REPARTITIONING FOR PERFORMANCE: FLEXIBLE DATA MOVEMENT IN CHAPEL

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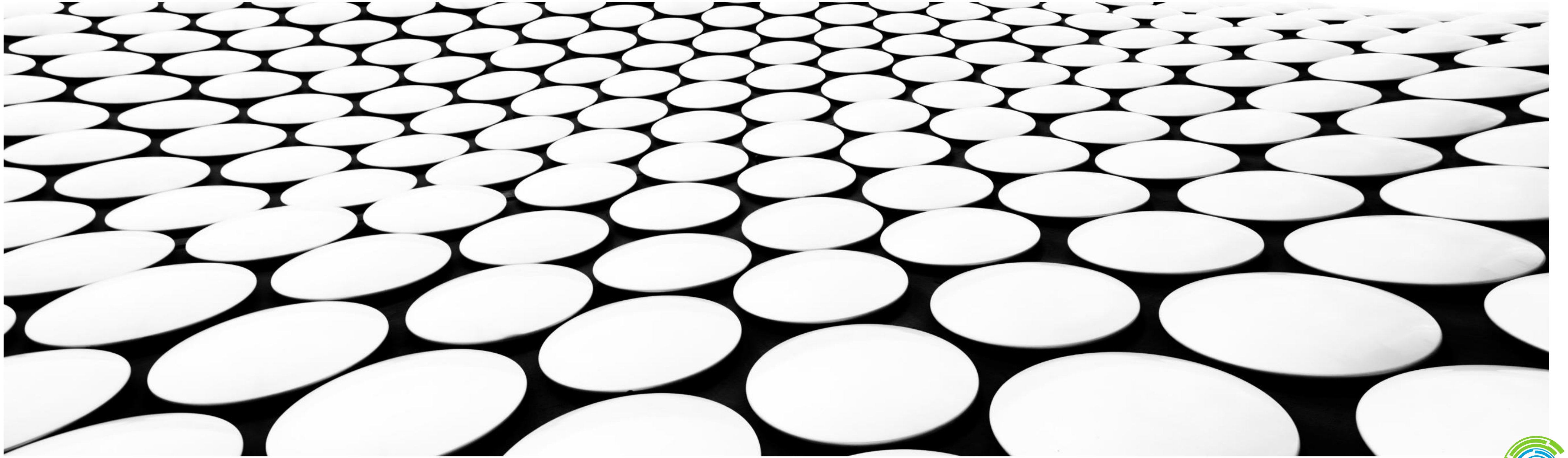


