

Probabilistic Risk Analysis and the concept of Bayesian Networks

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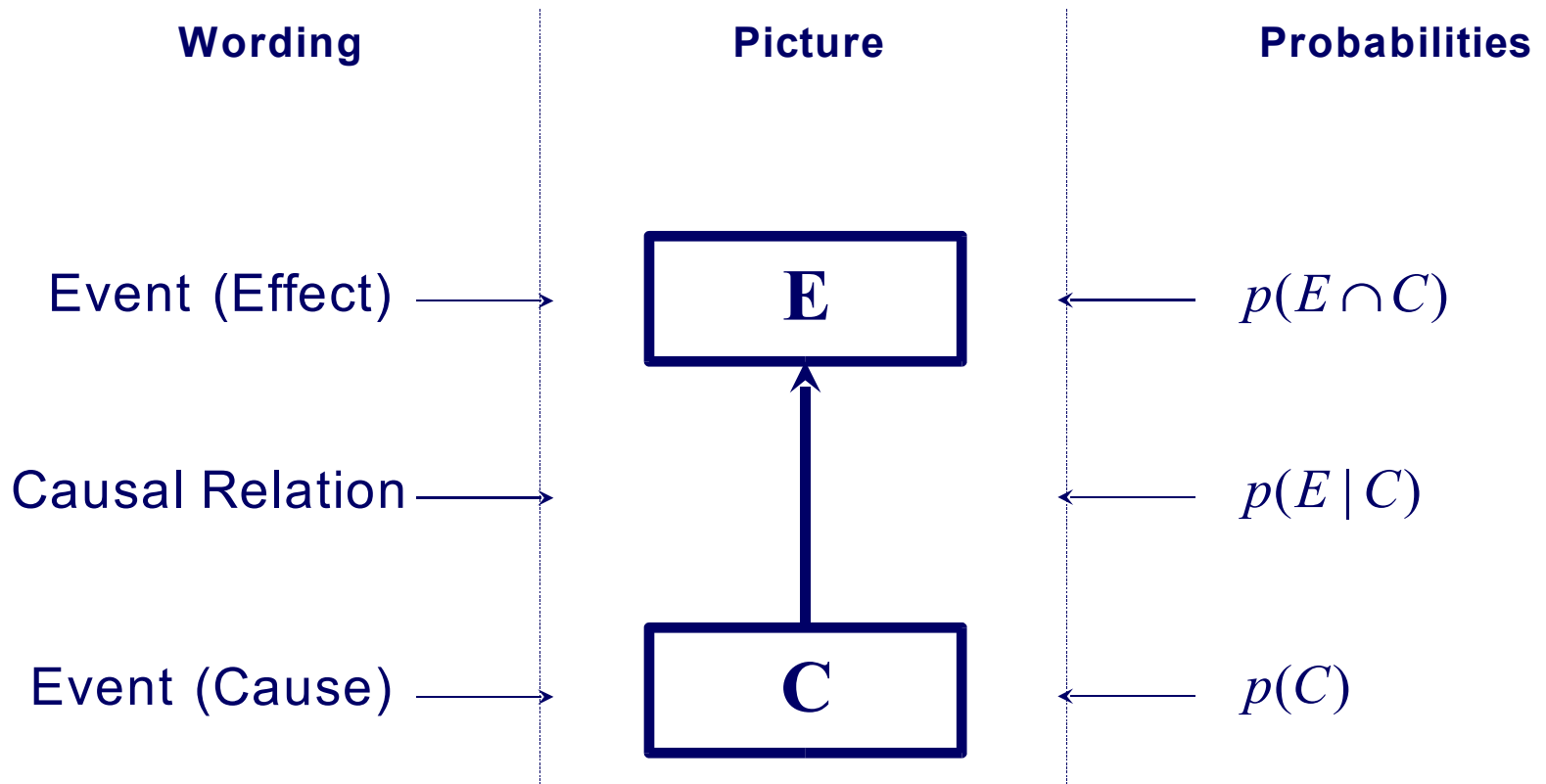
A **hazard** is an event in which there is actual or potential danger to people or to the environment.

