USING CATASTROPHE RISK MODELS TO OPTIMIZE SUPPLY CHAIN RESILIENCE

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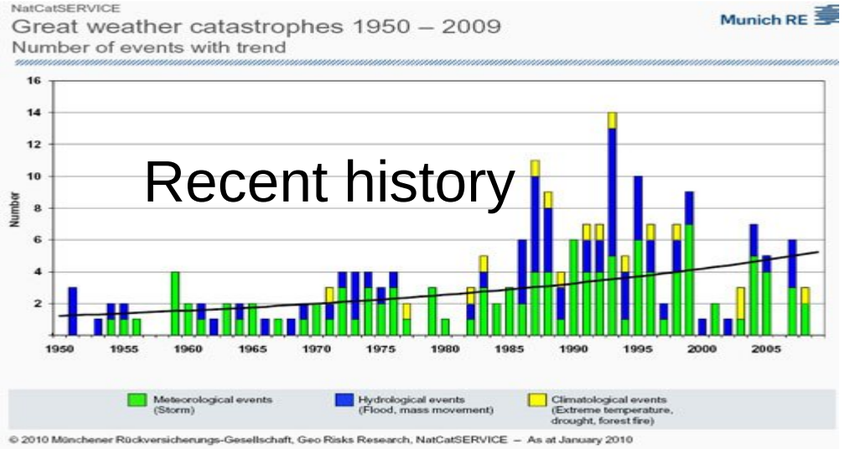
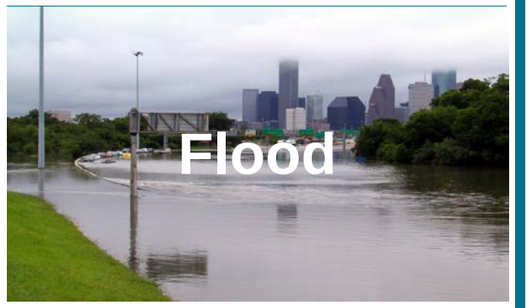
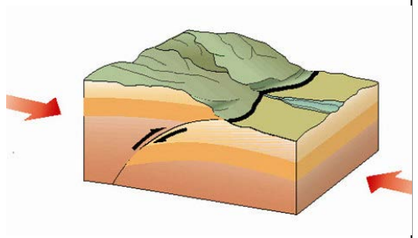
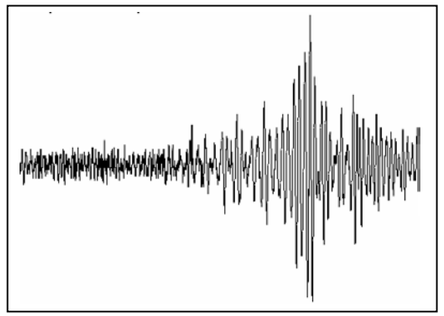
CATASTROPHE RISK MODELLING FOR INSURANCE





FRAMEWORK FOR EARTHQUAKE RISK MODELING





Define Events → **Assess Ground Motion** → **Calculate Damage** → **Quantify Risk**

Create a set of earthquake events that characterize long-term probabilities

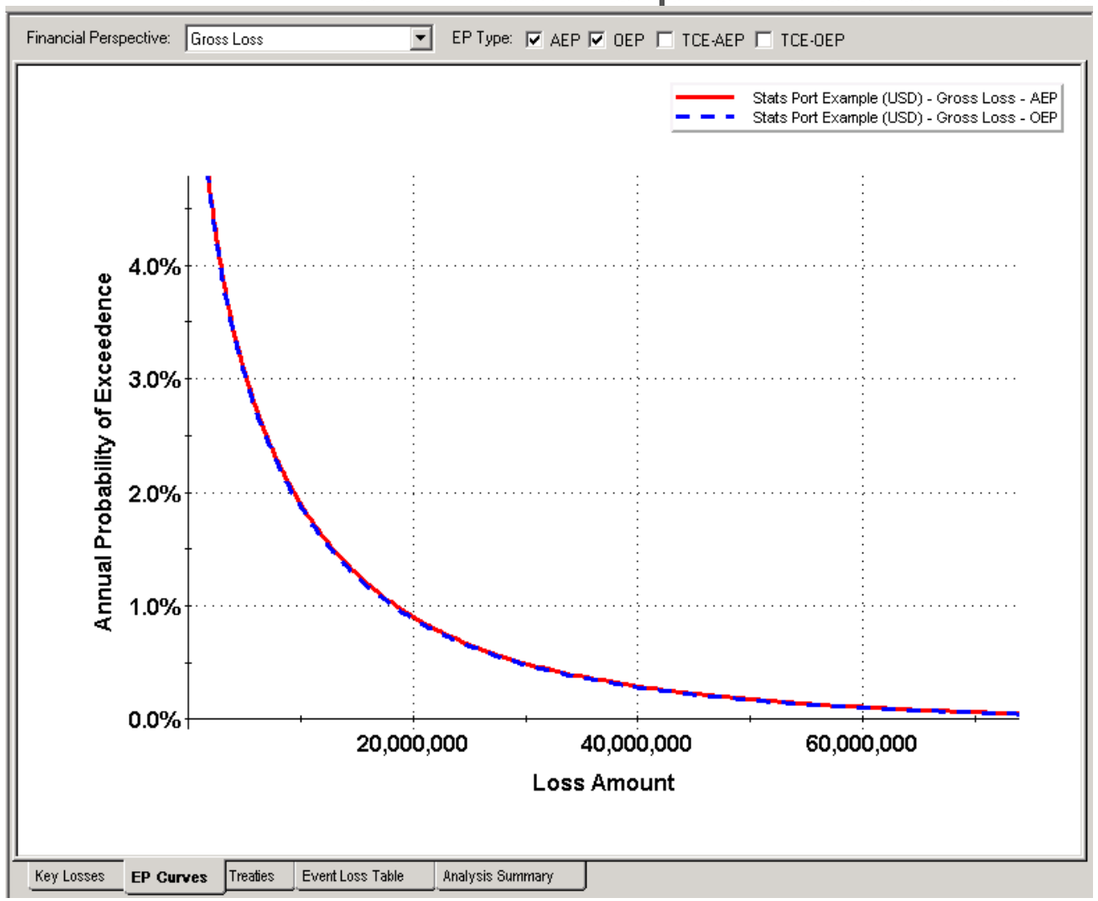
Calculate the ground motion for all sites due to each stochastic event

