KDC Research Agenda 2019

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[4] Acceptance: The client accepts the document which means that the document fulfils the purpose for which it was made.

Content overview

The Knowledge and Development Centre (KDC) is a foundation which objective is to support the development of the Mainport Schiphol. Within KDC, the sector partners KLM, AAS and LVNL co-operate coordinate their development activities and cooperate with knowledge institutes such as the Dutch Aerospace Laboratory, the NLR.

The research and development activities in KDC are managed on the basis of a KDC research agenda. The research agenda contains a description of studies that are currently active as well as proposed research topics. Furthermore, this document is used to set priorities between projects whilst maintaining a clear overview of proposed research questions. Research projects become active when the KDC board has given a formal ‘go ahead’, based on a study plan (or proposal) and the financial proposal by the KDC management team.

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1 Introduction

The Knowledge and Development Centre (KDC) is a foundation which objective is to support the development of Schiphol as a Mainport. Within KDC, the sector partners KLM, AAS and LVNL co-operate with knowledge institutes such as the Dutch aerospace laboratory NLR, Delft University of Technology, Amsterdam University of Applied Sciences and the Dutch meteorology institute KNMI. Industry partnerships are also incorporated within the KDC construction. The Joint Development Agreement with Boeing is an example of an industry partnership.

The KDC Research Agenda contains a work programme for the development of Mainport Schiphol, in particular the airside part of the Schiphol operation. Studies which require the involvement of multiple sector partners or knowledge institutes are candidate studies for the KDC Research agenda. KDC can initiate research projects if requested by e.g. the government or by one of the sector partners.

The objective of the research agenda is to provide guidance to the work program 2019.

2 KDC Research Agenda

KDC sets itself the task of offering valuable and useful solutions for the sustainable development of the Mainport Schiphol. This task is executed by defining and realizing target orientated projects with close consultation of both the air transport sector and the government (Dept. of Infrastructure & Water Management).

2.1 Scope

The scope of the KDC-projects varies from applied research to the development of executable system concept. Examples are: technology explorations, scenarios for growth and development, ATM-process analysis and simulations, concept development, feasibility studies, performance analysis (e.g. economical security aspects and/or environmental aspects).

Fundamental/basic research is considered outside the scope of the KDC. This is a task of the universities and knowledge institutes. Engineering and realisation (implementation) is a responsibility of the individual sector partner and are normally also considered outside the scope of the KDC.

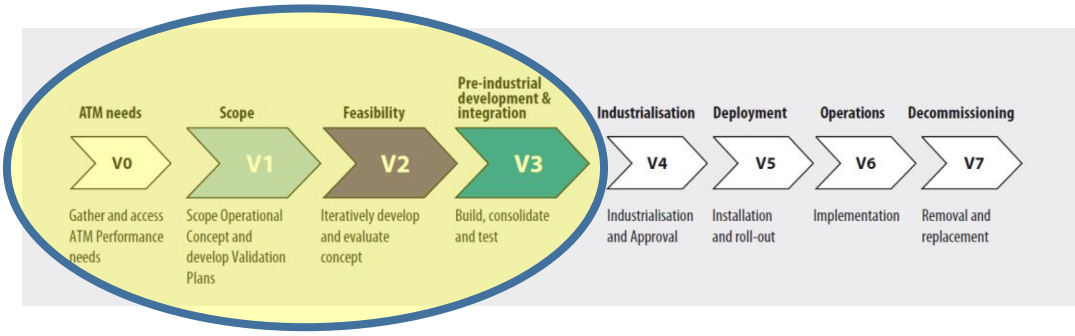


Figure 1: Scope of KDC-projects
(concept life cycle model, European Operational Concept Validation Methodology, E-OCVM)

2.2 Management of the Research Agenda

The initial version of the Research agenda was released in 2006, when KDC was established as a foundation. Since then the KDC Research agenda is maintained by means of annual updates (or in some cases two releases per year).

Priorities are set by the KDC-Board on the basis of proposals made by the KDC-MT, and in consultation with the Dept. of Infrastructure and Water Management. These priorities indicate the sequence of execution for the studies. The sequence can be based on the expected throughput time, urgency of the stated problem or on the assumed benefit for improvement of the ATM system in the short term.

Characteristics of KDC studies are:

- The assignment must has a direct relationship with the development of the Mainport Schiphol.
- Multiple stakeholders share the requirement(s).
- Collaboration between different (knowledge/expertise) parties to achieve a good/applicable solution (multidisciplinary solutions).
- The KDC studies focus on delivering results within approximately 1 to 2 years.

For each subject, a short description is given as well as the expected results and involved parties.

