Probabilistic Diagnostics with P-Graphs

Balázs Polgár and Endre Selényi

Diagnostics is one of the major tools for assuring the reliability of complex systems in information technology. System level diagnostics considers the main, replaceable units of the system and does not deal with the exact location of faults within the units. This is the case in multiprocessor systems where only identification of faulty processors is important. According to Preparata et al. [1] in such systems intelligent units test each other and on the basis of the set of test results, called syndrome, the good or faulty state of each unit should be determined. The difficulty comes from the method how a fault in the tester processor invalidates the test result. This is described by test invalidation models.

Deterministic algorithms aim at providing complete and correct diagnosis, i.e., determining the state of each unit without classifying any of the fault free processors as faulty and vice versa. Usually not only a single diagnostic outcome is consistent with the syndrome. To select the correct diagnosis from the set of syndrome-consistent diagnostic outcomes these algorithms need further information on the system. This is the assumption that no more than a predefined number of faults are present. In contrast with this, probabilistic methods generate a diagnostic outcome using solely the information included in the syndrome. These methods try to select the most probable diagnosis but this is not always the correct one, which means the classification can contain misdiagnosed processors. [2][3]

During our work we generalised the traditional test invalidation approach and developed a novel probabilistic syndrome-decoding algorithm. The main idea is based on the reformulation of the error propagation model as a Process Network Synthesis (PNS) model. PNS models are widely used in application fields related to chemical engineering to estimate optimal resource allocation and scheduling. In our approach the same mathematical paradigm is used to model information flow similarly to material flow. As a result, the diagnostic problem has been formulated as an optimisation problem.

The diagnostic accuracy of the solution is discussed on the basis of simulation measurements and a method is introduced how a general framework can be constructed for different aspects of a complex problem with the use of PNS-model.

References

[1] F. P. Preparata, G. Metze, R. T. Chien. On the connection assignment problem of diagnosable systems, IEEE Trans. on Electronic Computers, vol. EC-16, pages 848-854, 1967

[2] T. Bartha, E. Selényi. Probabilistic System-Level Fault Diagnostic Algorithms for Multiprocessors, Parallel Computing, vol. 22, no. 13, pages 1807-1821, Elsevier Science, 1997.

[3] T. Bartha, E. Selényi. Probabilistic Fault Diagnosis in Large, Heterogeneous Computing Systems, Periodica Polytechnica, vol. 43/2, pages 127-149, 1999.