Hewlett Packard
Enterprise

Productive, Vendor-Neutral GPU Programming Using Chapel

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What is Chapel?

Chapel: A modern parallel programming language

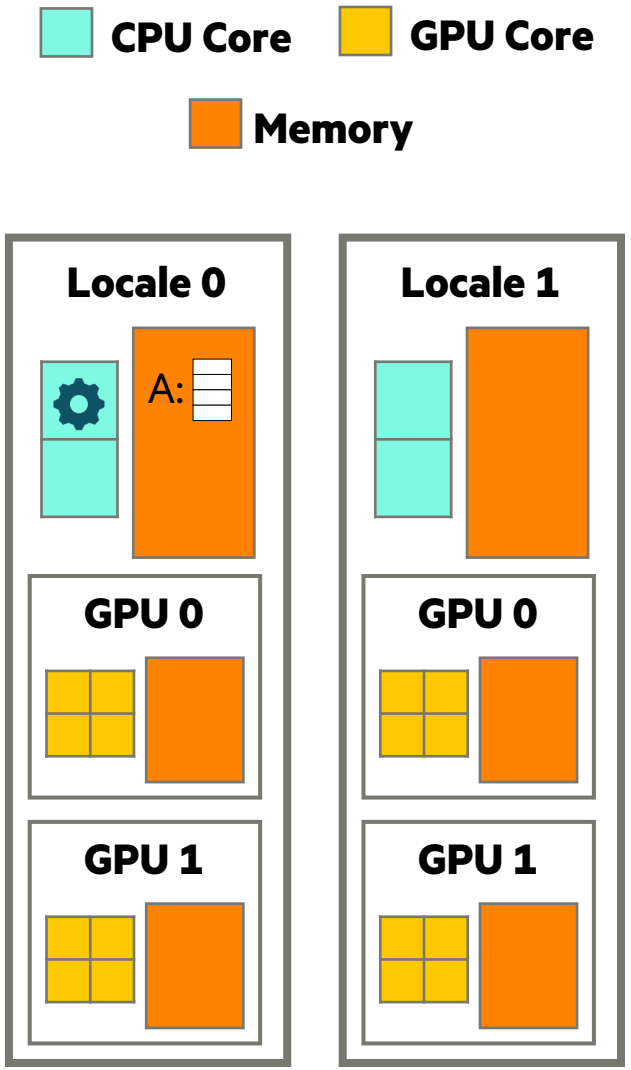
- portable & scalable
- open-source & collaborative

chapel-lang.org

Goals:

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

Programming GPUs with Chapel



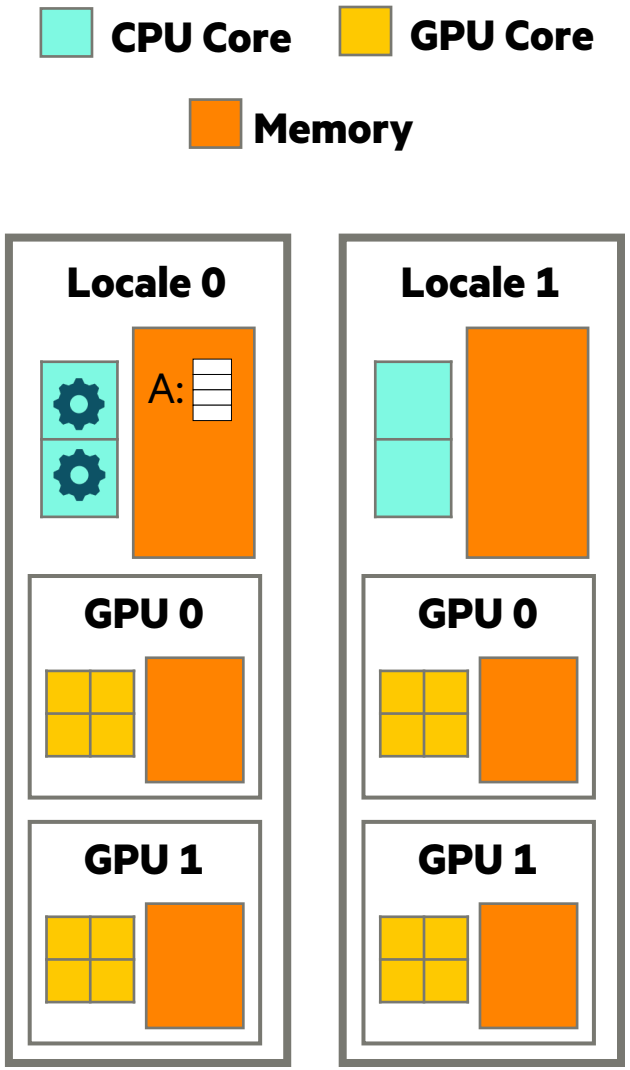

```
var A: [1..10] int;
```

Local, non-distributed array allocation

```
for elem in A do
  elem += 1;
```

Sequential iteration over the array

Programming GPUs with Chapel

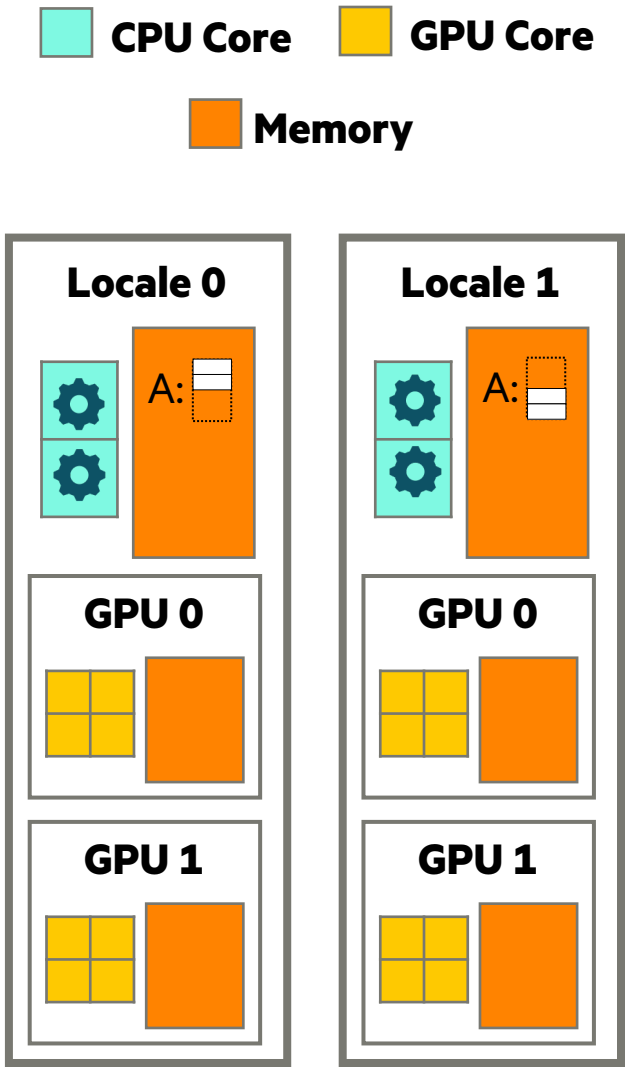



```
var A: [1..10] int;

forall elem in A do
  elem += 1;
```

