

Access Control Models Part II

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Introduction

Other models:

- The Chinese Wall Model – it combines elements of DAC and MAC
- RBAC Model – it is a DAC model; however, it is sometimes considered a policy-neutral model
- The Biba Model – relevant for integrity

The Chinese Wall Access Control Model

Conflict of Interest

- It is a well known concept
- An example in the financial world is that of a market analyst working for a financial institution providing corporate business services
- Such analyst must uphold the confidentiality of information provided to him by his firm's client; this means he/she cannot advise corporations where he/she has *insider knowledge* of the plans, status and standing of a competitor
- However the analyst is free to advice corporations which are not in competition with each other, and also to draw on general market information

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By Amey Stone

A Chinese Wall -- or Several Fences?

Strictly dividing Wall Street research from investment banking may be too painful. However, smaller but still useful steps can be taken

It sounds like a no-brainer: The best way to end conflicts of interest between research and investment banking would be for firms to separate the two divisions, right? If research operates independently, the theory goes, analysts could express their true views on stocks without fear of cramping the style of investment bankers, who typically earn the bulk of most firms' income.

The problem is that this obvious solution creates a lot of problems. Wall Street research operations are so costly that firms couldn't keep as many analysts on staff or cover as many companies if their work wasn't subsidized to some extent by investment banking. Most analysts would end up either paid a lot less or be out of a job. Even then, the new



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When the fix was in

How Wall Street's storied Chinese wall failed investors

By Richard J. Newman and Peter Basso

On Wall Street, there are bulls and bears. And now—well, now there are bloodhounds. With the collapse of the tech sector and the nose dive in the Dow, regulators, shareholders, and lawyers are baying for blood. Investigators from the Securities and Exchange Commission and the Department of Justice are examining whether questionable—and maybe criminal—behavior occurred at some of the top-tier underwriting firms that fueled the white-hot market for initial public offerings from 1998 to 2000. "I am deeply troubled by evidence of Wall Street's erosion of the bedrock of ethical conduct," said Republican Rep. Richard Baker of Louisiana last week at congressional hearings. "Our first goal . . . is to begin a process of rebuilding confidence in the market."

That's why the Securities Industry Association unveiled a new code of ethics for Wall Street stock pickers last week. The new rules are designed to prevent analysts from thinking of self-gain or their bosses' approval when they make "buy" or "hold" calls. But for many investors, the push for "integrity" comes way too late. Some of the same folks who once sued for access to IPOs are now joining class action suits,

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Chinese Wall Policy

Introduced by Brewer and Nash in 1989

The motivation for this work was to avoid that sensitive information concerning a company be disclosed to competitor companies through the work of financial consultants

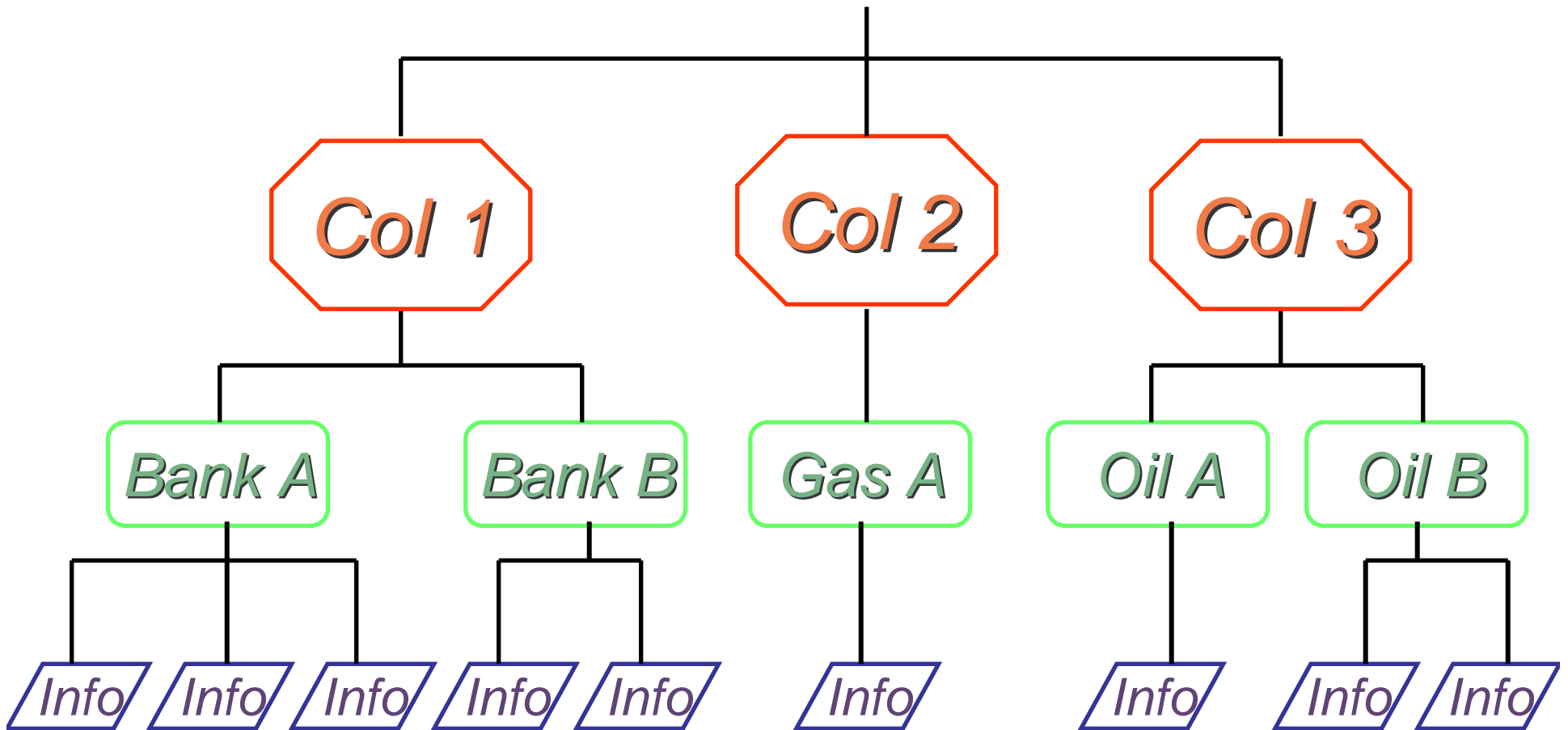
- It dynamically establishes the access rights of a user based on what the user has already accessed

