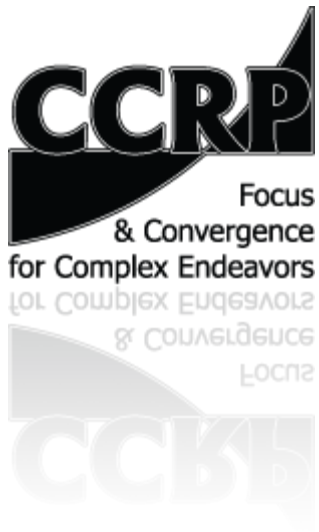




# Measuring Agility

presented to

**16<sup>th</sup> ICCRTS**

Quebec City

June 2011

Dr. David S. Alberts  
Director, Research  
OASD/NII & DoD CIO

| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                           | Form Approved<br>OMB No. 0704-0188                  |                                 |
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# Previously

- 21<sup>st</sup> Century mission challenges are Complex Endeavors with a complex mission, a complex environment, and a complex self
- There is no “one size fits all solution” to accomplishing the functions that our community associates with Command and Control; different approaches are appropriate for different situations
- The Command and Control (management, governance) of an entity is different from that of efforts to focus a Collective (complex self) and converge on a set of shared objectives
- In Complex Endeavors, the relationship between the two is critical
- Agility is not just a desirable capability, it is an Imperative
- More network-enabled approaches are more Agile

# Agenda

- What do you mean by Agility?
- How do you apply the concept of Agility to C2/M/G/F&C?
- How can we visualize and measure Agility?
- Does the evidence support the following assertions?
  - Different approaches work best in different situations
  - More networked-enabled Approaches are more Agile

# Agenda

- What do you mean by Agility?
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  - More networked-enabled Approaches are more Agile
- Is there a relationship between Cybersecurity and Agility?

# Acknowledgements

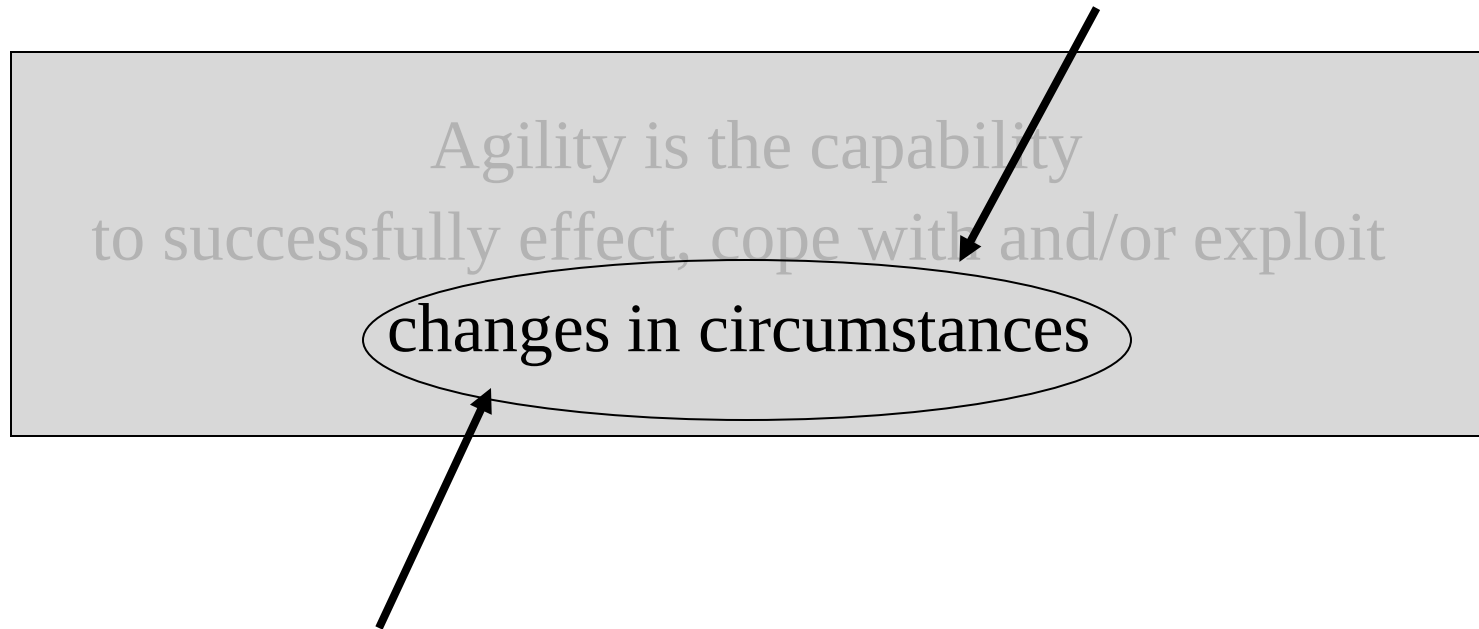
- SAS-085 Group Members
- ELICIT Team

# What is Agility?

Agility is the capability  
to successfully effect, cope with and/or exploit  
changes in circumstances

# What is Agility?

- relevant set = Endeavor Space



- The concept of Agility does not apply to a stable situation
- Changes may be external to self (e.g. regime change, permissive to hostile) or changes to self (e.g. a new coalition partner, loss of capability)

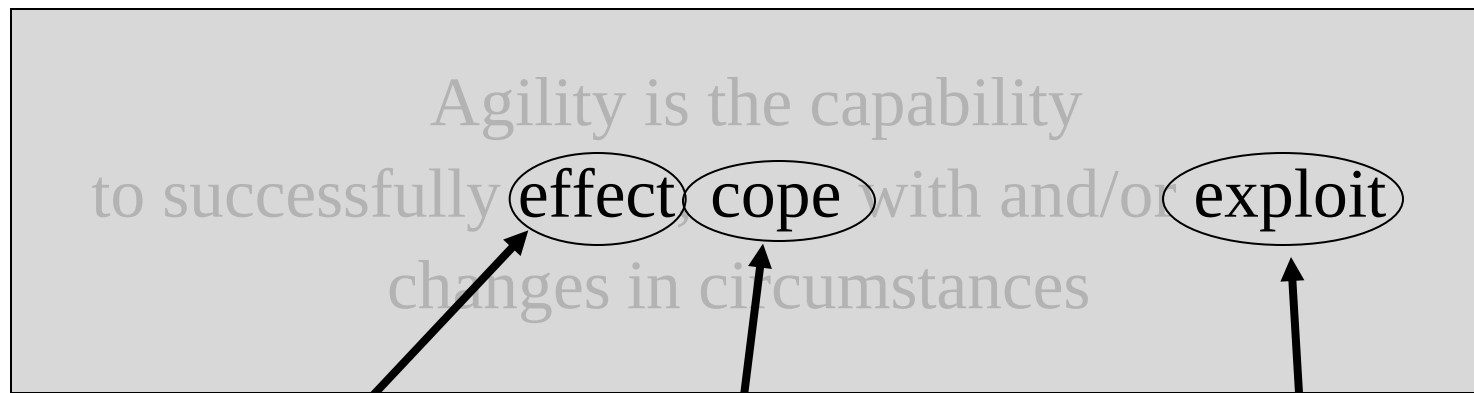


# What is Agility?

Agility is the capability  
to **successfully** effect, cope with and/or exploit  
changes in circumstances

within acceptable bounds of performance  
(e.g. effectiveness, efficiency, risk)

