NLR Air Transport Safety Institute

Research & Consultancy

Further development of a causal model for air transport safety (CATS): the complete model

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Outline

- Introduction
- Model constituents
- Data
- Uncertainties
- Advantage of Bayesian Belief Nets
- Conclusion

Introduction

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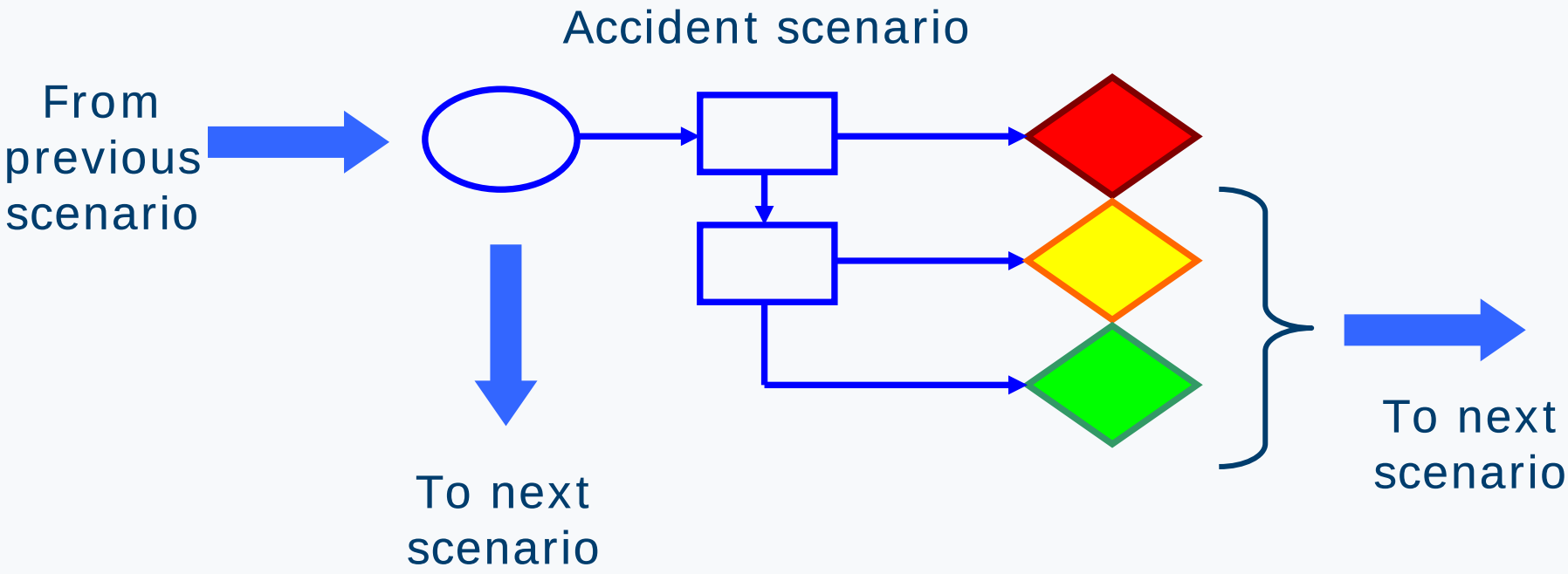
Model constituents



