Human Brain Project

EBRAINS

Co-simulation in the Modular Science Framework

Controlling complexity

Simulate with EBRAINS
7-10 November 2022, online

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Co-funded by
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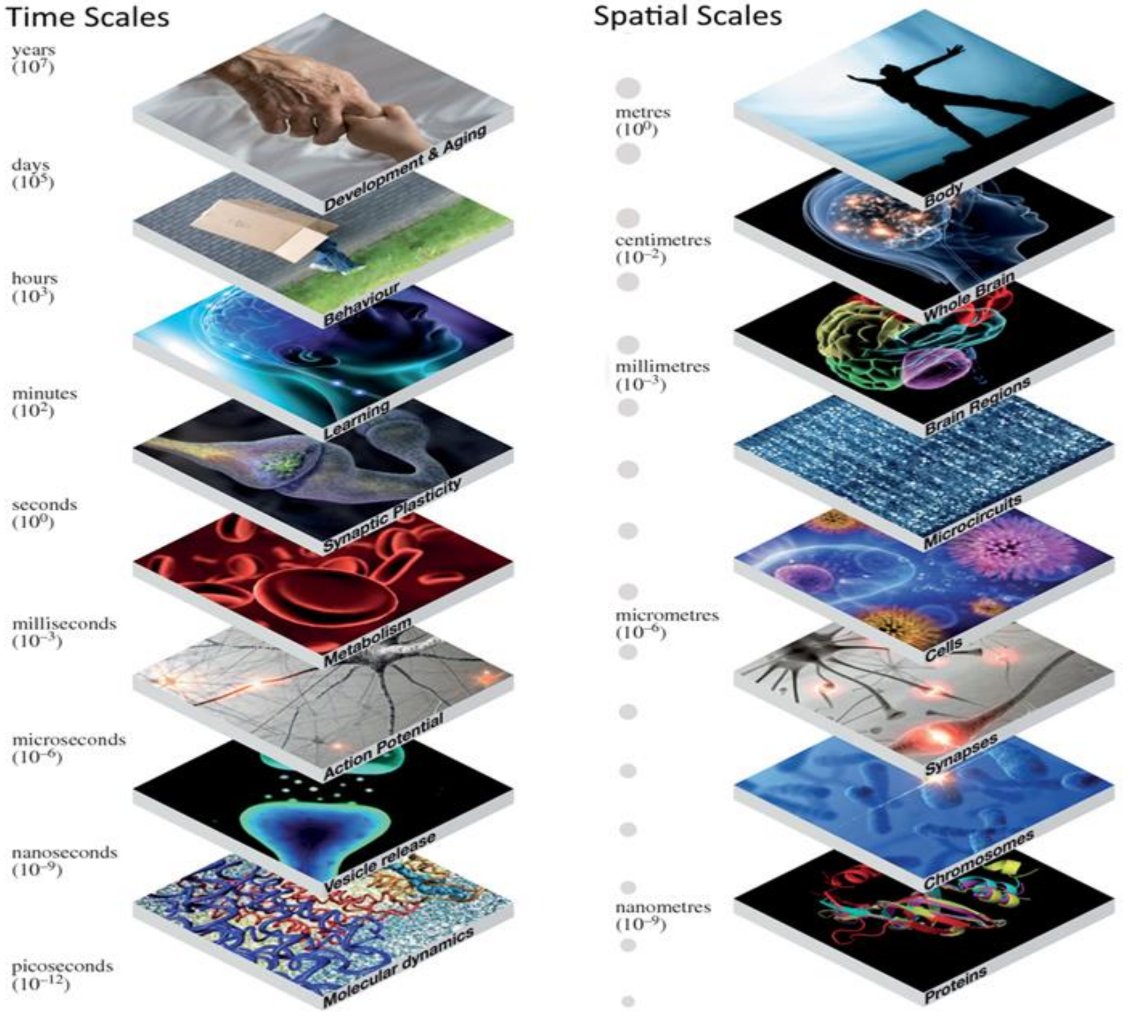
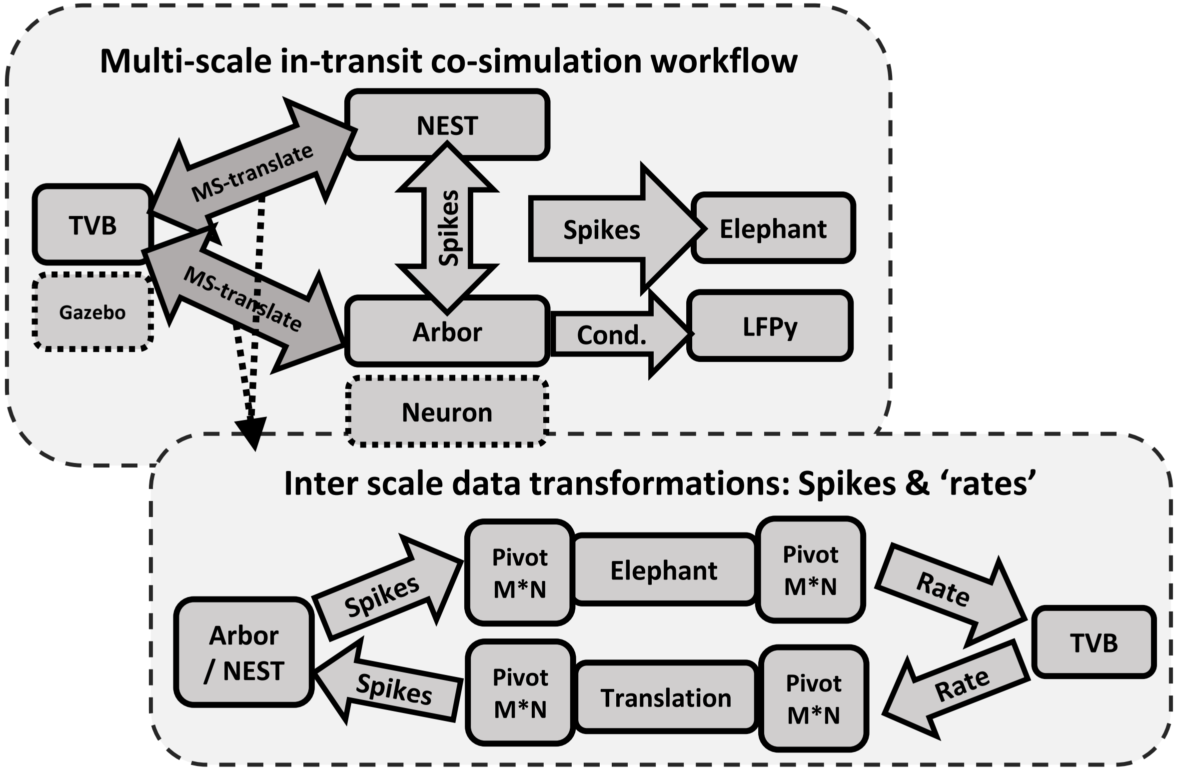
The Brain is a complex multi-scale system





