# From Real-world Identities to Privacy-preserving and Attribute-based CREDentials for Device-centric Access Control


## Killing the password and preserving privacy with device-centric, attribute-based and behavioral authentication

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European Commission | Horizon 2020 European Union funding for Research & Innovation

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# Complacency about authentication security


## Flight security in the 60s

ReCRED

# Insecure

WIRED

## Kill the Password: A String of Characters Won't Protect You

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"This summer, hackers destroyed my entire digital life in the span of an hour," says Wired senior writer Mat Honan. ETHAN HILL

This summer, hackers destroyed my entire digital life in the span of an hour. My Apple, Twitter, and Gmail passwords were all robust—seven, 10, and 19 characters, respectively, all alphanumeric, some with symbols thrown in as well—but the three accounts were linked, so once the hackers had conned their way into one, they had them all. They really just wanted my Twitter handle: @mat. As a three-letter username, it's considered prestigious. And to delay me from getting it back, they used my Apple account to wipe every one of my devices, my iPhone and iPad and MacBook, deleting all my messages and documents and every picture I'd ever taken of my 18-month-old daughter.

# Password reuse

WIRED

## Kill the Password: A String of Characters Won't Protect You

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Our other common mistake is password reuse. During the past two years, more than 280 million "hashes" (i.e., encrypted but readily crackable passwords) have been dumped online for everyone to see. LinkedIn, Yahoo, Gawker, and eHarmony all had security breaches in which the usernames and passwords of millions of people were stolen and then dropped on the open web. A comparison of two dumps found that 49 percent of people had reused usernames and passwords between the hacked sites.

"Password reuse is what really kills you," says Diana Smetters, a software engineer at Google who works on authentication systems. "There is a very efficient economy for exchanging that information." Often the hackers who dump the lists on the web are, relatively speaking, the good guys. The bad guys are stealing the passwords and selling them quietly on the black market. Your login may have already been compromised, and you might not know it—until that account, or another that you use the same credentials for, is destroyed.

Hackers also get our passwords through trickery. The most well-known technique is phishing, which involves mimicking a familiar site and asking users to enter their login information. Steven Downey, CTO of Shipley Energy in

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information. Steven Downey, CTO of Shipley Energy in Pennsylvania, described how this technique compromised the online account of one of his company's board members this past spring. The executive had used a complex alphanumeric password to protect her AOL email. But you don't need to crack a password if you can persuade its owner to give it to you freely.

The hacker phished his way in: He sent her an email that linked to a bogus AOL page, which asked for her password. She entered it. After that he did nothing. At first, that is. The hacker just lurked, reading all her messages and getting to know her. He learned where she banked and that she had an accountant who handled her finances. He even learned her electronic mannerisms, the phrases and salutations she used. Only then did he pose as her and send an email to her accountant, ordering three separate wire transfers totaling roughly $120,000 to a bank in Australia. Her bank at home sent $89,000 before the scam was detected.

An even more sinister means of stealing passwords is to use malware: hidden programs that burrow into your computer and secretly send your data to other people. According to a Verizon report, malware attacks accounted for 69 percent of data breaches in 2011. They are epidemic on Windows and, increasingly, Android. Malware works most commonly by

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# If secure, then it is not user-friendly

- A secure passwo
  dictionary attack
- It should not cor
- It should not be


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mple:

# Something you know -> something you have and you are

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Hack Brief: Password Manager LastPass Got Breached Hard

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ANDY GREENBERG SECURITY 06.15.15 05:01 PM

## HACK BRIEF: PASSWORD MANAGER LASTPASS GOT BREACHED HARD

EXPERTS RECOMMEND PASSWORD managers like LastPass as the easiest way to generate unique, strong security codes for every one of your online accounts—which sounds great, until that password manager itself is cracked, potentially offering attackers access to all the accounts it was designed to protect.

### The Hack

On Monday password manager service LastPass admitted it

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WIRED OPINION

Ethical Innovation Means

# ReCRED Consortium

- Funded by the EU under H2020
- Call Identifier: H2020-DS2-2014-1


Cyprus University of Technology

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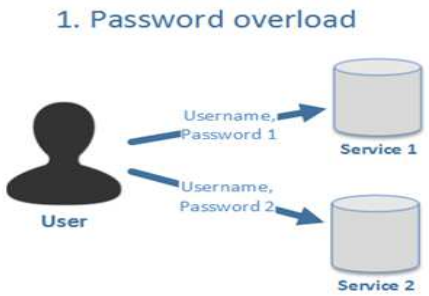
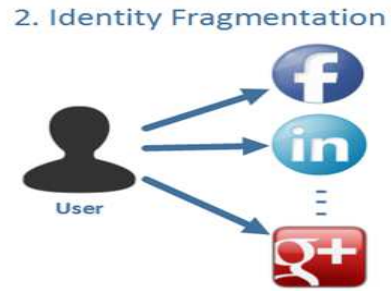
**www.recred.eu**

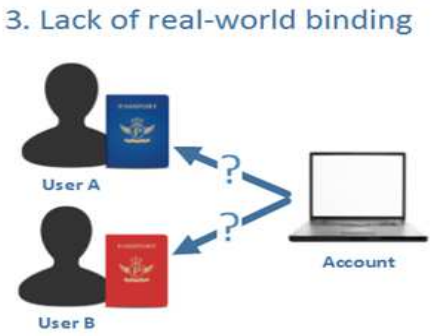
# ReCRED's goal

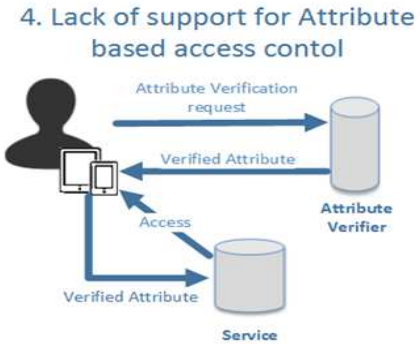
- To promote the user's personal mobile device to the role of a unified authentication and authorization proxy towards the digital world.




