EATCHIP Medium Term Conflict Detection

Part 1

EATCHIP context

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1. EATCHIP

The EUROCONTROL ATC Harmonisation and Integration Programme, known as EATCHIP, aims at ATC harmonisation and integration to be effectuated during the 1990's. EATCHIP phases I and II dealt with assessment and agreeing a programme. EATCHIP phase III is the acquisition and implementation phase.

As part of EATCHIP's Air Traffic Management Domains, the ATM Added Functions comprise a set of new functionalities: Conformance Monitoring, Arrival and Departure Management, Surface Movement Management, Safety Nets and **Medium Term Conflict Detection (MTCD)**, which is the subject matter of this presentation.

The introduction of ATM Added Functions into operations will allow a smooth transition towards the EATMS, the European Air Traffic Management System. While EATCHIP addresses the 1990's, the EATMS will satisfy the growing traffic demand and the need of the airspace users in the early part of the next century.

2. Prevention of collisions

Air Traffic Control is all about conflict detection and resolution.

ICAO Doc 4444 "Rules of the Air and Air Traffic Services" gives a very clear definition of ATC. The major objective of ATC is to provide a service for the prevention of collisions between aircraft, while expediting and maintaining an orderly flow of air traffic.

The definition of ATC has not changed since its adoption in the 1940's, despite substantial growth in demand and huge changes in technology since that time. The ATC definition was valid for the system with radio telephony as the sole technological means, as well as for the system based on radar and positive control as it was introduced in the 1960's.

Adding new ATM functions based on data processing, like Medium Term Conflict Detection, will again not require modifications to the good old ICAO definition.

3. Pilots/controllers

The overall objective being the prevention of aircraft collisions, there are two ways of achieving this goal. Either the pilot himself can do it on his own, or a ground ATC service ensures the separation of aircraft.

In the early days of aviation the pilots maintained their own separation. Collision risks were low due to the limited number of aircraft, the low speeds and the condition to fly in good weather only.

With the introduction of regular services to passengers, growing demand and increased air speeds, the requirement for a separate service became apparent. ATC was born. Today, pilots maintain their own separation only outside controlled airspace (although there are exceptions, varying per country).

The advent of new technology has started to reverse the trend of relying on separation assurance by a ground system. The successfull introduction of Airborne Collision Avoidance (ACAS) Resolution Advice has introduced the first changes in pilot/controller relationships. Secondly, Airborne Separation Assurance (ASAS) is conceivable through the introduction of Cockpit Displays of Traffic Information.

However, the MTCD, as the subject of this presentation, is still based on the continuation of a ground based, service providing ATC system. ACAS may already be in operation, ASAS has not left the research laboratories and has a long way to go yet before implementation. Until then, ground ATC systems need to develop enhancements to increase their level of service in the interest of safety and capacity.

4. Decision Support Tools

Ground based ATC systems (the word system to include technical means and human beings in perfect symbiosis) prevent collisions:

- procedurally by applying 15 minutes separation in areas without surveillance coverage
- based on radar service applying 5 nautical miles separation enroute or 3 miles (even two and a half) in terminal areas

Modern technology enables ATC to provide a better service by using data processing decision support tools for

- ♦ the detection of conflicts,
- ♦ advice on action to be taken,
- ♦ alerting in case of separation violation.

5. EUROCONTROL’s activities

For mere *conflict detection*, an MTCD Operational Requirement Document has been developed for EUROCONTROL under contract by the Dutch Aerospace laboratory, the NLR. The look ahead time of the Medium Term Conflict Detection is, generally, 20 minutes and the conflict search is based on trajectories produced by flight data processing. The MTCD detects the conflicts for presentation to the controller, who will resolve the detected problem.

Beyond the conflict *detection* performed by MTCD, EATCHIP will develop Operational requirements for a Conflict Resolution Assistance tool (CORA), with the aim of providing resolution *advice* to the controller. A first example of a conflict resolution tool has already been implemented in the Maastricht UAC under the name VERA, Verification and Resolution Advice. It produces advised headings to be given by the contrroller to aircraft for which a conflict has been detected. Another success story aimed at giving advice to controllers is HIPS, the Highly Active Problem Solver. Started as an EEC Bretigny research product for PHARE, HIPS now finds its way to an operational trial for Oceanic Traffic in the United Kingdom.

Conflict *detection* should also be clearly distinct from conflict *alerts*. EATCHIP (under contract by the UK) has developed Operational Requirements for Safety Nets, comprising Short Term Conflict Alert (time horizon 2 minutes), Minimum Safe Altitude Warning and Area Proximity Warning. The STCA serves as an alert for the ground system to take action, more or less similar to the ACAS RA function, alerting pilots.

While Safety Nets have an alerting function telling the controller that something may be wrong, MTCD is a planning tool assisting the control team to provide a better service.

6. The control team

Air Traffic Control is organised in geographical control sectors, where a control team of mostly two people handle the traffic.

Since the introduction of radar, the radar executive controller took all tactical control tasks (traffic monitoring, coordination, decision making and radiotelephony), leaving the procedural controller with a strategic planning and coordination task. The planner function, although dealing with the traffic before the aircraft are in radiotelephony contact with the radar executive controller, became secondary.

The evolution towards tactical, radar, executive, positive control (all terms are used to say basically the same) has increased capacity enormously over conventional, procedural control. Today we are, however, reaching the limits of the system as it has evolved. Clearly, the limiting factor in today’s ATC operations is the executive controller.

Flow Management has become a means to address capacity problems. Indeed, flow management is essential to cope with exceptional circumstances. But when flow management becomes a daily procedure, the time has come to address the real problems, in Air Traffic Control.

7. Addressing the bottleneck

For the years to come the ground ATC system will therefore need to be changed and improved in order to cope with the demand. We should be realistic enough to see that airborne separation assurance and free flight are not yet mature to be considered as an immediate alternative.

Addressing the real bottleneck in ATC, we must give tools to the executive controller to alleviate his or her job in coping with the ever increasing demand

For assisting in the monitoring of the traffic EATCHIP has developed the tool MONA, standing for Monitoring Aid. For relieving the controller of coordination functions EUROCONTROL has developed and improved the SYSCO function, system coordination.

Medium Term Conflict Detection (MTCD) addresses the control saturation problems at their roots. MTCD, ensuring the systematic detection of all conflicts, alleviates the traffic monitoring workload and enables a better decision making process by the controller team.

8. Capacity

MTCD allows the planning controller to resolve conflicts 20 minutes in advance, before the executive controller needs to be aware. This contributes in restoring the task distribution balance between planning and executive control.

The systematic detection of conflicts through MTCD will also allow the control team to accept more traffic on free routes. Without MTCD, many controllers prefer, for safety reasons, the routine of predictable traffic patterns following predetermined routes over the risks of sudden, unexpected conflicts of traffic on free routes. With MTCD, these risks are no longer there, conflicts emerge no longer unexpectedly.

MTCD adds therefore to the capacity of the ATC system. A EUROCONTROL study into the potential benefits from the use of a free route model has calculated a reduction of the number of potential aircraft conflicts in upper airspace of more than 30 % and a saving of 643 million ECU per year for the airspace users. It will be understood that 30 % fewer conflicts will not automatically result in a 30 % increase of capacity, but a positive effect on controller productivity is beyond doubt.

Decisions to turn EUROCONTROL's Maastricht UAC into a free route ATC centre, are well under way. Systematic conflict detection is a prerequisite on this road.

9. MTCD and R&D

This symposium is focussed on Research & Development.

For the MTCD an Operational Requirements Document has now been agreed by the EUROCONTROL organisation. Given that MTCD development has progressed to this stage, MTCD can be considered as a success story, where researchers and developers start to see their products deployed in the field.

In two European ATC centres, Amsterdam ACC and Maastricht UAC, one may observe the first applications of medium term conflict detection. In fact, their development began before the EATCHIP programme. The Amsterdam conflict detection tool has been the basis for the development of the European MTCD. Similarly, in the United States the URET tool (User Request Evaluation Tool) is being implemented as an operational trial in the Indianapolis ATC centre and extended to the Memphis centre. High tribute should also be paid to the French ERATO development, of which conflict detection is a basic element.

This means that further R&D work for MTCD should in the first place be geared to:

- deployment support
- quantification of capacity gains and benefits.

Mr Jos Beers of the NLR will continue with part 2, the technical presentation of MTCD.Medium Term Conflict Detection Functional Description

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Medium Term Conflict Detection

Functional Description

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Introduction

Within the context of EATCHIP Phase III (the acquisition and implementation phase of the European ATC Harmonisation and Integration Programme) a number of automated functions are developed which purpose is to support the ATC−controller team in their decision making process. One of these ATC tools is called Medium Term Conflict Detection (MTCD)

This paper gives a functional description of the EATCHIP Phase III Medium Term Conflict Detection function.

"What is MTCD?"

Purpose of MTCD

MTCD is a planning tool that will assist the ATC−controller in identifying situations in which a conflict may occur, providing the controller enough time to assess the severity of the situation, and, if necessary, to resolve the conflict in a deliberate fashion.

Conflict types

MTCD detects three types of conflict: aircraft conflicts, special use airspace penetrations (airspace conflicts), and descents below lowest usable flight level (ground proximities). Detection horizons for the conflict types are typically 20 minutes for aircraft conflicts and 60 minutes for airspace conflicts and ground proximities. In extension to aircraft conflict calculations, MTCD optionally detects nominal routes overlaps up to of 60 minutes into the future.

Definition of conflict

A conflict is defined as a state in which the closest distance between the (probable) positions of an aircraft and a specific object is less than a minimum required legal separation plus a buffer. Such a specific object can either be the probable positions of another aircraft, a special use airspace, or the area below the lowest usable flight level of an airspace.

Conflicts are only declared in situations that (may) require ATC−controllers intervention.

MTCD context

The MTCD context is depicted in figure 1. MTCD will receive trajectories from the Real−Time Flight Data Processing and Distribution function (FDP). Trajectories can either be system trajectories or tentative (what−if) trajectories. The trajectories are expected to be built by the FDP using best available flight plan data, which includes the latest coordination and surveillance data, and controller inputs.

MTCD also needs environmental data, such as airspace structures, separation criteria, special use airspaces and lowest usable flight levels. This will be provided by the Environment Data Processing and Distribution (EDP) function.

Conflict information calculated by MTCD is made available to the system, in particular to the Human Machine Interface (HMI). Other functions that are expected to need conflict data are the Arrival Manager and the Conflict Resolution Assistance.

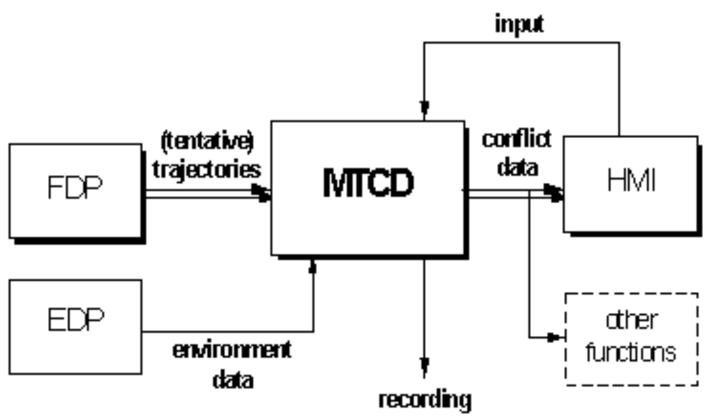

Figure 1: MTCD context

"How does MTCD work?"

Eligible flights

MTCD performs conflict detection for every flight under control of the ATC−controller team, for which a system trajectory is available, provided that the flight's time of entry in the area of operation is less than a pre−defined parameter.

MTCD also performs conflict detection calculations for a flight whenever a tentative trajectory for that flight is received.

Specific flights can be automatically excluded from MTCD conflict detection to avoid unnecessary conflict notifications. Exclusions can be based on:

- the phases of flight (*e.g.,* sequenced),
- the classes of flight (*e.g.,* en−route and on FL285 and above), or
- the airspaces (*e.g.,* around aerodromes up to FL95).

Individual flights can be deselected (or reselected) manually by the ATC−controller team, so that the flights are excluded (or re−included) from MTCD conflict detection.

Calculation frequency

MTCD performs conflict calculations in one of the following cases:

- when a new system trajectory or tentative trajectory is received, or when a trajectory is re−calculated,
- when an deselected flight is reselected,
- when environment data changes,
- or, optionally, when a pre−defined time since the last calculation on a system trajectory has elapsed.

Existing conflicts are deleted whenever one of the flights involved in the conflict leaves the area of operation, or when one of the flights involved in the conflict is deselected. An existing conflict is also deleted when, due to an update of the current position or changes in the environment data, the conflict is resolved.

Uncertainty areas

To account for unpredictable aircraft manoeuvers, MTCD constructs uncertainty areas around the trajectories that it receives from the FDP. The uncertainty areas are constructed independently for vertical inaccuracies (see figure 2) and for horizontal inaccuracies (see figure 3).

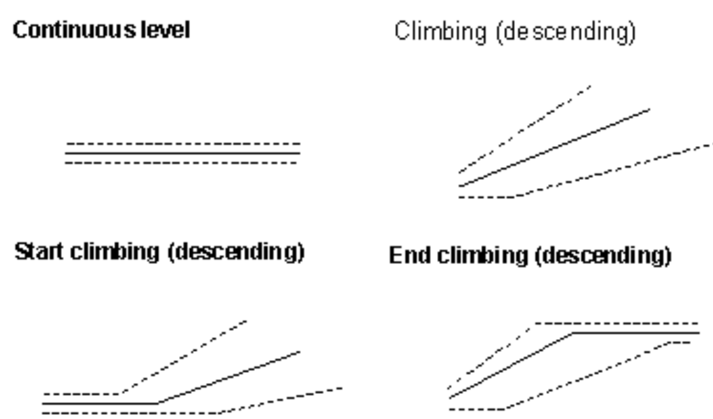

Figure 2: Vertical uncertainty areas

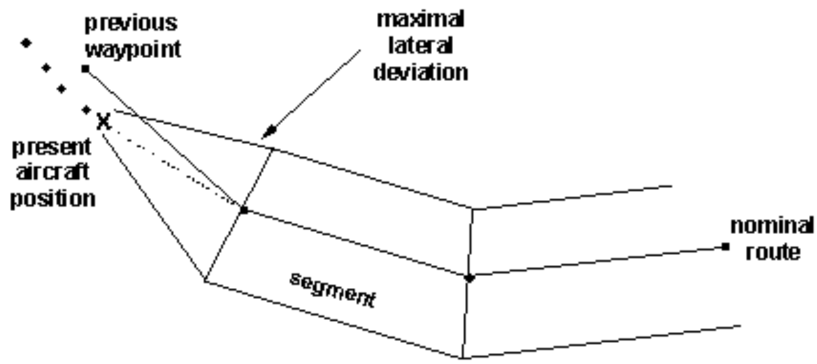

Figure 3: Horizontal uncertainty areas

MTCD uses default values for the uncertainty areas per area of operation. Exceptions can be made for specific airspaces, or, optionally, for specific phases of flight, or navigational capabilities.

The vertical and horizontal uncertainty areas around a trajectory define the probable positions of an aircraft at any given time. In the horizontal plane a segment is defined as the probable positions of an aircraft in a given time interval. In MTCD these intervals are bounded by the earliest time at which an aircraft is expected to be over one waypoint and the latest time at which it will be over the next waypoint.

Separation criteria

MTCD uses default values for the separation criteria per area of operation. Exceptions can be made for specific airspaces, or, optionally, for specific phases of flight, classes of flight, or the geometry of two trajectories. Different separation criteria can also be defined for parallel ATS routes.

Aircraft conflict

An aircraft conflict is declared when the distance between the probable positions of two or more aircraft is less than the required horizontal and vertical separation.

At first, the vertical distance between the probable positions of each pair of aircraft is evaluated. When this distance is larger than the required vertical separation criterium, there will be no need for further conflict calculations.

If there is no vertical separation, the distance between each pair of segments of two different flight is evaluated, given that the two aircraft can be in their subsequent segment at the same moment in time (see figure 4). When the distance between the segments is less than the required separation, a more detailed calculation is performed in which the probable positions of the two aircraft are compared for every individual time.

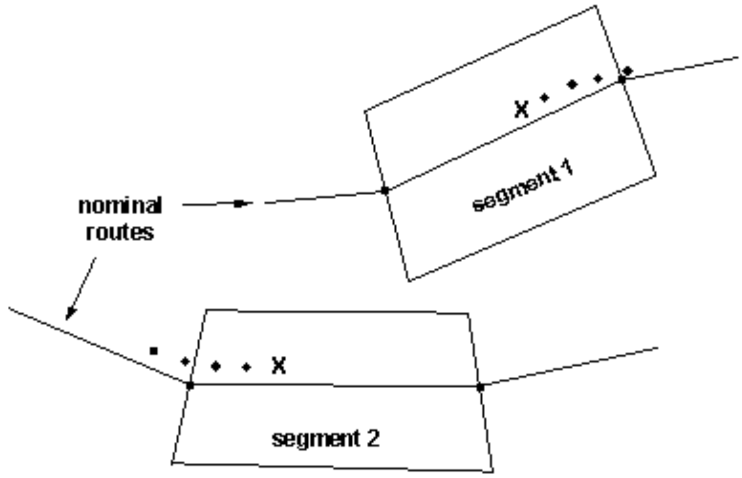

Figure 4: Aircraft Conflict

Special Use Airspace Penetration

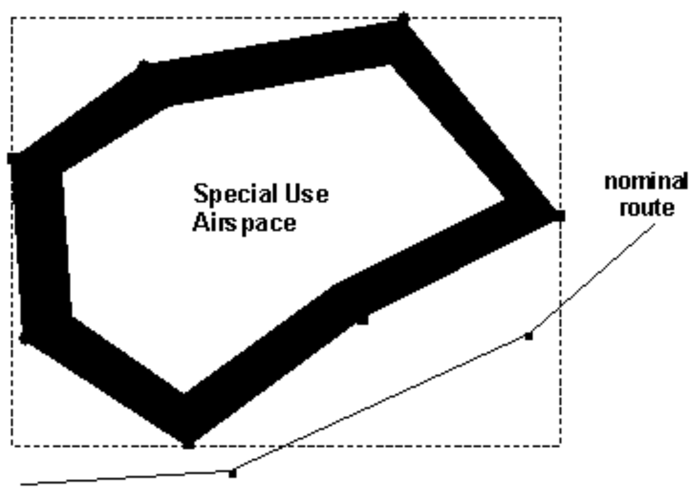

Figure 5: Special Use Airspace Penetration

Information concerning Special Use Airspaces is derived from the Environment Data Processing and Distribution (EDP) function.

Special Use Airspaces reported by the EDP are extended within MTCD with a buffer (see figure 5). A Special Use Airspace Penetration warning is given when the nominal route of an aircraft anters the buffer zone of a Special Use Airspace.

A quick comparison of flights and airspaces is made by comparing the nominal route of an aircraft to the smallest rectangle in which the Special Use Airspace plus the buffer still fits. Only when a nominal route crosses this smallest rectangle, an explicit airspace calculation is to be made.

Descent Below Lowest Usable Flight Level

Information concerning the lowest usable flight level of an airspace is made available by the EDP function.

Descents Below the Lowest Usable Flight Level are simply calculated by comparing the flight level of the nominal route of an aircraft to the Lowest Usable Flight Level of the relevant airspace (see figure 6).

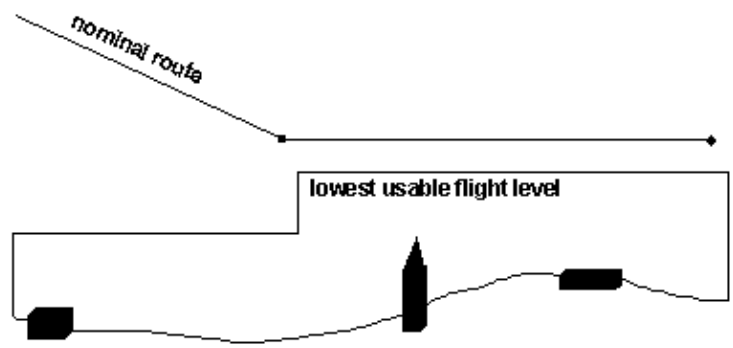

Figure 6: Descent Below Lowest Usable Flight Level

Concluding remarks

MTCD is a complete set of tools that will assist the ATC−controller in detecting, on a planning base, aircraft conflicts, airspace penetrations, and ground proximities.

MTCD supports direct routing.

MTCD is a flexible tool, based on operational requirements of administrations in different EUROCONTROL states.

Status of MTCD

Operational Requirements for the MTCD function were accepted in May 1997. The function’s Functional Specification will be completed in drafting in June 1997.

References

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