Augmenting Probabilistic Risk Assessment with Malevolent Initiators

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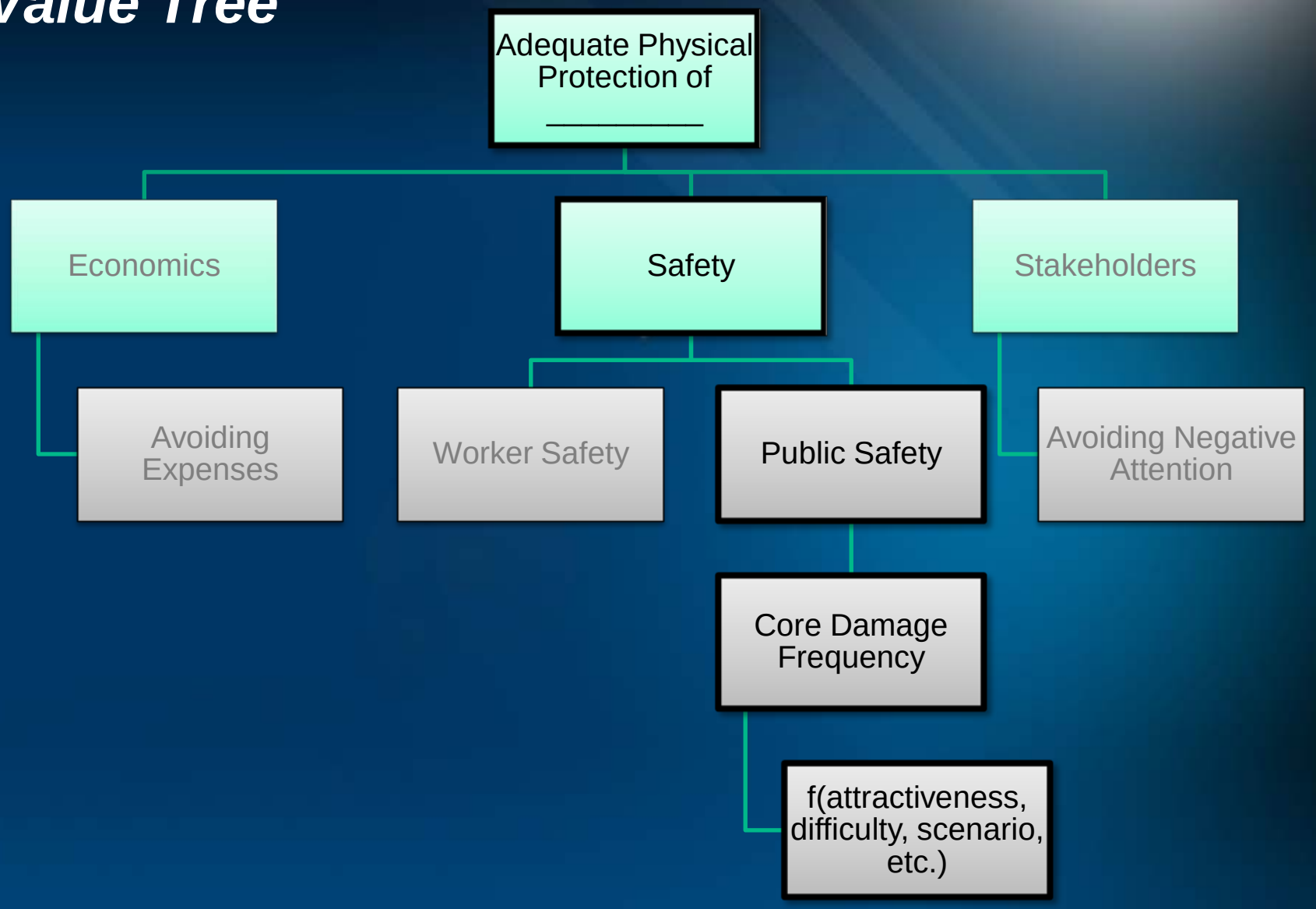
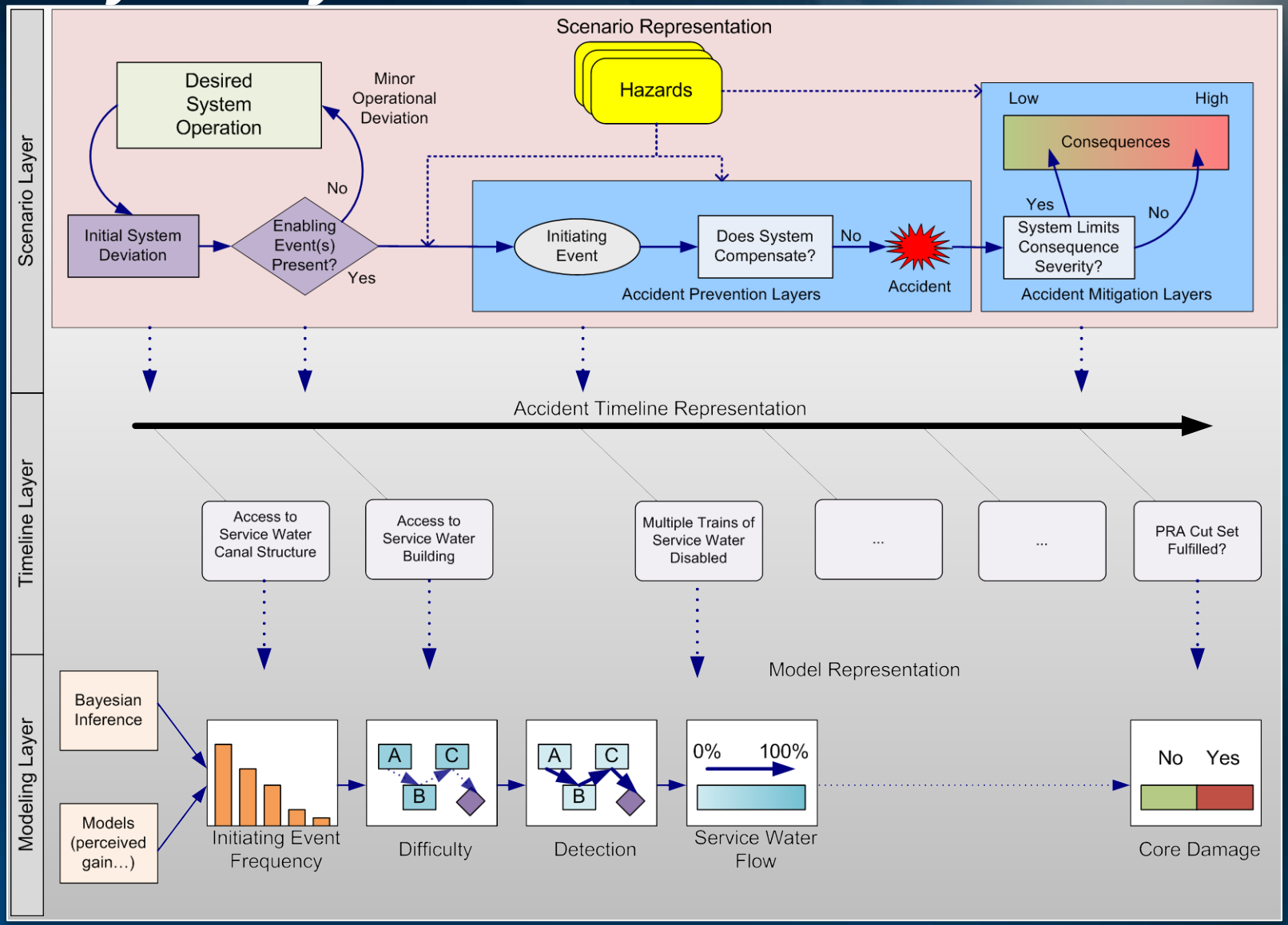
Topics