# What is Agility?



create an opportunity by  
changing an aspect of  
circumstances you can  
influence

anticipate or respond to an  
event that would otherwise  
have adverse consequences

take advantage of an  
opportunity to improve  
effectiveness, efficiency  
reduce risk

# Manifest v. Potential Agility

- As defined, the Agility (or a lack of ) can only be directly observed if, and when, a change of significance takes place.
- Some events that are possible, even probable, may not take place during a particular endeavor.
- It is important that entities do not confine their assessments of their Agility to what has actually occurred.
- There are two ways to assess an Entity's Potential Agility
  - Test predicted Agility using experiments and exploratory analysis
  - Develop a Model of Potential Agility based on indicants

# Agenda

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# C2/M/G/F&C Agility

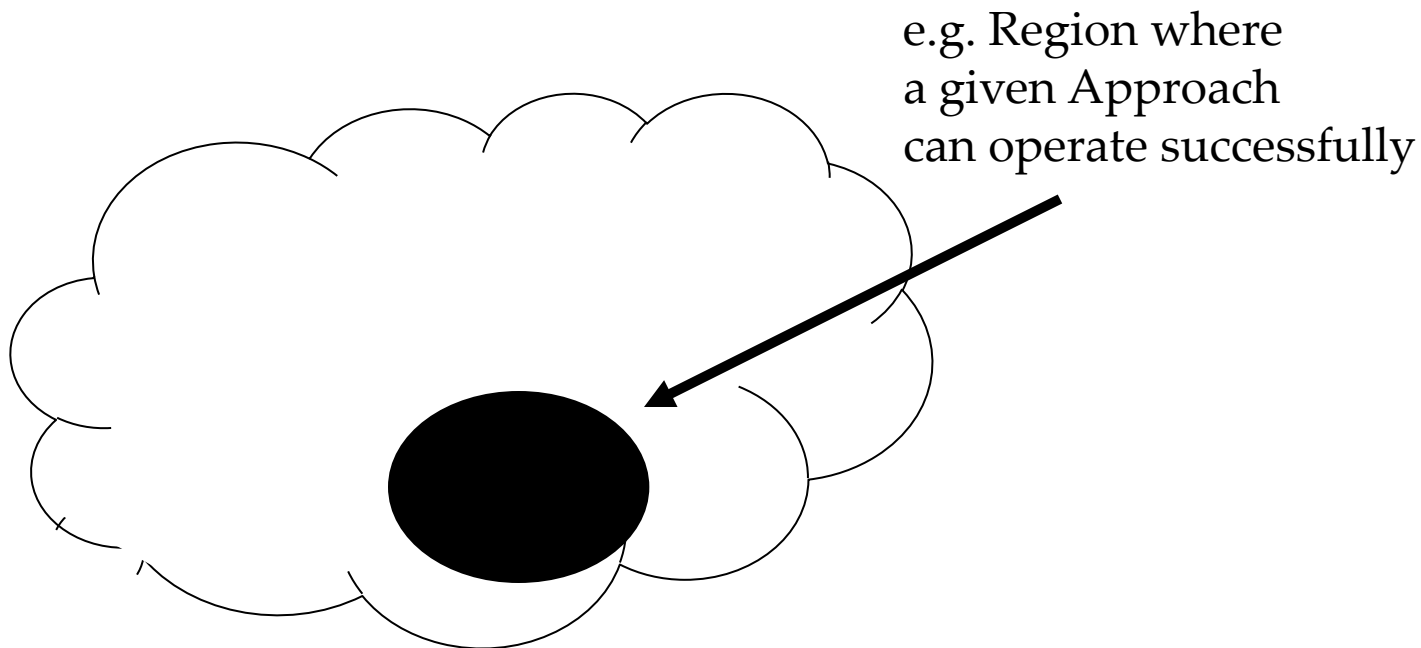
- There are many ways to accomplish the functions our community associates with Command and Control; the most appropriate approach will be a function of the nature of the endeavor and the prevailing circumstances.
- The set of relevant missions and circumstances forms an Endeavor Space; the set of possible approaches forms an Approach Space.
- The Agility of a given Approach is related to the area of Endeavor Space where the Approach can be successful.
- C2/M/G/F&C Agility is the ability to move around in the Approach Space in response to changing missions and circumstances
- Agile systems and processes are required

# Agenda

- What do you mean by Agility?
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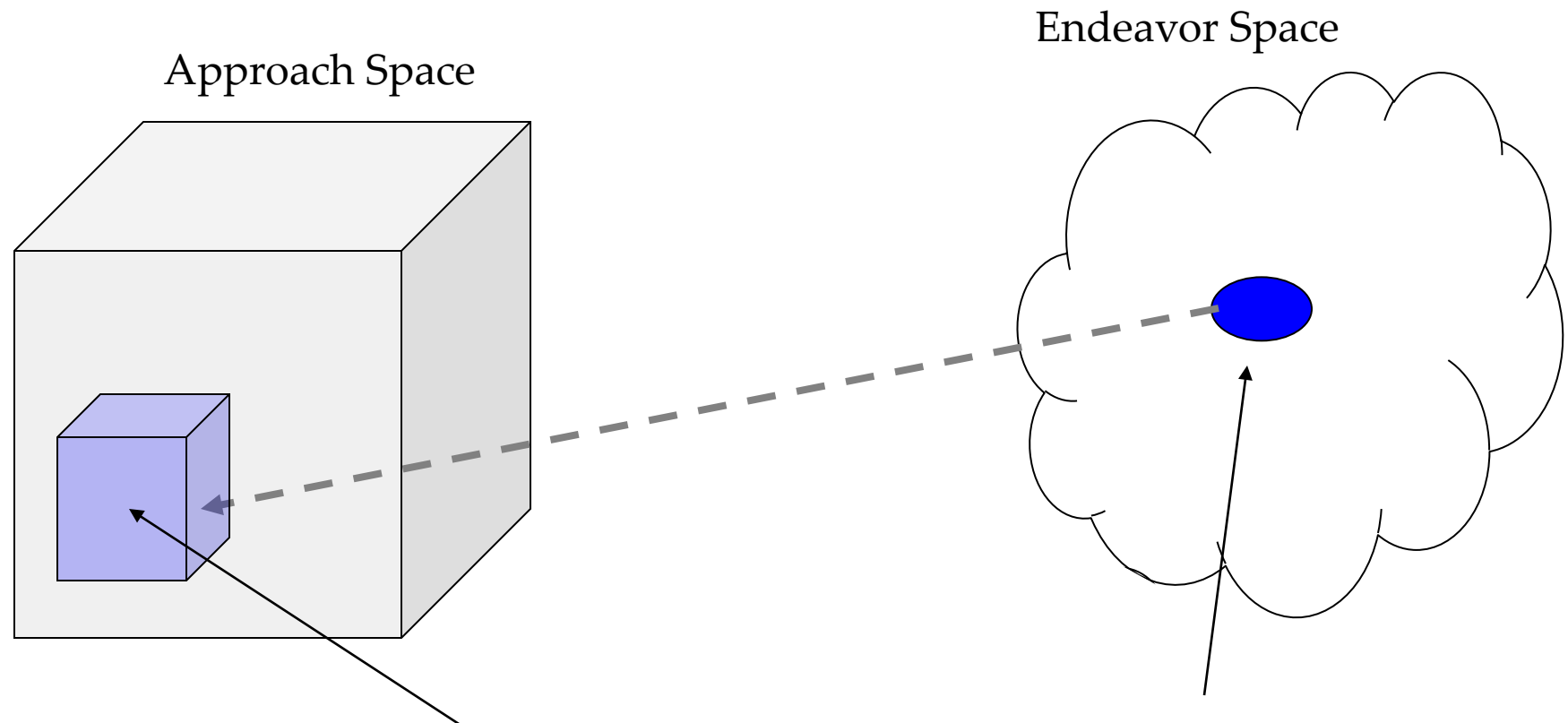
# Approach Agility Map

