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Abstract

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Keywords

E-learning system | Proxies | Peer to peer system | Prefix routing

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GrAPP&S, a Distributed Framework for E-learning Resources Sharing

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Abstract. This article presents GrAPP&S (Grid APPlication & Services), a specification of an E-learning architecture for the decentralized sharing of educational resources. By dealing with different resources such as files, data streams (video, audio, VoIP), queries on databases but also access to remote services (web services on a server, on a cloud, etc.), GrAPP&S groups the resources of each institution in the form of a community and allows sharing among different communities. Educational resources are managed on a transparent manner through proxies specific to each type of resources. The transparency provided by proxies concerns the location of sources of educational data, the processing of queries, the composition of the results and the management of educational data consistency. Furthermore, the architecture of GrAPP&S has been designed to allow security policies for data protection, both within a community and between different communities.

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1 Introduction

An interesting idea that people actually consider that the pedagogical integration of ICTs to all education degrees improve clearly the quality of African education systems. Online learning (E-learning) and mobile learning (M-learning) help not only to strength the planning and the management of a democratic and transparent education, but also to extend the access to learning, to improve quality and ensure inclusion.

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Thanks to the opportunities they offer in terms of use or adaptation, in particular in environments where there are insufficient resources, free access educational resources constitute an excellent opportunity to achieve the goal of a education of quality for everyone. This is the first motivation of the project GRAPP&S. The objective of this project is to construct an E-learning architecture for sharing and decentralized management of all educational resources formats like files, streams (video, audio, VoIP) and resources from web services, cloud and distributed computing services. These resources are transparently presented to the user (student, teacher) thanks to the use of proxies adapters tailored for each educational resources.

Nowadays, it is very easy to share and learn using Internet. The Internet has contributed greatly to the education system by introducing the concept of E-learning. The latter is now accepted in the various educational institutions to improve the learning process for students and teachers or administrators. An important characteristic of E-learning systems is the sharing and use of educational resources between institutions.

Although most of E-learning repositories give free access to their repositories of educational resources, the integration process is still costly [11] as most learning repositories [2,3] rely on different standards to access the resources [1]. Furthermore, several systems rely nowadays on storage facilities on the cloud, which poses a problem to isolate localities due to the access speed.

Therefore, an intuitive approach is to regroup different local learning repositories from each institutes (schools, universities, repositories of research laboratories, etc.) in a "Community", which can foster the aims of reusing and sharing educational resources without costly duplicating them into local learning repositories. Through the use of communities, we can promote the goals of reuse and sharing educational resources. By extending the coverage to different educational resources (files, videos, data in a database, even a video stream for example when subscribing to TV channel for learning languages), we can integrate all tools to improve education in a single infrastructure, with a smaller cost. Following this approach, two major research challenges must be considered to ensure interoperability across the Web:

1. Compatibility between systems: if today most APIs (Dropbox, Google Drive, etc.) allow to handle simples files, it is less clear how to integrate complex data such as queries on a database, data streams or web services.
2. Decentralized data management: most platforms are migrating to the cloud, but at the expense of losing its proximity to the consumers, as well as poor access speed and privacy threats.

From these elements, we present GrAPP&S, an architecture designed to connect institutes interested on the sharing of educational data sources through the network. GrAPP&S brings therefore:

1. A decentralized solution for sharing all types of educational resources, not only files (text/xml) but also databases, streams (video, audio), and resources

from remote services such as web services and distributed computing, all integrated through the use of data proxies.
2. A simpler way to connect a large number of institutes interested into resource sharing. This is obtained through the aggregation of resources from each educational institute in the form of a "community". This will allow quick access to resources due to the proximity to consumers, unlike most of the E-learning solutions based on cloud storage when consumers are penalized because of the slow access speed.
3. The possibility to define security policies for the protection of educational resources within a community, and access policies between different communities through the establishment of *Service-Level Agreements (SLAs).*

The remaining sections of the paper cover: Sect. 2 discusses the related work. Section 3 presents an overview of GrAPP&S architecture and describes the different elements of this architecture, while Sect. 4 describes the lookup algorithm used to locate resources inside GRAPP&S. Finally, Sect. 5 concludes this paper.

