ULS: A unified likelihood scale for cross-standard risk assessment

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Public C-SC0

Introduction

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Motivation

Smart traffic system Munich

Talking traffic program Netherlands

- What are **I**ntelligent **T**ransport **S**ystems **(ITS)?:**
  - They are smart systems that help vehicles, roads, and traffic signals work together to make travel safer and efficient.
- **ITS** is spreading rapidly across the globe.
- The faster **ITS** grows, the more essential it becomes to ensure consistent and reliable risk assessment.

Risk assessment

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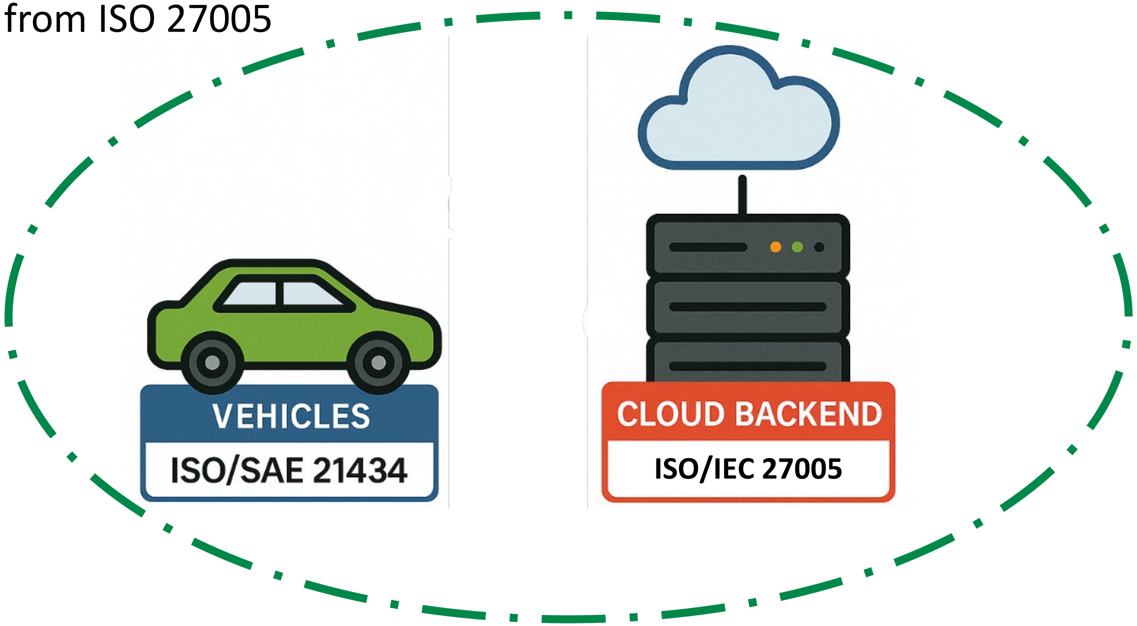
Introduction

Problem statement

- ITS systems such as vehicles, smart infrastructure, cloud backend systems use different standards.
- Hence, it is hard to perform a unified risk assessment.
- Different security standards use different methods for calculating risk likelihood.
  - Attack Potential (AP) from ISO 21434
  - Exploitability Sub-Score (ESS) of CVSS from ISO 27005



