

Asset Criticality Modelling

Dr. John Beckford

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Research Question

- Given that the UK Infrastructure is a 'network of networks', is it feasible to:



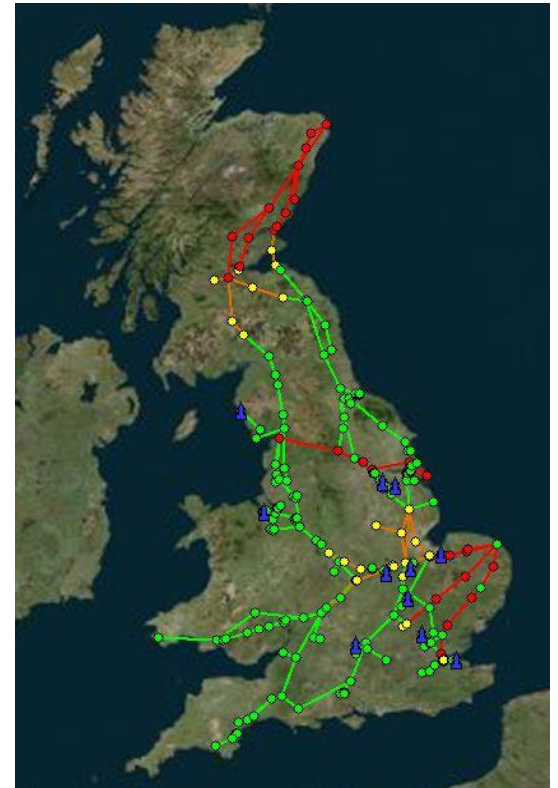
Research Question

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 - model the interdependencies



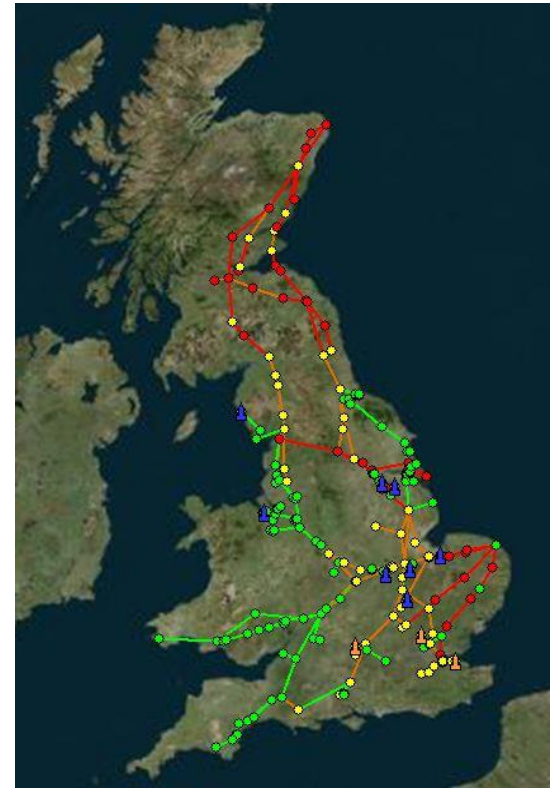
Research Question

- Given that the UK Infrastructure is a ‘network of networks’, is it feasible to:
 - model the interdependencies
 - represent the results graphically



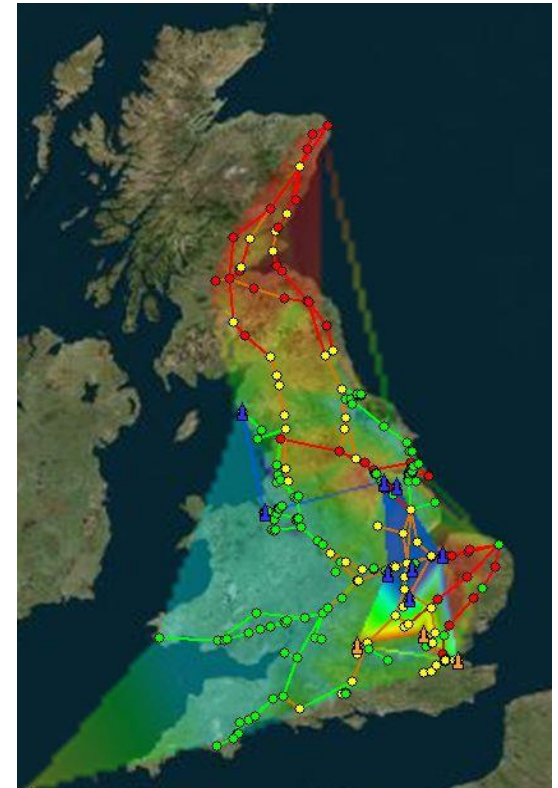
Research Question

- Given that the UK Infrastructure is a ‘network of networks’, is it feasible to:
 - model the interdependencies
 - represent the results graphically
 - model how failure propagates across
 - individual networks (e.g. gas, electricity)
 - multiple networks (e.g. gas AND electricity)



