Integration of cross-disciplinary project outputs

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On behalf of the R Futures project team

Resilient Futures final project workshop – Friday 31st May 2013

Engineering the demonstrator

Resilient Futures

- A tool for exploring resilience across sectors
- Draws together outputs from whole project team
- Version used today is one possible incarnation
- Scenario and episode development provides the structuring narrative
- Two other research strands of project have provided expertise
  - Abstract modelling of interconnected networks
  - Human factors and grassroots engagement activities

Implications of infrastructure interdependency for resilience: Lessons from modelling

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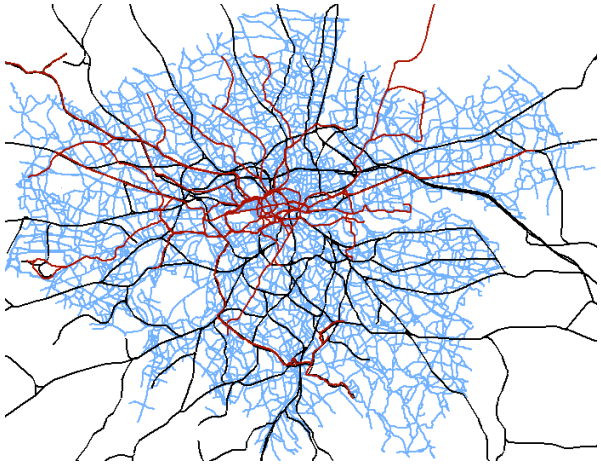
Overview

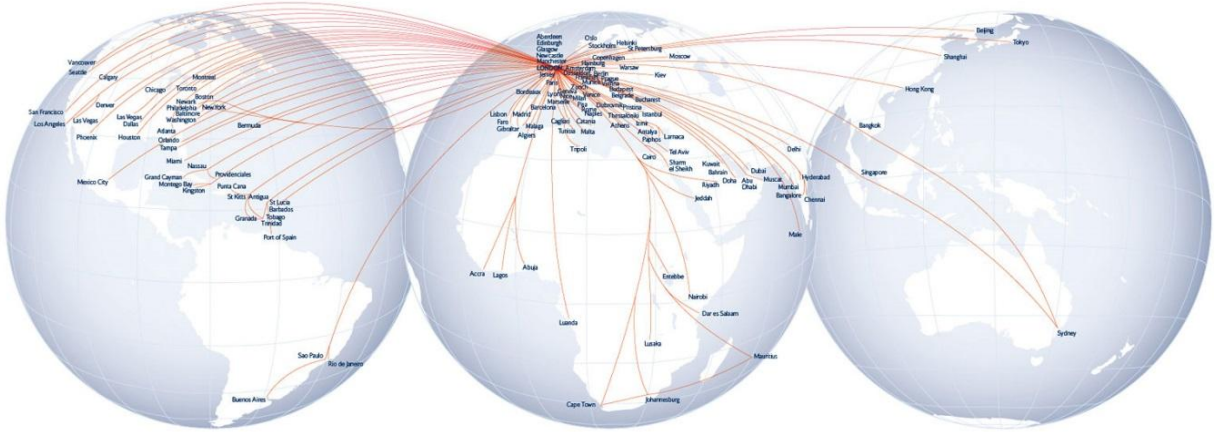
Resilient Futures

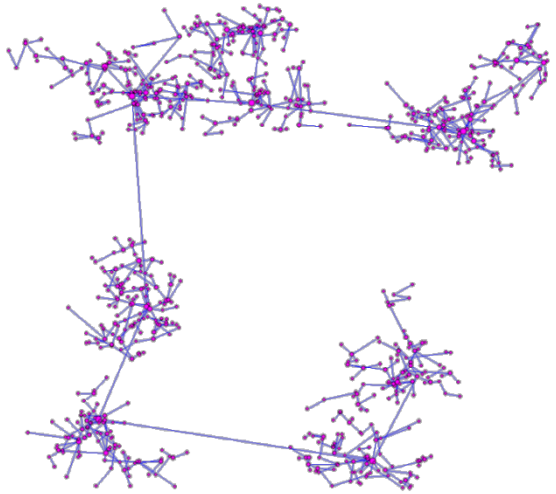
- Introduce reduced complexity model
- Explore influence of interdependency properties on ‘network of network’ performance during failure conditions
- Test the effectiveness of adaptation options to enhance ‘network of network’ resilience

