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A Systemic Perspective on the Many Faces of Grid Resilience

Prof. Amro M. Farid

Thayer School of Engineering at Dartmouth

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Presentation Outline

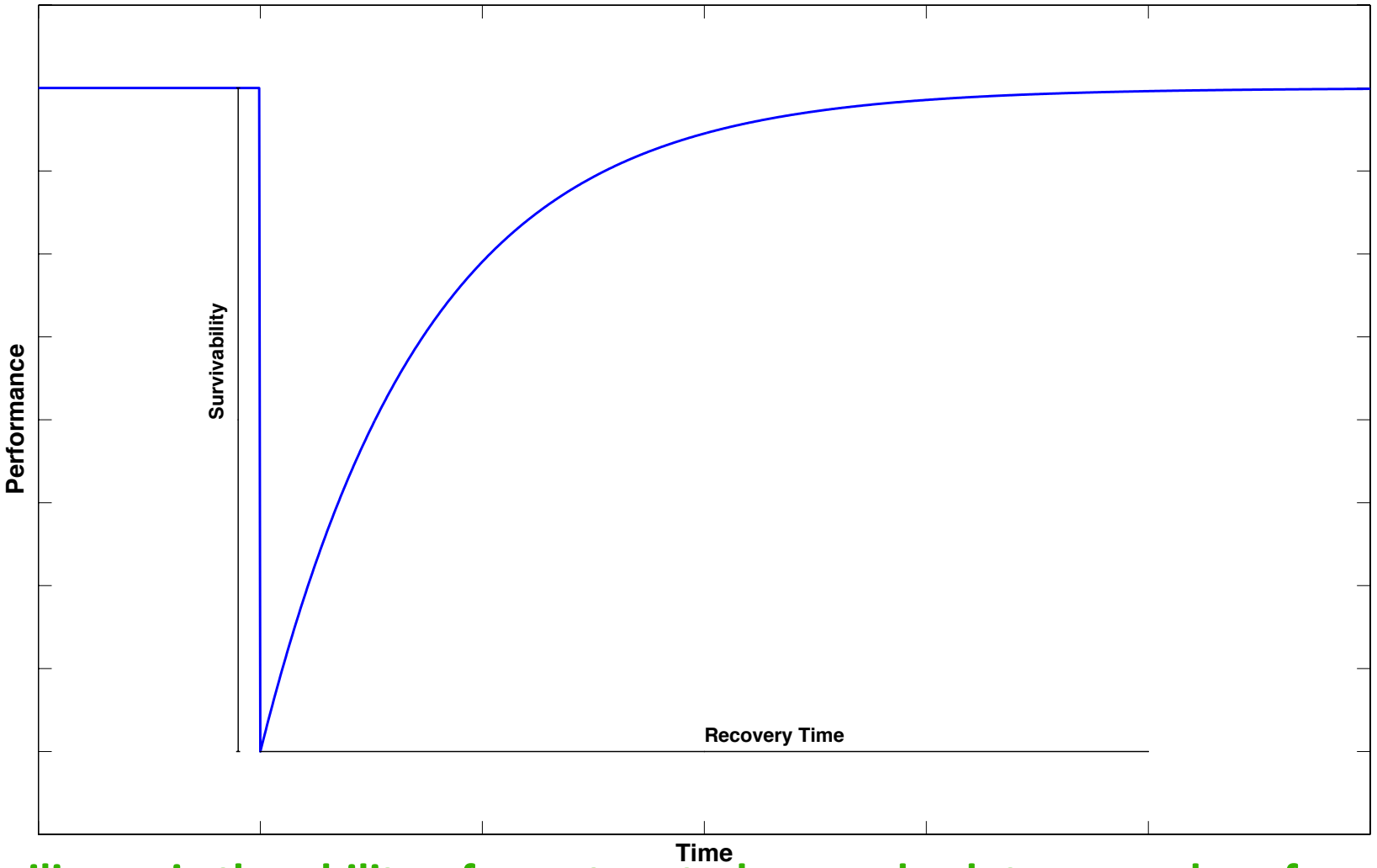
Goal: To provide a systemic perspective on the many faces of grid resilience.

- Understanding Resilient Systems
- Choosing the right system boundary
- Choosing the right time scale
- Choosing the measure of performance
- Choosing the type of performance
- Choosing the type of disruption
- Final Thoughts: Analysis Methods & the Way Forward

Understanding Resilient Systems

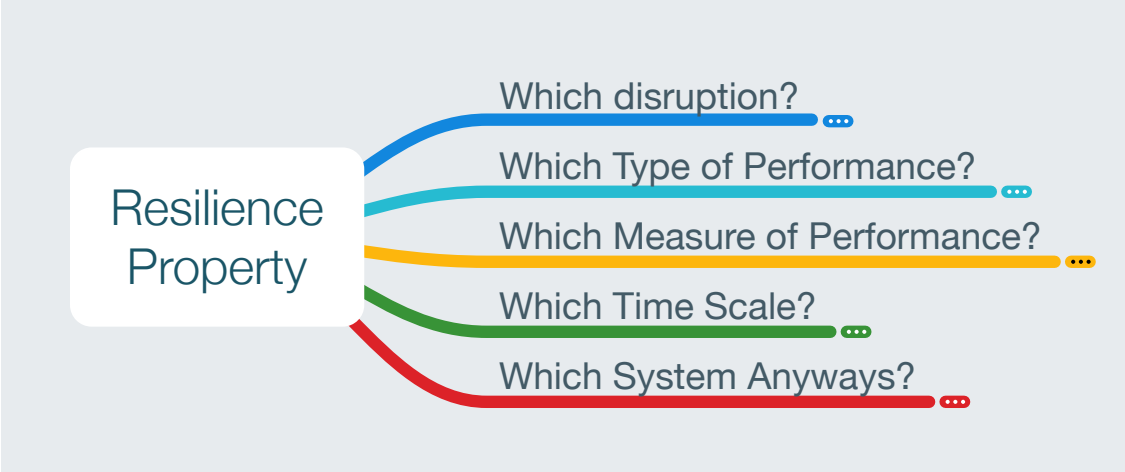
∴ There exists a diverse multi-disciplinary literature on resilient systems

