Heterogeneous Resource Allocation in the OurGrid Middleware: A Greedy Approach

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Introduction

The OurGrid Middleware

- **OurGrid**: open source middleware that enables the creation of peer-to-peer grids and volunteer-computing platforms
- Developed by researchers from *Universidade Federal de Campina Grande* (UFCG)
- Support applications following the Bag-of-Tasks (BoT) model; typically arises in grid and volunteer-based computing infrastructures
- Communications using the *eXtensible Messaging and Presence Protocol* (XMPP)
  - Internet-friendly, simple and efficient protocol
- Federations can be created easily and many sites can use the same XMPP server
Introduction

The OurGrid Middleware

- Four components for a regular OurGrid site:
  1. Peer
  2. Broker
  3. Worker
  4. Discovery Service
Introduction

The OurGrid Middleware

- All the components are integrated in a transparent way to the user; allowing the grid to provide a single-image of an infrastructure with a large computing power
- For experimentation, the OurSim simulator is available
  - Discrete-events simulator that implements a virtual grid site similar as deployed using the middleware
  - Realistic workloads (synthetic applications) can be used as input
  - Infrastructure can be described using data from different sources

OurSim is not a metascheduler; the whole infrastructure of a grid site is simulated. For each component of a regular site there will be an entity to simulate its behavior.
Introduction

Motivation

- OurGrid schedules tasks in a *round-robin* fashion; the *first* available node complying users specifications is taken.
- This scheduling policy may not assign the most *suitable* resources, especially for *heterogeneous* environments.
- Is it possible to change the scheduling policy in order to maximize/minimize some specific criterion?
- How is load balancing affected by the scheduling policy?

The main purpose of this work is to provide OurGrid with new allocation methods, and *support for heterogeneity*. A simple approach, yet very used and powerful, is chosen: a *Greedy* resource scheduler. The criteria is *processing time*. 
Resource allocation in OurGrid

Traditional vs greedy scheduler

• Traditional scheduler: does not provide support for heterogeneous environments
  – Resources within each site are implicitly ordered according to the time the corresponding peer registers them
  – OurGrid uses a *Network of Favours* to encourage the resource contribution; this feature prioritizes sites requesting the same resource

• Greedy scheduler: *dynamic priority scheduling* algorithm, provides support for heterogeneous environments
  – Resources are sorted according to processing capabilities
  – OurGrid paradigm is not changed: the Network of Favours is still used to rank sites
  – Support for volunteer-computing: resource contribution is encouraged
The Greedy scheduling approach

Implementation details

- Implementation is done by changing specific Java classes; the peer is aware of more information about the workers and functions according to the defined metric
- Modifications:
  - Method `takeNeededWorkers` totally rewritten
  - Classes `AllocationHelper`, `SamePriorityAllocationHelper`, `LowerPriorityAllocationHelper` modified
- Changes to `OurGrid/OurSim` code are now available within the official distribution
Experimental analysis

Results and discussion: Grid scenarios

- The greedy approach was tested using OurGrid simulated infrastructures (OurSim simulator)
- Methodology: the analysis was carried out for both related machines (low/medium/high heterogeneity) and unrelated machines models
- Resources within each site and the corresponding heterogeneity levels are defined based on the SSJ SPEC benchmark results
- Site dimensions: 1, 10, and 100 peers are considered
- A total of 30 grid instances per scenario were simulated and the number of workers per site are 8, 16, 32 or 64 (uniform distribution)
- Workloads: 30 instances representing 3, 6 and 12 months are created
- TOTAL: 390 grid scenarios and 90 workload instances in the experimental evaluation
Experimental analysis

Results and discussion: greedy scheduling policy

- The greedy scheduler outperformed the traditional mechanism; just in a few cases the traditional scheduler obtained shorter (<2.5%) times.
- As the number of peers increases, results stabilize (due to increasing number of network communication) near 25-30% improvement.
Experimental analysis

Results and discussion: load balancing

- The greedy scheduling method distributes the tasks over the workers of a specific peer in a more balanced way.
- This behavior is observed in all grid instances and workloads of different sizes.
Conclusions and future work

Main contribution: new scheduling method

• The experimental results demonstrate that the greedy scheduler is an effective method for reducing overall execution time of BoT jobs
• Load balancing is also improved
• Main contribution: the proposed greedy scheduling is now available within the official distribution of the OurGrid/OurSim code

• Future works:
  – New scheduling policies based on different criterion (e.g., node reliability and energy consumption)
  – Improvements for the methods of remote resources selection
  – Additional scalability studies regarding the numbers of brokers per site for both static and dynamic scenarios
THANKS FOR YOUR ATTENTION