



MAG - Mobile Agents for Grid
Computing Environments

MAG, um *middleware* de grade baseado em agentes: estado atual e perspectivas futuras

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MAG - Mobile Agents for Grid Computing Environments

Why use agents?

- The agent technology exhibits great adequacy for the development of Grid infrastructures
 - Cooperation
 - Autonomy
 - Heterogeneity
 - Reactivity
 - Mobility
 - Protection and Security



MAG middleware

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MAG (Mobile Agents Technology for Grid Computing Environments) explores the mobile agent paradigm as a way to overcome the construction challenges of computational grids.

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MAG middleware – Main Challenges

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- MAG is an opportunistic Grid middleware. Thus, it must provide support for non-dedicated nodes. To handle with this problem, we have implemented a **strong migration** mechanism;
- Grid environments are more prone to failures than traditional distributed systems. This way, **fault tolerance** becomes an important characteristic to be provided in MAG;
- One of the Grid promises is to provide **pervasive** access for its users, just like the *power grid*;
- A huge amount of data are being created in many application domains. The Grid must provide efficient mechanisms to store, retrieve and process these data sets.

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Agenda

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- Core Architecture
- Strong Migration
- Fault Tolerance
- Pervasive Grid
- Data Grid
- Conclusions and future works

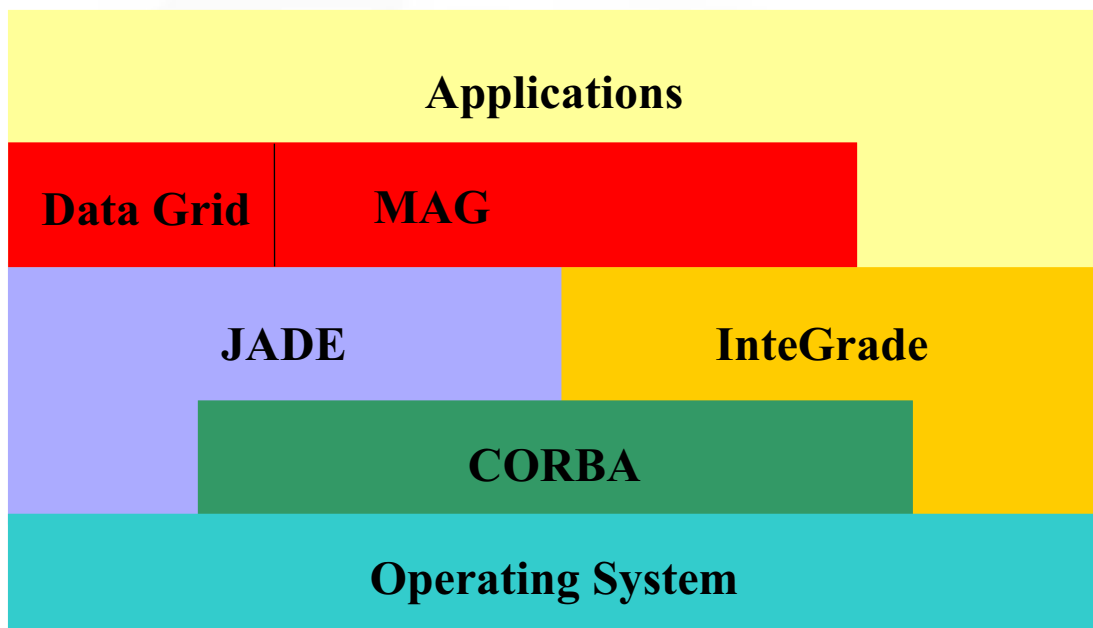
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MAG core components

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- **MagAgent**
 - Responsible for executing applications in the Grid. For each application execution, a MagAgent is created;
- **AgentHandler**
 - Maintains the container of agents executing in the node and is also responsible for creating a MagAgent in response to application execution requests;
 - It interacts with InteGrade components, making the agent paradigm transparent to the InteGrade middleware.

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Strong Migration

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- Machines that comprise the grid environment are not necessarily dedicated to the execution of applications;
- The grid must provide a mechanism that allows users to “release” their nodes in a transparent way, without loss of computation time;
- A suitable mechanism for capturing and reestablishing of Java threads state must be implemented.

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Approaches for capturing and restoring Java threads execution state

- Java does not provide enough mechanisms for capturing the computation state of threads;
- There are four basic approaches to capture the state of Java threads:
 - Modification of the virtual machine;
 - Instrumentation of the application *bytecode*;
 - Instrumentation of the application source code;
 - Modification of the JPDA (Java Platform Debugger Architecture).