An Agility Map is a projection of performance onto  
Endeavor Space



Endeavor Space is a multi-dimensional space consisting of regions that correspond to different endeavor characteristics and conditions

# Approach Appropriateness

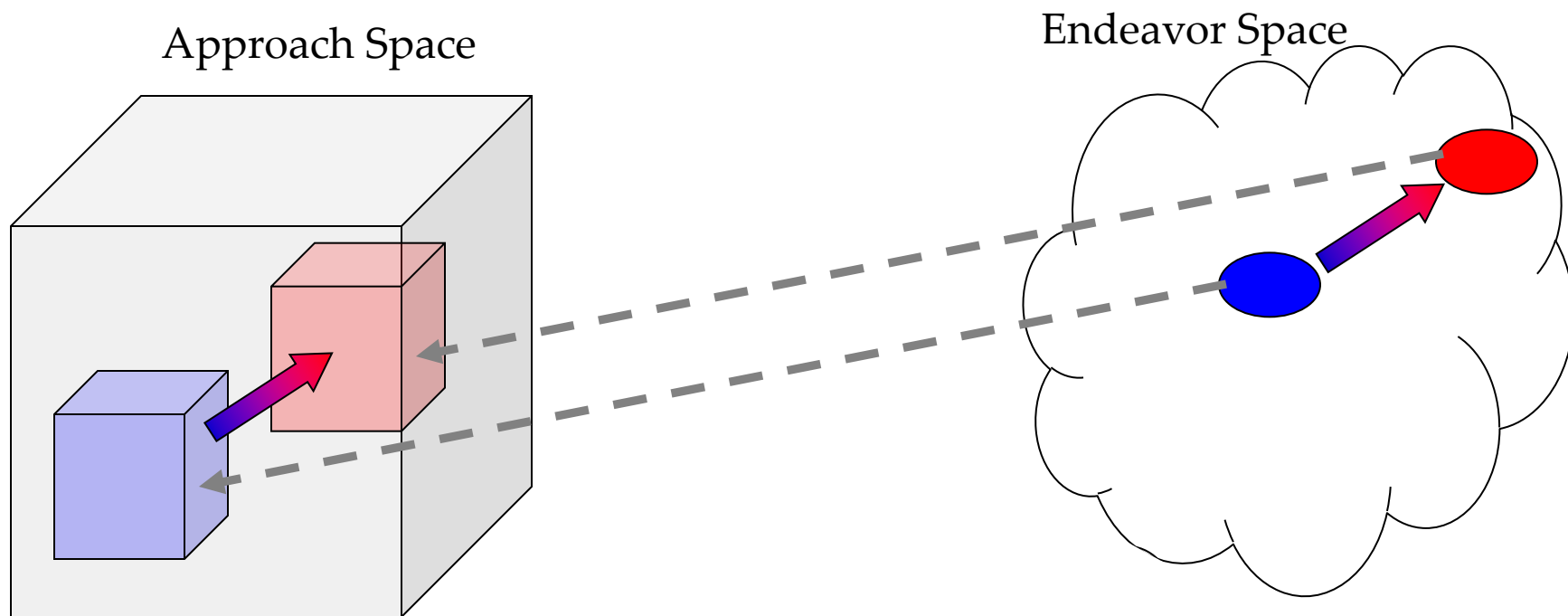


*This is a most appropriate Approach for this particular set of circumstances\**



# C2/M/G/F&C Agility

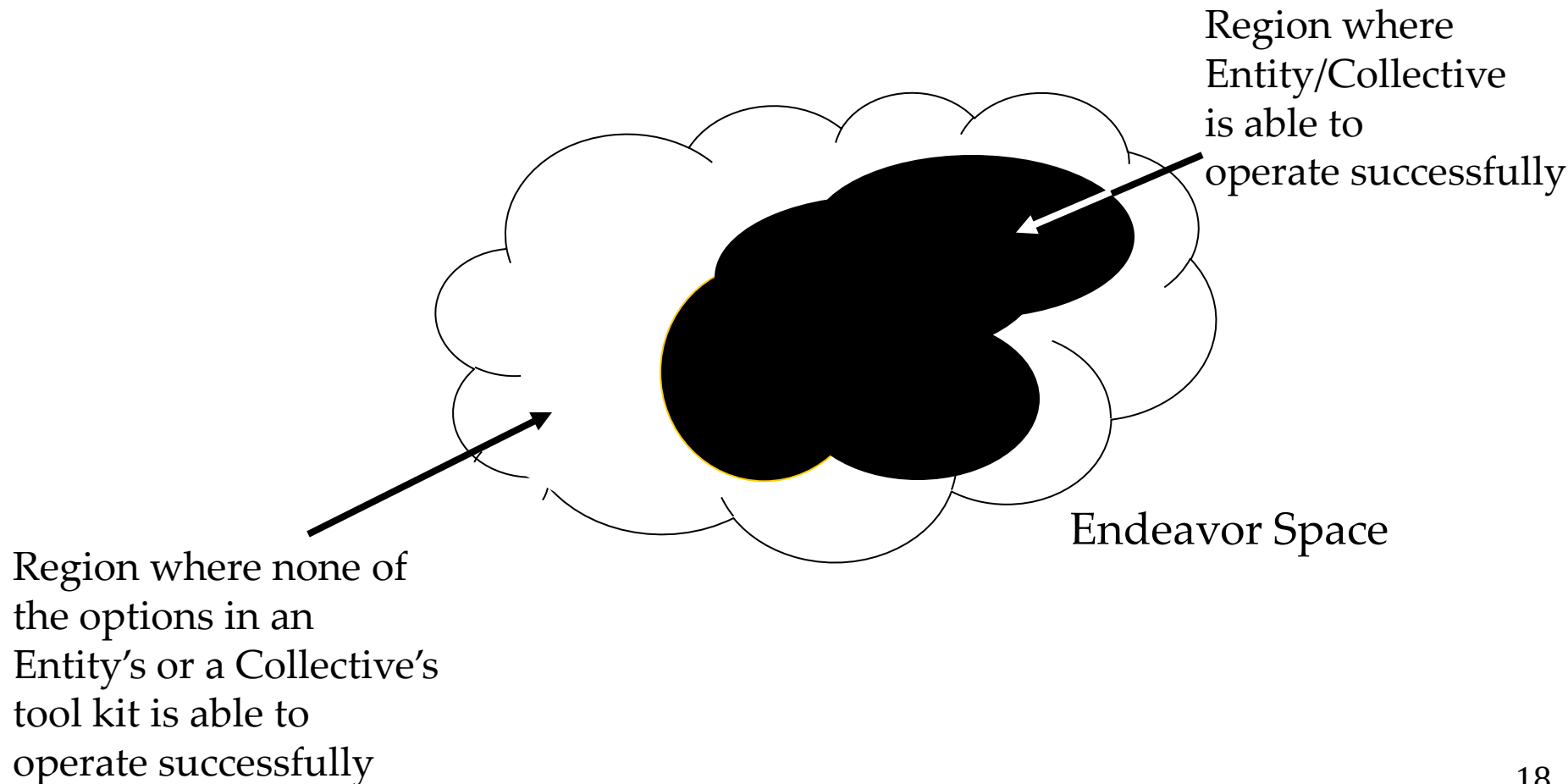
**When circumstances change, a different Approach may be more appropriate**



