An Internet of Cars

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Abstract

Despite describing the transport infrastructure as a 'network', most road and transport users see little similarity between the 'transport network' and the internet. This paper suggests that overcoming this difference is key to a new paradigm of transport in which connections, flow and sharing are synonymous with both social networking and travel behaviour.
In order to demonstrate the potentials, this paper presents an experimental platform that combines data gathered from Automatic Number Plate Recognition (ANPR) cameras and a smart phone application that allows participants to use cars as a form of internet. The speculative platform that is being developing for a tourism community in the South of England, is a creative approach to conceiving cars as data packets through the use of their license registration plate and offering a playful platform that allows users to engage with them as though they were part of social media. The paper introduces the concept of the Internet of Things and the technical and cultural shift that is anticipated as society moves to a ubiquitous form of computing in which every device is 'on', and every device is connected in some way to the internet. Using a substantial database of vehicle registration plates collected from the ROMANSE traffic control system in Southampton, It also investigates to what extent 'regular returners' make up the flow of vehicles in a network as opposed to one-off unique vehicles and the wider potential for some vehicles to become 'information carriers' due to their habitual behaviour.

The specific reference to 'things' refers to the concept that every new object manufactured will also be able to be part of this extended Internet, because they will have been tagged and indexed by the manufacturer during production. It also envisages that consumers will have the ability to 'read' the tags through the use of mobile 'readers' and use the information connected to the object, to inform their purchase, use and dispose of that object.

This paper introduces the background to the idea, the nature and location of technologies involved, the scale of data that we are processing, and feedback from participants involved in preliminary studies. The paper proposes that by adopting the 'habits' that consumers are currently developing to scan shopping items to access network data, the barrier between conceiving the transport network as a network comparable to social media may be overcome.

Introduction
The vision of an Internet of Cars is located within the emerging technical and cultural phenomenon known as 'The Internet of Things'. The term is attributed to the Auto-ID research group at MIT in 1999 (Ashton). The term, 'internet of things', refers to the technical and cultural shift that is anticipated as society moves to a ubiquitous form of computing in which every device is 'on', and every device is connected in some way to the internet. The specific reference to 'things' refers to the concept that every new object manufactured will also be part of this extended Internet, because they will have been tagged and indexed by the manufacturer during production. It is also envisaged that consumers will have the ability to 'read' the tags through the use of mobile 'readers' and use the information connected to the object, to inform their purchase, use and disposal of an object.

The implications for the Internet of Things upon production and consumption are tremendous, and will transform the way in which people shop, store and share products. The analogue bar code that has for so long been a dumb encrypted reference to a shops inventory system, will be superseded by an open platform in which every object manufactured will be able to be tracked from cradle to grave, through manufacturer to distributor, to potentially every single person who comes in to contact with it following its purchase. Further still, every object that comes close to another object, and is within range of a reader, could also be logged on a database and used to find correlations between owners, environmental conditions and applications.

The Problem
However the authors suggest that a technically determinist vision of tags and codes appears to be obscuring an opportunity to fold existing 'things' into an internet for traffic. Cars are the single most visual form of actual moving data that we know and yet they are wholly overlooked as packets of data that interface with humans, businesses and the environment. The vision within this paper introduces the principle that car registration plates can be used as unique identifiers in the same way as barcodes and offer a platform for people to store data on to them, use them as interfaces to social networks, pass messages between people, and connect to environmental data.

The authors speculate that the primary barrier is one of habit. The public do not identify the registration plate on a car as a portal to the internet in the same way that QR codes (quick response barcodes) or RFID are beginning to offer.

Our objective: Identifying cars as things within an Internet of Things that have the potential to link people, services, artefacts and places.

Our barrier: The public identification of cars as packets of data.

In Sixth Sense transport (Davies et al 2011) we are looking to provide travellers with many forms of interface to enable them to 'see' the flow of traffic and begin to anticipate new travel opportunities. Part of this work involves developing visualisations of future transport options as well as mobile applications that support sharing. Considering cars as extensions of social media is one way that we are exploring how to alter people's perceptions of automobiles and offer them new models akin to the fluidity of email, social networking and file sharing, systems that are part of the paradigm that Castells describes as the Network Society (1996).