2.3 Business perspective

A literature study, conducted in the analysis phase of the first version of the research agenda, revealed which of the research is relevant for each sector partner. Top priority for KLM as a hub carrier is to guarantee sustainability and capacity of the traffic stream in- and outbound Schiphol. Capacity and sustainability ensure passenger connections can be realised. An important part of the research agenda is aimed at improving the sustainability whilst increasing the capacity for various meteorological conditions.

For Airspace Users, including KLM, in general it is important to continuously improve its efficiency. Part of the research agenda aims at efficiency improvements at Schiphol and in the Dutch FIR in strong cooperation with LVNL and AAS.

The figure below (Figure 2) shows that certain runway combinations (indicated by roman numbers) deliver less hourly capacity compared to other runway combinations. Furthermore, the visibility conditions (good, marginal and poor) also have significant influence on the available capacity. Not all runway combinations are always available. Usage of less favourable runway combinations can result in reduced capacity.
The KDC research aims to increase airport capacity and sustainability as indicated by the arrows in Figure 2.

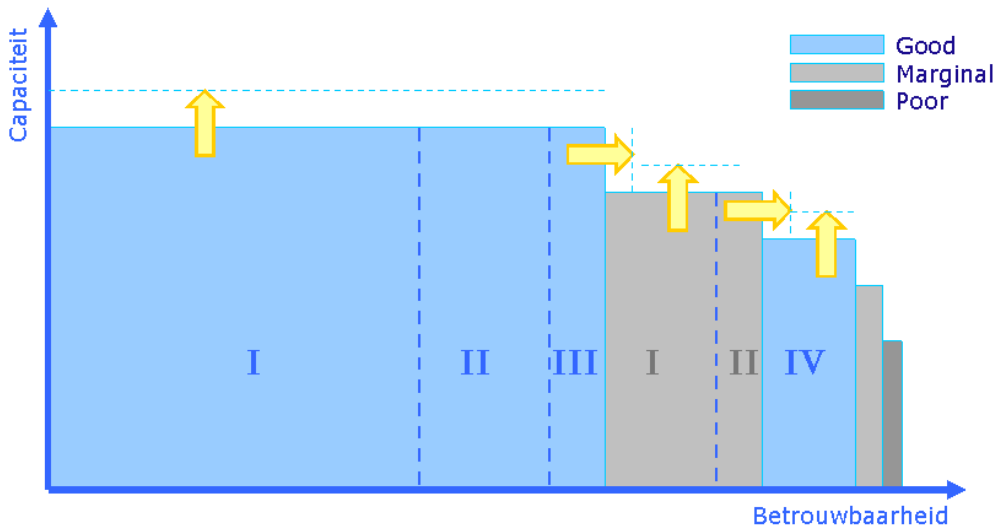


Figure 2: Sustainability vs. Capacity

2.4 Structure of the Agenda

The agenda is structured around the main objectives for the ATM system in terms of performance. These objectives are normally clustered in safety, environmental sustainability and capacity (and efficiency) benefits. A number of studies however, provide benefits in all these areas or can be seen as “enablers” for other developments. These kinds of studies have been labelled as “Future Concept” studies.

The research agenda clustered as depicted below:
Safety:
Chapter 3: Safe Airspace and Airport Navigation
Environmental sustainability
Chapter 4: Environmental sustainability
Capacity & Efficiency:
Chapter 5: Airline Operational Efficiency
Chapter 6: Capacity management
Chapter 7: Airspace Design
Chapter 8: Airport Capacity
Chapter 9: Schiphol Airport Meteo Development
Future Concept:
Chapter 10: AMAN Cluster including iCAS Development
Chapter 11: Fixed Arrival Routes and CDA’s

In figure 2 below, these clusters have been projected on a horizontal plane, indicating for which parts of the Airport/Airspace system the clusters are applicable.

