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Enabling Data Processing under Erasure Coding in Fog



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Big Data Processing in Fog

Fog Computing: Opportunities

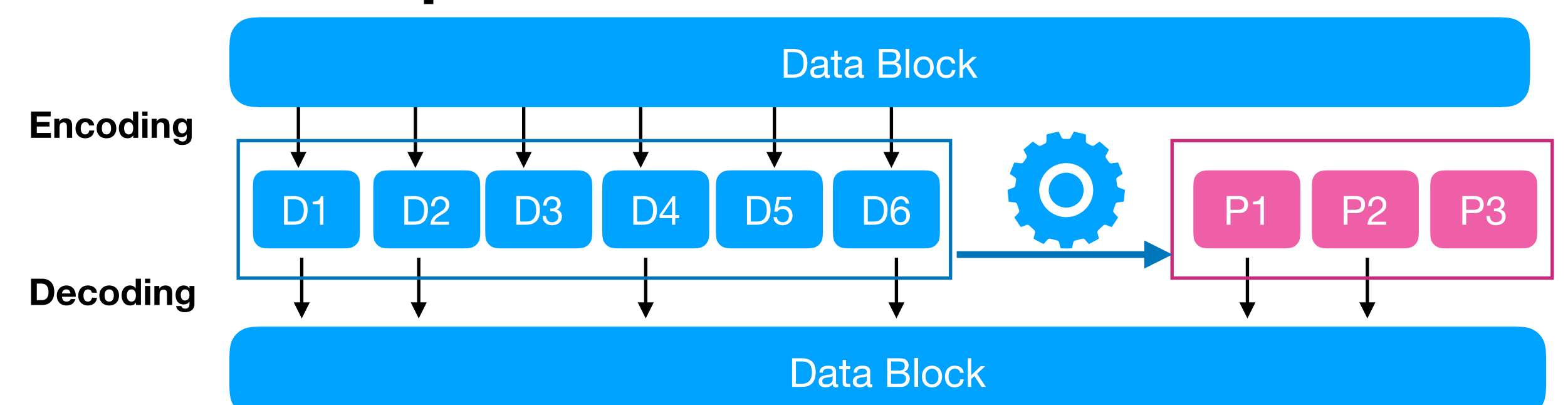
- Fog is widely adopted to extend the capacity of clouds
- It allows to deploy and run applications close to the users, e.g., Smart City applications^[1]
- Data processing applications, among others, can also benefit of Fog, e.g., Video Stream processing^[2], Query processing^[3] and Batch processing^[4]

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

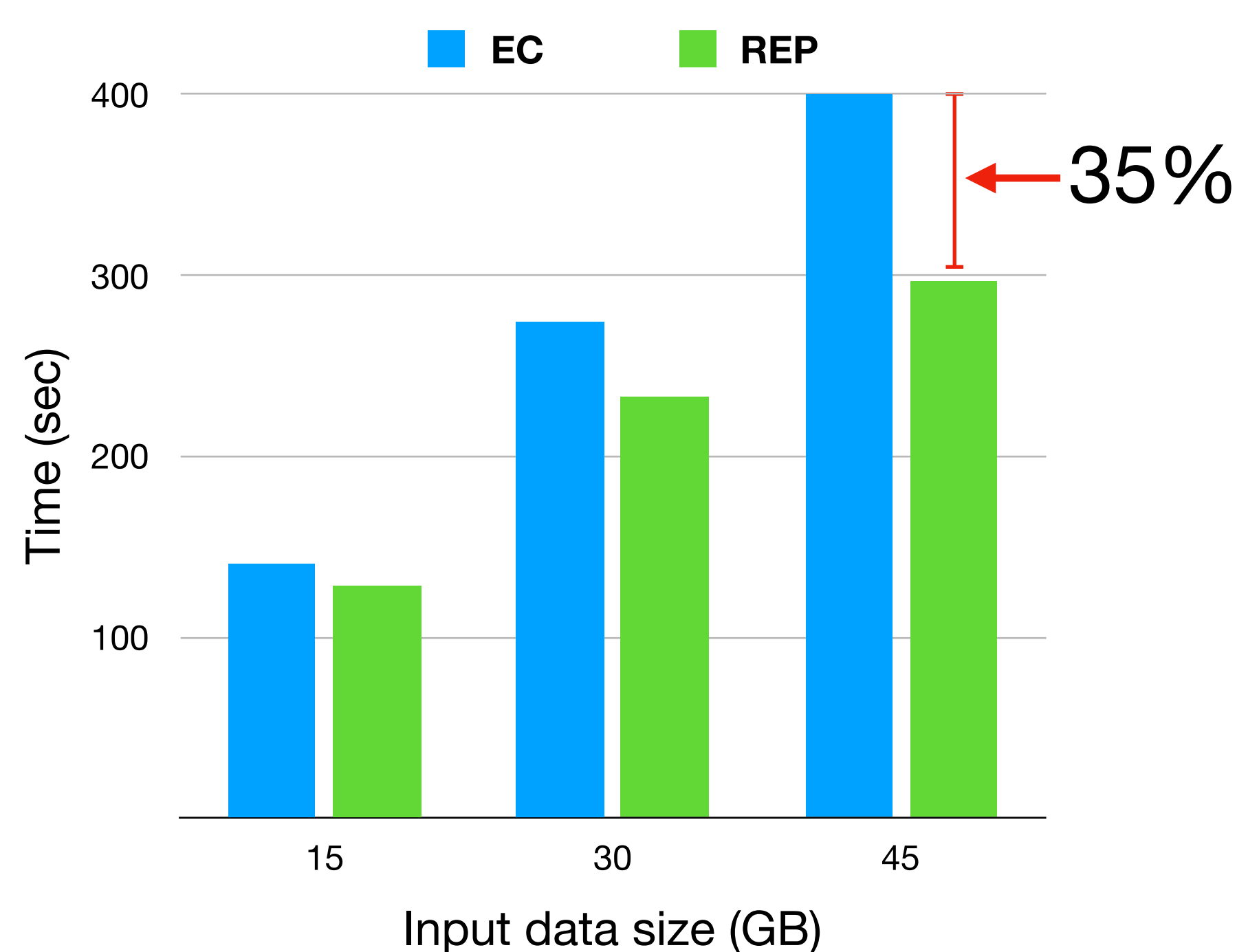
- **Half** the storage overhead of replication, for $RS(6, 3)$
- **Low** CPU overhead for encoding/decoding (5.3 GB/s)^[5]
 - EC have been deployed in storage and caching systems^[7]
 - HDFS is now equipped with EC since the 3.0.0 release^[6]
- When performing MapReduce applications in data-intensive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

