Time Based Risk Detection Tools

Executive Summary

This information paper presents the work being undertaken by the CANSO Safety Performance Measurement Work Group in the development of time-based risk detection tools. The tools are designed to complement the Risk Analysis Tool methodology and to provide a more complete picture of an Air Navigation Service Provider's mid-air collision risk and a method for the identification and monitoring of key airspace risk areas.

1 Problem Statement

As Air Navigation Service Providers (ANSPs), we need to understand and reduce our contribution to the risk of an aircraft accident as far as reasonably practicable. In the case of mid-air collisions, it is not helpful to only measure this directly, owing to the extremely low frequency of such events. Therefore, *losses of separation* have traditionally been used as a proxy for mid-air collision risk for the majority of ANSPs, whereby we record and monitor the number of losses of separation and quantify the level of the risk associated with each event.

ANSPs typically monitor the accumulated Risk Analysis Tool (RAT) score for each loss of separation and target a reduction in their contribution to such events through data identified by the RAT methodology. This is believed to be effective in reducing our contribution to the risk of a mid-air collision. However, for some ANSPs, the number of losses of separation and associated severity scores are approaching low levels, particularly when considered at the level of an individual unit. This can mean that an individual unit's safety performance is heavily influenced by a single high-scoring RAT event. This could result in reactionary, rather than considered, responses.

Perhaps more importantly, the RAT-predicted level of collision risk has proven inconsistent with actual collision risk. Some ANSPs have experienced a number of high-scoring RAT events that are believed to carry little actual risk of collision; conversely, several reported safety observations that did not accrue any RAT score could carry a significant risk of collision. This indicates that the RAT methodology on its own may not be sufficient to fully understand an ANSP's safety performance and its contribution to the risk of an accident within the overall risk picture.

In summary, the RAT score is a necessary and useful part of an ANSP's risk picture, but it may be insufficient on its own to provide a complete picture of an ANSP's contribution to mid-air collision risk. It is recommended that additional measures and tools are developed and become part of our organisational safety conversation to complement the RAT methodology and provide a more complete risk picture.

2 Proposed Solution

The underlying principle of the proposed solution is a simple concept. Time Based Risk Detection Tools (TBRDTs) employ a similar logic to the Traffic Alert and Collision Avoidance System (TCAS) (time-to-go) but can be adapted to reflect an ANSP's understanding of critical parameters. The TBRDTs process radar data to detect how often in an area of airspace a pair of aircraft point toward each other with only a short period of time until they would be predicted to either collide or come into very close proximity to one another without a subsequent change of trajectories.

For each detected interaction, the tools calculate a score that represents the significance of the interaction based on the aircraft geometries and additional adaptable parameters (e.g., altitude, civil-military mixed interaction). The geometric parameters used to determine the significance scoring vary from tool to tool, but may include:

- Current position
- Rate of closure
- Time to closest point of approach

- Estimated lateral separation at closest point of approach
- Estimated vertical separation at closest point of approach

2.1 Evolving to Safety 2

TBRDTs are intended to help us answer the questions "How reliant are we on the people, procedures, and equipment that we use to deliver a safe operational service in an area where losses of separation may not occur?" and "What is the potential risk if one of these is ineffective?"

TBRDTs enable us to explore what is traditionally considered normal, failure-free operations and understand the answers to the questions "What keeps us safe?" and "How did we do that?" In that sense, TBRDTs facilitate progression from a failure-based Safety 1 perspective towards more of a success-based Safety 2 perspective.

3 Use-Cases

TBRDTs potentially have a wide range of use-cases that are described as follows. The tools are still in the early stages of development, and the intention is for the Safety Performance Measurement Workgroup to explore and test each use-case and determine the pros and cons. Where a use-case is found to provide a clear safety benefit, whether that be an improved understanding of safety or a more efficient way of managing safety, for example, it is envisaged that the approach will be formally documented and made available to members as a CANSO paper.

3.1 Monitoring the Day-to-Day Operation

It is proposed that the tool could be used to monitor all of an ANSP's airspace and proactively identify hotspot areas where aircraft frequently come into close proximity with high rates of closure, irrespective of airspace rules, procedures, design, and the rules of the air being applied.

