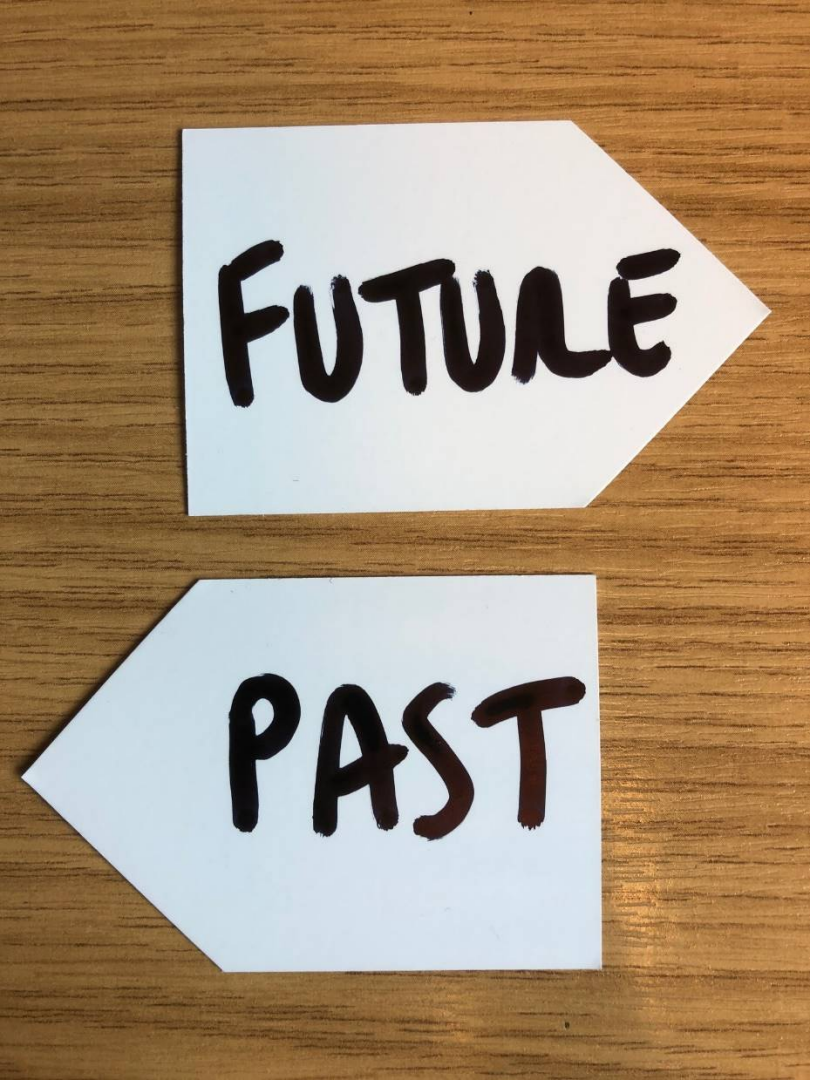


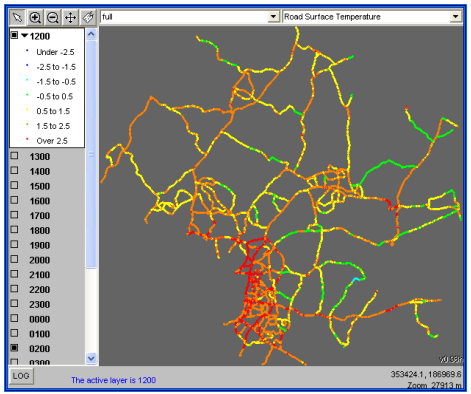
Network Design Considerations for High Resolution RWIS

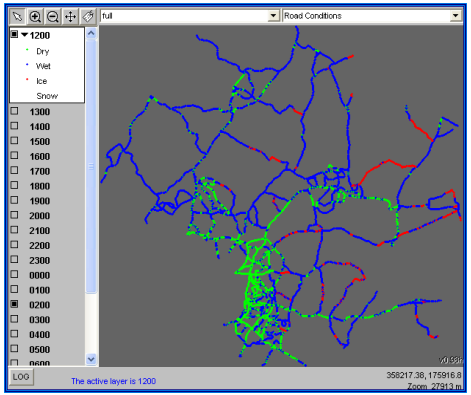
Lee Chapman
Professor of Climate Resilience
University of Birmingham, UK
l.chapman@bham.ac.uk

