Using SAML and XACML for Complex Resource Provisioning in Grid based Applications

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Outline

- General Complex Resource Provisioning (CRP) model
- gJAF components to support dynamic security context management
- AuthZ ticket format for extended AuthZ session management
- XACML Obligations – Implementation suggestions
- Future developments
- Additional materials
  - AuthZ service mechanisms and components
  - XACML policy examples

Background for this research

- EU funded Phosphorus Project “Lambda User Controlled Infrastructure for European Research” (EC Contract number 034115)
- EU funded EGEE (Enabling Grid for E-sciencE) Project (Reg. INFSO-RI- 508833)
- University of Amsterdam SNE Group ongoing research on GAAA-AuthZ – Generic Authentication, Authorization, Accounting (GAAA) AuthZ Framework

Complex Resource Provisioning (CRP)

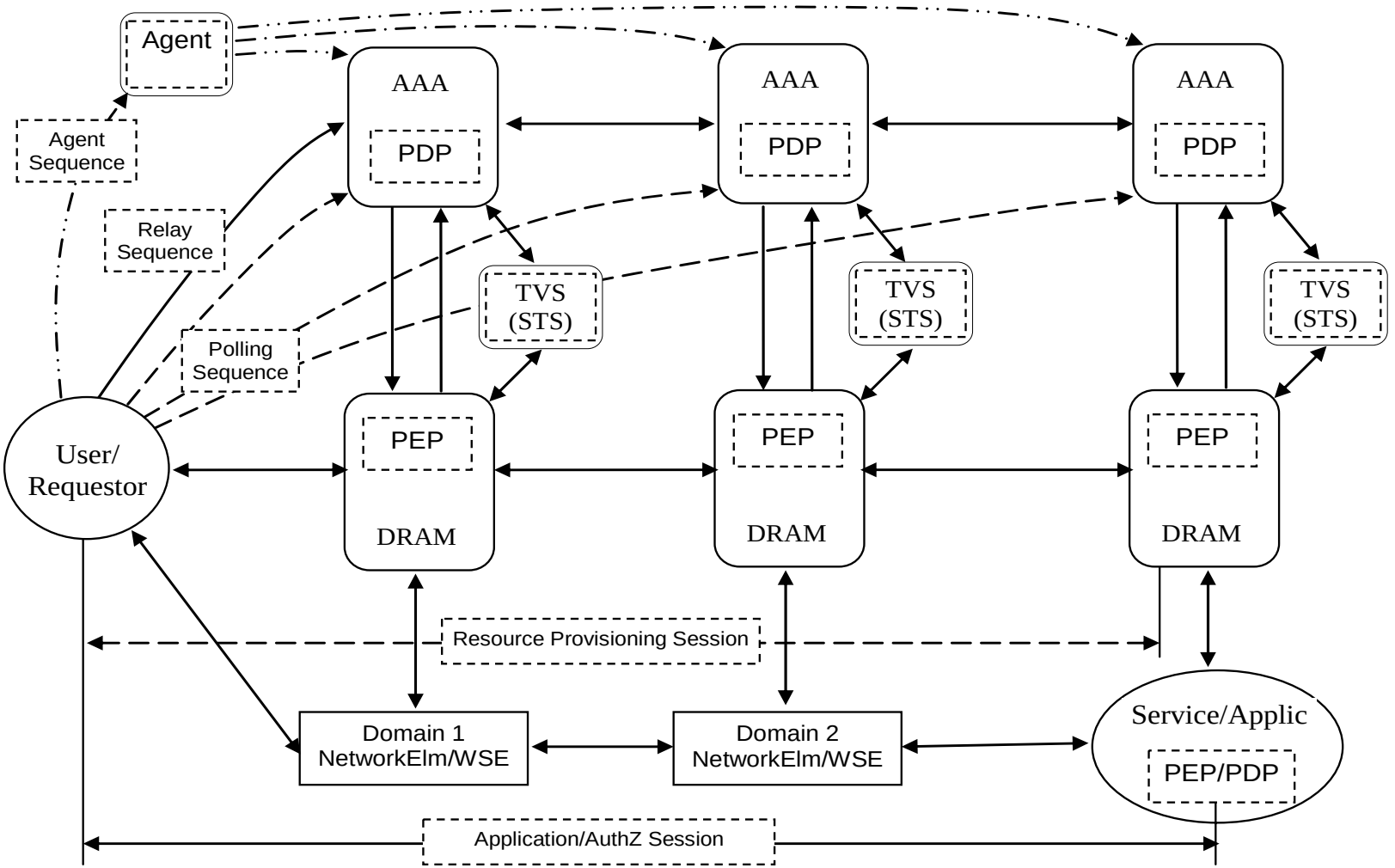
Basic use cases for CRP

- *OLPP and Network on-demand provisioning*
- *Virtual Laboratory - Hierarchical and distributed resources and user attributes*
- *Grid Computing Resource – Virtualised, distributed and heterogeneous*

2 major stages/phases in CRP operation

- *Provisioning stage consisting of 4 basic steps*
  - *Resource Lookup*
  - *Resource composition (including options)*
  - *Component resources reservation (reservation ID) including required AuthZ*
  - *Deployment*
- *Access (to the resource) or consumption (of the consumable resource)*
  - *Token Based Networking (TBN) reservation/AuthZ decision enforcement*

CRP/OLPP infrastructure elements and basic sequences



Provisioning sequences

* Polling
* Relay
* Agent

TVS – Token Validation Service

DRAM – Dynamic Resource Allocation and Mngnt

PDP – Policy Decision Point

PEP – Policy Enforcement Point

Required AAA/Service plane functionality for CRP/OLPP

Authentication and Identity management

- Federated Identity and Federated Resource Access
- Attribute management (issue, validation, mapping, delegation)

