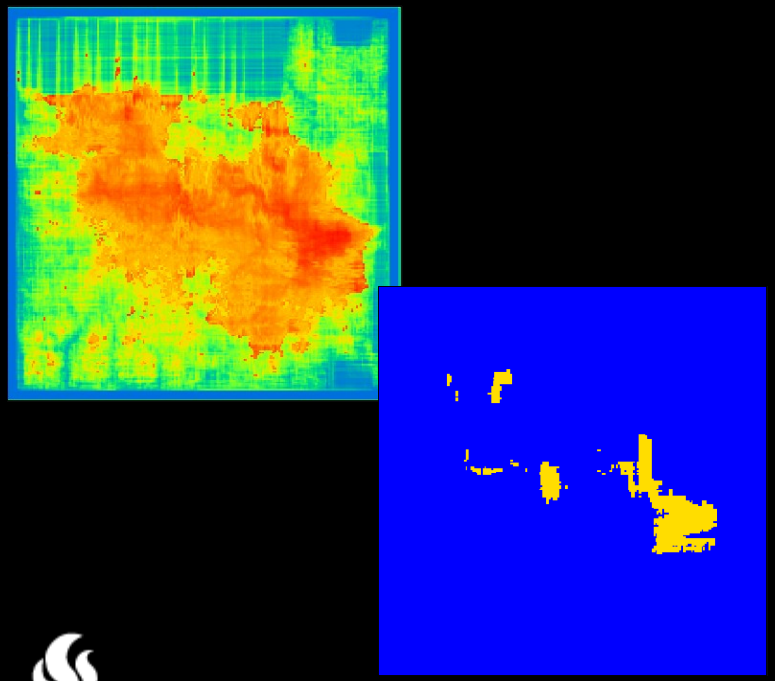
Global Routing Congestion Reduction with Cost Calibration Look-ahead



Leandro Nunes, Ricardo Reis
leandron85@gmail.com, reis@inf.ufrgs.br
SIM 2013
Porto Alegre/RS

UFRGS
PGMICRO

Problem Statement

- Grid based global routing is an exercise of cost calibration
  - There is a set of networks to be routed through the routing area
  - Interconnection will race by the routing region
  - Each tile has an associated capacity
  - Each tile has an associated cost

Global Routing Goals

- Try to find lower costs paths as possible
- Route all nets and do not exceed the capacity of any tile
  - Some nets will need to deviate

