Technische Universität Braunschweig

NIEDERSÄCHSISCHES FORSCHUNGSZENTRUM FAHRZEUGTECHNIK

INSTITUTE OF AUTOMOTIVE ENGINEERING
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Connected driving for inner-city applications

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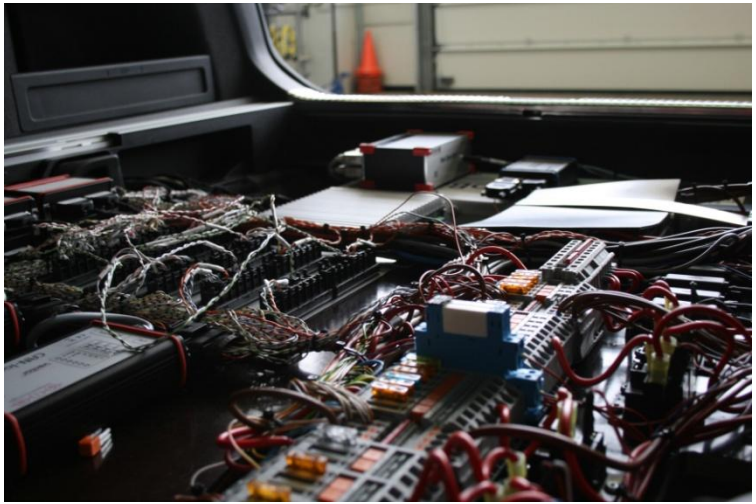
Connected vehicular systems

