A Overview of Si2 Interoperability Guide for Power Format Standards™

IEEE Std 1801™-2009 and Si2 CPF V1.1™

Qi Wang
Chair, Format Working Group, LPC

Interoperability – Standards – Collaborative Technology

Innovation Through Collaboration
Outline

• Background
• How is the document organized?
• Highlights of the document
• An example
• Future work
Background

• How was it started?
  – CPF 1.1 released in September 2008
  – IEEE 1801-2009 released in March 2009

• Interoperability discussions started in early 2009 to identify
  – An interoperable subset of commands and options between CPF 1.1 and IEEE 1801-2009
    • Direct mapping of commands or options
    • Compatible commands or options
  – Extensions to increase interoperability
  – Non-interoperable commands or options
Working Group Progress

- Subject of the weekly meeting of the Format Working Group since March, 2009
- Participating member companies
  - AMD, Cadence, Calypto, IBM, LSI, Sequence, SPiRIT Consortium
- Document was frozen in December 2009
- Document was reviewed by TSG and approved by TSG in January 2010
- Document was final published on February 4, 2010
  - Si2 Link: [http://www.si2.org/?page=1131](http://www.si2.org/?page=1131)
Document Organization

Categorized into different command groups:

- Power Domain
- Power Mode
- Retention Rules
- Isolation Rules
- Level Shifter Rules
- Power Switch Rules
- Miscellaneous

Command by command in each chapter:

- set_retention
- set_retention_control
- set_retention_elements
- map_retention_cell

Option by option comparison in each command:

- domain
- elements
- instance
Color Coding

- **Blue text**
  - Command or argument is not recommended
    - Because they are mainly UPF 1.0 legacy and can be replaced by more flexible commands or arguments in IEEE 1801

- **Orange text**
  - Command or argument is partially interoperable
    - Direct mapping to CPF command or argument is not possible. Most cases are many-to-one or one-to-many mappings

- **Red text**
  - Command or argument is non-interoperable
    - Multiple reasons: no corresponding constructs in CPF, unclear semantics, etc.

- **Black text**
  - Command or argument is interoperable
    - Direct mapping with a CPF command or argument is possible
Comparison Highlights

- Interoperability between CPF 1.1 and IEEE 1801-2009 has been improved when compared with CPF 1.0 vs UPF 1.0
  - IEEE 1801 introduced “supply sets” concept which is more aligned with CPF “power domain” concept.
  - IEEE 1801 allows supply set/power domain assignment to boundary ports which was a major limitation in UPF 1.0
  - IEEE 1801 allows isolation and level shifter rule specified based on supply set/power domain crossing which was not available before
### Comparison Summary

<table>
<thead>
<tr>
<th>Category</th>
<th>Inter-op cmds/args</th>
<th>Non Inter-op cmds/args</th>
<th>Partial Inter-op cmds/args</th>
<th>Non Recom. cmds/args</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Domain</td>
<td>25</td>
<td>5</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Power Mode</td>
<td>8</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Ret. Rules</td>
<td>21</td>
<td>5</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Isolation</td>
<td>16</td>
<td>4</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Shifter</td>
<td>15</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Switch</td>
<td>15</td>
<td>2</td>
<td>8</td>
<td>0</td>
</tr>
<tr>
<td>Misc.</td>
<td>26</td>
<td>17</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>146 / 65%</strong></td>
<td><strong>38 / 17%</strong></td>
<td><strong>25 / 11%</strong></td>
<td><strong>16 / 7%</strong></td>
</tr>
</tbody>
</table>
### An Example

<table>
<thead>
<tr>
<th><strong>IEEE 1801-2009</strong></th>
<th><strong>CPF 1.1</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><code>set_retention</code></td>
<td><code>create_state_retention_rule</code></td>
</tr>
<tr>
<td>retention_name</td>
<td>-name <code>string</code></td>
</tr>
<tr>
<td>-domain <code>domain_name</code></td>
<td>-domain <code>power_domain</code></td>
</tr>
<tr>
<td>[-elements <code>element_list</code>]</td>
<td>-instances <code>instance_list</code></td>
</tr>
<tr>
<td>[-exclude_elements <code>exclude_list</code>]</td>
<td>-exclude <code>instance_list</code></td>
</tr>
<tr>
<td>[-retention_supply_set <code>ret_supply_set</code>]</td>
<td>[-secondary_domain <code>domain</code>]</td>
</tr>
<tr>
<td>-save_signal `{logic_net &lt;high</td>
<td>low</td>
</tr>
<tr>
<td>-save_level <code>expr</code></td>
<td>-restore_edge <code>expr</code></td>
</tr>
<tr>
<td>-restore_signal `{logic_net &lt;high</td>
<td>low</td>
</tr>
<tr>
<td>[-save_condition <code>{boolean_function}</code>]</td>
<td>[-save_precondition <code>expr</code>]</td>
</tr>
<tr>
<td>[-restore_condition <code>{boolean_function}</code>]</td>
<td>-restore_precondition <code>expr</code></td>
</tr>
<tr>
<td>[-retention_condition <code>{boolean_function}</code>]</td>
<td></td>
</tr>
<tr>
<td>[-retention_power/ground_net <code>net</code>]</td>
<td></td>
</tr>
<tr>
<td>[-parameters]</td>
<td></td>
</tr>
</tbody>
</table>
Interoperable Power Format Guidelines

• EDA tools must follow the standards strictly
  – No tool or vendor specific commands
  – No tool or vendor specific syntax

• Companies should adhere to the identified interoperable subset to achieve practical mixed-tool low power design flow in the near term

• Both standard organizations should consider to extend current formats to promote better interoperability in the future
What’s Next

• Work with IEEE 1801 WG to improve IEEE 1801 for better interoperability
  – Clarify semantics
  – Extend 1801 to support features in CPF that is not available in 1801-2009

• Work within Si2 Format WG
  – Extension to improve interoperability in CPF 2.0
  – Extension the interoperability guide by including mapping from CPF 1.1 commands/arguments to IEEE 1801 commands/arguments
IEEE 1801 Semantics Clarification

- Send clarification questions to IEEE 1801 on isolation rules
  - i.e. PD1 and PD2 are switchable but with different shutoff conditions and PD3 is always-on in all power modes. Need to specify isolation between switchable domains and always-on domain.
  - Both CPF and IEEE 1801 can specify crossings from PD1 to PD3 and from PD2 to PD3. However, is the above crossing considered as PD1 to PD3 or PD2 to PD3?
CPF Features Not Supported by IEEE 1801

- **Disjoint Power Domains**
  - To support a power domain implemented by disjoint physical regions
- **Equivalent Control Pins**
  - To support time-sequenced control signals for power gating, state retention and isolation control
- **Implementation Constraints Setup**
  - For DVFS and MMMC optimization and analysis
- **Macro models**
- ...

Innovation Through Collaboration
CPF 2.0 Roadmap

• Extensions for better interoperability with 1801
  – Additional state retention assertion condition
  – More flexible power mode specification
  – Extend level shifter rule specification based on voltage differences between driver and receiver
  – Be able to disable/enable power aware simulation semantics

• Planned Release: end of Q3’2010
Working Group Products

Interoperability Guide
http://www.si2.org/?page=1131

CPF 1.1 document
http://www.si2.org/?page=811

CPF Tutorial
http://www.si2.org/?page=907

Si2 LPC (downloads)
http://www.si2.org/?page=726

LPC Glossary
http://www.si2.org/?page=1044
Q & A

Forum

https://www.si2.org/openeda.si2.org/forum/?group_id=51

Email

nenglish@si2.org