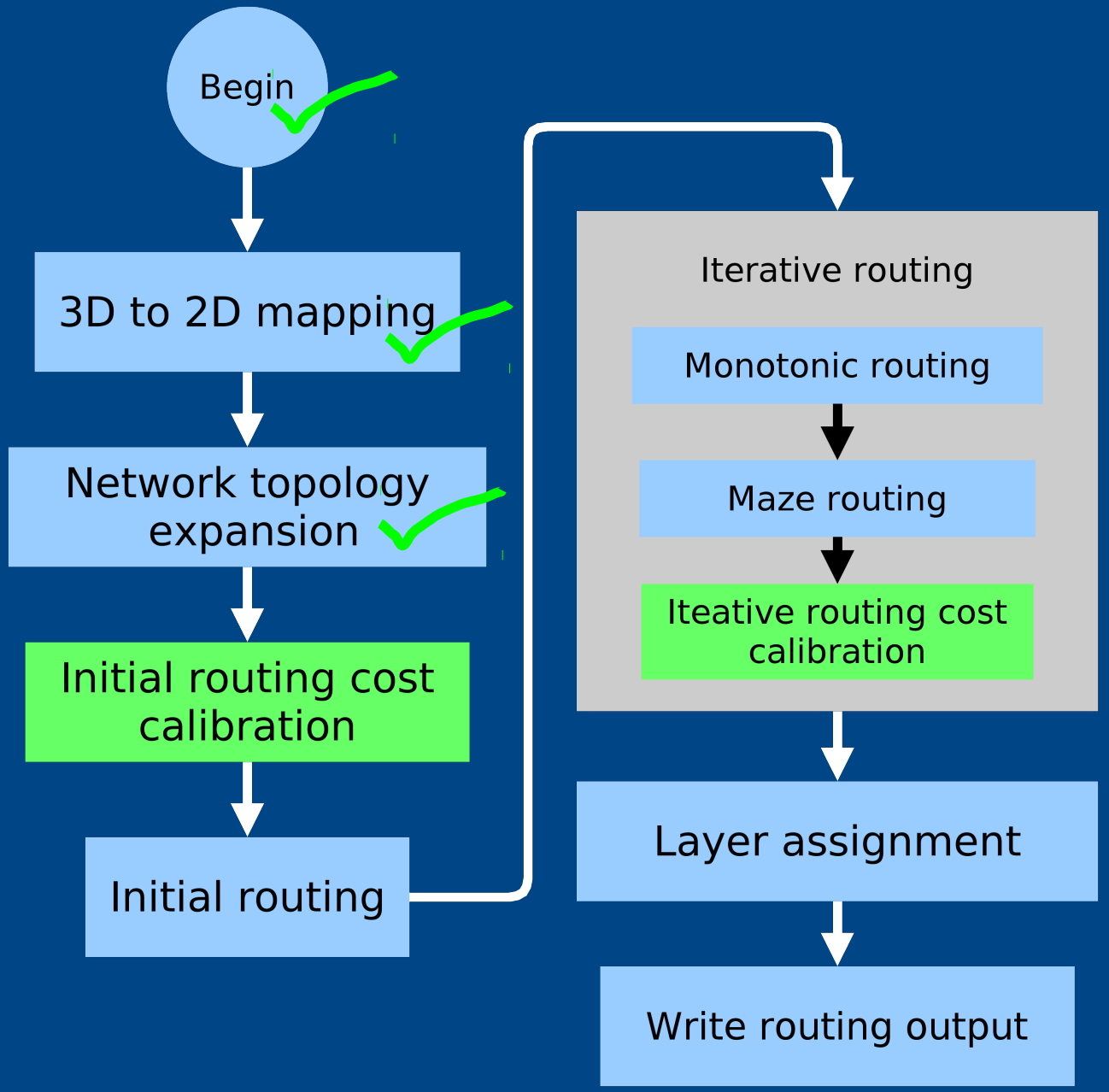
Objectives of this work

- Apply cost pre-allocation techniques to
  - speed up the global routing process
  - reduce overflow and
  - avoid side effects

GR-WL

- Used as a reference implementation
- Grid based 2D router
- Network topology using MST or FLUTE
- Iterative routing based on Ripup-and-reroute
  - Monotonic routing
  - Maze routing

