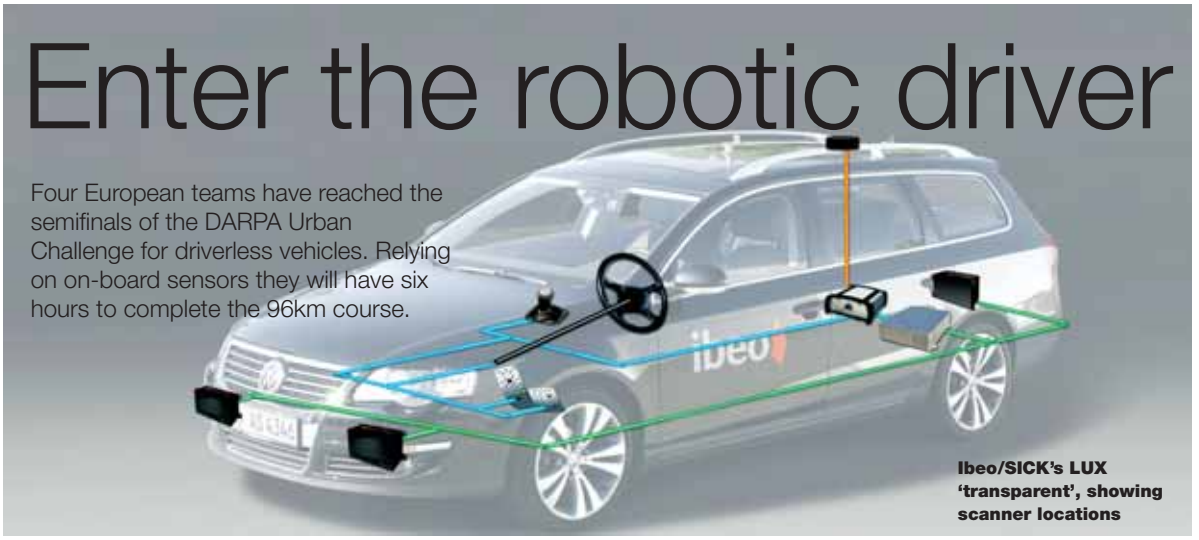
Enter the robotic driver

Four European teams have reached the semifinals of the DARPA Urban Challenge for driverless vehicles. Relying on on-board sensors they will have six hours to complete the 96km course.



Ibeo/SICK's LUX 'transparent', showing scanner locations

Four European teams have qualified to take on strong American competition in the 2007 DARPA (Defense Advanced Research Projects Agency) Urban Challenge for driverless vehicles. They have won though as semifinalists to race against 32 US teams for a US$2 million prize for the fastest completion of a testing mock urban circuit in California on 3 November 2007.

Their vehicles, all from Germany though DARPA rules demand official US team leaders. They will have six hours in which to complete – relying entirely on on-board sensors – a 96km course at Victorville, California. They will have to operate without human intervention, while passing a series of route markers and safely performing manoeuvres such as merging into moving traffic, navigating traffic circles, and avoiding moving obstacles.They will also have to comply with normal traffic regulations. Says DARPA Director Dr Tony Tether: 'The vehicles must perform as well as someone with a California driver's licence.'

Features such as traffic signs and speed limits will form part of a complete route network definition file, similar to a navigation DVD, which is to be handed over shortly before the race starts. The onboard sensors will pick up lane markings and stop lines on intersections.

This will be the third in a series of Grand Challenge events organised by DARPA, the central research faculty of the US Defense Department. They are key elements in a US military autonomous vehicle research and development programme aimed at perfecting technologies to minimise battlefield casualties – though some entrants are looking to test commercial civilian applications.

The new urban setting contrasts with the south west US Mojave Desert environment of the previous Grand Challenges in 2004 and 2005. It reflects the importance that the US military attaches, in modern wartime conditions, to the safe operation in traffic of autonomous ground vehicles carrying out supply missions and other operations. Comments Tether: 'It was an important step to have autonomous ground vehicles that can navigate and drive across open and difficult terrain from city to city. But the next big leap will be an autonomous vehicle that can navigate and operate in traffic, a far more complex challenge for a 'robotic' driver.'

