Process Harmonization of Objects for Learning Grid Computing Environment

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Abstract:* Advancements in computing and internet technologies have made it possible to share data storage and data transfer resources, and computing power that are distributed across the world in networks. This opportunity has led to the development of a distributed computing environment called 'Grid computing' or 'Grid'. Research publications are aplenty on methodologies and approaches for sharing such resources in Grids. Massive creation added with reduced cost has made rich education contents to explore avenues such as Education Grids or Education Cloud Computing. However, issues such as heterogeneity and task scheduling with respect to load balancing have become complex research problems that need to be addressed. Educational e-contents are highly heterogeneous in regard to processing sizes. Therefore uniform load balancing on e-Learning jobs in Grids may not be completely achievable. However, it is found from literature that load harmonization with respect to variety of computing resources have been tried out. Instructional modules in e-Learning environments are generally available in independent entities called 'Objects' of different volumes and computational intensities that use different variety of computing resources. This paper presents parametric representations of user requests, for Harmonizing Learning Objects in Grid Computing Environment. These parametric representations would be useful for effective Grid scheduling that applies semantics and also for modeling semantic grid.

***Keywords:* Technology Enhanced Learning, Education Grids, Virtual Organization, Semantic representation.**

I. INTRODUCTION

'Semantic Grid' approaches 'Grid computing' in a manner in which information, computing resources and services are described using semantic words [1]. The main objective of Grid is collection of idle resources that are available in the geographical area to form into a virtual supercomputer for solving computational tasks, particularly heavy computing jobs such as e-content development and uses of e-Learning packages, also called Education or Learning Grids. Grid differs from conventional distributed computing in the way of resource sharing and its organization. Cluster, a group of homogeneous resources with centralized control, fails in managing heterogeneous resources [2]. But issues in education grid are different. They are: heavy computing through heterogeneous resource sharing and harmonizing process loads [3]. Load balancing or harmonization in Grid computing is recommended for reducing costs. Due to heterogeneity of data in education arena and due to harmonizing different types of processes, scheduling becomes a complex issue [4].

Owing to these issues, we have proposed to represent certain educational or pedagogical parameters that would represent commands so as to use them in meta schedulers in Learning Grids. Nowadays the need for e-learning systems support a rich set of pedagogical representations [8].

Learning Grids promotes a paradigm shift from content-centered to process-centered solutions [6]. The infrastructure for Learning Grid project concerns with models, processes, and services supported by a service-oriented software architecture for creating dynamic and adaptive Virtual Organization (VO) for learning using Grid technologies. It should support growing loads of learning resources, services, and users who access resources and services. Learning resources consists of huge variety of such software and hardware resources and services in a dynamic environment. Grid must be complemented with other technologies in order to be fully effective in supporting instructional technology. Therefore, Learning Grids enable three technologies namely, Grid technology, Semantics and Educational modeling [8]. Mix of these diverse technologies must address specific issues like: difficulty in dominating learning process; cost effectiveness by harmonizing processes. The key feature of Learning Grid is vitalizing through integration of these three through dynamic and policy based harmonized processes. Educational model that infuses semantics in terms of information and services with well-defined meaning will be tried out for Learning Grid. This will be achieved by creating required input data for the Learning Grid scheduler. We have demonstrated this integration through experiments using GridSim 5.0 a Grid simulation package [5]. We have arrived at and presented representations of parameters for the integration process

II. LEARNING GRID SCHEDULER

The general core Grid Core component is an independent entity that receives input through one of its components called the 'Meta-Scheduler' or 'Scheduler'. This component sends output in the forms of 'Grid File Transfer Services', 'Grid Execution Services' and 'Grid Information Services' as shown in Figure 1. According to the design of our proposed model, all these three output data are fed inside the model's virtual learning site, termed as VO Package. This VO Package interacts directly with e-Learners through a two way communication; that means both these components often interact with each other, even though they are independent entities. A separate development package sends input to the meta-scheduler of the Learning Grid, as shown in the figure.

Manuscript received October, 2013.
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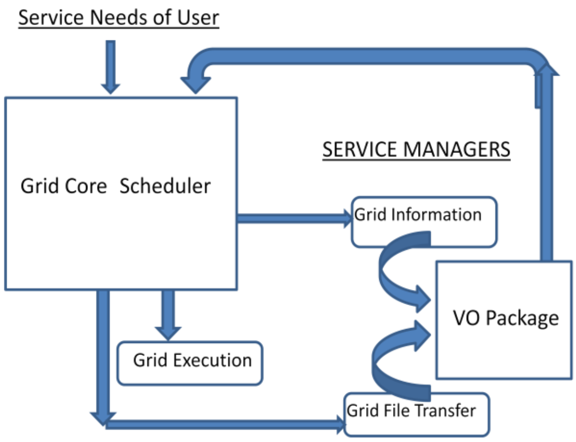