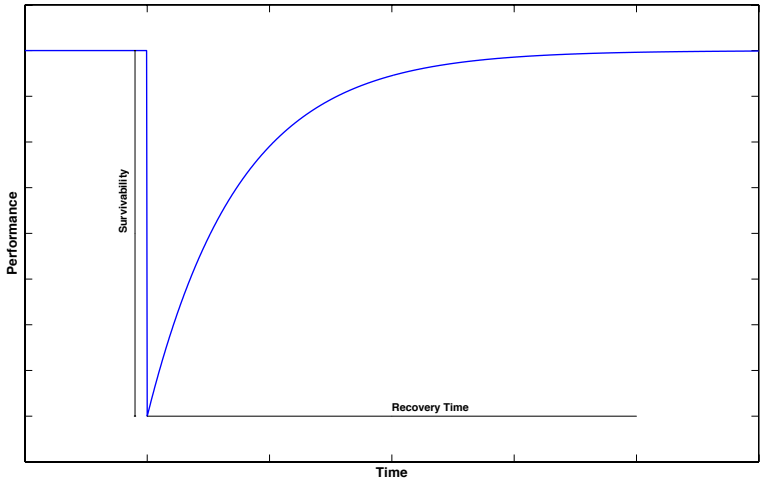
Resilience as a System Life Cycle Property



∴ Resilience is the ability of a system to bounce back to normal performance after a disruption

Characterizing Resilience as a Life Cycle Property

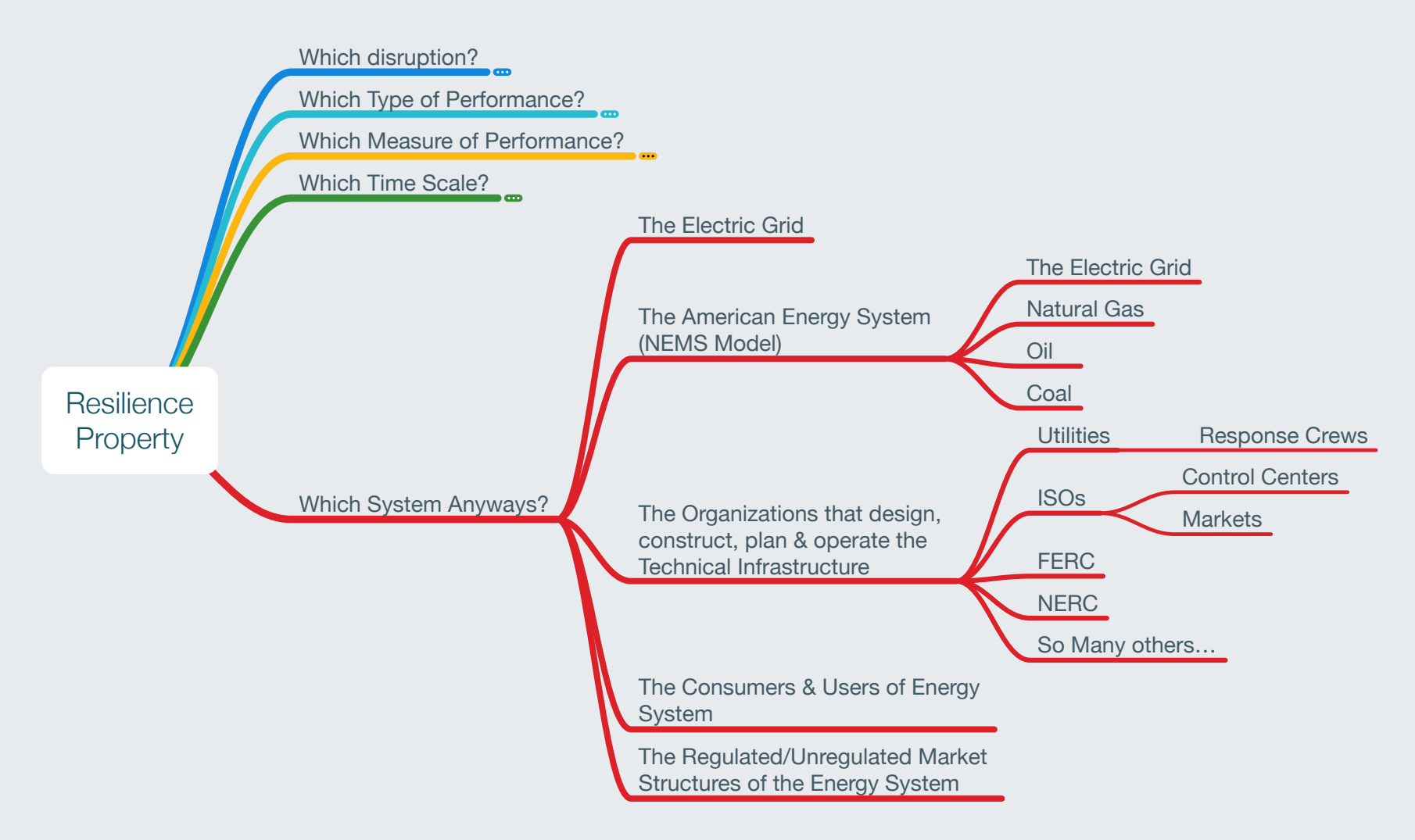




∴ Thoughtful discussion of resilience must answer each of these of questions.

