Smart Infrastructure

Getting more from strategic assets

Smart Infrastructure is a global opportunity worth £2trn-4.8trn. The world is experiencing a fourth industrial revolution due to the rapid development of technologies and digital abundance.

Smart Infrastructure involves applying this to economic infrastructure for the benefit of all stakeholders. It will allow owners and operators to get more out of what they already have, increasing capacity, efficiency and resilience and improving services.

It brings better performance at lower cost. Gaining more from existing assets is the key to enhancing service provision despite constrained finance and growing resource scarcity. It will often be more cost-effective to add to the overall value of mature infrastructure via digital enhancements than by physical enhancements – physical enhancements add `more of the same', whereas digital enhancements can transform the existing as well.

Smart Infrastructure will shape a better future. Greater understanding of the performance of our infrastructure will allow new infrastructure to be designed and delivered more efficiently and to provide better whole-life value.

Data is the key – the ownership of it and the ability to understand and act on it. Industry, organisations and professionals need to be ready to adjust in order to take advantage of the emerging opportunities. Early adopters stand to gain the most benefit. Everyone in the infrastructure sector has a choice as to how fast they respond to the changes that Smart Infrastructure will bring. But everyone will be affected.

Change is inevitable. Progress is optional. Now is the time for the infrastructure industry to choose: to be Smart.

This paper was produced by

Keith Bowers
Principal Tunnel Engineer,
London Underground

Volker Buscher
Director, Arup Digital

Ross Dentten
Asset Information
& Configuration Manager, Crossrail

Matt Edwards
Asset Maintenance
and Information Manager,
Anglian Water Services

Jerry England
Group Digital Railway Director,
Network Rail

Mark Enzer
Group Practice Manager,
Mott MacDonald

Ajith Kumar Parlikad
Senior Lecturer, University
of Cambridge Centre for Smart
Infrastructure & Construction

Jennifer Schooling
Director, University of Cambridge
Centre for Smart Infrastructure &
Construction

According to the World Economic Forum[1] in the years up to 2020 the world will experience a fourth industrial revolution due to the rapid development of technologies such as robotics, artificial intelligence and 3D printing.

Digitally enhanced or Smart Infrastructure will be part of that and will revolutionise how infrastructure is delivered, managed and automatically controlled. Traditional roles, business models and measures of value are all set to change and the infrastructure sector needs to recalibrate itself to meet that change.

Other industries have all been disrupted by the rise of abundant digital communication and information and had to adjust in the face of new technologies allowing new ways of working – as examples, finance, retail, health, education and the press. Specific sectors within broader industries have been rocked by new entrants – taxi operations for instance. In manufacturing humans stand side by side with robots in the workplace, while lawyers and doctors are seeing more of their work done by machines.

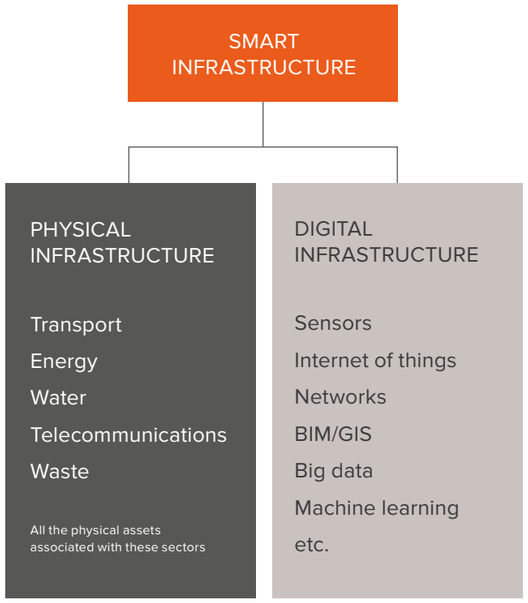
Infrastructure is on its own journey of transformation. In aviation, new capacity has been created with the digitalisation of the air traffic control system; smart motorways are doing the same for the strategic road network; the water sector is pursuing advances that will increase efficiency of supplies; and with the development of the digital railway, the rail industry is looking to find space for 40% more traffic on existing track.

