Model-Based-Diagnosis for Fault Management in telecommunications Networks

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Abstract

Fault management is a crucial problem for telecommunication networks. The network complexity requires artificial intelligence techniques to assist the operators in supervision tasks. Initially expert systems techniques were proposed, presently various techniques are used: neural networks, constraint satisfaction problems, Petri networks. These methods are based on the analysis of the breakdown situations observed in the real system, consequently, they have the same problem as expert systems: they are enable to reason about new faults and the level of explanation of fault is poor. The continual change of the telecommunication networks reduces the effectiveness of these methods. The model based techniques propose a framework based on the adaptive modeling of the system and the prediction of the behavior of the system from the simulation model.
Model-based-techniques are recognized more adapted to the evolutive systems, and give a good explanation of the faults. Model-based techniques typically compare observations of the behavior of a system being diagnosed to expectations based upon a model of the system in order to diagnosis faults. These approaches take a detailed view of the network. A generally accepted model for detailed system representation is that of a discrete-event system.
We have proposed in the GASPAR project a model-based approach to diagnose fault situations in greatest French telecommunication networks: TRANSPAC [BCD$^+$]. This approach is based on two steps (see figure 1): (1) *Off-line step:* The first step to studying faults management is to build a model [Osm99c]. This construction is done using two abstraction levels: structural abstraction where components of the network are modeled by temporal graph and behavioral model where each component is modeled by temporal and communicating finite state machines.
When the model is built, single and multiple faults are simulated in the model. The model is completed by a new kind of components "fault component". These components simulate faults [Osm00]. Corresponding to the two level abstraction I have proposed two kind of algorithm: propagating algorithm associated to the structural level and deducting algorithm associated to the behavioral level [ORC$^+$99, Osm99b, OL]. The simulation process generates for each simulated situation a set of possible sequences of alarms could by received by the supervisor center. At the end of simulation a learning database of fault situations is built. This database is used by discrimination module to classify given fault in the space of sequences of alarms [Osm99a]; (2) On-line step: the expert system generated by the off-line step is used to recognize on-fly fault situations from the stream of alarms arriving at the supervisor.

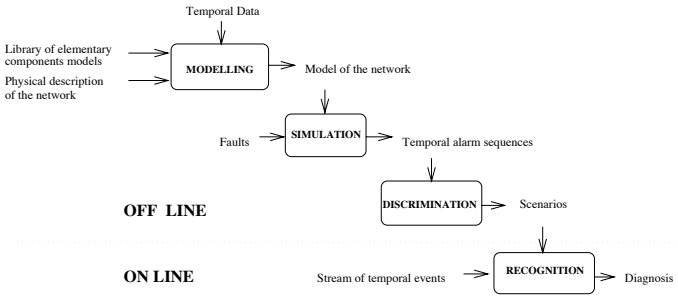

Figure 1: *Different steps of our approach*

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