Clustering Parallel Applications to Enhance Message Logging Protocols

Esteban Meneses

Jaguar is the top 2 supercomputer in the world with 224,162 cores...
During 537 days (Aug-22-2008 to Feb-10-2010)
2.33 failures per day

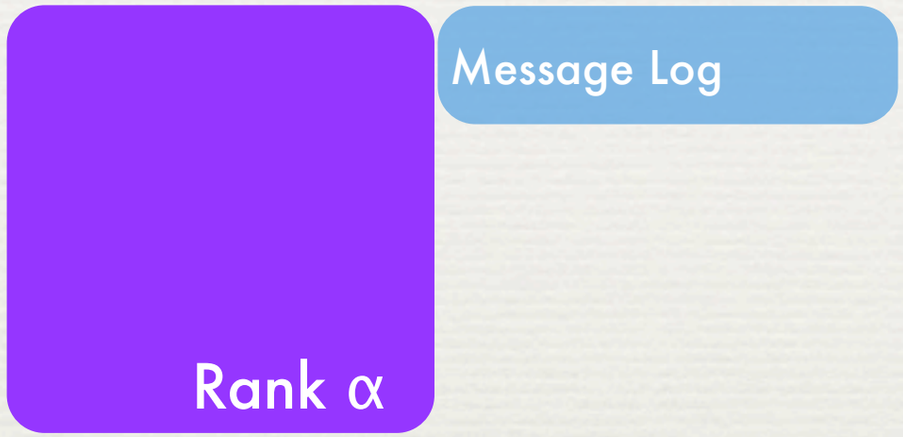
Sequoia will have 1.6 million cores and an exascale machine around 100 million cores...

We will see failures all the time

Agenda

- Clusters and Message Logging.
- Static Clustering (MPI).
- Dynamic Clustering (Charm++).
- Future Work.

Message Logging



- Every message sent *may* be logged.
- **Advantage:** only the failed rank is rolled back.
- **Drawback**: memory overhead.

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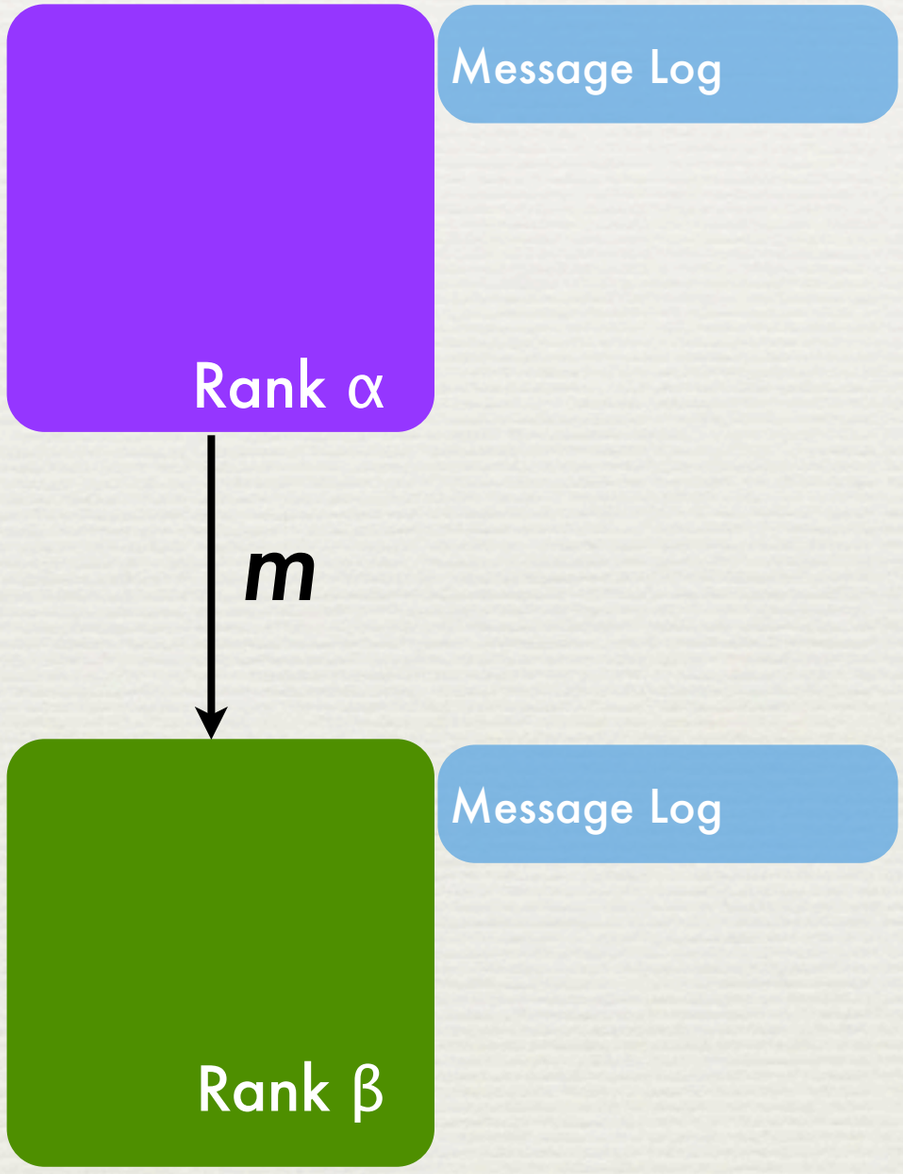

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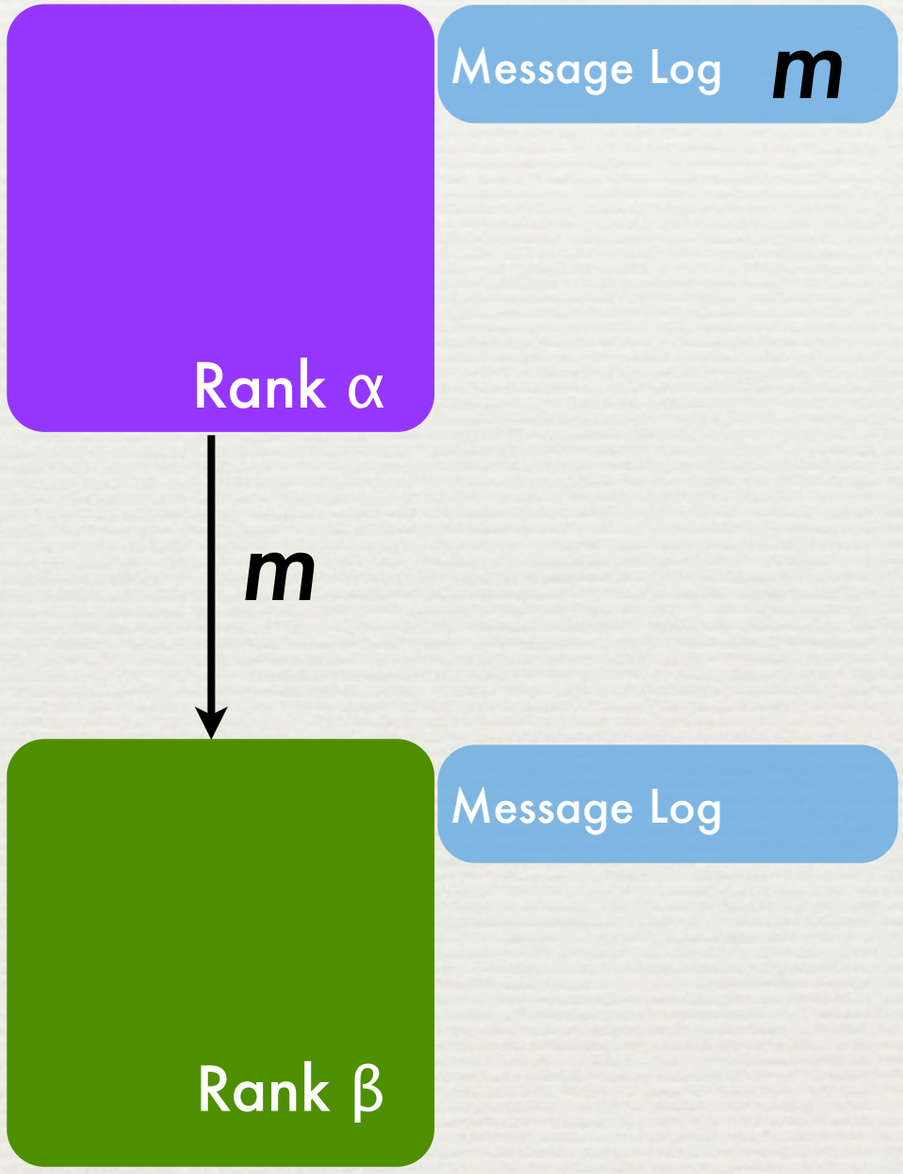

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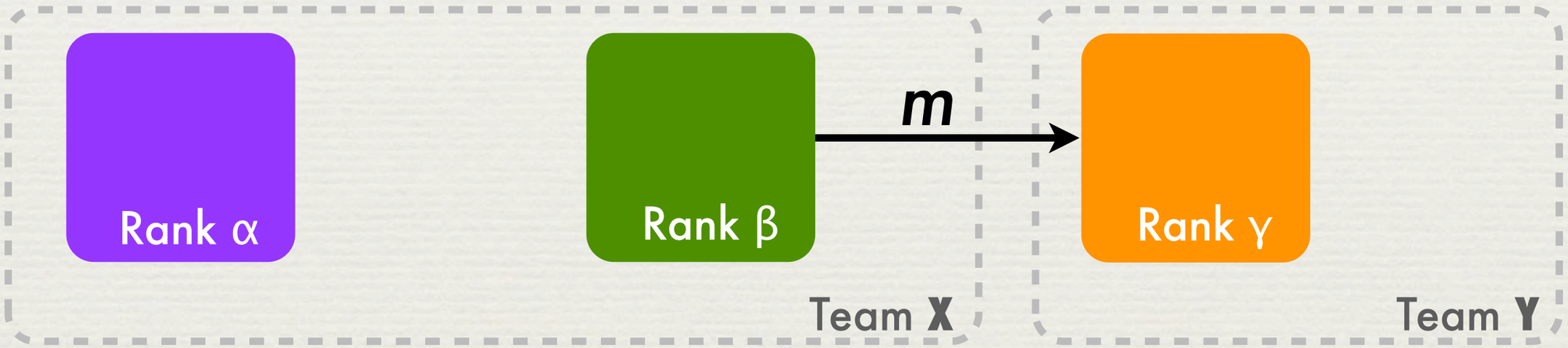

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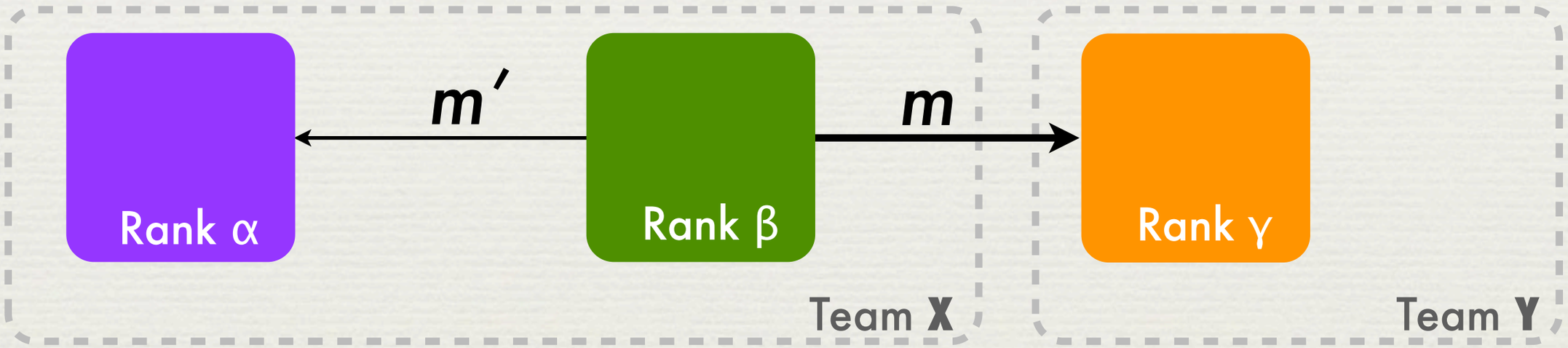

