Attribute-Based Access Control

insider threats, security, privacy and trust

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Outline

Access Control

- Mechanism that ensures only authorized users have access to computer resources
- The prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner
- The logical component that serves to receive the access request from the subject, to decide, and to enforce the access decision.

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Insiders: informal definitions

- Someone with access, privilege, or knowledge of information systems and services. (Brackney and Anderson)
- Anyone operating inside the security perimeter. (Patzakis)
- Wholly or partially trusted subject.
- A system user who can misuse privileges.
- Someone with legitimate past or present access to resources.
- Someone with authorized access who might attempt unauthorized removal or sabotage of critical assets or who can aid outsiders in doing so.

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- Trust is assumption about the way an entity will behave
- Authorized users (trusted) are assumed not to abuse their privileges for which they are authorized (trusted).
- Insider threat: when a trusted authorized user is not trustworthy
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The insider problem arises because the set of users trusted on some level in some particular context is not equal to the set of trustworthy users on the same level for the same context.

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Prevention

To counter insider threats and minimize mismatch (inconsistency) between trust and trustworthiness following features should be supported:

1. Using of proper authentications methods (some are more secure then other);
2. Management of privileges should not be based on identities;
3. Support of finer levels of granularity;
4. Contextual-awareness;
5. Support dynamic policies (privileges user authorized for can be modified automatically when a user is suspected to be untrustworthy, trust-awareness).
6. Provide dynamic policies combining access control and risk.

