TORCH: from Strategic Planning to Real-Time Optimisation

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To ensure that available capacity is managed as efficiently as possible, TORCH promotes to exchange more transparently available data to ensure that the distribution of information and decision making is located where it is most effective. This article presents an overview of the work carried out, with the aim of avoiding unstable scheduling delays through open, cooperative management of scarce ATM capacity.

he TORCH (Technical, Economical, and Operational Assessment of an ATM Concept Achievable from the year 2005) Operational Concept is based on two main pillars: an improvement in the planning phases through the introduction of layered planning and Collaborative Decision Making (CDM) procedures, and reducing the workload per aircraft of the tactical controller by introducing computer enhanced tools.

The TORCH project – co-funded by the European Commission Directorate General for Transport and Energy – identifies and assesses the viability of a European ATM/CNS Concept for the medium term timeframe based on EUROCONTROL's ATM 2000+ Strategy [1] and Operational Concept Document [2]. The TORCH consortium comprises twelve organisations that include representatives from almost all ATM sectors.

The main objective of TORCH is the definition of an Operational Concept that is viable from socio-economical, operational and technical points of view. The results from TORCH will require further research geared towards the final validation of the concept.

The Operational Concept proposed by TORCH is structured around two main pillars. The first pillar of the Operational Concept proposes a *continuous layered planning* based on a more flexible use of airspace and a stronger involvement of the actors. The objective is to optimise the management of the available resources instead of constraining the demand. Decisions are shifted into non-time-critical phases through enhanced co-ordination among all actors, thus reducing the need for time critical 'ad-hoc' decisions.

The second pillar of the Operational Concept deals with *Tactical Planning*. The Daily Operational Plan (DOP) ensures an enlarged planning horizon on Air Traffic Control centre and on (multi-) sector level. Unforeseen events not yet contained in DOP will be taken into account by re-planning actions. This will be achieved with new tools like the Traffic Load Analyser or the Medium Term Conflict Detection, which are being fed with more precise, real time updated data. There will be a shift of tasks and new roles will emerge around tactical flow planning. The ultimate goal is the reduction of the traffic complexity in the sector, thus reducing the workload of the air traffic controller. This should lead to improved sector throughput and an increase in capacity, including airport and TMA operations.

First pillar: Continuous Layered Planning

The idea of the Layered Planning Process is presented as a continuous Demand and Capacity Management process. It consists of four layers. The first layer (*Central Air Traffic Flow Management* (ATFM)) is performed during the pre-tactical flight phase. The second (*Tactical Centre Planning*) and third (*Multi-Sector Planning*) layers are performed during the tactical flight phase. The final layer contains real-time operations.

Continuous real-time updates (Re-Planning) to changing parameters[1] will be received through a layered planning process.

Situational awareness will be provided to the actors from the planning point of view by passing the information transparently from layer to layer in order to help them in the decision-making process. If potential bottlenecks are predicted users may carry out 'What-If' simulations to help them decide whether to change their planning.

Higher planning accuracy will reduce unexpected changes in real-time operations and thus allow operating critical resources close to their theoretical maximum. Decisions will be made in a non-time-critical phase, considering user preferences through Collaborative Decision-Making (CDM) processes. This will be an improvement with respect to the current situation in which too many decisions are solved in a time-critical phase. 'Ad hoc' decisions should be reduced to a minimum.

Pre-Tactical Central ATFM

The key enabler of the Layered Planning (*figure 1*) will be the Daily Operational Plan (DOP). It will be developed at the ATFM Layer and will be the main input for all subsequent layers. The main objectives of the DOP will be:

1. Because of network effects, last minute changes can generate significant changes across the system.

- to enable a more accurate and more balanced layered planning process;
- to provide an early balance of demand and capacity-the DOP will be concluded one day prior to operations and will be updated during the day of operations;
- to make better use of available capacity;
- to involve all airspace users in its development, providing:
- transparent decision making;
- synchronisation of data.

The implementation of the DOP principle is intended to shift planning complexity into non-time-critical planning phases.