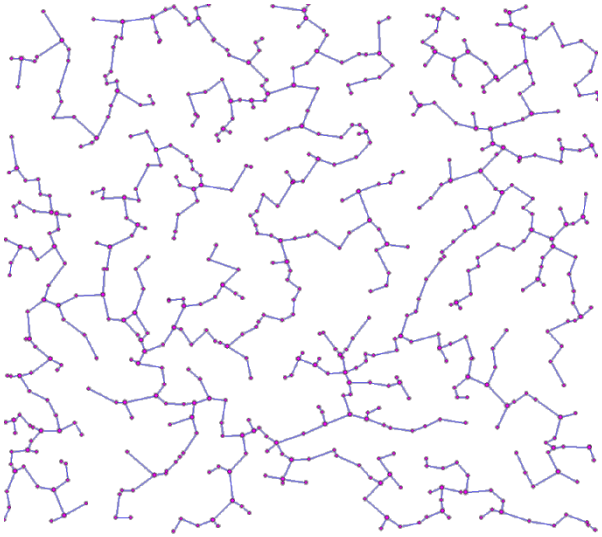
Vulnerability of single networks

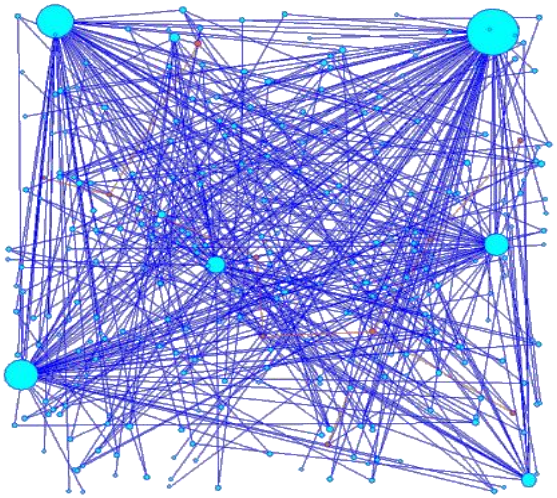
Resilient Futures











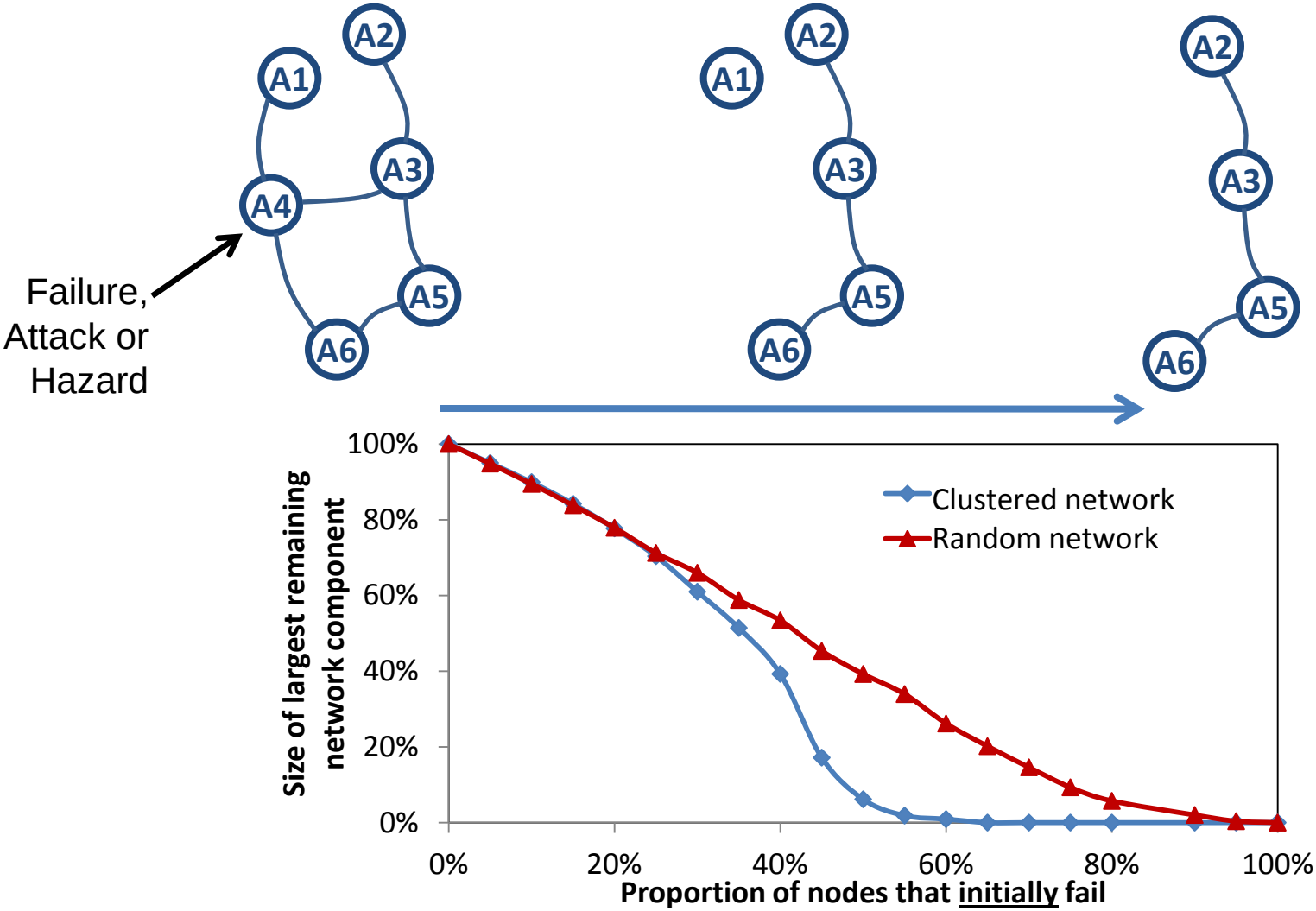
A network with spatial clusters

A decentralised network with nodes uniformly distributed

A highly centralised network

Vulnerability of single networks

Starting with some simple assumptions about failure…



