PER-MARE: Adaptive Deployment of MapReduce over Pervasive Grids

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Outline

Motivation

The PER-MARE initiative

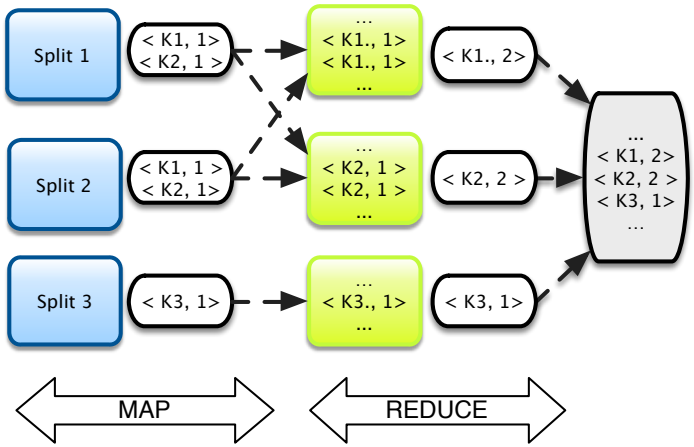
Preliminary results

Discussions & future works

Conclusions

MapReduce

- MapReduce as a computing paradigm
  - Proposed in 2004 by Google
  - Best known by **Hadoop**, an Apache project since 2005
- MapReduce basics
  - Map-Reduce algorithm = job
  - Operates with key-value pairs: (k,V)
  - MR Job defined by 2 functions
    - `map: (k1;v1)→{(k2;v2)}`
    - `reduce: (k2;{v2})→{(k3;v3)}`



Pervasive Grids vs Cloud

- Cloud computing and MapReduce
  - ✓ Elasticity of resources
  - ✗ Sensible data cannot be deployed on the cloud
- Why not use the enterprises own resources to provide computing power?
- Pervasive Grids
  - Computing environment built over available resources
  - "Costless" solution
  - Challenges
    - High volatility of resources
    - High heterogeneity

MapReduce Today

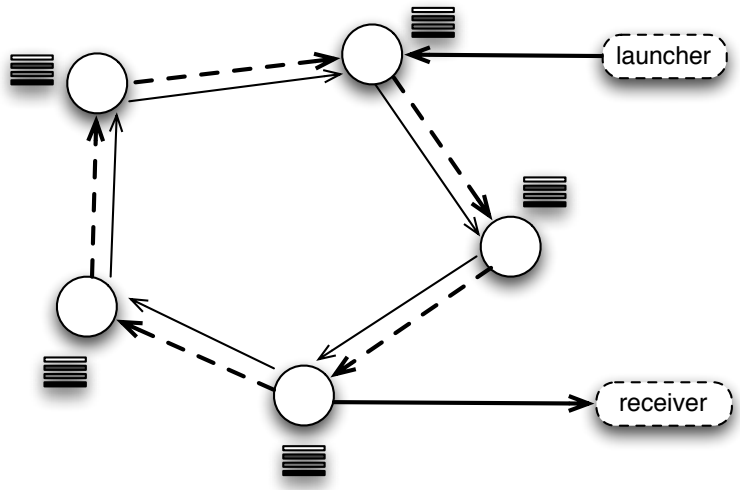
- Hadoop is not tailored for heterogeneous and volatile environments
  - Extensive configuration parameters
  - Limited to disconnections – no join
- A few works tried to port MapReduce to dynamic environments but lack some essential points
  - API compatibility
  - Adaptive scheduling
  - High volatility support

The PER-MARE Vision

- The PER-MARE project aims to adapt MapReduce to pervasive grids under a two-fold approach
  - Improving Hadoop
    - Context-aware task scheduling
    - Automatic tuning of nodes
    - Improved fault tolerance
  - Developing a MapReduce P2P framework
    - Compatible with Hadoop API
    - Easy to deploy in pervasive environments