**Problems addressed by ReCRED**



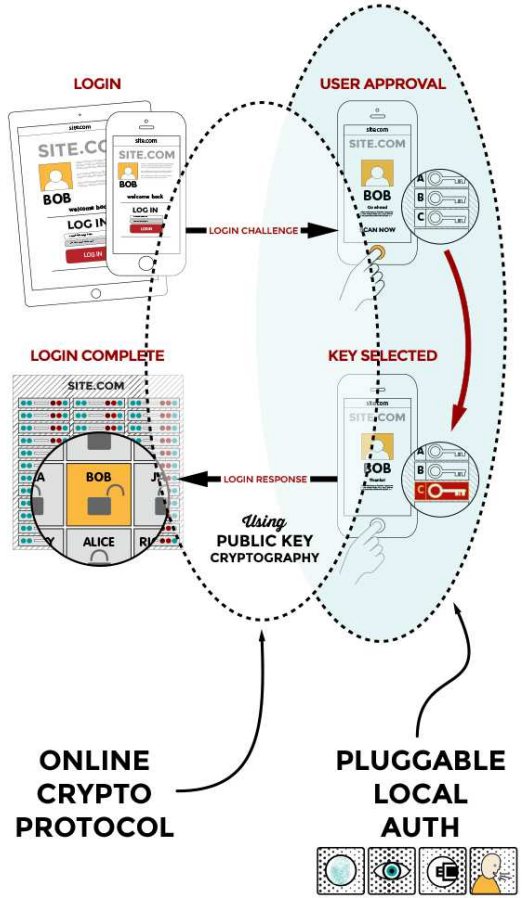



# Device-centric Authentication

- User to Device & Device to Service.

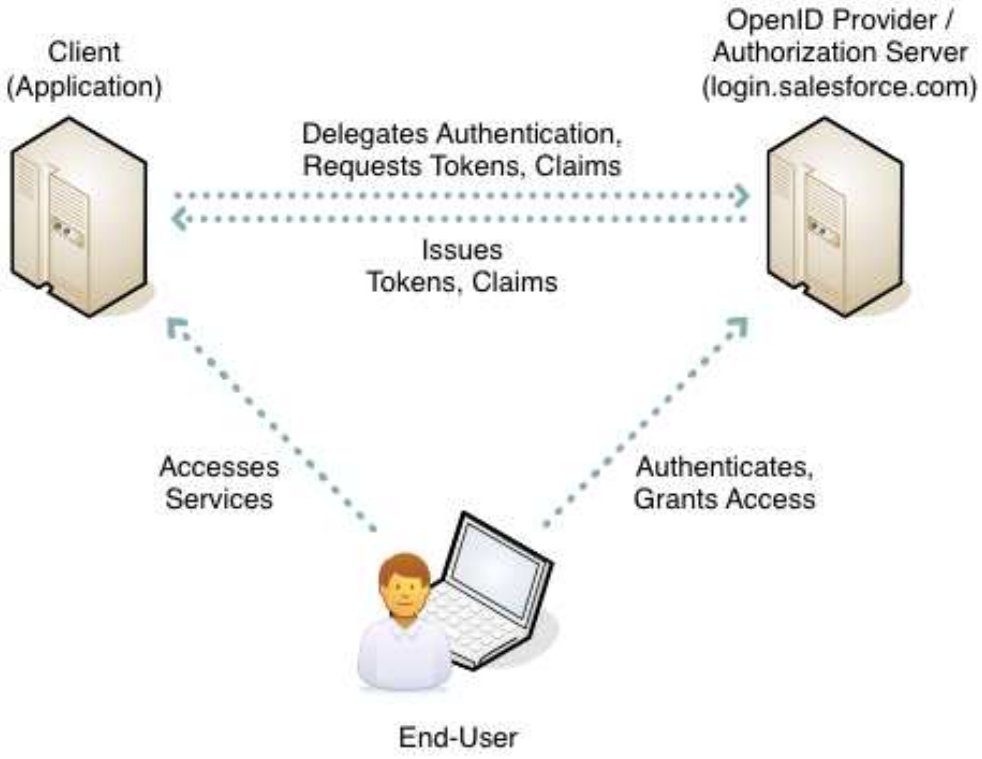
# Employed technologies - FIDO

- **FIDO** (Fast IDentity Online)
  - Standardized protocols for password-less authentication

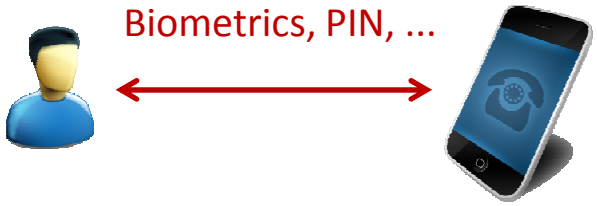


# Employed technologies – OpenID Connect

- **OpenID Connect** (Single Sign On)
  - Online services authenticate their users by employing **Google**, **Microsoft**, **PayPal**, accounts
  - **Mobile Connect** (Mobile operators as ID providers)
- **OAuth 2.0** (Open standard for Authorization)
  - Issues and uses **access tokens** to be used for **authorization**



