MAMMI Phase2 - Design and evaluation test bed for collaborative practices on en-route control positions

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***Abstract*—The MAMMI project studies ways to improve the collaboration between ATCOs on the same position, using modern ATC concepts and tools, and explores new opportunities for dynamic organizations and workload management. This paper presents the problems considered by MAMMI and the design and evaluation test-bed that will help progressively introducing and evaluating new solutions, with the overall objective to get relevant operational feedback.**

***Index Terms*—multi-touch and multi-user interaction, mutual activity awareness, tasks and workload sharing, tactic planner dynamic organization, collaboration models for Air Traffic Controllers**

I. Introduction

THE MAMMI project started in June 2006 with the objective of exploring how modern control positions could benefit of:

- Improvements of the collaboration between En Route Air Traffic Controllers working as team-mates, which has not progressed, and sometimes has even decreased, on modern digital systems with consequences on situation awareness and efficiency in high workload situations,
- New organization patterns and roles for the ATCOs, providing solutions to the limits reached by the complexity management techniques consisting in reducing the size of the sectors.

These objectives are motivated by several problems detailed in this document, and they rely on the concept of Multi Actors Man Machine Interfaces (MAMMI), proposed by EUROCONTROL Experimental Centre. The MAMMI concept is composed of three principles:

1. Several ATCOs to interact collaboratively on a single en route position.
2. Real time tasks sharing and workload repartition.
3. Lesser specialization for the ATCOs.

Manuscript received September 15, 2007.

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To explore the MAMMI principles, the consortium of the project has set up several research directions, feeding a participatory and iterative process. This process involves ATCOs and ATC experts from several European countries and aims at providing semi-realistic prototypes suitable to get a relevant feedback from operational users. The prototypes are gathered in the MAMMI test-bed composed of two facets dedicated to the design and to the evaluation of solutions. The definition and the early implementation of this test-bed are presented in this paper.

II. Importance and Nature of the Collaboration between Air Traffic Controllers on Modern Operational Systems

The non-verbal communication has been shown to represent up to 50% of the whole communication acts in a highly cooperative activity such as En Route ATC [1]. Usually, non-verbal communication is done while seeing the co-worker and/or the shared environment. For example, physical co-presence enables co-workers to use multiple sorts of gestures (deictic, passing, utterance-like) that improve common understanding of the situation. Physical distance between co-workers may not weaken performances in a collaborative activity, but it leads them to engage in more demanding communication acts [3], thus requiring additional efforts in their activity. The supplemental work is done at the expense of the main activity, which may be problematic in a situation where work is complex and cognitive load is high. Furthermore, knowing that the other knows as much as oneself makes the interpretation of the other's intentions easier, which in turns makes collaboration better [5], [2]. Multimodal communication involving speech and co-located gestures is better at building mutual knowledge of sharing than speech alone [6].

As teamwork was considered a major asset of previous systems for both safety and efficiency, several questions are raised about newer systems, which rely mainly on digitalized and individualized tools. This section provides additional elements to understand the stakes and issues around teamwork and collaboration between ATCOs, toward safety and efficiency.

A. *Evolution of the airspace*

According to the on-going traffic, sectors composing the En Route airspace can be grouped or split so that the controllers

A. *Evolution of the airspace*

According to the on-going traffic, sectors composing the En Route airspace can be grouped or split so that the controllers always have to manage a reasonable number of aircrafts. This way to manage the complexity of the traffic is the most commonly practiced at the moment. However, it is reaching a limit in a sense where sectors become so small that aircrafts cross new sectors every few minutes, implying an important communication activity both between controllers and pilots for frequency change, hello/goodbye messages, etc., and between controllers from different sectors for more and more coordination purposes.

If this direction is confirmed, the current model of always smaller sectors controlled by a tactic and a planner controller might reach its limits, even with efficient sector grouping/splitting procedures. This shows the interest of studying other organisations, especially regarding the roles of tactic and planner ATCOs, and the way they collaborate.

