

# Capillary Static Policy Setup and Multisensory Dynamic Feedback in Modern Cars

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# It's Official: Cars Are the Worst Product Category We Have Ever Reviewed for Privacy



By Jen Caltrider, Misha Rykov and Zoë MacDonald | Sept. 6, 2023



## Toyota Japan exposed millions of vehicles' location data for a decade

 cybernews®

[Home](#) » [Privacy](#)

## Smart cars vs. privacy: a driverless car could generate 100 GB of data per second

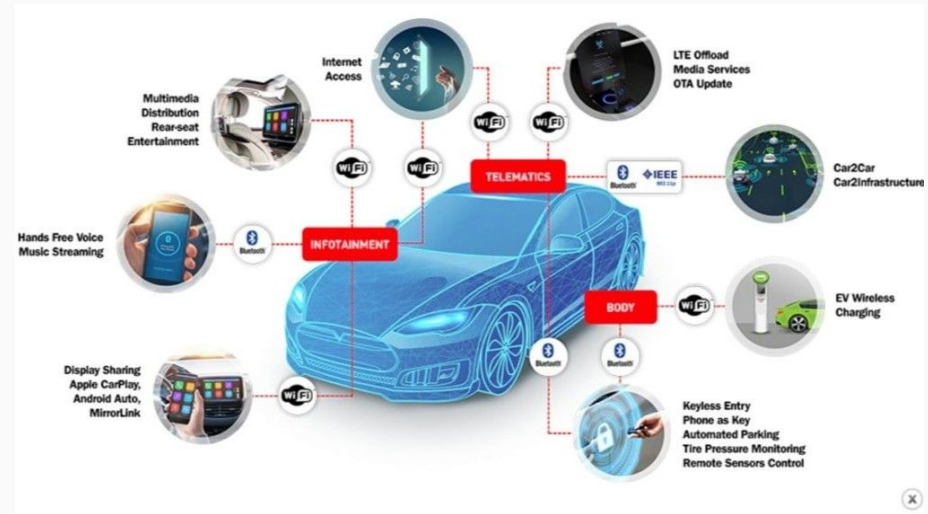


# Introduction

Modern vehicles collect **extensive personal data** (e.g., location, behaviour, media usage)

**GDPR compliance** remains limited in the automotive sector

Lack of transparency and real-time **user control** undermines *privacy and trust*



# Existing Solutions

**PRICON:** Privacy control system with policy presets

**Privacy4Cars:** Post-hoc data deletion and privacy reports

**Gamified consent UIs:** Improve understanding and transparency

## Literature Gap

Lack of *fine control* and *real-time multisensory feedback* for privacy



**RQ:** *How can we enforce user control and awareness on data privacy in modern automotive systems?*

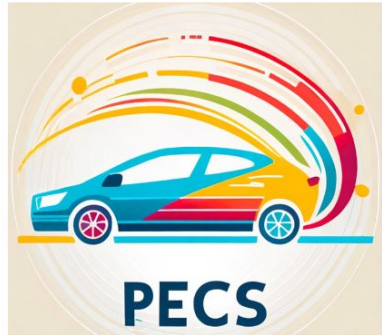
# Agenda

1. Introduction
- 2. PECS**
3. PECSi
4. Conclusions

# Privacy Enrooted Car Systems

The **Privacy Enrooted Car Systems (PECS)** prototypes pioneer privacy-enhancing technologies (*PETs*) tailored for **modern automotive** systems

PECS addresses systemic challenges in *data protection* for car drivers



**NEXT  
GENERATION  
INTERNET**  
INTERNET OF HUMANS



# Privacy Enrooted Car Systems

**PECS** is composed of two main components:

**PECSi** – PECS Multisensory-Media Car Interface  
(*Soft Privacy*)

**PECSo** – PECS Obfuscation Technologies  
(*Hard Privacy*)





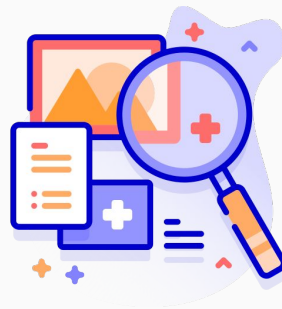
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# PECSi in a Nutshell

**PECSi** aims to provide an innovative approach to **privacy management** in vehicles by combining fine-grained privacy policies with dynamic multisensory feedback

PECSi is composed by a *frontend* and a *backend*: the **PECSi Client** and the **PECSi Service**



