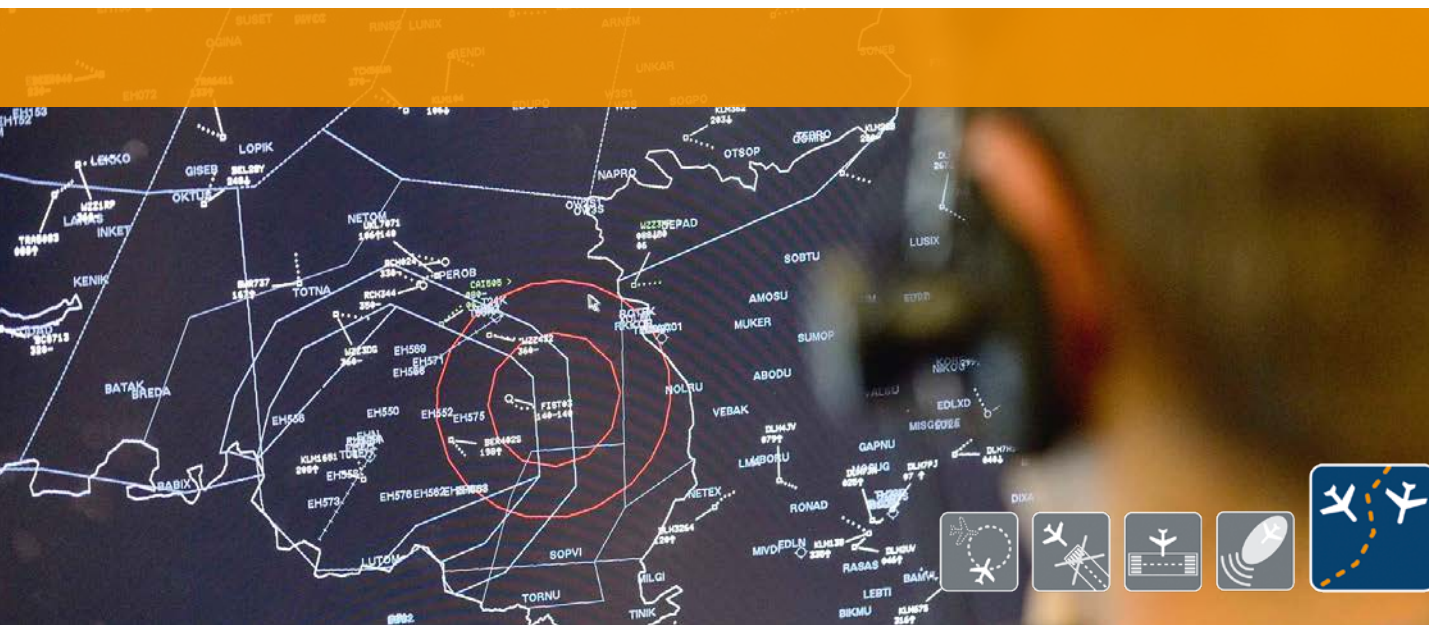




Network Manager
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Operational Safety Study: Conflict detection with adjacent sectors



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Abstract

The EUROCONTROL Safety Improvement Sub-Group (SISG), reporting to the EUROCONTROL Safety Team, was tasked to identify the Top 5 ATM Operational Safety Priorities. This purpose of this report is to document the operational safety study on one of the Top 5 Network Manager operational safety priorities – “Conflict detection with adjacent sectors”. This study has identified five basic operational scenarios of losses of separation because of ineffective sector coordination and eight potential barriers to prevent losses of separation due to ineffective detection of conflict with adjacent sector occurrences. This study suggests that a combination of four barriers seems to deliver the best reliable protection to prevent losses of separation due to ineffective detection of conflict with an adjacent sector.

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DOCUMENT APPROVAL

The following table identifies all management authorities who have successively approved the present issue of this documents.

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TABLE OF CONTENTS

DOCUMENT CHARACTERISTICS	3
DOCUMENT APPROVAL	4
DOCUMENT CHANGE RECORD	5
EXECUTIVE SUMMARY	9
CHAPTER 1 - INTRODUCTION	11
1.1 What is the purpose of this document?	11
1.2 What are the Network Manager Top 5 ATM Operational Safety Priorities for 2013 and 2014?	11
1.3 How did we identify the 'Top 5'?	12
CHAPTER 2 - THE GENERIC PROCESS: OVERVIEW	13
CHAPTER 3 - GENERIC SCENARIOS	14
3.1 How are generic operational scenarios defined?	15
3.2. Analytical deconstruction of operational scenarios - sources	15
3.3 Analytical deconstruction of operational scenarios – mechanism	17
3.4. Analytical deconstruction of operational scenarios – outcomes	17
3.5. The list of operational scenarios	18
CHAPTER 4 - ACTUAL EVENTS	19
4.1 Event 1: B777/C510	20
4.2 Event 2: B734/B1	21
4.3 Event 3: GLF5/DH8D	22
4.4 Event 4: FK70/FK15	23
4.5 Event 5: TBM7/A320	24
4.6 Event 6: B738/A319	25
4.7 Event 7: B7370/A319	26
4.8 Event 8: A319/AJET	27
4.9 Event 9: A321/A320	28
4.10 Event 10: A320/DO28	29
4.11 Event 11: A320/A310	30
4.12 Event 12: MD11/UNK	31
4.13 Event 13: A 342/B752	32
4.14 Event 14: A320/E190	33
4.15 Event 15: C25A/A321	34
4.16 Event 16: H25B/A321	33
4.17 Event 17: A319/F900	36
4.18 Event 18: B763 / A318	37
4.19 Oceanic Event 19: A343/ B77W	38
4.20 Oceanic Event 20: B77W/B767	39
4.21 Oceanic Event 21: B748/A34	40
4.22 Oceanic Event 22: A333/B77W	41

CHAPTER 5 - BARRIERS	42
5.1 Barriers as risk reduction opportunities	43
5.2 Two types of barriers	45
5.3 Barriers which may prevent a loss of separation due to ineffective conflict detection with an adjacent sector	46
5.4 Barriers which may mitigate the consequences of a loss of separation due to ineffective conflict detection with an adjacent sector	47
CHAPTER 6 - OPERATIONAL CONTEXT	48
6.1. Differentiator or not?	49
CHAPTER 7 - ANALYSIS	50
7.1. Analysis of Prevention Barriers	51
7.2. Top Potential Prevention Barriers	52
7.3. Analysis of contributing factors apparent in actual events	53
CHAPTER 8 - CONCLUSIONS	54

EXECUTIVE SUMMARY

The EUROCONTROL Safety Improvement Sub-Group (SISG), reporting to the EUROCONTROL Safety Team, was tasked to identify the Top 5 ATM Operational Safety Priorities.

SISG performed a review during summer 2012 and involved a series of dedicated workshops with 6 ANSPs, representing a large part of European air traffic.

Comprehensive barrier models – Safety Functions Maps (SAFMAPs) - were developed and populated with representative data from the participating ANSPs. The incident data is for high severity (classified as 'A' and 'B') events, which are on one side thoroughly investigated and on the other side – highly informative because the incident scenarios 'test' the majority of the available safety barriers.

As a result of the SAFMAP analysis the Top 5 priority areas were suggested, agreed by SISG and endorsed by the Safety Team:

- Risk of operation without transponder or with a dysfunctional one
- Landing without ATC clearance
- Detection of occupied runway
- "Blind spot" – inefficient conflict detection with the closest aircraft
- Conflict detection with adjacent sectors

This purpose of this report is twofold:

- To document the operational safety study on one of the Top 5 Network Manager operational safety priorities – "Conflict detection with adjacent sectors".
- To serve as a reference for the Network actors in case they undertake operational safety analysis and improvement activities for "Conflict detection with adjacent sectors".

The priorities were reviewed by SISG with SAFMAP analysis of the data for year 2013 and re-confirmed as Top 5 priorities for 2014.

The methodology employed for this operational safety study was as follows:

- Generate a set of generic scenarios that could result in a conflict with an adjacent sector event.
- Consider what barriers exist that if implemented and deployed could prevent a conflict with an adjacent sector event.
- Consider what barriers exist that if implemented and deployed could mitigate the result of a conflict with an adjacent sector event.
- Analysis of each generic scenario against the potential barriers to establish which of these barriers could be the most effective over the whole range of scenarios.
- Review a set of actual events to validate the barriers suggested by the generic analysis in the live environment.
- Review other published study data and conclusions to check upon convergence and source new information and ideas.
- Collate industry best practice in ATC training and system tools.

This study has identified five basic operational scenarios of losses of separation because of ineffective sector coordination and eight potential barriers to prevent losses of separation due to ineffective detection of conflict with adjacent sector occurrences.

This study suggests that a combination of four barriers seems to deliver the best reliable protection to prevent losses of separation due to ineffective detection of conflict with an adjacent sector:

- Predictive Separation Alert Tool (e.g. STCA) with downlinked flight deck selections.
- System Supported Coordination
- Structured Scan
- Formalised Coordination phraseology and procedures

This study identified that there are four most frequent contributing factors that influence the losses of separation because of ineffective conflict detection with adjacent sector occurrences, and that offer a good prevention potential if properly addressed:

- Early transfer of communication of traffic still within sector airspace
- Lack of coordination to next sector
- Incorrect/Insufficient plan not corrected
- Incomplete/misunderstood coordination

Recommendations are made that:

- ANSPs review the identified preventive barriers and contributory factors in case they undertake operational safety analysis and improvement activities for ineffective conflict detection with adjacent sectors.
- ANSPs and the EUROCONTROL Safety Improvement Sub-Group (SISG) monitor the occurrence of “ineffective conflict detection with adjacent sectors” events to determine changes in frequency and severity.

CHAPTER 1 - INTRODUCTION

1.1 What is the purpose of this document?

Documenting and communicating

This purpose of this report is twofold:

- To document the operational safety study on one of the Top 5 Network Manager operational – “Conflict detection with adjacent sectors”.
 - To serve as a reference for the Network actors in case they undertake operational safety analysis and improvement activities for conflict detection with adjacent sectors.
-

1.2 What are the Network Manager Top 5 ATM Operational Safety Priorities for 2013 and 2014?

Risk of operation without transponder or with a dysfunctional one

Operations without transponder or with a dysfunctional one constitute a single threat with a potential of “passing” through all the existing safety barriers up to “see and avoid”.

Landing without ATC clearance

For various reasons, aircraft sometimes land without ATC clearance resulting in Runway Incursions that are often only resolved by ‘providence’.

Detection of occupied runway

Some Runway Incursion incidents could have been prevented if controllers had had better means to detect that the runway was occupied at the time of issuing clearance to the next aircraft to use the runway.

“Blind spot” - inefficient conflict detection with the closest aircraft

Loss of separation “Blind Spot” events are typically characterised by the controller not detecting a conflict with the closest aircraft. They usually occur after an incorrect descent or climb clearance.

Conflict detection with adjacent sectors

Losses of Separation in the En-Route environment sometimes involve inadequate coordination with an adjacent sector. These typically involve either an early (premature) transfer of control to or from the neighbouring sector, or the infringement of a neighbouring sector without coordination.

1.3 How did we identify the 'Top 5'?

The Network Manager identifies Network safety issues to enable aviation stakeholders to mitigate existing hazards and anticipate new operational risks

The first step was to define broad priority areas for further prioritisation

The second step was a detailed review with SAFMAPS.

The priorities were re-confirmed for 2014

Our ultimate goal is to keep the Network safe and able to increase its capacity and efficiency.

The EUROCONTROL Safety Improvement Sub-Group (SISG), reporting to the EUROCONTROL Safety Team, was tasked to identify the Top 5 ATM Operational Safety Priorities. In 2012, the SISG followed a structured two-step process of operational safety prioritisation. Firstly SISG identified a list of priority areas.

The agreed list contains work priority areas addressing operational threats, safety precursors or undesired safety outcomes. The list includes:

- Airspace Infringement
- Runway Incursion
- Loss of Separation
- ATC sector overloads
- Level Bust
- Severe Weather Risk
- Air Ground communications
- Runway Excursion

The list of agreed priority areas contains issues that are too broad to be a part of a focussed work program. There was a need to get more "granularity" and select some of the areas for a detailed review. Based on the availability of reliable safety information, two of the risk areas were selected for detailed review:

- "Runway Incursion" and
- "Loss of Separation En-Route".

The review was performed during summer 2012 and involved a series of dedicated workshops with 6 ANSPs, representing a large part of European air traffic.

Comprehensive barrier models – Safety Functions Maps (SAFMAPs) - were developed and populated with representative data from the participating ANSPs. The incident data is for high severity (classified as 'A' and 'B') events, which are on one side thoroughly investigated and on the other side – highly informative because the incident scenarios 'test' the majority of the available safety barriers.

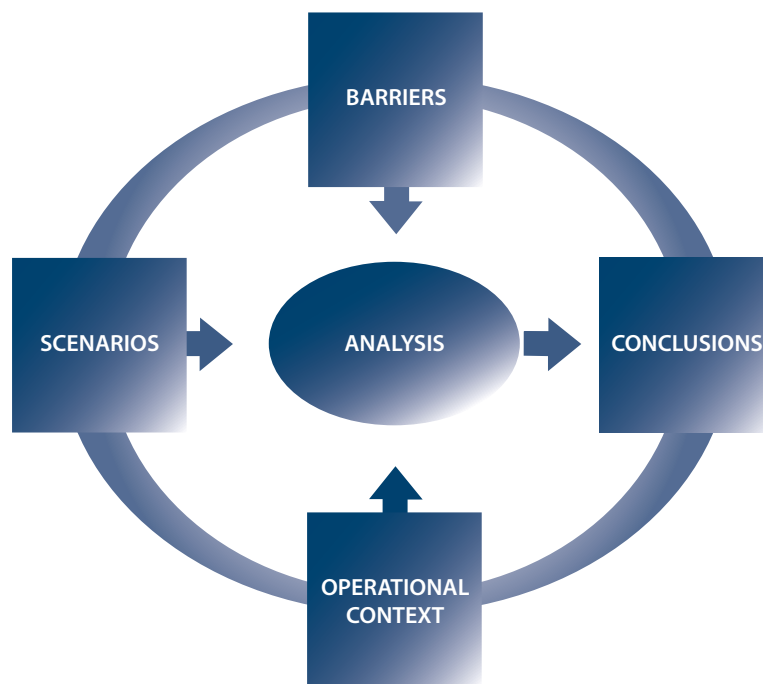
As a result of the SAFMAP analysis the Top 5 priority areas were suggested, agreed by SISG and endorsed by the Safety Team:

- Risk of operation without transponder or with a dysfunctional one
- Landing without ATC clearance
- Detection of occupied runway
- "Blind spot" – inefficient conflict detection with the closest aircraft
- Conflict detection with adjacent sectors

