Simulation Results steps

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1 First Step

Table 1: Benchmark used

Benchmark	# qubits	# gates	two-qubit gates (%)
$4gt11_{82}$	5	27	67

Table 2: Step 1 results after 100 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
No	No	3000	3000	0.03	0.99	0.98879	390
minextendrc	No	3000	3000	0.03	0.96	0.9404637	1582
minextendrc	Yes	3000	3000	0.03	0.98	0.9675513	1038
minextend	No	3000	3000	0.03	0.98	0.944128	1264
minextend	Yes	3000	3000	0.03	0.98	0.9585909	834
base	No	3000	3000	0.03	0.97	0.92331	1062
base	Yes	3000	3000	0.03	0.98	0.9568084	780

Table 3: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS	# meet. in between
No	No	5	78	84	0	0
minextendrc	No	7	226	237	17	3
minextendrc	Yes	6	173	174	10	2
minextend	No	8	158	228	16	1
minextend	Yes	6	139	165	9	0
base	No	6	177	228	16	
base	Yes	6	130	147	7	

1.1 Routing comparison

1.1.1 No initial placement

With Resource constraints

```
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[2]
       path from target[2]=[1->5] implying: swap(q1,q5)
... the minimally extending path with swaps is: cycleExtend=9
       path from source[1]=[3]
       path from target[2]=[2->0] implying: swap(q2,q0)
... the minimally extending path with swaps is: cycleExtend=20
       path from source[3]=[4->7->5] implying: swap(q4,q7) swap(q7,q5)
       path from target[3]=[3->0->2] implying: swap(q3,q0) swap(q0,q2)
... the minimally extending path with swaps is: cycleExtend=9
       path from source[1]=[0]
       path from target[2]=[5->2] implying: swap(q5,q2)
... the minimally extending path with swaps is: cycleExtend=12
       path from source[2]=[7->5] implying: swap(q7,q5)
       path from target[2]=[0->2] implying: swap(q0,q2)
... the minimally extending path with swaps is: cycleExtend=9
       path from source[1]=[5]
       path from target[2]=[0->2] implying: swap(q0,q2)
... the minimally extending path with swaps is: cycleExtend=9
       path from source[1]=[5]
       path from target[2]=[0->2] implying: swap(q0,q2)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[0]
       path from target[2]=[5->2] implying: swap(q5,q2)
... the minimally extending path with swaps is: cycleExtend=13
       path from source[2]=[0->2] implying: swap(q0,q2)
       path from target[2]=[7->5] implying: swap(q7,q5)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[2]
       path from target[2]=[3->0] implying: swap(q3,q0)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[2]
       path from target[2]=[3->0] implying: swap(q3,q0)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[7]
       path from target[2]=[2->5] implying: swap(q2,q5)
```

Without Resource constraints

```
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[2]
       path from target[2]=[1->5] implying: swap(q1,q5)
... the minimally extending path with swaps is: cycleExtend=0
       path from source[2]=[3->0] implying: swap(q3,q0)
       path from target[1]=[2]
... the minimally extending path with swaps is: cycleExtend=9
       path from source[3]=[4->1->5] implying: swap(q4,q1) swap(q1,q5)
       path from target[2]=[0->2] implying: swap(q0,q2)
... the minimally extending path with swaps is: cycleExtend=0
       path from source[3]=[3->6->8] implying: swap(q3,q6) swap(q6,q8)
       path from target[1]=[5]
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[1]
       path from target[2]=[8->5] implying: swap(q8,q5)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[1]
       path from target[2]=[8->5] implying: swap(q8,q5)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[1]
       path from target[2]=[8->5] implying: swap(q8,q5)
... the minimally extending path with swaps is: cycleExtend=10
       path from source[1]=[8]
       path from target[2]=[1->5] implying: swap(q1,q5)
... the minimally extending path with swaps is: cycleExtend=0
       path from source[1]=[8]
       path from target[2]=[2->6] implying: swap(q2,q6)
... the minimally extending path with swaps is: cycleExtend=8
       path from source[1]=[8]
       path from target[3]=[0->2->5] implying: swap(q0,q2) swap(q2,q5)
... the minimally extending path with swaps is: cycleExtend=4
       path from source[1]=[8]
       path from target[2]=[2->6] implying: swap(q2,q6)
... the minimally extending path with swaps is: cycleExtend=2
       path from source[2]=[1->5] implying: swap(q1,q5)
       path from target[1]=[8]
```

