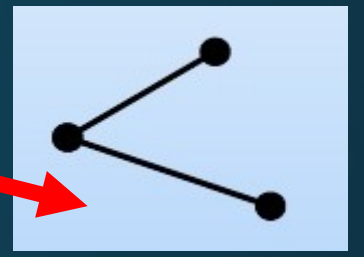
Routing Algorithm in VLSI

ROUTING

The routing is to locate a set of wires in the routing space that connect all the nets in the net list. The capacities of channels , width of wires , and wire crossings often need to be taken into consideration .

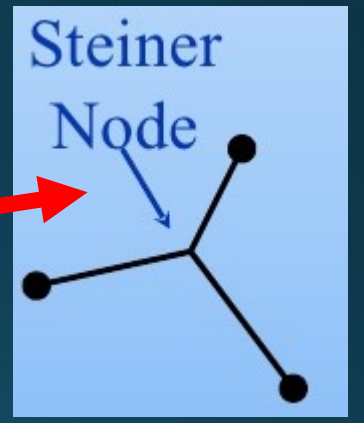
STEINER TREE

 # For a multi-terminal net, we can construct a spanning tree to connect all the terminals together.



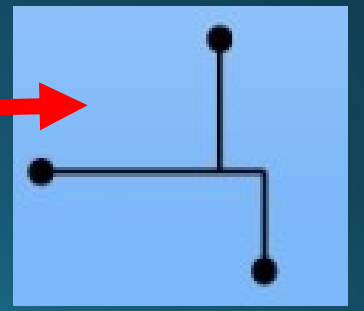
 # But the wire length will be large.

 # <u>Better use Steiner Tree :</u>



A tree connecting all terminals and some additional nodes (Steiner nodes)

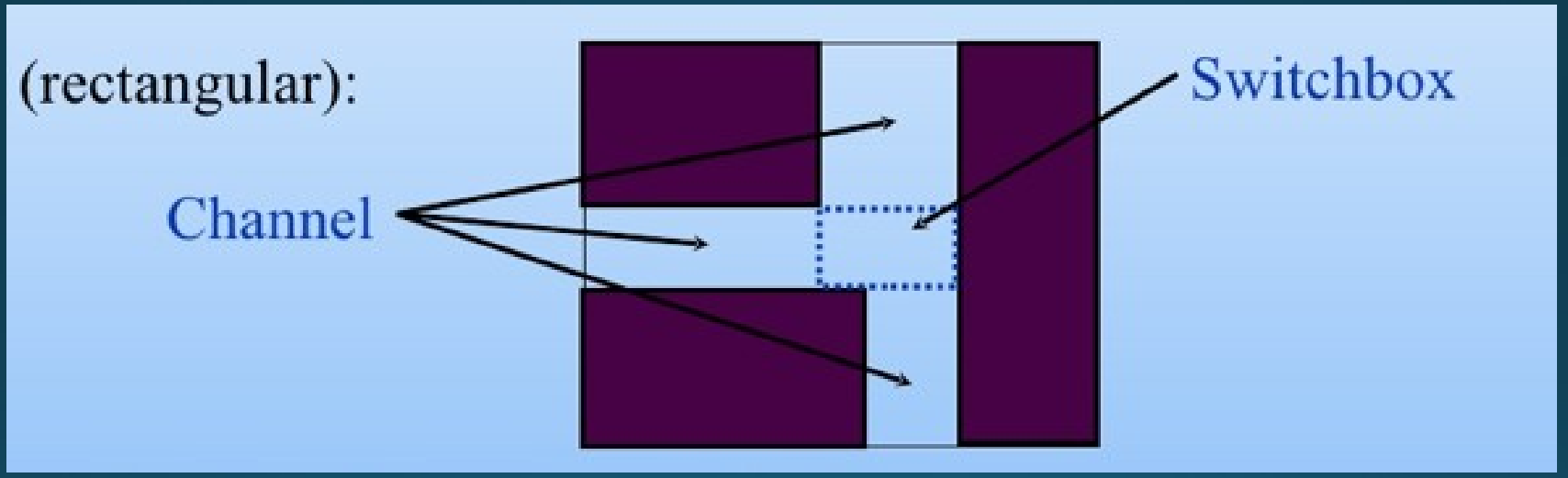
 # <u>Rectilinear Steiner Tree:</u>



Steiner tree in which all the edges run horizontally and vertically.

