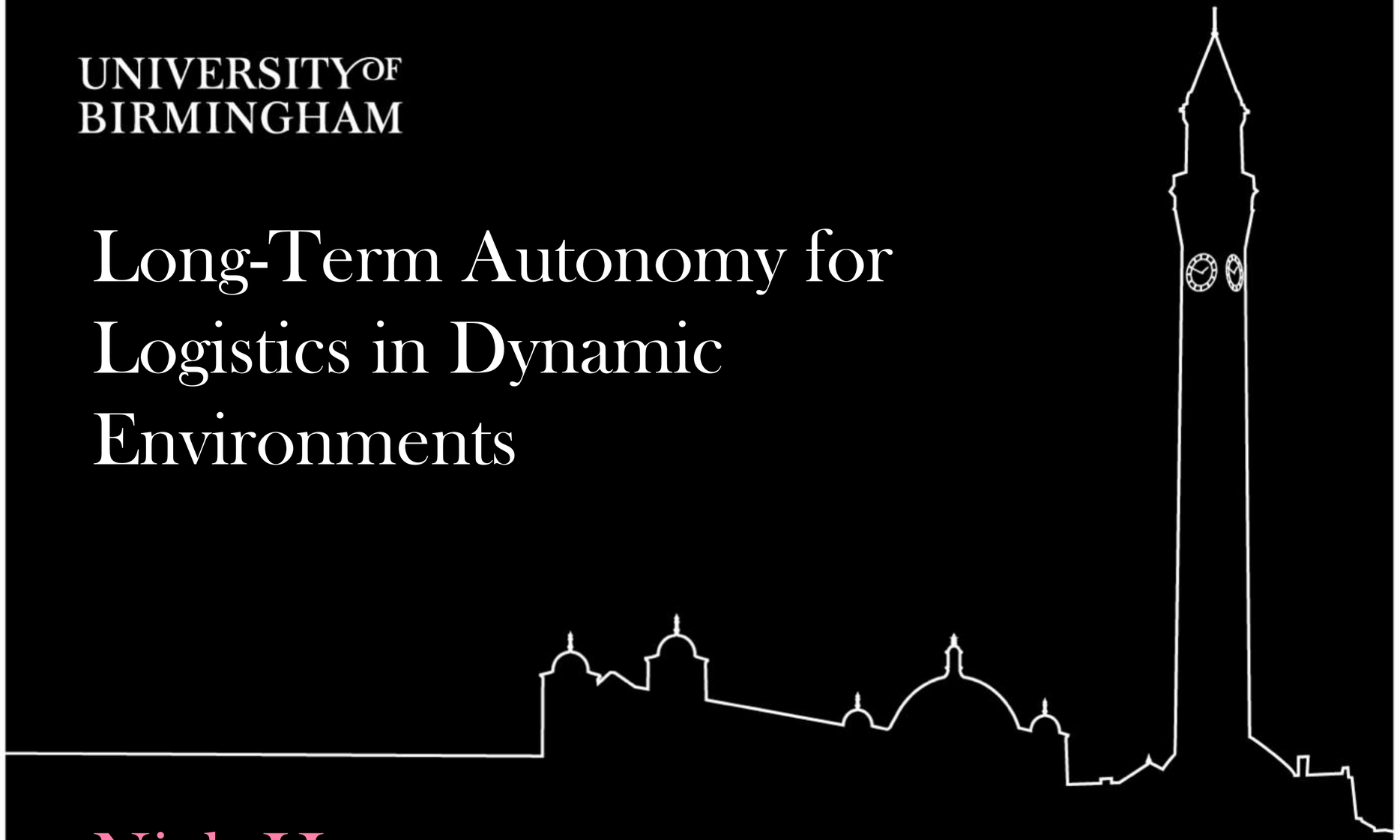
