EUROPEAN ORGANISATION
FOR THE SAFETY OF AIR NAVIGATION

EUROCONTROL

EUROCONTROL EXPERIMENTAL CENTRE

STANDARD AIRPORT TAXI ROUTE STUDY

EEC Technical/Scientific Report No. 2009-002

Project: ITWP

Public Issued: March 2009

© European Organisation for the Safety of Air Navigation EUROCONTROL 2007

This document is published by EUROCONTROL in the interest of the exchange of information. It may be copied in whole or in part providing that the copyright notice and disclaimer are included. The information contained in this document may not be modified without prior written permission from EUROCONTROL.

EUROCONTROL makes no warranty, either implied or express, for the information contained in this document, neither does it assume any legal liability or responsibility for the accuracy, completeness or usefulness of this information.

REPORT DOCUMENTATION PAGE

Reference: EEC Technical/Scientific Report No. **2009/002**	**Security Classification:** Unclassified
Originator: EEC - APT (Airport Throughput Research Area)	**Originator (Corporate Author) Name/Location:** EUROCONTROL Experimental Centre Centre de Bois des Bordes B.P.15 F - 91222 Brétigny-sur-Orge CEDEX FRANCE Telephone: +33 (0)1 69 88 75 00 Internet : www.eurocontrol.int
Sponsor: **EUROCONTROL AOE**	**Sponsor (Contract Authority) Name/Location:** EUROCONTROL Agency 96, Rue de la Fusée B - 1130 Brussels BELGIUM Telephone: +32 2 729 90 11 Internet : www.eurocontrol.int

TITLE:

STANDARD TAXI ROUTE STUDY

Author	Date	Pages	Figures	Tables	Annexes	References
Anders Kristensen, Søren Andersson, Ivana Matas, and Roger Lane	01/2009	xii+50	3	3	--	--

EATM	Project	Task no. sponsor	Period
--	ITWP	--	January 2009

Distribution Statement:

(a) Controlled by: Simulation Program Manager

(b) Special Limitations: None

(c) Copy to NTIS: ~~YES~~ / NO

Descriptors (keywords):

A-SMGCS, Taxiway, SATR, Standard Airport Taxi Routes, Route Change.

Abstract:

This report describes a EUROCONTROL Standard Taxi Route study which has been designed to validate the use of Standard Taxi Routes as an input to the routing function of an A-SMGCS. A set of 10 European airports have been visited, selected in cooperation with the EUROCONTROL team, in order to observe the controllers at their work, collect data for the study and discuss the issues regarding Standard Airport Taxi Routes and A-SMGCS.

Page intentionally left blank

EXECUTIVE SUMMARY

The Standard Airport Taxi Route (SATR) study, which is managed by EUROCONTROL, has been initiated in order to define and clarify the usage of Standard Taxi Routing systems in Europe. For this purpose ten different busy airports in Europe have been selected in order to observe and gather information about usage of SATR, compliancy to these routes and the frequency of route change. This information is collected in order to assess a potential future implementation of a routing function into an A-SMGCS system.

Each airport selected was visited for a whole day with the purpose of observing operations and collecting relevant data related to the use of standard routes, including how often these routes were changed. In addition, ATCOs were interviewed to supplement the data collection. At each airport a Senior ATCO gave a briefing, describing the taxi operations, the airport's standardisation of routing and view upon implementation of A-SMGCS routing function.

The observation phase comprised sitting with a controller for a few hours, listening and noting the route changes made on his/her shift. The role as an observer gave the possibility of hearing and noticing the daily issues the controllers have to deal with.

Subsequently, the ground controllers were interviewed. All questions regarding route changes and A-SMGCS were answered to better understand the issues at different airports and investigate whether Standard Airport Taxi Routes are applicable or needed at the airport.

The following was discovered;

- **Not all airports are able to implement SATR, or benefit from it.**
- **Frequency of route changes is independent of the level of taxi routing standardisation.**
- **Regarding A-SMGCS the attitude was hesitant but positive among the ATCOs.**
- **The level of knowledge concerning future A-SMGCS functions has to be increased among the ATCO community in order to increase the qualitative output from the A-SMGCS discussion.**
- **ATCOs expressed concern regarding the following connected with the use of the routing function;**
    - **HMI user friendliness**
    - **Use of Radio Telephony**

The report contains advantages and disadvantages in relation to SATR and barriers regarding A-SMGCS routing function.

Additionally, the recommendations made throughout the report can be used as guidelines as to whether or not SATR is a solution for all airports, and if not, use the recommendations as an optimising tool for possible further improvements.

Page intentionally left blank

ACKNOWLEDGEMENTS

EUROCONTROL would like to thank all ten participating Air Traffic Control Service providers /airports for their support and hospitality.

Page intentionally left blank

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **V**

ACKNOWLEDGEMENTS ..... **VII**

1. AMSTERDAM **4**
1.1. INTRODUCTION 4
1.2. NORMAL TAXI PROCEDURES 5
1.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 5
1.4. A-SMGCS ROUTING 6
1.5. CONCLUSION 7

2. BRUSSELS **8**
2.1. INTRODUCTION 8
2.2. NORMAL TAXI PROCEDURES 8
2.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 9
2.4. A-SMGCS 11
2.5. CONCLUSION 11

3. COPENHAGEN **13**
3.1. INTRODUCTION 13
3.2. NORMAL TAXI PROCEDURES 14
3.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 14
3.4. A-SMGCS ROUTING 15
3.5. CONCLUSION 16

4. DUBLIN **17**
4.1. INTRODUCTION 17
4.2. NORMAL TAXI PROCEDURES 17
4.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 18
4.4. A-SMGCS ROUTING 19
4.5. CONCLUSION 19

5. FRANKFURT **21**
5.1. INTRODUCTION 21
5.2. NORMAL TAXI PROCEDURES 21
5.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 22
5.4. A-SMGCS ROUTING 23
5.5. CONCLUSION 23

6. HELSINKI **25**
6.1. INTRODUCTION 25
6.2. NORMAL TAXI PROCEDURES 25
6.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 26
6.4. A-SMGCS ROUTING 27
6.5. CONCLUSION 28

7. LONDON 29
7.1. INTRODUCTION 29
7.2. NORMAL TAXI PROCEDURES 29
7.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 30
7.4. A-SMGCS ROUTING 31
7.5. CONCLUSION 32

8. MILAN 33
8.1. INTRODUCTION 33
8.2. NORMAL TAXI PROCEDURES 33
8.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 34
8.4. A-SMGCS ROUTING 35
8.5. CONCLUSION 36

9. PARIS 37
9.1. INTRODUCTION 37
9.2. NORMAL TAXI PROCEDURE 37
9.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 39
9.4. A-SMGCS ROUTING 39
9.5. CONCLUSION 40

10. PRAGUE 41
10.1. INTRODUCTION 41
10.2. NORMAL TAXI PROCEDURES 42
10.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION 43
10.4. A-SMGCS ROUTING 43
10.5. CONCLUSION 44

11. FINAL CONCLUSIONS 45
11.1. SATR 45

LIST OF FIGURES

Figure 1-1: Work Structure 2
Figure 10-1: New proposed runway, 2013 42
Figure 11-1: 48

LIST OF TABLES

Table 11-1: SATR 45
Table 11-2: 47
Table 11-3: 47

ACRONYMS

APN	**Apron**
A-SMGCS	**A**dvanced-**S**urface **M**ovement **G**uidance and **C**ontrol **S**ystem
ATC	**A**ir **T**raffic **C**ontrol
ATCO	**A**ir **T**raffic **C**ontrol **O**fficer
Cat	**Cat**egory
C/S	**C**all **s**ign (of an aircraft)
GMC	**G**round **M**ovement **C**ontrol
L/R	**L**eft/**R**ight
MLAT	**M**ulti**lat**eration
R/T	**R**adio **T**elephony
SMR	**S**urface **M**ovement **R**adar
SATR	**S**tandard **A**irport **T**axi **R**oute
TWR	**T**ow**er**
VCS	**V**oice **C**ommunication **S**ystem

Page intentionally left blank

0. INTRODUCTION

0.1 A-SMGCS

A-SMGCS ('Advanced Surface Movement Guidance and Control System') is a system providing surveillance, routing guidance and control for all surface movements and with the objective of enhancing safety and efficiency, in relation to such movements.

A-SMGCS is composed of the following basic functions (cf. ICAO doc. 9830). An ideal A-SMGCS completely integrates all these functions and makes them coherent.

Surveillance Real time display and identification of surface movements displayed on a screen using data based on cooperative and non-cooperative sensors.

Control Module intended to warn the air traffic controller of the occurrence of a potentially hazardous situation. Classic examples: runway incursion and stopbar violation alerts.

Guidance Automated assistance to the Flight Crew. Guidance can be carried out through a radio datalink and a cockpit display. The appropriate switching of the lighting system (e.g. follow-the-greens) is an application of this module.

Routing Automated decision support selecting a taxiway route based on a tactical decision.

0.2 OVERALL OBJECTIVE OF THE STUDY

This study has been initiated by EUROCONTROL Airport Research Area (APT) at the EUROCONTROL Experimental Centre (EEC). In this context A-SMGCS Routing and development of Human Machine Interface (HMI) is currently being worked on.

For this study it is necessary to elaborate the following objectives:

- To assess whether published standard airport taxi routes are applied to individual airports or not.
- At airports having published taxi routes, to assess compliancy to these routes.
- At airports not having published routes, to analyse the way they are operating and see if standard routes could be identified.
- To collect exact data on taxi routes utilisation and associated statistics, e.g.
  - How many times routes are changed compared to planned route?
  - When edited, is it for a standard solution?
- To confirm or invalidate the fact that route change is a real issue for the acceptance of the A-SMGCS routing.

For the purpose of this study, Standard Airport Taxi Routes (SATR) are considered to be routes published in the AIP and thereby available not only for the ATCOs but also flight crew and other operators at the airport. These routes are normally described in written or charted form, and specify to the ATCO and Flight Crew which route to follow going from one position to another at the airport.

0.3 STUDY DEVELOPMENT

A selection of ten representative airports was made in co-operation with the EUROCONTROL team. Subsequently, preparations for the visit to each airport were initiated.

Each airport was visited for one day and comprised the following activities:

- An introduction of each airport's ground operation procedures.
- An observation phase in the Control TWR.
- Interviews and discussions with two to three Ground Movement Control (GMC) ATCOs.

The overall work structure and time scales are illustrated in the Figure 1-1:

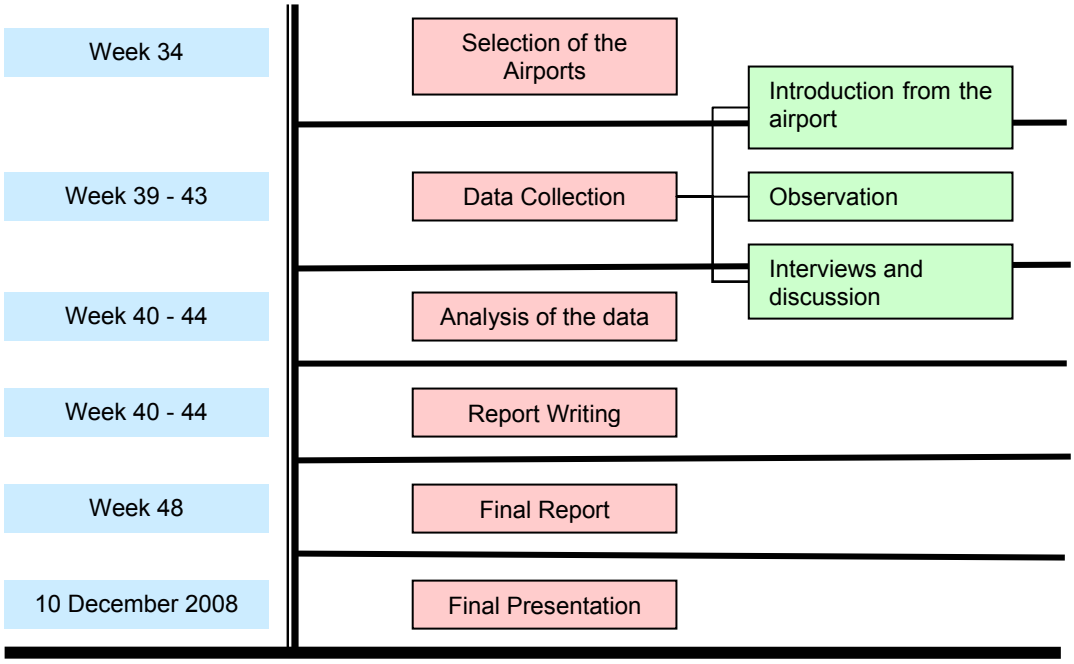


Figure 1-1: Work Structure

The airports were selected on the basis of aerodrome layout, traffic density, development/increase of traffic operations in the past few years and future, and whether or not the proposed airports have some sort of standard taxi routes. All ten airports selected are in the categories medium or heavy by traffic density during peak hour. Traffic density can also be complemented by the collected data of the recorded number of annual movements.

The data was collected by observing ATCOs at their work. Observation was based on sitting together with an operating GMC ATCO and listening in on the frequency. All route changes were noted and later discussed.

After the observations, interviews with the ATCOs were conducted. The interviews focussed on the issues arising from the observations combined with a set of pre-determined questions (prepared in order to structure the interview).

The data collected was then processed and evaluated. It is important to note that the answers from the interviews have not been altered and express the exact statements of the ATCOs. Only refinements relating to use of language and to ensure a fluent wording have taken place.

