



Advanced Authentication Scheme for Enhancing Security Issue in Grid Environment

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Abstract— This Grid computing harnesses the power of thousands interconnected processors and their associated storage as a single entity. Instead of using a network of computers simply to communicate and transfer data, Grid computing taps the unused processor cycles of numerous computers. Because of this distributed Virtual Organisation of Grid, security of Grid computing is very complex and most important issue. In this paper we tried to analyse the existing security architecture and proposed a novel architecture along with concerned algorithm for the purpose of authentication issue in Grid computing environment.

Keywords— Grid, Virtual Organisation, Security, Authentication, Authenticator.

I. INTRODUCTION

Grid computing [1], being a promising way for distributed supercomputing from its very beginning attracts many attentions worldwide. The term *Grid Computing* originated in the early 1990s as a metaphor for making computer power as easy to access as an electric power grid in Ian Foster 's and Carl Kesselman 's seminal work, "The Grid: Blueprint for a new computing infrastructure" (2004). When talking about Grid Computing Environment, the question of a Common security issue arises in mind of experts or Grid users. In Grid computing users accesses the unused CPU-cycles & memory of the resources attached with that Grid using the Grid portals. The resources are generally dispersed world wide, within different silos, called Virtual Organisations. Lee et al [2] proposed a dynamic procedure by which a remote resource can be used with optimal effectiveness. Lee et al [3][4] also advised a dynamic analysing resources model that can retrieve the information about the CPU usages, number of running jobs at a particular span of time on each Grid node to know the load-balancing factor & according to this information reschedule the jobs, make the Grid much effective.

As like all other Computing environments, Grid computing is also affected by the curse of many security issues. A Computational Grid is a collection of heterogeneous computers and resources spread across multiple administrative domains with the intent of providing users easy access to these resources. There are many ways to access the resources of a Computational Grid, each with unique security requirements and implications for both the resource user and the resource provider. A comprehensive set of Grid usage scenarios is presented and analysed with regard to security requirements such as authentication, authorization, integrity, and confidentiality [5]. The main value of these scenarios and the associated security discussions is to provide a library of

situations against which an application designer can match, thereby facilitating security-aware application use and development from the initial stages of the application design and invocation. A broader goal of these scenarios is to increase the awareness of security issues in Grid Computing. A computational grid is a hardware and software infrastructure that provides dependable, consistent, pervasive, and inexpensive access to high-end computational capabilities.

II. THE SECURITY FRAMEWORK FOR A GRID SYSTEM

The Open Grid Services Architecture (OGSA)[6] uses WS-security services for authentication.

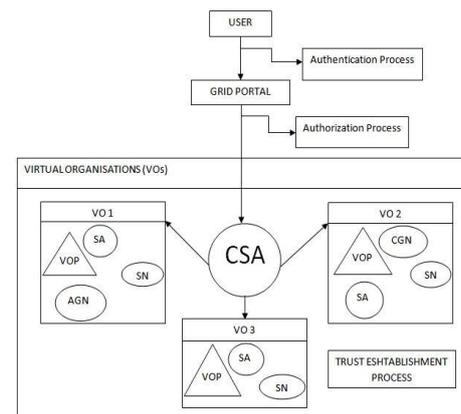


Fig: Block diagram of CACG.

The Control Architecture for Computational Grids (CACG) is shown above:

Acronyms used:

- CSA: CHIEF SECURITY ADMINISTRATOR
- SA: SECURITY ADVISOR
- SN: SECURITY NEGOTIATOR
- VOP: VIRTUAL ORGANIZATION POLICY
- AGN: ADMINISTRATOR GRID NODE
- CGN: COMPUTE GRID NODE

III. DESCRIPTION OF THE PROPOSED AUTHENTICATION SCHEME

To apply the proposed authentication scheme we have classified Grids into two distinct nodes, namely,

A. Administrator Grid Node (AGN) & B. Compute Grid Node (CGN). A user in CGN requests AGN to process the authenticator operation. After checking, AGN sends acknowledgement to CGN specifying whether the user can continue the process or not.