2 Related Work

Because GRAPP&S aims at the decentralized management of resources, it seems natural to identify peer-to-peer (P2P) works in this area. Indeed, an architecture for sharing educational resources among different learning institutions is proposed in [1]. This architecture, called LOP2P, aims at helping different educational institutions to create course material by using shared educational resource repositories. Nonetheless, resources of different formats cannot be easily integrated in this platform. Similarly, [7] develops a P2P based E-learning system that uses the video for learning. This system divides multimedia data into fragments managed by assigned agents, and this system allows the sharing of multimedia data, but it cannot deal with other data types.

Several E-learning systems based on cloud are being proposed, like [4] or [5]. In [4], an E-learning ecosystem based on cloud computing and Web 2.0 technologies is presented, and the article analyses the services provided by public cloud computing environments such as Google App Engine, Amazon Elastic Compute Cloud (EC2) or Windows Azure. It also highlights the advantages of deploying E-Learning 2.0 applications for such an infrastructures, and identify the benefits of cloud-based E-Learning 2.0 applications (scalability, feasibility, or availability) and underlined the enhancements regarding the cost and risk management. In addition, [5] is used to run web 2.0 applications, such as video teleconferencing, voice over IP, and remote management, over handheld devices and terminals. As [5] Leopard Cloud is targeted towards military usage, it has a multi-level security and the network infrastructure is encrypted.

It is quite evident that the cloud-based system would help the educational institutes or universities to share and disseminate knowledge among students, teachers and researchers, but the use of Cloud Computing in the educational system presents many risks and limitations: not all applications run in cloud, there are risks related to data protection, security and accounts management. Also, the access speed to cloud infrastructures may be a critical factor, amplified by the lack of a stable Internet connection that may affect the work methods in some isolated areas.

3 The GrAPP&S Architecture

The GrAPP&S framework is an E-learning solution for the decentralized sharing all types of resources. It allows pooling of data each institution in the form of community, and allow different communities to share resources based on predefined access rules. For this reason, GrAPP&S can also be extended to other areas of the school, by creating a community in the administrative part, separated from the education part, with safety rules and resource protection. In the following sections, we present the different elements of our framework GrAPP&S for the decentralized sharing of educational resources.

3.1 Model

We consider a model of communication represented by an undirected and connected graph $G = (V, E)$, where V denotes the set of nodes in the system and E denotes the set of communication links between nodes. The model used for this system is studied in [6]. Two nodes u and v are said to be adjacent or neighbors if and only if u, v is a communication link of G. $u_i, v_j \in E$ is a bidirectional channel connected to port i for u and to port j for v. Thus nodes u and v can mutually send and receive messages. Nodes communicate by using asynchronous messages.

A message m in transit is denoted $m(id(u), m', id(v))$ where $id(u)$ is the identifier of the node that sends the message, $id(v)$ is the identifier of the receiving node and, m' the message content. Each node u of the system has a unique id and has two primitives: **send(message)** and **receive(message)**.

3.2 Nodes of GrAPP&S

In order to present our architecture, we introduce some notations first. A community (C_i) is an autonomous entity, which includes educative resources sharing some properties: same location (resources institute, university, research laboratory), same administration authority, or same application domain (administrative resources vs teaching resources). A community contains one communicator process noted (c) and at least one *Resource Manager* process noted RM and one process *Data Manager* noted DM and these processes are hierarchically organized in the Community.

Communicator (c) nodes play an essential role that is related to information transmission and interconnection between different communities, such as when passing messages through firewalls. A Communicator is the community entry point and assures its security towards the outside, through establishment of *Service-Level Agreements (SLAs)* with other communities. The communicator also defines the security rules (access) for the protection of educational resources inside the community (for example the administration community can see the data on the educational system, but not the reverse, thanks to this access rules defined by the communicator).

Resource Manager (RM) processes ensure indexing and organization of educational resources in the community. The RM_i processes are involved in the search and indexing of data in the community c_i, and by receiving queries from its neighbors communities. Given the important role of RM processes in research and indexing of resources, we choose a RM among ordinary nodes that have good performance levels in both CPU, memory size and communication speed.

Data Manager (DM) processes interact with sources of educational data such as databases, file, email servers, WebDAV servers, FTP servers, disks, or cloud services. A DM node is a service that has the following components (see Fig. 1):

- a proxy interface adapted to the various formats of educational data,
- a query manager that allows to express queries on local or global educational resources, and
- a communications manager that allows the DM node to communicate with the RM node to which it is connected.

