Real-time simulations in support of the Point Merge live trials in Paris ACC

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Abstract

The present document reports on a study carried out at EUROCONTROL in preparation for the live trials to be conducted at Paris ACC with Paris CDG, Maastricht UAC and Brussels ACC. The objective of the live trials will be to evaluate the use of Point Merge in ACC with AMAN for sequencing Northern arrival flows to Paris CDG.

The study consisted of series of small scale real-time simulations that enabled the refinement and validation of design, procedures and working methods. It showed that Point Merge is applicable to Paris ACC NE and NW arrival sectors and compatible with AMAN. Key results are potential safety and capacity benefits in ACC and improved sequencing in approach, with neutral impact on flight efficiency.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
A. Trzmiel – EUROCONTROL DSR	Validation	19/09/2012
L. Rognin – EUROCONTROL DSR	Validation	
F. Vergne – EUROCONTROL DSR	Ops	
K. Zeghal – EUROCONTROL DSR	Point Merge	

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
B. Favennec – EUROCONTROL DSR	5.6.7 Point of contact	
E. Hoffman – EUROCONTROL DSR	ATS unit deputy	

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
<Name / Company>	<Position / Title>	<DD/MM/YYYY>

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
<Name / Company>	<Position / Title>	<DD/MM/YYYY>

Rejected By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
<Name / Company>	<Position / Title>	<DD/MM/YYYY>

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Executive summary

The present document reports on the study carried out in 2011 at EUROCONTROL in preparation for the live trials to be conducted in 2012 at Paris ACC with Paris CDG, Maastricht UAC and Brussels ACC (SJU project 05.06.07, exercise 427). The objective of the live trials will be to evaluate the use of Point Merge in ACC with AMAN for sequencing Northern arrival flows to Paris CDG.

The study was conducted jointly by DSNA (Paris ACC, Paris CDG and DTI) and EUROCONTROL (DSR) with the support of Belgocontrol. The objective was to refine and validate design, procedures and working methods, and to perform an initial benefit assessment. The study consisted of a series of small scale simulations iteratively focussing on NE then NW arrival sectors prior integrating approach sectors with an AMAN. It was conducted over five months (March to July 2011) and involved Paris ACC and Paris CDG controllers (27 in total).

Overall, the outcomes from the sessions were consistent and positive. The iterative process and continuity of participants allowed gradually testing and refining the new route structure and working method, with an efficient participation of the controllers that were fully familiarised and trained. The final design, consistent between NE and NW sectors, relies a Point Merge to sequence the main arrival flow (LFPG arrivals) and segregated routes for secondary arrival flows.

The main benefits reported by ACC controllers were confirmed by objective analysis: easiness, better task allocation in NE, reduction of workload and communication, and potential for safety and capacity increase. The main limitations were: compatibility with existing delivery conditions by upstream sectors in NE and potential interactions overflights in NW.

In Approach, the general feedback was positive with potentially an improvement of the situation compared to today due to better arrival traffic sequencing through better adherence to AMAN advisories in ACC.

In terms of flight efficiency, no significant impact on the overall distance and time flown was measured while aircraft are maintained at higher altitude and flying more predictable trajectories.

1 Introduction

1.1 Purpose of the document

The present document reports on the study carried out in 2011 at EEC in preparation for the live trials to be conducted in 2012 at Paris ACC with Paris CDG, Maastricht UAC and Brussels ACC (SJU project 05.06.07, exercise 427).

The objective of the live trials will be to evaluate the use of Point Merge in ACC with AMAN for sequencing Northern arrival flows to Paris CDG.

The objective of the present study was to refine and validate design, procedures and working methods, and perform an initial benefit assessment, through a series of small scale real-time simulations.

The study was conducted jointly by DSNA (Paris ACC, Paris CDG and DTI) and EUROCONTROL (DSR) with the support of Belgocontrol.

The document is organised as follows:

- Section 2 presents the context of the study.
- Section 3 outlines the main elements of Point Merge.
- Section 4 details the overall operational environment.
- Sections 5 to 12 present the outcomes of each session.
- Section 13 summarises the main findings.

The annexes contain the transcription of post-simulation questionnaires.

1.2 Intended readership

Partners involved in WP5 and 5.6.x projects in relation with queue management, arrival manager, Precision area navigation (P-RNAV), continuous descent and Point Merge.

1.3 Inputs from other projects

The present study relies on a previous study conducted in 2009-2010 by DSNA and EUROCONTROL [2].

1.4 Glossary of terms

None

1.5 Acronyms and Terminology

Term	Definition
ACC	Area Control Centre
AMAN	Arrival manager
ATM	Air Traffic Management
CDA	Continuous descent approach
CDG	Charles De Gaulle
E-TMA	Extended TMA
E-ATMS	European Air Traffic Management System
EXC	Executive controller
FAB	Functional Airspace Block
FABEC	FAB Europe Central
FL	Flight level
FMS	Flight management system
IAF	Initial approach fix
IAS	Indicated airspeed
MUAC	Maastricht Upper Area Control Centre
PLC	Planning controller
PMS	Point Merge system
P-RNAV	Precision RNAV
RNAV	Area navigation
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
TMA	Terminal control area

2 Overview of the study

2.1 Background

The present study relies on a previous study conducted in 2009-2010 by DSNA and EUROCONTROL which investigated the potential applicability, benefits and limitations of Point Merge for ACC arrival sectors [2]. The environment was based on the Paris ACC sectors feeding the Paris TMA from the North East ("TE" and "AP").

In this previous study, it has been shown that Point Merge was applicable to ACC arrival sectors, with substantial potential to improve safety and increase capacity, without increasing distance flown. It was also highlighted that careful consideration should be given to the vertical aspects, including entry conditions. It was stated also that further studies would be necessary to confirm the applicability of Point Merge on other sectors and with full scale arrival manager operations.

At that time and considering these positive outcomes, DSNA was envisaging further investigations in view of possible implementation to support the sequencing of Northern arrival flows for Paris CDG.

This interest led to the present study and the forthcoming live trials, in the context of project 5.6.7 addressing "Enhance Queue Management through a first integration of individual elements" (here Point Merge and AMAN).

2.2 Validation approach

The sectors of interest were the **NE** and **NW** sectors of Paris ACC (respectively AP+TE and TP; UK-UZ not impacted). These sectors performed the sequencing of Northern arrival flows to Paris CDG/TMA within the AMAN horizon (MAESTRO).

Specific Point Merge designs were developed by DSNA for **NE** and **NW** sectors.

Paris TMA remained unchanged. The APP North positions of Paris CDG (INI and ITM) were part of the validation as well as the AMAN position (sequence manager) to assess any impact on delivery conditions.

Upstream sectors of MUAC and Brussels ACC feeding Paris ACC were not part of the validation environment. It should be noted however that transfer conditions were modified.

As part of an iterative approach, it was decided to consider NE and NW separately prior integration with APP. Schematically, the study was split in three phases (partly overlapping):

- Operational feasibility in **NE** and impact in APP – This may be considered as an update of the previous study (same sectors with some changes).
- Operational feasibility in **NW** and impact in APP – This was a validation of a Point Merge design on a new sector (smaller sector than NE, one frequency).
- Benefits and limitations of **NE+NW+APP** – This consisted of initial measurements of NE, NW and APP with AMAN, against a baseline.

The study was composed of eight small scale real-time simulations ("prototyping sessions") conducted at the EEC between March and June 2011 (Figure 1).

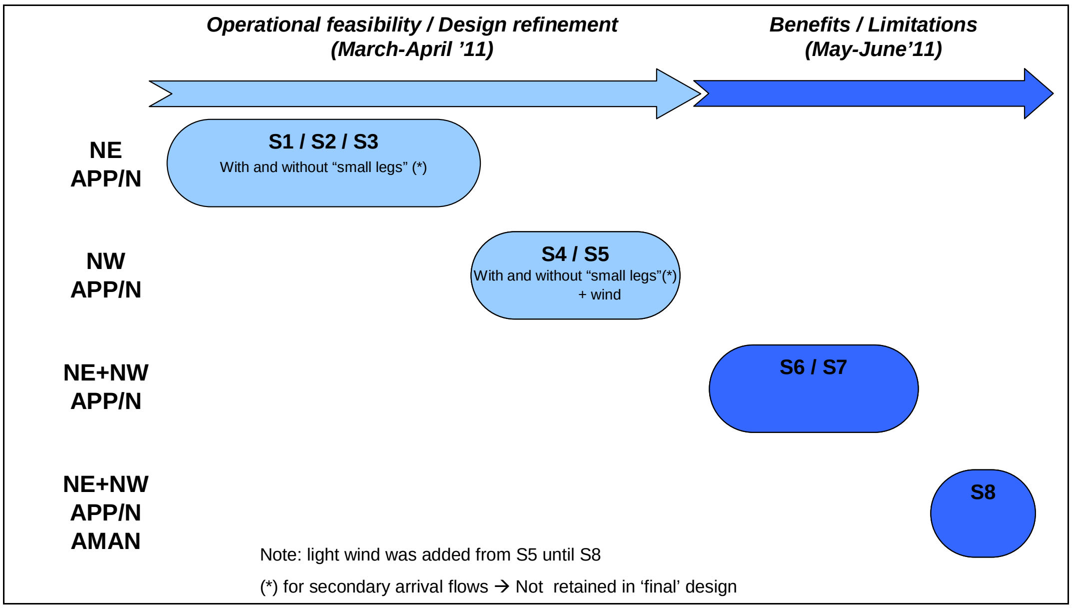


Figure 1: Session overview.

In addition to the core team of ACC and APP controllers, a total of 8 ACC controllers and 12 APP controllers participated over 22 days of simulation (~75 exercises), each session lasting 2-3 days (5 days for the last one).

Note: Although the new route structure does not only include Point Merge (e.g. also include new routes for secondary arrival flows), it is often denoted as "Point Merge" in the following sections, tables and graphics for readability purpose.

3 Overview of Point Merge

Point Merge is a systemised method for merging arrival flows with existing technology developed by the EUROCONTROL Experimental Centre[1]. It is designed to enable extensive use of lateral guidance by the FMS and continuous descent, even under high traffic load.

Point Merge is based on a specific P-RNAV route structure that is made of a point (the merge point) and pre-defined legs (the sequencing legs) equidistant from this point (and vertically separated). These legs are dedicated to path stretching/shortening (Figure 2).

The operating method comprises two main steps:

- Create the spacing by a “direct-to” instruction to the merge point issued for each aircraft at the appropriate time while on the leg.
- Maintain the spacing by speed control after leaving the legs.

The descent may be given when leaving the legs (and clear of traffic on the other leg). It should be a continuous descent as the distance to go is then known by the FMS.

The equidistance property is key for the controller to easily and intuitively assess the spacing between an aircraft on the leg and the preceding one (on course to the merge point), with no need for new support tool and solely relying on graphical markers (“range rings”).

It should be noted that path stretching is performed without controller intervention by letting the aircraft flying along the leg to the extent required (the published procedure coded in the FMS includes the full length of the leg).

Typical dimensions in the terminal area: merge point at 6000ft, legs at FL100/FL120 and 20nm from the merge point. Example of staffing in TMA: Approach controller creating spacing (“direct-to”) and final director maintaining spacing (speed control) and giving the descent.

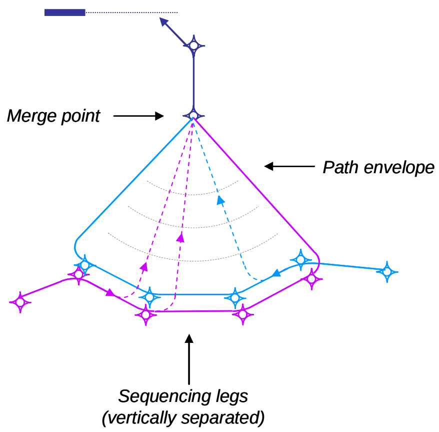


Figure 2: Example of Point Merge design with two entry points.

[1] “Merging Arrival Flows Without Heading Instructions”, L. Boursier, B. Favennec, E. Hoffman, A. Trzmiel, F. Vergne, K. Zeghal, 7th USA/Europe ATM R&D Seminar, Barcelona, Spain, 2-5 July, 2007.

4 Operational environment

IMPORTANT NOTE: The present section has been developed by EUROCONTROL DSR to facilitate the reading and understanding of the present document. In the final report covering the live trials, the section should be replaced by a description of the Paris environment made by DSNA.

The environment was composed of the existing North East and North West sectors of Paris ACC feeding the Paris TMA, and North arrival positions of Paris CDG (Figure 3).

The delivery conditions to and from adjacent sectors and centres were as today except for one flow (see hereafter). The pre-sequencing of arrival flights to CDG was supported by MAESTRO.

To enable the Point Merge design made by DSNA, two changes have been introduced:

- The transfer levels for the North arrival flow (DELOM/MOPIL) were more constraining ("stable FL250" compared to "descending to FL250") with an impact on Maastricht UAC and Brussels ACC (not assessed).
- The boundaries of the NE sectors were extended within the military zone (CBA16) considered not active, and the conditional routes in this zone were not available.

The ACC sectors were:

- In North East: The Paris terminal sector "TE" and the overlying "AP" (adjacent to Maastricht airspace). The TE sector has two delivery points (Initial Approach Fixes): LORNI and VEBEK. All arrival aircraft have to be delivered over those waypoints at 250kts[2], 8nm spacing (+AMAN constraints) and at delivery FLs described in Table 1. TE and AP also handle overflights and only AP is concerned by Paris departures.
- In North West: The Paris terminal sector "TP" and the overlying "UK-UZ" (adjacent to London and Brest airspaces). The TP sector has two or three delivery points (Initial Approach Fixes) depending on the runway configuration: MOPAR, MATID in Easterly runway configuration, plus MOBRO in Westerly runway configuration. All arrival aircraft have to be delivered over those waypoints at 250kts[3], 8nm spacing (+AMAN constraints) and at delivery FLs described in Table 1. As in NE, TP and UK-UZ also handle overflights and only UK-UZ is concerned by Paris departures.

The North positions of CDG Approach (APP/N) were simulated. INI/N and ITM/N mainly handle LFPG arrivals towards North runways and arrivals towards associated airports (e.g. LFPO and LFPB). Departures, to West, East and North, possibly interfering with North arrivals, were not manned but recorded and replayed for realism purpose.

The environment included the modifications planned for the environment initiative "Grenelle":

- Raising (1000') of the ILS interception altitudes for the Paris area airports, i.e. LFPG and LFPO and their associated airports;
- Consequently, relocation of the IAF feeding the Paris area airports. Generally the IAF were move 5/8nm away from the airports;
- The above led to modifications of the traffic delivery conditions between CRNA/N and Approach sectors: generally, the transfer FLs were raised (e.g. FL130 instead of FL110) and, under certain conditions, Approach sectors could accept the traffic with higher speeds (e.g. 280kts instead of 250kts when transfer levels were FL150 with North eastern arrivals or FL130 with North-western arrivals).

[2] 280kts could be possibly used at LORNI in East runway configuration.

[3] 280kts could be possibly used at MOPAR in West runway configuration.

- Finally, the areas of responsibility for CRNA/N and CDG/Orly Approach sectors were slightly modified to accommodate the above changes.

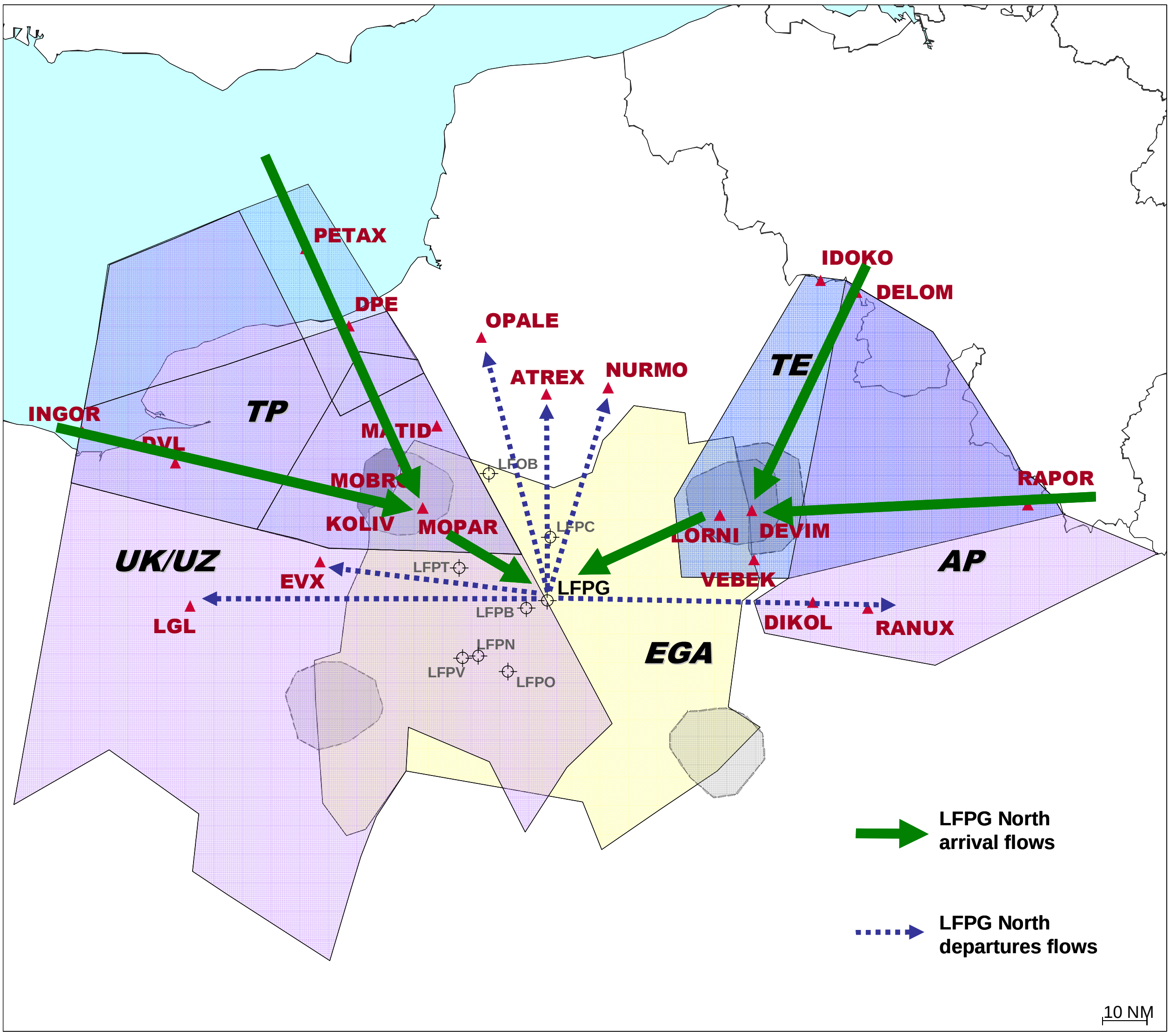


Figure 3: Simulated airspace and main flows.

Table 1: Delivery FLs over IAFs according to destination airport and runway configuration.

TP (ACC NW)		TE (ACC NE)	
Easterly	**Westerly**	**Easterly**	**Westerly**
• MOPAR : - PG FL100 - PB/PC/PT FL70 • MATID - OB FL70	• MOPAR : - PG-Jets FL120 - PB/PC/PT FL70 • MOBRO : - PG-Prop./PB FL70 • MATID - OB FL70	• LORNI : - PG FL150 - OB/PC/PT FL80 • VEBEK : - PB/PN/PV/PT FL110	• LORNI : - PG FL130 - OB/PC/PT FL80 • VEBEK : - PB/PN/PV/PT FL110

5 Session 1

5.1 Objective

The first session focused on ACC NE (AP and TE sectors). The objective was threefold:

- Initial validation of simulation environment.
- Familiarisation on design and operating method.
- Initial feedback on operability.

5.2 Organisation and setup

The session took place during two days (8th and 9th March 2011) and involved five controllers from Paris ACC and four from CDG. A preparation phase was carried out to define the simulated environment (airspace, traffic samples).

5.2.1 Airspace

The simulated environment consisted of current Paris ACC AP and TE sectors and Paris APP North positions (Figure 4). The military zone CBA16 was considered not active. For arrival flows, ACC sectors had three entry points (IDOKO, DELOM at FL250 max and RAPOR at FL310 max) and two delivery points DEVIM (upstream the Initial Approach Fix LORNI) and VEBEK. As in current operations, the objective was to deliver the traffic over DEVIM (main arrival flow) and VEBEK (secondary arrival flow) to the Approach at prescribed FLs (Table 1), 250kts (possibly 280kts in Easterly) and with 8nm spacing (and respecting AMAN delays).

5.2.1.1 ACC NE

Two conditions were simulated:

- “Baseline” corresponding to today’s situation (including the recent modifications from “Grenelle” and with modified transfer conditions from DELOM) as shown in Figure 4, left.
- “Point Merge” involving the redesign of arrival routes and the modifications of volumes between AP and TE as shown in Figure 4, right.

The design of arrival routes was developed by DSNA based on the previous study [2]. It relies on:

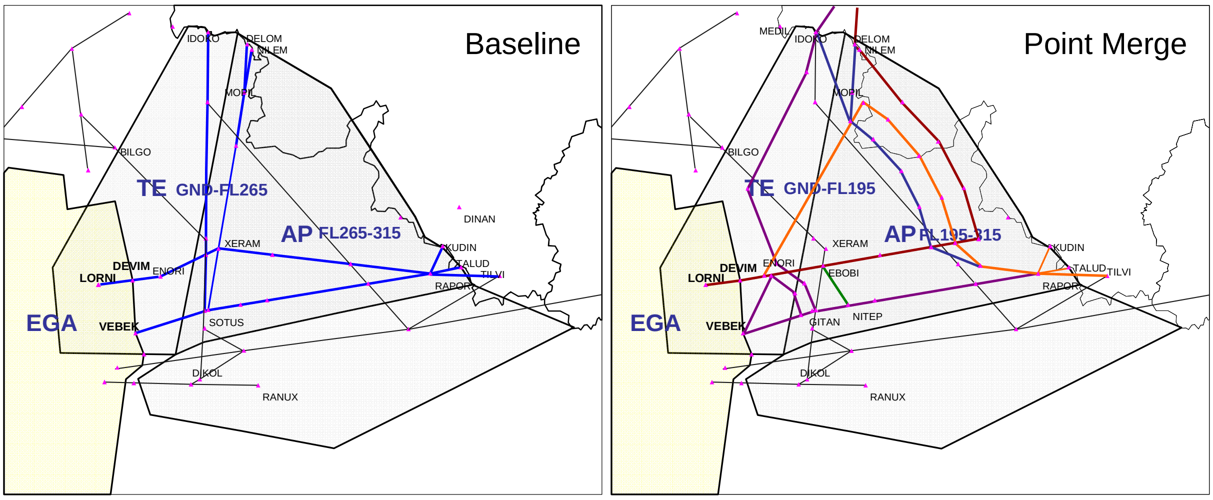
- A “large” Point Merge for the main flow (LFPG arrivals) composed of two main sequencing legs and a secondary one (bidirectional), all centred on the delivery point DEVIM (Figure 4, right). For delay absorption and flight efficiency considerations, the legs were up to 45nm length (outer leg) and up to FL280 (middle leg). The secondary leg (inner) was for low altitude LFPG arrivals (a few aircraft). The distance between legs was 5nm and located from 40nm (inner) to 50nm (outer) from the merge point (DEVIM).
- Route with “small” legs centred on VEBEK for the secondary arrival flows (mainly LFPO and LFPB arrivals). Considering the low arrivals load coming along these routes, the legs were 10nm/12nm from the exit point (VEBEK), at FL120 (outer leg) and FL130 (inner leg)[4]. The distance between legs was 3nm[5] (purple lines in Figure 4, right).

[4] As for the main Point Merge, it was not possible to have the exit path fully aligned with the bisector.

[5] Value used in TMA. For the main Point Merge, the distance was 5nm to account for potential emergency descent due to depressurisation. This was not considered necessary for the flight levels of the secondary Point Merge.

To segregate the arrival flows, the secondary arrival routes (prior joining the legs) were moved outside the main Point Merge. In addition, vertical constraints were added to these routes so that the secondary flow would pass below the main flow (as today).

The routes for overflights remained unchanged compared to the Baseline.



Deliveries:

- **DEVIM: PG FL130/150; OB/PC/PT FL80**
- **VEBEK: PO/PN/PV FL110**

FL constraints along the leg (prior entry):

- **FL250, 240 (230)**
- **FL280, 270 (260)**
- **FL220 Max (bilateral odd/even)**
- **FL130 (inner), FL120 (outer)**

Figure 4: S1-ACC NE simulated sectors in Baseline and with Point Merge.

