ORDNANCE SURVEY

Future Trends in Geospatial Information Management

Technical Trends

Jeremy Morley
Chief Geospatial Scientist

Trends

Drivers

Rise of new data sources & analytical methods

- Relevance of ***data integration and interoperability*** increase
- Products and solutions produced from ***multiple data sources*** becoming the norm
- ***New opportunities for data gathering***, i.e. autonomous vehicles
- ***Crowdsourcing and VGI*** become established ways of data collection
- ***High-resolution high-revisit Earth Observation*** data become valid alternative to aerial imagery
- ***Big Data processing*** has become a normal path of geospatial data processing
- Integration of multiple data sources requires ***licensing harmonisation***
- ***Digital platforms*** provide access to data at scale
- ***Linked Data*** enables knowledge-on-demand

Technological advancements

- ***Ubiquitous connectivity*** enables deployment of new tech
- ***Digital infrastructure*** through sensors and the Internet of Things
- Interconnecting modes of transport through ***intelligent mobility***
- ***Digital Twins*** for modelling, simulation and prediction
- Wide uptake of ***edge computing*** to enable intelligent mobility, the Internet of Things, and smart cities
- Visualisations and ***immersive technology*** widely used to enhance customer experience and decision making
- ***Machine learning, deep learning, and AI*** disrupt geospatial production
- ***Quantum computing*** enables intensive processing

Evolution of user requirements

- Rise of products and services specifically designed for the ***urban environment***
- Demand for ***real-time information*** provision
- ***Digital divide and exclusion*** continue to hold back universal digital transformation
- Seamless experience between ***outdoor and indoor mapping*** becomes an expectation
- Viable integrated ***Smart City*** solutions becoming wide spread

Industry structural shift

- Increased ***diversity at work*** in technology, science, and innovation
- ***Talent and consumer shift*** - changing values and attitudes
- ***Incubator spaces*** enable innovation to enter markets swiftly
- ***Regeneration of business ecosystem*** through the rise of non-geospatial start-ups
- ***New collaboration agreements*** with industries outside of geospatial emerge

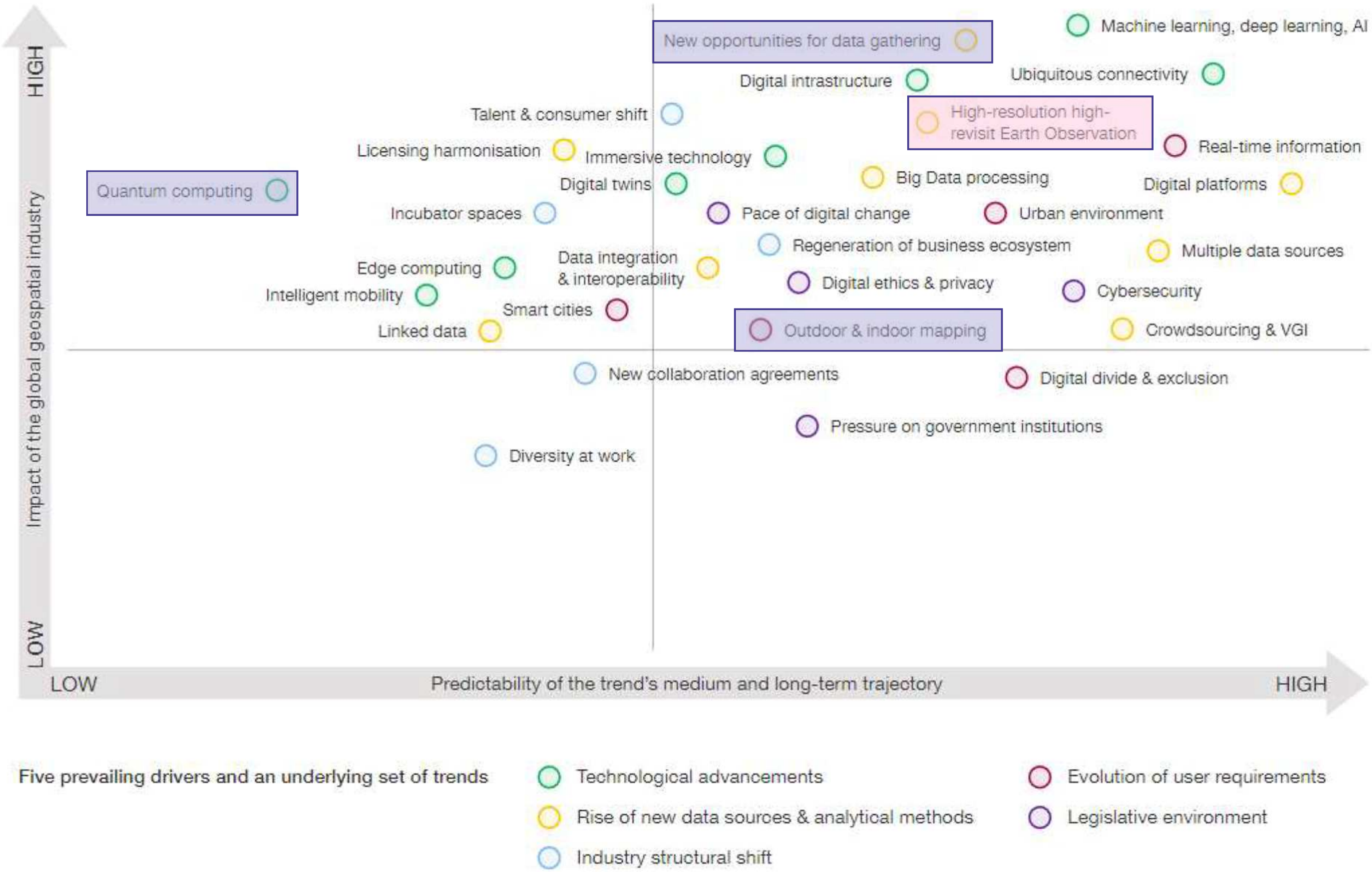
Legislative environment

- ***Digital ethics and privacy*** addressed by national and international initiatives
- ***Cybersecurity*** conversations increase in tandem with increase in digital devices
- ***Pace of digital and tech change*** puts pressure on national institutions to address policy and legislative shortcomings
- ***Pressure on government institutions*** to be more tech and digital savvy

Ordnance Survey

Graphic 1.