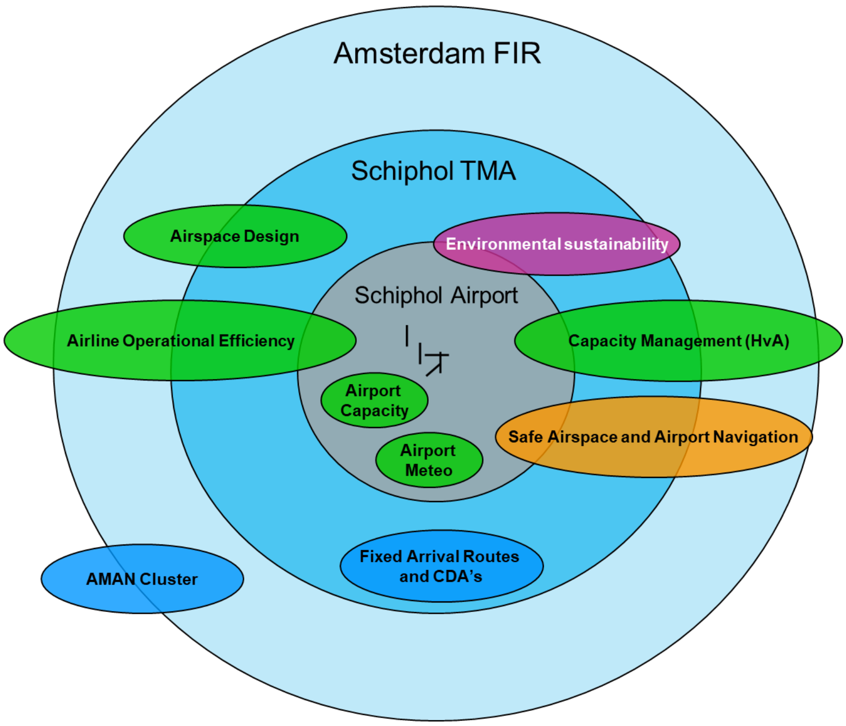


Figure 3: Research subjects projected on airport – airspace structure

2.5 The KDC Research Agenda and the Technology Readiness Levels

Furthermore, for each project a Technology Readiness Level (TRL) and a E-OCVM CLM phase have been assigned. The TRLs are a systematic metric/measurement system that supports assessments of the maturity of a particular technology and the consistent comparison of maturity between different types of technology. The TRL scale varies from TRL 1 to TRL 9. A more detailed description of the TRLs may be retrieved in Appendix A.

The E-OVM methodology is described by Eurocontrol as a framework to provide structure and transparency to the validation of operational ATM-concepts, from early phases of development towards implementation. The complete lifecycle is subdivided into eight ‘V’ phases. The principal relation between the TRLs and Concept Lifecycle Model (CLM) phases is shown in the figure 4.

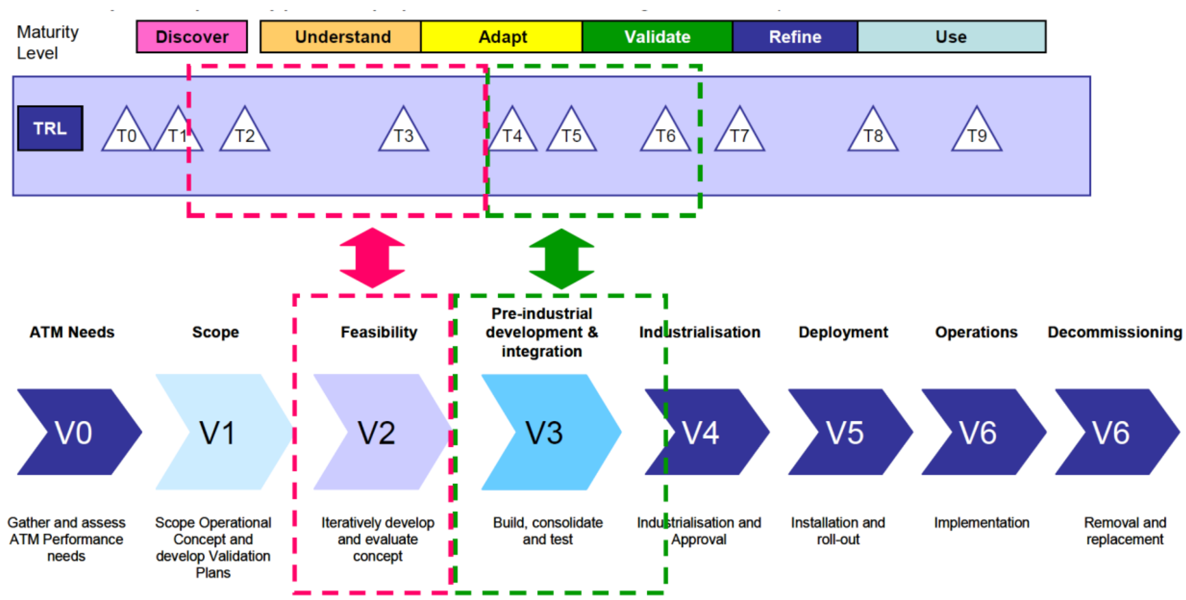


Figure 4: Principal relationship between the NASA TRLs and the E-OCVM CLM phases (source: Eurocontrol, 2018)

3 Safe Airspace and Airport Navigation

3.1 Convergent departures and arrivals

Ref. Ext. Programme	Sector ISMS	**Status**	**Initiative**			
Project Number	-	**Research Cluster**	Safe Airspace and Airport Navigation			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		✓	-	-	-
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓	-	-	
Project Lead	t.b.d.	**TRL**	6			
Sponsor	José Daenen (LVNL)	**Lifecycle phase**	Pre-industrial development & integration			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Increased safety of simultaneous convergent departures and landings (i.e. 24 and 18C, 09 and 06, etc).

