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EUROCONTROL

NET*ALERT* Newsletter
Stay tuned

Ensuring the effectiveness of Safety Nets

WELCOME

Welcome to our first all electronic edition of NET*ALERT*. The layout is the same, but for those of you reading online you can navigate to articles by clicking on the contents list at the bottom of the page.

We start this issue by looking at some of the different prediction methods used to optimise STCA in what is probably its most demanding operating environment, the TMA.

Moving on to MSAW, one of the findings of the ECAC-wide safety nets survey summarised in the last issue was that some ANSPs had experienced less than optimal performance. Our article on page 3 summarises the reasons behind this and some of the associated solutions.

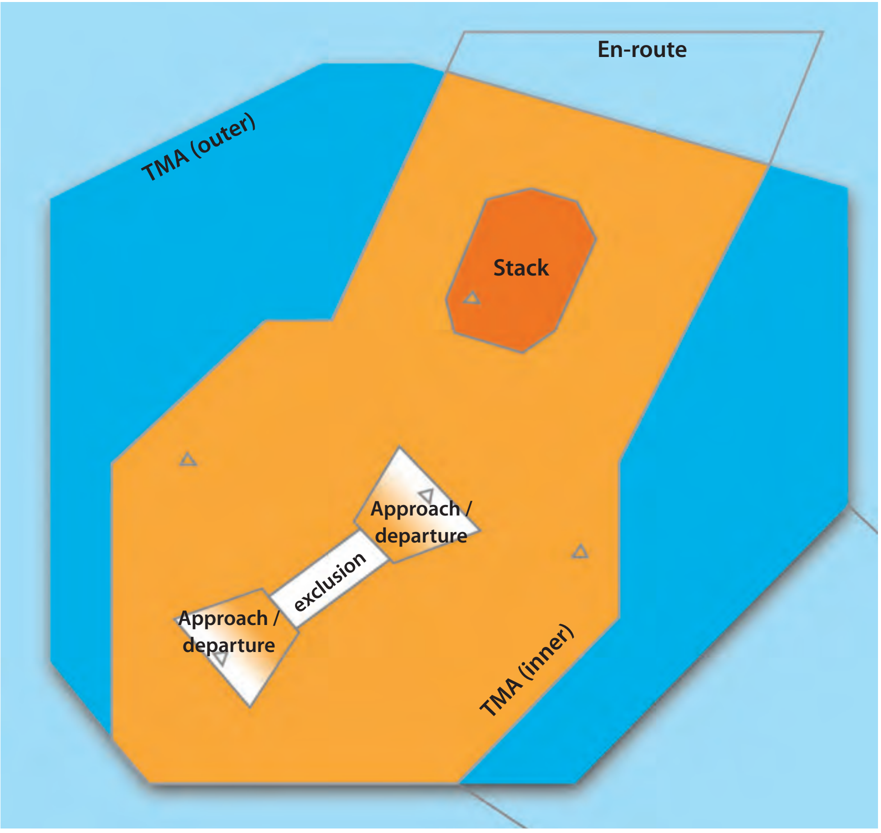
From the survey we also know that some of you are likely to procure new safety nets in the future, either as part of a new ATC system or as standalone systems. Inside we've some practical tips.

Finally we've an update on recent activity in SESAR safety nets related projects.

We're always keen to hear your feedback, particularly on future articles that would interest you - our contact details are on the back page.

Short Term Conflict Alert
in the TMA

Many ANSPs have found that it is more difficult to optimise Short Term Conflict Alert (STCA) for Terminal Control Areas (TMAs) than for en-route airspace. This is because the nature of TMA operations makes it hard to tune the look-ahead parameters used by STCA to predict potential conflicts. The reason for this is two-fold: TMA traffic is more closely spaced than traffic in en-route airspace; and TMA traffic undergoes far more turns in comparison to en-route traffic – often for much shorter periods of time and at higher rates of turn. These two factors can result in relatively poor warning time performance and a relatively high number of STCA nuisance alerts in the TMA. Some of the techniques used to address this are summarised in this article.



