

### HPWL Results:

#### Training Dataset:

S.No	Design	Post-Global Placement HPWL (RePLACE)	Post-Global Placement HPWL (DreamPLACE)
1	GCD - ASAP7	630976 um	$2.569043E+04 * 54 = 1386288 \text{ um}$
2	GCD - NanGate45	4355612 um	$8.989416E+03 * 380 = 3415978 \text{ um}$
3	IBEX - ASAP7	82440254 um	
4	IBEX - NanGate45	487236109 um	$6.216928E+05 * 380 = 236242264 \text{ um}$
5	AES - ASAP7	50856185 um	$3.822335E+05 * 54 = 20640509 \text{ um}$
6	AES - NanGate45	442496793 um	$1.065036E+06 * 380 = 404713680 \text{ um}$
7	ARIANE136 - NanGate45	13795038850 um	

#### Test Dataset:

S.No.	Design	Post-Global Placement HPWL (RePLACE)	Post-Global Placement HPWL (DreamPLACE)
1	JPEG - ASAP7	224839717 um	
2	JPEG - NanGate45	1788726097 um	$2.302547E+06 * 380 = 875968860 \text{ um}$
3	SWERV_WRAPPER - NanGate45		

### Timing Results:

#### Training Dataset:

S.No	Design	Post-Global Placement Timing (RePLACE) (Iterations)	Post-Global Placement Timing (DreamPLACE) (1000 iterations)
1	GCD - ASAP7	33.24 s (310)	4.7 s
2	GCD - NanGate45	29.99 s (360)	47.209 s
3	IBEX - ASAP7	295.94 s (410)	
4	IBEX - NanGate45	360.71 s (2180)	596.965 s
5	AES - ASAP7	178.54 s (390)	16.016 s
6	AES - NanGate45	316.70 s (2000)	328.55 s
7	ARIANE136 - NanGate45	96161 s (2210)	

#### Test Dataset:

S.No.	Design	Post-Global Placement Timing (RePLACE) (Iterations)	Post-Global Placement Timing (DreamPLACE) (1000 iterations)
1	JPEG - ASAP7	771.68 s (580)	
2	JPEG - NanGate45	1006.63 s (2920)	1379.515 s
3	SWERV_WRAPPER - NanGate45		

Results from using the netlist generator from ArtNetGen into DREAMPlace:

S.No.	Design(LEF)	Post-Global Placement HPWL (DreamPLACE)	Post-Global Placement Runtime (DreamPLACE)
1	ASAP7	$2.569043E+04 * 54 =$ 1386288 um	4.77 s
2	NanGate45	$8.989416E+03 * 380 =$ 3415978 um	38.3 s

Snapshots supporting the results:

GCD - ASAP7:

→ Post-Global Placement HPWL (RePLACE):

```
[INFO RSZ-0039] Resized 2 instances.
[INFO GPL-0106] Timing-driven: worst slack -3.53e-11
[INFO GPL-0103] Timing-driven: weighted 35 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 0.058 um^2 (+0.15%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.35871395
[NesterovSolve] Iter: 300 overflow: 0.126 HPWL: 622228
[NesterovSolve] Iter: 310 overflow: 0.103 HPWL: 630976
[NesterovSolve] Finished with Overflow: 0.099942
Took 26 seconds: global_placement -density 0.35 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...
```

→ Post-Global Placement HPWL (DreamPLACE):

```
[INFO ] DREAMPlace - iteration 999, ( 999, 0, 0), Obj 3.067962E+16, DensityWeight 1.837067E+10, wHPWL 2.569043E+04, Overflow 6.075843E-01, MaxDensity 1.000E+00, gamma 6.292017E+0
0, time 0.367ms
[INFO ] DREAMPlace - full step 3.660 ms
[INFO ] DREAMPlace - optimizer nesterov takes 4.674 seconds
[INFO ] DREAMPlace - non-linear placement takes 4.68 seconds
[INFO ] DREAMPlace - writing to results/i_synth/i_synth.gp.def
[INFO ] writing placement to results/i_synth/i_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.002 seconds
[INFO ] DREAMPlace - placement takes 4.701 seconds
root@24266cf0321c:/DREAMPlace/install#
```

→ Post-Global Placement HPWL (Customized):

GCD - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

```

[INFO RSZ-0039] Resized 2 instances.
[INFO GPL-0106] Timing-driven: worst slack -1.7e-11
[INFO GPL-0103] Timing-driven: weighted 55 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 1.330 um^2 (+0.22%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.6269475
[NesterovSolve] Iter: 340 overflow: 0.139 HPWL: 4302322
[NesterovSolve] Iter: 350 overflow: 0.115 HPWL: 4332725
[NesterovSolve] Iter: 360 overflow: 0.105 HPWL: 4355612
[NesterovSolve] Finished with Overflow: 0.098892
Took 28 seconds: global_placement -density 0.6676778888702393 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

