



Delivering digital infrastructure

Infrastructure client leadership to deliver digital transformation of construction processes.



Highways England leadership

At Highways England, we're committed to delivering a capable, resilient road network which maximises the safety of road users and workers.

The digital transformation of construction operations across our road network is a key area of focus that will deliver significant business benefits.

We commissioned the development of a roadmap and insight into what could be achieved using the automated construction technologies available today. This report brings that roadmap to life, highlighting best practice happening across the industry.

The connected and autonomous plant commitment statements are part of a programme in which Highways England is working with industry and the Infrastructure Industry Innovation Partnership (i3P). This is to demonstrate how the application of innovation can transform construction and deliver better outcomes.

We encourage you to adopt the commitment statements and publish the future benefits through i3P to demonstrate change across industry.

Paul Doney

Director of Innovation and Continuous Improvement, Highways England

i3P leadership

"Clear client leadership, innovation and collaboration has demonstrated how the 'Infrastructure Industry Innovation Partnership (i3P) can drive positive change. Our industry delivers great results when we invest our resources to drive innovation into our operation to deliver sustainable outcomes. The clear guidance and recommendations in this report provide new innovation benchmarks that should be adopted across industry to demonstrate the benefits of implementation."

Mark Thurston

CEO, HS2

Safety moment

"I have been delighted to steer and drive this work forward. Putting safety at the centre of our connected and autonomous site challenge has driven the industry to think differently, apply new technology and take the human out of harms way. Modern and innovative ways of working will make the industry a safer place to work and as a result deliver a significantly improved road user experience.

This document outlines the technology available to address these challenges and provides guidance for industry as to how we can collaboratively improve delivery for capital spend projects."

Muneer Akhtar

Project Sponsor, Highways England

Purpose statement

"This document outlines the design of a connected and autonomous site that will transform performance in delivery. It challenges industry to adopt leading edge practices to improve productivity outcomes in the services delivered to clients."

Dr Annette Pass

Head of Innovation, Highways England



Highways CAP community



Highways UK 2019

Roadmap 2020 to 2035

Journey to connected and autonomous plant

The roadmap sets a vision for 2035 - the use of connected and autonomous construction techniques will become the 'business as usual' approach across UK construction. The roadmap provides a tool for stakeholders to support decisions on planning, strategy, and investment.

By working collaboratively, government, clients and the plant and technology industry can optimise the implementation of autonomous construction techniques and deliver the 2035 vision. This capability showcase report highlights the best practice we need to be adopting now to set the 2020 baseline.

Strategic summary



Key elements of the roadmap that have influenced the report

People & society

- Harm reduction
- Workforce upskilling
- Health benefits of reducing repetitive tasks
- Cost and time savings

Technology & hardware

- 5G communications
- Drone surveying
- Semi autonomous and machine control plant

Data & digital

- Financial performance forecasting
- Live telematics feed
- Control room data platform

CAP implementation site design – Northern Powerhouse digital site

Bringing the CAP roadmap to life on the A19 Testo's junction improvement scheme

Newcastle Upon Tyne,
Northern Powerhouse

Product verification black
top (Volvo and Tarmac)

Quality assurance live telematics feed from piling
activities (Cementation Skanska Ltd)



A19
Testo's junction

Multi-platform
integration digitally
enabled live data
in control room
environment
(Costain)

Automating
earthworks
activities semi
autonomous
machine control
excavation,
(Komatsu, BOMAG
and Volvo)

3D machine control
demonstration area
(BOMAG, Lynch)

Managing
customer
experience live
traffic feeds
into the control
centre (Highways
England)

Reducing service strikes
augmented reality survey
(Korec, Skanska and
Trimble)

Enabling automation
and communication first
construction site 4.9G
private network (Nokia)

Improving site efficiency
machine control ADT (Volvo)

Available technology enabling CAP today



Cloud based platform for aggregating data into a single source of truth

Intelligent infrastructure control centre

The control centre is the digital heart of delivery. All data feeds are managed and controlled from a central location where data is benchmarked, AI predicts trends and decisions are made. Technology provides a data rich environment where insights help make informed decisions that increase productivity and reduce risks through prediction. Other benefits include remote access to enable monitoring of multiple sites simultaneously, and to interpret data across a portfolio of projects.

“Digital transformation will deliver greater productivity.”

Jim O’Sullivan
Chief Executive, Highways England



ROBOMAG fully autonomous roller, Komatsu and Volvo semi-autonomous excavators

Connected plant

Plant technology, such as the equipment listed below, is used to deliver modern methods of construction and drive factory-thinking outputs.

- Semi-autonomous excavator controlled by design information
- Semi-autonomous dozer reducing fuel consumption and stress on operator
- Semi-autonomous roller verifying work for product assurance
- Semi-autonomous paver demonstrating automated quality control
- Geofenced hauler working in conjunction with machines improving safety

The connected worksite demonstrates machines working together to show safety, productivity and commercial savings. The data from the machines feeds into the site office to give full visibility and performance of the plant.



