Beyond NatCat
Developing Scenarios for Use in Insurance Risk Management

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GLOBAL EXPOSURE ACCUMULATION AND CLASH (GEAC) INITIATIVE

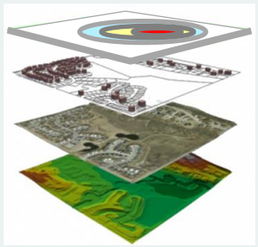
- Insurers are increasingly consolidating and standardizing exposure management across all their lines of business
- The GEAC initiative is to develop a standardized exposure data schema for classes of insurance that account for at least 80% of global insurance premium
- This is seen as an enabler of transfer of exposure data between market players
  - Reinsurance; intermediation; co-share; bordereau;
- It is also **an enabler of scenario development**
  - Encourages third party development: an eco-system of
  - Most insurers develop internal and proprietary scenarios
  - A standardized data schema means that scenarios can be shared and results replicated

USE CASES OF MULTI-LINE EXPOSURE MANAGEMENT

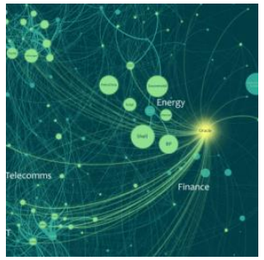
- **Single policyholder aggregation risk**
  - How many lines of cover do you provide to the same policyholder?
  - What are your worst aggregations for a single policyholder?
  - Tracing the chain of connected risks for a major corporation

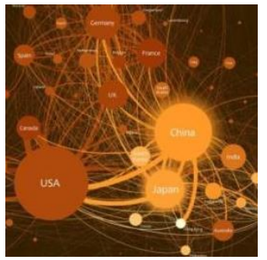
- **Enabling exposure analytics in more lines of business**
  - Ability to explore scenarios for PMLs in additional insurance lines
  - e.g. casualty liability, aviation, marine
  - Enable accumulation management beyond NatCat

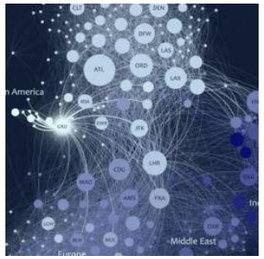
- **High value single location aggregation risk**
  - e.g. Deep Water Horizons, World Trade Centre losses
  - Where are my concentrations of multiple insureds on same risk?
  - Are “non-modeled” lines at risk?



- **Multi-line clash in complex loss events**
  - Consequences impact many different lines of insurance
  - Commercial interconnectivity and liability relationships between counterparties causes non-intuitive losses

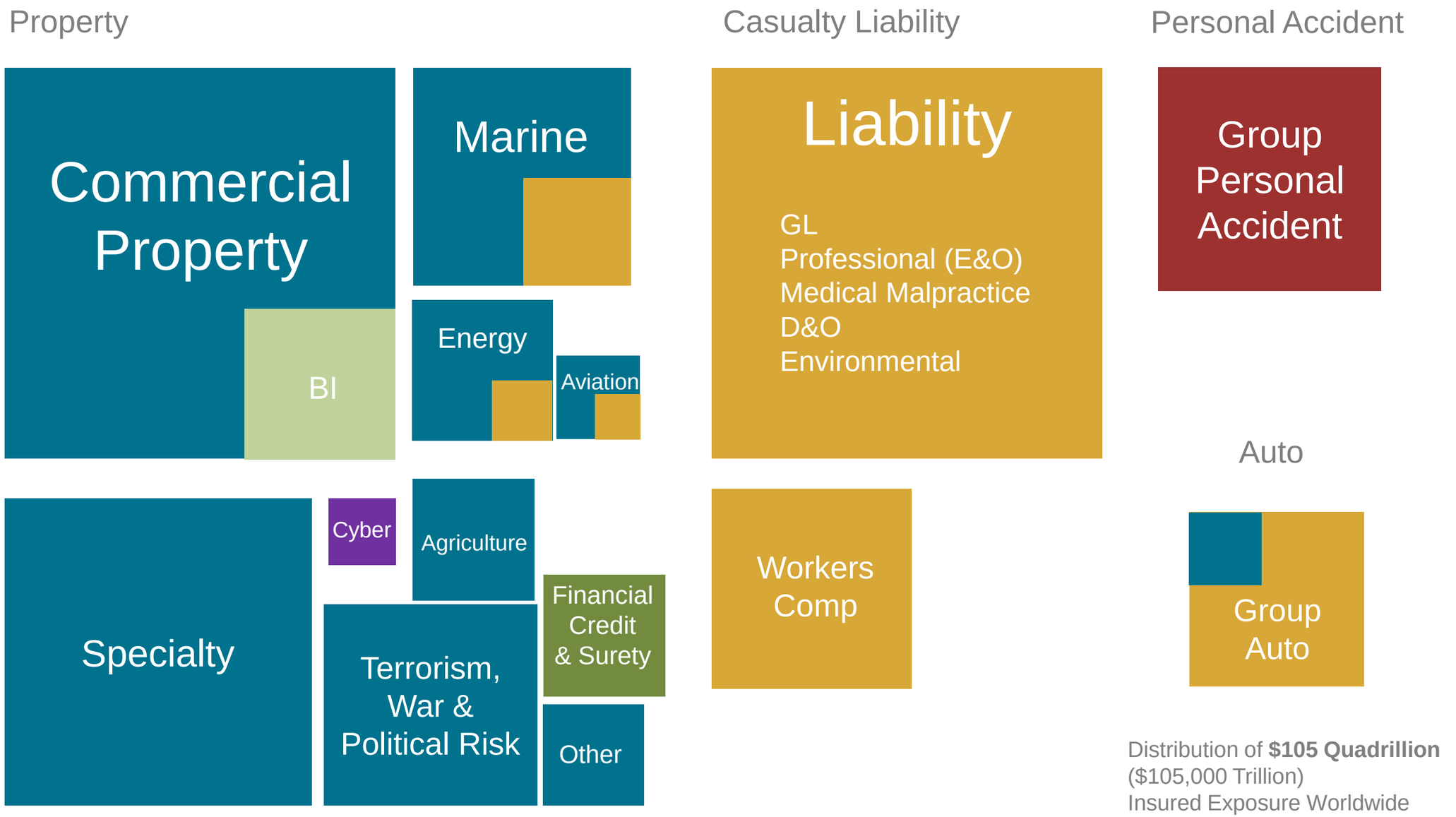






TOTAL EXPOSURE VALUE: COMMERCIAL LINES

Aggregate limits, Asset value under management

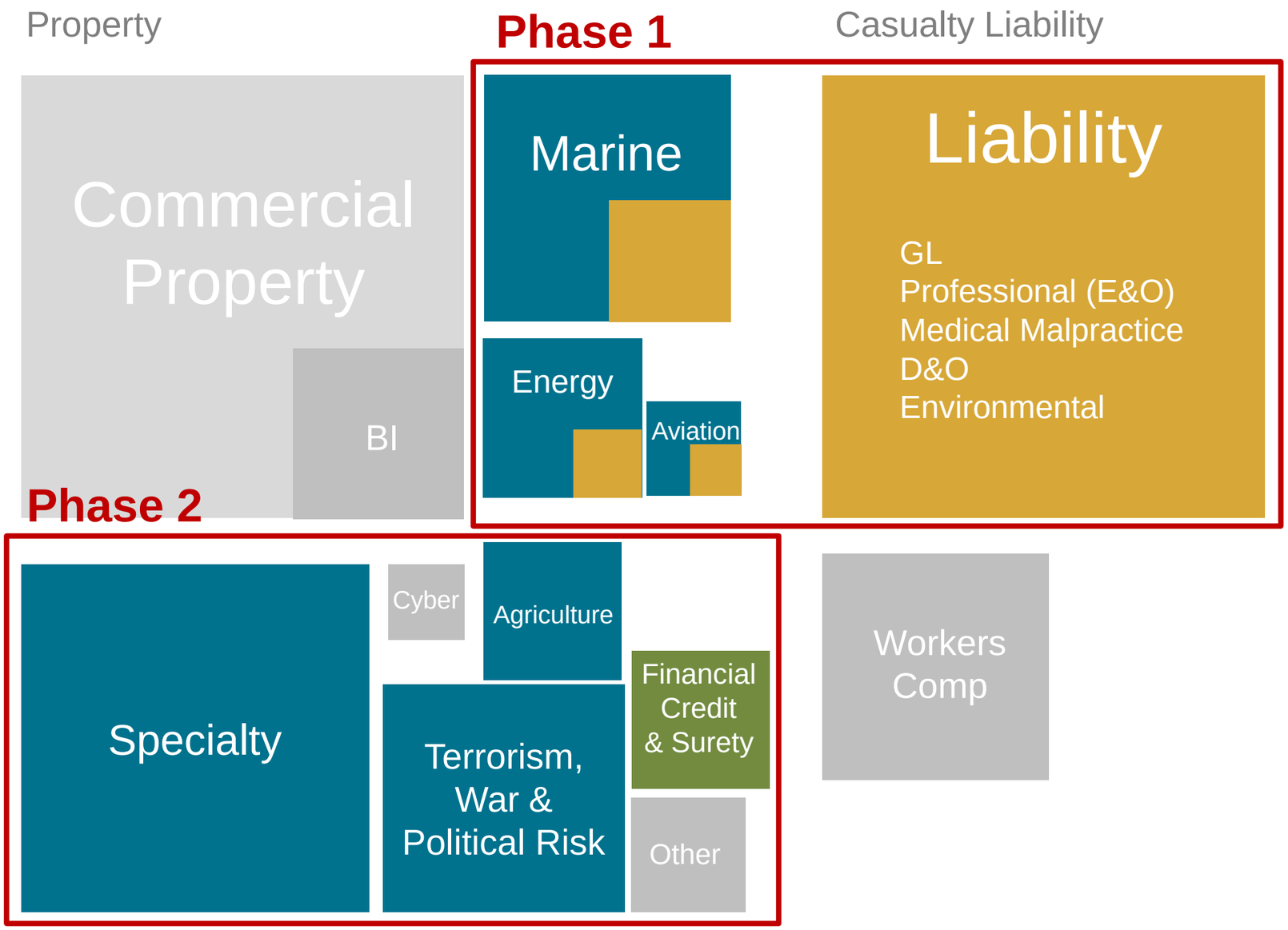


No specific limit for compulsory auto 3rd party liability; average upper limits assumed

