



## Cross-Domain Role Mapping in Grid Computing Environment

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**Abstract**— Lack of proper authorization techniques in grid computing technologies is a matter of much concern. The concept of virtual organizations which is at the core of computational grids further complicate the matter. Role-based access control (RBAC) is a security technology that is gaining importance now-a-days. It is used a lot in network security and can be effectively applied in grids too. Here a cross-domain policy mechanism for authorization is outlined based on the research of RBAC model at present, whereby equality is achieved between a local and a global role. The future work is to realize the model and implement it in practice.

**Keywords**— Grid authorization, Role, RBAC, Cross-domain framework

### I. INTRODUCTION

The dynamic and multi-institutional nature of grid computing environment[1] has produced challenging issues related to its security[2]. Grids are generally employed in high computation oriented tasks which needs secure collaboration among the various autonomous domains geographically dispersed at various places. A lot of research has been done on authorization in distributed systems but not much work has been done in real life distributed applications such as grids. The identity based authorization which was initially put into practice maps a user's global identity(distinguished name) to a local account that has to be setup at every grid site. This is maintained in a list called "Grid-mapfile". In a scalable grid infrastructure this should not be a likable solution for authorization purposes. The evolution of role based access-control mechanism is thus a natural choice in such a scenario[3][4].

A grid involves many management domains[1][6] and each domain is distributed in the network, so grid access control will be implemented in global management and local autonomy. The grid access control policy allots different access permissions and range to various global user in every local area. Users will be given roles according to his/her duty and permission. The user has to be restricted by access permission.

There is no standard solution for authorization in case of cross domain architectures. A service request may originate from one domain and may span several domains to accomplish its task. Thus the local role of the user has to be mapped to a global role and a proper authorization policy has to be envisioned for accepting or denying access rights to the

user. In such a scenario, the model described in the following section comes in handy to put to practice.

### II. CROSS-DOMAIN AUTHORIZATION MECHANISM

Cross-domain authorization[5] is a critical factor in multi domain access control policy. Generally the grid environment is composed of several domains and sub-domains having different roles and responsibilities. The role of a node in one domain will vary greatly in some other domain. So the need is of some policy that could result in some equality of roles in various domains. Here the approach which has been taken is of a weighted tree. By combining the role of a node with that of its parent a global ranking has been established for access control purposes.

Role based access control has gained significance for authorization and for providing RBAC, some sets of policies are to be created for the Grid computing environment with the corresponding virtual organizations. In this paper we have developed a novel architecture and cross-domain policy mechanism for authorization in Grid which is based on RBAC, where access control is attained through global-local role of users and resource providers.

The cross-domain architecture consists of the following components :

- Two domains A and B have been taken.
- Domain A consists of sub-domain A\_u and A\_r having user nodes and resource nodes respectively.
- Domain B consists of sub-domain B\_u and B\_r having user nodes and resource nodes respectively.
- There is an user authorization server1 for grid nodes from domain A\_u and a resource authorization server1 for resource nodes from domain A\_r.

- The user authorization server2 and resource authorization server2 plays a similar role for domain B\_u and B\_r respectively.
- Rating servers 1 and 2 for two domains A & B store the rating of the sub domains.
- Global rating server is used for redirection purposes.

Using the concept of role ranking, local role of a node is mapped to a global role ranking[4] so that authorization can be effected seamlessly across multiple domains or virtual organizations.

The proposed cross-domain architecture consisting of several sub-domains, user nodes, resource providers, rating servers etc as components are shown in the diagram illustrated below in Fig-1.