Driving use-cases and aims

Two-way coupling of NEST & TVB

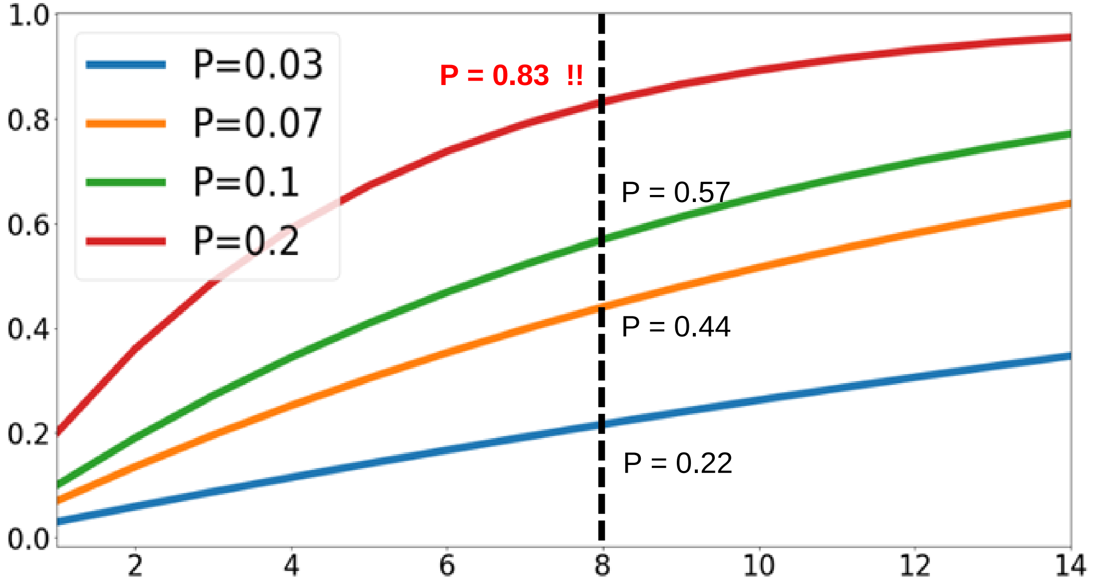
NEST-Arbor

LFPy as a one-way co-simulation

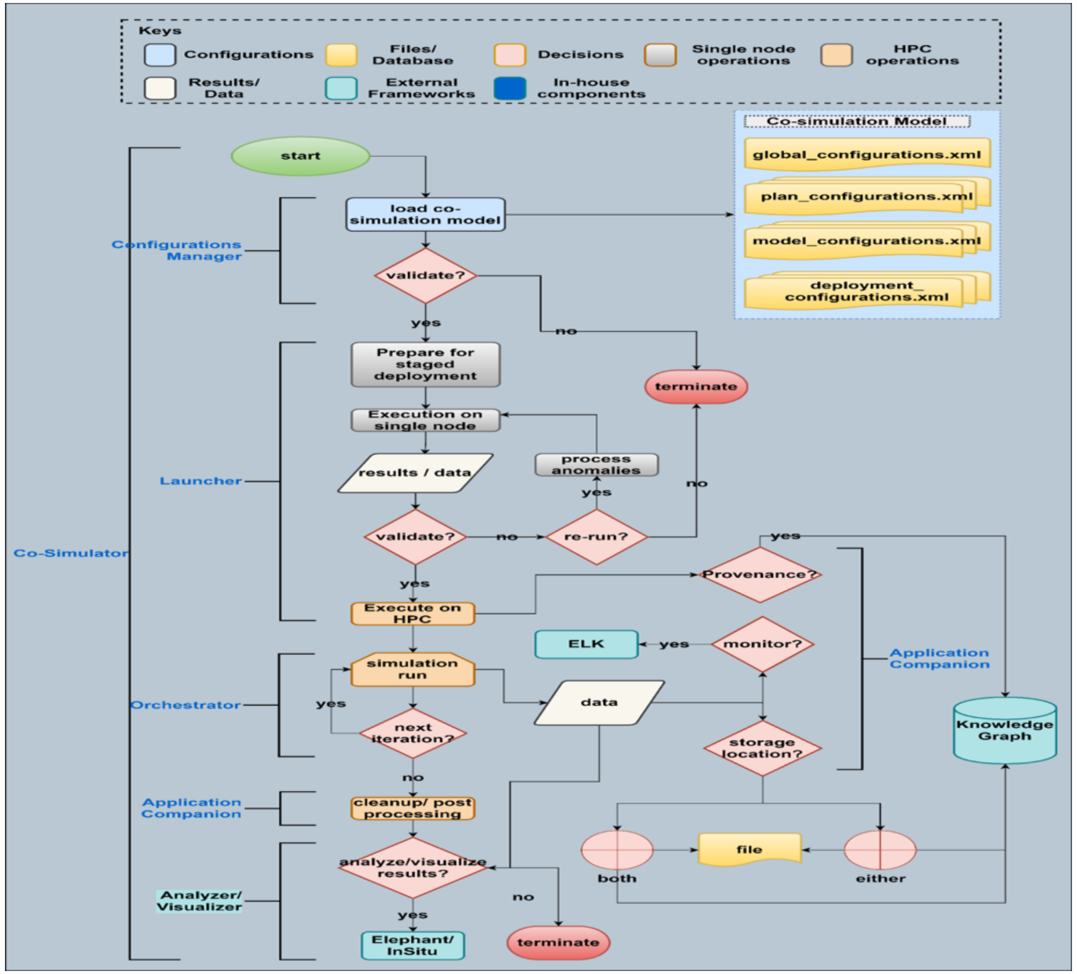
Common APIs and standards: **In situ infrastructure**: for data analysis and visualisation as well as common coupling infrastructure and architecture