Strong Migration in MAG

- MAG/Brakes is a specialization of the Brakes framework, implemented to provide strong migration through the *bytecode* instrumentation approach;
- MAG/Brakes achieves better performance and provides new functionalities to the original Brakes framework, such as:
 - Our framework allows the migration process to be initiated by an external source;
 - The user can now explicitly inform to the *bytecode* transformer additional code positions where application state must be saved;
 - The user can optionally disable the automatic code insertion after method invocations through a command line parameter.



Fault Tolerance

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- In general, Grid nodes are not dedicated to the execution of applications and do not comprise a controlled environment;
- Many Grid applications perform long tasks that may require several days of computation.



MAG fault tolerance mechanism features

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- MAG dependability infrastructure gives support for fail-stop failures (i.e. **nodes** and **processes** crashes) through the **checkpoint** approach;
- We are currently developing the support for **replication**, another failure handling mechanism commonly applied on Grid environments;
- After implementation of the replication technique, MAG will provide **flexibility** to Grid users.



MAG fault tolerance mechanism features

- **Flexibility** will be achieved by two ways:
 1. Allowing the user to combine replication with *checkpointing* techniques:
 - Retrying (without checkpoint or replication);
 - *Checkpointing* without replication;
 - Replication without *checkpointing*;
 - Replication with *checkpointing*;
 2. Allowing the user to customize parameters of the failure handling approach
 - e.g. to change the interval between consecutive checkpoints and the amount of replicas.



Components of MAG fault tolerance mechanism

- **ExecutionManagementAgent (EMA)**
 - Provides information about application executions (such as the location of input files), used by the recovery process;
 - Maps an application execution with the executing nodes, used to discover which applications must be recovered in case of a node crash;
 - Stored data are used to generate useful statistics to support decisions;
- **StableStorage**
 - It stores checkpoints of all executing applications;
- **AgentRecover**
 - This agent is responsible for initiating the recovery process in case of a node crash.



Pervasive Grid

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- One of the promises of the grid computing is to provide ubiquitous access to computational resources in a simple and transparent way, just like the *power grid*;
- Grid services must be available independently of physical location. So, a suitable mechanism must be available to provide **pervasive** access to grid.



PervMAG

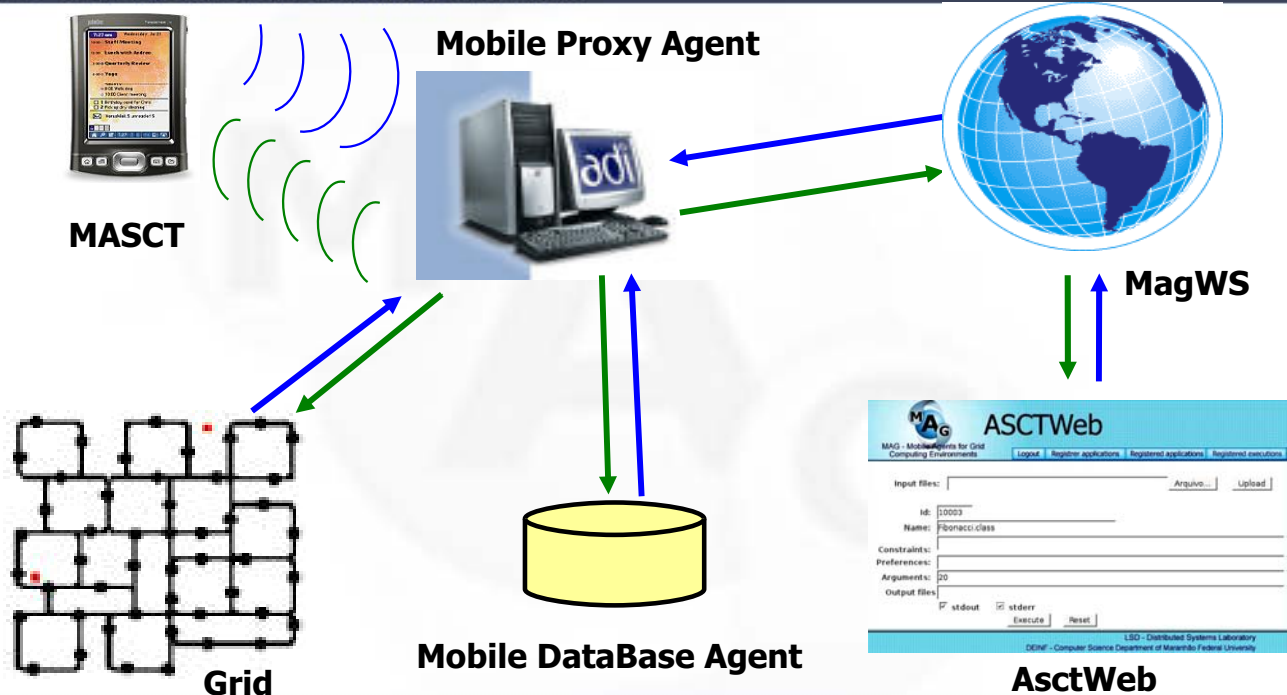
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- The pervasive grid mechanism of MAG is called *PervMAG*;
- PervMAG is composed by two mechanisms:
 - Support for mobile users (PalmOS and IEEE 802.11 network);
 - Support for nomadic users (web).