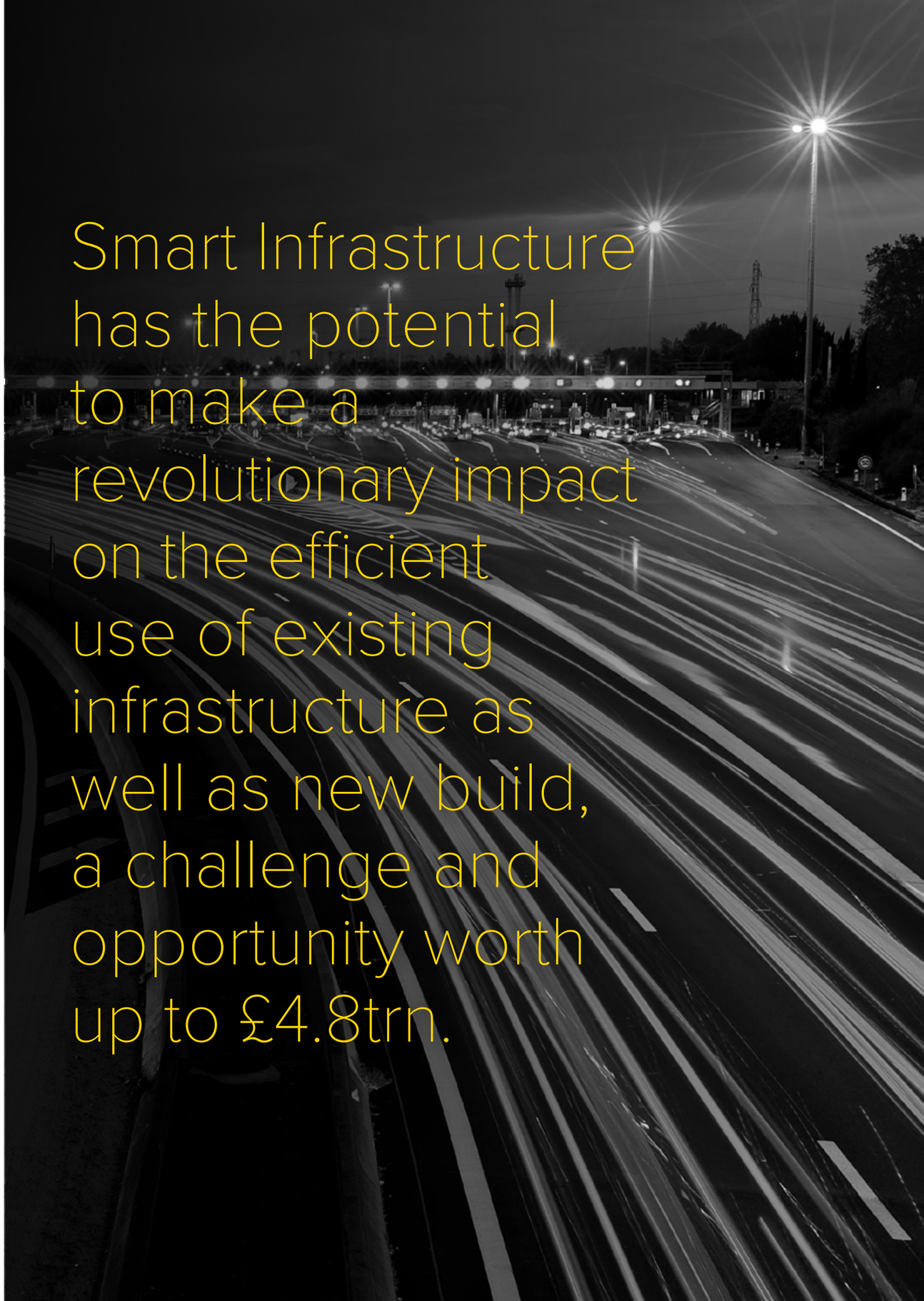
Smart Infrastructure is a core aspect of this new digital world in the infrastructure sector. It has the potential to make a revolutionary impact on the efficient use of existing infrastructure as well as new build, a challenge and opportunity worth up to £4.8trn.