Interdependent networks

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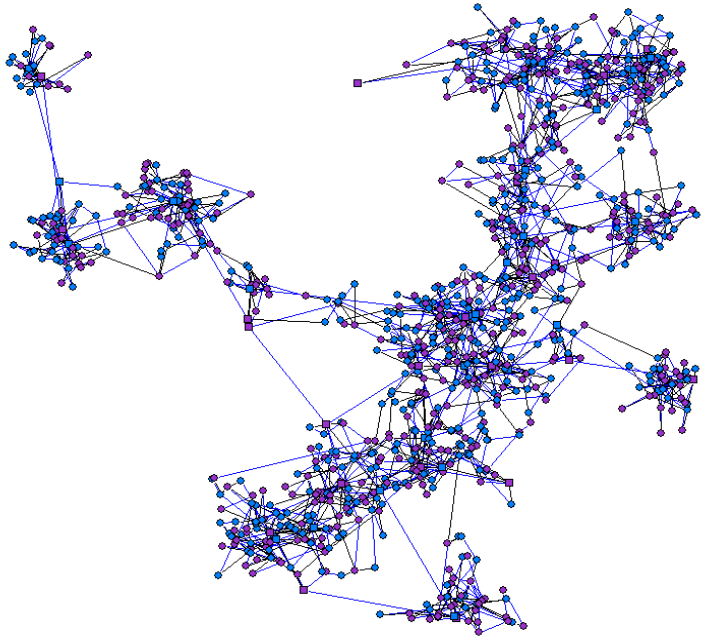
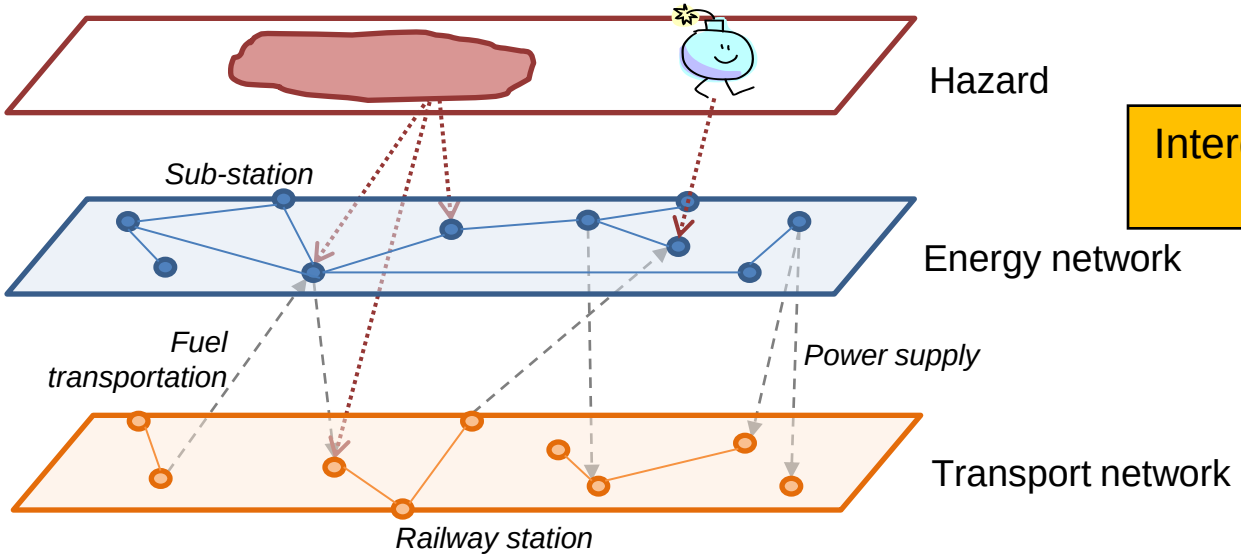
Interdependencies related to a number of factors:

- Geography
- Demand for network service
- Resource supply (e.g. gas, water, wind)
- Costs (e.g. capital, operational)
- Performance (e.g. efficiency, robustness)

etc.



