Demystifying Casualty and Cyber Risk Modeling

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Cyber Catastrophe Modeling

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Rethinking Coverage of Large Loss Events

Missed Opportunities

76% of existing insureds seek higher coverage and limits

Source: Partner Re & Advisen

Hindered Innovation

47% of insurers say recent events had no impact on their underwriting

Source: Partner Re & Advisen

Omitted threats

Insurers believe silent cyber can increase combined ratios by 7%

Source: Willis Re

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Sources of Systemic Cyber Risk

Leading IT Service Providers

Software Vulnerabilities

Internet Infrastructure

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Cloud Computing Trends by the Numbers

36%

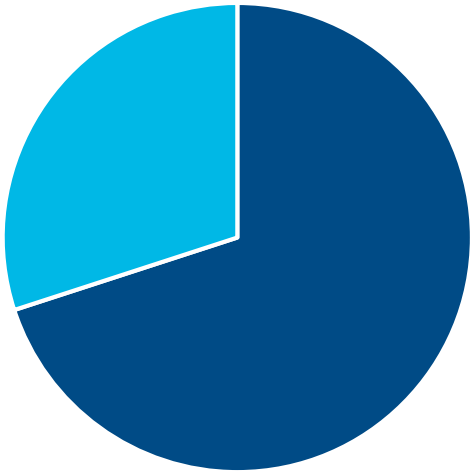
Compound annual growth rate of public cloud service industry

Source: Wikibon

12%

Increase of IaaS as the primary work environment

Source: McKinsey & Company



70%

Market share of top 15 cloud service providers

Source: AIR

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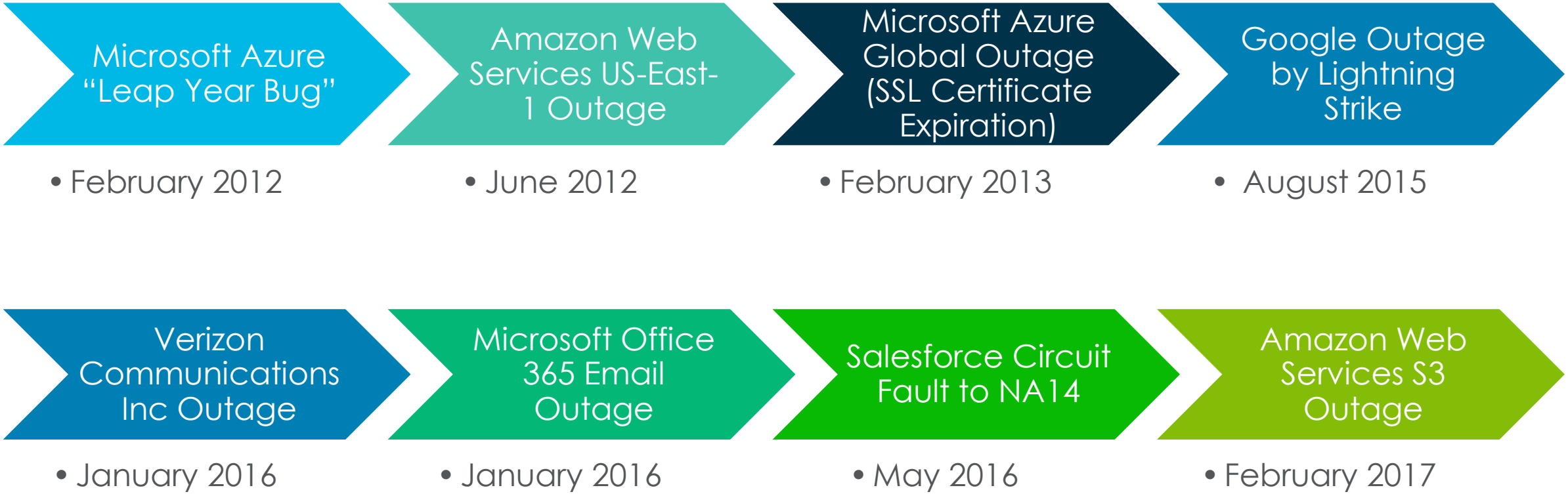
Historical Cloud Downtime Events



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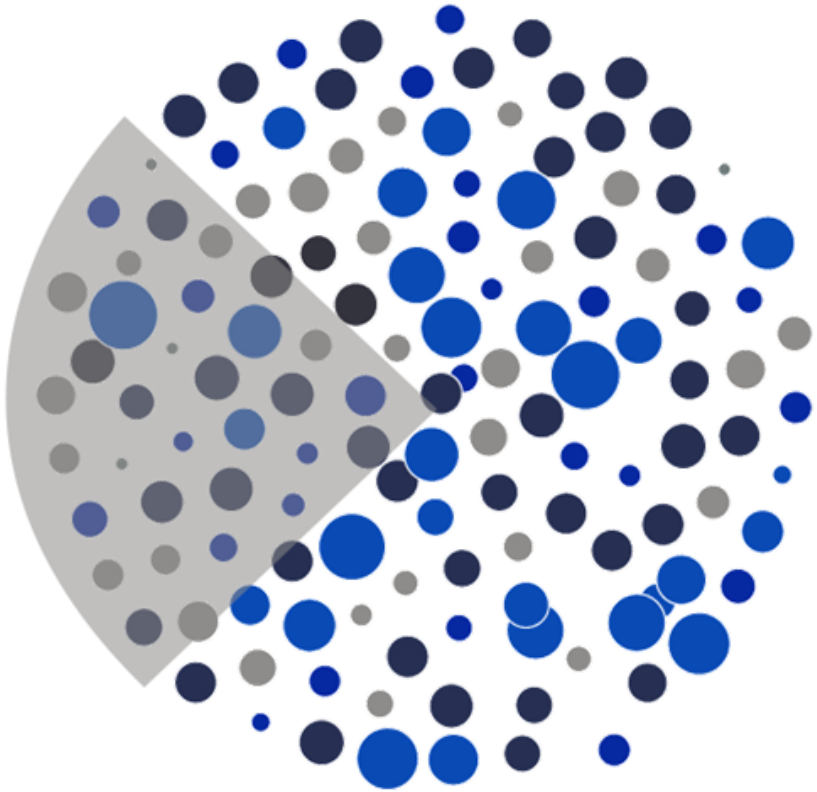
Impact of Cloud Downtime

Implications for (Re)insurance Industry

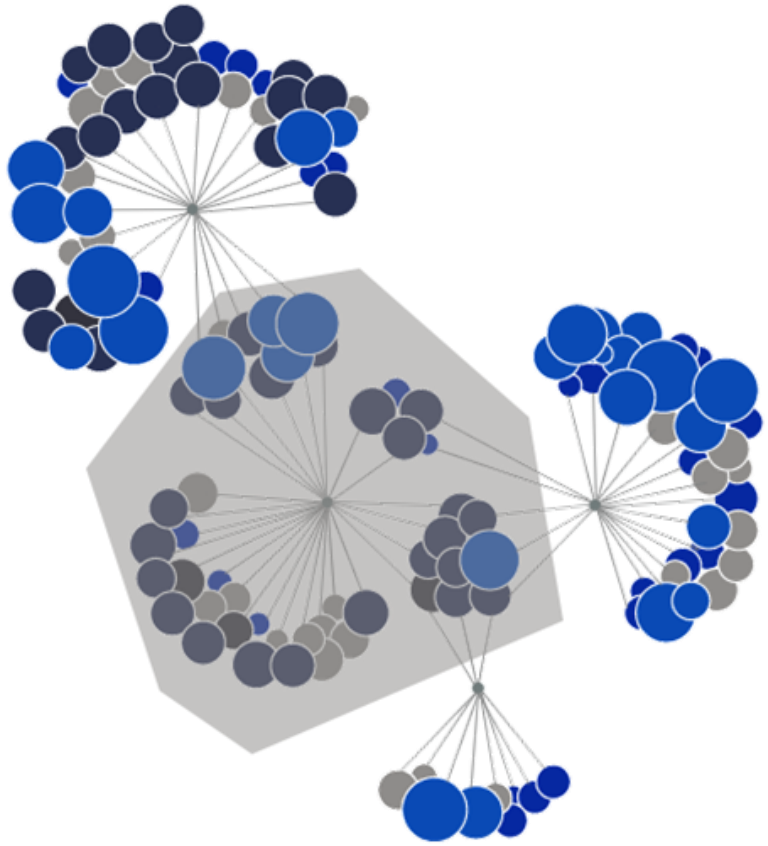
- (Contingent) business interruption coverage
- Third party liability coverage
- Development of reinsurance markets
- Non-affirmative (silent) coverage

Robust Risk Management Includes Several Approaches

Market Share Approach



Detailed Accumulation Approach



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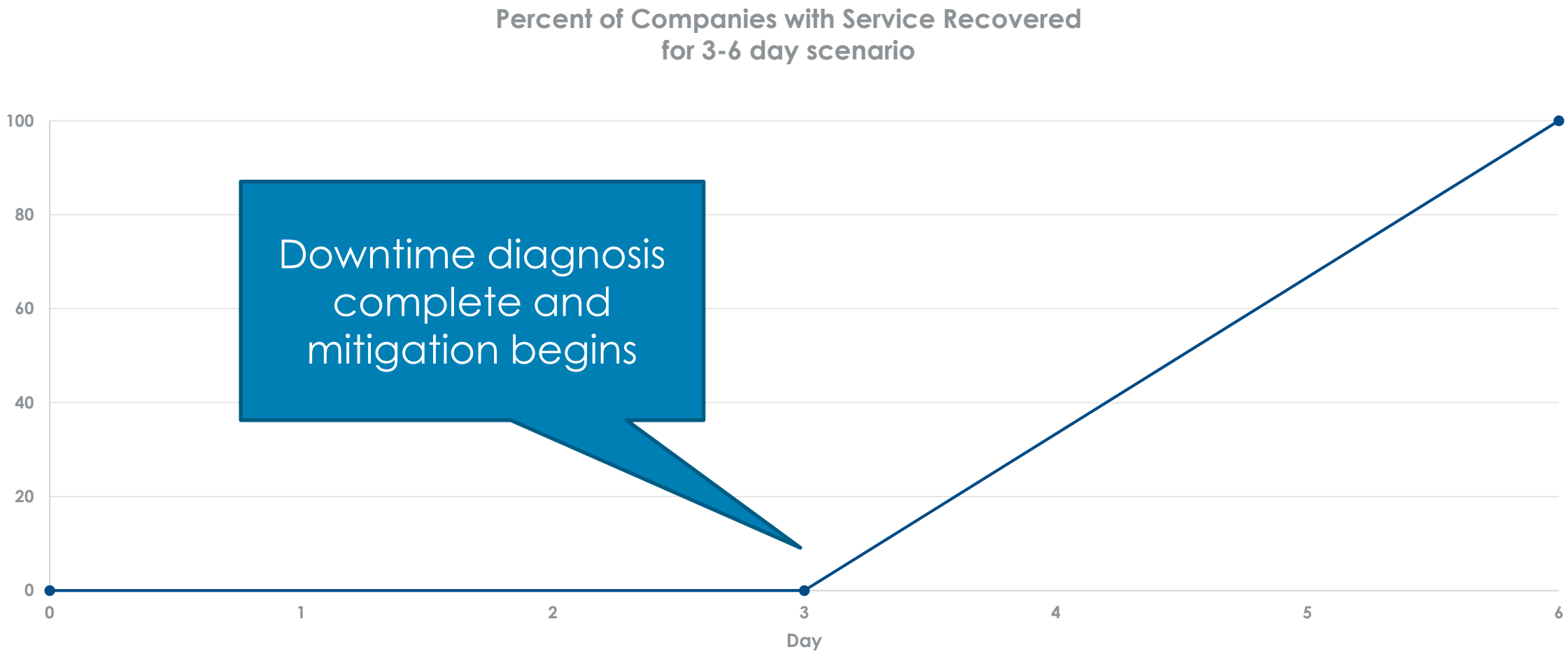
Cloud Service Provider Recovery