1. Background and overview of the methodology
2. Scenario representation and its tie to PRA models
3. Quantification of scenarios using simulation
4. Conclusions

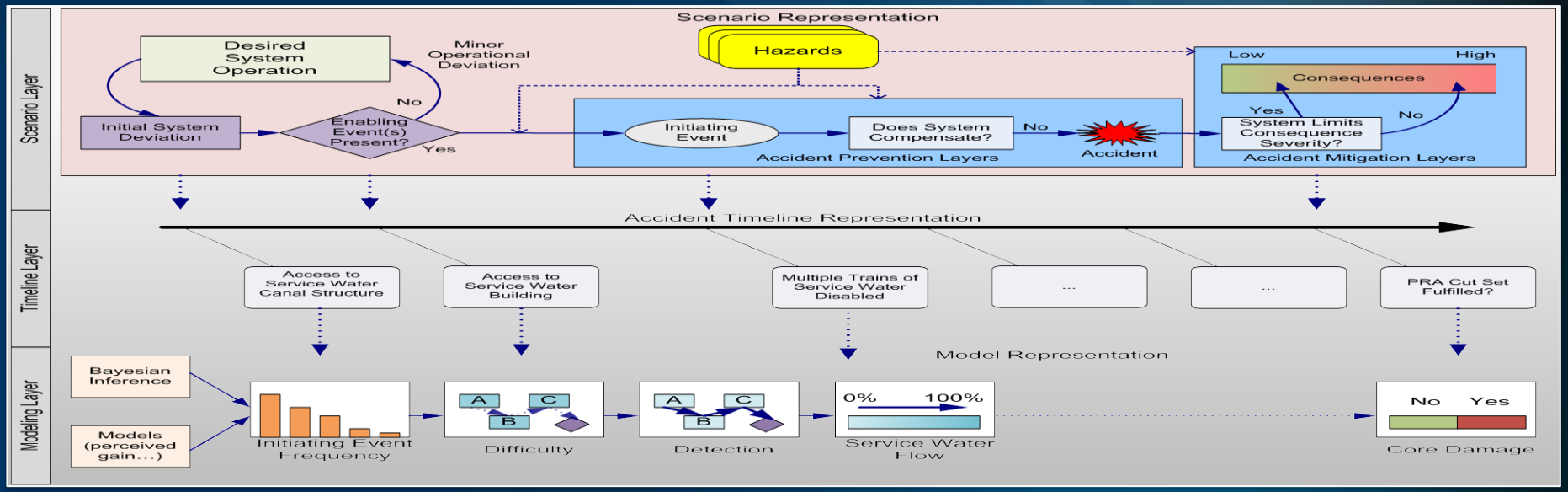
Value Tree


Adequate Physical Protection of _____
Economics
Safety
Stakeholders
Avoiding Expenses
Worker Safety
Public Safety
Avoiding Negative Attention
Core Damage Frequency
f(attractiveness, difficulty, scenario, etc.)

