Solvers, Programming Models and Proto Apps

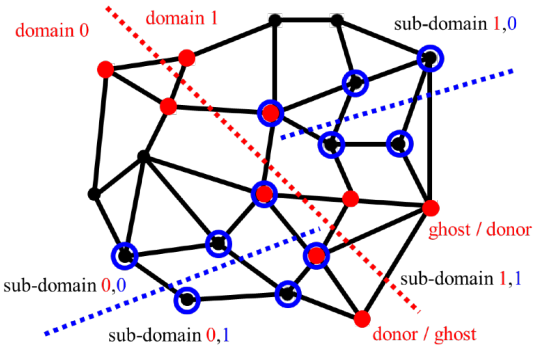
Tom Vander Aa

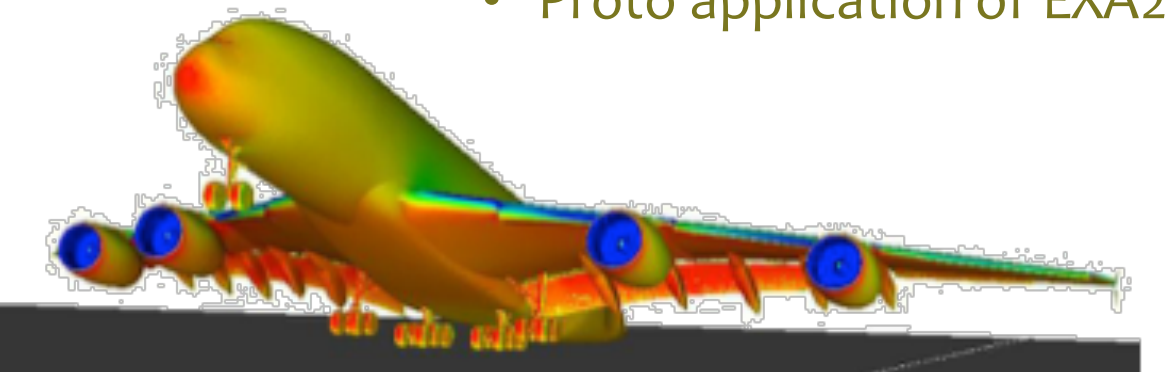
HPC Summit

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

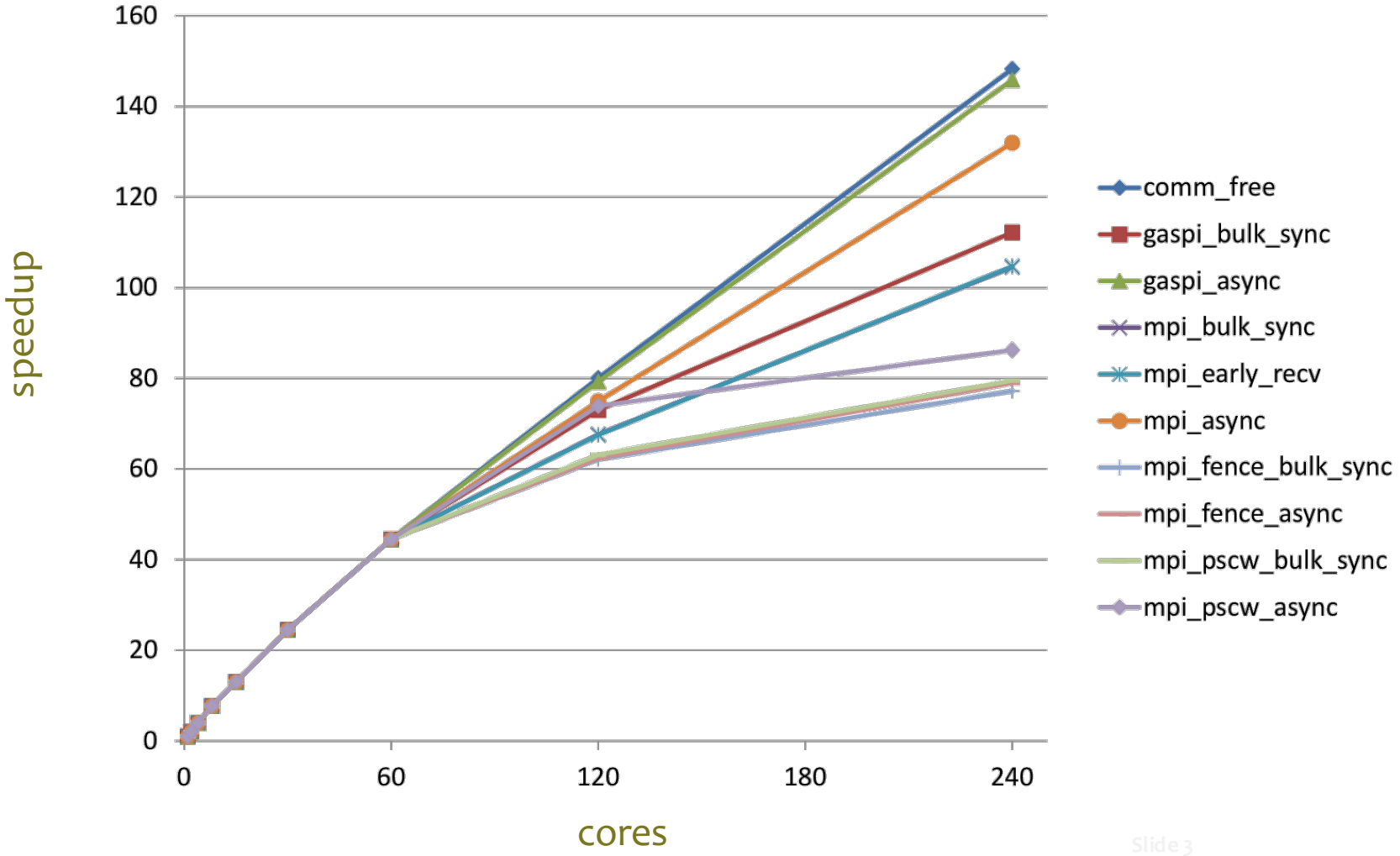




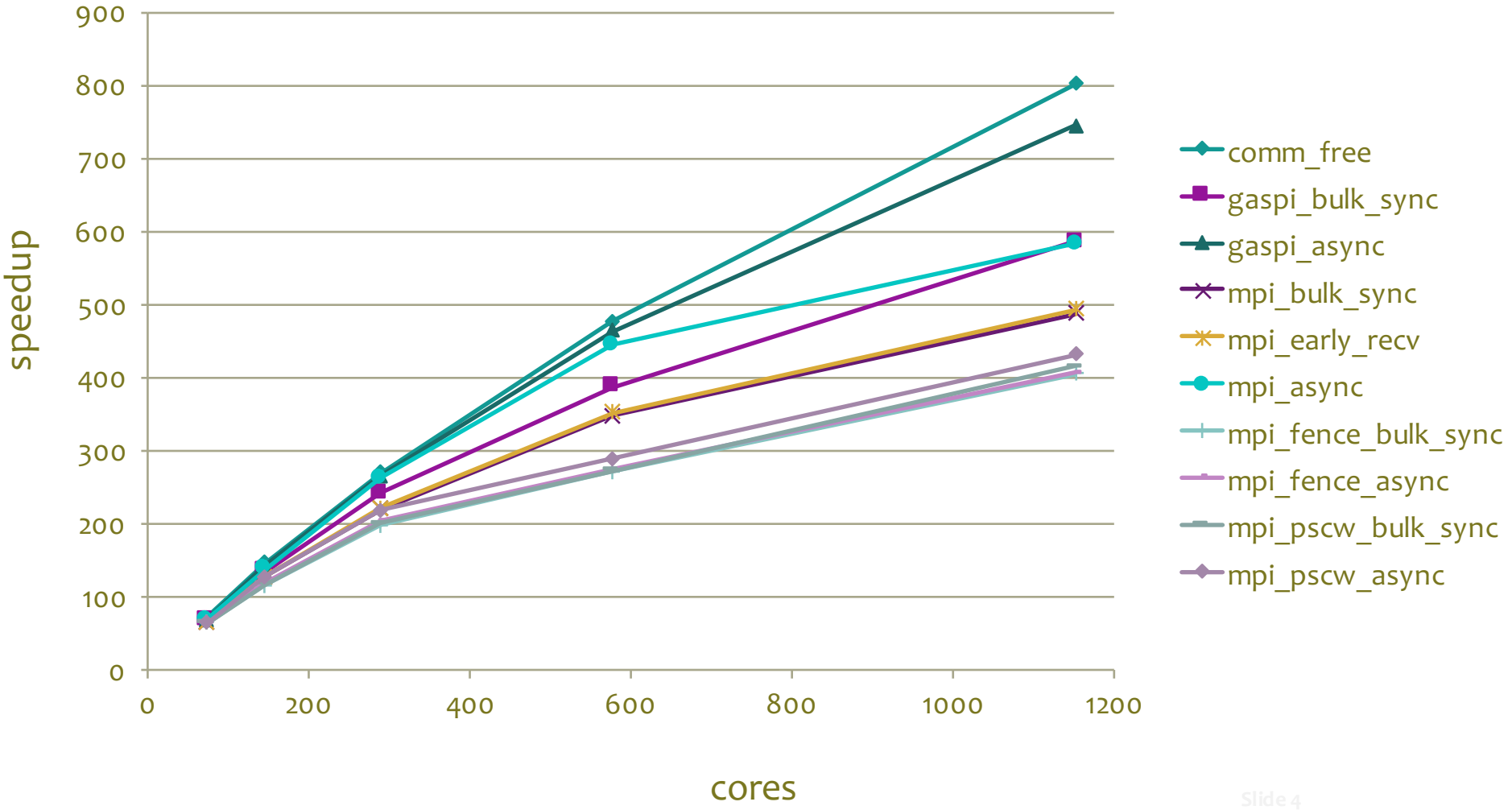
T Systems

DLR Deutsches Zentrum für Luft- und Raumfahrt e.V. in der Helmholtz-Gemeinschaft

CFD-Proxy on >1 Xeon-Phi



CFD-Proxy on >1 Xeon-Phi



Strong Exa-Scaling is Possible