Modeled Losses Driven by E-business Factors

B2B and B2C

E-commerce turnover

Order management system costs

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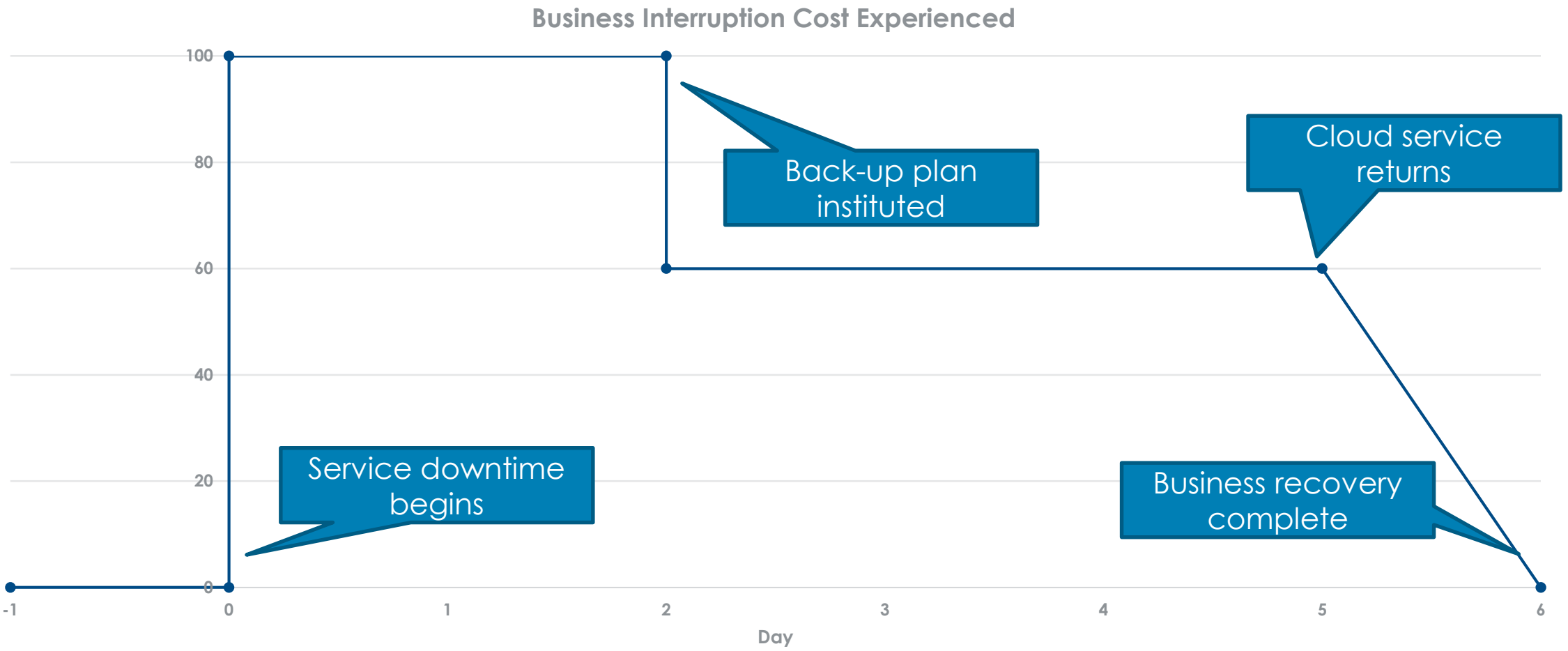
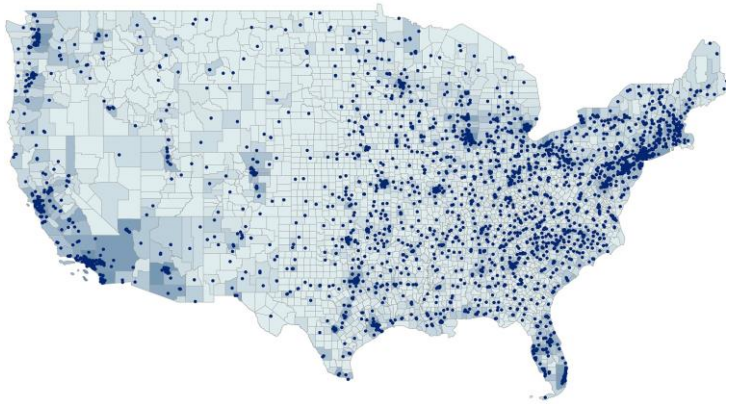
Losses Change Throughout Downtime Event



Note: Analysis considers probabilistic distributions that impact recovery

Industry Exposures Determine Event Footprint



12.4 million businesses

Cyber supply chain

Insurance terms

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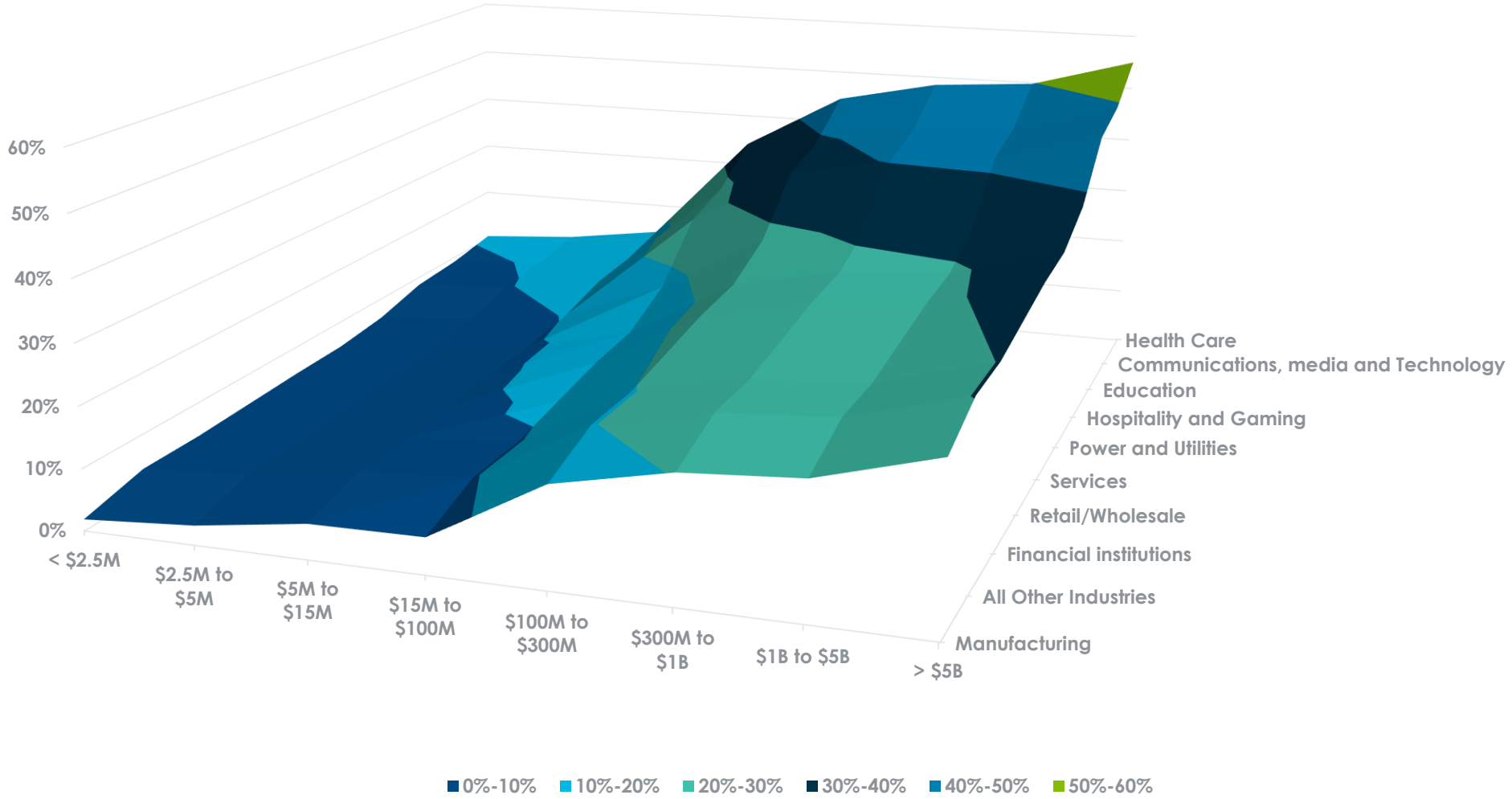
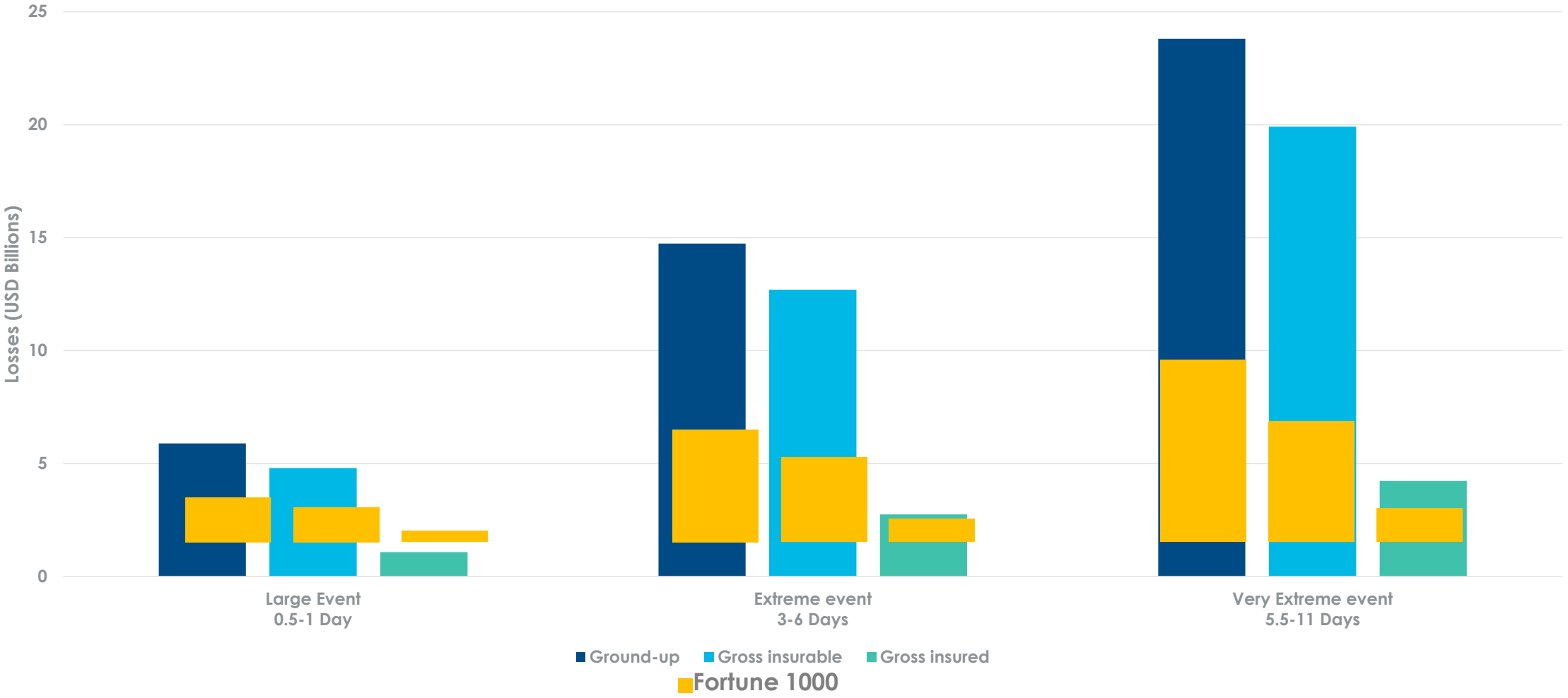
Cyber Insurance Take-up Rates Vary Widely

