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Automotive technology

The connected car

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Cars are becoming more connected, both to remote systems for navigation and information, and to each other

Illustration by Allan Sanders

IN "KNIGHT RIDER", a 1980s television show, Michael Knight fought for justice with the help of KITT, an artificially intelligent Pontiac Trans Am. The pair chatted amiably, with KITT sensing and reacting to nearby objects, navigating and looking up information about Mr Knight's immediate surroundings and deadly adversaries. KITT could even drive itself. Thirty years on, many of the fantastical Pontiac's features are becoming reality.

A modern car can have as many as 200 on-board sensors, measuring everything from tyre pressure to windscreen temperature. A high-end Lexus contains 67 microprocessors, and even the world's cheapest car, the Tata Nano, has a dozen. Voice-driven satellite navigation is routinely used by millions of people. Radar-equipped cruise control allows vehicles to adjust their speed automatically in traffic. Some cars can even park themselves.

Once a purely mechanical device, the car is going digital. "Connected cars", which sport links to navigation satellites and communications networks—and, before long, directly to other vehicles—could transform driving, preventing motorists from getting lost, stuck in traffic or involved in accidents. And connectivity can improve entertainment and productivity for both driver and passengers—an attractive proposition given that Americans, for example, spend 45 hours a month in their cars on average. There is also scope for new business models built around connected cars, from dynamic insurance and road pricing to car pooling and location-based advertising. "We can stop looking at a car as one system," says Rahul Mangharam, an engineer at the University of Pennsylvania, "and look at it as a node in a network."

It started with a satnav

The best known connected-car technology is satellite navigation, which uses the global-positioning system (GPS) in conjunction with a database of roads to provide directions and find points of interest. In America there were fewer than 3m navigational devices on the road in 2005, nearly half of which were built in to vehicles. But built-in systems tend to be expensive, are not extensible, and may quickly be out of date. So drivers have been taking matters into their own hands: of the more than 33m units on the road today, nearly 90% are portable, sitting on the dashboard or stuck to the windscreen.

Many consumers are now adding internet connectivity to their cars in the form of another portable device: the "smart" phone. A two-way internet link allows for more elaborate forms of navigation, and also makes it possible to gather and aggregate information from large numbers of vehicles, notes Dev Khare of Venrock, a Silicon Valley venture-capital firm that is investing in connected-car technology. Examples of such aggregation include Openstreetmap, a project to create open-source maps by collecting GPS data from users as they drive about, and Trapster, a constantly updated database of the locations of police speed traps, compiled from reports sent in by users of the software.

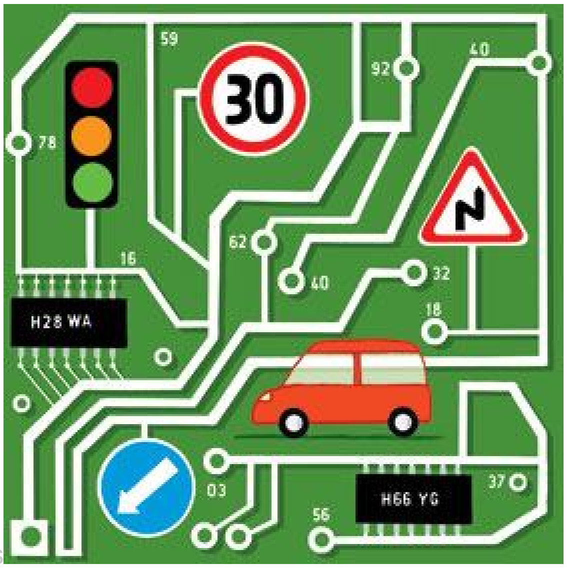

Illustration by Allan Sanders

Inrix, a provider of traffic data based in Seattle, has based its business model on this approach. It combines information from static sensors in the road with GPS information collected wirelessly from more than 1m fleet vehicles to provide real-time information about traffic flows. This information is piped in turn to navigation devices and smart-phones, in order to adjust a delivery route in response to an accident, for example. The company can also forecast traffic flows on a particular route at a particular time and date.

Information specific to individual cars can also present new opportunities. Some insurers, for example, offer dynamic insurance schemes that use GPS to determine a driver's premiums, based on distance travelled, driving style and where the car is driven and parked. Similarly, the ability to treat a car as a node on a network is shaking up the idea of car ownership itself. Zipcar, the largest car-sharing scheme, shares 6,000 vehicles between 275,000 drivers in London and parts of North America—nearly half of all car-sharers worldwide. Its model depends on an assortment of in-car technology. "This is the first large-scale introduction of the connected car," claims Scott Griffith, the firm's chief executive.

Zipcar's available vehicles report their positions to a control centre so that members of the scheme can find nearby vehicles through a web or phone interface. Cars are unlocked by holding a card, containing a wireless chip, up against the windscreen. Integrating cars and back-office systems via wireless links allows Zipcar to repackage cars as a flexible transport service. Each vehicle operated by Zipcar is equivalent to taking 20 cars off the road, says Mr Griffith, and an average Zipcar member saves more than $5,000 dollars a year compared with owning a car.