Internet of Cars
Dynamic, fluid and representing individual packets of information within a UK wide network, cars could be critical components within the emerging phenomenon known as the Internet of Things. Each one tagged with a unique identifier that is scannable with smart phones, as well as the highly sophisticated roadside cameras, cars with their number plates have been the equivalent of barcodes on supermarkets products for many years. However they remain woefully overlooked. This vision explores a commercial and social platform for turning cars into networked artefacts that will provide the missing link in connecting the flow of things to people, artefacts environments and businesses. Visible in the street, cars that are linked through a common web platform offer a fluid interface to the Internet of Things that will make visible the flow of products and services that could change the way we inhabit cities in the

21st Century. Able to 'see' where things have come from and where they are going, cars have the potential to become the next web browser.

Cars offer a local and dynamic interpretation of social activity: where people go, what their habits are. Lift sharing, moving things such as shopping, postal items and messages suddenly transforms the opportunities for an Internet that we can 'see'. In contrast is the static life of things such as barcoded products bought from supermarkets which only appear 'on the grid' when they are scanned at the point of manufacture, in the warehouse, and finally at the point of sale (Sterling 2005). We know that as individuals or as families we move 'things' around in bags and cars but these things are hidden and therefore are offline during transit preventing them from connecting to other people and services. We wouldn't dream of scanning a tin of baked beans in someone else's supermarket plastic bag. But cars are in the public domain and they offer an open platform upon which things in flow can suddenly be made accessible.

Figure 1. Vehicle registration plates and Quick Response barcodes both operate as individual identifiers.

The potential for registration plates to act as information carriers

The ability to tag a vehicle's registration plate with information to allow others to read at various points in the future offers a potentially new way of disseminating not only traffic information (journey times, congestion/incident hotspots), but data on weather/road conditions, special events, and user relevant offers. In terms of using vehicle registration plates as information carriers, it is important to understand the returning habits of vehicles within a network, what defines a 'regular' vehicle in terms of the variability in its arrival times, and the proportions of unique vehicles that may not be 'familiar' with the local area.

Behaviours which make up the daily travel pattern can be highly repetitious in nature (Huff and Hanson, 1986) with little variability in route choice occuring from day-to-day (Golledge, 1970: Clarke et al., 1982; Williams and Ortuzar, 1982). In a study of vehicle returning habits over 11 consecutive days during the morning peak period at four separate arterial roads in Southampton, Cherrett & McDonald (2002) found that the proportions of unique vehicles varied significantly with road and time. Vehicles appearing on more than one day formed

80% of the traffic before 08:15 but only 60% between the 08:45 and 09:00 peak period. Although the proportions of vehicles re-appearing from day to day varied significantly with road, their arrival variances were found to be very similar, with 65% of the returning vehicles re-appearing within +/- 5 minutes of their previous day's time implying that this frequency of arrival could be part of an habitual behaviour pattern. Their results suggest that for occasions where congestion can be anticipated in advance, such as prior to emergency roadworks or special events, warning messages would be most effective before 08:30 a.m. when the largest proportion of regular vehicles (and presumably more familiar drivers) would be using the roads.

Using a substantial database of registration plates collected from 18 automatic number plate recognition (ANPR) cameras across Southampton (Figure 2) over a 19 week period, (24 hours/day, 7 days per week, May to September 2012), the proportions of regular and unique (one off) vehicles were assessed by time period and road. Over the 19 weeks, 11,116,936 vehicles were detected, where the cameras had recorded a read rate confidence of >75%, equating to 1,365,337 individual vehicles once repeat plates were filtered out. Looking at detections by day of the week (Figure 3) showed that 686,000 vehicles (6.2%) only appeared once in 19 weeks and can be termed 'unique'. Saturdays contributed 13% of the total number of vehicles detected over the period but saw the greatest proportion of unique vehicles (17.8%), synonymous with out-of-town shoppers and leisure travellers. Friday's saw the greatest proportion of detections (16%) and unique vehicles across the working week with around 13% of vehicles being unique one-off visitors on Monday to Thursday.

