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Infrastructure Condition Assessment an Autonomous Decision Framework

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Increasing Pressure on the Cities

Growing Populations

Limited Resources

Ageing Infrastructure

Source: GETTY

Climate Change

Changes in Demand Patterns

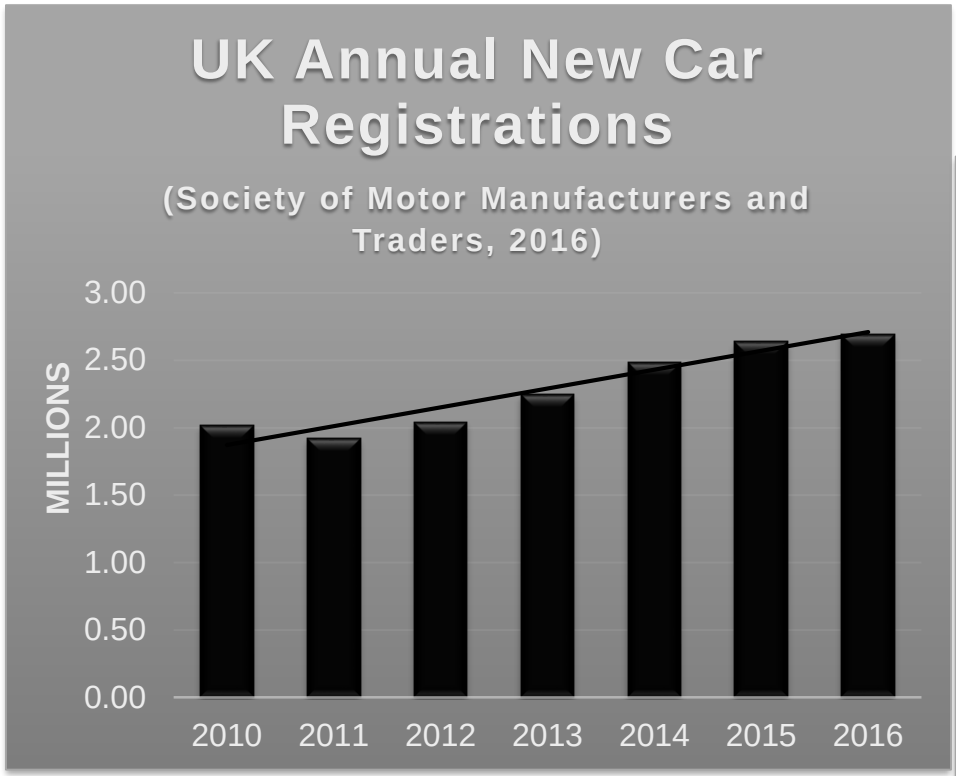
Ageing Infrastructure

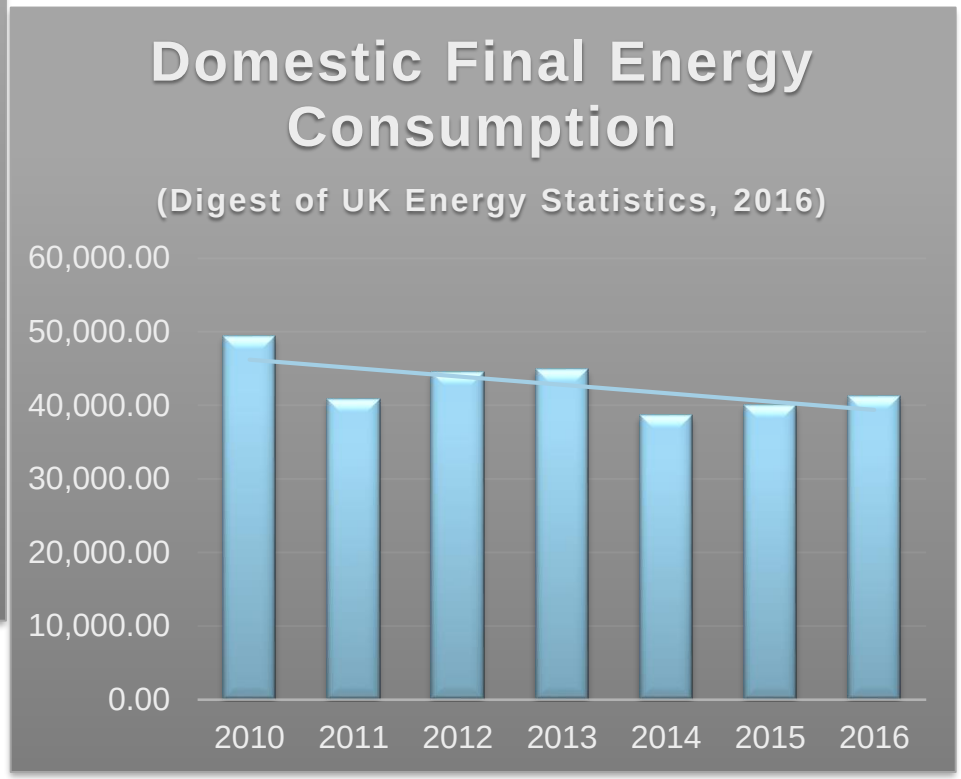
- **1** in **5** local roads could fail in the next **5** years (ALARM 2018)
- London sewer system, a triumph of Victorian engineering, dates back to **1868**
- **3.1 billion** litres (≈ **1,249** Olympic swimming pools) of UK's water leaks every day (Discover water)
- **52,547** mains water pipes burst in the UK Apr 2016 - Mar 2017 (Discover water)

