# Optimizing Performance Using the DPO Flow - Application Note

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# Optimizing Performance Using the DPO Flow

Starting with ZeBu S-2021.09, a new flow, **Data Path Optimization (DPO)**, is introduced which analyzes all critical timing paths in a design and optimizes a subset from those critical paths.

Unlike with the Resilient Localize Clock (RLC) flow, the focus of the DPO flow is to achieve best performance and not necessarily full localization. In addition, the DPO flow applies max and overflow constraints to all paths.

For more information, see the following topics:

- Overview of the DPO Flow
- Configuring DPO
- DPO Reporting

**Note:**
This document does not cover ZeBu Server 3 hardware.

## Overview of the DPO Flow

At a high-level, Data Path Optimization (DPO) is a timing-based replication algorithm between partitions that is applied to reduce the length of the critical path. It uses a multithreaded strategy focused on performance.

The flow works using an iterative approach where each iteration consists of the following steps:

1. Performing timing analysis (based on the fixed-delay timing-model).
2. Identifying critical subset of paths to be optimized.
3. Setting timing and performance budgets for timing data paths.
4. Optimizing the paths for timing.
5. Reporting IO cut and resource usage.

## Configuring DPO

The DPO flow can be configured using any of the following options with the `clock_localization` command:

- `clock_localization -core_max_io_cut <io_cut_value>`: Specifies the maximum IO cut (an integer value) that a partition can have at the core level. By default, it is set to 5000. If after partitioning, the IO cut is higher than the maximum IO cut, then maximum IO cut is ignored.
- `clock_localization -core_overflow_io_cut <io_cut_value>`: Specifies the overflow IO cut that can be used on top of the maximum IO cut value to improve performance. By default, overflow IO cut is 5000.

  It can be manually adjusted. However, in the DPO flow, a very high overflow IO cut value leads to FPGA compilation issues. This is because DPO is focused on optimizing every critical timing path as long as it has the IO cut value that it can consume.
- `clock_localization -core_max_reg_overflow <overflow_value>`: Enables you to specify the maximum register overflow value, `overflow_value`, that the localize clock can add at the core level. By default, it is 10%.
- `clock_localization -core_max_lut_overflow <overflow_value>`: Enables you to specify the maximum lut overflow value, `overflow_value`, that the localize clock can add at the core level. By default, it is 10%.

You can also configure the DPO flow for certain clock-path specific commands in Fetch Mode (FM) using the following options:

- `clock_localization -stop_at_async_set_reset=<boolean_value>`: In FM, this command enables you to exclude asynchronous set/reset logic from localization, where the `boolean_value` is set to `yes` or `no`. By default, it is `no`.
- `clock_localization -stop_at_latch_input=<boolean_value>`: In FM, this command enables you to exclude latch input logic from localization, where the `boolean_value` is set to `yes` or `no`. By default, it is `yes`.

## DPO Reporting

Results of the optimization for each iteration are logged in the `Data Path Optimization` section of the `zTopBuild.log` file report.

These results consist of configuration details, fan-out analysis, and the design status. The design status describes IO Cut and resource usage tables, details about the longest clock path, and a save of the `beforeDpo.html` file. See the following examples of the `zTopBuild.log` report for 1 Unit and 2 Unit ZeBu Server 4 hardware.

Feedback

*Figure 1 Example - zTopBuild.log File for Optimizing 1 Unit on ZeBu Server 4 Hardware*

**Start of the Flow**

```
#   step Data Path Optimization : Starting
#   step Data Path Optimization : ------------------------------------
#   step Data Path Optimization : Clock_localization command will be used for setting the options
#   step Data Path Optimization : MaxIoCut = 40000
#   step Data Path Optimization : IoCutOverflow = 30000
#   step Data Path Optimization : LutOverflow = 10%
#   step Data Path Optimization : RegOverflow = 10%
#   step Data Path Optimization : Full timing: disabled
#   step Data Path Optimization : ------------------------------------
```

