Smart Cities:
a joint position paper

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1 Introduction

1.1 About this document

1.1.1 This document is the final phase of the RTIG project *Smart Cities: Transport's Role*. This work was undertaken in collaboration with the UTMC Development Group.

1.1.2 We are grateful for the contributions and support of the Smart Cities Working Group, and of the participants at the Smart Cities Workshop in Manchester (January 2014).

1.2 Definition

1.2.1 There is no universal definition of a Smart City, though there are common elements. The following definitions are however widely used.

> *[A smart city is defined as the] effective integration of physical, digital and human systems in the built environment to deliver a sustainable, prosperous and inclusive future for its citizens.*
>
> From BSI PAS 181: Smart city framework.
> Guide to establishing strategies for smart cities and communities

> *A city can be defined as 'smart' when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic development and a high quality of life, with a wise management of natural resources, through participatory action and engagement. (Caragliu et al. 2009).*
>
> From Wikipedia

> *[T]here is no absolute definition of a smart city, no end point, but rather a process, or series of steps, by which cities become more "liveable" and resilient and, hence, able to respond quicker to new challenges. Thus, a Smart City should enable every citizen to engage with all the services on offer, public as well as private, in a way best suited to his or her needs. It brings together hard infrastructure, social capital including local skills and community institutions, and (digital) technologies to fuel sustainable economic development and provide an attractive environment for all.*
>
> From Innovate UK: Smart Cities Background Paper
> Department for Business, Innovation and Skills, Oct 2013

1.2.2 From the point of view of practitioners and projects, therefore, the concept of the "smart" city remains nebulous. It is, perhaps, more easily understood by its aims than by any single technology, innovation or system.

1.2.3 In this document we have taken the view that the aim of the Smart City is to create a place which, through interconnectivity of systems and technology, becomes better for the people in it. It is more about process than about product: continuous improvement in technology, coupled with joined-up policymaking, and supportive of (justified) cross-departmental innovation projects.

1.2.4 Indeed, the focus on *city* seems unnecessarily limiting. We anticipate that many of the technologies and systems which contribute to making a city smart would apply to all places, urban or rural, connected to make a better environment for everyone. This extension is particularly, though not uniquely, relevant for transport – the purpose of which includes carrying people and goods from one area to another.

1.2.5 For simplicity of language, we have used the phrase "Smart City" throughout this document, but encourage readers to think of "city" in this more extended sense.

1.2.6 Similarly, for simplicity we refer to "road users" through the document, as an accepted general term covering both motorised and non-motorised transport on the network. The relevant scope in individual circumstances, however, may well include non-road modes – track-based (whether road-running trams or guided busways, or full-fledged heavy or light rail), footpath and bridleway, water-based, air, or off-road.

1.2.7 Finally, references to individual road users should be taken as including professional and corporate users, and references in singular or masculine should be taken to include plural and feminine wherever appropriate.

1.3 Transport within a Smart City

1.3.1 An efficient transport system is a cornerstone of a Smart City. There are two main objectives of transport technology:

- Allowing the road user to make better individual choices; and
- Allowing the network manager to make better and more efficient use of the network as a whole.

1.3.2 There are many subsidiary objectives, including:

- Optimising the network of public transport services;
- Optimising the management of road-based or road-dependent services such as emergency services and waste collections;
- Optimising the management of freight movements;
- Optimising the environmental impact of transport.

Sometimes these objectives will be in conflict.

1.3.3 None of these objectives is particularly new, nor unique to the Smart Cities concept. Indeed, these objectives have always been fundamental to UTMC (in the context of road traffic) and to RTIG (in the context of passenger transport). This means that UK local authorities already have many of the resources available in order for their transport divisions to provide a constructive and active contribution to any local Smart City programme.

1.3.4 Becoming a Smart City requires understanding how the road network is being used. Who are the main users and what is it that they expect to get out of it? Again, this will require a multi-pronged approach.

