SITRAER 2015
AIR TRANSPORTATION SYMPOSIUM
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Automated label placement algorithm based on EUROCONTROL's HMI requirements for air traffic control system

atech
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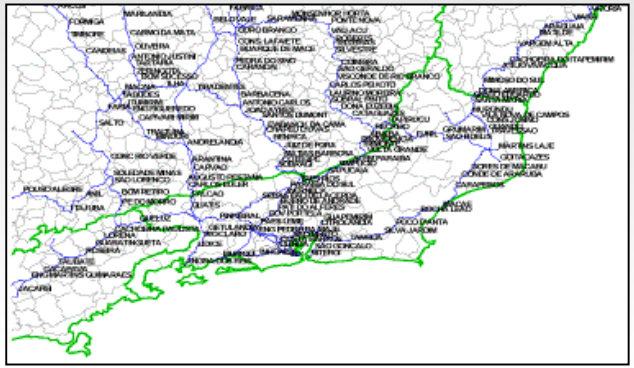
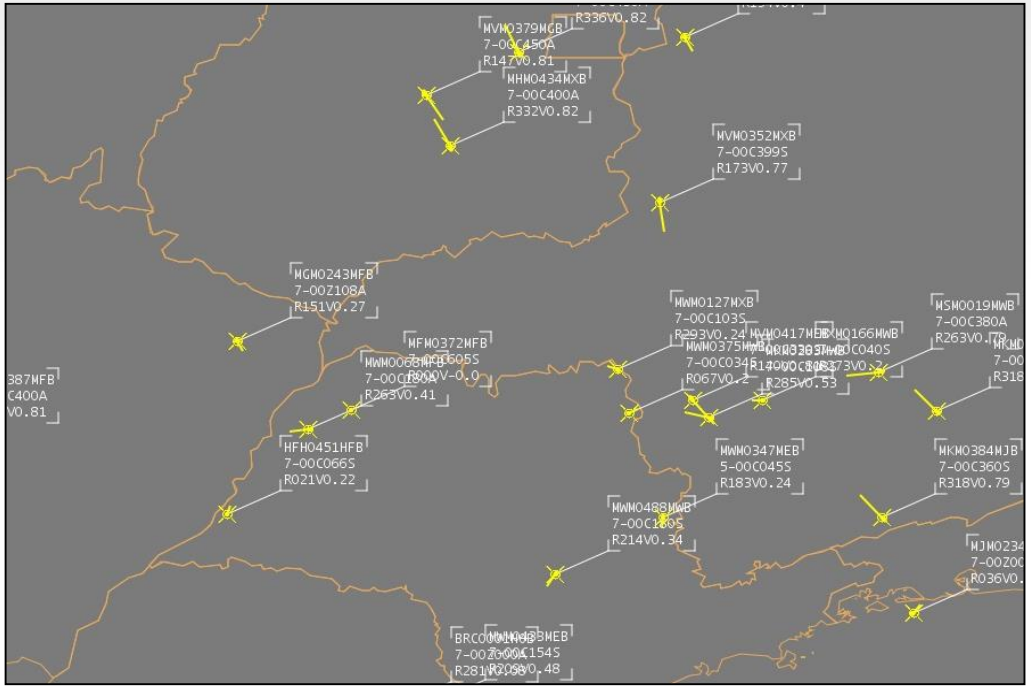
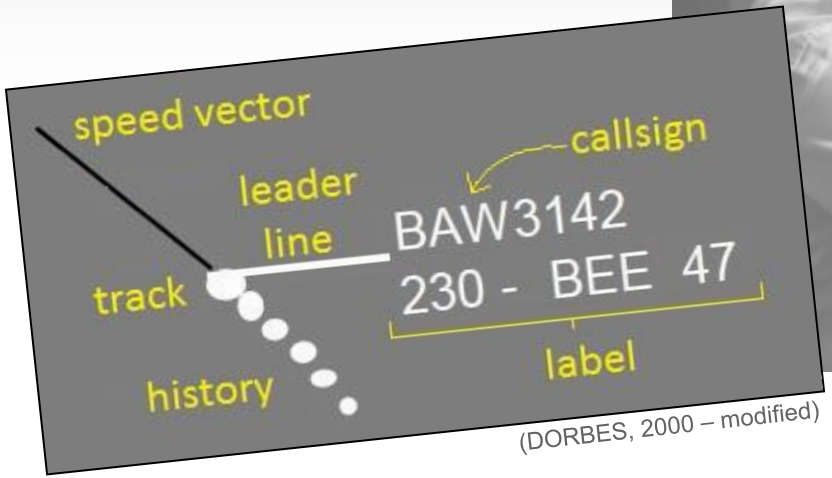
Motivation



Label overlapping problem is **NP-complete**



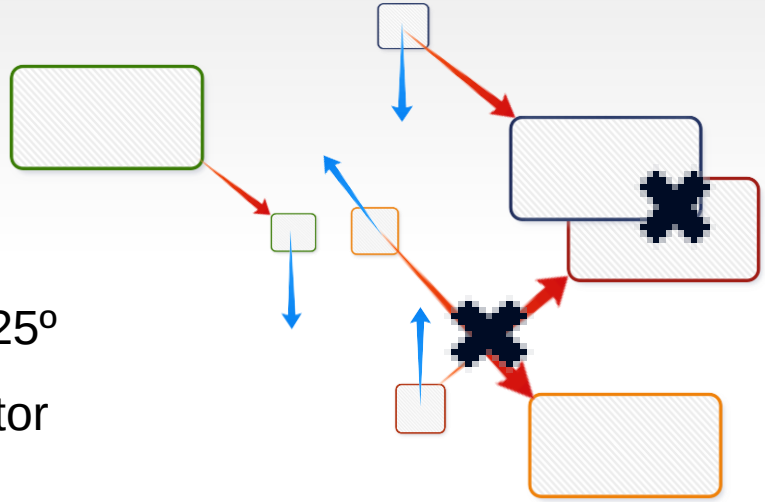
Definitions



(DORBES, 2000 – modified)

Requirements

- Conflicts priority defined by EUROCONTROL

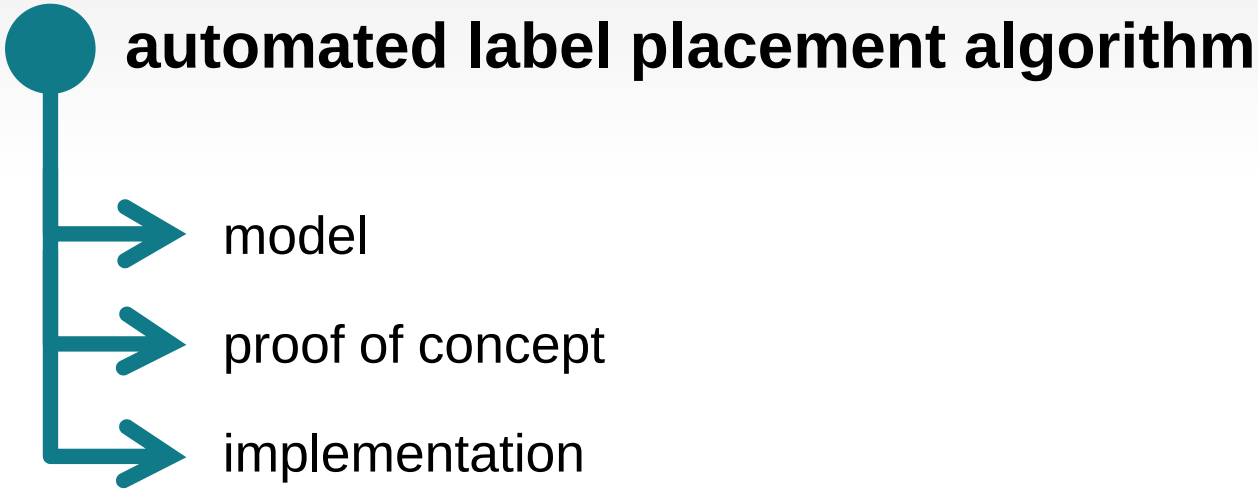


- 4 possible angles: 45º, 135º (default), 225º or 315º from top of screen or speed vector

