Characterization of Air Traffic Controllers' Visual Search Patterns and Control Strategies

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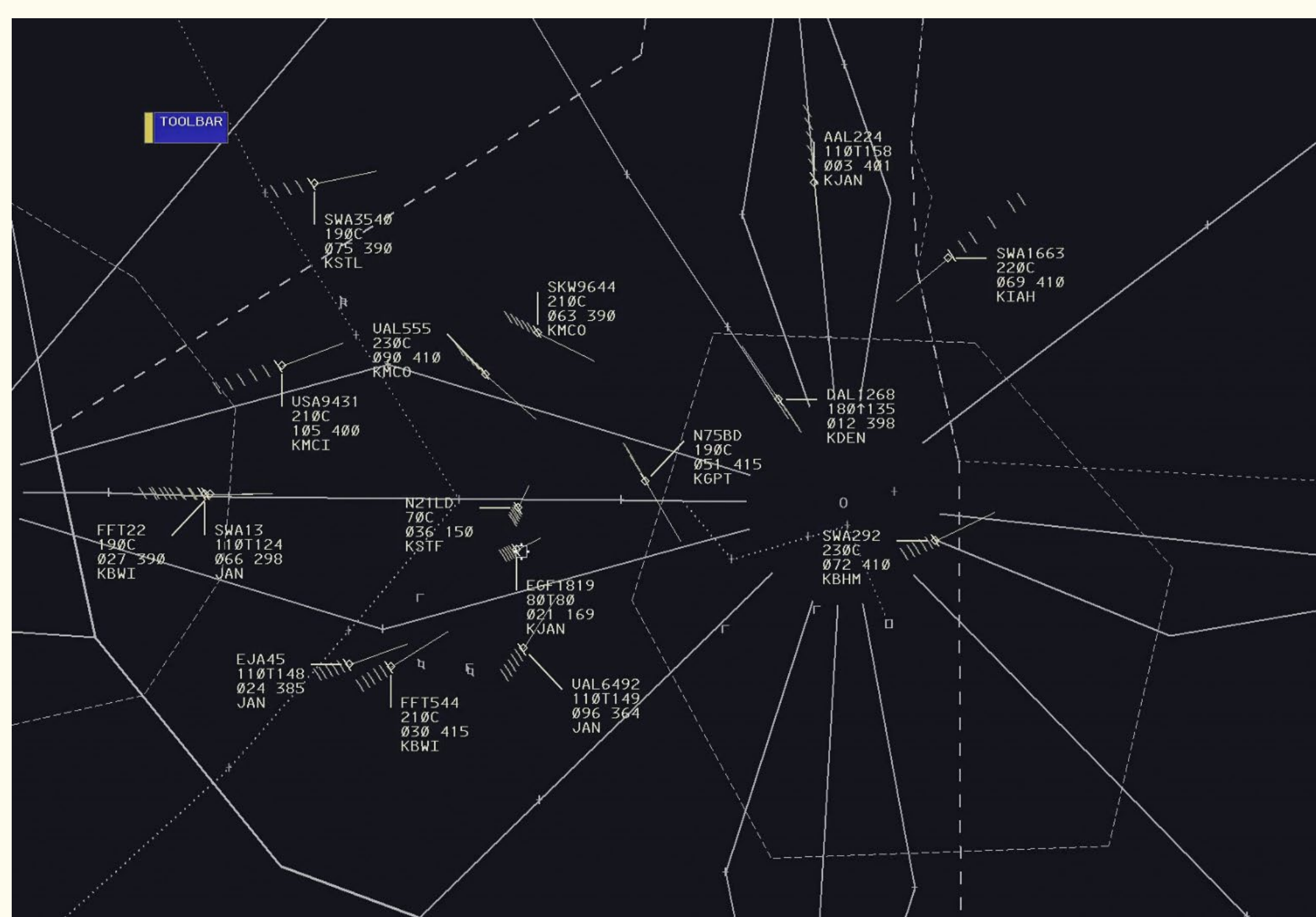School of Industrial and Systems Engineering

WHAT

Develop a better understanding of experts' visual scanning and conflict mitigation strategies through the analysis of eye movements and verbal protocols using a high fidelity en-route air traffic simulations of various conflict configurations.

GOAL

- Develop multimedia learning materials that include the characterized and classified visual search and mitigation strategies of experts.