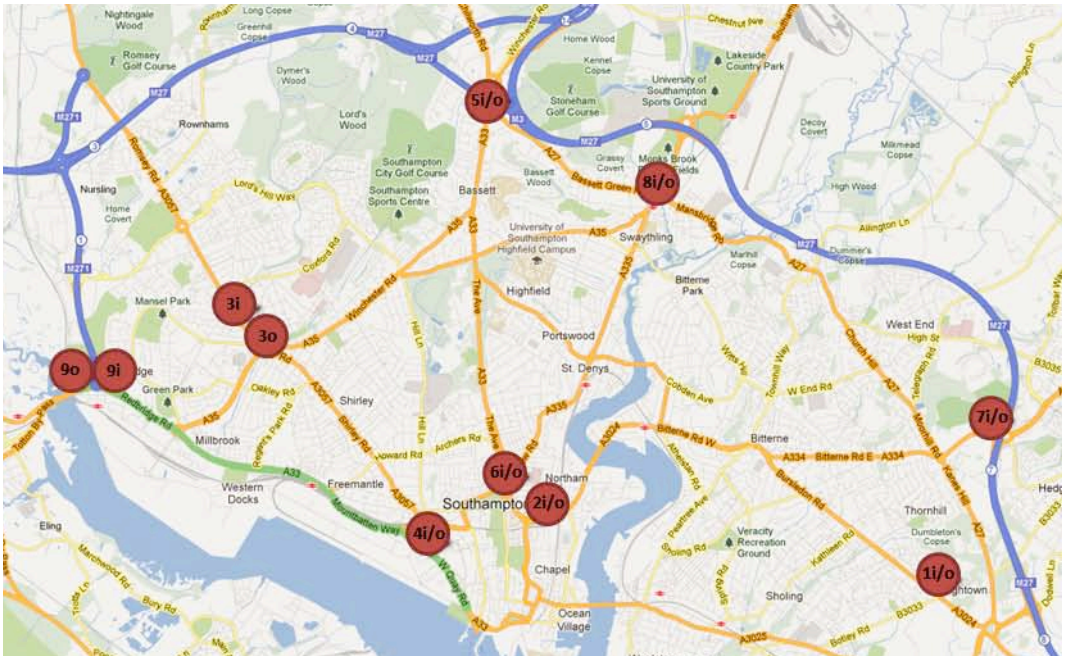


Figure 2. Registration plate reading cameras in Southampton (N=18) used in the study

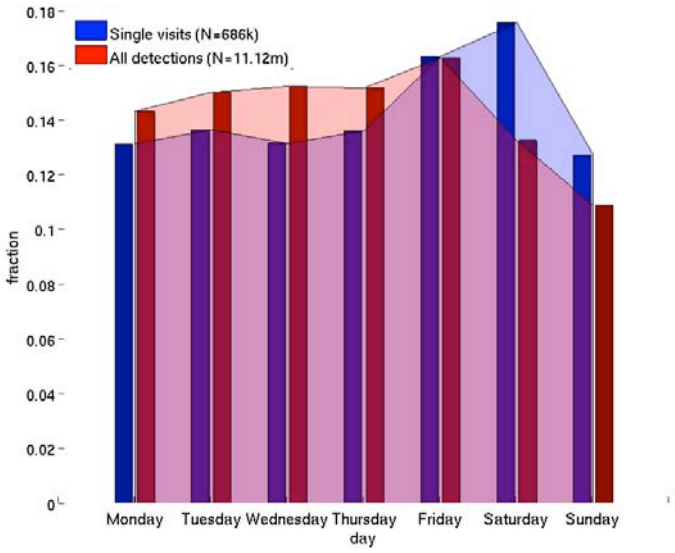


Figure 3. Proportion of unique (single visit) vehicles (N=686k) seen against all detections (N=11.1million) by day (Monday to Sunday) across 18 cameras (133 days) in Southampton.

Across the working week (Monday to Friday), only 5.7% of the vehicles seen were unique across the 133 days and the greatest proportion of these (44%) appeared between 10:00 and 14:00 each day (Figure 4). When looking across specific camera positions in the city, significant differences in the arrival variances of 'regular' returners (vehicles being seen on 40 or more occasions over 133 days) were observed with greater variances in repeat arrival times seen during the evening peak period compared to the morning (Figure 5). Some vehicles were so reliable that their mean arrival variance over 40 separate detections was 90 seconds. A key issue in using regular vehicles as information carriers is which group are the real habitual commuters, having such small return variance times that one could literally set ones watch by them. Further work is necessary to establish which particular vehicle group (in terms of return rate) would be the most reliable to target as information carriers (e.g. vehicles seen over 200 times in 133 days could well be taxis and therefore may need to be excluded).

