

Introduction

Placement Exploration is a strategy to randomize non-critical register location, enable Vivado explore more opportunities to apply difference placement and routing calculations to give different results without changing the design functionality.

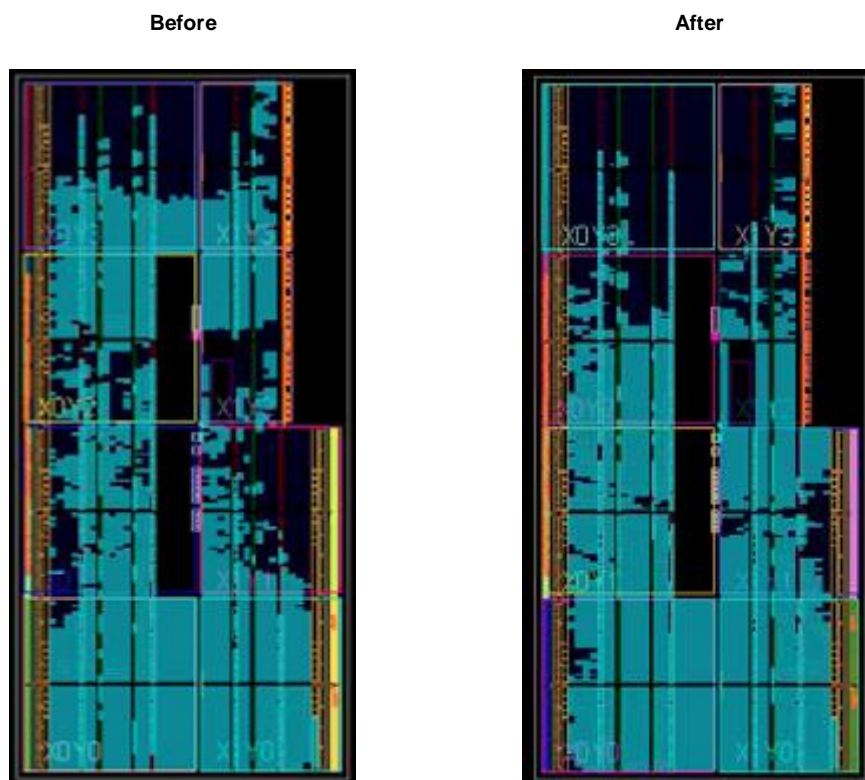


Figure 1: Noticeable placement differences prior to (left) and after (right) running Placement Exploration.

As randomness is involved, not all results generated via the new Placement Exploration recipe will be good, but it is a painless approach with no impact on functionality.

Supported InTime Version

The recipe is supported in InTime version 1.6.0 and above.

Supported FPGA tools

The recipe is supported for Vivado version 2015.4.0 and above.

Requirements

- 1) False path register

Prior to InTime version 2.2.1, the design must contain at least one false path in the design set by the user.

For InTime version 2.2.1 and onwards, the recipe supported the design without requiring any false path.

2) Free slices resources

The recipe requires the design has some non-critical cells (cells have met timing path) and some unused slices in the targeted device. The more unused slices in the design, the more combinations of the run can be created, hence increase the randomization and possibilities of getting better results.

If the requirements are not fulfilled, user will get following error when running the recipe:

```
16:39:47 [Error ] (VPlacement) No relevant slices in this design to automatically adjust placements, not generating any strategy.
16:39:47 [Error ] Suggestion: Add false path constraints for signals whose timing can be ignored, or try another recipe instead.
16:39:47 [Error ] =====
16:39:47 [Error ] GENERATE STRATEGIES FAILED
16:39:47 [Error ] after 00:00:00 (Local Job Id: 130, Design Id: 1488960333)
16:39:47 [Error ] =====
```

In this case, user might need to review the design to see if it is due to no false path (for the InTime version before 2.2.1) or too low free slice available for the device. If it is due to no false path, user might want to check whether false path can be set for the design.

About false Path register

False path register is the source/destination register along the false path set by the user. For more information on how to set false path in the design, please see following link:

<https://www.xilinx.com/video/hardware/setting-false-path-exceptions.html>

How to use

Before run the Placement Exploration recipe, it is recommended to run the InTime Default, InTime Default Extra and/or Extra Opt Exploration first to get the optimized results first, then use the best result as parent revision to run on the Placement Exploration recipe.

