Trust and Security Policy Specification for Internet Applications

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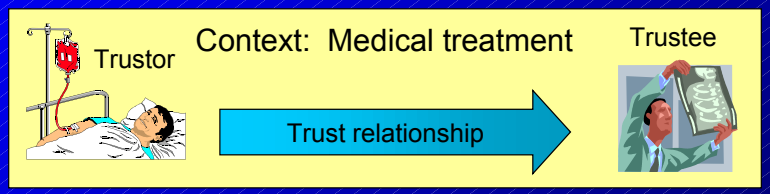
  - Naranker Dulay
  - Tyrone Grandison
  - Emil Lupu

Contents

What is Trust

- A quantified belief by a trustor with respect to the competence, honesty, security and dependability of a trustee within a specified context



- Dependability implies timeliness
- Distrust useful for trust revocation or in default trusted environments
- Quantification various degrees of trust/distrust

Trust Classification

- Provision of service by trustee eg financial advice
- Certification of trustee eg BMA or Verisign
- Delegation of trust eg accountant makes all my investment decision
  Although trust is not usually transitive
- Infrastructure trust eg trusted computer system and network

Trust Specification

- **Trust Predicate**
  trust (trustor, trustee, actions, level,) ← constraint set
  trust (Helen, _doctor, heart_diagnosis; operate, 50) ←
  is_consultant (_doctor, NHLI)
  - Distrust when level < 0
- **Recommend Predicate**
  recommend (recommedor, recomendee, actions, level) ←
  constraint set
  recommend (Morris, J.Bloggs, WebProgram, high) ←
  has_degree (IC-computing, 2i)
  trust (Harry, Frank, DesignHouse, medium) ←
  recommend (Tom, Frank, DesignHouse, high)

Trust, Experience and Risk

- Trust is not static but changes with time as a result of experience
- High risk low trust
- Trust framework must monitor experience, risk and constraints in order to dynamically update trust levels and relationships.

Trust Analysis

- Determine trust relationships eg
  - What are the relationships between A & B?
  - Who trusts B?
  - What relationships have A as recommendor?
  - Conflict of interest relationships
- Determine implicit trust relationships
- Generate security management policies from trust specification

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Basic policies – authorisation, refrain, obligation, delegation

Composite policies – roles, relationships, management structures

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Security Specification

- E-commerce, healthcare – multiple organisations
- Complex security policies with many constraints and exceptions
- Implementation is often the specification
- Need to specify security policy for groups and roles (organisational positions)
- Need to manage security – what actions to perform when a violation detected, or for registering a user
- Need for analysis tools

Policy

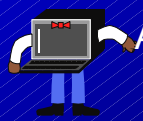
Rule governing choices in behaviour of the system

- Derived from trust specifications, enterprise goals and service level agreements
- Need to specify and modify policies without coding into automated agents
- Policies are **persistent**
- But can be dynamically modified

Change system behaviour without modifying implementation – **not new functionality**

Ponder Policy Language

- Precise specification of subjects, targets, actions and constraints for authorisations and obligations
- Needed for both:



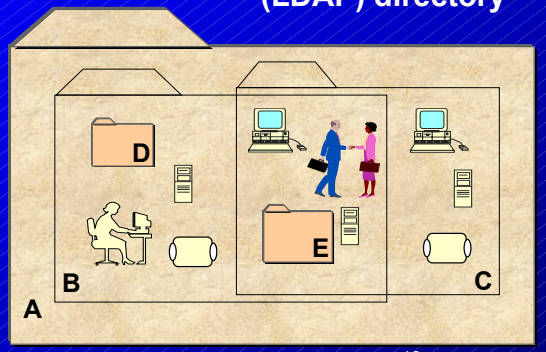
Automated agents

Human managers

- Clear specification of responsibility, rights and duties “job description”

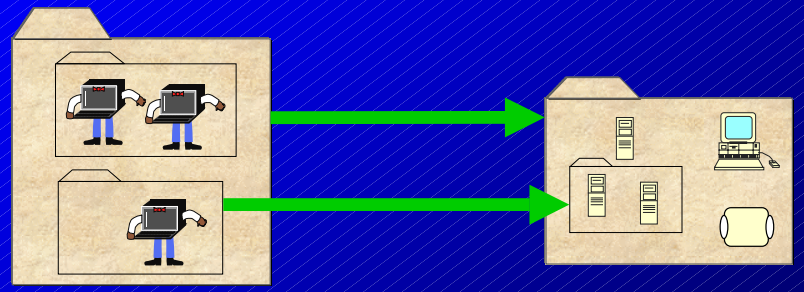
Domains Grouping

- A domain is a collection of objects which have been explicitly grouped together for management purposes e.g. to apply a common policy
  (LDAP) directory



