# A Comparison of Logical-Formula and Enumerated Authorization Policy ABAC Models

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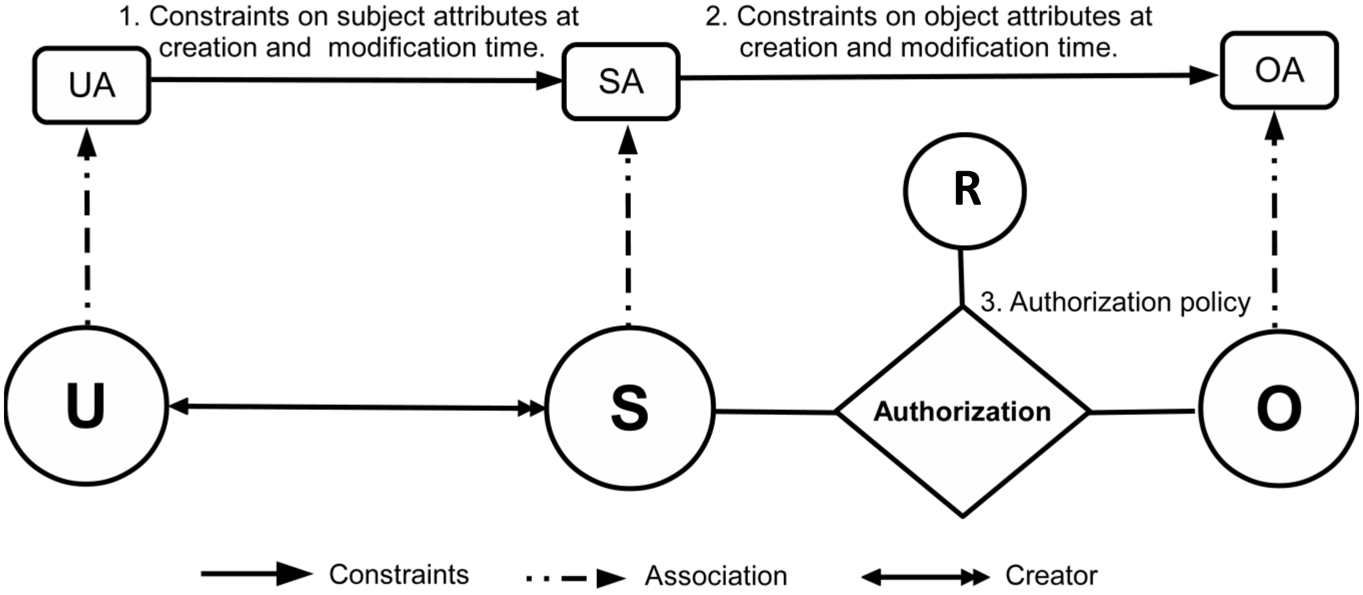
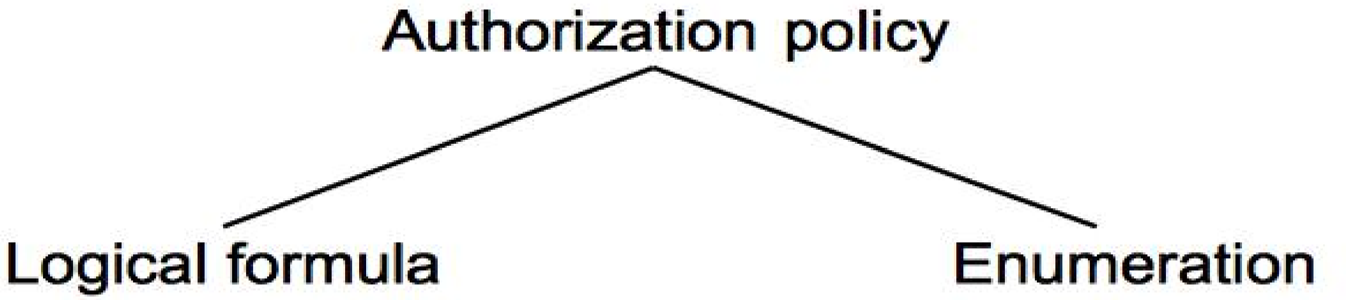
# ABAC