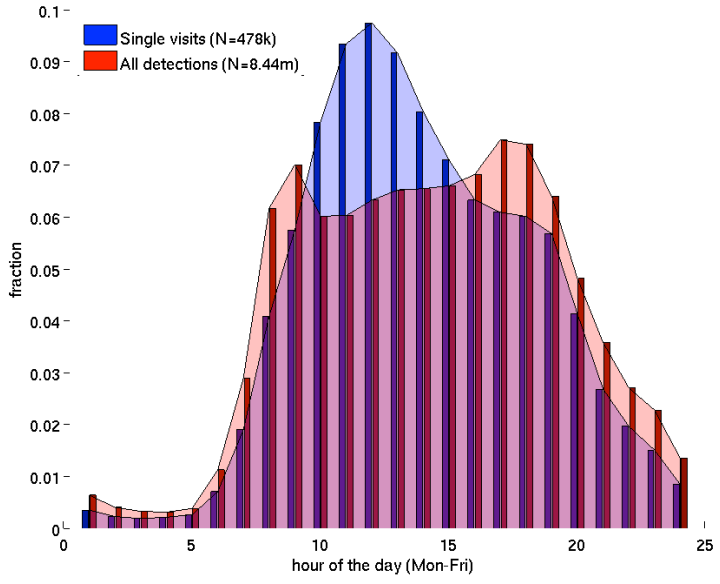


Figure 4. Proportion of unique (single visit) vehicles (N=478k) seen against all detections (N=8.44million) by time interval (Monday to Friday) across 18 cameras (133 days) in Southampton.

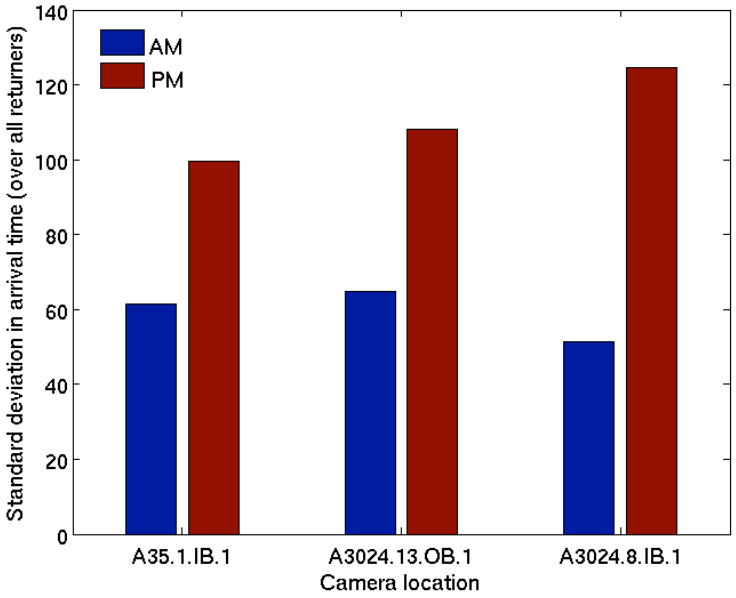


Figure 5. Standard deviation in arrival times (minutes) at three camera locations in Southampton for vehicles being seen 40 times or more over the 19 week survey period. (A35=9i; A3024.13=4o; A3024.8=2i in Figure 1)

Case studies

The use of car number plates as a social interface is informed in part by research carried out in the Tales of Things and Electronic Memory (TOTeM) project that was set up to explore how to disrupt the use of printed barcodes. Until very recently the scanning of barcodes on the side of product packaging was restricted to those who had 'red laser' scanners: till operators in supermarket checkouts, stock controllers and staff at airport check-in. The arrival of smart phones has enabled a wealth of software applications that have disrupted this previously exclusive practice. The TOTeM project developed a system that allowed somebody to not only scan a barcode and 'read' about it's history, but also the unique ability to add a further story on to a thing and effectively 'write back' to it (Barthel et al 2010). It is this concept applied to car registration plates which is being addressed here.

