Mobility and Human Behaviour – Urban Analytics

(Why did we find transmission modelling hard?)

Fred Shone
Technical Lead
Arup City Modelling Lab
fred.shone@arup.com

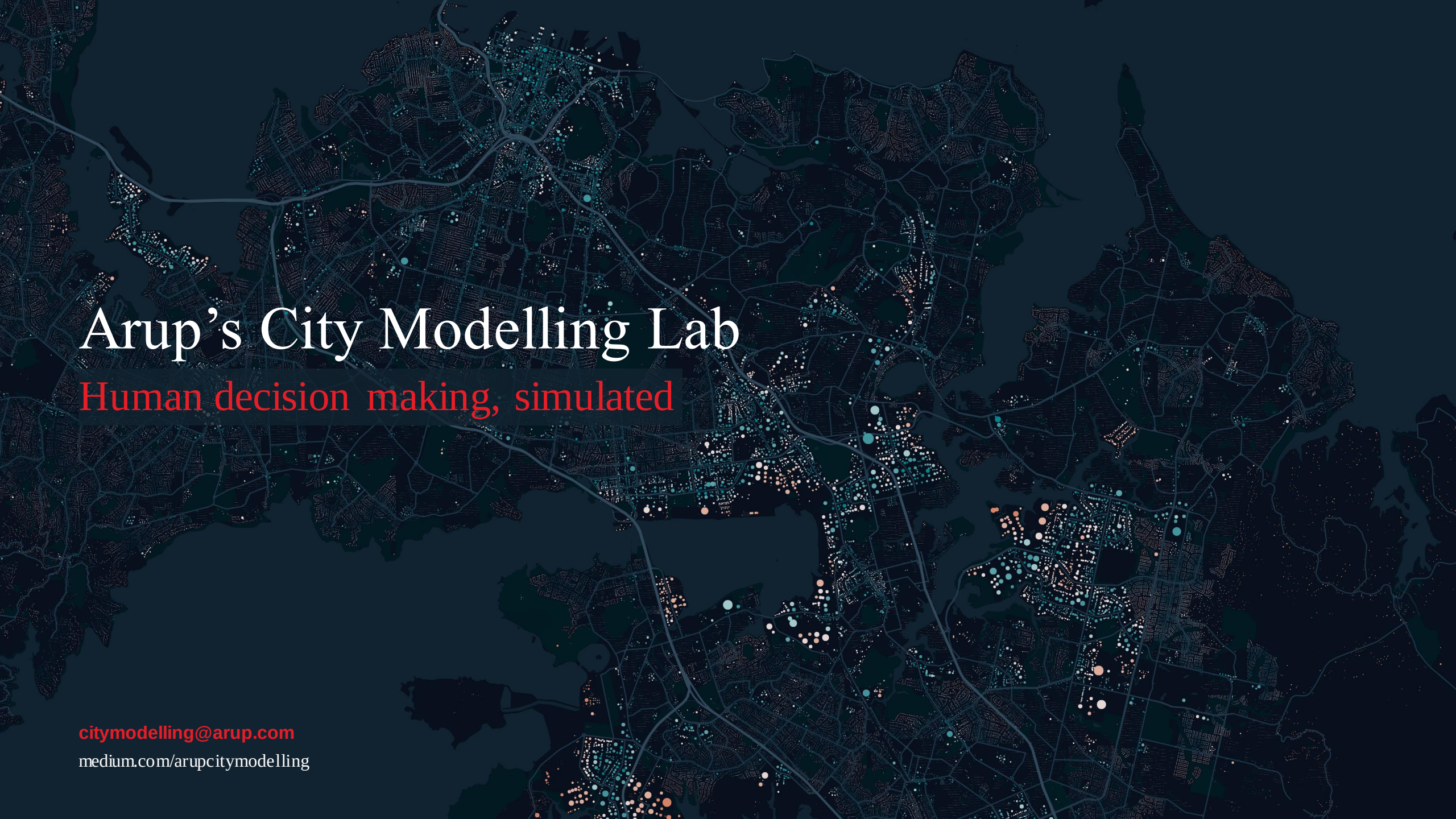
Gerard Casey
Research Lead
Arup City Modelling Lab
gerard.casey@arup.com

Modelling to Support Resilience for Pandemics – Open Questions

ARUP

Contents

- Arup City Modelling Lab (CML)
- The Stack
  - Transport choice model + simulation
  - + virus transmission model
- Challenges
  - Compute
  - Complexity
  - Assurance
  - Calibration
- Conclusions/Assertions
  - PAM - Pandemic Activity Modifier
  - The right questions



Arup’s City Modelling Lab

Human decision making, simulated

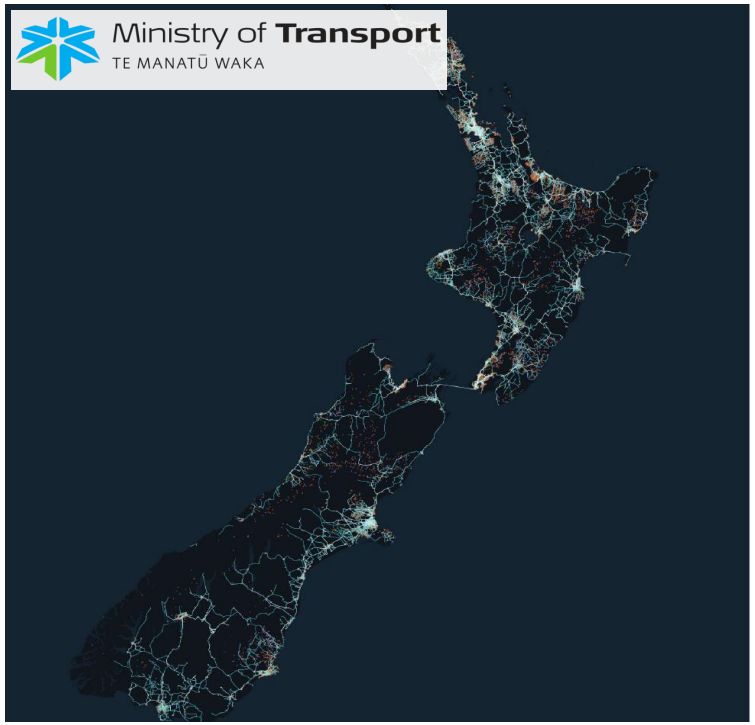
citymodelling@arup.com
medium.com/arupcitymodelling