Note: Compared to the design of the previous study, the main differences are:

- *Overall, modifications of positioning of legs and merge point resulting from the "Grenelle".*
- *Single entry point from East (RAPOR): to remain compatible with current interface (the second point created previously to segregate the main arrival flow from other flows).*
- *Altitudes on legs raised as a consequence of the altitude raise at the delivery point.*
- *Middle leg shorter to stay within AP volume.*
- *Unchanged transit route ("périphérique") to limit changes.*

For an efficient use of Point Merge, a "functional" split of AP / TE was needed with AP managing the legs and TE the descent to the merge point. More precisely, the proposed task allocation was as follows:

- AP
  - o Build LFPG arrivals sequence (speed reduction, initial descent to reach leg entry and direct to the merge point when spacing reached).
  - o Handle other arrivals and overflights above FL195.
  - o Handle LFPG departures.
- TE
  - o Maintain LFPG arrival sequence (descent to IAF and speed reduction).
  - o Build and maintain secondary arrival sequence towards VEBEK and DEVIM.
  - o Handle overflights below FL195.

For that purpose, the lower limit of the AP volume was lowered down to FL195 (compared to Baseline) in order to keep the sequencing legs within its area of responsibility (Figure 4, right).

AP and TE were each manned by an executive controller, both assisted by a planning controller (PLC). The fourth controller acted as an observer. Note: one planning controller per sector would still be needed to handle coordinations with adjacent sectors.

Distance markers on the controller screen (concentric arcs centred on the merge point and spaced by 8nm[6]) provided a visual indication to help deciding when to turn the aircraft to the merge point.

5.2.1.2 APP/N

The Approach North corresponded to the CDG North arrival positions handling LFPG arrivals to the North runway and associated airports (LFPB, LFOB; LFPT and LFPC arrivals from East and South-East). The APP/N positions were:

- INI/N
    - Receiving traffic from ACC and initiating the arrival sequence to LFPG North runway prior transfer to ITM/N.
    - Controlling North-Eastern arrivals to LFPO/PV/PN prior transfer to Orly APP.
- ITM/N
    - Finalising the sequence to LFPG North runway prior transfer to the tower (FEED sector in the simulation).
- COOR-INI SEQ
    - Coordinating INI and TE for arrivals delivery.
    - Sequence manager (i.e. handling AMAN to optimise the sequence on the runway).

During the present session, INI/N and ITM/N were grouped and received the main traffic (LFPG arrivals) only from one IAF (DEVIM) as ACC NW was not simulated. In addition, COOR-INI SEQ acted as an observer due to the absence of the NW arrival flows and AMAN.

Departures position was not manned, but departures traffic from North runway was simulated to increase realism (replay of traffic previously recorded with a CDG controller). Departures from LFPB, LFOB, LFPT, LFPC, LFPO and associated airports planned to enter a simulated sector were automatically activated and flying in the FEED sectors prior their transfer to the appropriate position.

5.2.1.3 Feed

The traffic was delivered to AP and TE from two automatic feed sectors (North and South). The main motivation is to guarantee comparable entry conditions in view of measurements (Baseline vs. Point Merge).

5.2.2 Traffic

Two traffic samples provided by DSNA were used, one for each runway configurations (Easterly and Westerly). These traffic samples lasting 2 hours each were derived from real traffic and were used in a previous Paris simulation.

The traffic samples contained arrivals from ACC NE and NW, departures and overflights. Note: in the present session, the traffic transiting through NW was not controlled.

The traffic load for NE (AP and TE) was: ~26 arrivals (19 LFPG) and 4 overflights per hour, in both runway configurations (E/W).

[6] Corresponding to the required spacing at DEVIM.

5.2.3 Run plan

The session was made of four runs (2 conditions x 2 runway configurations) each lasting about 1h30 (Table 2). The four ACC controllers switched positions (AP, TE, PLC and observer) every 30min, enabling each participant to experiment Point Merge in both executive positions. Each run was followed by a debriefing.

Table 2: Run plan (session 1).

Date	Conditions	Runway configuration	Sample	Duration
08/03/2011	Baseline	Easterly	T1E	1h30
	Point Merge	Easterly	T1E	1h30
09/03/2011	Point Merge	Westerly	T1W	1h30
	Baseline	Westerly	T1W	1h30

5.3 Outcomes

The outcomes mainly focused on technical and operational validation of the simulation environment, and were complemented by initial feedback on design and operating method.

5.3.1 Platform validation

The simulation platform was found globally acceptable by the participants.

The ACC controllers detected some mistakes in route allocation (e.g. traffic along the wrong route) and in strip printing rules. The APP/N controllers mentioned a few problems with the ILS interception (e.g. overshoot) and a few limitations concerning the speed reduction for aircraft on final (e.g. some aircraft not able to reduce below 180kts along the ILS axis).

The participants also pointed out some limitations with the automatic feeds. As deconfliction could not be done automatically, some aircraft were entering or calling AP/TE sectors already in conflict.

The arrival manager (MAESTRO) seemed to work properly in Baseline but was not configured for Point Merge.

The main limitation raised by the participants concerned the traffic load. Both traffic samples (E/W) were not found loaded enough for practicing Point Merge. Indeed, although the arrival load was found realistic for AP and TE, the absence of any delays that would have been generated by the NW arrival flow landing to the same runway, did not require an extensive use of the sequencing legs.

5.3.2 Operability in ACC NE

Despite the limitations described above, after an initial practice (1h in each executive positions), the controllers provided an initial feedback on design and operating method.

The controllers accepted the principle of Point Merge but could not really assess the potential benefits due to the “low” traffic load. They expressed a concern related with the roles and responsibilities between AP and TE. The new task allocation, rather “functional”, was found unusual for ACC controllers who are used to work within a defined volume of responsibilities. In addition, this task allocation was not found clear enough, in particular regarding the descent clearance towards the merge point. To keep aircraft under his/her area of responsibility, AP tended to issue an initial descent (e.g. to FL200) and kept aircraft on frequency. The further descent clearance to the IAF was then issued by TE. Although this did not necessarily imply a level-off, this may compromise continuous descent as the pilot could not plan his/her descent path from FL down to the IAF.

This initial feedback might reflect a lack of training and confidence in a new method (note: In the previous study, the controllers acknowledged that the split was unusual but this was not an issue). In view of implementation, due considerations should be given to this change of task allocation in the training.

The participants questioned the relevance of the "small" legs for the secondary flow (VEBEK arrivals). First, the traffic load is quite low on these flows (~20% of the main flow) and therefore may not justify the use of such Point Merge routes. Secondly, its use resulted in a late sequencing (10/12nm from the IAF) whereas it could have been done earlier through speed adjustments and direct-to instructions. This late sequencing may also have an impact in Approach, where aircraft flying along the small inner leg (at FL120) may interfere with LFPG arrivals which have to be descended early and often turned South shortly after DEVIM (particularly in Westerly runway configuration).

Note: The relevance of the small Point Merge was already raised during the previous study. Despite the late sequencing issue, it was retained as perceived useful to handle the simulated level of traffic (increased compared to real traffic).

5.4 Summary

This first session enabled to perform an initial technical and operational validation of the simulation environment in ACC NE and APP/N. The platform was globally found "workable" despite minor problems/limitations. The traffic load was found not high enough for an extensive use of Point Merge due to the absence of any delays from the NW flow. Initial comments were made concerning the unusual task allocation between AP and TE and the relevance of the "small" Point Merge.

5.5 Next session

The next session should address the two following points:

- Increase the traffic load, particularly of LFPG arrivals. This should allow controllers to use Point Merge more extensively, get more familiar with it and help clarify task allocation between AP and TE.
- Propose an alternative route design for the secondary flow (VEBEK arrivals). This new design should retain the principle of arrival routes segregated from the main flow but without the sequencing legs.

6 Session 2

6.1 Objective

This second session mainly focused on ACC NE with the following objectives:

- Validation of the simulation environment.
- Training on Point Merge and operating method.
- Operability assessment, regarding in particular:
  - clarification of roles and responsibilities AP / TE;
  - potential for continuous descents (single descent clearance);
  - further testing of the "small" legs for VEBEK arrivals (no other option proposed for this session).

The session also addressed ACC NW with a secondary objective of validation of the simulation environment. This was done in parallel.

6.2 Organisation and setup

The session took place during two days (17th and 18th March 2011) and involved the four controllers from Paris ACC who already participated to session 1 and two new CDG controllers.

The simulated environment remained unchanged (AP and TE sectors; INI/N and ITM/N positions grouped and NW not controlled) with modifications/improvements to address the problems/limitations identified.

6.2.1 Changes

From a technical perspective, HMI, strip rules and routes were corrected for NE and APP/N.

From an operational perspective, to enable an extensive use of Point Merge, LFPG arrival traffic samples were made more complex: increase up to 25 arrivals per hour (+6 compared to the previous session) with higher peaks up to 12 LFPG arrivals within 20 minutes interval (+5 compared to previous session).

The proposed task allocation AP / TE was further discussed and clarified during briefing:

- AP to build the sequence: initial descent to leg entry, speed reduction and direct to the merge point when spacing reached.
- TE to refine the sequence: descent to IAF (continuous descent whenever possible) and speed adjustments.

Both feed sectors were now manned by one controller to provide more realistic entry conditions (deconfliction prior entering ACC sectors) but with no guarantee of comparable entry conditions.

Regarding the secondary objective, one ACC controller took part in the validation environment of NW (UK-UZ and TP sectors) to assess in particular HMI, strips and routes. This was done for Baseline and Point Merge and in both runway configurations. The ACC NW traffic was simulated but not controlled, and was killed prior entering APP.

6.2.2 Run plan

The session was made of five runs (2 conditions x 2 runway configurations + 1 spare run with Point Merge) each lasting about 1h30 (Table 3). The four ACC controllers switched positions (AP, TE, PLC and observers/feeder) every 30 minutes to enable each participant to experiment Point Merge in both executive positions. Each run was followed by a debriefing.

Table 3: Run plan (session 2).

Date	Conditions	Runway configuration	Sample	Duration
17/03/11	Baseline	Westerly	T2W	1h30
	Point Merge	Westerly	T2W	1h30
18/03/11	Baseline	Easterly	T2E	1h30
	Point Merge	Easterly	T2E	1h30
	Point Merge	Westerly	T2W	1h15

6.3 Outcomes

The technical improvements and operational modifications allowed the controllers to focus on the operability of design and operating method.

6.3.1 Platform validation

For NE and APP/N, the simulation platform was accepted by the participants. Most of the limitations mentioned during the previous session were fixed.

The arrival manager (MAESTRO) was not configured and not used.

While the traffic load over 90 minutes was felt high (37 LFPG arrivals), the peaks of traffic over 20-30 minutes were found realistic and relevant for an extensive use of Point Merge.

The manning of ACC Feed sectors by a dedicated controller was appreciated (more realistic entry conditions with no conflict at NE entry).

The initial validation made for NW revealed some technical problems (strip rules and route allocation).

6.3.2 Operability in ACC NE

According to the participants, design and operating method were found globally feasible (example of trajectories flown shown in Figure 5).

Main flow (LFPG arrivals): With more practice and clarified task allocation AP / TE, the controllers better applied the proposed operating method for LFPG arrivals. The controllers reported a better and efficient balance of tasks between AP and TE compared to the baseline, enabling a large proportion of continuous descents for LFPG arrival (no level off from leaving the legs down to the merge point). However, they still expressed some difficulties to strictly follow the “functional” split. AP sometimes reverted back to the “volume of responsibilities” and issued intermediate descent clearances (typically to FL 200), in particular in case of crossing traffic (e.g. overflight). In case of bunches of traffic (particularly coming from RAPOR) to separate and descent traffic prior leg entry, it was suggested to use intermediate points of the sequencing leg.

Secondary flows: For the VEBEK arrivals, the participants found that the design of the arrival routes provided an efficient segregation from the main flow. This was especially the case for the North flow (IDOKO) whereas the East flow (RAPOR) was less segregated and therefore required more anticipated actions (e.g. early descent). However, as mentioned during the previous session, the use of “small” legs for such a minority flow was not found relevant, and resulted in a late sequencing close to the IAF. In addition, traffic on the outer legs could interfere with LFPG arrivals around DEVIM (already transferred to APP/N) which have to be quickly descended in Easterly runway configuration.

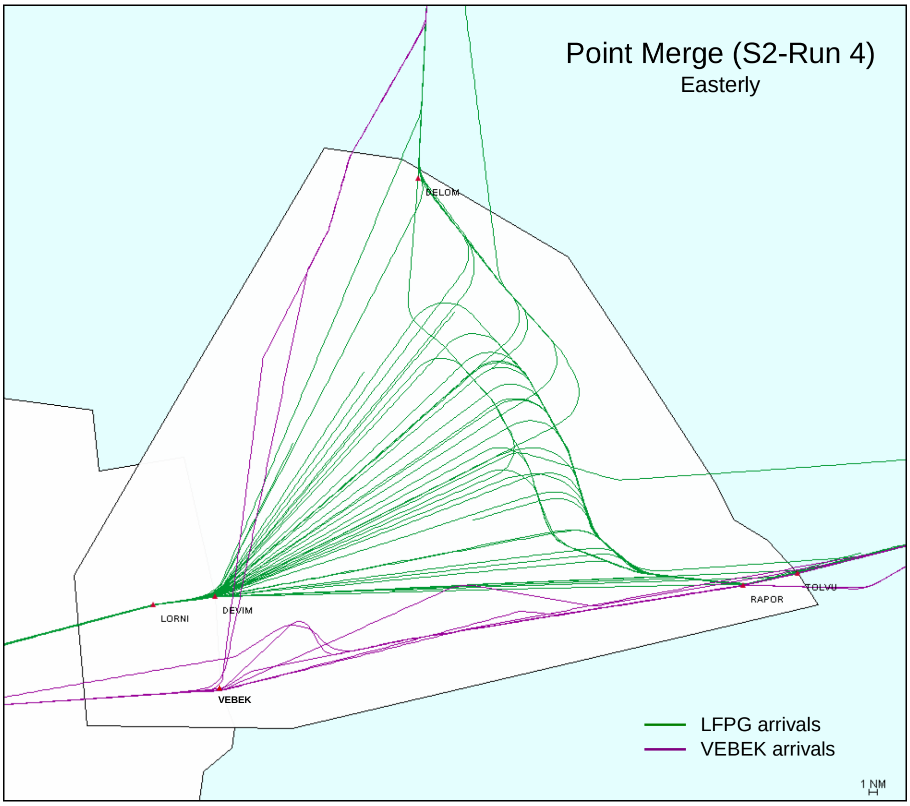


Figure 5: S2-Arrival flown trajectories with Point Merge.

The handling of the secondary flows to DEVIM (LFOB, LFPC, LFPT) resulted in interferences with the main flow around DEVIM. Indeed, the late segregation with other arrival flows from RAPOR did not allow those flow to be descended enough to respect the vertical constraints (FL100 to pass below the main flow).

6.4 Summary

Compared to previous session, Point Merge was used extensively (increased number of LFPG arrivals). According to the participants, the operating method was found globally feasible. The task load was found better balanced between AP and TE, although the controllers still expressed difficulties with the functional split. In addition, Point Merge enabled a large proportion of continuous descents (no level off) for LFPG arrivals from FL260 to FL130/150. It was confirmed that the route for secondary flows requires modifications (removal of “small” legs for VEBEK arrivals and further segregation of DEVIM secondary flow).

6.5 Next session

It was decided to propose an alternative route design for VEBEK arrivals (same arrival routes segregated from the main flow but without the “small” legs) to be tested at the next session.

7 Session 3

7.1 Objective

This third session still focused on ACC NE with the following objectives:

- Reinforce training.
- Assess operability, regarding in particular:
  - o confirmation of roles and working methods AP / TE;
  - o comparison of the two options for VEBEK arrivals (with and without “small” legs).

A secondary objective was to validate the simulation environment in ACC NW. This was done in parallel with ACC NE.

7.2 Organisation and setup

The session took place during two days (29th and 30th March 2011) and involved the same four controllers from Paris ACC, three Approach controllers (one new), plus two other ACC controllers dedicated to the validation of ACC NW.

The “measured” positions remained unchanged compared to the previous session: 3 in ACC NE (AP, TE and PLC) and 2 in APP/N (INI/N andITM/N grouped, and SEQ). Considering the outcomes from the previous session, changes were introduced in ACC NE (see below).

Technical problems identified in the previous session in NW were corrected. Although not initially expected, the controllers manning the ACC NW sectors expressed initial feedback as reported in the following section.

7.2.1 Changes in ACC NE

The main modification was the new route design for VEBEK arrivals. As illustrated in Figure 6, this modification lies on the removal of the “small” Point Merge. Flight level constraints along those routes remained unchanged not to interfere with the main arrival flow.

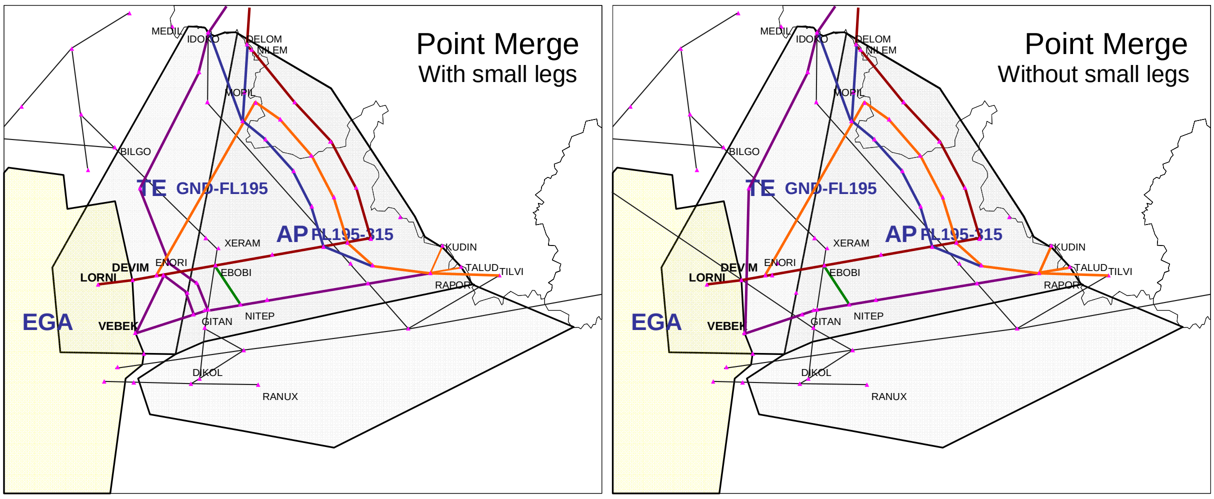


Figure 6: Route design for VEBEK arrivals: previous (left) and new (right).

The traffic samples were slightly changed to prevent controllers from boredom and being too familiar with the traffic situation. The start time of LFPG arrivals was randomly modified (within +/-2min) and callsigns were changed. This resulted in a new traffic sample (still named T2) with 26 LFPG arrivals per hour (+1 aircraft compared to previous session) in ACC NE. Technical limitations were fixed.

7.2.2 Airspace for ACC NW

Two conditions were simulated:

- “Baseline” corresponding to today’s situation (including “Grenelle”) (Figure 7, left and Figure 8, left).
- “Point Merge” involving the redesign of arrival routes (Figure 7, right and Figure 8, right).

It should be noted that, as today, the delivery point for the secondary arrival flow depends on the runway configuration (KOLIV in Easterly, MOBRO in Westerly).

The “Point Merge” design was developed by DSNA and relied on three elements: a “large” Point Merge for the main arrival flow (LFPG), segregated routes leading to “small” legs for the secondary arrival flow and dedicated arrival routes for the third arrival flow.

- The “large” Point Merge was composed of two sequencing legs centred on KOLIV at a distance of 35/40nm (see Figure 7). Typical altitudes on legs were FL210 (outer) and FL230 (inner). The legs were up to 40nm long (delay absorption considerations). It could be noted that, due to less airspace available (North part of TP delegated to UK to facilitate London departures), the dimensions are smaller than in NE.
- Route with “small” legs for secondary flows at FL90 (outer leg) and FL100 (inner leg) at 15nm/17nm from KOLIV (resp. 10/12nm from MOBRO) in Easterly (resp. Westerly) runway configuration.
- Routes for LFOB arrivals towards MATID were modified to provide maximum segregation from the “large” Point Merge.

The overflight routes remained unchanged compared to today’s situation.

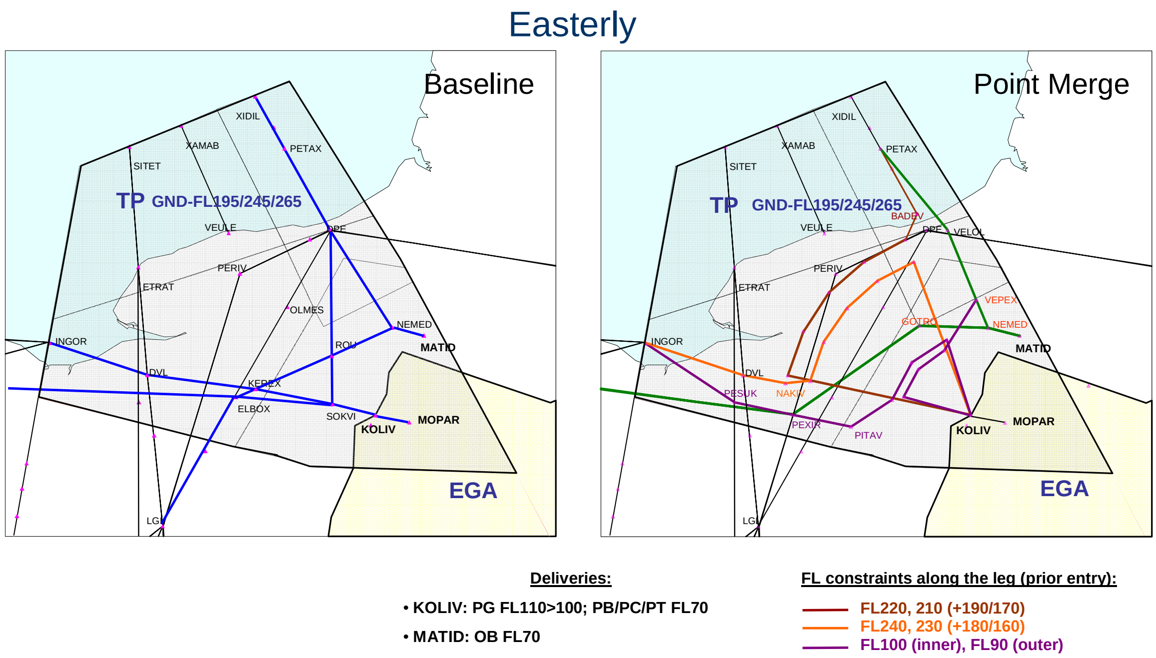


Figure 7: TP in Baseline (left) and with Point Merge (right) in Easterly runway configuration.

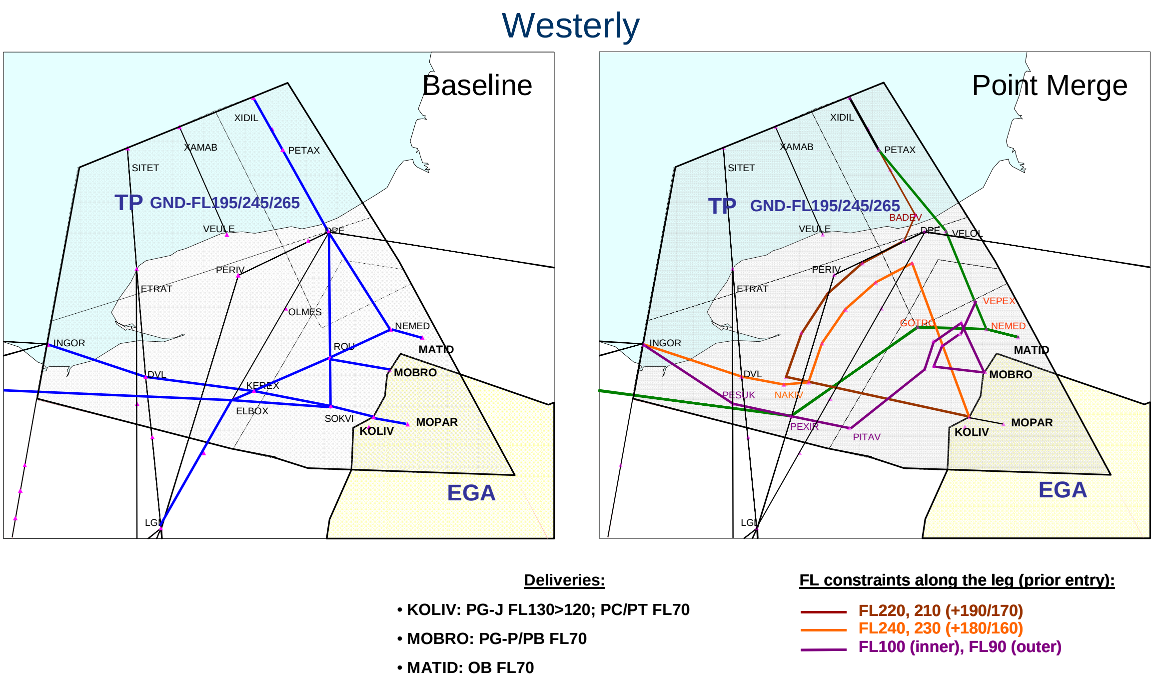


Figure 8: TP in Baseline (left) and with Point Merge (right) in Westerly runway configuration.