Burst Pipe in Wednesbury Apr 2018
(Source: BBC.co.uk)

Burst Pipe in Birmingham Nov 2016
(Source: West Midlands Fire Service)

Changes in Demand Patterns





Climate Change

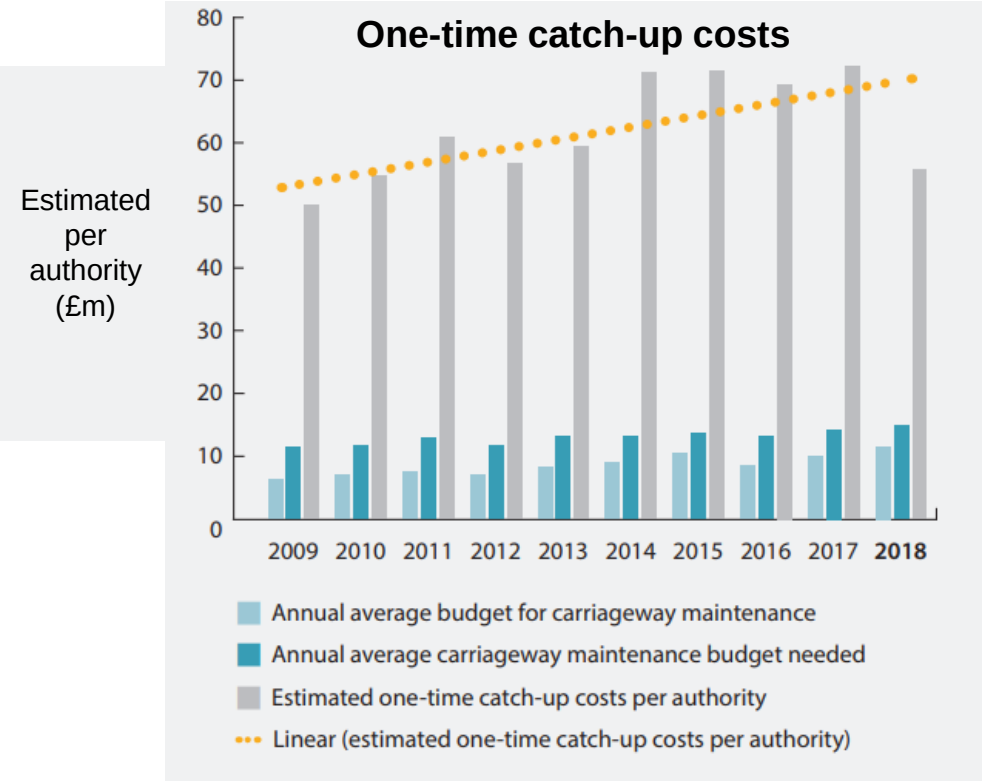
Challenges for the transport sector – European Environment Agency (2014):

- Increasing temperatures → increasing rail buckling & pavement deterioration
- Weather extremes → floods or landslides leading to traffic delays, service interruptions and detours … e.g. HGVs diverted onto minor, weaker roads
- Sea-level rise → threatening harbours and other transport infrastructure
- Changing wind patterns → air transport disruptions, flooding of airport infrastructure and other weather events.