- Controller can always move a label manually

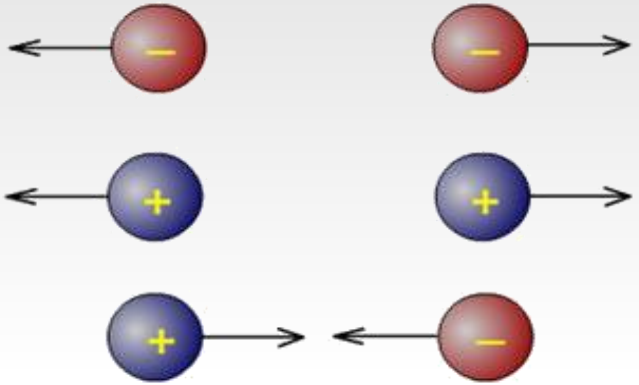
Objective

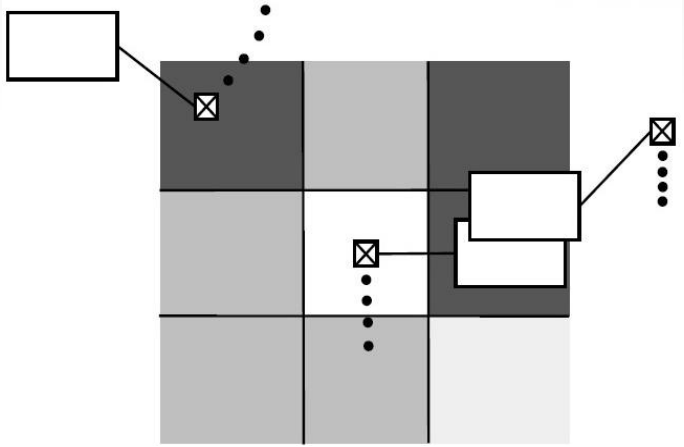
Atech's solution for an



Force-based model

Model objects as electrically charged particles that attract and repel each other





(REEK, 2010)

Cluster-based model

Group tracks, discretize area around the track and allocate the label in the cell of the lowest cost

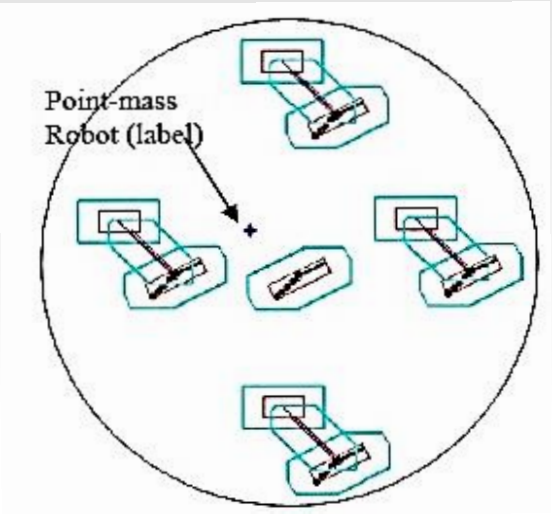
Model based on navigation functions

Avoid collision between the robot (label) and the obstacles (other symbols);

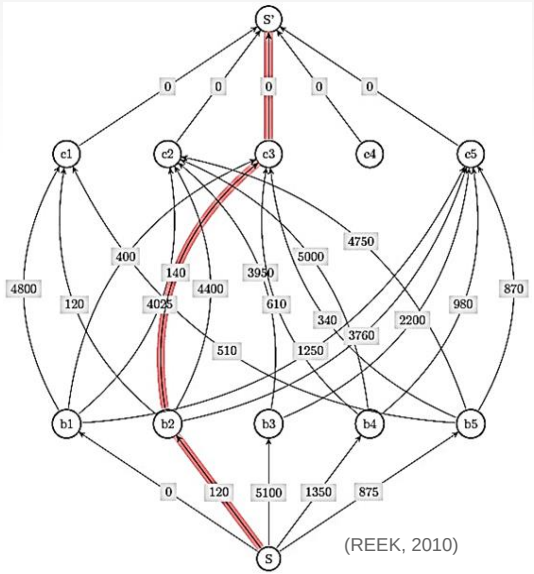
Robot → punctual,

Obstacles → rectangles;

Obstruction polygon



(KAKOS AND KYRIAKOPOULOS, 2005)



(REEK, 2010)

Model based on Probabilistic Roadmap

Create a graph with subsets of all available positions and choose the shortest path

Proposed approach

solution

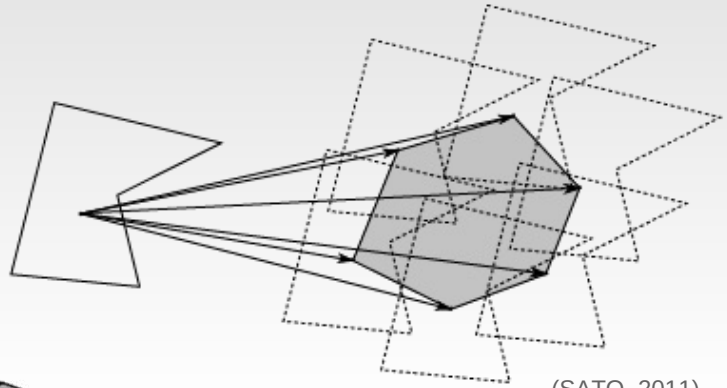
clusters

occupancy grid with costs

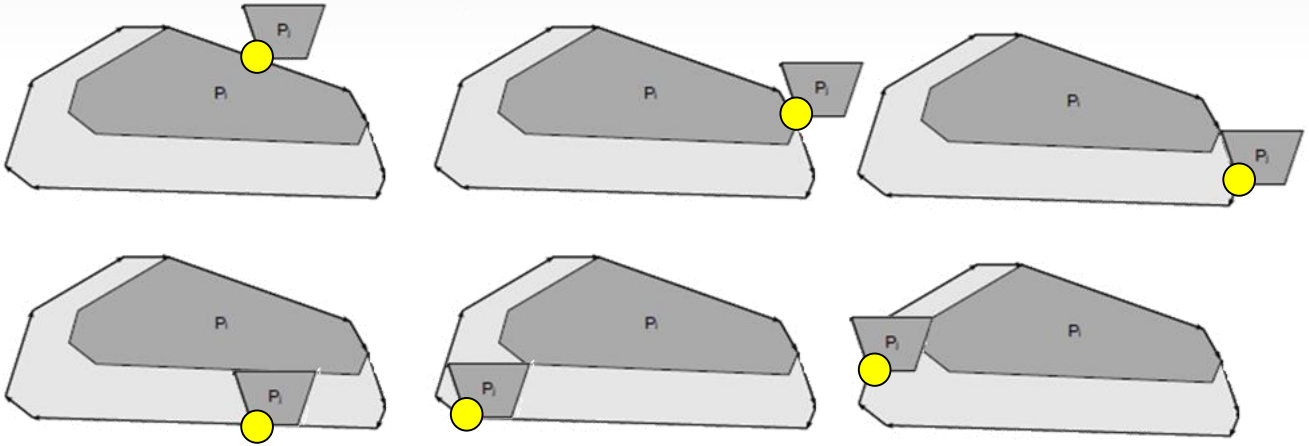
forbidden regions using obstruction polygon

Proposed approach

Obstruction polygon using Minkowski sum:
translations applied to elements



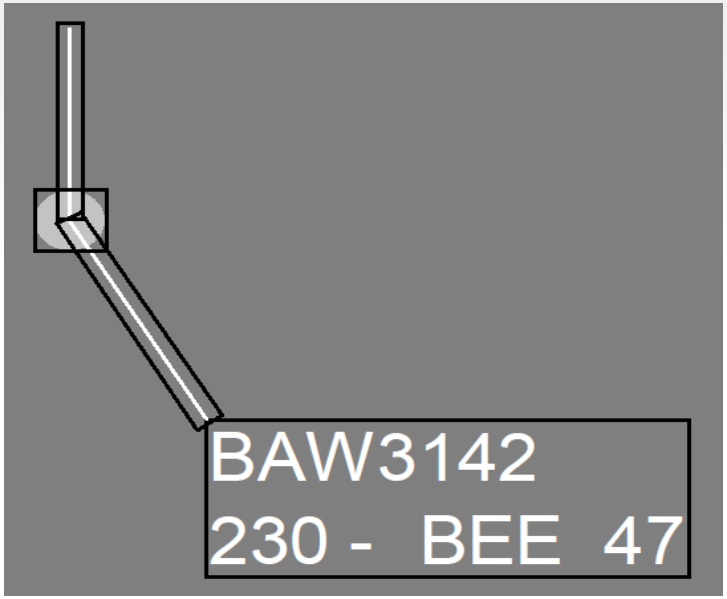
(SATO, 2011)

