

# Design and Evaluation of Topology-aware Scatter and AllGather Algorithms for Dragonfly Networks

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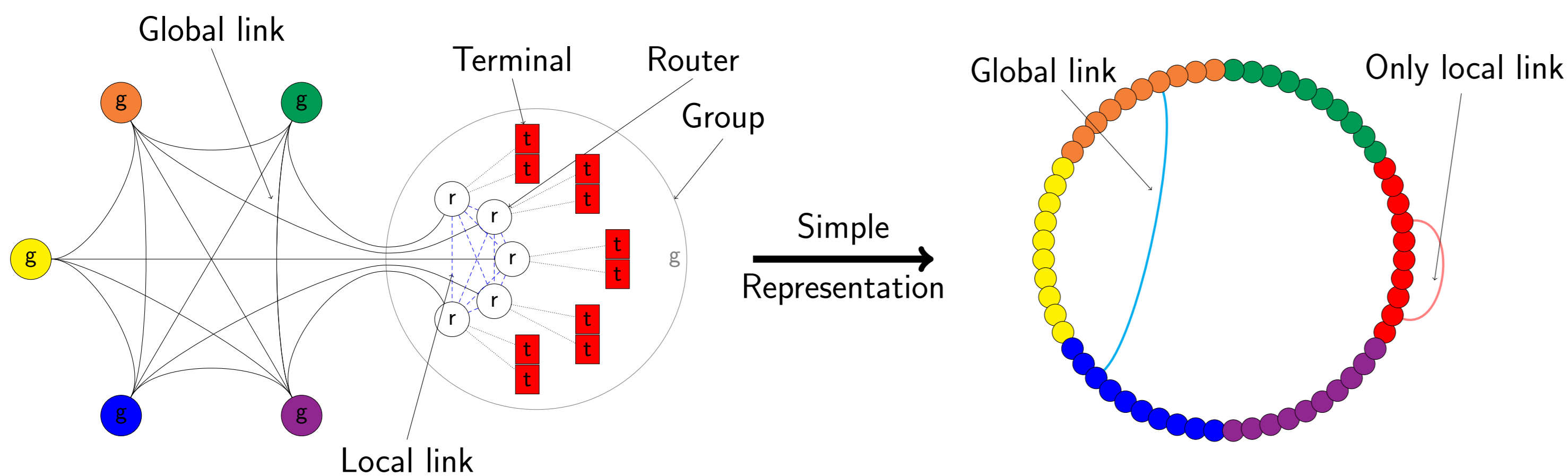
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# Design and Evaluation of Topology-aware Scatter and AllGather Algorithms for Dragonfly Networks

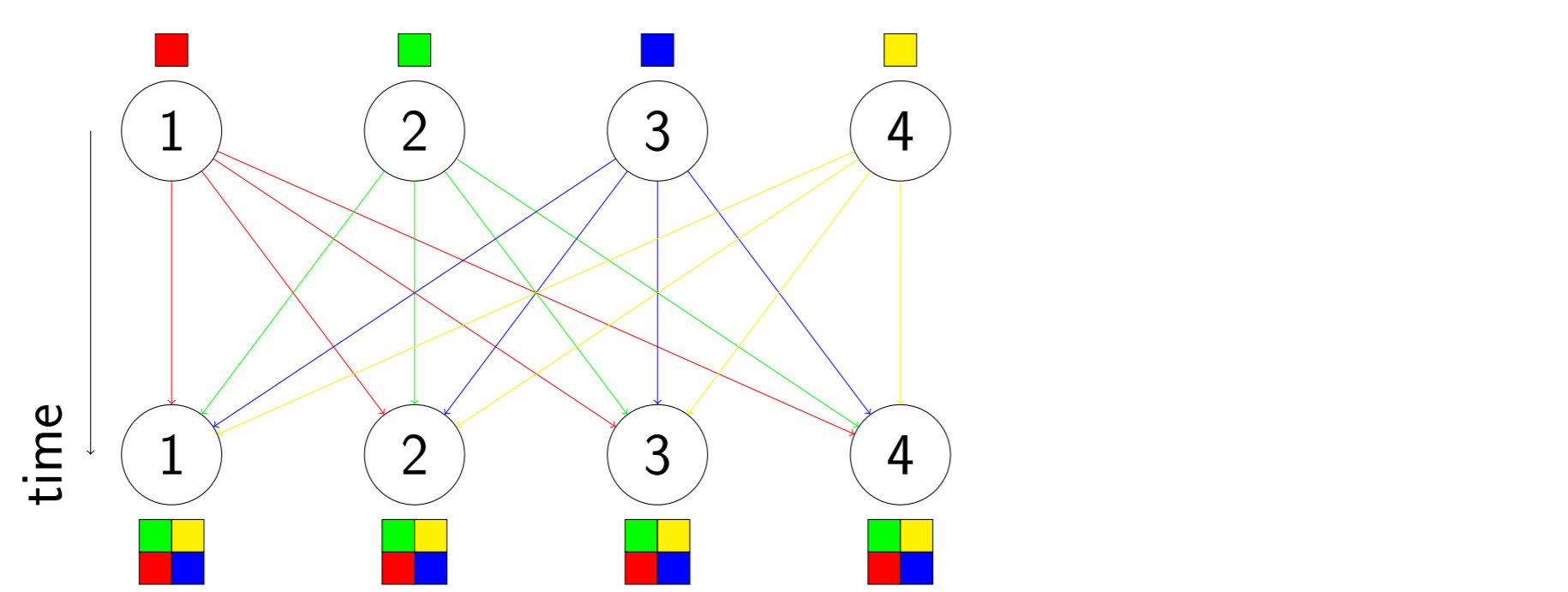
## New efficient communication algorithms for Dragonfly

