

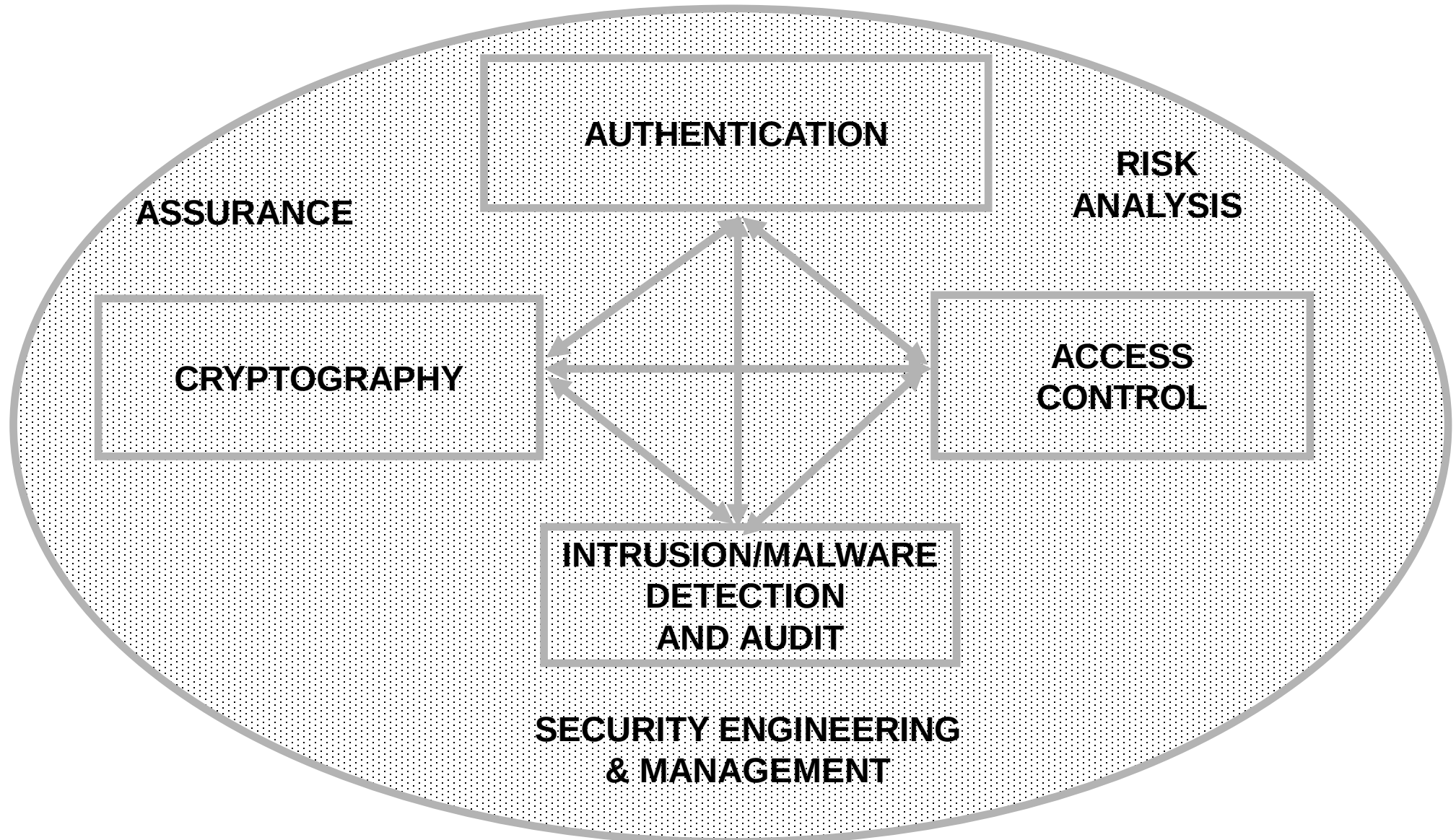
Attribute-Based Access Control Models and Beyond

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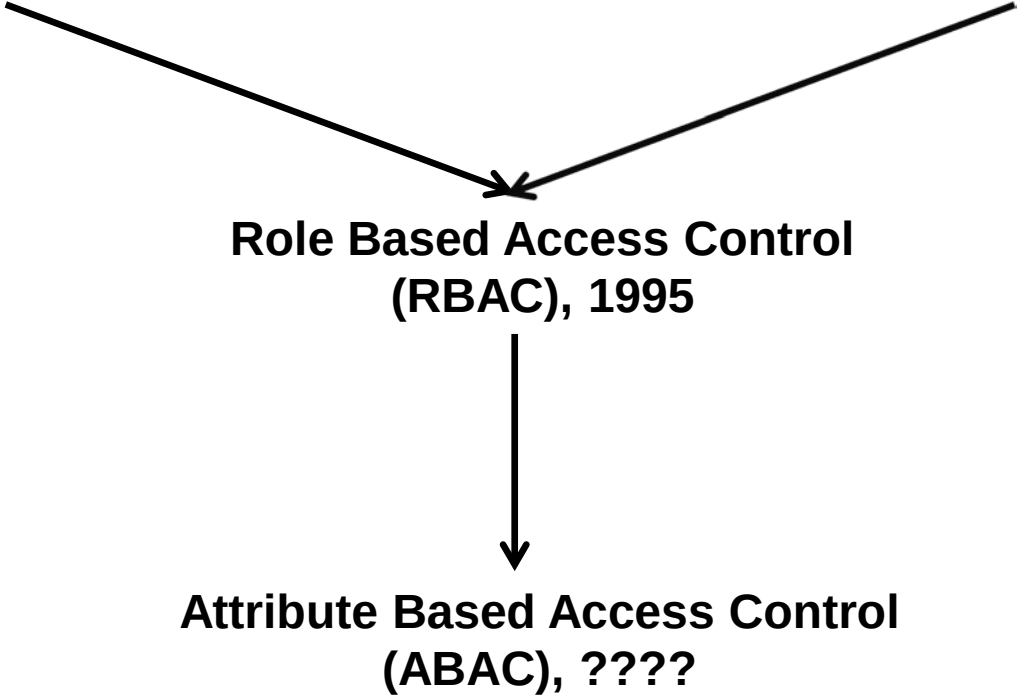


- Analog Hole
- Inference
- Covert Channels
- Side Channels
- Phishing
- Social Engineering
- Attack Asymmetry
- Privacy vs Security
- Base-rate Fallacy
-

Can manage
Cannot eliminate

**Discretionary Access Control
(DAC), 1970**

**Mandatory Access Control
(MAC), 1970**



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graph TD; DAC["Discretionary Access Control (DAC), 1970"] --> RBAC["Role Based Access Control (RBAC), 1995"]; MAC["Mandatory Access Control (MAC), 1970"] --> RBAC; RBAC --> ABAC["Attribute Based Access Control (ABAC), ????"];
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**Role Based Access Control
(RBAC), 1995**