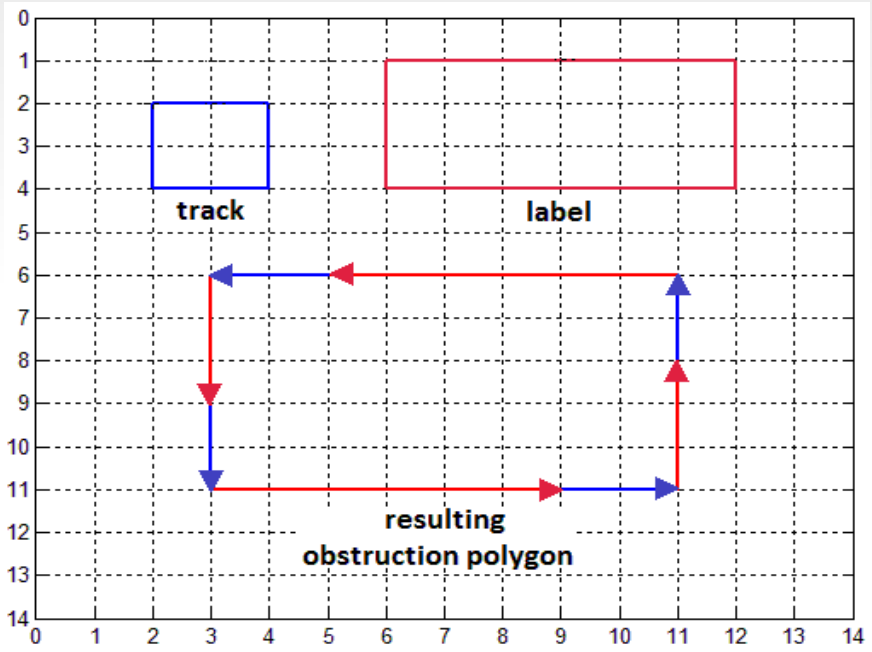


(SATO, 2011)

Proposed approach

In our case, all symbols become rectangles:



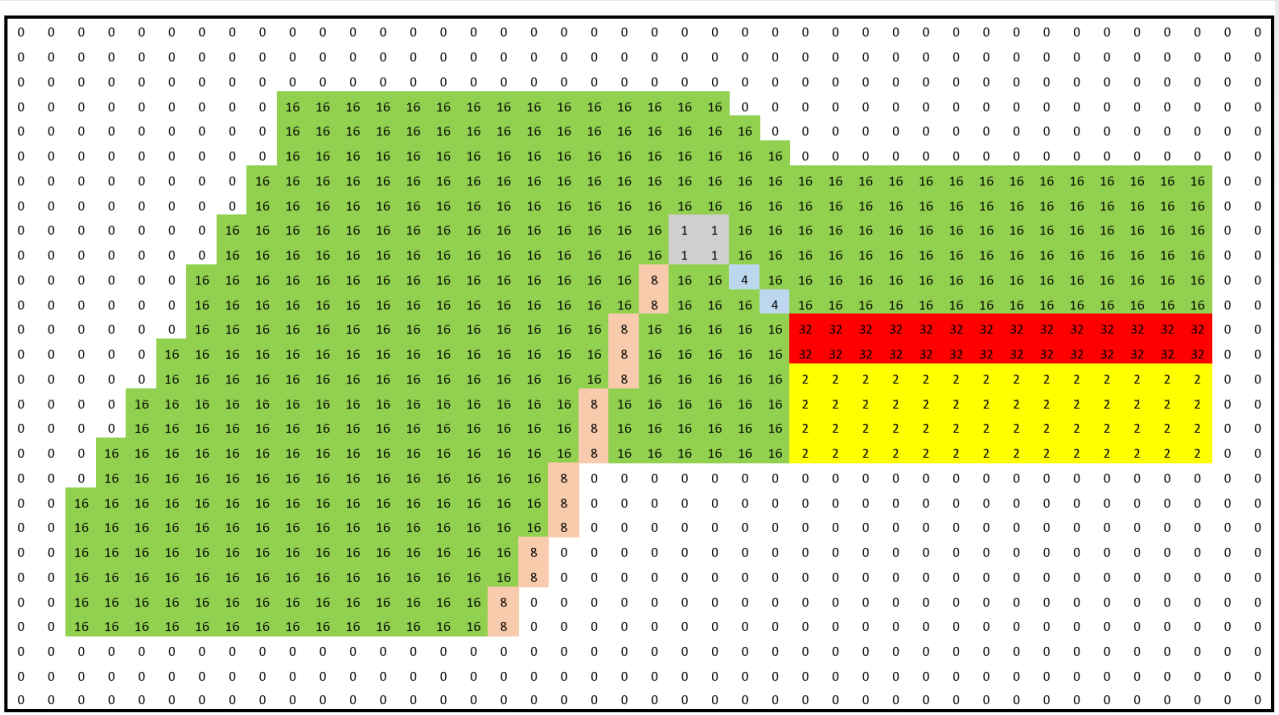


Occupancy grid

Type of overlap	Meaning
0	free position
1	track
2	label
4	leader line
8	speed vector
16	forbidden region
32	callsign