1.3.5 For instance:

- Already, a great deal of data is produced which help network managers to understand variations in the network by time of day, day of the week, season, weather etc. These can used to adjust traffic flows to smooth road usage, making more efficient use of the network that we currently have.

- Using real world data should also help transport planners (both logistical and infrastructure) to plan a more efficient road network into the future. Historically, transport planners have been reluctant to use operational systems data, although this may give a more "real life" picture of how traffic works than the data which is currently collected through surveys etc, and which is often also expensive to collect.

- Understanding how the various network users use the road network. There are a wide variety of road users – commuters, pedestrians, freight, emergency vehicles, bin lorries, utilities companies – and each of these will want different things out of the road network. Sometimes the needs of different road users will be in conflict.

1.3.6 Based on this approach, this document has three main sections:

- Section 2 covers institutional and process issues;
- Section 3 covers technical issues;
- Section 4 covers policy and regulatory issues;
- Section 5 offers a set of conclusions.

1.3.7 Annex A of this document gives a (very brief and non-definitive) selection of visions of potential Smart City implementation concepts that are complex enough to justify the term, but specific enough to be framed into a project structure. These may prompt some ideas within cities as to what might make a good basis for their own Smart City programme.

1.4 Status of this document

1.4.1 This document is a **draft**. In developing further guidance, we are happy to receive feedback and comment; please contact us at secretariat@rtig.org.uk or secretariat@utmc.eu.

2 Institutional and process issues

2.1 Introduction

2.1.1 As described in the Introduction, creating a Smart City is not a single project with a defined end-point. Rather, it is a philosophy of management that will result in an ongoing collection of multiple, specific interventions, which collectively improve the way transport contributes to the life of citizens and businesses.

2.1.2 The first step is, therefore, to define and prioritise the services, functions or activities that are to be undertaken, in terms of their intended *outcome*. This may entail new approaches to systems and data, but these technical aspects can only make sense in the context of a clear management goal and operational structure.

2.1.3 All but the simplest of these will involve discussions and agreements between different departments or even different organisations (possibly including both private and public sectors). Such operations are inevitably challenging, and can result in mismatches of expectation. They are, nevertheless, an essential part of the process.

2.2 Understanding the impact

2.2.1 Individual "traditional" interventions are generally focussed on specific outcomes, and the impact is generally well understood. Smart city approaches, by contrast, are essentially holistic, and therefore need to start with a reappraisal of the spectrum of road user dynamics and their conflicts.

2.2.2 Each road user will make decisions about his journey based on what is best for him personally. This will be a complicated balance of cost, journey time and purpose, as well as numerous imponderables. What is best for the network as a whole may not be best for an individual.

- A **commuter** wants to get to work in the quickest and most efficient way possible while a **bin lorry** wants to collect the rubbish. For the commuter, the bin lorry is an obstacle, but the bin lorry is largely unconcerned by the commuter traffic around him since it does not impede his slow progress. They are fundamentally using the road in different ways. How then, can the network manager convince the bin lorry to use the road in a way which does not impede traffic but also does not increase costs or reduce efficiency to the bin lorry?

- Similarly, when a Utilities Company needs to dig up the road for **maintenance** his works will impede the **flow of traffic**. The Utilities Company, by contrast, is largely unaffected by the traffic around him once the cones and traffic lights have been set up. The traffic is using the road as a highway; the Utilities Company is using the road as a work space. The two uses are in conflict. Clearly it is imperative that Utilities Companies repair their infrastructure. However, how is this best managed with the needs of the traveller in mind?

- Most of the UK's **cycle** network is a shared space with **motorised vehicles**. Both cyclists and car/lorry/bus drivers want to use the road space to make their journey effectively and efficiently. In this case, the cyclists and the driver are both using the road for the same purpose. Even so, they will often be in conflict because the cyclist travels more slowly than the car and therefore creates congestion. However, the cyclist supports the sustainability agenda by reducing his carbon footprint. How can the road network best be designed to accommodate the cyclist and driver safely and efficiently?