```

[INFO ] DREAMPlace - ABCDPlace input legal flag = 0
[INFO ] DREAMPlace - detailed placement takes 0.011 seconds
[INFO ] DREAMPlace - iteration 1001, wHPWL 8.989416E+03, time 0.106ms
[INFO ] DREAMPlace - non-linear placement takes 47.15 seconds
[INFO ] DREAMPlace - writing to results/1_synth/1_synth.gp.def
[INFO ] writing placement to results/1_synth/1_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.001 seconds
[INFO ] DREAMPlace - placement takes 47.209 seconds
root@24266cf0321c:/DREAMPlace/install#

```

→ Post-Global Placement HPWL (Customized):

IBEX - ASAP7:

→ Post-Global Placement HPWL (RePLACE):

```

[INFO RSZ-0039] Resized 182 instances.
[INFO GPL-0106] Timing-driven: worst slack -3.5e-11
[INFO GPL-0103] Timing-driven: weighted 1914 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 3.587 um^2 (+0.15%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.56239724
[NesterovSolve] Iter: 400 overflow: 0.125 HPWL: 82378154
[NesterovSolve] Iter: 410 overflow: 0.106 HPWL: 82440254
[NesterovSolve] Finished with Overflow: 0.098498
Took 213 seconds: global_placement -density 0.5329829549789429 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

→ Post-Global Placement HPWL (Customized):

IBEX - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

```
[INFO RSZ-0039] Resized 248 instances.
[INFO GPL-0106] Timing-driven: worst slack -2.3e-10
[INFO GPL-0103] Timing-driven: weighted 1876 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 51.235 um^2 (+0.15%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.70901114
[NesterovSolve] Iter: 2170 overflow: 0.131 HPWL: 486901310
[NesterovSolve] Iter: 2180 overflow: 0.114 HPWL: 487236109
[NesterovSolve] Finished with Overflow: 0.099271
Took 312 seconds: global_placement -density 0.6179086303710938 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...
```

→ Post-Global Placement HPWL (DreamPLACE):

```
[INFO ] DREAMPlace - ABCDPlace input legal flag = 0
[INFO ] DREAMPlace - detailed placement takes 0.538 seconds
[INFO ] DREAMPlace - iteration 1001, wHPWL 6.216928E+05, time 0.424ms
[INFO ] DREAMPlace - non-linear placement takes 596.60 seconds
[INFO ] DREAMPlace - writing to results/1_synth/1_synth.gp.def
[INFO ] writing placement to results/1_synth/1_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.013 seconds
[INFO ] DREAMPlace - placement takes 596.965 seconds
root@24266cf0321c:/DREAMPlace/install#
```

→ Post-Global Placement HPWL (Customized):

AES - ASAP7:

→ Post-Global Placement HPWL (RePLACE):

```
-----
[INFO RSZ-0039] Resized 263 instances.
[INFO GPL-0106] Timing-driven: worst slack -1.03e-10
[INFO GPL-0103] Timing-driven: weighted 1653 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 7.596 um^2 (+0.40%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.69641167
[NesterovSolve] Iter: 370 overflow: 0.143 HPWL: 50799474
[NesterovSolve] Iter: 380 overflow: 0.121 HPWL: 50822763
[NesterovSolve] Iter: 390 overflow: 0.103 HPWL: 50856185
[NesterovSolve] Finished with Overflow: 0.099594
Took 148 seconds: global_placement -density 0.65 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...
```

→ Post-Global Placement HPWL (DreamPLACE):

```

[INFO ] DREAMPlace - iteration 998, ( 998, 0, 0), Obj 4.260861E+21, Density
Weight 4.448604E+09, wHPWL 3.822152E+05, Overflow 9.351665E-01, MaxDensity 1.279
E+01, gamma 3.364045E+01, time 3.064ms
[INFO ] DREAMPlace - full step 11.847 ms
[INFO ] DREAMPlace - Stuck at early stage. Turn on quadratic penalty with doub
le density factor to accelerate convergence
[INFO ] DREAMPlace - optimizer step 16.999 ms
[INFO ] DREAMPlace - iteration 999, ( 999, 0, 0), Obj 4.472162E+21, Density
Weight 4.671027E+09, wHPWL 3.822335E+05, Overflow 9.351655E-01, MaxDensity 1.281
E+01, gamma 3.364085E+01, time 2.016ms
[INFO ] DREAMPlace - full step 19.895 ms
[INFO ] DREAMPlace - optimizer nesterov takes 15.637 seconds
[INFO ] DREAMPlace - non-linear placement takes 15.65 seconds
[INFO ] DREAMPlace - writing to results/1_synth/1_synth.gp.def
[INFO ] writing placement to results/1_synth/1_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.018 seconds
[INFO ] DREAMPlace - placement takes 16.016 seconds
root@24266cf0321c:/DREAMPlace/install#
PlaceObj.py 29 "legalize flag" : 0,