0.4 STRUCTURE OF THE REPORT

The structure of the report is as follows:

Short introduction

- Dovers a brief presentation of the airport

Normal Taxi Procedures

- Describes the use (or not) of SATR in the particular airport

Ground movement structure/data collection (where both advantages and disadvantages are identified).

- Is a sub chapter where all data gathered from the observations and interviews is presented. In addition, the advantages and disadvantages of the SATR implementation are identified including potential issues which must be taken care of before proceeding with implementation of SATR.

A-SMGCS routing

- Is a sub chapter, where route changes are identified and discussed.

Conclusion

- Concludes the individual chapters by listing the most discussed issues for the particular airport.

This structure allows the reader to understand the most important issues relating to each individual airport.

All airport charts, figures, tables and documents used for the study are included in the appendix. To get a better understanding of the airport description, it was decided to make the appendix a separate document, so it would be easier for the reader to supplement the text with the airport charts.

1. AMSTERDAM

Amsterdam Schiphol	AMS/EHAM
Passengers	47,793,602
Runways	18R/36L, 06/24, 09/27, 18L/36R, 18C/36C, 04/22
Typical RW configuration	Varies
Number of daily departures	700 aircraft per day
Maximum hourly runway capacity	110 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 and 2
Example of Taxi clearance	When an ACFT leaves runway 18R and needs to go to the S apron: "[C/S] taxi to S79 cross runway18C at W5 and hold short runway24 at S2, routing via Q." When an ACFT on east apron needs to go to runway 36L for departure:"[C/S] taxi to runway36L via G2 and E4 runway 18L, hold short of all runways". Most of the times long clearances are split into parts: "[C/S] taxi to runway 36L via Q there after B..." [READ BACK] "and cross runway36C at W5".

1.1. INTRODUCTION

Amsterdam Airport, Schiphol is the Netherlands' main airport, located 17.5 km southwest of Amsterdam, in the municipality of Haarlemmermeer.

Schiphol has five main runways, plus one used mainly by general aviation aircraft. The "fifth runway" (really the sixth) was completed in 2003. Plans have already been made for a seventh runway. The maximum capacity of the runway system is 110 operations per hour.

1.2. NORMAL TAXI PROCEDURES

The multiple runways at AMS and the fact that most of the runways are converging results in many different configurations for arrival and departure, as described in the AIP Netherlands. The selection of runways will be in accordance with the preferential runway system and will, among other things be based upon safety, different runways for departure and landing, preferably with ILS for landing, noise influence and traffic handling. A specified amount of tail or crosswind is allowed in combination with limitations in visibility and cloud base.

Despite the above considerations, the taxi operation is fairly smooth since the aircraft are spread over a large area with long taxiways. In addition, there is sufficient space between piers to allow aircraft to push back fairly independently of each other and rarely causes blockage of taxiways.

There are two taxiways, A and B, circumnavigating the main terminal and freight buildings, except for a small part to the southwest were they are substituted by a single taxiway, Q.

These taxiways (A and B) are unidirectional A clockwise and B counter clockwise, and they form the basis of the standard taxi system in AMS by making a carrousel or double round-about function possible.

GMC is divided into 3 sectors/frequencies but a taxi clearance to a **departing aircraft** from the terminal area to runway 36L, where aircraft have to change sector, is given without an intermediate clearance limit, and would typically be “KLM 234 via B and W5 to runway 36L”.

This clearance specifies which direction the aircraft will have to proceed after leaving the apron area and identifies where to cross runway 36C. After crossing runway 36C the aircraft is instructed to contact next sector with the new frequency and a reporting point “KLM 234 contact 121.9 and report VM”. Under normal circumstances the new sector will just acknowledge the handover since the initial taxi clearance is still valid, and the aircraft continues all the way to the departure runway. The procedure is similar for **arriving aircraft**, and AMS is an example of an airport where an implemented SATR system is well developed and well functioning.

1.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Amsterdam airport has been using SATR for years and is well adjusted to the system and functions.

In addition to the SATR, Schiphol has two unambiguous rules to handle ground-traffic stated in the AIP, all aircraft give way to aircraft vacating runways; and, all aircraft give way to aircraft on taxiway A and B (except if rule 1 is applicable).

Advantages and Disadvantages

The following data is divided into advantages and disadvantages as expressed by the ATCOs, i.e. the data is not processed.

Identified advantages are focusing mostly on reduction of workload for ATCOs:

- Less complex work – the workload has decreased for ATCOs.
- Less coordination – in combination with above mentioned there will be less coordinating and structuring between ATCOs.
- “Easy work” – combined with above stated, less work and more observing role.

Following **disadvantages** are identified:

- Insufficient preparation from the Flight Crew’s side – not necessarily only the Flight Crew’s fault, but can be caused by incorrect or not updated documentation, such as Flight Route Manual.

- Communicational misunderstandings – especially related to non European operators. A mitigation mean for the identified issue is progressive taxi guidance, meaning continuous ATCO assistance along the entire route to a specific aircraft.

Even though Schiphol is using SATR, some route changes do occur. This would normally be for one of two reasons:

1. **Sign of uncertainty** – if the Flight Crew shows signs of uncertainty or is unable to understand what he or she is told, the ATCO will use progressive taxi guidance, as mentioned above, and dictate the whole route to the Flight Crew.
2. **Short Cuts** – if possible, the ATCO will always try to improve the routing or make a short cut for the inbound/outbound aircraft. However, this is a highly individual matter, and it is up to an ATCO to decide whether or not any short cuts are possible at any given time.

For that reason, route changes are more common for the inbound than for outbound traffic, where most changes happen in the push-back alternative scenario.

It is stated that 95% of the time a clearance is issued it will be in accordance with SATR. The number will however drop to around 80% when an ATCO provides a service, like a short cut to an aircraft. It is highly individual from ATCO to ATCO how often the “short cut” service is given, taking into consideration the level of traffic intensity at the airport.

Route changes occur approximately 25% of the time, evenly split between conflict solving issues and for service purposes.

1.4. A-SMGCS ROUTING

When discussion proceeded to the A-SMGCS, the interviewed personnel disagreed on the issue. There are opinions in favour of and against the Routing Function. While it is argued that the Routing Function sounds like an easy and good solution, others feel that it is a time consuming system (use of datalink) and that there are safety related issues from the Flight Crew’s point of view – due to the head down approach. There were however no technical objections against the implementation of a routing function into the A-SMGCS.

Additionally, it was argued that the mixture of verbal and visual/written information can be confusing for the Flight Crew.

Other problems regarding the Routing Function system would be:

- Trust issues – is the system as reliable as an ATCO?
- Not listening to the “last minute” changes/incidents.
- Flight Crew’s vigilance level lower on the ground than in the air, which can cause difficulties for the Flight Crew to be aware of the possible changes given by datalink compared to changes given by voice.
- Change of roles – from an active ATCO, who is a decision maker to an observer. This might cause loss of concentration and lack of awareness of the current situation.

However, comments in favour of Routing Function are based on the punctuality, reduced workload and more efficient use of stand capacity.

1.5. CONCLUSION

Despite the fact that AMS have implemented SATR with success there seems to be an opinion against implementing a routing function within A-SMGCS since the traffic is presently flowing smoothly with very short instructions from GMC ATCOs.

It could obstruct the service to aircraft regarding short cuts and keep controllers out of the loop. It might also have a tendency to increase Flight Crew complacency by keeping them from listening carefully on the frequency.

The benefit of a Routing Function is doubtful, since the disadvantages seem to outweigh the advantages, but this is open to further discussion.

2. BRUSSELS

Brussels Zaventum	BRU/EBBR
Passengers	17,8 mill
Runways	02/20, 07R/25L, 07L/25R
Typical RW configuration	25L/R
Number of daily departures	400 aircraft per day
Maximum hourly runway capacity	74 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 – No vehicle tracking

Example of Taxi clearance

Outbound from Brucargo to the full length holding position for 25R:

"[C/S] taxi to holding point Runway 25R via N2, A6, cross runway 25R, B8, Outers, E6, cross runway 20, F5, W4, W41, hold short runway 25R."

This clearance will normally be split up into three separate clearances dividing it after A6 and E6 with these points defining intermediate clearance limits to avoid aircraft crossing runways 25R and 20 unintentionally

2.1. INTRODUCTION

Brussels Airport is operated by The Brussels Airport Company, formerly known as BIAC (Brussels International Airport Company), which was created by Belgian law through a merger of BATC with the ground operations departments of the RLW/RVA.

2.2. NORMAL TAXI PROCEDURES

Brussels ATC has divided its GMC into 2 sectors named North and South with the division line abeam Pier 2 going due east crossing taxiway INN 8 and OUT 8. The TWR control is also divided into 2 separate positions with one ATCO handling the landing runway and another ATCO responsible for the departure runway.

The most commonly used runway configuration is 25L/R (80%) with the majority of aircraft landing on 25L and all departing aircraft using 25R. A small number of aircraft with destination on Apron 1 North or north of runway 25R will be directed to land on 25R to reduce taxi congestion on the other part of the Airport. This procedure is known internally as “gate control”. This is however subject to coordination between Arrival and Departure Control and reduces the outbound flow of aircraft since increased spacing between departures and the possibility of a go-around has to be taken into account. **Landing aircraft** will be handed over to GMC by the arrival TWR ATCO, typically when clear of the crossing runway 02/20 on E1 or E3.

To reduce the load on the GMC North ATCO, **aircraft departing** from the south of the airport will be routed to cross runway 02/20 and sequence via W taxiway for departure runway 25R, while traffic from other parts of the Airport will sequence via INN and OUT sections and B1 and B3.

When easterly winds dictate opposite runway operation, runway 02 will be used for landing and 07R for departure. Only in extreme weather conditions will runway 07L be used for landing since BRU has strict noise regulations regarding arrivals from this sector.

2.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

An extensive study regarding the operational feasibility and advantages of implementing SATR at BRU was conducted five years ago and has since been followed by a trial period where proposed SATR were used by the ATCOs in order to evaluate the possibility of publishing these routes. The routes were discussed and elaborated over 2 years within the ATC and resulted in 13 pages of A4 size with routes describing each runway, each exit point, which apron or satellite including sections of stands and then the specified stand taxi route to follow. A route consisting of runway 25L, exit point C4 and destination stand 151 on Apron 1 South would be described as:

runway 25L (vacating via C4) DEST Apron 1 South (odd stands 143-169): Hold position / E3 / OUT 9 / OUT 8 / hold position / R4[1].

"Hold position" indicates a handover point between TWR/GMC or GMC/GMC sectors and thereby a frequency change.

The routes were designed to take into account the different runway configurations regarding arrival and departure, mainly dictated by weather and noise restrictions. In addition, a chart was developed with direction of taxi on various taxiways for each runway configuration.

The system was developed using Stockholm Arlanda as a model.

The project was abandoned early after publication because Flight Crews complained that it was too cumbersome to find the correct chart and text pages depicting the routes. Despite numerous discussions and presentations at the Local Runway Safety Team, where all the charts and routes were presented and approved, once it was published in the AIP it became clear that the international pilot community found this a problem and even a safety issue. Therefore the procedures were withdrawn from publication before the Air Traffic Controllers had sufficient time to get used to the changed working method.

In addition it was noted that ATCOs found it difficult to follow the specified routes for a number of reasons mainly focused on lack of flexibility in apron and hotspot areas and a change in direction on one-way taxiways.

As a result of the project described above, SATR has not been implemented in BRU and the ATCOs follow their own methods for inbound and outbound taxiing. For support, the ATCOs have on their A-SMGCS screens a function which will suggest a possible route for an aircraft, taking into consideration closed taxiways or closed taxi sections, construction work and similar restrictions. It does not solve or predict any conflict with other traffic as this among other things require knowledge of taxi speed for all aircraft on the airport and a system for controlling all stopbars in order to protect a section of a taxiway for a specific aircraft.

The system is however capable of showing intermediate clearance limits to aircraft visually by means of stopbars and it is also possible to track an individual aircraft on each section of a taxiway by means of the transponder onboard the aircraft.

The use of the route description function is optional and presently only sparsely/seldom used.

[1] Extract from the proposed standard route study.

During the briefing session by ATC the following focal points were identified acting against the usage of SATR:

- When aircraft turn off runway 02 they have to taxi onto taxiway OUT in order to clear runway 02, thereby blocking taxiway OUT.
- One-way direction on IN and/or OUT taxiway will always result in traffic conflicts when aircraft have to enter the IN and/or OUT taxiway after landing on runways 02/25L or when departing aircraft are joining from the apron areas. This requires a lot of coordination between ATCOs and will act as a huge barrier against SATR.
- The distance between the centre-lines on taxiways R4 and S is insufficient for independent operations and a lot of conflict solutions are solved by ATCOs.
- The same applies for the taxiways T and U constellation, and, in addition, taxiway U is not equipped with lighting for Low Visibility Procedures or night operation.
- Generally many restrictions for Cat D/E/F aircraft, both concerning taxiway width and opposite traffic on parallel taxiways.
- If an aircraft Cat E/F is parked on Apron 2 North this causes a restriction for similar sized aircraft on taxiway S.
- The hotspot area located around thresholds runway 20/25R requires a lot of attention by ATCOs regarding conflict solving, sequencing and runway incursion avoidance.
- Push-Back – is a general problem at Brussels Airport, since aircraft frequently are pushed back onto taxiway R4, S, T or U blocking other traffic.

Advantages and Disadvantages

The following data is divided into advantages and disadvantages as expressed by the ATCOs i.e. the data is not processed).

Identified advantages comprise mostly the decreased work load and less risk of communication misunderstandings. Too much workload and communication misunderstandings are both, in general, considered to be at risk to compromise safety levels.

