Attribute-Based Access Control: Insights and Challenges

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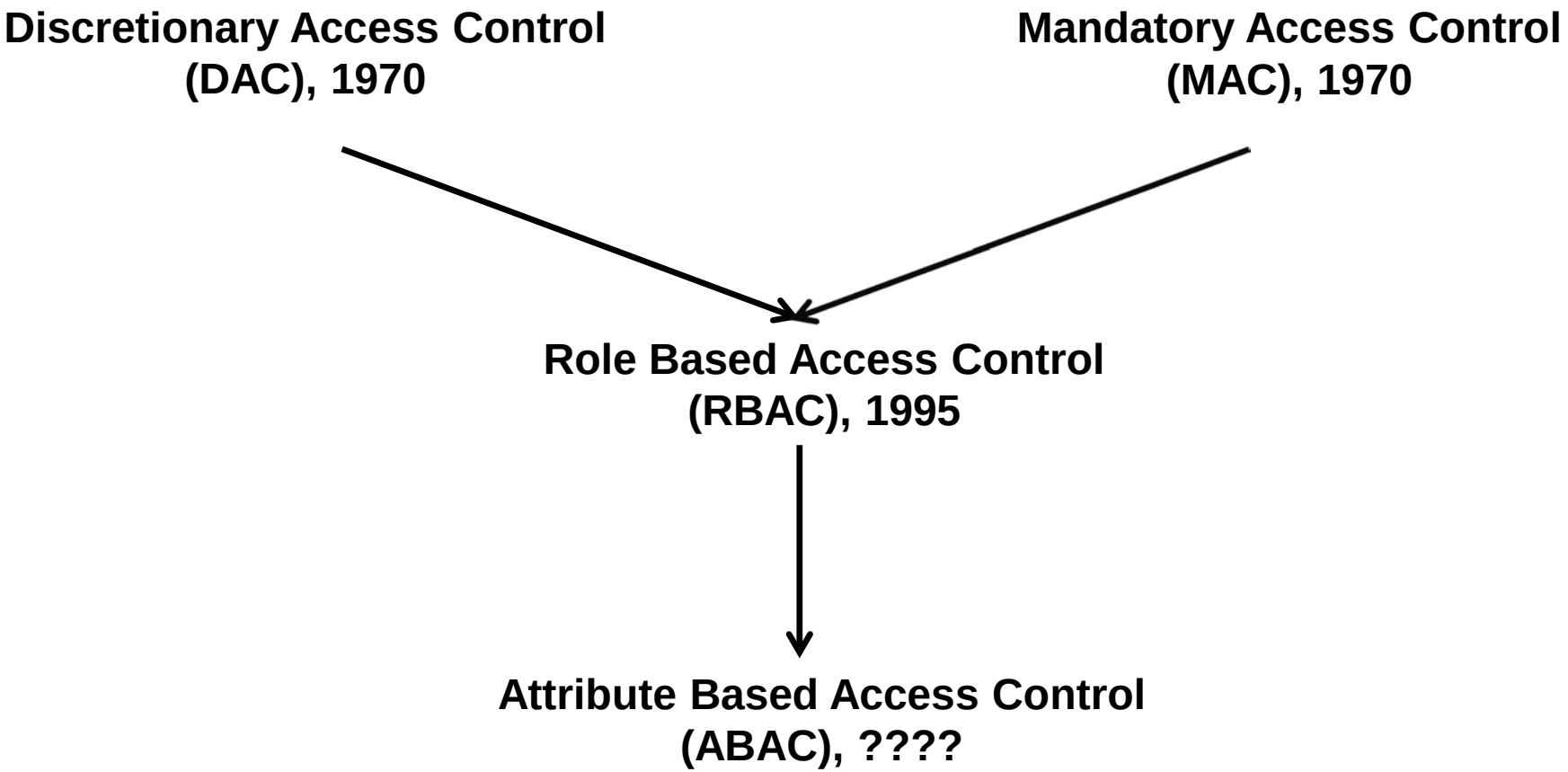
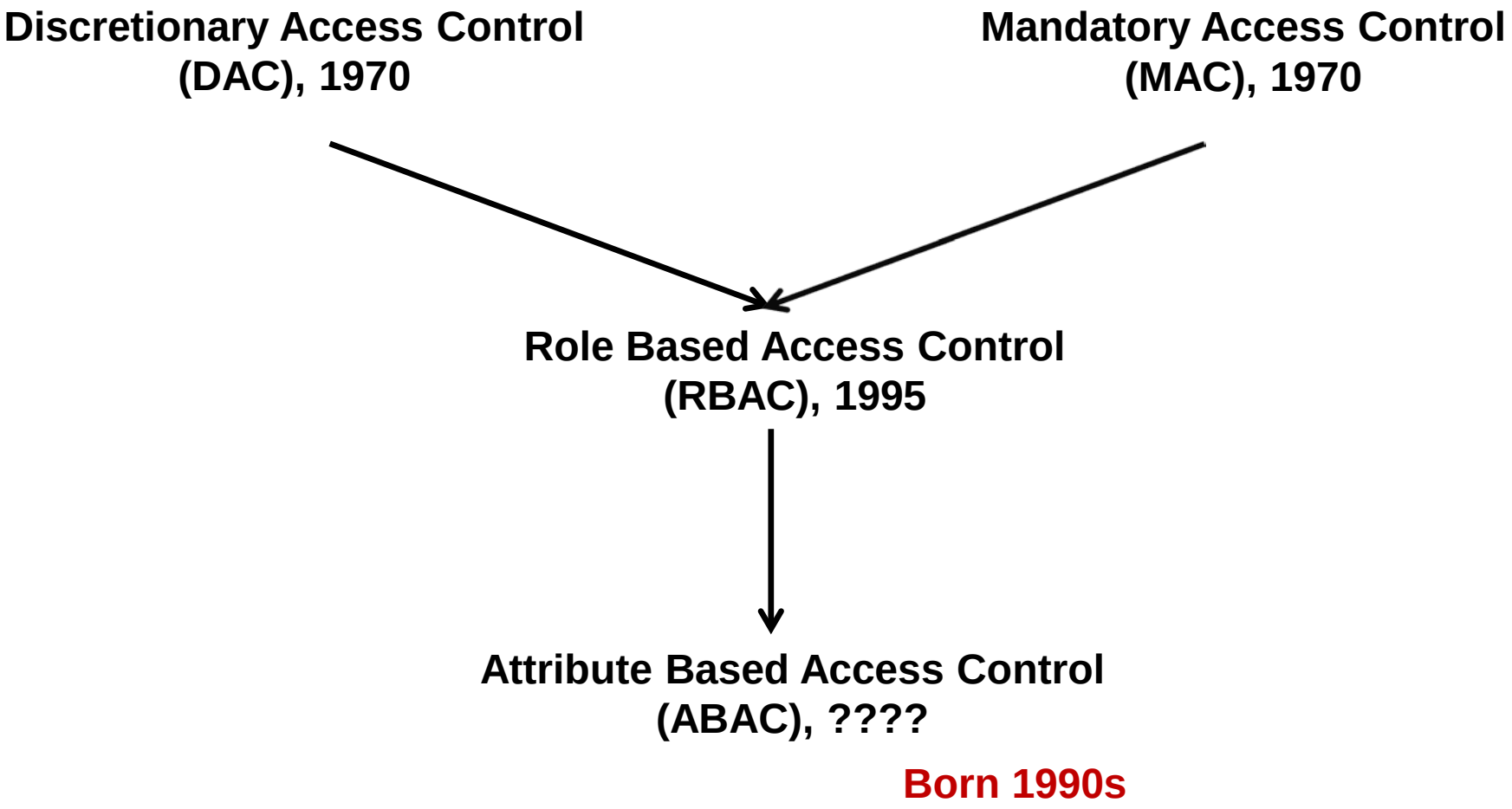
Policy-Mechanism

Policy	What?
Mechanism	How?

