

Information & Communication Security (SS2022)

Privacy Protection II

Prof. Dr. Kai Rannenberg

Chair of Mobile Business & Multilateral Security

Goethe University Frankfurt

www.m-chair.de

- Data Protection and Privacy
 - Origin and definition
 - Law, Technology, Standardization
- Technical Privacy Protection
 - Communication systems
 - Transaction systems
- Concepts of Privacy Protection
 - Privacy by Design (PbD)
 - Privacy Engineering
 - Transparency
 - Usability
- Integrated Privacy Protection
 - PRIME LBS
 - ABC4Trust
 - Privacy Advisor
 - Privacy Risk Communication and Mitigation

- Reachability management
- Credential technologies
 - U-Prove
www.microsoft.com/uprove
 - Idemix
www.zurich.ibm.com/security/idemix

Identity Management as part of Reachability Management

Statement of urgency

“It is really urgent!”

Specification of a function

“I am your boss!”

Specification of a subject

“Let’s have a party tonight.”

Presentation of a voucher

“I welcome you calling back.”

Provision of a reference

“My friends are your friends!”

Offering a surety

“Satisfaction guaranteed
or this money is yours!”

RMS Question

The subscriber wishes to be informed of your identity before the call could be connected.

Katrin Rannenberg's RMS requests for your identity:

◆ Id: ☒ none
Damker [DS 97], Herbert
Damker, Herbert
Pseudonym Harry Hurtig (P)

RMS Question

At the moment the subscriber can only accept urgent calls. Please decide!

Katrin Rannenberg's RMS requires an answer to the request above:

☒ My call is urgent, please connect.
☐ At the moment my call is not so urgent.

Cancel Answer

[Rannenberg2000]

Privacy (and Security) issues of typical Federated IdM Architectures

Identity Service Provider (IdSP)

Relying Party (RP)

IdSP usually learns about RP via token request.
IdSP learns time of access & attributes requested.

RP gets to know values of the tokens and thus too much of the user's identity.

4. token response

3. token request

1. request access

2. policy

5. token

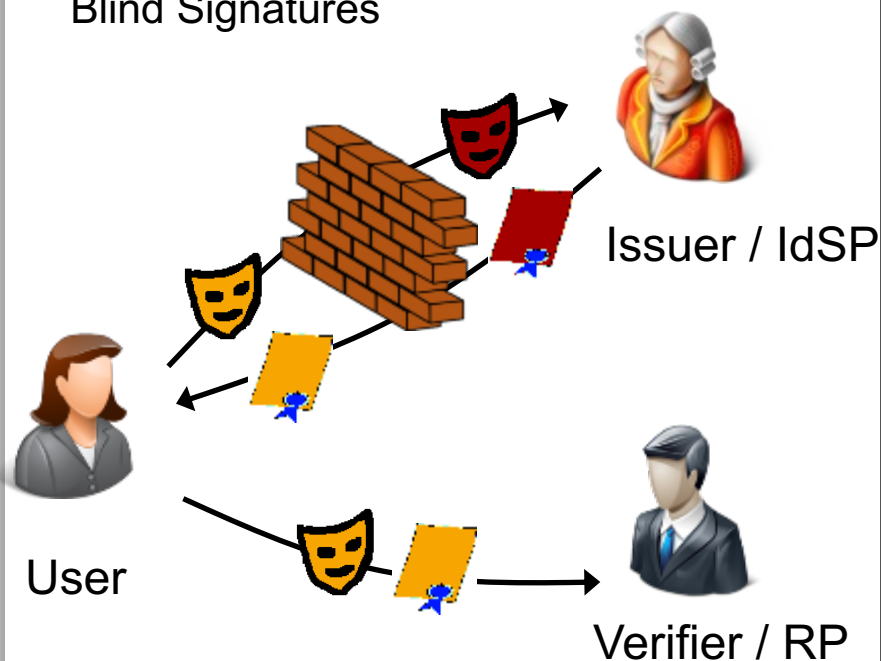
User



- Privacy features:
 - Different levels of pseudonymity
 - Selective (minimal) disclosure of attributes (attribute hiding)
 - Unlinkability of user's transactions
- Additional features are possible:
 - Prove age without disclosing birthday, e.g. for buying alcohol, showing being over 18
 - Proving of not being revoked, without disclosing the serial number in the credential
 - Predicates over attributes (no disclosure) with a constant value or another attribute
 - Inequality of attributes
 - Equality of attributes
 - Value belonging to a certain interval
 - Controlled linkability, e.g. avoid voting more than once
 - Conditional accountability, when needed

Two approaches for Privacy-ABCs

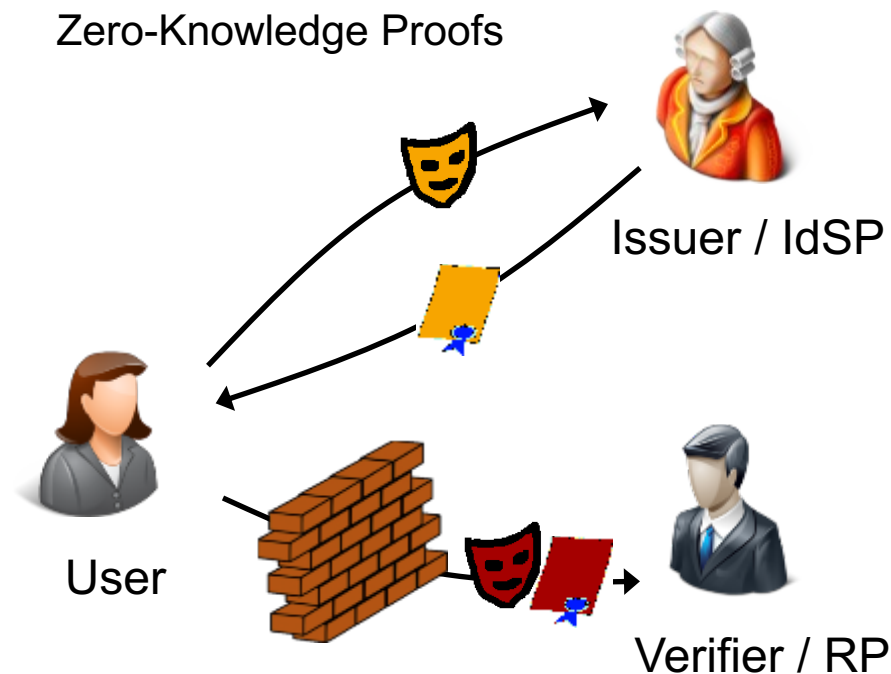
Blind Signatures



U-Prove

Brands, Paquin et al.
Discrete Logs, RSA,...