Parallel iteration over the array

Programming GPUs with Chapel



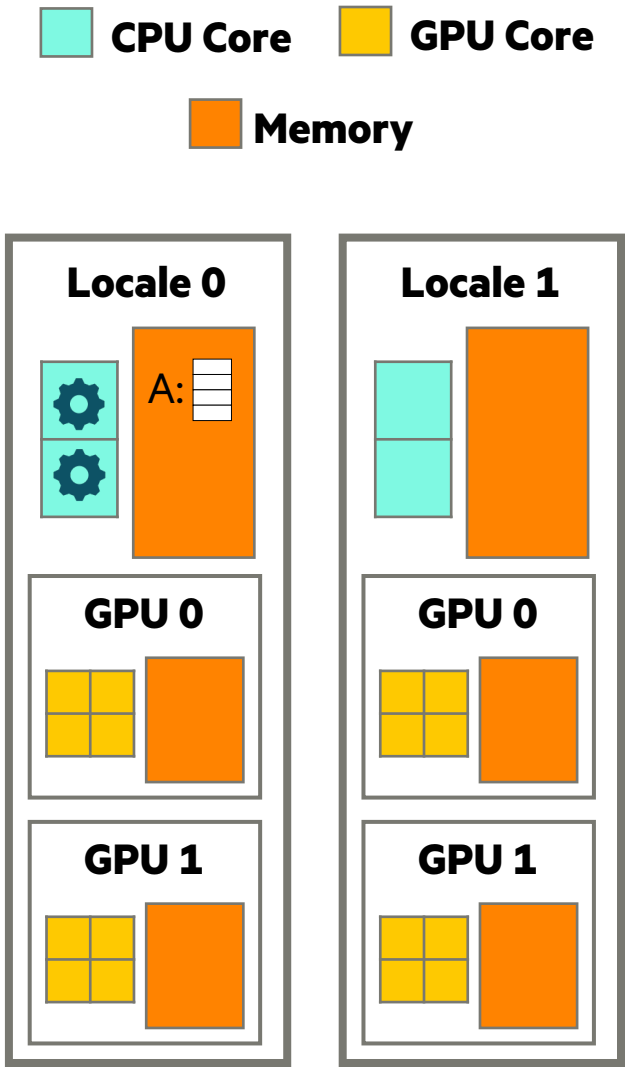

```
use BlockDist;
var Arr = blockDist.createArray(1..10, int);
```

Block-distributed array allocation

```
forall elem in Arr do
  elem += 1;
```

Distributed, parallel iteration over the array

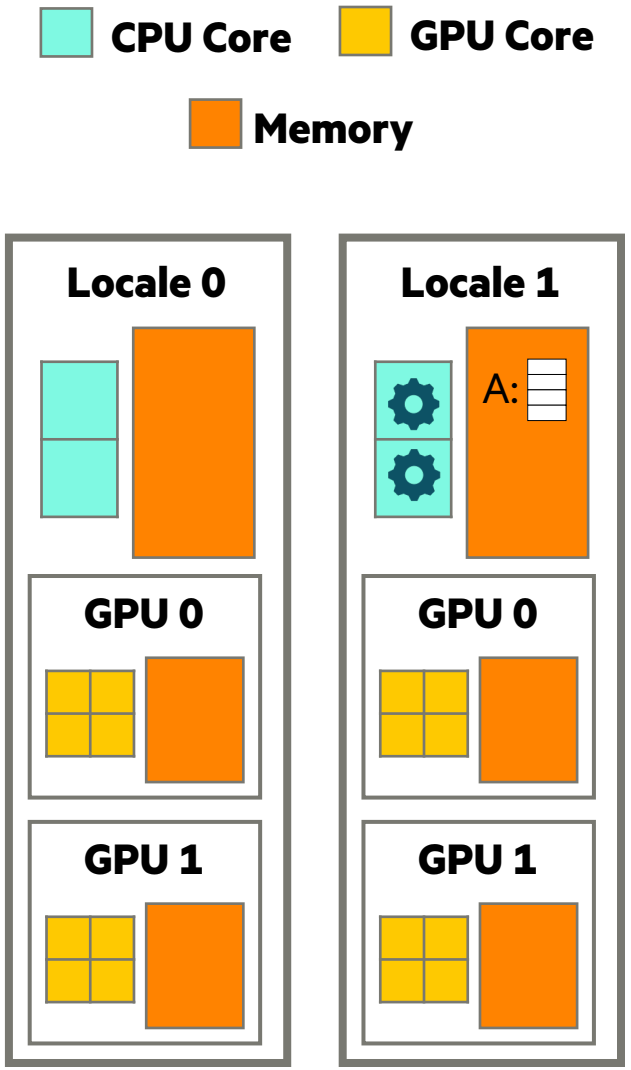
Programming GPUs with Chapel




```
var A: [1..10] int;

forall elem in A do
  elem += 1;
```