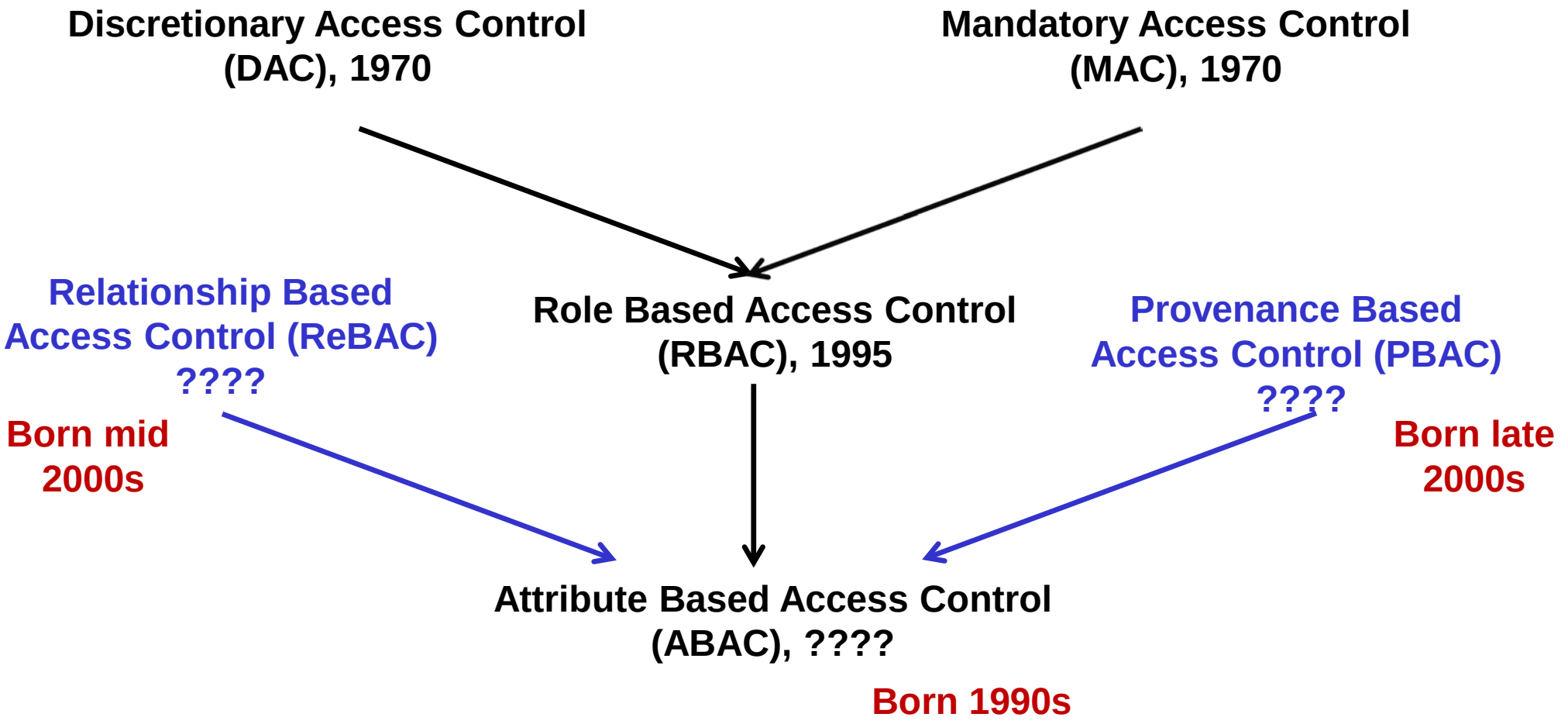
Access Control Evolution



Access Control Evolution



Access Control Evolution



ABAC = Final Word?

- NO!! Never!!

- Is ABAC the right word for the moment?
  - Certainly a strong candidate
  - Already too late?
    - ReBAC (relationship-based access control) not ABAC
    - Big Data, Analytics and AI will take care of everything

- What is lacking in ABAC?
  - Usage Control (UCON) concepts of attribute mutability, enforcement and obligation continuity, and post-obligations
  - Task-Based Access Control
  - Risk-Based Access Control
  - Policy-Based Access Control
  - ……

The ABAC Challenge

- ABAC is orders of magnitude more complex than anything that has been an Access Control winner so far (DAC, MAC, RBAC)
  - We need the complexity, but need to manage it
  - If Google can index the web, we can do ABAC!!
- Cloud-enabled IoT may be the killer app

