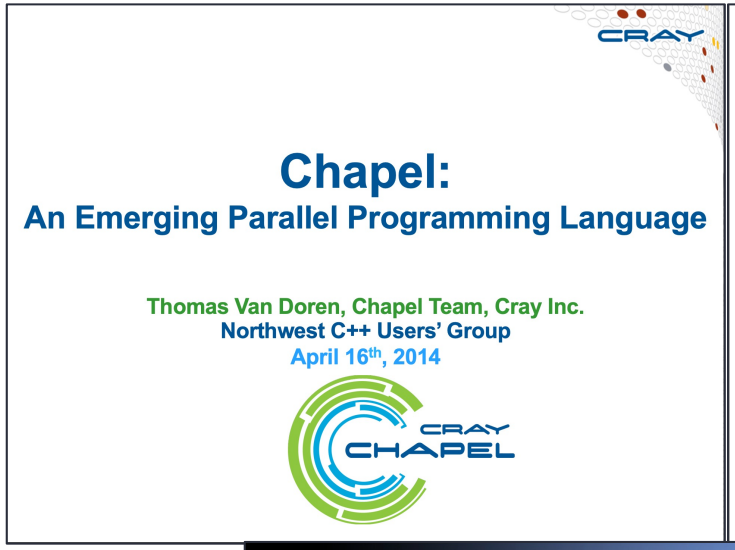
HPE

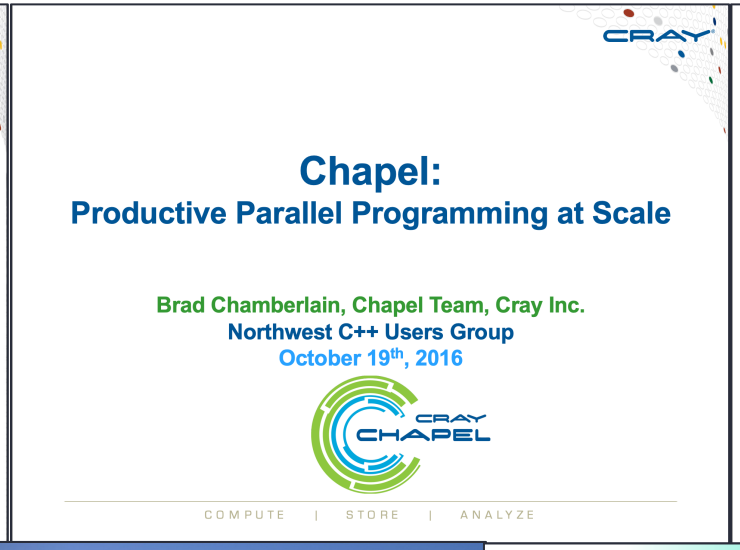
Productive Parallel Programming at all scales with Chapel

Brad Chamberlain and Jade Abraham, Advanced Programming Team, HPE

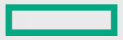
Northwest C++ Users' Group
May 21, 2026

Proud to be a member of the “NWC++ Five-Timers Club”





Motivation



30 Years Ago vs. Now: Top HPC Systems in the Top500

Top 5 systems in the Top500, November 1995:

- **Cores:** 80–3,680
- **Rmax:** ~98.9–170 GFlop/s
- **Systems:** Fujitsu, Intel Paragon XP/S, Cray T3D

Rank	System	Cores	Rmax (GFlop/s)	Rpeak (GFlop/s)	Power (kW)
1	Numerical Wind Tunnel, Fujitsu National Aerospace Laboratory of Japan Japan	140	170.00	235.79	
2	XP/S140, Intel Sandia National Laboratories United States	3,680	143.40	184.00	
3	XP/S-MP 150, Intel DOE/SC/Oak Ridge National Laboratory United States	3,072	127.10	154.00	
4	T3D MC1024-8, Cray/HPE Government United States	1,024	100.50	153.60	
5	VPP500/80, Fujitsu National Lab. for High Energy Physics Japan	80	98.90	128.00	

Top 5 systems in the Top 500, November 2025:

- **Cores:** 2,073,600–11,340,616
- **Rmax:** 561.2–1809 PFlop/s
- **Systems:** HPE Cray EX, Eviden Bullsequana, Microsoft Azure

Rank	System	Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
1	**El Capitan** - HPE Cray EX255a, AMD 4th Gen EPYC 24C 1.8GHz, AMD Instinct MI300A, Slingshot-11, TOSS, HPE DOE/NNSA/LLNL United States	11,340,000	1,809.00	2,821.10	29,685
2	**Frontier** - HPE Cray EX235a, AMD Optimized 3rd Generation EPYC 64C 2GHz, AMD Instinct MI250X, Slingshot-11, HPE Cray OS, HPE DOE/SC/Oak Ridge National Laboratory United States	9,066,176	1,353.00	2,055.72	24,607
3	**Aurora** - HPE Cray EX - Intel Exascale Compute Blade, Xeon CPU Max 9470 52C 2.4GHz, Intel Data Center GPU Max, Slingshot-11, Intel DOE/SC/Argonne National Laboratory United States	9,264,128	1,012.00	1,980.01	38,698
4	**JUPITER Booster** - BullSequana XH3000, GH Superchip 72C 3GHz, NVIDIA GH200 Superchip, Quad-Rail NVIDIA InfiniBand NDR200, RedHat Enterprise Linux, EVIDEN EuroHPC/FZJ Germany	4,801,344	1,000.00	1,226.28	15,794
5	**Eagle** - Microsoft NDv5, Xeon Platinum 8480C 48C 2GHz, NVIDIA H100, NVIDIA Infiniband NDR, Microsoft Azure Microsoft Azure United States	2,073,600	561.20	846.84	

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Cores: ~563x–141,750x
Rmax: ~3,300,000x–18,300,000x

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HPC HW has become far more capable…

And complex!

- **commodity vector processors**
- **commodity multicore/manycore processors**
- **multi-socket compute nodes**
- **NUMA processor/node architectures**
- **high-radix, low-diameter interconnects**
- **GPU computing**

(Often in ways that hurt programmability)

ank	System	Cores	Rmax (PFlop/s)	Rpeak (PFlop/s)	Power (kW)
1	El Ca…an - HPE Cray EX255a, AMD 4th Gen EPYC 24C 1.8GH… …D Instinct MI300A, Slingshot-11, TOSS, HPE DOE/… …NL Unite…	11,340,000	1,809.00	2,821.10	29,685
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30 Years Ago vs. Now: Broadly-adopted HPC Programming Notations

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Broadly-adopted HPC notations, November 1995:

- **Languages:** Fortran, C, C++
- **Inter-node:** MPI, PVM, SHMEM
- **Intra-node:** Pthreads, vendor-specific pragmas & intrinsics
  - OpenMP on the horizon (1997)
- **Scripting:** Perl, sh/csh/tcsh, Tcl/TK

Broadly-adopted HPC notations, November 2025:

- **Languages:** Fortran, C, C++
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HPC SW notations have largely stayed the same, modulo GPU computing and scripting

Notably, HPC has failed to broadly adopt any new programming languages…

30 Years Ago vs. Now: Ubiquity of Parallelism

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- **GPUs:** CUDA, HIP, SYCL, OpenMP, Kokkos, OpenACC, OpenCL, …
- **Scripting:** Python, bash

Availability of parallelism, November 1995

- HPC systems at national labs, large universities, industry

Parallelism has expanded beyond HPC, dramatically!

Availability of parallelism, November 2025:

- HPC systems at national labs, universities, industry
- laptops / desktops with multicore CPUs and GPUS
- cloud computing, AI data centers, …

What is Chapel?

Chapel: A modern parallel programming language

- Portable & scalable
- Open-source & collaborative
  - an HPSF / Linux Foundation project

Goals:

- Support general parallel programming
- Make parallel programming at scale far more productive

Chapel's Approach

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Chapel replaces the need to mix multiple notations: Use a single language for parallelism at all levels, targeting parallel systems of all types and scales

Unified notation for parallelism, HPC or otherwise:

- **Languages:** ~~Fortran, C, C++~~
- **Inter-node:** ~~MPI, SHMEM~~
- **Intra-node:** ~~Pthreads, OpenMP, Kokkos~~
- **GPUs:** ~~CUDA, HIP, SYCL, OpenMP, Kokkos, OpenACC, OpenCL, …~~
- **Scripting:** Python, bash

key: express parallelism and locality independently of hardware mechanisms

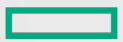
Availability of parallelism, November 2025:

- HPC systems at national labs, universities, industry
- laptops / desktop with multicore CPUs and GPUS
- cloud computing, AI data centers, …

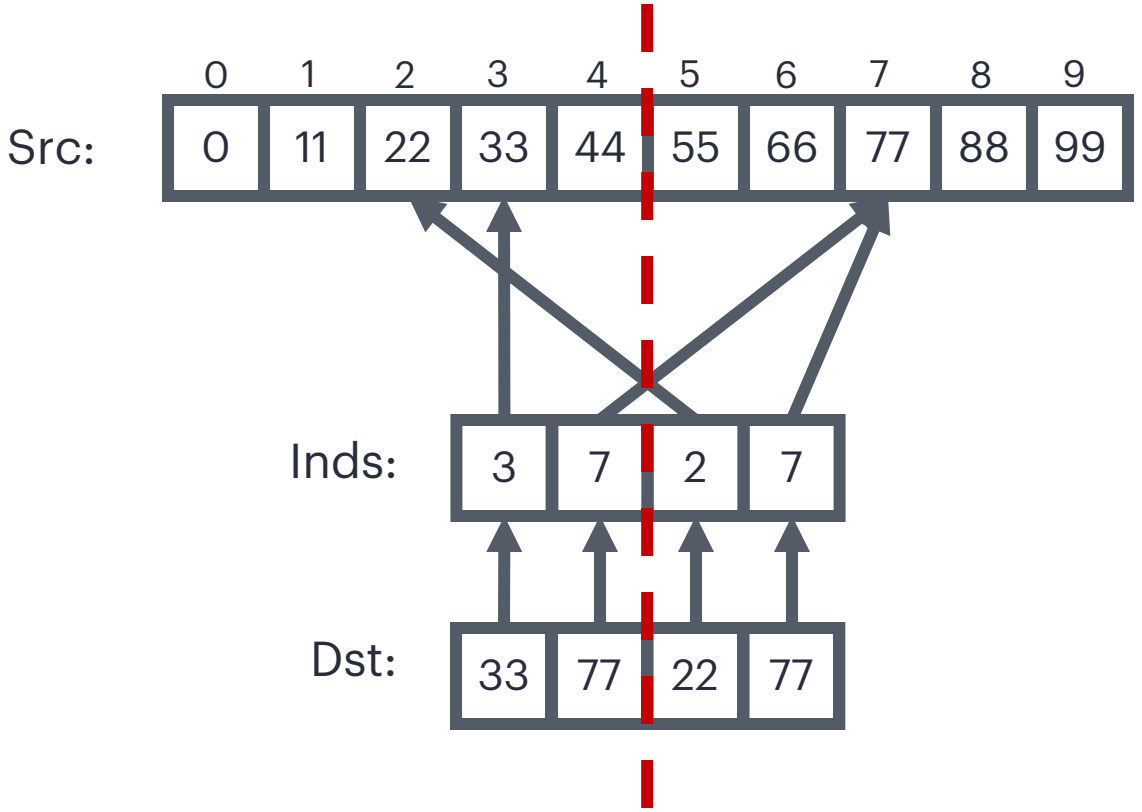
Goals of this talk

1. Motivate & introduce Chapel for those who've missed our previous NWC++ talks
2. Highlight some key milestones since our last talk in 2022:
   - Performance Results
   - GPU programming
   - User Applications
   - Chapel 2.0
   - HPSF
3. Provide information about how to learn more

Chapel By Example: Bale Index Gather



Bale Index Gather (IG): In Pictures

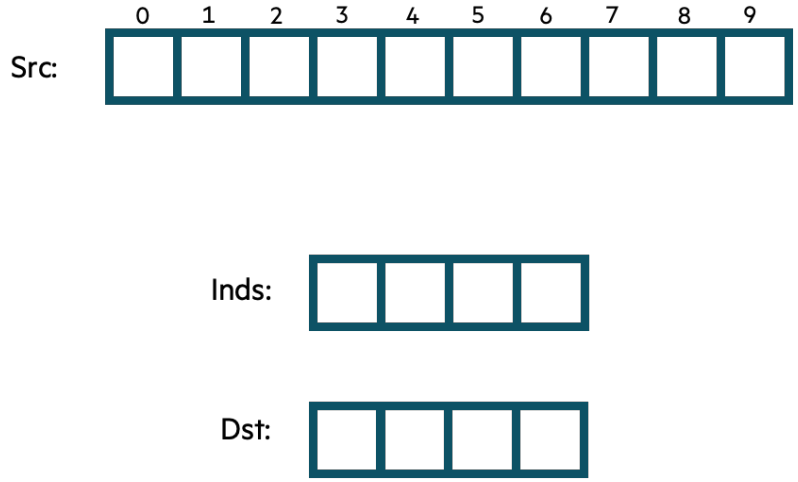


Bale IG in Chapel: Scalar and Array Declarations

```
config const n = 10,
             m = 4;



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
```




```
$
```

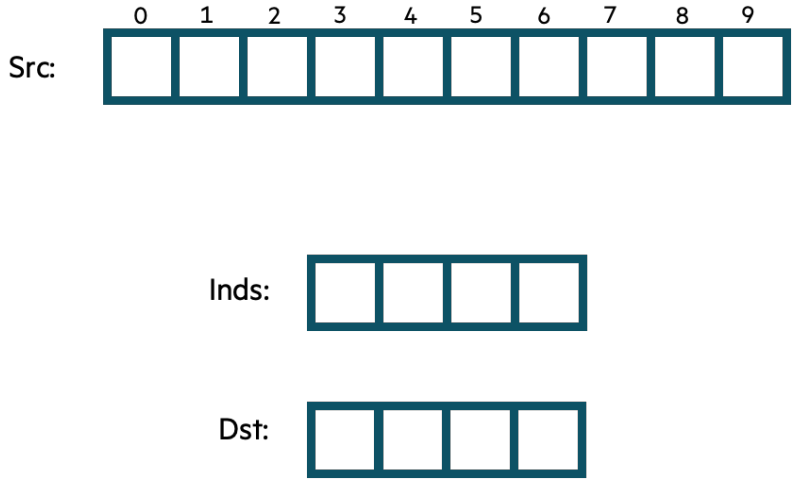
Bale IG in Chapel: Compiling

```
config const n = 10,
             m = 4;



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
```

```
$ chpl bale-ig.chpl
$
```



