

Good afternoon, Ladies and Gentlemen.

For those who don't already know me, my name is Jason Barnes. I see that on the programme I'm listed as an 'independent mobility expert', so perhaps I'd better briefly explain who I am. For something over 25 years now, I've been a technology and strategy writer. For most of the last 20, I've specialised in ITS and automotives, and more recently in smart cities and buildings.

I think that very potted CV already starts to make something of a point for me, given that I've been asked to speak today about the Internet of Things — I'll come back to this. And, incidentally, I will be talking today rather than using slides. That's always a dangerous gambit for the last speaker of the day, I know, as I'm supposed to be exciting and keep you engaged. 'Engaged' might also be seen as a euphemism for 'awake' and I hope to be interesting enough that at least some of you are still in the land of the conscious in about 30 minutes' time.

So — the Brave New World of the Internet of Things. The IoT — Internet of Things — is very much like Big Data. By that, what I mean is that it's one of those terms that whenever it's mentioned people nod sagely — because we all know what it is, right? — but in fact it can mean different things to different people. My concept as a one-man operation of 'big' data will fit in the back pocket of the back pocket of the back pocket of someone who sits in the back pocket of IBM.

I'd mention 5G telephony in the same vein — people talk about it like it's a done deal but it's still very much at the definition stage and people's perceptions vary widely. I've seen definitions of what people want which range from 1-2G performance but with guaranteed connectivity all the way up to streaming video and near zero-latency performance which will support car-to-car. It's not here yet.

If I were to pin down the IoT, I'd say it describes a world where many of the previously dumb objects around us have gained a level of sentience, or at the very least an ability to communicate in some form.

Now, people can look at that and think that it means that everything around us is chattering away in the background. I'm sure most of us have seen the 'Tomorrow's World'-type scenarios where the refrigerator at home realises that you're running out of milk or butter, or something else if you're one of those strange vegan types, and either adds them to your shopping list or actively orders more for you.

It's all very new, and it's all very 'Tomorrow'. And yet...

A few years ago, a colleague of ours from within the ITS sector made the point that while the media and early adopters will always get excited about the shiny and the fantastical, the majority of traffic control is done, and will continue for quite some time yet to be done, by humble and anonymous grey cabinets at the side of the road. I mention that because I think that in many ways the IoT is already here in a similarly unglamorous form.

If I go into a chain store and buy a new sweater or a jacket, on the back of the label there's probably an RFID tag. It's used for stock control and while my stylish new garment can't yet be described as 'intelligent' it does make a contribution to the intrinsic awareness which already exists in the environment around us. A quick scan is all it takes to adjust inventory levels, gain some feedback as to customer choice and sizing, and reduce production costs and wastage by being smarter about re-ordering. We're already talking about data-harvesting, here.

And we're also already doing some very clever things which rely on what I might call smart devices' 'dumb intelligence'. I say 'dumb' because while not actively engaging with each other to plot and plan, if I might put it like that, they are contributing to that intrinsic awareness.

In 2012, London hosted two very major public events — the Summer Olympics and the Diamond Jubilee celebrations of the reign of Queen Elizabeth the Second. Both were praised for their levels of organisation. In particular, I want to focus on the transport elements, because Transport for London did some very innovative things. It looked to encourage the highest-possible use of non-vehicular modes of transport — and it used technology to maximise the potential of those modes, in particular public transport.

For me, one of the key innovations was the use of anonymised tracking of smart devices to predict and manage demand for Underground/subway and bus services. TfL monitored smart devices' WiFi and Bluetooth MAC addresses to ascertain the existence of crowds and their movements. It then concertina-ed Underground and bus availability, running services closer together at locations and times of peak demand, such as when major events were starting and finishing.

It was, as I say, a resounding success and what marked it apart was the monitoring of personal devices. Anonymised tracking had been used in the past on strategic roads to provide probe vehicle data and such as origin-destination or journey time information but London in 2012 was ground-breaking in terms of tracking down to the level of the individual and on such a scale.

There's an example, then, of an IoT-type application that's already half a dozen years old and now in fairly common use.

Now, I've got a fairly circular brain. That means I'll loop back to things when I think and when I talk. I said I'd come back to my CV, and I'm thinking about the bit that relates to smart cities and buildings because I want to give another example of an 'already here' IoT-type application and demonstrate how we — actually, you — as transport professionals need to start broadening your horizons and thinking about how you engage with other sectors and service providers.