B. *Evolution of the control positions*

On modern control positions, each controller is using his/her own interaction means, consisting in a keyboard and a mouse. The progressive disappearance of the paper strips leads to a sort of "glass cockpit" effect imposing several potential disadvantages to the ATCOs.

First, the control positions are designed for two separated users, without any direct possibility to exchange information or actively discuss on a shared support. This forces the ATCOs either to work more independently, or to make efforts to create a common context, most of the time only by voice, to exchange analysis with their team-mate. The key concept of mutual situation awareness is, by the way, only poorly supported by the modern systems, either explicitly with dedicated functions, or implicitly by natural usages that the ATCOs might have built upon the basic functionalities.

Then, as each ATCO has his/her own tools (tactic and planner have different configurations), the organisation is rigidified by the system itself. The opportunities to delegate tasks between tactic and planner are strongly conditioned by the way the system has been designed. And as the systems have not been designed with strong considerations about collaboration, ATCOs have to cope with this rigidity in their every day activity.

This provides elements indicating that adding new functionalities dedicated to collaboration might not be sufficient or relevant to provide a good collaboration. On the one hand the number of functionalities on current systems is already very high: the constraints on the training, the efficiency and the saturation of the HMIs become a real stake in this context. On the other hand, a proper introduction of this kind of functionalities requires the evaluation of the impact on the global design of the control tools offered by the control position, and maybe also on the interaction means mandatory to support the collaboration, in a way, for instance, a paper strip board used to support it. This is linked to the frequently observed situations where ATCOs under heavy workload, massively change their use of the modern digital tools and abandon most of them to rely mainly on their short term memory and cognitive resources. This presents the requirements on the tools of the control position to provide an extended flexibility for these situations and to integrate seamlessly into the ATCOs' cognitive processes.

C. *More than two controllers on the same position?*

The control positions are designed for two separated controllers. However, interviews that have been conducted since the beginning of the project on French ATCOs show that during more than 50% of the time, more than two controllers (generally three) are working on the same control position at the same moment. The third controller can be there either for training or to help managing the on-going traffic. This simple fact reveals that thinking a control position for two users only is limiting and does not really help the efficiency or the collaboration, especially when the controllers really need it, during (not so) unusual situations.

In the same way, having a third controller on a given control position implies a new repartition of the roles compared to the one foreseen for tactic and planner team-mates. This suggests first a need for the control tools and devices to support this new and dynamic organisation. Then, even when only two ATCOs are on the position, it might be possible to provide them with an additional flexibility they could take advantage of.

D. *Nature of the collaboration*

Several studies [7], [8] have extensively explored the cognitive mechanisms used by the ATCOs. They describe how the ATCOs manage information, use their memory, and how their cognitive workload evolves. In parallel, the training received by the ATCOs includes rules and principles for the collaboration between tactic and planner, and with other sectors, based on the tools available on a control position.

However, only few studies focus on the real-time collaboration between En Route ATCOs. And when they do, the associated recommendations are based either on the modification of the practices or on the evaluation of specific functionalities (new or not) without an objective of designing a homogenous set of tools that would really be collaboration-oriented.

The first consequence is that, based on these studies, it is particularly difficult to get a global vision of the collaboration between En Route controllers. The actual practices of the controllers and the way they use their system to collaborate has been barely described, because they are hard to capture, especially when they have not been foreseen by the system designers initially. Output from a recently launched study of EUROCONTROL could provide interesting information on this topic (TRS T07/11041SA "Team Coordination study" to be started on 7/1/7).

The second consequence is that on a system that is neither collaboration-centred, nor designed to enable some flexibility, the ATCOs have to circumvent the limits of the system, by imagining solutions on their own. This phenomenon is not the sign of a non-adapted system but it authorises to think that a collaboration-friendly system, imagined from the beginning to facilitate collaboration, could enable to take advantage of both modern (with real added value) and old (with flexibility and good situation awareness) systems.

