Cybersecurity Management
T5- Identity Management

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Outline

- Basic Concepts
- Identity Federation (IdF) definition and models
- Academic IdF initiatives
- SAML2 protocol and workflows
- Multi-Factor Authentication
- Security-related concerns

Basic concepts

NIST Special Publication 800-63-3

Digital Identity Guidelines

Paul A. Grassi
Michael E. Garcia
James L. Fenton

https://nvlpubs.nist.gov/nistpubs/SpecialPublications/NIST.SP.800-63-3.pdf

Basic concepts

- **Digital Identity**
  - Unique representation of a subject engaged in an online transaction.
  - Always unique in the context of a digital service…
  - …but not necessarily need to uniquely identify the subject in all contexts
- **Identity proofing**
  - Establishes that a subject is who they claim to be
- **Digital authentication**
  - Process of determining the validity of one or more authenticators used to claim a digital identity
  - Establishes that a subject attempting to access a digital service is in control of the technologies used to authenticate
  - Provides reasonable risk-based assurances that the subject accessing the service today is the same as that which previously accessed the service

Physical Identity vs eID

- Real Identity is hold by physical or legal persons
  - Name
  - Gender,
  - Work position,
  - place of Residence,
  - Organisation, OU,
  - Phone, ISDN numbers,
  - Skills, etc.
  - Legal name
  - Official address
  - CIF / Tax Number
  - Code of Activity
  - Website
  - Brand Trademark
- **eID is the virtual representation of a real identity**
  - Ownership of information
  - Access rights to data and applications
  - Link to real identity

Accessing a digital service may not mean that the subject's real-life identity is known

Profiling

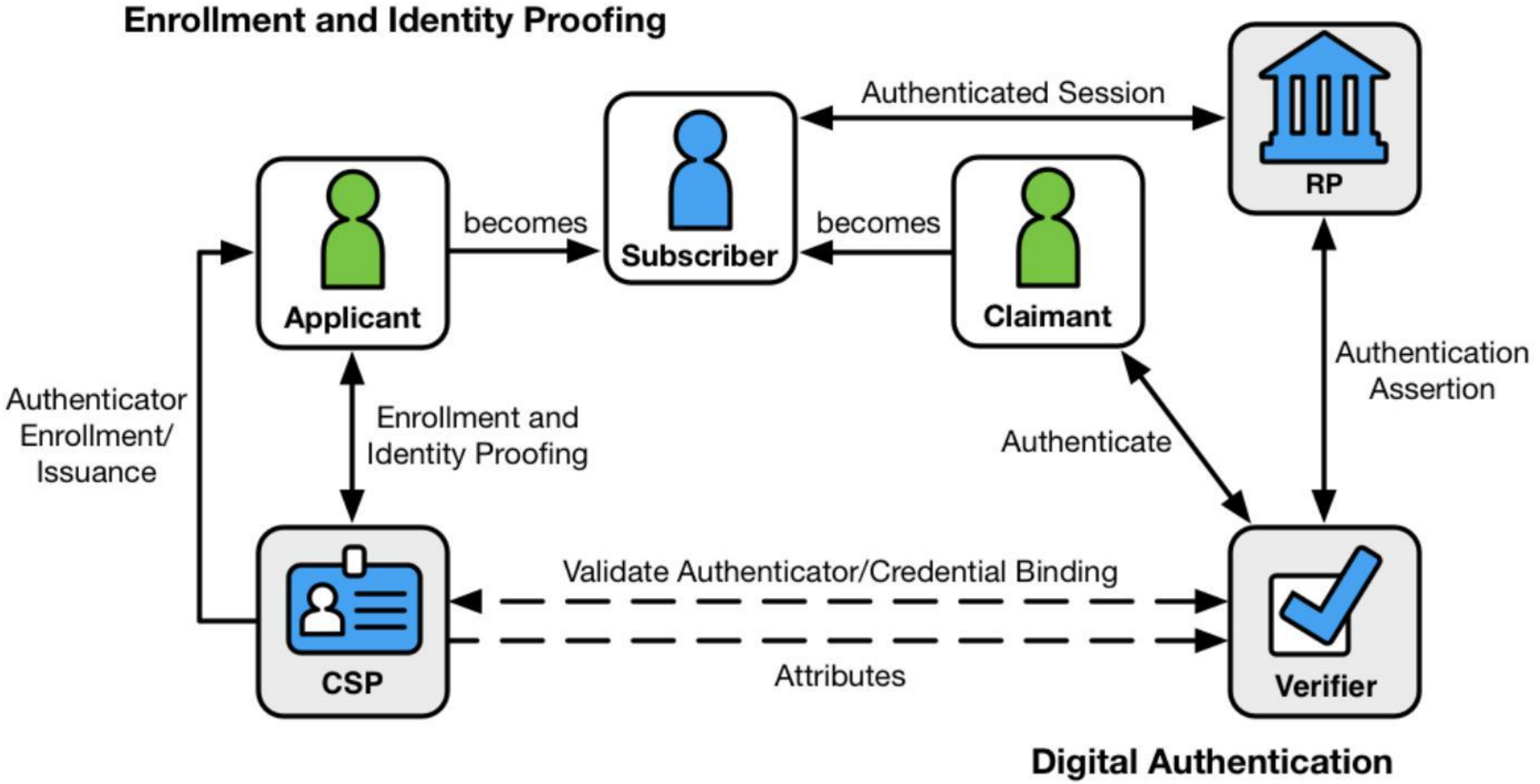
Physical persons may have several eIDs, depending on the relationships and attributes that the person wants to associate to that eID:

- "member of this community",
- "Alice Smith", or
- "licensed under contract A“

Attribute set standards:

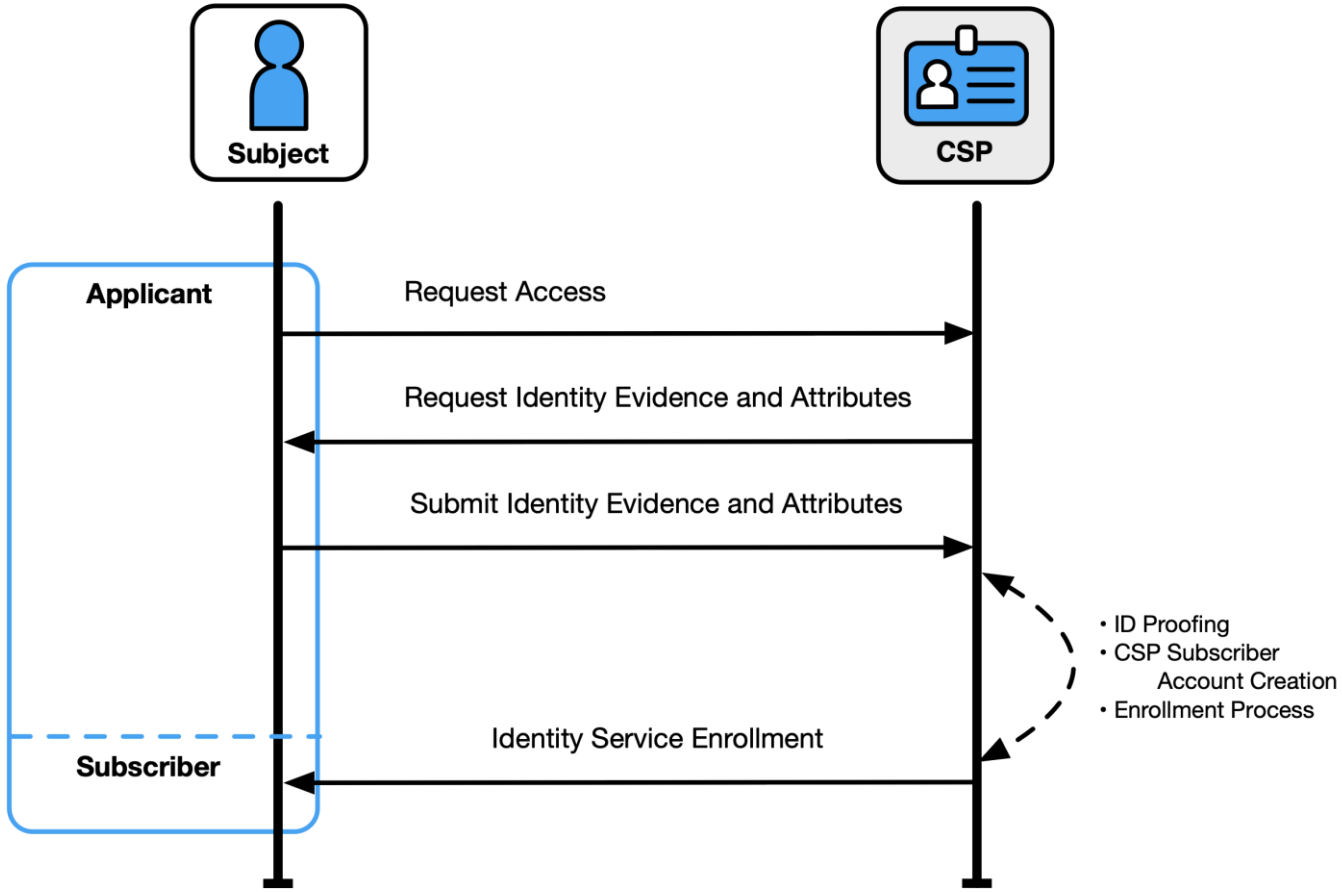
- DAP X520
- RFC2798 inetOrgPerson LDAP Object Class
- RFC3671 Collective Attributes in LDAP