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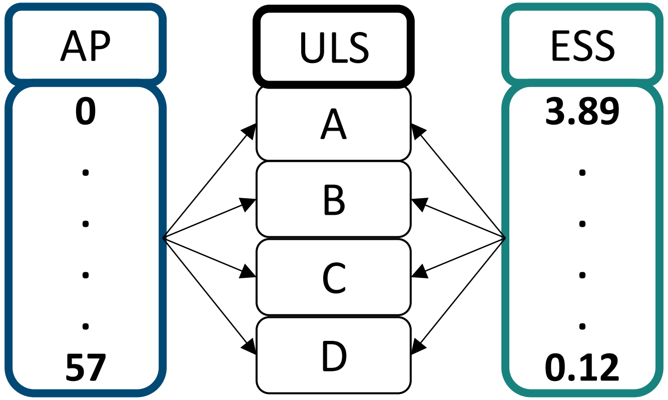
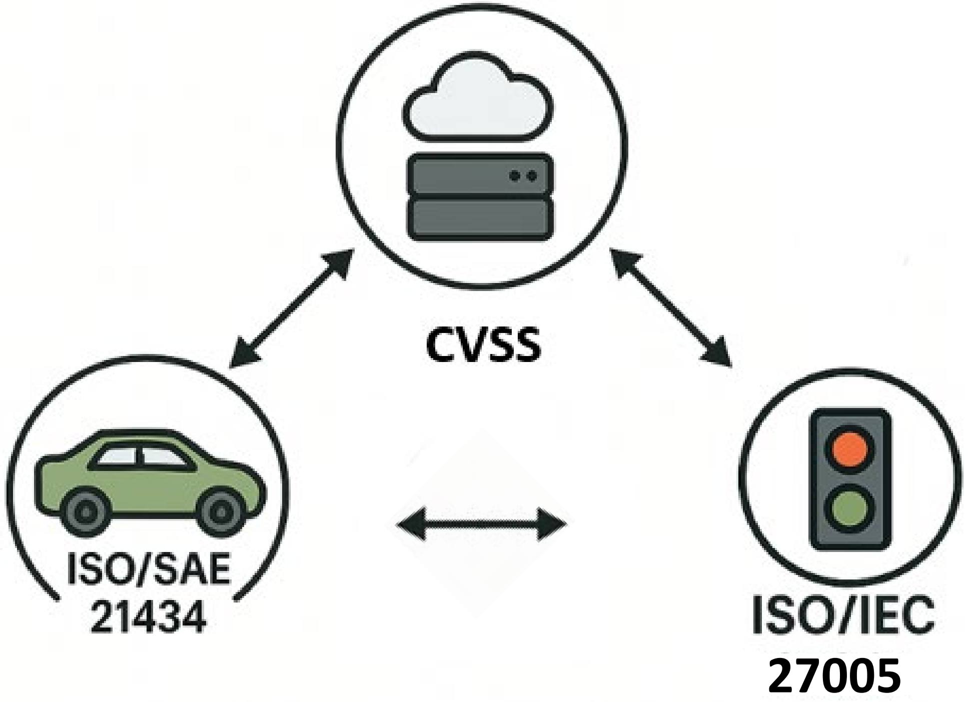
ULS

What is ULS?

- A common scale to map values of different likelihood methods.
- Allows for sharing likelihood values between different systems.
- Supports unified risk assessments.
- Allows for cross-standard risk assessment.





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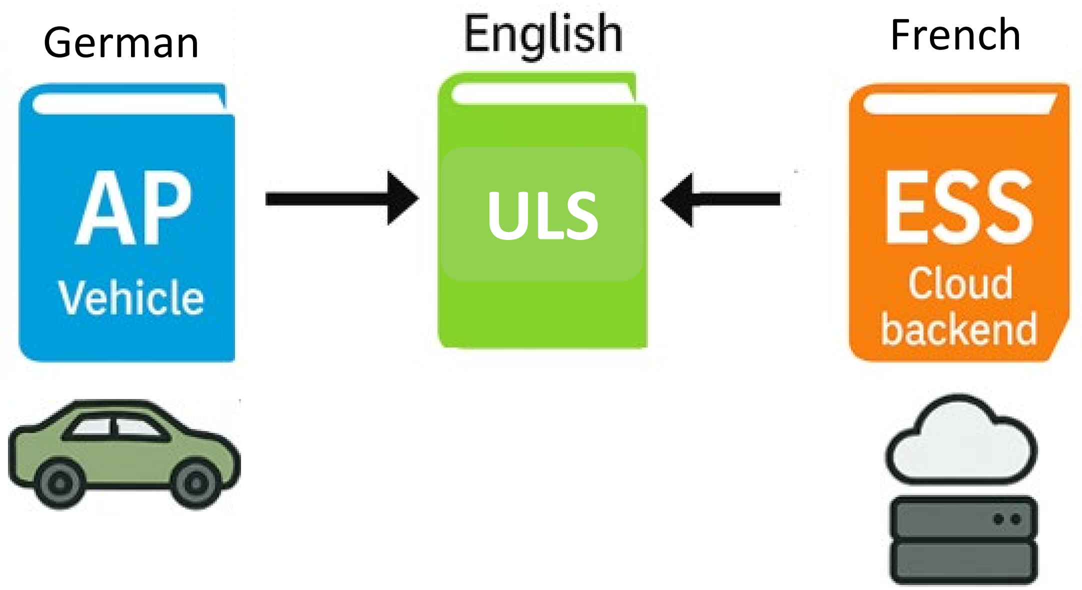
What is ULS?