These considerations raise the need to explore the collaboration between ATCOs on the same position under a new scope, oriented on real-time operations and with a more global approach including all facets of the control activity, in order to provide first a relevant analysis and then adapted design solutions. This challenge requires an adapted strategy, inline with the resources of the MAMMI project and the current state of the art for the collaborative practices. This strategy is presented in the next part.

III. A TEST-BED FOR THE DESIGN AND THE EVALUATION

The MAMMI test-bed is the global result of the first year of the project. It puts together the technological, software and HMI resources to create a couple of frameworks suitable to experiment and evaluate the MAMMI principles and solutions. This chapter presents the first version of the test-bed composed of:

- The design framework which enables to produce and expose design solutions to the ATCOs and ATC experts. It provides the necessary components to iteratively compose an innovative control position oriented toward the collaboration between ATCOs around the MAMMI principles.
- The evaluation framework which enables to run the design solutions in a semi-realistic context, based on recorded traffic to put the ATCOs in almost operational conditions so that they can provide an accurate feedback.

A. *Why a test-bed approach?*

The previous chapter shows the difficulty to find recent exploitation data for the collaborative practices between ATCOs in the different European control centres. The MAMMI project might not have sufficient resources to generate these data. To cope with this constraint while producing relevant solutions, the MAMMI partners have chosen a participative and iterative methodology, supported by rapid prototyping techniques. This means that the design process is animated by a continuous involvement of the end-users, i.e. the ATCOs. They are involved in the production of solutions and in their almost immediate evaluation. This requires an environment that is modular and reactive enough to support this flexibility.

The MAMMI test-bed enables to introduce and evaluate progressively the different facets of the foreseen collaborative control position, without waiting for a complete set to be available and avoiding any long break in the participation of the ATCOs.

All the efforts engaged in this first half of the project were to design this test-bed which is meant to become the major asset for the final success of the project and the evaluation phases.

B. *The design framework*

At this stage of the project, the design framework serves as a proof of concept providing a first set of components paving the way to a more complete control position. These first components have been imagined based upon interviews and design sessions with the ATCOs and ATC experts. They provide basic concepts for the collaboration and raise questions to be answered later on in the project with experimentations where they will be used by ATCOs facing recorded Air Traffic, as explained in 0.

1) *High level organization of the position*

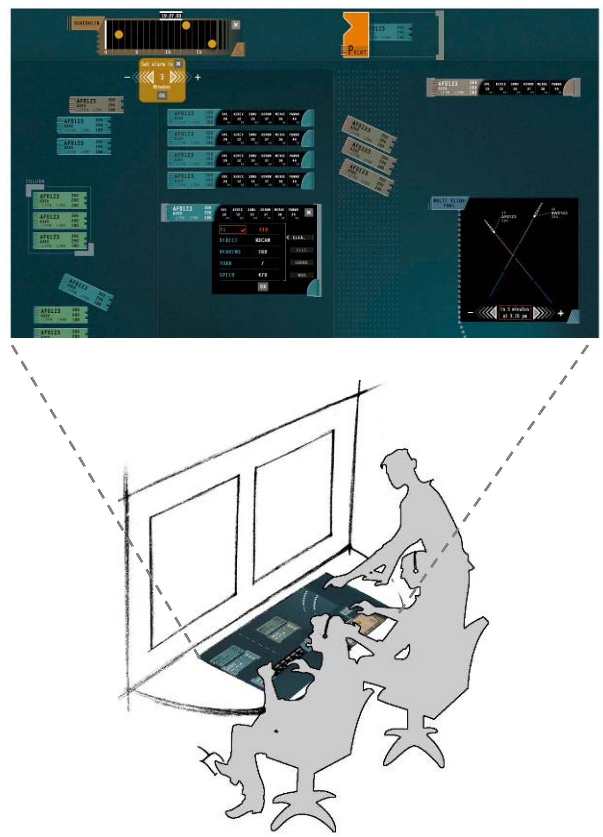

Fig. 1. A potential MAMMI position

The hardware arrangement foreseen for a MAMMI control position is the following:

- Two radar displays are presented vertically on the position. They serve as a reference view of the traffic situation and are dedicated to information visualisation rather than data input. Each display can be configured separately to fit the needs of the ATCO using it.
- A horizontal shared surface is placed below the radar displays. It centralises the input means on the control position, provides all the control tools and enables to setup the radar displays. This shared surface can be used by more than two ATCOs if needed.