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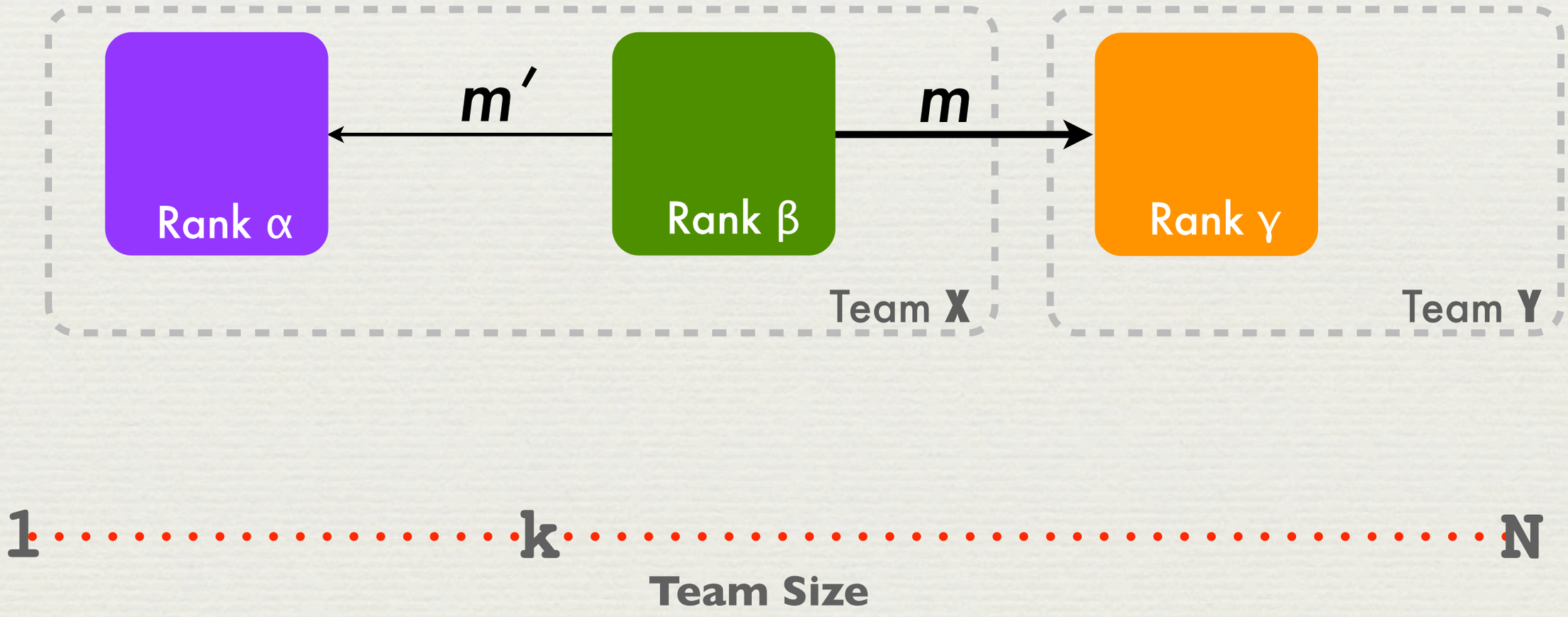

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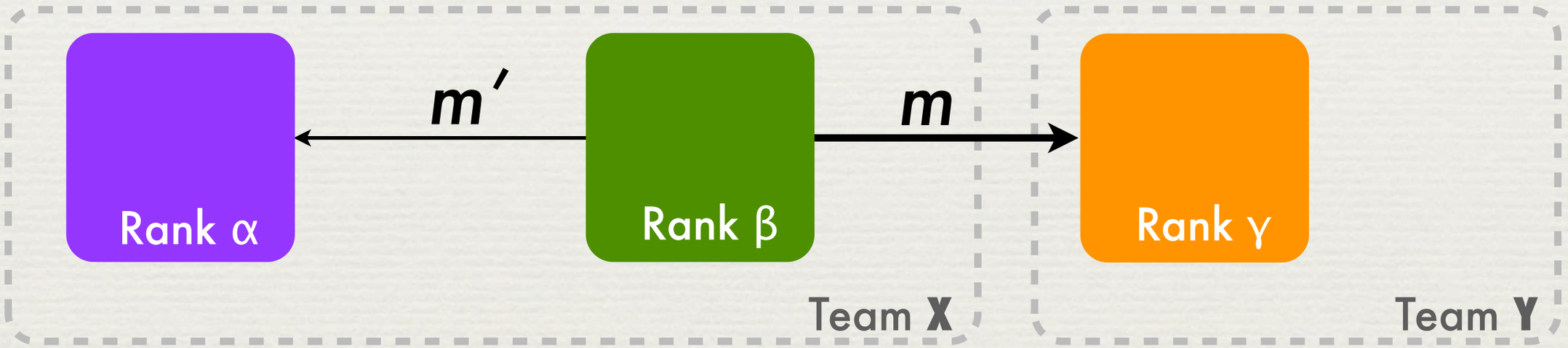

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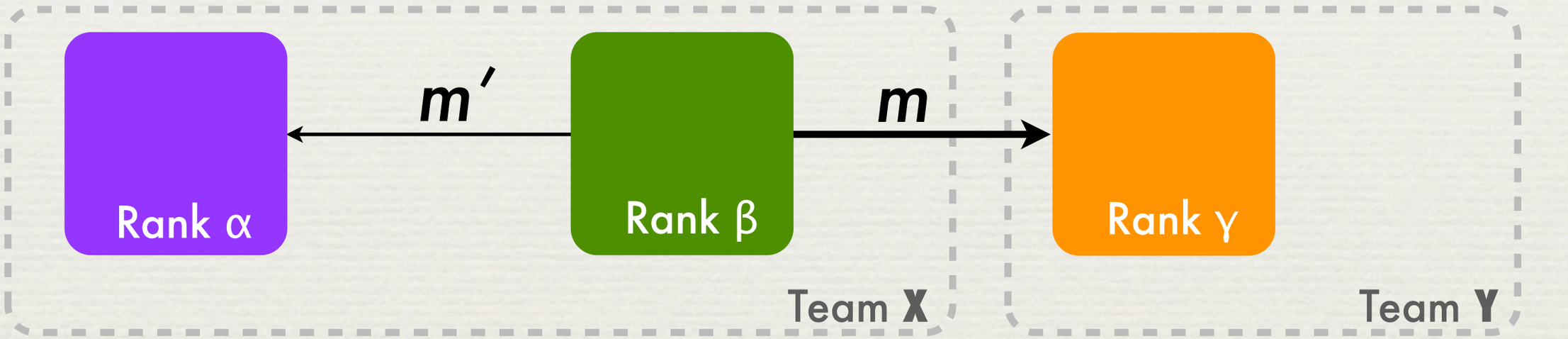

Message Logging — *Checkpoint/Restart*

1 . . . . . k . . . . . N

Team Size

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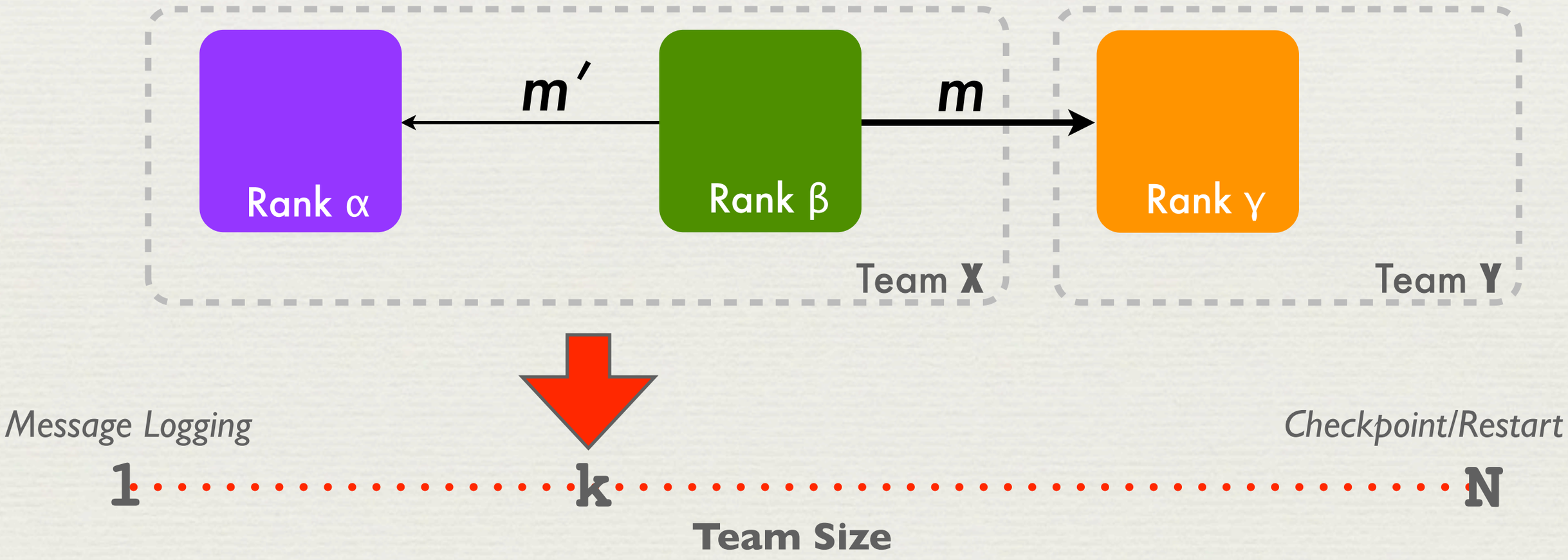