ULS translates different risk likelihood values into a common language



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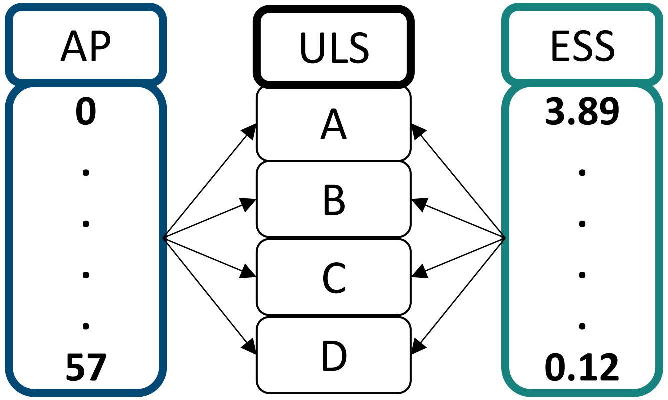
ULS

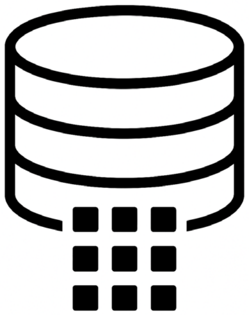
ULS development

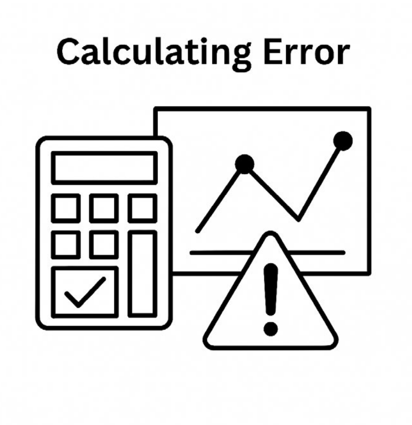
1. Generate all the possible AP and ESS mappings to the ULS.
2. Use an attacks dataset to evaluate each mapping.
3. Calculate mapping error per attack.
4. Select the optimal ULS based upon our criteria.

How to map the likelihood values to the 4 segment ULS?

How to select the best ULS mapping?







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ULS development

1. Generate all possible ULS mappings

a) **Define the possible value ranges**

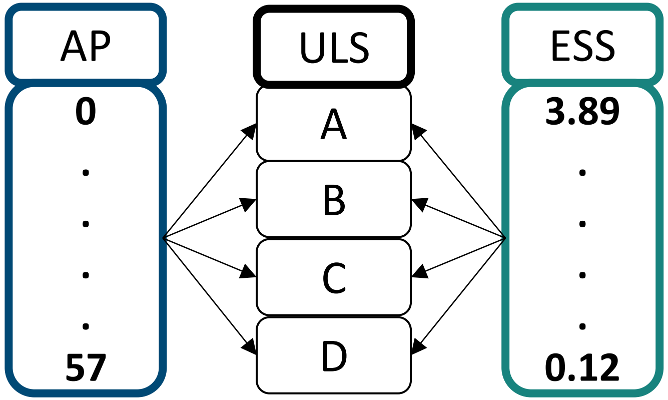
- **AP values** range from **0 to 57.**
- **ESS values** range from **3.89 to 0.12.**

b) **ULS segmentation**

- For AP and ESS, generate all valid ways to divide their values into 4 segments.

c) **Pair all AP and ESS mappings**

- Pair each possible AP-to-ULS mapping with each possible ESS-to-ULS mapping.



