

VLSI Design

Lecture 20: Placement and Routing

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Adapted from lecture notes prepared by author (from Prentice
Hall PTR)

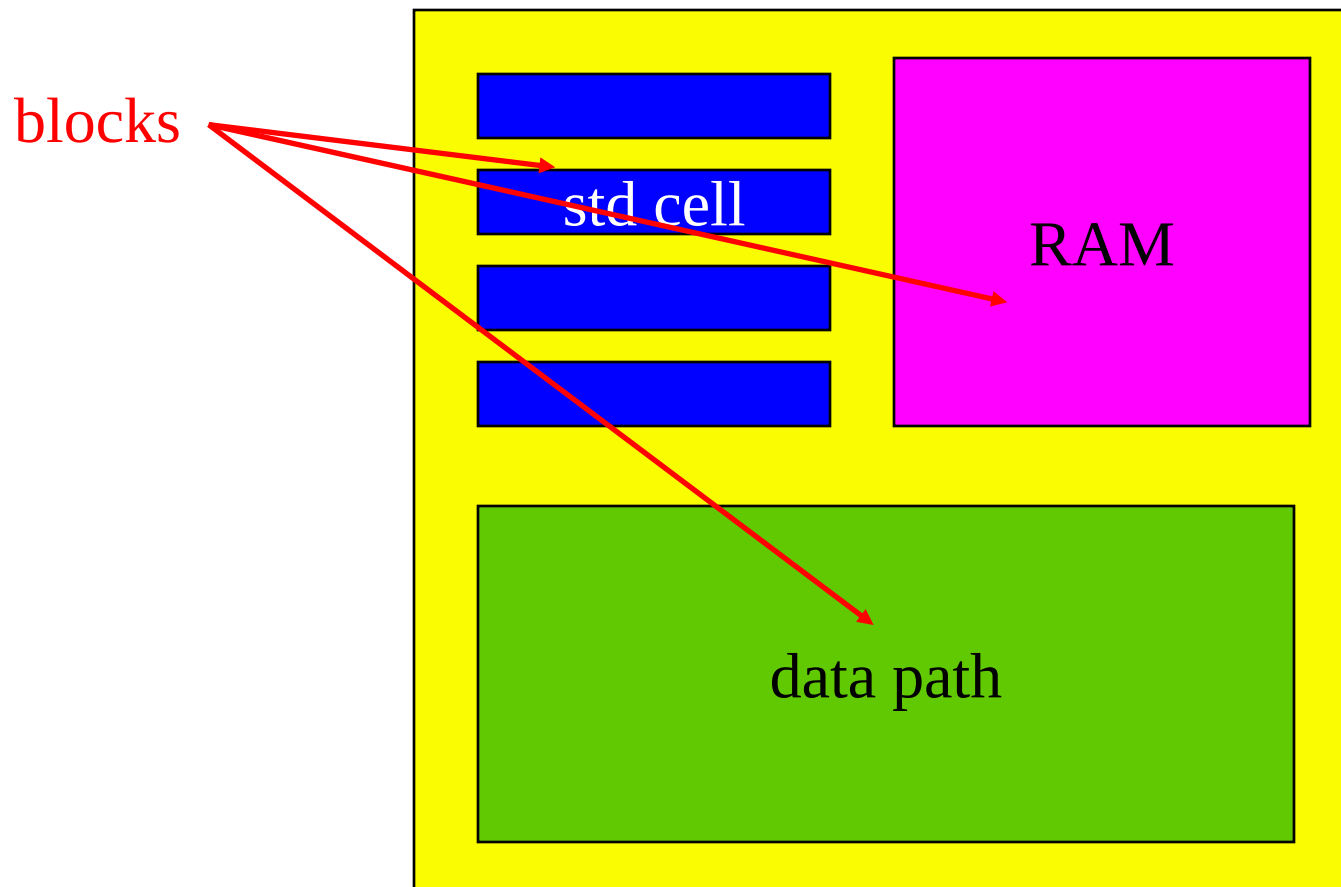
Topics

- Block placement.
- Global routing.
- Switchbox routing.