Figure.1 Role of Grid Scheduler for Grid services

The architecture of the Grid core is third party developed package and we do not claim any originality [9]. This architecture is available in public and hence taken for describing the proposed model by us. Here, an information manager module interfaces with the Grid information services. A File Transfer Manager module interfaces with Grid data services. The scheduling process is decoupled from the Execution Manager through the use of an external and selectable Grid core scheduler module. This is a very important component, because to this selectable module, the output from our package provides necessary input (service needs of user). The VO Package is designed in such a way that distributed applications can be developed using 'C' and 'Java'. It also provides reengineered input for scheduling. It is also capable in recovering failed jobs. The Grid core scheduler performs all submission stages and watches over efficient execution of jobs. The Information Manager through its middleware access driver is responsible for host discovery and monitoring. It interfaces with the monitoring and discovering services available in the Grid infrastructure. The Execution Manager through its middleware access driver is responsible for job execution and management. It interfaces with the Job Management Services that are available with the Grid resources.

The meta-scheduler is an interface between Grid Execution Services and Information Manager. In fact a Meta-Scheduler can itself be considered as an information manager module. The architecture of our package which provides the input data is explained later in subsequent sections. Scheduler makes scheduling decisions for jobs on available resources. According to [9], grid infrastructures of several scales are being deployed within the context of different research projects. With this direction, the researcher has introduced an interface with our package with an aim to provide efficient input of the three important technologies mentioned [8] in our introduction. It is also important to note that any centralized scheduler cannot allow partner grid participation with freedom. Therefore the deployment of this meta-scheduler is not made centralized, according to the design of this architecture.

III SEMANTIC TERMS FOR PEDAGOGICAL PARAMETERS

Merrill [7] divides any instructional event into four phases called cognitive structures, which he calls 'Activation', 'Demonstration', 'Application' and 'Integration'. Central to this instructional model is a real-time problem-solving theme, called 'Problem'. Merrill suggests that fundamental principles of instructional design should be relied on and these apply regardless of any instructional design model used. Violating this would produce a decrement in learning and performance. We have chosen these four cognitive structures as they yield to semantic representations. Besides, they are quantifiable. They are briefed as under.

Activation:

This is the first Cognitive Structure in the learning process. New knowledge builds on the learner's existing knowledge. Learners recall or apply knowledge from relevant past experience as a foundation for new knowledge. This could be from previous courses or job experiences undergone by the learner. For instance, recall the old relevant information such as dates, events and places. The importance of activation of existing knowledge has been addressed by a number of educational psychologists. During Merrill's Activation phase, prior knowledge (or experience) is recalled and emotions are triggered. Not only pre-knowledge should be activated during this phase, but mental models as well. If these mental models consist of misconceptions, the instructional process could modify them. In our model we have used pure textual information for this cognitive structure.

Demonstration:

New knowledge is demonstrated to the learner. Learners learn when the instructor demonstrates what is to be learnt, rather than merely telling information about what is to be told. The learner observes while the instructor demonstrates. The media used in the process is expected to play a relevant instructional role. Explain with examples, understand information with meanings, predict consequences, order, group, and infer causes are some samples for demonstration. During this phase, the instructor presents new material and demonstrates new skills. Demonstration focuses the learner's attention on relevant information and promotes the development of appropriate mental models. It shows actions in a certain sequence, which can simplify complex tasks and facilitate learning. In our model we have used mostly graphical elements for this cognitive structure.

Application:

The learner to his problem applies new knowledge. This is the practice phase, where learners are required to use their knowledge and skill to solve relevant problem. Some samples are: use information; solve problems using required skills or knowledge. The purpose of a practice phase in the instructional events is to provide an opportunity for learners to develop proficiency and become experts. During this phase, cognitive processes come into play; and there is a search for meaningful patterns and mental programmes occur in the learner's mind. In our model we have mostly used video/audio for this purpose.

Integration:

New knowledge is integrated into the learner's terminal behavior. This is the transfer phase where learners apply or transfer their newly found knowledge or skills into their workday practices. This is felt, if learners can a) demonstrate their new knowledge or skills, b) reflect-on, discuss their new knowledge and skills and c) create, invent and explore new ways to use their new knowledge and skills. Seeing patterns and organizing by recognition of hidden meanings, are some samples. Use old ideas to create new ones (relate knowledge from several areas). Assess values of ideas (make choices based on supported arguments). Most of the instructional events end with an assessment phase. During this phase learners have to prove themselves, that they have acquired the new knowledge and skills. Merrill calls this as the Integration phase, during which the learners get the opportunity to prove new capabilities and show newly acquired skills. We have used mixed media for this cognitive structure.

The four cognitive structures explained above, actually trigger the learners' inherent or acquired abilities namely: recalling or mental ability, demonstrating or observing and communicative abilities, applying and problem solving abilities and integrating or creative abilities. For the purpose of semantic representations on these four cognitive structures we have categorized certain action verbs for our package to identify the respective cognitive structure. They are briefed below.