Current Project: /home/plunify/kailiang/cp_prores_linked_3/cp_prores_linked_3.dcp
Best Result: TNS of 0.117 in placement_1 from job ID 80.

History	Change	2: TNS	Worst Slack	Worst Setup	Worst Hold	Worst Pulse Width	Area	Power	Fmax	Runtime	Start Time	Run Target	Job ID
cp_prores_linked_3	-7.792	-0.189	-0.189	0.024	0.059		9918	11083	297.00	03:42:42	2017-03-10 17:08:25	Local	77
calibrate_2	5.972	-1.62	-0.162	-0.162	0.024	0.059	9918	11088	297.00	03:46:07	2017-03-10 20:53:57	Private Cloud	78
explore_5	6.888	-0.904	-0.168	-0.168	0.005	0.059	9918	11103	297.00	03:21:32	2017-03-11 20:18:40	Private Cloud	79
optimize_2	7.615	-0.177	-0.105	-0.105	0.015	0.059	9918	11102	297.00	06:14:30	2017-03-12 03:40:34	Private Cloud	80
placement_1	7.679	-0.117	-0.099	-0.099	0.001	0.059	9918	11101	297.00	04:07:19	2017-03-12 09:35:33	Private Cloud	81
placement_3	7.671	-0.121	-0.094	-0.094	0.018	0.059	9918	11099	297.00	06:09:07	2017-03-12 19:35:33	Private Cloud	82
placement_6	7.664	-0.128	-0.068	-0.068	0.024	0.059	9918	11095	297.00	03:57:16	2017-03-12 23:29:00	Private Cloud	83
placement_12	7.642	-0.15	-0.113	-0.113	0.017	0.059	9918	11092	297.00	03:52:58	2017-03-13 03:50:01	Private Cloud	84
placement_10	7.625	-0.167	-0.088	-0.088	0.014	0.059	9918	11096	297.00	06:00:14	2017-03-13 01:48:53	Private Cloud	85
placement_14	7.612	-0.18	-0.116	-0.116	0.024	0.059	9918	11092	297.00	05:58:05	2017-03-13 10:47:41	Private Cloud	86
placement_27	7.568	-0.224	-0.094	-0.094	0.024	0.059	9918	11092	297.00	03:56:23	2017-03-13 14:55:19	Private Cloud	87
placement_19	7.564	-0.228	-0.099	-0.099	0.024	0.059	9918	11099	297.00	04:21:03	2017-03-13 10:59:02	Private Cloud	88
placement_4	7.558	-0.234	-0.11	-0.110	0.024	0.059	9918	11096	297.00	05:57:18	2017-03-12 19:36:03	Private Cloud	89
placement_7	7.552	-0.24	-0.099	-0.099	0.024	0.059	9918	1111	297.00	04:42:31	2017-03-12 23:46:53	Private Cloud	90
placement_11	7.551	-0.241	-0.124	-0.124	0.014	0.059	9918	11096	297.00	03:51:16	2017-03-13 03:30:07	Private Cloud	91
placement_30	7.53	-0.262	-0.099	-0.099	0.024	0.059	9918	11099	297.00	04:16:43	2017-03-13 15:31:52	Private Cloud	92
placement_9	7.529	-0.263	-0.09	-0.090	0.005	0.059	9918	11096	297.00	05:41:27	2017-03-13 01:37:27	Private Cloud	93
placement_5	7.489	-0.303	-0.092	-0.092	0.014	0.059	9918	11096	297.00	03:56:19	2017-03-12 23:49:47	Private Cloud	94
placement_15	7.379	-0.413	-0.092	-0.092	0.014	0.059	9918	1111	297.00	04:33:52	2017-03-13 10:50:27	Private Cloud	95
placement_2	7.244	-0.548	-0.099	-0.099	0.024	0.059	9918	11096	297.00	03:49:30	2017-03-12 19:35:57	Private Cloud	96
placement_29	7.207	-0.585	-0.105	-0.105	0.024	0.059	9918	11099	297.00	03:53:53	2017-03-13 15:29:11	Private Cloud	97
placement_28	7.205	-0.587	-0.099	-0.099	0.016	0.059	9918	11103	297.00	03:56:22	2017-03-13 15:25:00	Private Cloud	98

To achieve good coverage, it is recommended to set at least 30 runs for Placement Exploration. The more number of runs, the higher chance of getting better result. Note that the maximum number of run are also depends on the resources (number of machine and license) and the design (total number of unused slices).