**Attribute Based Access Control
(ABAC), ????**

**Fixed
policy**

**Discretionary Access Control
(DAC), 1970**

**Mandatory Access Control
(MAC), 1970**

**Role Based Access Control
(RBAC), 1995**

**Attribute Based Access Control
(ABAC), ????**

**Flexible
policy**

**Administration
Driven**

**Discretionary Access Control
(DAC), 1970**

**Mandatory Access Control
(MAC), 1970**

**Role Based Access Control
(RBAC), 1995**

**Attribute Based Access Control
(ABAC), ????**

**Automated
Adaptive**

**Enterprise
Oriented**

**Discretionary Access Control
(DAC), 1970**

**Mandatory Access Control
(MAC), 1970**

**Role Based Access Control
(RBAC), 1995**

**Attribute Based Access Control
(ABAC), ????**

**Beyond
Enterprise**

**Discretionary Access Control
(DAC), 1970**

**Mandatory Access Control
(MAC), 1970**

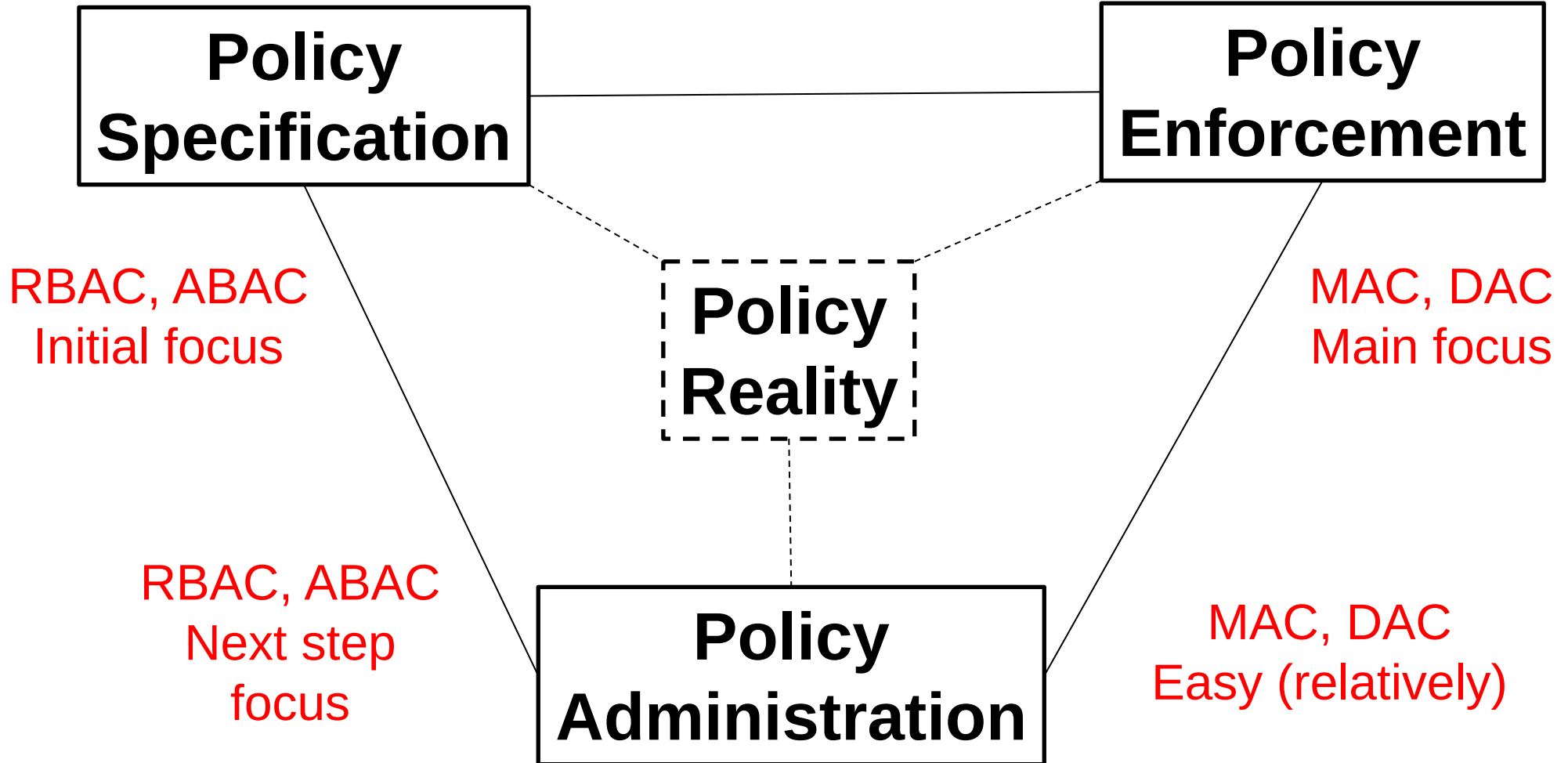
**Role Based Access Control
(RBAC), 1995**

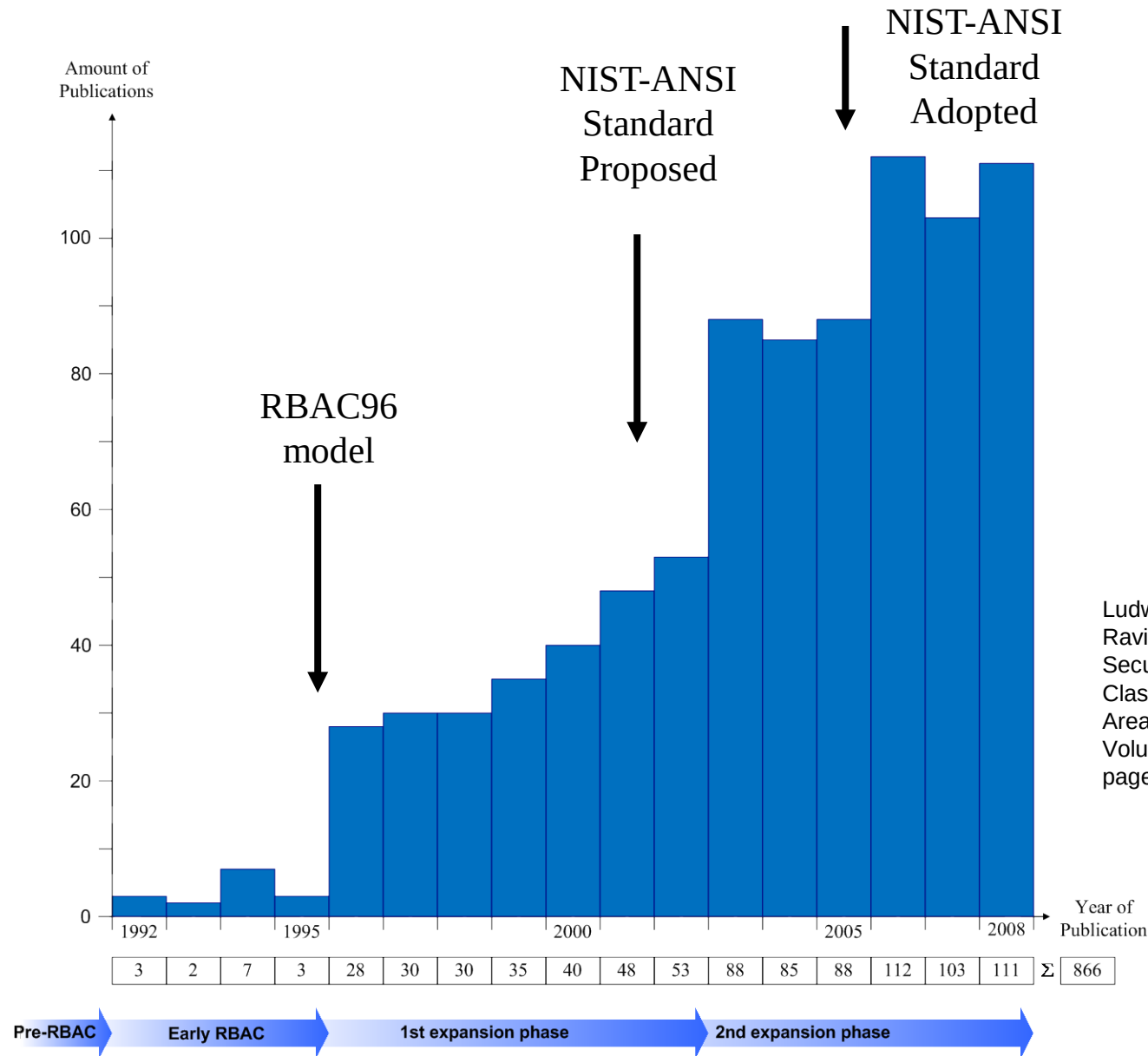
Messy or
Chaotic?

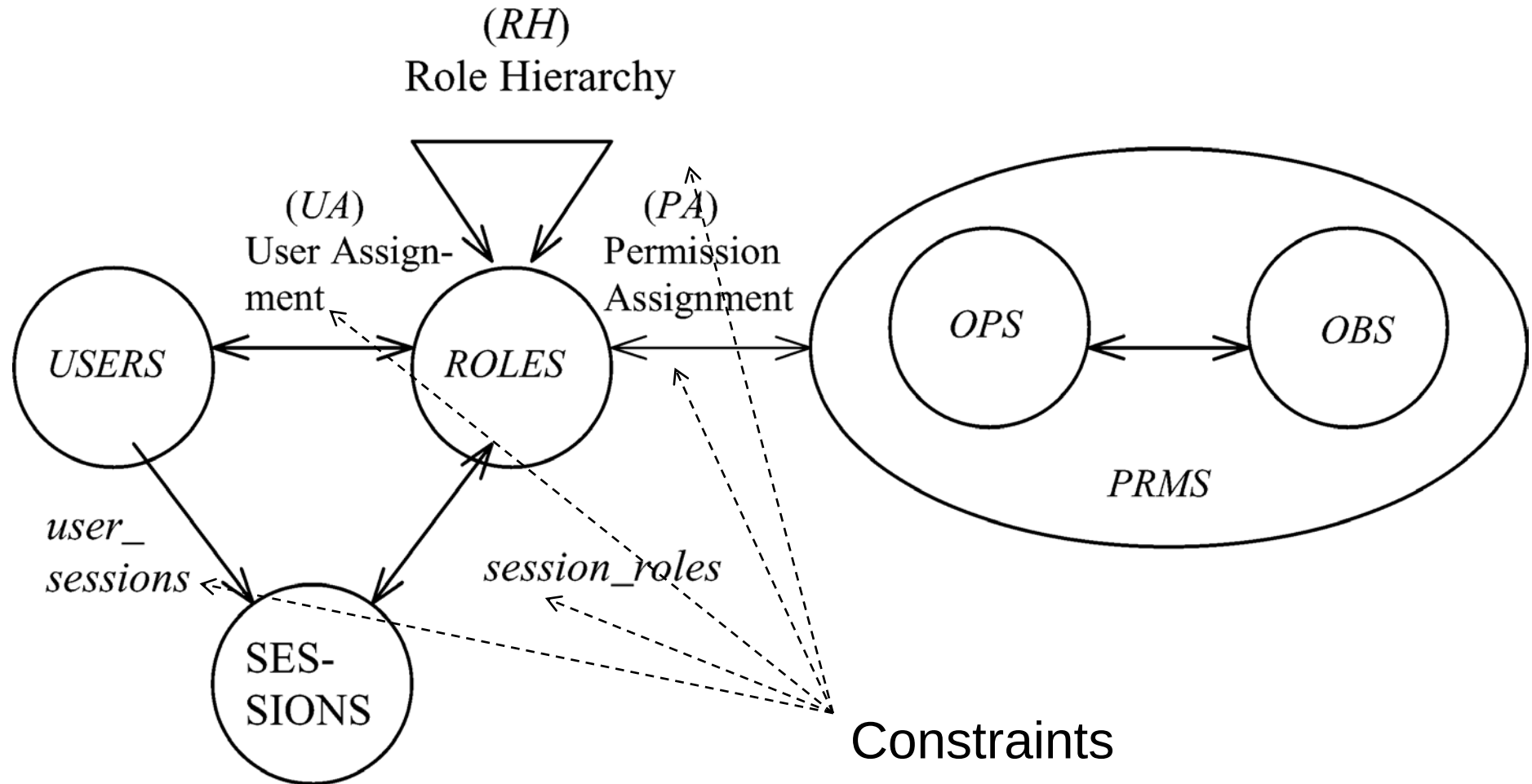
**Attribute Based Access Control
(ABAC), ????**

