

# ISPD 2007 Global Routing Contest

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# Contest Logistics

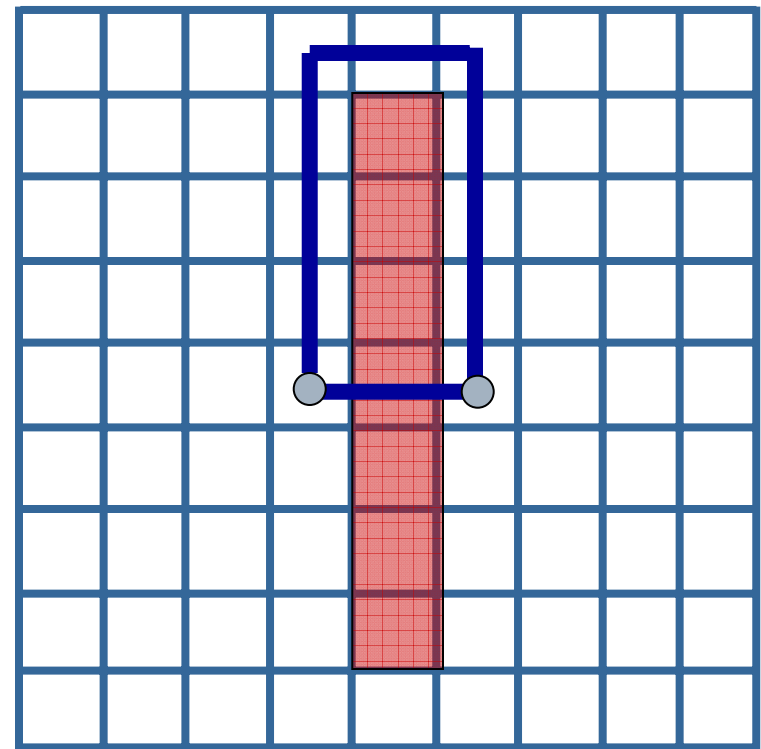
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- Open contest primarily for academic community
- Total 17 team registered initially
  - 14 academic teams, 3 industry teams
- 11 final entries
- 8 new global routing benchmarks are released
  - All derived from ISPD 2005/2006 placement benchmark solutions
- Contestants had about 2 weeks to run their global router on benchmarks
  - Organizer verified all global routing solutions with an official script
- Quality metrics
  - Minimizing overflows
  - No CPU time limits

# More Discussion on Quality Metrics

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- A bit of mishap on this
  - Originally AWL model is attempted
  - Didn't worked out
- Final quality metric
  - Minimum  $\Sigma$  Rank(circuit) wins the game
  - Rank per circuit is determined by
    - Minimum total overflows
    - Max overflow as the 1st tie breaker
    - Routed wire length as the 2<sup>nd</sup> tie breaker
- Routed wire length calculation considers via cost



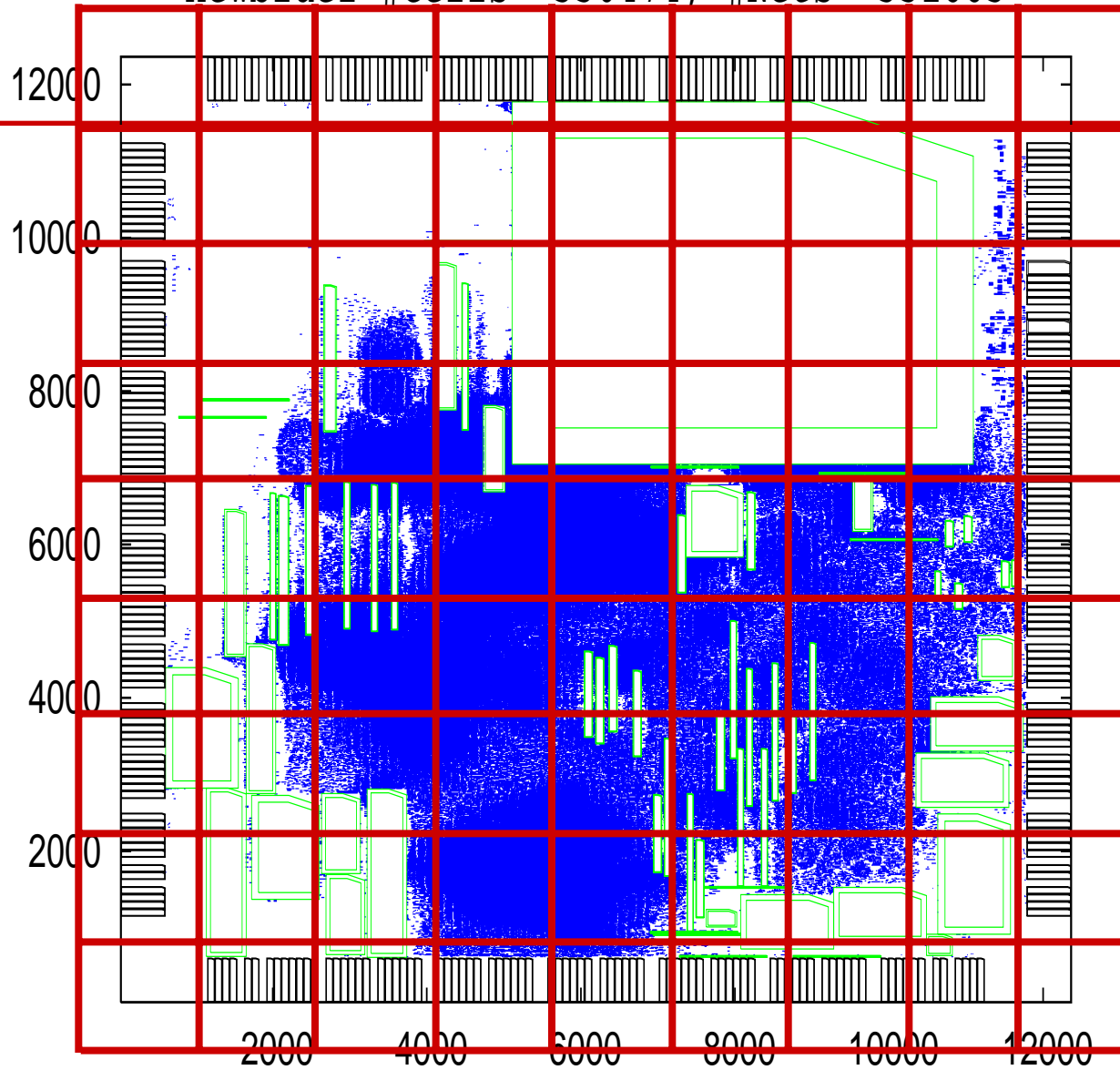
Example from Mustafa Ozdal, Intel. Corp.

