

# Role Based Access Right Specification for Secure Information Sharing\*

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## Abstract

In this paper we present an authorization system that allows an owner of a resource to decide who and how people from multiple agencies can access the resource. In this system authorization of access to resources in heterogeneous agencies controlled by administrator of individual agencies. We explore the issues involved with the access policy specification for such a large scale authorization system for information sharing using web server. We propose a new model for specification of the privilege rights in a large scale information sharing system, where resource behaviour is dynamic. The proposed model helps in easy role privilege specification for the four components of the RBAC model.

**Keywords:** Access Right Specification, Secure Information Sharing, Attribute Certificate.

## 1 Introduction

As the WWW is quickly becoming a place for sharing of information, piracy and misuse of information are becoming a real threat. Security and Authorization have become necessary. This situation not only provides excellent business opportunities but also posts research challenges. One of the most challenging problems is specification and manageability of authorization policies across the organization. Role-Based Access Control (RBAC) simplifies the access control administration and provides better manageability in enterprise environments by allowing permissions to be managed in terms of user job roles [7]. RBAC maps user job roles to application permissions so that the access control administration can be accomplished in terms of the job role of users. This means that administrators will have to set up and assign clients with roles, such as employee, supervisor, and manager, without having to change the access permission on each client.

Role based authorization policy specification is a critical task in managing an enterprise-wide information sharing system. This authorization policy specification must allow easy and flexible access control specification, as access control decisions are driven by an authorization policy. This authorization policy must be stored in a secure and untamperable format. IETF has proposed Attribute Certificates (AC) as a solution to store a potentially short-lived attributes rather than storing them in a Public Key Certificate (PKC). PKC strongly binds a public key to its subject (country, location, organization unit etc.) helping to identify the holder of the certificate, and cannot be used for holding the authorization policy. The attribute certificate points to a public-key certificate that can be used to authenticate the identity of the attribute certificate holder. The AC's can be used for storing the authorization policy [1, 5] associated with roles of the organization.

Authorization policy specification for users, where users can gain access to multiple information systems, creates administration and management challenges. Solutions to this problem of managing access to multiple applications, where each information system will maintain its own Access Control List(ACL) is currently available in many main-stream server operating systems like windows-2000, unix etc. The problem of authorization policy specification becomes complex especially if the users belong to multiple agencies and various information systems are involved. In this paper we present a framework for authorization policy specification where users belong to multiple agencies and various resources are involved.

The organization of this paper is as follows. Section 2 provides an overview of the related research. Section 3 describes the design of our authorization policy specification format. In Section 4 we present a case study for usage of authorization policy specification format. Conclusion of our privilege specification is presented in Section 5.

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## 2 Related Research Technologies

### 2.1 Role Based Access Control

Role-based access control [4, 10, 9, 12, 2] has gained attention as a proven alternative to traditional discretionary and mandatory access control mechanisms. RBAC helps specify organization's security policies reflecting its organizational structure. RBAC reference model and functional specification are organized into four components: Core RBAC, Hierarchical RBAC, Static Separation of Duty Relations (SSD), Dynamic Separation of Duty Relations (DSD).

In the core RBAC, a user can be assigned one or more roles, and a role can be assigned to one or more users. Roles are based on the user's job responsibilities in the organization. This provides for flexibility and finer granularity during the assignment of access permissions to roles and users to roles. In the hierarchal RBAC model, the role hierarchy partially determines which roles and permissions are available to users via inheritance. For example, a senior role can inherit permissions from junior roles. A user establishes a session during which he activates some subset of roles of which he is a member. SSD relations help in preventing conflict of interests, that arise when user gains permission associated with conflicting roles. DSD relations help to place constraints on roles that can be activated in the session of a user.

