

Classifying and Comparing Attribute-Based and Relationship-Based Access control

by

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ACM CODASPY

March 22-24, 2017

Outline

- Introduction
- Background & Motivation
- Attributes: Definitions and Assumptions
- ReBAC Classification
- ABAC Classification
- Multilevel Relationship Expression With Attributes
- Comparison: ABAC Vs. ReBAC
- Conclusion

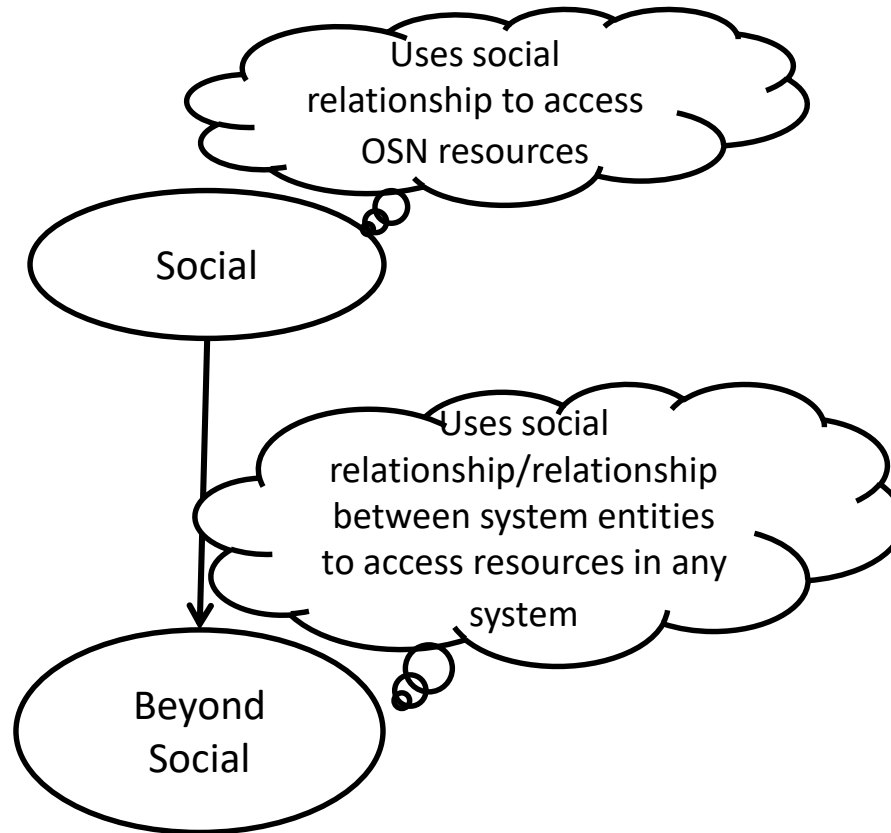


Figure 1: Using Relationship in Authorization policy expression is used for social and beyond social environment

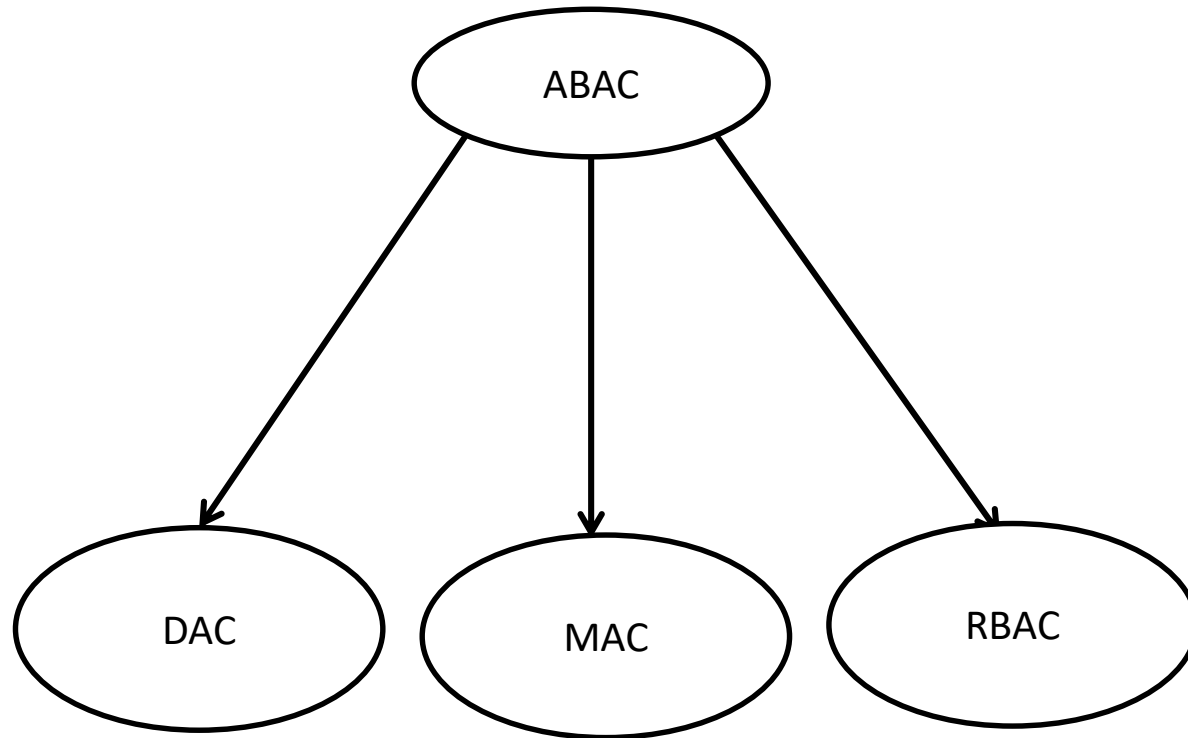
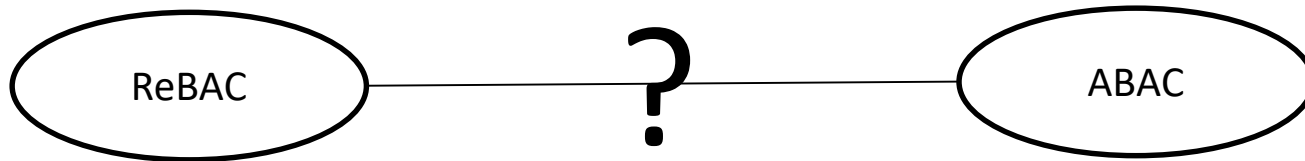


Figure 2: ABAC can configure DAC, MAC and RBAC [Zin et al. 2012]



- Are they Comparable ?
- Can Attributes Express Relationships?
- Can ReBAC Configure ABAC? Vice versa?
- Do they have equal expressive power?