One area of particular interest to the team was the second-hand retail market, typified by traditional charity retail outlets, car boot sales and online market places such as eBay. TOTeM wanted to investigate how shopping experiences are mediated when provenance information about an object are provided via a digital object memory that is accessible via QR Codes and RFID tags (Leder et al 2010). A series of three interventions, leading toward a regional roll-out, began with the RememberMe arts project at the Whitworth Park branch of Oxfam, Manchester during The Future Everything festival in 2010. For the first of two weeks a research associate asked people that dropped things off to tell a brief story about the object into a microphone, these audio tracks were then associated with Tales of Things QR and RFID tags. One week later the donated items and their tags were placed amongst stock items on the Oxfam shop shelves and tags allowed shoppers to listen to the stories through loud speakers or more discretely through their smart phone (De Jode et al 2012). Whilst doing the quarterly accounts the regional manager to the North West found a 52% spike in sales. Intrigued by this, the team were invited by Oxfam UK to develop a similar experience for the high profile Oxfam Curiosity Shop that appeared in Selfridges, Oxford Street, London in January 2011 and sold items donated from celebrities. The annual event generates hundreds of thousands of pounds simply due to the celebrity related provenance of each item. Previously tagged with luggage labels indicating the famous donor, TOTeM technology allowed Oxfam to attach QR codes and in special cases RFID tags, which launched video stories from the celebrities on to large LCD panels. Gaining wide press attention, the Curiosity Shop intervention galvanised the belief that personal stories transformed the value of a second hand item. The third iteration was to develop an Oxfam product that was powered by TOTeM technology but was tailored for high street use in their 650 high street

