An authorization Framework for Grid Security using GT4

Debabrata Singh[1], Bhupendra Gupta[2] ,B.M.Acharya[3], Sarbeswar Hota[4]

S 'O'A University, Bhubaneswar

Abstract

A Grid system is a Virtual Organization that is composed of several autonomous domains .It concerned with the sharing and coordinated use of diverse resources in distributed "virtual organizations." The dynamic and multi-institutional nature of these environments introduces challenging security issues that demand new technical approaches. In particular, one must deal with diverse local mechanisms, support dynamic creation of services, and enable dynamic creation of trust domains. We review the Globus Toolkit version 2 (GT2) approach; then, Globus Toolkit version 3 (GT3), then, for authorization in such virtual organization a system needs to be flexible and scalable(reviewed the blacklist/whitelist authorization) to support multiple security policies. Basing on the Web Services security specifications such as XACML, SAML, and the special security needs of the Grid computing we review Globus Toolkit version 4 (GT4), provides a simple, open and efficient method for Grid service access control.

Key Words : *OGSA, XACML,SAML, Blacklist / Whitelist Authorization*

1. Introduction

The term "Grid" refers to systems and applications that integrate and manage resources and services distributed across multiple control domains [1].It is a virtual organization comprising several independent autonomous domains [2]. Authorization is an important part of the Grid security system. In a grid computing environment, every autonomous domain may have its own policy and may change its policy dynamically. Hence, the authorization mechanism of the Grid system needs to support multiple security policies and needs to have the flexibility to support dynamic changes in security policies, which suggest new challenges to the Grid computing platforms. With the merging of Grid and Web Services, many new standards and concepts in Web Services are introduced into Grid computing area. Basing on the authorization related specifications in Web Services and the special authorization requirements of Grid, we reviewed a flexible multipolicy authorization framework in Globus Toolkit release 4.

The recent definition of the Open Grid Services Infrastructure specification and other elements of the Open Grid Services Architecture (OGSA) [3] within the Global Grid Forum introduces new challenges and opportunities for Grid security. In particular, integration with Web services and hosting environment technologies introduces opportunities to leverage emerging security standards and technologies such as the Security Assertion Markup Language (SAML) [4] and Web services security. Integration of GSI with OGSA enables the use of Web services techniques to express and publish policy , allowing applications to determine automatically what security policies and mechanisms are required of them. Implementing security in the form of OGSA services allows those services to be used as needed by applications to meet these requirements. To show the flexibility & scalability of the framework we studied blacklist/whitelist based authorization mechanism .

GT3's security implementation uses Web services security mechanisms for credential exchange and other purposes, and introduces a tight least privilege model that avoids the need for any privileged network service.

GT4 Authorization implements SAML (security assertion markup language),and uses the XACML(extensible access control markup language). XACML Authorized framework architecture implementation of the Open Grid Services Architecture, an initiative that is recasting Grid concepts within a service oriented framework based on Web services. The blacklist/whitelist authorization system established under the GT4 authorization framework can provide a simple, open, scalable, and flexible and efficient method for Grid service access control.

The rest of the paper is organized as follows: section 2 discusses some related work; section 3 introduces the XACML specification ; section 4 describes the design concepts, the structure, and the components of the authorization framework; section 5 discusses the design and implementation of the blacklist/whitelist-based authorization mechanism; section 6 summarizes of all.

2. Related Work

In Globus Toolkit, the security functionality is called the Grid Security Infrastructure (GSI) [5], and authorization is developing together with GSI. From version 1 in 1998 to the 2 release in 2002 and now the 4 release, GSI has been developing rapidly. In GT1, GSI mainly provided message protection and authentication. In GT2, GSI introduced X.509 proxy certificates to support dynamic creation of computing entities and provided Community Authorization Service (CAS) to implement access control in dynamic created overlaid trust domains.

In GT3, the Grid technology worked with the emerging Web services technology. Security functionalities of GSI3 are defined as OGSA(Open Grid Services Architecture) services [6]. In GT4, additional Web Services security specifications are implemented. Web Services has provided several security standards that have great influence to the Grid computing. XACML (extensible Access Control Markup Language) and SAML (Security Assertion Markup Language) are the two important authorization related standards [7]. There are also several authorization systems that support Grid Computing, such as Akenti[8], PERMIS , Shibboleth[9], VOMS . Akenti, PERMIS and Shibboleth use user attributes to make authorization decisions; VOMS provides user attributes which can be used for authorization. These authorization systems support their own policies, and can be integrated into GT4 authorization framework as authorization services.

