Have a Seat on the ErasureBench: Easy Evaluation of Erasure Coding Libraries for Distributed Storage Systems

2016 Workshop on Planetary-Scale Distributed Systems

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Outline

- Motivation
- Recap about erasure coding
- ErasureBench
- Evaluation
- Conclusion

Motivation

More and more data needs to be stored reliably on online servers.
Reliability can be provided through:

- Replication
- Erasure coding

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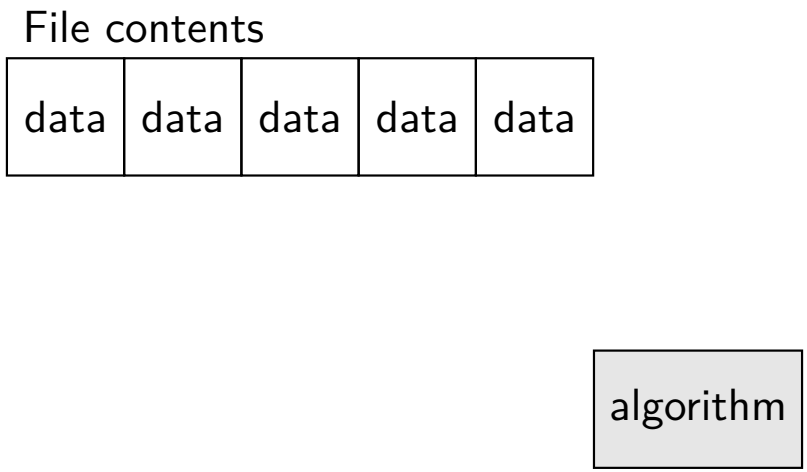
Motivation

- The characteristics of erasure coding algorithms are difficult to evaluate (encoding, decoding, complexity, latency, ...)
- Evaluation is often done theoretically or by simulation

Erasure coding

Goal: add redundancy to cope with data loss/corruption

Example using a $(5, 2)$ Reed-Solomon code:



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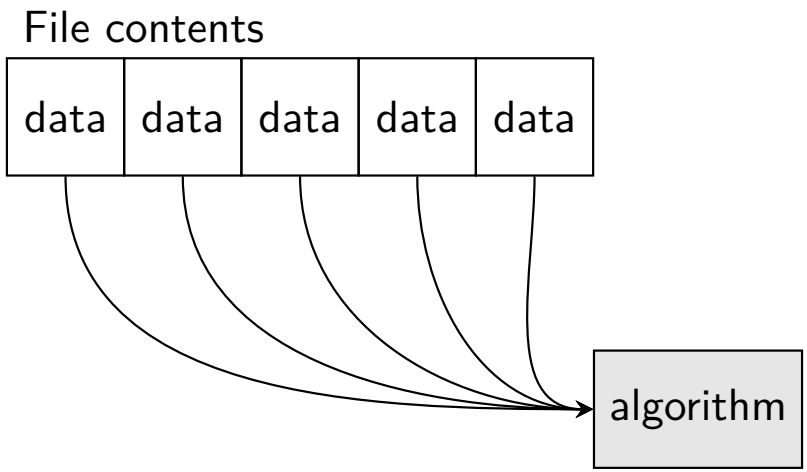

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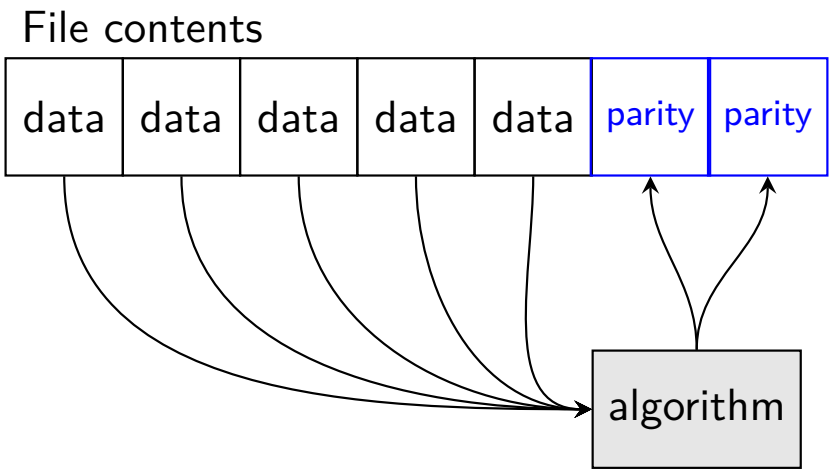