# How Benchmarks were Generated

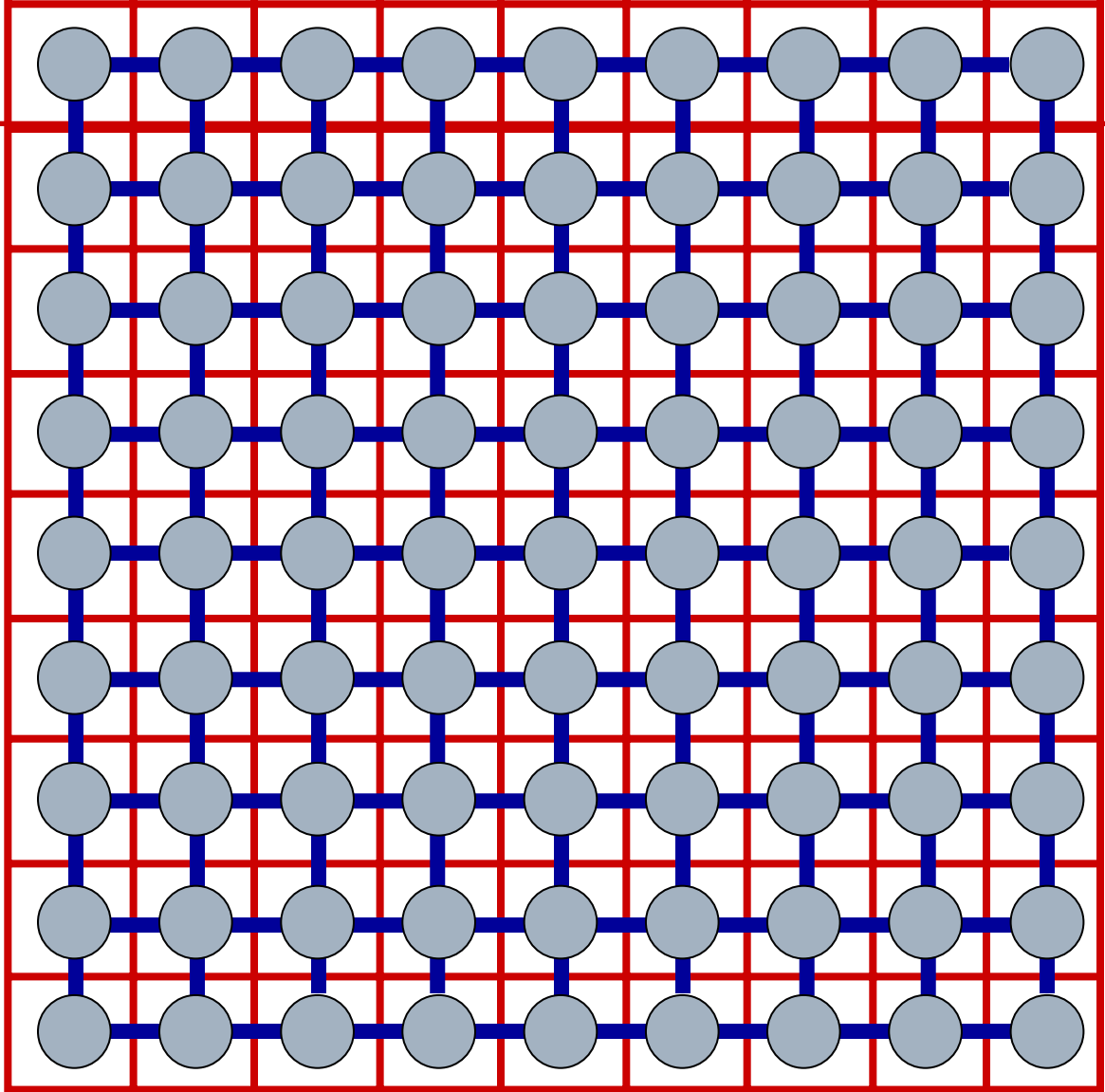
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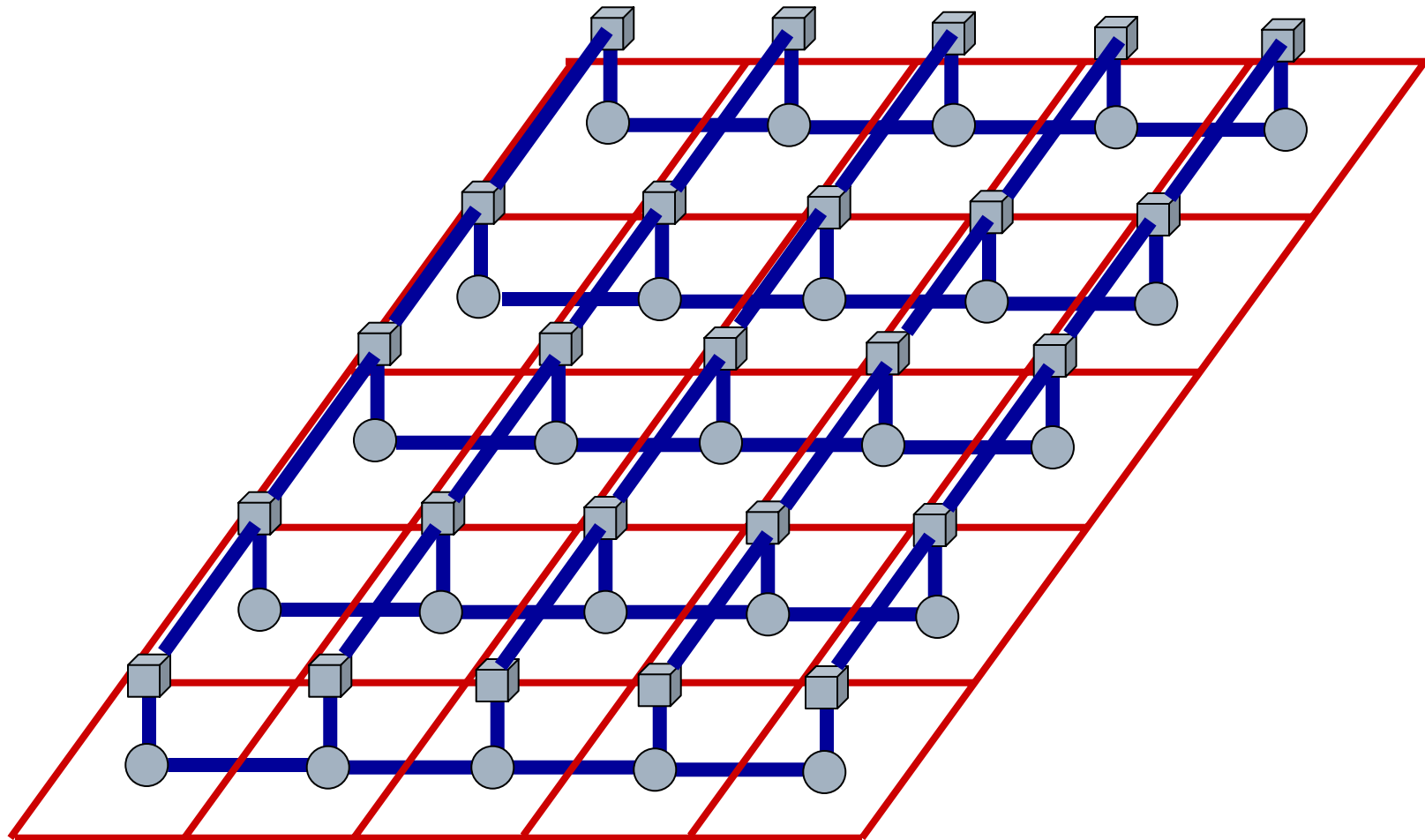
- For each ISPD 2005/2006 benchmark
  - adaptec1, adaptec2, adaptec3, adaptec4, adaptec5, newblue1, newblue2, newblue3
  - 1. Pick Placement tools
    - Capo, mPL6, Dragon, APlace3, mFAR, NTUPlace3.0, FastPlace3.0, Kraftwerk
  - 2. Pick density target
    - From 50% to 90%
  - 3. Generate placement solution
  - 4. Impose a tile structure
    - Basic routing resources are determined
  - 5. Adjust routing resources

