Risk-Aware RBAC Sessions

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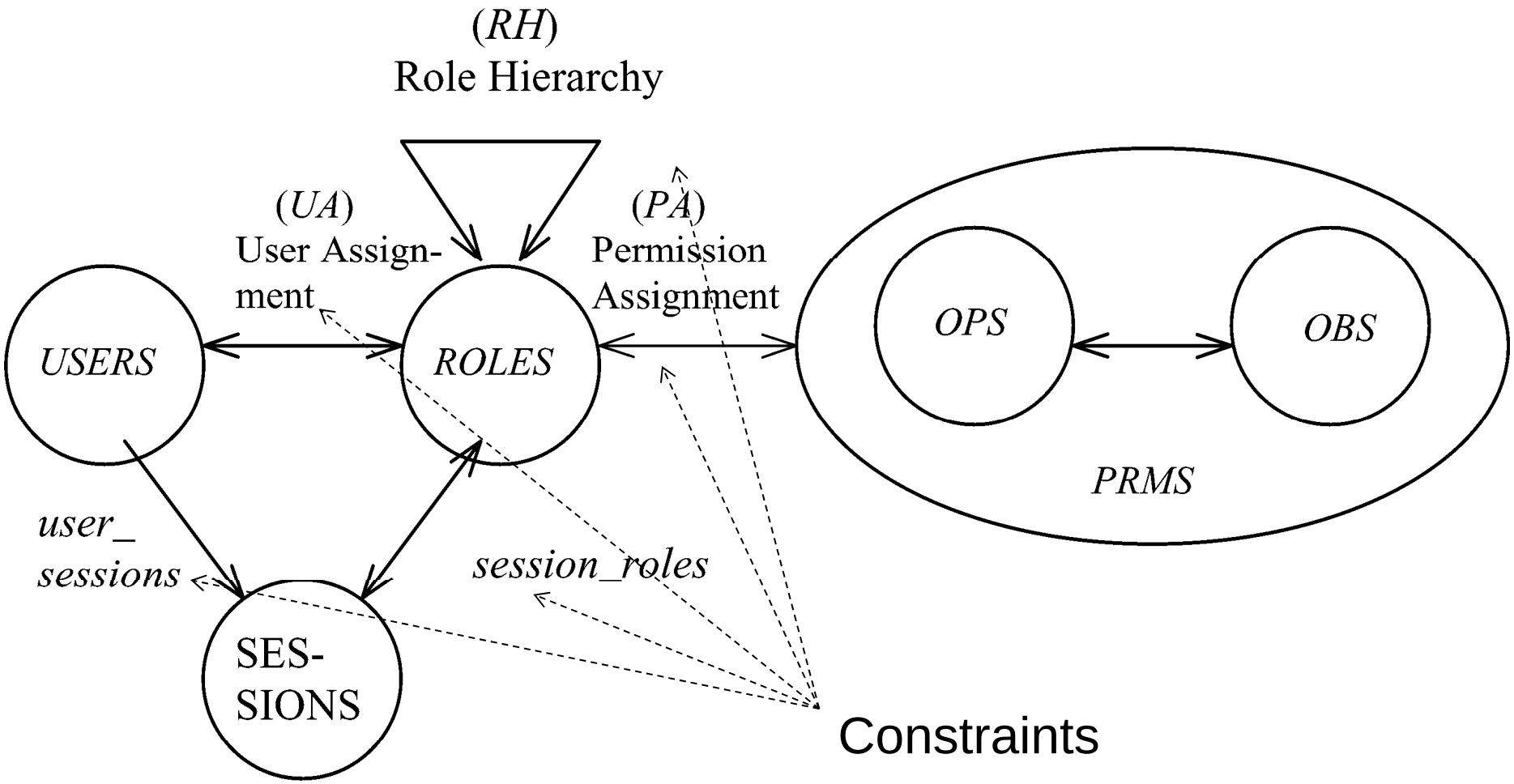
RBAC Sessions