Estimated total insured exposure values, aggregate limits. Pension asset value under management

MULTI-LINE DATA SCHEMA DEVELOPMENT PHASES

Aggregate limits, Asset value under management



$10,000 Trillion

To Scale

- Physical Damage
- Duty of care 3rd party
- Injury, illness or death
- Financial Asset Devaluation
- Revenue Loss. Business Interruption
- Digital asset loss (cyber)

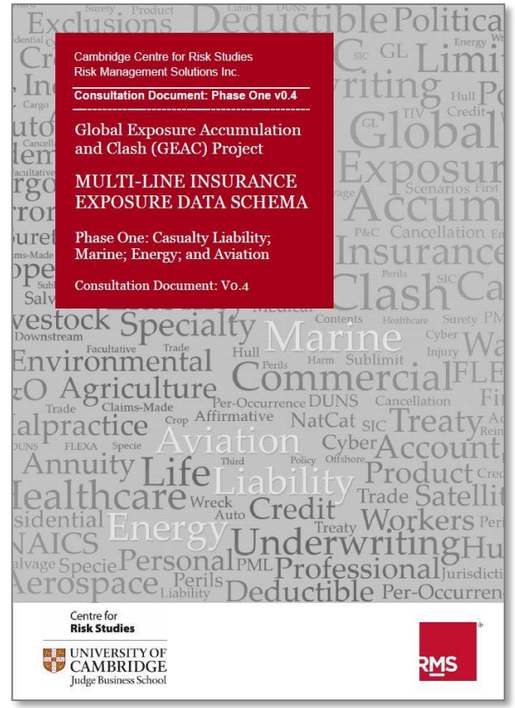
No specific limit for compulsory auto 3rd party liability; average upper limits assumed

Distribution of **$105 Quadrillion** ($105,000 Trillion) Insured Exposure Worldwide

Estimated total insured exposure values, aggregate limits. Pension asset value under management

CURRENT STATUS OF DATA SCHEMA DEVELOPMENT PHASE 1

		Casualty Liability	Marine	Energy	Aviation
1	Insured Policyholder				
2	Financial Structure				
3	Lines of Insurance				
4	Asset Types				
5	Asset Attributes				
6	Geographical Locations				
7	Coverage Wordings				
8	Exclusions				



v0.9
Consultation Document

Well defined (90%)

Still being developed (70%)

In development (50%)

SCENARIOS DEVELOPED BY CAMBRIDGE CENTRE FOR RISK STUDIES


Freeze Event: US-Europe


Marine Piracy: Horn of Africa


Interstate Conflict: China-Japan War


Systemic Cyber: Sybil Logic Bomb


Pandemic: São Paulo Virus


Social Unrest: Millennium Uprising


Financial: Global Property Crash


Financial: Eurozone Meltdown


Financial: High Inflation World


Financial: Dollar Deposed


Power Outage Cyber: US Business Blackout


Power Outage Cyber: UK Regional Blackout


Systemic Cyber: Data Exfiltration


Systemic Cyber: Denial of Service


Systemic Cyber: Extortion


Systemic Cyber: Cloud Outage


Systemic Cyber: Financial Theft


Power Outage: Solar Storm


Cyber-Physical: Commercial Property Laptop Fires


Cyber-Physical: Industrial Facilities Explosion


Cyber-Physical: Oil Rig Fire and Explosion


Cyber-Physical: Marine Cargo Theft


Cyber-Physical: Aviation Spoofing Attack


Cyber-Physical: Terrorism Cyber Attacks

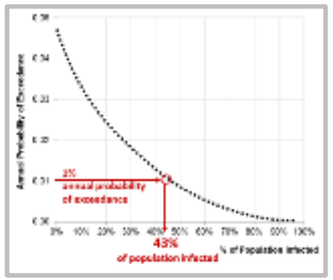

Investment Risk: Climate Change


Marine Realistic Disaster Scenarios


Project Pandora Scenario Suite


Trillion Dollar NatCats

CAMBRIDGE SCENARIO DEVELOPMENT METHODOLOGY

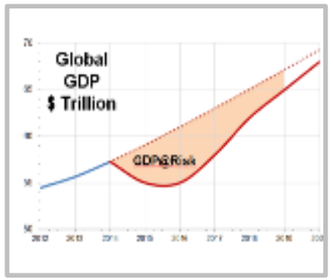


Context

A justification and context e.g. for a 1% annual probability of occurrence worldwide

Narrative & Variants

Detailed description of events
Multiple Variants of events
S1; S2; X1



Macroeconomic Consequences

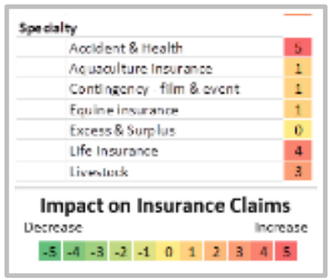
GDP@Risk: Quantification of effects on many variables in the global economy