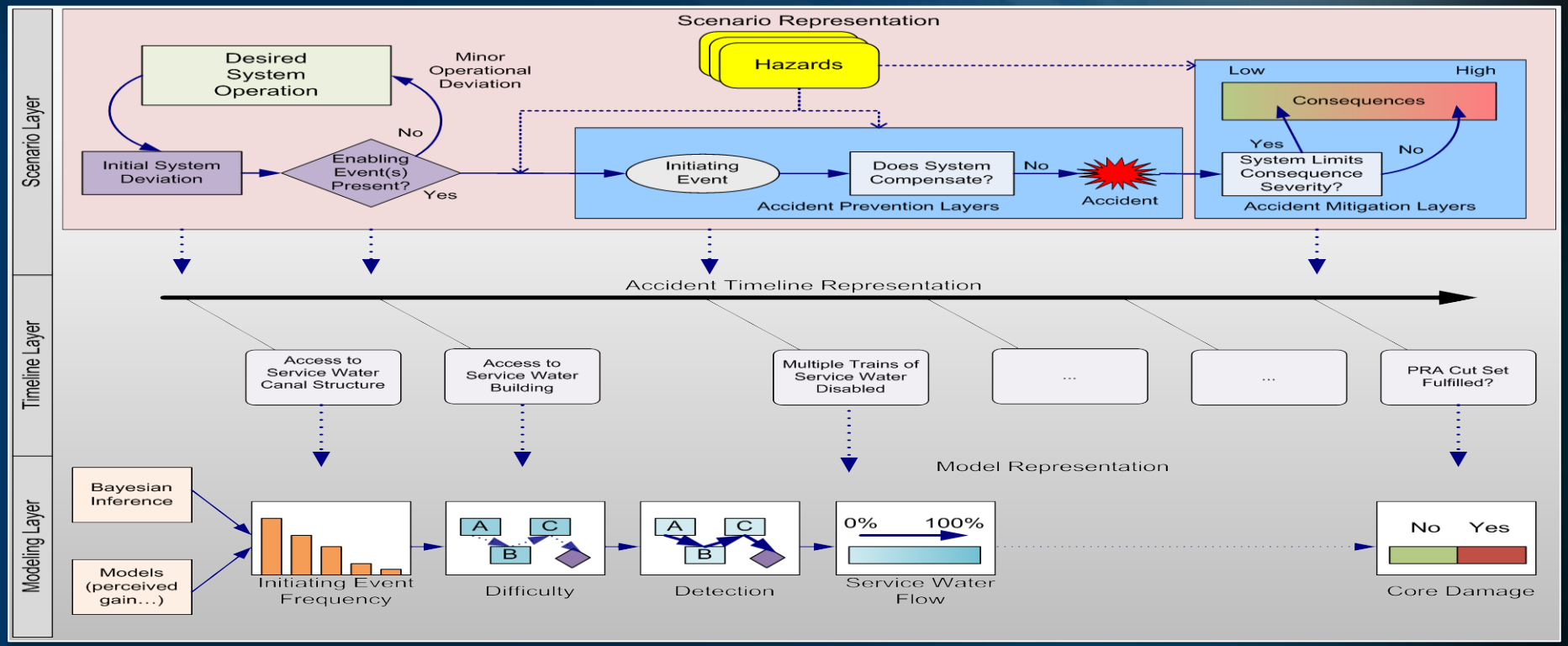
Analysis Layers



Analysis Layers (Scenarios)



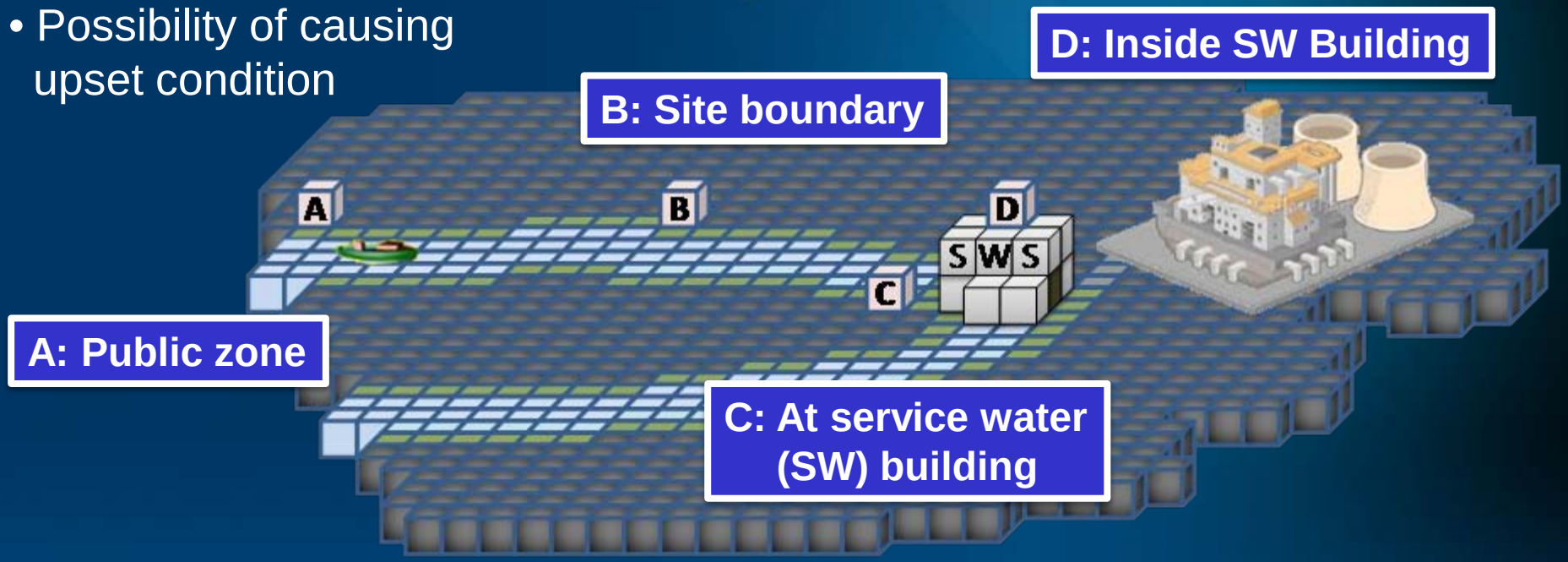
Analysis Layers (timeline & associated models)



What will the New Model do?

