Imperial College London

Digital Innovation in Cities: Smart Cities Reconsidered

Professor John Polak
Director, Urban Systems Laboratory
j.polak@imperial.ac.uk

Imperial College London

Looking back to look forward…

- In the early 1900s, almost all road vehicles in London were drawn by horses
- Over 300,000 horses worked the streets of London in 1900
- Each horse produced about 16kg of mature each day
- That's about 5000 tonnes of horse mature per day
- Or 1.3m tonnes of horse mature per year

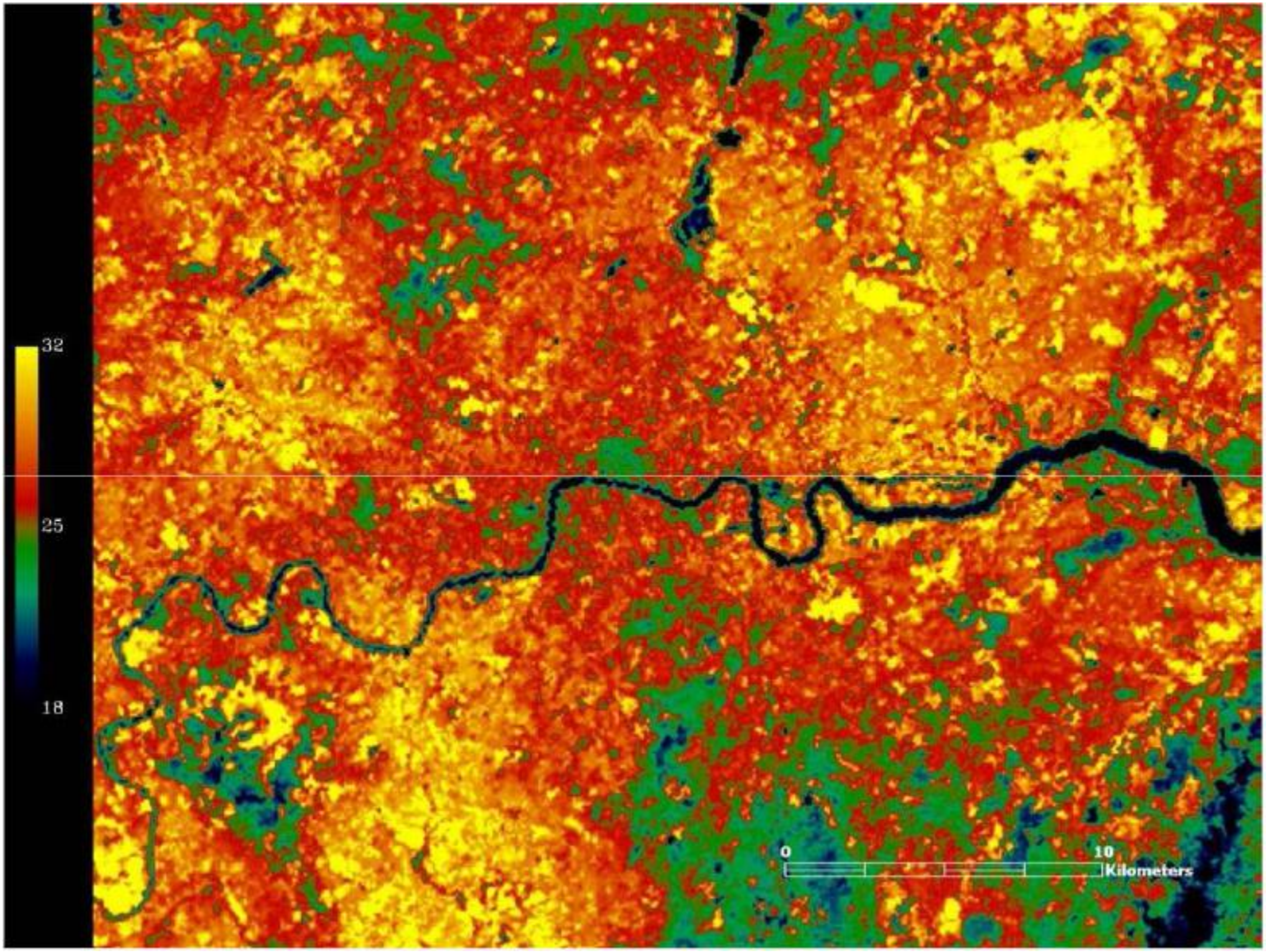

“In 50 years, every street in London will be buried under nine feet of manure…”
The Times of London, 1894