As opposed to AP and TE, sector roles and responsibilities for TP and UK-UZ remained unchanged:

- UK-UZ: handling Westbound departures and overflights.
- TP: essentially performing pre-sequencing of North West arrivals (from Brest and London ACC) to Paris Approach, and handling also a few overflights.

The main reason of unchanged roles and responsibilities being that the pre-sequencing is performed today by TP with only one executive controller. The new route structure including Point Merge, as strictly contained within TP boundaries, should not require any additional controller. TP and UK-UZ were thus each manned by an executive controller, assisted by one planning controller for both.

In view of future traffic increase, a split of pre-sequencing tasks between UK-UZ and TP could have been envisaged (e.g. with Point Merge: UK-UZ giving the directs and TP the descents and speeds). However, the UK-UZ sector is large and already busy with departures and overflights, and could not handle more tasks.

Note: The level of zoom will be larger than on AP, hence the moment for issuing the direct-to would be slightly less accurate (than on AP).

7.2.3 Run plan

The session was made of six runs: 2 Baseline and 4 Point Merge without “small” legs for VEBEK arrivals. To allow all the four controllers to test the new route for VEBEK arrivals, some exercises had to be shortened. The run plan is illustrated in Table 4 with the four controllers switching positions (AP, TE, PLC and observers/feeder). Each run was followed by a debriefing.

Table 4: Run plan (session 3).

Date	Conditions	Runway configuration	Sample	Duration
29/03/11	Baseline	Westerly	T2W	1h
	Point Merge without "small" legs	Westerly	T2W	1h
	Point Merge without "small" legs	Easterly	T2E	1h30
30/03/11	Baseline	Easterly	T2E	1h
	Point Merge without "small" legs	Easterly	T2E	1h
	Point Merge without "small" legs	Westerly	T2W	1h30

7.3 Outcomes

The simulated environments were found globally usable and were validated by the participants, except the AMAN (MAESTRO[7]) that still did not work properly. The following sections focus on operability in ACC NE and impact on Approach. In addition, although not initially expected, controllers in ACC NW expressed initial feedback on the new route structure reported in the last section.

7.3.1 Operability in ACC NE

Overall, the feedback from the controllers was (remained) positive. The proposed task allocation between AP and TE was found efficient. The PLC appeared to play an important role. He/she mainly supported TE (additional eye) and handled coordinations between TE and AP.

Main flow (LFPG arrivals): The controllers felt more and more familiar and confident with the method. They followed the proposed task allocation AP/TE, found it feasible (although not used to the functional split) and confirmed a better balanced task allocation. They also reported a reduction of frequency load for TE (compared to today where TE ensures all the pre-sequencing). This was also seen as potentially beneficial to safety as enabling more time for monitoring. The proposed task allocation was also efficient from an aircraft perspective as most of them performed a continuous descent (from the sequencing legs to the transfer point) without intermediate clearance anymore (AP only issuing intermediate descent clearances in case of overflights typically FL200). To "deconflict" traffic coming from RAPOR, AP used directs to intermediate points of the sequencing legs quite often (see green lines in Figure 9). This technique was found efficient and also facilitated the descent for the secondary flows (LFOB or VEBEK arrivals).

Secondary flows: Controllers confirmed their feedback (collected during previous sessions) that the segregation of routes from the main flow has a positive impact (safe and allowing continuous descents for LFPG arrivals). The new routes without "small" legs was felt better adapted (to the low traffic load) and allowed earlier sequencing/direct as current practices (see purple lines in Figure 9). For LFOB, LFPC and LFPT arrivals flying towards DEVIM, the vertical constraints (to pass below the main flow) were still difficult to respect, although the use of direct to intermediate points of the legs (from RAPOR) facilitated.

[7] MAESTRO is the Arrival Manager used in Paris Approach and ACC.

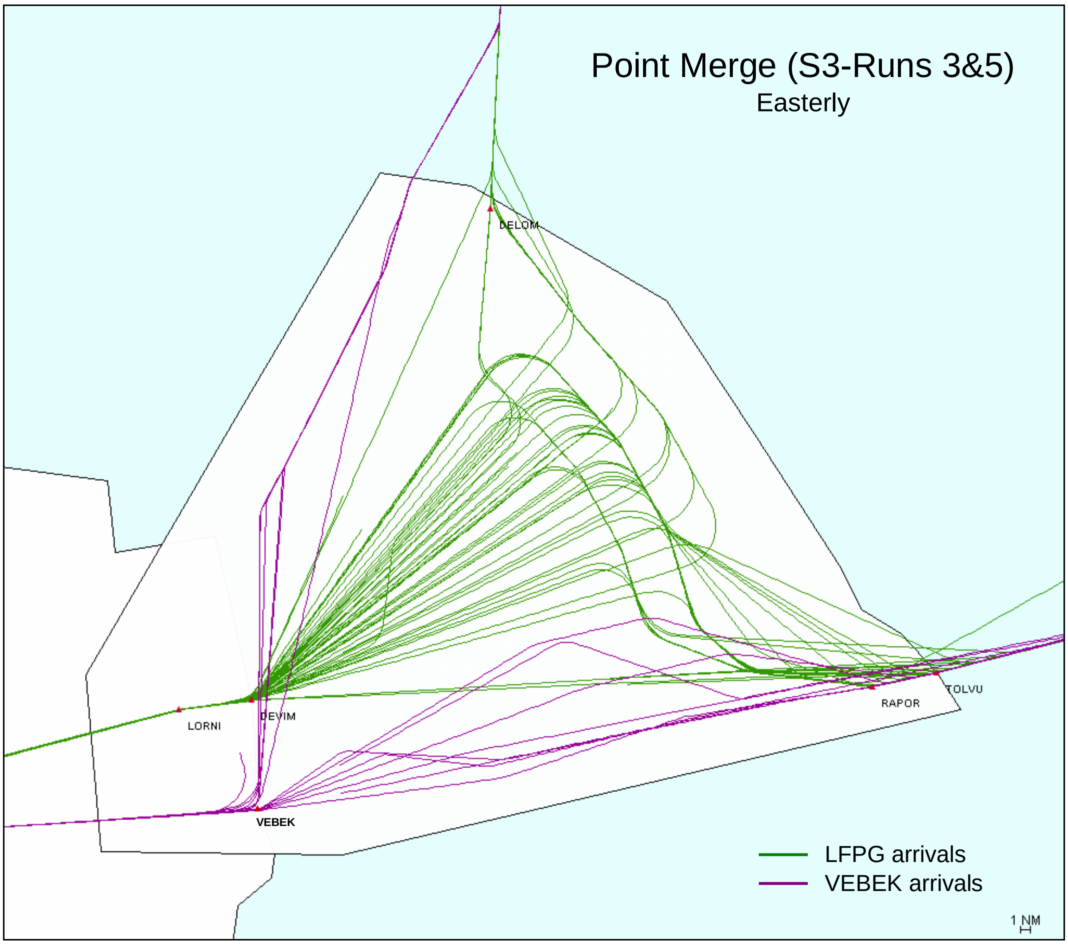


Figure 9: S3-Arrival flown trajectories with Point Merge.

7.3.2 Impact on APP/N

According to the participants, the new route structure in ACC NE had no significant impact compared to today in terms of delivery conditions. However, the new route IDOKO-VEBEK for arrivals was not found comfortable as not separated from the LORNI holding protection area and considered too close from the EGA boundaries. The participants raised the need for integrating NE and NW sectors, coupled with MAESTRO, to perform a more realistic assessment.

7.3.3 Operability in ACC NW

In ACC NW, the operational and technical environments were found correct and usable. The level of traffic was found loaded and realistic enough (arrivals had to be killed before entering Approach to avoid overloads). These conditions allowed controllers to express an initial feedback on the new route structure. The participants found the Point Merge design for LFPG arrivals globally acceptable and feasible by one executive controller (TP). This confirmed that UK-UZ is not changed and would therefore become a feed sector rather than a measured one[8]. In line with comments made in ACC NE, the controllers questioned the relevance and usability of the “small” legs for secondary flows.

[8] The fact that the new route structure has no impact on the UK-UZ sector will nevertheless have to be confirmed by objective analysis performed during the next sessions.

7.4 Summary

This third session allowed validating the simulation platform (NE, NW and APP). In NE, the Point Merge working method were found feasible and efficient, and considered as being validated. The handling of the VEBEK arrivals was found more feasible without the small legs as better corresponding to the current practices. In NW, initial validation confirmed that, as today, only one executive position (TP) could perform the sequencing with Point Merge (as opposed to two positions in NE).In Approach, no significant impact on LFPG delivery conditions was reported. The Approach controllers however stressed the need for an integrated environment (NE and NW with MAESTRO) for a more realistic assessment.

7.5 Next session

The next session will focus on the operability of the new route structure including Point Merge in ACC NW. A variant without “small” legs for secondary arrival flows will be proposed. The simulation will involve four new ACC and Approach controllers.

8 Session 4

8.1 Objective

The fourth session focused on ACC NW with the following objectives:

- Familiarisation and training.
- Operability assessment, including comparison of the two options for secondary flows.

8.2 Organisation and setup

The session took place during two days (04th and 05th April 2011) and involved four new controllers from Paris ACC and three Approach controllers (one new).

8.2.1 Airspace

8.2.1.1 ACC NW

The ACC NW airspace was the one validated during the previous session. As previously mentioned, the new route structure only concerns TP (UK-UZ remained unchanged compared to today's operations).

Following the comments made in the previous session (see §7.3.3), two design options were proposed to handle the secondary flows:

- With a “small” legs (purple lines in Figure 10 left and Figure 11 left) as tested during the previous session.
- Without “small” legs (purple lines in Figure 10 right and Figure 11 right): new design with incoming routes from INGOR and PETAX unchanged until PITAV and VEPEX (vertical constrained retained) and downstream those points, the small Point Merge was removed and replaced by a direct route until transfer points (KOLIV or MOBRO).

Easterly

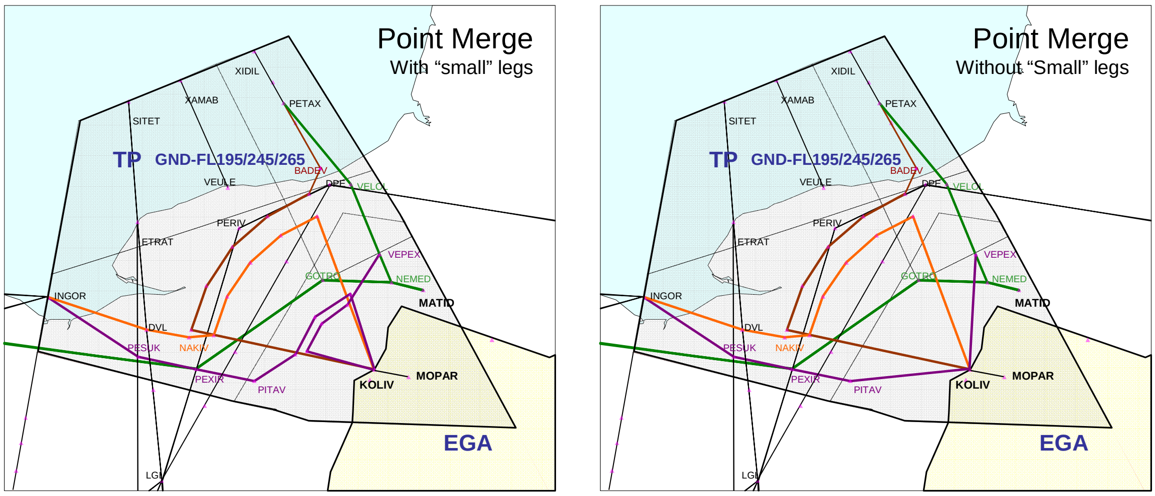


Figure 10: S4-New route for secondary flows with (left) and without (right) small legs (Easterly).

Westerly

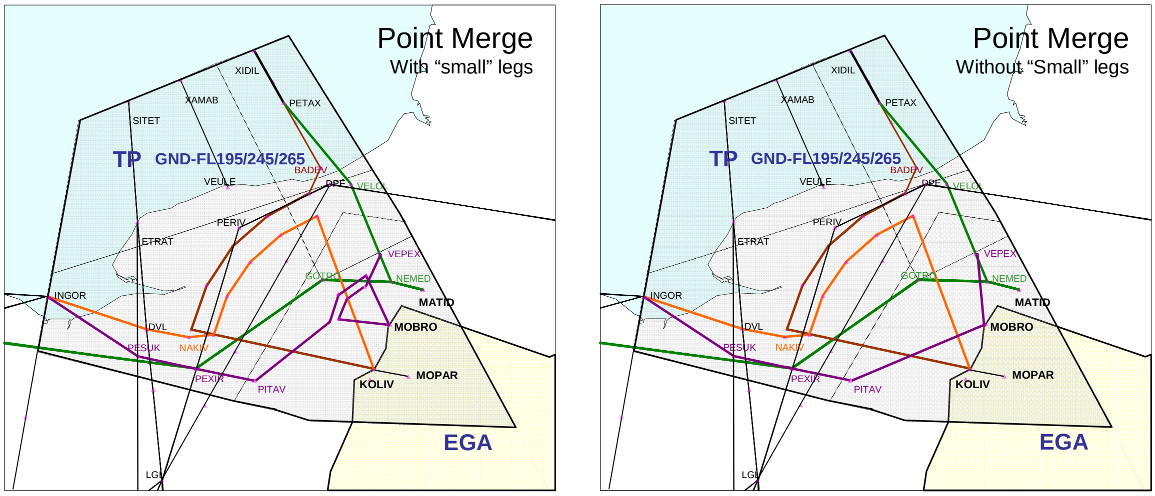


Figure 11: S4-New route for secondary flows with (left) and without (right) small legs (Westerly).

TP and UK-UZ were each manned by an executive controller, assisted by one planning controller (acting more on TP).

8.2.1.2 APP/N

The Approach North remained unchanged compared to the previous sessions. It was manned by one executive controller (INI/ITM grouped) and a sequencer (SEQ). The Approach still received “half of the traffic”: only arrivals coming from NW (ACC NE not simulated during this session). Departure traffic was in a replay mode.

8.2.1.3 Feed

Feed sectors remained unchanged compared to previous sessions and were manned by the fourth ACC controller.

8.2.2 Traffic

The two traffic samples from the last session were reused (T2 E/W). They included arrivals, departures and overflights in both ACC NE and NW. Traffic transiting through ACC NE was killed when entering the Approach. In TP, the traffic load was: ~36 arrivals (28 PG) plus 5 overflights per hour, in both runway configurations (E/W).

During the first day, the participants found incoming North and East arrivals flows too smoothed to enable an extensive use of Point Merge. To create more “bunches” in the traffic, the number of LFPG arrivals was increased up to 33 arrivals per hour (+5 compared to day 1) in both Easterly and Westerly T2 traffic. The new traffic samples were named T3 (E/W) and were used during day 2.

Note: The AMAN (MAESTRO) was still not configured.

8.2.3 Run plan

The session was made of seven runs: 2 in Baseline and 5 in Point Merge) each lasting about one hour (Table 5) and with the four ACC controllers switching positions (UK-UZ, TP, PLC and feed) each run. The length of the run was reduced to one hour compared to previous sessions in order to allow each controller to perform a run in Point Merge at the TP position[9]. Each run was followed by a debriefing.

Table 5: Run plan (session 4).

Date	Conditions	Runway configuration	Sample	Duration
04/04/11	Baseline	Westerly	T2W	1h
	Point Merge with “small” legs	Westerly	T2W	1h
	Point Merge with “small” legs	Easterly	T2E	1h
05/04/11	Baseline	Easterly	T3E	1h
	Point Merge without “small legs”	Easterly	T3E	1h
	Point Merge without “small legs”	Westerly	T3W	1h
	Point Merge without “small legs”	Easterly	T3E	1h

8.3 Outcomes

8.3.1 Operability in ACC NW

The controllers had to get familiarised and trained with the point Merge and the operating method (they have not been involved in any of the previous sessions).

Note: It could be recalled that NW was not assessed before as opposed to NE which benefits from a previous study.

The high arrival load (in day 2) allowed to practice Point Merge but sometimes led to complex situations for training, typically requiring deconfliction at sector entry points.

Operating the new route structure including Point Merge was found globally feasible and easy. An example of arrival flown trajectories is illustrated in Figure 12.

The controllers perceived a reduction of the frequency load due to fewer heading instructions. However, perceived benefits seemed to be less than in NE. This could be explained by two factors: smaller dimensions of the Point Merge system (40Nm in NW vs. 45Nm in NE) and no possibility to redistribute tasks (creation and maintaining of the sequence were handled separately by two executive controllers in NE).

The controllers reported a change of focus area. With Point Merge, there is a need for additional monitoring and action near sector entry to allocate and achieve correct FL prior entering the

[9] Only the TP sector is concerned by the changes brought by the new route structure and so the most interesting position to test and practice.

sequencing legs. In Baseline, the focus is closer to the exit point. It was suggested that with Point Merge this task of flight level management could be supported by the planning controller.

The key elements for the use of Point Merge were discussed and agreed.

Main flow (LFPG arrivals):

- Lateral separation between the legs: It was recalled that the proposed 5nm for lateral separation does not provide segregation of routes (not separated). This results from a trade off among safety (emergency descent in case of depressurisation), usability (smaller distance could lead to a cluttering on the screen) and accuracy (higher distance could lead to loss of accuracy when turning aircraft to the merge point). It was agreed to retain 5nm of separation between the legs.
- Recommendation to use two distinct instructions for 'direct-to' and descent clearances to avoid safety net alerts (5nm between both legs) [10].
- FL along the legs: In order to deconflict the incoming North traffic from DPE, the participants expressed the need for a third level on the outer leg. The tactical use of FL230 was not recommended for safety reasons (already used along the inner leg). To respect the design principles (remain below the inner leg for safety purpose), it was suggested to use FL200 when needed. However, this required to anticipate the descent. In addition, it was also suggested to use intermediate points of the sequencing legs to facilitate deconfliction prior leg entry[11].
- Recommendation to reduce speed along the legs (e.g. 260kts) under high traffic load not to exceed legs' length/capacity.
- Recommendation to further involve the PLC in the sequencing tasks, in particular in management and checking of FL at leg entry.

Secondary flows (other arrivals): As in ACC NE, the principle of segregating routes for secondary flows was found efficient. However, to ease the sequencing, it was stressed to systematically use the FL constraints along the secondary flows routes not to interfere with the main sequencing triangle (e.g. LFOB coming from the South on course to MATID fully crossed LFPG arrival flow). In line with previous participants (in ACC NE and NW), the use and relevance of "small" legs to sequence secondary flows was questioned. Although the two design options were tested (with and without "small" legs), the participants did not really noticed differences or clearly expressed any preferences between both. Indeed, purple lines in Figure 12 show that the small legs were not used and aircraft were generally sent direct to the transfer point (here MOBRO) prior the small legs.

The STAR for LFPG propellers in Easterly configuration was also discussed. Indeed, according to the "Grenelle" modifications, this flow has to be sequenced with jets and delivered to KOLIV at the same FL (FL100)[12]. As a result, the proposed STAR (in purple in Figure 10) either with "small" legs or not could not be used anymore due to FL constraints at PITAV and VEPEX (FL90 max). It was thus decided to integrate the LFPG propellers on the large Point Merge and sequence them as jets, acknowledging that disparities in aircraft performances could create difficulties. This was suggested to be tested at the next session.

Overflights: The handling of overflights along the route VEULE-RESMI (in upper airspace, on a North West / South East trajectory) was seen as problematic with the Point Merge design. Although it represents a small proportion of aircraft, this flow could interfere with arrival aircraft along the legs (e.g. in case of slow climb or aircraft transiting at FL250).

[10] This point was not raised in the NE area as, by definition, the proposed working method suggests that the direct-to and descent instructions, towards the merge point, are issued by two distinct controllers (AP and TE).

[11] Although it is less needed than in NE area (traffic better pre sequenced by upstream sectors), early deconfliction may be required in some situations in order to enter the legs at correct entry level.

[12] This modification was initially not planned in the route design and controllers thought that LFPG propellers had to be delivered over the transfer point below LFPG jets, as in today's operations.

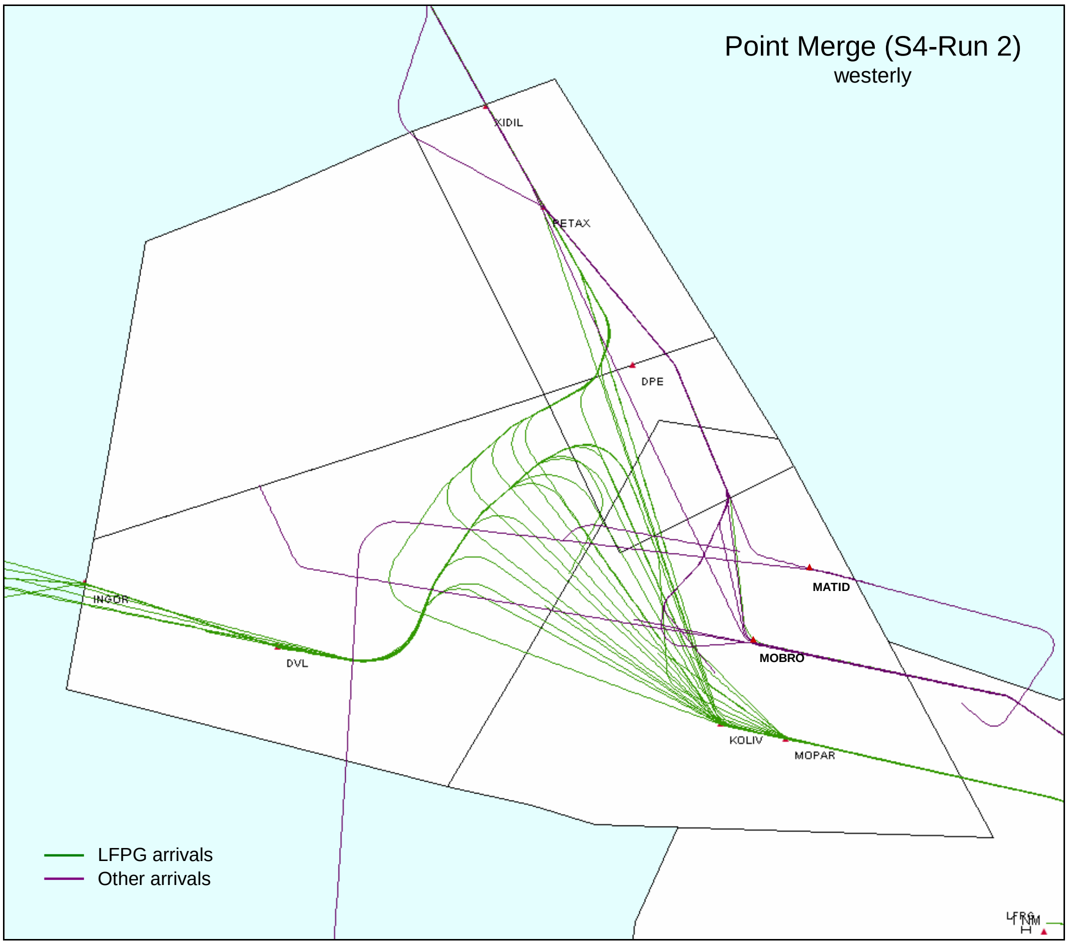


Figure 12: S4-Arrival flown trajectories with Point Merge and small legs for secondary flow.

8.3.2 Impact in APP/N

According to approach controllers, the new route structure in ACC had no impact on approach and no interaction was reported (note: one new route in NE was found to interfere with APP).

8.4 Summary

The outcomes regarding the operability of the new route structure and Point Merge in NW were globally positive (e.g. easy to operate, fewer heading instructions). However, perceived benefits seemed to be less than in NE due to smaller dimensions of the Point Merge system and no possibility to redistribute tasks. The lack of training and the high traffic load sometimes led to difficulties to follow the proposed working method. No decision was taken concerning the secondary flows (with or without “small” Point Merge). In addition, options for sequencing LFPG propellers with jets have to be tested (e.g. either along the legs with jets or with secondary flows). No impact was reported on Approach.

8.5 Next session

The next session will be used to further train the controllers on Point Merge in ACC NW. The traffic will be modified in order to further assess options for secondary flows and to create more interferences with overflights. Light wind could be added in some runs to increase realism.

9 Session 5

9.1 Objective

The fifth session focused on ACC NW with the following objectives:

- Reinforce participants' training.
- Further assess feasibility, in particular:
  - o sequencing of secondary flows with and without "small" Point Merge;
  - o interaction with overflights;
  - o integration of LFPG propellers.

9.2 Organisation and setup

The session took place during three days (26th to 28th April 2011) and involved the four ACC controllers who participated to the previous session and three Approach controllers (two newcomers).

The simulated environment remained globally unchanged compared to the previous session. Some changes have been introduced to address the outcomes from the previous session.

9.2.1 Changes

The following modifications were introduced:

- LFPG propellers sequenced with jets in Easterly configuration (FL100 MOPAR) using one of the following options:
  - o the jets' STAR (on the main Point Merge) with "small" legs; or
  - o the secondary flows' STAR without "small" legs.
- Traffic: While retaining the same overall traffic load over the measured hour, traffic samples (T2 and T3) were modified (start times of some flights) so as to create:
  - o Larger "bunches" for secondary flows to further assess the use of "small" Point Merge;
  - o More interferences between overflights and arrivals to further assess the compatibility of corresponding routes.
- Introduction of light wind (see Table 6). With wind, it was decided to slightly reduce the number of LFPG arrivals (-4 leading to 29 per hour). Corresponding traffic samples are T4 and T5.

