The DAC 2012 Routability-Driven Placement Contest and Benchmark Suite

http://archive.sigda.org/dac2012/contest/dac2012_contest.html

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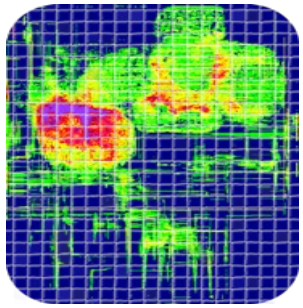
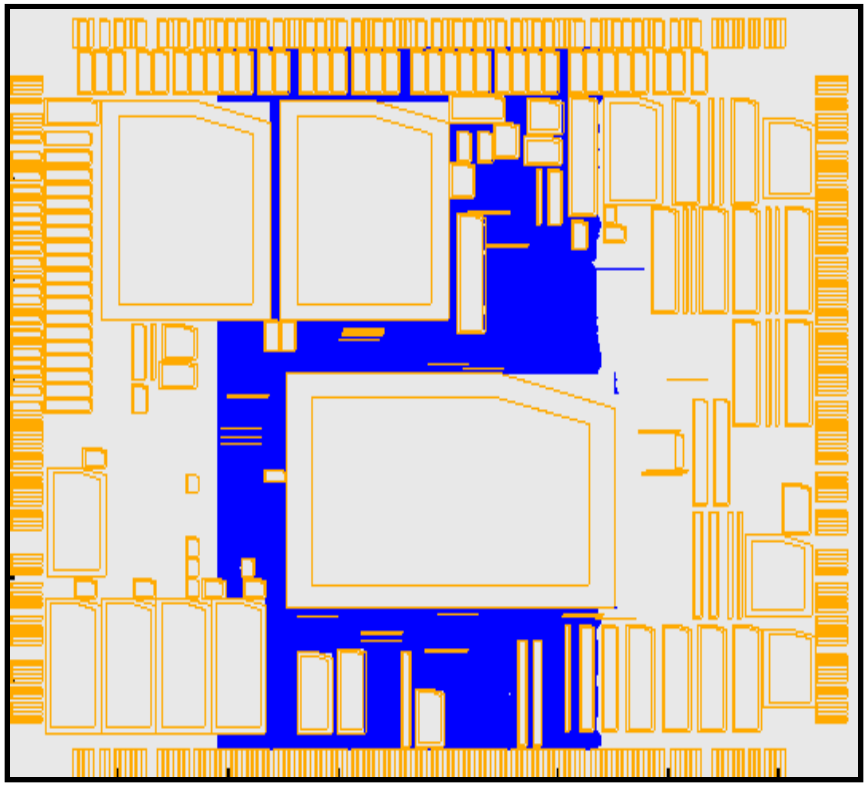
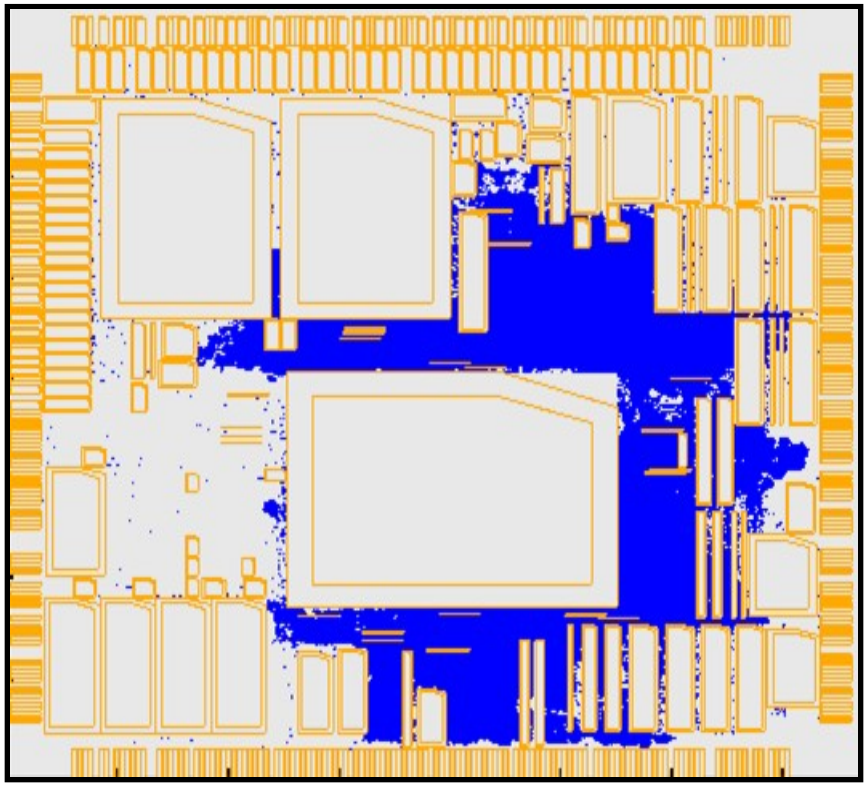
IBM Corporation, Austin TX

Co-Sponsored by:

ISPD 2005 Contest: Placement

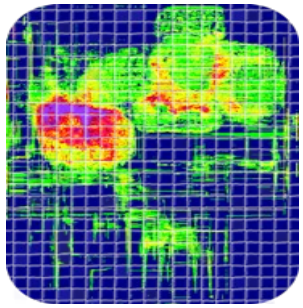


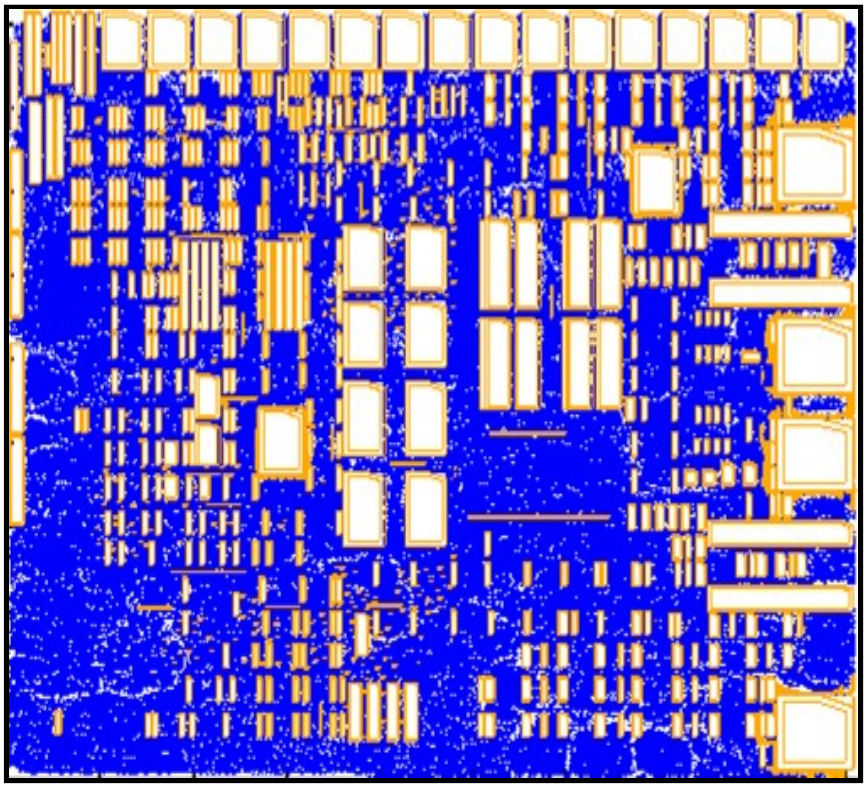


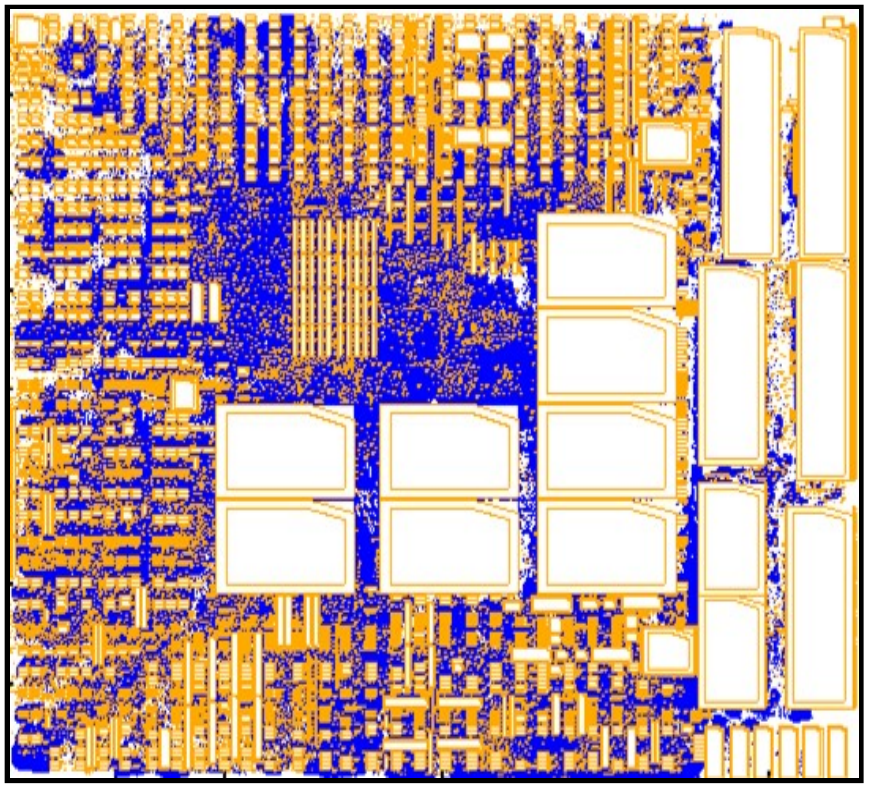


Wire Length

ISPD 2006 Contest: Placement

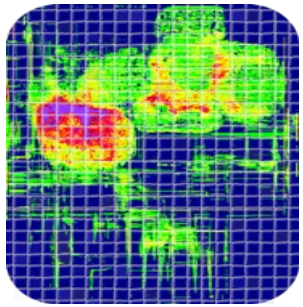


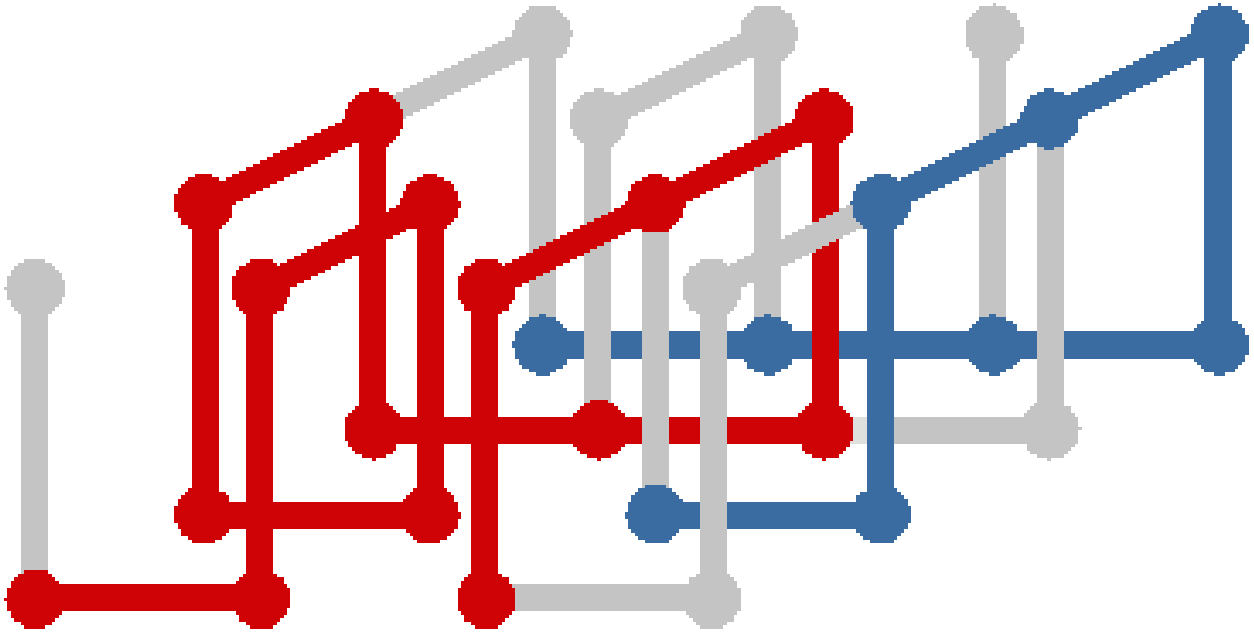




Wire Length and Cell Density

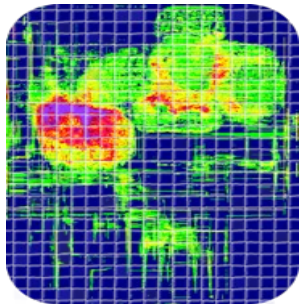
ISPD 2007/2008 Contests: Global Routing

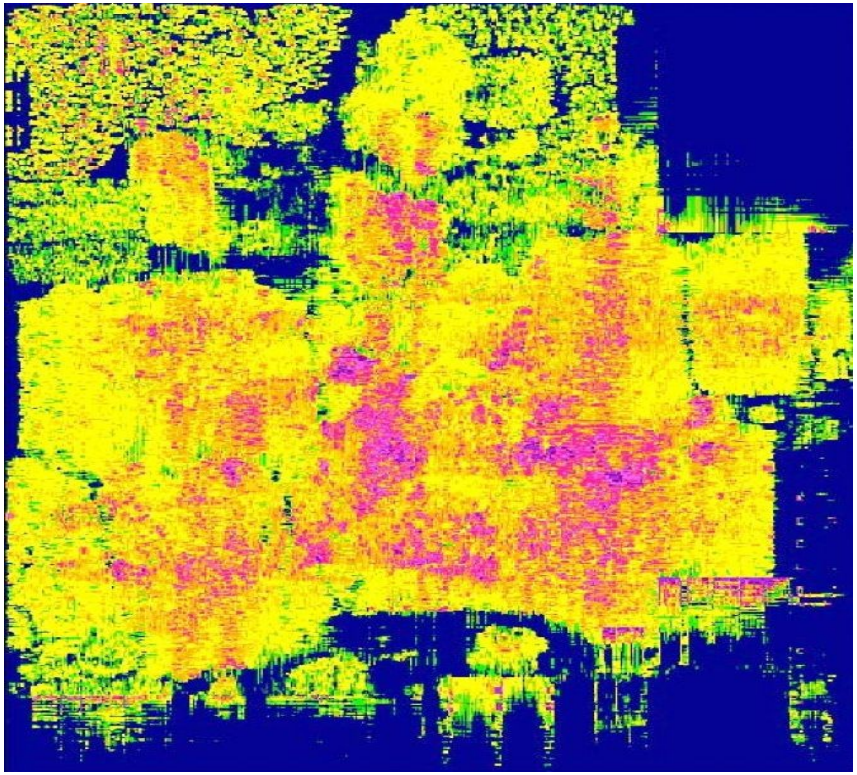


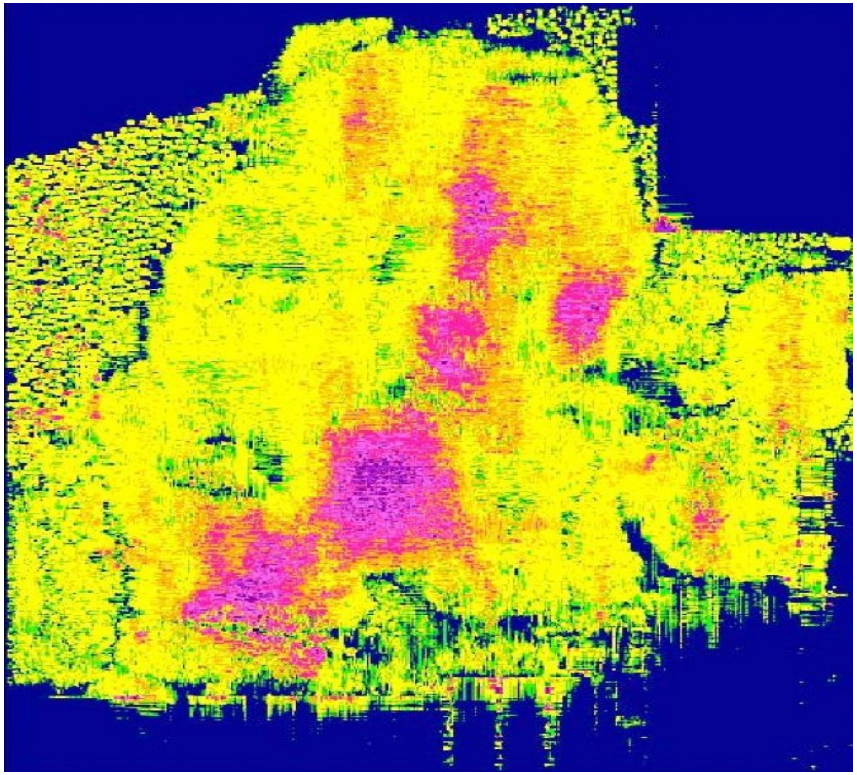


Multi-layer global routing – overflow minimization