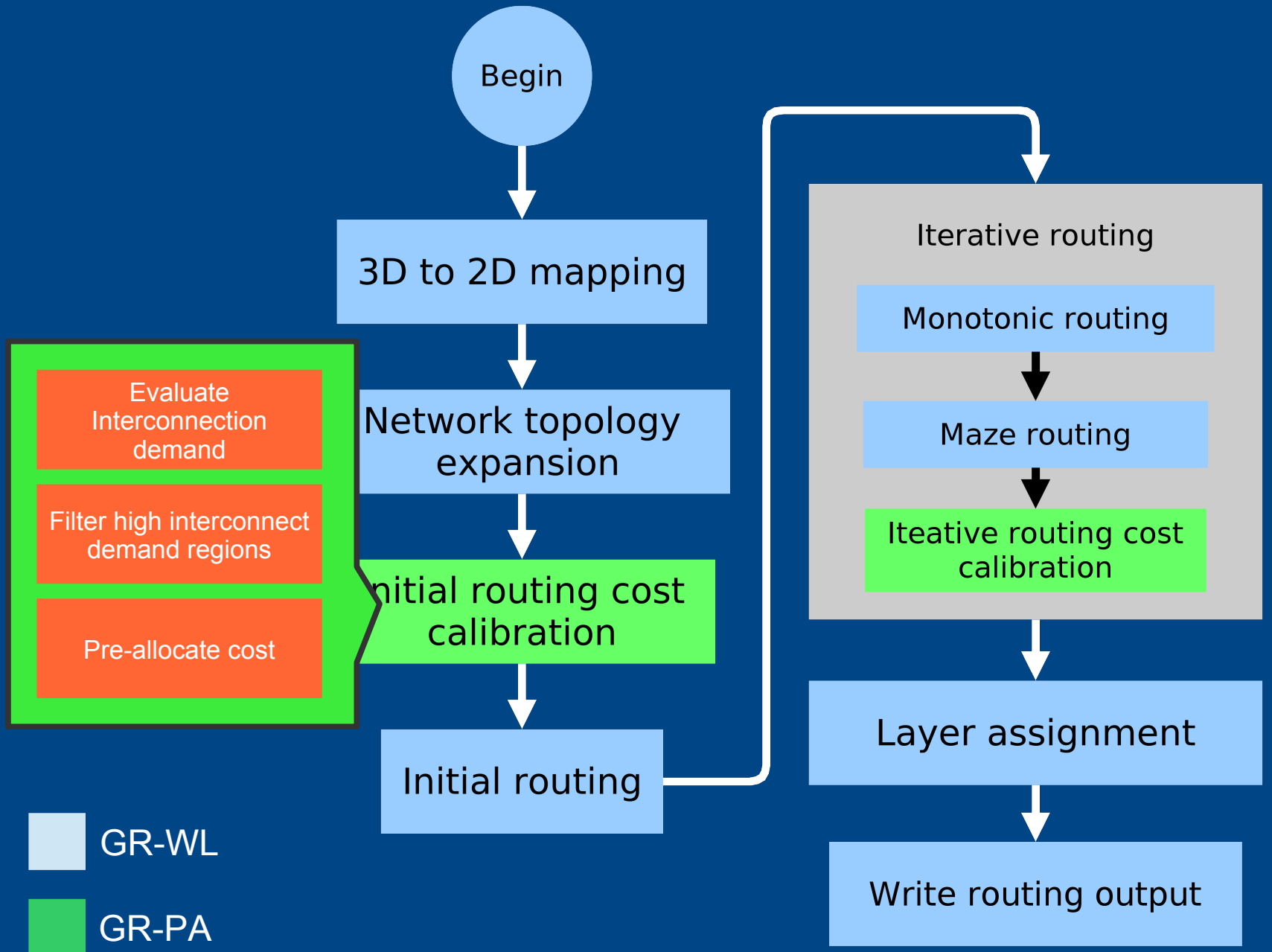
Global Routing Flow



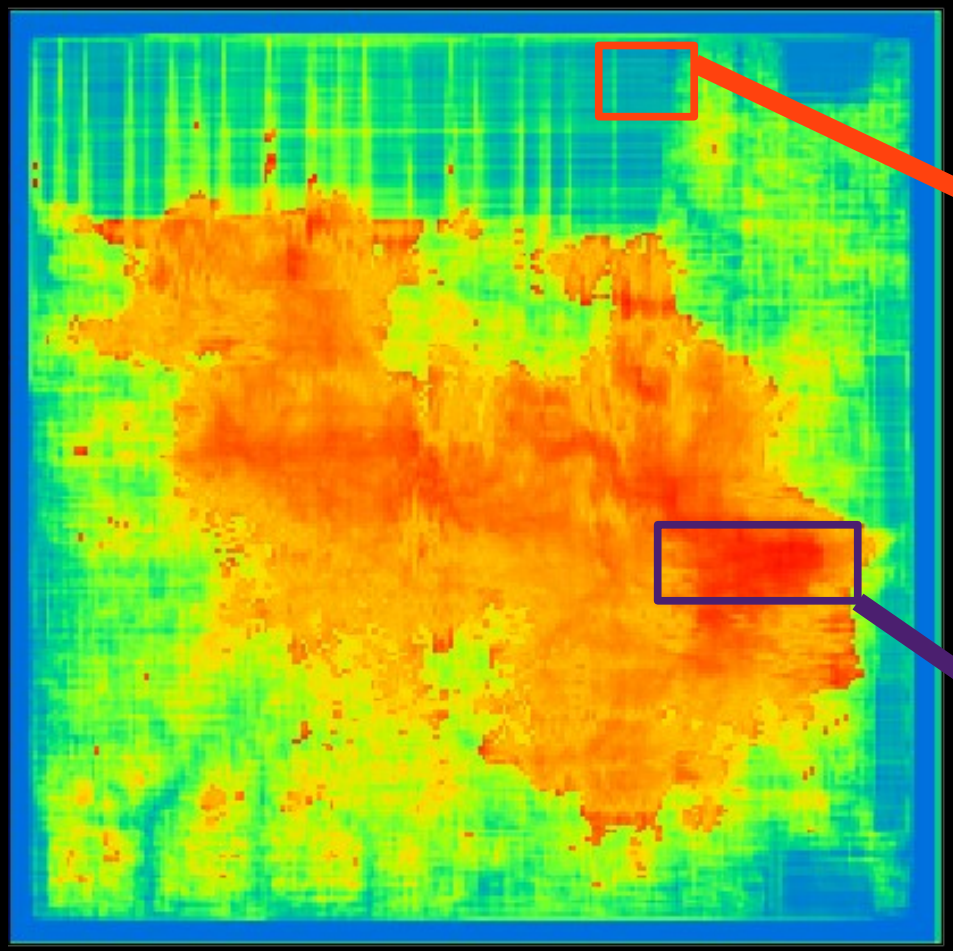
GR-WL

GR-PA

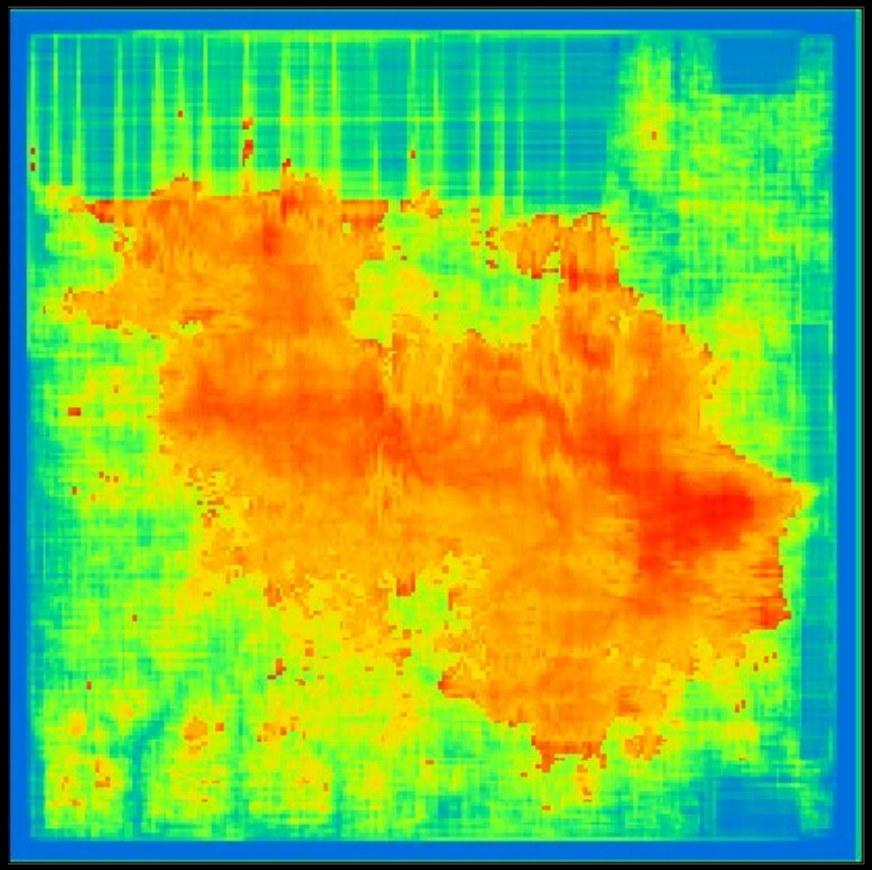
Global Routing Flow

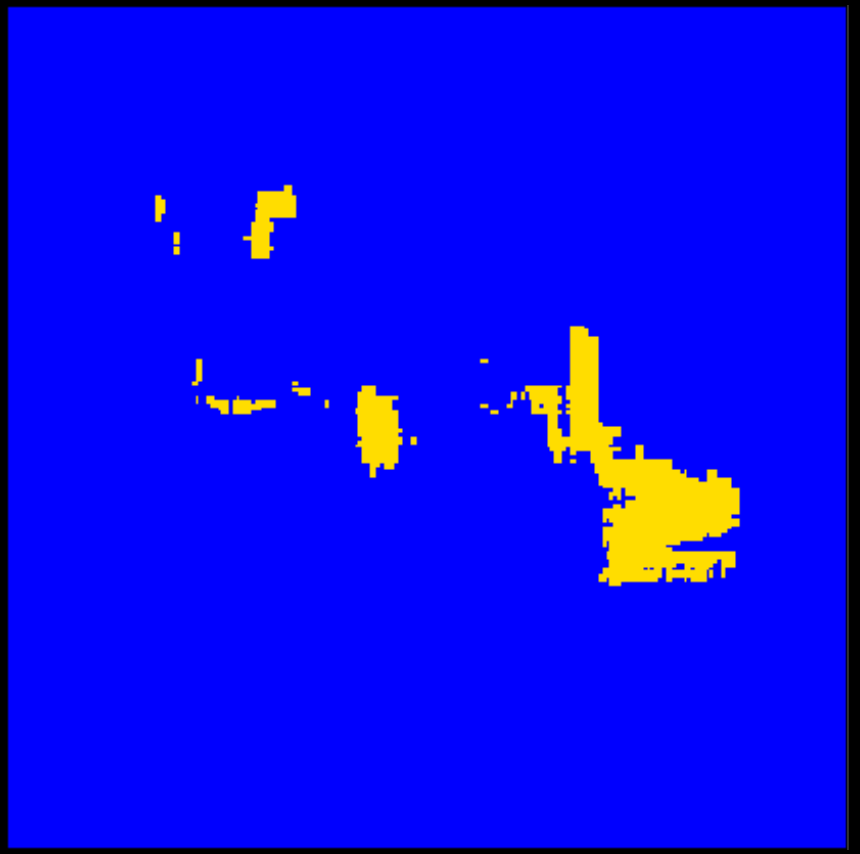