ABAC Research Agenda

7. ABAC Design, Engineering and Applications

5. ABAC Policy Architectures and Languages

3. Administrative ABAC Models

4. Extended ABAC Models

2. Core ABAC Models

6. ABAC Enforcement Architectures

1. Foundational Principles and Theory

Based on RBAC experience

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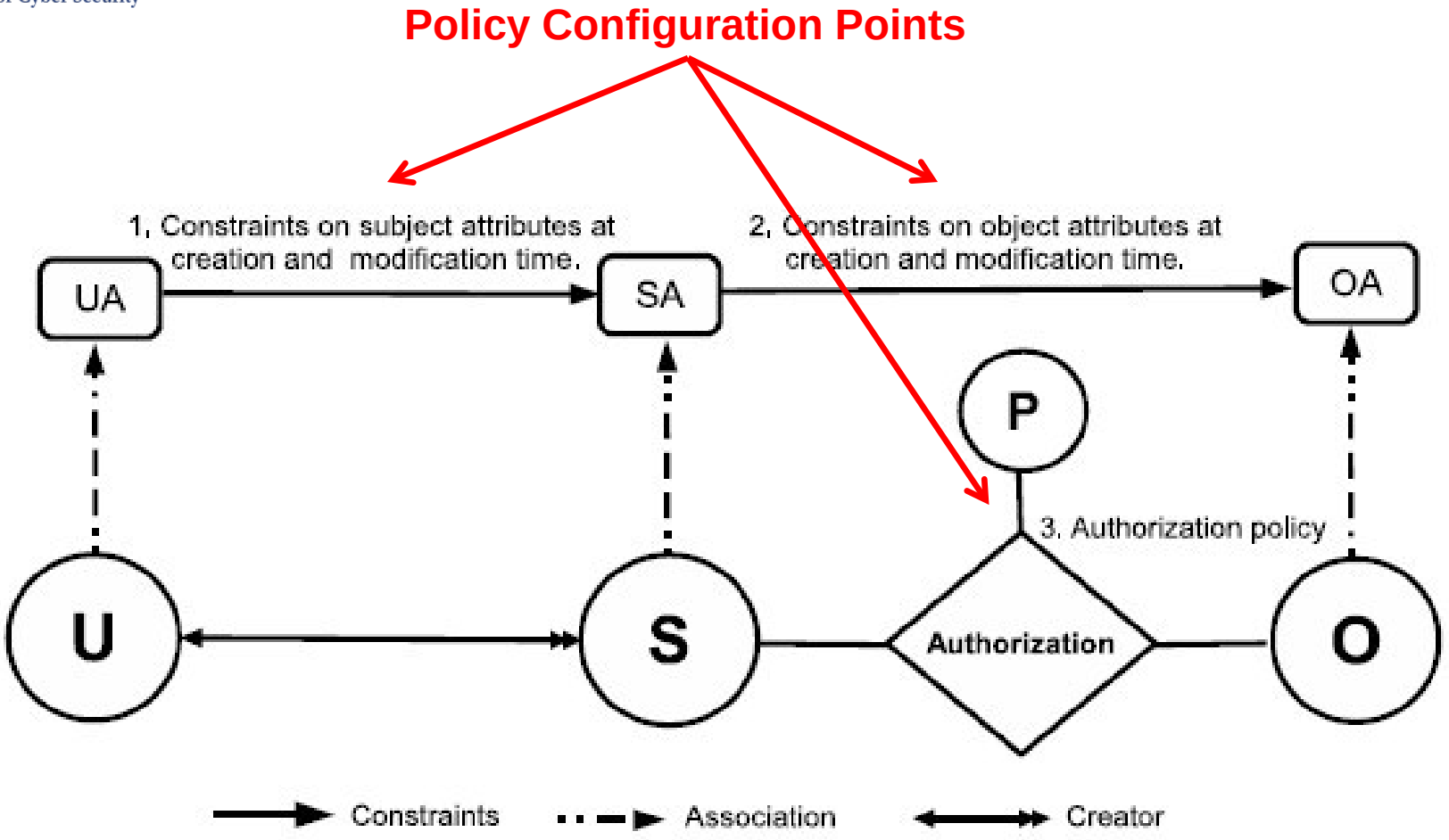
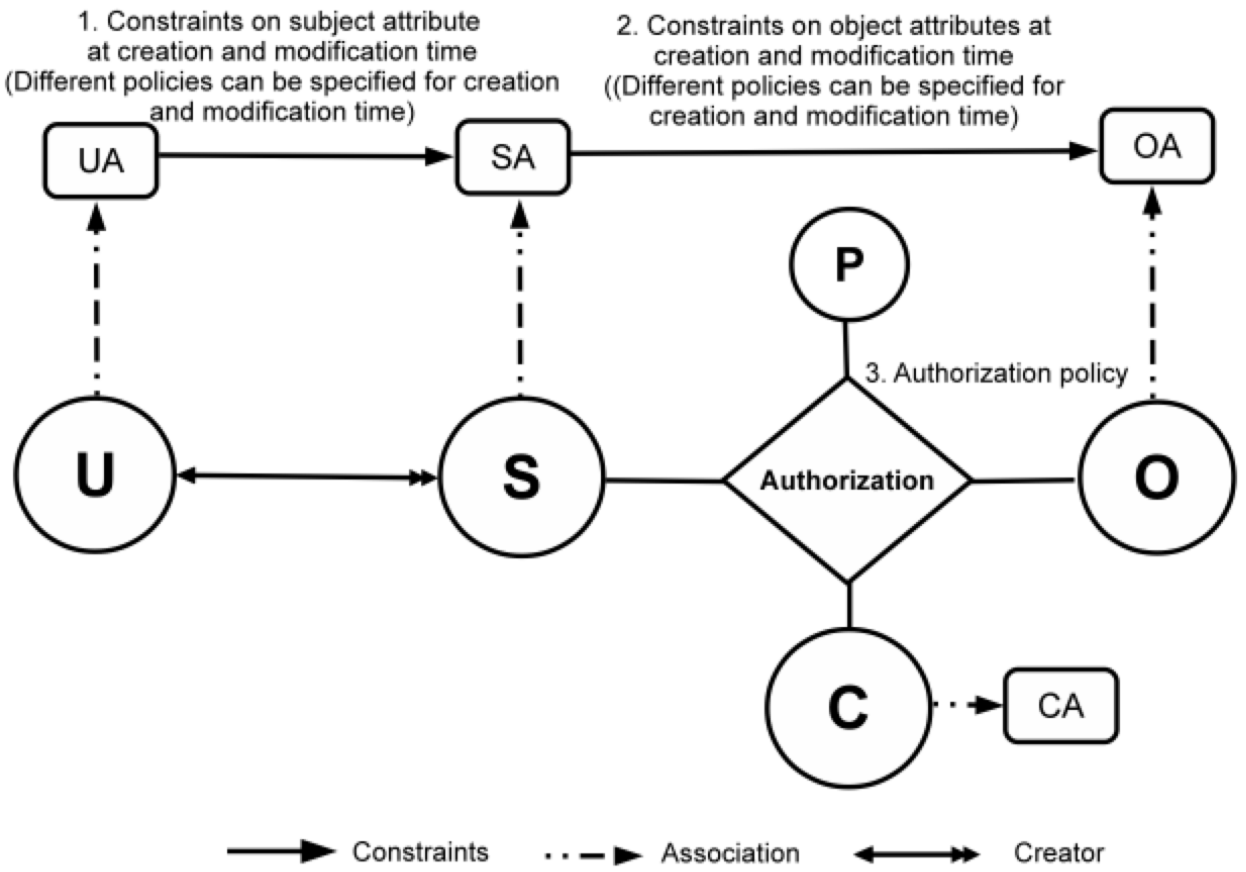
2. Core ABAC Models: $ABAC_{\alpha}$