Illustrative graphic of STCA regions in the TMA

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STCA in the TMA

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STCA volumes

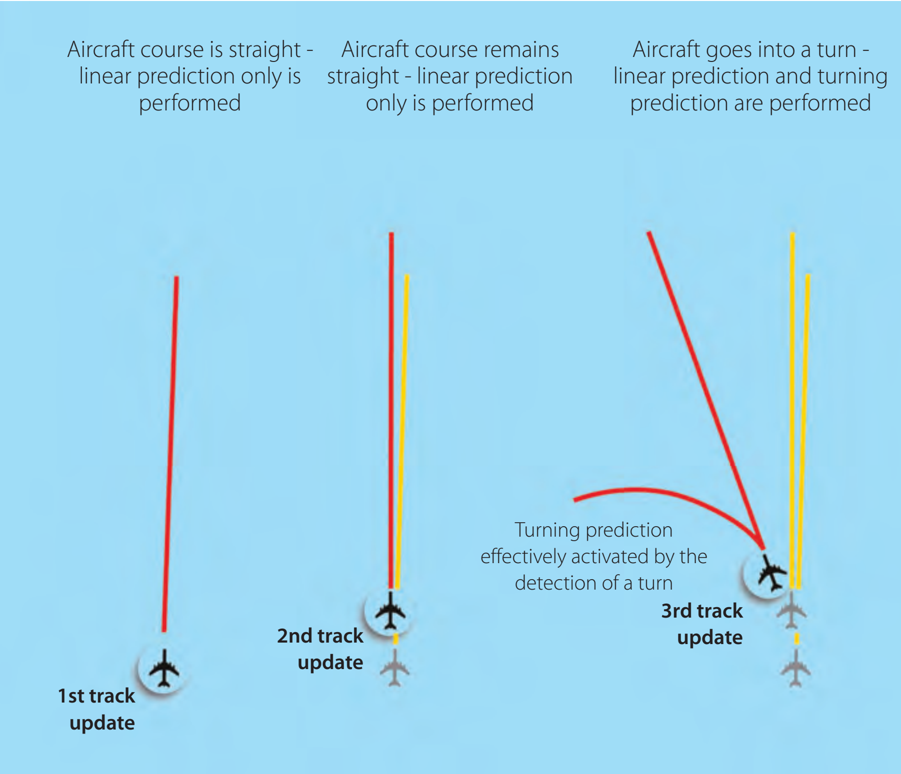
The key to a STCA system that performs well is to apply the conflict thresholds and prediction times that are most appropriate to each volume of airspace. This might mean defining some quite small STCA volumes in the TMA (see front page graphic) where very specific parameters will apply. For example, aircraft in stacks (holding patterns) rarely fly straight for more than a minute. Therefore, a linear prediction time set at two minutes is entirely inappropriate for holding aircraft and is, in fact, generally inappropriate for most of the TMA.

Sometimes it can be worthwhile setting up STCA volumes for different parts of the TMA. An outer TMA zone can, for example, provide for a gradual change in the STCA parameters between en-route airspace and the busiest part of the TMA (TMA inner). The outer TMA zone provides a buffer between the en-route corridor and the busy inner TMA. Further consideration may also be given to setting up specific STCA volumes for lower parts of the airspace, for example, to address potential nuisance alerts between IFR and VFR traffic.

Depending on the local rules, TMA traffic may have a 3NM ATC separation applied and the traffic often converges on a limited number of waypoints corresponding to navigational beacons or fixes; this can lead to 'hotspots' with a high proportion of nuisance STCA alerts. Taking the front page graphic as an example, one might expect to see alert hotspots in the approach zones close to the airport, in the stack region, and in other parts of the TMA where there are converging flows of arrival and departure traffic. To limit the number of nuisance alerts some ANSPs analyse these alert hotspots, and the associated traffic patterns. This reveals where new STCA volumes with very specific parameters should be established. As well as volumes where STCA alerts, exclusion volumes will also be set up to inhibit STCA for aircraft on or in very close proximity to the ground.

