The hidden ways traffic flows around us

Chris Baraniuk | 15 January 2015

(Getty Images)

Going from A to B? Whichever way you choose to travel, Chris Baraniuk discovers the hidden technologies which decide when and how you'll get there.

Get in your car and drive. If there's one thing that cinema and Bruce Springsteen songs have taught us, it's that there's nothing freer than the open road. Or is there? Although it might feel that way, behind the scenes a huge array of technologies will end up controlling the progress you make along your route. The same goes for train and boat travel. And should you head to the airport, you will fly subject to the demands of air traffic control, monitoring other aircraft and the ever-changing weather. Welcome to the hidden world that controls our transport infrastructure, and it's getting more sophisticated all the time.

Some of the subtle transport management techniques seem to be the stuff of urban myths – but they're very real. Take, for example, the "green wave". A green wave is when all the traffic lights into town conveniently turn green as traffic approaches, opening up an unhindered route to motorists.

Synchronised lights

It was a popular concept in Germany, where motorists were sometimes told that travelling at a certain speed would let them encounter consecutive green signals – a Grüne Welle. Today, green waves have become more sophisticated, with adaptive systems able to synchronise traffic lights when it is most advantageous and safe to do so. And it doesn't just stop at cars. In the Danish capital Copenhagen, the city has introduced green waves for its hordes of cyclists.

More accurate tracking of vehicles in real time is generally what makes this possible. In the UK, sensors hidden beneath roads such as Midas (Motorway Incident Detection and Automatic Signalling) allow traffic control rooms to monitor how congested a motorway has become . Midas detects the volume of vehicles passing over the tarmac in real time. At high volumes, traffic can be slowed down via variable speed limit signs, which allow cars to travel more closely together and therefore take advantage of the motorway's full capacity. This is often done “upstream” to prevent extreme cases of congestion which may already be forming. That’s why seemingly smooth-moving traffic is sometimes gently forced to slow down, because that reduction in speed helps prevent congestion further behind.

Riding the "green wave"; not an urban myth, but a real method to keep traffic flowing (Getty Images)

In towns and cities, a similar and widely used technology called Scoot (Split Level Offset Optimisation Technique) can tweak traffic signals for particular types of vehicles, such as buses, or those which are arriving along especially busy routes.

Nick Hounsell at the University of Southampton, an expert in transport research, says the dynamics of traffic movement are incredibly sensitive, which is why these clever, pseudo-intelligent systems are so useful. Hounsell points out one example, the “butterfly effect”, where a sudden slowing down – even something as simple as one driver braking a little too hard – can become amplified to a full-scale jam and even accidents happening further behind.

River register

“Once a shockwave forms you will get stationary traffic,” he says. “The shockwave moves and the potential then for a nose-to-tail accident is quite high.”

One classic cause of these shockwaves is “rubbernecking”, in which drivers slow down to look at accidents in nearby lanes. Easy solutions for this have been found, though. Britain’s Department of Transport simply decided to hide them from view, using screens.

Ideally, managing traffic using all these techniques would help to reduce crashes and fatalities in the first place. Paul Unwin at the UK’s Highways Agency notes that since the introduction of a smart motorway system on one of the country’s busiest routes, safety has improved considerably. “We’ve not had a fatality on the M42 since 2006,” he claims.

(Science Photo Library)

Similar principles to these are found off the roads. The Port of London Authority (PLA), for example, has found tha it makes sense to slow river traffic on the Thames so that vessels further up the river may turn sharply or berth. The PLA tracks which boats are where and what's on them – be it passengers or cargo – using a register known as Thames AIS , which stands for Automatic Identification System.

It's particularly useful on a river like the Thames, which has both a lot of traffic and a lot of bends, making it hard for captains to see what's ahead and react accordingly. Having a complete overview of traffic is probably what you'd expect nowadays, but as recently as 1989 controllers had nowhere near this level of visibility. That year a Thames pleasure boat, the Marchioness, collided with a dredger and sank, resulting in the deaths of 51 people.