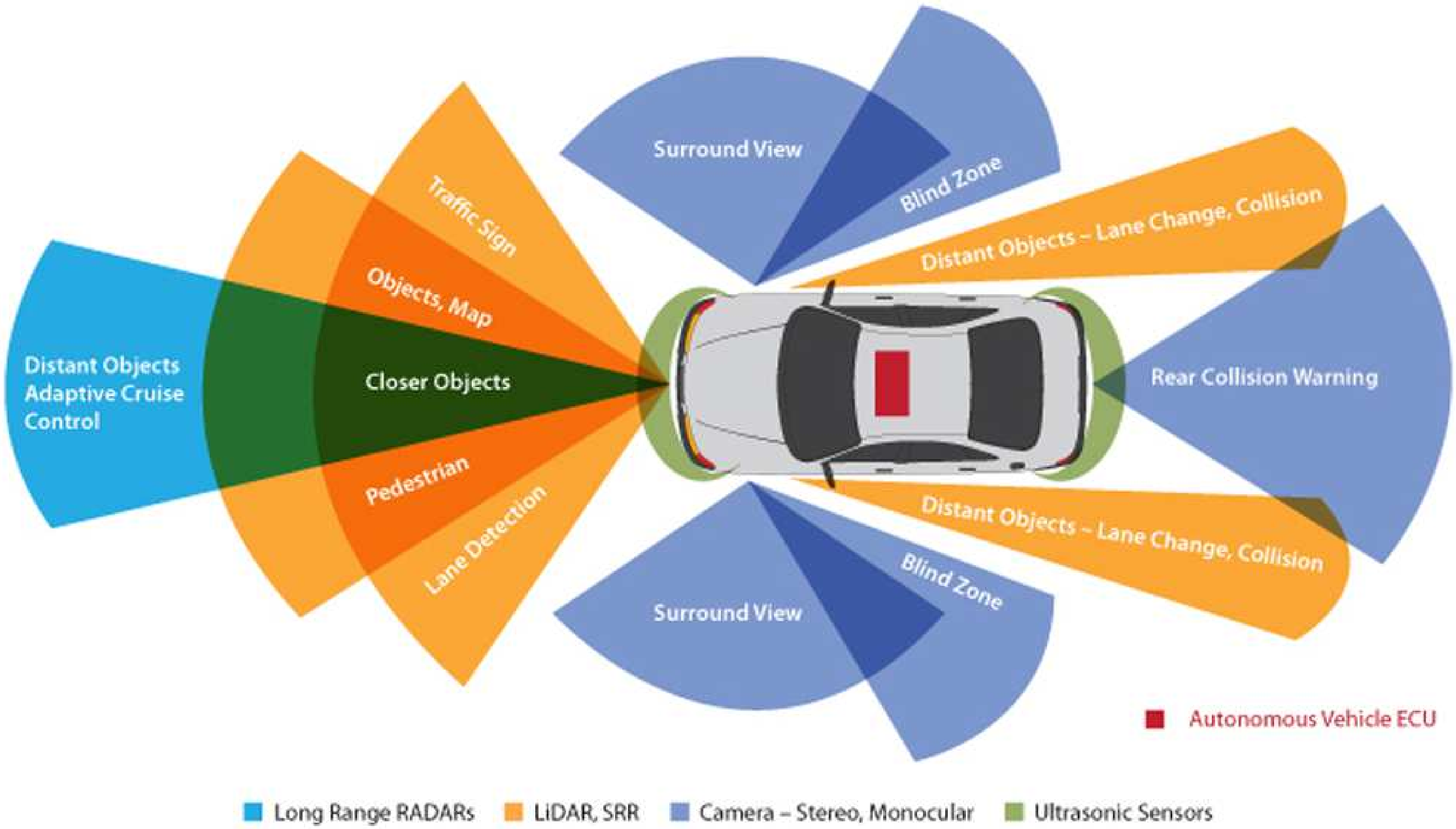
Five drivers will advance change in the global geospatial information management landscape over the next 5 to 10 years