Linear prediction

The most common STCA prediction filter is the linear prediction filter, which makes a straight-line prediction of the aircraft's trajectory. It is well suited to en-route airspace since aircraft spend a lot of time flying straight and the linear prediction assumption is reasonably accurate.



Illustrative graphic of the classic STCA turning prediction

However, in the TMA, where turns are common (sometimes at high rates), the linear prediction assumption can be very inaccurate indeed. Consequently careful consideration should be given to reducing the look-ahead time used by this filter in the TMA.

Turning predictions

If one aircraft starts to manoeuvre towards another the linear prediction filter can be slow to provide an STCA alert. As a result, in addition to the usual linear prediction, some STCA systems use a turning prediction which activates when an aircraft is detected as turning by the tracker (see graphic below).

Turning predictions are particularly appropriate for aircraft performing turns or that are being vectored by ATC (i.e. not part of a highly predictable traffic pattern), and they can improve the warning time of STCA alerts when one aircraft turns towards another.

However, the turning prediction is far from perfect. Since the prediction doesn't anticipate the turn (the prediction only activates after the turn has started), the amount of warning time gained over the linear prediction assumption can be limited.

Furthermore, aircraft generally do not perform turns for long periods. Without information indicating when the turn will cease, it is good practice in STCA to set the duration of the turning prediction to a small value (around 1 minute), and it is also essential that the linear prediction remains active in order to anticipate the trajectory at the end of the turn.

In fact, the limitations of a turning prediction are such that all the STCA conflict detection parameters related to turning prediction should be carefully set to values that will avoid excessive nuisance alerts.

Turning predictions based on arrival procedures

In many parts of airspace the future course of an aircraft is not predictable without specific additional information that only the controller or the pilot could disclose. However, there are some segments of certain flights when the aircraft trajectory is predictable due to the known approach procedures. This predictability allows some STCA systems to make predictions based upon the approach procedures.

For example, some STCA systems predict aircraft positions based on the holding patterns in active stacks. Prediction of the future position of an aircraft established in a holding pattern can actually be quite accurate, and can in specific cases provide an earlier STCA alert.

Other STCA systems predict that an aircraft will turn onto the localiser, when aircraft are in defined manoeuvring zones close to the airport and heading towards the localiser beam.

In all cases, the standard STCA linear prediction may be made less sensitive, although it should never be entirely deactivated. It should remain as a back up just in case the procedure-based turning hypothesis happens to be incorrect.

Conclusion

En-route and terminal airspace have different traffic patterns and consequently STCA needs to be set up differently in these environments to operate optimally. The main points highlighted in this article are summarised in the text box below.

SESAR and STCA in the TMA

As previously reported, enhanced STCA for TMA operations is an Operational Focus Area in the SESAR Release 1 Plan. An industrial prototype will be developed in Project 10.4.3 and undergo a standalone validation in Project 4.8.1. Our regular 'SESAR update' on page 6 provides the latest status of these projects.

STCA in the TMA – summary points

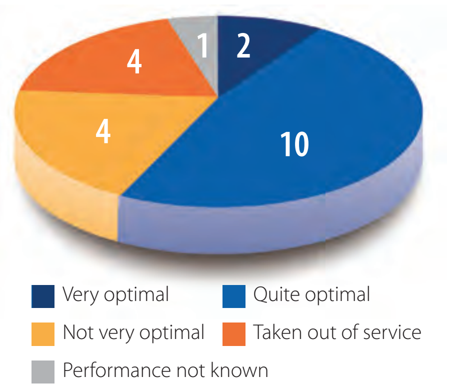
TMA traffic is often converging with other traffic or executing turns – this can be particularly challenging for STCA, leading to nuisance alerts. However, careful optimisation of STCA can help reduce nuisance alerts in the TMA by:

- defining STCA volumes at recognised hotspots, with specific parameters
- reducing linear prediction parameters
- use of standard turning prediction
- prediction filters which 'know' the traffic patterns associated with approach procedures

Survey follow up

Why was MSAW 'switched off'?