ISPD 2011 Contest: Routability-driven Placement



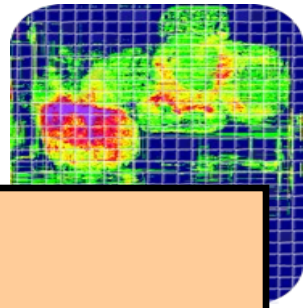




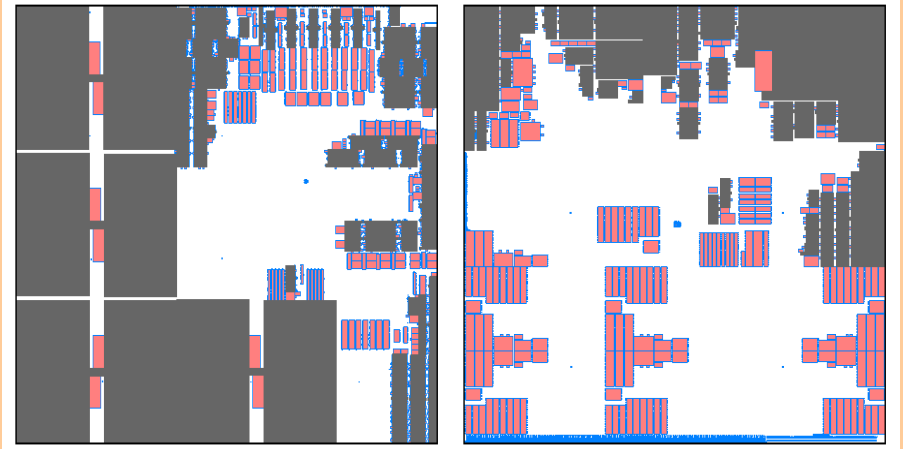
Total Overflow = 542786

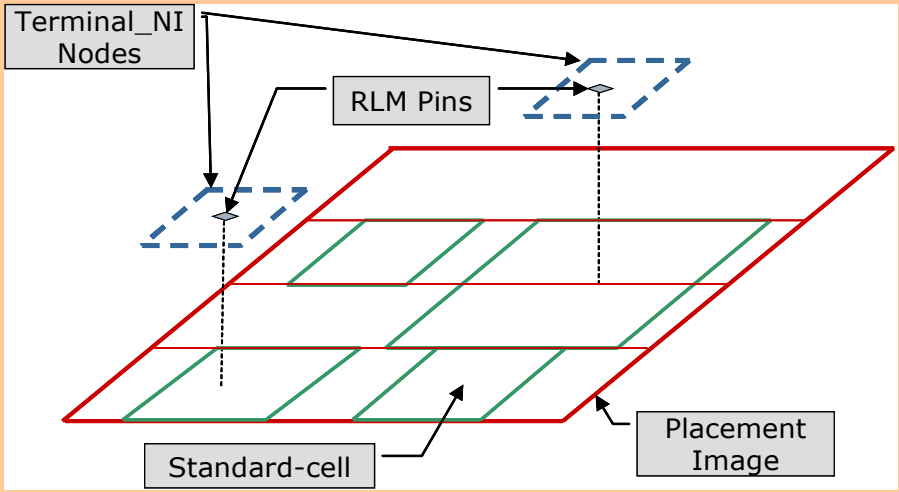
Total Overflow = 514614

DAC 2012 Contest: Objective 1



Advanced Industrial Benchmarks



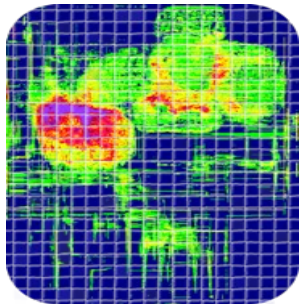


M1-M4: 1X width & spacing

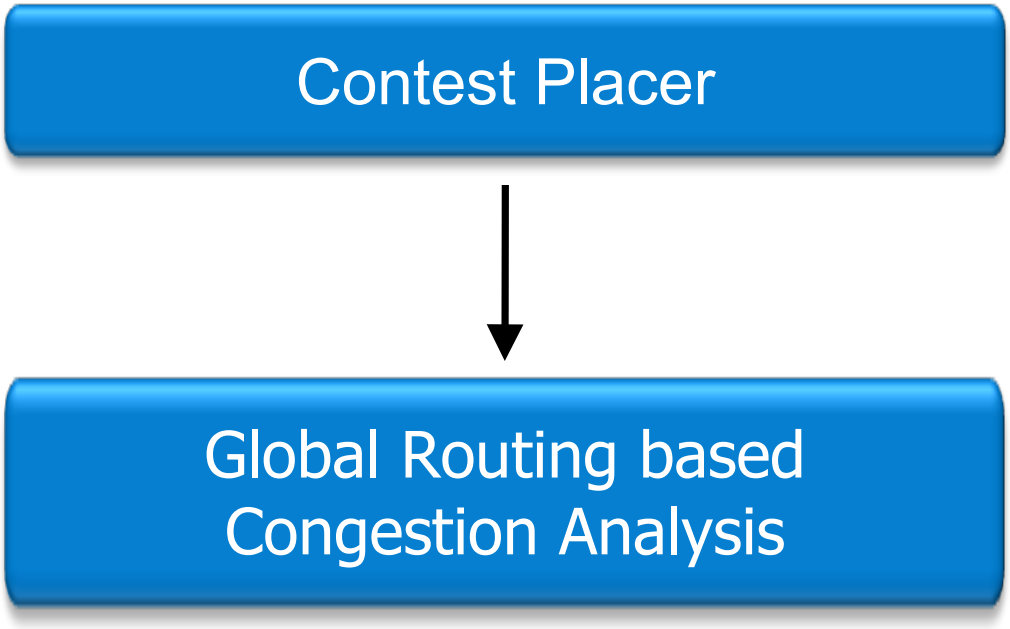
M5-M7: 2X width & spacing

M8-M9: 4X width and spacing

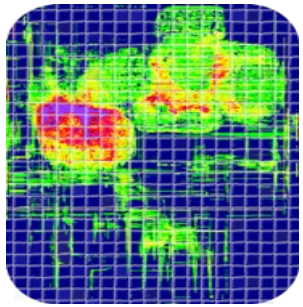
DAC 2012 Contest: Objective 2



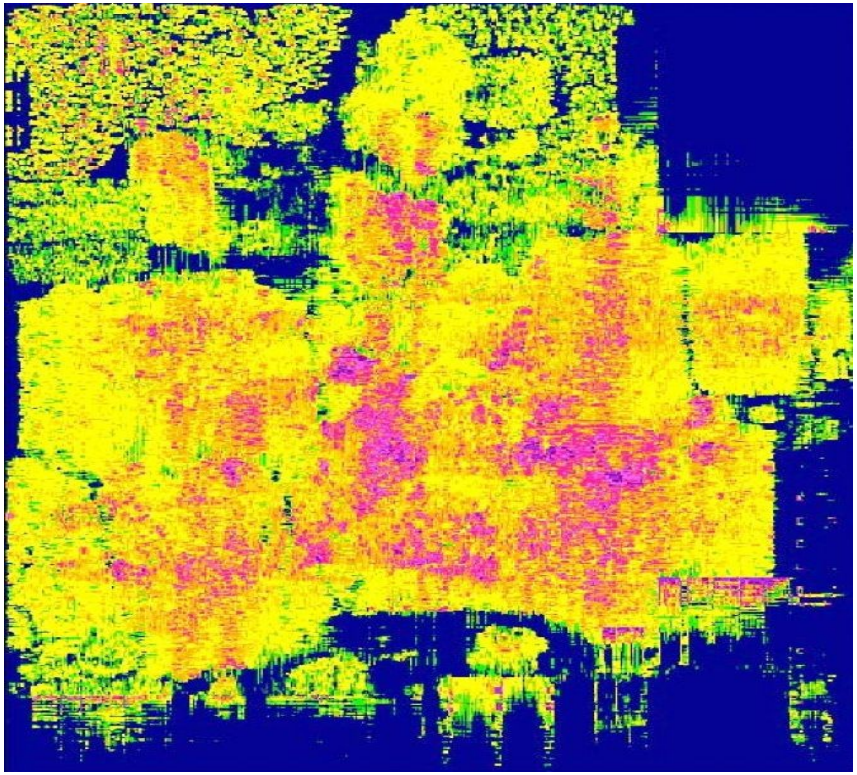