Ordnance Survey

New opportunities for data gathering

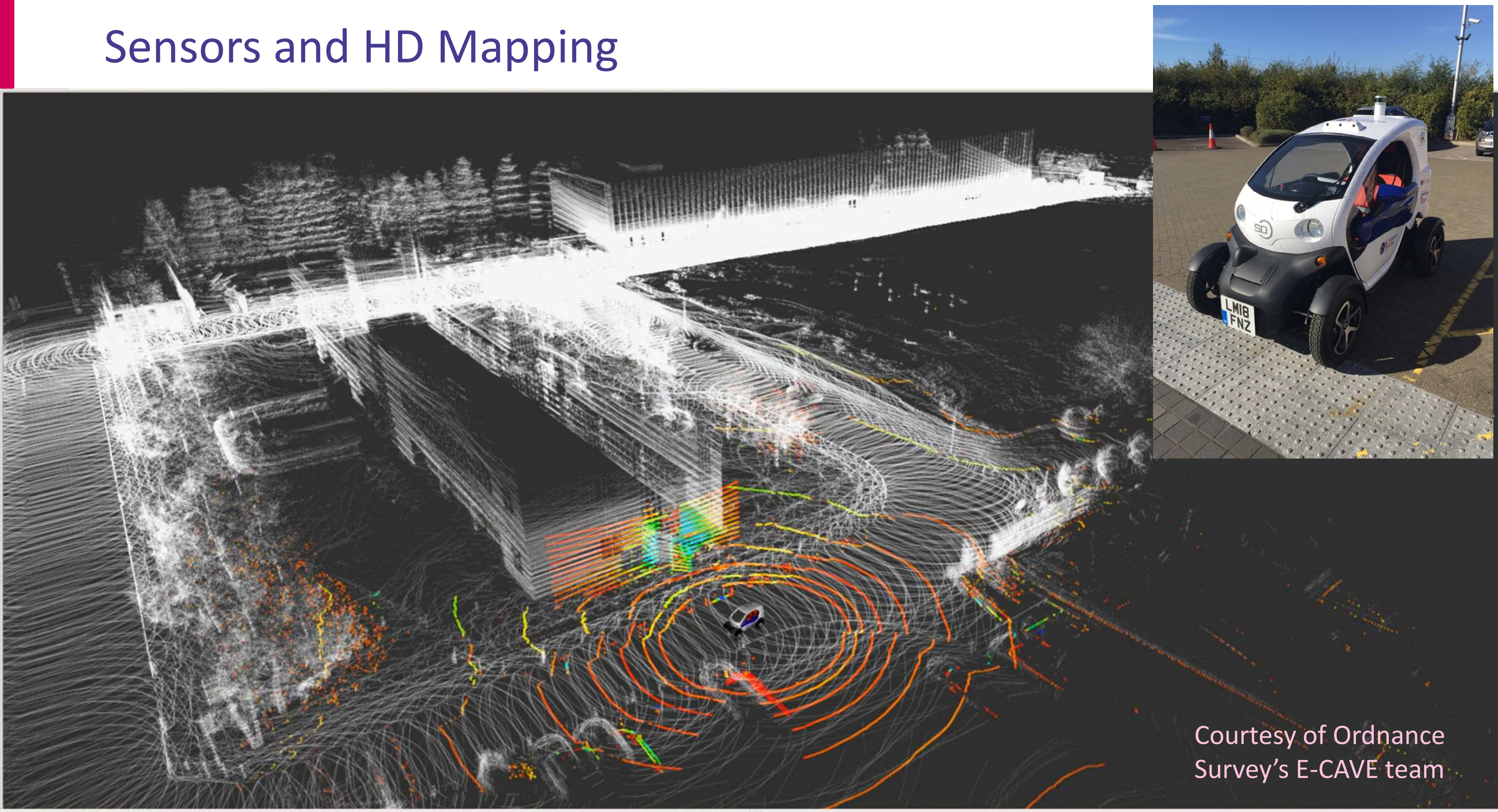
Vehicles as sensor platforms



Example system: Tata Elxsi's 'Autonomai' (2017)

From:
https://gaadiwaadi.com/tata-elxsi-autonomous-driving-tech-autonomai-793733/

Sensors and HD Mapping



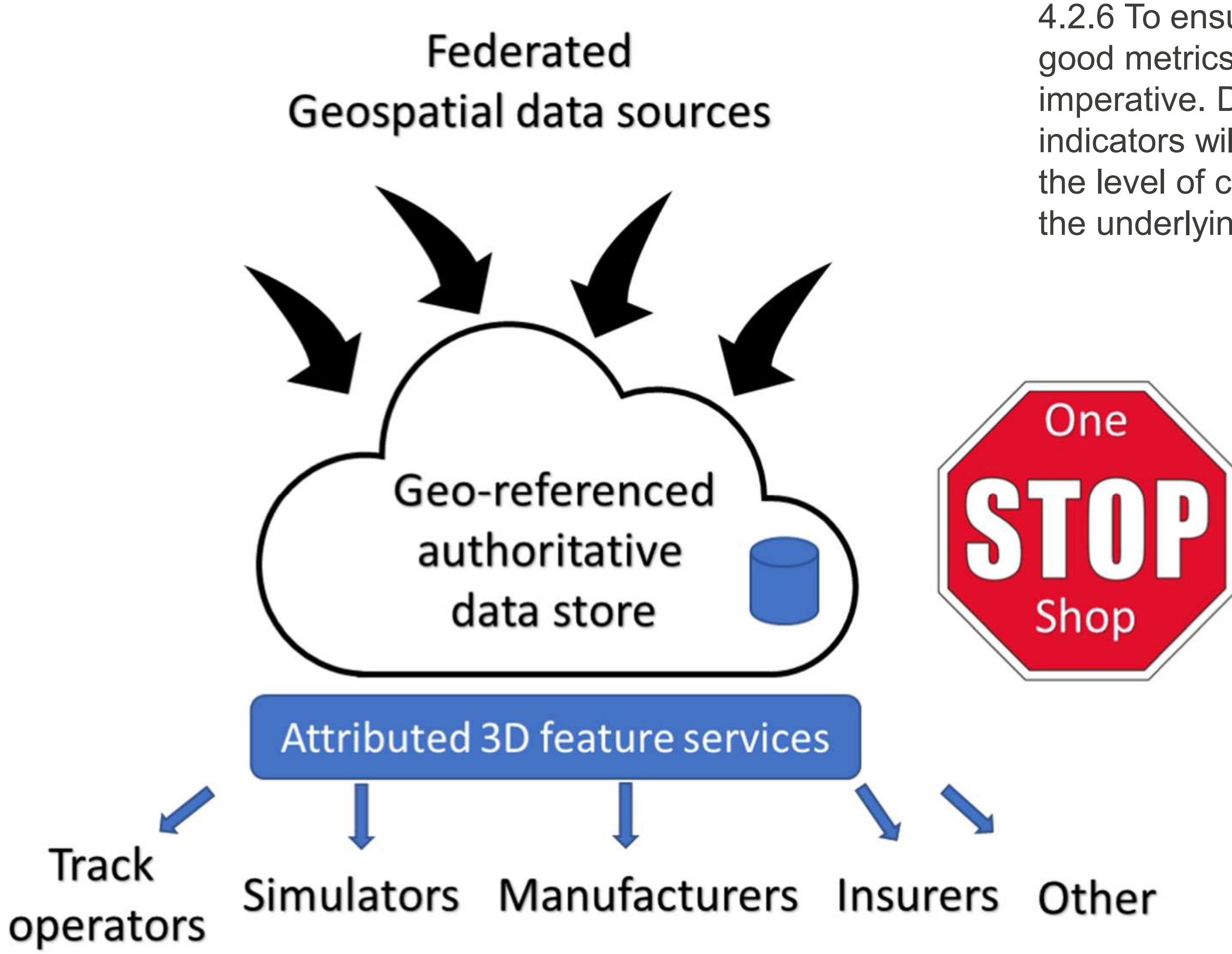
Courtesy of Ordnance Survey's E-CAVE team

