

System-level diagnostics through the system lifecycle

Enabling system-level diagnostics

The high-tech industry is facing an increasing demand from customers to deliver performance- and availability-based contracts. This pushes the high-tech industry to change its traditional diagnostics tasks as seen in service and repairs towards an efficient strategy that optimizes system productivity over the full lifecycle.

Facing this change, the high-tech industry is simultaneously challenged by the increasing complexity of its systems, turning the development of a diagnostic approach into a difficult engineering task. Also, scarcity of skilled personnel poses challenges to the service organizations.

For these reasons, there is a need to develop techniques to assist in efficiently diagnosing a complex system to minimize downtime, and new methodologies to assess the diagnosability of a system in an early stage of the design.

Towards a digital assistant to make the lives of service technicians easier.

Assisted Diagnostics Methodology

Together with multiple of our industrial partners, we are developing model-based methodologies supporting diagnostics during the design of a system as well as when the system is in operation. The knowledge- and data-driven methodologies leverage techniques from model-based system engineering and data science. Diagnostic models and a probabilistic reasoning framework based on probabilistic graphical models are at the core of the methodology. The diagnostic models are derived semi-automatically from design artefacts.

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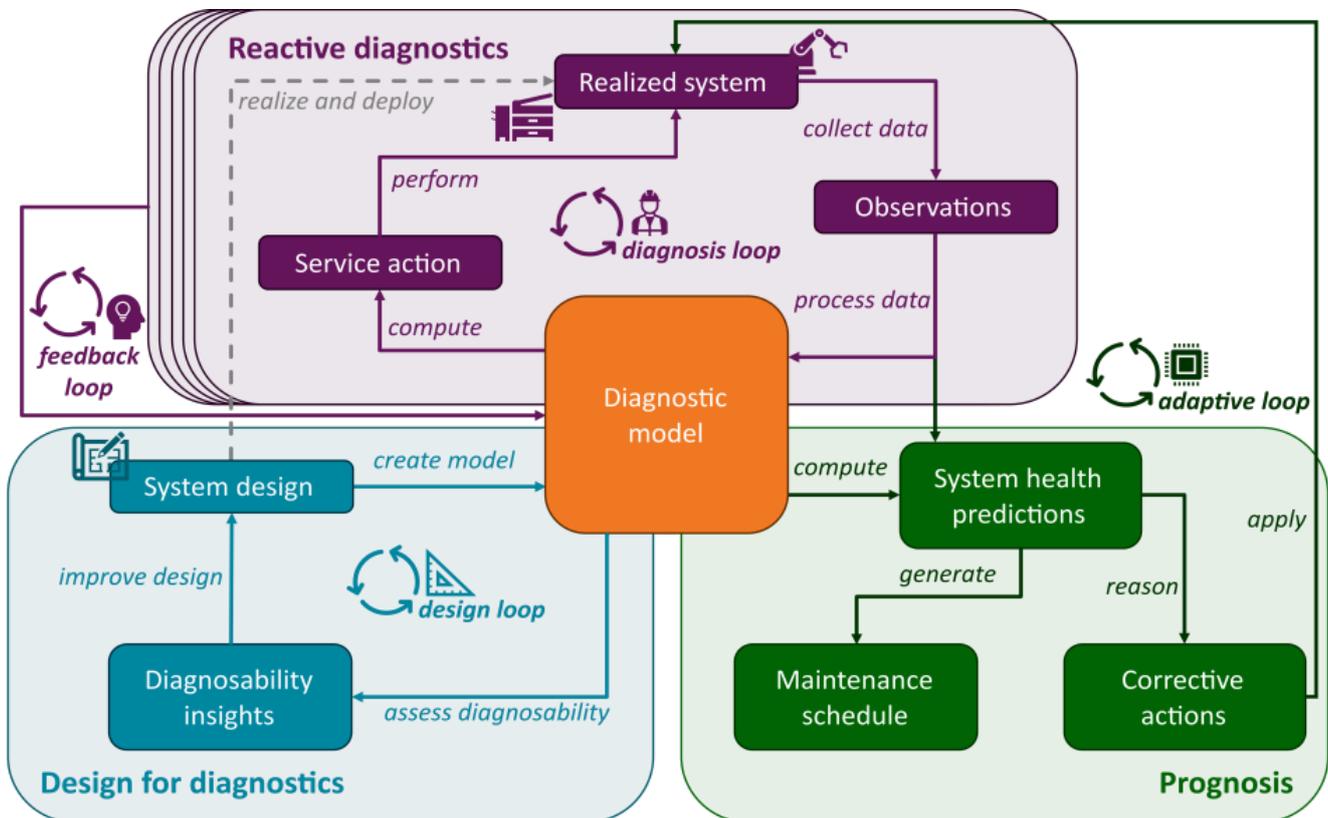


Figure 1. The diagnostic model plays a central role during design, for diagnostics and for prognosis.

During the design of a system, assessing its diagnosability is a complex task. Such a task is currently often human-centered and review-based. By using a model-based approach, the failure observability can be derived algorithmically and the degree of diagnosability can be computed automatically. This analysis provides valuable input in the exploration on sensor placement and diagnostic test specification during the design.

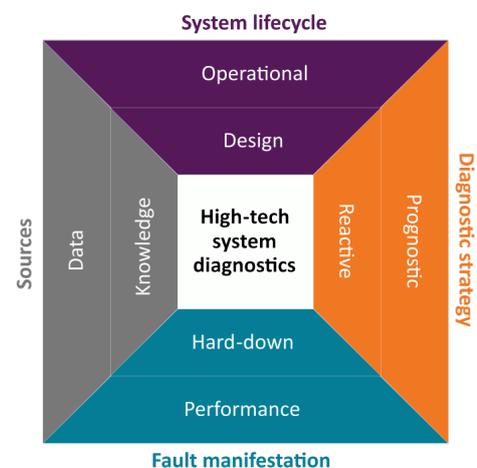
Guiding the service engineer

Once the system is in operation, the methodologies provide assistance for the service engineer. Logged data produced by the running system is provided as input for the diagnostic reasoning, which utilizes the design and expert knowledge formalized in the diagnostic model. Based on these system observations, the model comes to a diagnosis. This diagnosis may lead to corrective actions, such as maintenance or replacement. If not, the model suggests diagnostic tests that can be executed to acquire new observations from the system. By iteratively adding new observations to the model, the model will guide the service engineer to one or more repair actions that need to be done to resolve the issue.

Scalability of the diagnostic model creation is addressed by connecting to model-based systems engineering methodologies and the use of generic model building blocks. Compositional approaches allow for both top-down and bottom-up creation of the models. Readily available models can be transformed into partial diagnostic models to reduce the effort of creating them.

The generic nature of the methodologies allows for application in many different fields in the high-tech system landscape. The application of the methodologies in several case studies in the high-tech industry created positive results and further development.

Figure 2. Four key aspects to characterize diagnostic methodologies.



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