SUMMARY OF Ph.D. DISSERTATION

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Title

A Study on Asynchronous Circuit using Bundled Data method

Abstract

Recently, an asynchronous design using a state transition has received an attention.

The asynchronous method has some advantages. In this study, the following two advantages are specially focused.

- Each function block was processed without a synchronization of clock.

- Wasting time between an elapsed time of processing and a synchronized clock interval can be eliminated.

In this study, two advantages below are focused.

- Each function block processes without synchronizing.

- Each function block processes in each execution time for each process.

This study is moreover based on bundled data method in an asynchronous design.

Two major research products can be summarized as below.

1. A pioneering asynchronous switch was designed, which processes all signals as an asynchronous manner, and its arbitration process and data transfer process are perfectly separated. A circuit simulation for this switch was made and it proved its 32-Gbps transfer rate. Actual switch chip and a printed circuit board for evaluating it were also implemented and confirmed the expected operation of this switch.

2. Speculative completion, which attains high-throughput calculation by changing the processing time appropriately according to each function block, was proposed by Nowick..

This study improved this speculative completion method and proposed new synchronous speculative completion that transfers a processing signal synchronized to the most dominant pipeline stage in processing time in order to enable further high-throughput calculation. If a target design does not have pipeline stage, this design might be assumed as one-stage pipeline structure for receiving the benefit of this new method. The evaluation of this method is done by applying CPU core. This evaluation proved that the throughput using this method can be extended to be 1.65 times faster than the original throughput. This synchronous speculative completion method in particular can improve the throughput when applied to a process that is activated only in limited conditions and extends the latency of its critical-path.

This study described the bundled data method, which is the one of asynchronous circuit design method, and also described its application to a synchronized circuit for attaining high-throughput processing. These studies proved its efficiency by the actual simulation and implementations. Now, application area of the asynchronous design is limited. However, it is also expected to be widely used such as dynamic reconfigurable processors by this study.