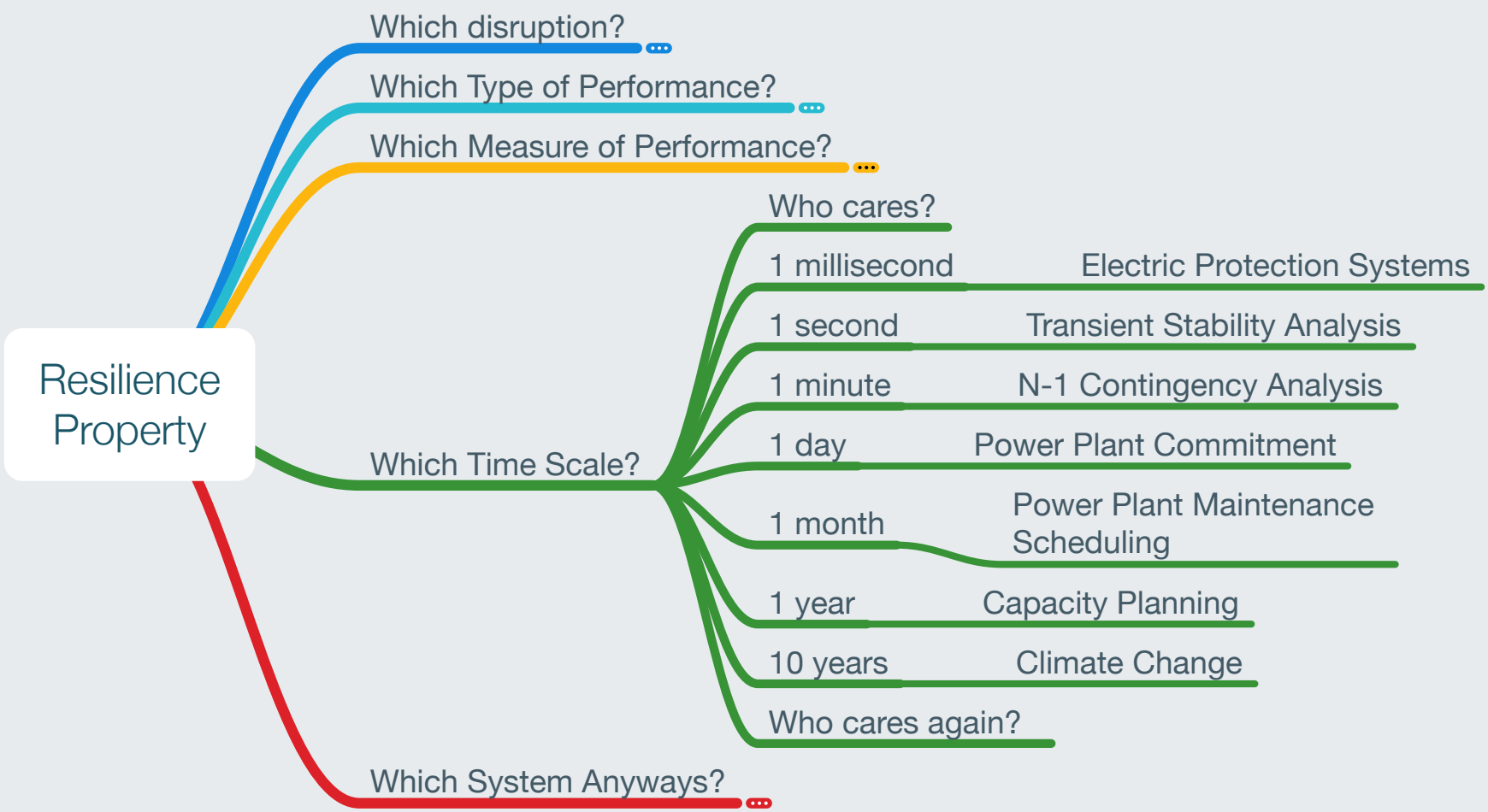
∴ The answers to these questions determine the problem-solving methods.

System Boundary: Which Resilient System Anyways?