- ABAC model components
  - Users (U), subjects (S), objects (O), their attributes (UA, SA, OA) and access rights (R)
  - Authorization policies…


1. Constraints on subject attributes at creation and modification time.
2. Constraints on object attributes at creation and modification time.
UA
SA
OA
R
3. Authorization policy
U
S
Authorization
O
Constraints
Association
Creator

# ABAC Auth Policies



Authorization policy

Logical formula

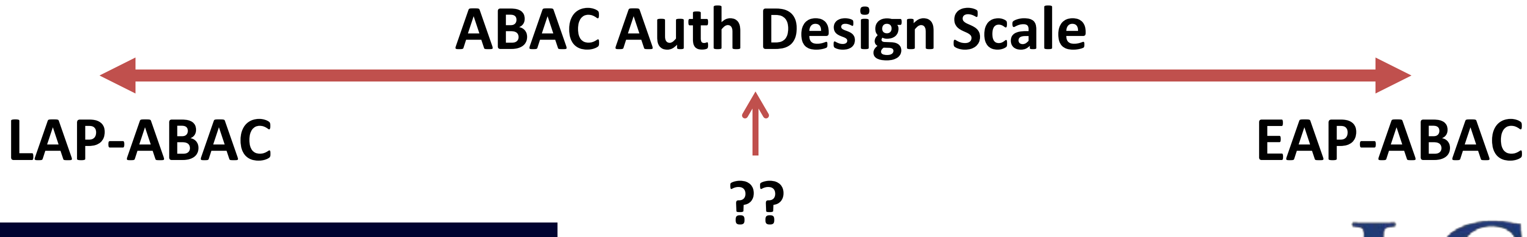
Enumeration

- Boolean expression
- E.g.: $auth(u,o,read) \leftrightarrow age(u)>18 \wedge age(u) <25$
- $\text{ABAC}_{\alpha}$ (Jin et al, DBSec 2012), HGABAC (Servos et al, FPS 2014)

- Set of authorizing tuples
- E.g.: {(age(u),19), (age(u),20), …(age(u),24)}
- Policy Machine (JSA 2011), 2-sorted-RBAC (Kuijper et al, SACMAT 2014)

# Objective

- Gain insights into different forms of ABAC auth policy representations
  - Logical Authorization Policy ABAC (LAP-ABAC)
  - Enumerated Authorization Policy ABAC (EAP-ABAC)
- Quantitative and qualitative comparison
  - Expressive power, ease of administration, etc.



