Vivado Design Suite Tutorial

Design Analysis and Closure Techniques

UG938 (v2020.2) February 4, 2021

XILINX®

Revision History

The following table shows the revision history for this document.

Section	Revision Summary
02/04/2021 Version 2020.2	
General Updates	Updated figures in Lab 2 and 3.

Table of Contents

Tutorial Overview

Introduction

This tutorial uses the Vivado® design rules checker (`report_drc`), clock domain crossing checker (`report_cdc`), and quality of results enhancer (`report_qor_suggestions`) to analyze example designs for issues, and shows you how to take corrective actions.

Tutorial Description

Lab 1 walks you through creating waivers for CDC, methodology, and DRC violations.

Lab 2 is a guide to using the `report_qor_suggestions` (RQS) command.

Note: The designs used in this tutorial are intended to exhibit issues for demonstration purposes, and should not be used as a reference for designs outside this tutorial.

Software Requirements

This tutorial requires that the 2020.1 Vivado® Design Suite software release or later is installed.

For a complete list of system and software requirements, see the *Vivado Design Suite User Guide: Release Notes, Installation, and Licensing* (UG973).

Locating Tutorial Design Files

1. Download the reference design files from the Xilinx® website.
2. Extract the ZIP file contents into any write-accessible location.

   This tutorial refers to the location of the extracted ZIP file contents as `<Extract_Dir>`.

Lab 1

Setting Waivers with the Vivado IDE

Introduction

In the Vivado® Design Suite, you can use the waiver mechanism to waive clock domain crossing (CDC), design rule check (DRC), or methodology check violations. After a violation is waived, it is no longer reported by the `report_cdc`, `report_drc`, or `report_methodology` commands. Waived checks are also filtered out from the mandatory DRCs run at the start of the implementation commands, such as `opt_design`, `place_design`, and `route_design`. For more information, see this link in the *Vivado Design Suite User Guide: Design Analysis and Closure Techniques* (UG906).

IMPORTANT! *The content of the waiver is built with the objects that exist when the waiver is created. However, if an instance referenced inside a waiver is replicated by Vivado®, the replicated instance is automatically added to the waiver and saved in subsequent checkpoints and XDC.*

This lab shows how to set waivers with the Vivado integrated design environment (IDE) using both menu commands and the Tcl Console. The lab focuses on CDC waivers, but the methods for waiving DRC and methodology violations are similar.

Step 1: Starting the Vivado IDE

This lab uses a Vivado design checkpoint (`.dcp` file), which is a snapshot of a design. When you launch the Vivado IDE using a design checkpoint, a subset of the Vivado IDE functionality is available.

TIP: *To launch the Vivado Tcl Shell on Windows, select **Start → All Programs → Xilinx Design Tools → Vivado <version> → Vivado <version> Tcl Shell**.*

1. From the command line or the Vivado Tcl Shell, change to the directory where the lab materials are stored:

```
cd <Extract_Dir>/src/Lab1
```

2. To start the Vivado IDE with the design checkpoint loaded, enter the following:

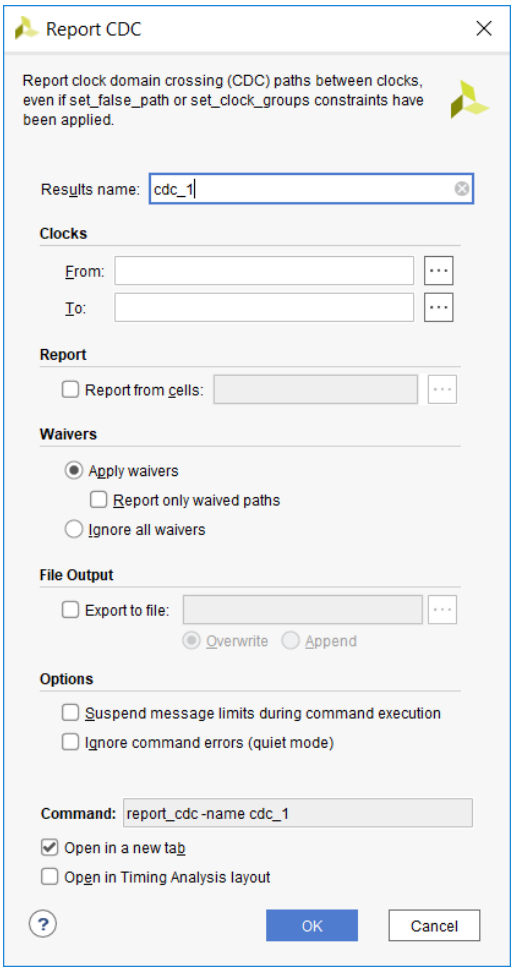
```
vivado my_ip_example_design_placed.dcp
```

TIP: *You can disregard the critical warnings about the unbounded GT locations.*

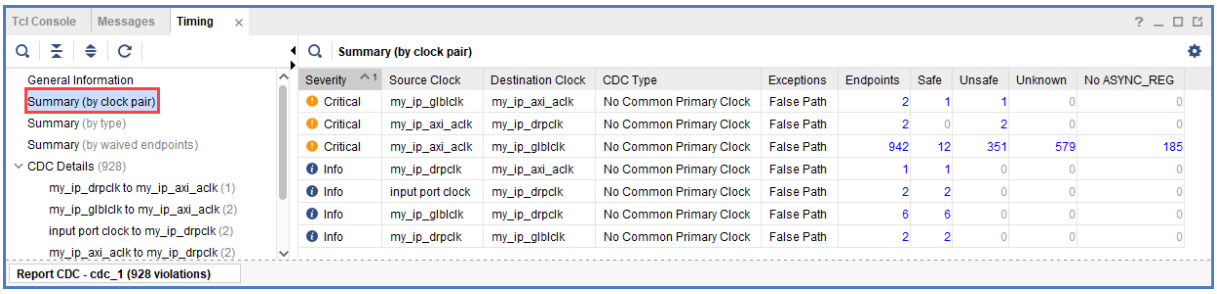
Step 2: Generating the CDC Report

In this step, you generate the CDC report to view the associated CDC violations.

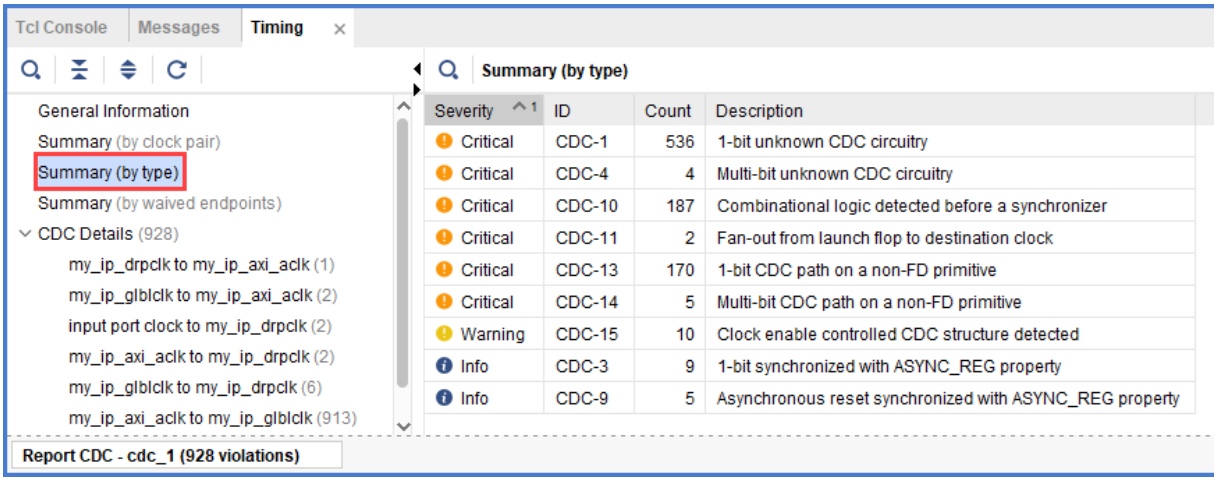
1. Select **Reports → Timing → Report CDC**.
2. In the Report CDC dialog box, leave the default settings as-is, and click **OK**.



The Summary (by clock pair) section of the CDC Report appears as follows.

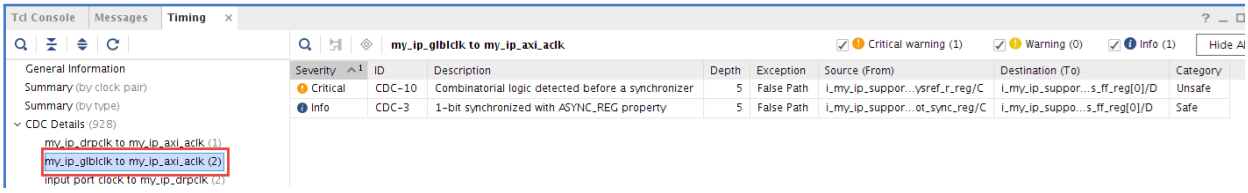


The Summary (by CDC type) section appears as follows.



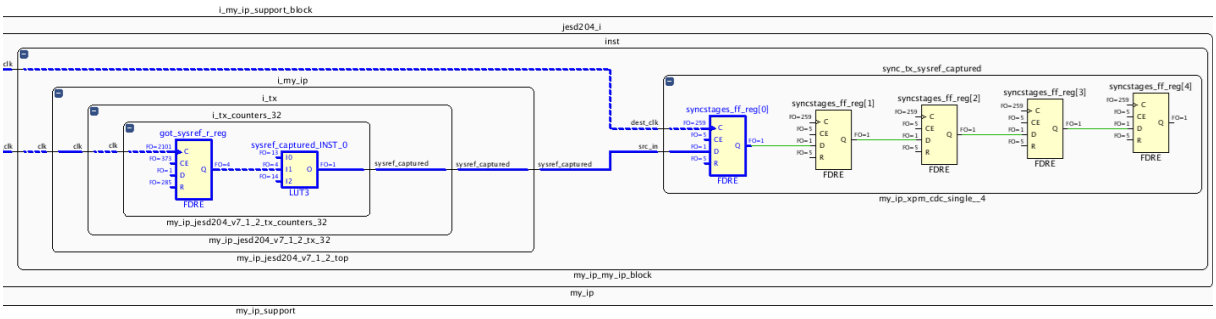
Step 3: Waiving a Single CDC Violation

The `my_ip_glblclk` to `my_ip_axi_aclk` clock pair includes one Critical CDC-10 violation due to combinational logic on the CDC path. This step covers how to waive the CDC-10 violation.

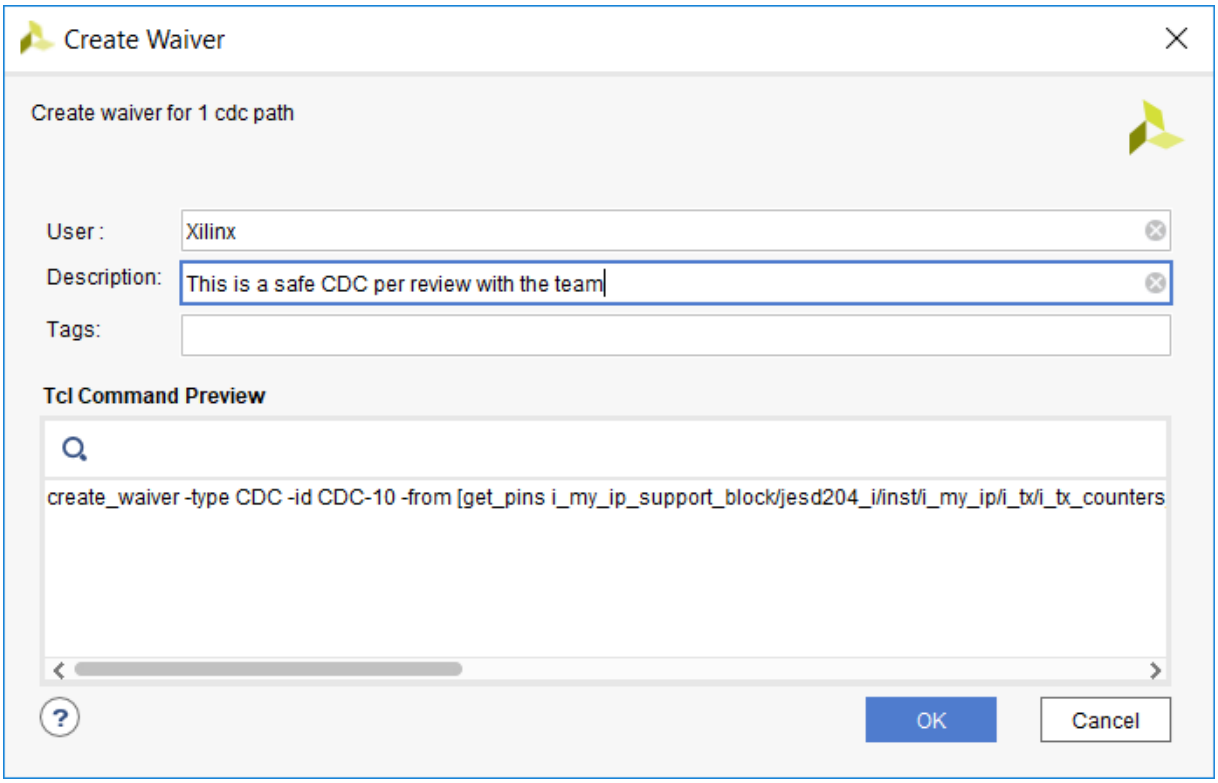


1. To view a schematic of the violation, select the CDC-10 row in the CDC Report, and click the Schematic toolbar button .

   Note: Alternatively, you can press **F4** to generate the schematic. However, using the toolbar button provides a more detailed schematic that includes all the levels of the downstream synchronizer.



2. To waive the violation, select the **CDC-10** row in the CDC Report, right-click, and select **Create Waiver**.
3. In the Create Waiver dialog box, enter a description, and click **OK**.

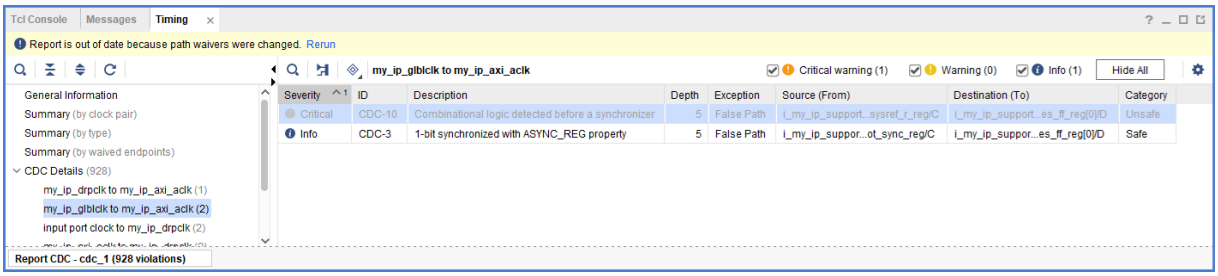


IMPORTANT! *A waiver tracks the date the waiver was added, the user that added the waiver, and a description of why the violation was waived. The date is automatically added by the system. The Tags field is an optional description or list of keywords that can be used for documentation purposes.*

4. After the waiver is created, check the CDC Report.

   To indicate that a waiver was created, the CDC-10 row is gray and disabled.

   Note: Rows are only disabled in the Report CDC result window from which the waivers were created.