Introduction:
In the TOP Safety Action Group of the sector Integral Safety Management System it was decided to initiate a taskforce to further increase the safety of these operations. This KDC assignment supports the work of this taskforce.

The use of independent converging departures and landings has a long history at Schiphol. Current operational procedures depend on visual separation of departures and potential missed approaches. A joint investigation of a recent missed approach that came in close proximity of a departure showed that the current safety procedures were effective and that there are opportunities to further improve safety.

In particular two possible solution strategies are of interest or further research:

- Development of a tool which informs the air traffic controller about the criticality of a conflict in case of a go-around. In this way the different geometries of Schiphol runway combinations and aircraft ground speeds can be taken into account. In the US a tool named ‘Arrival Departure Window’ is used for example at Chicago O’Hare, which can perhaps be applied in the Schiphol situation.

- Occurrences with converging runways took place in the United States as well, leading to an NTSB recommendation A-13-024, which was followed up by FAA issued Order 7110.65, “Air Traffic Control,” paragraph 3-9-9. Therefore, potential solutions may be found at US airports with similar runway geometries to Schiphol.

KDC is requested to support these lines of investigation.

Assignment:
Investigate the possibility to develop a tool that shows air traffic controllers the criticality of a (potential) missed approach. The investigation should provide

1) A proof of concept, including the following elements:
   - Criteria for the criticality of a conflict between a missed approach and a departure;
   - Analysis of required data accuracy & data availability;
   - Development of initial algorithm;
   - Implementation of initial algorithm in TWR – SIM;
   - Evaluation of potential use by air traffic controllers;
   - Identification of additional measures / aspects that require further development.

2) Inventory of safety measures taken in the United States in the implementation of FAA issued Order 7110.65, “Air Traffic Control,” paragraph 3-9-9. For each of the measures impact on capacity and applicability at Schiphol should be assessed.

Timing: on 1-6-2019 the results should be available the latest (depending taskforce planning).

Short term objective:
To determine whether introduction of a controller support tool is a feasible strategy to increase the safety of convergent departures and landings.

Midterm/Long term objective:
Develop and introduce a tool which increases the safety of convergent departures and landings.

4 Environmental Sustainability

4.1 Schiphol noise analysis for fixed arrival routings

<table>
<tr><td>University</td><td>TU Delft</td><td>Status</td><td colspan="12">Active</td></tr>
<tr><td>Student</td><td>Davey Hooymeijer</td><td>Research Cluster</td><td colspan="12">Environmental sustainability</td></tr>
<tr><td>Customer</td><td>KDC Board</td><td>Performance Targets</td><td colspan="3">S</td><td colspan="3">Ec</td><td colspan="3">Es</td><td colspan="3">Env</td></tr>
<tr><td>Assignment</td><td>Graduation assignment,
Max Mulder</td><td></td><td colspan="3">-</td><td colspan="3">-</td><td colspan="3">✓</td><td colspan="3">✓</td></tr>
<tr><td>Project Plan</td><td>Proposal</td><td>ATM concept</td><td colspan="4">ATS</td><td colspan="4">ATFCM</td><td colspan="4">ASM</td></tr>
<tr><td>KDC Board Approval</td><td>Sept 2018</td><td></td><td colspan="4">-</td><td colspan="4">✓</td><td colspan="4">-</td></tr>
<tr><td>Project Lead</td><td>Ferdinand Dijkstra (KDC)</td><td>TRL</td><td colspan="12">3</td></tr>
<tr><td>Sponsor</td><td>KDC Board</td><td>Lifecycle phase</td><td colspan="12">Feasibility assessment</td></tr>
<tr><td>Financial Partner</td><td>LVNL</td><td>Priority</td><td colspan="12">Normal</td></tr>
</table>

In order to respond to both national and international calls for more durability in the aviation industry, it has become clear to the Schiphol sector that a stable ATM System is needed. An important element of such an ATM system is the use of FIxed TMA Arrival Routing enabling Continous Descent Operations (CDO). Agreements to this effect have also been made with the council representing the neighbourhoods surrounding Schiphol (ORS).

To progress the development and introduction of such operations, a methodology is needed to design new TMA routings whilst addressing relevant aspects of noise integrally. An iterative development process is foreseen in which the effects for noise should be easily quantifiable at every step.

Examples of such iterations are:
1. Expansion of the current night-time procedures to other runways than 18R and 06.
2. Allowing more lateral degrees of freedom, compensated by higher profiles during the night.
3. Introduction of (partially) fixed TMA routing for use during the day, applying elements of points 1) and 2)
4. Introduction of higher profiles in the outer areas of Schiphol, i.e. before the IAF, during the day (element for airspace redesign).