Note: The last point of each main leg for LFPG arrivals is now defined as "fly over" (slight gain in leg capacity).

Table 6: Simulated wind according to runway configuration.

Runway configuration	Wind (gradient)
Easterly	360°/40kts at FL370 360°/30kts at FL250 060°/15kts at FL100 090°/10kts at GND
Westerly	310°/35kts at FL370 225°/30kts at FL250 255°/20kts at FL100 270°/10kts at GND

9.2.2 Run plan

The session was made of ten runs (2 in Baseline and 8 in Point Merge) with and without wind, each lasting about one hour[13] (Table 7), with the four ACC controllers switching positions (UK-UZ, TP, PLC and feed) each run. Each run was followed by a debriefing.

Table 7: Run plan (session 5).

Date	Conditions	Runway configuration	Wind	Sample	Duration
26/04/11	Baseline	Easterly	No	T3E	1h
	Point Merge with small legs	Easterly	No	T3E	1h
	Point Merge with small legs	Westerly	Light	T5W	1h
27/04/11	Baseline	Westerly	Light	T5W	1h
	Point Merge with small legs	Westerly	Light	T5W	1h
	Point Merge with small legs	Easterly	Light	T4E	1h
28/04/11	Point Merge with small legs	Easterly	Light	T5E	50min
	Point Merge without small legs	Easterly	Light	T4E	50min
	Point Merge with small legs	Westerly	Light	T4W	50min
	Point Merge without small legs	Westerly	Light	T4W	50min

13 During the last day, the run duration was reduced to 50 minutes in order to perform 4 runs in a day.

9.3 Outcomes

9.3.1 Simulated environment

The environment was found realistic and even more with the addition of wind. Slight adjustments of the wind gradient will be needed for next sessions (smooth variations in strength and orientation).

9.3.2 Operability in ACC NW

The controllers felt more familiar and more confident with Point Merge. Overall they found the new route structure comfortable and less demanding in terms of frequency occupancy compared to today's situation. However, as mentioned in previous session, they felt an increase of monitoring load (or change of focus) compared to today.

The use of the Point Merge structure was found feasible with light wind, considering the reduction of traffic load.

Example of arrival flown trajectories is illustrated in Figure 13.

Main flow (LFPG arrivals): With more practices and clarifications, the controllers better adhered to the Point Merge method. The required flight levels along the sequencing legs were better achieved. The high number of LFPG arrivals showed the relevance and efficiency of using reduced speed along the legs (250-260kts) not to exceed leg capacity. As a result, a large proportion of LFPG arrivals could perform a continuous descent from the leg to the transfer point (KOLIV).

When needed to deconflict traffic coming from DPE (North), the controllers used the intermediate points of the legs as illustrated in Figure 13 (green lines). This was done with the planning controller who supported the executive in proposing levels and in monitoring this area. As observed in ACC NE, the use of intermediate points was found very efficient and similar to current practices (vector to separate aircraft and then descent).

No clear preferences were expressed concerning the most appropriate STAR for LFPG propellers arrivals in Easterly configuration. The handling of propellers was found feasible in both cases (using jet STARs along the legs or secondary flow STAR). Indeed, it did not cause any difficulties to integrate them considering their quite limited number. Despite different performances compared to jet, they can be integrated via the legs or later in a tactical way. For the next sessions, it was thus decided, to maintain LFPG propellers along the sequencing legs, following the jets STAR.

Secondary flows (other arrivals): As during the previous session, the controllers found the segregation of routes at sector entry very efficient. Although secondary flows could be penalised (early descent to pass below the main flow), the main flow could perform continuous descents. The participants did not clearly expressed preferences between both options (with or without “small” legs). Even with the bunches of traffic, the small legs were not really used and did not seem justified for this low level of traffic. To keep consistency with NE, it was thus decided to use the second option: no “small” legs.

Overflights: As mentioned during the previous session, the overflights along the route VEULE-RESMI (e.g. at FL230 or slowly climbing to higher level) could be in conflict with LFPG arrivals along the sequencing legs. Instead of using another FL along the legs (safety issue regarding the aircraft along the other leg), it was rather proposed to retain the defined FL for LFPG and to handle those occasional overflights in a tactical manner (e.g. stay apart from the main triangle area with heading or level change).

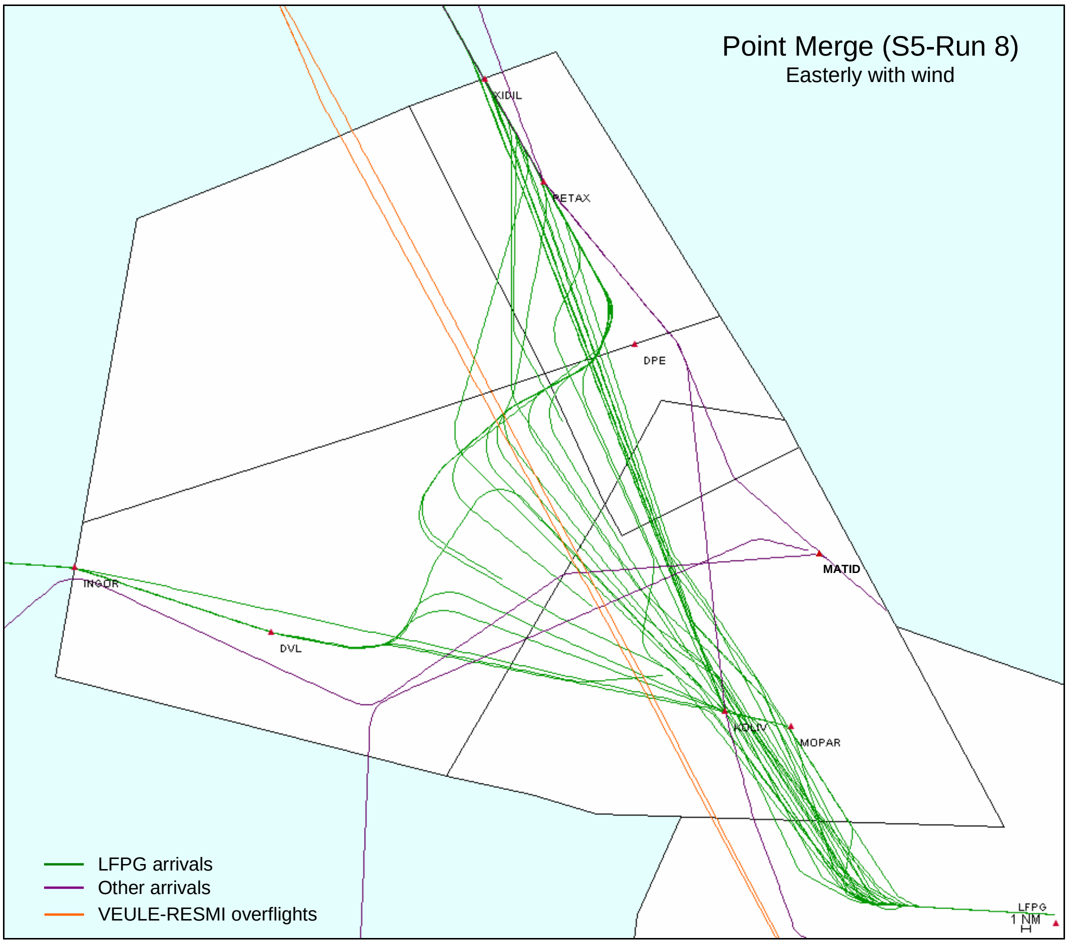


Figure 13: S5-Arrival flown trajectories with Point Merge without small legs for secondary flow.

9.4 Summary

This session allowed the participants to get more familiar and confident with Point Merge. Overall, they found the new route structure comfortable and less demanding in terms of frequency load compared to today's situation. Point Merge was found efficient to sequence LFPG arrivals and enabled continuous descent from the sequencing legs to the transfer waypoint.

The session ended up with a stable route design, consistent with NE: "large" Point Merge for the main flow (LFPG jet arrivals) and dedicated routes for secondary flows with no "small" Point Merge. In Easterly runway configuration, LFPG propellers will use the same STAR as jets ("large" Point Merge).

9.5 Next session

The next session will consider both NE and NW delivering traffic to the Approach (but most probably without MAESTRO). This should allow performing initial measurements on benefits and limitations and further/better assessing the impact on Approach in more realistic conditions.

10 Session 6

10.1 Objective

The main objective of the sixth session was to perform an initial assessment (qualitative and quantitative) of NE and NW delivering jointly traffic to the Approach. No AMAN delay was considered in ACC and Approach.

A secondary objective was to reinforce training for NW and refresh NE participants, and also to share experience among NE and NW controllers (by swapping sectors).

10.2 Organisation and setup

The session took place during three days (9th to 11th May 2011) and involved six controllers from Paris ACC who participated to the previous sessions[14] and three Approach controllers (one newcomer).

10.2.1 Airspace

The simulated airspace contained Paris ACC NE and NW with the North part of Paris Approach.

10.2.1.1 ACC

Two conditions were simulated: Baseline and Point Merge.

For the Baseline, sectors and route structure corresponded to the current ones as simulated during the previous sessions (Figure 14 and Figure 15).

Easterly

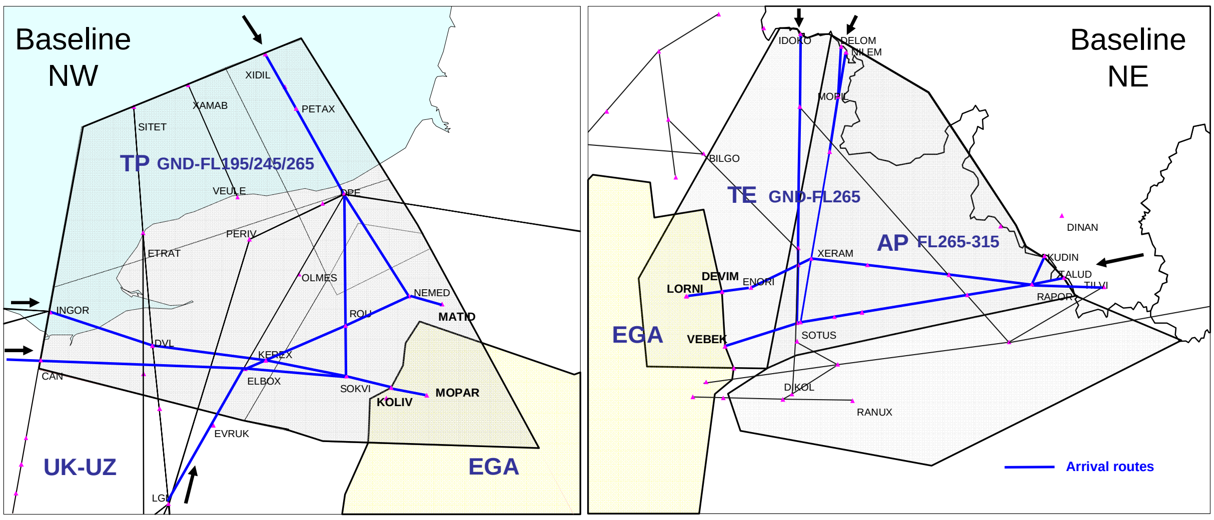


Figure 14: S6-Baseline in NW (left) and in NE (right) in Easterly configuration.

14 The four ACC "NW" controllers (involved in sessions 4&5) and two of the four ACC "NE" controllers (involved in sessions 1, 2&3) participated in this session.

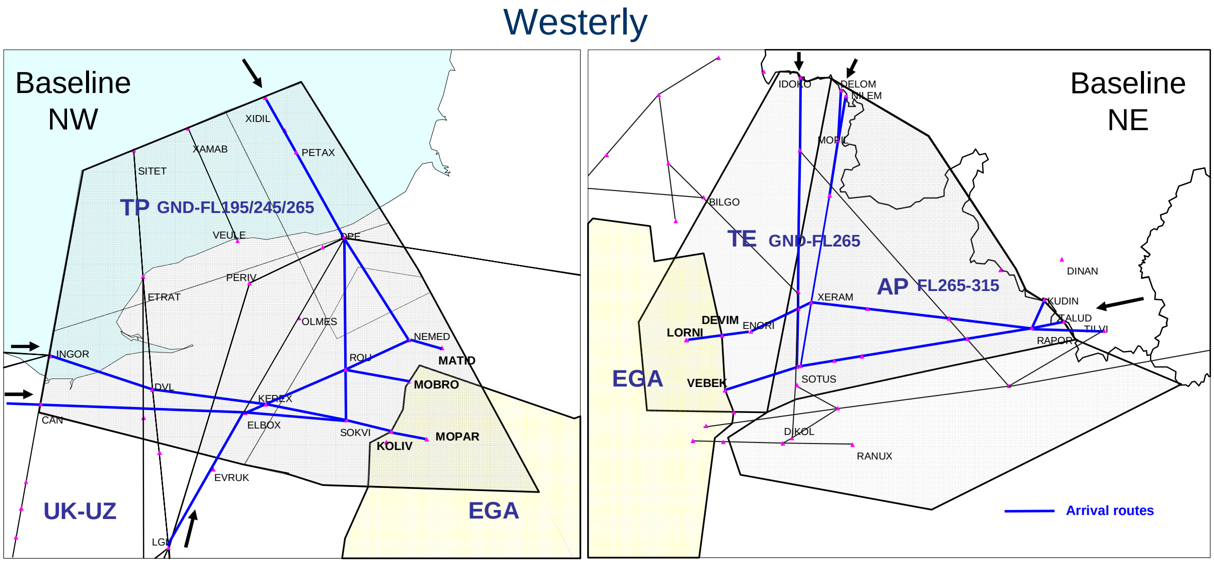


Figure 15: S6-Baseline in NW (left) and in NE (right) in Westerly configuration.

The previous sessions allowed defining and refining quite stable and consistent new route structures with Point Merge in NE and NW. Briefly, the new route designs included a main Point Merge to handle the main flow (LFPG arrivals) centred on the exit waypoint (DEVIM and KOLIV). The routes for secondary flows (e.g. LFOB, LFPB) are laterally and vertically segregated as much as possible from the main flow. In both designs the “small” legs initially introduced to handle secondary flows was removed as the amount of traffic was too low to “justify” a Point Merge. New routes are illustrated in both ACC NE and NW in Figure 16 and Figure 17.

The new route design in the NW corresponded to the last one tested during the previous session without the “small” legs for the secondary flows and LFPG propellers being sequenced as jets (along the main sequencing legs) in easterly configuration.

In NE, the following modifications were performed compared to the last session on NE (session 3):

- Slight modification of the route from IDOKO to VEBEK (now via ENORI) to be less close to EGA boundaries (see previous version in Figure 6, right);
- STARs for LFOB/PC/PT arrivals modified to further segregate them from the main flow and ease FL constraints achievement (route SOTUS-ENORI instead of NITEP-EBOBI)
- As in NW, the last point of each main leg for LFPG arrivals was defined as “fly over” (slight gain in leg capacity).

The manning and task allocation in ACC sectors remained unchanged compared to previous sessions.

Easterly

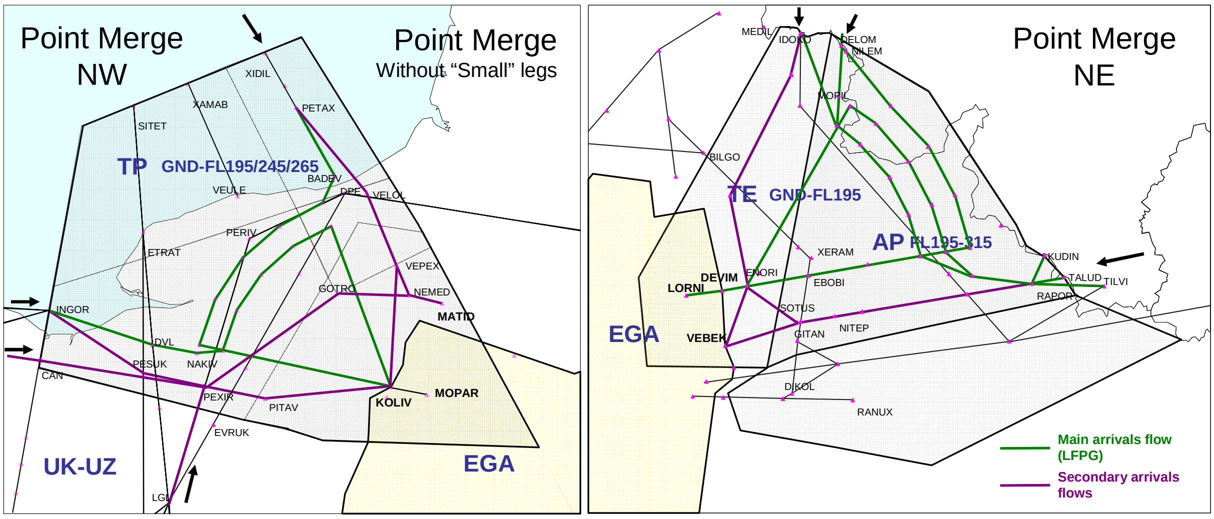


Figure 16: S6-Point Merge in NW (left) and NE (right) in Easterly configuration.

Westerly

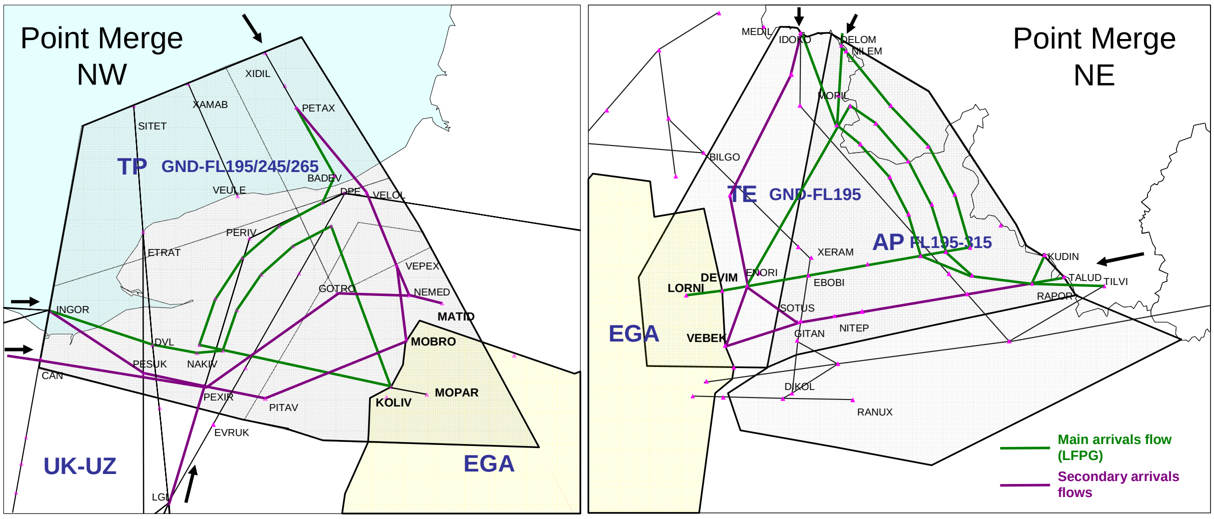


Figure 17: S6-Point Merge in NW (left) and NE (right) in Westerly configuration.

In both conditions, the ACC controllers were tasked to deliver the traffic with 8nm of spacing and at 250kts over the IAFs and according to the flight levels described in Table 1.

It should be noted that the Arrival Manager (MAESTRO) was not configured. Therefore, it was decided that the ACC controllers would sequence the traffic without considering delays sharing and synchronisation between NE and NW IAFs.

10.2.1.2 APP/N

The Paris North Approach was manned by two executive controllers INI/N and ITM/N. Compared to the previous session, both frequencies were ungrouped as all the arrivals from NE and NW were controlled and delivered to Approach.

Due to the absence of the MAESTRO, the Approach controllers were tasked to "kill" some LFPG arrivals when entering the TMA. Indeed, the traffic demand was far too high over both IAFs, without delay sharing between NE and NW, for the maximum runway capacity (see traffic section in 10.2.3)

As during previous sessions, departures position was not manned, but departures traffic from North runway were in a replay mode for realism purpose (previously recorded by a CDG controllers).

10.2.1.3 Feed sectors

No modifications on feed sectors. Both Feed North and South were manned by spare participants.

10.2.2 Meteo

During this session, it was decided to include wind in all runs. The same light wind conditions as in previous session were used (parallel to leg orientation and from 35-40kts at FL350 to 10kts at ground level) in slightly smoothing wind layers (see layers details in Table 6).

10.2.3 Traffic

As it was done in NW when the wind was introduced, it was decided to slightly reduce the number of LFPG arrivals in NE (-2 compared to session 3). Based on T4 and T5 traffic samples, T6 and T7 samples were developed for both Easterly and Westerly:

- In NE: 24 PG arrivals, 10 other arrivals and 5 overflights per hour;
- In NW: 29 PG arrivals, 10 other arrivals and 5 overflights per hour.

As mentioned, without playing MAESTRO, the LFPG arrivals load was far too high for a single arrival runway capacity. Therefore ~10 LFPG arrivals were "killed" by Approach controllers when passing the IAFs. This allowed keeping a high traffic load on the ACC sectors while maintaining the Approach controllers' workload acceptable.

10.2.4 Run plan

The session was made of eleven runs (2 in Baseline and 9 in Point Merge) scheduled according to the sessions' objectives (Table 8). During the training and measured runs, the participants switched positions but remained on their "current sectors" (ACC NE participants on AP and TE and ACC NW participants on UK-UZ and TP sectors). During day 2, the data were collected over a 1h measured period[15]. During day 3, ACC NE and NW participants switch "areas" to share experience.

To save time and perform four measured runs in a day, no post run debriefing was conducted. However, a global debriefing and questionnaire was held on day 3 over the "measured session". Both assessed the benefits and limitations of the new route structure in ACC and its impact in Approach sectors.

Controllers' feedback and questionnaires' ratings are reported in the following results section.

[15] The measured period started 10min after the run was launched to allow for traffic to build up in the measured sectors.

Table 8: Run plan (session 6).

Date	Conditions	Runway configuration	Objective	Sample	Duration
09/05/11	Point Merge	Easterly	Training / Refresh	T7E	50min
	Point Merge	Westerly	Training / Refresh	T6W	50min
	Point Merge	Easterly	Training / Refresh	T6E	50min
	Point Merge	Westerly	Training / Refresh	T7W	50min
10/05/11	Baseline	Westerly	Measurements	T6W	1h10
	Point Merge	Easterly	Measurements	T7E	1h10
	Point Merge	Easterly	Measurements	T7E	1h10
	Baseline	Westerly	Measurements	T6W	1h10
11/05/11	Point Merge	Westerly	Share experience	T7W	50min
	Point Merge	Easterly	Share experience	T6E	50min
	Point Merge	Westerly	Share experience	T6W	50min

10.3 Results

It was initially planned to perform quantitative measurements. However, slight differences in the traffic samples[16] between Baseline and Point Merge would not allow for quantitative comparison. Therefore, mainly final questionnaire ratings and feedback are reported.

With the numerous exercises performed so far, the participants felt trained enough and ready for measurements. They now consider Point Merge as a support for sequencing and not as a constraint to respect (training effect).

10.3.1 Operability in ACC

As during the previous sessions, the controllers were very positive on the new method. Overall, the feasibility was rated high to very high (Figure 18). According to the participants, the method led to fewer instructions, less workload, increased availability and comfort compared to today's situation. The safety level is considered maintained and even improved (by 5 out 6 controllers) (Figure 19). With all these elements, there is as a potential for a safe capacity increase for these ACC sectors. Wind logically increased difficulty (e.g. speed management and sequence order depending on the head/tail wind along the legs) but was not reported as more problematic than today under same wind conditions.

The use of Point Merge was found very efficient to sequence high LFPG arrivals load and enabled continuous descents.

[16] First aircraft not created exactly at the same location which had an impact on delays to be absorbed by the following aircraft.

The handling of secondary flows (without "small" legs) was found highly feasible (for 5 out 6 controllers) with the early segregation from the main flow (LFPG arrivals).

As observed during previous sessions, the handling of overflights was rated less feasible than arrivals (ratings: 1 low, 2 medium and 3 high). It was mentioned that some overflights trajectories could interfere with LFPG arrivals (along the sequencing legs in NW, and during descent to the IAF in NE).

The handling of departures did not cause any difficulties as not interfering with the new route structure for arrivals. In NW, the departures are still handled by UK-UZ sectors (not impacted by the changes made in NW) as today. In NE, AP controllers had enough availability to handle them, despite the additional task of handling arrivals introduced with Point Merge.

As anticipated, the Point Merge was found globally more beneficial in NE than in NW. In NE, Point Merge enabled a better balanced task allocation between AP and TE executive controllers which was found beneficial in terms of workload and efficiency. In NW, despite fewer instructions with Point Merge (i.e. no more/less need for heading), TP executive controller still ensures solely the whole arrivals sequencing (as today).