newblue1 #Cells= 330474, #Nets= 331663



\*Placement layout figure was generated by Capo Placer utility package.





# Routing Resource (Edge Capacity) Adjustment

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- Essentially determines the level of difficulty of benchmark
- Tile size
  - 30–50 wire tracks
- Limited usage in M1/M2 layer
  - 20% of available wire tracks
- Guard band
  - 90-100% of tile size
- Blockage Porosity

adaptec3.dragon70.2d.30.50.90.gr



ISPD Placement  
Benchmark Name

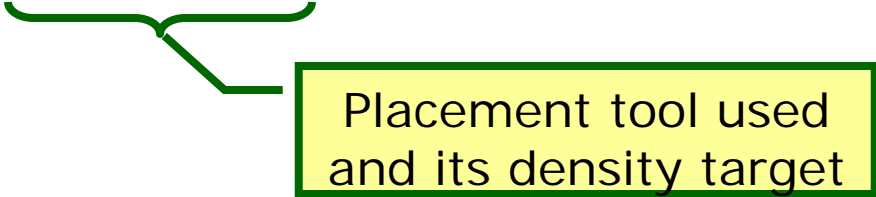


# Edge Capacity Adjustment

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adaptec3.dragon70.2d.30.50.90.gr



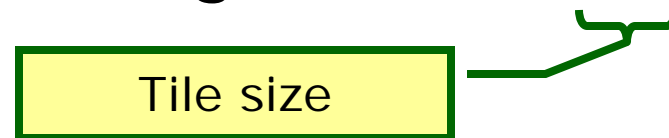
Placement tool used  
and its density target

# Edge Capacity Adjustment

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adaptec3.dragon70.2d.30.50.90.gr




# Edge Capacity Adjustment

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adaptec3.dragon70.2d.30.50.90.gr