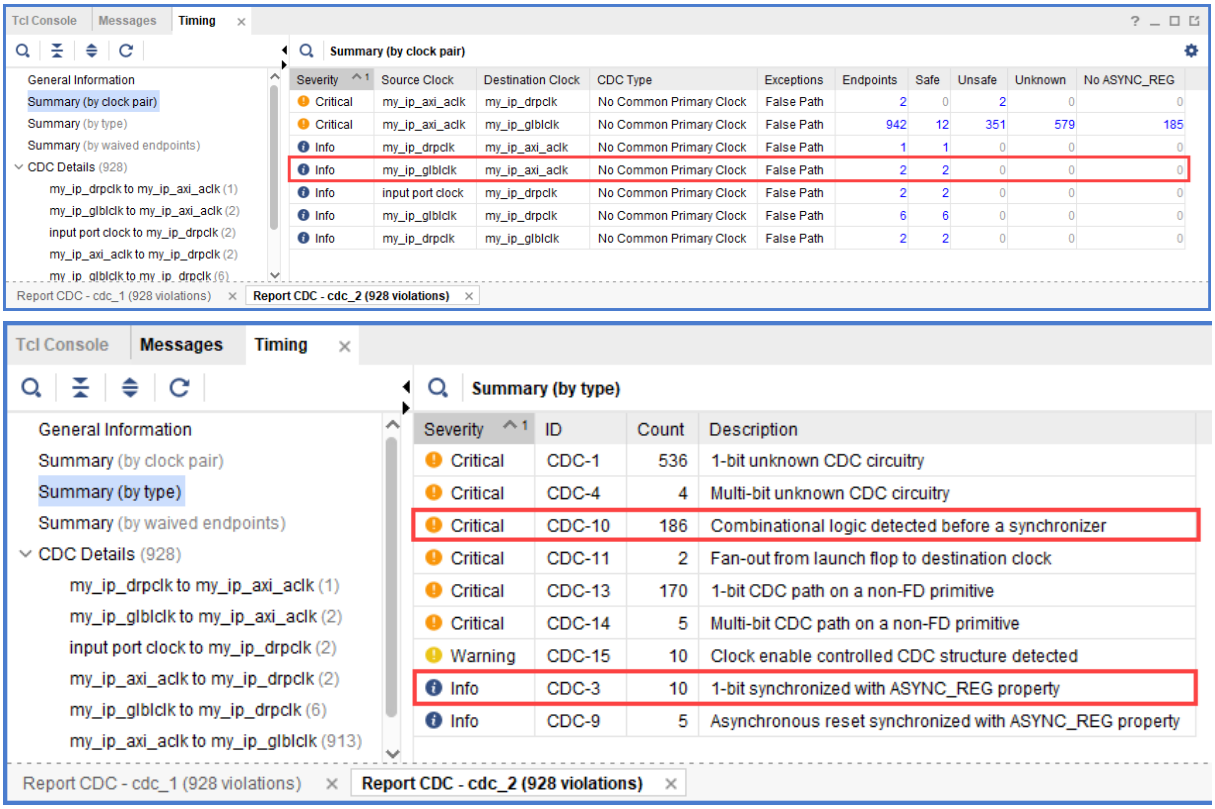


5. To see the impact of the CDC-10 waiver, select **Reports → Timing → Report CDC** to rerun Report CDC.

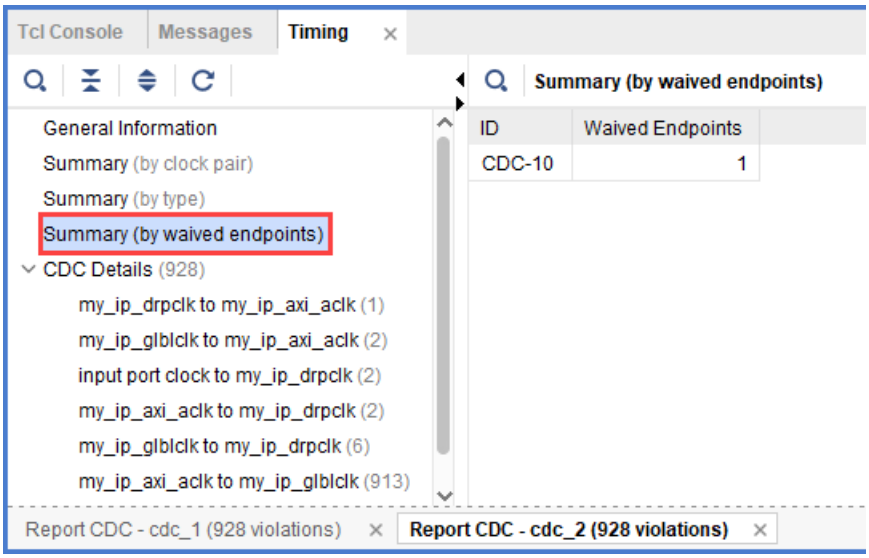
   ***Note*:** When a waiver is created or deleted, you must rerun Report CDC, Report DRC, or Report Methodology to see the updated results.

6. See the CDC Report to view the updated information.

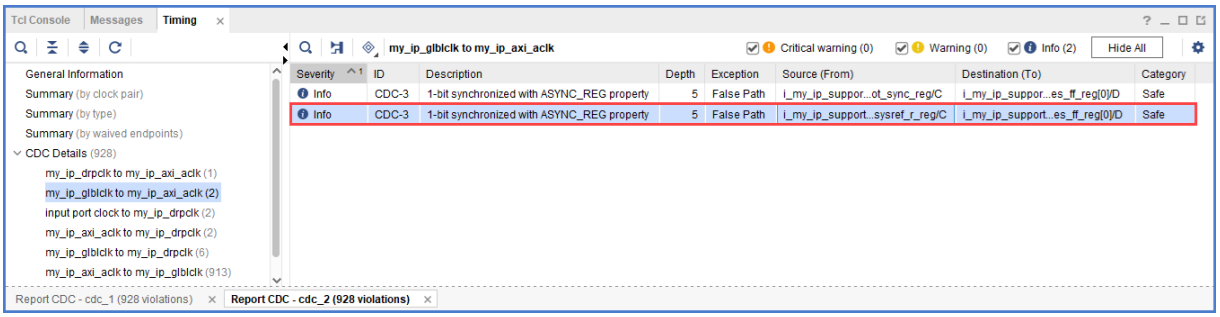
   The differences from the previous Summary by clock pair and Summary by type sections are highlighted in red in the following figures.



You can also view a summary with the list of waived endpoints.

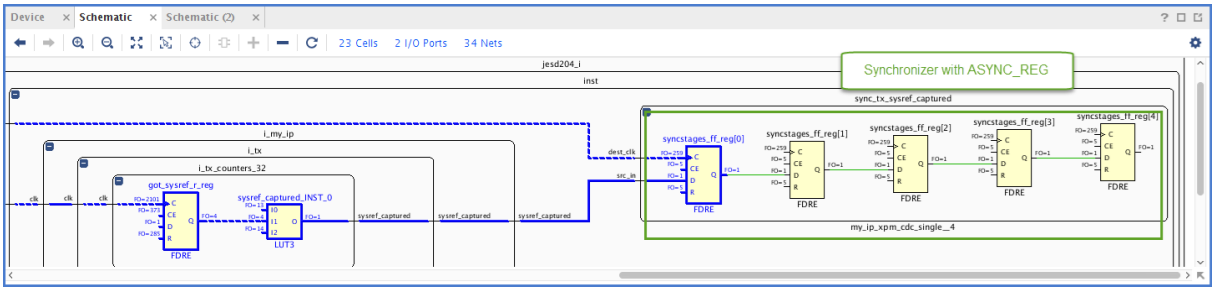


The detailed section for the `my_ip_glblclk` to `my_ip_axi_aclk` CDC shows that the Critical CDC-10 was replaced with an Info CDC-3.



7. Select the new CDC-3 row, and click the Schematic toolbar button . Double-click the **Q** pin of the output register to expand the schematic to match what is shown in the following figure.

   The CDC path includes a 5-level synchronizer on the output of the selected destination register. This is the reason the CDC-10 was replaced with CDC-3 for this topology, as shown in the following figure.



IMPORTANT! *By default, Report CDC only reports a single violation per endpoint and per clock pair. When multiple violations apply to the same endpoint, only the violation with the highest precedence is reported. Because CDC-10 has a higher precedence than CDC-3, only CDC-10 is reported when both CDC-10 and CDC-3 apply to the same endpoint. For more information on CDC rules precedence, see this link in the Vivado Design Suite User Guide: Design Analysis and Closure Techniques (UG906).*

TIP: *To report all of the CDC violations for each endpoint regardless of the precedence rules, use the command line option* `-all_checks_per_endpoint`. *However, unsafe rules are not reported on a register if at least one safe rule on the same register is detected.*

Step 4: Generating a Report for Waived Violations

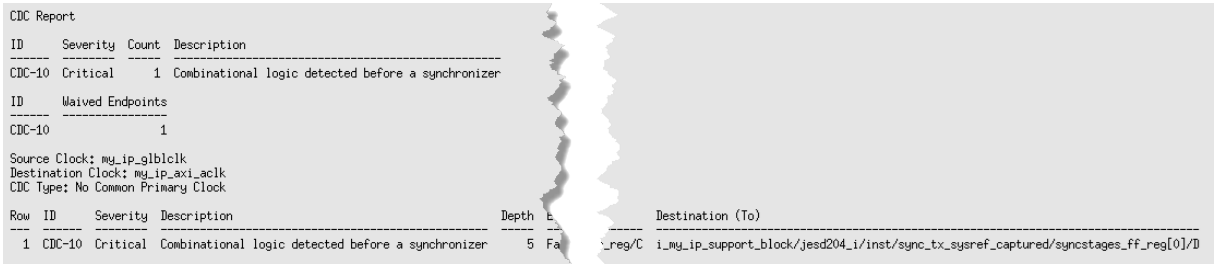
You can generate a report for the CDC, DRC, or methodology check violations that were waived. This step shows how to generate a report for waived CDC violations using the Tcl Console as well as the Vivado IDE menu commands.

Generating a Text Report for Waived Violations

1. In the Tcl Console, enter:

```
report_cdc -waived
```

2. In the CDC report, verify that a single CDC-10 violation is listed, because only one waiver was created.

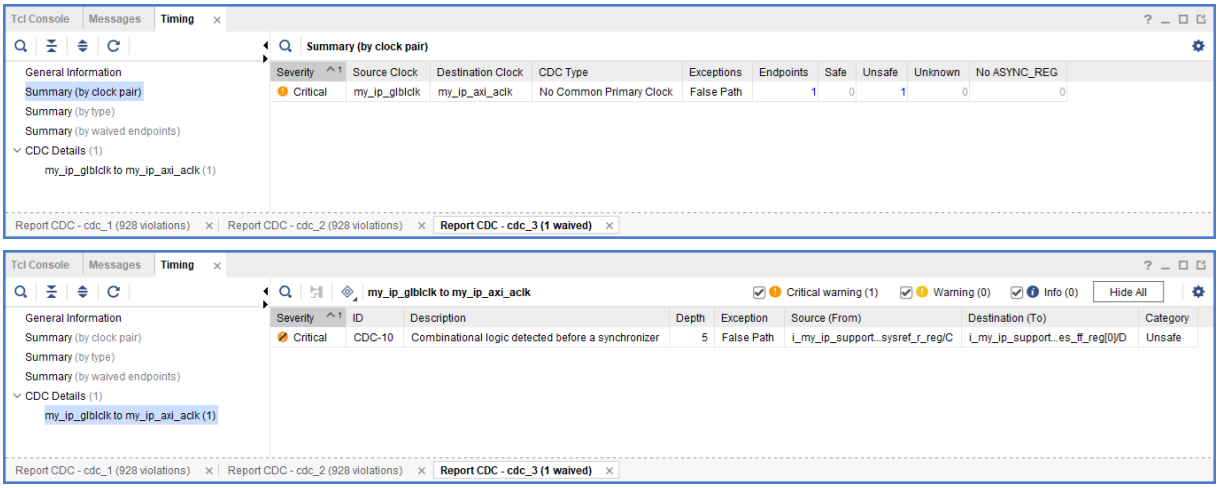


```
CDC Report

ID     Severity  Count  Description
-----  --------  -----  -----------------------------------------------------
CDC-10 Critical      1  Combinational logic detected before a synchronizer

ID     Waived Endpoints
-----  ----------------
CDC-10                1

Source Clock: my_ip_glblclk
Destination Clock: my_ip_axi_aclk
CDC Type: No Common Primary Clock

Row  ID     Severity  Description                                          Depth  E...  ...  Destination (To)
---  -----  --------  ---------------------------------------------------  -----  ---  ---  ------------------------------------------------------------------------------------------
  1  CDC-10 Critical  Combinational logic detected before a synchronizer      5  Fa...  ...reg/C  i_my_ip_support_block/jesd204_i/inst/sync_tx_sysref_captured/syncstages_ff_reg[0]/D
```

Generating a Vivado IDE CDC Report for Waived Violations

1. Select **Reports → Timing → Report CDC**.
2. In the Report CDC dialog box, enable **Report only waived paths**, and click **OK**.
3. In the CDC Report, check the Summary (by clock pair) and CDC Details to verify that a single CDC-10 violation is listed.

Note: The icon next to the violation shows that the violation was waived .



Step 5: Generating a Text Report with Details for Waived Violations

In this step, you generate text reports with additional details, including a list of all of the rules and all of the violations regardless of the waivers.

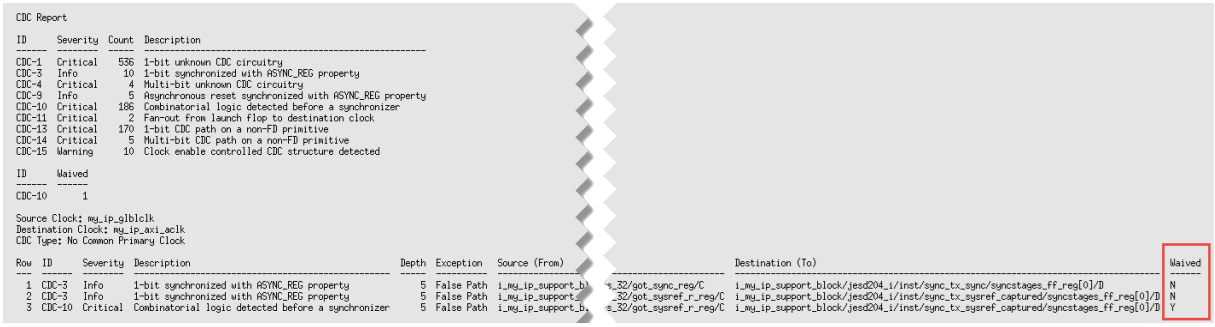
Generating a List of Rules with Waived Violations

1. In the Tcl Console, enter:

```
report_cdc -details -show_waiver
```

2. Verify that the `my_ip_glblclk` to `my_ip_axi_aclk` CDC-10 violation is waived and the two CDC-3 violations are not waived.

   Note: In the text report, all of the rules are reported, whether they were waived or not. The Waived column indicates the status of the rule.



Generating a List of All Violations Regardless of the Waivers

1. In the Tcl Console, enter:

```
report_cdc -no_waiver
```

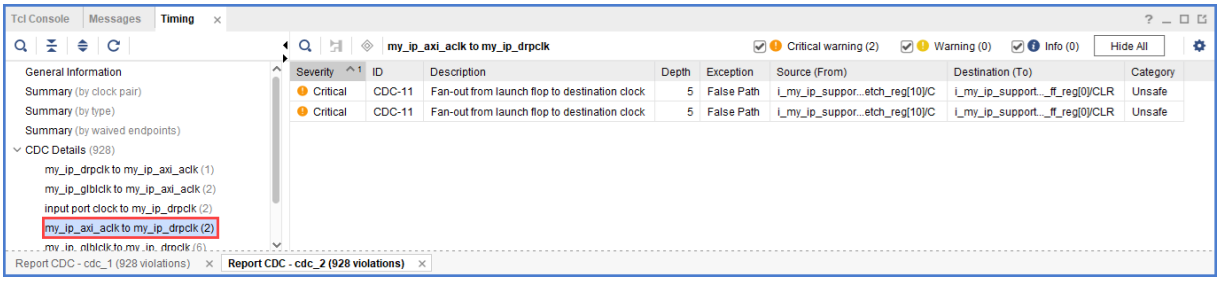
2. In the text report, verify that the table matches the original report from Report CDC before the CDC-10 waiver was created.

```
CDC Report

Severity  Source Clock      Destination Clock  CDC Type                 Exceptions  Endpoints  Safe  Unsafe  Unknown  No ASYNC_REG
--------  ----------------  -----------------  -----------------------  ----------  ---------  ----  ------  -------  ------------
Critical  my_ip_glblclk     my_ip_axi_aclk     No Common Primary Clock  False Path          2     1       1        0              0
Critical  my_ip_axi_aclk    my_ip_drpclk       No Common Primary Clock  False Path          2     0       2        0              0
Critical  my_ip_axi_aclk    my_ip_glblclk      No Common Primary Clock  False Path        942    12     351      579            185
Info      my_ip_drpclk      my_ip_axi_aclk     No Common Primary Clock  False Path          1     1       0        0              0
Info      input port clock  my_ip_drpclk       No Common Primary Clock  False Path          2     2       0        0              0
Info      my_ip_glblclk     my_ip_drpclk       No Common Primary Clock  False Path          6     6       0        0              0
Info      my_ip_drpclk      my_ip_glblclk      No Common Primary Clock  False Path          2     2       0        0              0
```