## FIDO Authentication





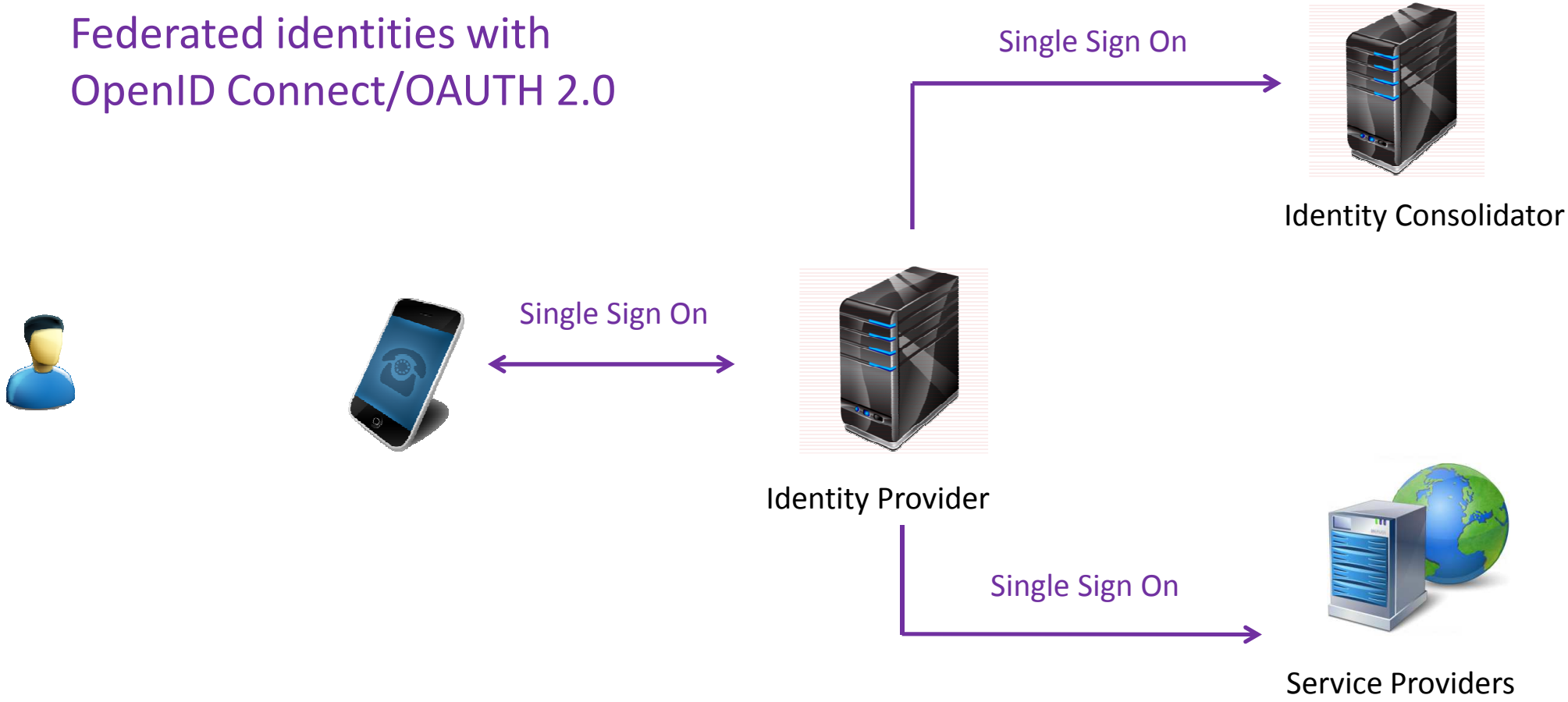
Identity Provider

Identity Consolidator

Service Providers

# FIDO + OpenID Connect (2)

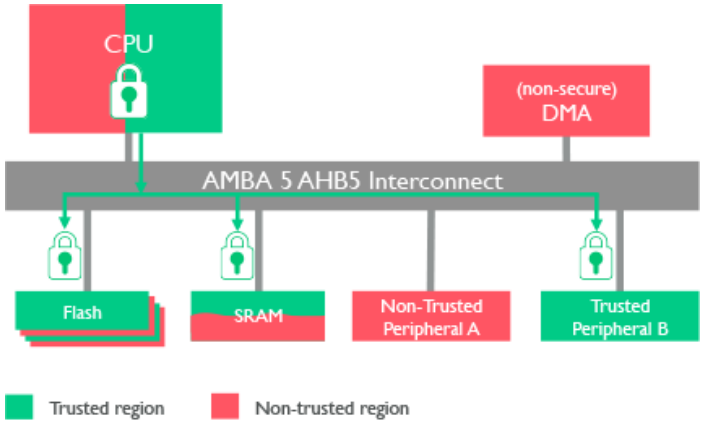
## Federated identities with OpenID Connect/OAUTH 2.0

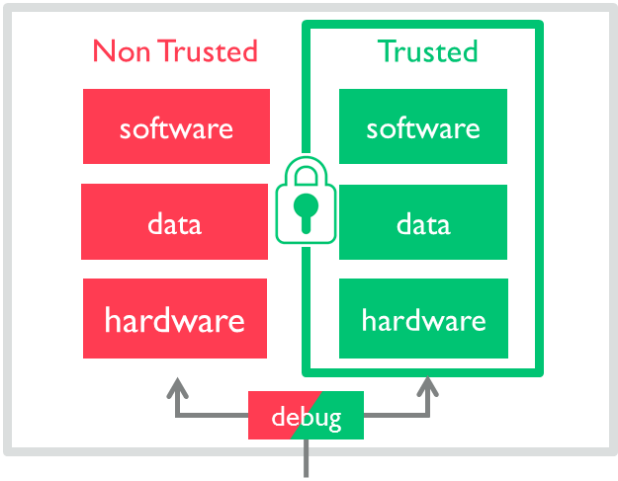


# Employed technologies – Trusted execution

- **Trusted Execution Environment** (TEE)
  - A secure area of the main processor of a smart phone that provides secure storage and cryptographic functions

