



Hewlett Packard
Enterprise

Productive, Vendor-Neutral GPU Programming Using Chapel

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WACCPD @SC24

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What is Chapel?

Chapel: A modern parallel programming language

- portable & scalable
- open-source & collaborative

Goals:

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



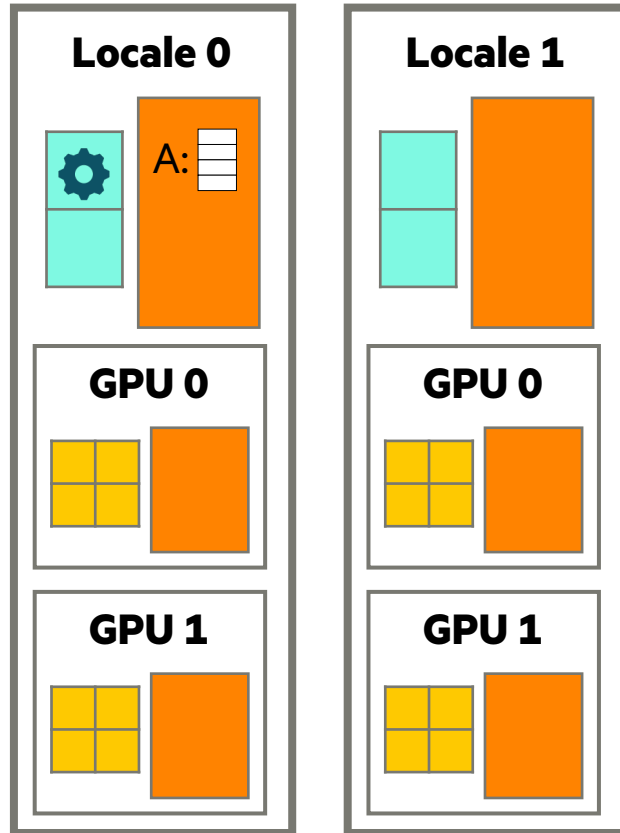
chapel-lang.org



Programming GPUs with Chapel

 CPU Core  GPU Core

 Memory



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

← Local, non-distributed array allocation

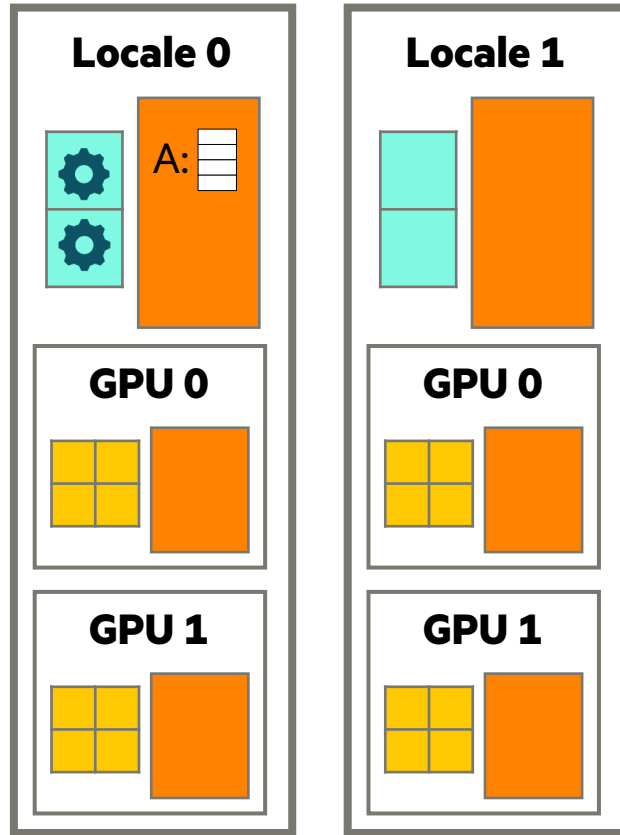
```
for elem in A do  
  elem += 1;
```

← Sequential iteration over the array

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

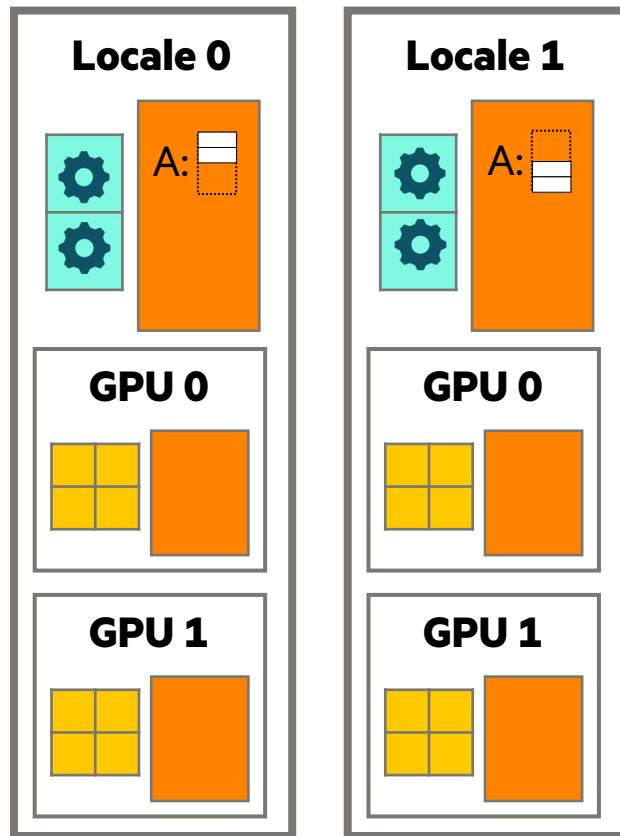
```
forall elem in A do  
  elem += 1;
```