If not

- Which one is more expressive?

1. Attribute Value Structure
 - Atomic-valued or Single-valued Attribute (e.g. gender)
 - Set-valued or Multi-valued Attribute (e.g. phoneNumber)
 - Structured Attribute (e.g person-Info (name, age, phoneNumber))
2. Attribute Value Scope
 - Entity Attribute (e.g. friend)
 - Non-entity Attribute (e.g. age)
3. Boundedness of attribute range
 - Finite Domain Attribute (e.g. gender)
 - Infinite Domain Attribute (e.g. time)
4. Attribute association
 - Contextual or Environmental Attribute (e.g. currentTime)
 - Meta Attribute (e.g. role(user) = manager , task(manager) = supervise)
5. Attribute mutability
 - Mutable Attribute
 - Immutable Attribute

$$f: X \rightarrow Y$$

$$g: Y \rightarrow Z$$

$$x \in X, g(f(x)) \in Z$$

- All non entity attribute are finite domain
- Entity attribute functions are partial functions defined on existing entities only
- Inner attribute function in an attribute function composition should always be entity attributes
- Structured attribute is a multivalued tuple of atomic or set-valued attributes. So it is more expressive than atomic or set-valued attribute.

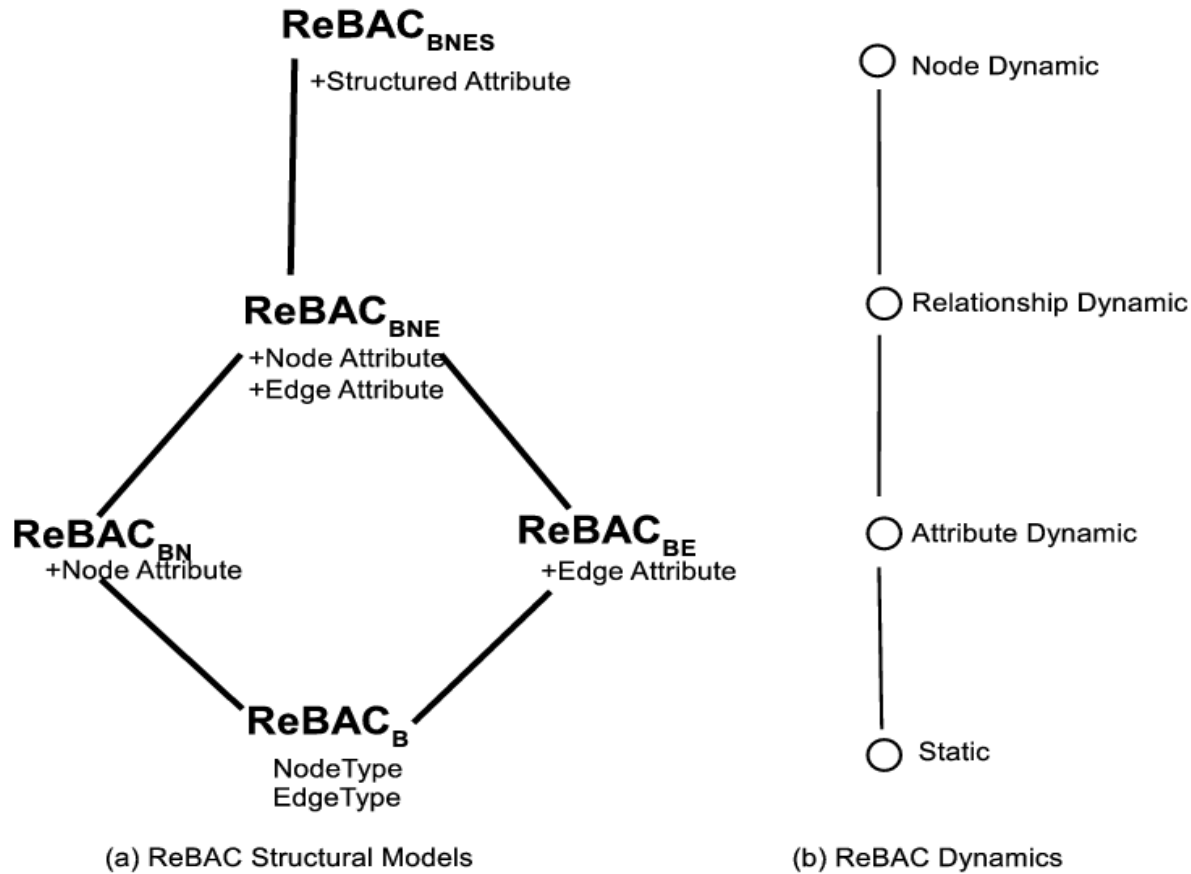


Figure 3.: ReBAC Framework

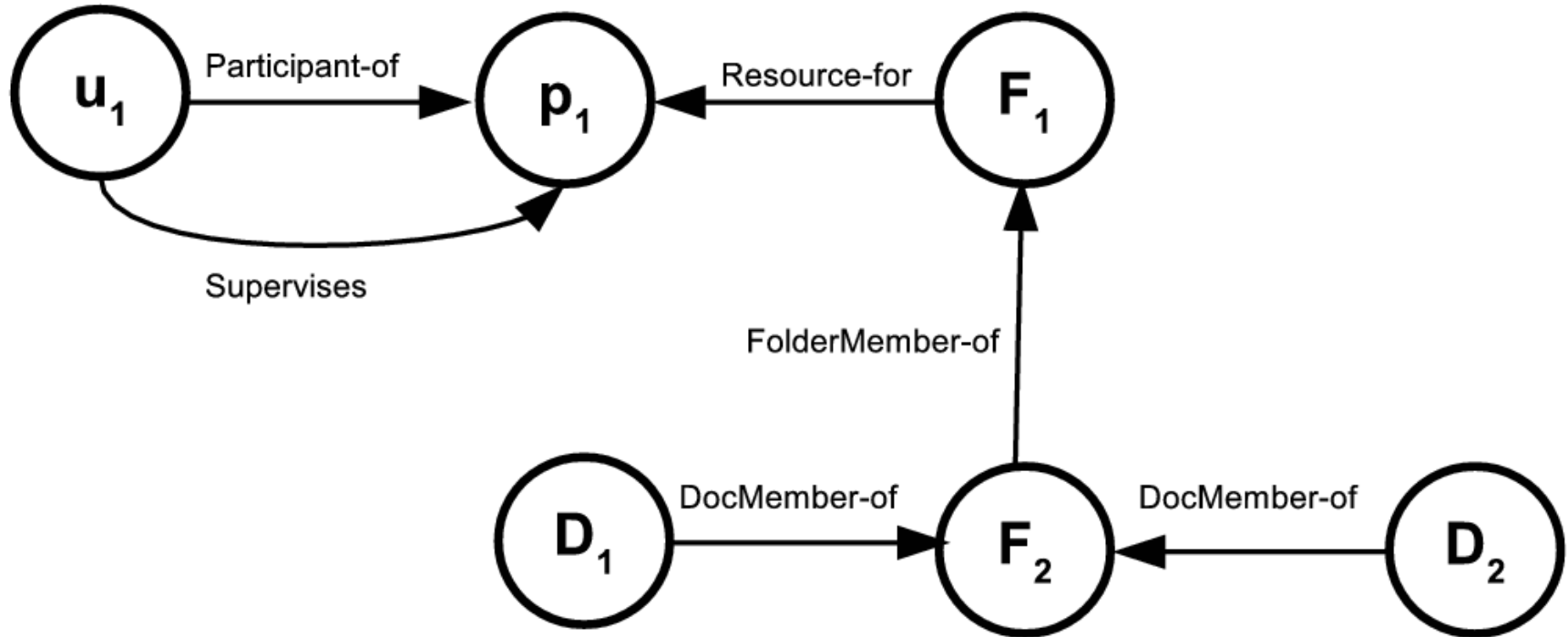


Figure 4.: A Simple Relationship Graph Expressible in ReBAC_B [Crampton et al. 2014]

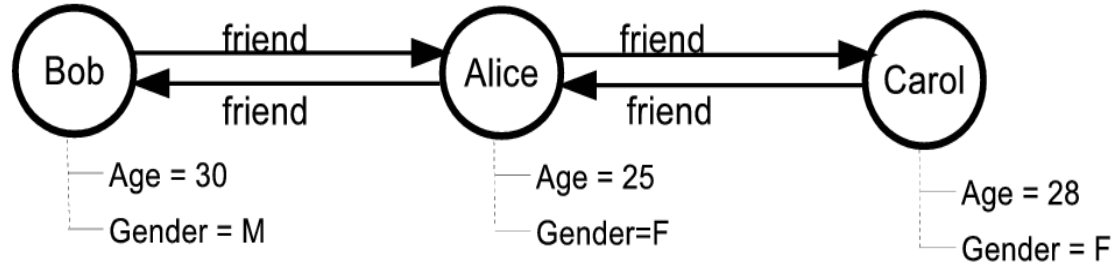


Figure 5: An Example of Node Attributes in Relationship Graph Expressible in ReBAC_{BN}

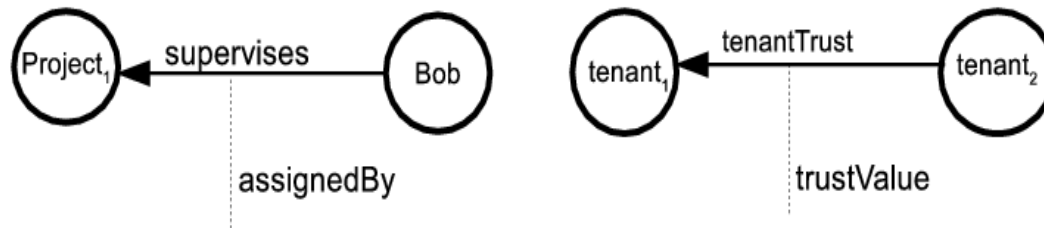


Figure 6: An Example of Edge Attributes in Relationship Graph Expressible in ReBAC_{BE}