# PECSi Contributions

## Capillary Static Policy Setup

Fine-grained privacy configuration

Per-app and global policies, including engine data

## Multisensory Dynamic Feedback

Alerts via audio, video, and haptic feedback

Real-time, user-defined violation notifications



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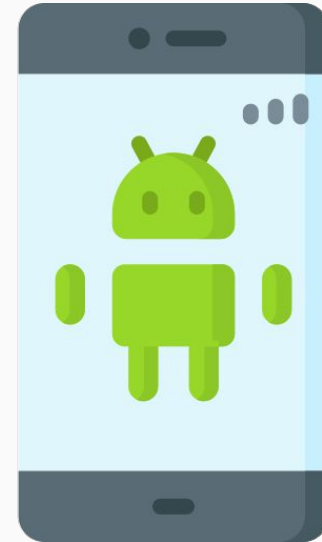
# PECSi Client

*Android app with 3 screens:*

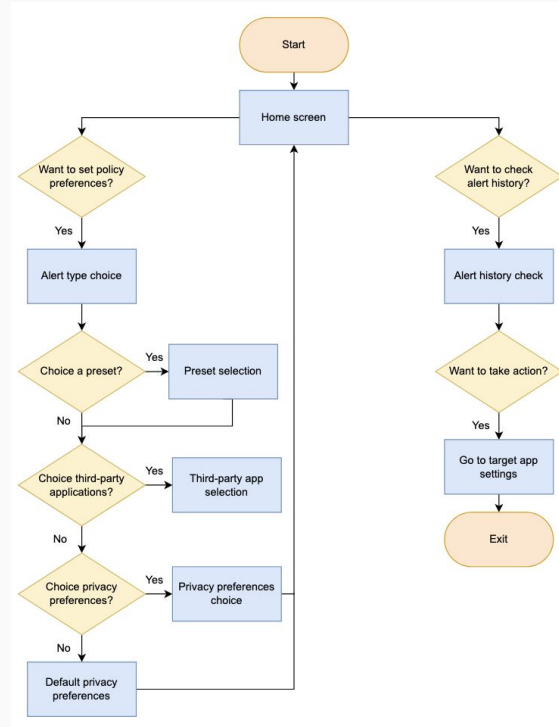
**Home** – dashboard of current settings

**Policy Settings** – wizard-based configuration

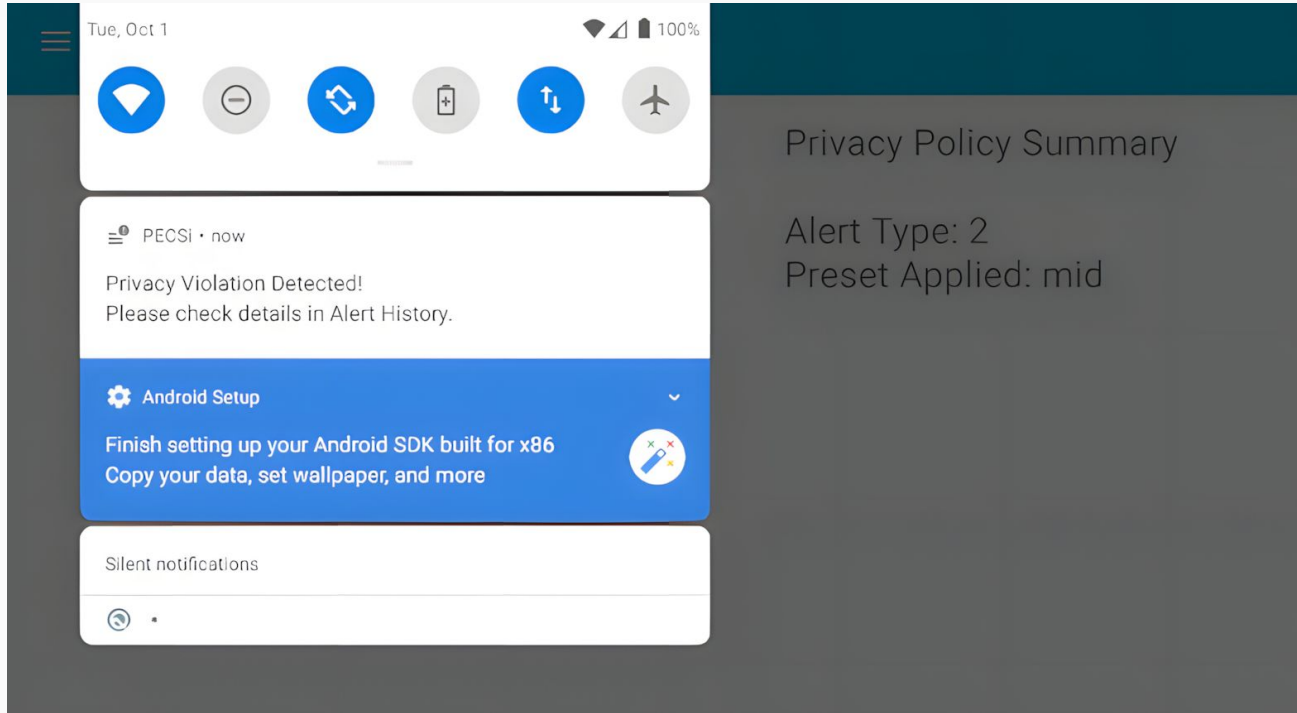
**Alert History** – list of detected violations





# PECSi Client – UX Workflow



# PECSi Client – Home Screen



# PECSi Client — Policy Settings Screen

 Policy Settings

## Welcome to the PECS Policy Settings Configuration Wizard!

PECS allows you to configure privacy policies through a set of presets or by creating fully custom policies. The available presets range from the most restrictive (maximising privacy with reduced user experience) to the most permissive (enhancing user experience at the expense of privacy).

