GEORG-AUGUST-UNIVERSITÄT
GÖTTINGEN

Usable Security and Privacy Day 2021

Let there be LITE
[on-line] Label for IoT Transparency Enhancement

Alexander Railean and Delphine Reinhardt

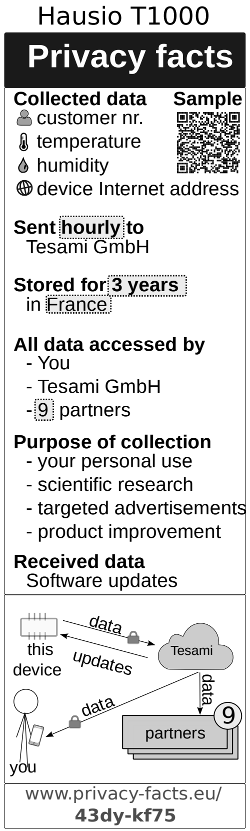
Motivation

- Proliferation of IoT devices
- Privacy impact of data collection
- The GDPR calls for transparency solutions
- This is not a solved problem *yet*

Objectives

- Improve IoT transparency as defined by the GDPR
  - **What** data are collected?
  - **Where** are they stored?
  - **How long** are they kept?
  - **For what** purpose are they used?
  - **Who** has access to the data?
- Help *non-experts* understand the impact
- Facilitate comparisons
- Neutrality
- Decide at a glance
- Reusable outside IoT (e.g., smartphone apps)

Means: printed label



Hausio T1000

Privacy facts

Collected data **Sample**
- customer nr.
- temperature
- humidity
- device Internet address

Sent hourly to
Tesami GmbH

Stored for 3 years
in France

All data accessed by
- You
- Tesami GmbH
- 9 partners

Purpose of collection
- your personal use
- scientific research
- targeted advertisements
- product improvement

Received data
Software updates

this device
data
updates
Tesami
data
9
partners
data
you

www.privacy-facts.eu/
43dy-kf75

Means: printed label

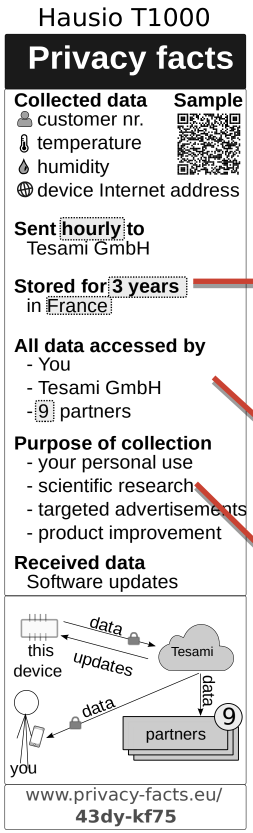
What?

How long?

Where?

Who?

What for?



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www.privacy-facts.eu/
43dy-kf75

Means: printed label

QR code:

customer number = 481-AHR-1831
temperature = 22 C
humidity = 34%
device Internet address = 93.184.216.34

priacy-facts.eu/43dy-kf75

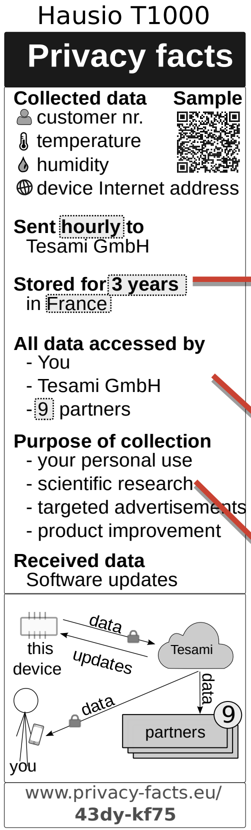
What?

Where?

How long?

Who?

What for?



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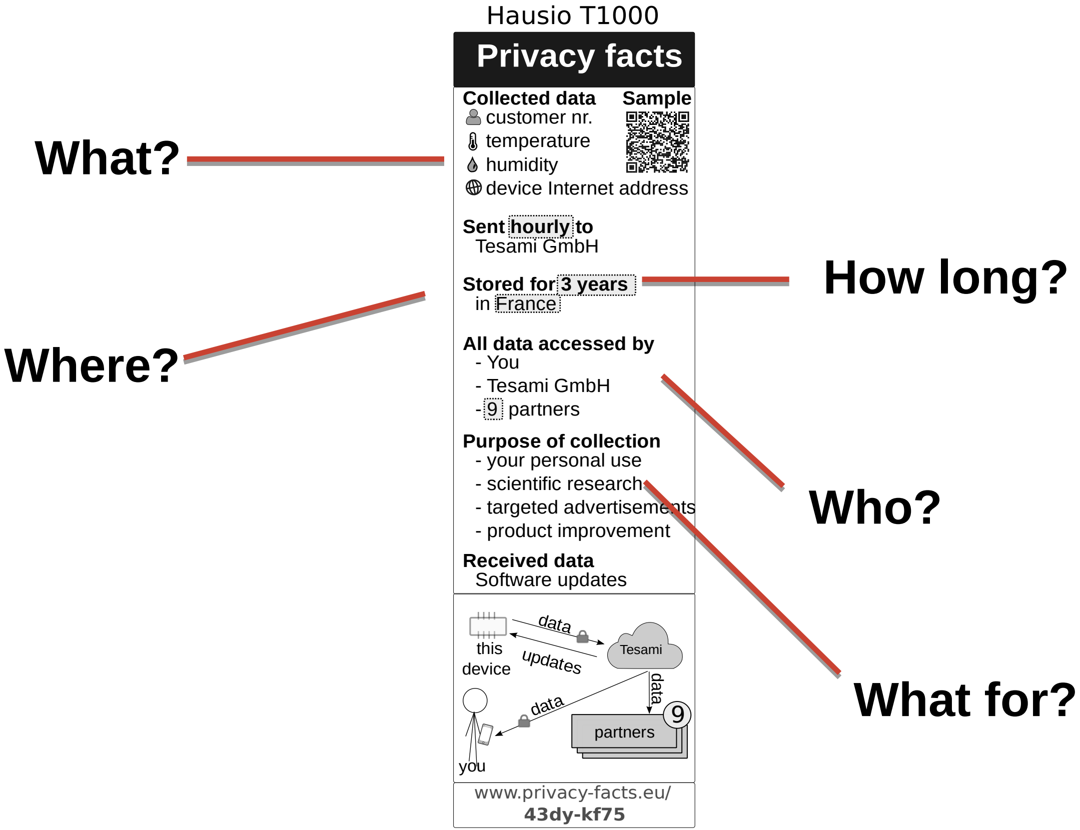
Means: printed label

- Evaluation
  - 31 participants
  - Karlstad, Sweden
  - Questionnaire, interview



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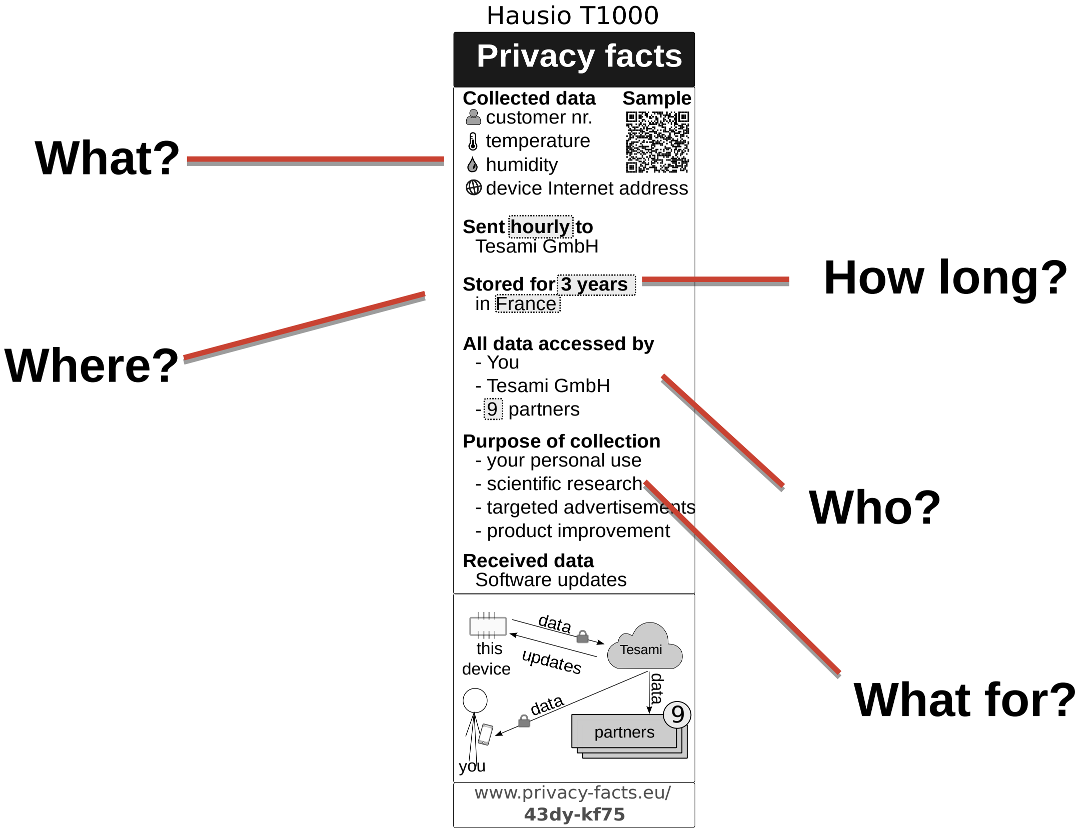
  - - Questionnaire, interview

What purpose are the data collected for?

□ Marketing offers
□ Home automation
□ Automatic billing
□ My personal use
□ Scientific research
□ ______________
□ ______________
□ I don't know



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What?

How long?

Where?

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What for?