1.1.2 With initial placement

With Resource constraints

```
... Virt2Real(v->r) ... result Virt2Real map of InitialPlace before adding unused virtual qubits and unused locations : (0->10) (1->4) (2->1) (3->5) (4->7) (5->2147483647) (6->2147483647) (7->2147483647) (8->2147483647) (9->2147483647) (10->2147483647) (11->2147483647) (12->2147483647) (13->2147483647) (14->2147483647) (15->2147483647) (16->2147483647)
... Virt2Real(v->r) ... final result Virt2Real map of InitialPlace: (0->10) (1->4) (2->1) (3->5) (4->7) (5->0) (6->2) (7->3) (8->6) (9->8) (10->9) (11->11) (12->12) (13->13) (14->14) (15->15) (16->16)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[10]
        path from target[2]=[4->7] implying: swap(q4,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[10]
        path from target[2]=[5->8] implying: swap(q5,q8)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[2]=[10->8] implying: swap(q10,q8)
        path from target[2]=[1->5] implying: swap(q1,q5)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[8]
        path from target[2]=[7->5] implying: swap(q7,q5)
... the minimally extending path with swaps is: cycleExtend=12
        path from source[2]=[4->1] implying: swap(q4,q1)
        path from target[2]=[8->5] implying: swap(q8,q5)
```

Without Resource constraints

```
... Virt2Real(v->r) ... result Virt2Real map of InitialPlace before adding unused virtual qubits and unused locations : (0->10) (1->4) (2->1) (3->5) (4->7) (5->2147483647) (6->2147483647) (7->2147483647) (8->2147483647) (9->2147483647) (10->2147483647) (11->2147483647) (12->2147483647) (13->2147483647) (14->2147483647) (15->2147483647) (16->2147483647)
... Virt2Real(v->r) ... final result Virt2Real map of InitialPlace: (0->10) (1->4) (2->1) (3->5) (4->7) (5->0) (6->2) (7->3) (8->6) (9->8) (10->9) (11->11) (12->12) (13->13) (14->14) (15->15) (16->16)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[4]
        path from target[2]=[10->7] implying: swap(q10,q7)
... the minimally extending path with swaps is: cycleExtend=10
        path from source[1]=[10]
        path from target[2]=[4->7] implying: swap(q4,q7)
... the minimally extending path with swaps is: cycleExtend=0
        path from source[1]=[10]
        path from target[2]=[5->8] implying: swap(q5,q8)
... the minimally extending path with swaps is: cycleExtend=8
        path from source[1]=[10]
        path from target[3]=[1->5->7] implying: swap(q1,q5) swap(q5,q7)
... the minimally extending path with swaps is: cycleExtend=4
        path from source[1]=[10]
        path from target[2]=[5->8] implying: swap(q5,q8)
... the minimally extending path with swaps is: cycleExtend=2
        path from source[2]=[4->7] implying: swap(q4,q7)
        path from target[1]=[10]
```

2 1000 iterations

Table 4: Step 1 results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
No	No	3000	3000	0.03	0.96	0.97823066	390
minextendrc	No	3000	3000	0.03	0.929	0.92937318	1582
minextendrc	Yes	3000	3000	0.03	0.939	0.94685216	1038
minextend	No	3000	3000	0.03	0.947	0.9312172	1264
minextend	Yes	3000	3000	0.03	0.949	0.94748374	834
base	No	3000	3000	0.03	0.932	0.906571	1062
base	Yes	3000	3000	0.03	0.9509	0.9459456	780

3 10000 iterations

Table 5: Step 1 results after 10000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
No	No	3000	3000	0.03	0.961	0.980342528	390
minextendrc	No	3000	3000	0.03	0.9372	0.937136544	1582
minextendrc	Yes	3000	3000	0.03	0.9435	0.951650597	1038
minextend	No	3000	3000	0.03	0.9519	0.93665818	1264
minextend	Yes	3000	3000	0.03	0.9556	0.954629151	834
base	no	3000	3000	0.03	0.9417	0.9156453	1062
base	yes	3000	3000	0.03	0.953	0.95037428	780

