

Figure 1: The functional role hierarchy and accessed system resources at each level.

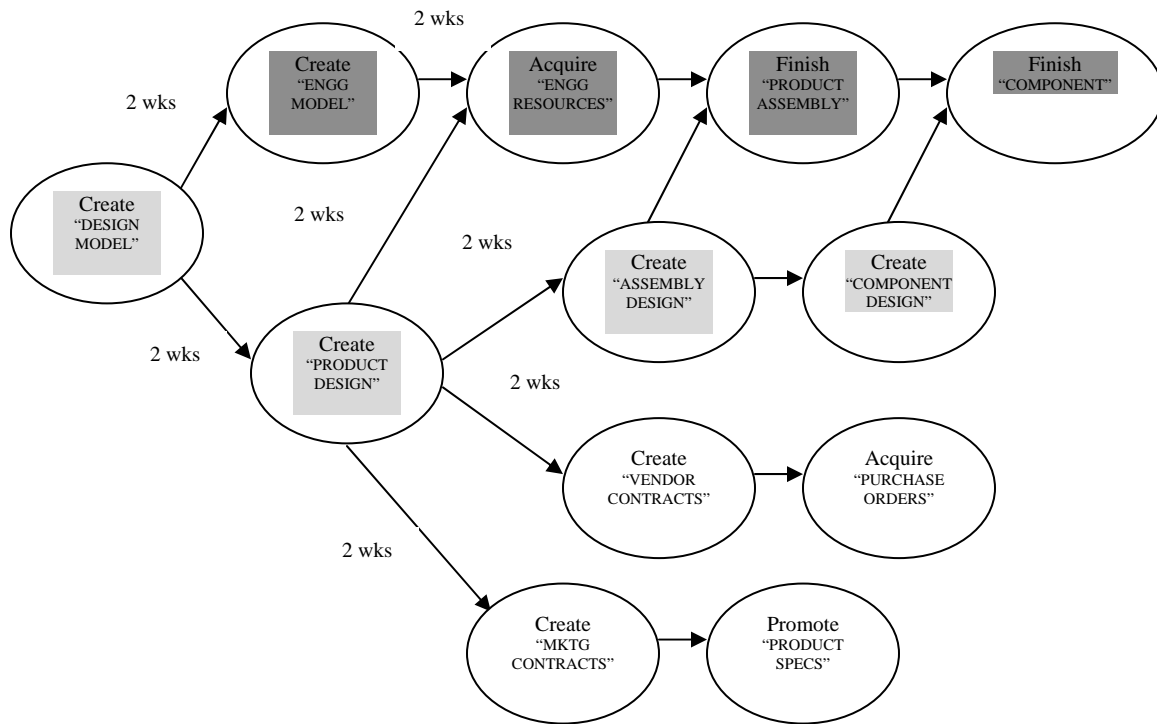


Figure 2: The DAG representing the execution time-frame for a project within the CIE.

**Table 1:**  
A subset of constraints derived from the role hierarchy and DAG for the CIE

#	Constraint Type	Role	Constraint Description
1.	Enabling	Design Manager	Is enabled only starting 1 <sup>st</sup> week of every quarter of year 2003
2.	Activation	Design Manager	May be activated only by one user at a time
3.	Enabling	Engg Manager	Is enabled only : (i) starting 3 <sup>rd</sup> week of every quarter of year 2003, and (ii) if Design Manager role is enabled
4.	Activation	Engg Manager	May be activated only if Design Manager role is activated
5.	Enabling	Product Designer	Is enabled only: (i) starting 3 <sup>rd</sup> week of every quarter of year 2003, and (ii) if Design Manager role is enabled
6.	Activation	Product Designer	May be activated only if Design Manager role is activated
7.	Enabling	Product Engineer	Is enabled only: (i) starting 5 <sup>th</sup> week of every quarter of year 2003, and (ii) if Product Designer AND Engg Manager role is enabled
8.	Activation	Product Engineer	May be activated only if Product Designer AND Engg Manager role is activated
9.	Enabling	Purchase Manager / Marketing Manager	Is enabled only: (i) starting 5 <sup>th</sup> week of every quarter of year 2003, and (ii) if Product Designer role is enabled
10.	Activation	Purchase Manager / Marketing Manager	May be activated only if Product Designer role is activated
11.	Static Separation of Duty (SSoD)	Purchase Manager and Marketing Manager	Both these roles may not be assigned to the same user at any given time
12.	Dynamic Separation of Duty (DSoD)	Product Designer and Product Engineer	Both these roles may not be simultaneously active in the same session by the same user
13.	Trigger	All roles	All active roles are de-activated at the start of 8 <sup>th</sup> week of every quarter of year 2003