Digital Identity Model (NIST)



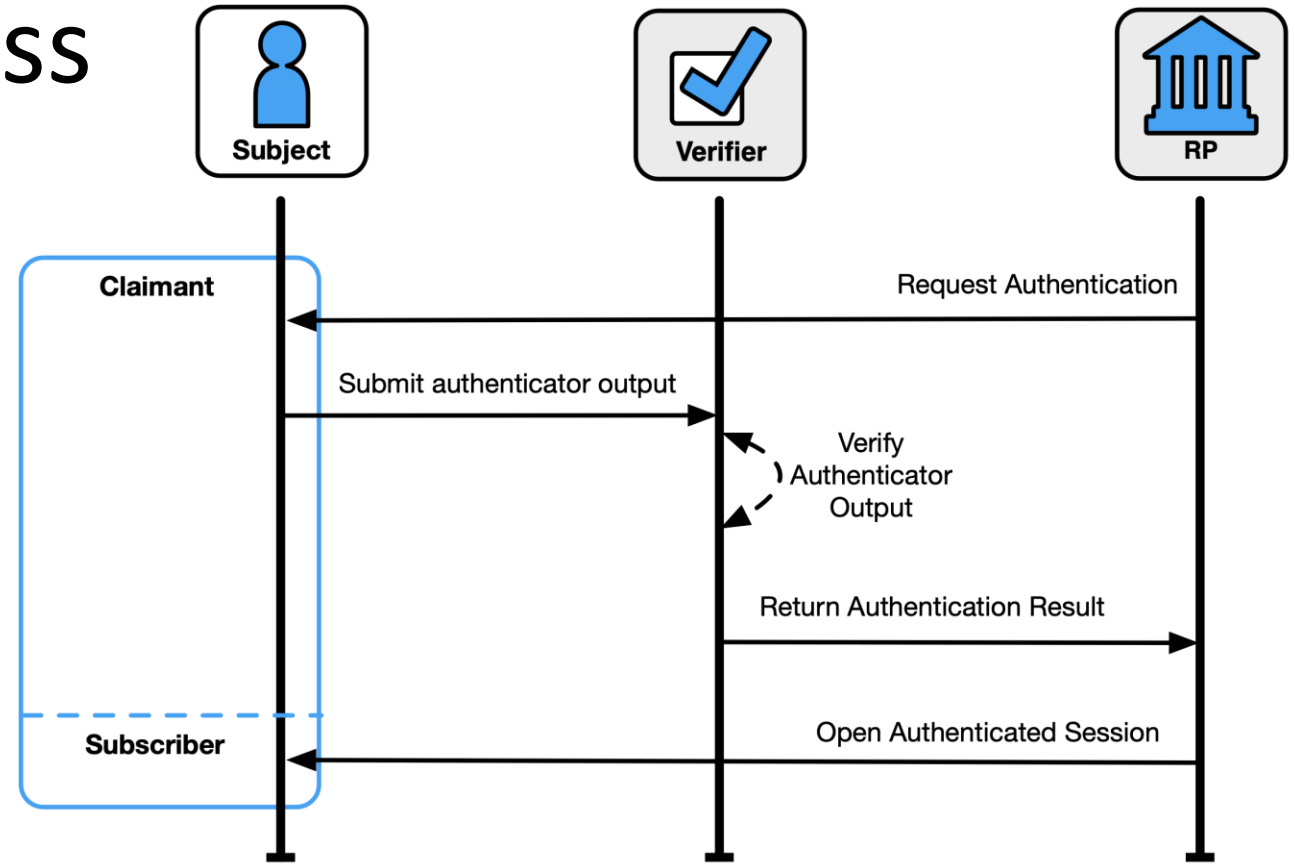
Enrolment and Identity Proofing

- **Applicant:** the party whose identity needs to be proofed (undergoing the processes of enrollment and identity proofing.)
- **Subscriber**: Applicant after successfully proofing process is completed
- **CSP (Credential Service Provider)**: A trusted entity that issues or registers subscriber authenticators and issues electronic credentials to subscribers



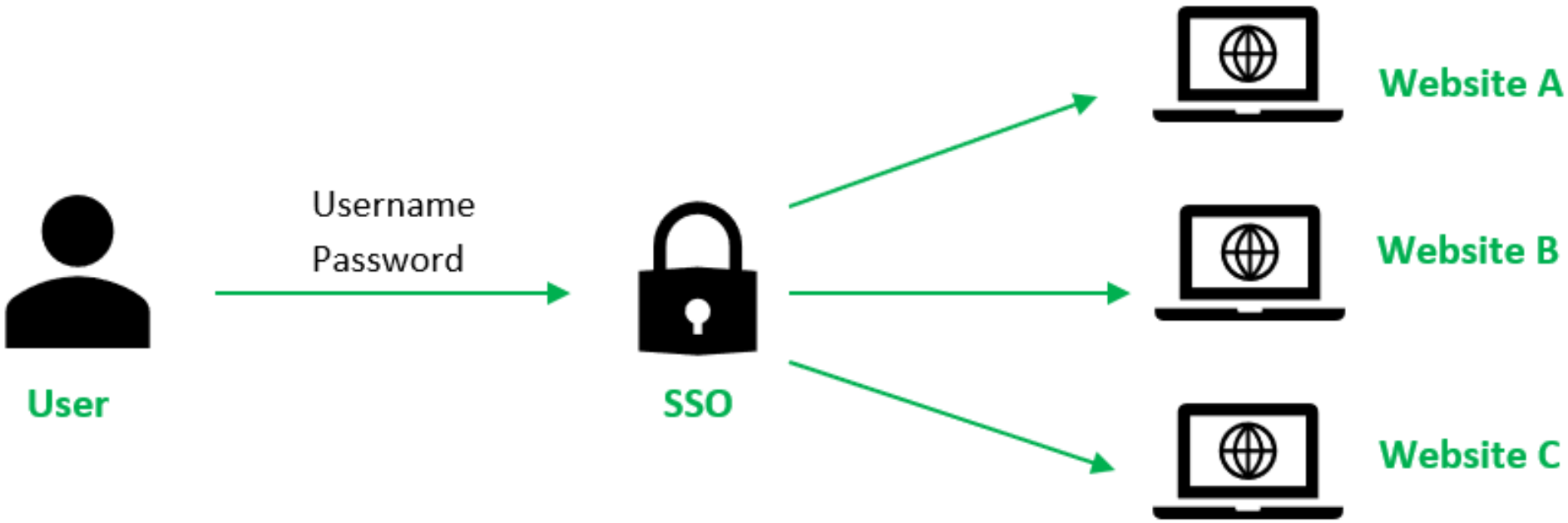
Authentication Process

- **Claimant:** A subject whose identity is to be verified using one or more authentication protocols.
- **Subscriber**: A claimant who has received successful authenticator from a verifier
- **Verifier (aka CSP)**: entity that verifies the claimant's identity by verifying the claimant's possession and control of one or multiple authenticators using an authentication protocol.