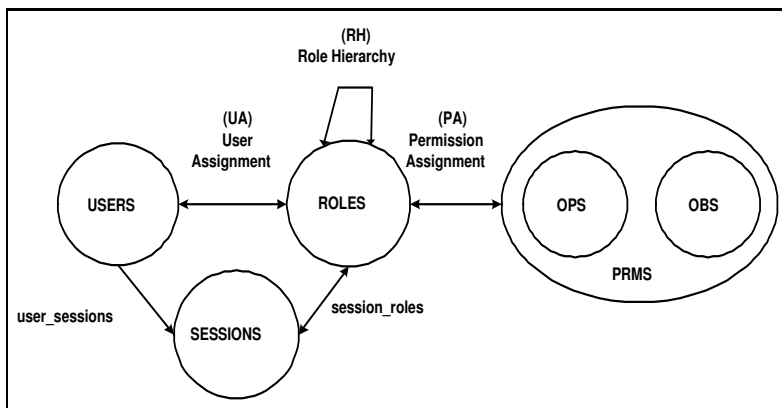


Figure 1: RBAC model[7]

The Core RBAC in Figure 1 consists of 1) a set of users (**USERS**) where a user is an intelligent autonomous agent, 2) a set of roles (**ROLES**) where a role is a job function, 3) a set of objects (**OBS**) where an object is an entity that contains or receives information, 4) a set of operations (**OPS**) where an operation is an executable image of a program, and 5) a set of permissions (**PRMS**) where a permission is an approval to perform an operation on objects. The cardinalities of the relationships are indicated by the absence (denoting one) or presence of arrows (denoting many) on the corresponding associations. For example, the association of user to session is one-to-many. All other associations shown in the figure are many-to-many. The association labeled Role Hierarchy defines the inheritance relationship among roles.

Further information about RBAC is available at [7].

### 2.2 eXtensible Access Control Markup Language

eXtensible Access Control Markup Language (XACML) is an XML based language that describes access control policy language and a request/response language. XACML is proposed by OASIS consortium and is currently in preliminary stages. XACML defines two entities: Policy Enforcement Point (PEP) and Policy Decision Point (PDP). Request for a resource is submitted to the PEP, which creates an XACML request based on attributes like subject, resource etc., and sends it to PDP. Policy Decision Point analyzes the request and retrieves policies that are applicable to this request, and determines whether access should be granted based on the XACML rules for evaluating policies. An XACML response is sent by the PDP to the PEP, which can then permit or deny access to the requester. Although XACML provides flexibility and expressiveness in specifying policies, it is very complex and cumbersome in specifying the policies [6]. XACML does not provide granularity in accessing resources, where the resource behaviour changes dynamically depending on the type of parameters passed to the resource.

Further information about XACML is available at [3].

## 2.3 Related work

Currently there are two authorization systems Akenti [11] and PERMIS that are closely related to our work. The focus of our work is towards multi-agency information sharing, while these models are currently being used for grid computing. Ours is the first work that focuses on the use of PKI, RBAC, PMI for information sharing where users belonging to multiple agencies can access information from various information systems. This system is based on the concepts of authentication, authorization, and access. There are two major differences between Akenti and our model. AC's used in Akenti are in a non-standard format while ours follow RFC-3281. The access control in Akenti is essentially a classical access control list (discretionary access controls) model, whereas our model implements role based access control. There is one major differences between PERMIS and our model. Our model requires the user to present an X.509 public key certificate at authentication time, whereas PERMIS is authentication agnostic and leaves it up to the application to determine what type of authentication to use.

## 3 Authorization Policy Specification

Organizational roles help in simplifying the management of privileges. These privileges can be expressed in a policy document that clearly specifies what privileges are needed by each role in the organization in order to carry out the duties required by that role. This policy document is called Authorization Policy, and is specified in terms of rights or privileges. We specify privileges for a resource using pre-conditions and consequences, where precondition is an expression which when evaluated to TRUE, consequence is evaluated. Consequence is evaluated to determine if the privilege needs to granted or not. This kind of privilege specification is not only simple and expressive but is also close to the human thought process.

Simplicity and expressiveness in the privilege specification are the major goals of our authorization policy in secure information sharing project. We identified four attributes that are required for role-based access privilege specification to allow fine grained access control for information sharing:

1. Resource Identifier: name or identity of the resource being requested. Each resource can have different privilege requirement and access to these resources can be restricted based on the user role privileges.
2. Finer resource granularity: resource behavior changes according to the type and number of parameters passed to the resource. For example, results of a query to a database table depends not only on the number of parameters being requested but also on the type of parameters being requested.
3. Privilege Validation Delegation: in a cooperative environment where information is shared between various organizations, privilege verification often involves checking for privileges with other organizations in order to process the resource request. This also helps to interact with external policy decision points for evaluating third party policy specification formats like xacml.
4. Role Hierarchy specification: this should allow for clear and precise specification of privilege(s) to avoid any conflict of interest privilege specification in and between the role(s).