3. The XACML Authorization Model

GT4 implements the WSRF specification. GT4 authorization framework was constructed based on the OASIS XACML and SAML standards [10]. The architecture of the framework uses the XACML authorization model that is shown in Figure 1.
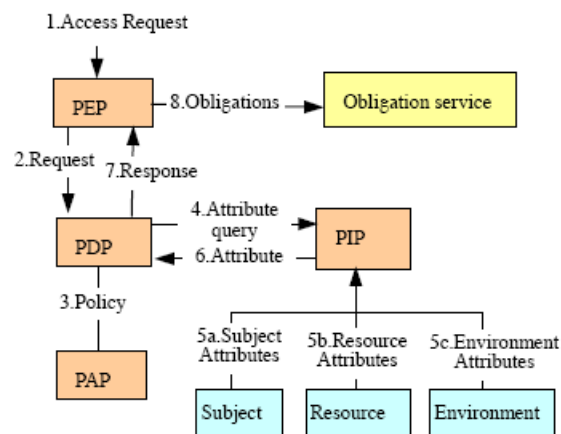

Figure 1. XACML authorization model

The XACML authorization model mainly contains PEP (Policy Enforcement Point), PDP (Policy Decision Point), PIP (Policy Information Point), and PAP (Policy Administration Point). The PEP intercepts the access requests from users and sends the requests to the PDP. The PDP makes access decisions according to the security policy or policy set written by PAP and, using attributes of the subjects, the resource, and the environment obtained by querying the PIP. The access decision given by the PDP is sent to the PEP. The PEP fulfills the obligations and either permits or denies the access request according to the decision of PDP. XACML also defines a policy language. Policies are organized hierarchically into Policy Sets, Policies and Rules, combined using combining algorithms. A rule is composed of a target, an effect and a condition. A Policy consists of a target, one or more rules, and an optional set of obligations.

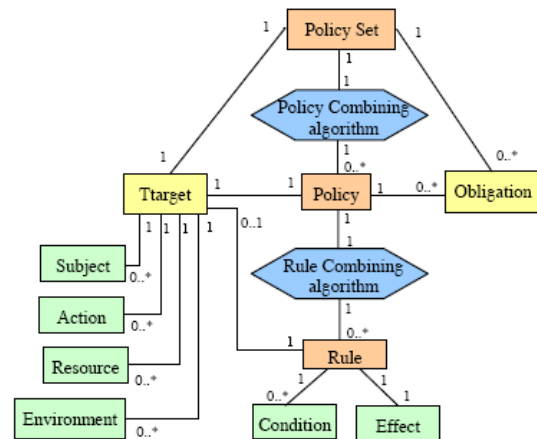## 3.1 XACML Policy Language Model

Fig 2 XACML Policy Language Model

The access control framework mainly contains PEP (Policy Enforcement Point), PDP (Policy Decision Point), PIP (Policy Information Point), and PAP (Policy Administration Point). The PEP intercepts the access requests from users and sends the requests to the PDP. The PDP makes access decisions according to the security policy or policy set written by PAP and, using attributes of the subjects, the resource, and the environment obtained by querying the PIP. The access decision given by the PDP is sent to the PEP. The PEP fulfills the obligations and either permits or denies the access request according to the decision of PDP. XACML also defines a policy language. The policy model is shown in Fig. 2. The main components of the model are the rule, the policy, and the policy set. A rule is the most elementary

unit of the policy and can be evaluated on the basis of its contents. The main components of a rule are as follows:

A target that defines the set of resources, subjects, actions and environment An effect that indicates the consequence of the satisfied rule A condition that further refines the applicability of the rule Rules are combined into a policy, which comprises four main components: a target, a rule-combining algorithm, a set of rules, and obligations. A policy set comprises four main components: a target, a policy-combining algorithm, a set of policies, and obligations. The rule-combining algorithm specifies the procedure by which the results of evaluating the component rules are combined when evaluating the policy. The policy-combining algorithm has a function similar to that of the rule-combining algorithm. Obligations are the actions that must be performed by the PEP in conjunction with the enforcement of an authorization decision; obligations are the mechanism for achieving finer-level access control.

4. The GT4 Authorization Framework

The convergence of Grid and Web services introduces both new opportunities and new challenges for Grid security. On the one hand, these specifications have provided standard and interoperable methods for Grid security. On the other hand, in order to establish an authorization mechanism suitable for Grid computing, these specifications may also need to be extended or changed to some extent, since Grid has its own special application requirements.

In a Grid system, each domain has its own security policy, such as the grid-mapfile, ACL (Access Control List), CAS, SAML authorization decision assertions, and XACML policy statements. Hence, the GT4 authorization framework needs to support multiple security policies and also needs to be flexible, so that it can be changed easily for different application environments. These special authorization requirements are not addressed in the XACML specification. Based on the XACML specification and the Grid access control requirements, we designed and implemented the GT4 authorization framework.

