CRESTA and the exascale challenge

Dr Lorna Smith, CRESTA Project Manager

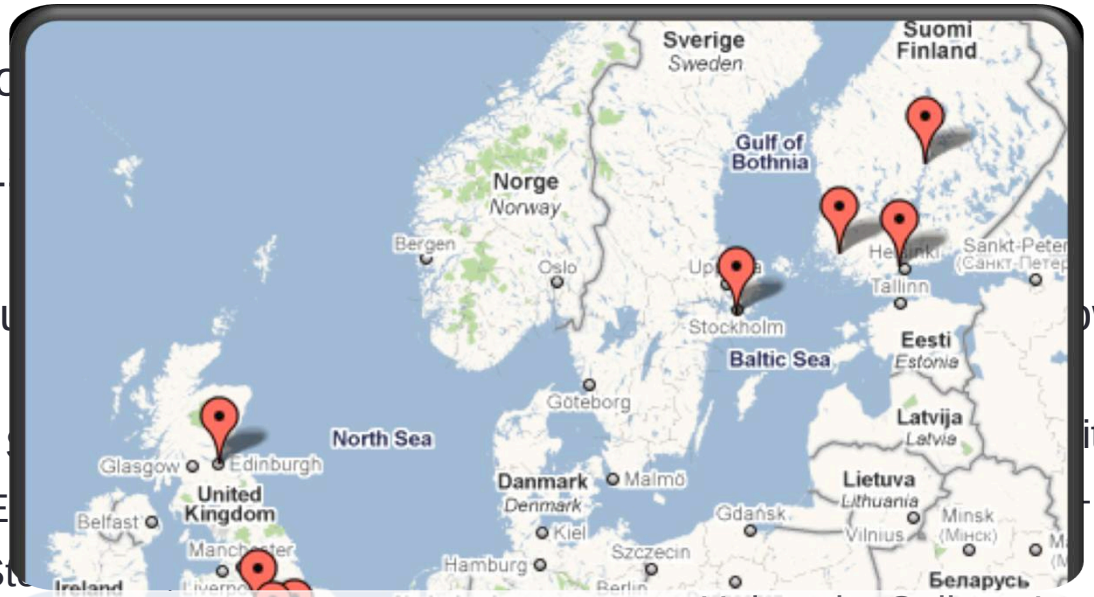
With thanks to Professor Mark Parsons for relevant slides

The University of Edinburgh

Collaborative Research into Exascale Systemware, Tools and Applications - CRESTA

- Exascale Sc
- 3 years - €1

  - Leading Eu
    - EPCC –
    - HLRS –
    - CSC – E
    - KTH – St
  - A world leading vendor
    - Cray UK – Reading, UK
  - World leading tools providers
    - Technische Universitaet Dresden (Vampir) – Dresden, Germany
    - Allinea Ltd (DDT) – Warwick, UK



owners and

ity – Abo, Finland

- Jyvaskyla,

  - University College London –UK
  - ECMWF – Reading, UK
  - Ecole Central Paris – Paris, France
  - DLR – Cologne, Germany
  - KTH – Stockholm, Sweden
  - USTUTT – Stuttgart, Germany

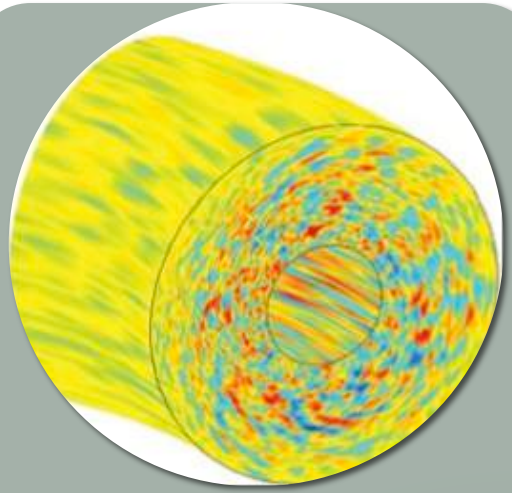
CRESTA

CRESTA objectives and outputs

- Objectives
  - Progress state of the art research in exascale development
  - Develop and produce software for future exascale platforms
  - Enable a set of key *co-design* applications for exascale
  - Demonstrate the success of the co-design process
- Major outputs
  - The CRESTA research portfolio
  - The CRESTA systemware software collection
  - The CRESTA co-design applications
  - The CRESTA co-design methodology, tried and tested
- Concepts
  - Co-design
  - Disruptive vs incremental approaches