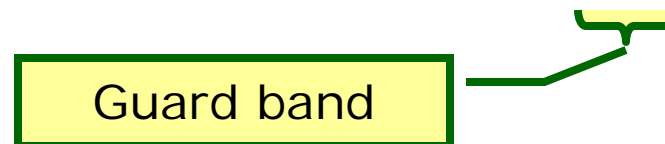
Block Porosity

# Edge Capacity Adjustment

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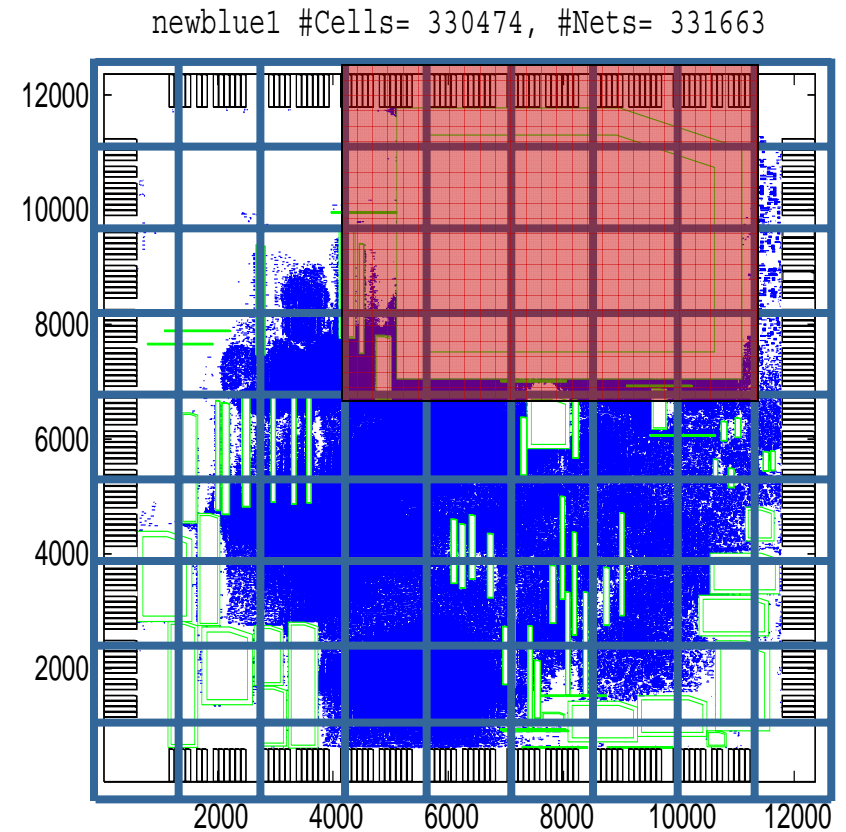
adaptec3.dragon70.2d.30.50.90.gr



# More on Block Porosity

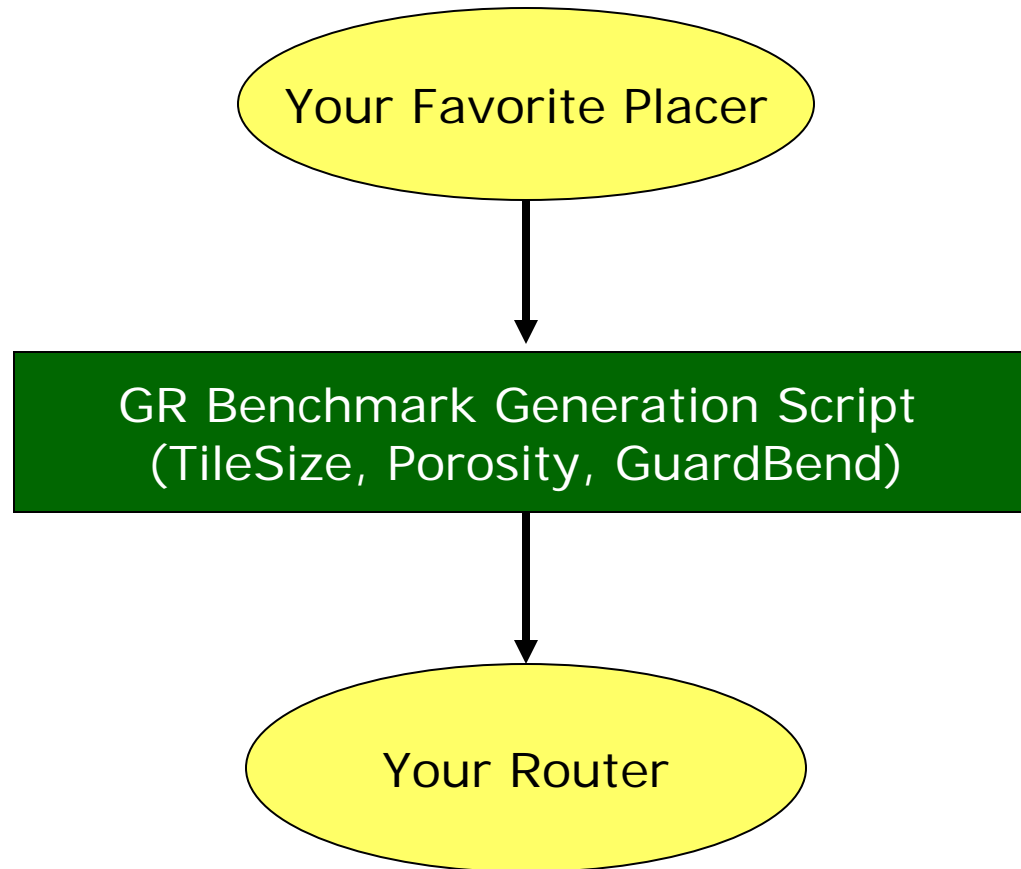
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- Affects any tiles that sit on top of blockages
- Only affects M3/M4 metal layers



# Interesting Research Setup

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# ISPD 2007 Global Routing Contest Winner