4.1. The Framework Architecture

The GT4 authorization framework[12][13] implements SAML and uses the XACML model, as shown in Figure 3. It is composed of a PEP, PDPs, and PIPs. For each existing authorization policy, the framework constructs a PDP for evaluating that kind of policy. The Master PDP is

responsible for coordinating the PDPs to render a final decision. The Master PDP and the PEP are collectively called the authorization engine. The framework provides different kind of PIPs. A subset of PIP, referred to as Bootstrap PIPs, collect information only about the request, such as the peer subject, the requested action, and the resource. An example of one such PIP, is the X509BootstrapPIP, which extracts the subject DN of the peer from the X509 certificate. When a request of the Grid resource comes, the PEP intercepts it and sends a decision request to the master PDP. The master PDP collects information needed by calling the Bootstrap PIPs and other PIPs and then invokes the corresponding PDPs with the request and the information collected. The PIPs and the PDPs used are all specified in the security configuration file. When the master PDP receives the decisions returned by each PDP, it combines the decisions, using a policy combination algorithm, such as deny override or permit override, to render a final decision and returns the decision to the PEP. The PEP then executes the decision, either denying or permitting the request.
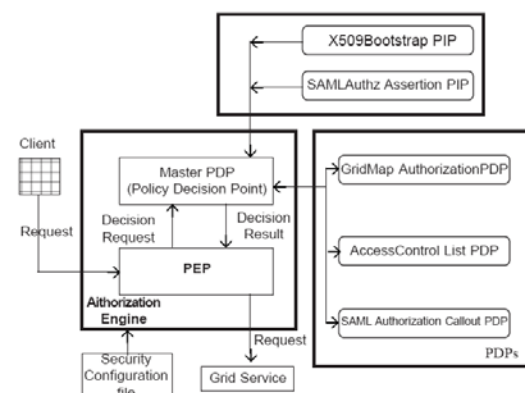

Fig 3. GT4 authorization framework

4.2. The Authorization Framework of PDP

The PDP is the core of the authorization framework. In order to make the framework support different kind of policies and be scalable, we built a multipolicy framework[11] as shown in Figure 3. Because every policy essentially needs its own custom decision evaluator that understands the intrinsic semantics of the policy expressions, it is necessary to encapsulate the policy into an independent PDP. At the same time, we abstract the common characteristic of the policies and define an abstract PDP. The PDP abstraction (the PDP class in Figure 3) defines a common interface that can be used to interact with the PEP or with other PDPs. Each specific policy is a subclass of the PDP abstraction, which implements the common interface inherited from PDP with its own policy and evaluation mechanism.

The policy framework is object-oriented. New policies can be added and modified at any time. Also, since PDP instances are queried through the same interface and the mechanism-specific details of the PDPs are all hidden behind the public interface, a change to the policy framework has no effect on the Master PDP: it can cooperate with any specific PDPs designated by the security configuration files. This multipolicy framework thus provides users with a flexible and scalable authorization mechanism. In Grid systems, there are several frequently used simple authorization policies or mechanisms, we provided PDPs that implement these existing policies, such as the Access Control List PDP and the Grid Map Authorization PDP

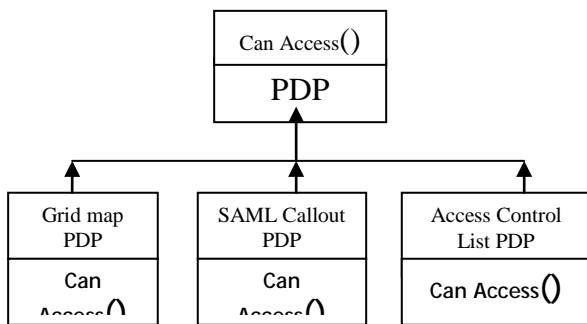.Some authorization systems like Shibboleth, VOMS and PARMIS.

Fig 4. Authorization policy framework

5. Blacklist/Whitelist Based authorization Framework

Blacklist and whitelist mechanisms are simple and well known in the security area. The most obvious advantages of this technology are simplicity and efficiency. They can also be introduced into the Grid services access control area for establishing a simple and effective authorization mechanism. If the authorization mechanism detects the requestor on the blacklist or whitelist, it will make an access decision immediately. Based on the blacklist and whitelist concept, we designed and implemented a prototype BlackList PDP and WhiteListPDP under the GT4 authorization framework. The Blacklist/whitelist-based authorization structure is shown in Figure 5.