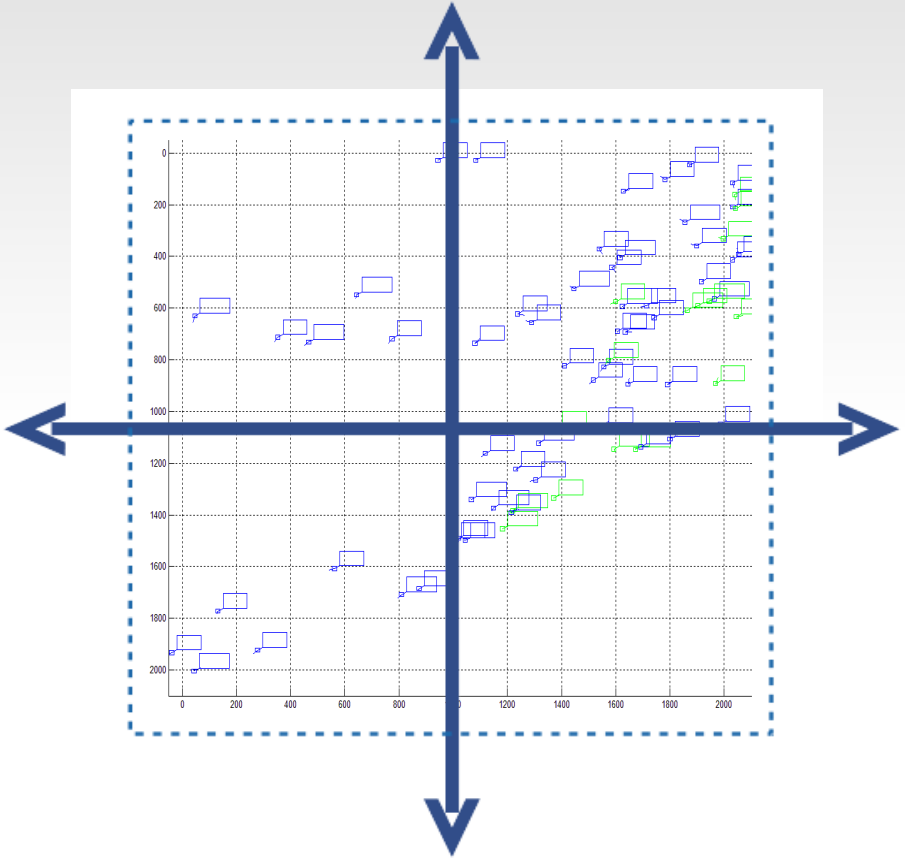
Proposed approach

Occupancy grid


0 0 0

Proposed approach

Analysis by quadrants



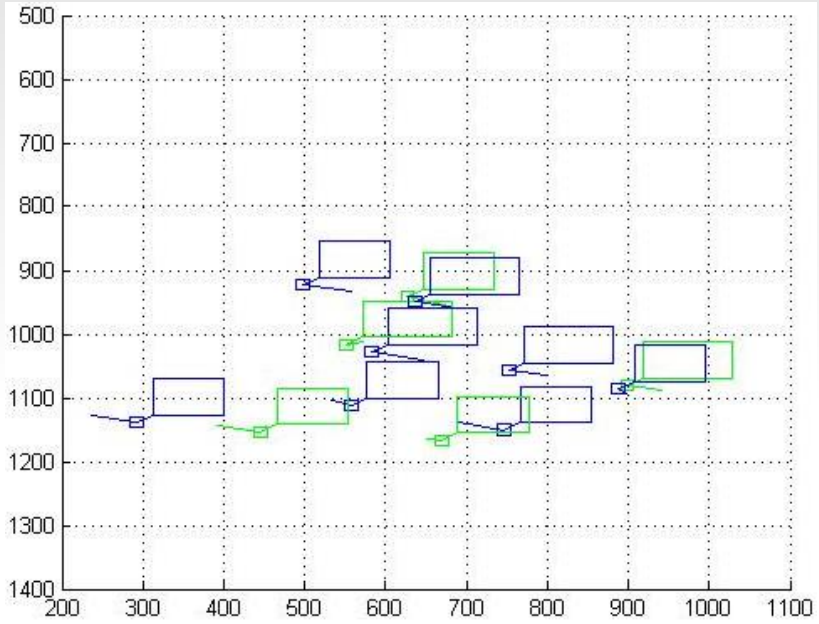
Proposed approach

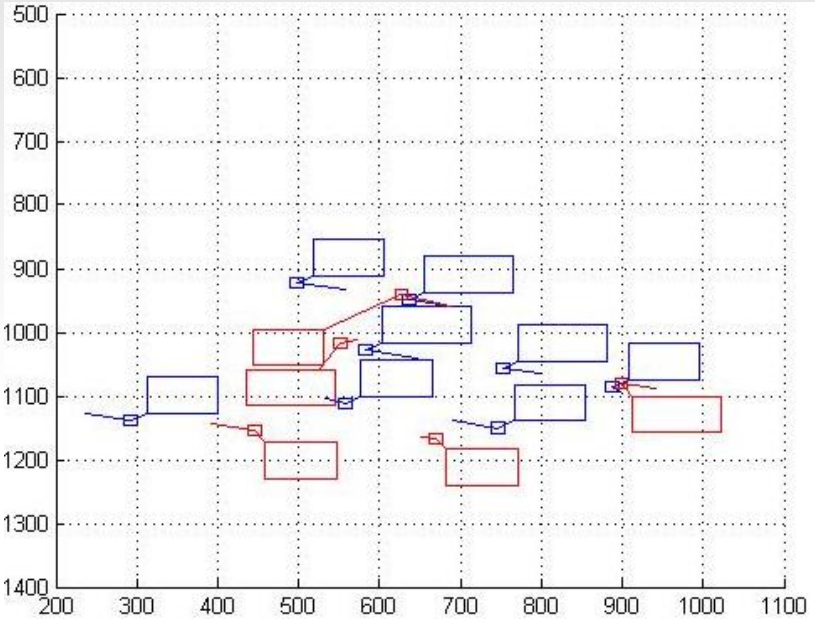
Relaxation:

penalties

Type of overlap	XOR	Adapted result	Penalty
callsign + X	32 ⊕ X	32 – 40 or 48	150
label + track	2 ⊕ 1	3	40
label + label	2 ⊕ 2	2	30
leader line + leader line	4 ⊕ 4	4	25
leader line + label	4 ⊕ 2	6	20
label + speed vector	2 ⊕ 8	10	15
leader line + track	4 ⊕ 1	5	10
leader line + speed vector	4 ⊕ 8	12	5
label + free position *or* leader line + free position	0 ⊕ X	0	0

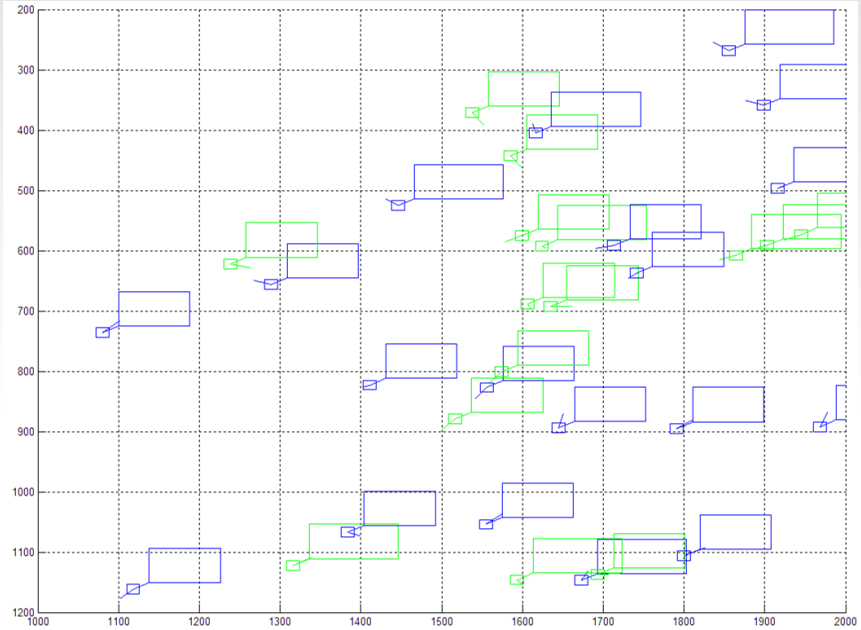
Model's validation: proof of concept using MATLAB

