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Developing software for space:
RAMS and introduction to **TASTE** framework

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The space context

- ESA missions “must” be **successful**
- Difficulty to test the software in its real **operational** environment (rockets, spacecrafts)
    - Low risk profile of engineering
    - Software engineering and PA standards
    - Software must be in full control
- **Minimize the risk** to activate a software design error (no software failure)
    - All behaviour tested, full coverage of code and of requirements
    - No dead code
    - No dynamic memory allocation (C++ malloc)
    - Real-time behaviour deterministic/predictable
- Secure all possible hazards (redundancies, safe mode “that must works”)

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The RAMS requirements

RAMS? *(RAM = Dependability)*

- Reliability (when the software works, it works well) (ECSS-Q-ST-30)
- Availability (the software always replies to request, even if it is failing)
- Maintainability (the software can be modified at reasonable effort)
- Safety (a software error is not going to kill someone) (ECSS-Q-ST-40)

Criticality: If a software error can cause

- the death of someone, the software is Category A
- the loss of mission, the software is Category B
- the loss of part of the system/mission, the software is Category C
- nothing really important, the software is Category D

➔ Category of a Rover?

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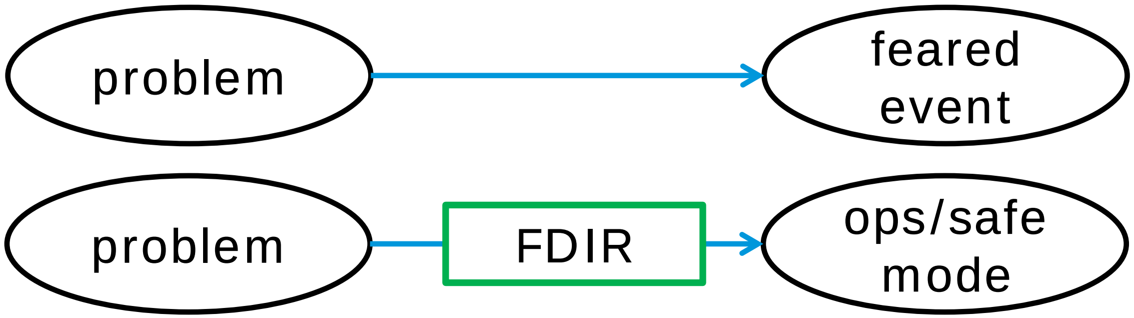
The RAMS requirements generate:

- The functional requirements of the **Fault Detection Isolation Recovery** (FDIR)



FMECA, FTA

- **Engineering and PA requirements**
  - good process and good product
  - Cat B = Cat A – code coverage at object level
  - Cat C = Cat B – ISVV, some code coverage, some verification, some models

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Good process and good product?

Coverage (by the test campaign):

- of the requirements (functional and non-functional coverage)
- of the source code (structural coverage)
- of the real-time behaviour

This is long and costly, therefore:

➔ replace testing by verification of design (schedulability analysis, *correct by construction*)

➔ *separating the concerns* in the architecture (real-time, communication, hardware access, etc) such as the test of each concern is easier.

➔ full visibility and understanding of the code (no dead code, no malloc)

- How to test the autonomy ? (→ formal methods)

Modern software development anyhow…

- Software schedule is shorter and shorter
  - **FASTER** production
  - **LATER** modification
  - **SOFTER** industrial organisation
- → automation → model based
- → reference architecture → component based approach
- → **software factory** (don't reuse software, reuse a solution)

- However, the middleware must follow the space constraints
- Cannot embed Ubuntu and spawn tasks
- Need "High Integrity" middleware & operating system