shops. Launched under the Oxfam brand as 'Shelflife', the TOTeM team worked with Oxfam user experience and web designers to develop a free iPhone app and an extension to the www.oxfam.org.uk website. For twelve weeks from February 2012 ten shops in the Manchester area carried out a full pilot with Shelflife branded tags, points of sale literature, posters and shop manager / volunteer support.

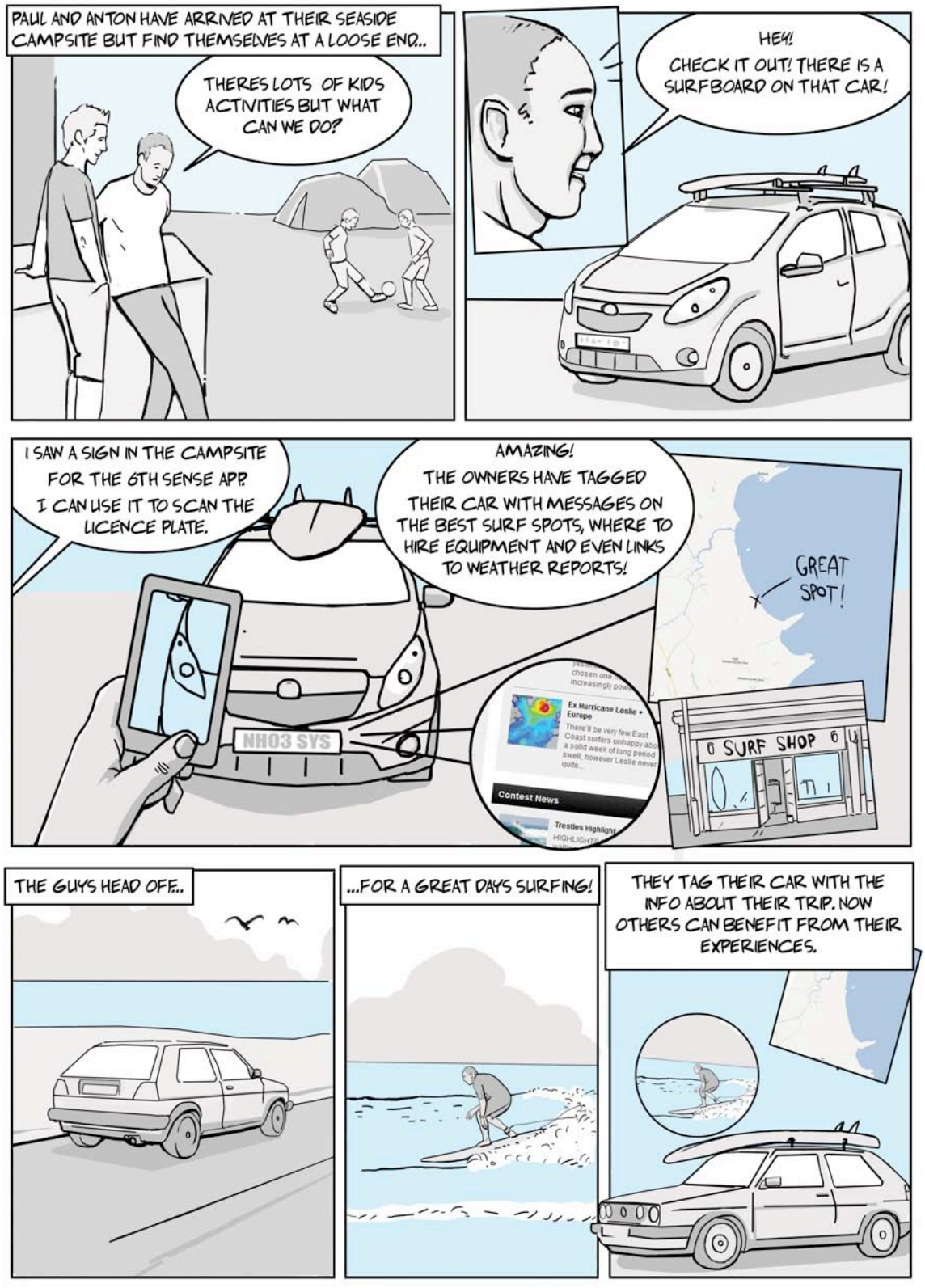
The success of the TOTeM project and its impact upon second hand clothing culture by disrupting a traditional technology such as barcodes and its associated habits, offered a transferable method for investigators involved in the Sixth Sense Transport project to disrupt the assumptions surrounding the role of car number plates. The primary convergence scenario for the Internet of Cars projects are the thousands of cars that travel around the roads between the English towns and cities of Weymouth, Dorchester and Southampton, in particular during the tourist seasons. The A35 Dorset corridor linking Weymouth to Bournemouth and connects the historic towns to the beaches and coast line of the south of England is no different to any other in its reliance upon the car as a conduit for moving people and things to support personal, social and commercial needs. At present though, there are no connections between people and the things (cars). Through correlating the data accrued by the roadside traffic cameras with social data that is mined at each location and data that is associated with specific cars, the research team are developing a platform that will reveal the car as a point of network inquiry for tourists. In short, cars that move around the area, being scanned by the ANPR system will carry with them up-to-date data about the area that is submitted by fellow car drivers who associate data with their car number plate.