Calculate the average damage and associated uncertainty. Determine the business downtime.

Calculate the financial impact for all perspectives

THE OUTPUTS OF A CATASTROPHE LOSS MODEL

- The EP curve provides a visual interpretation of loss potential



Financial Perspective: Gross Loss EP Type: ☑ AEP ☑ OEP

Summary Losses:

Critical Prob.	Return Period	Stats Port Example (USD) Gross Loss AEP	Stats Port Example (USD) Gross Loss OEP
0.010000 %	10,000	98,292,689.59	97,052,287.57
0.020000 %	5,000	88,344,656.39	87,283,383.61
0.100000 %	1,000	61,035,485.31	60,308,399.87
0.200000 %	500	47,435,560.45	46,815,438.67
0.400000 %	250	33,819,047.92	33,330,167.22
0.500000 %	200	29,731,248.08	29,292,523.91
1.000000 %	100	18,497,304.25	18,224,297.35
2.000000 %	50	9,406,319.05	9,274,258.44
4.000000 %	25	2,887,777.57	2,851,436.97
10.000000 %	10	14,124.93	13,987.61
20.000000 %	5	0.00	0.00

- Each point of the curve has an associated threshold and probability of exceedance

SUPPLY CHAIN CATS: 2011 THAI FLOODS

- Six large industrial estate ‘business clusters’ established on Chao Phraya flood plain in the 1990s

- Low levels of flood protection

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- 2011 Sept-Nov floods lasted 4-9 weeks

- 7,510 industrial and manufacturing plants flooded,

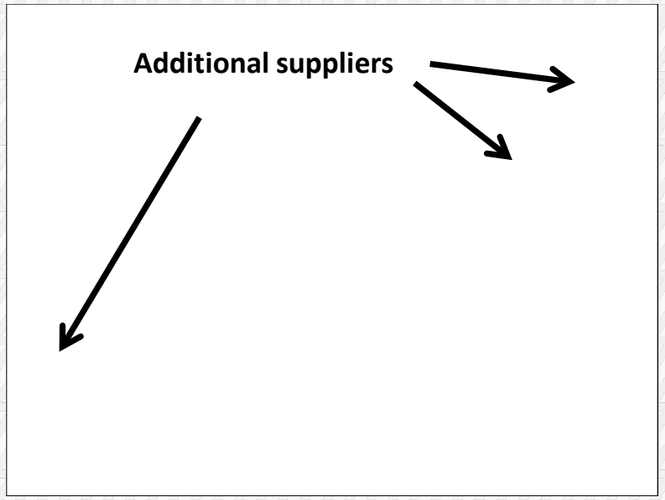
SUPPLY CHAIN CATS: 2012 SUPERSTORM SANDY

- Caused widespread damage to the logistics and transportation networks in the US MidAtlantic region.
- Ports and terminals from Baltimore to New York were temporarily closed causing shipping carriers to either delay or reroute shipments for a week
- Even after a month, Port Authority of NY & NJ only operating at 75 percent.