ARUP

Selected projects

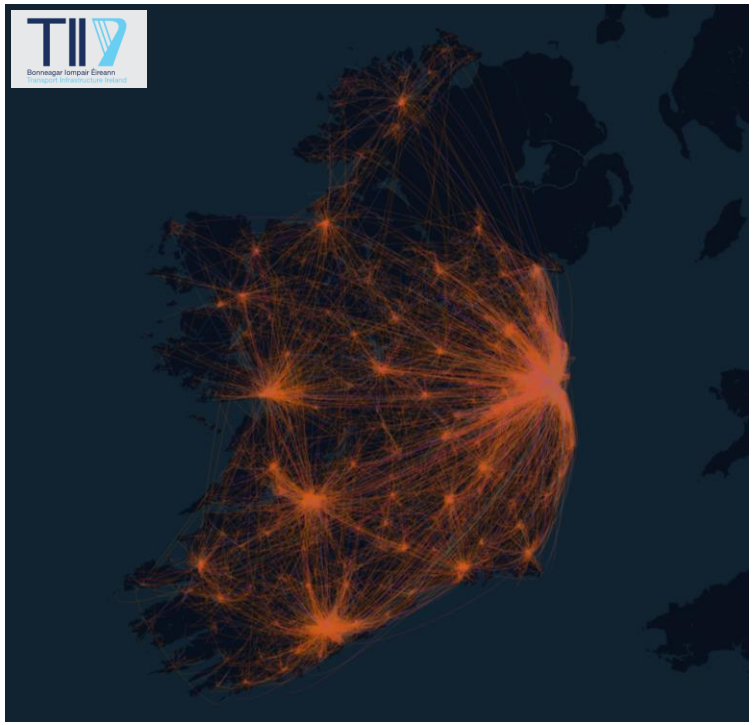
New Zealand Ministry of Transport

Embedded **simulation capabilities** within the Ministry of Transport. Started with a strategy phase followed by an Alpha model build owned by the client team. The models are helping to determine the effects of **road pricing** on congestion.



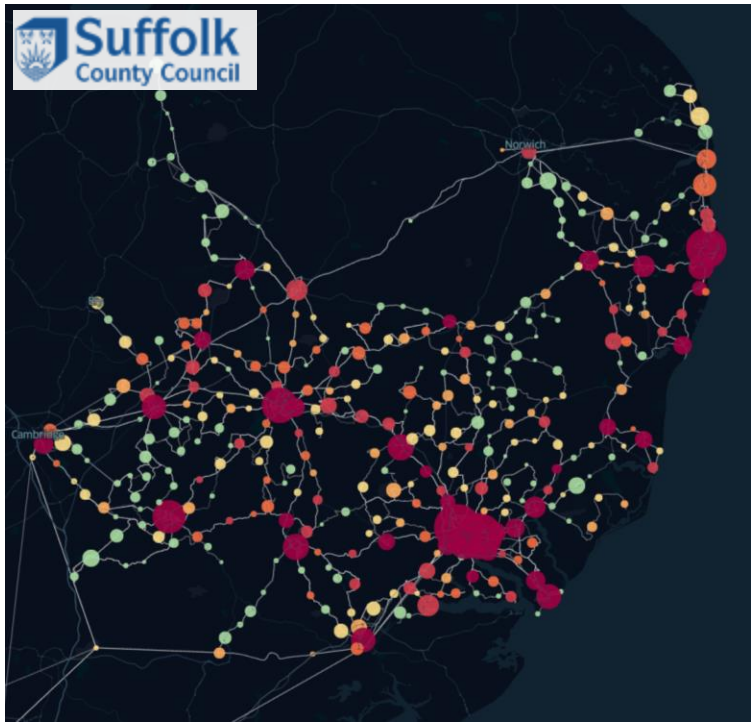
Transport Infrastructure Ireland

Built an Alpha and Beta model to investigate **road pricing** scenarios and how this might help to fund infrastructure in the future. There was a specific focus on **social equity** when considering road pricing schemes.



Suffolk County Council, United Kingdom

Built an Alpha model for the Suffolk region, and ran scenarios to inform their **bus strategy**. Carried out a **carbon assessment** which highlighted that additional bus services don't necessarily equate to lower carbon emissions.



ARUP

Collaborations, partnerships, and clients

We have strong partnerships to progress R&D and foster innovation across the industry

We have set up a **research partnership** with UCL to bridge the gap between client needs and academic research.

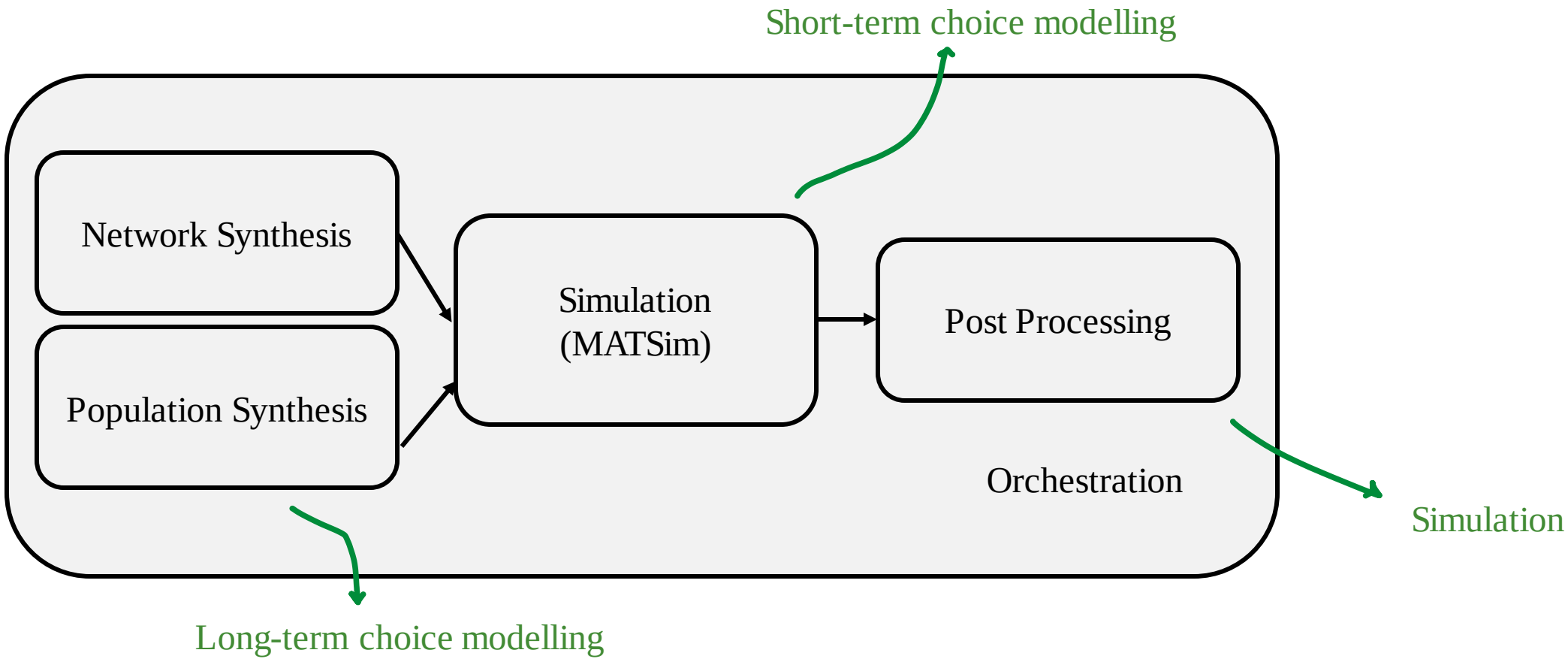
There is a growing international **community** engaging with us and discussing how this simulation capability can be leveraged.