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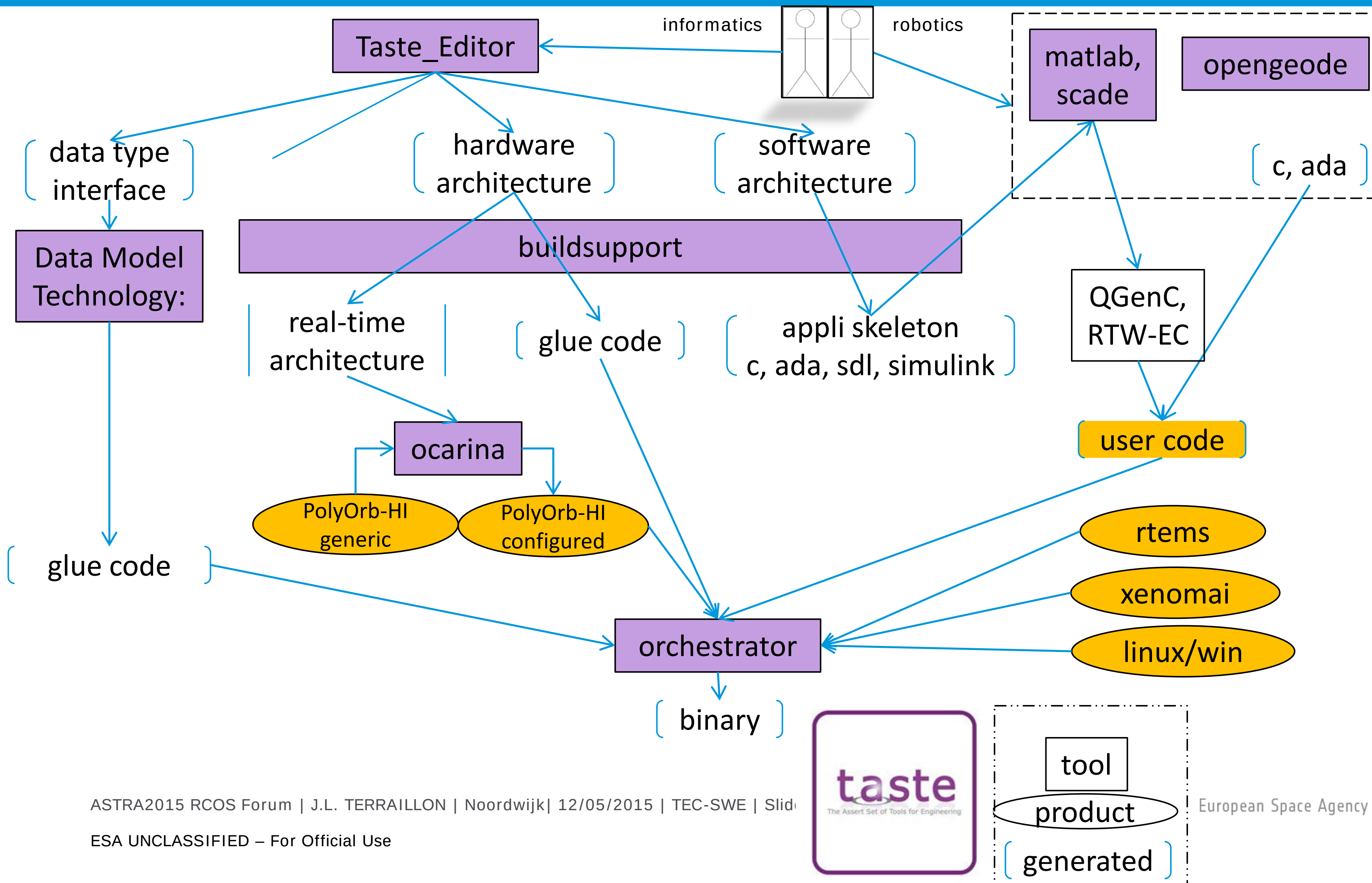
The example of TASTE: an automatic integrator of components