Zero-Knowledge Proofs

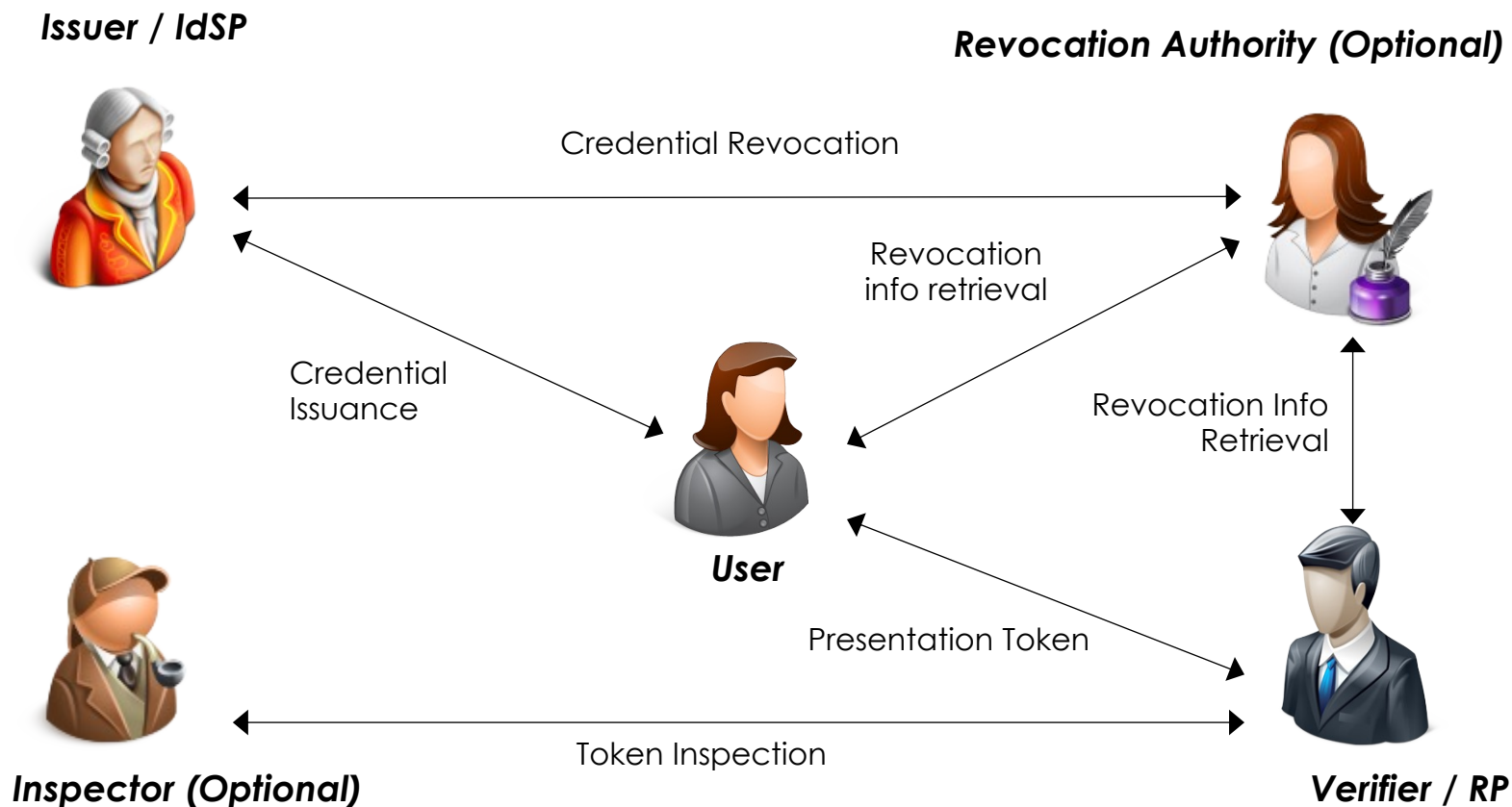


Idemix (Identity Mixer)

Damgard, Camenisch & Lysyanskaya
Strong RSA, pairings (LMRS, q-SDH)

ABC4Trust architecture

High level view



PETs alone are not sufficient

- Anonymization and Pseudonymization
 - Mix-Master, Onion Routing, Anonymous Payment, Anonymous Credentials
 - A myriad of techniques and algorithms
- Playing Cat and Mouse with Big Brother
 - Best example is Cookie Cooker
 - But many people do not have the time.
- Good pragmatic tool, but still no success
 - ⇒ Integrated privacy protection,
 - ⇒ Into business processes
 - ⇒ Into user interfaces

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Privacy by Design (PbD)

- PbD refers to the philosophy and approach of embedding privacy into the design specifications of various technologies.
- The concept is an example of value sensitive design, i.e., to take human values into account in a well defined manner throughout the whole process.



[Cavoukian2009]

Privacy-by-design

7 Foundational Principles



Proactive not reactive

Privacy as the Default setting

Privacy Embedded into the Design

Full Functionality

End-to-End Security

Visibility and Transparency

Respect for User Privacy

Adoption of Privacy by Design in regulation

- 2010: The International Conference of Data Protection and Privacy Commissioners unanimously endorsed PbD.
- 2012: The Federal Trade Commission (FTC) in the US, proposed a framework for business and policymakers with PbD as a core value.
- 2014: The European Commission announced that: ‘Privacy by Design’ and ‘privacy by default’ will become essential principles in EU data protection rules.
- 2016: EU GDPR published including Article 25 “Data protection by design and by default”
- 2018: GDPR to be implemented

Data protection by design and by default

1. Taking into account the state of the art, the cost of implementation and the nature, scope, context and purposes of processing as well as the risks of varying likelihood and severity for rights and freedoms of natural persons posed by the processing, the controller shall, **both at the time of the determination of the means for processing and at the time of the processing itself, implement appropriate technical and organisational measures**, such as pseudonymisation, which are designed to implement data-protection principles, such as data minimisation, in an effective manner and to integrate the necessary safeguards into the processing in order to meet the requirements of this Regulation and protect the rights of data subjects.
2. The controller shall implement appropriate technical and organisational measures for ensuring that, **by default, only personal data which are necessary for each specific purpose of the processing are processed**. That obligation applies to the amount of personal data collected, the extent of their processing, the period of their storage and their accessibility. In particular, such measures shall ensure that by default personal data are not made accessible without the individual's intervention to an indefinite number of natural persons.
3. An **approved certification mechanism** pursuant to Article 42 may be used as an element **to demonstrate compliance** with the requirements set out in paragraphs 1 and 2 of this Article.

[EU2016]

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- The protection of the rights and freedoms of natural persons with regard to the processing of personal data require that appropriate technical and organisational measures be taken to ensure that the requirements of this Regulation are met.
- In order to be able to demonstrate compliance with this Regulation, the controller should adopt internal policies and implement measures which meet in particular the principles of data protection by design and data protection by default.
- Such measures could consist, inter alia, of minimising the processing of personal data, pseudonymising personal data as soon as possible, transparency with regard to the functions and processing of personal data, enabling the data subject to monitor the data processing, enabling the controller to create and improve security features.
- When developing, designing, selecting and using applications, services and products that are based on the processing of personal data or process personal data to fulfil their task, producers of the products, services and applications should be encouraged to take into account the right to data protection when developing and designing such products, services and applications and, with due regard to the state of the art, to make sure that controllers and processors are able to fulfil their data protection obligations. The principles of data protection by design and by default should also be taken into consideration in the context of public tenders.

[EU2016]

Privacy-by-design

7 Foundational Principles (in a bit more detail)

- **Proactive not Reactive:**
 - anticipates and prevents privacy invasive events before they happen
- **Privacy as the Default Setting:**
 - seeks to deliver the maximum degree of privacy by ensuring that personal data are automatically protected in any given IT system or business practice
- **Privacy Embedded into Design:**
 - embedded into the design and architecture of IT systems and business practices. It is not bolted on as an add-on, after the fact
- **Full Functionality – Positive-Sum, not Zero-Sum:**
 - Privacy by Design avoids the pretense of false dichotomies, such as privacy vs. security, demonstrating that it is possible to have both.
- **End-to-End Security – Full Lifecycle Protection:**
 - having been embedded into the system prior to the first element of information being collected, extends securely throughout the entire lifecycle of the data involved – strong security measures are essential to privacy, from start to finish.
- **Visibility and Transparency – Keep it Open:**
 - seeks to assure all stakeholders that whatever the business practice or technology involved, it is in fact, operating according to the stated promises and objectives, subject to independent verification. Its component parts and operations remain visible and transparent, to users and providers alike. Remember, trust but verify.
- **Respect for User Privacy – Keep it User-Centric:**
 - PbD requires architects and operators to keep the interests of the individual uppermost by offering such measures as strong privacy defaults, appropriate notice, and empowering user-friendly options. Keep it user-centric.

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Privacy-by-design

Principle 4

Full Functionality — Positive-Sum, not Zero-Sum:

- *Privacy by Design* seeks to accommodate all legitimate interests and objectives in a positive-sum “win-win” manner, not through a dated, zero-sum approach, where unnecessary trade-offs are made. *Privacy by Design* avoids the pretense of false dichotomies, such as privacy *vs.* security, demonstrating that it *is* possible to have both.

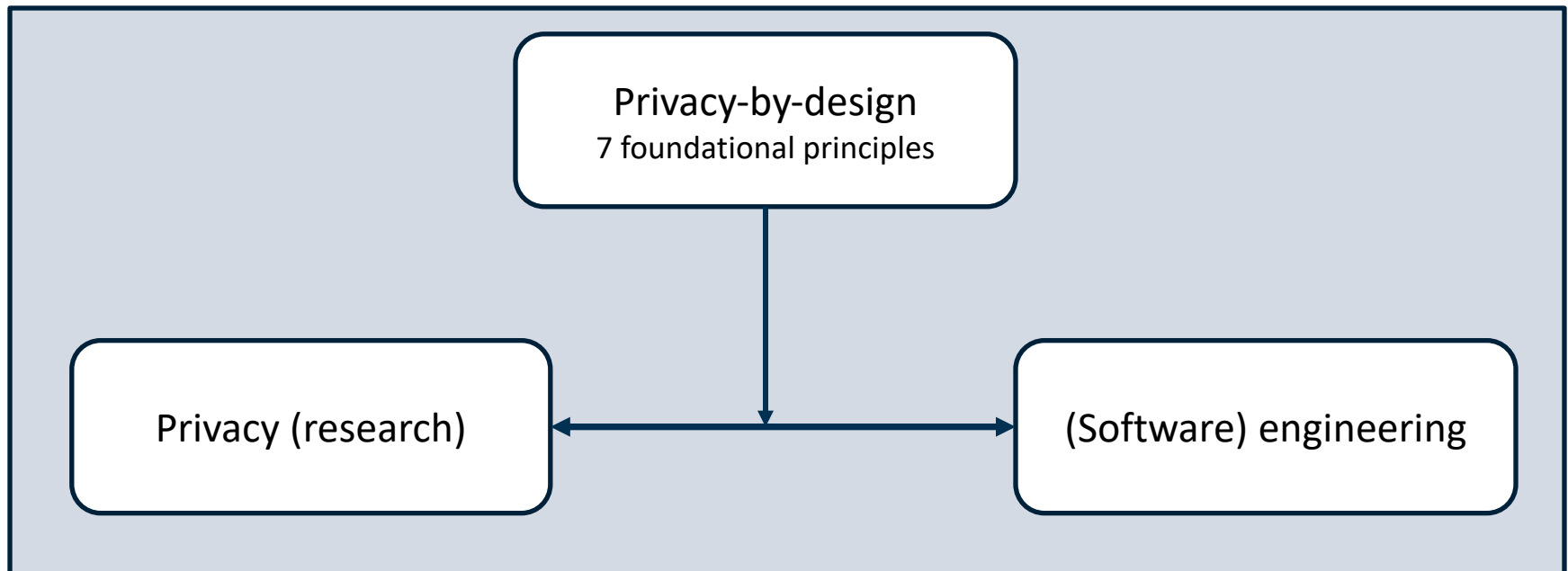
[Cavoukian2009]