The system will analyse the available capacity to define a number of configuration options for the allocation of resources in terms of geographic location, time, traffic mix and density. The anticipated capacity of the ATM system will be used as input for capacity management to meet demand. As compared with the current CFMU functionality, these processes will extend the functionality through the enlarged planning horizon and using more accurate information.

The development and implementation of the Daily Operational Plan will consist of air traffic situation simulations, the adjustment of capacity versus Demand, and calculation and distribution of the DOP. Differences from current practice include the integration of already available actor tools (e.g., airline flight planning and dispatch tools), the transparency of the DOP development process through actor access rights, detection of the bottlenecks and dynamic updates through re-planning actions.

Tactical Centre and Multi-Sector Planning

The main objectives of these two layers are:

- to close the current planning gap between Flow and Capacity Management (at pre-tactical and tactical levels) on one and real-time operations on the other hand;
- to pave the way for more autonomous aircraft operations and towards a more flexible use of airspace.

Local Tactical Planning at centre and (multi-) sector level will encompass *En-Route Planning and Terminal Area Sequencing* operations. This includes new functions such as Departure and Arrival Management or En-Route Metering.

Sector capacities will not be quoted as fixed values, as they are today, but as a range of values. This should allow for the definition of sectors and areas of responsibility to be changed according to demand at an early stage of planning. As the planning process progresses, capacities will increasingly be tailored to requirements. To support this model, the ability of the ATM system to illustrate and support this planning process and the ability of control personnel to adapt to a flexible-working environment is paramount.

In order to optimise the sectors, the control centre planning will need the capability to forecast the situation for a timeframe of around 2 hours. This could be achieved through new planning tools such as the Traffic Load Analyser and the Workload Predictor. They must not only be able to analyse expected traffic, but also to create workload profiles and make suggestions for the optimum use of resources (definition of sectors, distribution of roles). With a time horizon of 2 hours, these tools will not be able to recognise conflicts but rather identify overload and underload situations, as well as plan traffic peaks at supra-centre level.

Medium Term Conflict Detection, which will be available as a planning tool from around 2004 onwards, will cover a forecasting timeframe of approximately 30 minutes. It will allow the multi-sector planner to plan the traffic over several sectors and thus, among other things, to offer optimum support to timed approaches to hub airports (together with Arrival Management tools).

Real Time Operation: re-planning

During the day of operation, planning inaccuracies and unforeseen events, (e.g., fast changing weather conditions or new flights not yet contained in the DOP) will require real-time re-planning by all involved actors. The responsibility for decision-making at each layer is related to the magnitude of the event and the availability of the 'best' information (especially in the light of rapidly changing conditions like weather). Often a central planning unit reacts too slow and is not flexible enough to changing local conditions[2].

Re-planning actions and local optimisation will take place between the time of distributing the DOP (prior to the day of operation) and the individual event. The level of the involved ATS-units will range from individual planning at centre or multi-sector levels, to integrated planning carried out at the ATFM level. At major airports, new tools - so-called Local Decision Support Tools - are expected to be implemented, providing common data base, situational awareness and decision making.

Since the opportunities for analysis are so extensive, it is expected that there will be considerable scope of optimisation.

Second pillar: Tactical Flow Planning

Tactical Planning encompasses En-Route Planning, Terminal Area Sequencing and Real-Time operations. The ultimate goal of tactical flow planning is the reduction of the traffic complexity in the sector, thus reducing the workload of the air traffic controller as well as leading to improved sector throughput and an increase in capacity. This objective will imply a shift of tasks and new roles that will emerge around tactical flow planning.

A re-planning layer will close the current gap between planning and execution. Feedback loops between real time operations and re-planning will allow local optimisation actions when a central system reacts too slowly or does not provide accurate data in real time.

2. Take as example a flight MUC-HAM. Today flow regulations are imposed by CFMU but better situational awareness is available at centre level. Consequently, decisions should be taken there, e.g. adjustment of the departure time or sector entry time.