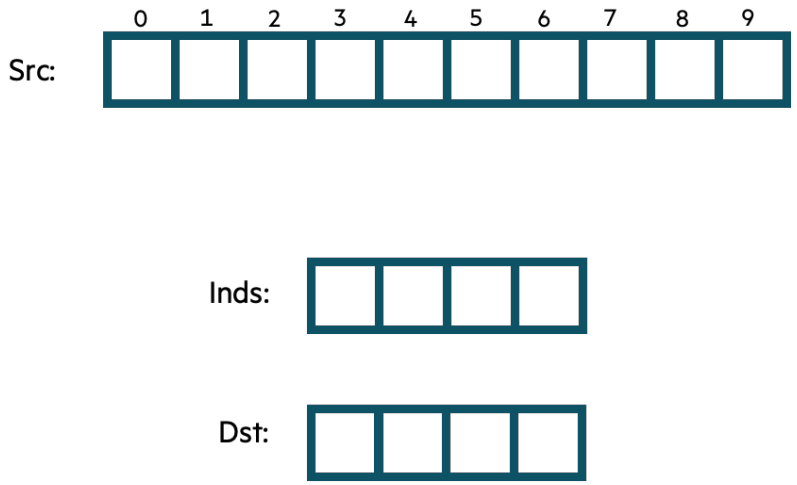
Bale IG in Chapel: Executing

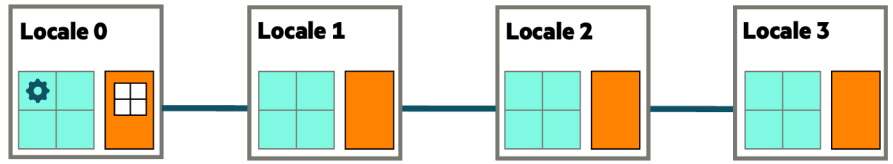
```
config const n = 10,
             m = 4;



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
```

```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```



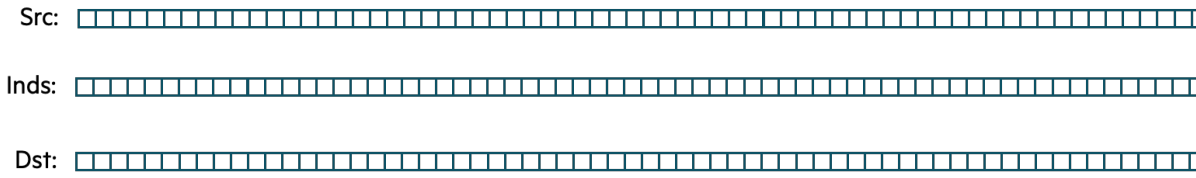


Bale IG in Chapel: Executing, Overriding Configs

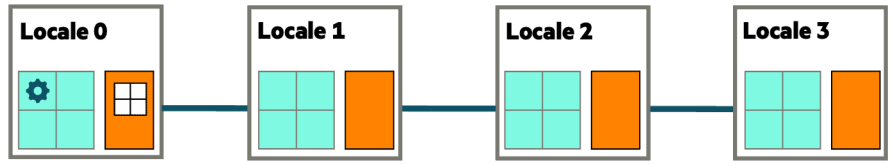
```
config const n = 10,
             m = 4;



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
```




```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4 --n=1_000_000 --m=1_000_000
$
```



Bale IG in Chapel: Array Initialization

```
use Random;

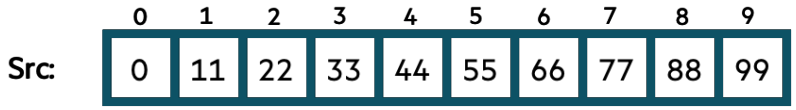
config const n = 10,
             m = 4;

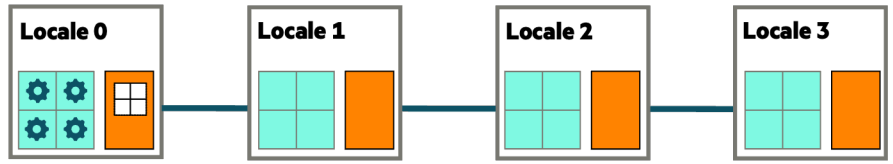



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;

Src = [i in 0..<n] i*11;
fillRandom(Inds, min=0, max=n-1);
```

```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```





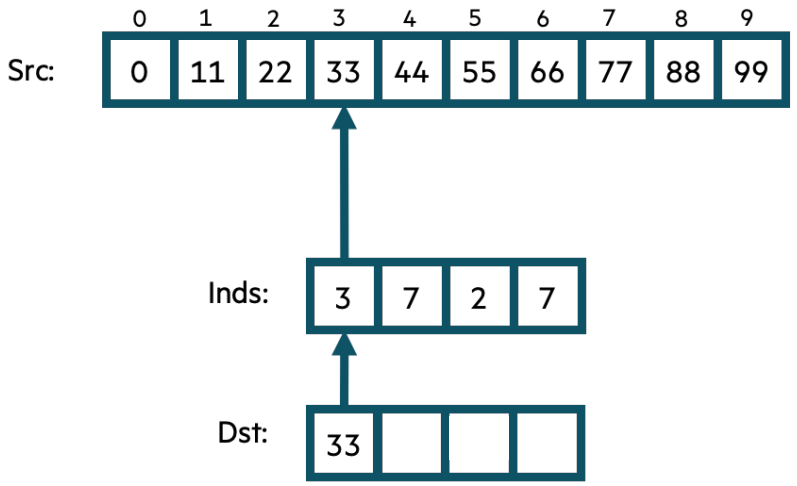
Bale IG in Chapel: Serial Version

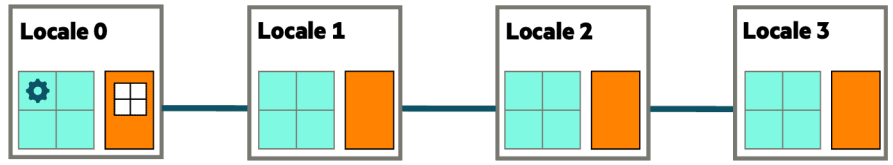
```
config const n = 10,
             m = 4;




var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
for i in 0..<m do
  Dst[i] = Src[Inds[i]];
```

```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```





Bale IG in Chapel: Serial, Zippered Version

```
config const n = 10,
             m = 4;




var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
for (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

```
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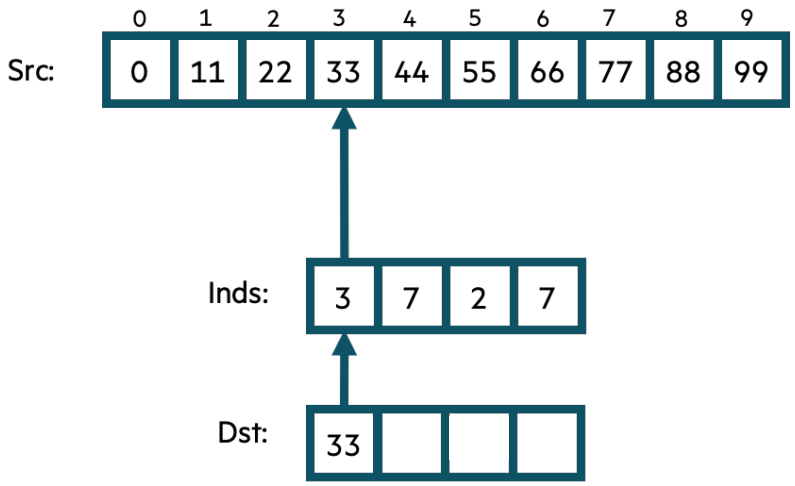
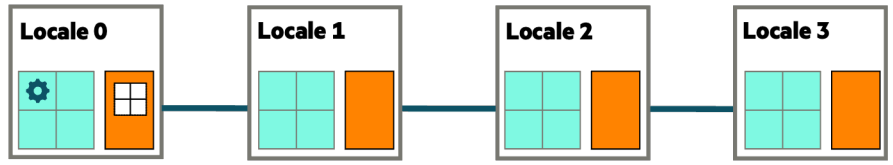
$
```



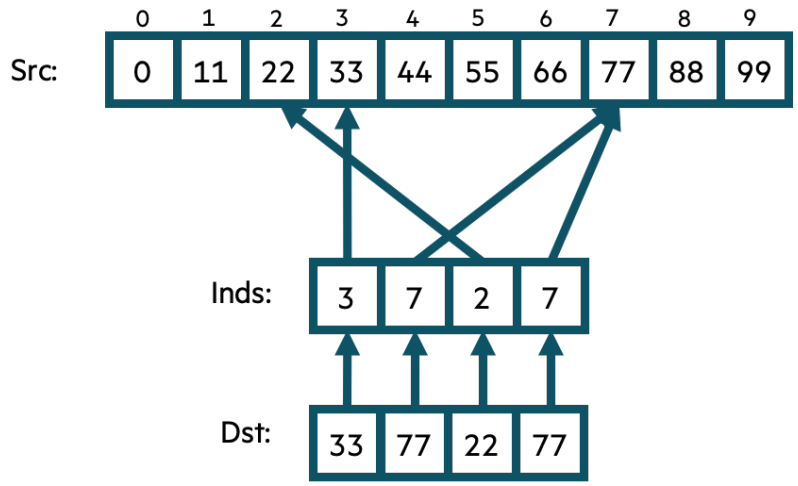


Bale IG in Chapel: Parallel, Zippered Version (vectorized)

```
config const n = 10,
             m = 4;




var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
foreach (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

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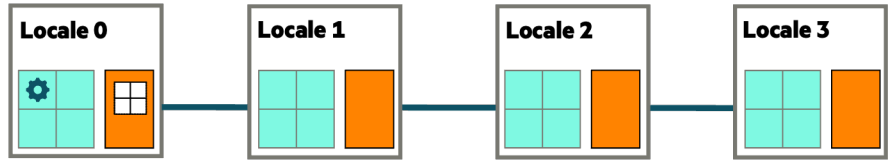

Bale IG in Chapel: Parallel, Zippered Version (multicore)

```
config const n = 10,
             m = 4;




var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

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$ ./bale-ig -nl 4
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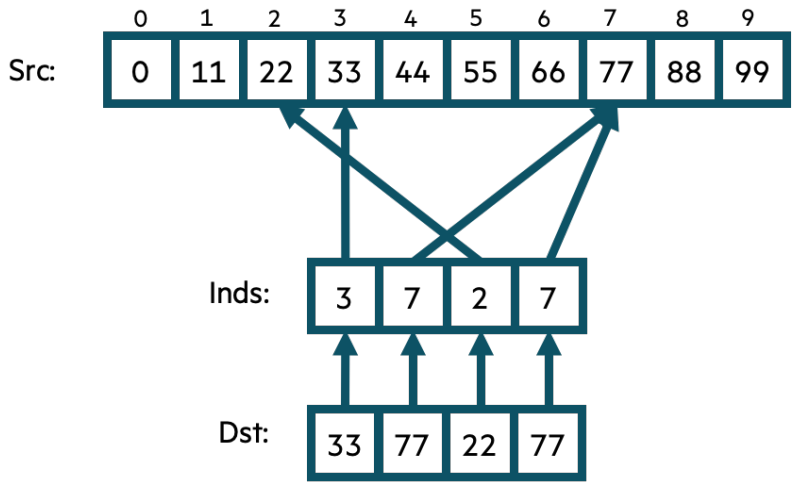
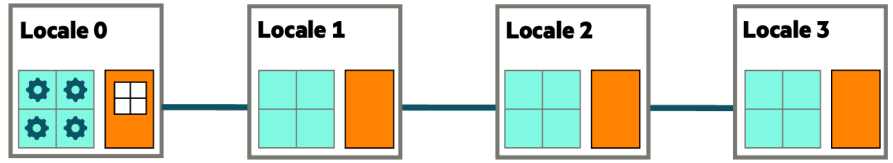
```



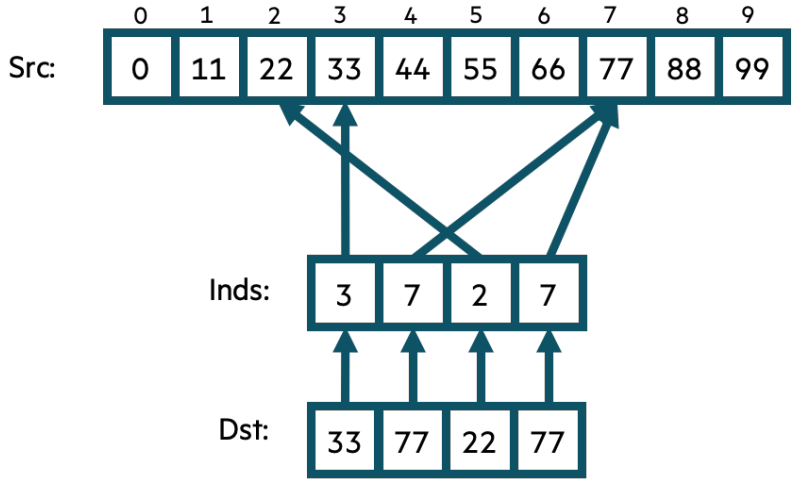


Bale IG in Chapel: Parallel Promoted Version (equivalent to previous version)

```
config const n = 10,
             m = 4;



var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
Dst = Src[Inds];
```

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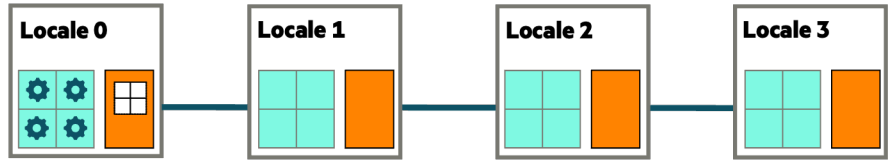

Bale IG in Chapel: Parallel, Zippered Version (Multicore, again)