2.2.3 There are already a number of holistic (and therefore "Smart City" focussed) interventions available.

- Providing the traveller with good quality multi-modal information is part of the answer. This should allow him to make the best choices to complete his journey. Much of this is already being done through existing websites, news, twitter and other channels depending on mode. However, ensuring that good quality information is available when the network is disrupted is more challenging.

- Reducing private traffic and driving a shift to public transport, or active modes, may be another part of the solution. Encouraging the use of public transport to reduce the number of vehicles on the road would also help to ease congestion. Ensuring that public transport is reliable, frequent and competitively priced will encourage greater uptake. Increasing walking and cycling, in addition, has health benefits and potentially supports community cohesion.

- Spreading the load by encouraging the use of the network at different times of day is another part of the solution. If bin lorries could be encouraged to collect bins when the traffic is at its lightest, rather than during rush hour this would make better use of the network as a whole.

2.2.4 As these examples show, though, a Smart City approach inevitably requires consideration of *balance of investment* and *full impact* issues. High quality information could create "herd effects", in which travellers stampede towards "good" services – and overload them. Bus priority might disrupt traffic management, and increase general congestion. Reducing speed limits might improve safety but increase congestion and emissions.

2.2.5 Such factors are not well understood, but we are beginning to see the creation of models which allow for this kind of analysis to be undertaken. Cities are encouraged to be aware of the opportunities such tools give. However, this makes for more nuanced policies than is currently the norm: elected members with strong personal priorities may prove to be resistant to this kind of analysis!

2.3 Understanding the risks

2.3.1 Smart Cities is essentially about bringing together disparate aspects of the city to make them work more efficiently and better for the citizen. For the reasons discussed above, this carries more risk than traditional projects where the outcome is simpler to evaluate.

2.3.2 Risk will arise from innovative or untested solutions. Cities need to be realistic about how much innovation is being called up, and therefore how much risk can be passed to the suppliers involved in project delivery. Therefore the risk needs to be managed at the time of procurement by understanding where the risks lie for the particular project: is it cost because there is a fixed budget; or is it time because there is an immovable date or political necessity; or is it scope/functionality because it absolutely has to do something. Once this is understood it is possible to start to mitigate and manage the risks and to compromise on less critical areas.

2.3.3 Furthermore, because Smart City solutions are still emerging, the relevant systems are less stable and mature than for more traditional services. There is, therefore, a risk that technology will evolve during the lifetime of the project. Project managers need to be aware of this and build it into the cost expectations for the project.

2.3.4 No project can be completely future-proofed and managers need to accept that there will need to be technology refreshes along the way. However, having a clear vision for the outcome which is well articulated to the supplier should help to work toward a common goal and enable suppliers to understand the context and interfaces that may be required. This should be clarified both within the specification at the time of procurement as well as during the negotiation and dialogue phases. Particular emphasis should be placed on the value of competitive dialogue during the procurement process to ensure a common understanding of the overall goals of the Smart City while allowing for innovation future proofing but not too innovative and nor undeliverable.

2.3.5 Procurement teams within the public sector tend to be process specialists. Many of them have only a basic understanding of IT projects, especially for specialist IT which is potentially critical to the core infrastructure of a city. For a successful Smart City, it is recommended to obtain or develop specialist procurement and legal skills (if necessary from external sources). Getting the contract wrong could have major long term consequences and the attraction of saving money by "doing it in house" should be avoided, unless the team is appropriately experienced: the cost of naivety could be much higher.

2.3.6 From the supplier side, cities should beware of suppliers who claim to be able to deliver the full vision. Unless the city has been able to articulate it exceptionally well, there will be a need to include a whole range of technical and project expertise; to couple this will a range of existing systems and services; and quite likely to engage with a range of external parties too.

