

Parallelized Analytic Placer

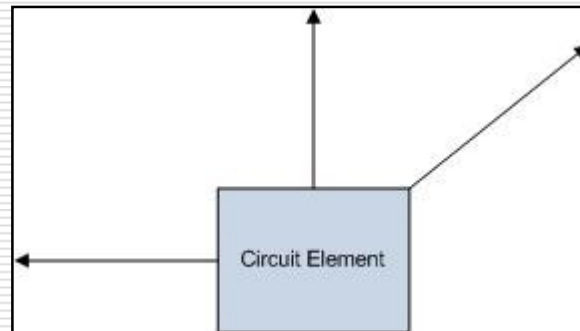
Bryce Leung, Jungmoo Oh, David
Goldman

Introduction

- ❑ Analytic Placement is a CAD algorithm for ASIC placement
- ❑ Takes arbitrary circuit netlist and finds physical location of each element
- ❑ Attempt to minimize wire-length, maximize performance

Introduction

- Each block treated as a physical element
- Each interconnect treated as a spring that exerts force



Introduction

- Algorithm creates a set of force equations for each node

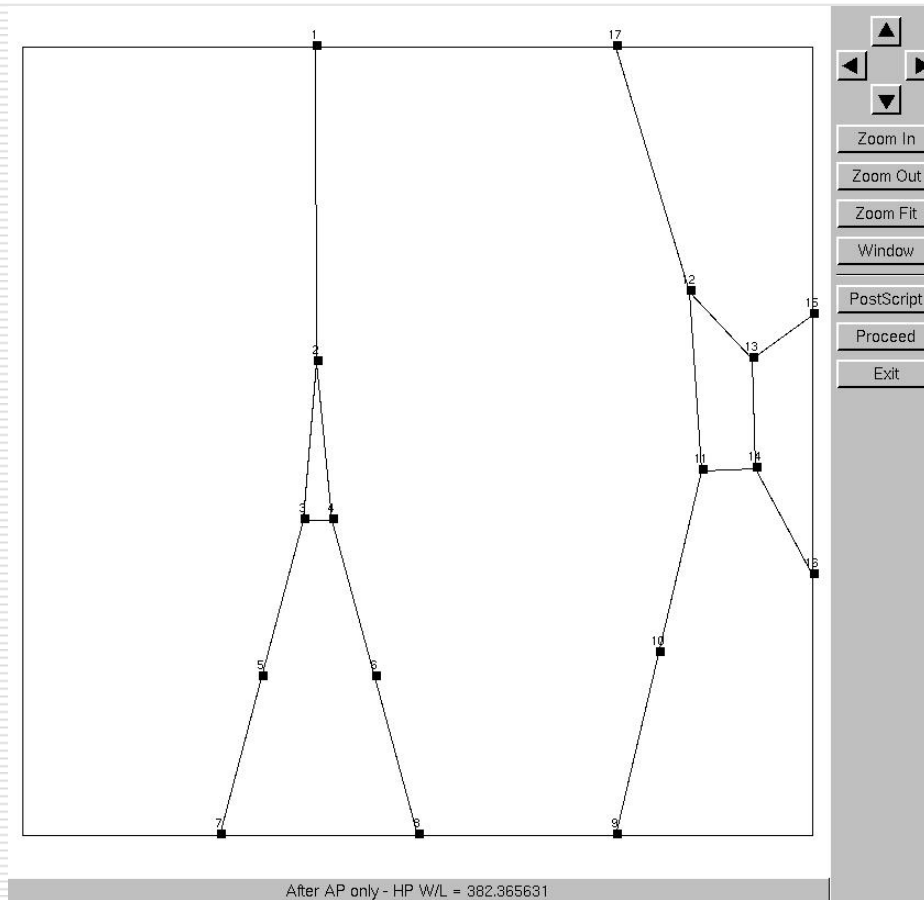
$$F_j = \sum_{i=1}^N k_{ij} (x_j - x_i)$$

Introduction

- Steady state location found when net forces are 0
- Creates a system of linear equations
- Solving X matrix gives position of all elements

$$\begin{bmatrix} k_{11} & \cdots & k_{iN} \\ \vdots & \ddots & \vdots \\ k_{N1} & \cdots & k_{NN} \end{bmatrix} \begin{bmatrix} x_1 \\ \vdots \\ x_N \end{bmatrix} = 0$$

Introduction



Parallelization

- Uses Gaussian Elimination to compute X and Y coordinate matrices
- Gaussian Elimination is composed of two stages, and each stage is parallelized independently
 - Upper-Triangular Reduction
 - Back-Substitution