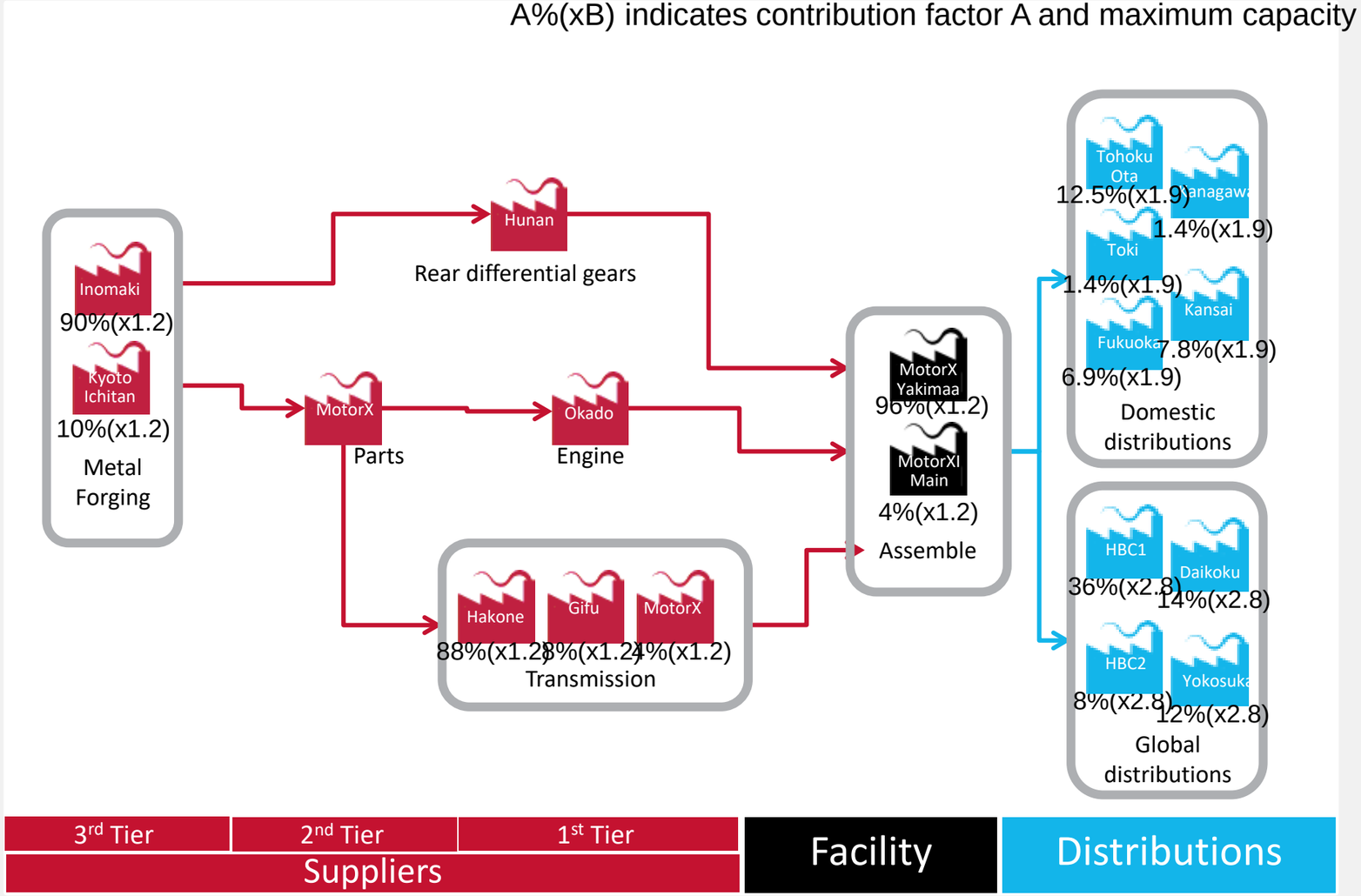
SUPPLY CHAIN CATS: XIRALLIC 2011 JAPAN EQ

- Sole manufacturer of a pearl-luster pigment paint that makes cars sparkle
- Plant suffered shaking damage in March 11th 2011 M9EQ
- Factory was situated in the initial radiation exclusion zone
- Site inaccessible until radiation release stabilized
- Production resumed May 8th 2011 – backlog cleared by September 2011