Lessons learned

- Easy to interpret
- Positive feedback
  - “they kind of show you their hand, like in poker almost” (P2)
  - “usually this type of information is buried under a lot of paper” (P7)
  - “I get so much data just by looking at that, [..] if you make it longer, I will probably not read it” (P10)

Lessons learned

- Easy to interpret
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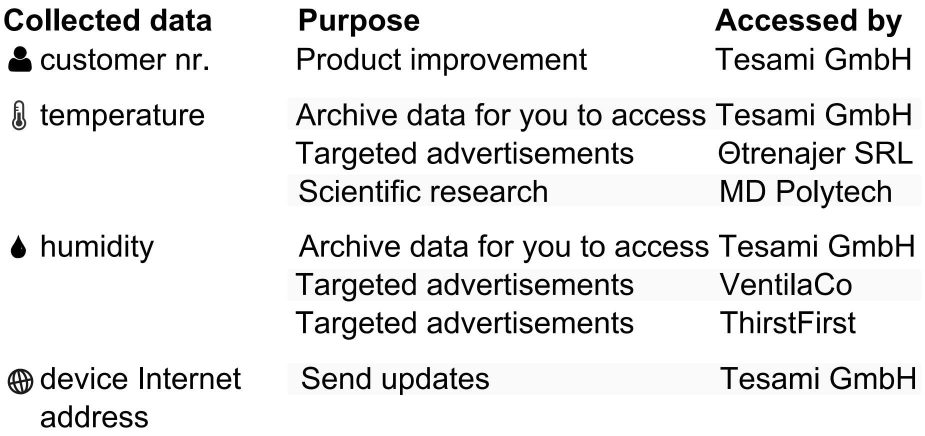
  - “usually this type of information is buried under a lot of paper” (P7)
  - “I get so much data just by looking at that, [..] if you make it longer, I will probably not read it” (P10)
- Caution
  - “I need to feel that I trust the label itself” (P17)
  - “labels can lie” (P9)
  - “it only informs me, but I cannot control the data or limit it” (P1)

Lessons learned

- Who are the partners?
- What data do they get?
- What do they use it for?



Collected data	Purpose	Accessed by
👤 customer nr.	Product improvement	Tesami GmbH
🌡 temperature	Archive data for you to access	Tesami GmbH
	Targeted advertisements	Ɵtrenajer SRL
	Scientific research	MD Polytech
💧 humidity	Archive data for you to access	Tesami GmbH
	Targeted advertisements	VentilaCo
	Targeted advertisements	ThirstFirst
🌐 device Internet address	Send updates	Tesami GmbH

Means: online interface

- Cross-disciplinary design (legal, usability, security, privacy)
- Iterative approach
- Heuristic evaluation with experts

- Technical aspects
  - HTML, Javascript, CSS, Python
  - vector graphics with SVG
  - accessibility, semantic markup

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- Technical aspects
  - HTML, Javascript, CSS, Python
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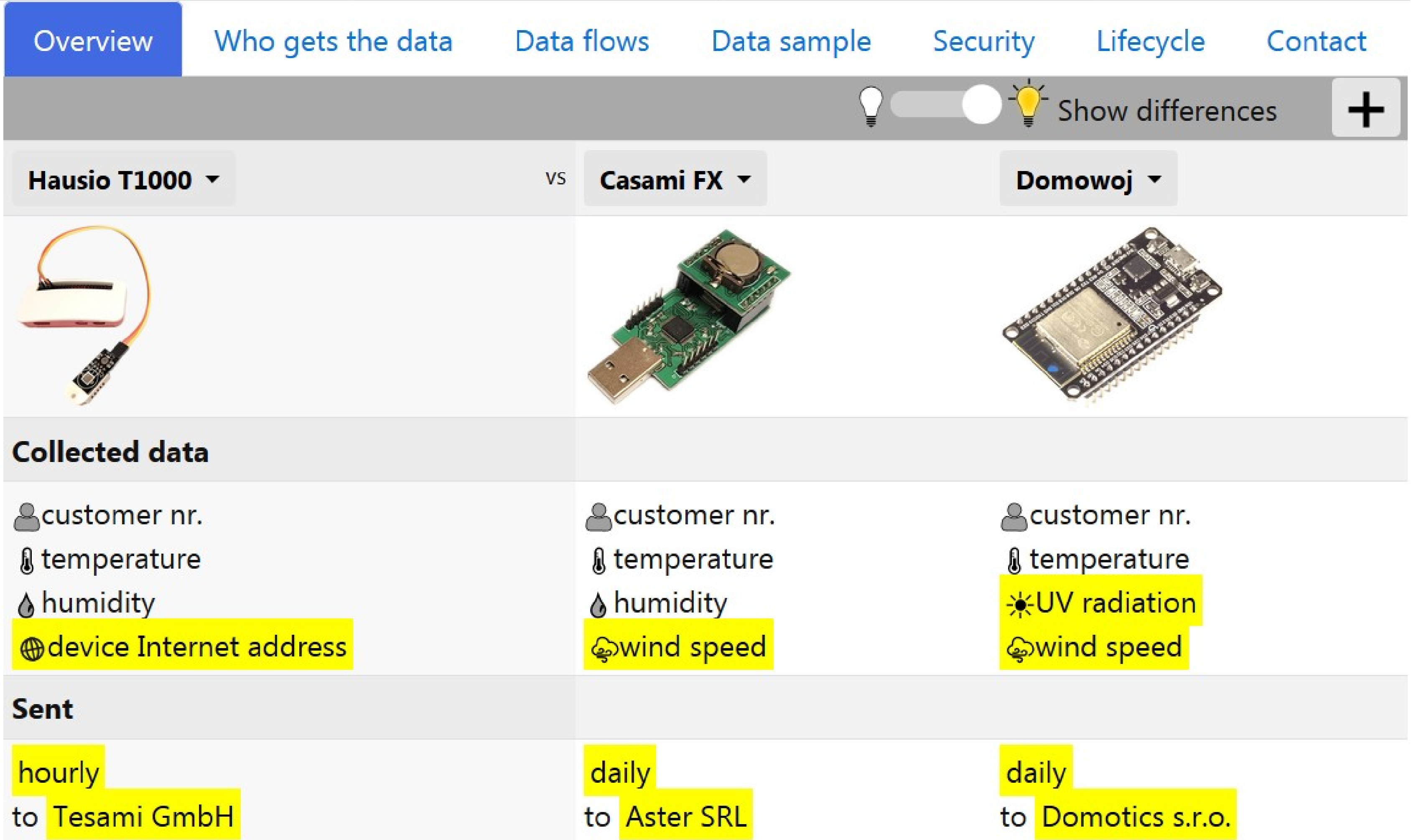
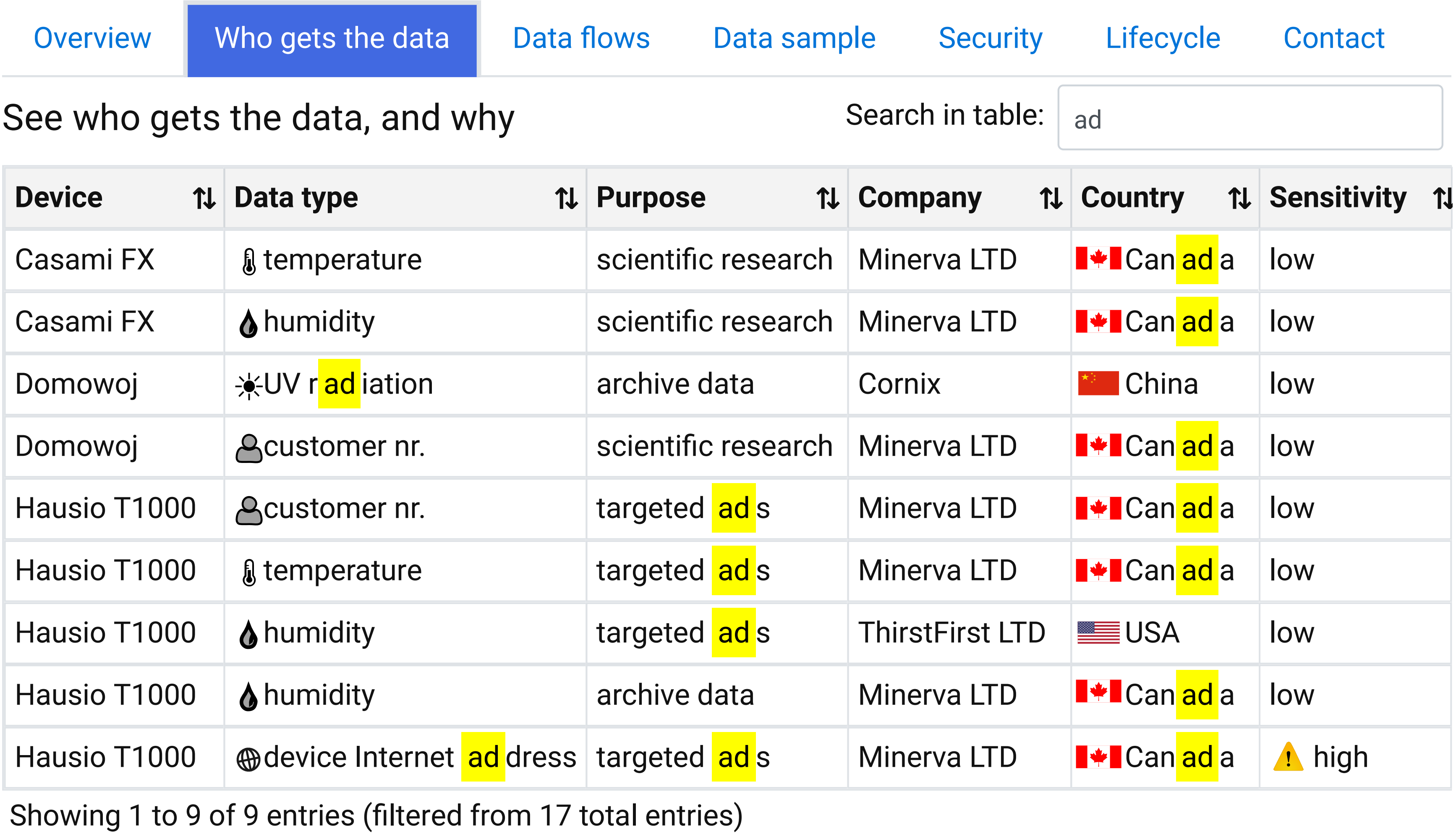
- Design principles
  - tabular format
  - progressive disclosure
  - use bullet-points
  - simple terminology
  - avoid sentences
  - channel redundancy (text, graphic)
  - classic UI widgets
  - “Intelligence amplified”



Hausio T1000	Casami FX	Domowoj
Collected data		
customer nr. temperature humidity device Internet address	customer nr. temperature humidity wind speed	customer nr. temperature UV radiation wind speed
Sent		
hourly to Tesami GmbH	daily to Aster SRL	daily to Domotics s.r.o.