Table 2: A subset of users and associated credentials for the CIE

#	User Id	Credential Type	Credential Expression
1.	john	Product Designer	age=39, level=B, qualification=MS
2.	nancy	Product Engineer	age=36, experience=15, qualification=MS
3.	george	Assembly Designer Product Supervisor	age=29, level=D, experience=5, qualification =BS
4.	carla	Product Supervisor	age=28, experience=5, qualification =BS
5.	smith	Procurement Officer	age=32, level=B, region=northeast
5.	dorothy	Procurement Officer Marketing Supervisor	age=34, level=C, experience=20, region=midwest

Table 3: A subset of role assignments in the CIE

#	Role	User Id	Credential Type	Assignment Condition
1	Design Manager	john	Product Designer	age>35 or level=A, qualification=PhD
2	Engg Manager	nancy	Product Engineer	age>35 or experience>10, qualification=MS
3	Product Designer	george	Assembly Designer	age>20 or level=B, qualification =BS
4	Product Engineer	george carla	Product Supervisor	age>20 or experience =5, qualification =BS
5	Purchase Manager	smith dorothy	Procurement Officer	age>30 or level=B, region=midwest
6	Marketing Manager	dorothy	Marketing Supervisor	age>30 or experience>10, region=midwest

Table 4: A subset of available permissions in the CIE

#	Permission ID	Object ID	Object Type	Allowed Operation
1.	P1	Design Model	Document	All
2.	P2	Design Model	Document	Read
3.	P3	Engg Model	Document	All
4.	P4	Engg Model	Document	Read
5.	P5	Product Design	Document	All
6.	P6	Product Design	Document	Read
7.	P7	Engg Resources	Material Equipment	Operate
8.	P8	Vendor Contracts	Document	All
9.	P9	Marketing Contracts	Document	All

Table 5: A subset of permission assignments in the CIE

#	Role	Permission ID	Assignment Condition
1.	Design Manager	P1	Is assigned starting 1 <sup>st</sup> week of every quarter of year 2003 for 6 weeks
2.	Engg Manager	P2 P3	Is assigned starting 3 <sup>rd</sup> week of every quarter of year 2003 for 2 weeks Is assigned starting 3 <sup>rd</sup> week of every quarter of year 2003 for 4 weeks
3.	Product Designer	P2 P5	Is assigned starting 3 <sup>rd</sup> week of every quarter of year 2003 for 4 weeks Is assigned starting 3 <sup>rd</sup> week of every quarter of year 2003 for 4 weeks
4.	Product Engineer	P4 P6 P7	Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 2 weeks Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 1 week Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 2 weeks
5.	Purchase Manager	P2 P8	Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 1 week Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 2 weeks
6.	Marketing Manager	P2 P9	Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 1 week Is assigned starting 5 <sup>th</sup> week of every quarter of year 2003 for 2 weeks

Table 6: The mapping of CIE specifications to X-GTRBAC framework

CIE Function / Task	Responsible X-GTRBAC module	Related X-GTRBAC data element
Specify Users and Credentials	Policy Loader	XUS, XCredTypeDef
Specify Functional Roles and Hierarchy	Policy Loader	XRS, XSoDDef
Specify Available Permissions	Policy Loader	XPS
Specify Task Scheduling and Timing (DAG)	Policy Loader	XTempConstDef
Specify Task Dependencies	Policy Loader	XTrigDef
Specify User Eligibility for Functional Roles	Policy Loader	XURAS
Specify Permission Criteria for Functional Roles	Policy Loader	XPRAS
Validate the Enterprise Policy	Policy Validation Module	Entire XML Policy Base
Generate Enterprise Policy Documents	XML Processor	Internal DOM tree structure
Create User-to-role / Permission-to-role Mapping	GTRBAC Module	UR and PR DataSets
Create and Maintain User Sessions	GTRBAC Module	XSS, Sessions DataSets
Request Access to Enterprise Resource	External GUI (local or remote)	XAR
Enforce Access Control Policy	GTRBAC Processor	UR, PR, Sessions DataSets