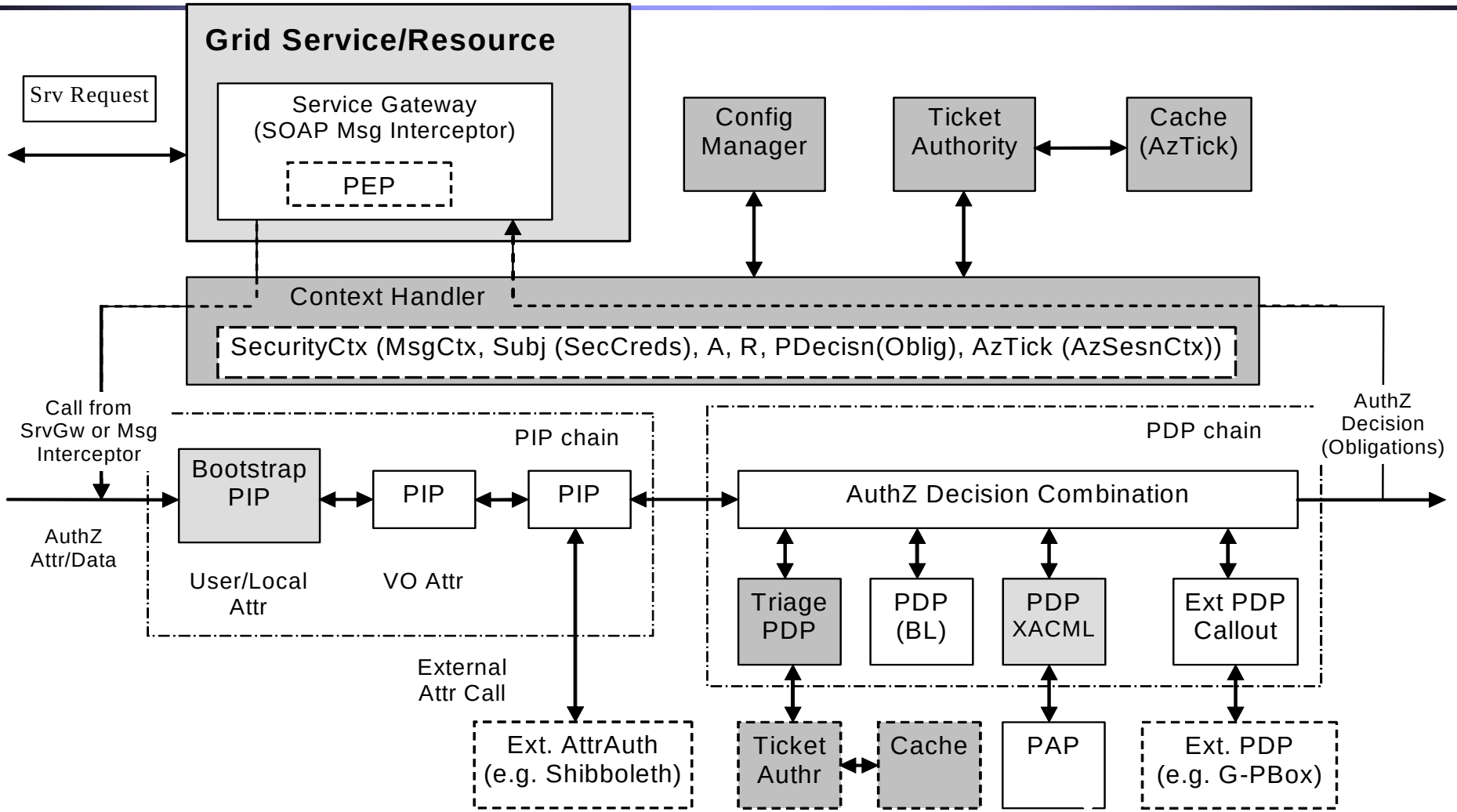
Authorisation

- Multidomain AuthZ policy and/or decisions combination
- AuthZ session Management to convey AuthZ decision between domains

Trust management

- User and Resource based Federations (Shibboleth, NREN/GN2 AAI, VO)
  - Pre-established trust relations
- Dynamic trust relations based on dynamic (session based) security associations
  - We distinguish Resource access dynamic security and static data/resource security
- Initial trusted introduction
  - Trusted Computing Platform (TCG) based hardware rooted trust anchors
  - DNSSEC based VO certificates publishing

gJAF (gLite Java AuthZ Framework) Extensions to support extended Security Context management