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- 3<sup>rd</sup> Place
  - 2D: BoxRouter
    - Minsik Cho from Univ. of Texas
  - 3D: FGR
    - Jarrod Roy from Univ. of Michigan
- 2<sup>nd</sup> place
  - 2D: MaizeRouter
    - Michael D. Moffitt from Univ. of Michigan
  - 3D: BoxRouter
    - Minsik Cho from Univ. of Texas
- 1<sup>st</sup> place
  - 2D: FGR
  - 3D: MaizeRouter

# Summary

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- Turned out to be a pretty interesting/successful event
  - A good set of global routing benchmarks
    - Overflow minimization
    - Routed wire length minimization
- Created interesting research test bench
  - Arbitrary combination of placement and global routing algorithm is possible for routability analysis
- Look forward to next global/detailed routing contest
  - Open to any suggestions/feedbacks
- <http://www.ispd.cc/rcontest>

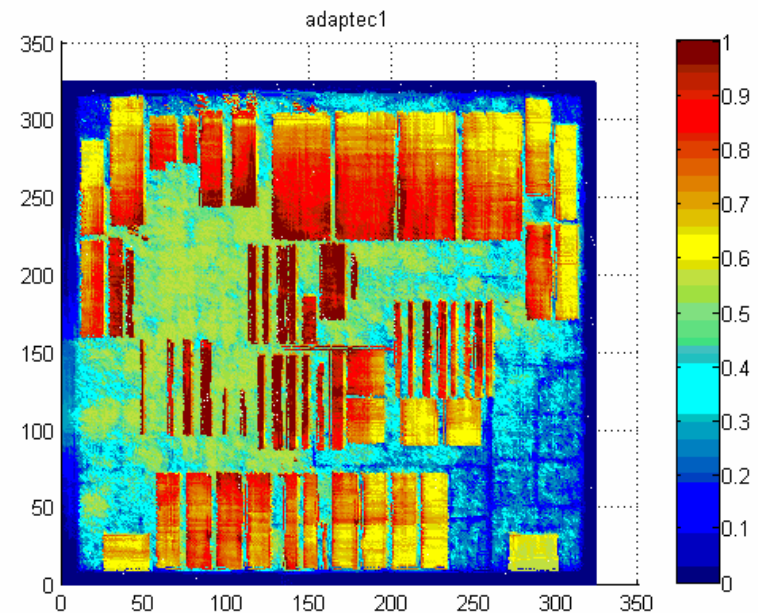


# ISPD 2007 Global Routing Contest Data

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# adaptec1.capo70.2d.35.50.90.gr

	Total OV	Max OV	WL
FGR	0	0	55.80
BoxRouter	0	0	58.84
MaizeRouter	0	0	62.26
FastRouter	122	4	90.47
Bockenem	608	4	79.76
NTHU-R(3)	3474	18	79.06
NCTU-R(10)	3800	16	80.91
FlexRouter	8698	24	64.97
NTU2-R(13)	32520	30	61.63
NTU1-R(9)	62638	14	61.93



The data are from grc\_eval.pl script. Also, thanks to MinSik Cho from BoxRouter Group for Congestion Map

# adaptec1.capo70.3d.35.50.90.gr

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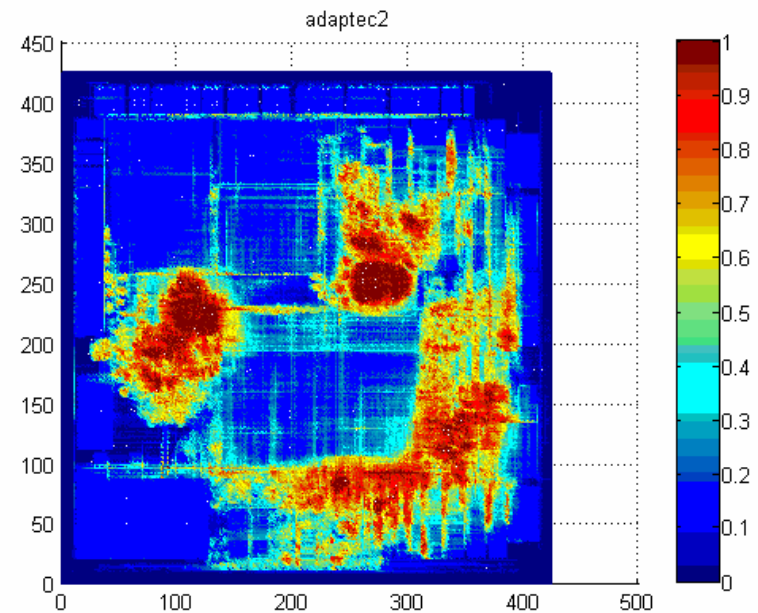
	Total OV	Max OV	WL
MaizeRouter	0	0	99.61
BoxRouter	0	0	104.05
FGR	60	2	90.92
FastRouter	122	4	248.95
Bockenem	1240	8	254.25
NTHU-R(3)	3476	6	193.71
FlexRouter	8698	16	120.22
NTU1-R(9)	62638	14	114.63
NTU2-R(13)*	32488	6	253.02

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\* 1 net had incomplete/invalid routing solution.