```

→ Post-Global Placement HPWL (Customized):

AES - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

```

[INFO RSZ-0039] Resized 395 instances.
[INFO GPL-0106] Timing-driven: worst slack -1.62e-10
[INFO GPL-0103] Timing-driven: weighted 1613 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: -5.267 um^2 (-0.02%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.7104745
[NesterovSolve] Iter: 1990 overflow: 0.126 HPWL: 441398479
[NesterovSolve] Iter: 2000 overflow: 0.110 HPWL: 442496793
[NesterovSolve] Finished with Overflow: 0.098735
Took 291 seconds: global_placement -density 0.5360774850845337 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

```

[INFO ] DREAMPlace - ABCDPlace input legal flag = 0
[INFO ] DREAMPlace - detailed placement takes 0.506 seconds
[INFO ] DREAMPlace - iteration 1001, wHPWL 1.065036E+06, time 4.630ms
[INFO ] DREAMPlace - non-linear placement takes 328.21 seconds
[INFO ] DREAMPlace - writing to results/1_synth/1_synth.gp.def
[INFO ] writing placement to results/1_synth/1_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.023 seconds
[INFO ] DREAMPlace - placement takes 328.550 seconds
root@24266cf0321c:/DREAMPlace/install#

```

→ Post-Global Placement HPWL (Customized):

ARIAN136 - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

```

-----
[INFO RSZ-0036] Found 15 capacitance violations.
[INFO RSZ-0037] Found 109 long wires.
[INFO RSZ-0039] Resized 6575 instances.
[INFO RSZ-0038] Inserted 125 buffers in 124 nets.
[INFO GPL-0106] Timing-driven: worst slack 1.24e-09
[INFO GPL-0103] Timing-driven: weighted 19274 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 2753.231 um^2 (+0.68%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 125 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 125
[INFO GPL-0110] Timing-driven: new target density: 0.43467823
[NesterovSolve] Iter: 2190 overflow: 0.135 HPWL: 13878148566
[NesterovSolve] Iter: 2200 overflow: 0.117 HPWL: 13852315744
[NesterovSolve] Iter: 2210 overflow: 0.102 HPWL: 13795038850
[NesterovSolve] Finished with Overflow: 0.099633
Took 95950 seconds: global_placement -density 0.35 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

→ Post-Global Placement HPWL (Customized):

JPEG - ASAP7:

→ Post-Global Placement HPWL (RePLACE):

```

-----
      0 |    +0.0% |      0 |      0 |      0 |    63748
final |    +0.2% |    394 |      0 |      0 |      0
-----
[INFO RSZ-0039] Resized 394 instances.
[INFO GPL-0106] Timing-driven: worst slack 3.21e-12
[INFO GPL-0103] Timing-driven: weighted 6374 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 11.314 um^2 (+0.17%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 0 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 0
[INFO GPL-0110] Timing-driven: new target density: 0.62566376
[NesterovSolve] Iter: 560 overflow: 0.133 HPWL: 224795153
[NesterovSolve] Iter: 570 overflow: 0.115 HPWL: 224736050
[NesterovSolve] Iter: 580 overflow: 0.099 HPWL: 224839717
[NesterovSolve] Finished with Overflow: 0.099069
Took 642 seconds: global_placement -density 0.6 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

→ Post-Global Placement HPWL (Customized):

JPEG - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

```

[INFO RSZ-0037] Found 1 long wires.
[INFO RSZ-0039] Resized 804 instances.
[INFO RSZ-0038] Inserted 1 buffers in 1 nets.
[INFO GPL-0106] Timing-driven: worst slack -3.55e-10
[INFO GPL-0103] Timing-driven: weighted 7311 nets.
[INFO GPL-0107] Timing-driven: repair_design delta area: 900.542 um^2 (+0.90%)
[INFO GPL-0108] Timing-driven: repair_design, gpl cells created: 1 (+0.00%)
[INFO GPL-0109] Timing-driven: inserted buffers as reported by repair_design: 1
[INFO GPL-0110] Timing-driven: new target density: 0.63103175
[NesterovSolve] Iter: 2900 overflow: 0.139 HPWL: 1786058089
[NesterovSolve] Iter: 2910 overflow: 0.120 HPWL: 1787415621
[NesterovSolve] Iter: 2920 overflow: 0.105 HPWL: 1788726097
[NesterovSolve] Finished with Overflow: 0.099383
Took 908 seconds: global_placement -density 0.5718526697158813 -pad_left 0 -pad_right 0 -routability_driven -timing_driven
Report metrics stage 3, global place...

```

→ Post-Global Placement HPWL (DreamPLACE):

