Towards a Framework for Group-Centric Secure Collaboration

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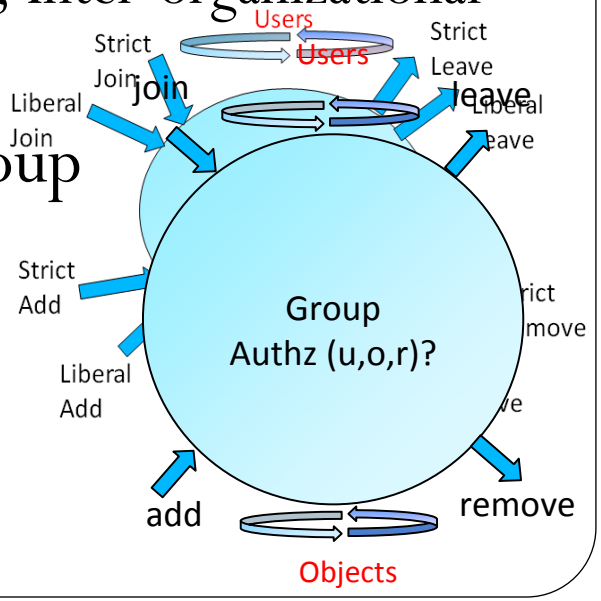
Group-Centric Collaboration

- Share/Collaborate for a specific purpose or mission
  - E.g. Collaboration in joint product design, merger and acquisition, etc.
- Emerging needs in Government and Commercial Organizations
  - E.g. Mission critical operations post 9/11, Inter-organizational collaboration, etc.
- Brings users & objects together in a group
  - Secure Meeting Room
  - Subscription Model



Group-Centric Collaboration (contd)

Operational aspects

- Group Characteristics
  - Core properties
  - Membership semantics
  - Membership renewal semantics
  - g-SIS specification
- Object Model
  - Read-only
  - Read-write (versioning?)
- User-Subject Model
  - User: Representation of human in the system
  - Subject: Programs/processes (untrusted)

Administrative aspects

- Group Lifecycle
- Group Membership

Inter-group relations

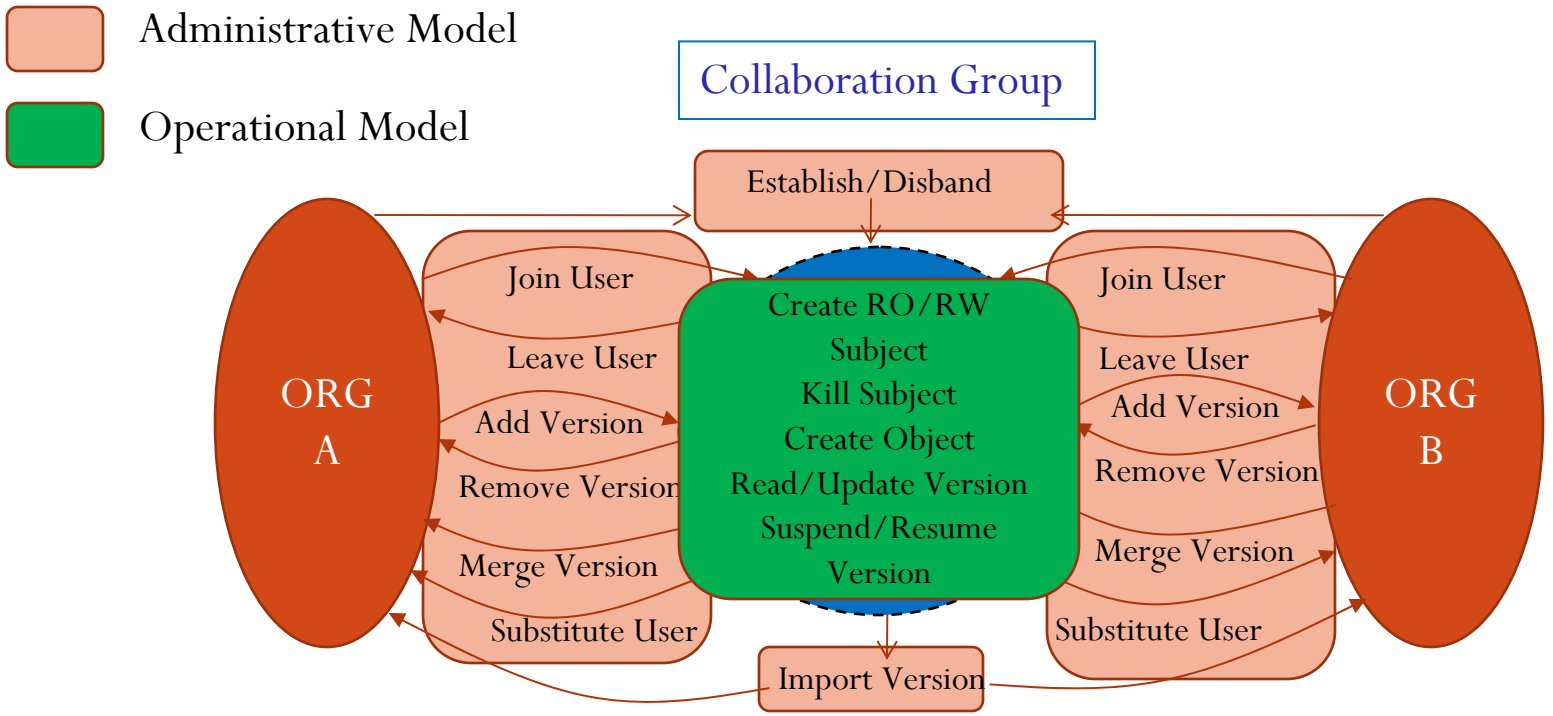
- Subordination
- Conditional Membership
- Mutual Exclusion

