

# Up-to-date Threat Modelling for Soft Privacy on Smart Cars

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SCHOOL  
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STUDIES  
LUCCA



Università  
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# Agenda

1. Introduction
2. Privacy Threat Modelling Methodology
3. Demonstration on Smart Cars
4. Conclusions

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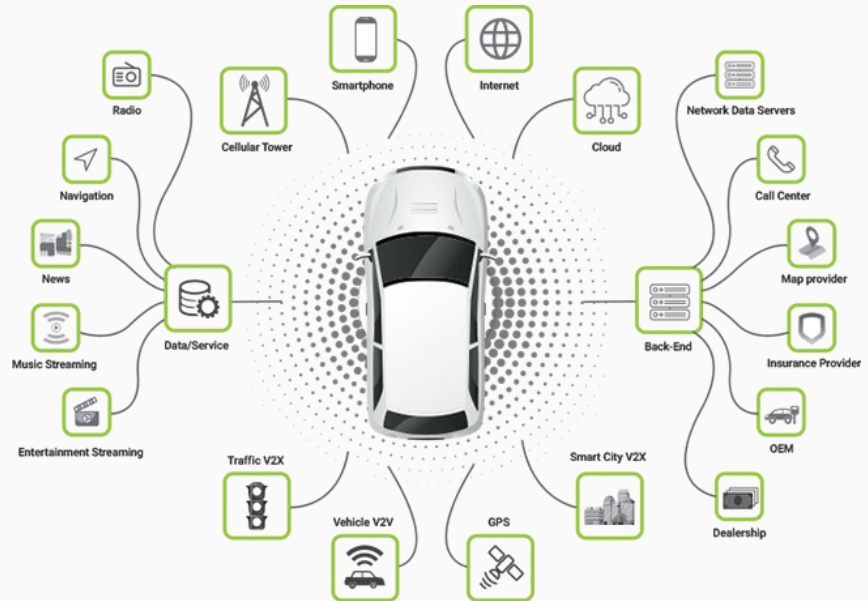
**Privacy** may be summarised as “the right of the data subject to control or influence what information related to them may be collected, processed and stored, and by whom and to whom that information may be disclosed.”

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- GDPR Interpretation

# Privacy Threats in Automotive

Citizens' privacy is particularly threatened when people generate personal data by driving modern cars as well as by surfing the Internet.



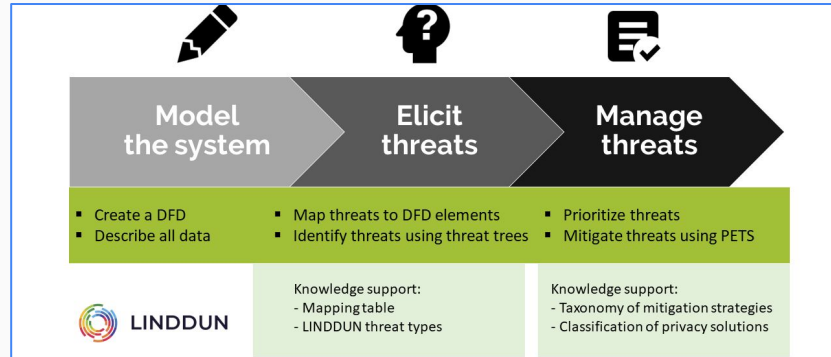
**“Threat modelling** works to identify, communicate, and understand threats and mitigations within the context of protecting something of value.”

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- OWASP

# Privacy Threat Modelling with LINDDUN

LINDDUN is a privacy threat modelling methodology that supports analysts in systematically eliciting and mitigating privacy threats in software architectures.