REGION DEFINITION

Divide the routing area into routing regions of simple shape

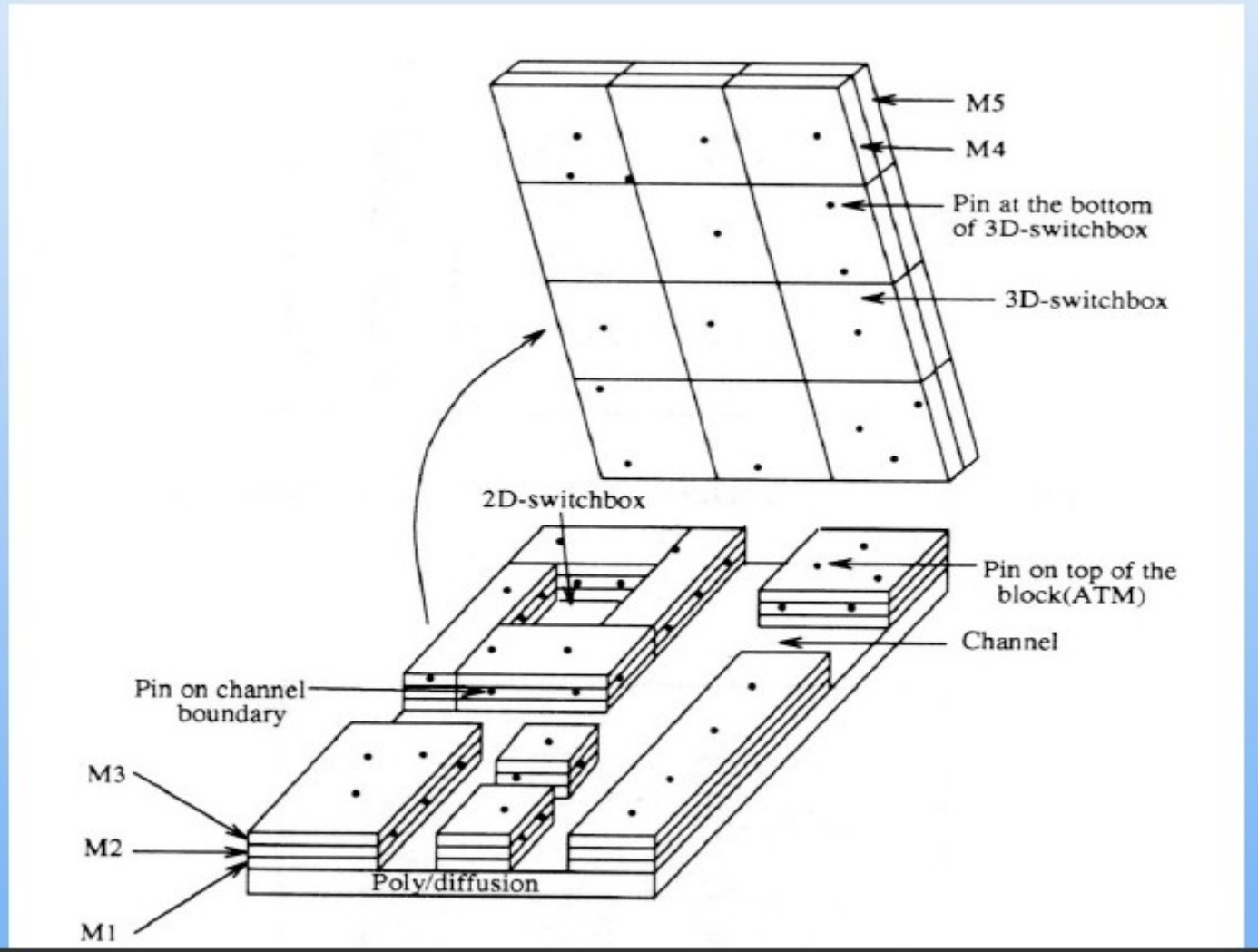


 # Channel : Pins on 2 opposite sides.

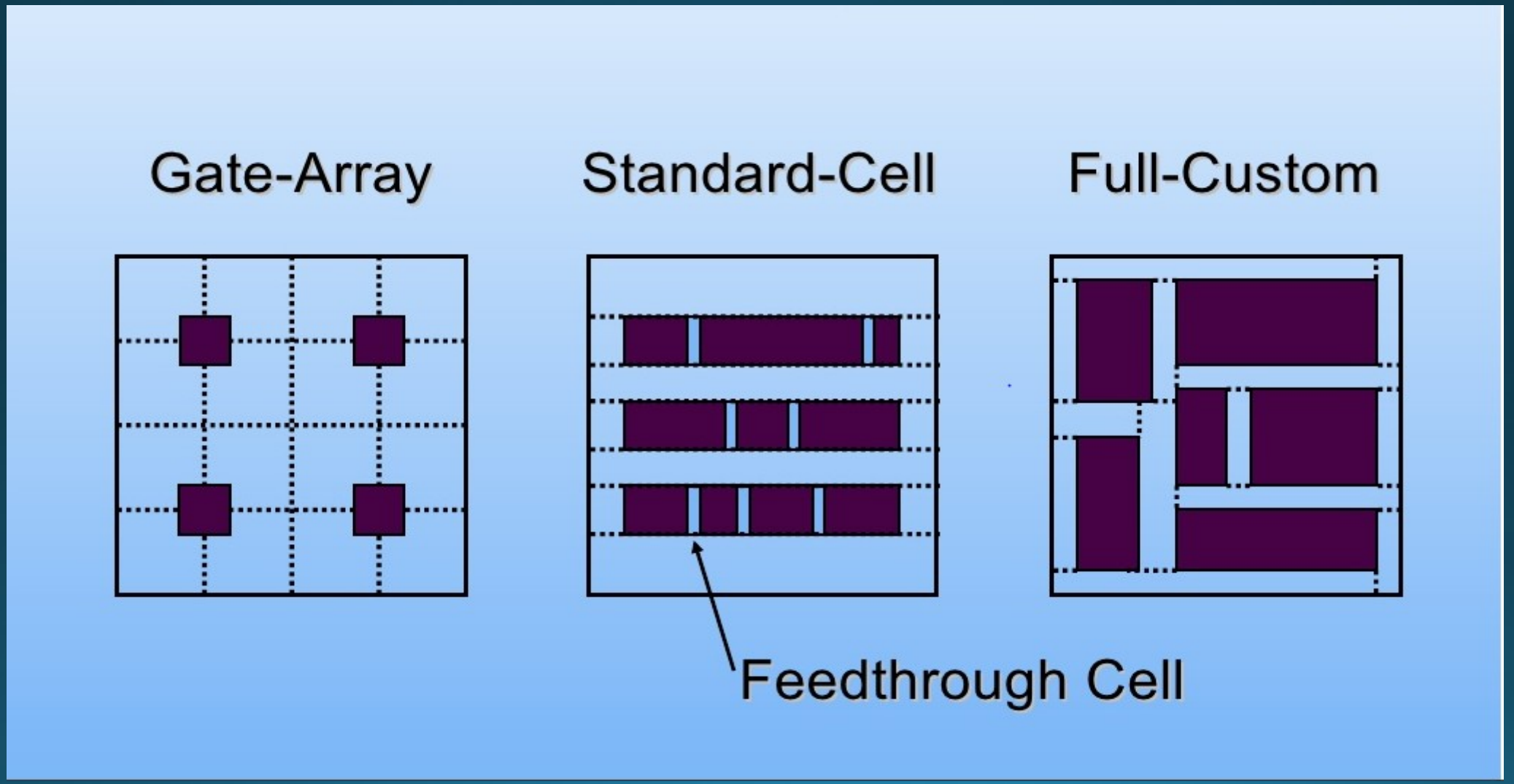
 # 2-D Switchbox : Pins on 4 sides.

