École Pour l'Informatique et les Techniques Avancées – EPITA

Masters program – 04 March 2022

Course: Data Privacy by Design

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Data Privacy by Design (PbD)

Course schedule (tentative)

Date & Time	No.	Topics	Duration (in hours)
04/03/2022 14:30-17:30	**1**	**Data & its types, Information & knowledge, Introduction to Data Privacy by Design (PbD)**	**3 hours**
18/03/2022 14:30-17:30	2	DPbd Case studies, Data privacy risks & solutions	3 hours
02/04/2022 10:00-13:00	3	Privacy Enhancing Technologies (PET's)	3 hours
22/04/2022 14:30-17:30	4	General Data Protection Regulation (GDPR), PbD and GDPR	3 hours
29/04/2022 14:30-17:30	5	Open session, Putting it all together, Quiz, Final project presentation	3 hours
		Total Lecture (hours)	***15***

Evaluation: 10% Class attendance + 10% Class participation + 30% Class/home exercises + 50% Final Evaluation

Notes & Collaboration

- MS Teams Channel:
  'Data Privacy by Design Spring (S1) Spring 2022'
  - Course specific channel to collaborate
    - You should all be added by the administration of EPITA
  - Will be used for:
    - Course related announcements
    - Share course slides/material
    - Carry out assignments & quizzes
- Course Mindmap:
  - For better organization and easy refreshing of course topics
  - Access link (read-only):
    https://www.mindomo.com/mindmap/60f6d856c480464ab9f113f60e2fc986

Lecture 1 Outline

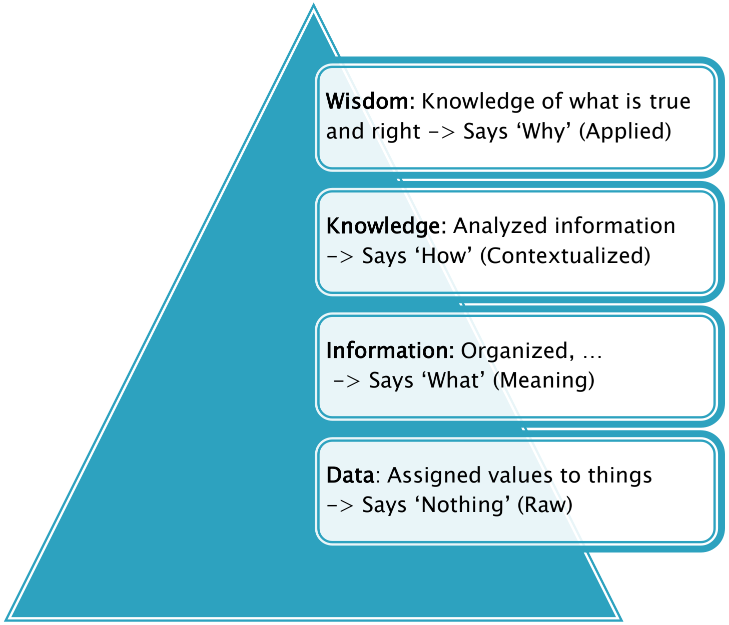
- Setting up the scene
  - Data & its types
  - Data privacy
  - *Class exercise 1*
  - Data privacy, secrecy & control
  - What can be done
- Introduction to Data Privacy by Design (PbD)
  - An obligation
  - PbD principles, goals & strategies
  - Assumptions & activities
  - Case Studies & *Class exercise 2*
  - Take away!

Data

- "Facts and statistics collected together for reference or analysis"

– Oxford dictionary

- Data is all around us
- Representing Data into Information, Knowledge and Wisdom
  - a.k.a the DIKW pyramid



Wisdom: Knowledge of what is true and right -> Says 'Why' (Applied)

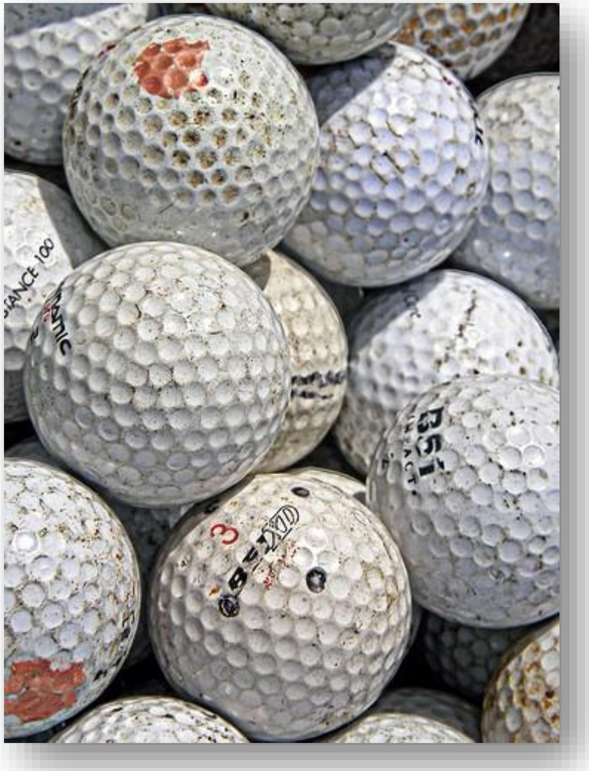
Knowledge: Analyzed information -> Says 'How' (Contextualized)

Information: Organized, … -> Says 'What' (Meaning)

Data: Assigned values to things -> Says 'Nothing' (Raw)

Let us take an example

- Check picture on the right:
  - What can we say about these?
    - Golf balls -> Sport
    - Category of sport: golf -> Taxonomy
    - No. of Golf balls: ~15
    - More to it?
      - Color: White
      - Condition: Used
      - …