Interconnection Demand Evaluation



Interconnection Demand Evaluation





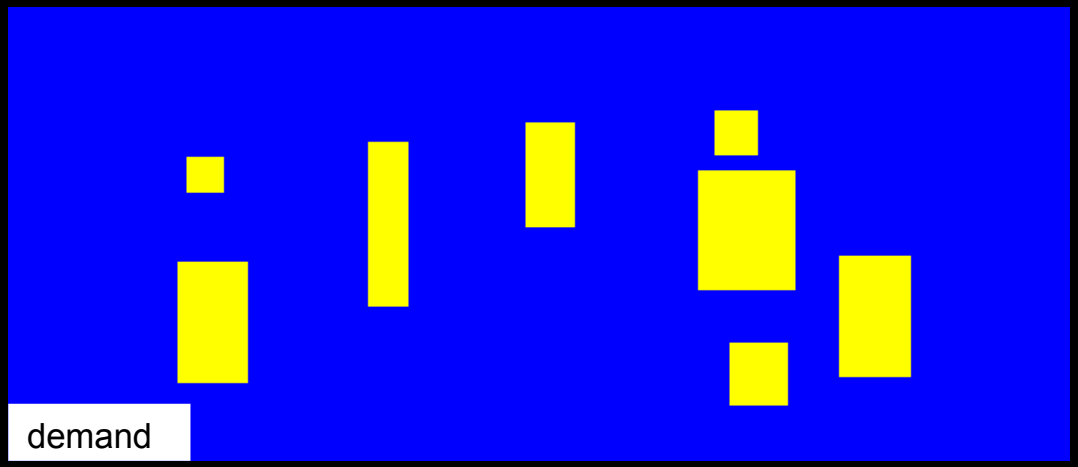
$$Cn / (Dn \times 100) > \beta$$

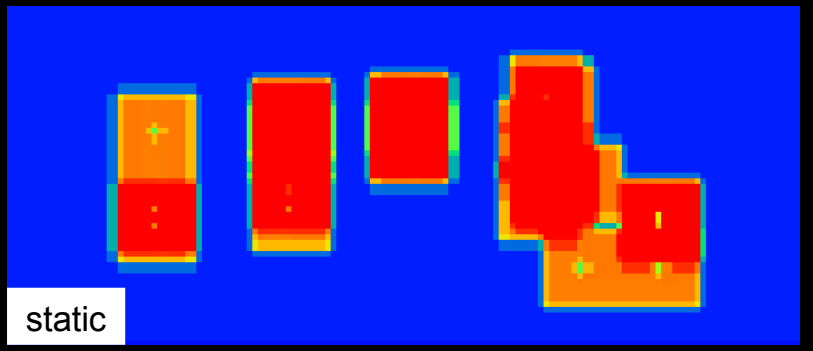
Cn = capacity of the tile
Dn = demand of the tile
β = threshold