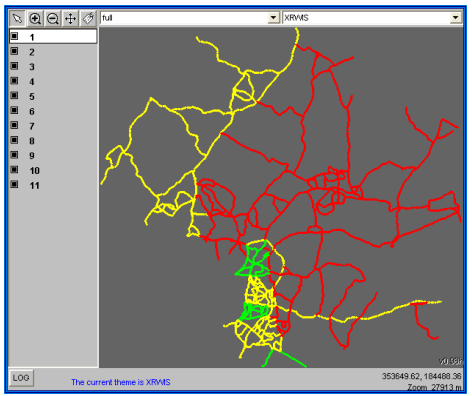
Route-based forecasting

- Now a standard technique used in many countries
- A large step forward from domain forecasts enabling decisions to be taken on a route basis…
- …or even finer resolution – selective salting

- Verification was easy for domain forecasts
  - 1 forecast per road weather outstation
- How do you verify a road weather forecast?
  - 1000's of forecasts across the network!







Selective Salting

- Selective salting is still not happening

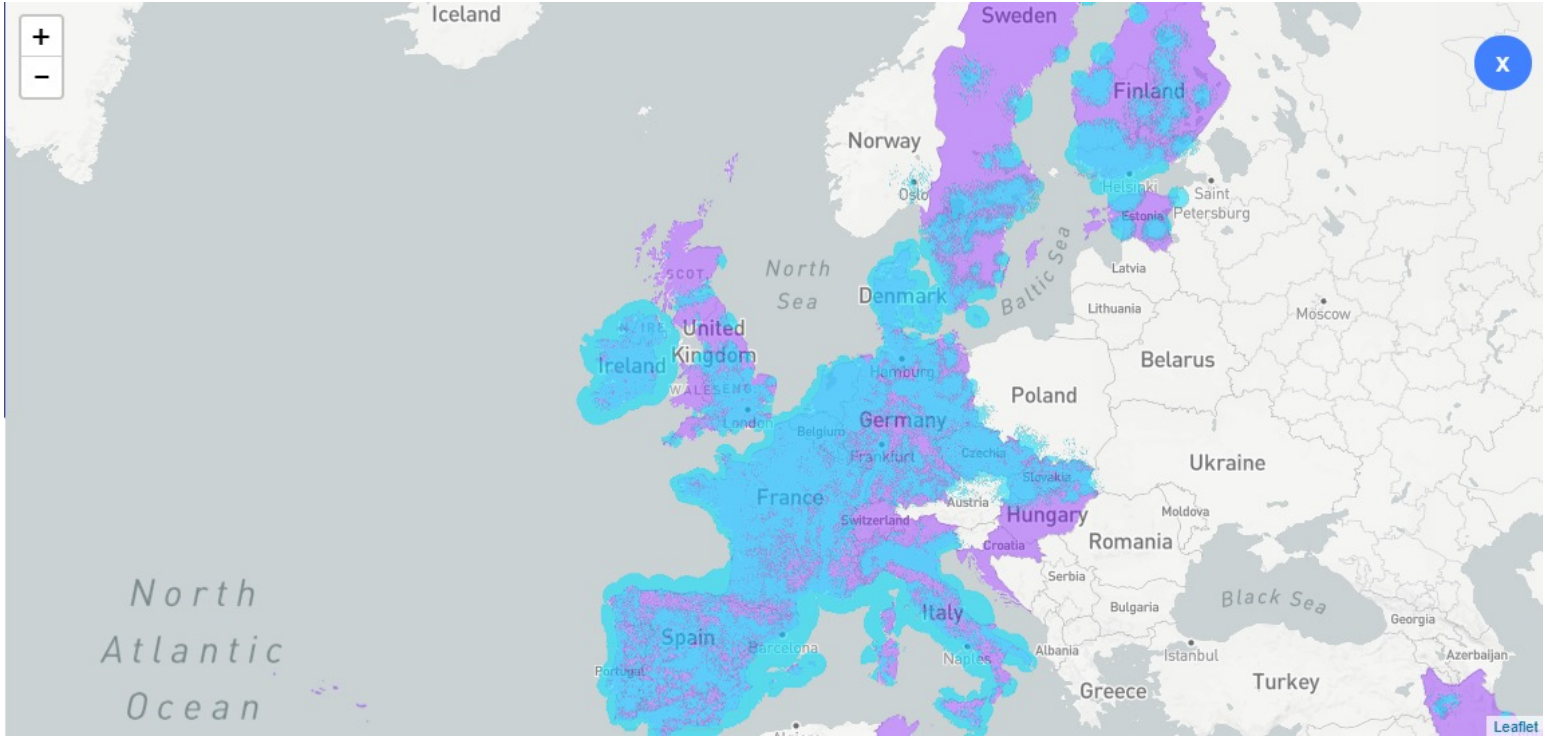
- In an age of litigation, users are very wary about relying on model output to this level.
- Hence, a lack of sufficient technologies to verify / supplement route based forecasts is a big problem:
  - Thermal mapping = good spatial resolution, but poor temporal resolution
  - Outstations = good temporal resolution but very site specific
- How do you verify a route based forecast?