***C2/M/G/F&C Agility involves 1) recognizing the significance of a change in circumstances, 2) understanding the most appropriate Approach for the circumstance and 3) being able to transition to this approach.***

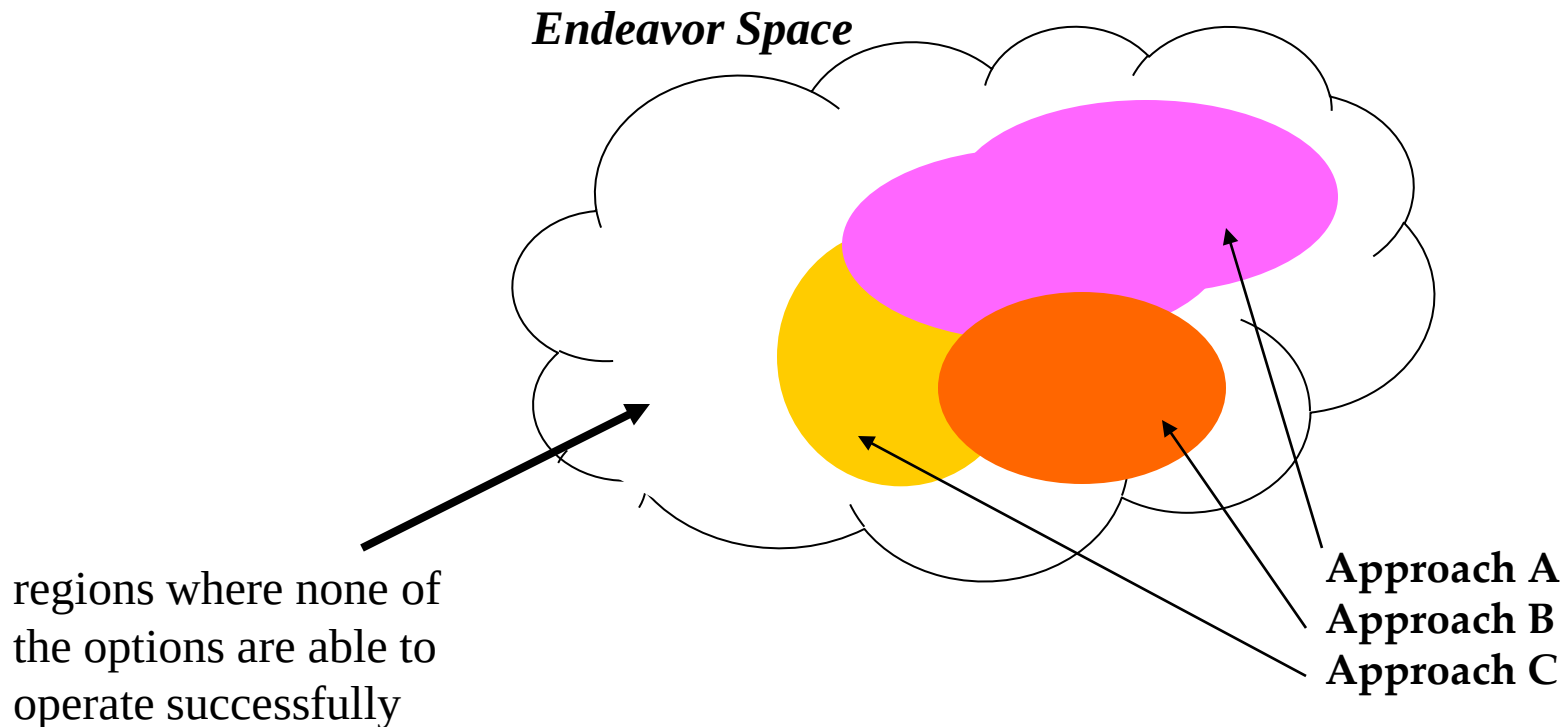
# Agility Map

Agility is a function of the Approaches that an Entity/Collective can employ



# Comparative Agility Map

A Comparative Agility Map shows the most efficient Approach for each region of Endeavor Space



# Metrics

- Endeavor Spaces can have a large number of dimensions, making it difficult to visualize and compare Agility Maps.
- Many desire a simple metric. A simple metric may be useful, if it is not misleading.
- Two candidates for a simple Agility metric:
  - % Endeavor Space Covered – the percentage of Endeavor Space where a particular approach or an Entity employing multiple approaches can successfully operate
  - Benchmarked Agility – involves a comparison between projected and expected performance

# Agenda

- What do you mean by Agility?
- How does one apply the concept of Agility to C2?
- How can we visualize and measure Agility?
- Does the evidence support the following assertions?
  - Different approaches work best in different situations
  - More networked-enabled Approaches are more agile
- Is there a relationship between Cybersecurity and Agility?

# Methodology

- Step 1: Define the Endeavor Space and the Approach Options to be considered
- Step 2: Conduct a series of experiments (simulation runs) for each Approach option under each mission-circumstance
- Step 3: Determine values for measures of effectiveness, timeliness and efficiency
- Step 4: Create Agility Maps and calculate values for Agility metrics

# Endeavor Space Dimensions

- Nature of the Mission Challenge
  - 4 Mission Challenges
  - from Industrial Age to Complex Endeavor
- Mission Requirements
  - 3 levels of Shared Awareness (low, medium, high)
  - 3 levels of Timeliness (low, medium, high)
- Signal-Noise in Data
  - 3 levels (no noise, 1/2 noise, 2/3 noise)
- Cognitive Complexity
  - 3 levels (low, medium, high)
- Level of Network Damage
  - 3 levels (none, 1 link down, 2 links down)

*972 combinations of mission / conditions*

# Approach Options

- Hierarchical
- Coordinated
- Collaborative
- Edge
- Post Only Edge
- Edge with Adaptive Information Sharing Policy



# Selected Results

- Approach Agility Maps and Metrics
- C2/M/G/F&C Agility Map
- Comparative Advantage Agility Map
- Impact of Adaptive Information Sharing Policy

# Hierarchical Approach Agility Map

(low cognitive complexity, no network damage)

