Strategies to Mitigate Tight Spatial Bounds Between Conflicts in Dense Traffic Situations

9 th SESAR Innovation Days

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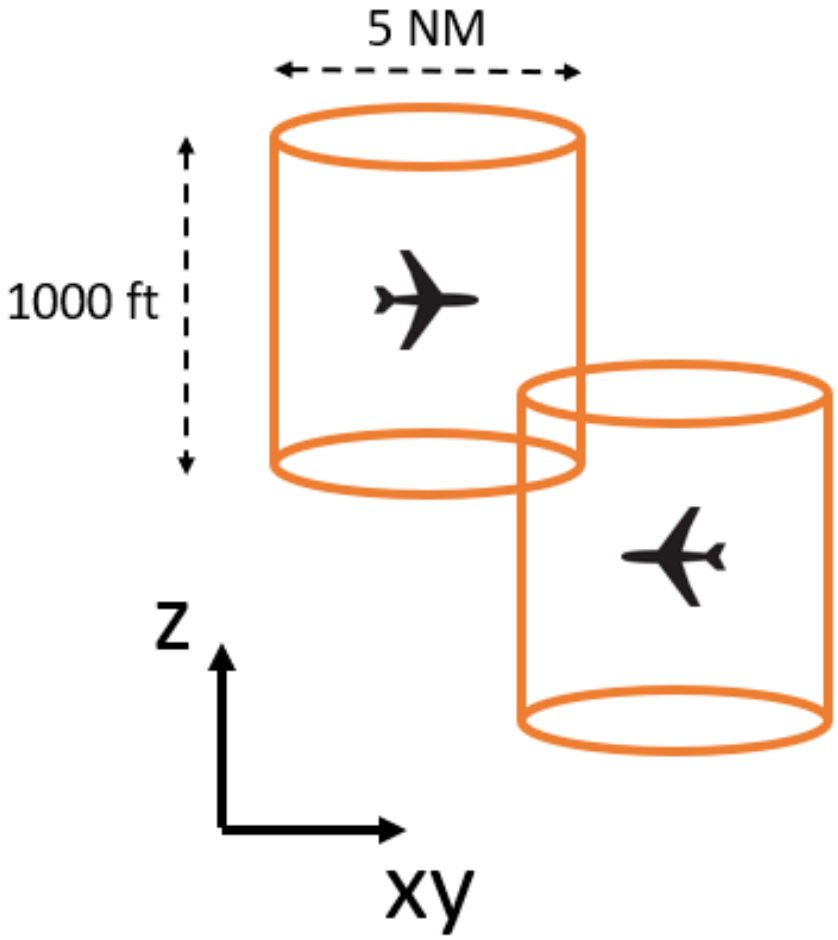
Content

- Conflict Detection & Resolution
- Identification of aircraft relevant to the conflict resolution
  - Spatio-temporal interdependencies
  - Use of spatio-temporal regions
  - Aerial ecosystems
- Compound aerial ecosystems
  - Definition of compound ecosystems
- Decomposition strategies
- Simulation results
- Conclusions

Conflict Detection & Resolution

Conflict Detection & Resolution

- Tactical level
- Safety through a minimum pairwise separation
- Avoid potential conflicts without generating new ones

