Unlocking the Road Ahead:

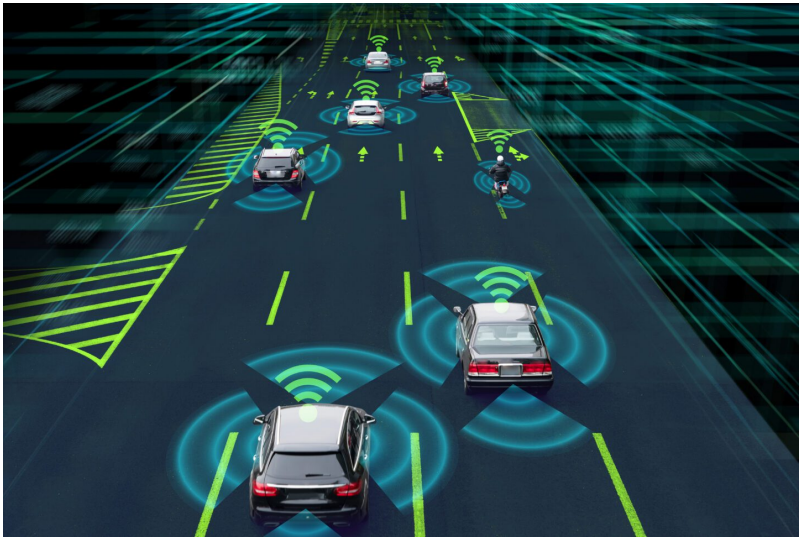
Automotive Digital Forensics

Kevin Gomez

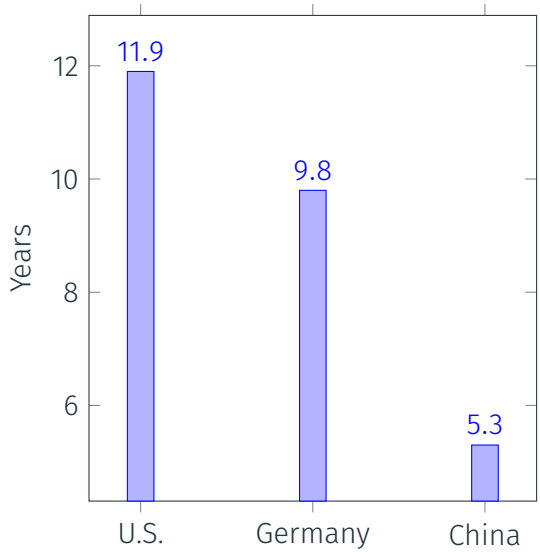
December 27th, 2023

University of Applied Science Ingolstadt

When you think about modern vehicles...



Average age of vehicles on the road



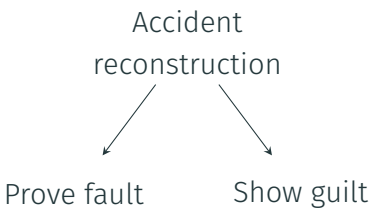
So what do we have to deal with?

What about modern vehicles?

- Smart-home integration
- Keyless-Go
- Smartphone integration
- Infotainment features
- Advanced driver assistant systems
- Many more...

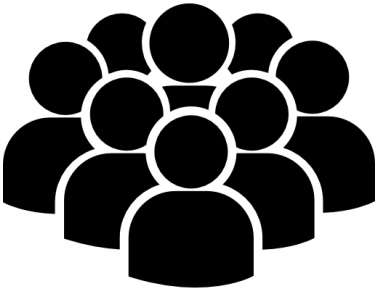
Automotive digital forensics

What are current use-cases for automotive digital forensics?



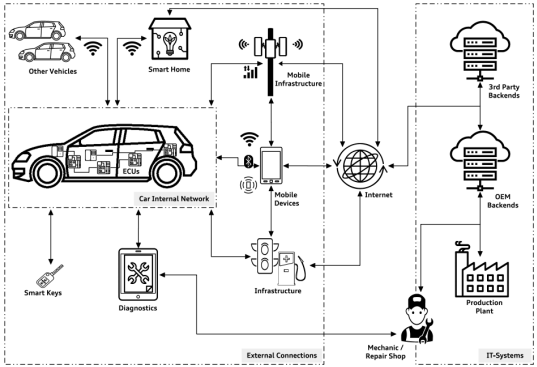
But why automotive digital forensics?

- Multiple users



But why automotive digital forensics?