 # 3-D Switchbox : Pins on all 6 sides.

ROUTING REGIONS

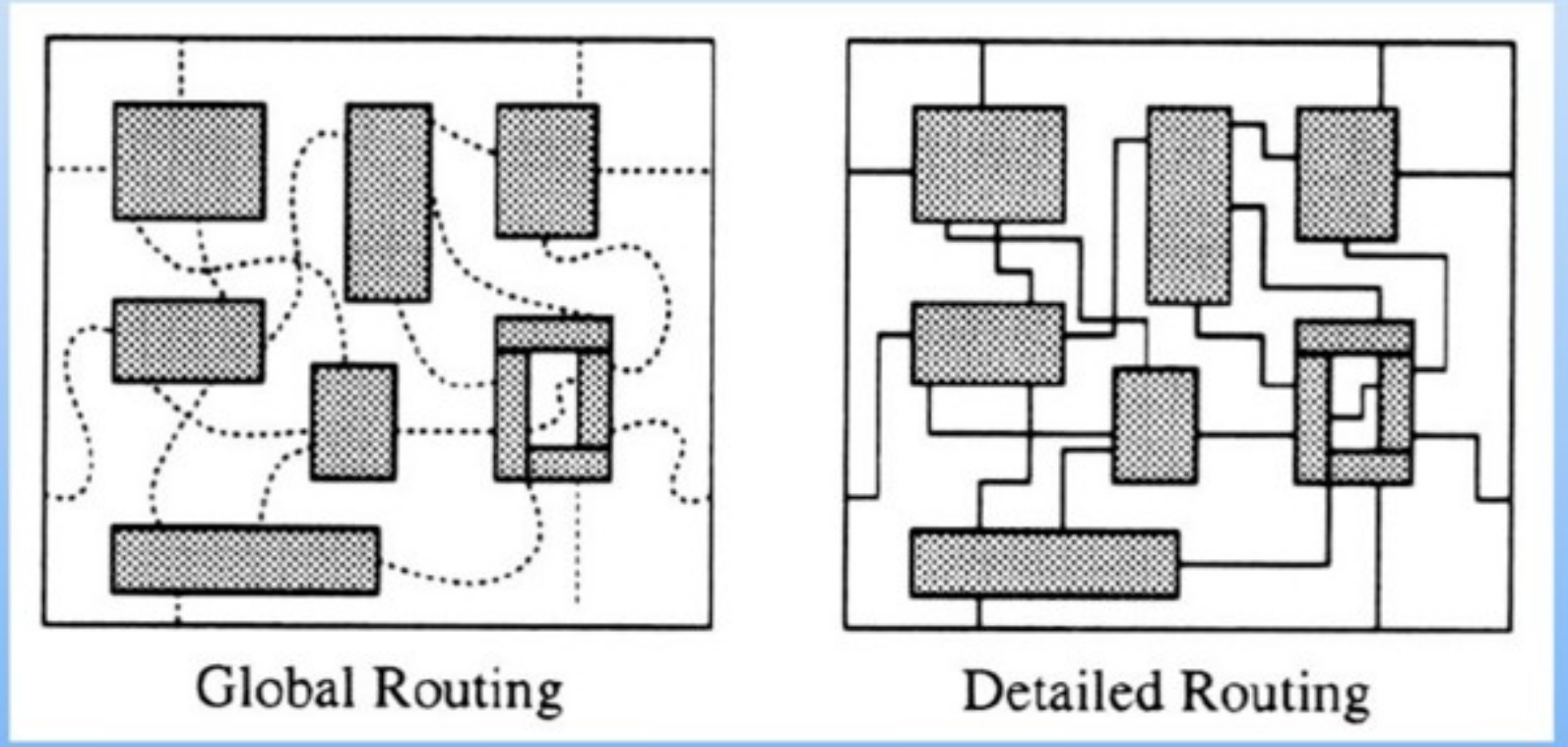


ROUTING REGIONS IN DIFFERENT DESIGN STYLES



GENERAL ROUTING PROBLEM

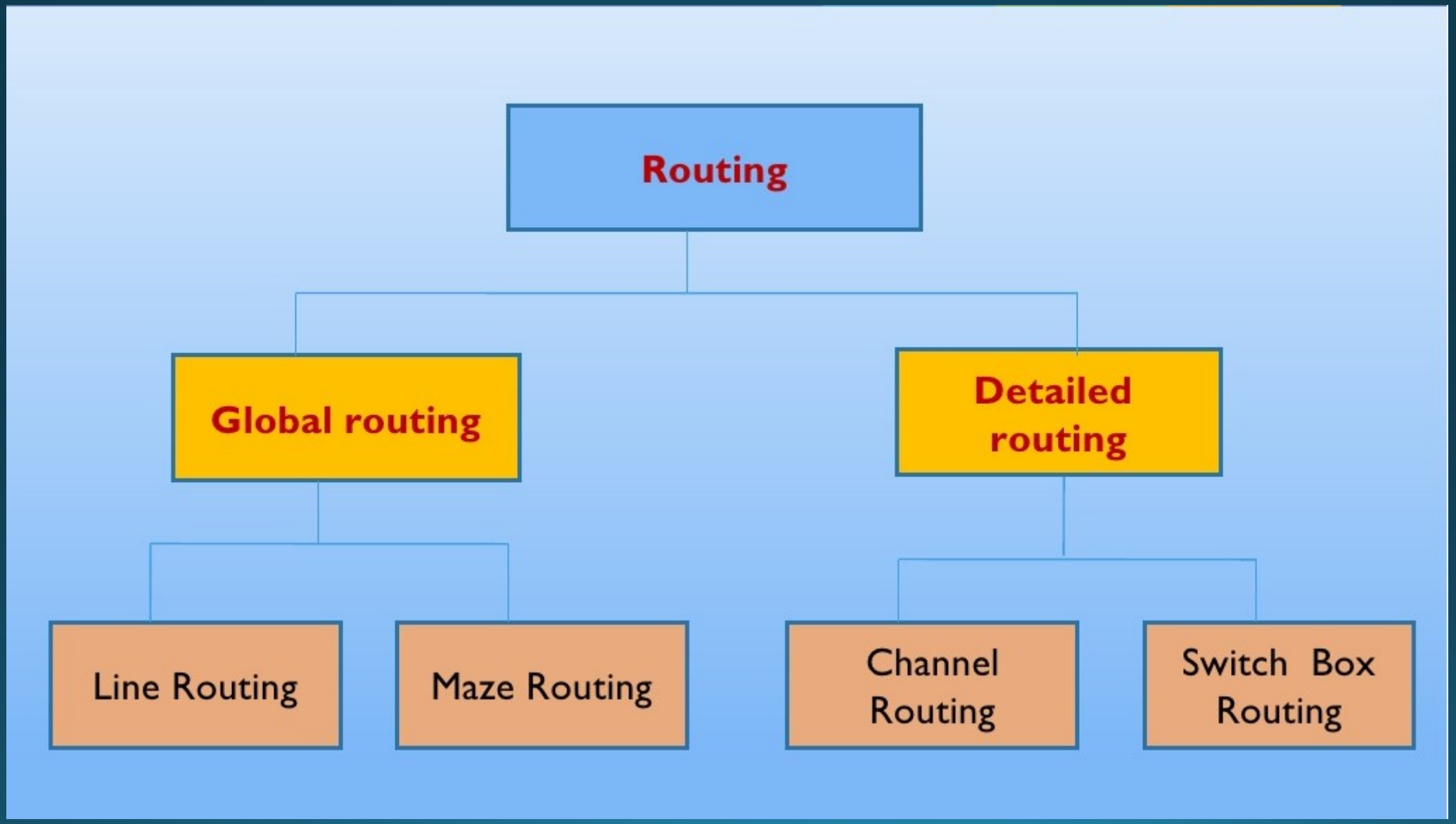
Two phases:



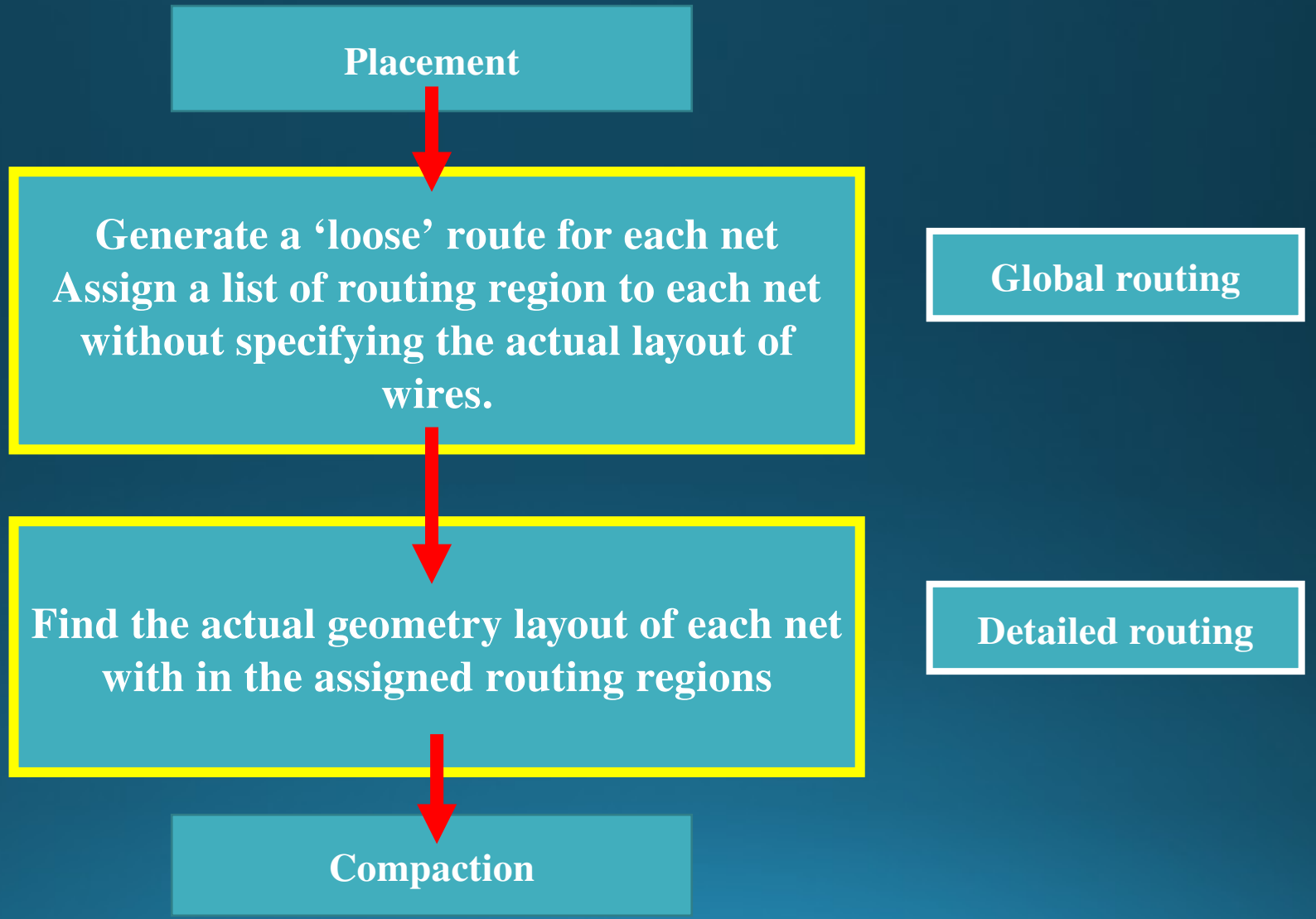
Global Routing

Detailed Routing

TYPES OF ROUTING



GLOBAL ROUTING & DETAILED ROUTING



GLOBAL ROUTING

OBJECTIVES OF GLOBAL ROUTING

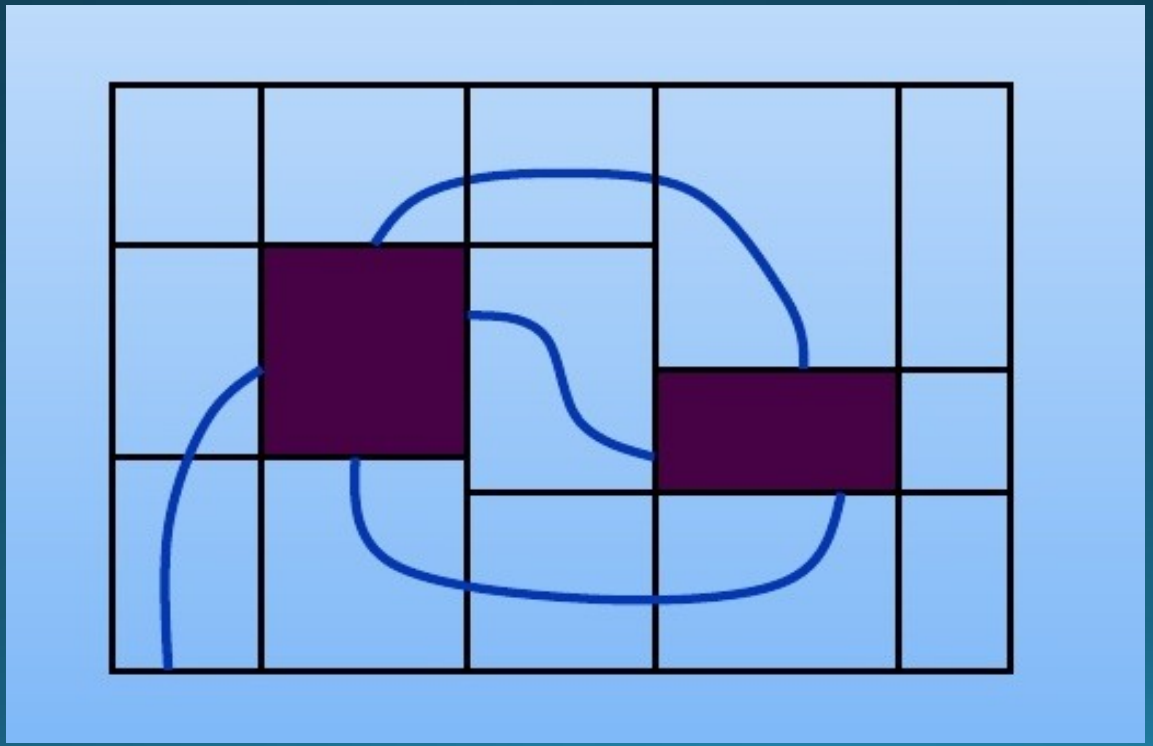
 # Minimize the total Overflow

 # Minimize the total wire length

 # Minimize running time

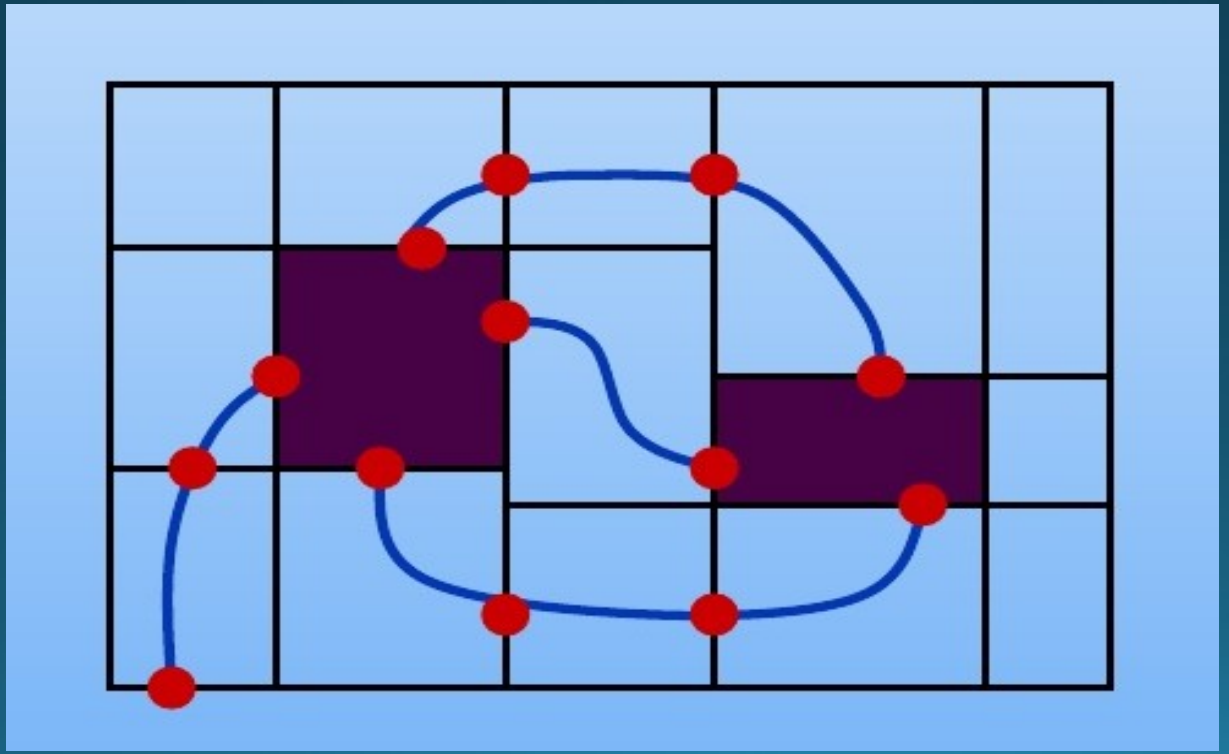
REGION ASSIGNMENT

Assign routing regions to each net. Need to consider timing budget of nets and routing congestion of the regions.



PIN ASSIGNMENT

Assign pins on routing region boundaries for each net.