Increasing vehicle connectivity

ECUs

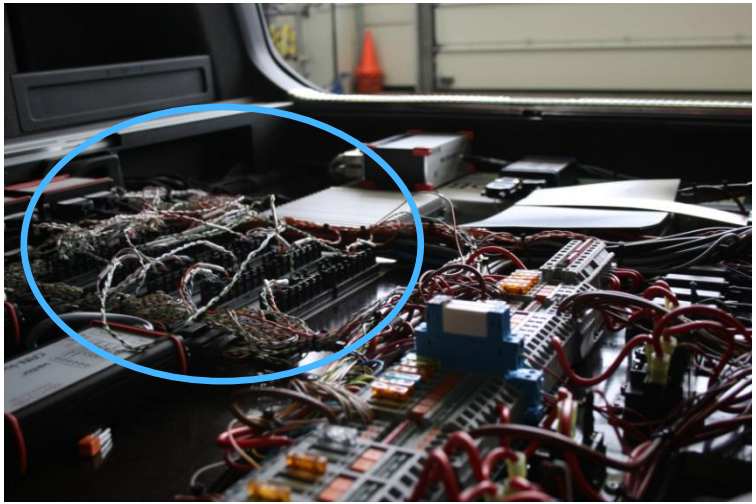


Connected vehicular systems

Increasing vehicle connectivity

ECUs

BUS-Systems



Connected vehicular systems

Increasing vehicle connectivity

- ECUs
- BUS-Systems
- Environment sensors

Connected vehicular systems

Increasing vehicle connectivity

ECUs	BUS-Systems	Environment sensors	Human-Machine Interfaces

Connected vehicular systems

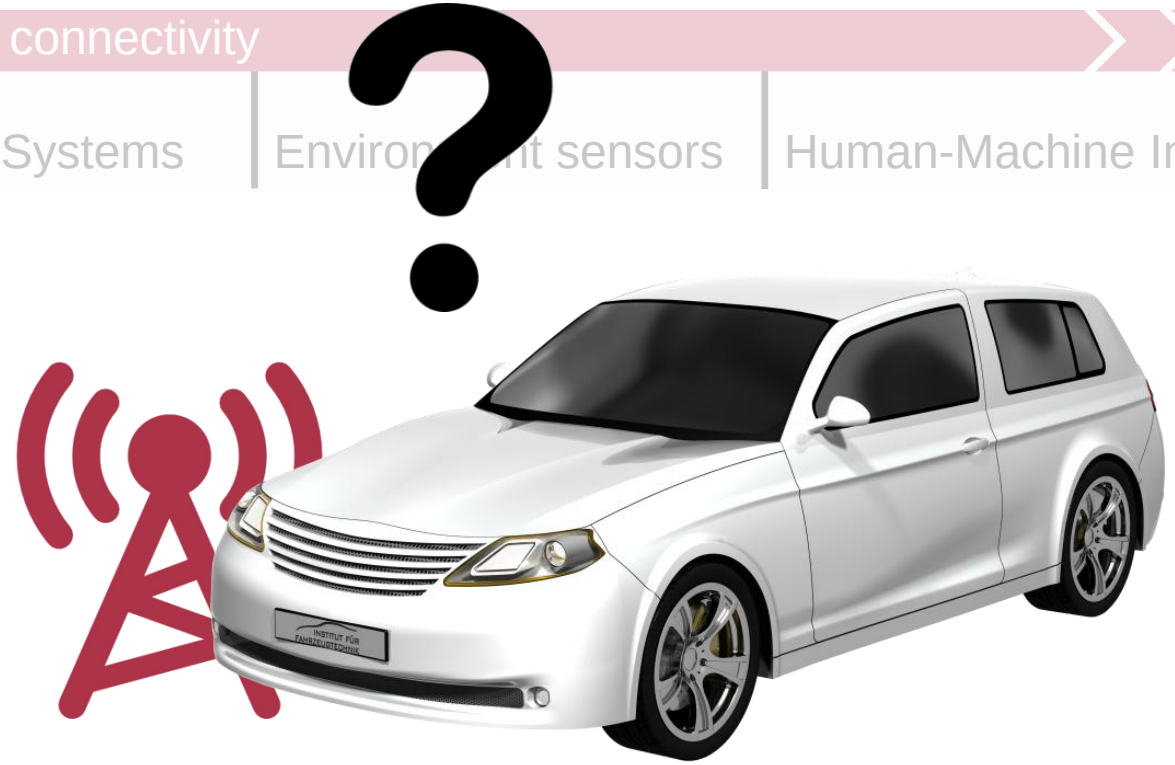
Increasing vehicle connectivity

ECUs | BUS-Systems | Environment sensors | Human-Machine Interfaces

Connected vehicular systems

Increasing vehicle connectivity

ECUs | BUS-Systems | Environment sensors | Human-Machine Interfaces



What is Car2X Communication?

Connected vehicular systems

Connected Vehicle	**Vehicle is equipped with systems to transfer data out of the car**
X stands for	**Every part of smart mobility and smart cities that the car can “talk” to**
Road users	**Other connected vehicles, vulnerable road users connected via apps**
Infrastructure	**Smart city infastructure, connected traffic lights and crossroads, smart parking lots…**

Connected vehicular systems

What are the advantages?

Connected vehicular systems

Safety

Connected vehicular systems

Efficiency

Source: [urlaubspriaten.de]

Connected vehicular systems

Comfort

CONTENTS

Wireless interfaces at the IAE

WiFi | Bluetooth | Cellular | 802.11p WAVE

Wireless interfaces at the IAE

WiFi | Bluetooth | Cellular | 802.11p WAVE

WiFi

802.11b/g/n

High data rates

Network connection

Application

Same system connects to smartphones and personal computers

Transfer measurement data to the server at the institute of automotive engineering

Connecting to Wifi requires handshakes and is only stable on short distance

Only useful for short range applications like wireless controls and bid data transfers while not moving