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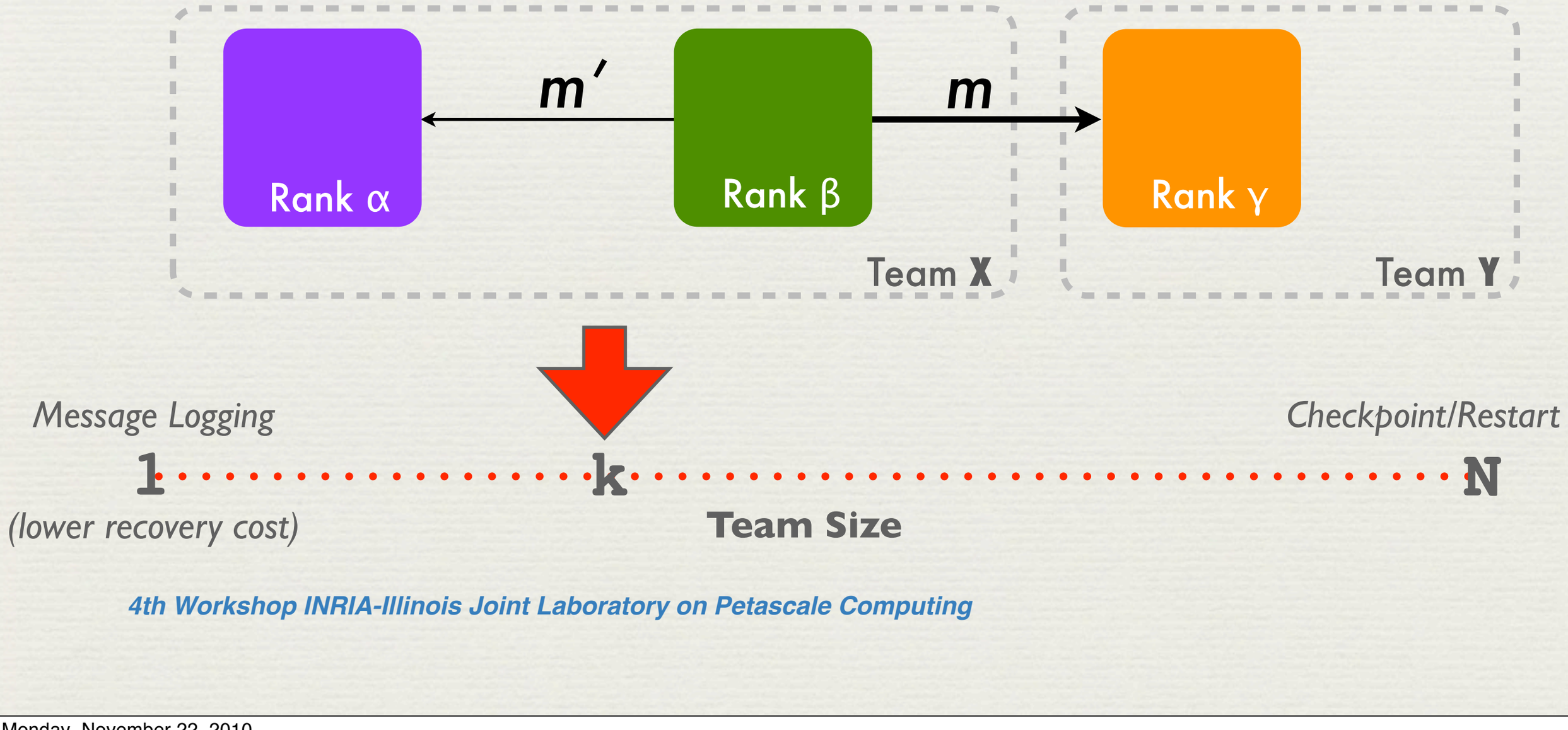

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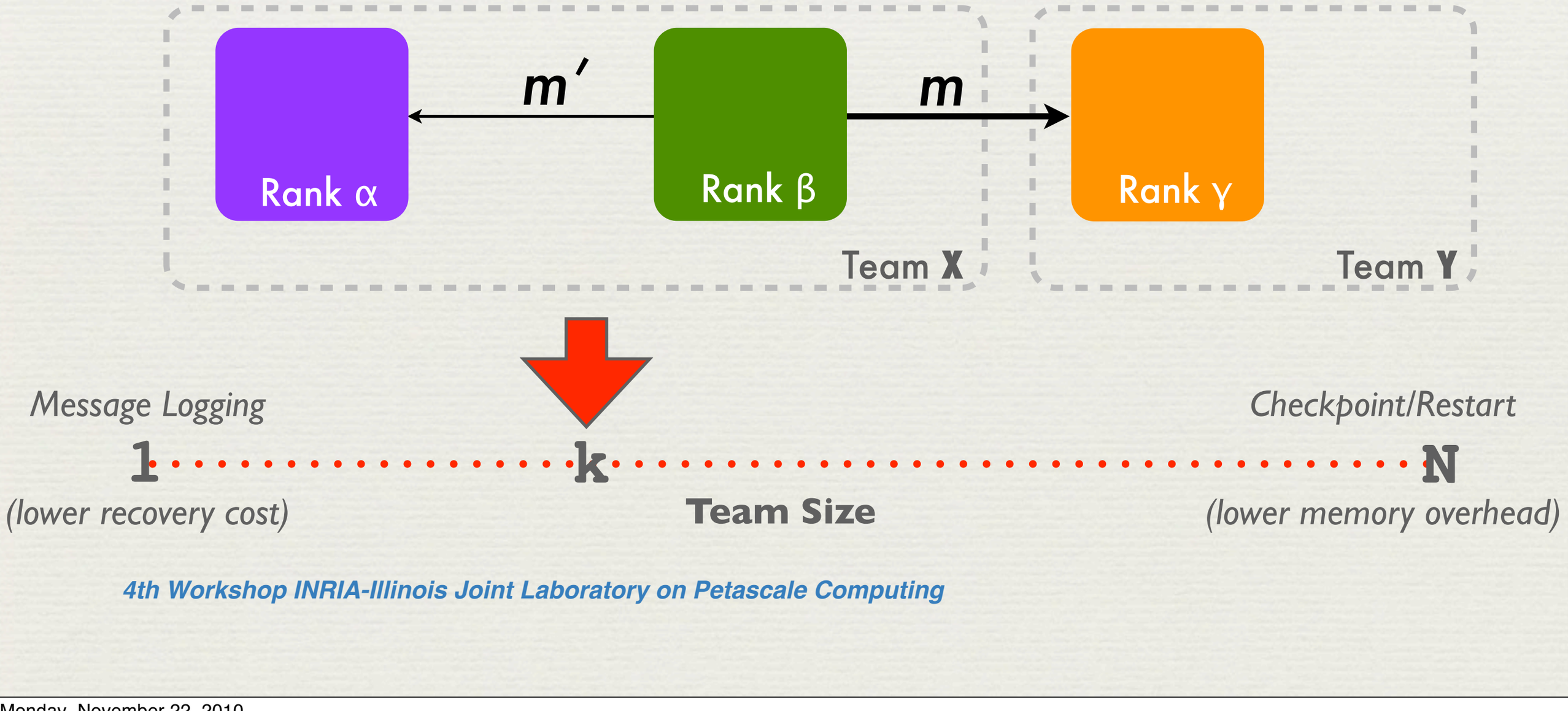

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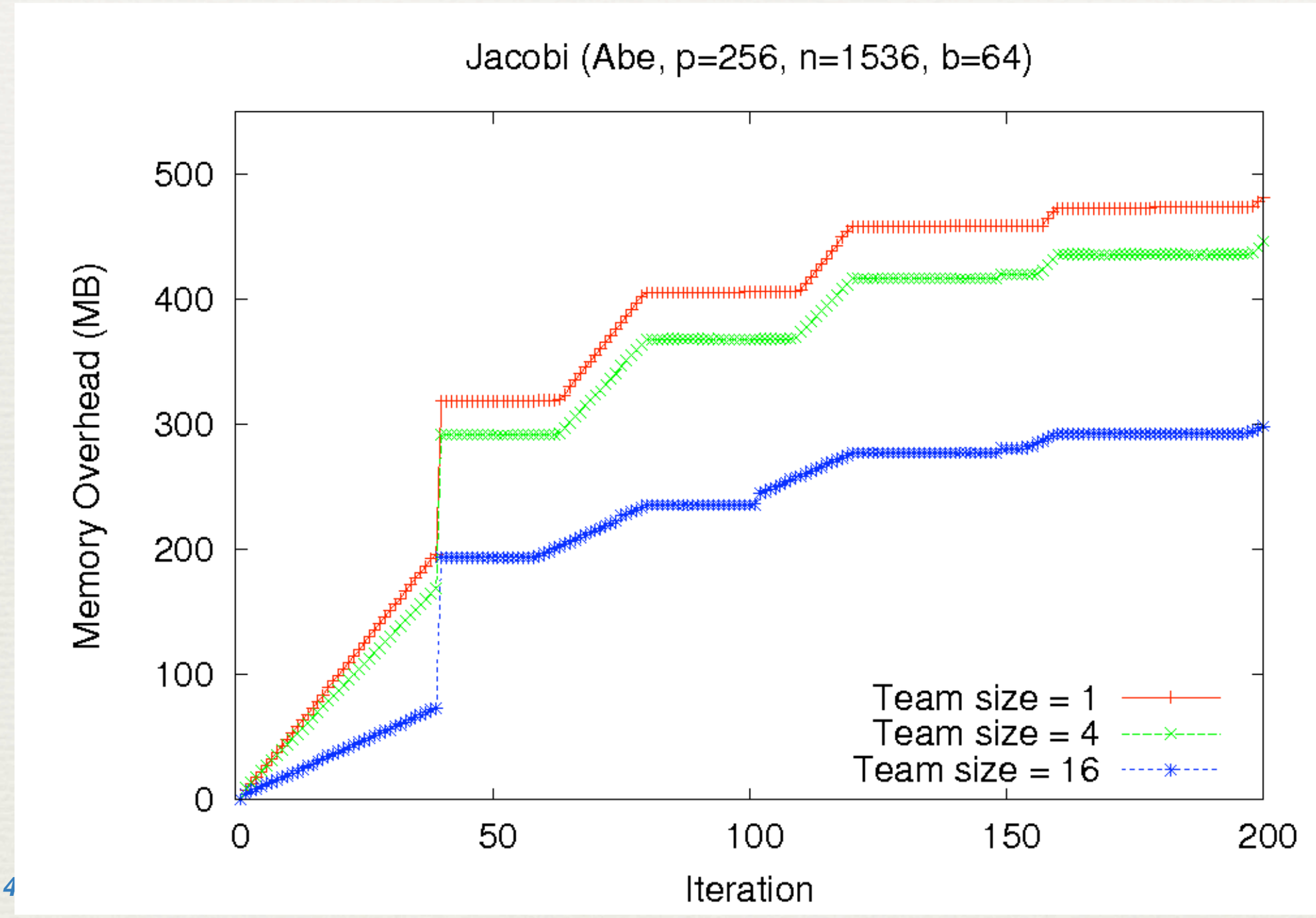