Through close collaboration with SCAN[1], the intention is to develop a public platform that enables car registration data gathered from the traffic cameras to be complemented by crowd sourced data. The promotion of free smart phone apps that allows residents and visitors to scan cars will provide further data that will contribute to an image of the cities social, economic and environmental flows. At present two initiatives are planned to encourage the use of the system: the first uses the car as a place to store photographs and text to share with others through the mobile scanning of the number plate, the second extends the reach of this data by sharing location specific information via APNR cameras. These two ideas are described below through cartoons that explain the context and user experiences for both initiatives:

Case Study 1:

The car holds the memory…

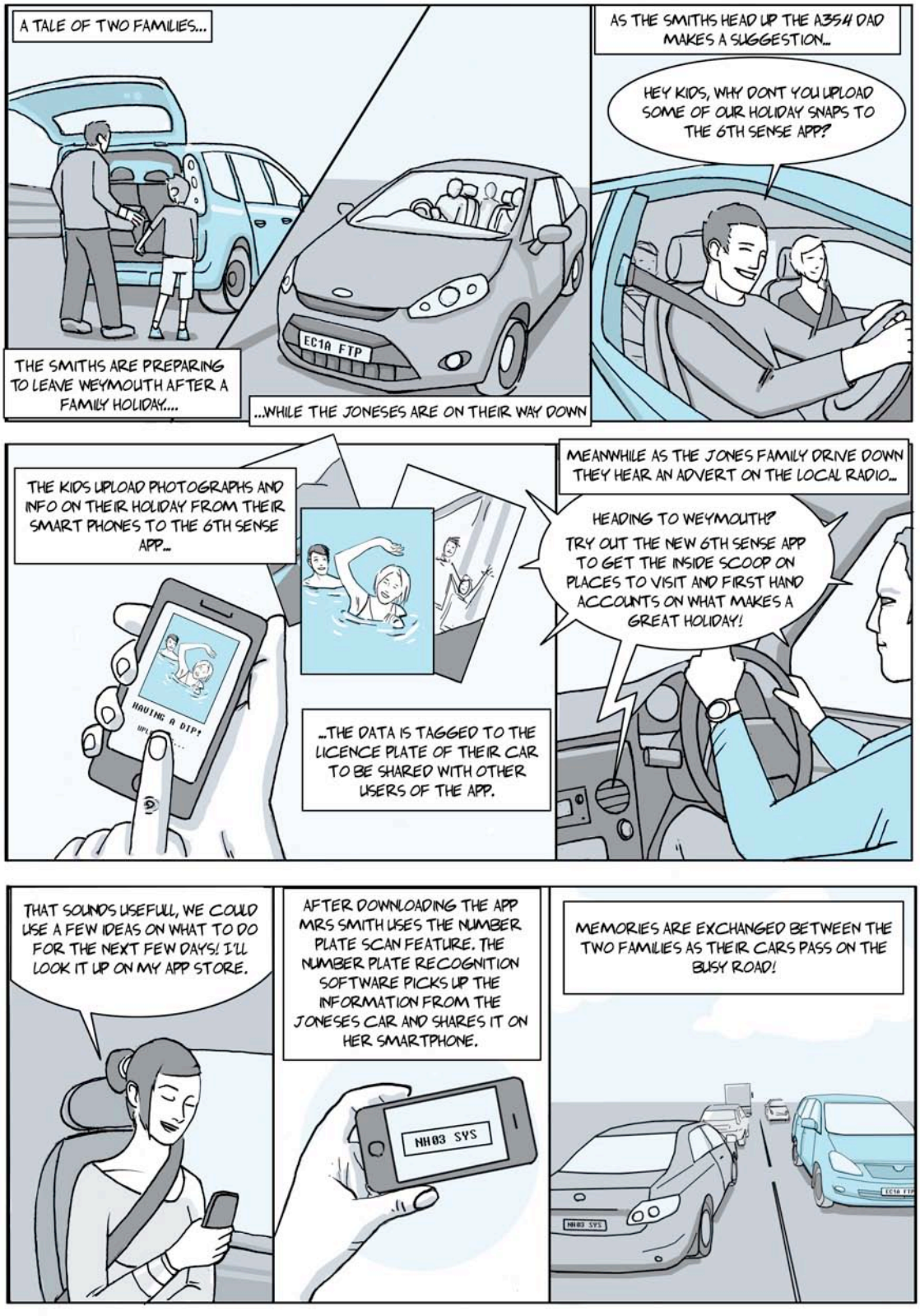
Two surfers get help from a car about where the best surf spots are whilst on their camping holiday…



Case Study 2:

The memories are spread through the use of roadside ANPR's

A family that has finished its holiday in Weymouth shares its memories with another family who are heading in the opposite direction and are about to start their holiday…



Preliminary Participant Feedback

Preliminary research has explored the topic during in-depth interviews with 15 participants at a campsite in Dorset (see Filimonau et al, 2013, in conference proceedings for more details) who were introduced to the car tagging idea illustrated in case study 1. Participants found the idea interesting but had some initial problems grasping the concept given they largely fail to appreciate the car as a node within a network. For instance, within the campsite environment, people felt they would probably talk directly to other visitors. On the other hand, the car provides an intermediary in the social exchange process which, for some people, overcomes barriers imposed by social interaction. Within a campsite community, visitors have 'weak ties' (Nahapiet and Ghostal 1998). In this setting the car has potential as a portal for exchange of information linked to visual clues about the occupants such as their equipment or children's age. It removes some of the problems associated with social exchange such as reciprocation (Burke et al 2011). For example, some campsite visitors were very reluctant to ask other visitors directly for help as this embeds them into a reciprocation arrangement that might impose subsequent costs they might be unwilling to provide. In this context, car tagging may extend 'network capital', that is people's access to the coordination systems that facilitate access to services and opportunities (Urry 2012). This, in turn, extends social capital (Larsen et al 2007).

On the other hand, given the highly personal associations with cars, participants expressed some concerns about privacy. People understand that car number plates can be traced directly to owner's details and this introduced some reticence as participants were not sure what type of information might be retrieved. There were also concerns about 'who' might be allowed to tag details onto 'their' number plate and 'what' information might be left for others to read. For instance, someone could leave a rude or highly personal message that other users could retrieve unbeknown to the car owner. This relates to trust, one of the core components of social capital (Burke et al 2011). Participants troubled by this aspect showed a preference for face-to-face interactions which they felt provided an opportunity to appraise the individual and the consequent value of their information.