Current Project: C:/Users/kl01_2/plunify/examples/vivado/eight_bit_uc_xpr/eight_bit_uc.xpr

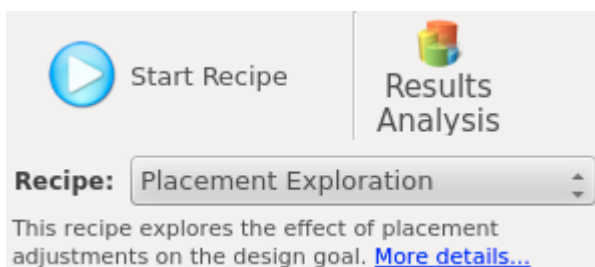
Best Result: TNS of -0.192 in optimize_2 from Job ID 5.

History	Change	▼ 2: TNS	Worst Slack	Worst Setup	Worst Hold	Worst Pulse Width	Area	Power
impl_1		-4.975	-0.384	-0.384	0.079	0.232	0.76	0.136
calibrate_2	4.549	-0.426	-0.179	-0.179	0.122	0.232	1.02	0.141
optimize_2	4.783	-0.192	-0.066	-0.066	0.085	0.232	0.77	0.134
optimize_5	4.552	-0.423						
optimize_9	4.442	-0.533						
cal_speed_tns_low_1	4.071	-0.904						
optimize_1	2.464	-2.511						
optimize_10	1.189	-3.786						
optimize_4	1.061	-3.914						
optimize_3	-1.499	-6.474						
optimize_7	-2.365	-7.34						
optimize_6	-51.048	-56.023						
calibrate_2	4.549	-0.426						
explore_5	3.864	-1.111						
explore_6	3.862	-1.113						
cal_speed_tns_low_1	3.819	-1.156						

History	Change	▼ 2: TNS	Worst Slack	Worst Setup	Worst Hold	Worst Pulse Width
impl_1		-4.975	-0.384	-0.384	0.079	0.232
calibrate_2	4.549	-0.426	-0.179	-0.179	0.122	0.232
optimize_2	4.783	-0.192	-0.066	-0.066	0.085	0.232
optimize_5	4.552	-0.423	-0.105	-0.105	0.083	0.232
optimize_9	4.442	-0.533	-0.147	-0.147	0.117	0.232

Following are the steps to run the Placement Exploration recipe:

1. Open your routed (project or DCP), or set the existing best run as parent revision in InTime.
2. From the recipes dropdown, click and select the Placement Exploration recipe.



Start Recipe

Results Analysis

Recipe: Placement Exploration

This recipe explores the effect of placement adjustments on the design goal. [More details...](#)

3. Specify the number of different results you want in the “Runs per Round” flow property (30 in this example).

Number Of Runs	
Runs Per Round	30

4. Click “Start Recipe” to start running.

Result

The following results are from running Placement Exploration recipe on a customer design.

Current Project: /home/fpgaone/kailiang/dcp/atomos/calibrate_2.dcp

Best Result: TNS of **-0.001** in placement_5 from Job ID 213.

