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► **To cite this version:**

Jad Darrous, Shadi Ibrahim. Enabling Data Processing under Erasure Coding in the Fog. ICPP 2019 - 48th International Conference on Parallel Processing, Aug 2019, Kyoto, Japan. pp.1. hal-02388835

**HAL Id: hal-02388835**

**<https://inria.hal.science/hal-02388835>**

Submitted on 2 Dec 2019

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# Enabling Data Processing under Erasure Coding in Fog



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## Big Data Processing in Fog

### Fog Computing: Opportunities

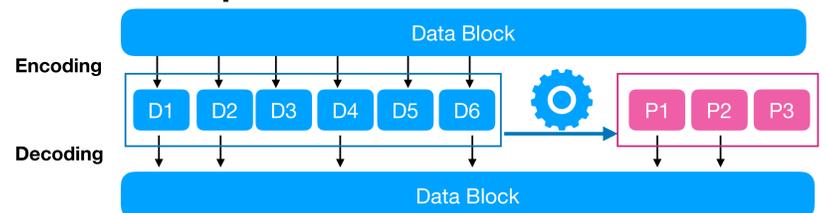
- Fog is widely adopted to extend the capacity of clouds
- It allows to deploy and run applications close to the users, e.g., Smart City applications<sup>[1]</sup>
- Data processing applications, among others, can also benefit of Fog, e.g., Video Stream processing<sup>[2]</sup>, Query processing<sup>[3]</sup> and Batch processing<sup>[4]</sup>

### Fog: Limitations and Challenges

- Limited storage capacity
  - Using replication to ensure data availability is expensive
- Heterogeneous and limited computation capacity
  - Difficult to exploit data locality efficiently
- Heterogeneous network
  - The cost of data transfer between nodes is high

## Erasure Coding as alternative to replication

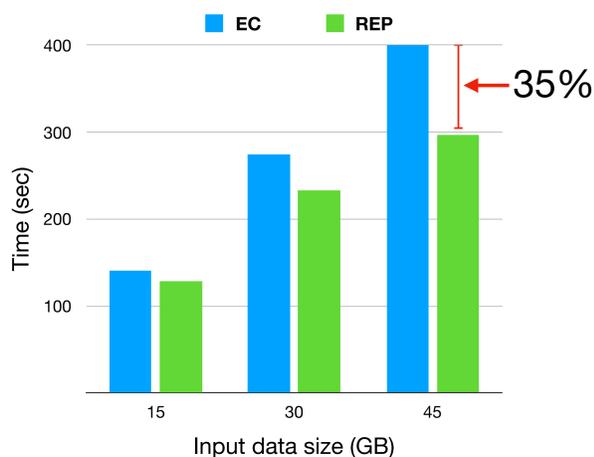
- **Half** the storage overhead of replication, for  $RS(6, 3)$
- **Low** CPU overhead for encoding/decoding (5.3 GB/s)<sup>[5]</sup>
  - EC have been deployed in storage and caching systems<sup>[7]</sup>
  - HDFS is now equipped with EC since the 3.0.0 release<sup>[6]</sup>
- When performing MapReduce applications in data-intensive clusters
  - Unlink replication, most of the (map) task input data is **transferred**
  - A **reduction** by half of the network traffic and disk accesses when writing the output data



*How to effectively realize EC for big data processing in Fog?*

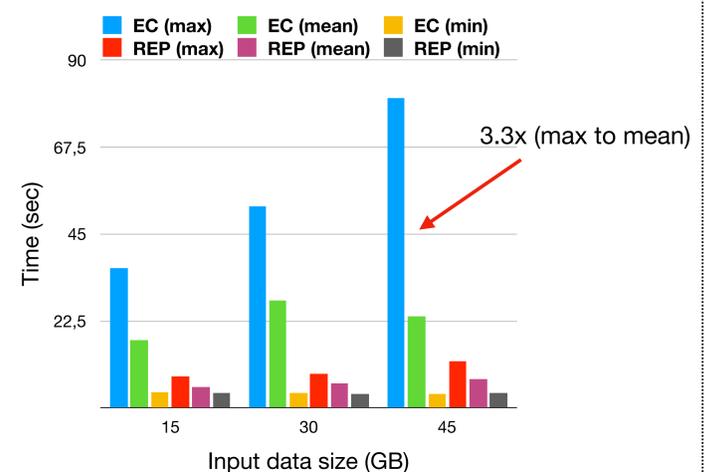
## Quantitatively analyze the impact of heterogeneity

A Fog infrastructure is emulated on 10 machines each representing a Fog site



Sort execution time

Bandwidth: 500Mbps → 5Gbps  
Computation: 2 → 10 cores  
Storage: main memory



Map tasks runtimes

- Sort application performs **35% faster** under Replication compared to EC
- The main reason behind the low performance of EC is the **heterogeneity of the network**
- Map tasks **wait for the last chunk** to process the current piece of data
- This leads to **high variation** in map runtimes under EC (60%)

## Towards Network-Aware map task scheduling

- A **network-aware** solution should be considered to lower the impact of network heterogeneity
- A potential solution is to **choose to which node** the data chunks (*original and parity*) should be transferred in order to minimize the maximum retrieving time
- To achieve the best job level performance, the scheduler should consider all the map tasks at once

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### ACKNOWLEDGMENTS

This work is supported by the Stack/Apollo connect talent project, Inria Project Lab program Discovery (see [beyondtheclouds.github.io](https://beyondtheclouds.github.io)), and the ANR KerStream project (ANR-16-CE25-0014-01). The experiments presented in this paper were carried out using the Grid'5000/ALADDIN-G5K experimental testbed (see [www.grid5000.fr](http://www.grid5000.fr)).



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