SUPPLY-CHAIN NETWORK WITHIN MOTORX

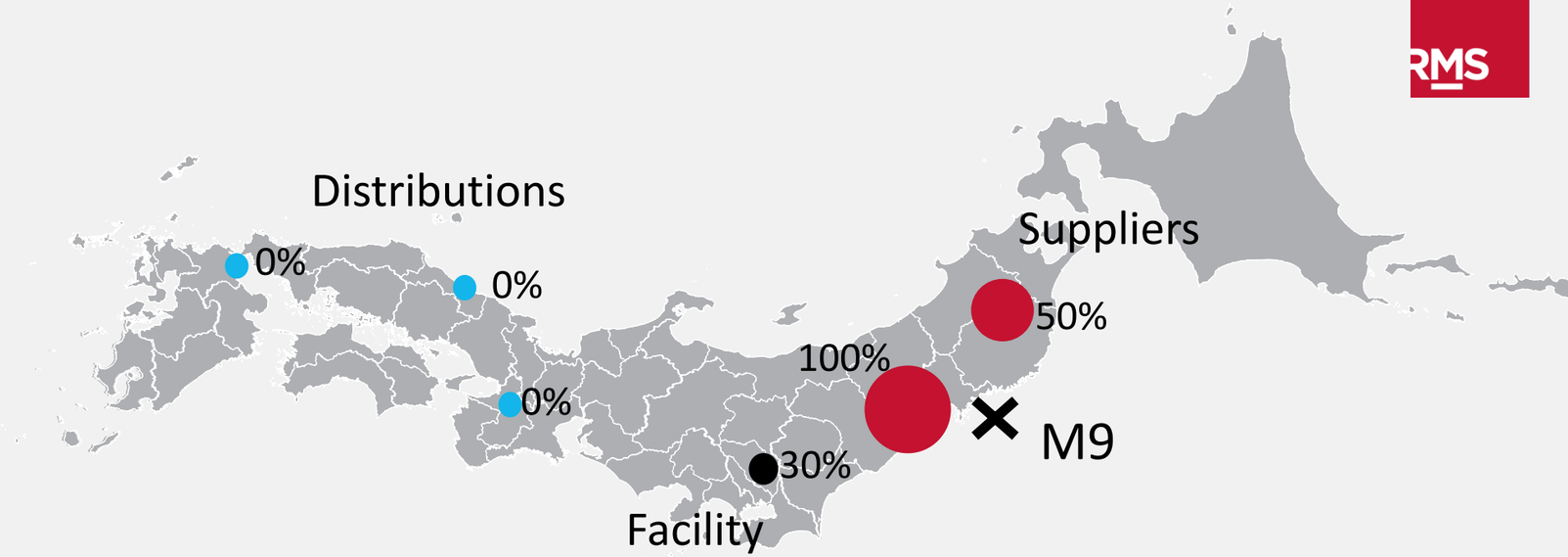


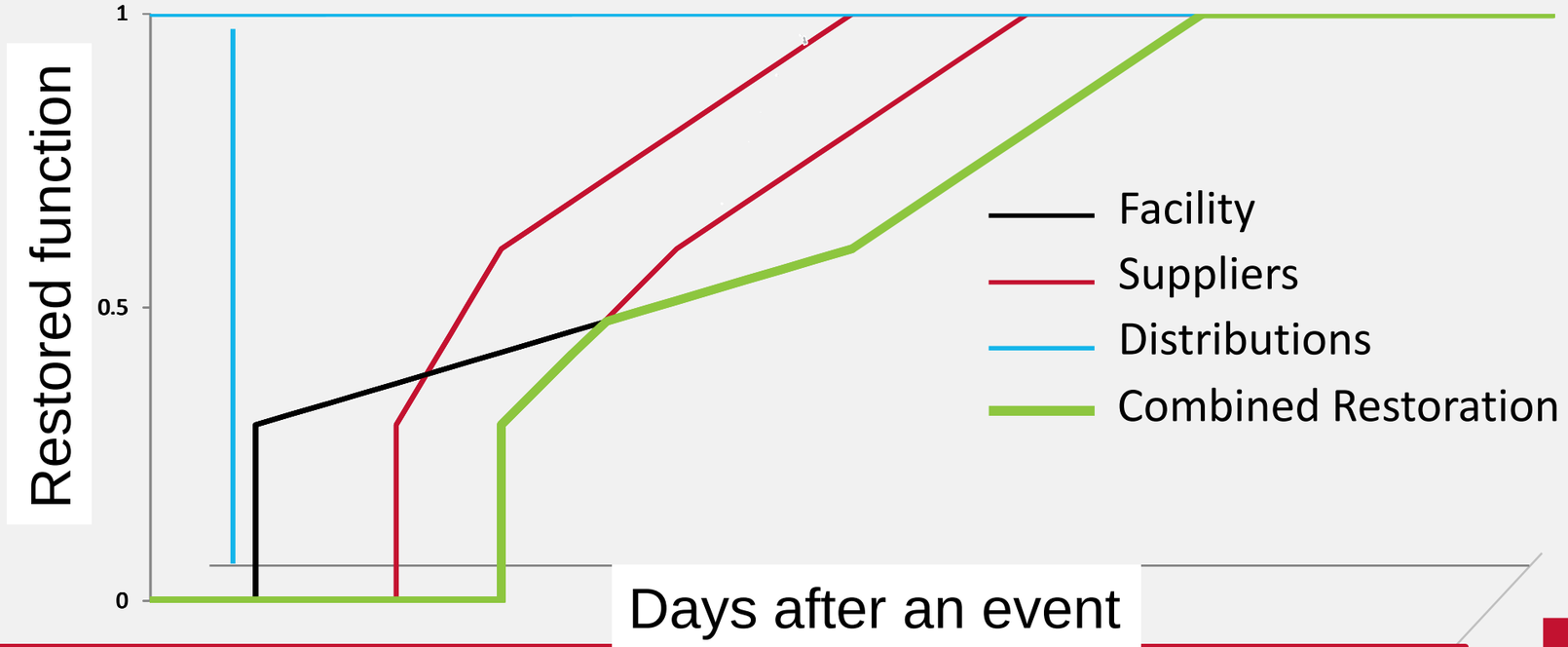
A%(xB) indicates contribution factor A and maximum capacity B.