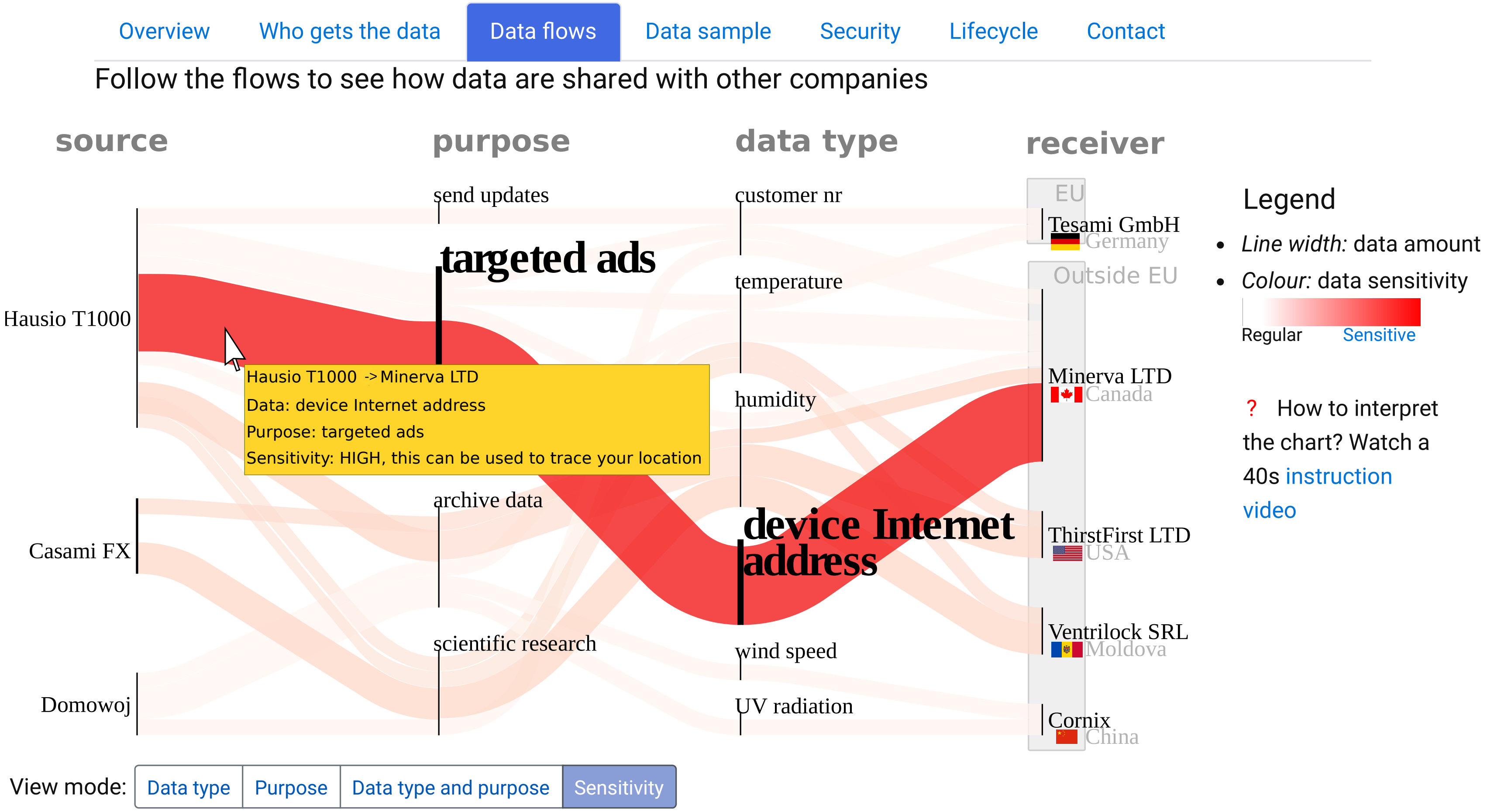


See who gets the data, and why

Search in table: ad

Device	Data type	Purpose	Company	Country	Sensitivity
Casami FX	🌡 temperature	scientific research	Minerva LTD	🇨🇦 Canada	low
Casami FX	💧 humidity	scientific research	Minerva LTD	🇨🇦 Canada	low
Domowoj	☀ UV radiation	archive data	Cornix	🇨🇳 China	low
Domowoj	👤 customer nr.	scientific research	Minerva LTD	🇨🇦 Canada	low
Hausio T1000	👤 customer nr.	targeted ads	Minerva LTD	🇨🇦 Canada	low
Hausio T1000	🌡 temperature	targeted ads	Minerva LTD	🇨🇦 Canada	low
Hausio T1000	💧 humidity	targeted ads	ThirstFirst LTD	🇺🇸 USA	low
Hausio T1000	💧 humidity	archive data	Minerva LTD	🇨🇦 Canada	low
Hausio T1000	🌐 device Internet address	targeted ads	Minerva LTD	🇨🇦 Canada	⚠ high

Showing 1 to 9 of 9 entries (filtered from 17 total entries)



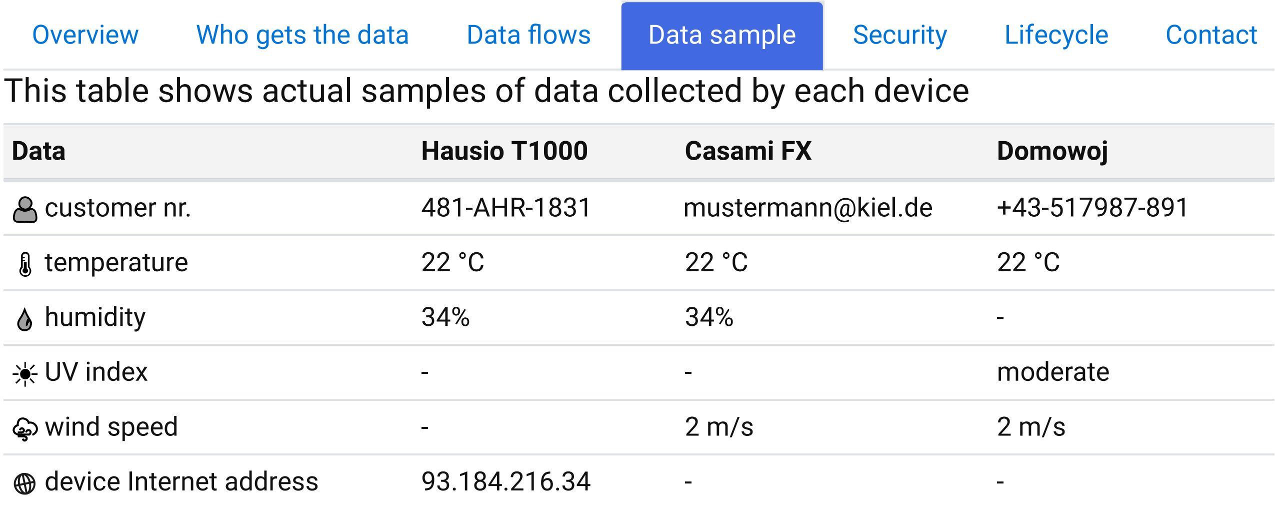
Follow the flows to see how data are shared with other companies

Hausio T1000 -> Minerva LTD
Data: device Internet address
Purpose: targeted ads
Sensitivity: HIGH, this can be used to trace your location

Legend

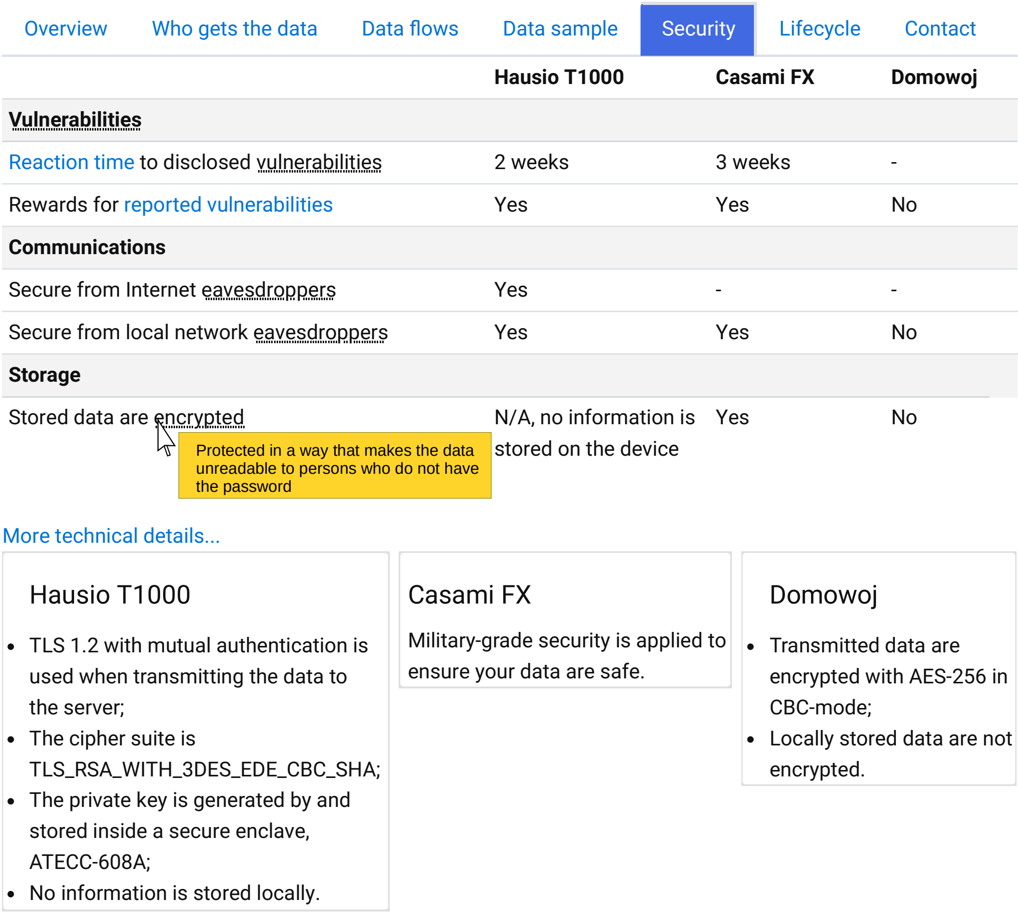
- *Line width:* data amount
- *Colour:* data sensitivity

? How to interpret the chart? Watch a 40s instruction video



This table shows actual samples of data collected by each device

Data	Hausio T1000	Casami FX	Domowoj
customer nr.	481-AHR-1831	mustermann@kiel.de	+43-517987-891
temperature	22 °C	22 °C	22 °C
humidity	34%	34%	-
UV index	-	-	moderate
wind speed	-	2 m/s	2 m/s
device Internet address	93.184.216.34	-	-



	Hausio T1000	Casami FX	Domowoj
Vulnerabilities			
Reaction time to disclosed vulnerabilities	2 weeks	3 weeks	-
Rewards for reported vulnerabilities	Yes	Yes	No
Communications			
Secure from Internet eavesdroppers	Yes	-	-
Secure from local network eavesdroppers	Yes	Yes	No
Storage			
Stored data are encrypted	N/A, no information is stored on the device	Yes	No

Protected in a way that makes the data unreadable to persons who do not have the password

More technical details...