2.3.7 The city then needs to accept the project integration role, and the accompanying risks. It needs to bring potential suppliers together, which may include big traditional industries as well as small innovative start-ups, and to set and manage the tone for their working together. The good news is that suppliers are generally content to do this, unless they feel that their own competitive position is under direct threat.

2.3.8 Finally, it may be tempting to "start small", with pilots, trials and demonstrators; or to rely on the enlightened self-interest of the local private sector. While this may be helpful in principle, because the Smart City agenda is so overarching and holistic, it will often rely on scale effects to succeed. Equally, there may be no meaningful leadership unless the city authorities take it upon themselves. Indeed, as project cost and risk will be largely dependent upon the integration processes, the cost of a pilot may be a substantial fraction of the full project cost anyway.

Risk and governance

2.3.9 With potentially numerous different bodies involved in delivering some aspects of the Smart City, it is important to have a clear governance structure to manage risk. The key to ensuring the success of high risk projects is to make sure that the governance arrangements are correct, understood and proven. Prior risk analysis is particularly important for these reasons.

2.3.10 If there is an option of extending a pre-existing partnership that has delivered projects – especially one that has encountered and overcome challenges – then this clearly provides a solid foundation. The delivery of a project is much more likely to be successful if the individuals within the partnership have already developed effective interpersonal relationships, and have invested some personal capital into the partnership.

2.3.11 If a new governance structure is required to be set up, then it is critical that this goes high enough within organisations to be able to sort out the initial problems and challenges that will arise.

3 Systems issues

3.1 Introduction

3.1.1 Whatever the aim of a Smart City project, it will involve connections between systems, and the exchange of data to the mutual benefit of the functions involved.

3.1.2 System integration is a long-standing discipline and there are many excellent texts on the challenges, good practice procedures, and maintenance of integrated systems. It is not the place for this document to rehearse these, but it is worth noting that UTMC is now a mature integration framework specially geared to road traffic systems. Accordingly, many of these features are built into UTMC, and are now quite familiar to both UTMC-using local authorities and the supply chain that serves them.

3.1.3 The passenger transport community is a little more complex, not least because also involves private sector transport operators, the work of RTIG and other organisations has helped to bring the same kind of systems discipline to this industry too.

3.1.4 Neither UTMC nor RTIG are full-fledged Smart Cities initiatives, since they focus principally on their own professional spaces. However, in light of the observations in Section 2, they can provide a foundation for at least the systems aspect of transport in Smart Cities projects.

3.2 System architecture

3.2.1 A systems solution to a complex, multiparty problem needs to begin with a clear depiction of the expected roles and connectivity of the individual systems participating in the solution – that is, a system architecture. The architecture needs to be sufficiently well defined, not only for implementation but also for maintenance and future evolution, to ensure the integrated function is not accidentally broken by an "upgrade" in one component.

3.2.2 It is worth designating an "owner" of the architecture. For systems integrated internally within an authority, the System Architect may have control powers over the whole project (at least in its systems aspects): a gateway role over any component development. For systems integrated externally with other parties, this is unlikely to be practical, and the System Architect is more likely to operate by respect and persuasion, under an overall policy commitments of the parties. A committee of representatives might help deliver the necessary authority.

3.2.3 Where a concept is already in place, the architecture (and in particular the parties involved) is likely to be relatively straightforward to define. For "brainstorming", it may be helpful for authorities to consider specifically how their systems might benefit from improved linkage to specific organisations and functions, including:

- The Highways Agency;
- Other Councils: County, Borough, District, Parish;
- LA functions: waste collection, schools, infrastructure maintenance and provision, gritters, etc;
- Environmental services: flood control and relief, air quality, weather;

- Large enterprises: ports and airports, sports and cultural venues, major local employers;
- The freight industry, as well as local retail distribution ("urban logistics");
- The emergency services, and vehicle recovery services;
- The criminal justice sector: courts, probation service, "tagged" offenders;
- The health and social care sector: patient transport, home care.