- Discretionary Access Control (DAC), 1970
 - ❖ Owner controls access
 - ❖ But only to the original, not to copies
 - ❖ Grounded in pre-computer policies of researchers
- Mandatory Access Control (MAC), 1970
 - ❖ Synonymous to Lattice-Based Access Control (LBAC)
 - ❖ Access based on security labels
 - ❖ Labels propagate to copies
 - ❖ Grounded in pre-computer military and national security policies
- Role-Based Access Control (RBAC), 1995
 - ❖ Access based on roles
 - ❖ Can be configured to do DAC or MAC
 - ❖ Grounded in pre-computer enterprise policies

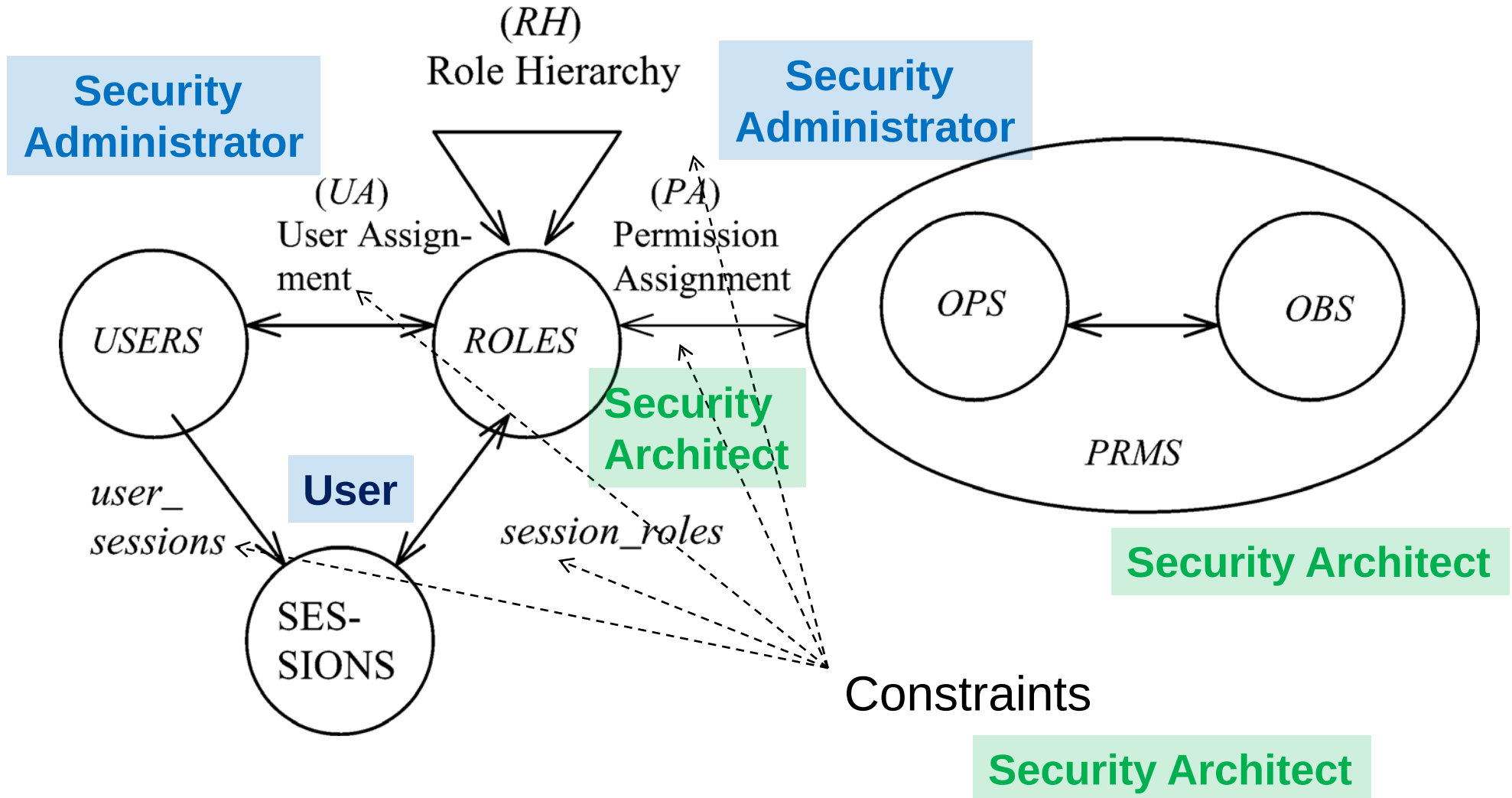
Numerous other models but only 3 successes: SO FAR







Security Architect



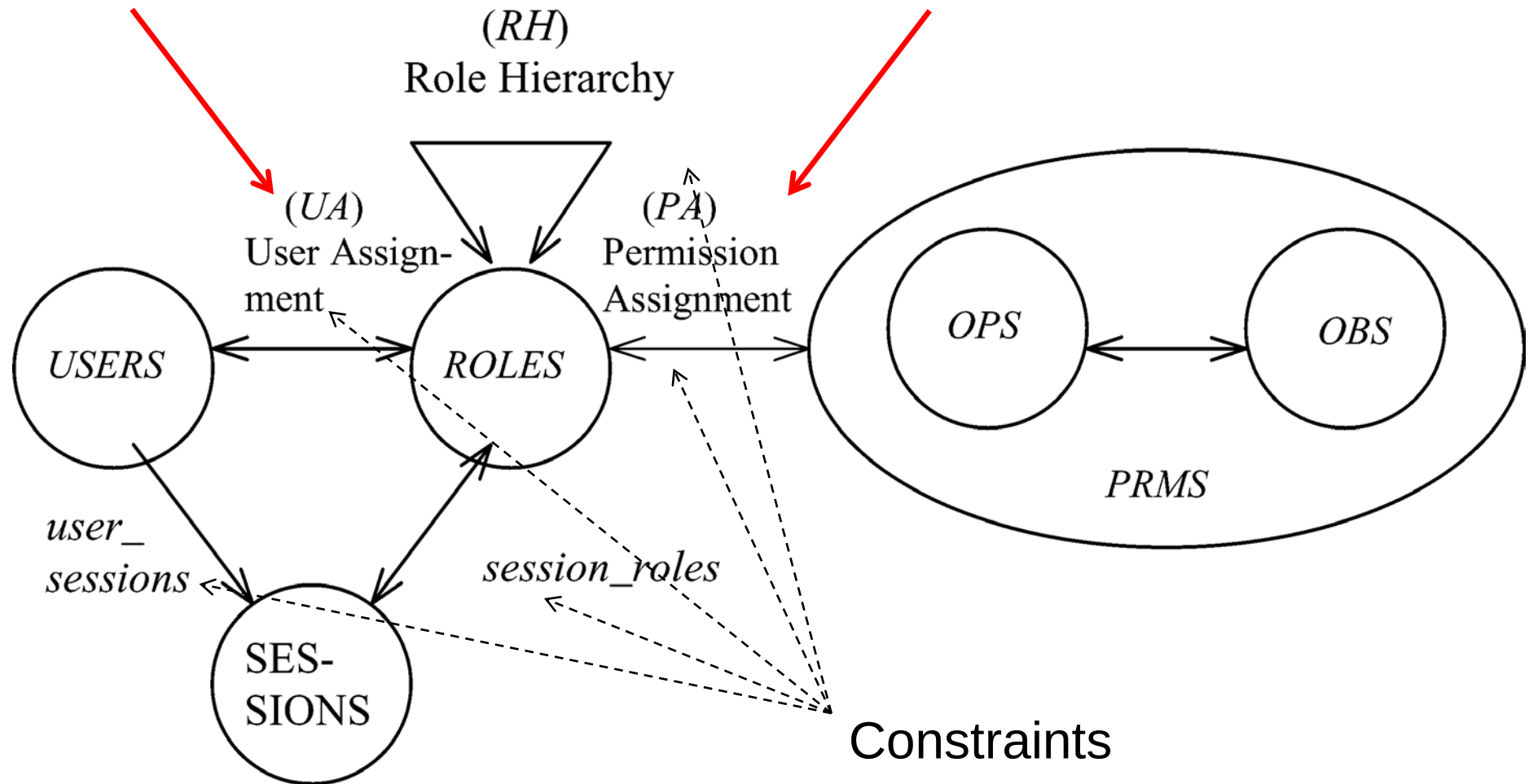
- RBAC can be configured to do MAC
- RBAC can be configured to do DAC
- RBAC is policy neutral