Floorplanning strategies

- Floorplanning must take into account blocks of varying function, size, shape.
- Must design:
 - space allocation;
 - signal routing;
 - power supply routing;
 - clock distribution.

Bricks-and-mortar floorplan



Purposes of Floorplanning

■ Early in design:

- Prepare a floorplan to budget area, wire area/delay.
Tradeoffs between blocks can be negotiated.

■ Late in design:

- Make sure the pieces fit together as planned.
- Implement the global layout.

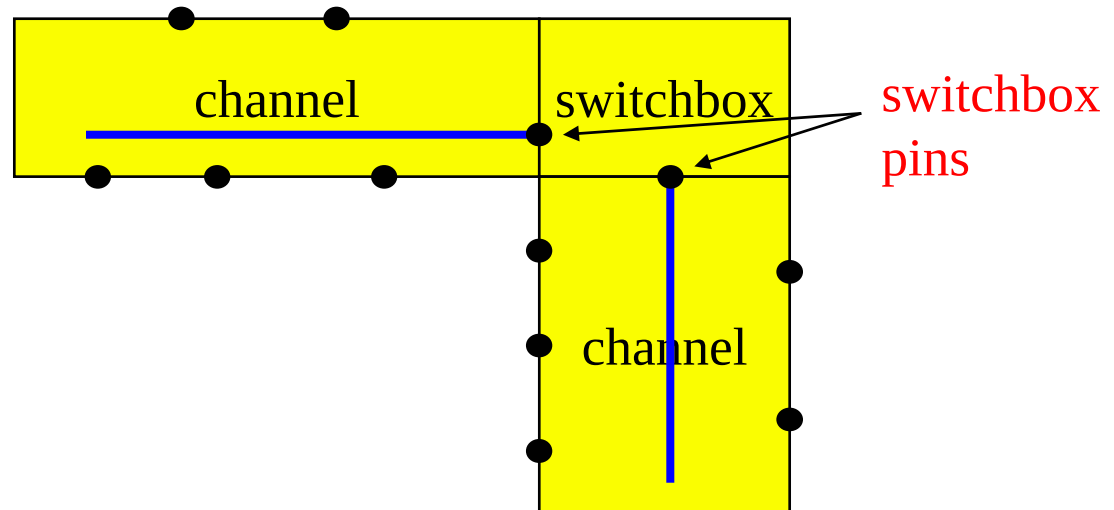
Types of routing

■ Channel routing:

- channel may grow in one dimension to accommodate wires;
- pins generally on only two sides.

■ Switchbox routing:

- cannot grow in any dimension;
- pins are on all four sides, fixing dimensions of the box.



Block placement

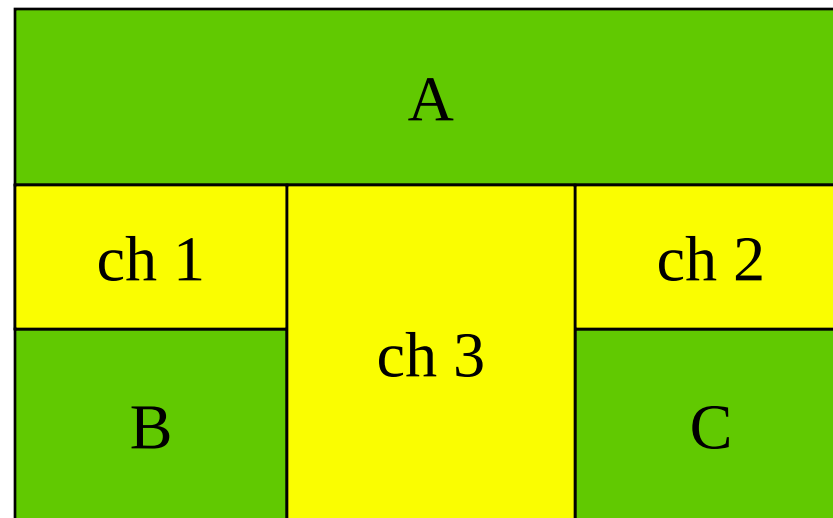
- Blocks have:
 - area;
 - aspect ratio.
- Blocks may be placed at different rotations and reflections.
- Uniform size blocks are easier to interchange.

