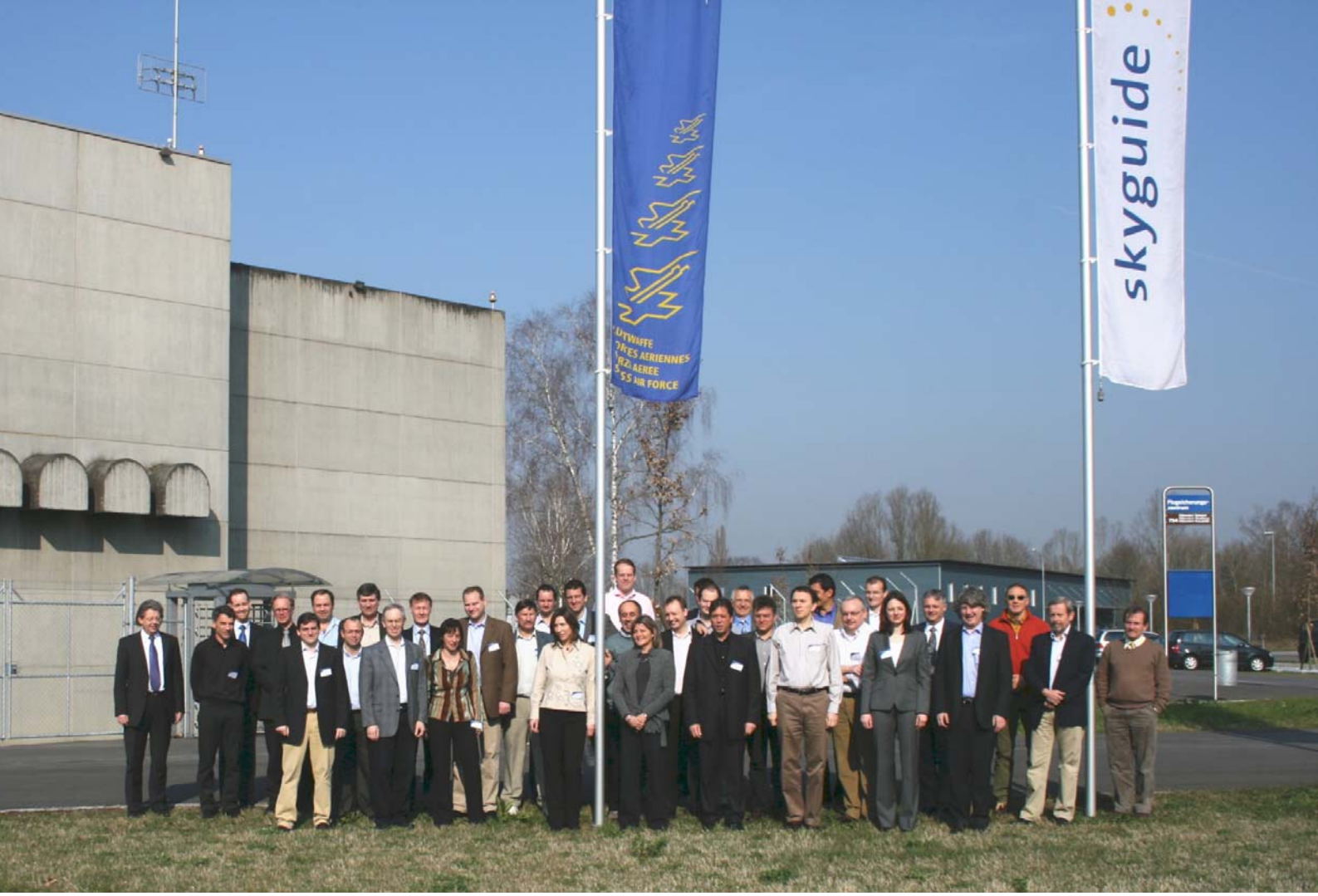

STCA & ACAS Interaction and Interoperability Workshop Report

Collision Avoidance: Quo Vadis?

27 – 28 March 2007, Dübendorf, Switzerland

14 May 2007, Released

Federal Department of the Environment, Transport
Energy and Communications DETEC

General Secretariat
Civil Aviation Safety Office

EUROCONTROL

This Report provides a factual account of the discussions during the 27 – 28 March 2007 STCA & ACAS Interactions and Interoperability Workshop. As such, the Report contains a strong stakeholder message that is expected to influence the work programmes of the organisers of this workshop, the Swiss Federal Department of the Environment, Transport, Energy and Communication/Civil Aviation Safety Office (DETEC/CASO) and EUROCONTROL.

Questions or observations regarding this report can be addressed to caso@gs-uvek.admin.ch and safety-nets@eurocontrol.int

Executive Summary

The purpose of the Workshop was to address, discuss and understand all relevant issues and problem areas related to STCA, ACAS and the interactions between them. Under the co-chairmanship of Mr Andrea Muggli (right), the Swiss Federal Department of the Environment, Transport, Energy and Communication (DETEC), Civil Aviation Safety Officer, and Mr Martin Griffin (left), EUROCONTROL, ATC Domain Manager, a broad mix of renowned experts in the subject matter (36 in total) spent two days alternating in brainstorm mode and in discussion mode. Questionnaires were used to collect any remaining points.

There was a broad consensus that key issues do indeed exist and these were openly and frankly discussed. Many of the key issues relate to the fact that both STCA and ACAS are technological answers to safety concerns and that they were developed independently. Furthermore there are significant differences between the two e.g. in the area of certification and requirements, as well as a lack of standardisation of STCA, which makes the combined behaviour unpredictable to some extent.

