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Solvers, Programming Models and Proto Apps

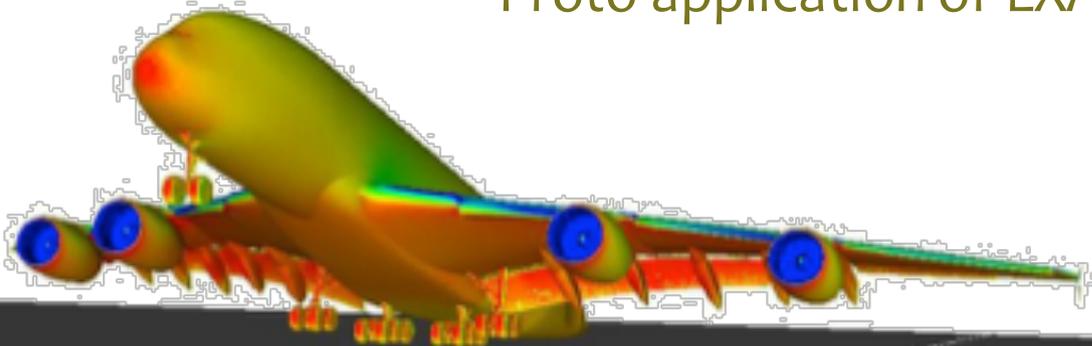
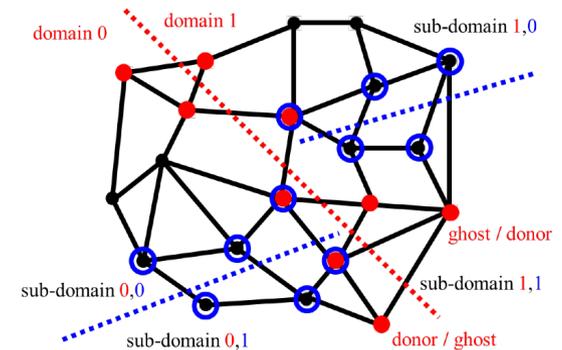


TOM VANDER AA
HPC SUMMIT
MAY 2016, PRAGUE



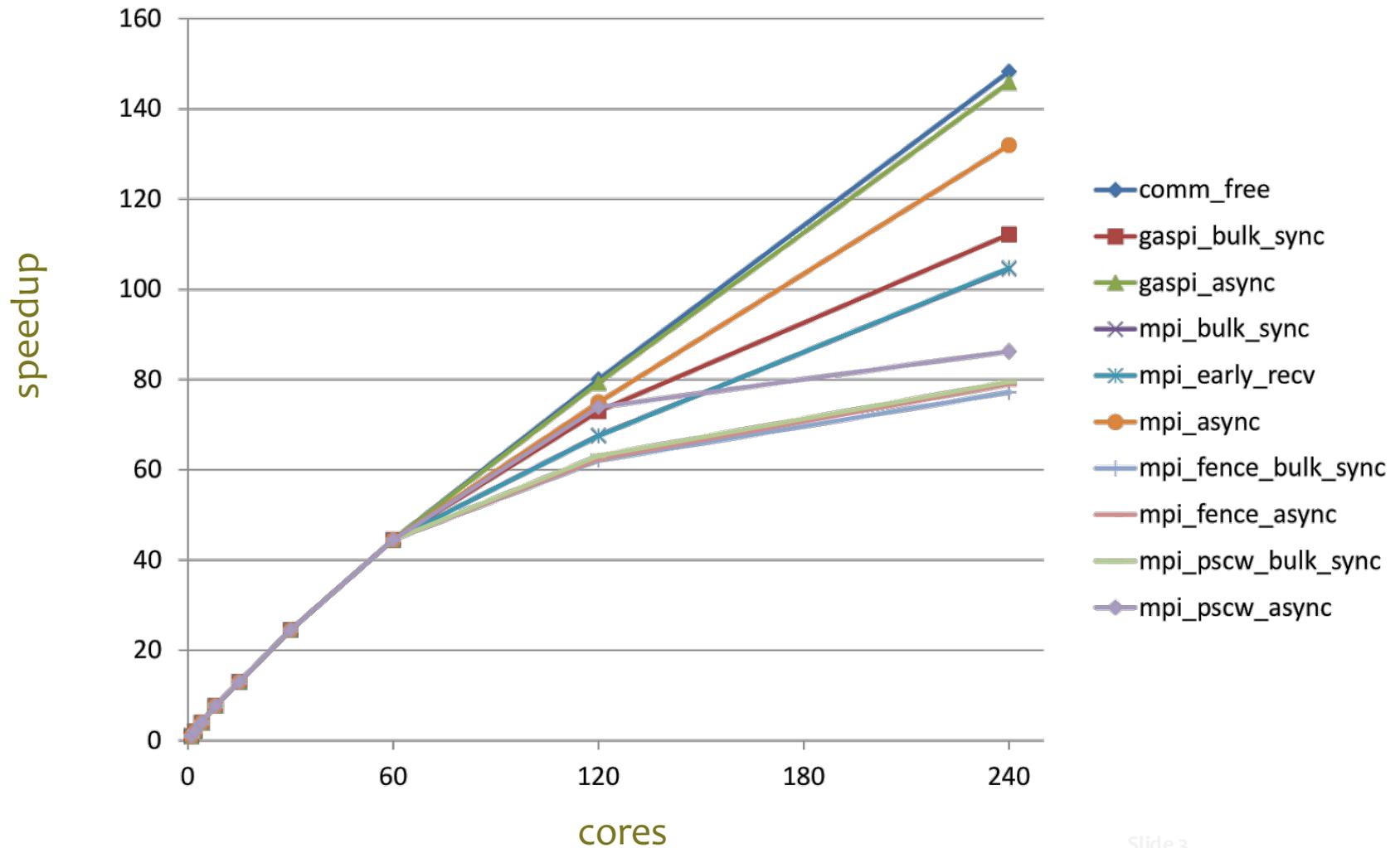
Strong Exa-Scaling is Hard

- CFD Application
 - Today: 50M mesh points
 - In ten years: 500M
- ExaScale Computers
 - 10M cores
 - Hence 50 mesh points per core
- CFD Proxy Application
 - Proto application of EXA2CT

