Perimeter-degree: A Priori Metric for Directly Measuring and Homogenizing Interconnection Complexity in Multilevel Placement

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Overview

- Background
  - Placement is becoming harder
  - Congestion
- Objective
- Motivation
- Experimental results
- Conclusions

Placement is becoming harder

- Support for physical synthesis
  - Fast and accurate prototyping
- Focus on timing
- Presence of macro cells
- Ever increasing problem size
- Congestion elimination

Congestion

- Why Congestion?
- Measuring congestion.
- Existing techniques

Why Congestion?

- Demand exceeds supply
- Non homogeneous supply
  - Location of bin
  - Macro cells

  Lets assume uniform supply for the rest of the discussion
- Non homogeneous demand.

Measuring Congestion

- Half-perimeter wirelength
- Router based congestion estimation
- Stochastic congestion estimation

Measuring Congestion

- Half-perimeter Wirelength
  - Good metric

    more wires => more congestion
  - But insufficient

    regional variations?

    Bounding box of high fan-out net Vs low fan-out net?
  - We need additional metrics
    - Pin density?
    - Bin degree? (no of external nets of a bin)

Measuring Congestion

- Router based estimates
  - Accurate
  - But computationally very expensive
- Stochastic estimates
  - Relatively accurate
  - Still expensive for fast prototyping

Existing Congestion Reduction Techniques

- Posteriori / online methods
  - Established methods
  - But too many constraints as the placement problem becomes harder
- Is priori feasible?
  - Required for fast prototyping

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Objective

- To come up with priori techniques to aid half-perimeter wirelength objective to produce placements with lower regional variations.
  - Use single objective of half-perimeter wirelength
  - Quality is measured in terms of congested edges after global placement

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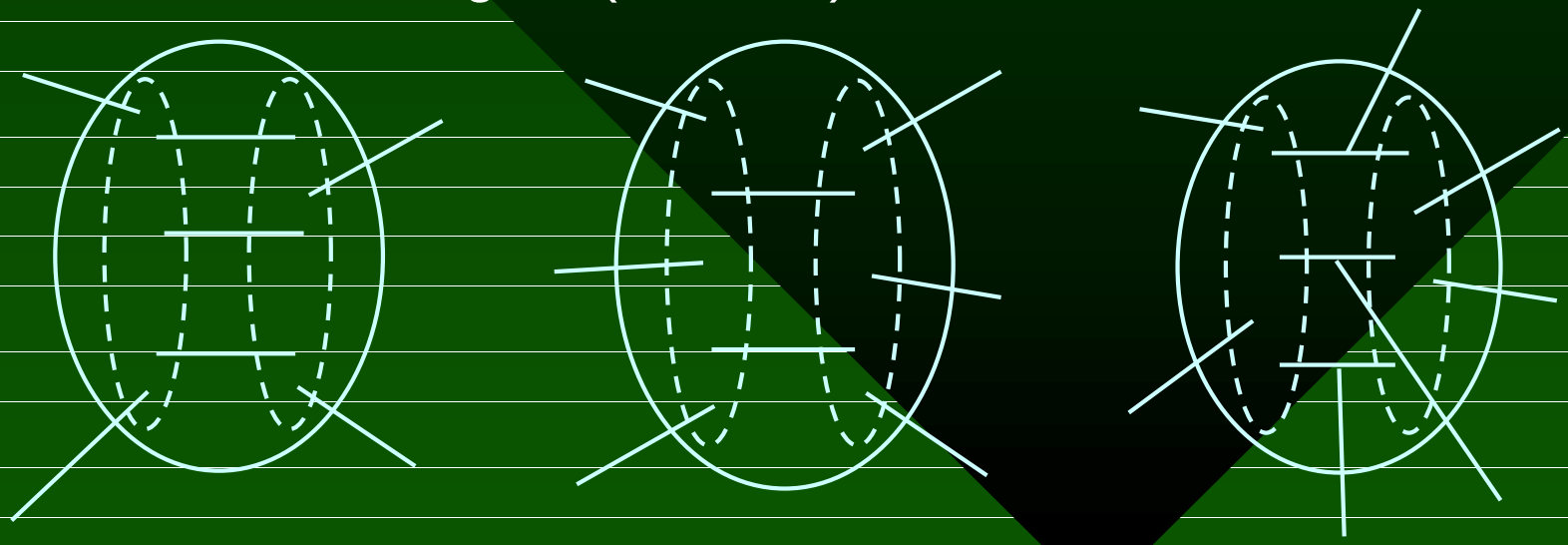
Motivation

- Known metrics for congestion control
  - Pin density
  - Bin degree
- Can we do better?