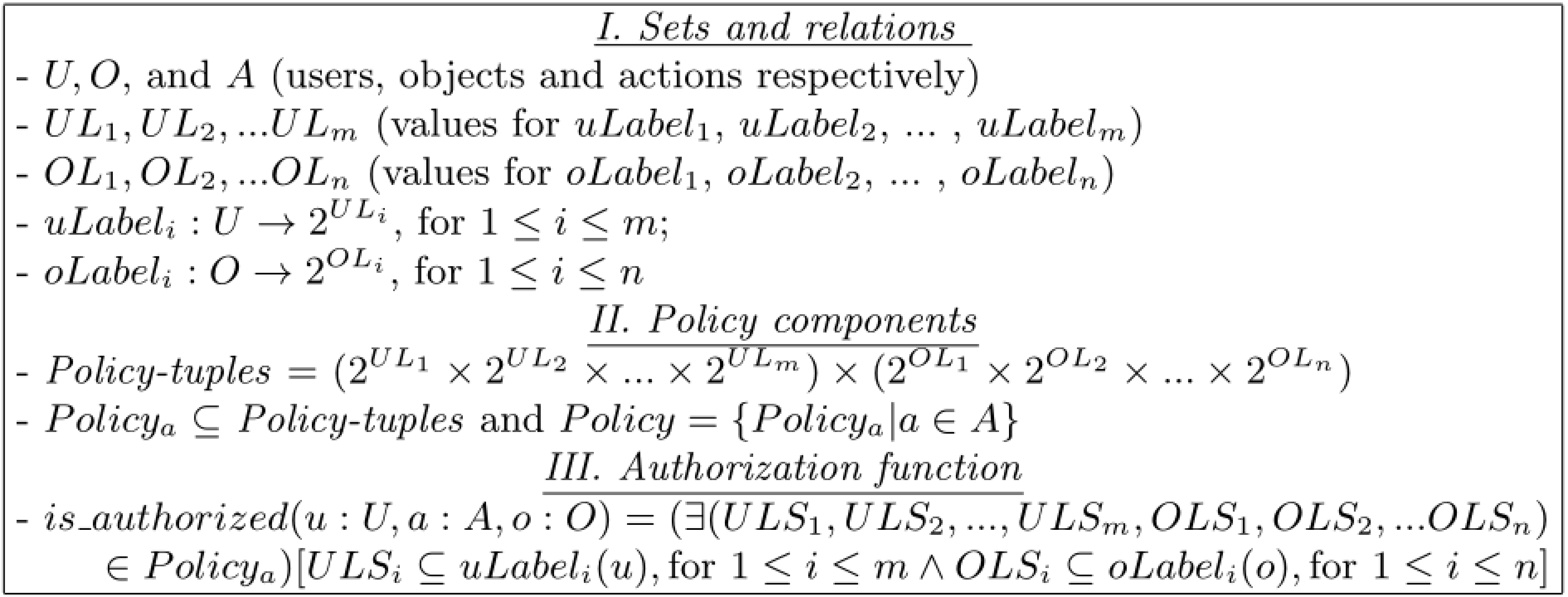
# Attribute Domain

- Assume attributes as functions
  - UA = {age,clr,friends}
  - Range(age) = {1…100}, Range(clr) = {H,L}, and Range(friends) = U
- Example finite domain attributes
  - Age of user, roles of user, object classification, etc.
- Example unbounded domain attributes
  - Friends of user, editors of objects, etc.
- We assume attribute domains to be finite

# Contributions and Results Summary

- Candidate LAP-ABAC and EAP-ABAC models for the purpose of this investigation
- LAP-ABAC and EAP-ABAC are equally expressive (recall finite domain)
  - Single (e.g. UA = {age}) and multi-attribute (e.g. UA = {age,group,clr}) ABACs are equally expressive
- However, LAP-ABACs and EAP-ABACs have their pros and cons on qualitative aspects

# EAP-ABAC$_{m,n}$



*I. Sets and relations*

- $U, O$, and $A$ (users, objects and actions respectively)
- $UL_1, UL_2, ...UL_m$ (values for $uLabel_1$, $uLabel_2$, ... , $uLabel_m$)
- $OL_1, OL_2, ...OL_n$ (values for $oLabel_1$, $oLabel_2$, ... , $oLabel_n$)
- $uLabel_i : U \rightarrow 2^{UL_i}$, for $1 \leq i \leq m$;
- $oLabel_i : O \rightarrow 2^{OL_i}$, for $1 \leq i \leq n$