Participants who grasped the concept were excited by the opportunity and experienced a moment of realization when they visualized the potential; one woman likening the car to her Facebook page and her 'wall' where others can write comments. Potential users were comfortable so long as they maintained control, as in a Facebook page, and had the ability to delete and edit contributions. The surfing scenario in case study 1 developed, in part, from an early interview in which a participant described the potential for linking up with likeminded people who would be able to see he is a windsurfer from paraphernalia on his car.

The Car to Smart Phone and back again

In his 2004 paper, Nigel Thrift argues for an update of de Certeau's romantic idea that the walker is the primary agent within the city. Thrift identifies digital technologies as offering a more complex substrate for enabling communications to become part of a negotiation with space (Thrift 2004). The car complimented with satellite navigation, air conditioning, musical soundtracks and a figure-hugging seat provides a very personal interface with a city, one that predisposes the driver to allow the car to become an extension of his/her body. Once driving, we find ourselves expressing a series of characteristics that indicate a deep embodiment of the car including: the charged emotional state in which we engage with others, communication techniques using lights and movement, and the 'tactics' that allow us to navigate spaces by reading the 'gestures' and actions of others (Katz 2000).

"The advent of a mixture of geographical information systems, global positioning and wireless communications means that getting lost will no longer be an option and, equally, that increasingly it will be possible to track all cars, wherever they may be. The result is that both surveying and being surveyed will increasingly become a norm: it is even possible that, through the new infor- mational and communicational conduits that are now being opened up, some of the social cues that have been missing from the experience of driving will be re-inserted (for example, who is driving a particular car), making the whole process more akin

to walking again, but with a new informationally boosted hybrid body, a new incarnation." (Thrift 2004)

Thrifts explored the potential for digital systems to extend the social negotiation with a space through the car. Published in 2004, eight years later the wide spread adoption of smart phones means that pedestrians now match and extend the technology that Thrift identified in the car. The Internet of Cars work for the Sixth Sense Project aims to capitalise on the connection between car and smart phone to offer a connection between transport network and social networking. Latour's model of the social through Actor Network Theory provides a vocabulary for acknowledging car's as 'actants' within a network, vital elements that contribute to the performance of agents and meaning. As the car becomes a node within an internet it has the potential to gain a form of agency and become party to the needs of a system.

"Society is not the whole 'in which' everything is embedded, but what travels 'through' everything, calibrating connections and offering every entity it reaches some possibility of commensurability. We should now learn to 'hook up' social channels like we do cable for our televisions. Society does not cover the whole any more than the World Wide Web is really worldwide." (Latour 2005)

Conclusion

With the opportunities that the scale of real-time data derived from the ANPR data is providing, coupled with the reticence of our preliminary users who struggle to connect their social media practices with that of driving their car, the project offers a critical exploratory platform upon which we can begin to ameliorate the disconnection between a transport network and a social network. As the Internet of Things begins to manifest itself in different forms, there is no doubt that as objects become connected to the internet, that they will begin to change the way that we go about transforming age old practices. From scanning second hand good to find out who formally owned them, to scanning cars to find out what the weather is like where we plan to go today, the connectivity of things is going to offer new opportunities for how we relate to the things that are around us.

Despite representing an extraordinary number of nodes within a system, of the 31,035,791 registered cars on UK roads accounted for in 2009, very few remain actually represented in most networks. In direct contrast is the precedent of 50 million users of mobile social networking worldwide. Not only does this build and reinforce social ties distributed over time and space, it also permits real-time data stream aggregates to inform network participants of new recommendations (e.g. new books on Amazon, 'second guessing' new contacts in the industrial networking tool LinkedIn) and the scope to establish new network nodes. This difference between the rich semantic networking facilitated by social networking technologies and the low-level communications capabilities often associated with vehicle networks represents the primary motive for the Internet of Cars projects.

It is hoped that through the case studies that opportunities for connections that are otherwise invisible to current users (e.g. sharing information about the local area) affords participants the potential to re-think decision making processes about travel and adopt social networking methods. As the reading and writing to objects through tags becomes more and more ubiquitous, 6ST Internet of Cars offers an open platform which will interface with current instances of the Internet of Things and offer a critical socio/technical substrate around which new transport habits may emerge.

Acknowledgements:

The Sixth Sense Transport project is supported by an Energy/Digital Economy UK Research Councils grant. Additional credits go to the wider 6ST team: Filimonau, V., Ghali, K., Harding, M., Kubitza, T., Lau, M., Mcleod, F.N., Shingleton, D., Smith, L.

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