- Solve the verification problem and the savings and potential of all these approaches becomes unlocked:
  - Route based forecasting
  - Selective Salting
  - Dynamic Routing

The ‘wintersensor’

- An ‘Internet of Things’ approach
- Based on an Infrared Thermopile
  - 5° Field of View
  - Range of -40 to 125°C
- Powered Lithium batteries for full season coverage+
- Wide range of communication options:
  - Standard IEEE 802.11 b/g/n 2.4 GHz WiFi (available via mesh / local hotspots)
  - New generation wide area networks (all major cities now covered)
- Completely self contained – put on a lighting column and get real-time data instantly

- A low-cost option that has the potential to be deployed at the same resolution as a route based forecast

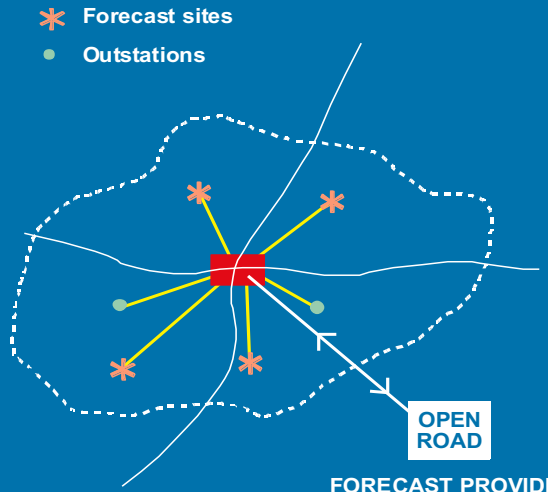


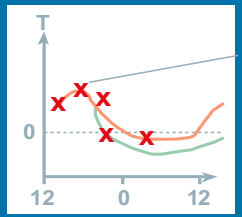
UNIVERSITY OF BIRMINGHAM

If the equipment needed to make a measurement of road surface temperature costed hundreds of euros as opposed to thousands, how many sites would you want?