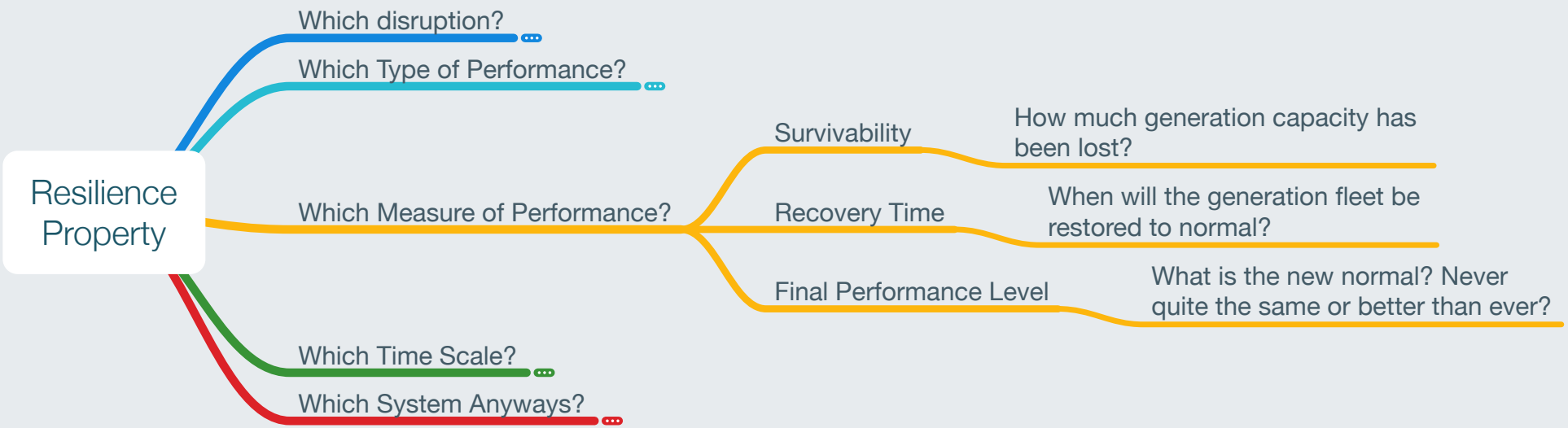
∴ **Understanding resilience must go beyond a purely technical view.**

Which Resilient System Time Scale?



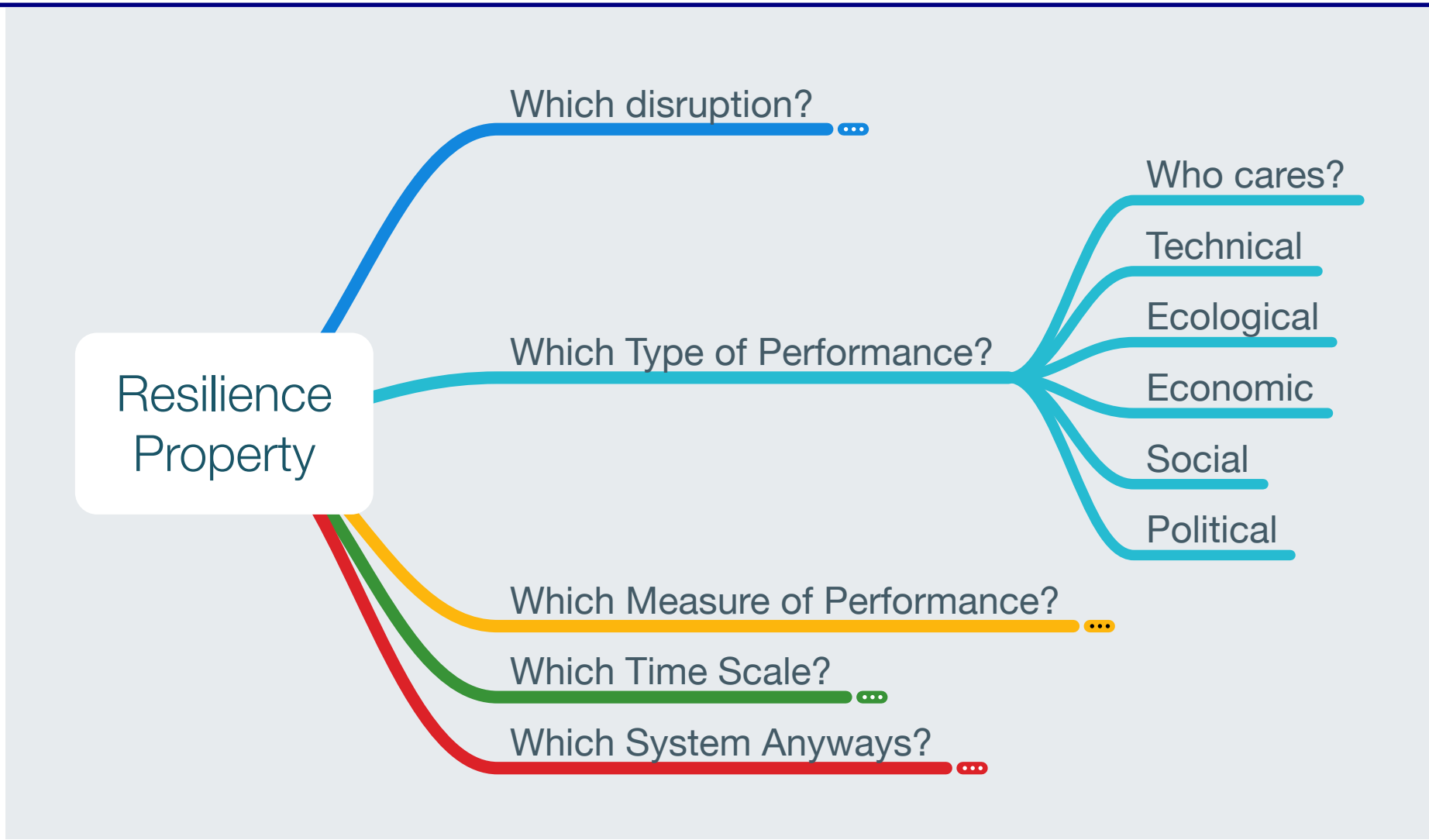
∴ The time scale focuses our efforts on relevant disciplines & resources.

Which Resilient System Measures of Performance?