Hausio T1000

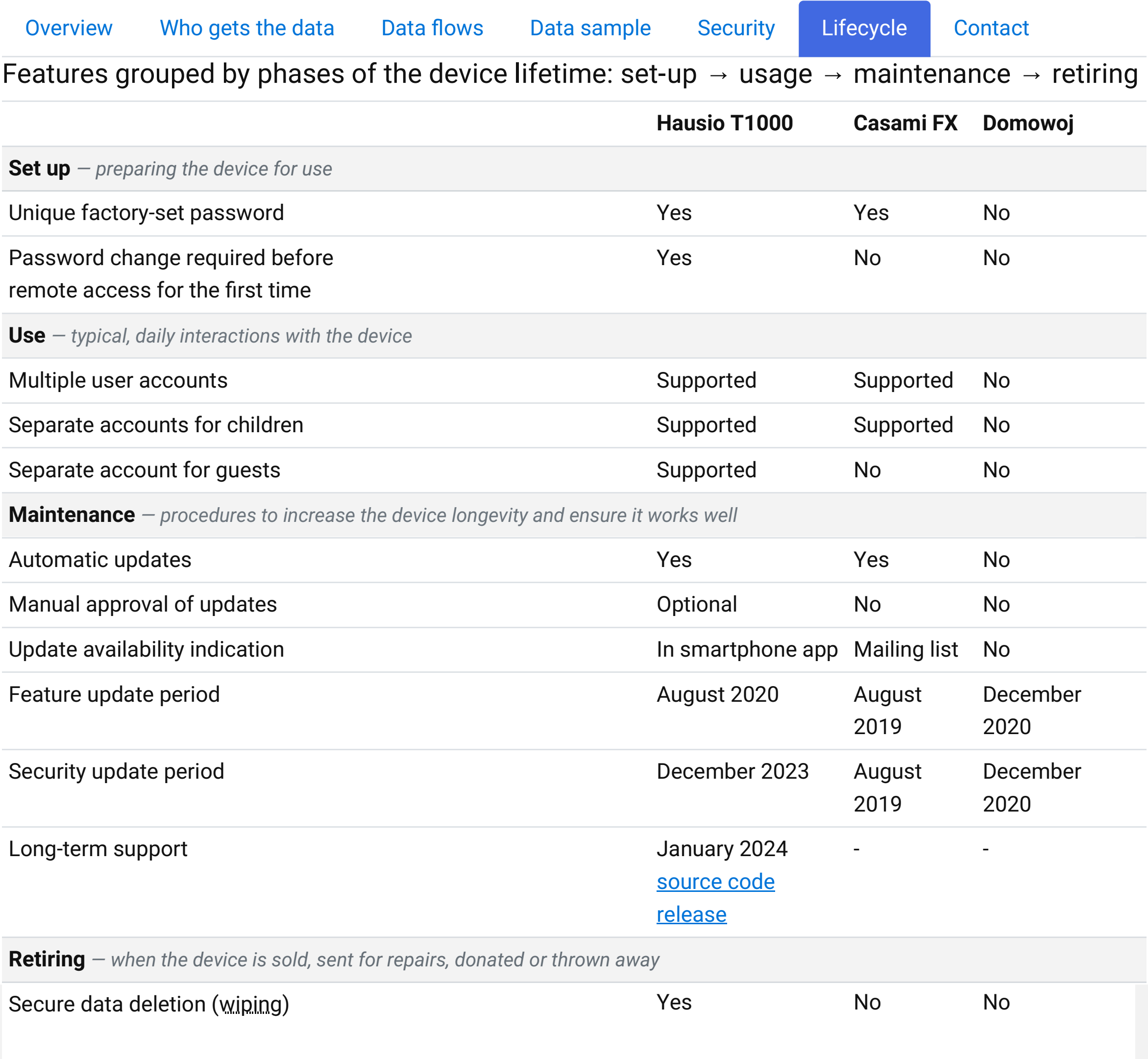
- TLS 1.2 with mutual authentication is used when transmitting the data to the server;
- The cipher suite is TLS_RSA_WITH_3DES_EDE_CBC_SHA;
- The private key is generated by and stored inside a secure enclave, ATECC-608A;
- No information is stored locally.

Casami FX

Military-grade security is applied to ensure your data are safe.

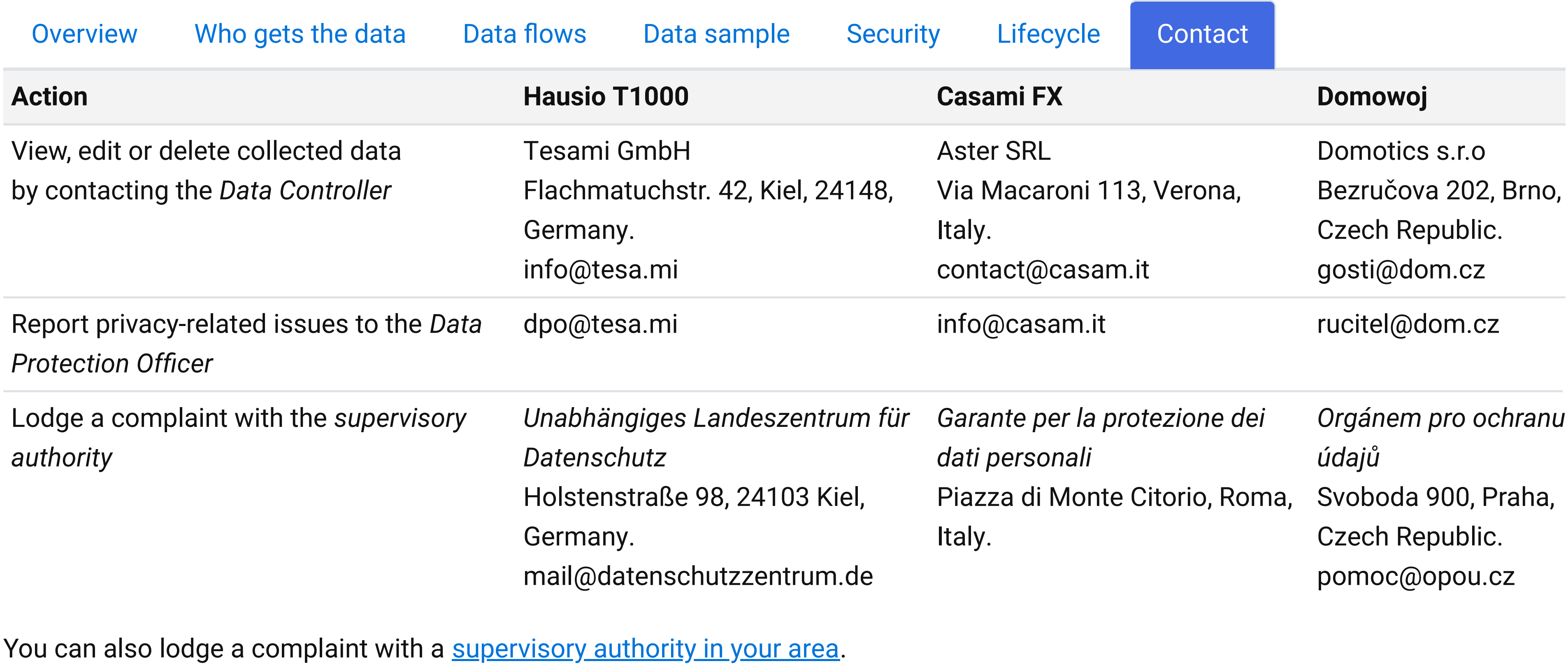
Domowoj

- Transmitted data are encrypted with AES-256 in CBC-mode;
- Locally stored data are not encrypted.



Features grouped by phases of the device lifetime: set-up → usage → maintenance → retiring

	Hausio T1000	Casami FX	Domowoj
Set up — *preparing the device for use*			
Unique factory-set password	Yes	Yes	No
Password change required before remote access for the first time	Yes	No	No
Use — *typical, daily interactions with the device*			
Multiple user accounts	Supported	Supported	No
Separate accounts for children	Supported	Supported	No
Separate account for guests	Supported	No	No
Maintenance — *procedures to increase the device longevity and ensure it works well*			
Automatic updates	Yes	Yes	No
Manual approval of updates	Optional	No	No
Update availability indication	In smartphone app	Mailing list	No
Feature update period	August 2020	August 2019	December 2020
Security update period	December 2023	August 2019	December 2020
Long-term support	January 2024 source code release	-	-
Retiring — *when the device is sold, sent for repairs, donated or thrown away*			
Secure data deletion (wiping)	Yes	No	No



Action	Hausio T1000	Casami FX	Domowoj
View, edit or delete collected data by contacting the *Data Controller*	Tesami GmbH Flachmatuchstr. 42, Kiel, 24148, Germany. info@tesa.mi	Aster SRL Via Macaroni 113, Verona, Italy. contact@casam.it	Domotics s.r.o Bezručova 202, Brno, Czech Republic. gosti@dom.cz
Report privacy-related issues to the *Data Protection Officer*	dpo@tesa.mi	info@casam.it	rucitel@dom.cz
Lodge a complaint with the *supervisory authority*	*Unabhängiges Landeszentrum für Datenschutz* Holstenstraße 98, 24103 Kiel, Germany. mail@datenschutzzentrum.de	*Garante per la protezione dei dati personali* Piazza di Monte Citorio, Roma, Italy.	*Orgánem pro ochranu údajů* Svoboda 900, Praha, Czech Republic. pomoc@opou.cz

You can also lodge a complaint with a supervisory authority in your area.