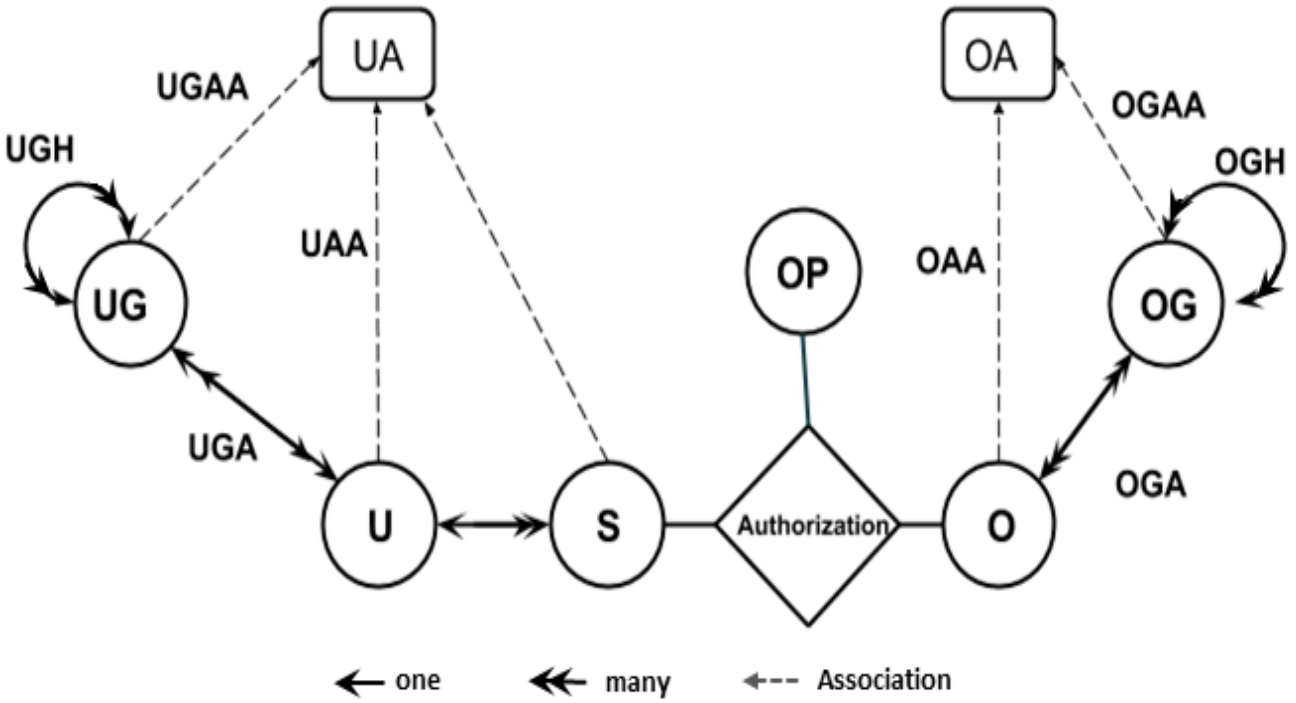
Can be configured to do simple forms of DAC, MAC, RBAC
Jin, Krishnan, Sandhu 2012

2. Core ABAC Models: $ABAC_{\beta}$



Can further be configured to do many RBAC extensions
Jin, Krishnan, Sandhu 2014

2. Core ABAC Models: HGABAC



U: User
UG: User-Group
S: Subject
UA: User Attributes
O: Object
OG: Object-Group
OA: Object Attributes
OP: Operations

- Hierarchical Group and Attribute Based Access Control (HGABAC)
  - Introduces the notion of User and Object Groups
  - Core advantage is simplified administration of attributes
  - User and Objects are assigned set of attributes in one go as compared to single assignment at a time.

Servos and Osborn, 2015

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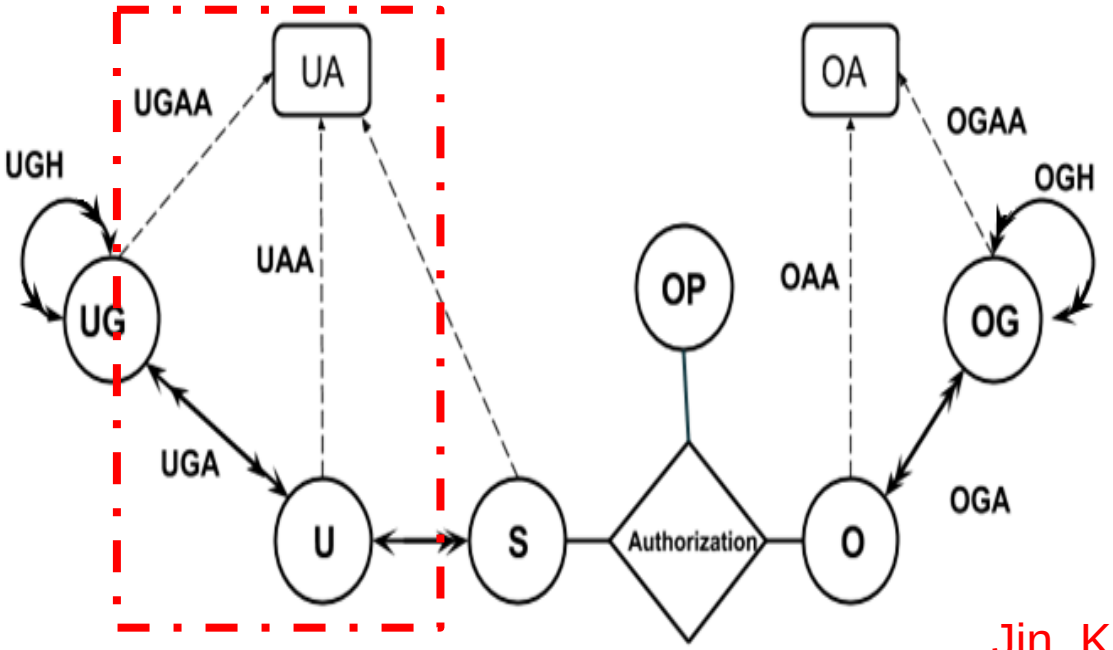
3. Administrative ABAC Models: GURA and GURA$_G$



Jin, Krishnan, Sandhu, 2012
Gupta, Sandhu, 2016

Administrative Relations

– User Attribute Assignment **(UAA)** & User-Group Attribute Assignment **(UGAA):**
For each att_u in UA,