Topology	# of main facility buildings / sites	# of suppliers buildings / sites	# of distributions buildings / sites	Total # of buildings / sites	description
4	2 / 2	8 / 7	9 / 8	19 / 17	Add Daikoku and Yokosuka Disclaimer or model ports

COMBINING RESTORATION CURVES IN A CBI MODEL

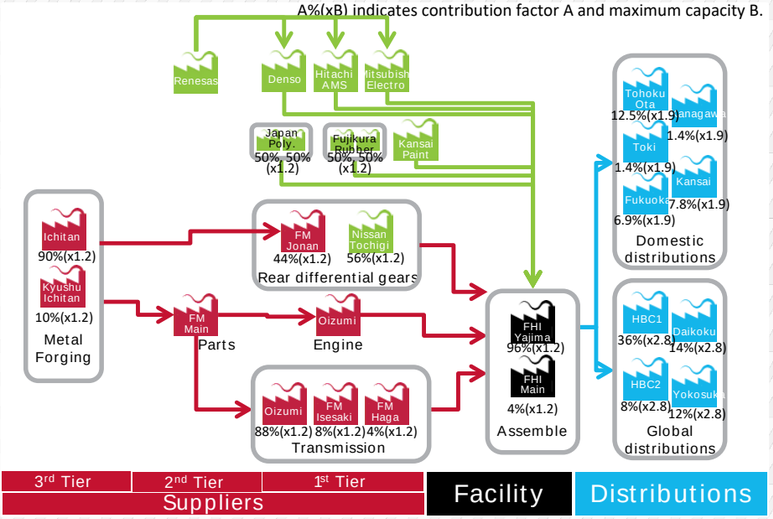




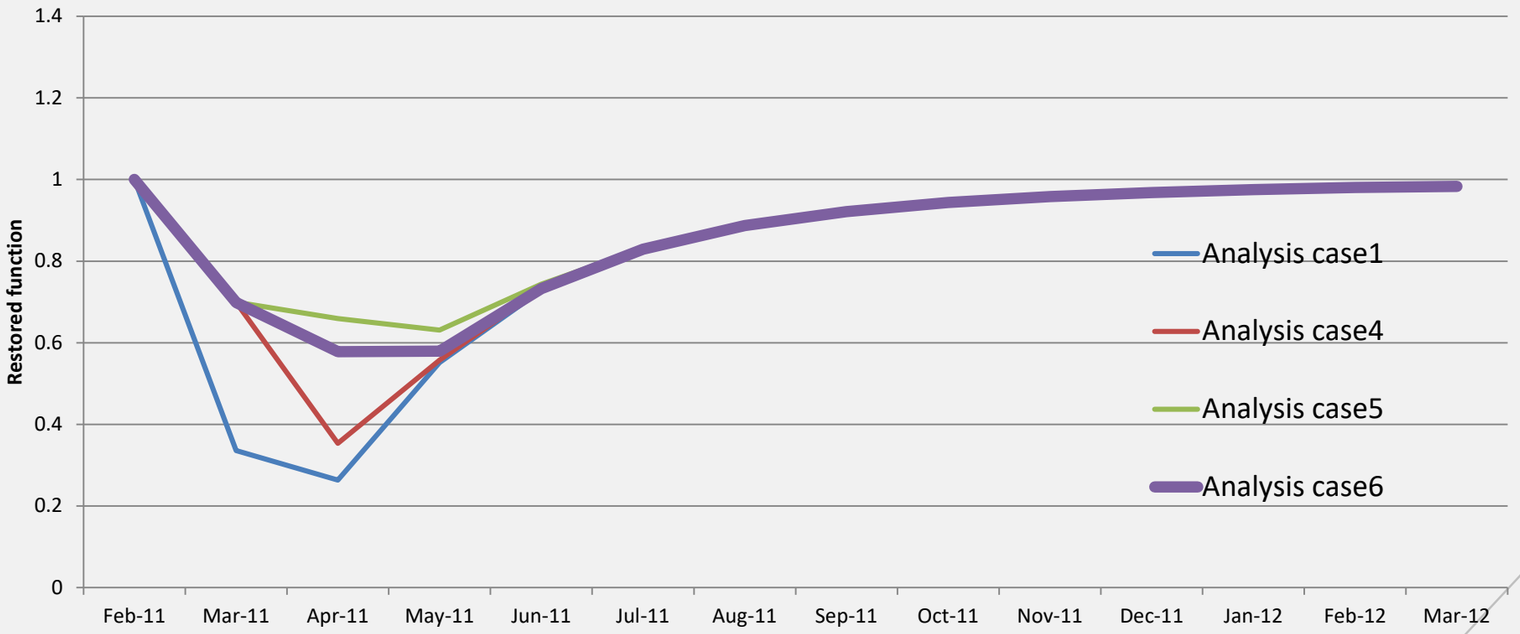
Network downtime caused by the specified earthquake event

AVERAGE EDT (CBI RATIO)

