

# UBICOMP

## Episode 13: What about cars?

Hannes Frey and Peter Sturm  
University of Trier

(C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

### Why are vehicles ideal platforms?

---

- They are big enough
- They have their own power supply
- They are expensive enough
- At least for germany, they are the primary commercial force and the most precious toy
- They are a major source of pollution
- ...
- Telematics
  - Telecommunication and Automation
  - For some it is about computers and mobility

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Early Applications

- Mobile communication
- Dynamic route planning
  - Sending actual traffic information to the vehicle
- General Motors, OnStar System
  - Simple to use button at the console connects to a human operator
    - Emergency call
    - Breakdown call
    - Information call
  - Experimented with voice scripting for automation (Voice XML)



UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## How many computers are in your car?



UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

Das Diagramm zeigt ein Auto von oben und vorne, das in eine Drahtgitterstruktur überzogen ist. Verschiedene Teile des Autos sind mit farbigen Punkten markiert: Grün für den Motorraum und die Vorderräder, Orange für die Hinterräder und die Heckpartie, Blau für das Cockpit und die Mittelkonsole, und Rot für die Dach- und Fensterbereiche. Diese Punkte repräsentieren die verschiedenen elektronischen Systeme, die im Text aufgelistet sind.

# 1 ANTRIEB

- Elektronische Antriebsbremse
- Wasserpumpe - Motorventil
- Stromrichter / Elektronische Ventilverstellung (ELV), mit elektrisch und pneumatisch Kraftschlüssig verbunden; elektronisches Ventiltrieb
- Leistung Diagnose, Leistungsregung (Kraftstoffe) usw.
- Automatisches Lenksystemsteuerung
- Die (Fahrer-)Diagnose
- Virtuelle Power Network (CAN)

# 2 KOMFORT

- Fahrgeschwindigkeitregelung
- Adaptives Fahrgeschwindigkeitsregelung (Radarsensor)
- Navigation / Klimaregelung
- Sitzverstellung mit Positionsspeicher
- Zentralverriegelung
- Fahrerassistenzsysteme
- Rückraumüberwachung
- Controller Area Network (CAN)
- System-Diagnose

# KOMMUNIKATION

- Elektronische Sprachsynthese
- Audiokanalsteuerung durch Speicher
- Speicherfunktion
- Audiodienste wie Radio, CD usw.
- Video
- Buchcomputer
- Autotelefon
- Navigation
- Neue Anzeigeinstrumenten (Head-up-/Display)
- Internet-PC
- Busssystem (z.B. CAN)
- System-Diagnose

# SICHERHEIT

- Airbagkontrollsystem (ABS)
- Aufmerksamkeitsfahrförderung (XSB)
- Elektronisches Stabilitätsprogramm (ESP)
- Scheinwerferfernstellungs-Verriegelung
- Lichtsensoren
- Wisch-Wisch-Steuern
- Individuelle Wartungsintervallanträge
- Überwachungssysteme für Betriebszustand und Verschleißgrade
- Aktive Instrumente für Licht, Getriebe und Bremsenpedal
- Fahrzeug-Schwingungssysteme
- Arbeitsdruckkontrolle
- Controller Area Network (CAN)
- System-Diagnose

Hightech-System Automobile Computer-Technologie hat sich zum zentralen Innovationstreiber der Autobranche entwickelt. Der steigende Softwareanteil ermöglicht den Entwicklern, immer mehr neue übergreifende Funktionen ins Auto zu packen.

- **Passenger-oriented services**
  - Information services such as OnStar (augmented with position context)
  - Productivity (Email, mobile office, ...)
  - Entertainment
    - Multimedia Car Platform (MCP)
    - Radio, Video, TV
- **vehicle-oriented services**
  - Maintenance, on-site inspection, firmware updates, ...
  - Security
  - anti-theft devices, ...
  - Comfort (heating, air condition, personalization)

## Service Categories (contd.)

---

- Trip-oriented services
  - Optimize energy consumption
  - Safety systems such as ABS, ESP, ...
  - Navigation