- Flight Crews /ATCOs awareness – everyone is aware of the expected procedures/taxi routing. This is however not a major issue in today's operation since Flight Crews generally posses a high level of understanding concerning the taxiway system and normal operating procedures.
- Less R/T congestion.
- Decreased workload for ATCO – shorter taxi instructions.
- It would be an advantage if same direction were to be maintained on taxiways IN and OUT.

Disadvantages are mainly focused on the lack of flexibility:

- Changes – since many route changes are already given in the initial taxi clearance, the concern in this case is based on the lower flexibility from the ATCO's point of view.

Although BRU ATCOs do not use SATR procedures in their daily work, approximately 80% of taxi clearances issued during non-peak hours are in fact similar to SATR. The corresponding number during peak hours is 50%. The remaining clearances are primarily different due to problems located in connection with taxiways R4 and S and taxiways T and U.

Route changes are issued to outbound traffic 10% of the time mainly for sequencing reasons while inbound traffic route changes are less frequent. It is more usual to stop an inbound aircraft by means of a redirecting it to a temporarily holding position while waiting for other traffic to pass, and in addition inbound traffic is less complex to handle since there is a minimum separation of 1-2 min between inbound aircraft.

2.4. A-SMGCS

ATCOs interviewed showed an interest in the implementation of the A-SMGCS routing function, even though it is not found realistic due to the complex layout of the apron structure.

The following barriers against the routing function were identified:

- Major loss of flexibility – it would no longer be possible for ATCOs to make “last minute” changes.
- Major loss of flexibility – it seems impossible to maintain a high traffic flow in and around taxiways R4 and S, taxiways T and U if ATCOs are locked by SATR from a routing function.
- Cultural issue – is mostly focused on the ATCOs who would most likely maintain their previous working methods.
- “Head down” time for ATCOs and Flight Crews – both parties would be inclined to obtain focus on the screen/printed instructions rather than maintain a vigilant lookout.
- Route change by R/T – it is foreseen by ATCOs that due to the time consuming methods of passing instructions by datalink the preferred method would be by R/T. The complex and often non-standard contents of a routing change is an additional key issue in this context.
- The routing function could be a factor that results in a loss of concentration where the result would be a mistake by an ATCO. It was clarified that this scenario would be most pronounced during non-peak hours where ATCOs might experience complacency. It was at the same time communicated that if ATCOs were kept active “in the loop”, the possibilities of the above scenario would diminish or disappear.

2.5. CONCLUSION

Brussels National is an Airport where a previous study has concluded that it is not practical to implement SATR. A foreseen closure of taxiway J will further substantiate this decision since a circular taxiway structure around Terminal 1 (Apron 1 North/South) will be impossible to implement as mitigation against the congestion on taxiways R4 and S.

It is not likely that SATR will be published due to the pre-identified barriers and in particular the high amount of aircraft being pushed back onto taxiways R4, S, T and U. This leads to many route changes for aircraft otherwise taxiing on these taxiways and also to many initial taxi clearances that would be contrary to SATR in order to solve a pending taxi conflict. As stipulated during the visit “ATCOs do not give standard taxi route clearances in order to avoid bottlenecks”.

A routing function in the A-SMGCS could possibly be applied. Whether or not these routes would be based on SATR is questionable, since the publication of SATR seems unlikely. It could however be based on a set of possible routes available at the time of the actual request from the aircraft.

This could be used as a default route by the ATCO who will have the right to accept or decline the suggested route. Any route change would most likely have to be made by R/T as many instructions are non-standard to a degree where it is not practical to use other means for time and safety reasons.

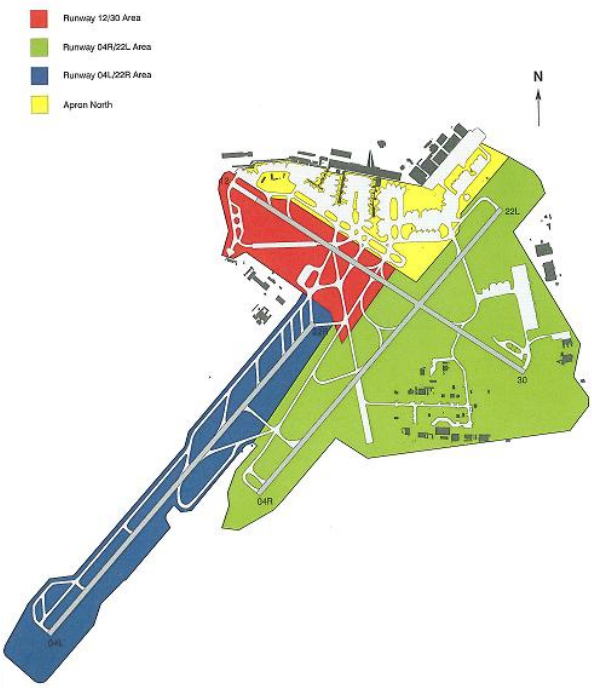
Page intentionally left blank

3. COPENHAGEN

Copenhagen Kastrup	CPH/EKCH
Passengers	21,4 mill
Runways	04L/22R 04R/22L 12/30
Typical RW configuration	22L/R
Number of daily departures	370 aircraft per day
Maximum hourly runway capacity	83 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1
Example of Taxi clearance	Outbound from stand 23A to runway 22R: "[C/S] taxi to holding 22R via J, L, Z and A, hold short runway 30." This is intermediate clearance limit point where a frequency change to taxiway will take place. Inbound off runway 22L off B5: "[C/S] via B, Y and P to stand B7." This is the final taxi clearance from GND after the aircraft has been transferred from taxiway.

3.1. INTRODUCTION

Copenhagen Airport (CPH) is the major airport serving Denmark. It is located 8 km south of Copenhagen city centre, and 24 km west of Malmö city centre at the other side of the Oresund Bridge.



The three runways divide the airport area, which is approximately 11.8 square kilometres, into four geographical sections.

The runway system consists of a main system (direction 22/04) with two parallel runways for take-offs and landings. They are 3500 and 3300 m long, and a 2800 m long cross runway in direction 12/30.

The main runway system, is used by about 95% of all flights, where arriving and departing aircraft are mainly flying over the sea. The maximum capacity of the runway system is 83 movements per hour. Last year there were approximately 260,000 movements.

3.2. NORMAL TAXI PROCEDURES

Normally the taxi operation in CPH is divided between 5 ATCOs. During peak hours the TWR function is split between 3 positions with 1 handling the departure runway, 1 handling the arrival runway and the complex area regarding the crossing of runway 12/30 shown in red in the figure above, is handled by a 3rd ATCO. When the activity level at the airport is lower, the responsibility of this 3rd area is split between the 2 other TWR ATCOs.

The traffic on the apron area is handled by an inbound GMC and an outbound GMC and these functions can also be merged into a single position during non peak hours.

The most common runway configuration is 22L/R followed by 04L/R. In both cases the L runway is used for landing and the R runway for departure. runway 12/30 will only be used in extreme weather conditions, for emergency reasons or in case of very little other traffic permitting the use without causing unnecessary delay and extra coordination for ATCOs. An **aircraft bound for departure** on runway 22R will normally receive clearance from Apron Control to taxi via either J, K, L, M, P, Q, R, S, V or W (all these taxiways are leading from stands) onto taxiway Z and thereafter join either A or F and hold short of runway 12/30. Here a change to the Area runway 12/30 TWR ATCO will take place and the crossing of the runway will be arranged in connection with further sequencing for departure followed by a handover to the departure runway ATCO who has different line up positions available for the final sequencing.

Arriving aircraft on 22L are expected to turn off the runway at a suitable exit point, remain on the landing frequency until otherwise instructed and hold short of the runway 12/30 Area. A procedure similar to the outbound but in reverse order is applied with the exception that taxiway Y (equals an inner taxiway) is used instead of taxiway Z (equals an outer taxiway) for the section parallel to runway 12/30.

When runways 04L/R are used the basic flow and handover between ATCOs are similar to that described for runways 22L/R.

In the rare cases when runway 12/30 has to be used, ATC tends to limit the use to arrivals only and when possible runway 22R is used for departures. This decreases the number of operations at the airport dramatically, and the situation is even worse when runway 12/30 are used for arriving and departing traffic.

3.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

From the observation and discussion with ATCOs it was emphasised that the concept of Standard Taxi Routing does not exist at this airport. What has been decided instead is to implement guidelines which are followed infrequently.

These guidelines are published in the "*Local ATS-instructions Kastrup APRON*[2]", but are not for Flight Crews to follow or depend upon, nor are they published in the AIP or any known Flight Route Manual. In addition, it has been agreed to use taxiways V and K3 as internal stop points/handover points.

Flight Crews are required to get clearance and a route from an ATCO regardless of the guidelines stated in the Local ATS instructions or in the AIP. As often as possible GMC will issue a clearance in accordance with the local instructions but the following constraints were identified by ATCOs (these constraints are also applicable concerning SATR):

- Push back – is a major problem as many aircraft are pushed onto taxiway Y or blocking the cul-de-sacs at L, M, P and Q, forcing GMC to redirect inbound traffic via taxiway Z which is normally reserved for outbound traffic. As a mitigation, runway 12/30 is often used as a parallel taxiway to taxiway Z. Another place where similar problems arise is when aircraft from stands F and H are pushed onto taxiways V, W and T.

[2] Copenhagen Airport Local Regulations

- Handover points – since the distance between taxiway Z and runway 12/30 is short it frequently forces aircraft to make a complete stop if the transfer from one ATCO to another is slightly delayed.
- Large number of gates – (stands which are prefixed letter F and H), where coordination is needed among GMC ATCOs concerning direction on taxiways W and V when opposite traffic is occurring. If SATR were to be applied a route change would be necessary 50% of the time.

Advantages and Disadvantages

Advantages of implementing SATR could not be clearly identified due to the airport layout

Disadvantages were identified as listed below:

- Number of published routes would be much too large, with too many restrictions for different categories of aircraft.
- Loss of flexibility – because of the general layout and complexity of the airport an implementation of SATR would decrease ATCOs flexibility regarding "non-standard" routing.
- It would be very difficult to manage the traffic on taxiway Y, especially considering the many aircraft being pushed onto the taxiway.
- The crossing of runway 12/30, involving frequency changes and short taxiways, mean significant delays compared to present operation.

The number of clearances issued in accordance with the above mentioned Local Guidelines is 75%, but will vary dependent upon aircraft size and traffic congestion, where an increase in traffic will bring the number of standard clearances down.

From observations and discussions it can be concluded that route changes happen 33% of the time – but it has been argued by ATCOs that it depends on the traffic situation, weather conditions construction work and other aspects that play an important role in the most efficient traffic planning.

Route changes are mostly made for tactical reasons in order to maintain the best possible traffic flow on the ground.

3.4. A-SMGCS ROUTING

The implementation of a routing function into A-SMGCS is not seen as a viable solution or as an aid to ATCOs at CPH. Below are listed barriers identified during the discussion:

- Number of route changes too high.
- Number of frequency changes too high.
- Complexity of route changes requires the use of R/T in order to pass message in the shortest possible amount of time.
- Flexible approach – due to the limitations on several taxiways for certain categories of aircraft, the complexity of the airport layout and the crossing of runway 12/30 it was anticipated that a solution based upon an A-SMGCS routing function would be too rigid in comparison to a human ATCO.

3.5. CONCLUSION

Due to the fact that the ATCO is free at any time to coordinate and make changes to the route, routes are not considered to be standardised.

Some time ago, CPH Airport Ltd. made a thorough investigation regarding Standard Taxi Routes, but after the study it has been concluded that it is not an efficient solution for CPH airport to implement SATR.

An argument for this decision is that in the end, with Standard Taxi Routes, there will be too many published routes, when including all gates, flight-types and taxiways. This will not only complicate the AIP but will also lead to possible misunderstandings, which will consequently impact safety levels.

Another identified restraint for CPH airport regarding SATR is the fact that all aircraft larger than group C, are restricted on many taxiways at CPH. This would necessitate many exceptions in a standard taxi route structure.

The location of runway 12/30 very close to the apron area and the frequent need to push aircraft onto taxiways are major constraints towards implementing SATR, and it seems unlikely that a solution to these constraints can be found.

4. DUBLIN

Dublin	DUB/EIDW
Passengers	23.2 mill
Runways	10/28, 16/34
Typical RW configuration	28
Number of daily departures	290 aircraft per day
Maximum hourly runway capacity	44 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 – December 2008
Example of Taxi clearance	Outbound from stand 12A to runway 10: "[C/S] taxi to via M1, cross runway 34, M2, B to holding point runway 10." Inbound from runway 28 off E6: "[C/S] taxi B, H2, cross runway 34, H1, F3, Link 3 to stand 34."

4.1. INTRODUCTION

Dublin Airport is located in Collins town, in the Fingal part of County Dublin, and is by far the busiest airport in Ireland – over 23.2 million passengers passed through the airport in 2007. It is operated by Dublin Airport Authority, DAA.

Passenger traffic at Dublin Airport is predominantly international; only 900,000 of its 23.2 million passengers last year were domestic. The maximum capacity of the runway system is 47 movements per hour.

4.2. NORMAL TAXI PROCEDURES

The most common runway in use at DUB is 28, directing outbound aircraft towards Links 1 and 2 via taxiways F-OUTER, F1, F2 and F3.

The **inbound traffic** will use taxiways B then H, M or P and inner taxiways to assigned stand.