Interdependencies between networks driven by proximity



Interdependent networks

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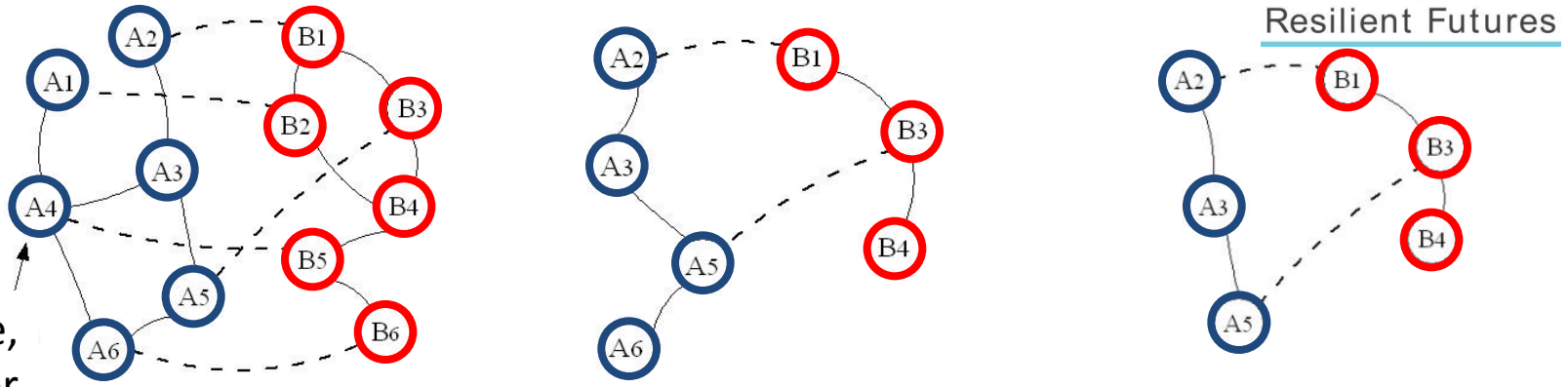
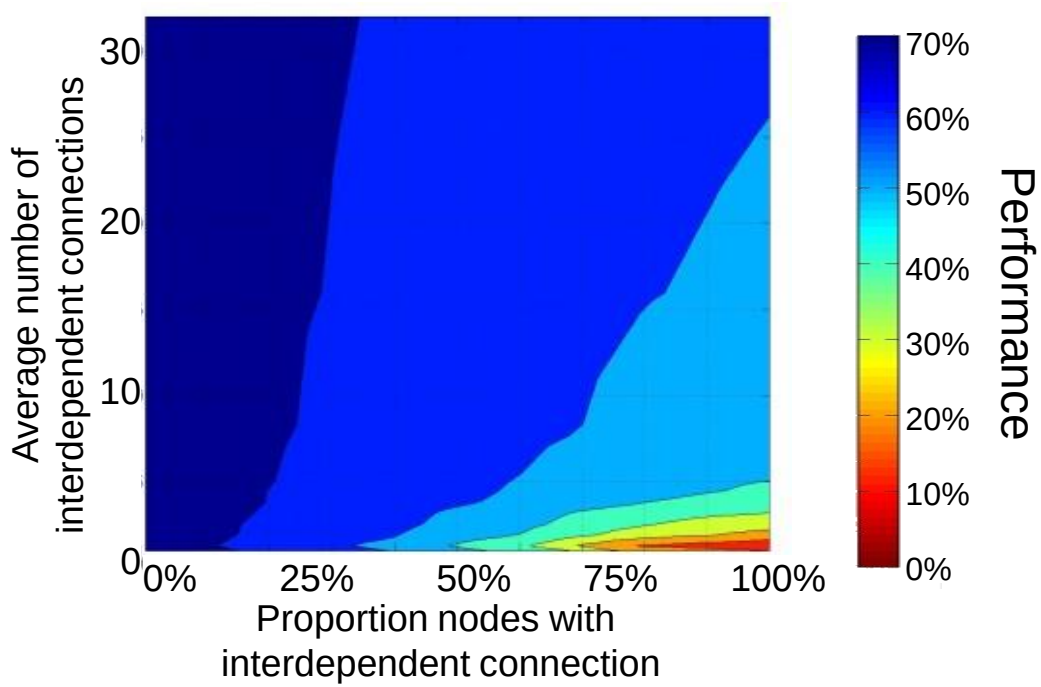
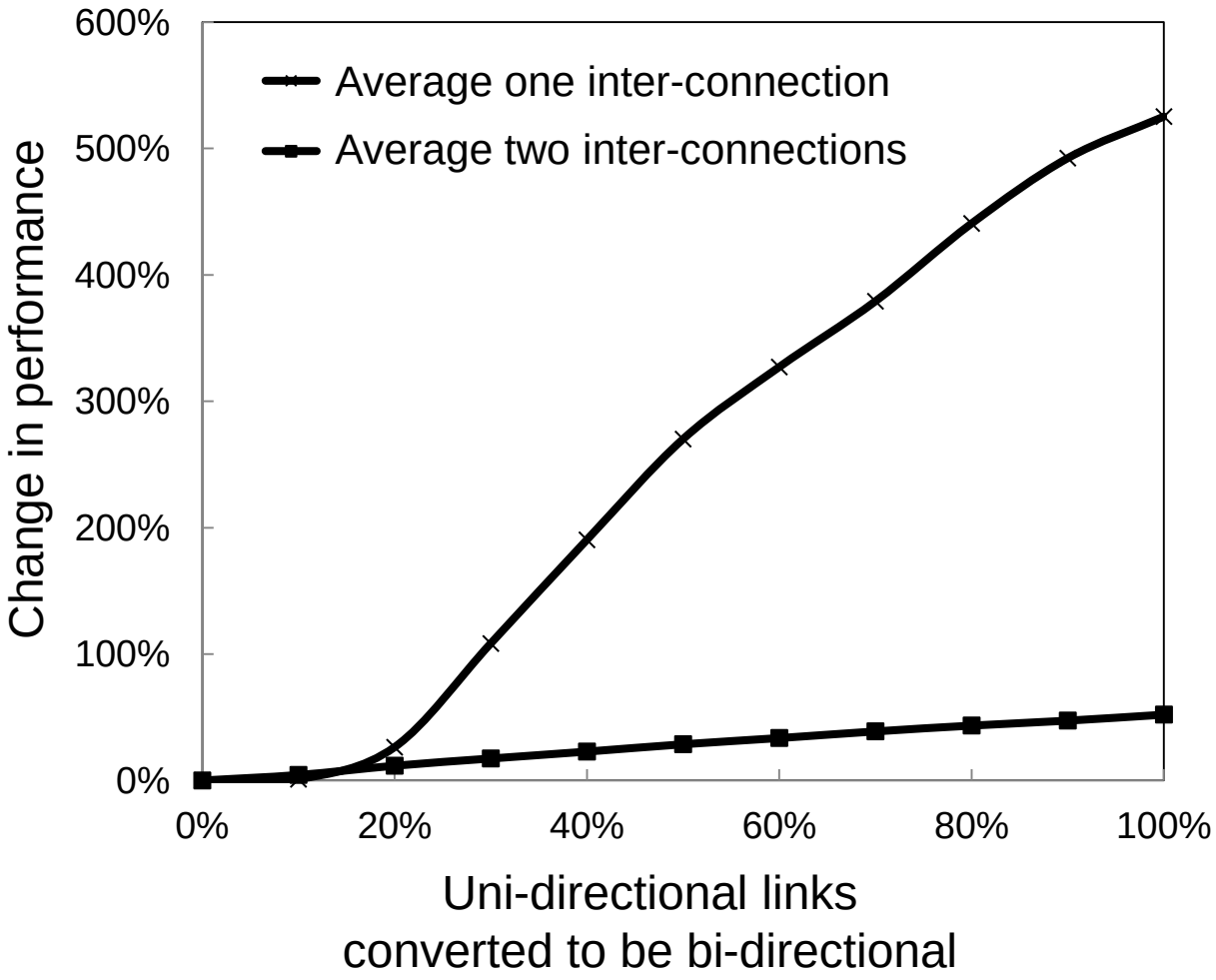