Figure 2 shows the context free grammar of the privilege specification format in our SIS model. Privileges are expressed in a bunch of simple 'if' statements, where each statement allows any depth of parentheses. This gives the users maximum convenience in specifying privilege rules. In each rule the precedence of operators can be changed by using parentheses. The operator '#' is used for regular expression matching.

```
sisprivilegeset <role name> <privilegeset name>
{
  <privilege> := if ( <expression> ) do <action>
  <expression>:= <term> | <term> && <expression> | ( <expression> ) |
                ! ( <expression> )
  <term>      := <factor> | <factor> || <term> | ( <term> )
  <factor>    := <variable operator value>
  <operator>  := > | >= | < | <= | == | != | #
  <action>    := grantAccess | rejectAccess | acquirePrivileges
                <privilegeset Name> | contact <authroization server>
}
```

Figure 2: privilege specification format

*acquirePrivileges* is used to tell the authorization Policy enforcer to check the feature set against the privilege set specified by its privilegeset name. This kind of privilege specification is especially useful in situations where all or a subset of privileges are delegated by one user to another. It is also useful in specifying the mapping of role hierarchy to privilege's in an organization.

External Privilege validation is achieved through *contact* action of the privilege specification. *contact* action in the privilege specification makes the authorization policy enforcer to query external authorization policy enforcer specified by the *authorization server*. *grantAccess* and *rejectAccess* are used to grant and reject privileges.

The privilege rules can be categorized into a list identified by the 'privilegeset name'. Categorizing privileges into a set allows for clear specification of the privileges based on the type of resource being accessed. In addition to delegated privilege specification, it also helps in evaluation of only a subset of privileges rather than all the privileges associated with a role. If none of the privilege rules in the *privilegeset* match then resource request is rejected.

## 4 Multi-agency information sharing system overview

Our information system is designed to support RBAC using X.509 PKIs and ACs. The authentication is implemented by PKI, and the authorization is implemented by AC. Role information is stored in User Role Specification AC's. All the access control decisions are made based on authorization policies, which are stored in ACs. ACs and their corresponding PKIs are all stored in LDAP servers [8]. A simple RBAC policy for the role *assistant* in an organization is shown in Figure 4. He/She is given access to place an order using webpage *purchase.html*, and check their status using cgi-program *orderStatus.cgi*. The access privileges are specified in the privilegeset *employeeprivileges*.

```
sisprivilegeset employee employeeprivilege {
#permission to create a purchase order using purchase.html
if ( ( url # '*purchase.html' ) && ( requestAction # .get. ) ) do grantAccess
if ( ( url # '*purchase.html' ) && ( requestAction # .post. ) ) do grantAccess
:
#permission to check status of purchase orders,
if ( ( url # '*orderStatus.cgi' ) ) do acquirePrivileges queryPrivileges
:
}

sisprivilegeset employee queryPrivilege {
#permission to check status of purchase orders about cartridges
if ( ( parameter # 'cartridges' ) && ( numberOfParameters == 1 ) do grantAccess
:
:
}
```

Figure 3: privilege policyset specification for the role *employeeAssistant*

An SIS system consists of the following components:

- *Administration Tool*: is used for creating key pair, PKIs, User Role Specification ACs.
- *RBAC Policy file*: specify the roles and what privileges the role can have on the resources. Access control decisions are made based on these privileges. This information is stored in AC generated using administrative tool.
- *LDAP Server*: stores the user's information along with User Role Specification ACs and Delegated Role Specification AC's.
- *Access Control Decision and Enforcement*: executes the function of authorization and inform the target if the user has the privileges or not.
- *Resources*: they may be web servers, database servers, or any other format of resources.

Figure 3 shows the interaction of the various SIS components. The administrative tool generates X509 certificates and User Role Specification AC for the users participating in the secure information sharing service. The RBAC policy file passed to the administrative tool is used for embedding the policy information in the AC. The ACs generated by

the administrative tool are stored in the LDAP server along with other information about the user. The user X509 certificates are installed in the his/her client application. Access Control Decision and Enforcement (ACDE) engine makes sure that the user has the required authorization privileges to access the resource. The user needs to submit his/her X509 certificate to the ACDE in order to access a resource. The ACDE verifies the user X509 certificate, and queries the LDAP server for the user AC. If the user has the required privileges to access the resource, access permission is granted.