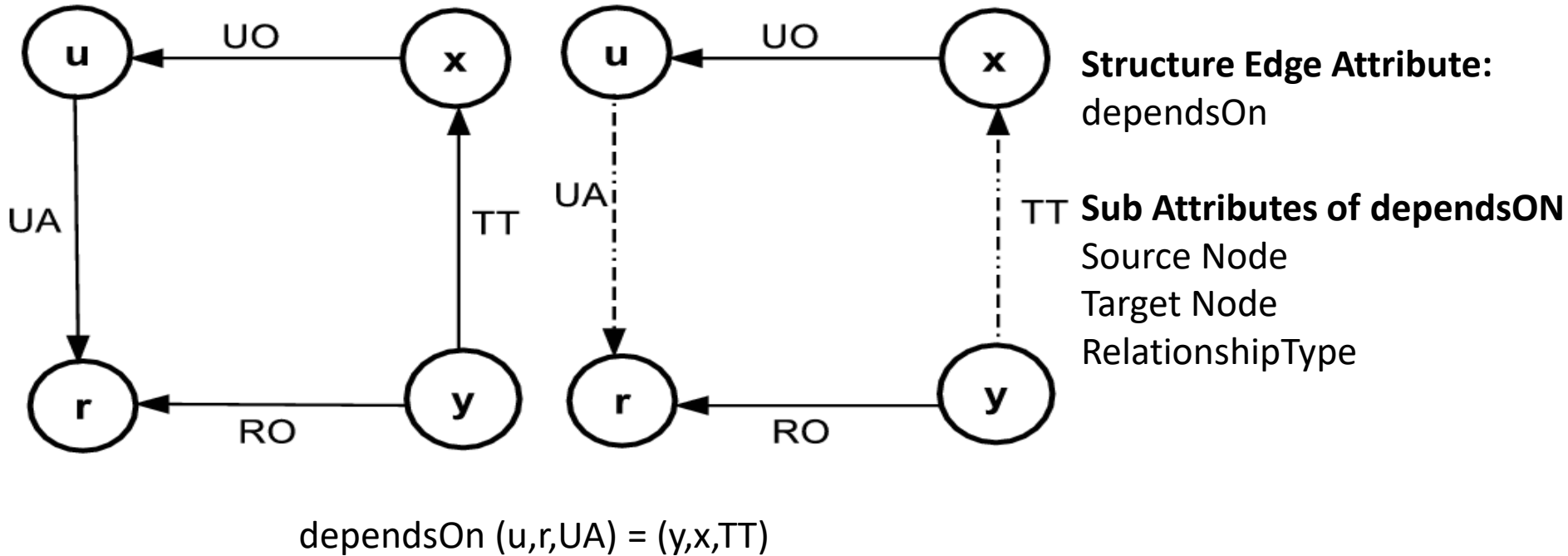


Figure 7: An Example of Node Attributes in Relationship Graph Expressible in $\text{ReBAC}_{\text{BNES}}$ [Cheng et al. 2016]

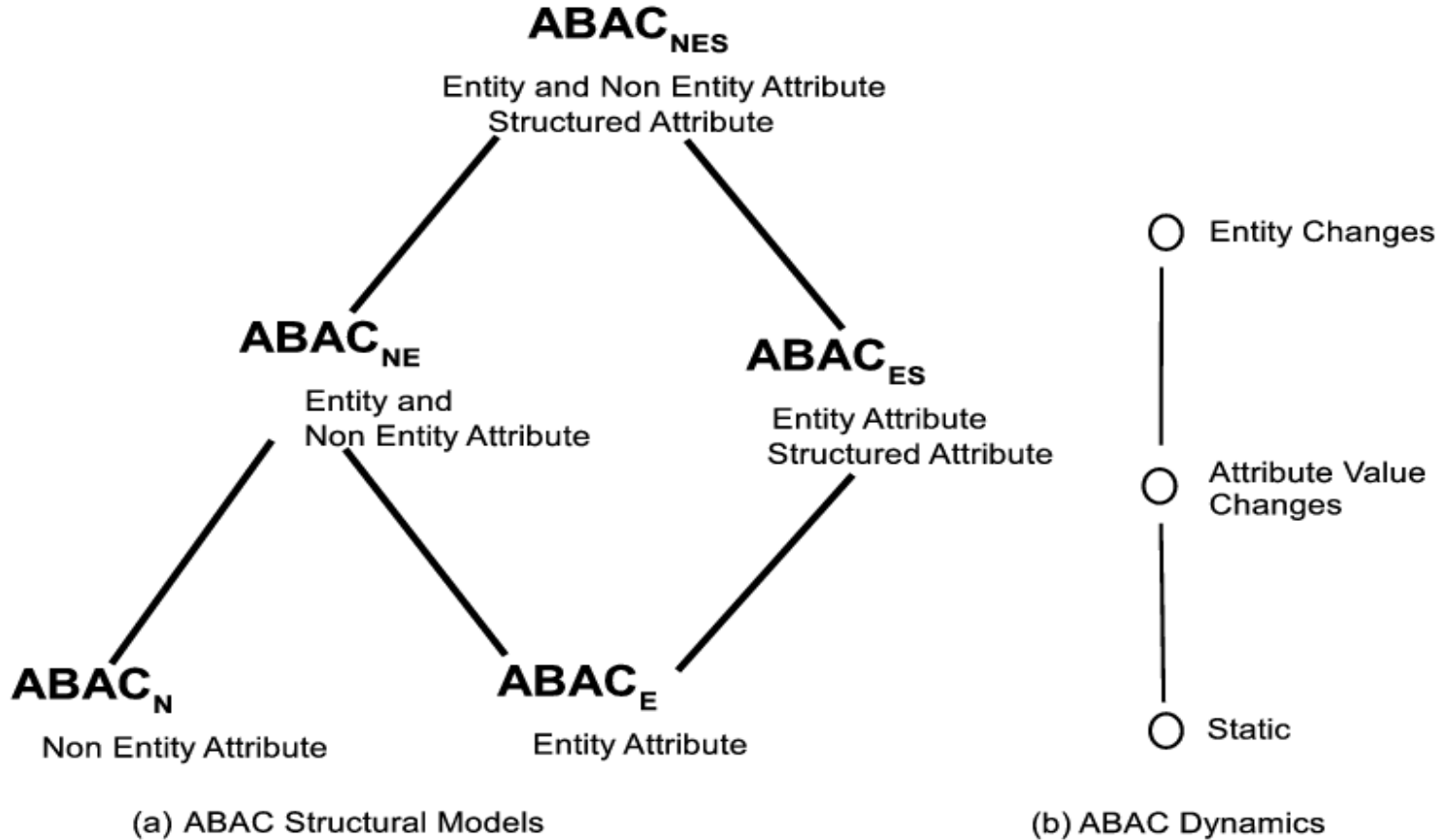
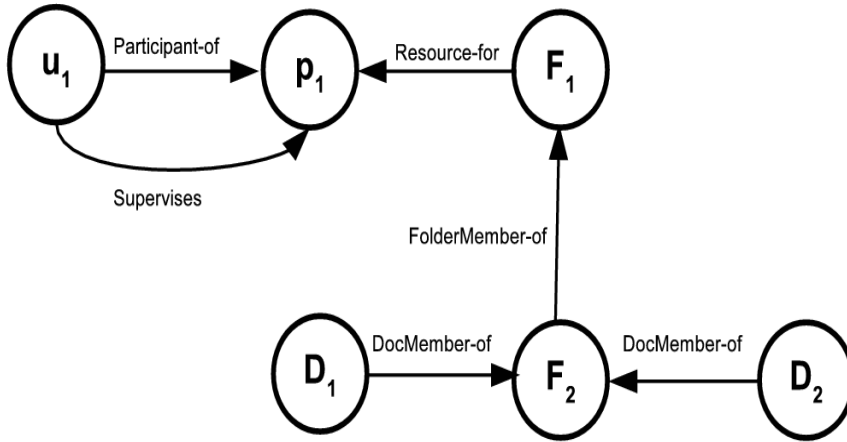
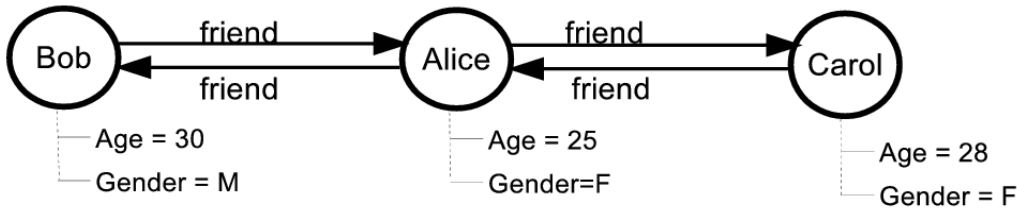