This hardware configuration is taken as a base for our design solutions. It will evolve in the next years according to the needs and functionalities that will be considered.

2) Flights representation and life cycle

The first concept to define on a control position is the way the flight data are represented and managed. We propose here that each flight is represented by a label, which serves as an entry point for the access to information and some functionality. The labels appear in a printer and are destroyed when dropped onto a shoot box. This set of interactions based on direct manipulation and supported by an advanced graphic design, has been proved [9], [10] to be specifically adapted to the collaboration between ATCOs.

Fig. 2. A label

Fig. 3. The printer

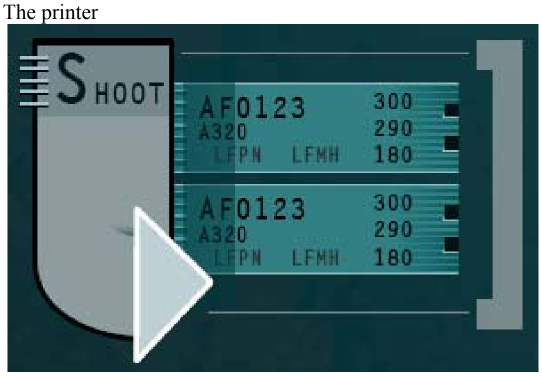

Fig. 4. The shoot box

The labels are moved when a user presses their left part with his/her finger and moves it.

The labels offer an extended view, which could be qualified as a 'strip view', enabling to show the route of the represented flight. The switch between the standard view and the strip view is achieved with a two fingers interaction or by placing the label on specific areas as explained here below.

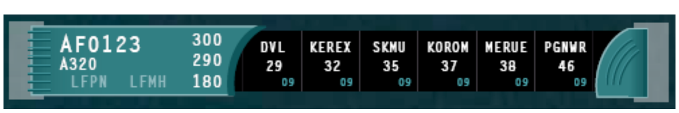

Fig. 5. The strip view for a label

The labels can also be rotated with a two fingers interaction. This enables an ATCO to catch the attention of his/her team-mate on specific flights with minimum effort.

Fig. 6. A rotated label

ATCOs can also take into account a flight explicitly. This is a reproduction of a classical and fundamental action used on paper strips to indicate to the team-mate that the flight is acknowledged and that the context it brings with it is correctly understood.

Finally, we propose to select the labels with the effect of giving feedback of this selection on the radar display, by highlighting the flight and display its route. A selection by a given user will be displayed on his/her display. If a user selects several flights at the same time (through multi-fingers interaction), these flights are all highlighted on the radar display.

QuickTime™ et un
décompresseur TIFF (non compressé)
sont requis pour visionner cette image.

Fig. 7. Labels with different feedbacks

The representation of the flights and the way they can be manipulated and highlighted are key factors for the construction of mutual situation awareness on the control position. The direct manipulation with fingers is much more easily perceived by team-mates than manipulations with a keyboard and a mouse.

The natural capability to organize the labels on the horizontal surface enables a natural share of the surface between private spaces for each controller and common spaces used for exchanges. The usual life cycle of the labels can thus be easily reproduced and even extended.

The way the ATCO will be able to use all the possibilities of the manipulation, of the orientation and the different highlighters to create their own language and communicate one with the others will be a major part of the MAMMI results.

3) Writing pad and columns for the underlying organisation

The organisation of the labels over the shared surface can be supported in different manners. The first one we propose here is a writing pad filling the background of the surface. This writing pad provides static information and is not meant to be interactive, just like a physical writing pad, laying on a desktop, can be. Several writing pads have already been considered:

- Geographical, representing a sector, its boundaries and its beacons. It enables to organise the labels with a geographical approach, easily indicating for instance conflicts areas and entry points for the flights.