Programming GPUs with Chapel

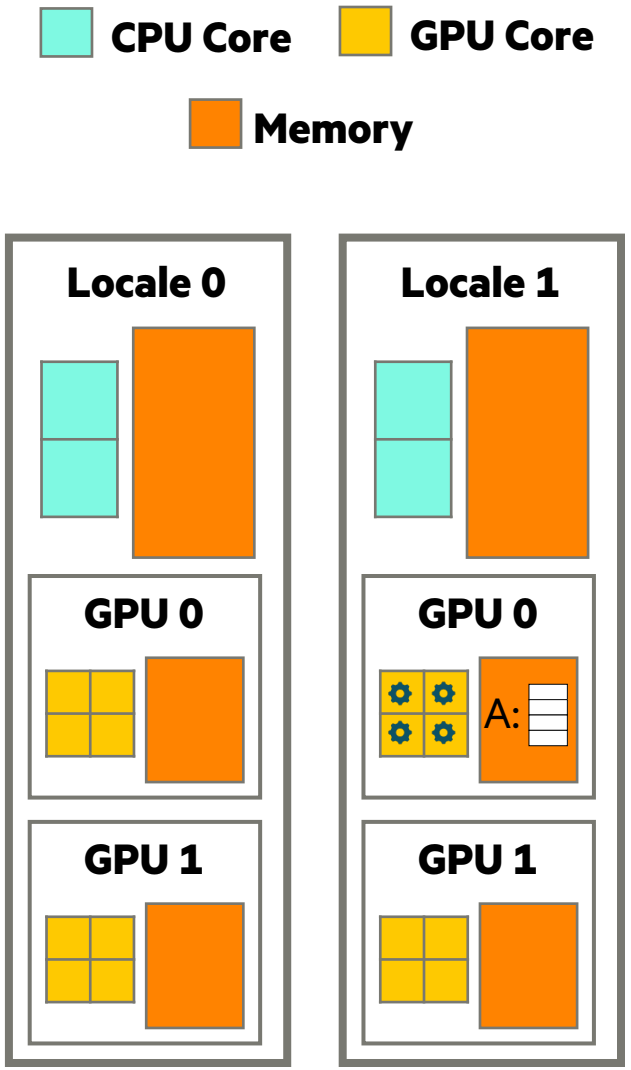



```
on Locales[1] {
  var A: [1..10] int;

  forall elem in A do
    elem += 1;
}
```

The 'on' statement moves the execution to a remote locale

Programming GPUs with Chapel

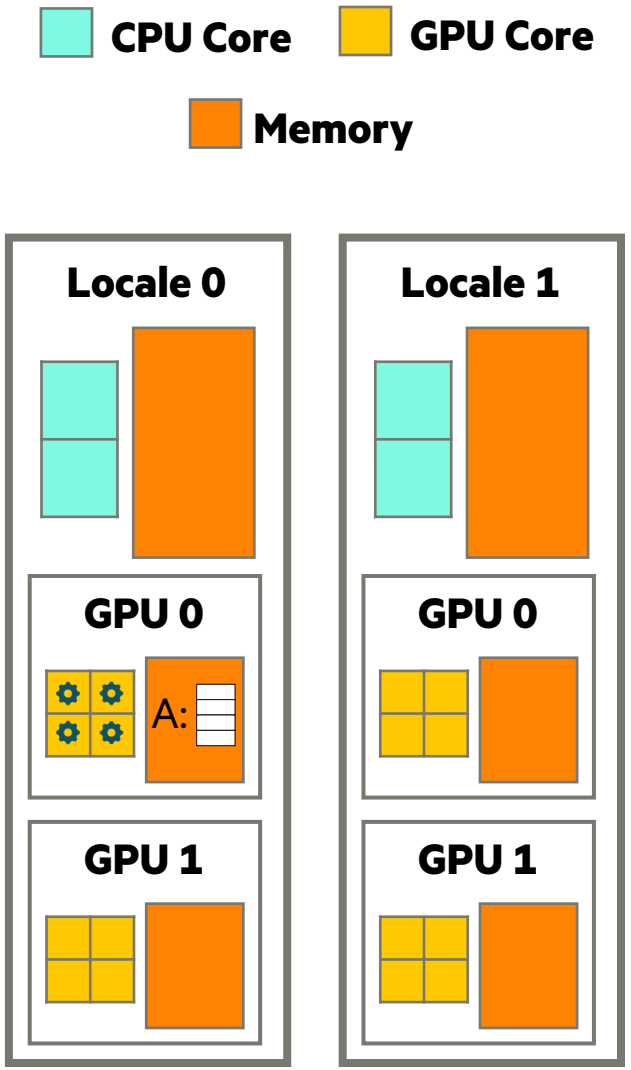



```
on Locales[1].gpus[0] {
  var A: [1..10] int;

  forall elem in A do
    elem += 1;
}
```