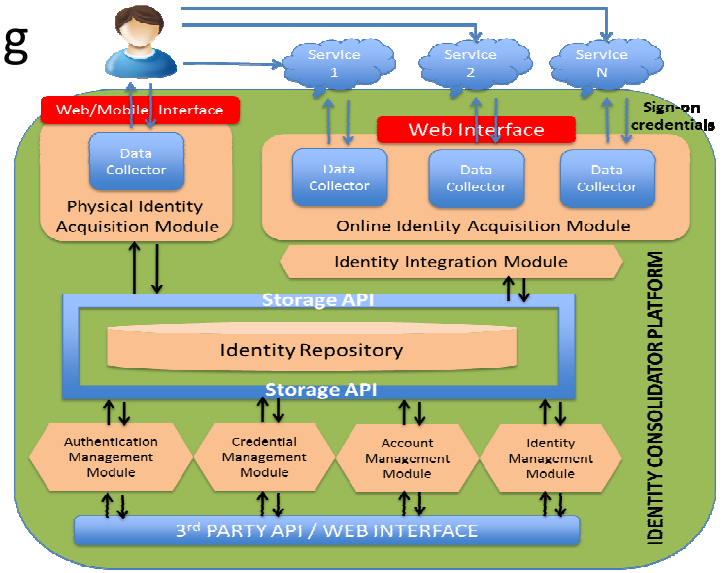
ARM TRUSTZONE
System Security



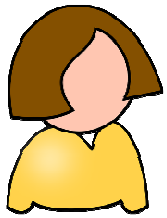
# Identity Consolidator

- **ID Consolidation and Management**
  - Profile Management
  - Credential Management
  - Real-to-online identity mapping




# Attribute-based Access Control

- **Privacy-preserving Attribute-based Access Control**



idemix
pseudonymity for e-transactions

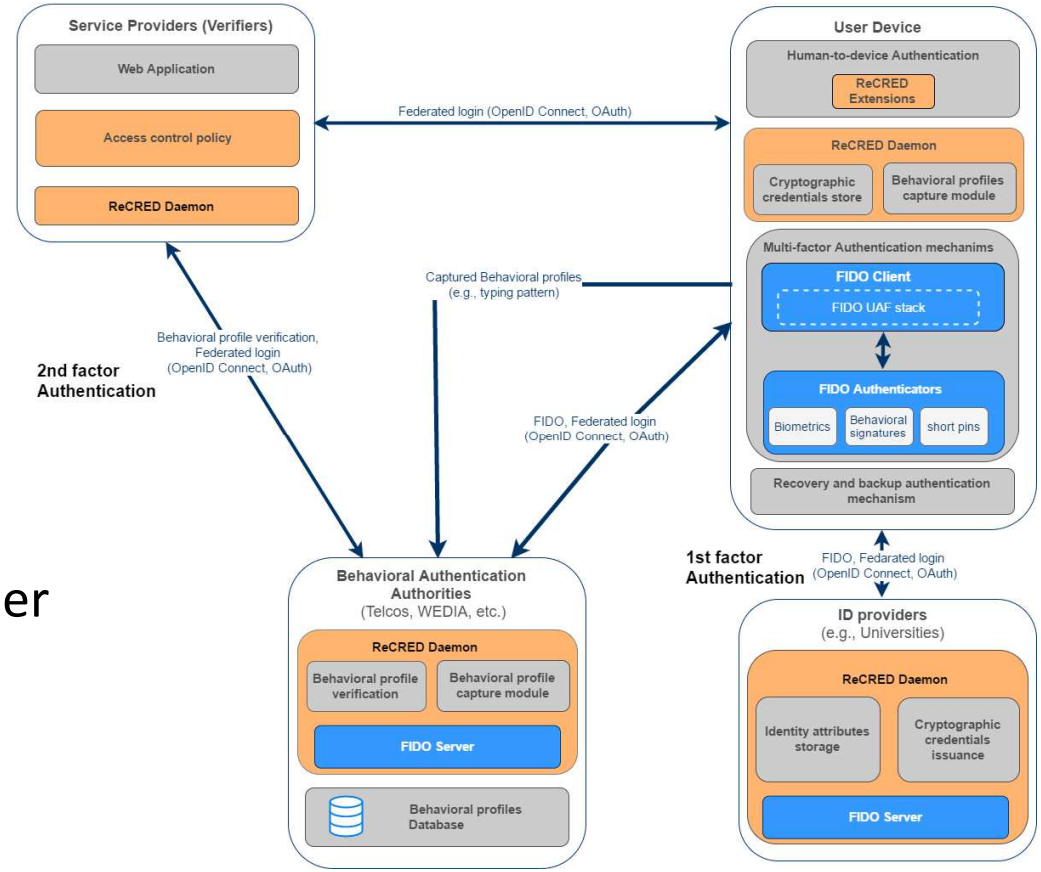

U-Prove

**Account-less access through verified identity attributes (e.g., Age, Location, etc.)**

**Issue cryptographic anonymous credentials**

# Behavioral Authentication Authorities

- Provides multi-factor device-to-service authentication based on the user's behavioral biometrics
- Extends the definition of biometric with mobility and traffic patterns
- Acts as an ID provider verifying that the user continues to behave as she has normally done in the past