In the most recent survey of safety nets use in the ECAC area, one finding was that while MSAW was generally regarded as operating well, some ANSPs had experienced less than optimal performance, and in as many cases the system had subsequently been taken out of operation (see pie chart below). There were also instances of MSAW not being put into operation because it could not be tuned in shadow mode.



Individual perceptions of MSAW operations (21 responses)

Scratching the surface - underlying reasons

High levels of nuisance alerts were cited as the reason for less than optimal performance of MSAW. These were attributable to five main sources; difficulties in tuning the MSAW surface, alerts due to VFR traffic, warning time parameters, a limited number of polygons and a lack of inhibition zones around airports (see bar chart overleaf). While over 50% of MSAW systems operate across the entire FIR, most nuisance alerts were experienced in the vicinity of airports, where each arriving and departing aircraft operates in close proximity to the MSAW surface.

Getting below the surface – digging a little deeper into the survey

As can be seen from the bar chart the main problem has been in tuning the MSAW surface. Over 40% of ANSPs surveyed said they were either currently experiencing or currently addressing this issue. This excludes systems that have been taken out of service or could not be tuned in shadow mode.

Why are difficulties with the MSAW surface so common? Rod Howell of QinetiQ who has been involved in developing a number of MSAW surfaces explains the complexity of the task: *"MSAW is typically configured as a series of predefined volumes of airspace, or polygons, each with a fixed ceiling height. Together, a group of polygons forms the 'MSAW surface'. When an aircraft is predicted to penetrate this surface, an alert is immediately generated and displayed to the controller. These polygons are usually defined manually by, for example, using topographical maps or based on the minimum vectoring altitudes used by ATC. However, this is time consuming and can result in oversized polygons which then leads to excessive nuisance alerts."*

System parameters can also play a part in the tuning of the MSAW surface. A typical MSAW system will allow between 64 and 256 polygons to be defined. A lower number of polygons clearly means less flexibility to accurately define the MSAW surface, particularly so if the terrain being mapped is relatively complex. This was the problem for some of the ANSPs surveyed.

However not all sources of nuisance alert are associated with the MSAW surface. VFR and military traffic are the second most common source of nuisance alerts. EUROCONTROL's experience of supporting ANSPs shows that this type of traffic can produce significant

Survey follow up Why was MSAW 'switched off'

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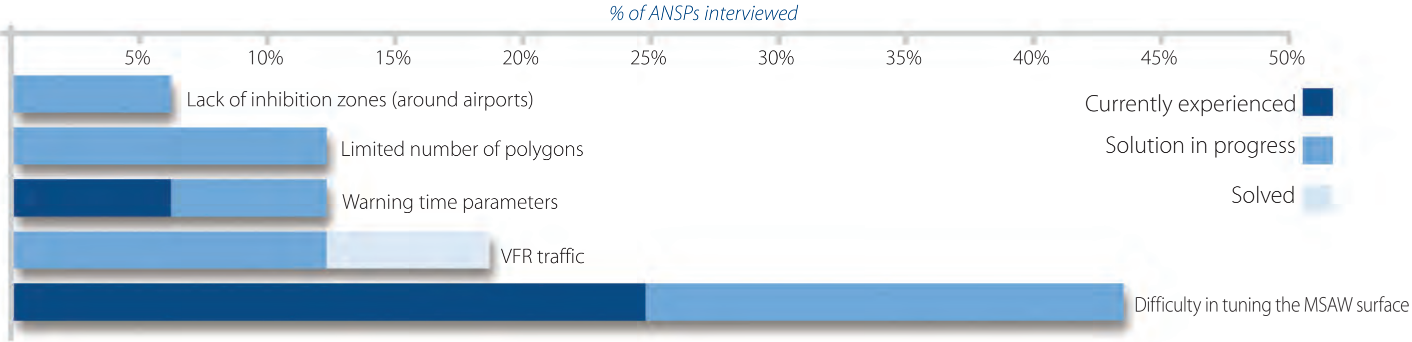


Sources of MSAW nuisance alerts (17 responses)

numbers of alerts. Perhaps they are flying close to the ground to maintain visual references or for operational reasons, or they are conducting visual approaches.