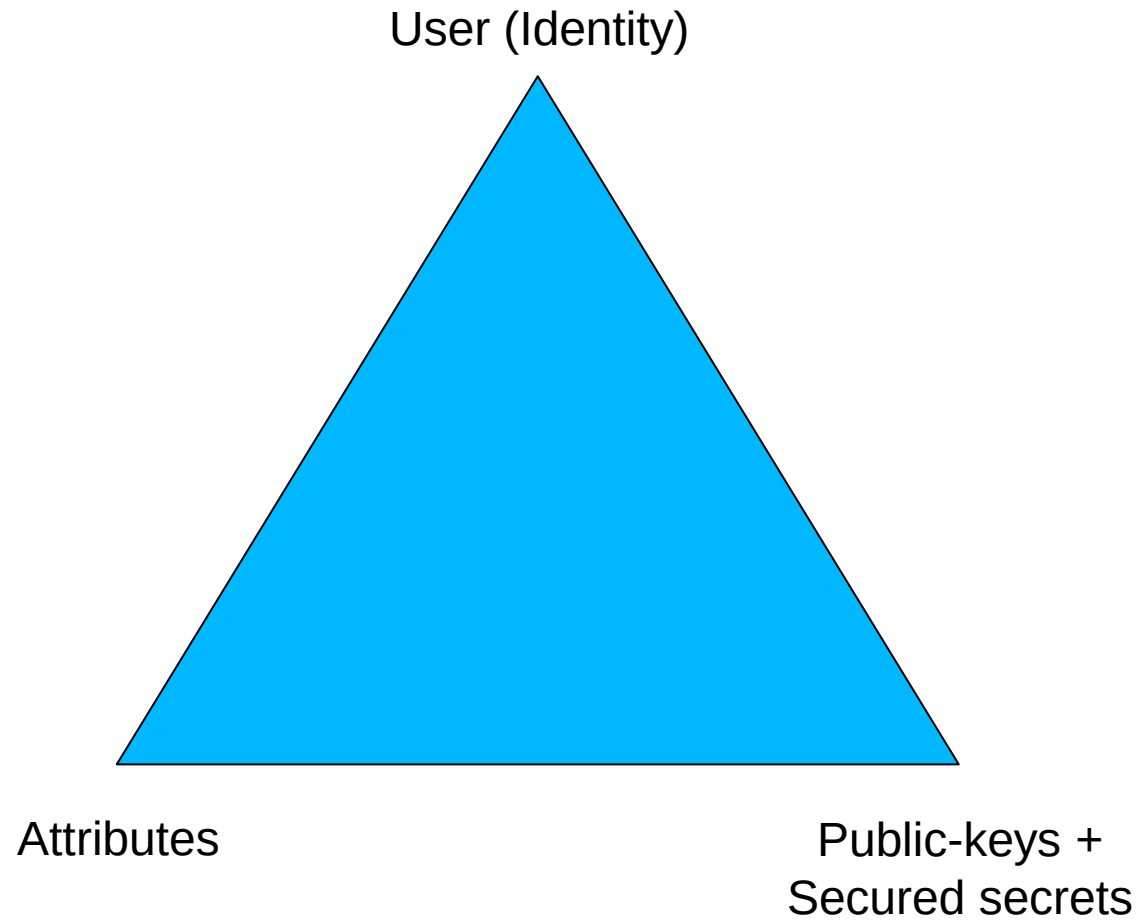
RBAC is neither MAC nor DAC!

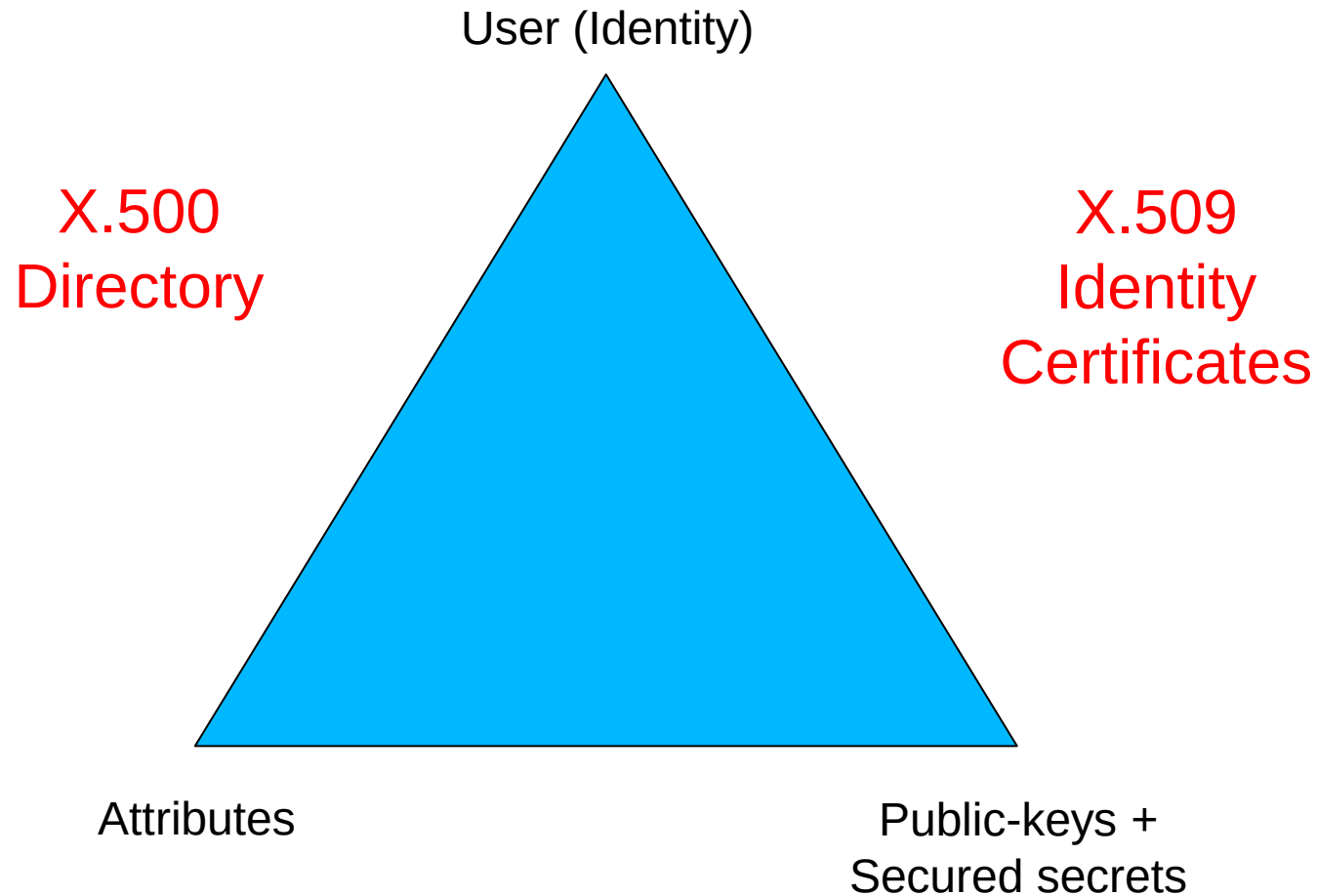
- Role granularity is not adequate leading to role explosion
 - ❖ Researchers have suggested several extensions such as parameterized privileges, role templates, parameterized roles (1997-)
- Role design and engineering is difficult and expensive
 - ❖ Substantial research on role engineering top down or bottom up (1996-), and on role mining (2003-)
- Assignment of users/permissions to roles is cumbersome
 - ❖ Researchers have investigated decentralized administration (1997-), attribute-based implicit user-role assignment (2002-), role-delegation (2000-), role-based trust management (2003-), attribute-based implicit permission-role assignment (2012-)
- Adjustment based on local/global situational factors is difficult
 - ❖ Temporal (2001-) and spatial (2005-) extensions to RBAC proposed
- **RBAC does not offer an extension framework**
 - ❖ **Every shortcoming seems to need a custom extension**
 - ❖ **Can ABAC unify these extensions in a common open-ended framework?**