Just a few weeks ago, I was asked to help set up and run the Twitter account of a very successful quantity surveying company based in London. As you do, because to do something like that you have to be on-trend and actually looking sometimes to set the pace, I went off to do a bit of research. That included ringing my brother-in-law, who's a consultant in the construction industry. He identified to me a series of areas that could be of interest.

Some of these are also non-traditional for those in the building sector. Yes, you can install an app on your smart device that allows to control your heating or cooling systems from afar, or to switch on the boiler to make sure that there's enough hot water for a bath or shower when you get home. But that's already old news in some ways. One of the 'next big things' is personalised services.

Given that there was a very risqué comedy film made some years ago called 'Personalised Services', I'd better move on quickly and explain what I mean.

Personalised services are already seen as a 'must-must-have' in top-end dwellings. They're a feature in many of the very luxurious houses and apartments that seem to be being built in their thousands in London at the moment.

So, as you journey back from your day at work, your smart device is in conference with the various electronic devices in your home. It makes sure that the ambient temperature and lighting are exactly as you want them when you arrive. Your phone tracks your progress and lets the other devices know precisely when you will arrive. When you get home, the security system has just been disabled, the garage door has just opened and the lights are on. In the kitchen, your coffee or tea — this is London, after all — is freshly made to your personalised requirements. All of this happens without you having to do anything and the same can happen for all of the other members of your family, each of whom probably has differing preferences.

Applications such as this are already starting to appear in offices, not just dwellings, and as always with such things what's currently luxury and expensive will eventually become commonplace. As intrinsic intelligence levels rise, so will our unconscious levels of expectation.

But think about the levels of interaction that take place to make happen what is after all a fairly banal event — the delivery to you of a beverage that's freshly made and just as you want it. Compare the computing power and instantaneous communication across numerous devices involved with the effort needed to realise another banal event such as — oh, I don't know — putting a man on the Moon.

As an historical aside, Apollo 11's guidance computer had just 2k of memory, and ran at a clock speed of 1.024MHz. Its external signalling was half of that. I'm a writer and I just looked that information up on the internet; you're engineers and I'm sure those numbers mean something more to some of you but compare that level of performance to the many gigabytes of memory and

operating speeds of modern smart phones. All of that capability in one device, the smart phone, reduced to being used to make sure you get a cup of freshly warmed coffee. The point is that we've now got capacity enough kicking around to enable us to do that.

But think of all that capacity and capability, and multiply it by the number of smart phones out there. I'll come back to that, and coffee, in a moment because I want to ask you what you think, in money terms, all of this stuff is worth?

Actually, I'm going to tell you, and do so by briefly introducing a sub-set of the IoT called the IoL — the Internet of Logistics. The IoL describes that environment in which the individual elements of a cargo are potentially all proactive. Not just an individual ISO container, but every pallet and parcel within it — each communicating about what it is, where it is, where it's trying to get to and when it needs to be there. Each, potentially, being parasitic and opportunistic about how it achieves those aims.

A couple of years back, DHL and Cisco estimated that the IoL will constitute around a quarter of the IoT. That's not unreasonable when you think about it, as movement of goods is a large part of what mobility is all about. The two companies estimated the worth to be generated by freight/logistics-related IoT developments as \$1.9 trillion.

'Worth generated' is obviously one of those phrases that's open to very wide interpretation but I think we can safely say that the sums involved are going to be huge — remember that \$1.9 trillion figure when next time someone asks you to explain how and why mobility is more than just a service, that it's a wealth-generator in and of itself.

Let's go back to mobility, and coffee.

In my mind, there are two main trends in the intelligent transport system sector at the moment. The first, the mainstream media have been all over. The second, the mainstream media remain almost entirely ignorant of.

The first is of course driverless vehicles and we've seen huge numbers of column inches written about them. The second is Mobility as a Service, or MaaS — and it's MaaS, I'd contend, which is perhaps the biggest game-changer of the two.

Why did I mention coffee? Because I'm back again to personalised services.

The premise of MaaS is a simple one. It's about the delivery of modally-independent mobility services down to the individual level.

Actually, it probably deserves a slightly longer definition than that. If I take a deep breath, I can get through this in one go: it's the seamless, infinitely adaptable delivery of mobility, together with associated information and payment services, across all modes of transport. All of this takes place in real time or predictively, wirelessly, securely, and with the end-user being unaware of the potentially huge number of behind-the-scenes interactions between stakeholders and facilitators.