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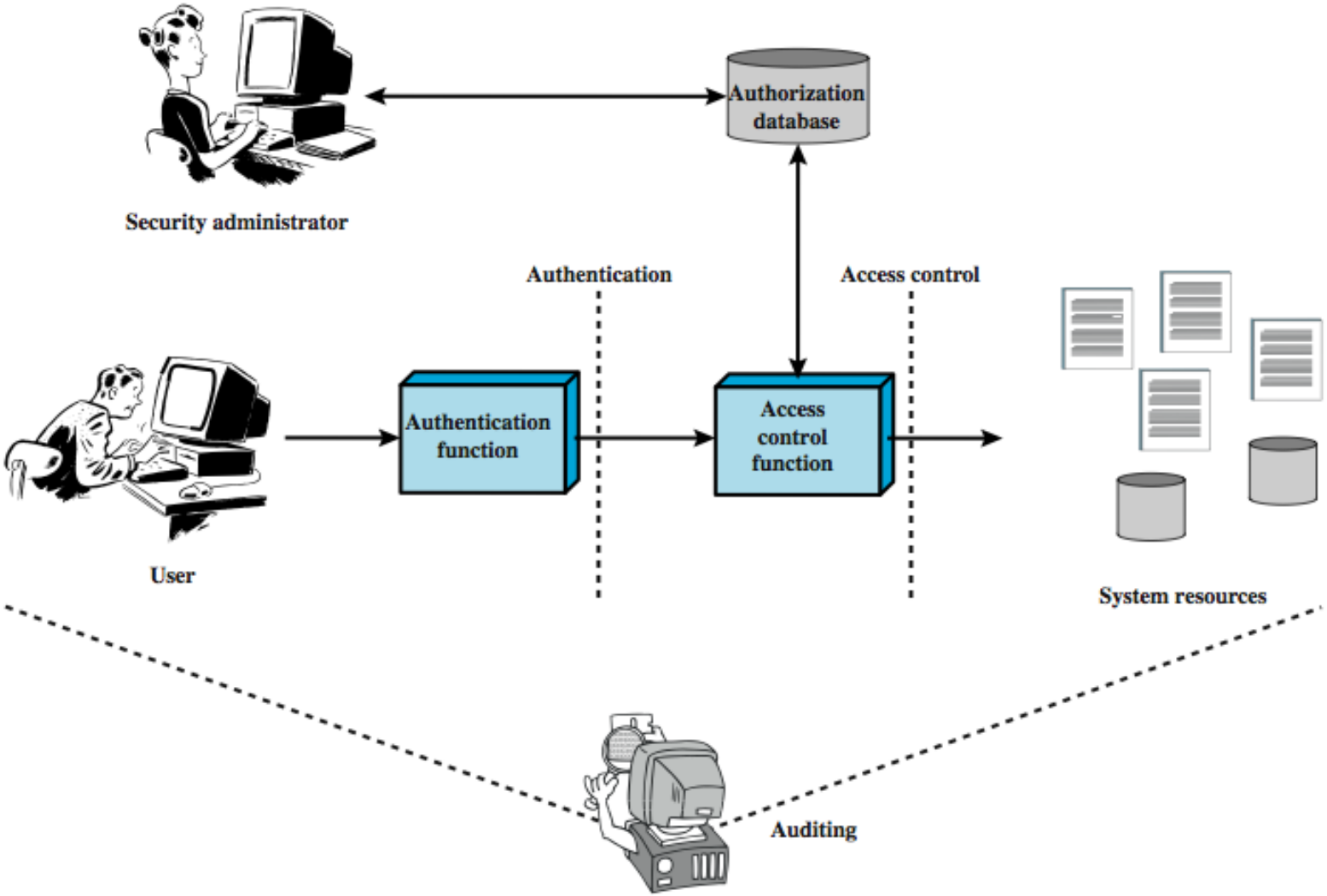
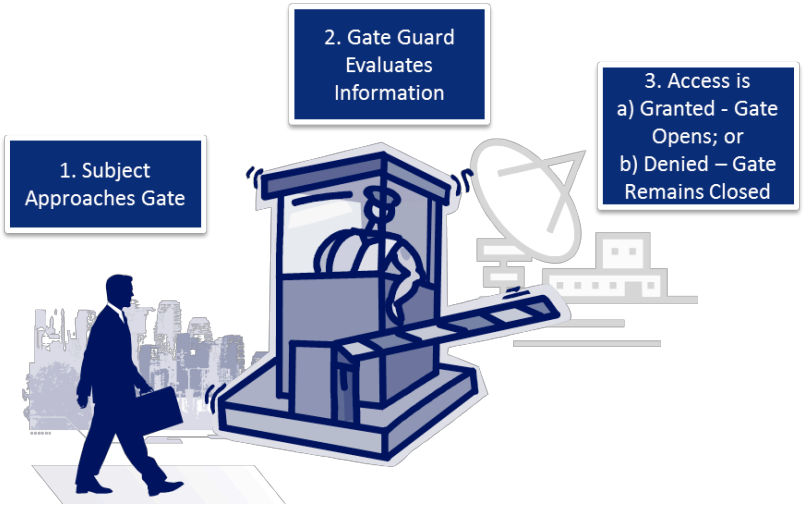
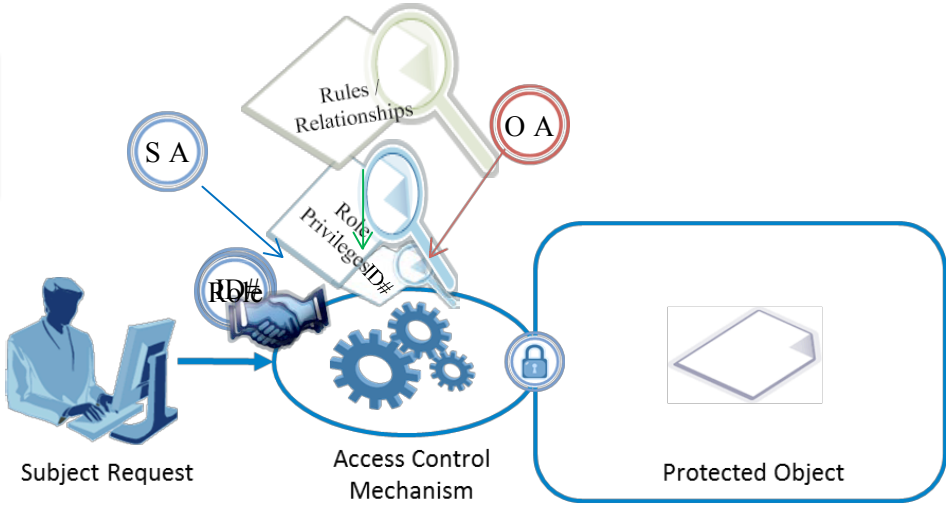
Access Control Model