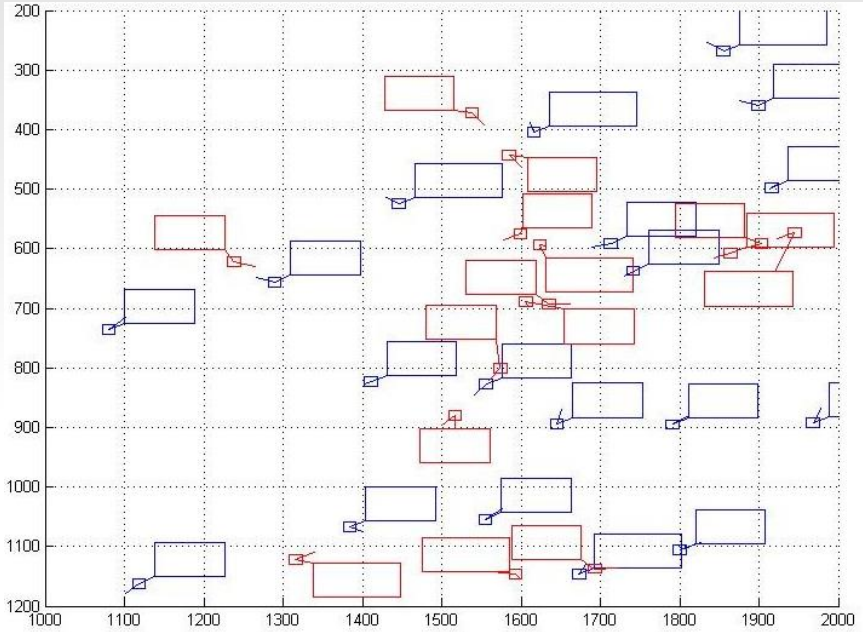




- Fixed labels
- Movable labels
- Repositioned labels

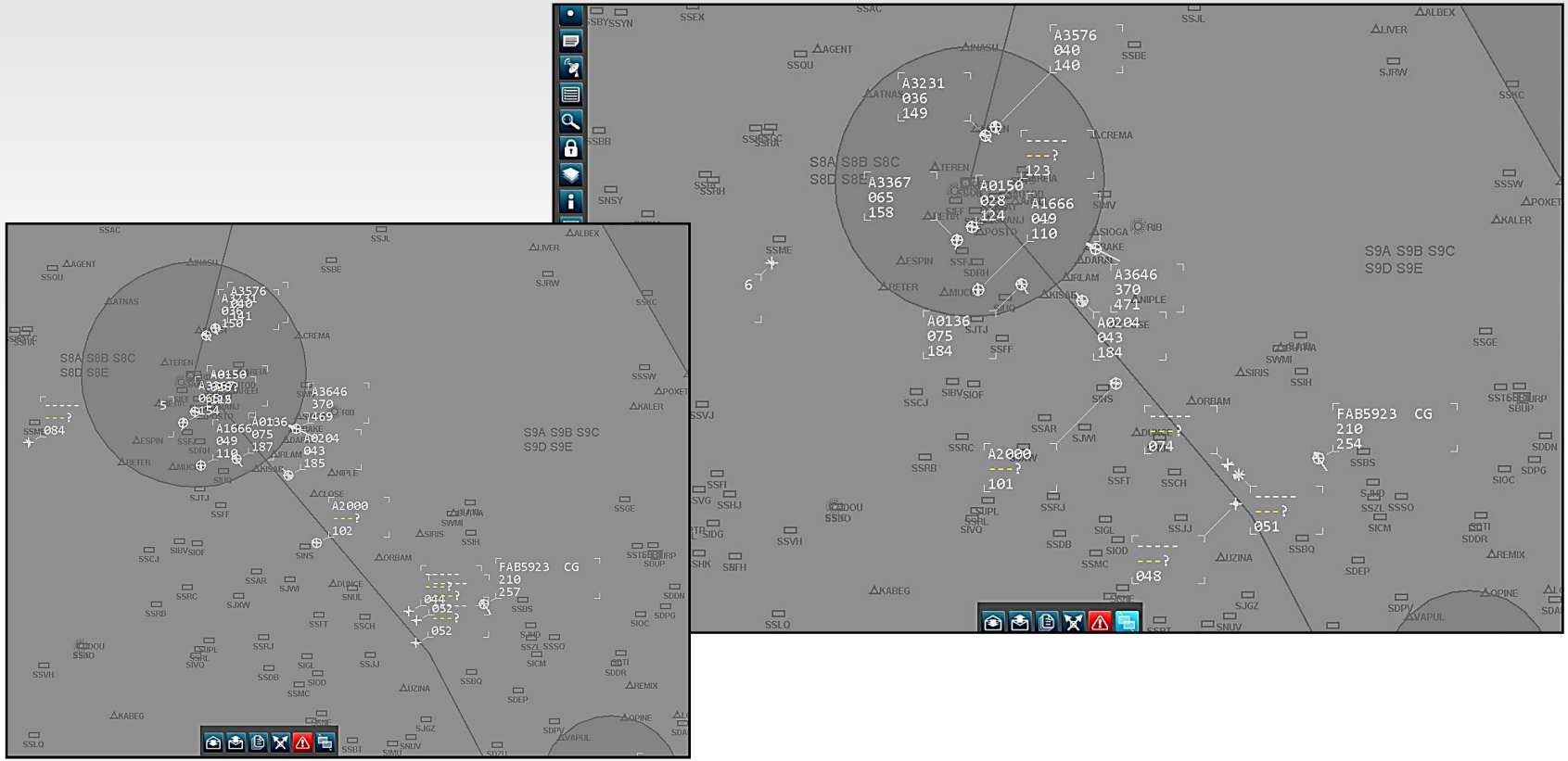
Model's validation: proof of concept using MATLAB





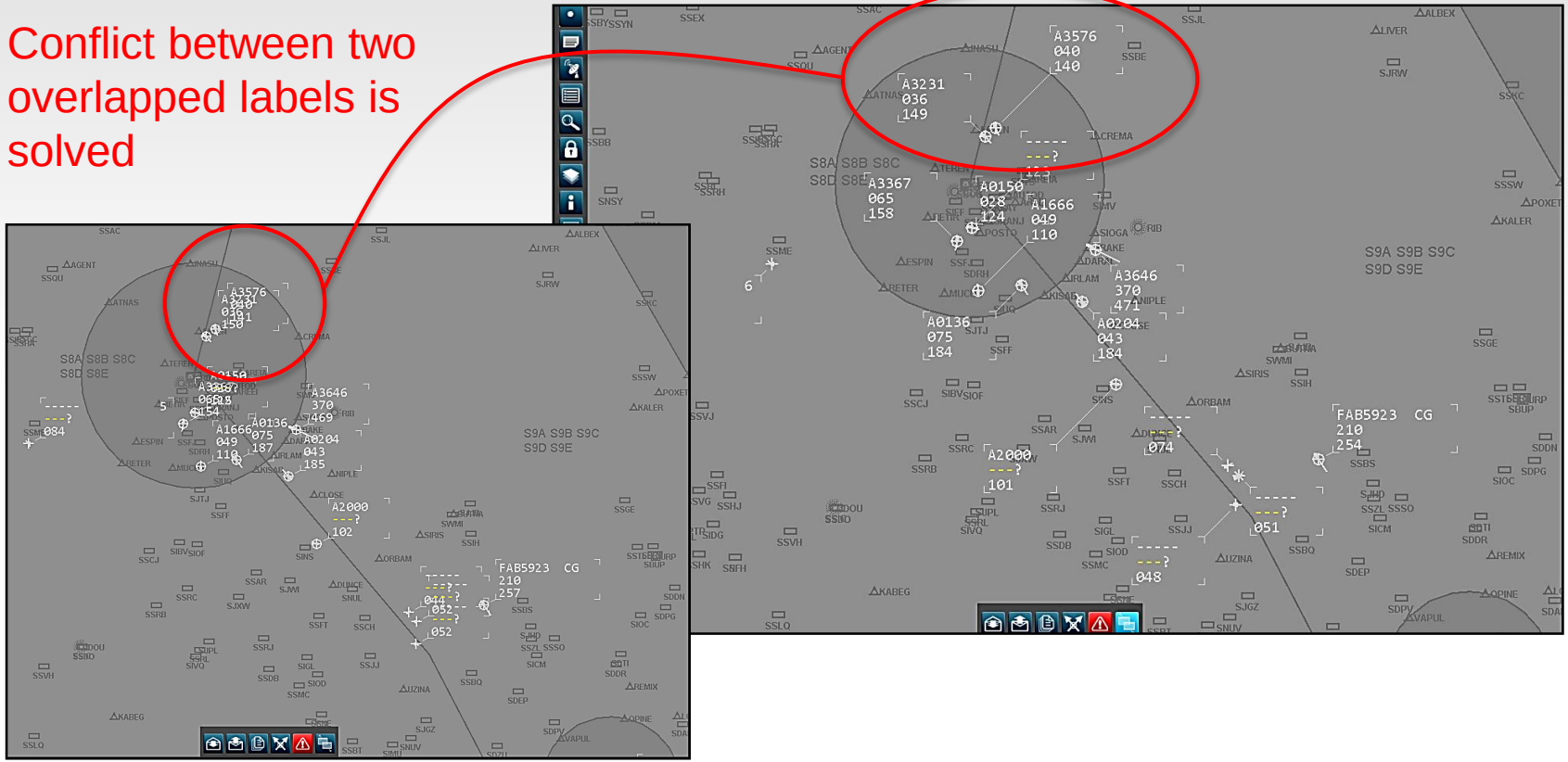
- Fixed labels
- Movable labels
- Repositioned labels