- Support efficient and effective training of FAA Academy candidates to meet the increasing future demand of controllers.
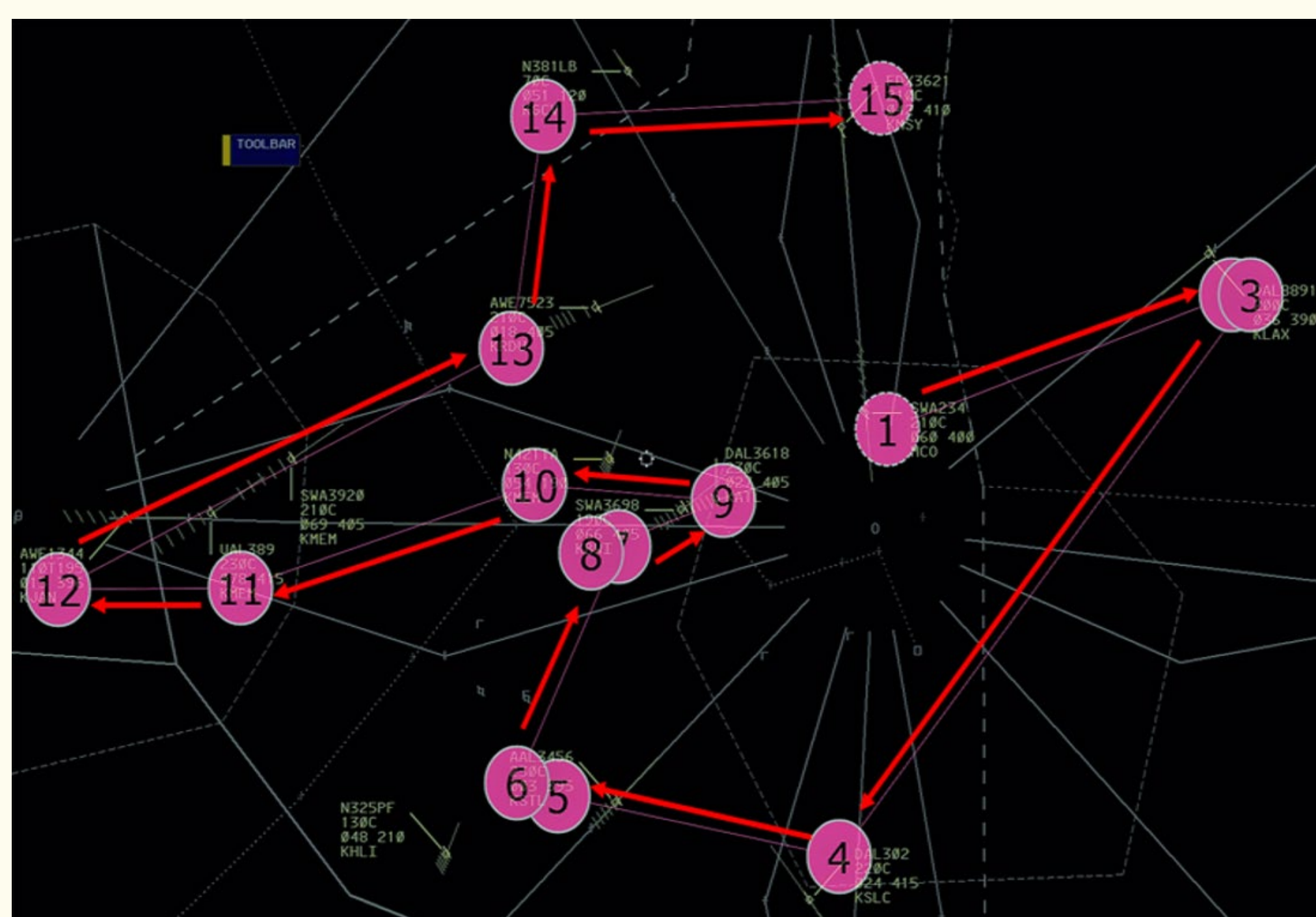