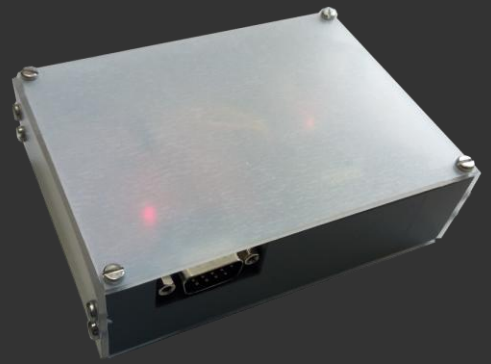
Wireless interfaces at the IAE

WiFi | Bluetooth | Cellular | 802.11p WAVE

Bluetooth

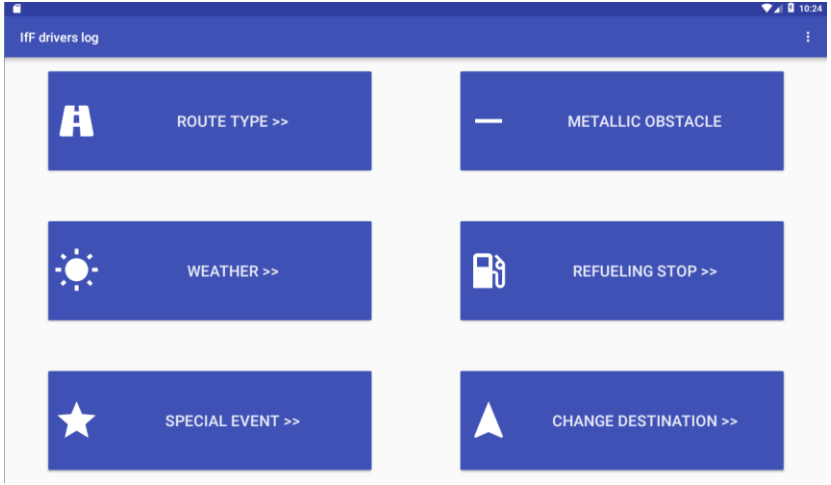
Short range connectivity

Application



Used to connect vehicle to other Bluetooth devices like tablets and smartphones

Labeling recorded radar and camera data, triggering events



Wireless interfaces at the IAE

WiFi | Bluetooth | Cellular | 802.11p WAVE

Cellular Network

LTE	Long ranges and high data rates
Connectivity interrupts	When leaving one network cells reach, connecting to another takes time
Long distance communication	Sending packages over long distance
Application	Transfer vehicle data from rural or not connected areas to distant infrastructure