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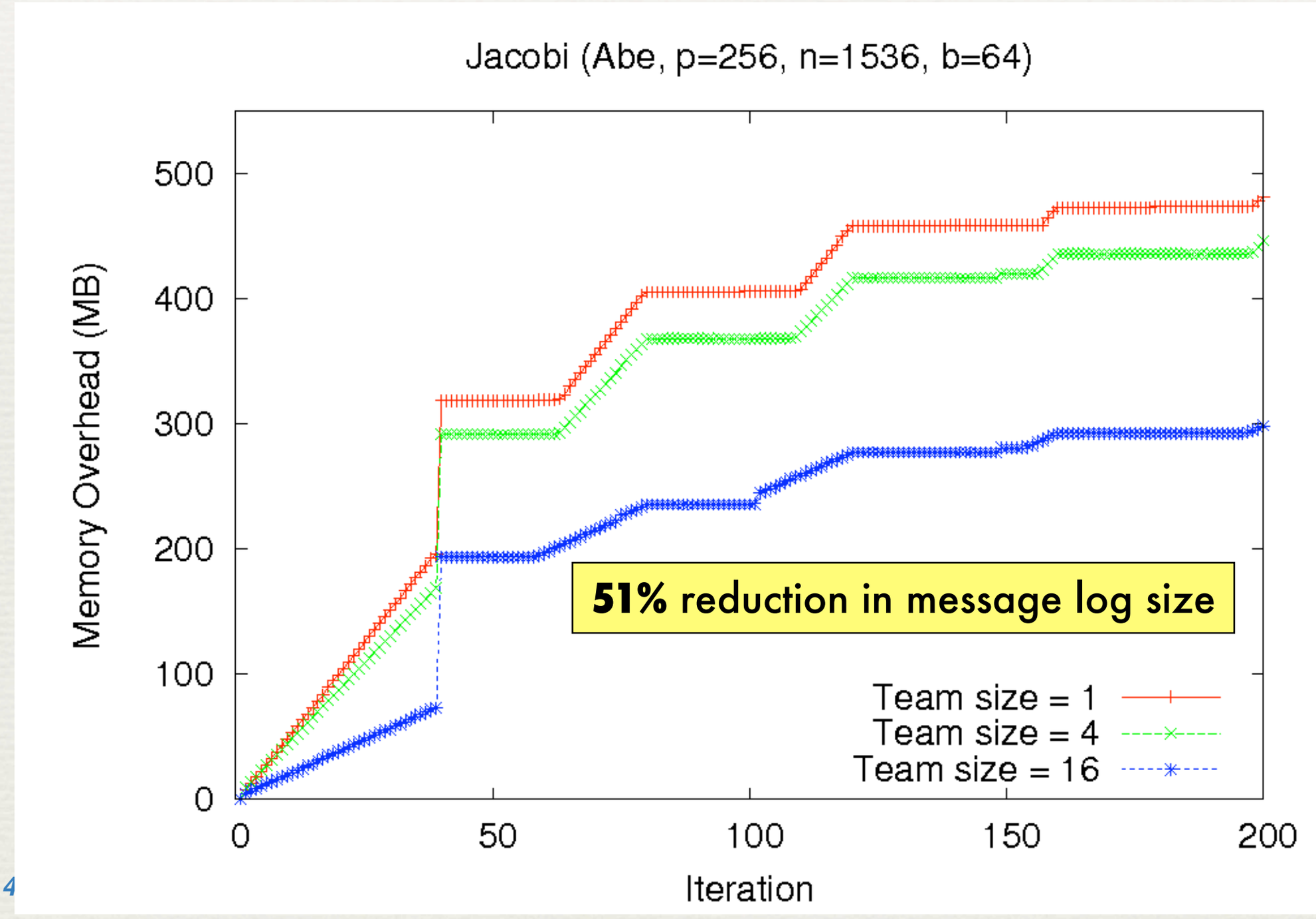
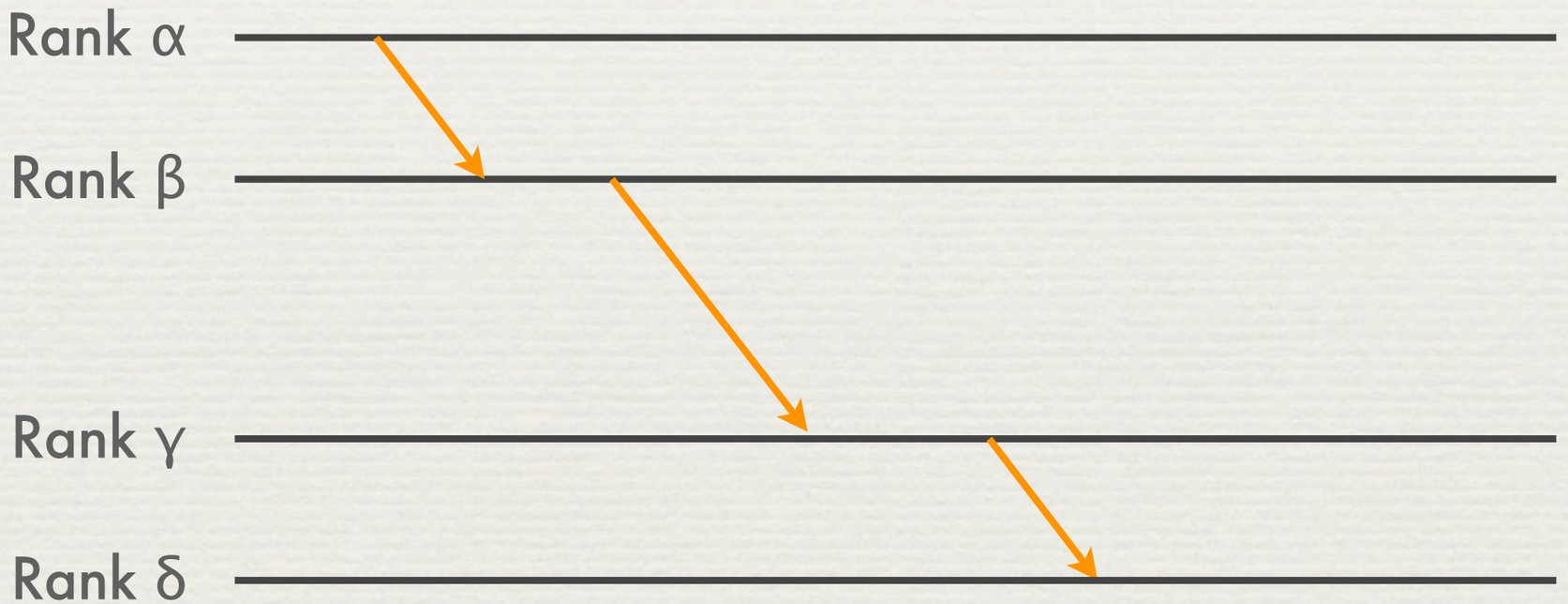


Bound Cascading Rollback



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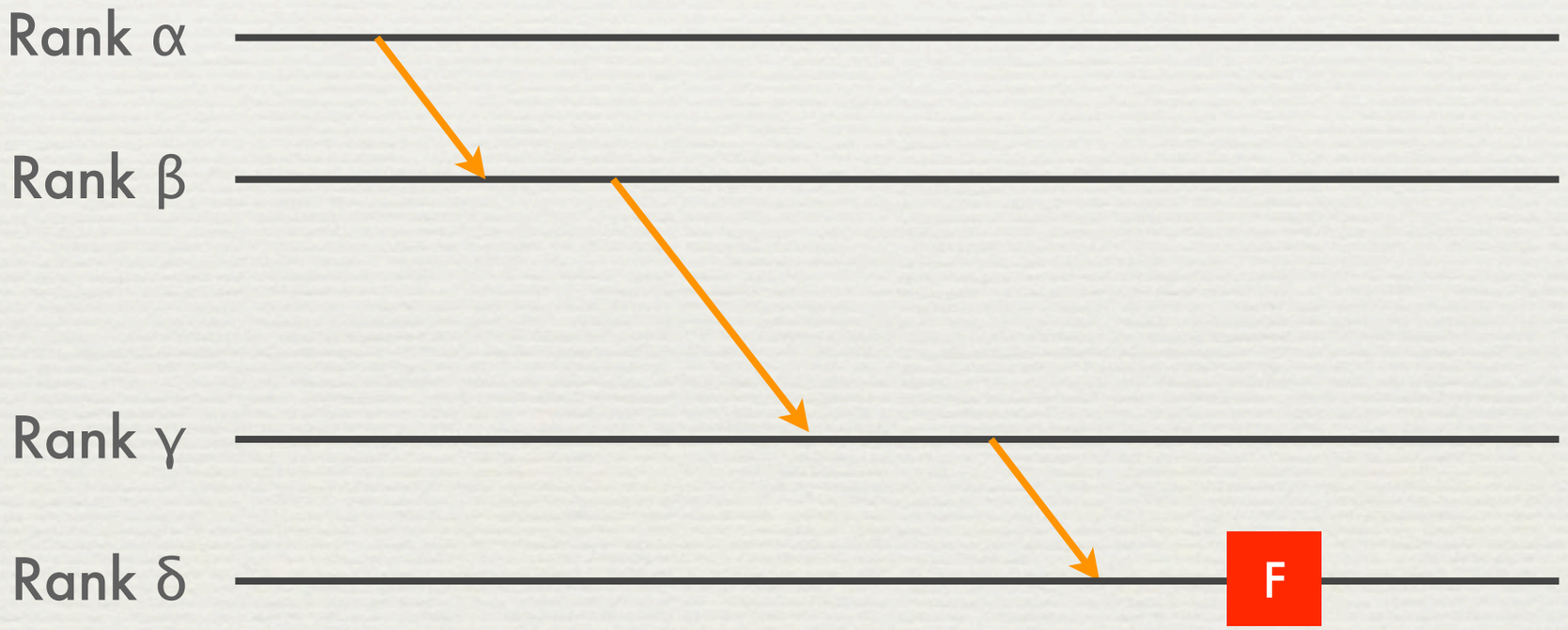

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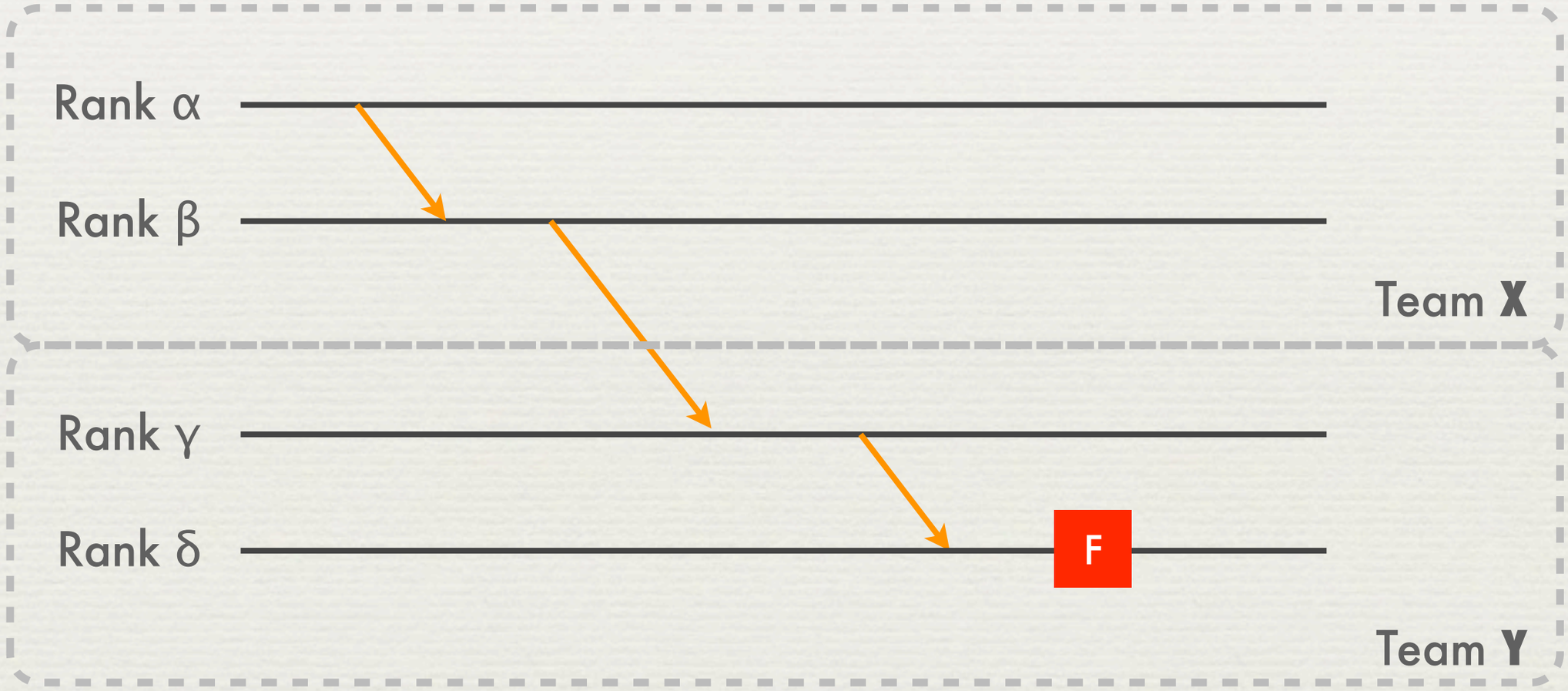