3.3 Specification

3.3.1 Within a Smart City system, there are layers of system specification.

3.3.2 As codified in the architecture, the links between components must be specified in a much clearer, more robust way than the functions within a system. The system interfaces will need to be stable (or at least have closely managed evolution) over the lifetime of the integration. Within the framework this circumscribes, local systems can be developed, enhanced, and extended in a much more flexible way.

Interfaces

3.3.3 Examples of interfaces that may be relevant include the following:

- Shared base data: geographical information, key dates, weather, demographics etc;
- Commands to control (or request control) of other systems: public signage, traffic signals, CCTV, barriers, etc;
- Information to be presented on signs, screens and applications ("our" messages on "your" signs and vice versa);
- Information about disruptions: potentially building on different organisations' perspectives to create a holistic picture (for professional use and/or for public use);
- Information about planned events, similarly: both "positive" (eg concerts and fixtures) and "negative" (eg road closures);
- Vehicle location data from road users: from specialist vehicles (buses, gritters, HGVs, patient transport etc) to prioritise traffic management, or from general vehicles to improve congestion monitoring and response;
- Data that allows a system to have extended relevance or scope – for instance, collating real time traffic information or ice warnings from neighbouring authorities in order to inform "our" traffic management system;
- Services that allow a system to have extended relevance or scope – for instance, access to neighbouring journey planning systems in order to provide the public with a one-stop shop;

– Data/services that allow extended or enhanced functionality – for instance, permitting a school/college smartcard to be used to pay for bus tickets or car parking.

Standards

3.3.4 Because interfaces are particularly challenging, and in particular are places where different stakeholders may clash, it is often useful to refer to relevant industry standards for these parts of the specification.

3.3.5 Not all standards are equally helpful, though:

– Some are very abstract, and require a lot of interpretation to use;

– Some are very complex, and may impose unnecessary costs;

– Some are little more than academic exercises, and have gained no traction among real world products;

– Some are stable and mature, but limited in scope or even obsolete for new procurements.

3.3.6 Overarching standards include Transmodel (EN12896) for public transport and DATEX II (EN16157) for traffic information. Internet protocols, as published by the IETF and W3C, offer a comprehensive suite of general purpose communication standards with pervasive adoption. More specific data standards, such as the UK's NaPTAN for bus stops and other PT points, are also very relevant.

3.3.1 To ensure effective procurement, interface standards should be available which offer flexibility and agility over time. Procurement teams, particularly within LAs, need to ensure that they understand the role of data and keep control of the data that they produce. This should include ownership, access and interface into the data

3.3.7 Generally the advice is that the standards adopted should go through three key stages:

– The authority should agree an overall framework, perhaps some key industry-specific standards, and a policy of how rigorously to validate and enforce compliance;

– Suppliers should be included in the discussion to determine specific profiles (ie which elements of available standards need to be implemented), subject to acceptance by the authority;

– The authority needs to possess, at all times, a definitive document specifying the precise profiles currently implemented or contracted for implementation.

3.3.8 Standards management is a complex area. It is worth gaining advice on which standards may be helpful in a specific circumstance, as this can dramatically reduce the whole-life cost of the system and sustain its effective operation for a considerable time. Both RTIG and UTMC provide helpful communities in this regard.

3.4 Data management

Process

3.4.1 Data that comes from an external system needs to be managed differently from "internal" data.

3.4.2 Depending on how it is captured, it may need to be buffered or cached; it may also be necessary to set a standard, minimum or maximum interval to update. It may be received in bulk and need teasing apart before it can be used; alternatively, it may come atomically, and need rebuilding, posting, or sorting into a useful data structure. Issues of this nature can be eased (but not eliminated) by designing the interface around a well-respected standard.

3.4.3 There may also be a manual component in the data exchange process:

- To initiate a data request;
- To subscribe to a data feed, or accept a subscription (or to change one that already exists);
- To request clarification or explanation of data received;
- To authorise a requested control access.