$$canAdd_{att_u} \subseteq AR \times EXPR(UA) \times 2^{Range(att_u)}$$

$$canDelete_{att_u} \subseteq AR \times EXPR(UA) \times 2^{Range(att_u)}$$

– User to User-Group Assignment **(UGA):**

$$canAssign \subseteq AR \times EXPR(UA \cup UG) \times 2^{UG}$$

$$canRemove \subseteq AR \times EXPR(UA \cup UG) \times 2^{UG}$$

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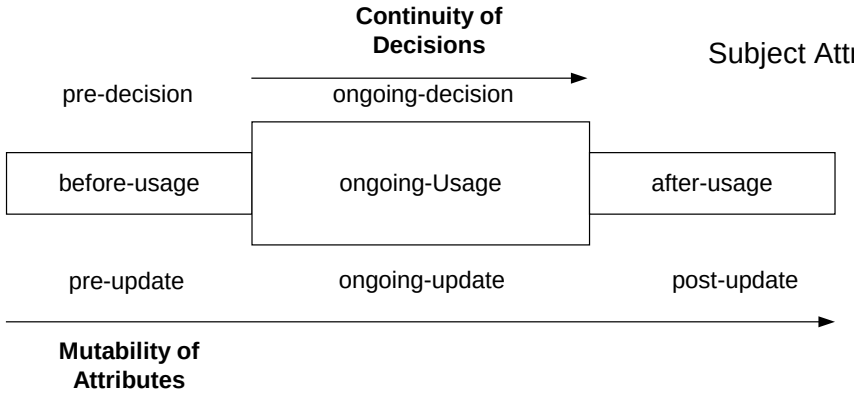
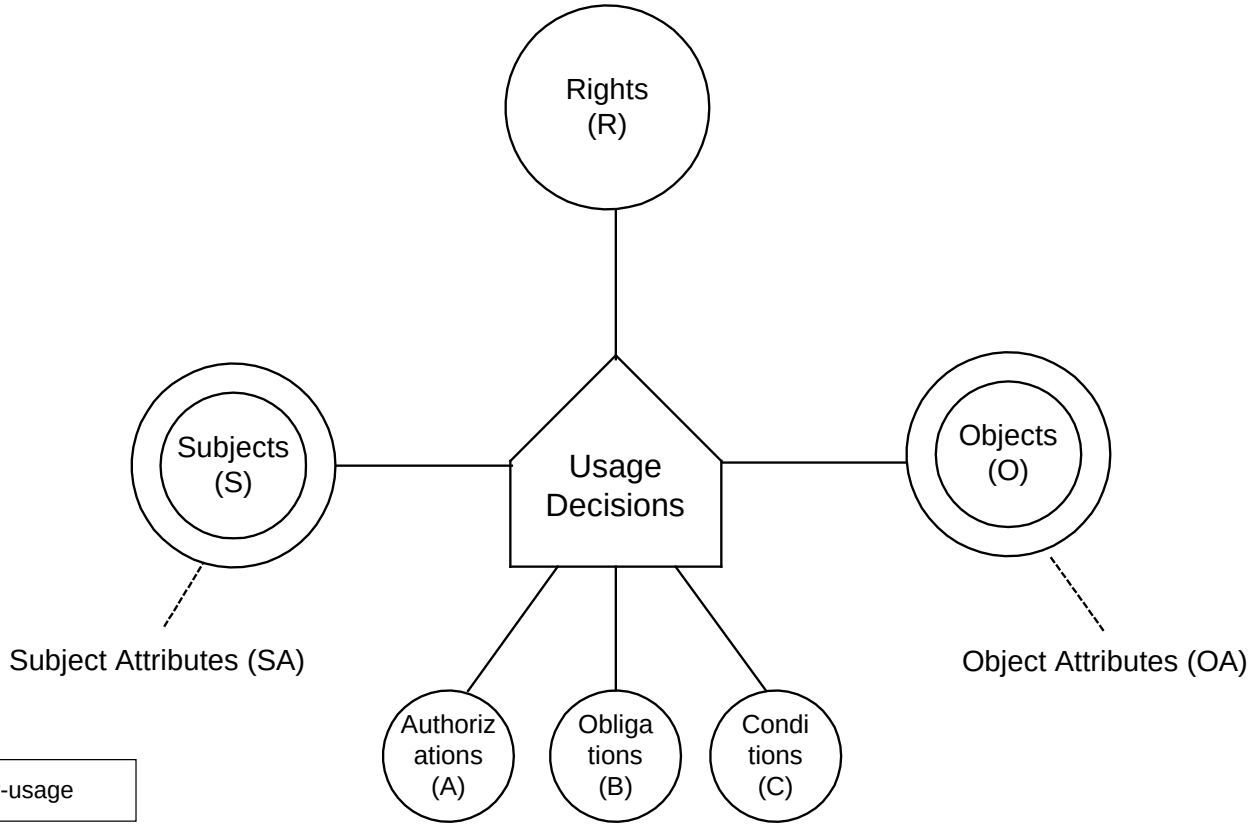
4. Extended ABAC Models: UCON

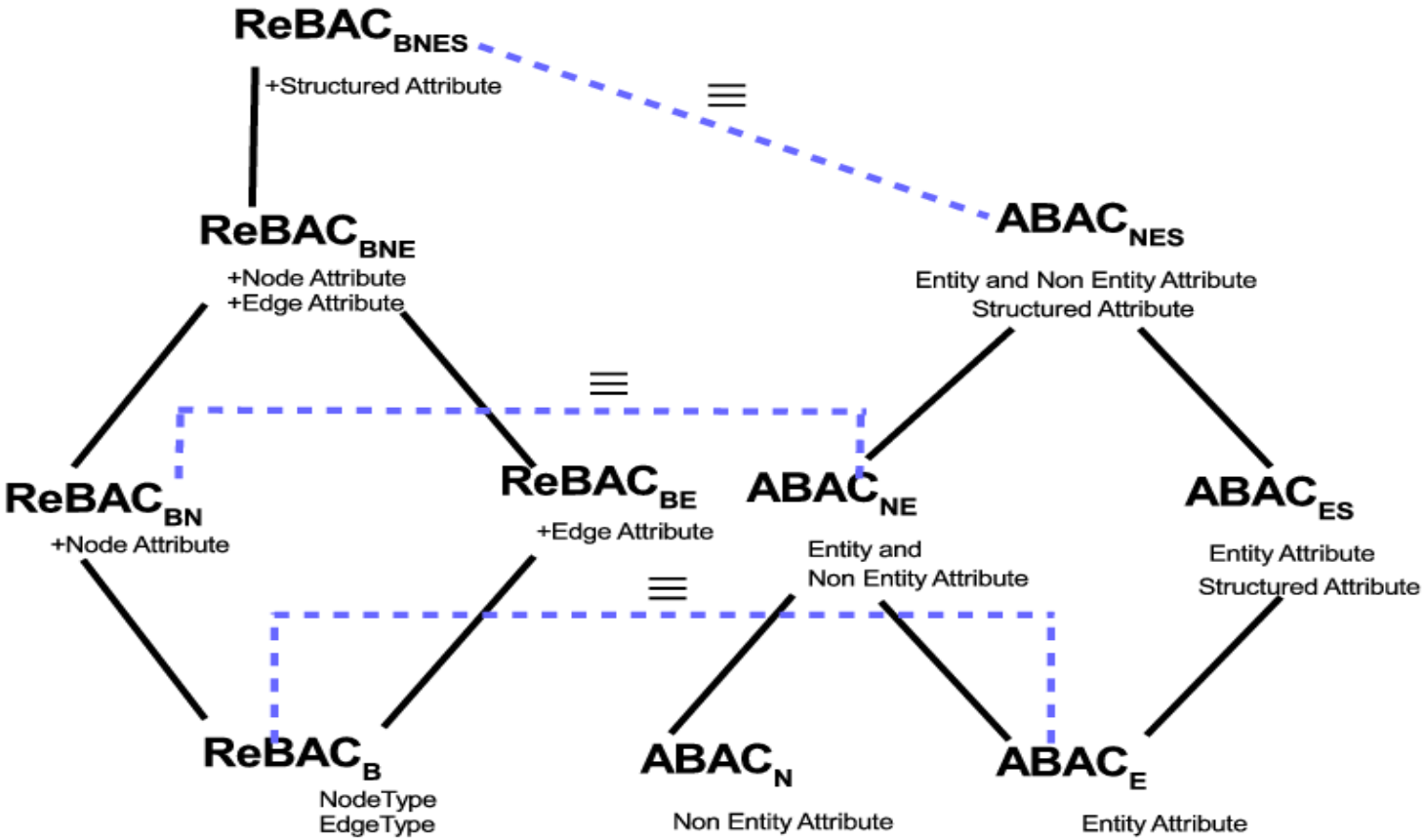
- unified model integrating
  - authorization
  - obligation
  - conditions
- and incorporating
  - continuity of decisions
  - mutability of attributes