In the event of a privacy violation, a notification will be triggered and you will be invited to see details in the Alert History screen. You are in control to take action following the provided link and change the permissions of the application that is violating your privacy policies.

### Steps to Configure Your Privacy Settings:

- 1. Configure Alerts:**

Choose your preferred alert type for notifications when an application violates your privacy settings. Available alert types include:

  - Text Logs (video feedback)
  - Notifications (audio feedback)
  - Haptic (haptic feedback)

Selecting a higher-level alert will include lower-level alerts (e.g., choosing Haptic feedback will also activate Notifications and Text Logs alerts).
- 2. Choose a Preset:**

Select a preset that aligns with your privacy and user experience preferences. Presets apply globally and to engine data.  
If you select a preset, the alert type will be always set to Audio.
- 3. (Optionally) Select Target Applications:**

After selecting a preset, you can select target applications to which apply custom policies, different from the global settings.
- 4. Customise Policy Settings:**

Review and adjust flags for:

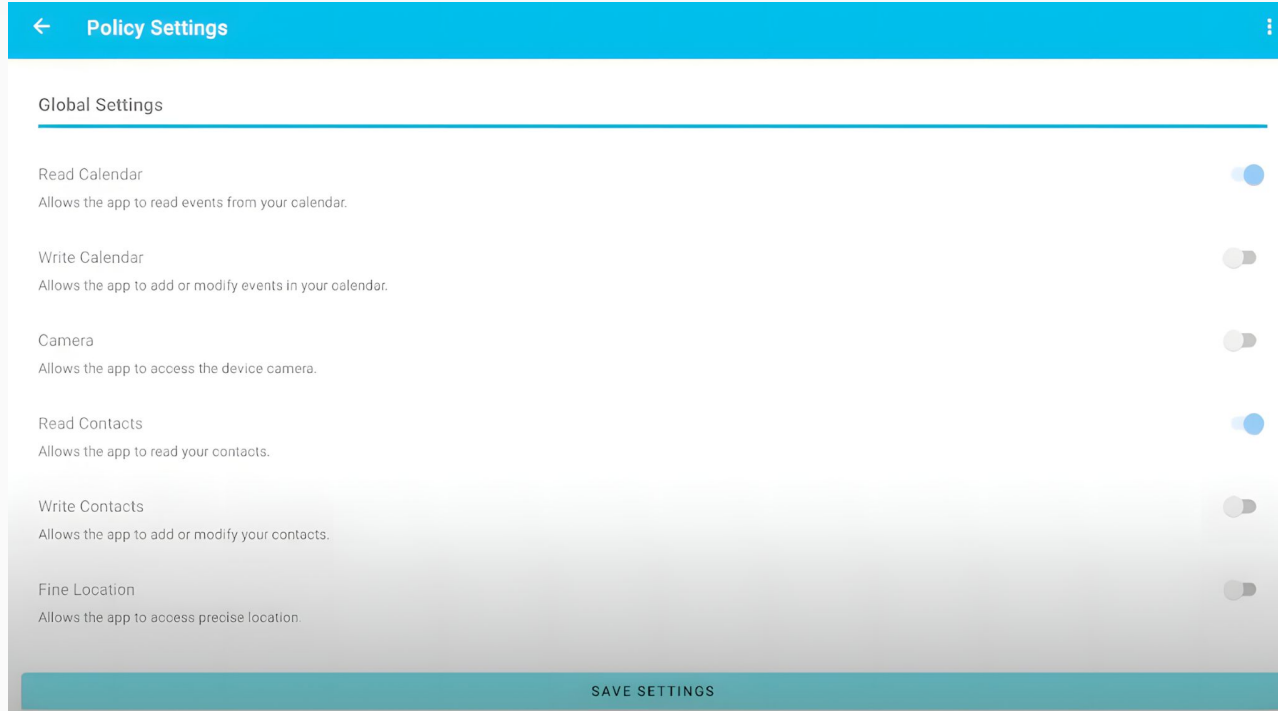
  - Global Settings
  - Engine Data Settings
  - App-Specific Settings (for the target applications you selected)

### Select Your Preferred Alert Type:



Text Logs ▼



# PECSi Client — Policy Settings Screen



# PECSi Client — Alert History Screen

 **Alert History** 

You can resolve an alert by clicking on the 'Go to app settings' link.  
You will be redirected to the settings of the application that is violating your privacy policies.  
Please update the app permissions according to your preferences.