 Satisfies Conditions

 Fails to Satisfy

no noise

normal noise

twice the noise

**Complex Endeavor  
Challenge**

high

Required  
Shared  
Understanding

med

low

|  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

no noise

normal noise

twice the noise

**Industrial Age  
Challenge**

high

Required  
Shared  
Understanding

med

low

|  |  |  |  |  |  |  |  |  |
|--|--|--|--|--|--|--|--|--|
|  |  |  |  |  |  |  |  |  |
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|  |  |  |  |  |  |  |  |  |

low med high

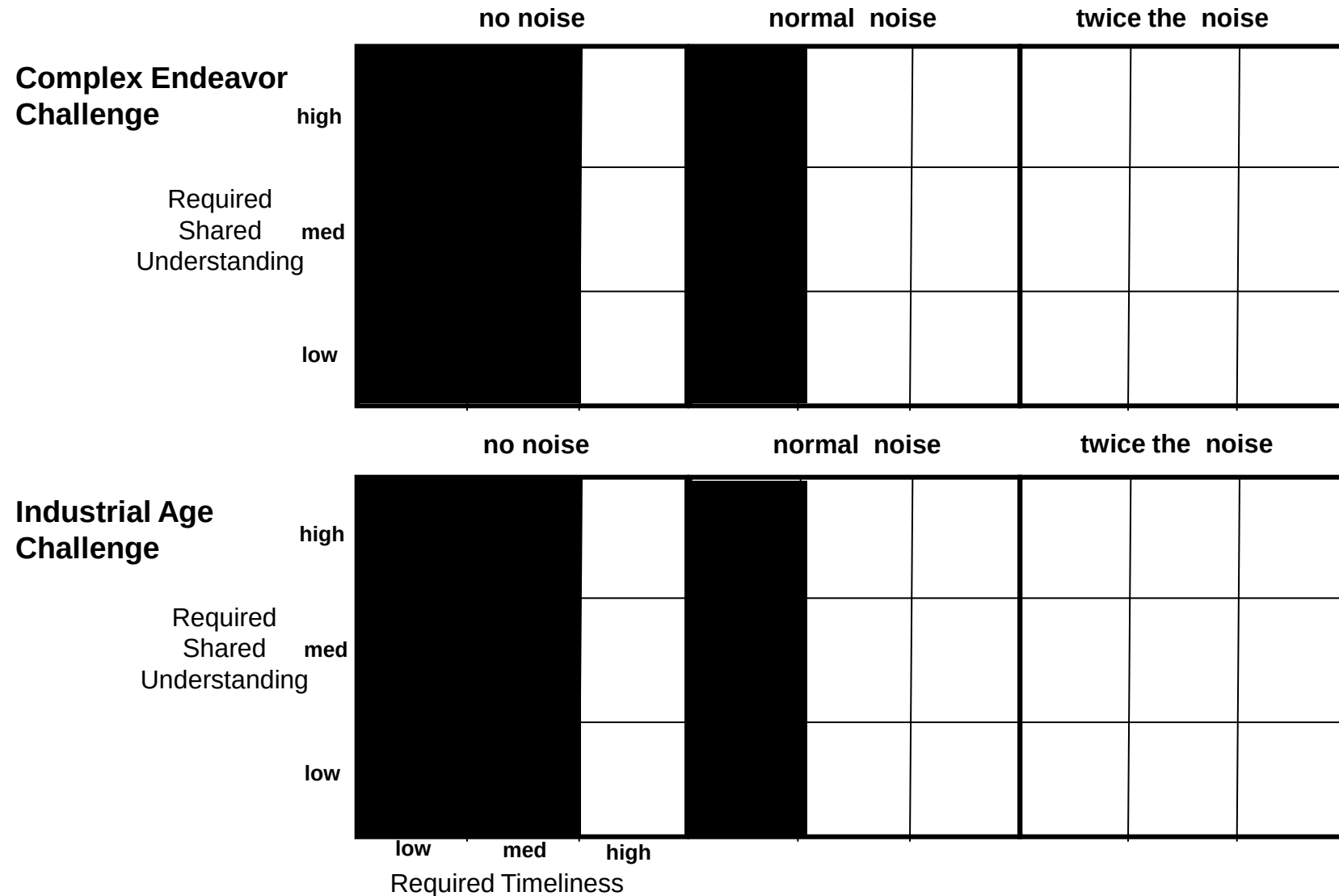
Required Timeliness

# Edge Approach Agility Map

(low cognitive complexity, no network damage)

 Satisfies Conditions

 Fails to Satisfy



# Agility Metrics

as a function of Organization-Approach Option

|                      | <b>Benchmarked<br/>Agility Metric<br/>(relative to<br/>expectations)</b> | <b>Agility Map Coverage<br/>(percent Endeavor<br/>Space where Entity<br/>can operate<br/>successfully)</b> |
|----------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Hierarchy</b>     | <b>16.6%</b>                                                             | <b>5.5%</b>                                                                                                |
| <b>Coordinated</b>   | <b>41.6%</b>                                                             | <b>9.2%</b>                                                                                                |
| <b>Collaborative</b> | <b>59.7%</b>                                                             | <b>26.5%</b>                                                                                               |
| <b>Edge</b>          | <b>56.5%</b>                                                             | <b>18.8%</b>                                                                                               |

# Agility Map

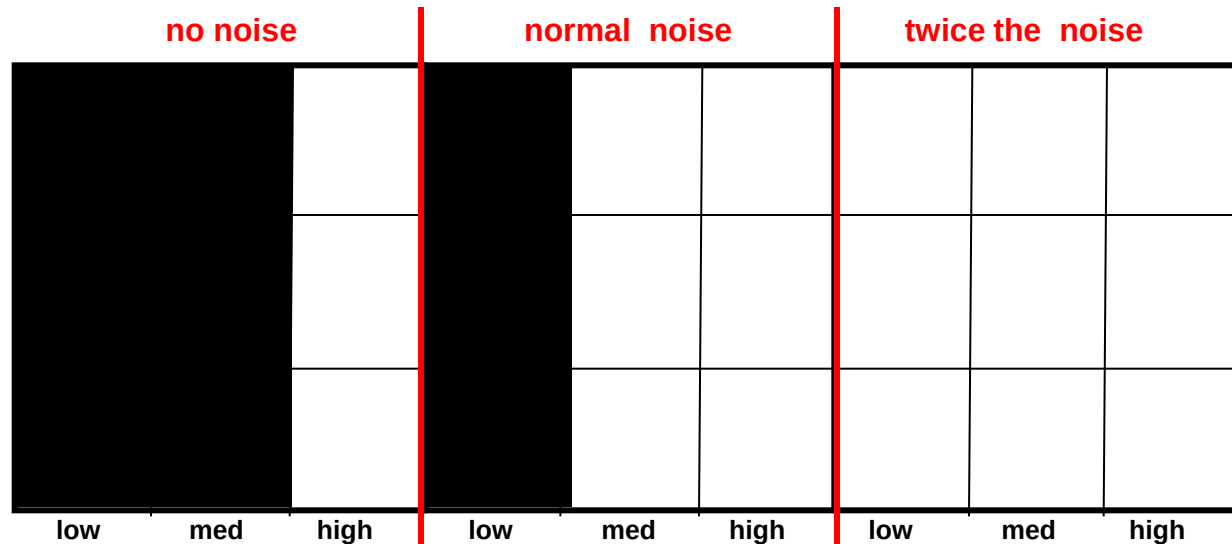
(low cognitive complexity, no network damage)

