

Panelist Introduction

Michael Ferguson

- ✉️ chapel_info@cray.com
- 🌐 chapel-lang.org
- 🐦 [@ChapelLanguage](https://twitter.com/ChapelLanguage)



What is Chapel?

Chapel: A modern parallel programming language

- portable & scalable
- open-source & collaborative

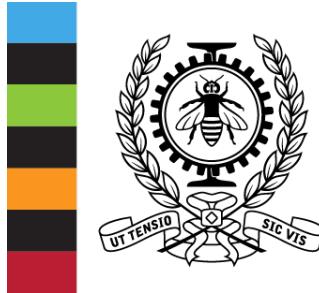
Goals:

- Support general parallel programming
 - “any parallel algorithm on any parallel hardware”
- Make parallel programming at scale far more productive
 - “as programmable as Python, yet as fast and scalable as C+MPI+X”



Two More Chapel Applications

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3D Computational Fluid Dynamics
Simon Bourgault-Côté,
Matthieu Parenteau, et al.
École Polytechnique Montréal



Chapel Hypergraph Library (CHGL)
Louis Jenkins, Marcin Zalewski, et al.
PNNL



Chapel CFD Computations

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Who: Simon Bourgault-Côté, Matthieu Parenteau, ...

École Polytechnique Montréal

What:

- Computational Fluid Dynamics solver for use in aircraft design research
- a 3D unstructured Reynolds Average Navier-Stokes (RANS) flow solver



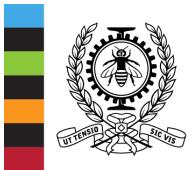
Chapel CFD Computations

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Why Chapel:

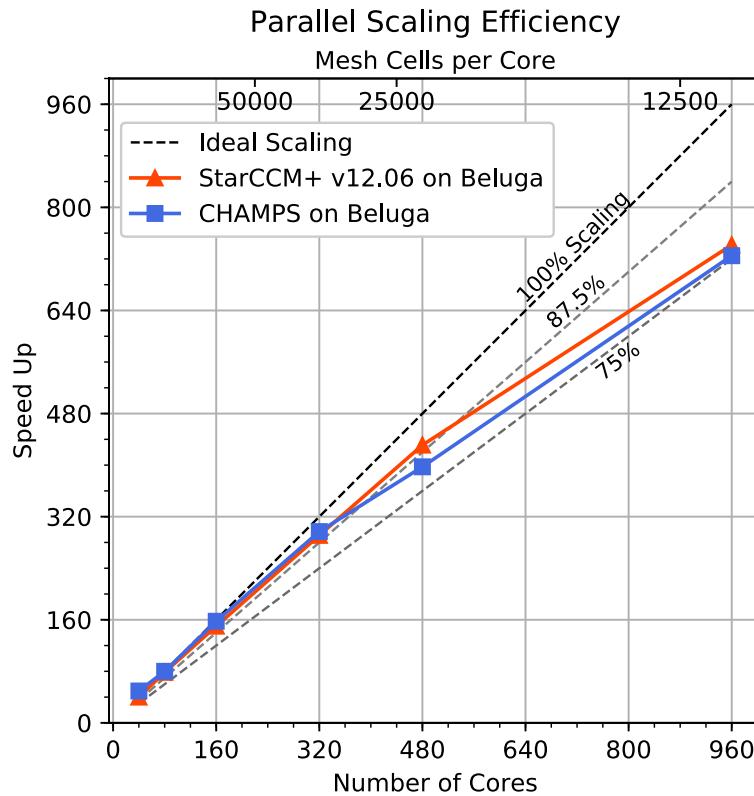
- simplifies development of distributed memory code:
 - easy to write and read
 - much more compact and flexible than MPI
- results in performance equivalent to other distributed C++ flow solvers
- interfaces with external libraries fairly easily

Challenges: requires care to avoid performance pitfalls
(e.g., unintentional or excessive remote accesses)



Chapel CFD Computations

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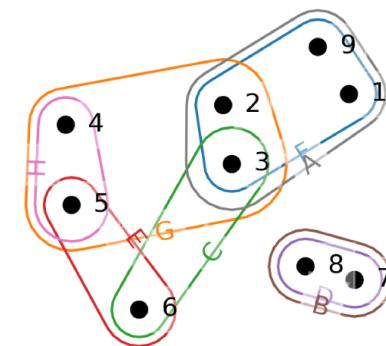


- **StarCCM:** commercial CFP package
- **CHAMPS:** new Chapel CFD solver

Who: Louis Jenkins, Marcin Zalewski, et al., *Pacific Northwest National Laboratory*

What:

- Library for computations on Hypergraphs
- Uses a distributed, scalable representation
- Forms analytic pipeline with a Python library - HyperNetX
- Pipeline used to study a large collection of DNS records





Chapel Hypergraph Library



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Why Chapel:

- Support for parallelism and distributed memory
- Generic programming and very flexible array data types
- Desire to improve Chapel for fine-grained applications

Challenges:

- Needed privatization and aggregation for performance

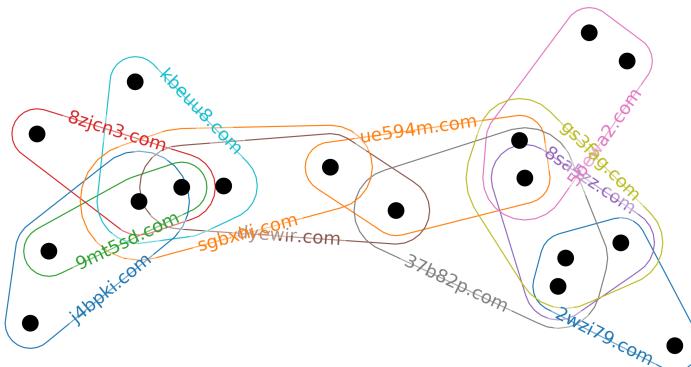


Fig. 11: The 2-component with largest 2-diameter.

- ~200 million DNS records → hypergraph
 - vertices are IPs
 - edges are domains
- Component on left consistent with DNS *fast flux*
 - likely indicating botnet / malware

References:

- GitHub repository: <https://github.com/pnnl/chgl>
- HPEC paper: **Chapel HyperGraph Library (CHGL)**. Louis Jenkins, Tanveer Bhuiyan, Sarah Harun, Christopher Lightsey, David Mentgen, Sinan Aksoy, Timothy Stavenger, Marcin Zalewski, Hugh Medal, and Cliff Joslyn. 2018 *IEEE High Performance Extreme Computing Conference (HPEC '18)*. September 25–27, 2018.
- **High Performance Hypergraph Analytics of Domain Name System Relationships**. Cliff Joslyn, Sinan Aksoy, Dustin Arendt, Louis Jenkins, Brenda Praggastis, Emilie Purvine, Marcin Zalewski. *HICSS Symposium on Cybersecurity Big Data Analytics*. Jaunary 8, 2019.

In Total

- Chapel applied to very different problem areas
- Users tell us that Chapel is easy to work with
- Not necessary to rewrite everything! External libraries, part of a pipeline
- Harder part can be identifying and addressing inefficient communication

Why is Chapel better than MPI+X?

- Lower learning curve
- Codes are shorter and easier to read and write
- Codes are easier to adapt and maintain



CHUG - Chapel Users Group - Tonight!

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Join us for drinks, dinner, discussion, and possibly even bocce (!?).

Where: Rhein Haus, Denver

When: ~ 6:15pm



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