History





MAC/DAC

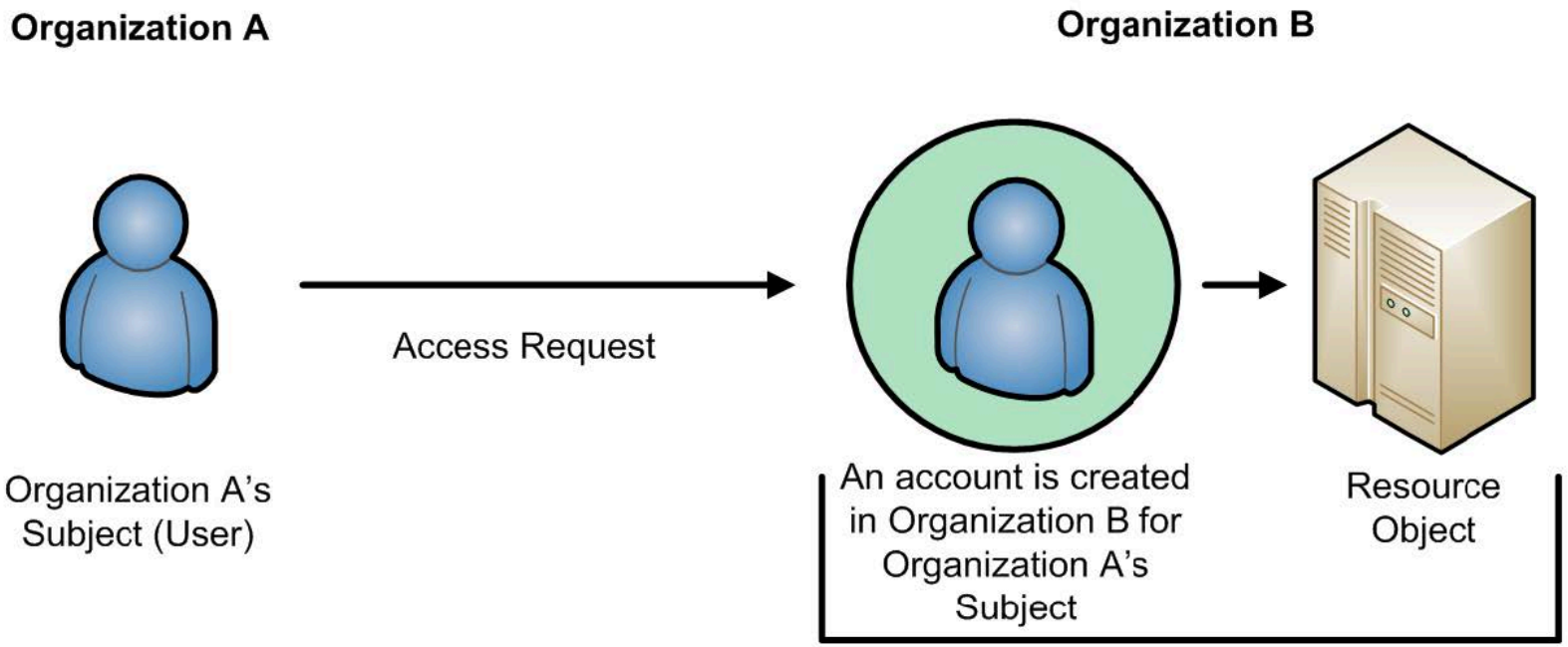
IBAC/ACL's

RBAC

ABAC

1960's 1970's 1980's 1990's 2000's Now

Multi-organizational access challenge



Organization B provisions an identity for Organization A's Subject prior to their accessing an Organization B Resource Object.

Attribute Based Access Control (ABAC)

Definition (from NIST)

A logical access control methodology where authorization to perform a set of operations is determined by evaluating attributes associated with the subject, object, requested operations, and, in some cases, environment conditions against policy, rules, or relationships that describe the allowable operations for a given set of attributes.