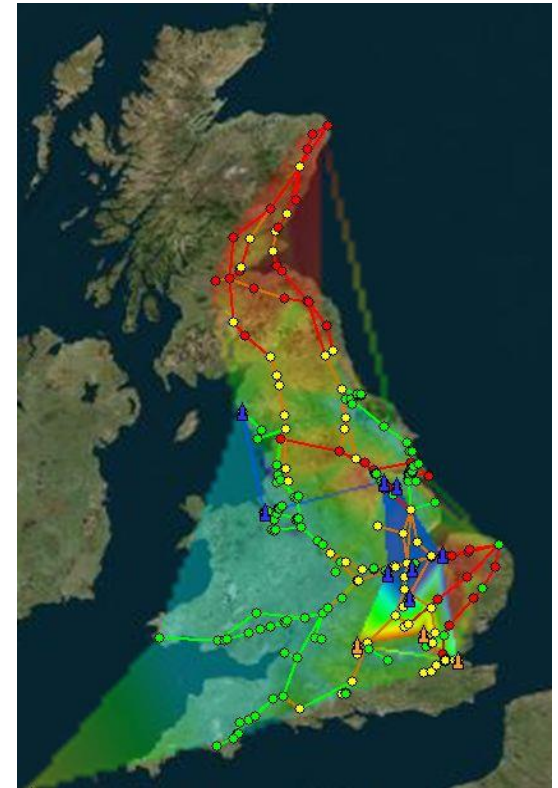
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 - identify affected populations

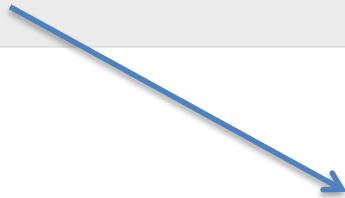


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 - multiple networks (e.g. gas AND electricity)
 - identify affected populations
 - develop a vulnerability and/or criticality index for:
 - the individual assets
 - the networks