Blocks and wiring

- Cannot ignore wiring during block placement—large wiring areas may force rearrangement of blocks.
- Wiring plan must consider area and delay of critical signals.
- Blocks divide wiring area into routing channels.

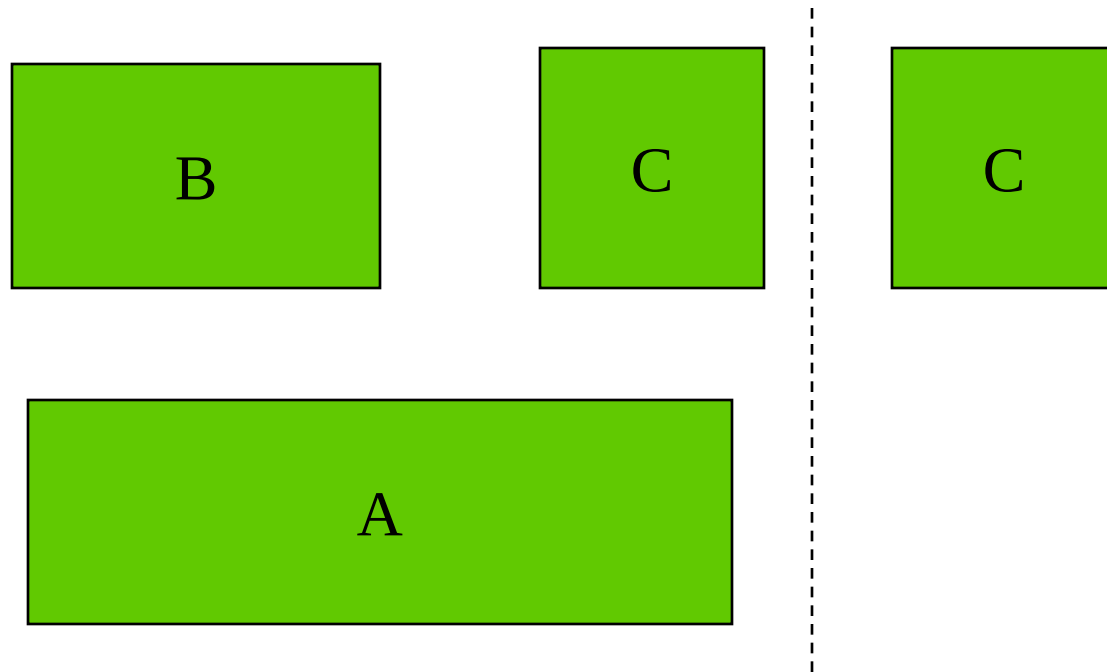
Channel definition

- Channels end at block boundaries.
- Several alternate channel definitions are possible:

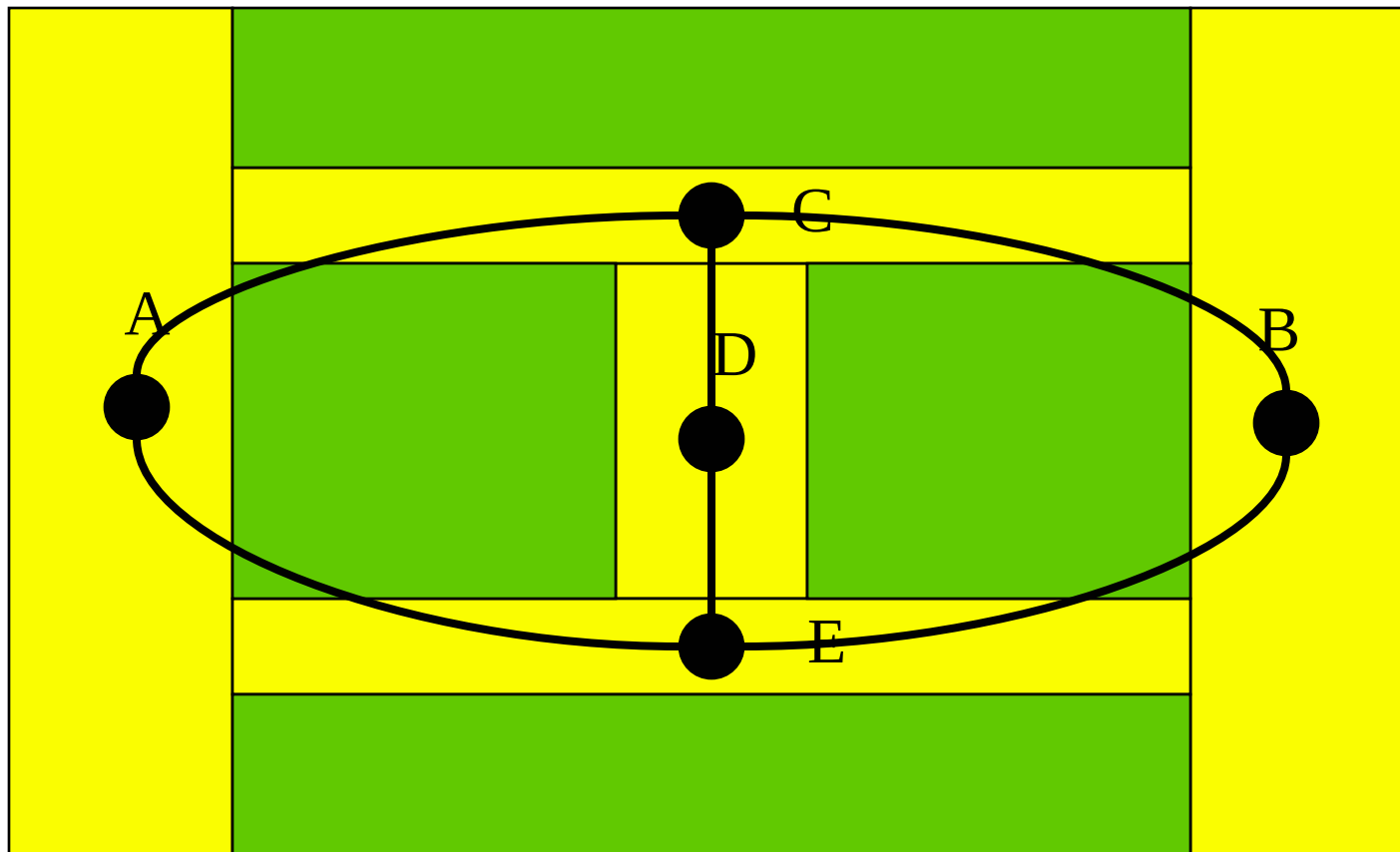


Channel definition changes with block spacing

Changing spacing changes relationship between block edges:



Channel graph

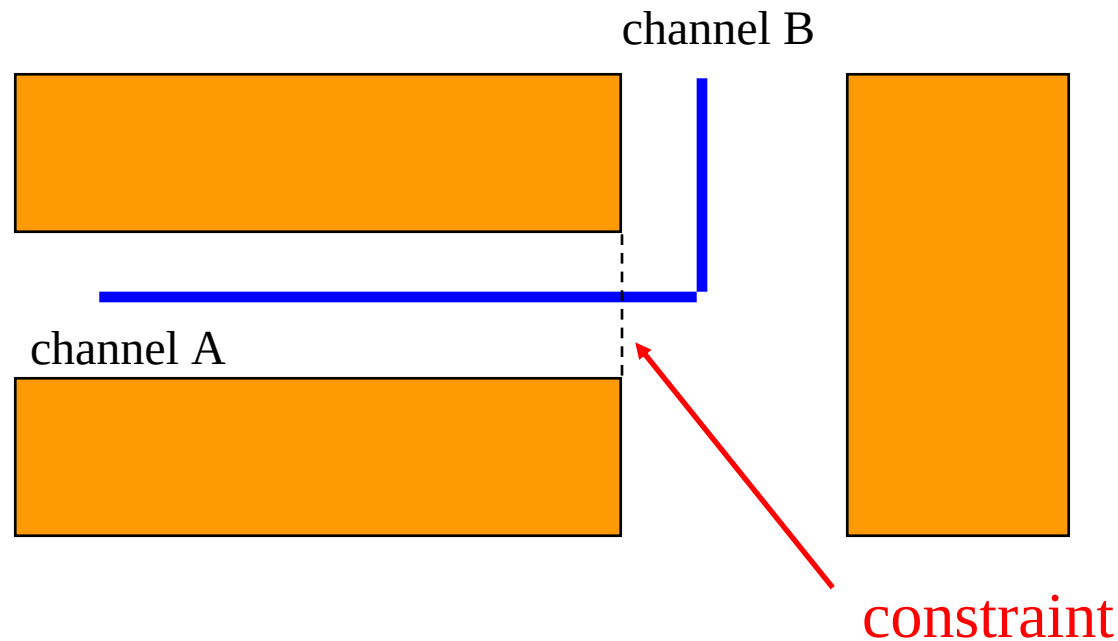


Channel graph usage

- Nodes are channels, edges placed between two channels that touch.
- Channel graph shows paths between channels.
- Channel graph can be used to guide global routing.

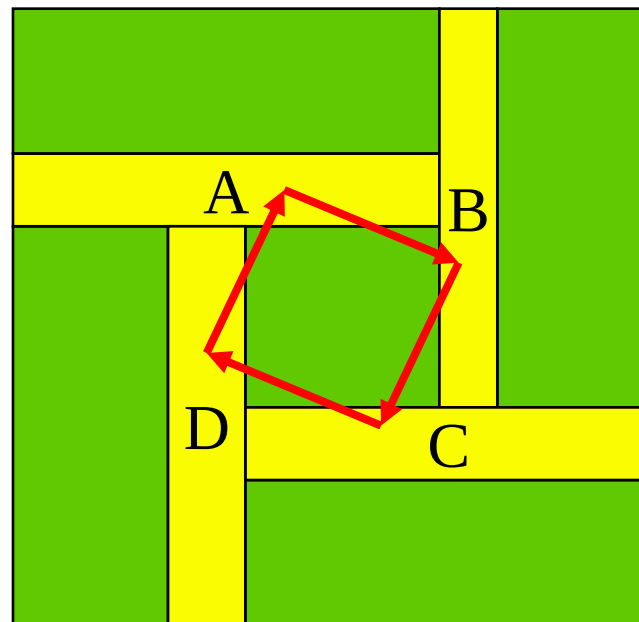
Channels must be routed in order

Wire out of end of one channel creates pin on side of next channel:



Windmills

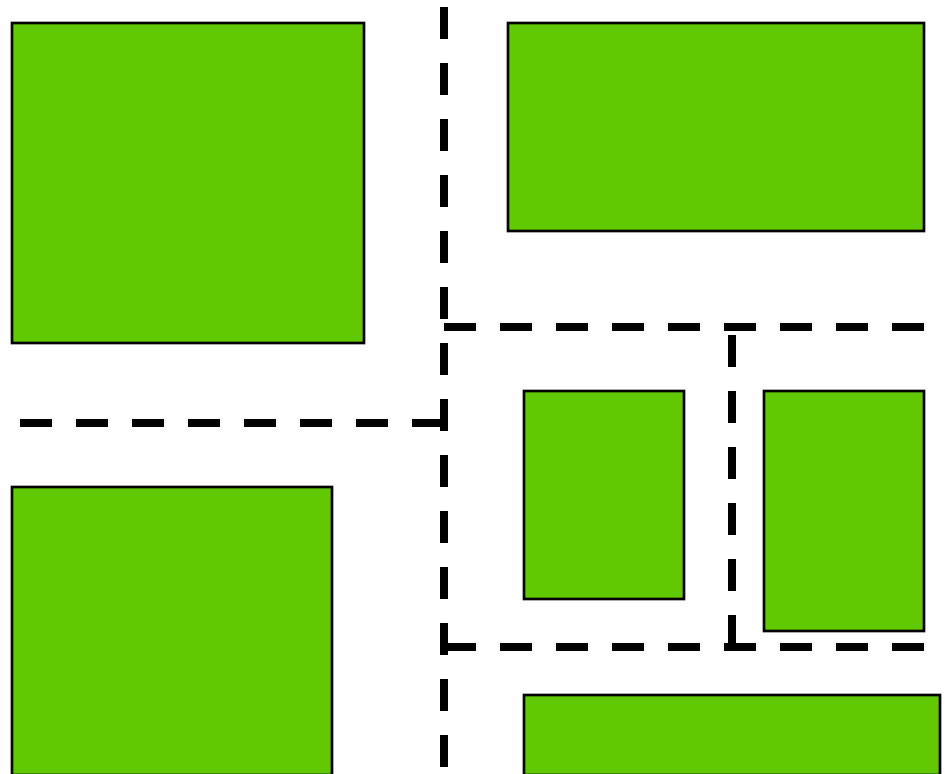
Can create an unroutable combination of channels with circular constraints:



Slicability property

- A slicable floorplan can be recursively cut in two without cutting any blocks.
- A slicable floorplan is guaranteed to have no windmills, therefore guaranteed to have a feasible order of routing for the channels.
- Slicability is a desirable property for floorplans.