The BlackList PDP and the WhiteListPDP are inherited from the PDP abstraction introduced in Section 4.2. The implementation of these two PDPs has two layers: the functional layer and the implementation layer. The blacklist/whitelist access interface, which now contains a member testing method, is defined at the functional layer. The implementation layer contains two levels: the first level is JNDI, which can integrate various naming and directory services and provide a common interface; the second level is composed by

different naming and directory services. In our prototype we use an LDAP server to store and manage the blacklist and the whitelist. The URL of the LDAP server is passed to the BlackList PDP and WhiteListPDP through a configuration file. The blacklist and whitelist are composed of attributes of requestors, such as DN (Distinguished Name, which can be abstracted from the requestor's X.509 certificate), name, and email address. We chose the DN as the identity attribute. Other attributes such as username and group membership can also be used as the identity attributes. This can be achieved by establishing a blacklist/whitelist PIP, which obtains these identity attributes by querying an outside attribute authority using the requestor's DN, and then provides the identity attributes to the BlackList PDP or WhiteListPDP. This will provides more flexibility for users in different application environments.

The blacklist/whitelist-based authorization can also be used together with other authorization mechanisms to make an efficient and rigorous authorization system. The Master PDP will first call the Blacklisted or the WhiteListPDP; if the requestor is not found here, other PDPs will be called to do further decision making.
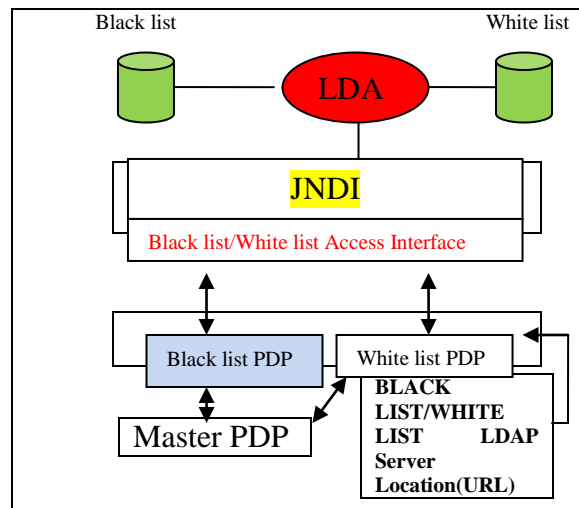

Fig 5 . Blacklist/Whitelist-based authorization structure

Based on this ,the prototype blacklist & whitelist PDP under the GT4 authorization framework ,which shown in fig 4.The blacklist & whitelist PDP are inherited from the PDP abstraction .The implementation of these two PDPs has two layers; the functional layer & the implementation layer. Functional layer helps for the Blacklist/Whitelist access interface & implementation layer helps for Java layer & Directory Interface &LDAP& Handel them.

6. Conclusion

We find that for a flexible multipolicy authorization framework for GT4, The framework is based on the XACML and SAML specifications. The blacklist/whitelist authorization system established under the GT4 authorization framework can provide a simple and efficient method for Grid service access control. Also, this work illustrates that the GT4 authorization framework is open, scalable, and flexible.

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Author Information

Debabrata Singh is an Assistant professor in the Department of Information Tecnology, holds MTech in Computer Science & Engg. (BPUT,BBSR) He has nearly four years experience in teaching, software development and research. Presently, he is working as Assistant professor in ITER,SOA University, Bhubaneswar,Orissa He has published 13 papers on multi agent technologies & Grid Computing environment in national & international journals and conferences.

Bhupendra Kumar Gupta is an Assistant professor in the Department of Computer Applications, holds MTech in Computer Science & Engg. (Utkal University,BBSR) He has nearly six years experience in teaching, and research. Presently, he is working as Assistant professor in ITER,SOA University, Bhubaneswar,Orissa He has published 6 papers on Wireless Mesh Networks, MANETs, multi agent technologies & Grid Computing environment in national & international journals and conferences.

Biswa Mohan Acharya is an Assistant professor in the Department of Computer Applications, holds MTech in Computer Science & Engg. (IIT, Guwahati) He has nearly 10 years experience in teaching, and research. Presently, he is working as Assistant professor in ITER,SOA University, Bhubaneswar,Orissa He has published 12 papers on Wireless Mesh Networks, MANETs, multi agent technologies & Grid Computing environment in national & international journals and conferences.

Sarbeswar Hota is an Assistant professor in the Department of Computer Applications, holds MTech in Computer Science & Engg. (ITER, Bhubaneswar) He has nearly 8 years experience in teaching, and research. Presently, he is working as Assistant professor in ITER,SOA University, Bhubaneswar,Orissa He has published 5 papers on Wireless Mesh Networks, MANETs, multi agent technologies & Grid Computing environment in national & international journals and conferences.