OS-Mobileye two ways of seeing the world

Relative - A car centric view of the world

Absolute - Eastings, Northings or GPS lat-lon

Neutral georeferenced data

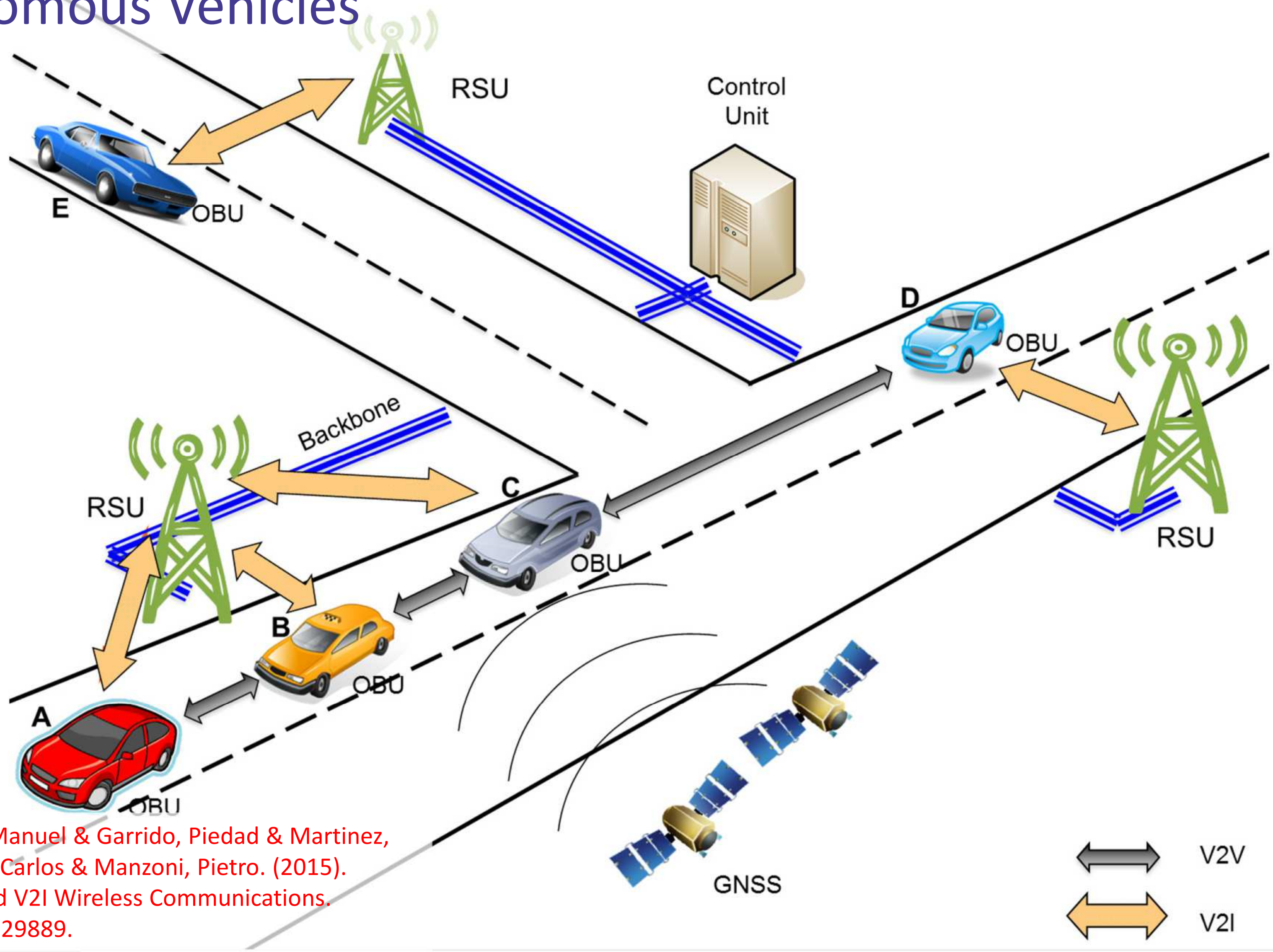


4.2.6 To ensure consistent accurate data good metrics about data quality are imperative. Displaying data quality indicators will enable the user to consider the level of confidence they should have in the underlying information.

Source: Zenzic, Geodata report – analysis and recommendations for self-driving vehicle testing, 2019.