- Cost of traditional topologies too high at scale
- Dragonfly: a new topology
- Opportunity for new efficient communication algorithms



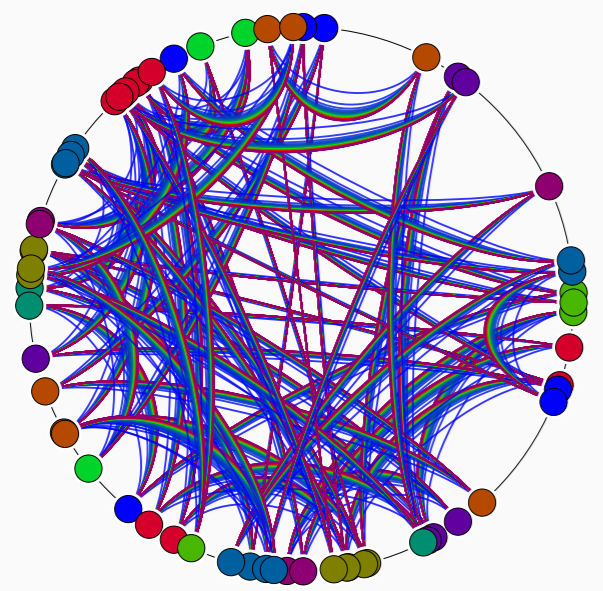
Challenge: Global links are potential bottlenecks

