

Airspace Node Holding Strategies

North American Simmod
Users Group

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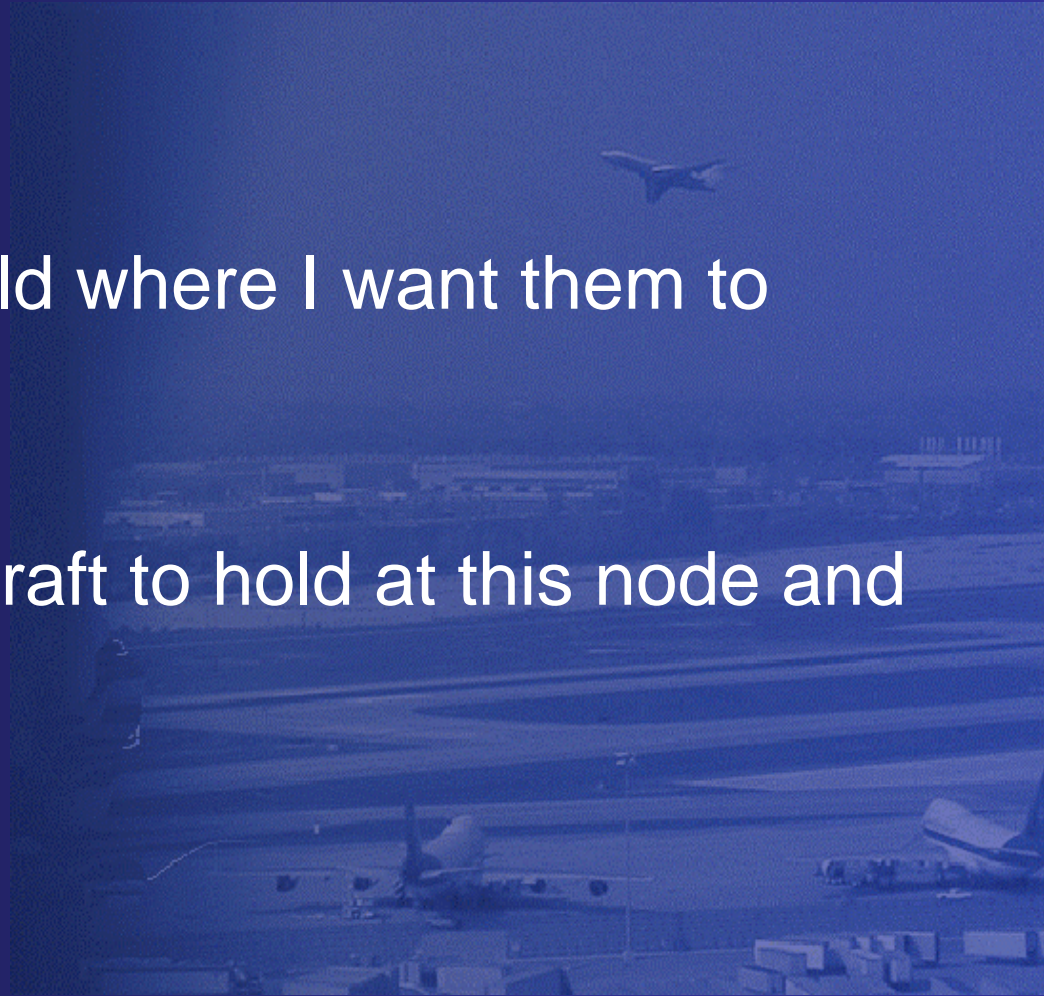
23 March 2007



Commonly Heard Statements/Questions

“My aircraft do not hold where I want them to hold!”

“How do I get the aircraft to hold at this node and not that node?”



SIMMOD Node Basics

Your airspace node-link structure should approximate the optimal tracks that aircraft would follow when there is *no* delay.

Nodes should then be placed at “points of interest” where aircraft

- Merge or diverge with other flows
- Cross a specific altitude
- Turn
- ***Hold***
- (combinations of the above)

SIMMOD Node Basics (Digression)

At which nodes should aircraft hold?