Ordnance Survey

Connected Autonomous Vehicles

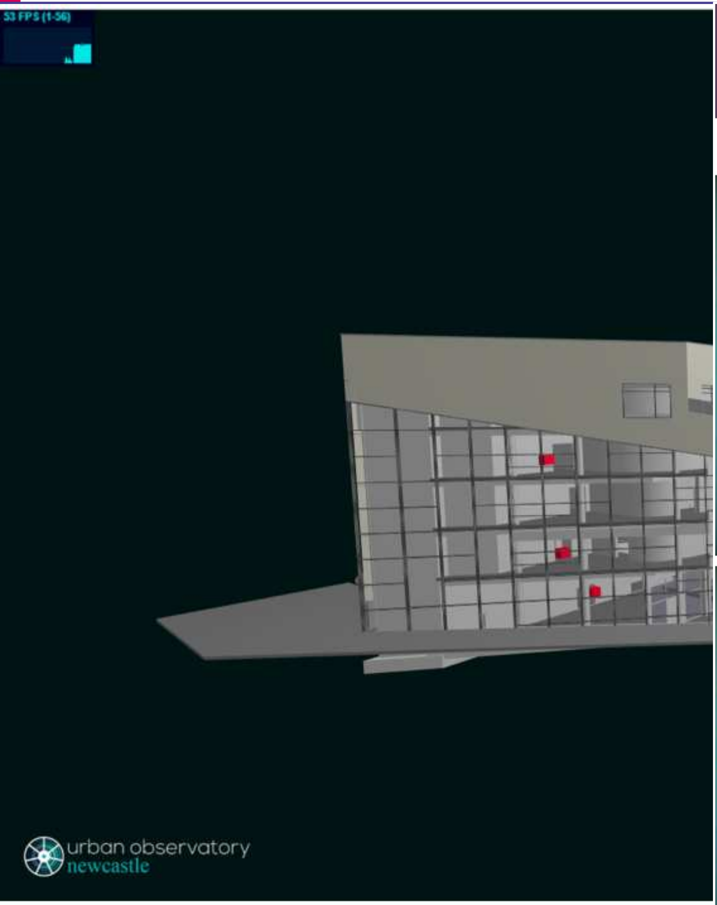


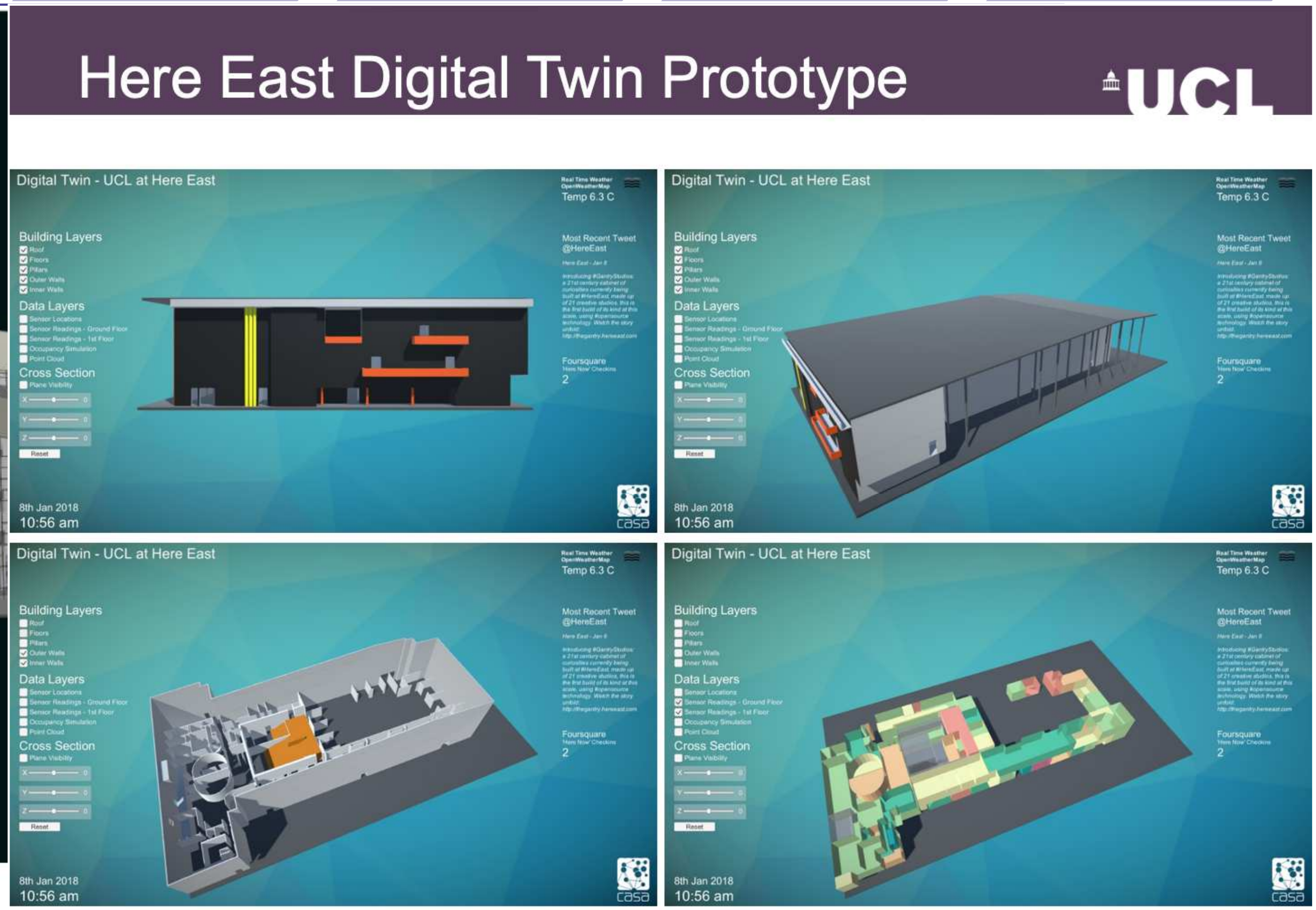
Sanguesa, Julio & Barrachina, J & Fogue, Manuel & Garrido, Piedad & Martinez, Francisco & Cano, Juan-Carlos & Calafate, Carlos & Manzoni, Pietro. (2015). Sensing Traffic Density Combining V2V and V2I Wireless Communications. Sensors. 15. 31794-31810. 10.3390/s151229889.