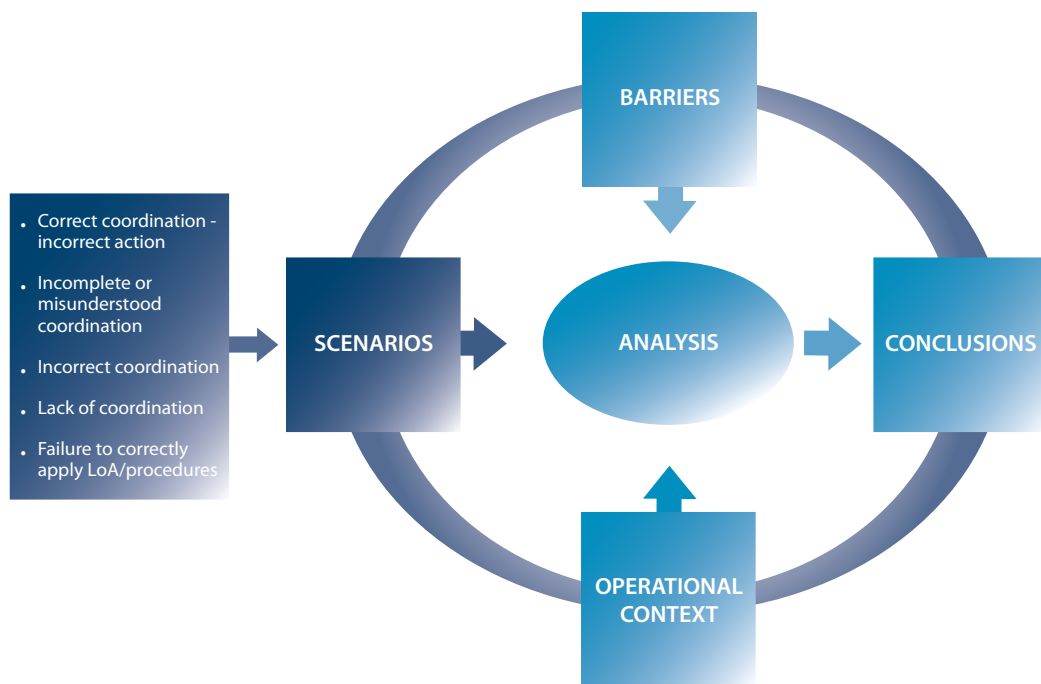
The priorities were reviewed by SISG using the same approach of analysing the high severity incident with SAFMAPs. As a result SISG re-confirmed the Top 5 priorities for 2014.

CHAPTER 2 - THE GENERIC PROCESS: OVERVIEW

The figure below provides an overview of the generic steps in the Operational Safety Study



CHAPTER 3 - GENERIC SCENARIOS



3.1 How are generic operational scenarios defined?

Combination of top-down and bottom-up approaches

Generic operational scenarios are used to help reduce the complexity of the subsequent analysis. Scenario definition is by “story telling”, specific - to help assess the effectiveness of the proposed safety barriers and generic enough - to keep their number relatively small. The scenarios draw upon two sources of information:

- A systematic analytical de-construction of each operational scenario into sub-scenarios. This is based on all theoretically possible combinations of scenario (1) sources, (2) mechanisms and (3) outcomes.
 - A review of the publicly available information from investigation reports of accidents and serious incidents investigated following the provisions of ICAO Annex 13 and confidentially provided data in respect of less significant incidents.
-

3.2 Analytical deconstruction of operational scenarios - sources

Scenario Sources identified

A review of the case study events identified five types of scenario sources (triggers) that have led to conflict with adjacent sector occurrences:

- A. Correct coordination with an adjacent sector but incorrect action** - incorrect execution of the coordination.
 - B. Incomplete or misunderstood coordination with an adjacent sector** - failure to correctly communicate the coordination.
 - C. Incorrect coordination with an adjacent sector** - failure to devise a correct, de-conflicted plan of air traffic control.
 - D. Lack of coordination with an adjacent sector** - failure to identify the need for coordination or failure to perform already planned coordination.
 - E. Failure to correctly apply Standing Agreements or procedures with adjacent sectors.**
-

A. Correct coordination with an adjacent sector but incorrect action

These events typically involve a failure to implement or achieve an agreed coordination. An example of this from the case studies concerned an aircraft entering Oceanic airspace below its clearance level. Although the crew was aware of its Oceanic entry requirements one hour before the boundary, the crew did not ask for climb and ATC left the climb too late. When the aircraft was given clearance to the Oceanic entry level it was asked if it would make it. The crew said that they would. The climb rate required was not achievable but as the boundary got closer, the crew did not inform ATC that they were in fact not going to achieve the entry level; and En-Route ATC did not inform Oceanic ATC that, from radar, the aircraft was unlikely to achieve it.

B. Incomplete or misunderstood coordination with an adjacent sector

These events typically involve poor phraseology or incomplete information, which are not challenged or confirmed. Examples in the case studies include a coordination that an aircraft was descending to FL280 "because of the 27". There were two aircraft at FL270 that could conceivably affect the flight. The recipient of the information focussed upon the wrong one. An example of poor phraseology is a coordination that included "after the A320". The recipient of this message believed that this meant that nothing would happen until after passing the A320. However, the other controller considered that the coordination meant "subject to the A320" which left him some flexibility.

C. incorrect coordination with an adjacent sector

These events fall into two categories. Some events could be classed as non-conformance. These are circumstances where coordination is agreed that is not in accordance with standard procedures; for instance agreeing on levels and tracks that are not in their sectors. The second category includes planning and decision events where the agreed coordination created an unsafe situation.

D. Lack of coordination with an adjacent sector

These events can follow on from non-conformance, failure to identify the need for coordination, forgetting to perform planned actions or from being in unusual situations such as weather avoidance. Examples from the case studies include an event where a Low sector coordinating an expeditious climb with a High sector, but forgetting to inform the Middle level sector that would be transited on the way.

E. Failure to correctly apply Standing Agreements or procedures with adjacent sectors

These events occur where there is not necessarily any individual coordination required, but Standing Agreements, Letters of Agreement or local procedures dictate the actions required. This can typically be something like a requirement to be at a level 10 NM before an airspace boundary, in order to pass above a block of airspace. Coordination is by exception, to vary the agreed procedure.

3.3 Analytical deconstruction of operational scenarios - mechanism

Only one Scenario Mechanism

The mechanisms as a scenario element describe how the scenario trigger together with the contextual conditions and other contributing factors to result in losses of separation with adjacent sector.

In the case of the loss of separation with adjacent sector occurrences the mechanism can be reduced to only one – conflicting trajectory of aircraft. This is because each of the scenarios ultimately results in a loss of separation and conflicting trajectory of aircraft is a necessary but not sufficient condition for it.

The contributing factors are not mutually exclusive and they may be dependent. Here is a list of some identified contributing factors:

Non exhaustive list of contributing factors

- Recent hand-over, sector split or sector collapse impacting the quality of the mental ‘traffic picture’.
 - Sector skipping/ jumping.
 - Early transfer of control/communication.
 - Incorrect/Insufficient plan
 - Not monitoring incorrect/insufficient plan
 - Controller workload issues – high workload or under-load.
 - Coordination phraseology and procedures
 - Obscured track labels – (1) other colour and intensity for tracks that are still within the controlled airspace but that are not anymore, or are still not, under control of the sector or (2) overlaps of the track labels, or a track label and other information, that make some of the information partially or completely obscured.
 - Inadequate frequency change.
 - Inadequate conflict resolution decision.
 - Inadequate air-ground communications.
-

3.4 Analytical deconstruction of operational scenarios - outcomes

Scenario Sources identified

Three scenario outcomes were identified:

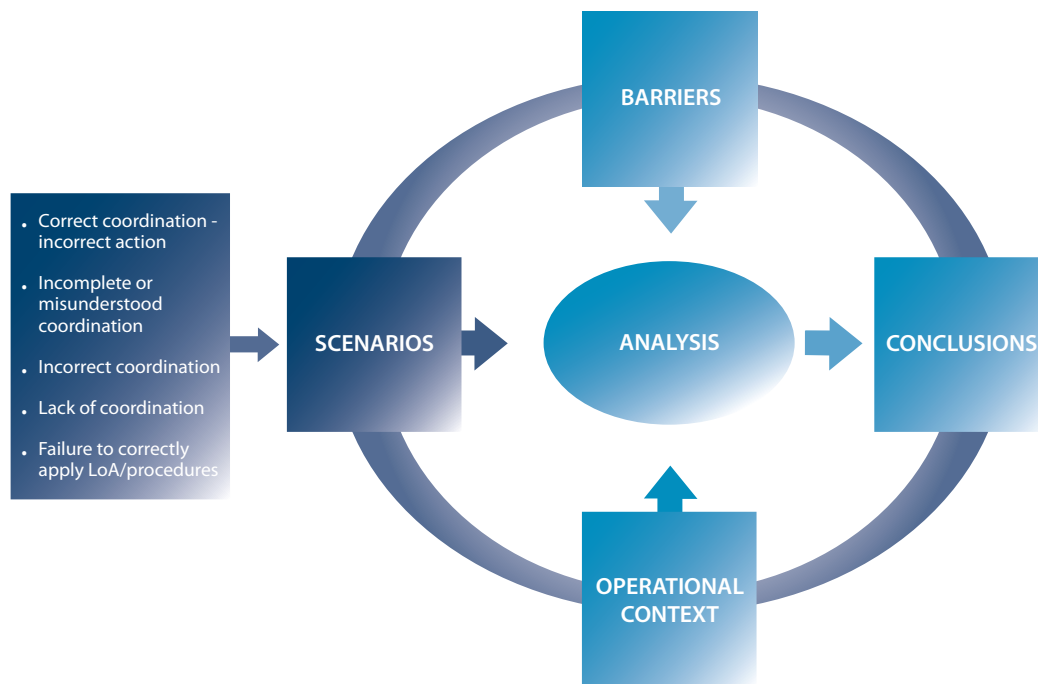
1. Loss of separation in which the controller with executive control for the sector is working both aircraft.
 2. Loss of separation in which the controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 3. Loss of separation in which the controller with executive controller for the sector is not working either of the aircraft.
-

3.5 The list of operational scenarios

The resulting list of generic operational scenarios for analysis

-
- A1** Loss of Separation due correct coordination with an adjacent sector but incorrect action. The controller with executive control for the sector is working both aircraft.
 - A2** Loss of Separation due correct coordination with an adjacent sector but incorrect action. The controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 - A3** Loss of Separation due correct coordination with an adjacent sector but incorrect action. The controller with executive controller for the sector is not working either of the aircraft.
 - B1** Loss of Separation due incomplete or misunderstood coordination with an adjacent sector. The controller with executive control for the sector is working both aircraft.
 - B2** Loss of Separation due incomplete or misunderstood coordination with an adjacent sector. The controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 - B3** Loss of Separation due incomplete or misunderstood coordination with an adjacent sector. The controller with executive controller for the sector is not working either of the aircraft.
 - C1** Loss of Separation due incorrect coordination with an adjacent sector. The controller with executive control for the sector is working both aircraft.
 - C2** Loss of Separation due The controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 - C3** Loss of Separation due incorrect coordination with an adjacent sector. The controller with executive controller for the sector is not working either of the aircraft.
 - D1** Loss of Separation due lack of coordination with an adjacent sector. The controller with executive control for the sector is working both aircraft.
 - D2** Loss of Separation due lack of coordination with an adjacent sector. The controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 - D3** Loss of Separation due lack of coordination with an adjacent sector. The controller with executive controller for the sector is not working either of the aircraft.
 - E1** Loss of Separation due failure to correctly apply Standing Agreements or procedures with adjacent sectors. The controller with executive control for the sector is working both aircraft.
 - E2** Loss of Separation due failure to correctly apply Standing Agreements or procedures with adjacent sectors. The controller with executive control for the sector is only working one aircraft but with immediate means to co-ordinate resolution with the other controller.
 - E3** Loss of Separation due failure to correctly apply Standing Agreements or procedures with adjacent sectors. The controller with executive controller for the sector is not working either of the aircraft.
-

CHAPTER 4 - ACTUAL EVENTS



4.1 Event 1: B777/C510

This event involved staff on 4 different sectors. Sector X controlled up to FL300. The sector was very busy, partially due to a European football match taking place in the capital. A northbound B777 was level at FL300 had been under the control of Sector X but had been transferred early to the next sector northbound, Sector Y.

Sector T to the west of Sector X had an eastbound C510 in the climb to FL300 requesting FL330. Sector T co-ordinated the C510 with Sector Z, which controlled from FL310 upwards at FL300, with the expectation of an early climb. Note that FL300 was not a level available for him to offer.

Sector T changed the electronic sequence from Sector X to Sector Z. Sector X Planning controller approved the plan but did not record the C510 as known traffic. This meant that the radar plot of the C510 remained greyed out (unconcerned) in the background of the Sector X Radar controller's display, who was unaware of the flight.

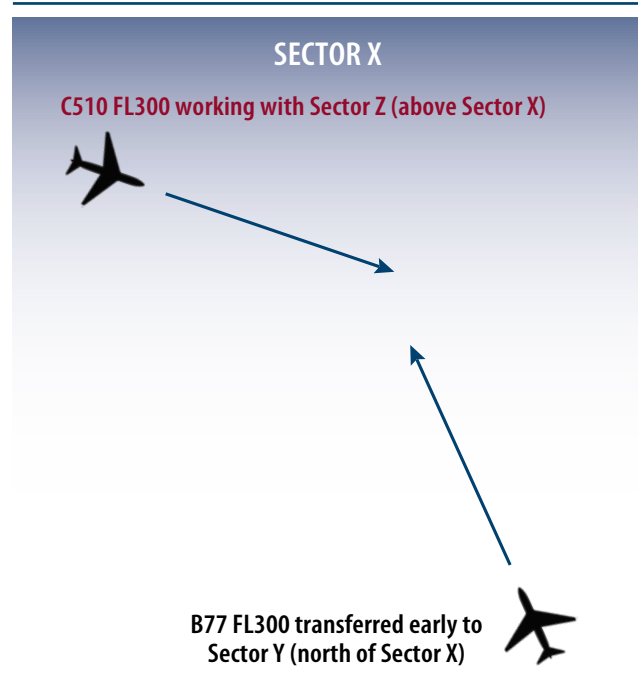
The Radar controller on Sector Y (talking to the B777 still in Sector X) airspace) was unaware of the C510. It was not in his sector and in the background/unconcerned.

The Radar controller on Sector Z (talking to the C510 still in Sector X airspace) was unaware of the B777. It was not in his sector and in the background/unconcerned; he assumed that Sector X knew about the C510.

The Radar controller in Sector X in whose airspace the event was about to happen was not talking to either aircraft. He was unaware of the C510 and had given away control of the B777.

The conflict was observed by the Sector T radar controller who alerted the Sector Y Planner. The Sector X Planner overheard this conversation and alerted the Sector Z Planner. Both alerts were thus passed to Planning controllers, not to the ones actually controlling the aircraft i.e. the Radar controllers.

A turn and a climb were given to C510 and an Avoiding Action turn was given to the B777.



