



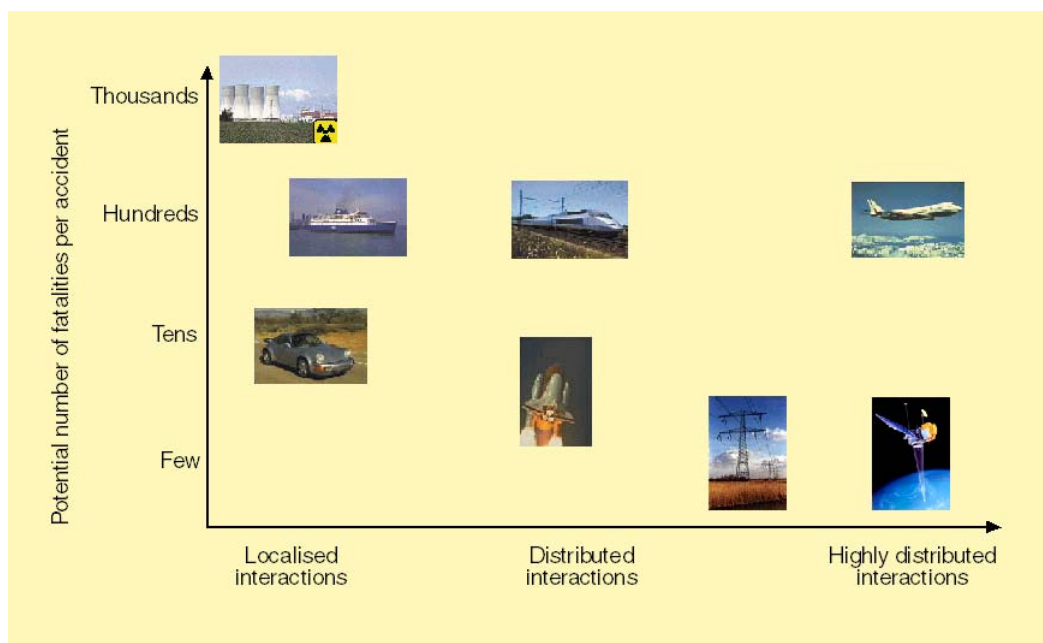
TOPAZ - Traffic Organization and Perturbation AnalyZer

Recognizing the significance of safety assessment as one of the primary filters in Air Traffic Management (ATM) concept design has initiated the development of the TOPAZ (Traffic Organization and Perturbation AnalyZer) methodology. TOPAZ provides feedback to ATM designers on the safety of the design at the required capacity level, and identifies the safety/capacity bottlenecks, also at an early stage of concept development.

Designing ATM inherently safe

ATM incorporates complex interactions between human operators, procedures and technical systems. These interactions essentially determine safety in relation to capacity requirements. Consequently, an ATM design aimed at supporting both capacity and safety requires more than safe systems and subsystems.

Assessment feedback concerning the safety of the overall ATM design at every stage of the concept development could avoid that a costly development programme turns out to be ineffective, or that an even more costly implementation programme fails. This insight can only be exploited if an ATM safety assessment methodology is available that provides the appropriate feedback to the ATM designers, also at an early stage of concept development.



Air traffic relative to other safety-critical operations

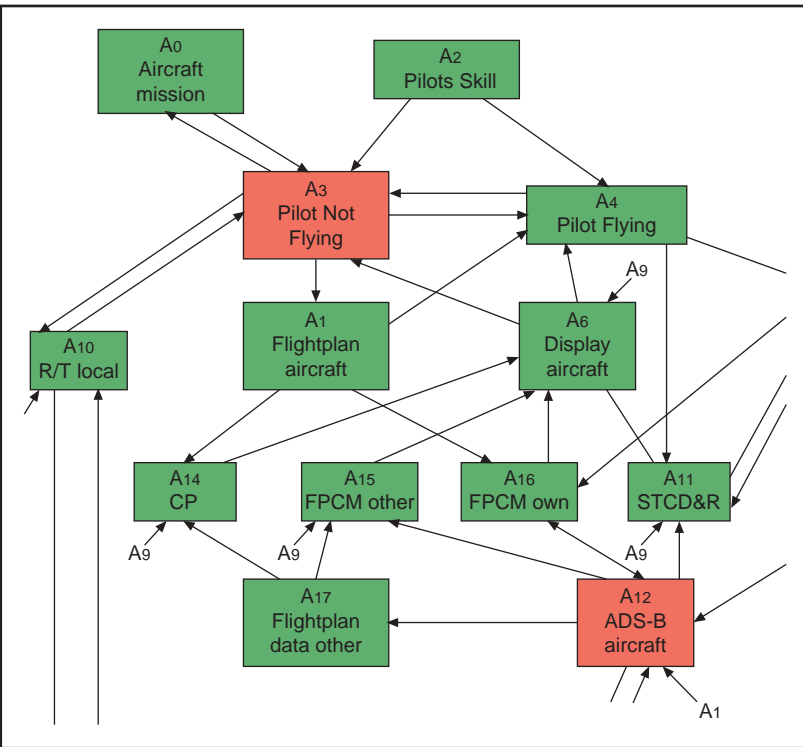
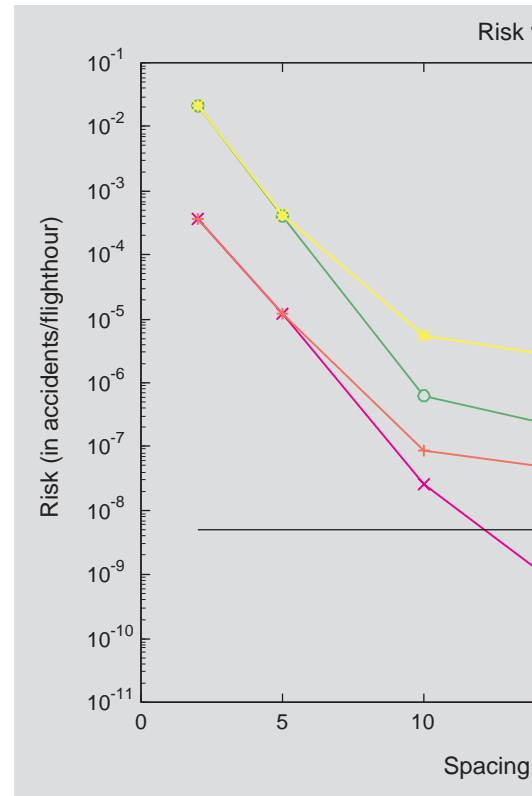
Designing ATM inherently safe with TOPAZ