Chinese Wall Policy

- *Subjects*: Active entities accessing protected objects
- *Objects*: Data organized according to 3 levels
 - » Information
 - » DataSet
 - » Conflict-of-Interest (Col) classes
- *Access Rules*
 - » Read rule
 - » Write rule

Data Classification

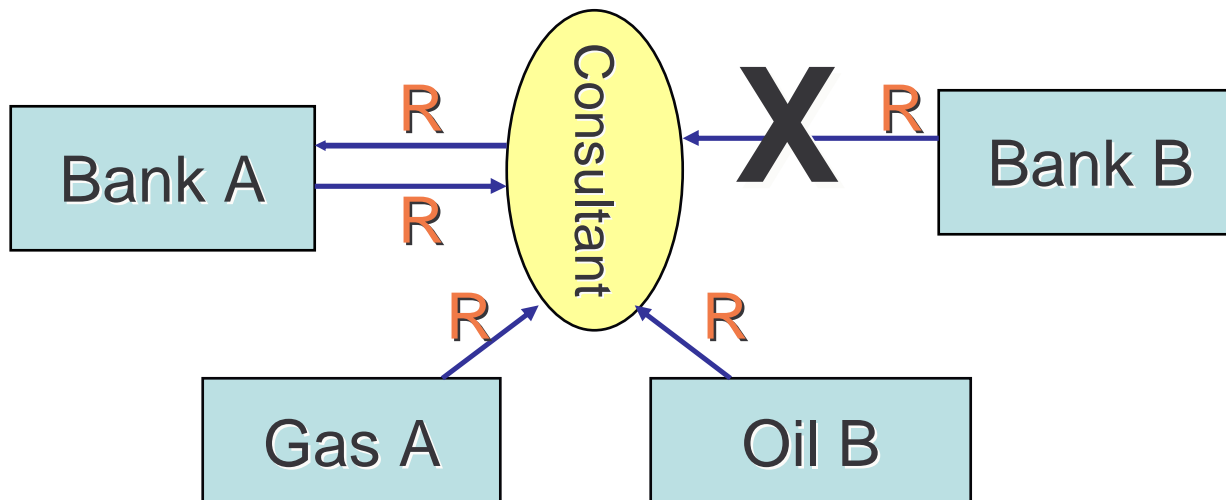
Set of All Objects




Read Rule

Read Rule: A subject S can read an object O if :

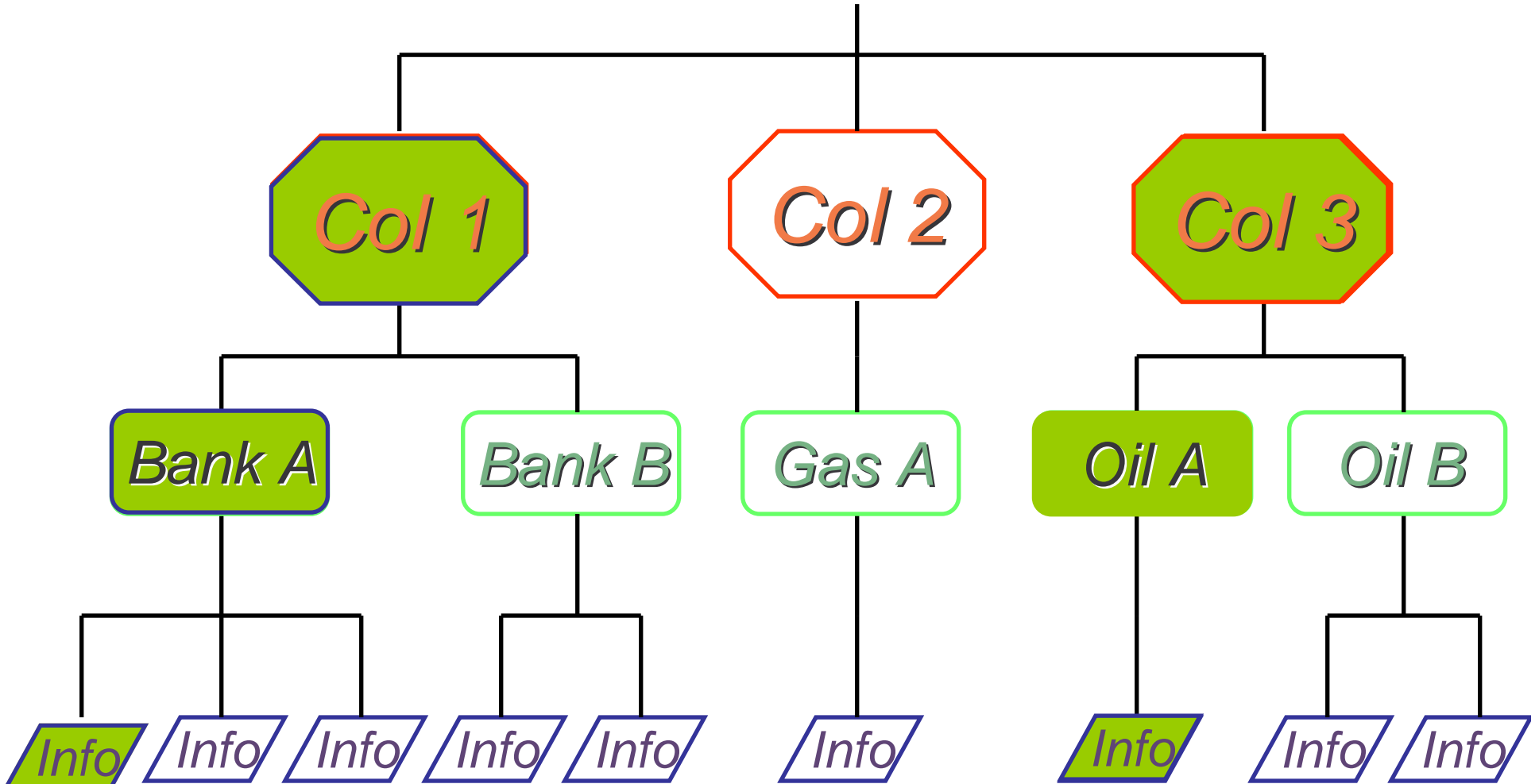
- O is in the same Dataset as an object already accessed by S OR
- O belongs to a Col from which S has not yet accessed any information