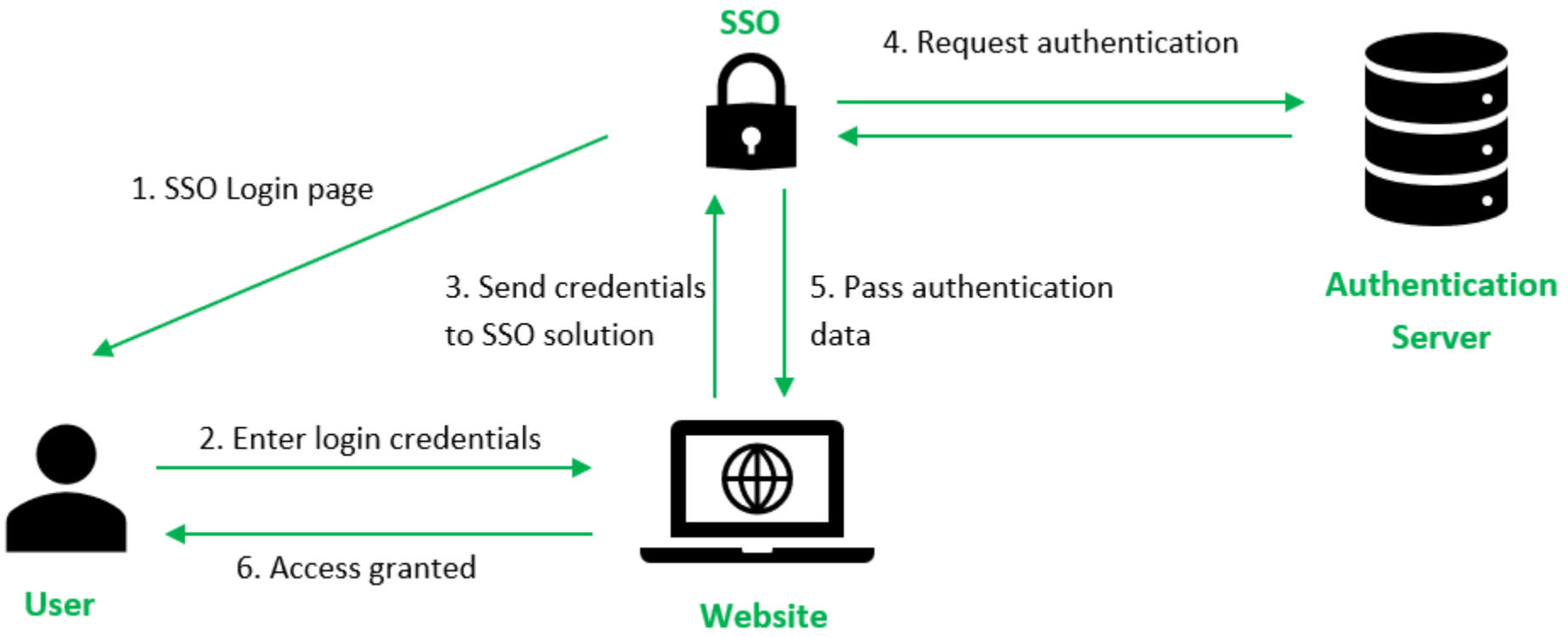
- **Relying Party (RP):** An entity that relies upon the subscriber's authenticator(s) and credentials or a verifier's assertion of a claimant's identity, typically to process a transaction or grant access to information or a system.

Single Sign-On Authentication



Source: https://www.geeksforgeeks.org/introduction-of-single-sign-on-sso

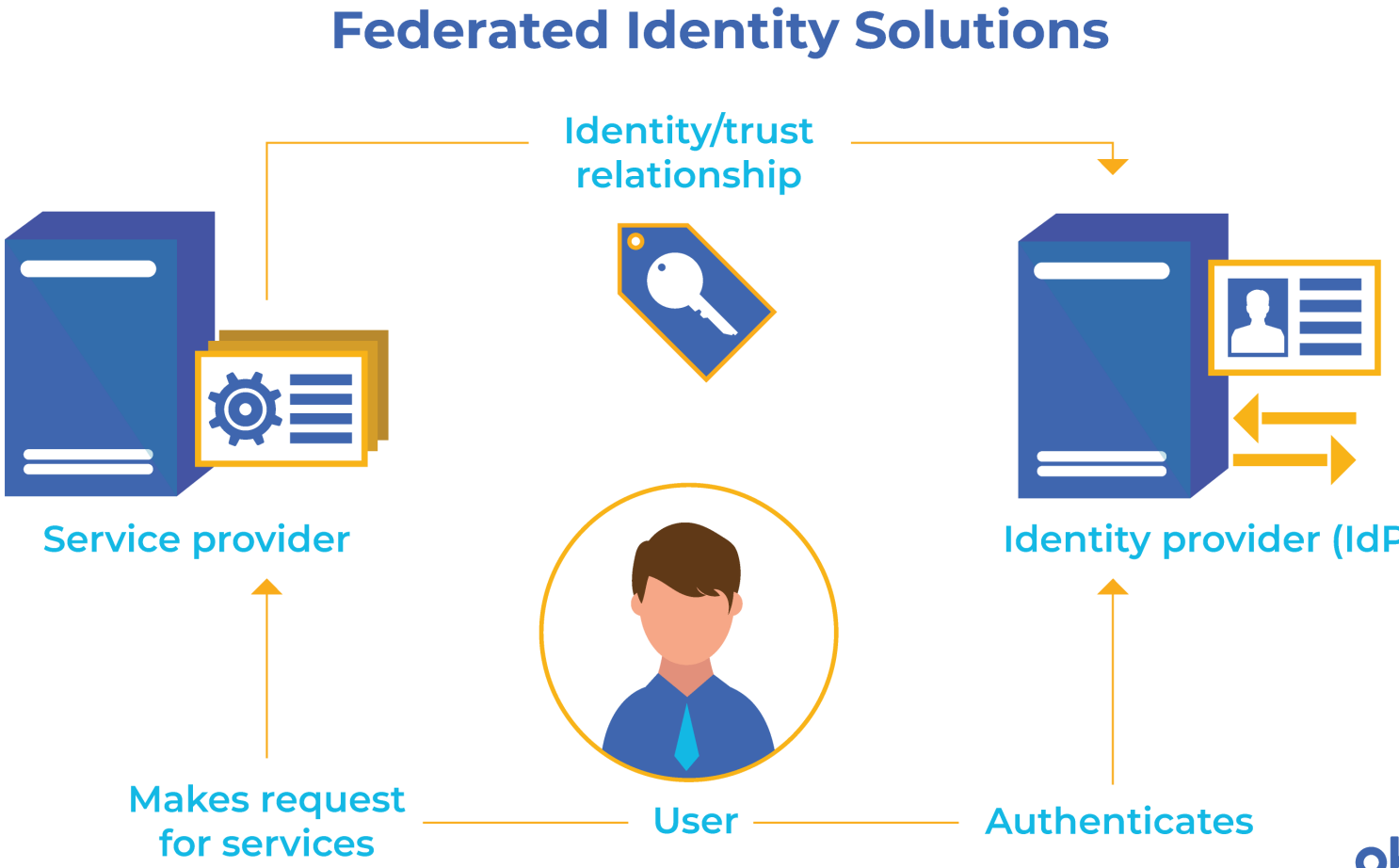
Single Sign-On Authentication



Source: https://www.geeksforgeeks.org/introduction-of-single-sign-on-sso

Identity Federation (IdF)