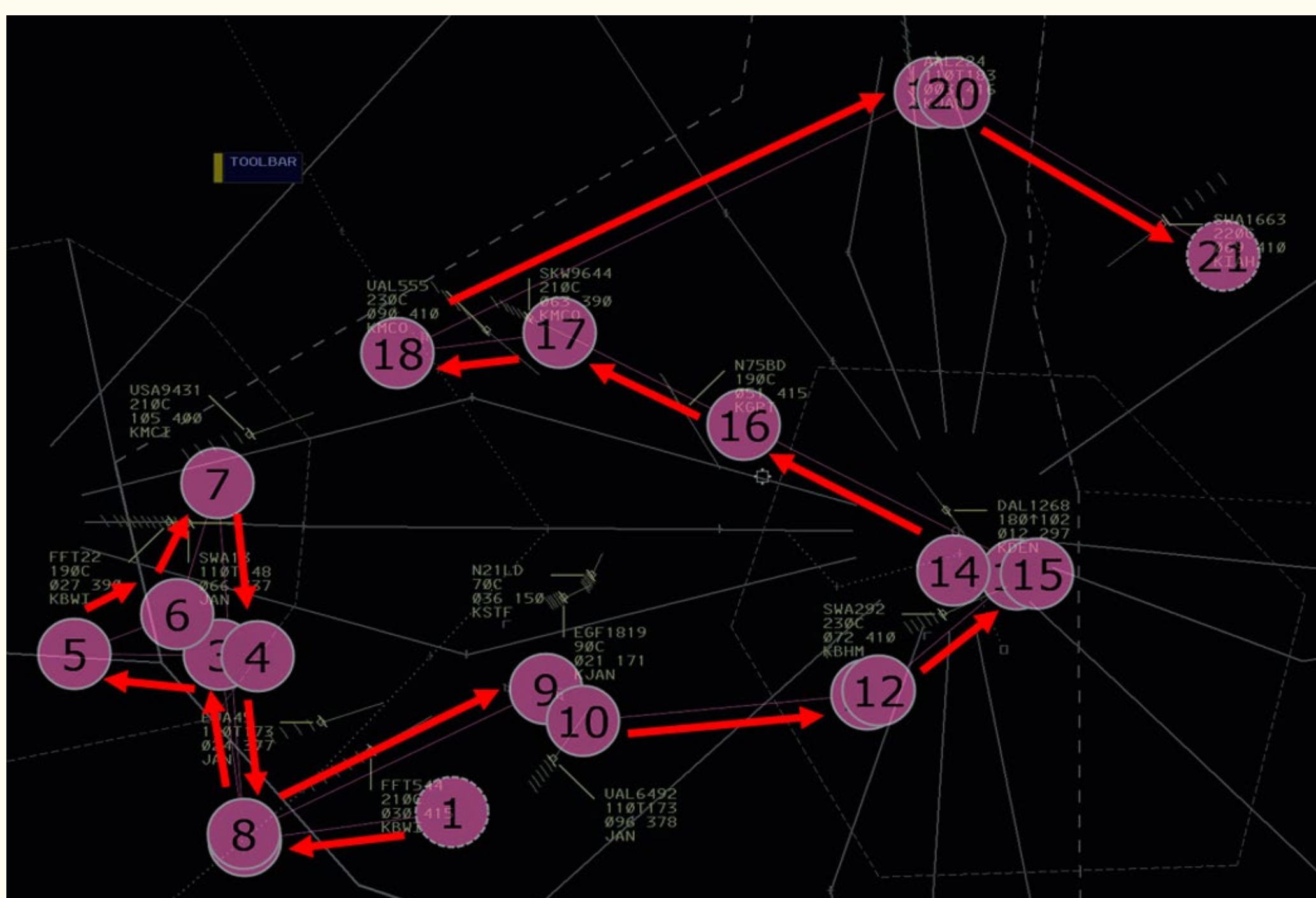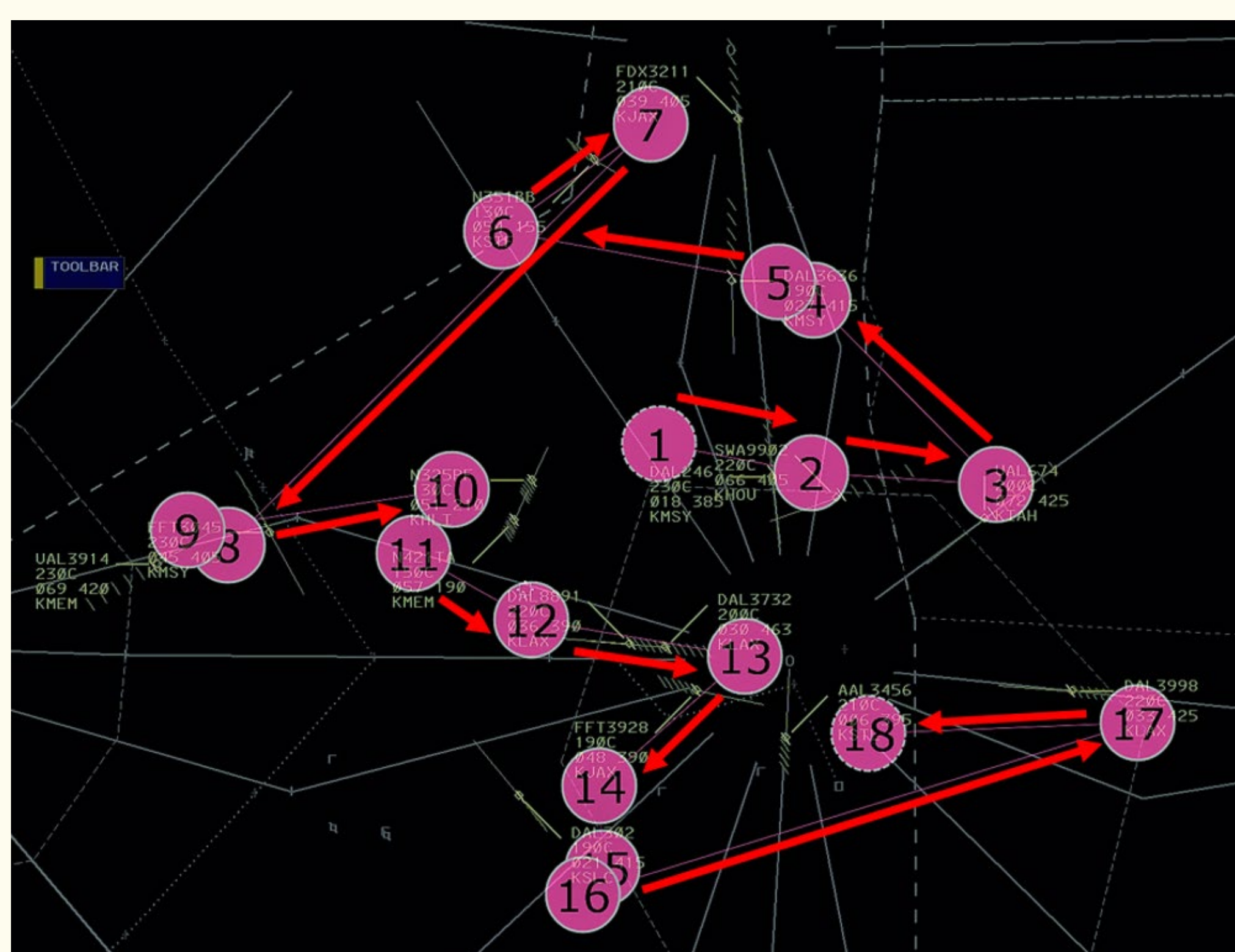
HOW