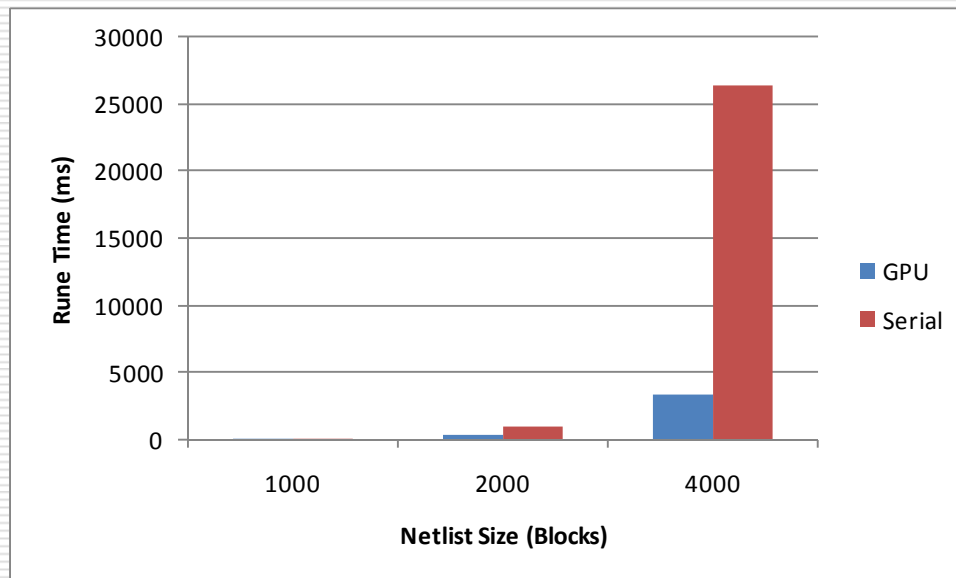
Parallelizing Upper-Triangular Reduction

- Perform row elimination on entire bottom right corner of the pivot at once
 - Iterate only number of row times
 - Reduced the number of threads spawned by ignoring left side of pivot
- Augmented A , xB and yB matrices
 - The same row operation is performed on all three matrices
 - Reduced number of row elimination calls

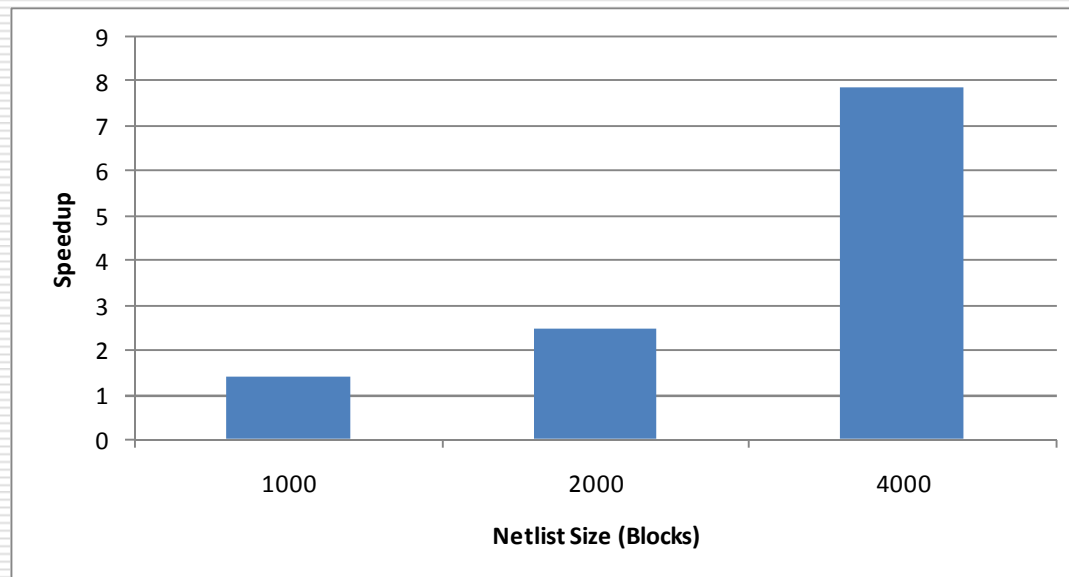
Parallelizing Back-Substitution

- Improved efficiency by decoupling dependency between rows
 - Original (serial) algorithm computes final result for one row by another
 - Compute partial results for entire rows at once for efficiency
- Minimized the number of threads spawned by ignoring zero columns