Generic Scenarios

C. Incorrect coordination

Contributing Factors

Handovers had taken place on two of the Sectors X within a 5-6 minute period before the incident took place.

Sector T co-ordinated a level with Sector Z which was actually in Sector X airspace

Sector X Planner aware of C510 but did not carry out correct actions, so Radar Controller was not aware of traffic in his sector. Label in a background colour.

Sector X transferred the B777 very early to Sector Y thus losing executive control on an aircraft in the middle of the sector.

Sector Y controller (working the B777) assumed that Sector X was aware of both aircraft – both of which were in the background to him.

Sector Z controller (working the C510) believed that Sector X Planner would act correctly, so X Radar would be aware of both aircraft.

Sector X controller who had executive control of the airspace was not talking to either aircraft and unable to resolve.

Sector jumping between T and Z to get above X.

Conflict Resolution was initiated and agreed between Planners who then had to repeat instructions to the Radar controllers.

4.2 Event 2: B734/B1

This is similar to Event 1 in that the incident took place in a Sector whose controllers were not in contact with either aircraft. The incident took place in Sector C's airspace, which controls FL175-FL215. Sector C cleared the B734 northbound to FL190 and transferred it to Sector M, which was the adjacent sector to the north and also limited from FL175-FL215. The B734 was still Sector C airspace when Sector M cleared it to climb to FL210.

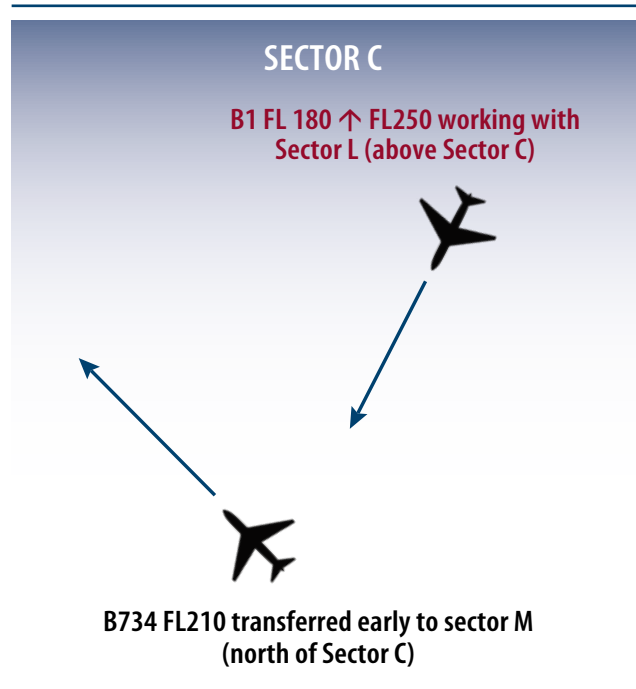
The B1 departed from a military base outside of Controlled Airspace and was cleared to join CAS at FL180 by Sector E (to the east) near the boundary between Sector E and Sector C. Sector E agreed a co-ordination with Sector L, which sits above Sectors C and M controlling FL215 – FL305. The co-ordination was at FL240. The intention was for the B1 to climb sufficiently well to jump Sector C and go direct to the higher Sector L.

Note: the plan was incorrect as it would not be possible to enter CAS at FL180 and then almost immediately be at FL240 for Sector L without encroaching on Sector C.

When it came on the Sector E frequency the B1 was immediately cleared to FL240 and transferred on to Sector L, who gave it further climb to FL250. The B1 was bound for a destination 3000 nm (5000km) away and therefore the climb performance was over-estimated. The climb rate of the B1 was approximately 500ft per minute. No coordination or traffic information was given to Sector C.

When Sector M (to the north) cleared the B734 from FL190 to FL210, the B1 was 27 nm ahead passing FL203. Just over a minute later Sector E phoned Sector C, in whose airspace both aircraft were now in, asking if they were working the B734. The response was "No, it's with Sector M, who's that (B1 callsign)?" Sector E advised that it was climbing really slowly and talking to Sector L. Sector C rang Sector M and then rang Sector L.

Sector M passed traffic information to the B734 and gave an avoiding action descent and left turn (the B1 being in its 1 o'clock position). The B734 responded with a TCAS RA. STCA triggered during this conversation with both aircraft at FL210 and 5nm apart. The Sector L controller twice instructed the B1 to expedite climb but no response was received. The B734 responded to Descent RA, the B1 did not carry TCAS. Minimum separation was recorded as 600ft vertical as the aircraft came within 3 nm of each other.



Generic Scenarios

C. Incorrect coordination

Contributing Factors

Sector C transferred the B734 very early to Sector M thus losing executive control on an aircraft in the middle of the sector.

Sector E controller considered that the B1 would reach the co-ordinated level with Sector L but did not monitor the climb rate of the B1 to ensure the co-ordination would be met.

Sector E plan was incorrect as it would not be possible to enter CAS at FL180 and then almost immediately be at FL240 for Sector L without encroaching on Sector C.

Sector E did not advise Sector C of the B1 flight so that they could be aware of the plan.

Sector C controller who had executive control of the airspace was not talking to either aircraft and unable to resolve.

Sector Jumping by E to L to get above C.

4.3 Event 3: GLF5/DH8D

The standard routing for the GLF5 from a TMA airfield was to remain at the Minimum Stack Level (FL70) until passed all of the TMA North's traffic and then be transferred to TMA South. For reasons of customer service and professional challenge, this is rarely done. Such aircraft are normally given expedited climb to get above all of the TMA traffic and passed to the En-Route sector. However in order to do this, co-ordination must be completed with 4 separate sectors.

The GLF5 had been under the control of TMA North whose Coordinator agreed an acceptance level of FL190 with En-Route Sector D. This co-ordination was correctly recorded on the strip for the Radar Controller who climbed GLF5 to FL190 on a heading of 160° and transferred it to Sector D.

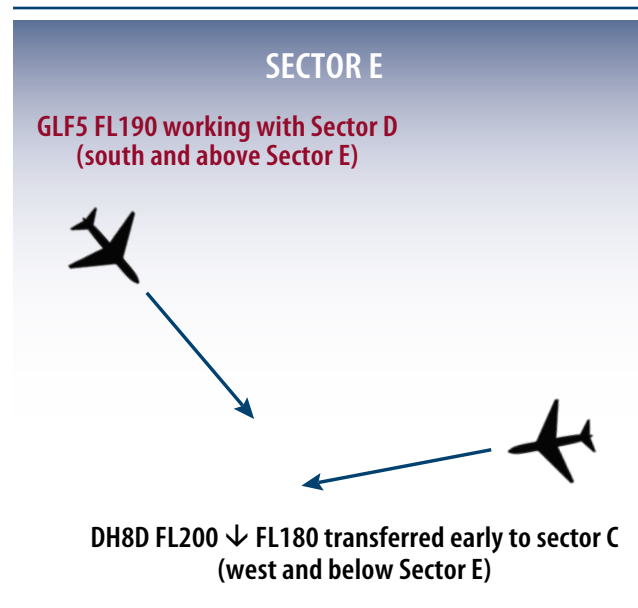
The DH8D was westbound under the control of Sector C descending from FL210 to FL180. It was actually still in TMA East airspace but had been transferred early and released for descend. Both TMA East and Sector C would have been involved in the co-ordination for the GLF5 had it have taken place.

Neither Sector E nor Sector C was aware of the presence of the GLF5. Sector D was unaware of the presence of the DH8D as traffic from TMA should be transferred "clean".

STCA triggered and Sector C turned the DH8D left onto 180° and requested it to stop descend. The pilot executed the turn but obeyed the TCAS resolution to climb.

The pilot of the GLF5 reported to Sector D: '(callsign) is in a deviation for traffic off the nose'. The controller asked him to confirm that it was responding to a TCAS instruction, to which the GLF5 affirmed. Minimum separation was 2.3nm / 600ft. TC North Coordinator reported that he had coordinated a series of departures with Sector D at levels above the normal standing agreed level. He was aware that this would require further coordination with 4 sectors but did not do this immediately as the aircraft had only recently departed and was still low level. He then became involved in a discussion within the team controller regarding aircraft STAR change before handing over position to another controller. He reported that during the handover he had 'missed' GLF5 and did not realise or pass on that coordination needed to be done.

The GLF5 transited TMA EAST airspace without TMA EAST controller's knowledge and subsequently came into conflict with DH8D which had been transferred early to Sector C, released for descent within TMA EAST airspace.



Generic Scenarios

D. Lack of coordination with an adjacent sector

Contributing Factors

TMA NORTH coordinator did not advise Sectors E, C that a higher than standard level had been coordinated for GLF5 with Sector D which would require the aircraft to transit through their airspace.

TMA NORTH coordinator became distracted by other sector tasks before completing the required coordination sequence.

TMA North co-ordinator handed over his task to another controller without mentioning the GLF5

Sector D was unaware of the DH8D being in receipt of a "correct co-ordination" and expected the aircraft to be clear of conflicts on handover.

Sector E controller who had executive control of the airspace was not talking to either aircraft and unable to resolve

Sector E controller had transferred the DH8D to Sector C early in order to facilitate continuous descent.

Sector skipping by NORTH to D through E and C

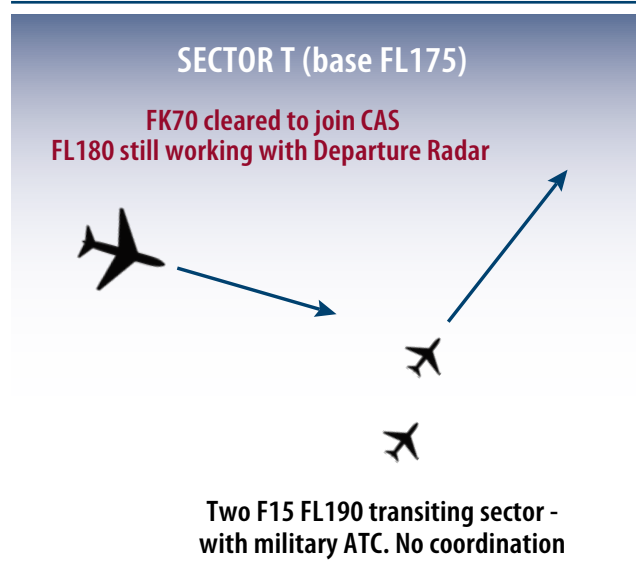
4.4 Event 4: FK70/FK15

Airport A was given a joining clearance for a FK70 to join CAS (base FL175) climbing FL180 by Sector T. A military controller was working a pair of F15's crossing the airway at FL190. Standard procedure requires that the Military either co-ordinate a level with Sector T or provide at least 5nm or 5000ft separation. No coordination was made for the crossing. Sector T, on observing the developing situation and talking to neither aircraft; attempted to call both Airport A and the military controller but without answer. Airport A had retained the FK70 on their frequency and called the Military when the aircraft were 3nm & 2600ft apart and identified the crossing traffic but no formal coordination took place.

A loss of separation occurred when the FK70 entered CAS at FL175 passing behind the F15s. The FK70 first called Sector T when separation had already been regained.

The Military Supervisor reported that the MIL Controller coordinated with Airport A and that they thought Airport A would pass the coordination on to Sector T. The Supervisor also mentions that the MIL Controller was very busy with a number of late calls from aircraft and that a second support Controller has just plugged in.

The Airport A controller could have reasonably assumed that the clearance had been issued by Sector T with due consideration given to the crossing traffic. However as the crossing traffic wasn't mentioned during the issuing of the clearance, the Airport A controller took additional steps to check with the Military. Whilst waiting for the Military to answer, the call from sector T was missed.



Generic Scenarios

D. Lack of coordination with an adjacent sector

Contributing Factors

Military controller forgot to co-ordinate the airway crossing with Sector T

Excessive Workload

Resolution - Military did not attempt to co-ordinate on becoming aware

Sector T controller who had executive control of the airspace was not talking to either aircraft and unable to resolve

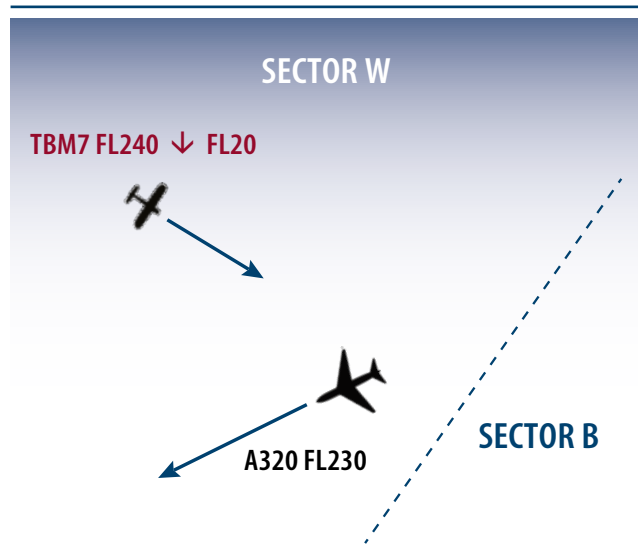
4.5 Event 5: TBM7/A320

TBM7 was heading southeast at FL240 and requested descent after the initial call on sector B frequency. The flight was still in Sector W airspace but Sector B cleared it to descent to FL220 shortly before overflying the sector boundary and came close to an A320 at FL230. This flight was in unconcerned/background state for Sector B being still with Sector W. In addition its track label was partially obscured by the stronger label of the TBM7.

Sector B Planner coincidentally had shifted the label of TBM7; hence, he detected A320 below TBM7. Subsequently, he informs the Radar Controller that there is another a/c below. The Radar Controller was so surprised that he, to solve the conflict, mistakenly re-cleared TBM7 to the same level as A320, maintaining FL230. The sector B controller did not comply with standard procedures as he did not have permission to amend the flight level of the TBM7 whilst it was still in Sector W airspace. Transfer of communication had taken place but transfer of control was at the sector boundary.

The separation gets to its recorded minimum with 3.7NM and 800ft.

Sector B Planner was the only ATCO who had detected the incident by chance. Sector W controller stated during a short telephone call that neither he nor his planner did recognize the loss of separation because of the redundant state of TBM7 and because the STCA did not highlight the incident. Because of the specification of the STCA no alert was triggered; hence, it worked as defined.



Generic Scenarios

E. Failure to correctly apply Standing Agreements or procedures with adjacent sectors

Contributing Factors

Early transfer to Sector B whilst in Sector W airspace.

Because both aircraft was still in previous sector's airspace, the track labels were suppressed

Sector B descended the TBM7 in another sector's airspace without co-ordination.

Routine team non-conformance

Lack of defensive controlling – transferring the TBM7 (known to be wanting descent) to next sector, knowing that there was conflicting traffic if Sector B descended early.

