Introduction to SOA Security

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Software Engineering Programme

Dec 2014

Security Aims

- Confidentiality
- Integrity
- Availability
- Authenticity
- Non-Repudiation
- Authorization

In Real Life

- The **opacity** of the envelope provides confidentiality
- The **seal** on the envelope provides integrity
- Royal Mail hopefully provides availability
- The **signature** provides authenticity
- The **proof of posting** and "**signed-for**" provide non-repudiation

None of these match up to the standards of electronic security

Confidentiality

- Provided by Encryption
- On the web, 99% of the time using TLS
- TLS is the successor to SSL
  - And often referred to as SSL!
- If you want to understand TLS well, this is about the best resource I've seen:
- http://www.moserware.com/2009/06/first-few-milliseconds-of-https.html

Encryption is pointless without authenticity/identity

- If I encrypt the message aimed at the wrong person, I have failed
- Encryption key distribution was the biggest issue until
  - 1973: Ellis, Cocks and Williamson of GCHQ created first "non-secret crypto"
    - Only made public in 1997
  - 1976: Diffie Helman key exchange
  - 1977: Rivest Shamir Adleman (RSA) public key cryptography

A simple analogy

- Padlocks which cannot be explored, re-engineered or re-used
- Keys which cannot be reverse-engineered into a padlock

Public Key Encryption

1. You send out as many padlocks as you like, but you keep the key secret

2. I lock the message in a box with YOUR padlock and send it to you

3. Only you have the key, so only you can read the message

Authenticity

- Need to Sign the message
- Now I send out lots of keys but keep the padlocks secret




- Anything I lock up in a box with my padlock must come from me
- Anyone can unlock it and verify its from me

Authenticity

- The actual implementation of this is different
- Most interactions
  - only use PKI for one sided authenticity (do I trust the server?),
  - HTTP Basic Auth for the client
- No direct trust of the server (I don't want to store a key for every server I talk to)
  - Certificate Authority model
  - I trust the CA, the CA trusts the Website => I trust the website

HTTP Authorization

- Mutual TLS/SSL
  - Hardly ever used. Requires managing certificates for every client
  - Have you tried to get your mum to install a client cert?!
- Basic Auth
  - Easy, fast, effective
  - Completely insecure except over HTTPS – base64 encoding
- Digest
  - Hash of the password

Basic vs Digest

- Digest looks good on the wire
  - Secure hash of the password is passed over the wire
- How does the server validate?
  - Needs to have the password stored using reversible encryption
- Basic looks bad on the wire
  - Unencrypted password
- Server can store the hash instead
  - Much more likely that a hacker will attack the server and steal 100m passwords, than break a TLS session and steal one!

Integrity

- A Hash Function
  - Takes a large input (e.g. a message)
  - Creates a (hopefully) unique shortened *hash*
  - e.g. a 160-bit, 256-bit, 384-bit or 512-bit output
  - Exact inputs will always end with identical outputs
  - You cannot go from the output back to the input (that would be a wicked compression algorithm)
    - Except maybe by guessing?!

Integrity

- Include a signed hash in with the message
- Only the sender could do this
- If the message is modified or manipulated the receiver will calculate a different hash to the sender
- This is used for both integrity AND authenticity
  - The signed hash is equivalent to signing the message

Non-repudiation

- This is done by passing back a signed hash of the signed hash!
- The receiver can prove that the sender sent the message (log the signed hash)
- The receiver then signs this and sends it back
- The sender logs this to prove that the receiver received the message

Availability

- Availability is an important aspect
- Many attacks have been based on bringing down one system before spoofing it
- e.g. famously Mitnick and Shimomura, Christmas Day 1994

Performance

- Public Key Cryptography is based on mathematics of very large prime numbers
- The aim is that to break it will take many many years
  - Though Quantum Computing may change that
- Its slow
- Usually PKC is only used for exchange of a secret key that is then used for a session