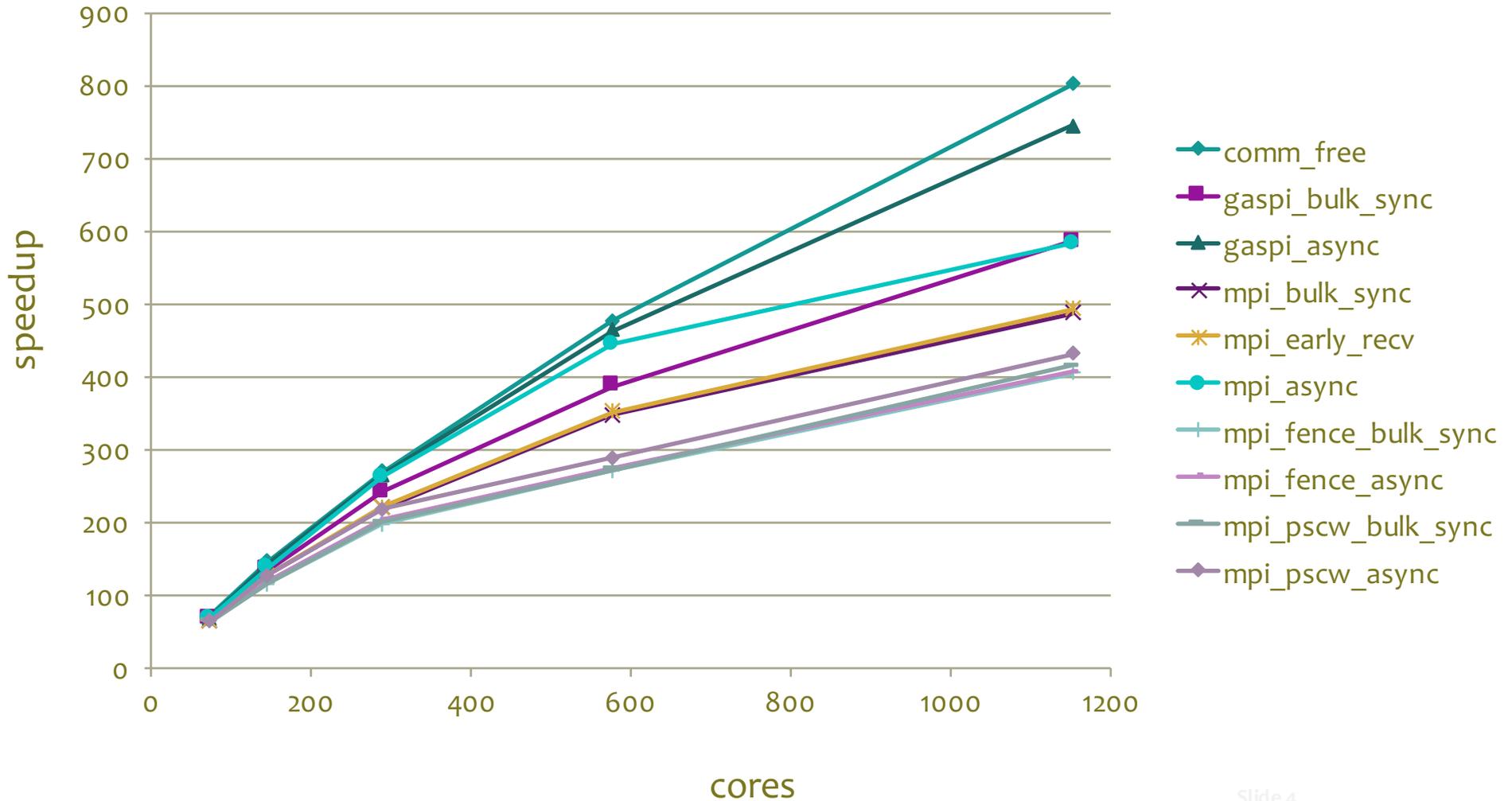


..... T .. Systems ..

CFD-Proxy on >1 Xeon-Phi



CFD-Proxy on >1 Xeon-Phi



Strong Exa-Scaling is Possible



DON'T

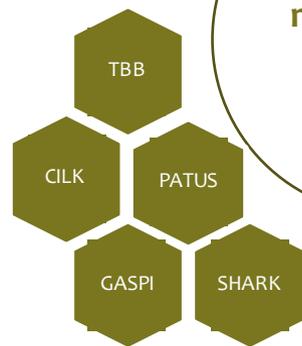
- Bulk Synchronous
- Single Threaded Communication
- MPI Data Types

- Asynchronous
 - GASPI write+notify
 - MPI ISend/IRecv
- Thread-to-thread communication
- Multi-threaded packing