"Only your real friends will tell you when your face is dirty. "
~Sicilian Proverb

While a broad list of issues was identified, the relevance of the respective issues could not be defined, for the simple reason that insufficient monitoring data is available for a full assessment. Hence, there was a strong call for action at European and possibly worldwide level for action in this field. Today's roles and responsibilities as well as the certification requirement engineering of STCA were also identified as shortcomings.

Nevertheless, it is recognised that further standardisation of STCA is needed in any case, while recognising strong limitations how far standardisation can go and also that standardisation work is time-consuming and subject to institutional, operational and technical constraints. Institutional change is needed to accelerate standardisation work.

But also in the short term improvement actions can be undertaken. Keywords here are training and awareness creation, in particular cross-awareness between controllers, pilots, technical, safety and management staff. There was a strong call upon EUROCONTROL to exhibit leadership in this field.

Both short term and long term actions should aim at increasing the distance between warning time of STCA and ACAS where possible. It is accepted that there always will remain some cases where both will warn more or less at the same time, but this does not have to be a problem as long as the combined behaviour is predictable and understood by all concerned.

Participants appreciated and recognised the added value of debating the issues in a truly multidisciplinary context and expressed interest in remaining involved in future proceedings.

Glossary

AAIB	Aircraft Accident Investigation Board (Switzerland)
ADS-B	Automatic Dependent Surveillance - Broadcast
ACAS	Airborne Collision Avoidance System
AGAS	High-Level European Action Group for ATM Safety
ANS	Air Navigation Services
APP	Approach Control
ASMT	Automatic Safety Monitoring Tool
ATC	Air Traffic Control
ATCC	Air Traffic Control Centre
ATM	Air Traffic Management
CASO	Civil Aviation Safety Office (Switzerland)
CFL	Cleared Flight Level
COSAR	Consultation of Safety Recommendation
DETEC	Federal Department of the Environment, Transport, Energy and Communication (Switzerland)
DFS	Deutsche Flugsicherung (Germany)
DSNA	Direction des Services de la Navigation Aérienne (France)
EATCHIP	European ATC Harmonisation and Integration Programme
EATM	European Air Traffic Management
ECAC	European Civil Aviation Conference
ECIP	European Convergence and Implementation Plan
ESARR	EUROCONTROL Safety Regulatory Requirements
ESP	European Safety Programme
EUROCAE	European Organisation for Civil Aviation Equipment
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Authority (USA)
FOCA	Federal Office of Civil Aviation (Switzerland)
HMI	Human Machine Interface
IANS	Institute of Air Navigation Services
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFALPA	International Federation of Air Line Pilots Associations
IFATCA	International Federation of Air Traffic Controllers Associations
InCAS	Interactive Collision Avoidance Simulator
IFR	Instrument Flight Rules
MTCD	Medium Term Conflict Detection

NLR	National Aerospace Laboratory – The Netherlands
PANS-ATM	Procedures for ANS - ATM
PANS-OPS	Procedures for ANS - Operations
RA	Resolution Advisory
RTCA	Radio Technical Commission for Aeronautics
SESAR	Single European Sky ATM Research
SFL	Selected Flight Level
SID	Standard Instrument Departure
SRC	Safety Regulation Commission
STAR	Standard Arrival Route
STCA	Short Term Conflict Alert
TA	Traffic Advisory
TCAS	Traffic Alert and Collision Avoidance System (note: for the purpose of this report, TCAS and ACAS should be considered synonymous)
TCT	Tactical Controller Tool
TMA	Terminal Control Area
USA	United States of America
VFR	Visual Flight Rules
VLJ	Very Light Jet

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CHAPTER 1

Introduction & Summary Results

Describes the purpose and the structure of the Workshop and lists the summary results. A list of Workshop participants is also included.

In this Chapter:

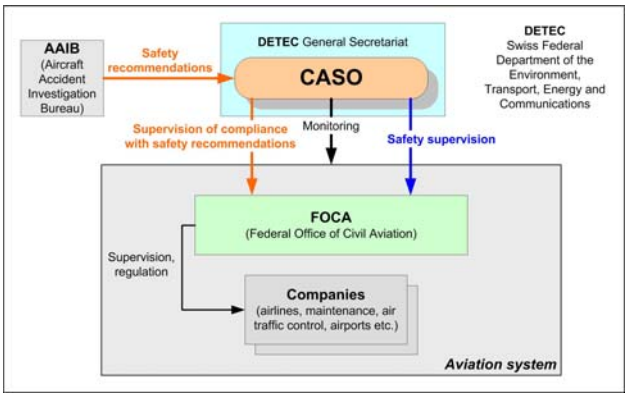
- Purpose of the Workshop
- Structure of the Workshop
- Summary results of the Workshop
- List of participants

Purpose of the Workshop

Between 2003 and 2006 the Swiss AAIB issued several Safety Recommendations concerning STCA and ACAS on subjects like:

- Procedures, tasks and responsibilities, HMI;
- Training and knowledge.

In Switzerland the CASO decides upon the implementation of Safety Recommendations and tasks FOCA (the Swiss Federal Office of Civil Aviation) by means of a so-called Safety Project Directive, mandating FOCA to conduct a respective Safety Project within the given project framework. In order to identify the key issues of a matter, CASO consults a standing industry meeting, the COSAR group (Consultation of Safety Recommendation). For further details, see www.uvek.admin.ch/caso.