Seamless indoor/outdoor experience

Ordnance Survey

Building | Locale | Neighbourhood | City | Region | Nation



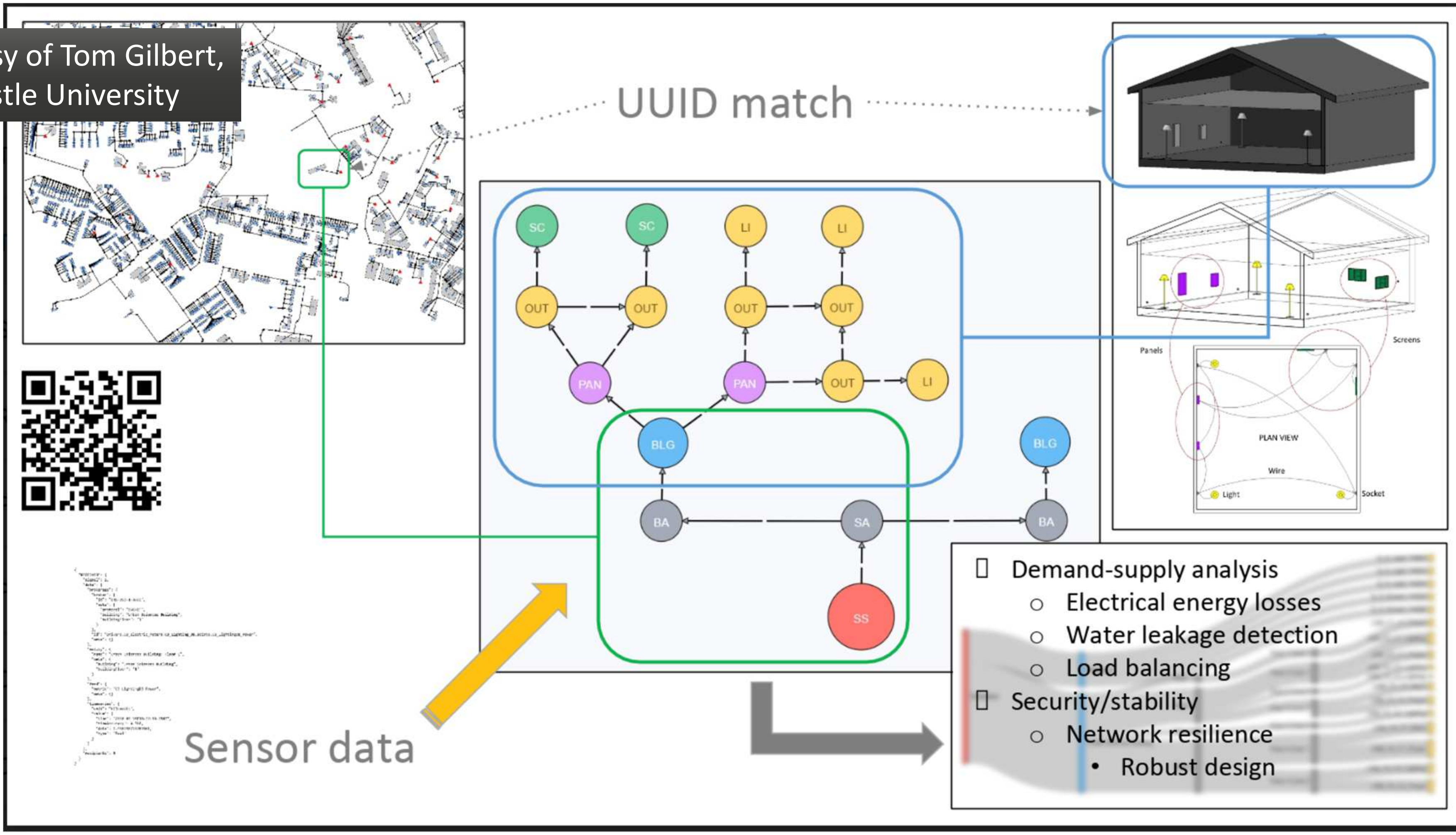


Email: T.Rodaway1@ncl.ac.uk

Courtesy of Oliver Dawkins, UCL CASA

Building | Locale | Neighbourhood | City | Region | Nation

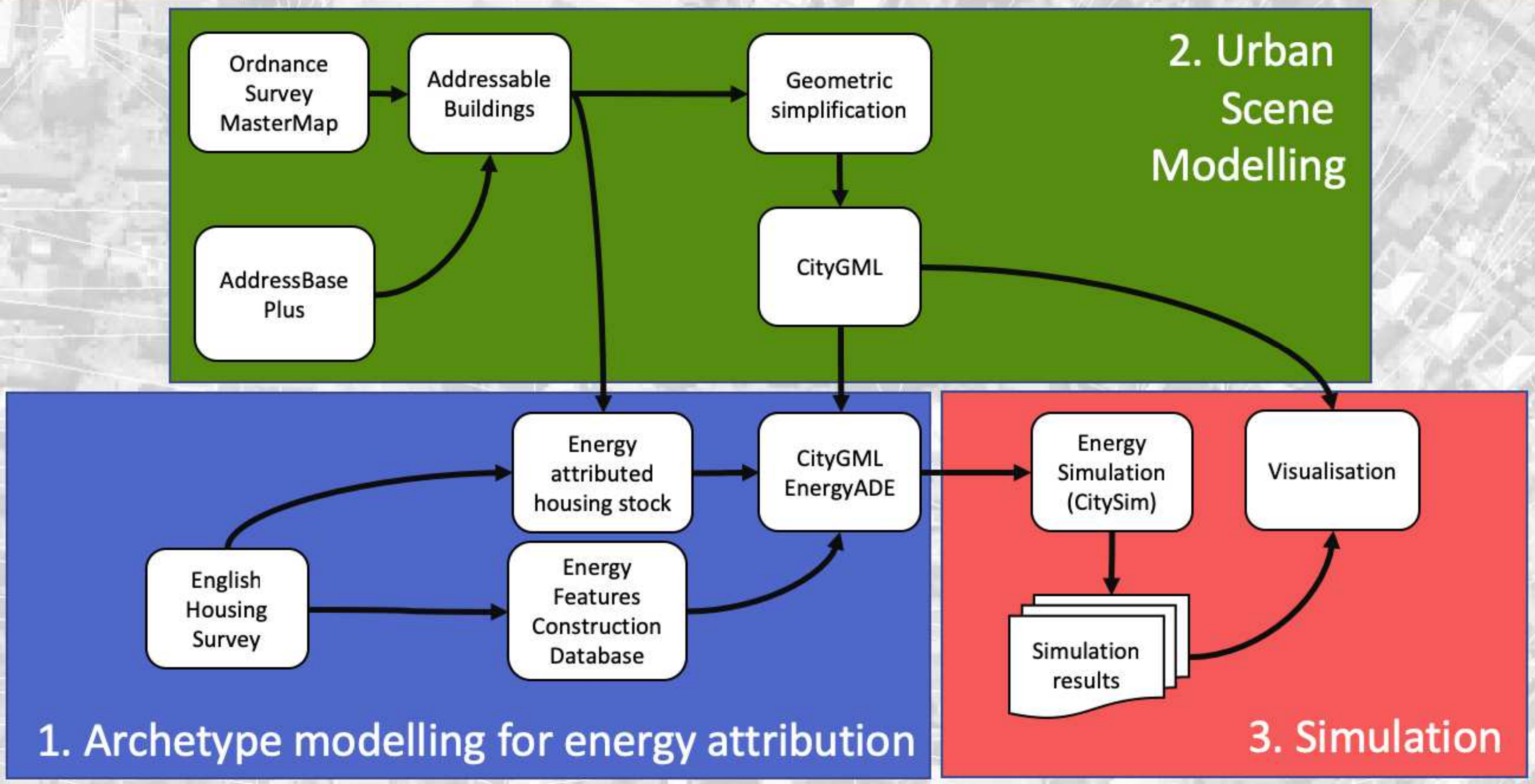
Courtesy of Tom Gilbert, Newcastle University

