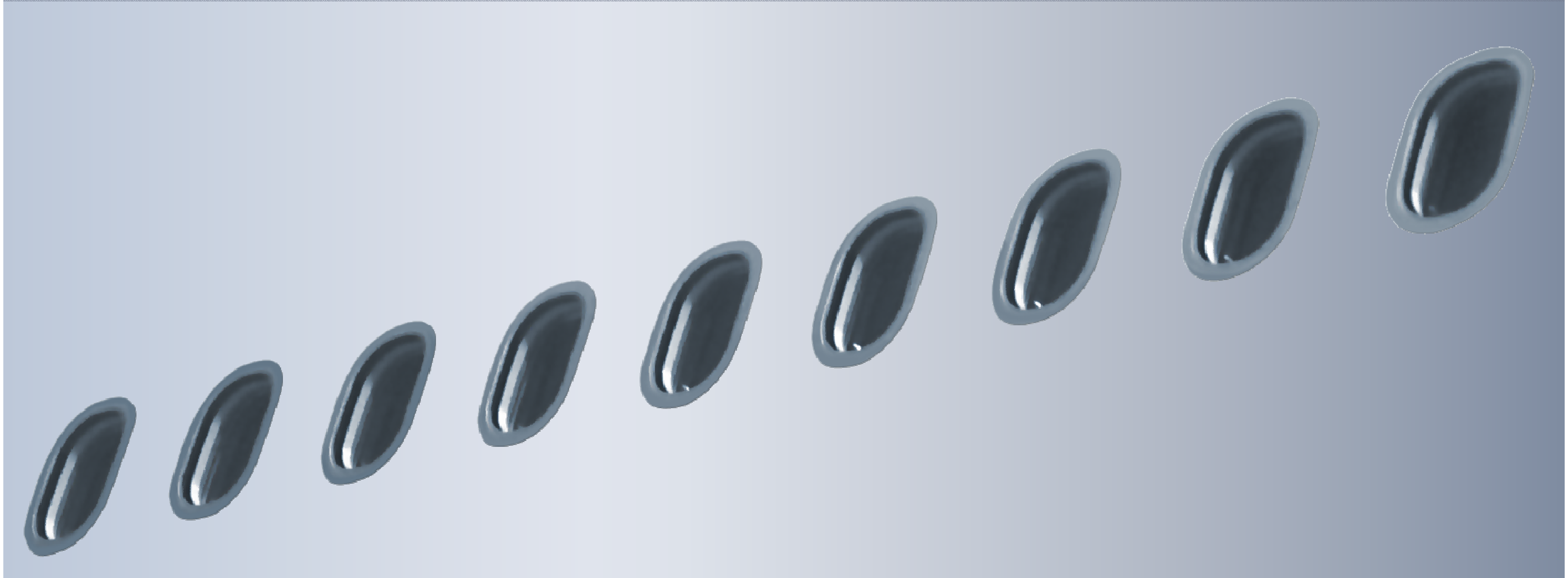


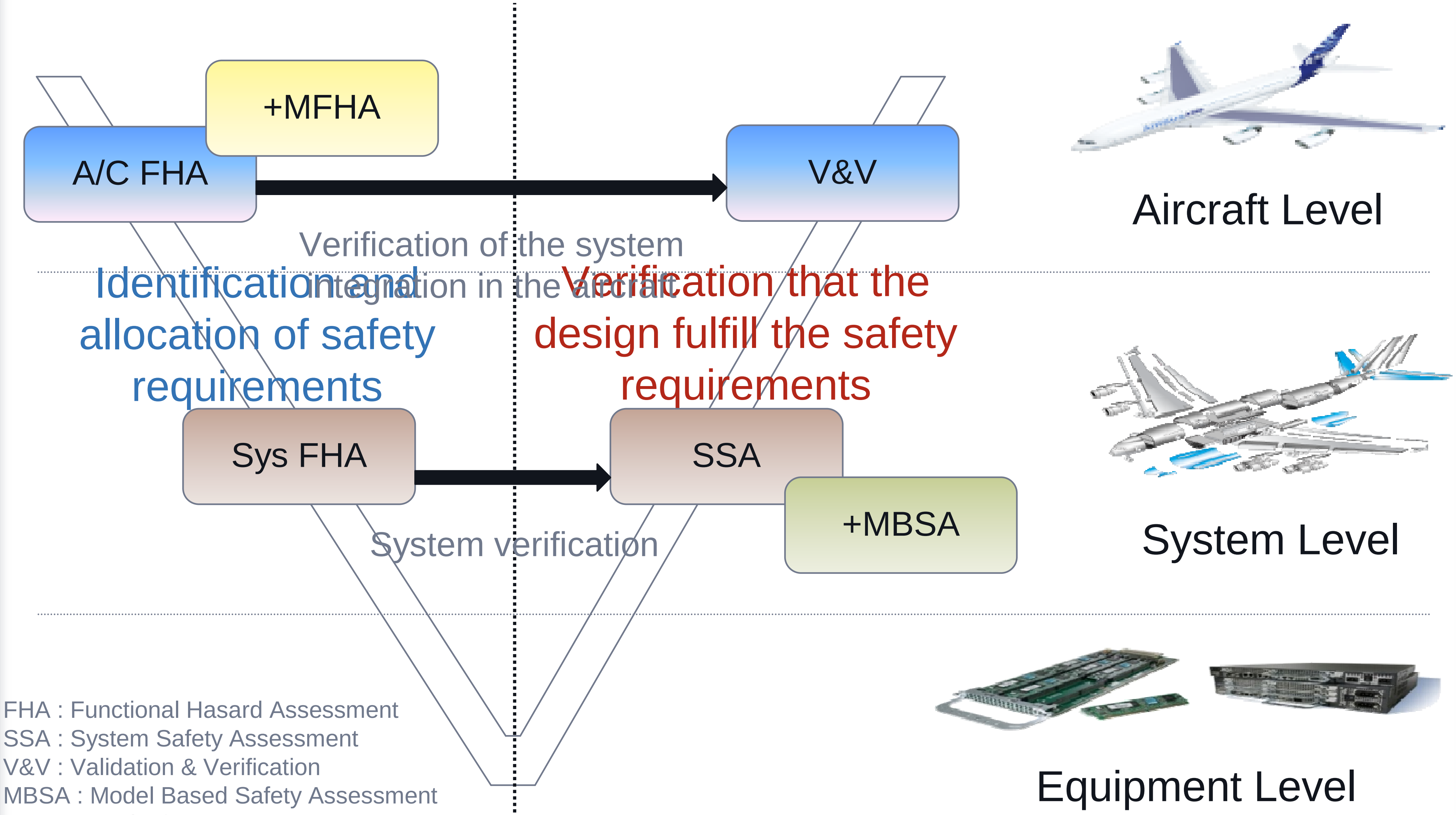
MBSAW 2012

Safety models generation to support Functional Hazard Assessment

Presented by
Sébastien Maitrehenry / PhD student Airbus/Onera/ENSMA

Plan

Context : Safety in aircraft design



FHA : Functional Hasard Assessment
SSA : System Safety Assessment
V&V : Validation & Verification
MBSA : Model Based Safety Assessment
MFHA : Model for FHA

AltaRica models to support the A/C FHA

Modeling of the functional failures propagation:

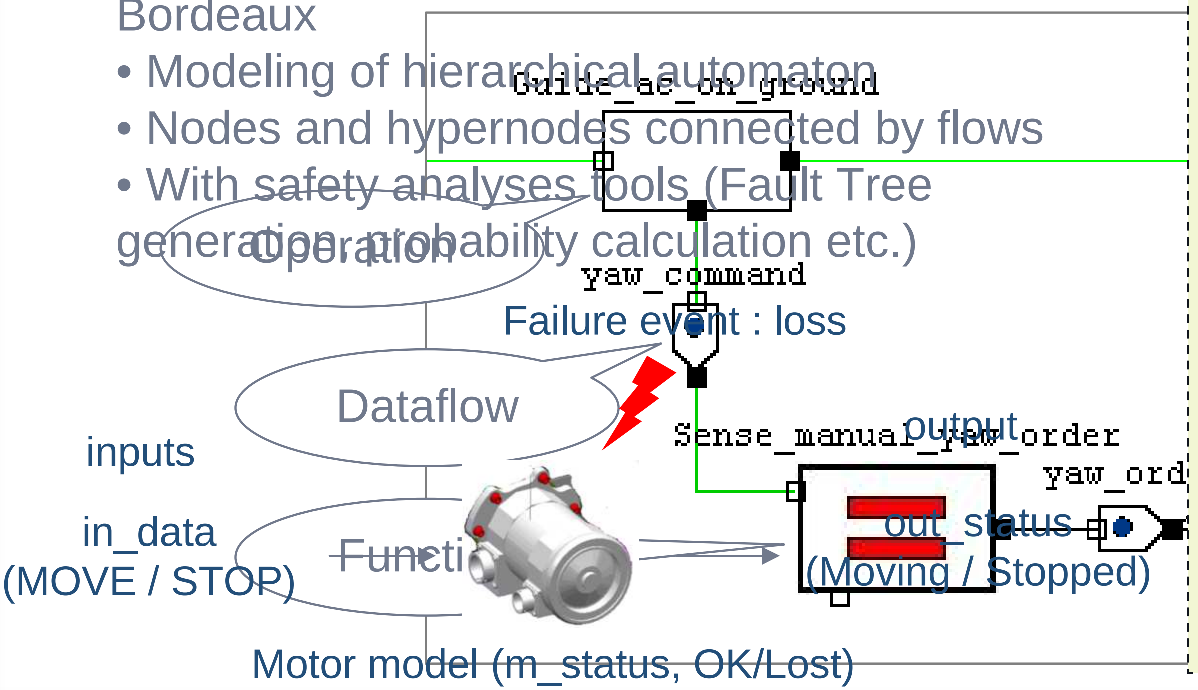
- Assessment of the contribution of a function to the flight (functional effectiveness)
- Modeling of the functional failures (total loss, partial loss, erroneous).
- Distinction of various functional data (needed, useful, etc.).

With the AltaRica language [Arnold & al. 2000]

- Formal modeling language developed at Bordeaux
- Modeling of hierarchical automaton
- Nodes and hypernodes connected by flows
- With safety analyses tools (Fault Tree generation, probability calculation etc.)