Currently…

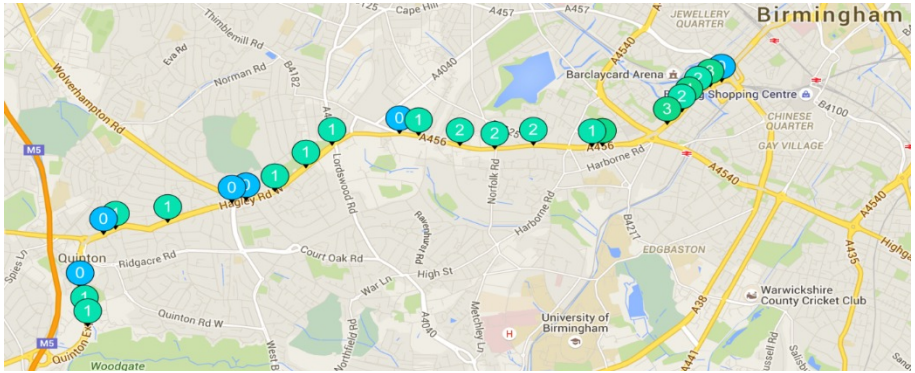
Ⓑ 1986 ICE PREDICTION

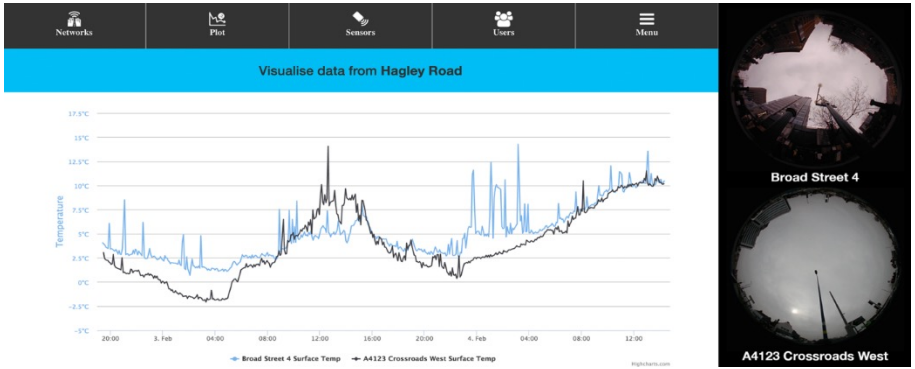




Forecast
Thermal Maps

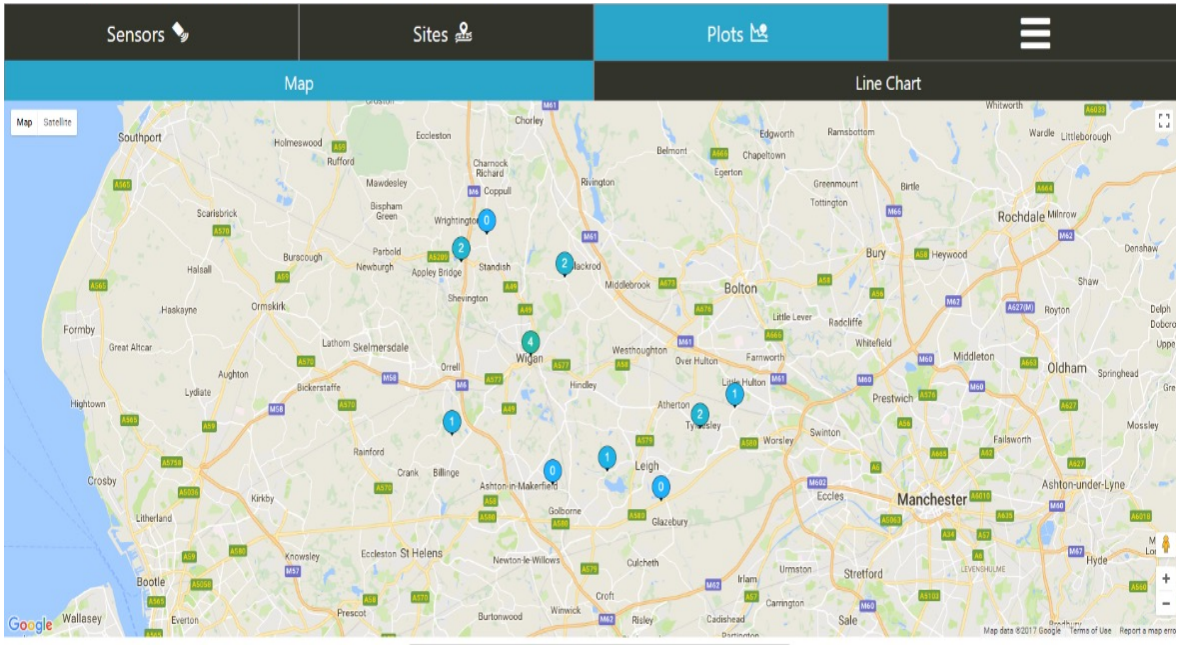
A: Same resolution as a Route Based Forecast?