Example scenario: contaminated wing

Take off with contaminated wing

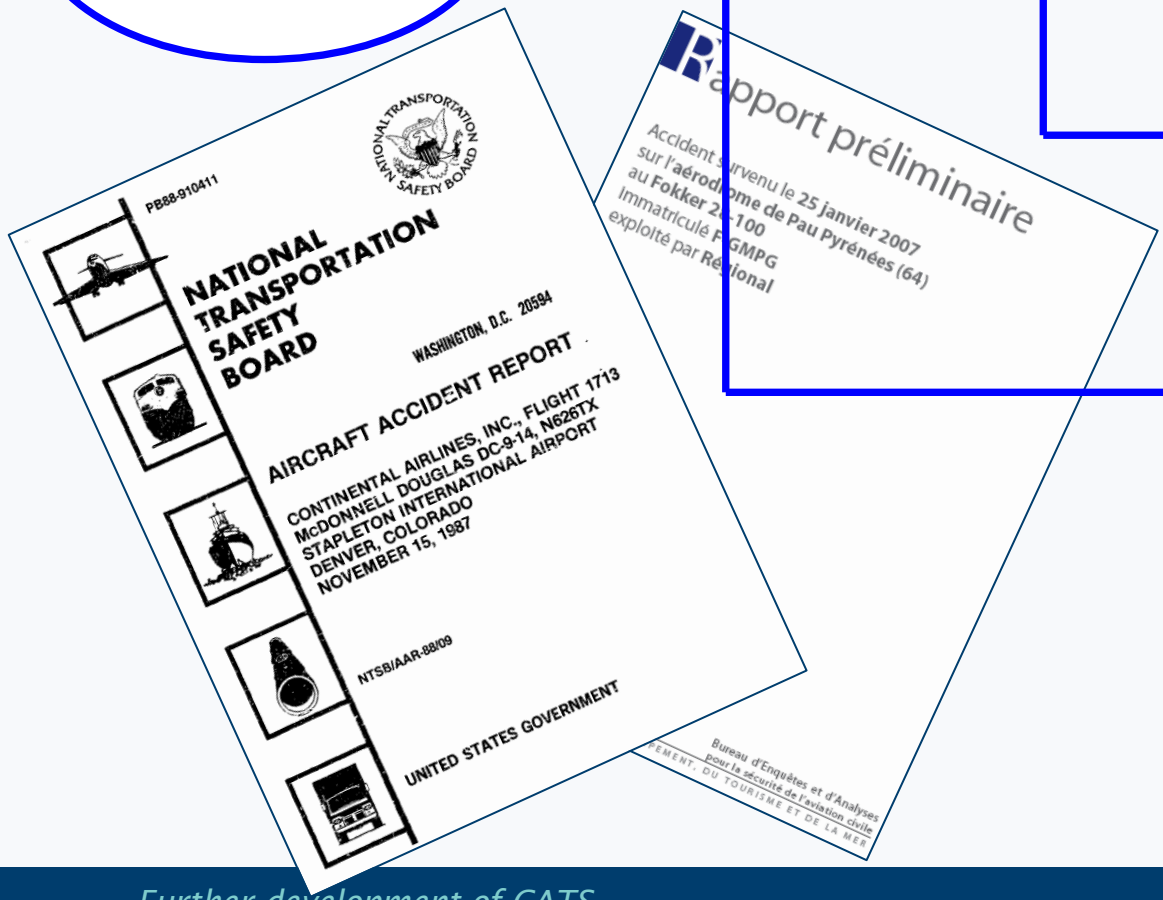
Stall

No recovery

Crash

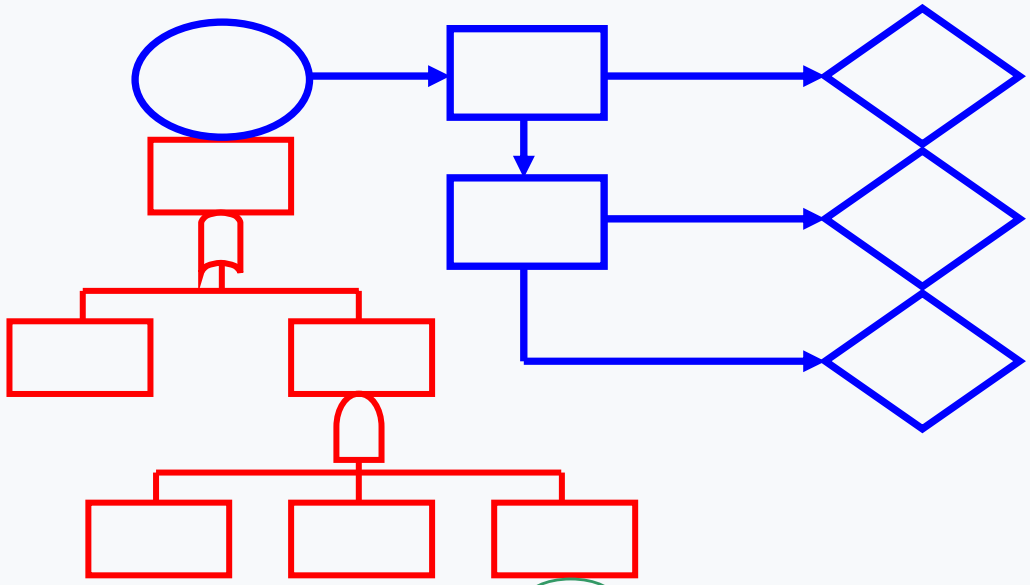
Flight continues

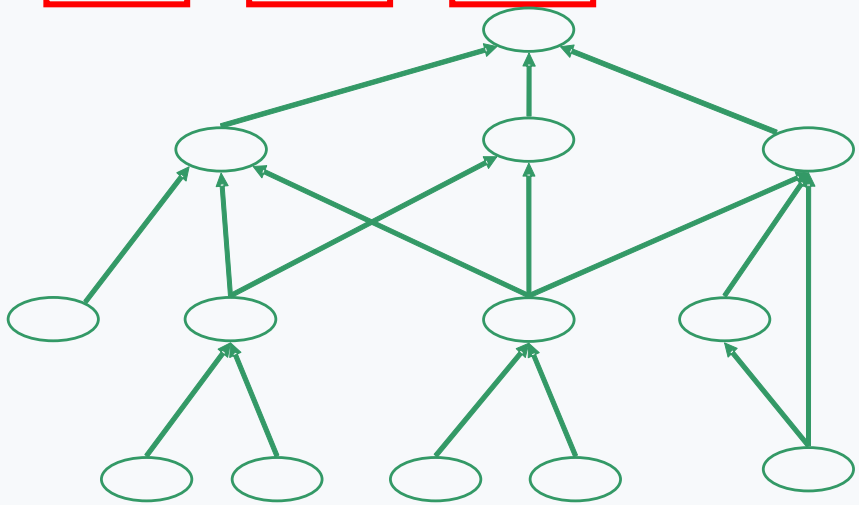
Flight continues



Scenario events are further detailed