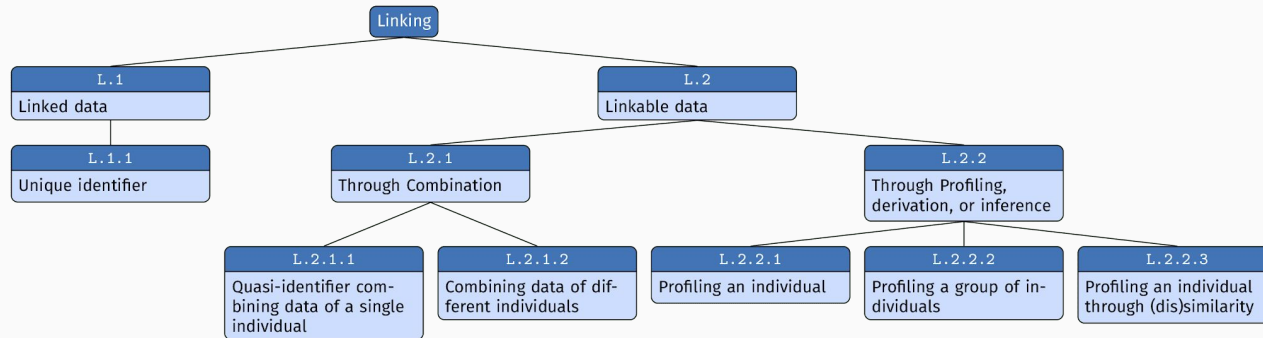


# LINDDUN Knowledge Base

LINDDUN provides a set of threats specific to privacy, named as “threat catalogue”, in the form of threat trees.

The root node represents the ultimate goal.

The children nodes embody different ways of achieving that goal.





# Hard Privacy vs Soft Privacy

## Hard Privacy:

Focus on minimising the risks associated with the collection and retention of personal data.

## Soft Privacy:

Focus on the appropriate use and sharing of personal data while respecting individuals' rights to control their data.

L-I-N-D



U-N

# Old vs New LINDDUN (1)



## Linkability

An adversary is able to link two items of interest without knowing the identity of the data subject(s) involved.



## Identifiability

An adversary is able to identify a data subject from a set of data subjects through an item of interest.



## Non-repudiation

The data subject is unable to deny a claim (e.g., having performed an action, or sent a request).



## Detectability

An adversary is able to distinguish whether an item of interest about a data subject exists or not, regardless of being able to read the contents itself.



## Disclosure of information

An adversary is able to learn the content of an item of interest about a data subject.



## Unawareness

The data subject is unaware of the collection, processing, storage, or sharing activities (and corresponding purposes) of the data subject's personal data.

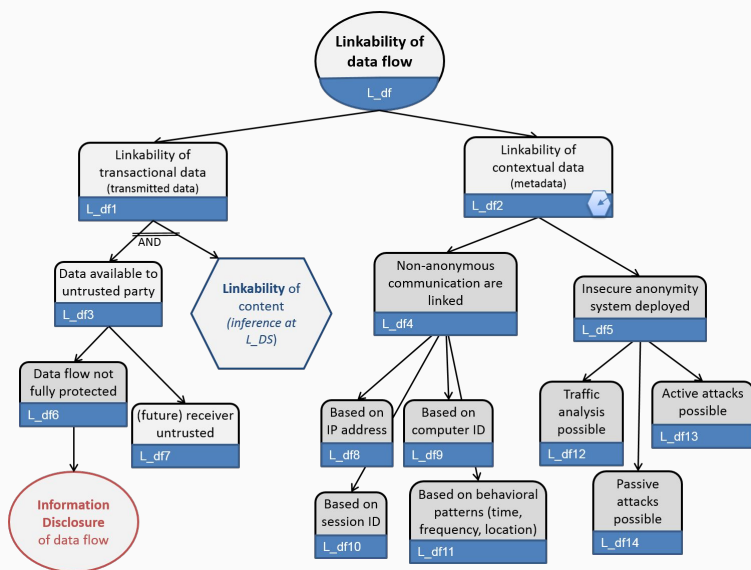


## Non-compliance

The processing, storage, or handling of personal data is not compliant with legislation, regulation, and/or policy.