The New Model will represent

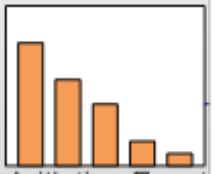
- Potential adversary movement to a critical location
- Possibility of detection
- Possibility of neutralization
- Possibility of causing upset condition



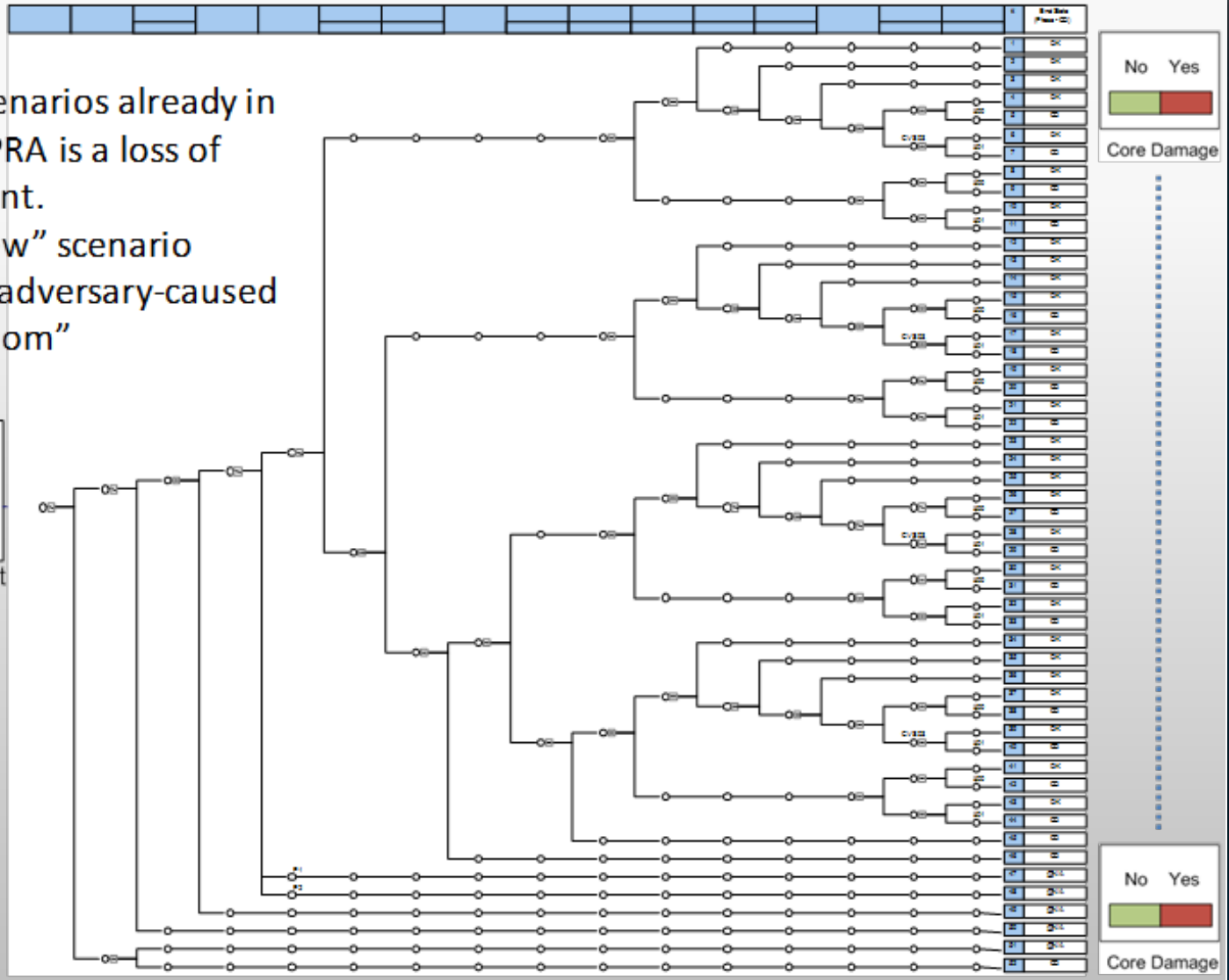
Tie to PRA Models

One (of many) scenarios already in the generic NPP PRA is a loss of service water event.