DO

EXA2CT

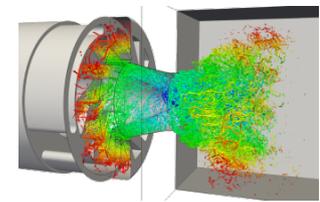
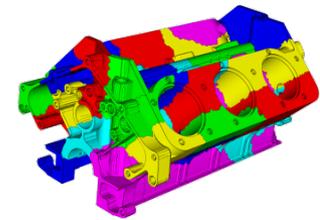
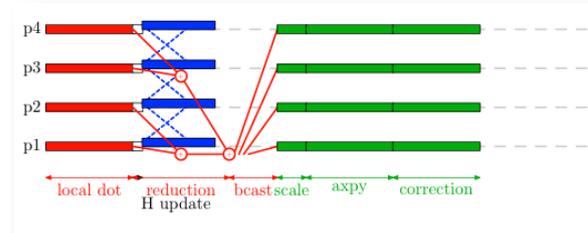


Programming models that scale to ExaScale

10^{18}

Solvers that scale to ExaScale

Using relevant real-life **proto** applications

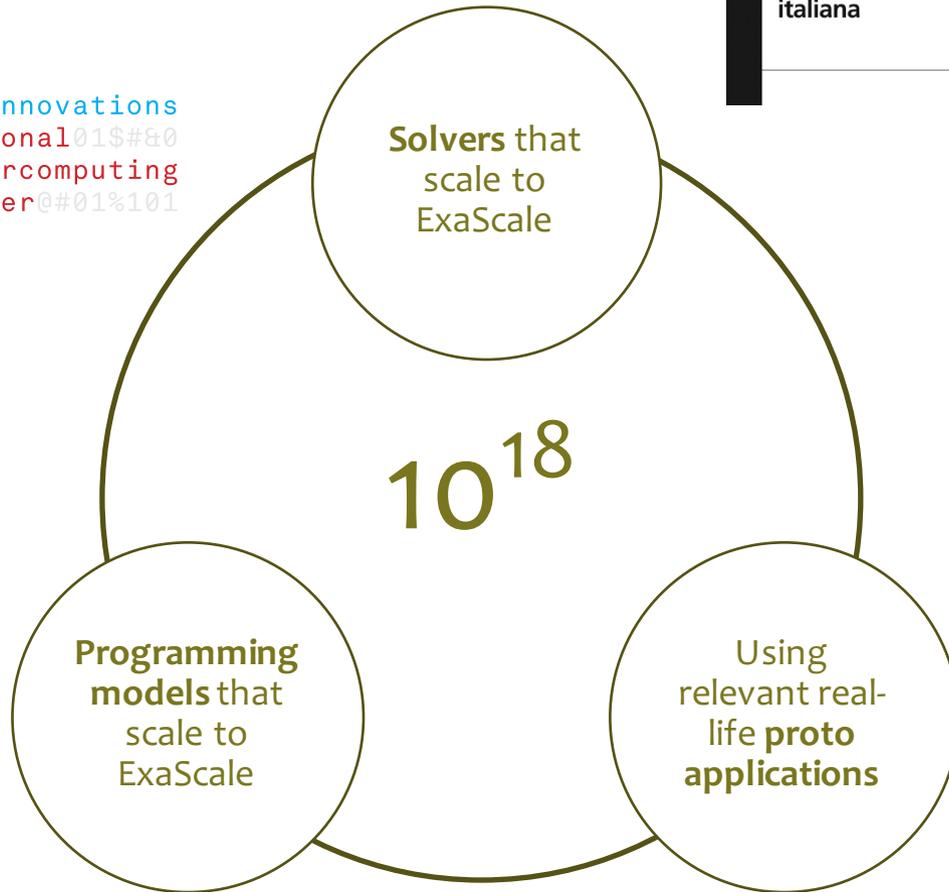


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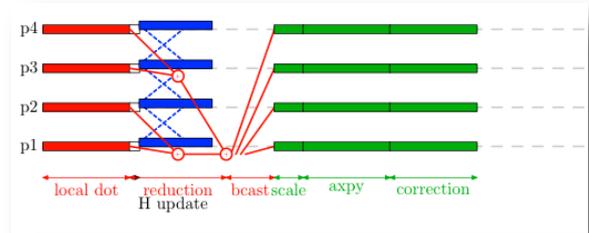
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T...Systems...

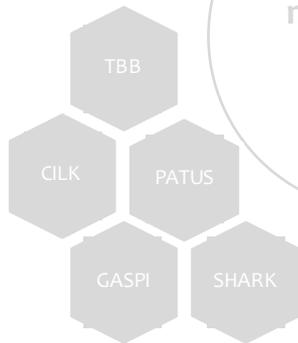
EXA2CT

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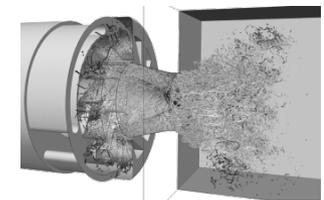
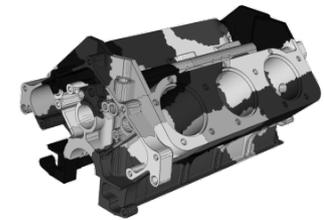