Basic Concept



aka RP

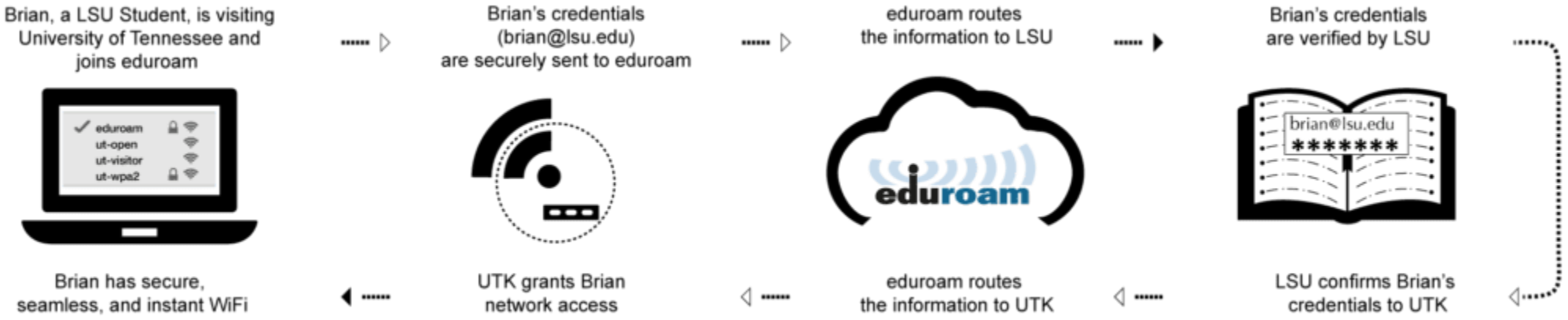
aka CSP, includes role of verifier

IdF in 5 minutes

https://www.youtube.com/watch?v=BFkFRnaylYY

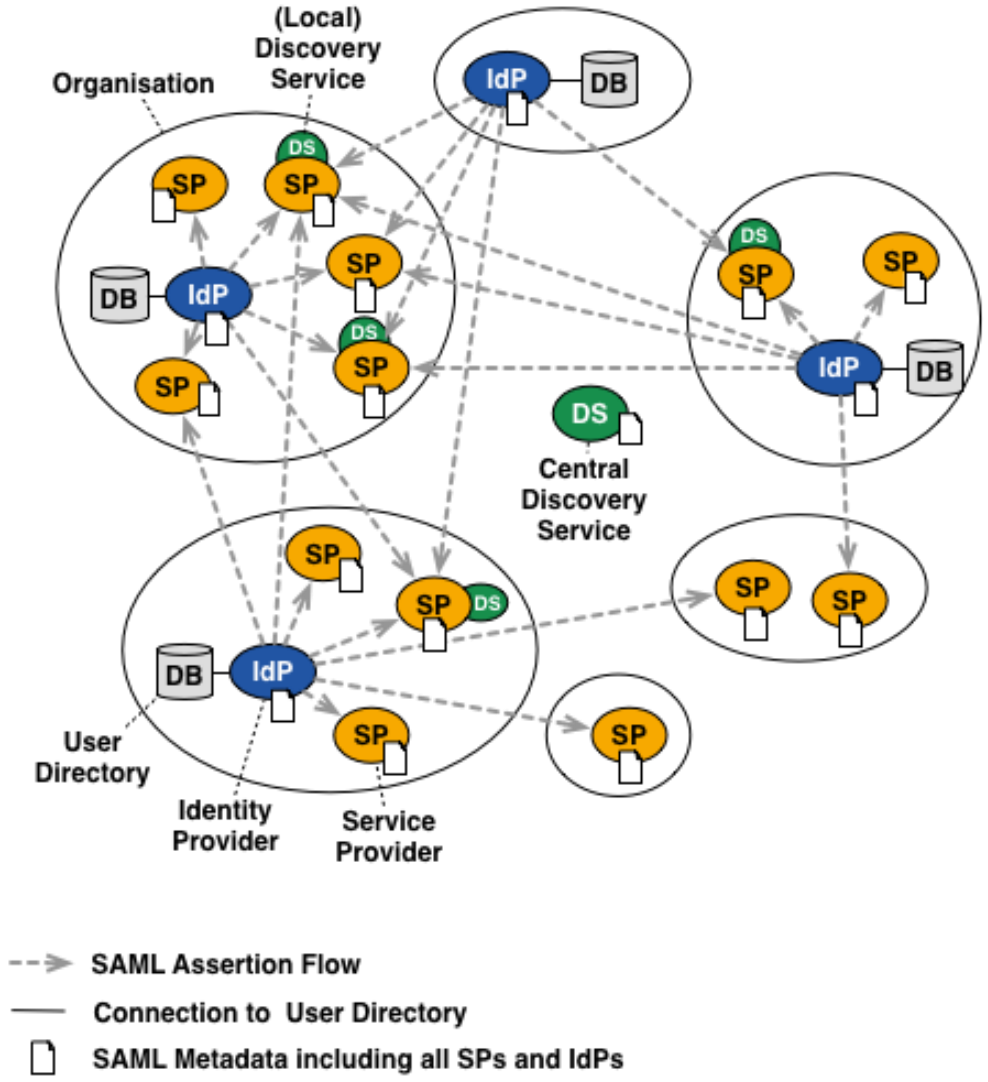
Example : Eduroam

- Users from participating academic institutions secure Internet access at any other eduroam participating location.
- The mechanism by which authentication and authorisation works:
  - The authentication of a user is carried out at their Identity Provider (IdP), using their specific authentication method.
  - The authorisation decision allowing access to the network resources upon proper authentication is done by the Service Provider (SP), typically a WiFi hotspot (University campus, etc.).



Full Mesh

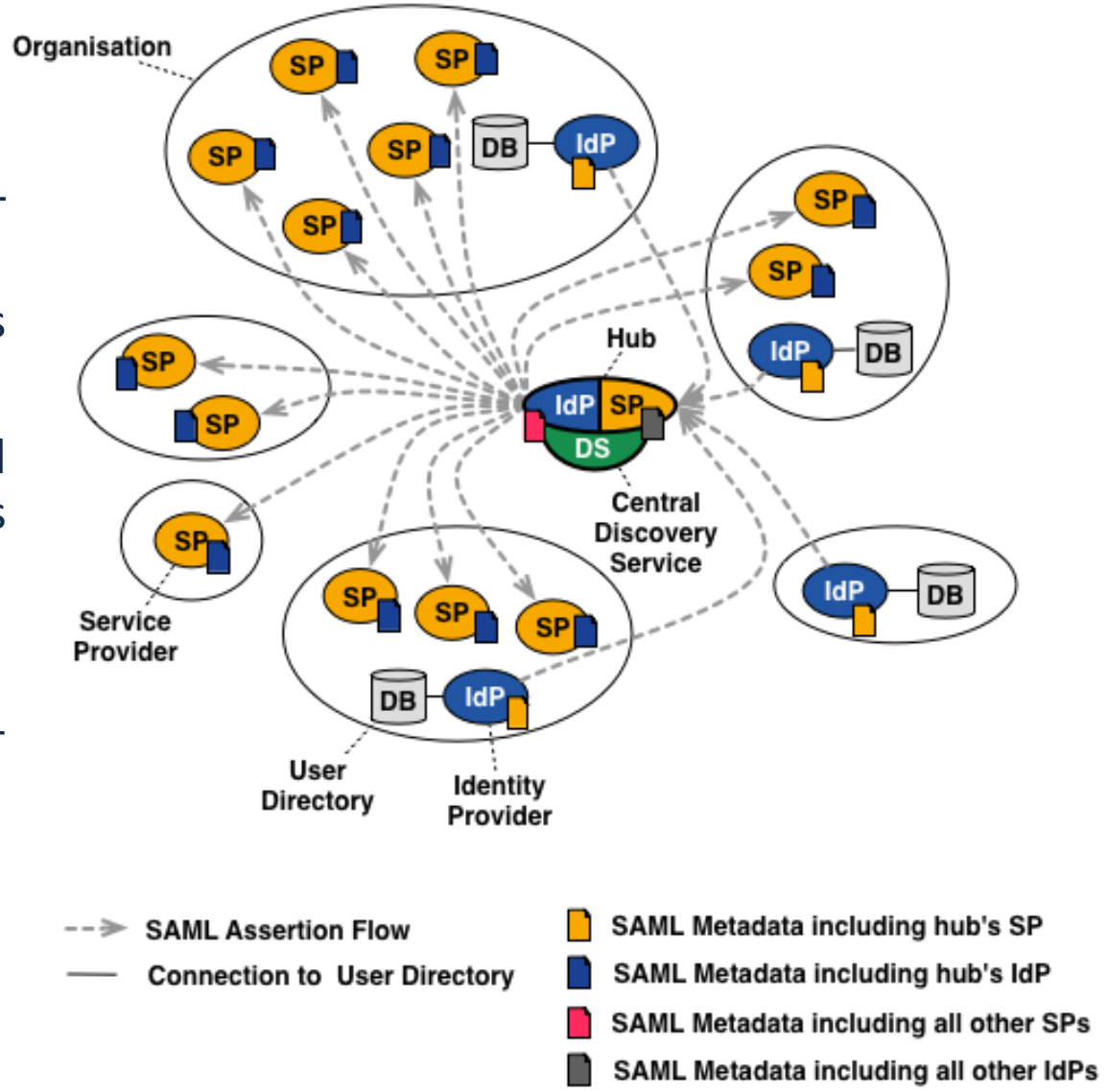
- Most common and straight forward to implement federations
- Everything is distributed and there is no need for a central component (failover management distributed as well)
- Every organisation operates their own IdP
- Centrally distributed SAML metadata file including all entities
- Requires efficient management of the metadata file
- Most federations also operate a central IdP Discovery Service/WAYF (not strictly needed).