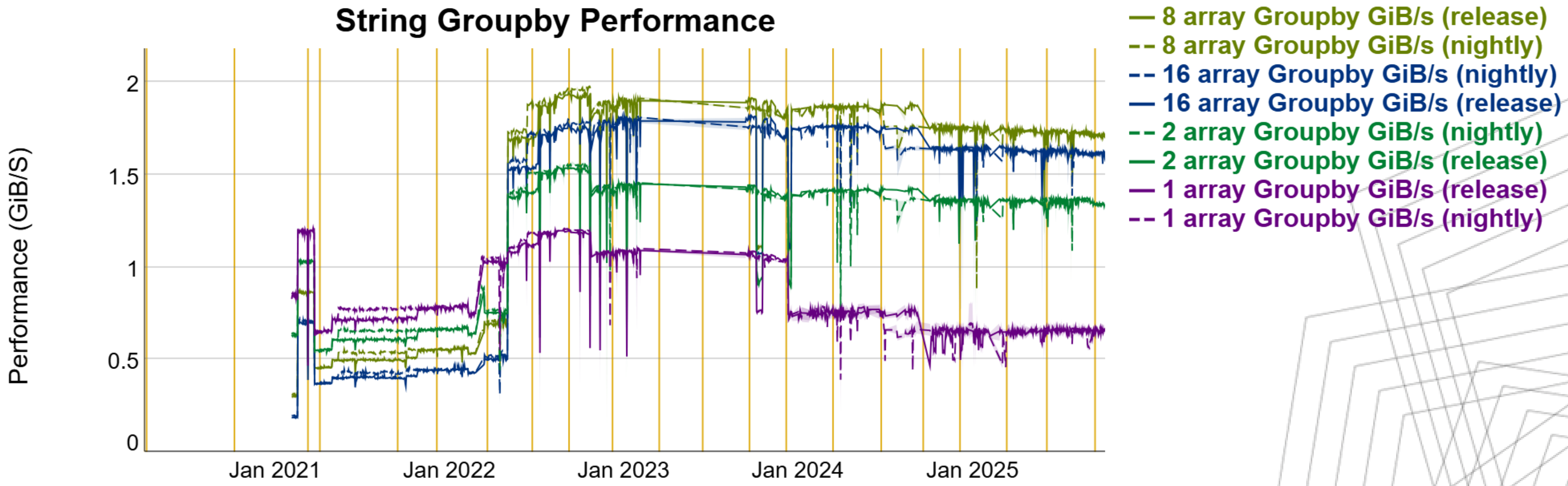
GIGATEC ENGINEERING

CHAPEL

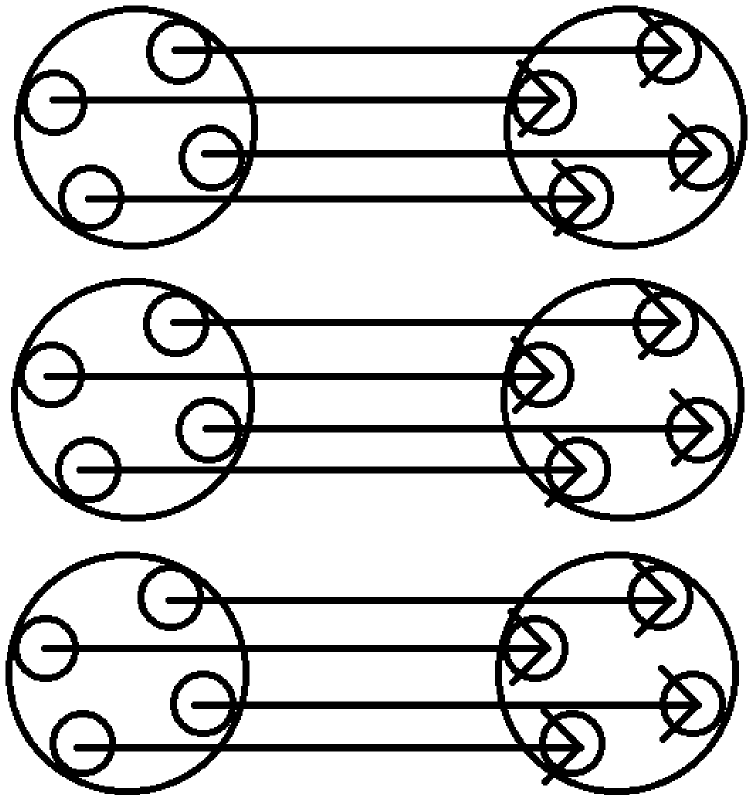
INTRODUCTION

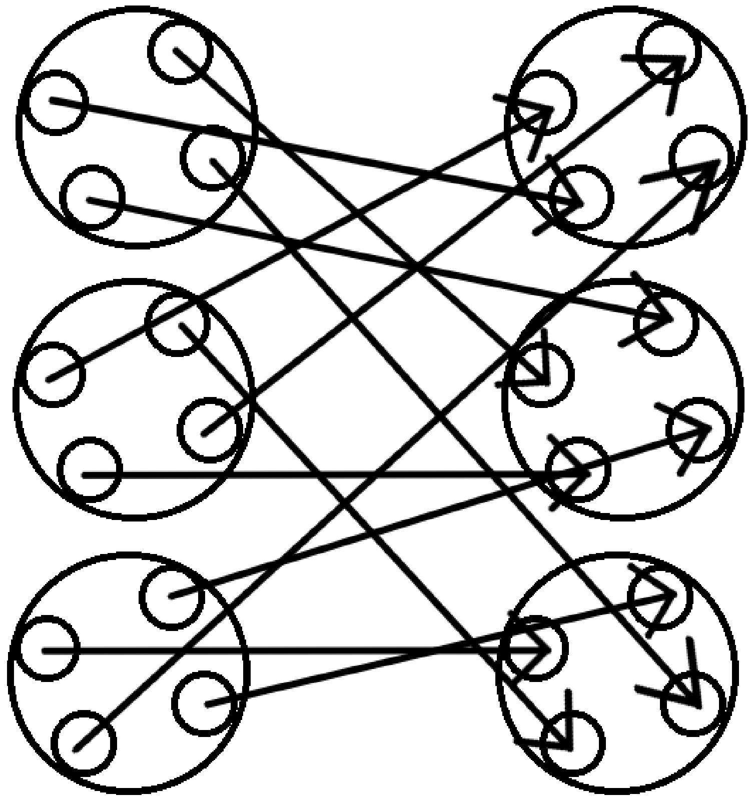
- Software engineer working on Arkouda, a Python+Chapel data analytics framework
- Focus area: performance optimization

AN UNEXPECTED BOTTLENECK



PARALLELISM





HASH BASED SHARDING

- Compute `hash(value) % numLocales`
- Potential drawbacks
  - Easy to generate data that would all get sent to the same locale
  - An array could be entirely composed of one value

REPARTITIONING MODULE

$$\begin{tikzcd}\boxed{\text{Original data}} \arrow[r] & \boxed{\text{Mark destinations}} \arrow[r] & \boxed{\text{Redistributed data}}\end{tikzcd}$$

- Redistributes data across locales based on a target mapping
- Includes the option to hash the data for you
- Performs the data movement in a single coordinated step
- Returns a new object with data placed on the right locales

IMPLEMENTATION DETAILS

- Data movement: Aggregators vs. bulk transfer
  - Decided on bulk transfer because it is simpler when destination indices are unknown
- Data structure for transferring: Lists vs. Arrays
  - Lists: No padding but many copies
  - Arrays: Better performance but some padding

INNERARRAY

```
record innerArray {
  type t;
  var Dom: domain(1);
  var Arr: [Dom] t;


  proc init(in Dom: domain(1), type t) {
    this.t = t;
    this.Dom = Dom;
  }


  proc init(type t) {
    this.t = t;
  }
}
```

Thanks to Engin Kayraklıoğlu!

RESULTS

N	Branch/Main	Locale	get	put	execute_on	execute_on_nb
1,000,000	Main	0	295	253	380	721
1,000,000	Main	Avg of others	315	401	383	0
1,000,000	Branch	0	239	928	84	1282
1,000,000	Branch	Avg of others	116	1209	116	155
10,000,000	Main	0	967	925	1052	721
10,000,000	Main	Avg of others	987	1072	1055	0
10,000,000	Branch	0	239	928	84	1282
10,000,000	Branch	Avg of others	116	1209	116	155
100,000,000	Main	0	7544	7502	7629	721
100,000,000	Main	Avg of others	7562	7648	7630	0
100,000,000	Branch	0	238	925	84	1283
100,000,000	Branch	Avg of others	117	1210	116	155

CONCLUSION

- Flexible mechanism to reorganize data across locales
- Reduces communication overhead and improves scalability
- Provides a foundation for future optimization (e.g., GroupBy)

THANK YOU

QUESTIONS?