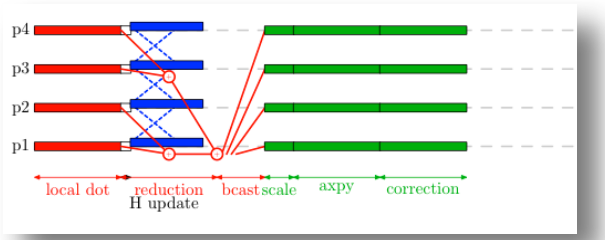
DON'T

- Bulk Synchronous
- Single Threaded Communication
- MPI Data Types

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

DO

EXA2CT

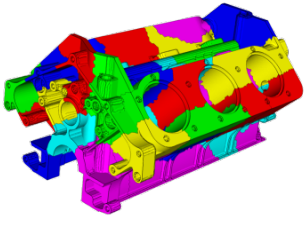


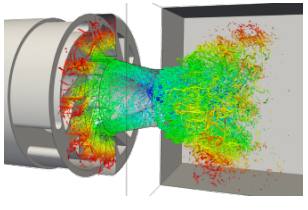
Solvers that scale to ExaScale

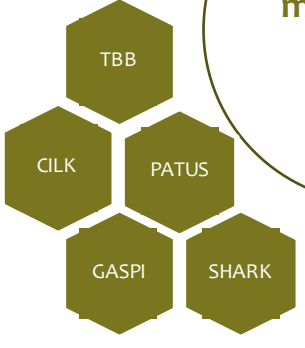
10^{18}

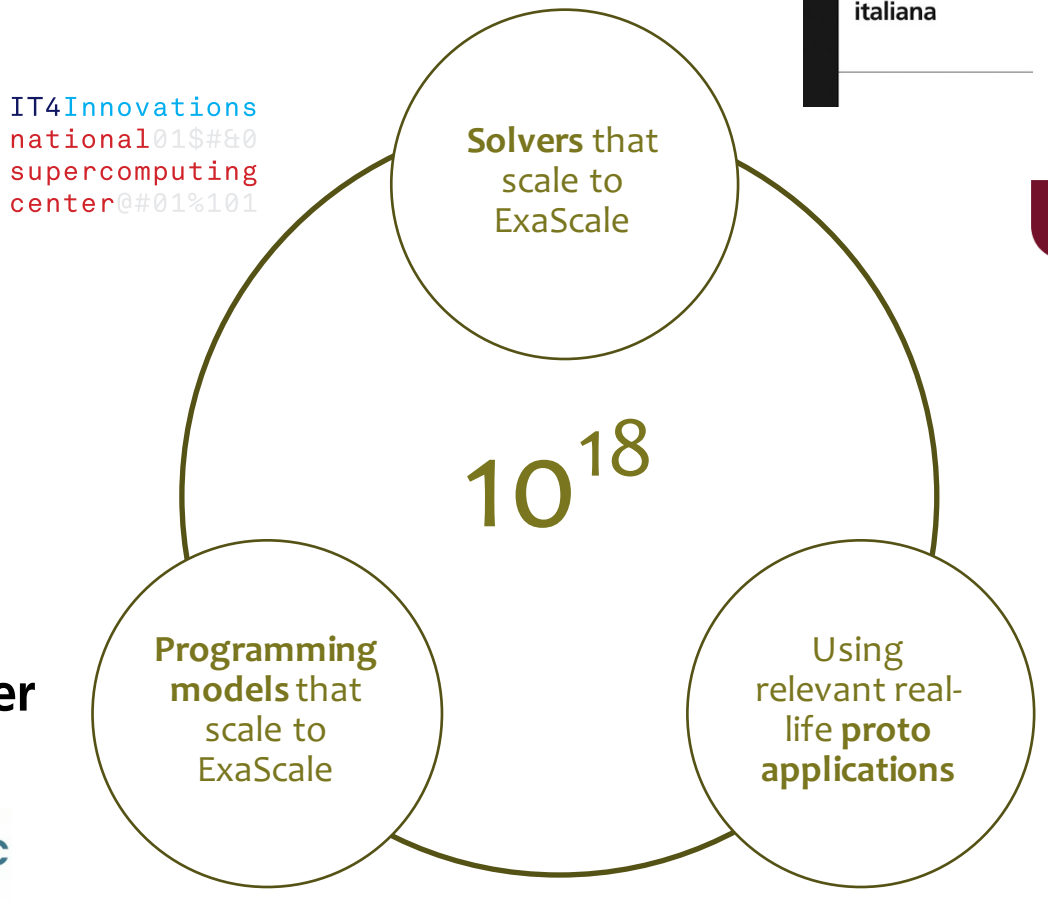
Programming models that scale to ExaScale

Using relevant real-life **proto applications**