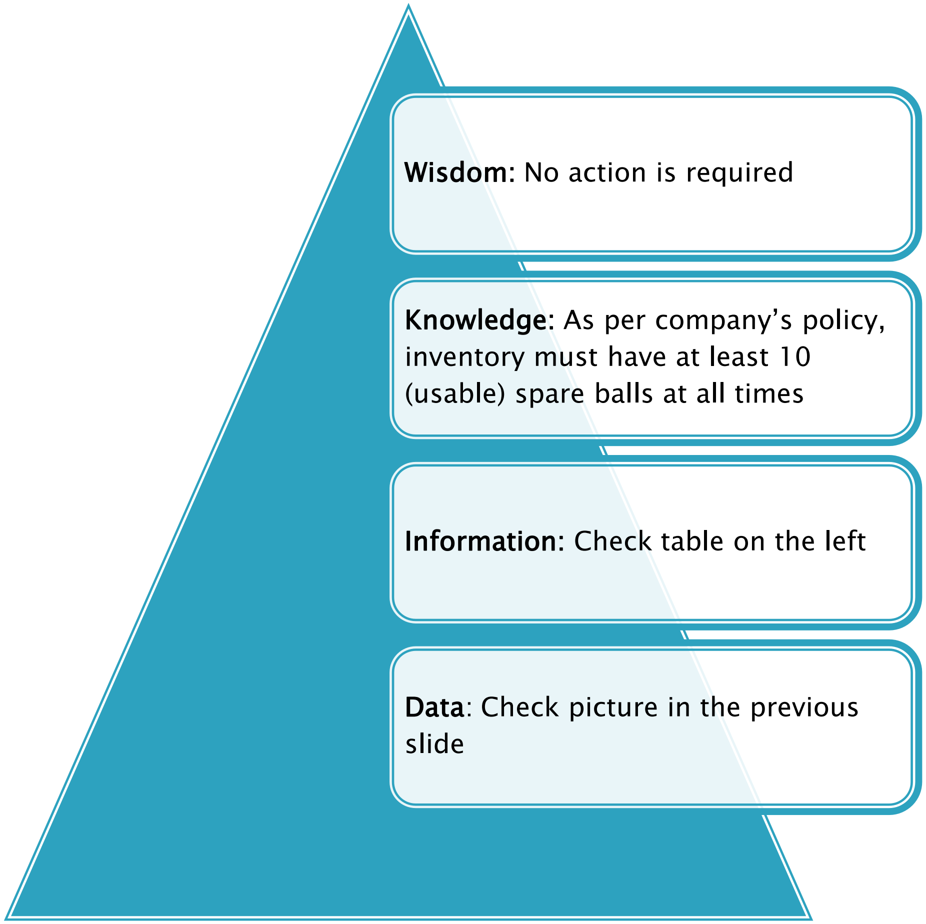
Golf balls (CC) by Kaptain Kobold on Flickr

From Data to Information to Knowledge

- Let’s organize that data:

‘XYZ’ Golf club inventory: Golf balls	
Color	White
Category	Sport
Condition	Used
Diameter	43mm
Price (per ball)	1 EUR
No. of balls	~15

Table form



Wisdom: No action is required

Knowledge: As per company’s policy, inventory must have at least 10 (usable) spare balls at all times

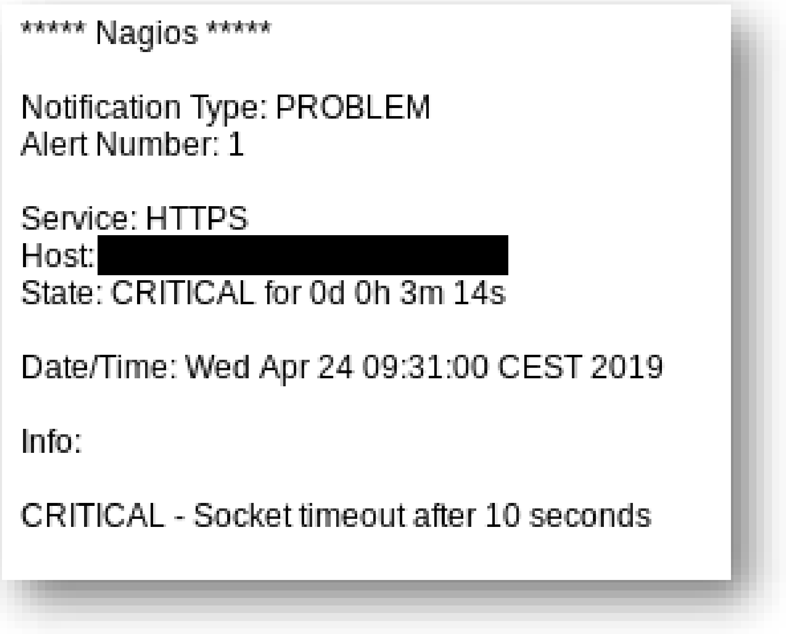
Information: Check table on the left

Data: Check picture in the previous slide

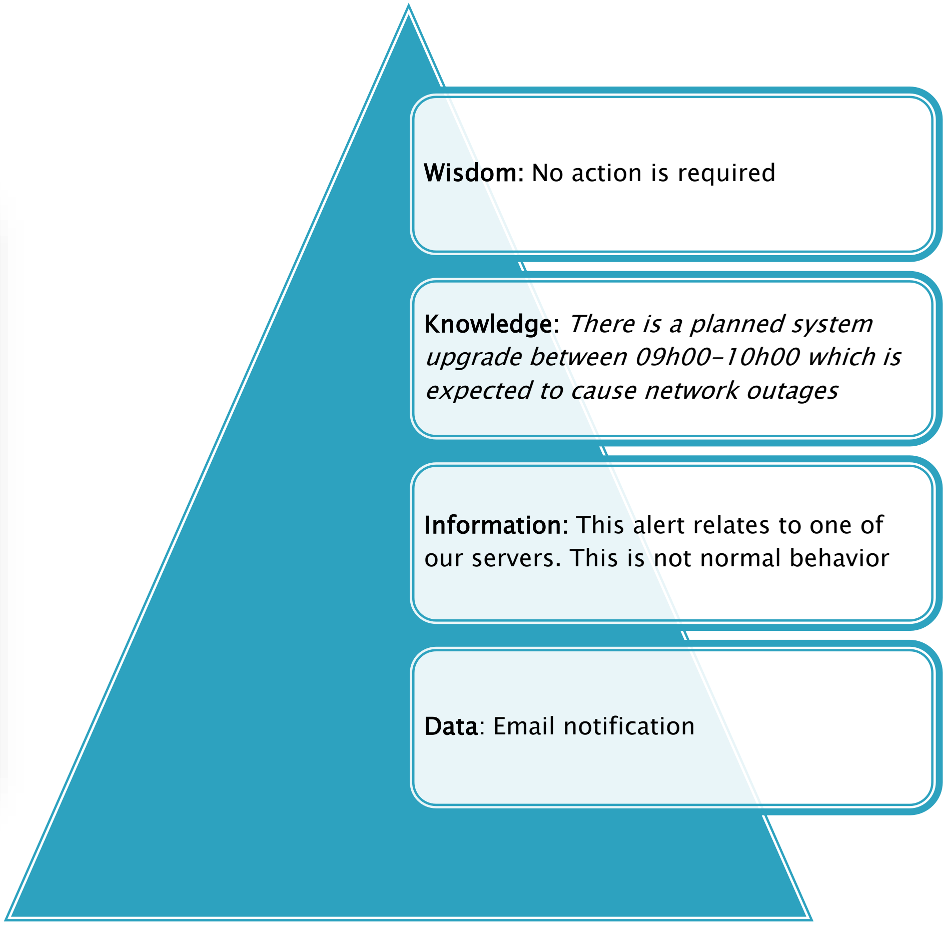
DIKW Pyramid

From Data to Information to Knowledge (another example)