TLS

- 99% of time used with only Server-Side authenticity
- Client validates the cert, and then authenticates via another model (e.g. Basic Auth, OAuth2, SAML2, etc)
- Mutual SSL/TLS is where both sides authenticate
- Most usually used in server-server communications

TLS pros and cons

- Strongly encrypted two-way data channel
- **(+)** standard and straightforward
- **(+)** highly trustworthy
- **(–)** entirely point-to-point
- **(–)** no scope for processing by intermediaries (that includes firewalls and filters)
  (–) protocol-based; no scope for fine-grained authorization

OAuth/OAuth2

- Designed to solve the problem of LinkedIn/ Gmail
  - I don't want to give LinkedIn my Gmail password so they can scan my contact list
  - I just want to give them 10 mins access to my contact list
- OAuth 1.x requires clients to implement signature algorithms
- OAuth 2.0 allows a vanilla client that implements HTTPS to work

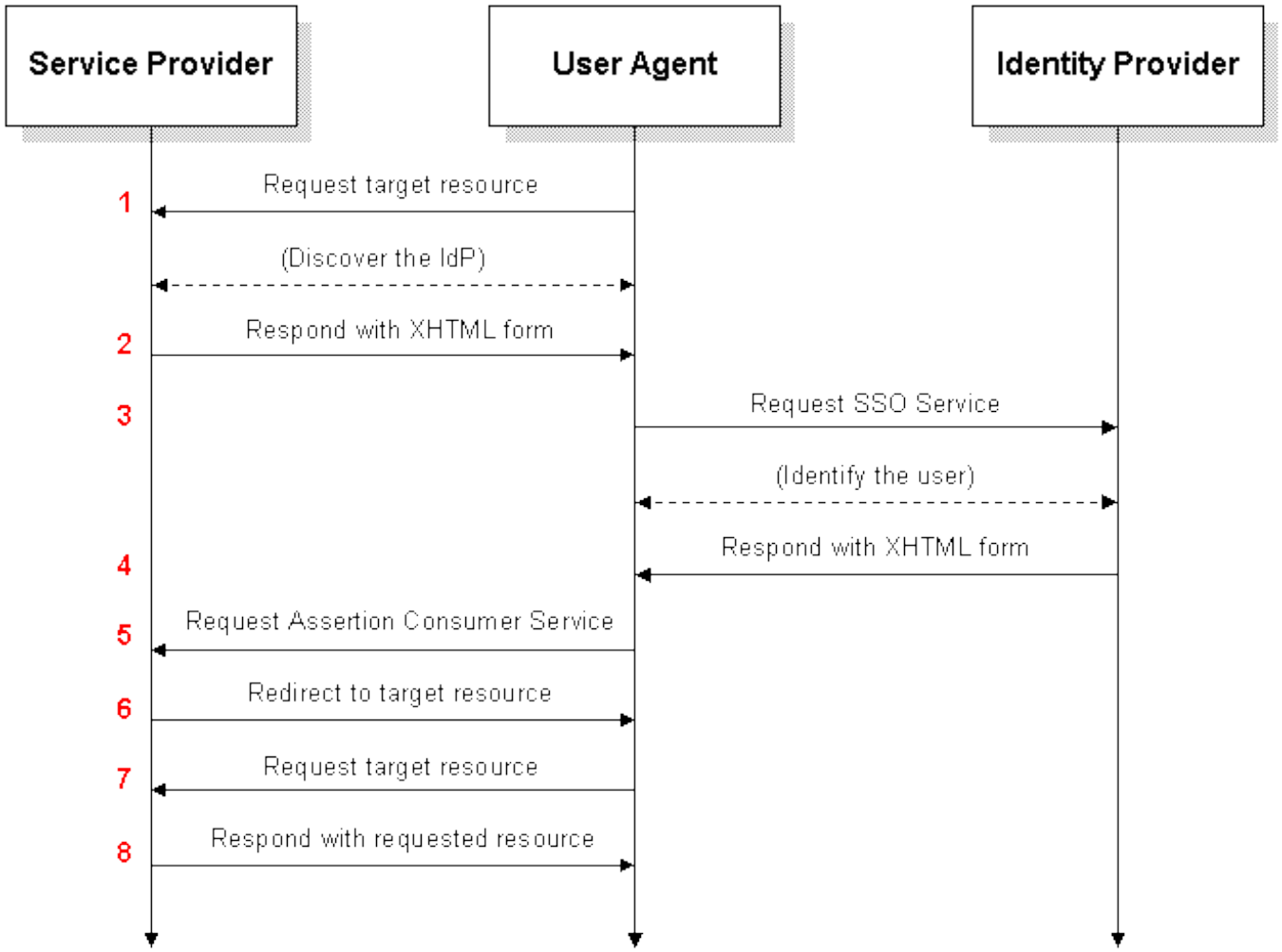
Tokens

- Security Tokens provide an effective way of managing sign-on, authenticity and identity across a network
  - I need to sign on to multiple systems
  - I go to the token server and prove who I am
  - The token server issues me with a token for a given period
  - I present that token to the other systems
  - They validate that the trusted token server has signed this token
  - Since they trust the token server, they now trust the claims made by that token
- The only system that needs to validate my password or identity is the token server