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- Privacy engineering is aimed to fill the gap between research and practice (between privacy and software engineering).



- Field of research and practice that **designs, implements, adapts, and evaluates methods, techniques, and tools:**
 - **Methods** are approaches for systematically capturing and addressing privacy issues.
 - **Techniques** are procedures, possibly with a prescribed language, to accomplish privacy-engineering tasks or activities.
 - **Tools** are means that support privacy engineers during part of a privacy engineering process.

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- A basic principle that users must be informed about **how much** and **to which level**, and **by whom** their information is being accessed
- Users must be informed **before**, **during** and **after** the processing takes place, thus it has to cover:
 - not only the actual processing, but also
 - the planned processing (ex-ante transparency) and
 - the time after the processing has taken place to know what exactly happened (ex-post transparency)

- The solutions for providing transparency should have some important features. They should:

be
comprehensible

not be time-
consuming

be easy to use

not require a
specific user
interaction

be adapted to the
limited size of
device displays

[Danezis2014]

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- Usability is defined as the **extent** to which a **system, product or service** can be used by **specified users** to achieve **specified goals** with **effectiveness, efficiency, and satisfaction**:
 - Effectiveness: The user is able to achieve his/her goal.
 - Efficiency: The user reaches the goal with minimal effort.
 - Satisfaction: The user reaches the goal without dissatisfaction.

■ Usability

“Can I do what I want to do?”

Effectiveness

“Do I feel secure and comfortable while using the system? “

Satisfaction

Efficiency

“Does the system accomplish my tasks quickly? “

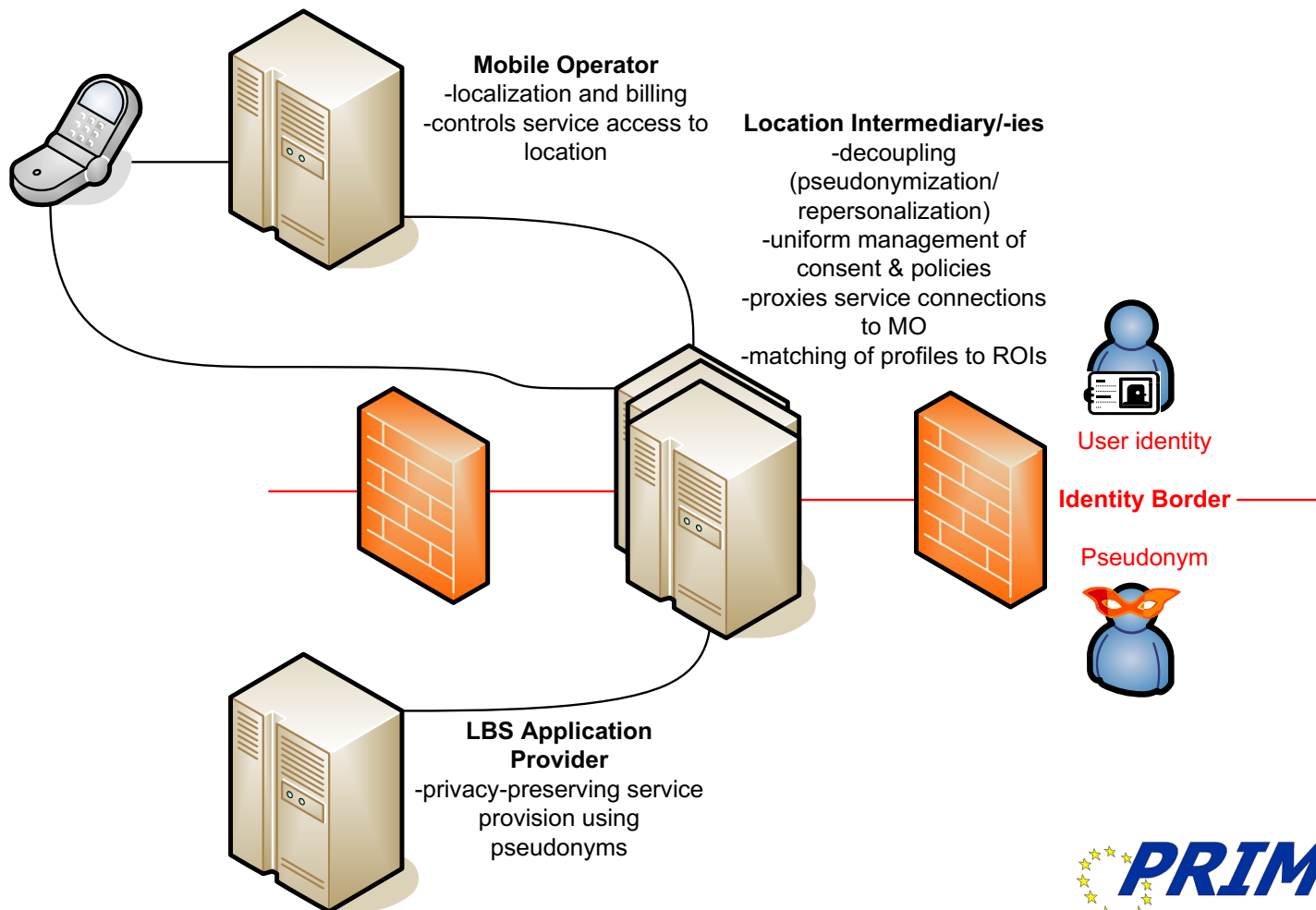
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PRIME Location-Based Services (LBS) Application Prototype

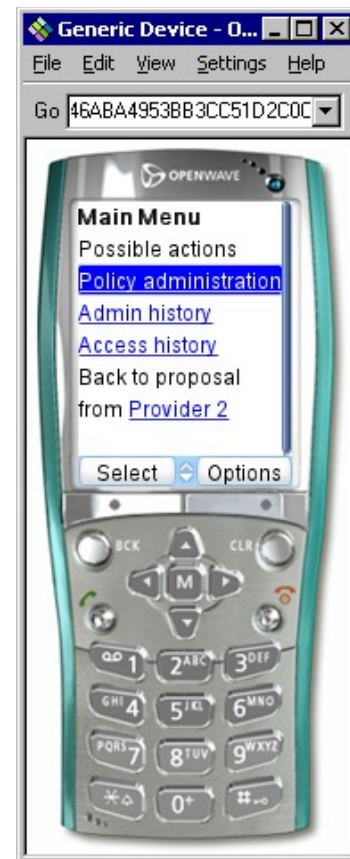
- Enhance privacy for typical Location-Based Services (LBS)
 - Pharmacy search (“pull”)
 - Pollen warning (“push”)
- Address wide user range by making only few requirements on the existing infrastructure
 - Simple WAP mobile phone (Version 1), Java phone (Version 2)
- Several challenges
 - Privacy problems
 - Regulation, e.g. of the handling of personal information (and mobile services in general)
 - Business constraints
 - Easy integration into existing infrastructure
 - Applicability to a wide range of business models
 - Adaptability for different market structures