When wind direction dictates the use of runway 10 **outbound traffic** will use F-OUTER, F2 and F3 followed by either taxiways H, M or P and then proceed via taxiway B for departure, inbound traffic will after leaving taxiway B proceed via P, M, H, A or E before continuing to the assigned stand via inner taxiways. Runway 16/34 is crossed for both inbound and outbound traffic.

DUB is facing serious problems with lack of space for parking and taxiing aircraft in the terminal areas and in connection with inbound and outbound aircraft using F-INNER and F-OUTER. In addition, the crossing of runway 16/34 via H, M and P taxiways are often restricted because traffic is blocking the path due to lack of space elsewhere. Very often outbound traffic has to be pushed onto taxiway F-INNER blocking the way and similar aircraft pushing in the cul-de-sacs around Pier A will block for other traffic. As a result of this, GMC often uses runway 16/34 as a taxiway in order to use F-OUTER for outbound traffic and runway 16/34 for inbound traffic.

Furthermore, due to the lack of available stands a lot of towed aircraft have to be dealt with by GMC. This is especially pronounced during rush hour.

GMC is manned by a single ATCO who is responsible for start up, push back and taxi operations on the entire airport. This position also handles towed aircraft and all vehicles. The TWR function is also operated by a single ATCO. The only other ATCO present in the TWR is handling Clearance Delivery.

Many diversified taxi clearances are being used at DUB and GMC ATCOs are often working in a stressful environment.

4.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

DUB does not use Standard Taxi Routes, but the implementation of SATR is under constant consideration and evaluation. This is due to the fact that DUB is undertaking a great deal of reconstruction, building not only a new runway but also a new TWR.

However, when low visibility procedures apply, SATR procedures are implemented which are published in the Irish AIP.

Daily inbound and outbound routes are based on the individual tactical coordination. There are no agreements on any internal procedures, but instead ATCOs are individually coordinating the routes.

Constraints identified by ATCOs for not having implemented SATR are:

- Construction work – since there has been much planning and construction work at the airport it has not been considered an advantage to implement SATR at this stage. Implementation of SATR is under serious consideration for future operations.
- Push-back – is considered to be a big issue, especially in the morning where the workload is too high.
- Lack of stands – is also an issue which can impact on the SATR, as the aircraft can not park at the pre-planned stand.
- Towing – due to the lack of stands, many towing movements are performed, which can block other traffic, resulting in possible delays.

Advantages and Disadvantages

Besides identified constraints regarding SATR, additional value is identifying the advantages and disadvantages from the ATCOs point of view.

Advantages identified (i.e. data is not processed):

- Reduction of R/T – based on previous experience, related to poor communication.
- Shortened clearance – ATCO clearance will be shortened and it would be easier to issue an abbreviated clearance, e.g. “standard one”. In this case only a few routes would need to be published.
- Less Flight Crew errors – the expectation of a taxi route, which is not standard, can lead to conflicts, whereas when SATR is implemented there are no misunderstandings; the Flight Crew would know their exact route.

Disadvantages: Errors that might occur from the ATCO’s side, due to the changes and new procedures. To avoid this new procedures could be briefed daily to the ATCOs from the supervisor or management.

Most commonly used routes at DUB are issued 90% for outbound traffic and 80% for inbound traffic. Route changes for outbound traffic happen about 30% of the time and for inbound traffic approximately 40%. These frequent changes are due to tactical reasons, in order to obtain the best possible flow on the ground. This is not only due to the traffic but also, due to the occupied stands – meaning lack of space, towing, push-back etc.

Runway 16/34 is an active runway that is used as a parallel taxiway, even when other taxiways are available. It is used as a taxiway due to the wind conditions (from south-west), when it is not feasible to operate on this runway.

At the moment, due to many changes at Dublin airport, a lot of coordination is necessary in order to maintain the best flow, and to reduce the number of conflicts.

One of the main challenges for DUB Airport is to maintain capacity and throughput. DUB is a major hub for Ryan Air and Aer Lingus, where peak traffic gives approximately 43 flights per hour, which is handled by a single runway, runway10/28.

4.4. A-SMGCS ROUTING

In December this year, Dublin Airport will implement level 1 of A-SMGCS and lighting control. This Surveillance Function will replace the existing system and ground control. The new system will provide tracking, automatic labelling, alerting and control of stopbars.

Additionally, under consideration is also Taxi Guidance System (HITT) and push-back planning system (AviBit).

Routing Function is seen as an advantage and especially the ‘follow the greens’ light function was emphasised as an advantage.

ATCOs commented that it is much more preferable to make all route changes themselves, due to the following:

- Head-down approach – a hazard both for an ATCO and Flight Crew due to too many data inputs that will require more focus on the system than “out of the window”.
- Passive ATCO – no ATCOs at DUB airport see an advantage in having the role of an observer, rather than an actor. This is related to deskilling and not maintaining full awareness of the situation.

4.5. CONCLUSION

DUB Airport is in a phase of change and reconstruction. Many construction areas are being worked on and others are still being planned.

Implementation of level 2 of A-SMGCS will be completed in 2009, a new terminal will be finalised the year after, in 2010, and a new runway in 2012. Additionally, a new TWR is being planned, but no fixed date or year for construction has been specified. A new runway measuring 3,110 m is to be built parallel to the existing runway 10/28 (opened in 1989).

With all these new changes and improvements to the airport, SATR is considered and planned, but nothing has been agreed on yet. Some simulations were performed regarding SATR, but they are considered to be out of date, and must be updated.

So far, a new pier (Pier D) has been added to the original terminal which has provided significant additional airside capacity, with 12 gate lounges serving 14 aircraft stands. This pier became operational on 28 October 2007. Also, terminal 2 is to be built and be operational by 2010, and a new pier (Pier E) will be connected to Terminal 2.

According to the DAA, the new parallel runway must be operational around 2012 to ensure that DUB Airport continues to operate effectively and airline operations are not subject to growing delays. In the meantime, the DAA has invested heavily in extending aprons and creating rapid exit taxiways to derive maximum efficiency from the existing main runway.

It was suggested from ATC Station Management that an implementation of SATR is mainly obstructed by lack of resources (project and manpower) but as soon as these problems are solved an implementation could be considered.

In relation to manpower, it was mentioned that an extra ATCO could be dedicated to GMC from Clearance Delivery, if all airlines were willing to use and pay for datalink Clearance Delivery service.

5. FRANKFURT

Frankfurt	FRA/EDDF
Passengers	54,161,856
Runways	07L/25R, 07R/25L, 18
Typical RW configuration	18, 25L/R
Number of daily departures	675 aircraft per day
Maximum hourly runway capacity	82 aircraft per hour
Level of A-SMGCS	Level 1
Example of Taxi clearance	Outbound from A18 to runway 25R: "[C/S] taxi via M, A to holding point D West runway 25R." Inbound off 25L to stand V114: "[C/S] right turn onto C, B and A to stand V114."

5.1. INTRODUCTION

Fraport AG is the German transport company operating Frankfurt International Airport and is also involved in several other airports outside of Germany.

The future plans at Frankfurt airport are to expand the airport with a fourth runway and a new Terminal 3. The work on the fourth runway has been delayed several times due to environmental concerns, but is planned to be in operation by 2011. The maximum capacity of the runway system is 80 movements per hour.

5.2. NORMAL TAXI PROCEDURES

The ground movement control at FRA is divided between DFS Aerodrome Control (FRA TWR) and Fraport AG Apron Control (FRA Apron Control). These Apron controllers are performing similar duties to GMC at other airports and will be referred to in this report as GMC. All traffic on the runways and taxiways C, S, B East and the parallel part of taxiway B plus the parts of taxiway N, A and L west of L East are handled by the TWR ATCOs. All other apron and parking areas are handled by GMCs from Fraport, split between Startup, Push-back and Apron Control. The TWR functions can be split in to 3 different positions/frequencies plus a Delivery function, whereas Apron Control handles 2 positions/frequencies for taxi on the apron area (East and West, which is the main apron control) and 1 position/frequency handling Push-back.

The East Apron Control located east of Terminal 2 handles the area located east of taxiway E and north of taxiway A and can split taxiway N in taxiway N orange and N blue with passing capabilities of 2 Cat C aircraft. This possibility is only available when East Apron Control is in operation, which is mainly during the daytime. Otherwise this part of the apron area will together with the rest of the apron areas be handled by the West Apron Control which is located on top of Terminal 1. From here, Apron Controllers are unable to visually overlook parts of the East Apron area, being the reason for the above mentioned restriction.

Aircraft are given permission for start up and push-back based on first come first served, unless an ATFM slot restriction applies for a specific aircraft or there is a major delay affecting all aircraft. This could occur if an aircraft would be blocking a cul-de-sac for a significant period of time. In such a case there will be a prioritising of aircraft taking place by the ATCO in order to expedite traffic and reduce delays as much as possible.

In order to optimise the flow of taxiing aircraft certain internal procedures have been agreed, mainly concerning the usage of taxiways A, B and N where GMCs tend to operate them in an identical way. This includes procedures regarding the handover points to TWR ATCOs where most of the departure sequencing of aircraft has been performed in advance by having large aircraft using full runway and smaller aircraft using intersections for departure. This is often done by directing smaller aircraft onto taxiway A and from here to an intersection for departure while keeping large aircraft on taxiway N until reaching the holding area in connection with the beginning of the runway.

The preferred runways for **arrival** are runways 25L/R, where an aircraft landing from 25R is handed over to GMC at Apron West when vacating the runway. If the aircraft is destined for parking east of taxiway E it will continue via either taxiway A or N until transferred to the GMC Apron East for parking. If the aircraft is destined for parking in any other location, the GMC at Apron West will issue the taxi instructions to the final stand. Aircraft landing on 25L will be directed by the TWR ATCO along taxiway C until it is suitable for the aircraft to cross runway 25R, where after a similar procedure as the one above is followed. Aircraft to the southern apron will be transferred to Apron West at a suitable location on taxiway S. (Apron West is handling traffic on the southern apron).

For **departure** aircraft flying to the northwest, north or northeast will be assigned runway 25R and aircraft departing to the west, south or east will be assigned runway 18 for departure.

Runway 25 departure: Aircraft parked on Apron East will be handed over to TWR before reaching D or B taxiways, unless they are sequenced for intersection take/off 25R, in which case the aircraft could be transferred via GMC West.

Aircraft parked elsewhere will initially be guided by Apron West until passing taxiway E, then transferred to Apron East and ultimately to the TWR.

Runway 18 departure: Aircraft will be directed either via taxiway N, A or S for departure following the same general methods of transfer between GMC ATCOs and TWR ATCOs as mentioned above.

5.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Standard Taxi Routes at Frankfurt airport are not published in their AIP, however, internal standard procedures exist and are regularly used.

These internal routes, are followed by GMC ATCOs at all times and in case of deviations they have to be coordinated with the other GMC or TWR ATCOs and everyone has to be informed and aware of the potential changes.

These internal SATRs are not published in the German AIP for the following reasons:

- Too much construction is being undertaken at the airport and publishing internal SATR would only make it harder for ATCOs to make the necessary deviations.
- Due to the many deviations that are already made, by having SATR, ATCOs will lose some flexibility as regards making tactical changes, and this might have a negative impact on the Flight Crews, e.g. longer taxi-time.
- Many towing and uncontrolled vehicles.
- Airport layout which makes it very hard to have any standard taxi routes implemented, especially because of the taxiways being affected by the push-backs and towing.

Advantages and disadvantages

The controllers interviewed were not able to identify any disadvantages of having internal standard taxi routes; however the following advantages were stated:

- ATCO's awareness – internal standard routes allow ATCOs to have a better sense of the traffic situation, especially concerning push back, which is a major issue for the Frankfurt airport.
- Flight Crew awareness – this is seen as an advantage to a certain limit, because the controllers do not consdier that it gives any benefit to the Flight Crews. It is seen as a "nice to have" feature due to the complexity of the taxi operation at Frankfurt airport.

The above mentioned internal standard routes at Frankfurt airport are issued 90% of the time, and 25% of the time route changes are issued depending on the traffic situation, the flow etc. This is in order to give extra service to the Flight Crews, e.g. shortcuts to the stand, or to speed up the process by using tactical procedures.

5.4. A-SMGCS ROUTING

At Frankfurt Apron Control, controllers use an "out of window" approach, radar screens and cameras installed around the airport. In the tower 15 TV screens are installed where different hot spots and corners on the airport can be observed. This allows controllers to see the areas which are covered by the terminals and other buildings except in low visibility conditions.

When discussing potential changes and having a system which will issue a potential route for an aircraft, it was argued that it would not be a preferable approach and no advantages are identified. It is still considered more preferable to use R/T in order to issue a route change, and also to issue a clearance of any kind. It is considered to be much faster and safer doing all the communication between an ATCO and Flight Crew via R/T.

It is also argued that the use of datalink communication is considered to be taking too much time to construct, relay and decode the clearance, and at Frankfurt airport where a lot of movements take place, it would not be a beneficial or helpful system.

5.5. CONCLUSION

FRA is a very complex airport with a high number of wide body aircraft (approx. 50%) serving many different operators, in addition to a large number of uncontrolled vehicles and more than 200 daily towings of aircraft. There are various apron areas spread around the airport, 3 cul-de-sacs and frequent construction work all resulting in many tactical taxi instructions.

The available number of by-pass opportunities for aircraft taxiing is limited, often necessitating a clearance contrary to internal standard routing, especially in the area around the main terminal. This can be caused by an aircraft blocking a taxiway after pushback, a towed aircraft, construction work or for departure sequencing reasons. Aircraft vacating runway 07L/25R having to hold short or joining taxiway A also causes many redirections since the length of the available taxiways between runway 07L/25R and taxiway A are very short.