SiteVision by Trimble enabling visualisation of asset

UK geospatial: Designing for machine

To enable connected and autonomous activities, construction processes need to be digitally connected and every process driven by data. Full automation will require 5G connectivity and design data to automatically operate construction activity through 3D machine control. We need to be ‘designing for machines’.

Design partners will provide file formats with the data required to drive automated machines with no human intervention, providing the dimensions and gradients for the machine to work and complete the activity. The machine will provide asset verification data on completion of the task for product assurance.



4.9/5G Nokia mobile private network

Digital toolkit to enable a connected site

Enabling connected technology on site requires a clear vision and objectives. Digital tools become effective when data is live and being used to deliver the infrastructure investment.

This includes technology such as a 4.9/5G network across the operation to provide ubiquitous connectivity across the whole site, IoT telematics devices to pull data, drone feeds for remote surveys, immersive technology (AR, VR) for training and collaborative workspaces with touch screens. All aspects of the process are affected and will need to embrace technology to achieve the full potential on offer.

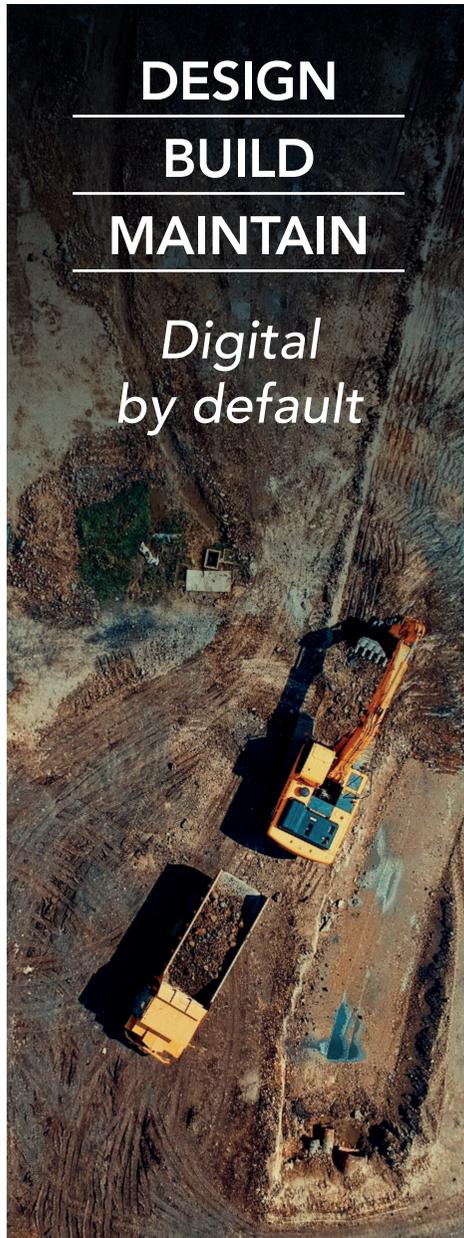
These commitment statements have been put together by industry experts to accelerate the adoption of connected and autonomous plant within the infrastructure sector. These statements will provide the foundations and the next steps to enable automation on sites through a common understanding of the new standards that need to be achieved. The group of stakeholders listed in the table are key players in the development of the project and have provided these statements in order to create a unified approach to achieving the CAP vision.

Our industry has invested its own resources to create a collaborative community designed to drive efficiency and productivity across the infrastructure sector. These commitment statements have been generated to drive industry transformation.

These are statements from industry, for industry - to improve industry. The adoption of these commitment statements are key for accelerating the CAP timeline across the infrastructure sector.

Clients	All i3P clients will reference where appropriate the i3P CAP statements in their business processes and procurement to accelerate and transform industry adoption of connected and autonomous plant.
Project conception stage	All i3P sites at pre-development consent order (DCO) review stage will investigate the possibilities for early installation of permanent communications network connectivity (4G/5G). The network will remain in use for the asset life to improve end user experience.
Design	All i3P client designers must deliver designs for machine in a digital format that allows automated design from drawing to machine.
Design managers	All design managers shall work with their design and construction teams to agree formats of data transfer for automated direct feeds of the design into the machine and other automated technology.
Contractors (Tier 1)	All i3P Tier 1 contractors to include plant data requirements in a common format across the industry. This will be embedded into their business processes and communicated through their contract process requirements to plant suppliers to improve operational performance.
Sub contractors (Tier 2)	All i3P Tier 2 contractors should invest to develop the data exchange technologies and techniques required to progress the data and design requirements of the industry.
Earthworks	All i3P client sites must use 3D machine control for all earthwork operations, unless a specific business case is provided.
Piling	All i3P client sites must use piling equipment with telematic data for asset verification.
Asphalt	All i3P client sites must use 3D machine control for all asphalt operations to improve efficiency, quality and material performance, unless a specific business case is provided.
Compaction	All i3P client sites must use automatic pass counting, mapping and operator visualisation for compaction operations unless a specific business case is provided.
Construction machines and tools	All construction machines on i3P member sites must provide core telematic data to assist the site teams with key data points to monitor and benchmark machine productivity. (A list of the core 12 data requirements is provided by i3P).
Plant suppliers	All plant suppliers must provide telematics to ISO15143-3 2020 and construction data through a live, or near live, feed. They must also accept design for machine data to automate activities.





