Arke Ltd

Strategic Cyber Cost-Effectiveness Analysis

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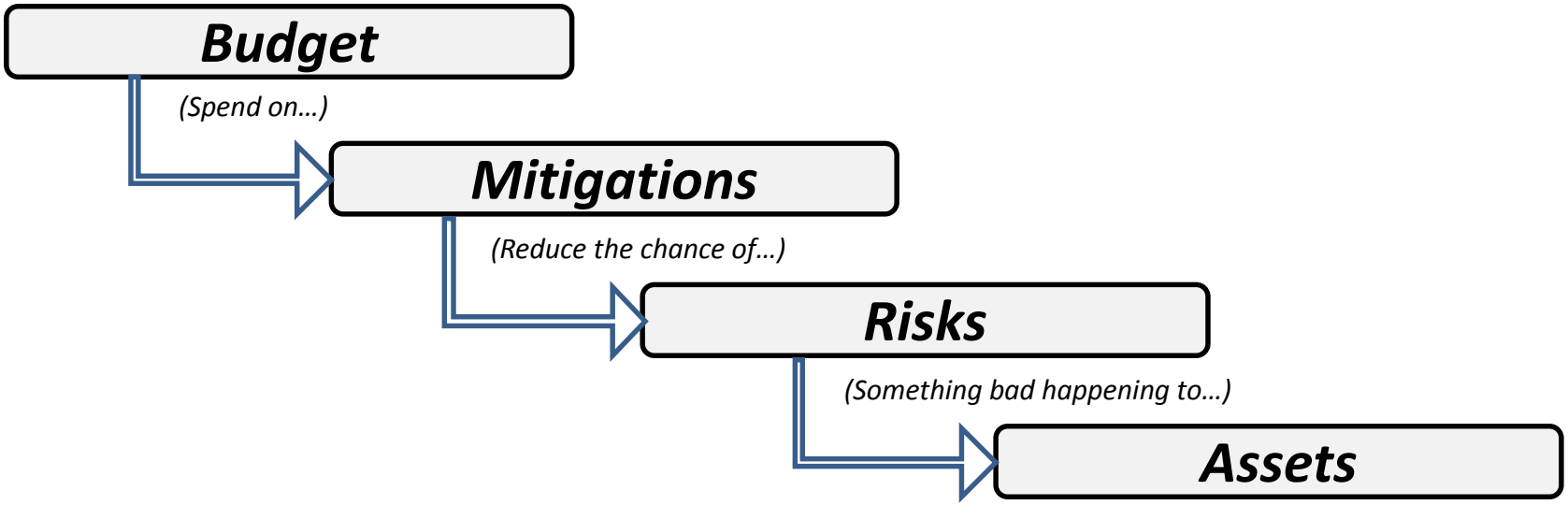
Brief Introduction

- Arke → Cost analysis, cost effectiveness and cost benefit

- Aim to present our thinking…
  - *Cost-Effectiveness/Cost-Benefit analysis of Cyber security…*
  - Different to the norm?
  - Interesting challenges?
  - How to address challenges?

To keep track:

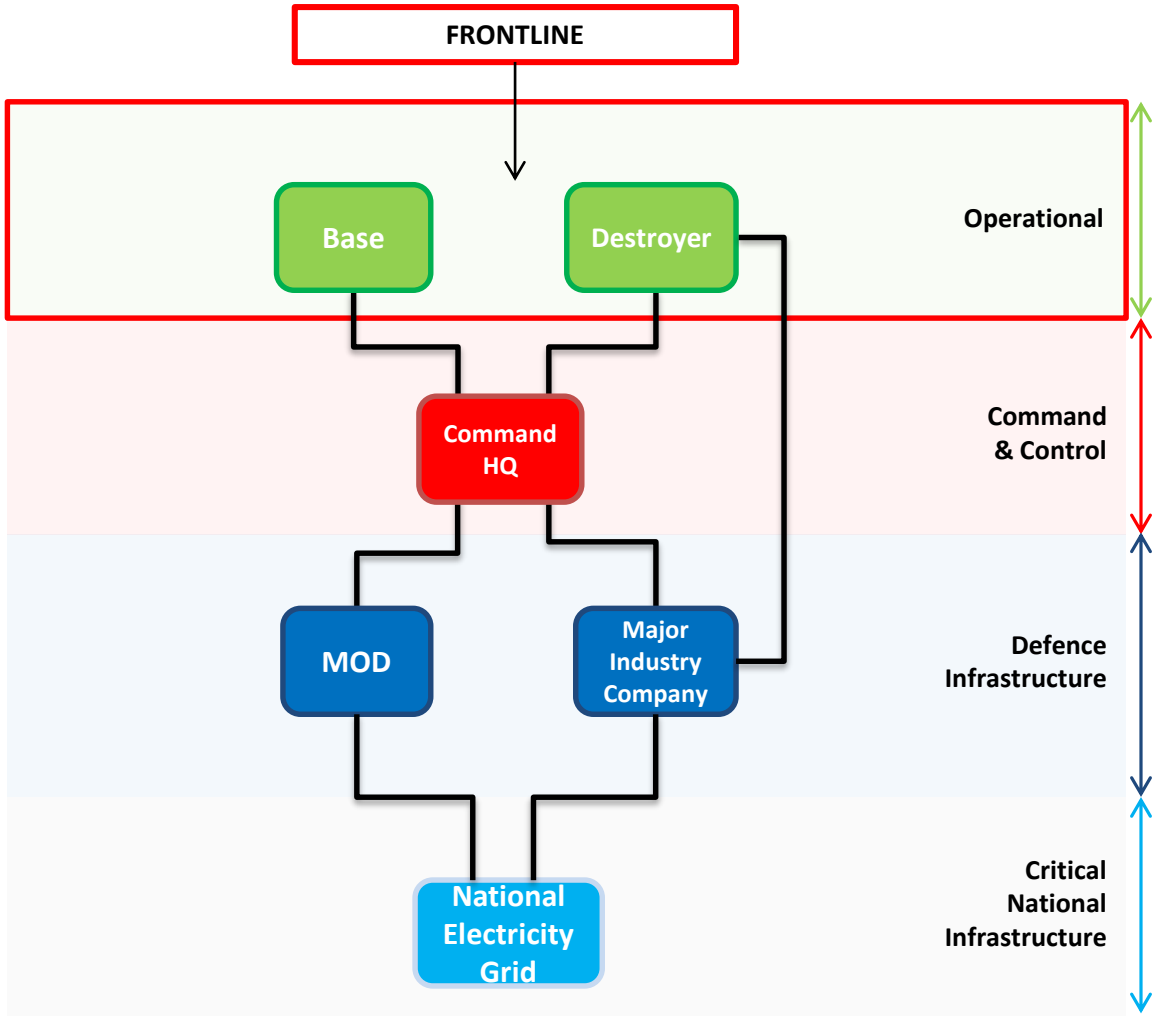
Usual Spending Decisions



Key aspects for usual cases…

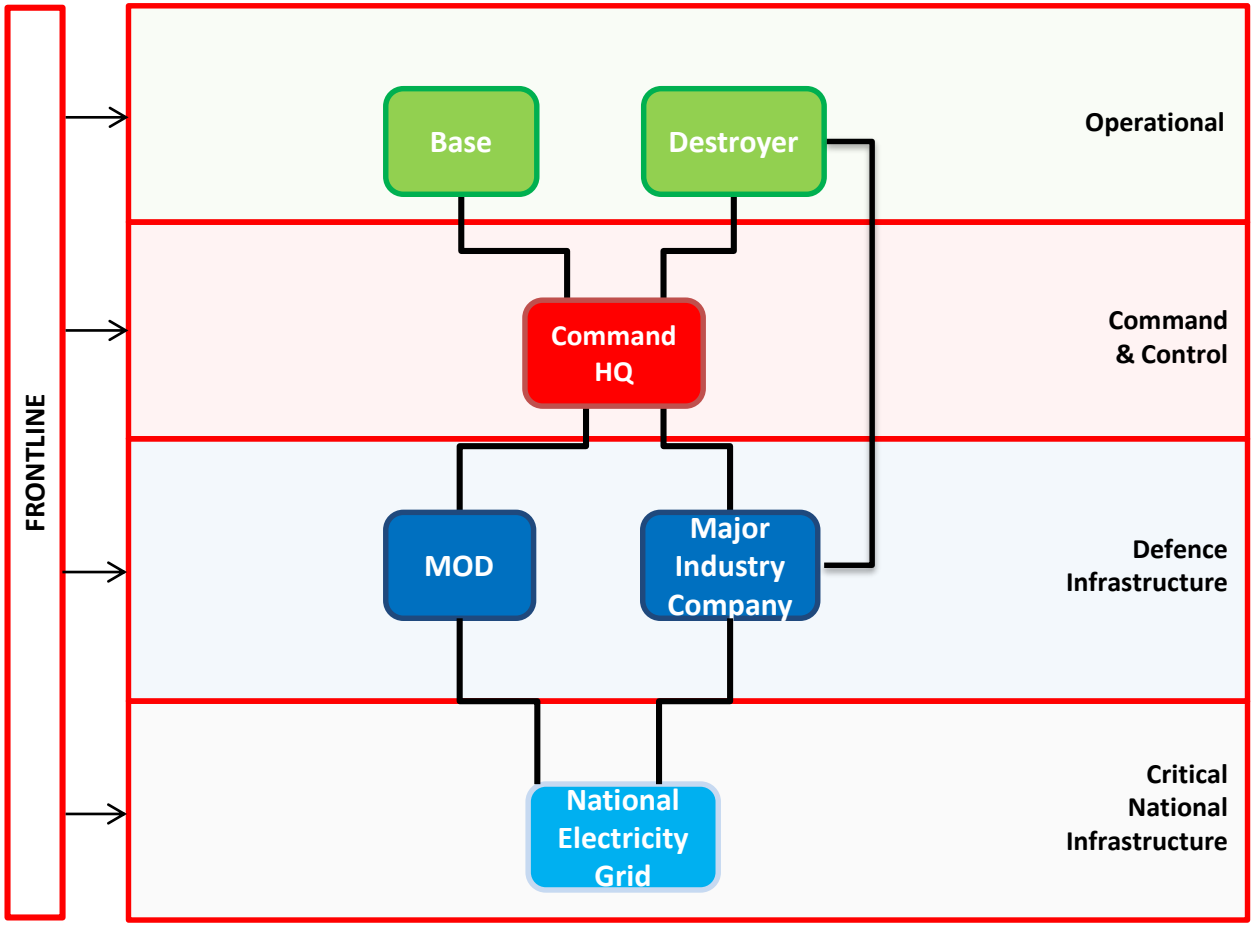
- Cost-Effectiveness directly related → ***value for money*** for taxpayer
  - Through defence perspective
- Assets → Entirely defence
- Assets → Not necessarily interconnections/interdependencies

Assets and Infrastructure: Strategic Level



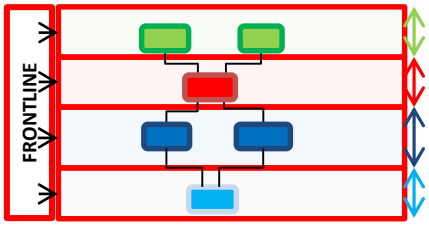
- Representation:
  - Network of nodes
- Nodes layered from the fighting end to the infrastructure that it depends upon in the long term
- Usually, risk of 'attacks' considered at the operational end.