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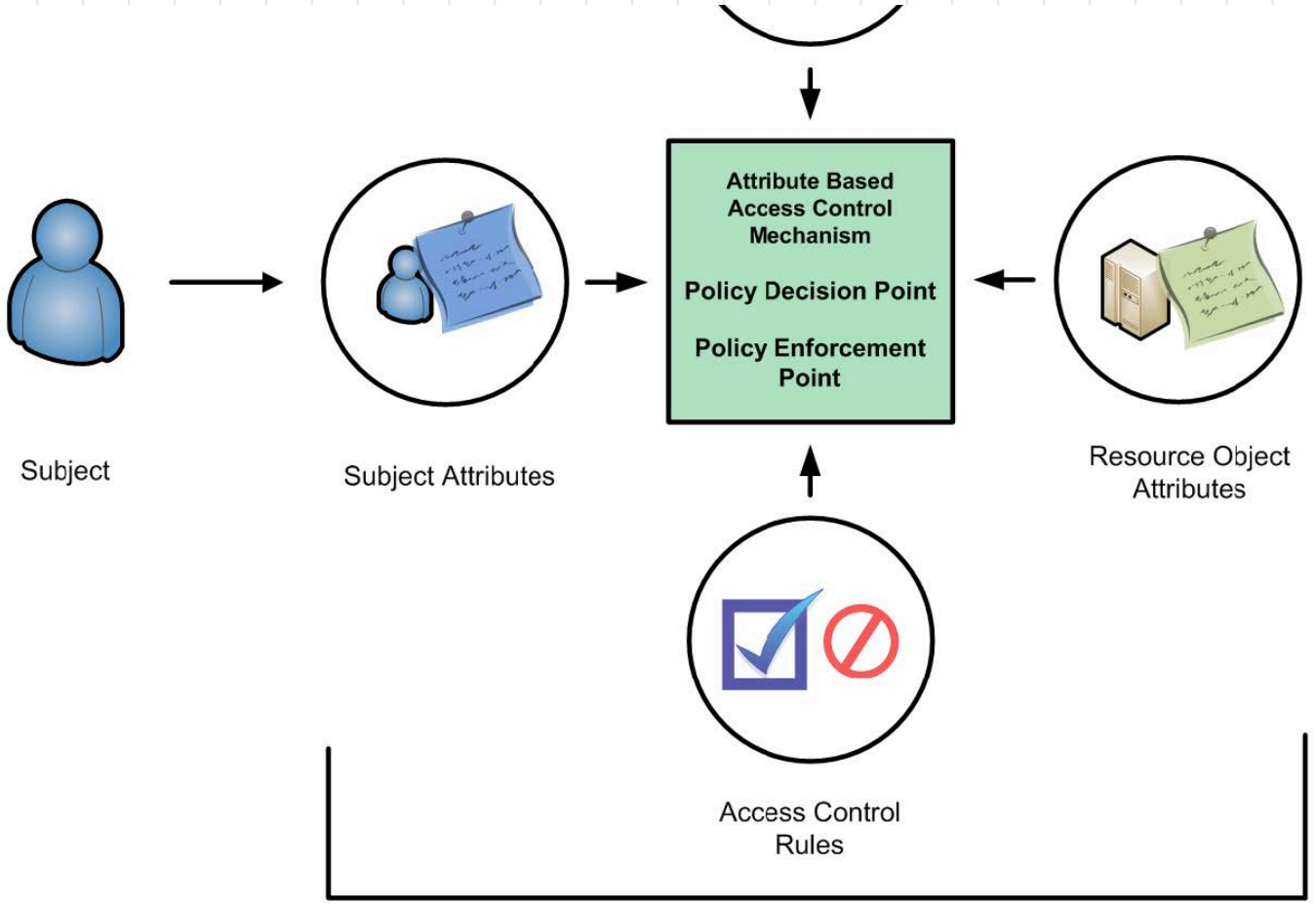
