ISSE 2016
15 & 16 November
Innovation Campus
Issy-les-Molineaux, Paris
www.isse.eu.com
Securing Future European Business

A privacy-preserving authentication service using mobile devices

Mihai Togan

Security Software Architect

certSIGN

Context

Mobile devices
- Present everywhere

High performance
- Computing power
- Security features

2 factors authentication
- Good candidates
- Easy to use

What to consider

Credentials transfer	Authentication protocols
• QR codes	• UProve • FIDO

Agenda

1. QR-based Authentication
   - QR-based Authentication using PKI

2. U-Prove & FIDO protocols

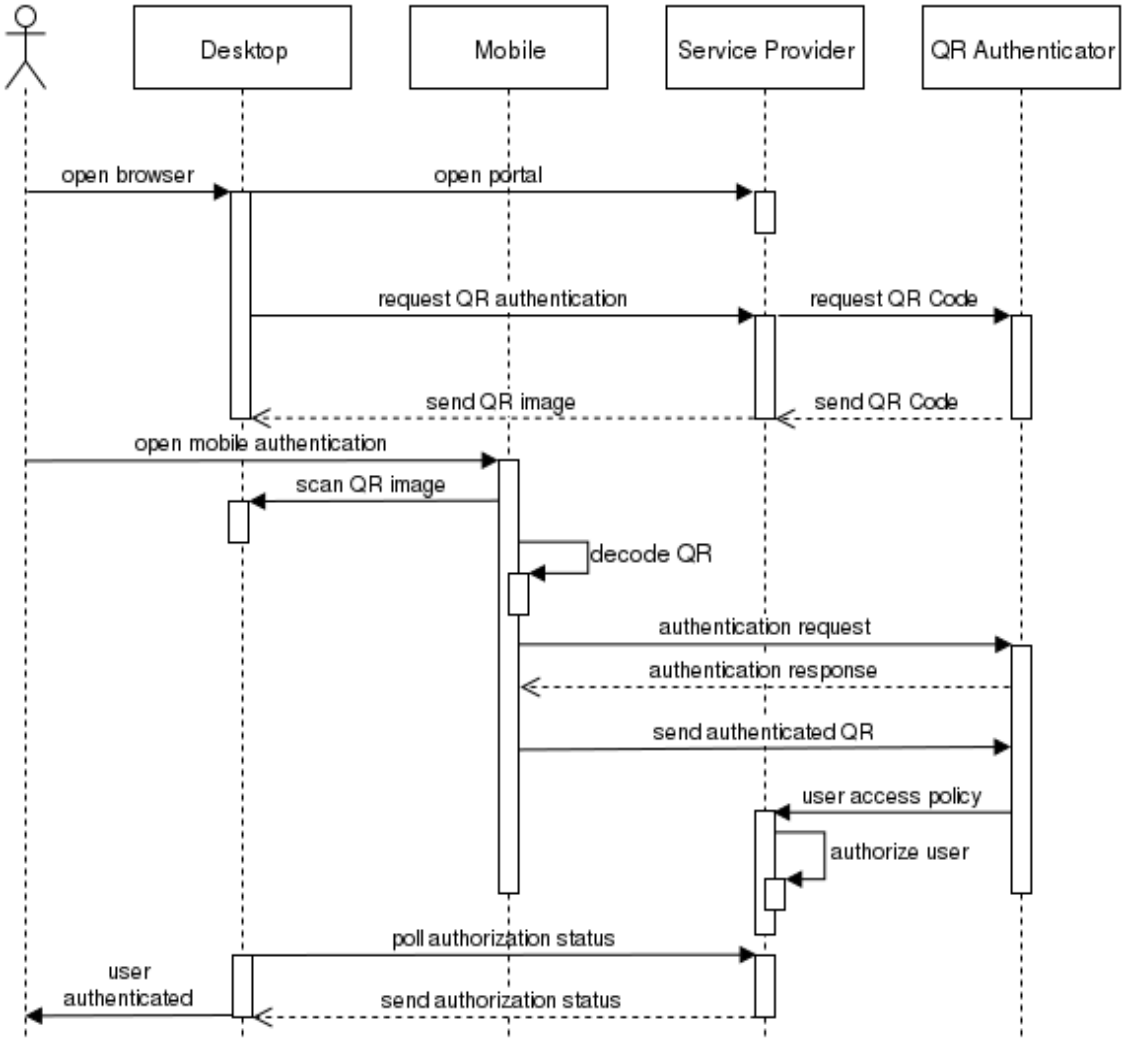
3. Privacy-preserving Authentication
   - *FIDO Attribute-based* Authentication
   - *FIDO* Authentication *with Privacy-preserving*