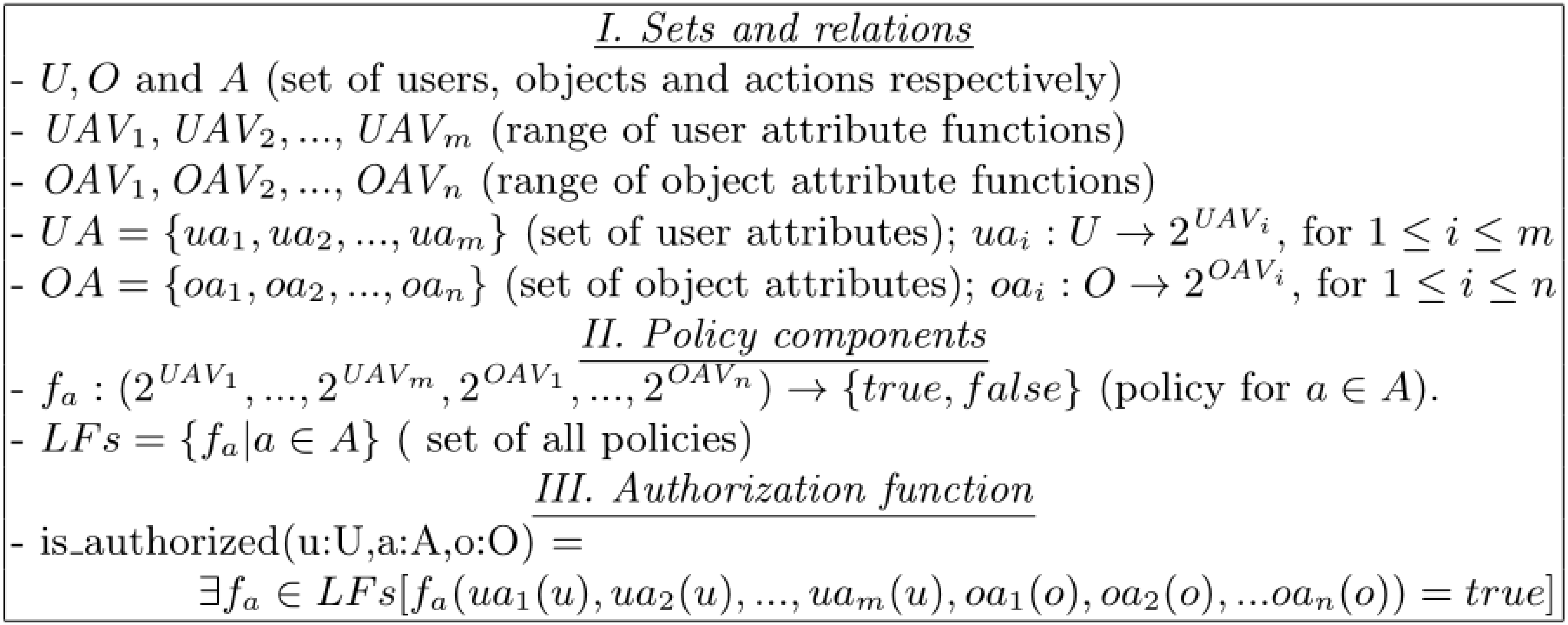
*II. Policy components*

- $Policy\text{-}tuples = (2^{UL_1} \times 2^{UL_2} \times ... \times 2^{UL_m}) \times (2^{OL_1} \times 2^{OL_2} \times ... \times 2^{OL_n})$
- $Policy_a \subseteq Policy\text{-}tuples$ and $Policy = \{Policy_a | a \in A\}$

*III. Authorization function*

- $is\_authorized(u : U, a : A, o : O) = (\exists(ULS_1, ULS_2, ..., ULS_m, OLS_1, OLS_2, ...OLS_n)$
  $\in Policy_a)[ULS_i \subseteq uLabel_i(u), \text{for } 1 \leq i \leq m \wedge OLS_i \subseteq oLabel_i(o), \text{for } 1 \leq i \leq n]$

# LAP-ABAC$_{m,n}$



*I. Sets and relations*

- $U, O$ and $A$ (set of users, objects and actions respectively)
- $UAV_1, UAV_2, ..., UAV_m$ (range of user attribute functions)
- $OAV_1, OAV_2, ..., OAV_n$ (range of object attribute functions)
- $UA = \{ua_1, ua_2, ..., ua_m\}$ (set of user attributes); $ua_i : U \rightarrow 2^{UAV_i}$, for $1 \leq i \leq m$
- $OA = \{oa_1, oa_2, ..., oa_n\}$ (set of object attributes); $oa_i : O \rightarrow 2^{OAV_i}$, for $1 \leq i \leq n$