```
config const n = 10,
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var Src: [0..<n] int,
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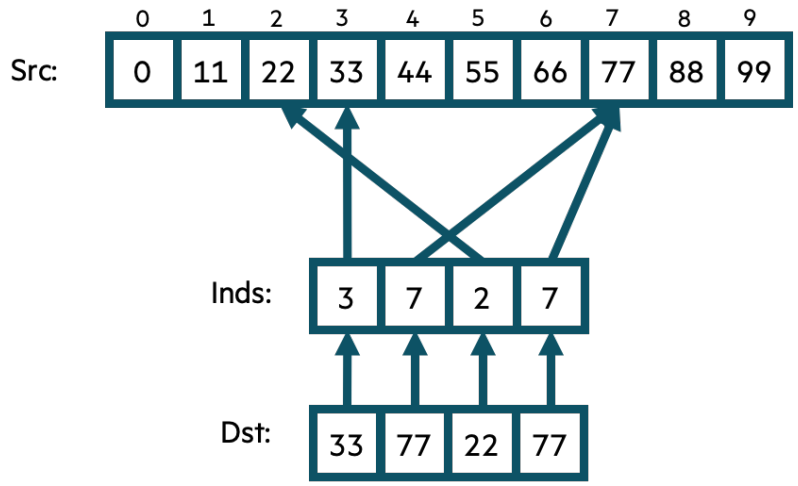


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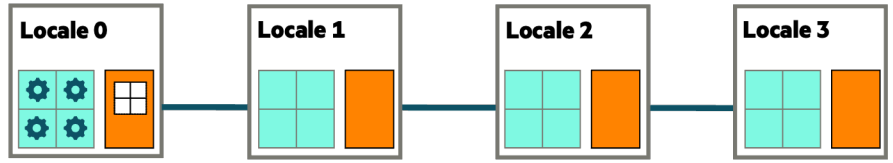
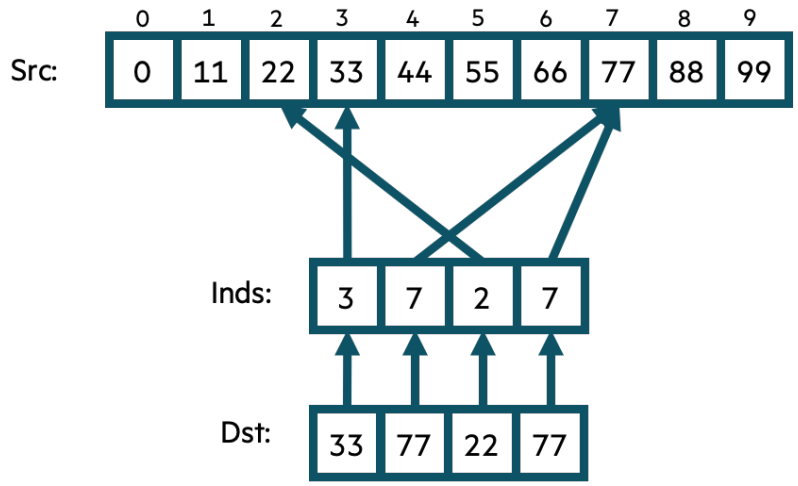


Bale IG in Chapel: Parallel, Zippered Version with Named Domains (Multicore)

```
config const n = 10,
             m = 4;

const SrcInds = {0..<n},
      DstInds = {0..<m};

var Src: [SrcInds] int,
    Inds, Dst: [DstInds] int;
…
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

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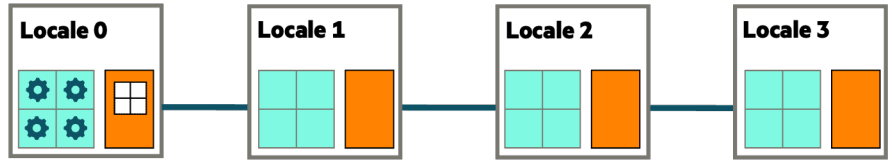
$
```



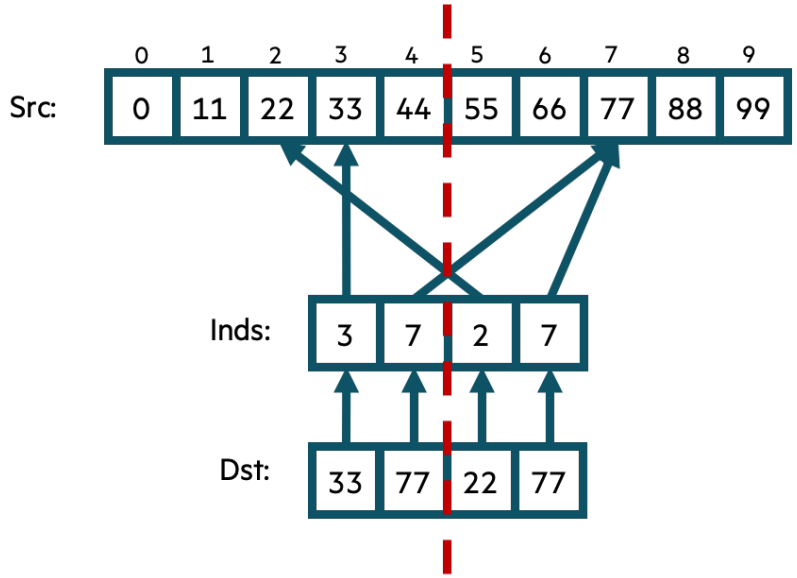
Bale IG in Chapel: Distributed Parallel Version

```
use BlockDist;

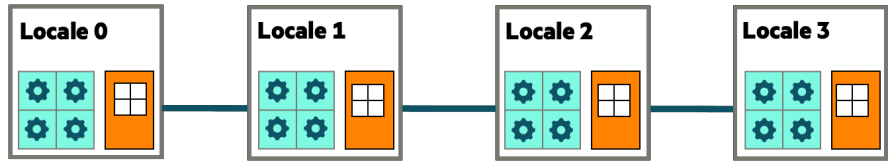
config const n = 10,
             m = 4;

const SrcInds = blockDist.createDomain(0..<n),
      DstInds = blockDist.createDomain(0..<m);

var Src: [SrcInds] int,
    Inds, Dst: [DstInds] int;
…
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```




```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```



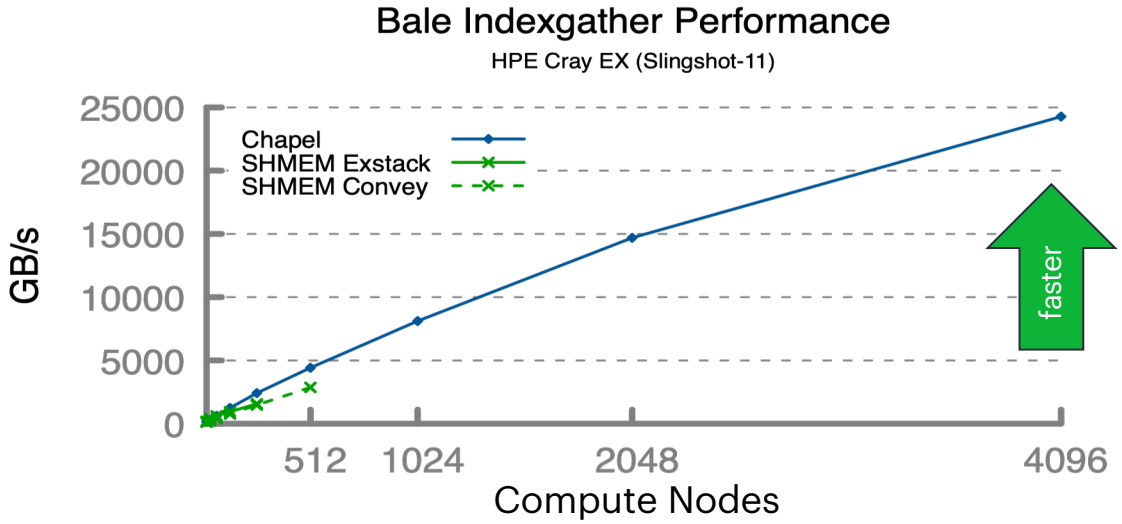
Bale IG in Chapel: Distributed Parallel Version on HPE Cray EX

```
use BlockDist;

config const n = 10,
             m = 4;

const SrcInds = blockDist.createDomain(0..<n),
      DstInds = blockDist.createDomain(0..<m);

var Src: [SrcInds] int,
    Inds, Dst: [DstInds] int;
…
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```




```
$ chpl bale-ig.chpl --fast --auto-aggregation
$ ./bale-ig -nl 4096 --n=… --m=…
$
```

Bale IG in Chapel vs. SHMEM on HPE Cray EX

Chapel

```
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

SHMEM (Exstack version)

```
i=0;
while( exstack_proceed(ex, (i==l_num_req)) ) {
  i0 = i;
  while(i < l_num_req) {
    l_indx = pckindx[i] >> 16;
    pe  = pckindx[i] & 0xffff;
    if(!exstack_push(ex, &l_indx, pe))
      break;
    i++;
  }

  exstack_exchange(ex);

  while(exstack_pop(ex, &idx , &fromth)) {
    idx  = ltable[idx];
    exstack_push(ex, &idx, fromth);
  }
  lgp_barrier();
  exstack_exchange(ex);

  for(j=i0; j<i; j++) {
    fromth = pckindx[j] & 0xffff;
    exstack_pop_thread(ex, &idx, (uint64_t)fromth);
    tgt[j] = idx;
  }
  lgp_barrier();
}
```

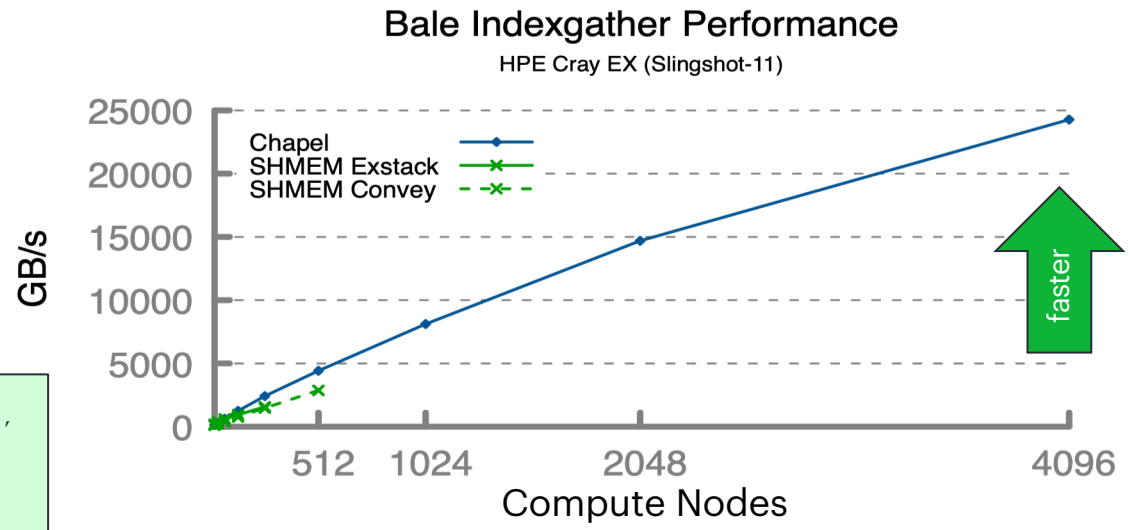
SHMEM (Conveyors version)

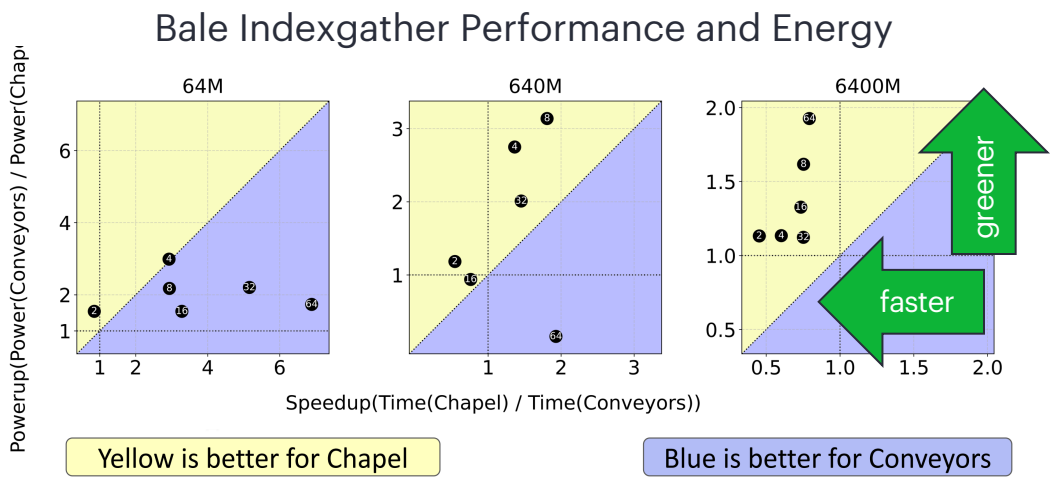
```
i = 0;
while (more = convey_advance(requests, (i == l_num_req)),
       more | convey_advance(replies, !more)) {

  for (; i < l_num_req; i++) {
    pkg.idx = i;
    pkg.val = pckindx[i] >> 16;
    pe = pckindx[i] & 0xffff;
    if (! convey_push(requests, &pkg, pe))
      break;
  }

  while (convey_pull(requests, ptr, &from) == convey_OK) {
    pkg.idx = ptr->idx;
    pkg.val = ltable[ptr->val];
    if (! convey_push(replies, &pkg, from)) {
      convey_unpull(requests);
      break;
    }
  }

  while (convey_pull(replies, ptr, NULL) == convey_OK)
    tgt[ptr->idx] = ptr->val;
}
```





[performance and energy results from *Heading Towards Energy Savings or Just Performance: Case-Study on Message Aggregation-Based Runtimes,* Shubhendra Pal Singhal et al., CUG 2026, April 28, 2026]

Summary of this section

Chapel supports language features for:

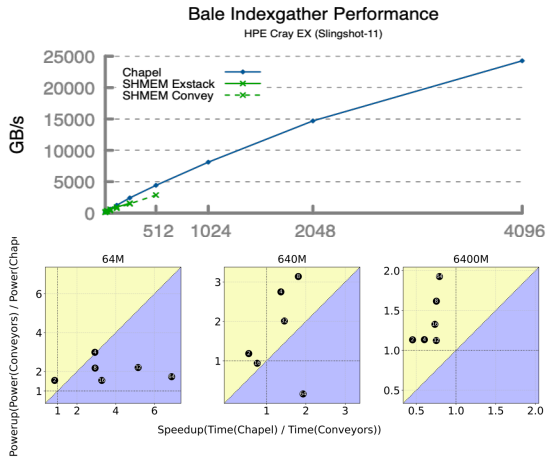
- **data parallelism:**
  - **foreach:** parallelism without creating tasks (e.g., vectorization)
  - **forall:** parallelism using an iterand-defined number of tasks
  - **[*i* in *Iter*]:** equivalent to 'forall' if *Iter* supports parallel iteration, serial otherwise
  - **whole-array operations / promotion:** call scalar operators & procedures with arrays
- **parallel zippered iteration:** loop over multiple iterands simultaneously
- **distributed arrays:** declared using a global problem size, mapped to multiple nodes

```
foreach (d, i) in
forall (d, i) in
[i in 0..<n] i*11;
Dst = Src[Inds];
zip(Dst, Inds)
```

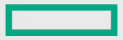
```
SrcInds = blockDist.createDomain(0..<n)
Src: [SrcInds] int
```

Chapel's features support:

- **great performance and scalability:** shown here using 4k processors, 500,000+ cores
- **energy-efficiency:** due in part to running a process per node or socket rather than core

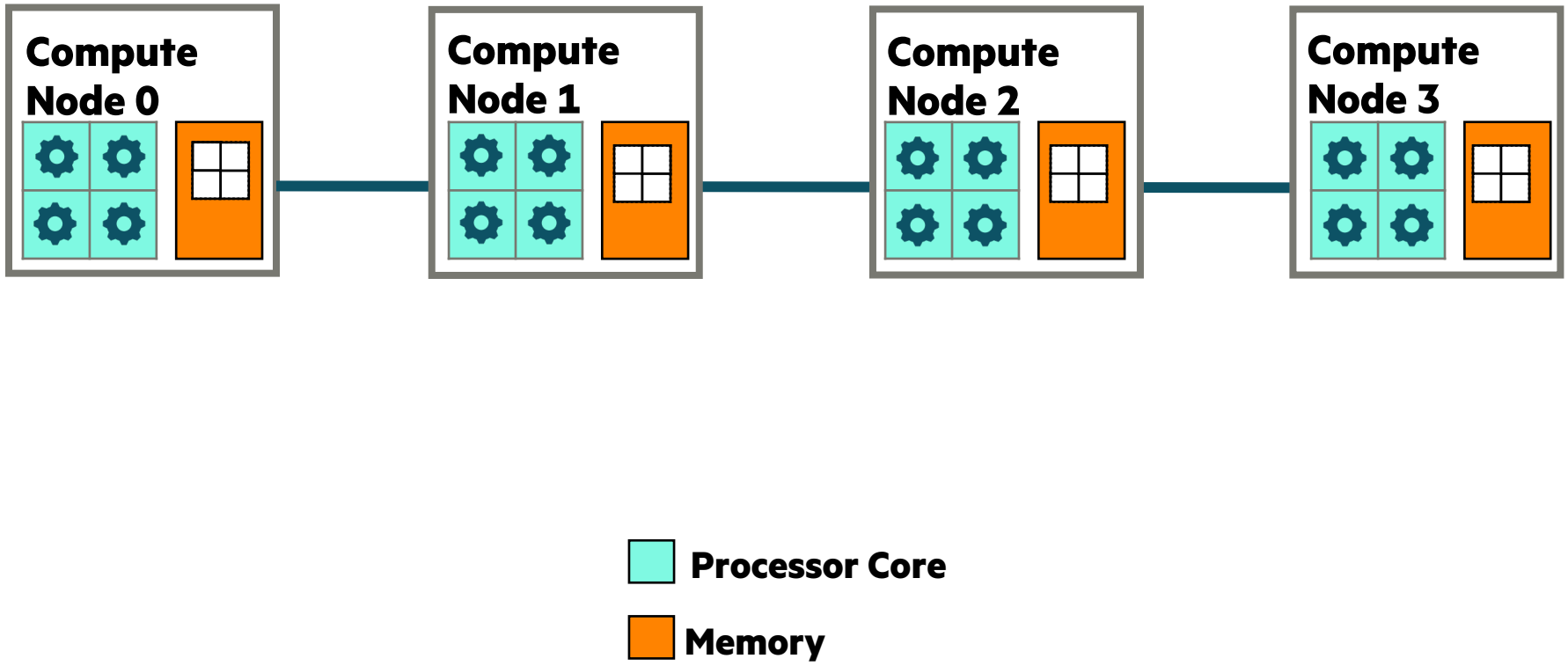


“Low-level” Chapel Features and GPU support



Key Concerns for Scalable Parallel Computing

1. **parallelism:** What computational tasks should run simultaneously?
2. **locality:** Where should tasks run? Where should data be allocated?

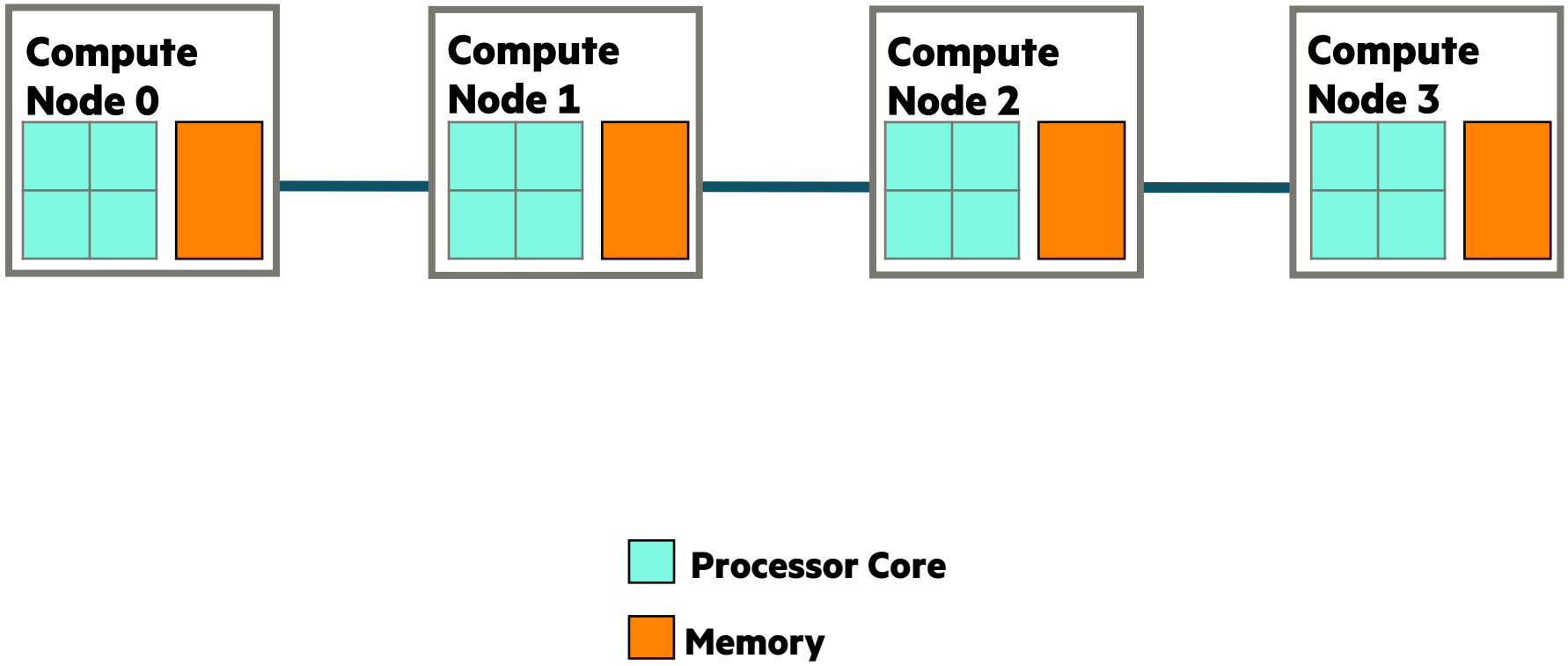


Locales in Chapel

In Chapel, a *locale* refers to a compute resource with…

- processors, so it can run tasks
- memory, so it can store variables

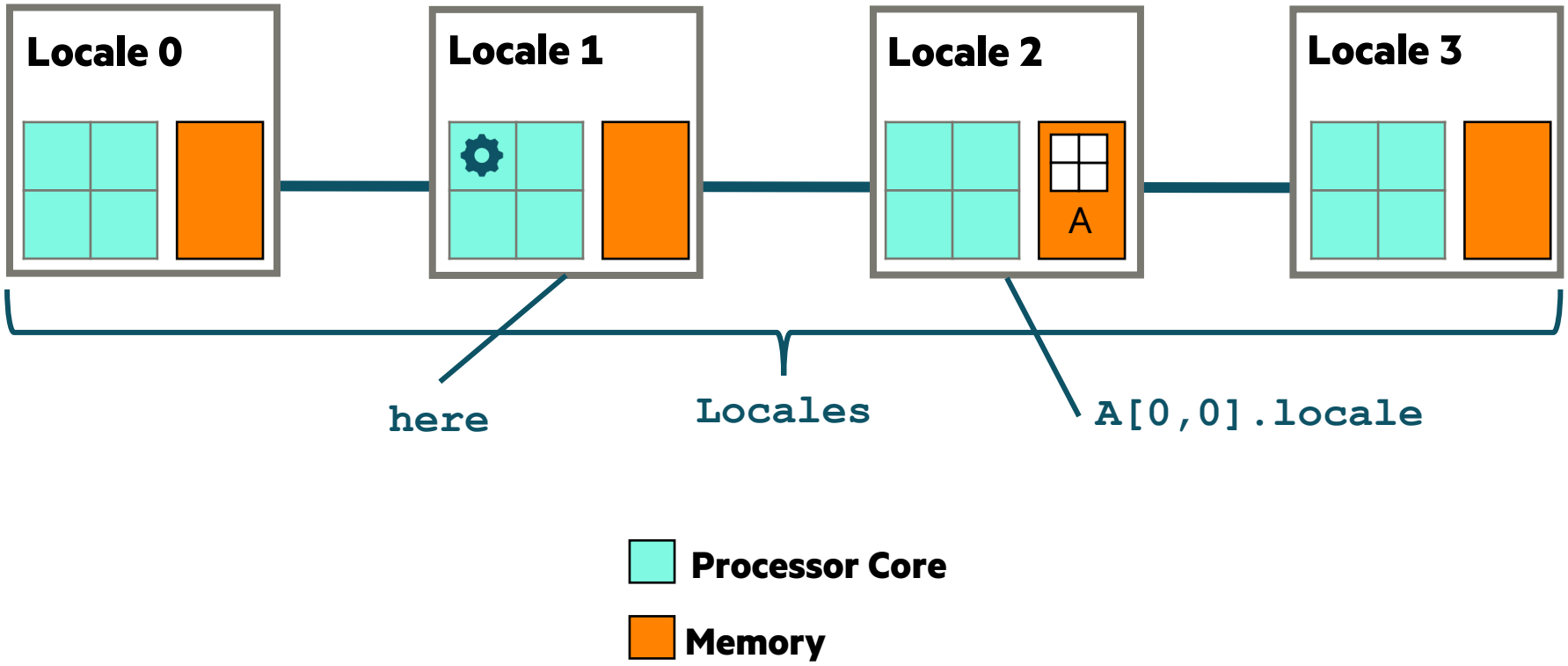
For now, think of each compute node as being a locale



Reasoning About Locales in Chapel

Built-in features for reasoning about locality within Chapel:

- **`Locales`**: An array of locale values representing the system resources on which the program is running
- **`here`**: The locale on which the current task is executing
- *expr*`.locale`: The locale on which a given variable is stored



Basic Features for Locality

```
writeln("Hello from locale ", here.id);

var A: [1..2, 1..2] real;

for loc in Locales {
  on loc {
    var B = A;
  }
}
```

All Chapel programs begin running as a single task on locale 0

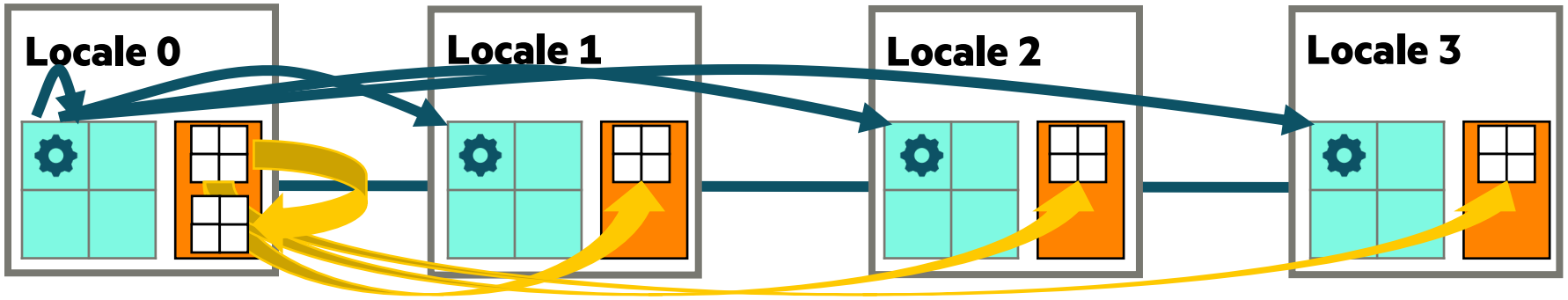
Variables are stored using the memory local to the current task