Another study finding was that the majority of respondents currently working to reduce the number of MSAW nuisance/false alerts ('solutions in progress' in the bar chart) were being supported directly by EUROCONTROL. Stanisław Drozdowski explains another factor in the 'switch off' figures: *"Having been involved with several ANSPs, I can confirm that it is no trivial task to properly tune MSAW to have an optimal surface, suitable warning time parameters and appropriate inhibitions of both certain categories of flight and volumes of airspace. The effort and resource required for their particular system and airspace has prevented some ANSPs from making progress."*

What are the solutions?

From the survey and other EUROCONTROL experiences, there are four main activity areas adopted by other ANSPs or recommended by EUROCONTROL to solve these problems. They are summarised in the table below.

Other information on solutions can also be found in the back-issues of NET*ALERT* (see text box at the bottom of the page). Stanisław Drozdowski concludes: *"Although tuning is complex and time-consuming it is well worthwhile, and EUROCONTROL is available to help. Please do get in touch with us if this might interest you."*

Example solutions to reduce MSAW nuisance alerts

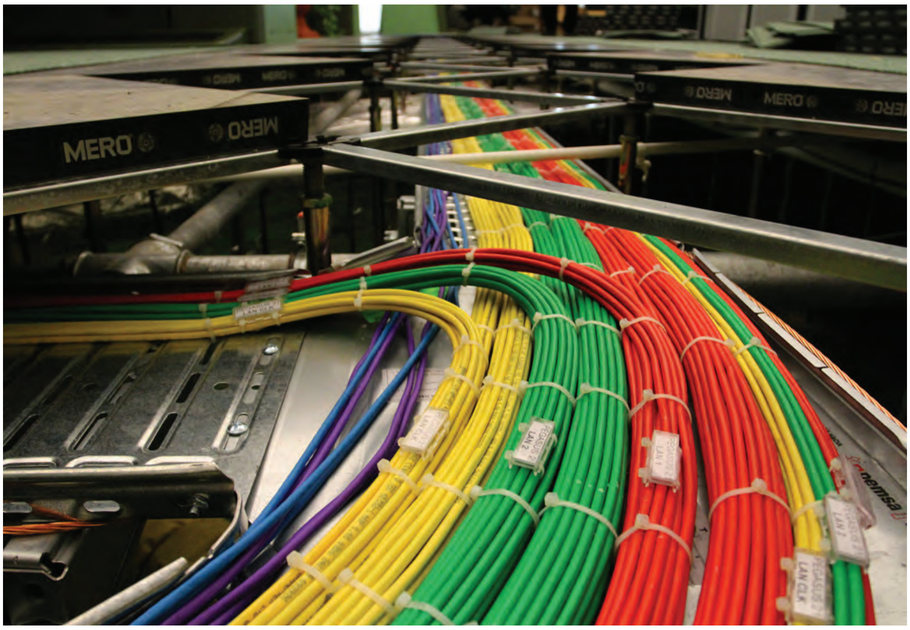
Re-tuning the MSAW surface	Investigate retuning the MSAW surface more accurately. Hotspots on the MSAW surface can be identified by surveying controllers and analysing system log files. One option, particularly if the system has a relatively small number of definable polygons, is to use the EUROCONTROL PolyGen tool which allows MSAW polygons to be defined more quickly and accurately using digital terrain data.
Warning time	Modify system parameters to get the right balance between warning time and the level of nuisance alerts.
Inhibition of certain types of flight	Solutions used by other ANSPs include inhibiting VFR and military traffic using a pre-defined list of SSR codes. Additionally, where some individual types of operation, such as visual approaches or approaches with high rates of descent are a source of nuisance alerts, some systems have the functionality to allow the controller to manually inhibit alerts for individual flights.
Inhibition zones	ANSPs have also defined inhibition volumes where MSAW does not alert; for example, military training areas or around nearby airfields not under a given controller's responsibility. In the vicinity of a specific airport it may also be necessary to define volumes where MSAW is inhibited, in order to prevent nuisance alerts for aircraft on final approach. However, if APM is available in the ATC system, it is highly recommended that APM should be activated, effectively to override the MSAW system for aircraft on the final approach segment.