# adaptec2.mpl60.2d.35.20.100.gr

	Total OV	Max OV	WL
FGR	0	0	53.69
BoxRouter	0	0	55.69
MaizeRouter	0	0	57.23
FastRouter	500	12	82.46
Bockenem	880	8	94.91
NTHU-R(3)	3588	16	65.91
NCTU-R(10)	5178	32	75.51
FlexRouter	7370	44	58.90
NTU2-R(13)	13860	72	62.03
NTU1-R(9)	24738	22	56.94



# adaptec2.mpl60.3d.35.20.100.gr

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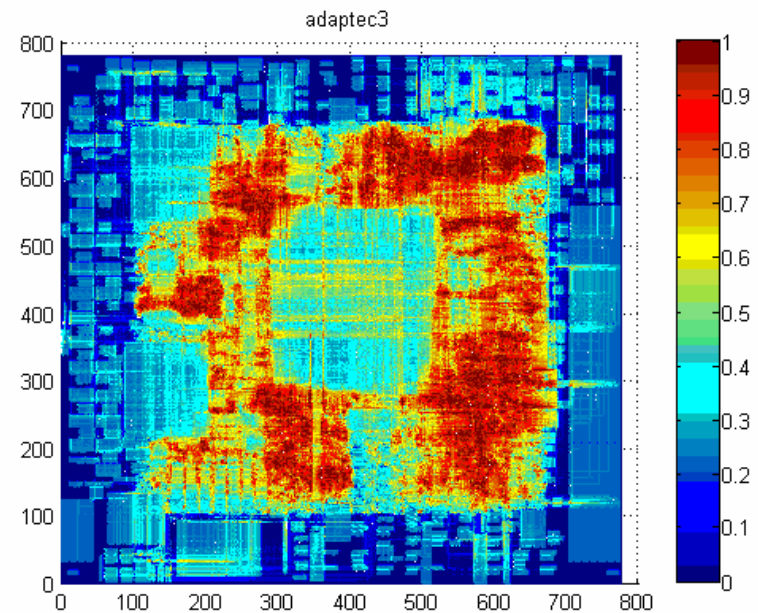
	Total OV	Max OV	WL
MaizeRouter	0	0	98.12
BoxRouter	0	0	102.97
FGR	50	2	92.19
FastRouter	500	12	244.41
NTHU-R(3)	3588	6	177.27
FlexRouter	7370	24	113.70
Bockenem	10428	12	210.68
NTU1-R(9)	24738	20	111.76
NTU2-R(13)*	13662	12	243.15

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\* 2 nets had incomplete/invalid routing solutions.

# adaptec3.dragon70.2d.30.50.90.gr

	Total OV	Max OV	WL
FGR	0	0	133.34
MaizeRouter	0	0	137.75
BoxRouter	0	0	140.87
FastRoute	0	0	202.53
NTHU-R(3)	64	6	176.49
NCTU-R(10)	98	4	184.31
FlexRouter	950	12	155.41
Bockenem	3266	24	177.59
NTU1-R(9)	31178	30	141.67
NTU2-R(13)*	43332	24	401.58



\* 10 nets had incomplete/invalid routing solutions.

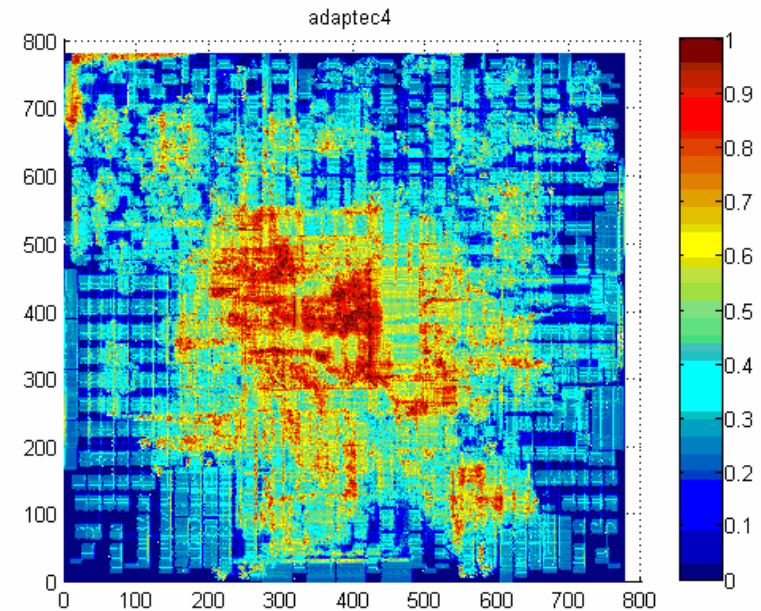
adaptec3.dragon70.3d.30.50.90.gr

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	Total OV	Max OV	WL
FGR	0	0	203.44
MaizeRouter	0	0	214.08
BoxRouter	0	0	235.87
FastRouter	0	0	523.21
NTHU-R(3)	64	2	405.88
FlexRouter	950	10	268.92
NTU1-R(9)	31178	22	412.65
NTU2-R(13)	43332	8	668.36
Bockenem	166498	42	406.89

# adaptec4.aplace60.2d.30.50.90.gr

	Total OV	Max OV	WL
FGR	0	0	126.05
MaizeRouter	0	0	128.45
BoxRouter	0	0	128.75
NTHU-R(3)	0	0	142.05
FastRouter	0	0	170.80
NCTU-R(10)	8	2	160.20
FlexRouter	18	4	135.19
Bockenem	396	8	156.57
NTU1-R(9)	1342	10	132.83
NTU2-R(13)	4064	26	143.19