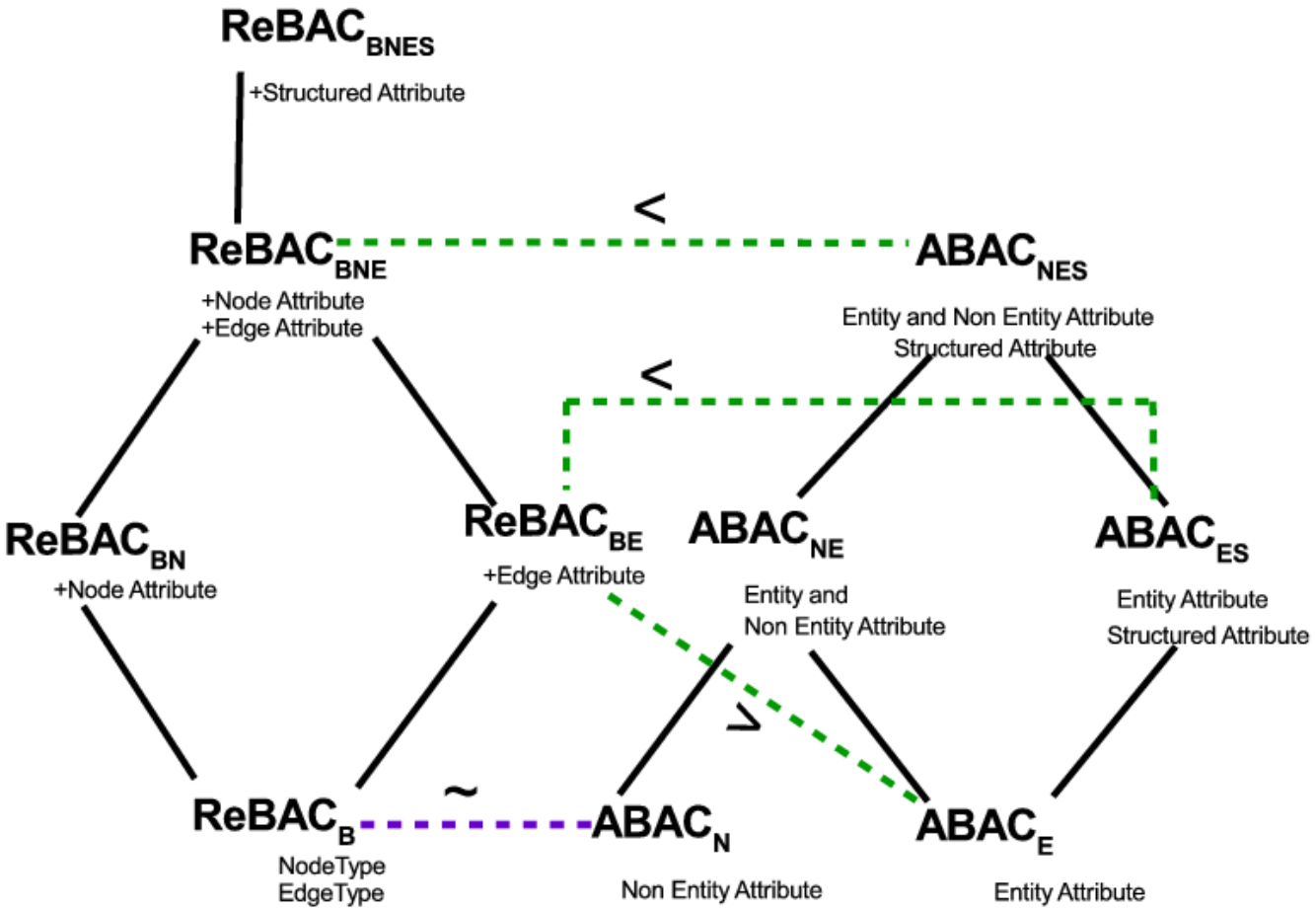
Usage Control Models, early 2000s
Park, Sandhu, Pretschner

4. Extended ABAC Models: ReBAC versus ABAC



Equivalence of ReBAC and ABAC Structural Variants

4. Extended ABAC Models: ReBAC versus ABAC



Non-Equivalence of ReBAC and ABAC Variants

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1. Foundations: Safety

- A single infinite attribute with no creation leads to undecidable safety. Rajkumar 2012
- Pre_UCON with finite attributes and unbounded creation has decidable safety. Rajkumar, Sandhu 2016
- $ABAC_{\alpha}$ has decidable safety. Ahmed, Sandhu 2017
- GURA has decidable safety/reachability. Jin, Krishnan, Sandhu 2017