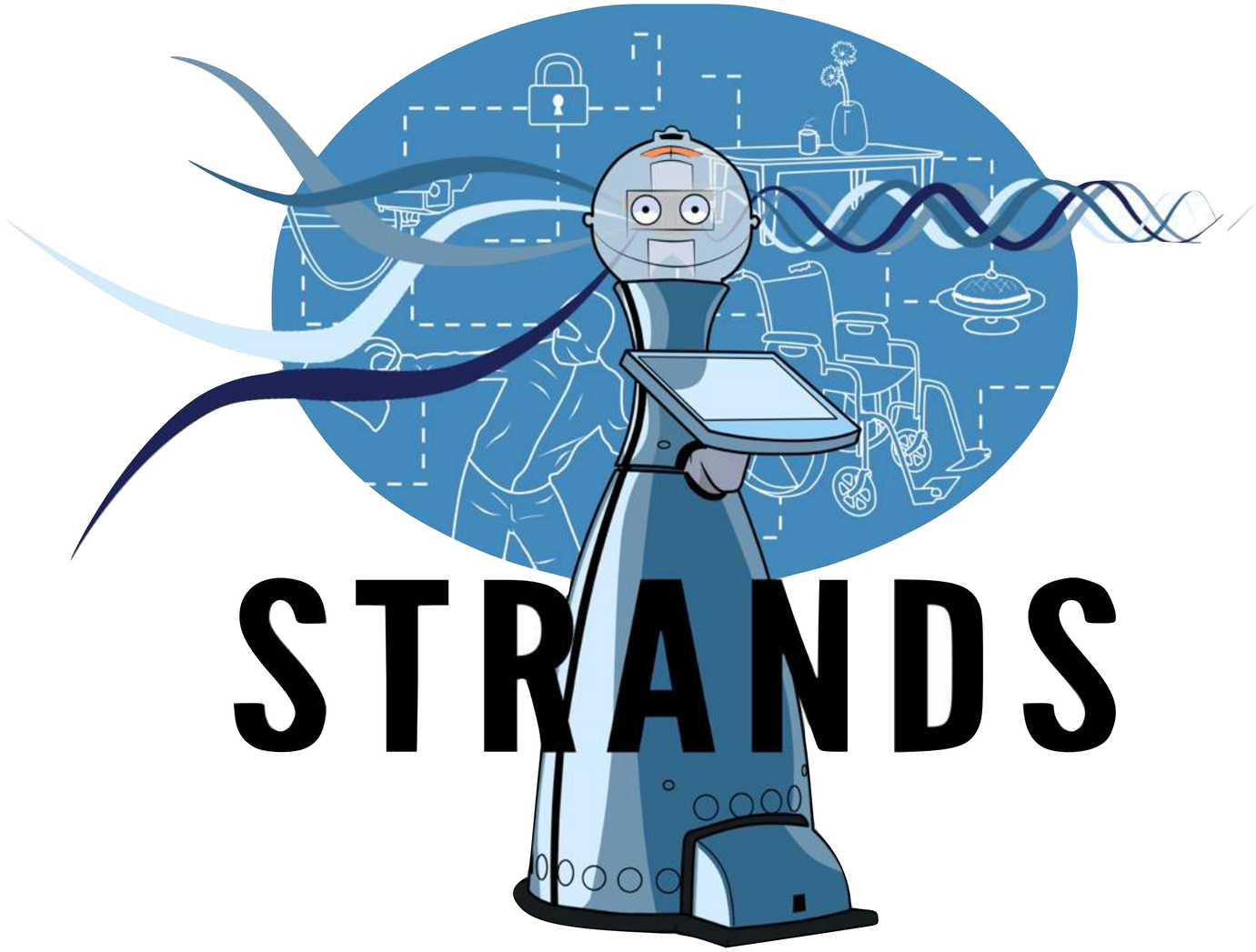
UNIVERSITY OF BIRMINGHAM