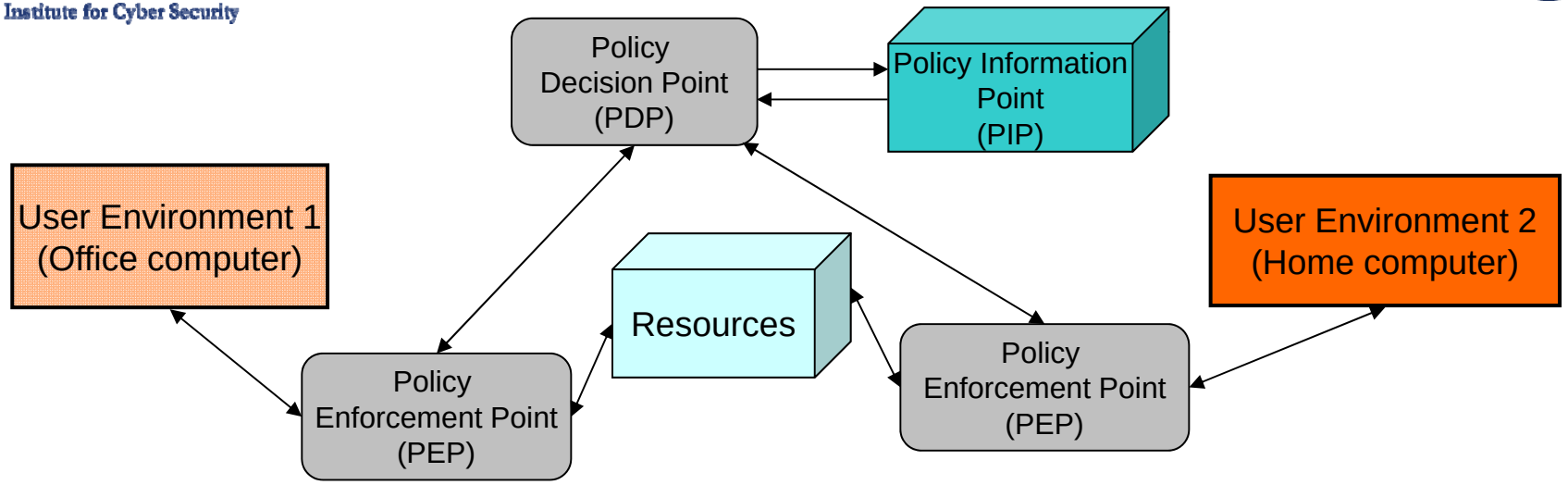
RBAC Sessions

- Motivation for Session in Classical RBAC
  - Least Privilege
  - Dynamic Separation of Duty
- A major risk mitigation feature in RBAC
- Functionalities:
  - Role Activation: Activate a role **(Increase the session's access capability)**
  - Role Deactivation: Deactivate a role **(Decrease the session's access capability)**

Concern:

1. User's complete discretion on activation and deactivation
2. No differentiation of sessions

Motivational Scenario



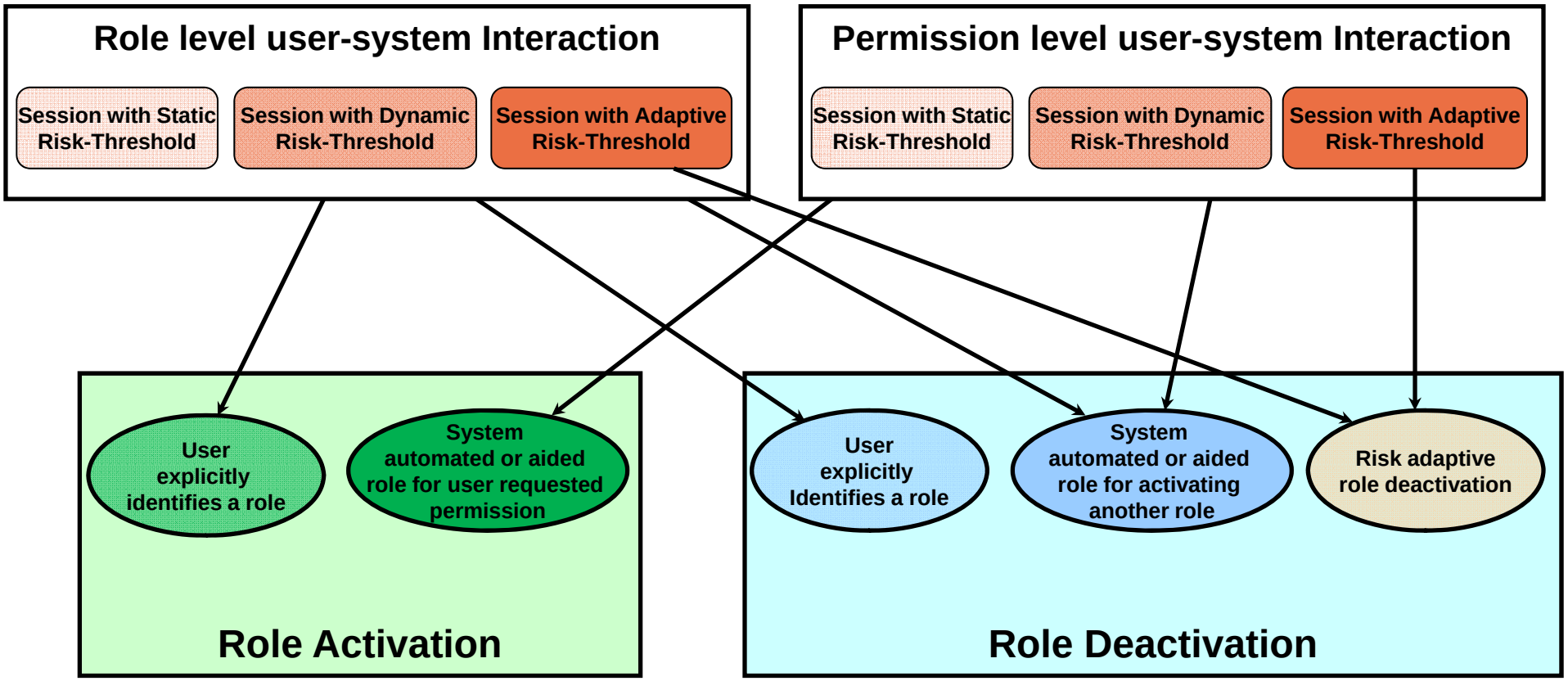
A simple PDP/PEP based Access Control Enforcement Model