The assignment is described as follows:
Analyse the outcome of the current model and compare it to real measured data to investigate its possibilities and shortcomings. This will be done by quantifying these differences based on real flight paths. We can make use of all types of operations, from daily operations for changing routings to night operations for fixed arrival routings/CDA.

4.2 Future runway use

Ref. Ext. Programme	-	**Status**	Initiative				
Project Number	-	**Research Cluster**	Environmental sustainability				
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env	
Assignment	-		-	✓	✓	✓	
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM		
KDC Board Approval	31-1-2019		✓	✓	✓		
Project Lead	t.b.d.	**TRL**	3				
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment				
Financial Partner		**Priority**	Normal				

Goal:
To develop a concept for future runway use which ensures stable airport operations within the boundaries of the environmental regulations and enables the hub-function of Schiphol.

Introduction:
With increasing traffic demand, and increasing concerns about environmental impact the aviation sector has to develop a concept which is future prove, meeting existing and new stakeholder requirements. The main requirements can be categorized as follows:

- Stable and predictable airport operations in order to optimally use airport infrastructure and resources (AAS)
- Minimal airport delays and punctuality of the operation (no-connection rate as low as possible (airlines)
- Stable airport operations by predictable traffic flows (LVNL).
- Respected environmental regulations: handling traffic on the preferred runways and limited fourth runway movements (environment and surrounding communities).
- Operating the airport in an environmentally sustainable manner (governmental bodies).

Assignment:

- Develop a concept for future runway use which ensures stable airport operations within the boundaries of the environmental regulations and enables the hub-function of Schiphol. In collaboration with airport and airline representatives and TWR/APP ATCOs
- Evaluate the alternative concepts on the basis of the above mentioned KPIs

Short term objective (first year): Support policy decision

Involved parties: KLM, LVNL, AAS

5 Airline Operational Efficiency

5.1 Inbound sequencing based on airline priorities

Ref. Ext. Programme	-	**Status**	**Initiative**			
Project Number	-	**Research Cluster**	Airline Operational Efficiency			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		-	✓	✓	-
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓	✓	-	
Project Lead	Coen Vlasblom (KLM)	**TRL**	3			
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Feasibility assessment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Expected benefits are in the area of efficiency.

Introduction:
Traffic flows inbound Schiphol are currently planned on a first-come-first-serve basis. Traffic is planned in such way to optimize runway capacity. No airline priorities are taken into account. 80% of the passengers onboard KLM aircraft are transfer passengers. Realizing passenger connections is therefore very important for KLM. Inbound KLM traffic has different values based on passenger flows and individual value of passengers.

In the future ATM system, inbound traffic flows will be handled based on the value of individual flights (ref. AAA replacement business case). The Arrival Management function will take airline priorities into account and traffic flows will be built upon these priorities. This process is dynamic, priorisation of individual flights shall be possible from preflight to the latest moment LVNL can accommodate prioritization. Priorisation of traffic flows inbound Schiphol shall be done as early as possible, the planning based on this priorisation shall be maintained in the NL-FIR.

Assignment:
Define, develop and test an experimental arrival management function which takes airline priorities into account. The study shall be done sequentially in the following defined steps:
1. Case study to identify the possibilities & benefits when LVNL prioritizes KLM flights based on airline priorities. In this initial step the studies performed in 2004/2005 (Inbound Priority Sequencing) should be taken into account as background material.
2. Identify which value information is needed to support the planning process based on airline priorities.
3. Define a concept of operations to handle KLM traffic based on airline priorities.
4. Small scale trial to test concept with KLM flights
5. Full scale trial to handle traffic based on KLM priorities
6. Define a plan including concept to enable trading of priorities between airlines.

For step 1 to 5 it is assumed that priorisation between inbound flights can only be done intra-airline.

Short term objective (first year):
Steps 1, 2 and 3 are expected in the short term objective.

Midterm objective (two – three years): Steps 4 is expected in the midterm objective.

Long term objective (> three years): Steps 5 and 6 are expected in the long term objective.