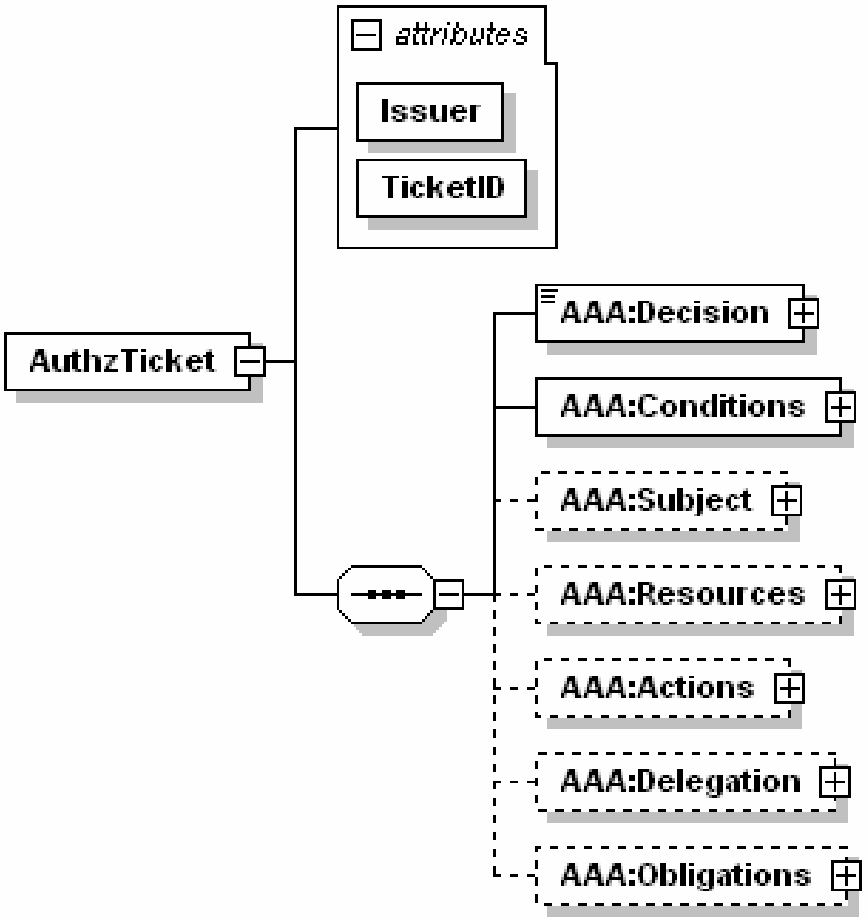
GAAAPI components to support dynamic security context management

- Context Handler (CtxHandler) that provides a container for all Security Context information including initial Request context and policy Obligations
- TriagePDP to provide an initial evaluation of the request against AuthZ ticket stored in Cache
  - Used also for flexible AuthZ session management
- Ticket Authority (TickAuth) generates and validates AuthZ tickets or tokens on the requests from TriagePDP or ContextHandler

AuthZ Session management in gLite/GAAA-AuthZ

- AuthZ session is a part of the generic RBAC and GAAA-AuthZ functionality
- Session can be started only by an authorised Subject/Role
  - Session can be joined by other less privileged users
  - Session permissions/credentials can be delegated to (subordinate) subjects
- Session context includes Request/Decision information and may include any other environment or process data/information
  - AuthZ Session context is communicated in a form of extended AuthZ Assertion or AuthZ Ticket
  - SessionID is included into AuthzTicket together with other AuthZ Ctx information
  - Signed AuthzTicket is cached by the Resource PEP or PDP
- If session is terminated, cached AuthzTicket is deleted from Cache
  - Note: AuthzTicket revocation should be done globally for the AuthZ trust domain

AuthZ ticket/assertion for extended security context management – Data model (1) - Top elements



Required functionality to support multidomain provisioning scenarios

- Allows easy mapping to SAML and XACML related elements

Allows multiple Attributes format (semantics, namespaces)