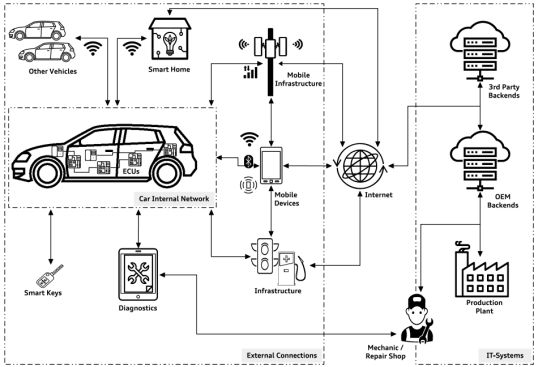
- Multiple users
- Massively networked



Corbett et al. (2018). Security Testing for Networked Vehicles.

But why automotive digital forensics?

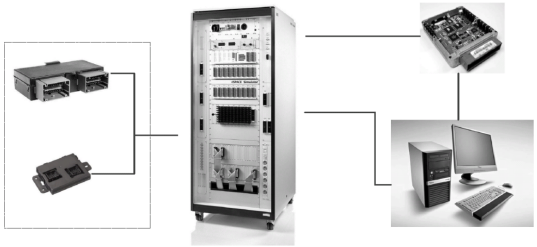
- Multiple users
- Massively networked
- Cyber-physical system



Corbett et al. (2018). Security Testing for Networked Vehicles.

But why automotive digital forensics?

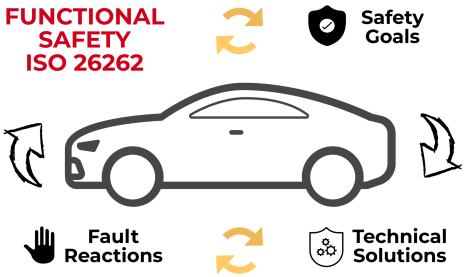
- Multiple users
- Massively networked
- Cyber-physical system
- Dependencies between components



Osswald et al. (2013). Hardware-in-the-Loop-Based Evaluation Platform for Automotive Instrument Cluster Development (EPIC).

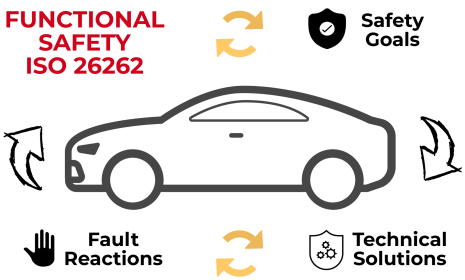
But why automotive digital forensics?

- Multiple users
- Massively networked
- Cyber-physical system
- Dependencies between components
- Functional data



But why automotive digital forensics?

- Multiple users
- Massively networked
- Cyber-physical system
- Dependencies between components
- Functional data
- Safety implications



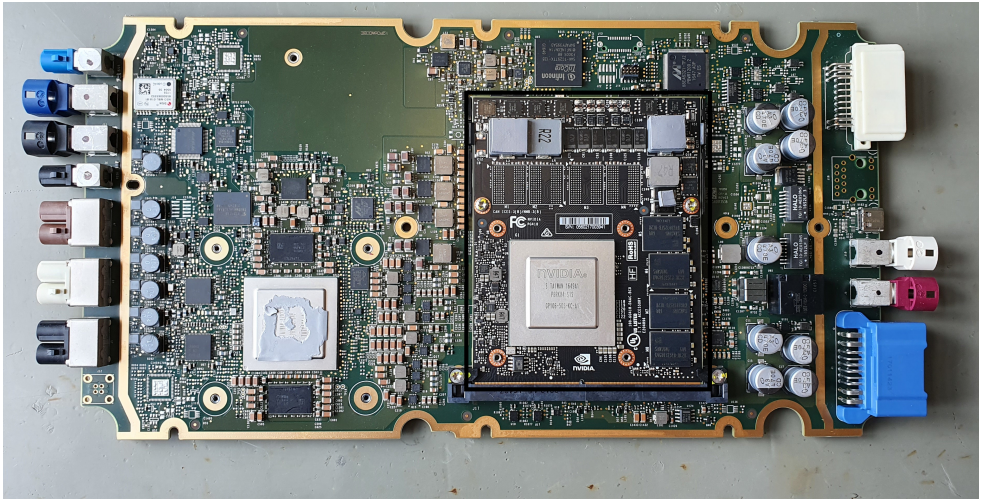
But why automotive digital forensics?

- Multiple users
- Massively networked
- Cyber-physical system
- Dependencies between components
- Functional data
- Safety implications
- Accessibility

How do I investigate a modern vehicle?