- Let’s have a look at the notification below:



```
***** Nagios *****

Notification Type: PROBLEM
Alert Number: 1

Service: HTTPS
Host: [redacted]
State: CRITICAL for 0d 0h 3m 14s

Date/Time: Wed Apr 24 09:31:00 CEST 2019

Info:

CRITICAL - Socket timeout after 10 seconds
```



Wisdom: No action is required

Knowledge: *There is a planned system upgrade between 09h00-10h00 which is expected to cause network outages*

Information: This alert relates to one of our servers. This is not normal behavior

Data: Email notification

DIKW Pyramid

Types of data (in light of previous example)

- Two major data categories are:
  - **Qualitative data:** Description that refers to the quality of something (e.g., color, texture, feel of an object, …)
  - **Quantitative data:** Description of something in numbers (e.g., number of golf balls, size, price, …)
- Other categories:
  - **Categorical data:** Categorizing items (e.g., used, …)
  - **Discrete data:** Number of data having gaps b/w it (e.g., count of golf balls, it can’t be 0.3)
  - **Continuous data:** Numerical data with a continuous range (or no gaps), can be any value (e.g., size of golf balls, …)

Unstructured vs Structured data (1/3)

- Data for Humans:

  “we have 5 white used golf balls with a diameter of 43mm at 50 cents each”

  -> Easy to understand for a human, but not for a machine

- The above sentence is what we call **unstructured** data
  - No fixed underlying structure

  -> Likewise, PDFs and scanned images may contain information which is pleasing to the human-eye as it is laid out nicely, but they are not machine-readable in as-is form

Unstructured vs Structured data (2/3)

- Data for machines: Hard to extract information from certain sources that humans find easy
  - E.g., Interpreting text that is presented as an image is a challenging task for a machine
  - It has to be able to read and process the data
    - This means it needs to be structured, and presented in a machine-readable form
- E.g., CSV (Comma Separated Values) format

  -> “quantity”, “color”, “condition”, “item”, “category”, “diameter (mm)”, “price per unit (AUD)”
  5,”white”,”used”,”ball”,”golf”, 43,0.5

  -> There are many more formats out there that are **structured** and machine readable e.g.,
  https://opendatahandbook.org/guide/en/appendices/file-formats

Unstructured vs Structured data (3/3)

- Unstructured DNS server log (example)

```
06-Jun-2020 07:55:34.142 info: client 192.168.100.105#58985 (_http._tcp.security.ubuntu.com):
query: _http._tcp.security.ubuntu.com IN SRV + (192.168.100.105)
```

- Structured example in JSON of DNS server log (example)

```
{
"EventReceivedTime": "2020-06-06 07:55:34",
"SourceModuleName": "dns_queries",
"SourceModuleType": "im_file",
"Date": "12-Mar-2019",
"QName": "example.com",
"QType": "A",
"RFlags": "+E",
"RemoteIP": "127.0.0.1",
"Severity": "info",
"Time": "07:17:09.816",
"EventTime": "2019-01-12 07:17:09“
}
```

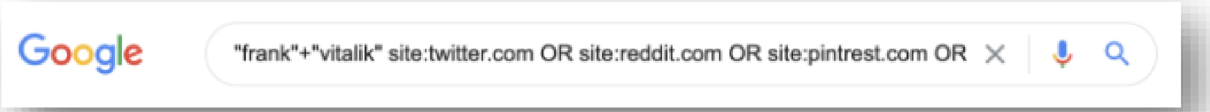
A fix data structure and format might not always be based on a standard data structure and format!

Data Privacy (definitions)

- "The claim of individuals to determine for themselves when, how, and to what extent information about them is communicated to others" – Westin (1970)
- "Privacy as contextual integrity" – Nissembaum (2004)
  - Appropriate information flows that conform with contextual information norms
- Legal frameworks:
  - GDPR: transparency, purpose, proportionality, accountability
  - ECHR Art 8: "respect for private and family life, home and correspondence"

Class exercise: 1(a)

1. Use any search engine of your choice
2. Perform OSINT on **your identity**:
   - Use google dorks (on your name/email ID/GSM no./…) and perform text, image/reverse-image, document, etc based searches



"frank"+"vitalik" site:twitter.com OR site:reddit.com OR site:pintrest.com OR

   - Social media:
     - Check if your username/email is taken, using aggregator service E.g., https://namechk.com/, piple.com, social-searcher
     - Look with your home connection public IP address
     - …
   - Leaked databases (HIBP, …), …
   - Forums: Reddit, 4chan, …
   - Common tools: osintframework.com, magma.lavafeld.org/guide/osint-sources.html
3. Look for information that was put there **without your consent!**
4. **Create a text file** (lastname_firstname.txt) and write down:
   1. Data you found that was put there **without** your consent!
   2. What would you prefer to do now (e.g., ask site owner to put it down? Let it remain online?)

Be creative!

Class exercise: 1(b)

- Get the template:
  1. Open *MS Teams -> Data Privacy by Design Spring (S1) Spring 2022 -> Files*
  2. Download the ‘Class_exercise_1b’
- Fill 5 entries (instant chatting apps) in the table, and answer questions on the next page for each of the entry
- After completing the exercise:
  - Export it as a pdf file, and name it with sender’s “lastname_firstname”
  - Upload it to the ‘Teams’ assignment section (using your EPITA account)

Deadline: See ‘Teams’ Assignment section

What did you learn?