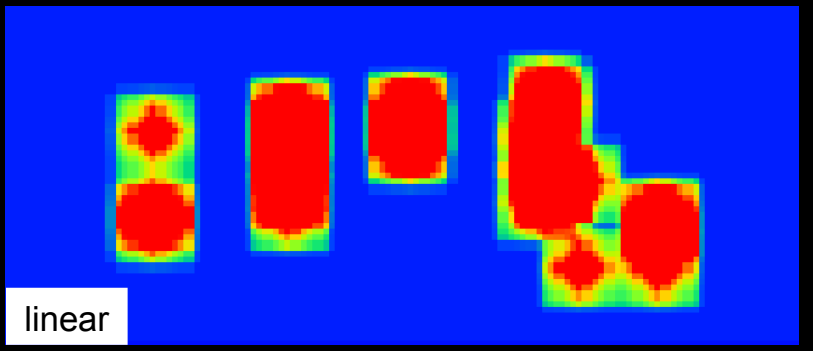
Cost Pre-allocation Functions

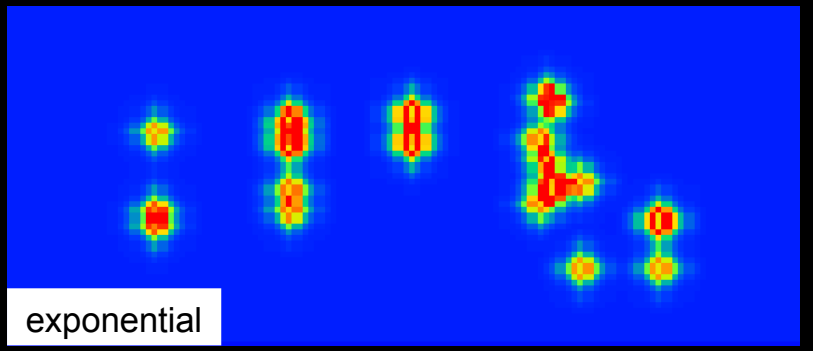
Parameters

ψ: Max increment
α: increment amplitude;
f: cost distribution function.