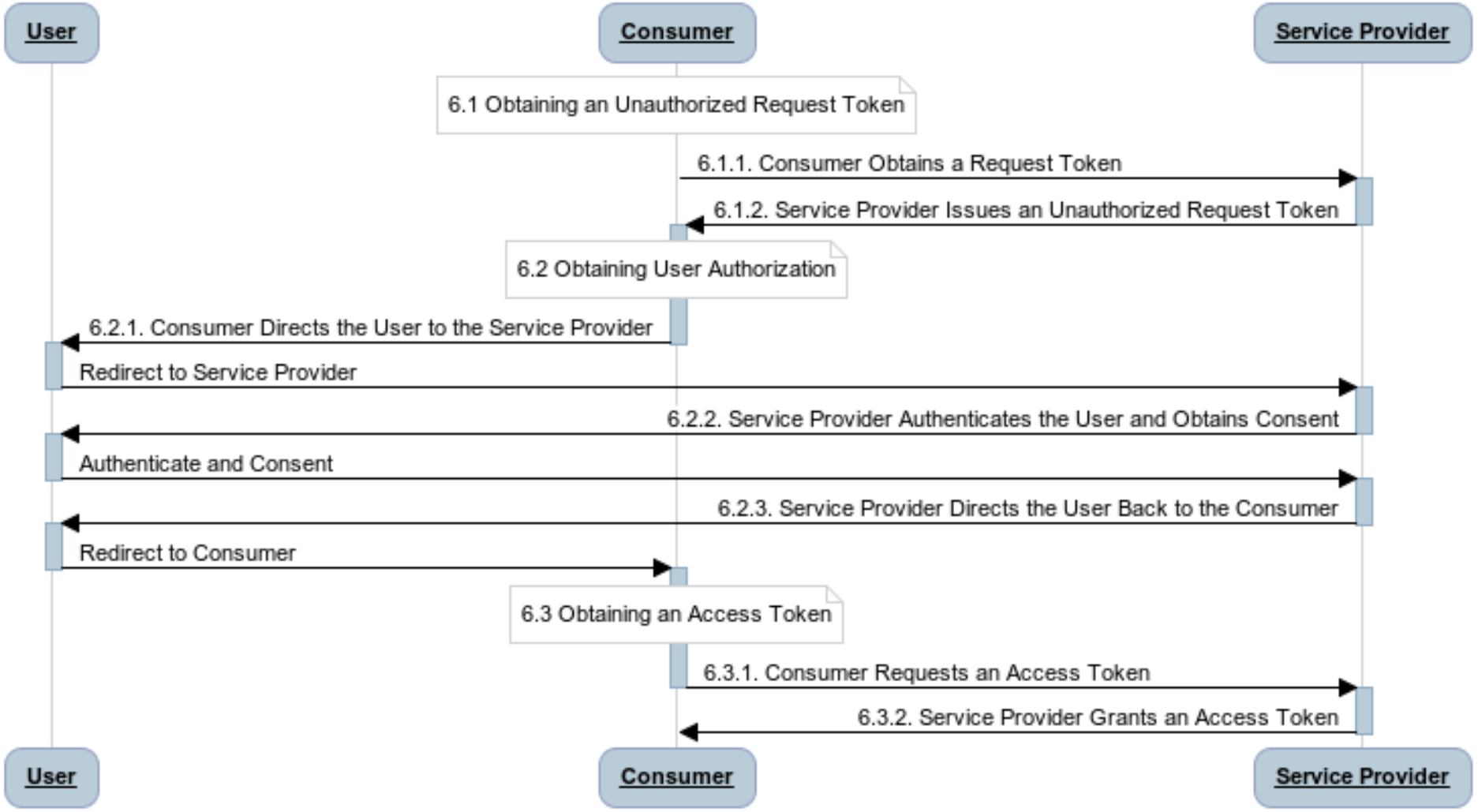
Tokens

- Kerberos (known as tickets)
  - Developed by MIT in the late 80's onwards
  - Designed to allow lots of campus machines to be secured easily (without having local UNIX password files!)
- SAML/SAML2
  - An XML version that has become a popular way of doing Single Sign On for the Web
  - Used by Google Apps
- OAuth/OAuth2
  - Rapidly gaining popularity with Facebook/LinkedIn/Gmail/Github/etc