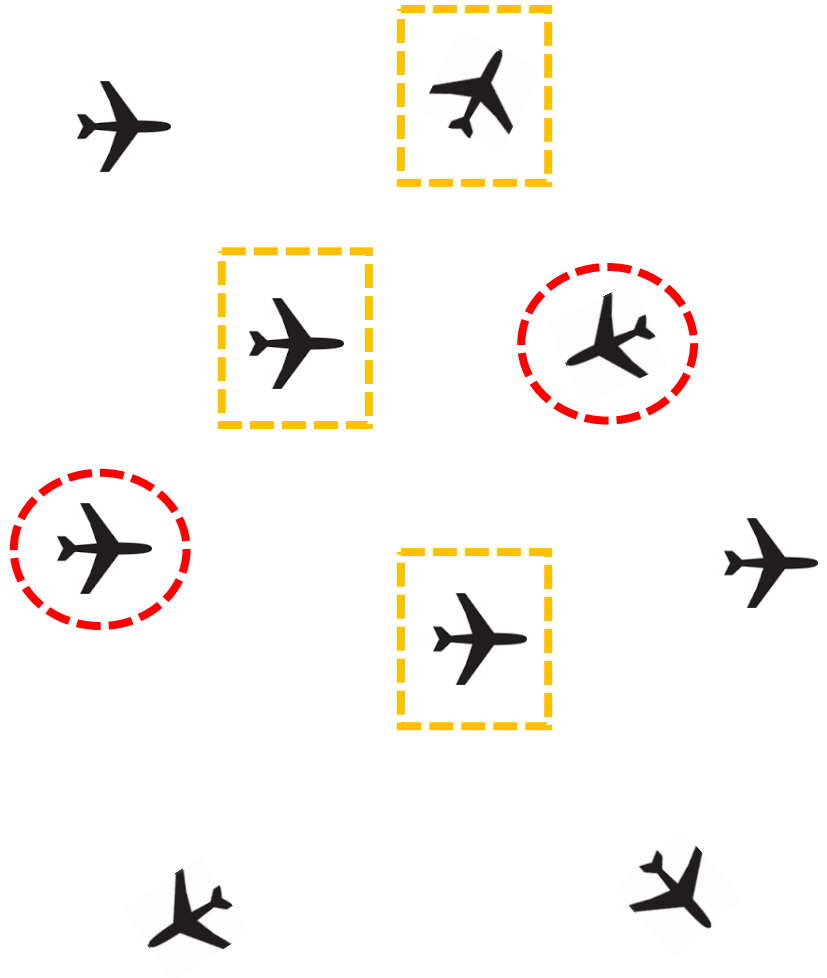


Conflict Detection & Resolution (1)

- How to detect the potential conflict?
- ***How to identify relevant aircraft to the potential resolution?***
- How to resolve the conflict?

Conflict Detection & Resolution (2)

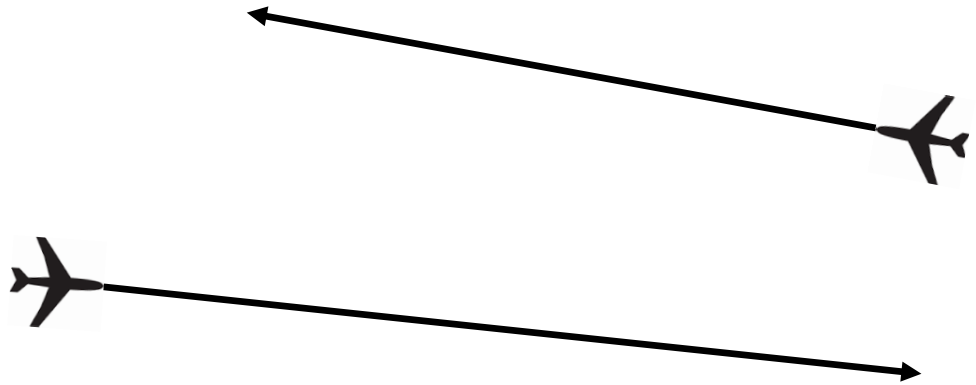
- There’s some traffic
- A potential conflict is detected
- We detect relevant traffic



HOW?

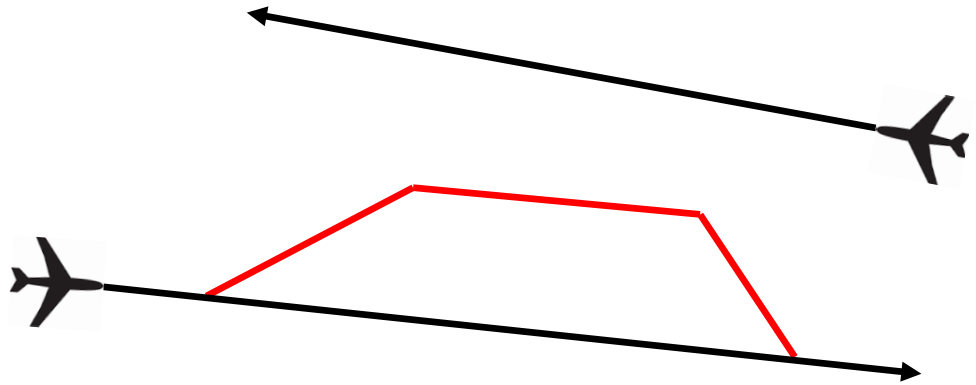
Identification of Aircraft Relevant to the Conflict Resolution