In the present case, this consultation revealed the need for and encouraged CASO to plan a Workshop on the subjects of STCA and ACAS. The CASO consequently identified the need for action to develop a systemic view regarding STCA - ACAS interaction and system dynamics.

In the early stages of organising the Workshop, decision for a joint EUROCONTROL – CASO Workshop was taken.

EUROCONTROL and CASO agreed to the need for a broad participation in the Workshop and invited renowned experts in the subject matter; the list of participants is at the end of this Chapter.

It was determined that the purpose of the Workshop is to address, discuss and understand all relevant issues and problem areas. Solutions and implementation were considered to be beyond the scope of the Workshop.

"Address, discuss and understand all relevant issues and problem areas"

Skyguide, FOCA and Swiss Intl. Air Lines sponsored the preparation and organisation of the Workshop, which took place on 27 – 28 March 2007 at the new ATCC in Dübendorf, Switzerland.

Structure of the Workshop

The Workshop had the following Agenda:

Welcome & general setting-the-scene provided the opportunity to Mr Christian Weiss, skyguide, Head of Customer Relations & Chief

of Staff, Terminal Control Center, Zürich, to welcome the participants in the new ATCC in Dübendorf.

Mr Andrea Muggli, DETEC/CASO, Civil Aviation Safety Officer, then briefed the participants on the CASO organisation. He explained that the scope of the Workshop would be ACAS, STCA and the unwanted interactions between them. The purpose of the Workshop would primarily be to identify key issues related to STCA and ACAS interoperability (or cohabitation) that need addressing.

Mr Martin Griffin, EUROCONTROL, ATC Domain Manager, provided a general introduction in the subject matter of the Workshop, addressing the general motivation for having safety nets, the challenges imposed on safety nets by the ever changing environment (increasing airspace complexity, traffic density and levels of automation), the emerging concepts and relationship with SESAR.

"Key issue: problem/subject not fully addressed in previous work, needing improvement, and/or arising from the evolution of the ATM System"

Mrs Dominique Van Damme, who together with Mrs Doris Dehn, both of EUROCONTROL, facilitated the brainstorm sessions of the Workshop, then explained the rules for those sessions. She explained that the the purpose of each session would be to identify key issues.

"What are the key issues regarding ACAS that still need to be addressed?" was the question for the first brainstorm session. The session was preceded by an introductory presentation by Mr Ken Carpenter of QinetiQ. A summary of his presentation, the brainstorm results and the subsequent discussions are contained in Chapter 2 of this Workshop Report.

Co-chairman Mr Andea Muggli closed the session by concluding that nobody wants to switch ACAS off, although there are "loose ends", such as:

- Compliance with RA.
- How to make sure Pilot follows RA.
- No uniform acceptance of Collision Avoidance concept & implications.
- Phraseology.
- Design, avionics system integration and development rates.
- Technical performance (pressure altitude; nuisance alert rate; TCAS logic).

"What are the key issues regarding STCA that still need to be addressed?" was the question for the second brainstorm session. The session was preceded by an introductory presentation by Mr Isa Alkalay of skyguide. A summary of his presentation, the brainstorm results and the subsequent discussions are contained in Chapter 3 of this Workshop Report.

Co-chairman Mr Martin Griffin closed the session by concluding that there is still insufficient clarity about purpose of STCA and lack of an agreed concept of use. But recent changes in SRC and ICAO documents are expected to improve the situation. Although there is a lack of Standards, the EUROCONTROL position regarding the need for Standards has become increasingly positive. Although STCA is now strongly advocated as being a safety net, there are still those who consider STCA being a controller tool. There is potential for improving STCA by taking more data into account (CFL, aircraft

The term Standards is usually referring to detailed technical specifications that are needed to allow interconnection and inter-working of equipment. They are particularly needed when airborne equipment and their ground-based counterparts have to exchange signals-in-space. As such, detailed ACAS Standards exist, for example in order to facilitate the coordination of RAs.

This type of Standards does not exist for ground-based equipment that doesn't fall in the above category. The ANS community is reluctant to go beyond voluntary or de-facto standardisation for such equipment. In this particular context the term Standards is typically referring to high-level, minimum requirement specifications.

parameters…). Furthermore, there is a need for training & awareness creation, also considering pilot expectations and assumptions.

Specific setting-the-scene (human factors) provided the opportunity to Mr Stan Drozdowski of EUROCONTROL at the end of the first day of the Workshop to already set the scene for the next brainstorm session at the beginning of the second day. Through a detailed account of the Yaizu, Japan, accident on 31 January 2001 he illustrated how unwanted and unmanaged system interactions can interfere in achieving the common goal, collision prevention, of multiple actors.

"What are the key issues regarding STCA & ACAS Interaction that still need to be addressed?" was the question for the third brainstorm session. The session was preceded by an introductory presentation by Mr Thierry Arino of Sofréavia. A summary of his presentation, the brainstorm results and the subsequent discussions are contained in Chapter 4 of this Workshop Report.

Co-chairman Mr Andrea Muggli closed the session by concluding that the Workshop was touching the fundamentals of this hybrid system that was not designed as "one system" and, therefore, causing inconsistency and unpredictable behaviour of this collection of systems.

Outlook, Conclusions & Recommendations were discussed during the last two hours of the Workshop. Potential solutions for the identified issues were proposed under the headings Quick Wins and Long Term. They are described in Chapter 5 of this Workshop Report.