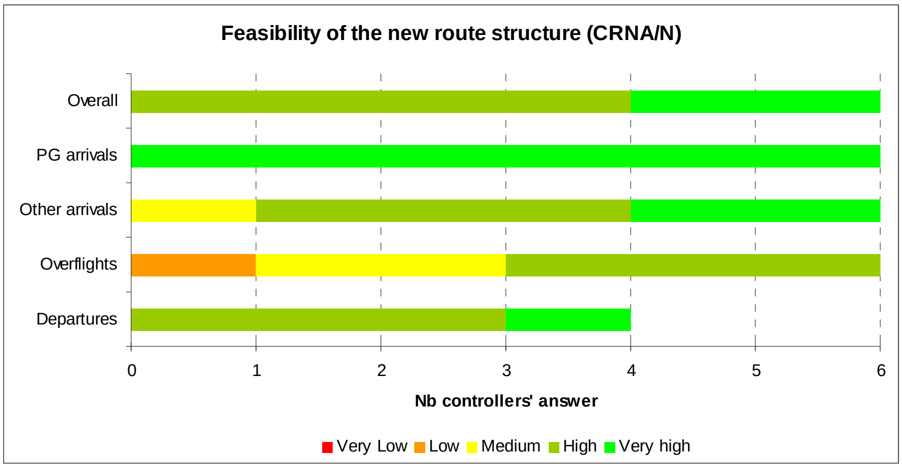


Figure 18: S6-ACC controllers' ratings regarding feasibility of the new route structure.

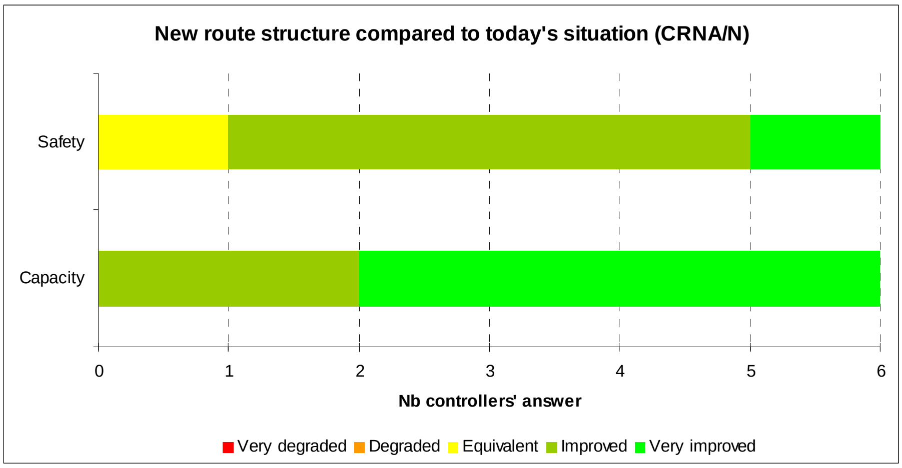


Figure 19: S6-ACC controllers' ratings regarding safety and capacity compared to today's situation.

Note: The swap of participants allowed each ACC controllers to test the other 'side' (NE or NW). The participants confirmed that the new task allocation in NE between AP and TE increased benefits of the Point Merge compared to NW.

10.3.2 Impact in APP/N

The Approach controllers reported that the new route structure had globally no impact (Figure 20). The quality of delivery of LFPG arrivals through Point Merge (lateral separation, respect of vertical and speed constraints) was considered similar as today in both runway configurations. However, the delivery of 'other arrivals' was rated as degraded due to the new route from IDOKO to VEBEK not separated from the LORNI holding and thus potentially requiring additional coordinations.

Although it was felt more realistic to receive aircraft from NE and NW, the Approach controllers emphasised the need for an Arrival Manager to assess the use of Point Merge for delays absorption with an arrival traffic load matching the runway capacity.

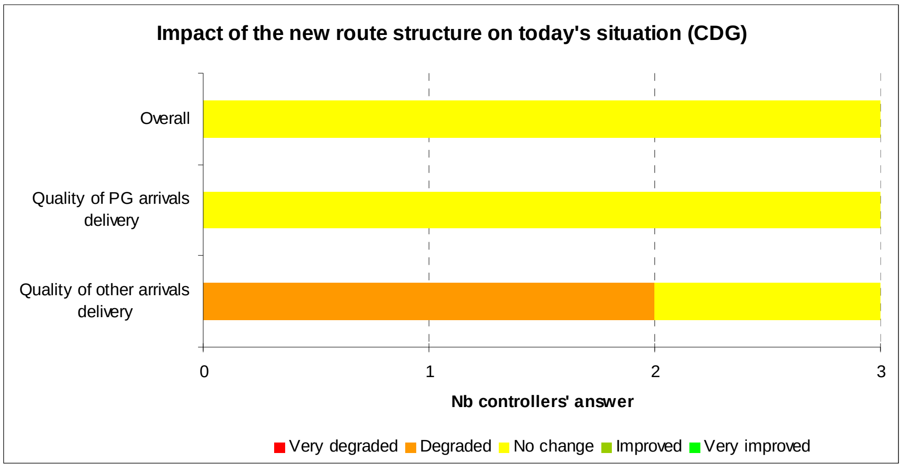


Figure 20: S6-APP controllers' ratings regarding impact of the new route structure.

10.4 Summary

The sixth session was the first integrating both NE and NW ACC sectors. In line with previous ("isolated") sessions, controller feedback was very positive. They found Point Merge very efficient to sequence high LFPG arrivals load. They perceived benefits in terms of workload, potentially providing gain in terms of safety and capacity. The only limitation (considered as minor due to limited number of flights) concerned the interaction between the main flow and overflights. Due to larger airspace available and better task sharing, Point Merge was found as globally providing more important benefits in NE than in NW.

Overall, no significant impact was reported by the Approach controllers. Despite the modifications brought, the route used for secondary arrival flows (IDOKO to VEBEK) was still found not separated from LORNI holding. The absence of an AMAN was felt not realistic by Approach controllers as it prevented ACC from considering delays.

10.5 Next session

The objective of the next session will be to further assess benefits and limitations of the new method with quantitative comparisons. It is planned to introduce MAESTRO.

11 Session 7

11.1 Objective

This session was initially planned as a “rehearsal” prior the last session. The previous session showed that the simulation environment and the new method were sufficiently stable and mature (MAESTRO aspects expected) to perform an assessment in ACC (quantitative) and in Approach (qualitative).

11.2 Organisation and setup

The session took place during three days (18th to 20th May 2011) and involved the eight controllers from Paris ACC who participated to the previous sessions and three Paris Approach controllers (two newcomers).

The environment remained globally unchanged (detailed description in 10.2 and maps of sectors in 10.2.1.1). The changes introduced are described in the following sections. Due to the absence of AMAN, the Approach controllers were still tasked to kill few aircraft (once passing the IAF) to remain under realistic traffic load.

11.2.1 Changes

The main modifications were:

- Traffic sample corrected to obtain comparable situations in ACC.
- Traffic load slightly reduced to better reflect current situations. Based on previous samples, new traffic (T8 and T9) were defined:
    - In ACC NE: 24 PG arrivals, 8 other arrivals (-2) and 5 overflights per hour,
    - In ACC NW: 27 PG arrivals (-2), 8 other arrivals (-2) and 5 overflights per hour.

Note: All ACC controllers were rosted on NE and NW positions.

11.2.2 Run plan

The session was made of 10 runs: 4 training and 6 measured runs (2 Baseline and 4 Point Merge) as illustrated in Table 9. Objective data were collected in ACC over a 1 hour measured period[17] as during previous session. Debriefings were conducted at the end of each run with all participants (ACC and Approach).

[17] The measured period started 10min after the run was launched to allow for traffic to build up in the measured sectors.

Table 9: Run plan (session 7).

Date	Conditions	Runway configuration	Objective	Sample	Duration
18/05/11	Point Merge	Westerly	Training / Refresh	T9W	50min
	Point Merge	Easterly	Training / Refresh	T8E	50min
	Point Merge	Westerly	Training / Refresh	T9W	50min
	Point Merge	Easterly	Training / Refresh	T8E	50min
19/05/11	Point Merge	Westerly	Measurements	T8W	1h10
	Baseline	Easterly	Measurements	T9E	1h10
	Point Merge	Easterly	Measurements	T9E	1h10
20/05/11	Baseline	Westerly	Measurements	T8W	1h10
	Point Merge	Westerly	Measurements	T8W	1h10
	Point Merge	Easterly	Measurements	T9E	1h10

11.3 Results

The results focused on ACC with a quantitative assessment in terms of operability and performances[18]. Sectors concerned were: AP, TE and TP[19].

No quantitative measurements could have been done in Approach as aircraft killed in the Approach differed between the conditions. The feedback from Approach controllers remained unchanged: the new method had globally no impact.

11.3.1 Operability in ACC

11.3.1.1 General feedback

Overall, the feedback from controllers remained positive and in line with previous sessions. The handling of arrivals with the new route structure was found feasible and Point Merge was seen as providing benefits in terms of safety and capacity due to reduced workload and increased availability. More benefits were reported in NE than in NW.

11.3.1.2 Controllers' activity

The analysis of frequency occupancy[20] (Figure 21) confirms controller perception of a reduction with Point Merge. In NE, Point Merge led to a better balanced frequency load between AP and TE. The

[18] As the data collection was performed over 4 runs in Point Merge and 2 in Baseline, there are twice more measurements with Point Merge.

[19] The route structure modifications did not concern UK-UZ and we checked that UK-UZ was indeed not impacted. Results are equivalent in Baseline and with Point Merge: 27% of frequency occupancy, ~65 manoeuvres instructions issued, and most of time (>~75%) spent with low or very low level of workload.

[20] Mean frequency occupancy is averaged per run and over 2 minutes steps. This was done to reflect quiet and busy periods (standard deviations) during a run rather than difference among runs.

frequency occupancy of the busiest controllers (TE) is reduced (-8%pt) whereas the less loaded controller (AP), by taking a more active part in the sequencing, became more loaded than in baseline (+11%pt) but remained at an acceptable level. In NW, Point Merge also led to a frequency load reduction (-3%pt).

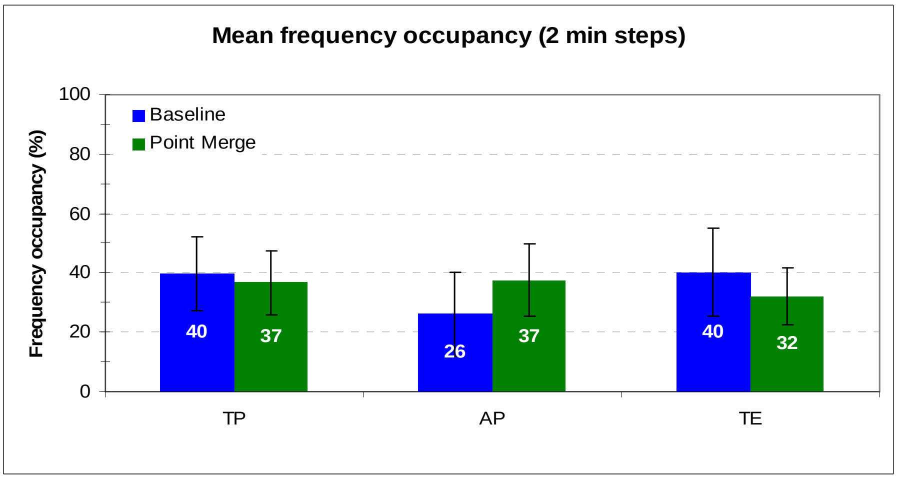


Figure 21: S7-Mean frequency occupancy in ACC.

The analysis of the number of manoeuvre instructions is in line with that of frequency occupancy (Figure 22). In NE, Point Merge led to a reduction of ~15% for AP+TE, with a better distribution between AP and TE. In NW, there is a similar reduction of 15%.

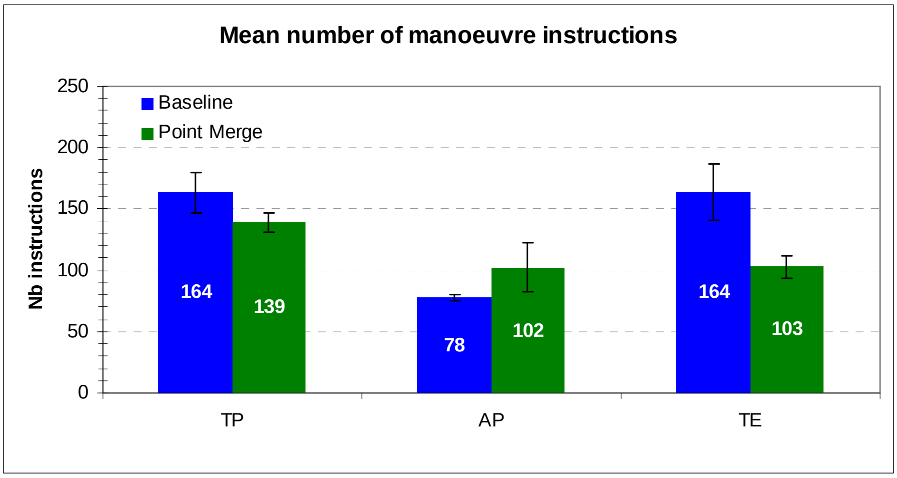


Figure 22: S7-Mean number of manoeuvre instructions in ACC.

To get more insight on controller working method and on pilot perspective, we analysed the number of manoeuvre instructions per LFPG arrival[21] (Figure 19).

In NE, Point Merge led to a reduction of 2 instructions per aircraft in TE and a slight increase (+0.3) in AP (Figure 19). This came from less need for route deviation instructions (reduction of direct-to in AP and headings in TE).

In NW, Point Merge led to a reduction of ~1 instruction per aircraft[22] which corresponds to the disappearance of one heading instruction. With Point Merge, the sequence is initiated with only one direct-to.

[21] This metric consider LFPG arrival that flew the whole sector (transferred in and transferred out).

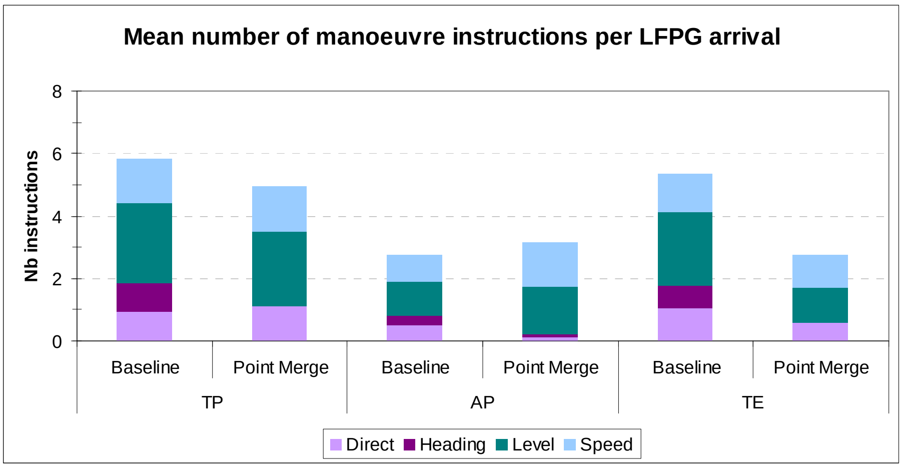


Figure 23: S7-Mean number of manoeuvre instructions per LFPG arrival in ACC.

11.3.1.3 Controllers' workload

Overall, controller perceived rather medium workload: the level of workload (instantaneous self assessment, ISA) was most of time (>95%) medium or below (Figure 24).

It could be noted that, for AP and TP, workload result is not completely in line with controller feedback, frequency occupancy and number of instructions. In AP, controllers reported slight decrease of workload in Point Merge while frequency occupancy and number of instructions are increased. In TP, workload was slightly higher in Point Merge despite slightly less instructions and reduced frequency load.

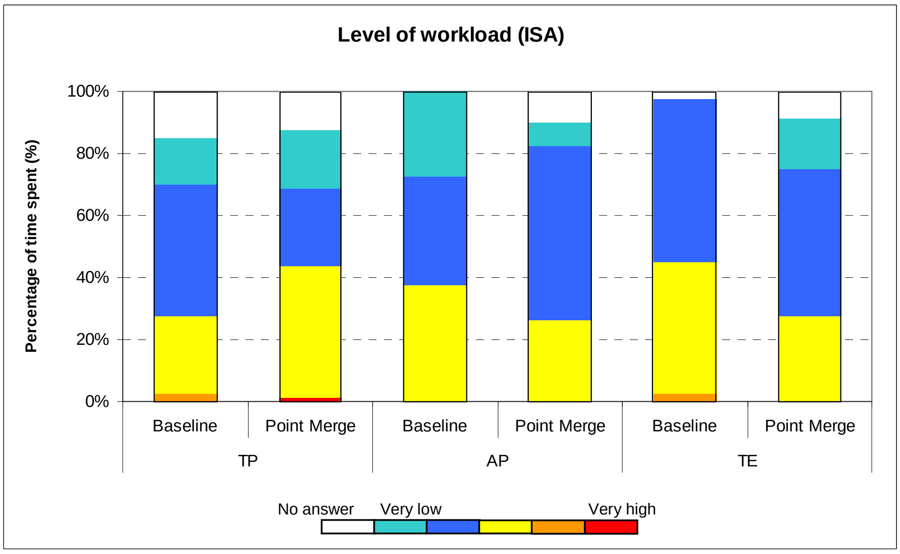


Figure 24: S7-ACC controllers' perceived level of workload (ISA).

[22] The reduction of 1 instructions can be linked with the global reduction observed in TP (-25), considering the number of LFPG arrival (27).

11.3.2 Performances in ACC

Two aspects are considered with a focus on the main flow (LFPG arrivals): quality of traffic delivery assessed through spacing accuracy at exit[23] and flight efficiency assessed through distance/time flown in ACC, vertical profiles and trajectories.

11.3.2.1 Quality of traffic delivery

The ACC controllers were tasked to deliver LFPG arrivals to APP/N with 8nm spacing (minimum) and 250kts, without any AMAN indications. As illustrated in Figure 25, the sequencing of both arrivals flows to DEVIM and KOLIV was similar in both conditions: more than 50% (over ~45 aircraft per run) of LFPG arrivals were delivered to APP/N between 7nm and 11nm[24]. Larger spacing values corresponded to gaps in the traffic.

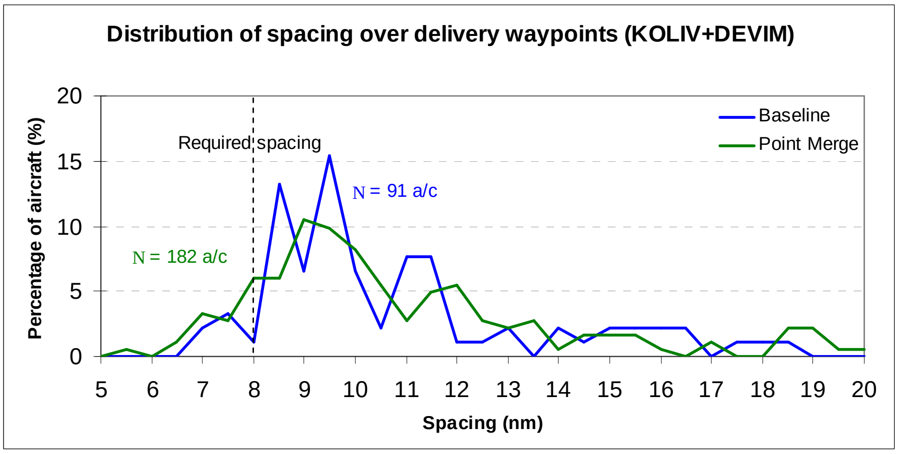


Figure 25: S7-Spacing accuracy for delivery to APP/N.

11.3.2.2 Flight efficiency

The analysis of distance and time flown (70nm from exit points until exit points resp. KOLIV and DEVIM) shows that aircraft flew slightly more distance in Point Merge (~3% to 5%) but with similar time (Figure 26). The sequencing is made at a slightly higher speed with Point Merge (longer distance with same time and equivalent spacing accuracy).

Note: Two runs were performed (spare runs on 6th June) to test the effect of reduced speed along the legs (250kts or 220kts) on distance and time flown. No significant impact was observed.

[23] The spacing accuracy was measured and between two successive aircraft once the first aircraft flew over the transfer waypoint (DEVIM and KOLIV). As the traffic was not continuously busy (included some quiet periods) high value of spacing occurred (e.g. >25nm). Therefore it was decided to rather present distribution than average values less meaningful.

[24] The minimum separation applicable here is 5nm.

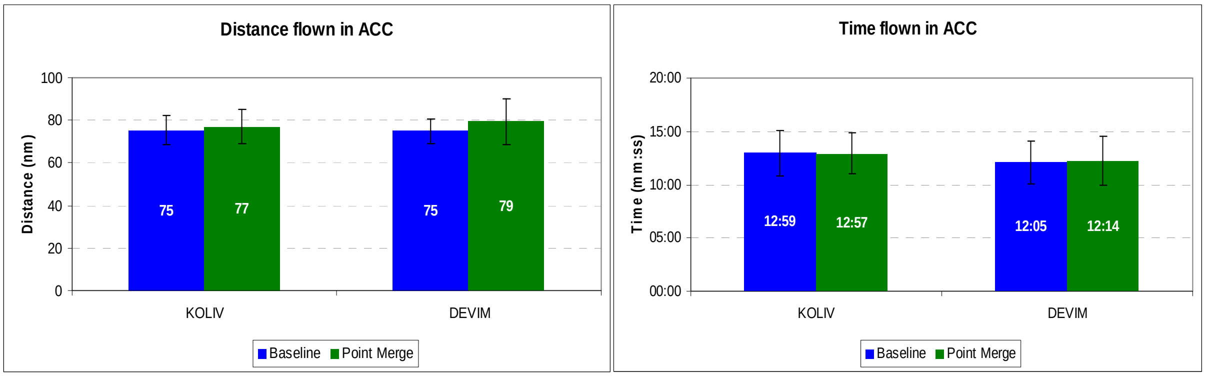


Figure 26: S7-Distance and time flown in ACC.

The analysis of distance and time flown per level band shows that with Point Merge aircraft stayed longer higher (typically between FL200 and FL350 as shown Figure 27). This illustrates the Point Merge method where the path stretching is done along the legs above FL200 whereas in Baseline the use of vectoring may require to further descent aircraft and levelling off at lower altitude.

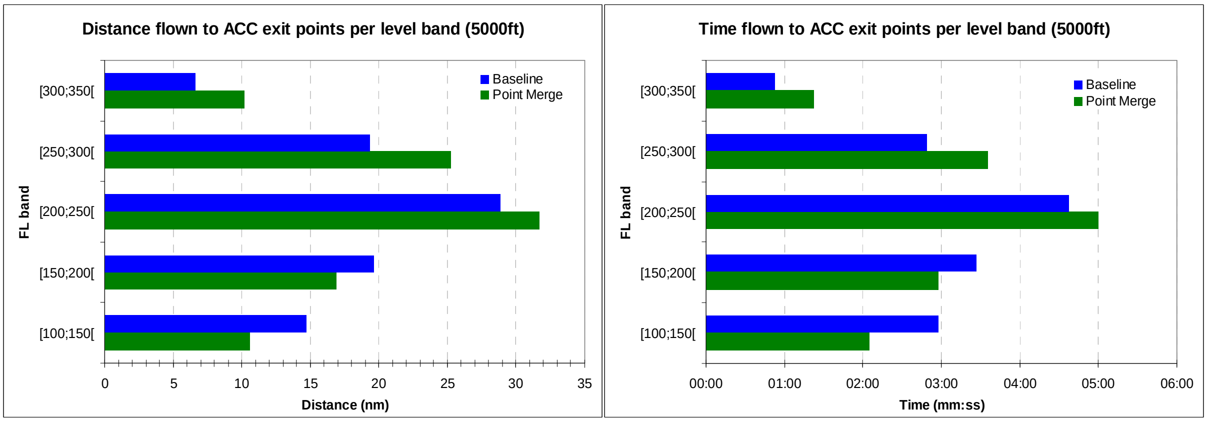


Figure 27: S7-Distance and time flown in ACC per level band.

The mean descent profiles of LFPG arrivals[25] shown in Figure 28 are consistent with previous results and show that, with Point Merge, aircraft were maintained longer at higher level, with a delayed (~20nm) and more continuous descent to delivery flight levels (reduced standard deviation). This was mainly the case in Easterly runway configuration whereas equivalent profiles are observed in Westerly configuration.

25 The term “distance” refers to the distance to go to KOLIV and DEVIM, (in nm) and not the direct distance to those points.