3.4.4 The applicability of each of these will depend on the sensitivity of the data concerned, the reliability required of the link, and the technical nature of the interface.

Security

3.4.2 Interfaces between systems are points of security weakness. A poorly designed system might enable a malicious connection to have significant access to important data, and thereby might open itself to hacking, viruses, sabotage etc. Even if you think you are connecting to a trustworthy partner, the fact that he may change his system configuration (for example, to allow third party connections) in a way that is outside your control means that the external boundary of your system is weakened.

3.4.3 There are essentially two ways to address this security issue.

- The safest way is to treat the connection as a public connection, and protect it with the relevant array of firewalls, malware checking, access authorisation etc. Of course this can compromise the functionality or efficiency of the link.
- The alternative is to agree a mutually acceptable security policy which allows some of these controls to be dispensed with. This may make for a much more open, rapid and effective interface, but raises the risk of network compromise.

3.4.4 The latter approach is worth considering if your system is not business critical, contains no sensitive or safety-critical data, and has adequate personnel/procedural checks –for example, a multi-operator bulletin board for incident management might pass this test. Even for higher-value connections, it may be possible to implement applications-level controls short of full protection – for example, user sign-in or time-outs.

Consistency

3.4.1 Where the system is delivering information or services to third parties – especially to the public – it is important to ensure that the fact of connectivity does not cause unexpected problems. For example, if a healthcare system links to a journey planner and a social transport scheduler, the user should get the same answer to a question like "what's the best way to get to my appointment?" whichever route they take.

3.4.2 The key issue here is to avoid accidents in which various parties make use of the data link to implement "helpful" features, without realising that others are doing the same – and doing so in a different way. Any use of shared data should, therefore, be discussed openly with the other parties to the system, even if there is no commercial or contractual issue requiring it.

3.5 Quality management

3.5.1 It is easier to describe a creative systems concept than to make it work well. This is particularly true where the effective operation of the system relies on several parties (and their IT) acting seamlessly together.

3.5.2 Paradoxically, a "professional" system can be useful at much lower levels of reliability than a system designed for end-users. A road user, provided with only the output of a system (in the form of a nugget of data) will need it to be comprehensible, relevant, actionable and accurate pretty much all the time – or will lose trust in the system altogether. The result will be that only a small proportion of the projected benefits are realised. Typical examples where this has happened include the HA's MIDAS system (notorious for showing "FOG" when it has cleared, for example) and bus real time information systems nationwide ("arriving in 5 minutes" doesn't recognise the fact that the bus has broken down).

3.5.3 By contrast, professional practitioners can allow for the fact that the data is not always perfect, can request confirmation or clarifications, can make value judgments based on experience, and so on. A system that projects exceptional peak congestion may not always be right, but if it helps the traffic manager respond better 90% of the time, it is still of overall network value.

3.5.4 The lesson for Smart City projects is that quality management is core to the effective delivery, and a sound quality management plan is essential to success. This should cover aspects such as:

- Having clear and meaningful quality targets, which are built into the costs and benefits assumptions;
- Monitoring the real-world performance of the system once deployed;
- Establishing processes to rapidly detect, diagnose and fix problems (including making sure that those affected are kept appropriately informed);
- Allocating clear responsibilities for quality management, in all contributing parties (with contractual force if necessary).

4 Policy and regulatory issues

4.1 Introduction

4.1.1 Smart Cities are fundamentally about better outcomes for citizens. However, as always what is best for one citizen is not always best for another. Inevitably, there will be conflicts between what is best for individuals and the community as a whole, what is best for different elements of the community and what is best to achieve a long-term outcome versus a short-term gain.

4.1.2 Navigating the best balance between all these elements is the role of policy makers. It is not the purpose of this document to dictate how those policies should be directed. However, in this section we highlight some of the issues and considerations which arise.