Looking back to look forward…

- By 1920, the number of horses had reduced to few thousand, mostly used for niche delivery operations (e.g. beer and coal)
- Horses were largely replaced by electric and diesel vehicles
- Lessons…
  - When the time is right, change happens quickly
  - Change can be unpredictable (horse ⇒ electric ⇒ diesel ⇒…electric?)
  - Change requires an ensemble of strong drivers (in this case it was cost and health)

Imperial College
London

Climate change



Source: Richard Miller, TSB

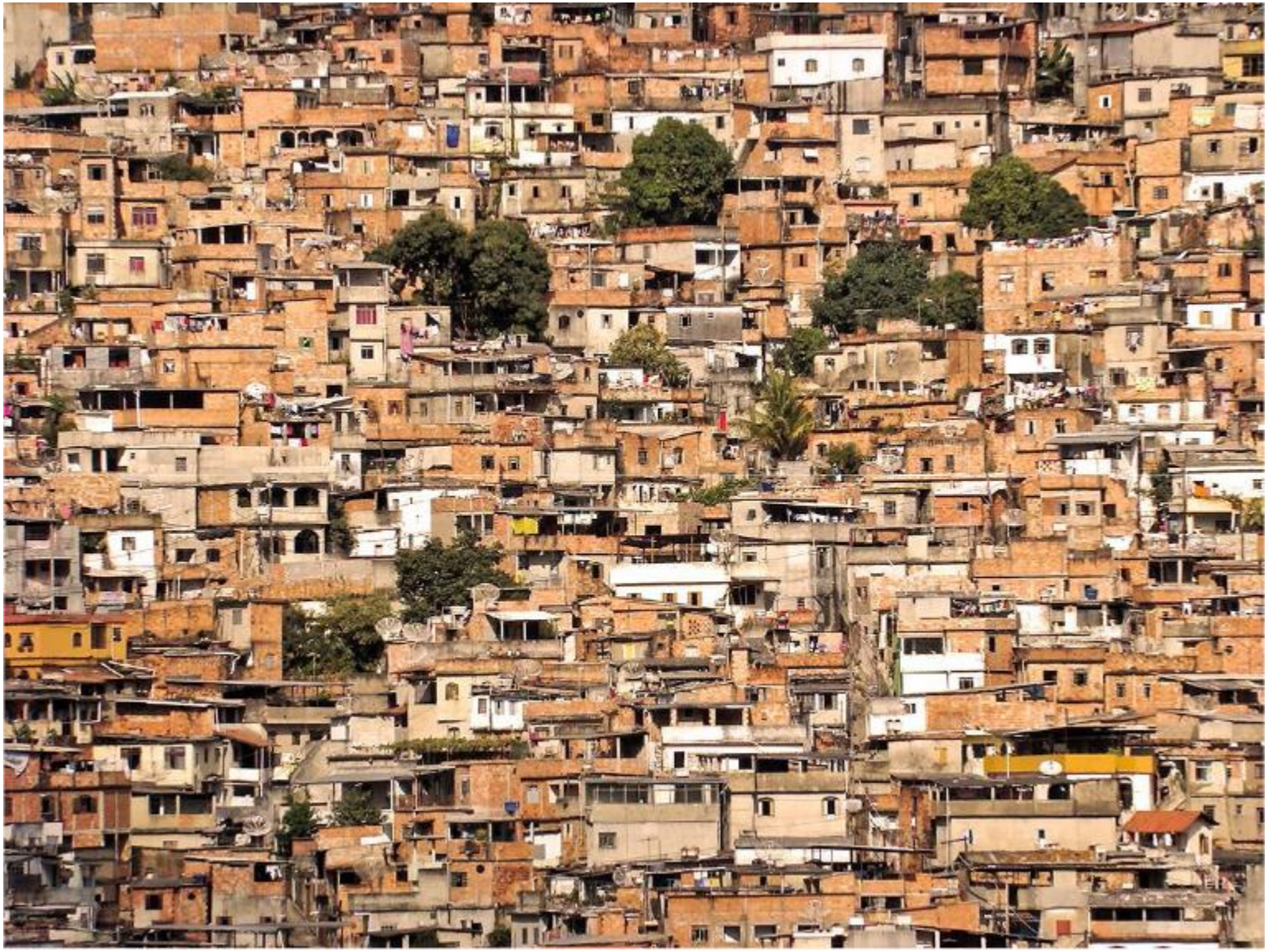
Imperial College
London

Water resources

Source: Richard Miller, TSB

Imperial College
London

Poverty



Source: Richard Miller, TSB

Imperial College
London

Healthcare

Source: Richard Miller, TSB

Imperial College London

Waste