## AllGather



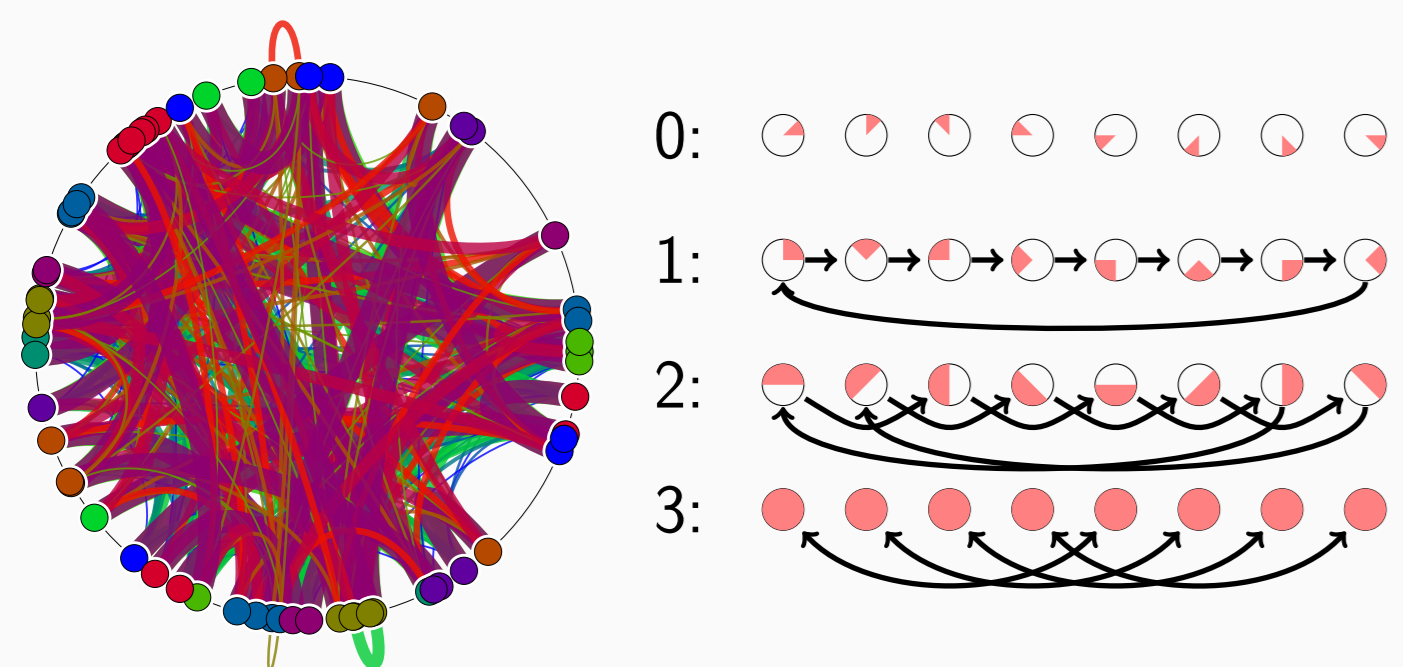
### Existing algorithms

#### RING



Default in MPICH for 80 KiB and more

#### BRUCK - Bruck's algorithm



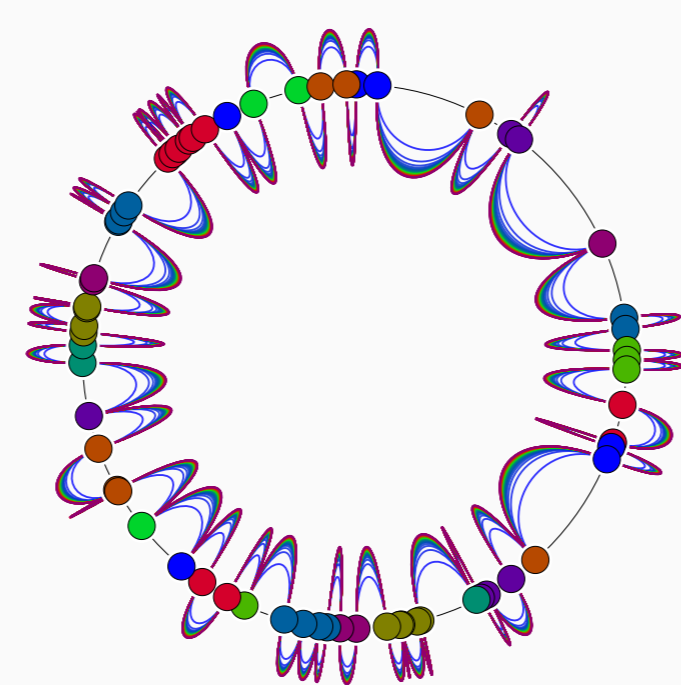
Default in MPICH for less than 80 KiB

### Our contribution

#### TAR - Topology Aware Ring

Idea: minimize global link utilization

1. Build a smart ring