**IO Cut and Resource Usage**

```
#   info : ------------------------------------------------
#   info :                  Design status
#   info : ------------------------------------------------
# +--------+-----+-------+------+------+------+
# |        |   IF| Part_0|Part_1|Part_2|Part_3|
# +--------+-----+-------+------+------+------+
# |     IF |   - |     1 |    0 |    1 |    0 |
# | Part_0 | 263 |     - | 1490 | 2829 | 1392 |
# | Part_1 |   0 |  1784 |    - |   12 |    8 |
# | Part_2 | 234 |  2656 |   19 |    - |    0 |
# | Part_3 |   0 |  1524 |   51 |    3 |    - |
# +--------+-----+-------+------+------+------+
# |  TOTAL | 499 | 11939 | 3364 | 5754 | 2978 |
# +--------+-----+-------+------+------+------+
# +--------+----------+----------+-----+
# |        |      REG |      LUT | DSP |
# +--------+----------+----------+-----+
# |     IF |        0 |        0 |   0 |
# | Part_0 | 11206359 | 12903411 |  74 |
# | Part_1 |  6751770 | 14507684 | 113 |
# | Part_2 |  4670948 |  6861819 |  58 |
# | Part_3 |  6279368 | 12562395 | 113 |
# +--------+----------+----------+-----+
```

**Longest Path Details**

```
#   step TIMING ANALYSYS : Longest path to optimize     : 655000ps
#   step TIMING ANALYSYS : Longest path to not optimize : 0ps
#   step TIMING ANALYSYS : Longest loop : 0ps
#   info :  ------------------------------------
#   info :    ArrivalTime  : 655000
#   info :    RequiredTime : 655000
#   info :    Slack        : 0
#   info :    NumCycles    : 1
#   info :  ------------------------------------
#   info :    ArrivalTime |       Delay | Details
#   info :             0ps |         0ps | zebuAutoTB.dut.ram_wb0.ram_wb_b3_0.unnamed_sys_fm_1824.Q (ZEBU_BB_CYCLE_DELAY) [Part_5]
#   info :             0ps |         0ps | zebuAutoTB.dut.ram_wb0.ram_wb_b3_0.inv227.I0 (INV) [Part_5]
#   info :             0ps |         0ps | zebuAutoTB.dut.ram_wb0.ram_wb_b3_0.inv227.O (INV) [Part_5]
#   info :       100000ps |    100000ps | zebuAutoTB.dut.ram_wb0.ram_wb_b3_0.mem.r1addr[0] (ZEBU_BB_ZRM) [Part_1] (static)
```

Feedback

*Figure 2 zTopBuild.log File for Optimizing 2 Units on ZeBu Server 4 Hardware*

**Start of an Iteration (Longest Delay + Histogram)**

```
#   info : ------ Iteration 0
#   info : focusing on paths up to 655000 ps
#   step Stats : +-----------------------------------+-----------------------------------------------------+-------------+
#   step Stats : | Slack                             | Num Timing Paths                                    | MCP == 1    |
#   step Stats : +-----------------------------------+-----------------------------------------------------+-------------+
#   step Stats : | [          0 ps:      218333 ps] |>                                        393 |         393 |
#   step Stats : | ]     218333 ps:      436666 ps] |                                             |             |
#   step Stats : | ]     436666 ps:      655000 ps] |-------------------->                  13509 |       13509 |
#   step Stats : +-----------------------------------+-----------------------------------------------------+-------------+
```

**Displaying Target Delay of Iteration Prior to the Degradation Phase**

(Target based on requirement to optimize 10% of paths)

```
#   step Visit graph : Starting
#   step Visit graph : Done in    elapsed:0.07 s   user:0.09 s
+0 m     um:2213 m       um:+0 m
#   info : compute slacks with required time 555000 ps
```

**Iteration IO Cut and Resource Result**

```
# +--------+-----+--------+--------+
# |        |   IF|  Part_1|  Part_5|
# +--------+-----+--------+--------+
# |     IF |   - |      0 |      0 |
# |        |   - |    (0) |    (0) |
# | Part_1 |   0 |      - |    164 |
# |        | (0) |      - | (+132) |
# | Part_5 |   0 |    441 |      - |
# |        | (0) | (+382) |      - |
# +--------+-----+--------+--------+
# |  TOTAL |   0 |    605 |    605 |
# |        | (0) | (+514) | (+514) |
# +--------+-----+--------+--------+
# +--------+-------+----------+-------+----------+-----+----------+
# |        |   REG | DIFF REG |   LUT | DIFF LUT | DSP | DIFF DSP |
# +--------+-------+----------+-------+----------+-----+----------+
# |     IF |     0 |        0 |     0 |        0 |   0 |        0 |
# | Part_1 |     2 |       +2 |   285 |     +285 |   0 |        0 |
# | Part_5 | 29913 |        0 | 38389 |     -285 |   4 |        0 |
# +--------+-------+----------+-------+----------+-----+----------+
#   info : #connections: 20154
#   info : Solution accepted
```