Read Rule

 = John

Set of All Objects



Comparison with Bell-LaPadula

- The Chinese Wall Policy is a combination of free choice and mandatory control
- Initially a subject is free to access any object it wishes
- Once the initial choice is made, a *Chinese Wall* is created for that user around the dataset to which the object belongs
- Note also that a Chinese Wall can be combined with DAC policies

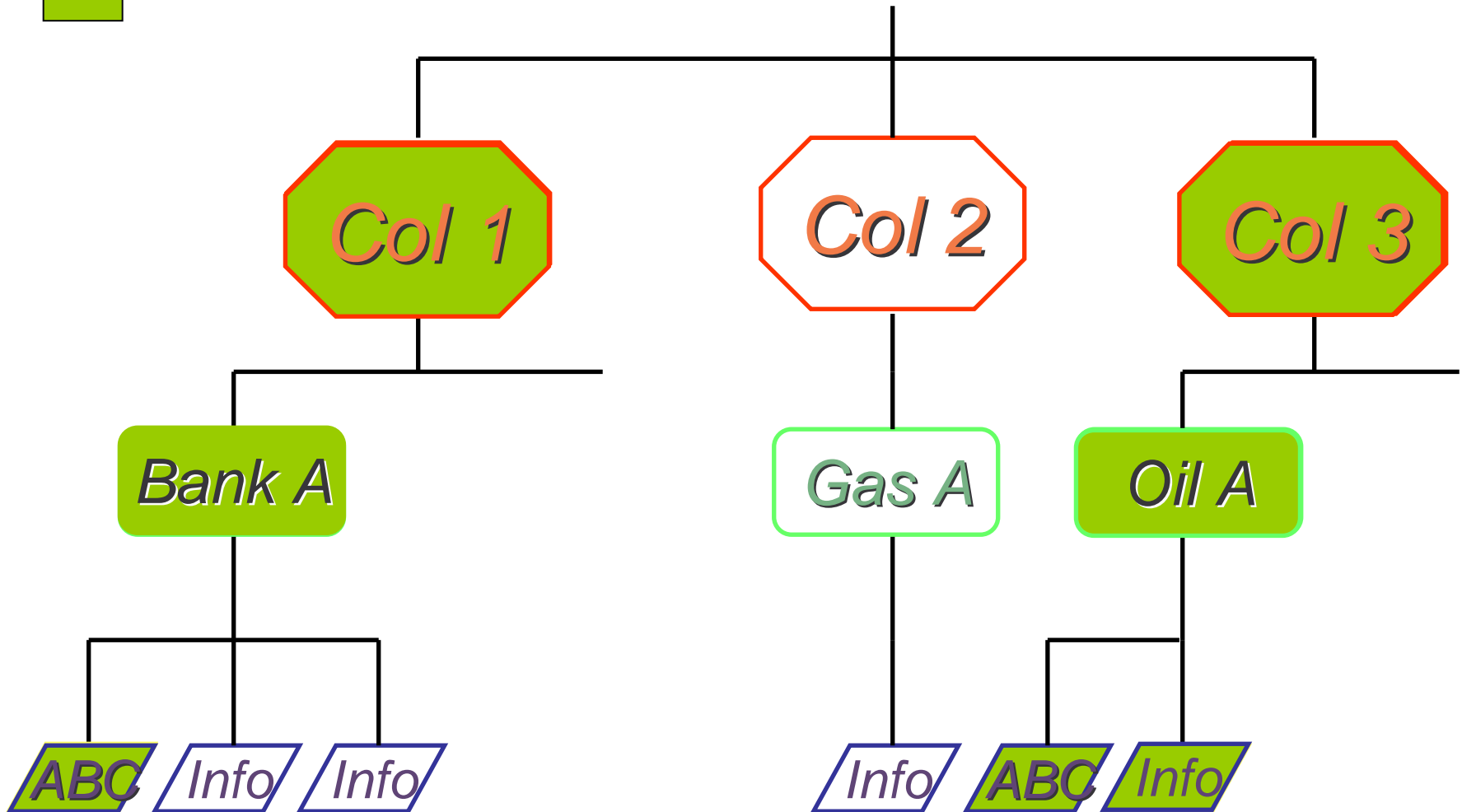
Write Rule

- The Read Rule does not prevent indirect flow of information
- Consider the following case:
 - John has access to
 - Oil A and Bank A
 - Jane has access to
 - Oil B and Bank A
 - If John is allowed to read Oil A and write into Bank A, it may transfer information about Oil A that can then be read by Jane