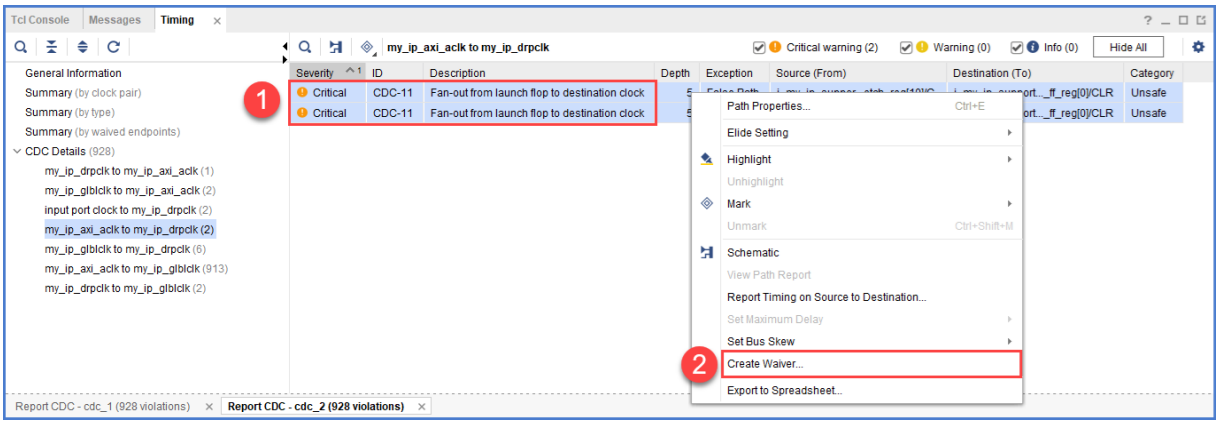
TIP: *You can also generate a list of all violations regardless of the waivers from the Vivado IDE. Select* ***Reports → Timing → Report CDC****. In the Report CDC dialog box, enable* ***Ignore all waivers****, and click* ***OK****.*

Step 6: Waiving Multiple CDC Violations

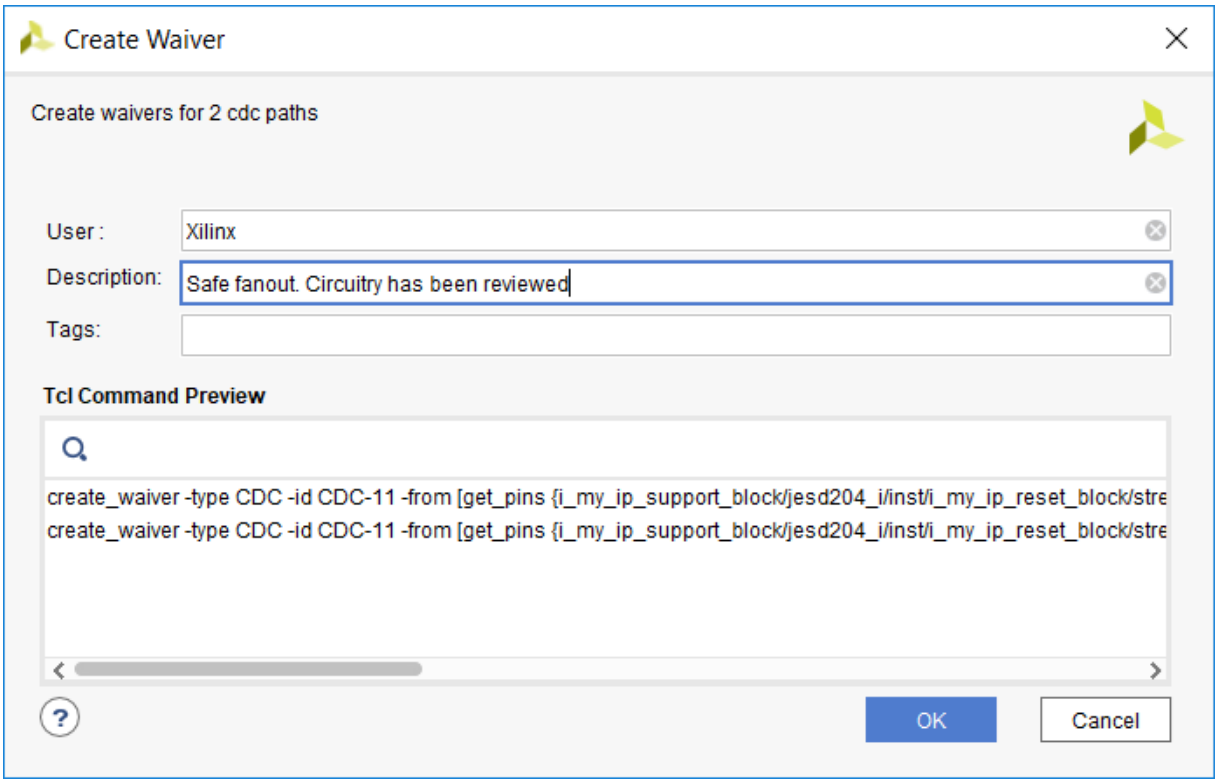
The `my_ip_axi_aclk` to `my_ip_drpclk` CDC includes two Critical CDC-11 violations. This step covers how to waive both CDC-11 violations simultaneously.



1. To waive the violations, select the **CDC-11** rows in the CDC Report, right-click, and select **Create Waiver**.



2. In the Create Waiver dialog box, enter a description, and click **OK**.



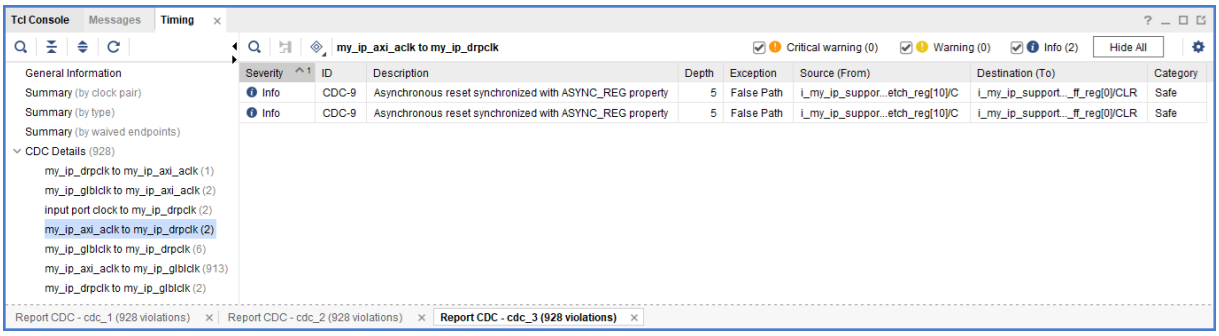
In the Timing Report, the two selected rows are disabled when the waivers are created.

***Note*:** One waiver is created for each selected row. In this example, two waivers are created.

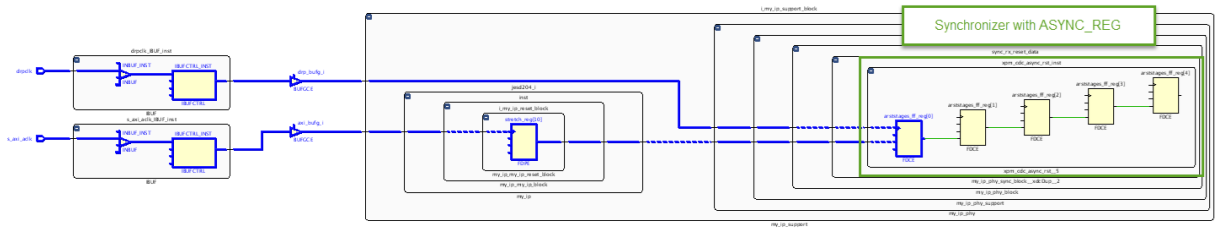
Severity	ID	Description	Depth	Exception	Source (From)	Destination (To)	Category
Critical	CDC-11	Fan-out from launch flop to destination clock	5	False Path	i_my_ip_suppo...tch_reg[10]/C	i_my_ip_suppor...ff_reg[0]/CLR	Unsafe
Critical	CDC-11	Fan-out from launch flop to destination clock	5	False Path	i_my_ip_suppo...tch_reg[10]/C	i_my_ip_suppor...ff_reg[0]/CLR	Unsafe

3. Select **Reports → Timing → Report CDC** to rerun Report CDC. In the Report CDC dialog box, make sure that *Report only waived paths* is unchecked, and click **OK**.
4. In the CDC Report, look at the `my_ip_axi_aclk` to `my_ip_drpclk` CDC.

The two Critical CDC-11 violations were replaced with two Info CDC-9 violations. Based on the CDC precedence rules, waiving CDC-11 unmasks CDC-9 for this circuit.

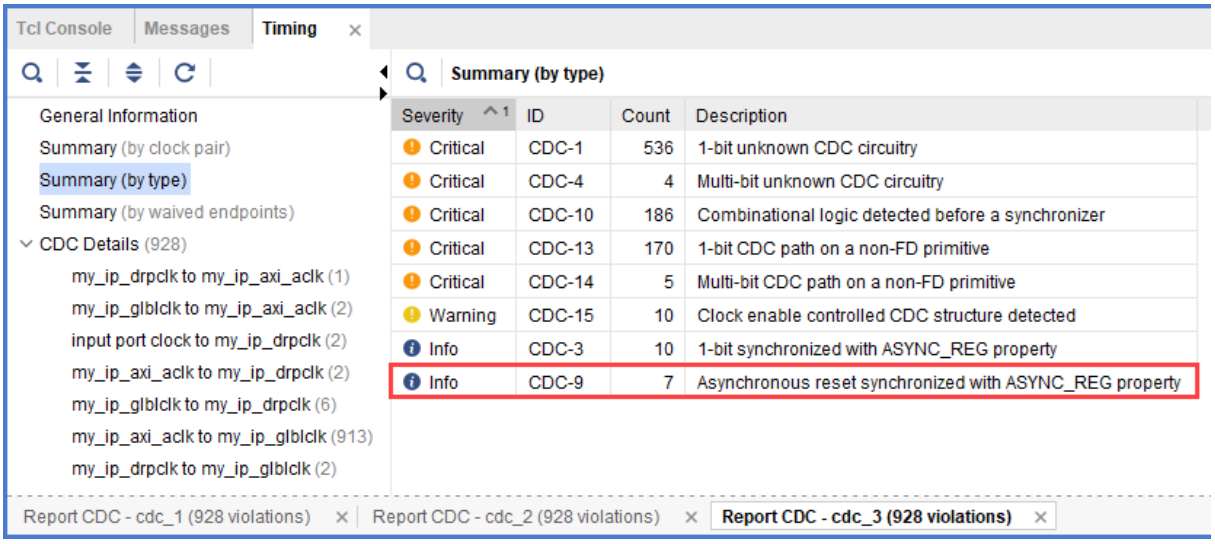


5. To view a schematic of the violation, select the CDC-9 row in the CDC Report, and click the Schematic toolbar button .
6. Verify that there is a 5-level synchronizer on the destination clock domain.



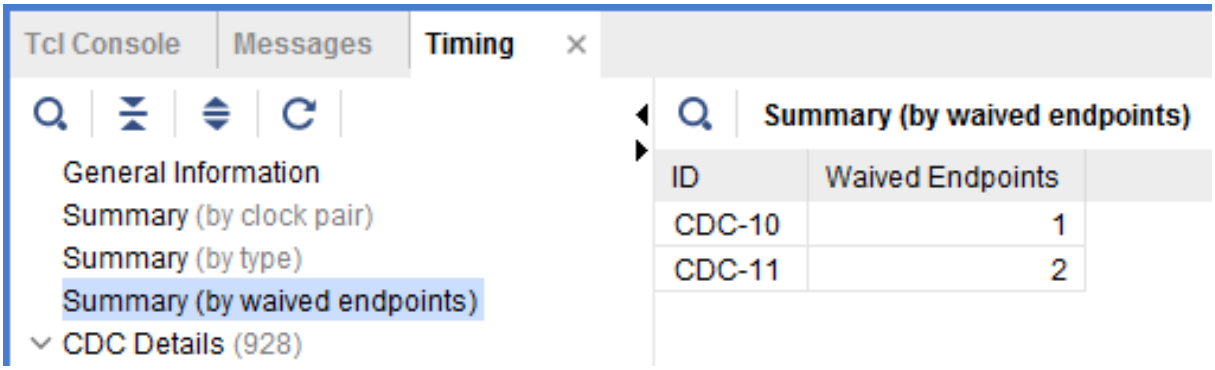
7. Compare the new Summary (by type) information with the information from the previous CDC Report.

   In the updated CDC Report, the two CDC-11 violations are no longer listed. Instead, there are two new CDC-9 violations.



8. Look at the Summary (by waived endpoints) information.

In the updated CDC Report, there are three waived endpoints. This number is different from the number of waived violations (2), because CDC-11 is a multi-bit violation.

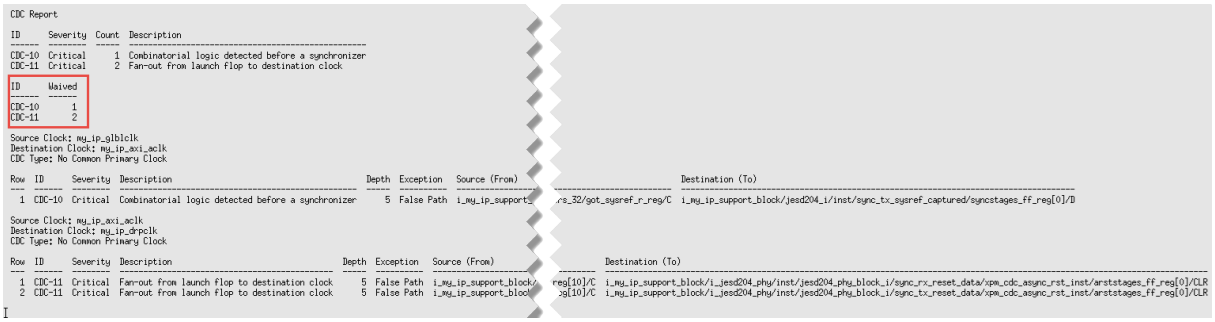


9. Generate different text reports and compare the results with previous reports.

   For example, you can run the following Tcl commands:

```
report_cdc -details
report_cdc -details -waived
report_cdc -details -show_waiver
report_cdc -details -no_waiver
```

   The following report was generated using the report_cdc -details -waived Tcl command and shows that three violations were waived.



Step 7: Exporting Waivers

In this step, you export waivers with the `write_waivers` Tcl command.

Note: The XDC output file can be imported using the `read_xdc` or `source` Tcl commands.

1. To export the CDC waivers, enter: `write_waivers -type cdc waivers.xdc`.

   TIP: *Alternatively, because there are no DRC or methodology waivers, you can enter:*

   `write_waivers waivers.xdc` or `write_xdc -type waiver waivers.xdc`.

2. Open the `waivers.xdc` file to view the three waivers.

Note: The following example is reformatted to better show the different command line options.

```
create_waiver -type CDC -id {CDC-10} -user "Xilinx" \
  -desc "This is a safe CDC per review with the team" \
  -from [get_pins i_my_ip_support_block/jesd204_i/inst/i_my_ip/i_tx/
i_tx_counters_32/got_sysref_r_reg/C] \
  -to [get_pins {i_my_ip_support_block/jesd204_i/inst/
sync_tx_sysref_captured/syncstages_ff_reg[0]/D}] \
  -timestamp "<timestamp>" ;#1

create_waiver -type CDC -id {CDC-11} -user "Xilinx" \
  -desc "Safe fanout. Circuitry has been released" \
  -from [get_pins {i_my_ip_support_block/jesd204_i/inst/
i_my_ip_reset_block/stretch_reg[10]/C}] \
  -to [get_pins {i_my_ip_support_block/i_jesd204_phy/inst/
jesd204_phy_block_i/sync_rx_reset_data/xpm_cdc_async_rst_inst/
arststages_ff_reg[0]/CLR}] \
  -timestamp "<timestamp>" ;#1

create_waiver -type CDC -id {CDC-11} -user "Xilinx" \
  -desc "Safe fanout. Circuitry has been released" \
  -from [get_pins {i_my_ip_support_block/jesd204_i/inst/
i_my_ip_reset_block/stretch_reg[10]/C}] \
  -to [get_pins {i_my_ip_support_block/i_jesd204_phy/inst/
jesd204_phy_block_i/sync_tx_reset_data/xpm_cdc_async_rst_inst/
arststages_ff_reg[0]/CLR}] \
  -timestamp "<timestamp>" ;#2
```

Step 8: Using the create_waiver Command

Waivers added from the Report CDC dialog box are created using the `create_waiver` command. You can view these commands as follows.

Note: You can use the `create_waiver` command line command for CDC, DRC, and methodology waivers. The options differ slightly depending on whether you are creating a CDC, DRC, or methodology waiver. For more information, including information on the different options, see the create_waiver command in the *Vivado Design Suite Tcl Command Reference Guide* (UG835).

1. Open the Vivado journal file (`vivado.jou`) to see the three distinct `create_waiver` commands issued by the Vivado IDE.
2. Scroll through the history of the Tcl Console to see the same three `create_waiver` commands.

