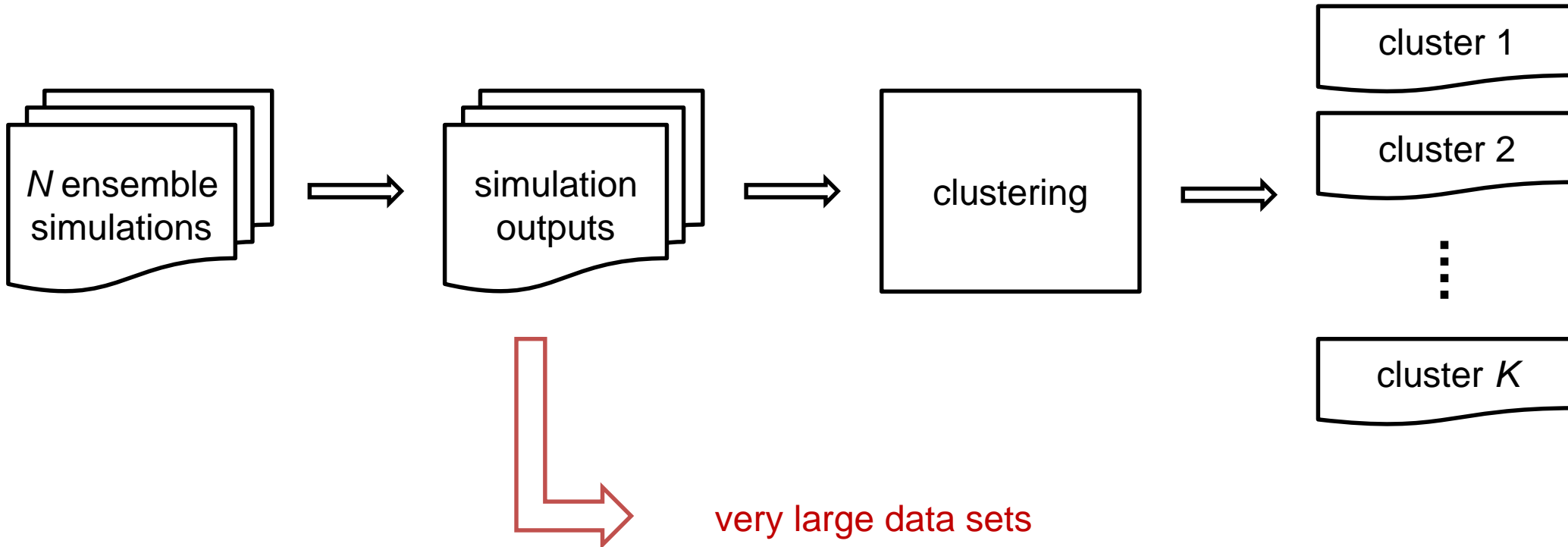
Topological Data Analysis in VESTEC

Identification of Different Scenarios from Ensemble Simulations



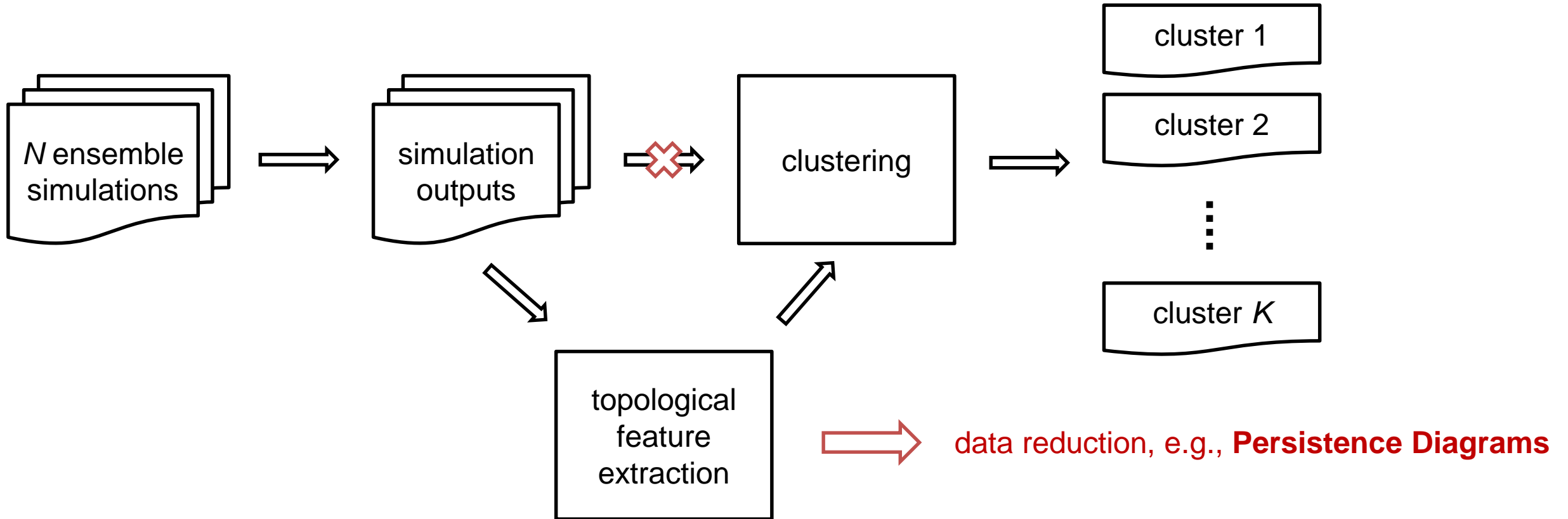
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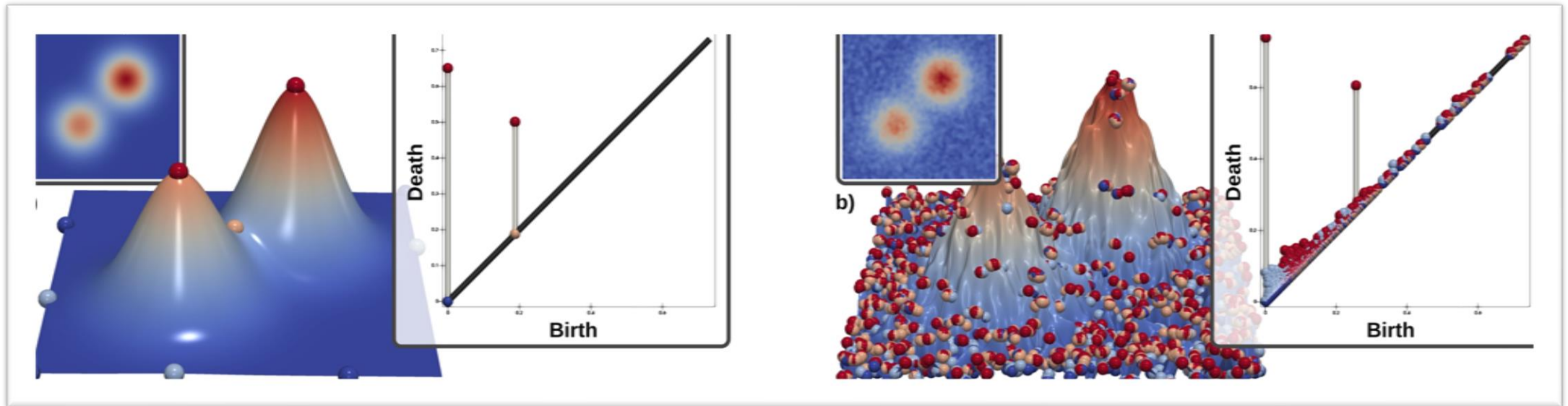
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Topological Data Analysis in VESTEC

Identification of Different Scenarios from Ensemble Simulations



J. Vidal, J. Budin, J. Tierny: Progressive Wasserstein Barycenters of Persistence Diagrams. Proc. of IEEE VIS 2019.
M. Kontak, J. Vidal, J. Tierny: Statistical Parameter Selection for Clustering Persistence Diagrams. Workshop Proc. of SC19.

Conclusions & Outlook

- The VESTEC system will support urgent decision making by using HPC infrastructure, interactive visualization, and real-time sensor data
- We face a lot of challenges – not only technical, but also regarding policies and security:
 - batch queues
 - closed ports
 - a variety of applications
 - large amounts of data
- In the second half of the project, we will continue implementing the developed architecture

The VESTEC vision

All tier 0 and tier 1 HPC machines in Europe subscribe to a disaster response scheme managed by the VESTEC system

Any Questions?

Contact:

Dr. Max Kontak

Institute of Software Technology

DLR German Aerospace Center

Cologne, Germany

max.kontak@dlr.de

<http://www.vestec-project.eu/>

Twitter: @VESTECproject

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