Risk is a combination of the frequency or probability of a specified hazardous event, and its consequence.

Definition:

A *Bayesian network* consists of the following:

- A set of variables and a set of directed edges between variables.
- Each variable has a finite set of mutually exclusive states.
- The variables together with the directed edges form a directed *acyclic* graph (DAG). (A directed graph is acyclic if there is no directed path $A_1 \rightarrow A_2 \rightarrow \dots \rightarrow A_n = A_1$.)
- To each variable A with parents B_1, B_2, \dots, B_n , there is attached the *potential table* $p(A | B_1, B_2, \dots, B_n)$.



$$p(E \cap C) = p(C) \cdot p(E | C)$$

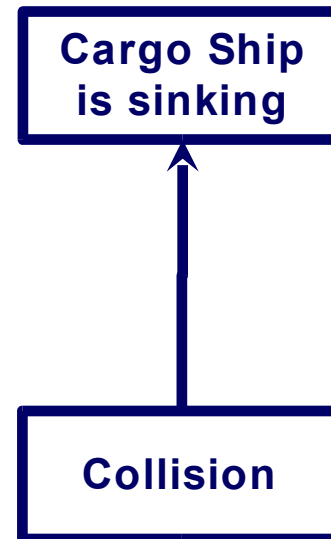


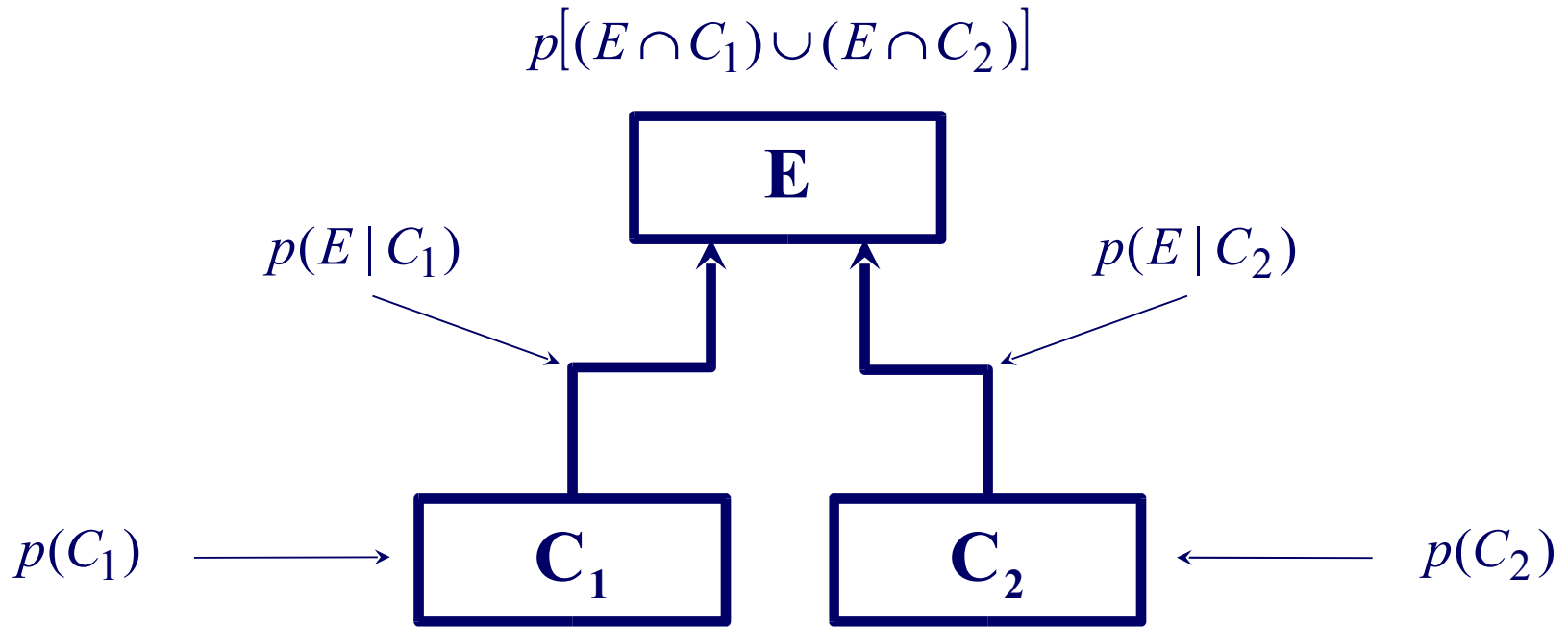
Typ: Singledeck/Bulkcarrier doubleskinned
Built: 2002
Op. Area: North Atlantic
Op. Time: 24h/Day, 365 Day/Year