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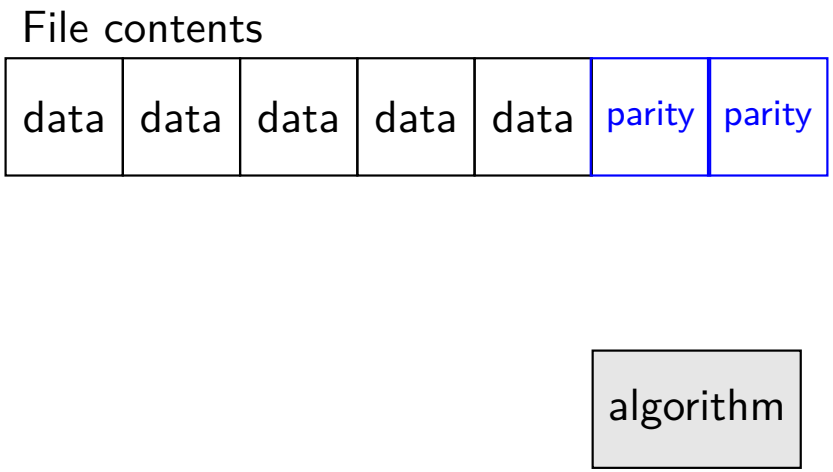

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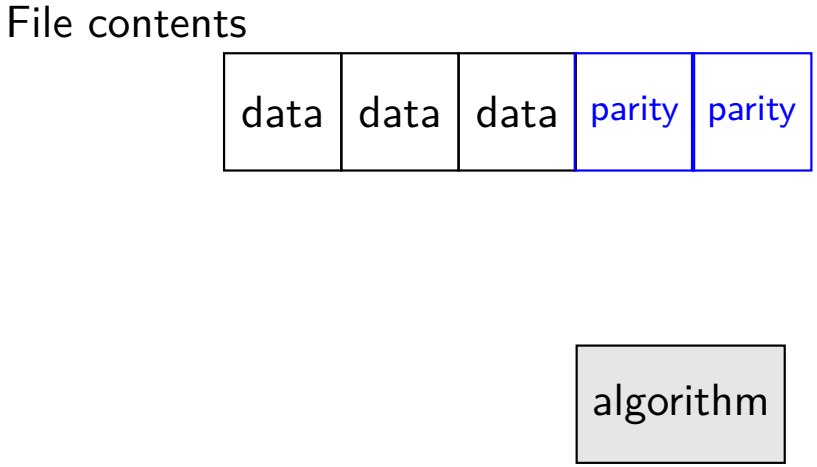

Erasure coding

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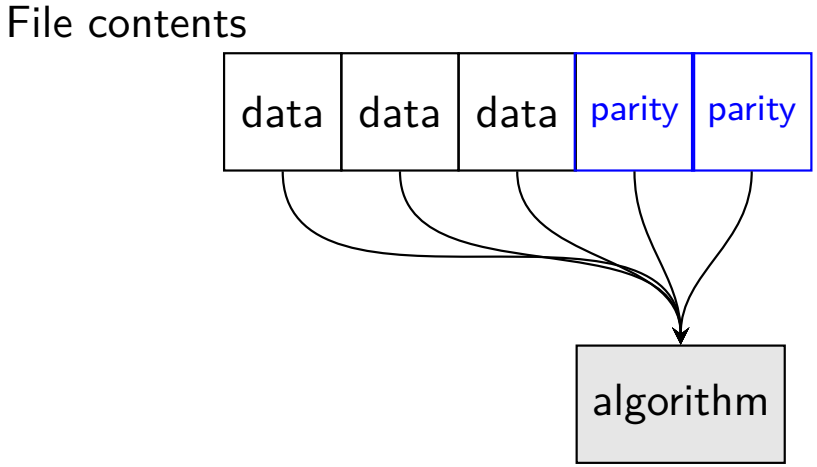