We have carried out **client projects** globally.

ARUP

Components

What did we do? (transport models/simulations)

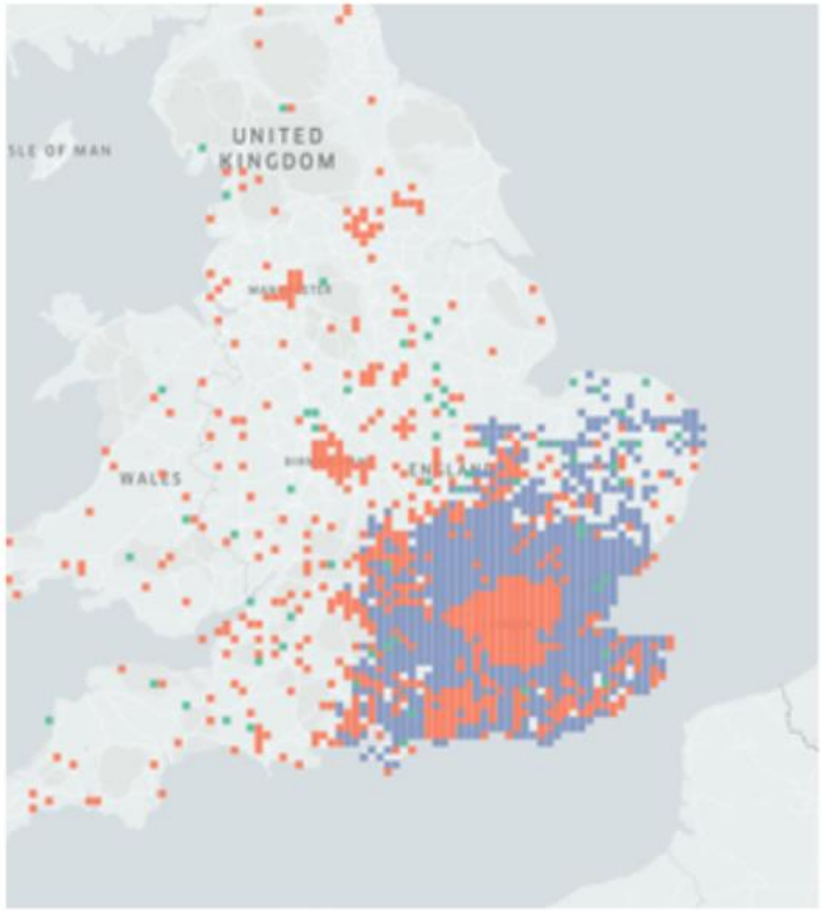


https://www.matsim.org/

ARUP

Components

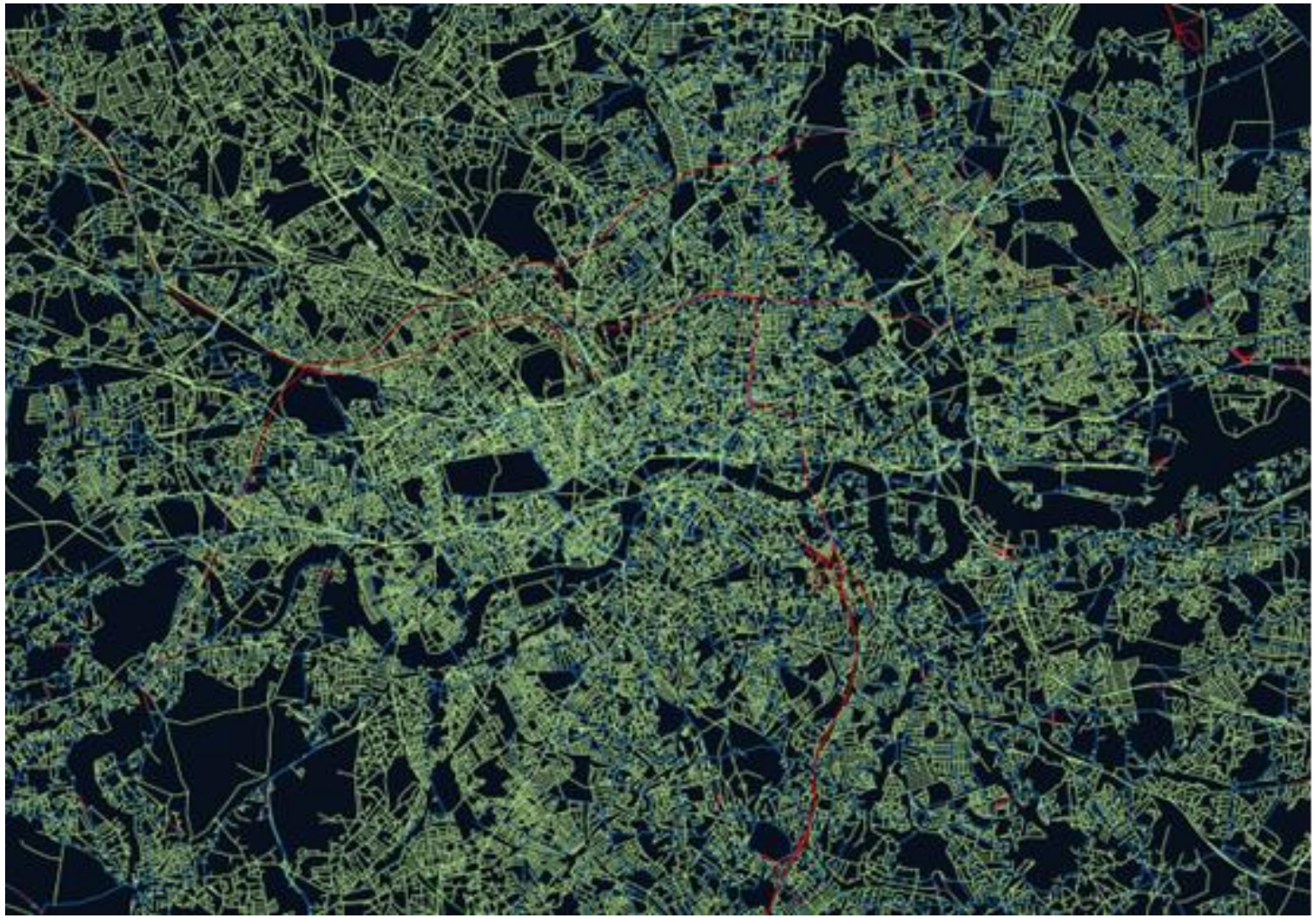
London



ARUP

Components

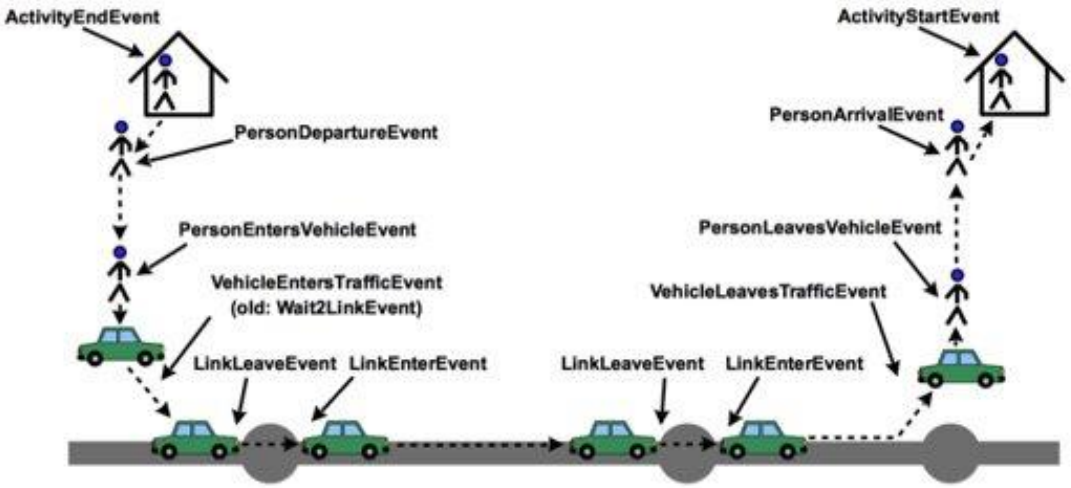
London

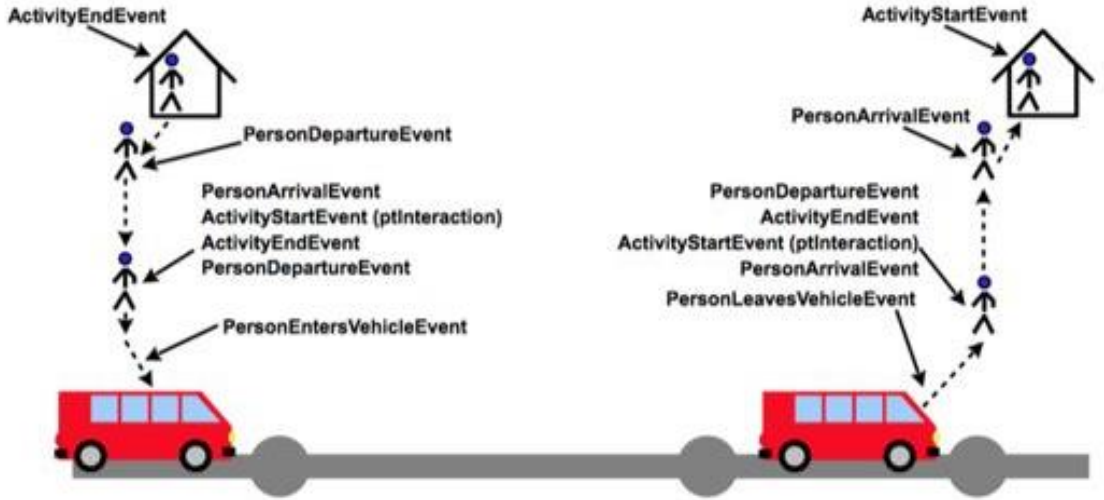


ARUP

Components

Output Events





https://www.matsim.org/

ARUP

Components

What did we do? (transport models/simulations)

- *Choice modelling*
  - *Where do people live/with who/do they own a car etc...*
  - *Where do people/work/shop/leisure etc...*
  - *When do people travel/how long do they spend at work etc...*
  - *How do people travel/which modes/what routes...*
- *Simulation*
  - *Where/when/who*

