

Fault-tolerance and Data Synchronization in Grid Service Registry

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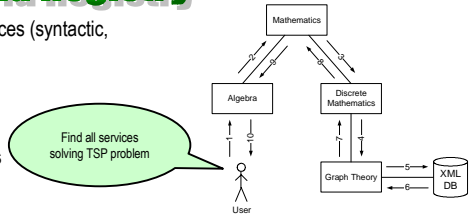
Motivation

- Building applications using Web or Grid services has become increasingly popular
- A user connects services into the workflow to perform needed computation
- There has to be a registry storing information about Web or Grid services (Grid Registry)
- Need of a fault-tolerant version of the Grid Registry
- For fault tolerance data stored in registry has to be redundant
- If data are duplicated, a synchronization mechanism is needed

M. Bubak, T. Gubala, M. Kapalka, M. Malawski, K. Rycerz, *Workflow composer and service registry for grid applications*, Future Generation Computer Systems, vol. 21, no. 1, 2005, pp. 79-86.

Functionality of Grid Registry

- stores information about Web and Grid services (syntactic, semantic and human-readable description)
- distributed, scalable
- Grid-enabled
- The system is composed of single nodes

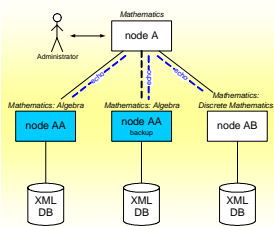


Description of the Problem

- Every node is a **single point of failure**
⇒ this problem could be solved by adding data **redundancy**
- Desynchronization** of data
- Overloaded** nodes

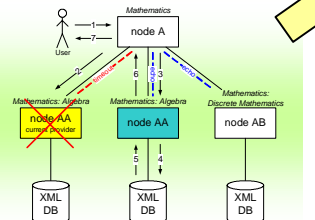
Functionality solving this problem is available in new version of the **Grid Registry**

Fault-tolerance

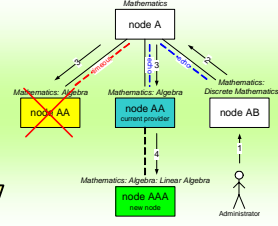


- Initial registry configuration.
- User can ask registry about information from *Mathematics*, *Mathematics: Algebra* and *Mathematics: Discrete Mathematics* domains
- Information stored in domain *Mathematics: Algebra* is duplicated
- Echo messages are sent to ancestors by all the nodes. It provides knowledge about current registry configuration

- Using Echo mechanism the registry detects that the node AA from domain *Mathematics: Algebra* crashed
- Registry reacts to this information – changes in *Local Routing Table*
- Query is redirected to backup node (1 – 7)

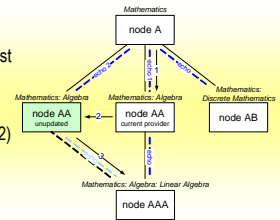


Data Synchronization

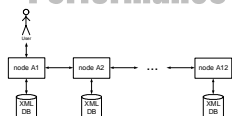


- One of the nodes from domain *Mathematics: Algebra* is still unreachable
- Administrator still can modify registry configuration (1 - 4)
- All information stored in registry is available for the user

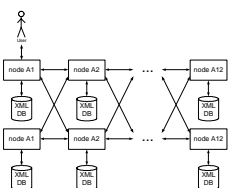
- When broken node is repaired, it synchronizes information with the most up to date node from domain (2)
- All changed entries in *Local Routing Table* are updated in repaired node (2)
- If necessary, new connections are established (3)



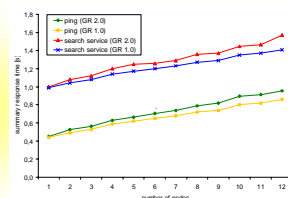
Performance Tests



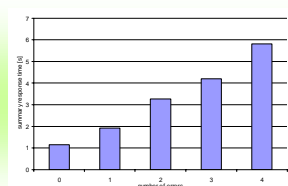
Basic Grid Registry configuration – there is not any backup data



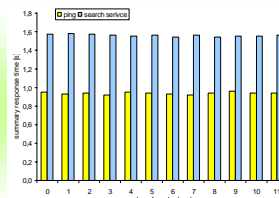
Grid Registry configuration where every domain has **duplicated** information



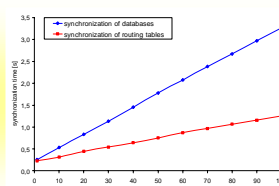
The test shows a comparison between response time depending on number of hops that message has to pass while reaching its destination in prototype and fault-tolerant version of the Grid Registry



Before Grid Registry reacts to unreachable nodes, user can send query. Then it can be redirected to broken node. In this case error message is generated and then user's query is redirected to backup node. This test presents such a situation. Response time depends on number of generated error messages



Grid Registry can modify its *Local Routing Table*, so query will not be redirected to broken nodes. Graph presents response time depending on number of broken nodes



When broken node becomes reachable, *Local Routing Table* and *XML database* have to be synchronized. Test shows synchronization time depending on number of items that have to be synchronized