Limited Resources

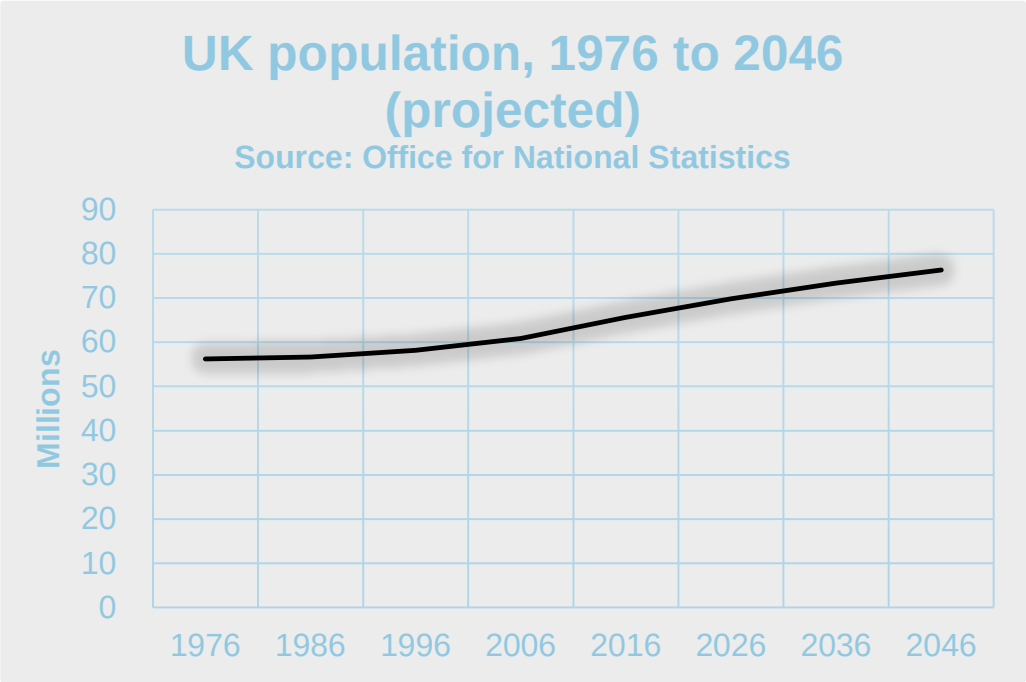
Annual Local Authority Road Maintenance (2018)

- In England and Wales the **gap** between the allocated budget in 2017/18 and the required budget was **£556 million**
- Having adequate funds and resources it would now take **14** years to get local roads back into a reasonable steady state