Example: AltaRica model of Guidan…

(with AltaRica equiped with a graphical t…



Node Motor_model
state
m_status : {OK, Lost};

flow
in_data : {MOVE, STOP};
out_status : {Moving, Stopped};

event
loss;

trans
m_status = OK |- loss -> m_status := Lost;

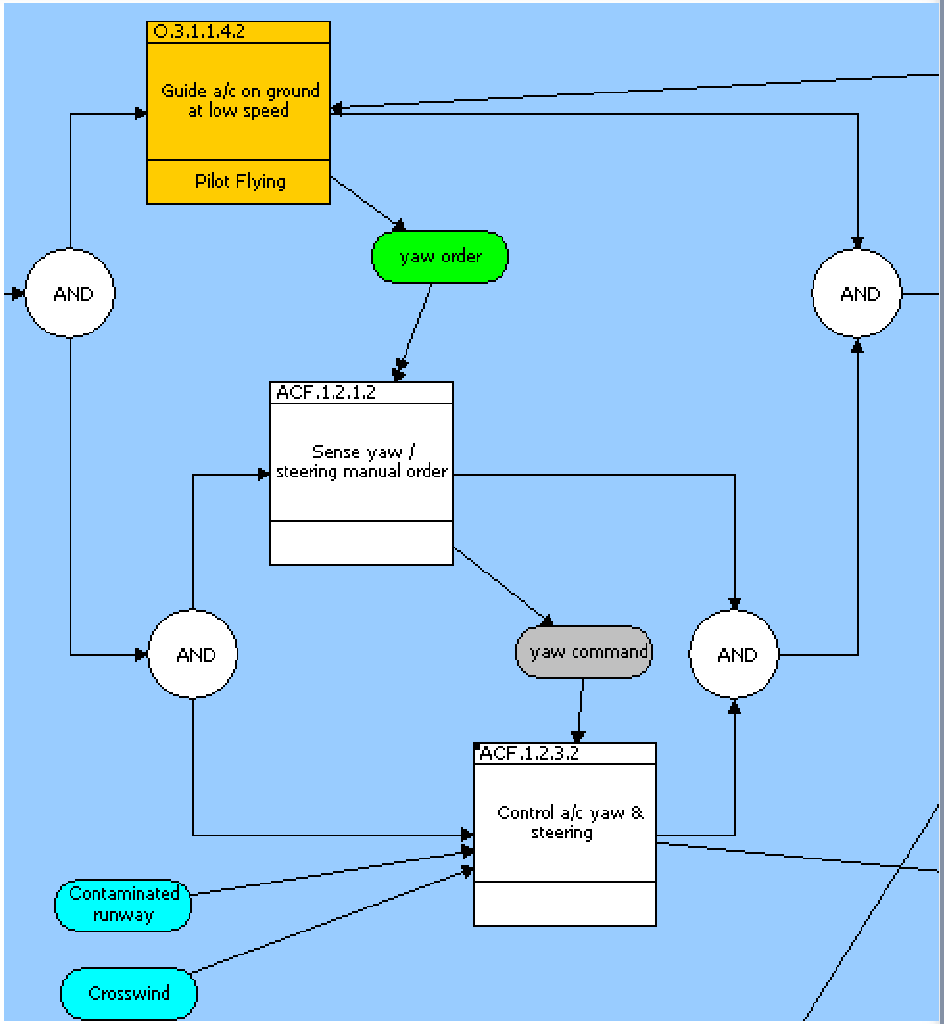
assert
out_status = case{in_data = MOVE
and m_status = OK : Moving,
else Stopped};
Edon

ALFA : Operational and functional models

ALFA (Aircraft Level Functional Approach)

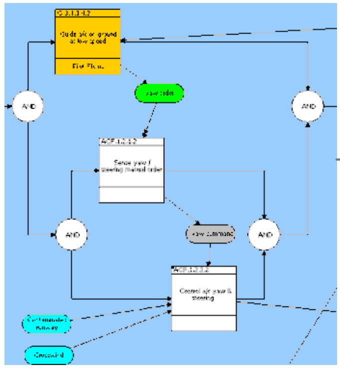
- Reference models to describe the fulfilment of flight scenarios in terms of:
  - human actions (**operations**)
  - aircraft actions (**functions**).

- Tool suported: CORE (Vitech Corporation) with the formalism EFFBD (Enhanced Functional Flow Bloc Diagram). [Seidner 2009]



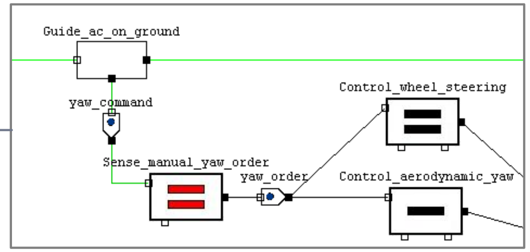
Designers are not safety specialists & CORE is not adapted for safety analyses

Bridge between design and safety



CORE model

AltaRica model



1. Manipulation of heterogeneous CORE models and heterogeneous AltaRica models → Meta-modeling
2. Need for an automatic generation of the AltaRica models from the CORE models, with traceability. → Model transformation
3. Taking into account the specificities of each domain, design and safety (complete separation of these two domains) → With annotations

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Requirements for the model transformation