Spatio-Temporal Interdependencies

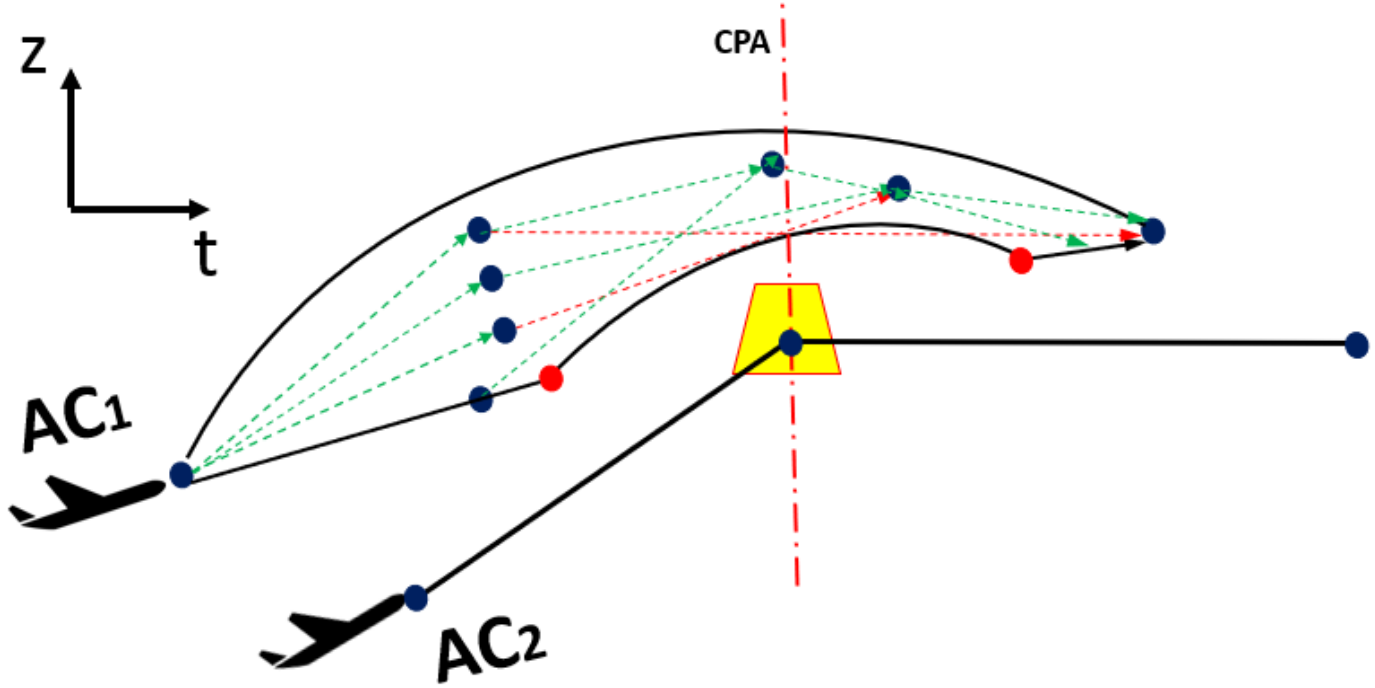


Spatio-Temporal Interdependencies (1)

- If there exist a modified trajectory, that generates a conflict, the two aircraft are ***interdependent***



Spatio-temporal regions



- Efficient consideration of a group of possible trajectories instead of individual ones

Types of regions

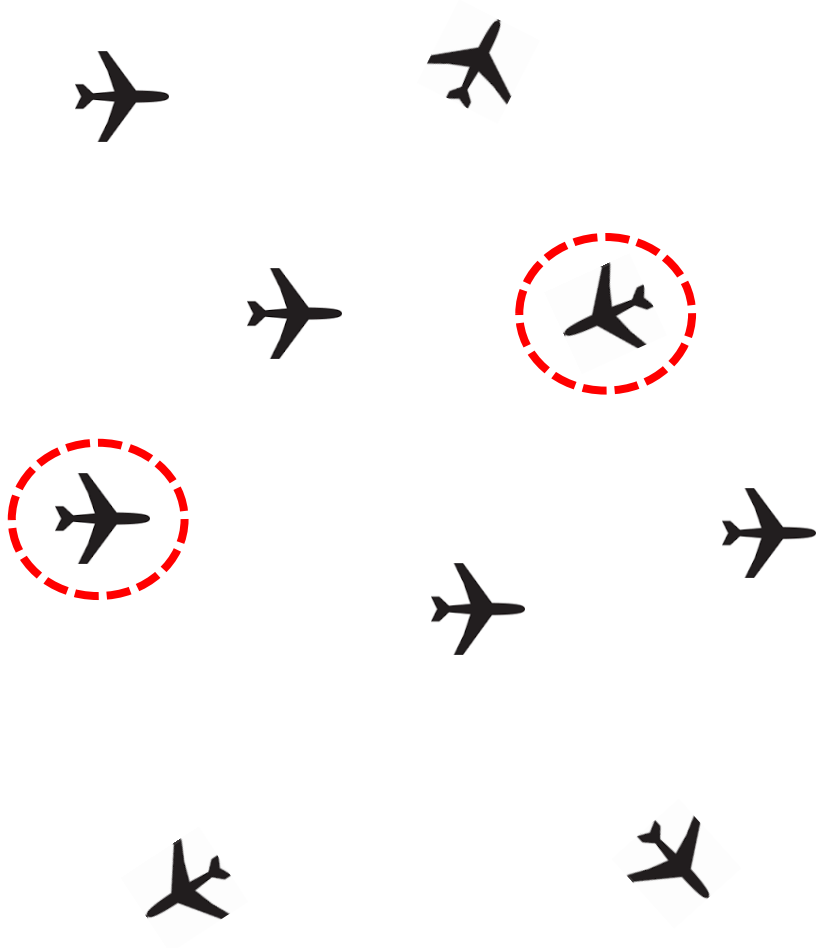
Based on alteration of:

- Heading
- Velocity module
- Altitude
- Heading and velocity module

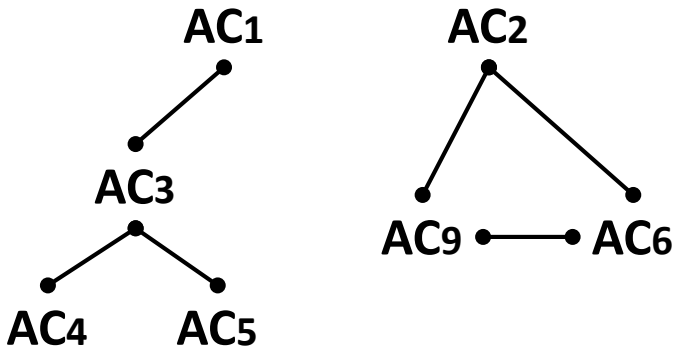
Aerial Ecosystem

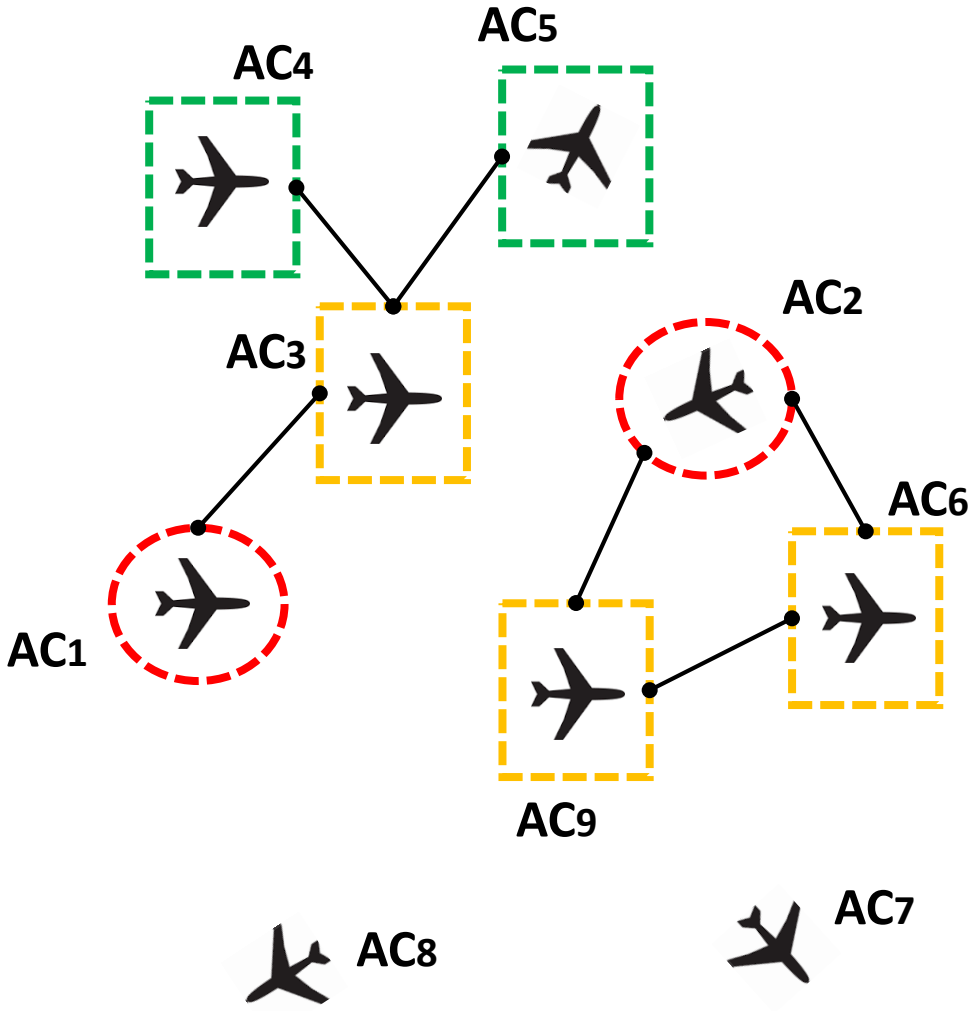
Aerial Ecosystem

- A hierarchical structure
- Based on:
  - An identified conflict
  - Its relevant surrounding traffic