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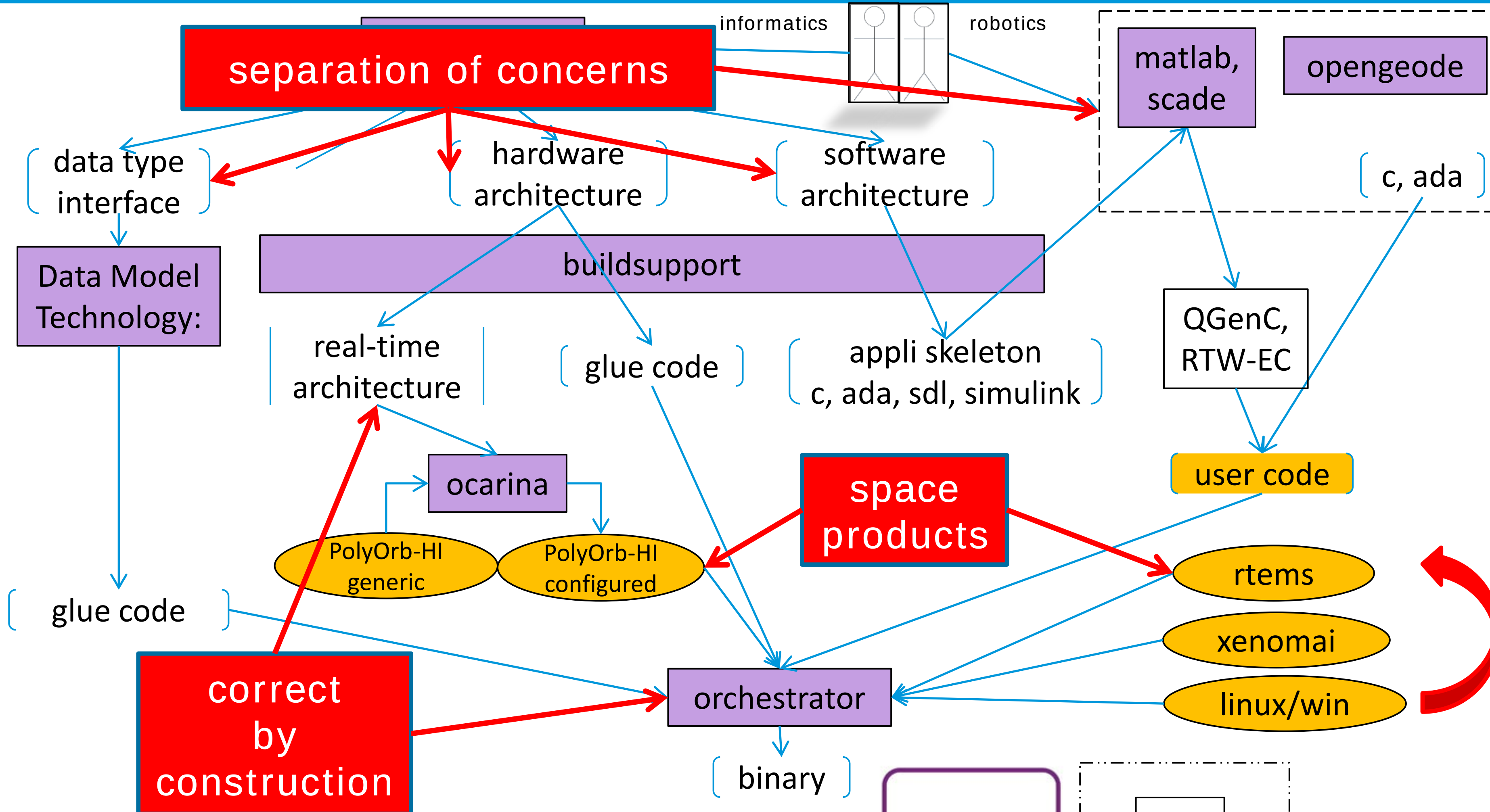

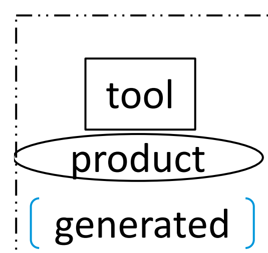

Conclusion

- **Dependability and Safety** are important in Space
- **FDIR** and **Software Standards** protect the spacecraft
- Software code must be **characterized**, known, covered, validated
- **Software factories** help to master the complexity and embed **pre-qualified** building blocks.

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