PRIME LBS Application Prototype Intermediary Approach

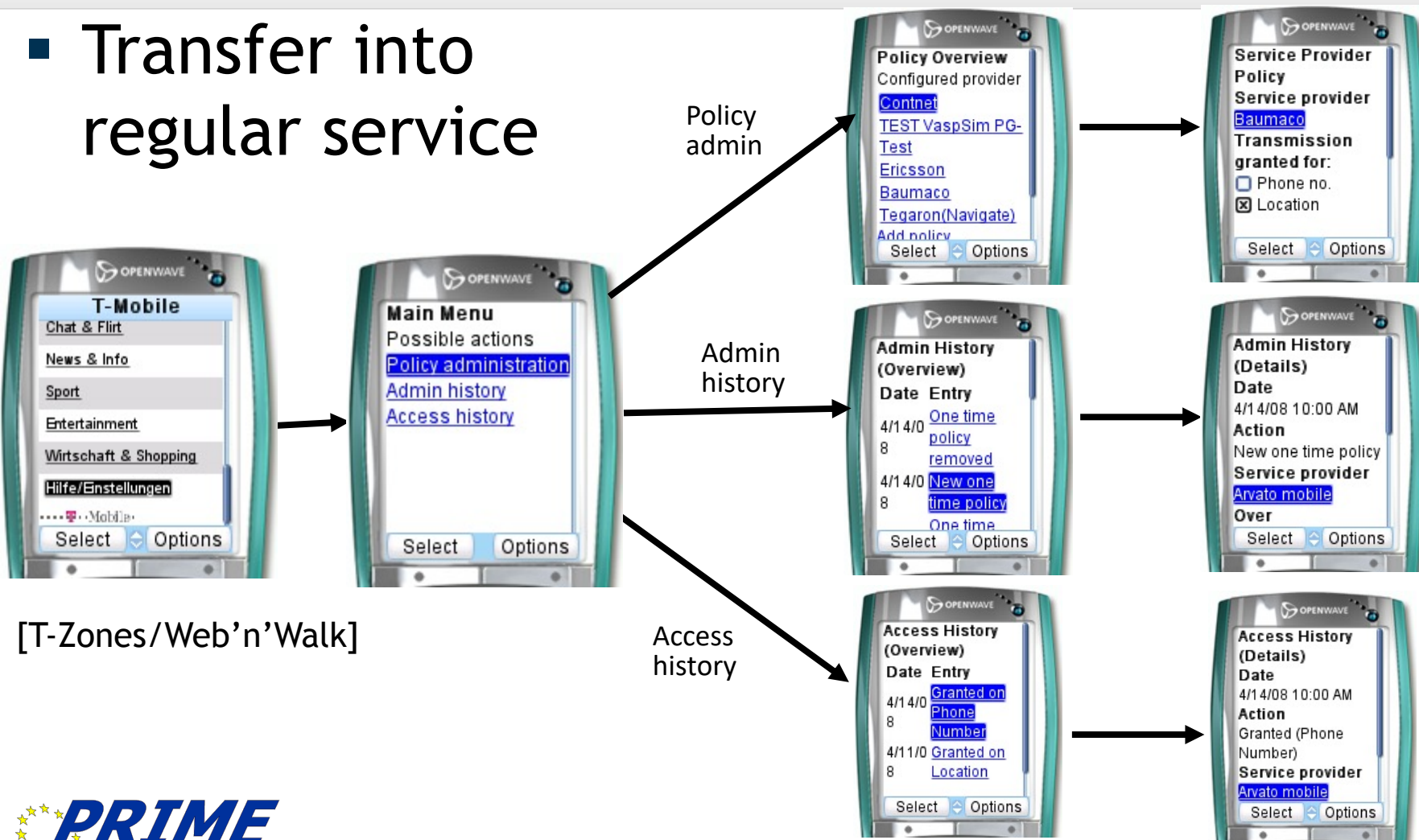
Architecture Overview



- First transfers into the “real world”
 - „Privacy Gateway“ infrastructure component deployed at T-Mobile Germany and then Deutsche Telekom
 - Allows subscribers to set
 - Which application provider gets data?
 - On which days and times?
- Request for more power on the device for e.g. maintaining one's own policies
- Computers reflect even closer one's mind, e.g. one's trust relations.



■ Transfer into regular service



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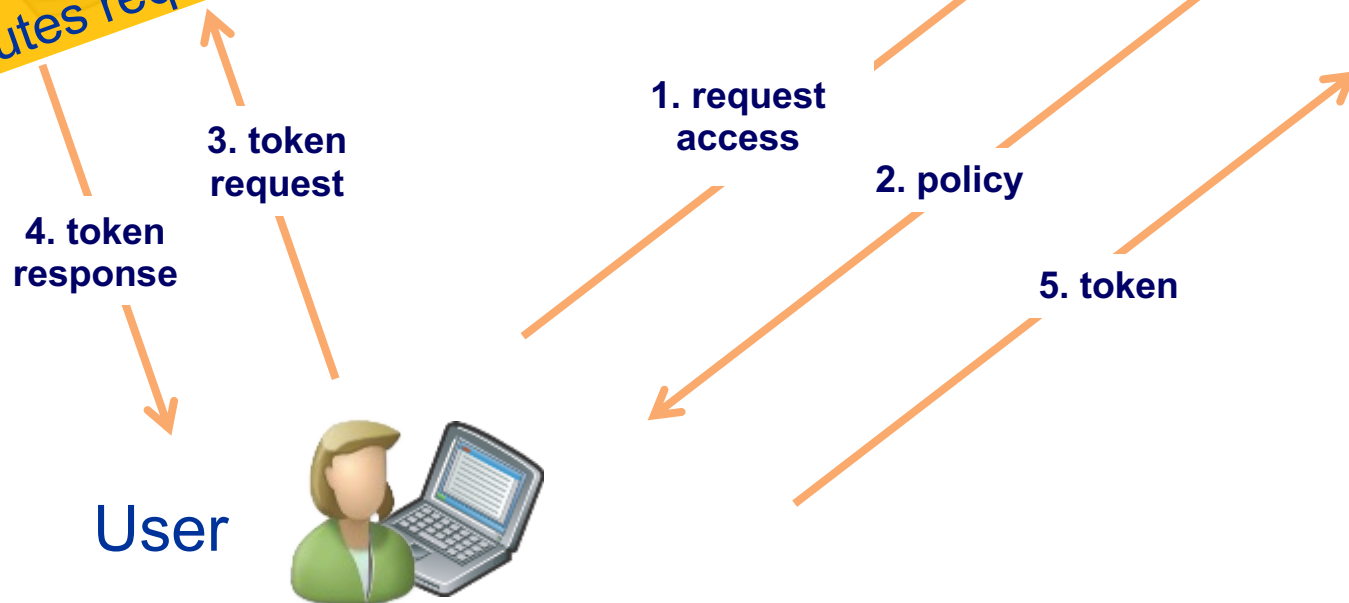
Privacy (and Security) issues of typical Federated IdM Architectures

Identity Service Provider (IdSP)

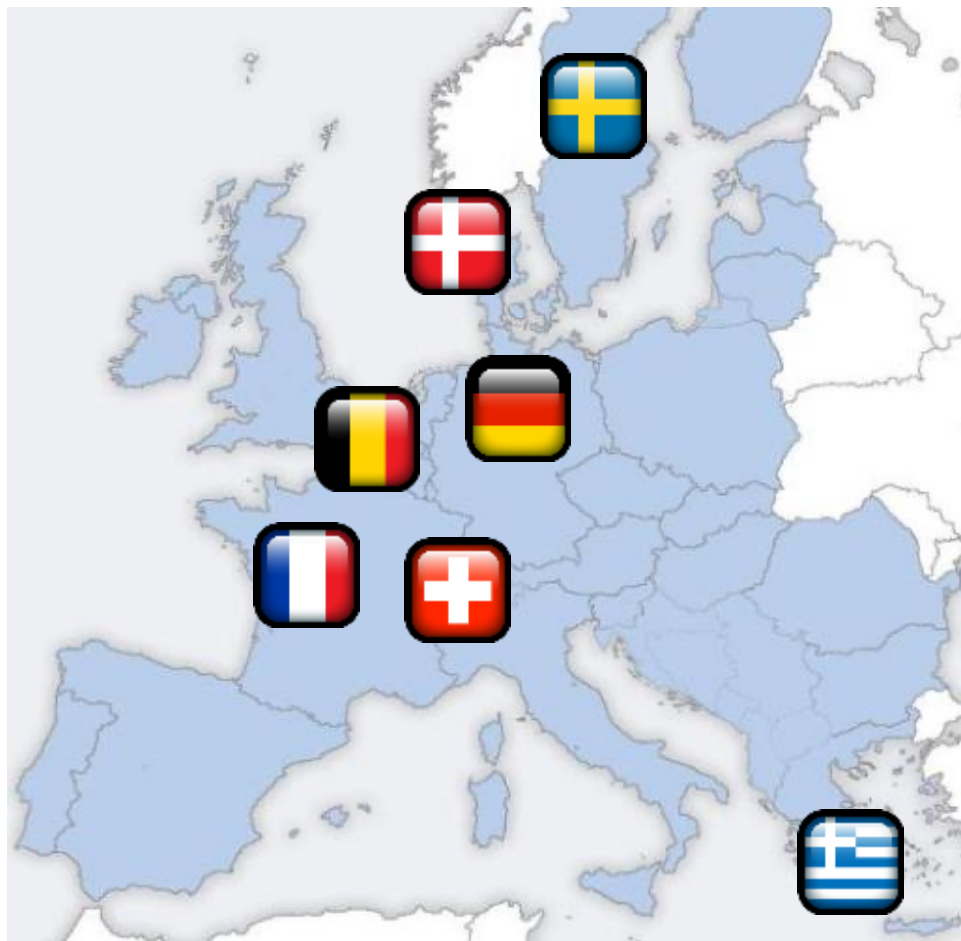
Relying Party (RP)

IdSP usually learns about RP via token request.
IdSP learns time of access & attributes requested.