TIP: *The `-from` and `-to` options are used to specify the startpoints and endpoints. When a waiver is set from the Report CDC dialog box, both `-from` and `-to` are specified to match the exact violation. However, you can specify a CDC waiver using only the `-from` option or only the `-to` option, but more paths might be waived than expected.*

Step 9: Waiving Multiple CDC Violations

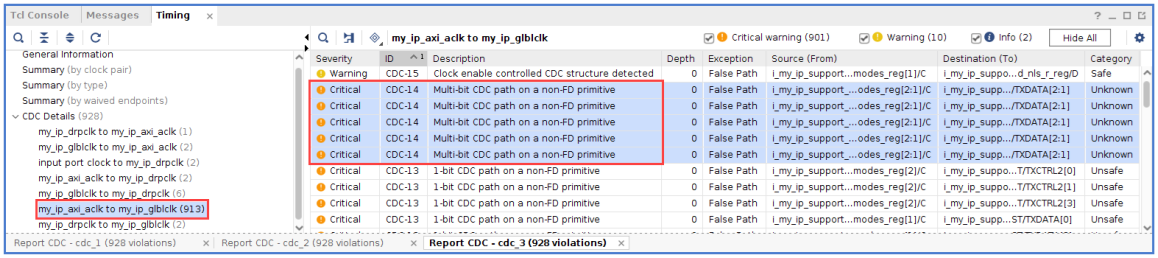
In this step, you waive multiple CDC violations simultaneously.

1. In the CDC Report, view the `my_ip_axi_aclk` to `my_ip_glblclk` CDC under CDC Details.

   This crossing has five CDC-14 violations, which are multi-bit violations. The five CDC-14 violations all start from the same two register clock pins:

   ```
   i_my_ip_support_block/jesd204_i/inst/tx_cfg_test_modes_reg[2:1]/C
   ```

   TIP: *You can sort the table by the column ID to more easily see the five CDC-14 violations.*



2. Because `i_my_ip_support_block/jesd204_i/inst/tx_cfg_test_modes_reg[*]/C` matches five pins and you only need to target two of those five pins, construct the list of startpoints as follows:

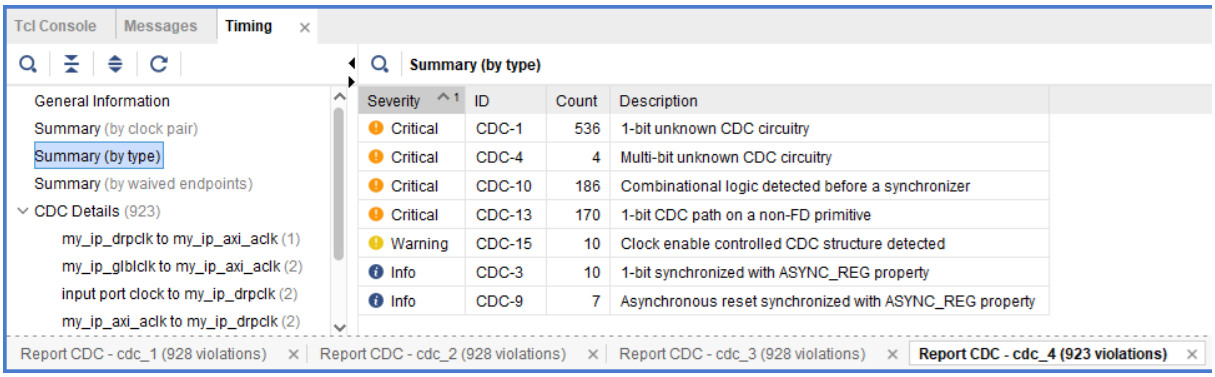
   ```
   set startpoints [list \
     [get_pins i_my_ip_support_block/jesd204_i/inst/
   tx_cfg_test_modes_reg[1]/C] \
     [get_pins i_my_ip_support_block/jesd204_i/inst/
   tx_cfg_test_modes_reg[2]/C] \
     ]
   ```

3. To waive the five CDC-14 violations, use the `create_waiver` Tcl command with the `-from` option:

   ```
   create_waiver -type {CDC} -id {CDC-14} -user {Xilinx} -desc {No more CDC
   14!} -from $startpoints
   ```

4. From the Vivado IDE, select **Reports → Timing → Report CDC** to rerun Report CDC.

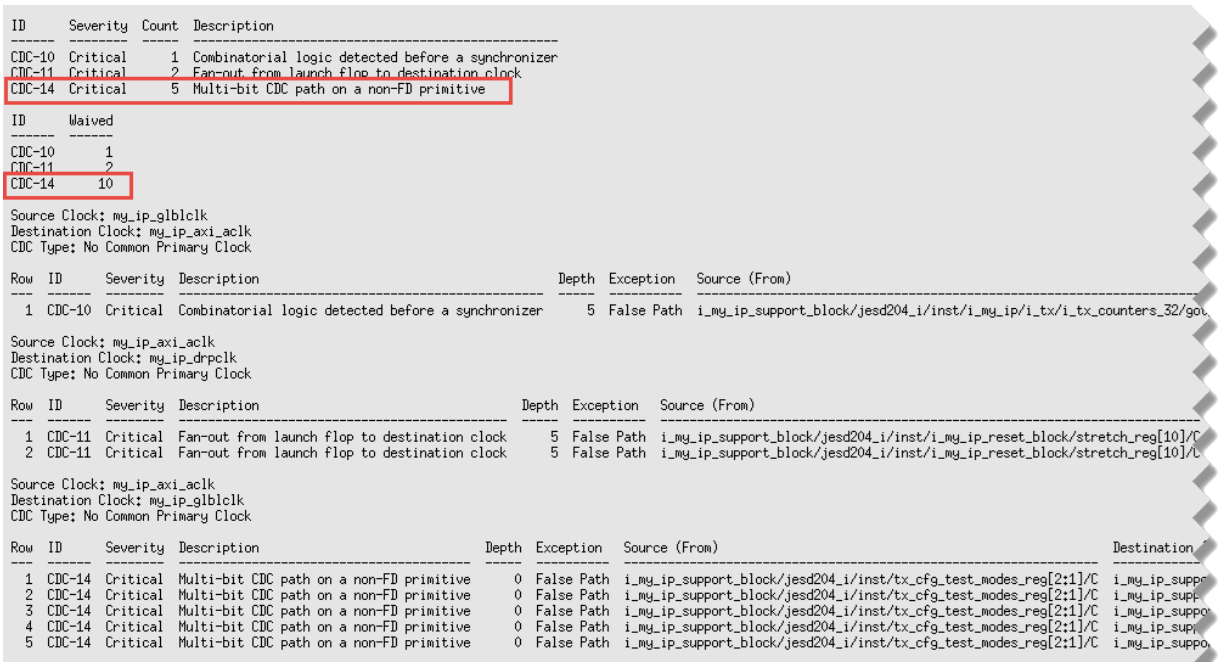
5. In the CDC Report, verify that the CDC-14 violations are no longer reported in the Summary section.



6. To report only the waived violations, enter:

```
report_cdc -details -waived
```

The following figure shows the waived CDC violations in two different tables. The first table shows the 5 CDC-14 violations waived as multi-bit violations. The second table shows the 10 single-bit violations, calculated by multiplying the 5 multi-bit violations by 2 bits per multi-bit violation.



7. To export all the waivers inside a script and verify that a total of four waivers were added, enter:

```
write_waivers -type cdc waivers.xdc -force
```

Note: Because the `waivers.xdc` file already exists, the `-force` option must be specified to override the file.

TIP: *Alternatively, because there are no DRC or methodology waivers, you can enter:*

```
write_waivers waivers.xdc -force
```

or

```
write_xdc -type waiver waivers.xdc -force
```

The list of waivers inside `waivers.xdc` appears as follows.

```
#
# WRITE CDC Waivers
# cmd: write_waivers -type cdc -file waivers.xdc -force
current_instance -quiet
create_waiver -type CDC -id {CDC-10} -user "Xilinx" -desc "This is a safe CDC per review with the team" -from [get_pins i_my_ip_support_block/jesd204_i/inst/i_my_ip/i_tx/i_tx_counters_32/got_
create_waiver -type CDC -id {CDC-11} -user "Xilinx" -desc "Safe fanout. Circuitry has been released" -from [get_pins {i_my_ip_support_block/jesd204_i/inst/i_my_ip_reset_block/stretch_reg[10]/C
create_waiver -type CDC -id {CDC-11} -user "Xilinx" -desc "Safe fanout. Circuitry has been released" -from [get_pins {i_my_ip_support_block/jesd204_i/inst/i_my_ip_reset_block/stretch_reg[10]/
create_waiver -type CDC -id {CDC-14} -user "Xilinx" -desc "No more CDC-14!" -from [list [get_pins {i_my_ip_support_block/jesd204_i/inst/tx_cfg_test_modes_reg[1]/C}] [get_pins {i_my_ip_support_
#
current_instance -quiet
```

8. To import the `waivers.xdc` file, enter:

```
read_xdc waivers.xdc
```

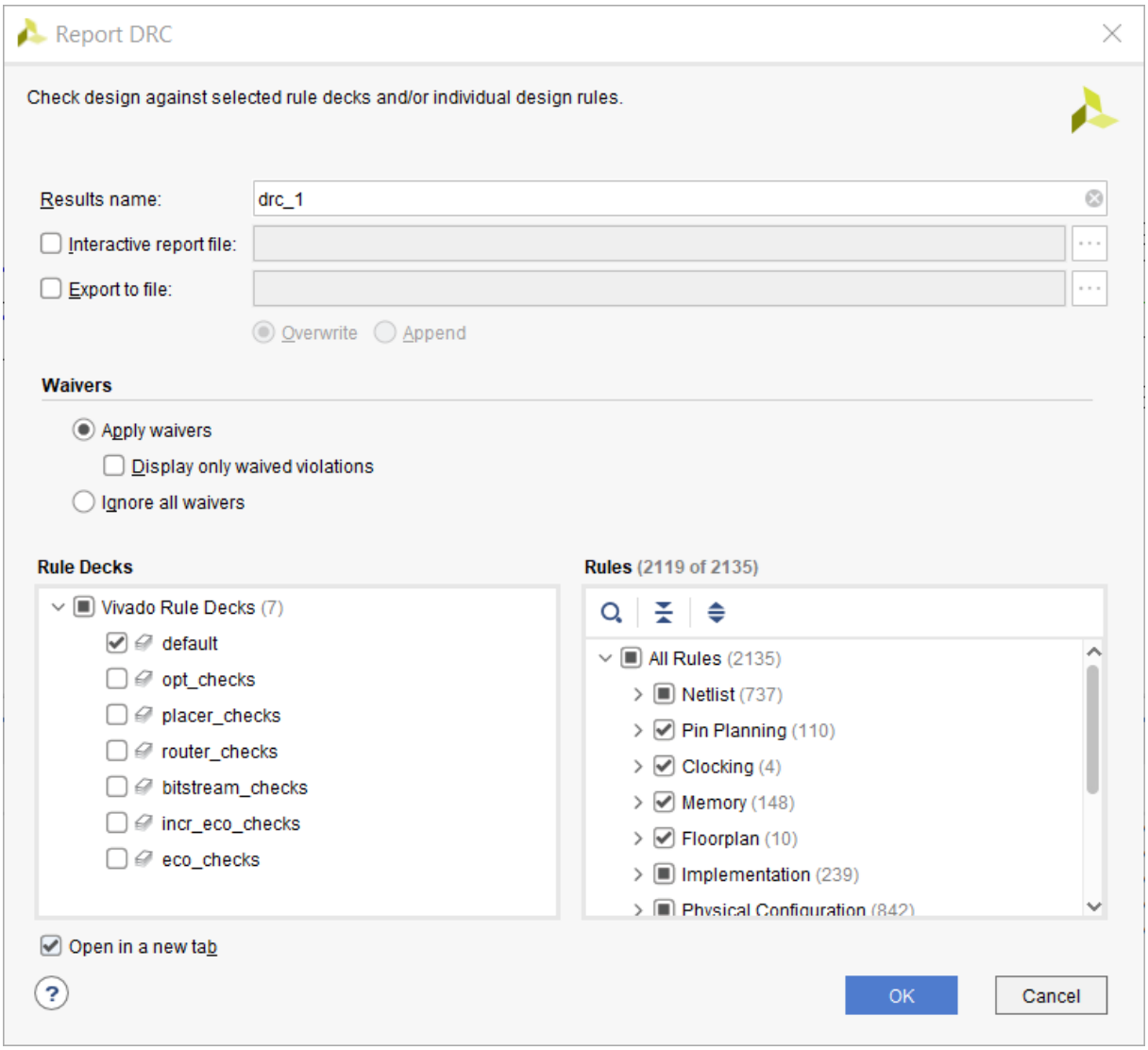
The following warnings show that duplicate waivers were not added to the existing waivers. Only waivers that are exact duplicates of existing waivers are rejected.

```
WARNING: [Vivado_Tcl 4-935] Waiver ID 'CDC-10' is a duplicate and will
not be added again.
WARNING: [Vivado_Tcl 4-935] Waiver ID 'CDC-11' is a duplicate and will
not be added again.
WARNING: [Vivado_Tcl 4-935] Waiver ID 'CDC-11' is a duplicate and will
not be added again.
WARNING: [Vivado_Tcl 4-935] Waiver ID 'CDC-14' is a duplicate and will
not be added again.
```

Step 10: Waiving Multiple DRC Violations

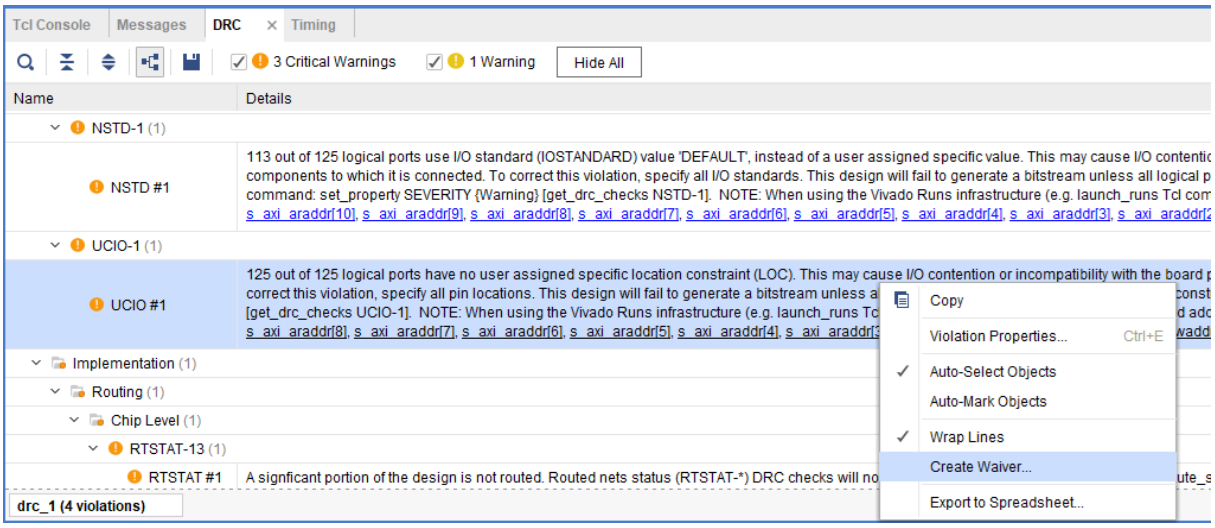
In this step, you waive multiple DRC violations simultaneously.

1. Select **Reports → Report DRC**.
2. In the Report DRC dialog box, leave all settings at their default, and click **OK**.

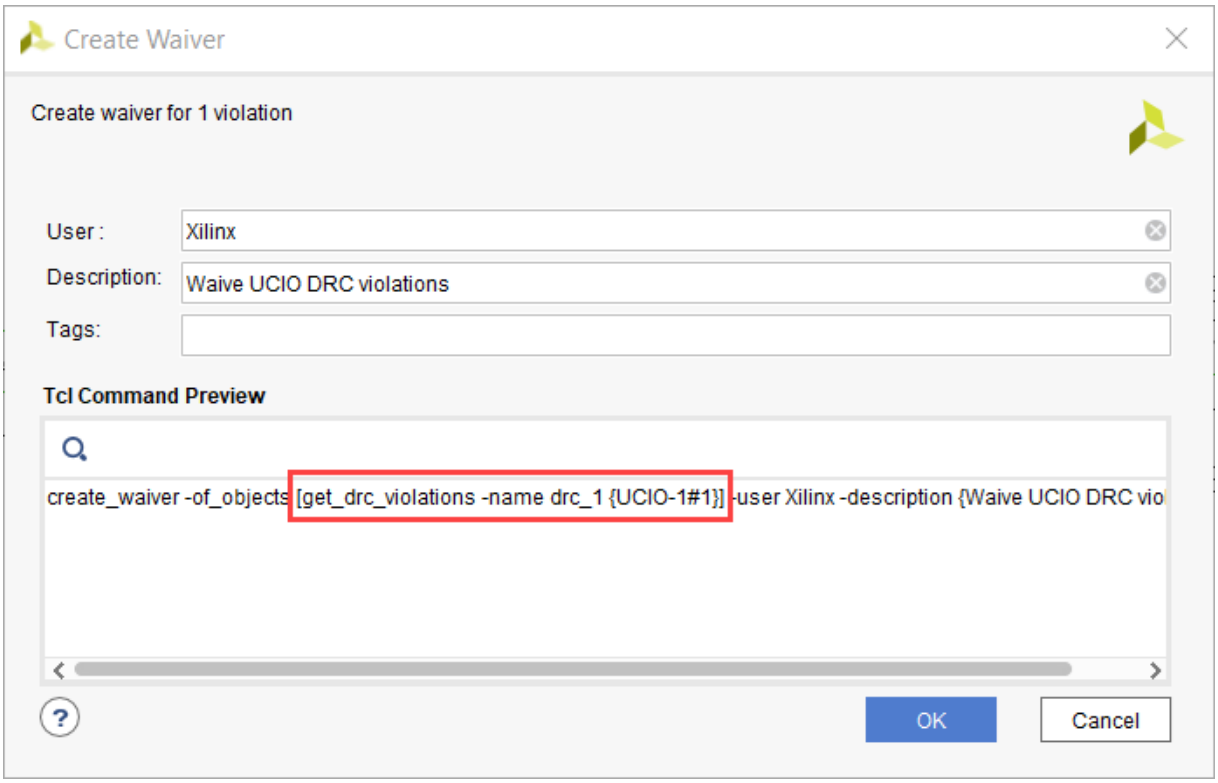


3. In the DRC Report, right-click **UCIO#1**, and select **Create Waiver** to create a waiver for the UCIO-1 violations.

   ***Note*:** The UCIO#1 violation combines 125 individual violations into a single violation. Similarly, the NSTD#1 violation covers 113 ports.