Long-Term Autonomy for Logistics in Dynamic Environments



Nick Hawes http://nickhaw.es @hawesie

School of Computer Science, University of Birmingham, UK



STRANDS

SEVENTH FRAMEWORK PROGRAMME

UNIVERSITY OF BIRMINGHAM

KTH VETENSKAP OCH KONST

RWTH AACHEN UNIVERSITY

TU WIEN

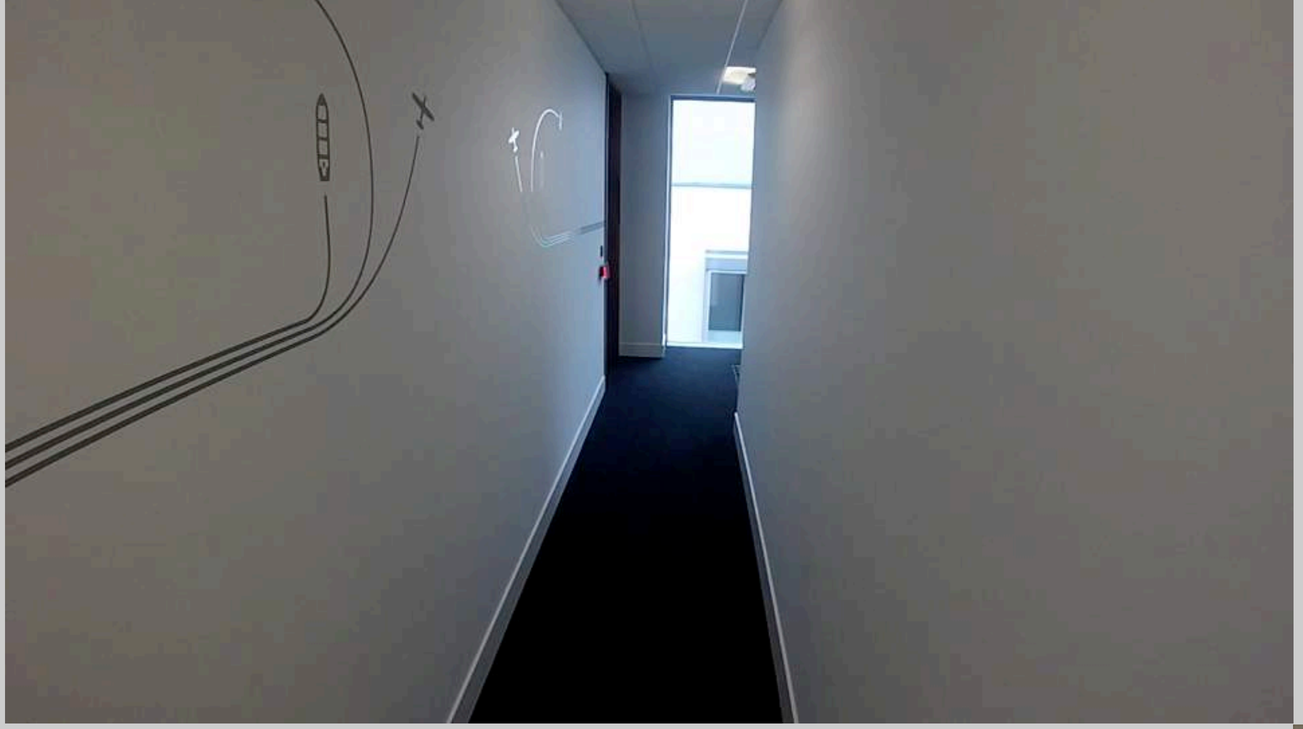
UNIVERSITY OF LEEDS