- Environment 2 might be less secure than Environment 1
  - Thus, user sessions from them should not be equally secure
- A user session can also be compromised
  - E.g. by malware running in user's computer (environment)
- Attacker could completely impersonate the user in a compromised session
  - Activating all the roles assigned to the user **(role activation is entirely at user's discretion in every session)**

Mitigation Strategy

- A procedure to identify how risky a session is
  - risk-estimation of a session
- Limit session's access capability based on its estimated risk
  - a threshold on role activation based on estimated risk
  - session risk threshold vs combined risk of activated roles
- Reduce User's discretion on Role activation and deactivation
  - involve system to select a role to activate or deactivate

Overview


Role level user-system Interaction
Session with Static Risk-Threshold
Session with Dynamic Risk-Threshold
Session with Adaptive Risk-Threshold
Permission level user-system Interaction
Session with Static Risk-Threshold
Session with Dynamic Risk-Threshold
Session with Adaptive Risk-Threshold
User explicitly identifies a role
System automated or aided role for user requested permission
User explicitly Identifies a role
System automated or aided role for activating another role
Risk adaptive role deactivation
Role Activation
Role Deactivation

Risk-Aware RBAC Session Characteristics

- Risk-Aware RBAC sessions could be different types
  - when and how the risk-threshold is estimated
  - system and user properties that influences the calculation process
- Session with static risk-threshold (SSR)
  - statically calculated
  - does not change across session
  - properties that does not change frequently (e.g. credential, assigned role-set)
- Session with dynamic risk-threshold (SDR)
  - calculated before each user session
  - may vary across session
  - Some dynamic properties (e.g. time, place, currently activated roles)
- Session with adaptive risk-threshold (SAR)
  - calculated before each user session
  - may vary across and within a session
  - affected by certain user activities during a session
  - need system functionalities to stop certain activities (e.g. system automated role deactivation)

User Driven Role Activation

- A User can activate a role in a session iff
  - the role is assigned to the user
  - activation of a role does not cross the risk-threshold of the session
    - individual risk of the role below the risk-threshold and
    - combined risk of activated roles is below the risk-threshold

- Activation of a role might also lead to deactivate certain activated roles in a session
  - in order to satisfy session risk-threshold
  - system guided or system automated

- Two different user-system interactions for role activation
  - role level (simply request a role to activate)
  - permission level (request a permission to access and system will activate the role)

Role Activation Framework
(role level user-system interaction)

- Strict Activation
  - activates if risk-threshold is satisfied
  - no deactivation of already activated roles in session

- Activation with System Guided Deactivation
  - activates if risk-threshold is satisfied
  - if not, system suggests user to deactivate certain activated roles in order to lower session risk

- Activation with System Automated Deactivation
  - activates if risk-threshold is satisfied
  - if not, system automatically deactivates roles
  - need a specific role deactivation algorithm (e.g. LRU, heuristics)

Role Activation Framework
(permission level interaction)

- Permission level interaction process:
  - users simply try to access a permission in a session
  - system checks whether necessary role is activated in the session
  - if yes, allow the user access
  - otherwise, finds if there is a role for the permission
- In the presence of multiple roles with the permission
  - system displays roles and user selects one, or
  - automatic role selection by the system
- Automatic role selection
  - less risky role, role with minimum permission, etc.
- Three different role activation models
  - strict activation (no deactivation)
  - activation with system guided deactivation
  - activation with system automated deactivation