Establish and maintain Trust relations between domains

- Including Delegation

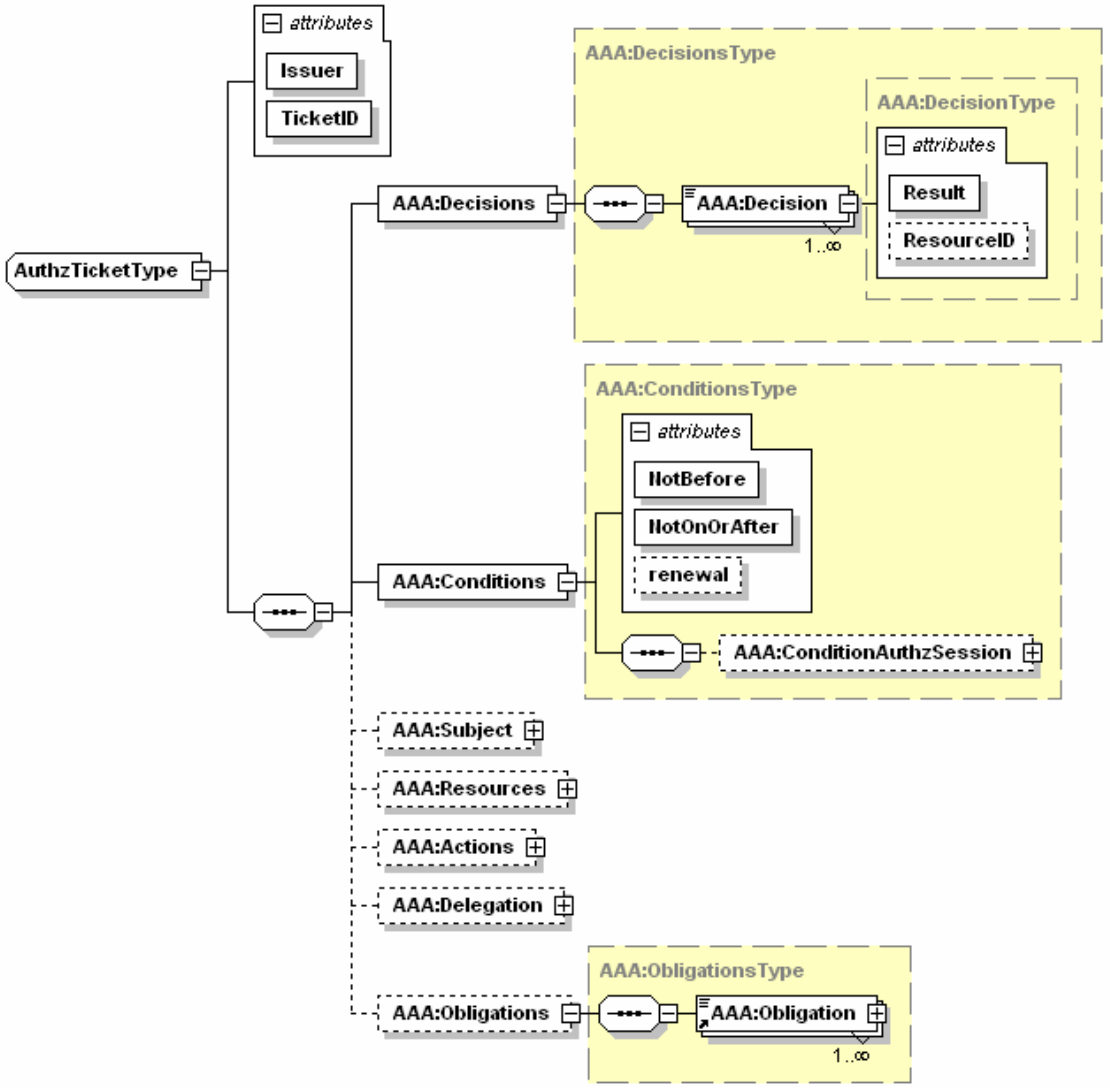
Ensure Integrity of the AuthZ decision

- Keeps AuthN/AuthZ context
- Allow Obligated Decisions (e.g. XACML)

Confidentiality

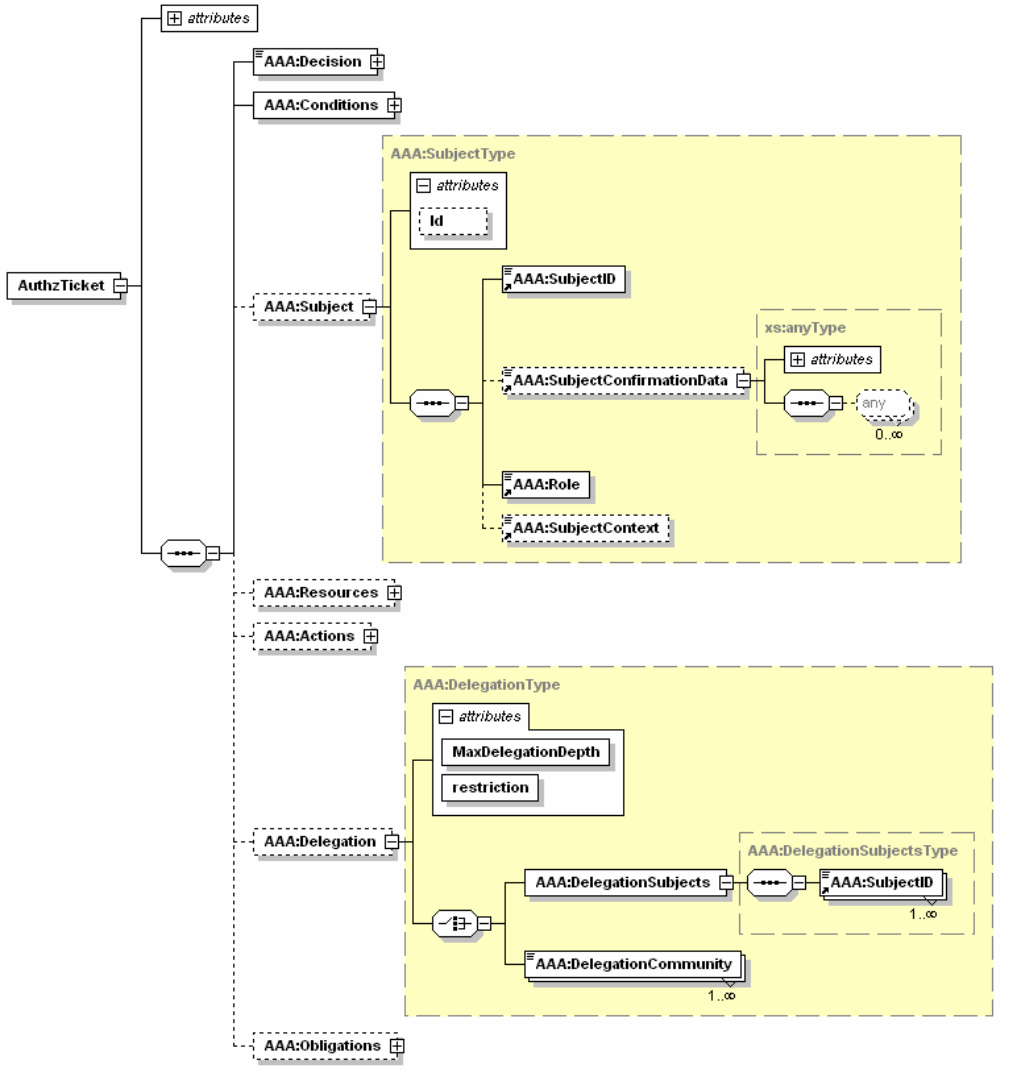
- Creates a basis for user-controlled Secure session

AuthZ ticket Data model (2) - Mandatory elements



- TicketID attribute
- Decisions element and ResourceID attribute
- Conditions Element and validity attributes
- Extensible element ConditionAuthzSession
  - Any AuthZ session related data

AuthZ ticket Data model (3) – Subject and Delegation elements



- Subject element to keep AuthN security context and Subject Attributes
- Delegation element to allow permissions/AuthZ decision delegation to other Subjects or groups/community

AuthZ ticket main elements

<Decision> element - holds the PDP AuthZ decision bound to the requested resource or service expressed as the ResourceID attribute.