Evaluation

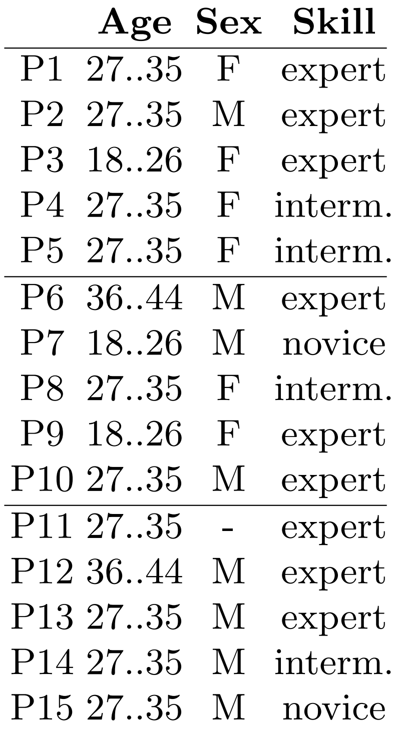
- 14 think-aloud tasks, e.g.
  - which company gets most data?
  - what data are used for targeted ads?
  - what data goes outside the EU?
- 8 open-ended questions, e.g.
  - which tab was most helpful?
  - what parts of the UI were not clear?
- SUS questionnaire
  - quantify usability
- Thematic analysis
  - typical friction points
  - common usage patterns

Evaluation

- 15 participants
- 10 EUR (opt out)
- Conducted in Kiel, Germany

Backgrounds: economists, mathematicians, computer scientists, environmentalists, and lawyers

Countries: Brazil, Peru, Mexico, Spain, Germany, Moldova, China, Vietnam, India, Pakistan, Iran, Ghana



	Age	**Sex**	**Skill**
P1	27..35	F	expert
P2	27..35	M	expert
P3	18..26	F	expert
P4	27..35	F	interm.
P5	27..35	F	interm.
P6	36..44	M	expert
P7	18..26	M	novice
P8	27..35	F	interm.
P9	18..26	F	expert
P10	27..35	M	expert
P11	27..35	-	expert
P12	36..44	M	expert
P13	27..35	M	expert
P14	27..35	M	interm.
P15	27..35	M	novice

Results

- Covers the gaps of the printed version
- Qualitative feedback is very positive
- Participants found OnLITE helpful
- … and would like to have such a UI in reality
- The tabular layout works well
- Graphical flows (Sankey diagrams)
  - Some like them more
  - It may take a while to understand them
- Interactivity makes interpretation easier
- “Overview” is most informative tab, followed by “Who gets the data” and “Flows“

Selected themes and quotes

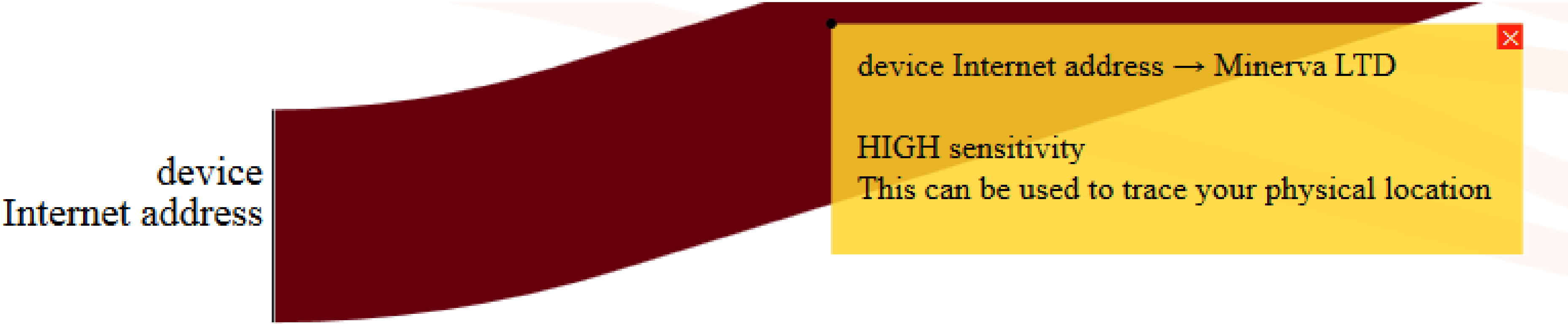
- OnLITE encourages **critical thinking**, e.g.,
  - “6 years, that’s a long time for such a small purpose, I can’t say it is reasonable” (P15)
  - “Truth be told, I don’t understand why they need to store the device Internet address“ (P2)
  - “Why would a temperature measuring device have this feature? This I don’t understand“ (P11)

- Participants would trust the information if it were **vetted by a reputable organization**:
  - “I will trust the EU“ (P15)
  - “Anything related to the government“ (P6)
  - But they *failed to name a specific organization!*

- Participants think OnLITE is **complete**:
  - “… it looks very complete” (P6)
  - “… there’s nothing else I could add that comes to mind” (P8)

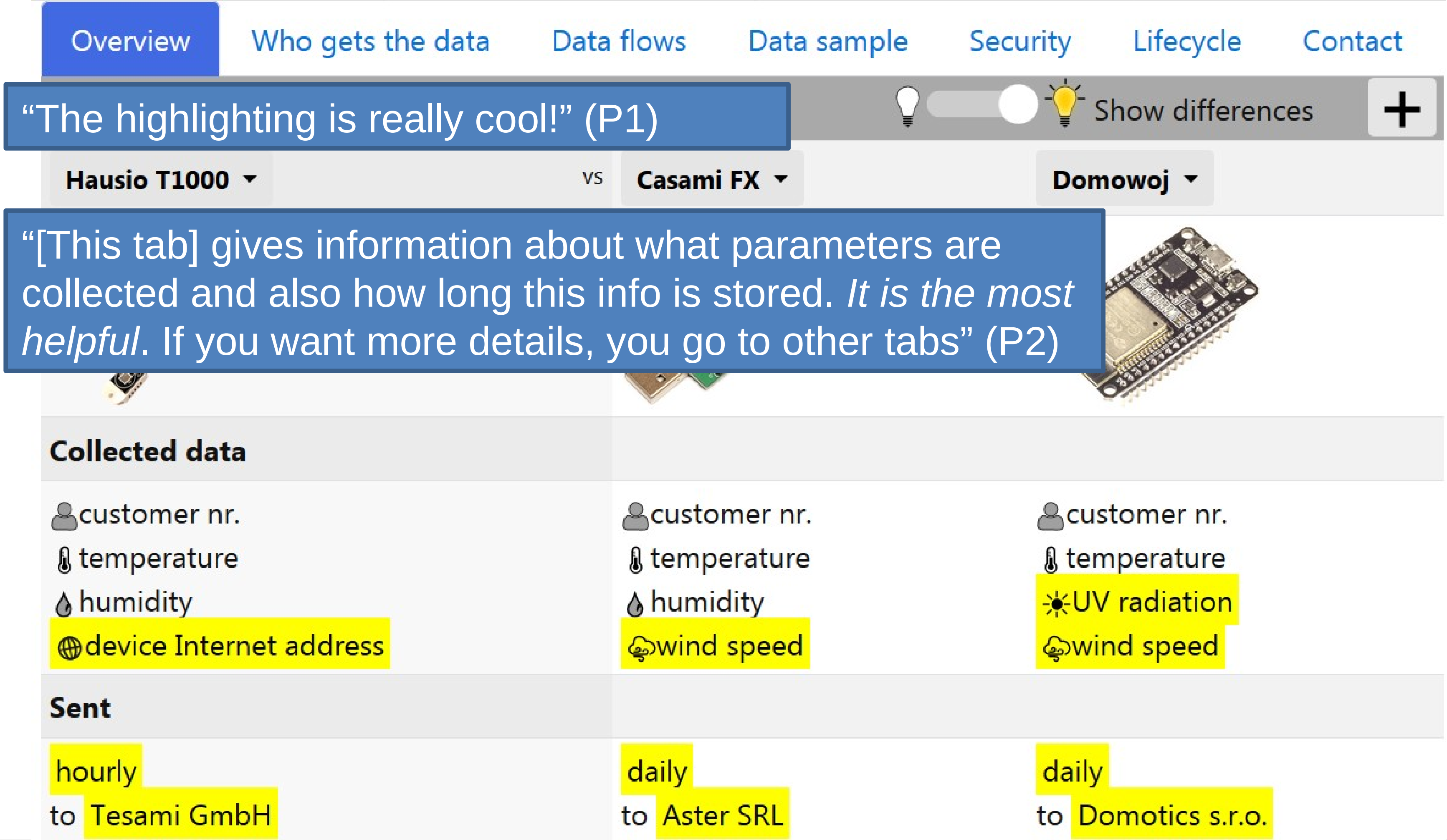
Selected themes and quotes

- OnLITE provides an **educational opportunity**, e.g.,
“I won't be very stressed or concerned if the information about the temperature in my apartment, for example, would be read by someone else. *I mean, what can they do*? I'm just... I'm guessing” (P2)



device Internet address → Minerva LTD

HIGH sensitivity
This can be used to trace your physical location



“The highlighting is really cool!” (P1)

“[This tab] gives information about what parameters are collected and also how long this info is stored. *It is the most helpful*. If you want more details, you go to other tabs” (P2)