This loop will serially iterate over the program's locales

on-clauses move tasks to target locales

remote variables can be accessed directly

This is a distributed, yet serial, computation



Mixing Locality with Task Parallelism

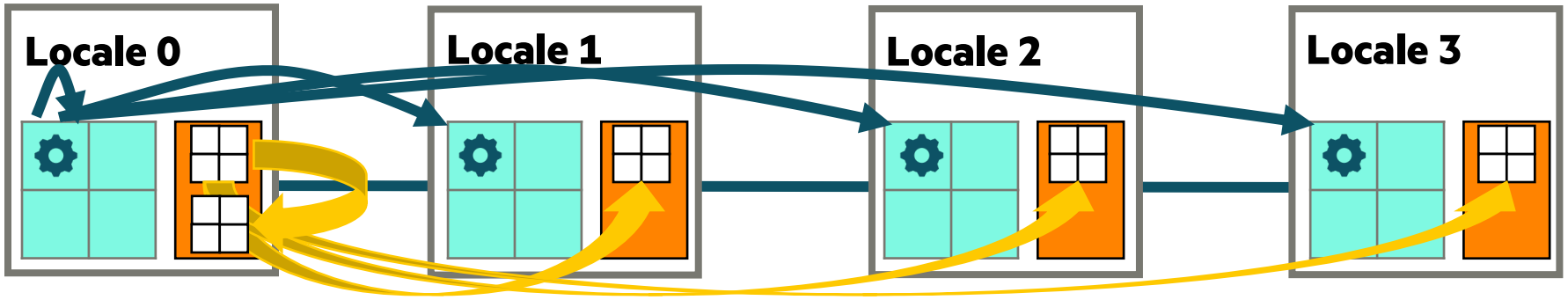
```
writeln("Hello from locale ", here.id);

var A: [1..2, 1..2] real;

coforall loc in Locales {
  on loc {
    var B = A;
  }
}
```

The coforall loop creates
a parallel task per iteration
(in this case, a task per locale)

This is a distributed parallel computation



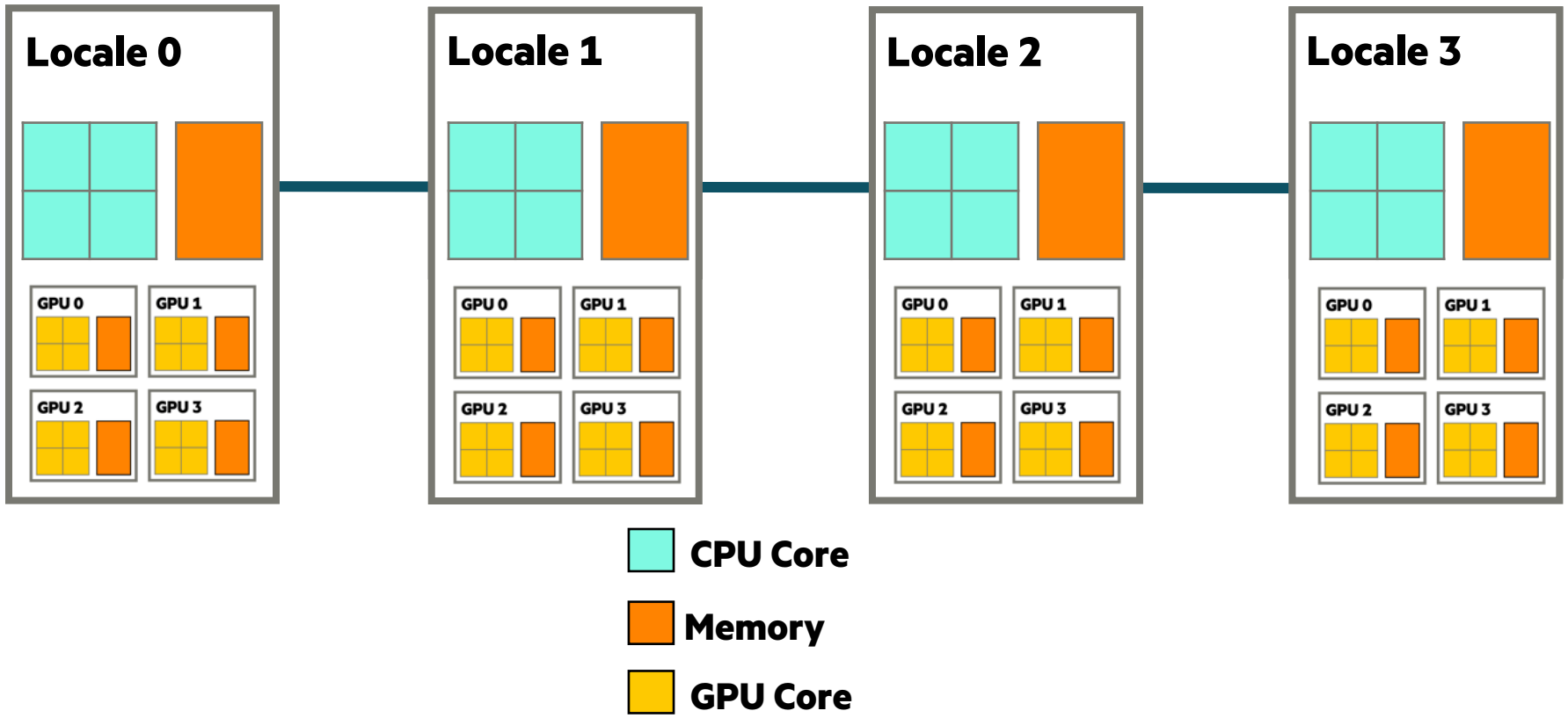
Chapel with GPUs

In Chapel, we represent GPUs as *sub-locales*

- Each top-level locale may have an array of locales called ‘gpus’
- We can then target them using Chapel’s traditional features for parallelism + locality

```
on here.gpus[0] { … }
```

```
coforall gpu in here.gpus do on gpu { … }
```



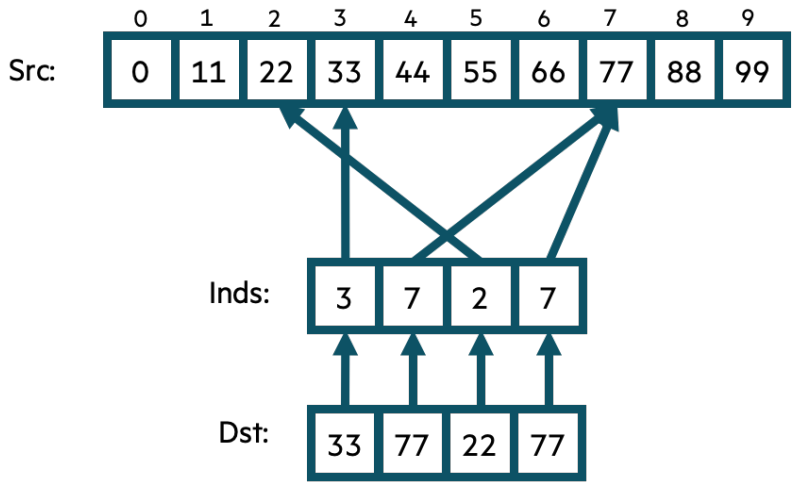
Bale IG in Chapel: Parallel, Zippered Version (Multicore)

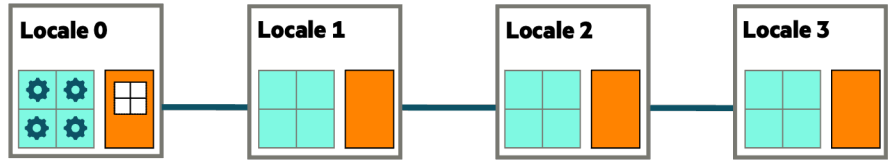
```
config const n = 10,
             m = 4;




var Src: [0..<n] int,
    Inds, Dst: [0..<m] int;
…
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```



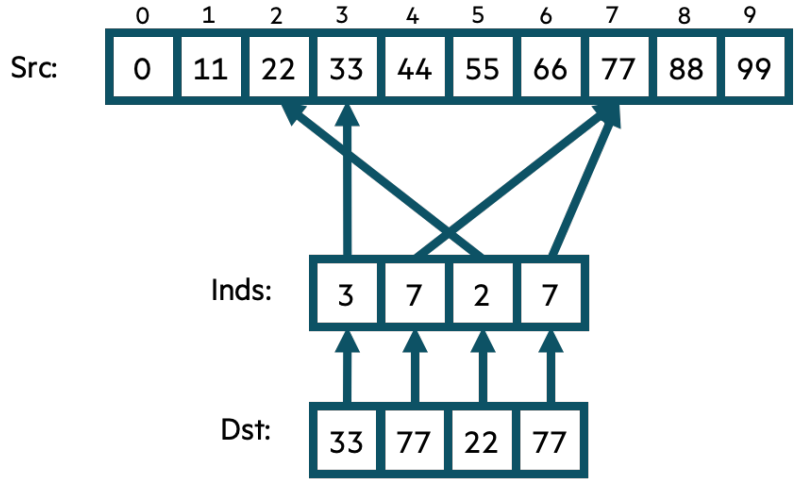


Bale IG in Chapel: Parallel, Zippered Version (single GPU)

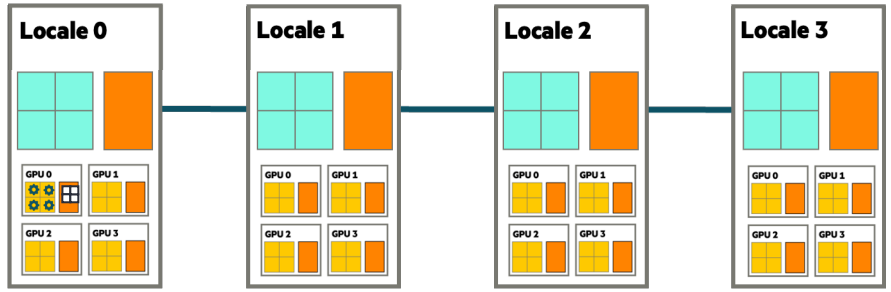
```
config const n = 10,
             m = 4;



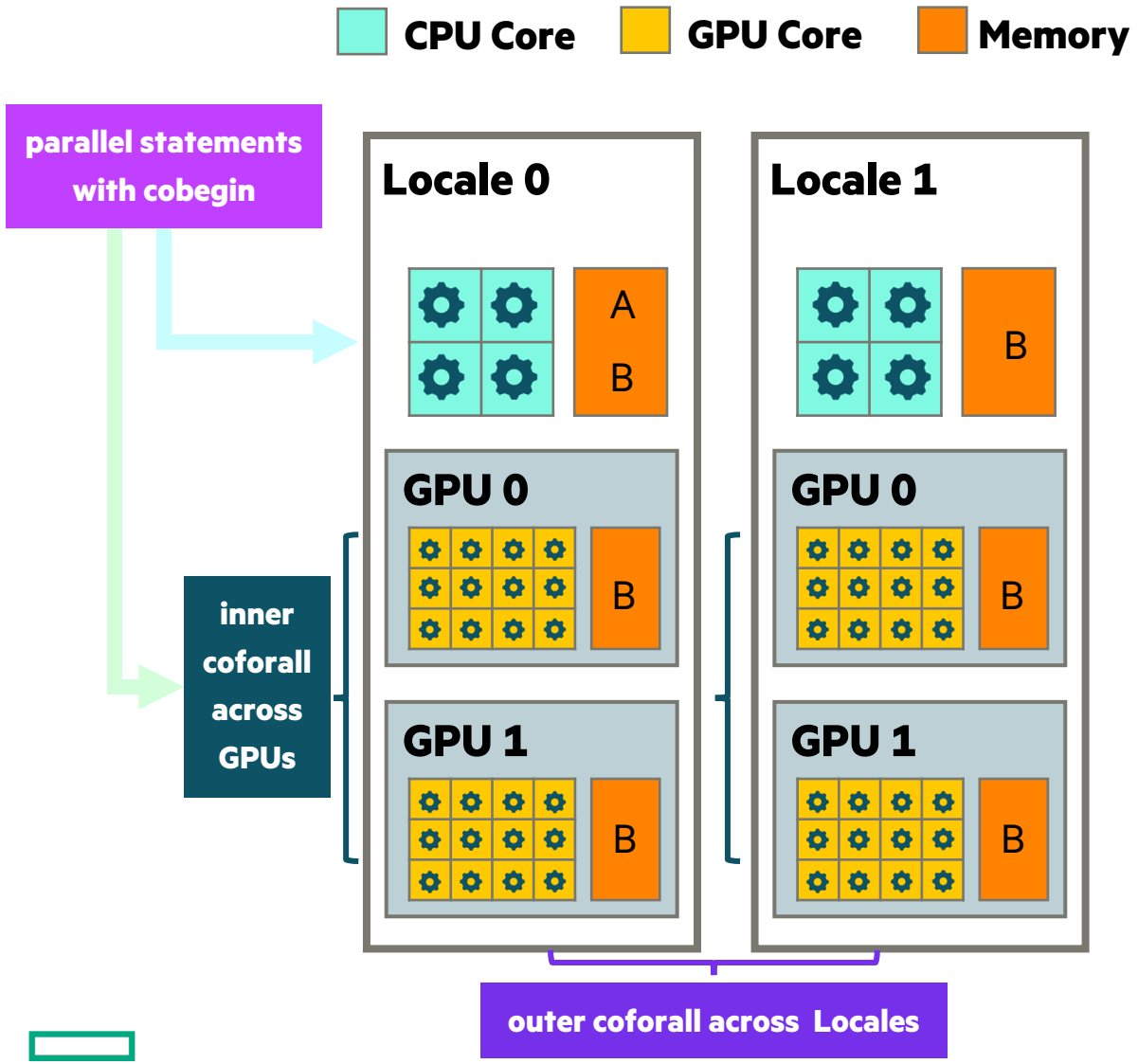
on here.gpus[0] {
  var Src: [0..<n] int,
      Inds, Dst: [0..<m] int;
  …
  forall (d, i) in zip(Dst, Inds) do
    d = Src[i];
}
```




```
$ chpl bale-ig.chpl
$ ./bale-ig -nl 4
$
```



Targeting CPUs and GPUs using Parallelism and Locality




```
var A: [1..n, 1..n] real;
coforall l in Locales do on l {
  cobegin {
    {
      var B: [1..n, 1..n] real;
      B = 2;
      A = B;
    }
    coforall g in here.gpus do on g {
      var B: [1..n, 1..n] real;
      B = 2;
      A = B;
    }
  }
}
writeln(A);
```

Summary of this section

Chapel supports language features for:

- **task parallelism:** creation of explicit tasks
  - **coforall:** creates a task per iteration
  - **cobegin:** creates a task per child statement

```
coforall loc in
cobegin
```

- **locality:**
  - **locales:** represent locality on the target system
  - **on-clauses:** specify where data should be allocated and tasks should be run
  - **locality queries:**
    - "Where is this task running?"
    - "Where is this data allocated?"
  - **sub-locales:** represent nested, potentially heterogeneous locality (e.g., GPUs)