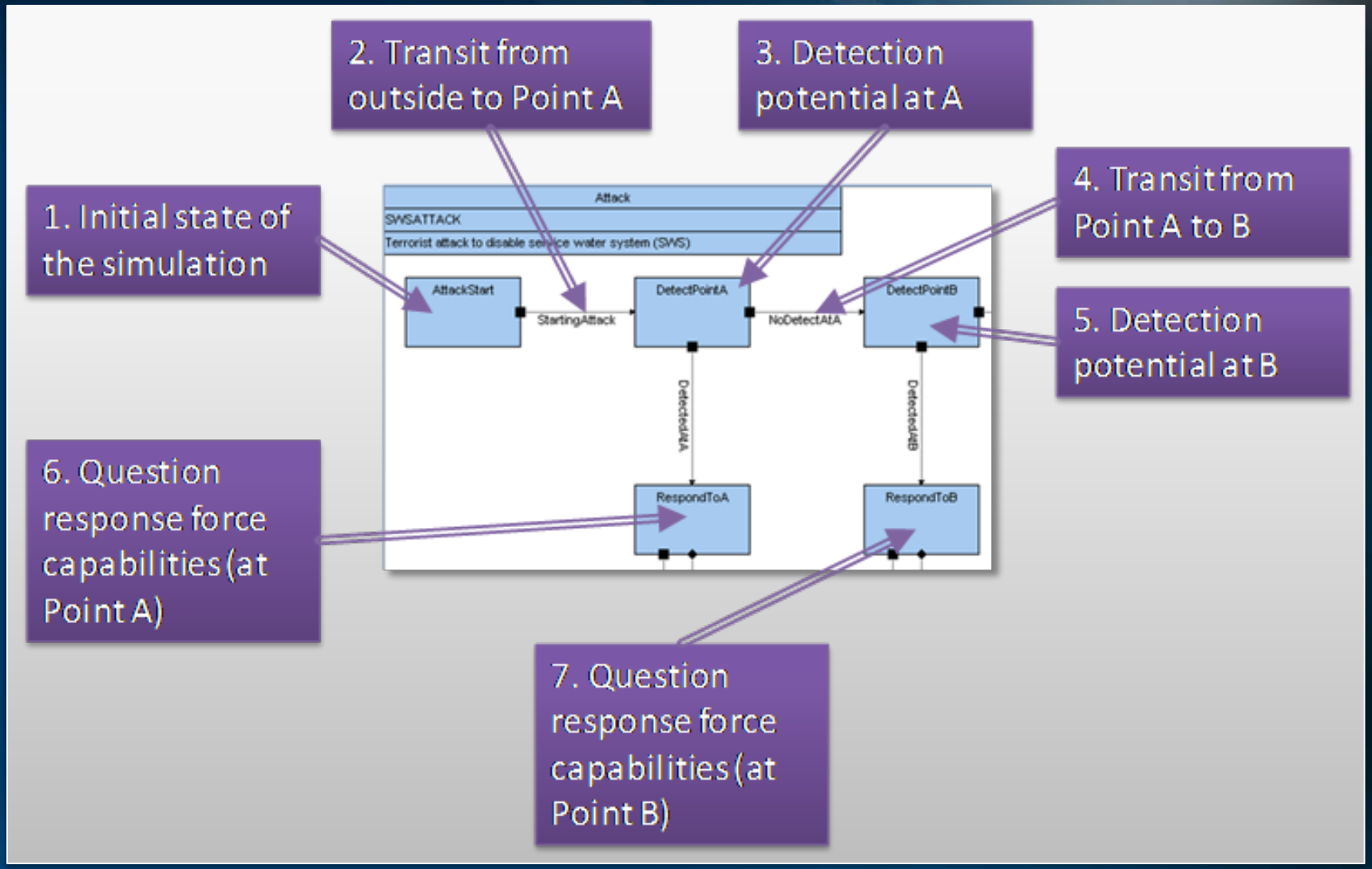
We can add a "new" scenario where the loss is adversary-caused rather than "random"