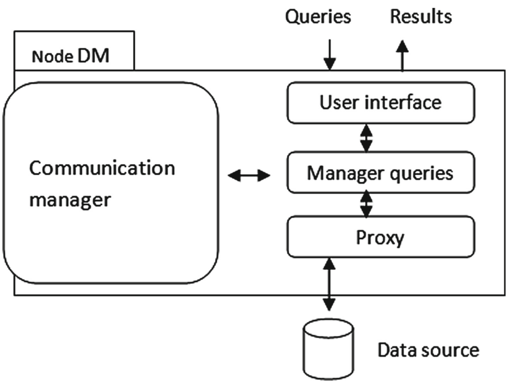

Fig. 1. DM node architecture

3.3 Management of the Community

GrAPP&S can be deployed in several ways, depending on the placement of the nodes. For example, we can find the following deployment topologies;

1. Nodes can be grouped into a single physical machine (see Fig. 2a). This is an example of a machine of a student or a teacher who wants to host a community of architecture.
2. The nodes are organized in a server farm such as a cluster, which is characteristic of an HPC network (Fig. 2b).
3. Nodes can be distributed over different machines, which corresponds to a grouping of educational resources in a university or a school with remote sites. These resources share the same administration entity (see Fig. 2c).

Each node on GrAPP&S has its own unique identifier (ID). The IP or the MAC addresses are not sufficiently accurate because they do not identify uniquely different nodes that can reside on a same machine (e.g. RM and DM). Thus, we rely on the identification method proposed by JXTA [12], which uses a string of 128 bits. Each node has a unique and string $ID - local$, as "$urn : name - community : uuid : string - of - bit$". As GRAPP&S is hierarchically structured, the expression of hierarchical addressing is done by concatenating the IDs as a prefix, i.e., ID c_i node is equivalent to its $ID - local$, the node ID is formed by RM_i $ID\text{-}c_i/ID\text{-}RM_i$, and DM_i node ID has the form $ID\text{-}c_i/ID\text{-}RM_i/ID\text{-}DM_i$.

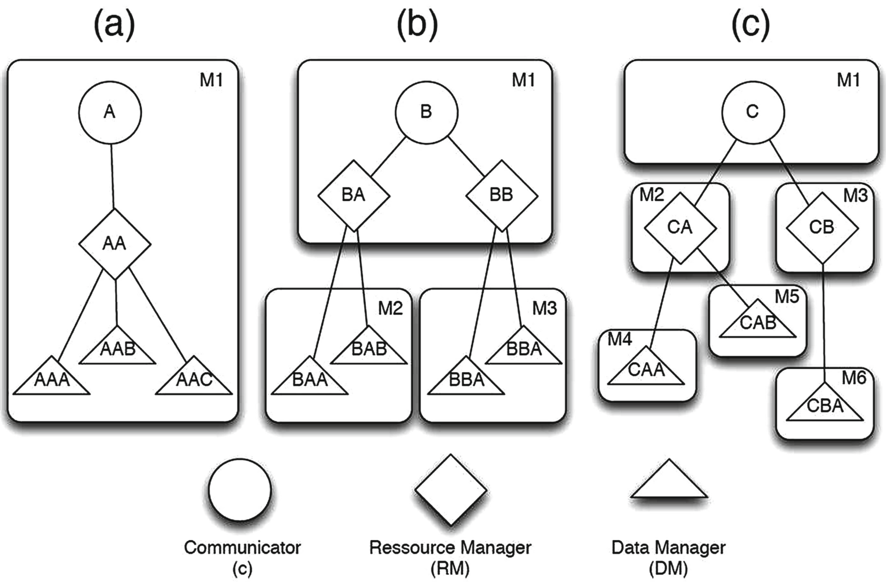

Fig. 2. Organization of the nodes in a machine (a), in a cluster (b) and in a network (c)