SAML2

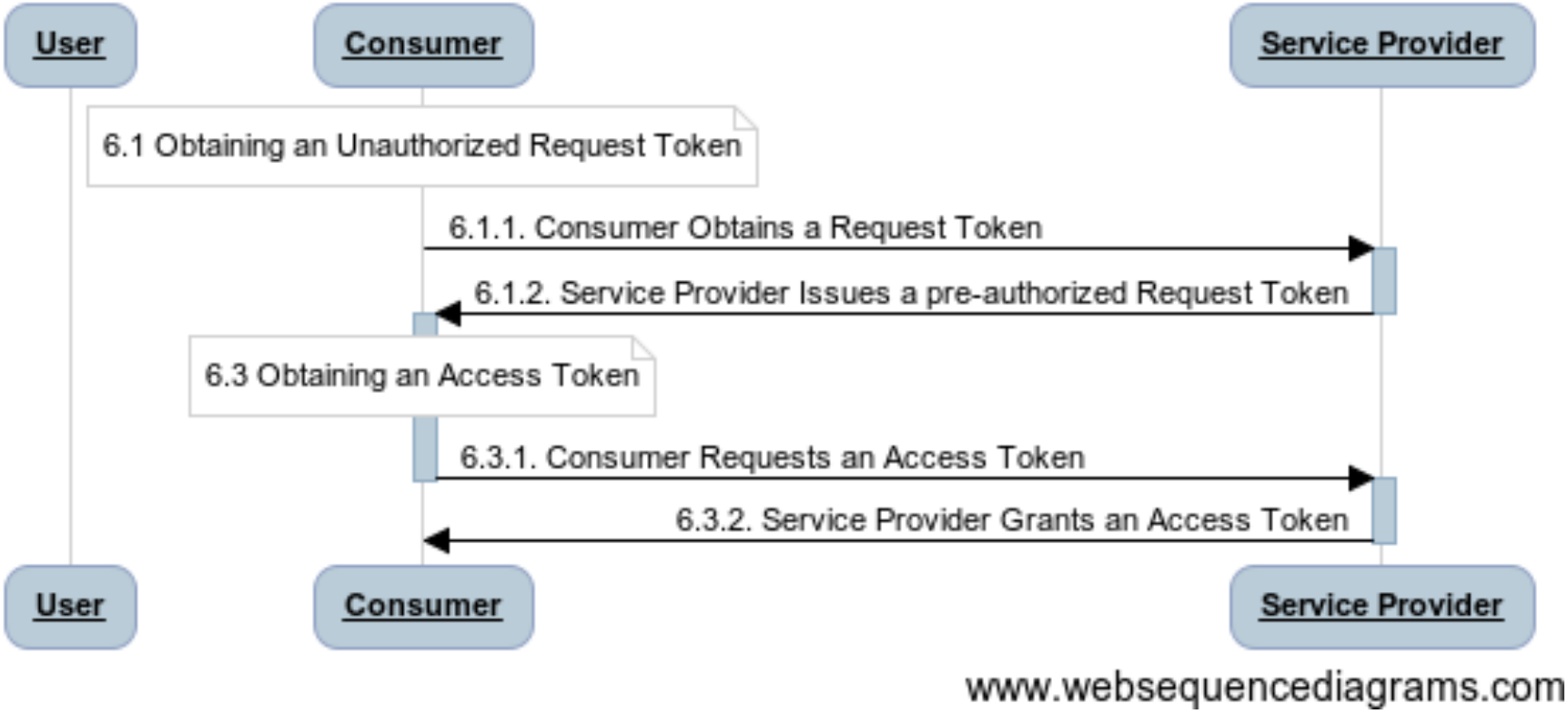


Three-legged OAuth



www.websequencediagrams.com

Two Legged OAuth



REST Security

- HTTPS + Basic Auth
- Rapidly moving to HTTPS+OAuth2
- Does not support signatures, or message level encryption
- New standards emerging
  - http://tools.ietf.org/html/draft-ietf-jose-json-web-encryption-07 (JWE)
  - http://tools.ietf.org/html/draft-jones-json-web-signature-07 (JWS)
  - http://tools.ietf.org/html/draft-ietf-oauth-json-web-token-05 (JWT)

Web Services Security
Covered in detail in another chapter

- WS-Security
  - Provides Message level encryption, signature and authentication
- WS-SecurityPolicy
  - Allows services to publish their security requirements
- WS-SecureConversation
  - Greater efficiency by bootstrapping fast cryptography for a session
- WS-Trust
  - Token-based security (inc Kerberos and SAML)
- WS-Federation
  - Federated security using WS-Trust

Authorization

Access Control

- Traditionally Authorization has been
  - Role-based
    - If I am a manager then I can look at salaries
    - Based only on user
  - Hard-coded
    - Authorization rules encapsulated in code and applications