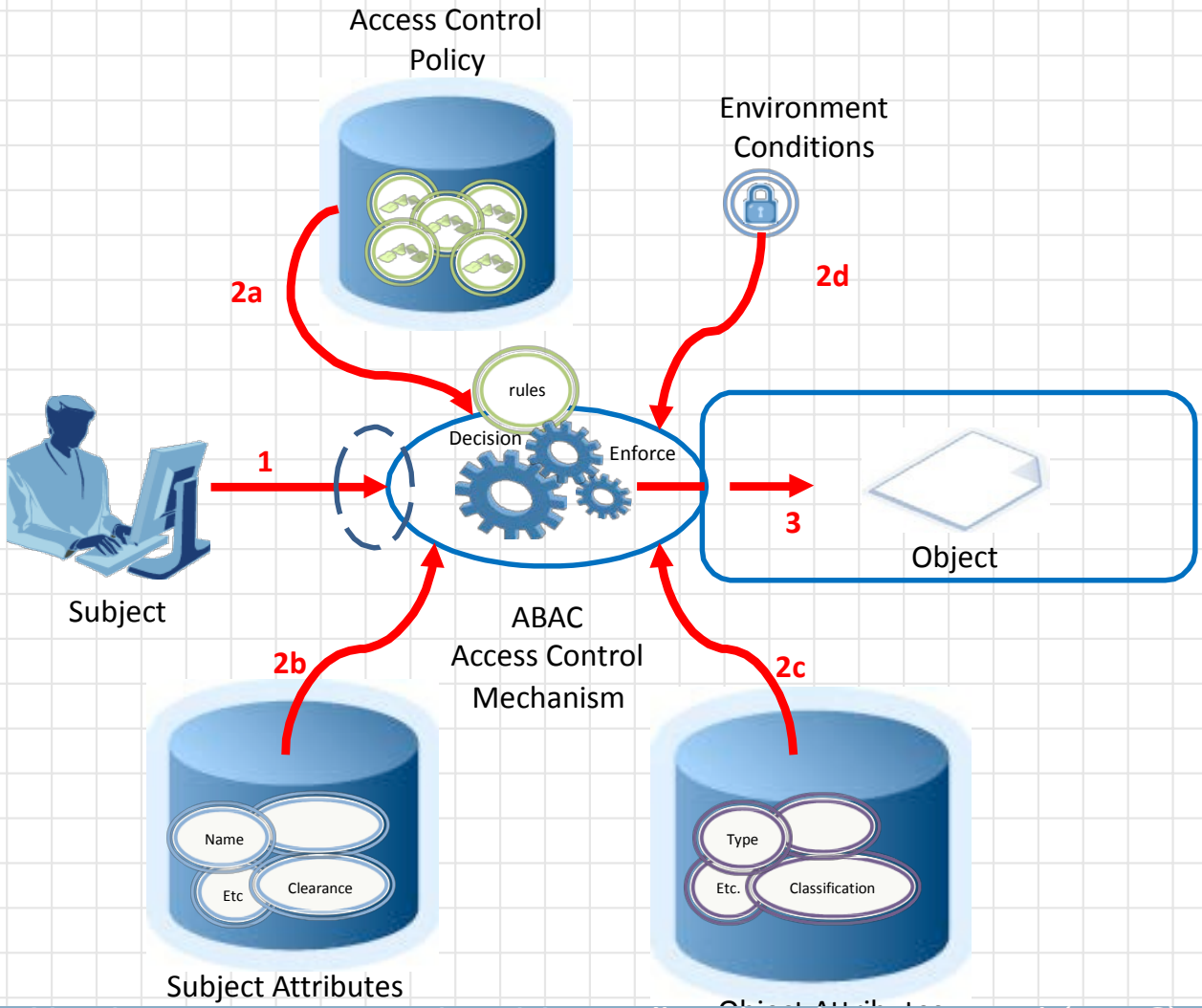
Core ABAC concept