Source: Richard Miller, TSB

Imperial College
London

Air pollution

Source: Richard Miller, TSB

Imperial College
London

Congestion

Source: Richard Miller, TSB

Imperial College
London

Crime

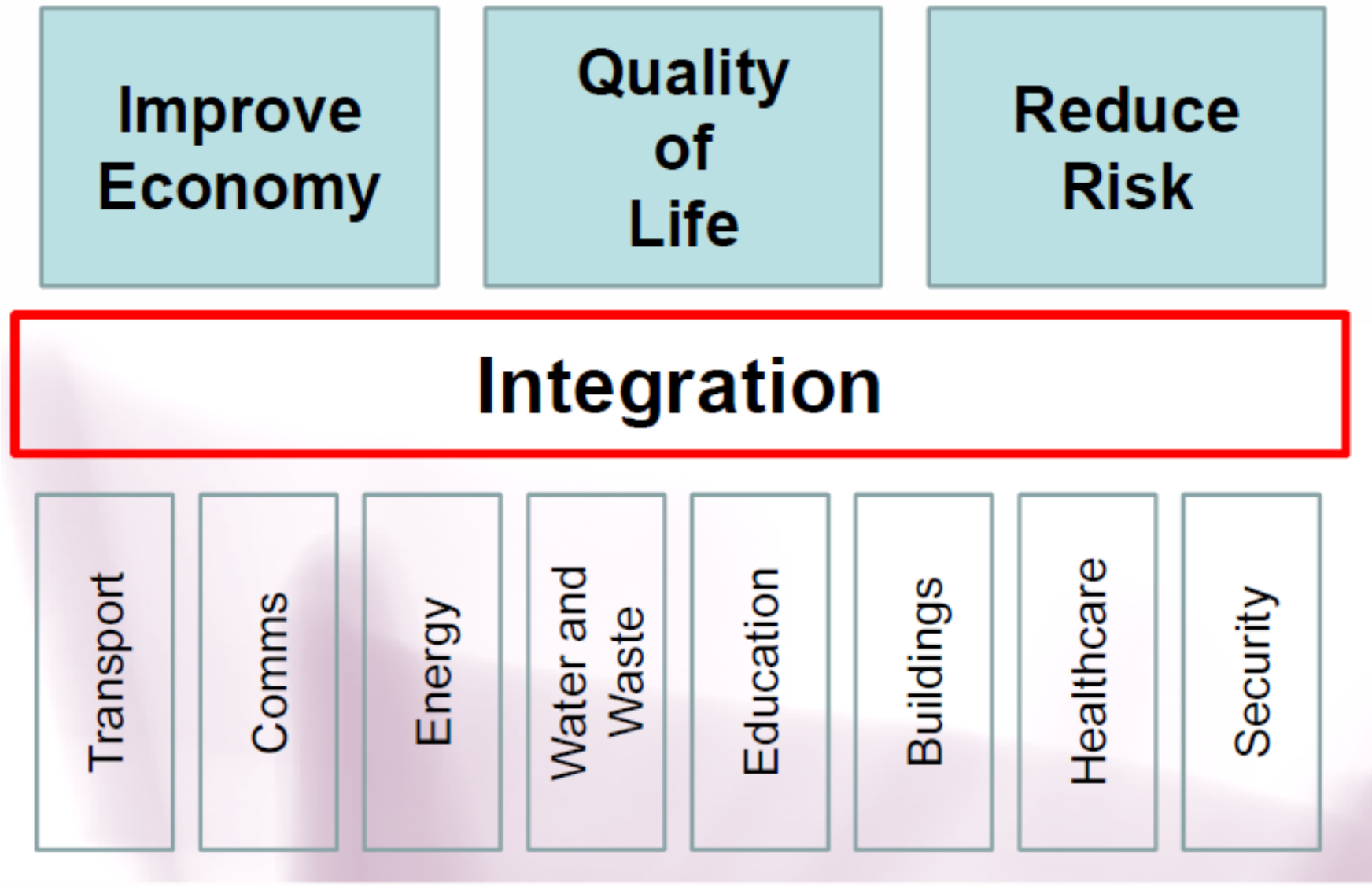
Source: Richard Miller, TSB

The Smart Cities narrative

- The standard Smart Cities narrative starts from the observation that these problems arise from, or are exacerbated by:
  - Siloed sub-systems that are
  - Strongly inter-dependent yet weakly coordinated
  - Lacking in situational awareness
  - Lacking in institutional and operational adaptability
- And from there, draws the conclusion that they can be addressed by better integration between sub-systems
- And that digital systems and technologies provide the means to achieve this integration