(Note that there might be some permissions that are automatically granted by your operating system and that are not revocable. This may depend on your operating system version.)

com.ilmeteo.android.ilmeteo

record-audio

1720818589

Fri Jul 12 23:09:49 CEST 2024

[Go to app settings](#)

com.ilmeteo.android.ilmeteo

camera

1720818591

Fri Jul 12 23:09:51 CEST 2024

[Go to app settings](#)

app2

bluetooth-admin

1720818589

Fri Jul 12 23:09:49 CEST 2024

[Go to app settings](#)

app2

access-network-state

1720818591

Fri Jul 12 23:09:51 CEST 2024

[Go to app settings](#)

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# PECSi Service

Implements full **PBAC (Policy-Based Access Control)** using *XACML 3.0*

## Key components:

PAP – generates and logs policies

PEP/PDP – enforce and detect violations

PRP/PSIR\* – retrieve policies and monitor system status

Real-time feedback loop with client

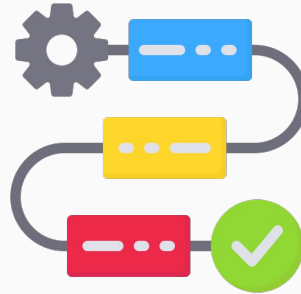


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# PECSi Workflow

1. User sets policy → 2. Policy generation → 3. Policy enforcement →



→ 4. Periodic permission checks → 5. Alert generation → 6. User notification

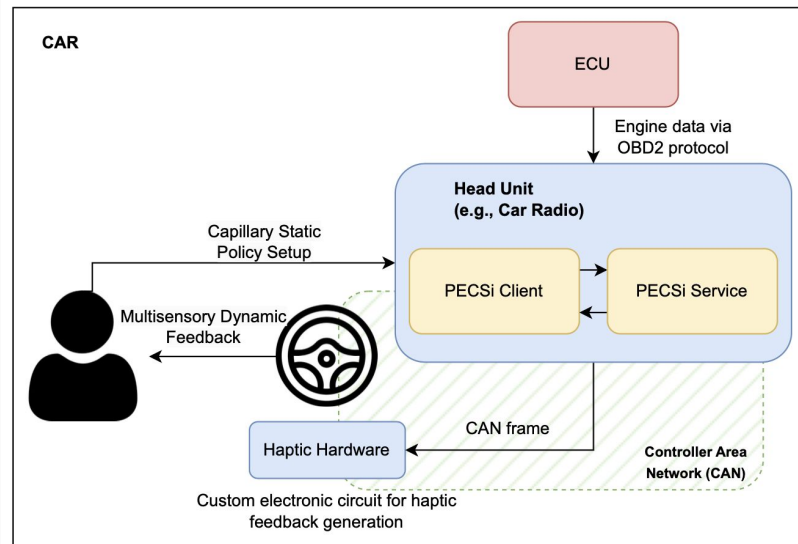
# PECSi Prototype

Installed on *SXAUTO PX6* (Android 12 head unit)

Custom circuit for **steering wheel vibration feedback**

Integrated **CAN bus** for engine data

**TRL 7 prototype** tested in real-world MASA setting



# Takeaways

- + Innovative use of haptic feedback
- + Modular and adaptable (tools for OEMs)
- Manual user action needed post-alert
- Usability needs refinement



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# Conclusions

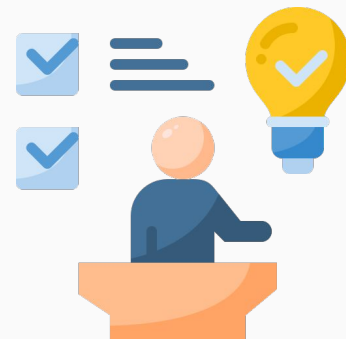
PECSi presents a novel, **GDPR-aligned privacy control interface** for vehicles

Empowers users with *proactive, sensory-rich* privacy management

Bridges significant **gaps** in the current *automotive privacy landscape*

## Future work:

- Usability improvements (UI/UX)
- TRL 8 readiness
- Natural language policy configuration via LLMs
- Broader OEM adoption



# References

PECS Project Website

<https://pecs-project.dmi.unict.it/>

PECS SDK and Docs (GitHub)

[https://github.com/NGI-TRUSTCHAIN/PECS/tree/dev/pecsi/policy\\_engine/docs](https://github.com/NGI-TRUSTCHAIN/PECS/tree/dev/pecsi/policy_engine/docs)

# Thanks for your attention!

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*Non-malicious QR (maybe)*