ACON: Activity-Centric Access Control for Social Computing

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Social Computing

• Characteristics
  – Social computing systems (SCS) provide services to promote information sharing by utilizing user activity information and shared contents
    • Best seller, friends recommendation, friend activity notification, location-based service
  – Both user and SCS provide/access information to be shared
  – A user wants to control other user’s or SCS’s activities against shared information or users related to her
  – User wants to protect their privacy
  – Both resource and user as a target of activity
    • Alice pokes bob, a buyer rates sellers
  – A user’s activity influences access control decisions
    • Rating based popularity
Activities in SCS

• No traditional access control can cover all the controls necessary for SCS
• Activity as a key concept for access control

• Why Activity-centric?
  – Multiple kinds of activities (in addition to user’s general usage activity against resource) that have to be controlled.
    • User’s usage/control activity on user/resource, SCS’s service/control activities
  – A user’s usage/control activity influences SCS’s control decision on own and other users’ activities as well as SCS activities.
    • Once Alice invites Bob as a friend, Bob is allowed to see Alice’s information
    • If Alice is a friend of Bob and Bob become a friend of Chris, 1) if Chris allows friends of friends to his contents, Alice can access Chris’s contents; 2) SCS can recommend Chris and Alice as a friend
    • Buyers’ ratings on a seller may collectively used to control the seller’s sale activity.
Activity Taxonomy in SCS

Activities in SCS
- User's Activities
  - Usage Activities (UA) on target resources, on target users
  - Control Activities (CA) on users, on resources, on sessions
  - Typical Focus of Access Control
- Service Activities (SA) on target resources, on target users
  - Focus of Discretionary Access Control
- Control Activities (CA) on users, on resources, on sessions
  - Decision Activities (DA) on User's UA, CA, on SCS's SA, CA

Activity Control
User’s Usage Activities

• Usage Activity on Resources
  – Read/view shared comments/photos
  – Typical Focus of Access Control

• Usage Activity on Users
  – Poke, recommend friends
User’s Control Activities

- **Control Activity on Resources**
  - By changing attributes and policies of resources
  - set a resource as a violent content (attribute), accessible only by direct friends (policy)
  - Parents can set attributes and policies of children’s resources
  - Focus of Discretionary Access Control

- **Control Activity on Users**
  - By changing user attributes and policies
  - To control activity performed by/against a particular user (self or other related users) without knowing a particular resource

- **Control Activity on Sessions**
  - By controlling session attributes and policies that are inherited from a user
SCS’s (Automated) Activities

• Service Activities
  – To promote users’ social interactions and information sharing
  – Friends recommendation, friend activity notification, location-based coupons, most-viewed videos

• Control Activities
  – Through managing policies and attributes of users, resources and sessions
  – User rating-based seller trustworthiness or product popularity

• Decision Activities
  – SCS evaluates requests for user’s usage and control activities as well as SCS’s service and control activities
Activity(-centric Access) Control Framework

- To capture various users and SCS activities and their influences on control decisions
- To support controls on various access/usage and control activities in SCS
- To support personalized user privacy control
- To support automated management of SCS services and controls
ACON Framework
ACON Framework Components

• **Users**
  - represent a human being who performs activities in an SCS
  - Carry attributes and policies

• **Sessions**
  - Represent an active user who has logged into the SCS
  - A user can have multiple sessions, but not vice versa
  - Carry attributes and policies that could be different from user attributes and policies
ACON Framework Components (cont)

- **Activities**
  - User, SCS, SCS administrator’s activities
  - Comprise action, target users, target resources
    - **Action**
      - An abstract function available in SCS
      - E.g., read, rate, poke, friend-invite, activity notification
    - **Target users(’ sessions)**
      - Recipients of an action
    - **Target Resources**
      - Include users’/SCS’s shared contents, user/resource/session policies and attributes
ACON Framework Components (cont)

• **SCS’s Decision Activity**
  – based on the consolidated individual user/resource policies and attributes together w/ SCS policies and attributes

• **SCS’s Activity Module (SAM)**
  – A conceptual abstraction of functions that performs SCS’s automated service and control activities

• **SCS Administrators**
  – Human being w/ a management role
ACON Framework Characteristics

• Policy Individualization
  – A user’s individual policy includes privacy preferences and activity limits
  – Collectively used by SCS for control decision on activities
  – Can be configured by related users

• Separation of user and resource policies
  – User policy allows controls on 1) user activities w/o knowing a particular resource and 2) activities performed against the user w/o knowing a particular resource or the actors
  – E.g., 1) Bart cannot be a friend of Homer’s coworker, 2) Homer doesn’t want to receive violent contents

• User-session distinction
• User relationship independent access control
• SCS’s automated service and control activities
ACON_{user} Model – User Activity Control