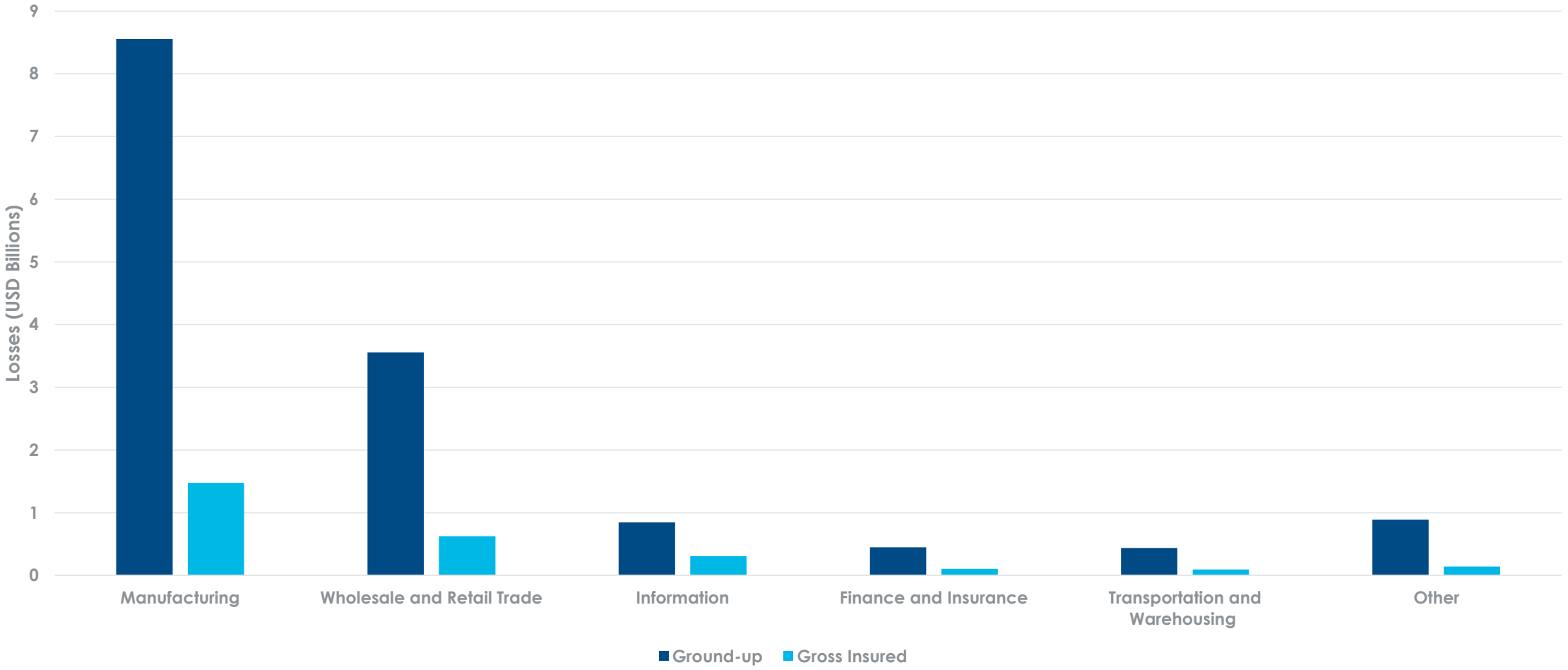
Cyber insurance take-up rates by industry and turnover



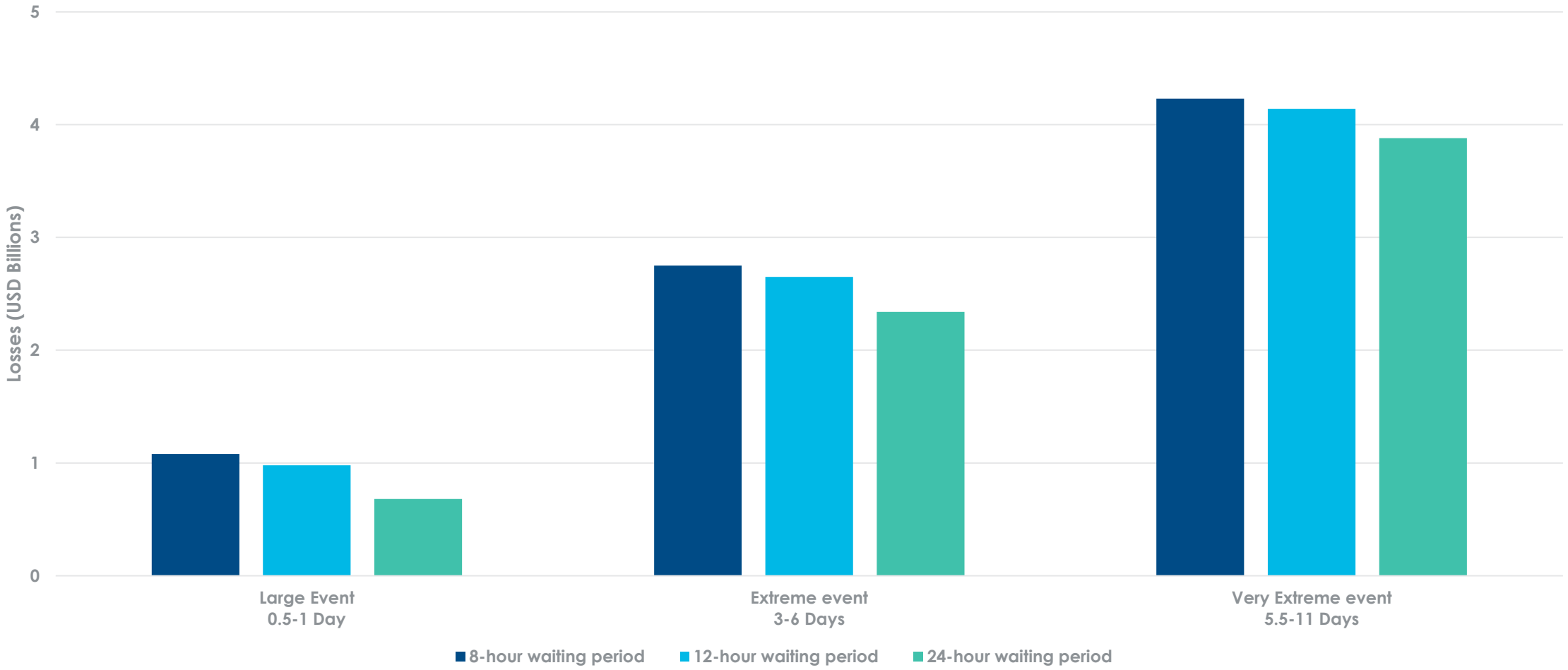
Total Industry Losses by Downtime Duration



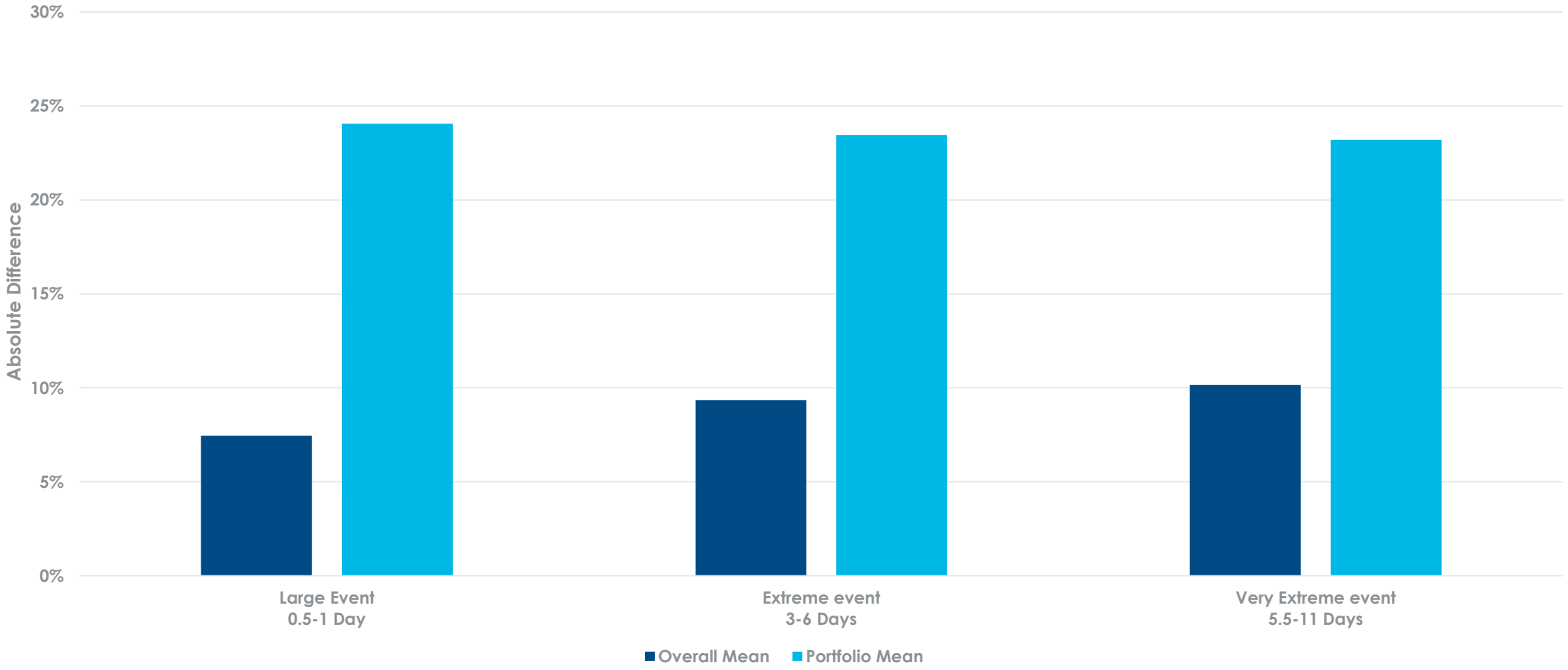
Industry Losses for Extreme Event (3-6 Day Downtime)