TOHOKU 2011



	Direct BI EDT (Yakita)	Scenario 1 Suppliers+ (Yakita+Main)+ Distributions	Scenario 2 Suppliers+ (Yakita)	Scenario 4 Suppliers outside MX (Yakita)	Scenario 3 (Yakita)+ Distributions
Analysis case 1 No inventory, no extra capacity	2.7	75.5 (2797%) 90pct: 137.6	7.5 (279%)	74.7 (2769%)	3.0 (110%)
Analysis case 4 With inventory, with extra capacity		65.3 (2421%) 90pct: 129.2	4.0 (149%)	64.7 (2398%)	2.7 (99%)
Analysis case 5 With inventory, with extra capacity 30 days inventory for Ketesa		53.3 (1974%) 90pct: 118.0	4.0 (149%)	52.1 (1929%)	2.7 (99%)
Analysis case 6 With inventory, with extra capacity 21 days inventory for Ketesa		57.6 (2135%) 90pct: 121.5	4.0 (149%)	56.5 (2095%)	2.7 (99%)



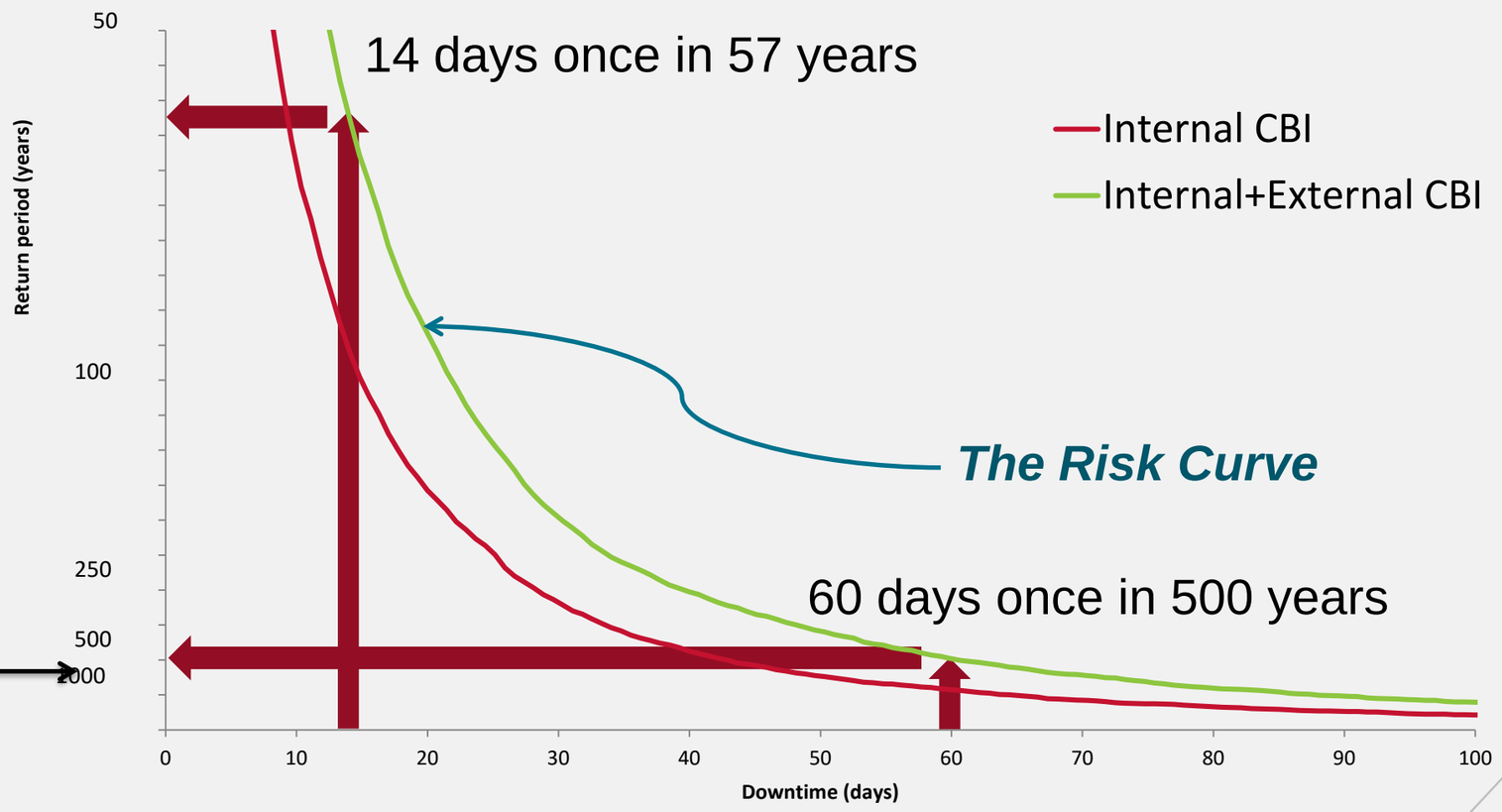
Average restoration function (Scenario 1)

DOWNTIME RISK CURVE OF MOTORX OPERATIONS

Probabilistic analysis produces a risk profile for the overall network and for each location of the network.