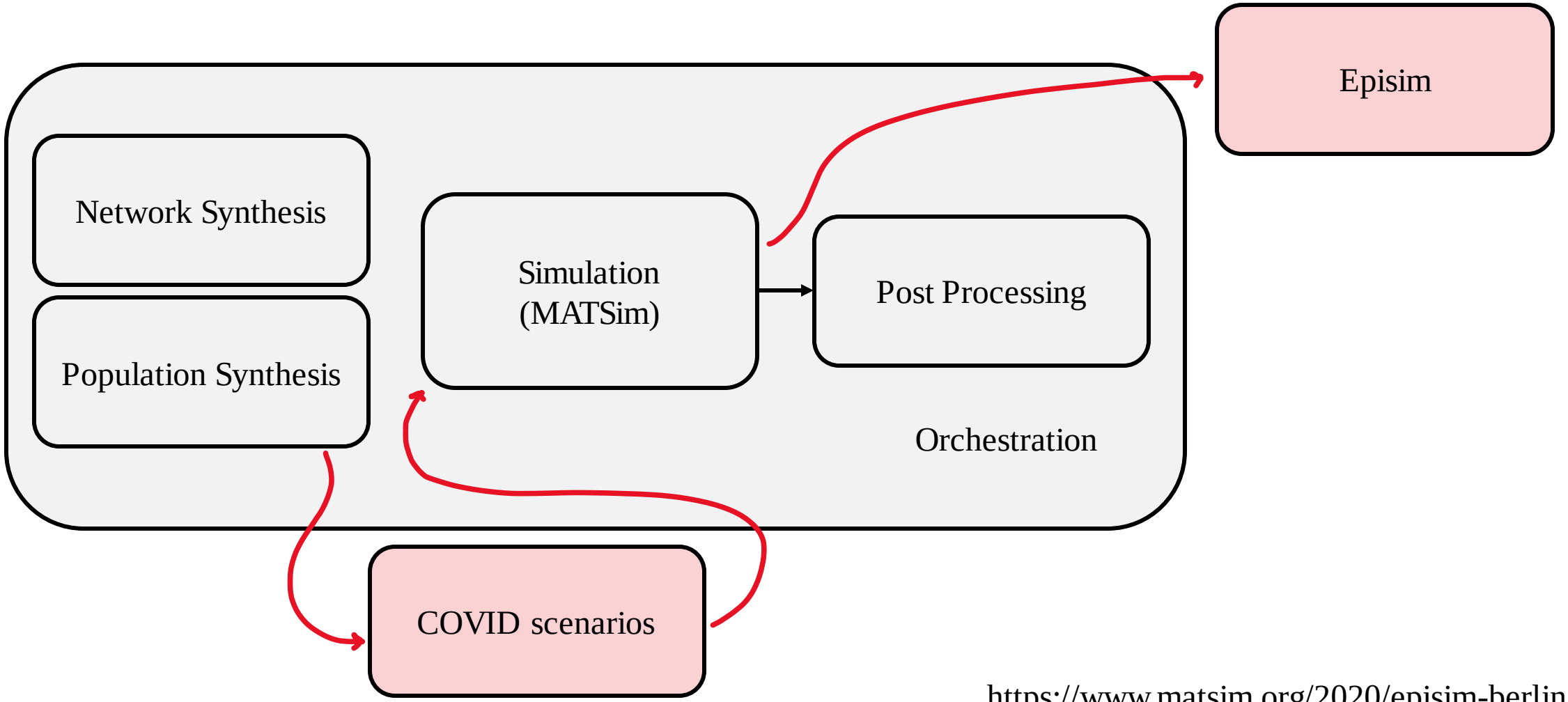
+ Transmission risk

  - Who?
  - Where? (areas/places/lines/vehicles)
  - When?
  - Transport scenarios not so much 'policy' scenarios

ARUP

Components

What did we do?

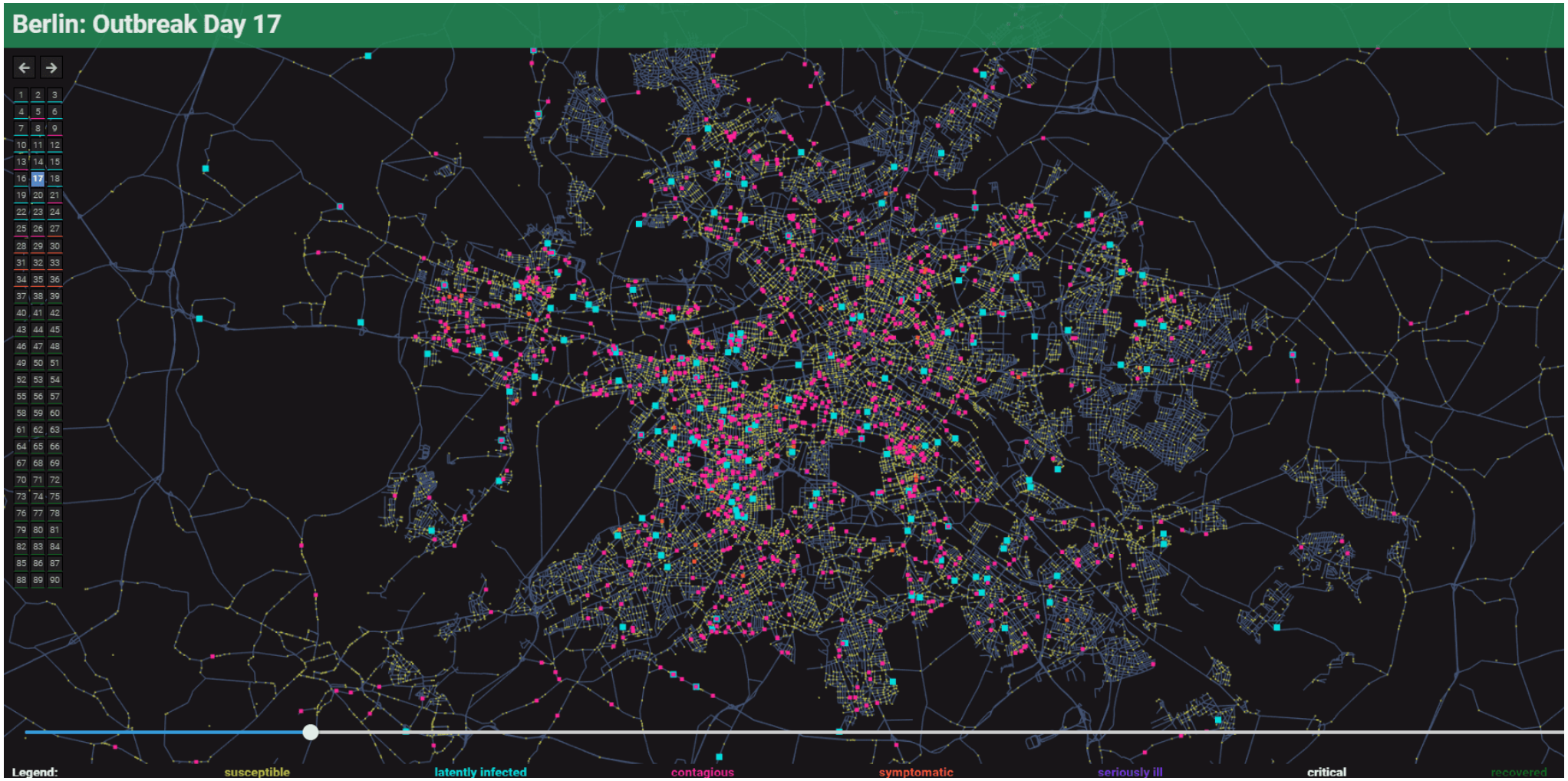


https://www.matsim.org/2020/episim-berlin

ARUP

Components

What did we do?