This paper is intended to establish what Smart Infrastructure is, why infrastructure is embracing its development, and what steps people and businesses in the sector need to take now to prepare for what will be fast paced change. The challenge is to provide better consistency across the infrastructure sector, to maximise the benefits, learn from each other, and realise the full potential for the UK.

What is Smart Infrastructure?

Smart Infrastructure is the result of combining physical infrastructure with digital infrastructure, providing improved information to enable better decision making, faster and cheaper.





Why Smart Infrastructure?

Infrastructure owners across all sectors need to embrace Smart Infrastructure because:

1. Smart Infrastructure will allow owners and operators to get more out of what they already have – increasing capacity, efficiency, reliability and resilience.

2. Getting more from existing assets will enable owners and operators to enhance service provision despite constrained finance, growing resource scarcity and, in mature economies, short supply of green field space.

3. Better understanding of the performance of our infrastructure will allow new infrastructure to be designed and delivered more efficiently, and to provide better whole-life value.

Better performance, lower cost

More intelligent operation of mature networks
Owners will be able to use technology to gather data from their infrastructure in use – monitoring condition so maintenance is targeted at the right time; and engaging directly with customers to manage demand and reduce the need for new construction.

Longer life and more efficient operation for new infrastructure
For developing economies and in particular the building of smart cities, with the need estimated at five new cities the size of London every year to meet worldwide population growth, the digital requirement has to be planned and designed-in up front, allowing cities to be operated at the optimum.

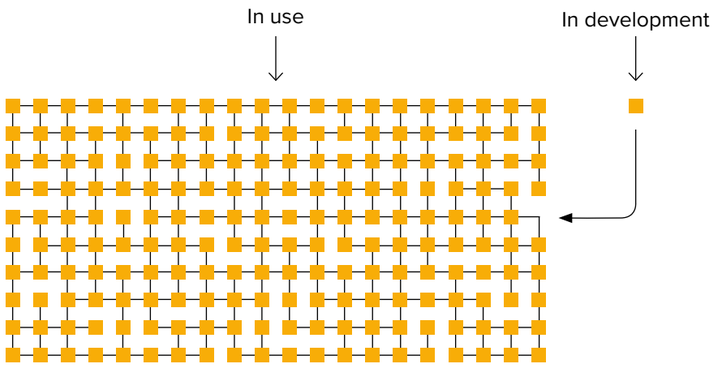
Better whole-life value
In the longer term the development of Smart Infrastructure will have the effect of pushing whole-life cost judgements to the fore when considering capital investments.

Why now?

Infrastructure maturity
In most mature economies the value of 'infrastructure in use' is substantially greater than the value of 'infrastructure in development'. In the UK, the addition of new assets adds less than 0.5% each year to the value of existing infrastructure. The key concerns are therefore to maximise customer service and value by getting more from the operational asset base.

Digital abundance
The rapid and ongoing reduction in the unit cost of collecting, communicating, processing and storing information is leading to a state of 'digital abundance'. The volume of data/information/knowledge is mushrooming.

Innovation explosion
This has been accompanied by a rapid increase of ideas and innovations that could benefit infrastructure.