In addition, ATCOs have expressed a strong concern about losing flexibility if SATR were to be published and having to comply with them, causing longer taxi routes, more stops for aircraft during taxi and a lot of bottlenecks.

Based on the above findings, it seems unlikely that an implementation of published SATR will take place at FRA at the present time. No advantages were identified in connection with a publication of internal routes, only setbacks in comparison to present procedures, and a similar outcome was identified when discussing the implementation of a possible routing function in A-SMGCS.

FRA is in the process of building a new runway for landing, parallel to runways 07/25 and located north of the present airport. It is planned to be operational in 2011 and will change the pattern of taxi operation at FRA. At that time it might be appropriate to conduct a study regarding a possible change in taxi procedures. It must be clarified, however, that this is only the opinion of the investigators and not a communicated fact from Fraport AG.

6. HELSINKI

Helsinki Vantaa	HEL/EFHK
Passengers	13,090,744
Runways	04L/22R, 04R/22L, 15/33
Typical RW configuration	15/22L, 22L/R
Number of daily departures	325 aircraft per day
Maximum hourly runway capacity	80 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 – (2007-2009)

Example of Taxi clearance	Outbound from stand 27 to runway 22R: "[C/S] via AD to APN Spot 71." After transfer to TWR next clearance will be: "[C/S] cross 22L taxi via D to holding point 22R." Inbound off runway 15 to stand 29: "[C/S] taxiway Y and AC to stand 29".

6.1. INTRODUCTION

Helsinki Airport Vantaa (HEL), Finland, is the main airport of the Helsinki metropolitan region and the whole of Finland. It is located 15 kilometres from the Helsinki city centre. In 2007 Helsinki airport had 180.000 movements, which is a growth of 6% on the previous year. Runway capacity is maximum 80 per hour.

6.2. NORMAL TAXI PROCEDURES

The control TWR in HEL Airport is normally manned by five persons:

- One TWR West ATCO controlling runway 04L/22R, Apron 6, taxiway G from Apron 6 and until PG holding point and taxiway S until holding point PS.
- One TWR East ATCO controlling runways 15/33 and 04R/22L plus taxiways Y and D northwest of runway 04R/22L.
- One GMC ATCO handling the traffic on the remaining taxiways and aprons.
- One ATCO handling Clearance Delivery.
- One TWR Supervisor (winter period 06:00-20:00) mainly handling de-icing and general coordination.

During the night all these functions may be handled by a single ATCO.

In addition, Apron Control is located in a separate room below the TWR, and handles the towing of aircraft. In order to avoid traffic congestion on the apron areas, Apron Control monitors the GMC frequency and gives instructions accordingly, but no coordination between GMC and Apron Control takes place.

In order to ease taxi operation certain Apron spots (APN spot) have been defined, located on the edge of the main apron towards the ATC Service Boundary (Manoeuvring Area). The function of these spots is to coordinate inbound and outbound traffic as well as to ease runway 04R/22L crossings. The use of these spots is restricted as they are painted markings, i.e. no snow coverage and daytime only.

The AIP description of HEL Airport contains instructions regarding right of way for inbound and outbound aircraft, both concerning runway vacating procedures, prohibited turn offs, priority for aircraft on taxiways Y and Z plus general guidelines for routing to taxiways oriented parallel to runways. Another paragraph specifies the automatic transfer to GMC when vacating runway 04R/22L or 15/33.

HEL Airport operates 18 different runway configurations but the most common ones are 22L/R, using 22R for departure and 22L for landing, and runway 15/22R for landing and departure respectively. The latter configuration is also used during night time. Furthermore, several environmental rules have to be adhered to.

A departing aircraft leaving the main apron for runway 22R is instructed by GMC to proceed for APN spot 71 where a transfer to TWR East will take place. After crossing runway 22L the aircraft continues, via taxiway D for final sequencing before departing on runway 22R.

For **arrivals** on runway 22L a restriction prohibiting aircraft to use taxiway ZG for vacating the runway is implemented in the AIP, but is often used by Flight Crews anyway. This can occur due to either a lack of knowledge or after asking permission from TWR/GMC. After the aircraft has contacted GMC it will ideally only be given the stand number and then follow instructions written in the AIP.

Similarly, aircraft landing on runway 15 should contact GMC after leaving the runway and only receive a stand number for taxi clearance.

However, experience has shown ATC at HEL Airport that it is necessary to relay much more comprehensive taxi clearances in order to guide aircraft correctly. The explanation from ATCOs regarding this is primarily that Flight Crews do not follow rules and instructions from the AIP in addition to ATCOs issuing many tactical changes, in order to avoid or solve traffic conflicts. Due to earlier runway incursions, it has been necessary to increase ATCOs attention on the three hot spot areas located on, or close to runway 04R/22L. This has a similar impact regarding ATCOs transfer procedures in the specified areas.

6.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

At Helsinki airport SATRs are not implemented but certain procedures are published in the Finnish AIP, as mentioned above. Internal guidelines exist that are sparsely used by the controllers for the following reasons:

- Flight Crews not following the local published procedures – from experience it is stated that Flight Crews will not follow the SATR, due to the following two assumptions; either the Flight Crew is not able to interpret the written documentation correctly or is unaware of its existence.
- Apron spots – impossible to use during darkness or when covered by snow. Additionally, experience has shown that locating these spots on the ground movement charts causes Flight Crews a lot of difficulties.
- Blocking of taxiways – caused by snow clearing, towing and/or construction work.
- Push-backs – due to the fact that taxiways are located closely to the main terminal, push-backs often cause restrictions.

Advantages and disadvantages

Advantages

- Certain parts of the airport would be easier to control, referring to other areas beside apron.
- During runway configuration when no crossings of active runways is necessary, SATR is considered as a helpful tool.
- Less R/T, especially valid since the GMC is only operating on one frequency.

Disadvantages

- Large documentation – might be confusing for the Flight Crews, not being able to distinguish between different routes.
- Apron layout – too complex and narrow, and thereby does not enable standard routing, but necessitates a lot of tactical changes.
- Towing –the towed aircraft is not controlled by GMC but by apron control, and without coordinating.
- Lack of stands – standard routes cannot be carried out, but changes must be made.

Most commonly used routes at Helsinki airport are issued 90% of the time. However, it depends on the individual controller, how the route clearance is given. ATCOs focus mainly on the hot spots and making Flight Crews aware of them.

Another reason for using standard routes frequently is that there are few taxiways – so there are limited possibilities for making changes.

Route changes; happen 30% of the time for the inbound traffic, due to the final coordination and especially in the case where the stand of the aircraft is occupied, which happens often. Route changes in outbound traffic happen only 25%.

6.4. A-SMGCS ROUTING

Since 2007, Helsinki airport has been working on implementation of A-SMGCS system. At the moment level 3[3] is being worked on, including the implementation of 3 SMRs, 1 MLAT and e-strips by year 2010.

Currently, vehicles are not equipped with transmitters, but certain ones will be mode S equipped in the near future.

Additionally, at the start of 2010, stopbars will be controlled by A-SMGCS system.

When the discussion touched upon the future implementation of A-SMGCS system, which automatically creates a route for an aircraft, following advantages were identified:

- Improved view from the TWR – it would be an advantage to implement a system which will have an improved view of the airport layout, since the overview from the control TWR is presently not optimal.
- Assisting tool – to have a tool that helps ATCOs in route planning would be positively welcomed, as long as the ATCOs remain the decision makers.

The user-friendliness of any new system remains a key issue for ATCOs.

The new system incorporates touch-screens which makes it harder for the controllers to use, due to small buttons or complicated interface. This might also have an impact on the safety and increase ATCOs' workload.

[3] Please refer to A-SMGCS chapter 0.1.

6.5. CONCLUSION

Despite the effort made by HEL ATC to standardise taxi routing on the airport, the Main Apron layout and the need to cross active runways has resulted in a taxi operation routine that is often non standard. The frequent tactical changes on the Main Apron, push-back related problems, towing of aircraft and the many uncontrolled vehicles are all barriers acting against a further publication of SATR.

A plan for a new taxiway between Apron B and the southernmost part of taxiway W is presently discussed. If realised this would, in connection with the implementation of A-SMGCS controlled stopbars in 2010, be a valid reason for a revision of taxi procedures, since new SATR could be defined to avoid crossing any active runway.

It is difficult at the moment to assess the impact of the new taxiway on the further development of the A-SMGCS and a routing function implementation.

7. LONDON

London Heathrow	LHR/EGLL
Passengers	68,066,028
Runways	09L/27R, 09R/27L
Typical RW configuration	27L/R
Number of daily departures	650 aircraft per day
Maximum hourly runway capacity	85-90 aircraft per hour
Level of A-SMGCS	Level 2

Example of Taxi clearance	Outbound from stand 155 to runway 09: "[C/S] taxi via B, Q and A, hold short of HORKA". Inbound off runway 27R to stand 311: "[C/S] Link 11, B, F and B stand 311."

7.1. INTRODUCTION

London Heathrow Airport (LHR), located West of London, is the principal and biggest airport serving the United Kingdom. Heathrow is the world's third busiest airport for passenger traffic, and handles more international passenger traffic than any other airport in the world. Last year it was noted that LHR had 481,476 movements. The maximum capacity the runway system can handle is around 80 operations per hour. Heathrow is owned and operated by BAA (British Airport Authorities), which also operates six other UK airports and is itself owned by an international consortium led by the Spanish Ferrovial Group.

7.2. NORMAL TAXI PROCEDURES

Ground Movement Control (GMC) at LHR is divided into 3 sectors. GMC1 is located around the central terminals 1, 2 and 3 covering the area from northwest to southeast in a clockwise pattern. GMC2 covers the remaining area around Terminals 1, 2 and 3 from southeast to northwest also in a clockwise pattern, and in addition the entire area south of Runway (runway) 09R/27L. The remaining area west of the Fire Station and including the entire Terminal 5 area is covered by GMC3 (Heathrow Airport-MATS, Appendix 7 A).

TWR control is divided in 2, 1 for each runway.

The most common runway configuration is 27L/R due to prevailing westerly winds. As stated in the Aeronautical Information Publication (AIP) **arriving aircraft** should clear the runway completely after landing, hold their position and contact GMC for taxi clearance to the arrival stand. In the majority of cases the aircraft will be in contact with GMC before they have vacated the runway. This allows further taxi instructions to be passed and allows the aircraft to continue taxiing.

Ideally this clearance will consist only of a stand number, a route direction on Taxiway (taxiway) B (or inner taxiway) and could, in addition, contain a clearance limit to a handover point between GMC sectors. If this is the case, the frequency change should then occur before the aircraft has to stop, and the clearance from the new GMC ATCO (Air Traffic Control Officer) should only contain a continued routing on taxiway B to the stand. Many stands pushback directly onto the taxiway system therefore, aircraft are often instructed to use Taxiway Alpha (the outer taxiway) to avoid these aircraft.

For **departing aircraft** the sequence of pushback clearance is normally given in order of call up time. Only in a situation where an aircraft is very limited regarding departure slot will a preference to that aircraft be issued. Otherwise the aircraft after push-back will request taxi instructions and receive clearance to a departure runway, but with an initial clearance limit to a holding section like LOKKI, SATUN or HORKA. There is the same possibility of an intermediate clearance limit at GMC's handover points as described for arriving aircraft above. At or just before the holding section transfer to the TWR ATCO takes place. There is often a need to rearrange aircraft in the departure queue to obtain the optimum sequence, which takes place between the holding sections and the departure runway.

The A380 operates regularly from LHR and can only use certain taxiways.

7.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Standard Taxi Routes (SATR) do not exist at LHR and the ground controllers follow their own internal methods for inbound and outbound taxiing. The reason for not publishing any Standard Taxi Routing is connected to several constraints (quotes here are as expressed by the ATCOs):

- Construction Work – due to frequent construction work at the airport, daily operations and routes are affected, e.g. closed taxiway sections or links.
- Internal Procedures – the ATCOs at LHR internally agree on some routes and methods to be used, but these agreements are applied individually as guidelines only.
- Push-Back – is a general problem at the LHR airport due to lack of space around terminals 1, 2 and 3, and it is often necessary to push back onto taxiway B, blocking other traffic.
- Flexibility – is another constraint for the ATCOs regarding implementing SATR. This way ATCOs' flexibility for making most suitable decisions is reduced.
- Flight Crew-awareness – by having published SATR, the possibilities for Flight Crew misunderstandings and false expectations are increased, e.g. due to complacency or lack of preparation.
- Towing – LHR is an airport with approximately 200 towings per day and about 66% of departing aircraft push-back directly onto the taxiway, which might interfere with published SATR.
- Departing sequence – due to the large amount of wide body aircraft (app. 60%) LHR has to focus on the optimum mix between departing narrow body and wide body aircraft in order to keep the separation time to a minimum. This is mainly done by tactical routing close to the departure runway by either final GMC ATCO or the TWR ATCO.

Advantages and Disadvantages

The following data is divided into advantages and disadvantages as expressed by the ATCOs, i.e. the data is not processed.

Identified advantages comprise mostly the decreased workload and less risk of communication misunderstandings. A heavy workload and communication misunderstandings are both, in general, considered to potentially compromise safety levels.

- Flight Crews/vehicle drivers/ATCOs awareness – everyone is aware of the expected procedures/taxi routing.
- Less radio telephony congestion.
- Decreased workload for ATCO – shorter taxi instructions.

Disadvantages comprise primarily the lack of flexibility:

- Changes – the concern in this case is based on the flexibility from the ATCOs point of view. ATCOs would not be able to make last minute changes and speed up the process, e.g. movements around gates/stands.
- Lack of Flight Crew's listening and interpretation of instructions from ATCOs due to Flight Crews' complacency.
- Deskilled ATCOs – ability to make flexible solutions are decreased since the majority of their work will become standardised and routine oriented.