Results: Atech SAGITARIO

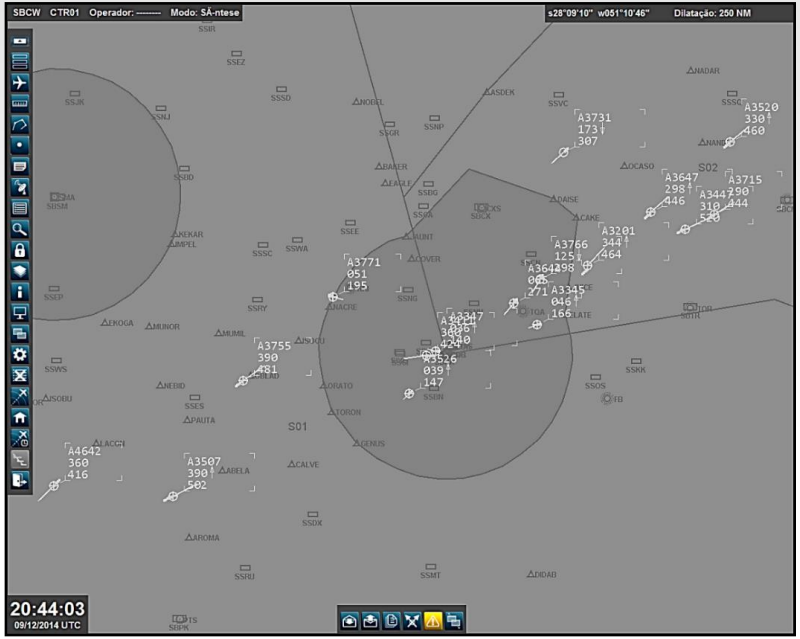


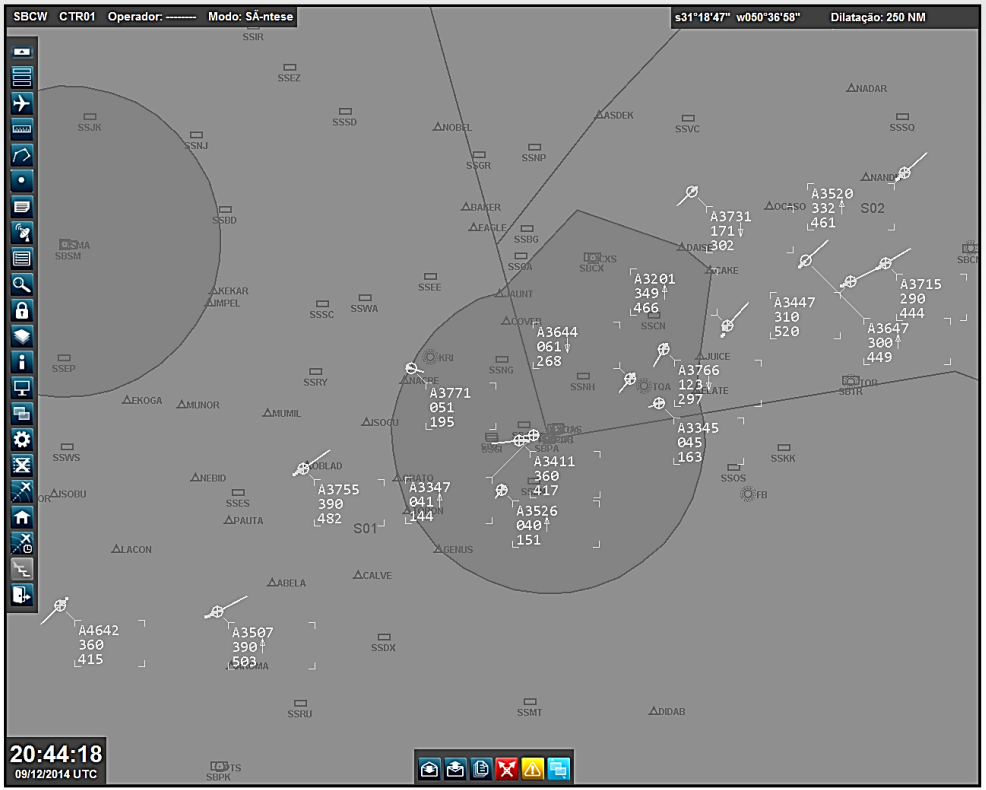
Results: Atech SAGITARIO

Conflict between two overlapped labels is solved

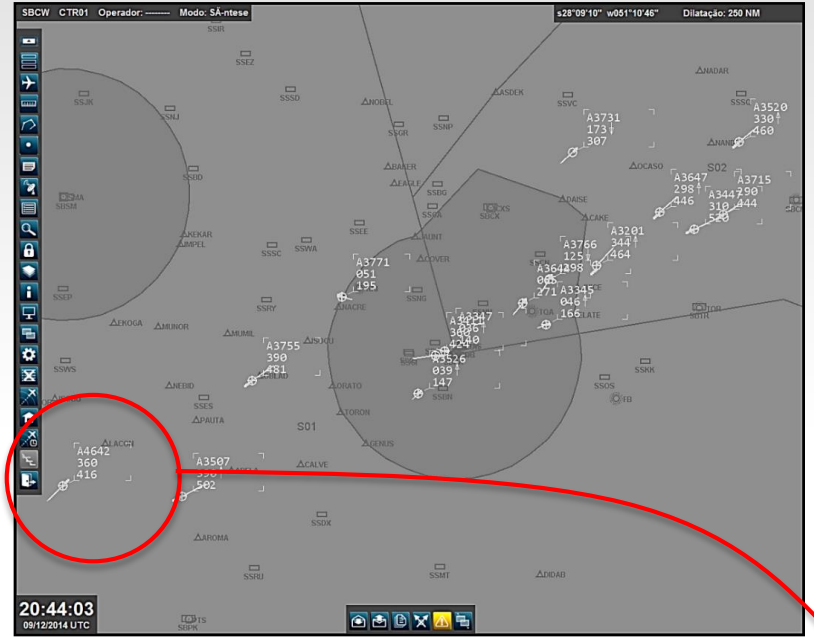


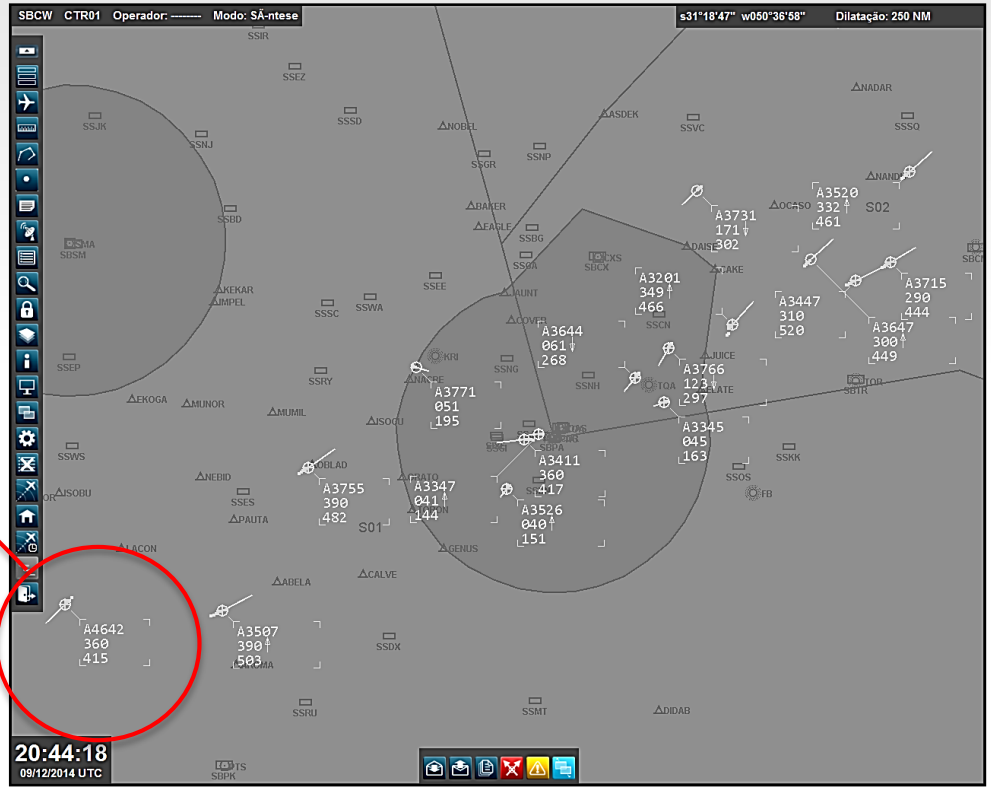
Results: Atech SAGITARIO





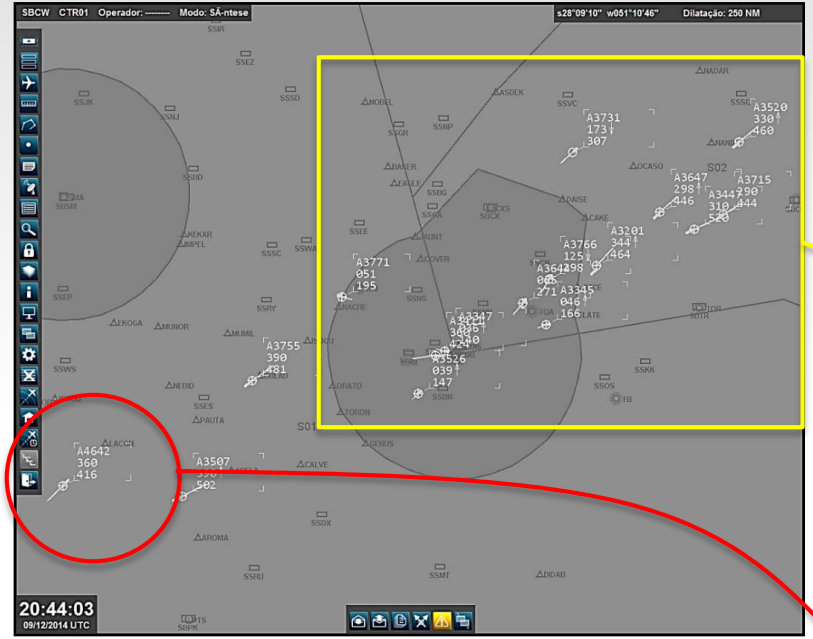