Supply



Supply
Vulnerability



Process



Process
Vulnerability



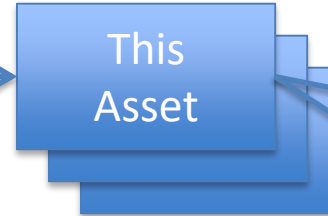
Asset
Vulnerability



Environmental



Environmental
Vulnerability

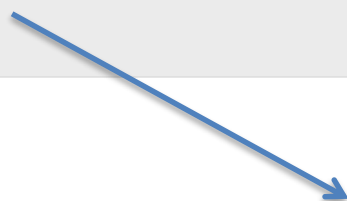


Onward Supply

Onward Delivery



Supply



Supply
Vulnerability



Process



Process
Vulnerability



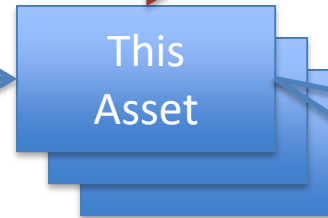
Asset
Vulnerability



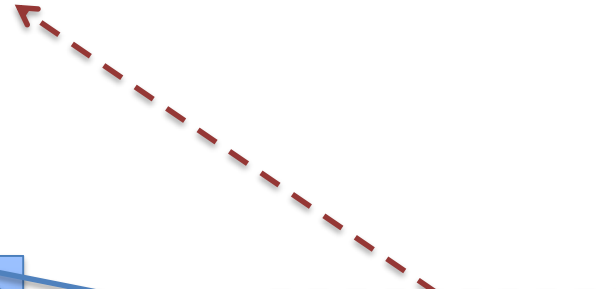
Environmental



Environmental
Vulnerability



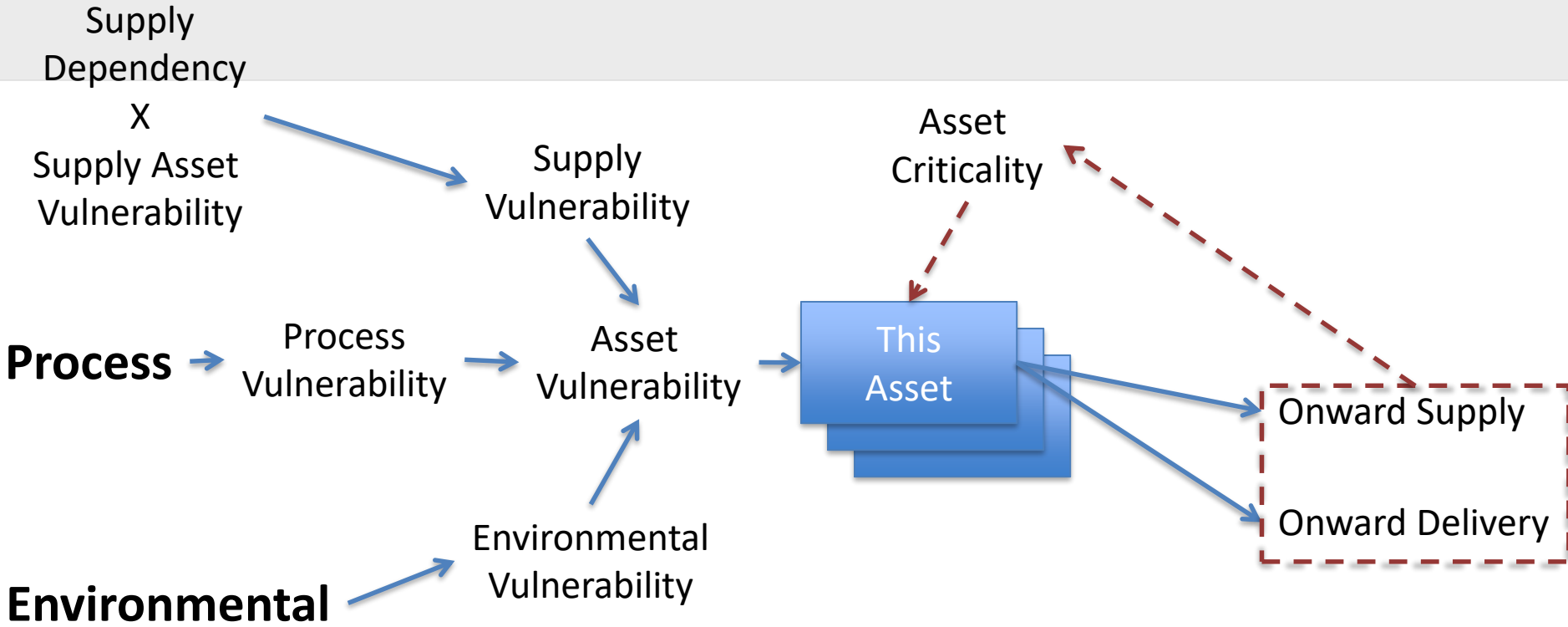
**Asset
Criticality**



Onward Supply

Onward Delivery

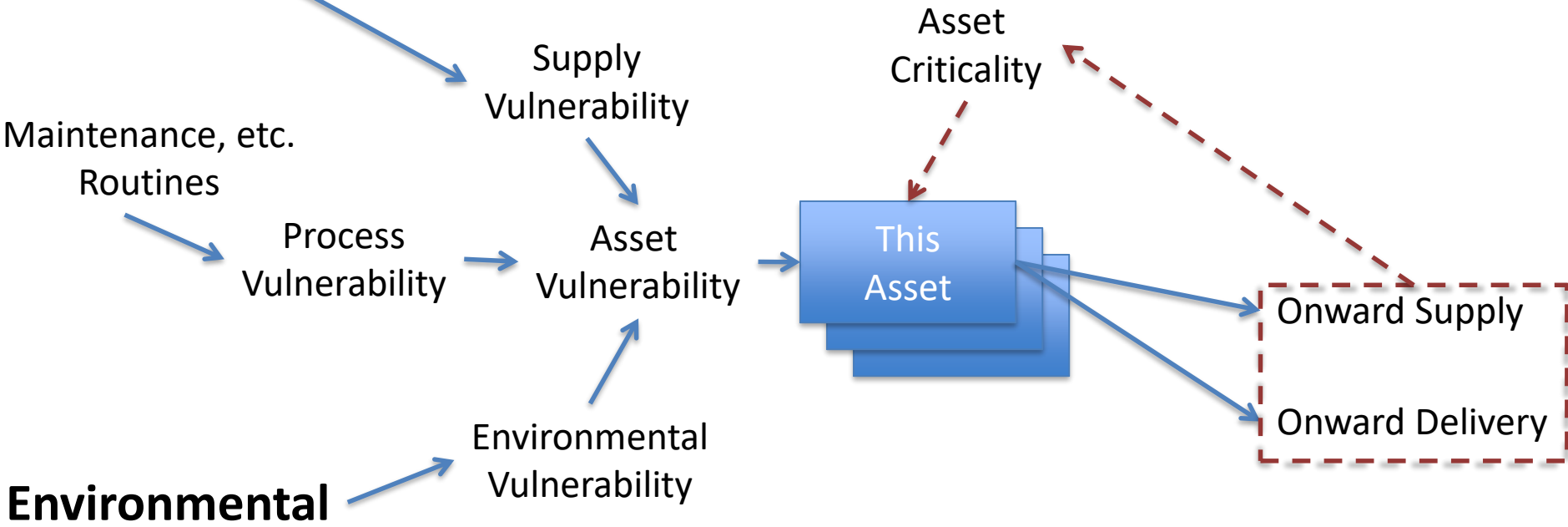
$$\text{Asset Criticality} = \Sigma (\text{Onward Asset Dependence} \times \text{Onward Asset Criticality})$$



$$\text{Asset Criticality} = \sum (\text{Onward Asset Dependence} \times \text{Onward Asset Criticality})$$

$$\text{Supply Criticality} = \text{Asset Criticality} \times \text{Supply Vulnerability}$$

Supply