# ReCRED's Innovation

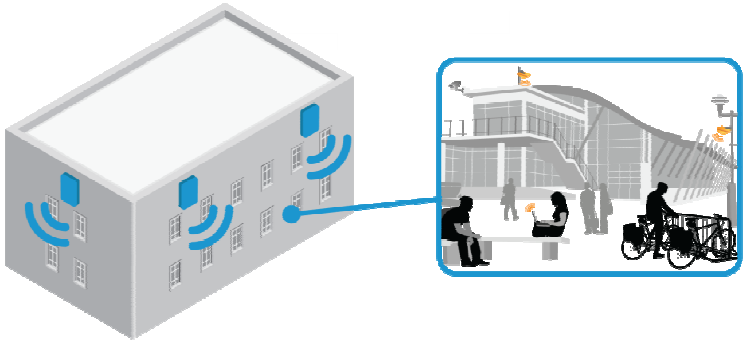
- **Standardized** and secure authentication using **FIDO**
- **Multifactor** & **easy to use** password-less authentication
  - Biometrics and behavioral authentication
- **Single Sign On** (SSO) with federated identities
- Enhanced security & privacy by employing the crypto functions and secure storage of **TEE**
- Privacy of **online identities** using **anonymous credentials**
  - Unlinkability & untraceability
  - **Attribute-based Access Control**

# ReCRED's Innovation

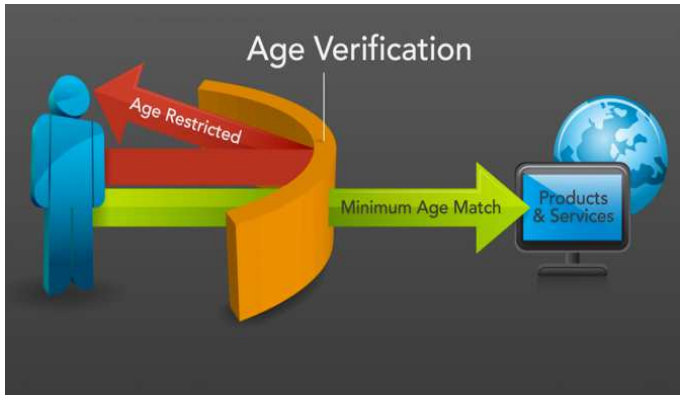
- It anchors all access control needs to mobile devices that users habitually use and carry
- It is aligned with current technological trends and capabilities.
- It offers a unifying access control framework
  - On-line authentication and authorization
  - Using off-the-self mobile devices
- It is attainable and feasible to implement in the existing products

# Business Cases

Support to financial services



Campus Wi-Fi and Campus-restricted Web Services



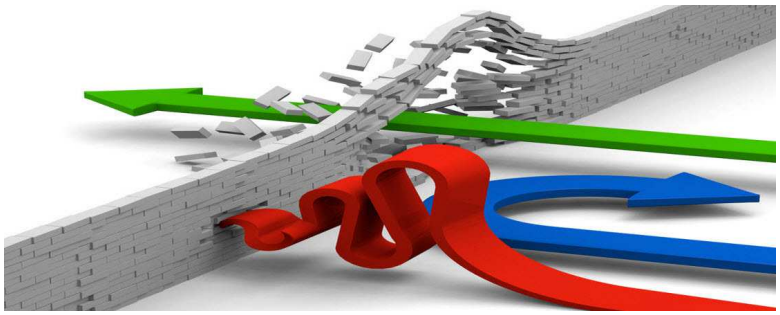

Age Verification


Student Authentication and Offers

# Security and privacy assessment

- Compliance with **EU Directives and Regulation**
  - 95/46/EC
  - 2002/58/EC
  - 2006/24/EC
  - GDPR/2016/EC

- Assessment of data privacy and security of ReCRED architecture
- Described process of
  - Code Review
  - Penetration Testing

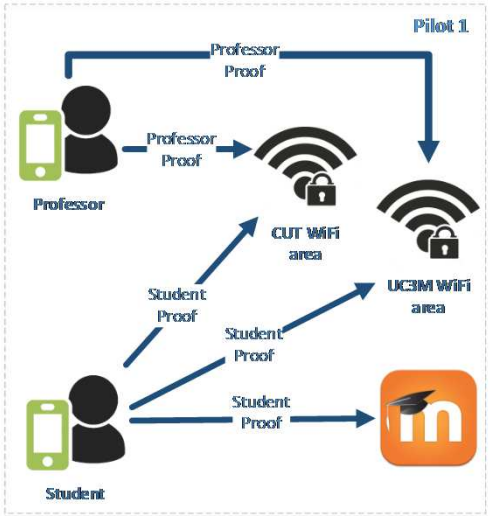


# Campus Wi-Fi and Web Services Pilot

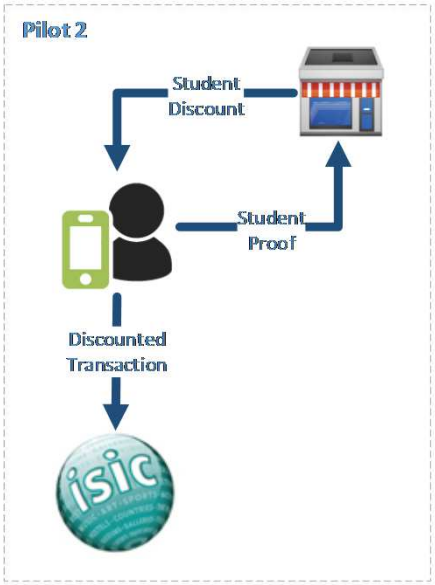
- **First integrated system**
- Started recruiting students from university and library
- Students can access Web Services
  - Device-centric Authentication
  - Password-less experience
  - Fine-grained control of identity attributes to be revealed (ABAC)
- **FIDO + OpenID Connect Integration**