(Prepare for the detailed routing stage for each region.)



APPROACHES FOR GLOBAL ROUTING

Sequential Approach :

 # Route the nets one at a time.

 # Order dependent on factors like criticality , estimated wire length , etc.

 # If further routing is impossible because some nets are blocked by nets routed earlier , apply Rip-up and Reroute technique.

#This approach is much more popular.

APPROACHES FOR GLOBAL ROUTING (CONTD.)

Concurrent Approach :

 # The major drawback of the sequential approach is that it suffers from the net ordering problem.

 # Consider all nets simultaneously.

 # Can be formulated as an integer program.

DETAILED ROUTING

DETAILED ROUTING

Three types of detailed routing methods:

 # Channel Routing

 # 2-D Switchbox Routing

 # 3-D Switchbox Routing

 # If the switchbox or channels are unroutable without a large expansion , global routing needs to be done again.

DETAILED ROUTING (CONTD.)

Channel routing:

 # channel may grow in one dimension to accommodate wires.

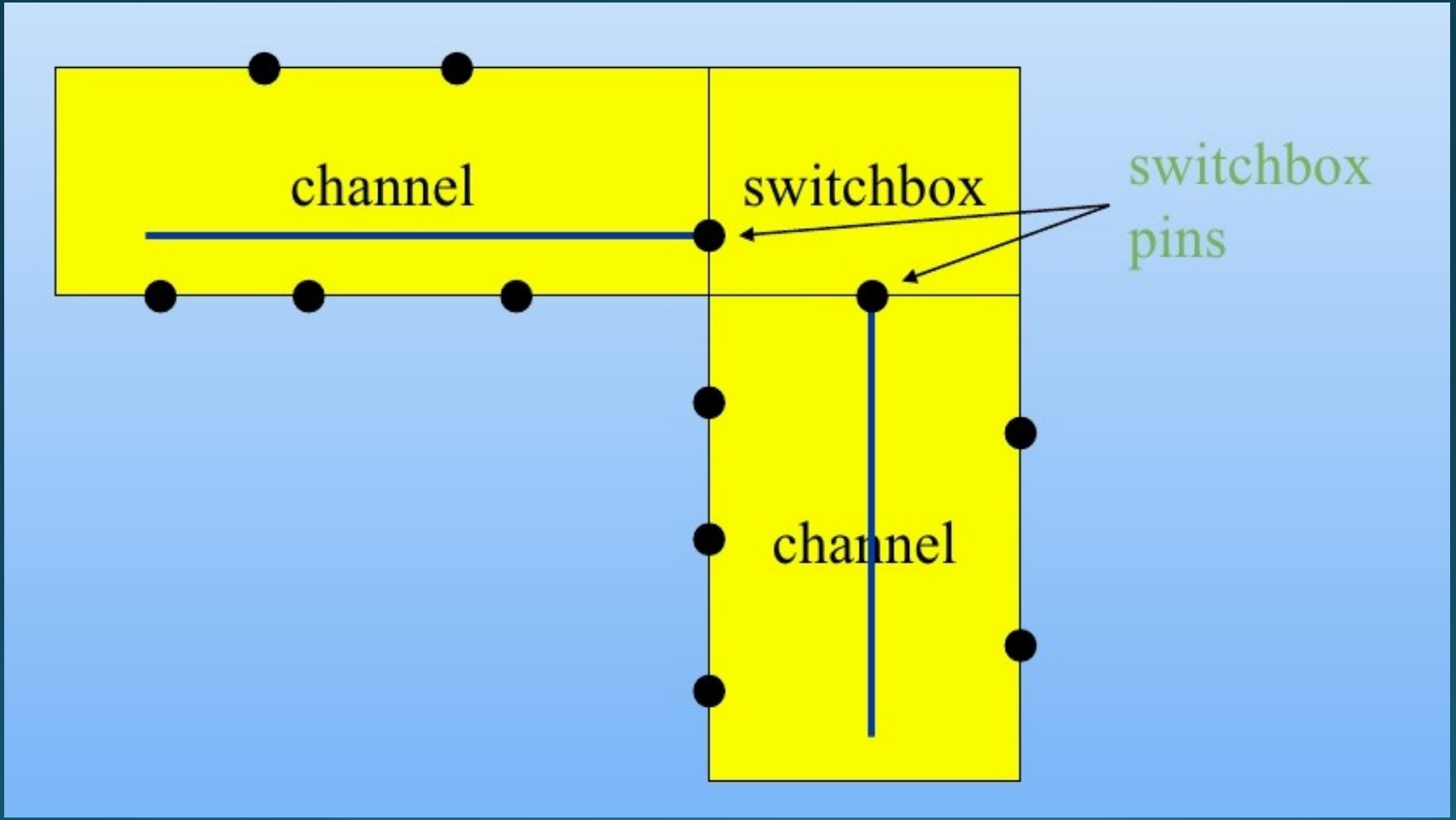
 # pins generally on only two opposite sides.