AP	AP	AP	ULS	ESS	ESS	ESS
0-12	0-15	0-19	A	3.89-2.22	3.89-2.07	3.89-1.83
13-20	16-25	20-31	B	2.07-1.34	1.83-1.05	1.62-0.76
21-35	26-39	32-45	C	1.23-0.67	0.91-0.51	0.71-0.49
36-57	40-57	46-57	D	0.66-0.12	0.49-0.12	0.46-0.12

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2. Use the dataset to evaluate each mapping

a) Every mapping pair is evaluated using the attacks in the dataset.

3. Calculate mapping error

a) Each ULS segment has a numerical value**, A=1, B=2, C=3, D=4.**

b) Error = |ULS(AP) – ULS(ESS)|.

c) Calculate the average error over all attacks.

Calculating Error

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4. Select the optimal ULS based upon our predefined criteria

a) Minimize the mapping error

b) Utilize the four ULS segments

  – To avoid too narrow or too wide segments.

c) Prioritize most frequent segmentations

  – As we could have several mappings with equal mapping errors.

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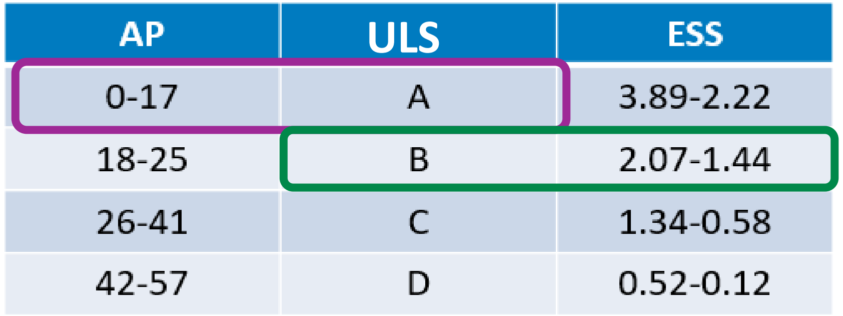
Example

- **Scenario:**
  - A vehicle’s ECU uses AP from ISO/SAE 21434 **(AP=17).**
  - A cloud backend system uses Exploitability Subscore (ESS) from CVSS **(ESS=2.07).**
- **Without ULS:**
  - AP and ESS values are **incompatible**; no direct way to compare their likelihood values.
  - Risk values stay **isolated within subsystems.**
  - Unified risk analysis becomes **subjective or challenging.**
- **With ULS:**

System	Likelihood method	ULS segment
Vehicle ECU	AP = 17	Segment A = 1
Cloud backend	ESS = 2.07	Segment B = 2



AP	ULS	ESS
0-17	A	3.89-2.22
18-25	B	2.07-1.44
26-41	C	1.34-0.58
42-57	D	0.52-0.12

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DATASET

- **Dataset challenges:**
  - Lack of publicly available rated attacks datasets.
  - Skew of available attacks online towards easy to execute attacks.
  - Manual effort required to rate attacks.
- We constructed our own dataset of vehicle cybersecurity attacks.
- **Documented-attacks**
  - **Real-world attacks** reported in public sources such as research papers, security blogs or vulnerability databases.
- **Derived-attacks**
  - **Constructed** based on variations or extrapolations of existing attacks.

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Conclusion

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- **Intelligent Transport Systems (ITS)** rely on interconnected systems where each uses different risk assessment standards and methods.
- ULS bridges the gap between the different likelihood methods in risk assessments.
- ULS enables cross standard risk assessments and more secure collaborations between systems.
- **Future work:**
  - Extending the method to more standards and likelihood methods.
  - Expanding the attacks dataset.

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