Figure 8: ABAC Framework



- Entity types = {user, project, folder , document}
- Attributes:
 - ❑ User attributes = {Participant-of, Supervises}
 - ❑ Folder attributes = {Resource-for, FolderMember-of}
 - ❑ Project attributes = {}
 - ❑ Document attributes = {DocMember-of}

Relationship Graph in Figure 4 is Expressible with ABAC_E

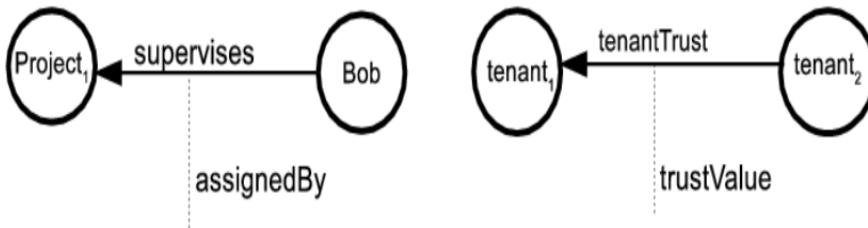


entityType = {user}

Attribute:

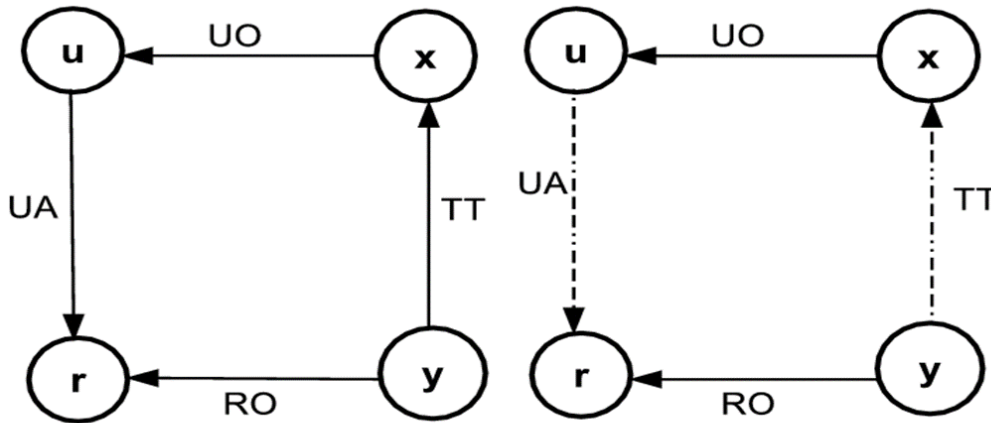
- User's entity attribute = {friend}
- User's Non Entity Attribute = {Name, Age, Gender}

Relationship Graph in Figure 5 is Expressible with ABAC_E



- entityType = {user, project, tenant}
 - Attribute:
 - user's atomic entity attribute = {supervises}
 - User's structured entity Attribute = {assignedBy}
- e.g. assignedBy(Bob) = ("Project1", "supervises", "Alice")

Relationship Graph in Figure 6 is Expressible with ABAC_{ES}



- Entity types: {user, tenant, role}
- Attribute:
 - ❑ User's atomic entity attribute: {UO,UA}
 - ❑ Users Structured Entity Attribute: {dependentEdge}
$$\text{dependentEdge}(u) = ("r", "UA", \{(y,x,TT)\})$$

Relationship Graph in Figure 7 is Expressible with $ABAC_{ES}$

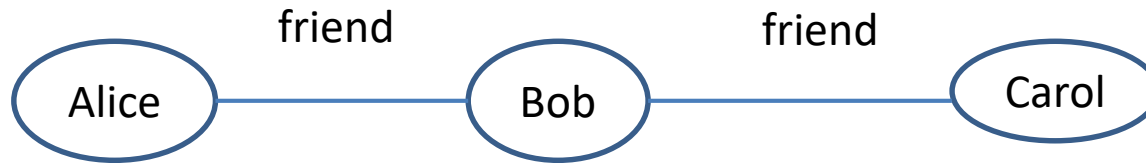


Figure 9. A simple Relationship Graph

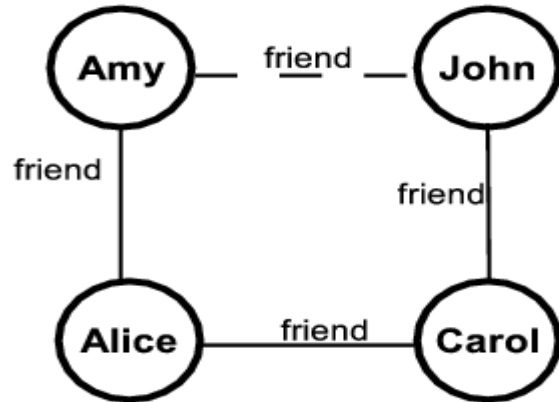
Attribute Composition

- ❑ Needs one attribute: friend
- ❑ Policy Expression uses Attribute composition

friend(Alice)={Bob}
friend(friend(Alice))={Carol}

Composite Attribute

- ❑ Needs two attribute
 1. friend
 2. friendOfFriend
- ❑ Policy Expression uses direct attributes
friend(Alice) = {Bob}
friendOfFriend(Alice)={Carol}