Activation ("Where do I Start?"):

i) Does the instruction direct learners to recall, relate, remember, repeat or recognize the knowledge from relevant past experience that can be used as a foundation for the new knowledge (problem)?
ii) If learners have limited prior experience, does the instruction provide relevant experience that can be used as a foundation for the new knowledge?

Based on the above questions a set of action verbs for this phase, as taken from literature are presented below:

- List, define, tell, name, locate, identify, distinguish, acquire, write, underline, relate, state, recall, select, repeat, recognize, reproduce, measure, memorize.

Demonstration ("Don't just tell me, show me!"):

i) Does the instruction demonstrate (show example) of what is to be learnt rather than merely providing information about what is to be learnt?
ii) Are the demonstrations (examples) consistent with the content being taught?

Based on the above questions a set of action verbs for this phase, as taken from literature are presented below:

- Demonstrate, summarize, illustrate, interpret, contrast, predict, associate, distinguish, identify, show, label, collect, experiment, recite, classify, discuss, select, compare, translate, prepare, change, rephrase, differentiate, draw, explain, estimate, fill in, choose, operate, perform, organize.

Application ("Let me do it!"):

i) Do learners have an opportunity to practice and apply their newly acquired knowledge or skill?
ii) Are the application (practice) and assessment (tests) consistent with the stated or implied objectives?

Based on the above questions a set of action verbs for this phase, as taken from literature are presented below:

- Apply, calculate, illustrate, solve, make use of, predict, construct, assess, practice, restructure, classify.

Integration ("Watch me!"):

i) Does the instruction provide techniques that encourage learners to integrate (transfer) the new knowledge or skill into their everyday professional life?
ii) Does the instruction provide an opportunity for learners to create, invent, or explore new and personal ways to use their new knowledge or skill?

Based on the above questions a set of action verbs for this phase, as taken from literature are presented below:

- Analyze, resolve, justify, infer, combine, integrate, plan, create, design, generalize, assess, decide, rank, grade, test, recommend, select, explain, judge, contrast, survey, examine, differentiate, investigate, compose, invent, improve, imagine, hypothesize, prove, predict, evaluate, rate.

Some of the action verbs may be repeating in two or more phases but should be used with respect to the context in which they are present. The action verbs are only indicative and they cannot be taken per-se for any analytical study. Many terms, in similar lines, cannot be used per-se and needs local definitions and interpretations.

IV PARAMETERS FOR HARMONIZATION OF OBJECTS

Two types of parametric representations have been considered, one with semantic representations and the other non-semantic. Pedagogical parameters as explained earlier have been considered for semantic representations with the help of action verbs as explained. Learning experiences and Learning Profile Management is another parameter that can be represented using semantic terms. This involves learner characteristics like levels of learning, choice of cognitive structures etc. The non-semantic parameters are creation of meta data and orchestration services. The former is related to Grid computing while the later is used for arranging learning objects in logical sequencing. The objects are independent entities that incorporates the three types of media namely pure graphics, video/audio and texts. It is important to note that the learning objects that is categorized under 'Learning Experiences' must be subjected to 'Learning Profile Management' by using orchestration services. The experiments performed under three clusters namely Cg for graphics objects, Cv for video/audio objects and Ct for textual objects. As with any Grid computing environment, the number of nodes used would be different at different times. The processed information are presented in Table 1.

Table 1. Elements of Learner Grid Process

Grid Cluster	NodeNo.	Semantic Parameter(s)	Semantic Representation	Non-semantic Parameter(s)	Object(s)
Cg	1	Learning experiences	'Demonstration' 'Integration'	Meta data Services	Object i
	2	Learning Profile Management	'Activation' 'Demonstration' 'Application' ;Integration'	Orchestration Services	Object i
	3	Learning experiences	'Demonstration' 'Integration'	Meta data Services	Object j
Cv	1	Learning experiences	'Demonstration' 'Application'	Meta data Services	Object m
	2	Learning experiences	'Demonstration' 'Application'	Meta data Services	Object n
Ct	1	Learning experiences	'Activation' 'Demonstration' 'Integration'	Meta data Services	Object p
	2	Learning Profile Managem	'Activation' 'Demonstration'	Orchestration Services	Object p

		ent	'Integration'		
	3	Learning experiences	'Activation' 'Demonstration' 'Integration'	Meta data Services	Object q

Where Cg : Cluster of Graphic resources; Cv : Cluster of Video/audio resources; Ct : Cluster of Text processing resources Object i : ith Object.

Important conclusions are drawn from the work that would be of immense use for the designers of Education Grid and e-Learning content designers. The design details of the experiments and the harmonization process is beyond the scope of this paper. This paper is part of a whole research program on Education Grid.

V. CONCLUSIONS

Semantic representation of pedagogical parameters has been integrated into meta-scheduler of a Learning Grid environment. Results have shown the capabilities of integrating semantic representations and non-semantic representations for improving the efficiency of Grid computing.

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