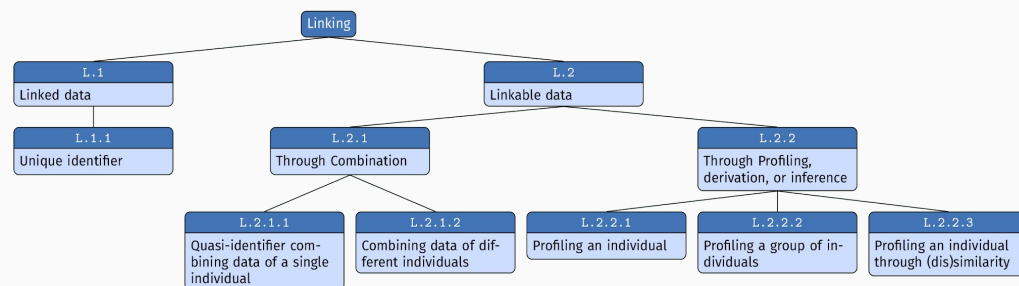


# Old vs New LINDDUN (2)



Hard privacy threats reduced from 109 to 28

Soft privacy threats increased from 9 to 17



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# Privacy Threat Modelling Ingredients



# Document Source

- > Internal
- > External
- > Hybrid



*It provides the means to keep track of the version of the threats, e.g., the year in which the specific threat list is published.*

# Specific Privacy Property

- > **Hard Privacy**
- > **Soft Privacy**
- > **Cybersecurity**



*Cybersecurity plays a complementary role in terms of protection against the unauthorised access of data.*

# Threat Agents

- > **Attacker**
- > **Data processor**
- > **Data controller**
- > **Third party**



*TAs may also be considered in combination.*



# Application Domain

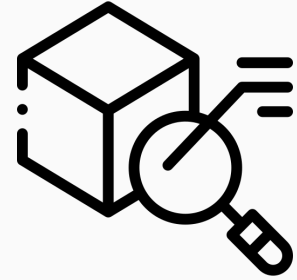
- > **Domain-Dependent**
- > **Domain-Independent**



*A combination of the two approaches may offer a more effective and efficient analysis.*

# Level of Detail

- > **Hyponym (higher / detailed)**
- > **Hypernym (lower / abstract)**



*A hyponym implies a more precise likelihood estimation. However, an excessive level of detail leads to an exact assignment of the likelihood (either the bottom or the top value).*

# Combinatoric Approach

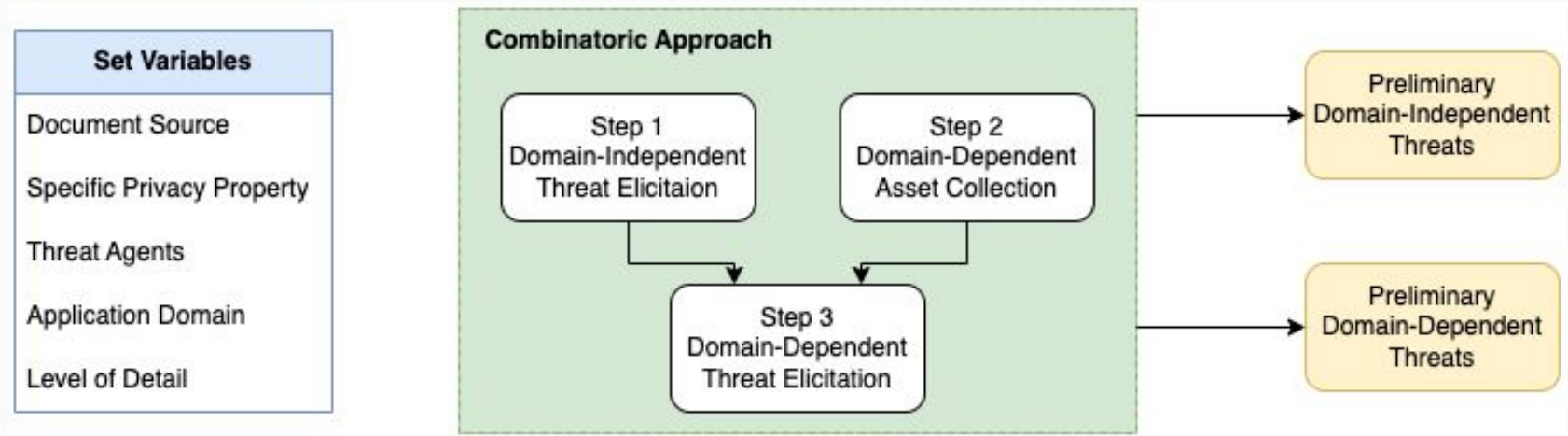
**Step 1 — Domain-Independent Threat Elicitation:** involves the collection of the threats that the analyst deems relevant.