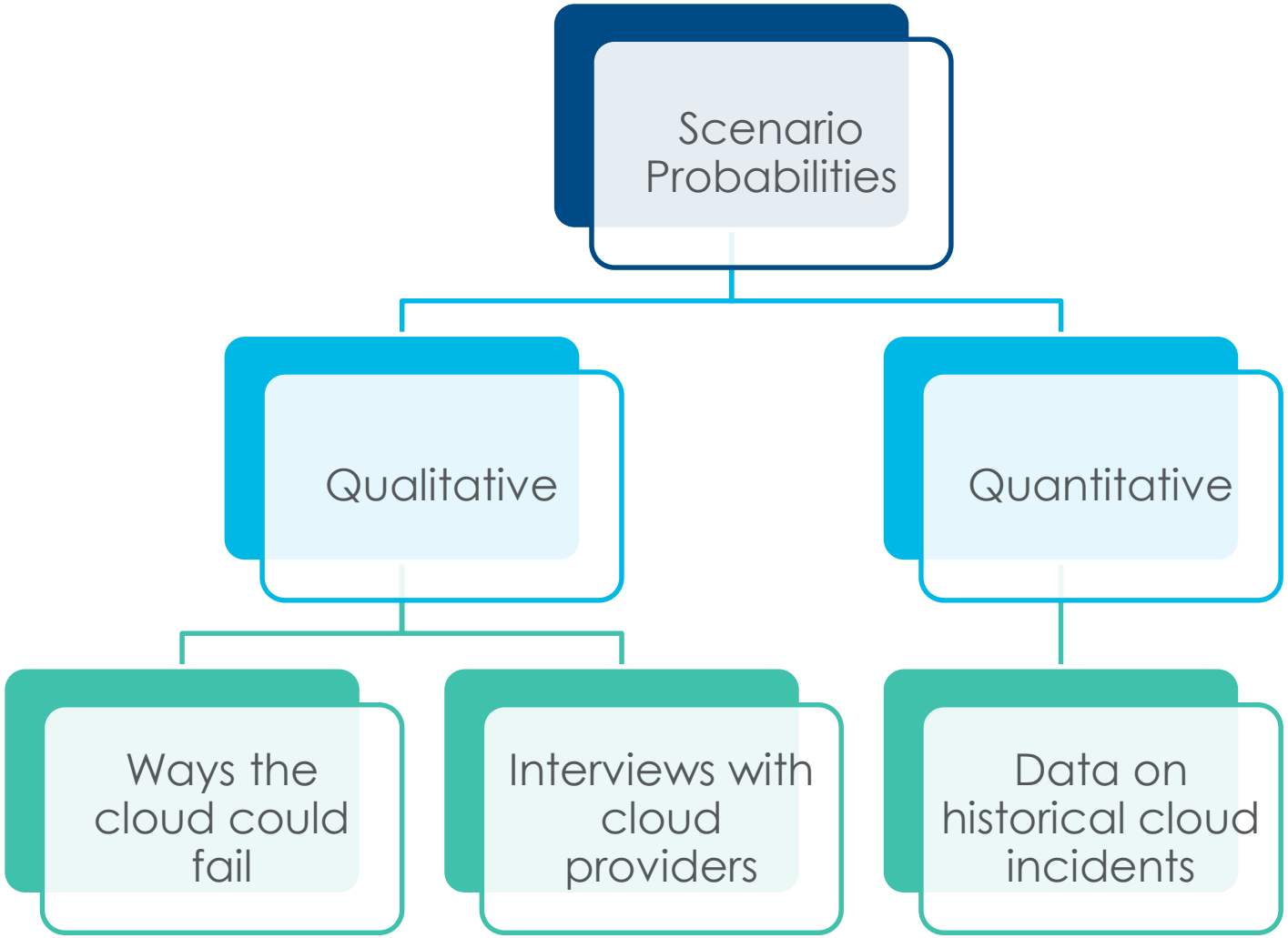
Gross Insured Losses by Waiting Period Length



Approach Differences Reveal Insights



The Challenge of Assigning Probabilities to Scenarios



How Can the Cloud Go Down?

Environmental

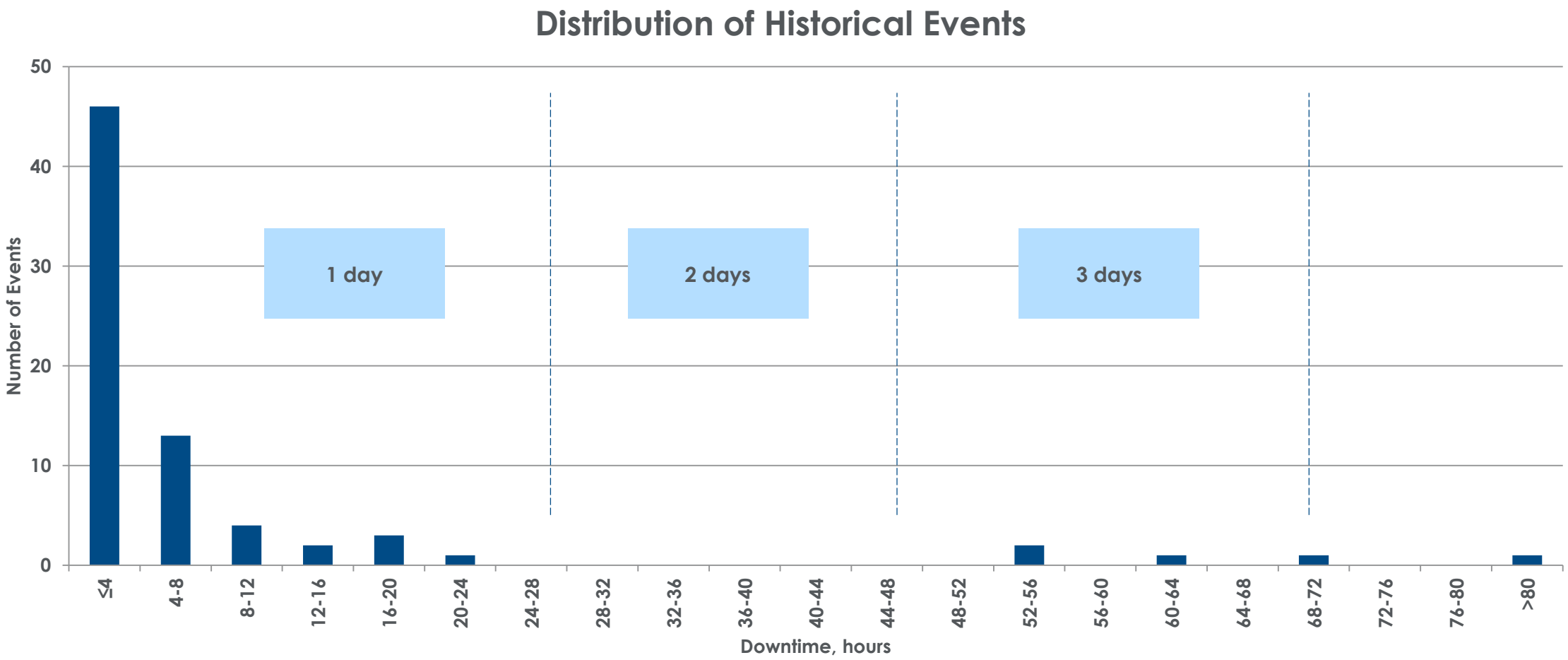
Accidental

Adversarial

Structural

Source: NIST

What is Likelihood of Cloud Downtime Event?



Cyber Data Improves Understanding of Risk

Outside-in

Inside-out

Process & Policy

Endpoint

Incident

Connectedness

Cloud Hosting

Threat Intelligence

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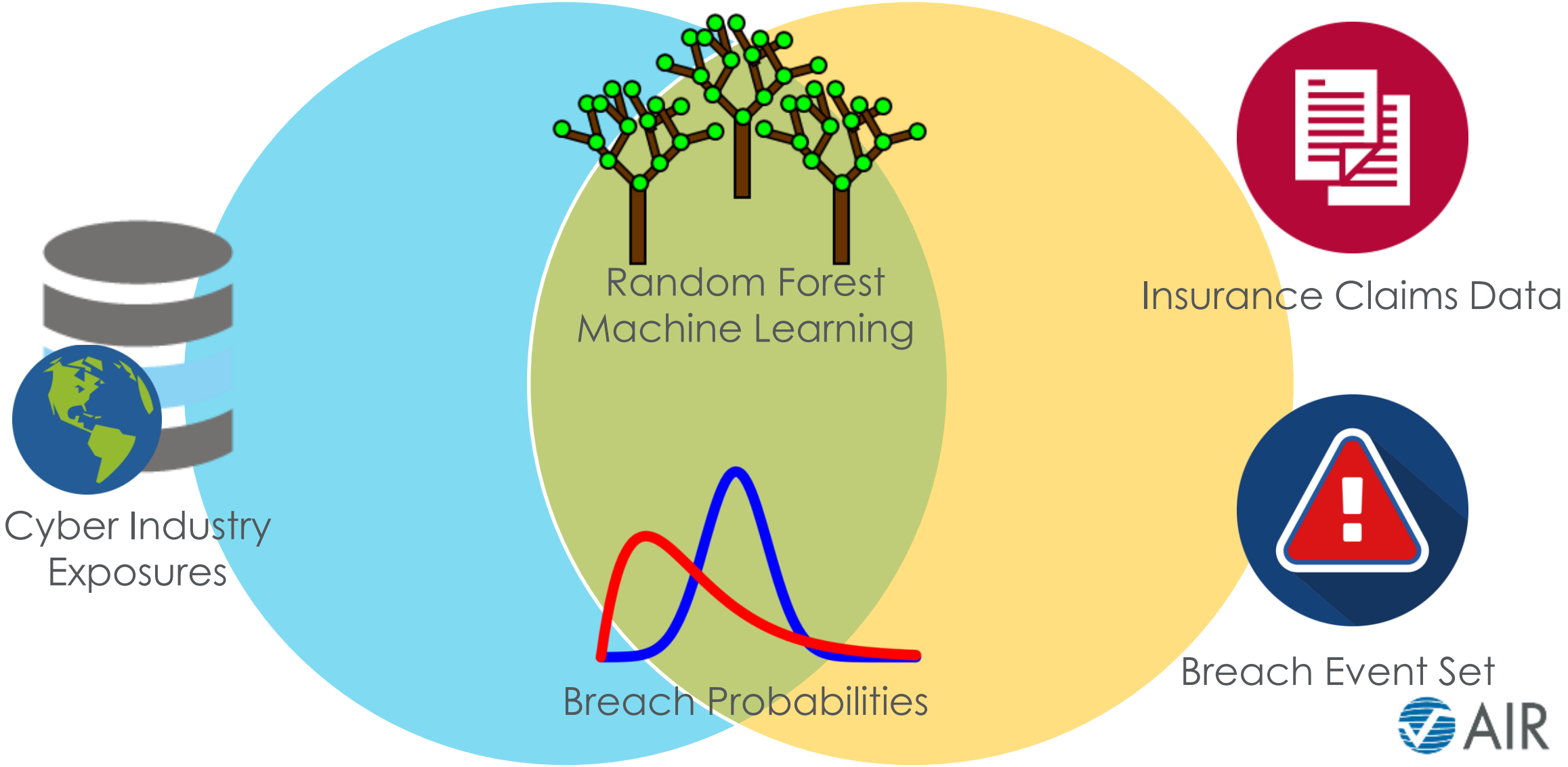
Building a Probabilistic Cyber Model for "One-Off" Breaches