$$p(E \cap C) = 1 \text{ per } 400 \text{ Years}$$

$$p(E | C) = 1:20$$

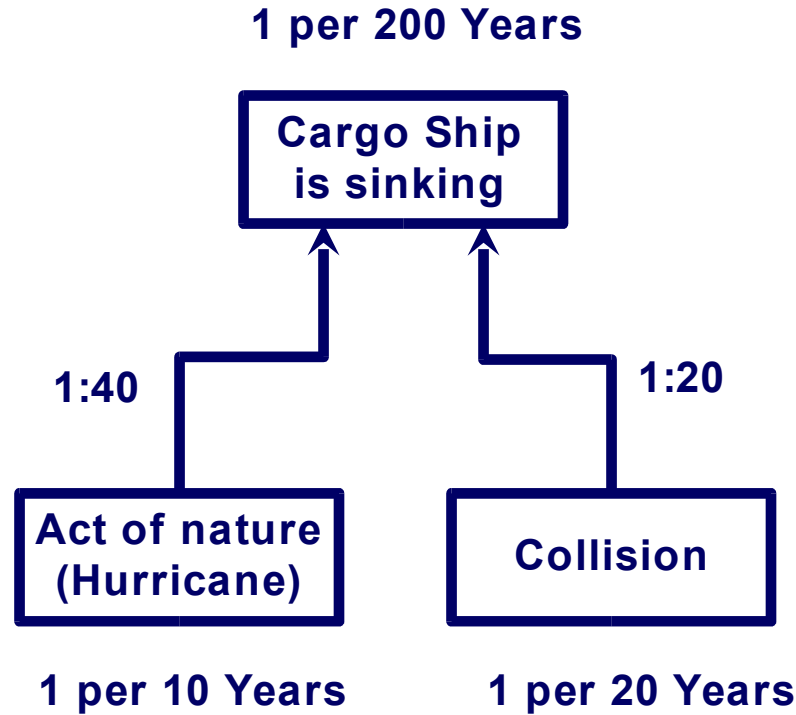
$$p(C) = 1 \text{ per } 20 \text{ Years}$$