<Conditions> element - specifies the validity constrains for the ticket, including validity time and AuthZ session identification and additionally context

<ConditionAuthzSession> (extendable) - holds AuthZ session context

<Subject> complex element - contains all information related to the authenticated Subject who obtained permission to do the actions

<Role> - holds subject's capbilities

<SubjectConfirmationData> - typically holds AuthN context

<SubjectContext> (extendable) - provides additional security or session related information, e.g. Subject's VO, project, or federation.

<Resources>/<Resource> - contains resources list, access to which is granted by the ticket

<Actions>/<Action> complex element - contains actions which are permitted for the Subject or its delegates

<Delegation> element – defines who the permission and/or capability are delegated to: another DelegationSubjects or DelegationCommunity

- attributes define restriction on type and depth of delegation

<Obligations>/<Obligation> element - holds obligations that PEP/Resource should perform in conjunction with the current PDP decision.

AuthZ ticket format (proprietary) for extended security context management

```
<AAA:AuthzTicket xmlns:AAA="http://www.aaauthreach.org/ns/#AAA" Issuer="urn:cnl:trust:tickauth:pep"
    TicketID="cba06d1a9df148cf4200ef8f3e4fd2b3">
  <AAA:Decision ResourceID="http://resources.collaboratory.nl/Philips_XPS1">Permit</AAA:Decision>
    <!-- SAML mapping: <AuthorizationDecisionStatement Decision="*" Resource="*"> -->
  <AAA:Actions>
    <AAA:Action>cnl:actions:CtrlInstr</AAA:Action>     <!-- SAML mapping: <Action> -->
    <AAA:Action>cnl:actions:CtrlExper</AAA:Action>
  </AAA:Actions>
  <AAA:Subject Id="subject">
    <AAA:SubjectID>WHO740@users.collaboratory.nl</AAA:SubjectID>    <!-- SAML mapping: <Subject>/<NameIdentifier> -->
    <AAA:SubjectConfirmationData>IGhA11vwa8YQomTgB9Ege9JRNnld84AggaDkOb5WW4U=</AAA:SubjectConfirmationData>
     <!-- SAML mapping:  EXTENDED <SubjectConfirmationData/> -->
    <AAA:Role>analyst</AAA:Role>
     <!-- SAML mapping:  <Evidence>/<Assertion>/<AttributeStatement>/<Assertion>/<Attribute>/<AttributeValue> -->
    <AAA:SubjectContext>CNL2-XPS1-2005-02-02</AAA:SubjectContext>
     <!-- SAML mapping: <Evidence>/<Assertion>/<AttributeStatement>/<Assertion>/<Attribute>/<AttributeValue> -->
  </AAA:Subject>
  <AAA:Delegation MaxDelegationDepth="3" restriction="subjects">
    <!-- SAML mapping:  LIMITED <AudienceRestrictionCondition> (SAML1.1), or <ProxyRestriction>/<Audience> (SAML2.0)  -->
    <AAA:DelegationSubjects> <AAA:SubjectID>team-member-2</AAA:SubjectID> </AAA:DelegationSubjects>
  </AAA:Delegation>
  <AAA:Conditions NotBefore="2006-06-08T12:59:29.912Z" NotOnOrAfter="2006-06-09T12:59:29.912Z" renewal="no">
    <!-- SAML mapping: <Conditions NotBefore="*" NotOnOrAfter="*"> -->
    <AAA:ConditionAuthzSession PolicyRef="PolicyRef-GAAA-RBAC-test001" SessionID="JobXPS1-2006-001">
     <!-- SAML mapping: EXTENDED <SAMLConditionAuthzSession PolicyRef="*" SessionID="*"> -->
      <AAA:SessionData>put-session-data-Ctx-here</AAA:SessionData>  <!-- SAML EXTENDED: <SessionData/> -->
    </AAA:ConditionAuthzSession>
  </AAA:Conditions>
  <AAA:Obligations>
    <AAA:Obligation>put-policy-obligation(2)-here</AAA:Obligation>  <!-- SAML EXTENDED: <Advice>/<PolicyObligation> -->
    <AAA:Obligation>put-policy-obligation(1)-here</AAA:Obligation>
  </AAA:Obligations>
</AAA:AuthzTicket>
<ds:Signature> <ds:SignedInfo/> <ds:SignatureValue>e4E27kNwEXoVdnXIBpGVjpaBGVY71Nypos...</ds:SignatureValue></ds:Signature>
```

AuthzToken example – 293 bytes

```
<AAA:AuthzToken TokenID="c24d2c7dba476041b7853e63689193ad">
<AAA:TokenValue>
0IZt9WsJT6an+tIxhhTPtiztDpZ+iynx7K7X2Cxd2iBwCUTQ0n61Szv81DKllWsq75IsHfusnm56
zT3fhKU1zEUsob7p6oMLM7hb42+vjfvNeJu2roknhIDzruMrr6hMDsIfaotURepu7QCT0sADm9If
X89Et55EkSE9oE9qBD8=
</AAA:TokenValue>
</AAA:AuthzToken>
```

AuthzToken is constructed of the AuthzTicket TicketID and SignatureValue

AuthzToken use suggests caching AuthzTicket's

XACML Obligations - Definition

Obligations semantics is not defined in the XACML policy language but left to bilateral agreement between a PAP and the PEP