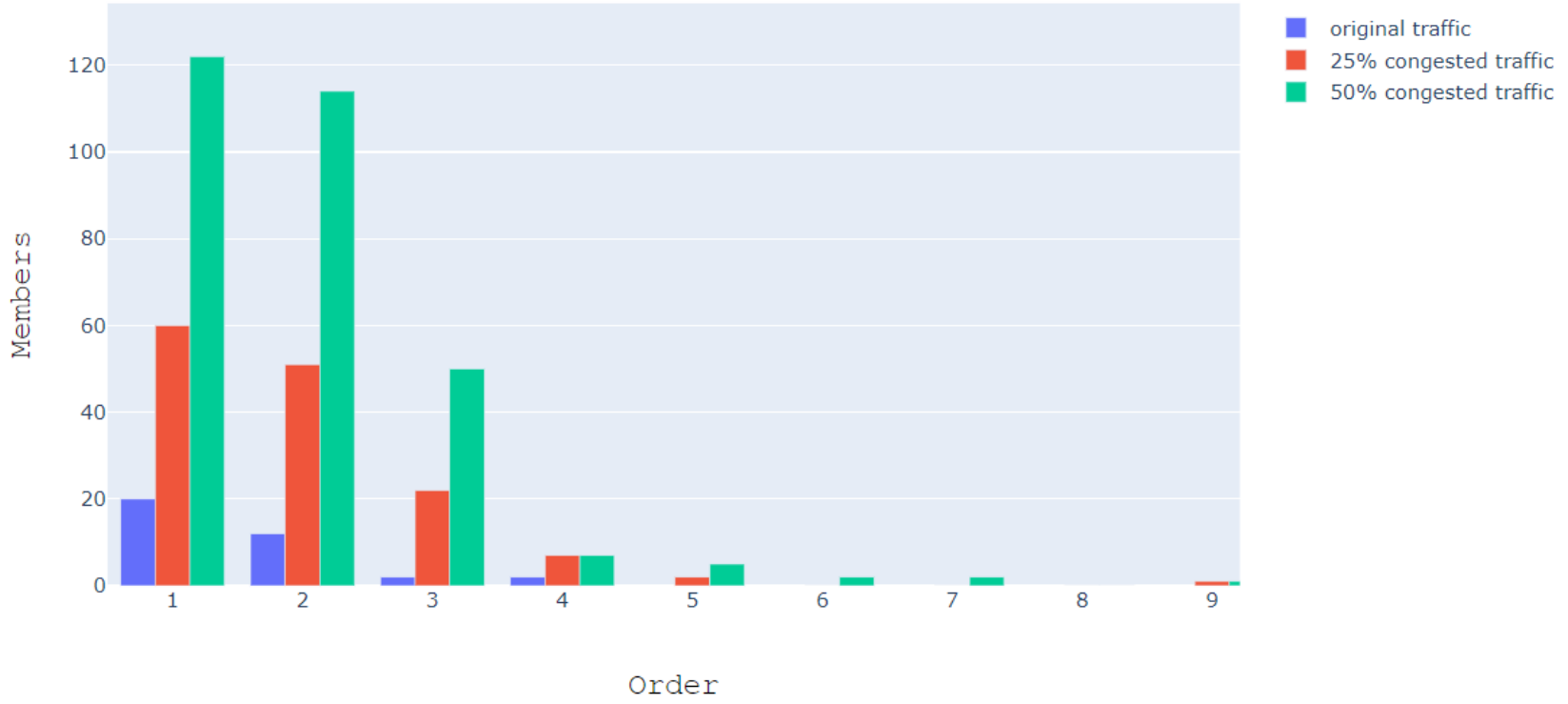
Aerial Ecosystem





Detected maximum depth

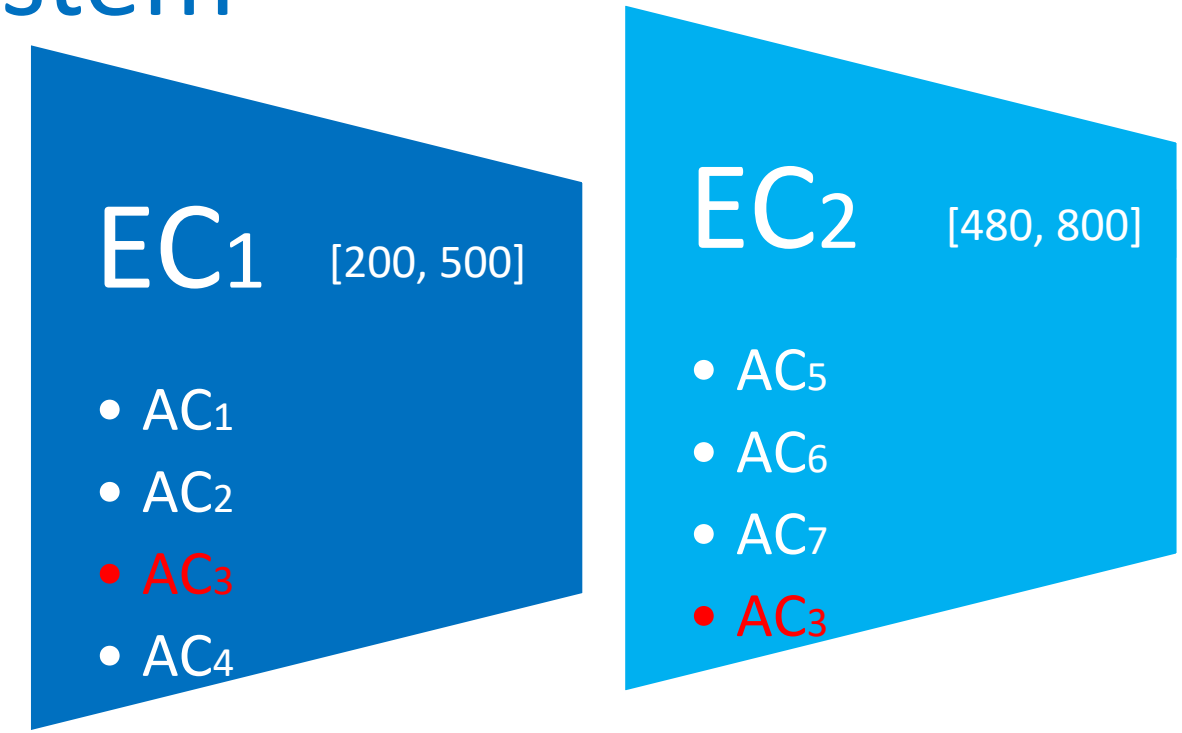
- DDR II data
- Minimum flight level FL250
- Congested flight level
- 5 minutes before + 2 minutes after