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Collision-Warning Systems

---

- Forward-collision warning
- Blind-spot warning
- Lane-departure warning
- Lane-change or merge warning
- Intersection-collision warning
- Pedestrian detection and warning
- Backup warning
- Rear-impact warning
- Rollover warning (for heavy vehicles)

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Driver Monitoring

---

- Detect and warn of drowsiness

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Driver Assistance

---

- Adaptive cruise control
- Lane keeping
- Precision docking
- Precise maneuvering

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Vehicle Automation

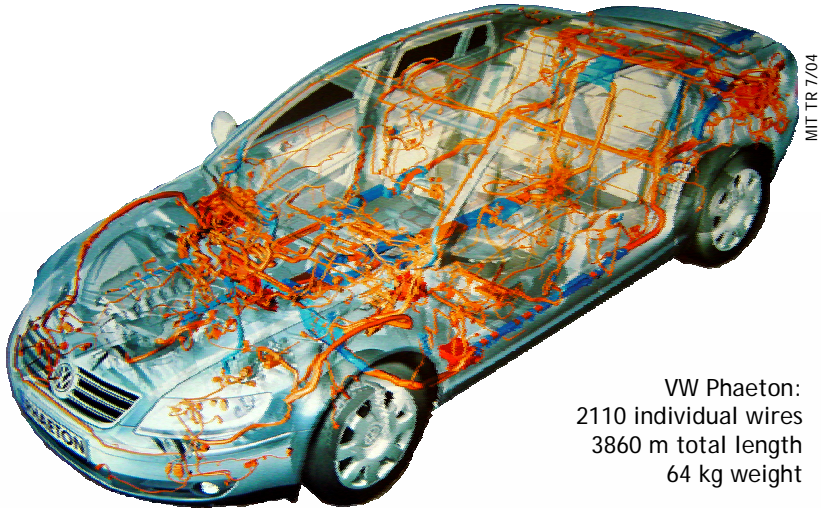
- Low speed automation
- Autonomous driving
- Close-headway platooning

