Taking part in the Grand Cooperative Driving Challenge

Kristoffer Lidström
Why platooning?
Video can be found at http://youtu.be/Suugn-p5C1M
Platooning

SARTRE Project, http://www.sartre-project.eu/

SCOOP Scania/KTH
Is platooning a new idea?
Platooning 2011

• Video can be found at http://youtu.be/45IRE8W_3L8

The SARTRE (Safe Road Trains for the Environment) project
Platooning 1997

• Video can be found at http://www.path.berkeley.edu/nahsc/
In the future of 1960
”…safe distance between cars is maintained by automatic radio control…”
The present invention relates to radio warning systems for use on vehicles intended to permit a vehicle to signal its presence by means of electric waves to other vehicles in its more or less immediate vicinity, equipped with similar or equivalent apparatus and devices, particularly to such vehicles located in front or on the side of the vehicle signalling its presence and facing in the approximate direction of said signalling vehicle.
Monolithic system design
Project outline

Project course 2010

Milestone 1
System Design

Milestone 2
Benchtop System

B.Sc. Projects 2011

Milestone 3
COMM

Milestone 4
Competition Prototype

Milestone 5
Race-ready Vehicle
Required functions

- Communication
- Positioning
- State estimation (own and others)
- Control
- Rules & logic
- Human-machine interface
Modules and dataflow

CACC-loop (Linux-land)
- CAN Parser (Java)
- INS Parser (Java)
- COMM (Java)
- GPS Parser (Java)
- GPS ClockSync (C)
- State Estimator (Java)
- HMI (Java)
- Simulink Gateway (Java)

Simulink Gateway (Java)

Safety-critical loop (dSpace HW)
- CACC Controller (Simulink)
- Volvo Propr. Interface (Simulink)
- Vehicle

Emergency Override
Milestone 2 – Benchtop system
Project outline

Project course 2010

Milestone 1
System Design

Milestone 2
Benchtop System

B.Sc. Projects 2011

Milestone 3
COMM

Milestone 4
Competition Prototype

Milestone 5
Race-ready Vehicle
Communication, interaction protocol

DynamicVehicleInfoPayload ::= SEQUENCE {
  vehiclePosition   Position,
  vehiclePositionTimestamp  Timestamp,
  vehiclePositionAccuracy  PositionAccuracy,
  vehicleVelocity  Velocity,
  vehicleHeading  Heading,
  ...
}

GCDC
ASN.1 Specification

GCDC Protocol

+ 

GCDC Protocol
Communication, layers

OSI Model
7. Application
6. Presentation
5. Session
4. Transport
3. Network
2. Data link
1. Physical

GCDC Model
Halmstad Application
GCDC Interaction Protocol

Internet Model
HTTP, FTP, DHCP, DNS etc.
TCP / UDP
IPv4 / IPv6
WiFi / Ethernet

Logic Link Control
Medium Access Control
802.11p
802.11p
WiFi / Ethernet
Helmond comm. workshop, January
Project outline

Project course 2010

Milestone 1
System Design

Milestone 2
Benchtop System

Milestone 3
COMM

B.Sc. Projects 2011

Milestone 4
Competition Prototype

Milestone 5
Race-ready Vehicle
System overview
CACC Controller
• "Standard ACC" with tuneable feed-forward acceleration
Testing at Stora Holm, March
Testing at Stora Holm
Project outline

Milestone 1: System Design
Milestone 2: Benchtop System
Milestone 3: COMM
Milestone 4: Competition Prototype
Milestone 5: Race-ready Vehicle

Project course 2010 vs. B.Sc. Projects 2011
Positioning, EKF

CAN, GPS, AHRS/INS

\[ \nu_{\text{car}}, q_{\text{car}}, \theta_{\text{car}} \]

\[ \hat{P}_x, \hat{P}_y \]

\[ v, a, \theta, \phi \]

\[ x_t \rightarrow \text{Predict} \rightarrow \hat{x}_{t+1} \rightarrow \text{Update} \rightarrow \hat{x}_{t+1} \]
Helmond preparation week, May
Project outline

Project course 2010
- Milestone 1: System Design
- Milestone 2: Benchtop System

B.Sc. Projects 2011
- Milestone 3: COMM
- Milestone 4: Competition Prototype
- Milestone 5: Race-ready Vehicle
A270 Eindhoven-Helmond
Follow the leader
Positioning issues
Positioning issues
Communication issues
Competition weekend video

• Video can be found at http://youtu.be/0JNqHhSxlng
Results

1. Karlsruhe Institute of Technology
2. Halmstad University
3. Chalmers University of Technology
4. Royal Institute of Technology (KTH)
5. Center for Automation and Robotics
6. Technical University Eindhoven
7. Istanbul Technical University
8. University of Twente
9. University of Latvia
Thank you!