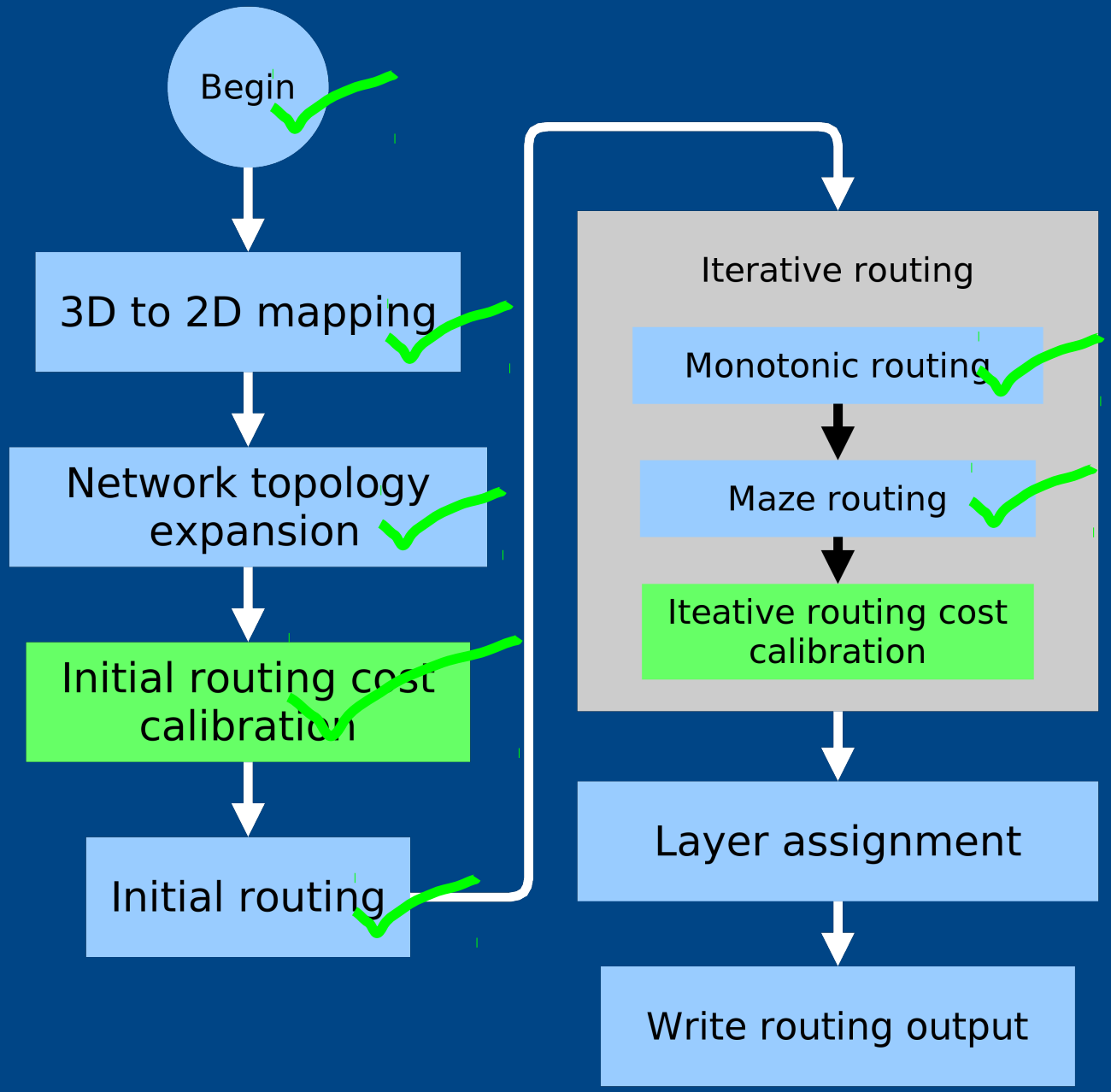








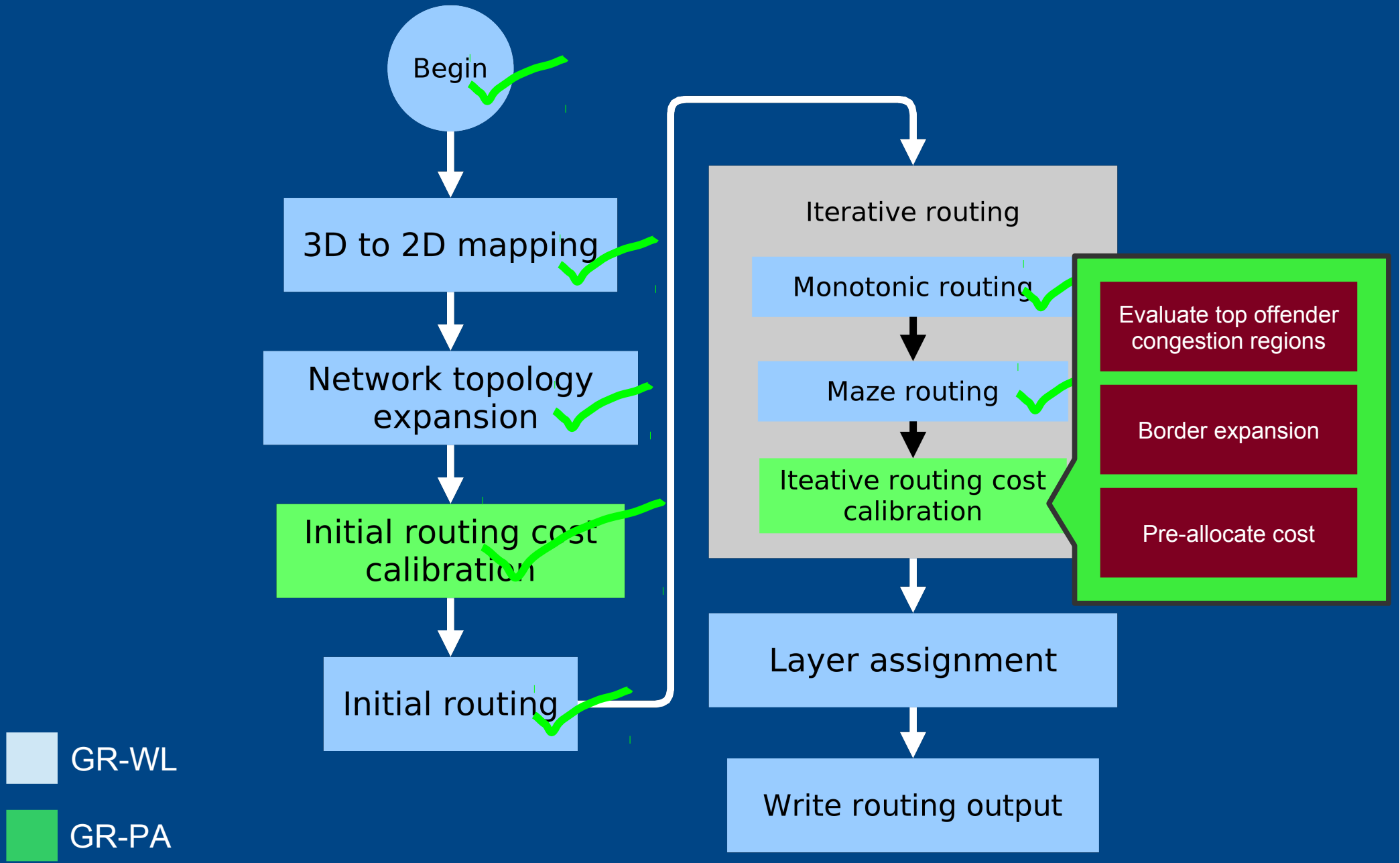
Global Routing Flow



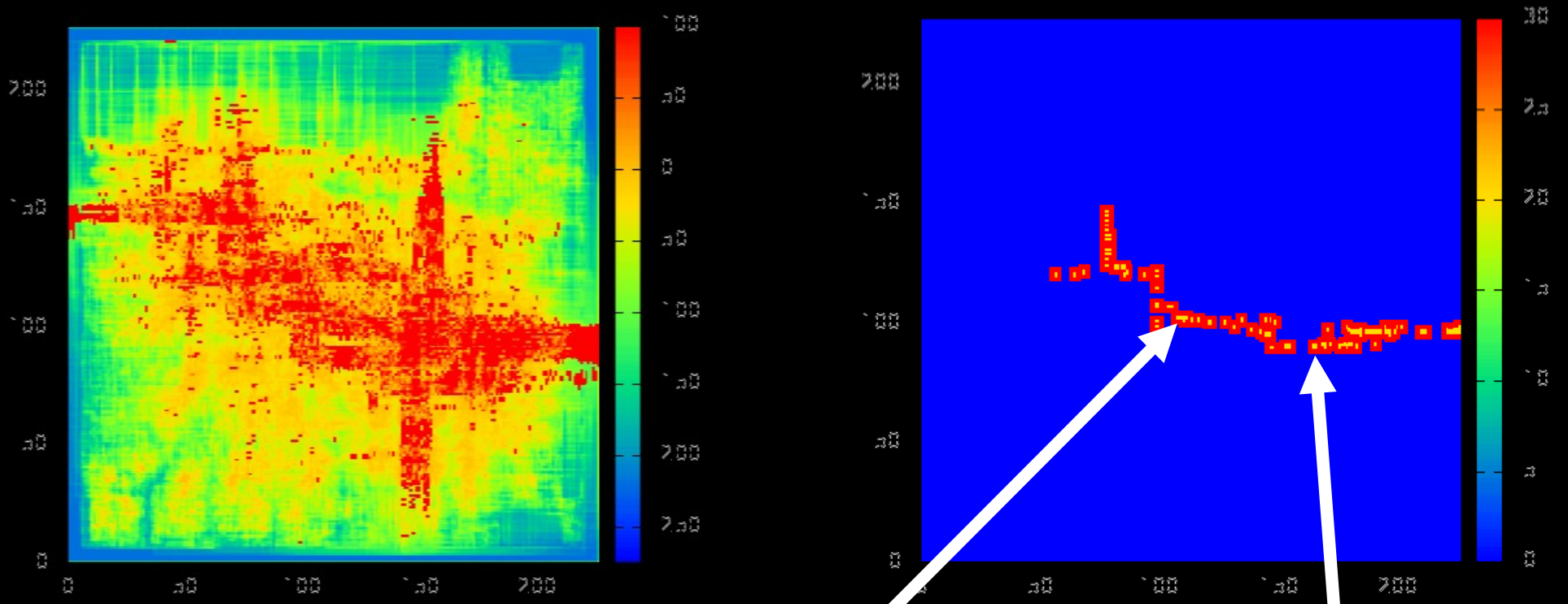
GR-WL

GR-PA

Global Routing Flow



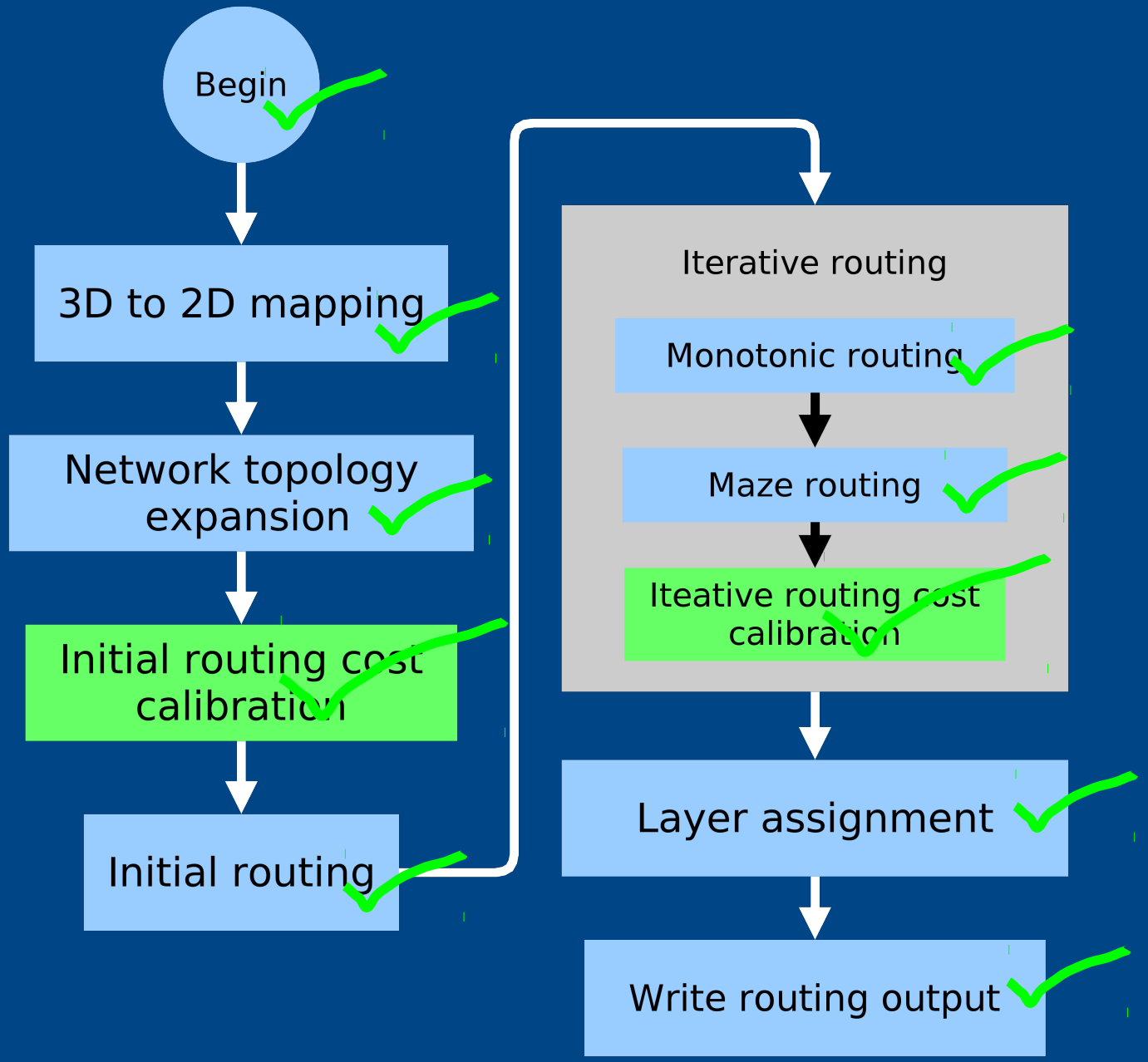
Iterative Routing Cost Calibration



Top offender
Congestion regions

Expansion
border

Global Routing Flow



GR-WL

GR-PA

Experiments

- ISPD 2008 benchmark suite
- MST was used to generate network topologies
- Exponential function for cost pre-allocation
  - $\Psi = 10$;
  - $\alpha = 5$ and
  - $\beta = 50$

Results – TOF and MOF

	GR-WL		Ours	
Circuit	TOF	MOF	TOF	MOF
bb2	122	2	138 (+12%)	2
bb4	780	6	1090 (+28%)	6
nb1	588	2	504 (-16%)	2
nb3	36280	1194	37382 (+2%)	608
nb4	462	2	460 (-0.4%)	2
nb7	5172	4	4620 (-11%)	4

Results – Wirelenght