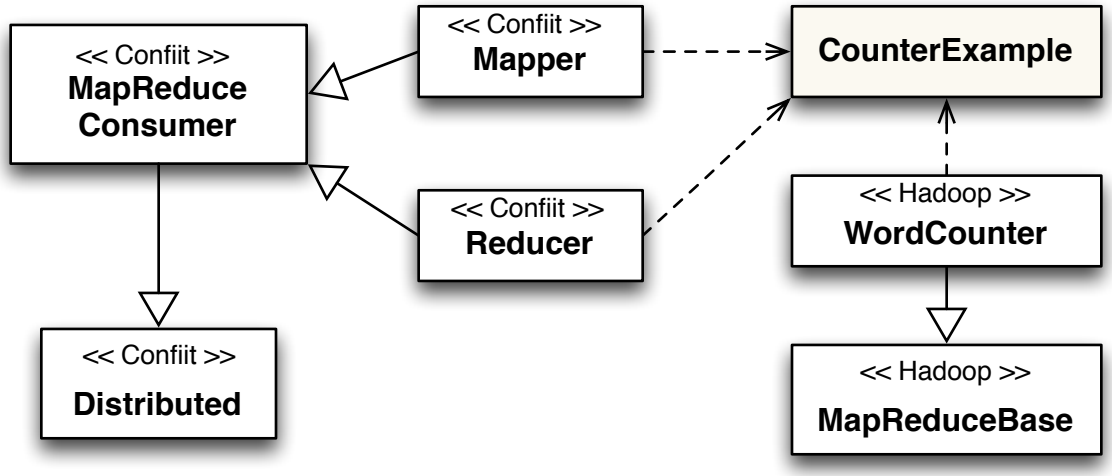
Some Results

- Porting MapReduce to a P2P environment
  - Use of CONFIIT P2P middleware
    - Support to nodes joining/leaving the network
    - "Bag of tasks" scheduling with speculative execution
    - Full replication of results to ensure high availability



Porting MapReduce to CONFIIT

- Two dependent jobs mimicking Hadoop behavior:
  - MAP – as many tasks as input files
  - REDUCE – as many tasks as computing cores
  - Intermediate data exchange (shuffle/sort)
    - Provided by the replication mechanism of CONFIIT
- Basic API compatibility