History	Change	2: TNS	Worst Slack	Worst Setup	Worst Hold	Worst Pulse Width	Area	Power	Fmax	Runtime	Start Time	Run Target	1: Job ID
calibrate_2		-0.47	-0.06	-0.060	0.002	0.059	99.76	12.459	999.00	00:12:03	2017-08-01 16:38:25	Local	219
● placement_20	0.431	-0.039	-0.022	-0.022	0.014	0.059	99.76	12.458	999.00	04:24:51	2017-08-02 08:35:40	Private Cloud	
● placement_11	0.423	-0.047	-0.021	-0.021	0.014	0.059	99.76	12.457	999.00	07:03:32	2017-08-01 23:47:46	Private Cloud	
● placement_13	0.423	-0.047	-0.021	-0.021	0.014	0.059	99.76	12.457	999.00	07:32:32	2017-08-02 00:58:56	Private Cloud	
● placement_6	0.421	-0.049	-0.024	-0.024	0.014	0.059	99.76	12.457	999.00	02:29:54	2017-08-01 19:33:41	Private Cloud	
● placement_3	0.413	-0.057	-0.034	-0.034	0.014	0.059	99.76	12.457	999.00	06:45:41	2017-08-01 16:54:38	Private Cloud	
● placement_14	0.405	-0.065	-0.019	-0.019	0.014	0.059	99.76	12.457	999.00	02:48:36	2017-08-02 01:01:12	Private Cloud	
● placement_1	0.396	-0.074	-0.037	-0.037	0.014	0.059	99.76	12.458	999.00	02:37:47	2017-08-01 16:53:02	Private Cloud	
● placement_8	0.372	-0.098	-0.022	-0.022	0.014	0.059	99.76	12.457	999.00	02:50:46	2017-08-01 22:04:04	Private Cloud	
● placement_19	0.368	-0.102	-0.033	-0.033	0.014	0.059	99.76	12.459	999.00	09:14:23	2017-08-02 06:59:07	Private Cloud	
● placement_5	0.361	-0.109	-0.064	-0.064	0.014	0.059	99.76	12.457	999.00	02:28:36	2017-08-01 19:31:52	Private Cloud	
● placement_12	0.352	-0.118	-0.043	-0.043	0.014	0.059	99.76	12.457	999.00	02:31:05	2017-08-02 00:48:58	Private Cloud	
● placement_10	0.347	-0.123	-0.042	-0.042	0.014	0.059	99.76	12.457	999.00	02:30:22	2017-08-01 22:10:50	Private Cloud	
● placement_16	0.341	-0.129	-0.072	-0.072	0.014	0.059	99.76	12.458	999.00	02:53:12	2017-08-02 03:53:18	Private Cloud	
● placement_4	-0.101	-0.571	-0.064	-0.064	0.014	0.059	99.76	12.457	999.00	02:30:38	2017-08-01 16:56:16	Private Cloud	
● placement_15	-0.101	-0.571	-0.064	-0.064	0.014	0.059	99.76	12.457	999.00	02:30:24	2017-08-02 03:27:29	Private Cloud	
● placement_9	-0.213	-0.683	-0.179	-0.179	0.014	0.059	99.76	12.456	999.00	02:47:55	2017-08-01 22:08:58	Private Cloud	
● placement_7	-0.853	-1.323	-0.105	-0.105	0.024	0.059	99.76	12.457	999.00	02:29:46	2017-08-01 19:34:57	Private Cloud	
● placement_17	-0.95	-1.42	-0.083	-0.083	0.024	0.059	99.76	12.457	999.00	02:40:46	2017-08-02 06:05:22	Private Cloud	
● placement_2	-1.217	-1.687	-0.327	-0.327	0.024	0.059	99.76	12.456	999.00	02:33:47	2017-08-01 16:53:41	Private Cloud	

The initial compilation “calibrate.dcp” is generated after running InTime default recipe. It is also the best result before running Placement Exploration recipe. Following are the details of the initial compilation:

- Vivado version: 2016.4.0
- Target device: xcku040-fbva900-2-e
- Utilization: (CLB) 99.76%, (RAM) 94.58% and (DSP) 29.84%
- Run time: ~3 hours 30 minutes (210 minutes)
- TNS (Total Negative Slack): -0.06ns
- WNS (Worst Setup Slack): -0.47ns

Among 20 runs of Placement Exploration recipe, the best result “placement_20” has successfully improved the TNS by around 91% (from -0.47ns to -0.039ns) and the WNS by around 63% (from -0.06ns to -0.022ns). The run time is increased by around 29% (from 210 minutes to 270 minutes)

As seen from the above diagram, the runs’ result and run time are not consistent. This could be due to the randomization effect of Vivado performance and efforts.

Conclusion

Placement Exploration recipe is a convenient and automated way to drive Vivado place and route the design in different fashion. The effort to use the recipe is less because it does not require design RTL change. It creates opportunity to improve the timing result when running out of way to try the Vivado built-in strategies and settings.