Imperial College
London

The Smart Cities narrative

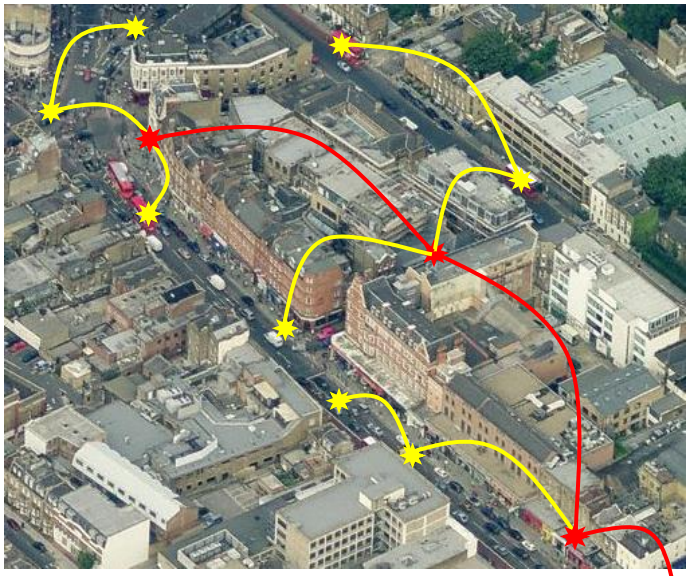


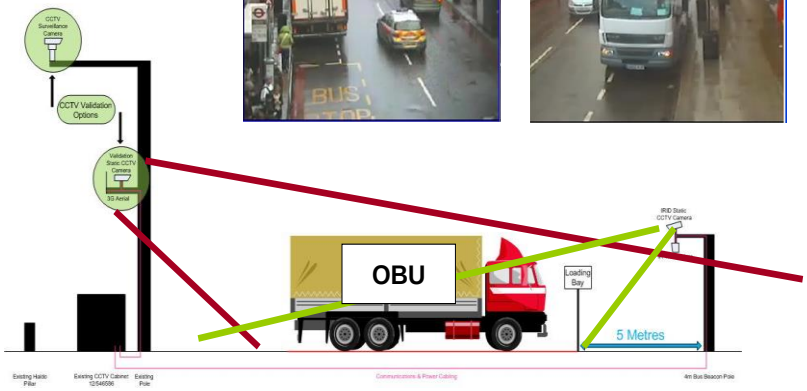
Smart Cities – core technologies

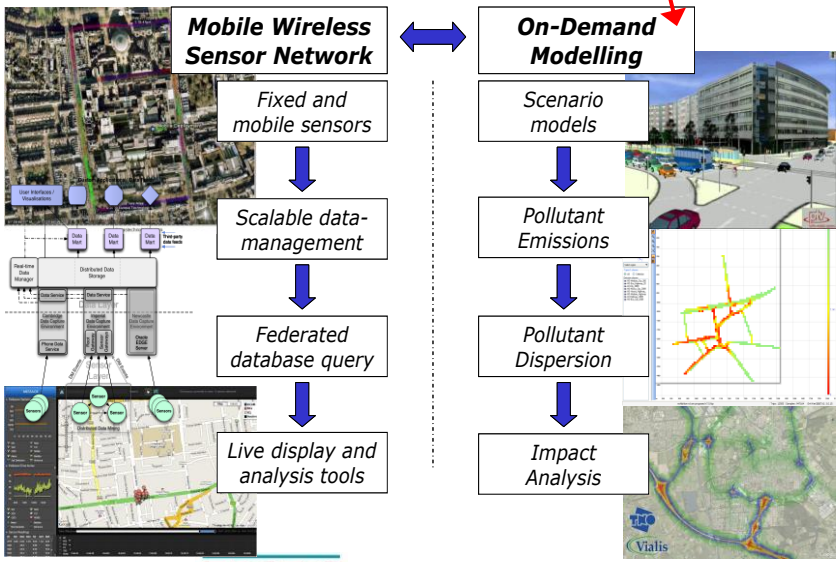
- There are a number of core technical capabilities that figure in most smart cities propositions:
  - Pervasive sensing (Internet of Things)
  - Big data platforms
  - Diagnostic and predictive analytics
  - Decision support systems
- And a great deal of work is being done to develop these capabilities…