2. Send data

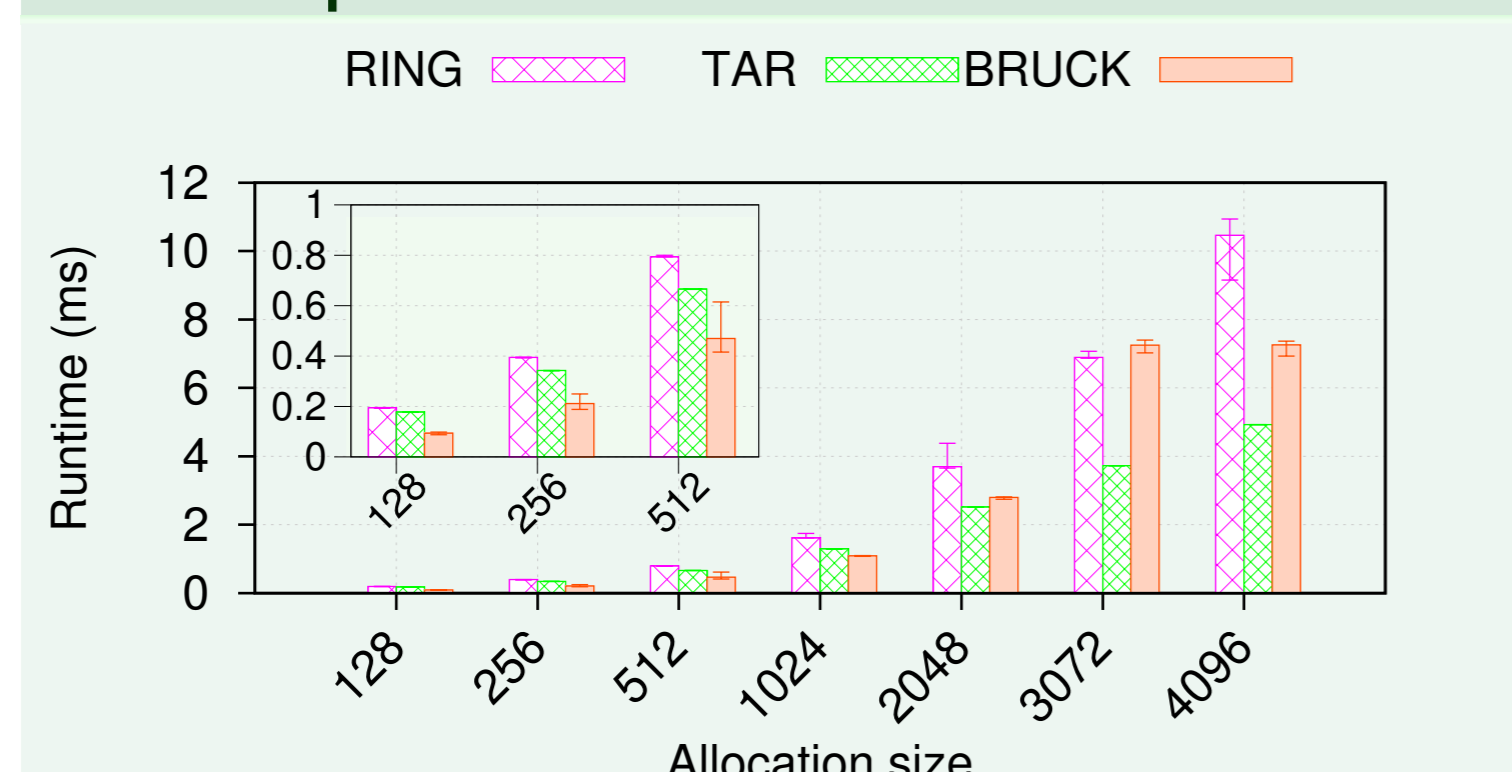


Minimize data transfers on global links

### Evaluation

- CODES based on ROSS, an event driven simulator
- 5256 terminals: 73 groups, 12 routers per group, and 6 terminals per router
- Bandwidth:
  - \* Global links at 4.7 GiB/s,
  - \* Local links at 5.25 GiB/s,
  - \* Terminal links at 5.25 GiB/s