A MotorX operational *Risk Curve* is a profile of potential network downtime caused by any earthquake event occurring anywhere in Japan

– Unique Risk Curve for each network, for each location of a network

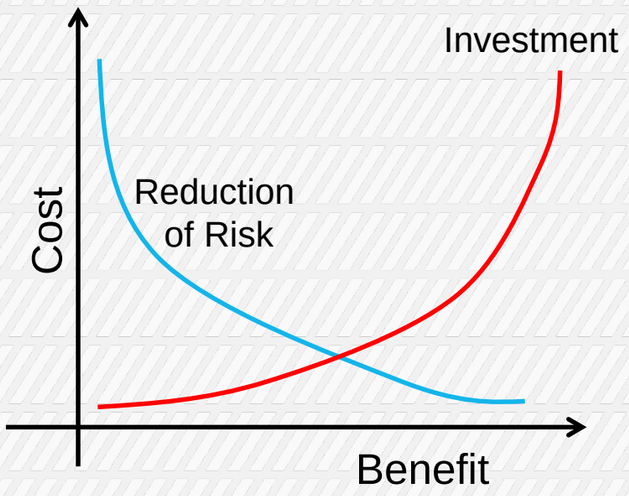


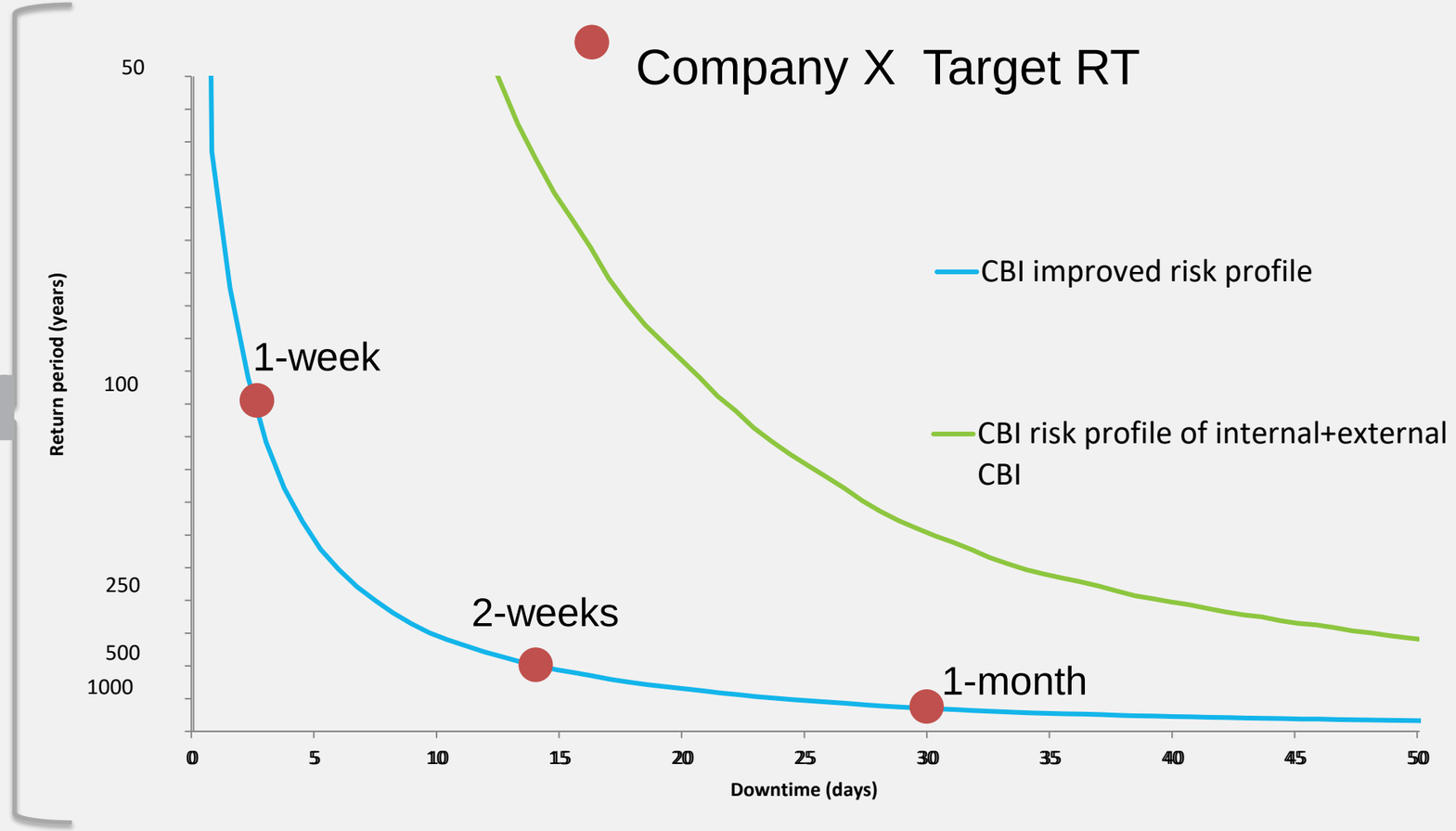
March 11th Tohoku event (600 years)

Example risk improvement to the network Risk Curve

Risk Curve supports traditional financial analysis of investment payback

WHAT IS THE COST-BENEFIT OF TAKING ACTION…?