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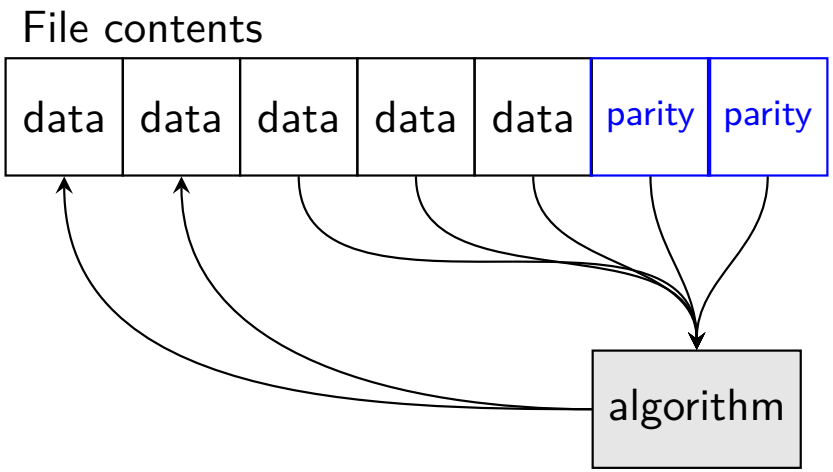


ErasureBench key features

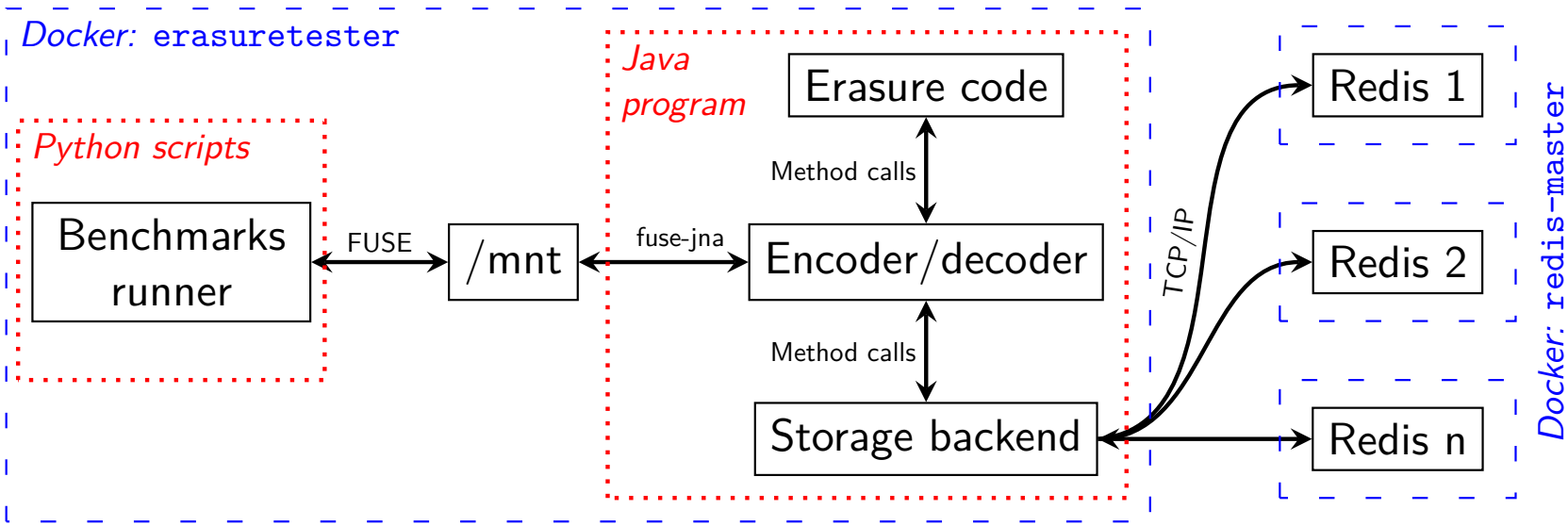
- Compatible with existing benchmark programs
- Automated benchmarks execution
- Containerized storage nodes (> 1 per physical node)
- Can replay fault traces