As it has already been stated, LHR does not use SATR procedures in their daily work, but in 90% of the time, both for inbound and outbound traffic, the same procedures are used. Once in a while a team is briefed, for instance when there have been changes to the taxiway structure, where some internal procedures are discussed, but it is up to individual ATCO whether or not the agreed route or procedure is followed or not.

However, internal agreements are followed regarding the handover points between ATCO at GMC boundaries.

Route changes are issued to outbound traffic about 5-10% of the time while inbound traffic is changed more frequently, i.e. 25-30% of the time depending on the final stand of the aircraft and the need to avoid departing flights which are pushed back onto the taxiways. Route changes are made for tactical reasons in order to maintain the best possible traffic flow on the ground.

7.4. A-SMGCS ROUTING

ATCOs interviewed showed an interest in the implementation of the A-SMGCS routing function, even though it is not yet implemented and its feasibility would be in question due to the complex layout of the airport.

After a longer discussion whether or not A-SMGCS routing function would be a good solution for Heathrow airport, several barriers were identified:

- Possible loss of flexibility – it would no longer be possible for ATCOs to make "last minute" changes.
- Cultural issue – is mostly focused on the ATCOs who might have a hard time adjusting to new systems and procedures.
- Deskilling.
- "Head down" time for ATCOs and Flight Crews – both parties would be inclined to obtain focus on the screen/instruments rather than maintain a vigilant lookout.
- Route change by radio telephony – it is foreseen by ATCOs that due to the time consuming methods of passing instructions by datalink, the preferred method would be by R/T. The complex and often non-standard contents of a routing change is an additional key issue in this context.
- Normal traffic rules are not always applicable, i.e. right of way is often neglected as aircraft tend to try to get ahead of each other for departure.

7.5. CONCLUSION

London Heathrow Airport is an airport with a very complex ground structure and under continuous re-construction which results in different constraints for the ATCOs and their daily work.

It is not likely that SATR will be published due to the pre-identified barriers and in particular the high amount of aircraft being pushed back onto taxiway B. This leads to many route changes for aircraft otherwise taxiing on taxiway B and also to many initial taxi clearances that would be contrary to SATR in order to solve a pending taxi conflict.

The implementation of a single direction taxi-system similar to the northern satellite system in Paris CDG has been discussed. This will simplify the implementation of SATR, but the average taxi time would increase from 20 to approximately 30 minutes, which could increase the possibility of an aircraft not meeting a slot restriction and increase emissions and ground congestion.

A routing function in the A-SMGCS could possibly be applied. It would, however, not be based on SATR but on a set of routes available at the time of the actual request from the aircraft.

This could be used as a default route by the ATCO who will have the right to accept or decline the suggested route. Any route changes would most likely have to be made initially by R/T and then followed up by datalink as many instructions are non-standard to a degree where it is not practical to use other means for time and safety reasons.

The optimum solution, suggested by an ATCO regarding the implementation of SATR, is a supplementary taxiway located parallel to taxiway A, especially around terminals 1, 2 and 3, but this would not be possible due to lack of space.

8. MILAN

Milan Malpensa	MXP/LIMC
Passengers	23,885,391
Runways	17L/35R, 17R/35L
Typical RW configuration	35L/R
Number of daily departures	375 aircraft per day
Maximum hourly runway capacity	70 aircraft (dep. and arr.)
Level of A-SMGCS	Level 2 - 2009
Example of Taxi clearance	Outbound from stand 511 to runway 35R: “[C/S] taxi runway 35R via taxiway Y, U and F, hold short runway 35L.” thereafter “[C/S] cross runway 35 L taxiways FE, C and CA to holding point 35R.” Inbound off runway 35L to stand 611: “[C/S] via taxiways P, Y and T to stand 612.”

8.1. INTRODUCTION

Malpensa Airport is located in the province of Varese, about 50 km from central Milan, Italy. It is one of three international airports in the Milan area.

Malpensa handled over 23.8 million passengers and 267,941 movements last year. Maximum runway capacity is 70 per hour. Until early 2008, Malpensa remained the top Italian airport in terms of international traffic, together with Rome’s Leonardo da Vinci Airport in terms of total passengers.

In late 2007, Alitalia announced the closure of its major hub operations at Malpensa after deciding to focus most of its hub operations at Rome's Leonardo da Vinci Airport. Several point-to-point flights will continue between Malpensa and some destinations in Europe, Africa, and Asia. Milan will be left with only three long-haul routes operated by Alitalia: New York-JFK, Tokyo-Narita, and Sao Paulo-Guarulhos.

Malpensa has two terminals, T1 for commercial traffic and T2 for charter and low-fare traffic. The T1 has two satellites: A – National and European traffic (Schengen area); B – International traffic (extra Schengen area). The third satellite (C) is under construction and a third runway is going to be built. There is also a terminal dedicated cargo called "Cargo City" with over 410.000 tons of yearly traffic.

8.2. NORMAL TAXI PROCEDURES

The layout of MXP airport with the location of the two terminals divided by runway 17R/35L and taxiway C, splitting the two parallel runways 17R/35L and 17L/35R, often necessitates a crossing of an active runway by taxiing aircraft. To handle this scenario normally 2 TWR ATCO and 2 GMC ATCO positions are manned. The TWR ATCOs handle either runway 17R/35L and the crossing of this runway or runway 17L/35R and taxiway C up to C1 position south of the Terminal 2 apron. GMC is divided into North and West sectors, but during non peak hours the sectors are merged into a single one operated by the West sector.

The normal runway configuration is 35L/R taking weather and noise restrictions into consideration. There is a possibility of performing dependant parallel approaches, but often one runway is used for departure and the other for arrival. To limit the impact of noise to the area surrounding the airport an alteration between the runways regarding departure and arrival status takes place.

The Italian AIP has published “taxi routines” and “taxiway preferential use” which are very similar to SATR but since it is not compulsory for ATCOs to follow them they are labelled as stated above. The routes were evaluated during 2004 by an expert group from MXP airport and based upon the normal taxi operation at the airport, which allowed for a smooth transition into operation. The publication is meant as a help to Flight Crews providing them with a tool to prepare for the ground operation at MXP. It has however been decided not to publish the routes as SATR for reasons involving loss of flexibility and safety.

This means that the GMC ATCO must give a complete taxi clearance to all aircraft and therefore the benefit of an abbreviated clearance relating to a SATR clearance is missing.

Arriving aircraft landing on runway 35R will remain on the Arrival TWR frequency until approaching runway 35L where a handover to the other TWR ATCO (Departure TWR ATCO) will take place and a clearance to cross runway 35L will be issued by this TWR ATCO. When the aircraft has completed the crossing, a transfer to GMC West will occur and it will then receive clearance to continue via taxiway W (IN taxiway) and suitable preferred taxiways leading to the arrival stand. Aircraft arriving on runway 35L follows similar procedures but are not faced with the crossing of an active runway, and turn directly off the runway and are handed over to GMC West.

For **departing aircraft** the OUT taxiways are K and Y followed by preferred taxiways to the runway for departure. If this is 35L a change in sequence for departure can take place using holding points W 6, 7 or 8, K7 or 8, Z1 GW1 or H1. The transfer to the TWR ATCO will occur at WB or GW. When runway 35R is used for departure normally aircraft will cross runway 35L via taxiway F, proceed via taxiway FE and C for CA or cross 35L via GW, and GE for CA. At this position, a bypass opportunity exists for a final change in departure sequence handled by the departure TWR ATCO.

8.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Malpensa airport has no standard taxi routes as such, but has published preferential routes in their AIP which is available to Flight Crews. These standard taxi routes are considered to be of great importance, and new trainees are trained to use them on a daily basis. However, deviations do occur due to operational reasons like shortcuts or other tactical reasons including conflict solving and sequencing

Advantages and Disadvantages

Advantages identified by the ATCOs are as follows:

- Decreased workload – here both the roles of ATCOs and Flight Crews are considered. Both parts are aware of the routes and responsibilities, so no further coordination is necessary.
- Reduction of misunderstandings – the communicational misunderstandings are reduced, and situation awareness is increased.
- Safety – the Flight Crew is aware of the route, it decreases the potential communicational misunderstanding and increases the situation awareness, especially for operators from specific geographical regions.

Disadvantages:

- Loss of flexibility from the ATCOs point of view – the worry here is that Flight Crews are too attached to the standard route, that it would not enable ATCO to make additional changes and would hamper coordination between ATCOs.
- Deskilling of ATCOs – SATR might have an impact on ATCOs by changing their role from an active decision maker and tactical coordinator to a more relaying operator.

ATCOs at Malpensa airport highly appreciate SATR in their daily work, and the use of SATR are strongly recommended to all new ATCOs under training. When route changes do occur it is mostly in situations when there is low traffic intensity and the ATCO coordinates different routes in order to give the Flight Crew the shortest route to the stand.

Nevertheless, it is up to an ATCO which route change to make and how often.

Taxi routes diverging from internal standard taxi routes are not given that often, 85% of the time ATCOs follow SATR.

At the moment an internal document is being made for the ATCOs, as an awareness report, in order to make all ATCOs aware of the importance of SATR. Route changes compared to the initial SATR clearance are issued less than 10% of the time.

Hopefully this internal report will increase the number of SATR clearances which is already high. The focus is on the reduction of workload and optimum procedure usage. At this point SATR at MXP airport are considered to be preferential SATR and not mandatory. The reason for not making them mandatory is not to lose flexibility towards making initial changes and thereby have a negative impact on the safety.

However, it is under consideration to publish the SATR but only if the flexibility of making final changes, e.g. tactical short cuts to the stand, remains.

8.4. A-SMGCS ROUTING

A-SMGCS routing at the Malpensa Airport is being looked upon as an assisting tool which could help the controllers in their daily work. Other ATCOs considered it to be an unnecessary tool, considering the today's traffic volume.

Advantages and disadvantages were identified for implementation of A-SMGCS routing:

Advantages

- User-friendly tool – it is considered to be a nice tool which could assist the controllers, but it is enormously important that the system is easy to use and easy to adjust to.
- Helpful tool – assists ATCOs in potential conflicts or incorrect routes/clearances.
- Method of issuing a clearance – it is seen as an advantage to use datalink and screen options to relay a clearance.

Disadvantages

- It has been argued that it is of no interest to have a system which will do "all the thinking". ATCOs are very sceptical of having a system to make the most convenient routes, without making decisions on their own.

- Method of issuing a clearance[4] – it is preferred to use R/T for route change instead of datalink. This is due to tactical reasons as it is considered being a faster and safer solution. Tactical solutions are not possible via datalink.
- No need – it has been argued that A-SMGCS routing is not a necessary tool for this airport.

At MXP airport, a good variety of feedback was collected, due to the fact that one of the controllers also had an engineering background. This made discussion much more diversified and A-SMGCS future plans were acknowledged in a positive way.

8.5. CONCLUSION

Milan Malpensa airport also has a functioning taxi operation that is based upon an airport layout enabling an effective sequencing of both inbound and outbound aircraft. The 3 taxiways K, Y and W constitute the main part of the preferential taxi system that both ATCOs and Flight Crews are appreciative of and have confidence in. Even though the routing system is based upon preference, the general experience is that it is only abandoned for operational purposes, but during peak hours ATCOs tend to comply with the preferred routes in order to optimise the flow of aircraft.

The only major barrier identified working against a redefinition of the preferred routes to published SATR is the ATCOs concern of loss of flexibility. It is necessary to improve awareness regarding SATR and to clarify that SATR not necessarily needs to be fixed, stressing that tactical changes resulting in better traffic flow are allowed.

The construction of the new taxiway and runway could be a deciding factor working towards a publication of SATR, and in this instance a further implementation of the routing function could be considered.

[4] At this airport it was possible to have a discussion with an ATCO and an ATCO/Engineer regarding A-SMGCS routing. This has given the study two different aspects and inputs. The engineer was able to relate to the A-SMGCS routing system and see benefits in additional A-SMGCS applications.

9. PARIS

Paris	CDG/LFPG
Passengers	59,919,300
Runways	08L/26R, 08R/26L, 09L/27R, 09R/27L
Typical runway configuration	26L/R, 27L/R
Number of daily departure	800 aircraft per day
Maximum hourly runway capacity	103 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 – No vehicle tracking
Example of Taxi clearance	Outbound from stand V5 to runway 27L: "[C/S] proceed A Loop, D holding point K7." Inbound to stand B8 off runway 26L after crossing of 26R and transferred to GMC:"[C/S] taxi via W2, N, E and GE to stand B8."

9.1. INTRODUCTION

Paris Charles de Gaulle airport is located North East of Paris and is the busiest airport in Europe with approximately 1600 movements a day in 2008. 552,721 movements were registered at CDG airport in 2007.

Operator of Charles de Gaulle is Aéroports de Paris which owns and manages 14 civil airports and airfields in the Paris area.

9.2. NORMAL TAXI PROCEDURE

Paris CDG airport is basically divided in 2 areas, the northern and the southern part, each consisting of 2 parallel runways and main terminal areas.

The northern part comprises runways 09L/27R (Outer), 09R/27L (Inner) and Terminal 1 and 3, while the southern part consists of runways 08R/26L (Outer), 08L/26R (Inner) and Terminal 2.

There are 4 control towers. The central tower is used for night shifts and is the only one in operation from 22h30 to 6h30 (local time). During daytime, two towers (one in the north and one in the south) manage each part of the airfield. The forth one opened in Sept 2008 and is devoted to apron operations in the south east part of CDG.