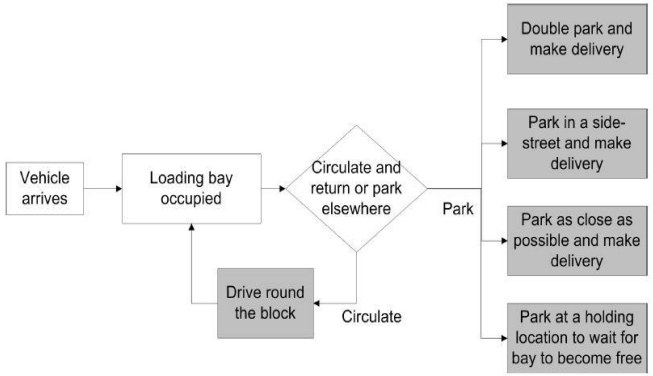
Imperial College London

New forms of sensing









EPSRC Engineering and Physical Sciences Research Council

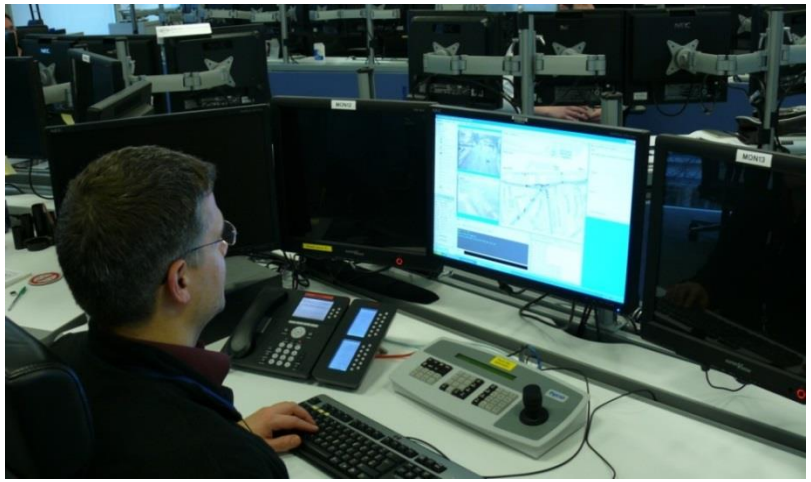
Department for Transport

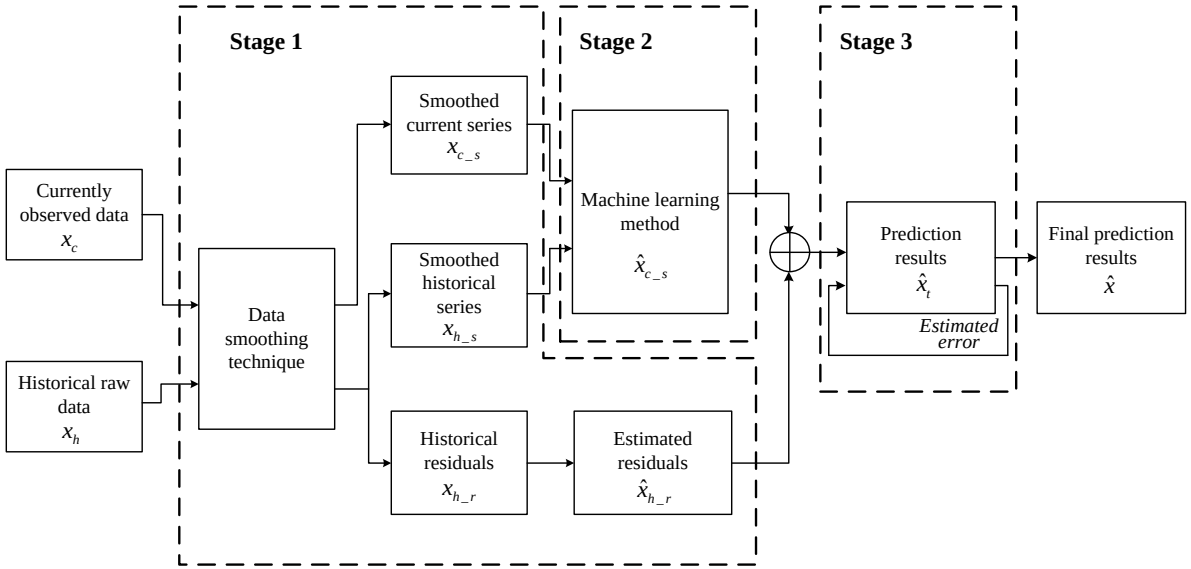
European Commission

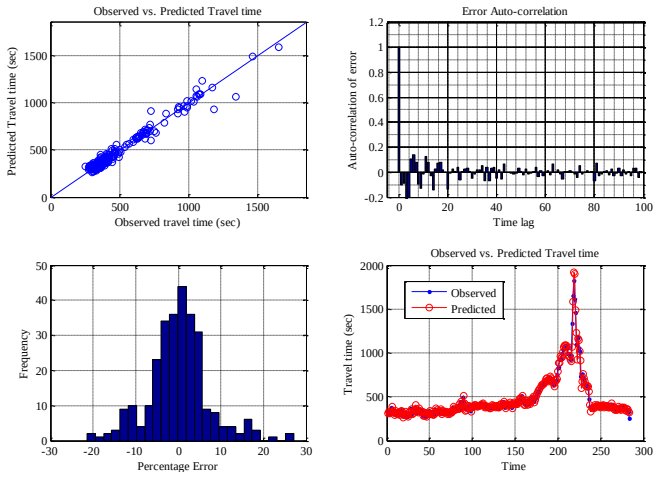
Imperial College London

Multi-modal predictive analytics

Sensor fusion and state estimation	Short term prediction	Decision support and control
