iQPilot – Key Aims

• To build up 2x autonomous buses for research and demonstration purposes

• To demonstrate some of the fundamental technology towards autonomous driving in urban / city areas

• To demonstrate ability of an autonomous bus to handle bus stop situations

• To demonstrate the feasibility of running an autonomous bus in an autonomous transport system (with partner project iQMobility)

• Why autonomous (driverless) vehicles;
  • Around 60% of total cost of operating a bus is the cost of the driver...
  • Shortage of drivers in many markets
  • Industry generally progressing towards autonomous across the automotive industry

Bus #1
“Klasse” (Normal Floor Omni Express 320)
“2D” sensor system

Bus #2
“Klara” (Low Entry Omni Express 320)
“3D” sensor system
iQPilot Working Areas

WP1: Project Management and Coordination
WP2: City Pilot
WP3: Bus Stop Pilot
WP4: Depot Driving
WP5: Remote Driving
WP6: Advanced HMI and Control Centre
WP7: Mission Planning + Communication
WP8: Vehicle and sensor system
WP9: Mapping and Localisation
WP10: Perception and Situation Awareness
WP11: Vehicle Control and Motion Planning
WP12: Vehicle Safety and safety concept
WP13: 5G, CMA test environment

Academia

KTH: 1 PhD

≈15 Masters thesis

Demonstrable Scenarios

Technical components or work packages

Academia

Project
iQPilot Timescale 2016 to 2020

- **Sensor / perception demos**
- **Remote Drive Demos**
- **Autonomous Drive Demos**
- **Control Centre Demos**

### iQPilot

- **2016**
  - Scania Start
  - FFI Start

- **2017**
  - Scania iQMatic Demo
  - Ericsson Demo
  - Scania VW Demo
  - Test Site Stockholm

- **2018**
  - Test Site Stockholm

- **2019**
  - UITP
  - Tekniska Museet + Scania Innovation day

- **2020**
  - Final iQPilot Webinar; - City Pilot - Bus Stop Pilot

### iQMobility

- **2016**
  - Project Start

- **2017**
  - Scania VW Demo
  - Scania Internal Demo

- **2019**
  - UITP

- **2020**
  - Final iQMobility Webinar; - Autonomous Bus Transport System

**Autonomous Drive Technology (Bus/Urban)**

**Autonomous Bus Transportation**
iQPilot + iQMobility’s end (30th June 2020) marked with a 2 part webinar

- **Part 1;**
  - Live studio talks and discussion on broadcast
  - Guests from Scania, project partners and KTH ITRL
  - Pre-recorded video demonstrations on key areas / showcases

- **Part 2;**
  - Live presentations + discussion for each project partner / technical work package area with presenters in Zoom
  - Guests from iQDeep + WASP funded PhD students
iQPilot / iQMobility Main Showcase – Strategic Overview

iQPilot Demo 2020 Drive Features

- Stop 1 - Stop in lane
  - Leave parking
  - Enter parking
  - Navigate through depot

- Stop 2 - Pocket Stop
  - Passengers on/off
  - Negotiate junction with obstacles

- Stop 3 - Pocket Stop
  - Passengers on/off
  - Follow in lane 30 to 50 km/h

- Stop 4 - Stop at electric charger
  - Passengers off
  - Re-enter traffic across lanes

- Stop 5 - Stop in lane
  - Single lane roundabout (V2V assisted)
  - Navigate junction with Give Way

- Depot
  - Enter parking
  - Take on passenger(s)

iQMobility Cycle
1) Pull out from depot
2) “Dead run” to first stop
3) Pick up passengers at first stop
4) Time-tabled bus run 5 stops
5) “Dead run” back to depot
6) Pull in to depot

Extended scenarios

Pedestrian in road

Lane Transition

Give way

2 lanes with oncoming traffic

Follow in lane 30 to 50 km/h

Negotiate junction with obstacles

Give Way

Single lane roundabout (V2V assisted)

Re-enter traffic across lanes

Stop at electric charger

Passengers off

Stop in lane

Stop 5
iQPilot Main Showcase – Scenario Summary

1) Pull-out from depot parking
2) Passenger Pickup
3) Merge with faster moving traffic
4) Cross lanes to desired lane
5) Follow vehicle in front
6) Navigate sharp corners
7) Drive into pocket bus stop
8) Multiple passenger pick-up/drop off
9) Electric Charger Bus Stop
10) Navigate difficult junctions/corners
11) Negotiate single lane roundabout
12) Return to depot parking
iQPilot + iQMobility = Autonomous Transport System

Vehicle Control System

Autonomous Vehicle in the System

Bus route and departure time plan
iQPilot Situational Awareness

Trajectory prediction in interaction-heavy environments [Joonatan Mänttäri]

$$x \ (\text{input}) \rightarrow \text{Encoder} \rightarrow z = \mu, \sigma^2 \rightarrow \text{Decoder} \rightarrow y$$

$$(\text{sample only during inference})$$

$$p_y(y|x,z)$$

Conditional Variational Auto-Encoder Neural Network

Predictions in a roundabout

Predictions on a 2 lane road
iQPilot Perception and the Streets of Södertälje

Object tracking with stereo camera

Red reference route on public road
iQPilot – 5G & Connectivity

Cellular connectivity as a service enabler

- Connectivity for road infrastructure
- Telematics services
- Vehicle as sensor
- Convenience & infotainment services
- Fleet management + remote assistance of AD vehicles
- OEM ADAS (ADAS) and AD
- Connected goods

Vehicle 2 Network 2 Vehicle (V2N2V) Communication
Occluded vehicle visible using V2N2V

Remote Driving over 5G

Vehicle 2 Network 2 Vehicle (V2N2V) Communication

2nd vehicle on roundabout occluded behind vehicle in foreground
Webinar (Part 1) Viewing Statistics;
- Approx. 75% Sweden
- Approx. 8% Germany
- Remaining 17% spread worldwide
- 1300 viewers (so far)
  - 700 live, average 1h5m watched
  - 600 on-demand, average 12m
Key iQPilot Outcomes

Starting platform and knowledge towards products, services and new pilot project(s)

Solid functional basis towards fully driverless buses (in the long term)

New / Continued research focus areas as dedicated projects

Expanded organisations with autonomous development and autonomous solutions
iQPilot Information + Video Result Links

• Contact George.Dibben@Scania.com for information / links

• Results Webinar Part 1;
  • iQPilot & iQMobility  [1h 58]  
  • Results Webinar Part 2;
  • Stream 1 (iQPilot technology) [1h 58m]
  • Stream 2 (iQPilot perception) [1h 34m]
  • Stream 3 (PhD students) [2h 3m]
  • Stream 4 (iQMobility) [1h 42]  
  • Other videos;
  • Trailer iQPilot & iQMobility [45s]
  • iQPilot & iQMobility Summary [9m]
  • iQPilot Autonomous Bus in the System [6m 30s]
  • iQMobility Autonomous Bus Transport [4m 30s]
  • iQPilot & iQMobility 5min countdown [5m]