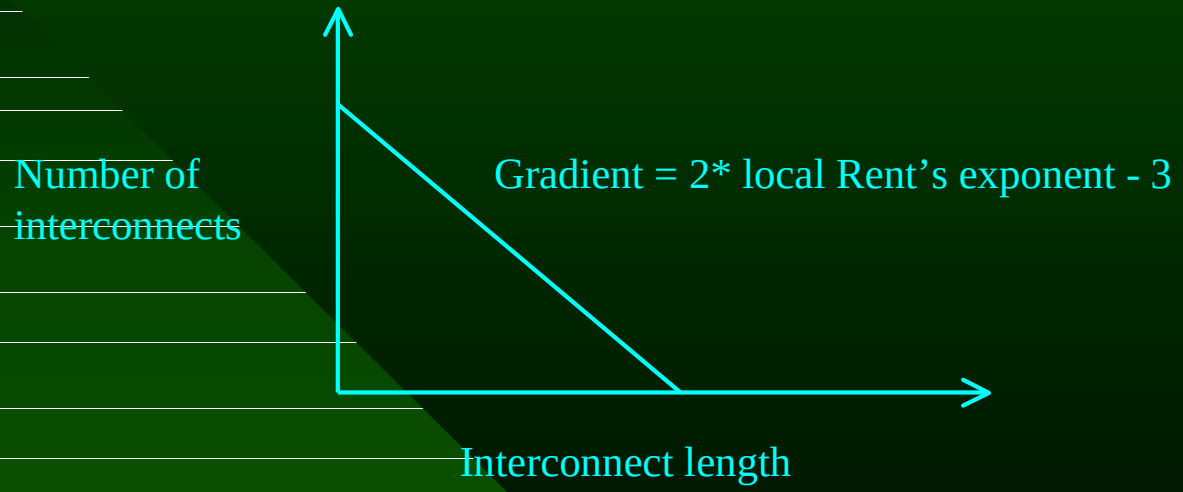
Motivation : known metrics

- Pin density
  - “dilute” high pin density portions of netlist
  - But equal pin density with varying demand possible
  - Following clusters show equal pin density but different degree (demand)



Motivation : known metrics

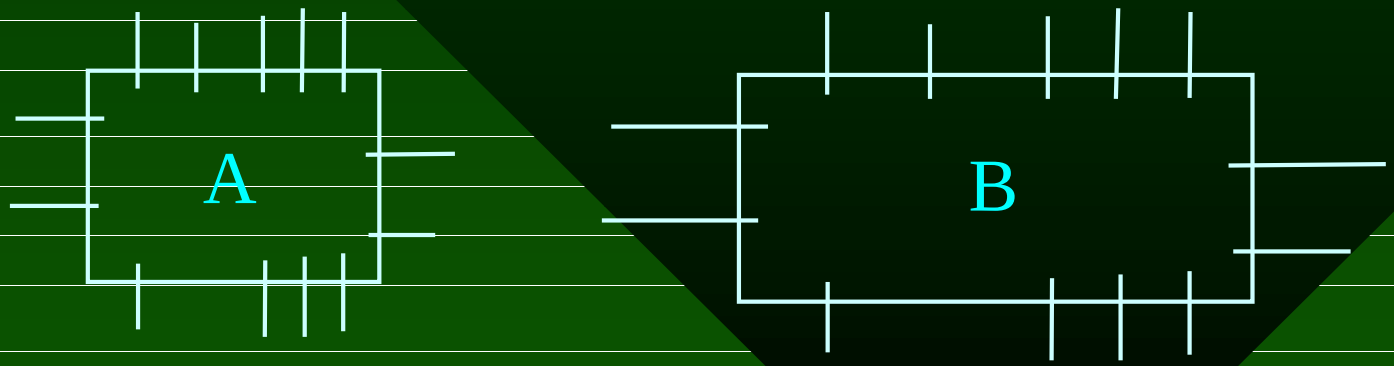
- Bin Degree
  - Impact of bin degree on regional wirelength



- Doubling bin degree results in **more than twice** as much wirelength associated with that bin

Motivation : known metrics

- Degree of a cluster
  - Good metric but captures only demand
  - Following clusters have equal degree but differ in routing supply



Motivation : a better metric

- Degree is a demand at the perimeter of a cluster
- Supply is proportional to perimeter
- Thus we define a new metric “perimeter-degree”
- Perimeter-degree = degree / perimeter