Source: https://wiki.geant.org/

Hub-And-Spoke with Distributed Login

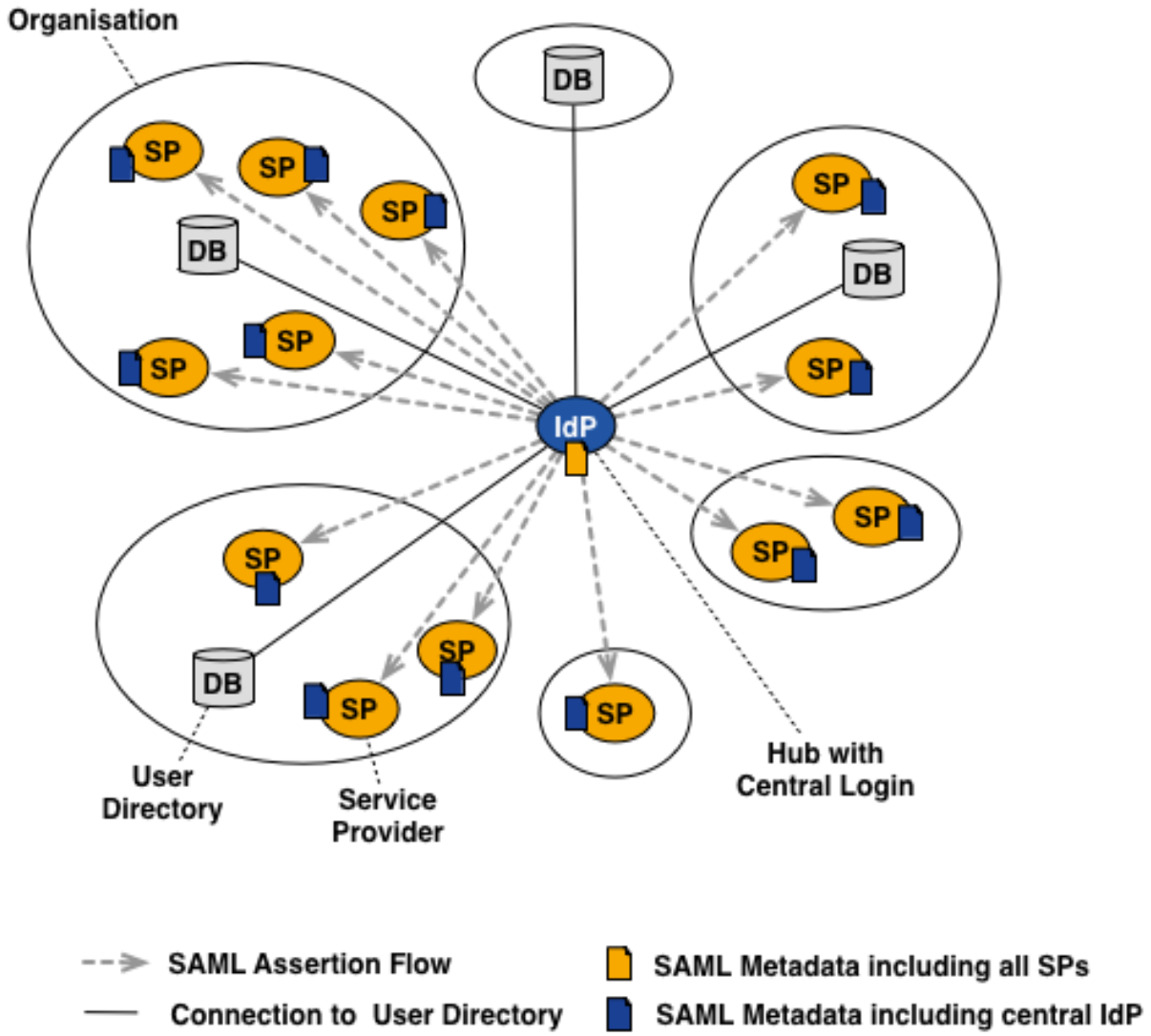
- Rely on a central hub or proxy via which all SAML assertions are sent.
- The hub serves as a SP versus the IdP and as an IdP versus the SP in the federation.
- Each organisation still operates their own IdP connected to a local user database but the IdP typically only needs metadata of the hub.
- SPs only need metadata for the hub.
- Hub has to be carefully secured and protected (single-point of failure).



Source: https://wiki.geant.org/

Hub-And-Spoke with Centralized Login

- Only one single IdP in the federation.
- All user databases are connected to a central IdP where users enter their organisation credentials on.
- IdP especially trusted by all organisations and highly available.
- Depending on the number of logins, scalability issues may arise.
- Very easy to support new authentication protocols on the hub thanks to the central login.



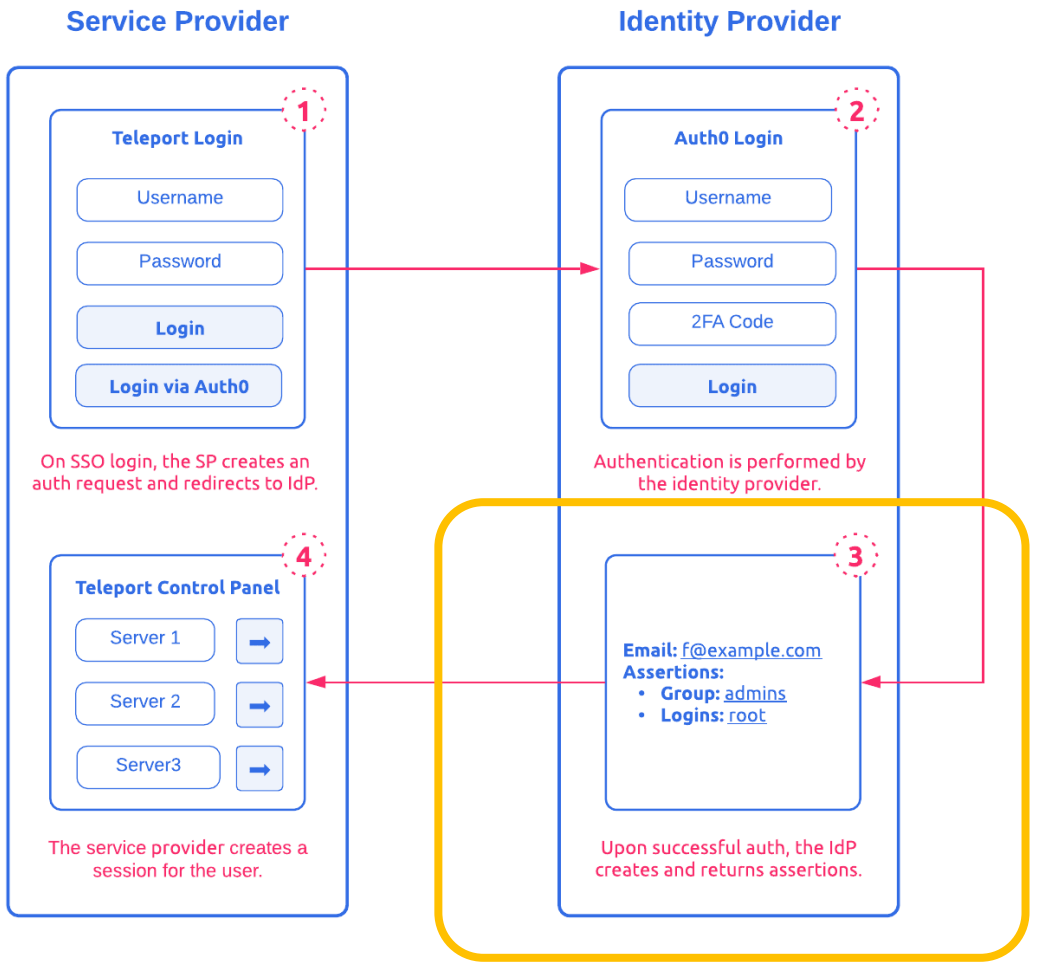
Source: https://wiki.geant.org/

SAML2: Security Assertion Markup Language

- Open standard
- Exchanging authentication and authorization data between parties
- XML-based markup language
- Key components/elements
  - Roles (principal, IdP and SP)
  - Assertions
  - Protocols
  - Bindings
- Profile = use case + assertions + protocols+ bindings
- Typical use case: Web SSO

SAML2 assertion

- Statements transferred from IdP to SPs
- SPs use to make access-control decisions
- Three main types:
  - Authentication statement
    - Asserts that the user is authenticated
    - Specifies IdP, time, method,…
  - Attribute statement
    - Asserts that a user is associated with certain attributes
  - Authorization decision statement
    - Asserts that user is permitted to perform some action