Multi application co-simulations are fragile

$$P(system\ Failure) = 1 - \prod (1 - P_i)$$

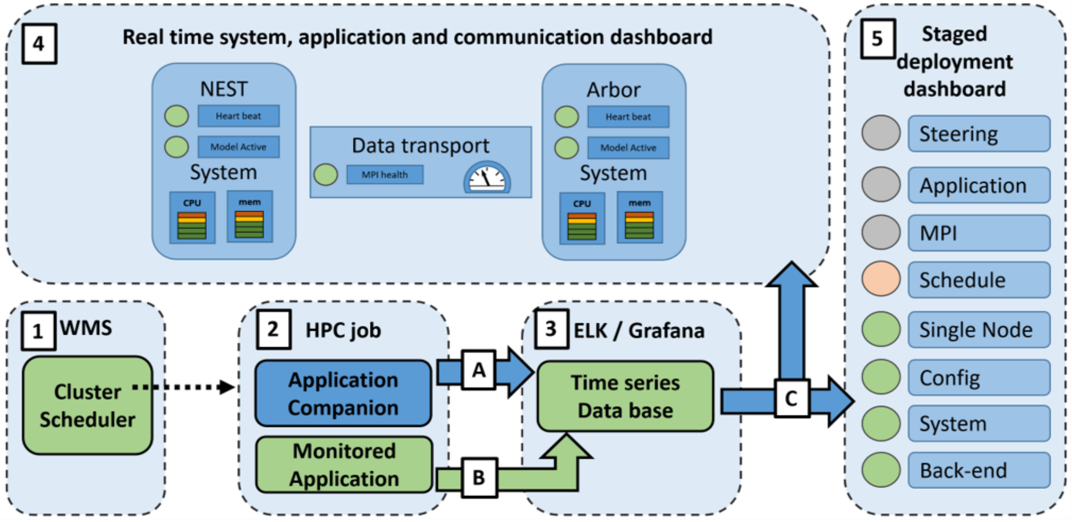


The probability of the whole system failing increases with the number of connected applications. Shown here is the probability of a system failing as a function of the number of connected applications. A failure rate of 0.03 is taken from an highly optimized system which is running automatically generated job configurations. The higher failure rates are not unrealistic for human generated configurations. The co-sim use-cases have 9 (3 simulator) and 4 (robotics) connected applications.



The modular science framework provides a set of integrated micro service based applications to help control the complexity by managing and monitoring the execution.

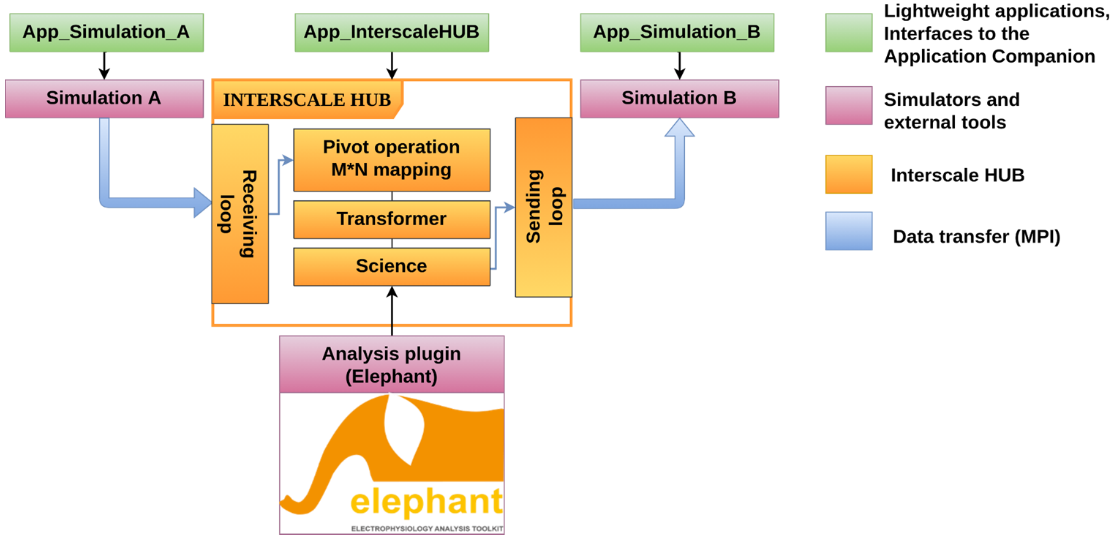
Selection of mini service applications part of Modular Science



The application companion. A lightweight application for managing and monitoring of integrated applications. It add non-science capabilities to a second application; Synchronization and coordination, application execution, performance/Memory profiling, up state monitoring.