Visual Scanning Strategies

(a)

(b)

A representative example a scenario from the high fidelity en-route air traffic simulation can be seen in Figure (a). These scenarios contained various types of conflicts, such as head-on, tailgating or converging. An example of a scenario containing a head-on (yellow box) and converging conflict (red box) can be seen in Figure (b).
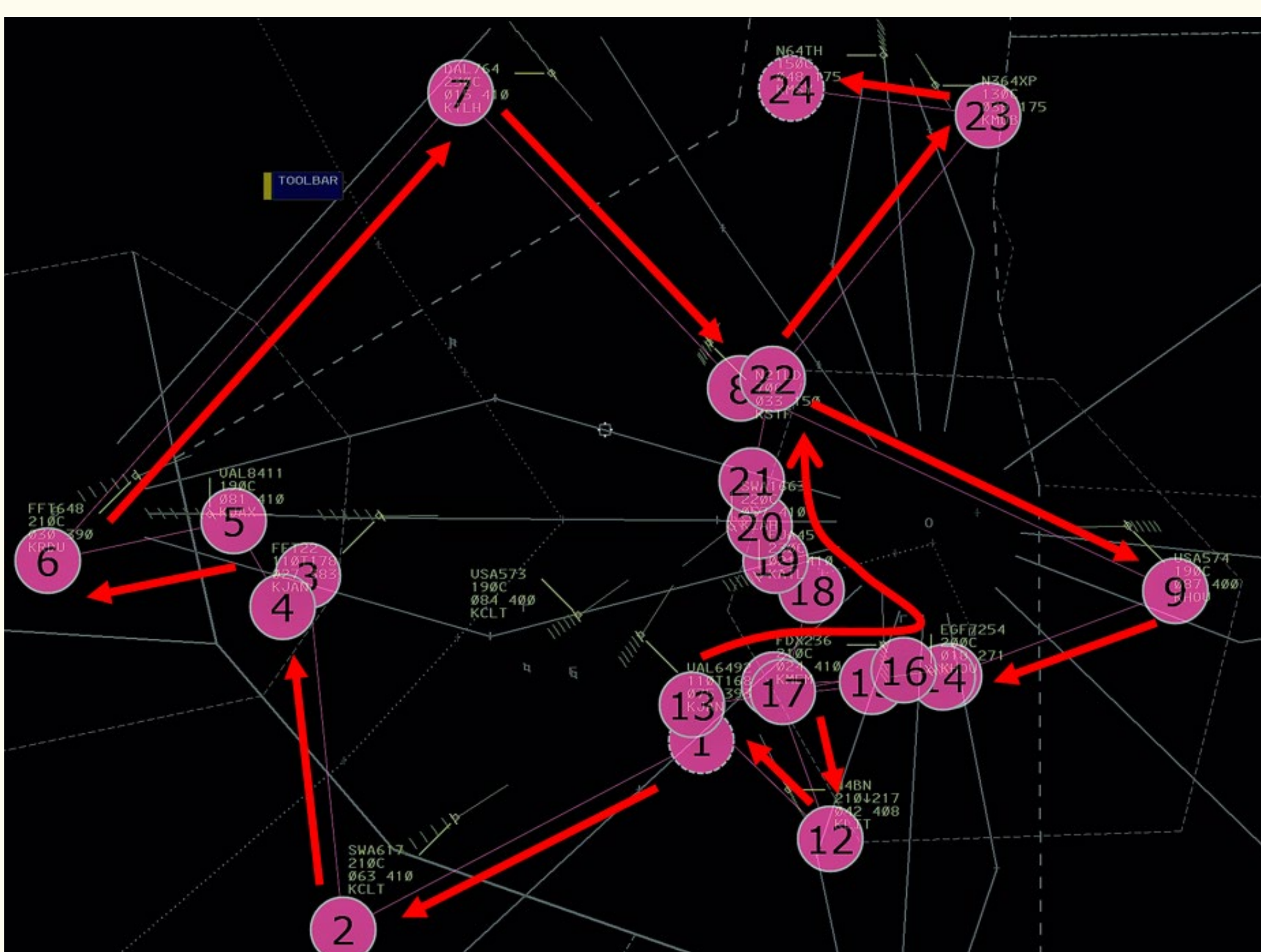

(c)

(d)

(e)

(f)

Throughout the multiple scenarios, participants had to apply their visual scanning strategies in order to identify and solve conflicts. Their strategies can be classified into patterns based on their geometry: circular, linear, spiral and mixed; shown in Figures (c) through (f) respectively.

Verbal Protocol Analysis

After the experiment was completed, a semi-structured interview was conducted with the participants. In this process, various key ideas, such as their preferred method of conflict mitigation or order in which they read the data tag, were explored in order to classify similar responses together. An example of this verbal protocol analysis can be seen below:

Table 1: Priority order of possible aircraft conflicts and associated reason.

Order of conflict observed			Freq.	Reason	Freq.	Participant
Converging	Head-on	Tailgating	4	Immediate Safety Issue	3	P1, P2, P3
				Loss of Separation	1	P4
	Tailgating	Parallel/Diverging	2	Time Sensitive	2	P7, P9
	Diverging	Tailgating/Parallel	1	Symbol Recognition	1	P5
	Parallel	Tailgating/Diverging/Head-on	1	Immediate Safety Issue	1	P6
Head-on	Converging	Parallel	1	Immediate Safety Issue	1	P10
Order based on training and experience			2	Immediate Safety Issue	1	P8
				Time Sensitive	1	P11

WHY

- To the best of our knowledge, there is no textbook that systematically shows different types of visual scanning patterns associated with mitigation strategies. An understanding of these strategies can improve the training efficiency, skills and performance of candidates.

IMPACT

- Categorized visual scanning patterns into various classifications such as: spiral, circular, quadrants, linear and mixed.

- Identified various hierarchical priorities that experts utilize: conflict mitigation, environmental impact, preferred strategies and order in which the available information is processed.