**Step 2 — Domain-Dependent Asset Collection:** consists of the collection of a list of assets for the target domain from relevant sources.

**Step 3 — Domain-Dependent Threat Elicitation:** produces a list of domain-specific threats.



# Privacy Threat Modelling Methodology



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# Automotive Demo



**Soft Privacy**



**Domain-dependent**



**External**



**Attacker, Data processor/controller, Third party**



**Abstract (Hypernym)**

# Automotive Demo – Step 1

We selected a total of **23 privacy threats** from:

“Threat Catalogue Trees” (LINDDUN)

“Threat Taxonomy v2016” (ENISA)

“Good practices for security of smart cars” (ENISA)

“Calculation of the complete Privacy Risks list v2.0” (OWASP)

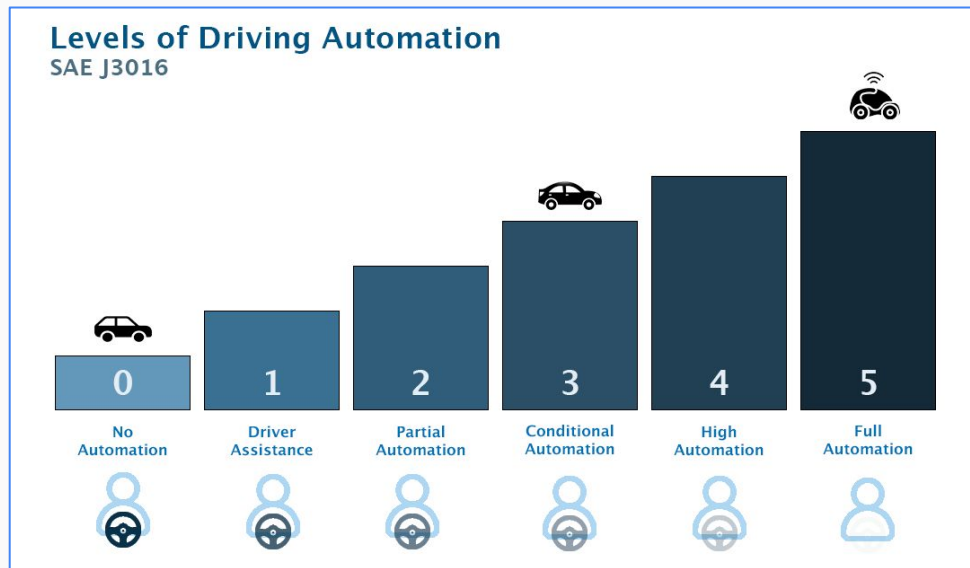
S	Threat
U	Unawareness of processing
	Unawareness as data subject
	Unawareness as a user sharing personal data
	Lack of data subject control
	Lack of data subject control – Preferences
	Lack of data subject control – Access
	Lack of data subject control – Rectification/erasure
N	Regulatory non-compliance
	GDPR
	Insufficient data subject controls
	Violation of data minimization principle
	Unlawful processing of personal data
	Invalid consent
	Lawfulness problems not related to consent
	Violation of storage limitation principle
	Improper personal data management
	Insufficient cybersecurity risk management
ENISA	Failure to meet contractual requirements
	<i>Unauthorized use of IPR protected resources</i>
	<i>Judiciary decisions/court orders</i>
OWASP	Misleading content
	Secondary use
	Sharing, transfer or processing through 3rd party

# Automotive Demo – Step 2

We selected a total of **43 assets** from:

“Good practices for security of smart cars” (ENISA)

“A double assessment of privacy risks aboard top-selling cars” (Bella et al.)