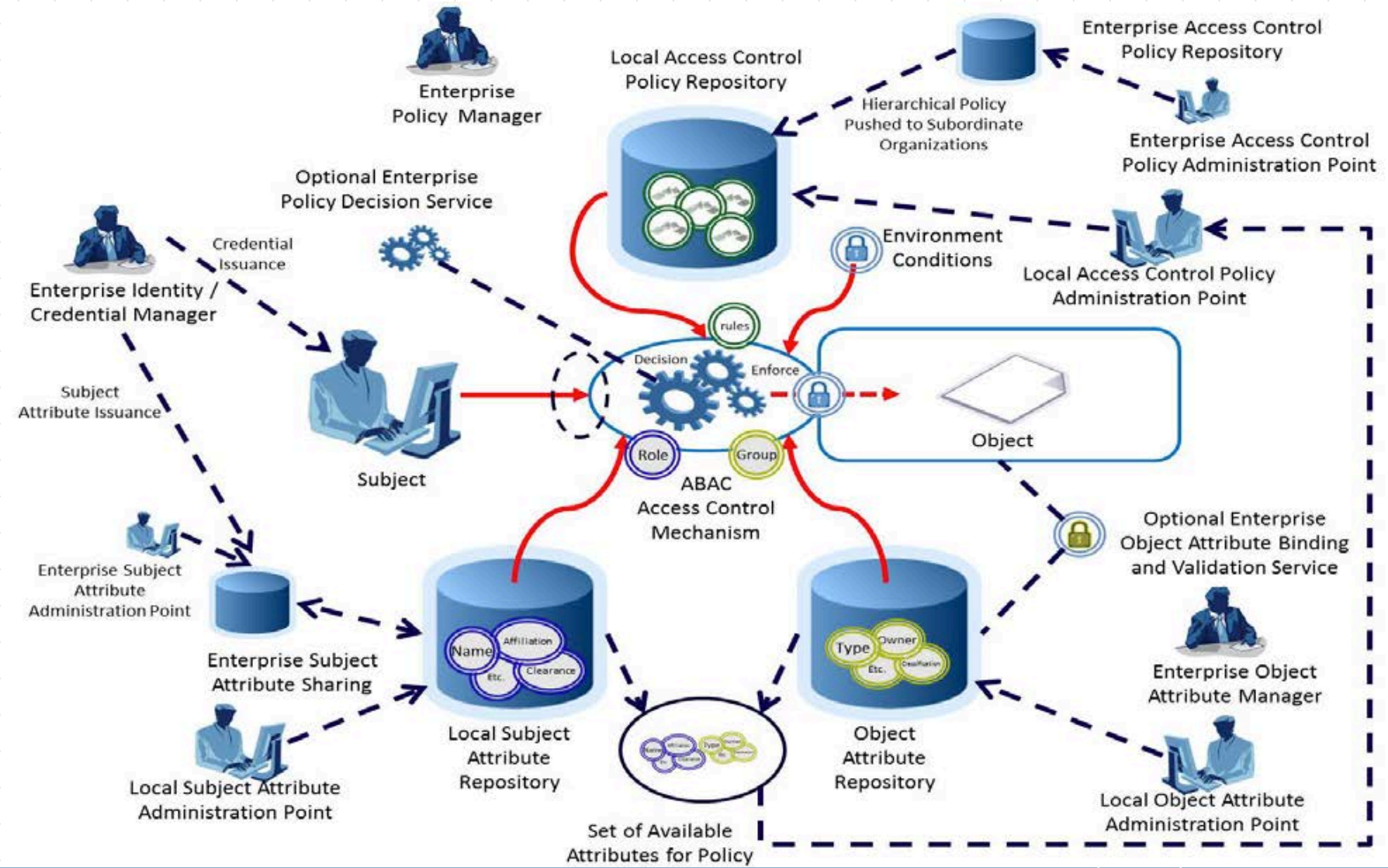


When an access request is made, Attributes and Access Control Rules are evaluated by the Attribute Based Access Control Mechanism to provide an access control decision. In ABAC's basic form, the Access Control Mechanism contains both a Policy Decision Point, and a Policy

ABAC scenario



Enterprise ABAC Scenario



ABAC summarized

Authentication and authorization are based on attributes.

- Service provider requires from a user to present a specific set of attributes certified by trusted authority (certifiers) to get access granted.
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Advantages of ABAC

- Requires no advance knowledge of requesters.
- An individual's attributes can be correlated from multiple sources to create a unified identity.
- Highly adaptable to changing needs, efficient for agencies where individuals come and go frequently.
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Example: Constraints in ABAC

Let $\{bf_1, bf_2, \ldots bf_n\}$ be a set of benefits a customer may have (attributes or attribute values)

1. Mutual exclusion (Separation of Duty (SoD)):
2. cardinality:
3. precondition:

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Privacy

"On the Internet, nobody knows you're a dog."