- Observations:
  - Companies have a lot of data on you
  - Shared data can be mapped from different data points to induce a more informative and useful result
    - See: https://trackography.org
  - Can we fool them?
    - See: https://trackthis.link
  - Deciding how much data you should share and with which company is an **important** decision
  - …

- Data therefore is a **commodity**, that fuels the business models of tech industry

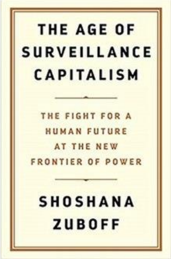
EFF 30
ELECTRONIC FRONTIER FOUNDATION
About Issues Our Work Take Action Tools Donate

Top Apps Invade User Privacy By Collecting and Sharing Personal Data, New Report Finds

BY CHRISTOPH SCHMON | JANUARY 14, 2020

Source: https://www.eff.org/deeplinks/2020/01/new-report-exposes-adtech-invading-our-privacy

Surveillance capitalism – Zuboff (2019)



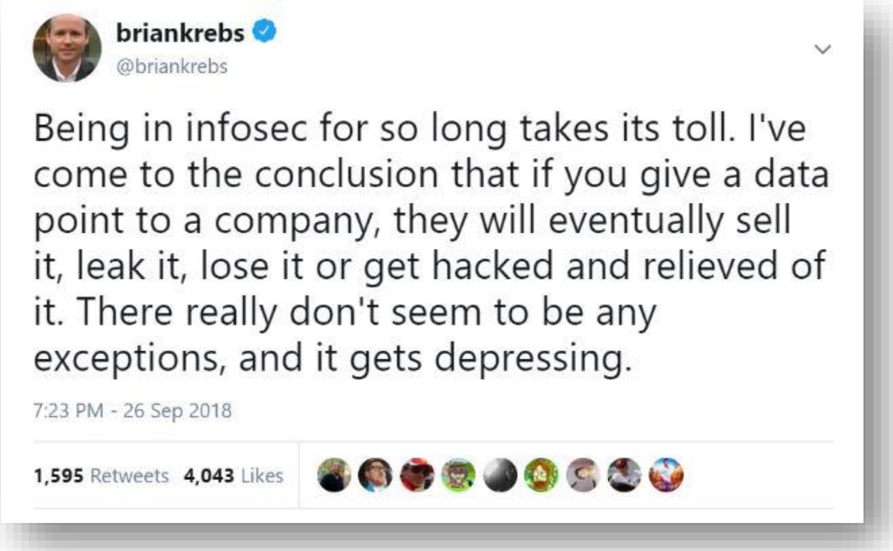
THE AGE OF SURVEILLANCE CAPITALISM

THE FIGHT FOR A HUMAN FUTURE AT THE NEW FRONTIER OF POWER

SHOSHANA ZUBOFF

- We are not the product and certainly not the customers: We are the **raw material.**
  1. Surveillance capitalism claims human experience as raw material for translation into behavioral data
  2. That data is […] fed into machine intelligence, manufacturing processes producing "behavioral predictions products".
  3. These prediction products are sold in a new type of market: the "behavioral futures market" (your clicks, your attention, your purchases, …
- Designed to be opaque and bypass our cognition
  - Social media, search, pokemon go, smart cities, …

Present situation!

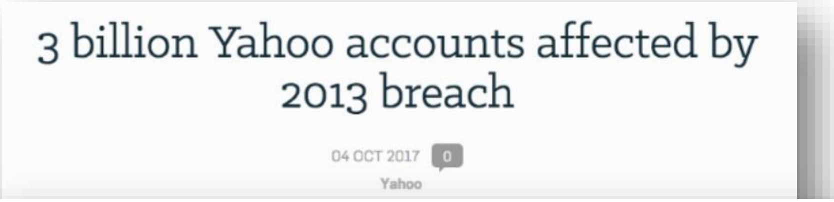


briankrebs @briankrebs

Being in infosec for so long takes its toll. I've come to the conclusion that if you give a data point to a company, they will eventually sell it, leak it, lose it or get hacked and relieved of it. There really don't seem to be any exceptions, and it gets depressing.

7:23 PM - 26 Sep 2018

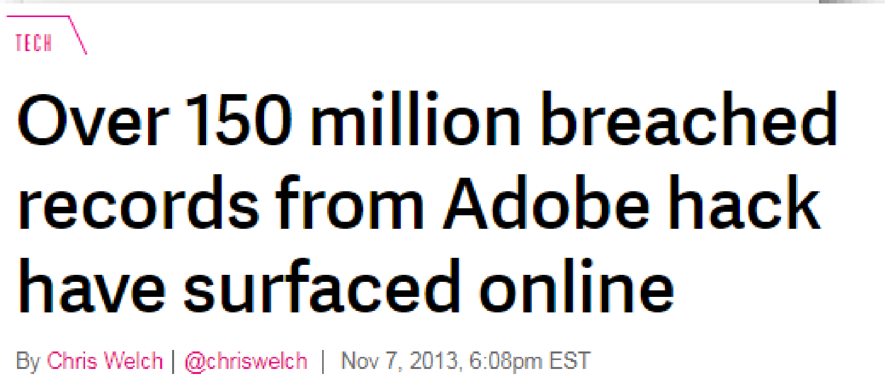
1,595 Retweets 4,043 Likes



3 billion Yahoo accounts affected by 2013 breach

04 OCT 2017 0

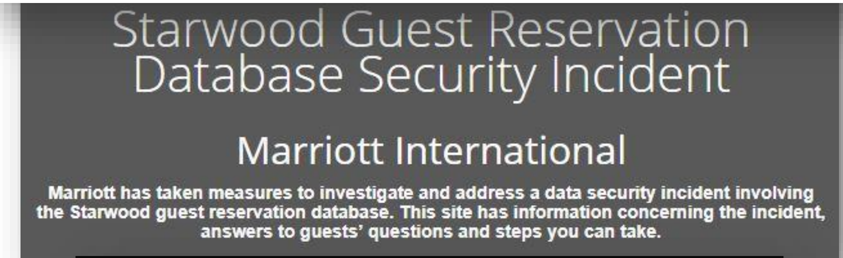
Yahoo



TECH

Over 150 million breached records from Adobe hack have surfaced online

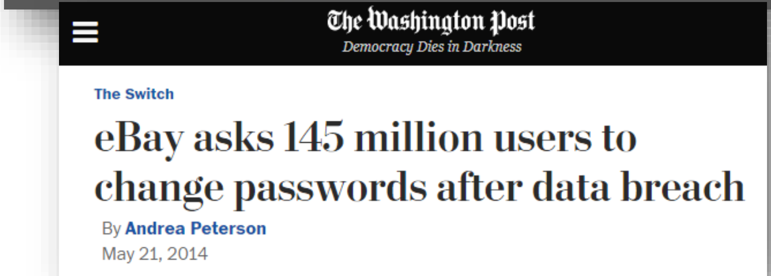
By Chris Welch | @chriswelch | Nov 7, 2013, 6:08pm EST



Starwood Guest Reservation Database Security Incident

Marriott International

Marriott has taken measures to investigate and address a data security incident involving the Starwood guest reservation database. This site has information concerning the incident, answers to guests' questions and steps you can take.