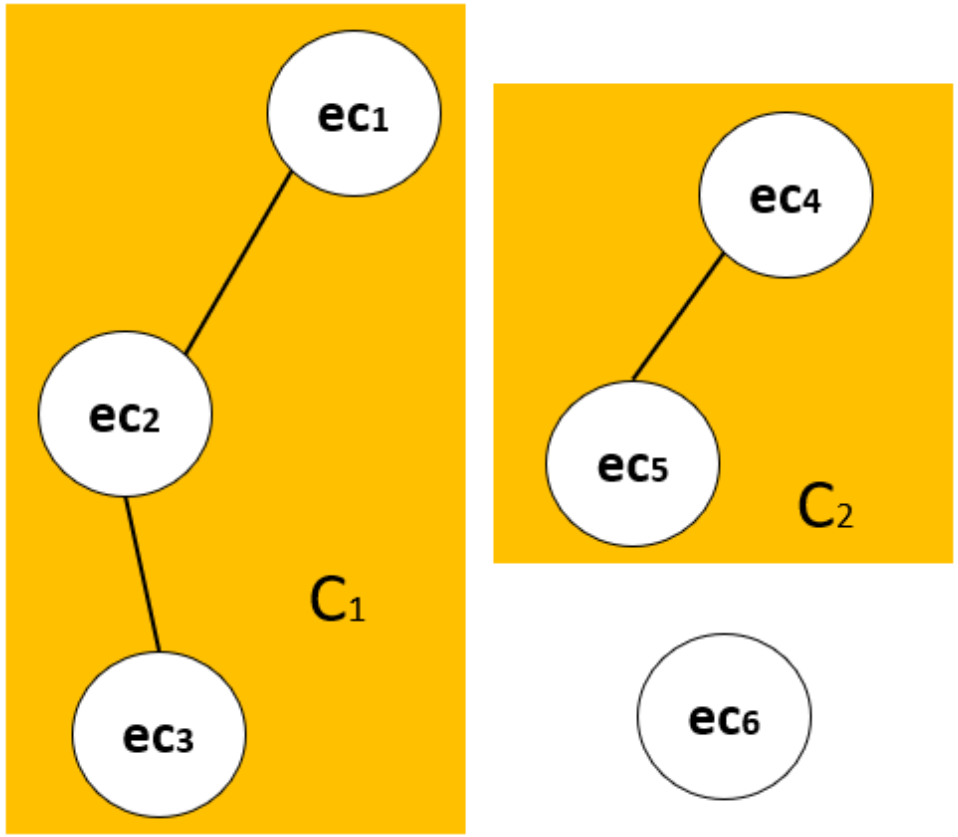
Compound Aerial Ecosystem

Compound Aerial Ecosystem

- Several conflicts can coexist in time and space
- Two ecosystems are interdependent if and only if:
  - Their time durations overlap
  - They have at least a common member



Compound Aerial Ecosystem (1)