Privacy vs Security

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- Security $\neq$ privacy.
- Radically change of reality demands new approaches to privacy
- Need means of detection, neutralization, ...
- Cryptographic protection can increase trust levels and protect privacy in some degree but usually it carries additional cost and will reduce efficiency.
- Need to find technological enforcement of privacy requirements: protect users' privacy to make new products and services possible

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- An access decision is based on user's identity and some secret the only user posses (something to know, something to have something to be).
- If to prove/get access to the resources the user need to reveal his attributes the privacy violation problem can arise.
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Privacy treats

To use attributes in access control they have to be trusted - certified by trusted certification authority.

- Two main approaches:
  1. Online: SAML, OpenID etc
     - Privacy violation in both cases
  2. Off-line: X.509 certificates
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- Solution: In privacy-preserving authentication schemes users derive unlinkable tokens offline from certified attributes they have preliminary received from trusted certification authorities.

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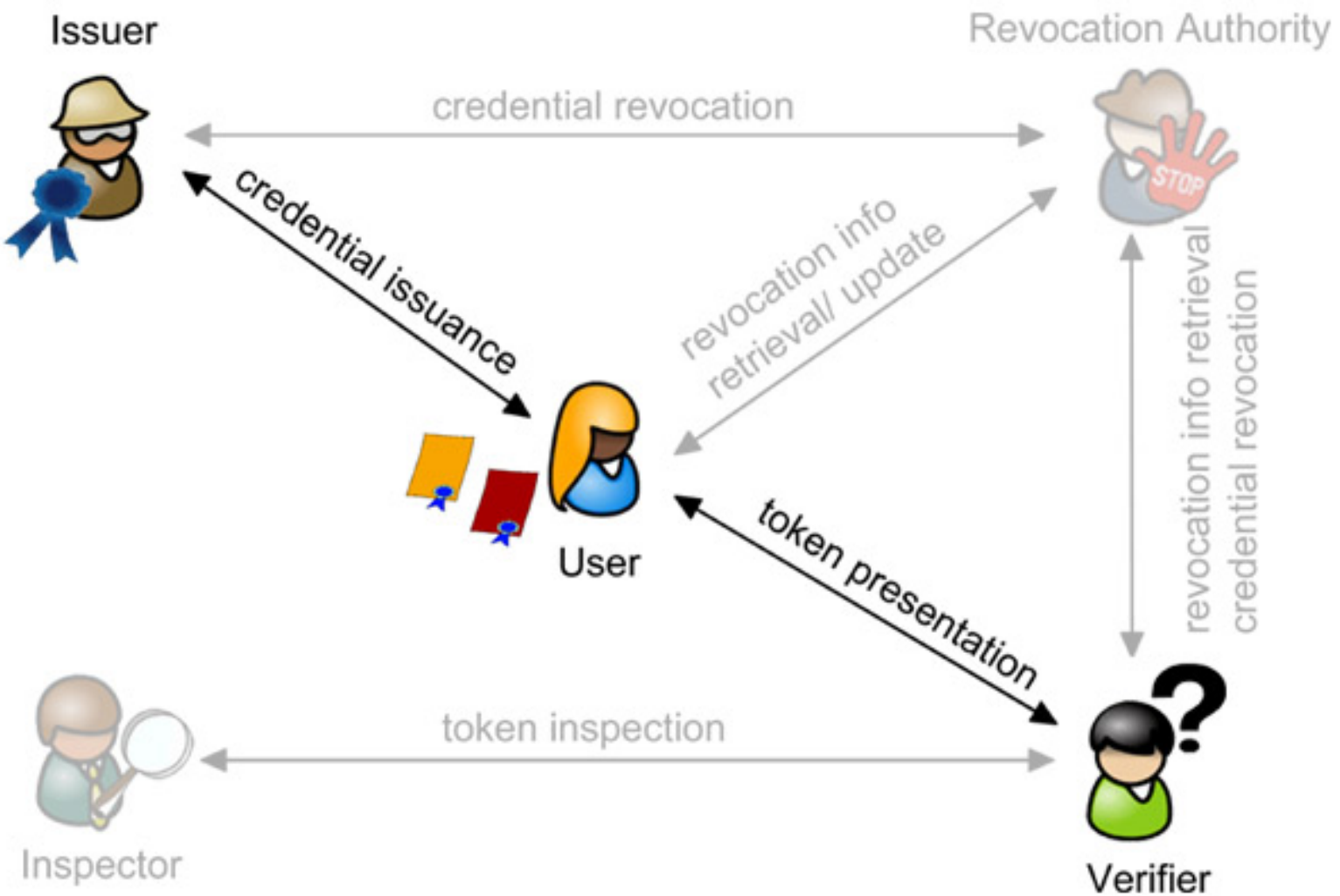
Entities