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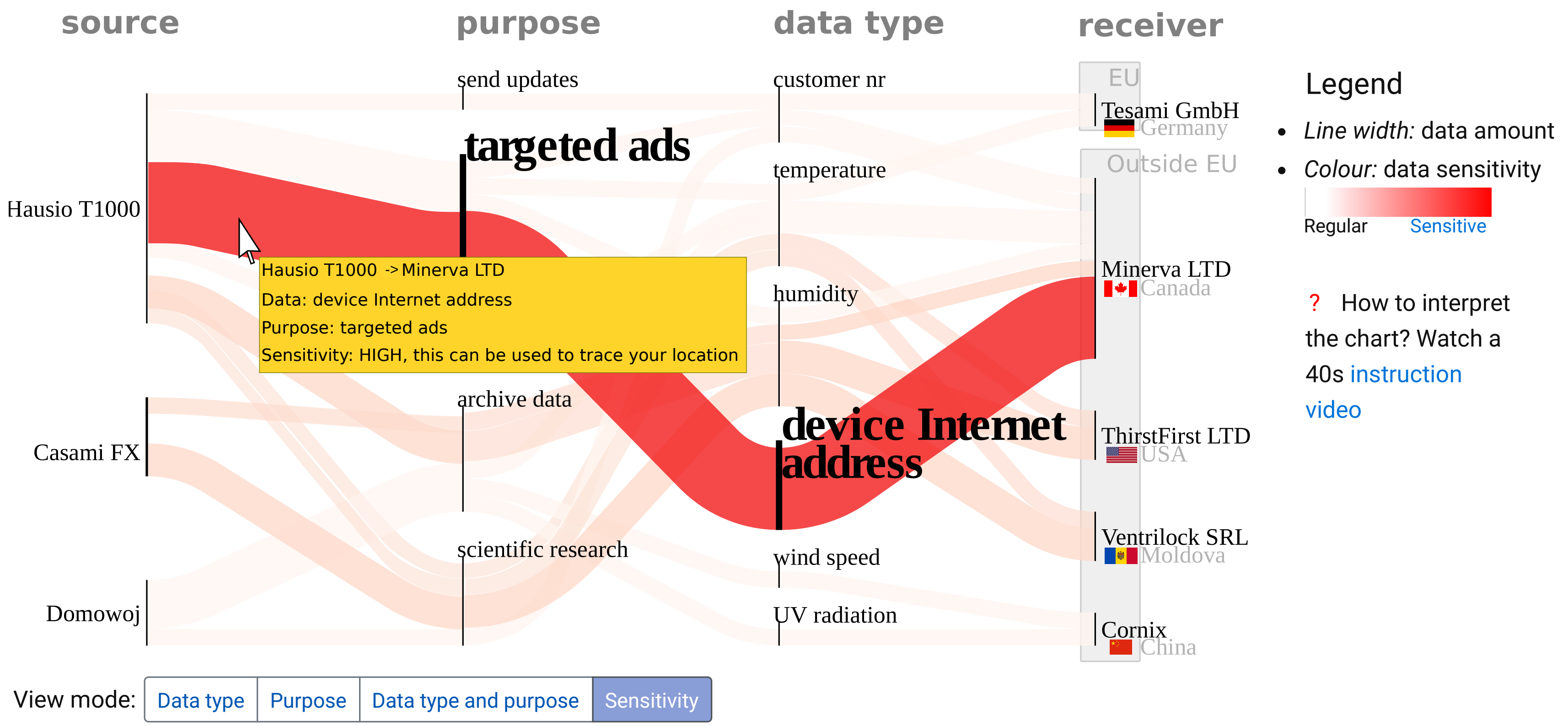
Collected data		
customer nr. temperature humidity device Internet address	customer nr. temperature humidity wind speed	customer nr. temperature UV radiation wind speed
Sent		
hourly to Tesami GmbH	daily to Aster SRL	daily to Domotics s.r.o.

> “The *faster* way for me was looking at the data flow, it was more *concise*!” (P12)
> “… same information as in the table, but shown in a graphical way, *very beautiful*” (P2)



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Purpose: targeted ads
Sensitivity: HIGH, this can be used to trace your location

Legend

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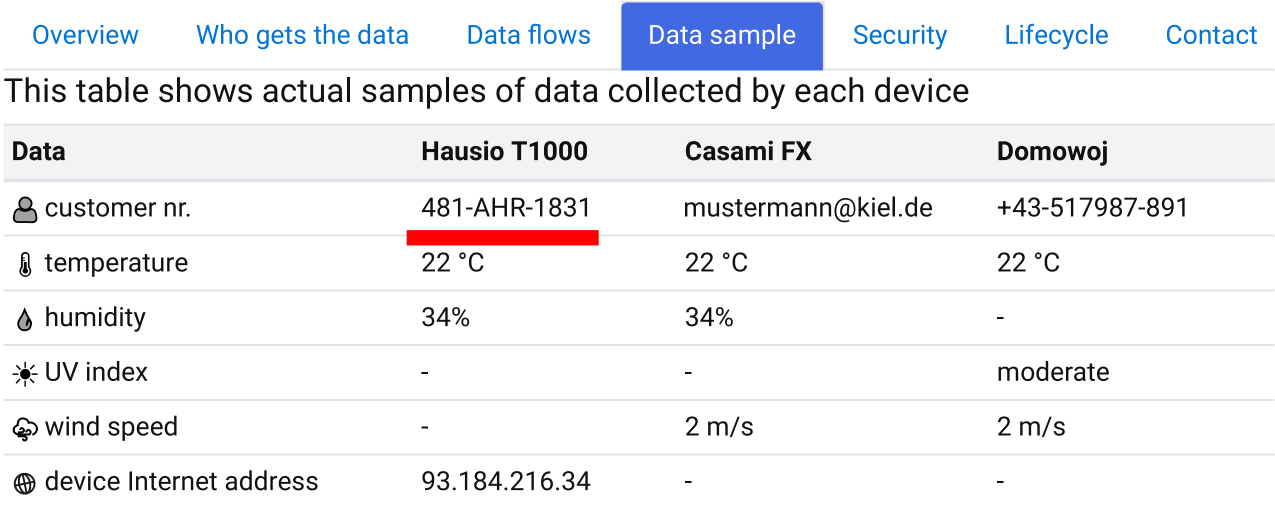
? How to interpret the chart? Watch a 40s instruction video

Which customer number is more privacy-preserving?

“I think the first one is better, because it is just a sequence of numbers and letters” (P1)

“The first one for sure!” (P6)



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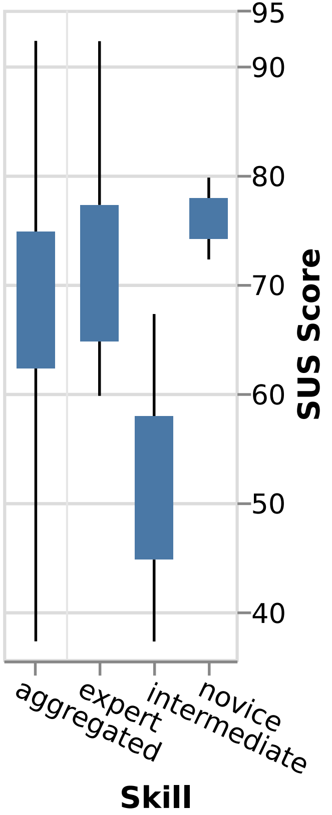
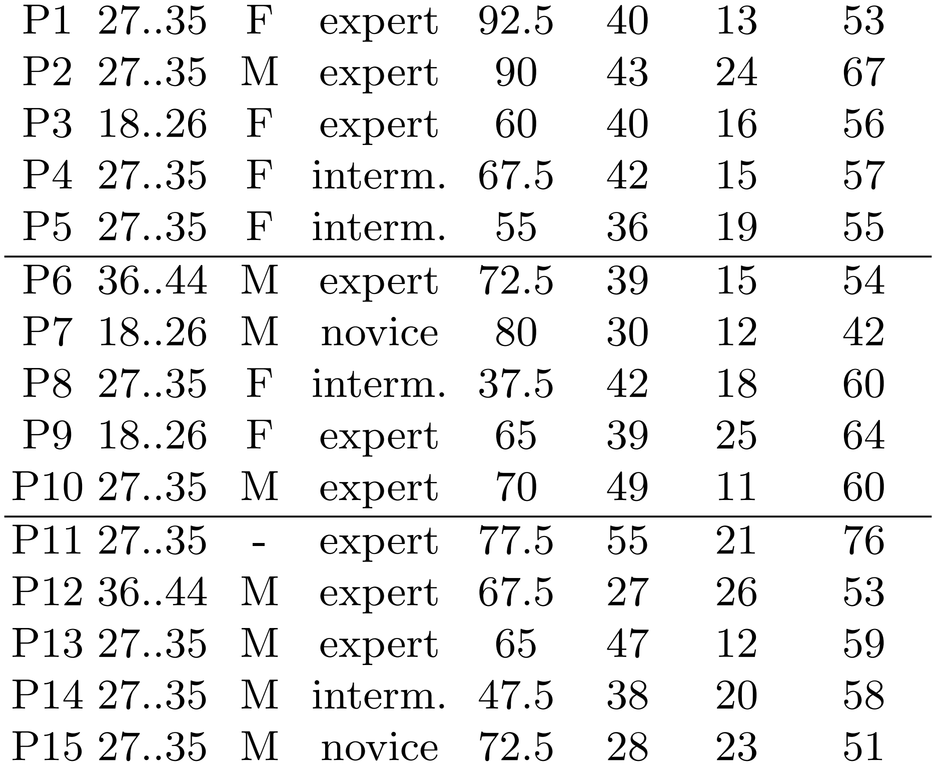
				SUS	Time (minutes)		
	Age	Sex	Skill	score	Tasks	Interv.	Total
P1	27..35	F	expert	92.5	40	13	53
P2	27..35	M	expert	90	43	24	67
P3	18..26	F	expert	60	40	16	56
P4	27..35	F	interm.	67.5	42	15	57
P5	27..35	F	interm.	55	36	19	55
P6	36..44	M	expert	72.5	39	15	54
P7	18..26	M	novice	80	30	12	42
P8	27..35	F	interm.	37.5	42	18	60
P9	18..26	F	expert	65	39	25	64
P10	27..35	M	expert	70	49	11	60
P11	27..35	-	expert	77.5	55	21	76
P12	36..44	M	expert	67.5	27	26	53
P13	27..35	M	expert	65	47	12	59
P14	27..35	M	interm.	47.5	38	20	58
P15	27..35	M	novice	72.5	28	23	51



The mean score matches the industry mean of 68.