- Specify policy for groups of objects
- Can change domain membership without changing policy

Policy Propagation



Subjects

Targets

Authorisation Policy

- Defines what a subject is permitted or not permitted (prohibited) to do to a target
- Protect target objects from unauthorised actions

  Target based interpretation and enforcement

Authorisation Policies

- All policies can be specified as a parameterised type from which instances can be created

```
type auth+ conf (subject s, target t, string start, string end) ;
   action VideoConf ();
   when time.between (start, end); }

inst  marketConf = conf (/UK/marketing, /US/marketing
                         "1400","1900");
      planConf   = conf (/UK/planning, /France/management
                         "0900", "1200");
```

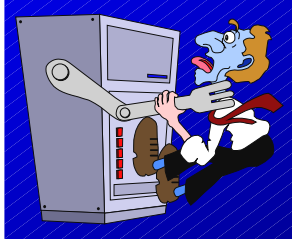
Negative Authorisation

- Used for revocation of access rights

```
inst auth-  revoke {
      subject     /users/JoeBloggs;
      target      /resources/database ;
      action      - ;   // any action
      when        time.date > 30:9:2001 }
```

- Reflect organisational policies and laws

```
inst auth- nostrangle {
      subject     staff;
      action      strangle;
      target      students; }
```



Refrain Policy

```
inst  refrain  politeBehaviour {
      subject  Agroup ;
      target   AGroupNY +  DGroupBoston ;
      action   videoconf ;
      when     (time.day=Friday); }
```

- Similar to negative authorisation but subject based interpretation

Filters

- Transformations on parameters of positive authorisation policies, where it is not practical to provide different operations to reflect permitted parameters

```
inst auth+ employeeAccess {
      subject    employees + managers ;
      target     <DB> employeeDB ;
      action     getEmp (empID) ;
        if (subject = employees)
        result = reject (result, salary, homeAddr); }
```


Obligation Policy

- Defines what actions a subject must do
  Assumes well behaved subjects with no freedom of choice.
- **Subject based** subject interprets policy and performs actions on targets
- Event triggered obligation
- Actions can be remote invocations or local scripts
- Can specify sequencing or concurrency of actions

Obligation Example

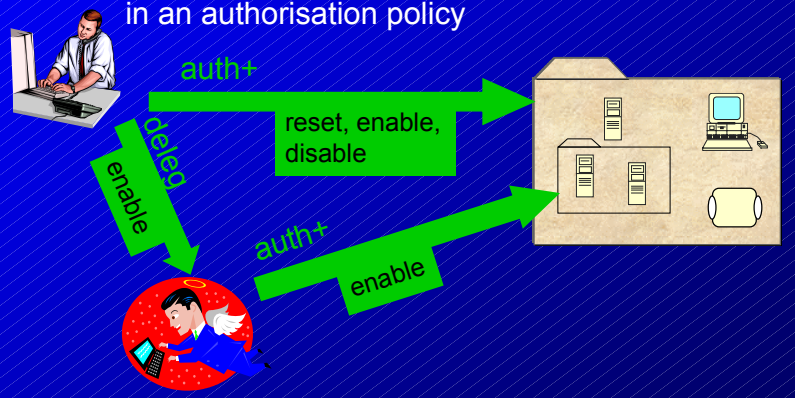
- After 3 consecutive login failures with the same userid, disable the userid, notify the administrator & log the userid.

```
type oblig   LoginFailure (subject s, set b, string phoneNo) {
  on         LoginFail (userID) ;
  target     <userT> t = b ^ {userID} ;
  do         t.disable(userID ) -> ( s.sms(phoneNo, userID,
                                       "message….")
                                     || s.log (userID) );  }

inst p = LoginFailure (/Nregion/secAgent, /Nregion/users,
                                     "07710123456" ) ;
```