*II. Policy components*

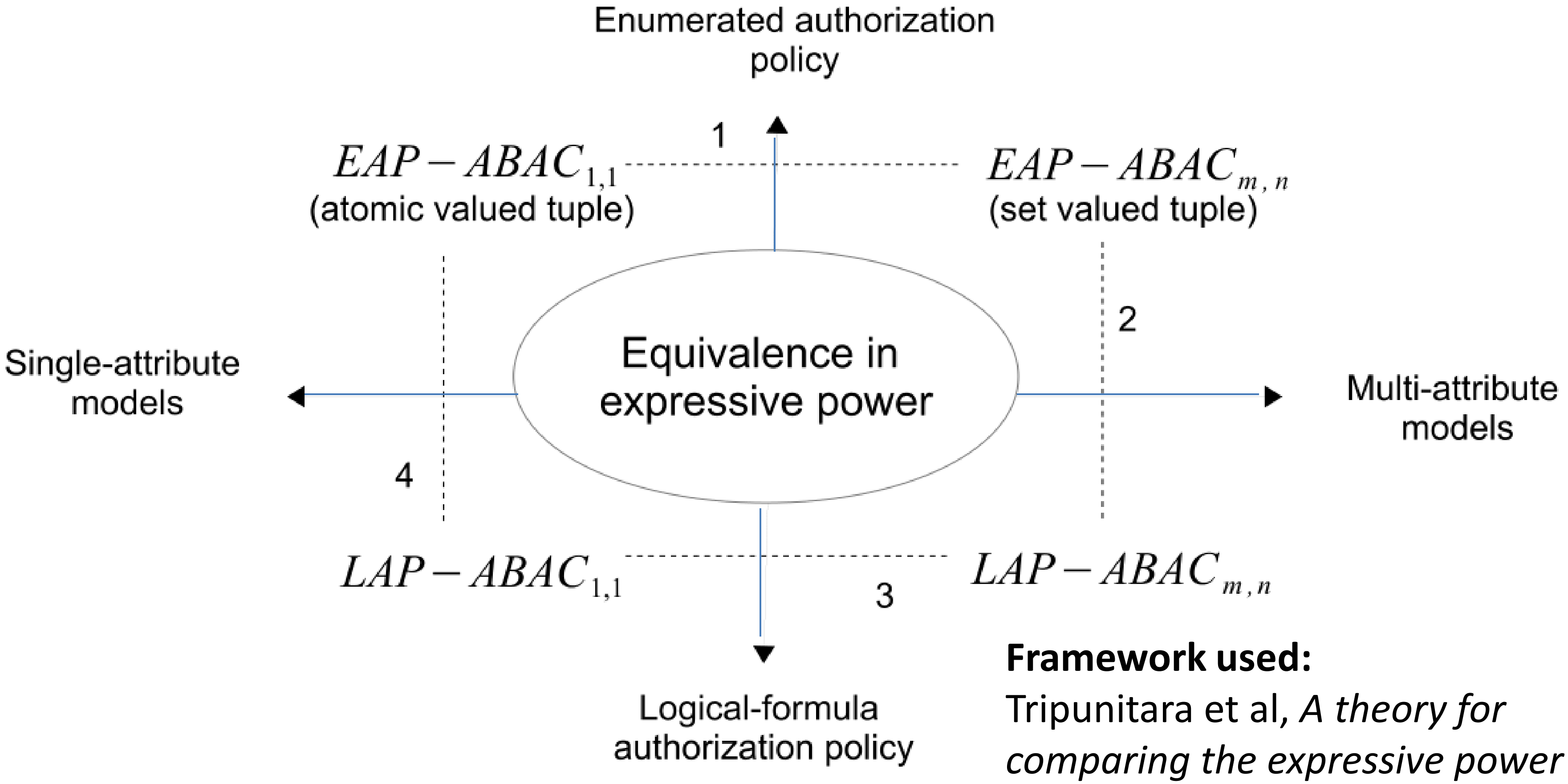
- $f_a : (2^{UAV_1}, ..., 2^{UAV_m}, 2^{OAV_1}, ..., 2^{OAV_n}) \rightarrow \{true, false\}$ (policy for $a \in A$).
- $LFs = \{f_a | a \in A\}$ ( set of all policies)