Failure, Attack or Hazard



Adaptation to improve resilience



Interdependent viability

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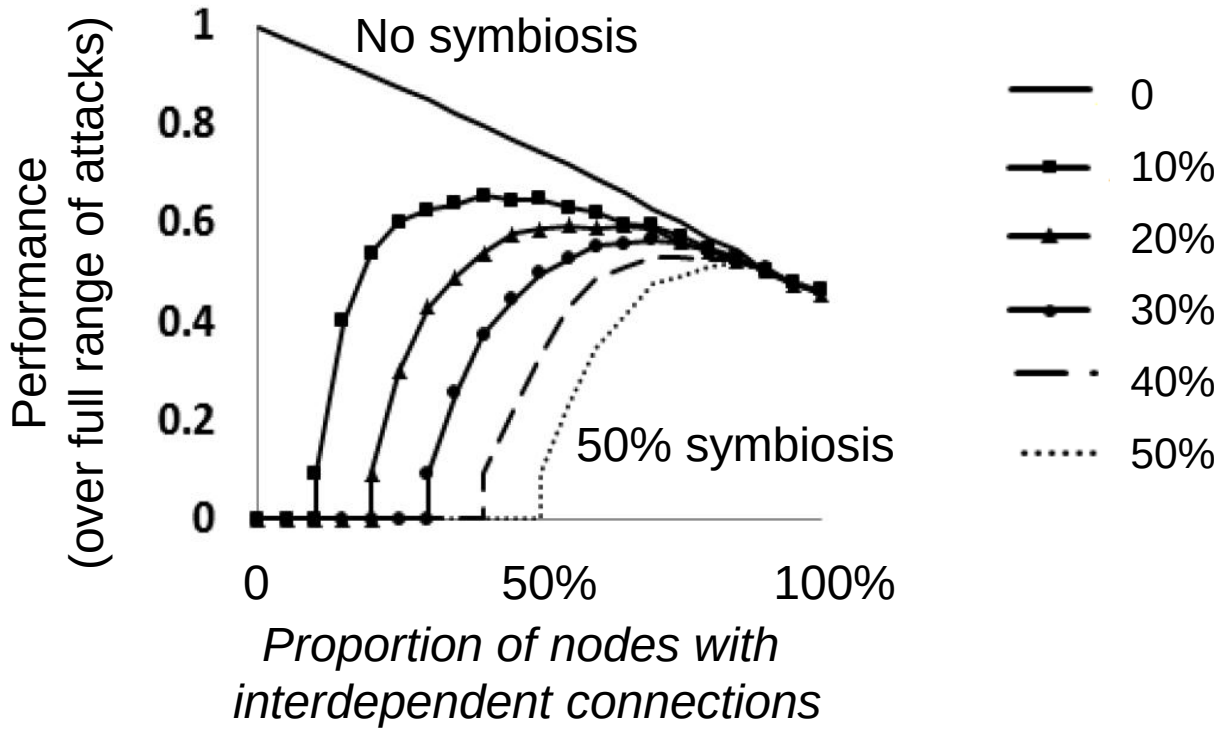
Different infrastructure systems have different requirements in terms of the extent to which they are coupled

e.g. Setting this to 10% => for a cluster of network B to be viable, at least 10% of it must be connected to network A

