Privacy by Design in Federated Identity Management

Interpreting Legal Privacy Requirements for FIM and Comparing Risk Mitigation Models

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Overview

FIM usage: why, who, where?
FIM-related privacy risks
Motivation for this project
Approach
Findings
# FIM Usage

| Why   | **Scalability**: registration cost  
|       | **Interoperability**: attribute semantics, trust policies  
|       | **Compliance**: Loss of control across many silos  
| Who   | Independent entities with common interests.  
|       | (Supply chains, government agencies, R&E institutions, enterprise group members, professional networks, markets with roaming agreements.)  
| Where | eduGAIN, airlines, defense supply chains, government extranets, G2C/G2B services, ..  
| Edge Cases | Mobile SIM, social networks, centralized (single IDP) federations.  

FIM-Related Privacy Risks

Due to FIM:

**Observability** of behavior by central instances

**Linkability** by introducing common identifiers

**Impersonation** by Identity/Credential Providers or because of weaknesses in SSO mechanism

Due to the lack of FIM with PbD

**Linkability** by reusing identifying attributes

**Impersonation** caused by password reuse
### Privacy Risks Unrelated to FIM

<table>
<thead>
<tr>
<th>Linkability</th>
<th>Identifying contents across services</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Services integration/large privacy domains</td>
</tr>
<tr>
<td>Observability</td>
<td>Device fingerprinting</td>
</tr>
<tr>
<td></td>
<td>IP-address</td>
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<tr>
<td>Impersonation</td>
<td>Weak endpoint security</td>
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<tr>
<td></td>
<td>Poor crypto</td>
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Motivation and Scope

- FIM Projects featuring cross-sector federation (smart cities, citizen eIDs, B2B across supply chains)

- How to handle the increased privacy risk considering legal requirements, cost, complexity, convenience, feasibility?

- Scope limited on WebSSO use case (SAML, OpenID Connect)

- Focus on Observability and Linkability
Approach to Understand Requirements

- Lex (Legal sources)
  - FIM models
  - PP (Privacy Principles)
  - BR (Business Requirements)
  - PDR (Privacy by Design Requ.)
  - AR (Architectural Requirements)
### Privacy Principles

| PP1 | Fairness + lawfulness |
| PP2 | Final purpose |
| PP3 | Proportionality |
| PP4 | Data quality |
| PP5 | Information security |
| PP6 | Openness + transparency |
| PP7 | Individual participation |
| PP8 | Accountability |

### Privacy by Design Rules

| PDR1 | Minimal identification | X |
| PDR2 | Disclose/need to know | X |
| PDR3 | Limited Linkability | X |
| PDR4 | Transparency + user control | X |
| PDR5 | Information security | X |
### Privacy by Design Rules

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<thead>
<tr>
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### Architectural Requirements

<table>
<thead>
<tr>
<th>X</th>
<th>AR1 Limited observability</th>
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<tr>
<td>X</td>
<td>AR2 Limited linkability</td>
</tr>
<tr>
<td>X</td>
<td>AR3 No unauthorized aggregation</td>
</tr>
<tr>
<td>X</td>
<td>AR4 Constrained linking</td>
</tr>
<tr>
<td>X</td>
<td>AR5 Consent handling</td>
</tr>
<tr>
<td>X</td>
<td>AR6 No supreme instance</td>
</tr>
<tr>
<td>X</td>
<td>AR7 Minimal attribute release</td>
</tr>
<tr>
<td>X</td>
<td>AR8 Unique identification</td>
</tr>
</tbody>
</table>

### Business Requirements

<table>
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<th>BR1 Allow limited linking</th>
<th></th>
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### Privacy by Design Rules

| PDR1 Minimal identification |  |  |  |
| PDR2 Disclose/need to know |  |  |  |
| PDR3 Limited Linkability |  |  |  |
| PDR4 Transparency + user control |  |  |  |
| PDR5 Information security |  |  |  |

### Business Requirements

| BR1 Allow limited linking |  |  |

### Architectural Requirements

|  | AR1 Limited observability |  |
|  | AR2 Limited linkability |  |
|  | AR3 No unauthorized aggregation |  |
|  | AR4 Constrained linking |  |
|  | AR5 Consent handling |  |
|  | AR6 No supreme instance |  |
|  | AR7 Minimal attribute release |  |
|  | AR8 Unique identification |  |
The Problem Children