Hard Enough

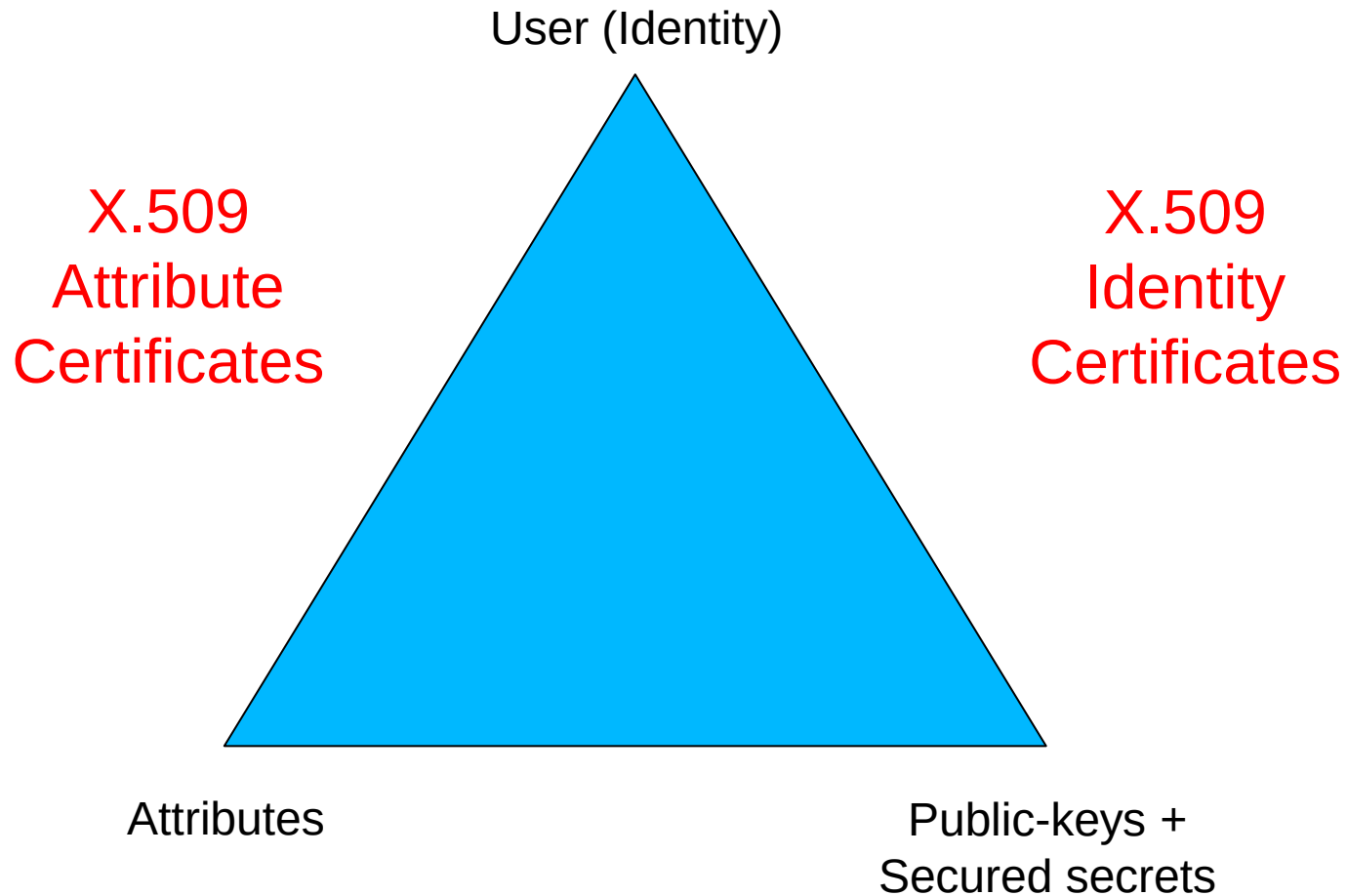
Impossible



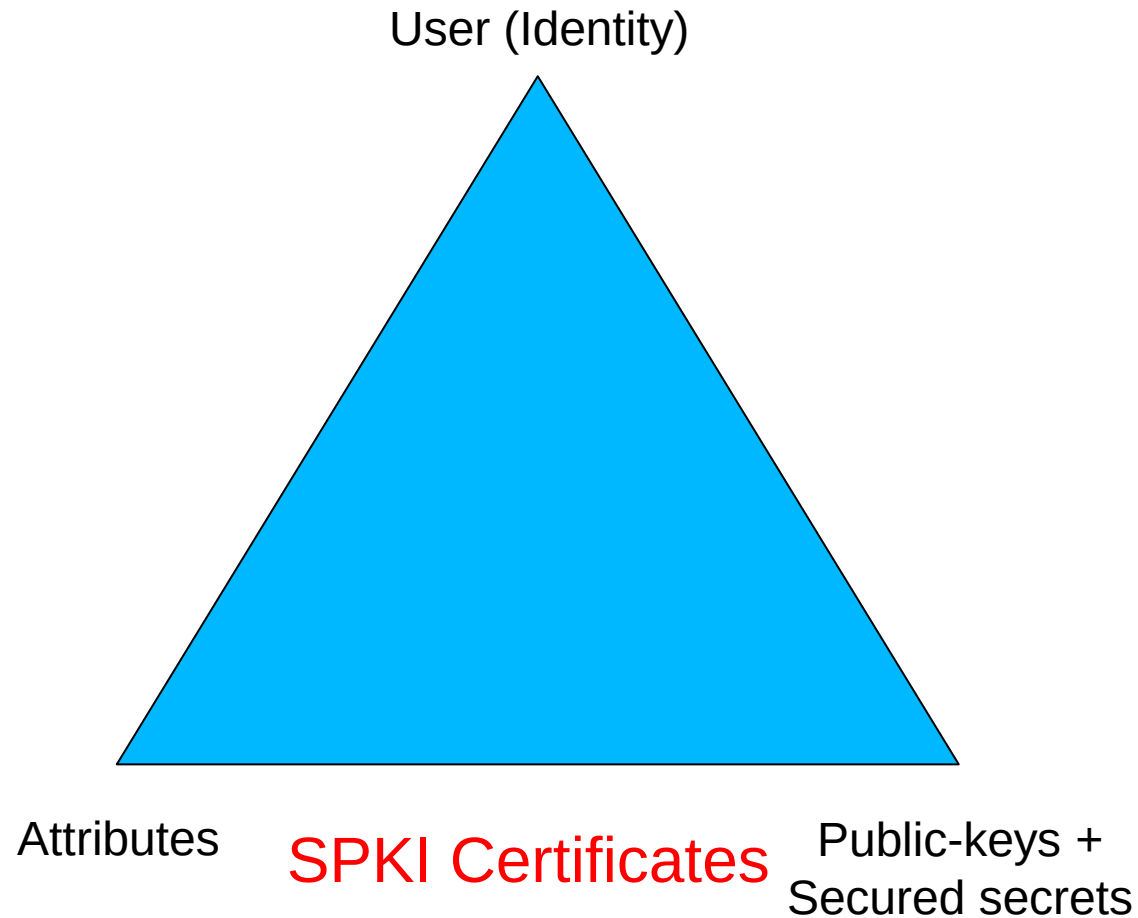




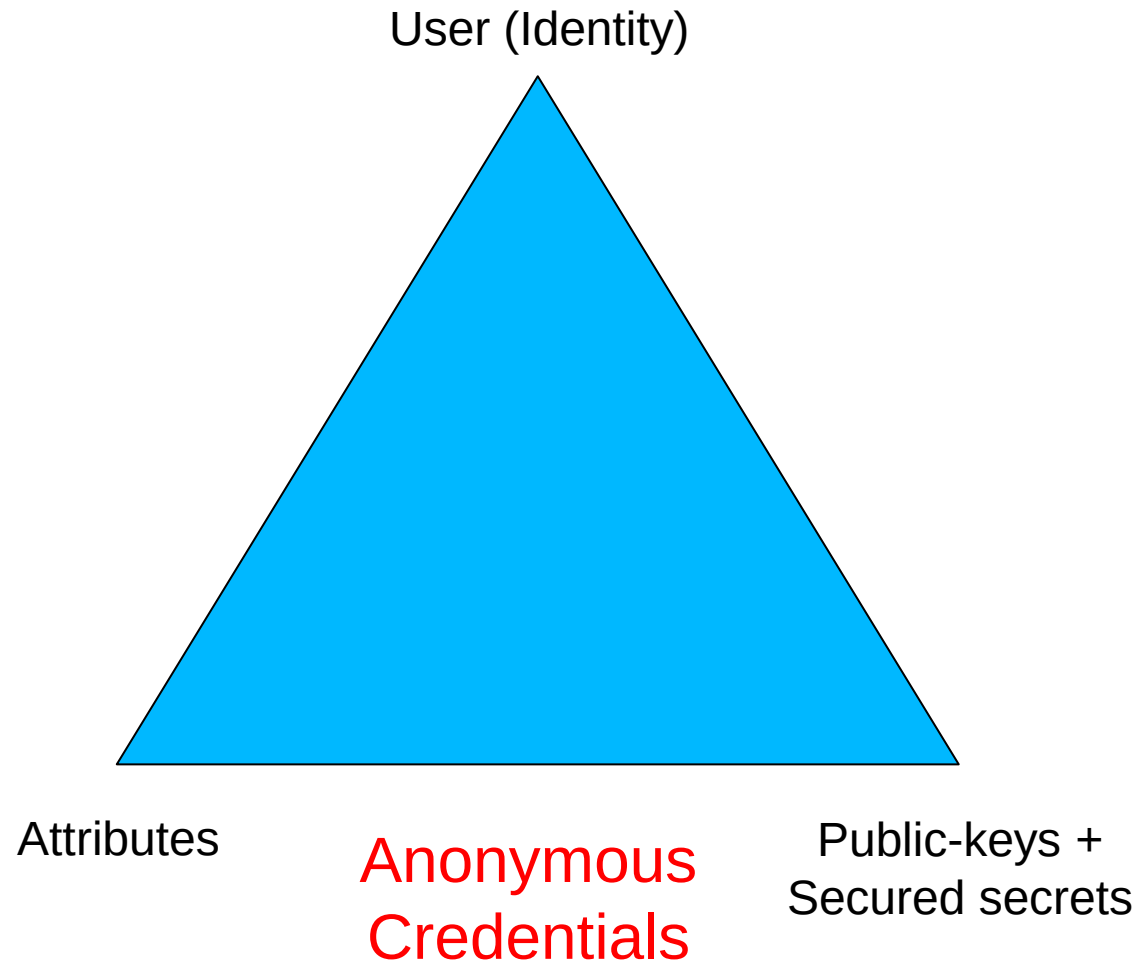
Pre Internet, early 1990s



Post Internet, late 1990s

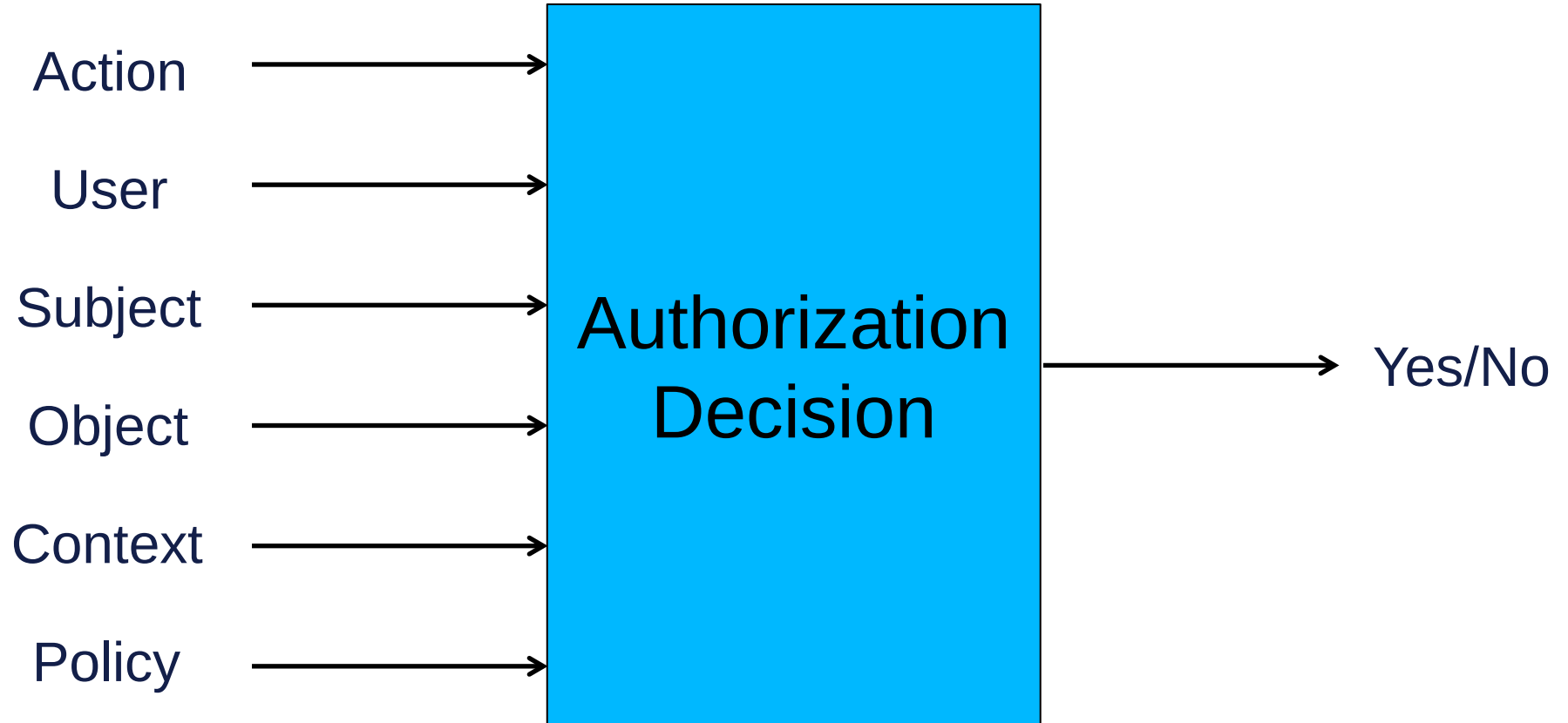


Post Internet, late 1990s

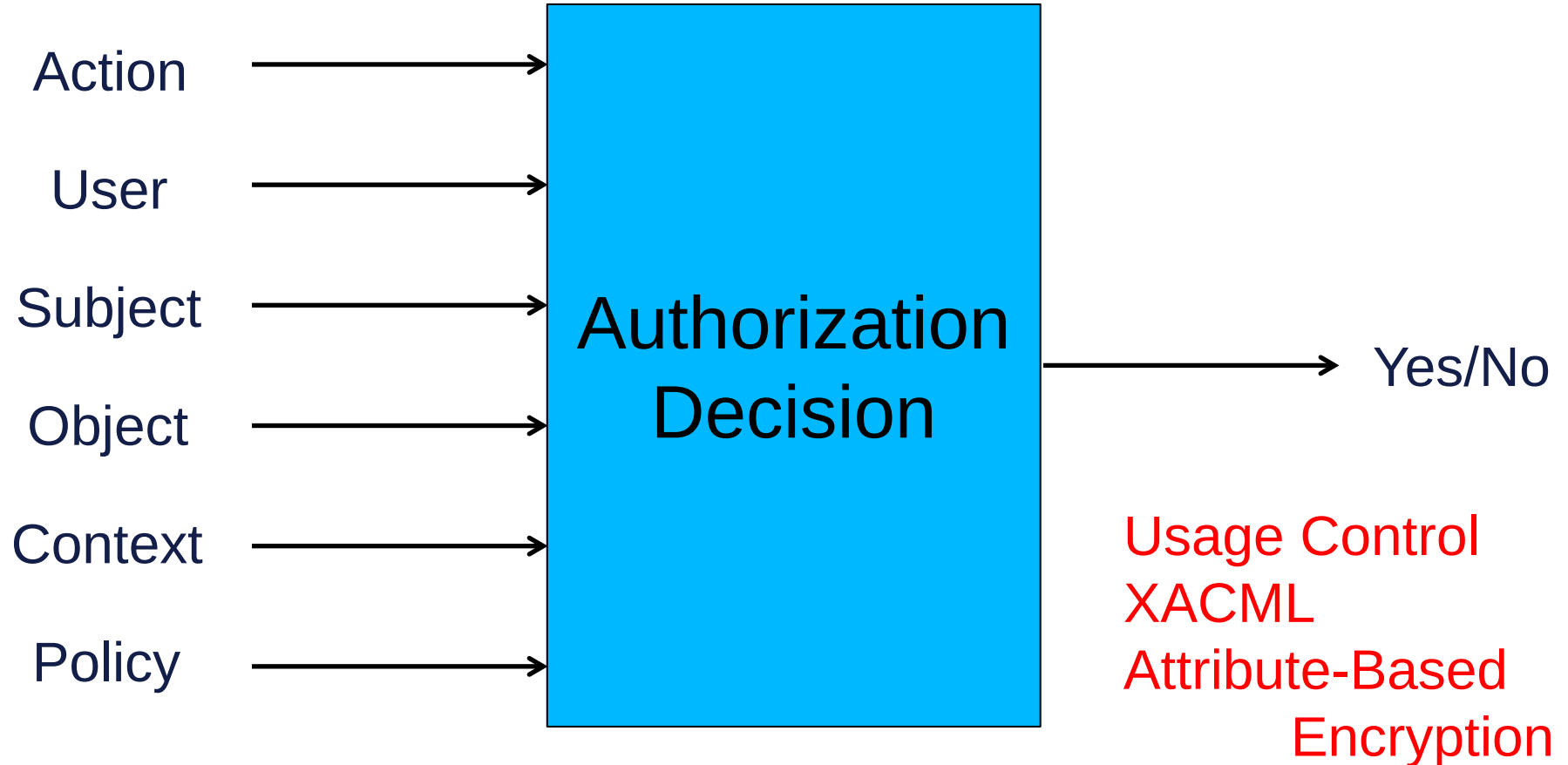


Mature Internet, 2000s

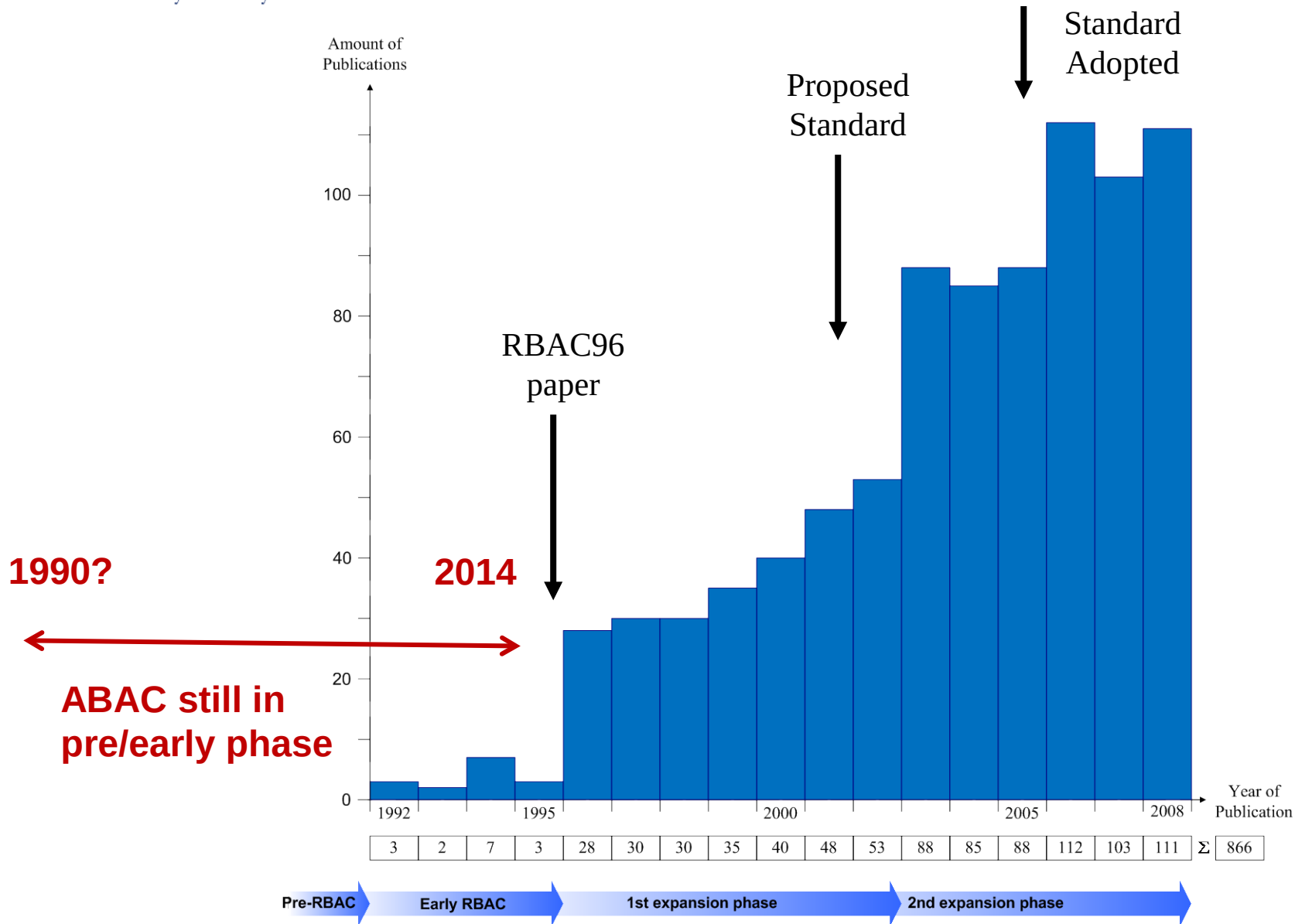
Attributes



Attributes



Mature Internet, 2000s

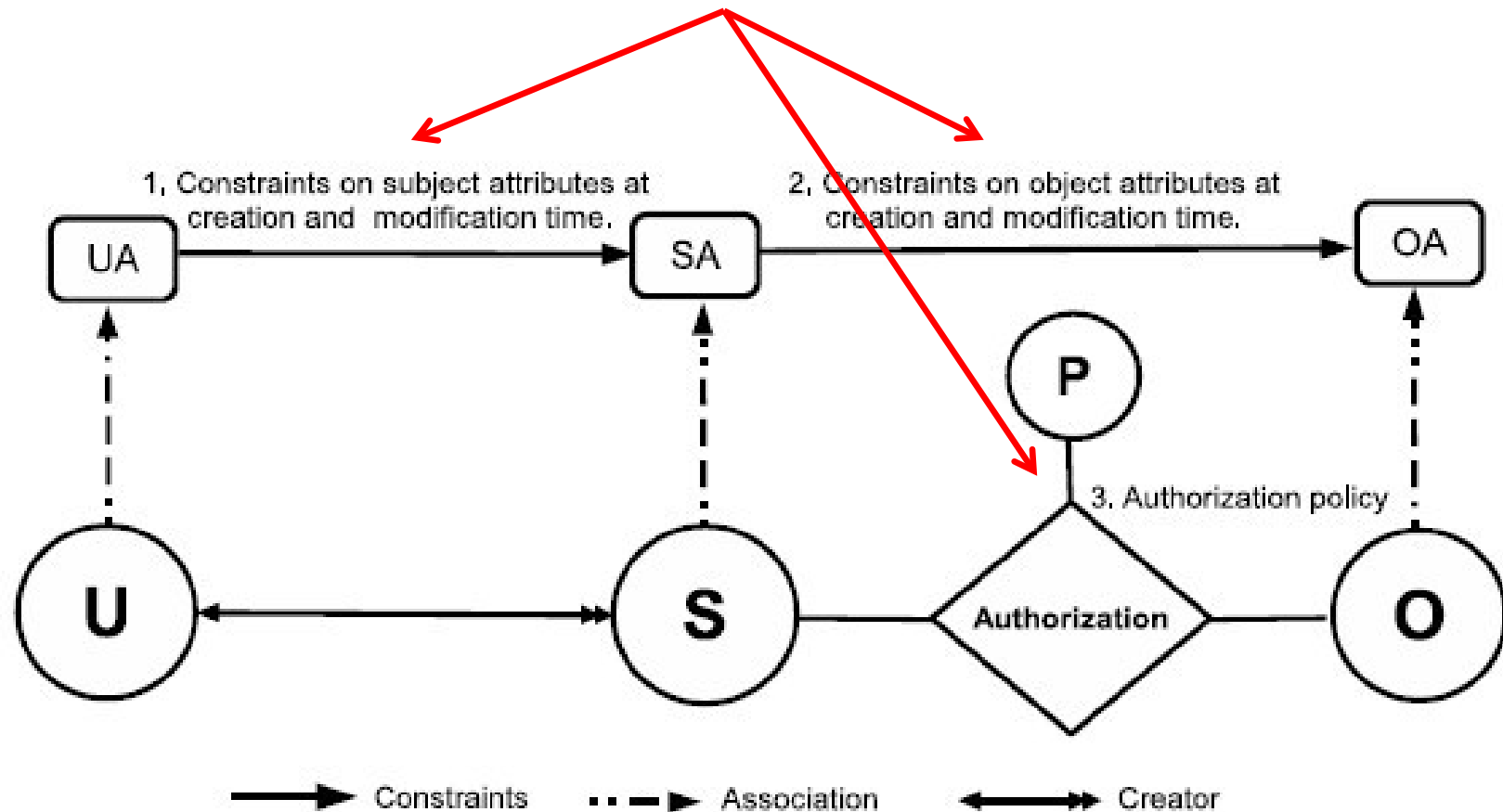