PEPs that conform with XACMLv2.0 are required to deny access unless they understand and can discharge all of the <Obligations> elements associated with the applicable policy

Element <Obligations> / <Obligation>

- The <Obligation> element SHALL contain an ***identifier*** (in the form of URI) for the obligation and a set of attributes that form arguments of the action defined by the obligation. The FulfillOn attribute SHALL indicate the effect for which this obligation must be fulfilled by the PEP.

```
<xs:element name="Obligation" type="xacml:ObligationType"/>
<xs:complexType name="ObligationType">
  <xs:sequence>
    <xs:element ref="xacml:AttributeAssignment" minOccurs=”0”
      maxOccurs="unbounded"/>
  </xs:sequence>
  <xs:attribute name="ObligationId" type="xs:anyURI” use="required"/>
  <xs:attribute name="FulfillOn" type="xacml:EffectType"
    use="required"/>
</xs:complexType>
```

XACML Obligations – Examples of expression for pool account mapping in Grid

```
<Obligations>
<Obligation ObligationId="http://glite.egee.org/JRA1/Authz/XACML/obligation/map.poolaccount"
    FulfillOn="Permit">
<AttributeAssignment AttributeId="urn:oasis:names:tc:xacml:2.0:example:attribute:text"
    DataType="http://www.w3.org/2001/XMLSchema#string">
     &lt;SubjectAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:subject:subject-id"
     DataType="http://www.w3.org/2001/XMLSchema#string"/&gt;
</AttributeAssignment>

<AttributeAssignment AttributeId="urn:oasis:names:tc:xacml:2.0:example:attribute:mapto"
    DataType="http://www.w3.org/2001/XMLSchema#string">
     &lt;UnixId DataType="http://www.w3.org/2001/XMLSchema#string"&gt;okoeroo&gt;UnixId&gt;
     &lt; GroupPrimary DataType="http://www.w3.org/2001/XMLSchema#string"&gt;computergroup&gt;GroupPrimary&gt;
     &lt;GroupSecondary DataType="http://www.w3.org/2001/XMLSchema#string"&gt;datagroup&gt;GroupSecondary&gt;
</AttributeAssignment>

<AttributeAssignment AttributeId="urn:oasis:names:tc:xacml:2.0:example:attribute:poolaccount"
    DataType="http://www.w3.org/2001/XMLSchema#string">
&lt;PoolAccountDesignator AttributeId="http://glite.egee.org/JRA1/Authz/XACML/obligation/poolaccount”
UnixId="okoeroo" GroupPrimary="computergroup" GroupSecondary="datagroup"
DataType="http://www.w3.org/2001/XMLSchema#string"/&gt;
</AttributeAssignment>

<AttributeAssignment AttributeId="urn:oasis:names:tc:xacml:2.0:example:attribute:text"
    DataType="http://www.w3.org/2001/XMLSchema#string">
     &lt;AttributeSelector
     GridMapPath="//gmap:/uid/gmap:primay/gmap:secondary"
     DataType="http://www.w3.org/2001/XMLSchema#string"/&gt ;
</AttributeAssignment>

</Obligation>
</Obligations>
```

XACML Obligations – Implementation suggestions

Obligation handling model proposed in the process of interoperability workshop between GT, OSG and EGEE

- ObligationId (of type URI) has to be mapped to a specific handler that is called by the PEP
- Obligation parameter values are passed to handler
- Handler returns True/False determines PEP's Permit/Deny
- Possible standardization
  - Obligations semantics and interface for passing obligation parameters to the Handler
  - Add Chronicle {before, at, after} attribute to indicate when Obligations should be applied by PEP and Resource

Future developments

- Implement AuthZ session management using AuthZ ticket for popular AuthZ frameworks gJAF, GT-AuthZ, GAAA-AuthZ
  - Including delegation and complex and obligated policy decisions
  - Needs more discussion on Delegation use cases and scenarios
- Defining XACML policy profiles and mapping
  - For other legacy policy formats: gridmap, ACL, GACL
  - For different Resource models (hierarchical, ordered, mesh, etc.)
- Standardisation and other initiatives
  - Proposing AuthZ session management framework to OGSA-AUTHZ
  - Site Central AuthZ Service using SAML-XACML protocol and assertion
  - Defining Policy Repository Service (PRS) protocol

Additional information

- Generic AuthZ service components and mechanisms
- Simple XACML policy example for Collaborative application

Generic AuthZ Components and Mechanisms

- An "authorization" is a process by which a right or a permission is granted to an entity/subject to access a resource.
- AuthZ Service Components
  - Subject (ID, Attrs), Policy (Locality/Environment), Resource/Object (State)
- AuthZ service interoperation and compatibility
  - The same AuthZ decision on the same set of Subject attributes based on the same Resource state
    - May contain Conditions/Obligations implied by the Policy decision
  - *Example 1: The same tour booked via different tourist offices (even if in different countries)*
- Basic mechanisms for interoperability
  - Credentials/Attributes validation/mapping
  - AuthZ decision assertions or tickets (usually bound to AuthZ session)
  - Authority binding (to convey trust relations)
    - All credentials and policy should match authority/issuer