- \( U, S, ACT, R, T, P, SCS \) and \( D \) (users, sessions, actions, resources, attributes, policies, social computing system and decision predicate, respectively);
- \( U_T \subseteq U \) and \( R_T \subseteq R \) (target users and target resources, respectively);
- dot notation: we understand \( e.T \) and \( e.P \) to respectively denote the set of attributes and set of policies associated with entity \( e \);
- \( A \), the set of activities is defined as \( A \subseteq ACT \times (2^{R_T} \times 2^{U_T} - \emptyset) \);
- Let \( A = \{a_1, a_2, ..., a_n\} \), we denote the components of each individual element as \( a_i = (a_i.ACT, a_i.R_T, a_i.U_T) \);
\textbf{ACON}_{user} Model – User Activity Control

- $AP_{R_T} : A \rightarrow 2^{R_T \times P}$, $AP_{U_T} : A \rightarrow 2^{U_T \times P}$, $AT_{R_T} : A \rightarrow 2^{R_T \times T}$, $AT_{U_T} : A \rightarrow 2^{U_T \times T}$, mappings of activity to a set of target resources and policies, a set of target users and policies, a set of target resources and attributes, and a set of target users and attributes respectively defined as:

  - $AP_{R_T}(\{a_1, \ldots, a_n\}) = \bigcup_{i=1}^{n} AP_{R_T}(\{a_i\})$
  - $AP_{U_T}(\{a_1, \ldots, a_n\}) = \bigcup_{i=1}^{n} AP_{U_T}(\{a_i\})$
  - $AT_{R_T}(\{a_1, \ldots, a_n\}) = \bigcup_{i=1}^{n} AT_{R_T}(\{a_i\})$
  - $AT_{U_T}(\{a_1, \ldots, a_n\}) = \bigcup_{i=1}^{n} AT_{U_T}(\{a_i\})$
ACON_{user} Model – User Activity Control

• \( AP(a) = AP_R_T(a) \cup AP_U_T(a), \)
• \( AT(a) = AT_R_T(a) \cup AT_U_T(a); \)

• \( allowed(s,a) \Rightarrow D(s.P, s.T, a, AP(a), AT(a), scs.P, scs.T), \) where \( s \in S \) and \( a \in A. \)
ACON_{user} Model – Session Management

- \texttt{user\_sessions} : U → 2^S, \texttt{session\_users} : S → U;
- \texttt{user\_added\_sessionT} : S → 2^T, \texttt{user\_removed\_sessionT} : S → 2^T;
- \texttt{scs\_added\_sessionT} : S → 2^T, \texttt{scs\_removed\_sessionT} : S → 2^T, \texttt{scs\_required\_sessionT} : S → 2^T;
- \texttt{user\_added\_sessionP} : S → 2^P, \texttt{user\_removed\_sessionP} : S → 2^P;
- \texttt{scs\_added\_sessionP} : S → 2^P, \texttt{scs\_removed\_sessionP} : S → 2^P, \texttt{scs\_required\_sessionT} : S → 2^T;

- \texttt{user\_removed\_sessionT}(s) ⊆ \{t ∈ T | t ∈ \texttt{session\_users}(s).T \land t ∉ \texttt{scs\_required\_sessionT}(s)\};
- \texttt{user\_removed\_sessionP}(s) ⊆ \{p ∈ P | p ∈ \texttt{session\_users}(s).P \land p ∉ \texttt{scs\_required\_sessionP}(s)\};
**ACON**<sub>user</sub> Model – Session Management

- **assignS_T** : \( S \rightarrow 2^T \), **assignS_P** : \( S \rightarrow 2^P \), assignment of attributes and policies to sessions respectively;

- **assignS_T(s)** \( \subseteq \{ t \in T | (t \in \text{session_users}(s).T) \lor (t \in \text{user_added_session}(s)) \lor (t \in \text{scs_added_session}(s)) \land \neg ((t \in \text{user_removed_session}(s)) \lor (t \in \text{scs_removed_session}(s))) \} \};

- **assignS_P(s)** \( \subseteq \{ p \in P | (p \in \text{session_users}(s).P) \lor (p \in \text{user_added_session}(s)) \lor (p \in \text{scs_added_session}(s)) \land \neg ((p \in \text{user_removed_session}(s)) \lor (p \in \text{scs_removed_session}(s))) \} \).
Examples

• A buyer can rate a seller only if the buyer bought a product from the seller (SCS.P).
  \[ N: \text{a list of users}, \text{sellerList: } S \rightarrow 2^N \]
  \[ \text{allowed}(s, \text{rate, } u_t) \Rightarrow u_t \in \text{sellerList}(s) \]

• A user can recommend a friendship between two friends if they are not a friend to each other (SCS.P).
  \[ N: \text{a list of users}, \text{friends: } S \rightarrow 2^N \]
  \[ \text{allowed}(s, \text{f-recommend, } u_{t1}, u_{t2}) \Rightarrow \]
  \[ (\{u_{t1}, u_{t2}\} \in \text{friends}(s)) \land (u_{t2} \notin \text{friends}(u_{t1})) \land \]
  \[ (u_{t1} \notin \text{friends}(u_{t2})) \]
Summary

• Developed activity-centric access control framework for security and privacy in social computing systems.

• Developed initial models for user activity controls and session management.