Machine Learning Provides Insights on Frequency



Rating Variables Refine View of Risk

Antivirus Effectiveness

Intrusion Detection

Patching Cadence

File Sharing

Firewall Health

Security Ratings

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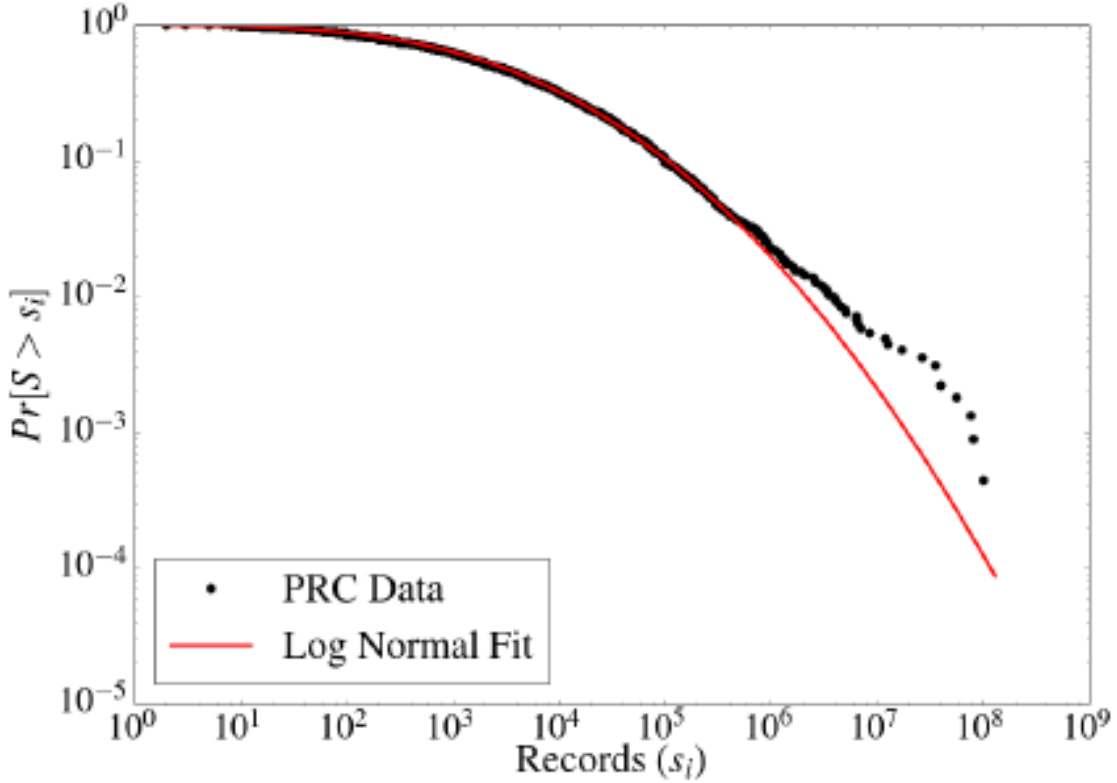
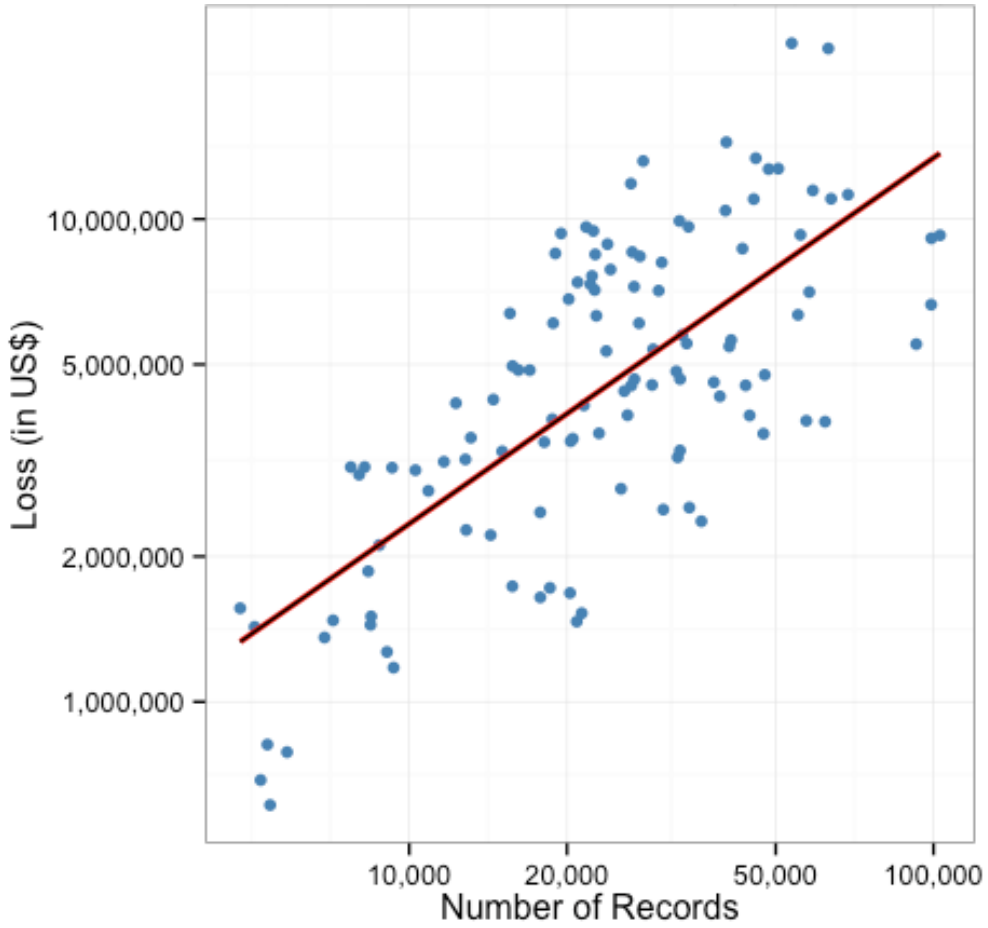
Records Lost Drives Financial Losses

Size of Breach



Source: Edwards, Benjamin, Steven Hofmeyr, and Stephanie Forrest. "Hype and heavy tails: A closer look at data breaches." WEIS, 2015.

Cost of Breach



Source: Jacobs, Jay. Analyzing Ponemon cost of data breach. Dec. 2014

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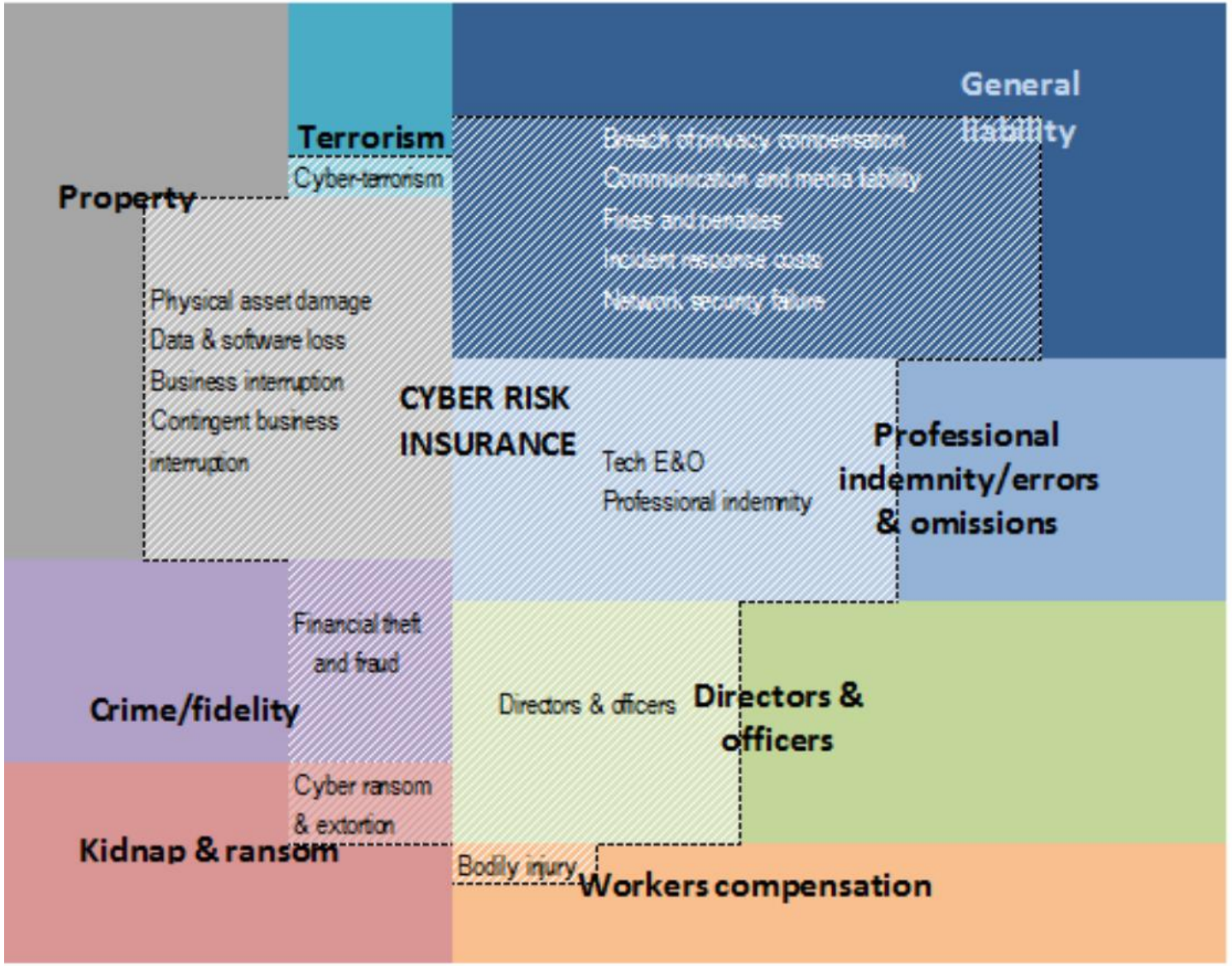
Silent Cyber Threat Looms Throughout



Source: OECD

Model Many Cyber Scenarios Today

ARC (Analytics of Risk from Cyber) Released in 2017

Exposure Management

Data Augmentation

Risk Modeling

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Modeling Supports Cyber Insurance Industry Growth

Understand Risk

Optimize Coverage

Identify Opportunities

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QUESTIONS?
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Casualty Catastrophe Modeling

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Overview

- Examples of casualty catastrophes
- Casualty CAT modelling use cases
- Scenario-based modelling approach
- Challenges with quantification
- Future research

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Casualty Catastrophe Examples

Casualty Cat Events Come in Two Main Types

Classic Clash Events

- Event occurring at a single point in time
- Examples: infrastructure e.g., *MGM Grand shooting, Deepwater Horizon, Grenfell Towers*

Other Systemic Events

- Event arising from a single trigger such as a product or business practice but not occurring at a single point in time
- Examples: product-based e.g., *opioids, Madoff, LIBOR, silicone breast implants, Chinese dry wall, asbestos* or practice-based e.g., *sport related concussions, Enron*