$$\text{Asset Criticality} = \sum (\text{Onward Asset Dependence} \times \text{Onward Asset Criticality})$$

$$\text{Supply Criticality} = \text{Asset Criticality} \times \text{Supply Vulnerability}$$

$$\text{Process Criticality} = \text{Asset Criticality} \times \text{Process Vulnerability}$$

Supply



Supply Vulnerability

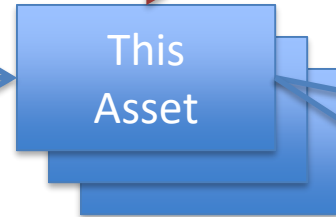


Asset Vulnerability

Process



Process Vulnerability



This Asset

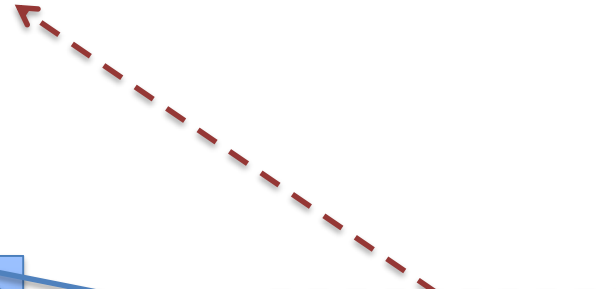
Environmental Risk
Asset Resistance



Environmental Vulnerability



Asset Criticality



Onward Supply

Onward Delivery

$$\text{Asset Criticality} = \sum (\text{Onward Asset Dependence} \times \text{Onward Asset Criticality})$$

$$\text{Supply Criticality} = \text{Asset Criticality} \times \text{Supply Vulnerability}$$

$$\text{Process Criticality} = \text{Asset Criticality} \times \text{Process Vulnerability}$$

$$\text{Environmental Criticality} = \text{Asset Criticality} \times \text{Environmental Vulnerability}$$