Inria

Università della Svizzera italiana

IT4Innovations national supercomputing center

Universiteit Antwerpen

Fraunhofer

nag

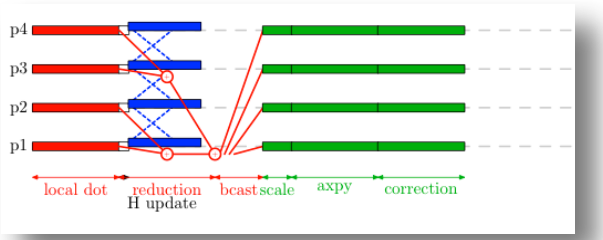
imec

intel

UNIVERSITÉ DE VERSAILLES SAINT-QUENTIN-EN-YVELINES

T-Systems

EXA2CT

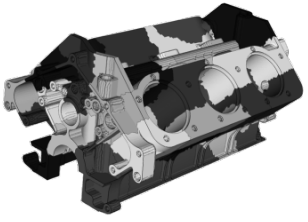


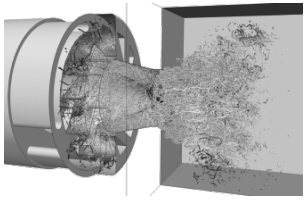
Solvers that scale to ExaScale

10^{18}

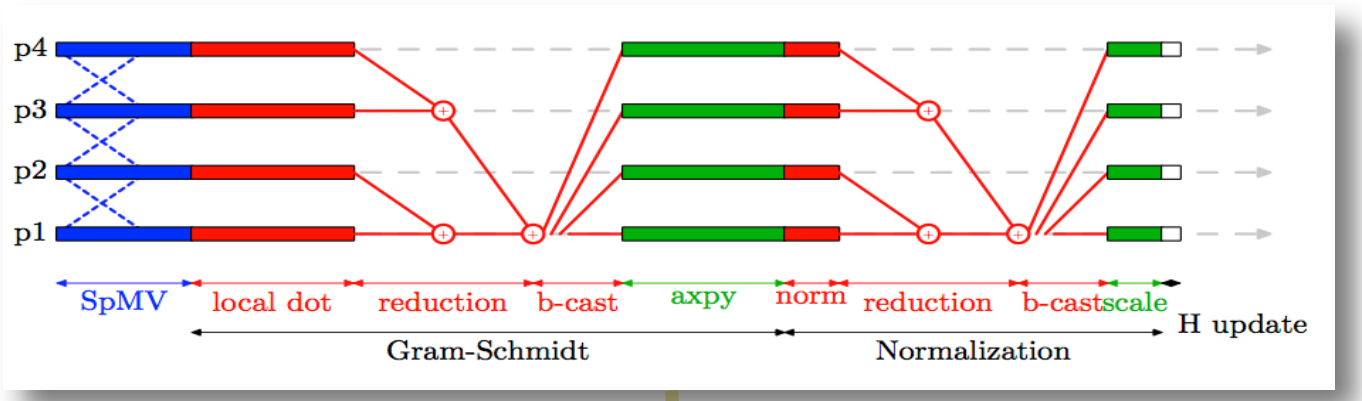
Programming models that scale to ExaScale