# ReCRED's pilots

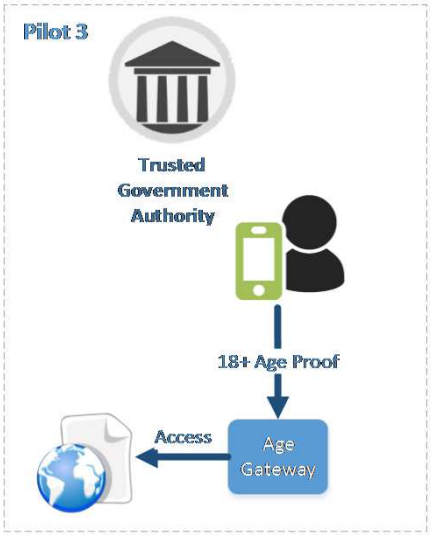
**Pilot 1:** Device-centric campus WiFi and web services access control



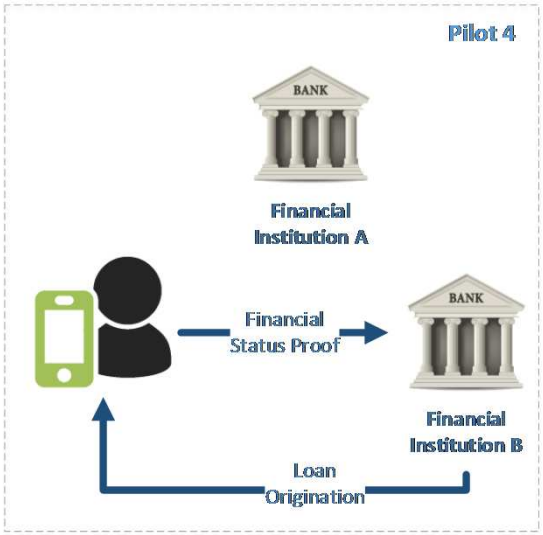

**Pilot 2:** Student authentication and offers




**Pilot 3:** Attribute-based age verification online gateway

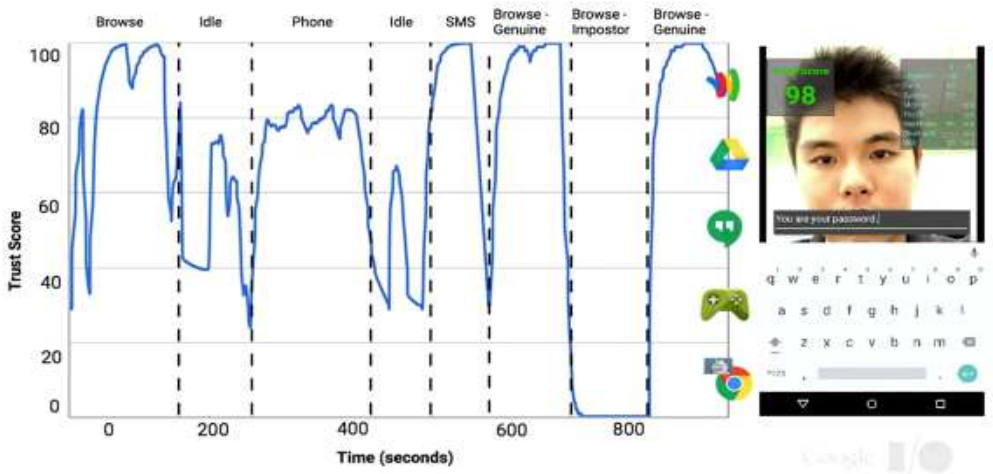



**Pilot 4:** Financial services – microloan origination



# Google Trust API (ex Abacus)

- Multi-Modal Continuous Authentication System
- Captured attributes
  - Typing patterns
  - Browsing habits
  - Location
  - Face recognition
  - Walking habits
  - Speech recognition
  - Touch dynamics