Co-chairman Mr Martin Griffin then concluded that this had been a very fruitful Workshop for EUROCONTROL as it provided an opportunity to listen to key stakeholders in this domain. There are confirmed issues that need to be addressed. In this respect the Workshop was a learning experience that will influence EUROCONTROL's work programme in this domain. Although there are no easy systemic fixes, there is certainly scope for short term improvement actions in the areas of training, awareness creation and education. A longer term strategy has to be developed in the context of SESAR.

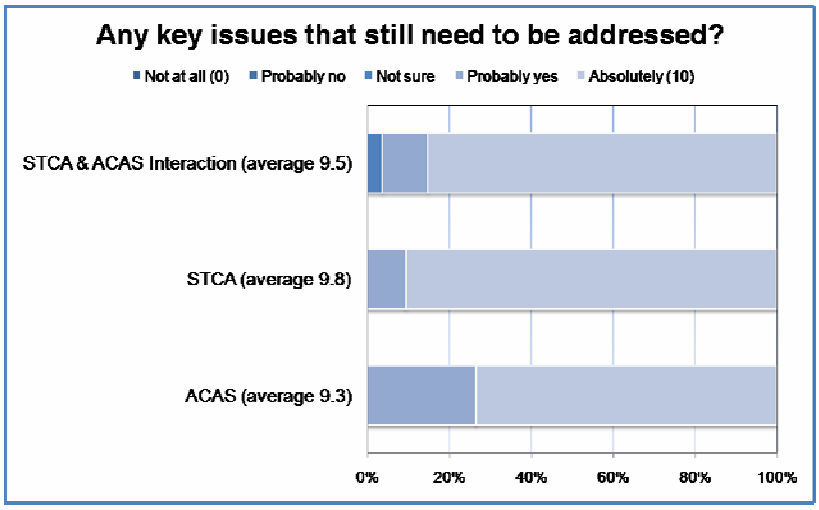
Co-chairman Mr Andrea Muggli then closed the Workshop by thanking the participants for making the Workshop a successful event. Many key issues are now identified and a broad portfolio of candidate action items needs to be considered in the follow-up of this event.

"If I know what I do not know, I can start asking the right questions!"

Summary results of the Workshop

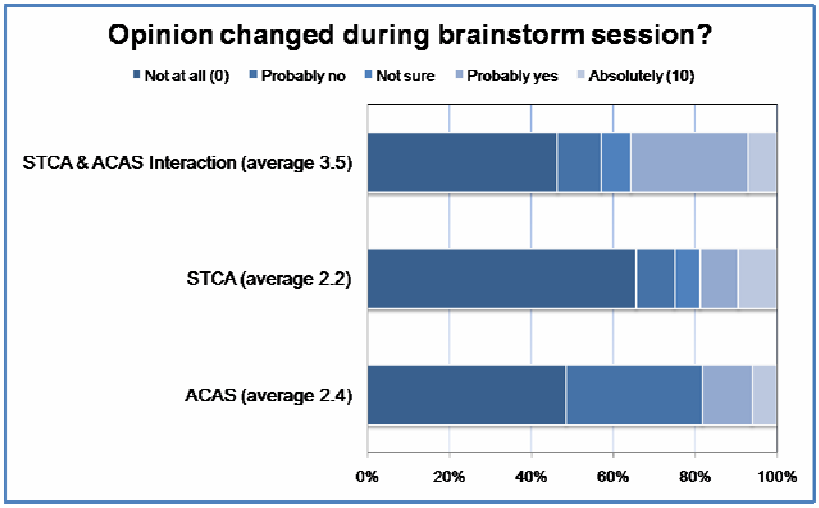
At the end of each of the three brainstorm sessions a short Questionnaire was filled in by the participants. These Questionnaires contained multiple choice questions with possible answers ranging from *"Not at all"* to *"Absolutely"*. The responses are captured in the following 100% stacked bar charts to visualise the percentage of answers for each possibility. Furthermore the calculated average on a scale of 0 to 10 is shown for each question.

The first question of each Questionnaire aimed to assess the degree of consensus whether or not key issues still need to be addressed.



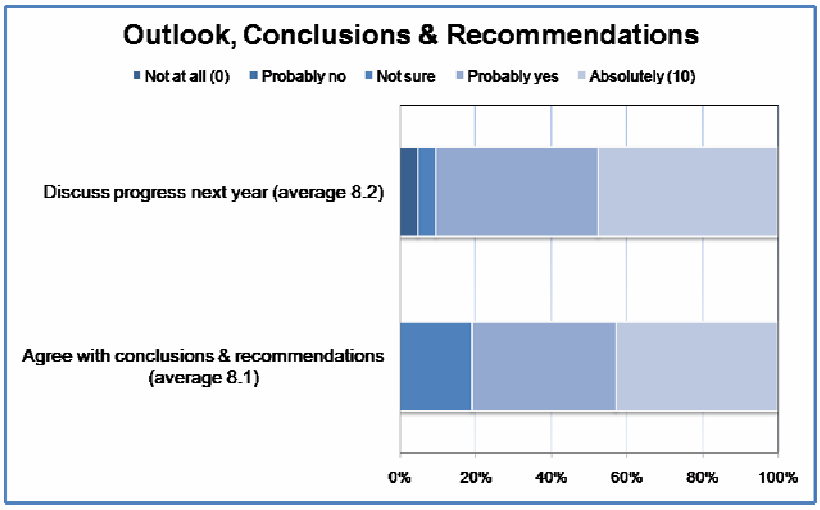
The responses illustrate that there is a broad consensus that there are key issues that still need to be addressed. The slight hesitation is most likely due to some concerns about the practicality of addressing the issues within the given constraints and without introducing new issues.

