BRIDGING THE PREDICTIVE AND ADAPTIVE ISSUES IN AIR TRAFFIC MANAGEMENT: THE SYNCHRONOUS PARADIGM

G. Gawinowski & V. Duong, Eurocontrol Experimental Center, BP15, 91220 Bretigny, France
J. Nobel, Transim for Eurocontrol, France
J.Y. Grau, Modis International for Eurocontrol, France
D. Dohy, Neosys for Eurocontrol, France

Abstract

The SuperSector project falls within the scope of research based on the hypothesis that the current proliferation of controlled sectors had led to a too rigid use of airspace to face with medium- to long-term traffic growth.

SuperSector suggests a shift of paradigm from sector-division to sector-regrouping, i.e. instead of subdividing sectors to accommodate traffic growth, SuperSector investigates a new control organization and practices from which traffic in large volume of airspace can be managed by teams of controllers with responsibilities no more restricted to sector-planning and radar-control but span from real-time traffic flow organization to conflict solving. In this way, it is expected that SuperSector can help filling the gap between long-term predictive issues of central flow management, and short-term adaptive issues of radar-control, and thus moving from an asynchronous Air Traffic Management System to a synchronous one, from a sector-control working methods to a network and flow management one, from conflict-based control to a time-based control one.

In this paper we present the results obtained so far with SuperSector: a novel working organization based on a layered-planning mechanism and contract of services in order to perform medium-term anticipation linking the long-term predictive part of traffic flow capacity management and the short-term adaptive part of the air traffic control actions. The Time-based approach and collaborative decision making mechanism associated to the contract are developed. Impacts on airspace design, flow planning and regulation, and tools are also discussed.

Introduction

Over the past decades, concepts aimed at improving Air Traffic Management (ATM) performance have embraced numerous imaginative ideas [1] without any significant success. Facing the challenge of triple traffic in the next twenty years [1], the air transport community is one the hand, between the limits of the improvements to the “traditional” ATM system and, on the other hand, the pace of the future ATM next generation period. Some European problems have been clearly identified as constrained by national barriers [3] and weaknesses in the capacity management due to the gap between the global predictive part of the system, performed by the Air Traffic Flow Management, and the local adaptive part performed by the tactical controllers [4]. To link the predictive and adaptive parts, layered-planning mechanisms were introduced in different ways [5][5-10]. In the same direction, SuperSector investigates a complementary, but global approach to reach a consistent and, coherent organization combining a review of controller working methods, the optimization of the Airspace Structure Management (ASM), and the mechanisms of Air Traffic Flow Management (ATFM).

The main goals in SuperSector have been:

- The simultaneous investigation of improvements in ASM, ATFM and, ATC in parallel with the accompanying working methods and their associated safety issues,
- The optimization at the global European level for congested area in upper airspace (FL195 – FL340)
This paper is organized as follows: Section 2 introduces the rationales of the concept. Section 3 outlines the concept, and Section 4 discusses the main issues and possible evolutions.

A Shift of Paradigm

Air traffic control is an open system, though many totally independent external parameters can have a great impact. This is a paradox as performance objectives consider that these parameters are comprehensively checked, monitored and verified by the system. Unfortunately, even if the complete set of parameters is known, each parameter outcome, i.e., the exact time when it interferes with the traffic and how it will interact with other parameters, is mostly unknown. To accommodate unforeseen event with respect to capacity objectives, traffic security and fluidity, a strategy for managing the unexpected components has been developed. Today, it is divided into a predictive level and a reactive level.