Assets and Infrastructure at Risk



- Representation:
  - Network of nodes
- Nodes layered from the fighting end to the infrastructure that it depends upon
- Communication with each other and some might depend on others to function
- Usually, risk of attacks considered at the operational end.
- All exposed to cyber security risks

Cyber Security



Budget

(Spend on…)

Mitigations

(Reduce the chance of…)

Risks

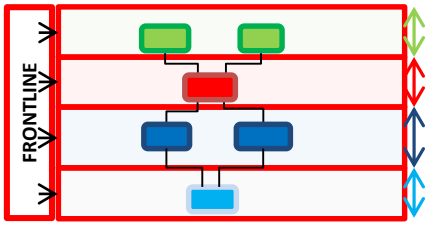
(Something bad happening…)

Assets

Key aspects for cyber security…

- Cost-Effectiveness directly related → ***value for money*** for taxpayer
  - Through defence, ***trade, energy.. Etc.***
- Assets → Not all entirely Defence
- Assets → Have interconnections/interdependencies

Defining Problem → **Approach** → **Process** → **Benefits of Process** → **Future?**



New problems with cyber security

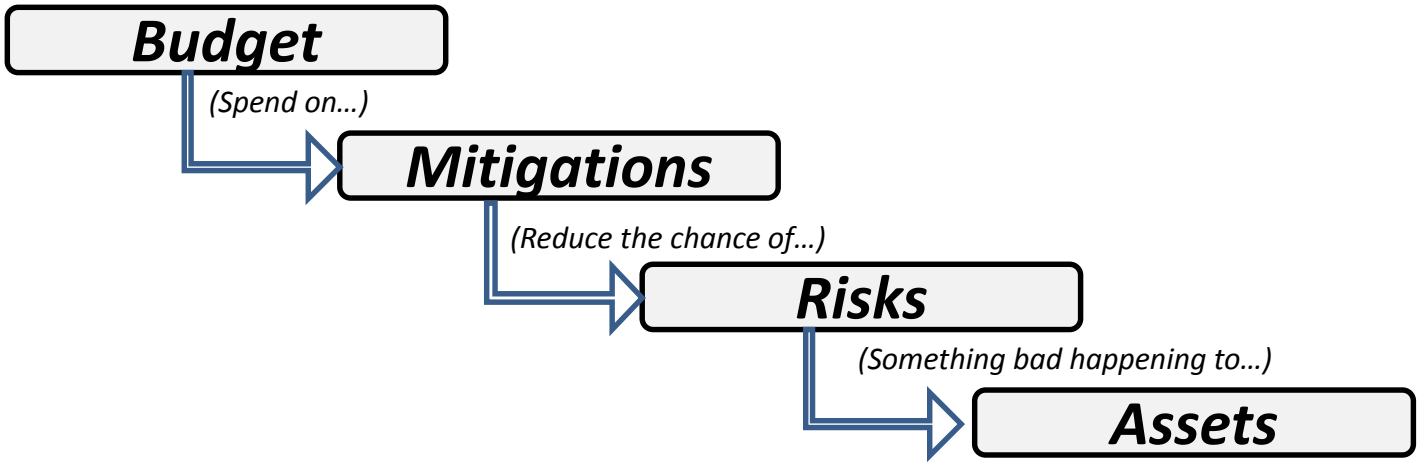
1. Wider Impacts (than just defence)

2. Risks propagate (between nodes)

Approach – Framework/Process

High-level understanding → Best way to spend money?

- On reducing chance of successful cyber attacks



Challenges

- Wider Impacts (than just military)

Influencing our approach

- Reflect principles of assessing risks to information systems in the UK

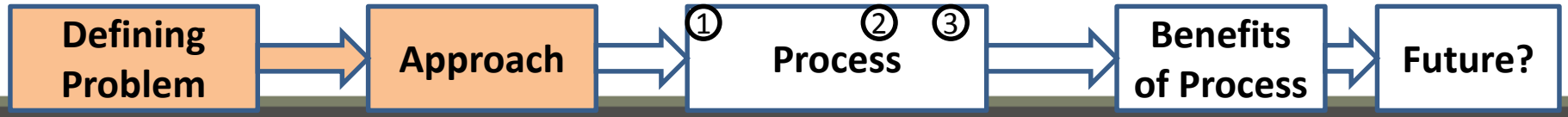
- "HMG Information Assurance Standard 1 – Technical Risk Assessment" (Government Standard) for information system risk assessment

  - Assess core goals of Information Assurance separately
    - *Confidentiality* -> Loss of privacy
    - *Integrity* -> Loss of trust
    - *Availability* -> Loss of presence

  - Assess relevant impact categories separately ('Business Impact Levels') e.g.
    - *Military Operations*
    - *Trade*
    - *Energy… etc.*

Assessing Cost-Effectiveness

1. **Quantifying Risks**
   - a. *CHANCE* of a successful attack
   - b. *IMPACT* of a successful attack
2. **Effectiveness of mitigations**
   - Highest ***reduction in probability*** of successful attack
   - (want to reduce risks where they have a ***high impact***)
3. **Cost**
   - a. Estimated costs of ***implementing mitigations***
   - b. Estimated costs of *risks* ***affecting nodes***



1 Quantifying Risks

ⓐ *CHANCE* of a successful attack

- Probability of successful attack – based on…
  - different parameters for different risks
- Example *Risks* could be quite different

Indicative Parameters

1.	*Compromised Hardware*	->	*quantities procured, percentage compromised*
2.	*IP Theft*	->	*# of people security cleared, percentage threats*
3.	*DOS attack – national scale*	->	*SME judged /work-shopped quantities?*

- Parameters may have different values for each node in the network

1 Quantifying Risks

ⓐ *CHANCE* of a successful attack

- Uncertainty – MUST capture the 'error margins'
  - Three point estimating
  - E.g. 'Best Case', 'Most Likely', 'Worst Case' → Weighted mean value
  - Manually set distributions – eliciting uncertainty