MSAW articles in back-issues of NET*ALERT*

The following MSAW related articles can be found on the EUROCONTROL website:

- Use of MSAW by skyguide (NET*ALERT* 4: Best approach – MSAW or APM?)
- Use of MSAW by DSNA (NET*ALERT* 6: Terrain alert - check your altitude immediately)
- EUROCONTROL PolyGen tool for defining MSAW surfaces (NET*ALERT* 7: PolyGen - a new solution for defining MSAW surfaces)
- Use of MSAW by NAV CANADA (NET*ALERT* 10: MSAW implementation in Canada)
- EUROCONTROL support to Malta Air Traffic Services (MATS) in the definition of a new MSAW surface (NET*ALERT* 11: Focus on safety nets in Malta)

Buying new safety nets?
Read on …



We've all probably bought something at some point in our lives only to find out it wasn't quite what we expected. New safety nets are often procured as part of a new ATM system, and are therefore a relatively small part of a much larger purchase. Subsequently, over the years, a number of issues have been identified with safety nets that could have been spotted and rectified before the system went into operation. This short guide provides some tips and advice on what to do before procuring and during testing of your new safety nets system.

Before you buy

When thinking about buying a new safety nets system, the top tips are:

■ **Seek the experience of others.** Ask other ANSPs of their experiences using their safety net system.

■ **Define operational requirements.** Draw up a set of operational requirements (see text box overleaf).

■ **Asks questions of the supplier.** Ask the prospective system supplier to provide you with a detailed description of the safety nets algorithms and system capacities.

■ **Clarify with the supplier.** If some details aren't clear, ask for clarification from the system supplier – they should be able to answer any question regarding their own safety nets.

■ **Be involved in testing.** Ensure your own safety nets experts are part of the testing and optimisation process.

■ **Think about the future.** It is absolutely essential that the safety nets will work and provide the required performance now and also in the future operational environment.

What to investigate

The operational requirements should identify the key areas to investigate with the system supplier. This can be a pretty exhaustive list, but to give some ideas of what to look for here are a few examples:

■ **Number of definable volumes.** Many safety nets systems place constraints on the number of STCA, MSAW and APW volumes that can be defined by the user. So, make absolutely sure that the number of volumes will be sufficient for your needs both now and in the future. To make setting up easier, check whether the volumes are allowed to overlap.

■ **Eligibility criteria.** A major aspect that can affect the performance of all safety nets is the eligibility criteria used to determine if a track is to be processed by the safety nets. Many safety nets systems offer quite a lot of flexibility, generally allowing the system to determine correctly which flights are of concern, and which ones are not. Nevertheless, it is fundamental to good safety nets performance, so make sure that the eligibility criteria fit with the way that aircraft are managed in your airspace.

■ **MSAW surface definitions.** If procuring MSAW, will the surface be defined using Digital Terrain Data (DTED) or polygons, or both? If the MSAW system uses DTED, make sure the cell (mosaic) size is of the order of 1NM x 1NM or smaller as larger cell sizes lead to increasingly poor MSAW alerting performance. If using polygons, ensure that maximum number definable by the system will be sufficient to define the MSAW surface accurately. If defined inaccurately, poor alerting performance will result.

■ **Have possible future requirements in mind.** When making investigations, consider the future as well as the present. For example, the concept of Advanced Flexible Use of Airspace (AFUA) is currently being developed under SESAR Project 7.5.2. As a consequence of this work, it is very likely that many APW systems will need to be technically modified (for example to support vertical limits in either Flight Levels or feet) and the number of APW volumes will need to be increased in order to support the potentially more modular approach to, for example, Temporary Restricted Areas (i.e. a larger number of small volumes).

