



K-Wf Grid: Knowledge-based Workflows in Grid

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We present an IST project of the 6th Framework Programme, aimed towards intelligent grid middleware and workflow construction. The project's acronym K-Wf Grid stands for "Knowledge-based Workflow System for Grid Applications". The project itself employs ontologies, artificial reasoning, Petri nets and modern service-oriented architectures in order to simplify the use of grid infrastructures, as well as integration of applications into the grid. K-Wf Grid system is composed of a set of modules. The most visible one is the collaboration portal, from which a user can control the infrastructure and manage his/her application workflows. Behind this portal are hidden services doing the workflow management, monitoring of applications and infrastructure, knowledge extraction, management, and reuse. The project is behind its prototype phase and a successful review by the Commission. The idea of the project is based in the observation, that users often have to learn not only how to use the grid, but also how to best take advantage of its components, how to avoid problems caused by faulty middleware, application modules and the inherent dynamic behavior of the grid infrastructure as a whole. Additionally, with the coming era of resources virtualized as web and grid services, dynamic virtual organizations and widespread resource sharing, the variables that are to be taken into account are increasing in number. Therefore we tried to devise a user layer above the infrastructure, that would be able to handle as much of the learning and remembering as possible. This layer should be able to observe what happens during application execution, infer new knowledge from these observations and use this knowledge the next time an application is executed. This way the system would - over time - optimize its behavior and use of available resources.

The realization of this idea has been split into several tasks and formed into the architecture, that became the K-Wf Grid project.

The main interaction of users with the system occurs through the Web Portal. Through it, users can access the grid, its data and services, obtain information stored in the knowledge management system, add new facts to it, construct and execute workflows. The portal consists of three main parts, the Grid Workflow User Interface (GWUI), the User Assistant Agent (UAA) interface, and the portal framework based on GridSphere, including collaboration tools from the Sakai project and interfaces to other K-Wf Grid modules. GWUI is a Java applet visualization of a Petri net-modeled workflow of services, in which the user can construct a workflow, execute it and monitor it. UAA is an advisor, which communicates to the user all important facts about his/her current context –the services he/she considers to use, the data he/she has or needs. Apart from automatically generated data, the displayed information contains also hints entered by other users, which may help anyone to select better data or services or avoid problems of certain workflow configurations. This way the users may collaborate together and share knowledge. Under the Web Portal lies the Workflow Orchestration and Execution module,

composed of several components. These components together are able to read a definition of an abstract workflow, expand this definition into a regular workflow of calls to service interfaces, map these calls to real service instances and execute this workflow to obtain the expected results, described in the original abstract workflow. This way the user does not need to know all the services that are present in the grid and he/she is required only to state what result is required.

To be able to abstract the grid in such a way as described in previous paragraph, the system has to know the semantics of the grid environment it operates on, and so we need to employ serious knowledge management, computer-based learning and reasoning. This is the area of the Knowledge module, which is split into the storage part –Grid Organization Memory (GOM), and the learning part –Knowledge Assimilation Agent (KAA). KAA takes observed events from the monitoring system, maps them to the context of the performed operation and extract new facts from them. These facts are then stored into GOM, as well as used in later workflow composition tasks in order to predict service performance. GOM itself stores all information about the available application services in a layered ontology and new applications may be easily added into its structure by describing their respective domains in an ontology, connected to the general ontology layer developed in K-Wf Grid.

The monitoring infrastructure is integrated into the original grid middleware, with the Grid Performance Monitoring and Instrumentation Service (GPMIS) as a processing core. GPMIS receives information from a network of sensors, embedded into the middleware, application services (where it is possible to instrument the services) and into the other K-Wf Grid modules. Apart from collecting observations for the learning modules, the monitoring infrastructure is also a comprehensive tool for performance monitoring and tuning, with comfortable visual tools in the user portal.

At the bottom of the architecture lies the grid itself –the application services, data storage nodes and communication lines. K-Wf Grid has three distinct and varied pilot applications, which it uses to test the developed modules. One of them is a flood prediction suite, developed from a previous effort in the CROSSGRID project. It consists of a set of several simulation models for meteorology, hydrology and hydraulics, as well as support and visualization tools, all instantiated as WSRF services. The second application is from the business area –a web service-based ERP system. The third application is a system for coordinated traffic management in the city of Genoa.

Summary

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