Delegation Policy

- Specify which actions a subject can delegate to a grantee
  - Must be a subset of subjects, actions and targets in an authorisation policy



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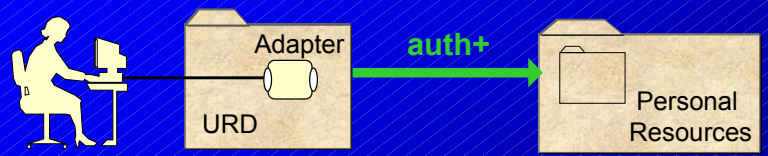
User Representation Domain



- Persistent representation of a registered user
- URD is subject of policies applying to a specific person
- At login adapter object created to represent and act on behalf of person in system command interpreter

Roles

- Role groups the rights and duties related to a **position** in an organisation
- E.g., network operator, network manager, finance director, ward-nurse
- Specify policy in terms of **roles** rather than **persons**

  do not have to re-specify policies when person assigned to new role

Role Example

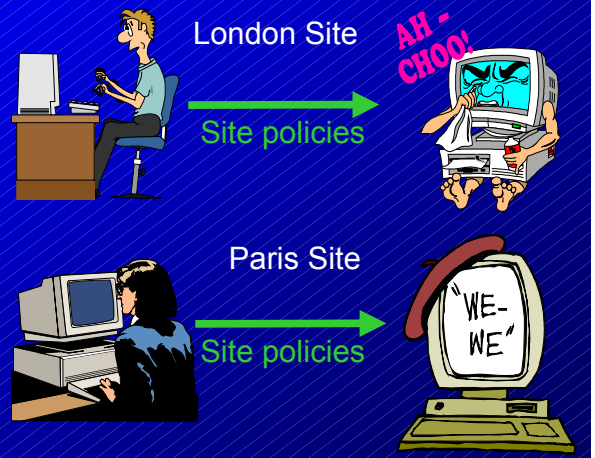
```
type role op (target firewalls) {
   // load new firewall policies
   inst oblig intruder {
        on intrusion ( );
        do firewalls.load (highSec) ;}

   inst auth+ fwAuth {
        target firewalls;
        action load, unload, readlog;
        }
// other  authorisation and obligation policies
}
```


Role Instances

- Multiple operator role instances
- Different persons assigned to roles
- Different target components
- Similar policies

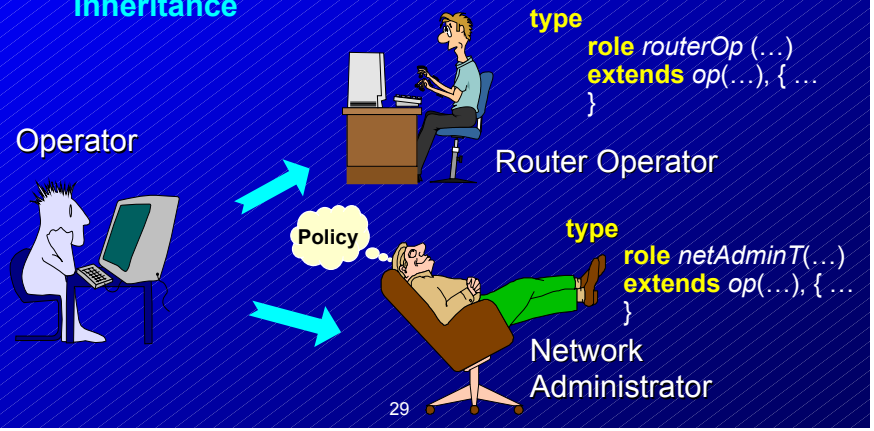
  Role Class
- Reuse of role specification



Role Specialisation

- Derive new composite policy specifications from existing ones
- Specialise roles by adding policies

Inheritance

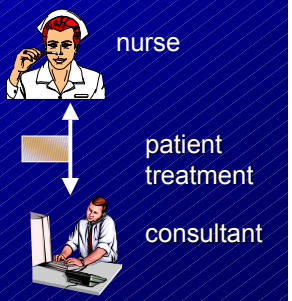


Role Relationships

- Relationships
  - Rights and duties of roles towards each other
  - Usage of shared resources
  - Interaction protocols