Approach Kit = Hierarchical + Collaborative + Edge

■ Satisfies Conditions  
□ Fails to Satisfy

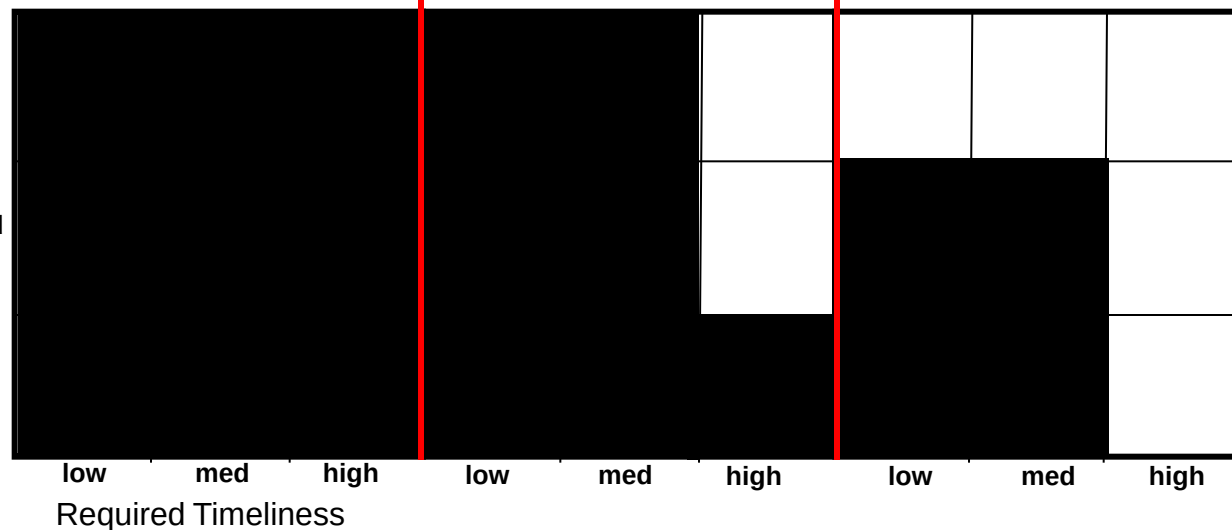
## Complex Endeavor Challenge

Required  
Shared  
Understanding  
high  
med  
low



## Industrial Age Challenge

Required  
Shared  
Understanding  
high  
med  
low



# Comparative Agility

*as a function of shared understanding, timeliness and noise*  
*cognitive complexity = low; no network damage*

## Industrial Age Challenge

Either the only approach that is successful or,  
in the case when more than one approach  
is successful, the entry is the most efficient one

**no noise**

|                               |                |     |      |
|-------------------------------|----------------|-----|------|
| high                          | E              | E   | E    |
| med                           | E              | E   | C    |
| low                           | E              | E   | H    |
| Required Shared Understanding | low            | med | high |
|                               | Required Speed |     |      |

|      |                |     |      |
|------|----------------|-----|------|
| high | E              | E   | -    |
| med  | E              | C   | -    |
| low  | E              | C   | H    |
|      | low            | med | high |
|      | Required Speed |     |      |

**twice the noise**

|      |                |     |      |
|------|----------------|-----|------|
| high | -              | -   | -    |
| med  | C              | C   | -    |
| low  | C              | C   | -    |
|      | low            | med | high |
|      | Required Speed |     |      |

|   |               |
|---|---------------|
| E | Edge          |
| C | Collaborative |
| C | Coordinated   |
| H | Hierarchy     |
| - | None          |

# Selected Results

- Approach Agility Maps and Metrics
- C2/M/G/F&C Agility Map
- Comparative Advantage Agility Map
- Impact of Adaptive Information Sharing Policy

# Information Sharing Policy

- The default information sharing policy for all Approach options involves both direct sharing (individual to individual) and web site posting / pulling
- Experiments were conducted with other information sharing policies including “share only” and “post only.” These policies remained in effect throughout the runs
- An adaptive information sharing policy was also developed to allow individuals to adapt their behaviors to changed circumstances (e.g. the loss of a web site)



# Impact of Post Only Information Sharing Policy on Edge Approach Agility

|                       | <b>Benchmarked Agility<br/>Metric<br/>(relative to<br/>expectations)</b> | <b>Agility Map Coverage<br/>(percent Endeavor<br/>Space where Entity<br/>can operate<br/>successfully)</b> |
|-----------------------|--------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------|
| <b>Hierarchy</b>      | <b>15.8%</b>                                                             | <b>5.5%</b>                                                                                                |
| <b>Coordinated</b>    | <b>41.0%</b>                                                             | <b>9.2%</b>                                                                                                |
| <b>Collaborative</b>  | <b>59.3%</b>                                                             | <b>26.5%</b>                                                                                               |
| <b>Edge</b>           | <b>56.1%</b>                                                             | <b>18.8%</b>                                                                                               |
| <b>Post Only Edge</b> | <b>77.1%</b>                                                             | <b>51.5%</b>                                                                                               |

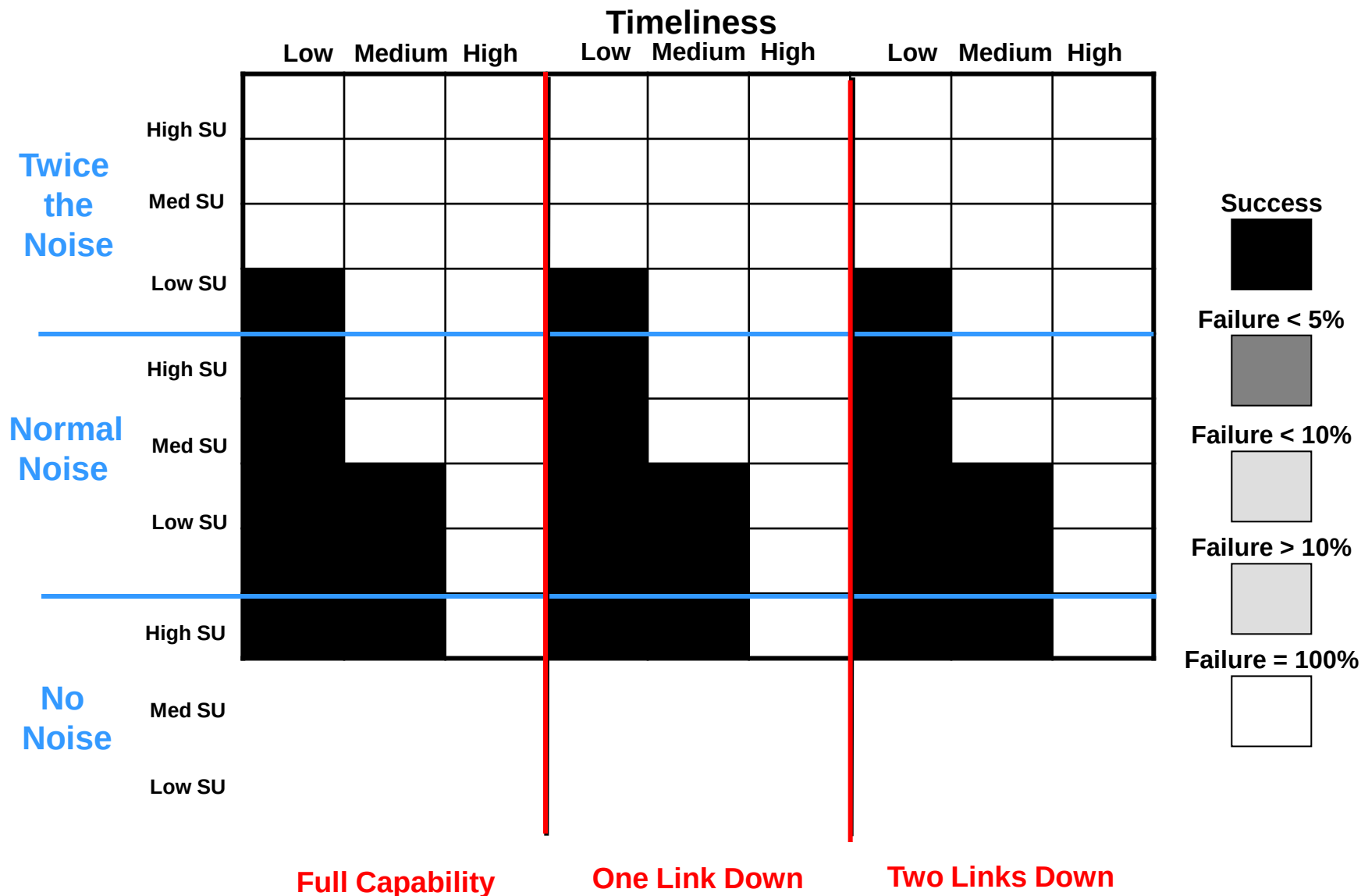
# Impact of *Adaptive* Information Sharing Policy on Edge Approach Agility