1. Independent of any modeling languages

- For the safety models
- For the design operational and functional models

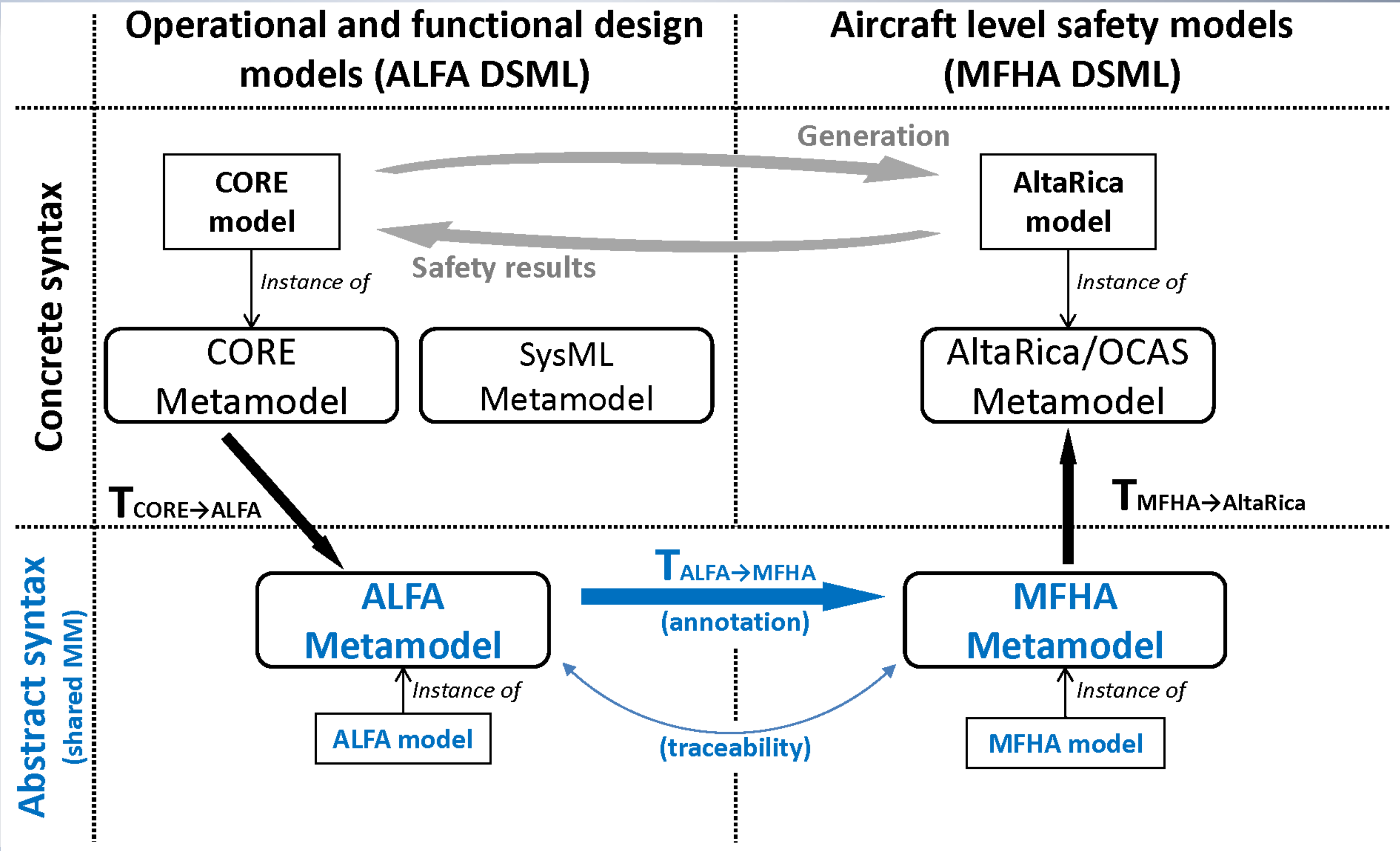
2. Preservation of the existing design and safety processes