4. Use-cases

5. Conclusions

QR-based Authentication

- **The aim**: authentication and authorization for the user on the Service Provider's web application
- Credentials stored on the mobile device
- Identity transfer from the user's mobile phone to his desktop by using QR codes
- **Authentication phase** (user's mobile – QR Authenticator)
- Multiple solutions:
  - **PKI**, TLS, FIDO, custom
- *A Honest* QR Authenticator adds **privacy-preserving** for the user



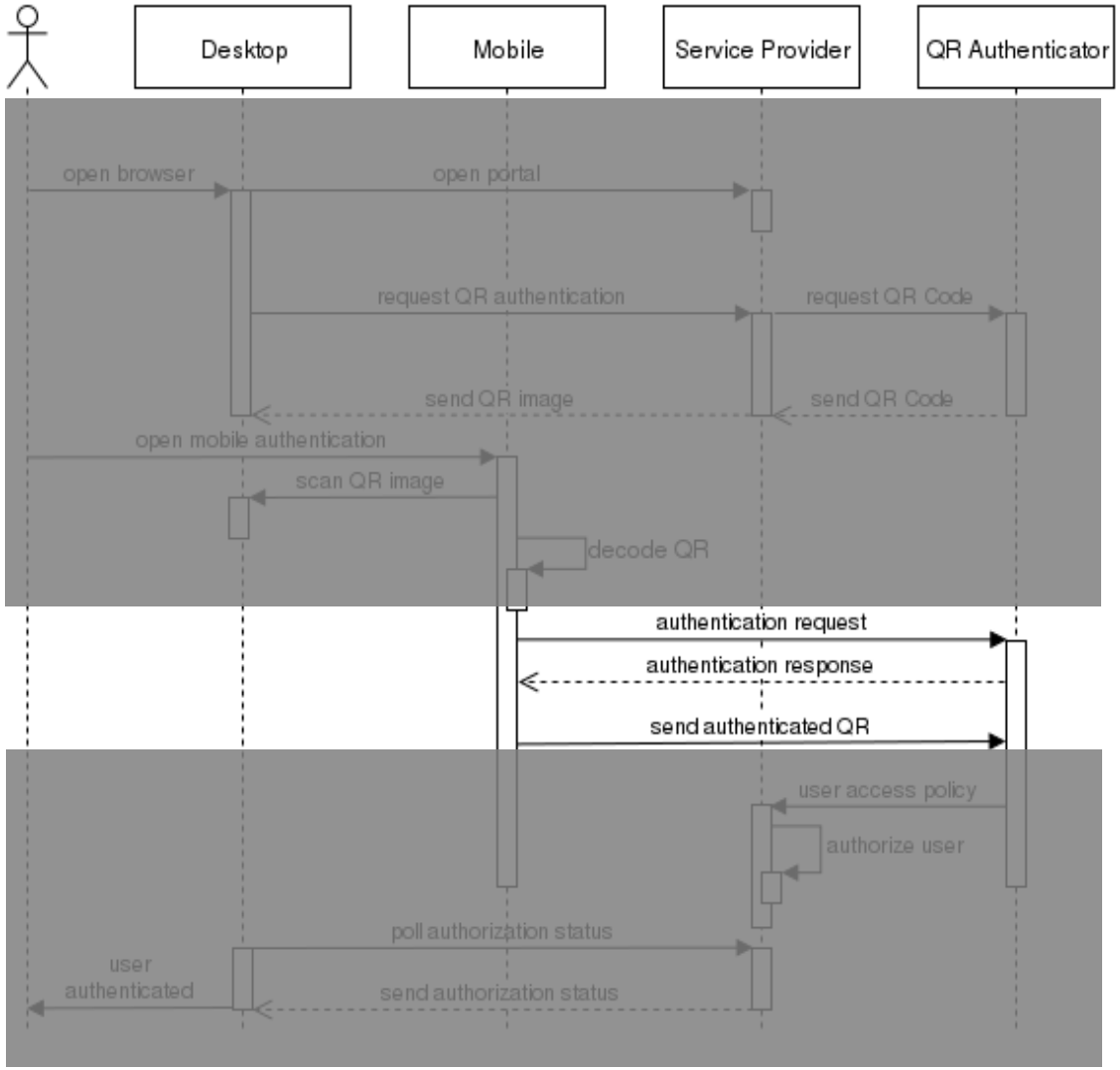
QR-based Authentication using PKI

- **PKI authentication of the user to QR Authenticator**
  - Secure key storage (Android/iOS key store, hardware secure element)
  - Digital signatures on the smartphone

- **Authentication process**
  1. The user signs the QR code content using **his private key** and **certificate** stored **on the mobile phone**

  2. The phone sends the signed content and his certificate to the QR Authenticator server using a special connection

  3. The QR Authenticator server verifies the digital signature, the content and the digital certificate of the user
     - If verification succeeds, the user is granted an access token which will be sent to the Service Provider



QR-based Authentication using PKI, cont.