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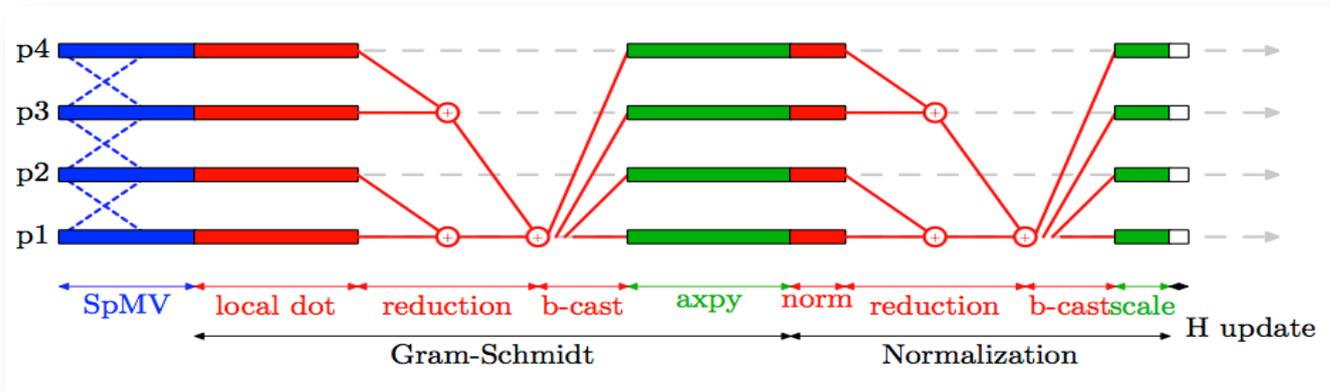
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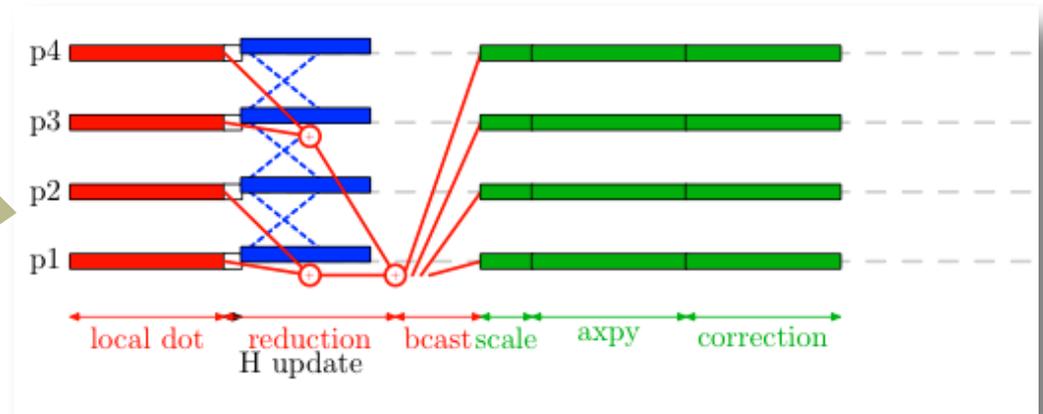
Using
relevant real-
life **proto**
applications



Overlap communication and computation in pipelined solvers

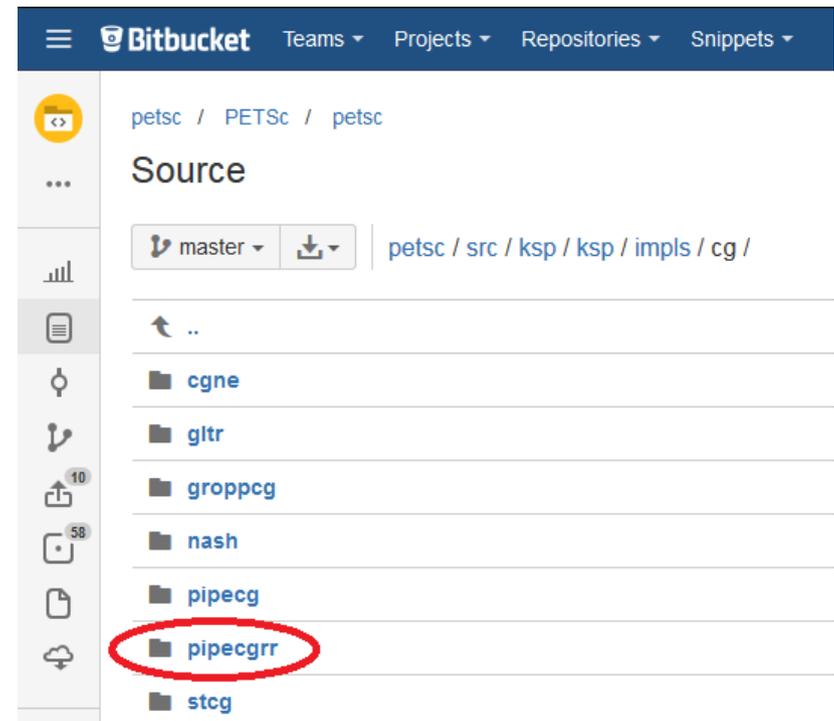
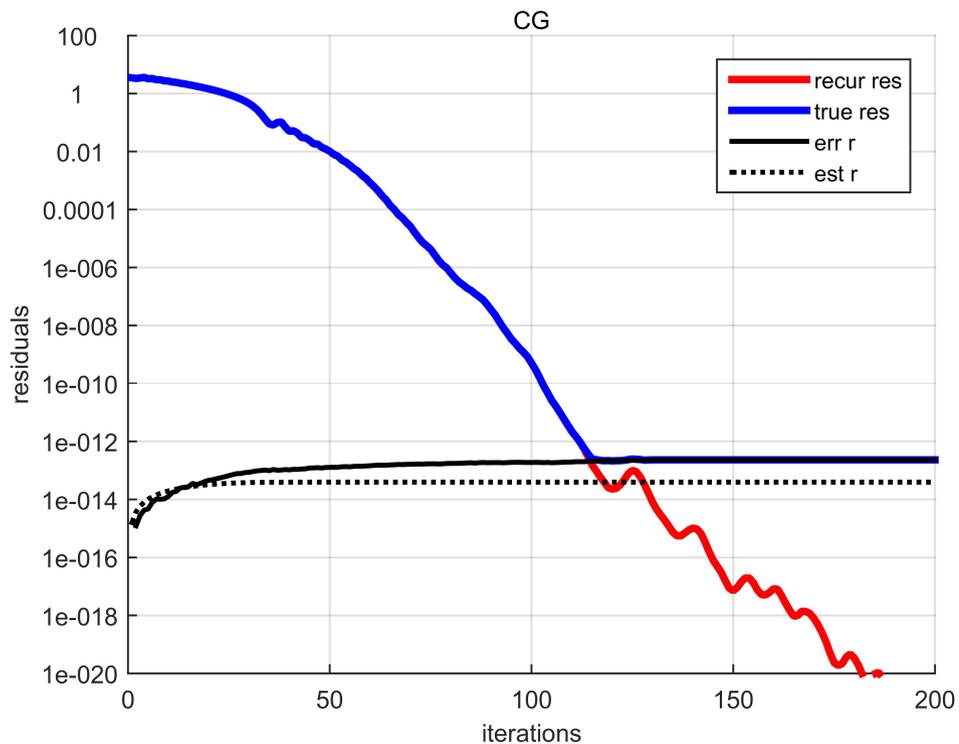