Accurate Congestion Analysis Framework



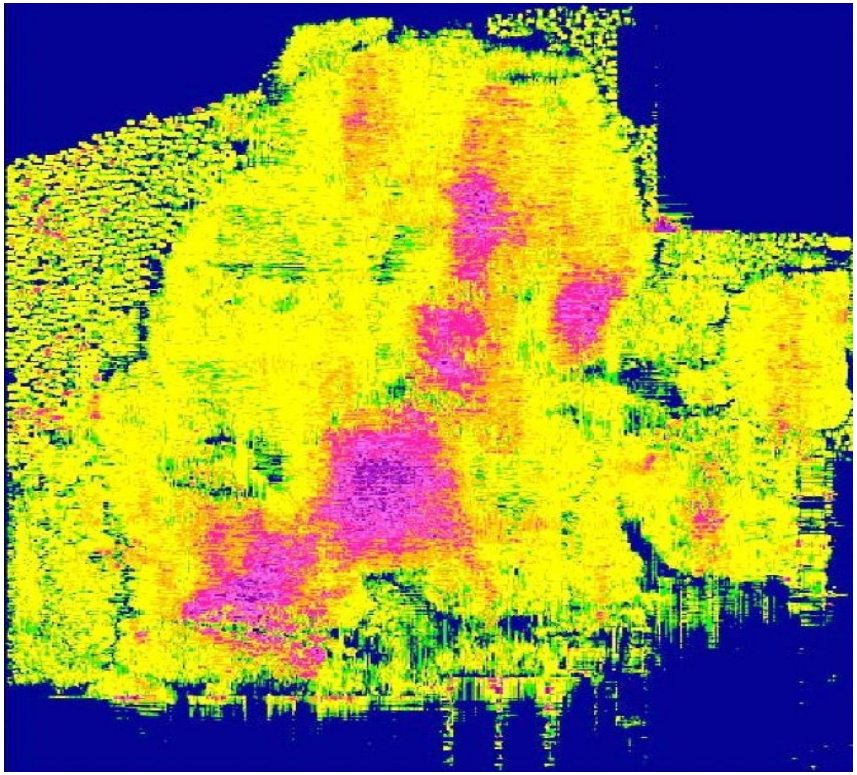
DAC 2012 Contest: Objective 3



Intuitive and accurate congestion metrics

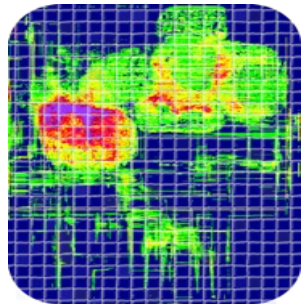


ACE(0.5)	ACE(1)	ACE(2)	ACE(5)
126.23	123.00	120.62	114.32



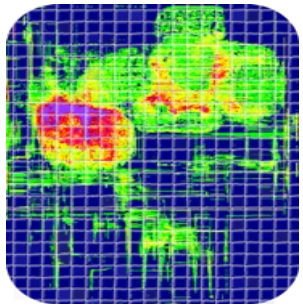
ACE(0.5)	ACE(1)	ACE(2)	ACE(5)
130.89	126.34	123.17	118.97

Contest Logistics



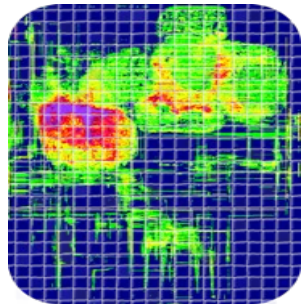
- **28 initial teams (Jan 2012)**
  - 20 academic and 8 non-academic teams
- **Release in advance**
  - Two sample benchmarks
  - Contest Evaluator and Evaluation metric
- **11 preliminary submissions (Apr 2012)**
- **Release two additional sample benchmarks**
- **7 final submissions – all academic (May 2012)**
- **Evaluate on 4 public + 6 hidden benchmarks**

Contest Finalists



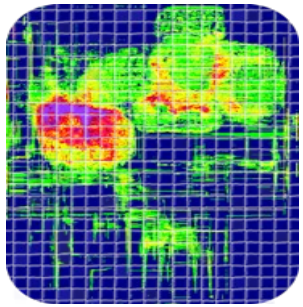
Team	Affiliation
Allecon	Tsinghua University
mPL12	UCLA / Beijing University
NCUPlacer	National Central University
NTUplace4	National Taiwan University
Ripple	The Chinese University of Hong Kong
SimPLR	The University of Michigan, Ann Arbor
VDAPlace	National Chiao Tung University