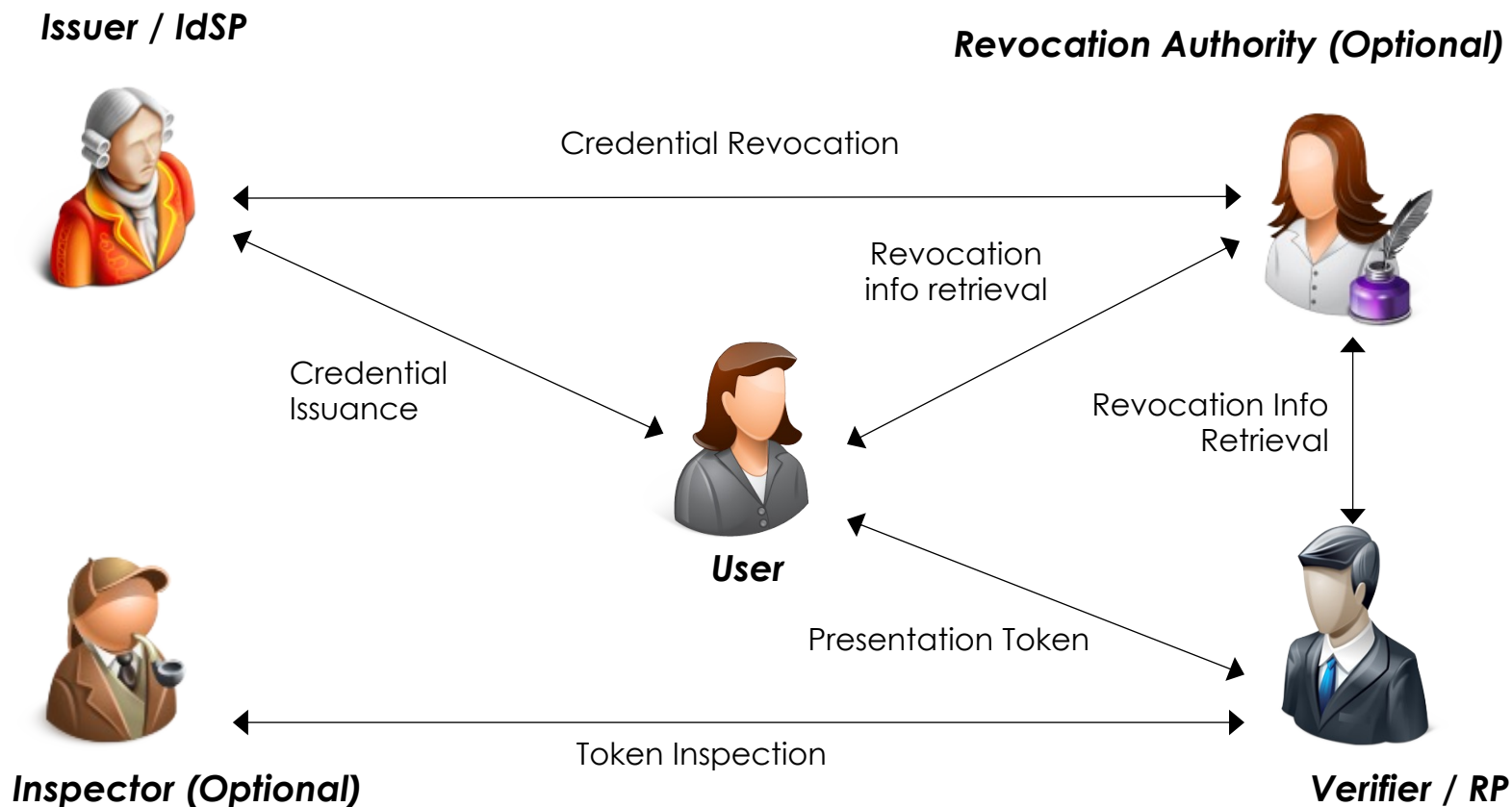
RP gets to know values of the tokens and thus too much of the user's identity.



- Attribute-Based Credentials for Trust:
<https://www.abc4trust.eu>
- Coordinated by Goethe University Frankfurt
- 12 partners from 7 countries.
- Objectives:
 - to define a common, unified architecture for ABC systems to allow comparing their respective features and combining them on common platforms, and
 - to deliver open reference implementations of selected ABC systems and deploy them in actual production pilots allowing provably accredited members of restricted communities to provide anonymous feedback on their community or its members.



ABC4Trust Architecture High Level View



- ABC4Trust tested the technology in two pilots:
 - Anonymous course evaluation in the University of Patras, Greece.
 - Students used smartcards to collect credentials for the courses they are attending.
 - At the end of semester they were able to evaluate the course if they had attended a sufficient number of lectures.
 - Their votes will not be linkable to their identity while the technology prohibits them from voting multiple times.
 - Privacy preserving school community platform in Söderhamn, Sweden.
 - Providing online services such as chat rooms, consultations, advices, etc.
 - Pupils satisfying certain policies based on their attributes can access certain services, e.g. based on age, classroom, level, etc.