4. In the Create Waiver dialog box, look at the output in Tcl Command Preview, and click **OK**.



5. To generate the `drc_waivers.xdc` file and verify that the waiver is waiving all 125 objects, enter:

```
write_waivers -type DRC drc_waivers.xdc
```

6. In the `XDC` file, look at the expanded port list, and notice that some of the strings from the violations message were converted to wildcards (*).

Strings are automatically converted to wildcards for UCIO-1, NSTD-1, TIMING-15, and TIMING-16 type violations. For UCIO-1, the numbers of objects in the violations are replaced with wildcards, because the numbers of elements are not meaningful.

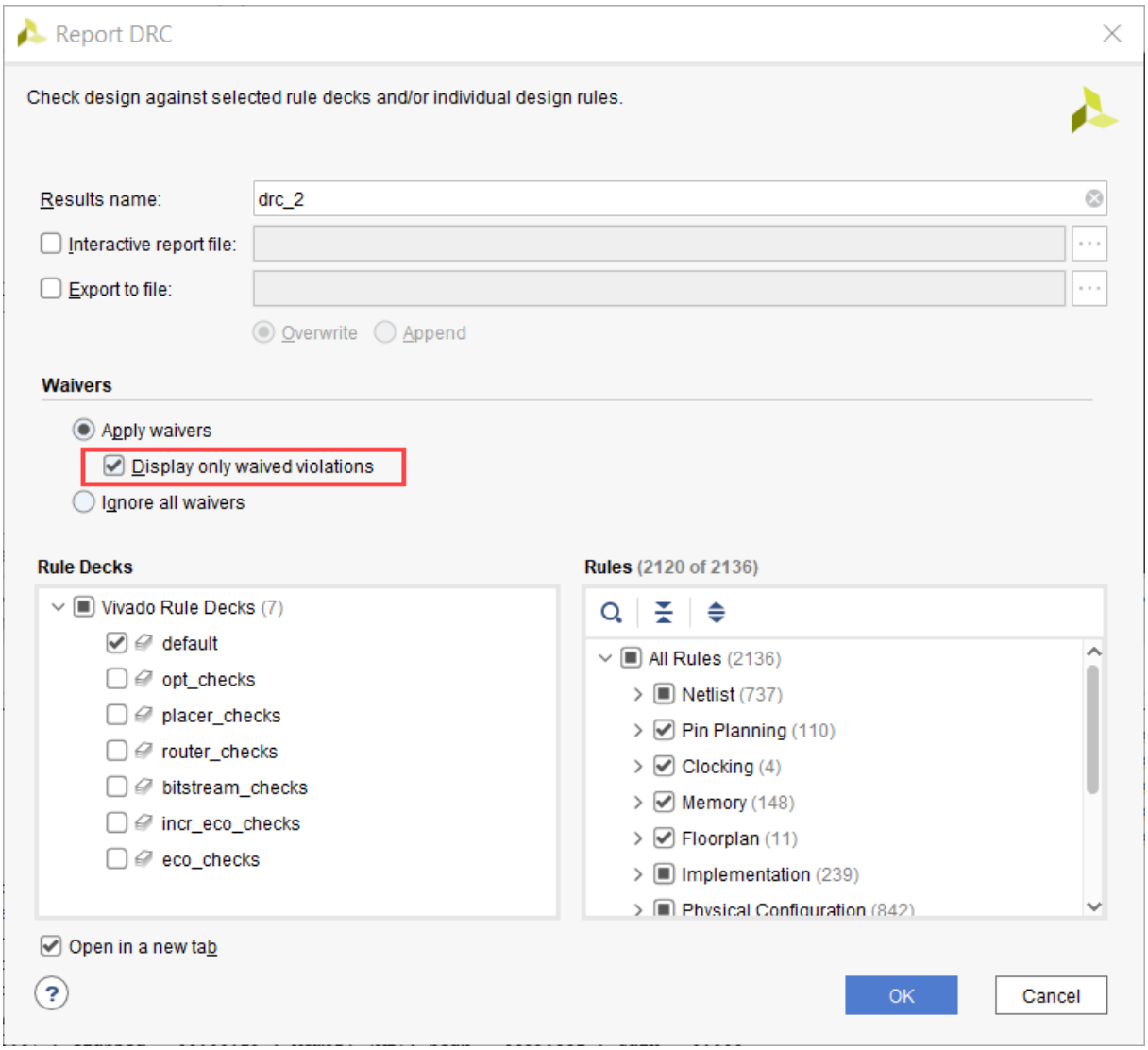
```
#
# WRITE DRC WAIVERS
# cmd: write_waivers -type DRC drc_waivers.xdc
current_instance -quiet
create_waiver -type DRC -id {UCIO-1} -user "Xilinx" -desc "Waive UCIO DRC violations" -objects [get_ports { refclk0p glblclkp refclk0n tx_start_of_frame[3] tx_start_of_multiframe[3] glblclkn
tx_reset drpclk tx_start_of_multiframe[2] txp[3] tx_start_of_multiframe[0] tx_start_of_frame[2] tx_start_of_frame[1] s_axi_rready tx_sync tx_sysref tx_aresetn s_axi_rdata[1] s_axi_rvalid
s_axi_rresp[0] s_axi_rresp[1] s_axi_rdata[0] s_axi_rdata[2] s_axi_rdata[3] s_axi_rdata[4] s_axi_rdata[9] s_axi_rdata[5] s_axi_rdata[10] s_axi_rdata[6] s_axi_rdata[7] s_axi_rdata[8]
s_axi_rdata[15] s_axi_rdata[11] s_axi_rdata[12] s_axi_rdata[13] s_axi_rdata[16] s_axi_rdata[17] s_axi_rdata[18] s_axi_rdata[14] s_axi_rdata[20] s_axi_rdata[21] s_axi_rdata[22] s_axi_rdata[27]
s_axi_rdata[23] s_axi_rdata[19] s_axi_rdata[25] s_axi_rdata[26] s_axi_arready s_axi_rdata[28] s_axi_rdata[24] s_axi_rdata[30] s_axi_rdata[31] s_axi_araddr[2] s_axi_arvalid s_axi_rdata[29]
s_axi_araddr[7] s_axi_araddr[3] s_axi_araddr[4] s_axi_araddr[5] s_axi_araddr[6] s_axi_bvalid s_axi_araddr[9] s_axi_araddr[10] s_axi_bready s_axi_wstrb[0] s_axi_wstrb[1] s_axi_araddr[8]
s_axi_bresp[1] s_axi_wready s_axi_wvalid s_axi_wdata[0] s_axi_bresp[0] s_axi_wstrb[2] s_axi_araddr[11] s_axi_wdata[4] s_axi_wdata[1] s_axi_wstrb[3] s_axi_wdata[2] s_axi_wdata[3]
s_axi_wdata[9] s_axi_wdata[5] s_axi_wdata[6] s_axi_wdata[7] s_axi_wdata[8] s_axi_wdata[14] s_axi_wdata[10] s_axi_wdata[11] s_axi_wdata[12] s_axi_wdata[13] s_axi_wdata[19] s_axi_wdata[15]
s_axi_wdata[16] s_axi_wdata[17] s_axi_wdata[18] s_axi_wdata[24] s_axi_wdata[20] s_axi_wdata[28] s_axi_wdata[25] s_axi_wdata[26] s_axi_wdata[27] s_axi_awready s_axi_awvalid txp[4]
tx_start_of_multiframe[1] txp[1] tx_start_of_frame[0] txp[2] txn[1] txn[3] txn[2] s_axi_awaddr[11] txn[0] txp[0] s_axi_aclk s_axi_aresetn s_axi_awaddr[7] s_axi_awaddr[10] s_axi_awaddr[8]
s_axi_awaddr[9] s_axi_awaddr[2] txn[4] s_axi_awaddr[5] s_axi_awaddr[6] s_axi_awaddr[3] s_axi_awaddr[4] }] -strings { "*" } -strings { "*" } -timestamp "Wed Mar 14 22:57:14 GMT 2018" ;#1
```

7. To delete the DRC waiver and rewrite the waiver using wildcards to target a subset of the ports objects, enter:

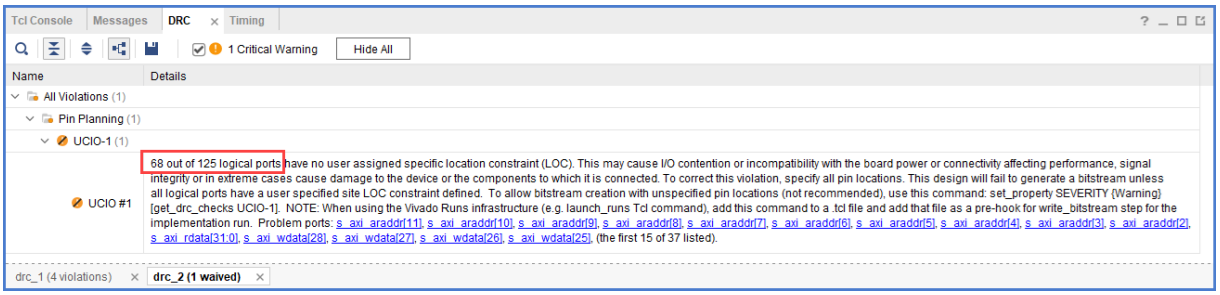
```
delete_waivers [get_waivers -type drc]
create_waiver -type DRC -id {UCIO-1} -user "Xilinx" -desc "Waive
selected UCIO violations" -objects [get_ports { s_axi_rdata[*]
s_axi_wdata[*] s_axi_araddr[*] } ] -strings { "*" } -strings { "*" }
```

   Note: This command only covers a subset of the original 125 objects.

8. Select **Reports → Report DRC** to rerun Report DRC.
9. In the Report DRC dialog box, select **Display only waived violations** to report only waived violations, and click **OK**.



In the DRC Report, verify that only 68 violations are waived out of 125.



IMPORTANT! *You cannot waive READONLY or NODISABLE violations. For example, if you enter:*

```
create_waiver -type DRC -id RTSTAT-1 -description "Waive RTSTAT-1"
```

The Vivado tools issue the following error:

```
 ERROR: [Vivado_Tcl 4-934] Waiver ID 'RTSTAT-1' is READONLY or
NODISABLE and cannot be waived.
These Factory designations specify that a check is required and may
not be overridden by user action.
```

Step 11: Generating a Summary Report for Waived Violations

This step covers how to use the `report_waivers` Tcl command to generate a summary report for CDC, DRC, and methodology waivers.

IMPORTANT! *Before running the `report_waivers` command, you must rerun Report CDC, Report DRC, or Report Methodology to ensure that added or removed waivers are included in the statistics reported by `report_waivers`.*

1. To rerun Report CDC, enter:

   ```
   report_cdc
   ```

2. To rerun Report DRC, enter:

   ```
   report_drc
   ```

   Note: You do not need to rerun Report Methodology, because no methodology waivers were set.

3. To create a summary report, enter:

   ```
   report_waivers
   ```

   By default, `report_waivers` reports only waived violations. The following figure shows the UCIO-1, CDC-10, CDC-11, and CDC-14 rules, which have defined waivers.

```
------------------
Table Of Contents
------------------
1. REPORT SUMMARY
2. REPORT DETAILS (DRC)
3. REPORT DETAILS (METHODOLOGY: no waivers)
4. REPORT DETAILS (CDC)


------------------
1. REPORT SUMMARY
------------------
Waiver Type  Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
-----------  ----------  --------------  -----------  ------------  -----------
DRC          239         171             68           1             1
METHODOLOGY  0           0               0            0             0
CDC          957         944             13           4             4
Note: This report is based on the most recent report_drc/report_methodology/report_cdc runs.


--------------------------------
2. REPORT DETAILS (DRC)
--------------------------------
Rule     Severity          Description                Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
-------  ----------------  -------------------------  ----------  --------------  -----------  ------------  -----------
UCIO-1*  Critical Warning  Unconstrained Logical Port  125         57              68           1             1


--------------------------------
4. REPORT DETAILS (CDC)
--------------------------------
Rule    Severity  Description                                          Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
------  --------  ---------------------------------------------------  ----------  --------------  -----------  ------------  -----------
CDC-10  Critical  Combinational logic detected before a synchronizer   187         186             1            1             1
CDC-11  Critical  Fan-out from launch flop to destination clock        2           0               2            2             2
CDC-14  Critical  Multi-bit CDC path on a non-FD primitive             10          0               10           1             1

Note: Any 'Rule' which is flagged by '*' is an aggregating message and its counts are based on the number of objects represented,
      rather than the number of messages.
```

Note the number of waived objects and total violations:

- The aggregating DRCs are reported as 1 violation per object inside the violation. Because there are 113 objects in NSTD-1, 125 objects in UCIO-1 plus 1 in RTDAT-13, a total number of 239 DRC violations are reported in the Summary table.
- The Report Summary table reports all of the violations.
- The Report Details tables only report the check IDs that have one or more waivers.

4. To generate detailed tables with all of the rules, including rules with no waivers, enter:

```
report_waivers -show_msgs_with_no_waivers
```

The following figure shows the report with all DRC and CDC rules reported in the Report Details.

```
------------------
Table Of Contents
------------------
1. REPORT SUMMARY
2. REPORT DETAILS (DRC)
3. REPORT DETAILS (METHODOLOGY: no waivers)
4. REPORT DETAILS (CDC)


------------------
1. REPORT SUMMARY
------------------
Waiver Type  Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
-----------  ----------  --------------  -----------  ------------  -----------
DRC          239         171             68           1             1
METHODOLOGY  0           0               0            0             0
CDC          957         944             13           4             4
Note: This report is based on the most recent report_drc/report_methodology/report_cdc runs.


--------------------------------
2. REPORT DETAILS (DRC)
--------------------------------
Rule       Severity         Description                Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
---------  ---------------  -------------------------  ----------  --------------  -----------  ------------  -----------
UCIO-1*    Critical Warning  Unconstrained Logical Port  125         57              68           1             1
RTSTAT-13  Critical Warning  Insufficient Routing       1           1               0            0             0
NSTD-1*    Critical Warning  Unspecified I/O Standard    113         113             0            0             0


--------------------------------
4. REPORT DETAILS (CDC)
--------------------------------
Rule    Severity  Description                                                Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
------  --------  ---------------------------------------------------------  ----------  --------------  -----------  ------------  -----------
CDC-10  Critical  Combinational logic detected before a synchronizer         187         186             1            1             1
CDC-11  Critical  Fan-out from launch flop to destination clock              2           0               2            2             2
CDC-14  Critical  Multi-bit CDC path on a non-FD primitive                   10          0               10           1             1
CDC-1   Critical  1-bit unknown CDC circuitry                                536         536             0            0             0
CDC-3   Info      1-bit synchronized with ASYNC_REG property                  9           9               0            0             0
CDC-4   Critical  Multi-bit unknown CDC circuitry                            28          28              0            0             0
CDC-9   Info      Asynchronous reset synchronized with ASYNC_REG property    5           5               0            0             0
CDC-13  Critical  1-bit CDC path on a non-FD primitive                       170         170             0            0             0
CDC-15  Warning   Clock enable controlled CDC structure detected              10          10              0            0             0

Note: Any 'Rule' which is flagged by '*' is an aggregating message and its counts are based on the number of objects represented,
      rather than the number of messages.
```

5. To run Report Methodology, enter:

```
report_methodology
```

6. To generate detailed tables with all of the rules, including rules with no waivers, enter:

```
report_waivers -show_msgs_with_no_waivers
```

The exact statistics are reported, as shown in the following figure.