CRESTA

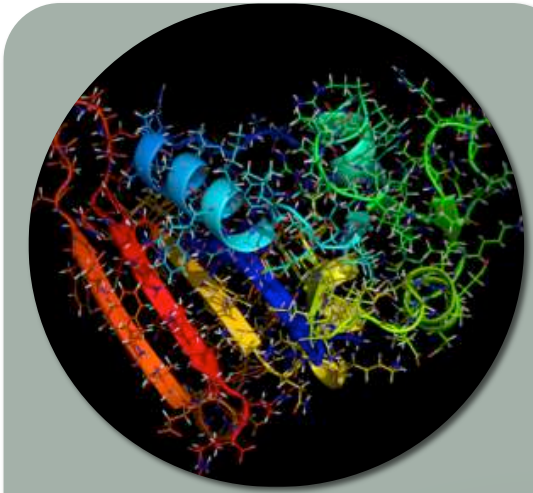
Co-design applications



Elmfire

Gyrokinetic code for turbulent fusion plasma
Simulating plasma behavior in large scale fusion reactors

An almost complete code restructuring
Radical reduction of memory consumption per core



GROMACS

Molecular dynamics for
- Modelling of biological systems
- computational material and drug design

10M atom simulation

Coupling strong scaling techniques with ensemble scaling

HemeLB

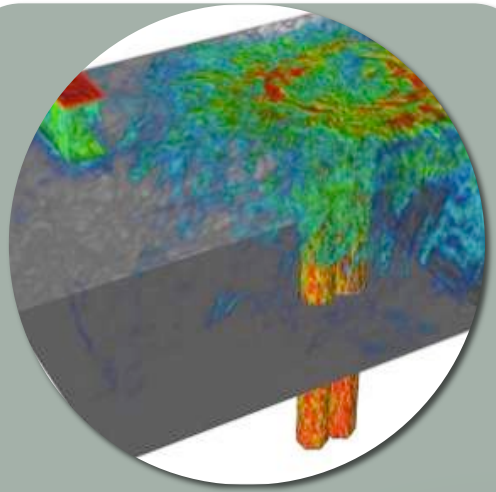
Simulation of cerebrovascular bloodflow, using LB
Medical simulations to help surgeries
Brain aneurysm simulation

Pre- and post-processing and load balancing, LB dev
Hybridisation, restructuring

Co-design applications

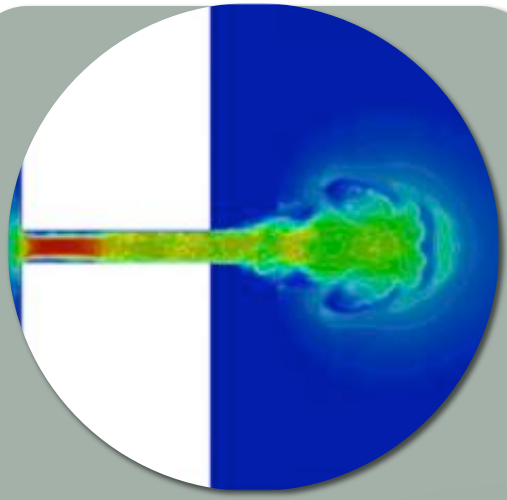
IFS
Numerical weather prediction
Timely and accurate weather forecasts can save lives
Simulating the trajectory of hurricane Sandy

Acceleration
Task-graph based parallelization
New communication models



Nek5000
Open-source CFD
Scaled to 1M cores on Mira
Nuclear power plant cooling simulations