Bound Cascading Rollback

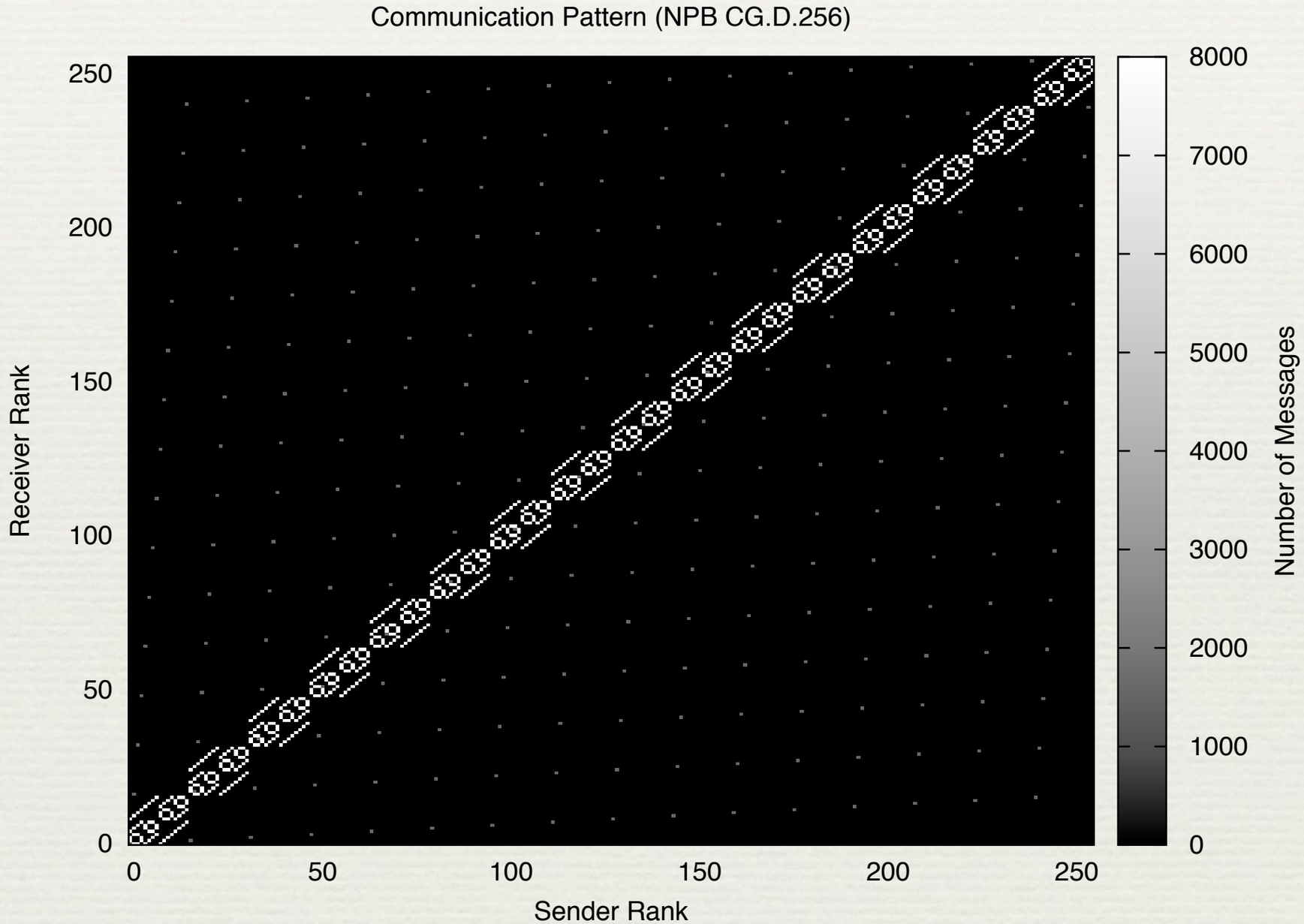
How to split the ranks to minimize the

communication volume?

Static Clustering

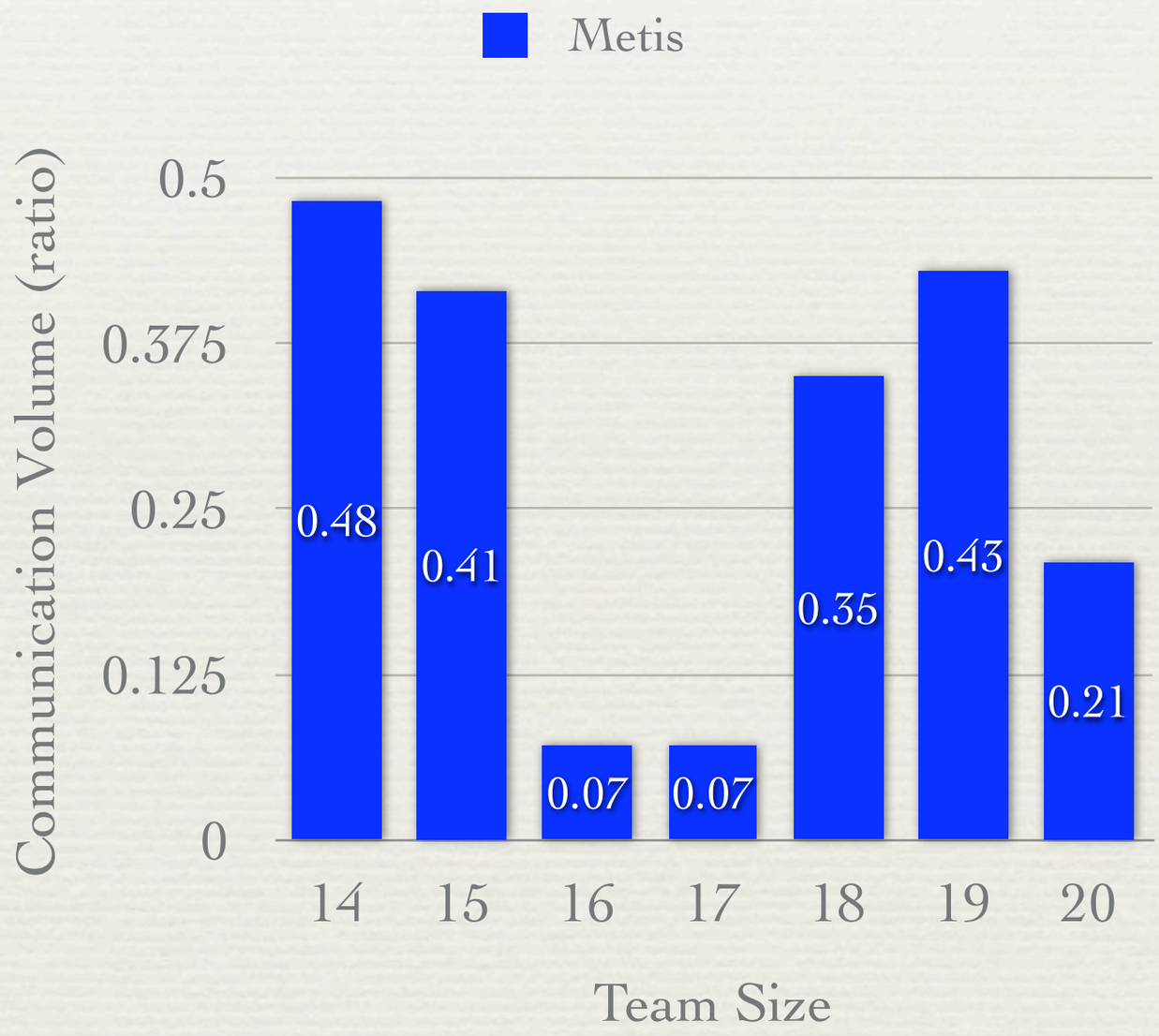
Amina Guermouche
Thomas Ropars
Prof. Franck Cappello
(INRIA)

Communication Pattern



Team Size

- **Constraint**: maximum team size (t).
- **Graph partitioning** techniques with k clusters: k=⌈N/t⌉.
- **Example**: t=20.



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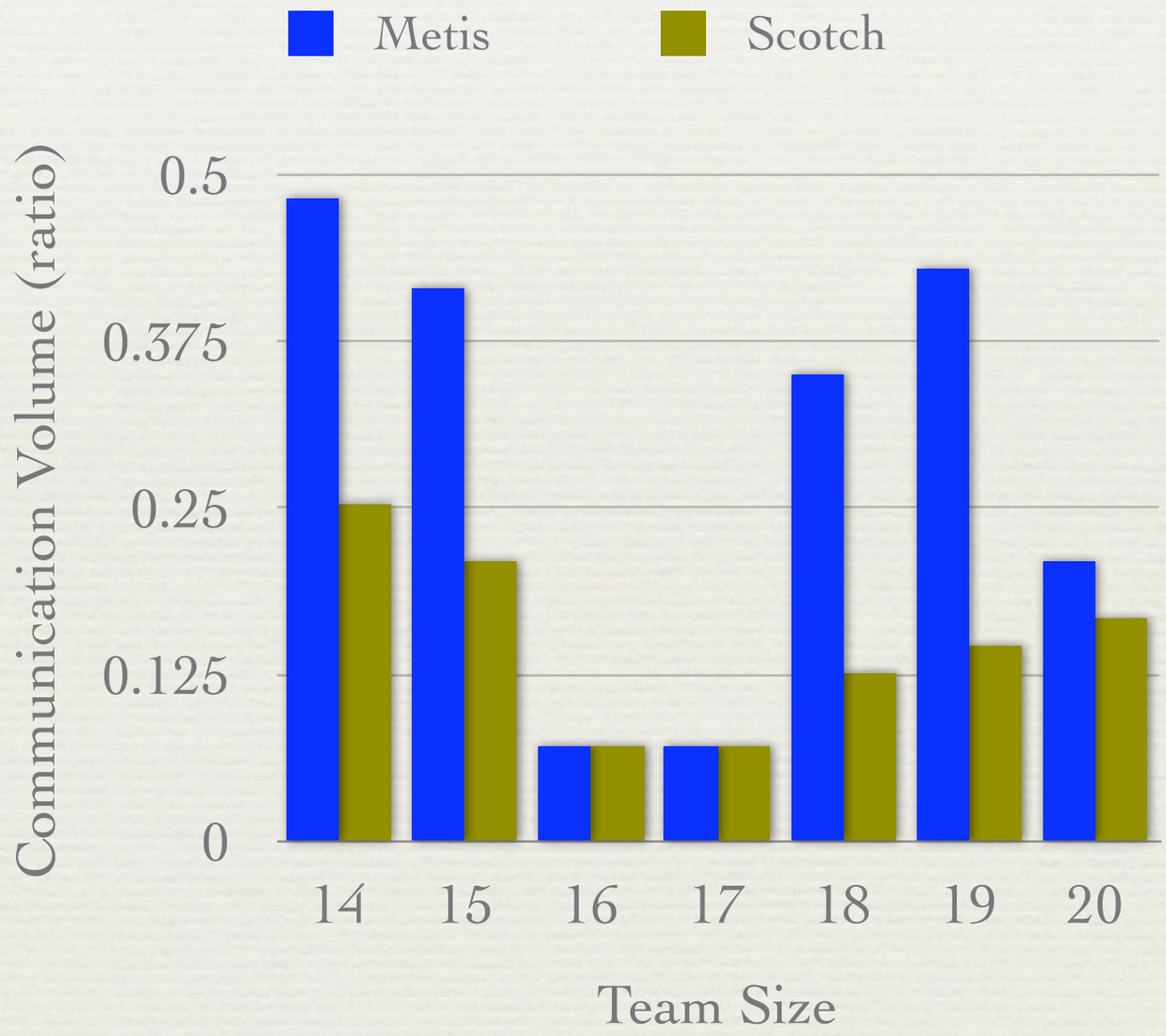