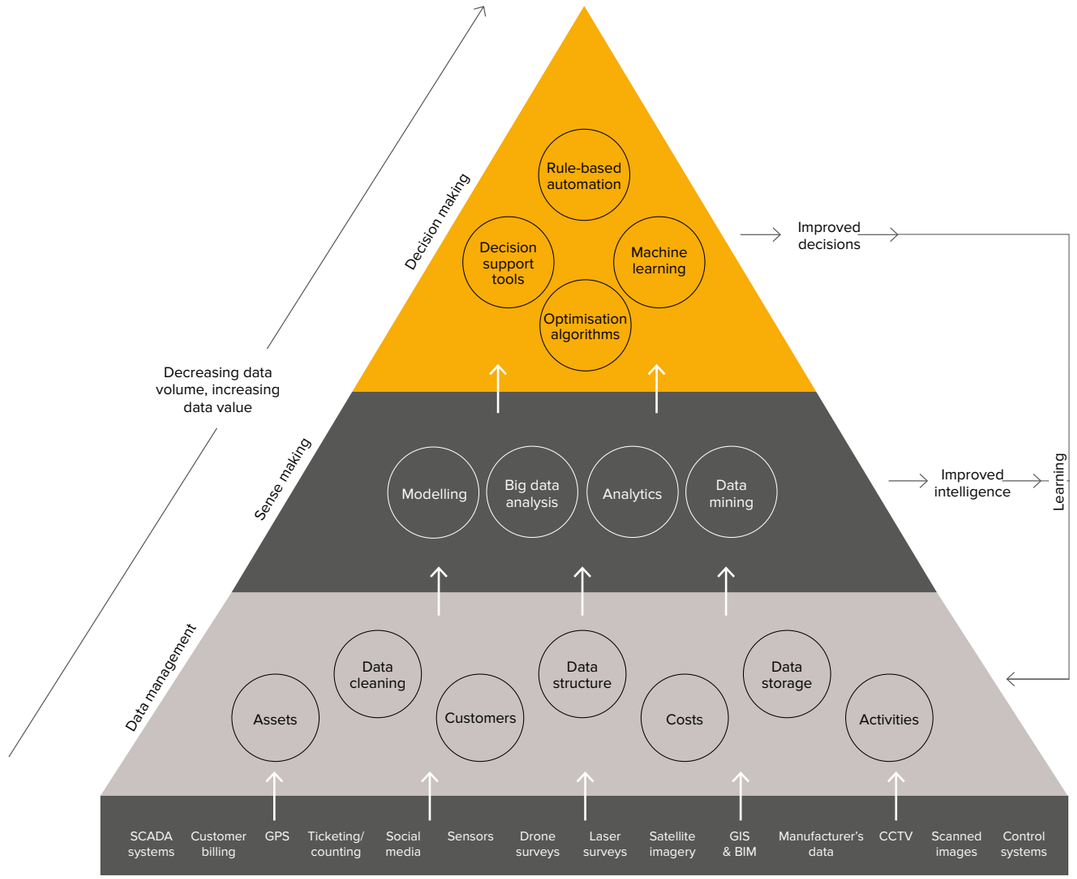


Infrastructure in use and development
Construction of new assets increases the total value of UK infrastructure by just 0.5% a year.

Smart Infrastructure will vary from sector to sector, but it always has a similar anatomy, made up of three basic layers connected by communications. Data is the key.

Decreasing data volume, increasing data value

All the main components of Digital Infrastructure have a place in this simple model. It is the overlay of this model onto physical infrastructure that makes it “smart”. At the base is raw data and at the apex are decisions – the higher up, the more valuable the information; the lower down, the greater the volume of data. Information processing occurs within each layer and communication connects both the layers and the outside world.