Using relevant real-life **proto applications**

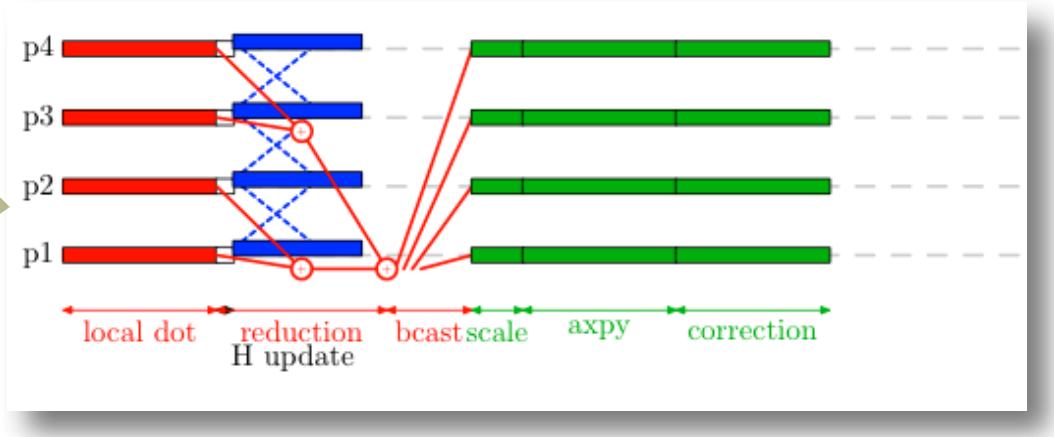




Overlap communication and computation in pipelined solvers



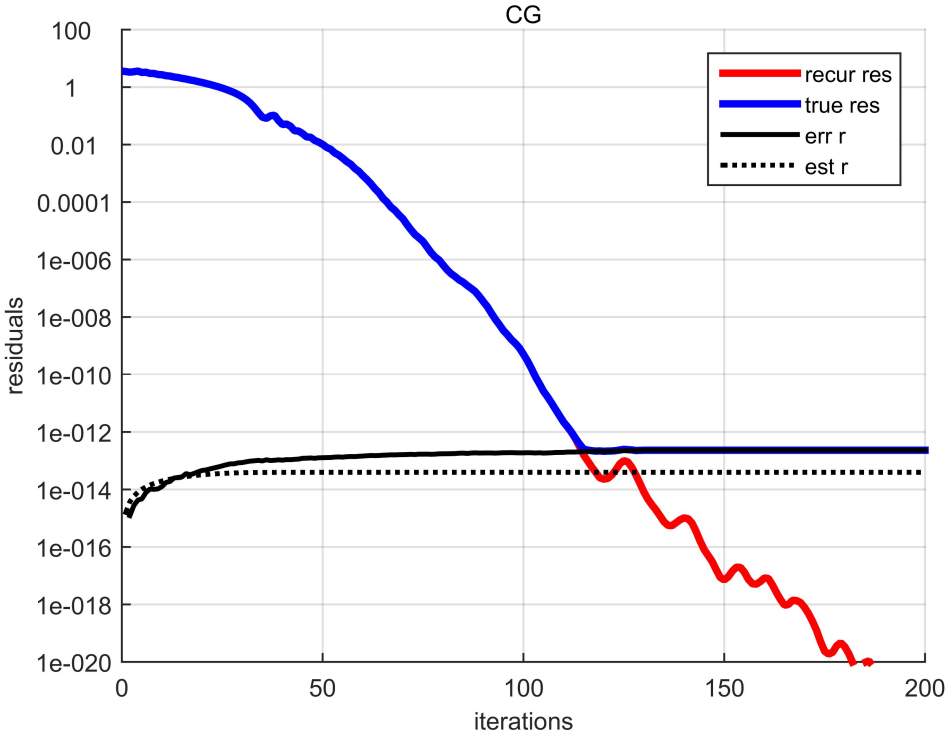
Pipelined GMRES overlaps dot-product global communication latency with SpMV