Involved parties: KLM, LVNL, TU-Delft

Source:
1) AAA Replacement Business Case Report S&I \ ATMS \ DOC-427
2) Concept of Operation (CONOPS) for "Inbound Priority Sequencing" Document D/R&D 03/089 Release 3.0

5.2 Drones at Schiphol Center for lightning strike inspections

Ref. Ext. Programme	Overleg voorbereiding dronevluchten in CTR	**Status**	**Initiative**			
Project Number	-	**Research Cluster**	Airline Operational Efficiency			
Customer	KDC Board, KLM E&M	**Performance Targets**	S	Ec	Es	Env
Assignment	-				✓	
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓			
Project Lead	Bas de Glopper (KLM)	**TRL**	3			
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Feasibility assessment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Application of automated drone inspections for lightning strikes at Schiphol Center (within CTR)

Introduction:
Unscheduled inspections, mostly caused by a lightning strike, result in major financial and operational strain for an airline, and in addition pose constraints for the logistics of an airport. Drones offer a potential smart and fast solution to perform these inspection within the turnaround time of an aircraft. Such inspections can be performed in the maintenance hangars but have a much higher impact (saving time) when executed at the gate. Alternatively, aircraft parking places or designated locations on the airport can be appointed for fast automated inspections by drones. Other benefits of using this modern technology is the option to advance the digitalization and automation of the aviation maintenance industry, making use of data collected by drones. For all parties to benefit most of the impact, automated drone inspections after lightning strikes should be performed at Schiphol Center. To find out how to implement and execute this safely, is most important goal of this project.

Assignment:
Step 1:
Research all relevant boundary conditions and setup guidelines for the safe deployment of drones at airports. Realize involvement of all the stakeholders associated with drone inspections at airport to validate assumptions.

- Form consortium with stakeholders: airlines, authorities, airport, air traffic control.
- Perform systematic risk analysis (SIRA) and assessments.
  - Identify potential risks involved with drone inspection at airport.
  - Develop plan for mitigation of found risks.
  - Setup safety requirements for drones in compliance with regulations.

Step 2:
Ensure functional readiness of developed technology and perform elaborate testing for the operational execution of inspections.

- Develop drone technology to execute inspections, keeping in mind factors such as:
  - Implementation of inspection in coordination with other air traffic, e.g. by maintaining communication and visibility with air traffic control.
  - Safety measures: such as geofencing, collision avoidance, abort/kill switch.
  - Weatherproof: wind, water, etc.
- Controlled testing of outdoor inspection procedure.
  - Test run inspections in a lower traffic CTR than Schiphol, to minimize disruptions.
  - Perform inspections at Schiphol at designated outdoor locations.
  - Coordinate inspections with regular ground activities handled during turn-around at an airport (maintenance, baggage, fuel trucks, other ground activities).

Step 3:

- Validate impact of the inspections and re-assess risk.
- Formulate follow-up steps for the actual implementation and adoption of automated drone inspections.
- Compile recommendations for including drone inspection in regular maintenance cycle of an aircraft.

Involved parties:
KLM, KDC, LVNL, Schiphol Group, Mainblades Inspections BV

Source:
-

6 Capacity management

6.1 Capacity analysis of flight execution in relation with planning

University	HvA	**Status**	Active			
Student	Marc Riebeek and Casper Moll	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Sept 2018		-	✓	-	
Project Lead	Frenchez Pietersz (CoE)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	LVNL	**Priority**	Normal			

Introduction:
Schiphol airport is a level 3 coordinated airport, which means that there is a capacity restriction on how many air traffic movements are allowed. This requires a slot coordinator to determine which airline can operate to Schiphol airport and when. The slot coordinator provides airlines with slots every season, the slots are provided on a 20-minute basis, thus an airline should for instance plan its landing within these 20 minutes, in its flight schedule. The challenge here is to determine if the flight execution is in accordance to the airport slots that were approved.

Goal / Expected benefit:
The customer wants have more insight into the connection between approved slot time and the flight schedule/flight plan (both can deviate) performed by the airline. Is there a large deviation? How often does this occur? Which airlines? What aircraft types? From which direction? And more, it is up to you to research this area, to provide the LVNL with insight, this will ultimately lead to a different approach to slot adherence and a better process to manage the slots. Currently there is no one managing this process, which is actually required to reduce delays.

Assignment:
Research into slot adherence is required to effectively provide insight into the initial slot time, scheduled time, flight plan time and actual time of the performed flight. There are cases where the scheduled time differs 30 minutes from the slot time, which off course is not acceptable for all sorts of reasons.

Main stakeholders:
LVNL, AAS, KLM

Keywords:
Operational impact, bunching, slot, air traffic flow distribution

Sub-area:
Airport/Airspace users

6.2 A-CDM Efficiency in connection with the Network Manager

University	HvA	**Status**	Active			
Student	Marc Voogt	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Sept 2018		-	✓	-	
Project Lead	Frenchez Pietersz (CoE)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	LVNL	**Priority**	Normal			

Introduction:
A-CDM is in progress of being fully implemented at Schiphol Airport, airports in Europe are gradually working towards an interconnected network of airports. An analysis of the actual efficiency of A-CDM can provide an airport and its stakeholders with insight after the have connected to the Network Manager (NMOC). The connection with the Network Manager is being established during April-May 2018. In addition, the connection with MUAC (Maastricht Upper Area Control Centre) is also created. From September 2018, there will be almost half year of data, that can be analyzed.

