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UPF 3.0 is Now Official

The Unified Power Format (UPF) 3.0, officially known as IEEE Standard 1801-2015, was approved by the IEEE in December 2015 and will be ready for distribution in early 2016. Like its predecessors, the standard will be available free of charge through a grant from Accellera, the Electronic Design Automation (EDA) and semiconductor industry's standards organization.

It's been almost nine years since UPF 1.0 was introduced in 2007. Since then, three major UPF revisions have been published. Unfortunately, EDA companies have been lagging with their UPF support. This lack of feature support affects how UPF is being written, preventing designers from using the latest features.

The new 3.0 standard offers additional enhancements to address and describe power intent of complex systems on chip (SoCs). Features include enhanced power state and transitions support, system-level power support, a new information model and programming interface, as well as bottom-up flow support. Eleven new UPF commands were introduced in this version.

Before further introducing UPF 3.0, let's first revisit how the industry got here.

A Brief History of UPF

In 2007, Accellera approved the 1.0 draft of UPF, and this standard was donated then to the IEEE that year. UPF is a Tcl extension and version 1.0 is comprised of 32 commands. UPF provides integrated circuit (IC) designers with a hardware design language (HDL) independent way of annotating a design with power intent. More specifically, low-power requirements and constraints can be specified early in the very large scale integration (VLSI) design process — such as the register transfer level (RTL) — allowing for electronic systems to be designed with power as a key consideration.

UPF is used to partition a design into power domains, where each power domain is powered by a supply network of supply ports, power switches, and supply nets. Various strategies can be applied to power domains to control logic values when power domains are being switched off and on. Isolation strategies are used to ensure undefined outputs from powered-down design elements do not drain power from those design elements that are not powered down. They also ensure a specific logic value is driven from the power domain's outputs. Retention strategies specify which objects in a domain need to be retained while powered down. Level shifter strategies translate signal values from an input voltage swing to a different output voltage swing.

UPF 2.0

IEEE Standard 1801-2009, also known as UPF 2.0, was published in 2009 with 57 new commands. This revision included general refinements of previously existing commands. Supply sets, the concept of successive refinement, the command find_objects, used to query HDL design data, and a substantial offering of query commands were introduced as well.

Adding the new commands to the remaining active UPF 1.0 commands, UPF 2.0 consists of 88 commands, — 49 Power Intent and 39 Query commands.

UPF 2.1 and 2.2

In 2013, IEEE Standard 1801-2013, or UPF 2.1, was published with 11 new UPF commands. This revision included further refinements of previously existing commands, the introduction of power models and a repeater strategy, along with a handful of power management cell definition commands.

Adding the new commands to the remaining active UPF 2.0 commands, UPF 2.1 consists of 86 commands, — 46 Power Intent, 6 Power Management and 34 Query commands.

Shortly thereafter, in 2014, an amendment to 2.1 was published. Officially known as IEEE Standard 1801a-2014, it is also referred to as UPF 2.2. No new commands were introduced, and none were deprecated or removed in this amendment. The amendment fixed technical and editorial errors identified in UPF 2.1. Changes and enhancements were made to remove ambiguities and inconsistencies related to the semantics of power states, power supplies, precedence rules and the location of power management cells.

What's New in UPF 3.0

And now we come to UPF 3.0, or IEEE Standard 1801-2015, finalized and approved in late 2015. With this standard, 11 new commands were introduced. Adding the new commands to the remaining active UPF 2.2 commands, UPF 3.0 consists of 62 commands — 51 Power Intent, 6 Power Management and 5 Query commands.

Additions include enhanced concepts for modeling power states and transitions, along with improved support for successive refinement and a bottom-up implementation methodology. It introduced a detailed information model that serves as the basis for enhanced package UPF functions and query functions. It now boasts support for component power modeling for system-level power analysis in virtual prototyping applications.

Industry support for UPF

While not all EDA tools have embraced the latest UPF versions, some have from the outset. Verific Design Automation, for example, has a UPF frontend supporting UPF 1.0 through 3.0. Besides parsing and analyzing the entire UPF language, a modern day UPF parser should be able to retain line/file information of where all UPF objects originate and are updated from. A flexible message handler is required for errors/warnings/info messages to be downgraded, upgraded or ignored. And once a UPF specification has been fully analyzed and resolved, a designer should be able to traverse over the resultant power intent data structure, and relate to any accompanying RTL or netlist representation.

To probe further

- A Brief IEEE 1801 UPF Overview and Update,
  John Biggs, ARM
  https://www.youtube.com/watch?v=UJA0liTwDCw

- Successive Refinement: A Methodology for Incremental Specification of Power Intent
  Gabriel Chidolue, Mentor Graphics
  http://www.testandverification.com/wp-content/uploads/banners/Mentor%20Graphics%20-%20Gabriel%20Chidolue.pdf

- 1801-2013 - IEEE Standard for Design and Verification of Low-Power Integrated Circuits
  http://standards.ieee.org/findstds/standard/1801-2013.html

- 1801-2015 - IEEE Approved Draft Standard for Design and Verification of Low Power, Energy Aware Electronic Systems
  Soon to be available at http://standards.ieee.org/findstds/standard/1801-2015.html

About Lawrence Neukom
Lawrence Neukom is a senior member of technical staff with Verific Design Automation. He has been a member of the IEEE 1801 working group since 2013.

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