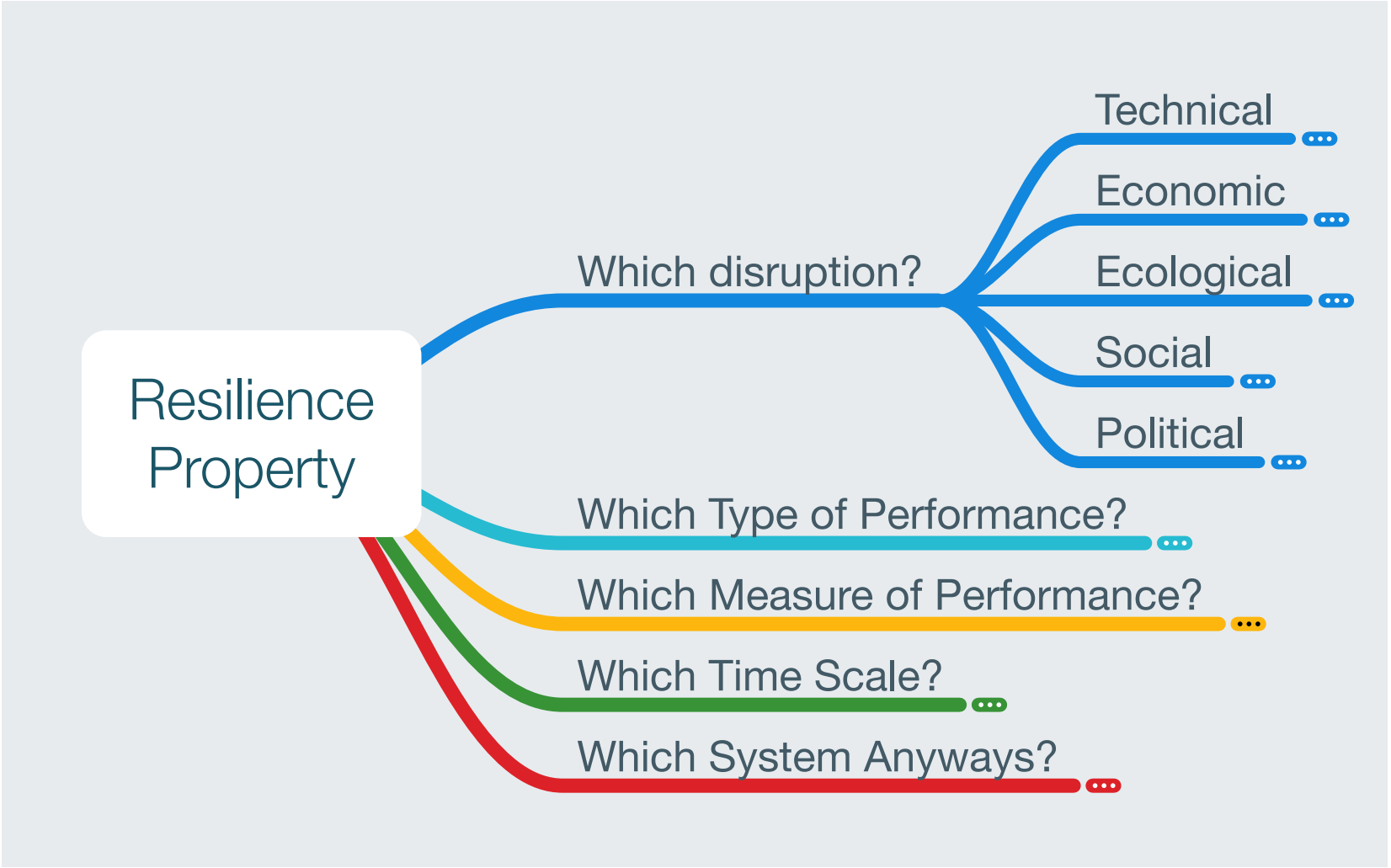
∴ Context-dependent priorities will drive their relative importance.

Which Resilient System Type of Performance?