Cellular Network

Vehicle Position

Vehicle route

Traffic information

Emergency calls

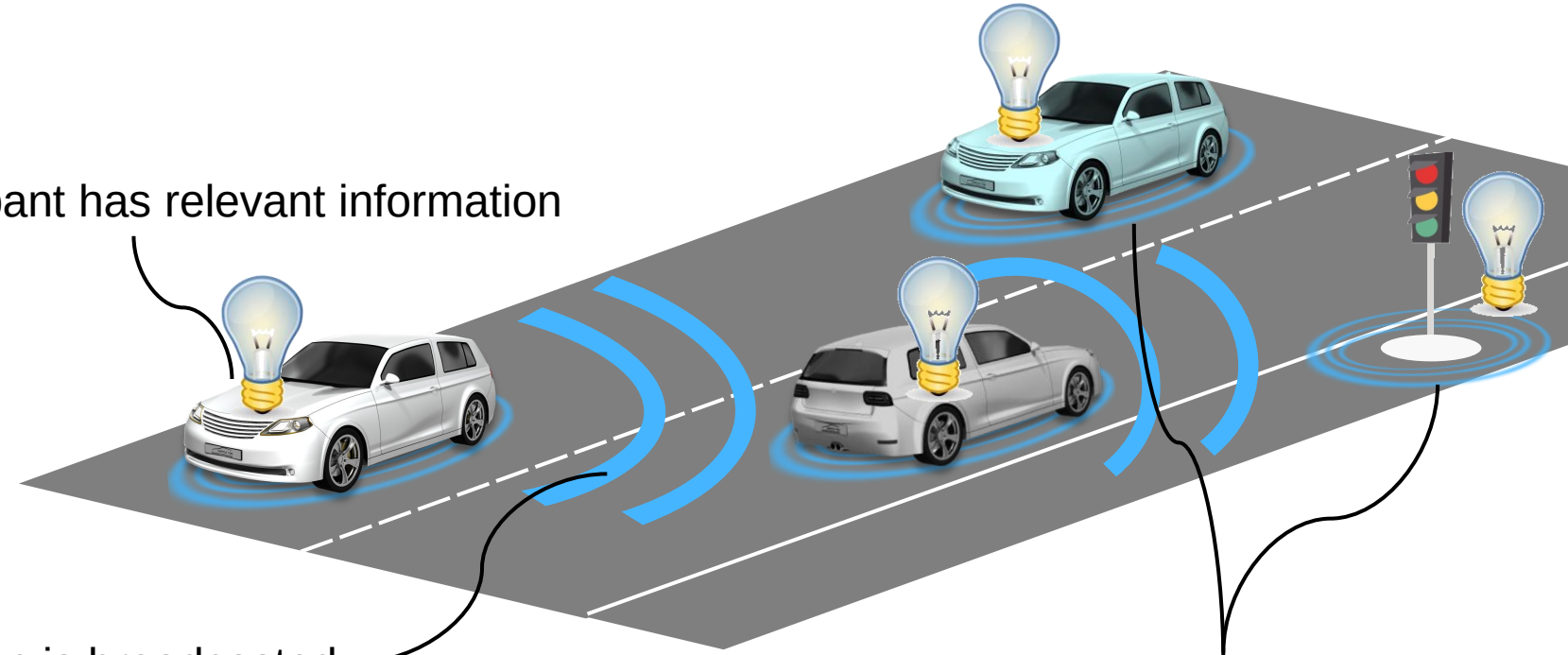
Wireless interfaces at the IAE

WiFi | Bluetooth | Cellular | 802.11p WAVE

802.11p WAVE\ITS G5

802.11p	IEEE Standard for Car2X Communication
Frequency Band	Utilizes specially reserved 5,9GHz band
Broadcasting	Users broadcasts their messages → no network registration
Knot hopping	Long distance communication via various users → message forwarding