3. Open infrastructure

4. Tracing safety results

5. Handling annotations

Our proposal



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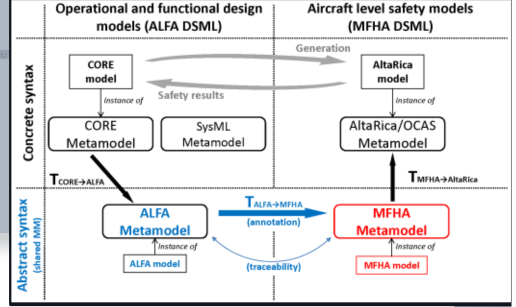
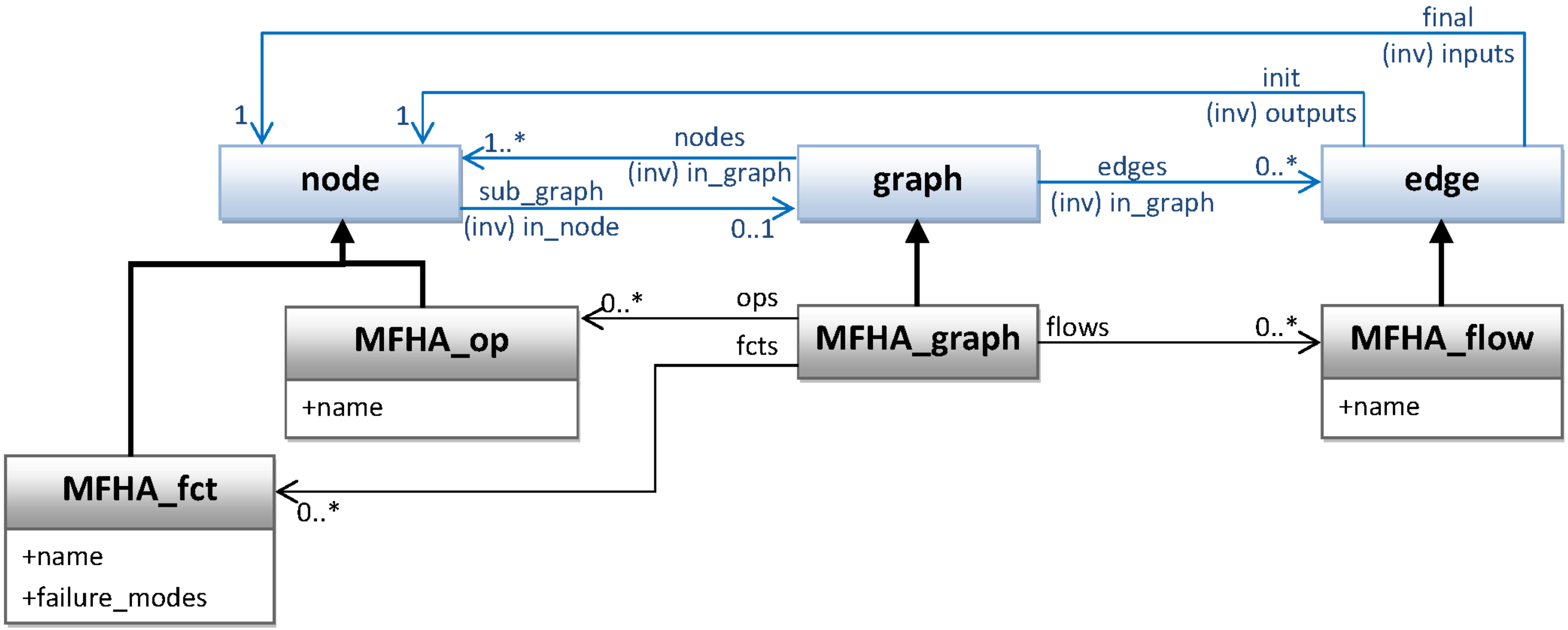
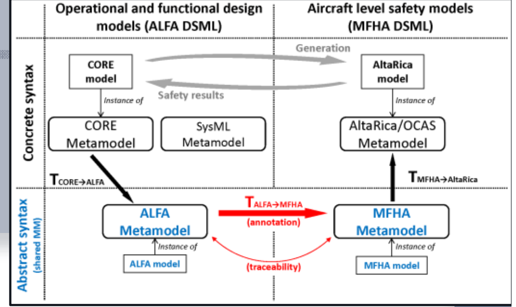


ALFA and MFHA metamodels

ALFA and MFHA models are hierarchical graphs

- Use of classical modeling techniques
- Definition of a generic model of graphs (with constraint rules)
- Specialization to ALFA and MFHA models by addition of DSML specific properties





Transformation

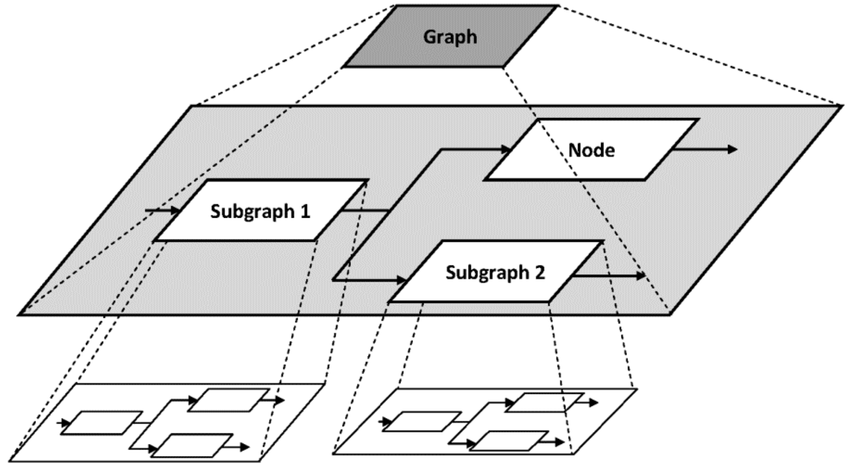
➔ Modeling language: EXPRESS

A data modeling language, with constraints declaration and procedural specifying.

➔Top down hierarchical transformation:

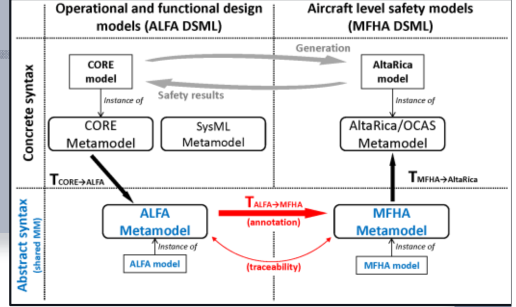
Graph, level N, is transformed (all contained nodes and links).