Problems with RBAC

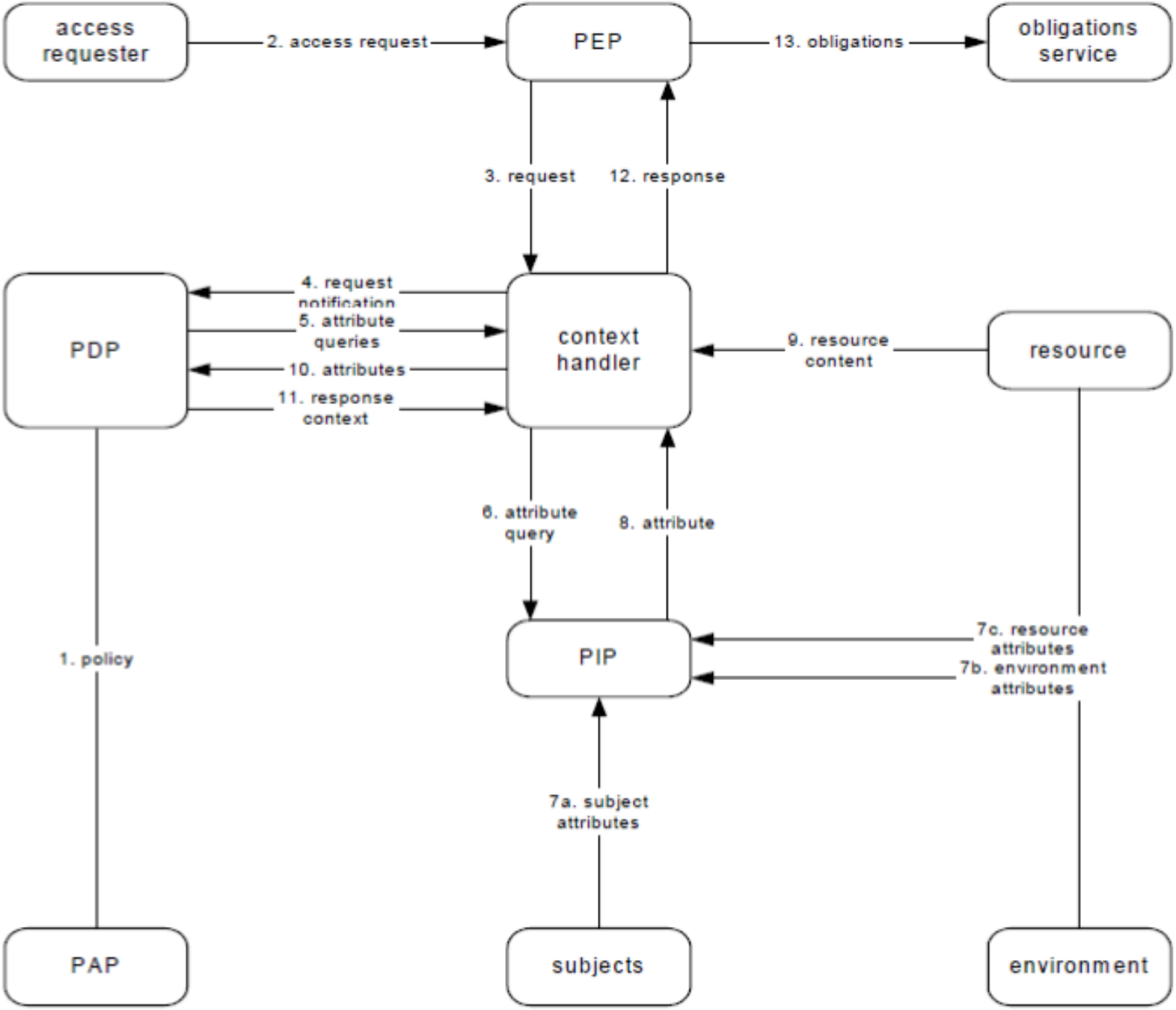
- Problems with this are:
  - Doesn't correctly model the real world
    - I should only be able to see my team's salaries, and only while participating in the salary review process
  - Hard to evolve
  - Hard to manage compliance
    - How do I find out who can make a trade of $30m?

Policy Based Access Control

- Delegate access control decisions to a "Policy Decision Point"
- Utilise more information in the decision
- Externalise the decision from the code

XACML 3.0

- An XML language for capturing authorization and entitlement
- Together with a powerful model
- Terminology
  - Policy Decision Point (PDP)
  - Policy Enforcement Point (PEP)
  - Policy Administration Point (PAP)
  - Policy Information Point (PIP)


access requester
2. access request
PEP
13. obligations
obligations service
3. request
12. response
PDP
4. request notification
5. attribute queries
10. attributes
11. response context
context handler
9. resource content
resource
6. attribute query
8. attribute
1. policy
PIP
7c. resource attributes
7b. environment attributes
7a. subject attributes
PAP
subjects
environment

What can you do with XACML?

- Encode rules such as:
- X can access record Y if:
  - X is the patient for record Y
  - X is the doctor of the patient and working on the patients behalf
  - X is the guardian or parent of the patient
- How does this data get to the decision point?
  - In claims (e.g. there may be a claim saying that the doctor is logged into the hospital records system)
  - In further information available to the PIP
    - LDAP lookup shows I am Z's guardian

Resources

- Applied Cryptography, Second Edition, Bruce Schneier, John Wiley & Sons, 1996, ISBN 0-471-11709-9
- Web Services Security, Mark O'Neill, 2003, ISBN 0072224711
- Google (sorry but there are too many links!)