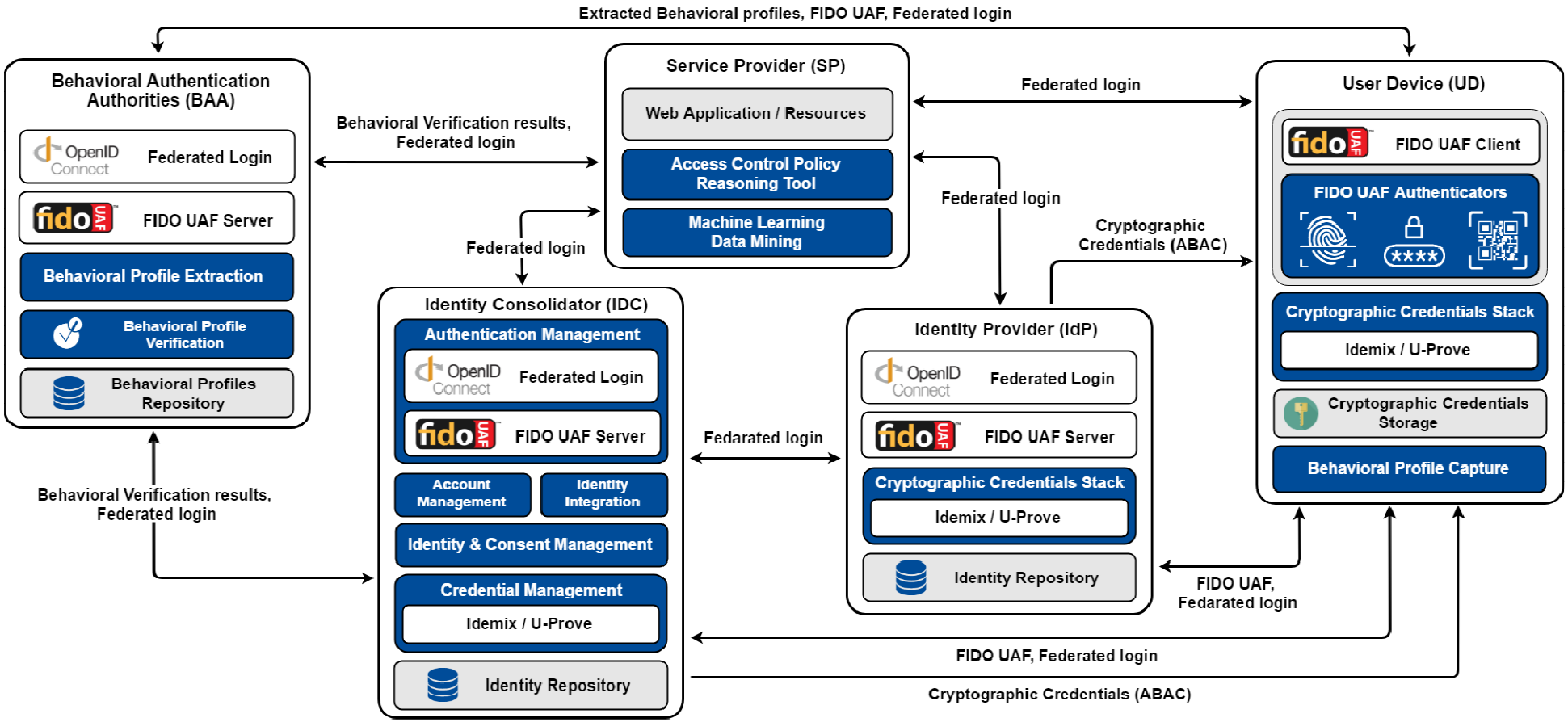

- Calculates trust score according to captured attributes

# ReCRED vs Google Trust API

- **Behavioral profiles** are stored on **BAA**
  - Innovative architectural component
- **Behavioral attributes** are either captured by the **user's device** or directly by the **BAA**
- **Account-wide** lockdown and **device-wide** lockdown

# Thank you

Dr. Michael Sirivianos
Electrical Engineering, Computer Engineering
and Informatics


Extracted Behavioral profiles, FIDO UAF, Federated login
Behavioral Authentication Authorities (BAA)
OpenID Connect
Federated Login
FIDO UAF Server
Behavioral Profile Extraction
Behavioral Profile Verification
Behavioral Profiles Repository
Behavioral Verification results, Federated login
Service Provider (SP)
Web Application / Resources
Access Control Policy Reasoning Tool
Machine Learning Data Mining
Federated login
Federated login
Federated login
User Device (UD)
FIDO UAF Client
FIDO UAF Authenticators
Cryptographic Credentials Stack
Idemix / U-Prove
Cryptographic Credentials Storage
Behavioral Profile Capture
Cryptographic Credentials (ABAC)
Identity Consolidator (IDC)
Authentication Management
OpenID Connect
Federated Login
FIDO UAF Server
Account Management
Identity Integration
Identity & Consent Management
Credential Management
Idemix / U-Prove
Identity Repository
Behavioral Verification results, Federated login
Fedarated login
Identity Provider (IdP)
OpenID Connect
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Cryptographic Credentials Stack
Idemix / U-Prove
Identity Repository
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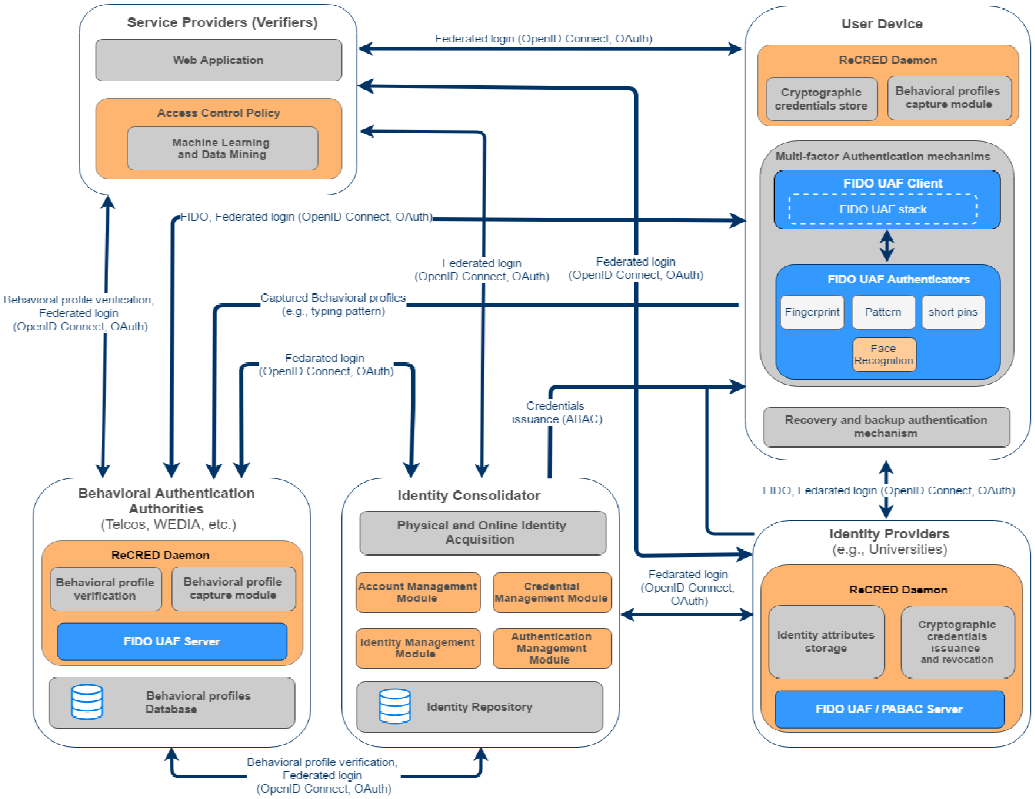
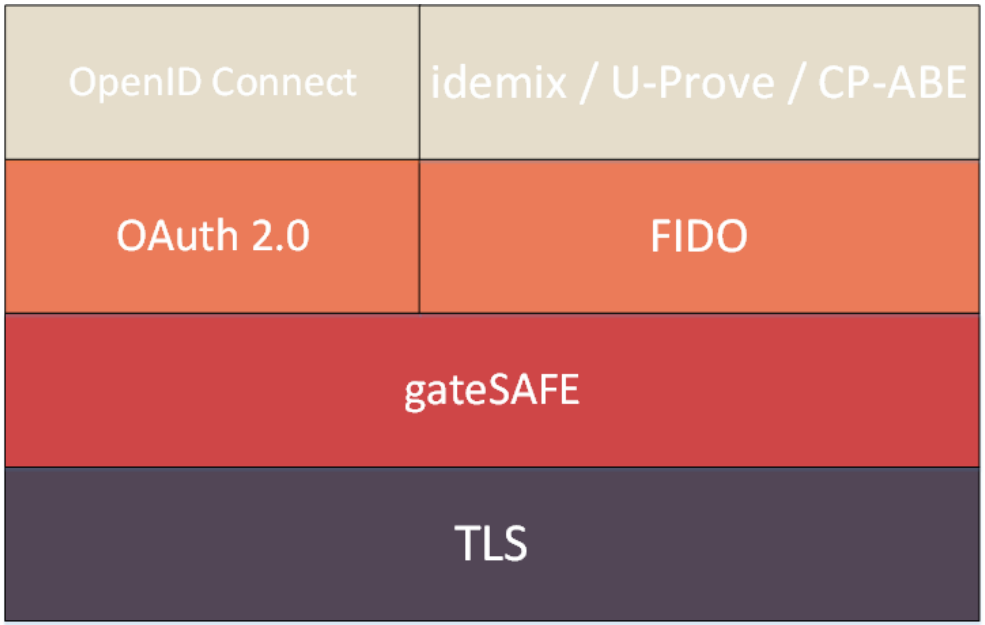
FIDO UAF, Federated login
Cryptographic Credentials (ABAC)

