MBSE 2023

Integration of software in model-based systems engineering (addressing the software to systems perspective)

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Pierre Dissaux, 16 Nov. 2023

Statement of the problem

System engineering is multidisciplinary by nature.

Software must be considered as one of these disciplines.

There is a lot of legacy in Model Based Software Engineering (MBSwE), however integration with Model Based System Engineering (MBSyE) is still an issue.

As the role, size and complexity of software is increasing in mission critical systems, stronger integration of MBSwE with MBSyE processes may become unavoidable

Illustrations

- End to end latency analysis at system level:
  - E.g., Sensor -> Data Processing -> Actuator
  - Needs software response time analysis, which requires precise knowledge about real time **software architecture**.

- Thermal engineering of an embedded system:
  - E.g., design of a mechanical structure encompassing a computer board
  - Needs assumptions about thermal dissipation of electronics, which itself depends on **software activity** (CPU load).

- Cyber-protected system:
  - E.g., considering system confidentiality, integrity & availability aspects
  - Obviously impacted by **software design choices**: data hiding, low coupling…

- Safety engineering:
  - E.g., system-wide fault detection solutions
  - Impact of FDIR functions on **software performance**

A few known issues

- Weak deployment of high value-added MBSwE approaches in industry (i.e., involving early verification and/or automatic code generation). Most software projects remain source code oriented or use low value-added modelling approaches (documentation).

- Weak importance often given to software sub-systems with regards to the other subsystems (mechanics, electronics, thermal…): "let's build the system first, and we will put the required software inside afterwards."

- Existing MBSwE solutions address different focus, and often need to be combined to address the complete picture, which may complexify integration or interaction with MBSyE processes:
  - Object-Orientation: UML, profiles and meta-modelling…
  - Control Logic: Matlab-Simulink, Scade…
  - Architecture: HOOD, AADL…

Questions

Is it desirable to merge MBSwE and MBSyE processes ?

Is it technically feasible ?

What would be the benefits and drawbacks ?

What is the right level of detail to represent software within a system ?