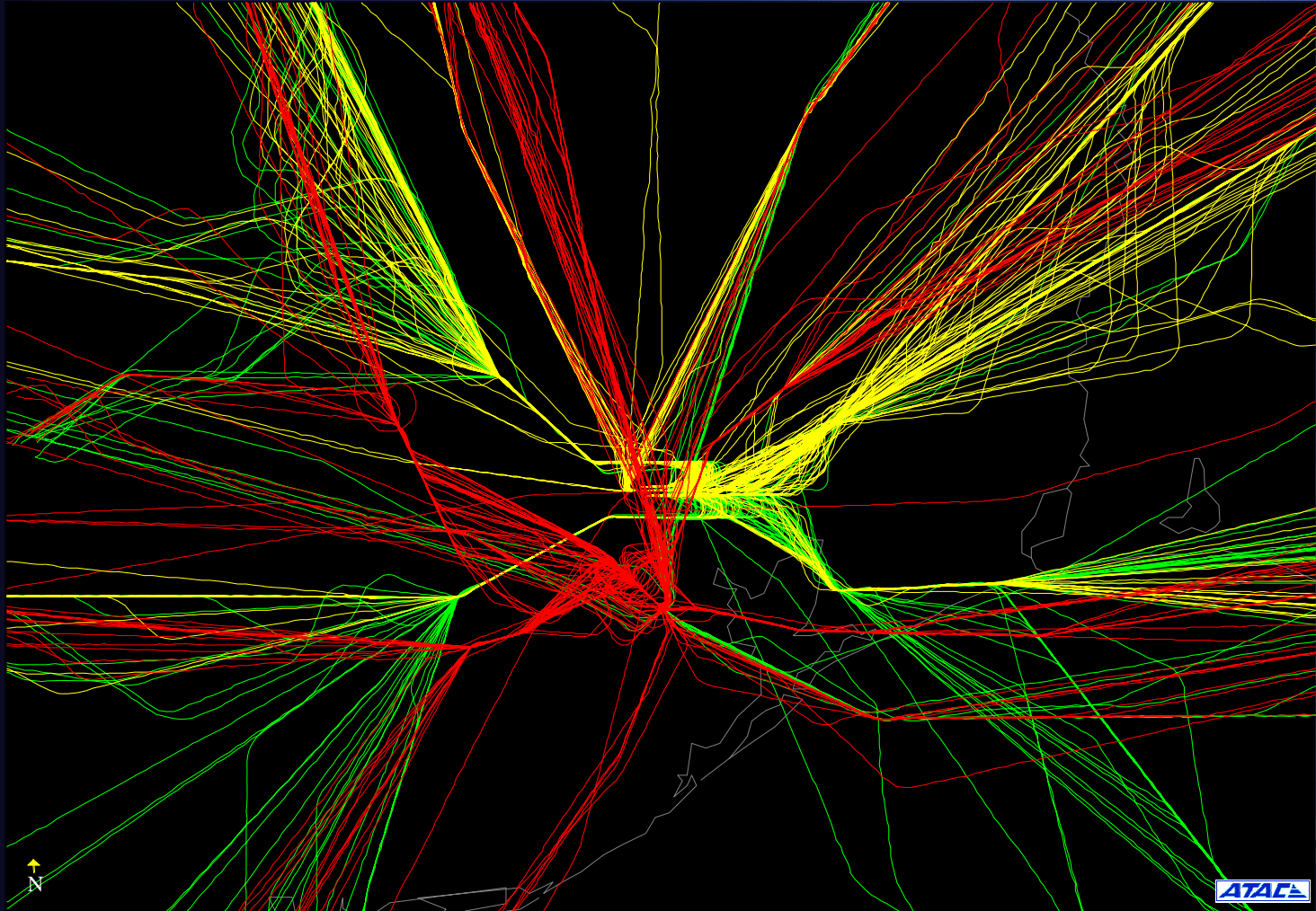
At any location in which aircraft would incur delay.

Aircraft incur delay commonly incur delay by vectoring away from the optimal track.

- Deflections
- Holding pattern

SIMMOD Node Basics (Digression)

Sample aircraft radar tracks:



SIMMOD Node Basics (Digression)

At which nodes should aircraft hold?

The final decision of node holding position is up to the analyst.

How closely does the position need to reflect reality?