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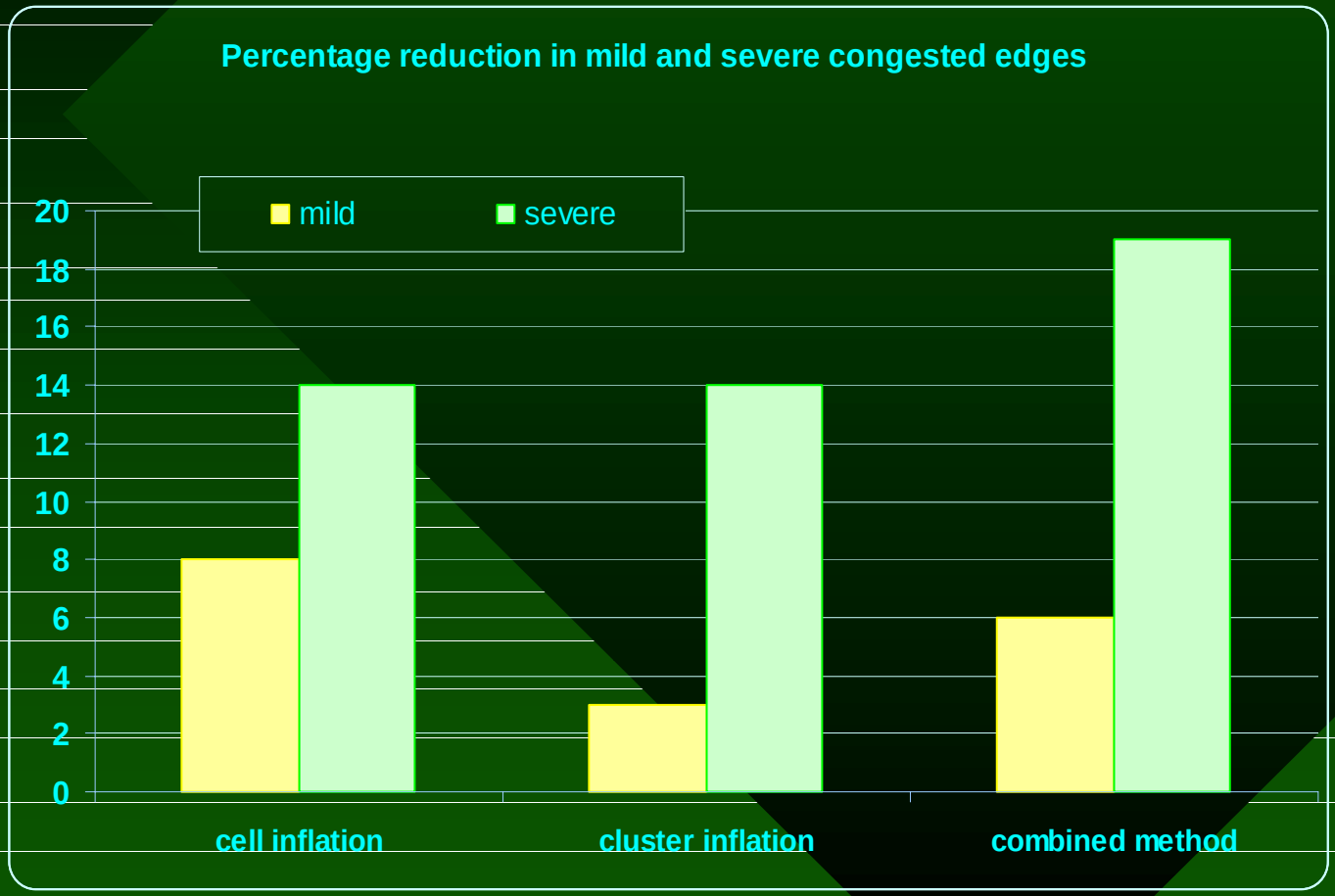
Experimental Results

- Allocate whitespace to clusters with high perimeter-degree
  - Cell level (pin density is equally effective)
  - Cluster level
  - Combined method
- Direct use of perimeter-degree as capacity constraint

Whitespace based schemes



Direct use of Perimeter-degree

- Set area of clusters in proportion of perimeter-degree of clusters so that total area does not change.
- Since actual area is not used. Bin capacity violations may occur.
  - More legalization iterations
- Results
  - Half-perimeter wirelength **increased by 0.1%**
  - Mild congested edges **reduced by 11%**
  - Severe congested edges **reduced by 26%**

Conclusion

- We have shown that congestion can be reduced substantially with negligible change in half-perimeter wirelength.
  - Same amount of interconnects but substantially lower congestion => homogeneous routing demand
  - Negligible computations required

Questions