```
Locales
on loc
```

```
here
expr.locale
here.gpus
```

Chapel Features Not Covered Tonight

Rich base language features:

- **object-oriented programming:** value- and reference-based objects
- **iterators**
- **procedures:** generics, polymorphism, overloading, default arguments, keyword-based argument passing
- **namespacing**
- **interoperability**
- **…**

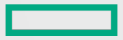
Additional parallel features:

- **begin:** create asynchronous tasks
- **atomic / sync variables:** synchronize between tasks
- **rich array types and operations:** multidimensional, associative, sparse, slicing, reindexing, …
- **reductions / scans:** apply operations to collections
- **user-defined parallel iterators and distributions**
- **…**

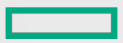
Tools: linter, language server, VSCode support, docs-generation, debugger, package manager, …

Live Demo of Chapel

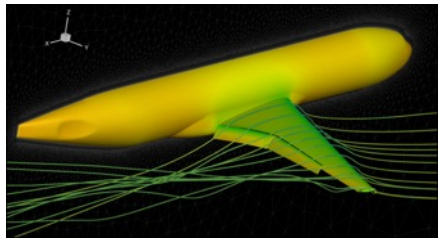
Jade Abraham



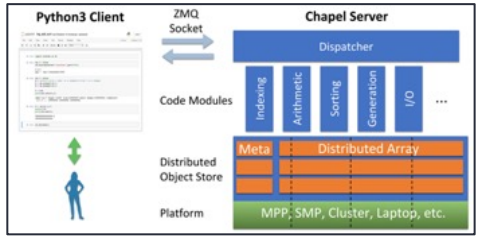
Applications of Chapel



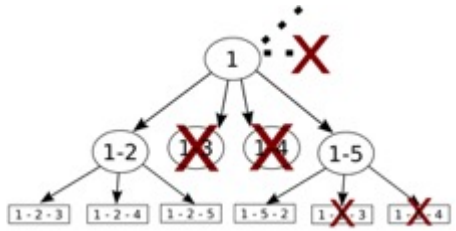
Applications of Chapel



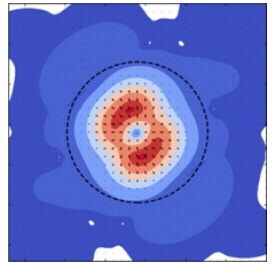
CHAMPS: 3D Unstructured CFD
Laurendeau, Bourgault-Côté, Parenteau, Plante, et al.
École Polytechnique Montréal



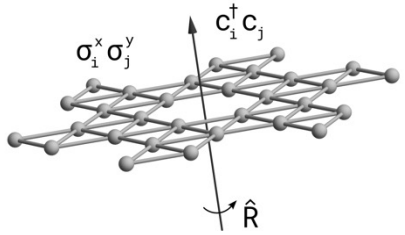
Arkouda: Interactive Data Science at Massive Scale
Mike Merrill, Bill Reus, et al.
U.S. DoD



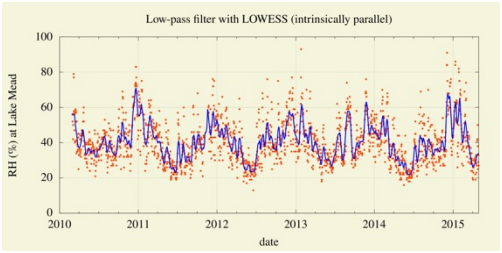
ChOp: Chapel-based Optimization
T. Carneiro, G. Helbecque, N. Melab, et al.
INRIA, IMEC, et al.



ChplUltra: Simulating Ultralight Dark Matter
Nikhil Padmanabhan, J. Luna Zagorac, et al.
Yale University et al.

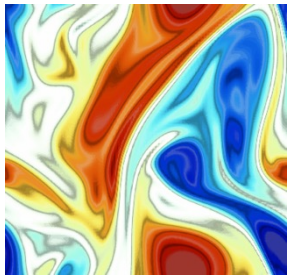


Lattice-Symmetries: a Quantum Many-Body Toolbox
Tom Westerhout
Radboud University

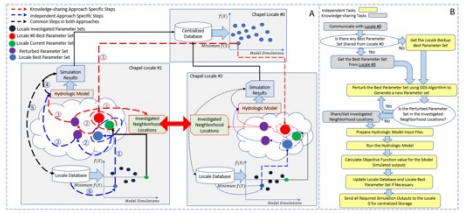


Desk dot chpl: Utilities for Environmental Eng.
Nelson Luis Dias
The Federal University of Paraná, Brazil

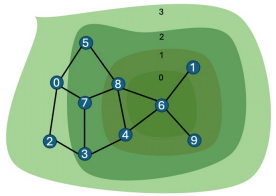
RapidQ: Mapping Coral Biodiversity
Rebecca Green, Helen Fox, Scott Bachman, et al.
The Coral Reef Alliance



ChapQG: Layered Quasigeostrophic CFD
Ian Grooms and Scott Bachman
University of Colorado, Boulder et al.

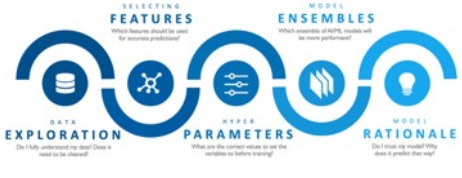


Chapel-based Hydrological Model Calibration
Marjan Asgari et al.
University of Guelph



Arachne Graph Analytics
Bader, Du, Rodriguez, et al.
New Jersey Institute of Technology

Modeling Ocean Carbon Dioxide Removal
Scott Bachman Brandon Neth, et al.
[C]Worthy



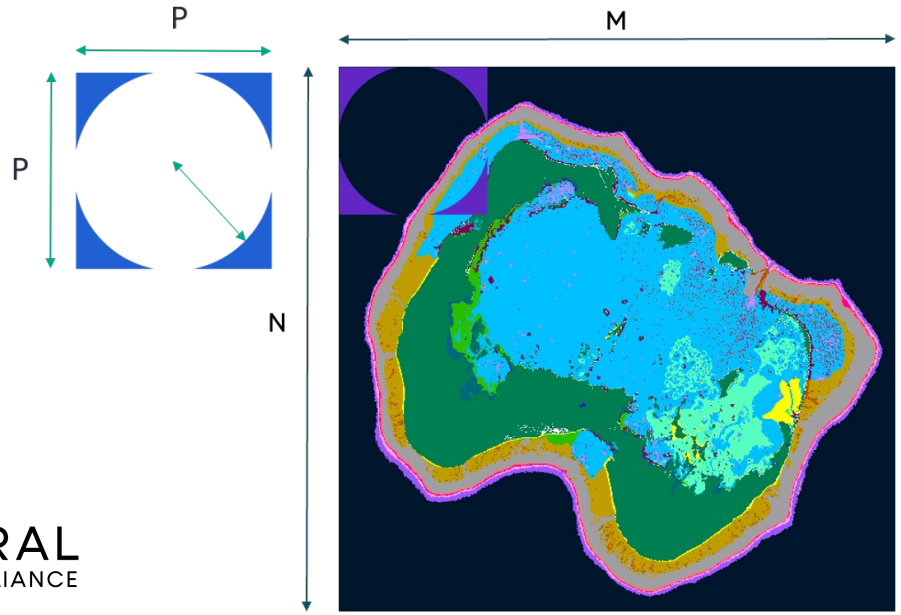
CrayAI HyperParameter Optimization (HPO)
Ben Albrecht et al.
Cray Inc. / HPE

[images provided by their respective teams and used with permission]

RapidQ Coral Biodiversity Application

What is it?

— Measures coral reef diversity using high-res satellite image analysis
— ~230 lines of Chapel code written in late 2022
— Initial version was CPU-only

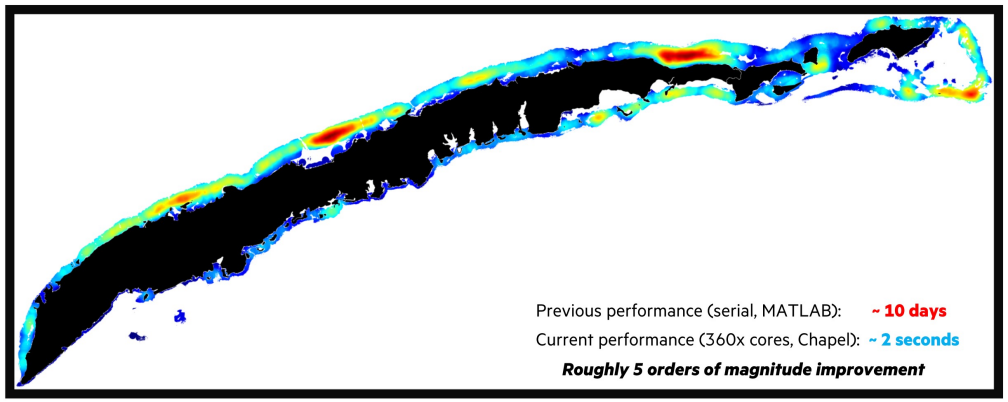


Who wrote it?

— Scott Bachman, NCAR/[C]Worthy
  • with Rebecca Green, Helen Fox, Coral Reef Alliance

Why Chapel?

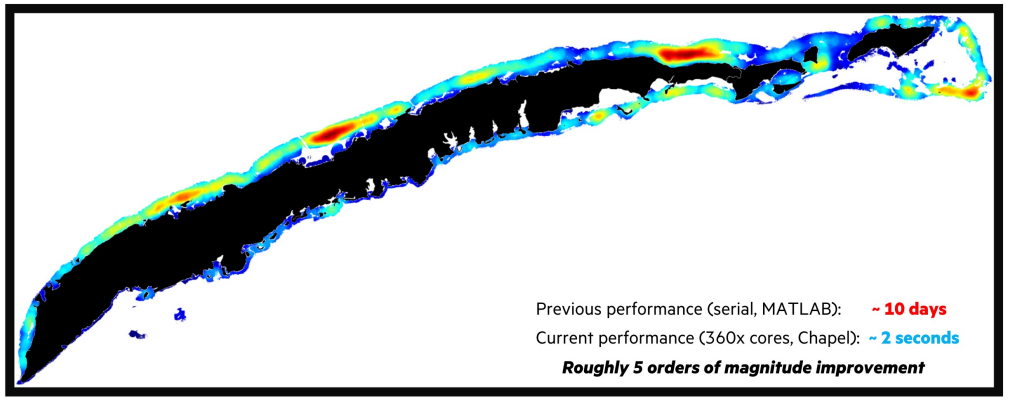
— easy transition from Python/Matlab, which were being used
— massive performance improvement:
  ~10-day Matlab run finished in ~2 seconds using 360 cores
— enabled unexpected algorithmic improvements

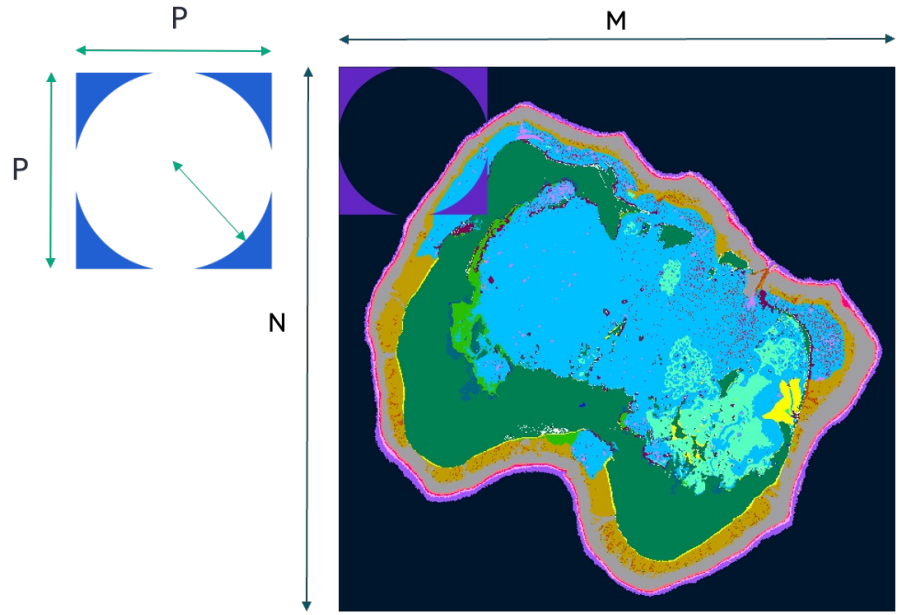


From Scott Bachman's CHIUW 2023 talk:
https://youtu.be/IJhh9KLL2X0

RapidQ Improvements on GPUs

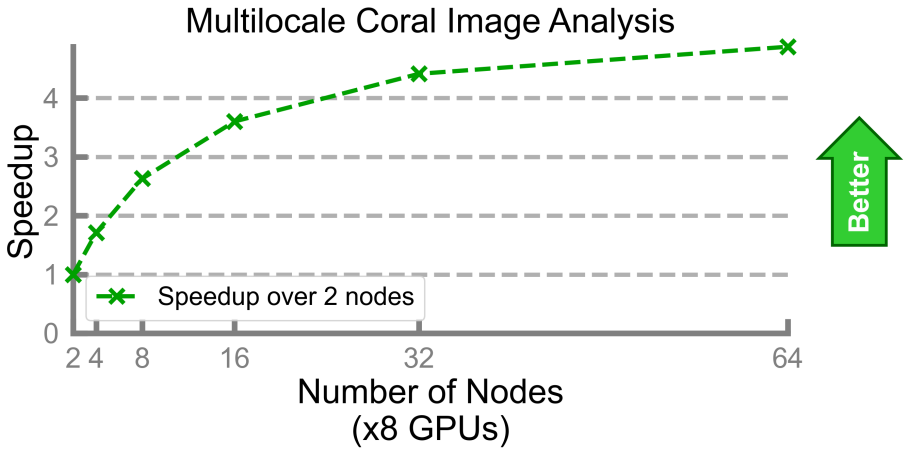
Original algorithm: Habitat Diversity, *O(M · N · P)*



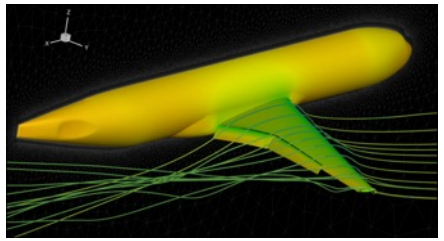


Improved algorithm: Spectral Diversity, *O(M · N · P³)*

- Chapel run was estimated to require ~4 weeks on an 8-core desktop
- code was updated to leverage GPUs during Chapel's early GPU days
  - required adding ~90 lines of code for a total of ~320
  - ran on Frontier, using NVIDIA K20X Kepler GPUs
- ran in ~87 minutes on 2 nodes (16 GPUs)
- and in ~17 minutes on 64 nodes (512 GPUs), a ~5x improvement

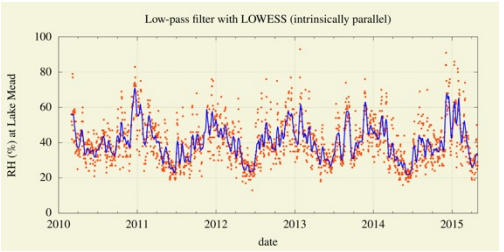


Productivity Across Diverse Application Scales (code and system size)

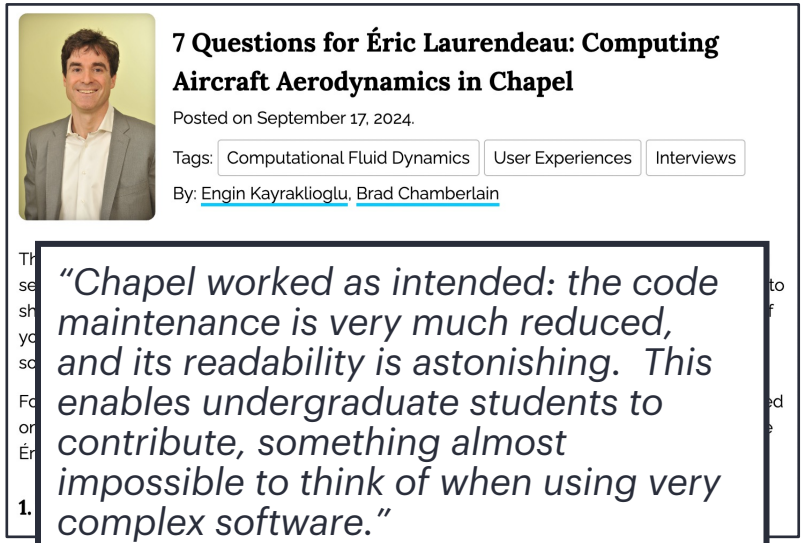


Computation: Aircraft simulation / CFD
Code size: 100,000+ lines
Systems: Desktops, HPC systems

Computation: Coral reef image analysis
Code size: ~300 lines
Systems: Desktops, HPC systems w/ GPUs



Computation: Atmospheric data analysis
Code size: 5000+ lines
Systems: Desktops, sometimes w/ GPUs



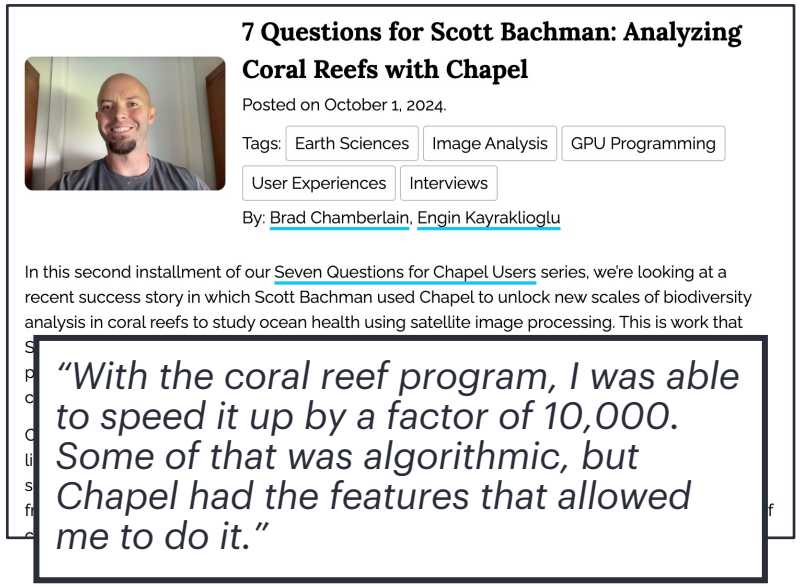
7 Questions for Éric Laurendeau: Computing Aircraft Aerodynamics in Chapel

Posted on September 17, 2024.

Tags: Computational Fluid Dynamics | User Experiences | Interviews

By: Engin Kayraklioglu, Brad Chamberlain

"Chapel worked as intended: the code maintenance is very much reduced, and its readability is astonishing. This enables undergraduate students to contribute, something almost impossible to think of when using very complex software."



7 Questions for Scott Bachman: Analyzing Coral Reefs with Chapel

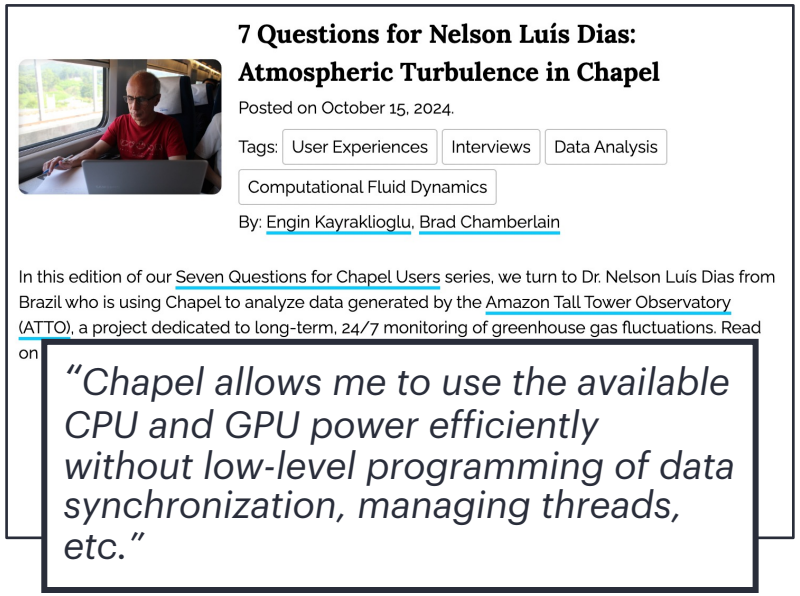
Posted on October 1, 2024.

Tags: Earth Sciences | Image Analysis | GPU Programming | User Experiences | Interviews

By: Brad Chamberlain, Engin Kayraklioglu

In this second installment of our Seven Questions for Chapel Users series, we're looking at a recent success story in which Scott Bachman used Chapel to unlock new scales of biodiversity analysis in coral reefs to study ocean health using satellite image processing. This is work that

"With the coral reef program, I was able to speed it up by a factor of 10,000. Some of that was algorithmic, but Chapel had the features that allowed me to do it."



7 Questions for Nelson Luís Dias: Atmospheric Turbulence in Chapel

Posted on October 15, 2024.

Tags: User Experiences | Interviews | Data Analysis | Computational Fluid Dynamics

By: Engin Kayraklioglu, Brad Chamberlain

In this edition of our Seven Questions for Chapel Users series, we turn to Dr. Nelson Luís Dias from Brazil who is using Chapel to analyze data generated by the Amazon Tall Tower Observatory (ATTO), a project dedicated to long-term, 24/7 monitoring of greenhouse gas fluctuations. Read on

"Chapel allows me to use the available CPU and GPU power efficiently without low-level programming of data synchronization, managing threads, etc."

“7 Questions for Chapel Users” Interview Series