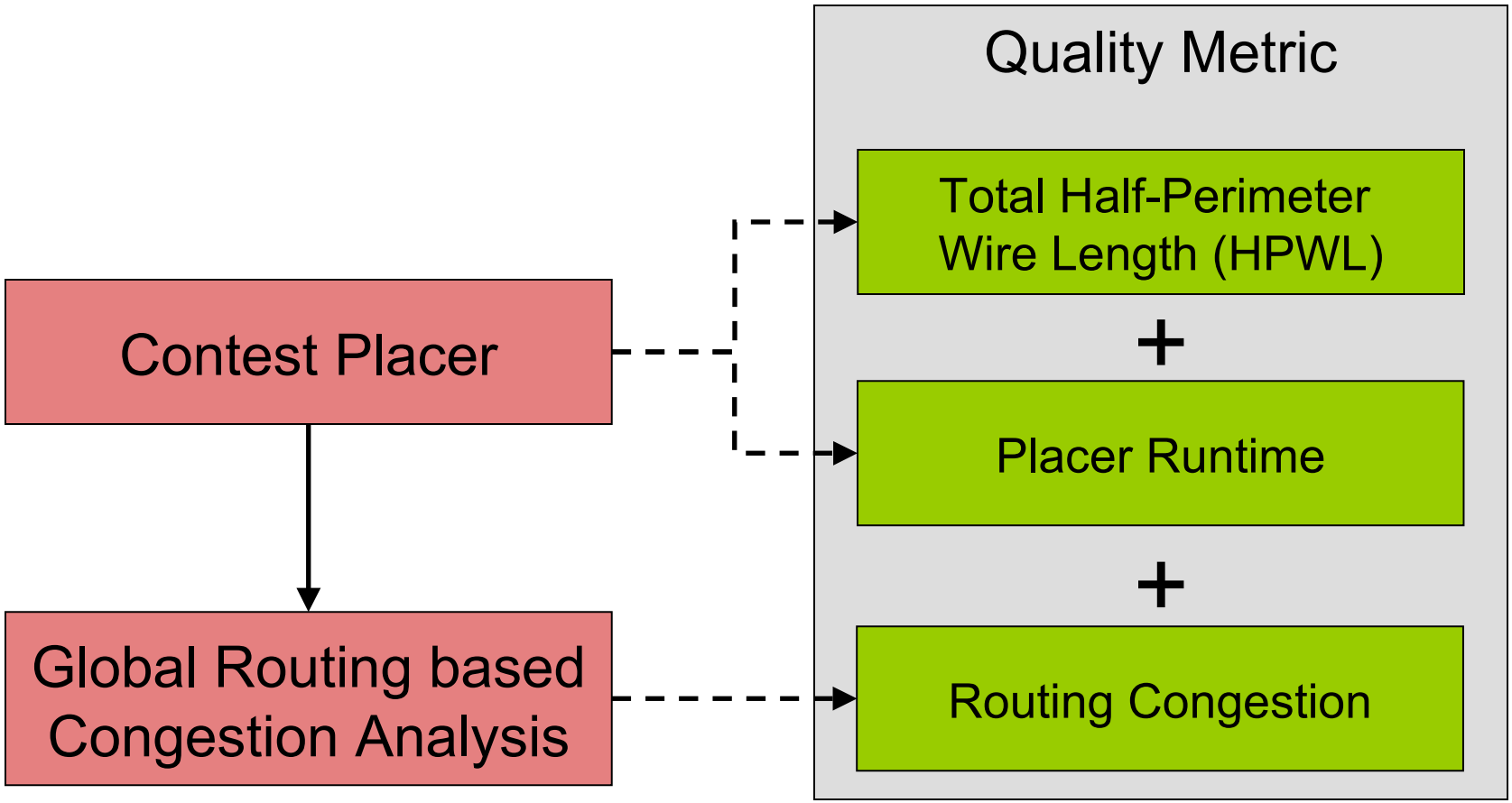
Global Routers for Contest Evaluation



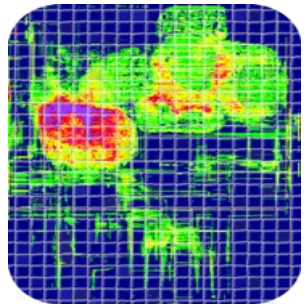
- **Requirements**
  - Handle new benchmarks with a complex layer stack
  - Reasonable runtime
  - Moderate overflow reduction
  - Stable
- **Qualifying Academic Routers**
  - Rigorous testing on multiple designs / placements
  - Mock contest – calibrate using internal congestion analyzer
- **NCTU-GR 2.0**
  - Wen-Hao Liu and Prof. Yih-Lang Li
    National Chiao Tung University, Taiwan
- **BFG-R 2.0**
  - Jin Hu, Jarrod A. Roy and Prof. Igor L. Markov
    University of Michigan, Ann Arbor, USA

Contest Flow and Quality Metric





Evaluation Metric: Routing Congestion



- **Congestion Metric**

  ACE(x): Average Congestion of the top x% congested g-edges

- **Peak Weighted Congestion**

$$PWC = \frac{k_1 \times ACE(0.5) + k_2 \times ACE(1) + k_3 \times ACE(2) + k_4 \times ACE(5)}{k_1 + k_2 + k_3 + k_4}$$

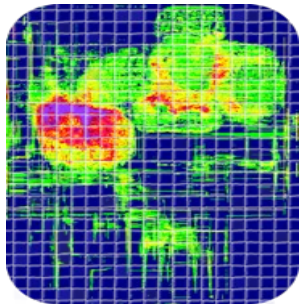
  $k_1 = k_2 = k_3 = k_4 = 1.0$

- **Routing Congestion:**

  RC = MAX(100, PWC)