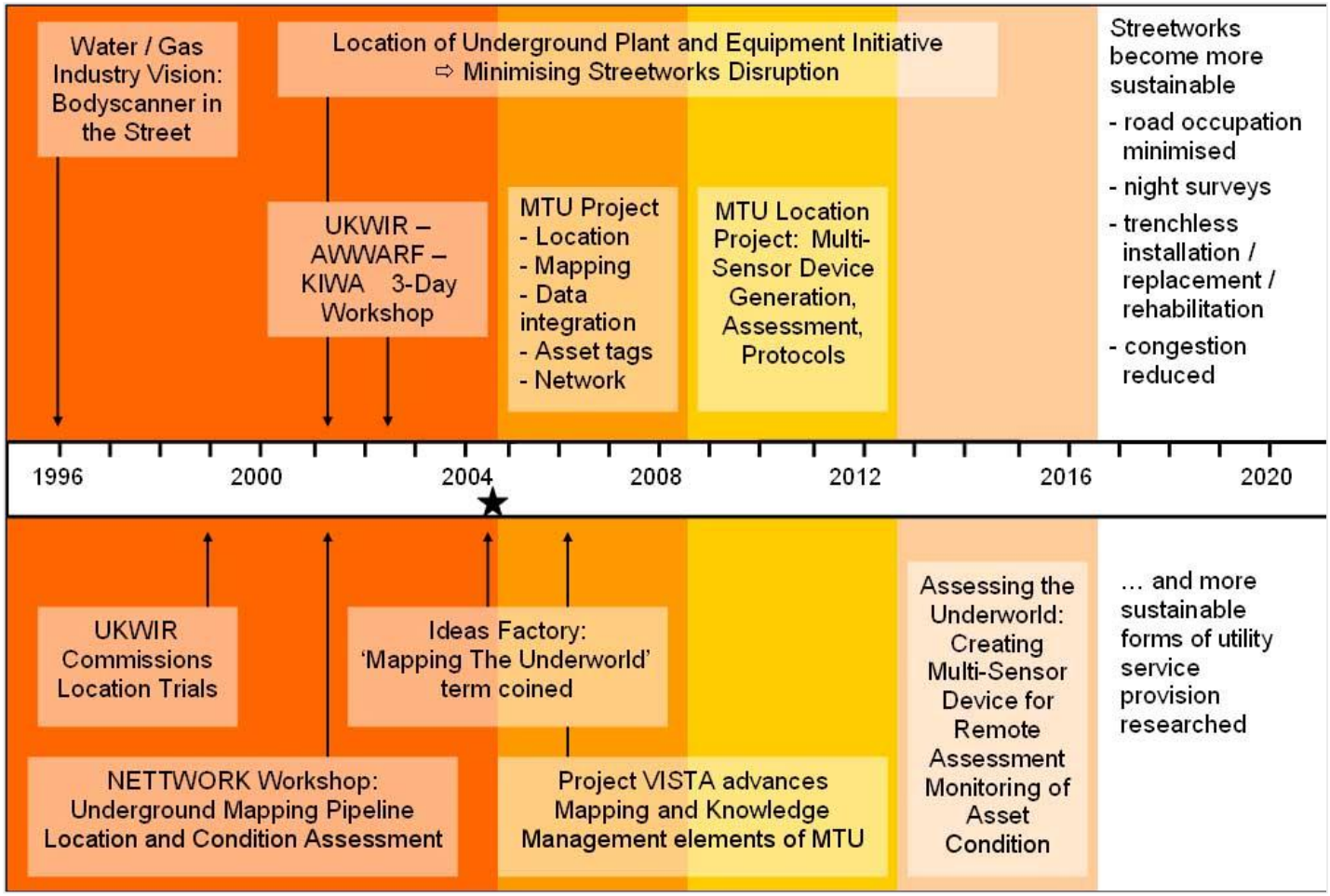


Growing Populations

- Over 50% of the world's population lives in urban areas and this is expected to increase by 1.5 times by 2045, adding 2 billion more urban residents



Solutions: Birmingham's Research Portfolio



Solutions: Birmingham's Research Portfolio

EPSRC
Pioneering research and skills

Urban Futures

ibuild

SELF REPAIRING CITIES

ASSESSING THE UNDERWORLD

Liveable Cities

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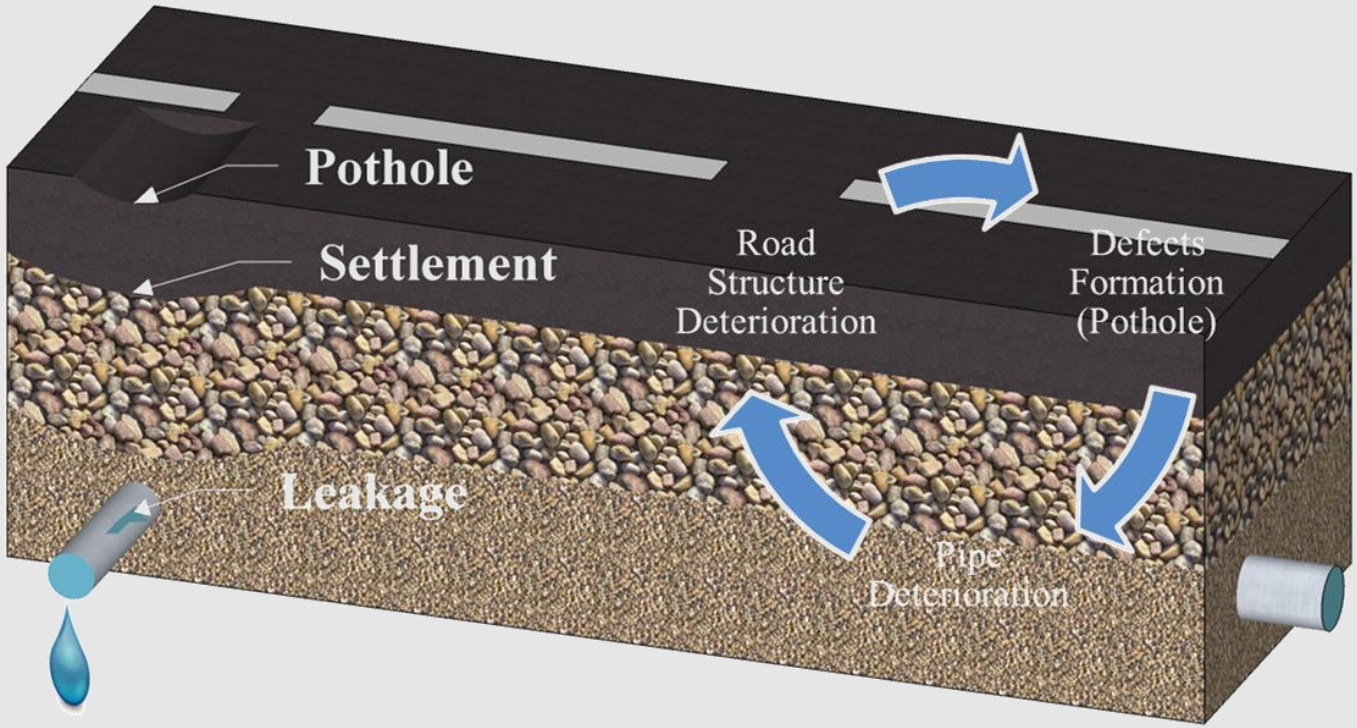
Resilience Through Innovation
Critical Local Transport and Utility Infrastructure