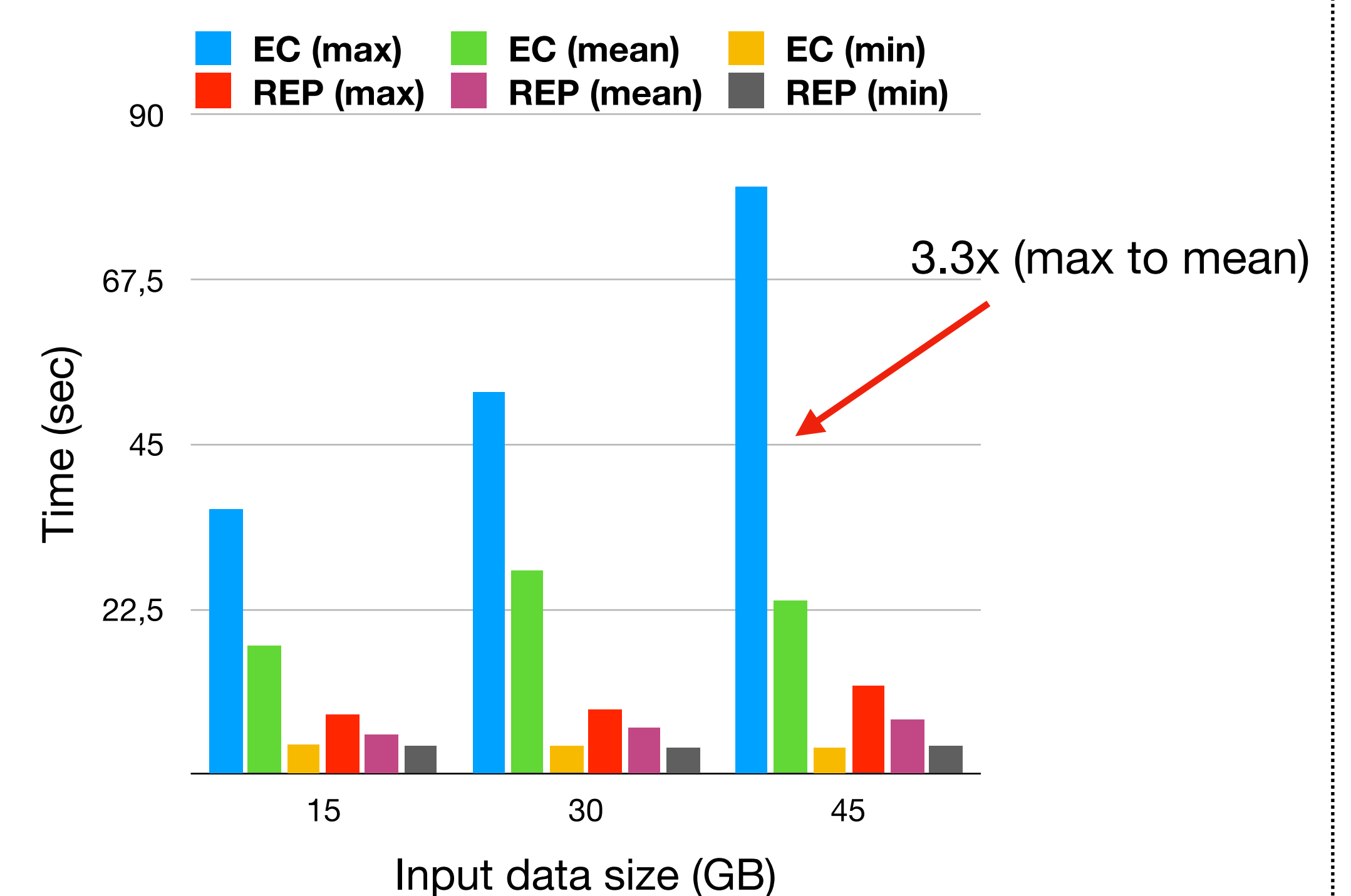
Quantitatively analyze the impact of heterogeneity

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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 [6] Apache Hadoop, 2019, Available online <http://hadoop.apache.org>
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