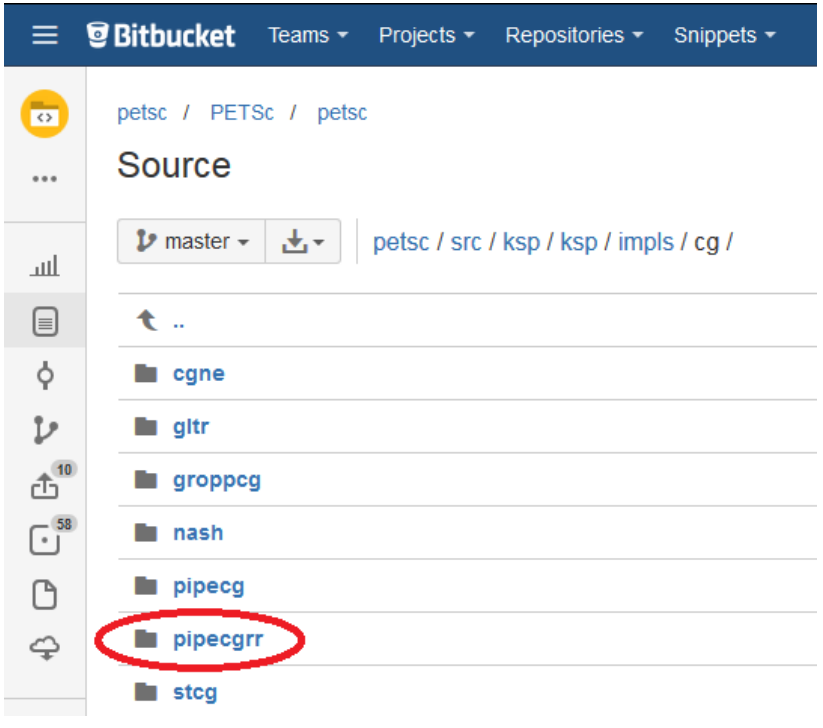


Available in PETSc

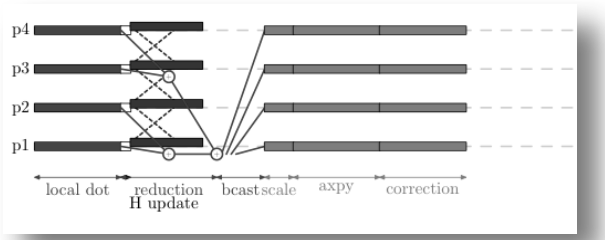
www.exa2ct.eu

Counter Rounding Errors due to more Local Computations





EXA2CT

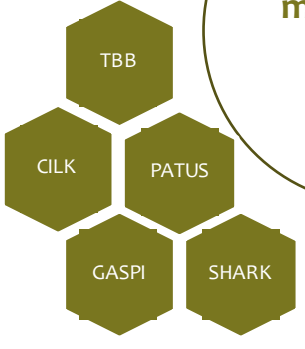


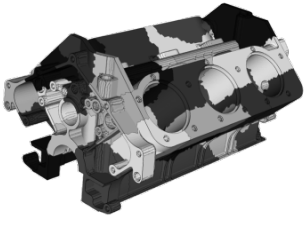
Solvers that scale to ExaScale

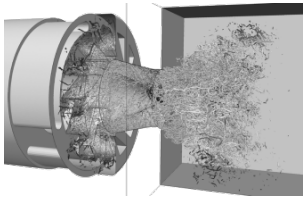
10^{18}

Programming models that scale to ExaScale

Using relevant real-life **proto applications**



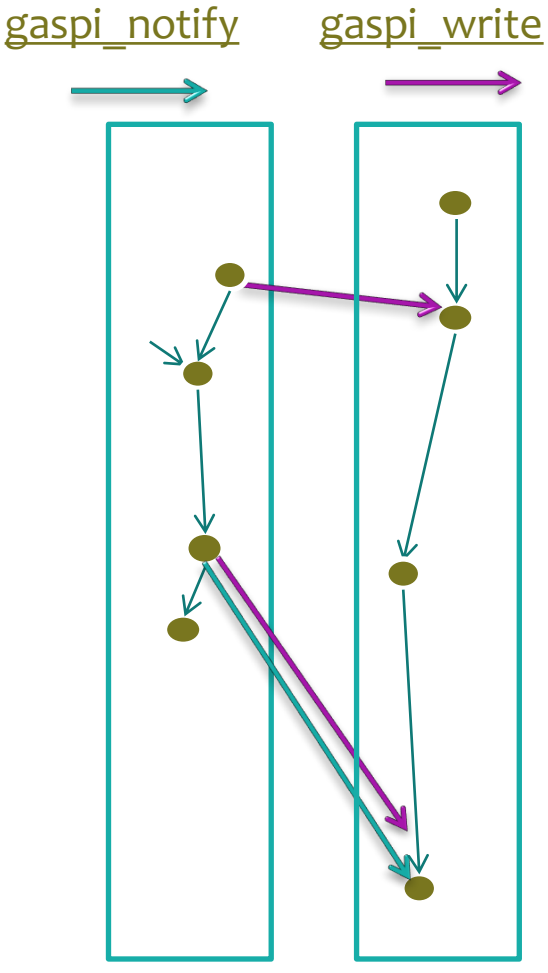




GASPI in a nutshell

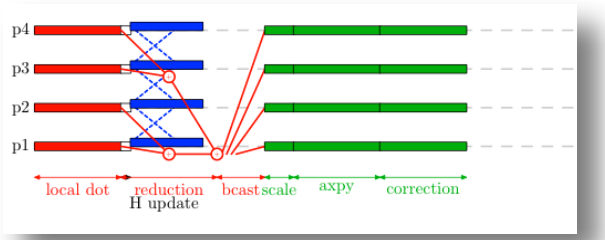
PGAS API - designed to be

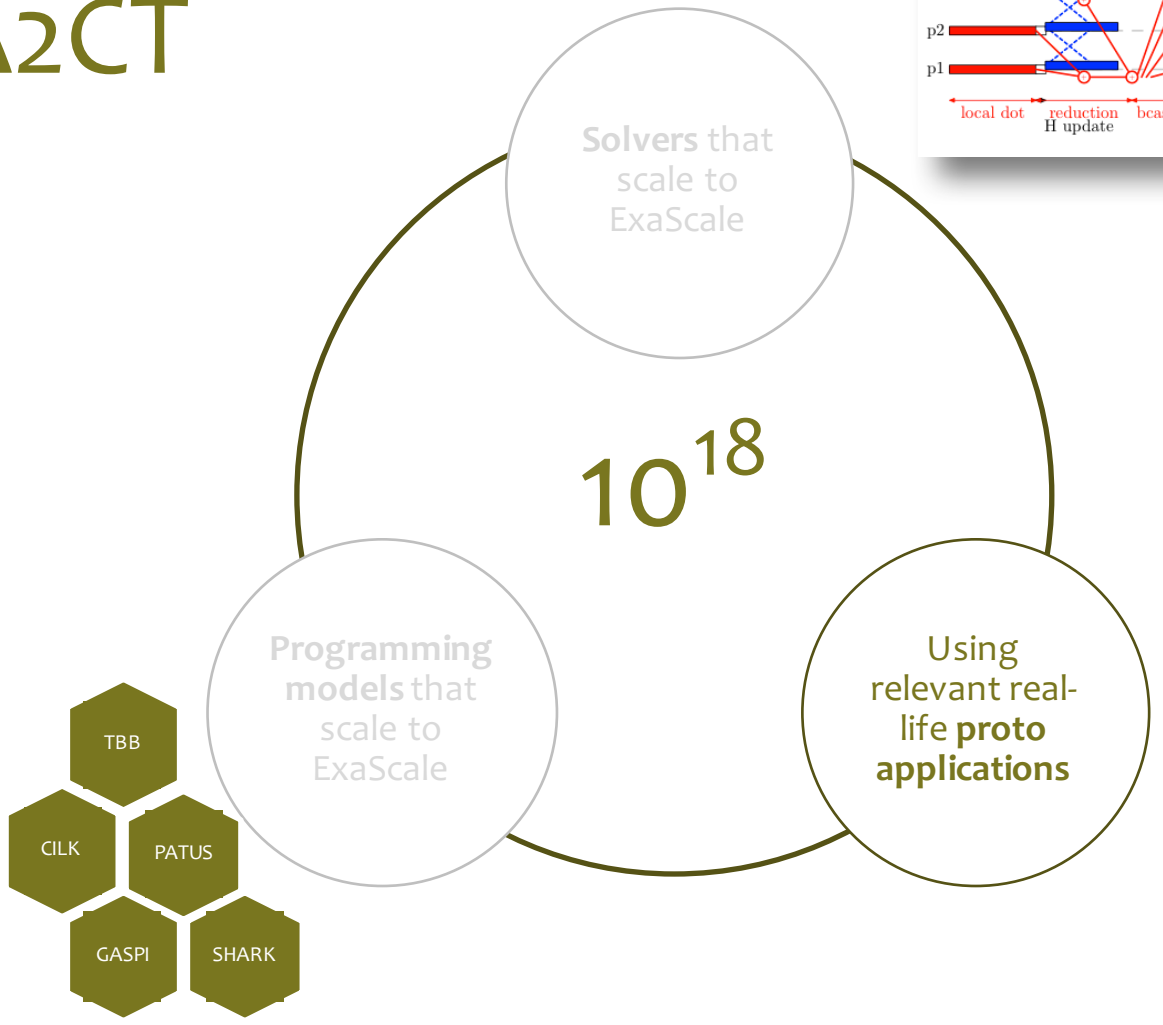
- Simple
- Multithreaded
- Global asynchronous dataflow
- Interoperability with MPI