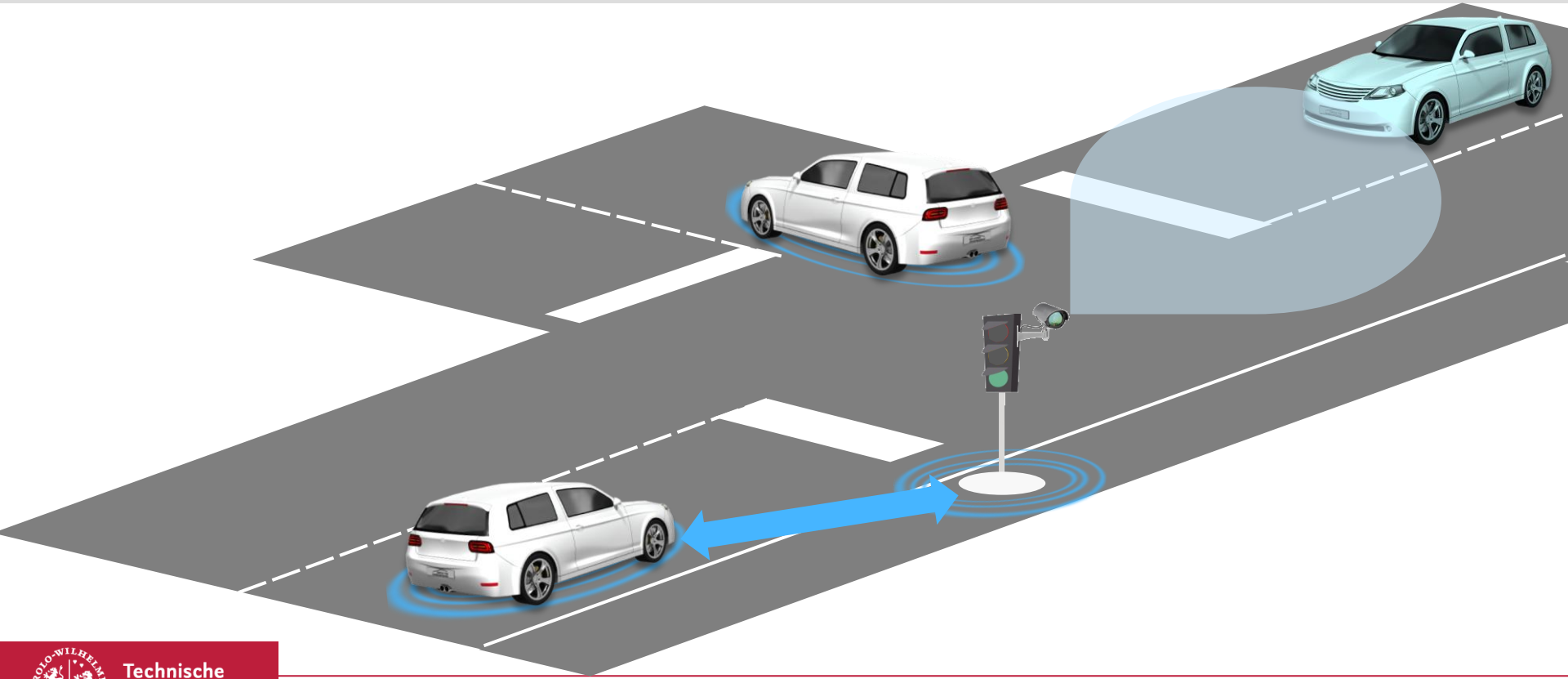
802.11p WAVE\ITS G5



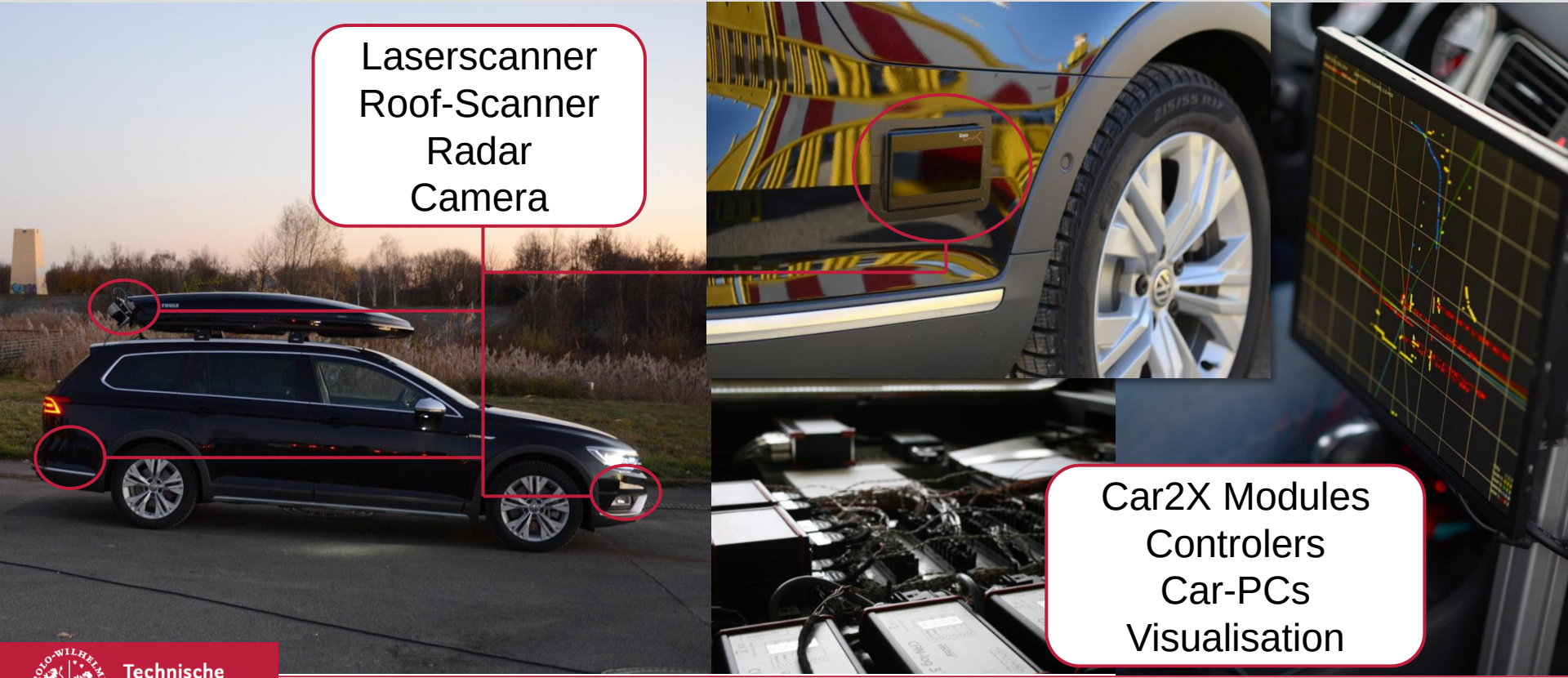
802.11p WAVE\ITS G5

CAM	Cooperative Awareness Message: “heartbeat”, cyclic status information
DENM	Decentralized Environmental Notification Message: non-cyclic information on events
MAPEM	Map (topology) extended message: Information regarding topology updates
SPATEM	Signal Phase And Timing Extended Message: Messages regarding infrastructure (crossroad/ traffic light)

Use-Case for connected inner-city driving



TEASY III (Testing and Engineering of Automated driving SYstems)