- Two-factor authentication mechanism
  - The smartphone (something the user has)
  - The password to access the certificate from the smartphone (something the user knows)
    - A hardware secure element can be used to protect the private key

- Problems…
  - A PKI infrastructure needed
  - CA to manage the users' certificates
  - Requires digital certificates on mobile device
  - Users' enrollment to get certificates
  - Users' certificates path validation
  - Users' certificates revocation status checking (OCSP service)

- Best fit in PKI enabled environments

U-Prove

- Attribute-based cryptographic protocol providing user's privacy
  - Maintained by Microsoft

- Three entities involved
  - The user (the prover)
  - The issuer – issues attribute containers
  - The verifier – verifies user's proofs (attributes)

- Two main protocols
  - **Issuing protocol** (issuer <–> user)
    - Issuing the *Token Information* (TI) including user's attributes

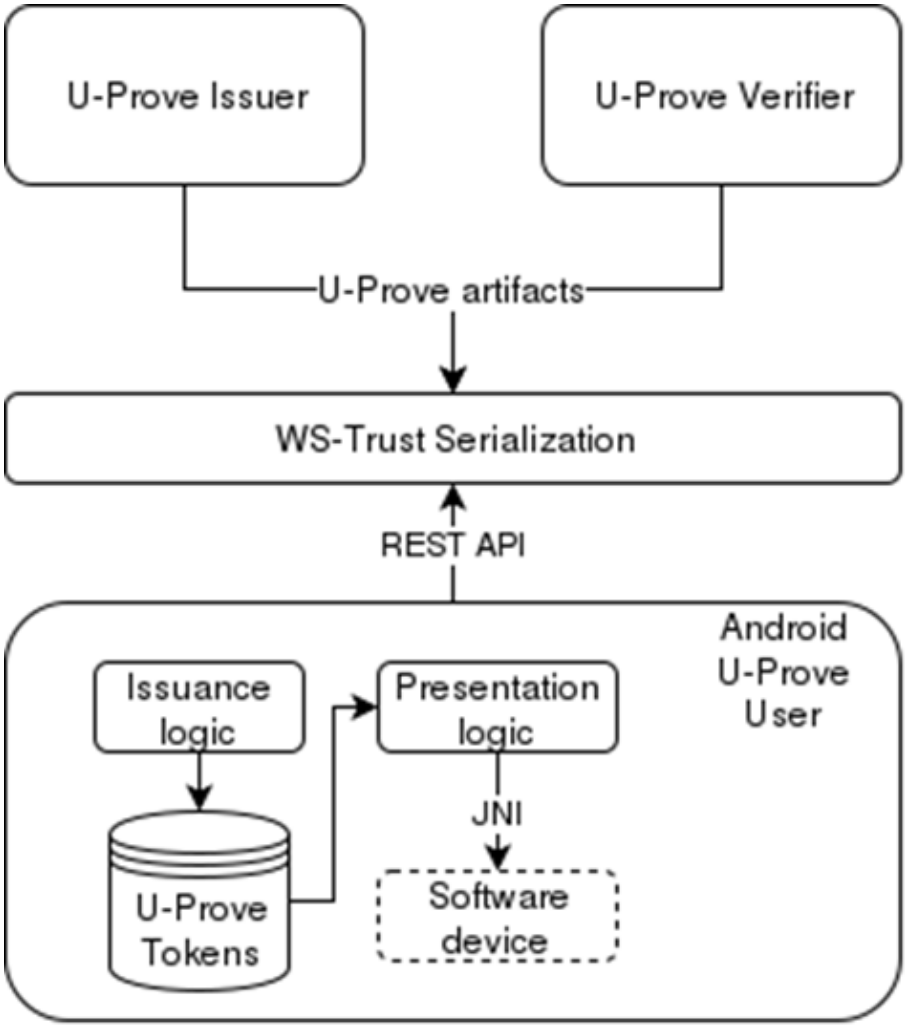
  - **Presentation protocol** (user <–> verifier)
    - Proving user's attributes validity & the user's private key ownership
    - Proof generation sub-protocol (user – device)
    - Proof verification sub-protocol (user – verifier)