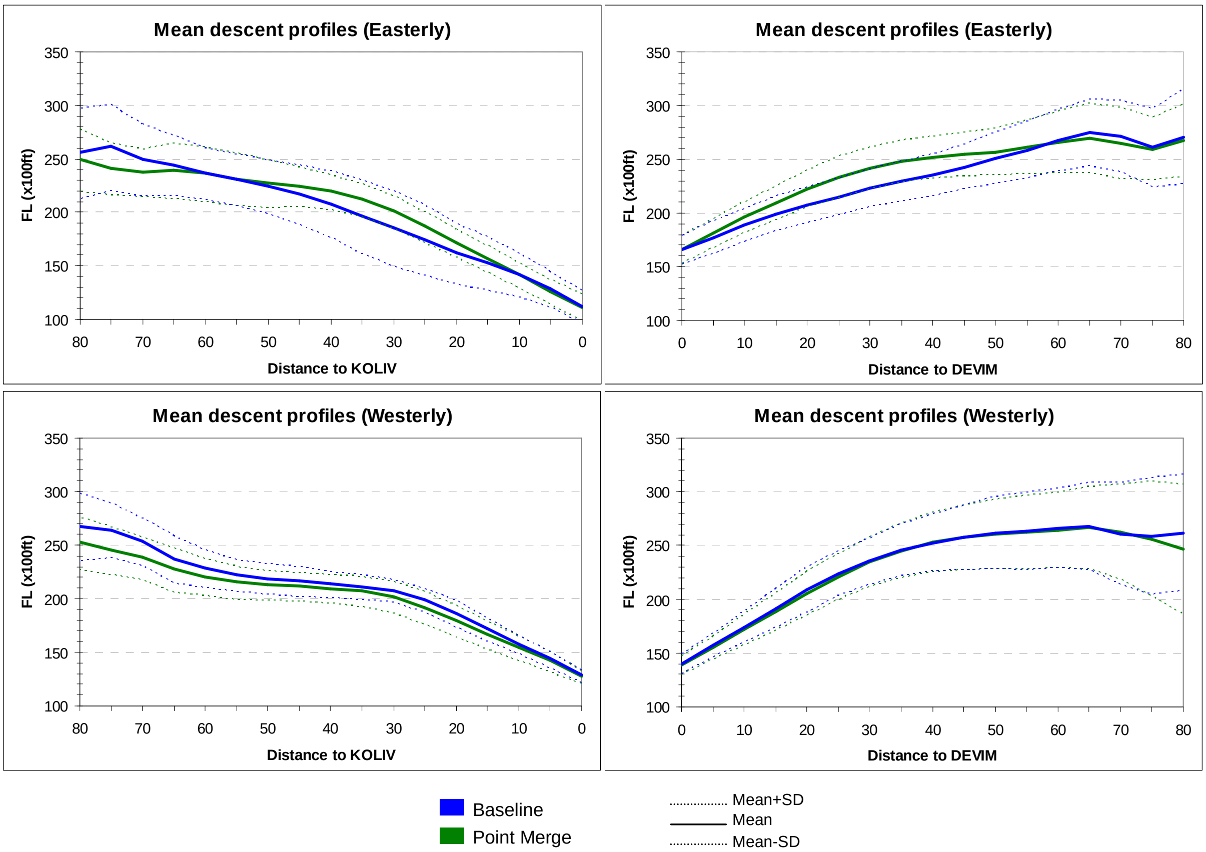


Figure 28: S7-Mean descent profiles in ACC from KOLIV and DEVIM.

The different working methods in Baseline and Point Merge are clearly visible on LFPG flown trajectories (Figure 29). The use of radar vectoring is apparent in Baseline whereas the flow of traffic was more ordered with a contained and predefined dispersion of trajectories with Point Merge.

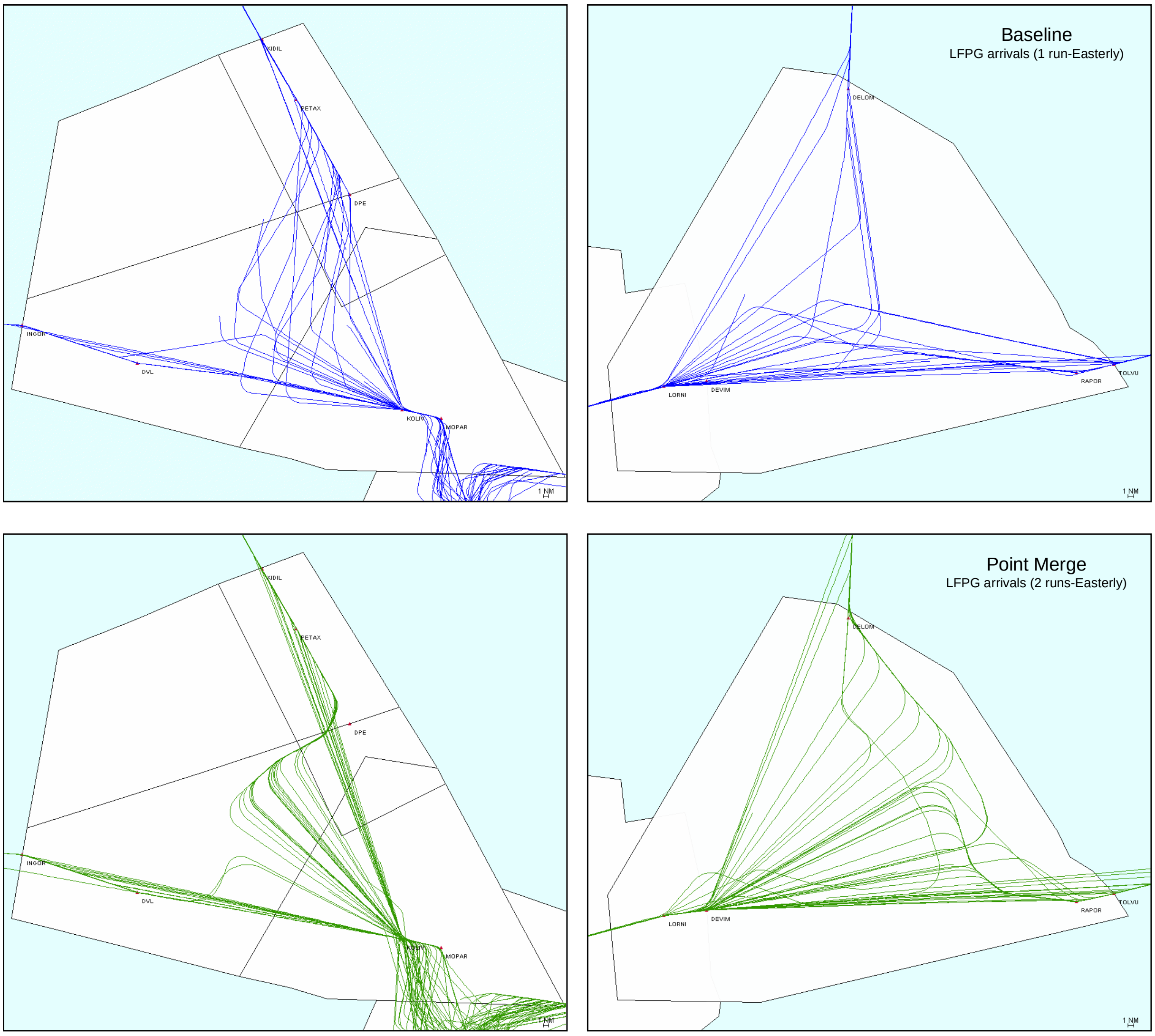


Figure 29: S7-LFPG arrival flown trajectories in Baseline (top) and with Point Merge (bottom) in Easterly configuration.

11.4 Summary

The seventh session aimed at conducting initial quantitative assessment in NE and NW. The objective results confirmed the positive feedback obtained during previous session. Point Merge reduced workload, frequency load (from -3%pts in TP to -8%pts in TE - the busiest position) and number of instructions (-15% in NE and NW). As anticipated, the workload reduction is more important in NE than in NW. The transfer conditions to the approach (spacing accuracy) was equivalent in Baseline and with Point Merge. The time flown in ACC was equivalent, and the distance flows slightly increased (3% to 5%) due to a path stretching is made at higher altitude (along the legs). This is anticipated to have a neutral effect on fuel efficiency. In Approach, the absence of an AMAN prevents the controllers from fully assessing the impact of the new route structure.

11.5 Next session

The last session should introduce an Arrival Manager, and assess benefits and limitations in ACC and in Approach.

12 Session 8

12.1 Objective

The objective of the last session was twofold:

- Develop a working method with the Arrival Manager (MAESTRO).
- Assess benefits and limitations of Point Merge in combination with AMAN, in particular:
    - assess operability in ACC;
    - assess impact on APP/N;
    - assess global performances ACC+APP/N.

12.2 Organisation and setup

The session took place during 5 days (30^{th}-31^{st} May, 1^{st}, 6^{th} and 7^{th} June 2011). The session involved the eight controllers from Paris ACC who participated to the previous session and seven Paris Approach controllers.

During the last two days of the session, demo and free (spare) runs were performed (e.g. test of reduced speed along the legs). This is not reported here.

The environment was the same as in previous session (see 10.2) with the introduction of an Arrival Manager.

12.2.1 Changes

The major change compared to previous session was the introduction of an Arrival Manager (MAESTRO).

For flight efficiency considerations, it was decided to reduce the delay absorption capability in Approach compared to today (here 2min for downwind and base legs) and allow for more delay absorption capability at high altitude (up to 6-7 minutes in ACC)[26].

The first day of the session allowed configuring MAESTRO and defining appropriate working method both in Baseline and Point Merge (see example of display in Figure 30). MAESTRO proposed sequence and delay indications were found usable by both ACC and APP controllers. As today, a sequence manager (SEQ) was in charge of handling the MAESTRO sequence. During the tuning phase, a new “flow manager” role was introduced to facilitate coordination between SEQ and ACC, and further refine MAESTRO proposals. This new role was retained for the measured runs.

The introduction of MAESTRO led to modify the traffic samples: the number of LFPG arrivals was reduced to fit with runway capacity and to maintain delays manageable in ACC (without need for holding). The new traffic samples (T10 and T11) contained:

- in NE: 20 PG arrivals (-4 compared to previous session), 8 other arrivals and 5 overflights;
- in NW: 24 PG arrivals (-3 compared to previous session), 5 other arrivals (-3 compared to previous session) and 5 overflights.

[26] The delays were calculated: along the STARs in Baseline, along the STARs assuming direct routes from leg entry to exit point (i.e. legs excluded) in Point Merge.

In terms of tasks and roles:

- Sequence manager (SEQ) active role in handling the sequence on MAESTRO.
- ACC controllers to deliver traffic according to MAESTRO advisories.

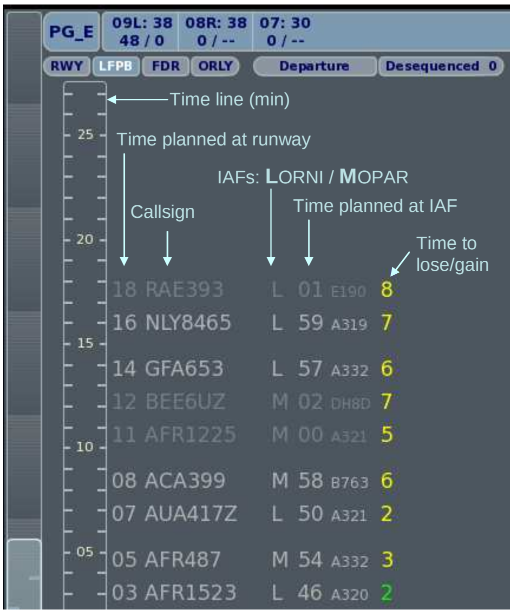


Figure 30: Example of MAESTRO display in Approach.

12.2.2 Run plan

The session was made of ten runs: 4 tuning runs on MAESTRO and 6 measured runs (2 in Baseline and 4 in Point Merge) as illustrated in Table 10. Objective data were collected in ACC and APP/N over a 1 hour measured period defined as during the previous session. It should be noted that the logs from MAESTRO (e.g. evolution of delay values) could not be analysed. A global debriefing with questionnaire was conducted at the end of the measured exercises (end of Day 3) with all the participants.

Table 10: Run plan (session 8).

Date	Conditions	Runway configuration	Objective	Sample	Duration
30/05/11	Point Merge	Westerly	MAESTRO tuning	T10W	50min
	Point Merge	Westerly	MAESTRO tuning	T11W	50min
	Point Merge	Easterly	MAESTRO tuning	T10E	50min
	Point Merge	Easterly	MAESTRO tuning	T11E	50min
31/05/11	Baseline	Easterly	Measurements	T11E	1h10
	Point Merge	Easterly	Measurements	T11E	1h10
	Point Merge	Westerly	Measurements	T11W	1h10
01/06/11	Baseline	Westerly	Measurements	T11W	1h10
	Point Merge	Westerly	Measurements	T11W	1h10
	Point Merge	Easterly	Measurements	T11E	1h10

12.3 Results

12.3.1 Operability in ACC

12.3.1.1 General feedback

As illustrated in Figure 31 and Figure 32, the feedback from ACC controllers was very positive and consistent with previous sessions. The overall feasibility of the new route structure including Point Merge was rated high or very high. According to them, the new route structure was safe (at least, as safe as today) and efficient to handle arrivals, with less workload and more comfortable compared to today. Most of the controllers (6 out of 8) rated that the capacity could be potentially increased compared to today.

In terms of limitations, the NE controllers mentioned that the Point Merge required adjustments of delivery conditions from upstream sector (EDDY) to reach sequencing legs required FL (lower than today). Specific training needs were foreseen for the different FL allocation between AP and TE compared to today. In NW, the controllers still foresaw interferences between arrivals and overflights.

As illustrated in Figure 31, the use of MAESTRO to sequence LFPG arrivals was found very comfortable and efficient when combined with Point Merge. Indeed, during peaks of arrival, most of the delay was absorbed on the sequencing legs with no need for vectoring. Once the delay becomes null, this was the indication to issue the direct-to the merge point.

The controllers also reported more flexibility to change the sequence order, typically to accommodate requests from the Approach. However, this requires the sequence to be “frozen” earlier than in Baseline (i.e. when aircraft are along the legs; a change when on track to the merge point would penalise aircraft as typically implying a need to vector and/or interrupt the descent).

The “flow manager” position was seen as beneficial in both conditions as facilitating the coordination.

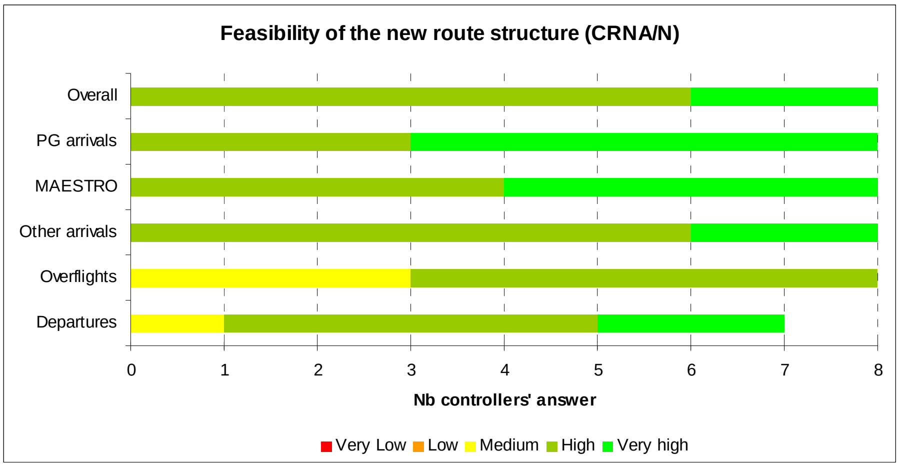


Figure 31: S8-ACC controllers' rating regarding feasibility of the new route structure.

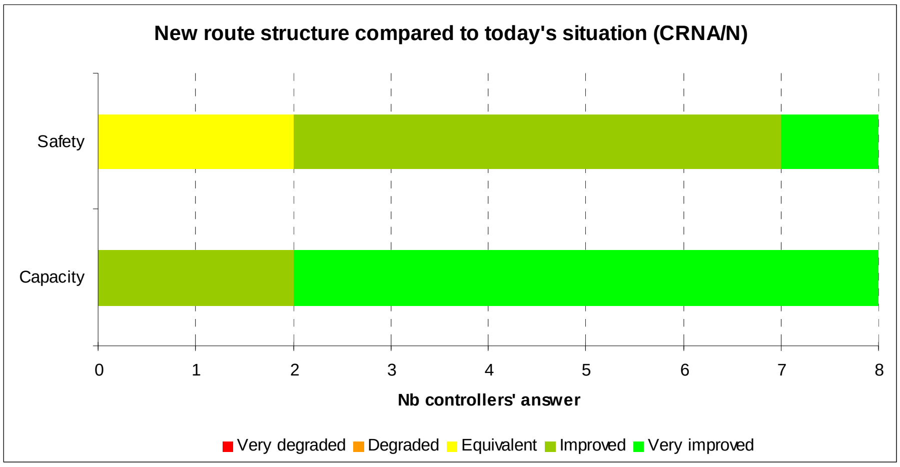


Figure 32: S8-ACC controllers' ratings regarding safety and capacity compared to today's situation.

12.3.1.2 Controllers' activity

Overall, the objective results are consistent with controller's feedback, as well as with those from previous sessions.

The frequency occupancy[27] (Figure 33) is reduced with Point Merge at the two busiest executive positions TP (-3pts) and TE (-11pts). The frequency load is also better balanced between AP and TE controllers.

[27] Mean frequency occupancy is averaged per run and over 2 minutes steps. This was done to reflect quiet and busy periods (standard deviations) during a run rather than difference among runs.

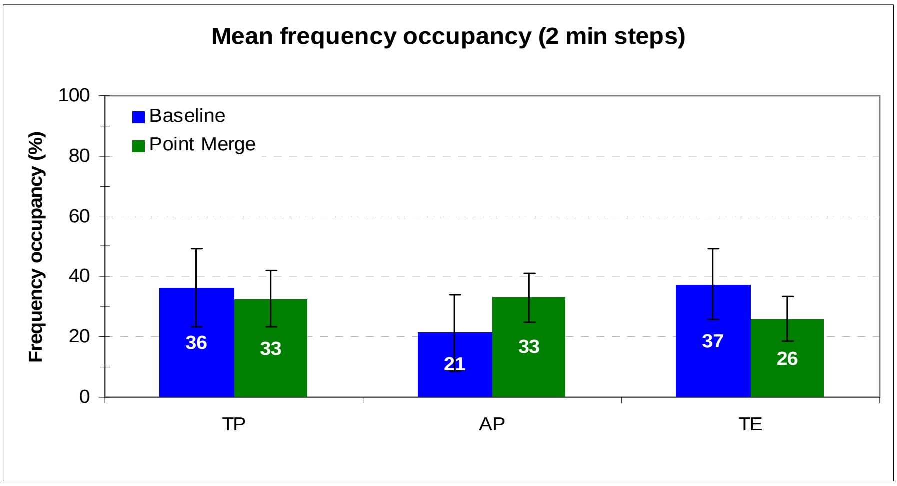


Figure 33: S8-Mean frequency occupancy in ACC sectors.

The analysis of the number of manoeuvre instructions is in line with that of frequency occupancy (Figure 34). As during the previous session, Point Merge led to a reduction of ~15% for AP+TE, with a better distribution between AP and TE. There is a similar reduction of 15% in TP.

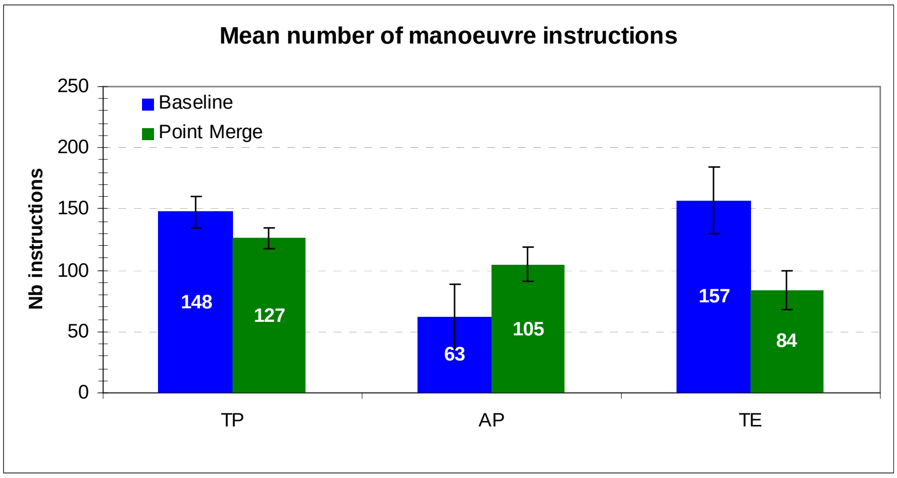


Figure 34: S8-Mean number of manoeuvre instructions in ACC.

The number of manoeuvre instructions per LFPG arrival[28] (Figure 35) is in line with the previous session. Point Merge tends to reduce the number of instructions mainly due to a reduction of heading.

In NE, Point Merge led to an important reduction of 3 instructions per aircraft in TE and an increase (+1) in AP (Figure 35). This came from less need for route deviation instructions (reduction of direct-to in AP and headings in TE).

In NW, there is a reduction (-0.5 per aircraft with Point Merge) but less important than in previous session (-1 per aircraft). Although number of heading is clearly reduced, more than one direct-to per aircraft was issued. This may be explained by the use of intermediate points on the legs to de-conflict aircraft.

[28] This metric considers LFPG arrivals that flew the whole sector (transferred in and transferred out).

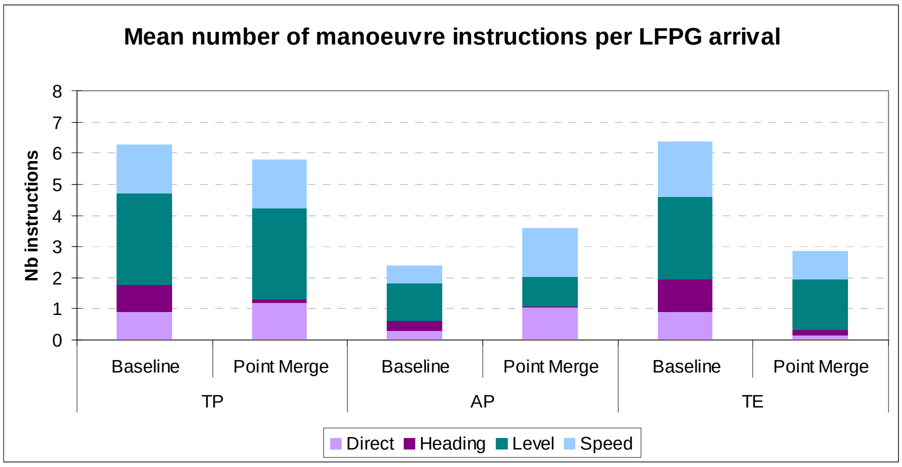


Figure 35: S8-Mean number of manoeuvre instructions per LFPG arrival in ACC.

12.3.1.3 Controllers' workload

Overall, ACC controllers were not overloaded (Figure 36) with a slight reduction compared to the previous session which could be explained by the reduction of traffic load[29].

Compared to the previous session, the workload ratings are more consistent with controllers' feedback, frequency occupancy and number of instructions. With Point Merge, AP controllers globally reported slightly more workload while TE controllers reported slightly less. On TP, the workload was still slightly higher in Point Merge despite slightly less instructions and frequency load.

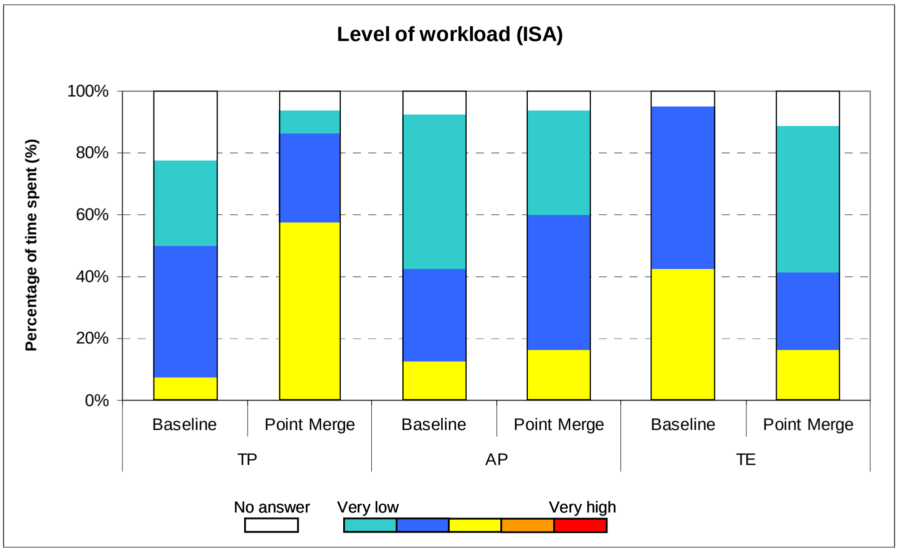


Figure 36: S8-ACC controllers' perceived level of workload (ISA).

[29] The traffic level was still found high and felt as a representative sample of peak hours.

12.3.2 Impact in APP/N

The impact on APP was assessed through controllers' feedback (final debriefing and questionnaire) and objective data on controllers' activity.

12.3.2.1 General feedback

The introduction of MAESTRO allowed assessing the impact of the Point Merge in more realistic conditions. The general feedback from the Approach controllers was positive (Figure 37) and all of them now foresaw improvements (no change or benefits reported during previous sessions).

