Design Automation of XBM Automata in Workcraft

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ASYNCHRONOUS DESIGN

Asynchronous circuits are known for their high performance, robustness and low power consumption, which are beneficial for the area of “little digital” controllers where low latency is crucial. However, asynchronous design is not widely adopted by industry, partially due to the steep learning curve inherent in the complexity of formal specifications, such as Signal Transition Graphs (STGs).

In this demo, we promote a class of Finite State Machines (FSMs) called Extended Burst-Mode (XBM) [2] automata as a practical way to specify many asynchronous circuits. The XBM specification has been automated on Workcraft (https://workcraft.org) with elaborate support for state encoding, conditionals and “don’t care” signals.

Formal verification and logic synthesis of the XBM automata is implemented via conversion to the established STG model, reusing existing methods and CAD tools.

BURST-MODE SPECIFICATION

Burst-Mode (BM) [1] is a trade-off between Single Input Change and Multiple Input Change fundamental modes, where signals change in groups called bursts. Each burst consists of a set of input and output signals where:

- Inputs can arrive in any order and time, but the set of inputs must never be empty during state changes.
- Inputs in a burst cannot be a subset of another burst generated by the same state.
- The encoding of all states must be unique.

XBM later extends BM by introducing conditionals and “don’t care” signals. Conditionals determine the system’s flow based on the signal’s sampled value, while “don’t care” signals allow inputs to change concurrently with outputs.

Another restriction is also enforced, where multiple input bursts generated by the same state must have unique conditionals or their inputs (including “don’t care” signals and terminating signals) must not be a subset of another burst.

WORKCRAFT IMPLEMENTATION

In this demo, features of the XBM plugin are showcased using several examples. These features include:

- Auto-generation of bursts via direction and encoding.
- Verification checks based on XBM properties.
- Simulation of XBM model.
- XBM to STG conversion.

The example used in Figure 1 and Figure 2 is IMEC’s allocation outbound design (imec-alloc-outbound). Figure 1 shows a simulation of the XBM model in Workcraft and Figure 2 shows the conversion of XBM model to STG model.

REFERENCES