3.1 Conclusions

3.1.1 Probability of success

Table 6: Probability of success difference between the number of iterations

Mapper	Init. place	100 it.	1000 it.	10000 it.	Diff 1000-100	Diff 10000-1000
No	No	0.99	0.96	0.961	-0.0300	0.0010
minextendrc	No	0.96	0.929	0.9372	-0.0310	0.0082
minextendrc	Yes	0.98	0.939	0.9435	-0.0410	0.0045
minextend	No	0.98	0.947	0.9519	-0.0330	0.0049
minextend	Yes	0.98	0.949	0.9556	-0.0310	0.0066
base	No	0.97	0.932	0.9417	-0.0380	0.0097
base	Yes	0.98	0.9509	0.953	-0.0291	0.0021

Table 7: Mean value of the probability of success difference between number of iterations

Iterations comparison	Mean diff
1000-100	-0.0333
10000-1000	0.0053

3.1.2 Fidelity

Table 8: Fidelity difference between the number of iterations

Mapper	Init. place	100 it.	1000 it.	10000 it.	Diff 1000-100	Diff 10000-1000
No	No	0.98879	0.97823066	0.980342528	-0.0106	0.0021
minextendrc	No	0.9404637	0.92937318	0.937136544	-0.0111	0.0078
minextendrc	Yes	0.9675513	0.94685216	0.951650597	-0.0207	0.0048
minextend	No	0.944128	0.9312172	0.93665818	-0.0129	0.0054
minextend	Yes	0.9585909	0.94748374	0.954629151	-0.0111	0.0071
base	No	0.92331	0.906571	0.9156453	-0.0167	0.0091
base	Yes	0.9568084	0.9459456	0.95037428	-0.0109	0.0044

Table 9: Mean value of the fidelity difference between number of iterations

Iterations comparison	Mean diff
1000-100	-0.0134
10000-1000	0.0058

4 Simplest benchmarks results

Table 10: Benchmarks used

Benchmark	# qubits	# gates
$4gt12_{v189}$	6	228
$4gt4_{v072}$	6	258
$4mod5_{bdd287}$	7	70
$4mod5_{v020}$	5	20

4.1 4gt12-v1$_{89}$

Table 11: Results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
no	no	3000	3000	0.005	0.768	0.66623522	2496
minextendrc	no	3000	3000	0.005	0.562	**0.44841106**	10548
minextend	no	3000	3000	0.005	**0.601**	0.40972458	9072
base	no	3000	3000	0.005	0.517	0.3581228	6414

Table 12: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS
no	no	6	416	658	0
minextendrc	no	9	1172	**1360**	**78**
minextend	no	9	**1008**	1549	99
base	no	6	1069	1423	85

4.2 4gt4-v0$_{72}$

Table 13: Results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
no	no	3000	3000	0.005	0.786	0.68007548	2652
minextendrc	no	3000	3000	0.005	0.452	**0.37749204**	12168
minextend	no	3000	3000	0.005	0.498	0.34067243	7704
base	no	3000	3000	0.005	**0.532**	0.35703954	6336

Table 14: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS
no	no	6	442	746	0
minextendrc	no	9	1352	1592	94
minextend	no	8	**963**	1736	110
base	no	6	1056	**1547**	**89**

4.3 4mod5-bdd$_{287}$

Table 15: Results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
no	no	3000	3000	0.005	0.916	0.87474237	1029
minextendrc	no	3000	3000	0.005	0.753	0.65935538	3924
minextend	no	3000	3000	0.005	**0.798**	**0.69281491**	2988
base	no	3000	3000	0.005	0.776	0.67942877	2338

Table 16: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS
no	no	7	147	203	0
minextendrc	no	9	436	500	33
minextend	no	9	**332**	500	33
base	no	7	334	**419**	**24**

4.4 4mod5-v0$_{20}$

Table 17: Results after 1000 iterations

Mapper	Init. place	t_1	t_2	meas. err.	p. success	f	V_Q
no	no	3000	3000	0.005	0.985	0.97145968	265
minextendrc	no	3000	3000	0.005	**0.944**	**0.9092329**	1251
minextend	no	3000	3000	0.005	0.938	0.88981602	1024

Table 18: Other mapper statistics

Mapper	Init. place	# qubits	depth	# gates	# SWAPS
no	no	5	53	61	0
minextendrc	no	9	139	**142**	**9**
minextend	no	8	**128**	160	11