Note: This figure does not include the Report Details (CDC) section.

```
------------------
1. REPORT SUMMARY
------------------
Waiver Type  Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
-----------  ----------  --------------  -----------  ------------  -----------
DRC          239         171             68           1             1
METHODOLOGY  163         163             0            0             0
CDC          957         944             13           4             4
Note: This report is based on the most recent report_drc/report_methodology/report_cdc runs.


--------------------------------
2. REPORT DETAILS (DRC)
--------------------------------
Rule       Severity         Description                Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
---------  ---------------  -------------------------  ----------  --------------  -----------  ------------  -----------
UCIO-1*    Critical Warning  Unconstrained Logical Port  125         57              68           1             1
RTSTAT-13  Critical Warning  Insufficient Routing       1           1               0            0             0
NSTD-1*    Critical Warning  Unspecified I/O Standard    113         113             0            0             0


--------------------------------
3. REPORT DETAILS (METHODOLOGY)
--------------------------------
Rule        Severity  Description                    Total Vios  Remaining Vios  Waived Vios  Used Waivers  Set Waivers
----------  --------  -----------------------------  ----------  --------------  -----------  ------------  -----------
AVAL-324    Warning   Hard_blocks_needs_LOCs         6           6               0            0             0
LUTAR-1*    Warning   LUT drives async reset alert   40          40              0            0             0
TIMING-9    Warning   Unknown CDC Logic              1           1               0            0             0
TIMING-10   Warning   Missing property on synchronizer  1        1               0            0             0
TIMING-18*  Warning   Missing input or output delay  115         115             0            0             0
```

Step 12: Using Waiver Commands

In this step, you run additional commands related to the waivers.

1. To return a collection of CDC waiver objects, enter:

```
get_waivers -type cdc
```

   The following CDC waivers are returned:

```
CDC-10#1 CDC-11#1 CDC-11#2 CDC-14#1
```

2. To filter the list of waivers to only return CDC-14 waivers, enter:

```
get_waivers -filter {ID == CDC-14}
CDC-14#1
```

3. To report all of the properties on a CDC waiver object, enter:

```
report_property [lindex [get_waivers -type cdc] end]
```

   The following properties are returned:

```
Property        Type    Read-only  Value
CLASS           string  true       cdc_waiver
DESCRIPTION     string  false      No more CDC-14!
ID              string  true       CDC-14
INDEX           string  true       1
IS_SCOPED       bool    true       0
NAME            string  true       CDC-14#1
OBJECT_COUNTS   string  true       pins:2
SCOPE           string  true
TAGS            string  false
TIME            string  true       <timestamp>
TYPE            string  true       CDC
USED_CNT        string  true       10
USER            string  true       Xilinx
```

   Note: You cannot retrieve the design objects attached to a waiver object.

4. To delete all of the previously created CDC-14 waivers, enter:

```
delete_waivers [get_waivers -filter {ID == CDC-14}]
```

   Note: After a waiver object is deleted, the waiver no longer applies and the violations that it waived are reported again.

5. To delete all of the remaining CDC waivers, enter:

```
delete_waivers [get_waivers -type cdc]
```

Summary

In this lab, you accomplished the following:

- Waived CDC and DRC violations
- Generated reports for waived violations

- Exported waivers
- Used waiver commands

Lab 2

Increasing Design Performance Using Report QoR Suggestions

Introduction

The `report_qor_suggestions` (RQS) command enables the Vivado® Design Suite tools to analyze a design and provide automated solutions for enhancing QoR. The command can be run on an open design after synthesis or after any stage in the implementation flow. RQS evaluates the design in five key areas and suggests fixes or improvements in these areas. The five areas are utilization, clocking, constraints, congestion, and timing. Recommendations from RQS can take the following forms:

- RQS objects. These can add:
  - Switches to a given command
  - Properties to a given design object
  - Implementation strategies customized for the design using machine learning algorithms
- Text recommendations that require intervention by the user.

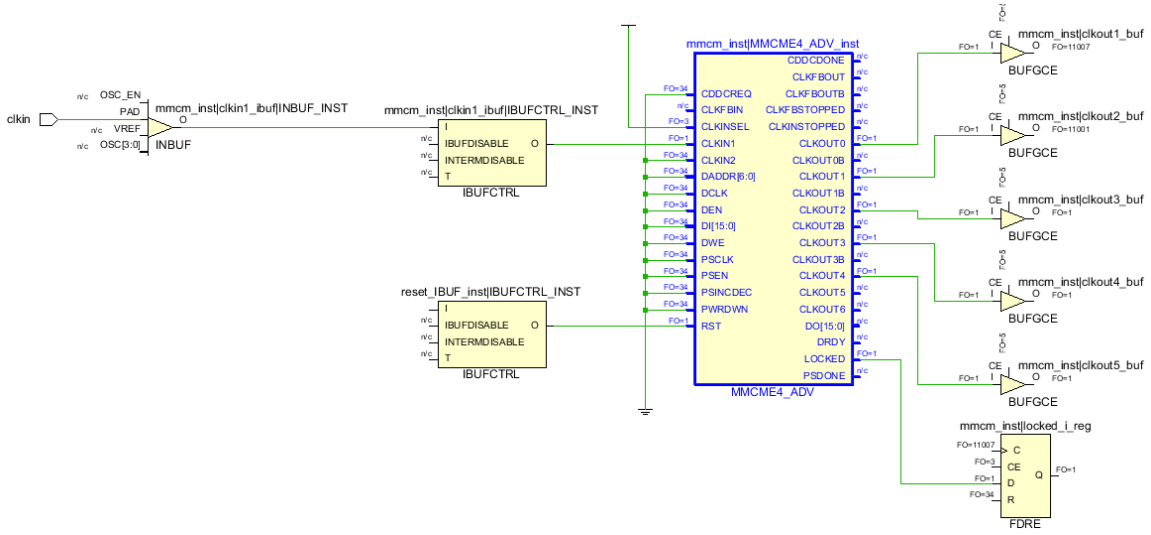
This tutorial will cover how to:

- Analyze the QoR suggestion report
- Export suggestions to an RQS file
- Add an RQS file to synthesis and implementation runs
- Accumulate suggestions in an RQS file by generating suggestions at different implementation stages or on different runs

Step 1: Understanding the Design

This lab uses an architected design to demonstrate some of the features of RQS. Suggestions are triggered by the design of the RTL and the placement of blocks using floorplanning. The design contains the following modules:

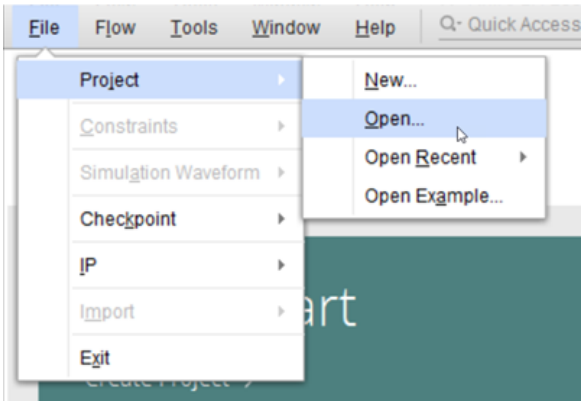
- **Clocking Module:** The main clocking circuit for the design resides in `clocking_module.vhd`. For simplicity, RST is tied to GND. LOCKED is registered and tied to an output port. The structure of this block is shown in the following figure.



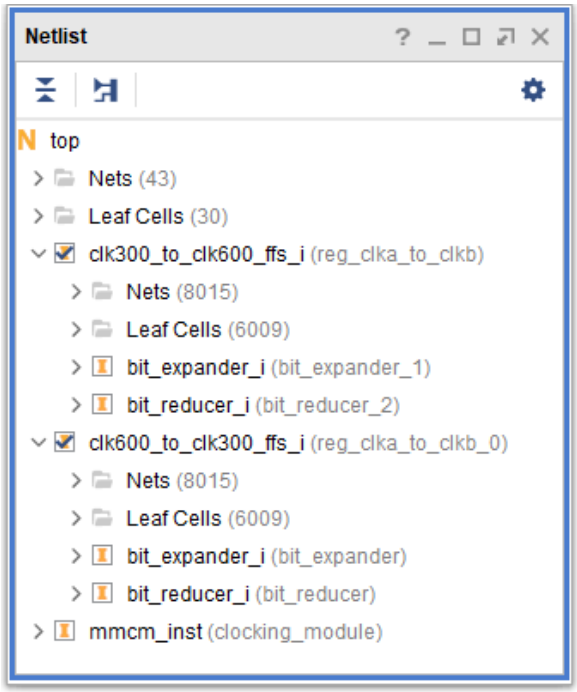
- **Reg CLKA to CLKB Module:** This module contains a synchronous CDC for a large bus. It registers input data using CLKA and then passes it to a register on the CLKB domain to be passed to the output. Registering large buses on different related clock domains can impact hold slack (WHS/THS) and setup slack (WNS/TNS).
- **Bit Expander and Bit Reducer Modules:** These modules enable the expansion and contraction of internal data widths so that the design does not run out of I/Os. The modules take an arbitrary data width and expand or contract it to or from a desired size. The contraction logic creates many logic levels.

The following steps cover opening the project and examining the placement of the floor-planned modules.

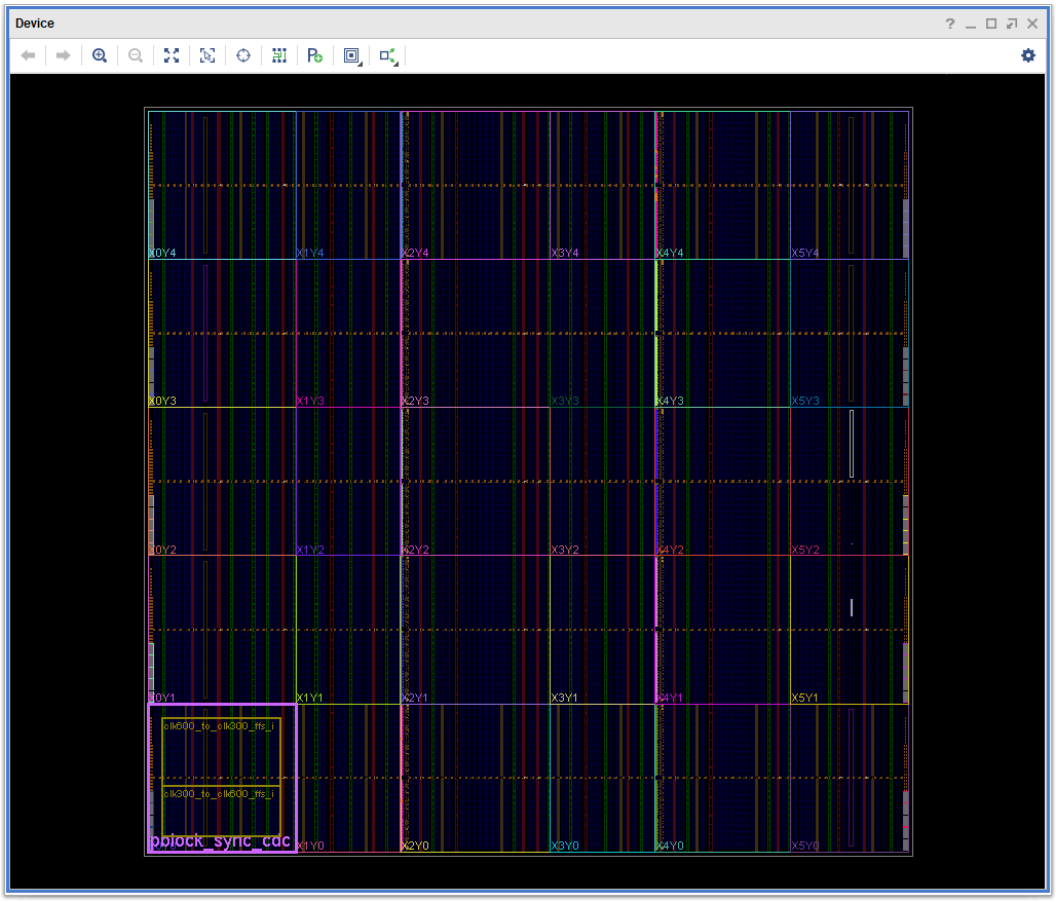
1. In the Vivado Design Suite, go to **File → Project → Open** and select the project located in `<extract_Dir>/Lab2/project_2`.



2. In the Flow Navigator, click **Run Synthesis** and wait for synthesis to complete.
3. In the Flow Navigator, click **Open Synthesized Design**.
4. In the Netlist view, look at the hierarchy.



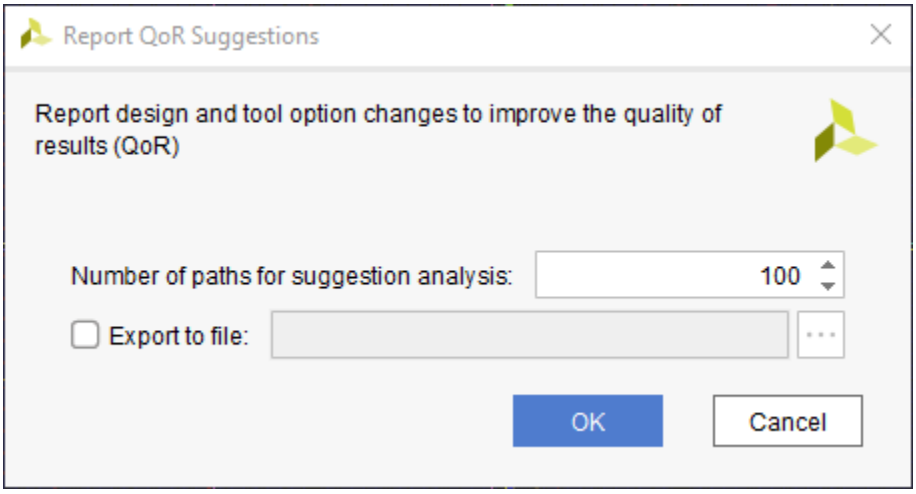
5. In Device view, look at the pblock. This has been added to control placement of the reg_clka_to_clkb modules and force a poor clock skew.



Step 2: Running Report QoR Suggestions

This step covers running the `report_qor_suggestions` command to generate a report. The command can be run on an open design at any stage of the implementation flow after synthesis. In project mode, this is typically after synthesis or implementation. In non-project mode, this can be after `synth_design`, `link_design`, `opt_design`, `place_design`, `phys_opt_design`, or `route_design`.

1. In the Vivado IDE, from the pull down menus, click **Reports → Report QoR Suggestions...** to bring up the dialog box shown in the following figure.



The equivalent Tcl command is:

```
report_qor_suggestions -quiet -name qor_suggestions_1
```

The command will:

- Examine the design and generate new suggestions
- Generate a report on the suggestions

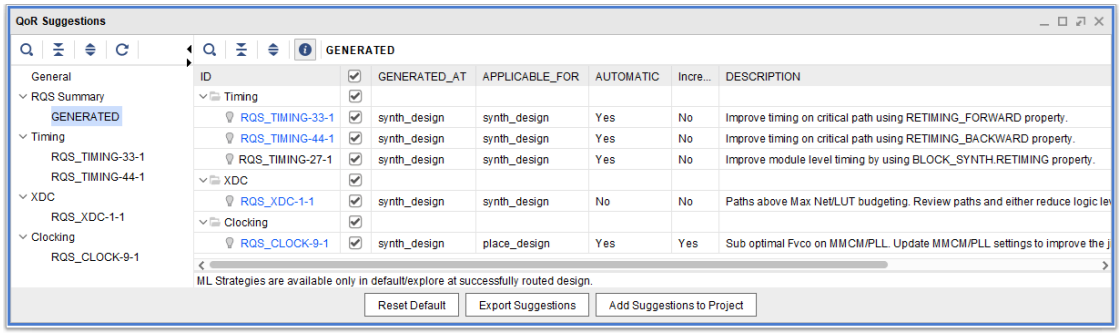
The report opens automatically in the integrated design environment (IDE). Due to the interactive nature of the report, only one instance of the report can be open at any time.

Note: By default, the RQS command reports on the 100 worst failing paths per clock group. You can change the number of paths that RQS uses for the analysis of timing-critical paths by modifying the `-max_paths` switch. Increasing this number generates more suggestions, but on paths that are reducing in criticality.

Step 3: Understanding the Report

This step explains the different sections of the generated QoR Suggestions report. On the left of the report window, you can navigate to the different sections of the report; on the right, more information is provided.

1. In the generated report, under RQS Summary, select **GENERATED**. This brings up the report section shown in the following figure.