Measurements(First Cut)



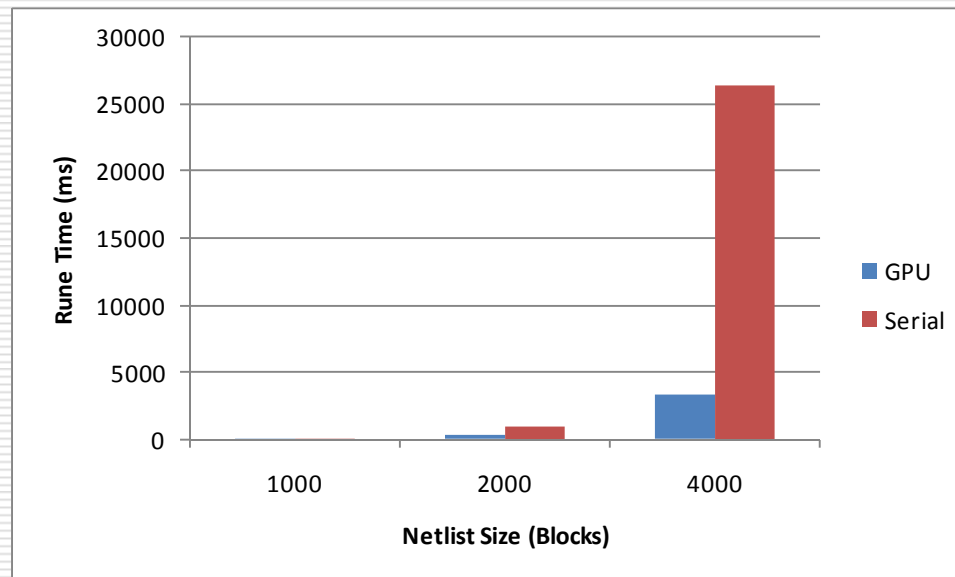
Measurements (First Cut)



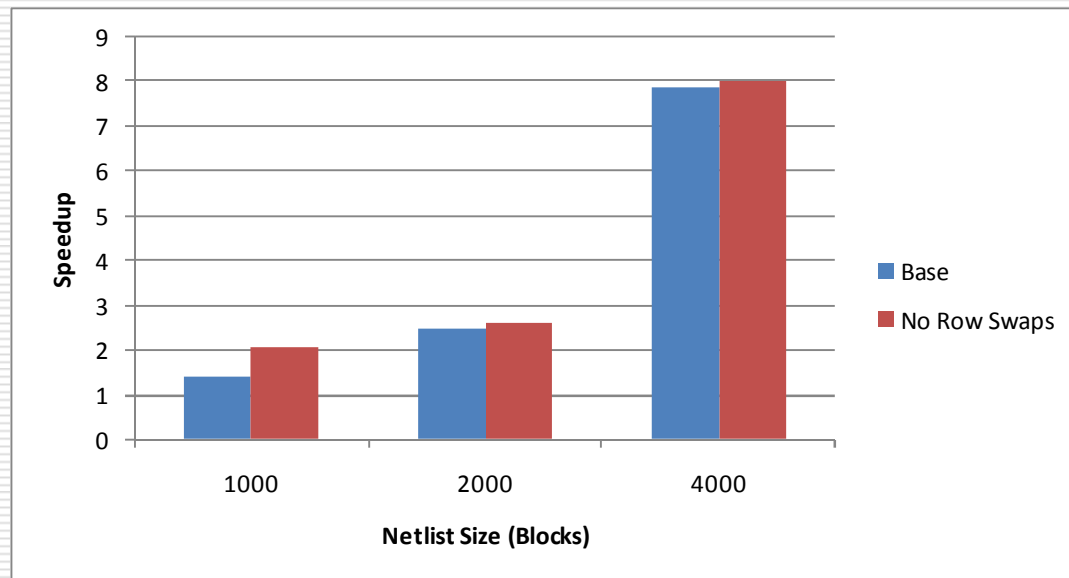
No row swaps necessary

- ❑ Row swapping only required if pivot entry is missing
- ❑ This only happens if net-lists form a disjoint subgraph
- ❑ This never happens, so row swapping unnecessary

Measurements (No row swapping)



Measurements (No row swapping)



Future Work

- Further coalesce global memory accesses
 - Access patterns already fairly coalesced
- Take advantage of shared memory
 - Possibly caching pivot value