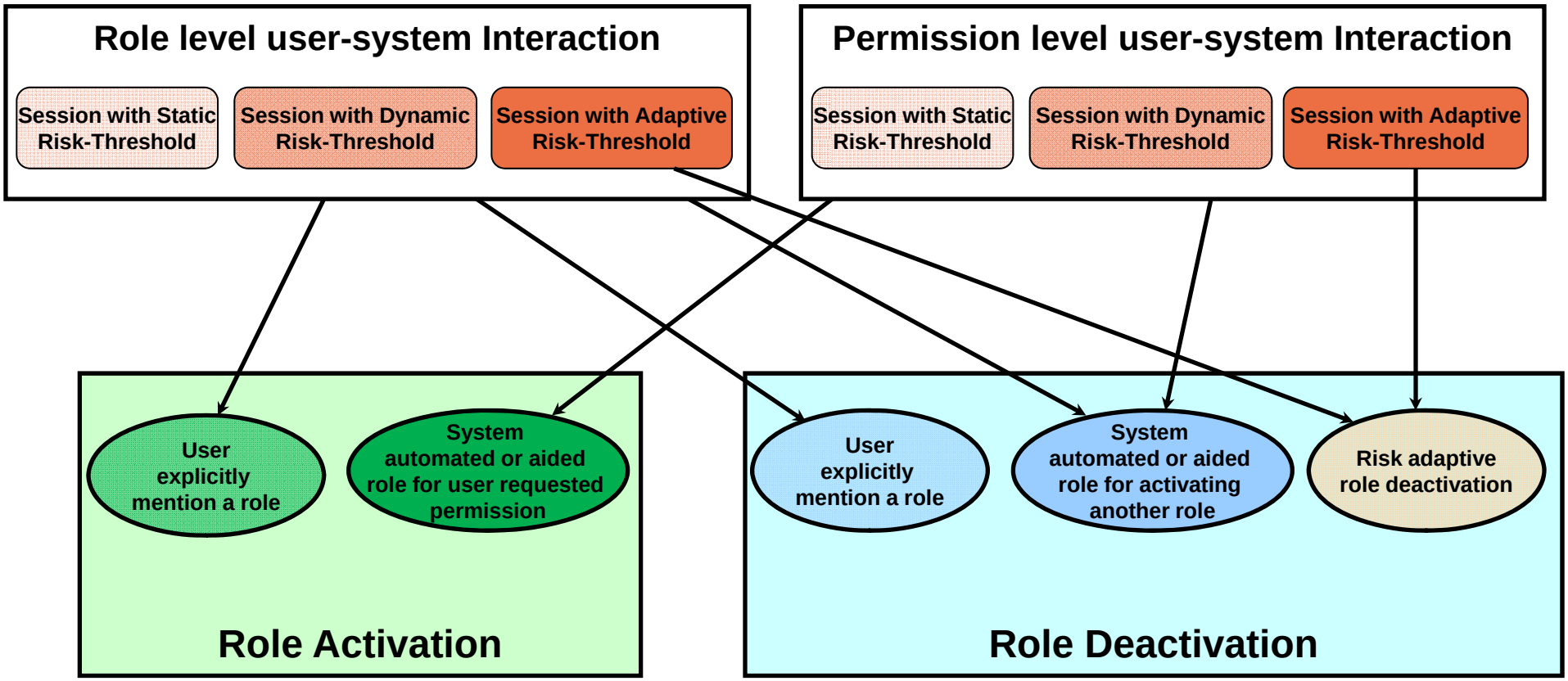
Risk-Adaptive Role Deactivation

- Risk-threshold varies during a session in SAR
  - might need continuous monitoring of a session activities
  - could be lowered by user's abnormal behavior or any detected malicious activities or other factors
  - further reduces the session's access capability

- Decrease of risk-threshold might cause deactivation of certain activated roles
  - roles that exceeds newly estimated threshold, roles that reduces the threshold, etc.

- System automated role deactivation function
  - called by the system each time risk-threshold change
  - automatically deactivates affected roles, or
  - forces user to deactivate certain roles (provides some choices on what roles to be deactivated)

Summary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Formal Specification

- Formally enhance NIST Core RBAC model
  - for a session with dynamic risk threshold
  - develop functionalities for a permission level user-system interaction (present NIST RBAC only supports role level interaction)
- Three required information of a risk-aware session in NIST Core RBAC
  - **assigned risk :** a mapping of permission p to a positive real value, which gives the risk assigned to a permission.
  - **risk threshold :** a mapping of session s to a positive real number that gives the maximum risk the session could contain.
  - **present risk :** a mapping of session s to a positive real number that gives the present risk value of the session.
- Necessary functions
  - **AssignRisk**: assigns a risk value to a permission
  - **RoleRisk**: returns estimated risk of a role
  - **CreateSession**: user creates a session and system calculate risk-threshold for the session
  - **PerformTask**: user tries to perform a task that might cause a role activation
  - **CheckAccess**: called by PerformTask function, it checks if user is authorized for a permission
  - **AddActiveRole**: called by CheckAccess, tries to activate if there is a role for the requested permission
  - **Deactivation**: called by AddActiveRole to deactivate some already activated roles in order to activate a role for the requested permission