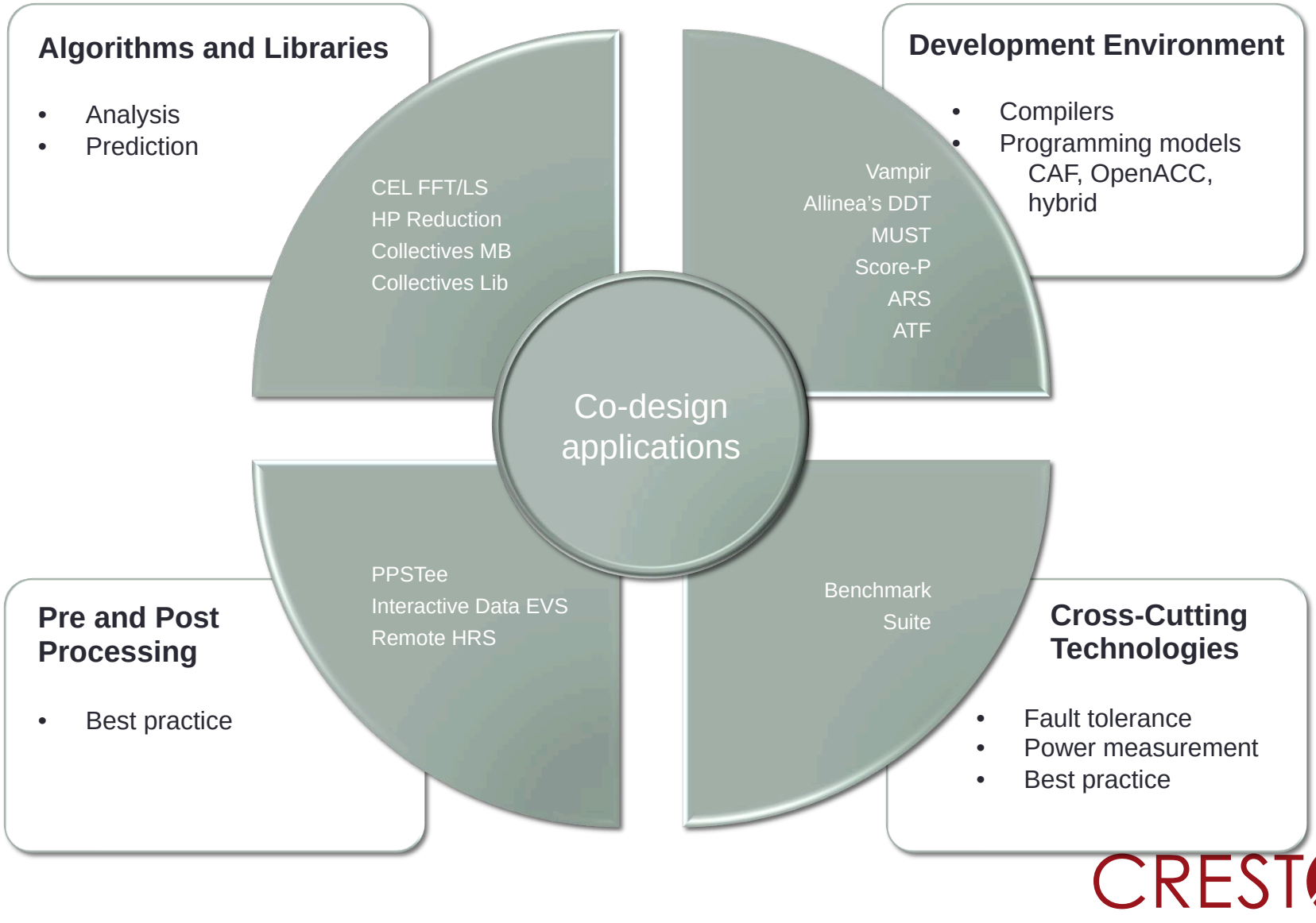
Adaptive mesh refinement acceleration



OpenFOAM
Open-source CFD
Turbulence models: fine resolution in space and time
Wind turbines, hydroelectric power plants
Francis pump turbine simulation

Linear solver optimization

CRESTA software and research portfolio



Concepts

Co-design

Recognises the need to include all relevant perspectives and stakeholders in the design process

CRESTA is a showcase for the co-design methodology

CRESTA has a series of co-design teams cross-cutting WPs

Series of co-design specific success metrics

Needs to be benefit for *both* software developers and for application developers

Needs to show the whole is greater than the sum of its parts

Disruptive vs incremental

Applications and systemware have made some major disruptive decisions within CRESTA

Disruptive technology meetings explore potentially disruptive solutions

Key outputs and their success metrics

- Applications
  - Exploit largest systems possible today: performance/ functionality demonstrations
  - Regularly updated set of roadmaps –relevance for anticipated future exascale systems
  - Socio-economic advances –examplar simulations with real scientific advances
- Systemware
  - Exploit largest systems possible today: performance/ functionality demonstrations
  - Enhanced roadmaps, driven by exascale requirements
  - Demonstrators with co-design applications
- Research portfolio
  - Published techniques and solutions to exascale challenges
  - Exploitation of techniques within co-design applications
  - Influence of community initiatives e.g. standard bodies
- Co-design
  - Systemware/research integrated into applications and application driven enhancements to systemware/research outputs
  - Both sets of roadmap enhanced through feedback from the other

CREST

Impact and exploitation outputs and success metrics

- Series of high level impacts
  - Enhancing European leadership in HPC system software and tools, exascale simulation, and industry
  - Enhanced productivity of European scientists
  - Impact on socio-economic issues
- CRESTA's major impact outputs include
  - The EASC conference series
  - Special journal edition
  - Pilot study programme
  - Socio-economic impact videos
  - High impact journal publications
  - Workshop and training courses
  - Case studies and white papers
  - Significant targeting of SC and ISC

- Collaboration with other European exascale projects
  - E.g this meeting - we are very glad to see you all in Edinburgh
  - And collaboration more widely

CRESTA

Conclusion

- CRESTA aims to:
  - Progress state of the art research in exascale development
  - Develop and produce software for future exascale platforms
  - Enable a set of key *co-design* applications for exascale
  - Demonstrate the success of the co-design process
- All co-design applications have made significant progress
  - Disruptive decisions a success in their own right
- Systemware software
  - All have prototype releases, working towards final releases
- Co-design
  - Series of examples of both the applications and the systemware benefitting
  - Case study series showcasing this success
- Impact
  - Creating impact across European industry, simulation software and with European scientists
  - Demonstrating leadership and engagement more widely: this is a *global* challenge

CRESTA