Goal / Expected benefit:
The customer wants an in-depth analysis of the impact – efficiency gains of A-CDM after the connection with the Network Manager. It is up to you to provide insight for and from the involved A-CDM stakeholders.

Assignment:
Where are the actual benefits within the operation and why? What does A-CDM provide for which stakeholder and how much? How did the air traffic flows improve? What is the impact for MUAC? A previous KDC-CoE student has researched the local A-CDM situation (before the connection), these results can be used as basis for continuing.

Main stakeholders:
LVNL, AAS, KLM, MUAC

Keywords:
Operational impact, A-CDM, Network Manager, MUAC

Sub-area:
Airport/Airspace users

6.3 Capacity requirements analysis of civil air traffic in military controlled airspace

University	HvA	**Status**	**Active**			
Student	Tessa Rietema	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Sept 2018		-	✓	-	
Project Lead	Frenchez Pietersz (CoE)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	LVNL	**Priority**	Normal			

Introduction:
In the Netherlands the airspace is controlled by the LVNL or the CLSK (Military Air Traffic Control), for instance Eindhoven and Lelystad airport have military ATC. This also provides the challenge at Lelystad, the Tower is controlled by LVNL, the TMA is controlled by Military ATC and the ACC again by the LVNL. For instance, for constructing the VEMER (VEM Effect Rapportage) Lelystad, CLSK has challenges with determining the capacity needed for civil air traffic next to the military air traffic in their sectors. There is a need for the CLSK to research the possibilities to correctly determine the capacity and advise how the LVNL and CLSK can improve this process.

Goal / Expected benefit:
Insight is needed into how much air traffic capacity is required for civil air traffic that uses military airspace and that is controlled by the military ATC, think of the TMA of Lelystad. In addition, this could lead to a proposal for a military ATC workload model, to determine capacity of military controlled airspace. This research could provide input for the airspace restructuring that will happen from 2020.

Assignment:
The client wants to know the capacity requirements, factors, characteristics of military airspace and which factors determine the capacity for handling civil air traffic.

Main stakeholders:
CLSK, LVNL

Keywords:
Operational impact, airspace structure, capacity planning, airspace control

Sub-area:
Service Providers

6.4 Time Based Separation implementation at Schiphol: analysis of implementation models (user interface level)

<table>
<tr><td>University</td><td>TU Delft</td><td>Status</td><td colspan="12">Active</td></tr>
<tr><td>Student</td><td>Mats Dirkzwager</td><td>Research Cluster</td><td colspan="12">Capacity Management</td></tr>
<tr><td>Customer</td><td>KDC Board</td><td>Performance Targets</td><td colspan="3">S</td><td colspan="3">Ec</td><td colspan="3">Es</td><td colspan="3">Env</td></tr>
<tr><td>Assignment</td><td>Graduation assignment, Dick Simons</td><td></td><td colspan="3">-</td><td colspan="3">✓</td><td colspan="3">✓</td><td colspan="3">-</td></tr>
<tr><td>Project Plan</td><td>Proposal</td><td>ATM concept</td><td colspan="4">ATS</td><td colspan="4">ATFCM</td><td colspan="4">ASM</td></tr>
<tr><td>KDC Board Approval</td><td>Augustus 2018</td><td></td><td colspan="4">-</td><td colspan="4">✓</td><td colspan="4">-</td></tr>
<tr><td>Project Lead</td><td>Ferdinand Dijkstra (CoE)</td><td>TRL</td><td colspan="12">3</td></tr>
<tr><td>Sponsor</td><td>KDC Board</td><td>Lifecycle phase</td><td colspan="12">Feasibility assessment</td></tr>
<tr><td>Financial Partner</td><td>LVNL</td><td>Priority</td><td colspan="12">Normal</td></tr>
</table>

In this thesis assignment an ecological interface prototype will be designed to support air traffic control in Time Based Separation (TBS) tasks. TBS, as yet to be implemented at Schiphol, is a method controlling separation on final approach based on time rather than distance. The method is used to mitigate capacity loss when high-speed winds prevail on final approach. TBS implementation is mandatory per European PCP regulation by 2024.

It is expected that a discrepancy between calculated and actual benefits may occur. For Schiphol, implementation in both the current ATM System (AAA) as well as the future system (iCAS) is foreseen.

An interface prototype will be developed, by using the Ecological Interface Design framework, which provides on-screen TBS support to help controllers increase the throughput on final approach. Special attention must be given to effects of time separation dynamics as a result of shifting wind fields and the effect of controller anticipation of aircraft dynamics on final approach, as a result of aircraft configuration changes. If time permits, a working prototype connected to a live traffic feed is one of the possibilities to consider.