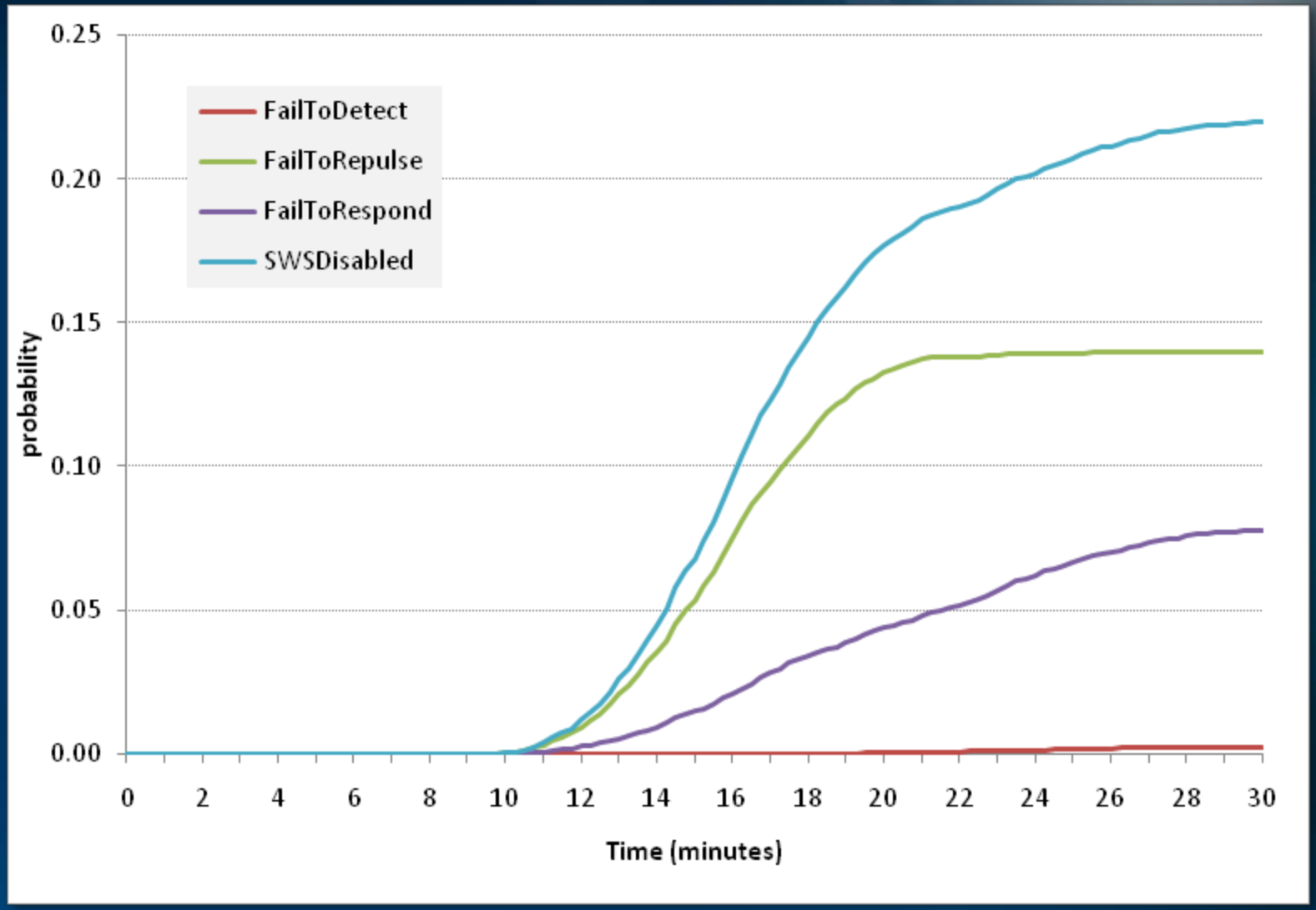
Initiating Event Frequency



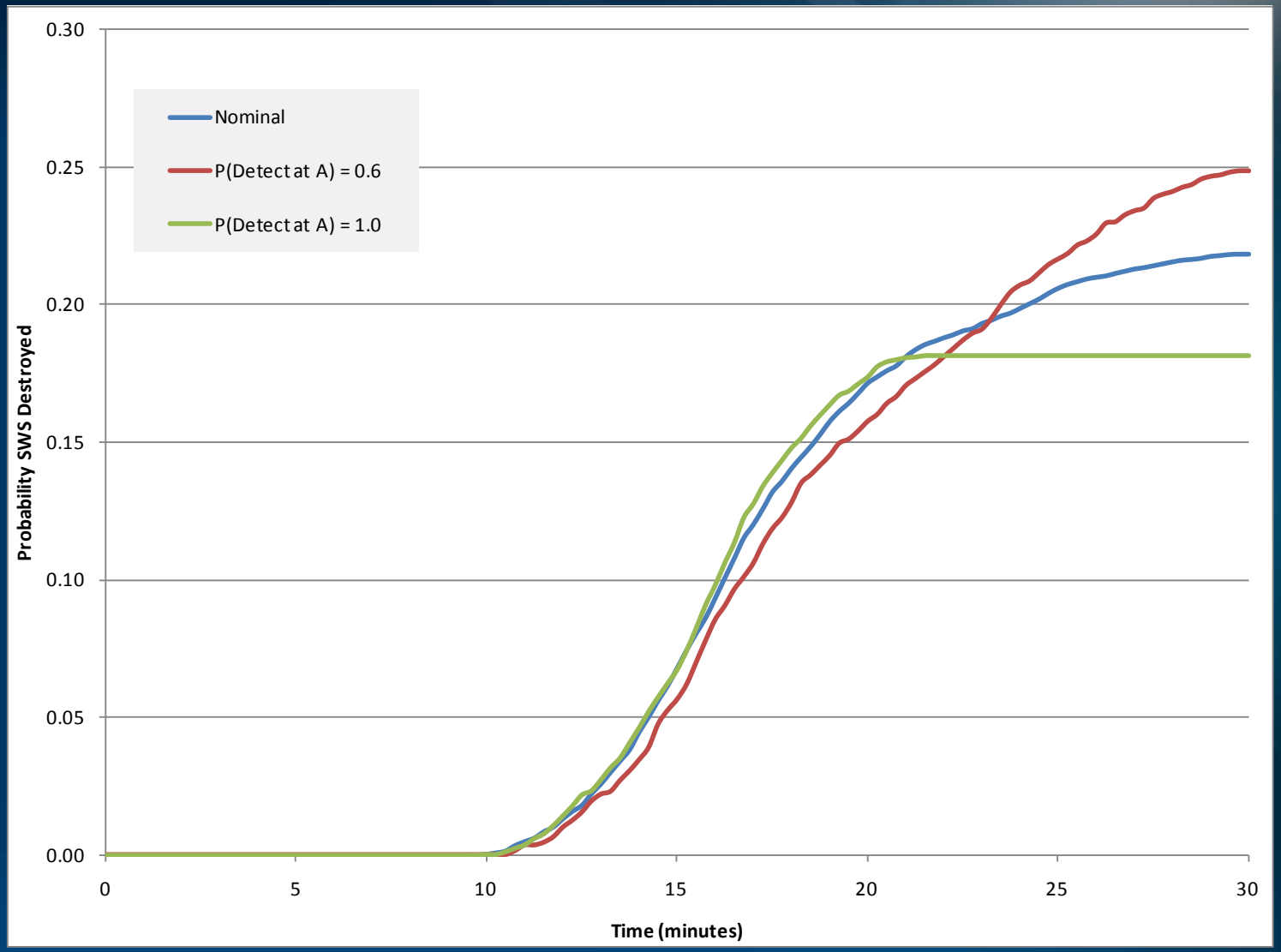
Quantification via Simulation



Simulation Results



Sensitivity Calculations



Integration with Traditional PRA

#	Prob.	Total %	Cut Sets	Description
8	2.6E-3	4%		
	2.2E-1		IE-LOSWS	TOTAL LOSS OF SERVICE WATER (ADVERSARY)
	1.2E-3		CVS-AOV-4A	ISOLATION VALVE AOV-4A FAILS TO OPEN
9	2.6E-3	4%		
	2.2E-1		IE-LOSWS	TOTAL LOSS OF SERVICE WATER (ADVERSARY)
	1.2E-3		CVS-AOV-5A	ISOLATION VALVE AOV-5A FAILS TO OPEN
10	2.6E-3	4%		
	2.2E-1		IE-LOSWS	TOTAL LOSS OF SERVICE WATER (ADVERSARY)
	1.2E-3		CVS-AOV-6A	ISOLATION VALVE AOV-6A FAILS TO OPEN

Integrated valve-related cut sets from a hypothetical PRA, including simulation

Conclusions

- Powerful approach that allows
  - Scenario-based modeling
  - Complex time, location, and physical interactions can be modeled
  - Facilitates integration into existing risk assessments
  - Security related insights in addition to risk-informed insights
  - Uncertainty is directly represented in the modeling layer
  - Prototype tools exist that perform the analysis
  - Simulation approach inherently parallel-processor friendly since multiple runs can be performed independently