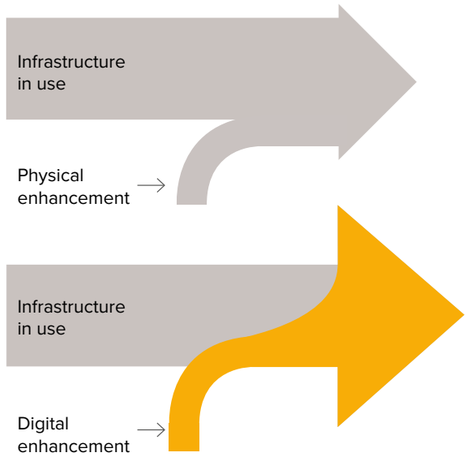


Using Smart Infrastructure to realise new value from existing assets

Smart Infrastructure offers a more cost-effective way of delivering better outcomes for customers. That value comes from:

Improving intelligence
Providing better information to the users and operators

Improving decisions
Enabling 'better decisions, faster and cheaper'



Physical versus digital enhancements

Value is created in a number of ways:

Infrastructure value
It is more cost-effective to add to the overall value of mature infrastructure via digital enhancements than by physical enhancements.

Customer value
Better value for money, measured in terms of improved customer service/experience.

Information value
Information itself has value, and loss of information represents a loss of value. Information value is created by increasing connectivity (the network effect) and increasing integration (reducing information loss at interfaces).

Integration value
Value is enhanced through integration and data sharing across:

- The infrastructure process (use, operation, maintenance, investment planning, feasibility, design, manufacture, logistics, assembly).
- The value chain (clients, asset managers, operators, contractors, consultants, suppliers, manufacturers).
- Sectors (communications, energy, transport, waste and water, but also health, education, policy).

A challenge to current business models

Whoever owns the data, and perhaps more pertinently understands the data, is going to own the future, it has been said. But that may not be the same people and organisations as now. Information that has been controlled by 'expert' professions or individual companies will shift to being in the control of the infrastructure owners who can create more open, collaborative connections with a far broader supply chain.

Established businesses, educational establishments and individuals need to be ready to adjust to avoid being left behind and to take advantage of emerging opportunities.

The high value-added opportunity will be the ability to make sense of data and work out how to use that information to drive better performance from infrastructure assets.

Scale of the opportunity

For people and businesses working in the infrastructure sector Smart Infrastructure will become a huge new industry, requiring new skills and replacing old ones. Worldwide some £400bn of investment in Smart Cities is planned. The government[2] puts the elements of digital infrastructure at between 5% and 12% of the total cost. Extrapolated out to include the world's £40trn[3] of mature infrastructure it can be said that retrofitting Digital Infrastructure to create Smart Infrastructure is a potential challenge and opportunity in the infrastructure sector worth £2trn-4.8trn globally.

Early adopters will get the most benefit

Five pressing infrastructure industry priorities

1. Set out the business case for digital investment in infrastructure

At the moment it is a hard fight to get backing to switch cash from capital projects to invest in digital tools for existing infrastructure. Shared case studies backed by strong financial data setting out the benefits of a whole-life approach in terms of longer lifespan and greater utilisation of existing infrastructure are required.

2. Develop a common language so information can be shared

Underlying the value of Smart Infrastructure is the principle that data collected can be shared throughout each sector and across sectors. A common language of terms and processes needs to be agreed and used so that data can be shared to fast-track the benefits of Smart Infrastructure and keep the UK ahead of its rivals.

3. Establish quality data and asset information

To maximise the benefits of Smart Infrastructure asset owners need to standardise their asset information and share the templates. Education needs to adapt to include an understanding of Smart Infrastructure in the courses that are on offer.

4. Address leadership and governance issues

This needs to be at an organisation/company level as well as an industry level.

5. Security

What are the protocols in a more open systems environment?

Next steps

A detailed assessment is needed by industry and the government of the opportunities, impacts, challenges and process of implementing Smart Infrastructure in the following areas:

- Policy and government
- Clients and markets
- Society and citizens
- Technology

Notes

[1] The Future of Jobs report by World Economic Forum

[2] 'Global Market Opportunities and UK Capabilities for future smart cities' report for the Department for Business, Innovation and Skills (BIS)

[3] McKinsey Global Institute, Jan 2013