*III. Authorization function*

- is_authorized(u:U,a:A,o:O) =

$$\exists f_a \in LFs[f_a(ua_1(u), ua_2(u), ..., ua_m(u), oa_1(o), oa_2(o), ...oa_n(o)) = true]$$

# Expressive Power Equivalence



**Framework used:**
Tripunitara et al, *A theory for comparing the expressive power of access control models*, JCS 2007.

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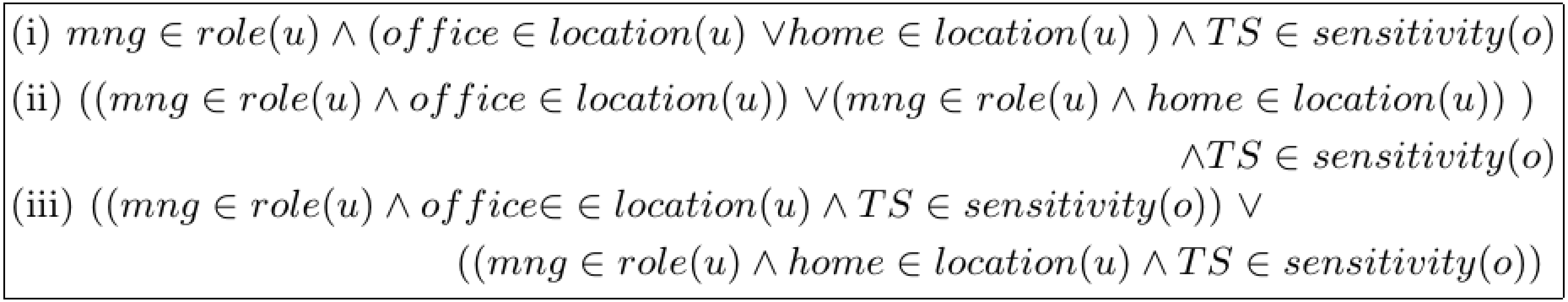
# Auth Specification in LAP-ABAC

*Multiple ways to set up a policy*

(***Auth**$_{read}$ allows manager* to read *TS* objects from *home* or *office*).



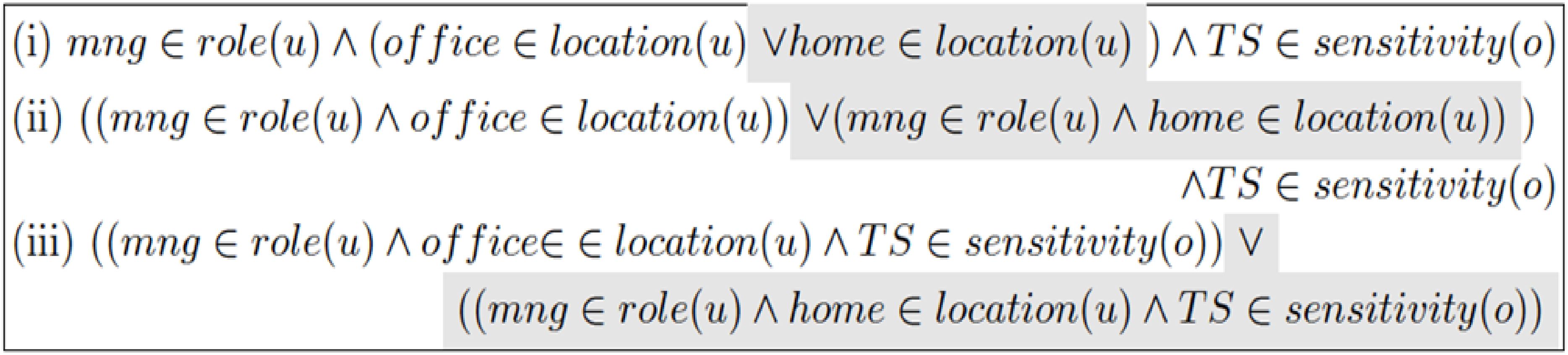
(i) $mng \in role(u) \wedge (office \in location(u)\ \vee home \in location(u)\ ) \wedge TS \in sensitivity(o)$