A team of experts creates a new ATM design....



....which is subject of a

- Aircrew overlo
- Crew hindranc
- Pilot reaction t
- Pilot ignores c
- Crew disagree
- Reduced visibi
- ...



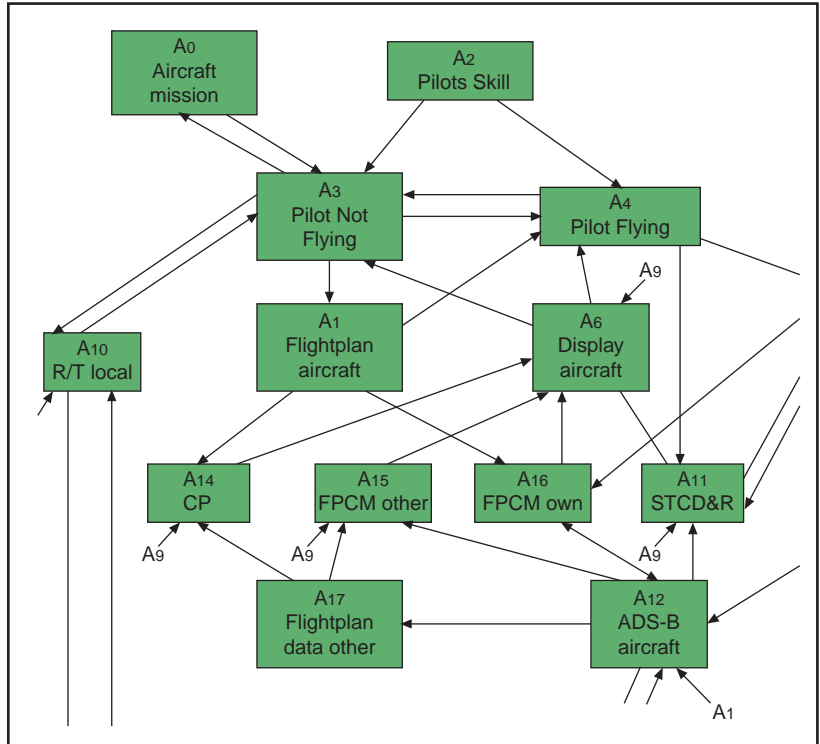
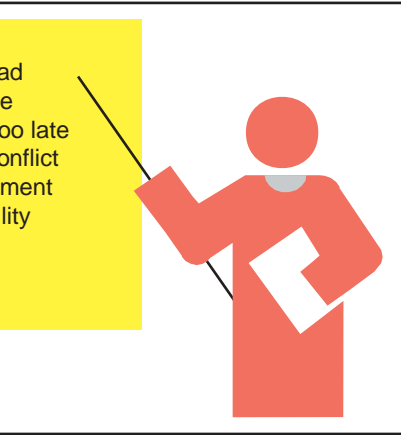
Finally the safety/separation critical modules are identified to support the experts in improving the ATM design.