UNIVERSITY OF LINCOLN

G4S

AKADEMIE FÜR ALTERSFORSCHUNG AM HAUS DER BARMHERZIGKEIT

http://strands-project.eu



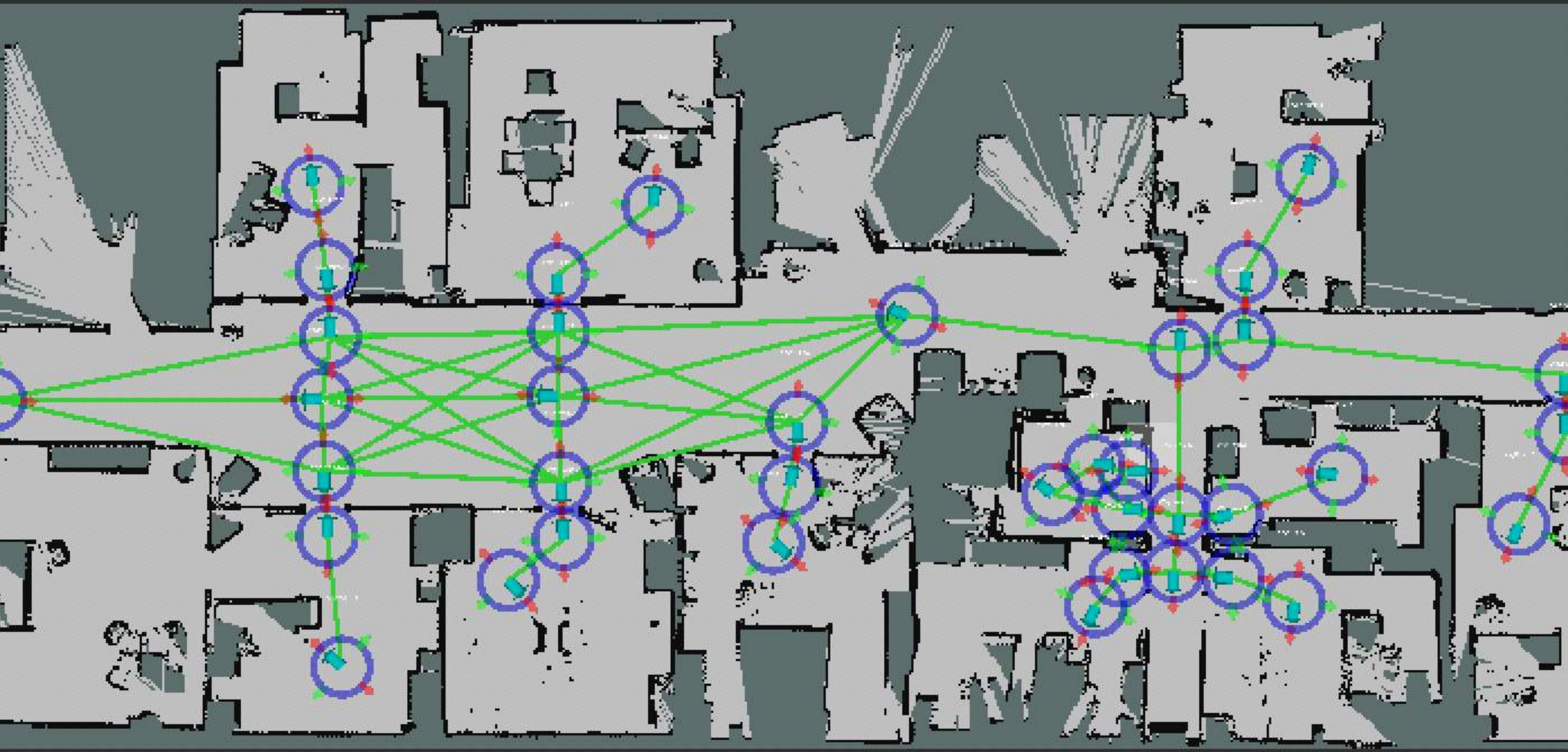
Transport Systems Catapult,
Milton Keynes, UK

months of
autonomous behaviour

no *expert* interventions

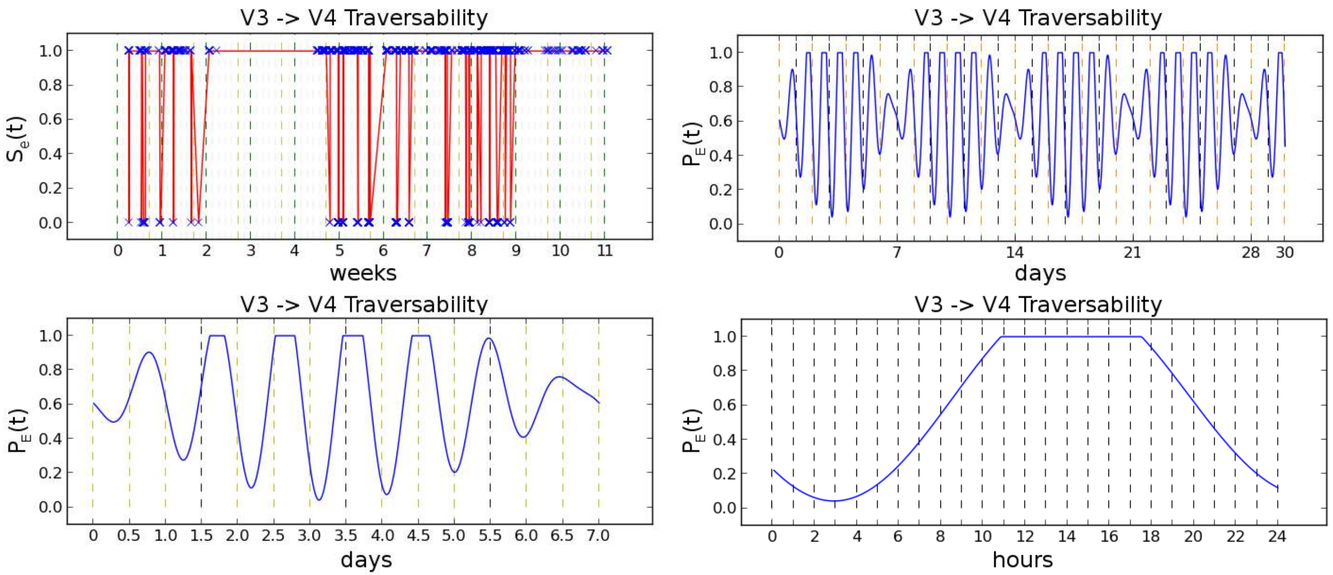
requires **verified**
behaviour planning
and control