- Workflow, representing different areas associated to a state of the flight. It is close to the use of existing paper strip boards with richer possibilities like an adaptation of the visualisation (standard vs. 'strip view') according to the position of the labels.
- Terminal sectors, to organise the flight according to their Flight Level, as shown, for instance, in the ASTER prototype from DSNA/DTI/R&D.

The second element for the organisation is the mobile column. This can be seen as a mobile container suitable to move or manage several labels at the same time. Depending on the writing pad, it could be used for instance to create stacks or to sort the flights by routes, flows, etc.

Fig. 8. A column with three labels

In this approach for the organization, we provide the ATCOs with an important flexibility, sustained by a given writing pad giving the global framework. The test-bed will enable the following observations:

- Evaluation and creation of new writing pads which will also provide interesting information on how the ATCOs organise their workspace when they are free to do so, even dynamically.
- Use of columns for a more personalised, individual and quick organisation. The meanings associated to the columns will also enable to express and experiment the classification techniques used by the ATCOs, especially in a collaborative context.

4) Clearances, modifications, tools and concept of association

Beyond the organisation of the flights, ATCOs also need to input data or use advanced tools to improve their perception and their analysis of the on-going traffic. Our initial proposition consists in two components:

- The input tool, enabling to operate clearances, modifications, coordinations, etc. to a specific (set of) flight(s). This tool is available within each label and independently (see below).
- The multi-flight tool, enabling to access advanced functionalities related to several flights. At the moment and as a proof of concept, we propose only a separation tool, which provides a representation to detect if several flights are conflicting and when.

The proposed way to summon these tools is explained here below.

To trigger the functions brought by the input tool and the multiflight tool on specific flights, we introduced the interaction of association: the left part of each label and the writing pad enable to draw curves when a user moves his/her finger on the interactive surface. This enables to create visual links between the different objects like labels and tools. A link between several labels and a tool will be interpreted as a call of the functionality provided by the tool on the concerned labels. This will initialise the tool with the appropriate parameters to be executed.

Fig. 9. The input tool integrated with a label

The interaction of association has already been refined to be robust to the crossing of unwanted objects (through a "short break" algorithm) and to be efficient in a multi-user context with each user having his/her own space.

The main objective of the interaction of association is to give a quick and flexible way to associate objects without needing to move them, knowing that the place of each object is already conditioned by other aspects (classifications, workflows, etc.).

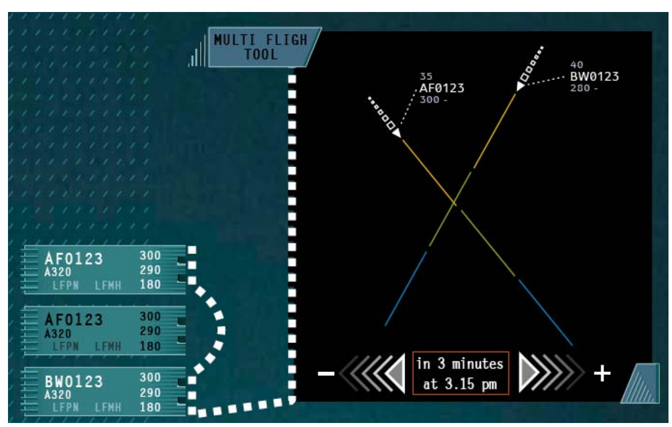

Fig. 10. The multi-flight tool associated with two labels

The global frame defined for the tools gives a large set of opportunities to integrate functionalities proposed by existing systems. Coupled to the capacity to summon and hide tools easily so that the ATCOs always have the right set of tools, this will enable:

- to establish what these set of tools are in the different situations
- to extend the set of tools with potentially missing functionalities
- to minimise the redundancy of information and functionalities on the control position

The interaction of association will also serve as a base for a graphical language whose first extensions are presented later in this paper. The objective upon this idea is to enable the construction of a real language to be used by the ATCOs to compose kinds of sentences corresponding to the tasks they have to achieve. In this perspective, we will try to add a new dimension to the use of ATC tools that is completely missing in existing systems and we would stay compatible with our collaborative context (composition of sentences between several ATCOs).