Timeline & Footprint

Sequencing of events in time and space in hypothetical scenario

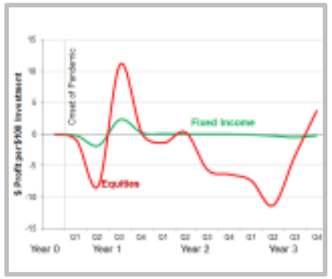
Loss Assessment

Metrics of underwriting loss across standardized lines of insurance business



Investment Portfolio Impact

Returns and performance over time of a range of investment assets



CAMBRIDGE SCENARIO DEVELOPMENT PROCESS

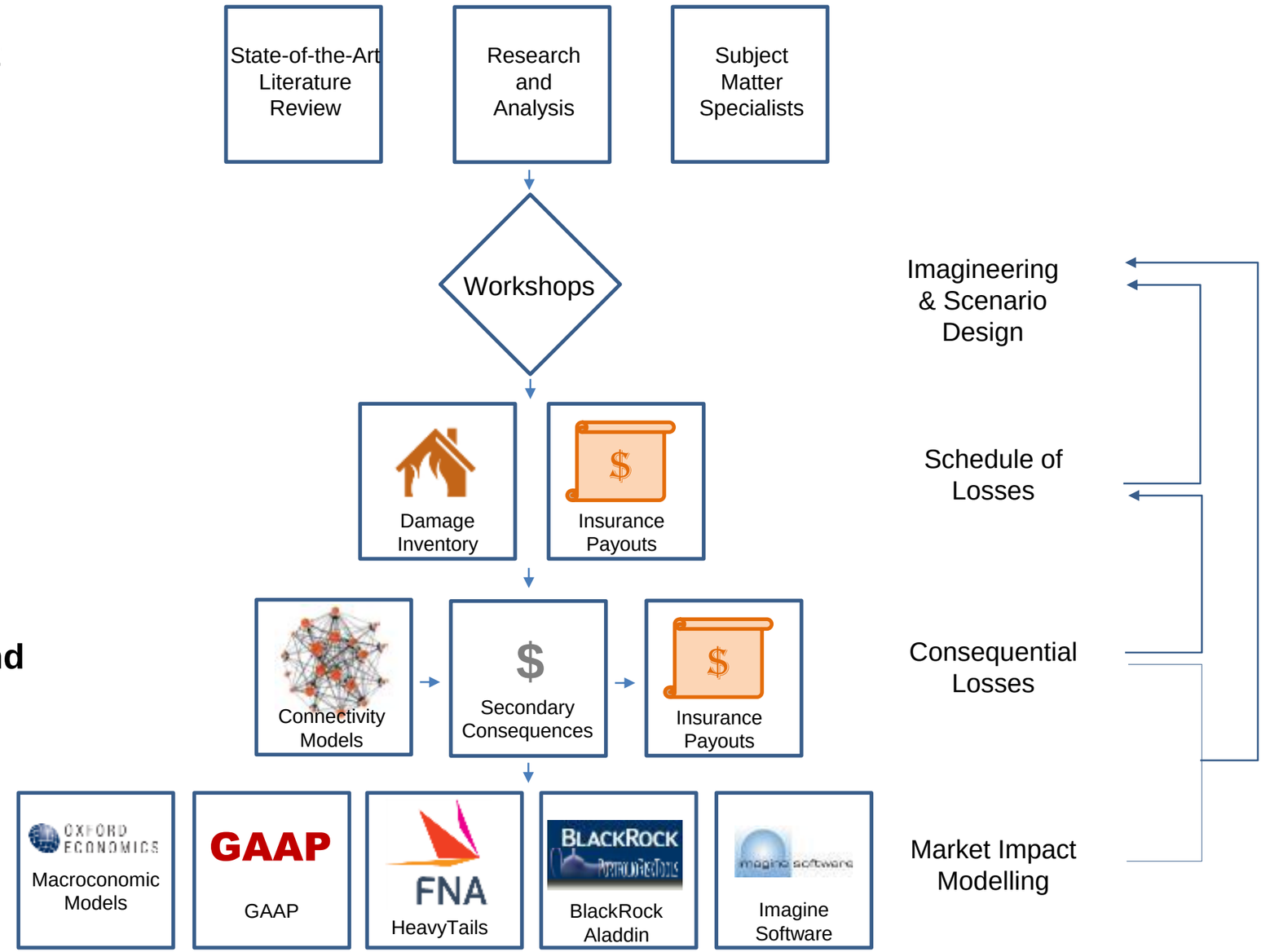
Research and Context Preparation

Scenario Specification

Primary Impacts and Insurance Loss

Secondary Impacts and Insurance Loss

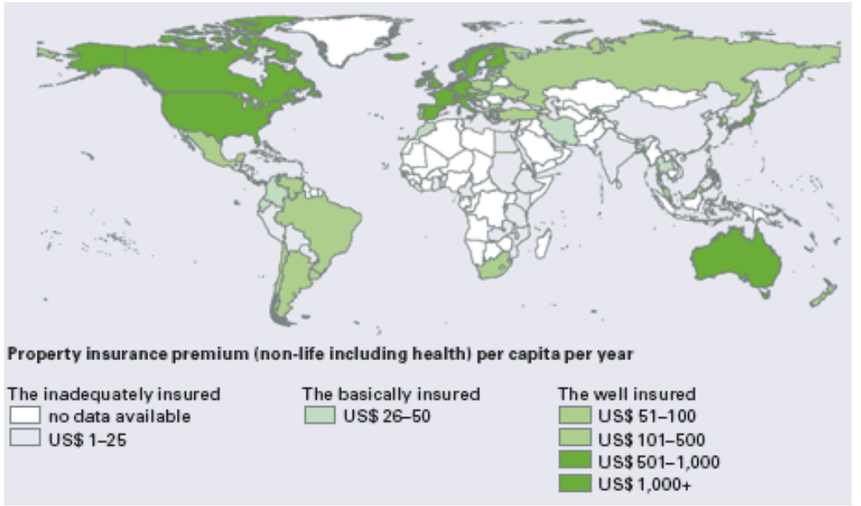
Macroeconomic Consequences and Investment Portfolio Impact



START WITH UNDERSTANDING THE EXPOSURE

- Identify the main exposure types
  - Geographical markets and locations of main exposure
  - Business sectors, company size, and characteristics
  - Insurance coverage inclusions, exclusions, T&Cs
- Identify the levels of loss that would be material
  - What are average annual loss rates?
  - What is an exceptional loss?
  - What would be catastrophic?

Property Insurance Penetration



Cyber Insurance Exposure by Business Sector and Company Size

	Premier	Large	Medium	Small
IT - Software				
IT - Hardware				
IT - Services				
Retail				
Banking				
Insurance				
Investment management				
Healthcare				
Business & Prof. Services				
Energy				
Telecommunications				
Utilities				
Tourism & Hospitality				
Manufacturing				
Pharmaceuticals				
Defense / Military Contractor				
Entertainment & Media				
Transportation / Aviation				
Public Authority / NGOs				
Real Estate / Property				
Education				
Mining & Primary Industries				
Food & Agriculture				
Other				

THREAT IDENTIFICATION

- Identify the threats to that exposure type
  - Historical precedents; Technical principles; Expert Opinion
- ‘Reverse engineer’ how the main classes of and geographies of exposure could be highly impacted
- Develop a list of loss causes (‘Threat Taxonomy’)
- ‘Imagineer’ potential causes of those levels of loss
  - ‘Red Team’ – how could you maximize loss?
  - What are the upper bounds of loss?
  - What prevents a loss from being even larger?
  - How does loss scale up? What are the step functions?
- Cascades: How might an event trigger other events?

Threat Taxonomy

Global Economy

Threat Taxonomy

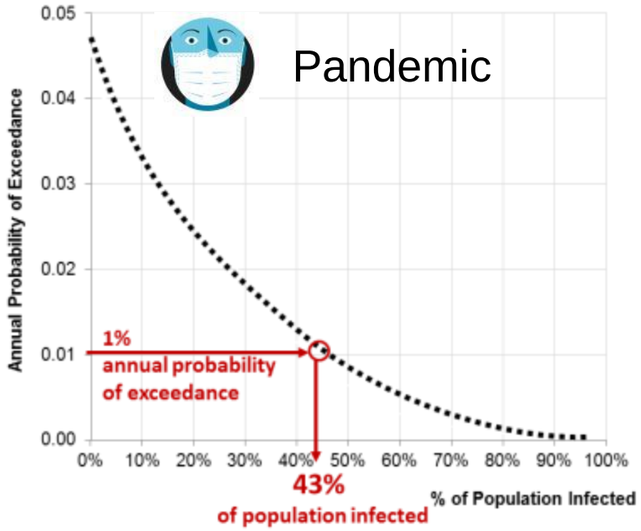
Cyber Insurance

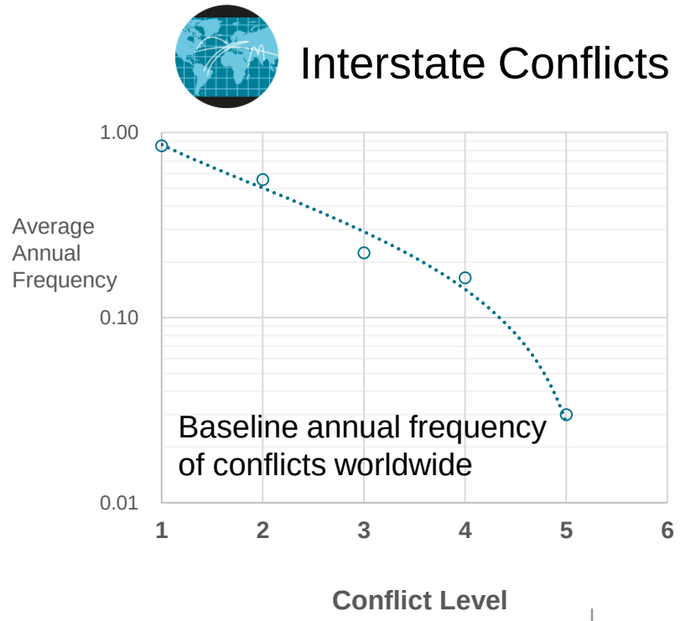
SCENARIO DEVELOPMENT WORKSHOPS

- Stakeholder engagement
- Interaction between subject matter specialists and the business users
- Plausibility testing
  - Can you ‘sell’ this scenario to senior management?
  - Answering the “well that would never happen” response
- Severity level sanity check