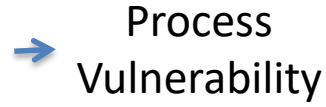
Supply



Supply
Vulnerability



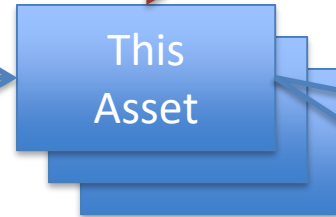
Process



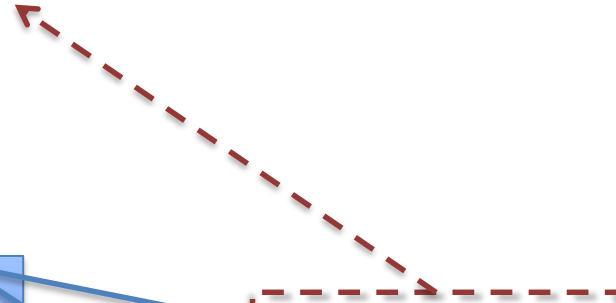
Process
Vulnerability



**Asset
Vulnerability**



Asset
Criticality



Onward Supply

Onward Delivery

Environmental



Environmental
Vulnerability



Asset Criticality = Σ (Onward Asset Dependence X Onward Asset Criticality)
 Supply Criticality = Asset Criticality X Supply Vulnerability
 Process Criticality = Asset Criticality X Process Vulnerability
 Environmental Criticality = Asset Criticality X Environmental Vulnerability
 Asset Vulnerability = Max of Supply/Maintenance/Environmental Vulnerability

Asset Exposure =

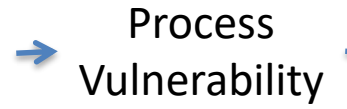
$$\text{Asset Criticality} \times \text{Asset Vulnerability}$$

Supply



Supply Vulnerability

Process



Process Vulnerability

Asset Vulnerability

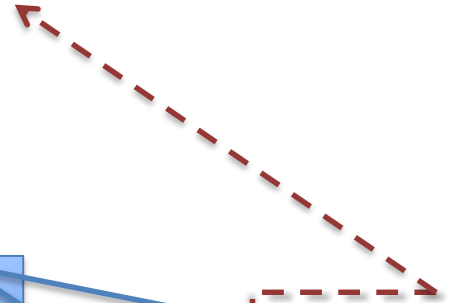
Environmental



Environmental Vulnerability



Asset Criticality



Onward Supply

Onward Delivery

$$\text{Asset Criticality} = \Sigma (\text{Onward Asset Dependence} \times \text{Onward Asset Criticality})$$

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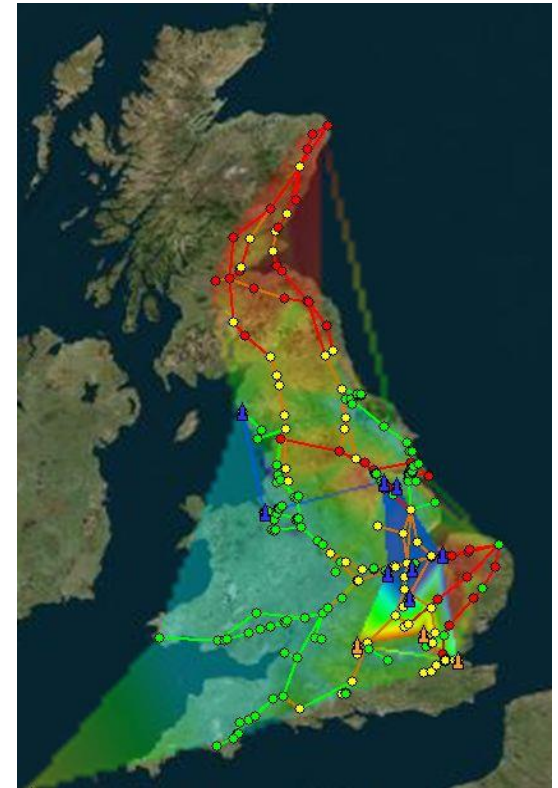
$$\text{Process Criticality} = \text{Asset Criticality} \times \text{Process Vulnerability}$$

$$\text{Environmental Criticality} = \text{Asset Criticality} \times \text{Environmental Vulnerability}$$

$$\text{Asset Vulnerability} = \text{Max of Supply/Maintenance/Environmental Vulnerability}$$

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 - model the interdependencies
 - model how failure propagates across
 - individual networks (e.g. gas, electricity)
 - multiple networks (e.g. gas AND electricity)
 - represent the results graphically
 - Identify affected populations
 - develop a vulnerability and/or criticality index for:
 - the individual assets
 - the networks
- And, therefore:
- identify locations where either
 - mitigating action will deliver most (population) benefit
 - investment will best increase resilience



- Identify apparent dependencies and connectivity from available data
- Make assumptions about the level of connectivity (if necessary)
- Build the network relationship models
- Test that the results make sense
- Model the effects of failure
- Develop a criticality/vulnerability index based on the now known connectivity
- Deploy results on a GIS tool