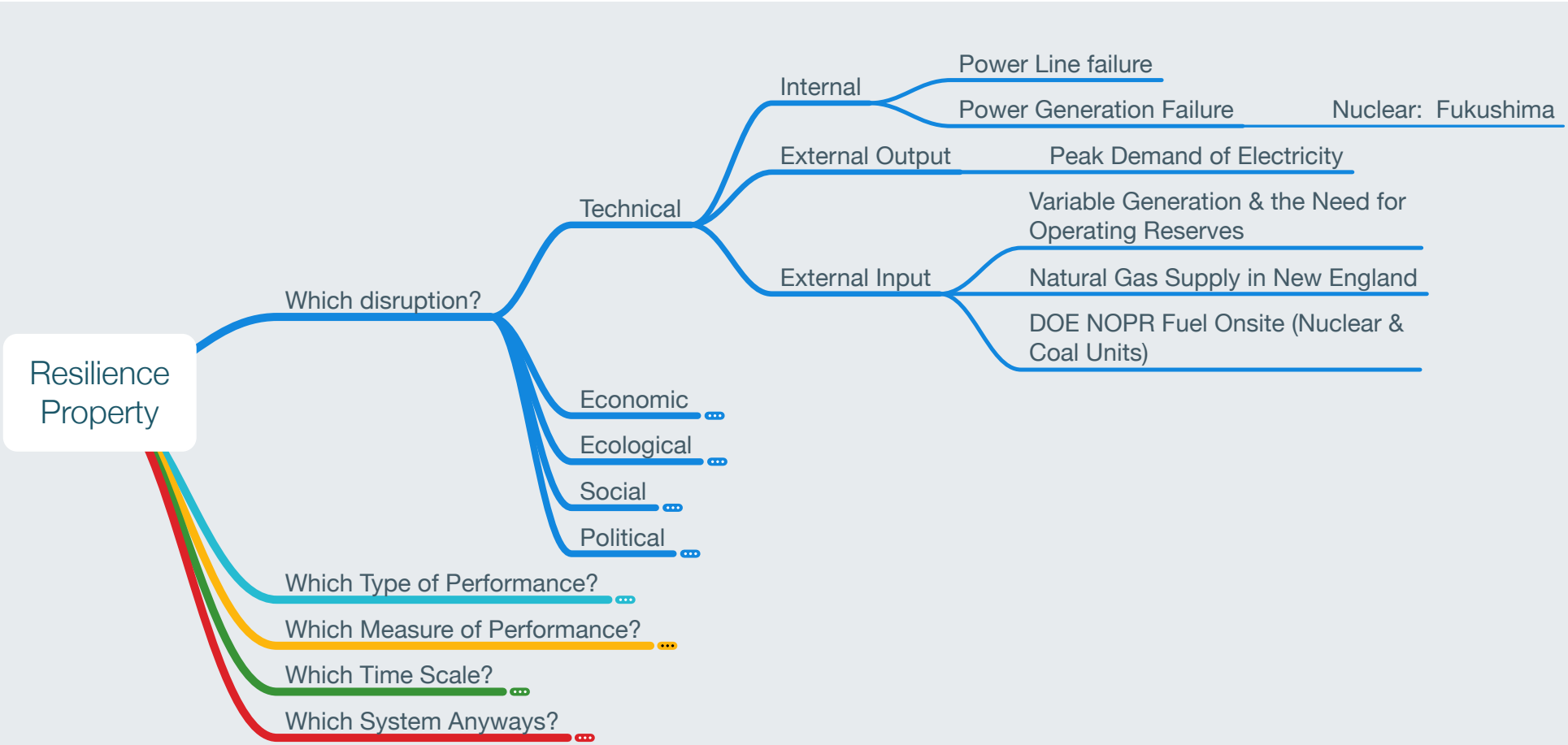
∴ The stakeholder's perspective will drive the type of performance

Which Resilient System Disruption: Overview



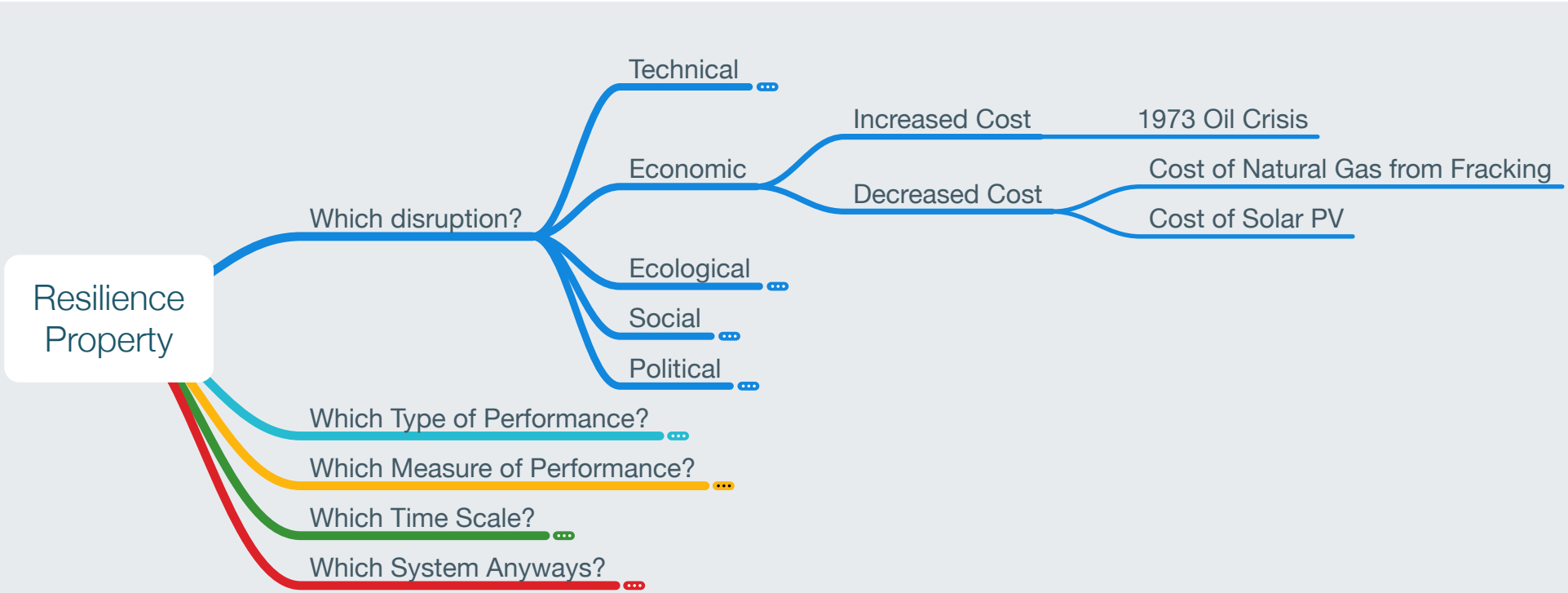
∴ **Resilient systems require a holistic analysis of the types of disruption**