SETTING THE SEVERITY LEVEL

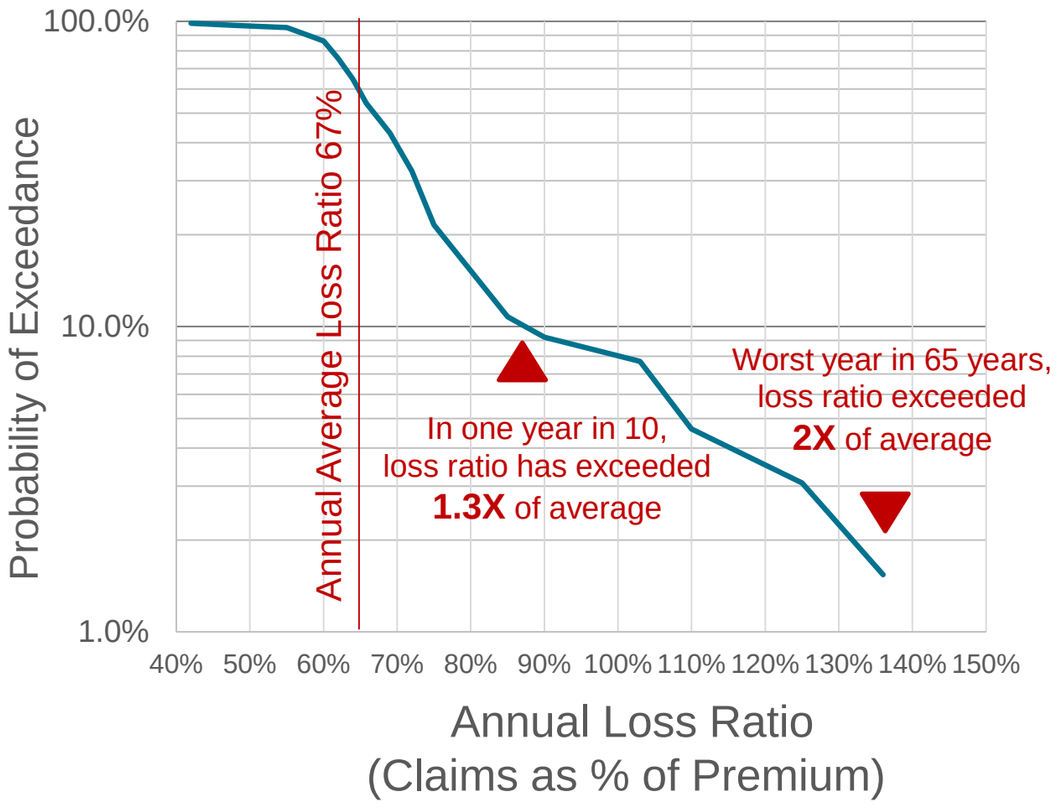
- A specified scenarios has no inherent return period
  - Only the loss has a probability of exceedance
- Physical, behavioural or technical processes are usually being reflected in the extreme scenario
  - Is there an objective para-metric that can be assessed as a frequency-severity distribution of the causal trigger? e.g.:
    - Virulence and infectiousness metrics for a pandemic
    - dB/dt for a solar storm
    - Gbps/hours for denial of service cyber attacks on businesses
- CCRS has typically attempted to identify the para-metric severity of the causal trigger with a global return period of 1-in-100 for the S1 variant



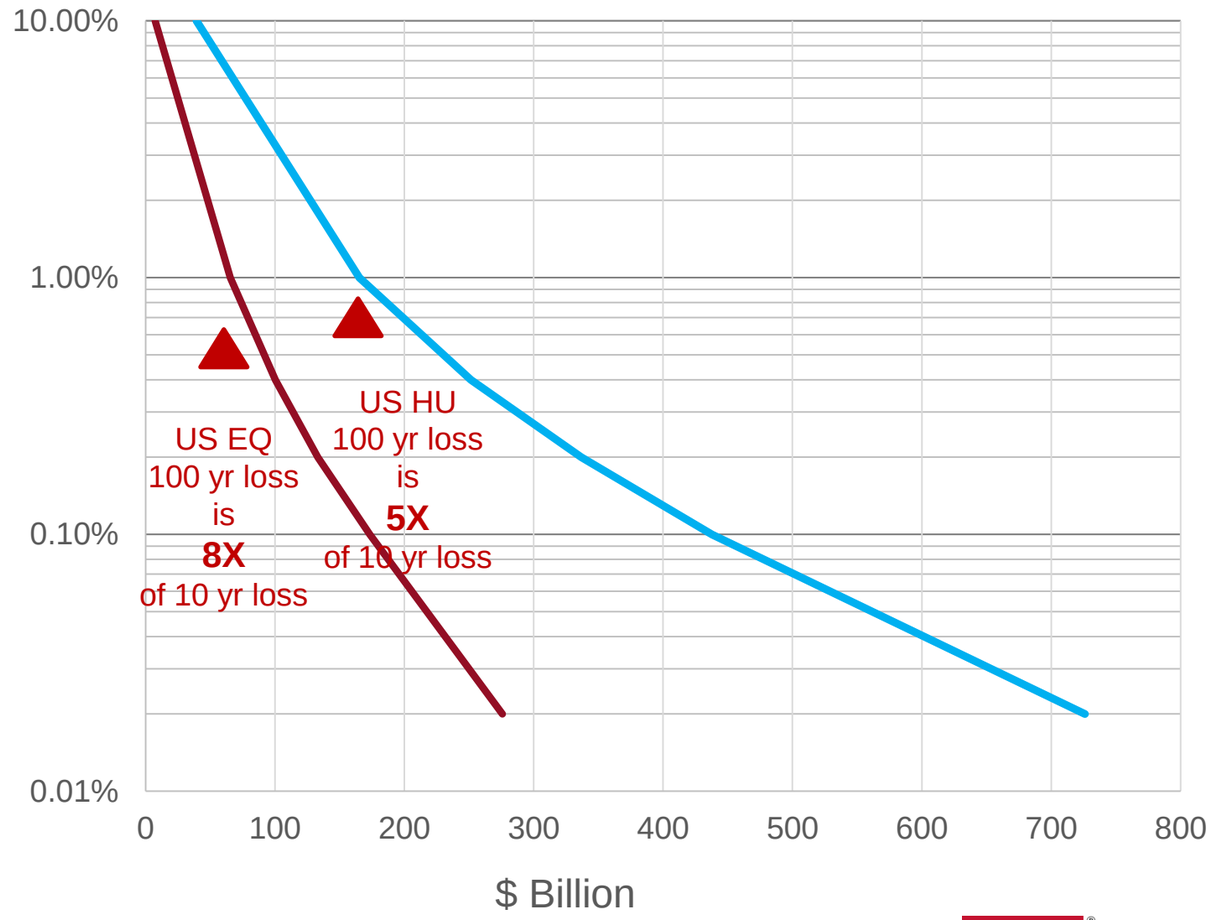


BENCHMARKING TO EP CURVES OF OTHER PERILS

US Homeowner Fire Insurance
Probability of Exceedance
Distribution of Industry Annual Loss Ratios
1950-2015



US Modeled NatCat Industry Loss
Probability of Exceedance
RMS EQ and HU Models, US Res+Comm

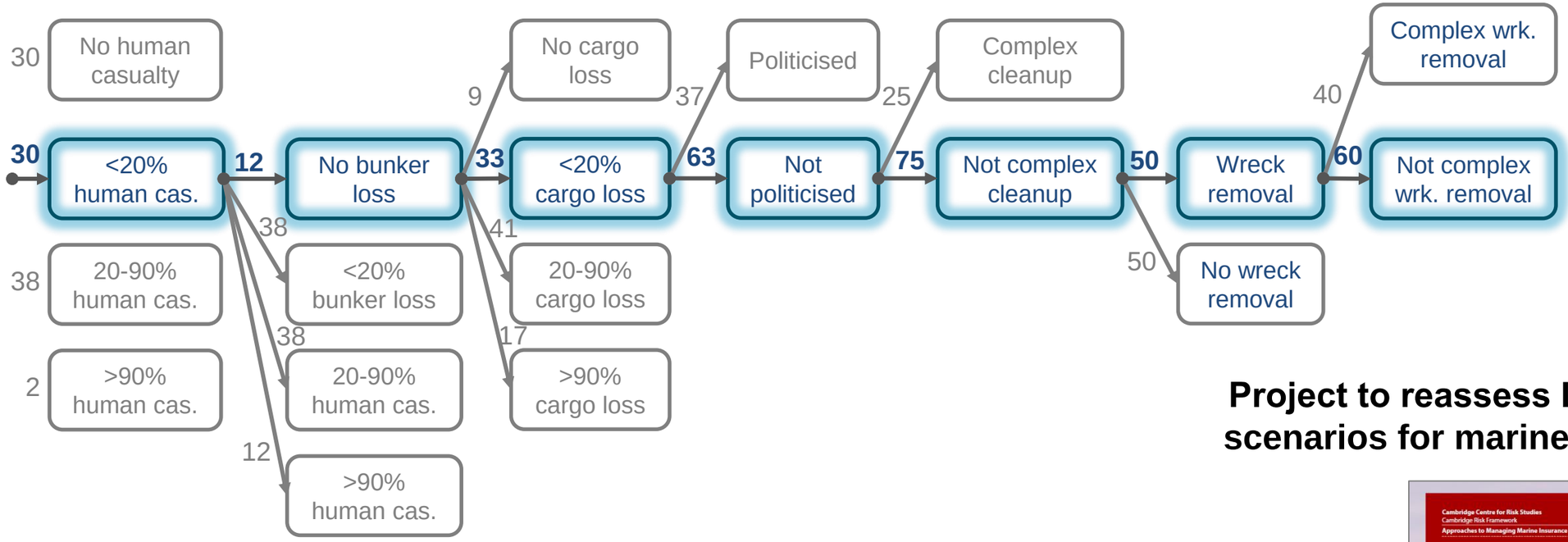


IMAGINEERING THE EVENT TREE

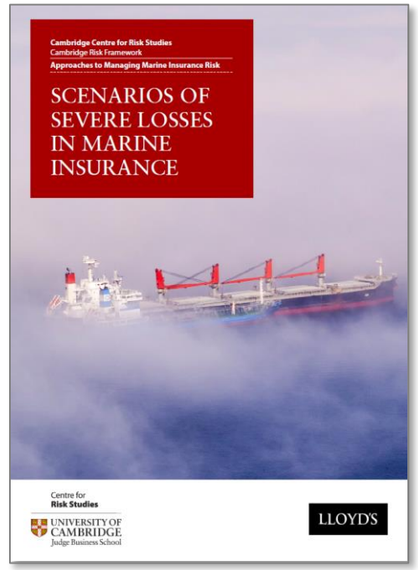
- From the ideation we develop a narrative
  - Identify a timeline and event sequence
- Plausibility is a major issue
  - Identify the near-precedents or counter-factual
- Various nodes where large variables can occur
  - Stress the key variables
- CCRS has typically developed three variants:
  - S1: 1-in-100 parametric trigger occurrence with ‘best estimate’ assumptions of consequences
  - S2: Significantly worse assumption set for the same event
  - X1: Worst case assumptions for same event