Evaluation example

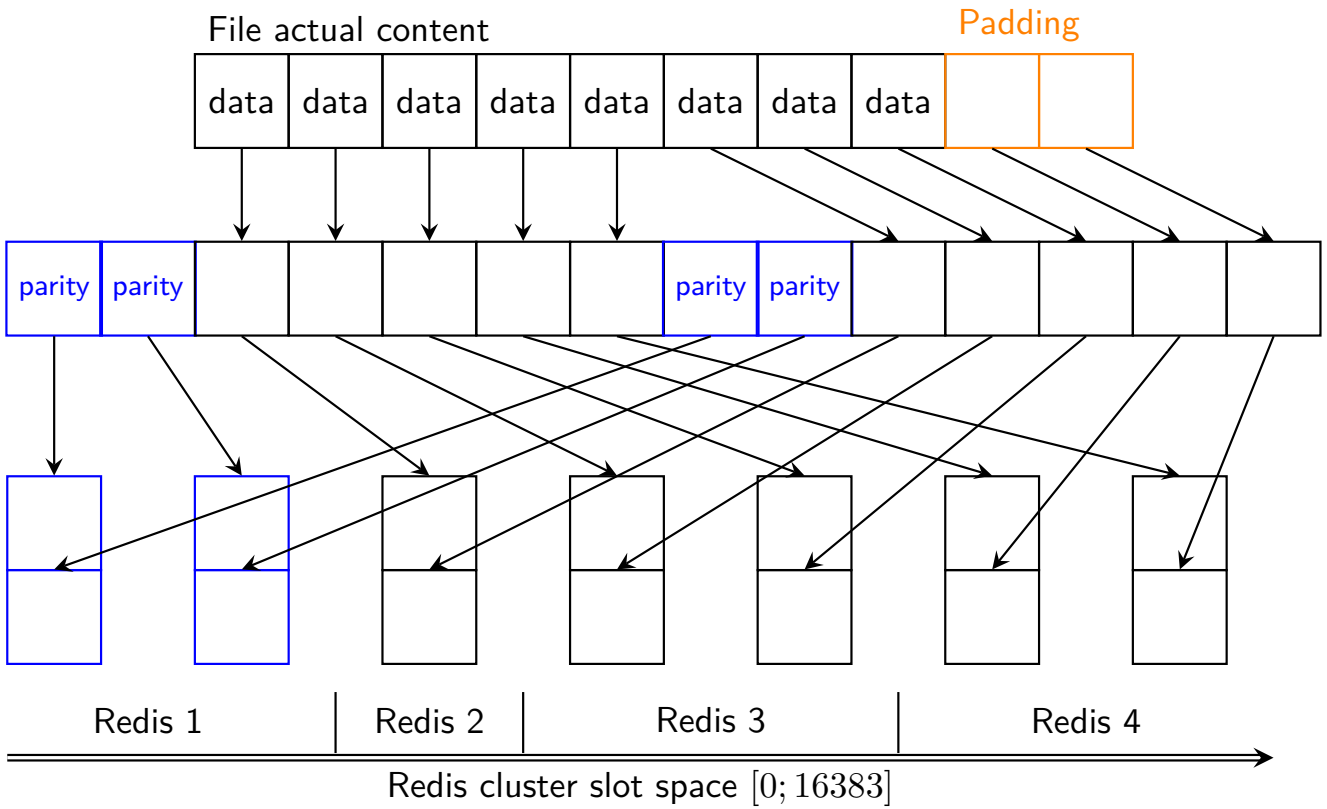
How to evaluate a new erasure coding algorithm

1. Program the algorithm as a Java class
2. Write benchmarks as Python functions
   - Debian-compatible programs can be launched as sub-processes
3. Configure the evaluation
   - e.g. algorithm parameters, fault trace, ...
4. Easily deploy the solution to a Docker cluster
5. Collect results

ErasureBench technical components



Blocks distribution



ErasureBench metadata management

- Each block is identified by a 32-bit key. Using it, we derive:
  1. Key of the blocks aggregation stored in Redis
  2. Offset within that aggregation
- The list of all block keys is kept in memory

ErasureBench automated deployment and scaling

As part of ErasureBench, we provide scripts that automate the deployment of the solution to a Docker Swarm cluster, up to the collection of results