5) Dynamic invocation pattern

In addition to representations of flights and the tools, ATCOs need to memorise specific information, create notifications (warnings, etc.), apply functions and specific clearances (shoot, direct, change frequency, etc.), all this for a certain number of flights. To study these possibilities, we propose to add a new type of objects called invokers. The invokers are created by gesture recognition on the writing pad. According to the recognized gesture the proper invoker is created.

Then, the invoker can be moved on the interactive surface like any other object. Placed in proximity of other objects and the interpretation by the ATCOs, it can modify its meaning. For instance, a warning invoker placed nearby two flights can indicate a conflict between these two flights, whereas placed over a precise area on the geographical writing pad, it can indicate a thunderstorm.

Fig. 11. The three states of the warning invoker

The invokers are compatible with the interaction of association. According to the type of invoker, an association can mean an actual association or can be interpreted by the system to trigger functions. For instance, a warning invoker associated with two labels will indicate that the warning concerns the two flights represented by the labels. A shoot invoker associated with two labels will send the two labels automatically in the shoot box.

Specific gestures over the writing pad are also used to summon the tools. An interesting point is that the size of the gesture enables to determine the desired size for the tool and the origin of the gesture indicates the position of the tool.

The concept of invoker is the less mature at the moment. This is mainly due to the complexity in the definition and the consistent integration of the different types of invokers, balanced with the definition of tools to avoid any overlap. However, the example of the warning invoker has caught the interest of the ATCOs with a set of actions they achieve frequently on the flights (e.g. force the heading of a flight, set a direct route, change the frequency, etc.). Representing these actions by invokers could significantly lighten some of their most frequent tasks.

6) Time management and notifications

Helping the controllers to anticipate and organise their activity is one of the major stakes of every control position. In our design, we had also to consider all the collaborative aspects and the already introduced concepts. This led us to the concept of scheduler. It is based on a horizontal timeline showing from 0 (now) to several minutes in the future. The length of the timeline can be adjusted.

The scheduler is designed to manage entries that are placed with a chosen duration in the future. The entries then move automatically to the present time. The insertion of a new entry in the scheduler is achieved with the interaction of association. The ATCOs can create an association of several objects and include the scheduler in this association. When the association is completed, a popup is displayed below the scheduler to select duration. When the duration is chosen, the entry is placed accordingly in the timeline. When the time is up for a given entry, a popup is displayed, remembering the list of objects (names or callsigns depending on their type) initially associated to the entry. The ATCOs have the possibility to highlight these objects for a quicker perception.

The associations between the scheduler and other tools may also have a signification. For instance, an association between our multi-flight tool and the scheduler will pre-configure automatically the duration for the entry with the extrapolation time used on the multi-flight tool and the labels used in the tool will be recalled when the entry runs out of time. An entry can be moved or removed by direct manipulation on the timeline even after its creation.

The scheduler has been designed to be extremely flexible both toward its integration with the other concepts and its use by several ATCOs at the same time. With this flexibility, it should enable to observe and provide solutions for the time management on a control position.

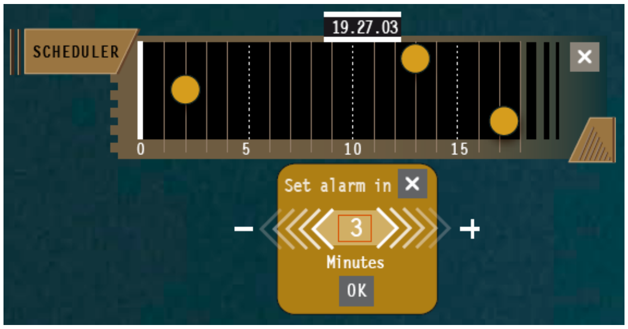

Fig. 12. The scheduler with several entries and a popup

The consistency between the scheduler and the other objects will also enable to position the time management in the panorama of the different concepts and to show the interactions between the time and these concepts to get an accurate design.