Scenario Specification Event Tree: Pandemic

IMPROVING SCENARIOS WITH EVENT TREES



Project to reassess Lloyd's RDS scenarios for marine vessel loss



- A Bayesian variant event tree enables a much clearer assessment of potential permutations of outcomes
- It generates thousands of scenario variants, which improves assessments of uncertainty and extremes
- An insurance PML, stress test, or accumulation scenario needs to explore uncertain extremes

LOSS CALCULATION

- Loss estimation is the most complex, resource intensive, and important part of the scenario development
- It might be possible to make top-down high level loss estimates, but the only way to try to make an assessment with any confidence is to build a ground-up loss estimate from component parts
- There are two stages
  - Primary impact (Direct loss)
  - Secondary, consequential losses as a result of direct losses
- Secondary losses in systemic events can exceed primary losses (by a multiple)
- Go through a checklist of each of the categories of exposure and test whether they would have a loss
- Estimating losses has to be carried out transparently
  - What is the evidence-base for the loss ratio being applied?
  - It is OK to make experienced guesses as long as these are flagged and can be adjusted by others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Summer blackout hits Northeastern US

City residents in New York City, Washington DC, try to keep cool while officials seek an urgent solution

Wednesday, July 8th

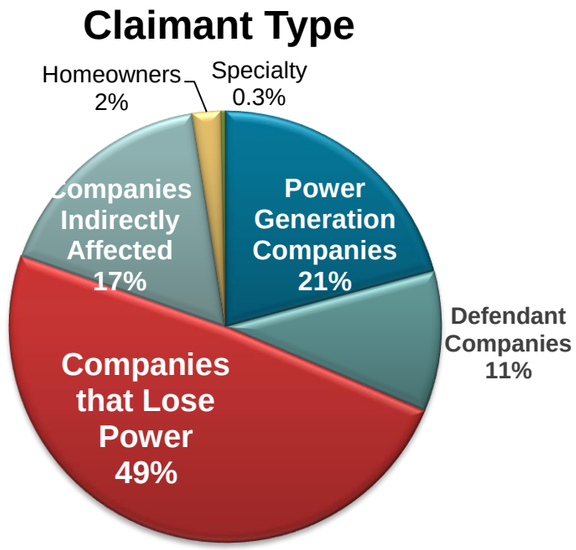
NEW YORK CITY, NY (0732 EST) – **The massive blackout has struck the region during the hottest summer in a decade, causing chaos for an estimated 50 million Americans.**

The outage spread westward from Washington DC to Chicago and south to the Tennessee border in the early hours of Tuesday morning, leaving millions stranded and unable to fight the in the heat.

The White House is due to issue an official statement later this morning once the full extent of the blackout is reported.

The cause of the outage is yet to be confirmed but official theories suggest a generator malfunction

Traffic systems have been shut down and emergency teams are struggling to free those stuck on subway cars beneath the city streets.



Share of **$21.4 Bn**
Insurance Loss Estimate
S1 Variant Business Blackout Scenario

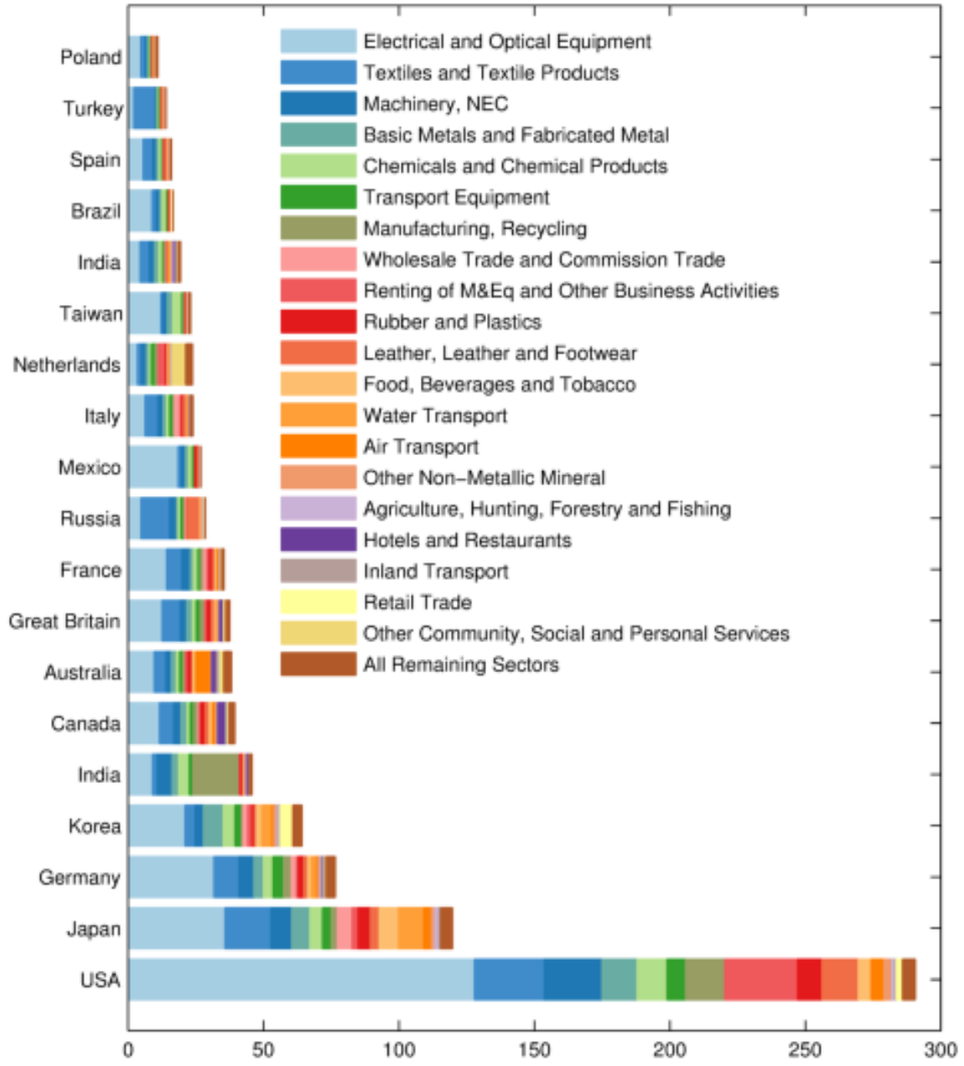
LOSS MODELLING: EXHAUSTIVE ANALYSIS OF ALL EXPOSURES

- Work through a check-list of exposed assets
- Direct loss estimates require a collation of global exposure
- Insurance industry loss estimation requires both an estimation of uninsured assets and their insured penetration
- Ground-up uninsured direct loss is often (confusingly) called an ‘economic loss’ estimate