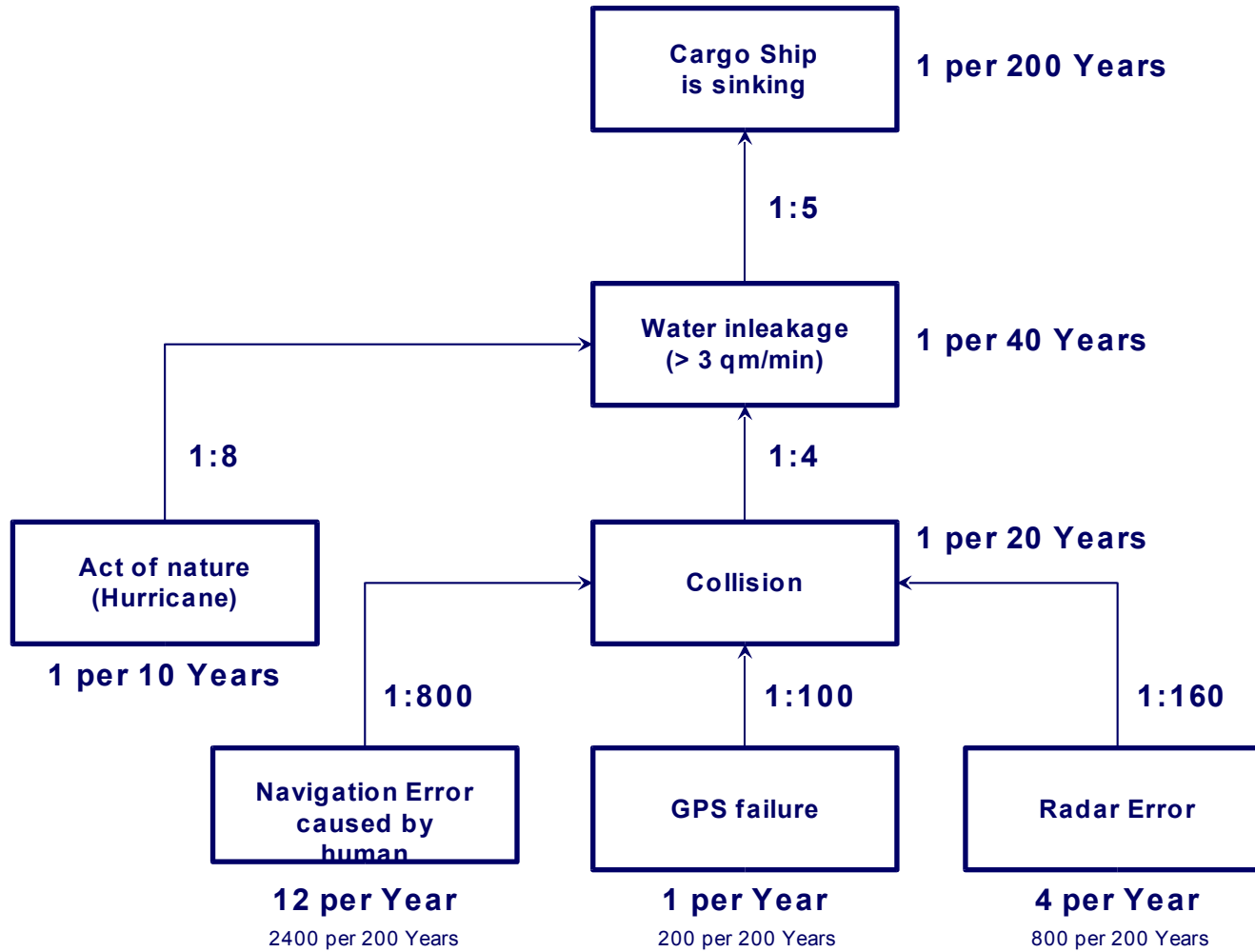


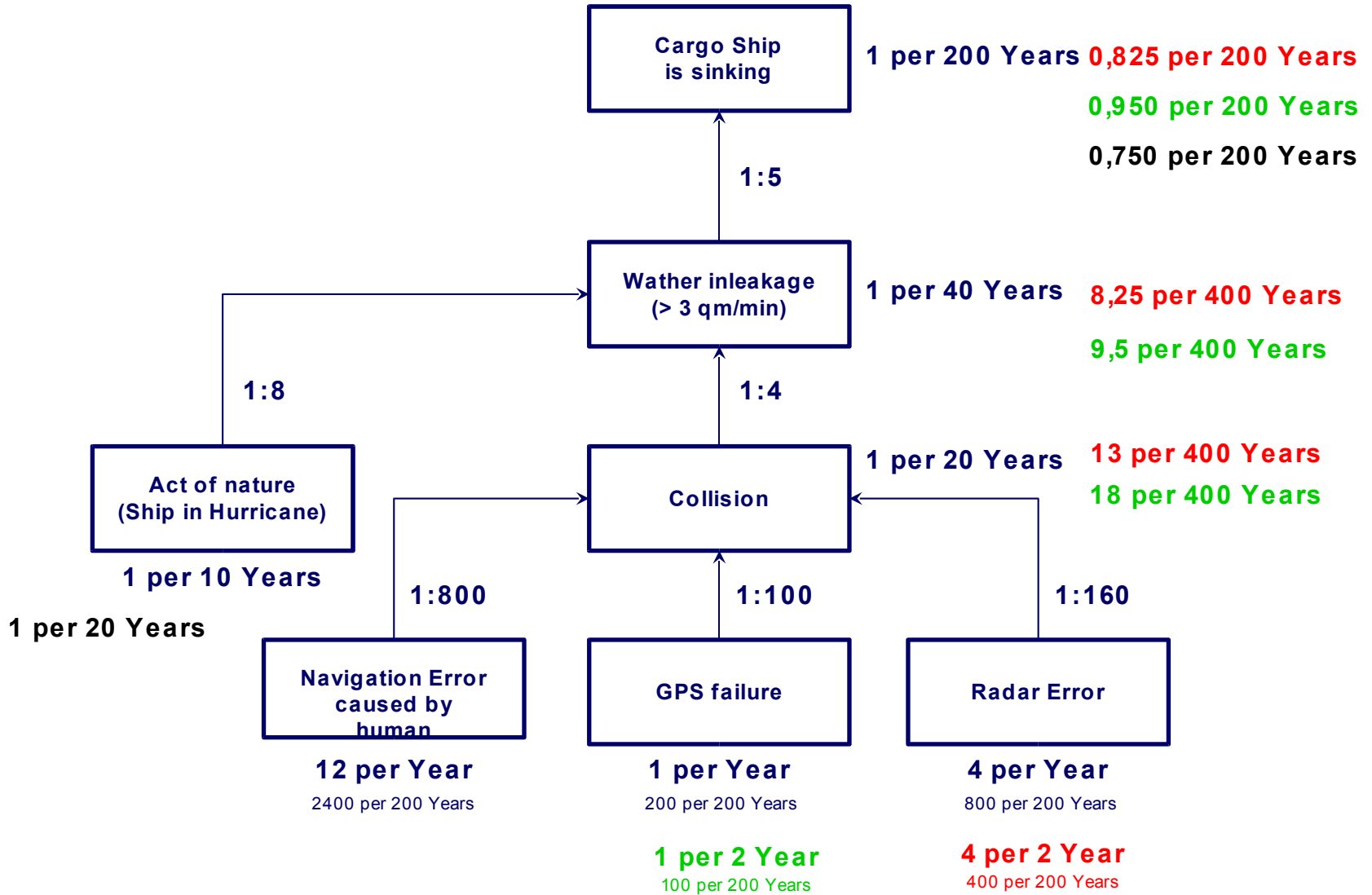


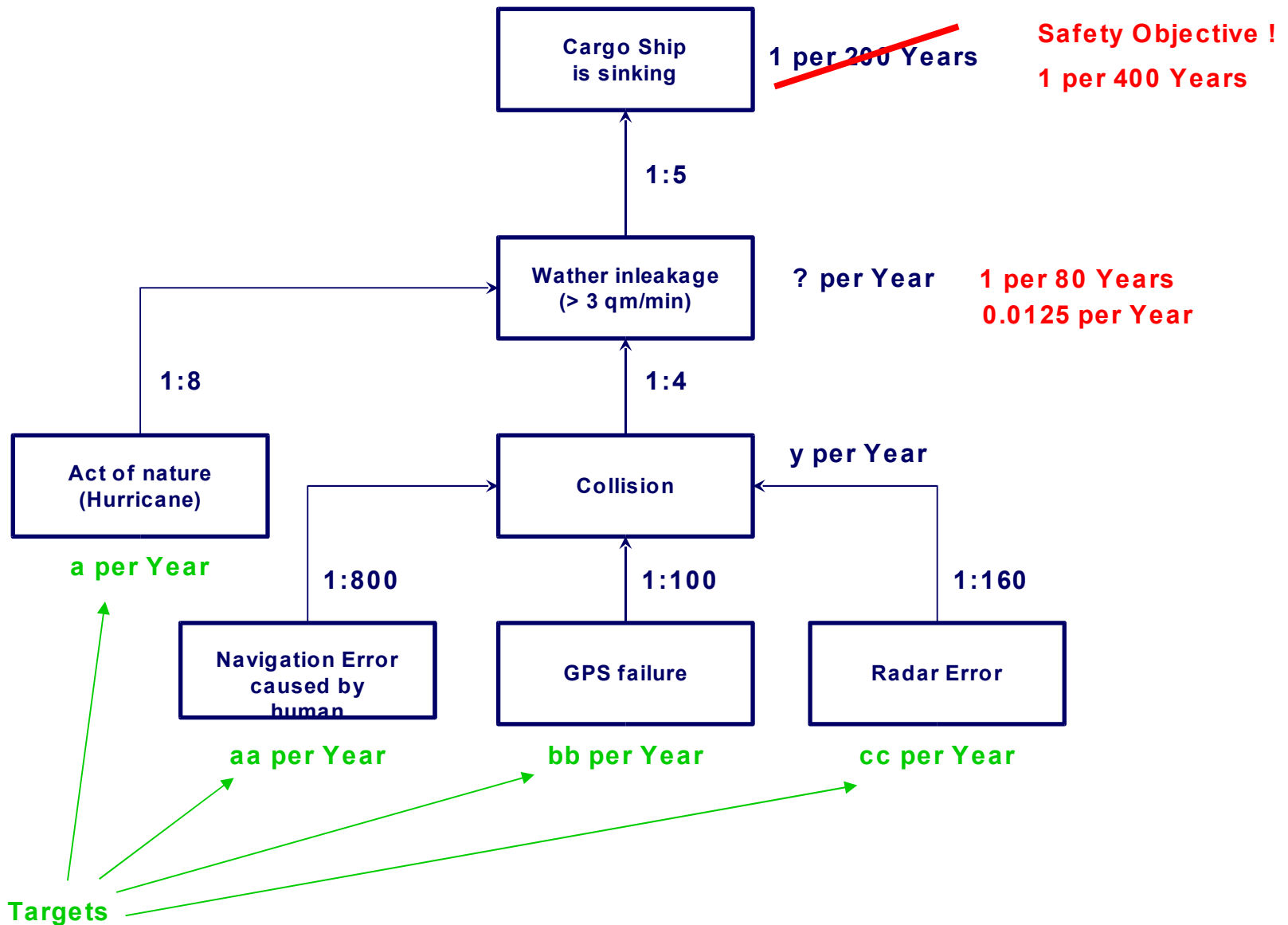
$$p[(E \cap C_1) \cup (E \cap C_2)] = p(C_1) \cdot p(E | C_1) + p(C_2) \cdot p(E | C_2) - p[(E \cap C_1) \cap (E \cap C_2)]$$

$$p(E) \approx p(C_1) \cdot p(E | C_1) + p(C_2) \cdot p(E | C_2)$$









Decision variables

Objective function

$$g_1a + g_2aa + g_3bb + g_4cc \rightarrow \max.$$

$$0,0125 \geq \frac{1}{8}a + \frac{1}{3200}aa + \frac{1}{400}bb + \frac{1}{640}cc$$

$$cc \geq 0,02$$

$$a = 0,1$$

Constraints

This is a linear optimisation problem !