Switchbox routing:

 # Switch box routing is harder than channel routing because we can’t expand the switchbox to make room for more wires.

 # pins are on all four sides , fixing dimensions of the box.

CHANNELS AND SWITCHBOXES



TYPES OF CHANNEL JUNCTIONS

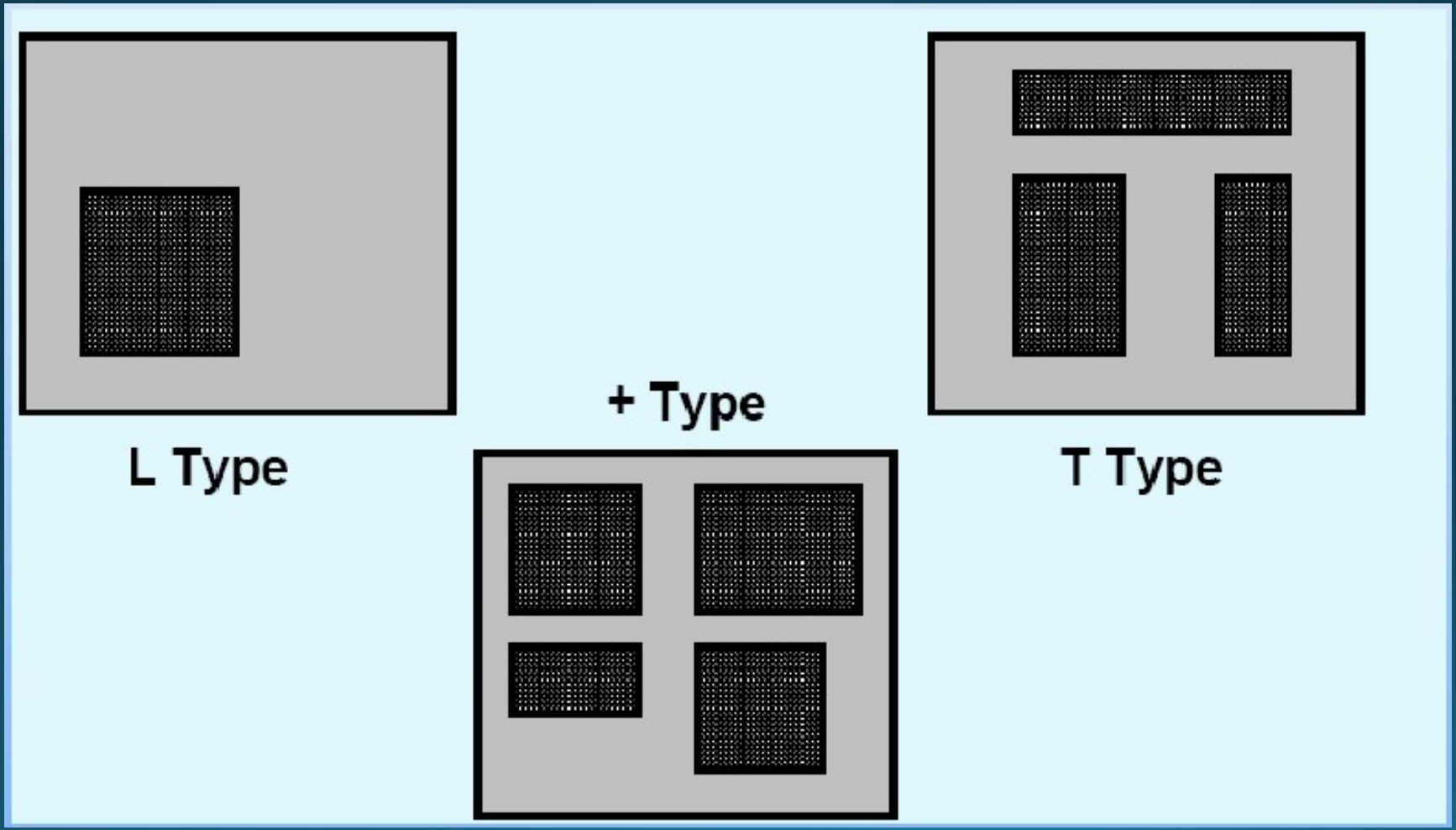
Three types of channel junctions may occur :