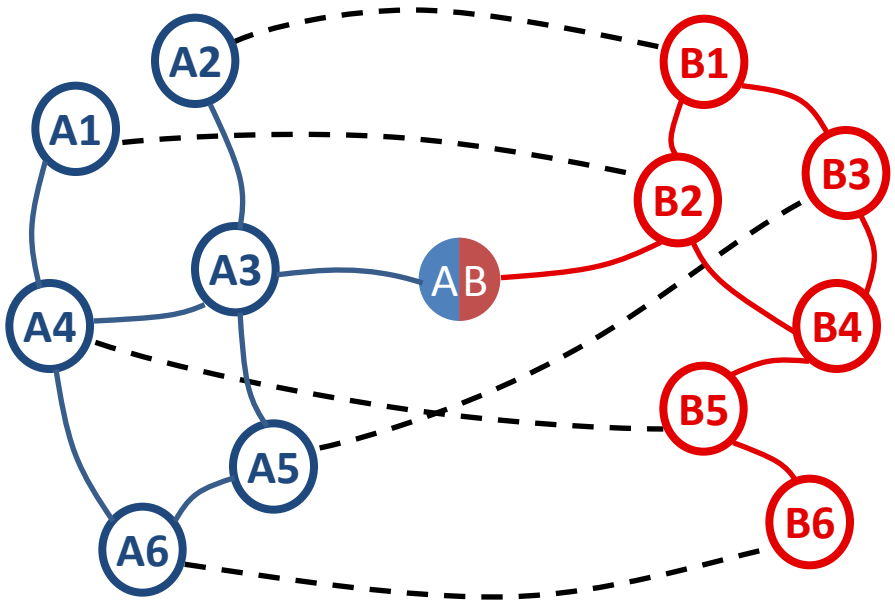


Permutable (adaptable) infrastructure

Components that can be configured to play a role in one system or another, BUT not simultaneously

- Roads convertible to landing strips,
- Stormwater Management / Road Tunnels
- Energy storage devices on board electric vehicles that can be plugged into the power grid

etc.



Benefits of permutable infrastructure

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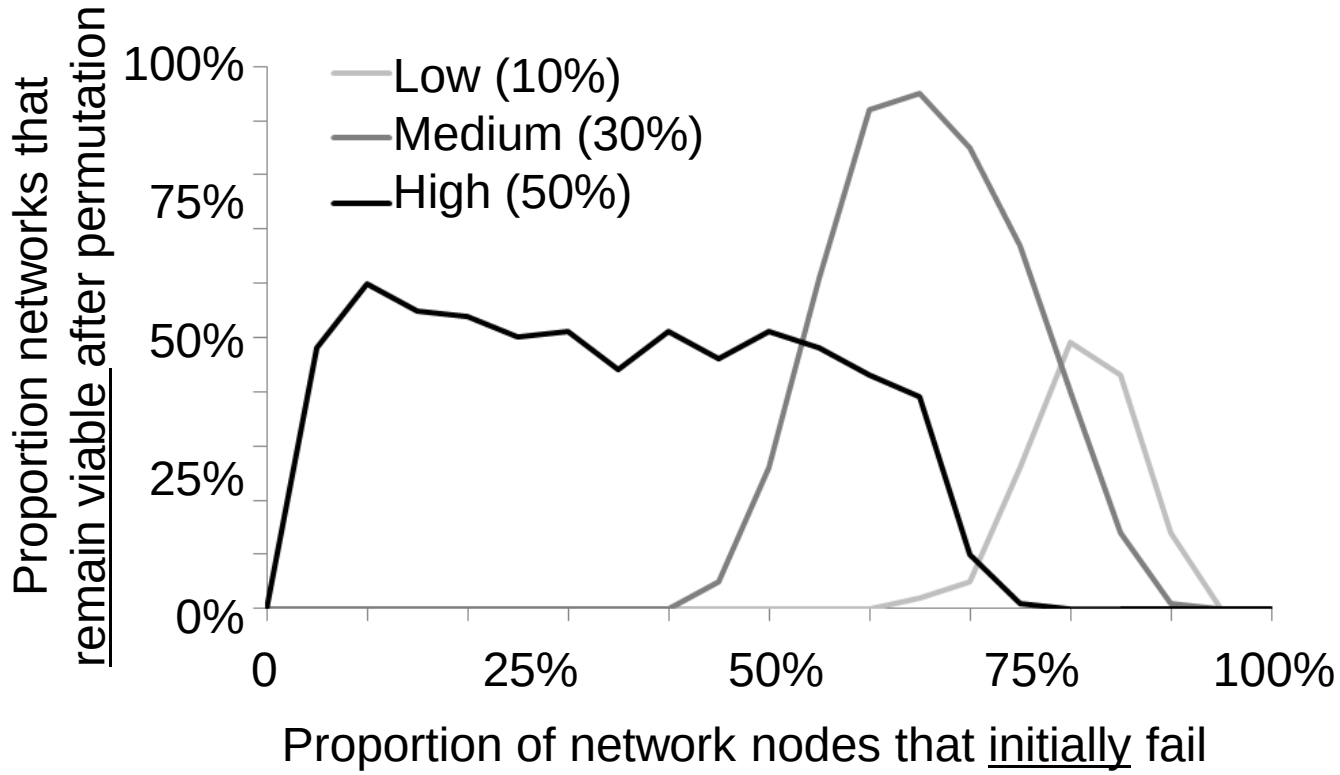