Vehicle shall speak unto vehicle

The next step is to enable cars to communicate with each other via vehicle-to-vehicle (V2V) networks, and with infrastructure such as toll gates and traffic lights via vehicle-to-infrastructure (V2I) links. A new wireless standard called Dedicated Short Range Communication (DSRC)—a sort of Wi-Fi for cars—provides high-speed data connections over distances of up to 200m, and safety and emergency communications at lower speeds over distances of up to a kilometre from one vehicle to another, and between vehicles and roadside transmitters. So far the technology is mainly used in electronic toll booths, but it has many other potential applications.

DSRC could be used, for example, to warn nearby cars of sudden braking or an airbag deployment, thereby alerting cars out of visual range and preventing or limiting accidents. It could be used to set up ad hoc networks to pass data between cars in order to, for example, signal icy spots on the road (many cars can detect ice as part of their skid-control systems) or co-ordinate "platoons"—groups of vehicles travelling closely together under automatic control. Other proposed uses include signalling the approach of emergency vehicles and ensuring that traffic lights give priority to buses and emergency vehicles.

V2V features depend on a network effect—the technology is useless to a driver who is the only one using it—but a network could emerge surprisingly quickly. Dr Mangharam says his simulations and on-road tests in Pittsburgh, carried out in conjunction with the research arm of General Motors, have shown that V2V networking has benefits when as few as 3-5% of cars are equipped to exchange just four pieces of data—position, speed, direction and time—with other vehicles in the vicinity. As these drivers respond to their enhanced awareness, they influence the overall flow of traffic, benefiting everyone. Dr Mangharam reckons this level of adoption is at least a decade away.

The prospects for adoption of new V2I technology, beyond road tolls, seem to be greatest in Japan, where researchers have been testing traffic signals that use video-cameras and infra-red beacons to communicate with approaching cars. Such systems can guide drivers into particular lanes as they approach a junction to ensure a smooth flow of traffic or allow emergency vehicles to pass, greatly improving safety. The Japanese government plans to deploy the system more broadly from 2010, in co-ordination with local carmakers, who will provide the necessary in-car technology in new models.

Such co-operation is lacking elsewhere, where carmakers are understandably reluctant to add new features to cars if the necessary infrastructure is not being built by local transport authorities. "It is a chicken and egg problem," says Dr Mangharam, who estimates it would take $4.5 billion to upgrade every traffic light and junction in America with smart infrastructure.

Commercial vehicles may get the ball rolling first. Connected-vehicle technology is being considered for roadside inspections, freight tracking, road-condition notifications, parking management and enforcing rules on drivers' working hours. And adoption of the technology could be mandated by governments, as in the case of Germany's Toll Collect system, a dynamic road-tolling system for lorries of 12 tonnes or over that has been operating since late 2004. Toll Collect uses a combination of satellite positioning, roadside sensors and a mobile-phone data connection to work out how much to charge each user. Over 900,000 vehicles are now registered with the scheme and there are plans to extend this approach to road-tolling across Europe from 2012. Eventually it may also be extended to ordinary cars.

Communication breakdown

Will drivers welcome this? Driving already involves a high degree of trust: people who do not know one another routinely engage in life-or-death co-operation. That trust, and the cues that engender it, may not translate into a V2V system, where a malicious or malfunctioning signal could snarl traffic or cause a pile-up. Another problem is privacy. Cars are closely associated with the notion of personal freedom, even if the reality often involves bumper-to-bumper agony. The use of GPS and roadside sensors to track vehicles and monitor how fast they are moving is already unpopular and controversial in some quarters.

Yet if the benefits are palpable, drivers will be prepared to place their trust in connected car networks, and even to give up some privacy. Early adopters of dynamic car-insurance schemes, for example, tend to be safer drivers who pay lower premiums in return for allowing insurers to track them. Connected-car technology could help drivers find parking spaces, avoid traffic and prevent accidents. "By 2045 it will be impossible for a driver to impact another vehicle or drive off the road without the serious intention of doing so," says Scott McCormick of the Connected Vehicle Association, an industry group established to promote the technology. Violating traffic rules could also become impossible—getting away with it certainly will be.

So why drive at all? Researchers at several universities have built autonomous cars to complete an urban-driving challenge set by the American armed forces in 2007. Some of the technology is already in production cars: Toyota's Lane-Keeping Assist, for example, could easily do much of the driving on long stretches of highway, but the firm requires drivers keep their hands on the wheel—for now. A team led by Alberto Broggi at the University of Parma has built an autonomous car that will be set loose this summer to navigate Italian urban traffic by itself—a formidable test. And Sven Beiker, the director of Stanford University's CarLab, says automatic driving in some situations, such as stop-and-go traffic or smooth motorway driving, could be reliable enough for general use in a decade. KITT would be proud.