All subgraphs, level N-1, are transformed with the same procedure (recursive transformation).



➔Each ALFA node transformed into a MFHA node.

➔ **New nodes** added (ex: model activation)

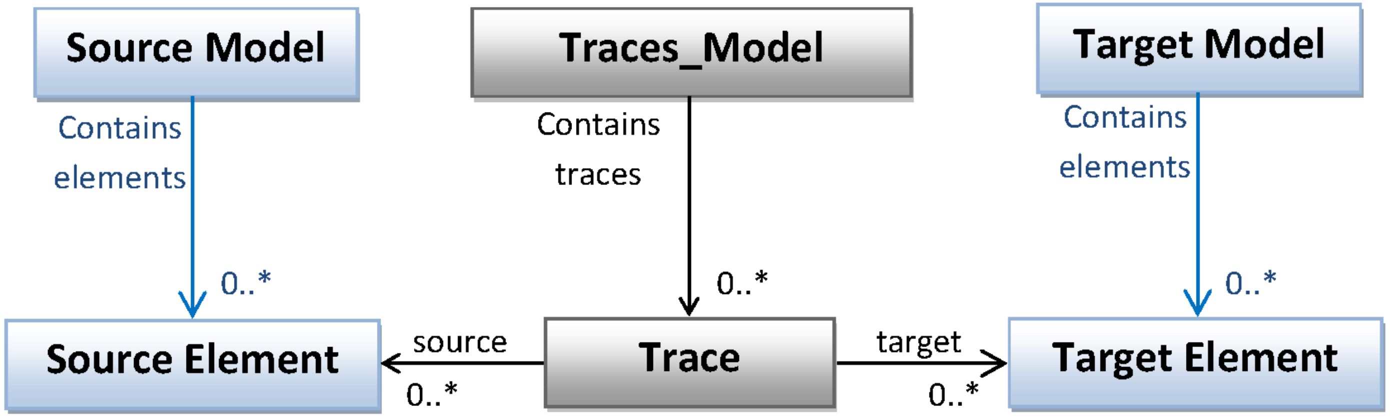


Traceability in the model transformation

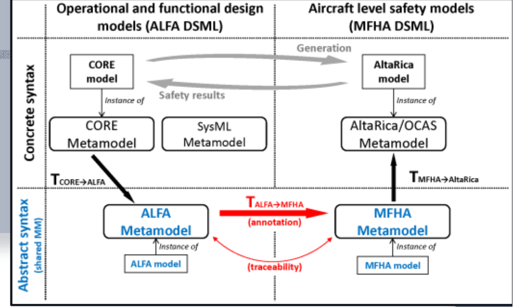
Why? → perform model management, evolution and validation (in particular for safety requirements).

What? → traceability of all elements (node, links) transformation.

How? → with a separate model of traceability



Exemple of trace:

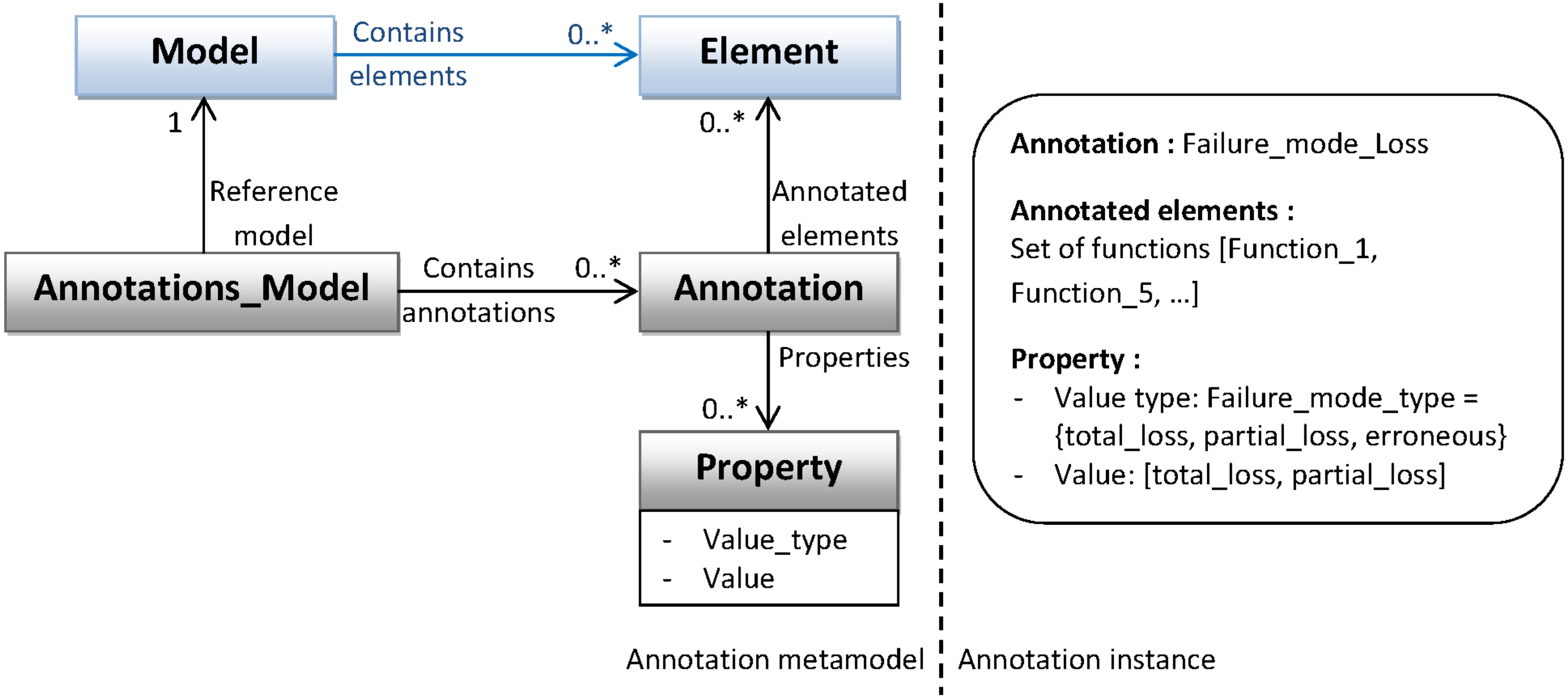


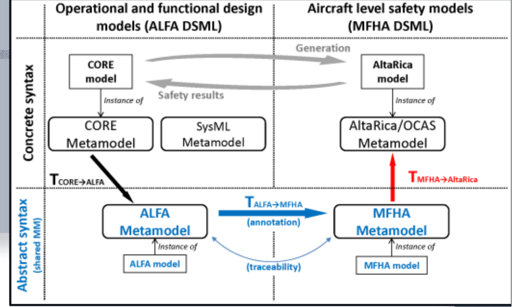
ALFA models annotation

Why? → enriching the operational and functional models with safety information

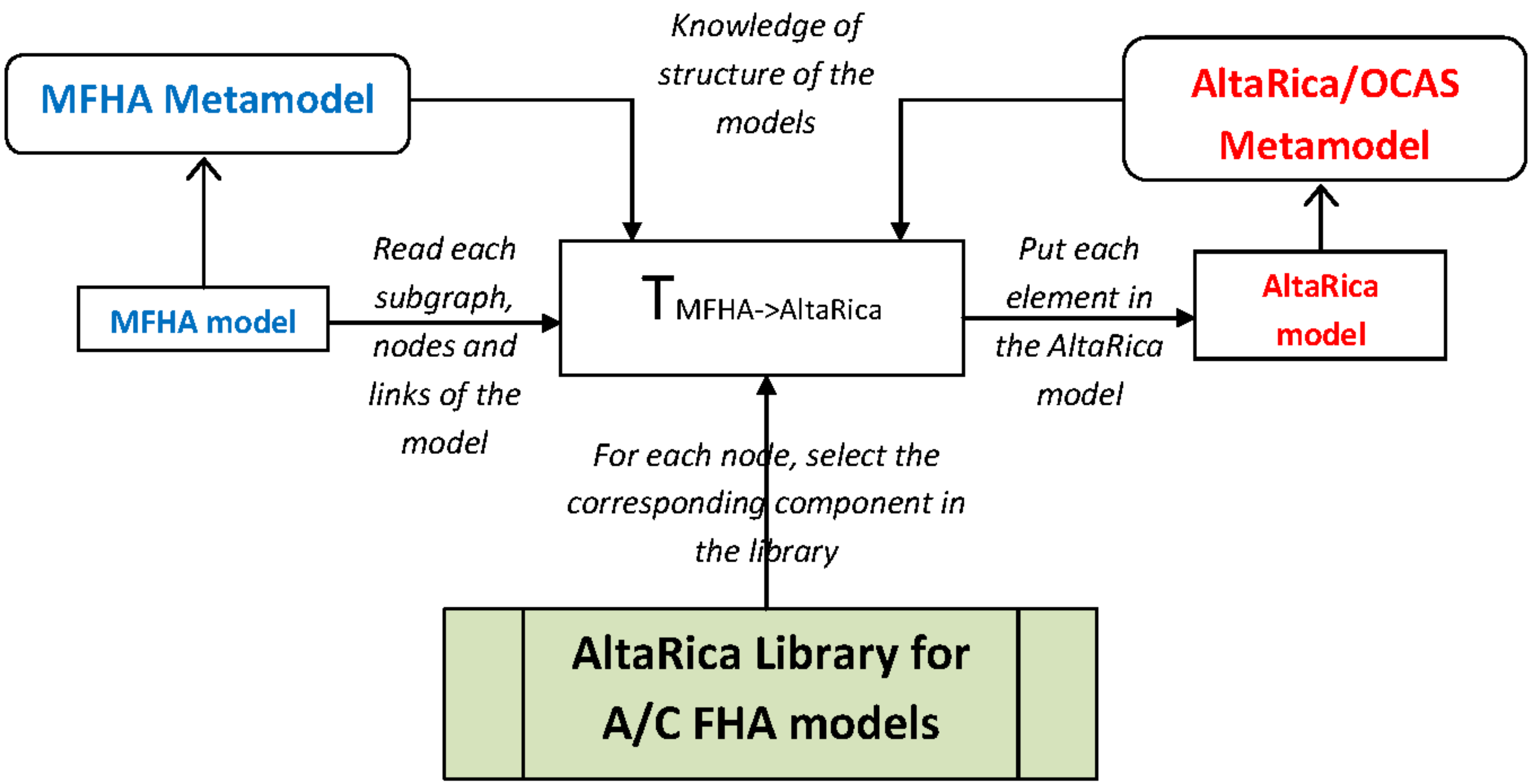
What? → safety domain knowledge: functional failure modes, functional effectiveness, etc.