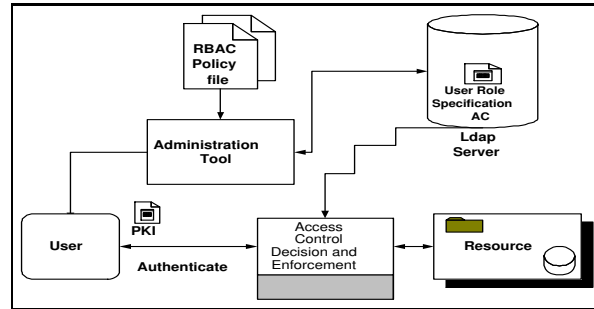


Figure 4: Interaction between various SIS components

## 5 Case Study

In order to illustrate the use of our privilege policy specification, the following scenario was considered: A web server is setup by each department in the university. Class Material and information about students like student-id, SSN, emergency contact number is available on the web and is maintained by the department in which student is majoring in. The student information is available through a web program called *displayStudentProfile.cgi* and the parameter is *updateStudentContactInformation* for updating their emergency contact information.

The following constraints are applied:

- Student can read all the tutorials on the web irrespective of the department he/she is enrolled in; also his/her personal information can be retrieved and modified.
- Department Assistant of departmentA needs to get student information to inform the student belonging to departmentB that he/she is allowed to take the course outside the students major.

The first constraint involves specification of the privileges required by the role student. The second constraint shows how additional privilege can be associated to a role in addition to the privileges required to carry out the duties associated with the role. The third constraint specifies how our role based privilege specification can be used in a distributed environment where cooperation of various organizations is mandatory to have a seamless interaction between them.

Figure 4, 5, and 6 shows the privileges associated with the roles of student, department chair and department assistant.

```
sisprivilegeset student filematch {
    if ( ( url # '*tutorial*' ) && ( requestAction # 'GET' ) ) do grantAccess
}

sisprivilegeset student cgimatch {
    if ( ( url # 'displayStudentProfile.cgi' ) &&
        ( parameter # 'updateStudentContactInfo*' ) ) do grantAccess
}
```

Figure 5: student privilege policyset specification file

```

sisprivilegeset departmentchair filematch {
    if ( ( url # '*tutorial*' ) ) do grantAccess
    if ( ( url # '*' ) ) do acquirePrivileges departmentchairprivileges
}

sisprivilegeset departmentchair cgimatch {
    if ( ( url # 'displayStudentProfile.cgi' ) && ! ( parameter # 'updateStudentContactInfo*' )
    && ( organizationalunit # 'departmentA' ) ) do grantAccess
    if ( ( url # '*' ) ) do acquirePrivileges departmentassistantprivileges
}

sisprivilegeset departmentchair departmentchairprivileges {
# web privileges required to carry out department chair duties
:
.
}

```

Figure 6: Department chair privilege policyset specification file

## 6 Conclusion

we have proposed a new privilege policy specification which is very powerful and flexible. we demonstrate privilege policy specification based on the user organization role can be used to create a secure information sharing environment. A simple case study is provided to show how our privileges specification format can be used to grant additional privileges to a role in addition to the privileges required to carry out the duties of the role.

```

sisprivilegeset departmentassistant filematch {
    if ( ( url # ‘order’ ) ) do grantAccess
    if ( ( url # ‘inventory*’ ) ) do grantAccess
    if ( ( url # ‘*’ ) ) do acquirePrivileges departmentassistantprivileges
}

sisprivilegeset departmentassistant cgimatch {
# contact other departments for information in case the student does not belong to departmentA
    if ( ! ( organizationalunit # ‘departmentA’ ) ) do contact departmentB departmentC
# display information about all students belonging to departmentA
    if ( ( url # ‘displayStudentProfile.cgi’ ) && ! ( parameter # ‘updateStudentContactInfo*’ )
    && ( organizationalunit # ‘departmentA’ ) ) do grantAccess
# acquire privileges that are needed to carry out department assistant duties
#that are general to all departments
    if ( ( url # ‘*’ ) ) do acquirePrivileges departmentassistantprivileges
}

sisprivilegeset departmentassistant departmentassistantprivileges {
# web privileges required to carry out department assistant duties
:
.
}

```

Figure 7: Department Assistant’s privilege policysset specification file

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