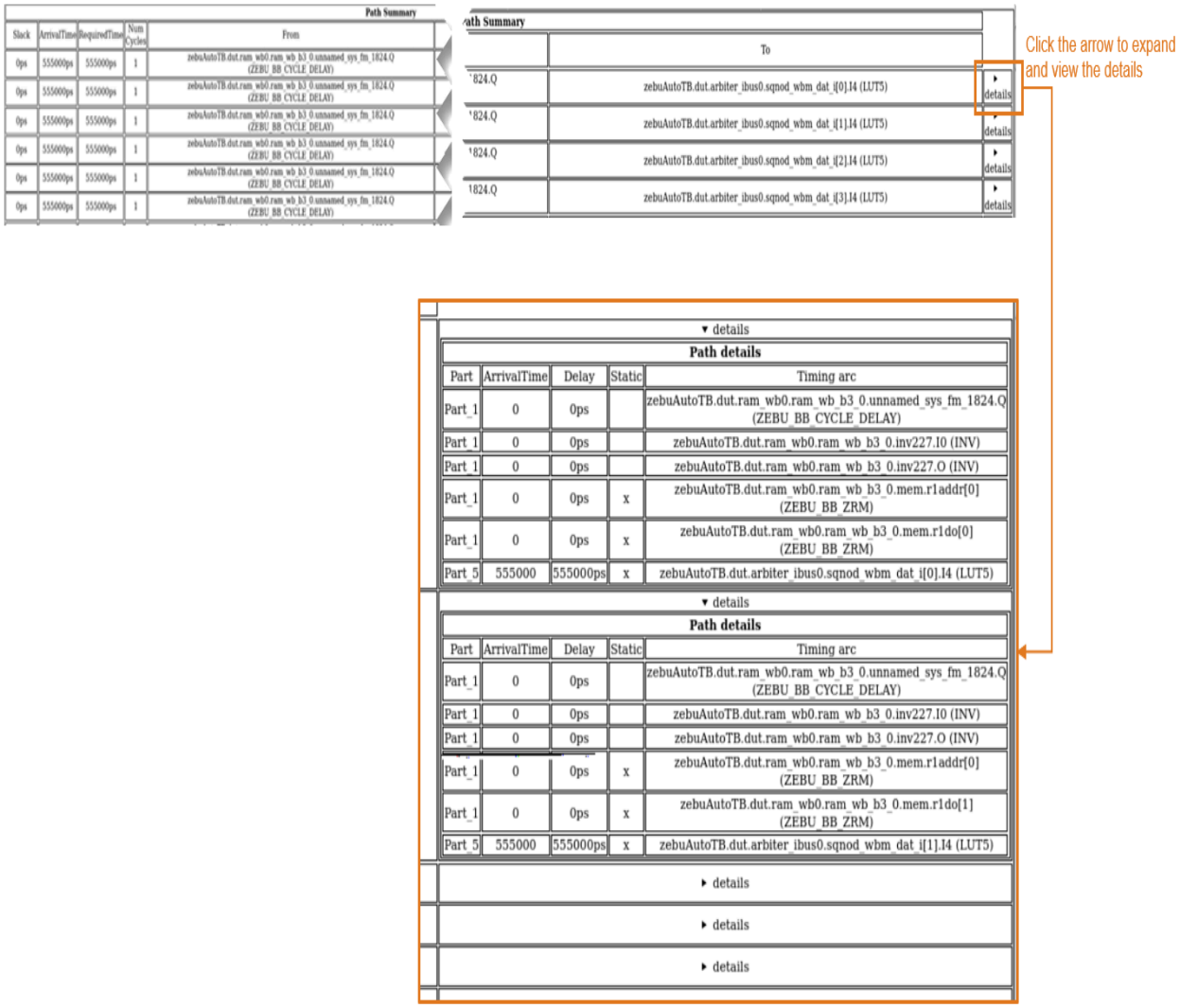
In addition, the `beforeDpo.html` and `afterDpo.html` files report the results before and after optimizing timing paths. These files are saved in the `backend_default` directory. In these reports, you can view the path summary with expandable details for each path. This is shown in Figure 3.

**Note:**

Starting with V-2024.03-1, the path optimization HTML reports have been renamed as `dpo_MODULE_before.html` and `dpo_MODULE_after.html`, respectively.

Feedback

*Figure 3 View Before and After Path Optimization Details*



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