Write Rule

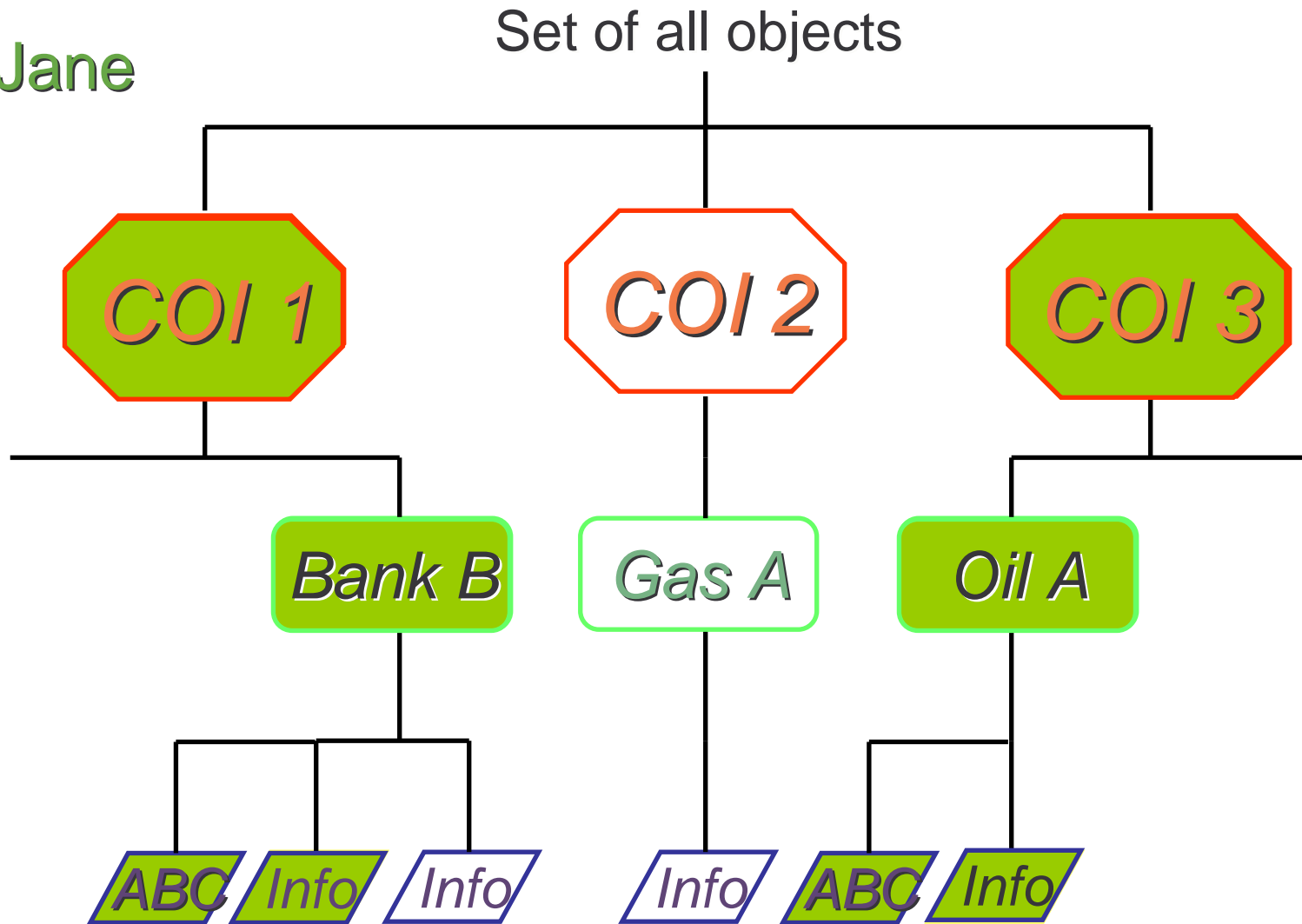
■ = John

Set of all objects



Write Rule

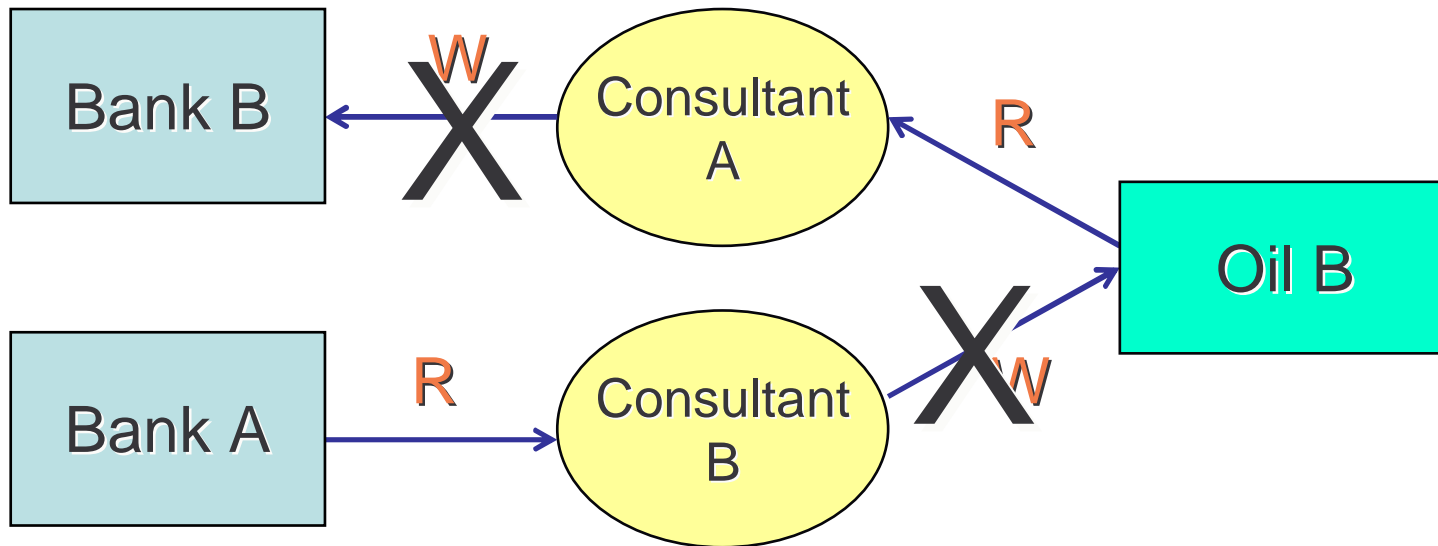
■ = Jane



Write Rule

Write Rule: A subject S can write an object O if:

- S can read O according to the Read Rule AND
- No object has been read by S which is in a different company dataset to the one on which write is performed



Write Rule

Thus, according to the write rule:

The flow of information is confined to its own company dataset

Sanitized Information

- Brewer and Nash recognize the need for analysts to be able to compare information they have with that relating to other corporations
- Thus they recognize that access restriction can be lifted for **sanitized information**
- Sanitization takes the form of disguising a corporation's information, so to prevent the discovery of that corporation identity

Criticisms to the Model

The Write Rule of BN is very restrictive:

- A user that has read objects from more than one dataset is not able to write any object
- The user can only read and write objects from a single dataset

Role Based Access (RBAC) Control Model

RBAC: Motivations

- One challenging problem in managing large systems is the complexity of security administration
- Whenever the number of subjects and objects is high, the number of authorizations can become extremely large
- Moreover, if the user population is highly dynamic, the number of grant and revoke operations to be performed can become very difficult to manage

RBAC: Motivations

- End users often do not own the information for which they are allowed access. The corporation or agency is the actual **owner** of data objects
- Control is often based on employee functions rather than data ownership
- RBAC has been proposed as an *alternative* approach to DAC and MAC both to simplify the task of access control management and to directly support function-based access control

RBAC: Basic Concepts

- Roles represent functions within a given organization and authorizations are granted to roles instead of to single users
- Users are thus simply authorized to "play" the appropriate roles, thereby acquiring the roles' authorizations

RBAC: Benefits

- Because roles represent organizational functions, an RBAC model can directly support security policies of the organization
- Granting and revoking of user authorizations is greatly simplified
- RBAC models have been shown to be policy-neutral

RBAC

- DBMS vendors have recognized the importance and the advantages of RBAC, and today most of the commercial DBMSs support RBAC features at some extents
- There is some consensus on a standard RBAC model
- The NIST model [Sandhu,Ferraiolo,Kuhn 00] has been the first step towards the definition of a standard
- A recent definition is by ANSI. American national standard for information technology – role based access control. ANSI INCITS 359-2004, February 2004

NIST Model

- Three main levels of increasing functional capabilities
 - Core RBAC – also called Flat RBAC
 - Hierarchical RBAC
 - Constrained RBAC

RBAC- Basic concepts

- *User* – is defined as a human being, a machine, a process, or an intelligent autonomous agent, etc.
- *Role* – is a function within the context of an organization with an associated semantics regarding its authority and responsibility

RBAC- Basic concepts

- *Permission* – is an access mode that can be exercised on objects in the system. Both objects and access modes are domain dependent. For example, in the case of databases, the object set includes tables, columns, and rows, and the access mode set includes insert, delete, and update operations.

RBAC- Basic concepts

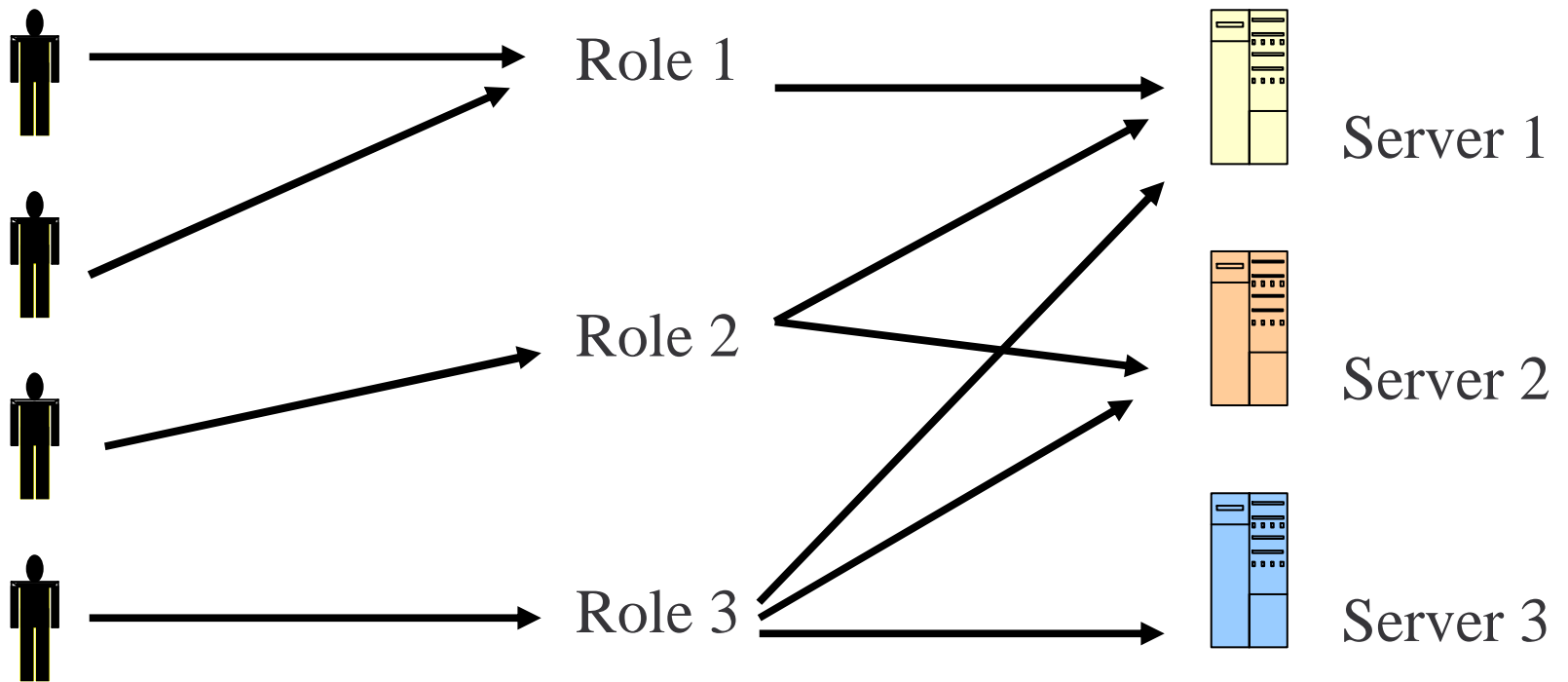
- *Session* – it is a particular instance of a connection of a user to the system and defines the subset of activated roles. At each time instant, different sessions for the same user can be active. When a user logs in the system, he/she establishes a session and, during this session, can request to activate a subset of the roles he/she is authorized to play. The user obtains all permissions associated with the role he/she has activated in the session