4.6 Event 6: B738/A319

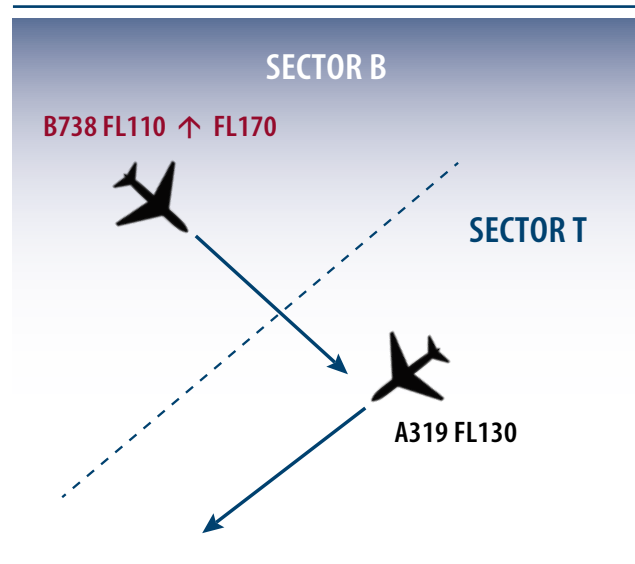
The Sector B controller climbed the B738 out of FL100 to FL170 for the En-Route Sector D that is above Sector T. He forgot about that the A319, under the control of the Sector T controller, was on a crossing track at FL130. The A319 had been issued with a direct routing, which had been co-ordinated with Sector B as it would track closer to the boundary as usual. The Sector B controller forgot about this co-ordination.

The Sector T controller alerted the controller to the confliction. Both controllers issued avoiding action in order to resolve the confliction.

The Sector B Controller instructed B738 to turn left onto a heading of 125° and then to climb to FL170. The A319 was 15 miles away in its 11 o'clock crossing left to right.

The Controller stated that there were 4 other aircraft and their track labels, at various levels in that 15 mile area.

STCA activated. Both controllers gave Avoiding Action turns. Minimum separation was 2.4 Nm and 400 feet.



Generic Scenarios

A. Correct coordination with an adjacent sector but incorrect action.

Contributing Factors

Personnel- memory. The Sector B controller forgot about the previous co-ordination.

Personnel – Visual perception – The Sector B controller did not see the traffic in Sector T

Track labels garbling obscured the traffic in Sector T

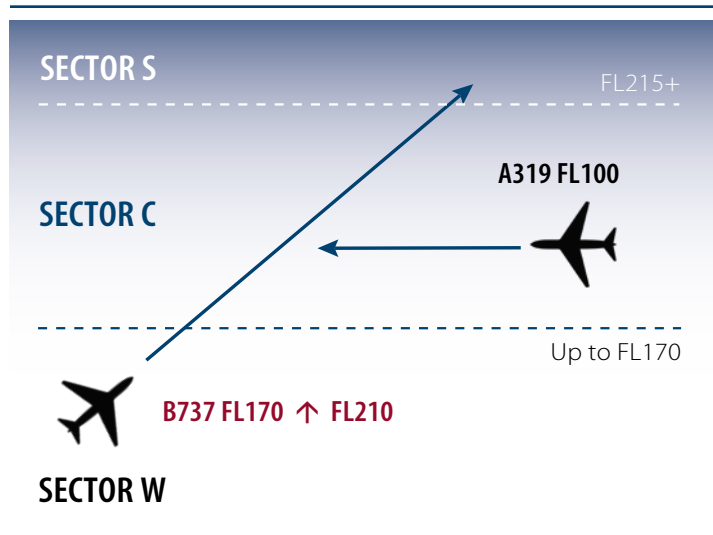
Sector jumping by B to get above T

4.7 Event 7: B7370/A319

Sector W controller climbed B737 to FL170 in accordance with the standing agreement but mistakenly transferred it to Sector S instead of Sector C, which was in between. Up to 4 weeks previously, Departures were transferred from Sector W directly to Sector S at FL170 and climb above this level before Sector S airspace required co-ordination with Sector C. Revised procedures were then introduced whereby this traffic was to be transferred from Sector W to Sector C at FL170 and climbed by Sector C to FL210 before transfer to Sector S.

The Sector S controller instructed the aircraft to climb in the belief it had been transferred from Sector C but did not notice the reported cleared level before doing so. Separation was lost against an A319 which was under the control of Sector C at FL180.

The Sector C controller stated that he was expecting B737 to contact him under the terms of the standing agreement. Having instructed the A319 to descend to FL180 he then observed the mode S Selected Flight Level readout of B737 change to indicate it was climbing to FL230. The controller immediately instructed A319 to turn right in order to ensure B737 would pass behind, and then made a telephone call to Sector 18 warning of the error.



The Sector S instructed B737 to turn right onto a heading of 180 degrees.

Minimum separation was recorded as 3.2NM / 300'.

The Sector S Planner reported that he did not hear B737 check in on the frequency or the Radar controller issue a climb clearance.

The pilot of A319 reported on the ATC frequency receipt of a TCAS TA warning and sighted the conflicting aircraft passing behind. No report was made by the pilot of B737.

Generic Scenarios

E. Failure to correctly apply Standing Agreements or procedures with adjacent sectors.

Contributing Factors

Long Term Memory – The Sector W controller temporarily forgot that the procedure had changed 4 weeks ago.

Auditory Perception – The Sector S did not notice that the B737 checked in climbing to FL170 rather than the expected FL210.

Procedures – The sequence of sectors and frequencies for departures changed 4 weeks prior to the event.

Recovery – The Sector C controller saw the Mode S intended level information for the B737 change and resolved the situation.

4.8 Event 8: A319/AJet

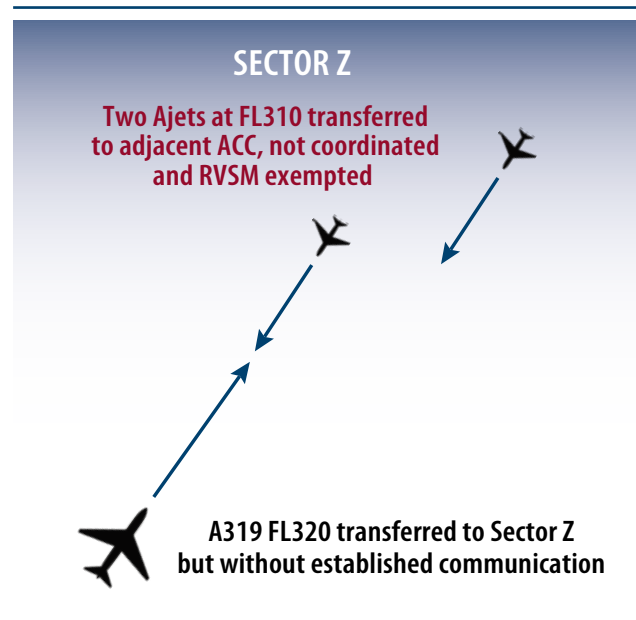
Loss of separation between an A319 and an Alpha-Jet due to the coordination performed by Sector Z when transferring 3 AJets on separate clearances to adjacent centre.

Sector Z controllers only provided the level of one AJet at FL270 without informing adjacent ACC that the other two AJets were established at FL310. The AJets were also RVSM exempt and so 2000ft vertical separation should have been applied; this was not stipulated in the co-ordination.

Sector Z controller believes incorrectly adjacent ACC has estimated times from all traffic, ACC knew only about the one at FL270, not the two at FL310.

The A319 was opposite direction at FL320. It was handed over to Sector Z but did not establish radio contact with the Sector when entering airspace. Sector Z called traffic twice. The AJets whilst in Sector Z airspace had been transferred to adjacent ACC.

The AJet was displaying FL311, thus the A319 passed 900ft above it.



Generic Scenarios

D. Lack of coordination with an adjacent sector.

Contributing Factors

Action – Sector Z did not co-ordinate the 2 AJets at FL310 with adjacent ACC.

Action – Sector Z did not inform adjacent ACC that the AJets were RVSM exempt.

Decision – AJets were transferred early to adjacent ACC whilst still in Sector Z airspace.

Action – Pilot of A319 was transferred to Sector Z but did not call at boundary or listen out.

Recovery – The controller with executive control in the airspace was not talking to either aircraft.

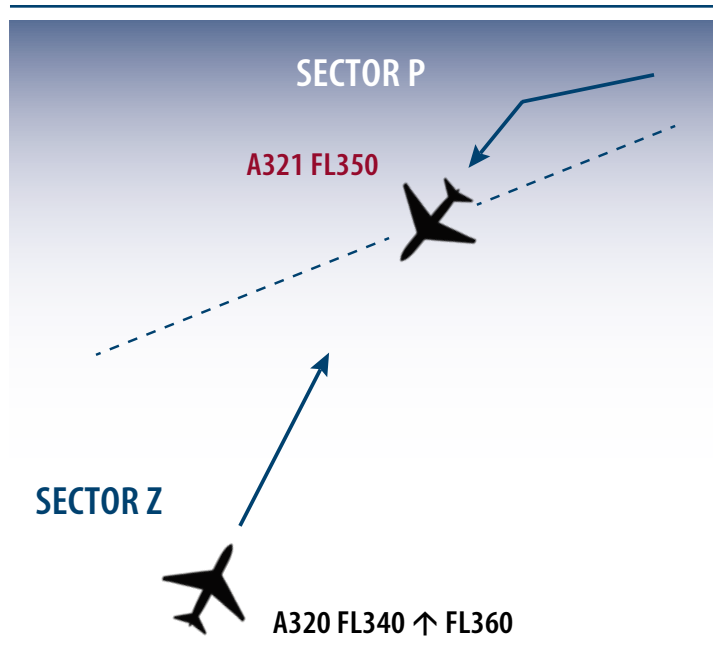
4.9 Event 9: A321/A320

Heavy storms forced the deviation of numerous traffic. The A321 was southbound at FL350, flight planned to enter ACC airspace into Sector Z. Instead of it, A321 entered the ACC airspace with heading 230° under Sector P control. The adjacent ACC had transferred the A321 to Sector P without previous coordination. To avoid storm front, A321 requested a change of course to heading 210°. This new heading made the A321 turn back into sector Z; however, it was not transferred to Sector Z, keeping communications with Sector P.

The A320 was climbing to FL 360 northbound (opposite direction to the A321) in contact with Sector Z. Sector P, seeing the conflict, requested Sector Z to stop the A320 at FL 340, but without specifying the reason. Once the A320 was free of conflict with another aircraft (not involved in the incident), it requested to resume climbing to FL360 again. Sector Z tried to coordinate A321 transference with Sector P, without being answered due to the high communication workload.

In spite of being unsuccessful, and not having A321 on frequency, Sector Z authorized A320 to continue climbing at FL360, crossing A321 flight level (at FL350). Both traffic were flying at almost reciprocal headings.

Once Sector Z authorized A320 to climb, a new request was made to transfer the A321 from Sector P. The A321 received a wrong frequency from Sector P. It was not in contact with any sector and could not be instructed to avoid the conflict. Sector Z turned the A320 but it was insufficient to avoid the loss of separation. A321 and A320 followed TCAS RA (ascending and descending).



Generic Scenarios

D. Lack of coordination with an adjacent sector.

Contributing Factors

Action – Adjacent ACC transferred A321 to Sector P without co-ordination.

Action – Sector P allowed A321 to enter Sector Z without co-ordination.

Action – Sector P conveyed incomplete information, asking for the A320 to be stopped at FL340 but not the reason.

Decision – Sector Z incorrectly decided to climb the A320 despite not having the now known conflicting traffic under its control.

Action – Sector P conveyed incorrect information (RTF frequency) to the A321.

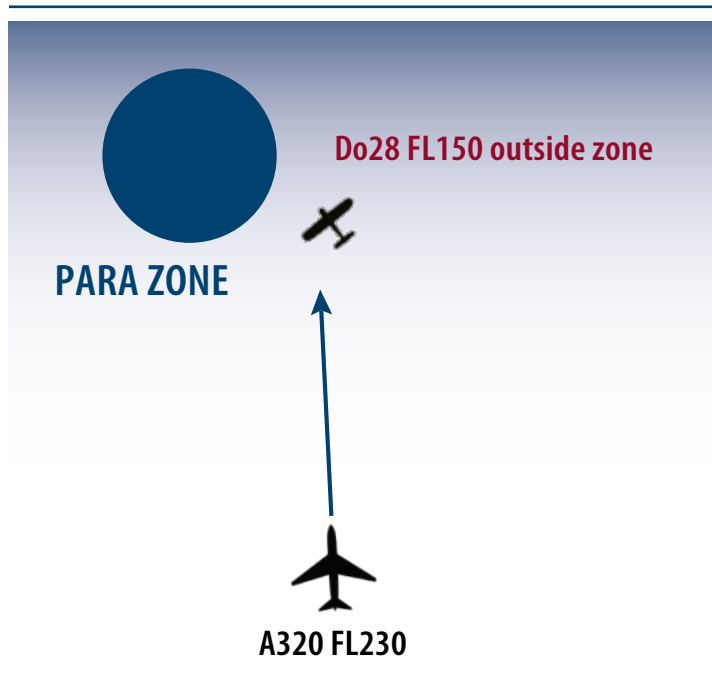
Recovery – Sector was only working one of the aircraft in its sector.

4.10 Event 10: A321/B763

Inadequate separation between a Do28 operating VFR drop parachutists and an A320 climbing south to north through the area. The Paradrop area was NOTAM'd active up to FL150. An A320 was heading northbound towards the parachuting zone, and climbing to FL200. The A320 was initially controlled by Sector A and then transferred to Sector B.

Neither sector informed the control authority for the paradropping zone (Unit N) about the A320, so the Do28 was unaware of the A320. Sector B assumed that Sector A had co-ordinated with Unit N, hence it's routing and climb profile heading for the NOTAM'd Zone.

Conflict Alert triggered when aircraft were 6.8 NM apart and the A320 600 ft. below. The Do28 was outside of the zone but ATC decided that the trajectories were such that no collision avoidance was necessary. Minimum separation between traffic was 2.2 NM and 0ft.



Generic Scenarios

D. Lack of coordination with an adjacent sector.

Contributing Factors

Action – Sector A did not inform Unit N of the A320.

Planning – Sector B plan was based on assumption that Sector A had co-ordinated with Unit N.

Planning – Sector B plan did not ensure adequate separation from paradrop zone.

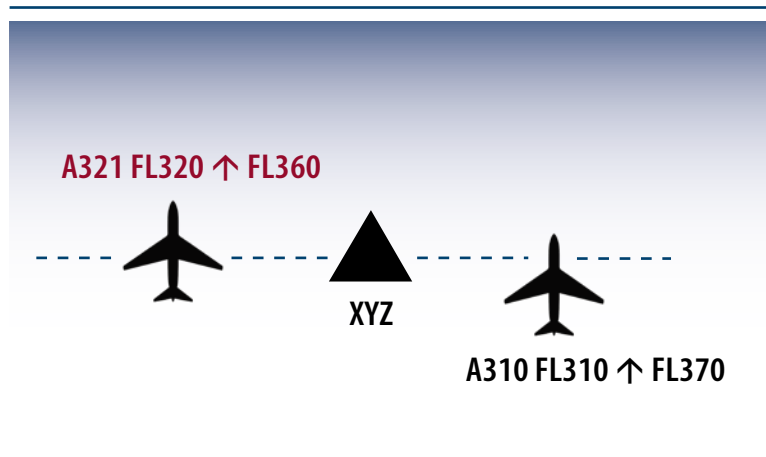
Pilot Actions – The Do28 did not stay within the confines of the zone.