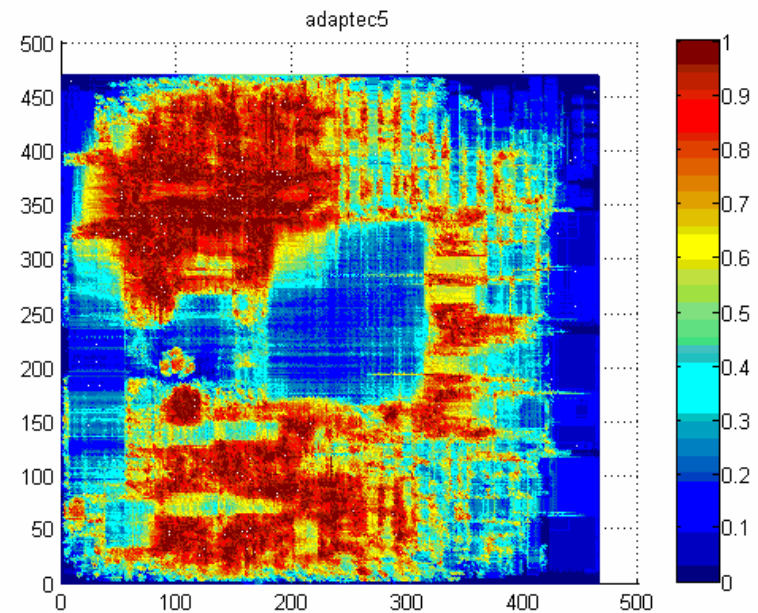
adaptec4.aplace60.3d.30.50.90.gr

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	Total OV	Max OV	WL
FGR	0	0	186.31
MaizeRouter	0	0	194.38
BoxRouter	0	0	211.95
NTHU-R(3)	0	0	302.79
FastRouter	0	0	469.34
FlexRouter	18	4	227.24
NTU1-R(9)	1342	10	252.07
NTU2-R(13)	4064	6	599.72
Bockenem	7370	10	391.80

# adaptec5.mfar50.2d.50.20.100.gr

	Total OV	Max OV	WL
FGR	0	0	155.82
BoxRouter	0	0	164.32
MaizeRouter	2	2	176.69
Bockenem	3496	14	231.65
FastRouter	9680	76	251.68
NCTU-R(10)	16400	38	235.65
NTHU-R(3)	20630	30	258.09
FlexRouter	21802	38	181.16
NTU1-R(9)	208804	60	165.65
NTU2-R(13)*	119822	46	437.92



\* 16 nets had incomplete/invalid routing solutions.

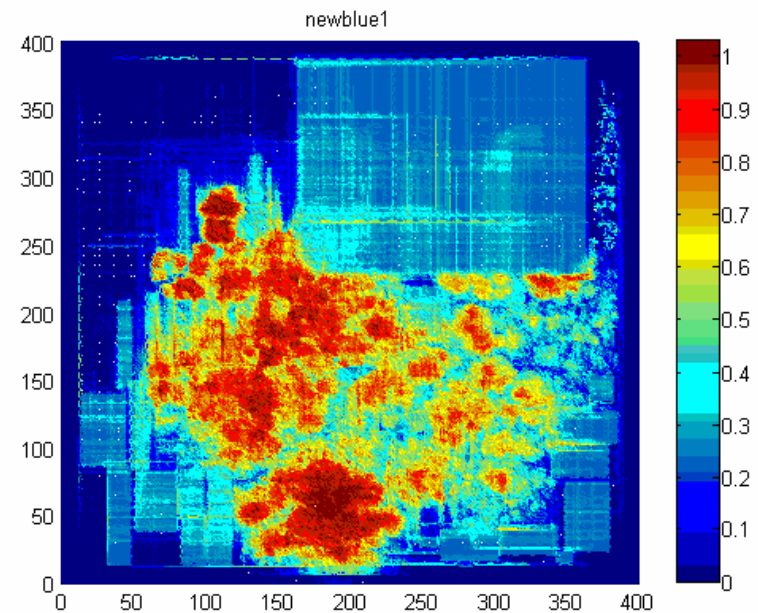
adaptec5.mfar50.3d.50.20.100.gr

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	Total OV	Max OV	WL
BoxRouter	0	0	298.08
MaizeRouter	2	2	305.32
FGR	2480	2	264.58
FastRouter	9894	76	707.86
NTHU-R(3)	20632	10	504.97
FlexRouter	21802	26	336.09
Bockenem	98950	20	575.76
NTU2-R(13)	120602	16	718.64
NTU1-R(9)	208804	48	556.45

# newblue1.ntup50.2d.30.50.90.gr

	Total OV	Max OV	WL
BoxRouter	400	2	51.13
FGR	1218	10	47.51
MaizeRouter	1348	16	50.93
FastRouter	1934	32	74.10
Bockenem	2754	10	84.00
NTHU-R(3)	5526	32	55.62
NTU2-R(13)	6570	42	53.37
NCTU-R(10)	6722	38	67.76
FlexRouter	7636	44	51.41
NTU1-R(9)	17872	36	50.02



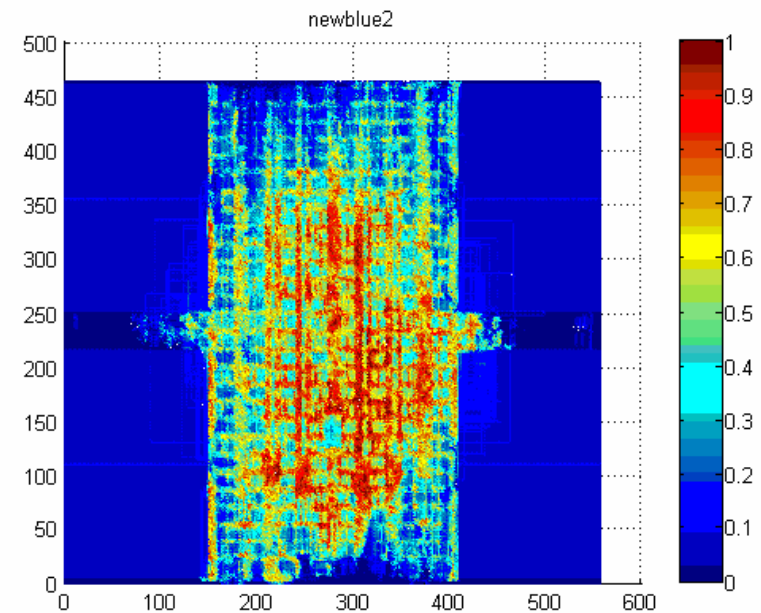
newblue1.ntup50.3d.30.50.90.gr

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	Total OV	Max OV	WL
BoxRouter	400	2	101.83
MaizeRouter	1348	16	101.74
FastRouter	2602	34	248.26
FGR	2668	4	92.89
Bockenem	3936	6	220.48
NTHU-R(3)	5526	12	179.89
NTU2-R(13)	6570	8	200.14
FlexRouter	7636	24	110.57
NTU1-R(9)	17872	22	114.52