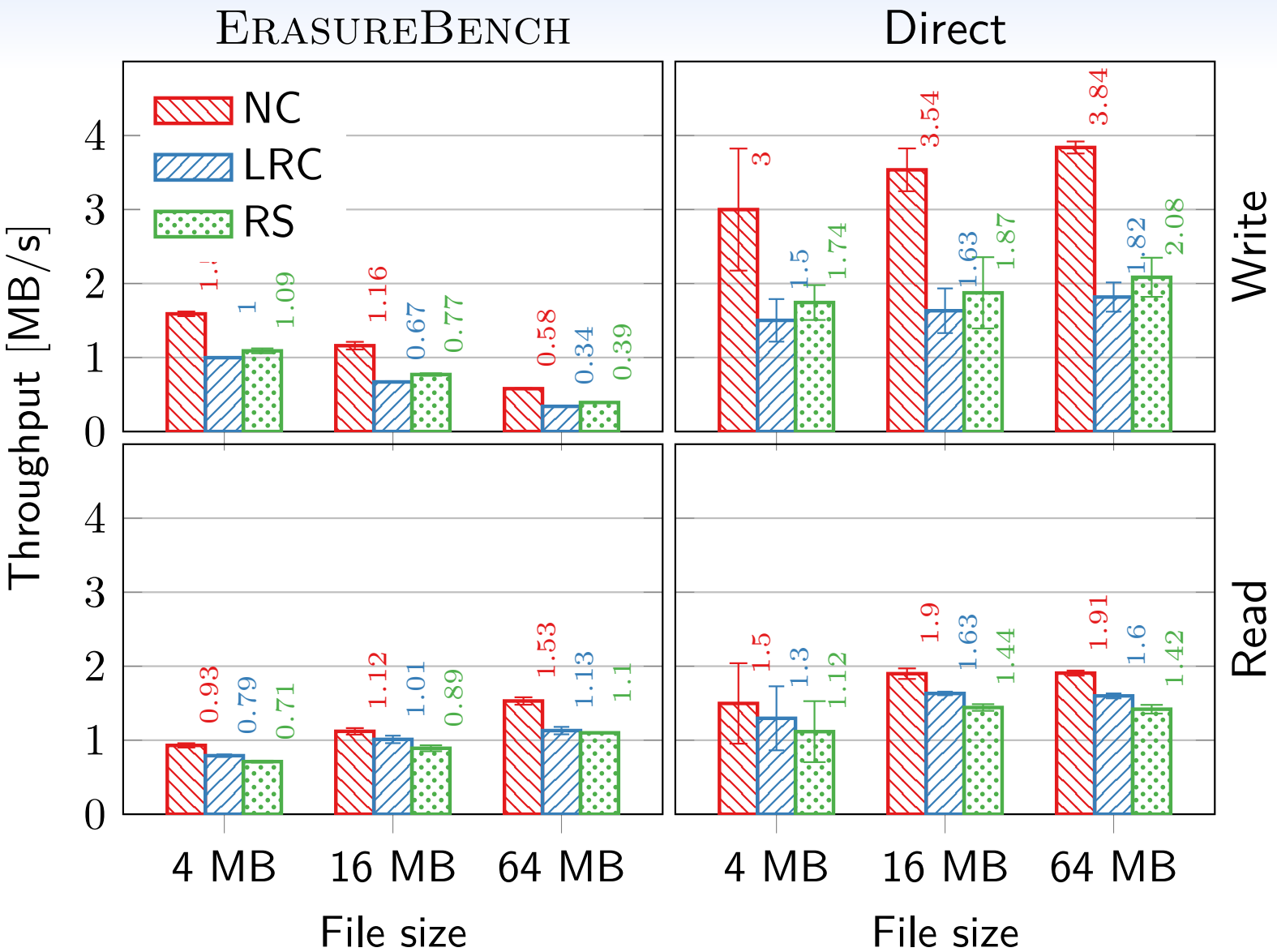
Evaluation

We evaluated algorithms from the following paper:

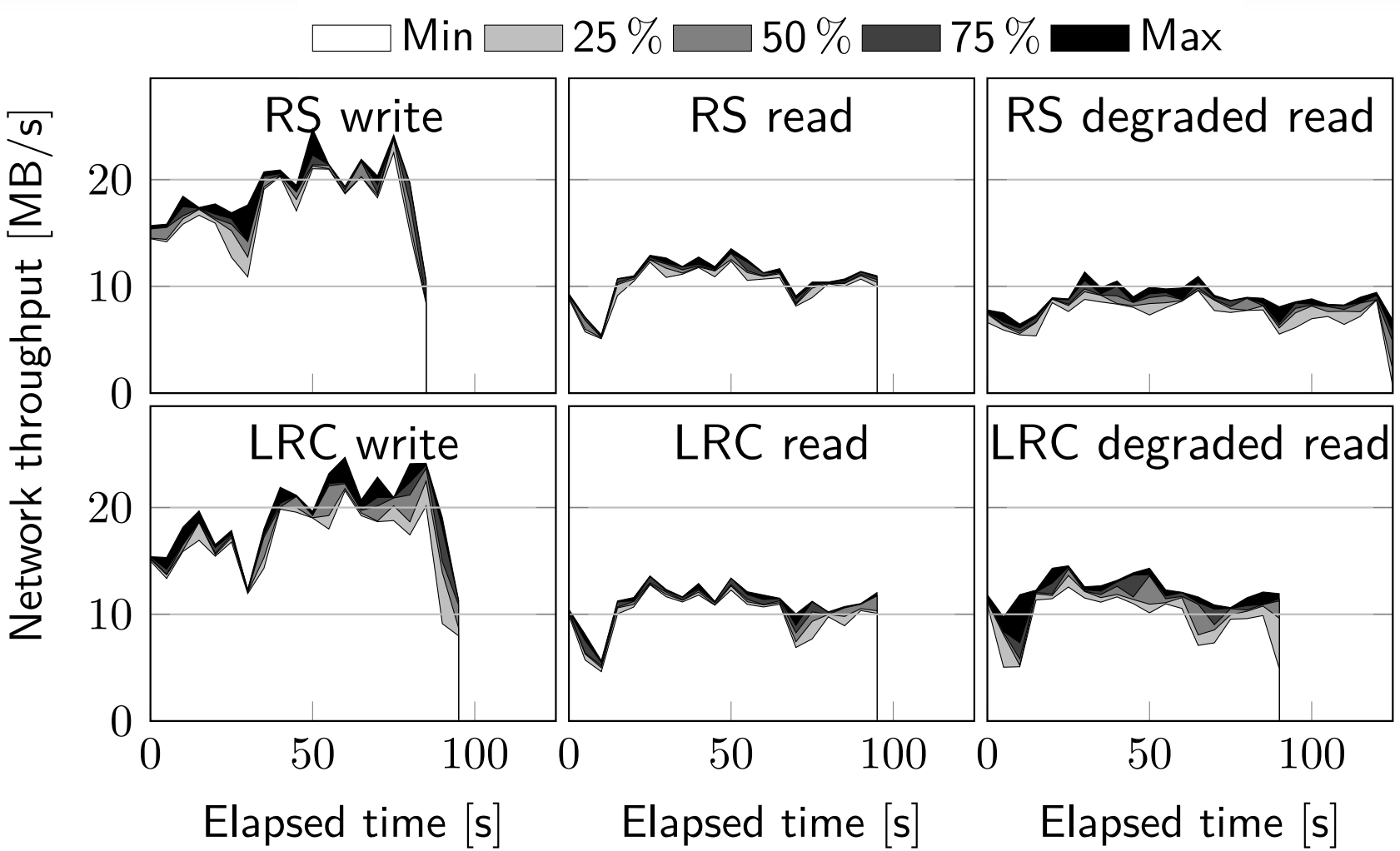
M. Sathiamoorthy, M. Asteris, D. Papailiopoulos, A. G. Dimakis, R. Vadali, S. Chen, and D. Borthakur, "XORing elephants: Novel erasure codes for big data," in Proceedings of the VLDB Endowment, vol. 6, 2013, pp. 325–336.

NC	No erasure coding
RS	$(10, 4)$ Reed-Solomon code
LRC	$(10, 6, 5)$ Locally Repairable Code