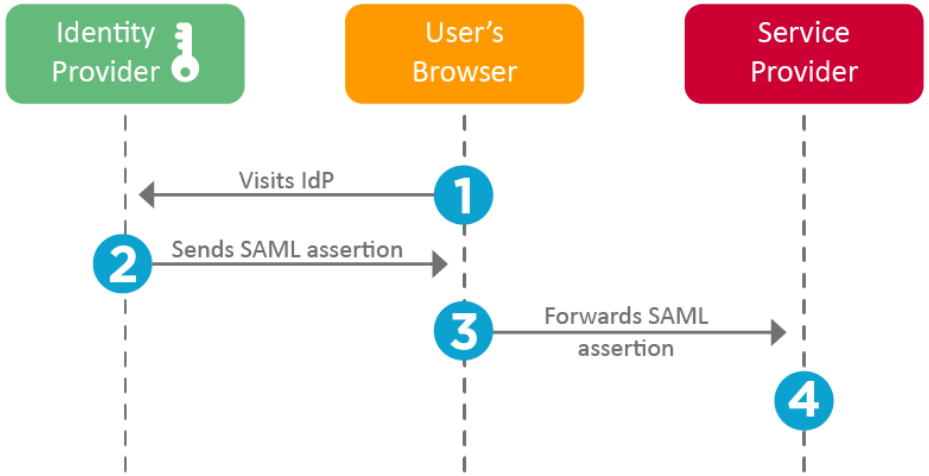


SAML2 protocols and bindings

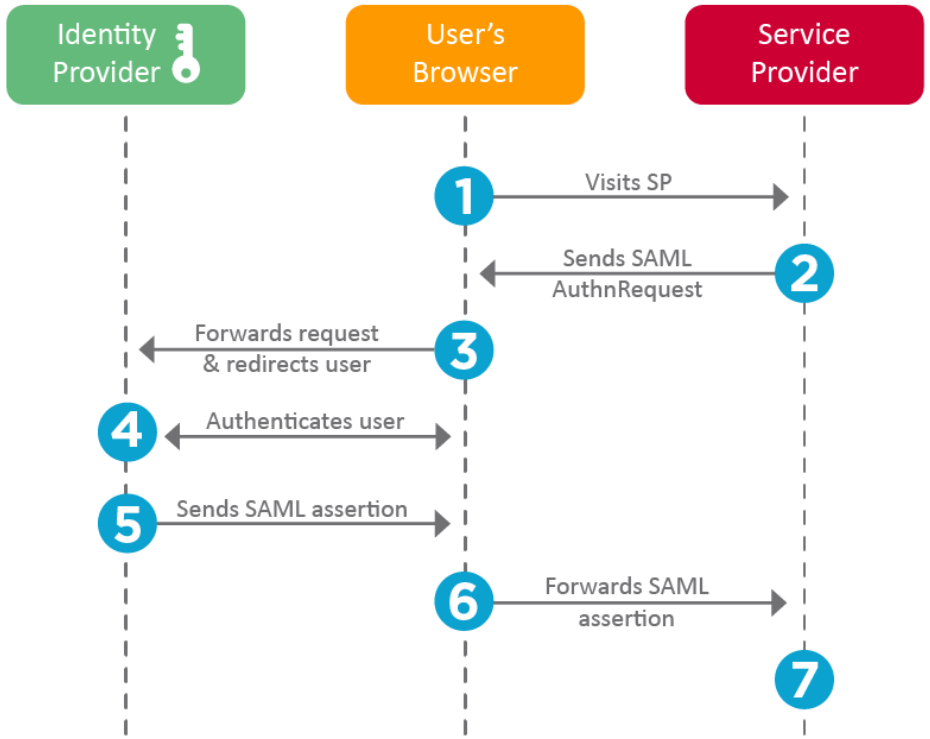
- **Protocol: What** is transmitted
  - Describes the way assertions are packaged and sent (workflows) in request/response elements
  - Main protocols
    - Authentication Request Protocol
    - Artifact Resolution Protocol
- **Binding: How** is transmitted
  - Map request/responses onto standard messaging protocols
  - HTTP redirect (browser redirect)
  - HTTP POST
  - HTTP artifact
  - SOAP

SAML2 workflows

IdP-initiated workflow



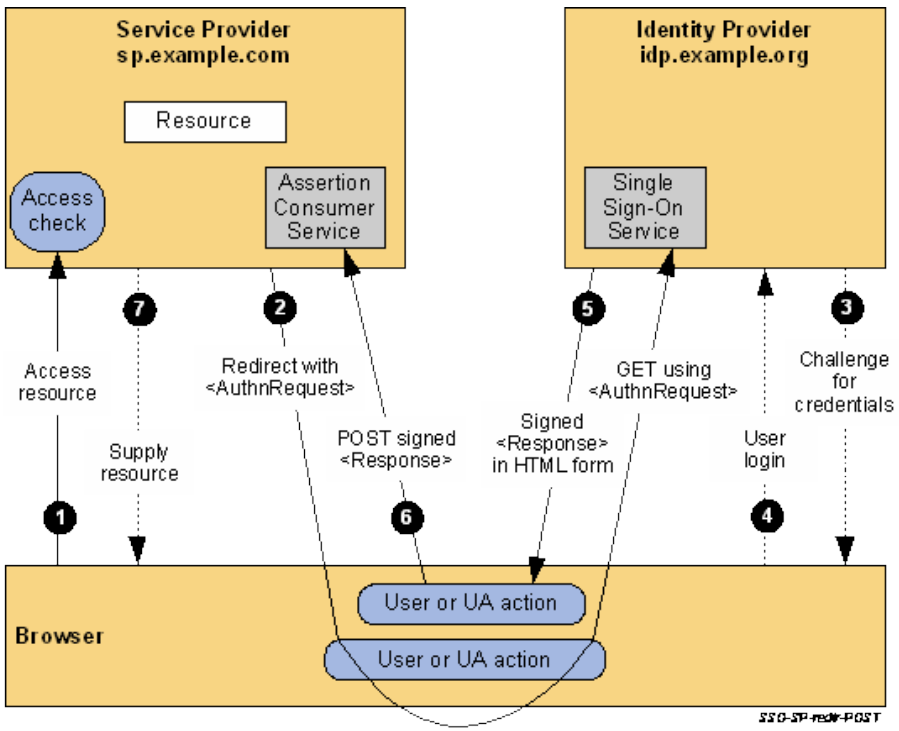
SP-initiated workflow



Source: https://developer.fourth.com/

Artifact Binding

without



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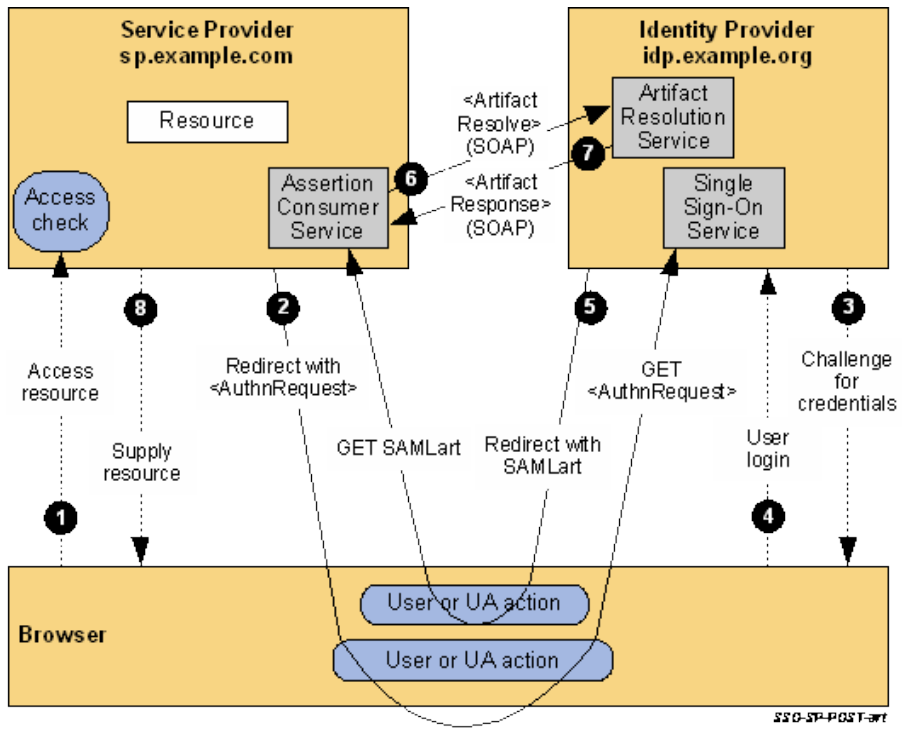
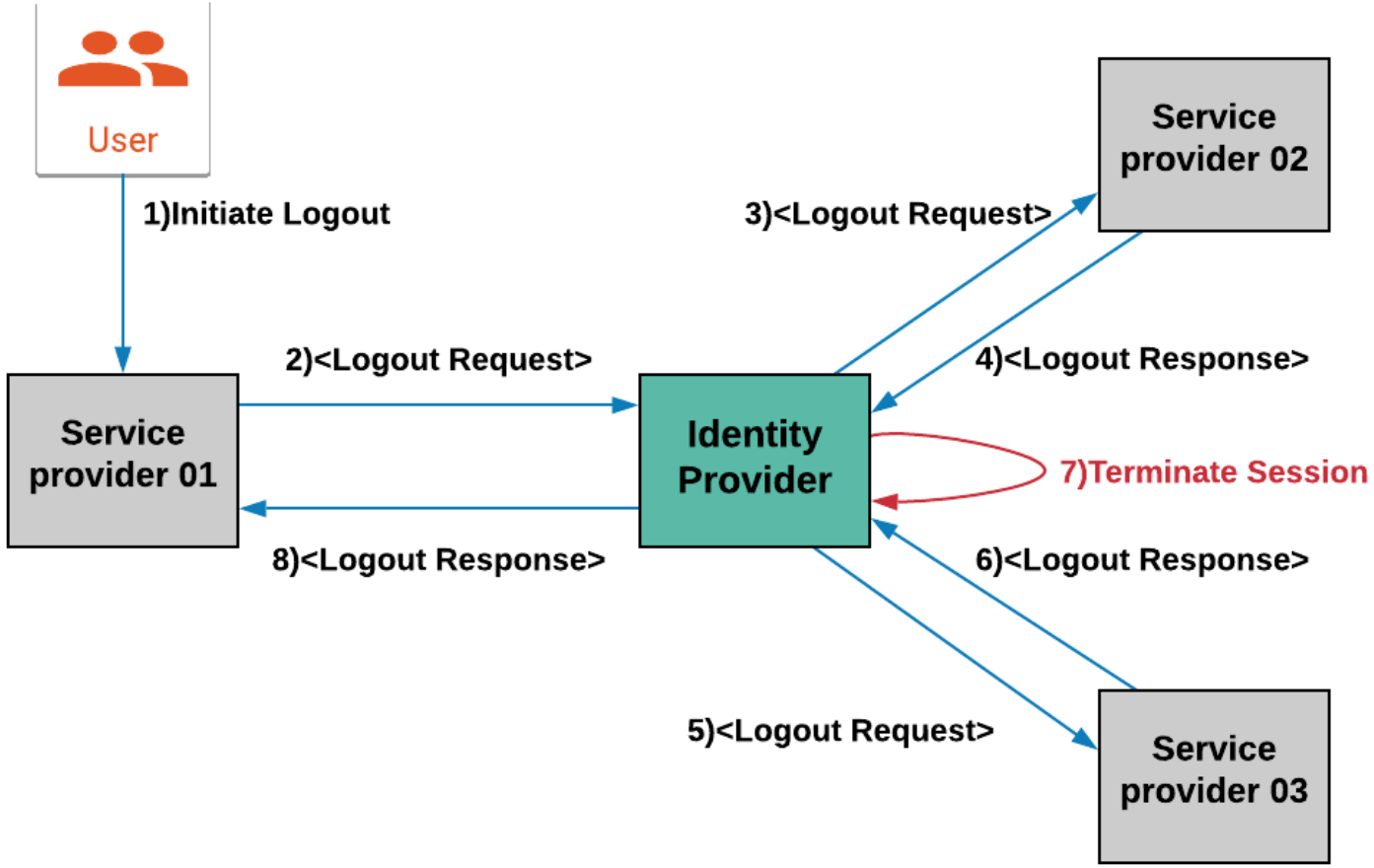