(ii) $((mng \in role(u) \wedge office \in location(u))\ \vee (mng \in role(u) \wedge home \in location(u))\ )$
$\wedge TS \in sensitivity(o)$

(iii) $((mng \in role(u) \wedge office\in \in location(u) \wedge TS \in sensitivity(o)) \vee$
$((mng \in role(u) \wedge home \in location(u) \wedge TS \in sensitivity(o))$

# Auth Update in LAP-ABAC

*Update* ***Auth***$_{\textbf{\textit{read}}}$ *so that*
*manager* can no longer read *TS* objects from *home*



(i) $mng \in role(u) \wedge (office \in location(u) \vee home \in location(u)\ ) \wedge TS \in sensitivity(o)$

(ii) $((mng \in role(u) \wedge office \in location(u)) \vee (mng \in role(u) \wedge home \in location(u))\ )$
$\wedge TS \in sensitivity(o)$

(iii) $((mng \in role(u) \wedge office\in \in location(u) \wedge TS \in sensitivity(o)) \vee$
$((mng \in role(u) \wedge home \in location(u) \wedge TS \in sensitivity(o))$

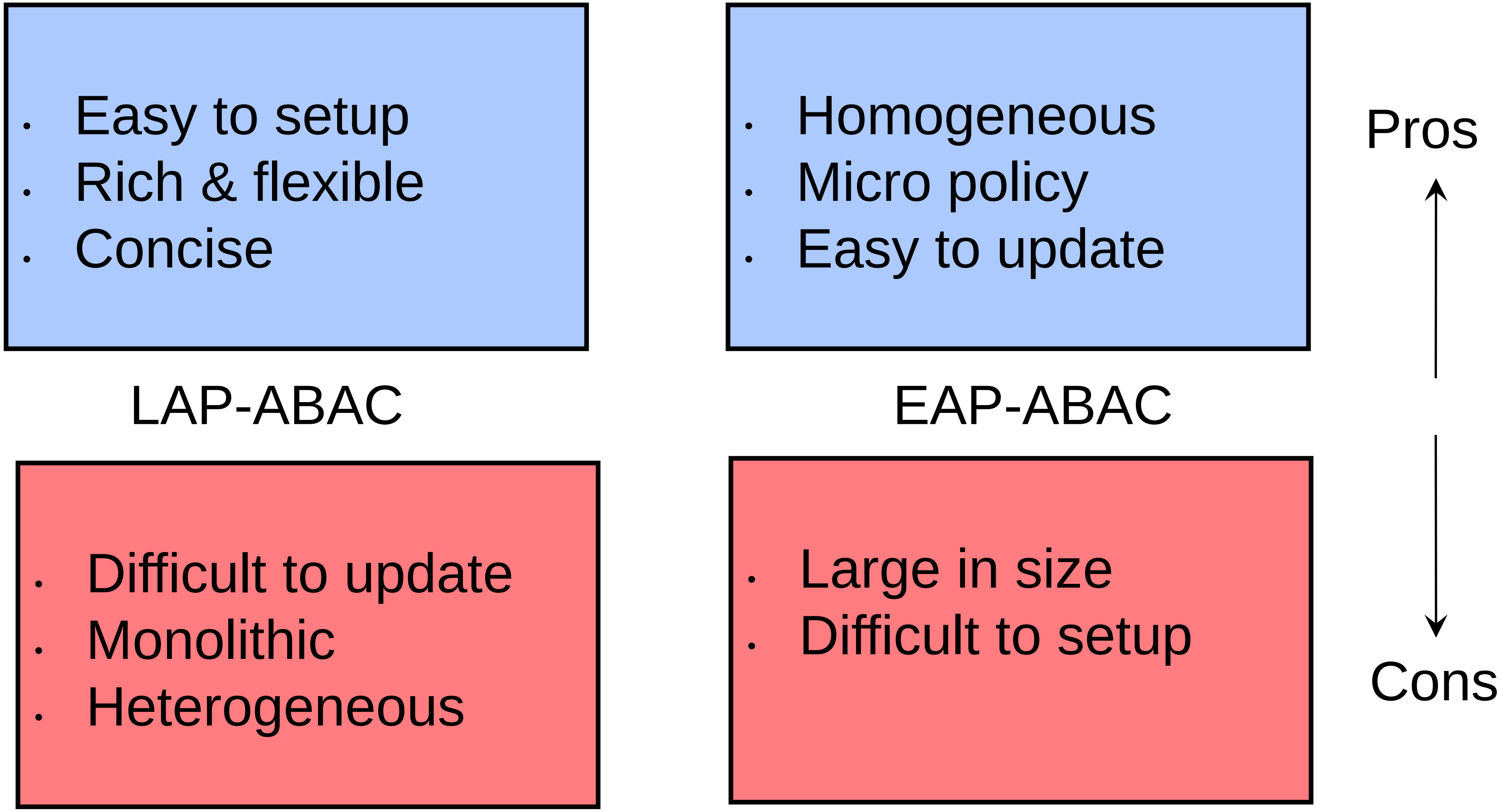
# Auth Update in EAP-ABAC

- ❑ $\text{Auth}_{\text{read}} \equiv$ {(mng, home, TS), (mng,office,TS)}
- ❑ $\text{Auth`}_{\text{read}} \equiv$ { ~~(mng, home, TS),~~ (mng,office,TS)}