ENRON®

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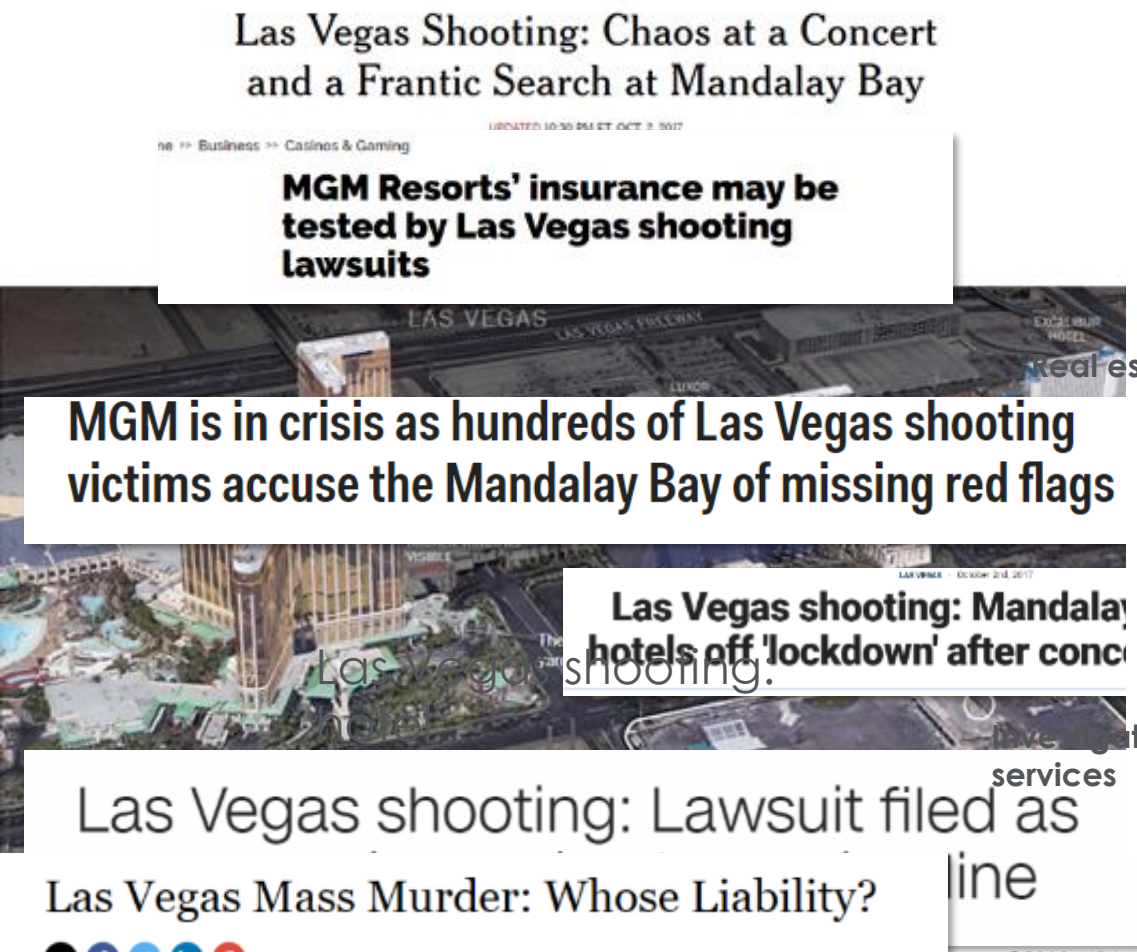
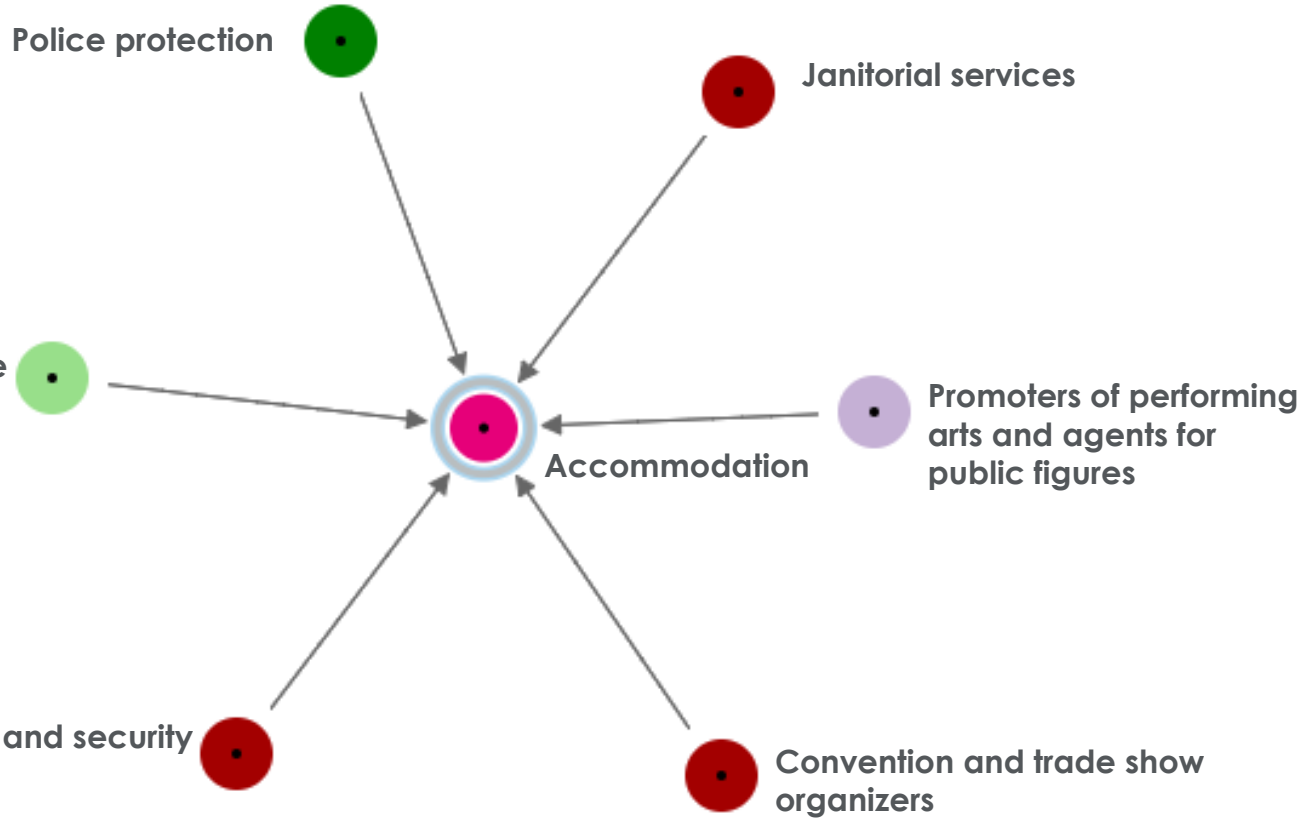
Majority of Historic Events Are Classic Clash Events

Type of Event	Total Number of Events	% of Cases	Sum of Losses	Avg. Losses per Event	Average Accident Period
Classic clash	14,118	88%	$970 B	$69 M	One day
Other systemic	1,865	12%	$1735 B	$930 M	4.6 years (stdev = 11.5 yrs)

Classic Clash Example: MGM Grand Shooting

2nd October 2017





Systemic Event Example: Sports Concussions

	NFL	College	Schools
# of players	~2,000	73,660	1,080,693
# of institutions	32	633	14,047

http://www.ncaa.org/about/resources/research/football

- NFL and colleges concentrated in fewer institutions
- Each high school (and medics serving those schools or physicians examining children) may be sued – particularly as diagnosis is difficult and high visibility / emotional impact – which may increase insured loss

Casualty CAT Modelling Use Cases

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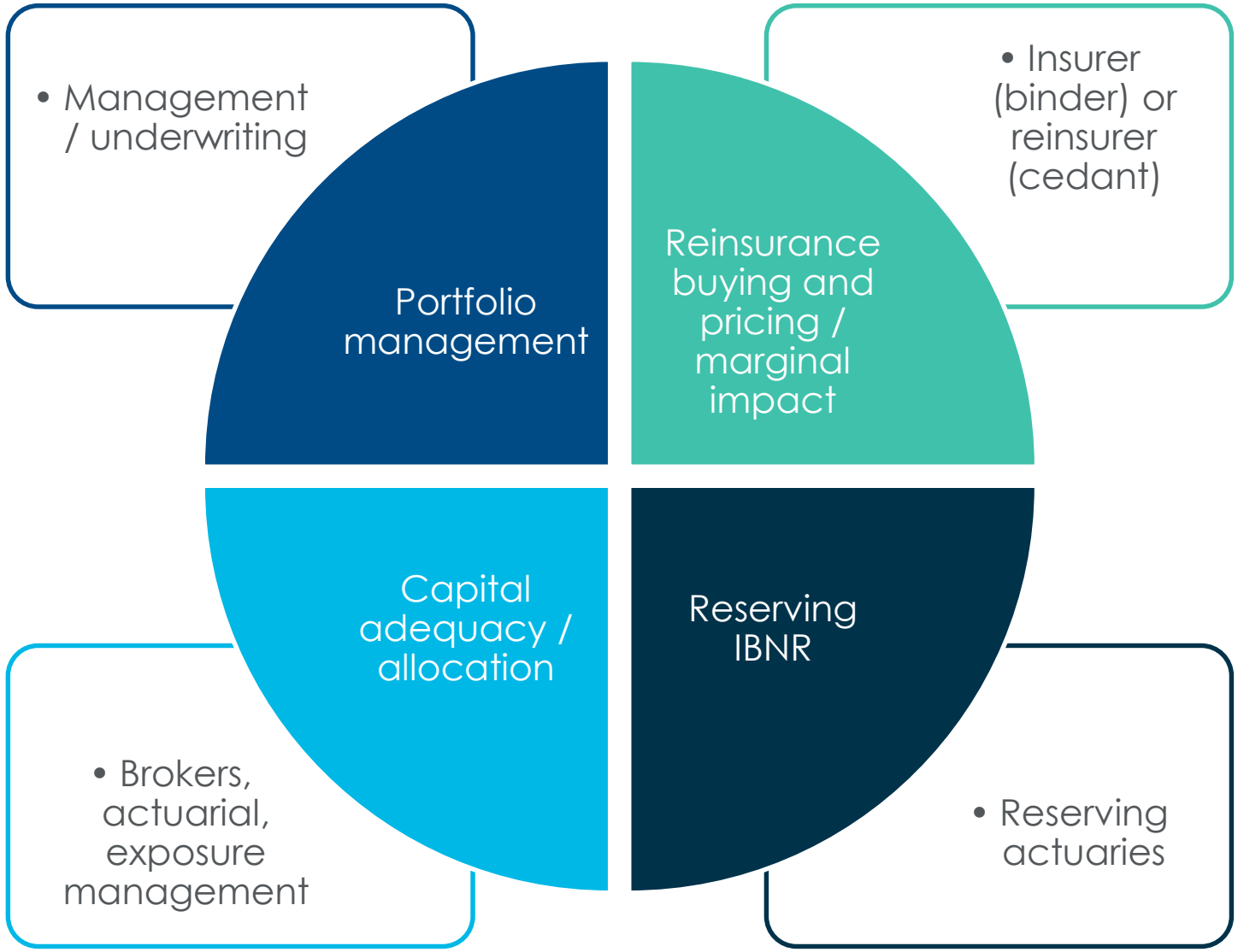
Use Cases



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Portfolio Management

- Exposure aggregation monitoring and management
  - Performed across casualty lines of business
  - Industry, not geographic, aggregation
  - Includes identification of under-exposed pockets as potential growth opportunities

- Estimate the impact of various changes to underwriting guidelines or any strategic initiatives under consideration

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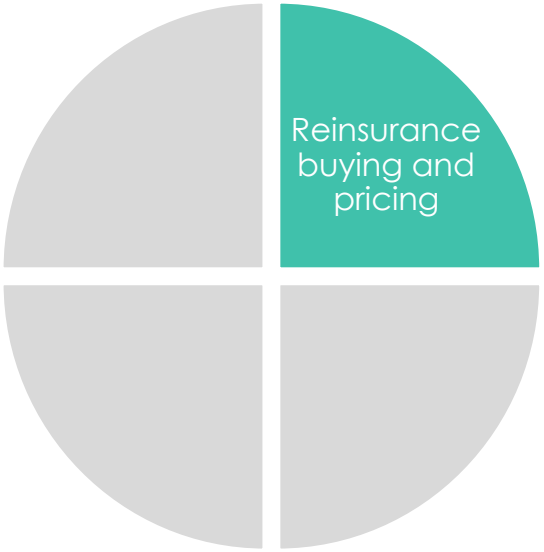
Reinsurance buying and pricing



- Marginal impact pricing
  - Side-by-side comparison of the distribution of loss results with and without a particular treaty on the books
  - Incorporate cost of additional capital as input into pricing
  - Could also apply to large accounts at primary insurers
- Develop an understanding of how different reinsurance structures/attachment points would react to various future scenarios

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Capital Adequacy and Allocation

- Stress testing: Consideration of large casualty event impacts on capital adequacy
- Capital allocation may be influenced by which lines of business are more often impacted by extreme events