- Range of inputs
  - Background work → through to → best judgement

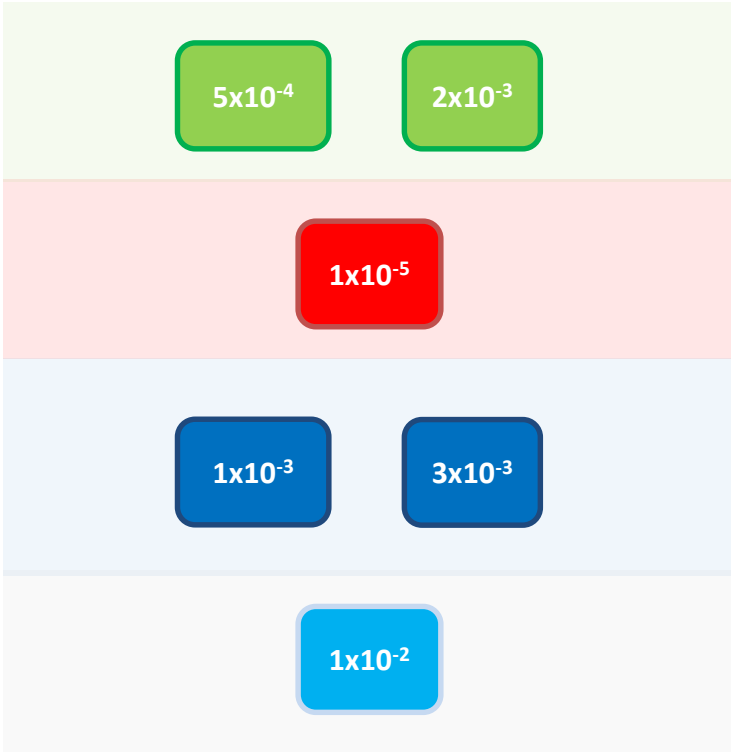
- Identify and engage relevant Subject Matter Experts

ⓐ *CHANCE* of a successful attack

Risk Propagation - problem

- For Risk x
  - Mean probability of occurrence at each node
- ***Usually***
  - (unmitigated) probabilities of occurrence
  - 'at risk' assets not connected
- ***Cyber***
  - consider propagation of risks
  - 'at risk' assets are connected

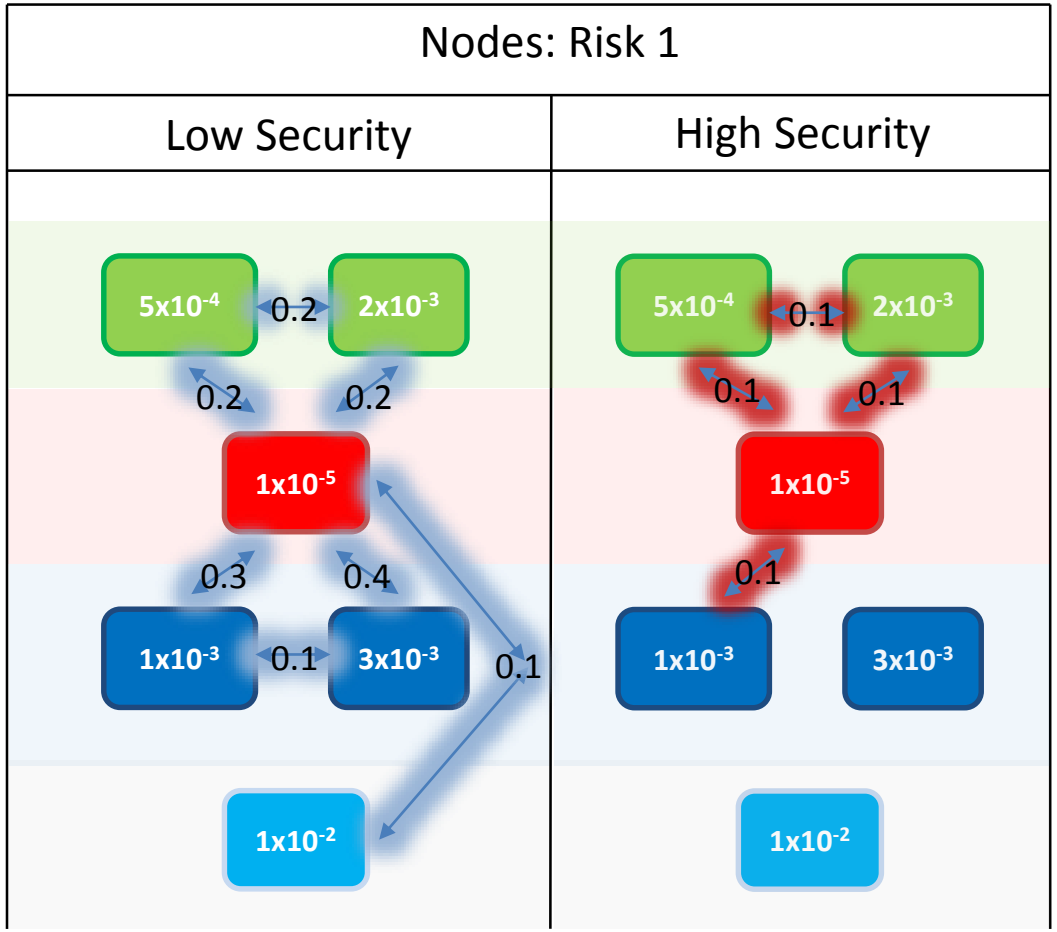
Nodes: Risk 1



ⓐ *CHANCE* of a successful attack

Risk Propagation - treatment

- Two connection types?
- ***Conditional probabilities***
  - Per risk per connection?
  - Two-way value, or one-way values?
- Implications
  - Simulation/modelling of probability
  - Triggers an impact at the node



- **Summary –** *CHANCE* of a successful attack

  - Detailed/not detailed info on risks
  - Capture uncertainty
  - Probabilities of Propagation
  - Use Subject Matter Expert judgement (where needed)