					CBI Insurance Penetration (Cyber covered or silent)			
					Penetration	Ave payout	Deductable	Limit
GICS Sector		GICS Industry Group		**Boreas Day Scenario Facilities Affected**	High/Low	$ per day	No. Days outage	Total Days
10	Energy	1010	Energy	**Large administrative operations buildings (non-generating)**	1 - Low	$??	3	21
15	Materials	1510	Materials	**Large mining and mineral processing facilities**	1 - Low	$??	3	21
20	Industrials	2010	Capital Goods	**Large manufacturing factories & despatch warehouses**	2 - Moderate	$??	3	21
		2020	Commercial & Professional Services	**Large commercial buildings**	2 - Moderate	$??	3	21
		2030	Transportation	**Airports, Railways, Port facilities**	3 - High	$??	3	21
25	Consumer Discretionary	2510	Automobiles & Components	**Auto manufacturing plants & warehousing**	2 - Moderate	$??	3	21
		2520	Consumer Durables & Apparel	**Manufacturing facilities and large commercial operations**	2 - Moderate	$??	3	21
		2530	Consumer Services	**Manufacturing facilities and large commercial operations**	2 - Moderate	$??	3	21
		2540	Media	**Broadcasting and headquarters operations**	2 - Moderate	$??	3	21
		2550	Retailing	**Large shopping malls and major retail outlets**	2 - Moderate	$??	3	21
30	Consumer Staples	3010	Food & Staples Retailing	**Large supermarket, cold storage facilities, warehousing & despatch**	2 - Moderate	$??	3	21
		3020	Food, Beverage & Tobacco	**Large factories and food processing plants, storage & despatch**	2 - Moderate	$??	3	21
		3030	Household & Personal Products	**Large factories, warehouses & despatch**	1 - Low	$??	3	21
35	Health Care	3510	Health Care Equipment & Services	**Large hospitals and healthcare facilities**	3 - High	$??	3	21
		3520	Pharmaceuticals, Biotechnology & Life Sciences	**Large pharma production facilities, R&D Labs, headquarters campuses**	3 - High	$??	3	21
40	Financials	4010	Banks	**Headquarters and financial operation hubs**	2 - Moderate	$??	3	21
		4020	Diversified Financials	**Headquarters and major commercial buildings**	2 - Moderate	$??	3	21
		4030	Insurance	**Headquarters and major commercial buildings**	2 - Moderate	$??	3	21
		4040	Real Estate	**Headquarters and major construction projects**	1 - Low	$??	3	21
45	Information Technology	4510	Software & Services	**Headquarters, Cloud server farms**	3 - High	$??	3	21
		4520	Technology Hardware & Equipment	**Manufacturing/assembly plants, warehousing, despatch**	2 - Moderate	$??	3	21
		4530	Semiconductors & Semiconductor Equipment	**Manufacturing/assembly plants, warehousing, despatch**	1 - Low	$??	3	21
50	Telecommunication Services	5010	Telecommunication Services	**Control centres, server farms, phone/data exchanges**	3 - High	$??	3	21
??	Education	????	Education	**Universities and large educational facilities**	2 - Moderate	$??	3	21
55	Utilities	5510	Utilities	**Major water processing plants, sanitation facilities**	1 - Low	$??	3	21
00	Public Sector	0010	National Government departments	**Department main offices, storage and operational centres**	0 - None	$??	3	21
		0020	Local Authority/Municipal	**Admin HQs, Fire/police HQs, emergency facilities**	1 - Low	$??	3	21
		0030	Military	**Army navy airforce bases**	0 - None	$??	3	21
ZZ	General Public	ZZZZ	Homeowners/Personal Lines	**Residential properties & homeowners**	0 - None	$??	3	21

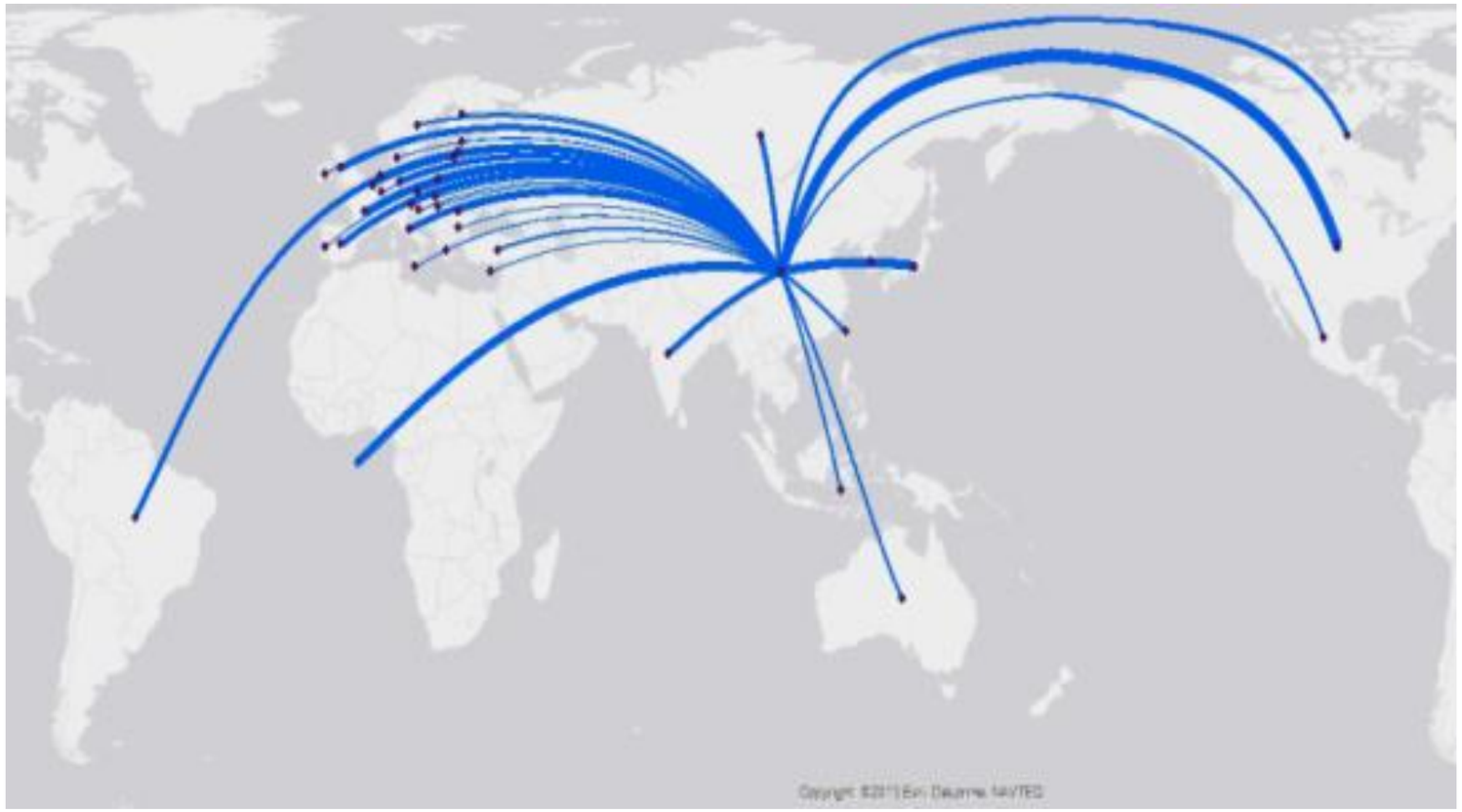
Checklist of facilities potentially impacted by Business Blackout scenario

CONNECTIVITY: WHAT HAPPENS IF CHINA STOPS EXPORTING?



China Export Value by Economic Sector (US$ Billions 2009)