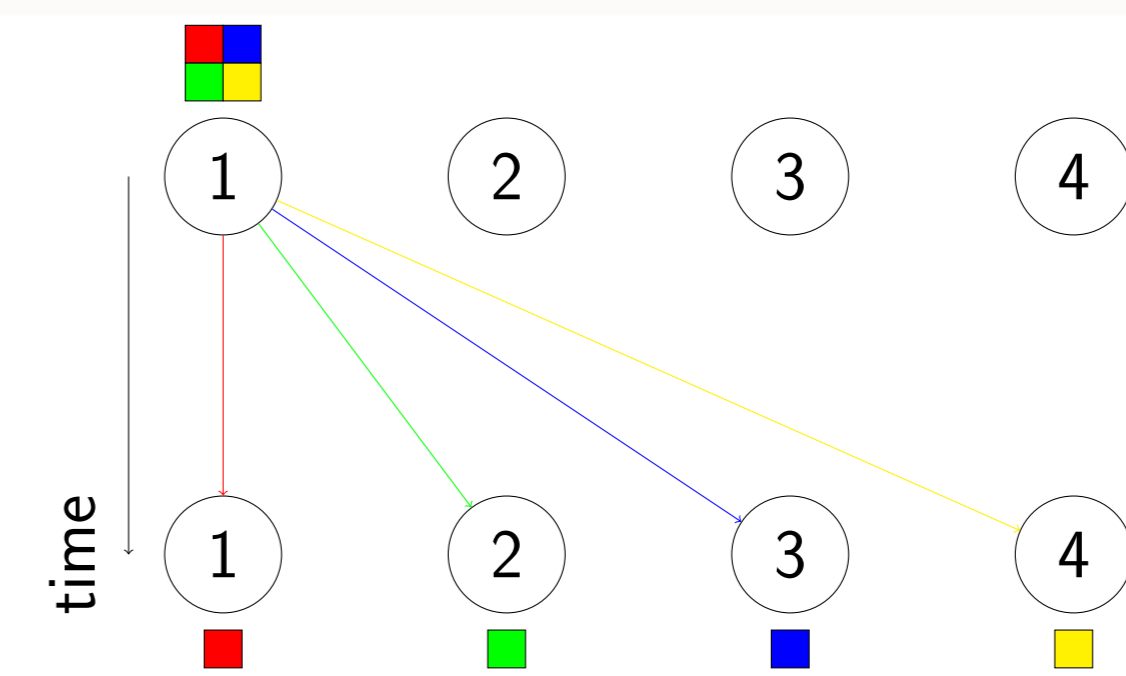
#### 1 KiB per terminal



### Conclusion

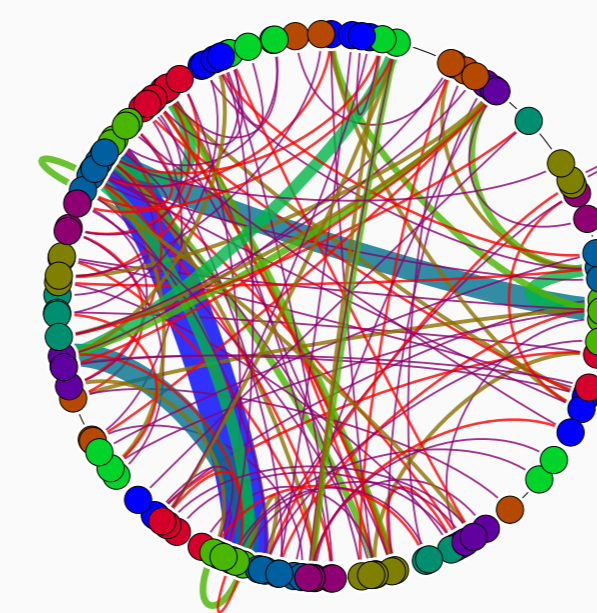
- Topology awareness matters: TAR wins!
- BRUCK still better for small transfers
- Background traffic does not change the behavior