Congestion Objective: RC ≤ 100%

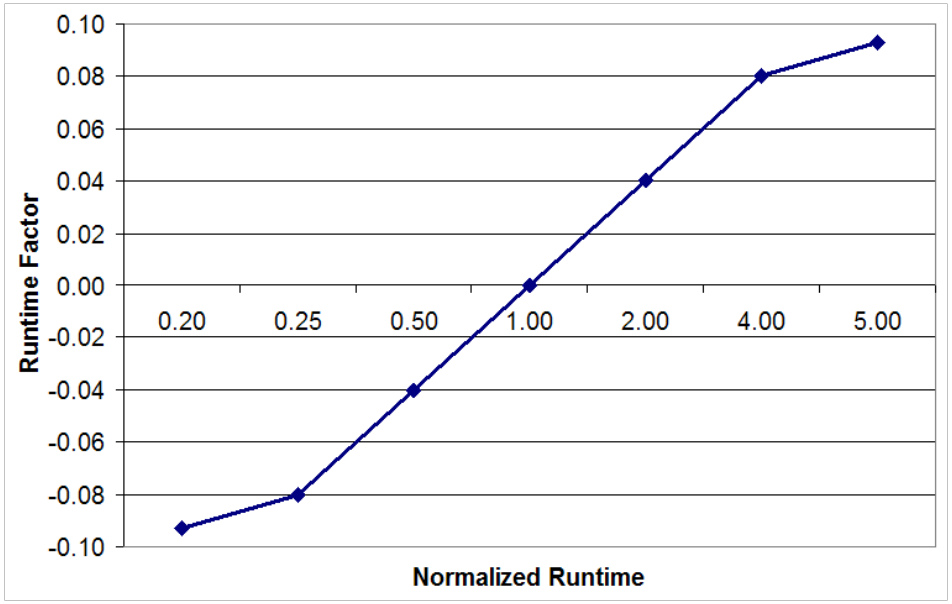
Evaluation Metric: Runtime



- **For each design**

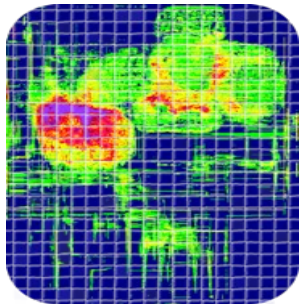
$$\text{Normalized Runtime} = \frac{\text{Placer\_Wall\_Time}}{\text{Median\_Wall\_Time}}$$

- **Runtime Factor**



±4% advantage for a 2X speed-up/slow-down (capped at ±10% advantage)

Overall Quality Metric



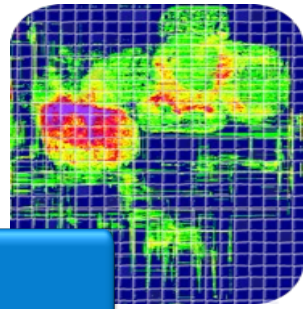
Scaled Wire length considering routing congestion and runtime

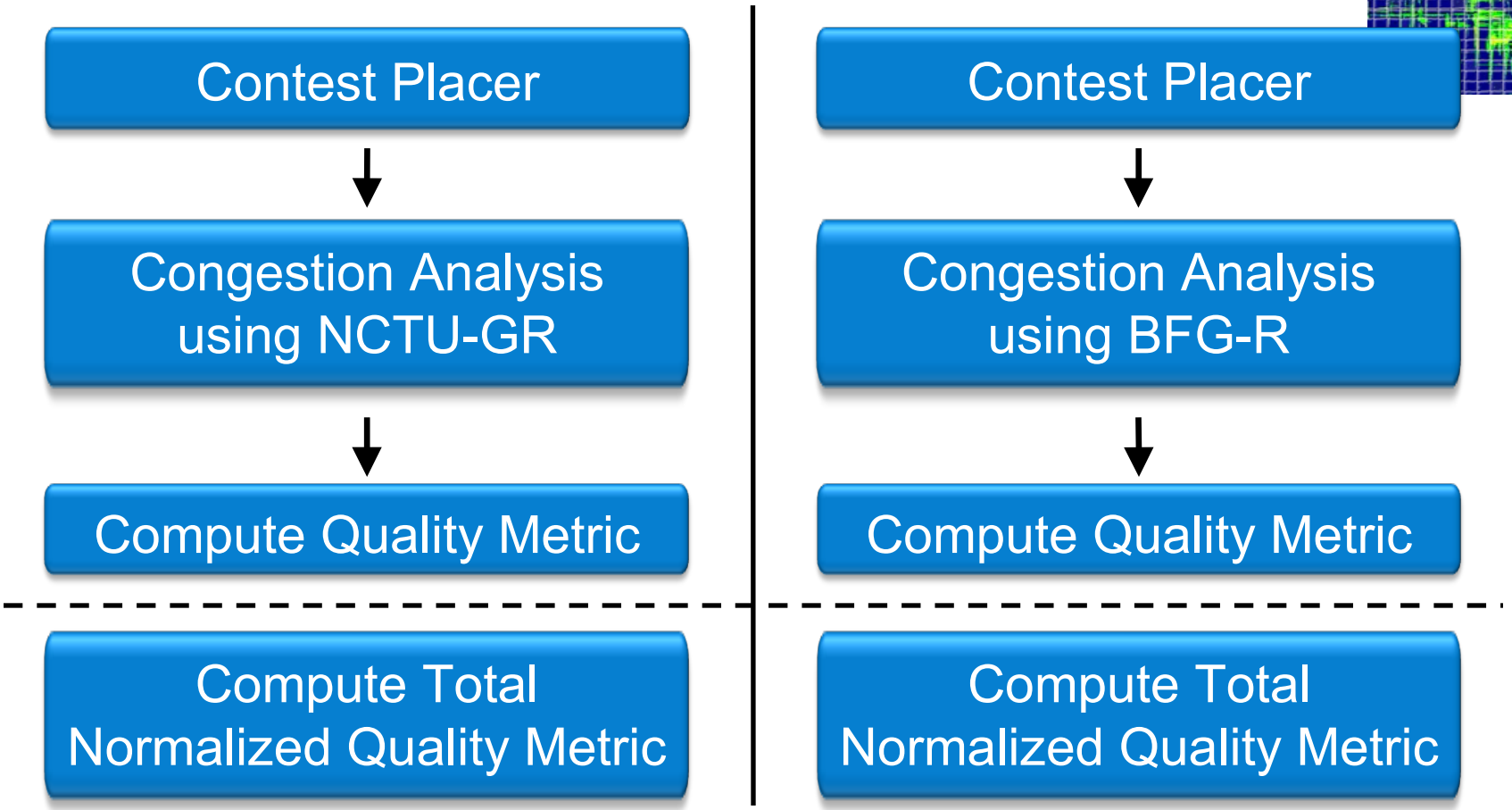
$$\text{HPWL} \times \underbrace{(1 + 0.03 \times (RC - 100))}_{\text{Routability}} \times \underbrace{(1 + \text{Runtime\_Factor})}_{\text{Runtime}}$$

- **Penalty Factor**

  For every 1% excess Routing Congestion (RC > 100%), there is a 3% wire length penalty

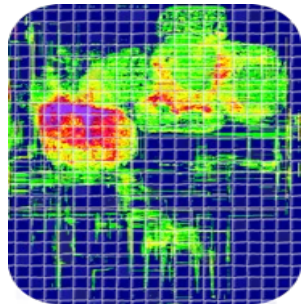
Evaluation: Two parallel contests





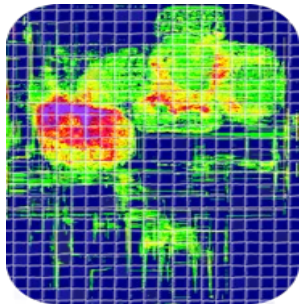
Lowest Total Score Across All Designs Wins the Contest

Awards for the Top Three Teams…



- **Certificate**
- **Cash Prize**
  - Rank 1: US $1200/-
  - Rank 2: US $800/-
  - Rank 3: US $500/-

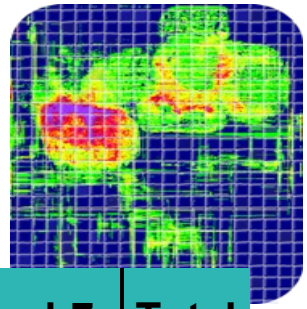
HPWL and Congestion Results



NCTU-GR	HPWL	RC	Scaled WL
Team 1	1.04	102.15	1.09
Team 2	1.00	100.91	1.00
Team 3	1.14	106.92	1.33
Team 4	1.06	103.85	1.14

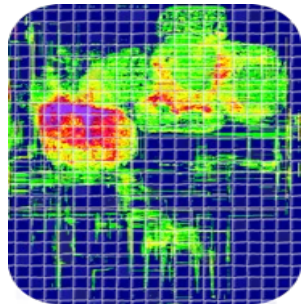
BFG-R	HPWL	RC	Scaled WL
Team 1	1.04	104.45	1.10
Team 2	1.00	102.63	1.00
Team 3	1.14	105.84	1.25
Team 4	1.06	106.19	1.16

Overall Quality Metric



Design		sb19	sb14	sb16	sb9	sb3	sb11	sb6	sb2	sb12	sb7	Total
Team 1	NCTUGR	1.08	1.00	1.00	1.14	1.16	1.00	1.05	1.12	1.00	1.06	**9.46**
	BFG-R	1.07	1.00	1.00	1.05	1.14	1.02	1.04	1.18	1.16	1.15	**9.61**
Team 2	NCTUGR	1.05	1.05	1.09	1.04	1.04	1.04	1.06	1.00	1.00	1.00	**9.27**
	BFG-R	1.05	1.02	1.13	1.04	1.02	1.06	1.11	1.00	1.00	1.00	**9.29**
Team 3	NCTUGR	1.71	1.24	1.21	1.33	1.36	1.38	1.26	2.18	1.70	1.30	**12.50**
	BFG-R	1.45	1.23	1.27	1.32	1.21	1.34	1.25	1.50	1.59	1.24	**11.81**
Team 4	NCTUGR	1.00	1.02	1.20	1.00	1.00	1.08	1.00	1.19	1.01	3.82	**9.51**
	BFG-R	1.00	1.02	1.29	1.00	1.00	1.00	1.00	1.27	1.06	1.90	**9.64**

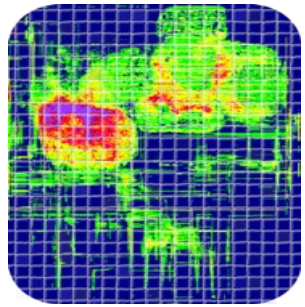
What's Next…



- We are still learning and improving the process…
- Conducting the next placement contest in ICCAD 2012
  - Design Hierarchy Aware Routability-driven Placement
- Key Features
  - Release the design hierarchy
  - Model local wiring congestion

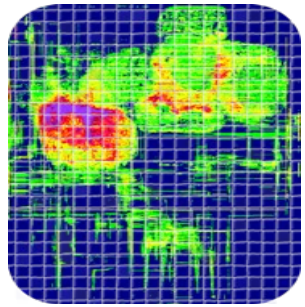
Hope this effort will further advance research in placement and routing for nanometer-scale designs

Fourth Place



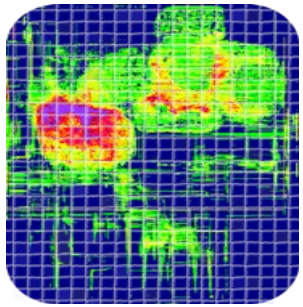
- **mPL12**
- **UCLA / Beijing University**
- **Jason Cong, Guojie Luo, Kalliopi Tsota, Bingjun Xiao**

Third Place



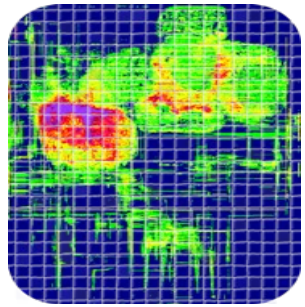
- **SimPLR**
- **The University of Michigan, Ann Arbor**
- **Myung-Chul Kim, Jin Hu, Igor Markov**

Second Place



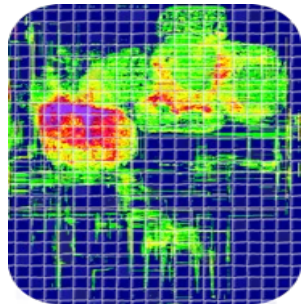
- **Ripple**
- **The Chinese University of Hong Kong**
- **Xu He, Tao Huang, Wing-Kai Chow, Lam Ka Chun, Evangeline F.Y. Young**

First Place



- **NTUplace4**
- **National Taiwan University**
- **Meng-Kai Hsu, Yao-Wen Chang**

DAC 2012 Contest Winners



- **First Place**
  - NTUplace4
  - National Taiwan University
  - Meng-Kai Hsu, Yao-Wen Chang
- **Second Place**
  - Ripple
  - The Chinese University of Hong Kong
  - Xu He, Tao Huang, Wing-Kai Chow, Lam Ka Chun, Evangeline F.Y. Young
- **Third Place**
  - SimPLR
  - The University of Michigan, Ann Arbor
  - Myung-Chul Kim, Jin Hu, Igor Markov