By uncovering individual hotspot areas, ANSPs could then start to understand in more detail the risk, the context, and the existing risk mitigations in place, whether they are procedures, airspace design, or a possible over-reliance on the human.

The assessments could then be documented and included in relevant safety cases enabling them to present a richer picture of a unit's operational risk, the associated risk control mitigations employed, and monitoring arrangements.

3.2 Monitoring the Effectiveness of Changes

When regularly monitoring an operation, the tool could also be used to build a risk baseline for each operation. This would involve monitoring and trending the frequencies of significant interactions for different sections of airspace.

It is expected that this would lead to in-service monitoring requirements and success and failure criteria being established to ensure that the effects of future changes (including traffic growth) are adequately understood and managed.

3.3 Proactive Airspace and Procedural Redesign

It is believed that the tool could also provide a means of objectively identifying the areas of airspace and associated procedures that would most benefit from future redesign. This could be determined from a review of the hotspot and key risk areas

identified and a projection of the future risk exposure based on predicted changes in traffic growth or other factors.

3.4 Efficient Airspace and Procedural Redesign

Once the requirement for an airspace or procedural redesign has been established, the tool could then be applied to simulations to provide objective evidence of the safety of future designs and would provide the ability to quantitatively compare design alternatives. This would be a significant improvement, as the current evidence gained from airspace simulations and procedural changes for a number of ANSPs is limited, being largely subjective and dependent on the qualitative judgements of controllers and relevant experts.

3.5 Efficiency Improvements

Rather than looking for hotspots in the operation, the tool could also be used to identify areas of airspace that are subject to high levels of traffic but have disproportionately lower frequencies of aircraft coming into close proximity of one another. Examination of these areas may reveal better ways of managing the airspace for the hotspot areas and may even unlock capacity improvements.

4 Benefits

It is believed that TBRDTs can deliver a number of benefits:

- TBRDTs provide an improved perspective of mid-air collision risk when compared to losses of separation. Losses of separation are determined based on breaches of compliance with the separation standard and therefore do not necessarily carry collision risk. In contrast, the interactions detected by TBRDTs are directly related to collision risk, as they are determined by the closeness in time of the aircraft geometries to a very close proximity event. Having said that, it is believed that losses of separation and the RAT provide an important compliance-based perspective of safety and that the combined perspectives of the TBRDTs and RAT together will provide a more complete risk picture and allow more effective safety management of the operation.

- TBRDTs automatically detect events at a much lower level of granularity than the number of reported losses of separation. The tools detect many more conflict events as compared to loss of separation events. This does not mean investigating every detected event, but the tools could be used as a surrogate for the amount of demand that is being placed on the controller, which, in turn, would allow for a more sensitive and anticipatory approach to safety.

- Through the identification of key airspace risk areas and associated monitoring arrangements, TBRDTs could provide the business with a level of protection from normalisation of risk and over-reliance on safety measures employed under "grandfather rights," as are often cited as key contributors in recent accident investigation reports.

- TBRDTs can be incorporated into simulations and provide an objective assessment of the safety of airspace and procedural design options, making the process of airspace and procedural design more efficient and reducing the number of airspace design iterations.

5 Future Work

Mature prototypes of TBRDTs are under development by several ANSPs. The specific implementations vary among the ANSPs, but the tools are very similar in concept.

The intention is to share experiences in the following areas:

- Reviewing the significance weightings that are applied by the tools to understand the rationale for any differences.

- Sharing how these tools are applied to the use-cases described in the previous paragraphs. Initially, it is proposed that the focus will be on the following topics:

    - **Monitoring the day-to-day operation—**this is will involve sharing operational dashboards and discussing how to incorporate the tool into the relevant safety procedures governing risk monitoring, decision making, assessment, and reporting, etc.

    - **Proactive and more efficient airspace and procedural redesign**—this will involve discussing how to link the use of the tool into the relevant processes for airspace design and simulation activities to objectively evaluate different airspace design solutions.

EUROCONTROL has agreed to extend the RAT User Group quarterly meeting by one day so that it can be used as a regular forum to discuss and share experiences in the application of TBRDTs.