Object Model

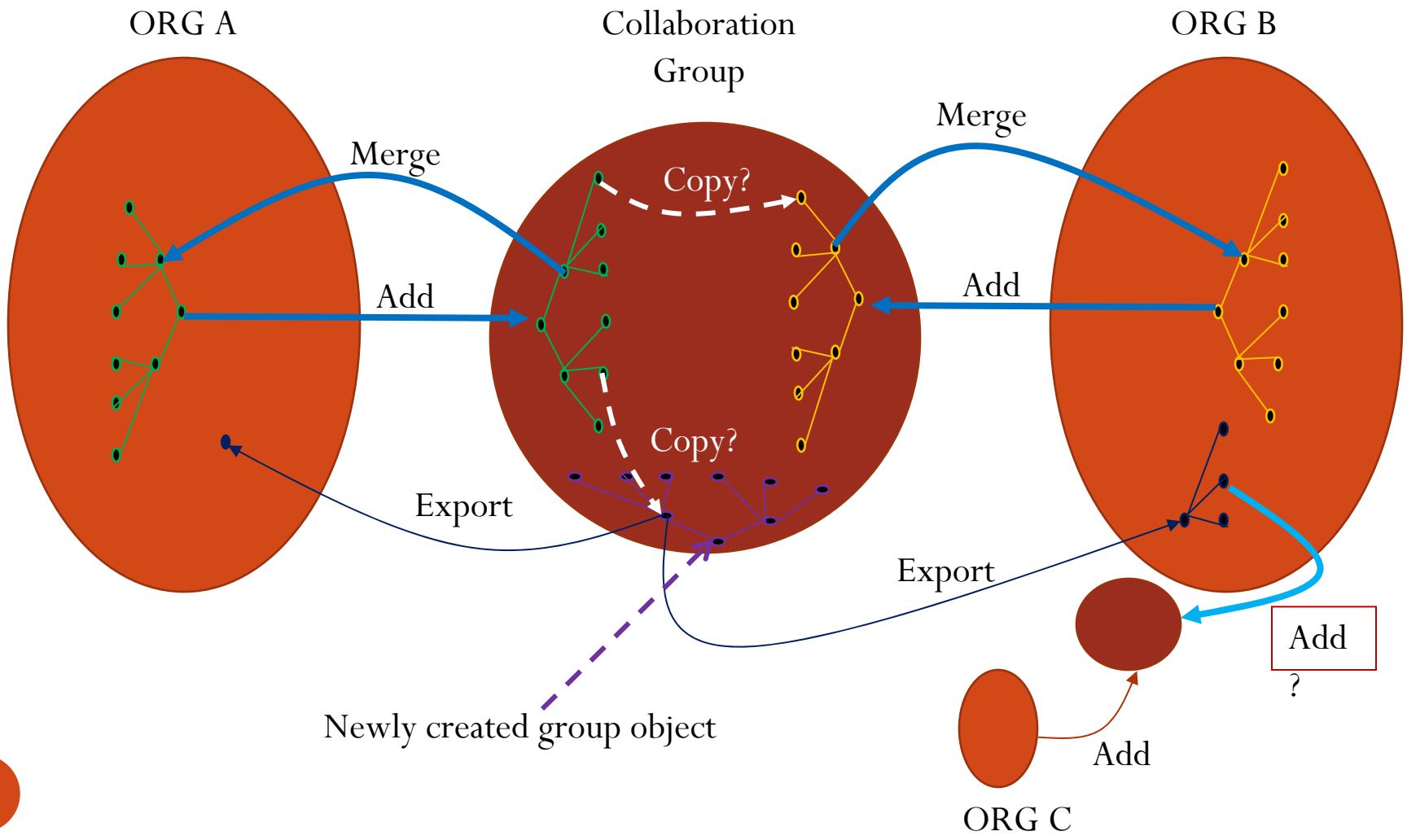
No Versioning	Versioning
1. Multiple users may update, latest write is committed (destructive write).	1. Multiple users may update, each update creates a new version.
2. Coarse-grained authorization (specified on the whole object).	2. Fine-grained. Authorization can differ for different versions of the same object.
3. Tricky issues if read allowed after leave. 3.1 Fix: No read after write	3. No such issues. Past users may continue to read versions authorized at leave time. No access to new versions after leave.
4. Write after Leave?	4. Write after Leave?

