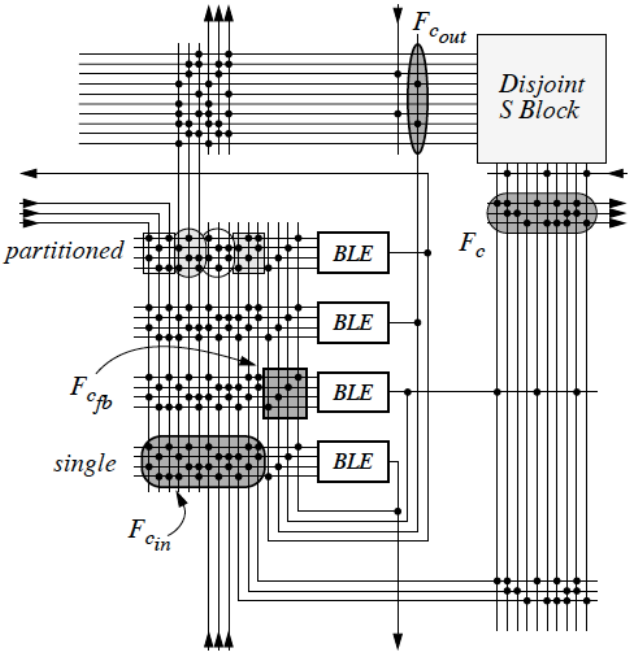
Using Sparse Crossbars within LUT Clusters

Guy Lemieux, David Lewis

Year of publication: *2001*
Area: *Architecture*



I consider this paper to be one of the most significant pieces of academic research on routing architectures for FPGAs. This paper investigates the previously unexplored realm of building intra-cluster routing without assuming full connectivity. The FPGA architectures based on clusters have been explored previously in the literature (and in particular at the FPGA Conference) by many research groups. All of this previous work however, went on to analyze cluster and LUT sizes and connectivity matrices while assuming that the intra-cluster routing was done by a full crossbar. What we learned from this paper was the very important fact that some of the conclusions of this analysis about the optimality of clustered FPGA architectures can be significantly altered by heavily depopulating the crossbar, while maintaining good routability and good performance.

The paper starts by proposing a highly generic type of clustered FPGA architecture in order to demonstrate the main point. To be able to calculate and compare relevant parameters (such as area and performance), the authors first introduce area and delay models. Then they introduce some enhancements to the CAD tools (VPR) in order to deal with the consequences of heavy switch depopulation. Finally they present experimental results on area and performance by exploring architectural parameters; they even consider additional LUT inputs and CAD tool mapping time.

This paper has been inspirational for further work in this area, especially in the FPGA industry. Today, most of the modern commercial routing architectures are based on clusters. In all known cases to me, these clusters contain partially populated crossbars. They are all optimized for slightly different objectives using different switch depopulation schemes. The impact of this paper is not purely industrial however. This paper also had a significant academic impact. In the following years, the experimental work of Lemieux and Lewis has been generalized and put on strong theoretical foundations by other researchers. I am certain that this paper will continue stimulating research in this fertile area of sparsely connected intra-cluster routing.

Sinan Kaptanoglu

DOI: http://doi.acm.org/10.1145/360276.360299