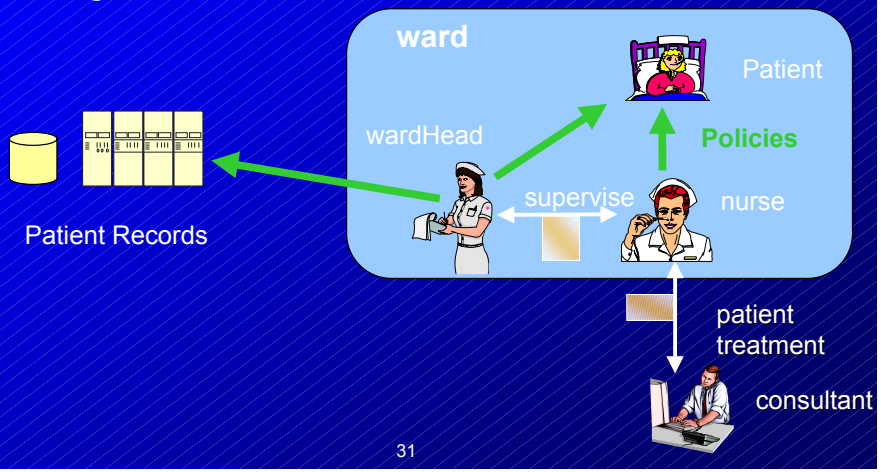
```
type rel pTreat  (
        consultant ExtCon, nurse wardNurse) {

 inst    oblig report { subject wardNurse ;
            on timer.at (1800);
            do report(p_info); target ExtCon; }
         auth+ prescribe { subject ExtCon;
            action setTreat; target wardNurse; }
}
```



Management Structures

- Configurations of roles and relationships in organisational units

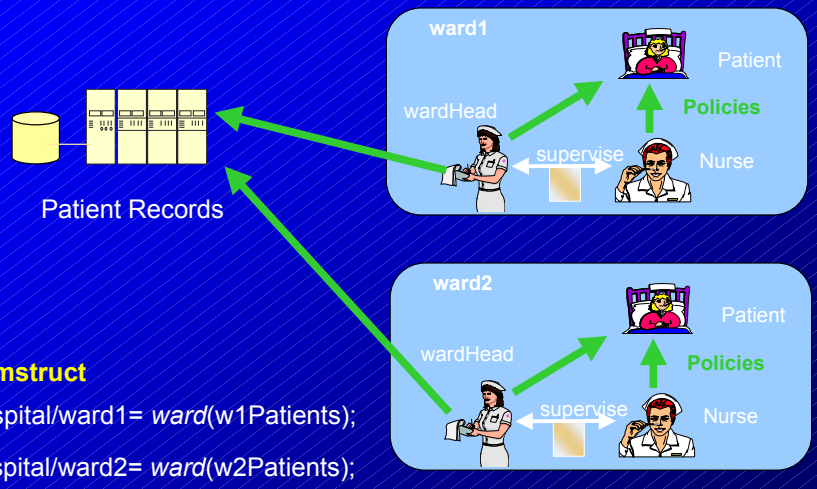


Ward Management Structure

```
type mstruct ward (domain patients) {
     import /type/wnurseT; /type/hnurseT;

     inst role wardHead = hnurseT;
               wardNurse = wnurseT;
          rel  supervise  (wardHead, wardNurse) {
               inst auth+ {subject wardHead;
                          target wardNurse;
                          action assign () ;
                          }
               inst oblig  ……
               }
}
```

Organisational Patterns



inst mstruct

hospital/ward1= *ward*(w1Patients);

hospital/ward2= *ward*(w2Patients);

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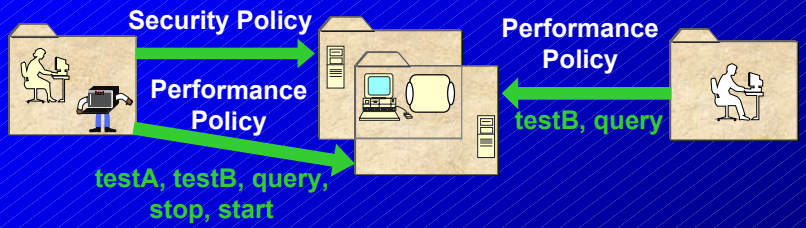
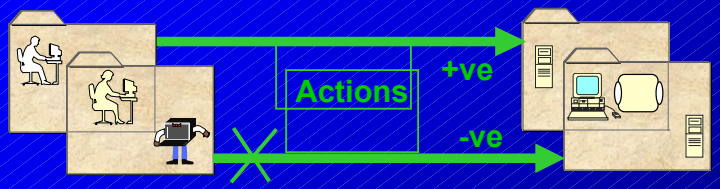
Multiple Policies May Apply

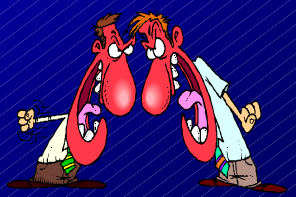


- An object can be a member of multiple domains (overlap)
- Multiple policies can apply to single domain
- Need conflict detection and resolution

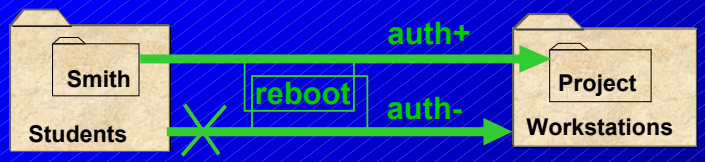
Modality Conflicts



- Potential conflict from overlap of subjects, targets and actions
- 3 types: auth+/auth-, oblig/auth-, oblig/refrain
- Note: auth+/refrain is not a conflict
- Detected by syntactic analysis



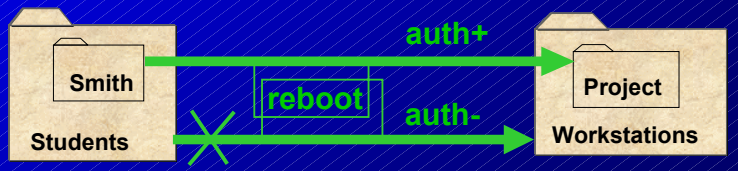
Example Conflicts



- inst auth- bootWS {
  subject students; target workstations; action reboot }
- Exception:
  inst auth+ projectWS {
  subject smith; target workstations/project; action reboot }

Precedence

- Can resolve some conflicts automatically by specifying precedence, e.g.:
  - **Negative** policies override
    Does not permit positive exceptions to negative policies.
  - More **specific** policies override
  - Explicit **priority**



Semantic Conflicts

- Types of conflict:
  - **separation of duty** e.g., the same person is not allowed to authorise payments and initiate them
  - **self-management** e.g., a manager cannot authorise it's own expenses
  - **conflict for resources** e.g., not more than 5 persons are authorised to change the DB
- Need to specify the conditions which result in conflict
- Constraints on a set of policies (Meta-Policies).
  Specified using Prolog, OCL
- Included in composite policies such as roles or mstructs

Separation of Duties

```
/policies/accounting->exists (P1, P2 |
  P1.subjects->intersection(P2.subjects)->notEmpty and
  P1.actions->exists(a | a.name = 'authorise') and
  P2.actions->exists(a | a.name = 'initiate') and
  P1.targets->intersection(P2.targets)->exists(t |
        t.isOclKindOf(payment)))
```

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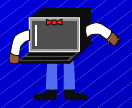
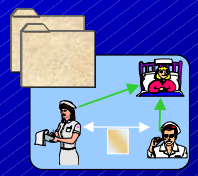
Conclusions

- Security specification
- Management
- Large scale
- Multiple Organisations





Authorisation, delegation, role

Event-triggered obligation

Domains + Composite policies

Future Work

- Refinement and analysis tools – Requirements Engineering approach
- Refinement of Trust into security policy
- Adaptive Security Management
- Service Level Agreements
  Authorisations + obligation policy for dynamic aspects
- Policy based programmable networks
  3 levels: applications, routers, hardware

Policy Workshop

- Policy 2002: Workshop on Policies for Distributed Systems and Networks
  http://www-dse.doc.ic.ac.uk/Events/policy-2002/
  5-7 June 2002
  Naval Postgraduate School
  Monterey, Ca, USA.

- Colocated with
  SACMAT 2002: 7th ACM Symposium on Access Control Models and Technologies
  3-4 June 2002 , NPS, Monterey.

Additional Information

- Links to Policy information
  - Ponder
  - Workshops
  - Papers

  http://www-dse.doc.ic.ac.uk/policies