Ah, coffee. Actually, not just coffee but a whole range of value-added services which are tailored down to the individual level.

Although we in the terrestrial transport sector see MaaS as something new, our efforts have already been presaged to an extent by the airlines and online booking services such as [hotels.com](https://www.hotels.com).

If I go online to book a flight to travel somewhere in Europe using an airline such as Easyjet, I'm bombarded with a whole series of options which require a conscious decision and a mouse-click or a swipe to get through — I'm offered car hire, room hire, restaurant reservations and theatre bookings... yes, it's done with a commercial imperative and profit in mind but it also makes it very easy in one place to put together everything I need to complete my trip. I'm using it as an example because it'll already be familiar to some of you.

The difference with MaaS is its real-time, multimodal nature and — from the user perspective — its seamless nature. In its ultimate form, the traveller need only instruct his or her smart device as to

where he or she wants to go, and when. The device does the rest. That includes taking care of the individual's preferences for mode, methods of payment, speed of journey, carbon footprint and all other factors. We just then get on and do what the device tells us.

Think back to 2012 in London, and how much smarter we made public transport. Think how much smarter we can make all modes if we can continually and dynamically manage demand while people are on the move. We may even be able to reduce capacity and so reduce the carbon burden in some cases whilst still increasing levels of mobility. It's a very exciting prospect.

But what all this is reliant upon, if it's to be accurate and therefore dependable, is huge amounts of data and very fast processing capabilities. That may sound obvious but it deserves more consideration from both the technological and the societal viewpoints.

Very quietly, something's happened in transport and infrastructure management over the last few years. I say 'very quietly' because you'll be aware of it once I spell it out but perhaps have only been unconsciously aware of it otherwise.

We've moved from a situation where, even relatively recently, it was assumed that it was a good thing to collect all possible data. The collection capabilities we had made us data-hungry and inculcated that mindset — and that was as much for asset management as traffic monitoring. If, for instance, you could very accurately profile the traffic passing over that bridge for a 10-or 20-year period, then you'd have a much better idea of its state of health.

Now, we've flipped over into a situation whereby our data-collection capabilities will potentially overwhelm us. We already manage or report by exception in many instances. We push intelligence, such as machine vision, out to the edges of our transport networks and only intervene, because of incidents or infringements, if we're invited to. We've done that because we have to because of the potential for information deluge. But now imagine where we'll be if we try to onboard information from every individual's smart device.

The IoT offers us many exciting possibilities. It also threatens us with stasis if we don't become much smarter about being smart, and we need to do so very quickly.

It's probably a good time to talk about algorithms, and about privacy. Algorithms, because we need to be able to wade through that sea of information and extract from it the macro and micro data that we need to make things work. And never forget — here's the coffee again — that it's not just going to be about traffic or mobility management. It's the payment and information services, the value-added services, the blurring of the boundaries between the roadside or the parking space and the rest of life. We 'do' traffic management and mobility. But we're going to have to stop treating that as a discrete entity in and of itself. We're going to have to contextualise what we do within a whole, seamless experience which doesn't stop when a traveller gets out of a vehicle, whether it be public or private.

That means we're going to have to work harder to extract the data relevant to us from a set that is not only far larger but also far greater in terms of variety. That presents us with some — I'm not allowed to use the word 'problem' any more, so I'll settle on 'challenges'.

Broadening our horizons, necessarily, lays us open to a far greater number of potential pitfalls — I'll use a different word beginning with 'P'.

I started writing about ITS almost 20 years ago. Then, privacy was a raging debate. In retrospect, the arguments of the time seem rather quaint. Some of the objections have long since been overtaken by the march of technology and individuals' habits but I can see the privacy issue making a comeback.

In the UK, several governments now have flirted with the idea of distance-based road charging. Around the world, in fact, governments are having to accept its inevitability, especially as the use of electric vehicles

ramps up. The US's Highway Trust Fund, its 'gas tax' which it uses to underpin the Interstate System has already been technically bankrupt for quite some years.

We also have to consider social equity — right now, you can buy an electric car and exempt yourself from fuel tax. Electric cars are still premium products, so we have the iniquitous position where the more wealthy pay less.