4.2 Individual choice versus network-wide outcomes

4.2.1 Central and Local Government have long grappled with balancing individual choices with the smooth operation of the network and other policy initiatives. Individual users of the road network want convenience, speed, safety and comfort. For many, that means the use of the car: it travels door to door; you don't have to share with strangers; you can leave on your own schedule; and it tends to be roomier for all your belongings. However, impact on the network as a whole is well understood: increased congestion, increased levels of pollutants, increased CO_2 emissions and increased requirement for parking infrastructure.

4.2.2 Central and Local Government will need to decide to what extent the smooth operation of the road network is to be left to individual choice, how much is to be achieved by intervention and how much will require regulation. Inevitably, all three will play a part, but the balance will depend on the policy objectives.

4.2.3 There may be opportunities to use Smart City measures to support transport policy, whether it focusses on smoothing the flow of traffic or on achieving modal shift. Easy potential solutions include providing public transport information (or tickets) with public appointments – schools, doctors, etc. More futuristically, roadspace booking – perhaps with a permit system or parking discounts – could be used to smooth traffic flows.

4.3 Prioritising network access

4.3.1 The road network has many users all of whom feel an entitlement to access: cars, delivery lorries, emergency services, buses, pedestrians, cyclists. However, not all streets give different users the same priority. Some streets in city centres are largely pedestrianised; others (especially in rural contexts) don't even have pavements for pedestrians to walk on; most are somewhere in-between. In all cases, where there is an emergency, fire, police and ambulance are given top priority because safety trumps everything.

4.3.2 Road priorities will be built up on a road-by-road basis, depending on purpose and position. A residential road doesn't do the same job as a town centre road, which will be different again from a trunk road. But the network still has to work seamlessly, as a whole. Keeping traffic flowing, whether vehicular traffic or foot traffic, is the primary job of the road network and those that manage it.

4.3.3 Understanding our roads and how they are used can be enhanced by some of the data that's being produced. Harnessing open data, apps, portals and citizen sentiment mapping can contribute to an understanding of how streets are being used and help to drive investment and inform policy.

4.4 Data ownership, data protection and privacy

4.4.1 Data is often seen as the key to creating a Smart City. There is ongoing pressure to make more and more data available. However, with the availability of so much data, users must accept responsibility for issues of ownership, privacy and security. Both users and producers need to ensure that standards and processes are in place to make the best use of data. These should include:

- standards to avoid re-keying data where possible. This will help to protect against corruption and promote consistency and accuracy;
- data security to ensure that data is protected from malicious attacks as well as corruption between systems;
- procurement processes which specify who owns and manages the data which is produced;
- processes which support the Data Protection Act 1998; those who store and use personal data are required to protect people's fundamental rights and freedoms and in particular their right to privacy with respect to the processing of personal data.

4.4.2 Conversely, public authorities will need to be aware of potential challenges under the Freedom of Information Act 2000, and of the more general "presumption" of the need to make public data available as open data. While personal data is of course excluded in line with the DPA – as are some other categories of data, such as those related to national security – any systems put in place should not be designed in a way that makes data release difficult to fulfil.

5 Conclusions

5.1 Summary

5.1.1 The "Smart City" is currently a popular but loosely-defined concept. We believe that it covers any initiative in which two or more information systems, from different functions or organisations, are connected together to yield public benefit in a geographical area (not necessarily a city).

5.1.2 With this definition, the Smart City can best be thought of as an environment which supports and sustains creative technology projects – not as a specific system solution to a known problem. Some Smart City systems are already in place, while others will not happen for many years (if ever) for practical, commercial or technical reasons.

5.1.3 Transport professionals have a responsibility in this context to consider who they might share data with, to mutual advantage. This goes well beyond the "open data" agenda, which is essentially unidirectional in concept. How far this yields results will depend not only on good partnership working with other functions and the supply industry, but also on strong support from senior officers and politicians.

5.1.4 This Position Paper has presented an overview of some of the challenges of governance, process and support that will arise, and has hinted at some specific project contexts that might be considered.