Link, route, network Flow, travel time Parking choice Trip diversion Next destination	Process simulation Time series Machine learning Prediction frameworks Single predictors Multiple predictors	Network mgt. services Traveller services Business services



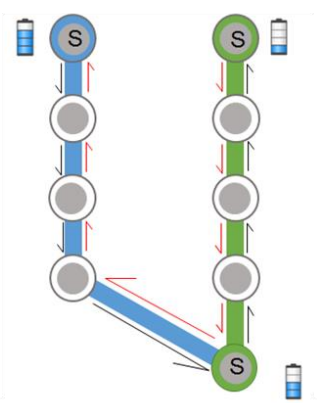


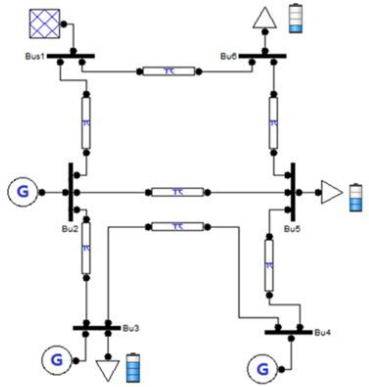


EPSRC Engineering and Physical Sciences Research Council

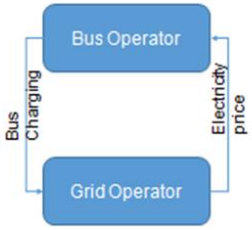
Imperial College London

Cross sectoral integration (transport + energy)