Chapel’s proven to be generally applicable & attractive for:

- Computational Fluid Dynamics
- Earth Sciences
- Exploratory Data Analytics
- Astrophysics
- Graph Analysis
- Artificial Intelligence
- …

Chapel Language Blog

About Chapel Website Featured Series Tags Authors All Posts

7 Questions for Scott Bachman: Analyzing Coral Reefs with Chapel

Posted on October 1, 2024.

Tags: Earth Sciences | Image Analysis | GPUs | User Experiences | Interviews

7 Questions for Éric Laurendeau: Computing Aircraft Aerodynamics in Chapel

Posted on September 17, 2024.

Tags: Computational Fluid Dynamics | User Experiences | Interviews

7 Questions for Akihiro Hayashi: Early Chapel GPU Support through Multiresolution Abstractions

Posted on March 18, 2026.

Tags: GPUs | User Experiences | Interviews | ChapelCon

7 Questions for David Bader: Graph Analytics at Scale with Arkouda and Chapel

Posted on November 6, 2024.

Tags: Graph Analytics | Arkouda | User Experiences | Interviews

7 Questions for Bill Reus: Interactive Supercomputing with Chapel for Cybersecurity

Posted on February 12, 2025.

Tags: Data Analysis | Arkouda | User Experiences | Interviews

7 Questions for Tiago Carneiro and Guillaume Helbecque: Combinatorial Optimization in Chapel

Posted on July 30, 2025.

Tags: Searching / Sorting | GPUs | User Experiences | Interviews

7 Questions for Marjan Asgari: Optimizing Hydrological Models with Chapel

Posted on September 15, 2025.

Tags: Earth Sciences | User Experiences | Interviews

7 Questions for Oliver Alvarado Rodriguez: Exploiting Chapel’s Distributed Arrays for Graph Analysis through Arachne

Posted on January 21, 2026.

Tags: Graph Analytics | Arkouda | Sparse Arrays | User Experiences | Interviews

By: Engin Kayraklioglu, Brad Chamberlain

Part of a series: 7 Questions for Chapel Users

7 Questions for CHAMPS Developers: Empowering Academic R&D to Create Cutting-Edge CFD Apps in Chapel

Posted on March 26, 2026.

Tags: Computational Fluid Dynamics | User Experiences | Interviews

By: Engin Kayraklioglu, Brad Chamberlain

Part of a series: 7 Questions for Chapel Users

7 Questions for Nelson Luís Dias: Atmospheric Turbulence in Chapel

Posted on October 15, 2024.

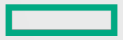
Tags: Earth Sciences | Computational Fluid Dynamics | User Experiences | Interviews | Data Analysis

By: Engin Kayraklioglu, Brad Chamberlain

Part of a series: 7 Questions for Chapel Users

https://chapel-lang.org/blog/series/7-questions-for-chapel-users/

Chapel Resources and News



Where Does Chapel Run?

In the Browser:
- Attempt This Online (ATO)
- GitHub Codespaces

Laptops/Desktops:
- Linux/UNIX
- Mac OS X
- Windows (leveraging WSL)

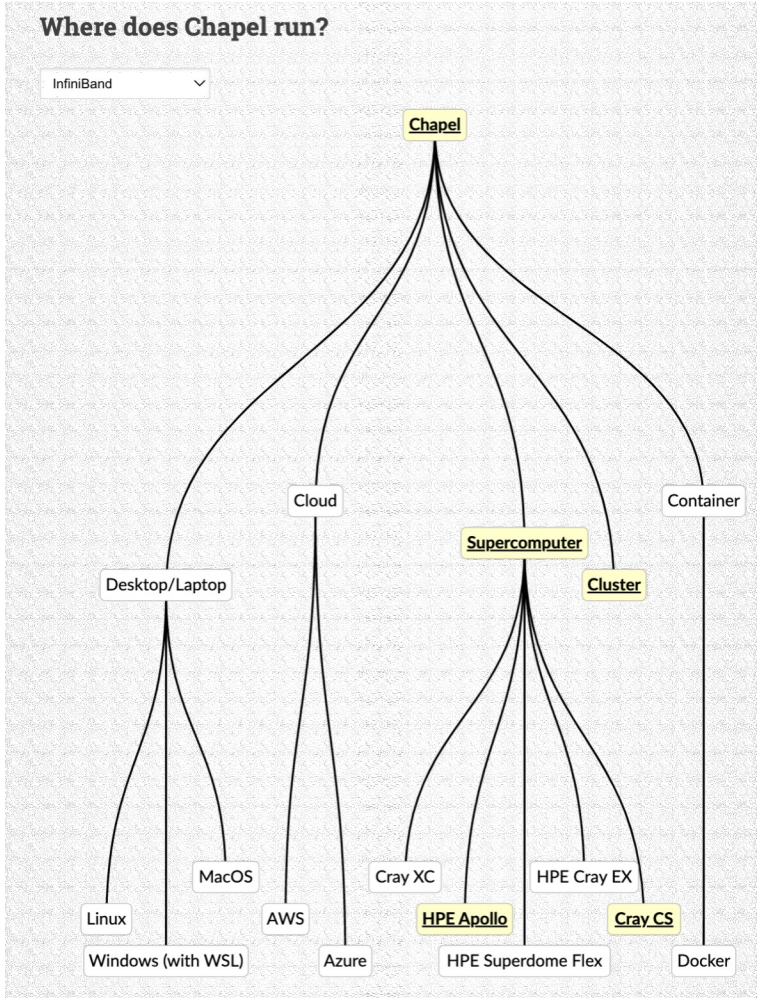
HPC Systems:
- Commodity clusters
- HPE/Cray supercomputers, such as:
  - Frontier
  - Perlmutter
  - Piz Daint
  - Polaris
  - …
- Other vendors' supercomputers

Cloud:
- AWS
- Microsoft Azure (?)
- Google Cloud (?)

CPUs:
- Intel
- AMD
- Arm (M1/M2, Graviton, A64FX, Raspberry Pi, …)

GPUs:
- NVIDIA
- AMD

Networks:
- Slingshot
- Aries/Gemini
- InfiniBand
- AWS EFA
- Ethernet

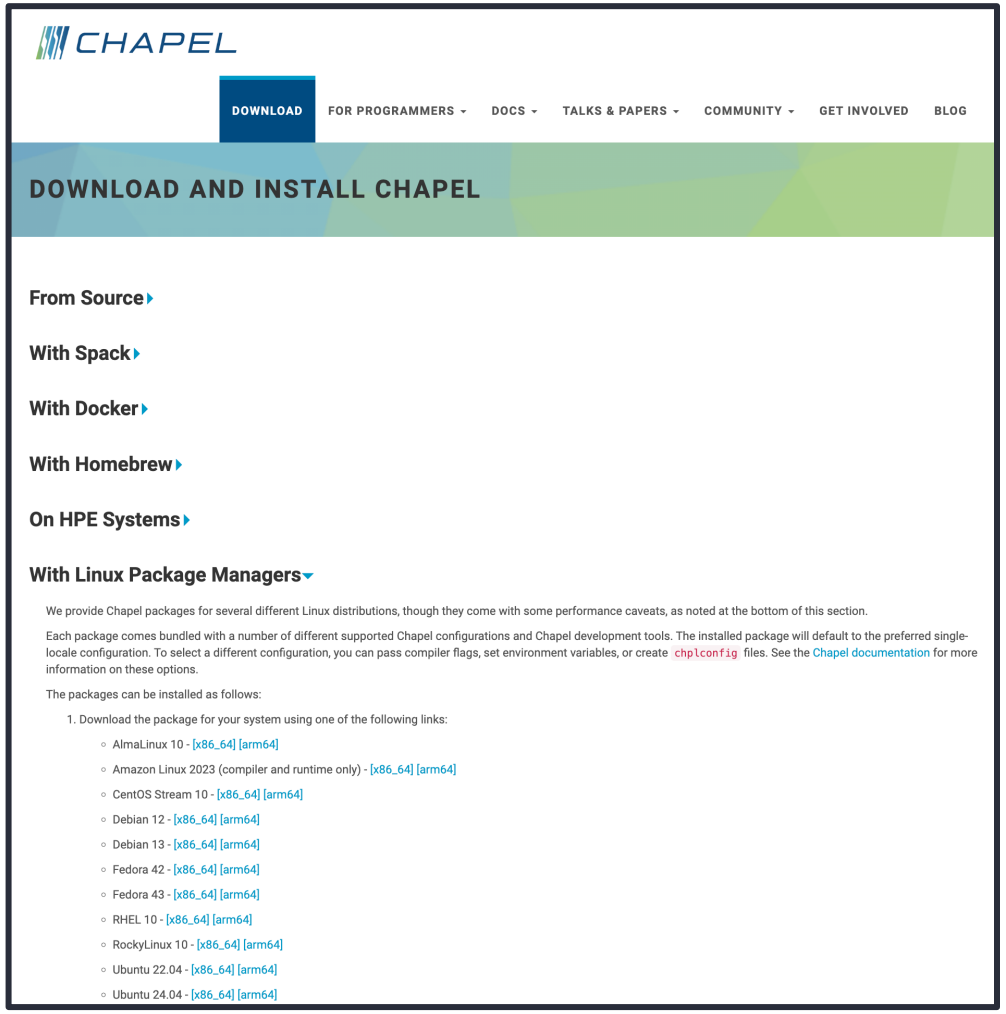


https://chapel-lang.org/docs/usingchapel/portability.html

Where can I get Chapel?

Release Formats:

— Source releases via GitHub
— Spack / E4S
— Docker
— Homebrew
— Modules on HPE Cray systems
— Linux packages via apt/rpm
— Attempt This Online / GitHub Codespaces



https://chapel-lang.org/download/

Ways to engage with the Chapel Community

Synchronous Community Events

- Project Meetings, weekly
- Deep Dive / Demo Sessions, weekly timeslot
- ChapelCon (formerly CHIUW), annually

Asynchrounous Communications

- Chapel Blog, typically ~2 articles per month
- Community Newsletter, quarterly
- Announcement Emails, around big events

Social Media

FOLLOW US

- BlueSky
- Facebook
- LinkedIn
- Mastodon
- Reddit
- X (Twitter)
- YouTube

Discussion Forums

GET IN TOUCH

- Discord
- Discourse
- Email
- GitHub Issues
- Gitter
- Slack
- Stack Overflow

Ways to Use Chapel

GET STARTED

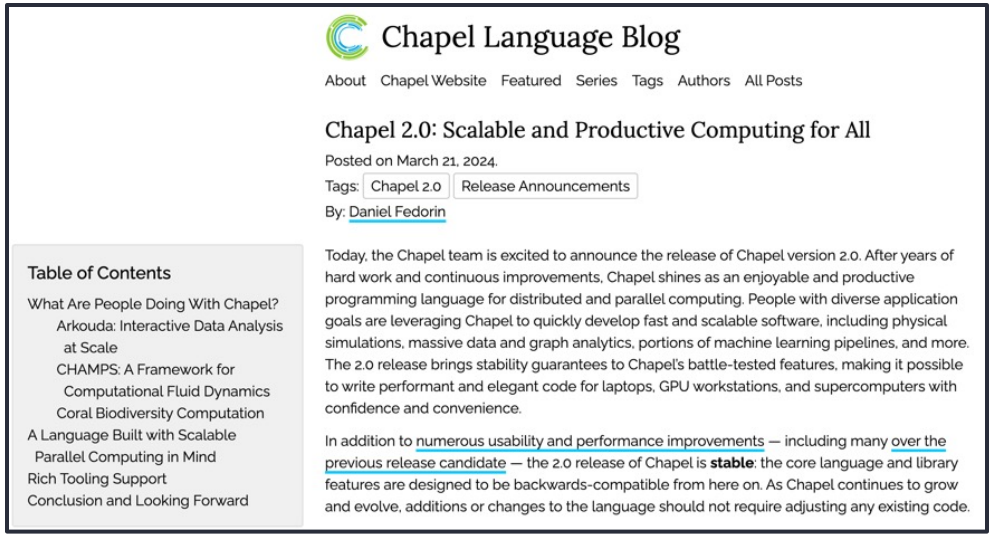
- Attempt This Online
- Docker
- E4S
- GitHub Releases
- Homebrew
- Spack

(from the footer of chapel-lang.org)

Recent News: Chapel 2.0 and HPSF

What is Chapel 2.0?

- **Released:** March 21, 2024
- Stabilizes core language and library features
  - In semantic versioning, essentially our "1.0" release
  - Non-core features marked as "unstable"
- Using an "editions" discipline to modify/add features now



https://chapel-lang.org/blog/posts/announcing-chapel-2.0/

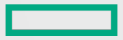
What is HPSF?

- A foundation within the Linux Foundation focused on open-source HPC software
  - Sponsored by AWS, Microsoft, DOE Labs, HPE, AMD, Arm, NVIDIA, CEA, and many others
  - https://hpsf.io/
- Chapel proudly became a member project in November 2025
  - As a result, we've opened up things like weekly meetings, governance, blog and website repos, etc.

HPSF
HIGH PERFORMANCE SOFTWARE FOUNDATION

THE LINUX FOUNDATION

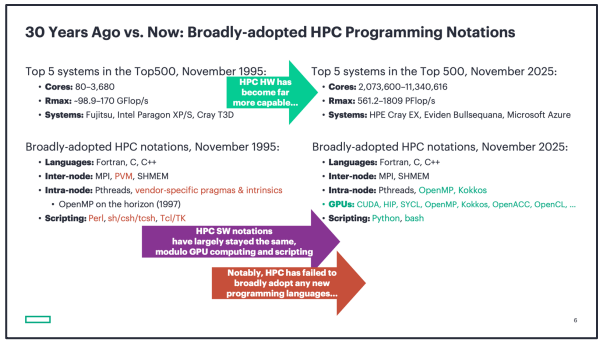
Closing Thoughts



Summary

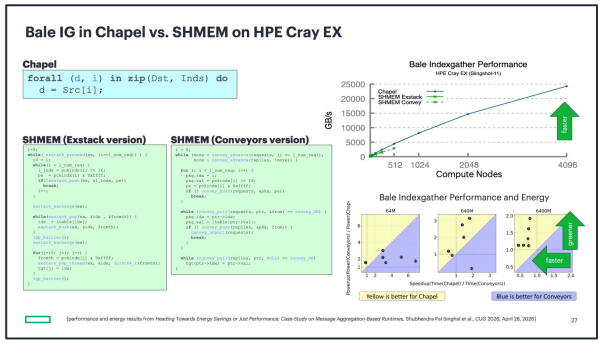
Parallel programming traditionally requires a mix of notations to leverage HW

- e.g., C++ with MPI, OpenMP, and/or CUDA
- such programming models are sufficient, but leave much to be desired
- hardware has generally become more difficult to program over time
  - and at HPC scales, hardware speeds & feeds tend to dominate budgets and attention



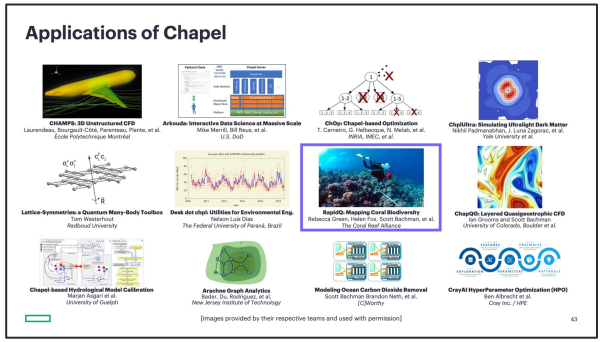
Chapel is a unique parallel language

- high-level features for parallelism and locality
- portable across CPUs, GPUs, networks, vendors, scales, …
- scalable, performant, energy-efficient (?)
- simplifies compiler optimizations on distributed systems (not discussed tonight)



Users are benefitting from Chapel, on laptops as well as supercomputers

- Coral Reef image processing
- Computational Fluid Dynamics
- Data Analysis
- …



AI and Parallel Languages

Q: Now that AIs can program*, do languages like Chapel still have value?

A: I'd say "definitely", at least for the foreseeable future:

- An AI targeting a single, unified parallel language should be at least as successful as one targeting a mash-up of lower-level notations
- As long as humans need to validate and maintain AI-developed code, the clearer it is the better

Chapel