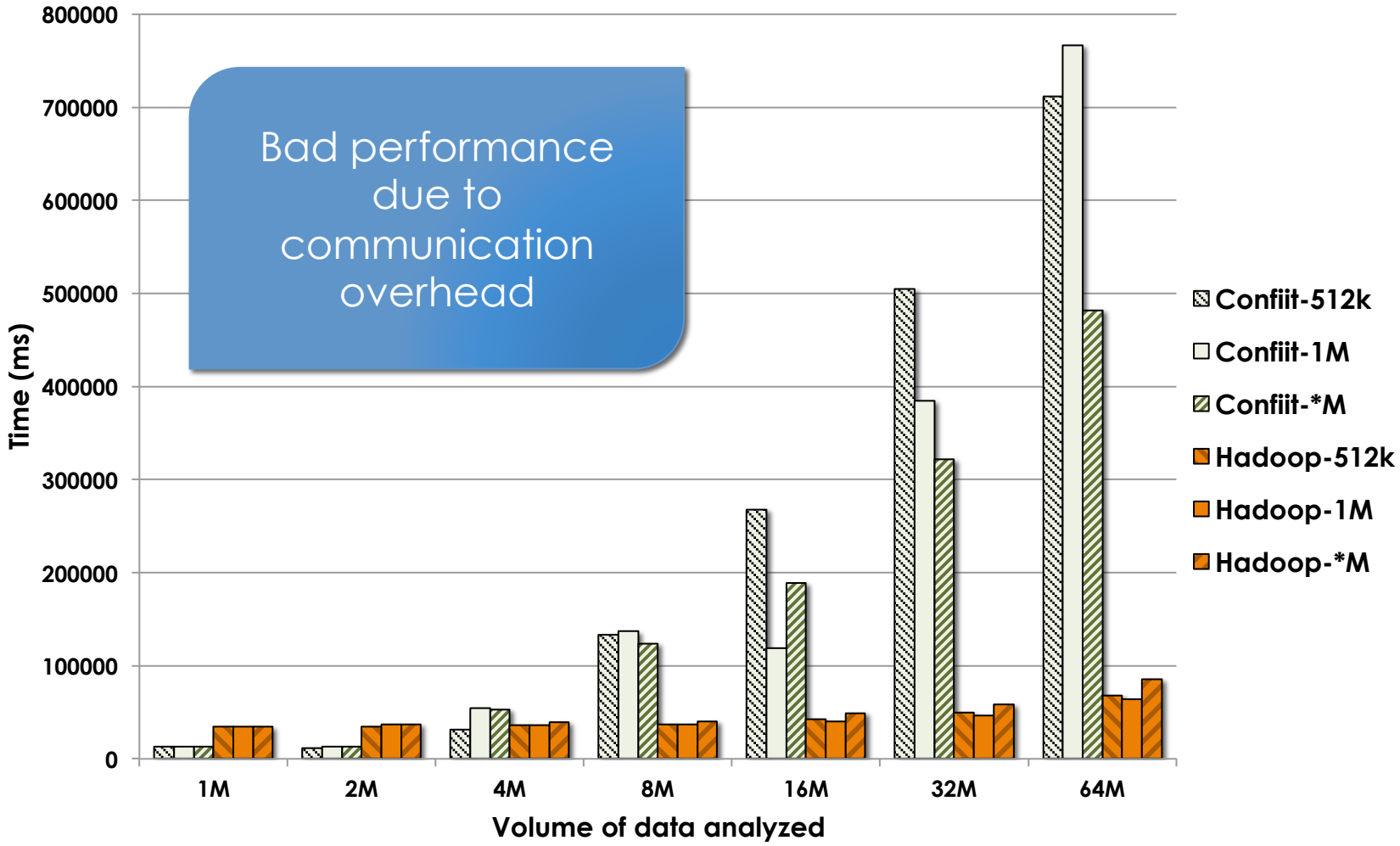


Basic experiment

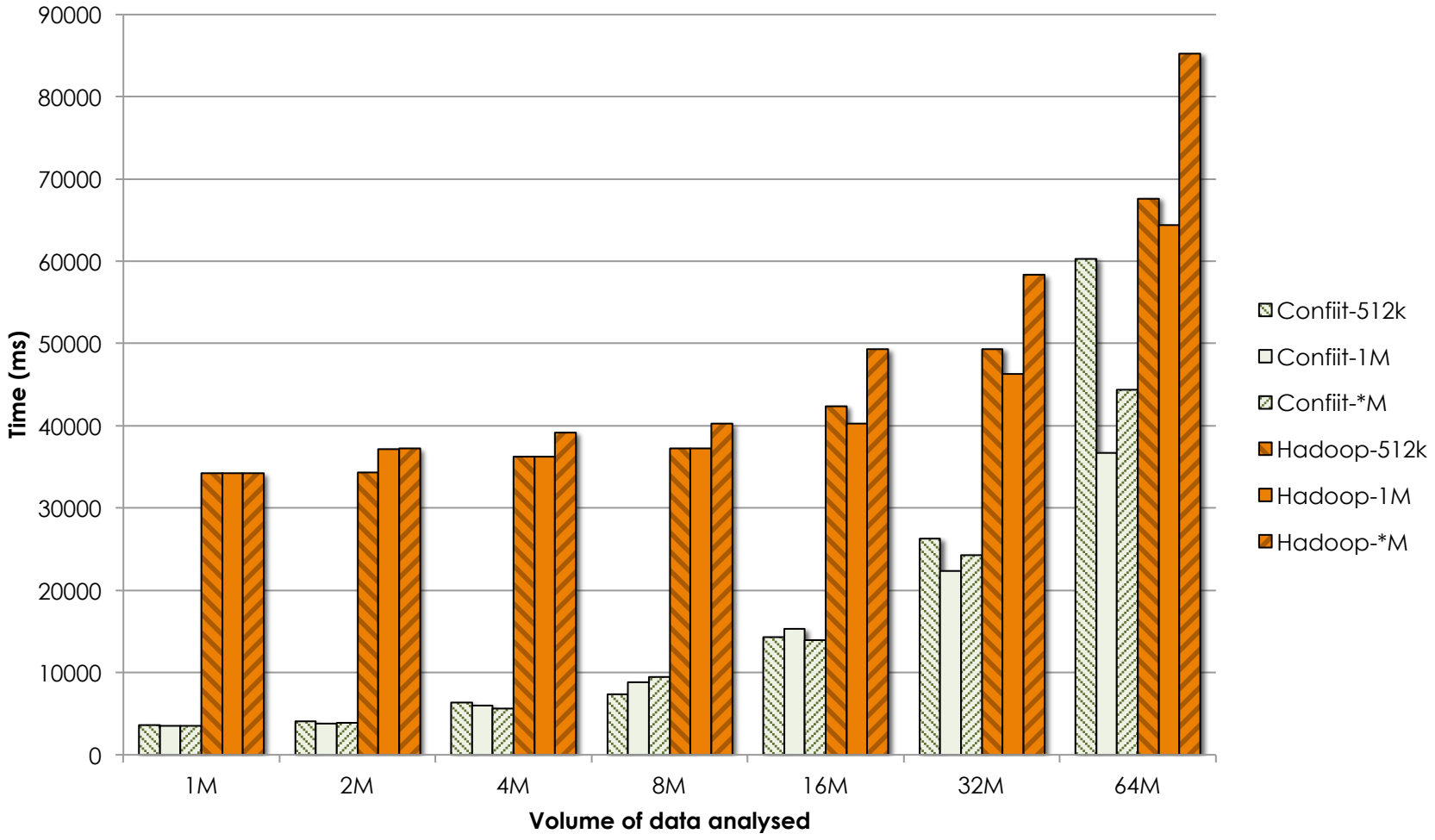
- MapReduce "WordCount"
  - Up to 16 nodes from Grid'5000 testbed
  - Gutenberg Project Science Fiction Bookshelf CD
- Comparison of Hadoop and CONFIIT-MR
  - Different data sizes
  - Different data blocks
    - 512kB, 1MB, full-file

Performance of MR over CONFIIT

(July 2013)



Performance of MR over CONFIIT (September 2013)



Discussions & Future Works

- P2P implementation
  - Explore different replication strategies to improve performance
- Context-awareness
  - Development of a context module
    - Automatic tuning of Hadoop nodes
    - Context-aware task scheduling for Hadoop and P2P
    - Improve data locality for the P2P implementation
- Fault tolerance on Hadoop
  - Hadoop 1.x and 2.x daemon architecture
    - Reinsertion of nodes

Conclusions

- MapReduce is one of the leading paradigms for BigData but is also a good paradigm for generic distributed computations (HPC, etc.)
- The PER-MARE initiative
  - Porting Hadoop to dynamic environments
    - Context-awareness is a key element
  - Implementing MapReduce on a P2P platform
    - Initial experiments offer encouraging results