7) Perspectives for the ATC usages and the design

On the ATC side, the design framework aims at providing all the mandatory elements to explore the three MAMMI principles presented here above:

- More than 2 ATCOs - the tools and interaction concepts as they have been designed are usable by several users at the same time without any consideration on the number of users. All the objects are all movable to configure the shared workspace easily, even with the possibility to distinguish different areas.
- Dynamic workload repartition - upon the natural flexibility of the tools, which is a mandatory feature providing real opportunities for a dynamic distribution of the activity, the introduction of a shared scheduler will enable, to evaluate more explicitly the anticipation and the delegation of the different tasks completed by the ATCOs.
- Lesser specialisation - the list of provided tools comes from an analysis of the current activity with a tactic and a planner controller. However, the proposed tools and solutions do not make a difference between these roles. This will enable any ATCO to potentially use any tool at any time, providing a flexible framework to explore a lesser specialization of the roles.

On the HMI side, in addition to the design perspectives mentioned above, the project will need to focus on the following directions:

- The organisation of the labels on the workspace will certainly need to be assisted to improve the comfort of the ATCOs. This issue will be explored by the introduction of new objects like magnetic lines or auto-arrangement invokers applicable to selections of labels. These objects will be prototyped in the next six months.
- The feedback and the progression of actions, defined as a requirement, need also to be included carefully, once the concepts for the inputs are well defined. Especially, it will consist in an enrichment of the input tool.
- The preparation of actions (particularly clearances) will also be introduced to explore the possibilities of delegations and anticipations. These concepts will be linked with the use of the scheduler.

C. The evaluation framework

The evaluation framework aims at enabling an efficient and relevant feedback from the ATCOs regarding the proposed design solutions, progressively forming a collaborative control position. To get this feedback, the evaluation framework relies on two main achievements:

- The simulation requires setting up semi-realistic traffic scenarios, so that the ATCOs can be put in a situation where the solutions can actually be tested. And these scenarios have to be supported by instrumented replay tools that support dynamic changes.
- The experimentation of the design solutions is also considered. This experimentation will be based on the traffic scenarios but will also include the collaboration models. As stated previously, these models aim at providing tracks for the design but also at assessing the benefits of our solutions regarding the way the workforce is spent and the opportunities to parallelize the tasks.

1) Simulated control environment

The MAMMI test-bed includes a reference radar display. This radar display application is adapted from previous achievements at DSNA/DTI/R&D (former Centre d'Etudes de la Navigation Aérienne) dedicated to the experimentations with ATCOs. It is also used in the on-going ERASMUS project led by Eurocontrol.

The radar display and the MAMMI software are powered by an application, also provided by DSNA/DTI/R&D and supporting the ASTERIX format to replay real recorded traffic, in accordance with the sectors to be managed by ATCOs in the chosen scenarios and showed on the radar display.

The gathering of two radar displays, the MAMMI software prototypes and the replay application forms an experimental control position that is suitable for our evaluation and experimentation sessions with operational ATCOs, based on semi-realistic traffic situations.

2) Instrumentation of the simulated environment

All the technical aspects of the evaluation framework are already working. The second step is to set up the theoretical and experimental background for the observations themselves. This will be achieved by the end of 2007, in parallel of the completion of the design.

3) Definition of the traffic scenarios

The MAMMI objectives include the assessment of the MAMMI benefits compared to existing solutions. They include also the evaluation of different principles and configurations (roles, number of ATCOs, etc.). This variability requires the definition of traffic scenarios that are large and complete enough to enable comparisons between the different configurations.