Key findings from modelling

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- Reduced complexity interdependent failure model shows that disruption to systems can be disproportionate to attack size

- System performance shown to be mediated by:
  - Redundancy: Average number of inter-connections per component
  - Directionality: Uni- or bi-directional
  - Extent: Number of nodes with inter-connections
  - Spatial configuration
  - Topology

- System performance can be improved by adapting these interdependencies in a cost effective way – such as:
  - Directionality of interdependencies
  - Number of interdependencies (redundancy and extent)
  - Permutable components

Incorporating human factors

Julia Pearce and Brooke Rogers (KCL)

Jonathan Rigg (Durham)

Beverley Searle (St Andrews)

Kate Cochrane (Durham)

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Why do human factors matter?

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- Public psychological and behavioural responses will help determine morbidity and mortality rates following a disaster (e.g. fly v drive)
- They will also have important social and economic impacts (e.g. Goiania)
- Staff behaviours will also help determine the effectiveness of your response (e.g. absenteeism, parental duties, ability to work remotely, etc.).

> "in the immediate aftermath of a [catastrophic] breakdown, an effective response will depend on the adaptive behaviour of citizens, front-line workers and middle-managers"
>
> (Boin & McConnell, 2007)

A human behaviours framework

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- Our aim is to develop a theoretically sound behavioural framework that draws attention to the complexity of human behaviour.

- In order to develop this framework we are drawing on theories of risk perception, risk communication and social psychological theories of health behaviour.

- The Risk literature highlights a number of key factors that will influence public perceptions of and behavioural responses to disaster:

  - Trust - Perceived control
  - Familiarity - Perceived fairness
  - Perceived choice - Whether the threat is natural or unnatural

Protection motivation theory (Rogers, 1975)

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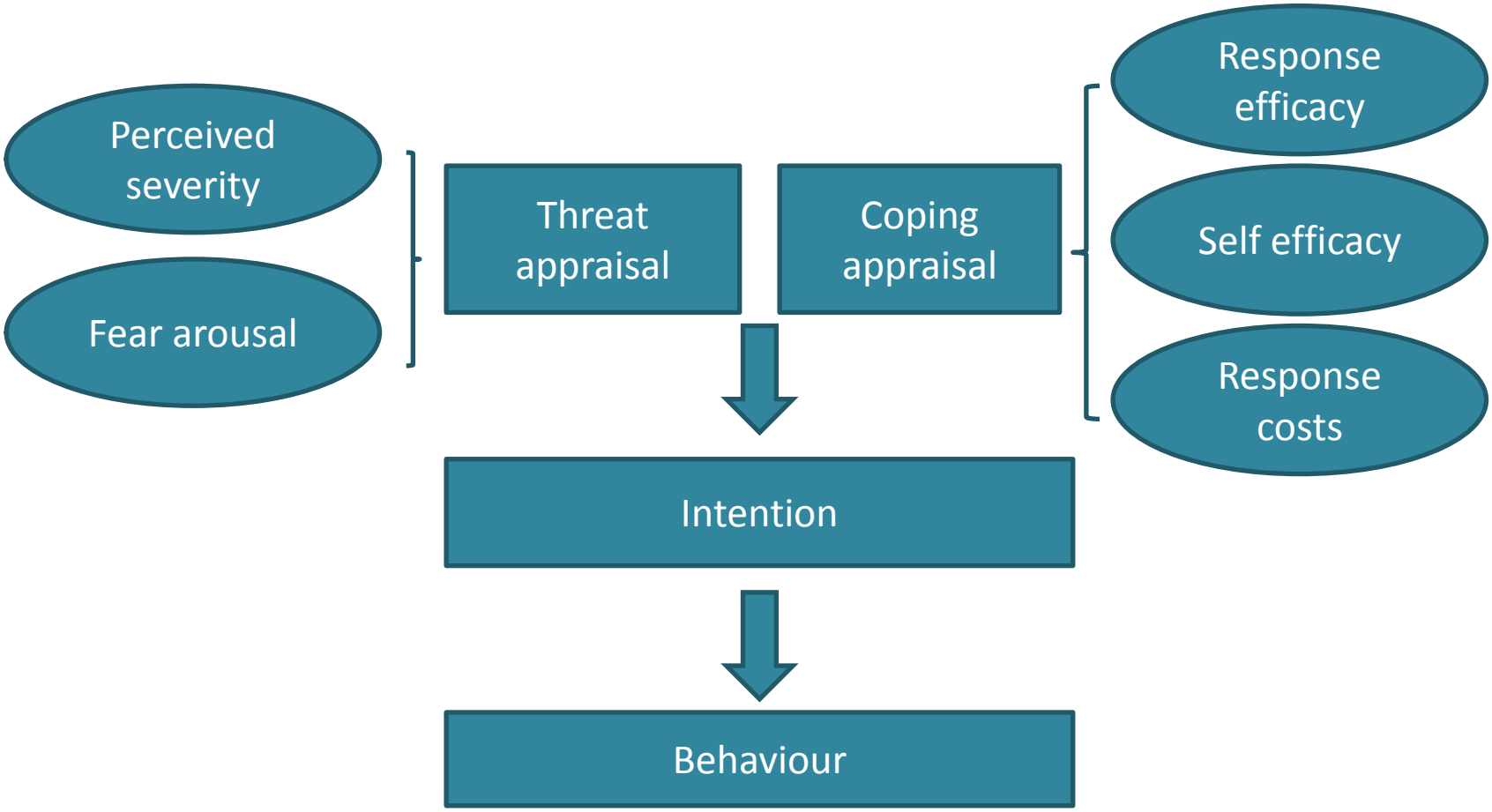