- contrast with the qualitative data
- no other scores to compare with yet



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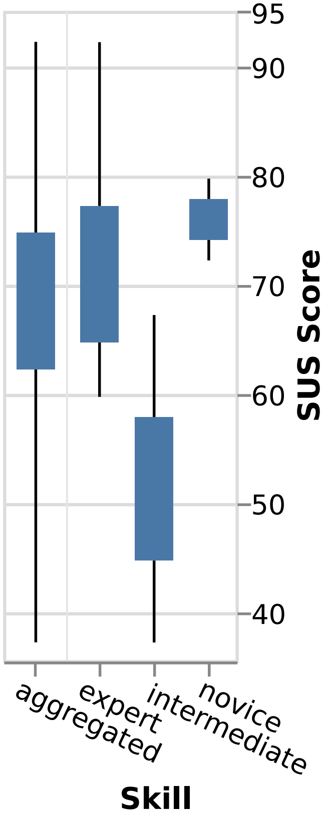

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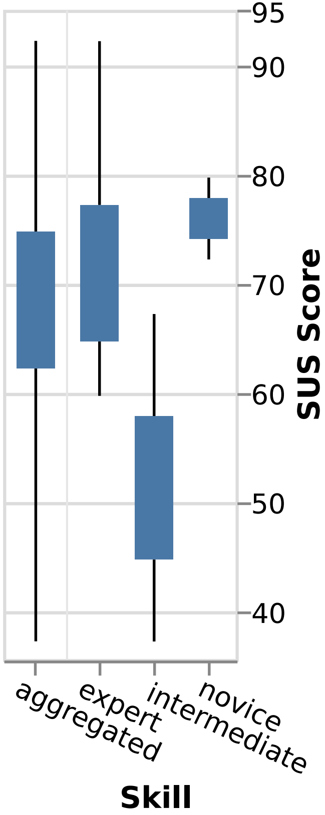
No significant difference between the SUS scores of
- experts and non-experts
- age groups
- gender groups



Summary of our contribution

- GDPR-centric transparency interface for IoT
- User-validated UI
- Laconic visualization of large data-sets
- Shared SUS scores for comparisons with alternatives
- Source-code for replication and derivative works

Call to action

- *Try* it: **privacy-facts.eu**
- *Tinker* with the source code
- Provide *feedback*
  - weaknesses
  - improvements
  - new use cases
- Talk to your *friends* about it
- Mention it to *policy-makers*

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    - new use cases
- Talk to your *friends* about it
- Mention it to *policy-makers*

Thanks to

- Heuristic evaluators
- Participants
- Privacy&Us
- ULD (Unabhängiges Landeszentrum für Datenschutz Schleswig-Holstein)
- USECON
- Open source community

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Bonus slides

- You‘ve unlocked a secret area!

Replication bundle

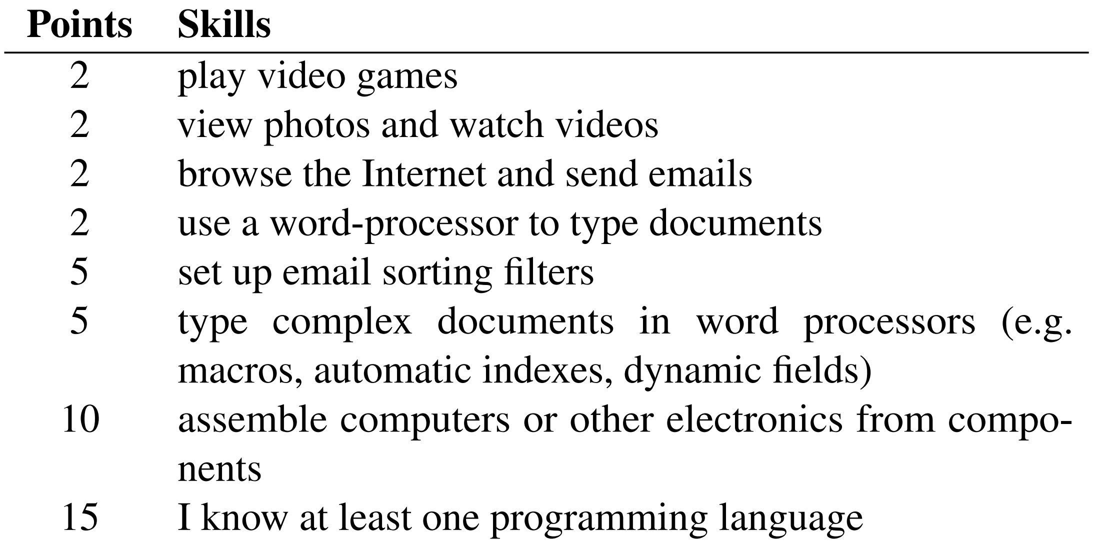
- Check **privacy-facts.eu** to find
  - more screenshots
  - source code and instructions
  - statistical calculations
  - other supplementary materials

Other remarks

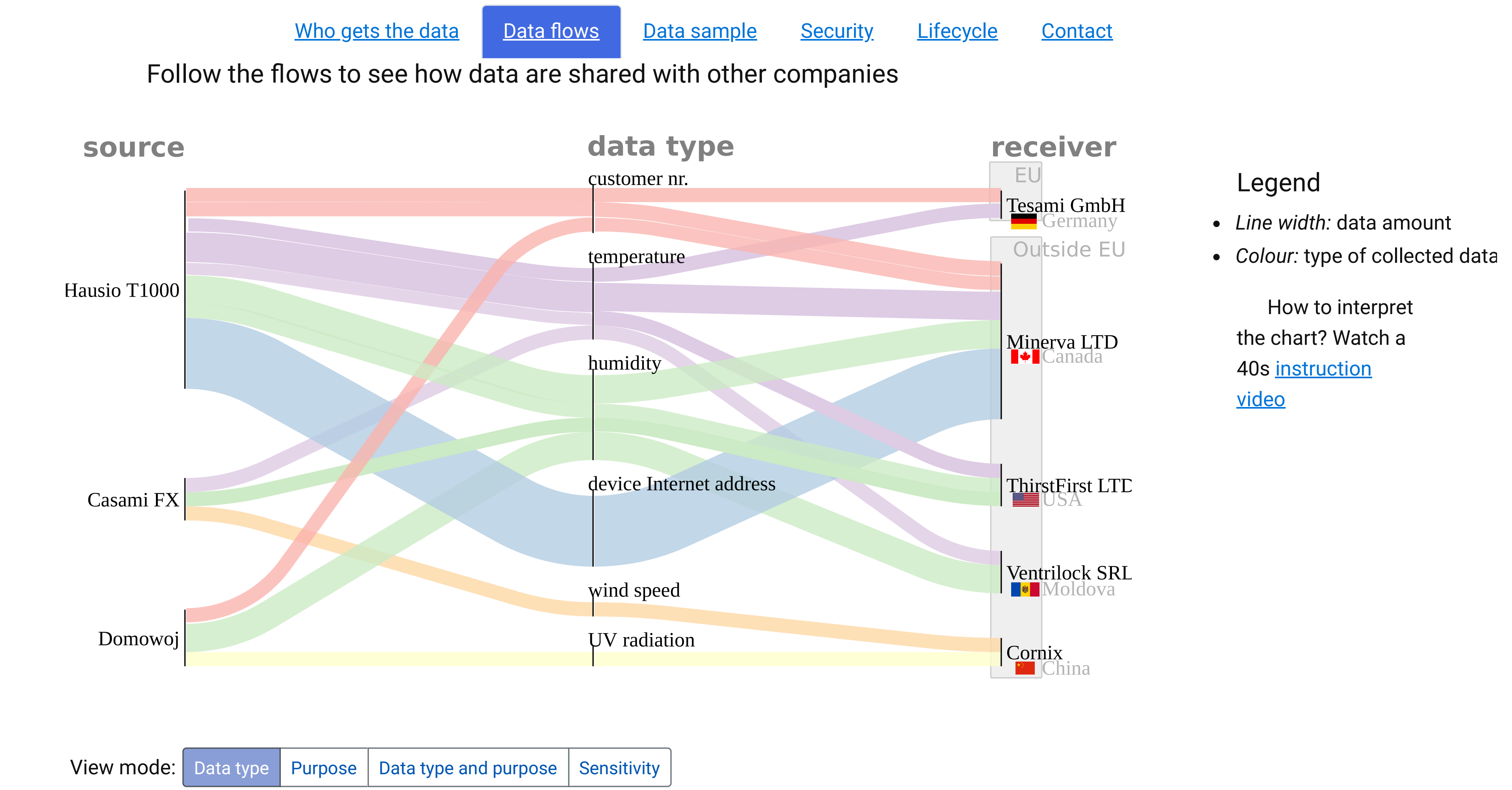
- „Military-grade security“ was planted in the “more technical details” section of “Security” (on slide#11) to see whether participants would want to clarify what it means.
  - Nobody did
  - We do not endorse the use of such terms

How the level of expertise was evaluated

- Novice < 8 < intermediate < 20 < expert



Points	Skills
2	play video games
2	view photos and watch videos
2	browse the Internet and send emails
2	use a word-processor to type documents
5	set up email sorting filters
5	type complex documents in word processors (e.g. macros, automatic indexes, dynamic fields)
10	assemble computers or other electronics from components
15	I know at least one programming language