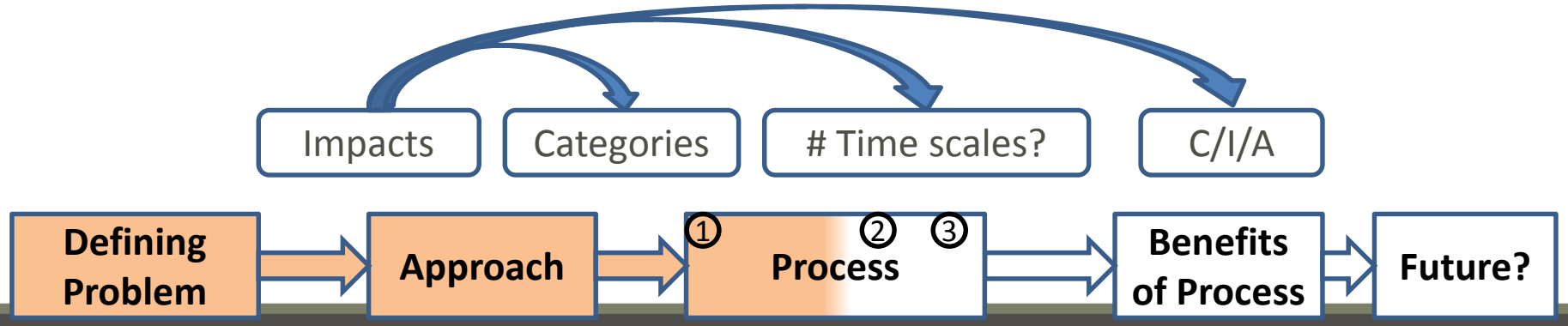
ⓑ *IMPACT* of a successful attack

Impact

- How bad is the loss of an asset?

1. ***Categories*** e.g. …
   - Military Operations
   - Trade
   - Energy
2. ***Time scale***
3. ***Confidentiality, Integrity or Availability***

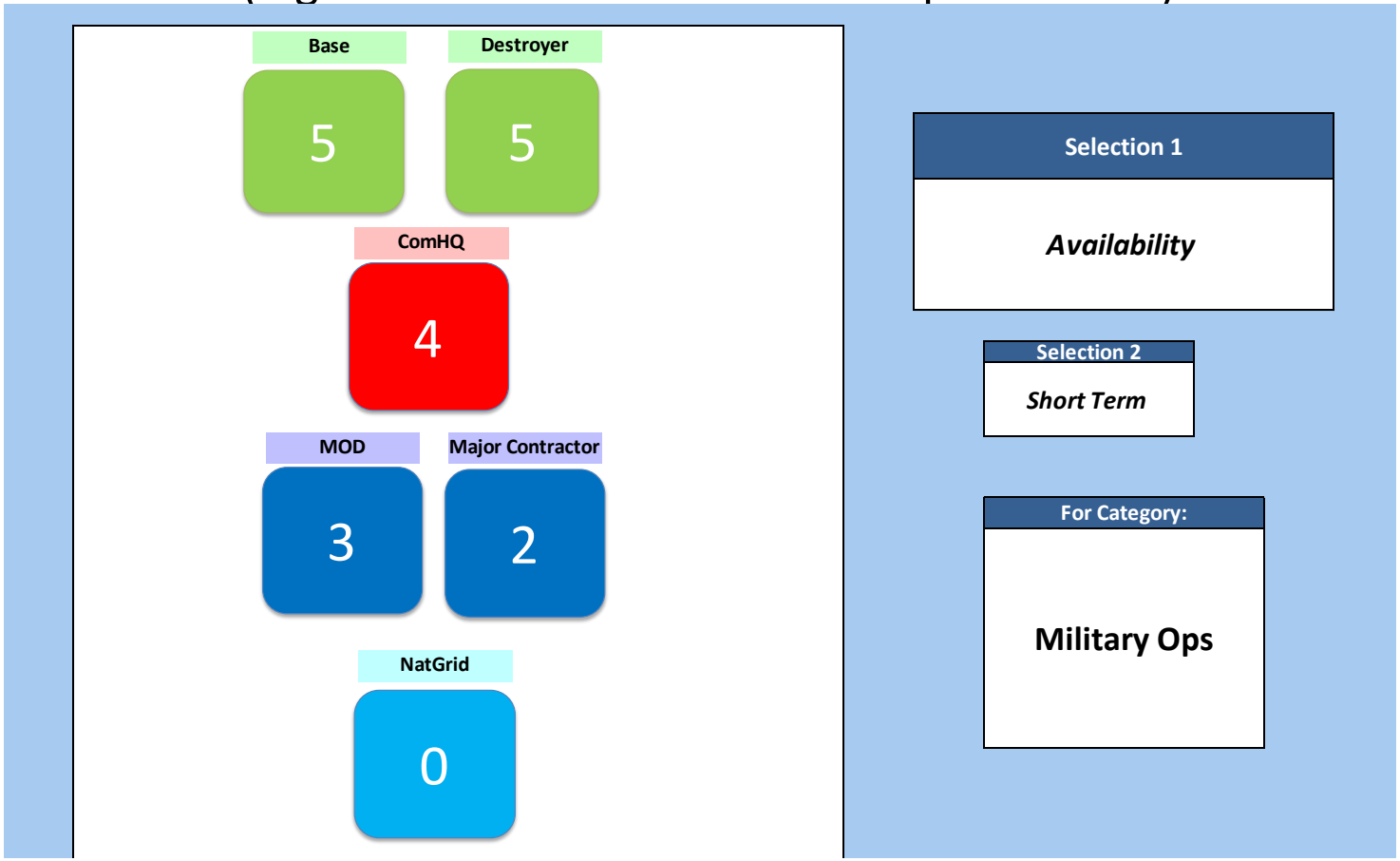
(loss of privacy, loss of trust, loss of presence)