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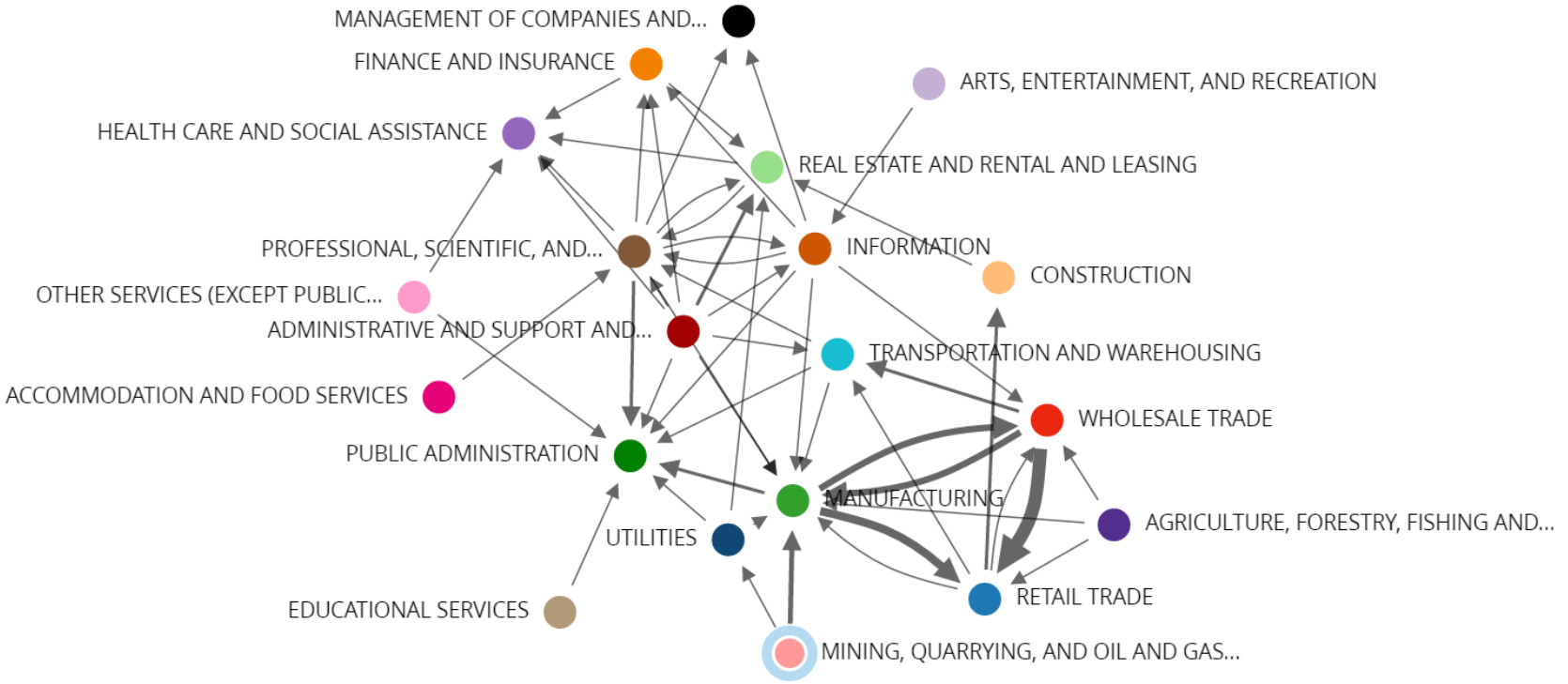
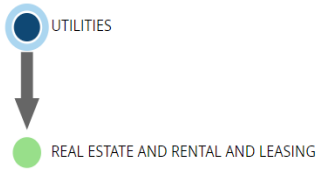
Scenario-based modelling approach

Framework: Supply chain

- Provides proximity and framework for casualty events
- Enables modeling of accumulations across insured portfolios



Nodes = industries:
Portfolio data



Arrows =
Direction and strength of trade:
Tool data (embedded)

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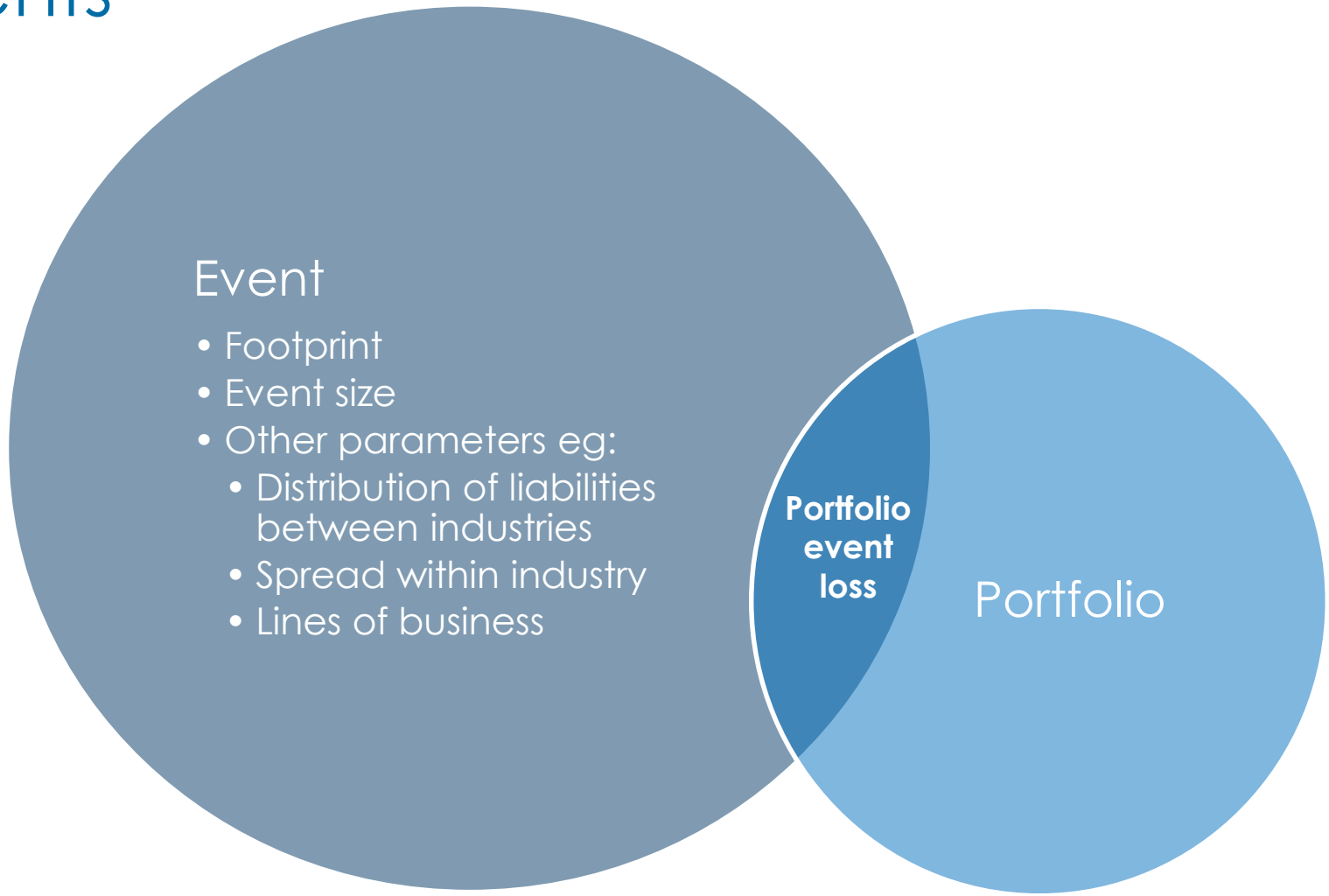
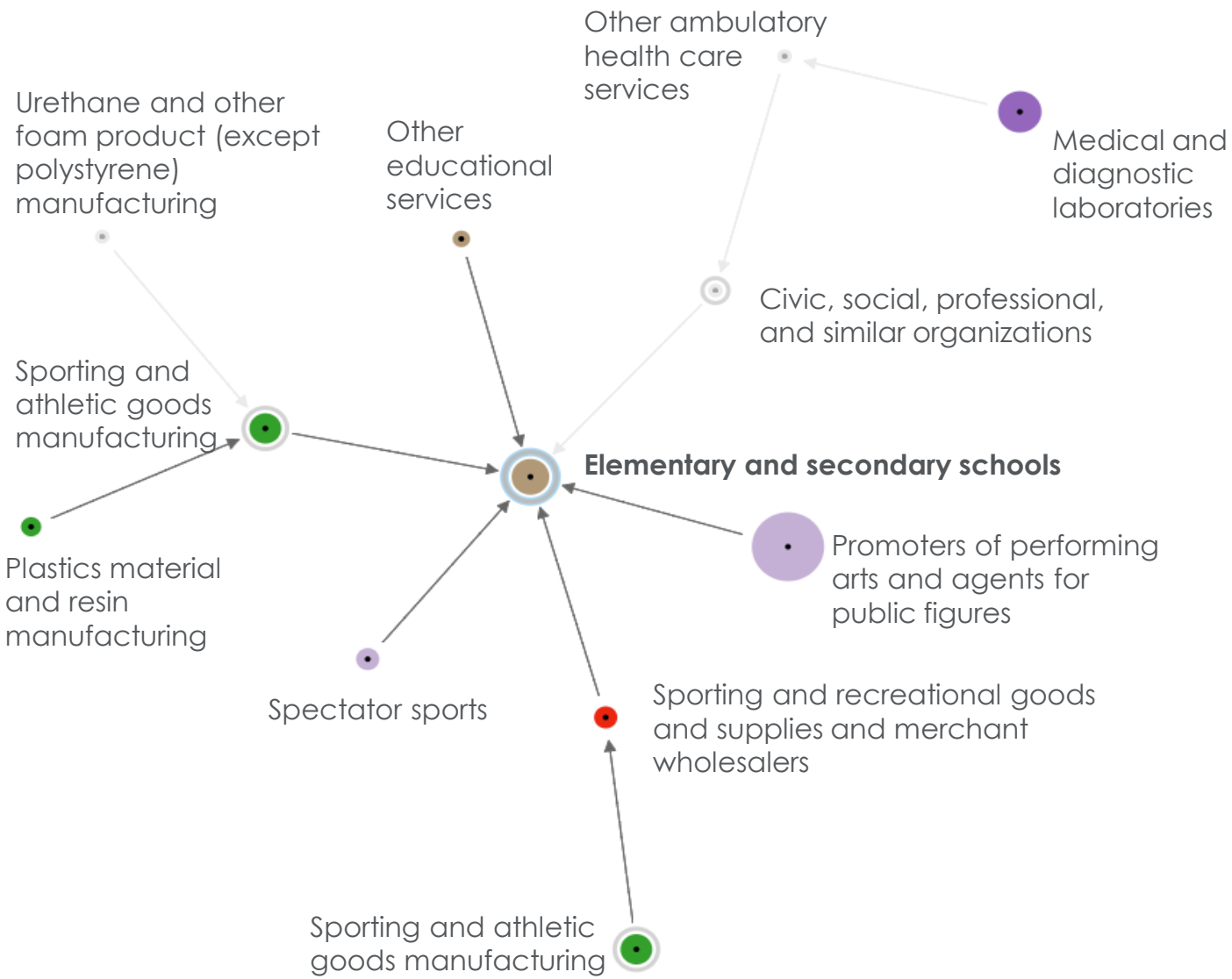
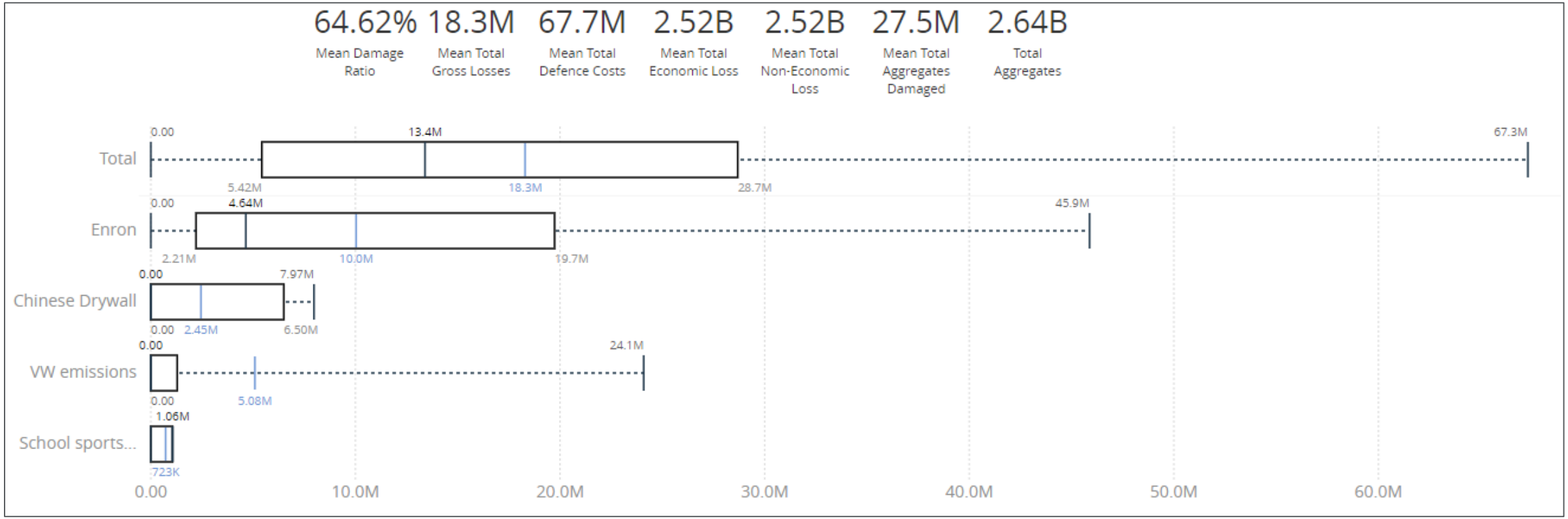
Events