The Washington Post

Democracy Dies in Darkness

The Switch

eBay asks 145 million users to change passwords after data breach

By Andrea Peterson

May 21, 2014

Source: **https://en.wikipedia.org/wiki/List_of_data_breaches**

Data privacy, secrecy & control

- Solove (2011):
  - "The problem with the 'nothing to hide' argument is its underlying assumption that privacy is about hiding bad things"
  - “Part of what makes a society a good place in which to live is the extent to which it allows people freedom from the intrusiveness of others. A society without privacy protection would be suffocation” – Solove (2011)
- Difference between "secret" and "private"
  - Your daily routine, your whereabouts, your interests, who your friends are, etc
  - These may not be secret, but you may not be comfortable with making it all public or with third parties knowing about it, analyzing it, extracting conclusions, making decisions that affect you based on those data.
- **Privacy measure:** Giving full Control to the user

What can be done?

- Establish countermeasures that we can take to avoid becoming a victim of data privacy/security incidents
- There is no ‘silver bullet’
  - The goal is to avoid as much risk as possible
  - Thus, any counter-approach should be based on a holistic view e.g., let’s put some hats on:

1. **Protecting yourself** ***(as an end-user)***

2. **Protecting others** ***(as an organization)***

- Spreading awareness *(passing on the message)*

Lecture 1 Outline

- Setting up the scene
  - Data & its types
  - Data privacy
  - *Class exercise 1*
  - Data privacy, secrecy & control
  - What can be done

- **Introduction to Data Privacy by Design (PbD)**
  - **An obligation**
  - **PbD principles, goals & strategies**
  - **Assumptions & activities**
  - **Case Studies &** ***Class exercise 2***
  - **Take away!**

An Obligation

- **Users expectations (part of user experience)**
  - Users expect companies to request only the personal data needed to deliver the product or service
  - Users want to know who accesses their data, how and for which purpose
  - Users want their personal data to be handled with care and security

-> In short, they expect to stay in control of their personal data

- **...translated into a law (mandatory compliance)**
  - Article 25 European General Data Protection Regulation (GDPR):

    "the controller shall [...] implement appropriate technical and organisational measures [...] which are designed to implement data-protection principles[...] in order to meet the requirements of this Regulation and protect the rights of data subjects."
  - Actually... "**Data Protection by design and by default"**

→ Organizations needs to cover both LAW requirements and USERS' expectations

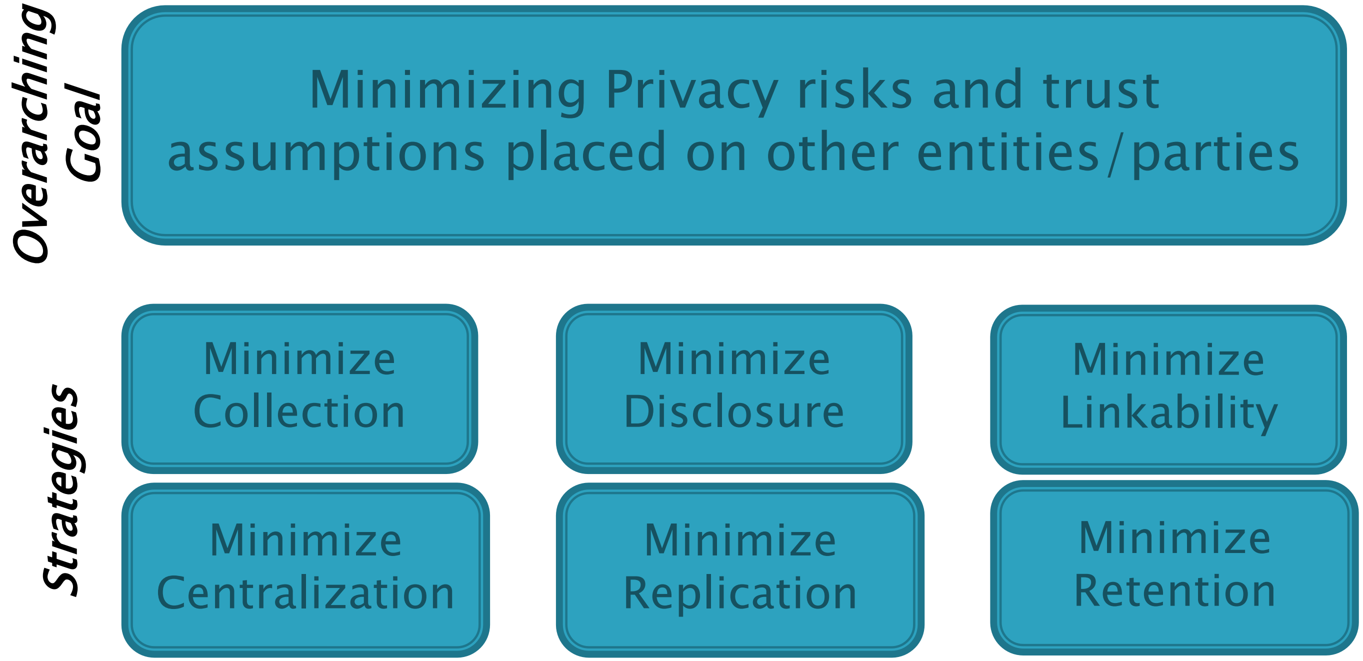
Privacy by Design (PbD) ‘foundational’ principles

- Proactive not Reactive; Preventive not remedial
- Privacy as the default setting
- Privacy Embedded into Design
- Full functionality – Positive-Sum, not Zero-sum
- End-to-end security – Full lifecycle protection
- Visibility and transparency – keep it open
- Respect for user privacy – keep it user-centric

Referred from the white paper by Ann Cavoukian
– Former Information and Privacy Commissioner – Ontario, Canada

Data privacy by design & by default

So what ‘Data by design and by default’ really means?



