

# On Using Graph Theory and Machine Learning to Improve SRAMs Diagnosis Accuracy and Quality

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## Abstract

Advanced semiconductor technologies continue to increase computing capacity and the volume of data that can be processed, leading to larger memory requirements in System-on-Chip (SoC) designs. As technologies shrink, manufacturing processes become more susceptible to complex defects, such as resistive faults. Testing and diagnosing these memory modules are therefore crucial for yield ramp-up and for preventing system failure. Diagnosing these systems is essential for Physical Failure Analysis (PFA), as its accuracy and resolution are directly related to the ability to identify the root-cause defect. The most common diagnosis technique relies on generating a dictionary of fault stimuli and corresponding responses, which is then compared with test data produced, for example, by an embedded test engine. The major drawback of this approach is the time required to build the dictionary, as it involves analog simulations of Cell-Aware (CA) models for thousands or even millions of transistors and their associated defects. To address this issue, an in-house automated flow suitable for industry environments was developed and evaluated on SRAM designs, yielding promising results. However, the flow relies on an inaccurate assumption to reduce the number of simulated elements: it considers only defects in Active Nets as potential cause of failures, which results in overlooked defects. With the development of the TrUnDeL approach — a graph-based solution for CA defect characterization — this assumption can be removed. Instead, the method considers breaking the memory into compartments and the possibly detectable defects surrounding their transistors. Nevertheless, both TrUnDeL's ability to reduce the number of candidates for simulation and the comparison between the generated dictionary and test stimuli require further improvement. This can be achieved through the use of machine learning classifier models, leveraging the structural regularity of SRAM compartments and the tabular nature of dictionary data for model training. This talk will outline the proposed work to integrate and optimize this approach within the existing diagnostic flow.