Event
• Footprint
• Event size
• Other parameters eg:
• Distribution of liabilities between industries
• Spread within industry
• Lines of business
Portfolio event loss
Portfolio

Football Concussions-Portfolio Overlay



Loss Simulation



- Blue bars represent mean outcomes--conditional AAL
- Box plots also show the 25/50/75th percentiles with extreme outcomes noted by vertical bars on each end

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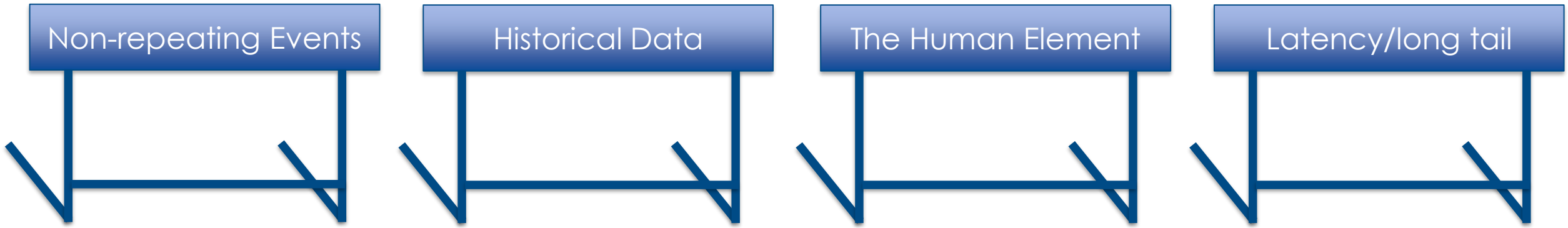
Challenges With Quantification and Future Development Work

Some Quantification Hurdles



- The specific companies or products at the center of a casualty event often do not survive the event
- Although they are non-repeating, past events may still teach us something about the future

- Due to the non-repeating and infrequent nature of casualty events, historical data must be used carefully
- Proxy data may exist
- Expert input can be used as an alternative data source

- Changes in socio-economic, environmental, health, and legal environments are difficult to model mathematically
- Expert opinion may be relied upon to estimate the impact of changes to these risk factors

- The latent nature of some casualty events increases uncertainty of estimation
- Example: asbestos loss allocation methods

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Further Development Work-A Stochastic Approach

- **Goal:** to randomly generate any number of events, defined by stochastic parameters, while ensuring a representative variety of realistic potential events.

- This is possible using a combination of expert opinion and historical data to define categories of casualty events and how each category should be parameterized

- Will allow future events to be simulated and their impacts to a portfolio investigated

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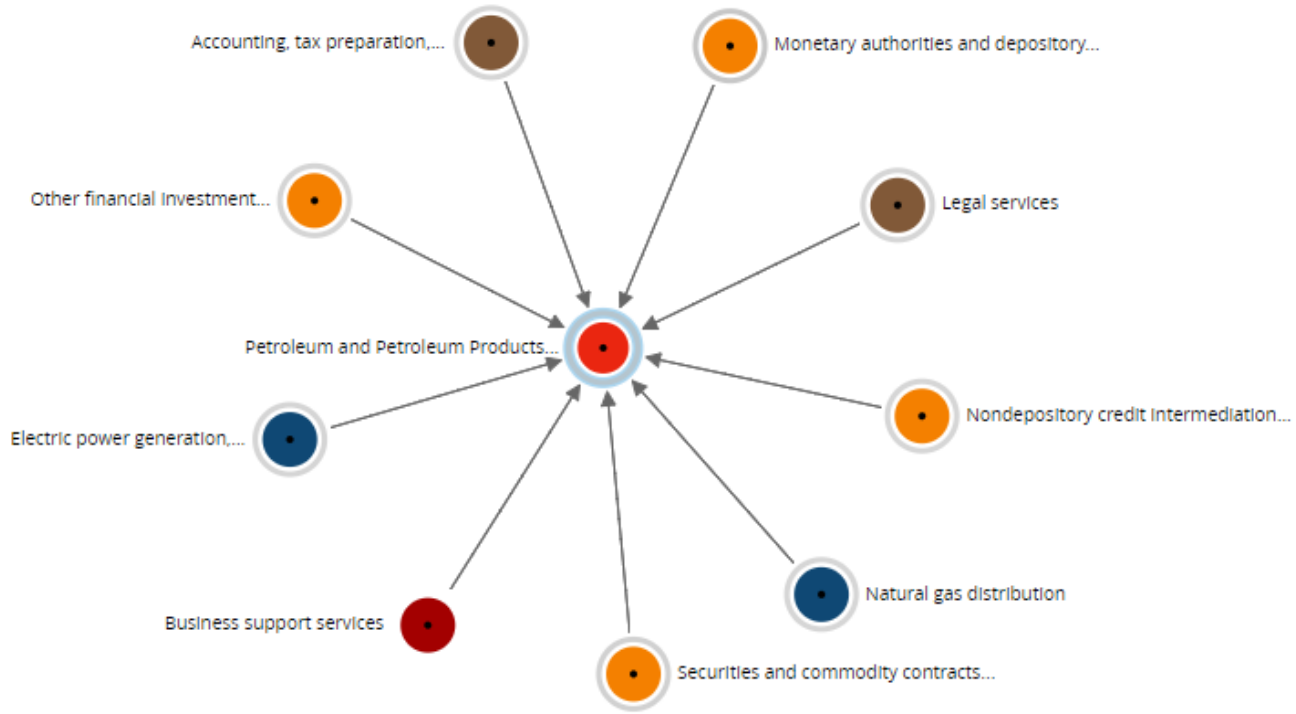
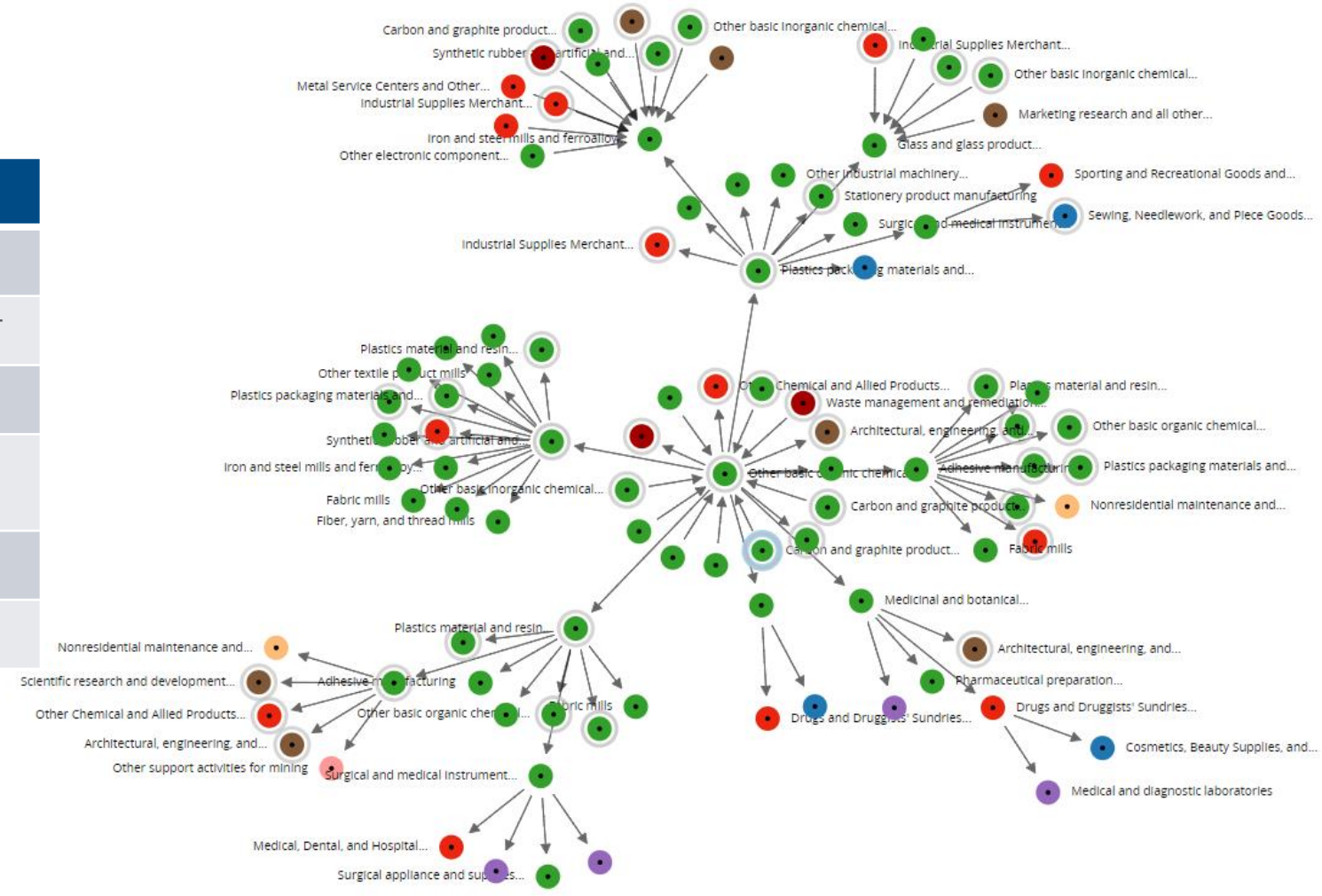
Example 1: Corporate Implosion Shape

Property	Description
Footprint Used	Enron
Shape	Corporate
Losses	Related to the number of causative parties, size of the business that implodes
Lines of Business	PL, D&O
Systemic	Mostly single, systemic within an industry
Probability	Stationary



Example 2: Product/Component Shape

Property	Description
Footprint Used	Carbon Nanotubes-Polymers
Shape	Product component/ingredient
Losses	Additive
Lines of Business	GL, WC, PL, Environmental
Systemic	Between and within industries
Probability	Non-stationary



For More Information

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- *Check out the Lloyd's paper that goes into more detail on our stochastic modeling methodology: https://www.lloyds.com/news-and-risk-insight/risk-reports/library/understanding-risk/arium*

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