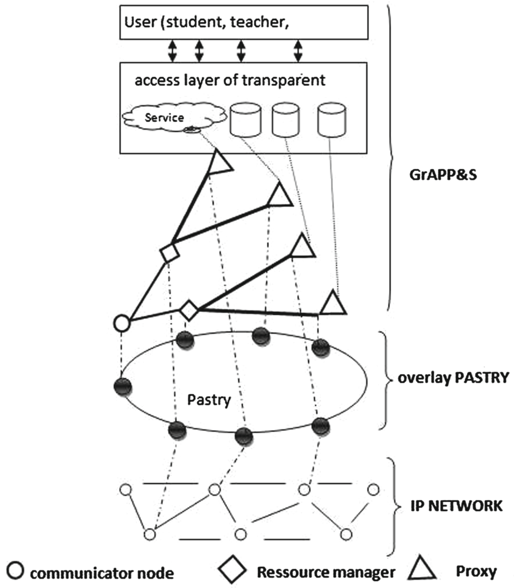

Fig. 3. Deployment of nodes GrAPP&S on Pastry

An advantage of using an addressing model specific to GrAPP&S is that it is independent of the overlay network addressing model that is implemented. Indeed, Fig. 3 presents an illustration of GRAPP&S implemented over the Pastry [10] P2P middleware. Thus, two communities GrAPP&S implemented on different middleware can still be compatible, once the connection is established between their communicators.

4 Accessing the Resources

A GrAPP&S community is an hierarchical network with an addressing system independent from the underlying network. This addressing scheme is used to help data lookup and also to help route data during transfers. This hierarchical addressing also simplifies the integration to another network community. In the following paragraphs, we will propose a routing algorithm and a method of data lookup in our system.

4.1 Routing Algorithm

Let T be the tree of a community GRAPP&S. Thanks to the results of Fraigniaud and Gavoille [8]; Thorup and Zwick [9] we can construct a routing scheme in the tree T. For each message m for a vertex y, the current vertex x sends m on a shortest path in T.

Let T be any *n-node* tree, and let r be any node of T. Suppose that T is rooted at r. For every node u, T_u denote the subtree of T rooted at u. We define $Id(u)$ as the numbering of the node of T by consecutive integers in $[1, n]$ obtained by a DFS traversal of T. For every node u$\neq$r, let as define $path(u)$ as the sequence of number of nodes encountered on the path from r to u. We set $path(r)$ =(), the empty sequence. More precisely, if the path from r to u is $r = u_0, u_1, \ldots, u_k$ then $path(u) = (\mathrm{Id}(u_0), \mathrm{Id}(u_1), \ldots, \mathrm{Id}(u_k))$. For every node x of T the address $l(u) =< Id(u), path(u) >$.

The message header consist solely of the destination address of the message and it not be modified along its paths from source to destination. Assume that a node x receives a message of header $h = l(y)$. The routing decision at x is described by a function $ROUTE(x, h)$ that return the neighbor w of x on which the message has to be forwarded form x.

```
ROUTE (x,l(y))
BEGIN
  IF Id(x) = Id(y)
        Return x;
 ELSE IF (Id(y) == p= (|path(x)|-1)-th element of path(x) Then
           Return p;
  Else Return (|path(x)|+1)-th element of path(y);
END
```

4.2 Lookup Algorithm

The search for a resource in a community GrAPP&S is illustrated in Fig. 4, and the procedure works as follows:

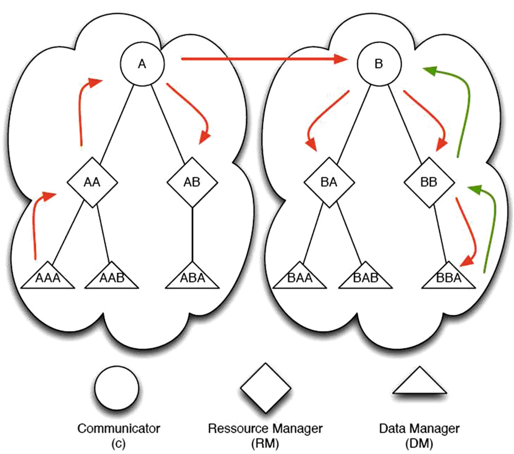

Fig. 4. looking for a resource in a routing GrAPP&S

1. User comes into contact with a DM_i proxy.
2. Node $DM_i \in C_i$ sends the request to its $RM_i \in C_i$.
3. RM_i checks in its index among its neighbors if there's a DM that contains the searched resource.
4. If so, then the node returns to RM_i DM node a list of nodes that contain DM information searched.
5. Otherwise, RM_i node forwards the request directly neighbors $RM_k \in C_i$, either to the node c_i to retransmit other $RM_k \in C_i$.
6. When node $RM_k \in C_i$ found the correct answer, then the query will be returned to transmitter node DM_i following the opposite path.
7. If the data sought is not in the community C, then c_i node forwards the query to other community.