- Berla iVe
- CDR/EDR tooling
- Embedded forensics techniques
- Proprietary development tools
- Third-party tooling
- Hardware-in-the-loop setups

The Tesla Autopilot investigation



Process steps in the investigation

1. Receive Tesla Autopilot component.
2. Identify storage unit on the component, eMMC in this case.
3. Perform chip-off of the eMMC.
4. Use eMMC reader to acquire data.
5. Identify SquashFS as a file system.
6. Perform metadata analysis and identify logs.
7. Document collected results.

So everything is fine right?

- Rare in-depth investigations
- Limited tools
- Manufacturer specifics
- Accessibility challenges
- Knowledge reuse and documentation is bad

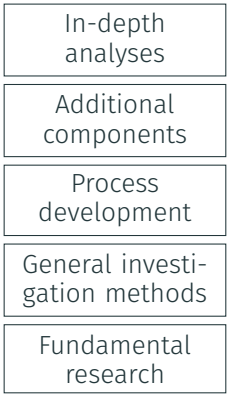
So everything is fine right?

- Rare in-depth investigations
- Limited tools
- Manufacturer specifics
- Accessibility challenges
- Knowledge reuse and documentation is bad

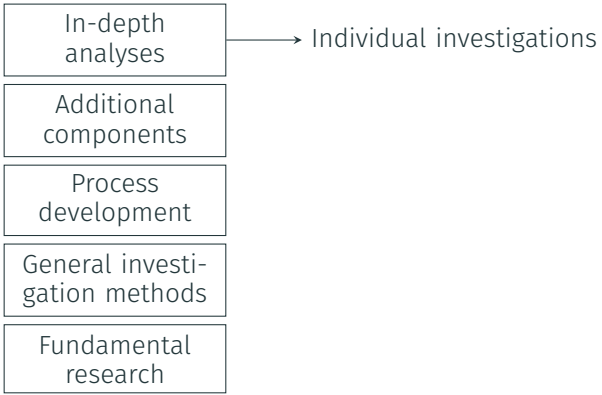
Individual investigations!

What is happening in science?

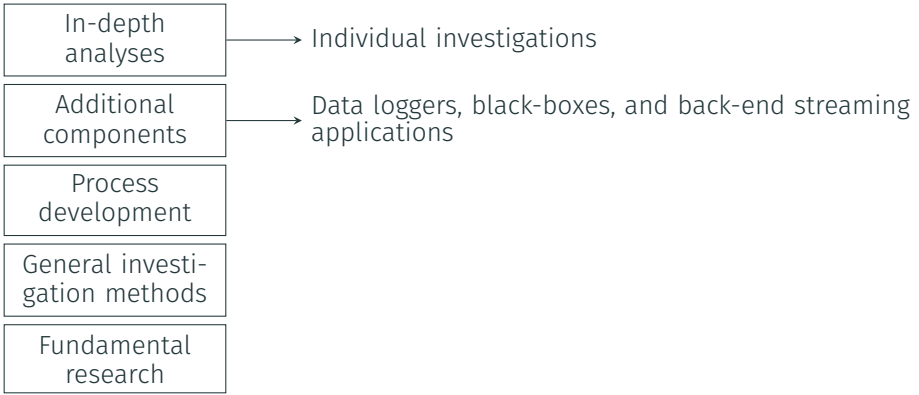
Where are people looking at?



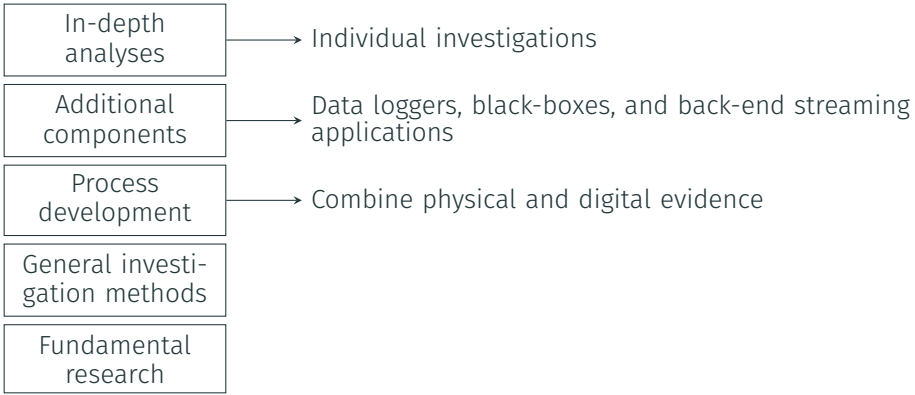
Where are people looking at?