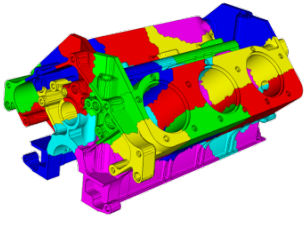


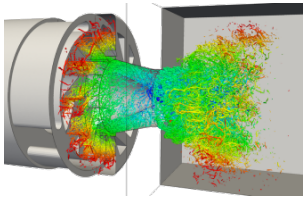
Global
Address Space
Programming Interface
GASPI

EXA2CT

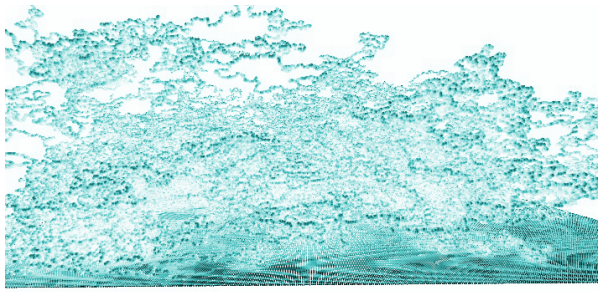

p4
p3
p2
p1
local dot
reduction
H update
bcast
scale
axpy
correction


Solvers that scale to ExaScale
10^{18}
Programming models that scale to ExaScale
Using relevant real-life proto applications
TBB
CILK
PATUS
GASPI
SHARK