Overarching Goal

Minimizing Privacy risks and trust assumptions placed on other entities/parties

Strategies

Minimize Collection

Minimize Disclosure

Minimize Linkability

Minimize Centralization

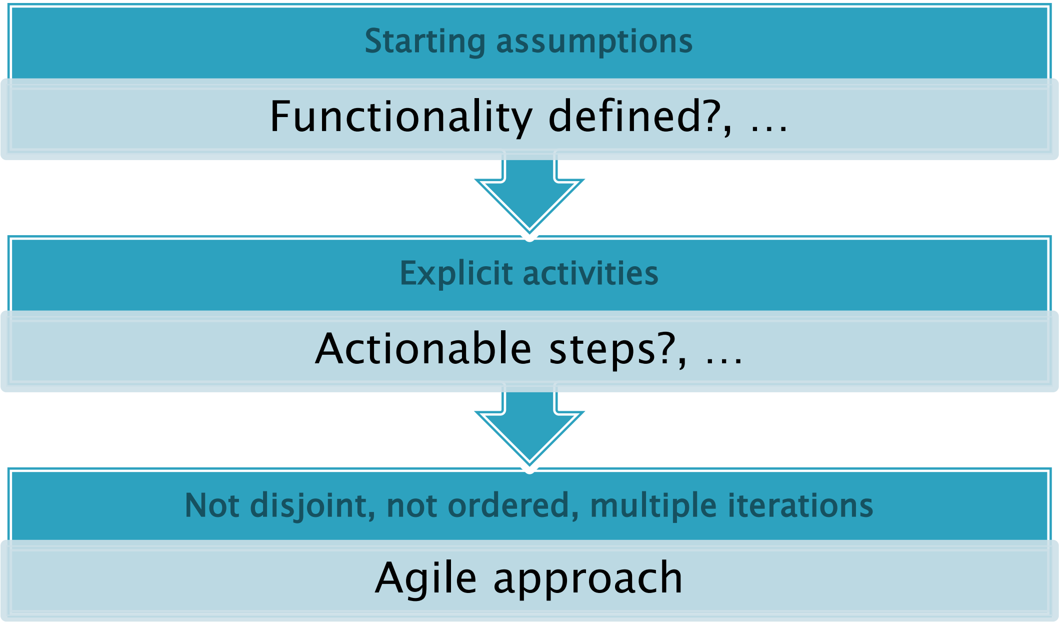
Minimize Replication

Minimize Retention

Great! but... how do we use these strategies?

Assumptions & Activities

- Case study 1: **Electricity smart metering system.**



Starting assumptions

Functionality defined?, …

Explicit activities

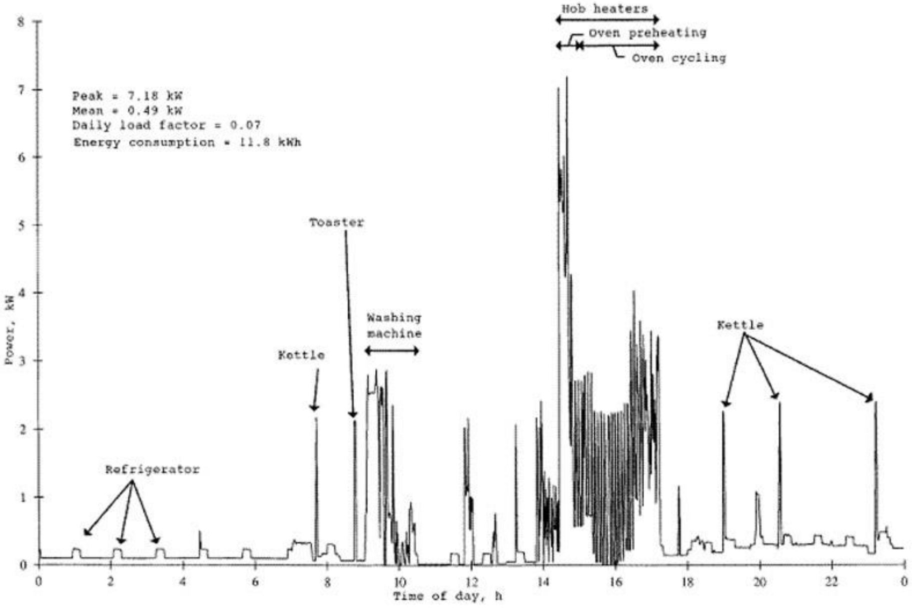
Actionable steps?, …

Not disjoint, not ordered, multiple iterations

Agile approach

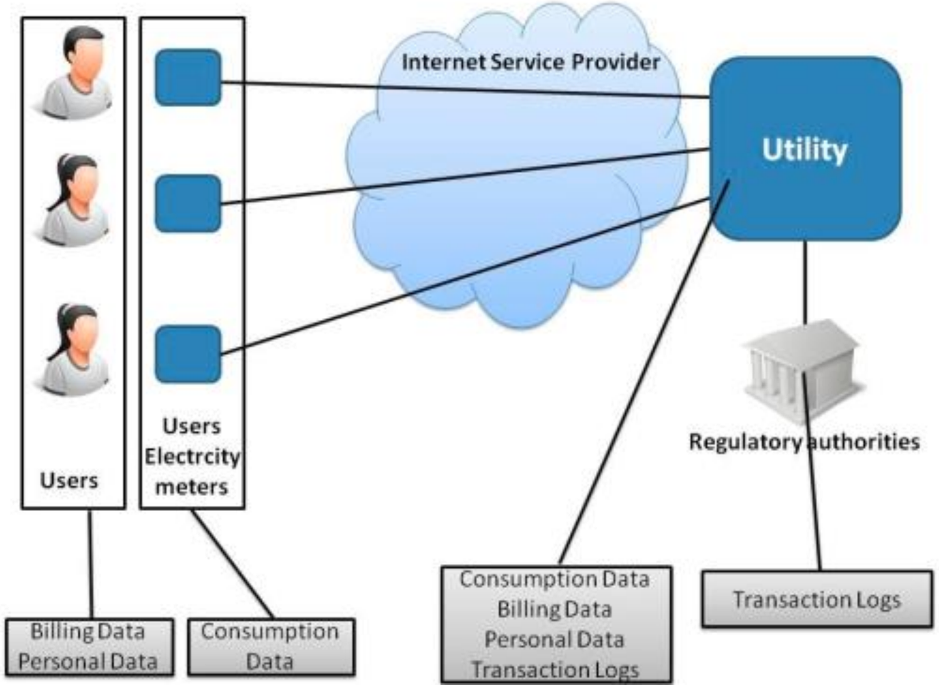
Case study 1: Electricity smart metering system