## Scatter



### Existing Algorithms

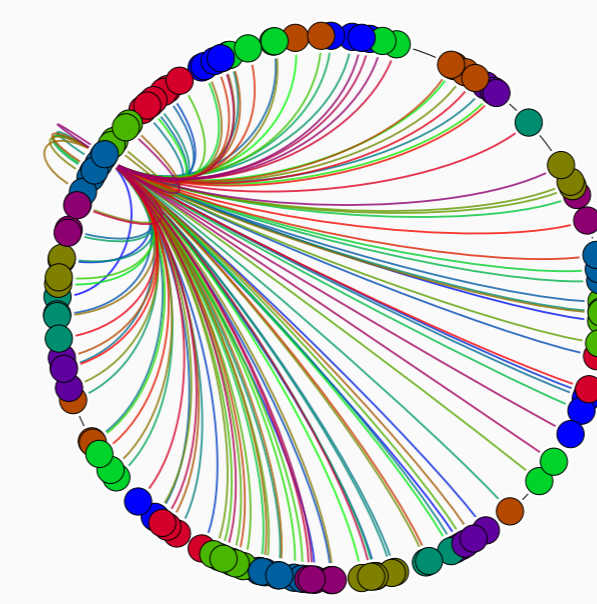
#### TREE - Binomial Tree



Default in MPICH

#### Simple approach

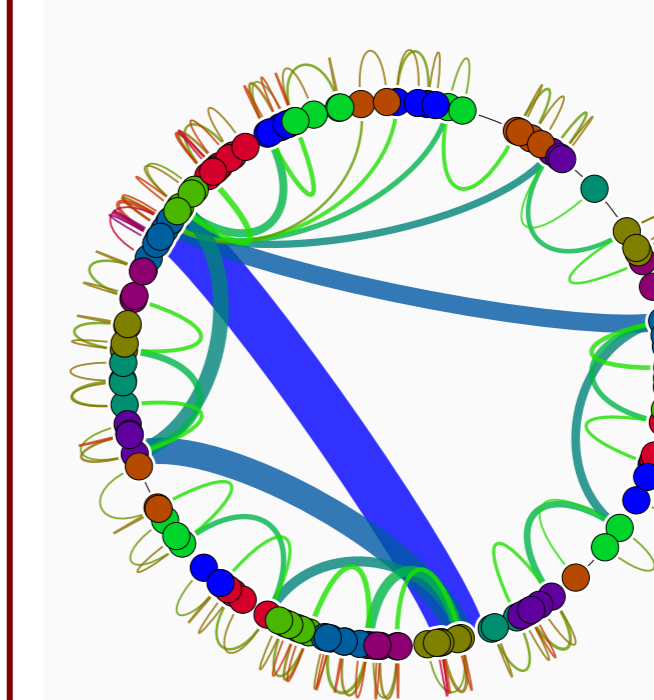
#### LIN



Send data to terminals one by one  
Minimize link utilization

### Our contribution

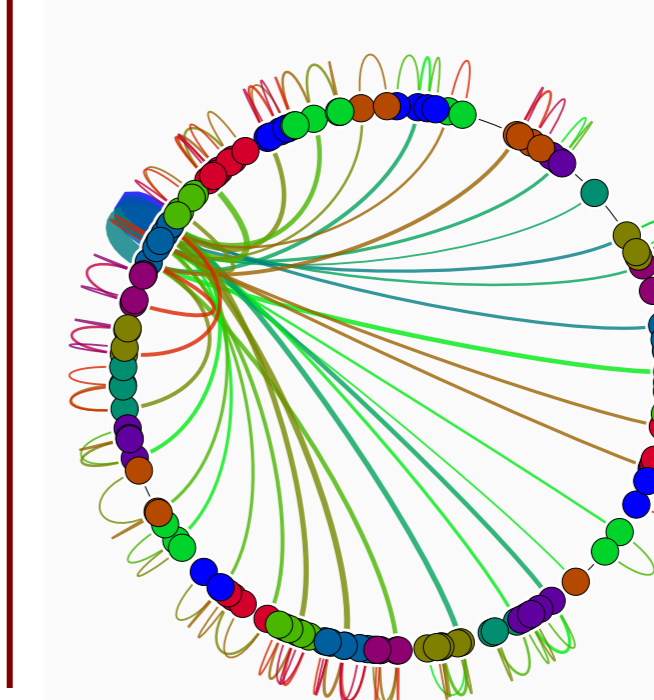
#### GLF - Global Link First



- Using TREE:
1. Send data to groups
  2. Send data to routers
  3. Send data to terminals