4.11 Event 11: A320/A310

Both aircraft are northbound on the same airway. Adjacent ACC calls Sector A to coordinate the A320 over XYZ, climbing to FL370. The adjacent ACC then calls Sector A with revision re the A320 climbing only to FL320, and additional coordination, an A310 over XYZ same time, climbing to FL310.

Adjacent ACC next calls Sector A to inform that the A320 is to continue climb to FL370 and the A310 (the lower one) is to continue climb to FL380. Sector A points out that this would entail the A310 climbing through the level of the A320. Sector A asks Adjacent ACC to transfer aircraft at original coordinated levels and transferred to Sector A for further climb.

Both aircraft pass XYZ at approximately the same time. The A310 calls Sector A first reporting over XYZ, passing FL345 climbing to FL370 (neither FL310 as coordinated nor FL380 as previously suggested). Sector A clears the A310 to continue climb to FL370 in the belief that the A320 must be going to FL380.



The A320 then calls Sector A reporting over XYZ, climbing to FL360 (neither FL320 as coordinated nor FL370 as suggested). Sector A instructs the A320 to maintain FL340 due to traffic 1000 feet above. No restrictions had been imposed on the climb rates of either of the two aircraft. Minimum vertical distance between aircraft was 900 feet. Horizontal distance was 2.7nm.

Generic Scenarios

A. Correct coordination with an adjacent sector but incorrect action.

Contributing Factors

Non-conformance – Adjacent ACC agreed a co-ordination and then apparently disregarded it.

Non-conformance – Adjacent ACC did not comply with requested solution from Sector A.

Non-conformance – Adjacent ACC transferred aircraft to Sector A going to unsafe levels without ensuring separation.

4.12 Event 12: MD11/UNK

Sector A en-route radar is off the air for routine maintenance, entailing loss of low coverage to the west of Sector A. The Letter of Agreement between the Adjacent ACC and Sector A lays down that aircraft departing from main airport in Adjacent ACC, a short distance from XYZ (on FIR boundary), will be coordinated climbing to FL230, while inbounds to same airport transiting from Sector A to Adjacent FIR will be coordinated over XYZ descending to FL240.

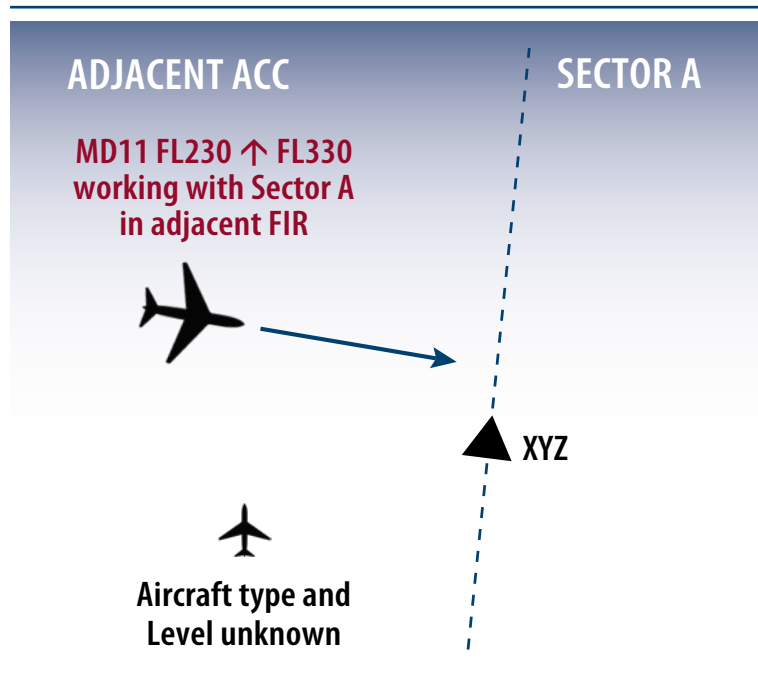
A MD11 calls Sector A passing FL200, climbing FL230, requesting FL350, en-route to XYZ and released for climb by Adjacent ACC. Sector A tells the MD11 to stand by for radar contact and to climb to FL350 on track XYZ.

The Adjacent ACC calls Sector A Coordinator saying: "The MD11, I gave you the traffic by mistake, please only 230 and give me in contact. I have converging traffic climbing." Sector A Coordinator: "230, 230 climbing", and "He is released to us?"

Adjacent ACC: "No, no, only level 230 and give me the traffic again in contact and give me higher level, please"

Sector A: You can have FL330

Adjacent ACC: "330, OK, 230 and we give him level 330 later after traffic. Give me traffic."



Sector A (Executive ATCO) instructs the MD11 to contact Adjacent ACC again and stop climb FL330. This is readback correctly by the MD11. Sector A Coordinator corrects the Sector A Executive ATCO, and the latter attempts to call the MD11 with a stop climb FL230 instruction. Sector A Executive ATCO calls the MD11 another nine times, but to no avail. It is not known what was the level of the conflicting traffic and no details of an event are forthcoming from the Adjacent ACC. For some reason, the MD11 got transferred from the Adjacent ACC to Sector A. It is not known if Adjacent ACC actually asked the MD11 to contact Sector A, or the aircraft misunderstood the transfer.

There was a misunderstanding in communication between Sector A Executive ATCO and Sector A Coordinator regarding the restriction imposed by Adjacent ACC before the aircraft was returned to Adjacent ACC.

Generic Scenarios

B. Incomplete or misunderstood coordination with an adjacent sector.

Contributing Factors

Early transfer to Sector A from Adjacent ACC

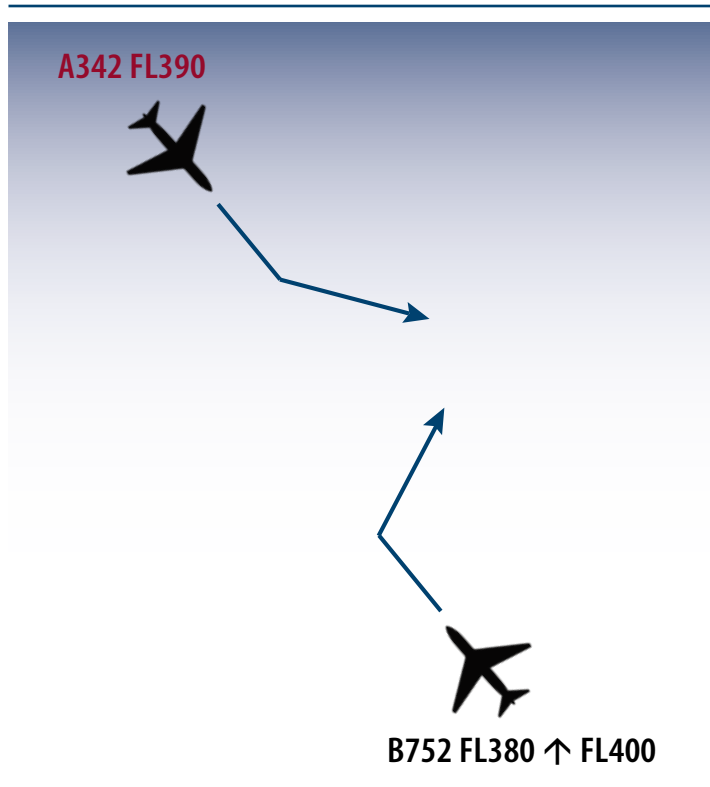
Perception – Sector A ATCO have different understanding of the co-ordination agreed between Adjacent ACC and Sector A Coordinator.

4.13 Event 13: A 342/B752

An A342 is southbound with Sector H at FL390. It is given a direct route to a waypoint and it turns some 20°. Sector H transfers a northbound B752 early to Sector U at FL380. Sector U is unaware of the direct route given to the A342 and climbs the B752 to FL400.

STCA triggered and both controllers gave avoiding action turns. Unfortunately, Sector H turned the A342 left and Sector U turned the B752 right, towards it.

The A342 reports a TCAS-RA. Sector U instructs the B752 to increase its rate of climb. The B752 reports visual with the A342.



Generic Scenarios

D. Lack of coordination with an adjacent sector.

Contributing Factors

Early transfer of the B752 to Sector U.

Sector H did not inform Sector U that the A342 had been given a direct route.

Sector H did not monitor the B752 whilst it was still in its airspace and thus did not detect the conflict.

Recovery – separate controllers took independent action which made the situation worse.

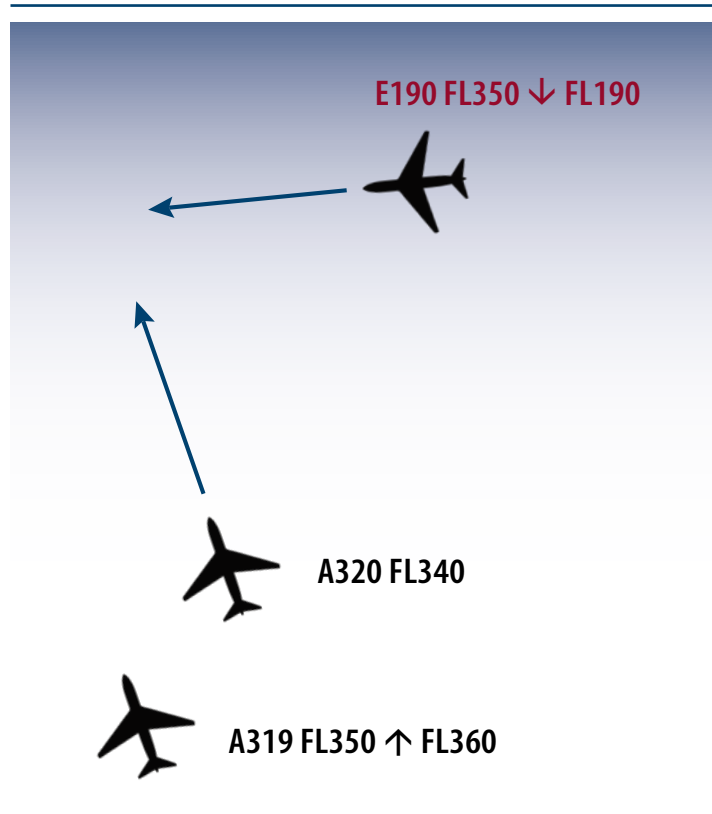
4.14 Event 14: A320/E190

Sector L transferred a northbound A319 to the higher Sector H at FL320 because there was no more conflicting traffic for A319 in sector L. Sector H asked Lower Sector L for the attribution of a FL for the northbound A319 and FL360 is agreed.

Sector H then asks sector L for a FL for a westbound E190 at FL350 because there is a conflicting situation with other FL350 traffic and the E190 needs descent soon anyway. Sector H adds that they will descend E190 “after” the A319. Sector L gives FL300 to Sector H for E190. Unknown to Sector H there is an A320 ahead of the A319, on the same track at FL340. Sector L Coordinator did not mention this traffic as “after the A319” meant that the A320 would be ahead and not conflicting traffic. The Sector H coordinator however believed that “after the A319” meant subject to the A319.

E190 requests Sector H for descent because of turbulence. The Sector H controller decides to approve the request as it would solve the situation with the A319 sooner. Sector H clears E190 for FL300. He does not see the A320 at FL340.

STCA triggers between the E190 and the A320. Sector H turns the E190 right and Sector L instructs the A320 to descend to FL320. The A320 however reports “TCAS climbing”. On Sector H the E190 also reports TCAS RA.



Generic Scenarios

B. Incomplete or misunderstood coordination with an adjacent sector.

Contributing Factors

Early transfer of traffic and co-ordination of climb whilst still in airspace.

Inadequate Co-ordination – ambiguous phraseology.

Perception – Sector H did not see the unknown conflicting traffic.

4.15 Event 15: C25A/A321

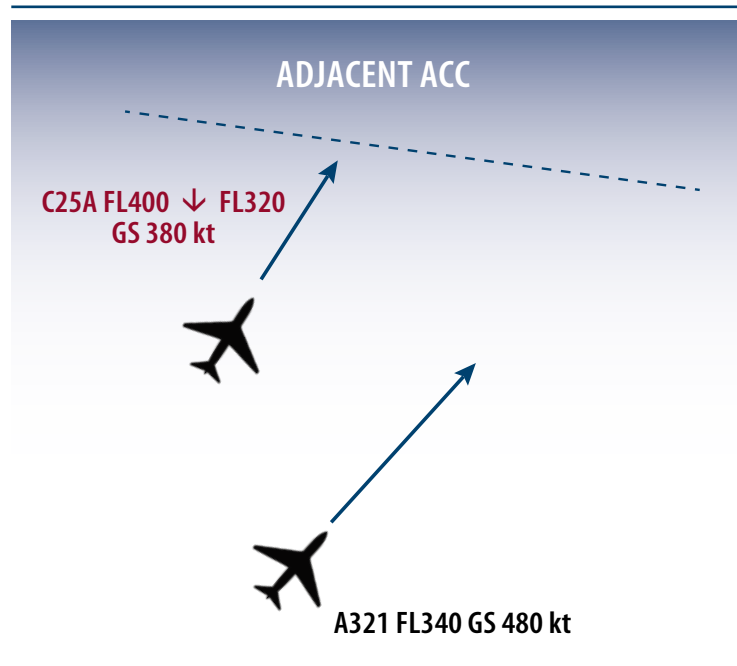
In sector M a C25A is heading north at FL400 and will need to start descent before leaving the sector. Descent to FL320 is agreed with Adjacent ACC. Behind the C25A, on the same track is an A321, which is climbing from FL320 to FL340. The two aircraft are sent on own navigation to waypoints that provide a 20° split. Sector M does not assimilate the fact that the A321 is 100kts faster than the C25A.

Sector M tells the C25A, which is passing FL360, that he must be level at FL320 in 2 minutes i.e. the sector boundary. The C25A is then transferred to the adjacent ACC. Shortly after Sector M transfer the A321 to the adjacent ACC. The A321 is 5 nm behind the C25A on a 20° diverging heading and faster.

Some 35 seconds later STCA triggers between the A321 and the C25A, both on the adjacent ACC frequency but still just inside Sector M airspace.

The Sector M coordinator calls the adjacent ACC sector to apologize for missing the “catching up”. The adjacent ACC confirms they stopped the descent of C25A at FL350.

The analysis of this event showed that there was a high rate of traffic and that the controllers should have split up the sectors.



Generic Scenarios

A. Correct coordination with an adjacent sector but incorrect action.

Contributing Factors

- Early transfer of aircraft to adjacent ACC before separation had been assured.
- Visual Perception – Sector M did not see the 100kt speed differential and catch up.
- Recovery – Correct but by adjacent ACC.
- Controller in whose airspace event took place not in communication with either aircraft.