AuthZ Models and Frameworks

AuthZ service component models

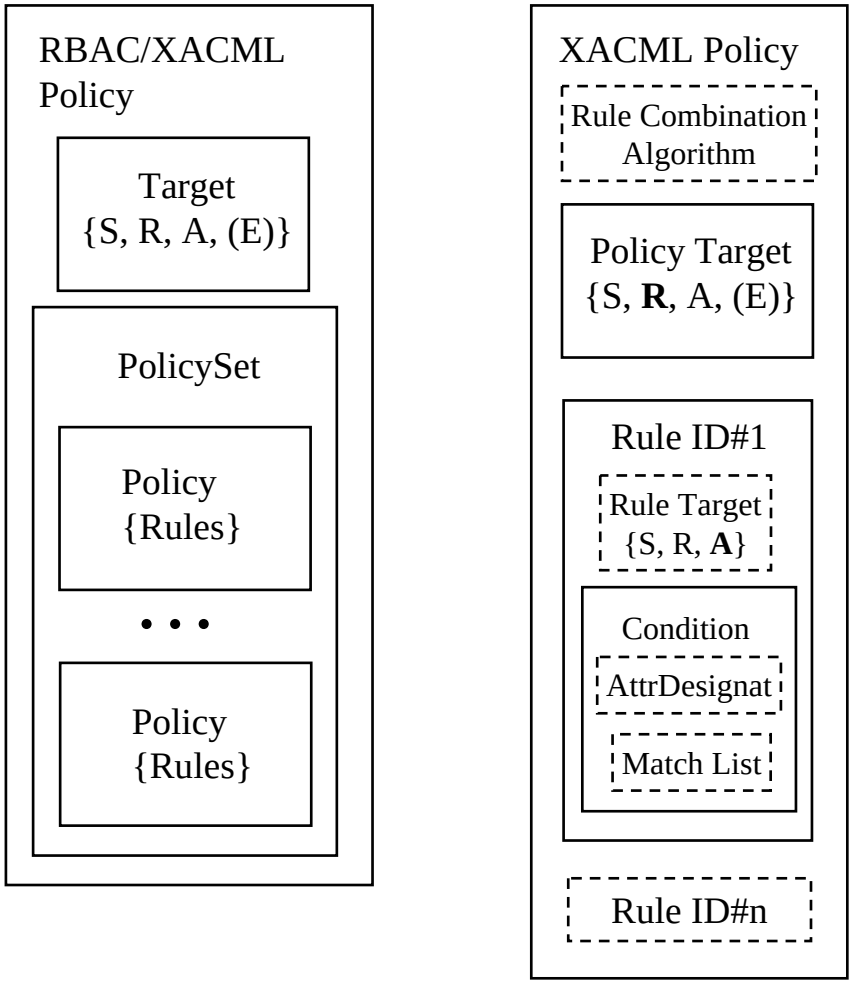
- User/AuthZ session and attributes management – RBAC, ITU/ISO X.812 PMI, GAAA-AuthZ, AAI, Shibboleth
- Application integration – Interceptor/Axis model (gJAF, GT4-AuthZ, Acegi), generic AAA-API
- Policy type – BlackList, ACL, gridmap, XACML, PERMIS
- Credentials/Attributes – X.509 AC/VOMS , SAML, Shibboleth

Existing AuthZ frameworks

- EGEE gLite Java AuthZ Framework and Globus GT-AuthZ
- LCAS/LCMAPS
- PERMIS
- GAAA-AuthZ (by UvA)
- COPS (Common Open Policy Service) – RFC2748, RFC2753, RFC3761
- Acegi (for J2EE/Spring)
- Shibboleth, Liberty and A-Select based AAI

XACML Policy structure

XACML Policy format



CNL AuthZ policy: XACML Policy generation conventions

- Policy Target is defined for the Resource
- Policy combination algorithm is “ordered-deny-override” or “deny-override”
- Rule Target is defined for the Action and may include Environment checking
  - Rule’s Condition provides matching of roles which are allowed to perform the Action
- Access rules evaluation
  - Rules are expressed as permissions to perform an action against Subject role
  - Rule combination algorithm “permit-override”
  - Rules effect is “Permit”
- Subject and Credentials validation – is not supported by current XACML functionality
  - Credential Validation Service (CVS) – proposed GGF-AuthZ WG development

RBAC AuthZ policy: Resource, Actions, Subject, Roles

Actions (8)

- StartSession
- StopSession
- JoinSession
- ControlExperiment
- ControlInstrument
- ViewExperiment
- ViewArchive
- AdminTask

Roles (4)

- Analyst
- Customer
- Guest
- Administrator
- (CertifiedAnalyst)