Nevertheless, every time distance-based charging is mentioned, the ill-informed and sensationalist mass media play on the idea that 'they' will know who you are. 'They' — the government. 'Big Brother', 'Spy in the Cab' and so on. Never mind that a different 'they', navigation service providers, know where you are. Never mind your electronic payments, your use of a mobile phone, the ubiquity of CCTV cameras in many of our towns and cities. Never mind the safety blanket provided by eCall and similar emergency services which rely upon accurate positional information. It's a nonsense argument, but it persists.

I deliberately didn't mention browsing habits in that list just now because I want to come back to algorithms. I'll give you an example.

I had a very brief involvement with the military and retain an interest in military matters from a geo-political perspective. I also still have friends serving, in one capacity or another. Recently, I was on a web forum, and made a comment on a thread about the threat of radical Islam. I then clicked over to another thread. The advert down the side of that new thread offered to introduce me to potential Muslim brides. I can see what happened. Somewhere, some algorithm knows that I'm unmarried and it picked out key words.

To me, the result was quite amusing. I'm not in the market at the moment, but two points come out of what happened — one, that the 'connection' was made near-instantly and the results were pushed back to me in the space of a mouse-click and two, because the algorithm made a clumsy assumption the result was wrong. I was amused, but other connections could well have offended someone else. And, to be fair, at other times those key-word results can be quite useful. A hobby of mine is hill-walking. My online comments and purchases have generated adverts for equipment suppliers I wouldn't have known of or considered, with excellent results.

So, we need our algorithms to be smarter...or do we? Do we want them in our lives at all?

Dare I mention coffee again? Do you take yours with milk? I mentioned earlier the refrigerator that takes care of ordering more for you. Well, some people don't want others to know such high levels of detail about them. But it's not just milk, is it? Maybe I don't want people to know my political affiliations. For the record, for those of you here, they're not extreme but they're something I consider private because if I share them someone, somewhere will be outraged. That seems to be the way of things these days.

We've seen Facebook's Mark Zuckerberg pulled in front of the US Senate to answer questions about Cambridge Analytica. People were outraged at the levels of intrusion exposed by a whistleblower. The same people, incidentally, who blindly respond to online quizzes on Facebook and elsewhere asking their mothers' maiden names or the makes and models of their first cars. All of these quizzes are potentially phishing scams. They could be being used to harvest information for identity theft purposes — and the very people objecting to invasions of privacy are happily supplying the potential thieves with confidential information.

Our notions of privacy are changing. Actually, that's not quite right: privacy is changing but our collective notions of it haven't yet. I've read that the internet has reduced the whole world to the size of a Medieval village. That's a stunning concept when you think about it.

How many of you are familiar with the term 'ubiquitous camera'? They're everywhere, on phones and tablets, on walls and poles and the sides of buildings. They challenge our traditional notions of physical, not

just electronic, privacy but even without an image being captured someone, somewhere will know, because of our mobile devices, that we're all in the same room together right now.

But we're still at the stage of having to deal with people's ignorance, and people are going to be blaming us, not themselves, for their ignorance. Change will take time. I've read that it's not our kids but their kids who'll be the first to have an intuitive understanding of the world that we're rapidly progressing towards. That's something to bear in mind.

A few years ago, I was talking about the privacy issue with a colleague. He was appalled that the publicity effort relating to mobility remains so defensive, especially where the privacy issue is concerned. We need, he said, to stress the positives with much greater energy and be much more proactive in the face of nay-sayers.

That's not to dismiss the negatives. So, to interpret his words slightly differently, I think what he was suggesting was a need for greater proactivity combined with a greater, well-considered level of transparency. Now more than ever we need to address notions of bureaucracies and the public sector being malevolent. They're not — all they're doing is trying to get stuff done, sometimes in spite of themselves and contrary to appearances. And we need to keep a firm check on the private sector's ambitions.

Most of the time, this stuff is innocuous. I mentioned eCall and navigation services earlier. Both very, very positive influences on our lives. I mentioned MaaS, which is going to be a game-changer in terms of mobility — I truly believe that. The global policy aims of increased safety, greater sustainability and reduced congestion are all going to be supported by the arrival and growth of the IoT.

Remember that some of those looking to use data are also early adopters. We'll see stops and starts and we'll see test cases and class actions. People's levels of sentience will rise just as the technology's sentience increases, if only by a process of osmosis — there's that generational thing.

I'll end by saying that it's not all doom and gloom. In that fine tradition of known knowns, known unknowns and unknown unknowns, I hope that I've given you some positive negatives to think about.

Thank you.