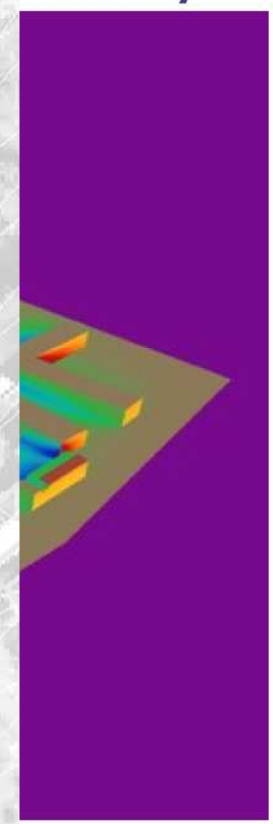


University of Nottingham
UK | CHINA | MALAYSIA

Modelling framework

inability

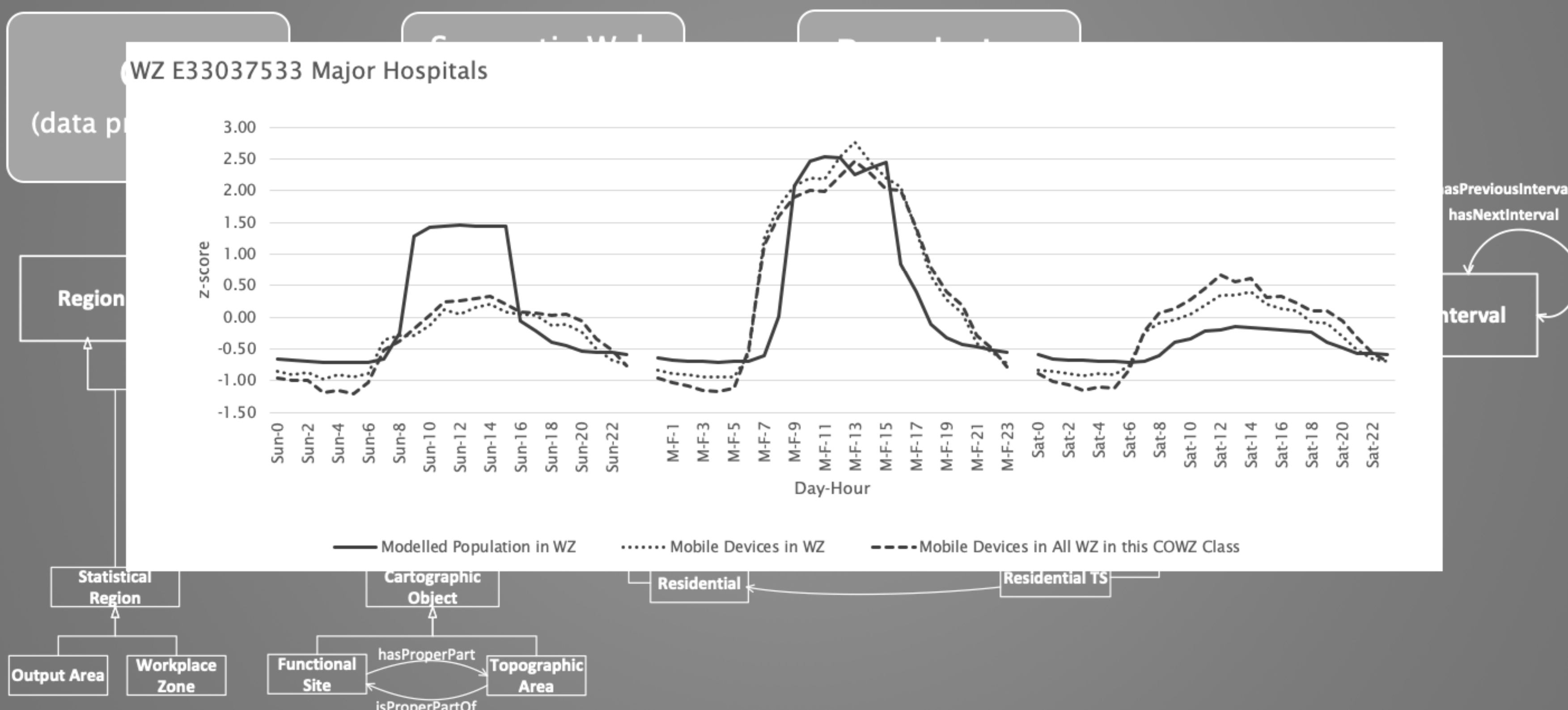




Building | Locale | Neighbourhood | **City** | Region | Nation

An Ontology-Based Modelling Framework for Detailed Spatio-Temporal Population Estimation

UNIVERSITY OF Southampton
Rebecca King



Email: T.Rodaway1@n

Quantum computing

Quantum computing

Based on “qubits” – rather than a traditional bit which holds a 0 or 1 value only.

Qubits actually store the *superposition* of every possible quantum state, so a single qubit can hold two binary values at once, meaning a single operation can be carried out on $\mathbf{2^n}$ values simultaneously, where n is the number of qubits. The power of the quantum computer storage scales exponentially with the number of bits.

A quantum computer uses other quantum physics laws such as *entanglement* (the “spooky” at-a-distance connection between quantum objects) and *interferences* to operate.

Qubits & quantum computers currently require very specialised hardware – ions at microkelvin temperatures or superconductors. They are not very fault tolerant, and the qubit state (the 0 vs 1 condition) cannot be indefinitely maintained (*decoherence* of the state).

Example uses of quantum computing

Optimisation problems

- Not usually suitable for brute-force algorithms, testing permutations of options one at a time
- The superposition scale-up in quantum computers should allow much larger scaling up in algorithms
- An example optimisation problem is planning in **logistics**

