Enabling Data Processing under Erasure Coding in Fog

Jad Darrous[1] and Shadi Ibrahim[2]

[1]Inria, ENS de Lyon, LIP

[2]Inria, IMT Atlantique, LS2N

Big Data Processing in Fog

Fog Computing: Opportunities

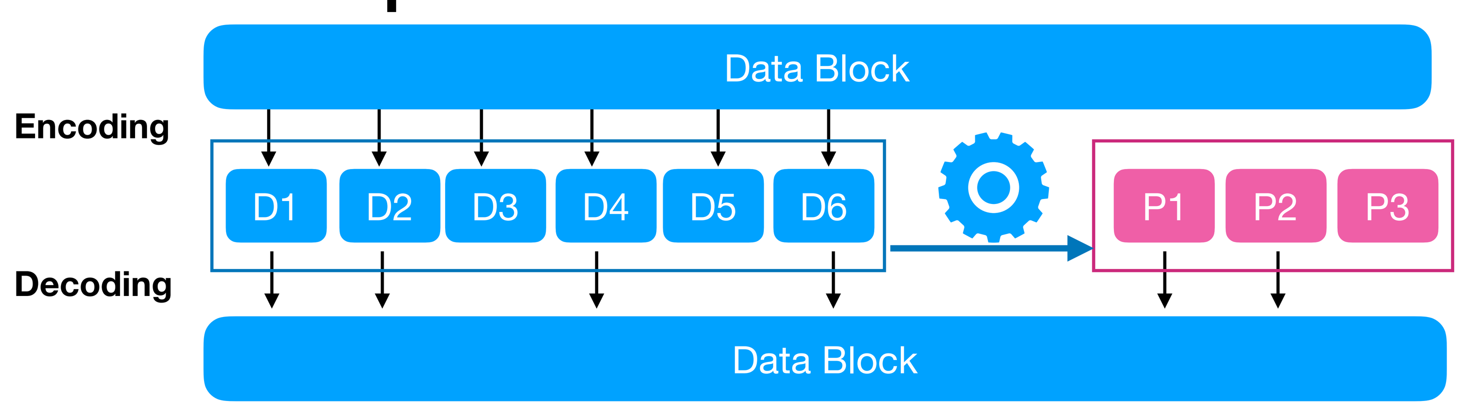
- Fog is widely adopted to extend the capacity of clouds
- It allows to deploy and run applications close to the users, e.g., Smart City applications[1]
- Data processing applications, among others, can also benefit of Fog, e.g., Video Stream processing[2], Query processing[3] and Batch processing[4]

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

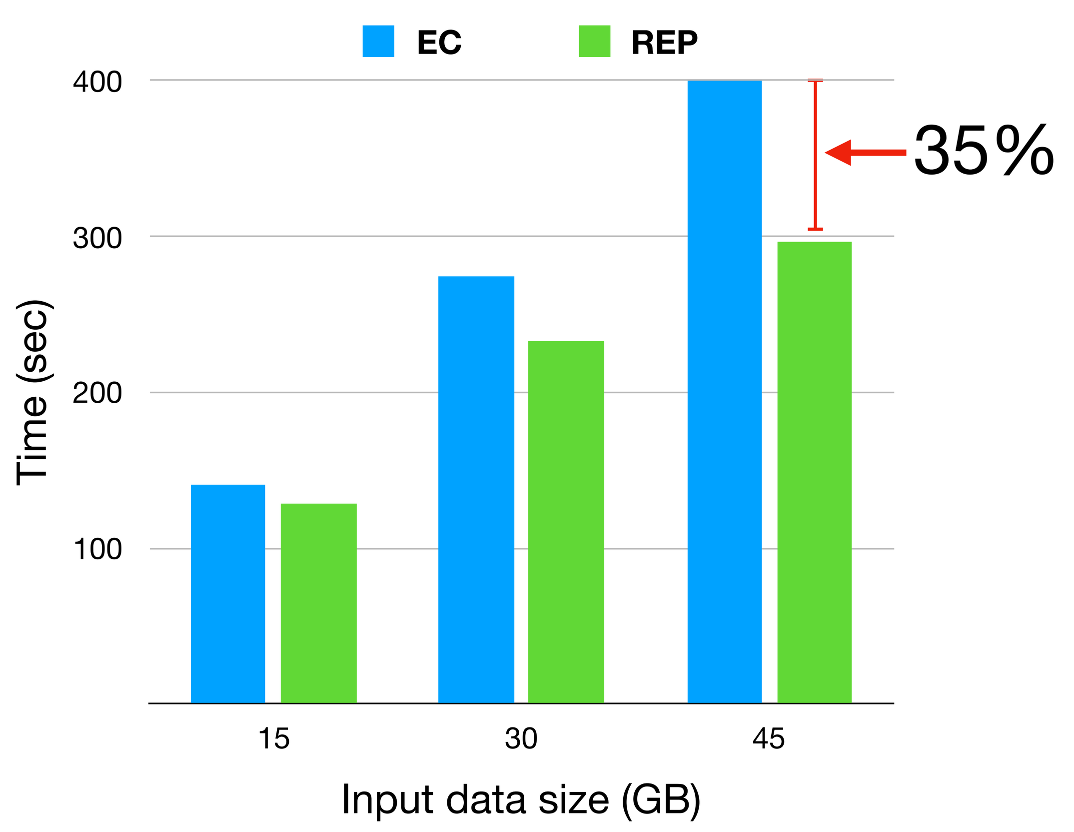
- **Half** the storage overhead of replication, for *RS(6, 3)*
- **Low** CPU overhead for encoding/decoding (5.3 GB/s)[5]
  - EC have been deployed in storage and caching systems[7]
  - HDFS is now equipped with EC since the 3.0.0 release[6]
- When performing MapReduce applications in data-intensive 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?