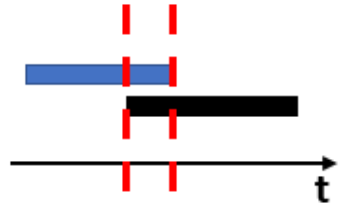
Decomposition Strategies

Decomposition Strategies

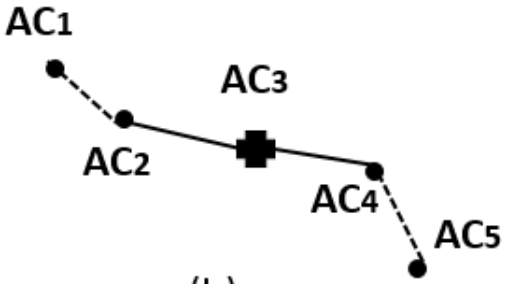
(a) Cut in time

(b, c) Cut in depth

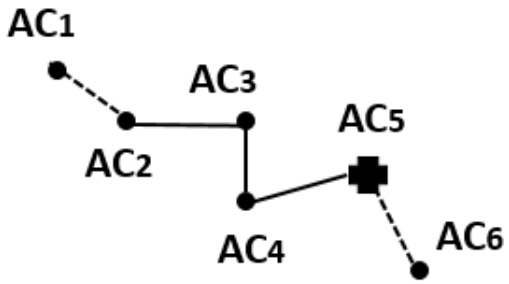
(d) Constrain solutions



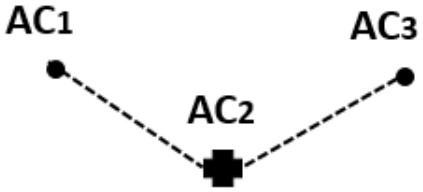
(a)



(b)



(c)

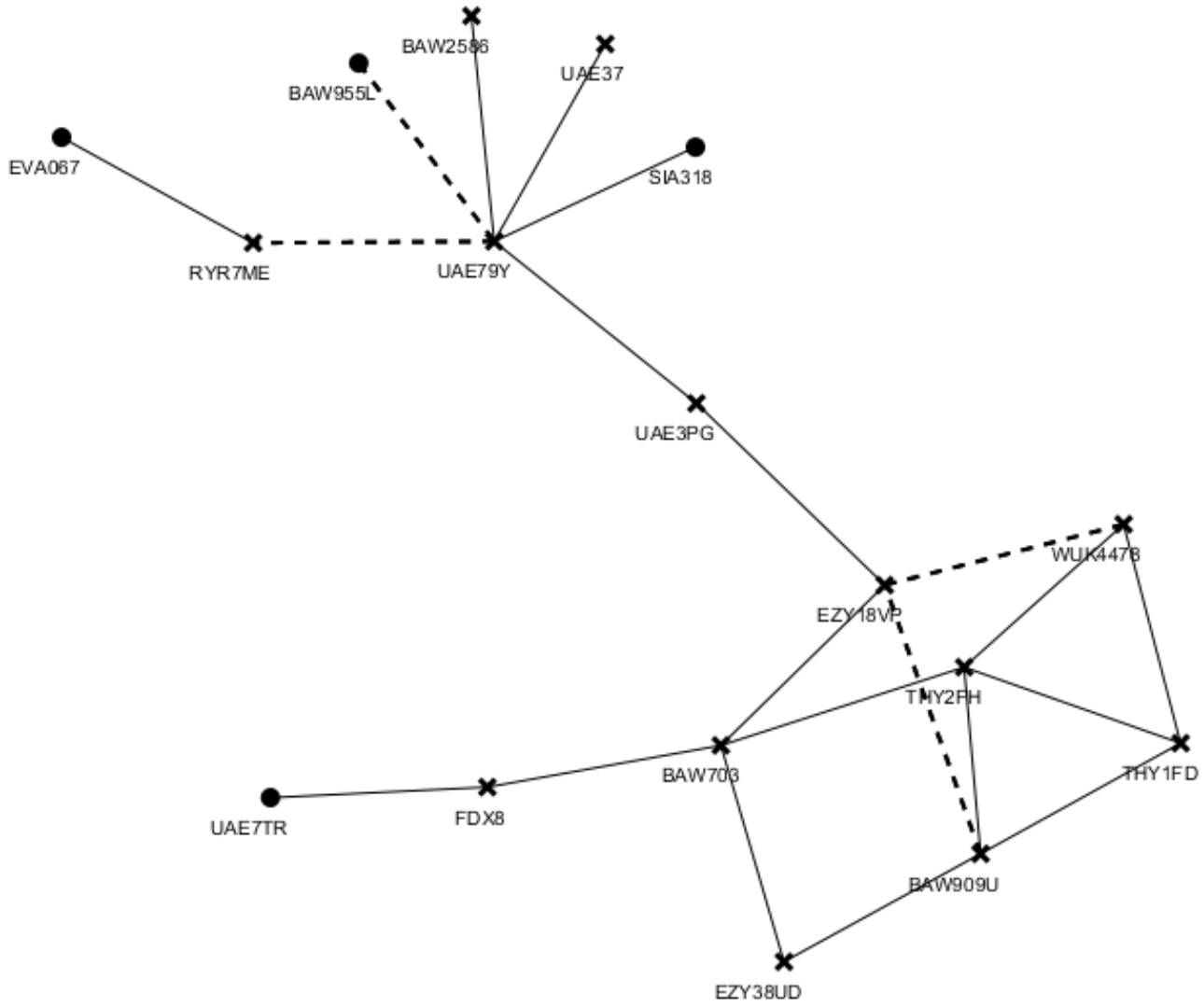


(d)