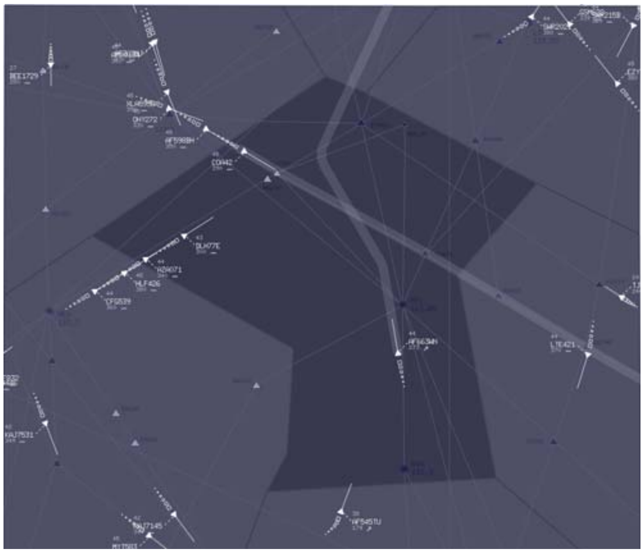

Fig. 13. The radar display

We might for example consider scenarios involving three sectors that could be grouped or even merged. The scenarios will also have to provide a sufficient and representative number of situations including conflicts, inter-sector coordinations, etc. Operational ATCOs and ATC experts already participating to the project are involved in the definition of the scenarios and the selection of the traffic to be replayed.

4) Evolution of the collaboration models

The evaluation framework will first contribute to extend and finalize the collaboration models –that are not presented in this paper as they are not fundamental to expose our current work-, following the evolutions of the design and the adaptations to the different traffic scenarios. Once they are ready, they will be integrated in an experimentation protocol for a more complete assessment, addressing some quantitative aspects. The collaboration models will be the key elements to be used for the analysis different tested solutions.

5) Emergence of solutions and formal validation

The evaluation framework is used as a hybrid. It first informs the designers on the usages of the ATCOs facing the traffic scenarios. The designers include the results of these (basic) experimentations to improve the design from an HMI point of view (quality of the interaction, of the presented information, etc.) and to refine the MAMMI concepts by a cross analysis of the different configurations.

Then, in the last phases of the project, the Human Factors specialists will define a test protocol. This protocol will rely on the collaboration models and will define objective and (some) quantitative variables to conclude, as much as possible according to the resources of the project, on the benefits brought by the MAMMI principles.

IV. Conclusion

Previous studies on collaborative practices between ATCOs on paper-based or older environments show the importance and the interest to understand the collaborative behaviours on current operational positions. In parallel, the natural evolution of the air traffic system shows an arising need to imagine new organisations for the ATCOs to provide alternatives to the reduction of the sectors sizes.

The MAMMI principles proposed by the EUROCONTROL Experimental Centre aim at leading the study in these directions through the use of multi-user and multi-touch surfaces that are relevant, although still experimental, technologies. The novelty of the technologies and the solutions they enable, combined with a relative lack of studies on current collaborative practices used on operational control positions justify an adapted strategy around a test-bed providing means for the implementation and the evaluation of features that enable to reintroduce collaboration-oriented solutions on fully digital air traffic control environments.

The MAMMI project is currently focused on the production and refinement of innovative solutions. The design presented in this paper is the result of 14 months of work, started from scratch in June 2006, knowing that MAMMI is the very first project exploring global collaborative solutions for the air traffic control positions on such hardware as shared surfaces. A new version of the MAMMI test-bed will be achieved until December 2007 and demonstrated at the 6th EUROCONTROL INO Workshop. This version will include the first feedback and comments from the operational ATCOs involved in the project, based on simple traffic scenarios. And this version will also be tested by these ATCOs to engage the next design iteration.

The evaluation side of the test bed is necessarily less advanced as it relies on the design framework to make progress. Moreover, it requires a functional enough position to enable relevant tests with ATCOs. The evaluation framework will be operational for the first time in the December version of the test-bed. After that, the iterations and exchanges between design and evaluation will become quicker and will thus enable a faster convergence to the objectives of the project.

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