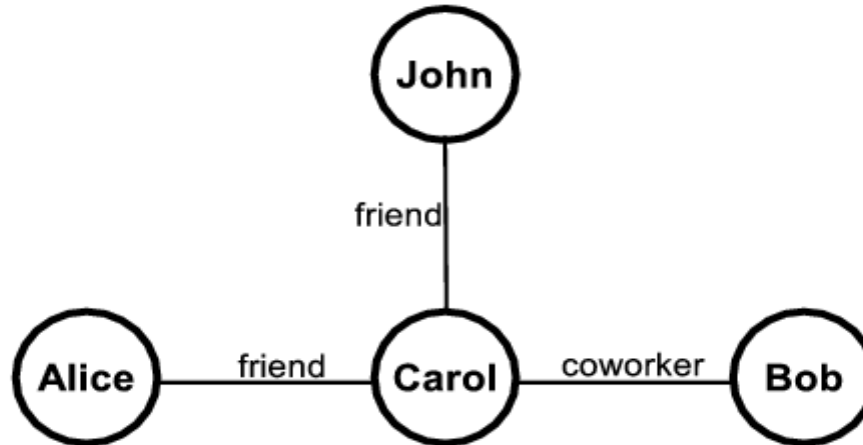
$\text{friend}(\text{Alice}) = \{\text{Amy}, \text{Carol}\}$
 $\text{friendOfFriend}(\text{Alice}) = \{\text{John}\}$

Figure 10. A simple Relationship Graph

If the friend relationship between Amy and John deleted

$\text{friendOfFriend}(\text{Alice}) = ?$

Instead of keeping the end user as attribute value we have to keep the exact path information.



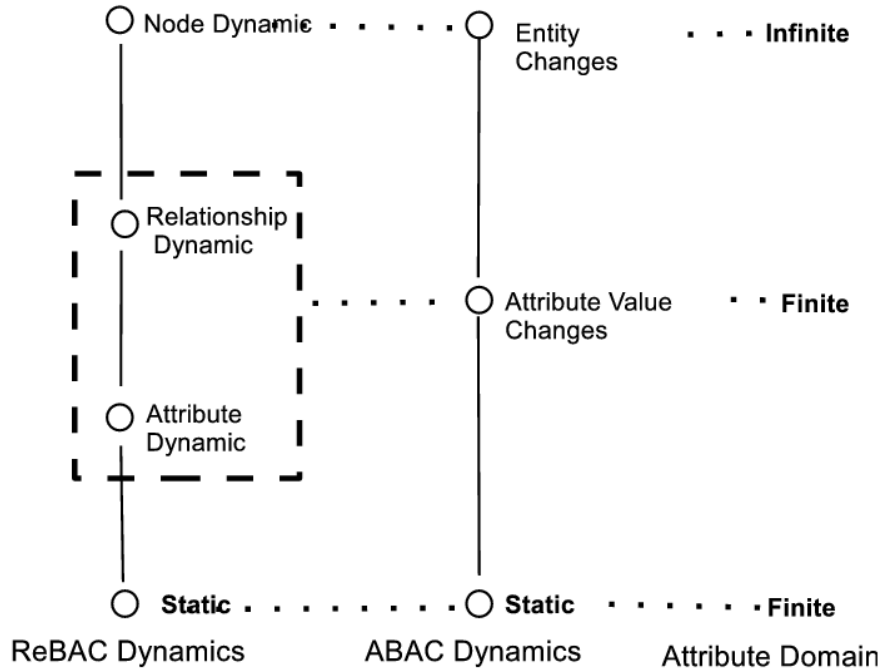
Attribute Composition:

friend ("Alice") = {"Carol"}
 coworker ("Alice") = { }
 friend (friend("Alice")) = { "John"}
 coworker(coworker("Alice")) = { }
 friend (coworker("Alice")) = { }
 coworker (friend("Alice")) = {"Bob"}

Composite Attribute:

friend ("Alice") = {"Carol"}
 coworker ("Alice") = { }
 friendOfFriend("Alice") = { "Carol.John"}
 coworkerOfCoworker("Alice") = { }
 friendOfCoworker("Alice") = { }
 coworkerOfFriend("Alice") = {"Carol.Bob"}

Figure 12: Multilevel Relationship Expression with Attribute



ABAC_X ≡ ReBAC_Y Means

- Static and finite attribute domain
ABAC_X ≡ Static ReBAC_Y
- *ABAC_X Attribute value changes with finite domain*
≡ Relationship Dynamic ReBAC_Y
- *ABAC_X with entity changes and infinite domain entity attribute*
≡ node dynamic ReBAC_Y

Figure 12: ReBAC Dynamics, ABAC Dynamics and Attribute Domain wise Comparison between ReBAC and ABAC