Role-Based AC

Individuals

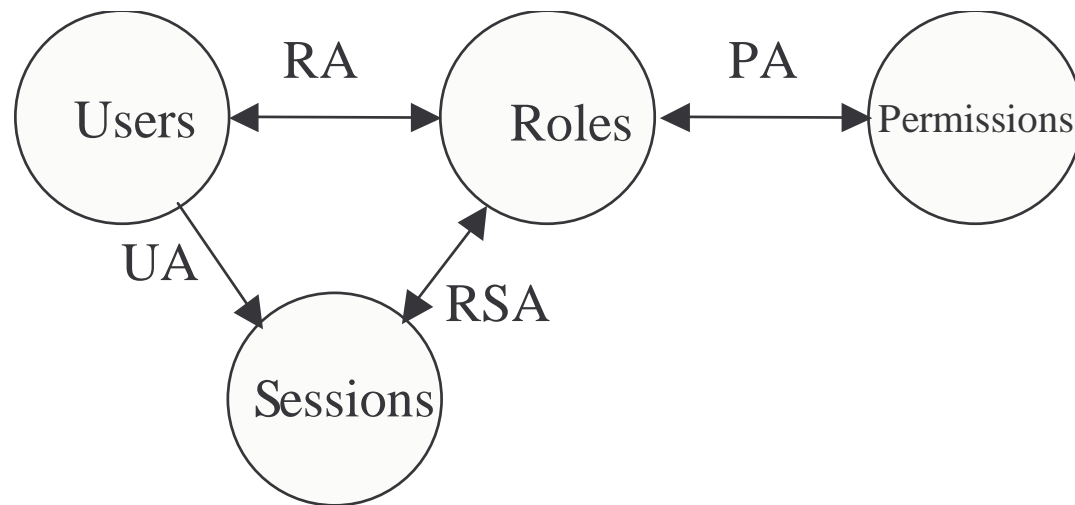
Roles

Resources

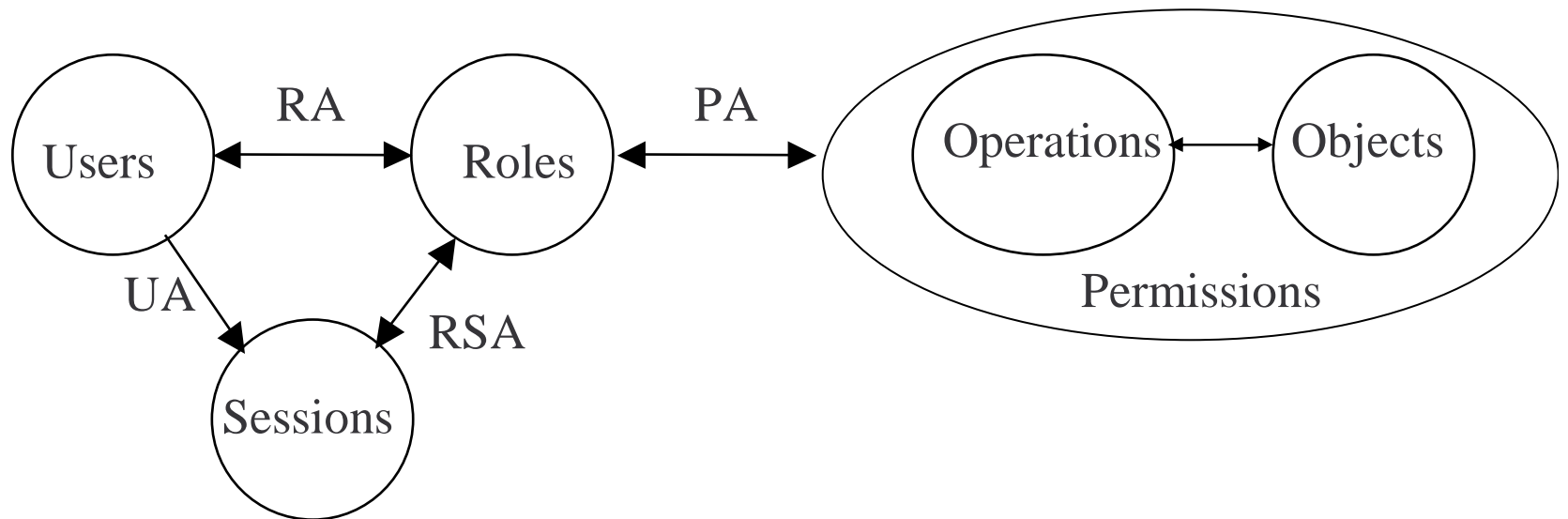


User's change frequently, Roles don't

Core RBAC



Core RBAC - Permissions



Core RBAC

Sets, Functions, and Relations

- $USERS$, $ROLES$, OPS , and OBS
- $UA \subseteq USERS \times ROLES$, a many-to-many mapping user-to-role assignment relation
- $assigned_users: (r: ROLES) \rightarrow 2^{USERS}$, the mapping of a role r onto a set of users. Formally:
 - $assigned_users(r) = \{u \in USERS \mid (u, r) \in UA\}$
- $PRMS = 2^{(OPS \times OBS)}$, the set of permissions
- $PA \subseteq PRMS \times ROLES$, a many-to-many mapping permission-to-role assignment relation
- $assigned_permissions: (r: ROLES) \rightarrow 2^{PRMS}$, the mapping of a role r onto a set of permissions. Formally:
 - $assigned_permissions(r) = \{p \in PRMS \mid (p, r) \in PA\}$