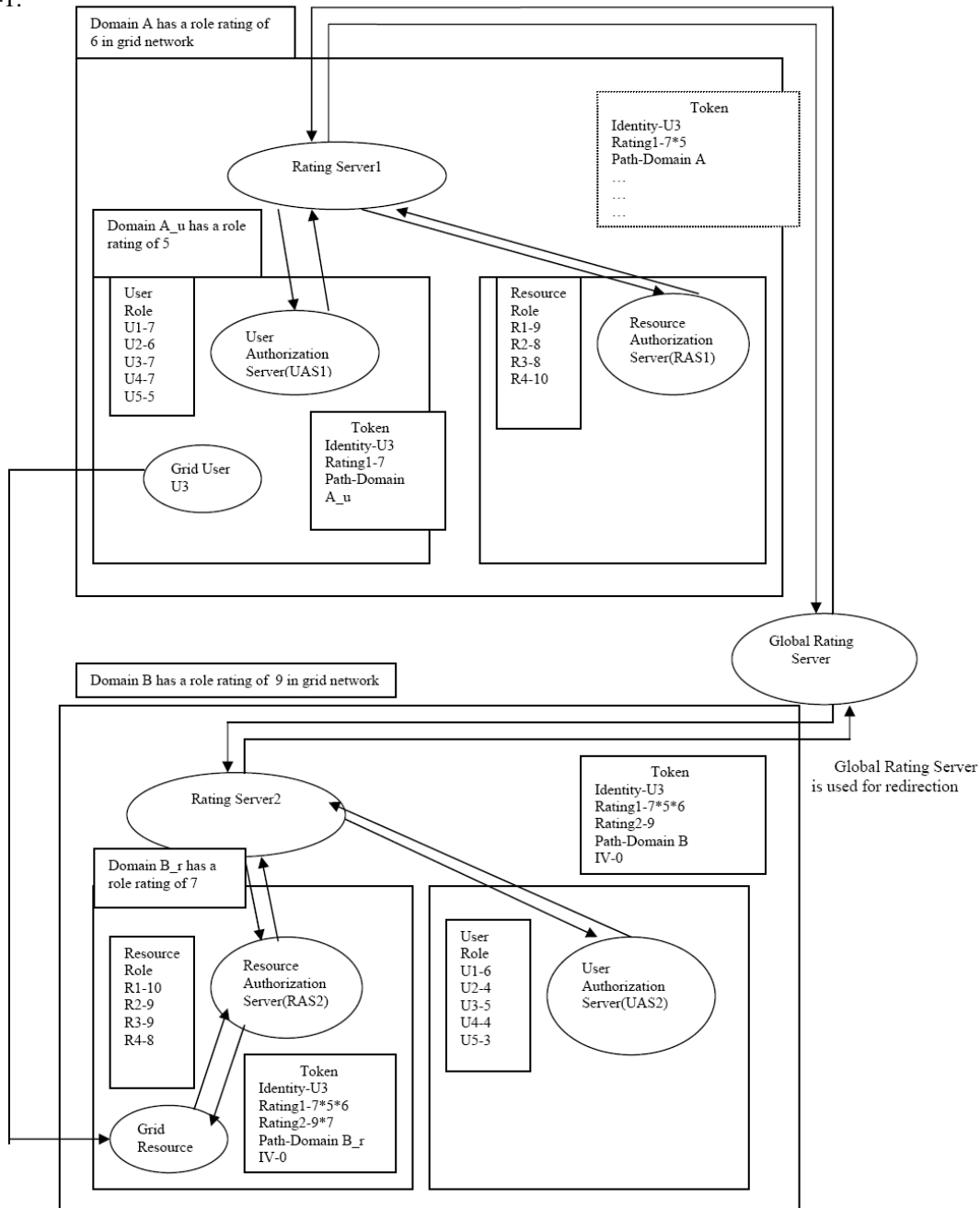


Fig:- Cross-domain authorization framework

Fig-1

$U_1, U_2, \dots, U_n$  : Users

$R_1, R_2, \dots, R_n$  : Resources

UAS1 : User Authorization Server of users at domain A

UAS2 : User Authorization Server of users at domain B

RAS1 : Resource Authorization Server of resources at domain A

RAS2 : Resource Authorization Server of resources at domain B

Three parameters have been chosen to assign a role value to a user node-computation, storage & data transfer. Combining the values of these three parameters, eight different values can be generated, 000...111 in binary & converted into decimal, thus 7 denotes a node which can perform all the three functions. The ratings are given on a scale of 10. The sub-domains are also given a role ranking based on importance & hierarchy on a scale of 10. The resource nodes have been classified into three categories namely cluster systems, mainframes & dedicated storage devices having roles of 10, 9 and 8 respectively.

The requested resource upon receiving the request asks for authorization of the requestor to its local authorization server which thereby redirects it to the global rating server to fetch user credentials. The global server passes the request to the authorization server of the domain in which the user resides. The authorization server creates a token and sends its reply through the same path in reverse direction, in every step the role rating of the parent domains get weighted into the global rating of the user. After getting the final token, rank of the user is normalized on a scale of 1. An interaction value (IV) is also contained in the token which has a value 1 if there was an earlier interaction between the two or 0 in case of no interaction. The authorization server executes the algorithm described below and takes the final call to deny or grant the request. The whole procedure is as follows:

- (1) Grid user  $U_3$  from domain  $A_u$  seeks a resource from domain  $B_r$  sending his identity, path & requested operation.
- (2) The requested entity asks the resource authorization server RAS2 for its decision.
- (3) The authorization server implements the authorization algorithm for checking user credentials.
- (4) As the user is from a different domain, RAS2 takes the help of the global server and redirects it to the user authorization server UAS1 of the domain in which user resides.
- (5) The user's role, rating etc are collected and UAS1 issues a token containing all those items. An interaction value IV is also given which has a value of 0 or 1. 1 signifies earlier interaction between the two and 0 signifies no interaction.
- (6) The token follows the same path in reverse direction and at every stage, the ranking of the parent domains get weighted, thus continuously modifying the global ranking.
- (7) RAS2 ultimately receives the token and normalizes the user rating on a scale of 1, obtaining the value  $7 \times 5 \times 6 / 1000$

(8) RAS2 finds the minimum role to access the resource. It is equal to the role of the domain in which the user resides which is 5. Normalization is done in this case also to get the value  $9 \times 7 \times 5 / 1000$

(9) Interaction value (IV) is then ascertained from the token.

