Modeling Trust in Distributed Systems

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Outline

- Problems
- What is Distributed Trust
- Background
- Limitations
- Overview of our system
- Design
- Ontology
- How it works
- Processing
- Ongoing Work
- Summary

Problem

There are 2 scenarios that we are trying to address
1. Supply Chain Management System
   - Focus of the paper
2. Dynamic Wireless Environment
   - Ongoing work

Supply Chain Management

- Inter company information access
- Sharing/accessing information, and performing actions across (or within) organizations
- have to observe organizational policies for security and authorization.
Supply Chain Management

- We need to:
  - grant authorization and rights
  - delegate authorization and rights
  - request certificates proving authorizations
  - request actions, attaching certificates as necessary
- Implemented a system for CIIMPLEX EECOMS project

CIIMPLEX EECOMS

CIIMPLEX: Consortium for Integrated Intelligent Manufacturing Planning and Execution
EECOMS: Extended Enterprise Coalition for Integrated Collaborative Manufacturing Systems

- Goal: Plug and Play framework of business objectives and integration-enabling tools allowing a suite of solutions that can be implemented "out-of-the-box" at small and midsized manufacturing and process sites including MES, ERP, Finite Scheduling, and Capacity Analysis/Decision Support
- Objectives: interoperability, configurability, adaptability, extensibility, plug and play
- Focus: supply chain management

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Technologies for the Integration of Manufacturing Applications (TIMA)

CIIMPLEX Participants

- IBM Corp
- University of Maryland
- Baltimore County
- University of Florida
- University of North Carolina at Charlotte
- Berclain USA Ltd.
- Boeing
- QAD Inc
- GSE Systems
- Lucent Technologies
- Ingersoll-Rand Co.
  - Demand Solutions
  - DLoG Remex Inc.
- Intercim
- EnvisionIt Software
- The Haley Corporation

Dynamic Wireless Environments

- Unknown entities
- Wireless devices are resource poor
- Authenticate other wireless devices
- Need to communicate and sometimes use other devices
We need to:
- specify ‘public’ policies
- Manage authorization and delegation
- Implementation should be ‘light’, yet effective

Issues:
- No central authority
- Logging in is not possible
- Access control for entities never encountered before

We use Distributed Trust to solve the above issues

Distributed Trust:
- trust = policies + credentials + determining if credentials fulfill policies + delegating trust to third parties

Background:
- PGP
  - Secure emails
  - Web of trust
- SPKI
  - used for access control
  - A PKC consists of key, name, authorization
  - includes notion of delegation + permission to delegate further
  - Authorization certificates
  - Depth of delegation is boolean or integer

Background (cont.):
- Role based Access Control
- Trust Establishment
  - based on role based Access Control
  - Policy Language is defined in XML
  - Certificate Collector collects missing certificates
  - Supports negative certificates
- PolicyMaker
  - binds public keys to predicates
  - no mapping between keys and personal id
  - Simple language to express trust info
  - Given policy, answers queries about trust
Delegation Logic
- Language for specifying trust information
- Ability to manage non-monotonic reasoning
- Expresses delegation depth explicitly

PGP and X.509 certificates
- Provide authorization
- No delegation

SPKI
- Provides authorization
- Limited delegation
- No constraints on delegations

Role based
- Difficult in inter company communication as roles are different across domains

Trust Establishment
- Specifies certificate types that makes interoperability with other TE systems difficult
- Used for mapping between entities and roles
- Limited support for delegation

PolicyMaker
- Policy is complex, fully programmable
- Hard to understand for non-programmers

Overview of our System
- Provides authorization
- Representation for credentials and trust relationships
- Flexibility in describing policies
- Constraints on execution
- Constraints on further delegation
Overview of our System

- Security and authorization policy represented as rules and constraints
- Principals make signed statements
- Principals can be humans (via a suitable interface) or software agents acting on behalf of humans
- Agents reason about the policy and statements to derive (prove) authorizations

Design

Supply Chain Management System
- Companies have security policies
- Policy enforced by a number of ‘security officers’
- Each agent in the system has an ID certificate, X.509
- All communication via signed messages
- Trust info encoded in Prolog

Design

Ontology

- Agents
  - Entities in the system
  - Associated with roles
- Actions
  - Application specific action
- Propositions
  - Permissions
    - Actions that an agent can perform
      permission(Agent, Action, Constraint)
Ontology

- Delegations
  Abilities that are deferred
  `delegate(Issue, Start, End, From, To, Permission, Constraint on redelegation, Flag)`
  Delegation is an ability

- requests
  `request(From, To, Action)`
  `requestCert(From, To, Action)`

Policy

- Security Policy
  - Authorization policies
    - Specifies rules for checking credentials
  - Delegation policies
    - Rules for deferring of permissions
  - Basic Permissions
    - Role based access rights for entities
    - Access rights for an agent
    - Certain basic rights

How it works: Initial delegation

How it works: Request
How it works: Delegation

Delegate to Developers

Processing

- Prolog is used to specify policies, delegations and queries
- An action is allowed if
  - the agent has the ability to perform the action or
  - has been delegated the ability by someone, who has the ability to delegate

How it works: Request

Processing

- An agent has the right to delegate if
  - it is an ability
  - or someone had delegated to it the right and the delegator had the right to delegate
Ongoing Work

- Use a semantic language based on XML (RDF/DAML) for representation of trust information
- Use XML Signatures
- Trust in dynamic wireless environment
- Specifying ontology for permissions, obligations, entitlements, prohibitions in RDF/DAML

Summary

- We have developed an infrastructure for distributed trust
- Designed a representation for trust info, credentials and policies
- Showed its feasibility through implementation
- Discussed some of our future research directions

Questions

- Reputation mechanism
- Using smart cards for authentication
- Delegating of obligations, entitlements, prohibitions
- Short lived Propositions
  - reduces processing time
  - easy handling of revocations