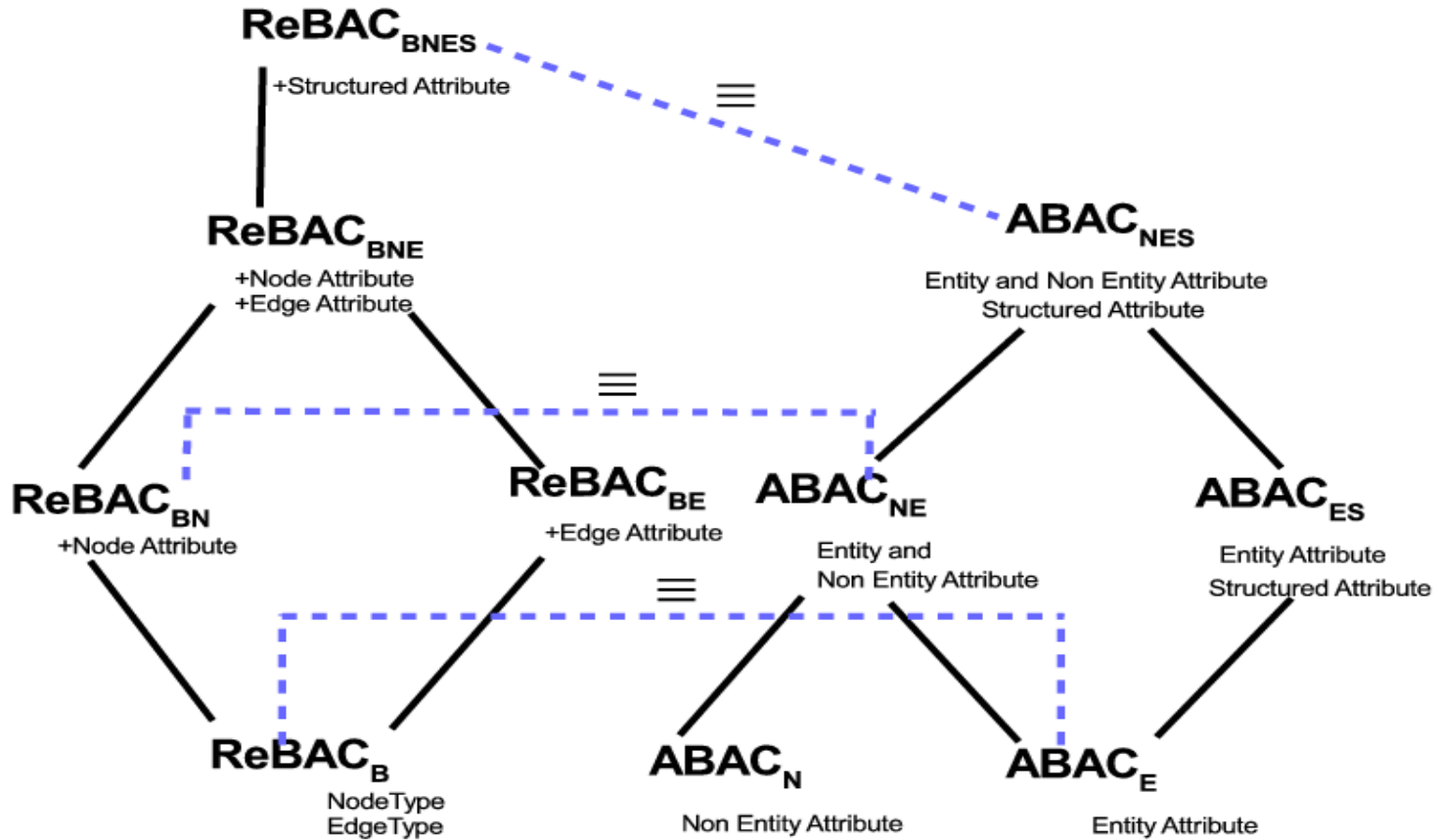


Figure 13: Equivalence of ReBAC and ABAC Structural Classification

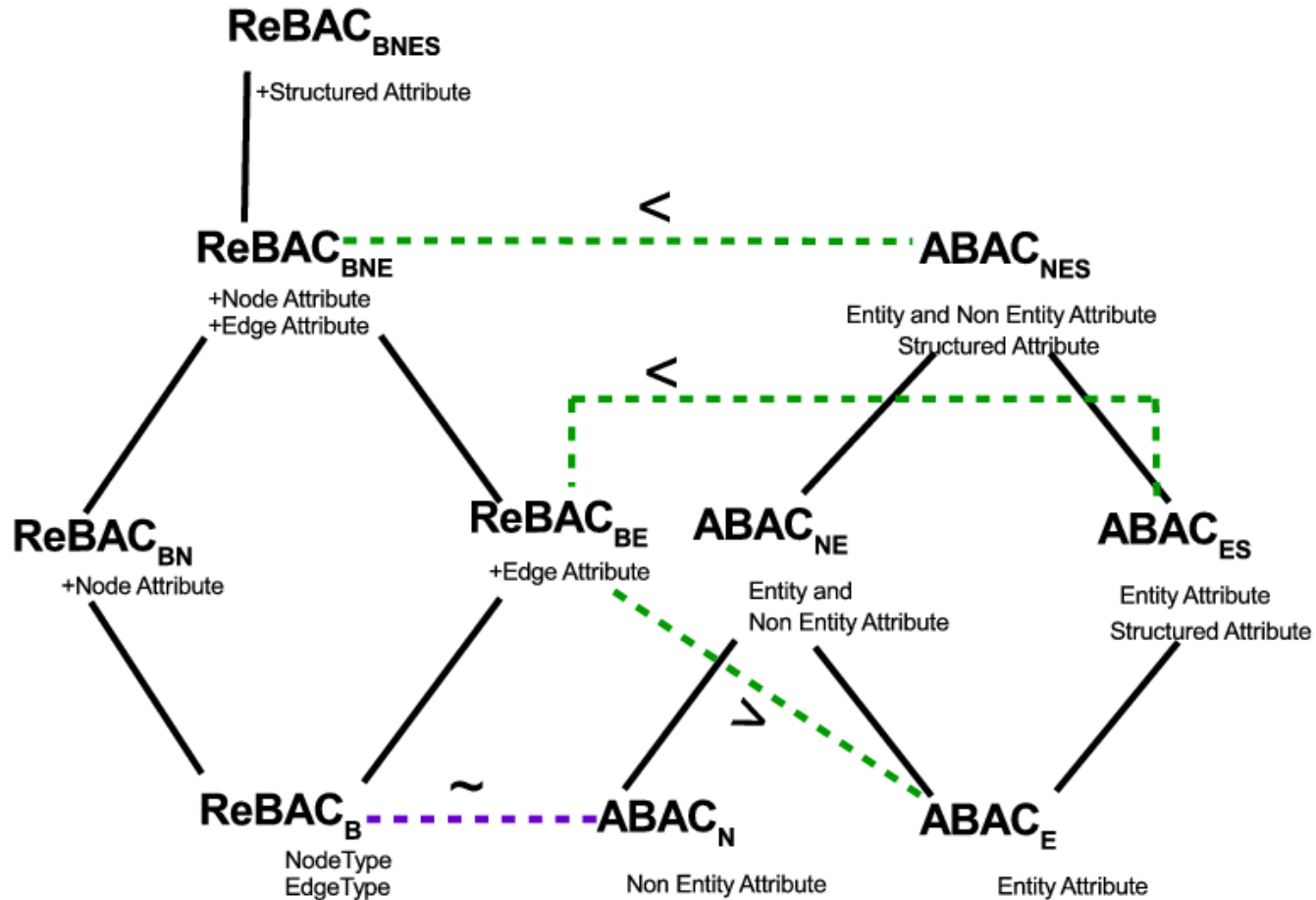


Figure 14: Non-Equivalence of ReBAC and ABAC Structural Classification

- Attribute Composition is similar to ReBAC and Both have polynomial complexity for authorization policy and constant complexity on update
- Composite attribute has constant complexity on authorization policy and polynomial complexity on update to maintain relationship changes.
- Performance Depends on :
 - Node Dynamics
 - Relationship Dynamics
 - Density of the Relationship Graph

- For static system or only non entity attribute change-----**Composite attribute is the best approach**
- System with huge node dynamics, relationship dynamics and high relationship density----- **Attribute composition is the best option**