Compared to today, in Baseline and Point Merge, controllers reported benefits of the new delay absorption strategy. This would lead to less residual delays to be absorbed in Approach hence potentially less workload and pressure, reduce distance in level off at low altitude particularly along the downwind leg.

With Point Merge, controllers reported an improved quality of delivery of LFPG arrivals through optimised sequence order and better adherence to MAESTRO advisories. At SEQ position, they expressed that Point Merge allowed a better view of the arrival sequence order as the sequence is established earlier on a pre-defined area (on the leg at around 40nm from transfer points compared with 20-30nm in Baseline). In addition, the controllers mentioned a reduced need for monitoring the interface with ACC.

As illustrated on Figure 37, the Approach controllers still expressed concerns on the delivery of other arrivals which was found degraded compared to today. As mentioned during previous sessions, this was especially caused by the new route IDOKO-VEBEK in NE which was still not separated from Approach holding protection area (at LORNI).

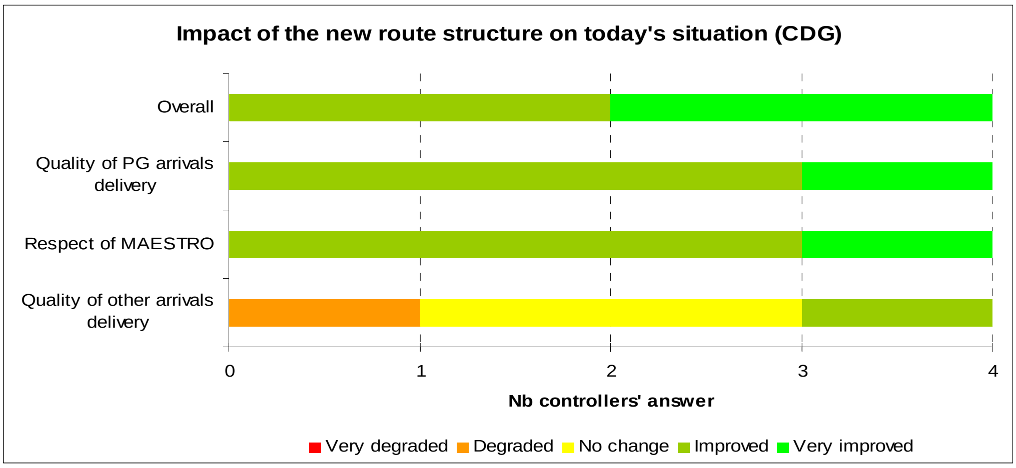


Figure 37: S8-APP controllers' ratings regarding the impact of the new route structure.

12.3.2.2 Controllers' activity

To assess controller activity, a similar analysis (as for the ACC) was performed on the INI/N and ITM/N positions: frequency occupancy, manoeuvre instructions (per LFPG arrivals) and workload (ISA). Overall, these indicators show no significant impact (Table 11).

Table 11: Objective results on APP controllers' activity.

	Baseline		Point Merge	
	INI/N	ITM/N	INI/N	ITM/N
Frequency occupancy	**48**%	**59**%	**44**%	**61**%
Number of manoeuvre instructions	~**10** instructions (**3** heading, **3** level and **4** speed)		~**10** instructions (**3** heading, **3** level and **4** speed)	
Workload	**88**% medium or below **12**% high or very high	**83**% medium or below **17**% high or very high	**98**% medium or below **2**% high or very high	**69**% medium or below **31**% high or very high

12.3.3 Performances ACC+APP/N

Performances focussed on the main flow of traffic (LFPG arrivals) with two aspects: quality of traffic delivery and flight efficiency. The quality of delivery between ACC and APP would strongly rely on the respect of MAESTRO indications (typically, value of remaining delay). However, no analysis of logs could have been made (absence of scripts). Thus, we only considered the delivery from APP to the tower, assessed through spacing accuracy at Final Approach Fix[30]. Flight efficiency was assessed through distance and time flown to FAF, vertical profiles and trajectories.

12.3.3.1 Quality of traffic delivery

As illustrated in Figure 38, the spacing on final was very accurate both in Baseline and with Point Merge. Overall, most of the LFPG arrivals (~70% in Baseline and ~80% in Point Merge) were delivered within]80s; 110s] interval (~102s ±23s on average). The throughput was ~32 LPPG arrivals, including 30% of heavy aircraft, delivered within the one hour measured period.

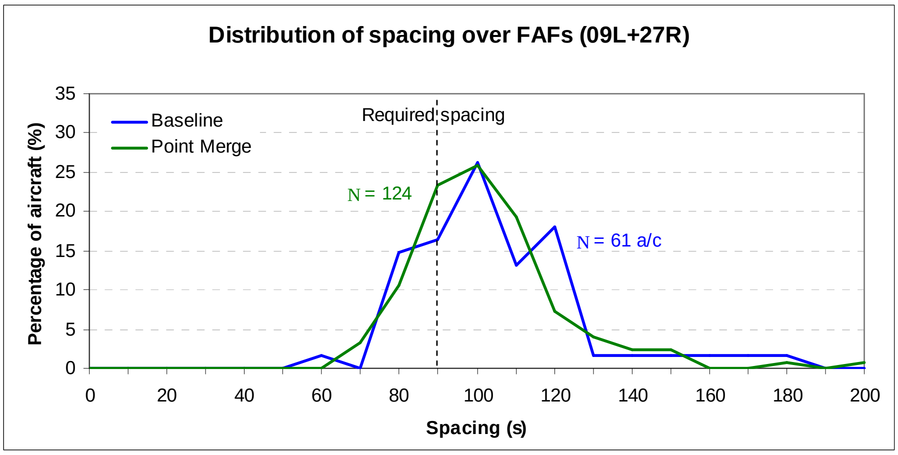


Figure 38: S8-Spacing accuracy over Final Approach Fixes.

30 The spacing accuracy was measured, in time, between two successive LFPG arrivals once the second aircraft flew over the FAFs (FA09L or FA27R). In addition, spacing values were normalised at 90s considering aircraft wake turbulence category.

12.3.3.2 Flight efficiency

Analysis of distance and time flown[31] (Figure 39) shows that aircraft fly an equivalent distance within an equivalent time in both conditions (~1% difference).

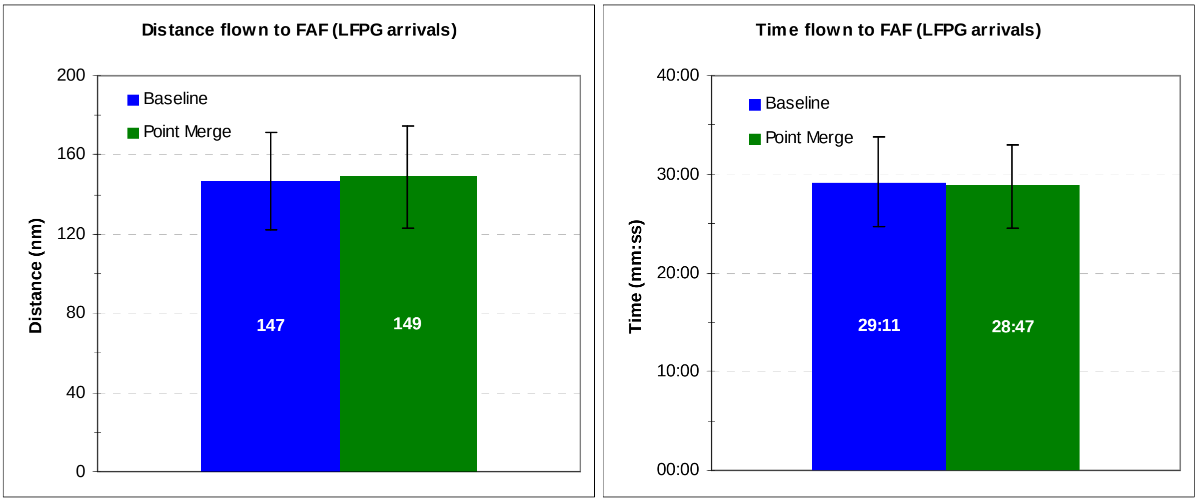


Figure 39: S8-Distance and time flown.

Results per level band[32] (Figure 40) are in line with the previous session. Considering the descent down to FL50, it is clearly observed that more distance/time are flown at a higher altitude (FL) with Point Merge. For an equivalent flight distance and time (~148nm in 29min), aircraft flew ~15nm and 2min30sec more with Point Merge between FL250 and FL200 while in baseline, these additional 15 miles were flown between FL200 and FL100. This should have a positive impact on fuel consumption.

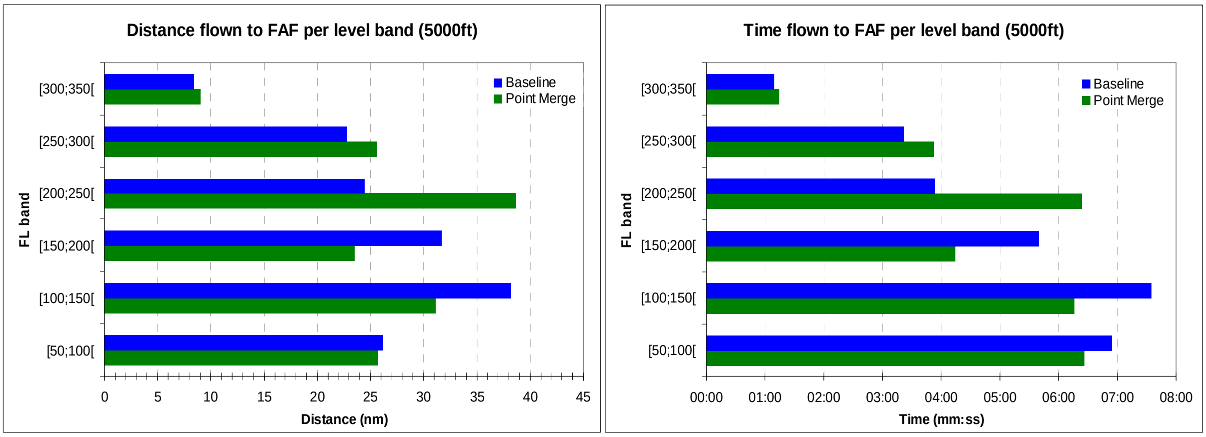


Figure 40: S8-Distance and time flown per level band.

31 Distance and time flown are calculated from 120nm (direct distance) of LFPG to Final Approach Fixes (FA09L or FA27R depending on runway configuration).

32 Distance and time flown per level band are calculated, as well, from 120nm of LFPG (direct distance) to Final Approach Fixes (FA09L and FA27R). However, the sum of distance flown per each level band on average does not correspond to the average distance and time flown. This is explained by the fact that a few aircraft entered the measured area above FL280. Most of them entered the measured area between FL280 and FL250.

The mean descent profiles (Figure 41 and Figure 42) are consistent with previous results and show that, with Point Merge, aircraft were maintained at higher level, with a delayed and more continuous descent in ACC. In Approach, no clear impact is visible.

It can be observed that there is more (positive) impact on profiles when the available distance to descent to IAF allows for optimisation. This is the case for NE in Easterly (Figure 41, right) and NW in Westerly (Figure 42, left).

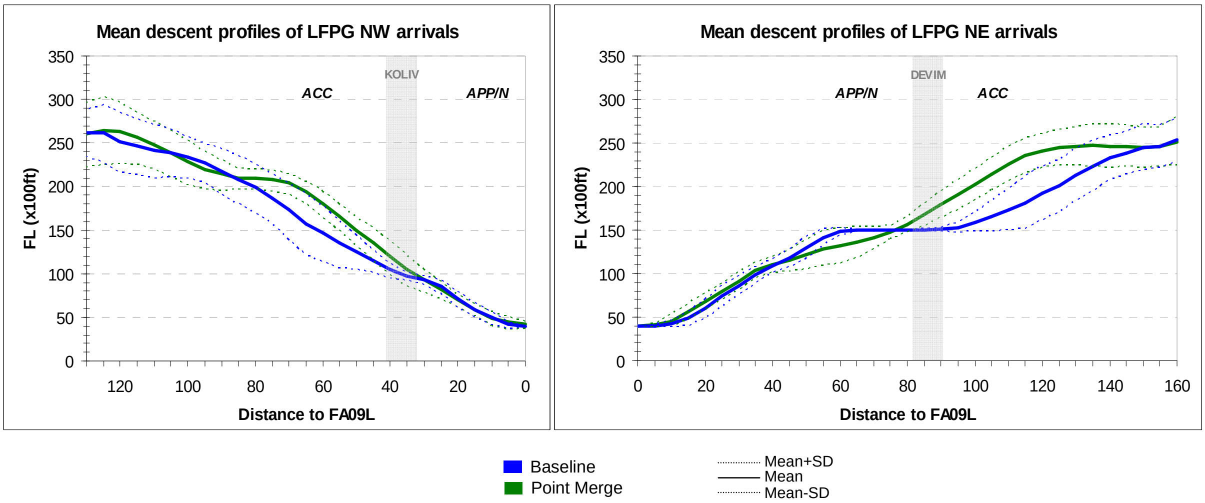


Figure 41: S8-Mean descent profiles from NW (left) and NE (right).

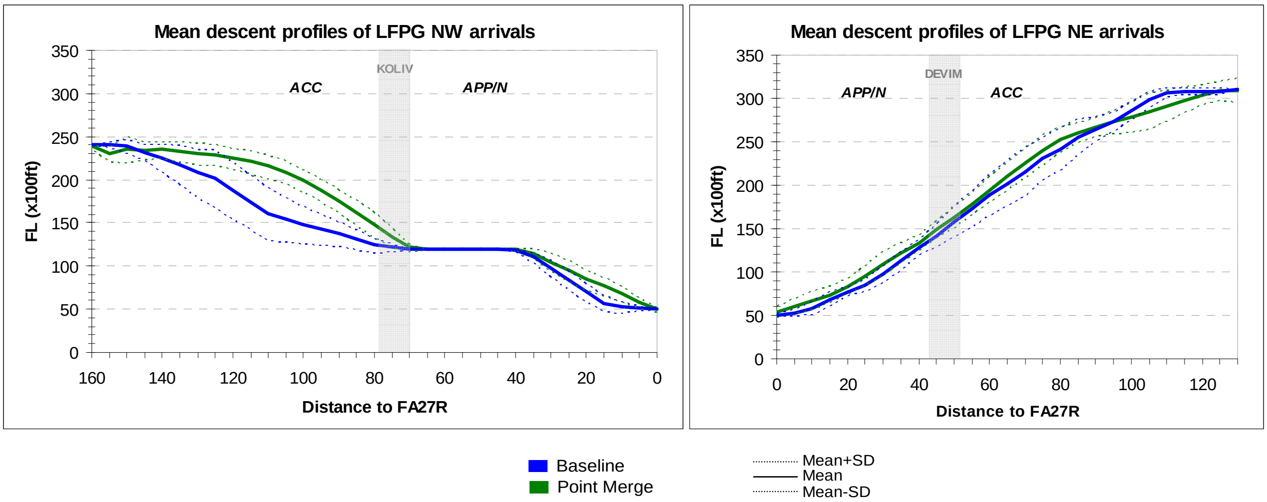


Figure 42: S8-Mean descent profiles from NW (left) and NE (right).

In line with previous session, the different working methods used in Baseline and Point Merge are clearly visible on LFPG flown trajectories (Figure 43 and Figure 44).

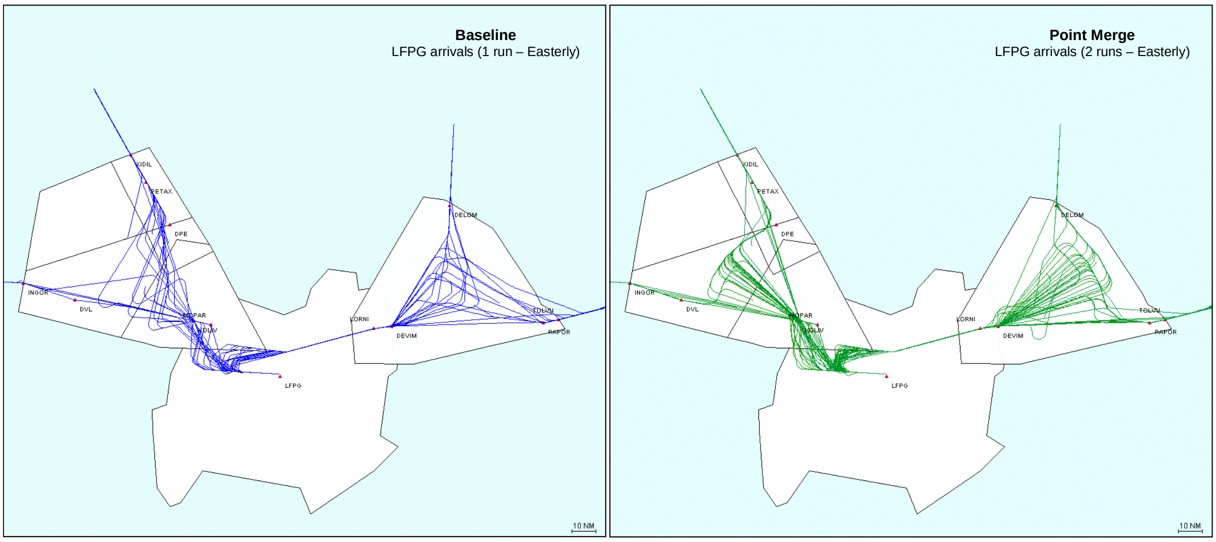


Figure 43: S8-LFPG arrival flown trajectories in Baseline (left) and with Point Merge (right) in Easterly configuration.

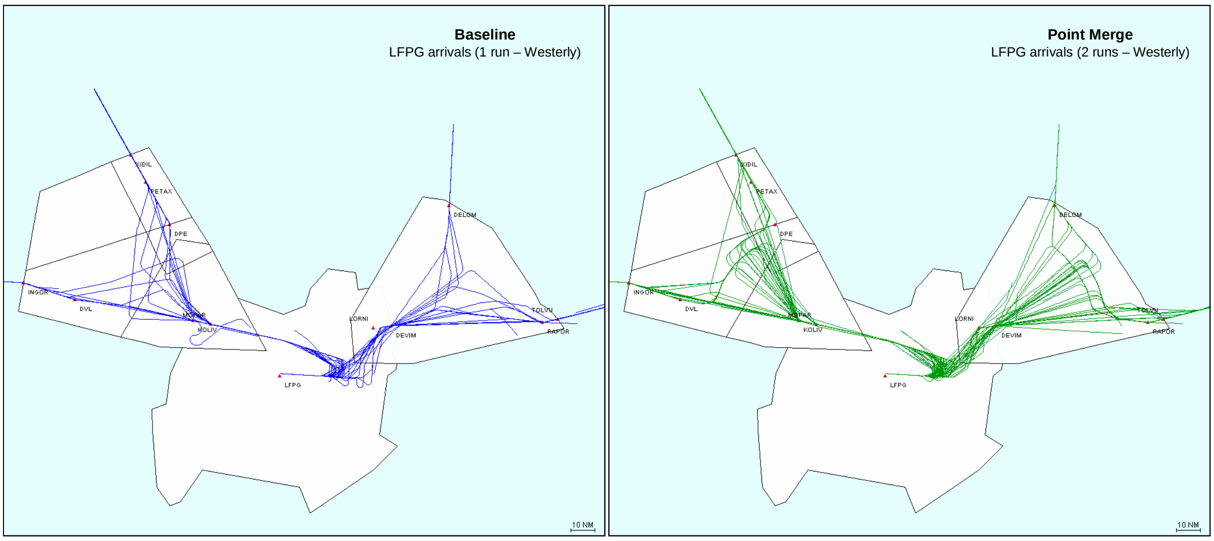


Figure 44: S8-LFPG arrival flown trajectories in Baseline (left) and with Point Merge (right) in Westerly configuration.

12.4 Summary

The last session aimed at conducting a quantitative assessment in a realistic environment including NE and NW sectors, Approach North positions and with an Arrival Manager (MAESTRO). The data were collected over the 6 measured runs (2 Baseline and 4 Point Merge) of 1h each.

Overall, the positive feedback obtained during previous session was confirmed by the quantitative analysis. The introduction of MAESTRO showed additional benefits for ACC and APP in terms of quality of delivery and better view/awareness of the sequence, which may contribute to further improve flight efficiency.

In ACC, the objective results on **operability** confirmed positive controller's feedback collected through questionnaires and final debriefing. The new routes structure was found efficient and safe to handle arrivals while reducing workload, frequency load (from -3%pts in TP to -11%pts in TE - the busiest positions) and number of instructions (-15% in NE and NW). The use of an AMAN for LFPG arrivals was found very comfortable and efficient when combined with Point Merge. Indeed, AMAN delays are absorbed along the sequencing legs (at high altitude) without any heading instructions. The main limitation mentioned was the modifications of the delivery conditions from upstream sector at DELOM (lower levels). In APP/N, the general feedback was positive with potentially an improvement of the situation compared to today. Point Merge allowed better arrival traffic sequencing due to a better awareness of the sequence by the sequence manager, and better adherence to AMAN advisories in ACC with positive impact in terms of delivery conditions. In terms of **flight efficiency**, the results showed that LFPG arrivals flew an equivalent distance and time in both conditions. It was shown that aircraft stayed at higher altitude with Point Merge, which could have a positive impact on fuel efficiency.

13 Conclusion

The present study aimed at assessing and refining the operational feasibility of Point Merge and AMAN in Paris ACC for sequencing Northern arrival flows to Paris CDG. It was conducted over five months (March to July 2011) and was composed of eight small scale real-time simulations ("prototyping sessions") conducted at EEC and involving Paris ACC and Paris CDG controllers (27 in total). The study followed an iterative approach with 2 main steps:

- Five sessions focussing on NE and NW ACC sectors in isolation with Approach positions included. The objective was to define/refine the new route design and the associated working method.
- Three sessions integrating NE+NW ACC sectors, Approach positions and with an AMAN. The objective was to assess benefits and limitations compared to a Baseline, through subjective and objective measurements.

Overall, the outcomes from the sessions were consistent and positive. The iterative process and continuity of participants allowed gradually testing and refining the new route structure and working method, with an efficient participation of the controllers that were fully familiarised and trained. The final design, consistent between NE and NW sectors, relies a Point Merge to sequence the main arrival flow (LFPG arrivals) and segregated routes for secondary arrival flows.

In terms of operability, the ACC controllers reported that Point Merge was easy to learn, comfortable and efficient to sequence arrivals. It allowed reducing frequency load and number of instructions on the busiest positions (TE and TP). In NE, the new task allocation between AP and TE sectors ("functional" rather than volume based split) was found better balanced and less demanding compared to today. In NW, the gain in workload was less important than in NE as TP due to smaller airspace available. Overall, the gain in controller's availability was reported as potentially providing "room" for safety and capacity increase. The main limitations reported were the respect of the transfer conditions by upstream sectors in NE and possible interferences between the main flow and overflights in NW. In Approach, the general feedback was positive with potentially an improvement of the situation compared to today due to better arrival traffic sequencing through better adherence to AMAN advisories in ACC.

In terms of flight efficiency, the results show no significant impact on the overall distance and time flown. In addition, it was shown that aircraft stayed at higher altitude with Point Merge, which could have a positive impact on fuel efficiency. From the pilots' perspectives, it can be expected that LFPG arrivals vertical profiles could be optimised and trajectories be more predictable.

14 References

[1] Point Merge Integration of Arrival Flows Enabling Extensive RNAV Application and Continuous Descent - Operational Services and Environment Definition, version 2.0, 19th July 2010, EUROCONTROL CND ATC Operations and Systems.

[2] Point Merge in Extended Terminal Area (PMS-TE 2009-2010), 22nd October2010, EUROCONTROL CND ATC Operations and Systems.

[3] Point Merge web page: www.eurocontrol.int/eec/public/standard_page/proj_Point_Merge.html

Appendix A Questionnaires

Transcription of the post-simulation questionnaires from the sessions 6 and 8 conducted at EEC for both ACC and APP controllers.

A.1 Session 6

A.1.1 ACC

1) Comment qualifieriez-vous la faisabilité de la méthode Point Merge ? *Très faible (TF) / Plutôt faible (PF) / Moyenne (M) / Plutôt élevée (PE) / Très élevée (TE)*

ACC NE

Réponse 1 : TE

Se heurtera peut être à la mauvaise foi légendaire de certains contrôleurs conservateurs…si nous passons les obstacles des militaires, Maastricht, compagnies…

Réponse 2 : TE

Sous réserve de l'obtention des CBWV, de la rédaction d'une lettre d'accord correcte avec Maastricht, de la bonne volonté de la salle, de la faisabilité pour les pilotes.

ACC NW

Réponse 3 : PE

Pas de problème de faisabilité.

Réponse 4 : PE

Design très satisfaisant, cohérent avec les projets espace et les évolutions du trafic. Il me semble indispensable que les méthodes de travail Point Merge soient validées par des compagnies aériennes.

Réponse 5 : PE

Très pratique et capacitif

Réponse 6 : PE

Prise en main aisée. La livraison en entrée me semble faisable. Inquiétude sur les traversier et encore plus sur les montées lentes car aujourd'hui Londres les coordonne rarement.