Use global links only during the first phase

#### LLF - Local Link First

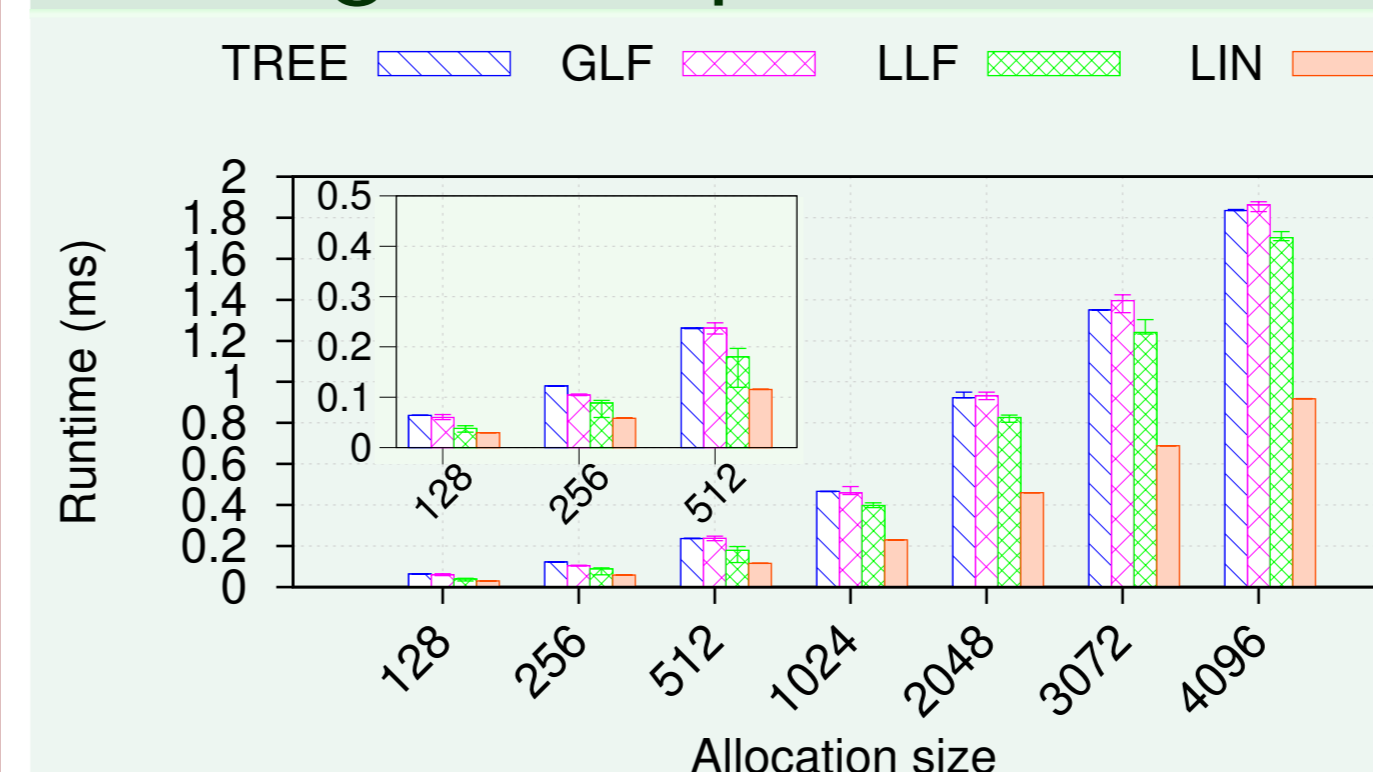


- Using TREE:
1. Send data to routers in root group
  2. Send data to groups
  3. Send data to routers
  4. Send data to terminals