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Beispiel WLAN und Bluetooth

WiFi	Bluetooth	Cellular	WAVE\ITS G5
+ High speed	+ Easy connection	+ High speed	+ High speed
− Low reach	− Lower speed	+ Very high reach	+ Average reach
− Complicated connection	− Low reach	+ Easy connection	+ No registration
		− Connection interrupts	− Delay tolerant

Advantages of connected driving

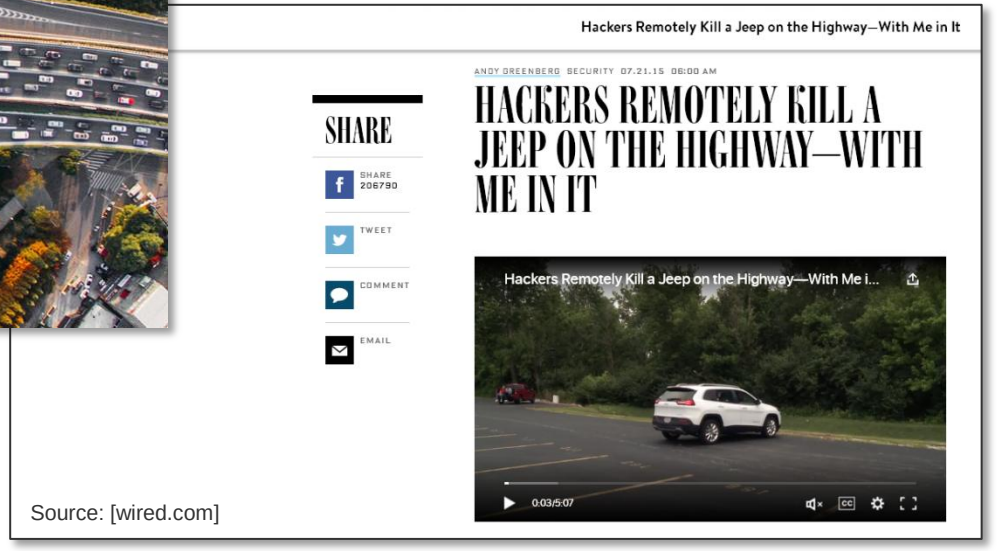
Safety

Efficieny

Comfort

Challenges of connected driving

Source: [inhabitat.com]



Source: [wired.com]

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