SAML2 Single Logout (SLO)



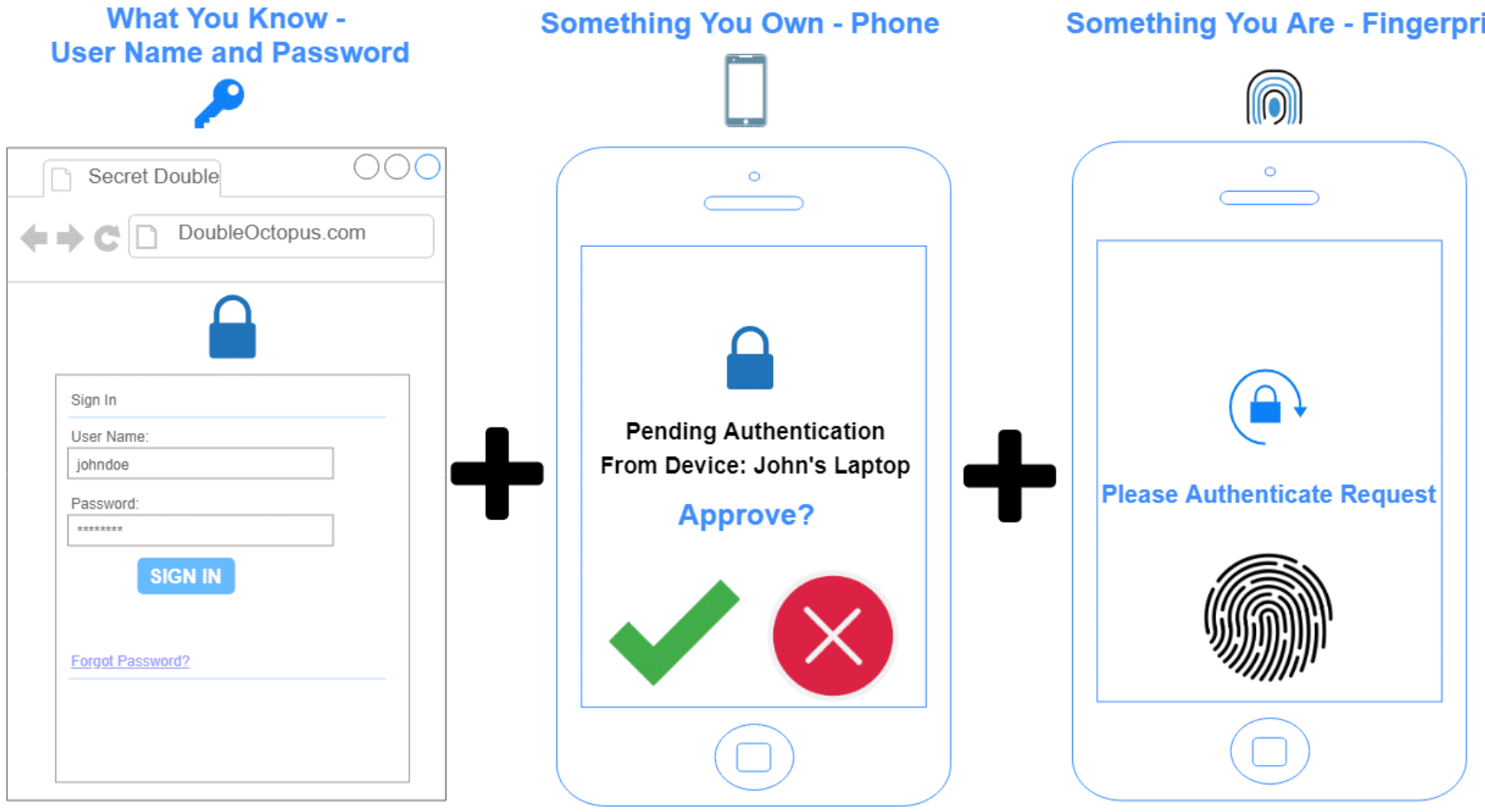
SAML attacks

- **Replay attack**
  - Valid SAML messages are intercepted and reused by an attacker to gain unauthorised access
  - Countermeasure: use tokens with a limited lifespan; assertions must be invalidated as soon as they are used
- **Assertion manipulation**
  - The absence of a digital signature means that the assertion's integrity and authenticity cannot be verified
  - Allowing an attacker to modify the assertion's attributes, such as roles or privileges
  - Countermeasure: all SAML assertions are digitally signed by the IdP; SPs must systematically check the signature of each assertion to ensure that it has not been altered in transit.

SAML attacks

- **XXE (XML External Entity)**
  - Based on exploitation of vulnerabilities in the processing of XML documents by misconfigured parsers
  - Read sensitive files on the server, make network requests from the server and execute remote commands on the remote server
  - Countermeasure: avoid custom parser configurations (e.g., disallowing the Doctype declaration completely)
- **Email forwarding attack**
  - Exploits attribute validation flaws in SAML assertions
  - If the system does not check that the email in the SAML assertion actually belongs to the tenant's domain, an attacker can gain unauthorised access by using a valid email from another tenant.
  - Countermeasure: Crucial to test the possibility of stealing an account from another tenant.