1 Quantifying Risks

ⓑ *IMPACT* of a successful attack

- What is the impact of a successful attack?
- Score 0→6 (e.g. consistent with 'Business Impact Levels')



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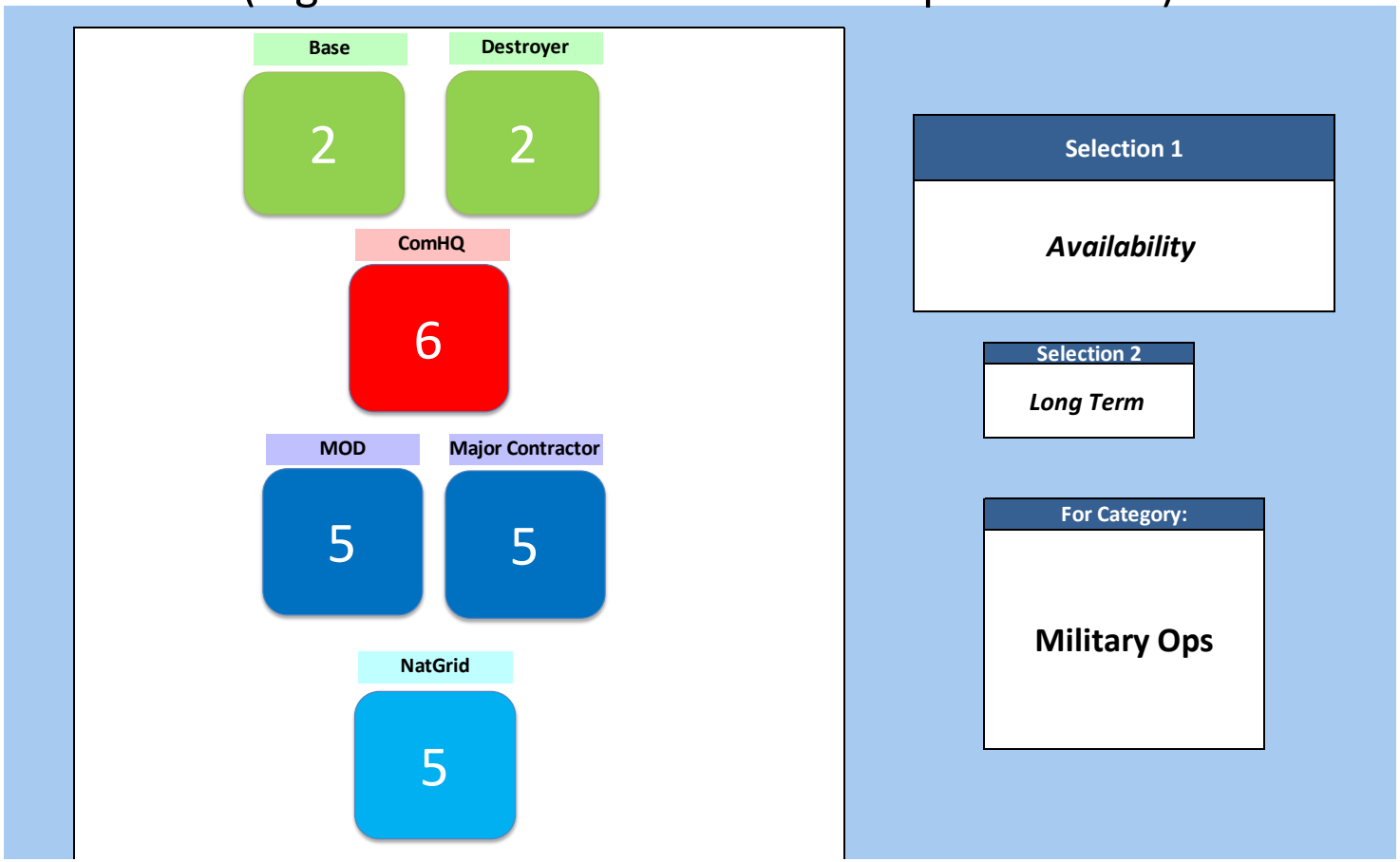