Who gets the data | Data flows | Data sample | Security | Lifecycle | Contact

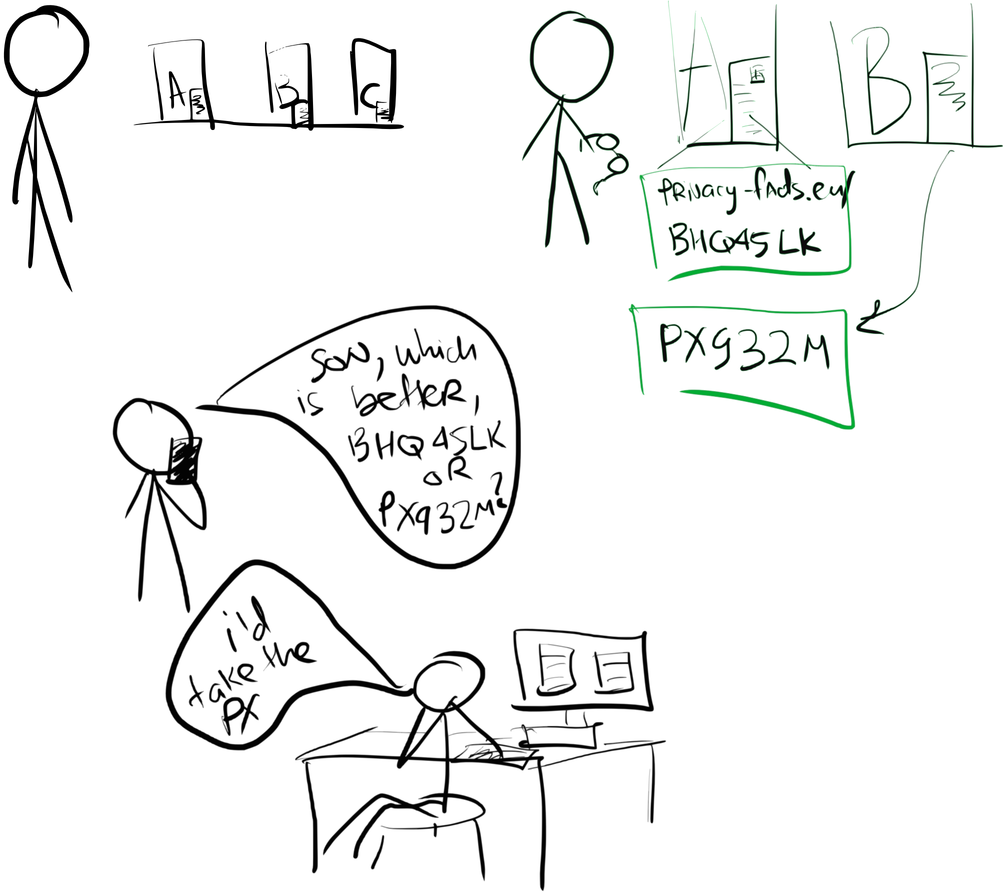
Follow the flows to see how data are shared with other companies

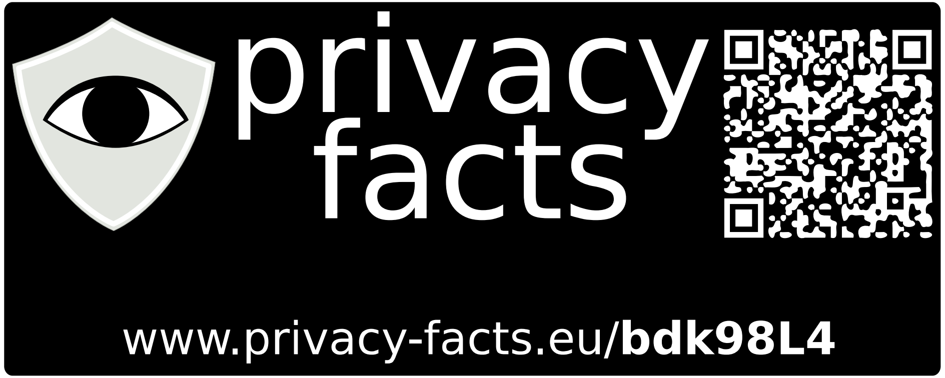
Legend

- *Line width:* data amount
- *Colour:* type of collected data

How to interpret the chart? Watch a 40s instruction video

View mode: Data type | Purpose | Data type and purpose | Sensitivity


A
B
C
A
B
privacy-fads.eu/
BHQ45LK
PX932M
Sow, which is better, BHQ45LK or PX932M?
i'd take the PX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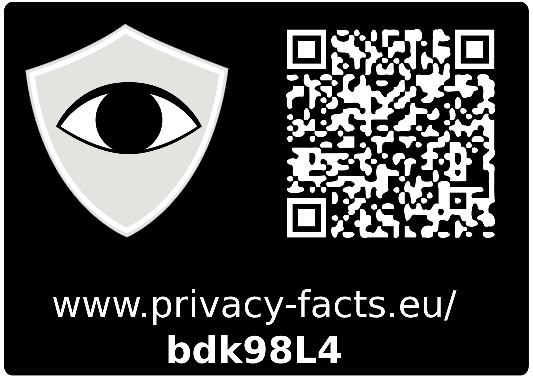
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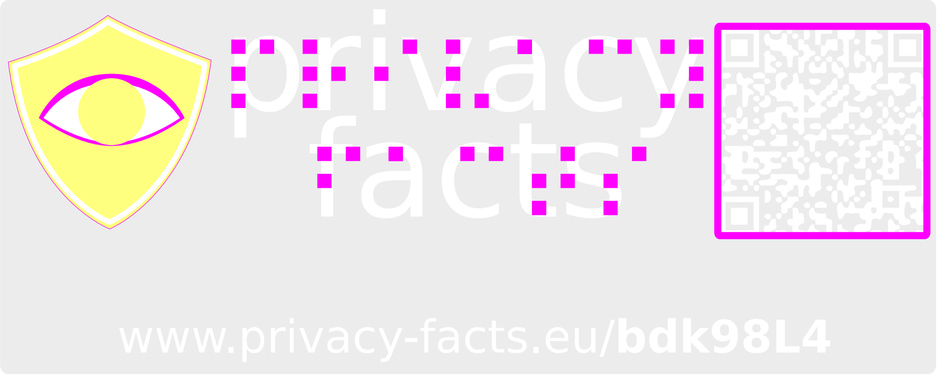
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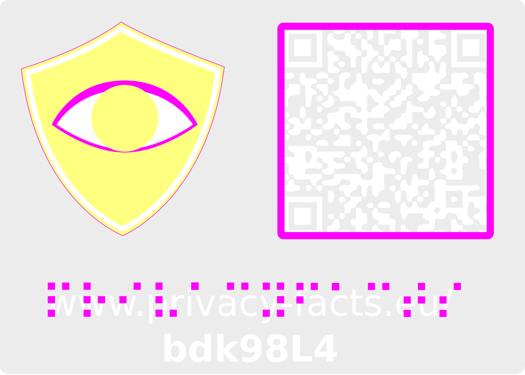
www.privacy-facts.eu/bdk98L4


www.privacy-facts.eu/
bdk98L4

What purpose are the data collected for?

- ❑ Marketing offers
- ❑ Home automation
- ❑ Automatic billing
- ❑ My personal use
- ❑ Scientific research
- ❑ ________________
- ❑ ________________
- ❑ I don’t know

0 errors

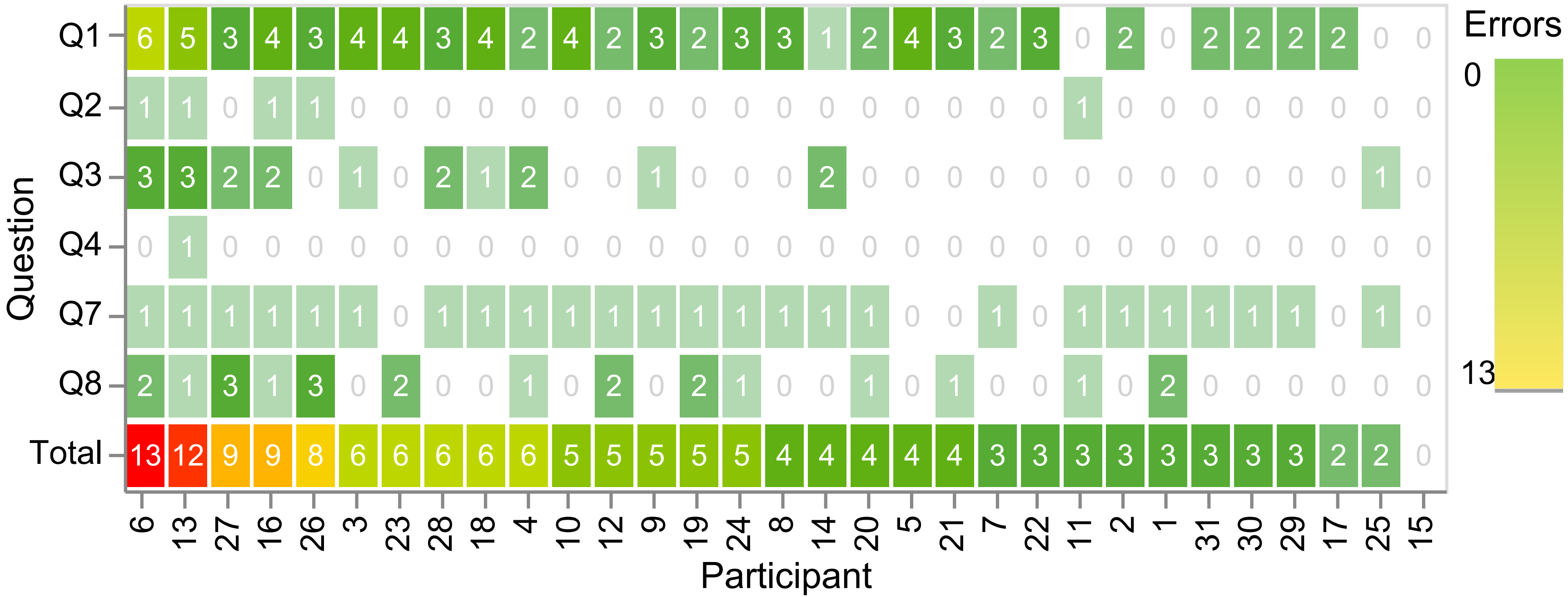
Expected answers

- ❑ Marketing offers
- ❑ Home automation
- ❑ Automatic billing
- ❑ My personal use
- ❑ Scientific research
- ❑ Targeted advertisements
- ❑ Product improvement
- ❑ I don’t know

2 errors

Every deviation = 1 error

- ❑ Marketing offers
- ❑ Home automation
- ❑ Automatic billing
- ❑ My personal use
- ❑ Scientific research
- ❑ ________________
- ❑ Product improvement
- ❑ I don’t know



	6	13	27	16	26	3	23	28	18	4	10	12	9	19	24	8	14	20	5	21	7	22	11	2	1	31	30	29	17	25	15
Q1	6	5	3	4	3	4	4	3	4	2	4	2	3	2	3	3	1	2	4	3	2	3	0	2	0	2	2	2	2	0	0
Q2	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Q3	3	3	2	2	0	1	0	2	1	2	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Q4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Q7	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	0	0	1	0	1	1	1	1	1	1	0	1	0
Q8	2	1	3	1	3	0	2	0	0	1	0	2	0	2	1	0	0	1	0	1	0	0	1	0	2	0	0	0	0	0	0
Total	13	12	9	9	8	6	6	6	6	6	5	5	5	5	5	4	4	4	4	4	3	3	3	3	3	3	3	3	2	2	0

That‘s all, fellow scholars!