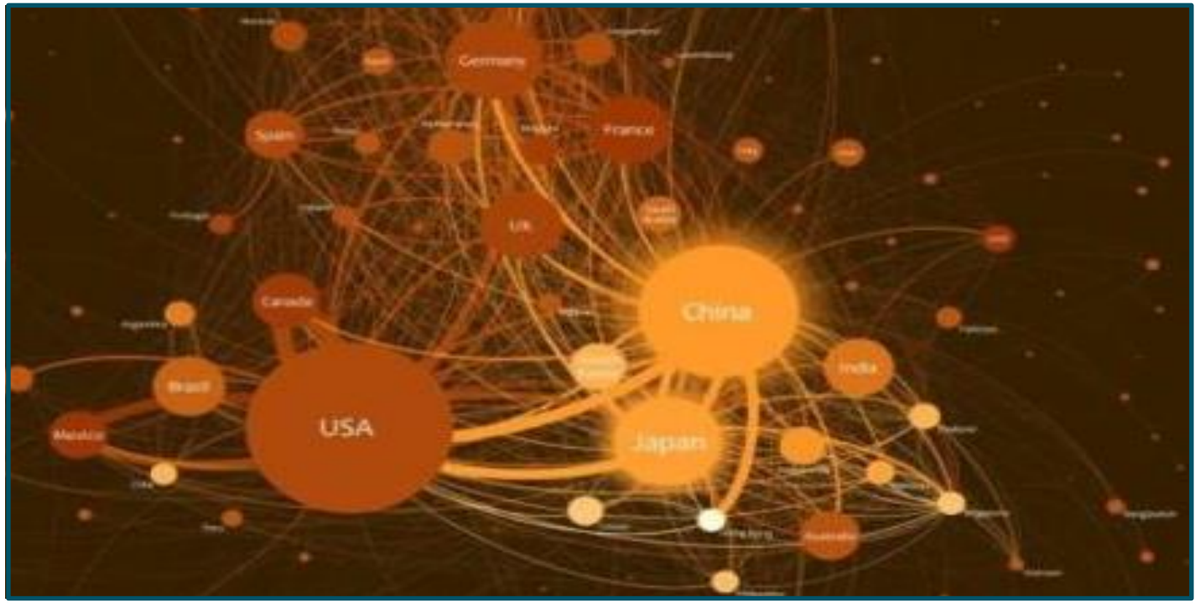
* Excludes exports to the Rest of World



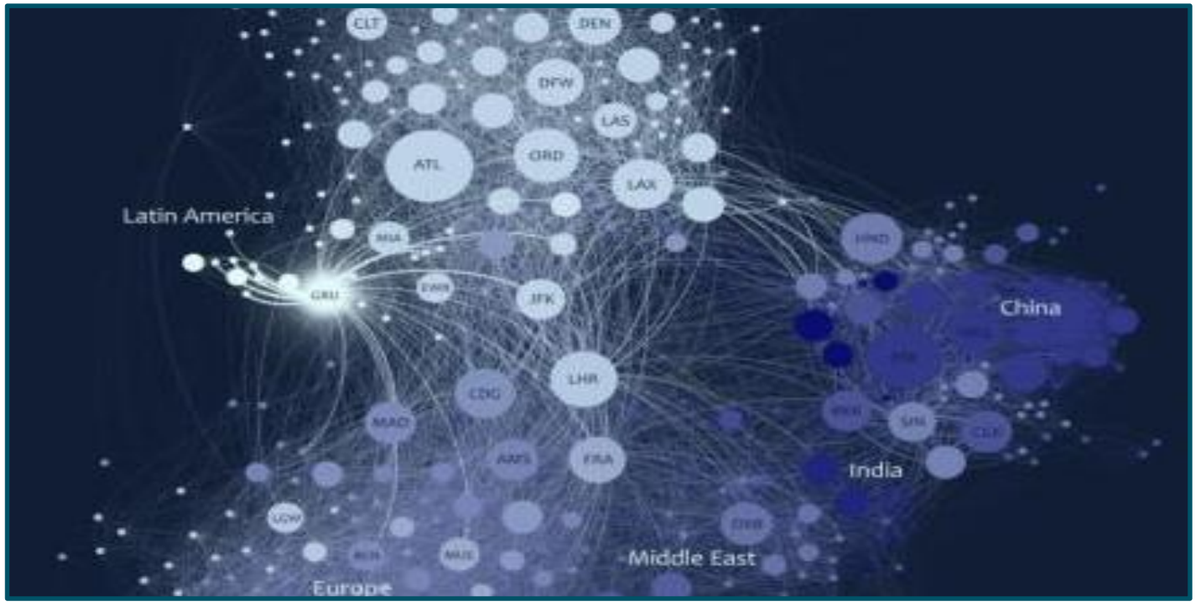
Total value of Chinese exports: $1.33 Trillion ($US 2009)

MANY CHANNELS OF CONNECTIVITY IN GLOBAL ECONOMY

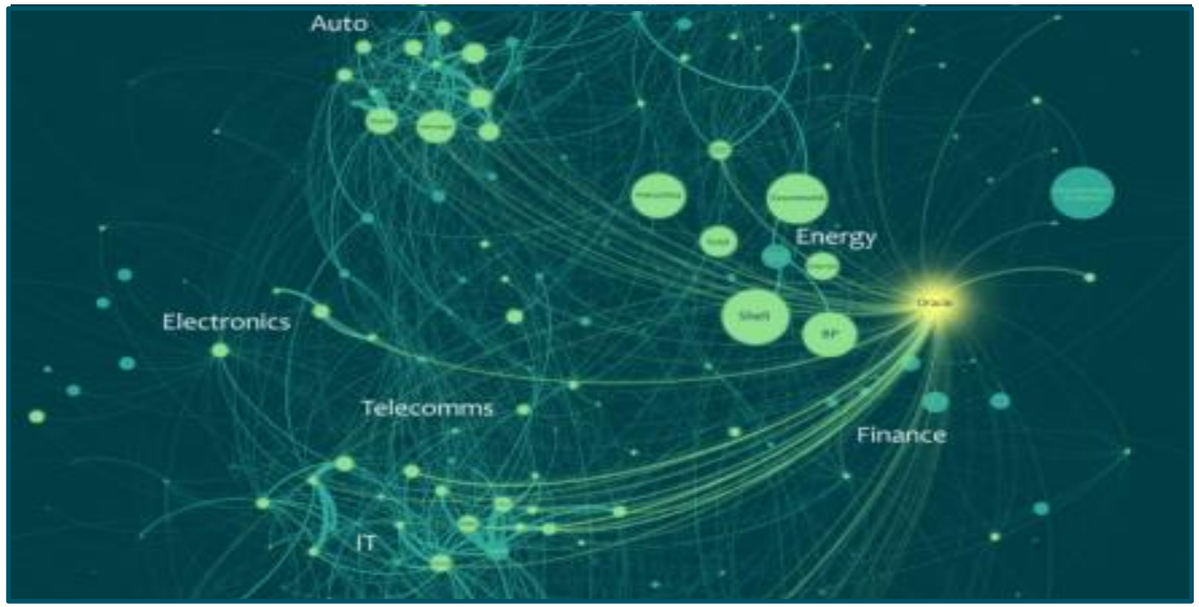
International Trading Networks



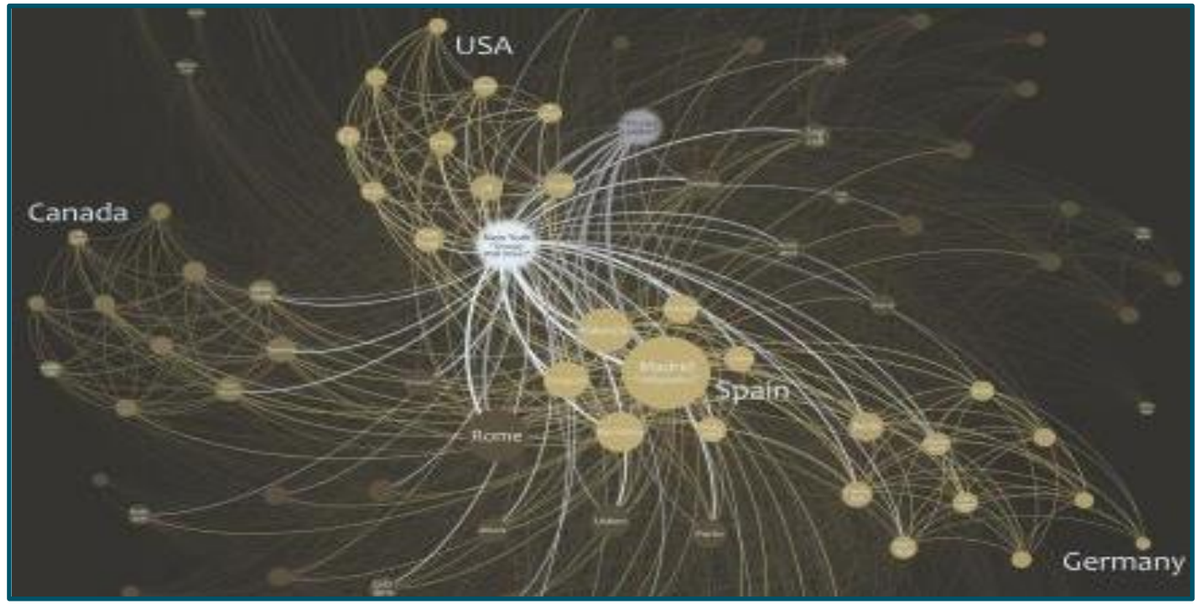
Travel Flows of People and Goods



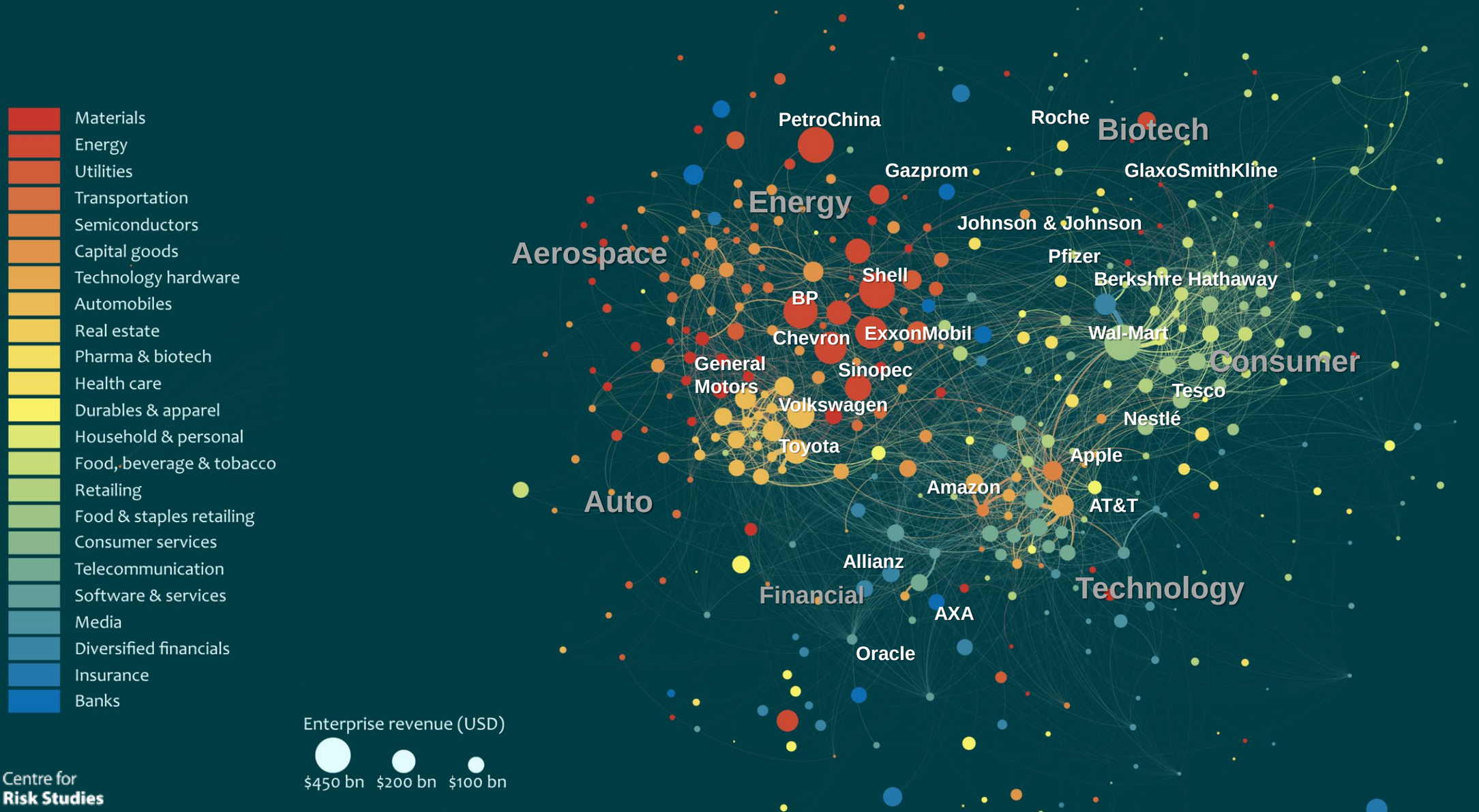
Business Relationships between Companies