How? → with a separate model of annotation (no modification on the design models)





MFHA models to AltaRica models



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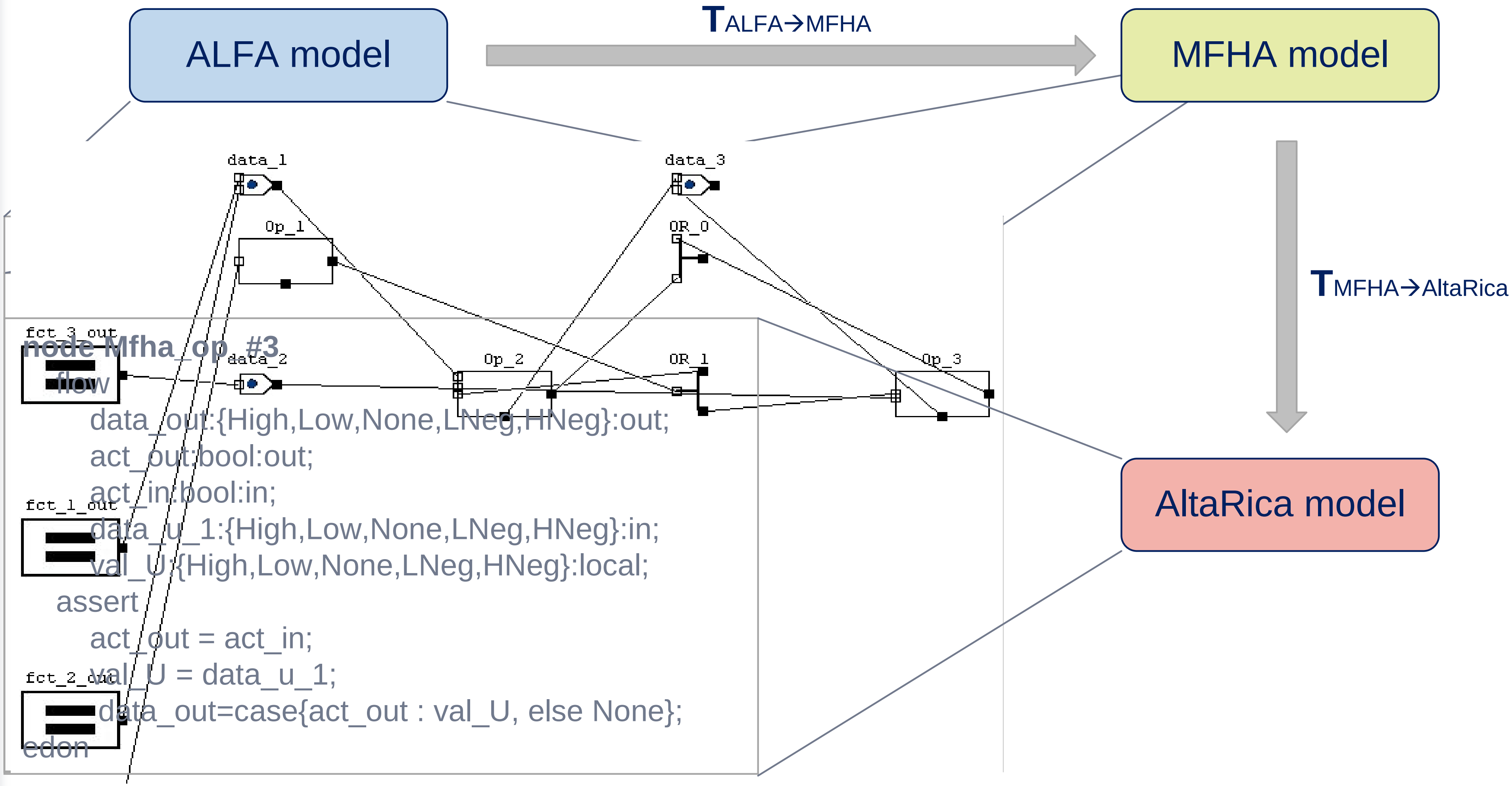
Prototyping and experimentations



Experiments: Take-Off models, ~30 nodes, 2 levels of hierarchy

Open questions and improvements

- ➔ **Improve the global modeling process**
  - ➢ **Who should define annotated data?**
    - *Failure Modes* are defined by the safety specialists
    - *Functional Effectiveness (performance)* should be defined by the designers
  - ➢ **Are the annotation sufficient to analyse all functional dependencies?**
- ➔ **Formalize the design and safety domain knowledge**
  - ➢ **Use of Ontologies?**
- ➔ **Scalability**
  - ➢ **Composition/Decomposition in graphical views?**

Plan

Conclusion

1. Reduce the gap between the design and the safety

2. Formalised models for safety analyses

3. By a generic approach

4. Preserving existing modeling activities

5. Including traceability

6. Handling domain annotation