Pipelined GMRES overlaps **dot-product** global communication latency with SpMV

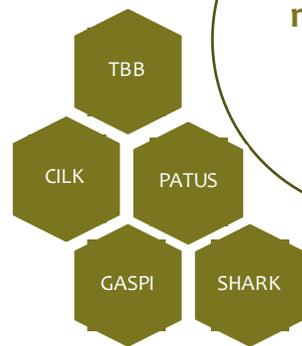


Available in PETSc

Counter Rounding Errors due to more Local Computations



EXA2CT

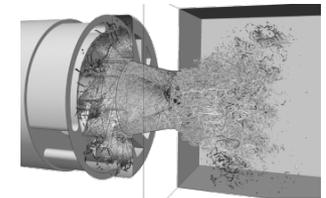
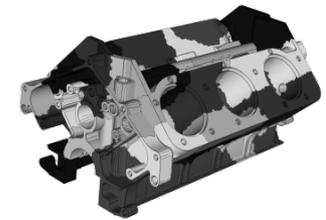
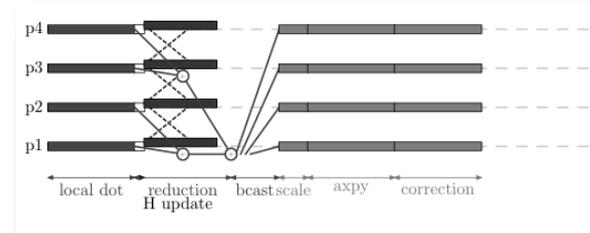


Programming models that scale to ExaScale

10^{18}

Solvers that scale to ExaScale

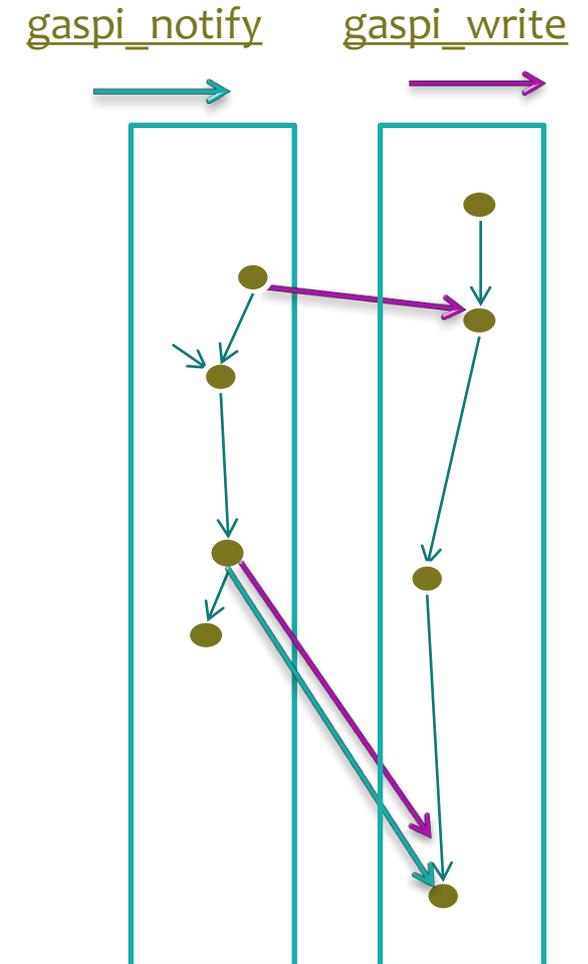
Using relevant real-life **proto** applications