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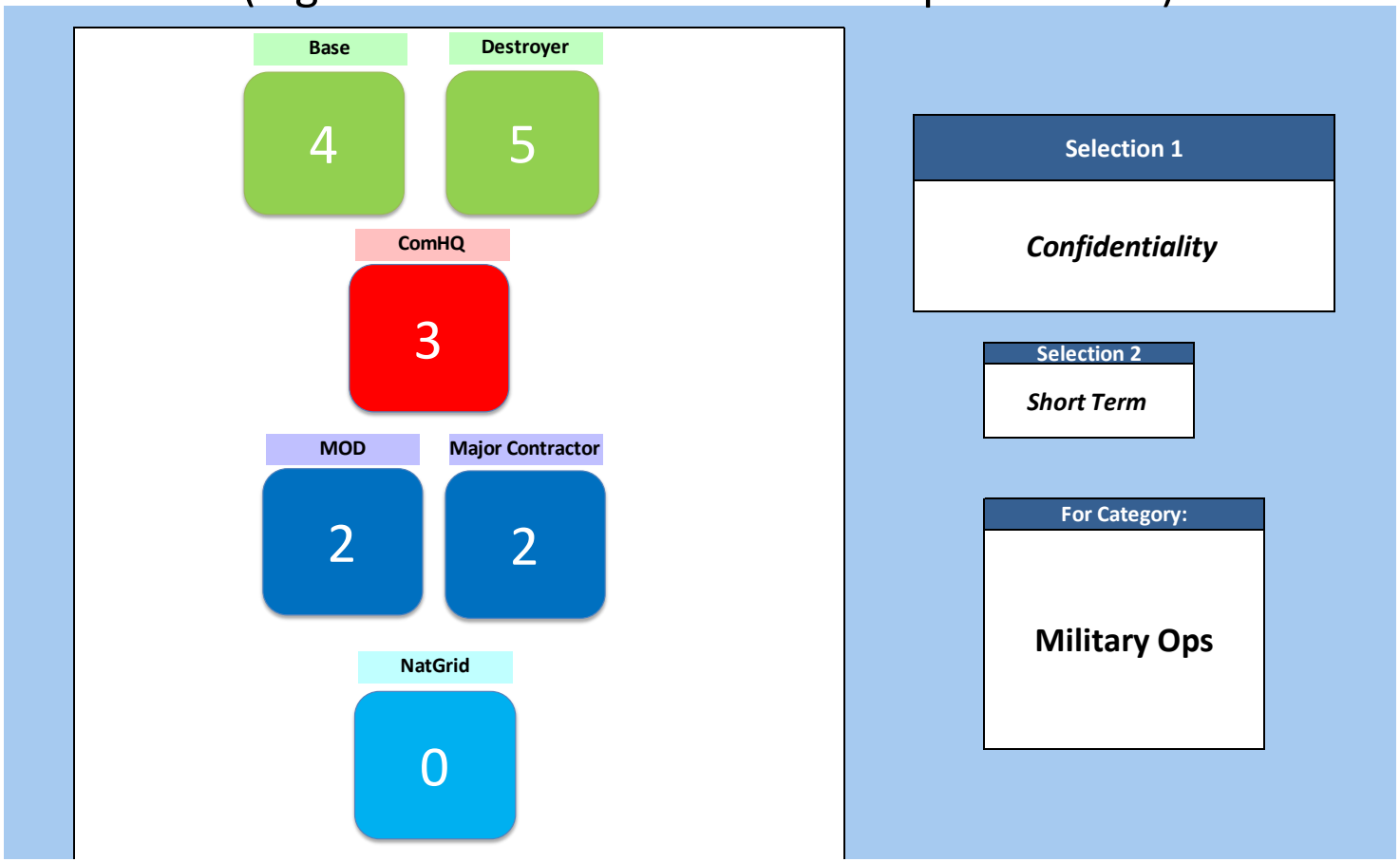

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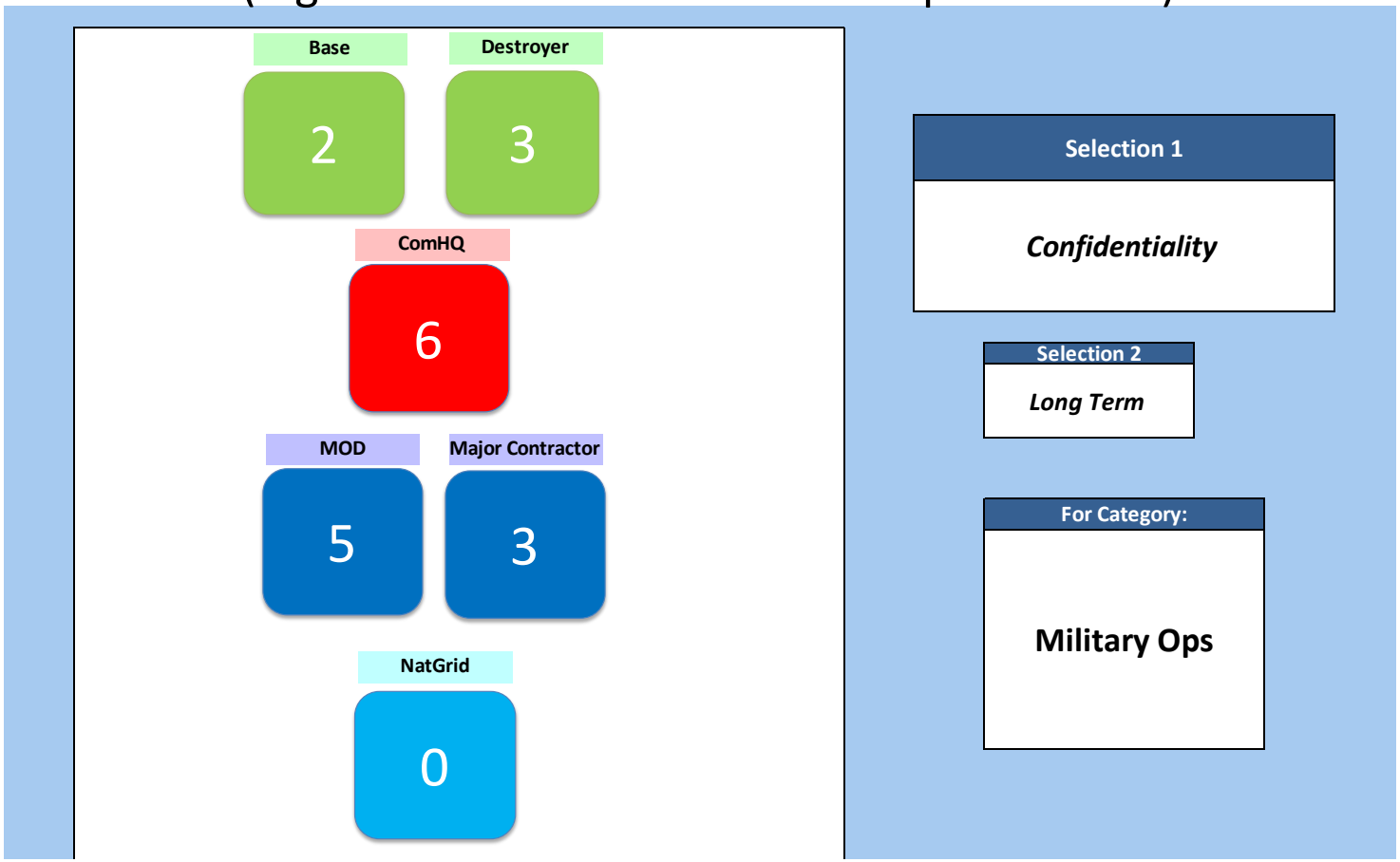