- Attributes are name:value pairs
 - ❖ possibly chained
 - ❖ values can be complex data structures
- Associated with
 - ❖ actions
 - ❖ users
 - ❖ subjects
 - ❖ objects
 - ❖ contexts
 - ❖ policies
- Converted by policies into rights just in time
 - ❖ policies specified by security architects
 - ❖ attributes maintained by security administrators
 - ❖ but also possibly by users OR reputation and trust mechanisms
- **Inherently extensible**

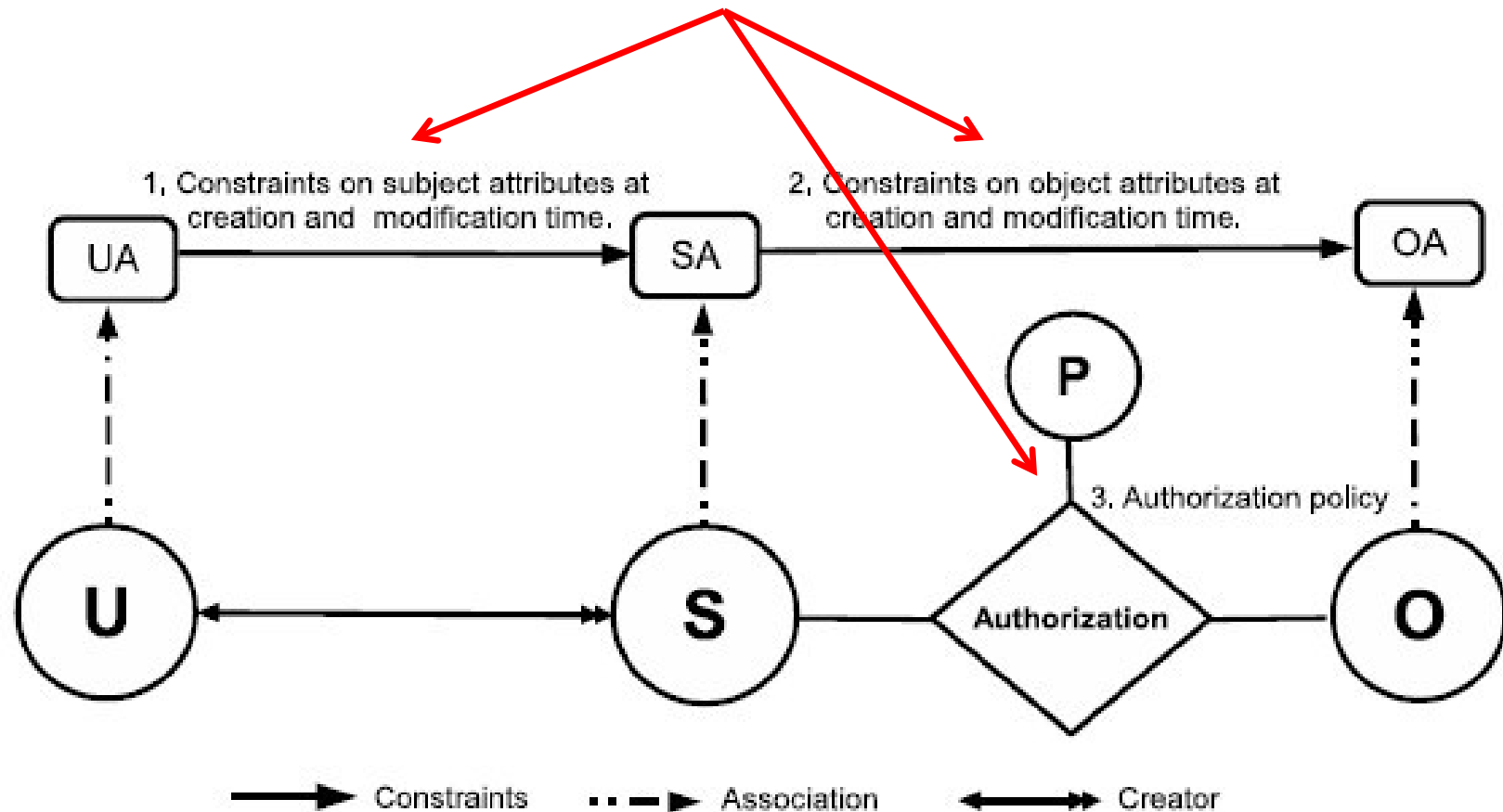
- An ABAC model requires
 - ❖ identification of policy configuration points (PCPs)
 - ❖ languages and formalisms for each PCP
- A core set of PCPs can be discovered by building the ABAC α model to unify simple forms of DAC, MAC and RBAC
- Additional ABAC models can then be developed by
 - ❖ increasing the sophistication of the ABAC α PCPs
 - ❖ discovering additional PCPs driven by requirements beyond DAC, MAC and RBAC