The second question of each Questionnaire aimed to assess the depth and relevance of the discussions.



Not surprisingly, many of the issues were already known by the concerned experts. But the above graph clearly shows that bringing all expertise and viewpoints together in one Workshop contributed to a better appreciation of the issues and constraints on candidate solutions.

Finally, two further questions were asked at the end of the Workshop to assess the common understanding reached and the overall usefulness of the Workshop.



The results are positive as illustrated in the above graph.

List of participants

Alkalay Isa	skyguide, Head of ATM Procedures and chairman of the Safety Nets Task Force of skyguide
Arino Thierry	Sofréavia, Head of Surveillance Separation Safety Skill Unit
Bakker Ben	EUROCONTROL, European Safety Programme AF4 (System Safety Defences) Lead
Bichsel Juerg	FOCA, Safety & Risk Manager
Bleeker Okko	Rockwell Collins
Butter Max	Lufthansa, Flight Safety Officer
Carpenter Ken	QinetiQ
de Nijs Luc	NLR
Dean Garfield	EUROCONTROL, ACAS Expert
Dehn Doris	EUROCONTROL, Human Factors Expert
Dickmann Beate	DFS, Air Traffic Controller
Drozdowski Stan	EUROCONTROL, Safety Nets Expert
Ehrsam Adrian	Armasuisse
Gilgen Christoph	IFATCA, Air Traffic Controller and IFATCA Representative
Griffin Martin	EUROCONTROL, ATC Domain Manager
Heiniger Serge	FOCA
Howell Rod	QinetiQ, Senior safety Nets Expert
Krebber Andreas	DFS
Kuettel Gerold	Swiss International Air Lines, Captain and Manager Flight Safety Investigation
Laursen Tom	skyguide
Law John	EUROCONTROL, Mode S and ACAS Programme Manager
Legrand Fréderic	DSNA
Lorenz Bernd	EUROCONTROL, Human Factors Expert
Luginbuehl Markus	FOCA
Maurer Simon	CASO, Deputy Civil Aviation Safety Officer

Muggli Andrea	CASO, Civil Aviation Safety Officer
Ott Felix	FOCA
Pasquini Alberto	Deep Blue
Raynaud Béatrice	Sofréavia, ACAS-ASAS Specialist
Regli Christoph	FOCA
Saeuberli Hanspeter	CASO
Save Luca	Deep Blue, Human Factors & Safety Consultant
Shepherd Jean-Philippe	skyguide, Safety Nets Engineer
Van Damme Dominique	EUROCONTROL, Human Factors Expert
Wellauer Roger	FOCA
Zeitlin Andrew	The MITRE Corporation

CHAPTER 2

ACAS Issues

Provides a summary of the introductory presentation, the brainstorm results and the subsequent discussions about key issues regarding ACAS that still need to be addressed.

In this Chapter:

- Introductory presentation
- Brainstorm results
- Summary of the discussions

Introductory presentation

Mr Ken Carpenter started his presentation with a short overview of the history of TCAS, noting that its development was driven by a number of mid-air collisions. Development started in 1956 and it took until 1993 to reach full equipage of the mandated part of the fleet in the USA. The first European mandate was in 2000. There is a long history of safety studies, many of those being carried out by Sofréavia, DSNA and QinetiQ under contract for EUROCONTROL in support of the European mandates.

Safety is expressed as Risk Ratio (does TCAS make safety better or worse); for Europe the Risk Ratio is estimated in ACAS safety studies to be 0.22. TCAS reduces the risk of collision of an equipped aircraft by 73%. But TCAS can also induce collision, equating to 20% of today's risk.

"A pilot who never follows RAs faces three times the risk faced by a pilot who always correctly follows RAs"

TCAS uses two pieces of information, range and altitude, which is not enough to determine a risk of collision. TCAS therefore assumes that a collision will take place and calculates the time to the assumed collision. It generates an RA at the last moment (up to 35 seconds before the assumed collision).

TCAS RAs are "coordinated" in TCAS-TCAS encounters. Both announce their intention, and the higher Mode S address reverses its RA, if required.

"In practice there are aircraft with the same Mode S address; these are usually operated by the same airline and therefore frequently tend to be close to each other!"

RAs can be generated before separation is lost and even when separation is not going to be lost. For about half of all RAs the separation minima are not significantly eroded. In reality, 1 in 10^6 RAs prevents a collision, i.e. the rate at which RAs are generated is 1 in 300 flying hours, while the rate at which collisions occur is 1 in $3x10^8$ flying hours (the purpose of RAs is to prevent collisions; it is not to prevent near misses).

RAs can disrupt ATC but this is not necessarily a safety issue. Frequent occurrences of RAs are too disruptive and then either the ATM system or TCAS has to be changed. On the other hand, ATC can disrupt the response to RAs, which is a safety issue. The ICAO PANS-OPS now states "Follow the RA", but in practice this does not yet always happen.

TCAS operates in the third, presumably independent layer of conflict management: collision avoidance. However, the shared use of

pressure altitude causes real problems. Moreover, for the humans involved the active layer of conflict management is not always obvious.

Today there are two pending TCAS change proposals:

- Improvement of RA sense reversal logic;
- Introduction of “level off” vice “adjust vertical speed”.

Brainstorm results

Each participant was given two cards to write down two key issues. The facilitators then asked randomly selected participants to read out and briefly explain one card. Only questions of clarification were then allowed, after which similar cards from other participants were collected. This was repeated until all cards were collected.