**AR1 Limited observability**

**AR2 Limited linkability**

**AR3** No unauthorized aggregation

**AR4 Constrained linking**

**AR5 Consent handling**

**AR6 No supreme instance**

**AR7 Minimized attribute release**

**AR8 Unique identification**

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**Organizational Controls**

- Attribute-Based Credentials
- Late Binding
- Proxy Pool
- User-based IdPs
- Constrained Logging Proxy
- Blind Proxy
Models for Limited Observability:

(2) Attribute-Based Credentials

ABCs provide assertions to the RP without the IdP knowing the actual RPs.

Pro: Strong technical control.

Con: (a) No implementation in mainstream products; lack of deployment profiles for SAML or OpenID Connect; (b) IdP business model; (c) performance; (d) Increased complexity.
Models for Limited Observability:

(3) Late Binding/Federated Credentials

Credential-only federation (CSPs with brokers, or U2F tokens) rely on the separation between credential service assurance and identity assurance. Attributes are not released by the IdP, but obtained by the RP.

Pro: Straightforward architecture that goes well with existing technology based on common SAML profiles. Credential providers have only a minor privacy risk.

Con: (a) Less business value because attributes are collected per RP; (b) Identifying attributes like name, residential and e-mail addresses could enable linking.
Models for Limited Observability:

(6) Constrained Logging Proxy

The proxy stores log files only in a separate, well-protected system for a very limited time.

Pro: Has been implemented without changes to FIM protocols.

Con: While an adversary could cause only limited damage with a single data breach, a complete take-over of the proxy would compromise the privacy goal.
Models for Limited Observability:
(7) Blind Proxy

Pro: It proposes reasonably strong technical control, works with any credential technology and is fairly easy to fit into hub-and-spoke federations.

Con: (a) Requires (small) extension to existing SAML and OIDC implementations. (b) It requires RPs to participate in a considerably large anonymity set.
The Problem Children

AR1 Limited observability

AR2 Limited linkability

AR3 No unauthorized aggregation

AR4 Constrained linking

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AR8 Unique identification
Approaches for Limited Linkability Between Privacy Domains

- Unique Identifiers limited in scope:
  - Pairwise identifiers (IDP - RP)
  - Group or sector-specific identifiers
- Proxy attributes for identifying attributes:
  - Blind „reverse proxy“ for e-mail and jabber
  - User-selected pseudonyms for display names
  - Virtual credit cards, crypto-currencies for payments
  - PO-boxes etc. for physical shipment
The Problem Children

AR1 Limited observability
AR2 Limited linkability
AR3 No unauthorized aggregation
AR4 Constrained linking
AR5 Consent handling
AR6 No supreme instance
AR7 Minimized attribute release
AR8 Unique identification
Approaches for Constrained Linking (Between Privacy Domains)

• Types of link constraints:
  • A group of privacy domains (>=2)
  • By direction (i.e. unidirectional)
  • Temporal (e.g. until expiry or revocation)

• Examples:
  • Austrian eID with sector-specific identifiers encrypted for another sector’s target application
  • Mediated links in a blind proxy model: All access via proxy is encrypted end-to-end, except the identifier that is mapped by the proxy.
Conclusions

• Increased privacy risks introduced by FIM can be mitigated with technical controls.

• Effort to implement controls for limited observability varies with the strength of the controls.

• Limited likability with pairwise identifiers is current practice. However, identifying attributes are left out of the equation. There is room for improvement with moderate effort.
Blind Proxy Profiles & Implementations

- **SAML PEFIM Profile**
  https://kantarainitiative.org/confluence/x/-wIxB

- **PEFIM Proxy reference implementation**
  http://github.com/its-dirg/pefim-proxy_docker/

- **PEFIM IDP & SP implementations**
  - **PySAML2**
    https://github.com/its-dirg/pefim_sp
    https://github.com/its-dirg/pefim_idp
  - **Shibboleth**
    Will be available soon at shibboleth.net
  - **OpenAM**
    on request from cryptas.com