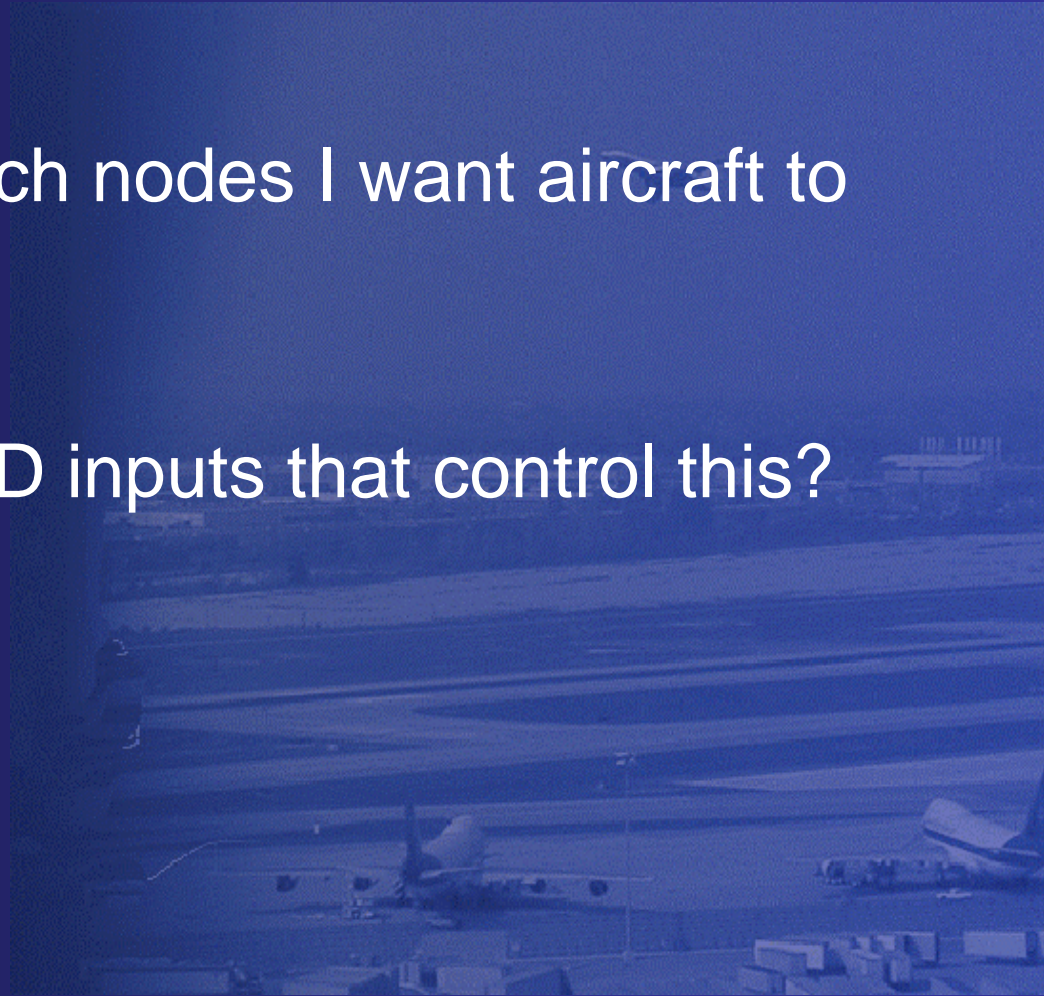
- If the animation is important, then you need to have accurate holding locations.
- If the animation is not important, you can often simplify the model by forcing holding to occur only at specific nodes.

Airspace Node Holding

Okay...

I have decided at which nodes I want aircraft to hold...

What are the SIMMOD inputs that control this?



Airspace Node Holding

In the airspace node inputs...

SIMU3

NODES inputs

Database

AIRSPACE_NODE table

Cap

HStrat

Opt

MAX_HELD_AC

HOLDING_STRAT

ARRIVAL_STRAT_FLAG

Node Holding Capacity

SIMU03

Cap

Database

MAX_HELD_AC

The maximum number of aircraft that can occupy the node.

Once the number of aircraft holding at the node reaches this value, other aircraft will hold at nodes upstream.