4.16 Event 16: H25B/A321

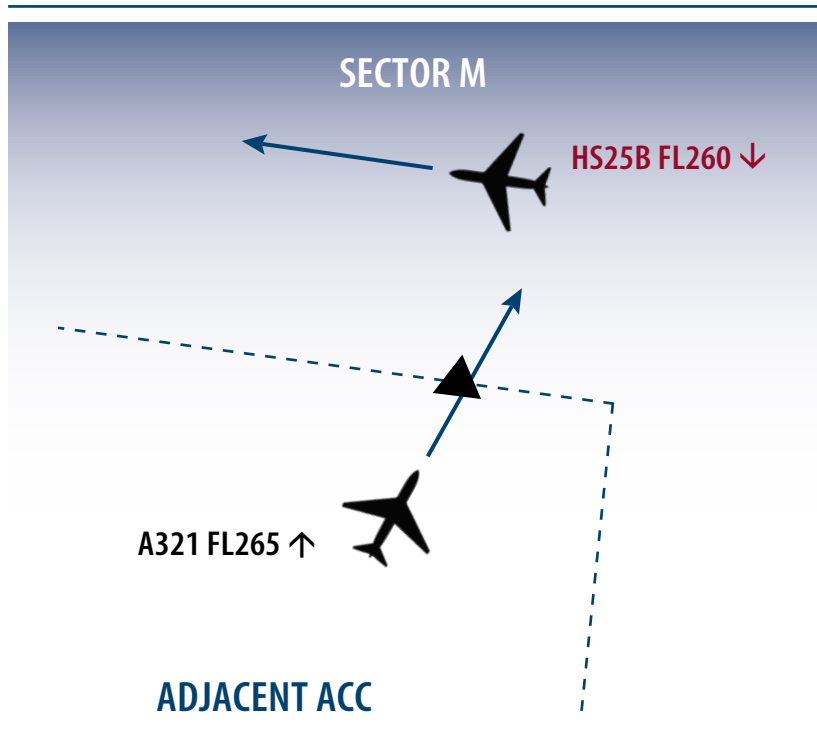
This event occurred between two ACCs that we will call ACC1 and ACC2.

H25B is heading about 280° with Sector M. It is well to the south of its Flight Plan route having been given a direct routing by the previous sector. Its track will take it very close to the boundary of the adjacent ACC to the south.

The A321 is in the adjacent ACC's airspace, heading about 040° and climbing to FL300. It is heading towards Sector M's airspace.

Sector M turns the H25B 10° to the right and clears it to descend to FL150 with a 2000fpm minimum.

One and a half minutes later STCA triggers between the H25B and the A321. Sector M turns the H25B 20° right. No further action is taken and a minute later, minimum separation occurs as the H25B is passing FL260 in the descent and the A321 crosses the boundary 3 nm to the south and climbing through FL265.



Shortly afterwards, the A321 contacts Sector M and confirms that it had a TCAS RA.

Generic Scenarios

E. Failure to correctly apply Standing Agreements or procedures with adjacent sectors.

Contributing Factors

Planning – Sector M accepted the H25B on a direct route and continued with the same plan – which was an incorrect plan.

Perception – Sector M did not detect the potential conflict.

Decision – Sector M took inadequate action to ensure the H25B would remain clear of the adjacent ACC boundary and flights entering the sector from there.

Recovery – Inadequate ATC recovery. One 20° turn, no avoiding action or traffic info.

4.17 Event 17: A319/F900

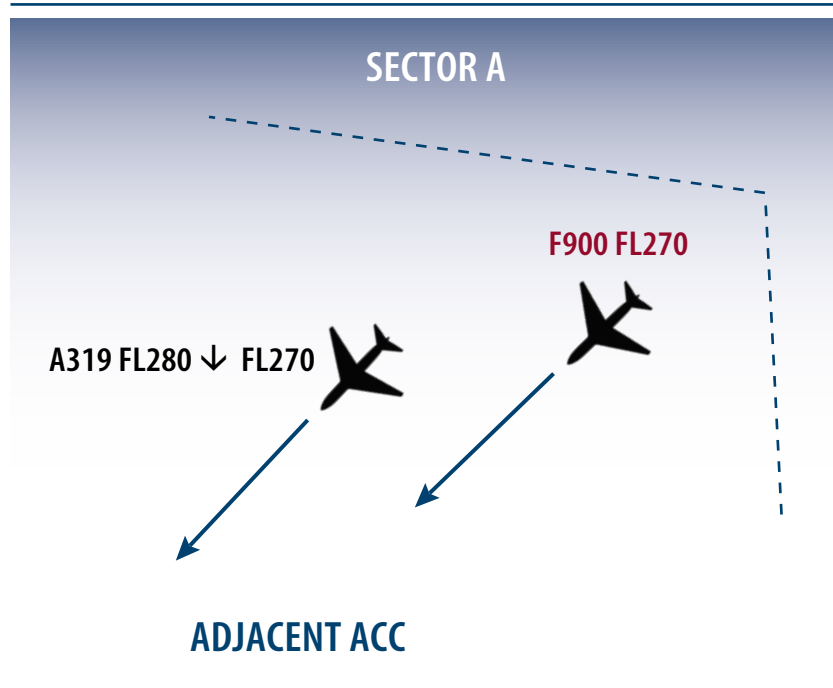
This event occurred in the airspace controlled by the Adjacent ACC but was initiated by instructions given by the Sector A of the Home ACC before transfer.

The A319 is at FL350 southwest bound towards the adjacent ACC. The F900 is following the same route, some 10 Nm behind at FL270.

Sector A clears the A319 for FL280. One minute later a handover of the sector takes place. The new controller is told by the outgoing controller that the A319 was cleared to FL280 "because of the 27". By this the outgoing controller meant the F900 (10nm behind) but there was other traffic at FL270, 10nm ahead of A319. The new controller taking over the sector did not notice the "catch-up" between A319 and F900 and thought the outgoing controller was talking about the one ahead.

One minute after taking over Sector A the A319 was cleared to FL270 and transferred to the adjacent ACC. The Sector A controller retained the F900 until it had passed the boundary and then transferred it to the adjacent ACC. He was unaware of the potential conflict until he saw STCA trigger, 30 seconds later.

The Adjacent ACC Supervisor advised Sector A of the incident and reported that the Minimum Separation was 3.2Nm and 300ft. The A319 had a TCAS RA and continued 300ft below its cleared level.



Generic Scenarios

B. Incomplete or misunderstood coordination with an adjacent sector.

Contributing Factors

Handover – ambiguous information.

Perception – New controller did not detect potential conflict.

Recovery – Correct by adjacent ACC.

4.18 Event 18: B763/A318

This event involved two Sectors A and B and an adjacent ACC.

The B763 is eastbound descending from FL350 to FL290. It is transferred from the adjacent ACC to Sector A.

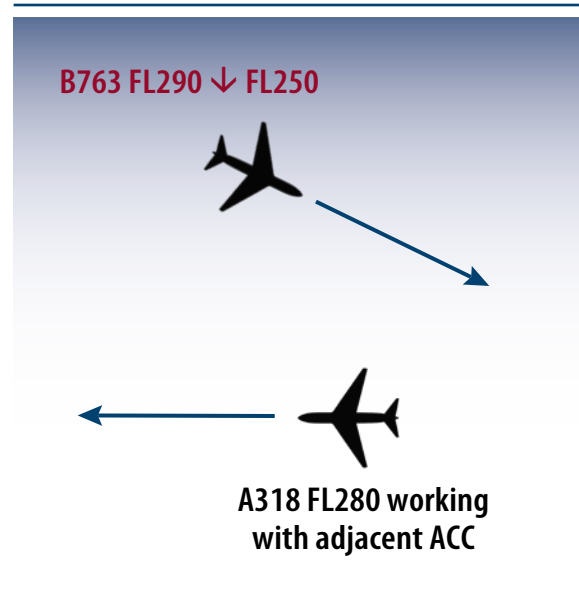
The A318 is westbound climbing to FL240 and was transferred to the adjacent ACC by Sector B.

The adjacent ACC clear the A318 to FL280, being aware of the recently transferred traffic descending to FL290.

Phone call from the sector B to the adjacent ACC to ask it not to continue the climb of A318 “because of the traffic descending”. The adjacent ACC controller believed this meant not to go above FL280. Shortly after STCA triggers.

When the adjacent ACC controller observed the B763 going below FL290 he stopped the A318 at FL270 and turned it right. Note that the aircraft is still inside Sector A airspace.

Sector A had descended the B763 to FL250 being unaware that Sector B had “given away” the opposite direction A318 early to the adjacent ACC and without restriction or coordination. When Sector B asked the adjacent ACC not to climb the A318 “because of the descending” he was referring to the B763s descent to FL250 – however this was not specified.



Generic Scenarios

B. Incomplete or misunderstood coordination with an adjacent sector.

Contributing Factors

Early transfer of the A318 to adjacent ACC and without restriction, whilst still in Sector A airspace.

No coordination between Sector A and sector B.

Sector A assumed Sector B complied with procedure and still had the A318.

Recovery - Inadequate recovery by ATC due to unclear traffic information.

4.19 Oceanic Event 19: A343 / B77W

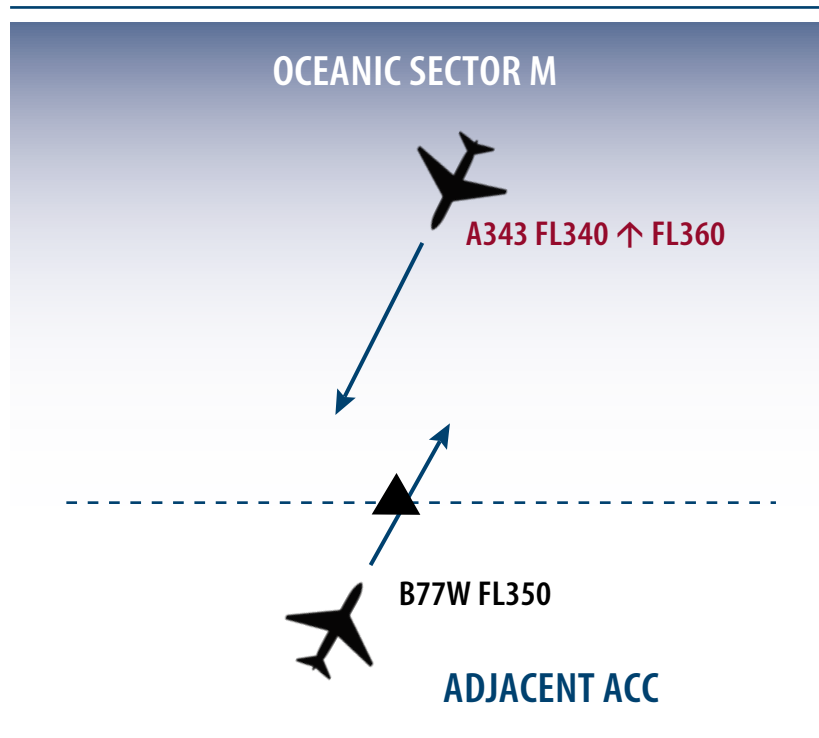
Loss of Oceanic separation in Sector C between an A343 heading southwest climbing from FL340 to FL360 and a B77W entering the sector opposite direction at FL350.

ATCO in Oceanic Sector C was not conscious (until the recovery of the situation) of B77W existence at the boundary. The cause was an incorrect placement of correspondent strip, so ATCO was unable to detect the coordination of the B77W.

The A343 requested climb to FL360. This request was passed on to Adjacent ACC, which approved the request. It is unknown why the adjacent ACC approved the request to climb the A343 to FL360 as the B77W was conflicting traffic and still in their airspace. The adjacent ACC did not notify the existence of B77W at FL350, and Sector C did not ask if there was any conflicting traffic at FL350.

The B77W did not establish an ADS/CPDLC contract on time, and so did not comply with the mandatory CPDLC position reports. The adjacent ACC did not comply with LoA with Sector C, because the B77W was not requested to contact Sector C at least 15 minutes before the boundary. If contacted, Sector C controller could have detected the potential conflict and planned a resolution.

When the 20 minute lateral separation was compromised, Vertical separation was 400ft.



Generic Scenarios

C. Incorrect coordination.

Contributing Factors

Action – select/position. The Sector C controller did not place the strip for the B77W in the correct place.

Decision – The Adjacent ACC controller agreed to an incorrect plan.

Action – The B77W did not convey CPDLC position reports.

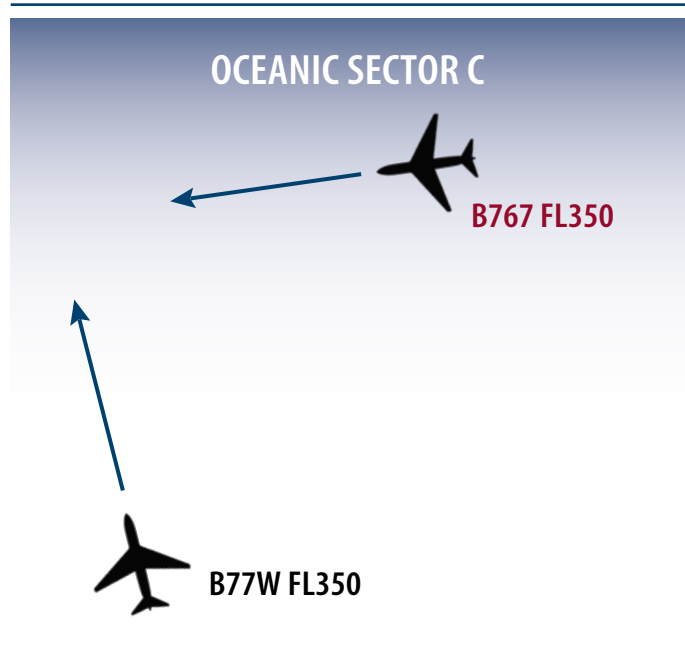
Action – The Adjacent ACC controller did not instruct the B77W to call Sector C.

4.20 Oceanic Event 20 B77W/B767

Loss of separation between B77W and B767 at Oceanic Sector C.

The B767 is erroneously accepted westbound by Sector C at FL350 from adjacent ACC. The B77W is accepted from the south also at FL350 from a different adjacent ACC N. When Sector CC realized a possible conflict an estimated time over the entry point for the B767 was requested to ACC N. Sector C called ACC N three times, but each time the answer was “I call you back”.

Sector C ATCO requested time to Waypoint A to B767 in the first transmission, to which response was 02:18. 20 minutes separation is required at same level, so the B77W would need to be at Waypoint A not before 0238, however its ETA was 0229. The Sector C ATCO did not take positive action to prevent a loss of separation.



Generic Scenarios

C. Loss of separation involving incorrect coordination.

Contributing Factors

Decision – Sector C controller incorrect plan.

Action – Adjacent ACC did not convey information.

Recovery – Sector C controller recovery inadequate.

4.21 Oceanic Event 21: B748/A342

B748 is cleared climb to FL340. Trailing traffic, A342, also FL340, is 7 minutes behind the B748. A 10 minute separation is required for aircraft to be same level when transferring to next Oceanic sector. A342 is unable to climb to FL350 so it is decided that the B748 should be given a higher level.