It is a (optionally) standalone mini Python application. Runs isolated on core 0, minimally additional modules to be installed as most functionality is written as part of the mini application.

Future work: plugin system to add new capabilities to monolithic applications steering, multi-tiered memory, check pointing



The Interscale hub. A lightweight application for handling data transfer, transformation and science.

Different scales of abstraction typically 'speak' a different language. This necessitates a coupling mechanism to allow transformation between the scaless. The methods and computational needs of this transformation are not fully understood. Modular science has module dedicated to this task. It isolates the engineering and science challenge allowing each to be optimized and changed as needed.

Currently supported out of the box is the Elephant analysis which can be used in a in-situ / streaming fashion allowing you to use this state of the art tool in your co-simulations.

Further information and acknowledgements

Description	URL
MS/ Multiscale Cosim architecture and design document (v1.0)	https://drive.ebrains.eu/d/9050f6873f8945fbacaf/
The central repo which contains the Kanban board for issue tracking	https://github.com/multiscale-cosim/EBRAINS-cosim
NEST-TVB (two-way) coupling use-case 1	https://github.com/multiscale-cosim/TVB-NEST-usecase1
InterscaleHUB for inter-scaled data exchange	https://github.com/multiscale-cosim/EBRAINS-InterscaleHUB
Rich Endpoint (Orchestrator, Application Companion, etc.)	https://github.com/multiscale-cosim/EBRAINS-RichEndpoint
Other links: Central Repo with canban board: https://github.com/multiscale-cosim/EBRAINS-cosim Bootstrap and setup files: https://drive.ebrains.eu/d/afd7d3cba65e4926bcb7/ Communication protocols: https://drive.ebrains.eu/d/028959c139c349329624/ Use-case template: https://github.com/multiscale-cosim/ModularScience-Cosim-Template	

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univ-amu.fr Viktor Jirsa, **Lionel Kusch**, Marmaduke Woodman	**in.tum.de** Michael Weberu	**charite.de** Petra Ritter, **Dionysios Perdikis**	**uni-trier.de** **Benjamin Weyers, Jörg Rudnick**
nmbu.no Gaute Einevoll, **Espen Hagen**, Hans Ekkehard Plesser, **Torbjørn Vefferstad Ness**	**we.ac.uk** Martin Pearson		**clinic.cat** Arnau Manasanch

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 785907 (HBP SGA2). Specific Grant Agreement 3 (04/2020-03/2023)
This project/research has received funding from the European Union’s Horizon 2020 Framework Programme for Research and Innovation under the Specific Grant Agreement No. 945539 (HBP SGA3). Specific Grant Agreement ‘Interactive Computing E-Infrastructure for the Human Brain Project – ICEI’ (01/2018-03/2023)
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 800858 (HBP SGA ICEI).

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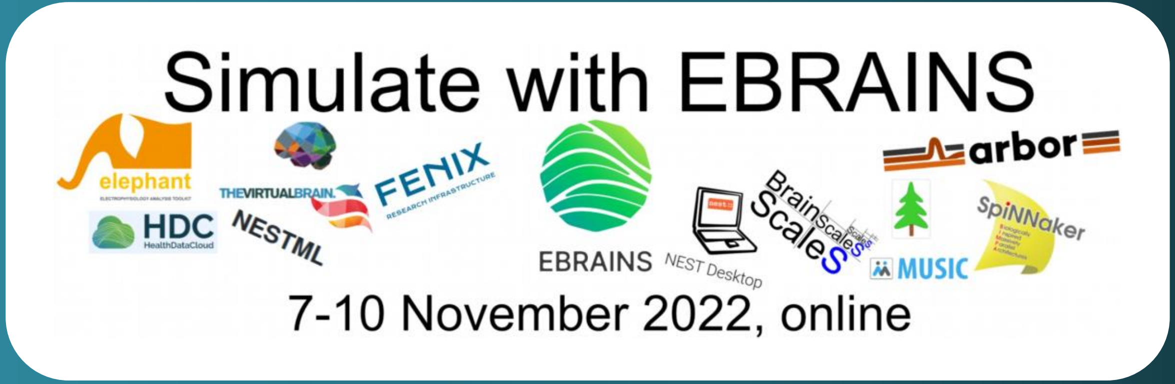
Thank you



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