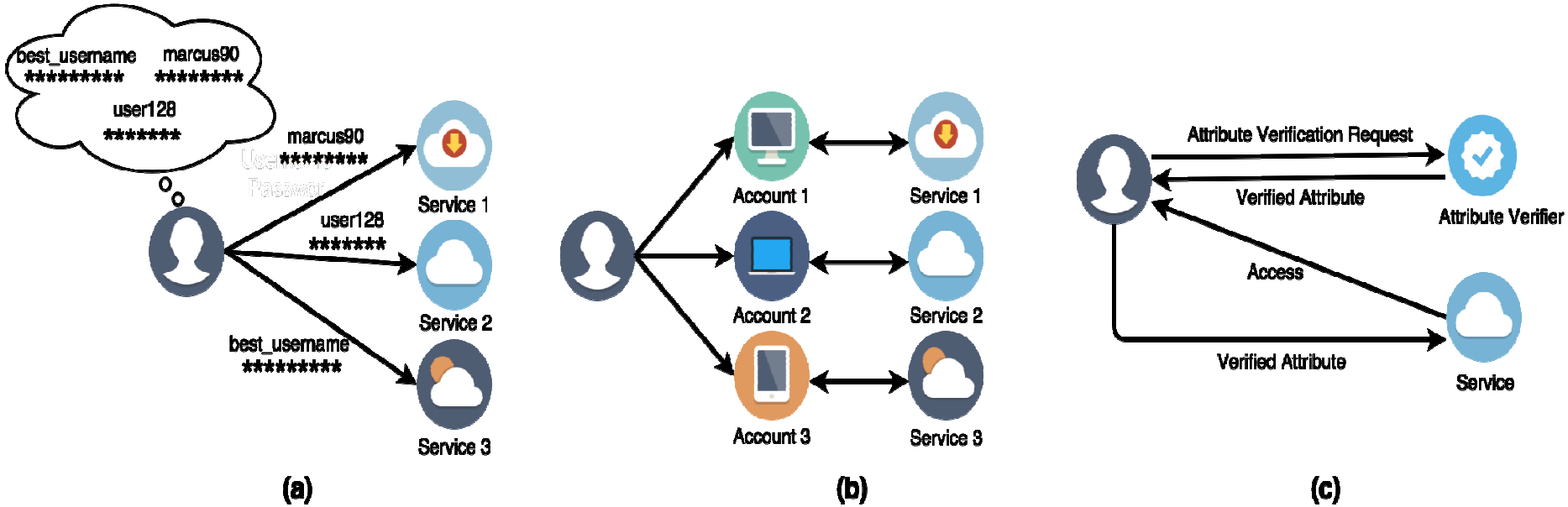
# Reference Architecture

- Definition of the ReCRED architecture



# The problems with the password paradigm



# Reference Architecture