 # L-type : Occurs at the corners of the layout surface. Can be routed using channel routers.

 # T-type : The leg of the "T" must be routed before the shoulder.
Can be routed using channel routers.

 # +- type : More complex and requires switchbox routers, Advantageous to convert +- junctions to T-junctions.

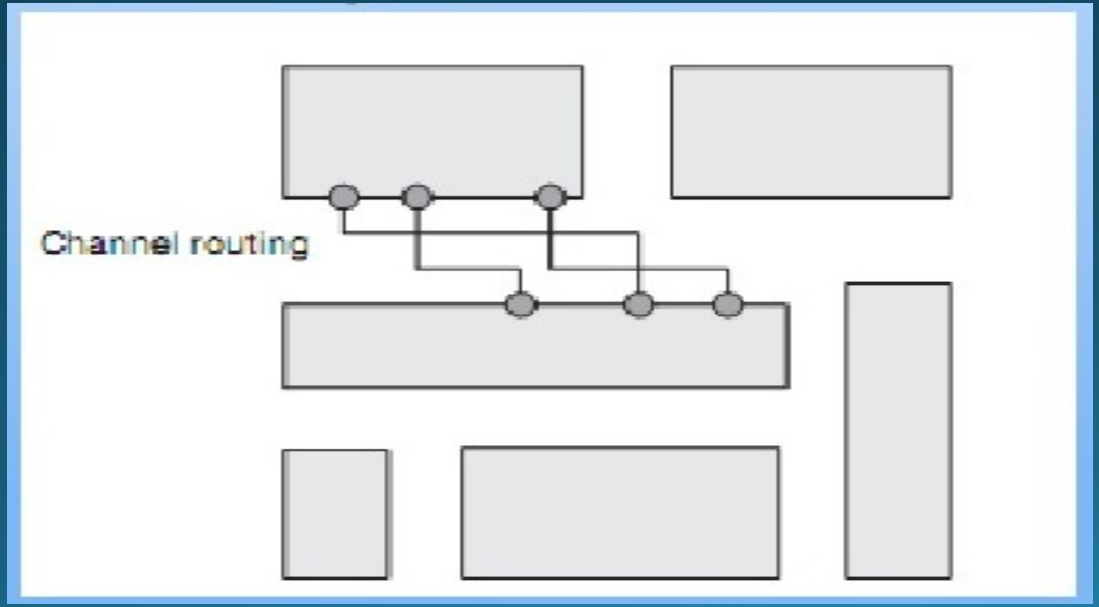
TYPES (CONTD.)



CHANNEL ROUTING

 # Channel routing is a special case of the routing problem in which wires are connected within the routing channels.

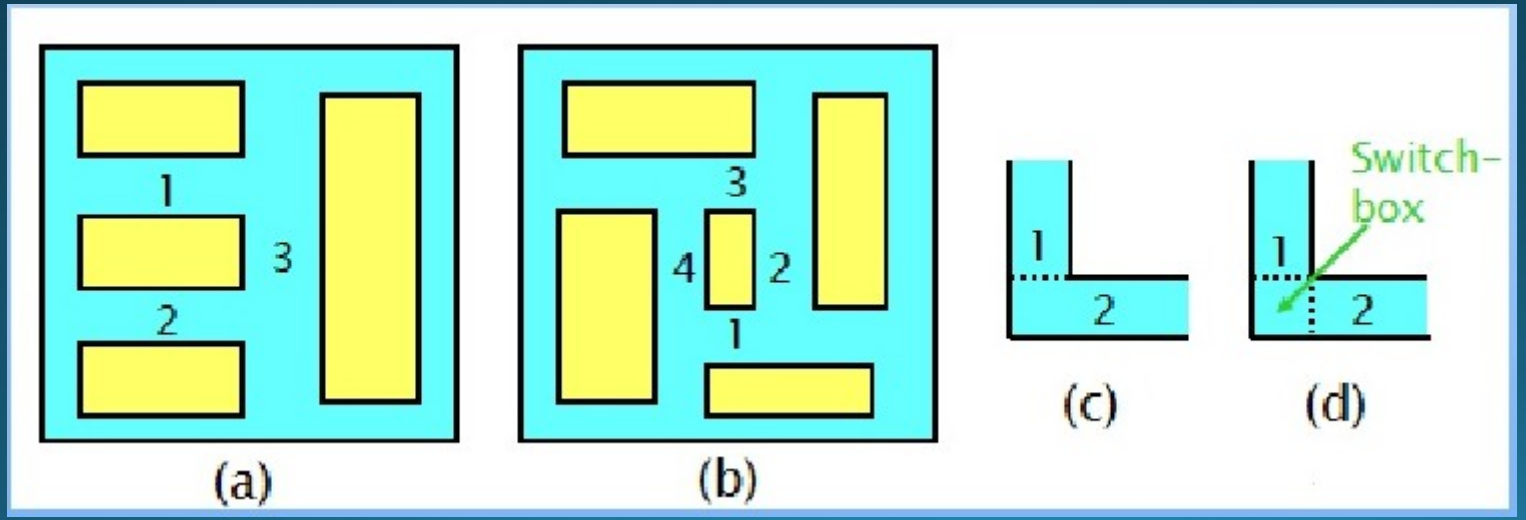
 # To apply channel routing , a routing region is usually decomposed into routing channels .



DETAILED ROUTING: CHANNEL VS. SWITCHBOX

a) Channels have no conflicts
b) Conflicting channels
c) Conflict resolved using L-shaped channels
Order matters

d) Switchbox used to resolve the conflict
Order matters
Harder problem (compared to channel routing)



EXTRACTION AND TIMING ANALYSIS

 # After global routing and detailed routing , information of the nets can be extracted and delays can be analyzed.

 # If some nets fail to meet their timing budget , detailed routing and/or global routing needs to be repeated.

ROUTERS AVAILABLE

 # NTHU – Route

 # MaizeRouter

 # BoxRouter

 # Archer

 # FastRoute

#NTUgr

 # FASHION

CONCLUSION

 # Routing is one of the most fundamental steps in the physical design flow and is typically a very complex optimization problem.

 # Effective and efficient routing algorithms are essential to handle the challenges arising from the fast growing scaling of IC integration.

 # We have discussed Global and Detailed routing techniques.

 # Routers will keep evolving with emerging design challenges such as nanometer effects , signal integrity , reliability etc .