Victorville is a former US Air Force base currently used by the US Army to train for urban operations. DARPA has chosen it because its network of urban roads simulates the type of terrain that American forces typically face when deployed overseas. Says Tether: 'The robotic vehicles will conduct simulated military supply missions at the site, which adds many of the elements they would face in operational environments.' Following a US Army training rotation, DARPA will carry out clean-up operations to ready the site for the competition.

Of the European entrants, three are from German universities and research institutes. The fourth, Team-LUX, is unusual as representing suppliers of specialist sensor equipment being used by a number of its competitors (including two of the other European entrants). It is a joint venture between Düsseldorf, Germany-headquartered laser technology developer Sick and its automotive-oriented subsidiary Ibeo Automobile Sensor, located in Hamburg. Comments Team-LUX marketing team leader Tanja Müller: 'After two races as a supplier of sensors, the new urban environment motivated us to create our own team.'

The Team-LUX race car is a 2006-model VW Passat 2.0 TDI, with three prototypes of the new Ibeo LUX laser sensor concealed in its bodywork – to make it look like a normal passenger vehicle. The vehicle has already experienced normal urban traffic, on an April 2007 drive from Hamburg for exhibition at the London Science Museum in London, UK – with its autonomous driving mode disabled for legal reasons.

The three laser sensors, two at the front and the third in the rear, are designed to give the car 360° 'vision' by continuously scanning its surroundings. Each full scan rotation gives a full 2.5D profile of the vehicle environment consisting of over 2500 measurements.

One on-board computer classifies these, using algorithms that distinguish between large and small stationary obstacles, cars, trucks, motorbikes, bicycles and pedestrians, and tracking those that are in motion. The second performs route processing, navigation and manoeuvring functions, using drive by-wire systems developed by Ibeo that use standard industrial motors and controllers with in-house-developed controller software.

Grand Urban Challenge timetable

Of the 89 teams that initially expressed interest in participating, DARPA chose 53 to go on the next stage. Its officials then made site visits to each of these in June 2007, to select the 36 semifinalists (announced on 10 August 2007. 20 teams will emerge as finalists. In addition to the US$2 million first prize, there will be US$1 million for the runner up and US$500,000 for third place.

Commenting on the site visits, DARPA Director Dr Tony Tether said: 'We have seen a dramatic increase in vehicle capabilities since the first Grand Challenge in 2004. The ingenuity and dedication of these teams, and the growth of the community in this area, are phenomenal.'

The Victorville Urban Challenge location

Spirit of Berlin used SICK and Ibeo laser scanners.


CarOLO's Caroline which uses Ibeo lasers scanners. Below AnnieWay which uses Velodyne's lidar.

The LUX sensor is designed to be cheaper, smaller and lighter than the existing ALASCA XT, which other Urban Challenge competitors will be using, and to serve the mass market. It is currently in its final test phase, of which the Urban Challenge will be part, and commercially available from October 2008 for driver assistance applications. Says Müller: 'Our market is normal cars running on normal streets in normal cities'. One change in the production version of the LUX is that it will have a smaller field of vision (110°), as being more widely accepted by the automotive industry for mass-production sensors.

Ibeo is supplying laser scanners to 12 of the Urban Challenge semifinalists, including the Stanford University, California, Racing Team, whose 'Stanley' vehicle won the 2005 DARPA Grand Challenge. Sick is also equipping 12 teams. Austrian company Riegl is equipping seven (non-European) teams. One European entrant, Team AnnieWay, is using lidar from California, US-based Velodyne.

European semifinalists in the 2007 DARPA Urban Challenge

Team name	Team	Vehicle	Vehicle name	Location	Website
CarOLO	University of Braunschweig Technology, supported by German Industry consortium.	2006 VW Passat	Caroline	Braunschweig, Germany	www.sse.cs.tu-bs.de/CarOLO
Team AnnieWAY	Spin-off from German Research Foundation (DFG)'s Collaborative Research Centre on Cognitive Automobiles	VW Passat 2.0 FSI	AnnieWAY	Karlsruhe, Germany	http://annieway.mrt.uni-karlsruhe.de
Team Berlin	Freie Universität Berlin researchers/ students with US partners.	Dodge Grand Caravan	Spirit of Berlin	Berlin, Germany	http://robotics.mi.fu-berlin.de/pmwiki
Team-LUX	Ibeo technical staff led by Richard Bishop of US Bishop Consulting	2006 VW Passat 2.0 TDI	LUX	Hamburg, Germany	www.team-lux.com