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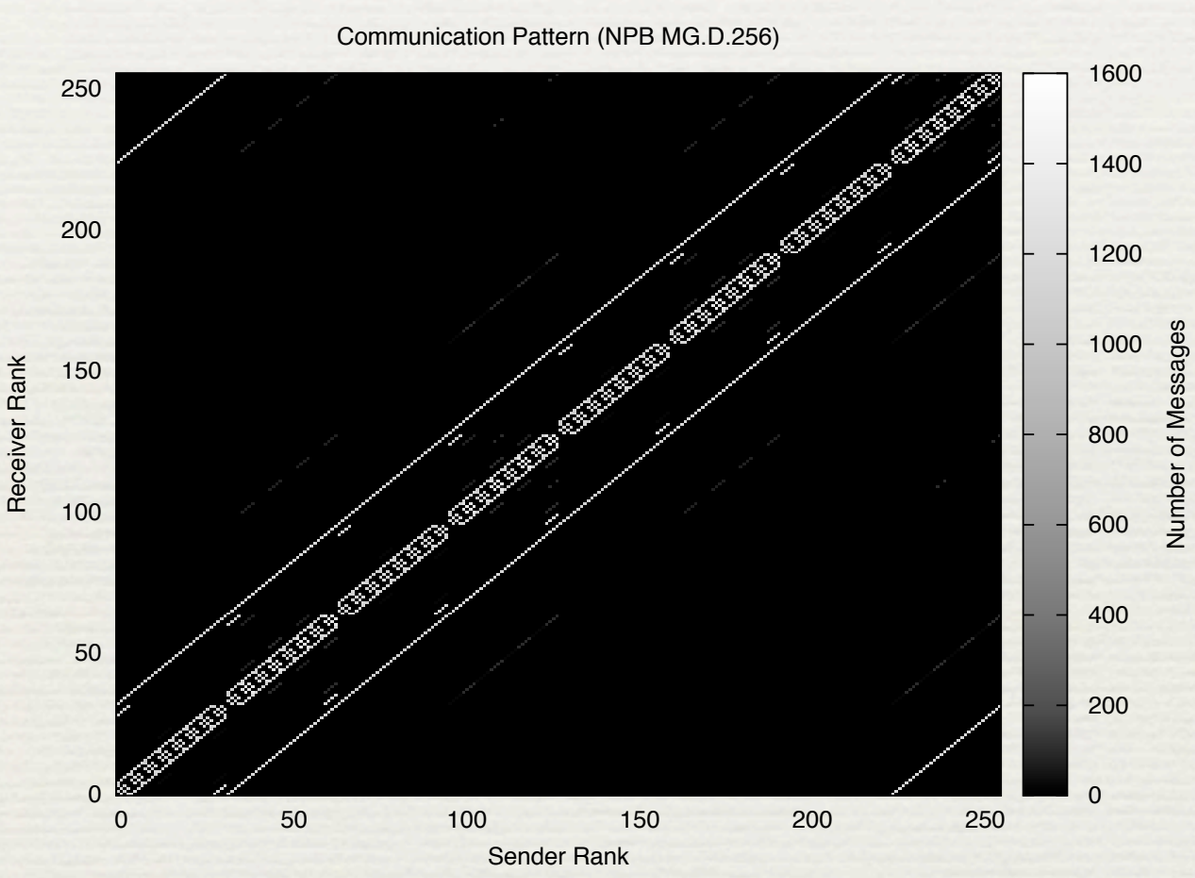
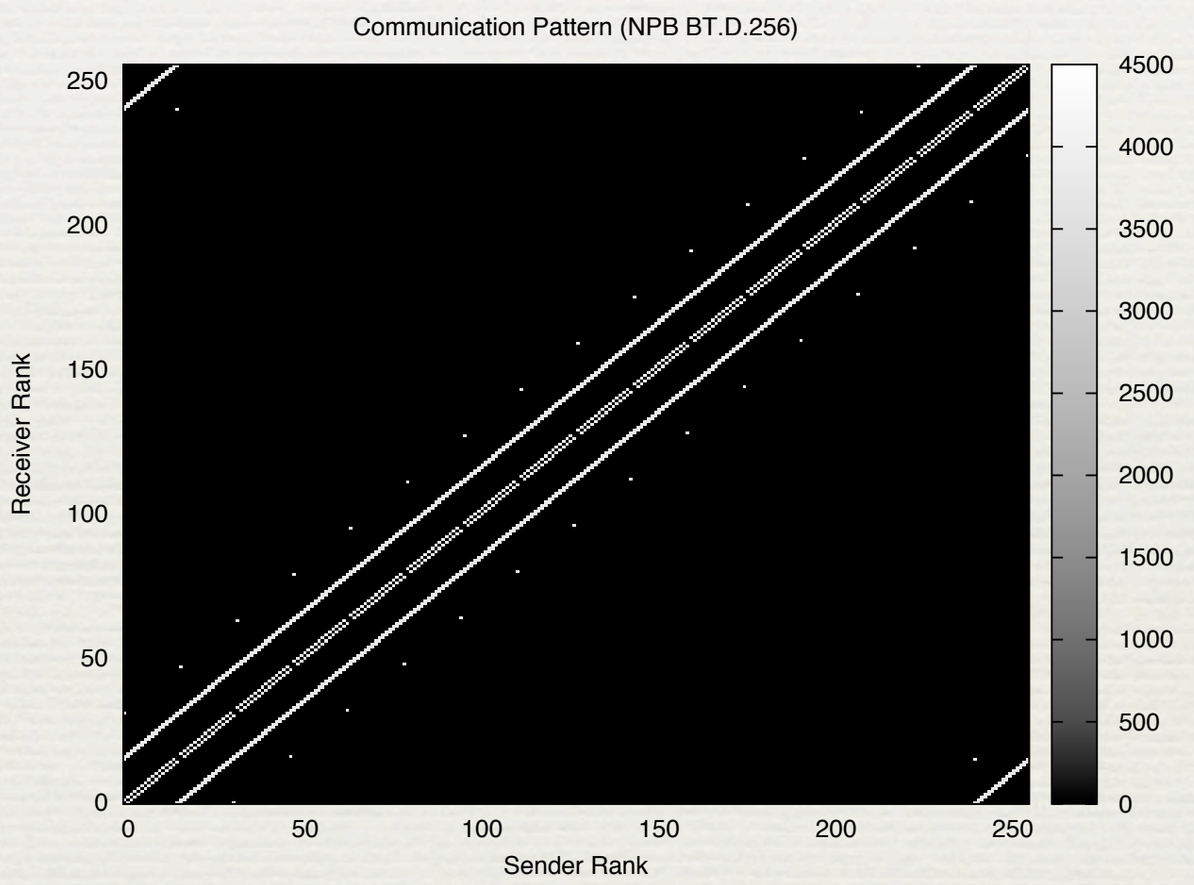
Benchmarks



NPB-MG



NPB-BT

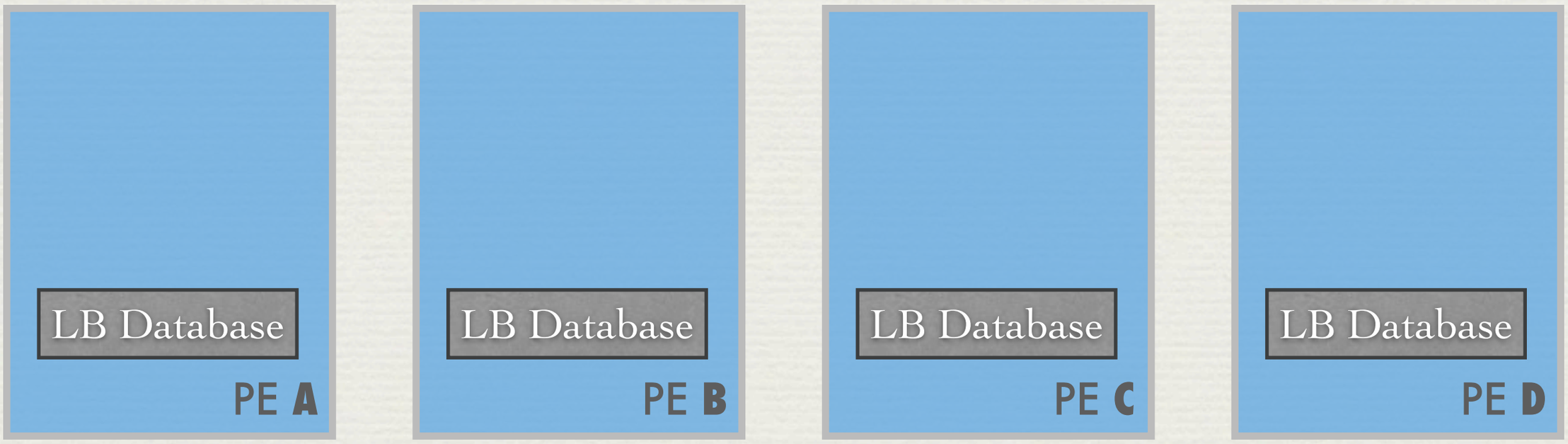
Graph Properties

Program	Average Path Length	Clustering Coefficient	Communication Volume (ratio)		
			Metis	Scotch	Random
NPB-CG (t=16)	4.49	0	0.07	0.07	0.93
NPB-MG (t=32)	3.82	0.09	0.27	-	0.87
NPB-BT (t=16)	6.24	0.40	0.35	0.33	0.93

Dynamic Clustering

Load Balancing in Charm++

- **Migratable** objects, asynchronous method invocation.
- **Measurement-based** load balancing: collects computation load and communication structure.