GASPI in a nutshell

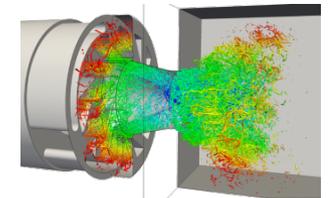
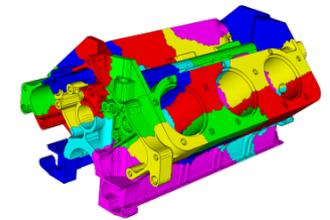
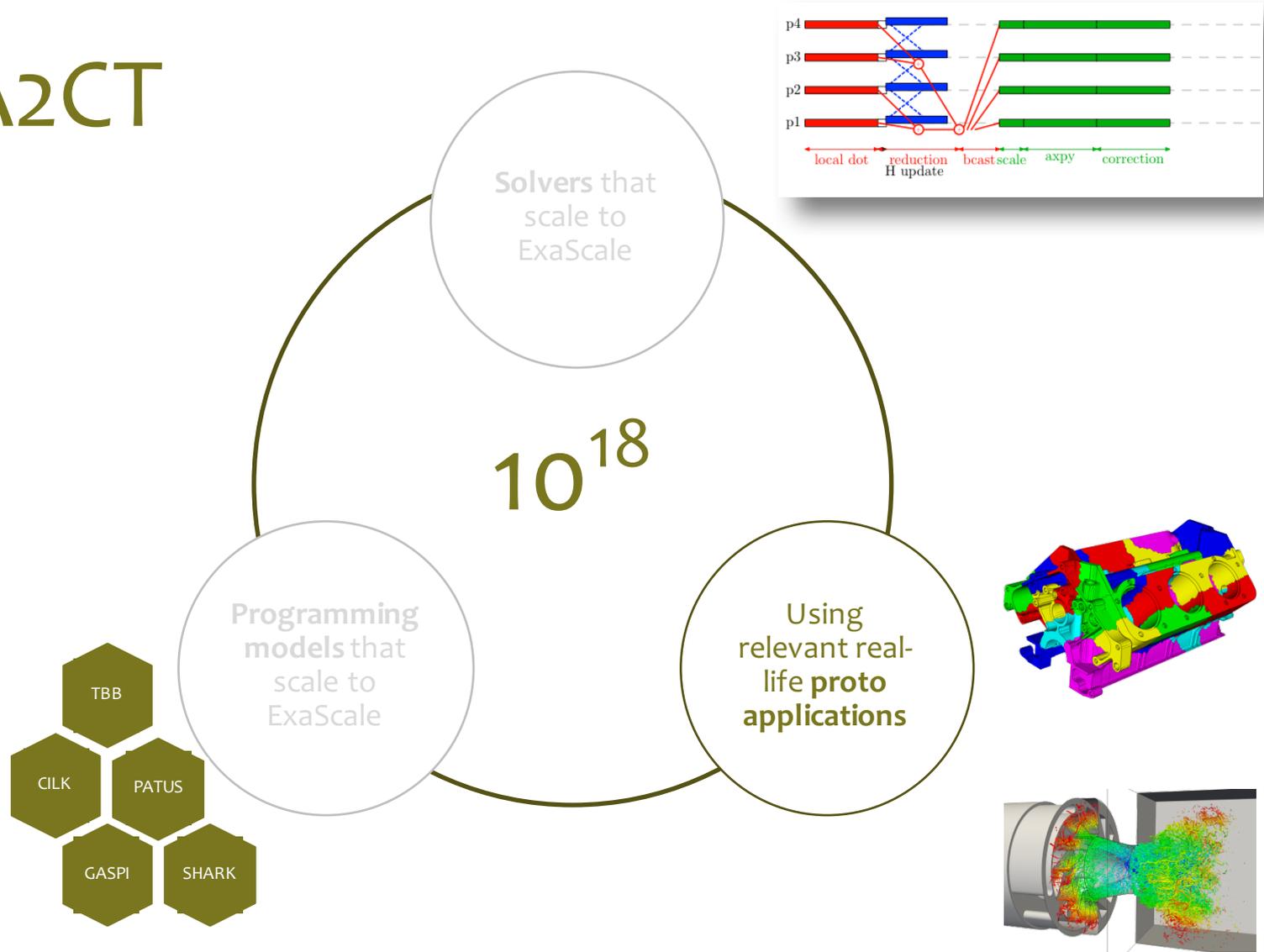
PGAS API - designed to be

- Simple
- Multithreaded
- Global asynchronous dataflow
- Interoperability with MPI