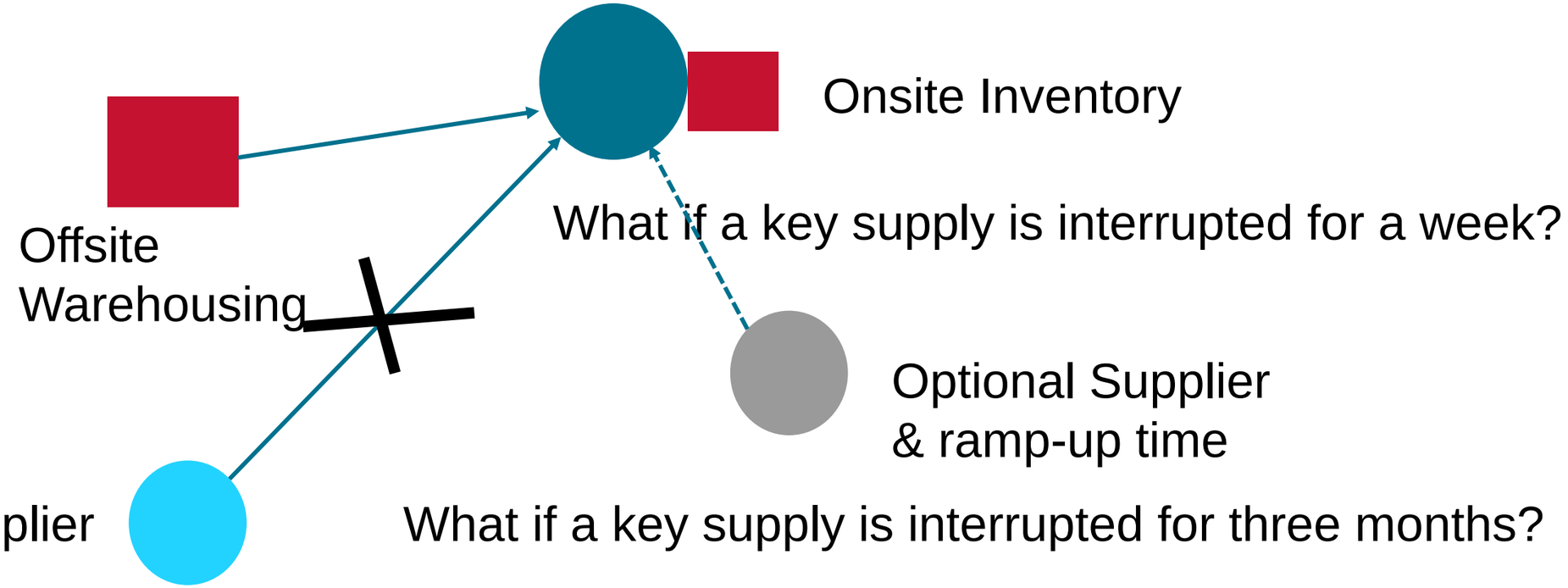
IDEALLY EACH ELEMENT OF SUPPLY IS TRACKED USING THE ‘SUPPLIER’S DATA SCHEMA’

- High Res location of supplier
- Buildings, Ages, Construction, etc
- Lifelines of the supplier
- Details (Code) for what is being supplied
- Flow of supplies (per day/week)
- Route of supply
- Key ports/airports
- Destination

- Information is also requested for the supplier’s own upstream sub-supply chain

THE SUPPLY CHAIN RISK MANAGEMENT SYSTEM IS USED TO EXPLORE REDUNDANCY AND MANAGE SHOCKS

Flows are viewed passing through the supply chain



USING CATASTROPHE RISK MODELS TO MEASURE SUPPLY CHAIN RISK

Focus on unique suppliers/technology

Full range of potential catastrophes

Exceedance probability loss outputs

Explore risk costs to optimize supply chain

10 KEY DISASTERS FOR SUPPLY CHAIN RESILIENCE PLANNING

VEI 6 Eruption Mt Fuji

NEUS Hurricane and flooding *

M7.4 Tokyo Earthquake *

Rhine River flooding *

10 KEY DISASTERS FOR SUPPLY CHAIN RESILIENCE PLANNING

Mw7.2 Hayward Fault *

Pearl River Delta Typhoon & Flooding

Cascadia M9 earthquake *

Pandemic work disruption *

10 KEY DISASTERS FOR SUPPLY CHAIN RESILIENCE PLANNING

Mw7.8 Earthquake Taiwan *

Los Angeles M7.2 earthquake *

PORT TRANSPORT INTERRUPTIONS – TOP 12 EARTHQUAKE ‘RISK’ (PROBABILITY X CONSEQUENCE) LOCATIONS

1. Nagoya
2. Yokohama*
3. Izmit
4. Oakland
5. Lazaro Cardenas
6. Chiba*
7. Los Angeles
8. Tokyo*
9. Seattle
10. Osaka@
11. Taichung
12. Kobe@

* / @ Potential to be hit by the same earthquake