- **Summary –** *IMPACT* of a successful attack
  - Minimum information to capture wider impacts:
  - Categories
  - Time Scales
  - Confidentiality, Integrity, Availability

2 Effectiveness of Mitigations

2

- **Effectiveness of mitigations**
  - How much does ***CHANCE*** of a successful attack ***decrease?***
  - (how high an impact might there be if attack is successful)

- Similar to assessing ***CHANCE of a successful attack…***

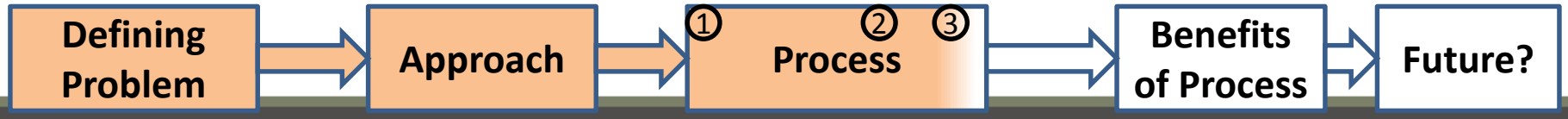
  - **Summary –**

    - Detailed/not detailed info on mitigations
    - Capture uncertainty
    - Probabilities of Propagation
    - Use Subject Matter Expert judgement (where needed)

3

- **Costs**
  - ⓐ Estimated costs of ***implementing mitigations***
  - ⓑ Estimated cost impact of *risks* ***affecting nodes***

- **Q. How complex might the estimating be?**



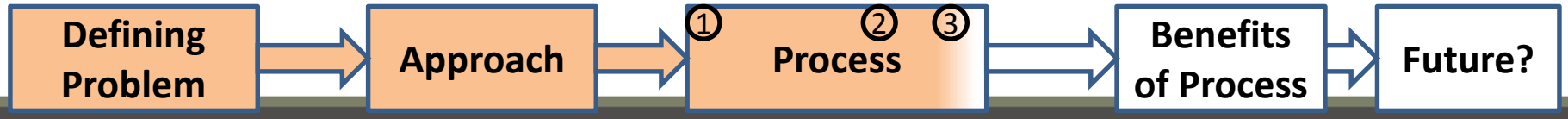
ⓐ Mitigations

e.g.

1. Reduce chance of an Edward Snowden?
   - *Interview all personnel with security clearance X, every 5 years*
2. Reduce chance of buying compromised hardware?
   - *Set up and run an organisation to scrutinise imports*

Estimate cost of implementing

- Not too difficult
- Based on people and effort?



Costs – cost 'impact' at nodes

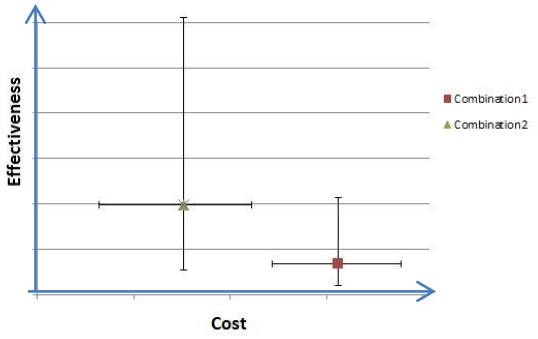
ⓑ • **Cost 'impacts' of a successful attack**

- **What is the cost of losing an asset (for each 'C/I/A' property)**

CIA	Data Sources		Issues
	Military	Non-Military	
Availability (loss of presence)	Country Force Structure Cost Model, military accounts (e.g. UINs)	Overheads from company accounts	Time-related Short and Long term costs of running the asset (inc. existing response information system staff etc.)
Confidentiality (loss of privacy)	!	!	Loss of profit, re-development costs of exposed research, very uncertain
Integrity (loss of confidence)	!	!	E.g. Battlefield pictures untrustworthy. Difficult to define, proportion of availability/confidentiality?

Benefits of Process

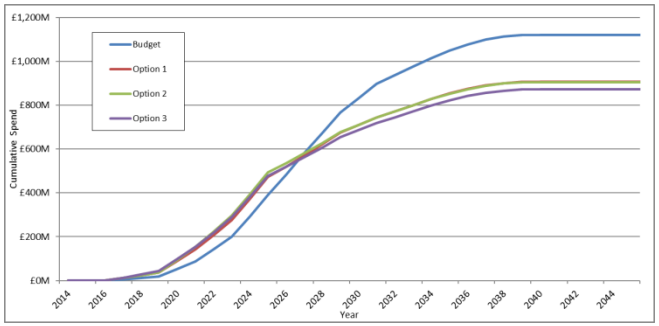
- **Summary of Process**
  - Describe Assets (at high level) – network of nodes
  - Quantify Risks
  - Quantify Mitigation Actions
  - Quantify Costs
  - Feed information into a tool → assess most cost-effective combinations of mitigations



Cost-Effective?

Affordable?

Etc…



- ***Same outputs for cyber security, by the approach discussed?***

Defining Problem → **Approach** → **① Process ② ③** → **Benefits of Process** → **Future?**

Benefits of Process

- **Benefits**
  - Audit trail for the evidence
  - Quickly assess alternative combinations of mitigations
  - Engage stakeholders – buy-in?
  - A Tool allows: Evolving Threat, Learning Curves in Mitigation
  - Assess at different levels of detail
  - Run strategic-level ‘attack’ scenarios

- ***Applicable to cyber security, by the approach discussed?***

- **Future Effort**
  - Risk Propagation
    - Test methods of simulation
  - Cost Impacts
    - Estimating ‘loss of trust’, ‘loss of privacy’
  - Example framework
  - Example tool
  - Scalability?
    - Easy/fast to add risks?
    - Easy/fast to add nodes (to the network of assets)?