It was rapidly apparent that those who are familiar with, but not experts in the field of TCAS were surprised by the inherent limitations of TCAS as explained in the introductory presentation. Hence, a number of cards highlighted known issues and sometimes suggested ways of addressing them. Some highlights:

- The shared use of pressure altitude and the critical role of transponders; one suggestion was to consider using GPS as second source for altitude data.
- The limited functionality of TCAS-TCAS coordination and the inability of TCAS to detect risk of collision.
- The high number of “nuisance” alerts and the “incompatibility” of ATC separation minima and TCAS thresholds (mostly due to high vertical rate before level off).

“It is necessary to fully understand the problem before trying to fix it!”

Another recurring theme was the issue of pilots not always following RAs. There was a call for building up a better understanding of why, under which conditions, where and how frequently this is happening. It was also pointed out that this issue requires continuous monitoring as adherence to RAs (and therefore TCAS effectiveness) may change over time due to system evolution and concept changes.

Still on the subject of system evolution, the attention was drawn on the impact of the coming generation of very light jets (VLJs), i.e., not required to be TCAS-equipped under the current mandate. Along the same lines, the issues related to military aircraft were mentioned: everything is different, resulting in integration issues at all levels. It was suggested to consider differentiating warning time as a function of aircraft type.

Another group of issues can be summarised under the heading Human Factors and related to HMI design, phraseology, procedure design, the need for but also limitations of training, etc.

Finally, the long lead time to effect changes to TCAS was considered being a key issue as such changes might increasingly be needed to keep up with system evolution and concept changes.

Summary of the discussions

The observation was made that ADS-B is not necessarily the magic solution for many key issues. The independent nature of TCAS would be further eroded, but there are also concerns regarding increasing complexity and its potential side effects, as well as regarding cost/benefit ratio.

Further to the issue of pilots not following RAs, a number of possible reasons were mentioned:

- Contradictory ATC instruction;
- Visual contact established;
- Very short RA;
- Manoeuvring in response to TA;
- No confidence in “Climb” RA during approach.

Except for the last point, lack of pilot confidence in TCAS does not appear to be an issue in European airspace; it is probably more of an issue in USA airspace due to the mix of VFR and IFR traffic.

It was reiterated that the human is the weakest element in the ACAS control loop because pilots do not always follow the RA; without “human in the loop” the risk ratio would improve by a factor of 10.

Finally, the most-wanted improvement related to TCAS was considered being related to airspace design: many “hot spots” can be removed by taking TCAS characteristics into account when, for example, designing strategically de-conflicted SIDs and STARs.

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CHAPTER 3

STCA Issues

Provides a summary of the introductory presentation, the brainstorm results and the subsequent discussions about key issues regarding STCA that still need to be addressed.

In this Chapter:

- Introductory presentation
- Brainstorm results
- Summary of the discussions

Overview and Definitions

Mr Isa Alkalay commenced his presentation with recalling the ever growing traffic demand in the constantly evolving ATM system utilizing ever-evolving technologies through the constantly changing set of regulations and procedures constantly putting new requirements on the profile of controller performance and personality. STCA is a socio-technical system in an ever changing operational and legal framework.

The first documented implementation of STCA was put in operation by FAA on the 9th January 1976: "*The conflict alert system is warning controllers of less-than-standard separation between aircraft. The new system projected the flight paths of all aircraft on the controllers' radar sector for two minutes ahead, and flashed the relevant aircraft data tags if the projection showed the paths approaching closer than the required horizontal and vertical minimums. The controller could then radio appropriate orders to the aircraft to avoid a collision. The conflict alert system initially operated only above 18,000 feet, but by December 1978 all 20 centers had implemented it from the ground up. FAA later installed a similar capability in the Automated Radar Terminal System computers.*"

"Are we not all aware of the fact that the most sophisticated technique in an ATC system is almost useless unless it is prudently used operationally and carefully maintained by well educated and trained staff?"

~Dr. Hansjürgen Freiherr Von Villiez, honorary Director of EUROCONTROL

Early implementations materialised in Europe shortly thereafter but EUROCONTROL operational requirements for STCA have not been published until 1998 and ICAO published their STCA-related provisions in the PANS-ATM only in 2001.

However, many questions related to the operational implementation of STCA were left open, such as:

- What does it protect (separation minima or close proximity)
- Is it a Controller Tool or a Safety Net
- Does it perform in the Separation Provision and/or Collision Avoidance Layer
- TCAS competition/interoperability/interaction
- What is the acceptable ratio between Desirable Vs Un-desirable alarms
- Training
- What type of alarms – visual and/or audible
- What type of audible alarms (tone, word, continuous…)

- HMI
- "Crescendo effect"
- Does it influence capacity (normal and degraded mode)
- Should it protect increased separation minima in the degraded modes
- STCA architecture (independent server or embedded software)
- Coupling with TCT & MTCD
- Cleared and/or selected FL input
- …

Moreover, in 2003 the EUROCONTROL SRC published its Policy Document 2 that placed STCA in the collision avoidance layer, outside ATM.

More recently, concerted action has commenced and is now progressing in the EUROCONTROL European Safety Programme to provide high-level standards and comprehensive guidance material for STCA.

"A ground based safety net is a function within the ATM system that is assigned by the ANSP with the sole purpose of monitoring the environment of operations in order to provide timely alerts of an increased risk to flight safety which may include resolution advice"

(SRC definition)

The EUROCONTROL SRC withdrew its Policy Document 2. Ground-based safety nets are now confirmed being part of the ATM system and have to comply with ESARR 4. Their sole objective is to contribute to safety, and they should not be relied upon for separation assurance in the provision of Air Traffic Services.