## Example VW Touran



MIT TR 7/04

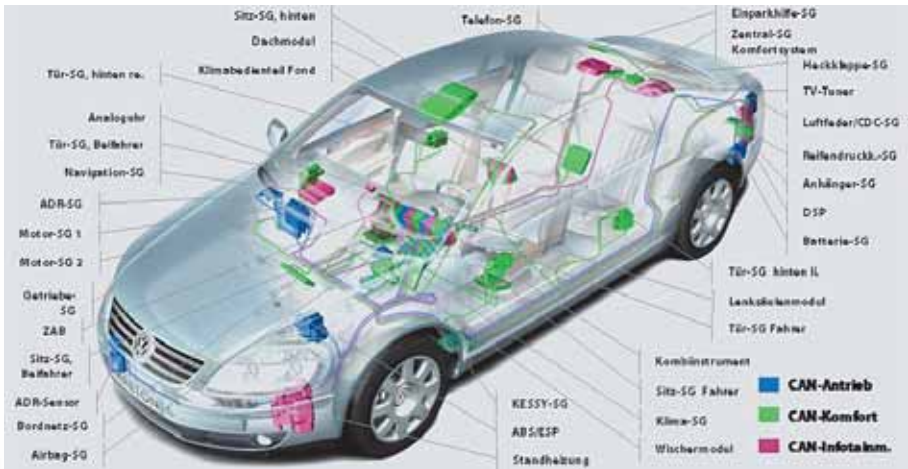
### Many computers = long wires



UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

### Inside the vehicle

- Pervasive computing is reality



## Adaptive Cruise Control (ACC)



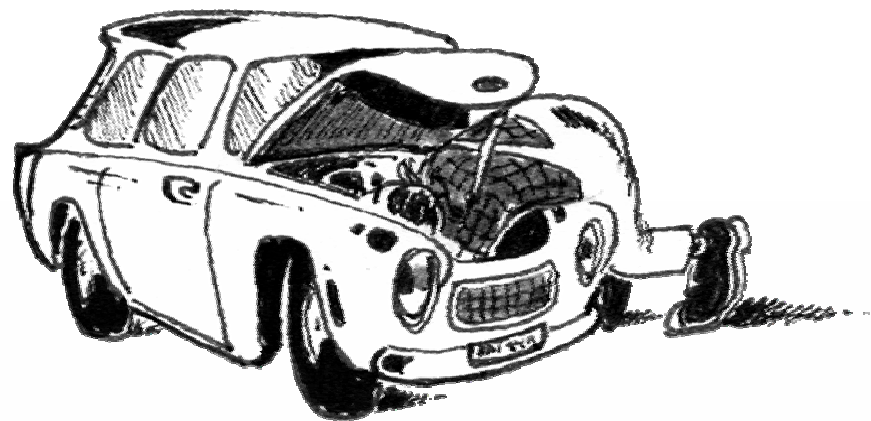
## X-by-wire

- Electronic control of essential functions
- Suspension-by-wire
  - Change the suspension while driving
- Steer-by-wire
- Brake-by-wire

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER



... and the consequences



Most cars break down because the battery is drained!

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

UBICOMP

Fleetnet

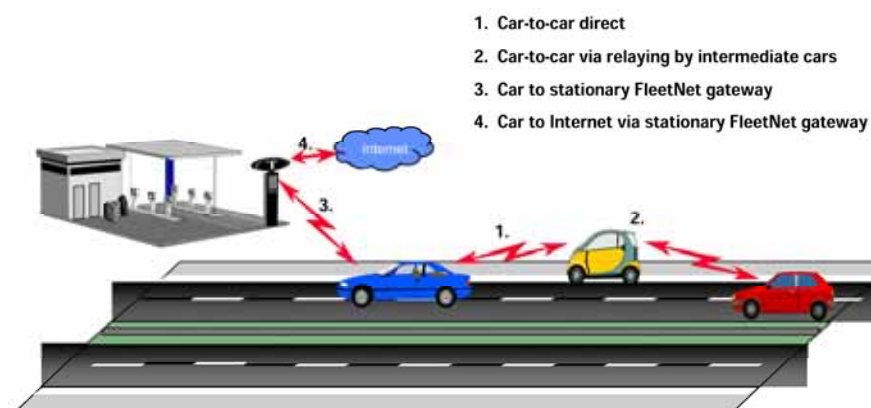
(C) 2004 AG SYSOFT - UNIVERSITY OF TRIER



- German research project
  - Development of a platform for inter-vehicle communication systems
  - Usage of mobile ad-hoc radio networks
- 2000 to 2003
- Consortium
  - DaimlerChrysler AG
  - Fraunhofer Institut FOKUS
  - NEC Europe Ltd.
  - Robert Bosch GmbH
  - Universities of Hannover, Mannheim, Hamburg-Harburg, and Braunschweig
- Funded in parts by BMBF, Germany

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Fleetnet Scenario



Aus Franz et al. "Internet on the Road via Inter-Vehicle Communications", 2001 ([www.fleetnet.de](http://www.fleetnet.de))

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Services and Applications

---

- Cooperative driver-assistance
  - Exchange of sensor data between vehicles (e.g. road condition)
  - Emergency breaking
  - Passing assistance
  - Security distance warning
  - Coordinated lane entering
- Decentralized floating vehicle data applications
  - Inter-vehicle communication system
  - Recognition of traffic jams
- User communication and information services
  - Accessing the Internet from vehicles

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Radio Hardware

---

- Requirements
  - Minimum 1 Mbps data rate
  - Several 100 m communication range
  - Usage of unlicensed frequency band
- Considered candidate hardware
  - WLAN 802.11
  - HIPERLAN Type 2
  - UMTS in time division duplex modes (UTRA-TDD)
  - Communication via Radar (will be used in future cars anyway)
- Speed of cars (200 km/h and more) is a major problem for frame and slot synchronization

UBICOMP (C) 2004 AG SYSOFT - UNIVERSITY OF TRIER

## Demonstrator

- 6 instrumented Smart cars



## Resources

- MIT Technology Review, July 2004
- R.G. Herrtwich, "Fahrzeuge im Netz". In "Total Vernetzt", Hrsg. Friedemann Mattern, Springer, 2003
- R. Bishop, "Intelligent Vehicle Applications Worldwide", IEEE Intelligent Systems, 2000
- [www.fleetnet.de](http://www.fleetnet.de)