PervMAG

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Data Grid

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- Currently, a great amount of data are generated in many application domains;
- More and more applications need to execute some kind of computation over these data collections;
- Sophisticated mechanisms for access and sharing data are necessary to process these collections;
- The mechanism that provides these capabilities to the grid is called **data grid**.

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Data Grid Services

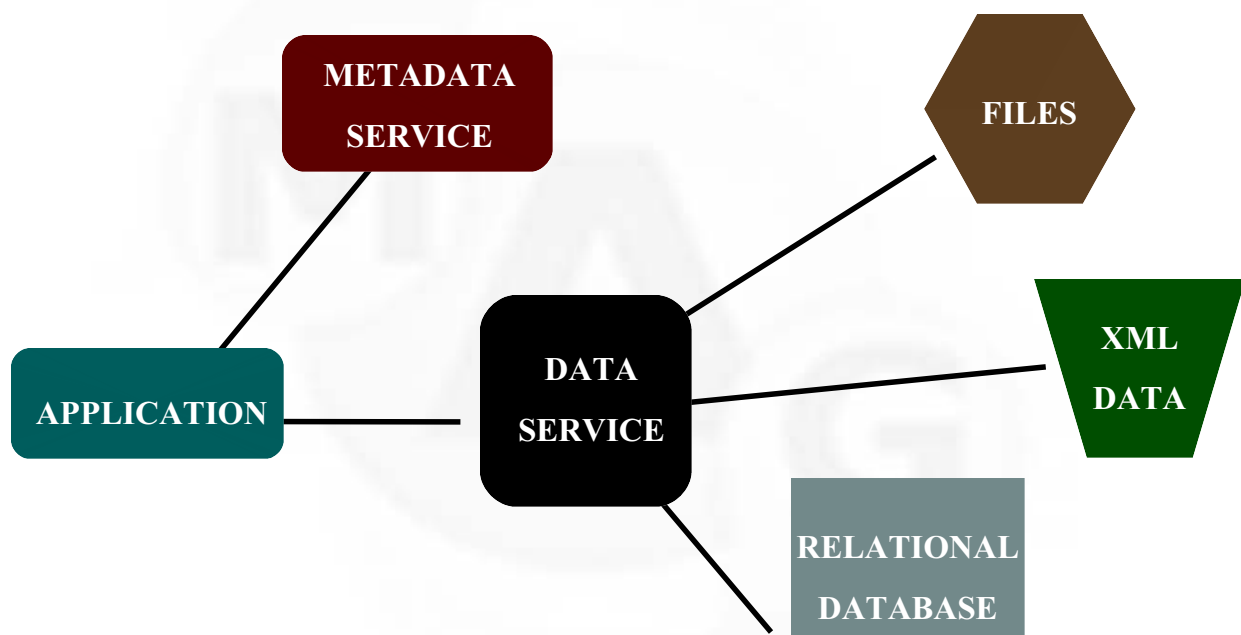
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- Metadata service
 - Provide mechanisms for publication and discover of data through the metadata that describe them;
 - In MAG, this service is called **MagCat**;
- Data service
 - Provides access to huge distributed data sets in efficient way.



Data Grid Overview

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Metadata Service

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- **CatalogManager**
- **SchemaManager**
- **SearchAgent**
- **RequestMonitor**
- **ReplicationManager**
- **SecurityAgent**

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Data Service

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- The data service is in a preliminary version;
- It is composed by only one agent: the **DataManager**;
- Currently, DataManager is implemented as a centralized data repository;
- A distributed version of this agent is being designed and developed.

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Conclusions

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- The use of software agents has contributed to simplify the development of the grid *middleware*;
- This conclusion comes from the analysis of some agents characteristics
 - Mobility
 - Autonomy
 - Cooperation
 - Security



Future work

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- Investigate adaptive approaches to the fault tolerance mechanism;
- Provide mechanisms for protection against hostile and damaged applications;
- Implement a load balancing mechanism;
- Provide support for the execution and fault tolerance of parallel MPI applications;
- Customization of JADE platform.



Questions and Acknowledgements

Questions?

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