ICAO now describes STCA as follows in the PANS-ATM: "*The generation of short term conflict alerts is a function based on surveillance data integrated into an ATC system. The objective of the STCA function is to assist the controller in preventing collision between aircraft by generating, in a timely manner, an alert of a potential or actual infringement of separation minima.*"

This positioning of STCA is particularly important in the context of emerging controller tools as MTCD and TCT.

Brainstorm results

Again, participants had two cards each to highlight key issues. Many identified issues were directly or indirectly related to the lack of standardisation of STCA, e.g.:

- Lack of standards related to the purpose and use of STCA (rather than related to uniform solutions as needed at the airborne side).
- The lack of (or need for) uniform validation criteria, definition for "nuisance" alerts and measurement/benchmarking methods.
- Development and certification requirement engineering not done.

"The average pilot doesn't know much about STCA and may believe or assume that STCA and TCAS are coordinated."

- Insufficient common understanding amongst operational, technical and (safety) management staff involved in STCA and insufficient awareness of purpose and limitations of STCA amongst those who are affected by it.
- Setting of parameters often done on technical level and not on operational level.

On the other hand, also the potential downside of standardisation was pointed out: possible disruption of local optimisation if there

would be a need to adopt different optimisation criteria, with consequences for controller training and acceptance.

Attention was drawn to the fact that STCA issues in the TMA are quite different from those in an En-route environment.

And, like for TCAS, many STCA issues were related to Human Factors because they were designed without sufficient consideration for human performance.

In fact, more STCA issues are the same as TCAS issues: the dependency on pressure altitude and transponders and the potential impact of system evolution and concept changes on effectiveness.

Summary of the discussions

The question what the position of EUROCONTROL is regarding standardisation of STCA was answered by Mr Ben Bakker. In 1999 the EUROCONTROL Organisation (not to be confused with the Agency) was firmly of the opinion that voluntary harmonisation through the then established operational requirements for (amongst others) STCA would be sufficient. After the wake-up call from the Linate and Überlingen accidents this position was reconsidered and is now changing to an increasingly firm acknowledgement of the need for standardisation. This need was substantiated by the results of comprehensive surveys that were conducted in 2004 and 2005.

In the ongoing standardisation activities STCA is strongly reconfirmed as being a safety net rather than a controller tool. The new SRC position stresses, amongst others, the applicability of ESARR 4 and the importance of STCA during degraded modes of operation. IFATCA should reconsider its policy regarding STCA in the light of the latest developments.

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CHAPTER 4

STCA & ACAS Interactions Issues

Provides a summary of the introductory presentation, the brainstorm results and the subsequent discussions about key issues regarding STCA & ACAS Interactions Issues that still need to be addressed.

In this Chapter:

- Introductory presentation
- Brainstorm results
- Summary of the discussions

Objectives

Mr Thierry Arino started his presentation with recalling that ACAS and STCA are two safety nets of different maturity and scope that were developed independently from each other. He highlighted a number of differences:

- While STCA standardisation is under progress, ACAS performance-oriented Standards and Recommended Practices are defined at ICAO level.
- Although not mandatory, STCA is deployed in several States with a wide range of implementation choices. ACAS carriage, on the other hand, is mandatory worldwide and there is a single ACAS-compliant equipment (i.e. TCAS II version 7).
- The STCA control-loop is longer than the ACAS control-loop since it needs to include an intervention buffer for controller decision, action and communication to the pilots.
- STCA uses ground-based surveillance data (and possibly other data such as CFL) as also used for separation provision. ACAS is independent from this primary means of separation provision, except for use of the barometric altitude.
- STCA estimates the remaining time until implementation-dependent lateral and vertical separation thresholds are violated, while ACAS estimates the remaining time until reaching the closest point of approach for comparison with fixed alerting thresholds.
- In the event of an STCA, the controller shall -without delay- assess the situation and if necessary take appropriate action. In the event of an RA, the pilot shall "follow the RA" (even if there is a conflict between RA and ATC instruction to manoeuvre).

"Contrary to the expectations of many, STCA may trigger simultaneously (and possibly later) than ACAS in specific situations."

The "golden rule" for controllers is to recover unsafe situations by any means. Controllers are trained to rapidly react to detected errors. Unexpected STCA alerts are stressful; the controller has to take a rapid decision, possibly based on biased situational awareness.

"The boundary between ATC instructions for separation assurance and avoiding actions is unclear."

RAs are stressful for pilots. Pilots are trained and used to follow ATC instructions. The pilots' situational awareness is limited and the

pilots' response to RAs may be affected by ATC instructions for avoiding action (confidence issue, delayed reaction, etc.).

Despite a number of studies of STCA & ACAS interactions, there are unanswered questions:

- Can STCA be "tuned" to prevent issuance of RAs?
- Is STCA effective in case of imminent (or actual) separation infringements?
- Can STCA and ACAS be coordinated at system level?
- Is training sufficient enough to ensure appropriate pilot reaction to RAs?
- Can procedures and working methods for controllers be developed to limit interaction with possible RAs?
- Is pilot report of RAs effective enough to prevent disruptive ATC intervention?
- Can RA Downlink help?
- Is training sufficient enough to ensure appropriate controller behaviour in case of ACAS / STCA events?
- Which level of training on unusual situations is required for controllers?