Which Resilient System Disruption: Technical



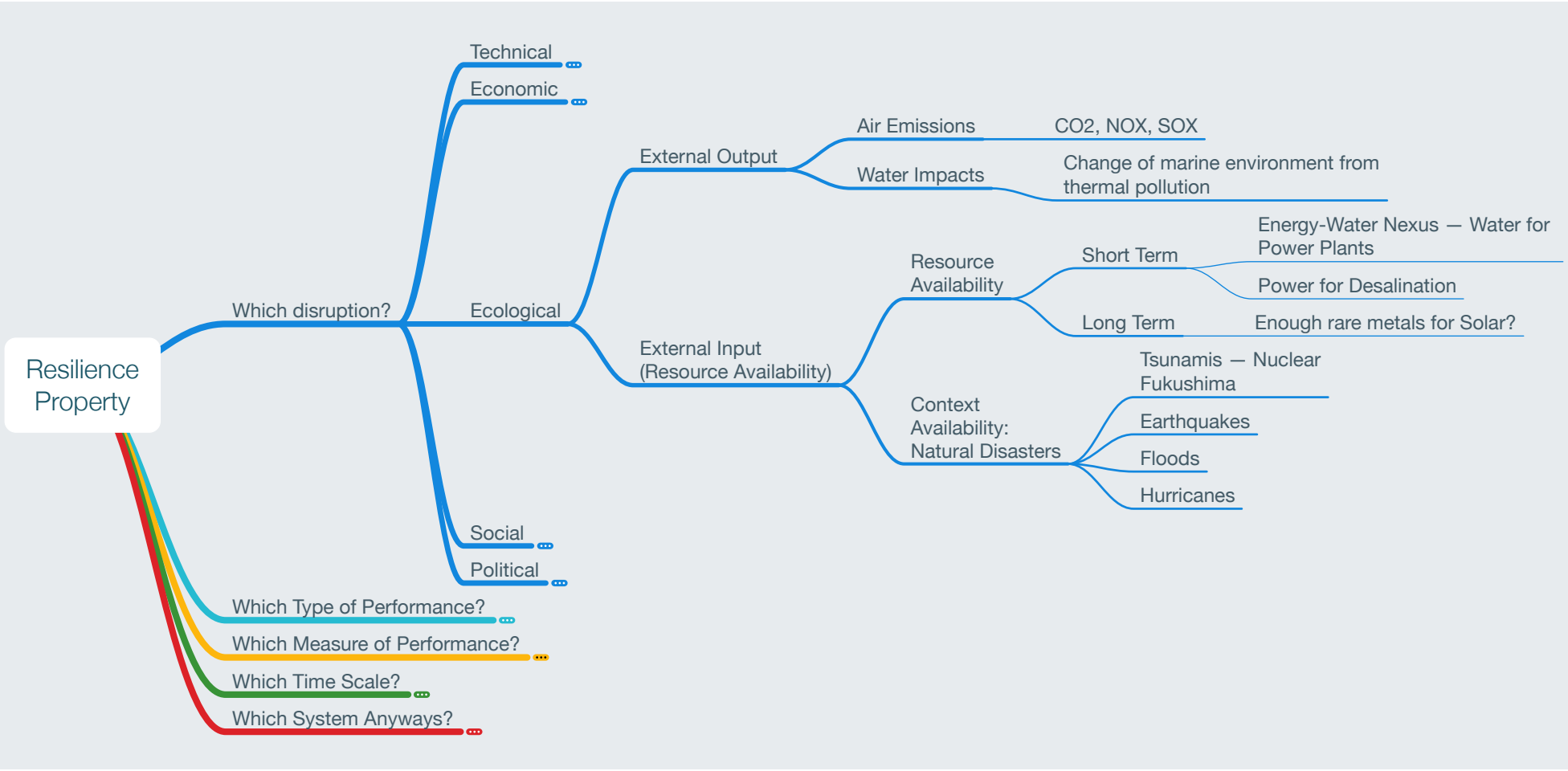
∴ **Resilient systems require a holistic analysis of the types of disruption**

Which Resilient System Disruption: Economic



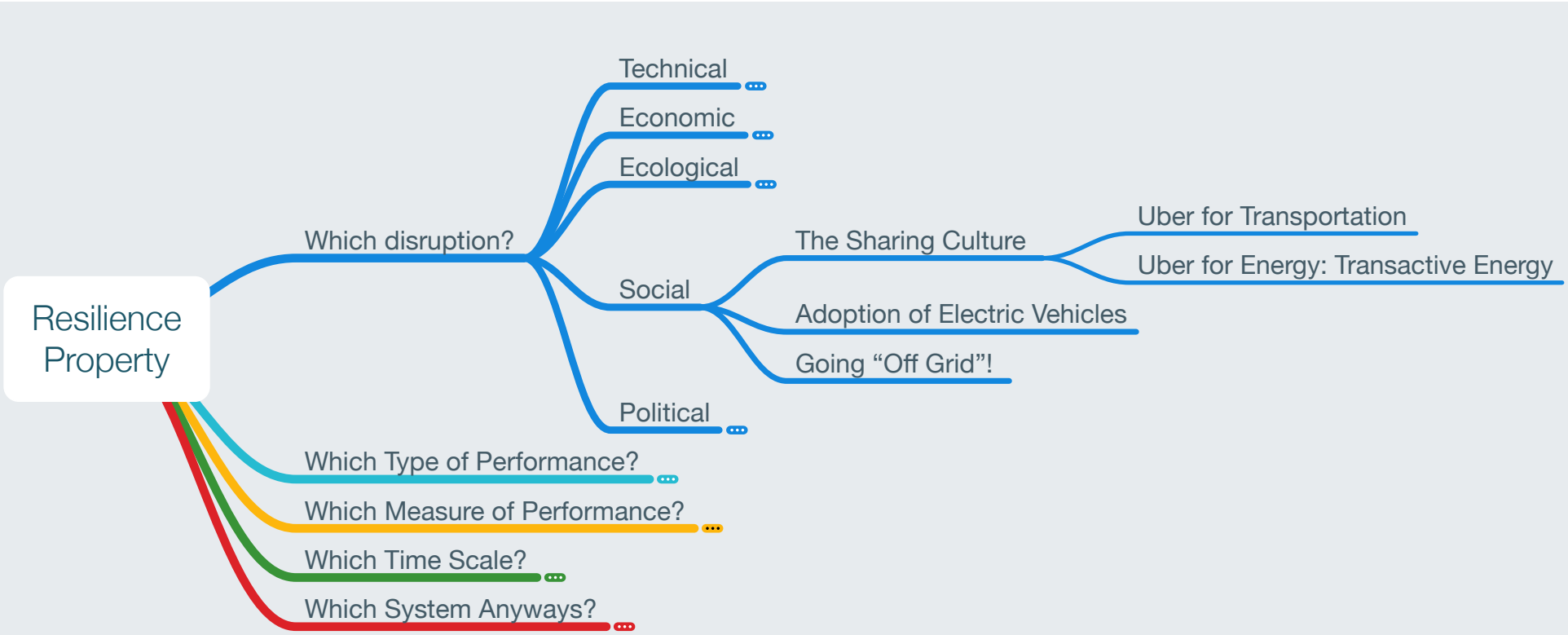
∴ **Resilient systems require a holistic analysis of the types of disruption**