Communications and Social Media



Global Enterprise Trading Network



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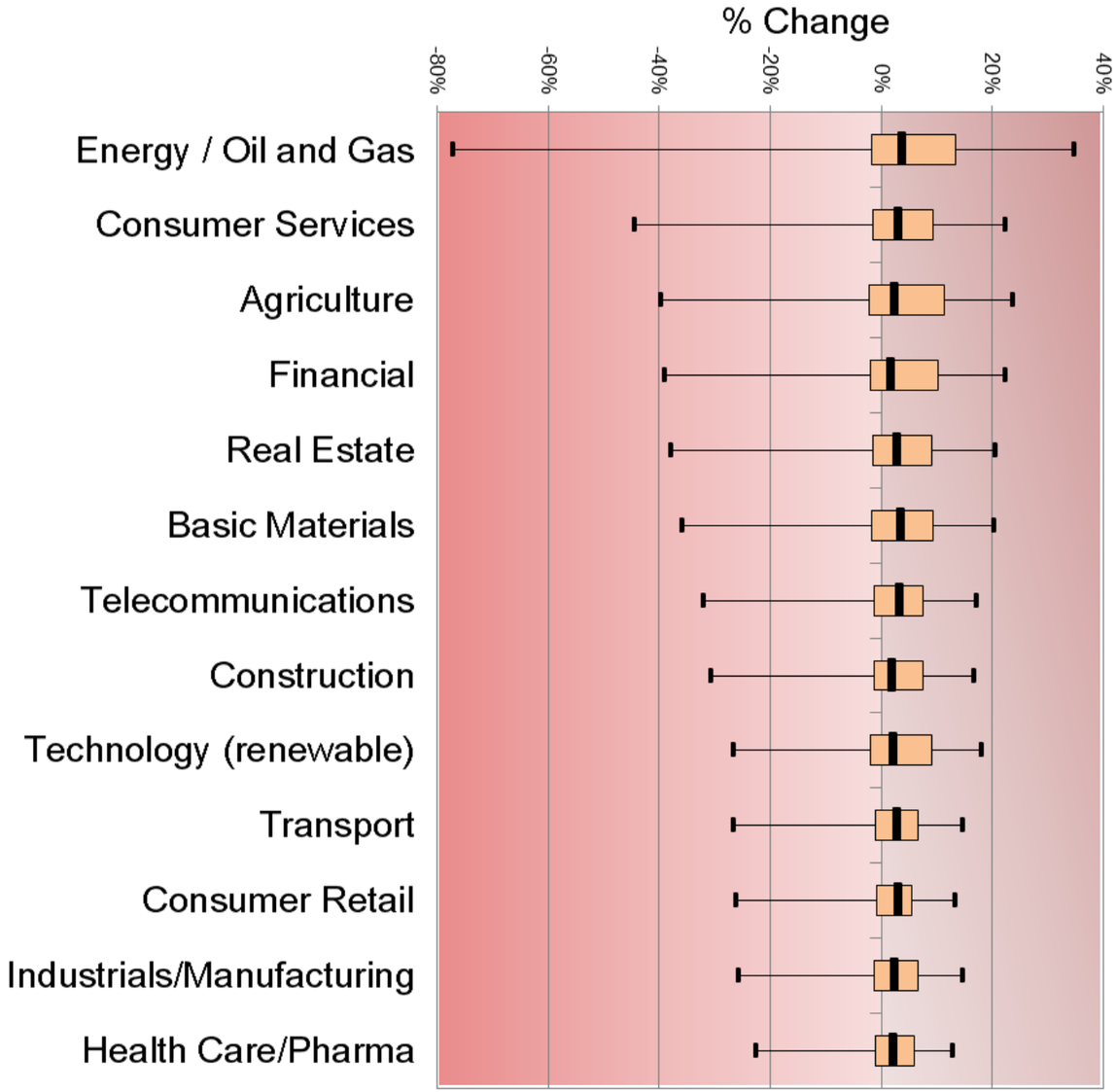
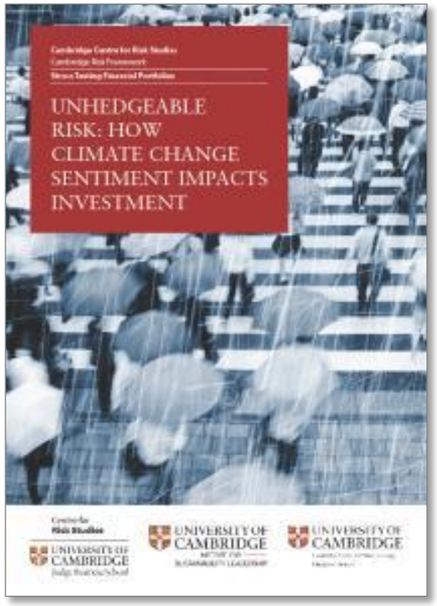
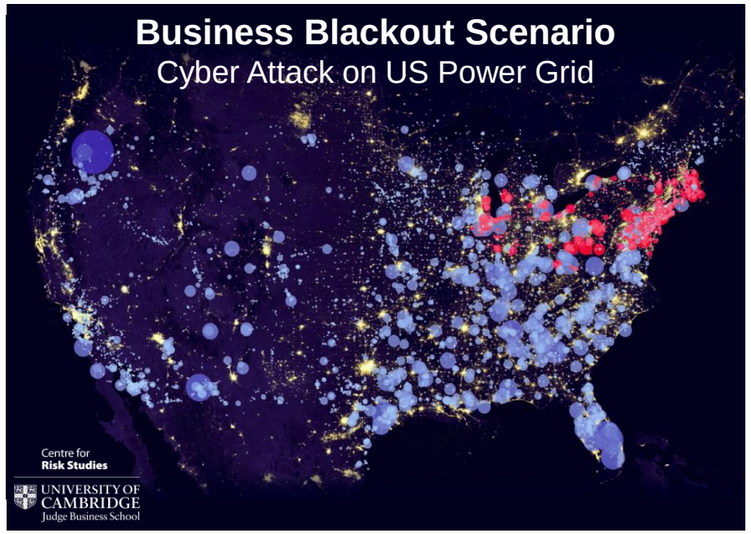
GRANULARITY OF OUTPUTS: E.G. LOSS MODELLING BY SECTOR

- Granularity of loss estimation is important in some scenarios
- May not be vital for overall accumulation management
- But differentiating by business sector is a common requirement for insurers
  - Usually manage their exposure by business sector
- Individual company or account differentiation is not usually a requirement for scenarios
  - More advanced modelling required for risk selection





INSURANCE LOSS BREAKDOWN BY LINE OF BUSINESS



- Important to iterate from the loss numbers back to the scenario design to converge on a useable scenario
- Variants of the scenario explore different aspects of the threat
- Impact of scenario on macroeconomy, investment portfolio and business context is also important for holistic estimate

Power Generation Companies		**$ millions**
	Property Damage (Generators)	633
	Business Interruption (Generator Damage)	3,817
	Incident Response Costs	3
	Fines - FERC/NERC	4
	Other liabilities	-
Defendant Companies		
	Liability	2,253
Companies that Lose Power		
	Perishable Contents	595
	Contingent Business Interruption - Suppliers Extension	6,769
	Liability	3,120
Companies Indirectly Affected		
	Contingent Business Interruption - Critical Vendor	2,928
	Liability	749
Homeowners		
	Household Contents	465
Specialty		
	Event Cancellation	63
Total	For variant S1	**$ 21,398**

CONCLUSIONS

- The Cambridge Centre for Risk Studies methodology for scenario development has proven versatile and produced many scenarios for a wide range of applications
- We will be adapting this framework to develop the multi-line clash scenarios for the GEAC project
- Aspects of this methodology may be a useful framework for others to produce their own scenarios
- We look forward to getting the feedback of today's attendees on what constitutes 'Best Practice' in scenario development