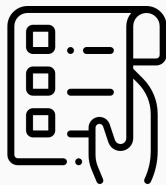
# Automotive Demo – Step 3

S	Threat	Assets
U	Unawareness of processing	Sensors data, Map data, V2X information, Device information, User information, Special categories of personal data, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Unawareness as data subject	Map data, V2X information, Device information, User information, Special categories of personal data, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Unawareness as a user sharing personal data	User information, Special categories of personal data
	Lack of data subject control	Map data, Device information, User information, Special categories of personal data, Driver's behaviour, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Lack of data subject control - Preferences	User preferences, Purchase information
	Lack of data subject control - Access	User information, Special categories of personal data
	Lack of data subject control - Rectification/erasure	Sensors data, Map data, V2X information, Device information, User information, Special categories of personal data, Driver's behaviour, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
N	Regulatory non-compliance	All assets
	GDPR	All assets
	Insufficient data subject controls	Map data, V2X information, Device information, User information, Special categories of personal data, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Violation of data minimization principle	Sensors data, Map data, V2X information, Device information, User information, Special categories of personal data, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Unlawful processing of personal data	All assets
	Invalid consent	All assets
	Lawfulness problems not related to consent	All assets
	Violation of storage limitation principle	Sensors data, Key and certificates, Map data, V2X information, Device information, User information, Special categories of personal data, User preferences, Purchase information, Vehicle information, Vehicle maintenance data
	Improper personal data management	User information, Special categories of personal data
	Insufficient cybersecurity risk management	All assets
ENISA	Failure to meet contractual requirements	All assets
	Unauthorized use of IPR protected resources	All assets
	Judiciary decisions/court orders	All assets
OWASP	Misleading content	Map data, V2X information, Device information, User information, Special categories of personal data, User preferences
	Secondary use	All assets
	Sharing, transfer or processing through 3rd party	Sensors data, Key and certificates, Map data, V2X information, Device information, User information, Special categories of personal data, Driver's behaviour, User preferences, Purchase information, Vehicle information, Vehicle maintenance data

# Automotive Demo – Results

> **23 soft privacy threats** (17 before)

> **43 assets** (41 before)



These soft privacy threats are both *domain-independent* and *domain-dependent*.  
(by appropriate combinations, we obtain 525 automotive-specific threats)

Crucial difference from past results:

Among the 8 threats added to the list in our previous work, 4 were deemed to be embraceable with the new LINDDUN threat catalogue.

# Case Study

Technology

## Toyota's Indian unit warns of a possible customer data breach

Reuters

January 3, 2023 9:41 PM GMT+1 · Updated 6 months ago



A Toyota Logo is seen at a Toyota dealership in Zaventem, Belgium, November 25, 2022.  
REUTERS/Johanna Geron/

Jan 1 (Reuters) - A data breach at Toyota Motor's (7203.T) Indian business might have exposed some customers' personal information, it said on Sunday.

Reviews

## The Ring Car Cam takes Ring's great security smarts on the road

Jason Cipriani, CNN Underscored  
Updated 11:08 AM EST, Thu February 16, 2023



February 22, 2023 08:09 AM

## Tesla escapes fine from Dutch watchdog after automaker alters security cameras

Tesla made changes to its "Sentry Mode" that include warning passers by of its activation and requiring approval from the car's owners in order to begin filming.

Reuters

### Some matching threats:

*Insufficient data subject control*

*Violation of data minimization principle*

*Judiciary decisions/court order*

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# Conclusions

The risks for “*natural persons with regard to the processing of personal data and on the free movement of such data*” can be now assessed more precisely, especially if those natural persons drive **smart cars**.

Future work includes:

- *deeper semantic analysis (semantic relations for the level of detail)*
- *application to different tuple of variables (e.g., hard privacy, high level of detail)*

# Thanks for your attention!

For more information or questions:



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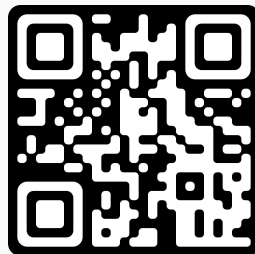
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*Non-malicious QR (maybe)*