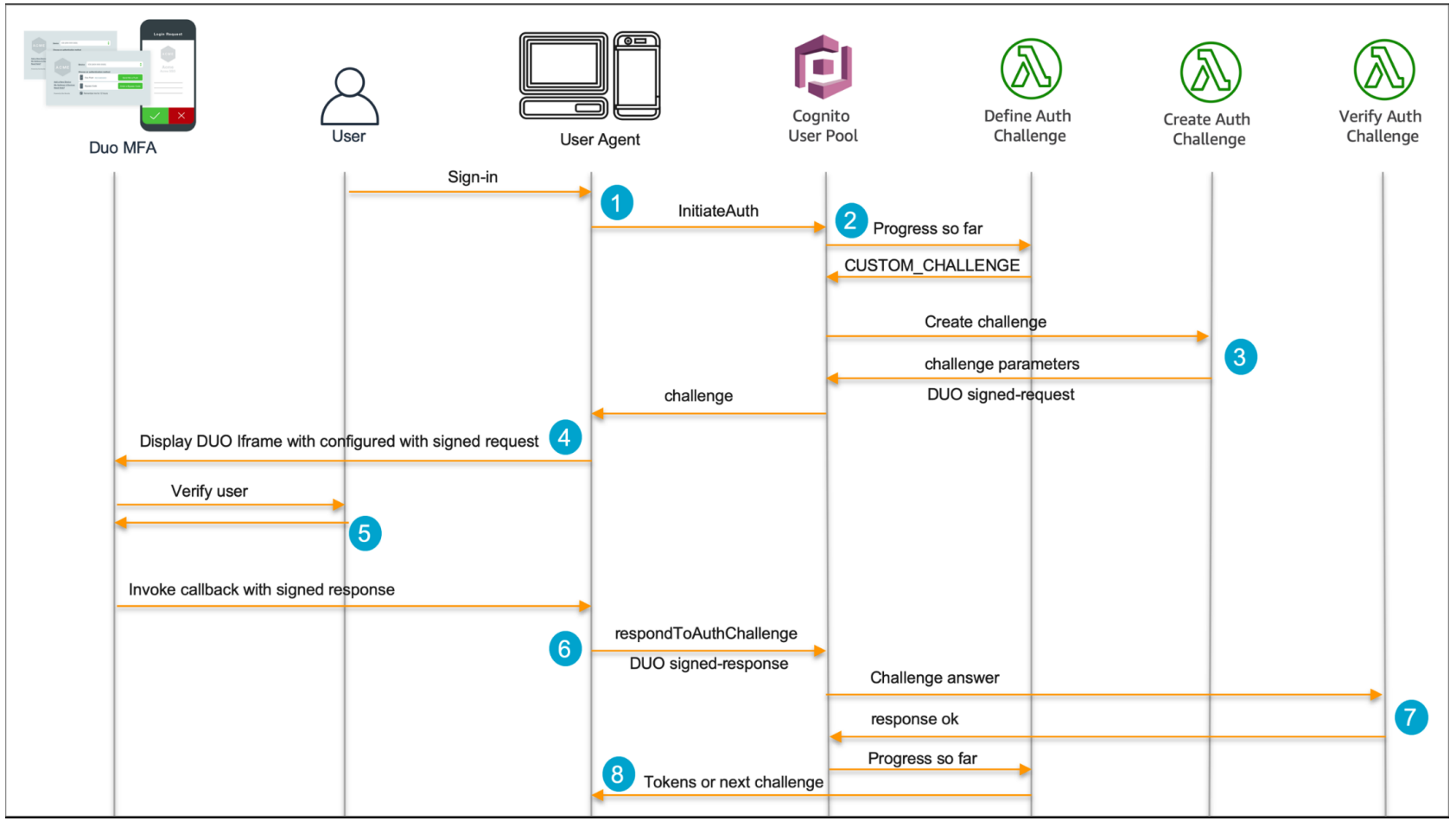
Multi-Factor Authentication (MFA)



https://doubleoctopus.com/security-wiki/authentication/multi-factor-authentication/

SECRET DOUBLE OCTOPUS

Multi-Factor Authentication (MFA)



https://aws.amazon.com/blogs/security/how-to-configure-duo-multi-factor-authentication-with-amazon-cognito/

MFA fatigue attacks (aka MFA bombing)

MFA fatigue attacks

Major Target: Enterprise
Complexity: Medium
Prevalence: Medium/high

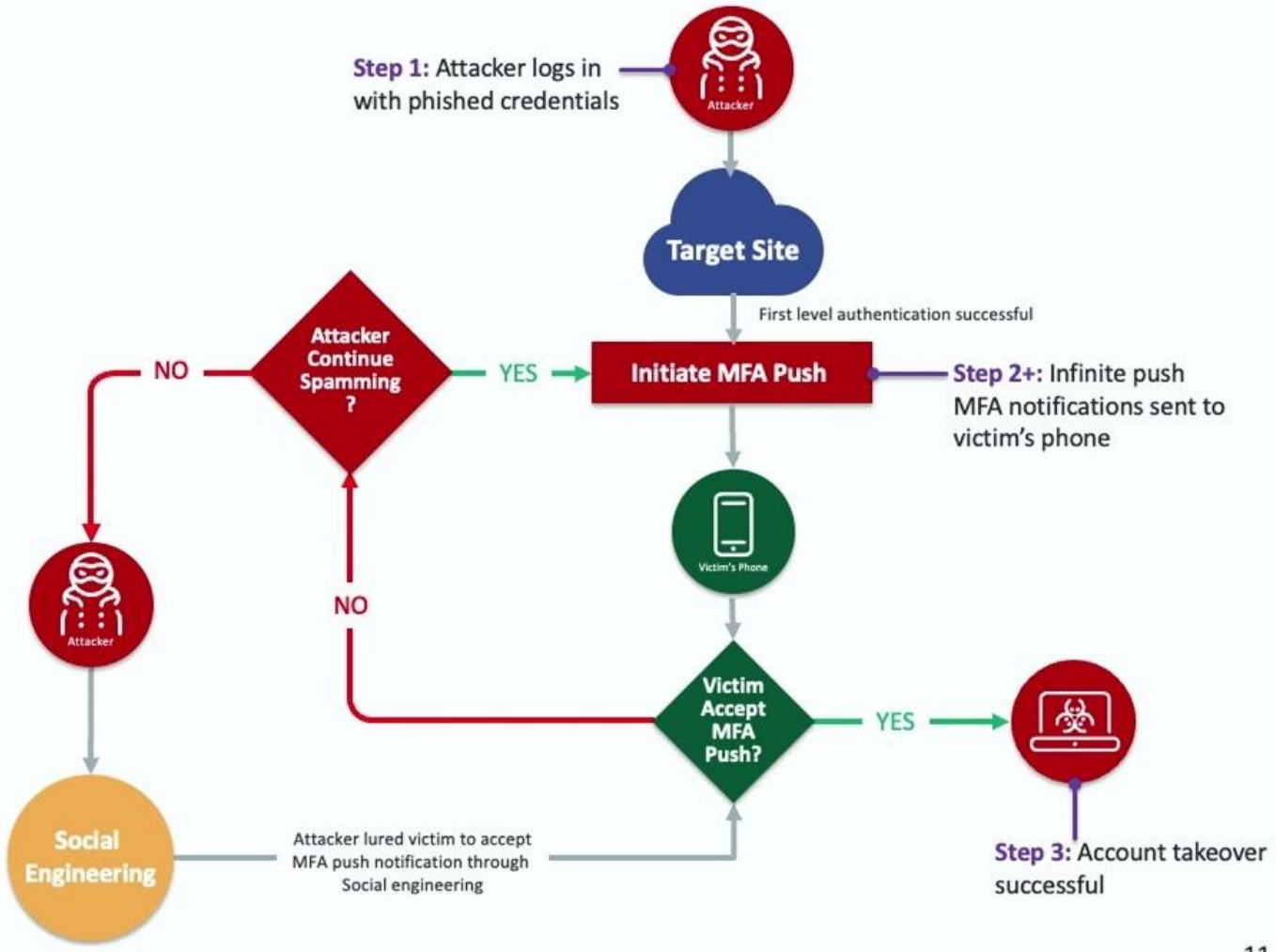
Spam push notifications to users' device

User might accept push notification as a result of MFA fatigue

Sometimes MFA fatigue is combined with **social engineering methods**

Attack type increasing in popularity. Used by APT groups like APT29

Multiple recent high-profile enterprise breaches were a result of MFA fatigue. Examples – Lapsus$, Yanluowang



Wrap-up: Security concerns of IdF

- Breaches caused by the use of weak passwords.
- A single compromised set of federated credentials can grant hackers access to multiple applications
- Lack of federated identity management plans in many businesses.
- User information must be shared with the third party entrusted with authentication.
- Not all providers within a federation conform to the same security standards
- The use of multiple providers creates additional points of vulnerability.
- Insider threats and identity theft remain problematic even with the use of a federated system.
- Companies need to be completely certain of the trustworthiness of users in the network and have authentication protocols designed to ensure each user is who he or she claims to be.
- Employee education is necessary to minimize the risk of human error
- Improper provisioning leading to privilege creep can also leave the door open for devastating breaches.
- Any temporary access necessary for short-term projects should be revoked as soon as it’s no longer needed.

Additional References

National Institute of Standards and Technology
U.S. Department of Commerce

Document	Title	URL
SP 800-63-3	Digital Identity Guidelines	https://doi.org/10.6028/NIST.SP.800-63-3
SP 800-63A	Enrollment and Identity Proofing	https://doi.org/10.6028/NIST.SP.800-63a
SP 800-63B	Authentication and Lifecycle Management	https://doi.org/10.6028/NIST.SP.800-63b
SP 800-63C	Federation and Assertions	https://doi.org/10.6028/NIST.SP.800-63c

- M. Aldosary and N. Alqahtani, “A Survey on Federated Identity Management Systems: Limitation and Solutions,” IJNSA, vol. 13, 2021.
- A. Armando et al., “Formal analysis of SAML 2.0 web browser single sign-on,” in Proc. ACM FMSE, 2008.
- W. Li and C.J. Mitchell, “Analysing the Security of Google’s implementation of OpenID Connect,” Lecture Notes in Computer Science, 2016.

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