(10) Algorithm is being executed to take final call.

Some fine-grained access control policy may also be included thereafter to further strengthen the authorization policy.

### III. ALGORITHM

The authorization algorithm can be defined as :

1. Procedure for role mapping is executed (credentials).
2. Normalized global rating of user (NGU) is calculated from the value received in the token.
3. Minimum rated role to access resource in the domain is calculated, which is the role ranking of the domain in which user resides.
4. Normalized global rating (NGR) of that role is determined.
5. Interaction value (IV) is checked from the token.
6. If  $NGR + IV \geq NGU$ ,  
Accept user as authorized  
else  
return unauthorized user.

The procedure for mapping role is as under :

1. Accept token seeking user credentials.
2. Rating of domain is added to the global rating of the entity in the token.
3. Return the token.

### IV. EXPERIMENTAL RESULTS

For experimental results, ten domains-domains A, B, C, D, E, W, X, Y, Z, K have been taken each consisting of sub-domains  $X_u$  and  $X_r$  where X denotes the corresponding domains. The rating of the sub-domains are indicated within the braces following those sub-domains. They were given a rating within 10 based on hierarchy and importance. Ten random cases are then taken for resource access of which three cases are repetitions, indicating earlier interactions. Normalized values are computed, interaction values are taken into consideration. The algorithm is being executed to finally grant or deny access. The results are also compared with a model as proposed by

G. Geethakumari et. al[5]. The results thus obtained made us change the value of the interaction value from 1 to 0.1 because 1 would have given a biased result in some cases. The results are given below in a tabular format in Fig-2. The values from case 8 clearly shows the removal of the said biased ness in the proposed final model. In spite of the earlier interaction, access for the second time is not

allowed which clearly shows a high degree of security in the proposed final model.

Serial No	Requestor & resource	Initial model proposed by us	Model as proposed by Geethakumari et all	Modified model proposed by us
1	U3(7) from domain A_u(5) seeks resource from domain B_r(7)	NGU 0.21 NGR 0.31 Accept	0.21 0.31 Reject	0.21 0.31 Accept
2	U5(5) from domain C_u(6) seeks a resource from domain A_r(5)	NGU 0.24 NGR 0.18 Reject	0.24 0.18 Accept	0.24 0.18 Reject
3	U4(3) from domain C_u(6) seeks a resource from domain D_r(5)	NGU 0.14 NGR 0.21 Accept	0.14 0.21 Reject	0.14 0.21 Accept
4	U1(7) from domain E_u(8) seeks a resource from domain C_r(6)	NGU 0.56 NGR 0.38 Reject	0.56 0.38 Accept	0.56 0.38 Reject
5	U2(4) from domain B_u(7) seeks a resource from domain D_r(5)	NGU 0.25 NGR 0.24 Reject	0.25 0.24 Accept	0.25 0.24 Reject
6	U2(4) from domain B_u(7) seeks a resource from domain C_r(6)	NGU 0.25 NGR 0.33 Accept	0.25 0.33 Reject	0.25 0.33 Accept
7	U4(4) from domain B_u(7) seeks a resource from domain D_r(5)	NGU 0.25 NGR 0.24 Reject	0.25 0.24 Accept	0.25 0.24 Reject
8	U1(7) from domain E_u(8) seeks a resource from domain C_r(6)	NGU 0.56 NGR 0.38 IV=1 to be added to NGR Accept	0.56 0.38 Accept	NGU 0.56 NGR 0.38 IV=0.1 to be added to NGR Reject
9	U3(7) from domain A_u(5) seeks resource from domain B_r(7)	NGU 0.21 NGR 0.31 IV=1 to be added to NGR Accept	0.21 0.315 Reject	NGU 0.21 NGR 0.31 IV=0.1 to be added to NGR Accept
10	U2(4) from domain B_u(7) seeks a resource from domain D_r(5)	NGU 0.25 NGR 0.24 IV=1 to be added to NGR Accept	0.25 0.24 Accept	NGU 0.25 NGR 0.24 IV=0.1 to be added to NGR Accept

Fig- 2

**V. CONCLUSION**

Access control is most vital parameter in Grids and thus it is of critical importance to introduce access control to impose Grid system security. The proposed role mapping authorization architecture will make it possible to

practically authorize users at time of collaboration among multiple domains. The interactions once established can be used repetitively in future endeavors also in the form of interaction value. More fine grained access control policies can also be formulated in future. The future work is to realize the model and apply it in practice.

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