A small but crucial first step

Policy Configuration Points



Policy Configuration Points



Can be configured to do DAC, MAC, RBAC

1, 2, 4, 5

Extended Constraints on Role Activation:

Attribute-Based User-Role Assignment- 2002 [6], OASIS-RBAC-2002 [9], SRBAC-2003 [46], Rule-RBAC-2004 [5], GEO-RBAC-2005 [16]

1,4

Extended Concept of Role:

Role Template-1997 [45], Parameterized RBAC-2004 [2], Parameterized RBAC-2003 [34], Parameterized Role-2004 [43], Attributed Role-2006 [99]

1, 4, 5

Changes in Role-Permission Relationship:

Task-RBAC-2000 [77], Task-RBAC-2003 [78]

4, 5

Organization and Team:

Relationship-RBAC -1997 [12], TeamMAC-1997 [87], TeamMAC-2004 [7], ROBAC-2006 [103], Group-RBAC-2009 [66], RABAC-2013 [51], Domain-RBAC -2013 [98]

4

1, 4, 5

Context:

C-TMAC-2001 [44], GRBAC -2001 [70], Context Role-2001 [30], Context-Sensitive RBAC-2002 [63], Contextual RBAC-2003 [69], STRBAC-2006 [64], Spatial-temporal-RBAC-2007[81], CA-RBAC-2008 [62], Modelling Context-2008 [32]

Extended Permission Structure:

RBAC with Object class- 2007 [24], Conditional PRBAC 07 [74], PRBAC 07 [75], Purpose-aware RBAC- 2008 [67], Ubi-RBAC-2010 [76], RCPBAC-2011 [55]

1, 2, 3, 4, 5

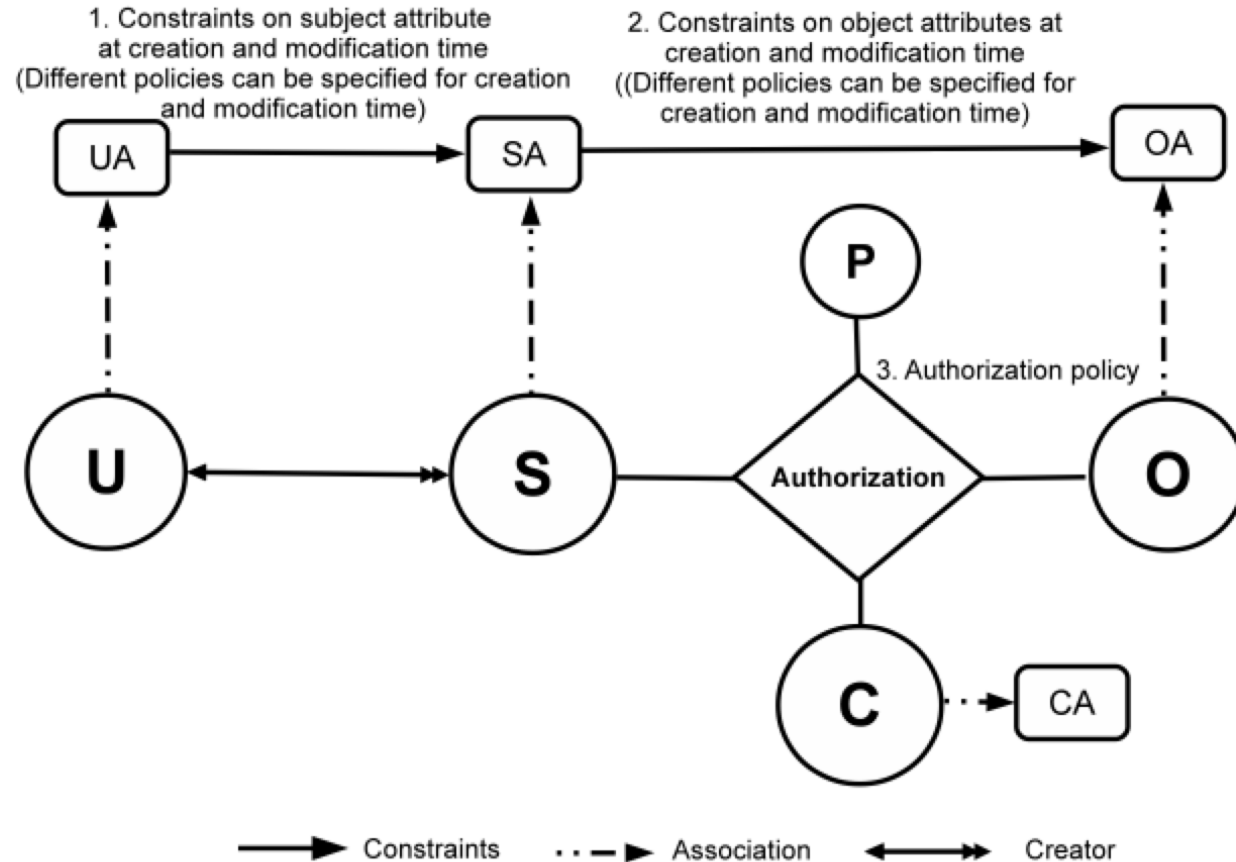
1. Context Attributes

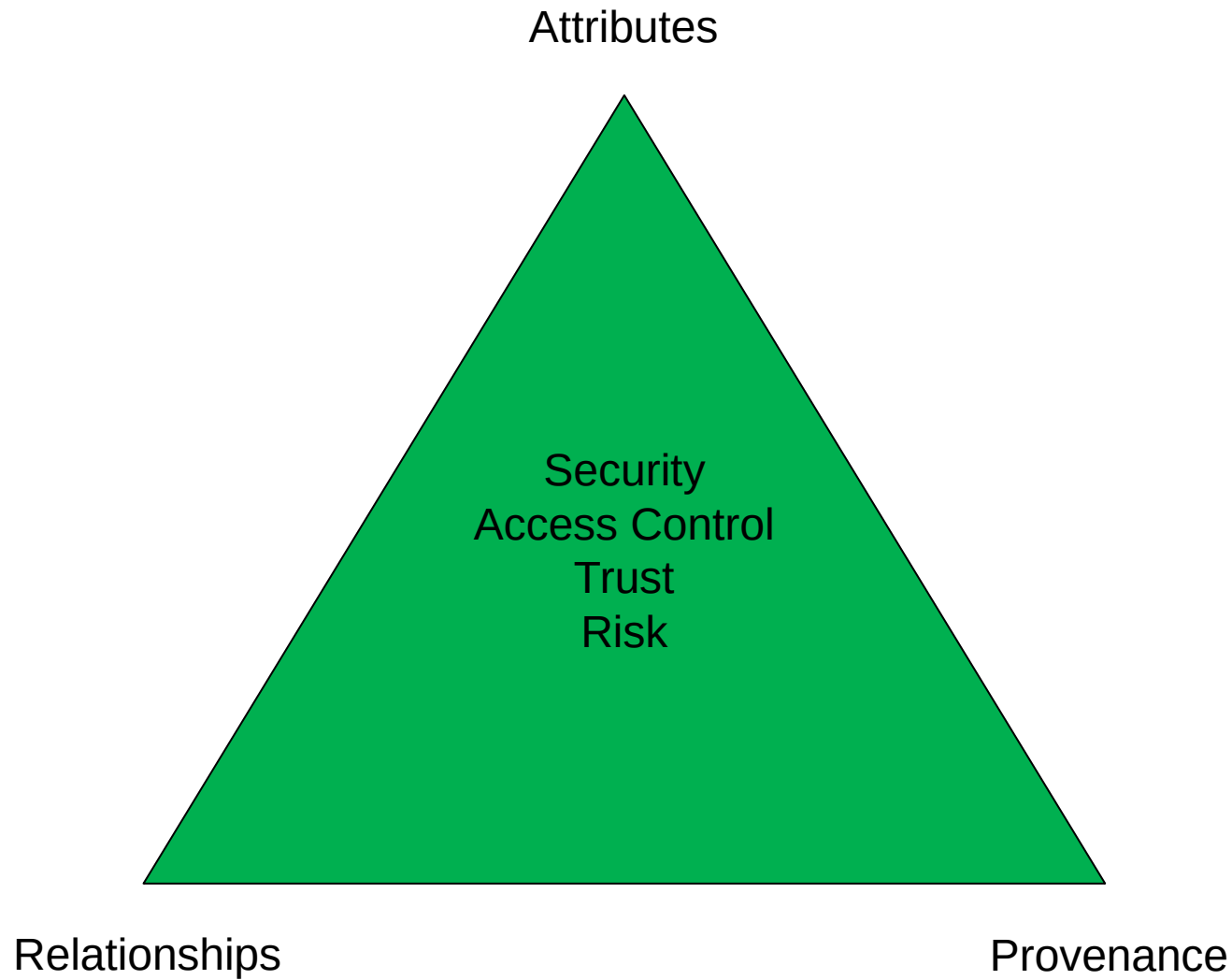
2. Subject attribute constraints policy are different at creation and modification time.

3. Subject attributes constrained by attributes of subjects created by the same user.

4. Policy Language

5. Meta-Attributes





- GURA model for user-attribute assignment
- Safety analysis of $ABAC_{\alpha}$ and $ABAC_{\beta}$
- Undecidable safety for ABAC models
- Decidable safety for ABAC with finite fixed attributes
- Constraints in ABAC
- ABAC Cloud IaaS implementations (OpenStack)
- Attribute Engineering
- Attribute Mining
- Unification of Attributes, Relationships and Provenance