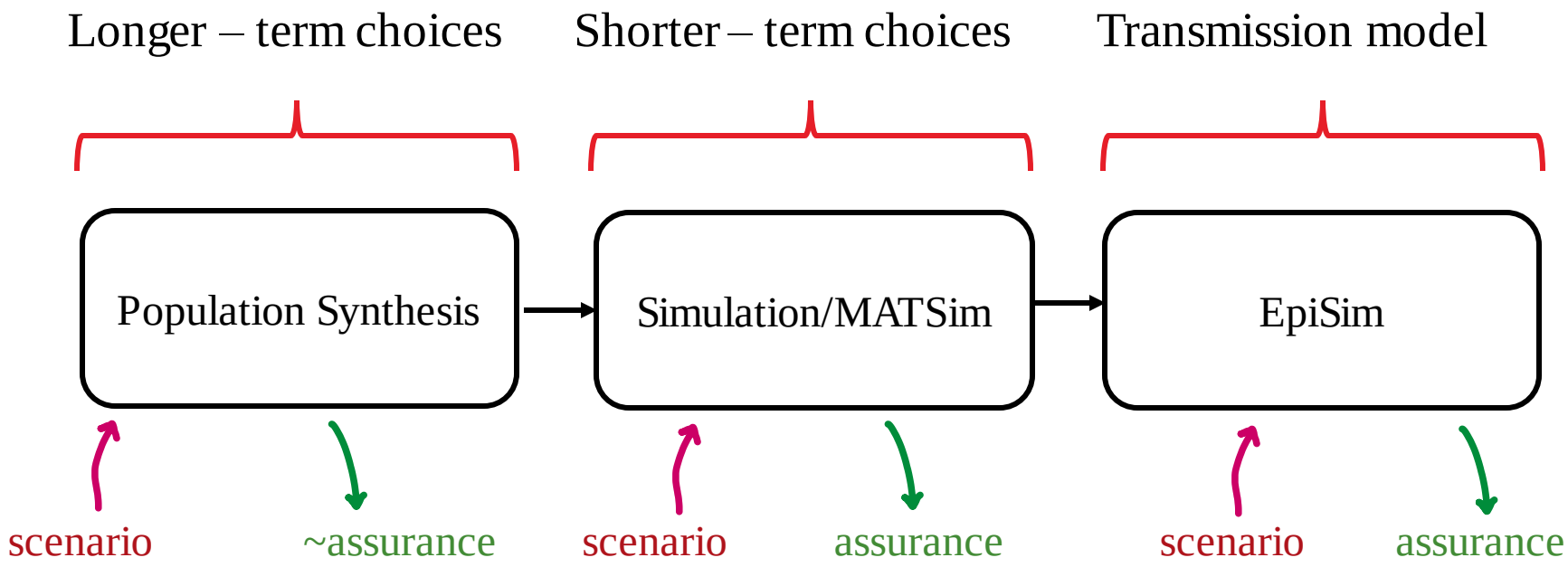


https://www.matsim.org/2020/episim-berlin

ARUP

Components

What do we do? - as a choice model



ARUP

Challenges

Compute

- "ABMs are slow"
  - Not really
  - If you have the right tools
    - Big computers & parallelised scenarios
    - Staged calibration (no feedback)
    - Focus should more often be on using them faster not running them faster

ARUP

Challenges

Complexity

- "ABMs are too complex/random"
  - Complexity + uncertainty = unstable outputs?
    - Not so much for MATSim
    - Yes for Episim – you have to run it a lot
  - Make uncertainty exogenous
    - "Forecast" → "scenario"
    - "Model" → "modify"
    - (pam)
  - Complexity makes some bits easier (never mind better)
    - Assurance
    - Flexibility

ARUP

Challenges

Assurance & Flexibility

- "It's hard to validate an ABM"
  - More sources of validation data
  - Looks right
    - Too many people at this train station
    - Bus is too slow
    - This person is stuck
  - "Look at all these moving dots" - persuasive
  - "Good code"
    - Behave like computer engineers
    - Open
    - Build components not scripts/stacks
- Flexibility

ARUP

Challenges

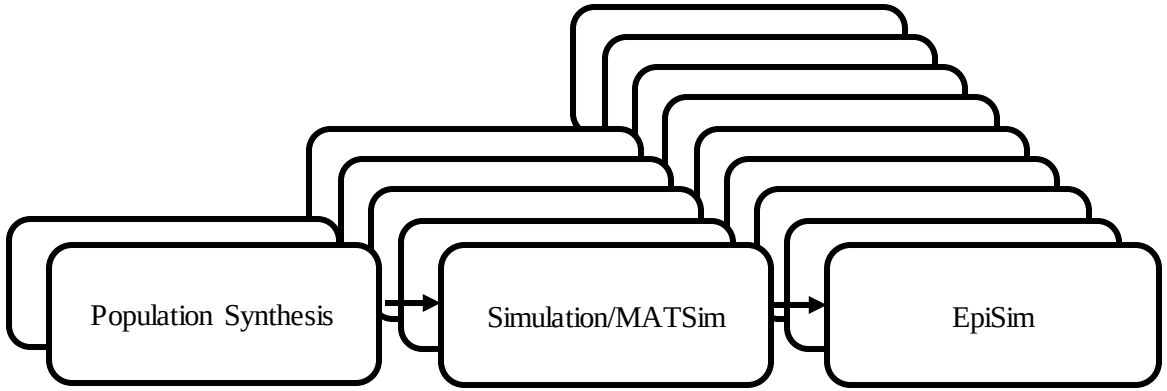
Calibration

- "It's hard to calibrate an ABM"
  - Yes it is
  - Most research seems to point at some trade-off with the simulation
  - Approach
    - Compartmentalise/sequentially calibrate & validate
    - Restrict unknowns
      - Realistic simulation > abstraction
      - "Scenarios"
      - Be fast
        - Stability / low unknowns / build fast
        - Instability / lot's of unknowns / run fast

ARUP

Challenges

Different Approaches



No data
Unstable
Slow

Scenarios

Seems stable
Complexity helpful?