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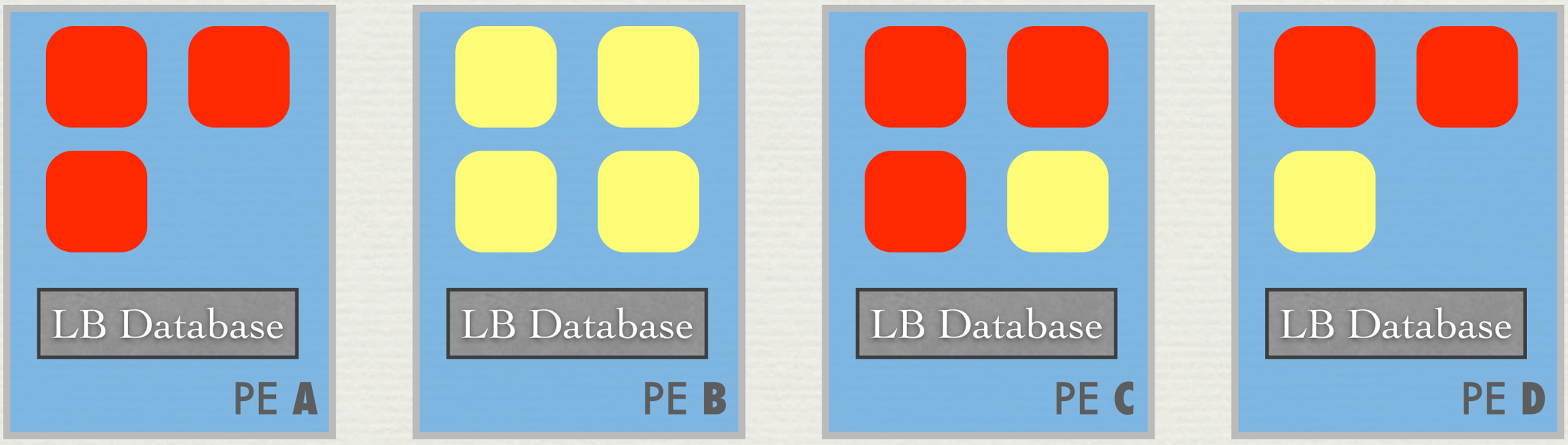

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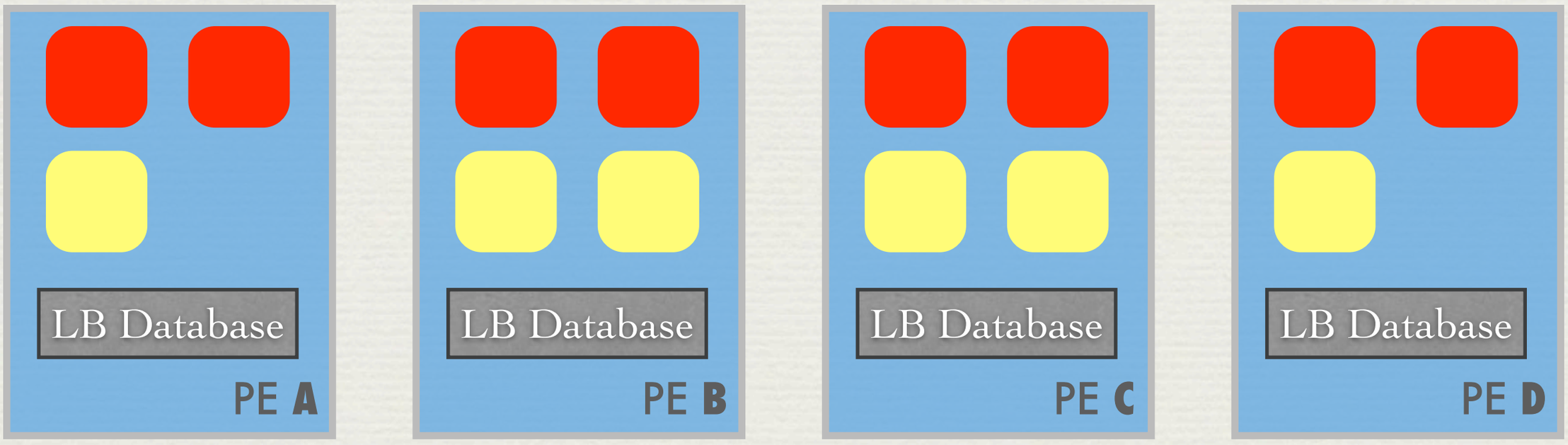
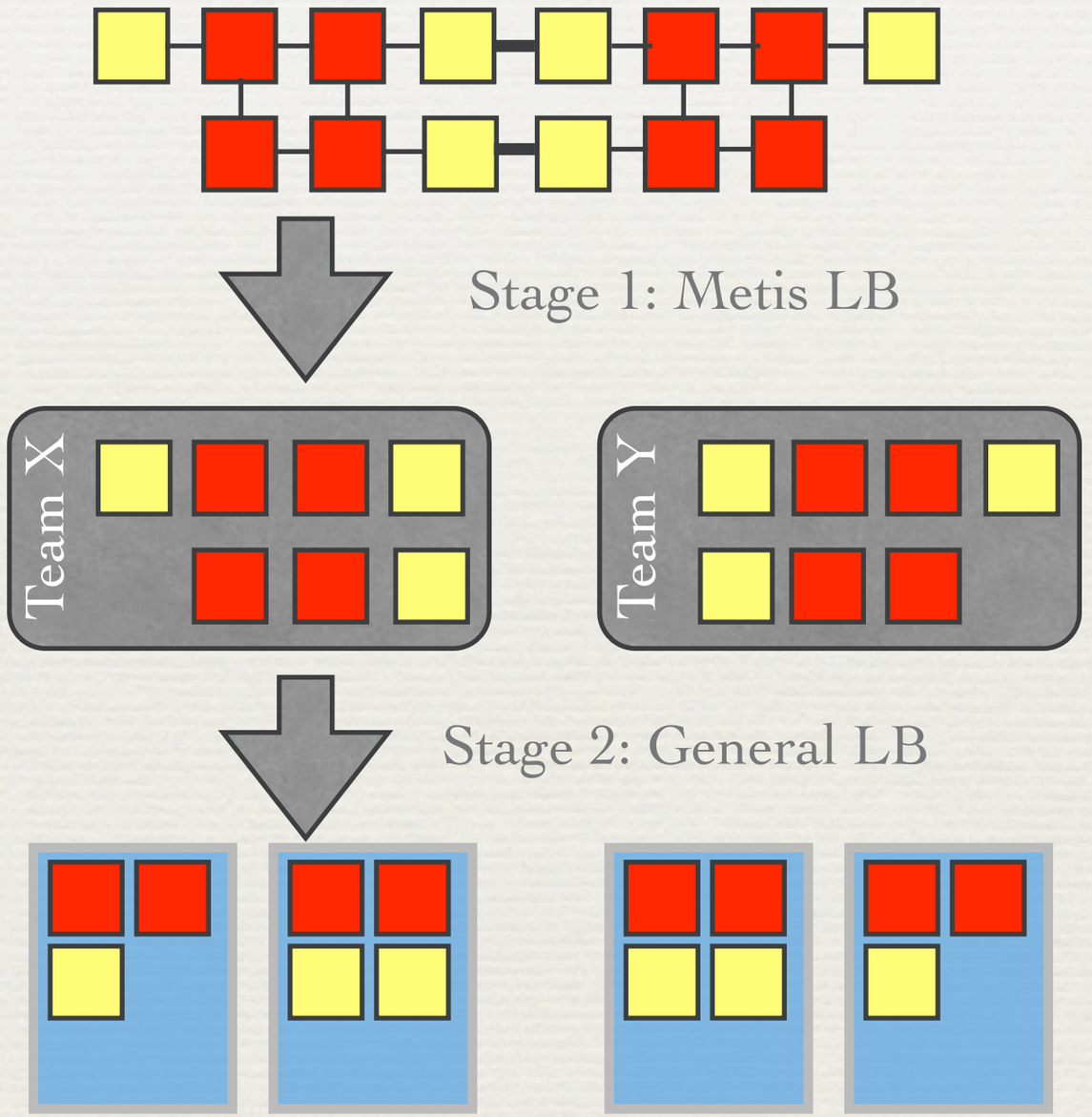
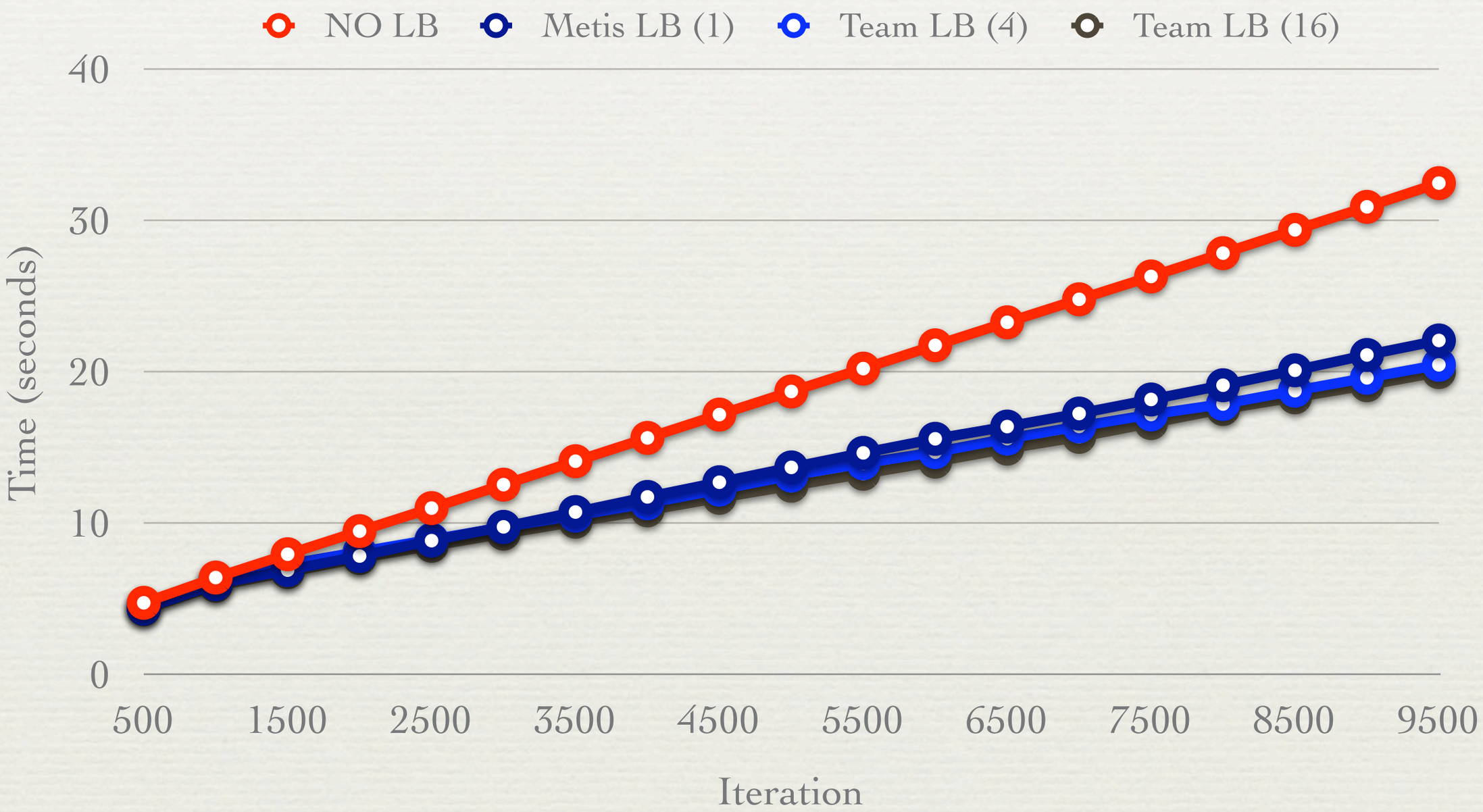