Each part has 1 TWR frequency in charge of the landings, take-offs and runway crossings from the parallel runways and 2 GMC frequencies, 1 covering the eastern area and 1 covering the western area. In addition, the southern part operates up to 6 apron control frequencies (half is based at the lower level of the south control tower and the other half is in the new apron tower).

The splitting of traffic between the northern and the southern part is for both arrivals and departures depending upon routing before landing/after departure in geographical relation to the airport. This means that an aircraft arriving at the south east or south west TMA entry fix will be designated to land at the southern runway (08R/26L) regardless of stand location. Similarly, an aircraft with a north departure route will take off from the north departing runway (09R/27L). These are basic rules used by ATC at Paris CDG. When traffic is not so busy, runway changes may take place. In particular the approach often uses runway changes to help to increase arriving capacity.

The use of the runways is normally Outer runway for arrival and Inner runway for departure, as the inner runways are far longer than the outer runways. This leads to very strict rules regarding the crossing of the inner runways for arriving aircraft, in order to avoid runway incursions, involving designated taxiways for stopping and crossing.

There are 2 patterns of operation named the East and West Configuration decided mainly by the wind direction. The most common operation is towards the west (West Configuration) using runways 27R and 26L for landing, respectively 27L and 26R for departure. East Configuration will use runways 09L and 08R for landing and 09R plus 08L for departure.

SATRs are published in the French AIP which are shown on ground movement charts with arrows indicating the direction of taxi. The following taxiways are one-way: N, F, G, P5, A, B (west of N) and D (east of BD12) with the same direction regardless of which configuration is used (East or West). taxiways Q, R, E, B (east of N), D (west of BD12) and several exits are also one-way oriented but the direction will change depending upon which runway configuration is used.

A typical taxi scenario for an **arriving aircraft** landing on runway 26L will be to vacate the runway as soon as possible and pull up to the holding point on S1, S2 or S3, and from the same TWR ATCO that issued landing clearance receive a clearance to cross runway 26R, and when fully clear of runway 26R contact GMC SW. If the aircraft is bound for Terminal 2D, the clearance will be via taxiways N, E to the “stop” GE2 where a transfer to Apron Control will occur, and the final instructions for taxi to the stand will be issued by this apron controller.

It is worth noticing that the taxi clearance issued to aircraft will normally consist of the entire route up to the clearance limit and not be abbreviated. An exception to this could happen with very familiar operators, mainly Air France aircraft.

There are incorporated standard hand over points or “stop” between the ATCOs, which will be the clearance limit given to a certain aircraft. In order to achieve a smooth operation a silenced handover procedure has been implemented by the CDG ATC enabling ATCOs to deliver aircraft internally between Apron, Ground and TWR ATCOs without speaking to each other, but relying upon internal standard procedures. This has allowed a reduction in workload for a number ATCO positions.

Aircraft bound for **departure,** face a similar procedure in reverse order. Two basic line-up taxiways are used, one for heavy jets and one for medium/small sized. In order to optimise runway use a medium aircraft is given the full runway with suitable intervals to avoid extra spacing when departing a number of medium aircraft from intersections.

[5] P is often used the other way round (with coordination between apron and ground). The 2A and 2C aprons are for long haul flights, so there are either just arriving or departures (during hub times).

9.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Charles de Gaulle is a very busy and complex airport with approximately 1600 movements a day in 2008. For this reason, Flight Crews are usually always well prepared and very cautious of ATCO's clearance.

In addition, much construction work is taking place and this has an impact on the implementation of SATRs. However, in the French AIP for the Charles de Gaulle airport layout charts of the airport marked with arrows is published, which indicates routes and directions on the airport depending on the configuration in use (facing East or West).

Advantages and disadvantages

Advantages

- Easier for Flight Crews and ATCOs – meaning that both parties will be aware of their responsibilities.
- ATCOs out of routine – since an ATCO is working as ground controller, apron controller, tower controller and approach controller, they rely to a great extent on standard taxi routing, due to the fact that when an ATCO gets back to the position of a ground controller, he or she, by the help of standard routes is capable of maintaining an acceptable level of routine to perform the required duties.
- Safety issues – a large number of uncontrolled vehicles which rely on the standard procedures.
- Flight Crews can plan in advance – even though most Flight Crews are well prepared before coming to Charles de Gaulle airport. This is an advantage also for avoiding additional misunderstandings.

Disadvantages

- Confused Flight Crews – who are expecting a certain route, and do not focus on the changes or ATCO's clearance.

Even though the charts are made with arrows indicating different routes, the whole route clearance is read by an ATCO and confirmed by a Flight Crew. Although 90% of the time SATR is issued, route changes do appear 15% of the time. This is due to tactical solutions in order to give a Flight Crew short cuts or a quicker route, but also to avoid a foreseen conflict and arrange a proper sequence between aircraft.

9.4. A-SMGCS ROUTING

ATCOs considered an implementation of an A-SMGCS system which could propose a route to ATCOs and then using datalink be acknowledged by Flight Crews to be a good idea. The only hazard is that datalink is not considered to be fast enough, and therefore all potential conflicts and changes would have to be done via R/T.

The positive side of this system is also that the frequency will be less busy, and will therefore also give more time to ATCOs to solve potential conflicts.

The system is not considered to be a replacement of an ATCO, but instead as an additional supporting tool. ATCOs will still make all decisions and remain as decision makers of the initial routes.

Following advantages are identified:

- Still ATCO in control – as above mentioned, ATCOs will still make a final decision regarding initial route.

- Less frequency congestion – also resulting in more time for solving potential conflicts.

One disadvantage was discussed:

- Role change of ATCO – even though some feel that A-SMGCS system will have no impact on the ATCOs, others argue that it will change their way of working, and change their working environment. An observing role is considered to be boring and deskilling over a period of time for ATCOs.

9.5. CONCLUSION

Paris CDG is an airport with a very dynamic traffic situation. In order to reduce the workflow and flight crew/ATCO confusion, charts marked with arrows indicating which direction is to be taken when receiving clearance for taxiing are published in the French AIP.

These charts are of great assistance to Flight Crews, especially unfamiliar Flight Crews, but also the ATCOs working at the tower. Especially since ATCOs are not working only in one position, e.g. ground controller or apron controller, and because their positions change on a daily basis, they sometimes experience a lack of routine and therefore need the charts in order to give the safest and best clearance possible.

From the discussions it was clear that ATCOs were not in favour of elaborating the SATRs further due to the following two reasons:

- Use of entry point to Apron – if these entry points were fixed due to the implementation of SATR the ATCOs would lose total flexibility and would not be able to make tactical changes in order to get better traffic flow.
- Large number of pages published in AIP – this is a general worry at the big airports, with many stands and possibilities.

10. PRAGUE

Prague Ruzyně Airport	PRG/LKPR
Passengers	12,436,534
Runways	06/24, 13/31
Typical RW configuration	24
Number of daily departures	300 aircraft per day
Maximum hourly runway capacity	44 aircraft (dep. and arr.)
Level of A-SMGCS	Level 1 + stop bars monitoring
Example of taxi clearance	For departure: taxi to holding point runway 06 via taxiways Z, H, F and E, hold short of runway 13 For arrival: taxi via taxiway F, cross runway 13, after crossing contact Ruzyne Ground, 121, 9

10.1. INTRODUCTION

Prague Ruzyně Airport (PRG) serves Prague, the Czech Republic. Located 10 km from the city centre, the airport is a hub for Czech Airlines. It was opened on 5 April 5 1937. Prague Ruzyně Airport is the largest airport in the Czech Republic and with 12.4 million passengers in 2007 the busiest within the new EU member states. It was named the best airport in Central and Eastern Europe by Skytrax in 2005 and 2007.

Most flights depart Prague Ruzyně Airport from the Northern Terminals (North 1 and North 2). The Southern Terminals (South 1 and South 2) handle a few irregular flights, as well as VIP flights, special flights and small aircraft.

As the capacity of the airport has reached its limit for the last couple of years (as of 2005), further development of the airport is being considered. Besides regular repairs of the existing runways, the Prague Ruzyně Airport began preparations for building a new runway parallel to the runway 06/24. The construction with estimated costs of CZK 5-7 billion was scheduled to begin in 2007 and the new runway marked 06R/24L (also called the BIS runway) is to be put into service in 2013.

It will be over 3500 m long and will be located about 1500 m south-east of the present main runway. The 24L runway will be equipped with a category III ILS allowing landing and taking off under bad weather conditions.

Figure 10-1: New proposed runway, 2013

10.2. NORMAL TAXI PROCEDURES

The most used runway is 24 accounting for 60% of daily operations followed by runway 06 with 30% and the remaining 10% split between runway 13/31. This includes 2x4 weeks of closure of runway 06/24 in April and October each year for reconstruction/resurfacing. If the proposed new runway 06R/24L is realised then the use of runway 13/31 will reduce to 3-4% of the movements.

The manning of the TWR consists of 1 Clearance Delivery ATCO, 1 GMC ATCO who also handles the pushback function, 1 TWR ATCO and 1 TWR Assistant ATCO who has the responsibility for VFR traffic, ground vehicles and towed aircraft, working on a different frequency from GMC. All ground vehicles are transponder equipped.

For turboprop and light **aircraft arriving** on runway 24 the normal exit off the runway is via taxiway C where there will be a change to GMC shortly after. The exit point for jets is normally via taxiway D, followed by a routing direction from the TWR ATCO specifying if the aircraft is to cross runway 13/31 on taxiway D or F. The handover to GMC will happen after the crossing of runway 13/31.

When runway 06 is in use the respective turn off points for turboprop and light aircraft is taxiway L intersection and for jets it is taxiway L or B. In this scenario all aircraft will be handed over to GMC as soon as possible by the TWR ATCO.

In 2007 a rearranging of taxi lines, named Blue, Yellow and Orange, between the A, B and C piers with additional push back positions 1-4 allowed a more flexible mixture between arriving and departing aircraft. The distance between the Blue and the Orange lines are sufficient for 2 Cat C aircraft passing each other with required clearance. This has aided GMC in reducing delays for inbound and outbound traffic to and from gates.

For **departing** turboprop and light aircraft using runway 24 intersection B is normally used, whereas medium to large jets will be given either intersection A or intersection Z for take off. For aircraft being cleared via taxiway Z to threshold runway 24 there is presently approximately 30% mistakenly turning onto taxiway A at Apron East for intersection A departure. This problem will be solved in spring 2009 with the construction of a new taxiway T in the hotspot area.

The handover point between GMC and TWR ATCOs is abeam Pier A. At this stage almost all departure sequencing and traffic conflicts are solved by GMC.

When runway 06 is in use for departure turboprop can use intersection D and medium jets can use intersection E or threshold runway 06, large jets can use threshold for departure. Handover point between GMC and TWR ATCOs is prior to crossing runway 13/31 and sequencing is mostly performed before handover. The TWR ATCO has however the possibility to change the departure sequence by the use of different intersections for line up.

10.3. GROUND MOVEMENT STRUCTURE/DATA COLLECTION

Main reason for Prague not to have SATR is that it is in a phase of construction, and at the moment there is no place or need for SATR. In case that the need for SATR is identified, the first step would be to make SATR only for internal use, so that ATCOs can adjust to new procedures and way of working.

Advantages and Disadvantages

Advantages identified at the Prague Airport are:

- Reduction of ATCO workload – not only is reduced workload mentioned as an advantage by implementing SATR, but also reducing the number of conflicts and communicational misunderstandings.
- Published in AIP – means that all role-players will be aware of their responsibilities.
- Repeatable – due to the fact that the operation is repeated, it also makes it very easy for both Flight Crews and ATCOs to work.

Disadvantages identified

- Part of taxiway closed – in case of a taxiway being closed due to construction work, changes to SATR will be made, and if Flight Crews are unaware of the changes this can cause conflicts or accidents.
- Flight Crew's complacency – referring to lack of focus and interpretation of ATCOs instructions.
- ATCO's mindset – it is argued that it would be hard for ATCOs to adjust to the new procedures and new responsibilities.
- Deskilled ATCOs – in case that the system breaks down, the question is whether or not an ATCO would be capable of proceeding with their work. The training is considered to be necessary at all times in order to keep ATCOs up to date.

About 90% of the time the same routes are issued for both inbound and outbound traffic. Route changes occur in Prague, but very infrequently, and only about 5-10% of the time. Route changes are more frequent to the inbound rather than to outbound traffic.

10.4. A-SMGCS ROUTING

ATCOs view on the possible barriers towards a routing function:

- Very complex apron – this would mean that many route changes would have to be issued both inbound and outbound.
- Very compressed apron – this gives too little time to issue route changes in any other way than by R/T.
- Increased workload – the two statements above would result in an increase in workload for ATCO. It would definitely only be possible to issue route changes by R/T.

Prague Airport has implemented level 1 of A-SMGCS where the ATCO is assisted by a surveillance system capable of providing airport traffic situational awareness through the identification and position of aircraft and vehicles within a predefined area.

Level 2 of A-SMGCS is under development now, Levels 3 and 4 are for now not going to be developed, due to the lack of space.

10.5. CONCLUSION

Prague is considered to be a medium size airport with increasing traffic. Due to the increase of traffic, PRG airport has been under constant development and reconstruction since 2004. A new runway is planned in year 2013, which will be parallel to runway 06/24, and more than 3000m long.

It is being considered whether or not to implement SATR with the new runway, but no conclusions have been achieved yet.

Nevertheless, if SATRs are implemented, it will at the beginning only be implemented for internal use, until ATCOs are used to the system. Presently it is considered as a “nice to have” feature, rather than “need to have”.