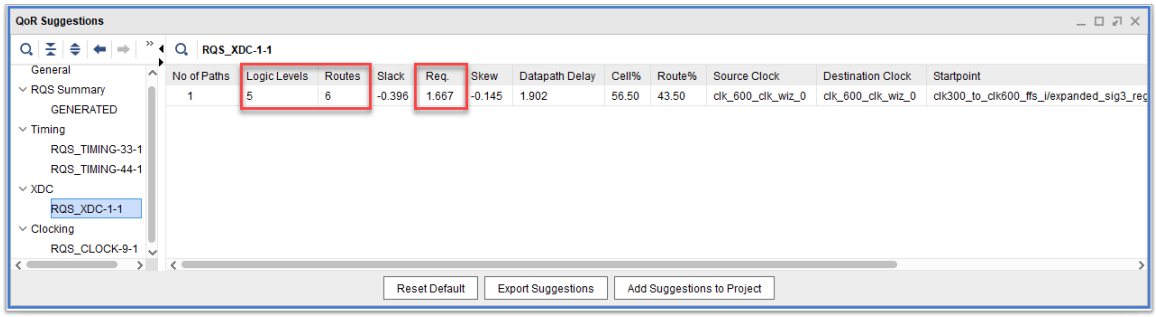
The GENERATED section provides a list of all the suggestions that have just been generated at this stage of the current run. Each suggestion has a description that details the reason for the suggestion. Additionally, for each suggestion the following information is provided.

Table 1: **RQS Summary Column Description**

Item	Description	Comment
GENERATED_AT	This shows what stage of the design the suggestion was generated at. Typical values `place_design` or `route_design`	As you progress through the design stages, the decisions that the tool makes are based on the information available at the time. Additionally, information accuracy increases after placement and again after routing.
APPLICABLE_FOR	This is the stage that must be rerun in order for the suggestion to take effect.	Most suggestions are executed at either `synth_design` or `place_design`
AUTOMATIC	Details whether the suggestion is executed automatically or the user must manually intervene	Automatic suggestions will either recommend a switch to the tool or a property to be added to a cell or net
INCREMENTAL FRIENDLY	Details if the suggestion is optimized for the incremental flow or not.	Non-incremental friendly suggestions must be already present in the reference checkpoint. If you want to add non incremental friendly suggestions, an updated reference checkpoint must be used.

Under the other sections of the report there are usually details about the individual suggestions that have been generated.

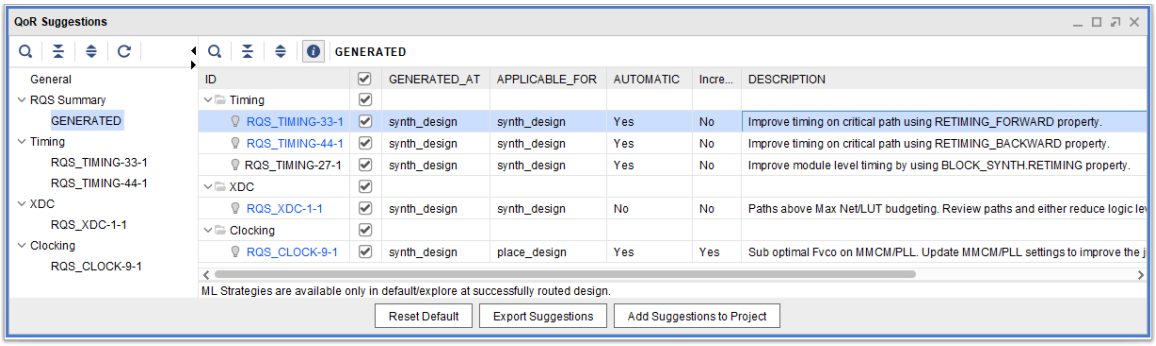
2. Click on the **RQS_XDC_1_1** hyperlink. This will take you to the details section for this suggestion.



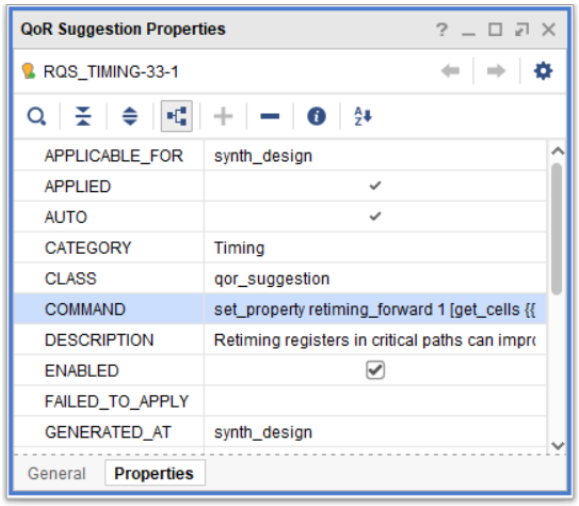
The suggestion description says that the timing constraint is too tight for the given path(s).

The path has a large negative slack which would stand out in a timing report. Timing paths use net delays that are optimal, this gives the tools the correct order to place and route them. Close analysis shows this is a 600 MHz path with high logic levels. This is a path that will need to be fixed.

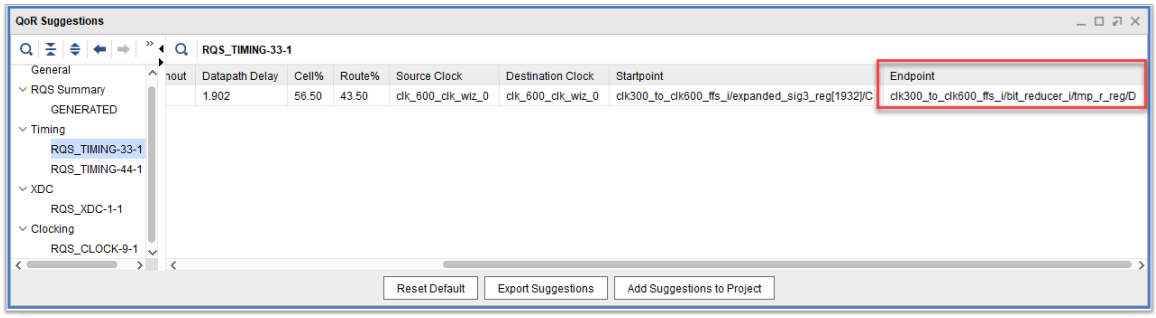
3. Click on the back arrow button to go back to the GENERATED view.
4. In the GENERATED view, click on **RQS_TIMING-33_1** row. You can see this is an AUTOMATIC suggestions that is APPLICABLE_FOR synth_design. This tells us that you must rerun the synth_design command in order to make use of this suggestion.



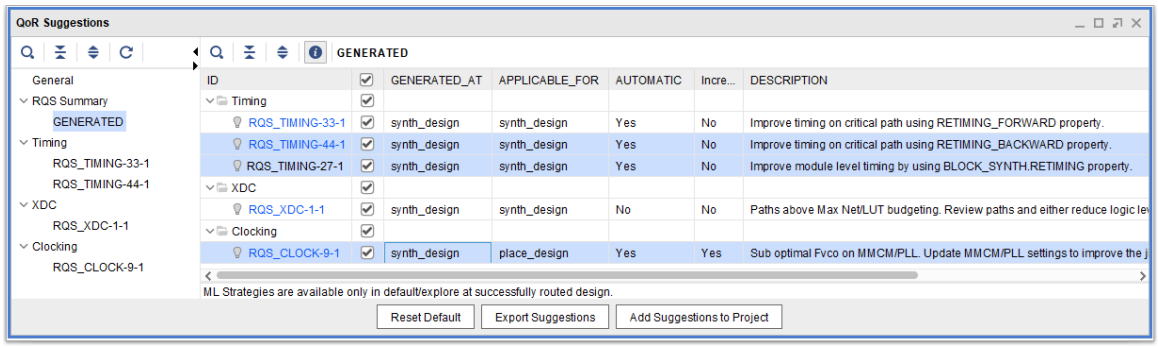
When you select the row in the RQS Summary view, the suggestion object is selected and the properties can be seen in the QoR Suggestion Properties window. If you examine the command property, you can confirm that generates a retiming forward property for synth_design.



5. In the GENERATED view, click on **RQS_TIMING-33_1** ID to take you to the details table for that suggestion. Careful examination of the Endpoint column will confirm that this is the same path that was mentioned for RQS_XDC-1.

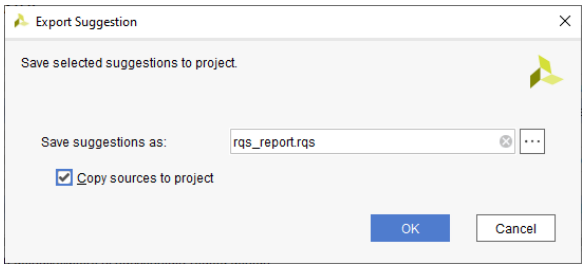


6. In the GENERATED view, you can see the remaining suggestions. Note that the RQS_CLOCK-9 suggestion is APPLICABLE_FOR = place_design. This is shown in the following figure:

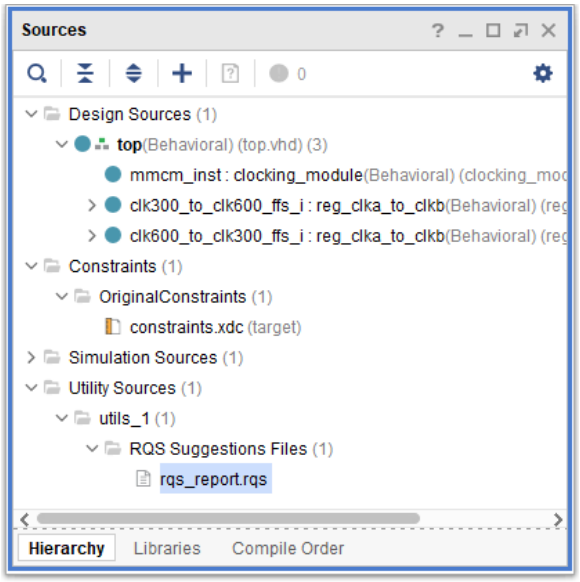


7. Note also RQS_TIMING-27. This suggestion uses BLOCK_SYNTH properties at synthesis and will apply to the entire module. You can determine the target cell by looking at the properties of the object as described in step 4.

8. With all the boxes checked, click **Add Suggestions to Project**. When the report suggestion dialogue box is open, change the filename to **rqs_report.rqs** and select **Copy sources to project** as shown in the following figure.



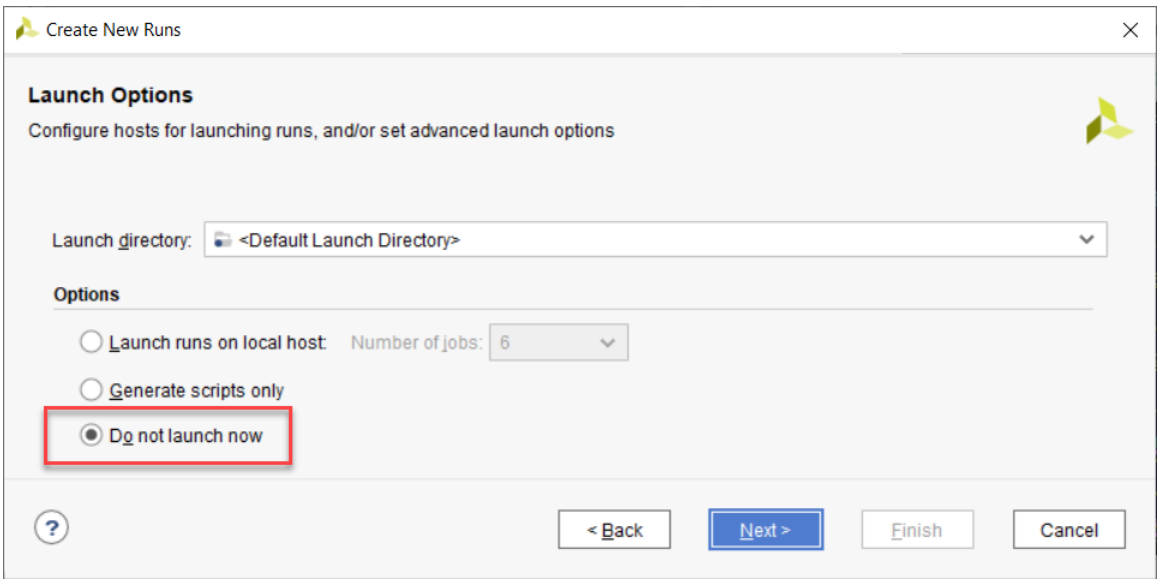
9. Examine the Sources window. You will see that the RQS file has been added to the utils_1 fileset. This ensures that the file is captured using the `get_files` command, project archives and recognized in the next step when we add the file to a run.



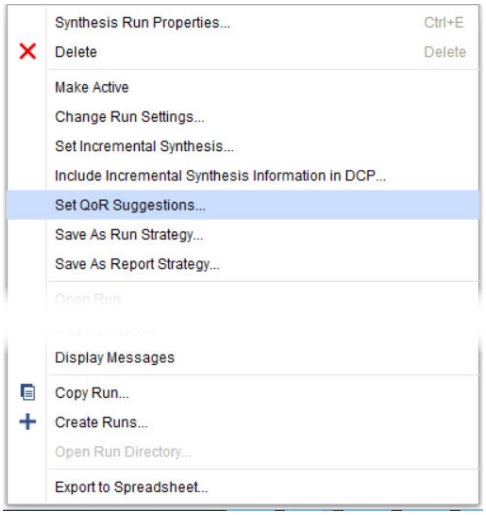
Step 4: Run with Suggestions

You will now add a suggestion to a run and examine what happens when a suggestion is applied and how it is reported.

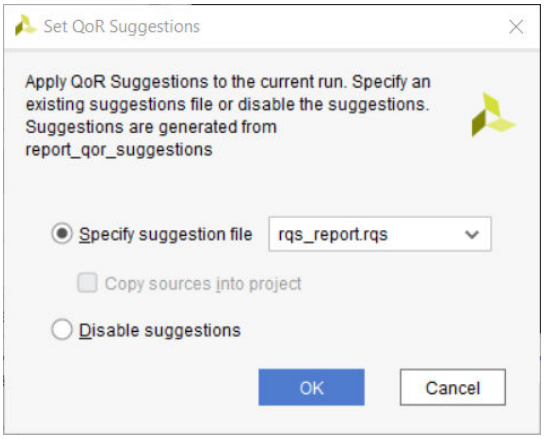
1. In the Design Runs window, click the + icon and generate both a new Synthesis and Implementation run. Ensure both runs have the Default run strategy and in the final step, select **Do not launch now**.



2. In the Design Runs window, right-click on the new **synth_2** run and select **Set QoR Suggestions ....**

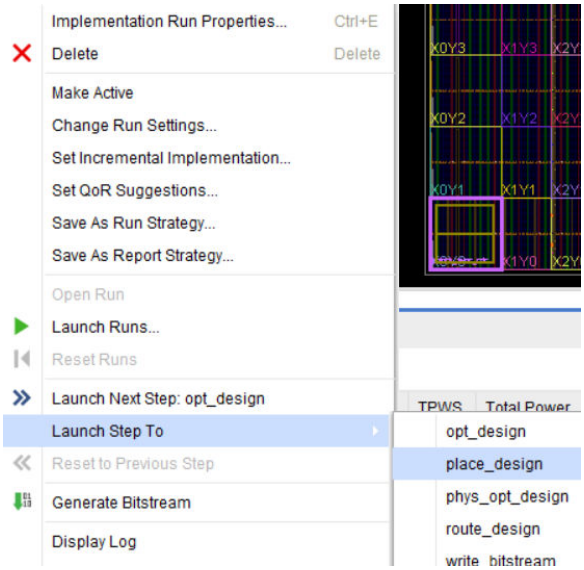


3. Specify the suggestion file as the RQS file added to the project from the previous step and click **OK**.



4. Repeat steps 2 and 3 for the implementation run. Specify the same RQS file for each run.
5. In the Design Runs window, right-click on synth_2 and select **Make Active**.
6. In the Flow Navigator, click **Run Synthesis**.

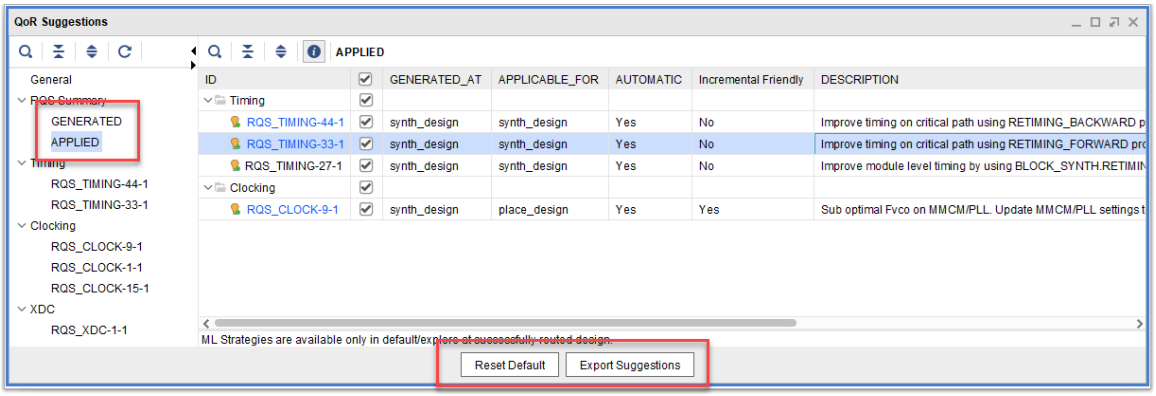
7. As this design takes a long time to route, we will only run to place_design and analyze at this stage. When synthesis is complete, in the Design Runs window, right-click on the new implementation run and select **Launch Step To→place_design**.