The predictive level is set to optimize traffic management regarding air traffic control system capacities. The main actor in Europe is Eurocontrol’s Central Flow Management Unit (CFMU), which both organize flights and adjust adequate means of the control system. This mechanism is aimed at reducing traffic complexity in order to facilitate the traffic control. The reactive part is located in the sector unit at controller level. It is mostly related to the mechanism used to manage traffic complexity induced by planning imprecision. This notion of sector is presently touching its limits. To increase the capacity, numerous decision support tools are imagined in order to detect and resolve automatically the conflicts. Vertical aircraft separation has been reduced [12]. The paradigm based on ground-centralized control will eventually shift to an alternate view either totally or partially managed in the cockpit[13]. However, these evolutions are based mainly on controller ability, sometimes interpreted as “sector capacity”. In consequence traffic increase has usually been associated with a growing number of sectors, controllers and the volume of the sectors has been reducing to size of diminishing returns, sometimes called capacity maxima, leading to what can be referred as the “capacity wall” [5].

This paradigm is now reaching its limits:

- Controller workload has been dramatically increased by inter-sector co-ordination,
- Traffic control actions are constrained by the decreasing flight time in a sector, and thus significantly reducing the maneuvering options,
- Anticipative mode, i.e., the pre-tactical organization of traffic to increase fluidity and to avoid eventual conflicts, is being replaced by a reactive mode, which focuses on short-term conflict detection and solving,
- Sector operational signification is lost; the same aircraft can be commonly managed by several sectors.
- Each sector is consuming room of manoeuvre in terms of safety and capacity in order to manage the uncertainty because the network is not managed.

The major limitation of the present ATM system is the loss of effectiveness due to the weak interactivity between the two main contributors (i.e. imprecise long term planning coupled to a very accurate local adaptation) and could explain the “capacity wall” due to the inability to manage the network and flows.

Improved capacity with respect to traffic flexibility and safety require better synergy from these contributors and hence a better control on traffic complexity.

The shift of paradigm is there: it aims at creating a continuum between the predictive and reactive parts in proposing a medium-term anticipative layers which will enable the synchronisation of all the layers (predictive, anticipative, reactive) and therefore the managing of the network. This concept will synchronize ATM operations and result in efficiency gains. The challenge consists to move from the today’s asynchronous ATM to a synchronous ATM one which is expected to provide extra-capacity.

- The Synchronised ATM

The synchronisation of ATM components required flow stretched and just-in-time delivery mechanisms performing mainly using time and processes management. It requires interactive and distributed processes.
• distributed cognition which is a human cognition and knowledge representations, rather than being solely confined to the boundaries of an individual, is distributed across individuals, tools and artefacts in the environment. The concept of distributed cognition stresses the cognitive importance to the individual in environmental objects (human or otherwise), and it is a useful approach for designing socio-technical cooperative environments.

• collaborative actions (volume of actions, explicit assume of responsibilities, contract of services)

which should be performed through the exploitation (controller working methods)

It requires anticipations windows to manage the look-ahead flow control (flow in large volume of actions) and predefined patterns of problems of solutions (simplified route network, rerouting) which could be performed the infrastructure.

In such a synchronised system and compared to the asynchronous one, it needs to move from a conflict-based control methods (detection and resolution of conflicts) to a time-based control methods (time-based traffic organisation in order to push traffic on flow with a better management of the uncertainty), to move from a sector control unit to a flow control in a volume of responsibilities approach. Majors enablers identified are layered planning and contract of services, 3D tube airspace design and management, and 4D facilities. In this approach, traffic trajectories will be predicted in accordance with the level of system capabilities, defined roles and responsibilities of human and machine, addressing uncertainties. In the 2020-2040 horizon, it is envisioned that the predictive part will be not determinist, and therefore required human-centered roles to adjust the uncertainty and predictable events. To manage the predictive 4D in an anticipative/adaptive way, it is proposed to constraint the airspace with 3D constraints and working methods focusing on the time management.

• Layered planning and contract of services

The proposed approach is based on the layered concept initially proposed by Villiers [5]. Many studies have considered layered concepts, but very few operational applications have been implemented. Perhaps because layers are partially integrated within air traffic control system without considering the tight relationship between working methods, airspace design, traffic planning and tools. To be efficient, the layered concept should be considered at the level where tasks can be decoupled from the roles and responsibilities of the operators. The approach should also take into account the information exchanges and planning actions as well as time ranging associated with each layer. This induces of course major impacts on airspace design, ATFM mechanisms, working procedures and tools. This should lead to a better control on complexity by strategic actions resulting simplification of the system. Expected benefits are highly dependant on new working methods and traffic planning principles. A better management of the uncertainty and complexity from long-term to short-term should facilitate the control of networking effects by organizing, deconflicting and simplifying traffic. It is the key feature that provides the basis for service provider and service user negotiation of contracts for aircraft trajectories that optimize the use of aviation system resources. The dynamic nature of the planner will permit renegotiation of the contract to deal with aircraft no-nominal situations. Key challenge is the capabilities to support the distributed cognition and highly interactive and collaborative processes between operators [11]

Controller capabilities and cognitive limits are a constraint. Manipulating a set of aircraft in a four dimensional space is highly complex. This requires huge mental resources. We propose that by restriction of the degrees of freedom to be manipulated it will allow the management of a larger number of aircraft with the same resources. Thus, defining a working method for which only speed management is authorized, in other words eliminating two degrees of freedom (altitude change and vectoring), will allow a more realistic design to maintain traffic fluidity while capacity is growing. It follows that:

- Airspace design should be reworked to provide a route network to resolve conflicts strategically. Concatenation of the current flows using City-pairs, highway/trunk and
FLAS mechanisms should minimize the flight route crossings.

- Sectorization should be reworked, as managing only one degree of freedom (speed management) involves biggest responsibility and action volume, sector size should be enlarged (SuperSector).

- Speed management concept needs to implement techniques similar to regulation, spacing, tunneling or mile-in-trails. ATFM role is then to generate a traffic planning which optimizes airspace resources but taking into account traffic demand and capacity. A tight co-operation between the various stakeholders (i.e. Airline Operation, airports & en-route center) is also mandatory all over flight time.

- 3-Dimensions tube airspace network design and management
  
  It is proposed a 3D tube structure (tubular airspace) with main characteristics as
  
  - Trunk-Highway (Trunk Route Network)
  - Parallel route to support offset capabilities
  - Flight Level Allocation System (FLAS)
  - Large volume sector based on cross-border and modular sectorisation based on sub-sector blocks of airspace. Sectorisation is adapted to traffic patterns (principal traffic flow and their orientation) in order to accommodate the synchronised ATM working methods (anticipation). The operating philosophy is to push traffic through the tubes to optimize the scarce large airport capacity resource. In such a structure the increased ease at managing airspace and aircraft trajectories will allow more capacity at high-demand airports than provided by the current airspace system.

- 4-Dimensions facilities
  
  4D Trajectories will be assigned to aircraft to ensure an acceptable level of traffic complexity and density. The assignment of 4D trajectories will be a collaborative process between a probably centralised entity and the operations centres of the airspace users. This 4D “ATFM slot” can either be constraints on entire 4D trajectories or subsets of these trajectories. These “4D contracts” will also contain buffers which can make sure that it is operationally feasible in good conditions to fulfil the contract and taking into account the minor operational aleas such as atmospheric conditions. These 4D contracts will likely not be conflict-free trajectories, but will de-complexify the traffic enough so that controllers can devote their effort to high added-value tasks

  - Interdependent constraints

  Constraints mechanisms identification is a key issue required for an in-depth understanding in order to propose relevant solutions to improve the global ATM system. All the system components (airspace design and management, tactical flow and capacity management, traffic and capacity management, separation provision, …) are intertwined and inter-dependant and must taken account as a whole in an holistic approach. In consequence, fixing or relaxing constraints is depending of the balance between these different components.

  The Challenge is to address the question of new constraints in a paradigm supporting

  - a synchronised ATM (versus asynchronous),
  - a time-based approach (versus conflict-based),
  - a flexible and dynamic approach (versus fixed).

The Operational Concept

Working Methods & Flow Regulation

Between the long term predictive and the adaptive short-term part of the traffic management, the SuperSector concept defines five layers (Figure 1):

- The strategic traffic planning (CFMU) ensures quantitative management of the aircraft flow on a time base of 2 hours before take-off.

- The tactical and qualitative flow management (FMP) [9] with an anticipating time threshold between 20 and 30 minutes. This is applied by a traffic balancing mechanism.
The qualitative aircraft management (Boundary Spacing) using an anticipating time threshold between 5 and 10 mn, according to a spacing regulation mechanism.

The qualitative exception management (Core Spacing), in other words taking into accounts all the specific cases that cannot be regulated by the previous layer.

The qualitative aircraft management (Separation) for all the situations for which radar separation is needed.

Figure 1. Planning Layer

The first two layers are part of the FAM\textsuperscript{2} project [14]. The SuperSector project focuses mainly on the last three layers.

Each layer is associated with typical information accuracy, scenario complexity and “network effect” direct impact. As a consequence, aircraft maneuvering complexity as well as the associated degrees of freedom should be correlated to the layer characteristics, i.e., a complex maneuver should only be used for a conflict involving two aircraft.

A radar separation can be implemented using the three degrees of freedom (e.g. altitude change, heading and speed regulation) to optimize the space regarding time. Whereas, for an anticipating situation linked to many aircraft, one has to minimize the degrees of freedom used (e.g. “simplified clearances”) as the spatiotemporal range is getting bigger. Thus, a regulation mechanism is defined for delivering aircraft with a dedicated spacing, and using a restricted set of simple maneuvers (speed management, route offset).

This approach imposes:

- New constraints on airspace design, as large volumes (SuperSector) are needed to support anticipation,
- A new simplified airway network (trunks). This network defines also parallel routes (offset) to increase the flexibility of the spacing management, as speed range regulation is small at the considered flight levels,
- Constrained flight level allocation (FLAS) to minimize evolving aircraft.

Derived from these principles, the layer notion is extended to the controller work and represents the fundamental basis for the definition of the working methods applied at the Control Working Position (CWP). The model suggests four controller roles, as stated in the following table (Figure 2).

- Inbound Manager (IM)
- Outbound Manager (OM)
- Sector Manager (SM)
- Conflict Manager (CM)

\textsuperscript{2} Future ATFM Measures project run at the EUROCONTROL Experimental Center
Each operator is linked to a specific functional layer/filter. Controller role, task and responsibility are defined by a contract of services based on competency and/or action volume.

A volume starting from 70NM before the sector boundary to the last convergence point before the sector exit defines the Inbound Manager responsibility area. His contract of services is to regulate the traffic with at least a 5-mn separation threshold. As anticipating time is big enough, only simple maneuvering order such as speed or offset clearances are available to the operator.

The Outbound Manager is responsible for the traffic when the last convergence point has been over-flown until the sector boundary. His contract of services is to regulate the traffic with at least a 5-mn separation threshold in order to provide a clean traffic to the adjacent sectors IM. The regulation volume associated with the OM is quite similar to the IM, so the maneuvering order set is the same than the latest. This guarantees efficient traffic planning in the adjacent sectors.

The Sector Manager is essential to the team as he is in charge of the supervision and the consistency of the IM, OM and CM work across the sector. Furthermore, he has to be able to take over the traffic when the IM or OM cannot assume their contract of services for an aircraft. His own contract of services is to regulate traffic with at least a 3-mn separation threshold. The temporal range is shorter than IM or OM, so the degrees of freedom associated to the authorized maneuvers are larger. In addition to speed and offset clearances, the Sector Manager is allowed to use level clearances. SM is also able to manage traffic regulation ranging between 5 and 3-mn if IM or OM has to apply too drastic constraints regarding traffic flow to fulfill their contracts. If for any reason SM is not able to fulfill his contract of services, aircraft responsibility is delegated to CM in order to perform radar separation.

The Conflict Manager is managing radar separation after delegation by other team members of the corresponding aircraft. He is dealing with short-term situations, thus all the degrees of freedom are authorized, in other words all clearances including vecting are allowed.

The proposed working method is a collaborative mode, where each controller is in charge of his own sphere of action and responsibility. At a given time, each aircraft is explicitly managed and under the responsibility of a unique controller. SM ensures supervision but also consistency of the controlling orders and responsibility transfers. To enable controllers to achieve their contract of service, it is then necessary that each controller is able to communicate with the aircraft under his responsibility. Communication means devoted to each controller have to be adapted to the functional objectives linked to the contract of services as well as the situation temporal status. Complex and short-term situation are managed using voice communication (i.e. radio frequency) whereas anticipating and simple actions can make the best of data-link capability

Each controller ensures the safety of the aircraft under his responsibility. Overlaps between controllers responsibilities ensure crosschecking during the sector over-flight. The layer concept also applies to safety: ultimate safety is based on a duplicated mechanism: a short-term separation mechanism done by CM and the supervision of all the controlling activity made by the SM.

Each controller position is equipped with dedicated tools designed to take into account specificity related to the associated contract of services. Those tools are related to various information, such as: flight plan or radar information, decision-making facility, traffic perception assistant and also adequate means to exchange information inside the SuperSector team. Each team member has the same qualification and so is able to take on any role of the CWP.

The scenario presented hereafter describes the suggested working methods:

The a/c1, a/c2 and a/c3 are in the 70 NM pre-active area of SuperSector 1 Inbound Manager (Figure 3). The three aircraft are at the same level, and two of them are conflicting over TUR beacon. The pre-active anticipating area allows IM to analyze the situation, identify regulation alternatives to achieve his contract of services (5 mn spacing on convergence point). If he detects that he is not able to manage it for a/c1 & a/c2, negotiation is engaged with SuperSector 2 Outbound Manager for a given aircraft time
sequence over TUR convergence point. SuperSector 2 OM is analyzing on his own the request, or eventually with his team SM or CM. In our case, the request is accepted and the relevant action made by SuperSector 2 OM (solution is consistent with his contract of services). When necessary, explicit transfer responsibility of the three aircraft to SuperSector 1 IM will be performed (Figure 4).

Figure 4. Scenario

Due to traffic evolution SuperSector 1 IM has now also ac/4 under his responsibility. However, during scenario evaluation, IM notices that he is not able to ensure his contract of services for ac/4 & ac/2 over CHW beacon. Referring situation to SM, he negotiates responsibility transfer with him. Supervision Manager analyses the context to estimate potential solving actions and verify he is able to fulfill his contract for these two aircraft (Figure 5).

Figure 5. Scenario

If SM assumes the aircraft, aircraft responsibility is transferred and foreseen corrective actions are engaged. SM will keep responsibility until aircraft over-flies CHW waypoint (i.e. the last convergence point in the SuperSector).

On the other hand, if SM is not able to fulfill his contract of services, responsibility is transferred to the Conflict Manager and radar separation is applied. As previously, responsibility is kept until the flight will over-fly CHW waypoint. As soon as regulation separation has been achieved, either by SM or CM, and the last convergence route beacon over-flown, the aircraft responsibility is transferred to Outbound Manager. OM should fulfill his contract of services for all the exiting aircraft. If for any reason traffic complexity does not not allow OM to achieve separation, he will negotiate with SM and CM the same way IM did.

Responsibility transfers between team members are done using « natural voice » (i.e. without any devices), but are also explicitly displayed on the controller display.

Flight integration for evolutionary aircraft, either for route insertion of taking off aircraft or...
descending aircraft, is managed using link routes. SM is initially responsible of those flights.

The two teams coordinate altitude level changes on the trunks. Coordination responsibility is agree by the two SM’s, with CM help if necessary.

**Airspace Design**

The general trends is to move from a fixed airspace (route, sector) to a more flexible and dynamic one. SuperSector propose some flexible issues which will provide multiple and adaptable route options to better meet the users preferred trajectories. Fixing and relaxing airspace constraints will be that, on the one side, traffic assignment onto the airspace will have to be more directive, in order to solve strategically a significant proportion of problems, and on the other side, a better use of the entire airspace will be guaranteed by using predefined geographical routes

This could typically be done by segregating the airspace according to different modus operandi. It is worthwhile noting that the airspace structure must accompany new operational concepts, in particular in the definition of control areas or ‘sectors’ which, depending upon the evolution of the operational mode, could be significantly different from today’s situation (i.e. to define ‘control sectors’ not on physical airspace but on a more functional dimension i.e. ‘arrivals into’, ‘flows through’, etc…).

This development of airspace structure will enable dynamic and flexible capacity management through re-routing, to be executed at the strategic, pre-tactical and tactical level.

**Route Network**

SuperSector will provide

- a more dynamic route network, together with an adapted sectorisation (cross-border, modular) which will facilitate an increased number of route options based on pre-determined direct route segments and enable occasional re-routing.
- An optimisation of the En-route/Terminal airspace interface. The Terminal/En-route interface areas are becoming the most critical factor for airspace capacity. Efficient structure based on segregated arrival/departure routes are proposed.

Route network are grouped to define trunk within the SuperSector. The trunk are designed on preferred level to resolve the conflicts (strategic resolution of conflict on cross-points) and use of fixed level flight and level parity (flow and flight level allocation) to discriminate the circulation orientation)

It is proposed a 3D tube structure (tubular airspace) with main characteristics as

- Trunk-Highway (Trunk Route Network)
- Parallel route to support offset capabilities
- Flight Level Allocation System (FLAS)
- Large volume sector based on cross-border and modular sectorisation based on sub-sector blocks of airspace. Sectorisation is adapted to traffic patterns (principal traffic flow and their orientation) in order to accommodate the synchronised ATM working methods (anticipation). Weak interaction areas are created in order to have room of maneouvre to manage the network effect. These zones of lesser complexity will contain absence of main crossing flows, strategic de-confliction through parallel routes. Area of strong interaction is represented in the Inbound Manager responsibility area and weak interaction area is represented in the Outbound Manager responsibility area.

The operating philosophy is to push traffic through the tubes to optimize the scarce large airport capacity resource. In such a structure the increased ease at managing airspace and aircraft trajectories will allow more capacity at high-demand airports than provided by the current airspace system.

**Airspace Management**

The dynamic and flexible airspace management will be supported by

- Traffic assignment onto the airspace will have to be more directive in order to solve strategically a significant proportion of problems

5.E.4-8
• Multiple route option (using predefined geographical routes)
• Pro-active and real-time coordination between all the planning layers

It is considered an airspace infrastructure for the upper airspace FL195-FL340.

In order to take account the first constraint which has been identified as

1) the Terminal-En Route interface, it is proposed the following structure in order to optimise the airport throughput and input. In the figure 8, it is represented as example the Paris-CDG and Paris-Orly Terminal Area. Geometrical principal routes are designed around this area with square of 70 NM x 70 NM (Figure 6).

![Figure 6. Terminal En-Route Interface](image)

The En-route Network is designed from several constraints

1) It is required to solve strategically the number of crossing points

To respect this constraint a rigid Flight Level Allocation Scheme is proposed

- S (FL210, 250, 270, 310)
- N (FL200, 240, 260, 300)
- W (FL230, 290, 330)
- E (FL220, 280, 320, 340)

but to be applied to a very large area (as the European core area),

1) It is required to have a limited number of major route. It is proposed to link the different node (airport square of 70 NM x 70 NM) using a trunk/highway network.

2) To have an efficient topology

It is important to be noted that efficient future route design should be based on (similarity with the network-telecom technological domain)

- Point-to-Point Trunk Route Network (CT-pairs Trunk)
- Switch Route Network
- Mix of Point-to-Point and Switch
- Switch Route Network with “channel” allocated for specific point-to-point connection

The solution investigated is the Switch Route Network with “channel” allocated for specific point-to-point connection.

In the Figure 7, this Terminal structure is applied for the major airports, which result of the following networking.

![Figure 7. Global Network Structure](image)
1) It is required to perform efficiently the regulation techniques (it has been defined in the working methods that the regulation contract of service will have a limited set of manoeuvres using speed management and vectoring but not the flight level change). As the speed management has some limitation due to the aircraft performance above in the upper airspace (above FL280), it needs to have some flexibilities and facilities to meet the objectives.

To respect this constraint an offset mechanism is proposed (Figure 8),

- Offset dedicated for the cruising traffic: one offset at the right of the trunk, one offset at the left of the trunk
- Offset dedicated for the departure traffic: two offsets at the right of the trunk
- Offset dedicated for the arrival traffic: two offsets at the left of the trunk

![Offset Mechanism Image]

**Figure 8. Global Network Structure**

The sector volume is designed from several constraints

1) Volume of the Terminal-En Route Interface square of 70 NM x 70 NM

2) Depending of the working methods, the Inbound Manager anticipation has been defined for 10-15 mn (in accordance to the previous Traffic Manager filter which act at the timeframe of 20-30 mn). It results an anticipation distance of 70 NM. This 70 NM distance is composed of 35 NM inside its own sector and 35 NM in a look ahead in the previous sector. It was also defined a distance of 70 NM for the Outbound Manager.

3) Aircraft performance constraints which require a 70 NM distance during the take-off and climb to reach the FL195. In accordance to the working methods, the aircraft in a climb evolution must be controlled by the Inbound Manager at the entry of the SuperSector and the aircraft in a descend evolution must be controlled by the Outbound Manager at the exit of the SuperSector.

To respect these constraints, it is resulting a sector volume of 150 NM x 150 NM.

Depending of the working methods, the four main traffic flow inside a SuperSector are divided in two parts

- Flow South and West dedicated to the first team (IM, OM, CM, SM) (color red in the figures)
- Flow North and East dedicated to the second team (IM, OM, CM, SM) (color blue in the figures)

**Support Tools**

It has been defined adequate tools to support

- Short-term action (radar picture)
- Anticipative action (dynastrip)

It is based on a time-based flight plan management which demonstrated high potentiality to anticipate the traffic organisation (Figure 9)

- Support to collaborative mechanism and distributed cognition

It is based on facilities supporting the information sharing (transfolder approach) [15,16], the plannification and the action memorisation (memo, scheduler)

---

3 FAM Concept (Future ATFM Measures, Eurocontrol Experimental Center)
• Sequencer aid

   It has been observed that such tool should be provided to support the controller decision on the aircraft speed management tuning.

   Figure 9. Global Network Structure

Discussion

   Beyond the initial concept, SuperSector is part and parcel of an evolving framework in which several developments are possible:

   □ Adaptable to a more automated system due to the methods put in place to link the predictive and adaptive mechanisms.

   □ Compliant to ATFM enhancement as CDM (Collaborative Decision Making), DMAN (Departure Manager), EMAN (En-Route Manager), flow management [9].

   □ Compliant to delegation of separation tasks [13]

   □ Placing new technology (Data-Link) on their right place

   □ In line with the Single Sky [3] and ACARE [1] initiatives

Conclusion

   Initial results obtained so far with SuperSector are encouraging as they indicate significant opportunities for a tractable shift in control paradigm, which could handle traffic increase in medium and long-term perspective.

   Some ATC/ATFM modeling activities using COSAAC\textsuperscript{4} tools as part of SuperSector developments are presently on going. In addition, several human-in-the-loop real-time experimentations are planned for 2003 with the aim of assessing the operational benefits of the concept in terms of acceptability and capacity. Up-to-date results will be discussed at the seminar.

Reference


\textsuperscript{4} COSAAC, COmmon Simulator to assess ASM and ATFM Concepts