UNIVERSITY OF BIRMINGHAM

B: One sensor per route?



C: Or something in between?

An early UK perspective

- Option B is proving popular
- Provides a good opportunity to achieve benefits from route based forecasting
  - Selective salting at the route scale
- But… where do you actually locate the sensor?
- Domain forecasts in the UK are usually based on road weather outstations located in 'representative locations'
  - Not the same across the world = cold spots.
- To maximise value of route level decisions, it makes sense to adopt the cold spot approach.
- Best practice of most use to weather service providers could be 2 sensors per route:
  - 1 located in coldest spot
  - 1 located at a representative location
  - Other at other key localities (i.e. bridges)
- This would complement existing RWIS outstation infrastructure

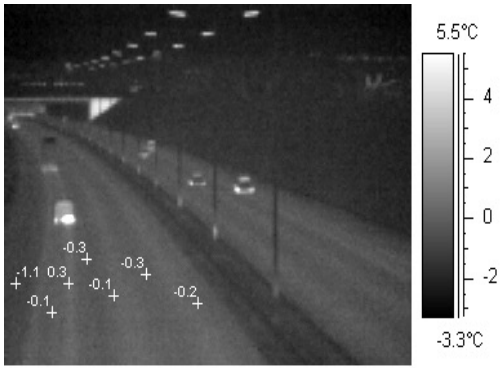
Is thinking constrained by existing RWIS outstations?

What would a RWIS designed from a blank sheet of paper look like?

Other considerations

- Mobile sensing
- Semi-mobile sensing
  - IoT sensors can easily be moved unlike embedded sensors
- Opportunistic sensing
- All put downward pressure on the number of traditional sites needed

- Thinking not constrained to route level
  - High resolution deployments at strategic sections (i.e. bridge decks)
  - Cross profile instrumentation (multi-laned roads)

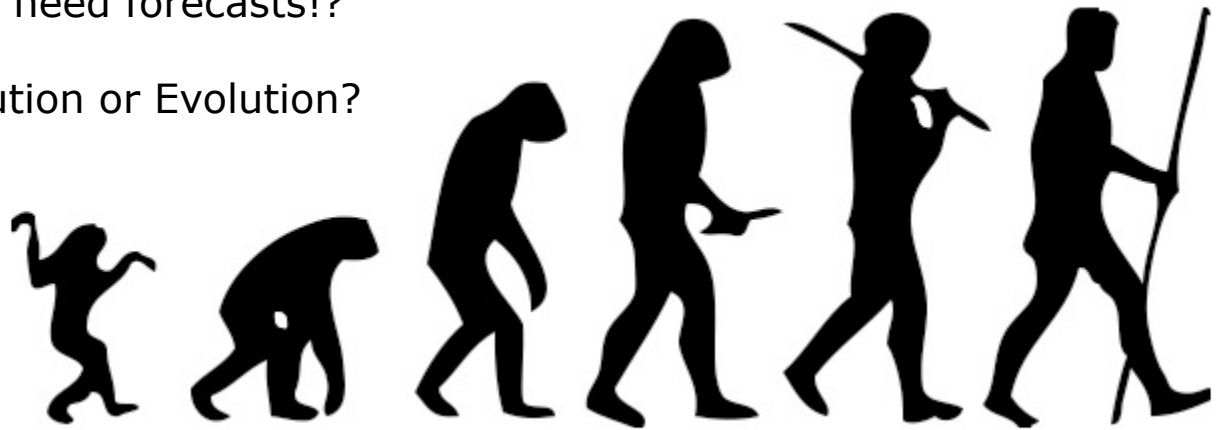


Conclusions

- RWIS equipment just got low-cost
- Myriad of available options to get data

- A real opportunity to think outside the box
- What do we really need?
- What do forecasts need?
- Do we need forecasts!?

- Revolution or Evolution?



Chapman, L. and S.J. Bell, 0: High-Resolution Monitoring of Weather Impacts on Infrastructure Networks using the Internet of Things. *Bull. Amer. Meteor. Soc.*, **0**,https://doi.org/10.1175/BAMS-D-17-0214.1