```

[INFO ] DREAMPlace - ABCDPlace input legal flag = 0
[INFO ] DREAMPlace - detailed placement takes 0.842 seconds
[INFO ] DREAMPlace - iteration 1001, wHPWL 2.302547E+06, time 0.641ms
[INFO ] DREAMPlace - non-linear placement takes 1378.44 seconds
[INFO ] DREAMPlace - writing to results/i_synth/i_synth.gp.def
[INFO ] writing placement to results/i_synth/i_synth.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.039 seconds
[INFO ] DREAMPlace - placement takes 1379.515 seconds
root@24266cf0321c:/DREAMPlace/install#

```

→ Post-Global Placement HPWL (Customized):

SWERV\_WRAPPER - NanGate45:

→ Post-Global Placement HPWL (RePLACE):

→ Post-Global Placement HPWL (DreamPLACE):

→ Post-Global Placement HPWL (Customized):

ASAP7-ArtNetGen:

→ Post-Global Placement HPWL (RePLACE):

→ Post-Global Placement HPWL (DreamPLACE):

```

[INFO ] DREAMPlace - iteration 999, ( 999, 0, 0), Obj 3.067962E+16, DensityWeight 1.837067E+10, wHPWL 2.569043E+04, Overflow 6.075843E-01, MaxDensity 1.000E+00, gamma 6.292017E+00, time 0.340ms
[INFO ] DREAMPlace - full step 3.351 ms
[INFO ] DREAMPlace - optimizer nesterov takes 4.737 seconds
[INFO ] DREAMPlace - non-linear placement takes 4.74 seconds
[INFO ] DREAMPlace - writing to results/netlist/netlist.gp.def
[INFO ] writing placement to results/netlist/netlist.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.001 seconds
[INFO ] DREAMPlace - placement takes 4.772 seconds
root@24266cf0321c:/DREAMPlace/install#

```

→ Post-Global Placement HPWL (Customized):

NANGATE45-ArtNetGen:

→ Post-Global Placement HPWL (RePLACE):

→ Post-Global Placement HPWL (DreamPLACE):



```
[INFO ] DREAMPlace - ABCDPlace input legal flag = 0
[INFO ] DREAMPlace - detailed placement takes 0.006 seconds
[INFO ] DREAMPlace - iteration 1001, wHPWL 8.989416E+03, time 0.103ms
[INFO ] DREAMPlace - non-linear placement takes 38.23 seconds
[INFO ] DREAMPlace - writing to results/netlist/netlist.gp.def
[INFO ] writing placement to results/netlist/netlist.gp.def
[INFO ] DREAMPlace - write SolutionFileFormat.DEF takes 0.001 seconds
[INFO ] DREAMPlace - placement takes 38.304 seconds
root@24266cf0321c:/DREAMPlace/install#
```

→ Post-Global Placement HPWL (Customized):

Few runs had these issues:

IBEX\_ASAP7 and JPEG\_ASAP7:

```
[ASSERT ] /DREAMPlace/dreamplace/ops/place_io/src/PlaceDB.cpp:361: virtual void DreamPlace::PlaceDB::add_def_component(const DefParser::Component&): Assertion 'node.status() == PlaceStatusEnum::FIXED || node.status() == PlaceStatusEnum::PLACED' failed: non-CORE or non-BLOCK class cells must be FIXED or PLACED: _112416_ CORE TIEHIGH
Aborted (core dumped)
root@24266cf0321c:/DREAMPlace/install#
```

ARIANE136\_NANGATE:

```
[ASSERT ] /DREAMPlace/dreamplace/ops/place_io/src/PlaceDB.cpp:1471: void DreamPlace::PlaceDB::addPin(const string&, DreamPlace::Net&, DreamPlace::Node&, std::string): Assertion 'macro PinId < std::numeric_limits<index_type>::max()' failed: failed to find pin clk in macro AND2_X1
Aborted (core dumped)
root@24266cf0321c:/DREAMPlace/install#
```