A human behaviours framework

Resilient Futures

- We tested the influence of PMT factors on behavioural intentions in response to a chemical spill (CIE Toolkit)
- Interviews with HCRs + online survey with UK and Polish public (N=1200)
  - If this situation occurred while you were at home (post office), in the 8 hours following this incident would you...
- Key factors influencing public intention to comply were:
  - Ease of compliance
  - Intention to collect children from school
  - Coping appraisals (response efficacy, self efficacy, response cost)
  - Trust in authorities providing advice
- These factors form the basis for the human behaviours framework that we have been refining through stakeholder engagement (e.g. focus groups)

Grassroots engagement

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Modelling human behaviours necessarily involves simplification. To capture the complexity of community responses this project also includes Grassroots and Stakeholder engagement (Durham and St Andrews)

Grassroots and Stakeholder Engagement		Demonstrator Development
'Toon Floods' expo – hearing the experiences of those affected by summer floods. Provided opportunities for people to talk and meet specialist agencies	→	Merging outputs from grassroots and stakeholder engagement with the simulation model in the form of: personal experiences, direct quotations and counter-intuitive examples
Community engagement – storying with those living and working with the consequences across the city including the culvert collapse in Newburn		
Stakeholder engagement: local authority, emergency services, Environment Agency and National Flood Forum		

Bringing it all together

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Focus group data collection

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- Ran series of focus groups at end of last year
  - (Thank you to those of you in the audience who took part!)
- Towards an informed model: understanding the link between the theory and the practice
- Aim
  - Explore concepts of infrastructure and community resilience
  - Examine planning assumptions and communication strategies in relation to a natural and malicious hazard
  - Provide feedback on the prototype to aid development of interactive versions of the demonstrator
- Analysis of data lead to focus on COST across infrastructures
  - Community, Organisational, Security and Technical

Traceability and data sources

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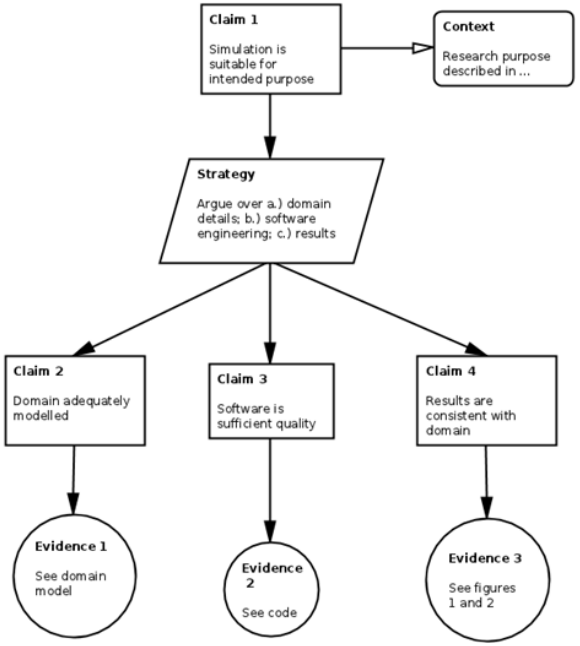
- Provide confidence in the science and implementation behind the demonstrator
- Traceable links back to primary data sources
- Expose assumptions, simplifications etc.
- Embed within demonstrator



Moving forward

Resilient Futures

- Today is a snapshot
- Full (small) group interaction
- Web-based, universally accessible
- Exploring and modelling human behaviours