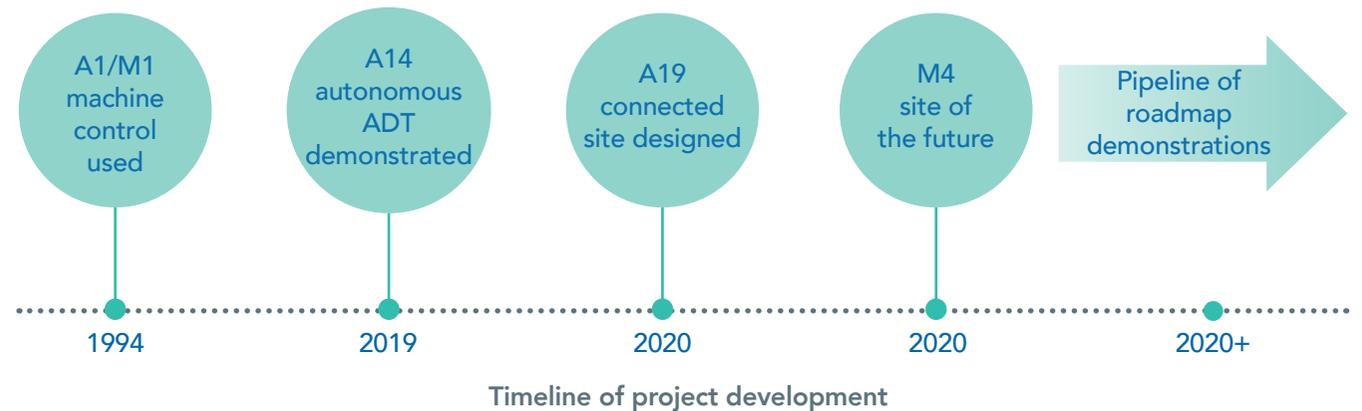
Drone governance	All i3P clients will evaluate the Civil Aviation Authority (CAA) drone governance guidelines to encourage increased usage of drone data technology.
Software providers	All software providers will make available a common data transfer format to accelerate connectivity of technology across design, construction and maintenance phases.
Logistics to site	All logistics vehicles should report through their telematics systems: Journey data, idling at the point of destination and the quality of the material on arrival. Contractors should write data requirements into contracts to encourage service improvements.
Procurement	All procurement should encourage the adoption of CAP technology where there is a clear whole life outturn business case.
Safety	All construction machines must report on safety in operations via digital technology. The machine is a source of safety monitoring for site.
Environmental	All i3P members to report environmental and carbon performance for plant using machine telematic data.
Machine manufactures	All construction machine manufacturers will comply with the Part 4 ISO 15143, to allow data exchange between different types of equipment and acceptance from design.
Pre design survey	All operations must produce a survey control report to align to the design for machine guidance requirements.
Geospatial	All designers must aim to use good quality geospatial data.
Planners	All i3P members to agree a common format for work breakdown to allow the sharing of data.
Engineers and land surveyors	Survey control report to define method of data capture for start-up of site to assist digital delivery and CAP adoption on site.
BIM / information management	All i3P BIM teams to automate data flow and information exchange through design, construction and handover phases to enable CAP.
i3P	All i3P members will positively reinforce the commitment statements to drive change across the industry. They will call on members to demonstrate the impact of CAP through innovation case studies illustrating benefits.

CAP call for action

A clear implementation pipeline needs to be defined by the community

Significant progress has been made through industry response to the roadmap, demonstrating the need to increase adoption across all major projects. The following actions will promote increased adoption of the roadmap:

- Pipeline of projects that are willing to commit
- Projects signing up to the CAP roadmap
- Case studies, demonstrators, investment cases to be shared across the community



Connected and autonomous plant will improve the following key areas in the industry:



Safety



Efficiency



Environment



Quality



Productivity



Risk

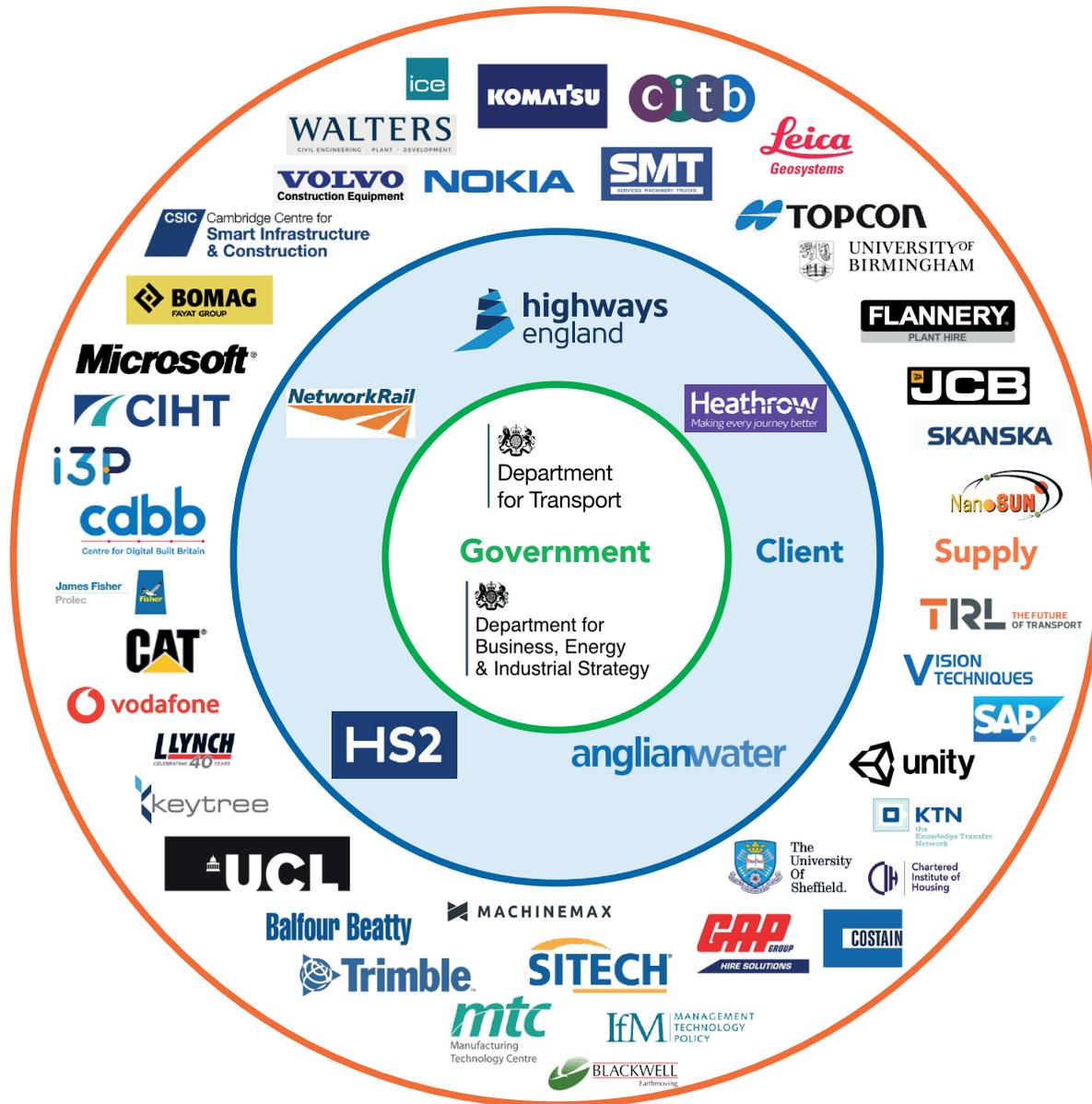


Reward

How can you influence change?

- Take the learnings from this report to drive change within your business and function
- Understand the long term cost benefits of digitisation to guide decisions in procurement and incentivise change
- Support clients and the industry move towards connected and automated worksites by following the roadmap and the CAP commitment statements
- Proactively assess your worksites to implement change that will positively disrupt the 'business as usual' and then showcase the achievements
- Follow the i3P CAP commitment statements to drive change and transformation within the industry, and report the benefits with i3P
- Change starts with you - you will be able to say "I was there when we transformed our industry". Send i3P your case studies of success.

Community formed – committing to adoption of CAP



Profiles



Dr Annette Pass

*Head of Innovation
Safety, Engineering & Standards
Highways England - i3P client
member*



Muneer Akhtar

*Innovation Supply Chain Manager
Safety, Engineering & Standards
Highways England*



Tim Embley

*Group Research, Development
and Innovation Director
Costain - i3P founding member*



Mark Lawton

*Head of Engineering Surveying
and GIS
Skanska*

We would like to take this opportunity to thank all contributors for working collaboratively to understand how we can transform our industry. If there are contributors who have been missed off or need to be brought into the community, please contact cap@highwaysengland.co.uk