Simulation Results

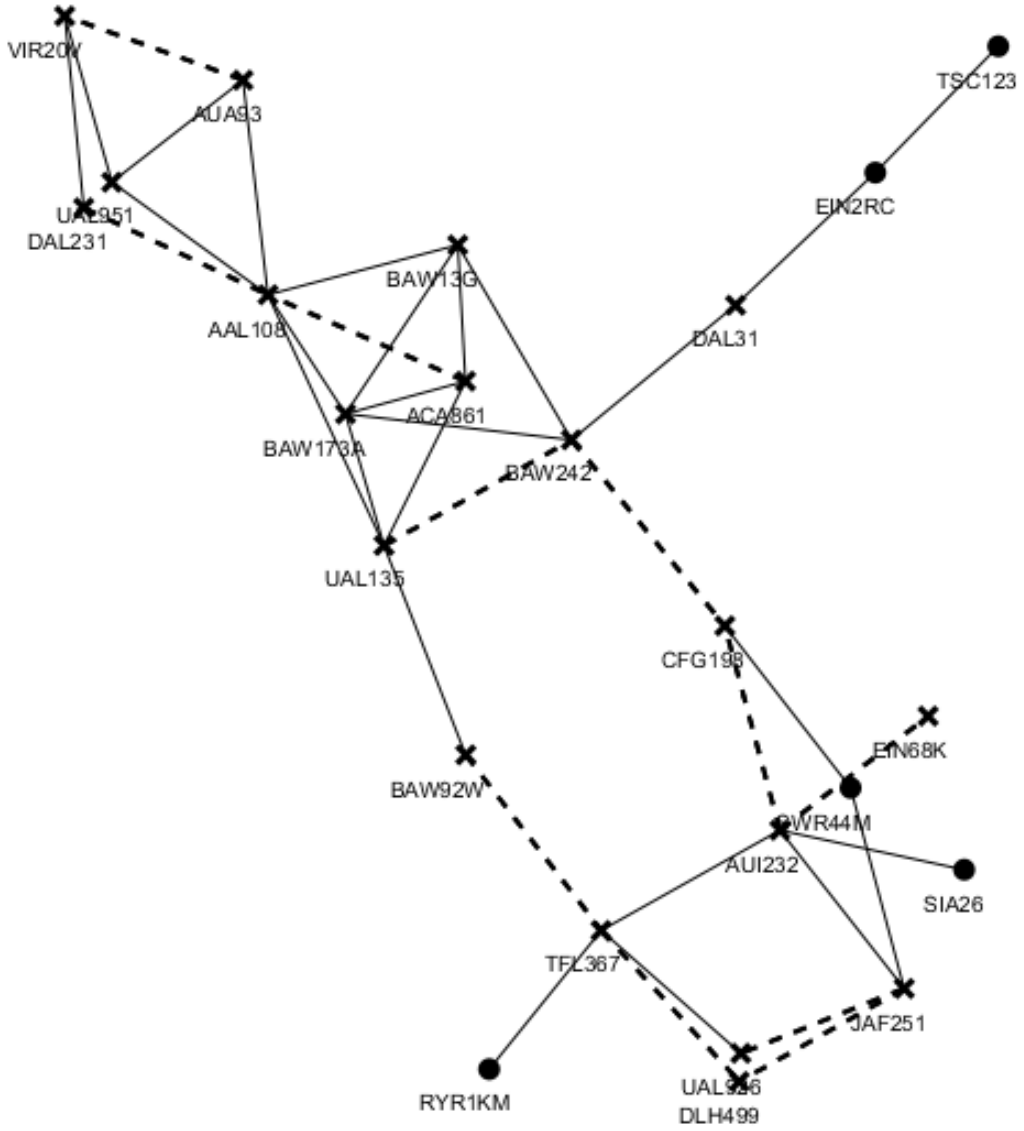
Simulation Results

Traffic	Simple Ecosystems	Not isolated Ecosystems	Compound Ecosystems	Strategies			
				Cut in time (%)	Cut in level (%)	Move one (%)	Join ecosystems (%)
Original	36	6	3	0	0	100	0
25% congested	143	49	20	5	20	60	40
50% congested	303	120	49	10.2	8.16	51.02	48.08



Partial decomposition

Complex scenario



Conclusions

Conclusions

- We define in this work compound ecosystems
- Several, simple strategies in decomposing them are proposed
- Simulations give a quite high success rate
- In the considered scenarios, the depth of the ecosystem does not change significantly

Future Steps

- Current interdependencies are conditioned by time overlap
- Consider downstream effect
  - Through spatio-temporal regions?
- (Graphical) representation of the regions

THANK YOU!

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