$$\mathfrak{R}_{[0, T_H]} = \frac{1}{2} \sum_i \sum_{j \neq i} \sum_l \int_0^{T_H} \varphi^{ij}$$

the risk is e

....and the resu

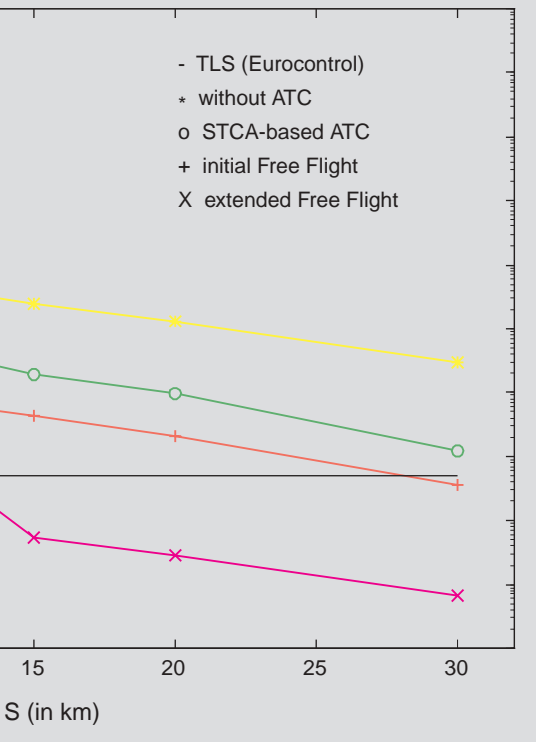
hazard identification session.



A modular representation of the design....



vs. route spacing

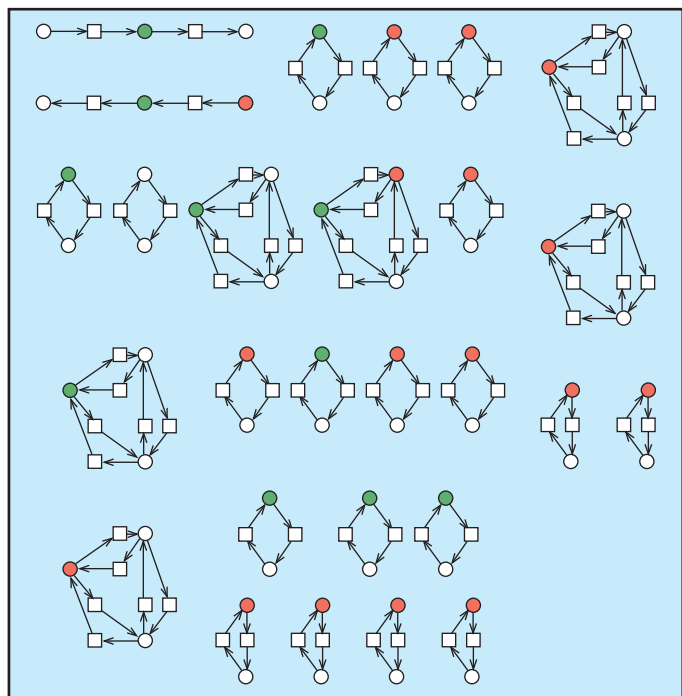


Results are shown.



$$\int_0^t \mathbb{1}_{\{\kappa_{t_*}^{ij} = \kappa^l\}} dt \cdot P\{\kappa_{t_*}^{ij} = \kappa^l\}$$

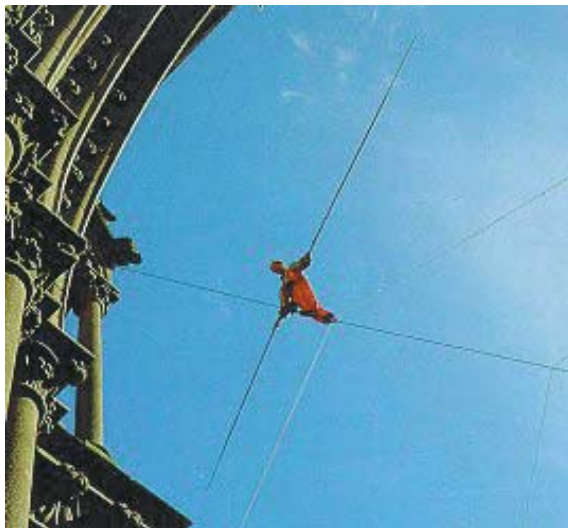
evaluated...



...is modelled through Dynamically Coloured Petri Nets,

The TOPAZ methodology

TOPAZ is designed to provide feedback during all design and life stages of a safety critical operation. Embedded within a safety case approach, this safety information has already been recognized by other safety critical industries to be a valuable decision-support management tool.



ATM safety criticality: balancing actors responsibilities

With respect to advanced procedures in air traffic, TOPAZ is the most advanced safety/capacity assessment methodology currently available, going beyond established approaches by incorporating the following features:

- a modular representation, for effective communication with designers;
- context-related human reliability models at cognitive level, enabling the impact on safety/capacity of new technological advances, including resulting changes in operator workload, to be assessed;
- a sound combination with aircraft collision risk models;
- posterior traceability of safety-critical elements in the design.

Examples of TOPAZ applications

- ATC controllability of safety, for the European Commission (EC DG VII)
- Safe spacing assessment of ASAS for NASA/FAA and Eurocontrol
- Active runway crossing for Schiphol and for NASA and EC (DG VII)
- Simultaneous converging instrument approaches for Schiphol and for Eurocontrol
- Assessment of wake vortex induced accident risk, for DFS and EC (DG XII)
- Safety-based design of advanced ATM, for Eurocontrol
- Satellite-based communication and surveillance, for EC (DG VII)
- Capacity/safety performance of datalink, for EC (DG XIII)

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