- Aircraft will hold upstream only if there are aircraft actually holding at the downstream node.
- (See example)

Node Holding Strategy

SIMU03

HStrat

Database

HOLDING_STRAT

Four strategies:

- 1 Hold if any aircraft are holding at the next node.
(Default)
- 2 Hold if the next node is filled to capacity.
- 3 Hold if the number of aircraft approaching the next node plus the number holding fill it to capacity.
- 4 Hold if the number of aircraft approaching the next node fill it to capacity.

Node Holding Strategy

Strategy 1 *may not* be the best choice.

For models that have lower levels of air traffic or long air links, strategy 1 may result in excessive air delay.

Strategy 3 is often the best choice in situations of low or moderate traffic.

Node Separation Strategy

SIMU03

Opt

Database

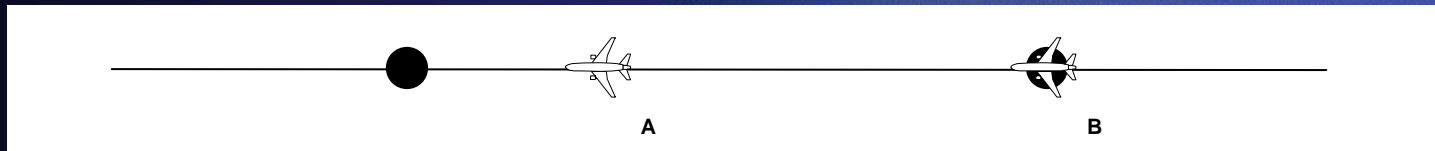
ARRIVAL_STRAT_FLAG

Originally there were only two strategies:

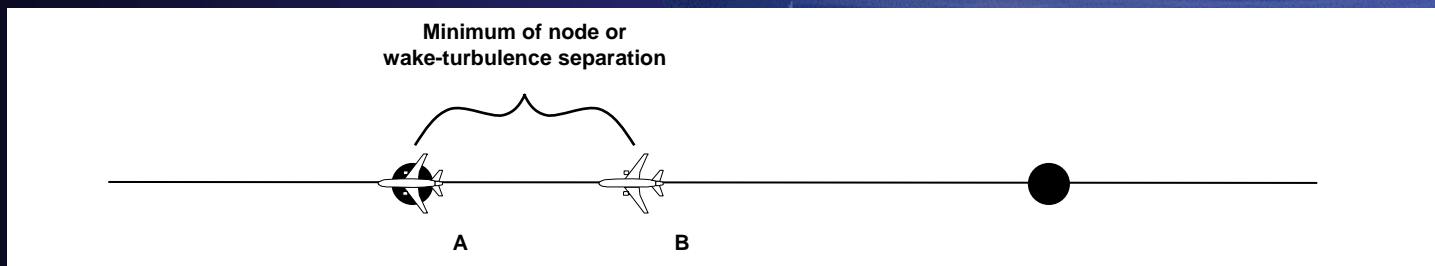
- 0 Separation is applied to aircraft sharing a common link entering or exiting the node. (Default)
- 1 Separation is applied to all aircraft passing through the node.

Node Arrival Separation Strategy

Given the following situation in which aircraft B is traveling faster than aircraft A and would overtake it:

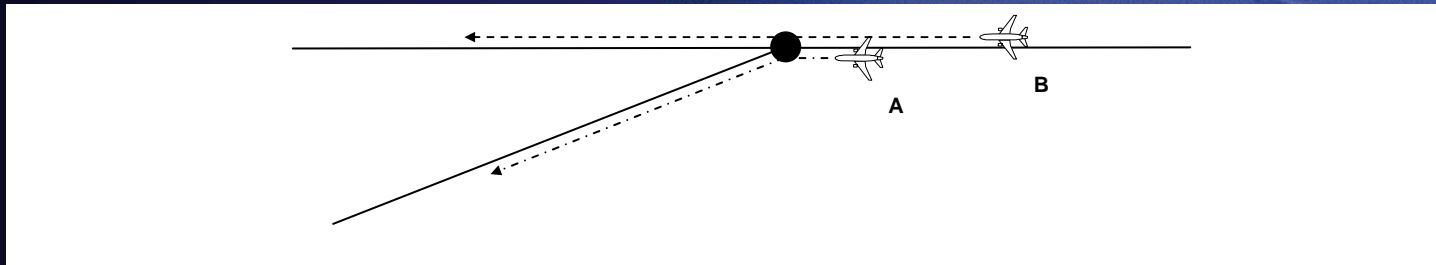


Aircraft B must hold such that when aircraft A reaches the destination node, aircraft B is no closer than the minimum wake turbulence separation as shown:

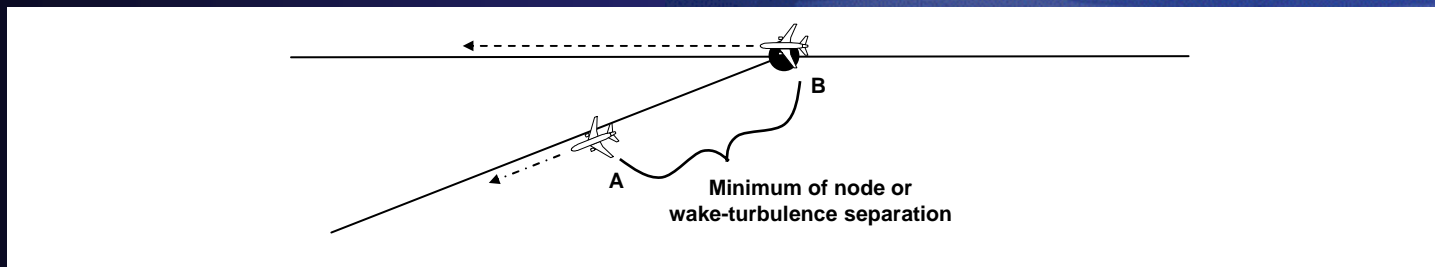


Node Departure Separation Strategy

Given the situation :



Aircraft B must hold at the node until the separation requirement is satisfied as shown:



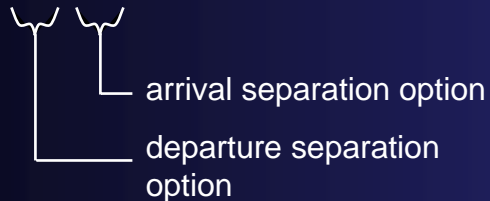
Node Separation Strategy

The decision to impose either node-arrival separation, node-departure separation, or both, is made through the use of the Opt field for each airspace node in the NODES inputs of the airspace input file (SIMU03).

NODES

1 D 1500 1

0101 0.0 ;



Option Value	Links In	Links Out	Logic	Interpretation
00	COM	COM	OR	Common link in or common link out
01	ANY	ANY	OR	Any links in or any links out
02	DIF	DIF	OR	Different links in or different links out
03	COM	ANY	OR	Common link in or any links out
04	COM	DIF	OR	Common link in or different links out
05	ANY	COM	OR	Any links in or common link out
06	ANY	DIF	OR	Any links in or different links out
07	DIF	COM	OR	Different links in or common link out
08	DIF	ANY	OR	Different links in or any links out
10	COM	COM	AND	Common link in and common link out
11	ANY	ANY	AND	Any links in and any links out
12	DIF	DIF	AND	Different links in and different links out
13	COM	ANY	AND	Common link in and any links out
14	COM	DIF	AND	Common link in and different links out
15	ANY	COM	AND	Any links in and common link out
16	ANY	DIF	AND	Any links in and different links out
17	DIF	COM	AND	Different links in and common link out
18	DIF	ANY	AND	Different links in and any links out

COM denotes common links into or out of the node
 ANY denotes any links into or out of the node
 DIF denotes different links into or out of the node

Node Separation Strategy

Example:

NODES

```
1 D 1500 1 1516 0.0 ;  
2 D 1500 1 1615 0.0 ;
```

Apply node-arrival separation for two aircraft that exit node 1 by different links (code xx16) and apply node-departure separation for two aircraft that exit the node by the same link (code 15xx).

Apply node-departure separation for two aircraft that exit the node 2 by different links (code 16xx) and apply node-arrival separation for two aircraft that exit the node by the same link (code xx15).

Node Separation Strategy

Older SIMU03 files may use only the 1 and 0 options. These are interpreted by the engine as follows to be consistent with the rule as it was applied by older engines:

NODES

```
1 D 1500 1 1 0.0 ; means 1 D 1500 1 0101 0.0 ;  
2 D 1500 1 0 0.0 ; means 2 D 1500 1 0000 0.0 ;
```

Node Separation Strategy

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