Raytheon ASR-XXL

Radar Error: 2 per Year

Price: 100 000 €

Raytheon ASR-L

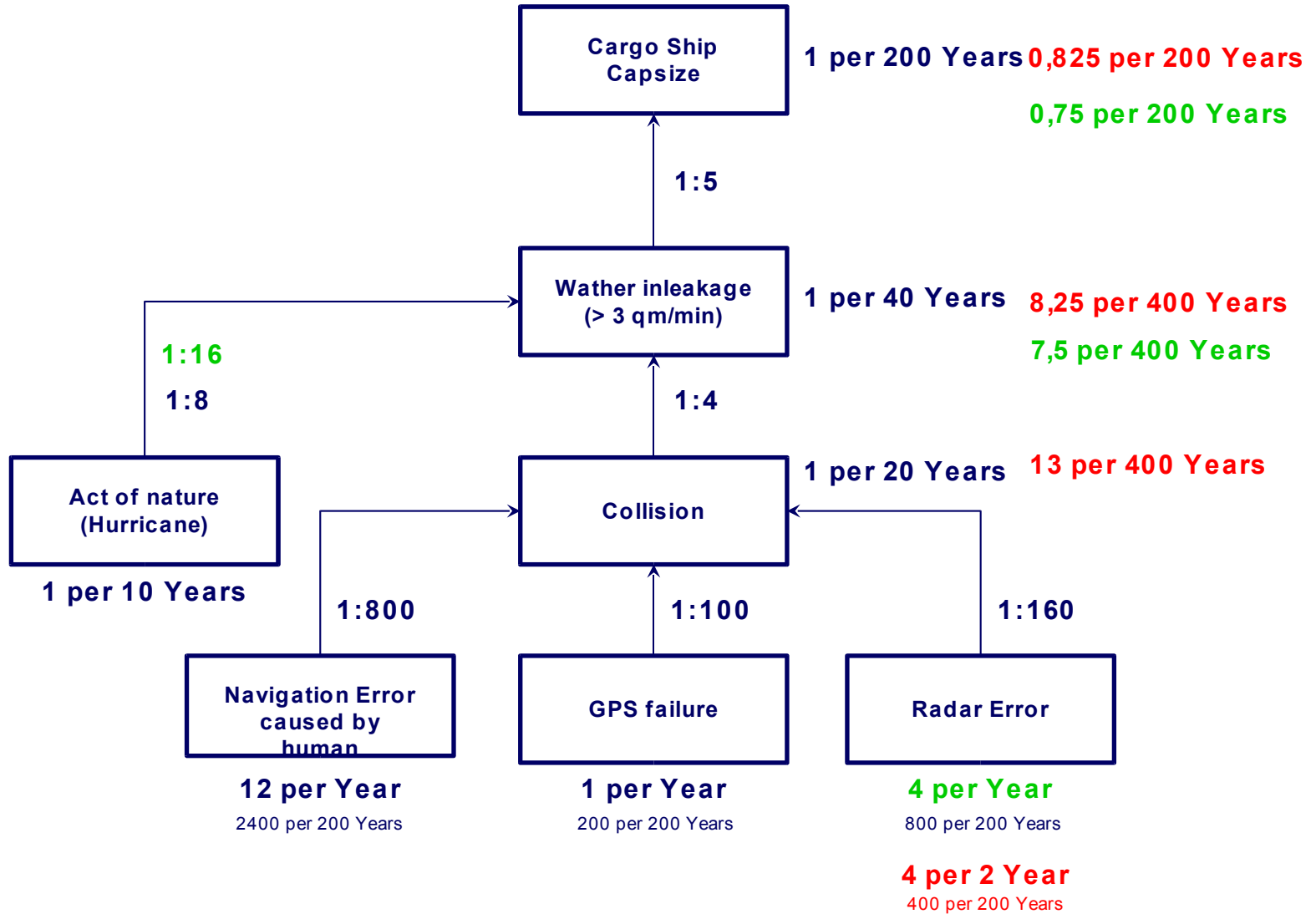
Radar Error: 4 per Year

Price: 80 000 €

Meteor Hurrigan Forecast 2000+

Forecast quality: 1 of 2 hurricanes

Price: 20 000 €



Risk analysis in essence is a decision problem subject to uncertain information.

In today's complex world, managers have to make more and more critical decisions in less and less time. Most companies possess knowledge, experience and data in large quantities – usually far more than individuals can keep in their heads. So to ensure more effective decision making, companies need to build and use decision support systems.

Bayesian Networks are a good basis for those Systems.