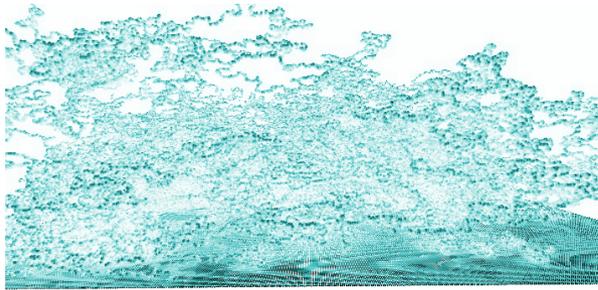


Global
Address Space
Programming Interface
GASPI

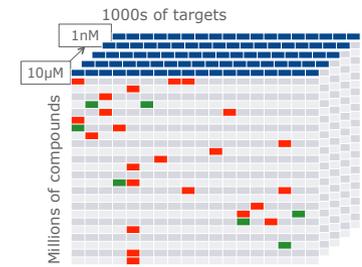
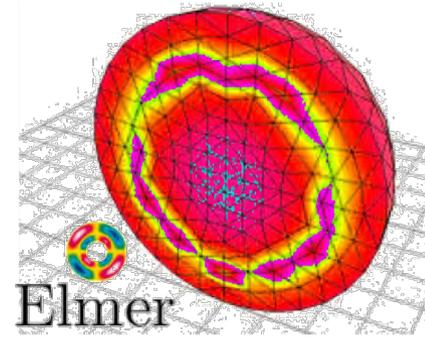
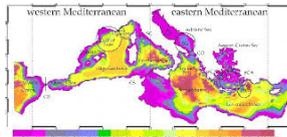
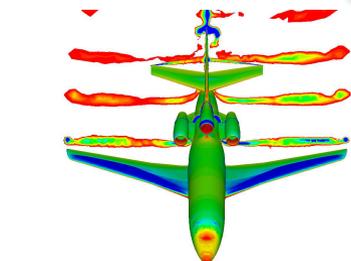
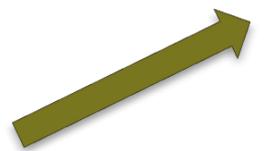
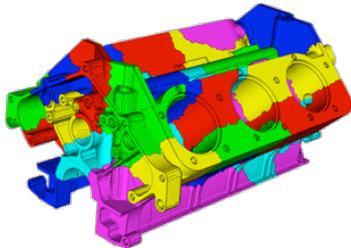
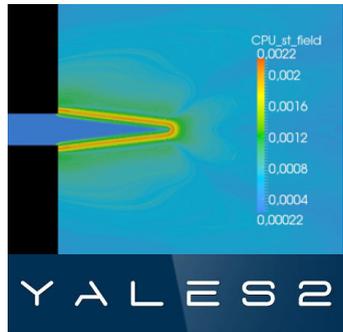
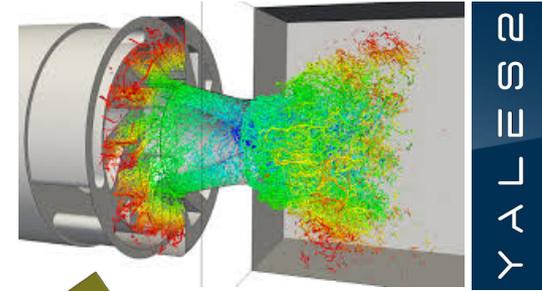
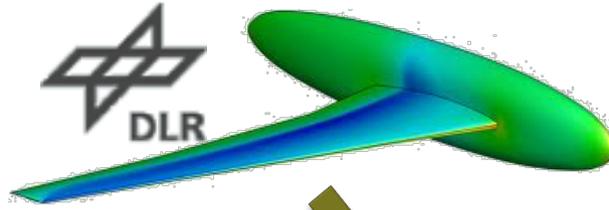
EXA2CT



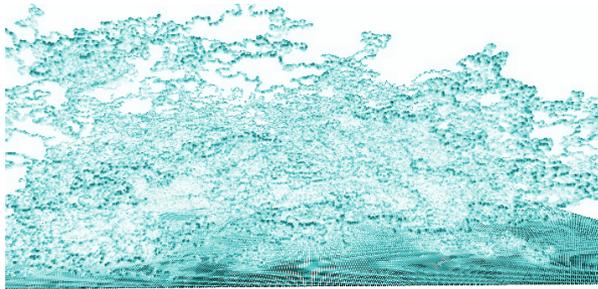
Proto Applications



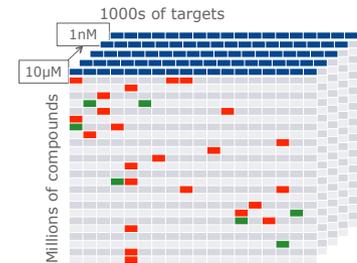
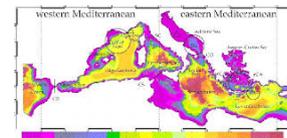
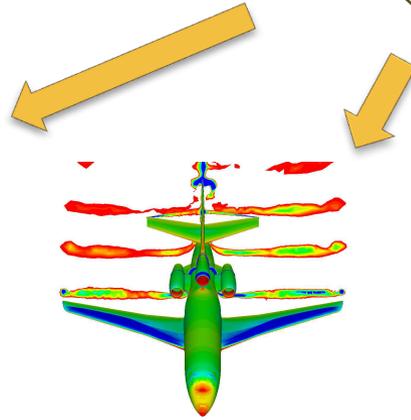
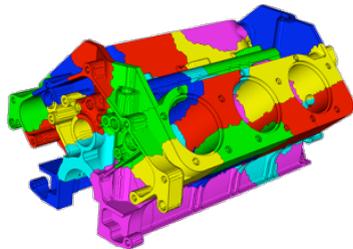
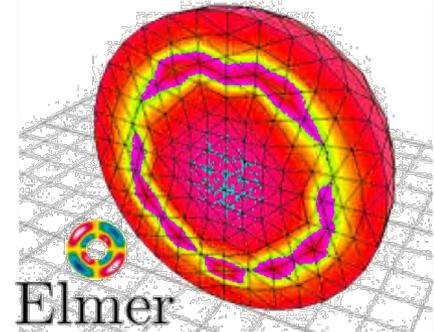
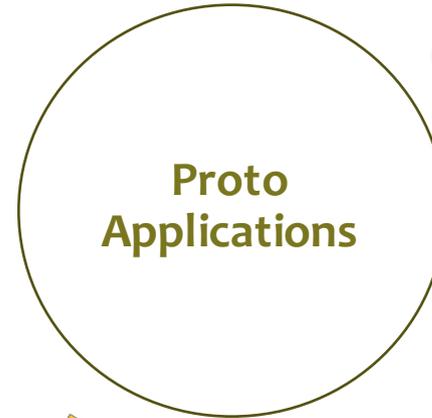
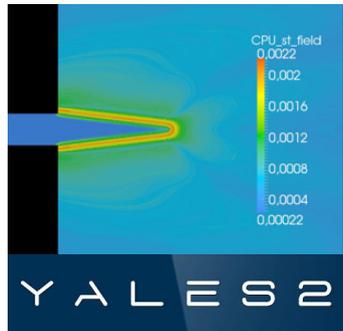
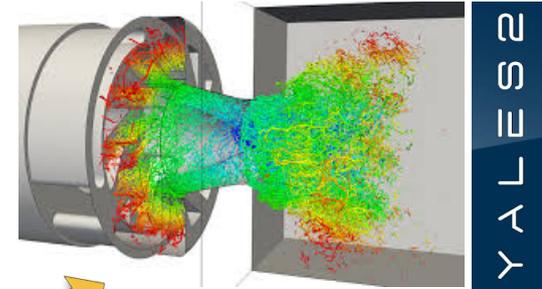
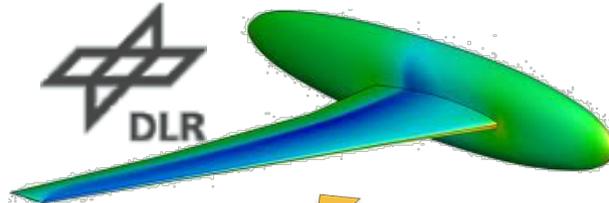
MUPHY



Proto Applications



MUPHY



www.exa2ct.eu

EXA2CT open source for you!