2) Comment qualifieriez-vous la compatibilité de la méthode Point Merge avec : Le séquencement des arrivées PG Le séquencement des arrivées vers terrains satellites La gestion des transits La gestion des départs *Très faible (TF) / Plutôt faible (PF) / Moyenne (M) / Plutôt élevée (PE) / Très élevée (TE)*

ACC NE

Réponse 1 : TE, PE, PE, PE

Quelques problèmes avec les arrivées terrains satellites au début semblent avoir été gommés par une adaptation des méthodes de travail (expérience)

Réponse 2 : TE, PE, PE, PE (ou sans objet)

En AP/TE, pas d'interférence avec les départs TMA (plus de travail en AP, mais on avait un peu de marge). D'une manière générale, l'AP n'a pas d'intérêt à gérer les départs TMA, dans le dispositif actuel ou dans le PMS.

ACC NW

Réponse 3 : TE, PE, PE, PE

Méthode très utile pour séquencer les arrivées PG.

Réponse 4 : TE, TE, M, TE

Gestion des transits, compatibilité moyenne : au niveau stratégique, on crée un nouveau conflit de trajectoire avec les transits sur VEULE-RESMI.

Réponse 5 : TE, TE, M, -

Les transits VEULE-RESMI nécessitent beaucoup plus d'attention. Ecraser les LFOB !!

Réponse 6 : TE, M, PF, -

Arrivées terrains satellites : Obligation de descendre sous le cône (difficile par exemple pour arrivées LFOB par LGL si beaucoup de travail en TH)

3) Comment qualifieriez-vous le niveau de sécurité de la méthode Point Merge par rapport à la situation actuelle ?
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

ACC NE

Réponse 1 : E

A voir à l'usage. Les problèmes rencontrés ne sont pas les mêmes qu'à présent, mais en général travail à vitesses réduites (PMS) = plus de temps de réflexion donc moins de risques.

Réponse 2 : TA

Meilleure répartition de la charge de travail et de l'occupation de fréquence, plus de disponibilité du contrôleur pour des taches extérieures au séquencement.

ACC NW

Réponse 3 : PA

Moins de suivi (par rapport à aujourd'hui où l'on donne des caps à presque tous les avions en regul) et moins de conflits potentiels.

Réponse 4 : PA

Malgré la création d'une nouvelle zone de conflit, j'ai le sentiment d'avoir plus de marge/disponibilité pour assurer la sécurité sur le secteur.

Réponse 5 : PA

A trafic équivalent, la méthode Point Merge nécessite moins de messages donc beaucoup moins incidentogène.

Réponse 6 : PA

Amélioration due à plus de temps de réflexion et gestion des trafics en niveau.

4) Comment qualifieriez-vous le potentiel de capacité de la méthode Point Merge par rapport à la situation actuelle ?
Très réduit (TR) / Plutôt réduit (PR) / Equivalent (E) / Plutôt augmenté (PA) / Très augmenté (TA)

ACC NE

Réponse 1 : PA

La répartition plus « équitable » du trafic entre les deux secteurs permet une répartition de la charge de travail qui justifie pleinement le dégroupement et permettra probablement d'augmenter les capas.

Réponse 2: TA

La répartition du travail entre AP et TE rend le séquencement à 8nm plus facilement réalisable.

ACC NW

Réponse 3: TA

Fréquence beaucoup moins chargée car nombre de message nécessaires en forte baisse à trafic équivalent.

Réponse 4 : PA

C'est comme si on développait les attentes de DPE et DVL en gardant la fluidité de nos méthodes de séquencement : c'est assez difficile de mettre les avions à 8nm en utilisant les attentes (caps intermédiaires, grosse occupation de fréquence). Avec le Merge Point, c'est beaucoup plus naturel.

Réponse 5 : TA

Moins de conflits entre les arrivées, séquencement plus simple, fréquence allégée.

Réponse 6 : TA

Plus de disponibilité mentale du contrôleur et un sentiment de moins d'urgence à ramener les avions qu'en Baseline.

5) Quels sont les 3 principaux bénéfices de la méthode Point Merge ?

ACC NE

Réponse 1 :

1. Allège la charge de travail pour réaliser une séquence d'arrivées (baisse du nombre de décision)
2. Gain de temps pour gérer les arrivées (augmentation du temps pour la prise de décision) (baisse du nombre de clearances)
3. facilité pou faire perdre du temps (MAESTRO)

Réponse 2 :

1. Simplicité/facilité du séquencement PG
2. « Confort » du contrôleur / impression de maîtrise
3. répartition du travail / disponibilité du contrôleur

Je dirais bien gain de trajectoire/conso parce que c'est l'impression que j'ai mais je laisse ce point aux mesures et aux mesureurs.

ACC NW

Réponse 3:

1. Soulagement important ressenti pour la gestion du trafic car attention focalisée principalement sur les niveaux uniquement
2. Du coup, nombre de messages en baisse
3. Et donc capa augmentée

Réponse 4 :

1. Occupation de fréquence largement allégée (à vérifier) → confort contrôleur mais surtout pilotes
2. Gain de capa et de niveau de sécurité global
3. Gestion plus fine des situations bien chargées, permettra de retarder l'utilisation des attentes au maximum

Réponse 5 :

1. Secteur plus capacitif
2. Moins de mobilisation de fréquence
3. Plus de ressources mentales pour anticiper

Réponse 6 :

1. Temps pour réfléchir
2. Moins de parole → moins de confusion à la fréquence
3. bénéfices pour les pilotes

6) Quelles sont les 3 principales limitations de la méthode Point Merge ?

ACC NE

Réponse 1 :

1. Mise à jour des docs arrivées pour toutes les compagnies sera nécessaire. Une description de la STAR trop complexe, sinon pt par pt
2. Il faut espérer une collaboration étroite de EDDY pour nous livrer correctement les arrivées PG…
3. Arrivées satellites doivent être très basses

Réponse 2 :

1. Faisabilité pour les pilotes (à voir)
2. Situation orageuse / fort vent (à tester)
3. La piste à Roissy

ACC NW

Réponse 3 :

1. Prise de message par mauvais pilote dans une leg qui se mettrait à descendre…comme ils peuvent être point-point avec seulement 1000ft
2. Leg intérieure face à l'est : FL240 vers FL100…A 250kts tous les avions pourront-ils être stables FL100 KOLIV ?.. Peut être reculer un peu les legs…

Réponse 4 :

1. Nouvelles méthode de travail : une formation théorique et pratique semble nécessaire
2. Profils des vols plus écrasés → conso carburant en hausse ?
3. Crée de nouveaux conflits

Réponse 5 :

1. Un seul secteur en TP contre 2 en AP/TE
2. Le problème des transits VEULE-RESMI (surtout l'hiver, UP ski)
3. Conduite machine coté pilote surtout par vent fort ? (trajectoire coté contrôle)

Réponse 6 :

1. Transit
2. Ecrasement des non LFPG
3. On rapproche les avions sur les legs (quid des erreurs de niveaux)

7) Quels seraient les points à améliorer sur le dispositif/méthode de travail Point Merge pour les UOPs ?

ACC NE

Réponse 1 :

- Bien décrire les méthodes de travail concernant la délégation de l'espace entre AP et TE ou croisement arrivées VEBEK et DEVIM

Réponse 2 :

- Bien expliquer la séparation/délégation de FL entre AP et TE
- Face à l'ouest, garder les LORNI et les VEBEK jusqu'à séparation après croisement
- Tester le système en limitation : livraison non conforme par Maastricht, stack, panne radio

ACC NW

Réponse 3 :

- Dans un premier temps, limiter les transits FL210 et FL230 VEULE-RESMI qui risquent de « faire peur »

Réponse 4 :

- Questions réglementaires :

- Quelle est la STAR par défaut ?
- Quand on donne la STAR Point Merge, les pilotes doivent ils réduire la vitesse d'eux même ?

Réponse 5 :

- Insister sur le rôle de l'organique dans la prise de décisions.

Réponse 6 :

- Eviter les livraisons hautes à DPE et si possible pré-séquencées.

8) Autres commentaires

ACC NE

Réponse 1 :

J'aurais aimé tester la mise en attente (stacks) associée au PMS, pour voir, ainsi que quelques situations dégradées réalistes (livraisons trop hautes par EDDY, non contact radio d'un aircraft…)

Réponse 2 : -

ACC NW

Réponse 3 :

Très satisfait de la méthode.

Réponse 4 :

Vidéo map : attention à ne pas alourdir la visu avec des traits fluo partout

Réponse 5 :

Alléger l'affichage sur l'écran (pas trop de marqueurs, pas de petites legs….)

Réponse 6: : -

A.1.2 APP

1) Comment qualifieriez-vous l'impact du dispositif/méthode Point Merge sur les secteurs d'approche CDG nord ?
Très négatif (TN) / Plutôt négatif (PN) / Neutre (N) / Plutôt positif (PP) / Très positif (TP)

Réponse 1 : N

Les livraisons pour les terrains satellites sont un peu plus pénalisantes qu'en Baseline i.e. trop proches des limites de l'EGA et empêchent l'anticipation de la descente des arrivées pour CDG

Réponse 2 : N

-

Réponse 3 : N

Les trajectoires Bourget, OB etc ne sont pas terribles en PMS-TE surtout sur LORNI (trop proches de l'EGA)

2) Globalement, comment qualifieriez-vous la qualité de livraison du trafic avec la méthode point Merge par rapport à la situation actuelle ?
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : E

-

Réponse 2 : E

-

Réponse 3 : E

-

3) En détails, en face à l'Est, comment qualifieriez-vous le respect des conditions de livraison avec la méthode Point Merge par rapport à la situation actuelle :
Respect de l'espacement pour les PG
Respect des contraintes verticales pour les PG
Respect des contraintes de vitesse pour les PG
Respect des conditions de livraison pour les arrivées vers terrains satellites
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : E, E, E, PD

-

Réponse 2 : E, E, E, E

-

Réponse 3 : E, E, E, PD

-

4) En détails, en face à l'Ouest, comment qualifieriez-vous le respect des conditions de livraison avec la méthode Point Merge par rapport à la situation actuelle : Respect de l'espacement pour les PG Respect des contraintes verticales pour les PG Respect des contraintes de vitesse pour les PG Respect des conditions de livraison pour les arrivées vers terrains satellites La gestion des départs *Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)*

Réponse 1 : E, E, E, PD

-

Réponse 2 : E, E, E, E

-

Réponse 3 : E, E, E, PD

-

5) Autres commentaires

Réponse 1 :

Il est difficile de juger de la capacité du dispositif Point Merge à absorber les délais nécessaires sans un outil capable de les déterminer. Bref sans MAESTRO….pas facile.

Réponse 2 :

Bémol, MAESTRO n'est plus capable de calculer un ordre correct à l'arrivée mais corrections en cours.

Réponse 3 :

En plus de ce dispositif qui devrait augmenter la capacité TP et TE, il faudra bien entendu un MAESTRO opérationnel pour éviter tout débordement en approche.

D'autre part, ne pas oublier les trajectoires OB/PB etc en PMS-TE ne sont pas séparées des attentes

A.2 Session 8

A.2.1 ACC

1) Comment qualifieriez-vous la faisabilité de la méthode Point Merge ? *Très faible (TF) / Plutôt faible (PF) / Moyenne (M) / Plutôt élevée (PE) / Très élevée (TE)*

Réponse 1 : TE

Très satisfait de cette méthode

Réponse 2 : PE

Si tous les PC n'étaient pas si récalcitrants au changement….

Réponse 3 : PE

-

Réponse 4 : PE

Techniquement aucun problème de faisabilité. Sauf peut être quelques réticences de certains mais qui seront vite levées par la facilité du dispositif

Réponse 5 : PE

-

Réponse 6 : PE

Toujours les mêmes incertitudes quant à la réglementation et les publications.

Réponse 7 : PE

Toujours à vérifier les livraisons par Londres et EDDY.

Réponse 8 : TE

Après un peu de théorie et de pratique, c'est très facile à utiliser.

2) Comment qualifieriez-vous la compatibilité de la méthode Point Merge avec : Le séquencement des arrivées PG Respect des contraintes MAESTRO pour les PG Le séquencement des arrivées vers terrains satellites

La gestion des transits
La gestion des départs
Très faible (TF) / Plutôt faible (PF) / Moyenne (M) / Plutôt élevée (PE) / Très élevée (TE)

Réponse 1 : PE, PE, PE, PE, PE

-

Réponse 2 : TE, TE, PE, PE, TE

-

Réponse 3 : TE, PE, PE, M, PE

MAESTRO : il est nécessaire que les a/c soient gelés dans la séquence avant de quitter les legs. Après, c'est toujours possible mais on perd la moitié de l'intérêt du dispositif si on doit redonner des caps

Terrains satellites : C'est la tache de la TE qui est libérée de la séquence PG donc qui a du temps pour ça.

Transits : Ne change rien au séquencement. Interfère si volonté de descente lisse

Départs : il serait préférable que l'AP se débarrasse des départs MEDOX….

Réponse 4 : TE, TE, PE, M, Sans objet

Les transits perturbent le séquencement en PMS dans le sens où le contrôleur est obligé de revenir aux caps.

Réponse 5 : PE, PE, TE, PE, M, -

Un seul bémol, je ne prêtais pas assez d'attention aux départs RANUX, étant plus focalisée sur les legs.

Réponse 6 : PE, TE, PE, M, PE

TP : problème des VEULE-RESMI

AP/TE : compatibilité VEBEK/DEVIM plus problématique qu'avant (lié surtout à la nouvelle secto induite par le relèvement de l'altitude d'interception).

Réponse 7 : TE, PE, PE, PE, PE

Séquencement aisé, délais <=5min facile à résorber.

Réponse 8: TE, TE, TE, PE, TE

Pré-régulation pour CDG très simplifiée.

Délai facile à résorber.

3) Comment qualifieriez-vous le niveau de sécurité de la méthode Point Merge par rapport à la situation actuelle ?
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : PA

Plus de souplesse, fréquence moins chargée…uniquement concentration sur le FLs.

Réponse 2 : E

-

Réponse 3 : PA

Plus de confort de la méthode→ plus de reçu, plus grande impression de maitrise.

Réponse 4 : PA

Plus de disponibilité du contrôleur pour la gestion des trafics annexes.

Réponse 5 : TA

-

Réponse 6 : PA

TP :

(-) pour le conflit VEULE-RESMI

(+++) pour les ressources mentales libérées par le dispositif Merge Point

AP/TE :

(-) pour les VEBEK/DEVIM

(-) pour les conditions de transfert « brouillon » entre AP et TE

(+++) pour les ressources mentales libérées par le dispositif Merge Point

Réponse 7 : PA

On se soucie des niveaux en entrée de leg seulement alors qu'aujourd'hui il faut donner plus de niveaux intermédiaires dans la descente.

Réponse 8 : E

Bien anticiper pour les transits sur l'axe VEULE-RESMI à 210, 230 en TP !

4) Comment qualifieriez-vous le potentiel de capacité de la méthode Point Merge par rapport à la situation actuelle ?
Très réduit (TR) / Plutôt réduit (PR) / Equivalent (E) / Plutôt augmenté (PA) / Très augmenté (TA)

Réponse 1 : TA

Clairement on peut augmenter la capacité du (des) secteur(s) concernés.

Réponse 2: TA

-

Réponse 3: TA

On passe facilement beaucoup de monde sans mobiliser trop de ressources.

Réponse 4 : TA

-

Réponse 5 : TA

-

Réponse 6 : PA

Il va falloir construire au moins un nouveau doublet de pistes à CDG….

Réponse 7 : PA

Plus de temps libre → on peut prendre plus d'avions

Réponse 8 : TA

-

5) Quels sont les 3 principaux bénéfices de la méthode Point Merge ?

Réponse 1 :

1. Sécurité améliorée
2. Encombrement de fréquence diminué
3. Plus facile de faire perdre du temps aux avions en les laissant tout simplement sur la standard

Réponse 2 :

1. Simplicité, unicité des méthodes de séquencement/régulation
2. Baisse d'occupation de fréquence
3. Possibilité accrue de descentes continues

Réponse 3:

1. Facilité/fluidité du séquencement
2. Capacité à absorber du délai facilement
3. Confort du contrôleur

Réponse 4 :

1. Facilité de séquencement
2. Capacité
3. Disponibilité du contrôleur

Réponse 5 :

1. Capacité
2. Moins d'occupation de fréquence
3. Gestion plus facile des arrivées

Réponse 6 :

1. Gain de ressources mentale → sécurité
2. Plus de lisibilité pour les pilotes de leur trajectoire à venir
3. Gain en termes de possibilité de résorption de délais

Réponse 7 :

1. Augmentation de la capacité
2. Séquencement plus facile
3. Délais plus facile à résorber (<=5min)

Réponse 8 :

1. Gain en capacité et séquencement plus simple
2. Délai MAESTRO plus facile à résorber
3. Disponibilité générale accrue pour les contrôleurs → plus de vigilance et d'anticipation

6) Quelles sont les 3 principales limitations de la méthode Point Merge ?

Réponse 1 :

1. Capa augmentée pour nous mais du coup limitation plus du coté de CDG au niveau des pistes
2. Pas facile parfois de donner l'ordre de la séquence très tôt.

Réponse 2 :

1. Faire comprendre le système aux différents intervenants (et ses avantages)
2. Pb des transits pour CDA
3. Coopération des secteurs donnant (EDDY..) et pilotes

Réponse 3 :

1. Faisabilité physique (obtention d'espace, livraison par Maastricht)
2. Nécessité d'un gros travail en amont du séquenceur pour figer tôt la séquence et optimiser le dispositif (surtout en conf W à KOLIV et E à DEVIM)

Réponse 4 :

1. Gestion des vitesses
2. Il reste un flou par rapport au FL de transfert entre AP/TE
3. Contraintes de niveau seront-elles respectées en réel

Réponse 5 :

-

Réponse 6 :

1. A quelle limite ouvre-t-on les attentes ?
2. Paramétrage MAESTRO précis ?
3. Comment choisir les vitesses optimales sur les legs ?

Réponse 7 :

1. Niveaux en entrée (à faire respecter sinon ?)
2. Vitesse en entrée si beaucoup de trafic

Réponse 8 :

1. Capacité CDG
2. Interface AP/TE : qui fait quoi ?
3. Redécoupage TP ?

7) Quels seraient les points à améliorer sur le dispositif/méthode de travail Point Merge pour les UOPs ?

Réponse 1 :

- Léger recul des legs en TP (en face à l'Est, 35nmdu FL240 au FL100 peut être juste dans certain cas).

Réponse 2 : -

Réponse 3 : -

Réponse 4 :

- La gestion des FL AP/TE risque de poser problème à beaucoup de contrôleurs

Réponse 5 : -

Réponse 6 :

- TP : conflit VEULE-RESMI
- AP/TE : condition de transfert AP→TE et méthode de travail

Réponse 7 :

- Faire respecter les entrées par secteurs amonts
- + règle AP/TE

Réponse 8 : -

8) Autres commentaires

Réponse 1 : -

Réponse 2 : -

Réponse 3 : -

Réponse 4 : -

Réponse 5 : -

Réponse 6 : -

Réponse 7 : -

Réponse 8 : -

A.2.2 APP

1) Comment qualifieriez-vous l'impact du dispositif/méthode Point Merge sur les secteurs d'approche CDG nord ?
Très négatif (TN) / Plutôt négatif (PN) / Neutre (N) / Plutôt positif (PP) / Très positif (TP)

Réponse 1 : TP

Situation claire, séquence bien préparée en amont. Meilleure implication du SEQ dans la gestion de flux avec la possibilité d'organiser des paquets et de grouper les Heavy pour gagner en sécurité et peut être en capacité.

Réponse 2 : PP

Plus facile de réguler. Possibilité de gérer des vagues de heavy. Avec un bon paramétrage de MAESTRO, régulation beaucoup plus aisée, et charge de trafic plus régulière.

Réponse 3 : PP

Juste un point négatif au sujet des flux secondaires qui passent dans les attentes…

Réponse 4 : TP

Meilleure pré-régulation qu'aujourd'hui.

Coord/SEQ : moins de surveillance à l'entrée de l'EGA et plus de coopération au niveau des sequencing legs.

2) Globalement, comment qualifieriez-vous la qualité de livraison du trafic avec la méthode point Merge par rapport à la situation actuelle ?
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : TA

Plans mieux respectés (en particulier TE). MAESTRO mieux utilisé et mieux respecté.

Réponse 2 : PA

Plus (+) d'anticipation, meilleure visibilité de la situation à venir ; Optimisation du trafic avec plus de facilité. Par contre, on ne se rend pas compte réellement car une seule piste → pas les contraintes liées aux approches simultanées. A voir également en situations dégradées.

Réponse 3 : PA

Ces 2 derniers jours on a pu voir que ca semble être plus facile pour Athis de résorber les délais précisément afin d'intégrer des avions venant de d'autres flux. Le délai est mieux résorbé en ACC donc moins de délai résiduel chez nous.

Réponse 4 : PA

Standardisation des méthodes de travail garantissant une meilleure régularité des pré-séquencements aux IAFs.

3) En détails, en face à l'Est, comment qualifieriez-vous le respect des conditions de livraison avec la méthode Point Merge par rapport à la situation actuelle :
Respect de l'espacement pour les PG
Respect des contraintes verticales pour les PG
Respect des contraintes de vitesse pour les PG
Respect des contraintes MAESTRO pour les PG
Respect des conditions de livraison pour les arrivées vers terrains satellites
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : PA, TA, PA, TA, E

A priori les plans TE semblent mieux respectés.

Réponse 2 : PA, PA, PA, PA, PA

Par contre zone de régulation en Approche qui parait moins large. Pas énormément de latitude si besoin d'espace en cas de remise des gaz (ou autre). Tous cela, surtout dû au relèvement des altitudes d'interception

Réponse 3 : E, E, E, PA, PD

Cf remarque questions 1 et 2. De plus, attention au biais de simu. Les avions descendent beaucoup mieux qu'en vrai.

Réponse 4 : TA, TA, PA, PA, E

Feedback procédure : la longue vent arrière LORNIN-BUNOR permet de résorber 4' → à garder sous le coude si transfert ACC→ APP avec plus de 2' de délai.

4) En détails, en face à l'Ouest, comment qualifieriez-vous le respect des conditions de livraison avec la méthode Point Merge par rapport à la situation actuelle :
Respect de l'espacement pour les PG
Respect des contraintes verticales pour les PG
Respect des contraintes de vitesse pour les PG
Respect des conditions de livraison pour les arrivées vers terrains satellites La gestion des départs
Très dégradé (TD) / Plutôt dégradé (PD) / Equivalent (E) / Plutôt amélioré (PA) / Très amélioré (TA)

Réponse 1 : PA, PA, PA, TA, E

-

Réponse 2 : PA, PA, PA, PA, PA

Pas de gros changements, le PMS améliorant les régulations, et permettant de gagner en capacité. Le travail parait beaucoup plus simple à l'INI et à l'ITM (à voir si cela restera le cas en cas d'orage, de piste fermée ou autre…)

Réponse 3 : E, E, E, PA, PD

Cf remarque question 3.

Réponse 4 : TA, TA, PA, PA, E

Même remarque sur la vent arrière MOPAR-CRL (4' résorbable).

Dans les 2 configurations : attention à ne pas tomber dans l'excès inverse (peut résorber en CCR ??) : le guidage radar et les stacks en EGA peuvent aussi résorber du délai, + ordre définitif seulement à l'ITM.

Eviter les transferts à 220kts : mieux vaut ouvrir les stacks dans ces cas. Dispositif à tester en ouvrant les stacks (TMA plus éloignée) = coordination FL de transferts différents + retour au guidage radar inévitable.

5) Autres commentaires

Réponse 1 :

Situation peu réaliste à l'ITM car pas d'ITM Sud et perfos avions perfectibles.

En PMS, possibilité de choisir la séquence pour créer des paquets et grouper les Heavy sans forcement coordonner à chaque fois. Une fois les avions dans les legs, il est toujours possible d'affiner les flux en coordination directe avec les secteurs concernés. Une fois sortie des legs la séquence est figée.

→ Il faudrait améliorer l'interface MAESTRO pour bien visualiser « l'état » des vols sur chaque Point Merge.

PMS apporte un système capacitif qui permet de garder une « pression » sur le IAF pour alimenter au mieux l'approche.

Par contre ceci est un peu en contradiction avec la philosophie de réduction de vitesse en attente linéaire. Mais pourrait améliorer la visibilité, la capacité, la sécurité et le CDM.

Réponse 2 : -

Réponse 3 :

En vue des expés en réel ça semble satisfaisant par contre il faudra trouver des trajectoires standards qui ne passent pas dans les stacks. Rem : j'étais content d'avoir pu tester MAESTRO, ça a rendu un peu de réalisme aux simus et on a pu s'assurer qu'Athis était capable de résorber du délai au coup par coup en fonction de ce qu'indique MAESTRO.

Réponse 4 :

En espérant que cette méthode puisse s'appliquer :

- Sur le dispositif actuel même si le relèvement des altitudes d'interception n'a pas lieu.
- Dans la partie nord de CDG, en APP (un PMS sur les routes d'approche NW et NW)

END OF DOCUMENT