The DARPA Grand Challenge: Ten Years Later

Autonomous vehicle challenge led to new technologies and invigorated the prize challenge model of promoting innovation

At the break of dawn on March 13, 2004, 15 vehicles left a starting gate in the desert outside of Barstow, Calif., to make history in the DARPA Grand Challenge, a first-of-its-kind race to foster the development of self-driving ground vehicles. The immediate goal: autonomously navigate a 142-mile course that ran across the desert to Primm, Nev. The longer-term aim was to accelerate development of the technological foundations for autonomous vehicles that could ultimately substitute for men and women in hazardous military operations, such as supply convoys.

The Grand Challenge was designed to reach beyond the traditional defense performer base and tap into the ingenuity of the wider research community. It was DARPA's first major attempt to use a prize-based competition to attract novel performers and ideas and encourage collaboration across diverse fields. The first team to pass a series of qualification tests and then complete the course in less than the prescribed ten-hour time limit would receive a $1 million cash prize.

The technological hurdles and rugged desert course proved to be too much for the teams' first attempt. None finished the course—the top-scoring vehicle traveled only 7.5 miles—and the prize went unclaimed. The competition wasn't a loss however; it offered a promising glimpse at what was possible.

"That first competition created a community of innovators, engineers, students, programmers, off-road racers, backyard mechanics, inventors and

dreamers who came together to make history by trying to solve a tough technical problem," said Lt. Col. Scott Wadle, DARPA's liaison to the U.S. Marine Corps. "The fresh thinking they brought was the spark that has triggered major advances in the development of autonomous robotic ground vehicle technology in the years since."

Just one day after the first challenge ended, DARPA announced it would hold a second Grand Challenge in the fall of 2005, 18 months after the first. This time, after analyzing lessons learned, five vehicles out of the 195 teams that entered successfully completed a 132-mile course in southern Nevada. Stanford University's entry, "Stanley," finished first with a time of 6 hours and 53 minutes and won the $2 million prize.

To further raise the bar, DARPA conducted a third competition, the Urban Challenge, in 2007 that featured driverless vehicles navigating a complex course in a staged city environment in Victorville, Calif., negotiating other moving traffic and obstacles while obeying traffic regulations. Six teams out of 11 successfully completed the course. The "Tartan Racing" team, led by Carnegie Mellon University, placed first in points awarded based on time to complete and ability to follow California driving rules and won the $2 million prize.

Although it isn't easy to quantify the effects of these DARPA challenges on the development and deployment of autonomous vehicle technology, ten years later defense and commercial applications are proliferating. The rapid evolution of the technology and rules for how to deploy it are being driven by the information technology and automotive industries, academic and research institutions, the Defense Department and its contractors, and federal and state transportation agencies. Within DoD, some of the efforts to improve upon and deploy autonomous ground vehicle technology include:

- Oshkosh Defense developed the TerraMax unmanned ground vehicle for the Marine Corps;
- TORC Robotics, one of six finishers of the Urban Challenge, continues

to develop utility-vehicle-scale autonomous capabilities for Marine Corps platforms;

Today, three other DARPA challenges are building on the DARPA Grand Challenge prize-based competition model:

- The Spectrum Challenge is a competition to demonstrate a radio protocol that can best use a given communication channel in the presence of other dynamic users and interfering signals, with a goal of enabling reliable communication in a congested environment. The challenge includes head-to-head competitions between competing teams in a structured test bed environment. The Spectrum Challenge Finals will occur March 19-20, 2014 at DARPA.
- The DARPA Robotics Challenge (DRC) has a goal of developing robots for use in responding to natural and man-made disasters. The DRC was structured with three planned competitions to allow teams time to incorporate lessons learned from one event to the next. Teams are currently preparing for the third and final planned competition, the DRC Finals. Strong performance by the teams in the second event, the December 2013 DRC Trials, encouraged DARPA to increase the difficulty of the final round. The results of the DRC Finals will give DARPA, DoD, and industry a preview of what is possible with robots.
- The Cyber Grand Challenge (CGC) is a tournament for fully automated network defense. Similar to computer security competitions played by expert software analysts, the CGC will require automatic systems to reason about software flaws, formulate patches, and deploy them on a network in real time. The CGC aims to unite program analysis experts with the computer security competition community to bring automation research out of the lab and into the field.

DARPA expects that, like the original Grand Challenge before them, these challenges will encourage new waves of research and development that will spur continued innovation, encourage commercial investment, and lower the

cost of advanced technologies.

# # #

Associated images posted on www.darpa.mil may be reused according to the terms of the DARPA User Agreement, available here: http://www.darpa.mil/policy/usage-policy.

Additional images available at:

- 2004 Grand Challenge: https://archive.darpa.mil/grandchallenge04/media_gallery.htm
- 2005 Grand Challenge: https://archive.darpa.mil/grandchallenge05/mediagallery.html
- 2007 Urban Challenge: https://archive.darpa.mil/grandchallenge/gallery.html

Tweet @darpa