The user has two options for accessing the resource either through a direct connection (if the network support is) or a routed connection (if the user is in another different network node that owns the resource).

5 Conclusions and Future Works

In this article we present an E-learning architecture specification named GrAPP&S, which is a decentralized solution for managing and sharing educational resources. GrAPP&S has been constructed as an hierarchical network to allows a pooling resources of each institute under the concept of "community", and to take advantage of the proximity of data and the users (students, teachers, administrative, etc.). One can even extend the use of a community of GrAPP&S to other sectors of an institute such as a community just for the administrative departments, separated from the educational users. In addition, GrAPP&S uses security rules to protect the resources of each community, and defines access policies between different community. The use of proxies for each specific type of data allows sharing a transparent manner not only files but also databases, streams (video, audio, VoIP), resources from the web services, cloud services, distributed computing.

The next step towards the validation of this specification is its use under real situations. We are starting to develop a prototype of GrAPP&S that will be used for testing and deployment on educational institutions. This prototype uses P2P Pastry underlying network to distribute the nodes of a community (local network institution) of GrAPP&S as illustrated in Fig. 3. The choice of Pastry allows a community GrAPP&S a P2P network, which will allow a community institute include a large number of nodes and to perform scaling tests.

References

1. de Santiago, R., Raabe, A.L.A.: Architecture for learning objects sharing among learning institutions LOP2P. IEEE Trans. Learn. Technol. **3**(2), 91–95 (2010)
2. Cheng-Zhong, X., Rao, J., Bu, X.: URL: a unified reinforcement learning approach for autonomic cloud management. J. Parallel Distrib. Comput. **72**(2), 95–105 (2012)
3. Fardoun, H.M., Lopez, S.R., Alghaz-zawi, D.M., Castillo, J.R.: Education system in the cloud to improve student communication in the institutes of C-LearniXML++. Procedia Soc. Behav. Sci. **47**, 1762–1769 (2012)
4. Ouf, S., Nasr, M., Helmy, Y.: An enhanced e-learning ecosystem based on an integration between cloud computing and Web2.0. In: Proceedings of the IEEE International Symposium on Signal Processing and Information Technology (ISSPIT), pp. 48–55 (2011)
5. Cayirci, E., Rong, C., Huiskamp, W., Verkoelen, C.: Snow leopard cloud: a multinational education training and experimentation cloud and its security challenges. In: Jaatun, M.G., Zhao, G., Rong, C. (eds.) Cloud Computing. LNCS, vol. 5931, pp. 57–68. Springer, Heidelberg (2009)
6. Chalopin, J., Godard, E., Métivier, Y., Ossamy, R.: Mobile agent algorithms versus message passing algorithms. In: Shvartsman, M.M.A.A. (ed.) OPODIS 2006. LNCS, vol. 4305, pp. 187–201. Springer, Heidelberg (2006)
7. Hayakawa, T., Higashino, M., Takahashi, K., Kawamura, T., Sugahara, K.: Management of multimedia data for streaming on a distributed e-learning system. In: 2012 26th International Conference on Advanced Information Networking and Applications Workshops (WAINA), pp. 1282–1285 (2012)
8. Fraigniaud, P., Gavoille, C.: Routing in trees. In: Orejas, F., Spirakis, P.G., van Leeuwen, J. (eds.) ICALP 2001. LNCS, vol. 2076, p. 757. Springer, Heidelberg (2001)
9. Thorup, M., Zwick, U.: Compact routing schemes. In: 13th Annual ACM Symposium on Parallel Algorithms and Architectures (SPAA), pp. 1–10. ACM Press, July 2001
10. Rowstron, A., Druschel, P.: Pastry: scalable, decentralized object location, and routing for large-scale peer-to-peer systems. In: Guerraoui, R. (ed.) Middleware 2001. LNCS, vol. 2218, pp. 329–350. Springer, Heidelberg (2001)
11. Yu, H.Q., Dietze, S., Li, N., Pedrinaci, C., Taibi, D., Dovrolls, N., Stefanut, T., Kaldoudi, E., Domingue, J.: A linked data-driven & service-oriented architecture for sharing educational resources. In: 1st International Workshop on eLearning Approaches for Linked Data Age (Linked Learning 2011), 8th Extended Semantic Web Conference (ESWC2011), 29 May 2011, Heraklion, Greece (2011)
12. Ahkil, B.T.: Project JXTA 2.0 Super-Peer Virtual Network (2005)