- Smart energy meters record household consumption every 30 mins
- Privacy Risks:
  - Inference of sensitive personal attributes. E.g., health, work, …)
- Requirements:
  - Billing should be correct
  - Aggregate statistics per household or group should be available
  - Fraud/tampering detection



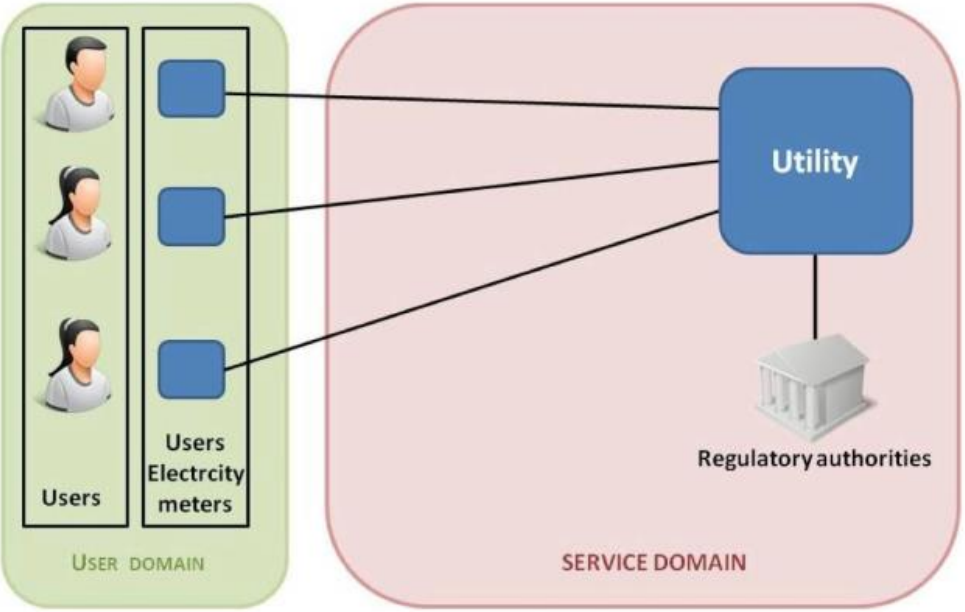
Starting Assumptions

- ✓ Functionality defined
- ✓ Basic system model(s)
- ✓ Service integrity requirements elicited
- …


Internet Service Provider
Utility
Users
Users Electrcity meters
Regulatory authorities
Billing Data Personal Data
Consumption Data
Consumption Data Billing Data Personal Data Transaction Logs
Transaction Logs

Activity 1: Classify Entities in domains

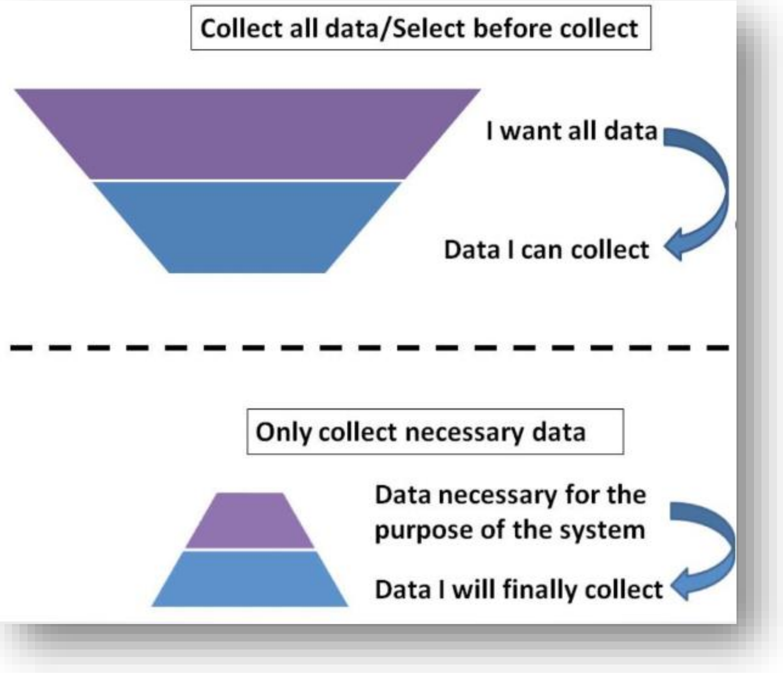
- User domain (trusted):
  - Components under the control of the user, e.g., user devices
- Service domain (non-trusted):
  - Components outside the control of the user, e.g., backend system (at provider side)



TEAM ACTIVITY

Activity 2: Identification of Necessary data

- User domain:
  - Personal data
  - Billing data
  - Consumption data
- Service domain:
  - Personal data
  - Billing data
  - Consumption data
  - Transaction logs


Collect all data/Select before collect
I want all data
Data I can collect
Only collect necessary data
Data necessary for the purpose of the system
Data I will finally collect

Changing the approach!