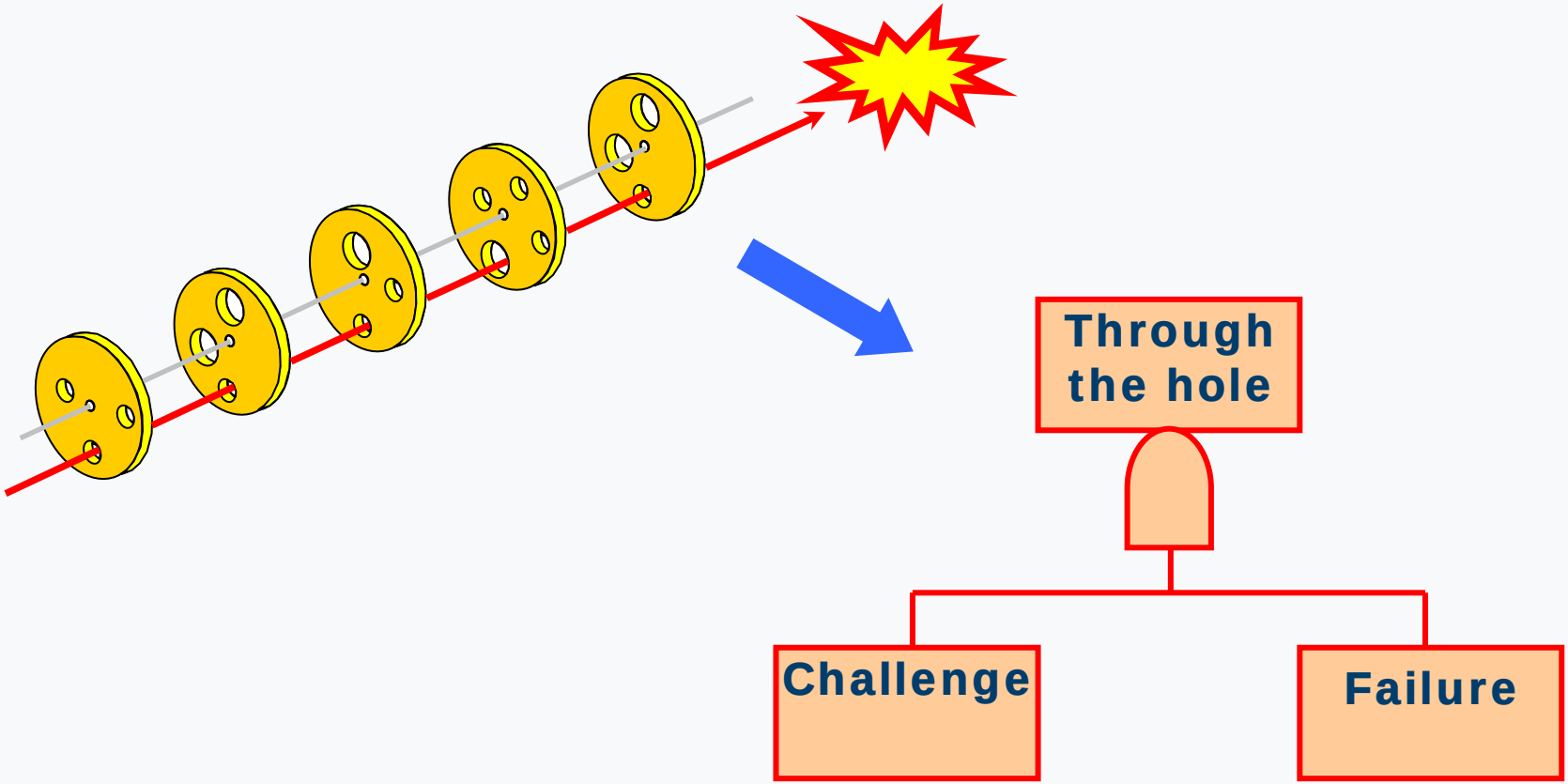
Fault Tree



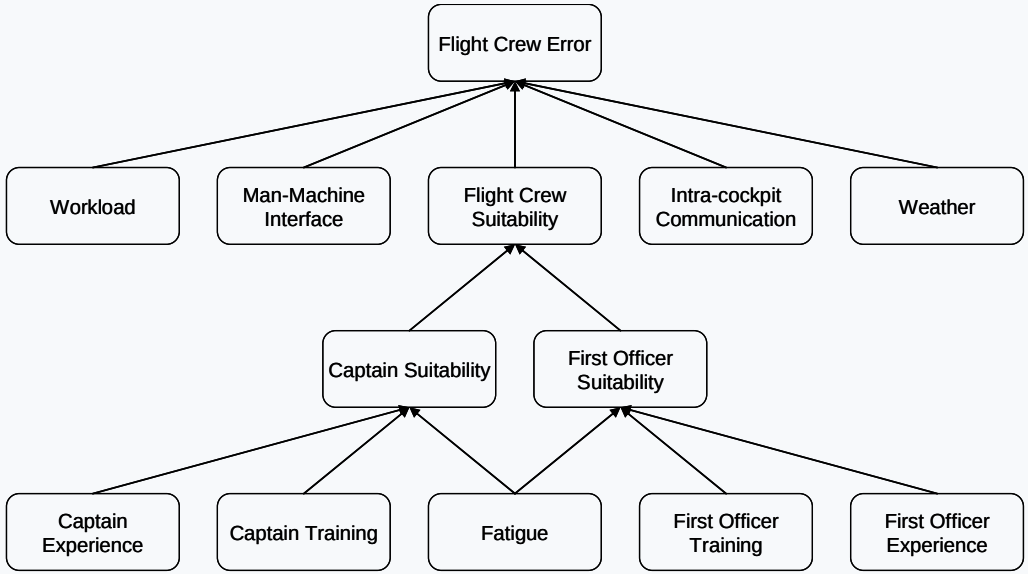


Influence Diagram

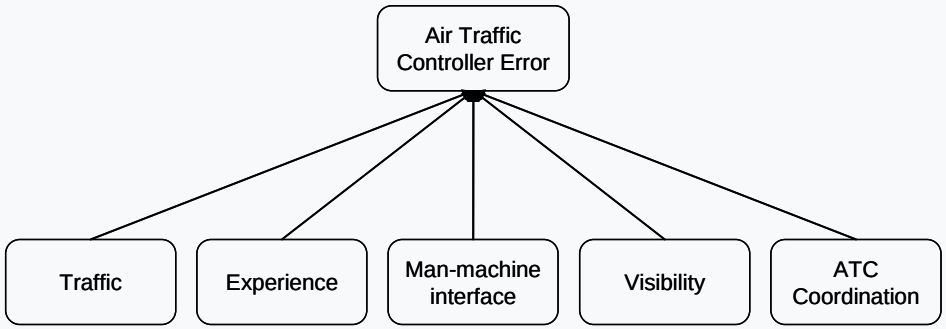
Fault trees



Influence diagrams

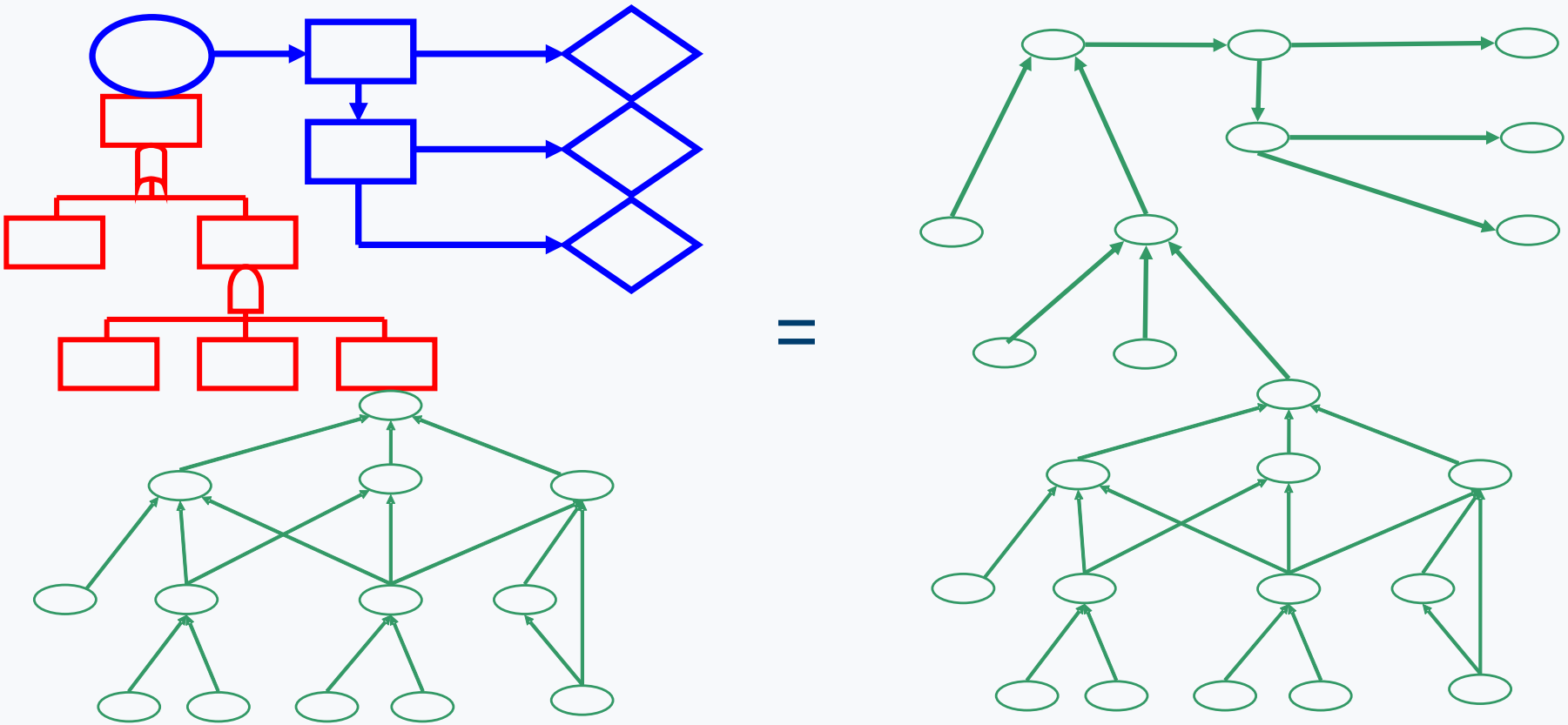


Flight crew performance



Air Traffic Controller performance

One integrated BBN



Model quantification

Quantification = Unconditional and conditional probability distributions

P (A) P(B)

P(B|A)

Probabilities are expressed per flight

⇒ requires denominator data

$$\frac{\text{\# of occurrences}}{\text{\# of flights}}$$

numerator

denominator

Data configuration control

Origin and quality of the data are held in a separate database:

CATS PArameters With Sources [CATSPAWS]

Uncertainties

- Epistemic (lack of knowledge)
- Aleatory (randomness of input parameters)