Self-Repairing Cities – UoB Contribution

Aim: to improve the efficiency of infrastructure maintenance through a proactive approach by:

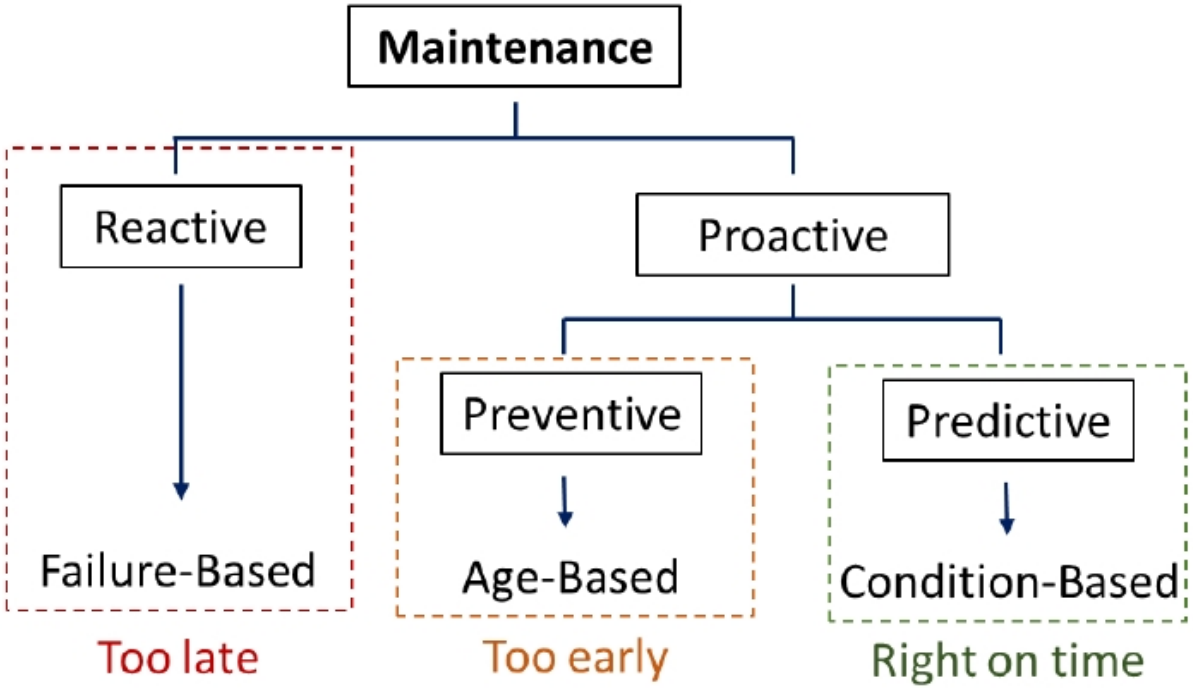
- Detecting a defect at its early stages
- Identifying and eliminating the defect's main trigger(s), by considering the infrastructure systems interdependencies



Self-Repairing Cities – UoB Contribution

Benefits of a proactive approach:

- Extended asset life
- Reduced maintenance expenditure
- Huge savings at the network level



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Self-Repairing Cities – UoB Contribution

Benefits from robotic and automated systems:

- Minimising human errors (image processing vs visual inspection)
- Using geophysical technologies (e.g. GPR and ultrasound) where human access is:
  - **Impossible** (e.g. inside pipes) or
  - **Undesirable** (e.g. at height in the streetscape, in close proximity to vehicles on busy roads, in confined spaces)
- Systematic monitoring over long periods (e.g. throughout overnight closures)
- Eliminating or removing destructive methods
- Enhancing the overall efficacy of maintenance systems

Self-Repairing Cities – UoB Contribution

We are developing a decision support system for these emerging robotic and autonomous systems.

This will enable autonomous decision-making by:

- Suggesting the most appropriate geophysical and/or alternative method(s) for identifying defects (e.g. cracks in asphalt)
- Establishing associated triggers (e.g. failed drainage, a leaking pipe, physical overloading, embrittled asphalt)
- Suggesting alternative (robotic) repair methods, future maintenance regimes and future monitoring regimes (type, frequency)
- Proposing appropriate quality control measures and establishing risks associated with future contextual change