- An Edge Approach is well suited to situations, but does not perform well work load exceeds a certain threshold (e.g. noise conditions are high)
- A Post Only Edge out performs the Edge when noise conditions are high but is vulnerable to network damage
- A Edge that can adopt its information sharing behaviors to suit the conditions combines the best of both approaches

# Edge Approach Agility Map

## Industrial Age Challenge

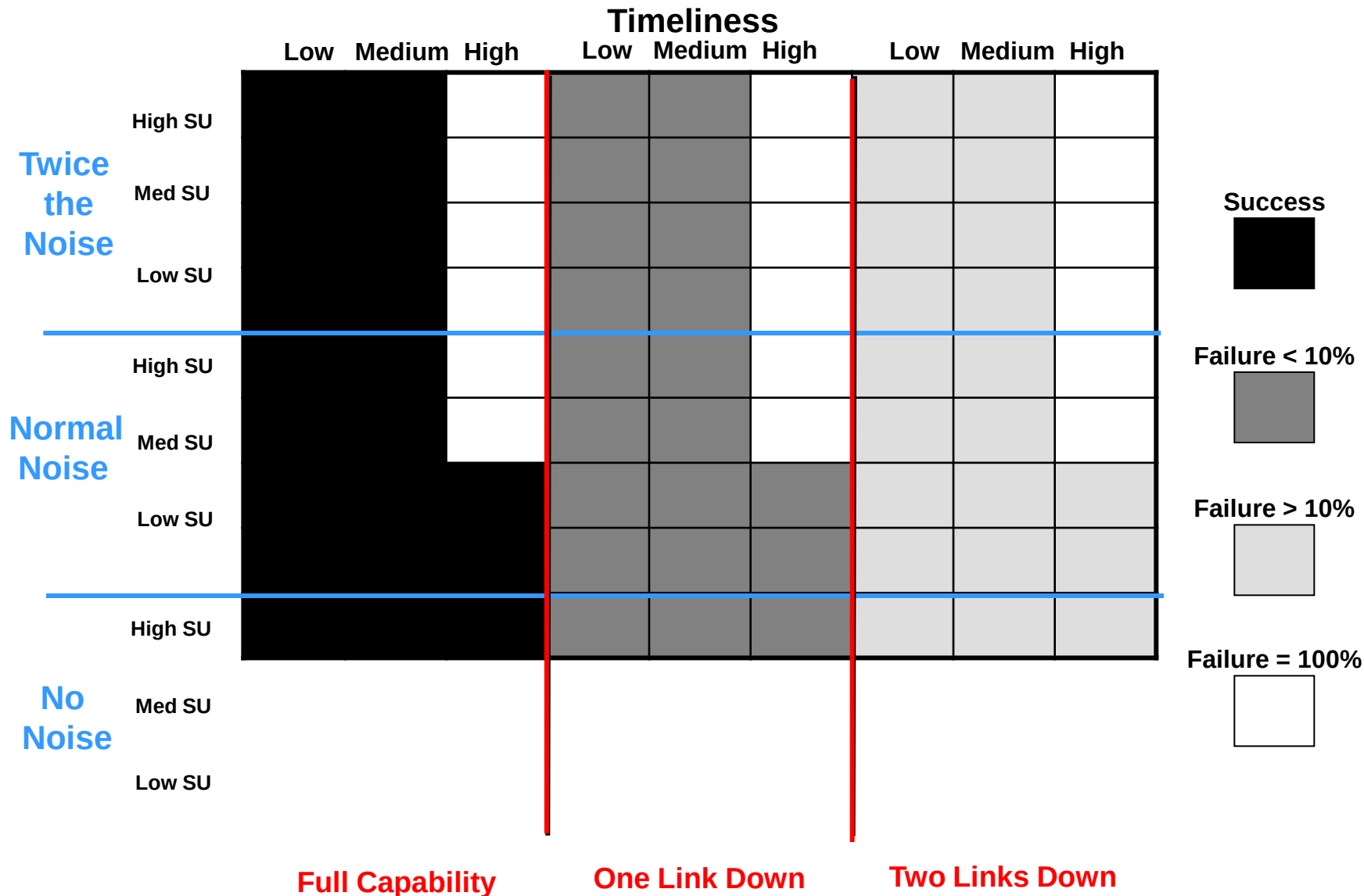
Under Varying Noise and Sustained Network Damage