Objective

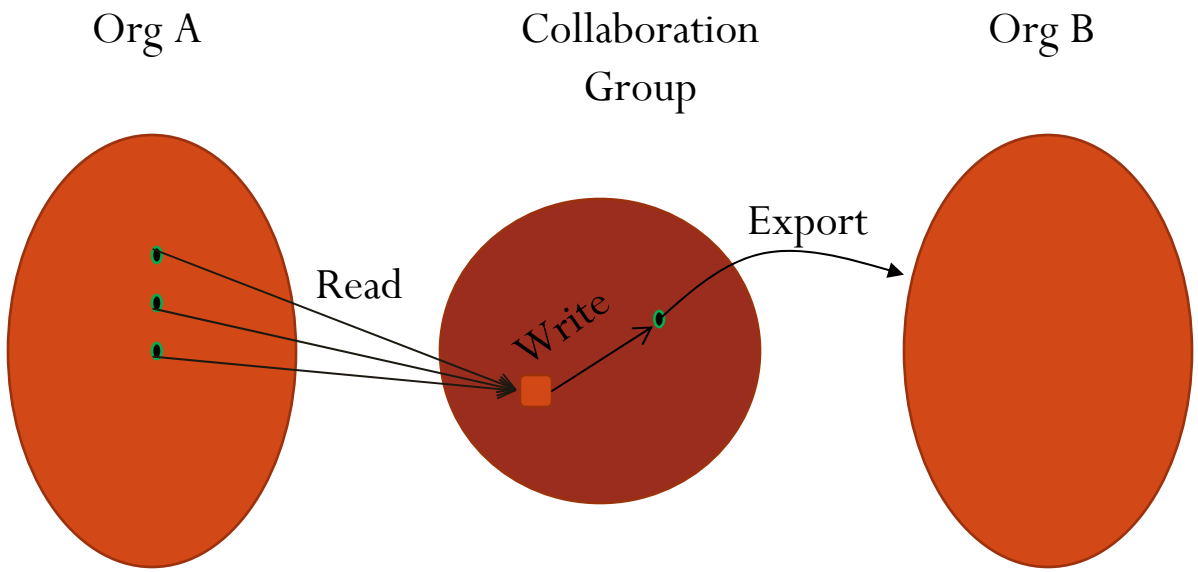
- Systematically study authorization aspects in a simple inter-organizational collaboration scenario



Merge Vs Export of Object Versions



Read-only Vs Read-Write Subjects



- Read Only subjects can read from multiple groups/entities
- Read-Write subjects restricted to one group

Malicious Group Subject

Object

Attribute Definitions

Universal sets of names:
UNIV_ORG: The universe of organizations
UNIV_CG: The universe of collaboration groups
UNIV_U: The universe of users
UNIV_S: The universe of subjects
UNIV_O: The universe of objects
UNIV_V: The universe of versions

Existing sets of names:
ORG: Set of all existing collaborating organizations
CG: Set of all existing groups established between orgs in ORG
U: Set of all existing users
S: Set of all existing subjects
O: Set of all existing objects

User Attributes: Att (U) = {uorg, ucg, orgadmin, cgadmin}
uorg : $U \rightarrow ORG$
ucg : $U \rightarrow 2^{CG}$
orgadmin : $U \rightarrow \{True, False\}$
cgadmin : $U \rightarrow 2^{CG}$

Objects Attributes: Att (O) = {member, currV}
member : $O \rightarrow ORG \cup CG$
currV : $O \rightarrow 2^{UNIV\_V}$

Object Version Attributes: Att (O, UNIV_V) = {vMember, vSuspended, importable}
vMember : $O \times UNIV\_V \hookrightarrow 2^{ORG \cup CG}$
vSuspended : $O \times UNIV\_V \hookrightarrow \{True, False\}$
importable : $O \times UNIV\_V \hookrightarrow \{True, False\}$
As shown, vMember, vSuspended and importable are partial functions that are undefined for object versions that do not currently exist.

Group Attributes: Att (CG) = {assoc}
assoc : $CG \rightarrow 2^{ORG}$

Subject Attributes: Att (S) = {sOwner, type, belongsTo}
sOwner : $S \rightarrow U$
type : $S \rightarrow$ {ro, rw}
belongsTo : $S \rightarrow ORG \cup CG$

Specified a complete authorization model: Administrative and Operational

What can be guaranteed?