Core RBAC

Sets, Functions, and Relations

- $Op(p : PRMS) \rightarrow \{op \subseteq OPS\}$, the permission to operation mapping, which gives the set of operations associated with permission p
- $Ob(p : PRMS) \rightarrow \{op \subseteq OBS\}$, the permission to object mapping, which gives the set of objects associated with permission p
- $SESSIONS$ = the set of sessions
- $session_users(s : SESSIONS) \rightarrow USERS$, the mapping of session s onto the corresponding user
- $session_roles(s : SESSIONS) \rightarrow 2^{ROLES}$, the mapping of session s onto a set of roles. Formally:
 - $session_roles(s) = \{r \in ROLES \mid (session_users(s), r) \in UA\}$
- $avail_session_perms(s : SESSIONS) \rightarrow 2^{PRMS}$, the permissions available to a user in a session. Formally:
 - $avail_session_perms(s) = \bigcup_{r \in session_roles(s)} assigned_permissions(r)$

Core RBAC - Sessions

- The notion of session is quite abstract – it is defined as “*a mapping between a user and an activated subset of roles that are assigned to the user*”
- Basic distinction:
 - *Single-role activation (SRA)* Only one role can be activated
 - *Multi-role activation (MRA)* Multiple roles can be activated in one session, and dynamic separation of duty constraints may be used to restrict concurrent activation of some roles
 - There are trade-offs between the use of these two types of session

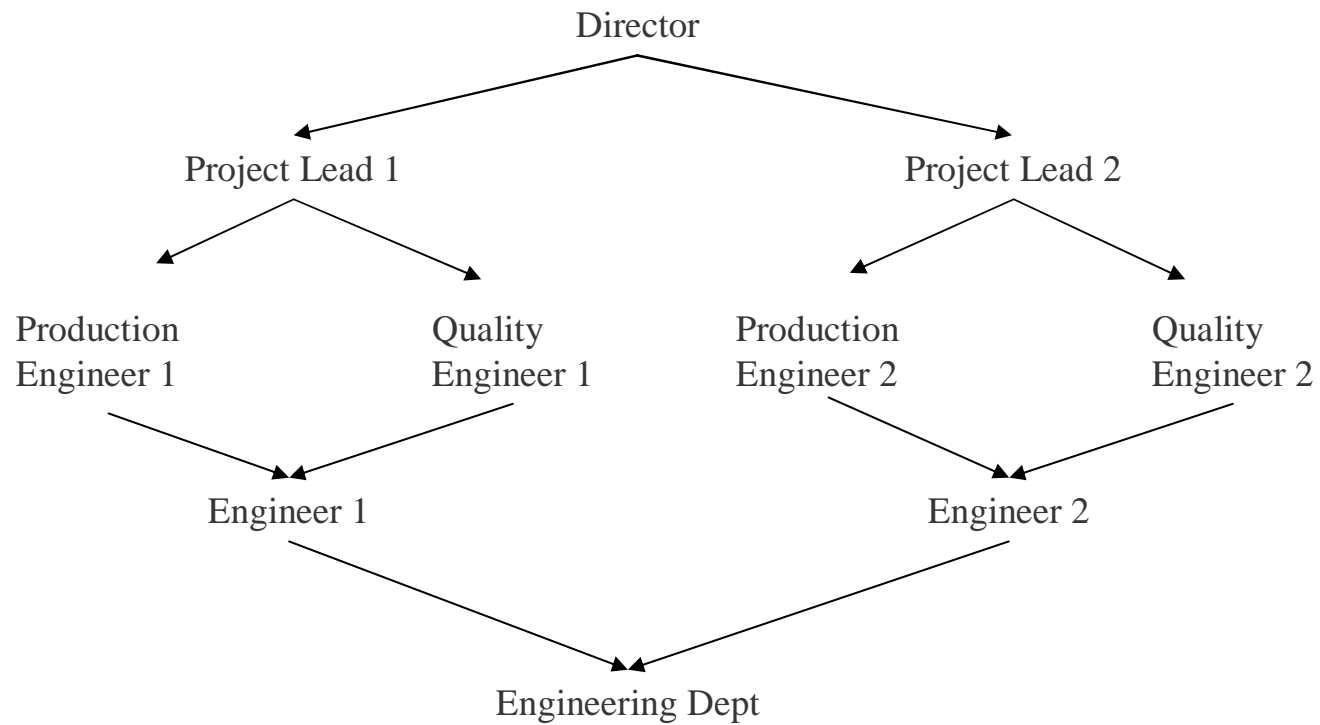
Hierarchical RBAC - Motivations

- Role hierarchies are a natural means for structuring roles to reflect an organization's line of authority and responsibility

Hierarchical RBAC - Model

- $RH \subseteq ROLES \times ROLES$ it is a relation defined on the set of roles in the system
- It has to be irreflexive and acyclic. We refer to this relation as *dominance relation*; if $(r_i, r_j) \in RH$ we say that r_i dominates r_j
- We also define a partial order \geq which is the reflexive and transitive closure of RH .
- An RBAC system may choose to store \geq or to compute it when needed

Example of RH



Hierarchical RBAC - Semantics

- User Inheritance (*UI*): All users authorized for a role r are also authorized for any role r' where $r \geq r'$
- Permission Inheritance (*PI*): A role r is authorized for all permissions for which any role r' , such that $r \geq r'$, is authorized
- Activation Inheritance (*AI*): Activating a role r automatically activates all roles r' , such that $r \geq r'$. This semantics can be used only if MRA sessions are used

Constrained RBAC

- Constrained RBAC is an RBAC model with the capability of supporting *Separation of Duties* policies
- Two main categories:
 - Static SoD
 - Dynamic SoD

RBAC - SoD Policies

- Enforces conflict of interest policies employed to prevent users from exceeding a reasonable level of authority for their position.
- Ensures that failures of omission or commission within an organization can be caused only as a result of collusion among individuals.