# Canonicalization of EAP-ABAC

- Suppose $\text{Auth}_{\text{write}}$ = {({mgr},{TS}), ({mgr,Dir},{TS})}
- This can be reduced to $\text{Auth}_{\text{write}}$ = {({mgr},{TS})}
- EAP-ABAC auth policies can be efficiently canonicalized as per policy semantics

# Comparison



LAP-ABAC

- Easy to setup
- Rich & flexible
- Concise

- Difficult to update
- Monolithic
- Heterogeneous

EAP-ABAC

- Homogeneous
- Micro policy
- Easy to update

- Large in size
- Difficult to setup

Pros

Cons

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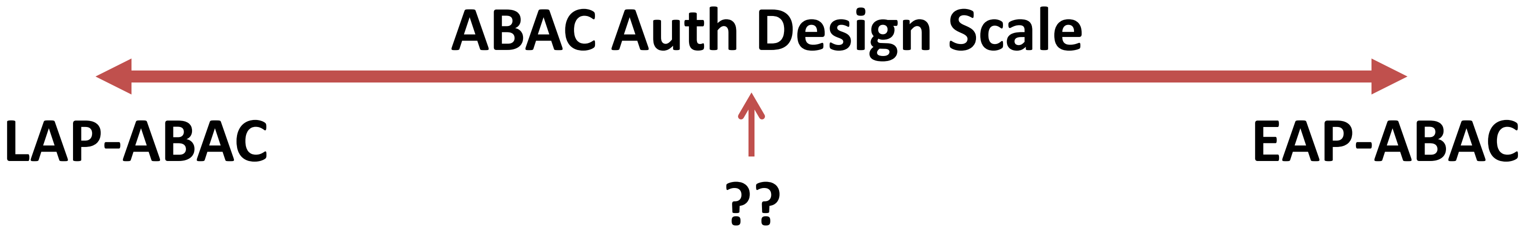
# Conclusion

- ❑ ABAC should be designed with objectives that go beyond expressive power
  - ➢ E.g.: Administration of authorization policy
    - Setting up new policies, update existing policies, etc



ABAC Auth Design Scale

# Q&A

Consider submitting your work to ACM CODASPY ’16
Submission deadline: Sept 15, 2016
http://www.codaspy.org/

7th ACM Conference on Data and Application Security and Privacy (ACM CODASPY 2017)

March 22-24, 2017, Scottsdale, Arizona, USA

# Thank you!