Mr Ben Bakker then briefly summarised the results of a feasibility study of reusing the encounter model-based methodology as successfully developed and applied in the ACAS safety studies. It turns out that this methodology can be adapted and used to study STCA performance aspects as well as understanding and management of possible interactions between STCA and ACAS.

Brainstorm results

For the third and final time, participants had two cards each to highlight key issues. Many identified issues were directly or indirectly related the critical timing overlap of STCA and ACAS that can and has to be minimised but that can't be completely eliminated for all encounter geometries.

"STCA increases the probability of controller intervention and therefore "designs" conflicts into the system."

The use of STCA for the purpose of collision avoidance was questioned, as TCAS RAs will always have priority anyhow. However, also the case of aircraft not equipped with TCAS has to be considered, including the current situation that aircraft are allowed to continue to fly for 10 days with non-functioning TCAS and that there is no mandate for equipage of "light jet aircraft". It was furthermore noted that having two safety nets cannot be avoided because there are two parties who have responsibilities. There are certainly also legal liability issues to be considered.

A word of caution was raised against reliance on engineering concepts with insufficient consideration of human performance aspects in terms of strengths as well as weaknesses. The need for training and awareness (for both parties) was reiterated, and the need for shared situational awareness should be considered, e.g., the utility of up-linking STCA alerts.

Training should use real-life examples and avoid time-lines (linear change being an over-simplification of real-life). Training should include practicing of unusual situations.

Quoting a famous Dutch soccer player (now frequently guest commentator): *[pronounced with a heavy Amsterdam accent] every advantage has its disadvantage*. For example:

- Making the pilot aware of an STCA alert could prepare the pilot for an ACAS alert. On the other hand, it could make the pilot trust ATC over ACAS. STCA alerts need to be interpreted (which can only be done by the controller); the pilot needs positive instructions or traffic information.
- STCA and ACAS could be "de-correlated" by restricting controllers to providing heading instructions, knowing that TCAS will provide vertical instructions. However, vertical separation can be achieved faster, and vertical manoeuvres can have a negative effect on ACAS effectiveness.
- Down-linking of RAs could improve controllers' situational awareness, but can also lead to information overload. Voice reports implicitly also provide an indication of pilot intent and makes the "hand-over" of responsibility explicit. In both cases there is the issue of latency, but, in case of RA Downlink the latency is more predictable.

It was suggested that STCA needs to take into account extra information (SFL, turn rate, bank angle…) to gain a time advantage over ACAS. The question was raised if it would be possible to provide automatic (ground-based) conflict resolution advice to the controller (when STCA triggers) in order to minimises the risk of controller/ACAS contradictory instructions.

It was stated that training would not help because, apparently, situations with both STCA and RAs are pretty much out of control; humans will always make mistakes although we already have highly trained professionals! For the short term STCA & ACAS will exist but for the long term an integrated approach for a new concept with humans as a starting point should be developed.

Summary of the discussions

"Down-linking amplifies voice reports and provides redundancy; if a voice report is lost for example due to noise it is lost forever."

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CHAPTER 5

Outlook, Conclusions & Recommendations

Provides a summary of potential solutions for the identified issues were proposed.

In this Chapter:

- Quick Wins
- Long Term

Although beyond the purpose of the Workshop but because unavoidably during the brainstorm sessions there were many suggestions for actions that would possibly reduce or even eliminate key issues, such actions were discussed at the end of the Workshop.

Quick Wins

First, participants were asked to suggest Quick Wins. The fast majority of suggestions were related to training and awareness creation, including:

- Establish training syllabus for operational, technical and managerial staff.
- Review existing EUROCONTROL IANS courses and adjust or complement as appropriate.
- EUROCONTROL to organise “Road Shows”.
- Produce targeted publications, possibly using existing ones like ACAS Bulletins.
- Organise joint controller-pilot TRM sessions.
- Develop (WakeNet-alike) network of stakeholders, involving organisations like ICAO, RTCA/EUROCAE, IFATCA, IFALPA, IATA, etc.

“A proactive approach is needed in order to ensure that all airlines and pilots are informed or addressed. It is not sufficient to publish information on the Internet.”

Another main theme was related to monitoring in order to feed training and awareness creation actions, to identify opportunities for optimisation (hot-spot removal, parameter settings…) and to identify and substantiate the need for Long Term actions, including:

- Use of Mode S to monitor RAs.
- Consider using the EUROCONTROL ASMT as monitoring and analyses tool, however, this should be done in a standardised manner.
- Systematic analysis of STCA and ACAS behaviour in incident analyses, noting the incident reporting obligations stemming from ESARR 2 and the need for coordination with ESP Activity Field 2.
- The need for airborne data, at least in some cases, to cater for the limitations of ground-based data analyses using ASMT and InCAS.

Long Term

Then suggestions for Long Term actions were discussed.

It was agreed that there is a need to take a strategic view, taking into account the system evolution and introduction of new concepts as now progressed in the SESAR context.

Also in the light of insufficient available monitoring information, it is too early to identify specific Long Term actions. But it was also noted that Industry initiatives, for example related to provision of RA downlink, and to linking TCAS to Autopilot, are already underway. Such initiatives could aggravate existing issues or create new ones, or pre-empt a more fundamental reengineering of requirements if that turns out to be required.

Whilst the need for further standardisation of STCA is commonly agreed, it is also recognised that standardisation is a time-consuming process and subject to institutional constraints.

Hence, there is a need for leadership to carry forward the prerequisite actions and the participants called upon EUROCONTROL to undertake the necessary initiatives without delay and with sufficient priority.


ACAS


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