"All the investigations that followed changed forever the way we deal with safety and navigation on the Thames," explains Kevin Gregory at the PLA. "Because we were determined that we would never have something like that happen again."

Up in the air

Safety concerns are also behind the fastidious traffic control we see in the air. Tens of thousands of flights take off and land every day around the world and it's largely down to air traffic controllers to get them up and down again without accidents. Nats, which used to be known as National Air Traffic Services, handles about 5,000 flights a day in the UK alone. It has recently been trying out its own clever technologies to help increase capacity and safety. A recent addition to the air traffic controller's toolbox is iFACTS, which predicts aircraft trajectories and lets operators peer up to 18 minutes into the future to see where planes will be at that time.

A "conflict" in air traffic control is when a plane is predicted to move within a certain distance of another aircraft. iFACTS allows controllers to prevent this ahead of time, and more confidently schedule planes through sectors of airspace. "We had a 20% increase in overall capacity based on the introduction of iFACTS because the workloads on the controllers was that much less," says Stuart McBride, customer and network service manager at Nats. This happened because controllers didn't have to take the time to make such drastic adjustments to a plane's course when conflict was getting close. Instead, minor adjustments which are easier to do could be made further ahead of time.

(RIA Novosti/Science Photo Library)

Another company, Airbus ProSky, has a product that calculates optimum arrival times for planes so that connections aren't missed and less fuel is used. In order to do that, the software has to calculate data on all the flights coming to and leaving from a given airport. The company's CEO, Paul-Franck Bijou, says the amount of information going into these calculations is gargantuan.

"For one airport, it's about the size of the database for a bank like Credit Agricole in France for example, the size of a national bank," he says. "This is what we're talking about with regard to data we're handling at just one airport. Imagine what we're talking about for a whole country."

Natural solutions?

That's the thing about traffic; the greater the volume, the sooner capacities are reached. But capacity can become flexible if vehicles and the systems which control their movements become smarter, and don't need to be constantly controlled by us.

In the future, the way all of this is done could look quite different from today. Researchers are increasingly looking to the animal kingdom for inspiration. Ants, for instance, have helped researchers create "bio-inspired algorithms", which allow traffic to move in a similar way ants hunting for food; the insects automatically find preferred routes, without any central control.

This approach allowed JJ Merelo at the University of Granada to design a program that could tell the Spanish military how to route vehicles during a training simulation .

Bats, too, could prove useful teachers to help manage tomorrow's air traffic. Rolf Mueller at Virginia Tech's Department of Mechanical Engineering has been studying Chinese bats in order to better understand how the animals are able to fly in such dense swarms even in tight areas. A 3D scan of their cave was taken and an array of infrared cameras captured the bats' movement. One day, Mueller believes a system similar to this could manage aircraft in busy pockets of airspace.

Could air traffic control learn lessons from how bats navigate? (Science Photo Library)

“The bats are not afraid of touching each other. They come very close but in a very controlled manner, they know what they’re doing,” he says. “They don’t have to get in touch with air traffic flow control and say, ‘should I fly now to the right of that guy or the left of that guy?’ They make those decisions automatically.”

Mueller observed that this remained true even when his team placed unfamiliar obstacles in the cave. Unflinching, the bats simply flew around them and carried on. What if planes were just as safe to fly in? Nats’ Stuart McBride says capacity could be increased if planes didn’t have to be so far apart from one another.

In all these areas – road, sea or air – man-made traffic has often reached a point where behind-the-scenes control is not just essential, but also increasingly automated. It means that the traveller is ever further away from knowing why the traffic around him or her flows the way it does. The sense of being a cog in a distantly operated machine may be disarming to some, but it’s testament to the sophistication of systems that keep the world’s traffic moving. The “driver”, simply, has become split up. He or she is part human, part vehicle, part road and computer.

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