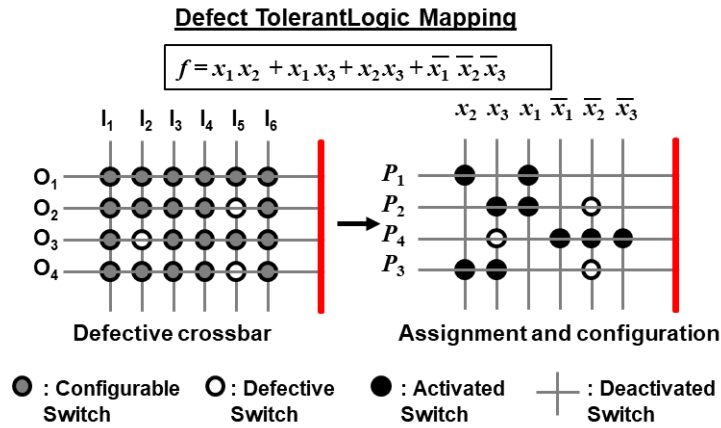


# Crossbar Size Finder Tool for Defect Tolerant Logic Mapping

This tool calculates the required crossbar size in advance according to a given logic function and a defect rate. Using a crossbar with determined size, a valid physical implementation of the logic function with a reconfigurable nano-crossbar array can be achieved. Tool accepts two parameters, logic function file and defect rate as inputs and returns the size of crossbar.

In short, a reconfigurable nano-crossbar is constructed from two layers of orthogonal wires/lines. Every crosspoint/junction acts as a switching element. Nevertheless, in case of defects, mapping of a logic function is not a trivial task. So finding the crossbar size is closely related to defect tolerant logic mapping problem which is basically an assignment problem. Determining which products ( $P_i$ ) of logic function are assigned to outputs ( $O_i$ ) of crossbar is the main challenge. An example of valid mapping is shown in Figure below.

However, if the probability of a successful mapping in case of defects can be formalized



mathematically in terms of the size of inputs and outputs of crossbar array, one can find the

$$P_{suc} = \prod_{t=0}^{M-1} \left[ 1 - \left( 1 - \left( 1 - \frac{P_d}{k_i} \right)^{IR_{\{t+1\}} \cdot N} \right)^{M \cdot k_o - t} \right]$$

sufficient crossbar size by finding the corresponding parameters maximizing the probability. Without going into too many details following formula is used to calculate the probability of finding a valid matching. The tool maximizes  $P_{suc}$  by finding the minimum  $k_i$  and  $k_o$  showing how many times the size of crossbar should be larger than the size of a given logic function. It should be noted that for small defect rates, function and crossbar size might be equal meaning optimum crossbar size.

As a following step, established crossbar size is shown to be sufficient for a 100% success rate using Monte Carlo simulation by randomly generating defective crossbars with given defect rate (a sample size of 100) and finding a valid mapping for each case. Logic function is stored in an excel file named "function.xlsx". An example file is added to the distribution.

Tool and functions are given in separate files having a readme file that gives brief information of the functionality as well as running instructions.