Anonymous Course Evaluation

University Registration Office



Class Attendance System

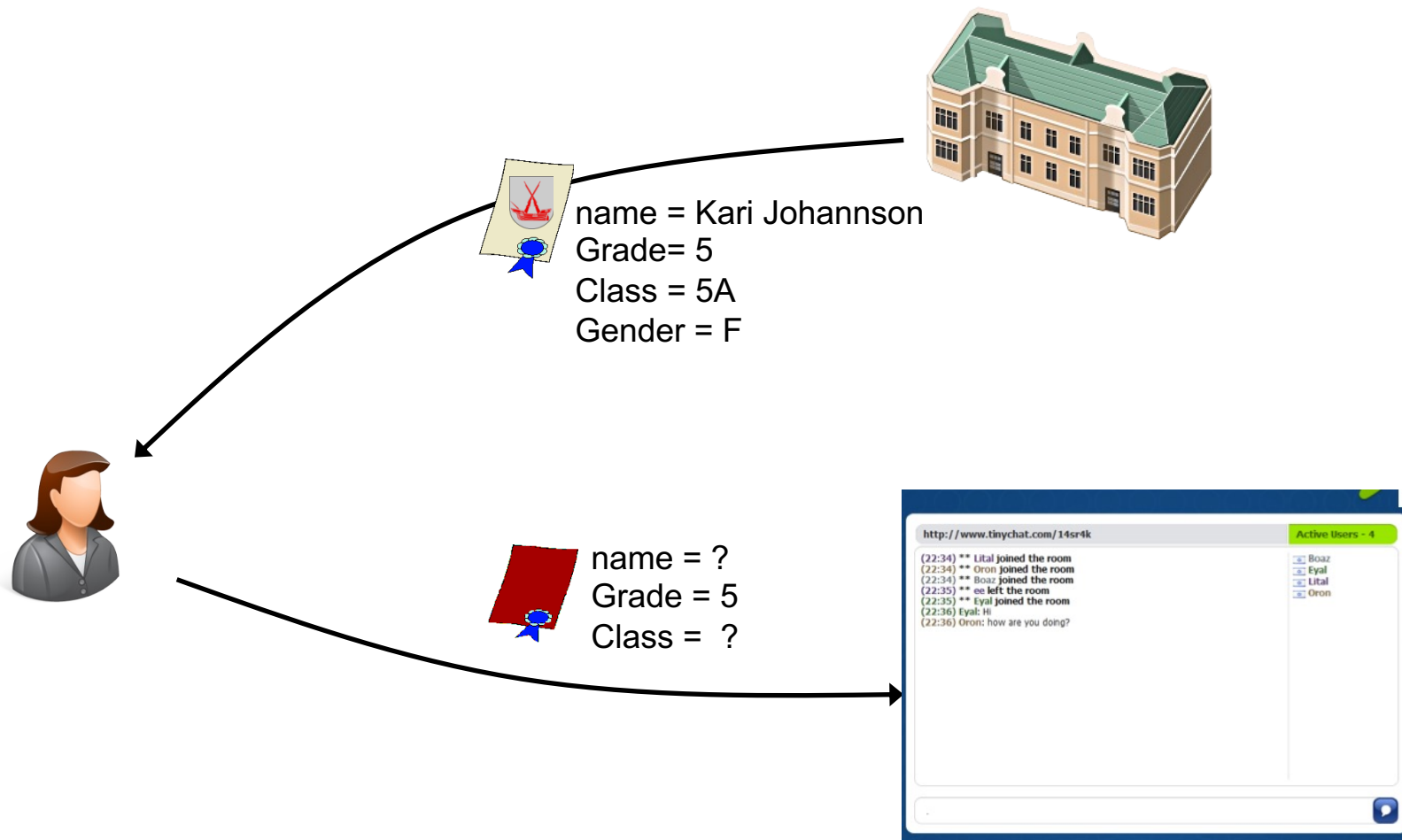


Course
Evaluation
System



- ① The students receive a credential when they enrol in a course.
- ② The students anonymously collect credentials for attending each lecture of the courses.
- ③ At the end of semester they can prove that they have taken the course and participated at a sufficient number of lectures to be able to evaluate the course without disclosing their identity.

Privacy Preserving School Community Platform



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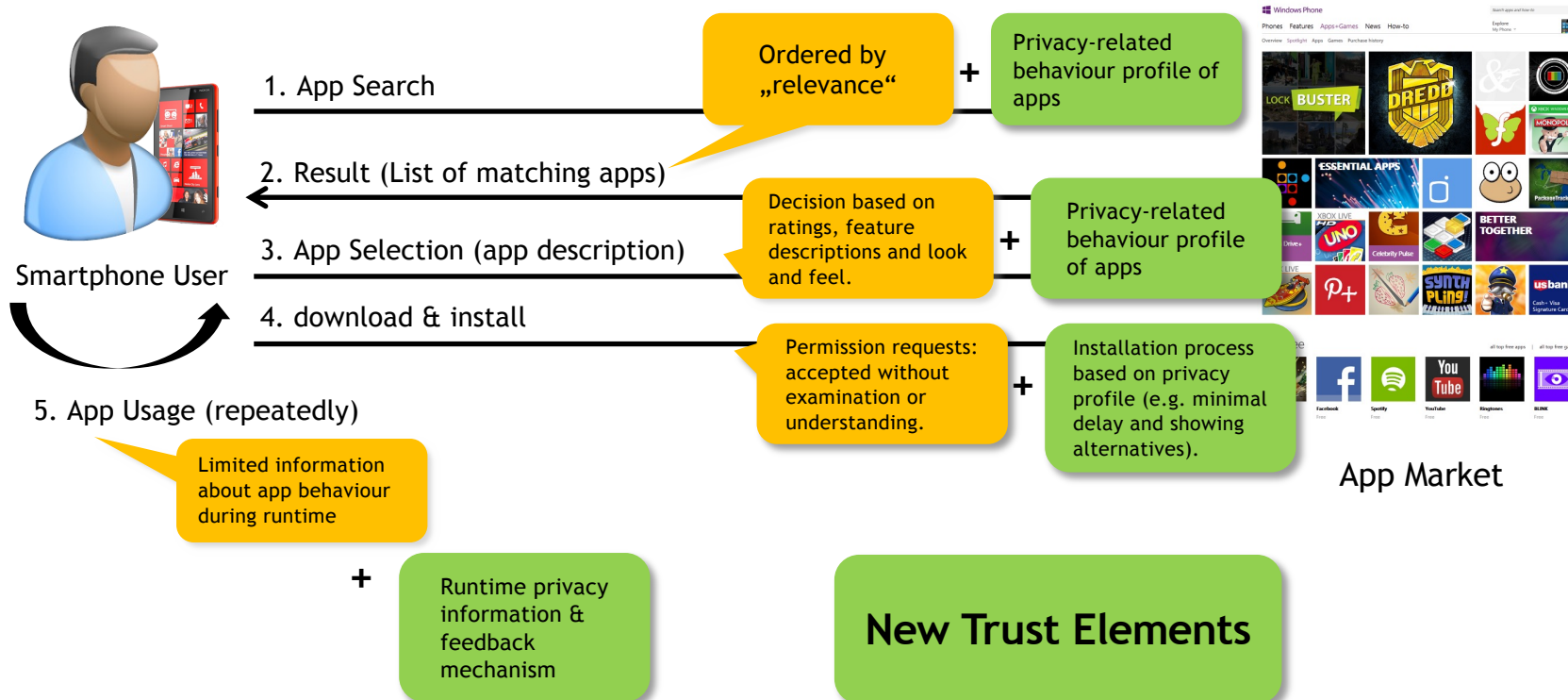
Privacy Advisor on top of Privacy-ABCs

- Privacy advisor that helps users against potentially identity revelations while using privacy-preserving systems
- Automatic detection of privacy sensitive data
- Risk analysis
- Effective communication of the risk to users

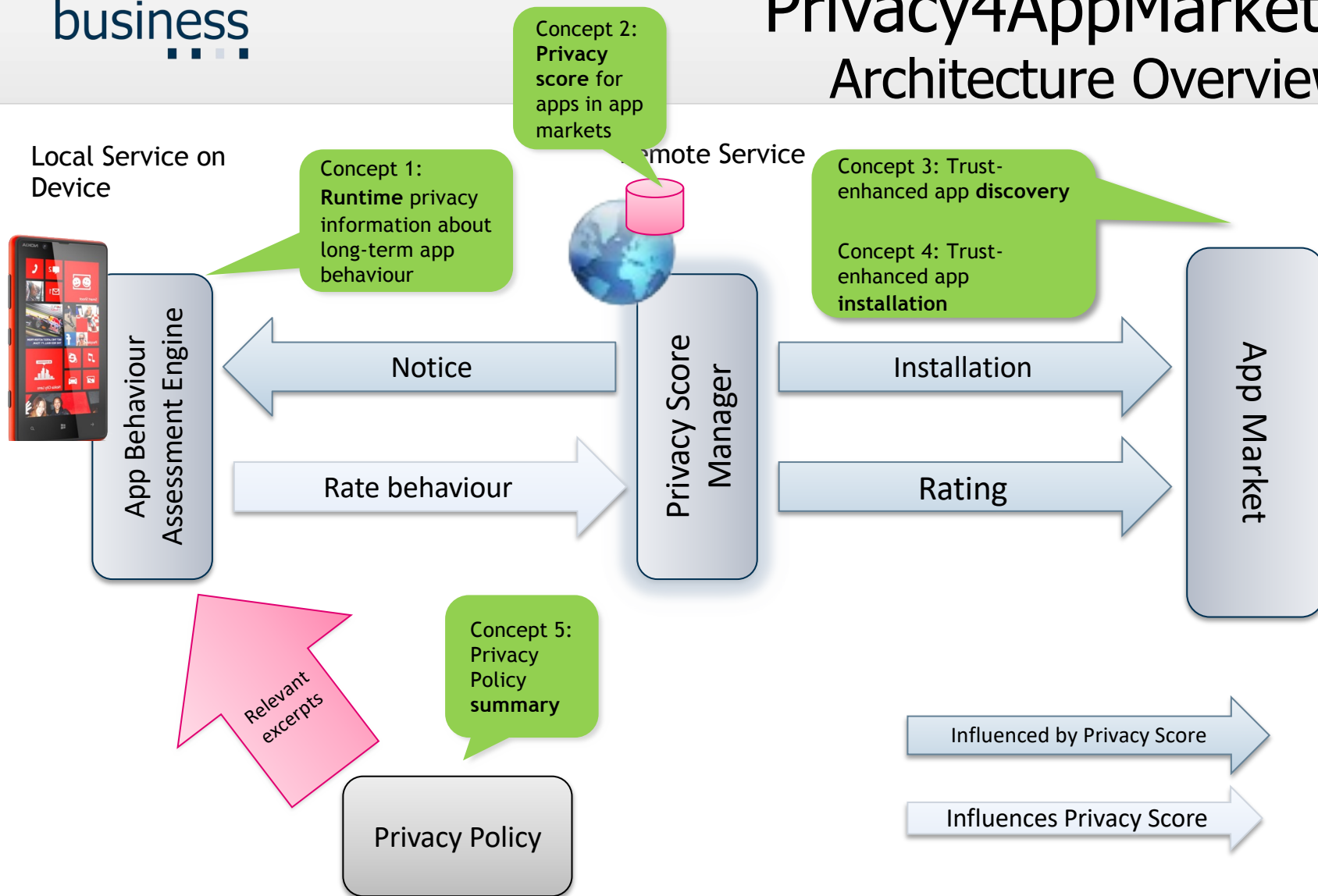
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Privacy4AppMarkets

Aiming to keep up with data flows



Privacy4AppMarkets Architecture Overview



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Runtime privacy information

A3: Android App behaviour Analyser

Scan Options

Scan Duration: Default (..)