Uncertainty in risk assessment of socio-technical system is largely aleatory

=> Uncertainty is reduced by better assessment techniques

Advantage of Bayesian Belief Nets

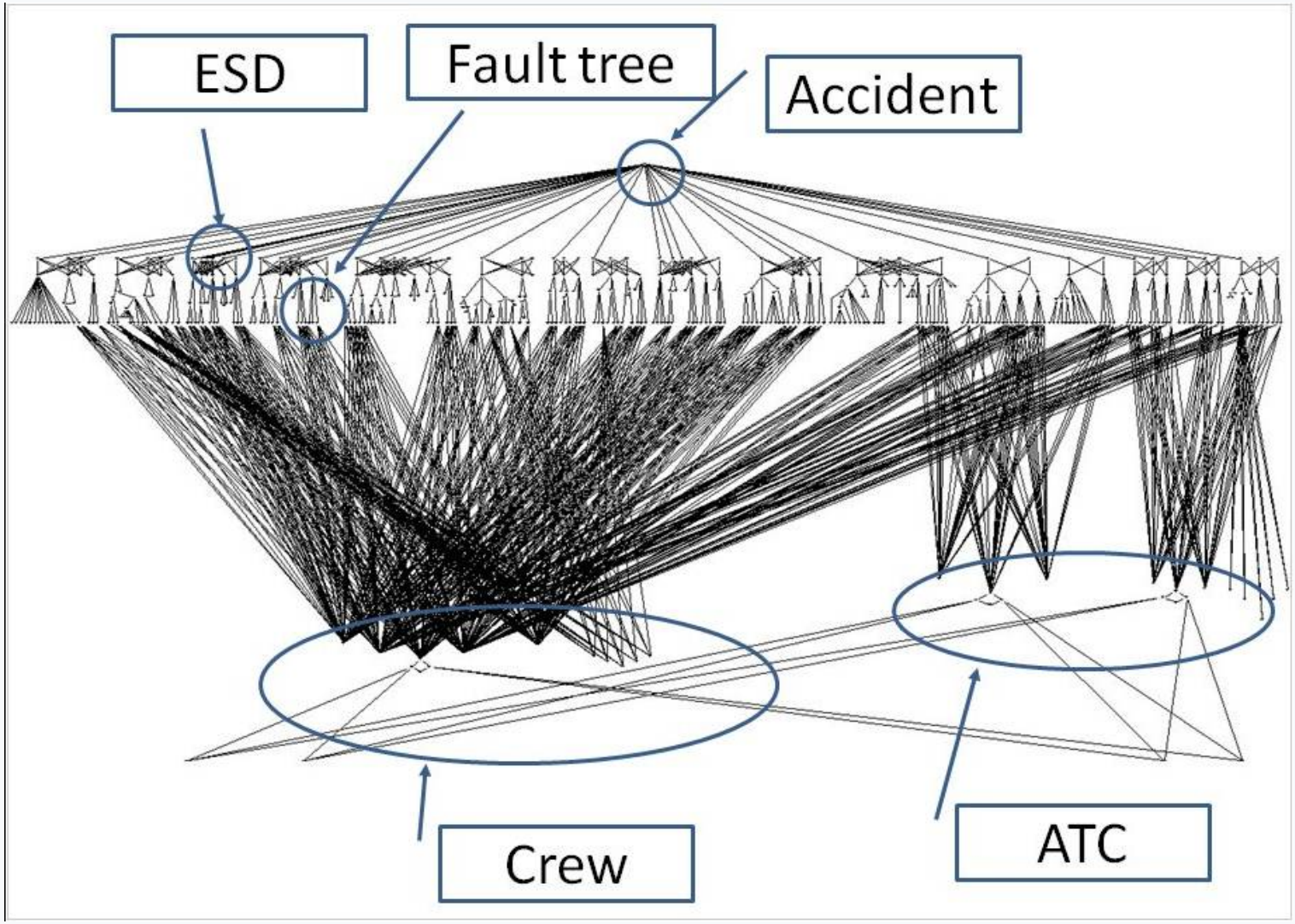
Events can have multiple states

- Example: Fatigue

Degree of Sleepiness	Scale Rating
Feeling active, vital, alert, or wide awake	1
Functioning at high levels, but not at peak; able to concentrate	2
Awake, but relaxed; responsive but not fully alert	3
Somewhat foggy, let down	4
Foggy; losing interest in remaining awake; slowed down	5
Sleepy, woozy, fighting sleep; prefer to lie down	6
No longer fighting sleep, sleep onset soon; having dream-like thoughts	7

Interdependencies are an integral part of the model

The complete model (so far)



Preliminary results

BBN Node	Baseline risk	Crosswind > 15 kts Dry	Crosswind > 15 kts Rain	Crosswind < 15 kts Dry	Crosswind < 15 kts Rain
Runway overrun (landing)	1.0	2.8	185.8	0.7	182.6
Runway veer-off (landing)	1.0	5.1	152.1	0.8	149.2

Conclusion

User test phase starts this year.

Expected and unexpected outcomes will be carefully evaluated.