Results: Atech SAGITARIO





Rotated to the default position (135º from the top of the screen and default leader line's length)

Results: Atech SAGITARIO



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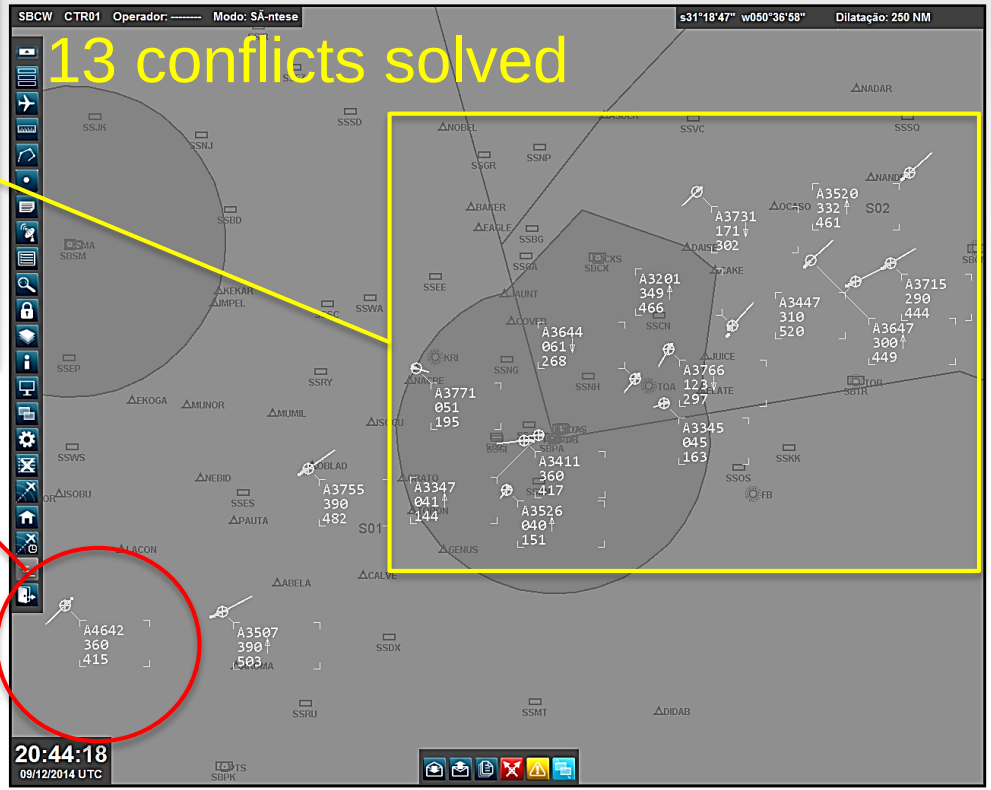
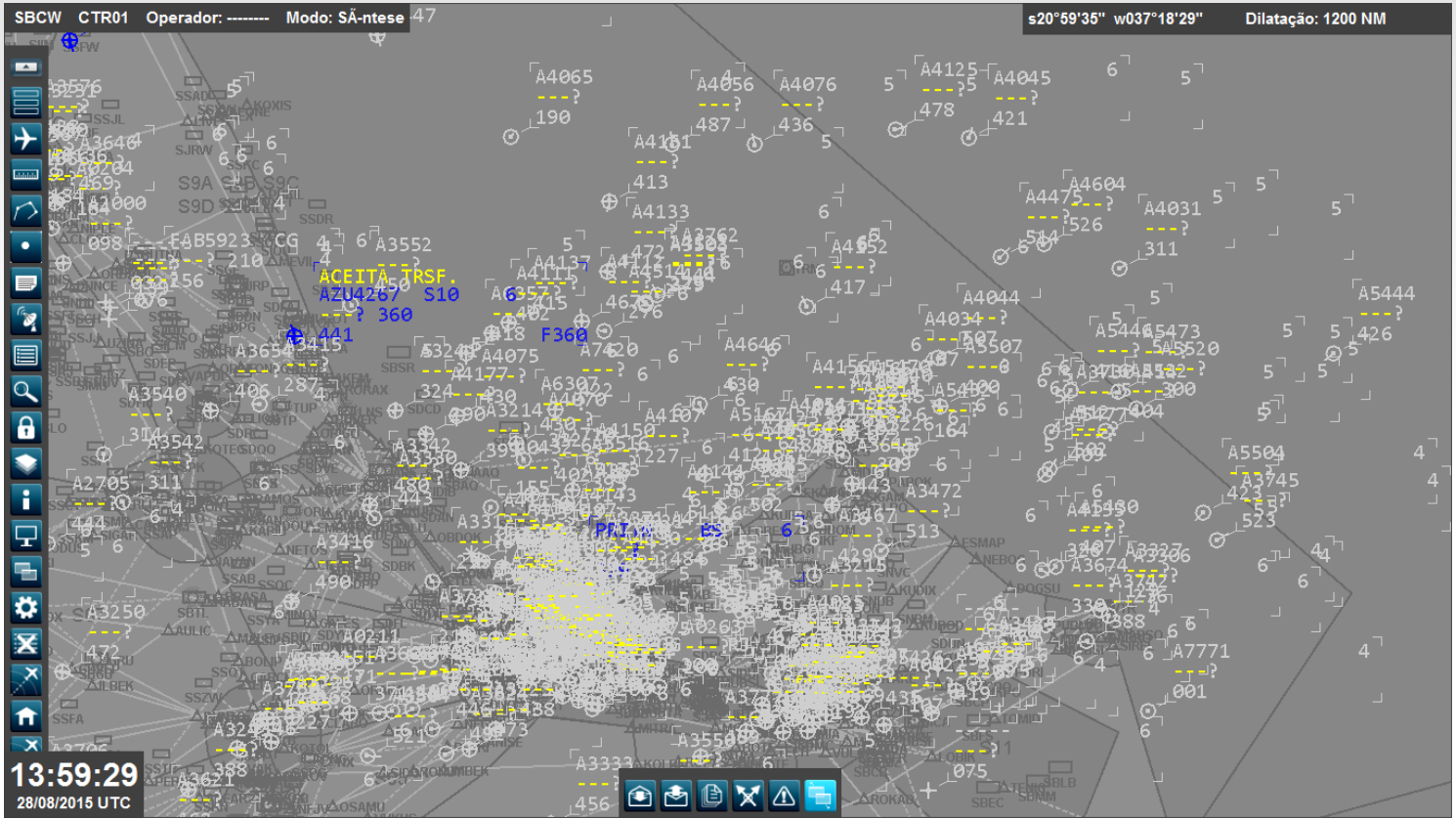
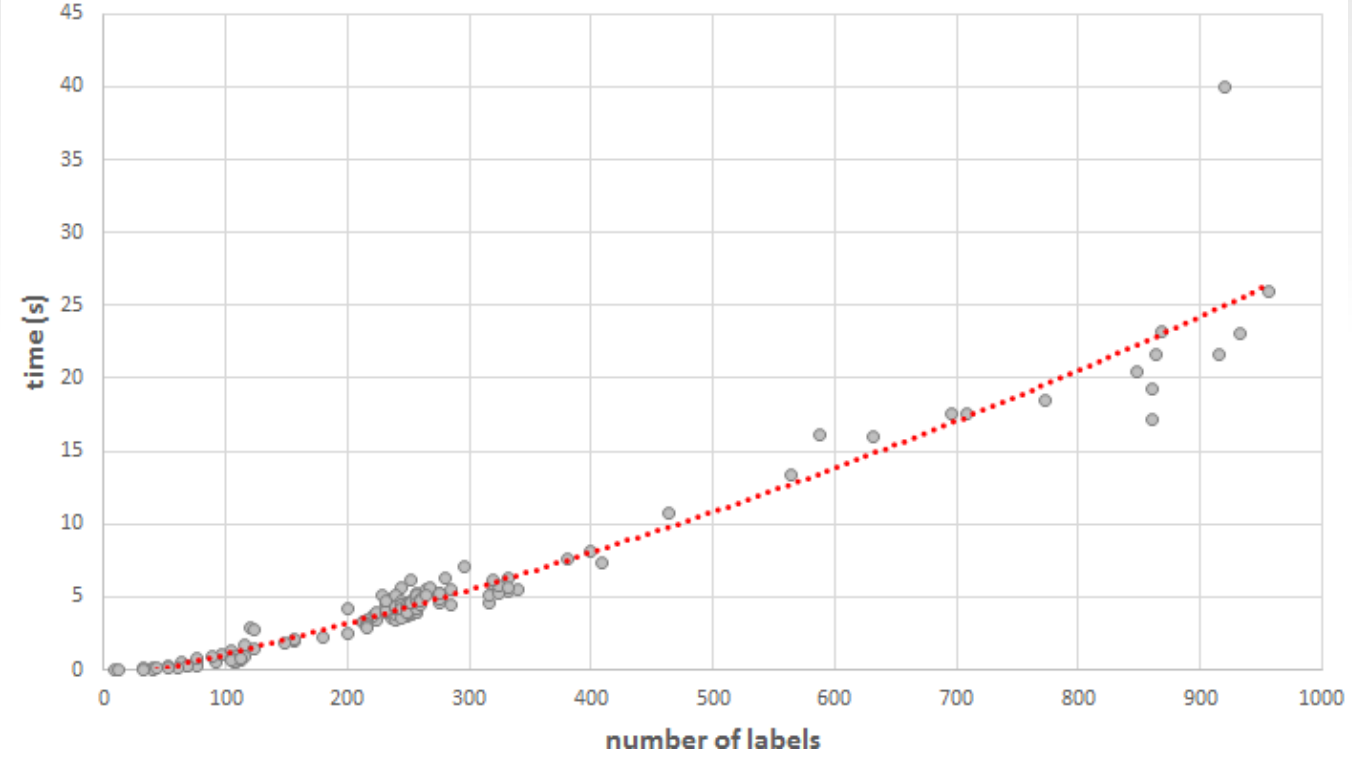