Test, test and test some more

If you take early delivery of a test ATC system, then this provides a golden opportunity to try out the safety nets. Live data can be used as an input to the test system, and whilst it is usually not practical to set up the safety nets fully during testing, there are a number of important aspects that can be analysed, for example:

■ **HMI and alerting.** Test the HMI for the visual and audible presentation of alerts.

■ **Eligibility criteria and inhibition volumes.** It is certainly worth checking that the eligibility criteria and inhibition volumes can be set up to identify which traffic is of interest

Buying new safety nets?

Read on …

continued

and which is not. For example, if you can't automatically inhibit MSAW and STCA in the immediate vicinity of an airport, then you potentially have a problem.

- **RVSM functionality.** If the RVSM status of a flight is unknown, then many STCA systems apply a wider default (2,000 feet) vertical threshold. If there are a significant number of aircraft in RVSM airspace without flight plan information (common just outside the FIR boundary), then the default STCA behaviour could well cause problems in your airspace, generating a significant number of nuisance alerts. If you have a track simulator, then you could try injecting some artificial tracks into the test ATC system separated by 1,000 feet and laterally converging. Then, alter the RVSM status of these flights (approved versus approved, approved versus unknown etc), and see how the STCA system behaves.

Finally, remember that it's far easier to get something changed or fixed before it goes into operation. So consult widely, seek advice, ask for information from the prospective supplier, and test it before you complete the purchase. CAVEAT EMPTOR – let the buyer beware!

Defining operation requirements

Determining operational requirements is very important, since time spent defining a set of high quality operational requirements is time spent reducing the risk of partial or complete project failure.

In general terms, operational requirements are qualitative and quantitative parameters that specify the desired capabilities of a system and serve as a basis for determining its operational effectiveness and suitability prior to deployment. This covers both functional and non-functional requirements, including, but not limited to, the examples in the panel opposite.

The above material has been extracted from the EUROCONTROL Guidance material for STCA, MSAW, APM and APW. These contain further guidance on defining operational requirements, including requirements capture, analysis, recording, plus example requirements checklists and specific points to consider for each safety net. All documents can be found on the EUROCONTROL website.

Functional requirements

- Capabilities or features of the system (e.g. prediction methods, use of CFL, RVSM etc)
- System capacities (e.g. number of regions)
- Requirements on environment data (both on-line and off-line)
- HMI requirements (as far as is relevant for the system)
- Data recording requirements

Non-functional requirements

- Usability requirements (e.g. visibility of visual alerts, ease of Cleared Flight Level input)
- Quality attributes (e.g. reliability, maintainability, supportability, testability, safety standards and availability requirements)
- Constraining factors imposed externally (e.g. cost, legislation, policy)
- Interoperability/interface requirements (e.g. physical, process, support and information interfaces to other capabilities/ systems)

SESAR update

Our regular review of SESAR safety nets related projects follows…

Evolution of Ground-Based Safety Nets (P 4.8.1)

Activities in work area 1 (enhanced ground-based safety nets using existing down-link aircraft parameters (DAPs) in TMA and en-route environments) continue for each of the ground-based safety nets. In the coming months DSNA plans to conduct model-based simulations to evaluate the performance benefits associated with STCA using existing DAPs. In order to increase the realism of the simulations, DSNA has updated the STCA model to include multi-hypothesis functionality.

Work is also underway to determine the benefits of APM, APW and MSAW using existing DAPs with both DSNA and NATS analysing the actual quality of this information. At the same time, the frequency of scenarios where the use of DAPs is expected to provide benefits is being determined through analysis of Mode S recordings. A parallel activity in work area 1 is evaluating the costs associated with using existing DAPS in ground-based safety nets.