5.2 Way ahead

5.2.1 **Public bodies** need to create and support "blue-sky" thinking. Obviously, this needs to be practical, supported by an appropriate level of cost-benefit analysis. It is worth considering available sources of research funding for novel project ideas. It is also worth listening to the concepts that other authorities are considering – they may or may not be transferable, but even if not, they may help seed some new thinking.

5.2.2 **System suppliers** should continue to identify potential opportunities to improve the performance or functionality of their systems through drawing in other data. It may be difficult, in a specific public procurement where the requirements are well-defined, to introduce these ideas without distracting from the main offer (and potentially implying higher costs). Non-contractual exploratory discussions are more likely to be practical.

5.2.3 **Innovation sponsors**, including central/devolved government, Innovate UK, the research councils, and supported entities such as the Transport Systems Catapult, should explore ways in which they can facilitate the creation of Smart City concepts, their definition into systems, practical trials, and commercial evaluation. Open competitive calls are of course helpful but may be too crude to nurture nascent ideas.

5.2.4 **Sector groups**, in particular RTIG and UTMC, will need to provide a forum in which smart city concepts can be floated and discussed. Such bodies have the opportunity to provide valuable consolidation of requirements, impartial challenge on concepts, and evaluation of impacts, as well as being an important communication channel for ideas and successes. Some of these conversations may need to be confidential.

A Indicative smart city concepts

A.1 Introduction

A.1.1 The short pieces in this Annex provide some indicative cases for potential Smart City concepts, identified through a workshop session with users and systems suppliers. Solving these would require the development and fulfilment of projects that pull together diverse systems, in most cases from several organisations, to achieve overall goals that would be beneficial to the public.

A.1.2 Some of these already exist in some places; others have been developed but are not yet fully deployed. They are all, however, practical short term options.

A.1.3 The purpose of these descriptions is not to provide a pick-list of Smart City concepts for cities to consider. Rather, it is to indicate the kind of issue that a practical – but still challenging – Smart City project might address, and to prompt cities to think of the things that would make a real difference locally.

A.2 Concept I – motorway traffic and school trips

A.2.1 Parents waiting for a school coach to come back from a trip know more certainly when it will be arriving back at school, because the current traffic and likely travel time under those traffic conditions is known off the HA road network.

A.3 Concept II – council vehicles and public safety

A.3.1 The state of roads in snow conditions is known because of data from gritters, buses and cars that has been crowd sourced. Public therefore know which routes are OK to travel on, and which may not be because there has not been much traffic along it.

A.4 Concept III – scheduling patient transport

A.4.1 Community transport or patient transport services are booked and routed automatically to people who have a doctor/hospital appointment to collect the patient at a time appropriate to get to the appointment.

A.5 Concept IV – traffic monitoring to save lighting energy

A.5.1 Street lights are only switched on when people are walking or driving along a road, historical data on use is used to make sure that they do not keep getting switched on and off like strobe lights. Event data is used to cope with out of normal situations.

A.6 Concept V – transport tracking and domestic heating

A.6.1 The heating system in someone's house knows when they are going to arrive home and will ensure that the house is at the right temperature at the point of arrival, minimising energy use. The systems would need to know the persons schedule (possible now) and if they were delayed or running early (not automatically possible now).

A.7 Concept VI – highways and traffic linked

A.7.1 Work to install a new bus stop will involve two way traffic lights on busy urban A road. A "data capture" of road usage could provide information on which day and time is best to undertake this work and also allow transport planners to move traffic to alternative routes. Information captured that may be of help is: other planned disruptions (Gas, Water, Council etc), school times, bin collection days, peak traffic flow times.

A.8 Concept VII – seamless bus information

A.8.1 Bus services go across borders between two LA areas. Real Time Passenger Information for all services should be available in both authorities, wherever they are registered. The authorities and their operators need to have a common approach to structuring and publishing their data, in order to allow seamless and reliable information on all services.