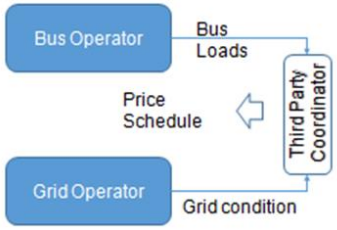




E-Bus Operator and Grid Operator
Competition v.s. Cooperation



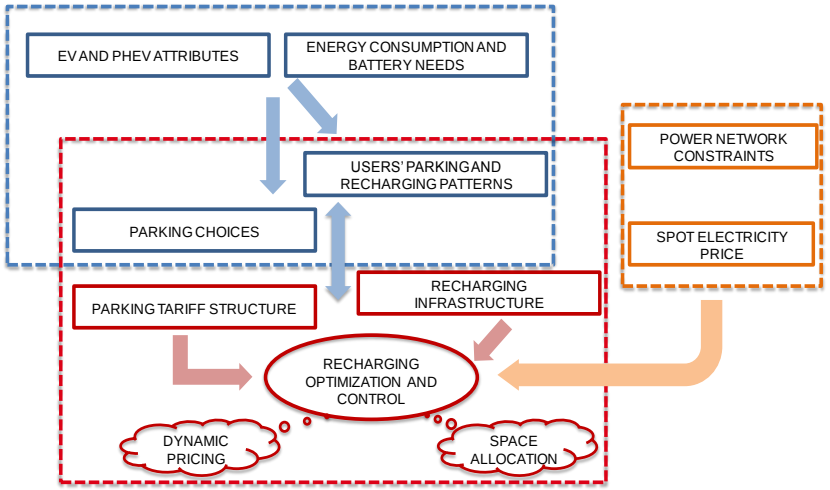
- Stackelberg Game
- Equilibrium existed when there is no incentive to change strategies

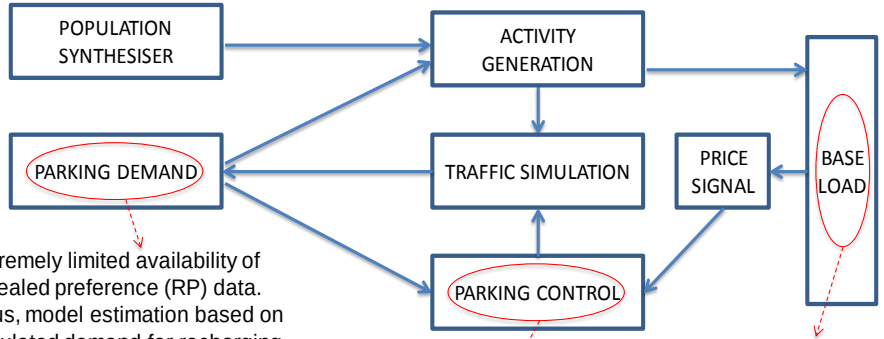


- Minimize the social cost
- Both players share the saving of cost

http://evworld.com/news.cfm?newsid=28113

http://www.greaterlondonphotos.co.uk/





Extremely limited availability of revealed preference (RP) data. Thus, model estimation based on simulated demand for recharging facilities. Validation could be based on ongoing trials in Central London.

Generic power simulation. Provided the simulated parking demand and available data for electricity base load gives a price signal for the parking operator

Either empirically or design SP survey to estimate EV users' willingness to pay (or change their habits) under hypothetic scenarios

EPSRC Engineering and Physical Sciences Research Council

Grantham Institute for Climate Change

Imperial College London

But in fact smart cities aren't developing as originally expected…

- The vision of grand top-down integration is struggling
  - Over-hyped capabilities and lack of demonstrated real-world benefits
  - Persistent *and increasing* data silos
  - Lack of convincing and sustainable business models
  - Dysfunctional public sector procurement
- Instead, to date, the most effective forms of digital innovation has been bottom up, focused on specific customer pain points e.g.,
  - Personalised information services e.g., City mapper
  - Peer to peer services e.g., Uber, Airbnb
  - Demand aggregation/arbitrage services e.g., KiWi Power

Conclusions

- Smart cities is a big idea; it won't go away
- But in many respects the narrative underlying "smart cities 1.0" was vulgar and simplistic, and is dated
- Digital innovation in cities has taken a different course
- Yet many of the problems it sought to address remain real and pressing
- The challenge is therefore to re-invent the smart cities narrative

Thank you