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Reinventing Mobility

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Today's cars are networked computer systems on wheels: features such as antilock brakes, lane departure warning systems, adaptive cruise control, and self-parking have gone mainstream, increasing safety and convenience.
On the horizon, though, are fully autonomous vehicles – self-driving cars.

There are many motivations:

- Humans are terrible drivers. After the U.S. Department of Transportation recorded 32,788 traffic fatalities in 2010, Secretary of Transportation Ray LaHood referred to distracted driving as "a deadly epidemic." This has affected me personally: when I was 18, I lost a close friend to a car accident; roughly a year ago, I lost my lab manager. Traffic is the greatest killer of young people in this country.
- Commuting involves a huge amount of lost productivity – an average of one hour each day spent staring at the pavement.
- Highways are very lightly utilized. Because our reactions are slow and our peripheral vision is inadequate, we must surround our vehicles on all sides with large amounts of unused pavement. At peak carrying capacity, only six percent of the surface area of a typical highway is covered with cars. At off-times, utilization is much less even than this.
- Cars, too, are very lightly utilized – only about three percent of the time. This means that the environmental and financial costs of manufacturing them are not well amortized, and we devote lots of our urban infrastructure to storing them. (There are three times as many parking spaces as there are cars. Sixty percent of the Los Angeles land mass is devoted to cars!)

Self-driving cars have the promise of reducing accidents, recovering lost productivity, increasing the utilization of highways (a factor of two should be easy – highways would still be 88% empty at peak carrying capacity!), and enhancing our ability to share vehicles (by delivering them to where they are needed).

Research on autonomous vehicles goes back many decades. Real breakthroughs have occurred in the past 10 years, though – because of dramatic improvements in sensors, computation, and artificial intelligence. In 2004, the DARPA Grand Challenge offered a $1 million prize for a robot car that could successfully traverse a challenging 150-mile course in the Mojave Desert. None of the vehicles finished the course – the "winner," from Carnegie Mellon University, completed only five percent of the course. A second competition was held in 2005. That year, five vehicles successfully completed the course, led by a team from Stanford University. The third competition, known as the DARPA Urban Challenge, was held in 2007 – a 60-mile urban course involving various realistic traffic scenarios. Carnegie Mellon was declared the winner, collecting a $2 million prize, with Stanford finishing second.

Researchers from Stanford and Carnegie Mellon then moved to Google, with the goal of making autonomous cars practical. To date, Google's fleet of robot Toyota Prius vehicles has traveled 200,000 accident-free autonomous miles in every imaginable environment: on highways, on mountain roads, and in cities; day and night; good weather and bad; open and congested. Computing research – extending over many decades, much of it under NITRD sponsorship – is turning science fiction into reality. I envision a future in which our technology is available to everyone, in every car; a future without traffic accidents or congestion; a future where everyone can use a car.