- Main idea: disclose only the required attributes to verifier
  - *Unlinkability*
  - *Untraceability*

U-Prove (cont.)

- On the server-side
  - Issuer (web-app)
  - Verifier (web-app)
  - REST API interface
  - WS-Trust Serialization [Paq11]

- On the user-side
  - Android application
  - U-Prove attributes stored as blobs in the application database



[Paq11] Christian PAQUIN, "U-Prove WS-Trust Profile V1.0", 2011

FIDO

- Passwordless authentication framework
  - FIDO Alliance (great support)
  - UAF, U2F

- FIDO entities
  - FIDO server (server-side)
  - FIDO client (client-side)
  - FIDO authenticator (client-side, trusted HW device)

- FIDO protocols: registration, authentication, deregistration
  - Generate user RSA key-pair
  - Challenge-response protocol
    - User unlocks his private key using various protection mechanisms

- Protocol messages
  - Extensions (used in our work to include attributes in FIDO)

- FIDO extension (not Extensions!)
  - FIDO Attribute-based Authentication
  - FIDO Authentication with Privacy-preserving

FIDO Attribute-based Authentication

- Combine the FIDO and U-Prove
  - With FIDO: **user authentication**
  - With U-Prove: **user authorization** (based on attributes)
    - Improved security layer on the server side
    - Granular access

- FIDO *extended* version
  - FIDO UAF standard messages (not modified)
  - Usage of FIDO extensions to carries user's attribute info
  - Server asks the required attributes using *AuthenticationRequest*
  - The client responds with U-Prove proofs in *AuthenticationResponse*
    - Attributes are embedded in Response extensions

FIDO Attribute-based Authentication


```
Dictionary AuthenticationRequest {
  required OperationHeader header;
  required ServerChallenge challenge;
  Transaction[ ] transaction;
  required Policy policy;
}
```