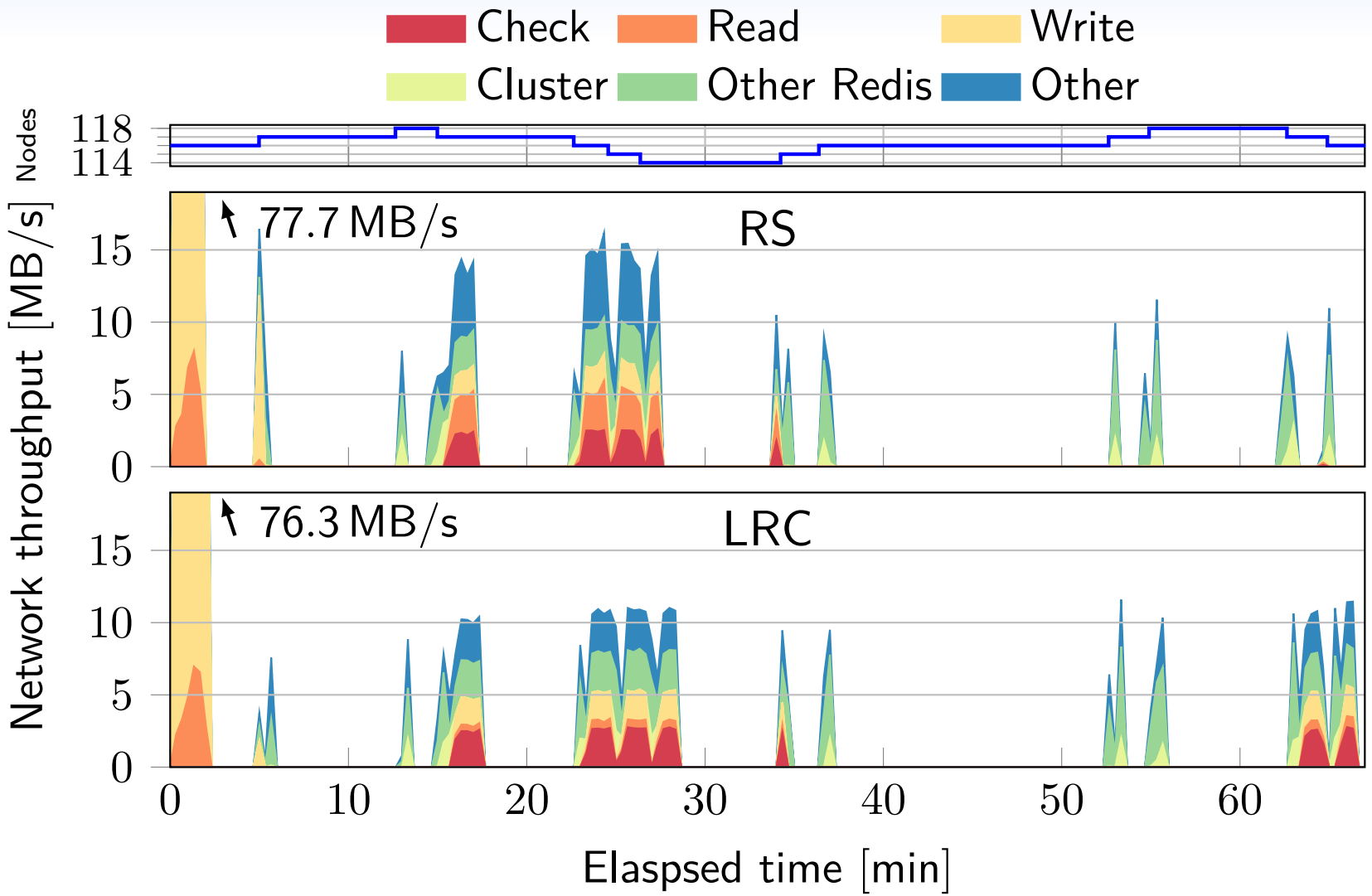
Throughput


ErasureBench
Direct
NC
LRC
RS
Throughput [MB/s]
Write
Read
0
1
2
3
4
1.6
1
1.09
1.16
0.67
0.77
0.58
0.34
0.39
3
1.5
1.74
3.54
1.63
1.87
3.84
1.82
2.08
0.93
0.79
0.71
1.12
1.01
0.89
1.53
1.13
1.1
1.5
1.3
1.12
1.9
1.63
1.44
1.91
1.6
1.42
4 MB
16 MB
64 MB
File size

Traffic


Min
25 %
50 %
75 %
Max
RS write
RS read
RS degraded read
LRC write
LRC read
LRC degraded read
Network throughput [MB/s]
0
10
20
0
50
100
Elapsed time [s]

Trace


Check
Read
Write
Cluster
Other Redis
Other
Nodes
118
114
77.7 MB/s
RS
76.3 MB/s
LRC
Network throughput [MB/s]
15
10
5
0
0
10
20
30
40
50
60
Elaspsed time [min]

Limitations

- Algorithms need to be written in Java
- High memory consumption
- Strong dependency on Docker and Redis

Conclusion

Using ErasureBench, evaluating an erasure coding algorithm under real conditions is easier and cheaper

Available open-source at
`https://github.com/safecloud-project/erasurebench`