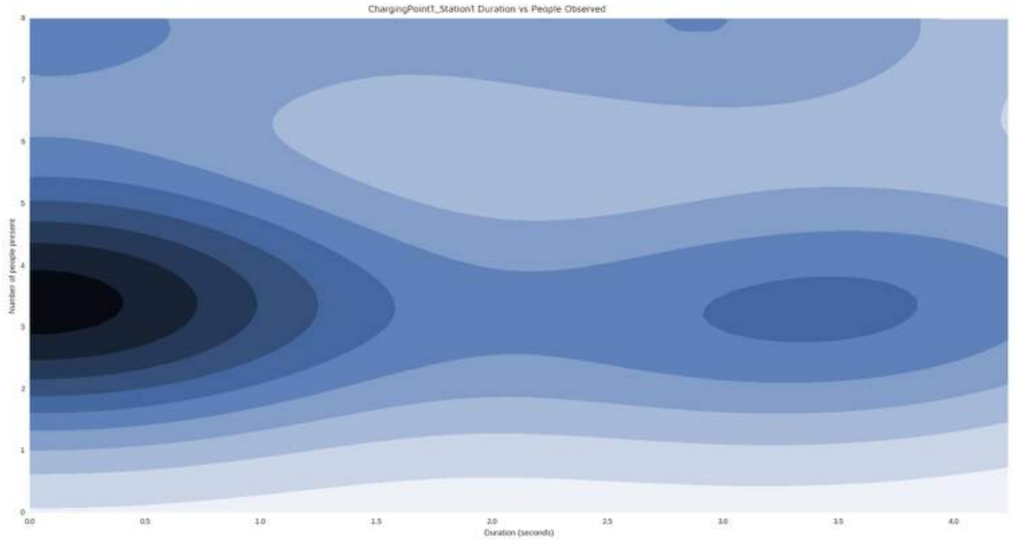
planning world model



Topological Prediction

- With the data, we can build temporal models of:
  - Probability of successful edge traversal
  - Expected time for edge traversal





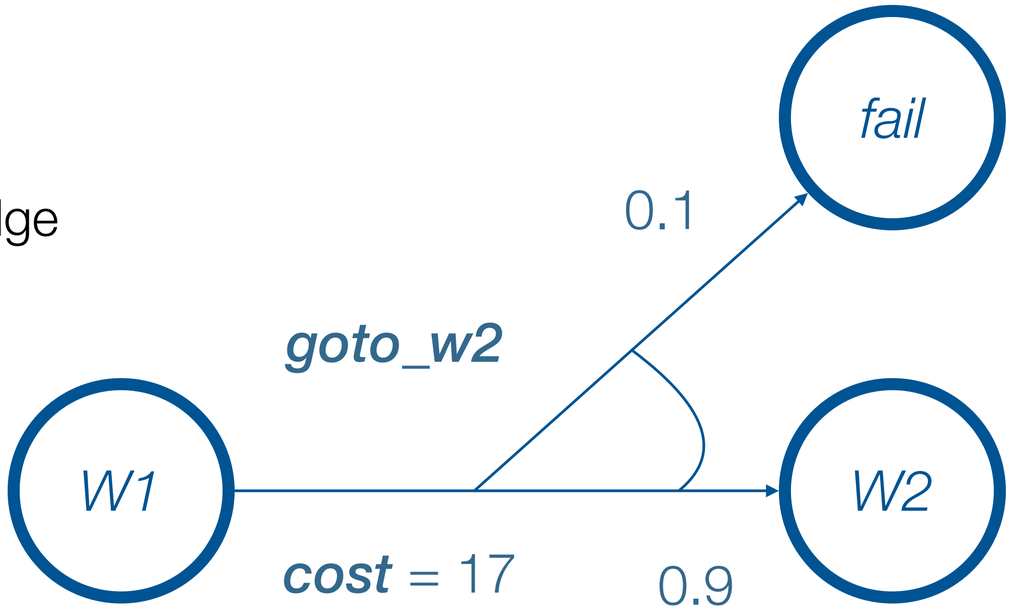
J. Pulido Fentanes, B. Lacerda, T. Krajník, N. Hawes, and M. Hanheide. *Now or later? Predicting and maximising success of navigation actions from long-term experience.* In ICRA, 2015.