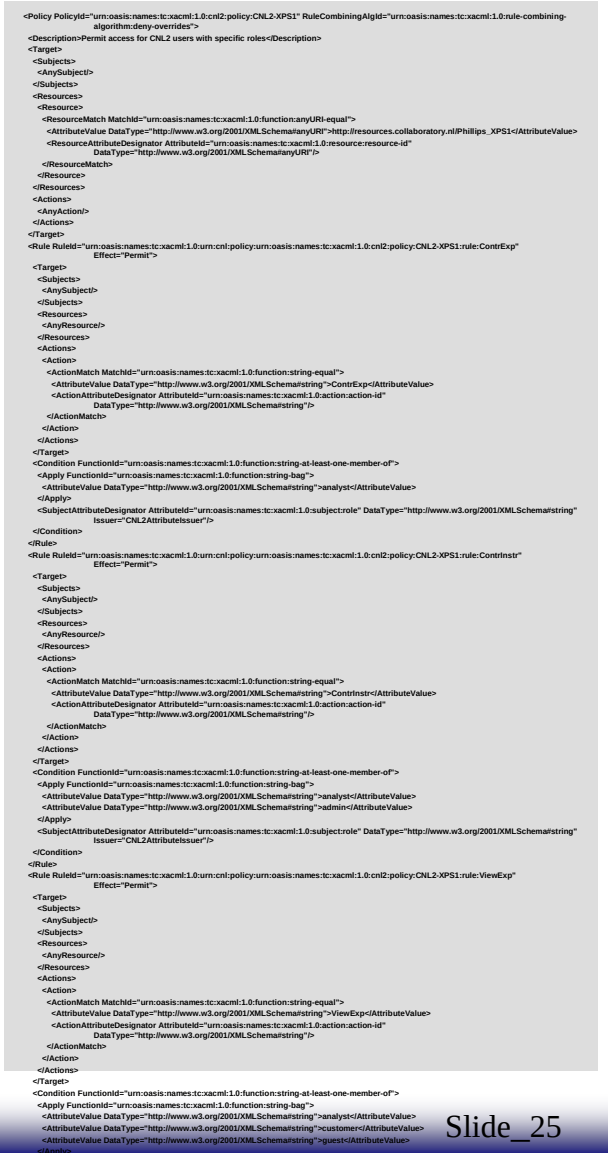
Naming convention

- Resource - “http://resources.collaboratory.nl/Phillips_XPS1”
- Subject – “WHO740@users.collaboratory.nl”
- Roles - “role“ or “role@ExperimentID”

Simple Access Control table

Roles	Anlyst	Custm	Guest	Admin
ContrExp	1	0	0	0
ContrInstr	1	0	0	1
ViewExp	1	1	1	0
ViewArch	1	1	0	1
AdminTsk	0	0	0	1
StartSession	1	0	0	0
StopSession	1	0	0	1
JoinSession	1	1	1	0

See XACML policy example =>



```
<Policy PolicyId="urn:oasis:names:tc:xacml:1.0:cnl2:policy:CNL2-XPS1" RuleCombiningAlgId="urn:oasis:names:tc:xacml:1.0:rule-combining-
                algorithm:deny-overrides">
 <Description>Permit access for CNL2 users with specific roles</Description>
 <Target>
  <Subjects>
   <AnySubject/>
  </Subjects>
  <Resources>
   <Resource>
    <ResourceMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:anyURI-equal">
     <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#anyURI">http://resources.collaboratory.nl/Phillips_XPS1</AttributeValue>
     <ResourceAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:resource:resource-id"
                DataType="http://www.w3.org/2001/XMLSchema#anyURI"/>
    </ResourceMatch>
   </Resource>
  </Resources>
  <Actions>
   <AnyAction/>
  </Actions>
 </Target>
 <Rule RuleId="urn:oasis:names:tc:xacml:1.0:urn:cnl:policy:urn:oasis:names:tc:xacml:1.0:cnl2:policy:CNL2-XPS1:rule:ContrExp"
                Effect="Permit">
  <Target>
   <Subjects>
    <AnySubject/>
   </Subjects>
   <Resources>
    <AnyResource/>
   </Resources>
   <Actions>
    <Action>
     <ActionMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
      <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">ContrExp</AttributeValue>
      <ActionAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:action:action-id"
                DataType="http://www.w3.org/2001/XMLSchema#string"/>
     </ActionMatch>
    </Action>
   </Actions>
  </Target>
  <Condition FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-at-least-one-member-of">
   <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-bag">
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">analyst</AttributeValue>
   </Apply>
   <SubjectAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:subject:role" DataType="http://www.w3.org/2001/XMLSchema#string"
                Issuer="CNL2AttributeIssuer"/>
  </Condition>
 </Rule>
 <Rule RuleId="urn:oasis:names:tc:xacml:1.0:urn:cnl:policy:urn:oasis:names:tc:xacml:1.0:cnl2:policy:CNL2-XPS1:rule:ContrInstr"
                Effect="Permit">
  <Target>
   <Subjects>
    <AnySubject/>
   </Subjects>
   <Resources>
    <AnyResource/>
   </Resources>
   <Actions>
    <Action>
     <ActionMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
      <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">ContrInstr</AttributeValue>
      <ActionAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:action:action-id"
                DataType="http://www.w3.org/2001/XMLSchema#string"/>
     </ActionMatch>
    </Action>
   </Actions>
  </Target>
  <Condition FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-at-least-one-member-of">
   <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-bag">
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">analyst</AttributeValue>
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">admin</AttributeValue>
   </Apply>
   <SubjectAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:subject:role" DataType="http://www.w3.org/2001/XMLSchema#string"
                Issuer="CNL2AttributeIssuer"/>
  </Condition>
 </Rule>
 <Rule RuleId="urn:oasis:names:tc:xacml:1.0:urn:cnl:policy:urn:oasis:names:tc:xacml:1.0:cnl2:policy:CNL2-XPS1:rule:ViewExp"
                Effect="Permit">
  <Target>
   <Subjects>
    <AnySubject/>
   </Subjects>
   <Resources>
    <AnyResource/>
   </Resources>
   <Actions>
    <Action>
     <ActionMatch MatchId="urn:oasis:names:tc:xacml:1.0:function:string-equal">
      <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">ViewExp</AttributeValue>
      <ActionAttributeDesignator AttributeId="urn:oasis:names:tc:xacml:1.0:action:action-id"
                DataType="http://www.w3.org/2001/XMLSchema#string"/>
     </ActionMatch>
    </Action>
   </Actions>
  </Target>
  <Condition FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-at-least-one-member-of">
   <Apply FunctionId="urn:oasis:names:tc:xacml:1.0:function:string-bag">
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">analyst</AttributeValue>
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">customer</AttributeValue>
    <AttributeValue DataType="http://www.w3.org/2001/XMLSchema#string">guest</AttributeValue>
   </Apply>
```