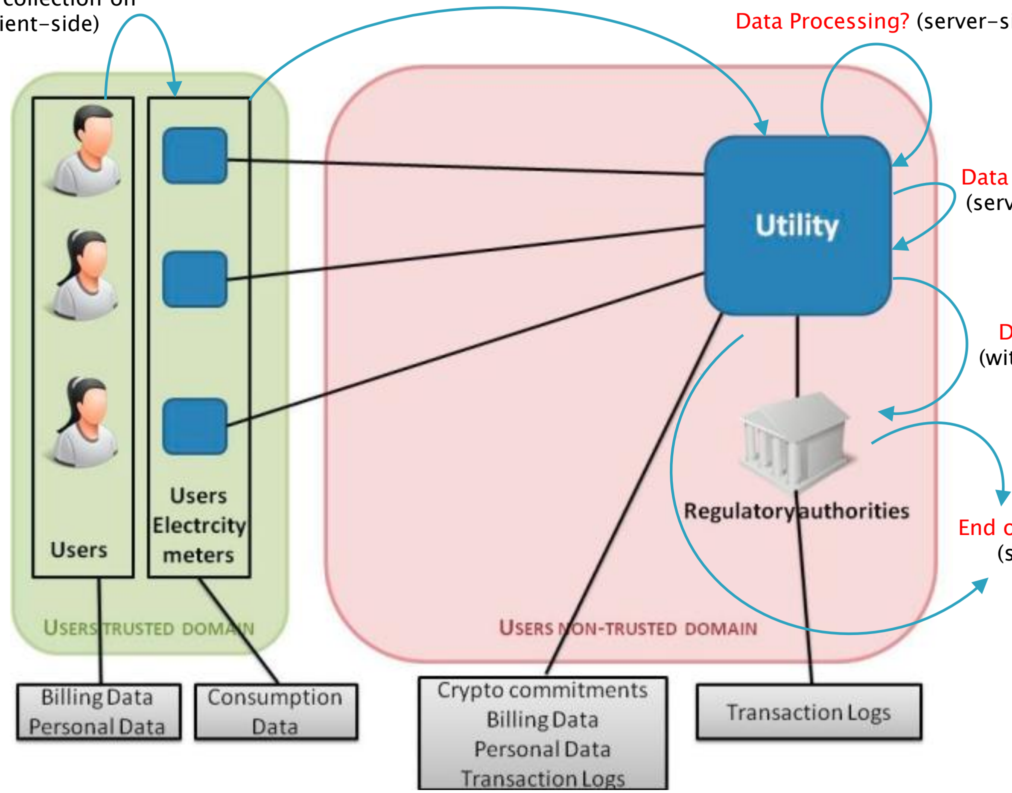
TEAM ACTIVITY

Activity 3: Distribution of data in the architecture

Initiation? (data collection on client-side)

Data transport? (to the server)

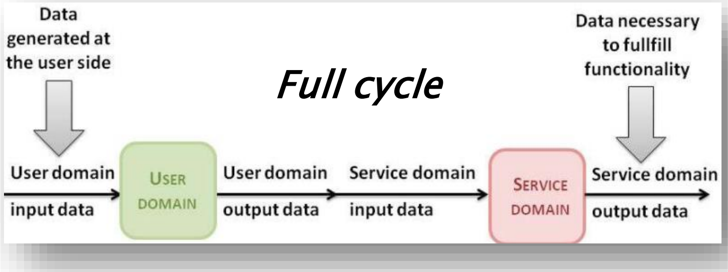
Data Processing? (server-side)



Data Storage? (server-side)

Data sharing? (with third-party)

End of data retention? (safe disposal)



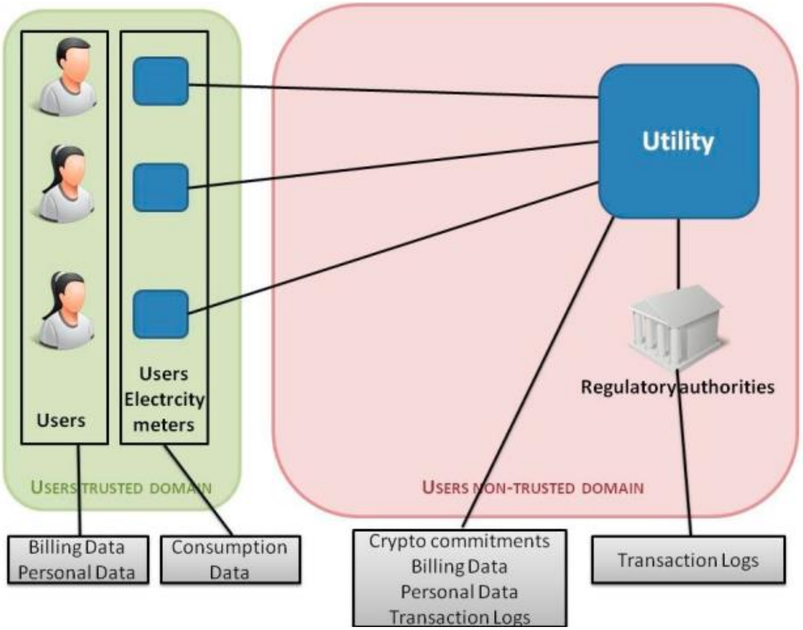
Data generated at the user side
Full cycle
Data necessary to fullfill functionality
User domain input data
USER DOMAIN
User domain output data
Service domain input data
SERVICE DOMAIN
Service domain output data

- Threat modeling
  - Systematically thinking about negative scenarios
  - Techniques:
    - STRIDE (for Security)
    - STRIPED (for Privacy & Security)
    - LINDDUN (for Privacy)
    - Other factors: data lifecycle, maintenance, etc.
- Risk analysis
  - Likelihood vs Impact

TEAM ACTIVITY

Activity 4: Select technological solutions (Patterns)

- Address main threats/risks first:
  - Keeping as much data as possible out of the service domain (while satisfying service integrity requirements)
    - Client-side protections (against common attacks)
  - Transport encryption (e.g. SSL/TLS)
  - Processing (e.g. obfuscating/ anonymizing specific data in system logs, Advanced privacy-preserving protocols)
  - Storage (e.g. Encryption at rest, Privacy Enhancing Technologies)
  - …
- Apply the six strategies i.e. minimize collection, disclosure, linkability, centralization, replication, and retention od data



TEAM ACTIVITY

Case Study 2: European Electronic Toll Service (EETS)

- Defined functionality:
  - Pay according to road use: time, distance, road type, …
- Requirements:
  - Privacy & integrity risks to be mitigated:
    1. Third party access to traffic/location data of driver.
    2. Abuse of traffic data by authority performing the billing (location data cannot be easily anonymized).
  - The provider needs to know the final fee to charge
  - The provider must be reassured that this fee is correctly computed and users cannot commit fraud

Note: Location as a means to compute above points -> not intrinsic

Class exercise 2: activity

<u>Form basic information model & perform the 4 activities:</u>

1. **Classify entities in domains**
2. **Identify necessary data for providing the service**
3. **Distribute data in architecture**
4. **Select technological solutions**

Deadline: See 'Teams' Assignment section

Lecture 1 ends here

- Course Slides: Go to MS Teams:
  ‘Data Privacy by Design Spring (S1) Spring 2022’
  -> Files section

- Send your questions by email:
  mohammad-salman.nadeem@epita.fr
  OR via direct message using MS Teams

- Thank You!