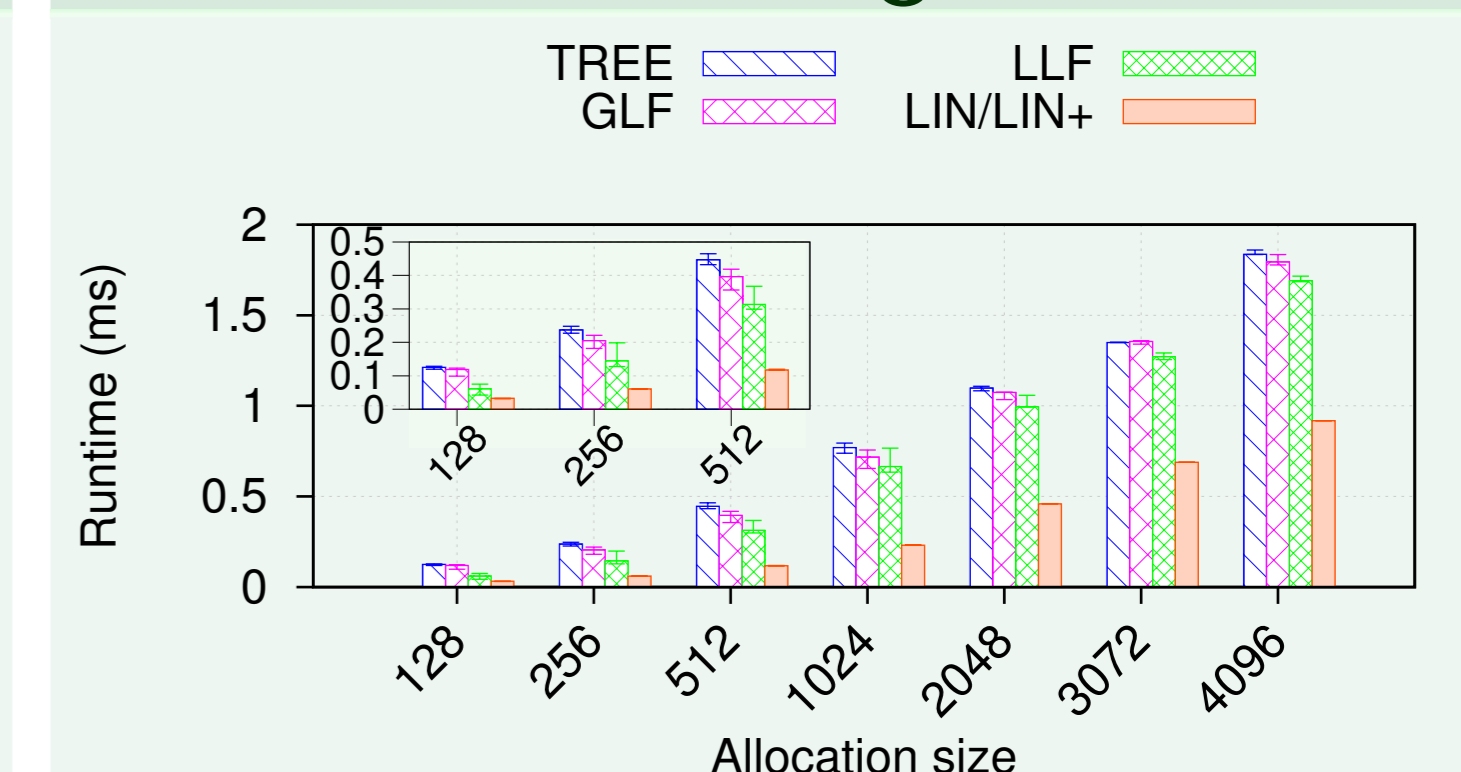
Minimize data transfers on global links

### LIN twice faster than the others!

#### Sending 1 KiB per terminal

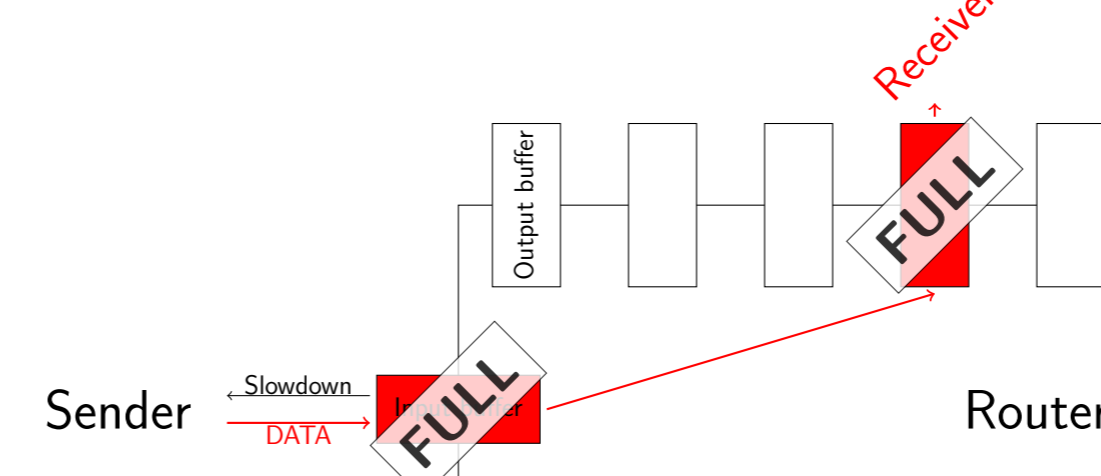


#### With uniform background traffic



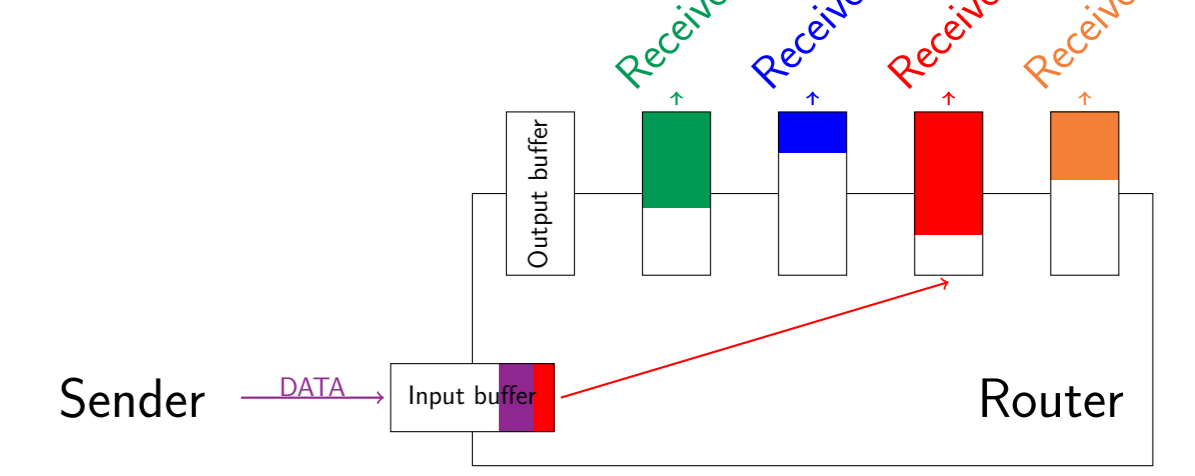
### Major impact factor: the buffer size!

For TREE, GLF, and LLF:



- Large amounts of data transferred
- Fills buffers, slows down transfer

For LIN:



- 1 KiB transferred each time
- No buffer saturated, no slowdown

### Conclusion

- Topology and hardware characteristics impact the performance of algorithms
- LIN is twice faster than LLF, GLF, and TREE
- No significant differences between LLF, GLF, and TREE

## Discussion

### Why is it complex to make AllGather hardware-aware?

- A lot more data sent over the network creating more contention
- Overall run time determined by the slowest link due to the ring structure
- Terminals transfer on the same path (TAR, RING), no balance across buffers

### Ongoing work

- Broadcast as Scatter followed by AllGather
- Computation and communication algorithms such as Reduce
- Energy efficiency of communication algorithms