Team Load Balancer

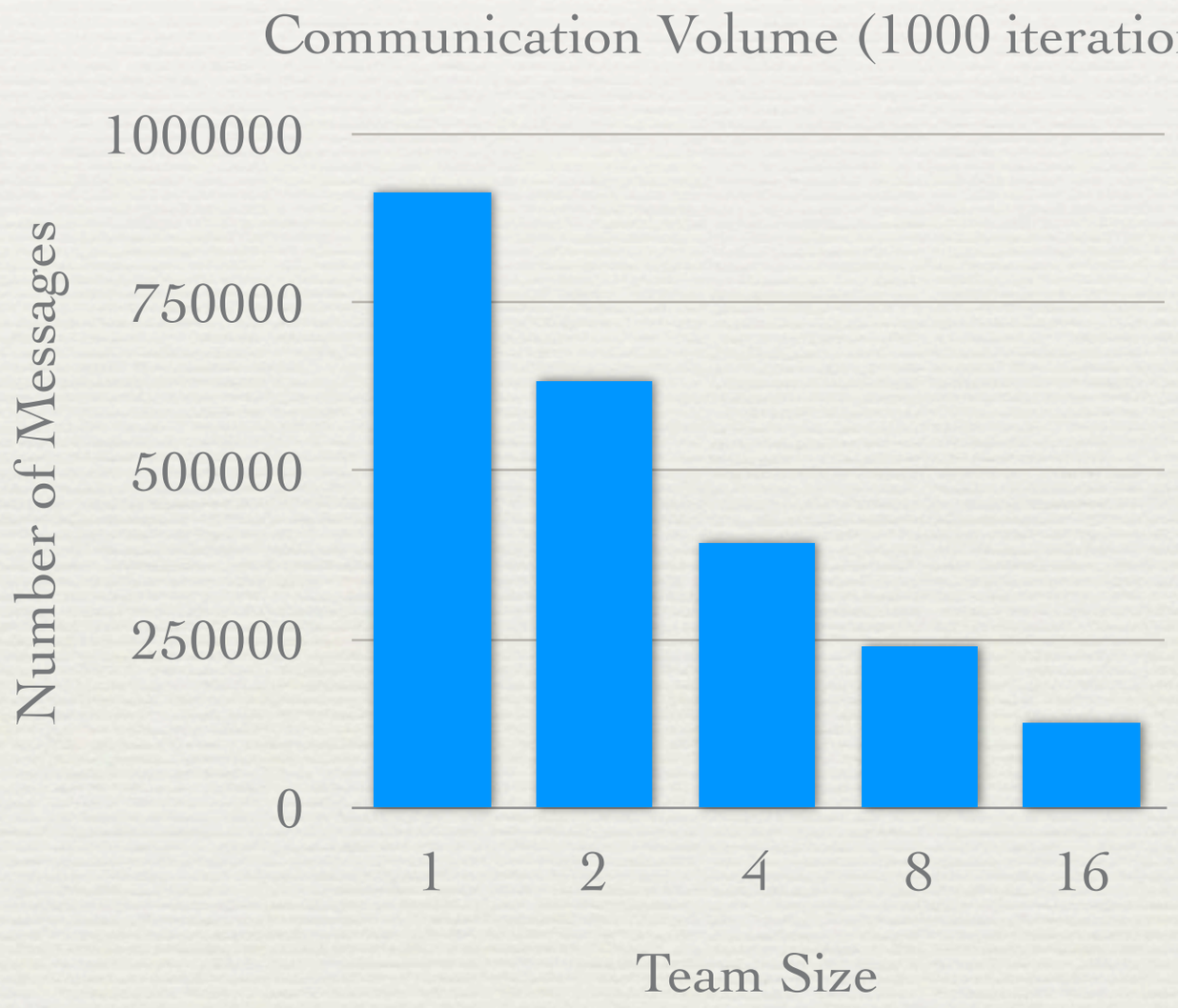
- Divides (evenly) the objects into teams while minimizing **communication volume**.
- Team LB (*t*), *t* is the team size (number of PEs).
- **Two stage** process:
  - Divide objects into teams.
  - Load balance each team.



Reducing Execution Time



Reducing Message Log Size



Conclusions

- Graph partitioning techniques are a promising alternative to cluster parallel applications.
- Message logging protocols benefit from team partitioning:
  - Reduce message log size.
  - Avoid cascading rollback.

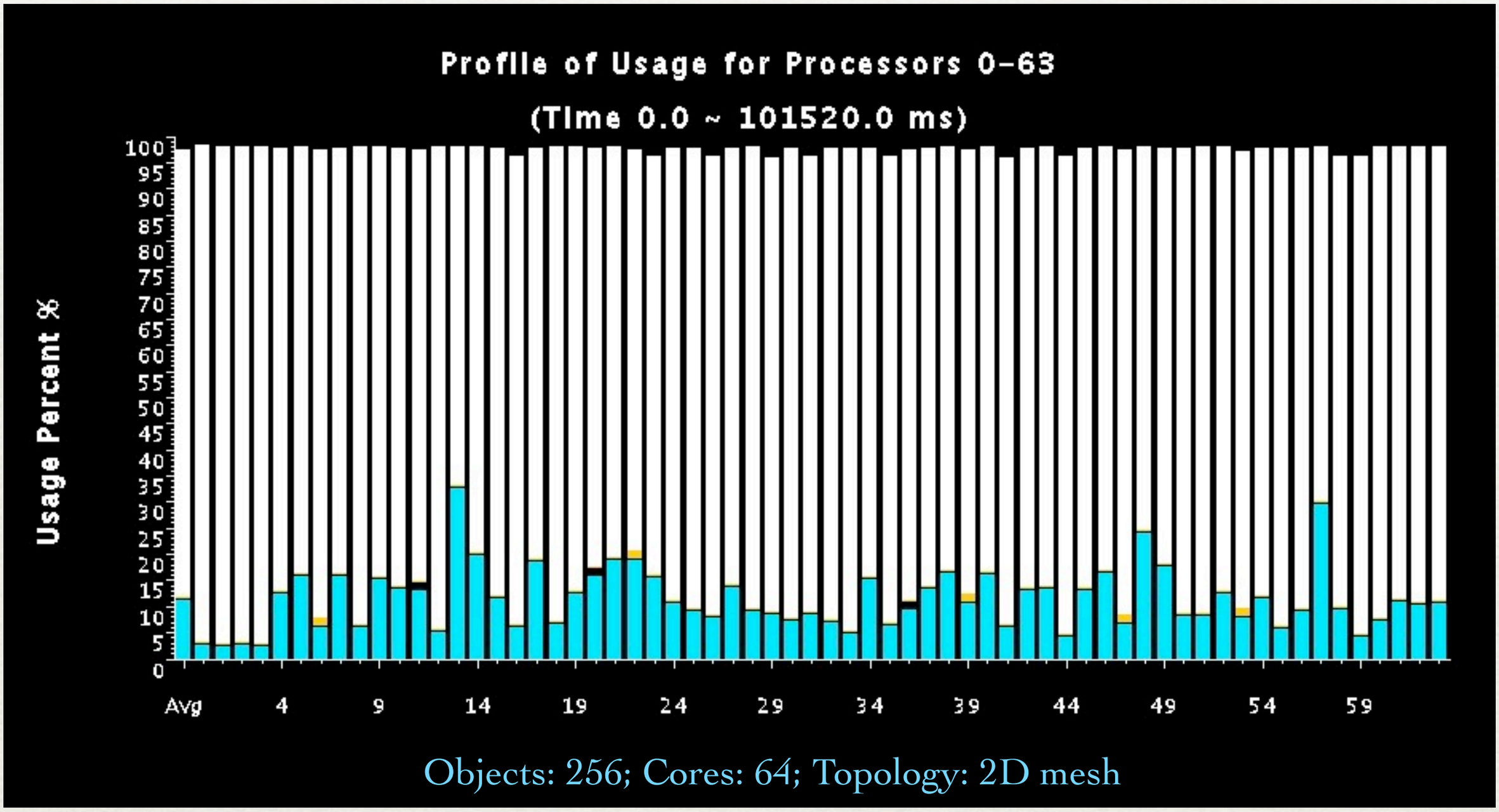
Future Work

- Scalable tool to collect communication information in MPI (collectives, notion of time).
- Evaluate more applications to inspect their clustering properties.
- Integration of clustering algorithms into parallel frameworks.

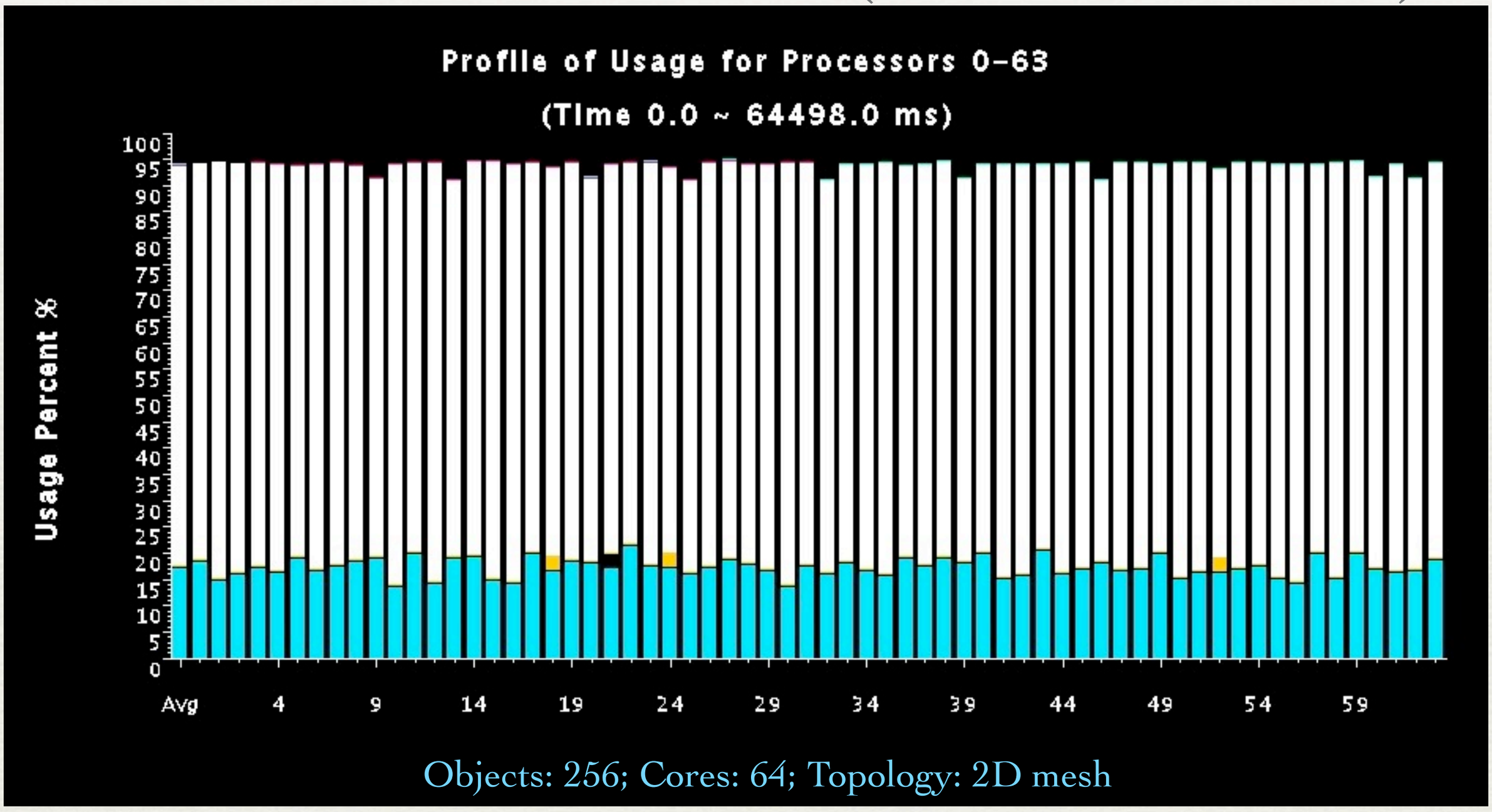
Q&A

Thank you!

LB Test


Profile of Usage for Processors 0-63
(Time 0.0 ~ 101520.0 ms)
Usage Percent %
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0
Avg
4
9
14
19
24
29
34
39
44
49
54
59
Objects: 256; Cores: 64; Topology: 2D mesh

Load Balance (Metis LB)



Load Balance (Team LB)