- Solvers in PETSC
- Programming libraries
 - GASPI
 - Dynamic programming
- Proto-Applications
 - FEM/CFD, but also
 - Machine Learning, Multi-Physics

The EXA2CT European Project
Exascale Algorithms and Advanced Computational Techniques

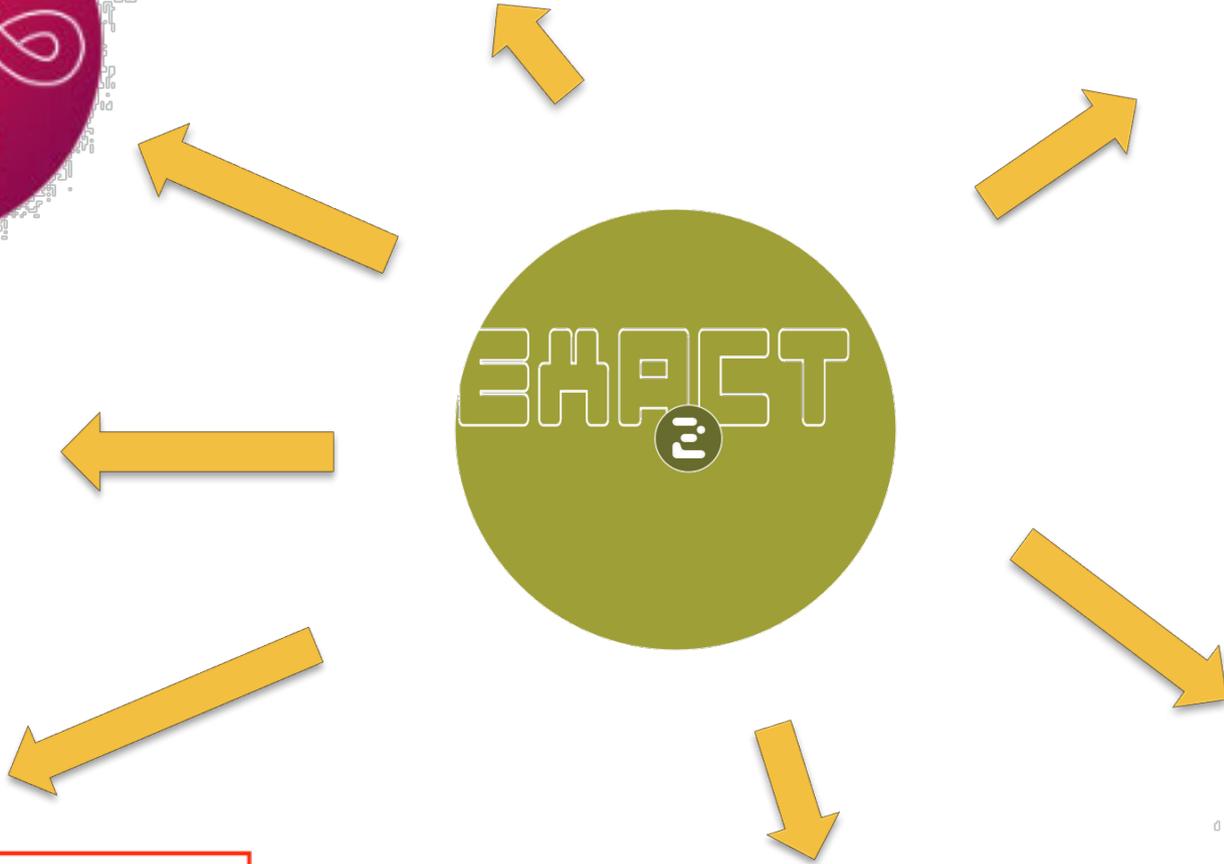
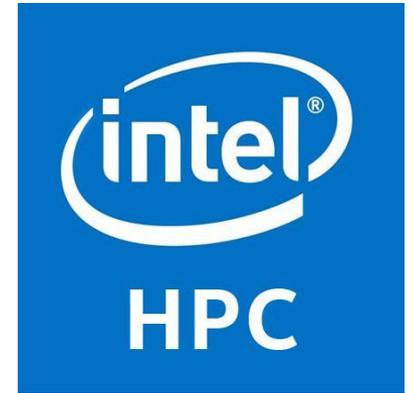
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We Help You Scale

The results of this work will be combined in a selection of proto applications. These will be disseminated to the reference application owners through a scientific and industrial board (SIB) to help generate momentum behind our approach. The open-source proto-applications will serve as a proof-of-concept and as a basis for constructing future exascale full applications. In addition, the use of the SIB is a means to extract the commonalities of a range of HPC problems from different scientific domains and different industrial sectors to be able to concentrate on maximising the impact of the project by improving precisely those parts that are common across different simulation needs.

Do you have a scientific application and want to be involved? Contact us: [contact](#)

Prepared for the ExaScale era? Then consider participating in the SIB!



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Partners