- A set of core safety properties can be guaranteed for group-centric collaboration models
- That is, we have shown that the specified authorization model satisfies the core safety properties

Core Properties

- Authorization Persistence
  - *Authorization cannot change if no group event occurs*

$$\varphi_0 = \Box(\text{Authz} \rightarrow (\text{Authz}\ \mathcal{W}\ (\text{Join} \vee \text{Leave} \vee\ \text{Add} \vee \text{Remove})))$$

$$\varphi_1 = \Box(\neg\text{Authz} \rightarrow (\neg\text{Authz}\ \mathcal{W}\ (\text{Join} \vee \text{Leave} \vee\ \text{Add} \vee \text{Remove})))$$

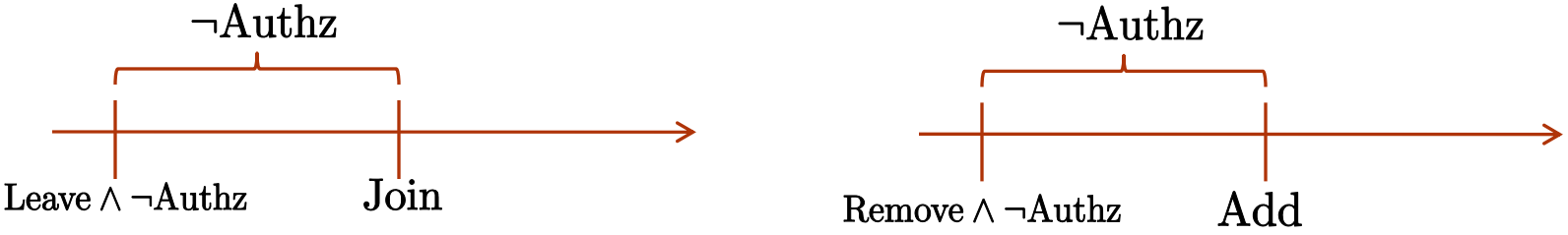
- Authorization Provenance
  - *Authorization can begin to hold only after a simultaneous period of user and object membership*

$$\varphi_2 = (\neg\text{Authz}\ \mathcal{W}\ (\text{Authz} \wedge (\neg\text{Leave}\ \mathcal{S}\ \text{Join}) \wedge (\neg\text{Remove}\ \mathcal{S}\ \text{Add})))$$

Core Properties

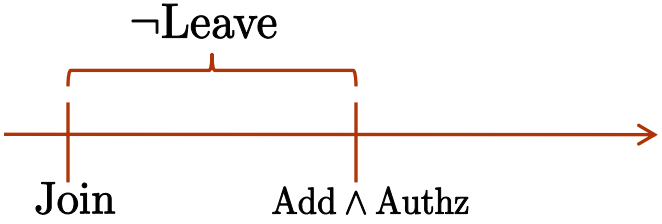
- Bounded Authorization
  - *Authorization cannot grow during non-membership periods*

$$\varphi_3 = \Box((\text{Leave} \wedge \neg\text{Authz}) \rightarrow (\neg\text{Authz}\ \mathcal{W}\ \text{Join}))$$
$$\varphi_4 = \Box((\text{Remove} \wedge \neg\text{Authz}) \rightarrow (\neg\text{Authz}\ \mathcal{W}\ \text{Add}))$$



- Availability
  - *On add, authorization should hold for all existing users at add time*

$$\varphi_5 = \Box(\text{Join} \rightarrow (\text{Add} \rightarrow ((\text{Authz}\ \mathcal{W}\ \text{Leave})\ \mathcal{W}\ \text{Leave})))$$



Richer Group-Centric Models

- "Begin Collaboration" Phase
  - Collaboration Group (CG) administration
  - Collaboration Structure
    - Flat group (no differentiation)
    - Flat group with differentiation (e.g. clearance/classification)
    - Structured groups with constraints (subordination, mutual exclusion etc.)
  - Participation Policy (users from non-collaborating orgs?)
- "Collaboration" Phase
  - Authentication to CG (Local Vs Federated)
  - CG membership (Local Vs Federated)
  - CG permissions (read-only, read-write, create, etc.)
- "End Collaboration" Phase (Publish Vs No Publish)
  - Tear down
  - Suspend

Conclusion and Future Work

- Group-Centric models are a natural fit for a many collaboration scenarios
  - Practical applications might require additional access control aspects
    - E.g. DAC, LBAC, RBAC, ABAC, etc.
- Future Work
  - Inter-group Relations: Subordination, Conditional Membership, Mutual Exclusion
  - Handling authorizations in case of change in relations
  - Study information flow