Scan Interval: 1 Seconds

Delete Older Scans: Default (..)

WiFi only: ☒

Networking, only when connected to a Wifi network

(a)

List of suspicious apps

Search Here

2 permissions used

Pinterest 7 permissions used

SayHi 9 permissions used

Tinder 8 permissions used

Twitter 12 permissions used

AASAservice 2 permissions used

Active applications 2 permissions used

Android system 16 permissions used

ANT Radio Service

(b)

List of suspicious apps

Search Here

Photo Editor Pro 2 permissions used

Pinterest 7 permissions used

54x Read external storage

51x Write external storage

36x Access to read the Clipboard

6x Allows an application to read the users contacts data

6x App prevent the System to change in the sleepmode

5x Required to be able to access the camera device

(c)

Report

Read external storage 08:12:34
No anomalous access at that time

Read external storage 08:12:35
No anomalous access at that time

Read external storage 08:12:45
No anomalous access at that time

Read external storage 08:12:48
No anomalous access at that time

You can give an explanation to why you want to report these resources:

Enter your explanation here

CANCEL REPORT

(d)

Runtime privacy information

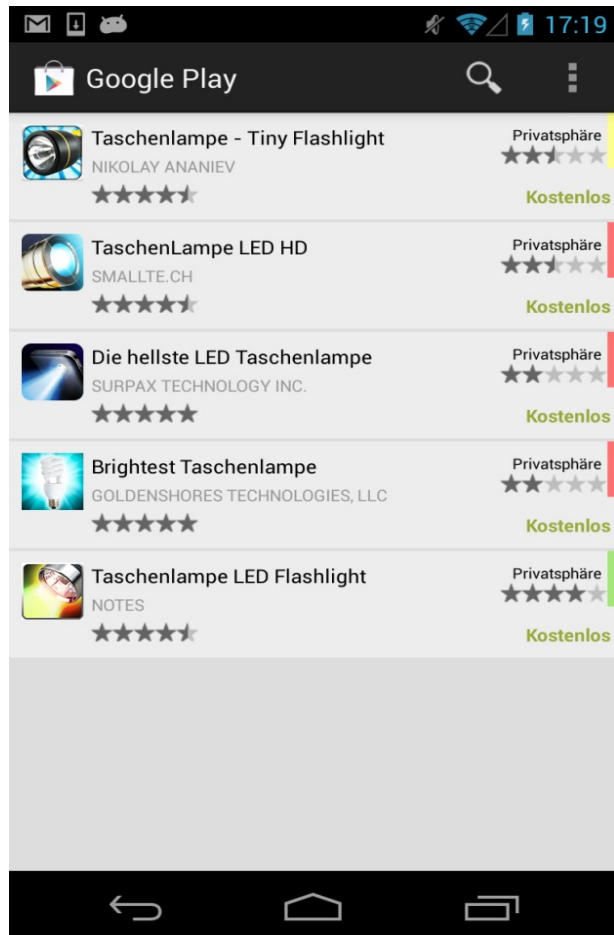
A3: Android App behaviour Analyser

○ (Selected) Results – Permission access pattern analysis:

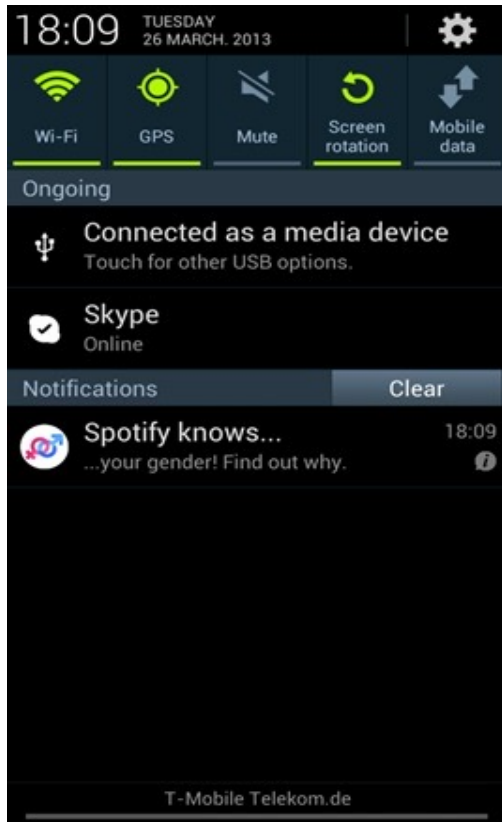
#	APP ID	CAMERA	SMS	CONTACTS	GPS	PHONE	AUDIO	BODY SENSOR
1	com.sec.android.app.shealth	0	0	0	0	0	0	0
2	com.google.android.apps.fitness	0	0	62	32	0	0	1
3	com.sillens.shapeupclub	0	0	0	0	0	0	0
4	cc.pacer.androidapp	0	0	0	0	35	0	0
5	com.myfitnesspal.android	0	0	0	0	0	0	0
6	pedometer.steptracker.calorieburner.step	0	0	0	0	0	0	0
7	com.stt.android	0	0	0	985	284	0	0
8	com.fitnesskeeper.runkeeper.pro	25	0	53	183	0	0	0
9	com.fitbit.FitbitMobile	53	17	31	650	534	0	0
10	4com.nike.plusgps	86	0	653	403	87	0	0
11	com.runtastic.android	0	0	0	217	0	0	0
12	com.popularapp.sevenmins	0	0	0	0	0	0	0
13	com.popularapp.thirtydayfitnesschallenge	0	0	34	116	0	0	0
14	si.modula.android.instantheartrate	0	0	0	96	0	552	0
15	com.playsimple.fitnessapp	0	0	0	412	0	0	0
16	com.mapmyrun.android2	0	0	0	3780	0	0	0
17	com.macropinch.hydra.android	0	0	0	0	0	34	0
18	com.fitness22.running	15	0	0	670	0	0	0
19	com.endomondo.android	0	0	0	566	0	0	0
20	comm.cchong.BloodAssistant	14	0	142	1526	0	0	0

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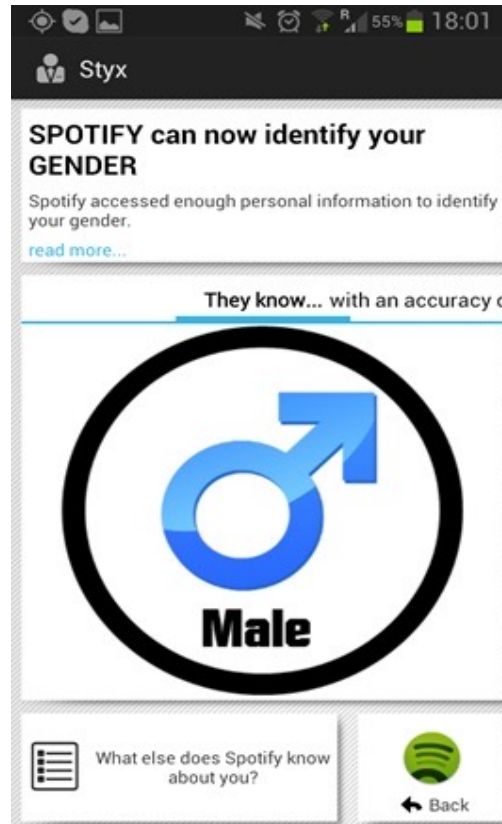
Styx Privacy Score App store to inform users ...



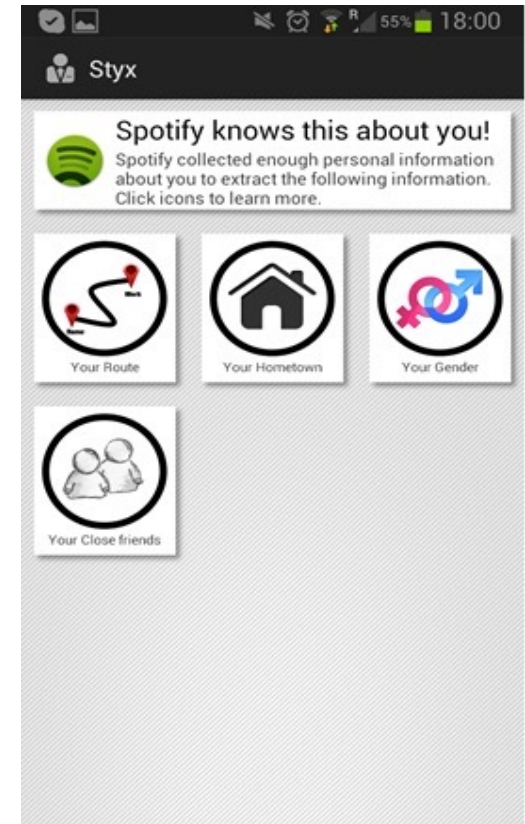
Styx Privacy Score App store to inform users ...