# Post Only Edge Approach Agility Map

## Industrial Age Challenge

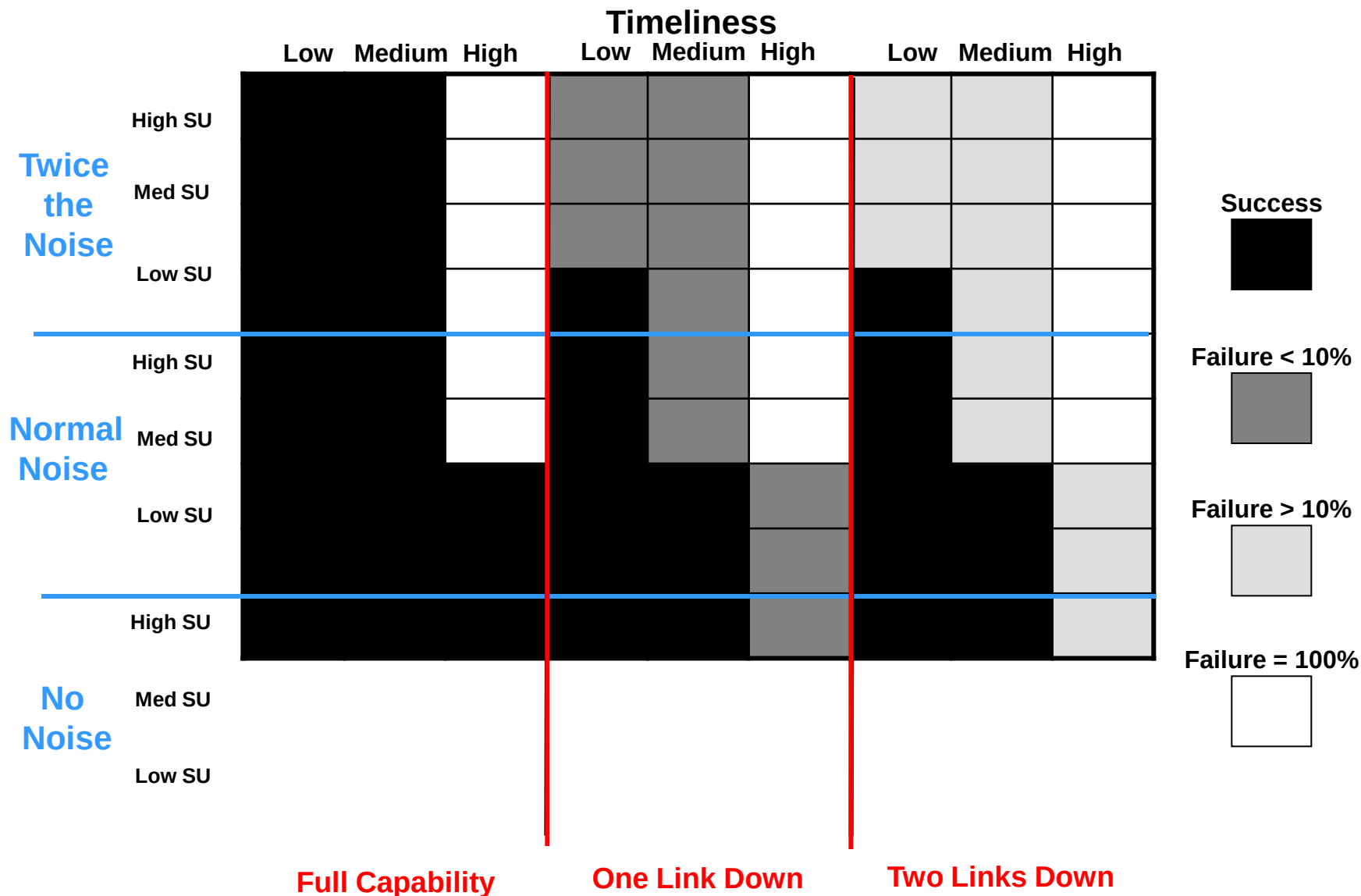
### Under Varying Noise and Sustained Network Damage



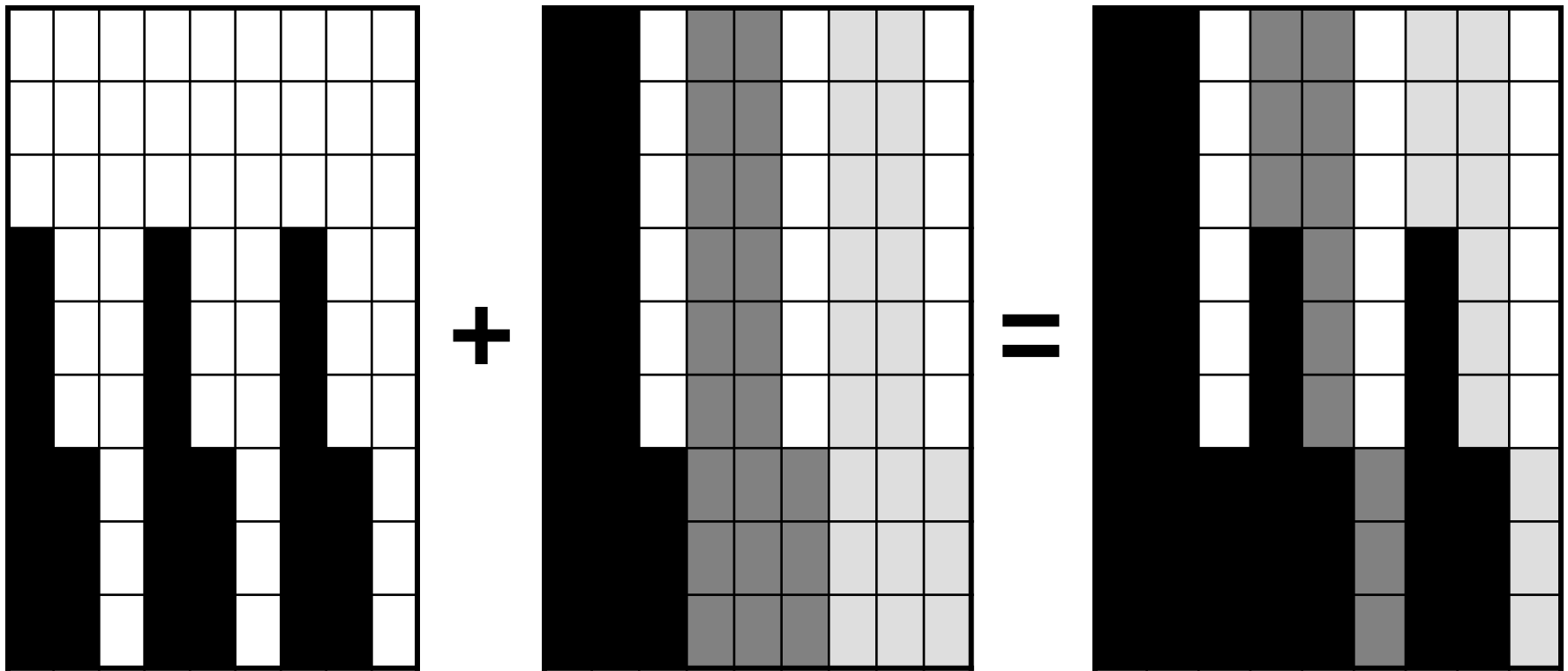
# Edge Approach with an Adaptive Policy

## Industrial Age Challenge

### Under Varying Noise and Sustained Network Damage



# Impact of an Adaptive Policy



# Impact of Adaptive Policy

|                       | <b>Benchmarked Agility<br/>Metric<br/>(relative to<br/>expectations)</b> | <b>Agility Map Coverage<br/>(percent Endeavor<br/>Space where Entity<br/>can operate<br/>successfully)</b> |
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| <b>Edge</b>           | <b>56.1%</b>                                                             | <b>18.8%</b>                                                                                               |
| <b>Post Only Edge</b> | <b>77.1%</b>                                                             | <b>51.5%</b>                                                                                               |
| <b>Adaptive Edge</b>  | <b>78.1%</b>                                                             | <b>53.0%</b>                                                                                               |

*Simple metrics can be misleading!*

## Findings and Conclusions

- Agility can be depicted and measured; simple metrics must be used with caution
- No Approach is best in all circumstances
- Network-enabled Approaches have the potential to be more agile
- Adaptive information sharing policies enhance Agility
- Being able to employ multiple Approaches enhances Entity or Collective Agility
- Cybersecurity and Agility are related
- Formulating the Endeavor Space appropriately is, perhaps, the most challenging aspect of Agility-related analysis



# Questions ?