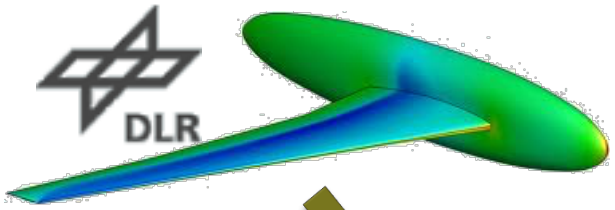


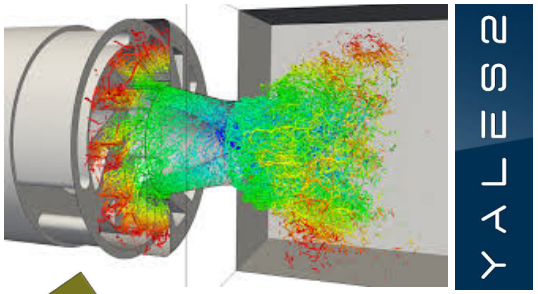


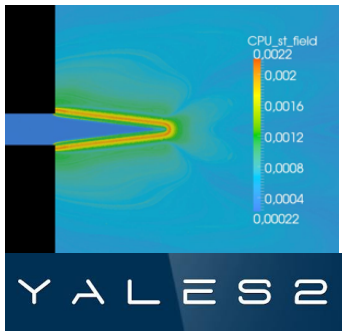
Proto Applications

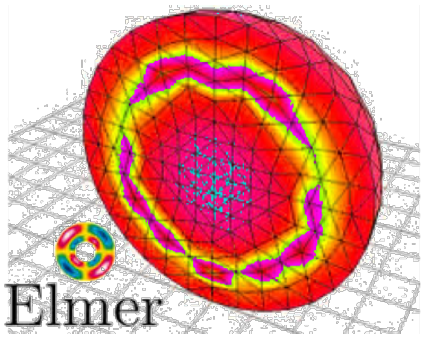


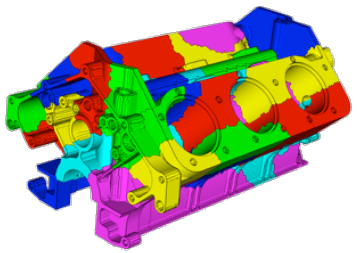
MUPHY

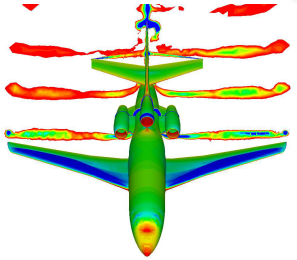


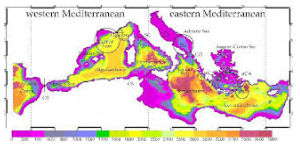


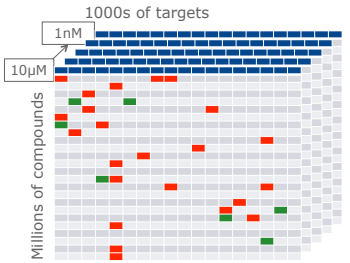






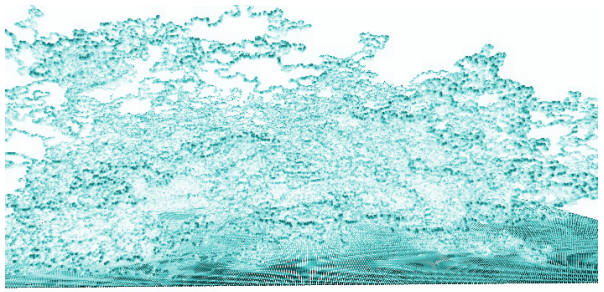




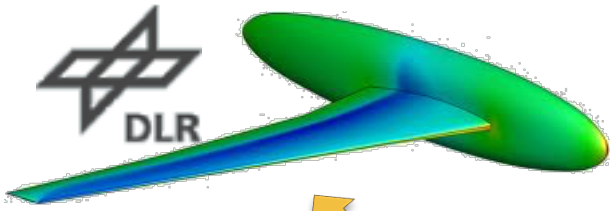


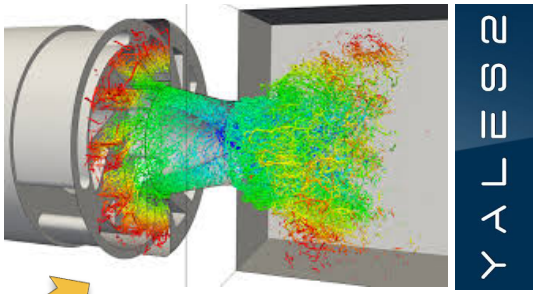
Proto Applications

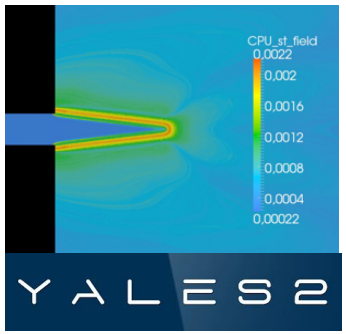
Proto Applications

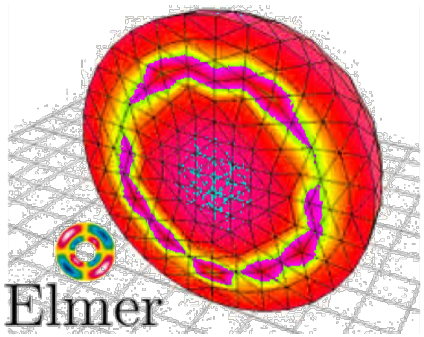


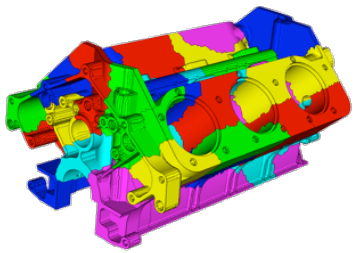