Styx Notification



Styx Inference
Screen



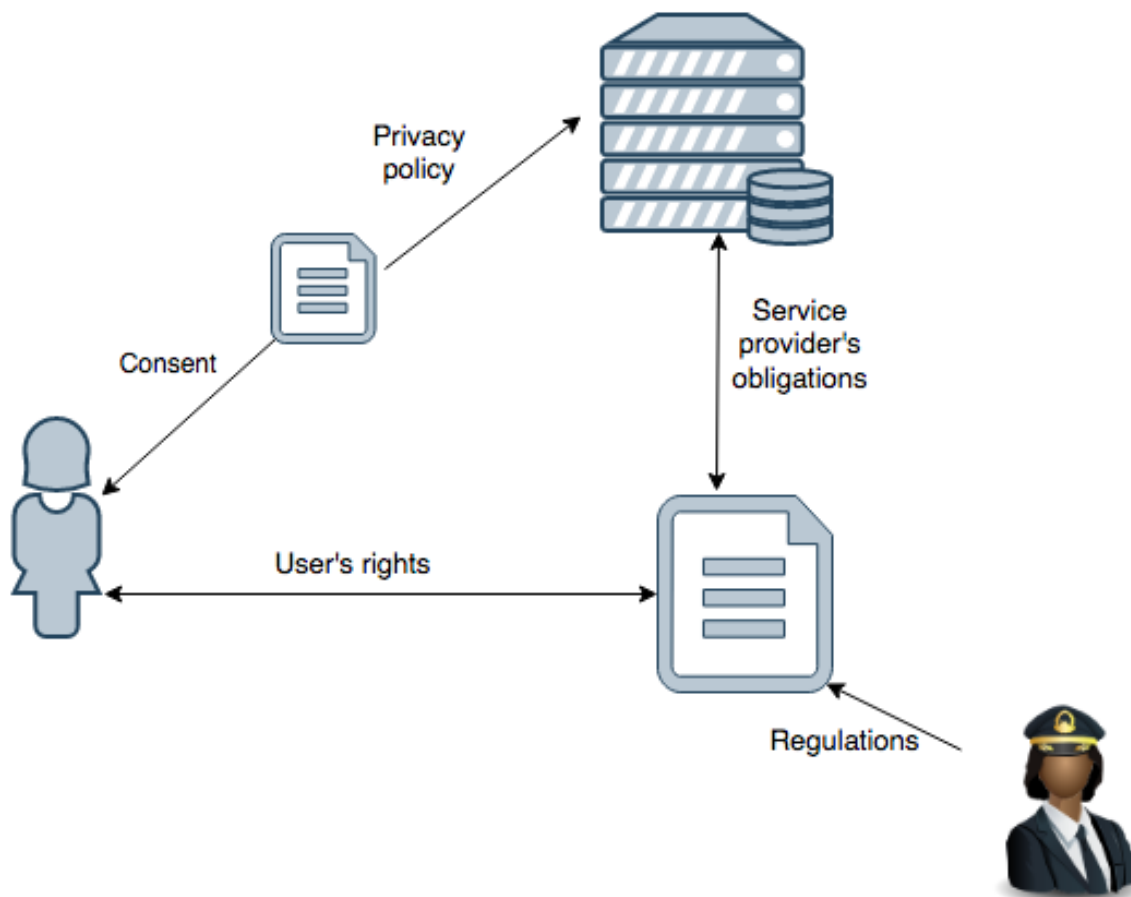
Styx Dashboard

[BaRa2014], [BaRaHo2015]

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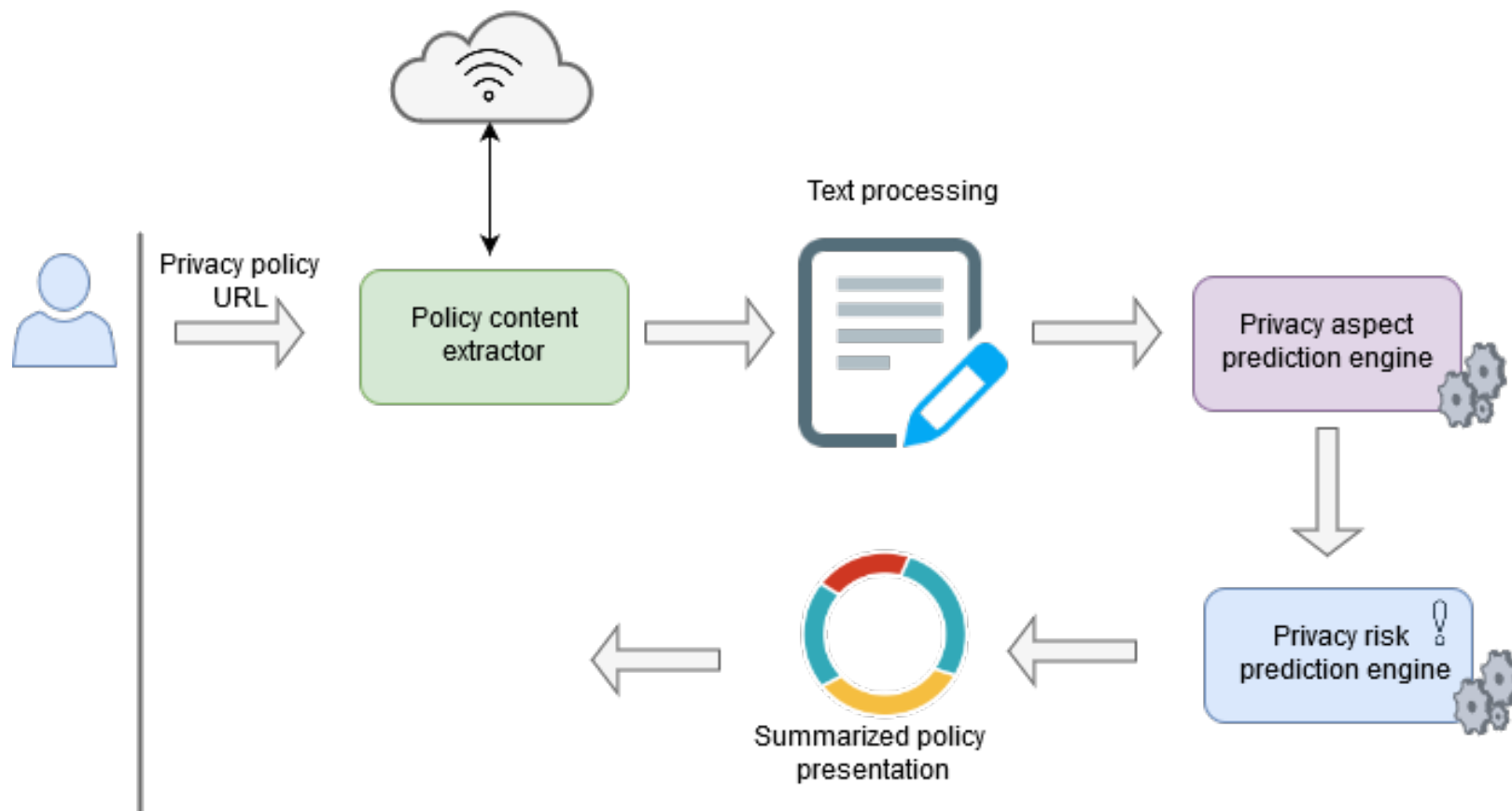
Privacy Policy summary

Policy analysis: Problem description



Privacy Policy summary

Policy analysis: PrivacyGuide architecture



PrivacyGuide

Policy analysis: PrivacyGuide results














PrivacyGuide

Please insert the link of the privacy policy you want to check:

Start processing!

Task: Execution time: 1208 ms

 Data collection: B	 Protection of children: A	 Third-Party sharing C	 Data security: A
 Data retention: C	 Data aggregation: B	 Control of data: B	 Privacy settings: B
 Account deletion: A	 Policy changes: A	 Privacy breach notice: ?	

Please hover over the icons for further details

Predicted Class: A

Description: Individual notification in case of policy changes

Original paragraph:
"we will give you reasonable notice of any material change"

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