A. Administrator Grid Node (AGN)

To process the user's request AGN needs some tables & operations. To store user information & compare it with the Grid information, AGN needs one database, which is named as Data Base for Generating User Authenticator (DBGUA). The required tables are as follows:

Table: Receive Request: It is used to match the authenticator for the existing users.

Request Command	User-Id	Authenticator
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Table: DBGUA: It is used to store the authenticator (produced by the encryption algorithm) for each user.

User-Id	Authenticator
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Table: New User Request: This table is used to produce new authenticator for new users. The operation is called new user operation.

New	User-Id	Password	Authenticator
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Table: Update User Request: If any user sends update request to AGN for changing his authenticator, AGN uses different attributes to check for authenticator & then if the verification produces no error, it updates the existing authenticator of the user with a new one.

Up date	User -Id	Old Password	Old Authent icator	New Passw ord	New Authenticator
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Table: Delete User Request: If any user sends delete request to AGN for removing his authenticator, AGN uses different attributes to check for authenticator & then if the verification produces no error, it deletes the existing authenticator of the user.

Delete	User-Id	Password	Authenticator
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Table: User Permission Request: If any user needs to access his authenticator, it sends permission request to AGN for getting the chance for accessing.

Permission	User-Id	Password	Authenticator
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B. Compute Grid Node (CGN)

The user resides in the CGN sends requests to AGN for processing some operations. The acknowledgements received from the AGN are stored in the local database of CGN, namely Compute User Information Data Base (CUIDB).

Table: CUIDB:

User-Id	Authenticator
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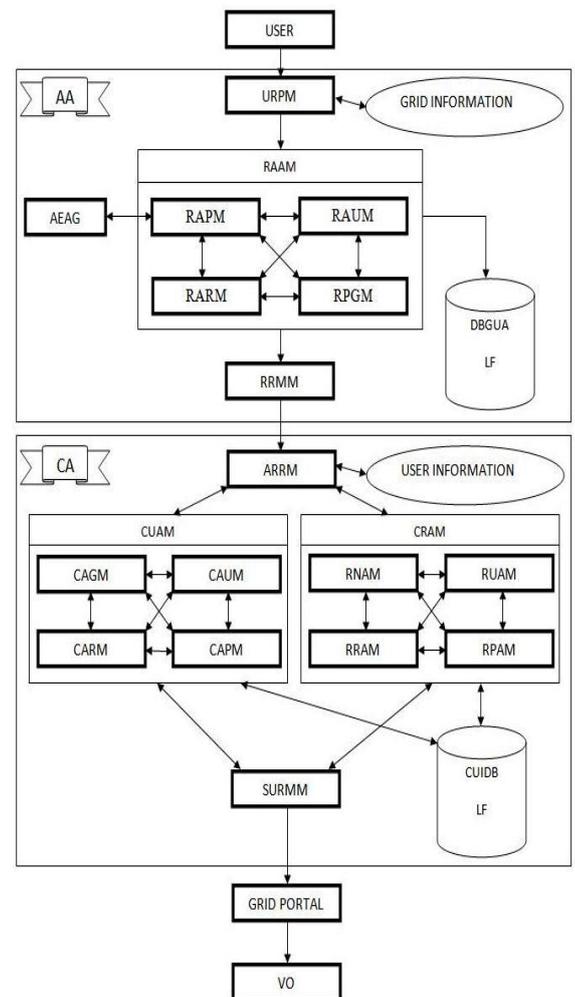


Fig: The Architecture of the proposed Authentication scheme:

IV. THE ARCHITECTURE FRAMEWORK OF THE PROPOSED AUTHENTICATION SCHEME

The acronyms used in the above figure, are described below:

AA: Administrative Authentication: The authentication process used in Administrator Grid Node.

CA: Compute Authentication: The authentication process used in Compute Grid Node.

URPM: User Request Process Module: It resides within AGN & processes the user requests from CGN using the following modules.