	GR-WL	Ours	
Circuit	Wirelength	Wirelength	Difference
ad1	6380538	6418268	+0.59
ad2	6084400	6101664	+0.28
ad3	15155118	15182090	+0.17
ad4	13981761	13992148	+0.07
ad5	18102395	18149818	+0.26
bb1	6685407	6741135	+0.83
bb2	11204002	11181906	-0.2
bb3	15594684	15688085	+0.59
bb4	27602838	27481693	-0.56
nb1	5437199	5495484	+1.07
nb2	9245356	9266090	+0.22
nb3	13316366	13218553	-0.73
nb4	15329779	15410331	+0.52
nb5	26983599	27360317	+1.39
nb6	20708074	20769146	+0.29
nb7	42224489	42503107	+0.65

Results – Execution Time (min)

	GR-WL	Ours	
Circuit	Exec. Time (min)	Exec. Time (min)	Difference (%)
ad1	46.2	41.7	-9.7
ad2	15.3	13.1	-14.4
ad3	45.4	47.5	+4.6
ad4	9.4	10.5	+11.7
ad5	120.9	103.1	-14.7
bb1	165.9	182.1	+9.8
bb2	281.3	229.6	-18.4
bb3	56.3	61.5	+9.2
bb4	197.1	161.7	-18.0
nb1	89.8	108.3	+20.6