Which Resilient System Disruption: Ecological



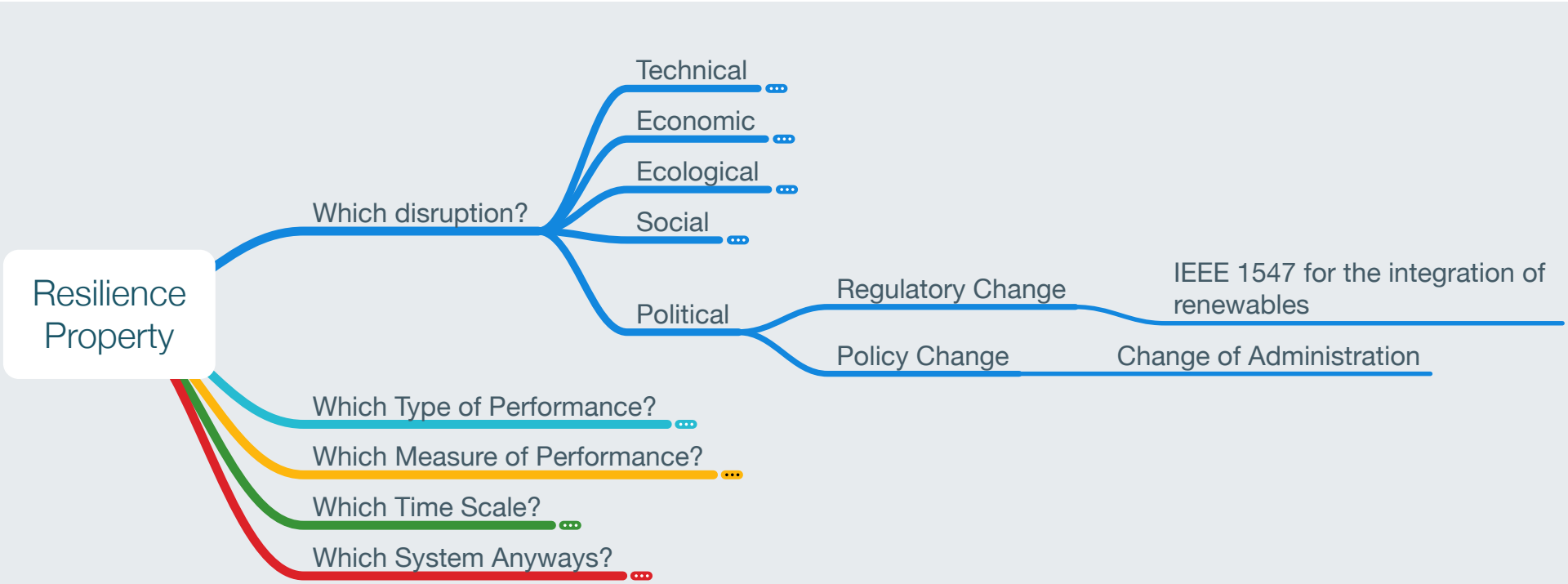
∴ Resilient systems require a holistic analysis of the types of disruption

Which Resilient System Disruption: Social



∴ Resilient systems require a holistic analysis of the types of disruption

Which Resilient System Disruption: Political



∴ **Resilient systems require a holistic analysis of the types of disruption**

Final Thoughts

Resilient systems literature has generally taken two approaches:

1.) Graph theoretic methods understanding system structure

- **Traditional graph theoretic measures often uses → neglect system function**
- **hetero-functional graph theory brings a new more insightful approach**

2.) Simulation of System Response to Disruptions

- **Time Intensive: Choose disruption and then many alternative scenarios**
- **Requires a flexible simulation environment**
- **Must address time scale issues**

- **Grid resilience has generally been mastered the fast technical-engineering time scales and performance issues**
- **Grid resilience as integrated with economic, ecological, social, and political issues remains a real concern in theory and practice.**

∴ The field of engineering systems has made the holistic study of resilience a central research topic. A deeply multidisciplinary approach is required.