Results: Atech SAGITARIO



Results: Atech SAGITARIO

Algorithm's runtime

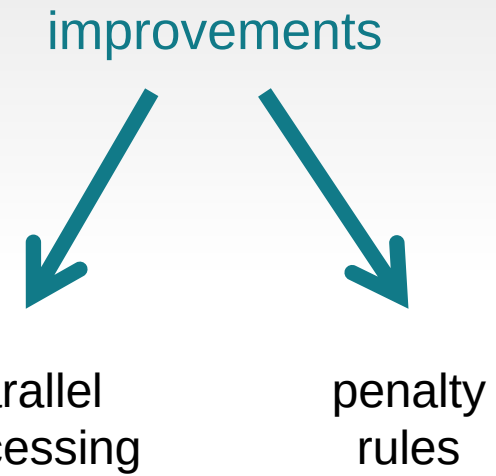


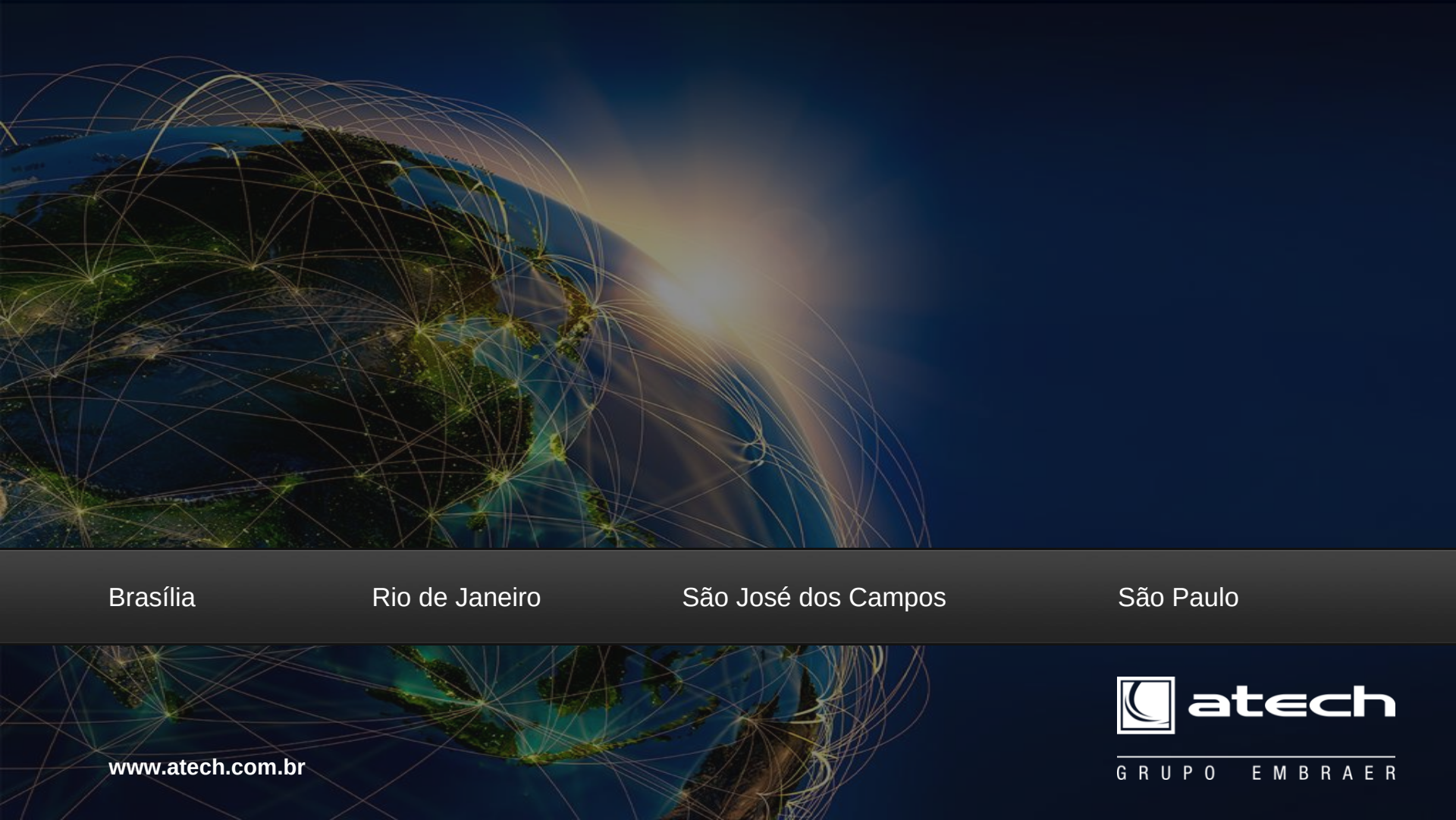
Conclusion and future work

✓ Label-overlapping problem

✓ 8 kinds of overlap

- The solution is efficient → real time
- Easy inclusion of relaxation rules





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