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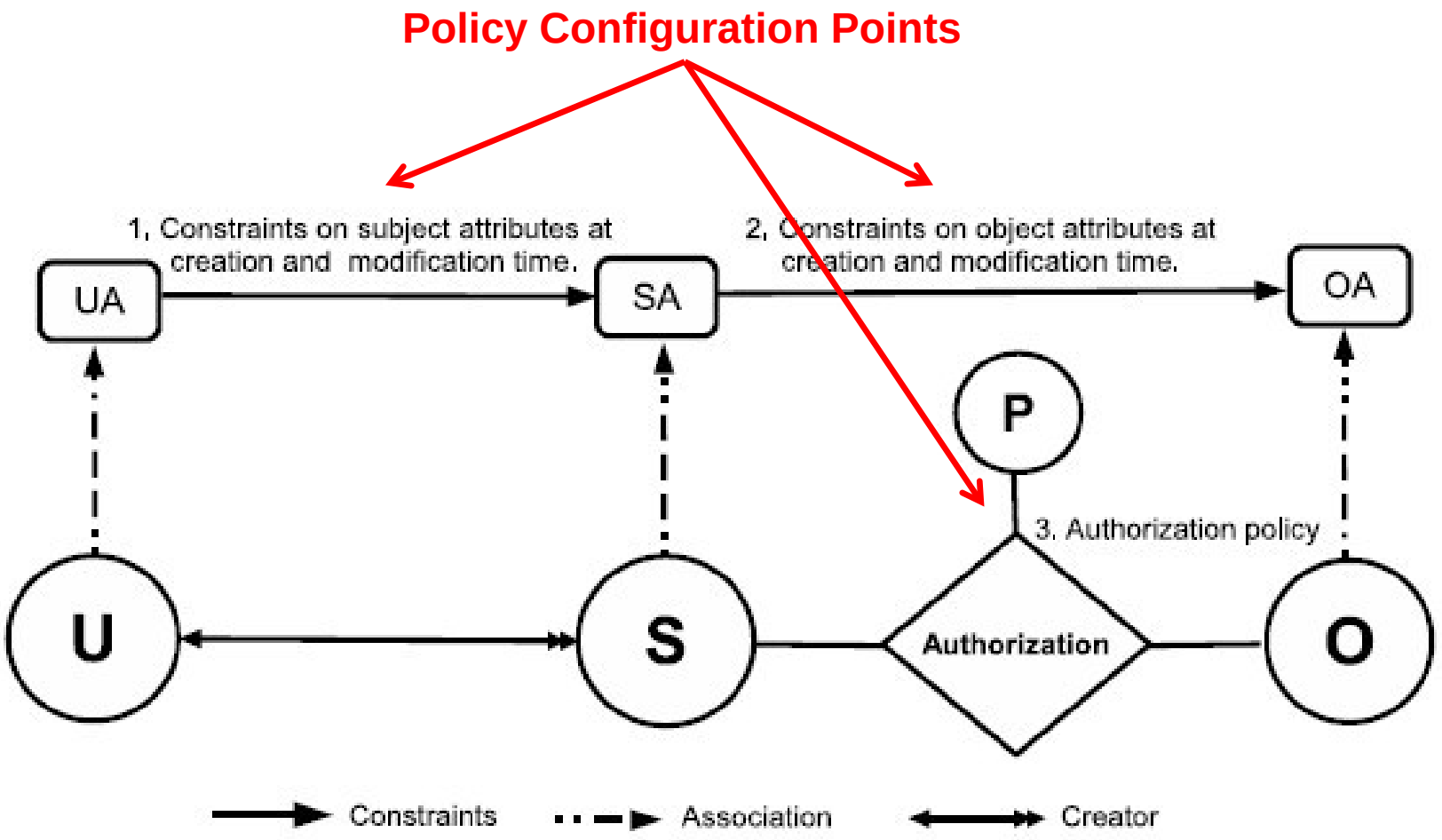
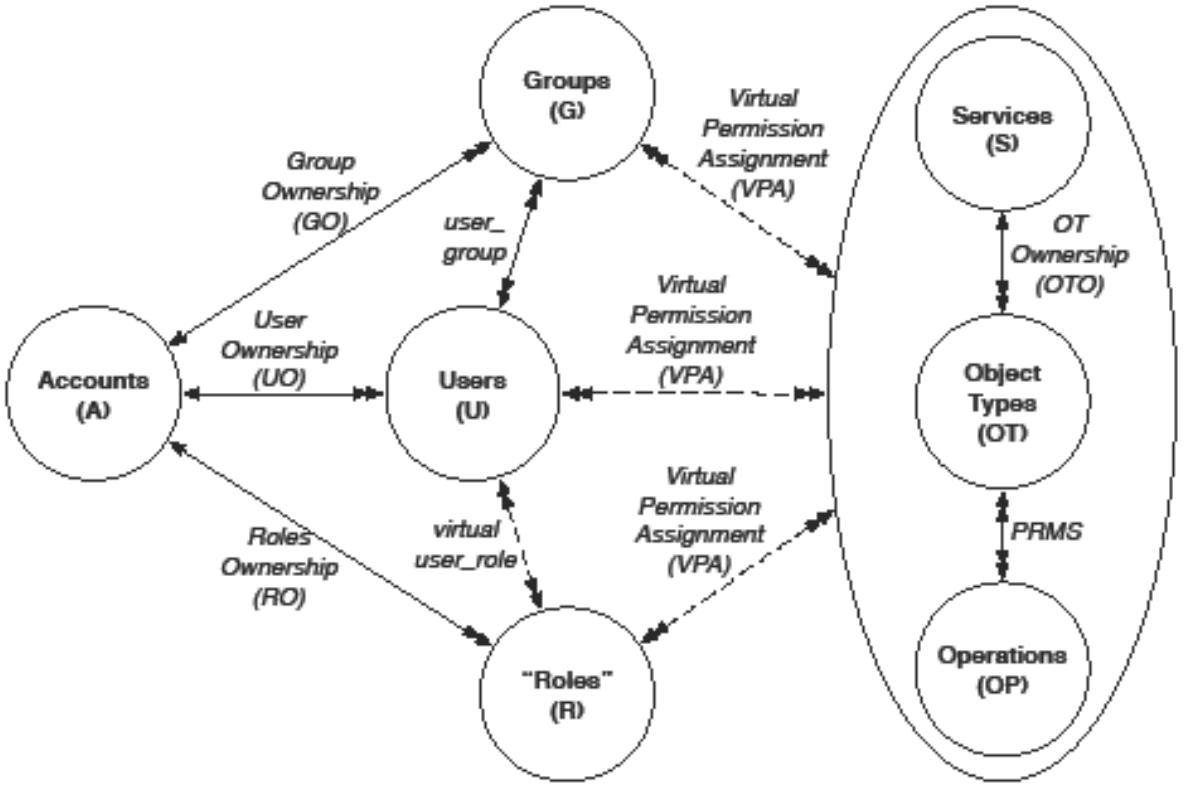
5. Policy Architecture: Centralized $ABAC_{\alpha}$ style