```
forall (d, i) in zip(Dst, Inds) do
  d = Src[i];
```

SHMEM (Exstack version)

```
i=0;
while( exstack_proceed(ex, (i==l_num_req)) ) {
  i0 = i;
  while(i < l_num_req) {
    l_indx = pckindx[i] >> 16;
    pe  = pckindx[i] & 0xffff;
    if(!exstack_push(ex, &l_indx, pe))
      break;
    i++;
  }

  exstack_exchange(ex);

  while(exstack_pop(ex, &idx , &fromth)) {
    idx  = ltable[idx];
    exstack_push(ex, &idx, fromth);
  }
  lgp_barrier();
  exstack_exchange(ex);

  for(j=i0; j<i; j++) {
    fromth = pckindx[j] & 0xffff;
    exstack_pop_thread(ex, &idx, (uint64_t)fromth);
    tgt[j] = idx;
  }
  lgp_barrier();
}
```

SHMEM (Conveyors version)

```
i = 0;
while (more = convey_advance(requests, (i == l_num_req)),
       more | convey_advance(replies, !more)) {

  for (; i < l_num_req; i++) {
    pkg.idx = i;
    pkg.val = pckindx[i] >> 16;
    pe = pckindx[i] & 0xffff;
    if (! convey_push(requests, &pkg, pe))
      break;
  }

  while (convey_pull(requests, ptr, &from) == convey_OK) {
    pkg.idx = ptr->idx;
    pkg.val = ltable[ptr->val];
    if (! convey_push(replies, &pkg, from)) {
      convey_unpull(requests);
      break;
    }
  }

  while (convey_pull(replies, ptr, NULL) == convey_OK)
    tgt[ptr->idx] = ptr->val;
}
```

(* = your mileage may vary)

“This all sounds great… So, what’s the catch?”

(Or: “What keeps Brad up at night?”)

— **Adoption of Chapel:**
- a challenge for any new language
- most people aren’t actively shopping for new languages, particularly in an age with Python, Rust, Swift, Julia, …
- and even fewer are actively grappling with scalable parallel computing
- **how I get back to sleep:** Users like Nelson for whom Chapel replaces conventional desktop programming languages

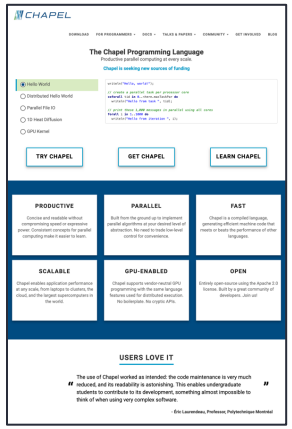
— **Technical debt / incomplete efforts**
- Chapel is now 20+ years old, and in many respects, the code reflects this
- Many language features and libraries feel rock-solid; others are squishier than we’d like
- Meanwhile, preserving portability and tracking third-party software is taking more and more time (see Jade’s recent HPSFCon talk)
- **how I get back to sleep:** “This is the nature of SW and open-source projects”; seeing how quickly things can improve with effort

— **Funding**
- Chapel has enjoyed long-term stability and growth in funding, but that has recently stalled and reversed
- Without new sources of funding or staffing/collaboration, we expect to move to a maintenance-only mode this fall
- See our recent *Chapel Project Seeks New Funding* blog post for more information
- **how I get back to sleep:** Currently, I often don’t

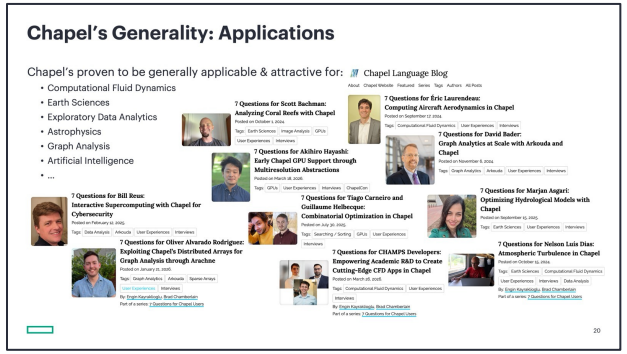
For more about…

…Chapel:

- Browse the Chapel website and blog:
- Reach out to our team and community



…applications of Chapel: Browse the *7 Questions for Chapel Users* interview series:



…me grappling with socio-technical aspects of parallel language adoption:

- *Reflections on 30 Years of HPC Programming: So many hardware advances, so little adoption of new languages*
- *10 Myths About Scalable Parallel Programming Languages (Redux)*
  - Consider starting with its summary

Closing Statements

I consider current and aspiring [scalable] parallel programmers to be at least as worthy of modern languages as the Python, Rust, Swift, and Julia communities are

Over the next 30 years, I hope we see the number of broadly adopted languages for scalable parallelism grow to be ≥1, rather than the current 0

Thank You

@ChapelLanguage