Slicable floorplan



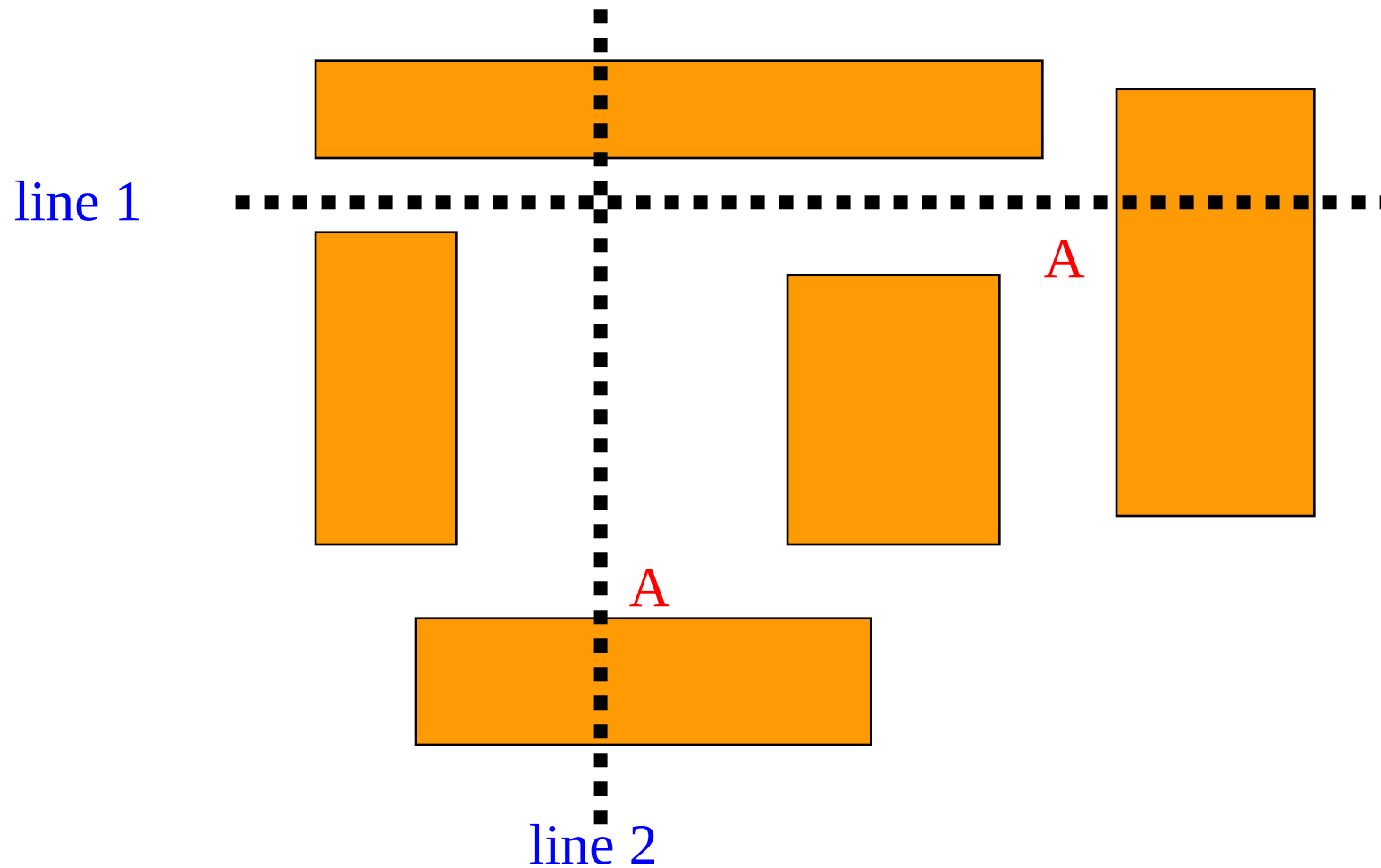
Global routing

- Goal: assign wires to paths through channels.
- Don't worry about exact routing of wires within channel.
- Can estimate channel height from global routing using congestion.

Line probe routing

- Heuristic method for finding a short route.
- Works with arbitrary combination of obstacles.
- Does not explore all possible paths—not optimal.

Line probe example

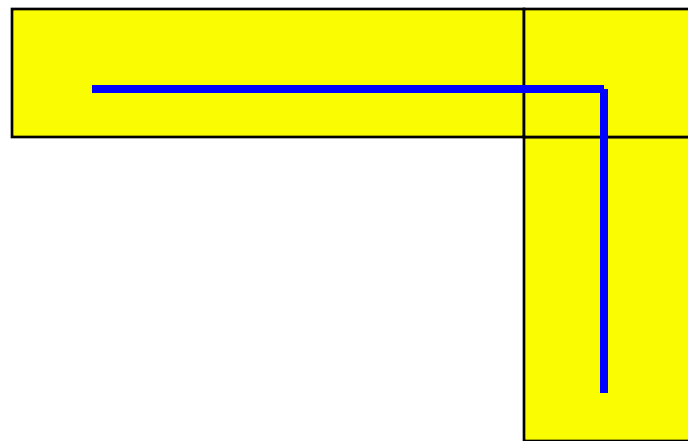


Channel utilization

- Want to keep all channels about equally full to minimize wasted area.
- Important to route time-critical signals first.
- Shortest path may not be best for global wiring.
- In general, may need to rip-up wires and reroute to improve the global routing.

Switchbox routing

- Can't expand a switchbox to make room for more wiring.
- Switchbox may be defined by intersection of channels.



Routing order and switchboxes

Switchboxes frequently need more experimentation with wiring order because nets may block other nets:

