Operational Concepts For SuperSector

G. Gawinowski[+], J. Nobel[*], J.Y Grau[**], D. Dohy[***], L. Guichard[+], JP Nicolaon[+], V. Duong[+]
{surname}.{name}@eurocontrol.int

+ EUROCONTROL Experimental Center, BP15, 91220 Bretigny, FRANCE
* Transim for Eurocontrol
** Modis International for Eurocontrol
*** Neosys for Eurocontrol

ABSTRACT

The SuperSector project falls within the scope of research based on the hypothesis that the current proliferation of controlled sectors has 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 improving safety while being able to accommodate steady growth in traffic demands.
In this paper we present the results obtained so far with SuperSector: a novel working organization based on a layered-planning mechanism 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. Complexity and safety issues are major constraints and a "Contract of Services" is defined at each layer.
Impacts on airspace design, flow planning and regulation, and tools are also discussed.

1. INTRODUCTION

Over the past decades, concepts aiming to improve Air Traffic Management (ATM) performance have embraced numerous imaginative ideas [1] without any drastic success. Facing to the challenge of triple traffic in the next twenty years [2], the air transport community is persuading that the situation is in a "hinge area" between, in one hand, the limits of the improvements to the "traditional" ATM system and, on the other hand, the pace of the future ATM supersonic period. Some European problems have been clearly identified as depending of the national barriers [3] and weaknesses in the capacity management due to the gap between the global predictive part of the system, performed by the Central Flow Management Unit (CFMU), 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][6][7][8][9][10]. In the same direction, SuperSector investigates a complementary, but global approach to reach a consistent, coherent organization combining a revisiting of the controller working methods, the optimization of the Airspace Structure Management (ASM), and the mechanisms of Air Traffic Flow Management (ATFM).

Main goals in SuperSector have been:

- The simultaneous investigation of improvements in ASM, ATFM, ATC in parallel with the suggested 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 results obtained, and Section 4 discusses the main issues and possible evolutions.

2. RATIONALES

Major objective of air traffic control is safety even in permanently traffic increases. To achieve this, working method has been incrementally evolved and more efficient technologies have been introduced. Radar separation had replaced procedural control methods. Paper strips have become electronic or even disappeared on "stripless" working positions. Numerous decision support tools have been developed and some have been incorporated into ATM systems. Vertical aircraft separation are reduced. The paradigm based on ground-centralized surveillance will be eventually shifted to an alternate view either totally or partially distributed to aircraft crew [13]. However, those evolutions are mainly based on controller ability, sometimes interpreted as "sector capacity" therefore, traffic increase has usually been associated with a growing number of sectors, hence controllers, and the volume of the sectors has been reducing to a limit, 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 numerous intersector co-ordinations,
- Traffic control actions are constrained by the decreasing over-flight time over a sector, leading to very few maneuvering options possible,
- Anticipative mode, i.e., the pre-tactical organization of traffic to increase fluidity and to avoid eventual conflicts, is being given up and to be 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.

2.1 A shift of paradigm

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

The predictive level is set to optimize the 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 aims at reducing traffic complexity in order to facilitate the traffic control. The main limitations are:

- Calculation reliability,
- External parameters management,
- Accuracy lack linked to temporal and system interactivity ("network effect").

The adaptive part is located at the control room and especially at controller level. It is mostly related to the mechanism used to manage traffic complexity induced by planning imprecision. Currently the controllers have a broad pallet of tools based on the management of the four degrees of freedom. With respect to the cognitive limits of a single controller, one may deduce the traffic maximal capacity allowed for a controller regarding the kind and progression of the traffics. To reduce traffic complexity, some regulation mechanisms have been implemented and installed in control room via dedicated positions such as Flow Management Position (FMP). This intermediate layer is very important as it allows decreasing uncertainty by adjusting traffic to adaptive tools used by the controller.

The loss of effectiveness due to the weak interactivity between the two main poles (i.e. a global long term planning with a weak precision and a local adaptation very accurate) of the current system could explain the "capacity wall". Improve capacity with respect to traffic flexibility and safety needs to get better synergy between those poles and hence having a better control on traffic complexity.

The shift of paradigm is there: to come to grip with the traffic complexity by traffic planning actualization, inducing increase of accuracy and so allowing controller to work without using short-term adaptive tools. One way is to define middle-term intermediate layers that create a functional link between long-term traffic planning and short-term adjustment. Thus enhance controller capability with respect to safety and traffic fluidity. The objectives of a new concept are to take into account complementarities in the operational concept definitions and to propose a holistic approach regarding unexpectedness as well as complexity management.

Expected benefits are highly connected to new working methods and traffic planning principles. A better management of the unexpectedness and complexity from long-term to short-term should allow to control networking effect by organizing, deconflicting and simplifying traffic.

The proposed approach is based on the layered concept initially proposed by Villiers [5]. Many studies have considered layered concept, but very few operational applications were implemented. Perhaps because layers was 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 decoupling tasks level, roles and responsibilities of the operators. It should also be based on the information exchanges, 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 inducing simplification of the system (Figure 1).

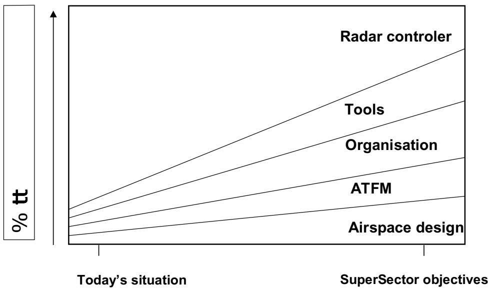

Figure 1 : Strategy to decrease the complexity

2.2 Define the constraints at the right place

Constrained system approach is often opposed to unconstrained one. Using a joint approach, predictive and adaptive, it is possible to impose constraints that allow the adaptive approach to be more capacitive. The main goal is to put constraints on the relevant issues to globally optimize the system.

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. Restriction of the degrees of freedom to be manipulated will allow managing a bigger 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 & vectoring), will allow a more realistic design to maintain traffic fluidity whereas capacity is growing. It follows that:

- Airspace design should be reworked, in order to provide a route network defined to solve strategically the conflicts. Concatenating the current flows using CT-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.

Besides technology should allow managing, with a high synergy, the planning and adaptation activities by using highly collaborative means.

2.3 A Safety challenge

The layer concept allows having both predictive and adaptive joined approach. Nevertheless, one should take care that characteristics linked to safety are addressed at the very beginning of the project and are on line with the operational concepts. Safety issues will be integrated in each development and implementation steps in order that safety drives concept design

For a human factor perspective, safety results from both contextual adaptation of system organization and operator adaptation to situation constraints (airspace, tools, and traffic characteristics).

Various studies describes in literature [15][16] or performed at EUROCONTROL [11] have identified safety parameters linked to human factors in air traffic control activities. Seven invariant parameters are described:

- Give to the controller sufficient anticipating capabilities in order to manage control situations that are dynamics and evolving. Design impacts are: present necessary information to the controller, but let him time to understand traffic evolution and define management responses. Anticipating is a key factor as beyond detection and conflict management, it allows controllers to plan and organize their own activities and thus to save adaptive time spaces dedicated to solve unexpected events.
- Save to controller sufficient problem resolution time spaces to apply optimal solutions that are not damaging traffic fluidity and avoid propagating problems to adjacent sectors. This characteristic is directly linked to the properties of decision

making in dynamic environments [17]. From design point of view, controlling space allocated to an operator is important to understand the situation but also to get and apply a set of solutions that optimize both safety and traffic fluidity. Non-stable inter-sector situations should be exceptional and only used if operator has enough resources to keep a close eye on it.

- Provide to controller various information sources or different presentation of the same information. "Pseudo-redundancy" induces that the same data may be displayed using different look & feel or different logic. This allows building the same mental representation based on different information. The associated interest is to verify that both mental representation are identical and thus avoiding a wrong analysis.
- Information certainty and uncertainty management. Air traffic control is an open system, where information are numerous, more or less accessible/available, uncertain and sometimes information overflow which cannot be managed during the allowed time frame. Nevertheless, controller has take decision in order to modify or not flight parameters. To face that, controller is using "default" or "blurred" deduction based on their declarative knowledge and experience. Design must then take care that system induced certainty, interfaces or organizational operation should be a permanent concern to guaranty safety.
- Provide to controller memorizing tools/support. Controller is manipulating a huge number of information mostly dynamical and at the same managing interruptions. Working memory is then faced to constraints that may induce errors or forgetfulness. To mitigate those limits, working activity should be right-handed by both active (manipulated or not by the operator) or passive (displays) memorization supports.
- Privilege collective work by allowing any member of the team to know what are the intent of the other. Even if the tasks are well defined, flexibility and controller complementarities are beneficial to safety. This means that every controller is able to access/visualize information that helps him to understand the situation and infer intentions of other controller.
- Increase safety feeling by allowing crosschecking of the controller activity by a third party. This surveillance is essential because it take part in the confidence that controller has to make his job. On a design perspective, collective aspect of the work related to safety and performance should be taken into account at an early stage in order to encourage controller shared task spaces. Besides, shared data flows and information accessibility should be provided to controllers.

3. THE OPERATIONAL CONCEPT

3.1 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 2):

- 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 performed through 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.

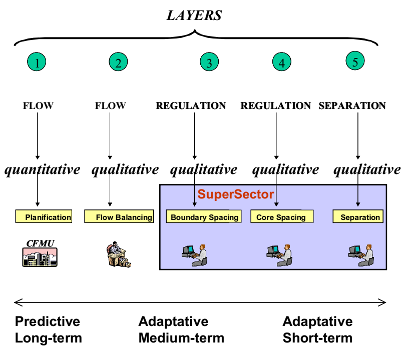

Figure 2 : Planning Layers

The two first layers are part of the FAM project [14]. SuperSector project mainly focuses on the three last layers (Figure 3).

Each layer is associated to 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) in order 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 big volume (SuperSector) is needed to support anticipation,
- New simplified airway network (trunks). This network defines also parallel routes (offset) to increase 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 those principles, the layer notion is extended to the controller work and represents the fundamental basis for the definition of the working methods applied to the Control Working Position (CWP). The model is suggesting four identified controller roles, as stated in the following table (Figure 3).

	IM	SM	CM	OM
Timeframe	10' 70 NM	5' 30 NM	3' 20 NM	10' 70 NM
Contract of Service	•Regulation 5 mn • Entry	•Regulation 3 mn •Supervision	•Separation 2 mn	•Regulation 5 mn • Exit
Procedure	• Speed • Offset	• Speed • Offset • Flight Level	• Speed • Offset • Flight Level • Vectoring	• Speed • Offset
Technology A/G	• Data-Link	• Data-Link	• Radio	• Data-Link
ATCO support tools	• Time-based	• Radar • Time-based	• Radar	• Time-based

Figure 3 : Layers Definition

One SuperSector is managed by two teams each dedicated to a specific flow, e.g. one for South-North and one for East-West. Four controllers compose a team, namely:

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

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 authorized to operator.

The **Outbound Manager** is responsible from 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 to the OM is quite similar to the IM's one, so maneuvering order set is the same than the latest. This allows guarantying an 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 allover the sector. Furthermore, he has to take over the traffic when IM or OM cannot assume their contract of services for some 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. Besides 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 vectoring are allowed.

The proposed working method is a collaborative mode, where each controller is in charge of his own space 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. Controllers must achieve their contract of service, it is then necessary that each controller is able to communicate with the aircraft he is responsible of. 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 “maturity”. 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 (Figure 4).

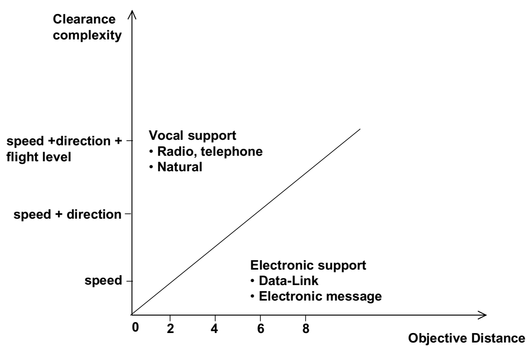

Figure 4 : Collaborative Support

Regarding safety, each controller ensures safety of the aircraft he is responsible of. Anyway, redundancies between controllers allow performing crosschecking during the sector over-flight. Layer concept also applied 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:

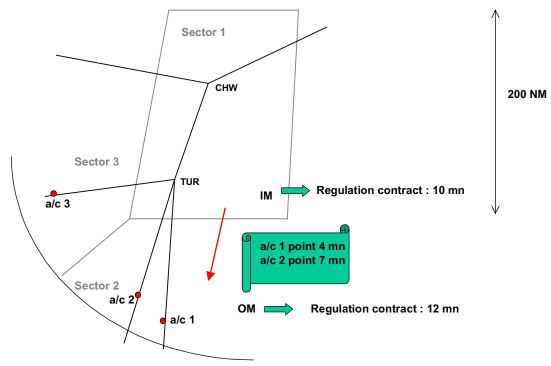

Figure 5 : Scenario

a/c1, a/c2 and a/c3 are in the 70 NM pre-active area of SuperSector 1 Inbound Manager (Figure 5). 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 6).

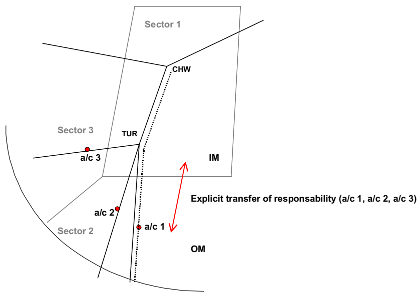

Figure 6 : Scenario

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 7).

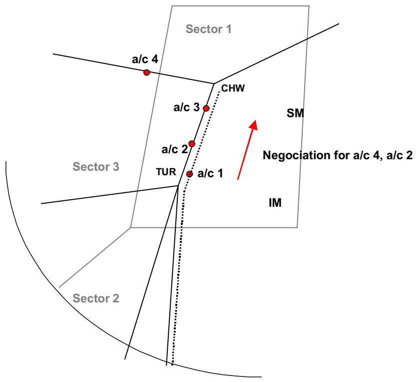

Figure 7 : Scenario

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 Conflict Manager and radar separation is applied. As previously, responsibility is kept until flight will over-fly CHW waypoint (Figure 8).

As soon as regulation separation has been achieved, either by SM or CM, and 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 is not allowing OM to achieve separation, he will negotiate with SM and CM the same way IM did.

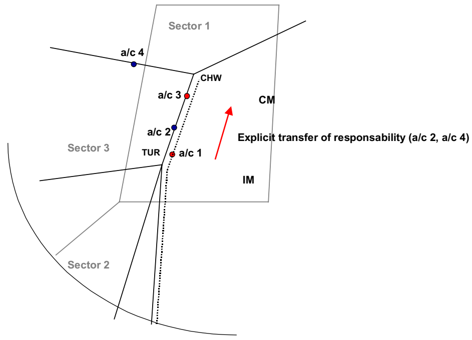

Figure 8 : Scenario

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, are managed using link routes. SM is initially responsible of those flights.

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

3.2 Airspace Design

The airspace design is constrained by the working method in order to perform more efficiently the anticipation mechanism and the network effect management. In order to perform the regulation mechanism it is proposed to define CT-pairs Trunk Route Network (TRN) (> 400 IFR/day) and secondary route network (SRN) while constraining the maximum route lengthening ratio [18].

Working methods using TRN will be to perform spacing techniques while avoiding flight level change and vectoring. Nevertheless, offset facilities (parallel route) will be provided to assume in a better way the spacing mechanisms. In consequence, offset routes will be added to the TRN when necessary. This approach consists to build group of parallel route in order to rationalize and simplify the global network.

In order to decrease strategically the number of conflict points, it is proposed to allocate strongly flight plan to flight level and to defined a new

Flight Level Allocation System (FLAS) at the European level.

The sectorization shape is constrained by the working methods and related anticipations requirements. Distance of such large sector is about 150 to 200 NM.

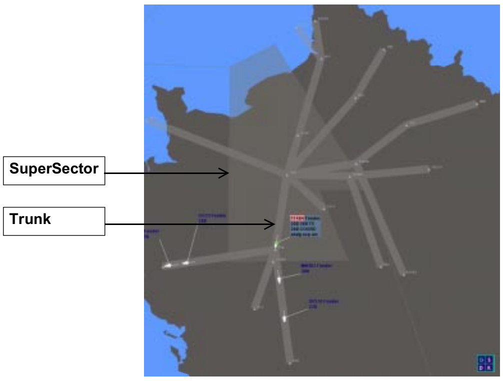

Figure 9 : SuperSector Design (France Area)

4. DISCUSSION

4.1 An evolving concept

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 [2] initiatives

4.2 Immediate expected benefits

Some immediate benefits can reasonably be expected.

- Safety, due to the airspace design and flow management aiming at reduce potential conflict, and working methods through anticipation and more explicit mechanisms to prevent problem.
- Efficiency, due to the link between the predictive and adaptive parts in order to enhance the traffic regulation
- Efficiency, due to the contract of services in which is responsible each layer.
- Efficiency, due to the global benefits of all ATC actors.

4.3 Major Issues

The gain expected through this approach is the increase of the safety, efficiency and capacity. The major issues that are still be addressed are:

- Human Factors and safety related aspects about the clear roles, responsibilities and efficiency of the controllers in the different layers;
- An airspace design optimized at the European level beyond national barriers and military constraints;
- Procedures and maneuvers applied to the aircrafts;
- Technology support tools;

5. 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 HADES[1], RAMS[2], COSAAC[3] 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.

---

[1] HADES , Help tool for Airspace DESign
[2] RAMS, Reorganized ATC Mathematical Simulator
[3] COSAAC, COmmon Simulator to assess ASM and ATFM Concepts

REFERENCE

[1] R. Graham, E. Hoffman, C. Pusch, K. Zeghal, Absolute versus Relative Navigation: Theoretical Considerations from an ATM perspective. *In proceedings of ATM Symposium 2002*, Capri Italy, September 2002

[2] ACARE, http://eu.int/comm/research/growth/ gcc/projects/in-action-acare.html

[3] SingleSky, http://europa.eu.int/comm/transport/themes/air/english/single_eur_sky_en.html

[4] P. Jacquard, Patrick Ky, Olivier Delain, Stéphanie Stoltz, Study for ATFM improvement. *IGACEM*, SOFREAVIA, 2000

[5] J. Villiers, *Perspectives for Air Traffic Control for Advanced Phases of Automation – the Method of Layers*, Navigation n° 61, Paris, 1968

[6] PHARE Medium Term Scenario, 2000 to 2015, Issue 1. EUROCONTROL July 1990

[7] N. Suarez, M. Poppe, N. Makins, TORCH: From Strategic Planning to Real-Time Optimisation, European Commission, 2002

[8] R. Graham, A. Marsden, I. Pichancourt, F. Dowling, Controller Roles - Time to Change. In *Proceedings of the 3rd USA/EUROPE ATM R&D Seminar*, Napoli, 2000

[9] S. Stoltz, P. Ky, Reducing Traffic bunching through a more Flexible Air Traffic Flow Management, In *Proceedings of the 4th USA/EUROPE ATM R& D Seminar*, Santa Fe, 2001

[10] V. Duong, G. Gawinowski, JP. Nicolaon, D. Smith, SectorLess Air Traffic Management, In *Proceedings of the 4th USA/EUROPE ATM R&D Seminar*, Santa Fe, 2001

[11] JY Grau, L. Guichard, F. Drogoul, S. Guibert, G. Gawinowski, Safety Assesment in the Validation of New Concept in Ultra-Safe System: The Air Traffic Control Example, *NATO Conference, Varsaw, 2002*

[12] RVSM, www.eur-rvsm.com

[13] E. Hoffman, K. Zeghal, A. Cloerec, I. Grimaud, Jean-Pierre Nicolaon, Operational Concepts for Limited Delegation of Separation Assurance to the Cockpit, In Proceedings of the AIAA conference, 1999.

[14] Future ATFM Measures, *FAM Operational Concept Document*, Eurocontrol Experimental Center, 2002

[15] Abdesslem et al, *Evaluation ERATO 1997-1998*. Rapport CENA/R98 842/ICC, Fev 1999

[16] Kallus K.W., Van Damme D & Dittmann A. (1999). *Task aalysis of en route controllers : Integrated task and job analysis of air traffic controllers*, phase 2, EATMP/Eurocontrol, HUM.ET1.ST01.1000-REP-04, Oct 1999

[17] Klein G.A. (1993). A recognition-primed decision (RPD) model of rapid decision making. In *G.A. Klein, J. Orasanu, R. Calderwood, & C.E. Zsambok (Eds), Decision making in action : model and methods* (pp. 138-147). Norwood, New Jersey, USA : Ablex Publishing Corporation

[18] R. Zanni, *Air Traffic Control Handbook*, Internal Note, 2002

KEYWORDS

Working methods, Safety, Airspace design, Flow regulation, Global optimization, Medium-term anticipation, Layer Planning, Contract of Services.

BIOGRAPHIES

Gilles Gawinowski is Deputy Head of the Innovative Research Business Area at the EUROCONTROL Experimental Center and is currently leading the "SuperSector" project. He received his MSc (DESS) in Computer Science (1990), and graduated in Human Factors (2000).

Jean Nobel is consultant at EEC from Transim, and is the Operational Expert of SuperSector. He had been Head Supervisor at Paris ACC, Head of Operational department at CENA, and responsible of the General Aviation bureau at DGAC. Jean is IFR two engines qualified pilot.

Jean-Yves GRAU, MD, is psychologist in aviation and consultant to EEC. He was senior scientist in the Aviation Ergonomics Department of the French Military Institute of Aerospace Medicine (IMASSA) before being consultant in human reliability. His topics of interest are human error, human-centered design, support system, and human factors training.

Didier Dohy is the software development leader of SuperSector. Consultant to EEC from Neosys, he had been project manager for data link programs VIVO III, LORADS, EASY or ABROAD.

L. Guichard, Master in Electronics (ENAC, 1986), graduated. in Human Factors in Aeronautics (Univ. Paris 5, 2000-2001). He is currently the Project Leader of HADES.

Jean-Pierre Nicolaon is Senior Operational Advisor at the EUROCONTROL Experimental Center. He had been Head of Operations at Paris ACC and had also been the Operational Advisor for ARC2000, PHARE, FREER, Wake Vortex.

Vu Duong is Head of the Innovative Research Business Area at EUROCONTROL Experimental Center. He holds a Master Degree in Engineering, and a Ph.D. degree in Artificial Intelligence, both from Ecole Nationale des Ponts et Chaussées, France.