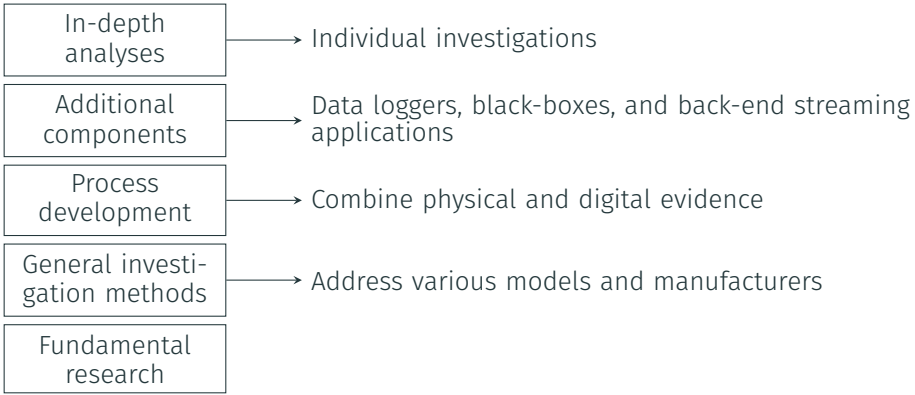
Where are people looking at?



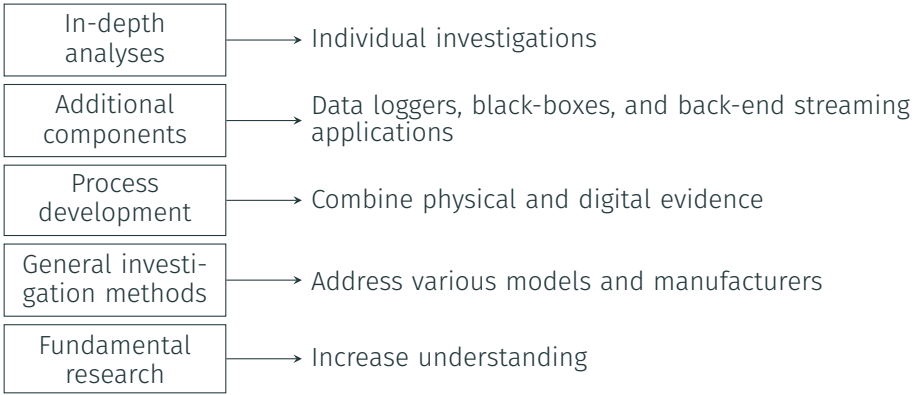
Where are people looking at?



Where are people looking at?

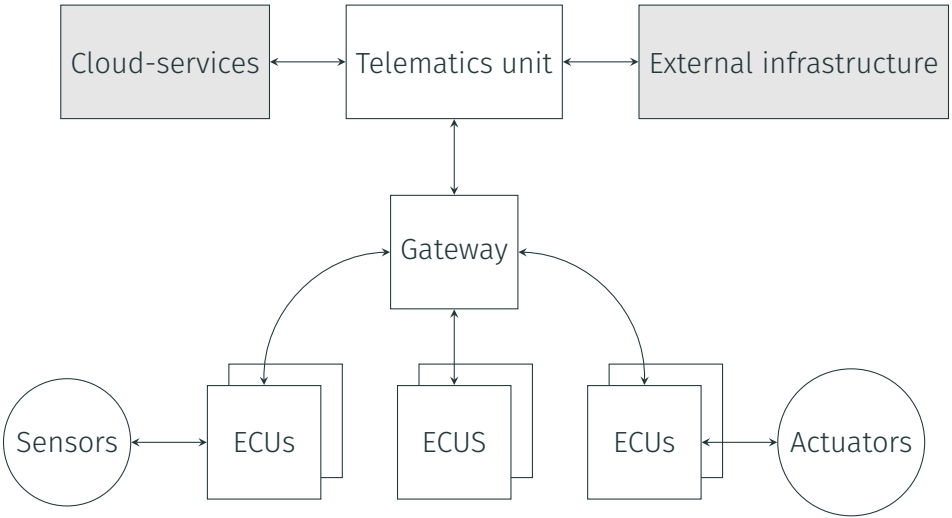


Where are people looking at?



Meanwhile at the manufacturers

Centralized is cheaper?



Moooooooore features!