# newblue2.fastplace90.2d.50.20.100.gr

	Total OV	Max OV	WL
FGR	0	0	77.67
MaizeRouter	0	0	79.64
BoxRouter	0	0	79.78
NTU1-R(9)	0	0	81.36
FlexRouter	0	0	81.59
NTHU-R(3)	0	0	87.74
NTU2-R(13)	0	0	89.25
Bockenem	0	0	99.11
NCTU-R(10)	0	0	105.24
FastRouter	0	0	114.95



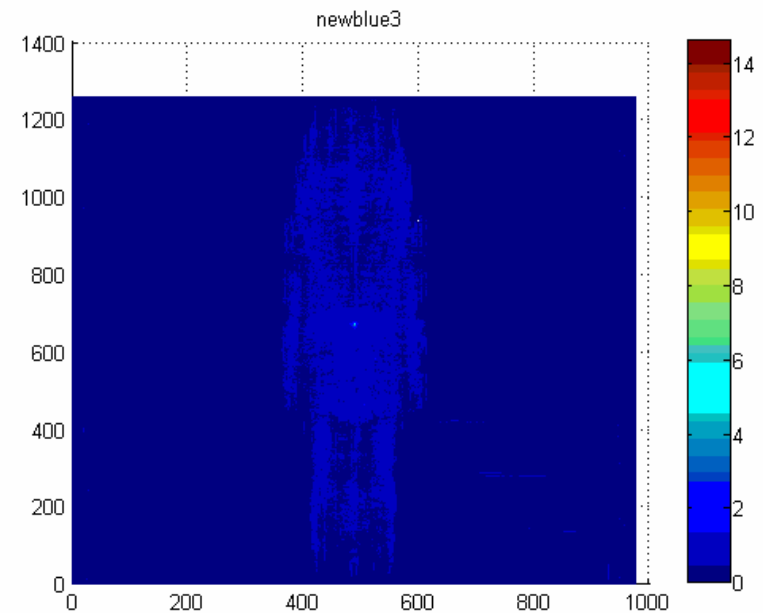
newblue2.fastplace90.3d.50.20.100.gr

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	Total OV	Max OV	WL
FGR	0	0	136.08
MaizeRouter	0	0	139.66
BoxRouter	0	0	155.07
NTU1-R(9)	0	0	167.77
FlexRouter	0	0	171.45
NTHU-R(3)	0	0	231.84
NTU2-R(13)	0	0	361.77
FastRouter	0	0	379.60
Bockenem	674	10	272.49

# newblue3.kraftwerk80.2d.40.50.90.gr

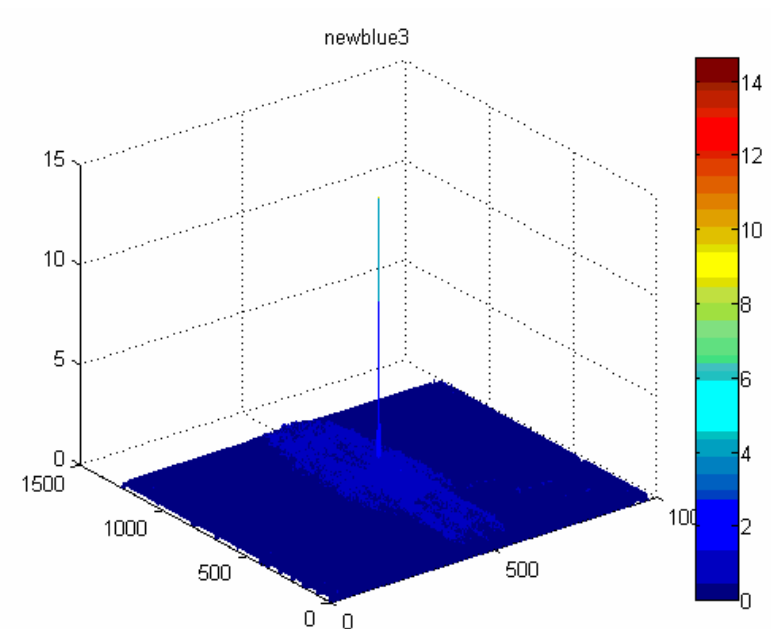
	Total OV	Max OV	WL
MaizeRouter	32588	1236	114.63
FastRouter	34236	1306	154.59
NCTU-R(10)	34310	1328	146.75
FGR	36970	1090	108.18
NTHU-R(3)	38146	810	160.80
BoxRouter	38976	1088	111.64
FlexRouter	39488	1250	118.70
NTU2-R(13)	64130	1592	119.27
Bockenem	100078	1098	130.38
NTU1-R(9)	148646	1426	117.09





# newblue3.kraftwerk80.3d.40.50.90.gr

	Total OV	Max OV	WL
MaizeRouter	32840	1058	184.40
FastRouter	34236	1306	442.72
NTHU-R(3)	38146	270	317.07
BoxRouter	38976	1088	195.50
FlexRouter	39488	780	215.88
FGR	53648	636	168.42
NTU1-R(9)	148646	1404	203.05
Bockenem	301052	1026	309.20
NTU2-R(13)*	64102	266	604.88



\* 1 net had incomplete/invalid routing solution.