The following transmission takes place:

ACC: «B748, due traffic, like you to climb FL350 to be maintaining before FIX.»

B748: «Okay, to expect 350 prior to FIX».

ACC does not catch the word «expect» on the readback and coordinates FL350 for the B748 with next sector.

B748 then leaves the sector maintaining FL340, thus ending up with less than prescribed separation to the trailing A342, still maintaining FL340.

Generic Scenarios

A. Correct coordination with an adjacent sector but incorrect action.

Contributing Factors

Perception – Auditory. B748 misinterpreted the clearance from ACC to be maintaining FL350 before the fix.

Perception – Auditory. ACC did not assimilate the erroneous readback to “expect FL350 prior to fix”.

Action – ACC did not monitor/confirm the requested climb for B748.

4.22 Oceanic Event 22: A333/B77W

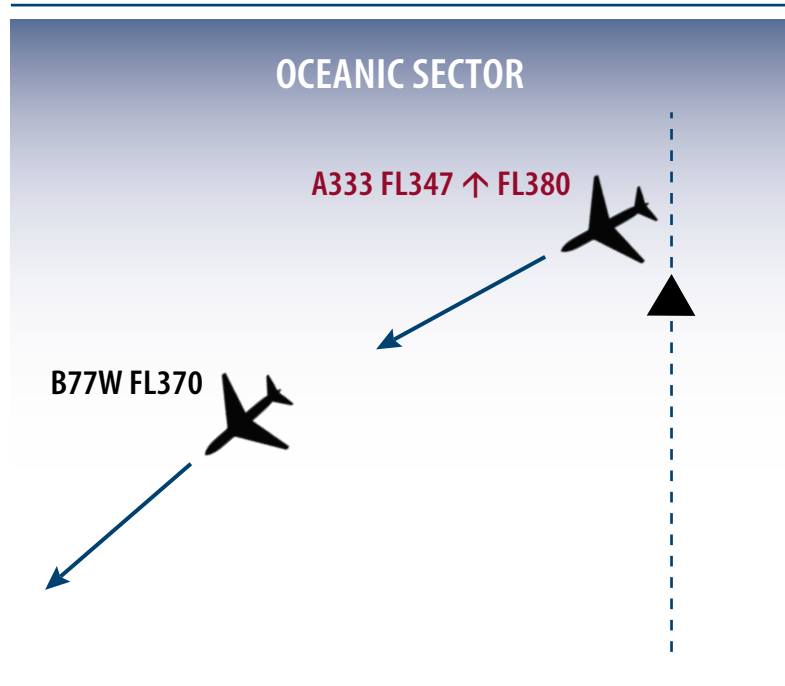
An A333 was cleared to cross the Oceanic entry point at FL380 but crossed climbing through FL374. A loss of separation occurred against a B77W on the same track 2 minutes ahead at FL370 achieving 2 minutes and 400ft where 10 minutes or 1000ft were required.

The A333 received its Oceanic clearance at FL380 one hour before the boundary.

ATC clearance to climb to FL380 is given 6 minutes before the boundary (42nm). The A333 is still at FL320 and requires aircraft to be level at FL380 10nm before the boundary. The crew had not requested a climb until then. The controller had been focusing on other traffic. He knew that the climb clearance was late, but thought that the crew would make it, especially as they had accepted the clearance without comment.

A climb rate of at least 1500fpm was needed from this point.

2 minutes before the boundary the A333A reported that it was unable to make FL380 10nm before the boundary, but could achieve it by the boundary. At this point the aircraft was 333



Generic Scenarios

A. Correct coordination with an adjacent sector but incorrect action.

Contributing Factors

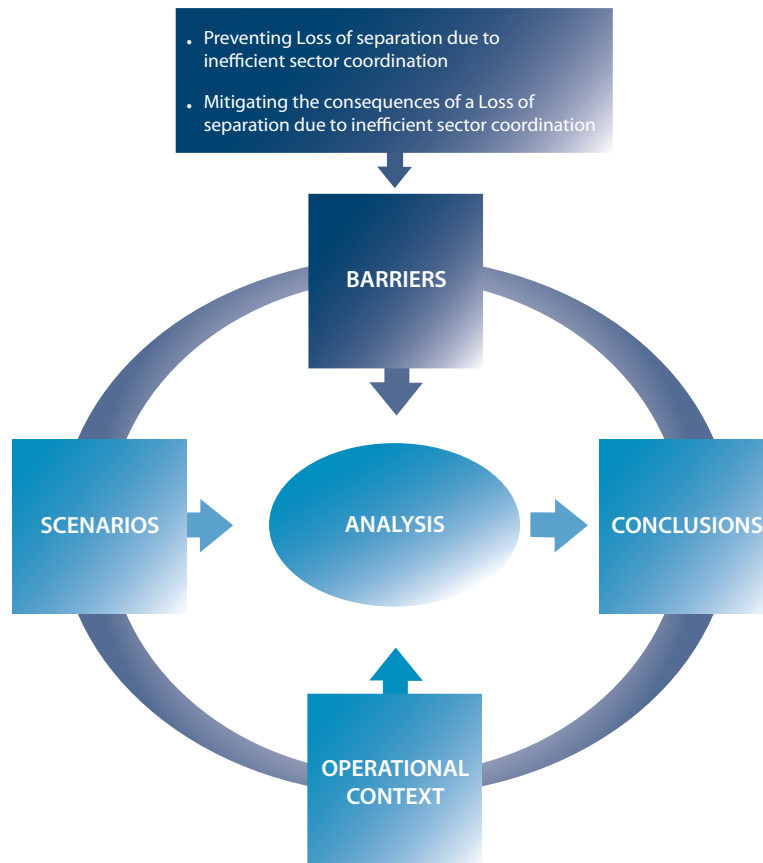
Planning – The crew of the A333 did not request climb to Oceanic clearance level in time.

Decision – The crew of the A333 accepted a clearance that they could not achieve.

Action – The crew of the A333 did not convey their inability to meet the clearance.

Action – The En Route controller knew that the clearance would be tight, but did not inform the Oceanic controller.

42



5.1 Barriers as risk reduction opportunities

Opportunity versus responsibility

The Barriers included in this risk analysis have been identified as possible ways that Loss of Separation due ineffective sector coordination could be prevented or the consequences mitigated. Their inclusion does not imply that they are relevant to all situations and neither does it imply that their adoption by aircraft operators or ANSPs as a group would necessarily be appropriate. It may be possible to identify more potentially useful barriers than are included here.

In order to define the specific barriers it is useful first to define the generic barrier groups for reducing the risk of Loss of Separation due ineffective sector coordination.

The figure below represents a generalised SAFMAP for Mid-Air Collision in En-Route airspace at the top, level 0, of the safety functions.

The Highlighted block 'Preventing Conflict generated by ATC' under 'Tactical Conflict' event is the act of ATC to break that barrier. There is the opportunity to correct the error before any separation minima infringement – to prevent 'Separation Infringement'. When this opportunity is not taken the barriers become collision avoidance barriers. Firstly for ATC, then by pilot resolution with the aid of ACAS. The last barriers are pilot resolution by visual acquisition and when all positive barriers are broken the final collision prevention barrier is providence i.e. good luck.

Mid-air collision en-route SAFMAP v1.0 - Level 0

PROVIDENCE						
POTENTIAL COLLISION UNRESOLVED BY VISUAL WARNING						
CA_V01 The other aircraft is visible	CA_V02 Crew observes the visible a/c in time	CA_V03 Adequate collision avoidance decision	CA_V04 Crew initiates action on time	CA_V05 The avoidance action is correctly implemented and collision is avoided		
POTENTIAL COLLISION UNRESOLVED BY ACAS COLLISION AVOIDANCE						
ACAS03 Functional ACAS and transponder	ACAS04 Correct and timely RA	ACAS06 RA maneuver is possible	ACAS05 RA is detected and correct, on time collision avoidance is initiated	ACAS08 The avoidance action is correctly implemented and collision is avoided		
ACAS01 - The closest point of approach distance is higher than ACAS trigger (ACAS RA not needed)						
POTENTIAL COLLISION UNRESOLVED BY ATC COLLISION AVOIDANCE						
CA_ATC02 Opportunity for ATC collision avoidance	CA_ATC03 The infringement is detectable and ATCO detects it	CA_ATC04 Effective ATC decision and action	CA_ATC05 Communication is functional	CA_ATC06 Adequate Communication	CA_ATC07 Crew acts on time on the ATC collision avoidance instruction	CA_ATC08 The avoidance action is correctly implemented and collision is avoided
CA_ATC01 - No need for ATC collision avoidance - ATC Collision avoidance is not challenged - e.g. diverging trajectories						
SEPARATION INFRINGEMENT / INADEQUATE SEPARATION						
SIP02 Opportunity for ATC tactical resolution	SIP03 The conflict is detectable and ATCO detects it before the separation infringement	SIP04 Effective ATC decision and action	SIP05 Communication is functional	SIP06 Adequate Communication	SIP07 Crew acts on time on the ATC infringement prevention instruction	SIP08 Adequate pilot action and infringement is prevented
SIP01 – No need for ATC separation infringement prevention - ATC Infringement Prevention not challenged – e.g. crew acts						
TACTICAL CONFLICT						
TCP01 Pre-tactical conflict prevented by ATC tactical planning	TCP02 Preventing tactical conflict caused by clearance deviation	TCP03 Preventing tactical conflict caused by airspace infringement	TCP04 Preventing conflict generated by the ATC plan	TCP05 Preventing conflict generated by AG Communications	TCP06 Preventing conflict generated by military activity	

Preventing conflicts generated by ATC

The generic Level 0 barrier 'Preventing conflict generated by ATC' can be divided into the following Level 1 barriers:

- Preventing potential conflict being generated by inter-sector and inter-centre coordination.
- Preventing a potentially conflicting aircraft to be overlooked when clearing or instructing another one (including 'Blind Spot').
- Preventing ATCO controlling techniques to generate potential conflict.
- Preventing ATCO clearing/instructing an aircraft after confusing it with another one
- Preventing potential conflict being generated by ATC execution.

Only the first barrier from the above list is in the scope of this study.

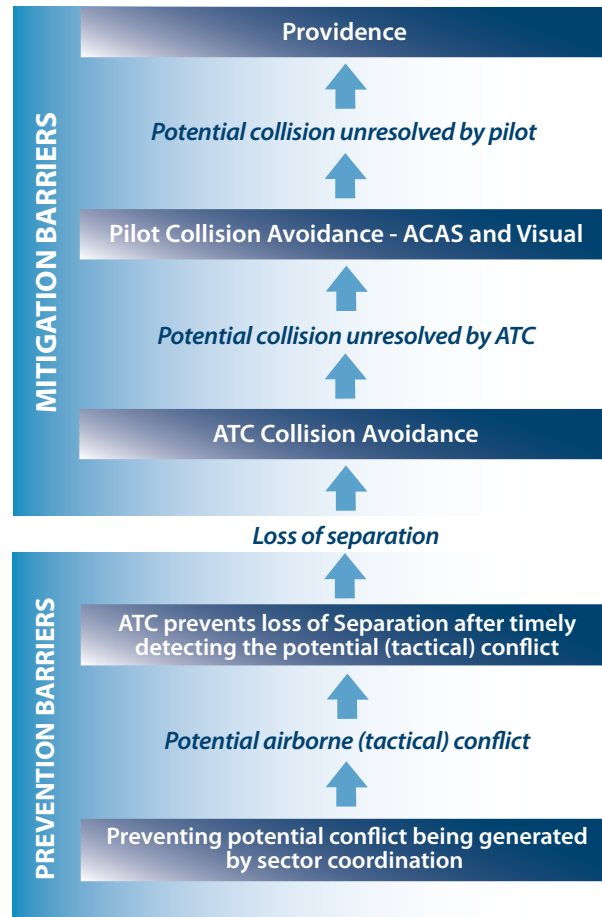
Mid-air collision en-route SAFMAP v1.0 - Level 1

TCP04 PREVENTING CONFLICT GENERATED BY THE ATC				
TCP04.01 Preventing potential conflict being generated by the inter-sector and inter-centre coordination. This involves correct and not missing coordination, complete and correctly understood coordination, applying standard procedures and LoA and preventing wrong actions after correct coordination.	TCP04.02 Preventing a potentially conflicting aircraft to be overlooked when clearing or instructing another one. Not overlooking an aircraft when cleaning or instructing another one. This includes also avoiding "Blind spot", overlooking aircraft in non-concerned state (still under control of adjacent sector or already transferred to). Distraction, attention grabber, inadequate scan, fatigue, non-standard trajectory and a rushed action to meet a constrain can be contributing. Short term probe functionality can help mitigate the risk.	TCP04.03 Preventing ATCO controlling techniques to generate a potential conflict. This involves avoiding misjudgement of horizontal, vertical, speed, vertical speed or all the aspects of the situation. Preventing vectoring, speed or rate of climb/descent techniques used to generate a conflict.	TCP04.04 Preventing ATCO clearing/instructing an aircraft after visually confusing it with another one. This involves clearing or instructing an aircraft with its correct call sign while confusing the surveillance position and/or the flight data with another aircraft. ADF information can help mitigate against the confusion.	TCP04.05 Preventing potential conflict being generated by the ATC execution. This involves preventing conflicts being generated by ATCO slips of the tongue, delays in the execution of the plan or other deviations from otherwise efficient plan of work.

5.2 Two types of barriers

A barrier model

The straight line route of the barrier failures can be shown more simply as the figure below.



There are two sets of barriers which can reduce the risk associated with Loss of Separation due to ineffective sector coordination. These barriers have been identified from both a wide literature search and from consultation. These are:

- Barriers to prevent the occurrence of a Loss of Separation due to ineffective conflict detection with an adjacent sector.
- Barriers to mitigate the consequences of a Loss of Separation due to ineffective conflict detection with an adjacent sector.