Issuer
Revocation Authority
credential revocation
credential issuance
revocation info
retrieval/ update
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credential revocation
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Inspector
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Cryptographic Realization: Blind signature

Cryptographic primitive that provides the following functionality:
An entity (originator) is able to obtain a valid signature σ on a message m without the signer being able to learn anything about m at the time of signing.
Formally:

- Originator: blinds m: and gets blinded message $\bar{m}$: $\bar{m} = b(m)$
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Privacy preserving SoD validation

Verifier creates anonymous unlinkable one-show token:

- User has an initial signed token from Verifier (t, σ)
- User creates a new token t' and sends $[(t, \sigma), B(t')]$ to Verifier
- If signature σ is valid, Verifier produces partially blind signature σ of (t', ID), where ID is a unique name identifying f ex list of conflicting attributes
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Measuring trust: subjective logic

- An opinion about trustworthiness of A:

$$\omega^A = \{t^A, d^A, u^A\}, \; t^A + d^A + u^A = 1$$

where t^A, d^A, u^A denote trust, distrust and uncertainty.

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Conjunction of opinions

$$\omega^s_{a_i} = \left\{t^s_{a_i}, d^s_{a_i}, u^s_{a_i}\right\}, i = 1, 2$$
$$\omega^s_{a_1 \wedge a_2} = \omega^s_{a_1} \wedge \omega^s_{a_2} = \left\{t^s_{a_1 \wedge a_2}, d^s_{a_1 \wedge a_2}, u^s_{a_1 \wedge a_2}\right\}$$
$$t^s_{a_1 \wedge a_2} = t^s_{a_1} t^s_{a_2}$$
$$d^s_{a_1 \wedge a_2} = d^s_{a_1} + d^s_{a_2} - d^s_{a_1} d^s_{a_2}$$
$$u^s_{a_1 \wedge a_2} = t^s_{a_1} u^s_{a_2} + u^s_{a_1} t^s_{a_2} + u^s_{a_1} u^s_{a_2}$$

Recommendation operator

When A does not have direct opinion ω_p^A about p, A needs to deduce indirect opinion ω_p^{AB} about trustworthiness of p based on recommendation of B and opinion ω_B^A of A about trustworthiness of recommendation of B:

$$\omega_p^{AB} = \omega_B^A \otimes \omega_p^B = \{t_p^{AB}, d_p^{AB}, u_p^{AB}\} \quad where$$
$$t_p^{AB} = t_B^A t_p^B;$$
$$d_p^{AB} = t_B^A d_p^B;$$
$$u_p^{AB} = d_B^A + u_B^A + t_B^A u_p^B$$

Consensus of opinions

Two independent opinions ω^A and ω^B about the same event can be combined into new opinion ω by consensus operator $\oplus$:

$$
\begin{aligned}
&\omega = \omega^A \oplus \omega^B \quad where \\
&t = (t^A u^B + t^B u^A)/(u^A + u^B - u^A u^B) \\
&d = \left(d^A u^B + d^B u^A\right) / \left(u^A + u^B - u^A u^B\right) \\
&u = \left(u^A u^B\right) / \left(u^A + u^B - u^A u^B\right)
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Attribute delegation: informal example

Objective: Support delegation of $attr$ by u to u' can be seen as recommendation of u to the AC system to accept $attr$ from u' with trustworthiness:

$$\hat{\omega}_{attr} = \omega_u \otimes \omega_{attr}$$

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Objective: Support for dynamic policies (privileges user authorized for can be modified automatically when a user is suspected to be untrustworthy).

- Trustworthiness of each user will be tracked and modified with respect of his activity in the system.
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Questions?

Thank you!

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