Quantitively analyze the impact of heterogeneity

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

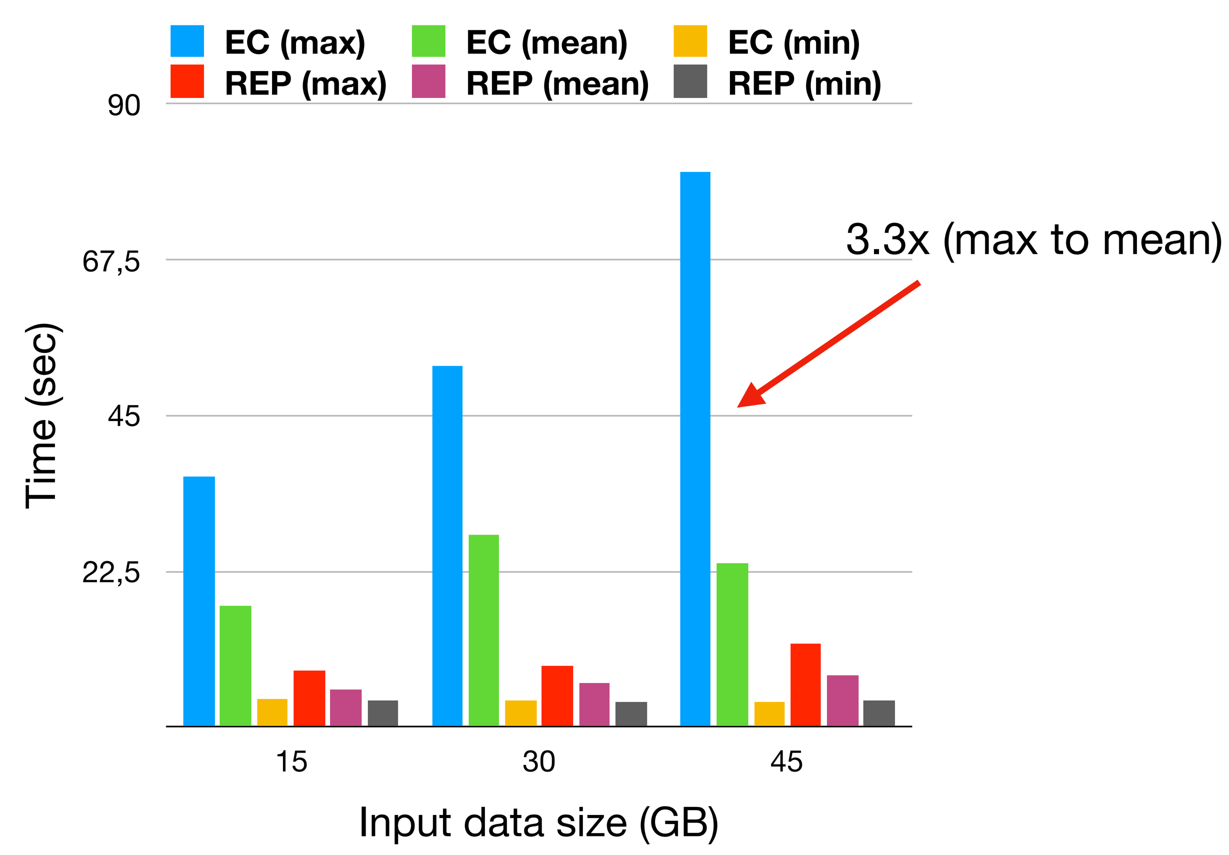


Sort execution time

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

Grid'5000

hadoop



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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