PER-MARE: ADAPTIVE DEPLOYMENT OF MAPREDUCE OVER PERVERSIVE 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: \((k_1;v_1)\rightarrow\{(k_2;v_2)\}\)
    - reduce: \((k_2;\{v_2\})\rightarrow\{(k_3;v_3)\}\)
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

Diagram:

- launcher
- receiver
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)

Bad performance due to communication overhead
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