Learning Reliability Models of Grid Resource Supplying

Cyril Briquet
Pierre-Arnoul de Marneffe

Montefiore Institute
Department of Electrical Engineering & Computer Science
University of Liège, Belgium

Learning Reliability Models of Grid Resource Supplying,
22 November 2005
Agenda

● Motivation
● Resource trading
  in an unstable resource environment
● Distributed bartering
● Grid resource supplying reliability
● Summary, conclusions
Agenda

- **Motivation**
- Resource trading
  in an unstable resource environment
- Distributed bartering
- Grid resource supplying reliability
- Summary, conclusions
Grid resource exchange: current trends

- Interactions between multiple admin. domains: exchange of resource allows Grid sites to use the resources of other Grid sites

- Sites have to be motivated to supply their resources

- Current trends = Grid economy, market methods
How do you select a supplier when several suppliers offer the same price?

- Current focus of most market-based methods = How to balance supply and demand?

- But ... when supply and demand are balanced ... which criteria do you take into account to select a resource supplier?

  => focus of this presentation
Agenda

● Motivation

● Resource trading in an unstable resource environment

● Distributed bartering

● Grid resource supplying reliability

● Summary, conclusions
Resource trading is not an easy problem

Real-world resource environment:

• sites enter and leave the Grid without notice
  => risks of free riding (due to ID changing)

• PI (Partial and Intermittent) resources
  => unstable resource availability
Resource trading is not a simple problem

Grid users/Grid sites:

• not necessarily willing/able to pay real $$$ for the consumption of external resources

2 trends of resource trading will probably coexist:

• commercial supplying of resource (1-sided: sell only)
• « goal-oriented » exchange of resources
  
  (2-sided: sites both consume and supply resources)
Decentralized resource trading

Benefits of decentralized resource trading:
• no requirement for a central banking component
• more scalable
• more resilient to a degraded environment
Agenda

- Motivation
- Resource trading in an unstable resource environment
- **Distributed bartering**
- Grid resource supplying reliability
- Summary, conclusions
Auctions are common, moneyless methods are gaining attention

Distributed bartering =
- decentralized
- moneyless
- market-based

resource trading method

Accounting of resource consumption is very important to avoid free riding
Network of Favors model

Example of a recent successful middleware:

OurGrid, based on the Network of Favors model

- a peer supplies its non-busy resources to other peers (= makes favors)
- each peer maintains a separated « favors count » (= debt count, always ≥ 0) with all other peers
- priority in supplying given to the peers who have contributed the most resources in the past
Resource exchange accounting

OurGrid currently proposes 2 accounting schemes:

- simple accounting model: time-based
  => biased towards slower resources

- more robust accounting model: relative power
  => weight supply time with relative computing power between consumer and supplier

Known problem: the accounting may be asymmetrical
Asymmetrical accounting is unavoidable

Task execution may be affected by multiple factors:
- preemption of the supplied resources (when the supplier has more urgent local tasks)
- resource failure
- supplier departure from the Grid

=> asymmetrical accounting
- supplier: some computing time has been supplied
- consumer: the task has not been completed
Agenda

- Motivation
- Resource trading in an unstable resource environment
- Distributed bartering
- **Grid resource supplying reliability**
- Summary, conclusions
Back to the initial interrogation: how do you select a supplier?
Existing middleware selected as an illustration of current work in distributed bartering:

• Network of Favors model =
  how to prioritize resource supply?

What we propose:

• Another interesting question =
  how to prioritize resource consumption?
Asymmetrical accounting: what can be done?

An interesting couple of observations:

- resource unreliability leads to task uncompleteness, which causes asymmetrical accounting and delays increase of consumer utility

- a peer should then avoid to consume resources supplied by an unreliable peer (use of explicit or implicit resource negotiation)
Modelling the reliability of resource supplying

Available data for a given peer about remote execution of tasks (= supplying of resources) by another peer:

- favors count: mean and recent history
- task acceptation/rejection: recent history
- task execution times: mean and recent history
- success/failure: mean and recent history
- ... only own data + externally observable data
Modelling the reliability of resource supplying

For a given peer, let:

- $p = \text{another peer}$
- $a(p) = [\text{favors count at submission time, expected execution time of a task on } p, ... ]$
- $c(a(p)) = \text{task success/failure}$

$\Rightarrow c(.) = \text{classification of } p \text{ as reliable/unreliable from the perspective of the given peer}$
Modelling the reliability of resource supplying

Learning problem:
• given a finite set of examples \([ a(p) , c(a(p)) ]\),
• find a decision model \( d(a(p)) \) that classifies a peer given the collected input data about it (e.g. \( a(p) \))
• decision model \( d(.) \) should be as close as possible to the true classification \( c(.) \)

Then, use the model to select reliable suppliers.
Modelling the reliability of resource supplying

How to automatically find such a model $d(.)$?

$\Rightarrow$ Automatic Learning algorithms:
   $k$-NN, Decision Trees, ...

Be aware that the true classification $c(.)$
might/will change over time:
learning must be continuous/periodic ($\Rightarrow$ challenge)

Learning Reliability Models of Grid Resource Supplying,
22 November 2005
Modelling the reliability of resource supplying

Results ?

All this is **early work**, we are currently (now !) testing:

- different AL algorithms
  (k-NN seems OK, requires instance editing ...)
- different attributes vector

=> seeking balance between precision, complexity
Further uses of reliability modelling?

A Grid peer may obviously:

- consume preferably reliable resources
  
  => increase own utility

It may also:

- supply preferably its own resources to peers owning reliable resources
  
  => increase potential of reliable consumption

Delayed rewards: use of Reinforcement Learning?
Roadmap of future work on resource profiling

- linking models that are computed when consuming with models that are computed when supplying, seeking to select optimal action (resource selection) with delayed reward
- exploiting temporal variations of reliability (modelling with time series)
- going further than simulation: implementation into existing middleware of machine learning algorithms used to compute reliability models
Agenda

- Motivation
- Resource trading
  in an unstable resource environment
- Distributed bartering
- Grid resource supplying reliability
- Summary, conclusions
Summary

• distributed bartering
  (decentralized, moneyless, market-based)
  is interesting, middlewares are appearing
  (OurGrid with the Network of Favors approach)

• we have observed that resource exchange/trading
  might benefit from studying consumption, supplying,
  and linking both

• we have proposed that sites consuming resources
  should avoid unreliable suppliers,
  and formulated this as a learning problem
Conclusions

- Use of Automatic Learning in the new context of distributed bartering
- Early work
- Links with scheduling, Multi-Agent frameworks, ...
Thank You