As reported in the last edition of NET*ALERT*, in the final quarter of 2011 work area 5 (Enhanced STCA for TMA specific operations (Release 1)) will conduct a standalone validation of an STCA industrial prototype being developed by Project 10.4.3. A review of a mature validation plan has been made by a wide group of stakeholders and the plan is now being executed. These activities will

support the enhanced STCA for TMA operations Operational Focus Area which is part of the SESAR Release 1 Plan due at the end of 2011.
Partners: DSNA (leader), NATS, ENAV, SELEX, EUROCONTROL

Evolution of Airborne Safety Nets (P 4.8.2)

Work area 1 is evaluating and validating the safety benefits from the modification of autopilot laws for altitude capture (TCAS Alert Prevention (TCAP)) to avoid false alerts during high vertical approaches. Work area 2 is undertaking the same task for the coupling of ACAS to the Auto Pilot/Flight Director (AP/FD) to provide automatic compliance with Resolution Advisories. Simulations for both have taken place at DSNAs premises in Toulouse and the associated validation reports have been reviewed by the SESAR Joint Undertaking (SJU). The development of candidate safety and performance requirements (SPRs), under the leadership of DSNA, is underway and these will be proposed to EUROCAE for industrialisation.

The EUROCONTROL led work area 3 is identifying and evaluating possible modifications to ACAS (for time and trajectory-based) operations in future environments. A validation plan and Operational Service and Environment Description (OSED) are being developed and are planned to be delivered to the SJU during mid-September.
Partners: DSNA (leader), AIRBUS, NATS, EUROCONTROL

Ground-Airborne Safety Net Compatibility (P 4.8.3)

This project continues to address ACAS RA Downlink. The draft preliminary operational concept has been reviewed by a broad group of stakeholders and now serves as baseline for further refinement and validation activities. DFS is conducting an analysis of RA encounters collected from ACAS monitoring stations and Mode S radars in P 15.4.3. Approximately 400 encounters have been collected to date for analysis .
Partners: DSNA (leader), DFS, AENA, INDRA, AIRBUS, EUROCONTROL

ACAS Monitoring (P 15.4.3)

Initial data collection and evaluation of ACAS events from a technical perspective has started and the results have been consolidated into a 'Preliminary Data Evaluation Report'. Over the coming months work will continue on the system specification, prototype development, sensor sitting and integration of the ACAS monitoring system.
Partners: THALES (leader), INDRA, EUROCONTROL, DFS

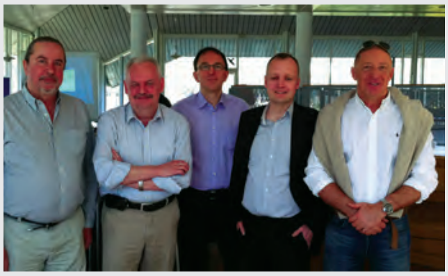
Safety Nets Adaptation to New Modes of Operation (P 10.4.3)

This technical project will provide the industrial prototype of the enhanced STCA for TMA operations for validation by Project 4.8.1. The test plan and description of system requirements has been produced with work now taking place on the development, and verification of the prototype, and a verification test report. Over the coming months work on the definition of a performance evaluation method for safety nets will also continue.
Partners: THALES (leader), DSNA, ENAV, EUROCONTROL, INDRA, NATMIG, SELEX

Snippets

SPIN meeting: The next meeting of the SPIN Sub-Group will be hosted by Air Navigation Services of the Czech Republic in Prague (Jeneč) on 12th and 13th October. The agenda will include RA Downlink and compatibility of safety nets.

The next SPIN meeting is the 25th for the group; those in the picture below have attended from meeting one (from left to right Carlos Santos (NAV Portugal), Ben Bakker (EUROCONTROL), Stan Drozdowski (EUROCONTROL), Rod Howell (QinetiQ) and Isa Alkalay (skyguide)).



New ACAS Bulletin available: The latest issue of ACAS Bulletin is dedicated to a rare but critial Resolution Advisory (RA), the reversal (i.e. "Climb NOW" or "Descend NOW") RA. It describes and examines three real-life examples of reversal RAs and draws lessons to aid both pilots and controllers in preventing future accidents and incidents. ACAS Bulletin can be found at: www.eurocontrol.int/acas.

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EUROCONTROL

ENSURING THE EFFECTIVENESS OF SAFETY NETS