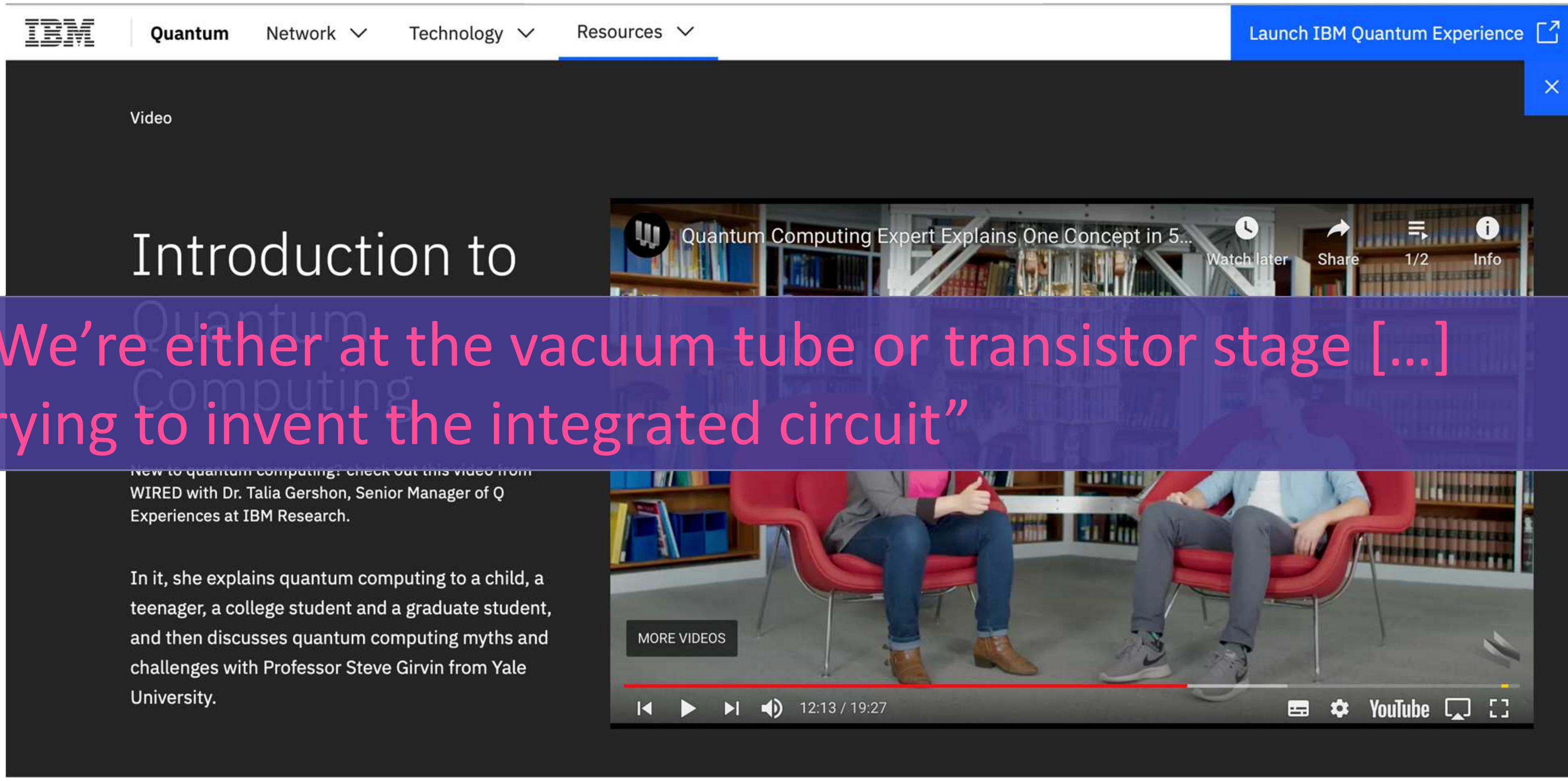
Machine learning

- ML techniques allow big data analysis to find patterns in large datasets, e.g. using cloud computers
- "Lately, because of the rapid growth of the size of datasets, the dimensionality of the input and output space, and the variety and structure of the data, conventional learning techniques have started to show their limits." L.Oneto, S.Ridella, D.Anguita 2017
- Quantum computers show promise for exponential speedup of clustering algorithms, e.g. "q-means" to replace k-means: https://towardsdatascience.com/quantum-machine-learning-a-faster-clustering-algorithm-on-a-quantum-computer-9a5bf5a3061c
  Kerenidis, Landman, Luongo, Prakash, 2019 "q-means: A quantum algorithm for unsupervised machine learning ", 33rd Conference on Neural Information Processing Systems (NeurIPS 2019), Vancouver, Canada.

Ordnance Survey

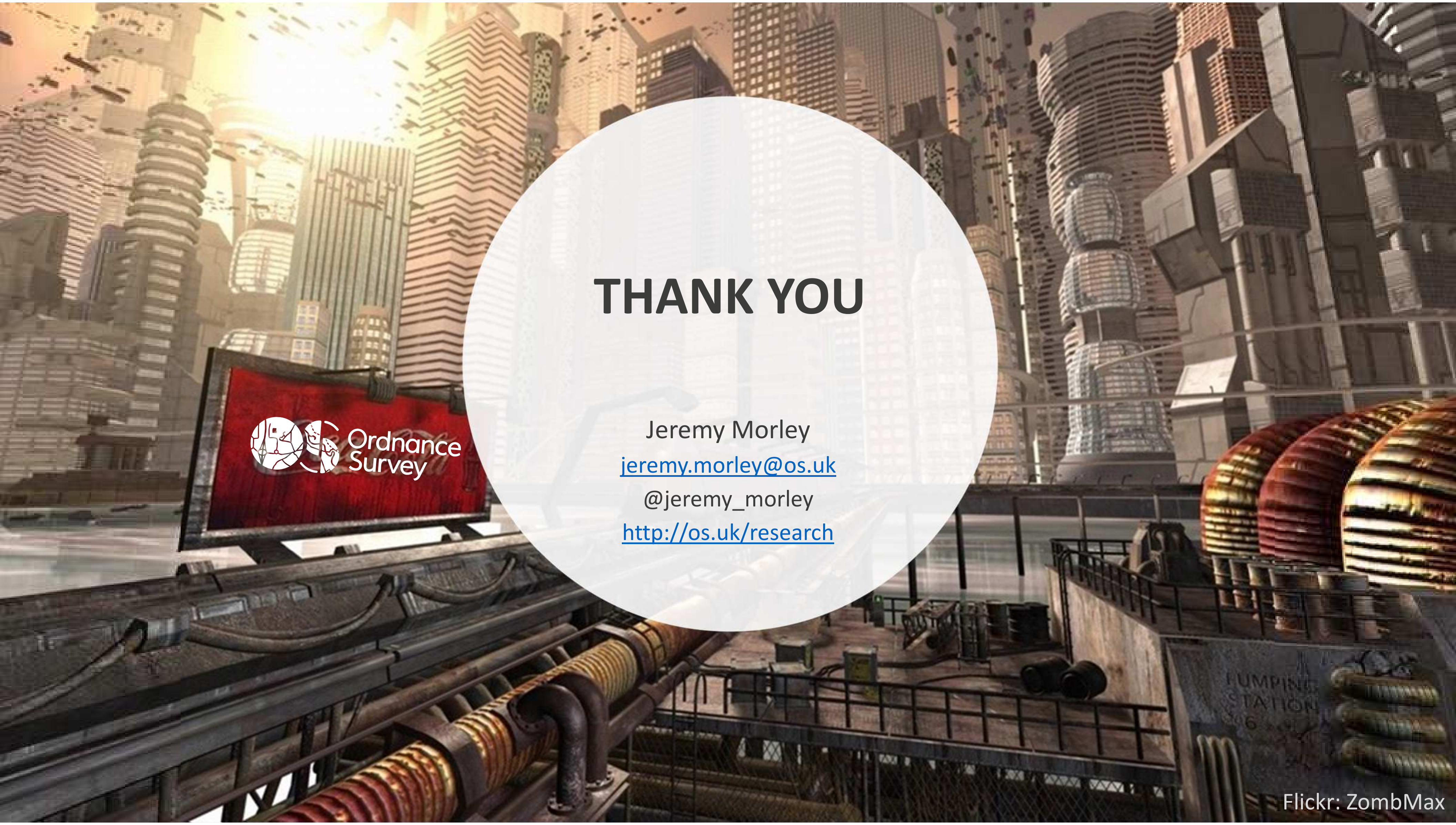
Example resource

https://www.ibm.com/quantum-computing/learn/what-is-quantum-computing/



"We're either at the vacuum tube or transistor stage […] trying to invent the integrated circuit"

Concluding thoughts



THANK YOU

Jeremy Morley
jeremy.morley@os.uk
@jeremy_morley
http://os.uk/research

Flickr: ZombMax