SoD Definitions

- ANSI: “Dividing responsibility for sensitive information so that no individual acting alone can compromise the security of the data processing system”
- The U.S. Office of Management and Budget’s Circular A-123: “Key duties and responsibilities in authorizing, processing, recording, and reviewing official agency transactions should be separated among individuals”.

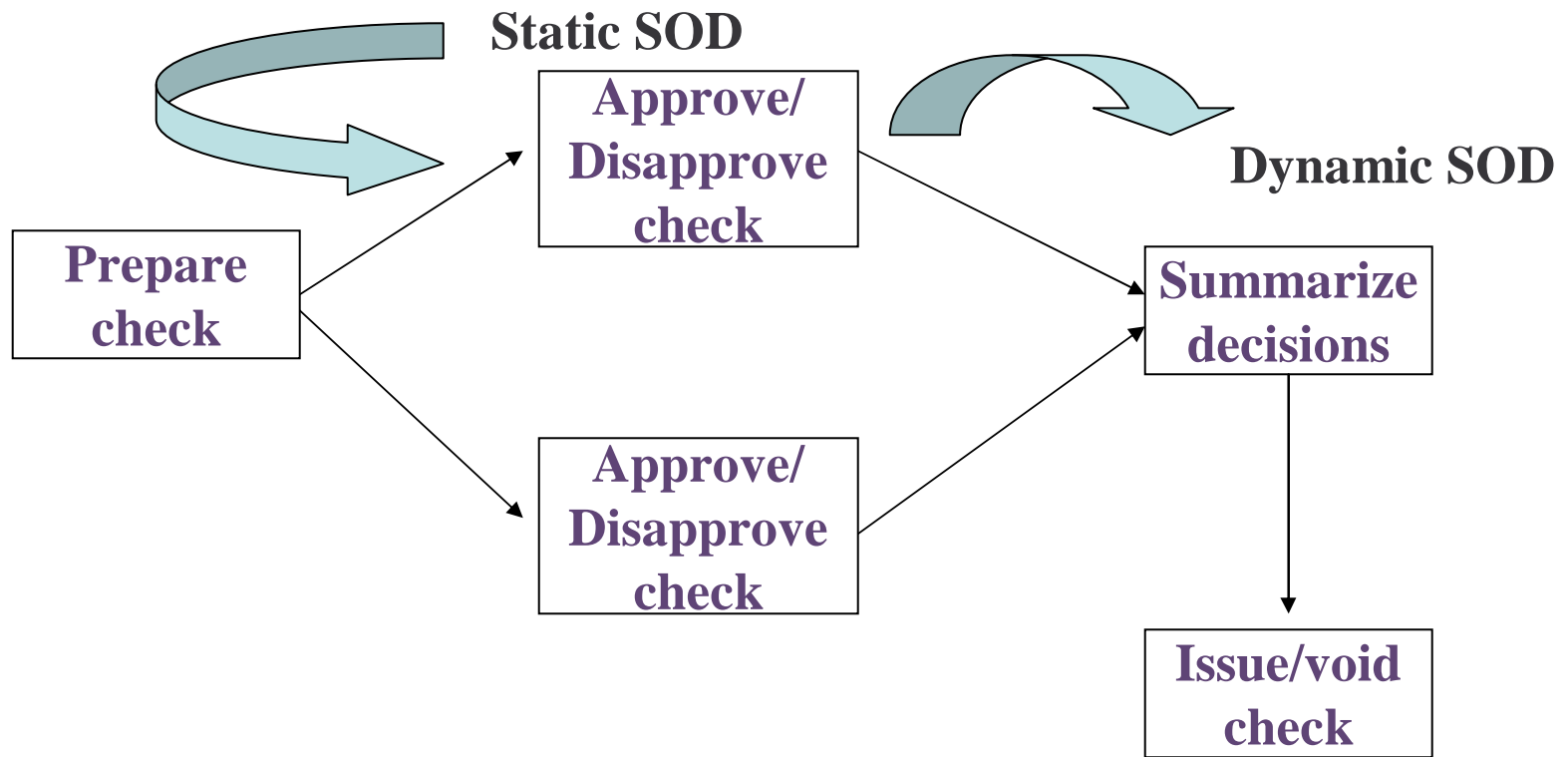
RBAC – Static SoD Constraints

- SSoD places restrictions on the set of roles and in particular on their ability to form *RA* relations.
- No user is assigned to t or more roles in a set of m roles
- Prevents a person being authorized to use too many roles
- These constraints can be enforced based on the users assigned to each role

RBAC – Dynamic SoD Constraints

- These constraints limit the number of roles a user can activate in a single session
- Examples of constraints:
 - No user may activate t or more roles from the roles set in each user session.
 - If a user has used role $r1$ in a session, he/she cannot use role $r2$ in the same session
- Enforcement of these roles requires keeping the history of the user access to roles within a session

Constraint RBAC



RBAC System and Administrative Functional Specification

- Administrative Operations
 - Create, Delete, Maintain elements and relations
- Administrative Reviews
 - Query operations
- System Level Functions
 - Creation of user sessions
 - Role activation/deactivation
 - Constraint enforcement
 - Access Decision Calculation