MDP Modelling

Navigation Markov Decision Process

- Use a Markov decision process (MDP) to encode the learned probabilistic models

e.g., for a single edge



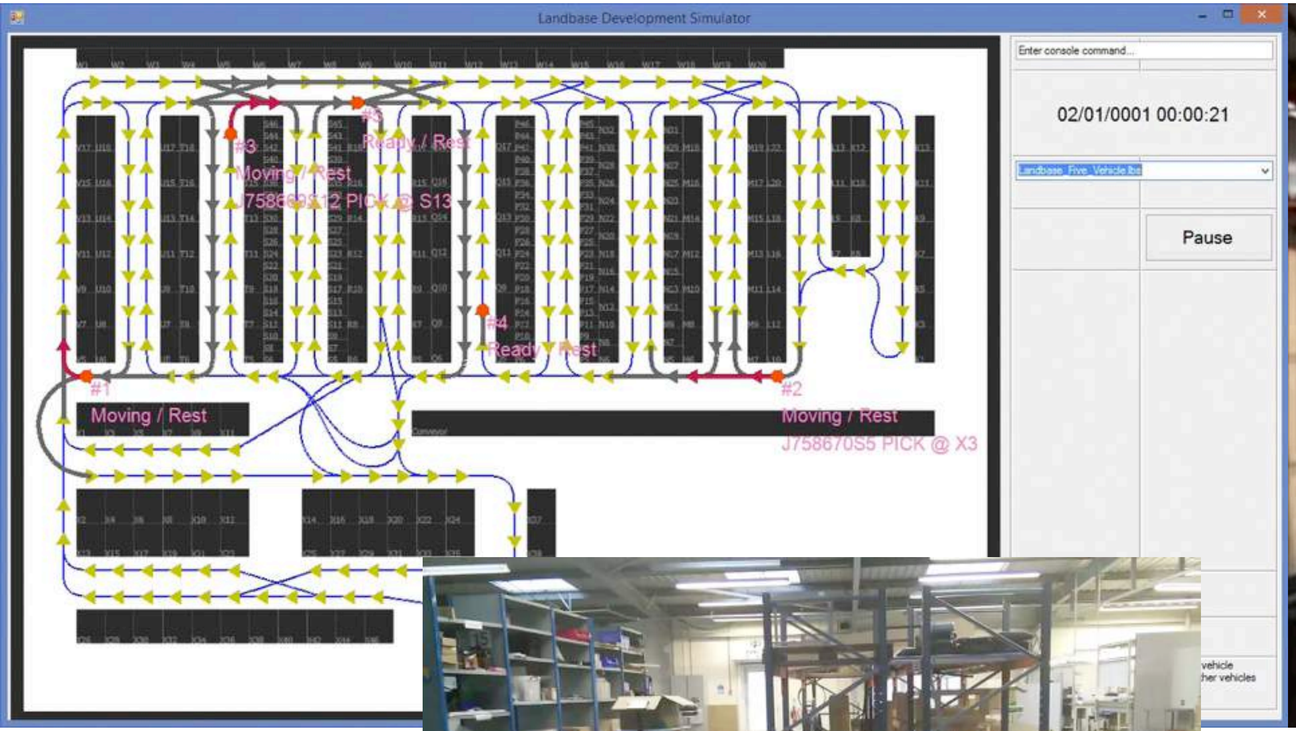
B. Lacerda, D. Parker and N. Hawes. Optimal and Dynamic Planning for Markov Decision Processes with Co-Safe LTL Specifications. In ICRA 2014.

WHCA* with continuous time and kinematics

TSP and greedy item ordering

FIFO job selection

with Guidance automation
operational technologies for smarter working



WHCA* with continuous time and kinematics

TSP and greedy item ordering

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how can we apply long-term learning in logistics?

- planning to avoid workers
- planning to meet workers

this brings in planning under uncertainty which makes MRPF event harder!

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