Automation of Waiver and Design Collateral Generation on Scalable IPs

Gopalakrishnan Sridhar,
Midhun Krishna,
Vadlamuri Venkata Sateesh

Agenda Overview

- Problem Statement
- Perl Template Toolkit
- Template Based Scalability
- Intel Proprietary Integration Tool
- Flow Diagram
- Results and Conclusion

Problem Statement

- An IP developer has to cater to multiple System on Chip (SOC) customers.
- Every new SOC who wishes to use the IP have different feature requests.
- Given a new set of parameters for each SOC configuration the designer has to run the tools and develop waivers from scratch
- Due to multiple SoC requests, we need to make IP's scalable.
- Develop features useful to SoC and parameterize them

Perl Template Toolkit (PTT)

- PTT is a powerful presentation language which supports all standard templating directives, e.g. variable substitution, includes, conditionals, loops.
- It has full support for complex data types including hashes, lists, objects and subroutine references.
- It has a basic syntax and is simple to use.

Template based Waiver Changes

- PTT requires a list of input variables to be passed to its templates in order to generate output files.
- When converting tool waiver files to templates, a particular waiver may be based on a top level parameter or a local parameter.
- The local parameter is internal to the design and may be derived from multiple top level parameters.
- For example, the local parameters shown on the side is derived from multiple top level parameter with a mux logic.

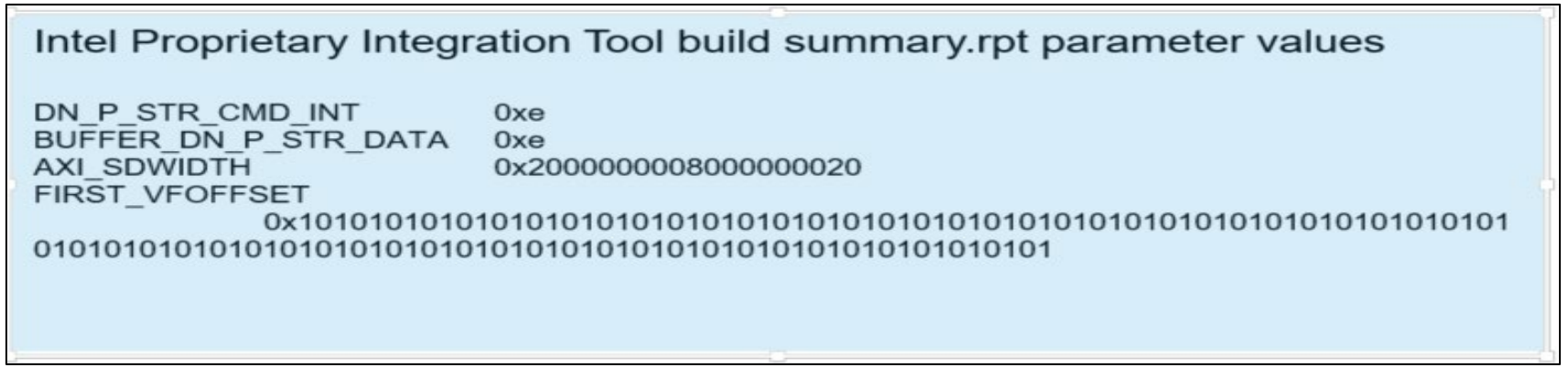
```
localparam          DN_P_STR_DATA_DEPTH   =
                        (TD_WIDTH==31) ? ((IPPPRIM_AXI_CLOCK_CROSSING_MODE==1) ?
                    (8'h1C + IPP_P_TGT_ISM_PIPE_EN[7:0]): (8'h20 +
IPP_P_TGT_ISM_PIPE_EN[7:0])) :
                        (TD_WIDTH==63) ? ((IPPPRIM_AXI_CLOCK_CROSSING_MODE==1) ?
                        (8'h14 + IPP_P_TGT_ISM_PIPE_EN[7:0]) : (8'h10 +
IPP_P_TGT_ISM_PIPE_EN[7:0])) :
                        (TD_WIDTH==127) ? ((IPPPRIM_AXI_CLOCK_CROSSING_MODE==1) ?
                        (8'h10 + IPP_P_TGT_ISM_PIPE_EN[7:0]) : (8'h8 +
IPP_P_TGT_ISM_PIPE_EN[7:0])) :
                        (TD_WIDTH==255) ? ((IPPPRIM_AXI_CLOCK_CROSSING_MODE==1) ?
                        (8'hE + IPP_P_TGT_ISM_PIPE_EN[7:0]) : (8'h6 +
IPP_P_TGT_ISM_PIPE_EN[7:0])) :
                        (TD_WIDTH==511) ? ((IPPPRIM_AXI_CLOCK_CROSSING_MODE==1) ?
```

