Model-Based Methods and Tools for the Information Supply Chain Process

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Abstract: The diagnostic development process can be viewed as a part of the complete information supply chain process. In this presentation model-based diagnostics is seen as a key solution to industrialize the whole process. New insights in how model-based approaches for diagnostics should perform in order to provide a wider solution in industry today are briefly presented and discussed.

1. INTRODUCTION

The information supply chain process provides the information, tools, and know-how needed to operate, maintain and manage complex systems and product such as vehicles in automotive, aerospace and in defence sectors. The growing systems complexity, based on modern design principles where electronics and software becomes a fundamental ingredient in the overall system architecture, provides a challenge for dealing with the overall need for information of logistics and support. While the modern system architectures provide a flexible way for designing functions and system features, fulfilling the requirements of the normal behaviour, the challenge for creating and maintaining good information supporting these systems becomes difficult.

The Integrated Logistics Support process (ILS) combines the steps of analyses of safety, reliability, operational availability, logistics of maintenance and spare parts, as well as production of technical information for operators and service resources. All of these activities are vital for ensuring system product quality.

One of the most prominent parts of the ILS chain is the development of the diagnostic information for troubleshooting guidance. Diagnostics is also a classic area for model based approaches which is the reason why the focus of this presentation is on diagnostics. Still, model based methods can be used to gain more advantages in the ILS chain than just diagnostics.

2. DEVELOPMENT OF DIAGNOSTICS

Today the development of diagnostic information is typically initiated with a technical specification phase where information is assessed for the production of the diagnostic information. This information is gathered from the product development’s design data that is available in different forms including pure text document, software and schematics. In order to efficiently introduce model-based approaches in the overall process, it is of high importance to adapt the modelling approach to minimize the effort of “reengineering” the design information. Once the design information is represented in a proper model, the job to turn this information into useful diagnostic outputs like decision trees, interactive model based diagnostics (IMBD), Failure Mode and Effect Analysis (FMEA) and on-board diagnostics can be done cost efficiently and in time.

The generic and ideal process for Product Development follows the typical V-chart. The left side of the V-process shows the steps taking top level requirements stepwise down to an implementation of hardware and software, which is then integrated and tested with respect to the specifications on the right hand side.

Ideally the diagnostic process should utilize design information as early as possible in the development process. This is typically facilitated by the failure analyses performed to support the design work, such as safety, reliability and FMEA analyses that will, in turn, generate the data for diagnosis such as failure modes, probabilities, symptoms, cross function consequences, detectability, failure codes etc.

However, in reality, the product development is not able to follow the ideal process. Typical problems are:

- Time pressure. Making the process more focused on the implementation phase, thus making the specification information incomplete.
- Late design iterations during implementation phase. Making the stable information based on what is actually implemented very late in the process.
- Lack of early failure analysis, makes the design of onboard diagnostics including DTC a result of design engineers ideas for fault detection rather than the complete support cycle aspect.

The consequence of these problems is that the hand-over of product development process to the diagnostic process has to cope with what is available at the time it is needed. Often the design information is not stabilized until the implementation phase in the V-chart making the data assessment looking for data in the details of the implementation, e.g., assessing data from software rather than specifications of the software. This leads to a trend to look for diagnostic model based approaches that should utilize very detailed design information even though it often is not appropriate for the
purpose of diagnostics, at least not for decision tree production.

To improve efficiency in these processes, as well as improving quality and customer satisfaction, the long term trend must be to introduce model-based approach for failure analysis as early as possible in the product development.

3. CHALLENGES TO MEET THE CHALLENGES

Ideally model based approaches are well suited to capture design information and to industrialize the information supply chain in general. However, going into a model-based approach may not be easy even though it is very powerful.

Model-based methods are well known in architectural design and simulation areas, where many tools and language has been developed over the years. The specific purpose with simulation is to predict the behaviour of the systems and to do this with proper accuracy. In the same tradition it is often assumed that models for the purpose of diagnostics also needs very detailed information to give proper output. This is often not the case. Too detailed modelling can create problems to reach the needed diagnostic output. One reason is that the traditional diagnostic development simply lacks the detailed information to put into the model, another reason is that common sense and human experience should still play a vital role for developing diagnostics and should not be put on hold just for the sake of the model-based approach. One example is that reasoning about failure modes can often be done correctly without quantified entities, e.g., reasoning about a leakage can be done with the exact knowledge about the size of the hole in the hose. Another example is that modelling the exact behaviour of a control unit in the event of loss of power is rarely practically meaningful for diagnostics. This means that there are cases where common sense has to over rule the detailed systems engineering view.

3.1 Model Based for the Horizontal Process

Human experience and common sense is the foundation of the current diagnostic development process when it comes to the overall diagnostics of a system, due to lack of alternative methods, but also from the fact that there is a need to validate and reason about failures from an orthogonal view that differentiates from the engineering design view. That is why, brain storming, and committee discussion activities are hard to replace when it comes to quality assurance and diagnostics. Model-based approaches that aim to provide benefits for the whole process has to be less technical and very easily used by non engineering resources, making the resulting process recognizable but still much more efficient.

3.2 Model Based for the Vertical Problems

As stated above there is a need for easy and process adapted approaches for model-based tools. However, even though the majority of the diagnostics can be produced in a simplified model-based approach, there are cases where very detailed system behaviour analysis is needed for specific reasons.

Therefore the model based approach has to handle both the wide aspects of process support but also being able to “go down to the atoms” if needed. If the detailed analysis is excluded in the model-based approach then there are cases that cannot be handled properly and this will often create a sense of “distrust” also for total result of the diagnostic process.

4. CONCLUSIONS

The presentation gives an overview of the ILS process and how diagnostic information plays a role as a core ingredient in this. The task to introduce model-based methods in the ILS process is different from the development process and there are several issues to deal with which will be exemplified in relation to industrial cases and project experiences using the tools RODON and UpTime.