RAAM: Remote Authenticator Access Module: It helps user to request for accessing authenticator using the following sub modules.

RAPM: Remote Authenticator Producer Module: It produces authenticator for users. It calls **Authentication Encryption Algorithm Generator (AEAG)** to produce authenticator for a particular user.

RAUM: Remote Authenticator Updater Module: It updates the existing authenticators as per needs.

RARM: Remote Authenticator Remover Module: It deletes the corresponding authenticator if an authentic user wants to delete that.

RPGM: Remote Permission Granting Module: This module is used to provide permissions to access resources as per needs.

RRMM: Returning Result Message Module: It returns the result message to the CGN.

ARRM: Administrator Request Response Module: It returns the user's information as per the needs of AGN.

CUAM: Compute User Authentication Module: It has following four modules:

CAGM: Compute Authenticator Generate Module: It sends new user request to AGN to produce authenticator for the same.

CAUM: Compute Authenticator Update Module: It sends update request to AGN to update existing authenticator.

CARM: Compute Authenticator Remove Module: It sends delete request to AGN to delete existing authenticator.

CAPM: Compute Authenticator Permit Module: It sends permission request to AGN to get permission to access procedures & databases.

CRAM: Compute Receive Authentication Module: It also has the following four modules:

RNAM: Receive New Authenticator Module: It receives new authenticator produced by the new user request & sends it to be stored in the CUIDB.

RUAM: Receive Updated Authenticator Module: It receives the updated version of the existing authenticator.

RRAM: Receive Remove Authenticator Module: It receives the authenticator to be removed.

RPAM: Receive Permit Authenticator Module: It receives the authenticator who got the permission.

SURMM: Send User's Request Message Module: Finally the produced authenticator is sent to the Grid portal.

V. AUTHENTICATION ENCRYPTION ALGORITHM GENERATOR

Related Work: Lee et al presented one algorithm, where they solved some security issues. We, here will modify the

existing solution & will provide another solution for user authentication.

Concept: When a user enters his/her User-Id & Password, it comes as plain text; but for security reasons we will convert it into Cipher text. To do so, we must perform the following things:

1. Change the contents of plain text, 2. Network Transmission, 3. Position Exchange, 4. Data Uncertainty & 5. Produce Authenticator.

Modified Algorithm:

1. Change the contents of plain text:

Input: plaintext (PT) (User-Id=UI, Password=PW), input by the user.

Do: for N users,

Create a Symbol Table (ST) to store PT as $U_1P_1U_2P_2U_3P_3\dots U_NP_N$, where $N=U+P$,

For all $1 \leq i \leq N$,

Set a key of string by taking $KS=U_{i+1}P_{i+2}$ up to N times.

Convert each semantics of User-Id of user U_i into its BCD value.

Convert each semantics of user U_{i+1} into its BCD value.

Perform XOR operation as

$U_i'' = \acute{c}(U_i')$, where \acute{c} is the 1's complement operation, & U_i' is

defined as $U_i' = U_i + U_{i+1}$

Convert each U_i'' into its decimal value DU_i'' .

Get the Cipher value CU_i'' for the same as: $CU_i'' = D U_i'' \% 26$

Consider this CU_i'' value as the ASCII of a particular semantics. Replace this semantics with the previous one.

Repeat the same for Passwords to get CP_i'' .

End Do.

Output: The plaintext equivalent Cipher text.

2. Network Transmission:

For network transmission, we can use TFRC protocol [7], which stands for TCP Friendly Rate Control protocol. We use the following equation (as described by Y. Falik et al.) for transmission through the network:

$$DSR = \frac{K * PS}{D * \sqrt{PLR}}$$

Where, DSR = Data Streaming Rate,

K = Constant factor between .01 to 1.0 depending on the particular network used to transmit the data,

PS = Data Packet Size,

D = End-to-End Transmission Delay &

PLR = End-to-End Packet loss Rate.