- If the system is in the middle between two extremes ---- **A hybrid approach where both composite attribute and attribute composition is used.**
- Hybrid Approach:

To achieve p level relationship composition it uses m level composite attribute and n level attribute composition where $p = n \times m$.

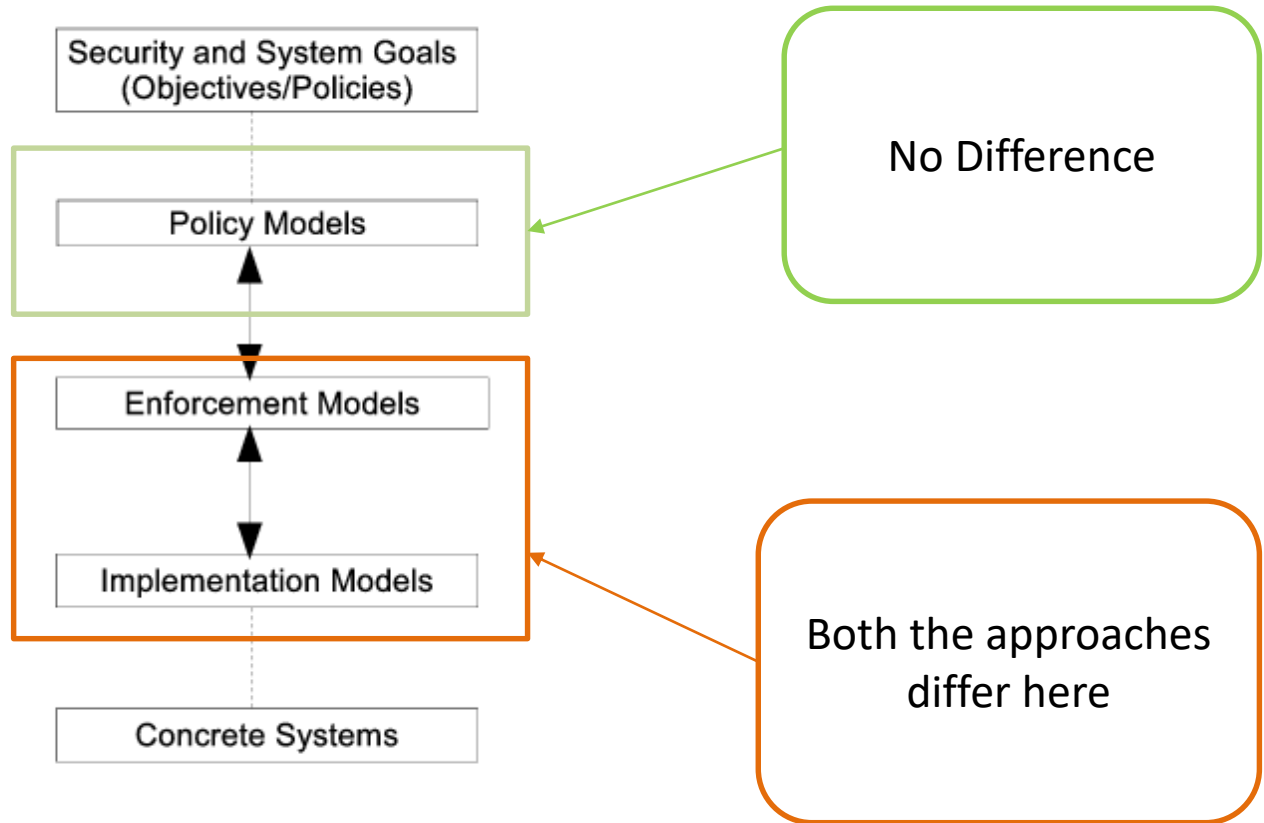


Figure 15: PEI Framework

- Our results indicate that the relationship between ABAC and ReBAC is subtle and variable depending on the precise flavor of these two access control approaches in any given model. At the same time we are able to make some general statements about this comparison.
- Metrics beyond theoretical equivalence need to be brought into consideration to better understand the relative advantages and disadvantages of these two approaches. Performance is one such metrics but others such as maintainability, robustness, and agility, also need to be studied.

Questions/Comments