Each locale object has a 'gpus' array that store GPU sublocales

Programming GPUs with Chapel



'here' is a built-in representing the current execution locale

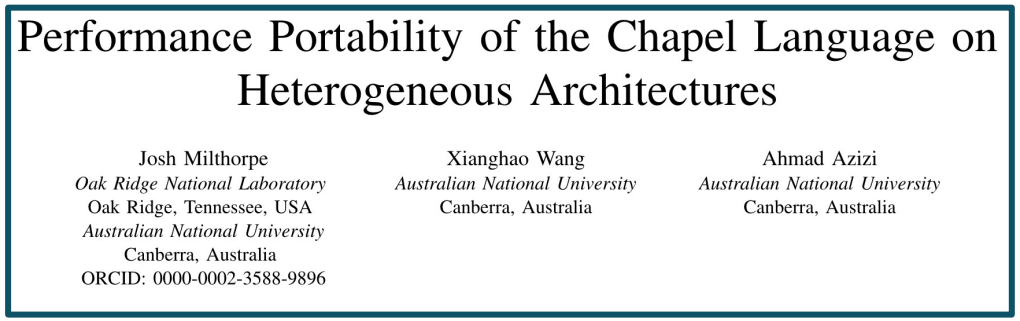
```
on here.gpus[0] {
  var A: [1..10] int;

  forall elem in A do
    elem += 1;
}
```

Frequently Asked Questions

- Using distributed arrays to distribute data on multiple GPUs is an active work area
- GPUs are supported only with the LLVM backend, which is the default
  - Chapel can also use C backend
- NVIDIA and AMD GPUs are supported with no special code needed from the user
  - We are on holding pattern to add Intel support
- How does the performance compare?
  - TL;DR Comparable to other technologies, with some exceptions, which we are aware

Milthorpe et al. IPDPSW 2024



Performance Portability of the Chapel Language on Heterogeneous Architectures

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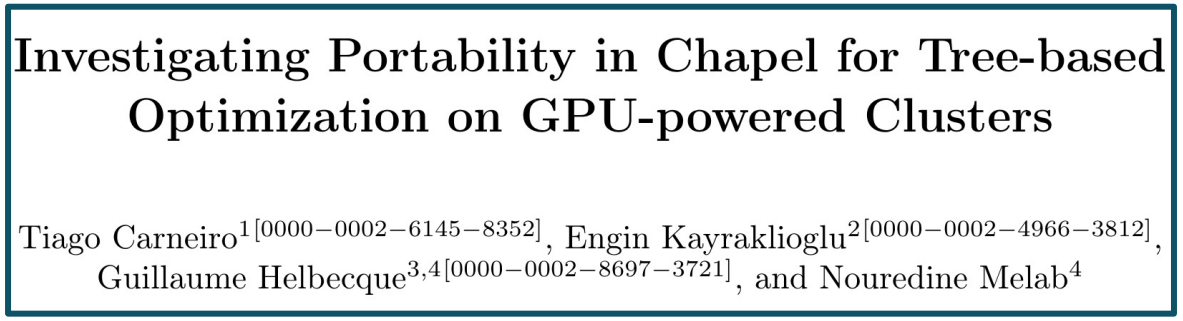
Using single GPU, compares against

CUDA, HIP, OpenMP, Kokkos

Carneiro et al. Euro-Par 2024



Investigating Portability in Chapel for Tree-based Optimization on GPU-powered Clusters

Tiago Carneiro[1][0000−0002−6145−8352], Engin Kayraklioglu[2][0000−0002−4966−3812], Guillaume Helbecque[3,4][0000−0002−8697−3721], and Nouredine Melab[4]

Using Frontier and Perlmutter, compares against

CUDA, HIP

Learn More

Meet us at the HPE Booth (2219)

Read blog articles

chapel-lang.org/blog/series/gpu-programming-in-chapel/

chapel-lang.org

Watch a Chapel+GPU tutorial

youtube.com/watch?v=1gMFtJN-4_E

Watch a hands-on demo

youtube.com/watch?v=5OqjQhfGKes

Watch a talk+demo

youtube.com/watch?v=nj-WqhGEy24

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Thank you!

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