nb2	5.4	3.5	-35.2
nb3	141.6	140.6	-0.7
nb4	323.5	213.2	-34.1
nb5	283.8	182.5	-35.7
nb6	164.6	176.4	+7.2
nb7	974.2	1138.2	+16.8

Conclusions

- Positive impact on execution time
  - Reduction in exec. time up to 35.7%
  - Average 6.30%
- 1.39% of maximum wirelength impact
- For the benchmarks that do not have a valid solution
  - TOF has negative impact (up to 28%) in three of six cases
  - MOF was reduced in one case and equals in all other cases

References

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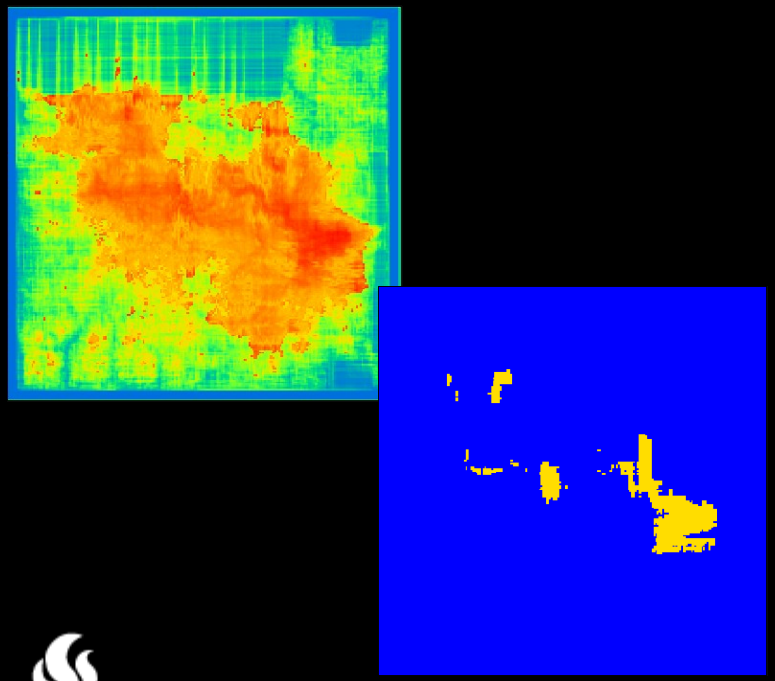

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Images

(1) http://4.bp.blogspot.com/-LudJ3cWq5nk/UTv2yQzHJpI/AAAAAAAAAzc/jNOmc4qKmYQ/s1600/photo-6.JPG

(2) http://cdncms.todayszaman.com/todayszaman/2012/07/13/fsm.jpg