- Biometric authentication
- Vehicle-to-X communication
- Advanced comfort systems
- Vehicle personalization
- Advanced automated driving functionality
- Features on demand

Automotive and IT, what can possibly go wrong?

Huawei Starts to Sell New SERES SF5 Car in its China Flagship Stores

Today, at the 19th Shanghai International Automobile Industry Exhibition, Huawei announced that China's automotive company SERES has launched an extended range electric vehicle-the new SERES SF5, and it will be available in Huawei flagship stores across China. For the first time, Huawei welcomes a vehicle partner to its "1+8+N" ecosystem.

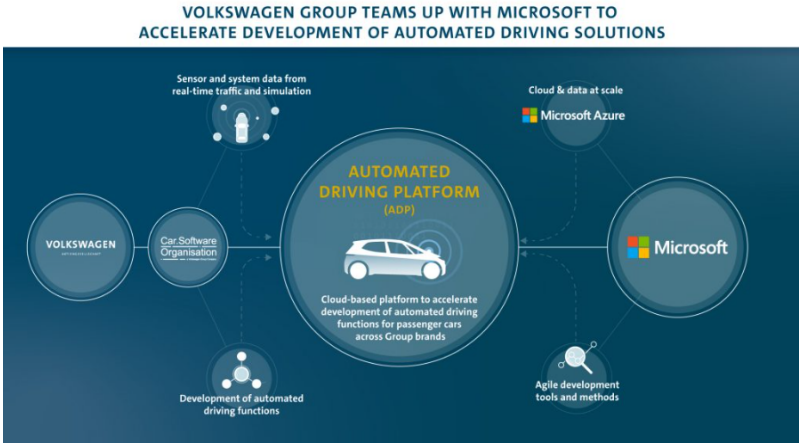
My Porsche App provides new features within Apple CarPlay®

07/10/2023 - Porsche becomes the first carmaker to integrate vehicle functions within an app in Apple CarPlay® to create an innovative, personalized user experience.

Just put everything on the cloud!

Volkswagen Group teams up with Microsoft to accelerate the development of automated driving

February 10, 2021 | Microsoft News Center



What are opportunities and challenges?

Opportunities:

- Event reconstruction
- Combination of sources
- Benefiting from centralized architectures
- Utilizing forensics computing methods and tools in automotive digital forensics

Challenges:

- Big data
- Normalization
- Data owner and holder issues
- Event correlation
- Anti-forensics
- Data integrity

So, all good in automotive?

Oh, we forgot privacy?

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

Update: **We're hosting a Reddit AMA on Sept. 21!**

Ah, the wind in your hair, the open road ahead, and not a care in the world... except all the trackers, cameras, microphones, and sensors capturing your every move. *Ugh.* Modern cars are a **privacy nightmare**.

Car makers have been bragging about their cars being "computers on wheels" for years to promote their advanced features. However, the conversation about what driving a computer means for its occupants' privacy hasn't really caught up. While we worried that our doorbells and watches that connect to the internet might be spying on us, car brands quietly entered the data business by turning their vehicles into powerful data-gobbling machines. Machines that, because of all those brag-worthy bells and whistles, have an unmatched power to watch, listen, and collect information about what you do and where you go in your car.

All 25 car brands we researched earned our *Privacy Not Included warning label -- making cars the official worst category of products for privacy that we have ever reviewed.

Security pitfalls

- Internet-of-Things devices

Security pitfalls

- Internet-of-Things devices
- Software bugs and vulnerabilities

Security pitfalls

- Internet-of-Things devices
- Software bugs and vulnerabilities
- Lack of updates and security update mechanisms

Security pitfalls

- Internet-of-Things devices
- Software bugs and vulnerabilities
- Lack of updates and security update mechanisms
- Keyless entry and ignition systems

Security pitfalls

- Internet-of-Things devices
- Software bugs and vulnerabilities
- Lack of updates and security update mechanisms
- Keyless entry and ignition systems
- Data collection and sharing

Security pitfalls

- Internet-of-Things devices
- Software bugs and vulnerabilities
- Lack of updates and security update mechanisms
- Keyless entry and ignition systems
- Data collection and sharing
- Third-party components

Conclusion

- Vehicles are complex, important, and valuable for forensic investigations
- Automotive industry evolution holds challenges, opportunities, and dangers
- Fundamental research in automotive privacy is still missing
- Digital forensic capabilities of vehicles will probably increase

Thank you very much!

Further information and slides (later):
https://k-gomez.com

Research (ORCID):
0000-0002-5597-3913

Contact:
mail@k-gomez.com