Total Data Transmission Time (DTT) may be achieved by the following equation:

$$DTT = \frac{\text{Total amount of Data to be Transmitted}}{DSR}$$

3. Position Exchange:

To exchange the position of the elements in the Symbol Table we use Transposition properties & Permutation properties of Matrices along with each other as below:

We assume that the $N \times M$ matrix is stored in row-major order with zero-based indices. This means that the (n, m) element, for $n = 0, \dots, N-1$ and $m = 0, \dots, M-1$, is stored at an address $a = Mn + m$ (plus some offset in memory, which we ignore). In the transposed $M \times N$ matrix, the corresponding (m, n) element is stored at the address $a' = Nm + n$, again in row-major order. We define the *transposition permutation* to be the function $a' = P(a)$ such that:

$Nm + n = P(Mn + m)$ for all $(n, m) \in [0, N-1] \times [0, M-1]$
 This defines a permutation on the numbers $a = 0$ to $MN-1$.
 P can be defined as:

$$P(a) = \begin{cases} MN - 1 & \text{if } a = MN - 1, \\ Na \bmod MN - 1 & \text{otherwise,} \end{cases}$$

Where mod is the modulo operation [8].

Algorithm:

Case 1: (If Symbol Table is in the form of square matrix):

for $n = 0$ to $N - 2$
 for $m = n + 1$ to $N - 1$
 swap $A(n, m)$ with $A(m, n)$

Case 2: (If Symbol Table is in the form of non-square matrix):

for each length > 1 cycle C of the permutation
 pick a starting address s in C
 let $D = \text{data at } s$
 let $x = \text{predecessor of } s \text{ in the cycle}$
 while $x \neq s$
 move data from x to successor of x
 let $x = \text{predecessor of } x$
 move data from D to successor of s [8]

4. Data Uncertainty:

Data uncertainty refers to the discrepancy between data and the spatial characteristic represented by the data. It is the quantitative estimation of error present in the data. It is generated by either systematic error, or random error or statistical error. This uncertainty affects the reliability of applications using the data. Careful methodology can reduce uncertainty by correcting for systematic error and minimizing random error. However, uncertainty can never be reduced to zero. In Authentication, correlated uncertainty is generated because the User-Id & Password is dependent to each other. We will solve data uncertainty problem using cumulative joint probability distribution.

Case 1. If both the User-Id & Password are discrete random strings, we will use Probability Mass Function (PMF). So,

$$PMF(U=u \ \& \ P=p) = PMF(P=p|U=u).PMF(U=u) \\ = PMF(U=u|P=p).PMF(P=p)$$

According to the rules of probability, we can write,

$$\sum_u \sum_p PMF(U=u \ \& \ P=p) = 1$$

Case 2. If both the User-Id & Password are discrete random strings, we will use Probability Density Function (PDF). So,

$$PDF_{U \ P}(u, p) = f_{P|U}(p|u) f_U(u) \\ = f_{U|P}(u|p) f_P(p)$$

Again, according to the rules, we can write,

$$\int_U \int_P PDF_{U \ P}(u, p) \ du \ dp = 1$$

Error Correct Factor: If the probability factor becomes less than 1, the result will be feedback to the first step of the authentication process & will restart again.

5. Produce Authenticator:

An authenticator is a way to prove to a computer system that you really are who you are (called Authentication). The Authenticator is an object that knows how to obtain authentication for a network connection. Usually, it will do this by prompting the user for information. The algorithm is as follows:

Input: User-Id & Password.

Do: Get the hostname & host address of the Authentication Server or NULL if not available.
 Get the port number for the requested connection.
 Get the prompt string given by the requestor.
 Get the Authentication scheme for the connection.
 Set the protocol for the requested connection.

End Do.

Output: Generate the Authenticator for the current user who had entered User-Id & Password.

VI. CONCLUSION

Grid computing is basically a wide area distributed parallel computing environment. Although this computing technology has been accepted worldwide, but still it has got lot of problems mainly regarding with different security issues. In this paper, we have provided a high-level overview of security issues mainly concerned with authentication and presented an advanced architecture with algorithm for secure authentication process.

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