Once again, ATCOs’ culture and familiarisation have been discussed. In Prague, due to the many pre-mentioned changes, ATCOs are adjusting to many things, but it is a long process, and it takes time. Nonetheless, when it comes to deskilling of ATCOs due to the implementation of SATR, the managing team is afraid of situations where the system might not work or operate as it is supposed to. In that case the ATCO should be able to handle the situation with various system failures, and the question is whether or not that could be achieved.

From an observer’s point of view it seems likely that with the projected and proposed construction work completed, the implementation of SATR could be successful. If this materialises there would also be a fair chance of implementing a routing function within A-SMGCS, since the layout of the airport at that stage seems suitable for this purpose. It would probably be used for initial clearance purposes only, or as a guideline to ATCOs, and all routing changes would be issued by R/T.

11. FINAL CONCLUSIONS

The purpose of this study is to define and clarify the usage of Standard Airport Taxi Routing (SATR) schemes in Europe. For this purpose ten different airports in Europe were selected in order to observe and gather information about usage of SATR, compliancy to these routes and the frequency of route change.

This information is collected in order to assess a potential future implementation of a routing function into an A-SMGCS system.

The conclusions are based upon briefings, observations, data collection and interviews with ATCOs from the ten representative airports in Europe. The visits to the airports, some were conducted in conjunction with the EUROCONTROL team, took place during September and October 2008.

11.1. SATR

In order to assess whether SATR are published and applied to the individual airports or not, it has been necessary to expand the categorisation with airports applying published *preferred* routes. The reason is that these airports are operating in a very similar manner to airports applying SATR, and will only need to modify their operating procedures and documentation slightly in order to having fully applied SATR. Remaining airports specified in the Table 11-1 as not using SATR have also some kind of internal procedures.

Table 11-1: SATR

Airport	Standard Taxi Routes	Route Changes
Amsterdam (AMS)	SATR	• Outbound traffic about 25% of the time • Inbound traffic more frequent
Brussels (BRU)	NO SATR	• Outbound traffic about 10% of the time • Inbound traffic less frequent
Copenhagen (CPH)	NO SATR	• Outbound traffic about 30 % of the time • Inbound traffic same as outbound
Dublin (DUB)	NO SATR	• Outbound traffic about 30% of the time • Inbound traffic about 40%
Frankfurt (FRA)	NO SATR	• Outbound traffic about 25% of the time • Inbound traffic about the same
Helsinki (HEL)	NO SATR	• Outbound traffic about 25% of the time • Inbound traffic about 30%
London (LHR)	NO SATR	• Outbound traffic about 5-10% of the time • Inbound traffic about 25-30%
Milano (MXP)	Preferred Published	• Outbound traffic less than 10 % of the time • Inbound traffic same as outbound
Paris (CDG)	Preferred published	• Outbound traffic about 15% of the time • Inbound traffic less frequent
Prague (PRG)	NO SATR	• Outbound traffic about 5-10% of the time • Inbound traffic more frequent

The reasons for not having implemented published SATR are different from airport to airport.

In Amsterdam Schiphol, SATR are fully published and used to a very high extent. However, route changes appear on a regular basis, about 25% of the time.

A minority of the route changes is due to constraints such as: construction work, special runway configuration, snow removal etc, but the majority of the route changes are given for punctuality purposes, e.g. short cuts.

This indicates that even though SATR are fully implemented the flexibility for the ATCOs in relation to issuing route changes remains unaffected.

Paris CDG and Milan Malpensa are two airports that have published taxi procedures up to a point that to the Flight Crews seem similar to SATR, but due to the impression of losing the flexibility the procedures have not been fully published.

From the performed observations it can be stated that full implementation of SATR would require minor changes in relation to present operating procedures.

The remaining seven airports have all implemented internal routes6 to a differing extent. Some airports have published a majority of their internal procedures, guidelines, hot spots and restrictions, while others choose to publish only some of the mentioned items.

The possibility of future implementation of SATR divides these seven airports into two categories.

Possible	Not Possible
DUB	BRU
HEL	CPH
PRG	FRA
	LHR

The first category of airports selected all have plans for expanding the number of runways, taxiways, aprons etc., in order to increase the capacity. These future plans incorporate an airport layout that could possibly support a SATR system.

For the second category of airports it is concluded that due to the following constraints it is not possible to implement SATR in the near future.

- **Complex airport and apron layout**
- **Push back issues**
- **Short links[7] between the runways and parallel taxiways**

The following schemes (Table 11-2 and 11-3) illustrate the findings regarding the most common advantages and disadvantages connected to the use of SATR. The full schemes are included in Appendices 14 A and 14 B, and below are issues identified in more than 50% of the airports.

These advantages/disadvantages have been identified by ATCOs during the interview sessions. The data has not in any way been altered.

Advantages identified are focusing mostly on the awareness from the Flight Crews and the ATCOs side and less complex work. These advantages are appreciated because at the same time they decrease the communicational misunderstandings and possible errors.

[6] Internal routes are similar to *preferred* or SATR routes, but are used as internal aid for ATCOs.

[7] Short links – meaning short taxiways connecting runway and taxiway or apron.

Table 11-2:

Advantages	Number of airports identifying the issue
Less complex work	7
Increased Flight Crew's awareness	8
Increased ATCO's awareness	7
Decreased workload for ATCOs	6
Less communication misunderstandings	5

Disadvantages, on the other hand, identified by different airports are mostly focusing on the work pattern of ATCOs. The results demonstrate major constraints acting against implementation of SATR relating to changes of ATCOs' working methods.

Table 11-3:

Disadvantages	Number of airports identifying the issue
Loss of flexibility – ATCO	9
Too large number of routes – large AIPs	8
Construction work[8]	7
ATCO's adjustment to changes	5
ATCO deskilling	7
Last minute changes	5
ATCO's new role – observer	8

It is important to mention that these results are generic and not necessarily applicable for all ten visited airports.

[8] It has been noted that construction work on the airports happen very frequently

The graph below shows the standardisation of taxi routing at the individual airport. It illustrates the usage of same routes irrespective of whether SATR are implemented or not.

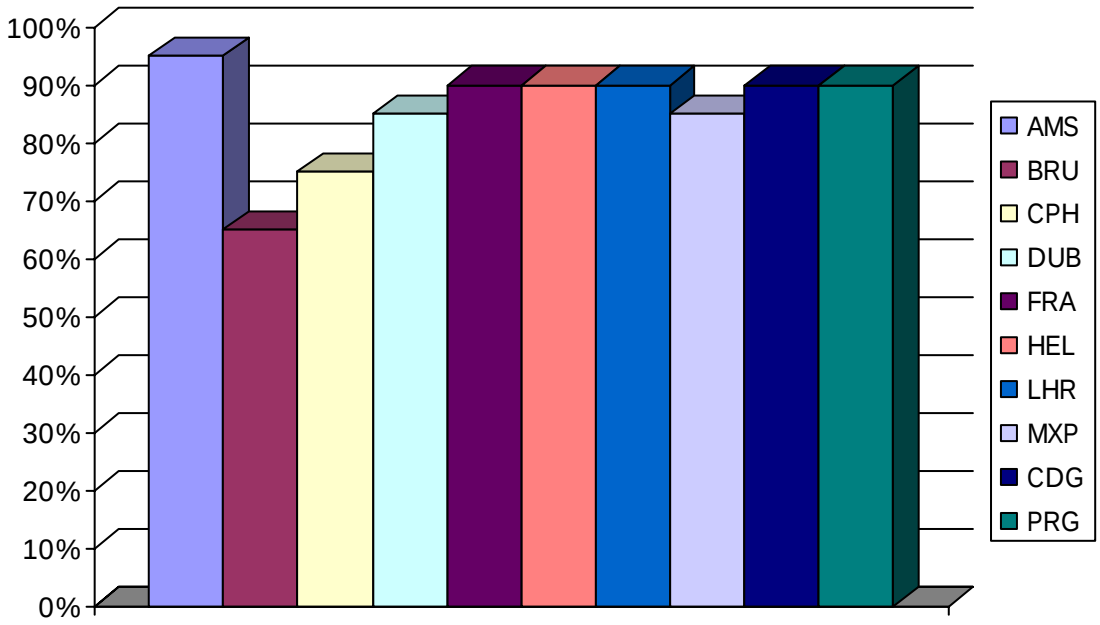


Figure 11-1:

As the Figure 11-1 indicates, airports most of the time use the same route pattern whether SATR is implemented or not. However, this does not indicate that all airports are capable of implementing SATR despite the high percentage presented in the graph, due to the disadvantages listed in Table 11-3.

Route Changes

Route changes happen at the airport regardless of the SATR being implemented or not, as indicated in Table 11-1.

The study shows that most of the route changes occur to inbound traffic and mainly due to the following reasons:

- Push-backs – a major factor at many airports as push-backs often cause blockage of taxiways.
- Extra service to the Flight Crews – giving short cuts, making their routes shorter in distance or time to the stand.
- Lack of stands – at some airports this is a major issue and due to the lack of stands, some changes have to be made.
- Towing of aircraft.
- Departure sequencing/slot coordination.

In accordance with the issues listed above, and the statement that route changes occur with the frequency presented in Table 11-1, it can additionally be concluded that these route changes are not performed the same way each time which doesn't favour a standard solution.

Different solutions for conflict solving are applied by individual ATCOs, but the majority of route changes are made for tactical reasons, e.g. in order to bypass another aircraft.

A-SMGCS

It was very clear that there is a large difference in knowledge regarding A-SMGCS and the future routing function capability in the ATCO environment. At management and ATCO instructor levels the knowledge is generally higher than for the regular ATCOs. The main reason is that regular ATCOs are not informed to the extent as the management regarding A-SMGCS development.

Therefore it was difficult to illustrate the potential future changes and developments in the A-SMGCS systems and to obtain a levelled discussion.

When discussing a routing function enabling A-SMCGS to construct aircraft taxi routes, issue clearances and alert ATCOs if a deviation between cleared and observed aircraft taxi route is observed, the following findings constitutes the general opinion among ATCOs:

- **A system helping the ATCO by providing/suggesting a valid taxi route to a specific aircraft is regarded as a "nice to have" feature and not as a "need to have" feature**. The argument for this is that since the ATCO still need to accept the suggested route (at least from the ATCOs point of view), there is no benefit for the ATCO when comparing this procedure with present ones.
- **The route deviation alert function is looked upon as a system which will increase safety in regard to stopping or redirecting aircraft deviating from their cleared taxi route.** This system could be based upon suggested route, accepted by the ATCO or upon an ATCO constructed route inserted manually into the A-SMGCS system.
- **The alert function could increase Flight Crew awareness in relation to present procedures and act as an extra safety feature against for instance runway incursion.** These benefits would only be achieved if presented by means of a screen suitably located on the flight deck within both pilots normal field of vision.

Listed below are barriers identified by ATCOs against giving route changes in relation to A-SMGCS routing function:

- Communication method of issuing route change
- ATCO becoming observer
- Loss of flexibility
- Head Down approach
- Deskilling ATCOs
- Complex airport layout
- Cultural issues
- Complexity of route change
- Safety issues
- Trust issues
- Not listening to last minute changes
- Too many route changes
- Too many frequency changes
- User friendly system
- No need

Out of these identified barriers, the first six were discussed almost at every airport.

- Communication method of issuing route change – the major concern was regarding the method of transferring the route change to the Flight Crew without using R/T. Datalink is considered as too time consuming and a complex communicational tool for tactical route change.
- ATCO becoming observer – is a general concern among ATCOs, as this could lead to complacency.
- Loss of flexibility – could have negative impact on the airport capacity and restrict ATCOs from making tactical changes.
- Head Down approach – this is identified as a safety issue, since both Flight Crews and ATCOs would not be able to maintain a sufficient "look out".
- Deskilling ATCOs – it is considered that the system will have a negative impact on the ATCOs ability of working and solving complex scenarios compared with today if all routes and route changes are managed by the system.
- Complex airport layout – it is considered that not all airports have a layout suitable for A-SMGCS routing function.

From the observer's point of view it can be concluded that the following issues must be taken into consideration in regard to implementation of A-SMGCS routing function.

- **HMI user friendliness – it is of great importance that the system is easy to use and unambiguous in its presentation both for Flight Crews and controllers. Datalink is considered to be too complex and time consuming in this context.**
- **R/T - Radio telephony – is a must for ATCOs when issuing route changes for two reasons. Firstly, it is the quickest and easiest method, which at the same time allows the ATCO to observe the situation directly. Secondly, this also keeps aircraft informed about route changes issued to other aircraft.**
- **Information – as it is now, not many ATCOs are aware of the future routing function system capabilities. By introducing them to the potential capabilities, it might change their mindset towards a more positive attitude.**

Finally, attention was drawn to the fact that it is not a requirement to have a published SATR system in order to implement a routing function. The system could instead be based upon the most commonly used or preferred taxi routes at the specific airports.

However, all barriers identified at the airports without SATR should be taken into consideration before proceeding with the implementation of an A-SMGCS routing function.

Is route change a real issue for the acceptance of the A-SMGCS routing?

This question cannot be unambiguously answered due to the following:

- Some issues invalidating the A-SMGCS routing are technical barriers where solutions in most cases can be found but are probably very costly (upgrading present a/c equipment with for example screen displays)
- Other issues relate more to the ATCOs' mindset which certainly can be addressed, where dissemination of awareness is an essential prerequisite.
- Finally, safety considerations must be made including lack of traffic information to all aircraft operating in a specific airport, the head down issue and the complacency aspect.