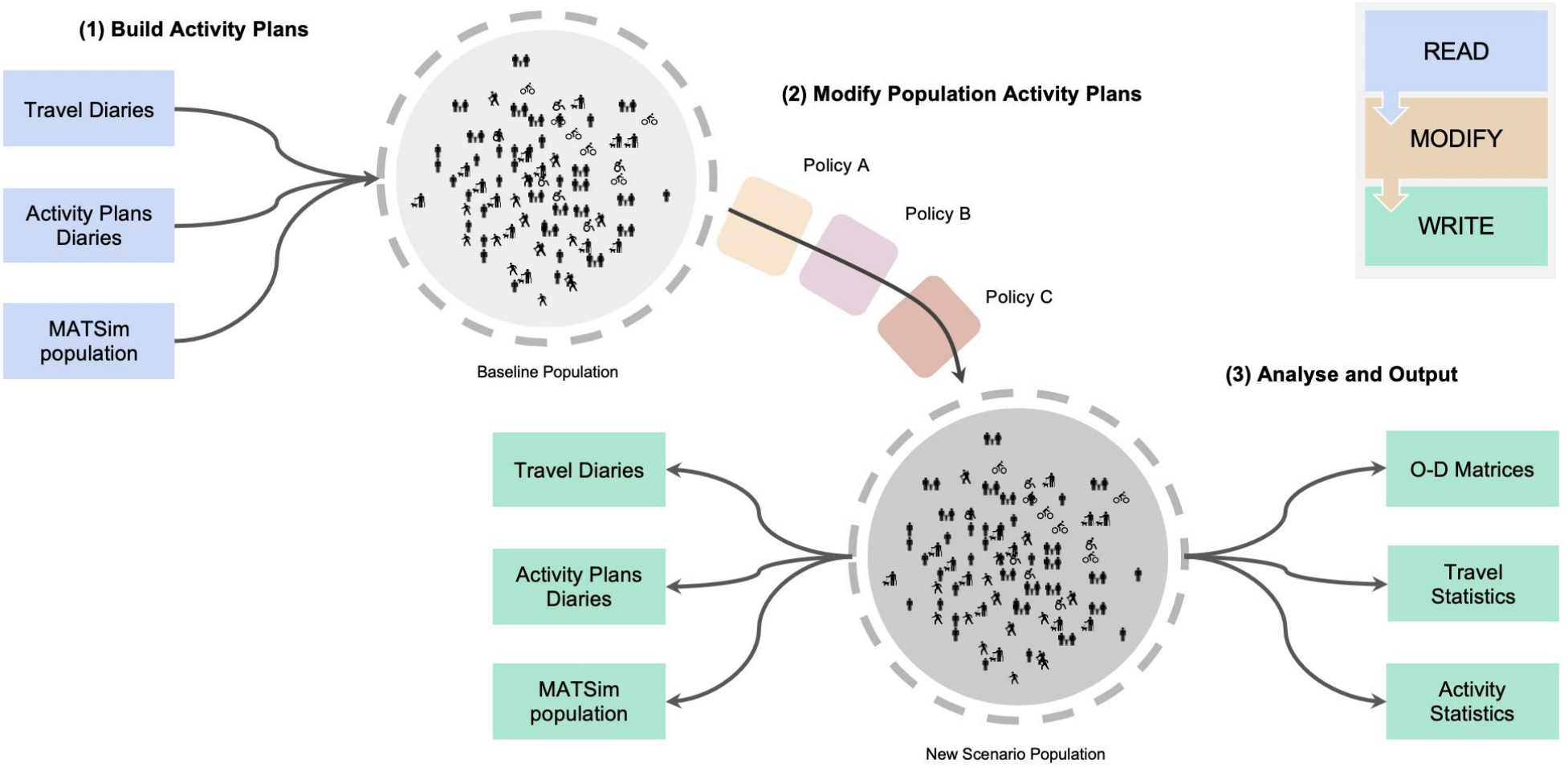
Add complexity
Build faster

Very unstable
Unknown variables

Run fast

ARUP

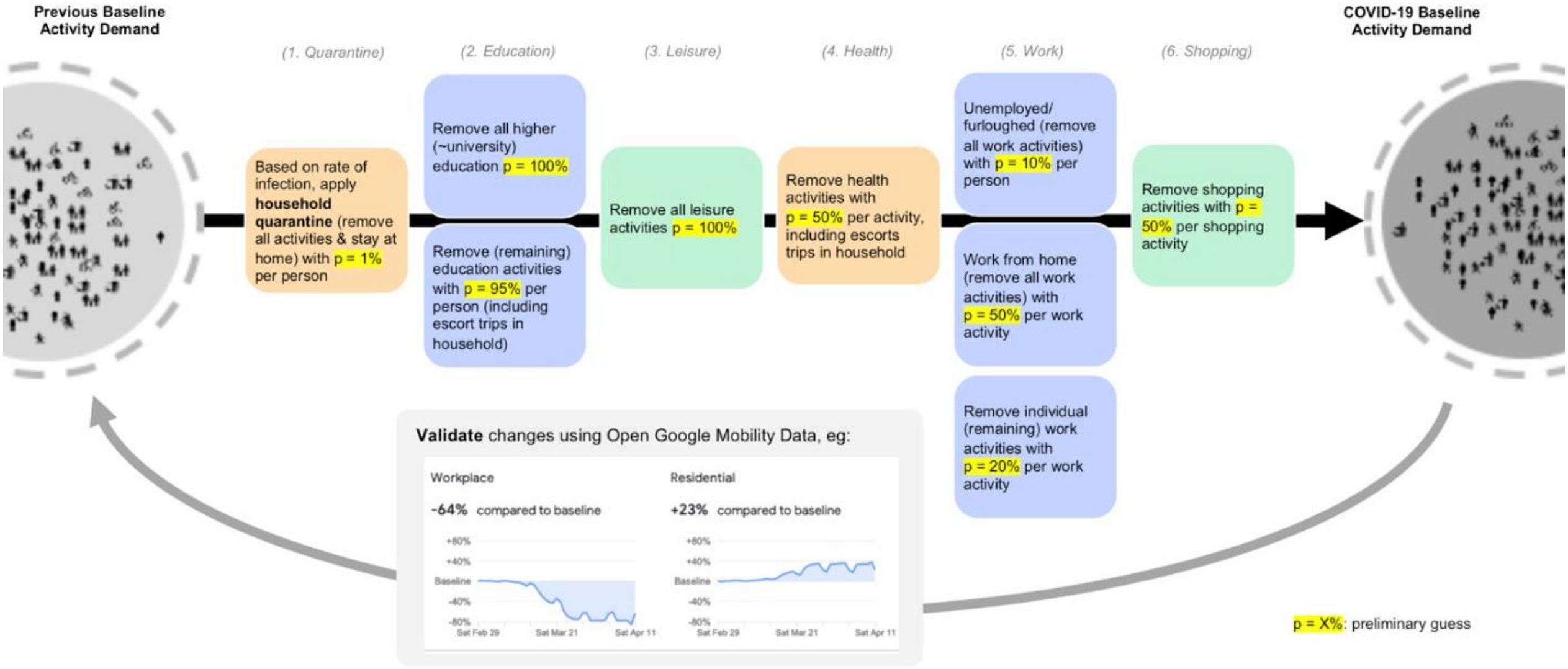
PAM



https://github.com/arup-group/pam

ARUP

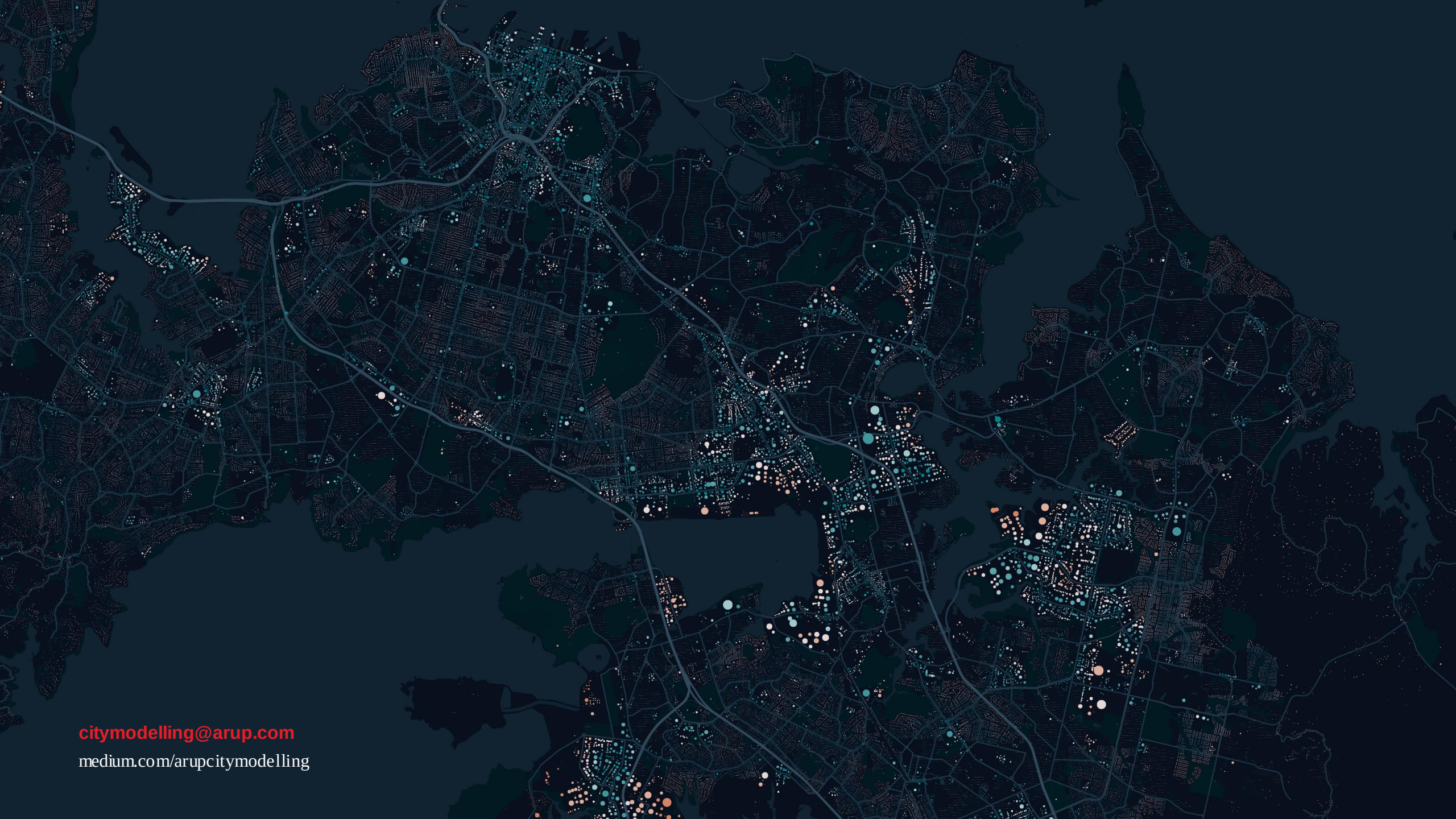
PAM


Previous Baseline Activity Demand
(1. Quarantine)
Based on rate of infection, apply household quarantine (remove all activities & stay at home) with p = 1% per person
(2. Education)
Remove all higher (~university) education p = 100%
Remove (remaining) education activities with p = 95% per person (including escort trips in household)
(3. Leisure)
Remove all leisure activities p = 100%
(4. Health)
Remove health activities with p = 50% per activity, including escorts trips in household
(5. Work)
Unemployed/ furloughed (remove all work activities) with p = 10% per person
Work from home (remove all work activities) with p = 50% per work activity
Remove individual (remaining) work activities with p = 20% per work activity
(6. Shopping)
Remove shopping activities with p = 50% per shopping activity
COVID-19 Baseline Activity Demand
Validate changes using Open Google Mobility Data, eg:
Workplace
-64% compared to baseline
+80%
+40%
Baseline
-40%
-80%
Sat Feb 29
Sat Mar 21
Sat Apr 11
Residential
+23% compared to baseline
+80%
+40%
Baseline
-40%
-80%
Sat Feb 29
Sat Mar 21
Sat Apr 11
p = X%: preliminary guess

ARUP

Answer the right questions

- Which routes do the most connected people use most?
- What times are busiest?
- If I shut schools/work-places/Pret, who will be affected?
- If I shut this station do people walk or get the bus?
- If I operate a more frequent tube do people become less connected?



citymodelling@arup.com
medium.com/arupcitymodelling