5. Policy Architecture: Diffused AWS style



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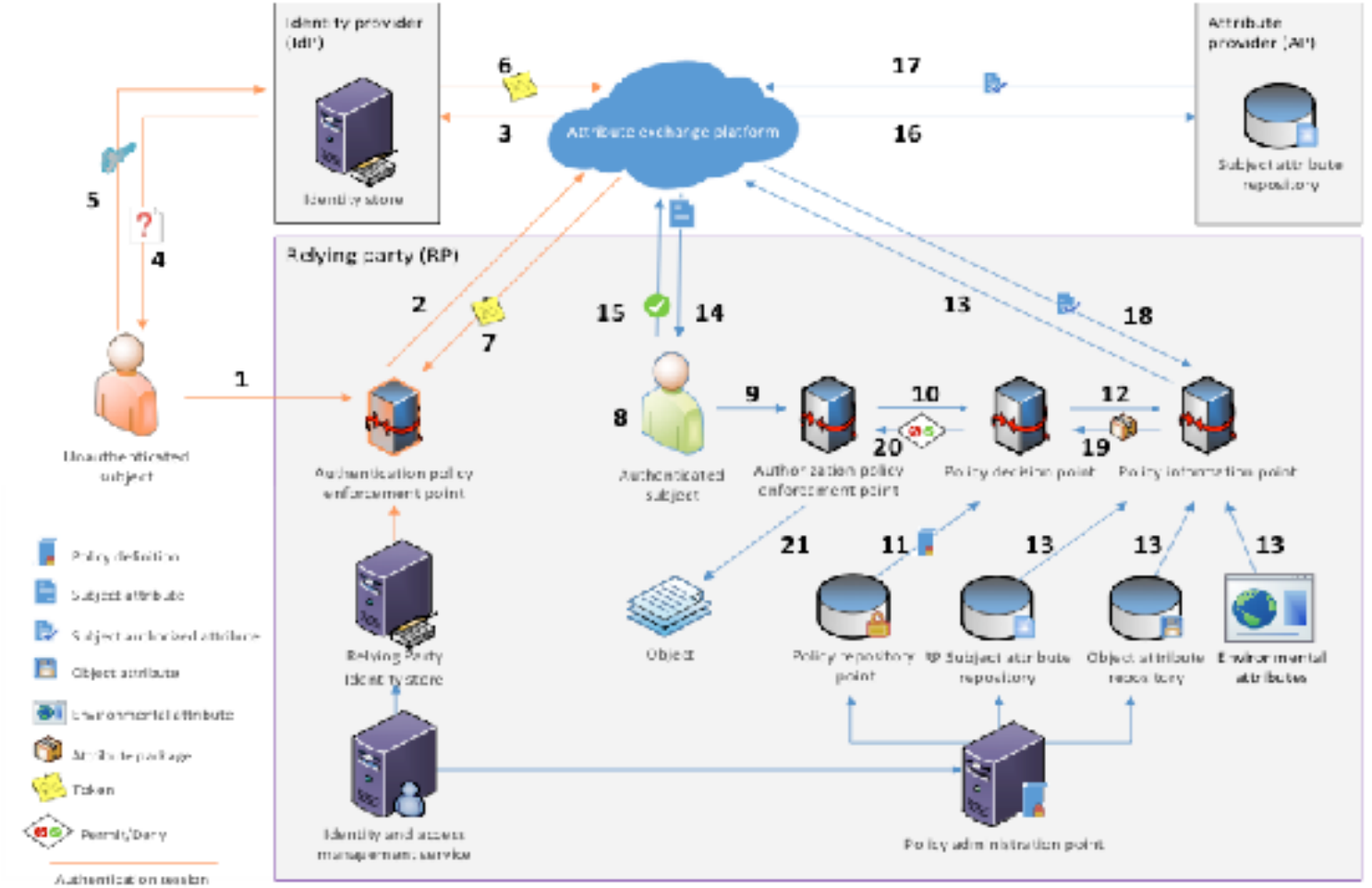
6. ABAC Enforcement Architecture: Federated ABAC



Fisher 2015
NCCOE, NIST, Building Block

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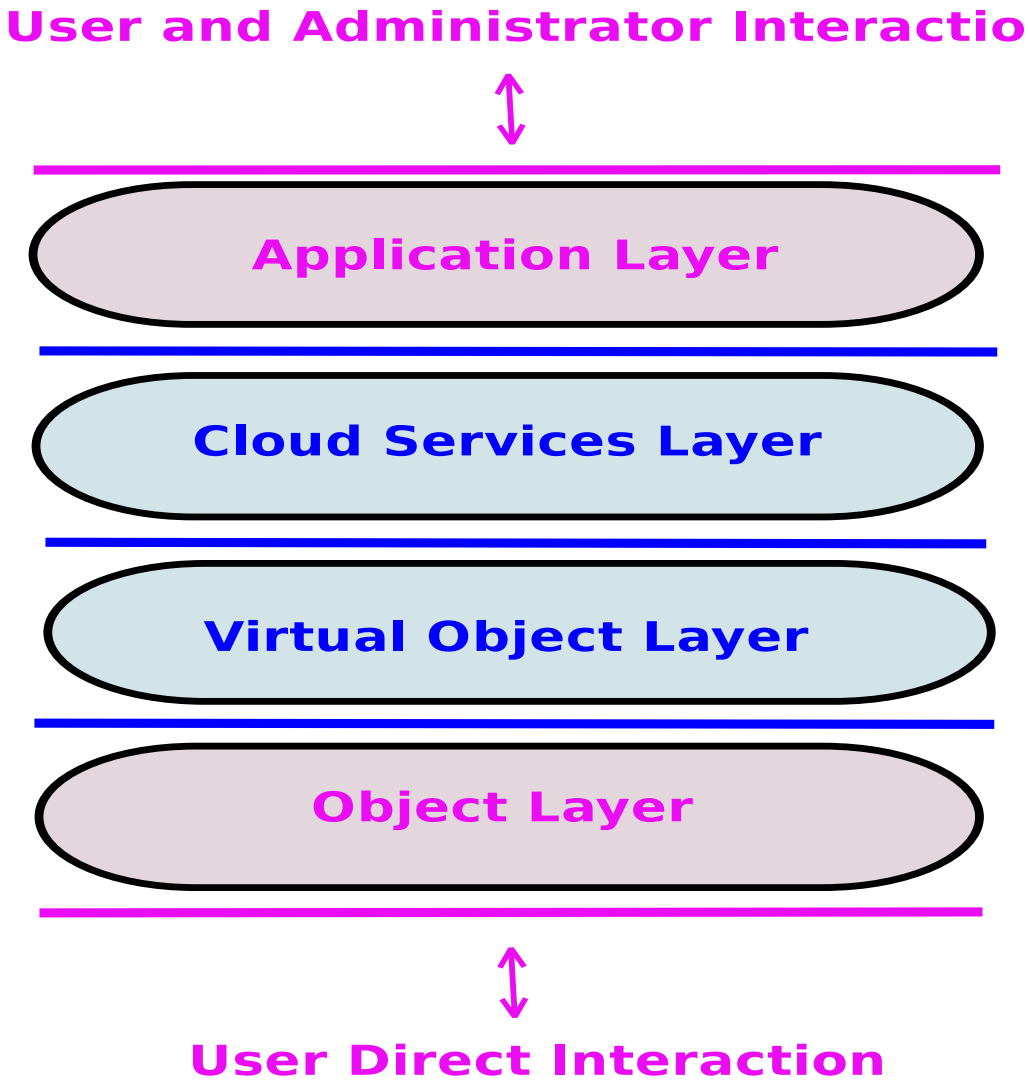
7. ABAC Applications: Cloud IaaS

- Cloud Computing IaaS
  - Single tenant
  - Multi tenant
  - Multi cloud

Jin, Tang, Dang, Bijon, Pustchi, Zhang, Biswas, Ahmed, Cheng, Patwa, Krishnan, Sandhu
2012 onwards

7. ABAC Applications: Cloud Enabled IoT



Alsheri, Bhatt, Patwa, Benson, Sandhu 2016 onwards

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