Authentication Request

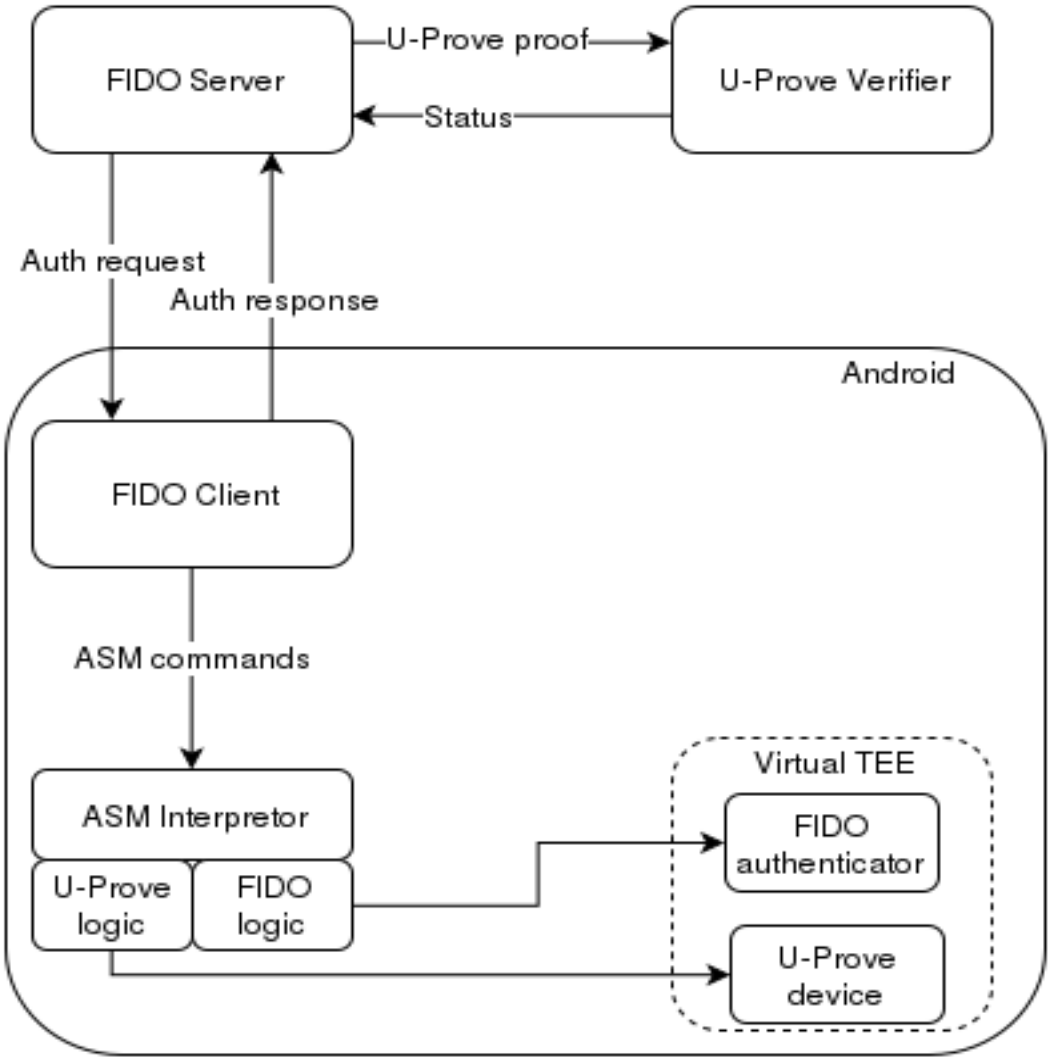
FIDO server → User

Authentication Response

FIDO ASM → FIDO server

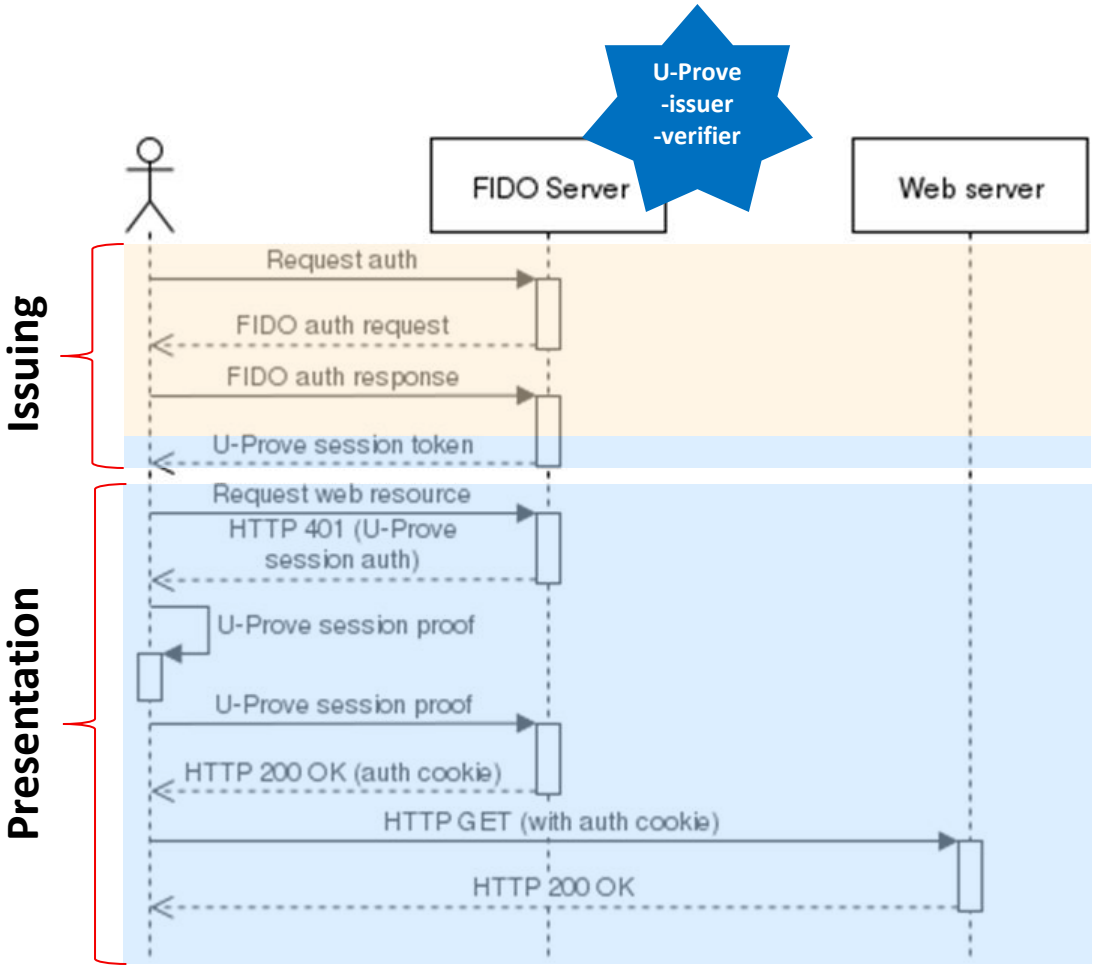
```
Dictionary AuthenticatorSignAssertion {
  required DOMString assertionScheme;
  required DOMString assertion;
  Extension[ ] exts;          /* Serialized U-Prove proof */
}

Dictionary Extension {
  required DOMString id;                  /* Bind to 'U-Prove - attribute' */
  required DOMString data;                /* Required attribute encoded as base64 */
  required boolean fail_if_unknown;       /* Bind to true */
}
```

FIDO Attribute-based Authentication



- Does not provide:
  - Unlinkability
  - Untraceability

FIDO Authentication with Privacy-preserving



- The user doesn't trust the FIDO server
- *Unlinkability* and *Untraceability* are required
- FIDO and U-Prove logic are separated
  - Step 1 (UP-Issuing), after FIDO authentication. User receives:
    - "***authenticated***" attribute
    - "***validity timeframe***" attribute
  - Step 2 (UP-Presentation): U-Prove authorization
    - User presents attributes to U-Prove verifier
- Get a **K-anonymity** scheme

Use cases

- Pilot implementation – ReCRED project
  - Access to campus resources
    - Registered professors and students
    - Granting access to guests
  - Access to on-line restricted content
    - 18+
    - Legislation can be enforced

www.recred.eu

Conclusion

- Mobile devices are used for 2 factor authentication
  - Credential transfer – QR codes
  - Authentication protocols
    - U-Prove
    - FIDO
- Combination of authentication protocols
  - Easy to use (FIDO)
  - Privacy preserving (U-Prove)
    - Untraceability
    - Unlinkability
- Pilot implementation – ReCRED project

- **Next steps**
  - Implementation using TEE equipped hardware

Thank you!