8. When place_design is finished, first go and examine the very top of the implementation log file for the new implementation run. You can see a table summary of the suggestions that have been read in. This summary helps confirm that what is read in is what you expect.

```
1. Read QOR Suggestions Summary
-------------------------------

Read QOR Suggestions Summary
+-----------------------------------------------+----------------+--------+
|              Suggestion Summary               | Incr Friendly  | Total  |
+-----------------------------------------------+----------------+--------+
| Total Number of Suggestions                   |              1 |      5 |
|   Automatic                                   |              1 |      4 |
|   Manual                                      |              0 |      1 |
|   APPLICABLE_AT                               |                |        |
|    synth_design                               |              0 |      4 |
|    opt_design                                 |              0 |      0 |
|     That overlap with synthesis suggestions   |              0 |      0 |
|    place_design                               |              1 |      1 |
|    postplace_phys_opt_design                  |              0 |      0 |
|    route_design                               |              0 |      0 |
|    postroute_phys_opt_design                  |              0 |      0 |
+-----------------------------------------------+----------------+--------+
```

9. Right-click on the implementation run and select **Open Run Directory**. Next open the checkpoint file by double-clicking on **top_placed.dcp**. This step is necessary as we are examining an intermediate run step in the interests of saving time.
10. In the new instance of Vivado tools, select **Reports → Report QoR Suggestions ...** and click **OK**.
11. In the new report, you will notice that there are more sections under RQS Summary.



- GENERATED - This is where new suggestions are listed
- EXISTING - These are suggestions that existed previously but are not applied (Not Shown)
- APPLIED - These are where suggestions that have been applied are listed
- FAILED TO APPLY - Suggestions where the design objects no longer exist and consequently were not applied (Not shown)

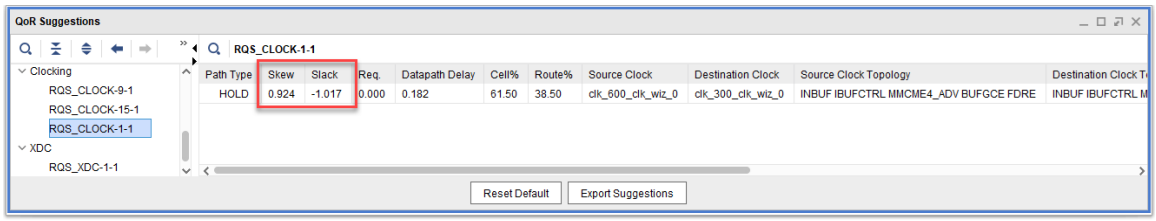
Also note that the option to add to the project is not available when a checkpoint is opened. You can still export a file but it is not added to a project.

12. Click **APPLIED** and select the details table for one of the items. For APPLIED suggestions, the timing path summary is still available but it is not possible to cross probe to other views in Vivado as some items may have changed.

Step 5: Accumulating Suggestions

You can now review the newly generated suggestions and add them to the RQS file.

1. Click on **GENERATED**. RQS_CLOCK-15 is a message that reports the high THS paths but does not provide an automatic suggestion. Therefore, we will focus on RQS_CLOCK-1-1. This suggestion applies CLOCK_DELAY_GROUP to related clocks.
2. Click on **RQS_CLOCK-1-1** to view the detailed report. In this report, you can see that there is a high clock skew.



   Clock skew is difficult to identify before place_design as the skew estimate depends heavily on placement. As a consequence, RQS does not offer this suggestion unless a design is placed. Whenever there is a change in information level, it can be worth running `report_qor_suggestions`. The following summarizes the changes as you progress through the tool flow:

   - Clocking estimates are accurate after place_design
   - Congestion is available after placement and improves further after routing
   - Timing estimates improve throughout the flow and are impacted by the number of paths analyzed

3. Click **Export Suggestions**. When suggestions are exported, the APPLIED status is reset. All the previous suggestions and the new RQS_CLOCK-1-1 are combined into one file. You can overwrite the previous file and reuse the runs, or create a new file and runs.
4. Select the file location to overwrite the existing file. You can find out the location of this by selecting it in the sources window. Alternatively, it should be at the following location if you have followed the steps carefully `<extract_dir>/Lab2/project_2/project_2.srcs/utils_1/imports/project_2`.

You are now at the point where you know the fundamentals in handling RQS files and accumulating suggestions. If you have time, rerun implementation through to route_design and examine the impact of the latest suggestion. Alternatively generate alternative suggestions by running `report_qor_suggestions` on your own design.

Summary

In this lab, you used RQS to conduct a complex analysis of a demonstration design. You firstly examined the reports that showed RQS provided recommendations to solve implementation problems, then generated an RQS file and added it to a project implementation run. The Vivado implementation tools executed these suggestions automatically for you. You subsequently performed further analysis and generated further suggestions, accumulating them in the RQS file.

Lab 3

Running ML Strategies

Introduction

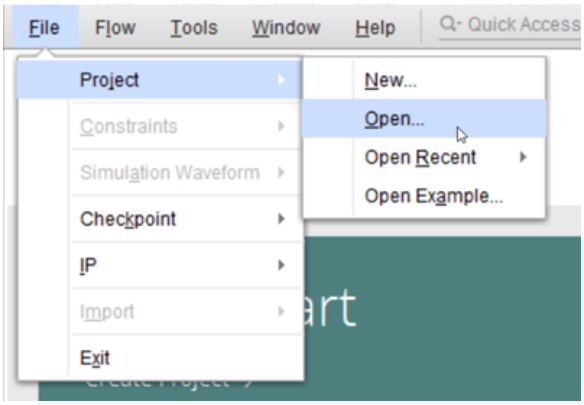
The `report_qor_suggestions` command can generate an implementation design strategy that is predicted to be optimal for the design using machine learning algorithms. In this tutorial, you will look at:

- How to generate ML Strategy suggestions
- How to setup the implementation run to use ML Strategy suggestions
- Reporting specifics related to ML Strategies

Step1: Generating an ML Strategy RQS File

This step shows the process of opening a routed design with QoR Suggestions and generating a new RQS file with strategies. For details on the design refer to Step 1: Understanding the Design.

1. In the Vivado Design Suite, go to **File → Project → Open** and select the project located in `<extract_Dir>/Lab3/project_2`.



2. In the Flow Navigator, click **Open Implemented Design**.
3. At the Tcl console, type `report_qor_assessment` at the Tcl console.

4. In the following Overall Assessment Summary table, you will see Flow Guidance. This table helps to identify good candidate designs to use ML Strategy suggestions. In this case, it is not a good candidate as it is the constructed design from lab 2 and the flow guidance recommends to further improve the design using QoR Suggestions.

```
1. Overall Assessment Summary
-----------------------------

+----------------------+-------------------------------------------------------------+
| QoR Assessment Score | 2 - Implementation may complete. Timing will not meet       |
+----------------------+-------------------------------------------------------------+
| Flow Guidance        | Run report_methodology and fix or waive critical warnings |
+----------------------+-------------------------------------------------------------+
```

   Whilst this design is not recommended for ML Strategies, this does not prohibit it from being used. The reason this design is not recommended, is down to the large timing violation.

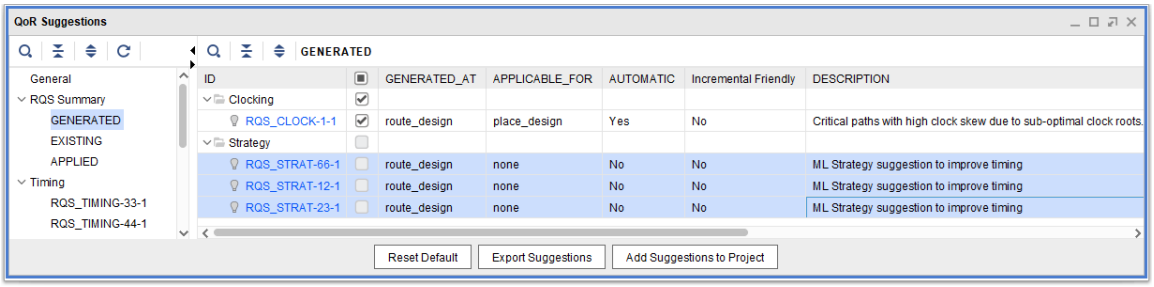
5. Further down the report in table 4 is the ML Strategy Availability table. This table details the required directives for the reference run in order to generate strategies.

```
4. ML Strategy Availability
---------------------------

+-----------------------------------------+---------+--------+
| Conditions for ML Strategy Availability | Value   | Status |
+-----------------------------------------+---------+--------+
| opt_design directive                    | Default |     OK |
| place_design directive                  | Default |     OK |
| phys_opt_design directive               | Default |     OK |
| route_design directive                  | Default |     OK |
+-----------------------------------------+---------+--------+
* opt_design can be Default or Explore
** other commands must have the same directive as each other. Either Default or Explore
```

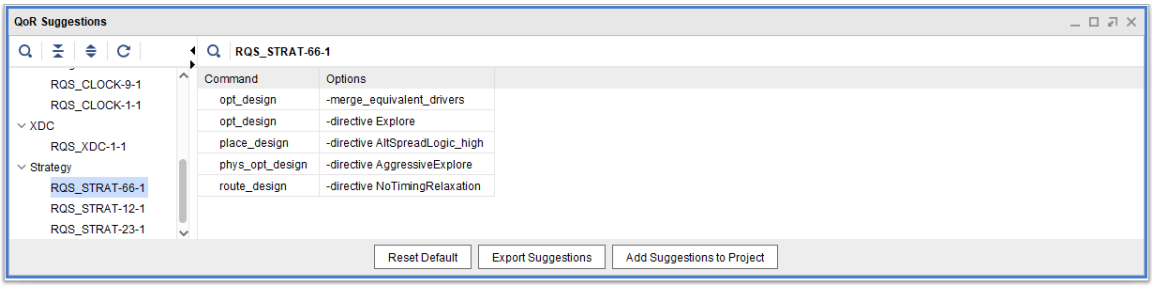
   The status for all directives must be "OK" in order to generate strategies. In summary the requirements are:

   - opt_design directive must be either Default or Explore
   - place_design, phys_opt_design and route_design must be the same as each other and be either set to Default or Explore

6. In the Design Runs window, confirm the strategy is Vivado Implementation Defaults. The above requirement is met when a design has been run with either the Vivado Implementation Defaults or Performance_Explore strategy.
7. From the pull-down menus, select **Reports → Report QoR Suggestions ...**, and click **OK**.
8. In the QoR suggestion report, select **GENERATED**. Here you will see 3 new strategies generated but they are not selectable. Strategy generation is currently only available using Tcl and for this reason they are not selectable.



9. Select **RQS_STRAT-66-1**. Here you can see the details of the strategy being recommended. It is possible to see the details of the strategy suggested. It would be possible manually set these up as shown but in order to automate the process more easily, the recommended flow is to read an RQS file containing strategies, and set the directive to RQS on the implementation commands.



10. At the Tcl console, ensure you are in a suitable writable directory. This can be at the same level as the project. Also, issue the `write_qor_suggestions` command to write out the suggestions as shown in the following example.

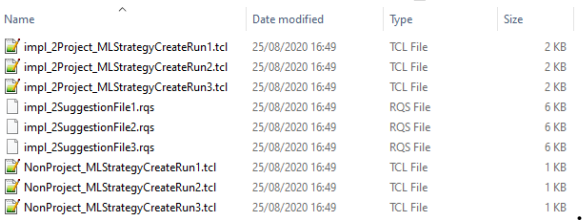
```
file mkdir <extract_Dir>/Lab3/project_2/ML_STRAT
cd <extract_Dir>/Lab3/project_2/ML_STRAT
write_qor_suggestions -strategy_dir ./
```

This writes one RQS file per strategy. Each RQS file also contains all of the other suggestions that are not strategy suggestions. This ensures you can use all the other QoR suggestions and the tools do not get confused which strategy suggestion they should select.

Step 2: Creating ML Strategy Runs

In this step we will use the files generated to create ML Strategy project based runs.

1. Examine the contents of the ML_STRAT directory



You can see the following contents:

a. 3 x RQS files

b. 3 x Project based Tcl scripts

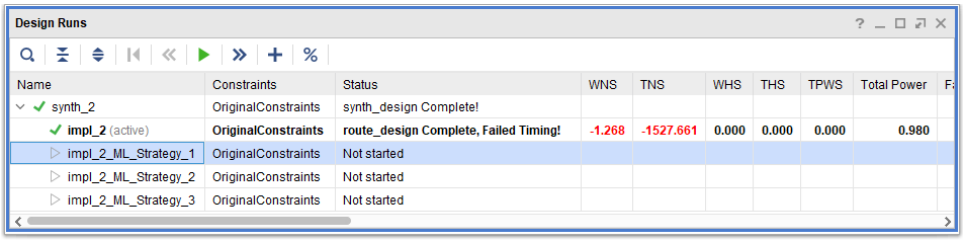
c. 3 x Non project based Tcl scripts

The RQS files are common for both project and non project flows. The non project scripts are examples of how to use the RQS file. The project based scripts can be sourced. Each of the 3 scripts references one of the RQS files. All three should be sourced.

2. Source each of the project based Tcl files. Each will create a run in the Design Runs window, setup the RQS file and set the directives to RQS. The run options will be copied from the reference run.

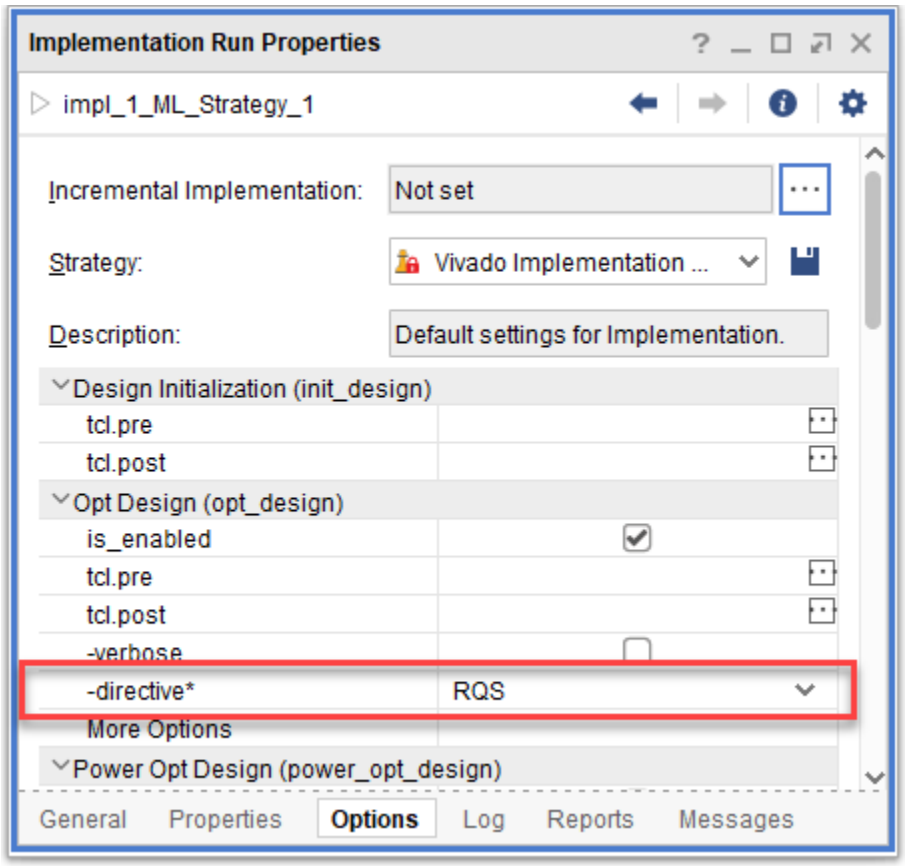
```
source ./impl_2Project_MLStrategyCreateRun1.tcl
source ./impl_2Project_MLStrategyCreateRun2.tcl
source ./impl_2Project_MLStrategyCreateRun3.tcl
```

3. In the Design Runs window, select **impl_2_ML_Strategy_1**.



4. In the Implementation Run Properties window, select the **Properties** tab and confirm that RQS_FILES is set.

5. In the Implementation Run Properties window, select the **Options** and confirm the directive is set to RQS for each for the commands.



You are now setup to run with ML Strategies. Once you have an ML Strategy file, you cannot generate new strategies after design changes but you can add other suggestions.

6. You are now ready to launch the runs. Select all the ML Strategy runs, right-click, and select **Launch Runs...**. The runs will now complete like a standard run.

Summary

In this lab, you used `report_qor_suggestions` to generate ML Strategies. Then created the RQS and Tcl files using `write_qor_suggestions`. Finally you sourced the Tcl to setup the ML Strategy runs and confirmed the key aspects of how to setup an ML Strategy run.

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Appendix A

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