Intel Proprietary Integration Tool

- Intel Proprietary Integration Tool (IPIT) to calculate the local parameters of the top file and print them in its report was used.
- Intel Proprietary Integration tool is a tool used for the integration of different Ips
- It helps integrate protocol signals and makes integration easier.
- IPIT prints the values of parameters and local parameters of the top module in IPIT build summery. Any parameter/local parameter which maybe mathematical expression or arrays is calculated by IPIT

IPIT Advantages

- IPIT prints the values of parameters and local parameters of the top module in Collage build summery.
- Any parameter/local parameter which maybe mathematical expression or arrays can be calculated by collage.
- The calculated values are printed in this report either in Hex or Dec. For Example:



Intel Proprietary Integration Tool

Sub Routines used	Description fo Sub Routine	
	Sub Routine	Description
1	DEC_TO_HEX(n)	Convert a Dec number into Hex number.
2	f_log2(n)	Number of bits required for a Dec number
3	num_to_array(n,c)	Chop a number “n”, each with “c” number of characters and join by “,”.
4	DEC_TO_BIN(n)	Convert a Dec number into Hex number and then to Bin number.
5	HEX_STRING_TO_DEC_NUM(num_to_array(DEC_TO_HEX(n),c)).split(',')	Convert a decimal number “n” into an array, the number of characters in each element is decided by “c”.
6	size_arr(n)	To get the size of an array.

Flow of param/localparam usage in waivers

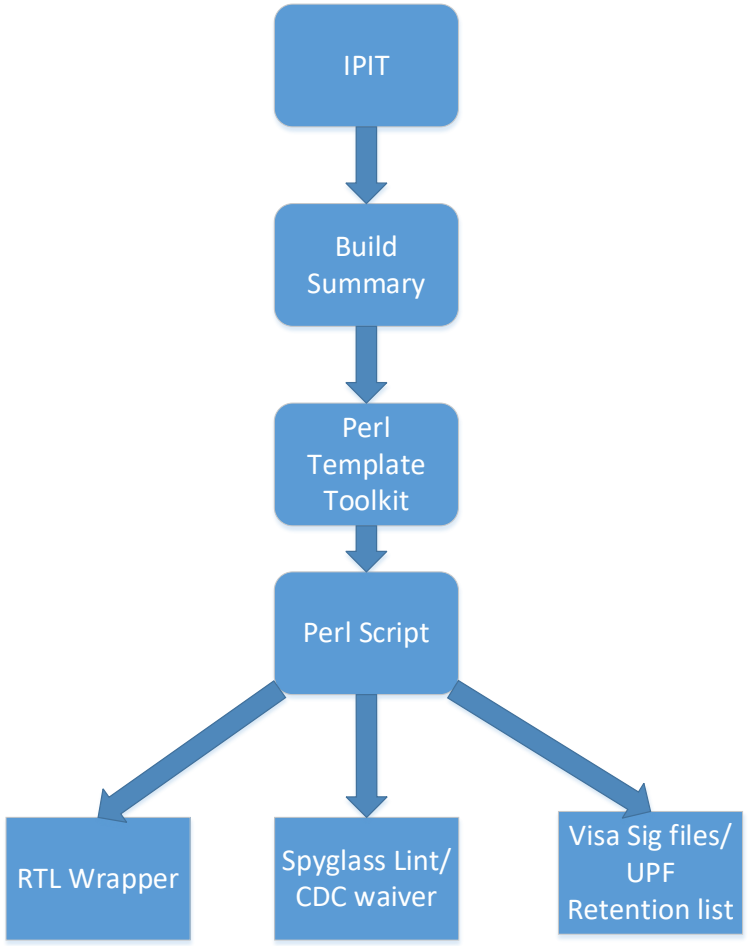
```
parameter  [NUM_AXIS_PORTS-1:0][31:0] AXI_SDWIDTH          = {32'd512,32'd128,32'd32}

Collage build summary output
AXI_SDWIDTH              0x2000000008000000020

Hexadecimal values converted using Perl script to Decimal value
AXI_SDWIDTH=9444732966289046241312

Output after PTT subroutines
[% AXI_SDWIDTH_arr                =
HEX_STRING_TO_DEC_NUM(num_to_array(DEC_TO_HEX(AXI_SDWIDTH),-8)).split(',') %]

AXI_SDWIDTH_arr.0   → 32
AXI_SDWIDTH_arr.1   → 128
AXI_SDWIDTH_arr.2   → 512

[% FOREACH i IN [0 .. size_arr(AXI_SWID_WIDTH_arr) ] %]
AXI_SDWIDTH_arr.$i
[% END %]
```