Parallel iteration over the array

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```
use BlockDist;
```

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

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

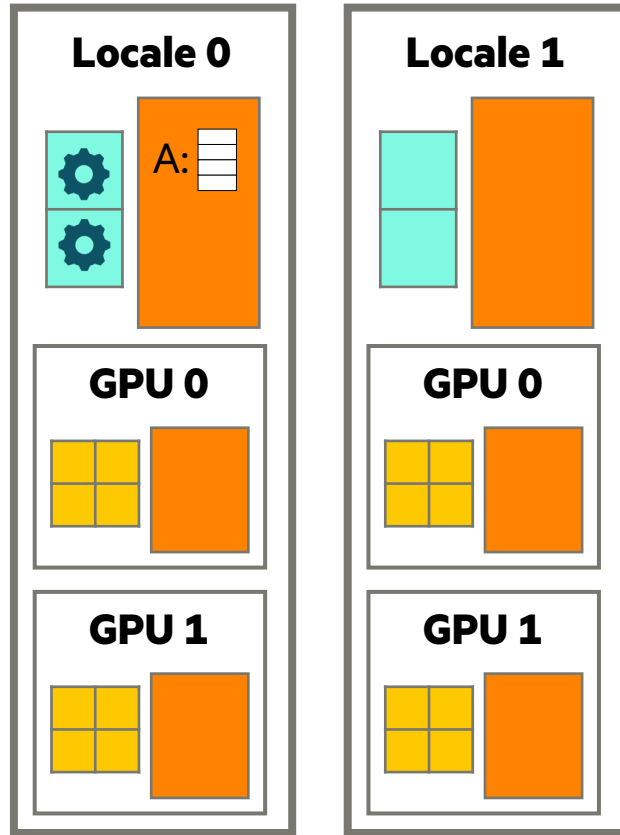
Block-distributed array allocation

Distributed, parallel iteration over the array

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

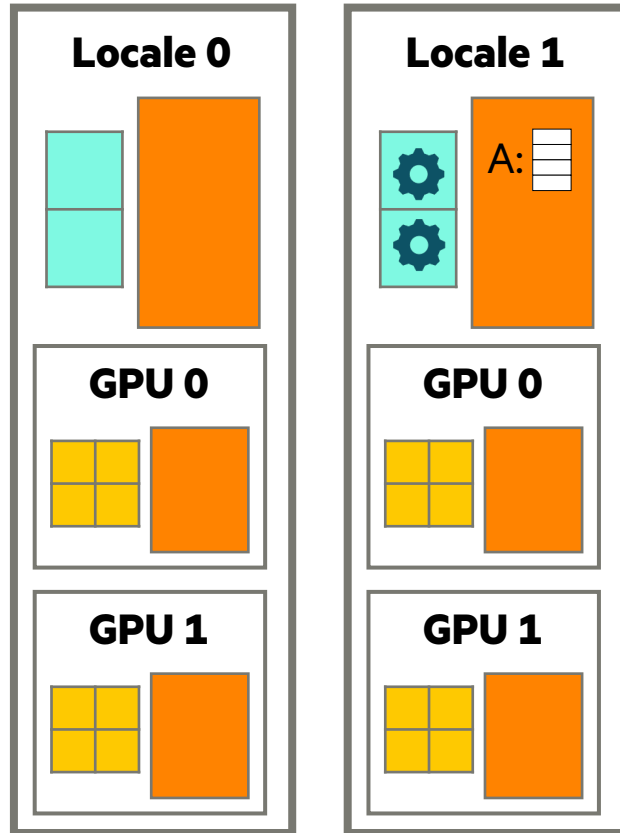
```
forall elem in A do  
  elem += 1;
```



Programming GPUs with Chapel

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

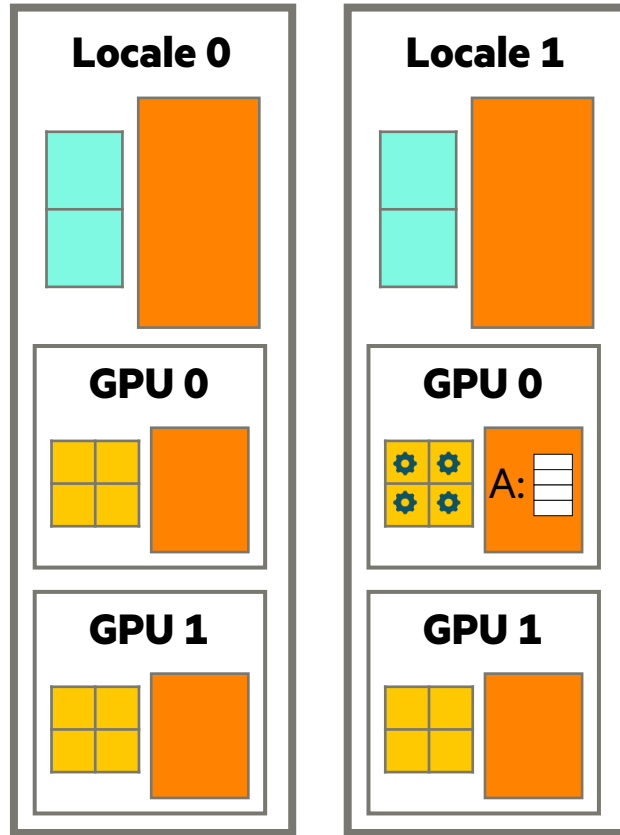
```
  forall elem in A do  
    elem += 1;  
}
```

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

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

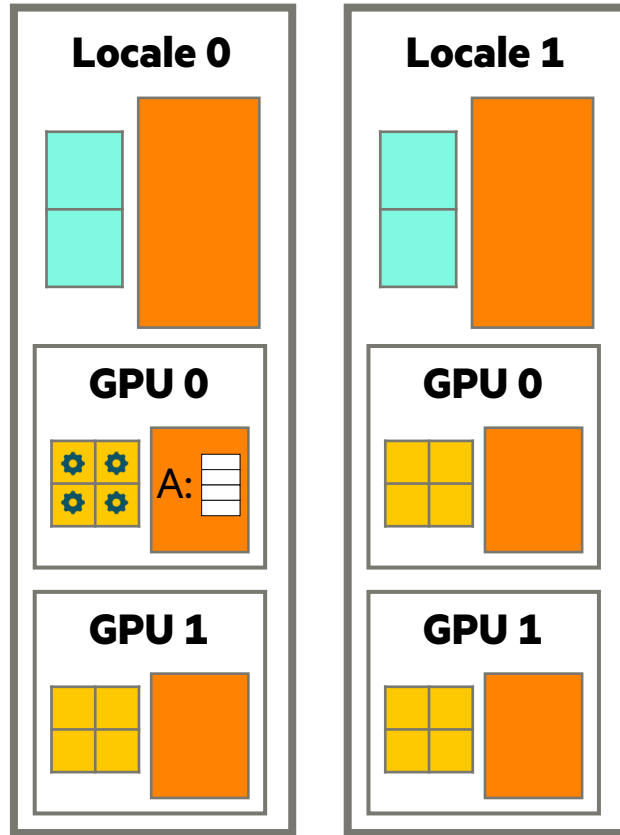
```
  forall elem in A do  
    elem += 1;  
}
```

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

Programming GPUs with Chapel

 CPU Core  GPU Core

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

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

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

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

Josh Milthorpe
Oak Ridge National Laboratory
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Xianghao Wang
Australian National University
Canberra, Australia

Ahmad Azizi
Australian National University
Canberra, Australia

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 Carneiro¹[0000-0002-6145-8352], Engin Kayraklioglu²[0000-0002-4966-3812],
Guillaume Helbecque^{3,4}[0000-0002-8697-3721], and Nouredine Melab⁴

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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