MUPHY

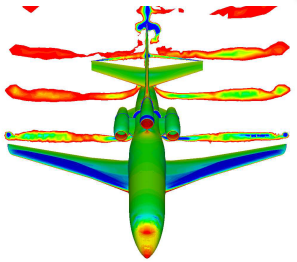


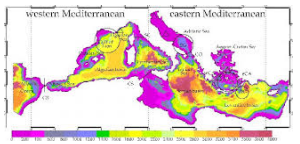


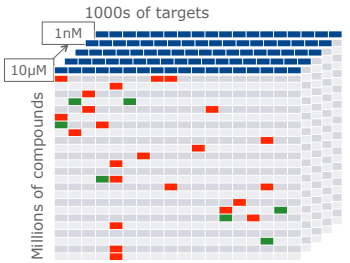






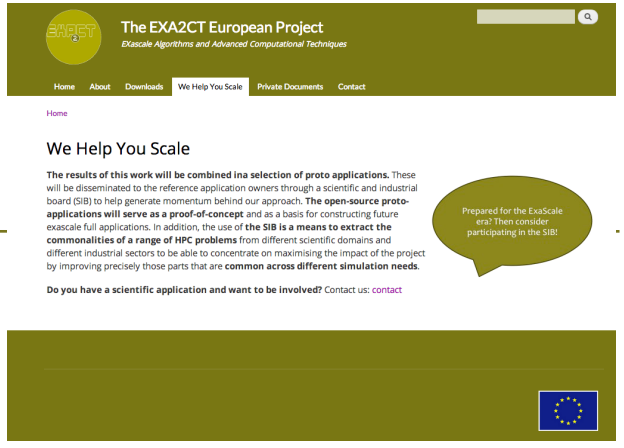






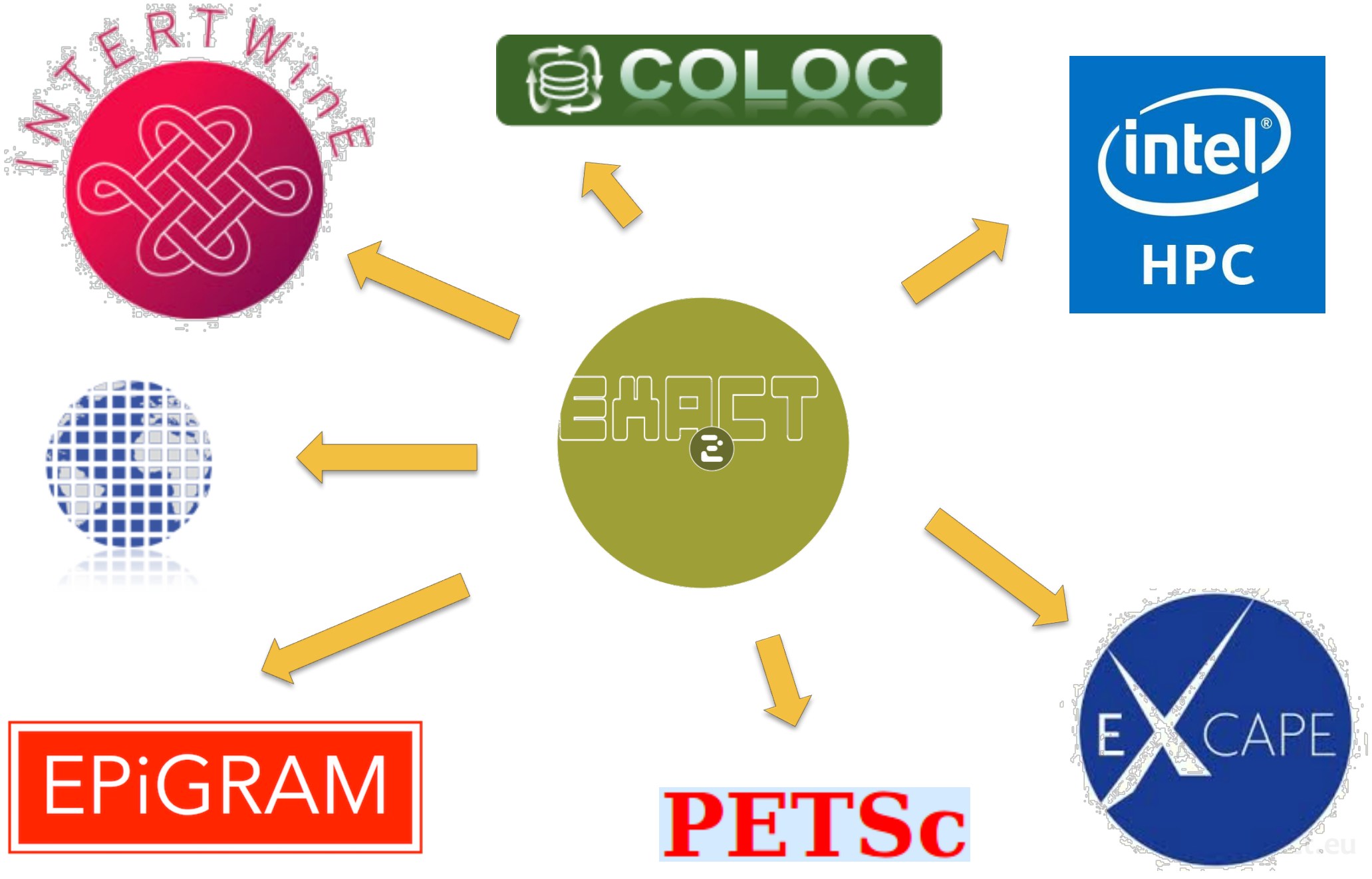
Proto Applications

www.exa2ct.eu



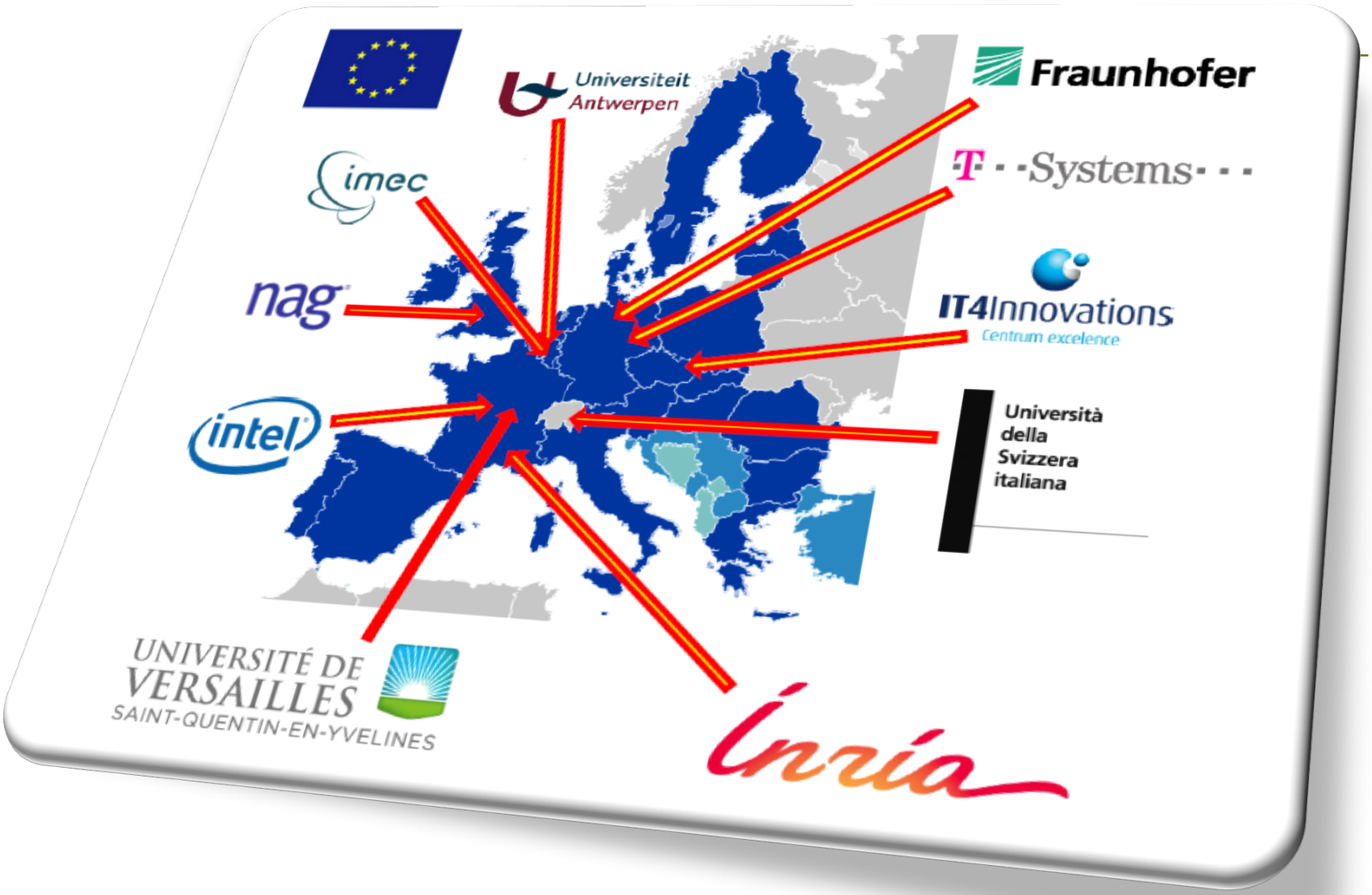
EXA2CT open source for you!

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


INTERTWINE
COLOC
intel
HPC
EXACT
EPiGRAM
PETSc
E CAPE

WWW.EXA2CT.EU

Partners


Universiteit Antwerpen
Fraunhofer
imec
T · · Systems · · ·
nag
IT4Innovations
Centrum excelence
intel
Università della Svizzera italiana
UNIVERSITÉ DE VERSAILLES SAINT-QUENTIN-EN-YVELINES
Inria