Waiver template file example

```
[% AXI_SDWIDTH_arr              = HEX_STRING_TO_DEC_NUM(num_to_array(DEC_TO_HEX(AXI_SDWIDTH),-8)).split(',') %]
[% UPSTREAM_SUPPORT_arr   = num_to_array(DEC_TO_BIN(UPSTREAM_SUPPORT),-1).split(',') %]

[% FOREACH i IN [0 .. TNUMCHAN] %]

    [% IF (US_AREQ_SPLIT_DISABLE == 1) && ( NARROW_BURST_ENABLE == 0) && ( (TD_WIDTH + 1) == AXI_SDWIDTH_arr.$i )%]

        [% H = NUM_AXIS_PORTS - 1 %]

        [% FOREACH k IN [0 .. H] %]
            [% IF UPSTREAM_SUPPORT_arr.$k == 1 %]
              waive -du {  {iosf2axibr_axi_slave_cpl}  }  -msg {Detected
              unloaded\(unconnected\)input port iosf_axi_top\. np_trk_addr\[.*\]}
              -rule {  {UnloadedInPort-ML}  }  -regexp -comment {CAM_ENABLE}

               waive -du {  {iosf2axibr_axi_slave_cpl}  }  -msg {Detected
               unloaded\(unconnected\)input port iosf_axi_top\.np_trk_arsize\[.*\]}
               -rule {  {UnloadedInPort-ML}  }  -regexp -comment{CAM_ENABLE}
                                        ……..
```

Flow

- Intel Proprietary Integration tool is run first which generates the build summary containing the values of parameters and local parameters.
- Perl Template Toolkit takes the parameter values from build file and generates the required output file.
- Perl script uses this template file to generate the required outputs needed.



RTL Top File Integration

- A significant amount of the IP integration time at the SOC goes to make sure all the input and output ports of the design are connected correctly.
- Since the IP is generic it has many ports that may not be relevant to the current SOC configuration.
- The integrator has to review these and make sure he doesn't need to worry about them.
- By creating the top file as a template RTL ports can be exposed selectively based on the top level parameter.
- The other inputs can be tied off locally.

Result

Effort Comparison	Tools used and effort taken			
	Tools	Previous Approach	Template based collateral implementation	Review
1.	Lint	Few Days	10 minutes	1 Day
2.	CDC	Few Days	10 minutes	1 Day
3.	Debug Signal File	Few Days	10 minutes	1 Day
4.	UPF retention list	Few Days	10 minutes	1 Day

Key Takeaways

- No need to recalculate manually or through Perl scripts(which are parsed HDL parameter converted to PERL variables)
- Easy to generate waivers for the modules which are instantiated through the loops.
- This Approach and all sub routines can be easily reused across different IPs.
- The time required for spyglass lint scalability for new designs can be reduced to half using this approach.

References

- David Cross *et.al*, "Perl Template Toolkit," *O'Reilly Media, Inc.,* Dec 2003.

Questions?