Balancing preventing and mitigating the risk associated with Loss of Separation due to Controller Blind Spot

5.3 Barriers which may prevent a loss of separation due to inefficient detection of conflict with the closest aircraft

Barriers preventing loss of separation

-
- PB1 Routine Structured Scan.** Scanning is a basic building block in ATC and Pilot training. Prior to making an executive decision the controller should scan all of the appropriate information, including the situation display and the flight data (strips or other information). It is akin to crossing the road. Listen, check right, check left, check right again. In ATC, it is check situation display, check flight data (strips), check co-ordinations agreed, evaluate immediate situation, and consider future implications – all to be done between “standby” and “affirm”.
- PB2 System Supported Coordination.** System supported coordination provides automatic notification of a flight by an ATC sector/unit to the next downstream sector/unit; coordination of boundary conditions, any subsequent changes to boundary conditions and also permits the negotiation of the boundary conditions by counter proposals, acceptance or rejections of the proposals. System supported coordination also helps the actual transfer of frequency process and hand-over processes. The status of a flight within the coordination/transfer process is depicted through attributes of the track label, indicating both where a reply is awaited from the neighbouring sector/unit and where a proposal has been issued by the neighbouring sector/unit.
- PB3 Shared surveillance trajectories** - mainly for sectors part of a common centre. Sectors downstream from the planned trajectory are presented with amended flight profiles as these are amended tactically.
- PB4 Coordination phraseology and procedures.** Several events are initiated by imprecise and unchallenged coordination. For example, in one event the receiving sector was informed that the aircraft being transferred was being stopped at FL280 “because of the 27”. There were two aircraft in the vicinity at FL270 and the receiving controller focussed his actions in relation to the wrong one.
- PB5 Medium term conflict prediction tools with route updates** (e.g. **MTCD**). These are tools that predict the trajectory of the aircraft in mid-term of up to 20-30 minutes and are usually based on flight plan information, updated with surveillance information about the position and speed of the aircraft and actual and forecasted meteorological information. Considering the aircraft type performance the tools calculate if the aircraft will come into conflict with another aircraft. Some medium term conflict detection tools are equipped with functionality for the controller to update the route of the aircraft should this not follow the flight planned route.
-

Barriers preventing loss of separation

PB6 Short Term Conflict Probe (What if). There are various forms of “What if” or Level Assessment tools available to probe the safety of an offered level change. To some extent, it fulfils the role of Scanning.

PB7 Predictive Separation Alert Tool (e.g. **STCA**) with flight crew intentions inputs like the downlinked Final State Selected Altitude (FSSA or Selected Flight Level) are used by STCA for detecting conflicts early in advance.

Some medium term conflict prediction systems have tactical update facility. This part of their functionality falls within this study description of predictive STCA with flight crew intentions inputs. The NATS Separation Monitor (part of the iFACTS architecture) is such an example. The system starts with the FPL routing but updates tactically when the aircraft deviates from that route. The display is updated according to downloaded aircraft headings and selected flight levels.

PB8 Compliance monitoring aids - tools monitoring for compliance between planned and executed flight trajectory and providing alerts in case of discrepancy.

5.4 Barriers which may mitigate the consequences of a loss of separation due to ineffective conflict detection with an adjacent sector

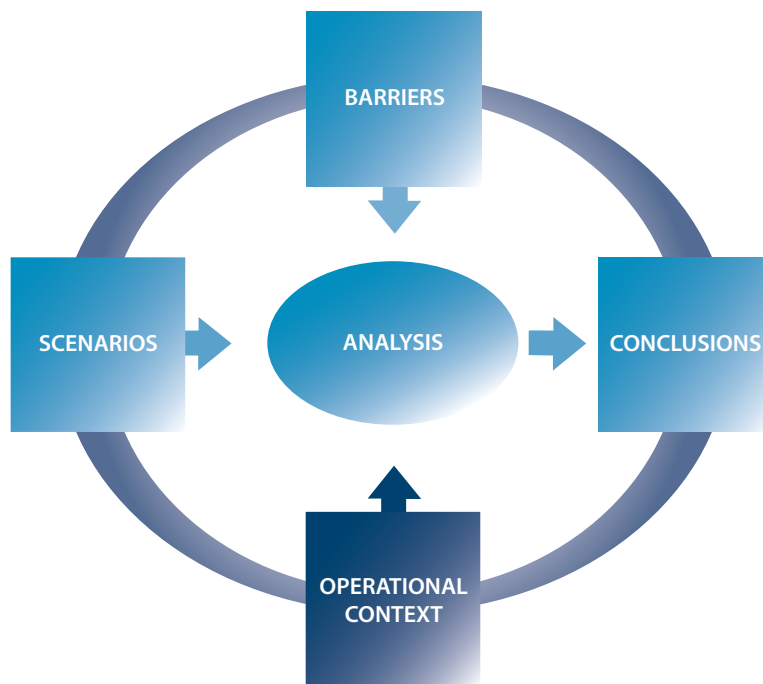
The first step was to define broad priority areas for further prioritisation

Using the SAFMAP barrier model, several barriers were identified which could mitigate the consequences of a loss of separation due to ineffective sector coordination. These are:

- Routine Structured Scan.
- Operational TRM – colleague warning.
- Short Term Conflict Alert.
- ACAS.
- See and avoid.
- Providence (geometry of encounter).

The analysis of the mitigation barriers against the generic and actual scenarios led to the conclusion that these barriers are generic. Their presence and effectiveness are independent of the sector coordination as a reason for the loss of separation. It was therefore decided not to retain in the analysis a review of the mitigation barriers effectiveness.

CHAPTER 6 - OPERATIONAL CONTEXT



6.1 Differentiator or not?

No differentiation of Operational Context for the purpose of this study

In the European En-Route environment there is very little variation in Operational Context. Short Term Conflict Alert in one form or another is present virtually everywhere.

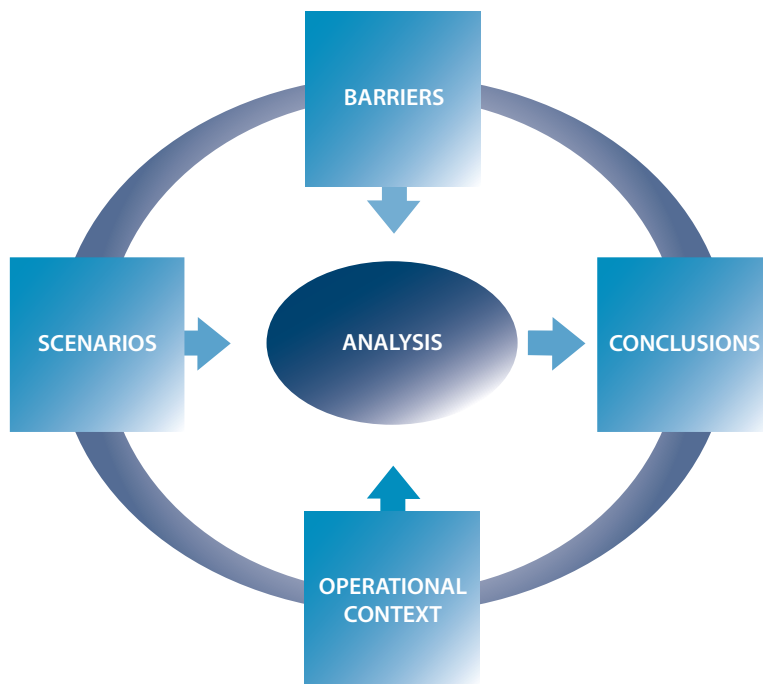
The carriage of TCAS up to Version 7 is a common European requirement. Some States may stipulate more stringent requirements. Area Control Centres will have some functionality that others do not have, but this study is by nature generic across the European theatre of operation. Some case studies occur on TMA sectors but there is no significant difference. It is concluded that there is insufficient cause to consider differing Operational Contexts for TMA and En-Route in this study.

The last four case studies, however, involve Oceanic airspace sectors - a significant Operational Context differentiator. Prescribed separation is procedural and considerably more than the En-Route environment. Communication, both to aircraft and to adjacent sectors, is more basic and can add a time lag to the execution of the plan and the recovery back to prescribed separation. Most of the Oceanic airspace examples are resolved in the pilot domain, usually by an untested TCAS barrier.

It is concluded that there is insufficient cause to consider differing Operational Contexts for this study apart from:

- Procedures specific to Oceanic operations.
-

CHAPTER 7 - ANALYSIS



7.1 Analysis of Prevention Barriers

OPERATIONAL SCENARIOS:	PREVENTION BARRIERS EFFICIENCY ¹ :							
	PB1: Routine Structured Scan	PB2: System Supported Coordination	PB3: Shared surveillance trajectories	PB4: Coordination phraseology.	PB5: MTCD	PB6: Short Term Conflict Probe	PB7: Predictive STCA	PB8: Compliance Monitoring Aids
A1:		2	2		1		2	2
A2:	2+1	2+1	2+1		1		2+1	2+1
A3:		2+1					2+1	2+1
B1:	4		4		4+1		4	
B2:	4+1		4+1		4+1		4	
B3:							4+1	
C1:		2	2	4	2			
C2:	2+1	2+1	2+1	4+1	2+1			
C3:		2+1					4	
D1:	3		3		3			
D2:	3+1		3+1		3			
D3:							3+1	
E1:	4		4					
E2:	4+1		4+1					
E3:							4+1	

Key to Yellow constraints:

1. Prevention possible subject to time and opportunity to act.
2. Prevention possible subject to controller focus of attention on information that shows discrepancy.
3. Prevention possible subject to controller becoming aware of airspace intrusion.
4. Prevention possible subject to controller noting anomaly, challenge mind-set and act.

¹ Note: Red shading defines either an inefficient barrier or barrier that is not intended for the operational scenario. Yellow shading defines barrier that is partially effective or partially efficient for the operational scenario or efficient under certain conditions (see key below). Green shading defines barrier that is effective and efficient for the operational scenario.

7.2 Top 4 Potential Prevention Barriers



PB7 - Predictive Separation Alert Tool (e.g. STCA)

Predictive STCA tools with downlinked flight deck selections can wholly prevent these losses of separation in some scenarios and may prevent losses of separation in other scenarios, depending upon the circumstances. Potential to prevent losses of separation in the studied sample: around 60%.

PB2 - System Supported Coordination

System Supported Coordination is capable of wholly preventing about one-third of losses of separation, but would have no positive impact on an equal number of other scenarios. Potential to prevent losses of separation in the studied sample: around 50%.

PB1 - Routine Structured Scan

The use of Routine Structured Scanning techniques is capable of wholly preventing a couple of generic losses of separation and may prevent the loss of separation in the majority of scenarios, depending upon the circumstances. Potential to prevent losses of separation in the studied sample: around 30%.

PB4 - Coordination phraseology and procedures

Formalised and employed correct coordination phraseology and procedures could prevent one-fifth of generic loss of separation scenarios. It may prevent a couple more, depending upon the circumstances, but will have no positive impact on the majority of scenarios. Potential to prevent losses of separation in the studied sample: around 25%.

7.3 Analysis of contributing factors apparent in actual events

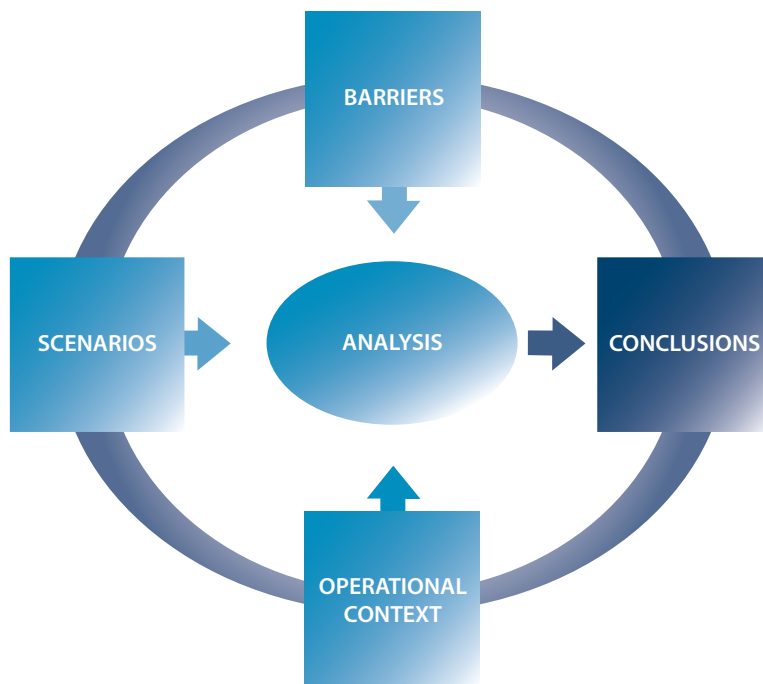
Preventing the contributing factors will not prevent the occurrences but would only reduce the chance of them to happen. Although probabilistic, there is considerable prevention potential in addressing some of the most frequent contributing factors.

The analysis reveals that the highest prevention potential is associated with addressing the following contributing factors:

The 4 most frequent contributing factors

- **Early transfer of communication of traffic still within sector airspace.** The most common contributing factor, present in around half of the losses of separation is the early transfer of communication, to the next sector, of an aircraft that is still significantly within the subject sector. The inability to immediately communicate instructions and avoidance manoeuvres to this aircraft is a constraint on the ability of the controller to maintain prescribed separation.
 - **Lack of coordination to next sector.** Allowing an aircraft to enter a sector without any coordination is a factor in around one-third of the losses of separation. The underlying reasons are varied. Some follow an erroneous expectation that the flight profile of an aircraft will enable it to avoid, usually by climbing or descending a sector. Other examples include aircraft that are off-route from their flight plans due to weather avoidance. The subsequent change in track is then not coordinated with the adjacent sector.
 - **Incorrect/Insufficient plan not corrected.** Coordinating an incorrect or insufficient plan is a factor in around one-third of the losses of separation in the sample.
 - **Incomplete/misunderstood coordination.** An incomplete or misunderstood coordination is a factor in around one-quarter of the losses of separation in the sample. This is manifested by a lack of precise and unambiguous phraseology, coupled with a lack of read-back or challenge. Assumptions are made that are not correct. One example involved coordination "I won't descend until I go behind yours". Neither controller mentioned a callsign resulting in differing understandings of what had been agreed.
-

CHAPTER 8 - CONCLUSIONS



Conclusion 1

This study has identified five basic operational scenarios of losses of separation because of ineffective sector coordination and eight potential barriers to prevent losses of separation because of ineffective conflict detection with adjacent sectors.

Conclusion 2

The single most efficient barrier is **Predictive Separation Alert Tool (e.g. STCA) with downlinked flight deck selections**. This has the potential to wholly prevent losses of separation, in some scenarios, caused by ineffective conflict detection with adjacent sectors. In addition it may prevent losses of separation in all other scenarios, depending upon the operational circumstances.

Conclusion 3

This study suggest that a combination of four barriers seems to deliver the best reliable protection to prevent losses of separation because of ineffective conflict detection with adjacent sectors:

- **Predictive Separation Alert Tool (e.g. STCA) with downlinked flight deck selections.**
- **System Supported Coordination**
- **Structured Scan**
- **Formalised Coordination phraseology and procedures**

Conclusion 4

This study identified that there are four most frequent contributing factors that influence the losses of separation because of ineffective conflict detected with adjacent sector occurrences, and that offer a good prevention potential if properly addressed:

- **Early transfer of communication of traffic still within sector airspace**
- **Lack of coordination to next sector**
- **Incorrect/Insufficient plan not corrected**
- **Incomplete/misunderstood coordination**

Recommendation 1	It is recommended that ANSPs review the identified preventive barriers and contributory factors in case they undertake operational safety analysis and improvement activities for Ineffective Conflict Detection with Adjacent Sectors.
Recommendation 2	It is recommended that European ANSPs and the EUROCONTROL Safety Improvement Sub-Group (SISG) monitor the occurrence of controller ineffective detection of conflict with adjacent sectors to determine changes in frequency and severity.



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