## XUS

```
<?xml version="1.0" encoding="UTF-8"?>
<XUS xus_id="CIE_XUS">
  <User user_id="john">
    <UserName>John</UserName>
    <CredType cred_type_id="cPD"
              type_name="Product Designer">
      <CredExpr>
        <age>39</age>
        <level>B</level>
        <qualification>MS</qualification>
      </CredExpr>
    </CredType>
    <MaxRoles>2</MaxRoles>
  </User>
  .....
</XUS>
```

## XRS

```
<?xml version="1.0" encoding="UTF-8"?>
<XRS xrs_id="CIE_XRS">
  <Role role_id="rDM" role_name="Design Manager">
    <Junior>Product Designer</Junior>
    <Cardinality>2</Cardinality>
    <EnabConstraint>
      <EnabCondition
        pt_expr_id="PTQuarterWeekOne"/>
    </EnabConstraint>
    <ActivConstraint>
      <ActivCondition>
        <LogicalExpr>
          <Predicate>
            <Operator>eq</Operator>
            <NameParam type=role>Design Manager</NameParam>
            <FuncParam>activated</FuncParam>
            <Value_param>>false</ValueParam>
          </Predicate>
        </LogicalExpr>
      </ActivCondition>
    </ActivConstraint>
  </Role>
</XRS>
```

## XPS

```
<?xml version="1.0" encoding="UTF-8"?>
<XPS xps_id="CIE_XPS">
  <Permission perm_id="P1">
    <Object
      object_type="Document" object_id="DesignModel"/>
    <Operation>all</Operation>
  </Permission>
  .....
  <Permission perm_id="P7">
    <Object
      object_type="MaterialEquipment"
      object_id="EnggResources"/>
    <Operation>operate</Operation>
  </Permission>
  .....
</XPS>
```

## XURAS

```
<?xml version="1.0" encoding="UTF-8"?>
<XURAS xuras_id="CIE_XURAS">
  <URA ura_id="uraDM" role_name="Design
    Manager">
    <AssignUsers>
      <AssignUser user_id="john">
        <AssignConstraint>
          <AssignCondition cred_type="Product
            Designer">
            <LogicalExpr op="AND">
              <Predicate>
                <LogicalExpr op="OR">
                  <Predicate>
                    <Operator>gt</Operator>
                    <NameParam>age</NameParam>
                    <ValueParam>35</ValueParam>
                  </Predicate>
                <Predicate>
```

```

    <Predicate>
      <Operator>eq</Operator>
      <NameParam>qualification
    </NameParam>
      <ValueParam>PhD</ValueParam>
    </Predicate>
  </LogicalExpr>
</AssignCondition>
</AssignConstraint>
</AssignUser>
</AssignUsers>
</URA>
.....
</XURAS>

```

## XPRAS

```

<?xml version="1.0" encoding="UTF-8"?>
<XPRAS xpras_id="CIE_XPRAS">
  <PRA pra_id="praDM" role_name="Design Manager">
    <AssignPermissions>
      <AssignPermission d_expr_id="SixWeeks">
        <PermId>P1</PermId>
      </AssignPermission>
    </AssignPermissions>
  </PRA>
  .....
  <PRA pra_id="praPE" role_name="Product Engineer">
    <AssignPermissions>
      <AssignPermission d_expr_id="TwoWeeks">
        <PermId>P4</PermId>
      </AssignPermission>
      <AssignPermission d_expr_id="OneWeek">
        <PermId>P6</PermId>
      </AssignPermission>
    </AssignPermissions>
  </PRA>
</XPRAS>

```

**Policy Display : Users and Credentials**

User Id:

Credential Types (select):	Credential Expression
Assembly Designer	age: 29
Product Supervisor	level: A
	qualification: BS

**Policy Display : Roles and Hierarchies**

Role Name:

ID : rPD DSDRoleSetID : DSD_PD_PE Junior Role : Assembly Designer Senior Role : Design Manager	<b>Junior Roles</b> Level 1: Assembly Designer Level 2: Component Designer	<b>Senior Roles</b> Level 1: Design Manager
	<b>SSD Roles</b>	<b>DSD Roles</b> Product Engineer

**Policy Display : User to Role Assignments**

User Id:

Assigned Roles	Authorized Roles
Engg Manager	Engg Manager Product Engineer Product Supervisor Product Technician

**Policy Display : Permission to Role Assignments**

Role Name:

Assigned Permissions	Authorized Permissions
P2 P3	P2 P3 P4 P6 P7