6.5 Workload reduction possibilities for Amsterdam sector 3 (South) using tool for traffic sequencing

University	TU Delft	**Status**	Active			
Student	Eline Bakker	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment, Max Mulder		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Juni 2018		-	✓	-	
Project Lead	Ferdinand Dijkstra (CoE)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	LVNL	**Priority**	Normal			

The current working methods of an area controller are investigated and a graphical assistance to the radar display will be developed.
The goal of the display is to assist the Area Controller in the decision-making process, whilst considering the capabilities and current work domain. The idea is that when the display is able to show the solution space of the problem at hand, the controller can, ideally, make control decisions that are more optimal and/or taken at an earlier stage. Ultimately this should lower the workload of the controller.

In order to accomplish this, a scope has been defined to frame the research conducted. This thesis will focus on solving the objective using the principles of ecological interface design. This design framework, that shows the affordances of the system, has proven to work well in complex systems. When the goal-relevant properties and constraints of tasks are identified, an interface can make effective use of their human perception and action capabilities. As a first attempt to use these techniques within the area control sector the thesis will focus solely on the task to merge the inbound traffic towards an Initial Approach Fix.

The interface will be created for current Air Traffic Control support, using the information and technology that is currently available. Furthermore, the Amsterdam South sector is chosen as a starting point for the design. An additional complexity of this sector is its size. The small sector gives the controller less room to maneuver. The display will be created specifically for this sector and can later be extended to match other sectors.

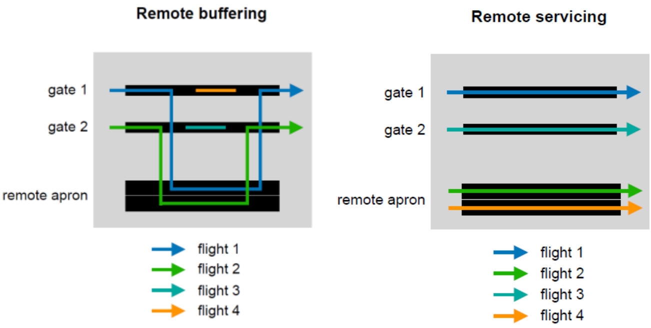
In this thesis assignment an ecological interface prototype will be designed to support air traffic control in inbound traffic sequencing for Amsterdam Sector South (sector 3).

6.6 Evaluation of plan stability deviations in the flow at Schiphol Airport

University	HvA	**Status**	Active			
Student	Sybren Kuiper	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Feb 2019		-	-	✓	
Project Lead	Boudewijn Lievegoed (AAS)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	Normal			

The operations at Schiphol airport are a collaborative activity of stakeholders organizing their flows in the most optimal manner, from runway operations to gate handling. The airport system is a very complex, system to manage, more so during the peak moments, the situation doesn't become easier considering we are operating on the boundaries of the airport's capacity. Because of this constrained situation the stakeholders are adding more to the complexity without considering the consequences, which increases the pressure to manage the system effectively, which in turn places stress on the plan stability of the complete airport system. Especially the ground to take-off and landing flows experience stress on the planning.

Providing this situation how can the stakeholders improve the system stability, thus the plan stability and create a flow? How can we reduce the number of interventions, such as towing, buffering and other bottlenecks in the flow? For instance, remote buffering (see figures) or remote servicing, which was implemented during the summer of 2018.



Did these interventions actually solve the root problems in the system? Is it still logical concentrate all the activities to one central terminal, or does it make sense to spread the activities between terminals? Is there a relationship between the arrival flow and issues in the departure flow, especially when aircraft arrive too early or too late? How often do we deviate from the planning under normal conditions, how much do we deviate and what are the cause-effects through the system, how and do we manage the cascading effect (snowball effect) in the chain? In case of a disruption what happens to the planning and how fast/well are we able to recover?

The aviation sector at Schiphol requires research into; how can we create better plan stability of the flow for the whole airport system, especially consider solution such as remote buffering/servicing?
Which critical X's prevent flow and cause the deviations from the planning. A 0-measurement of the current plan stability is required to provide insight and recommendations to improve the plan stability at Schiphol airport. Previous research performed within the KDC-CoE on planning deviations can provide a starting point.

6.7 Evaluation of AMAN implementation to establish improvements in the arrival efficiency

<table>
<tr><td>University</td><td>HvA</td><td>Status</td><td colspan="12">Active</td></tr>
<tr><td>Student</td><td>Anouk Hollebeek</td><td>Research Cluster</td><td colspan="12">Capacity Management</td></tr>
<tr><td>Customer</td><td>KDC Board</td><td>Performance Targets</td><td colspan="3">S</td><td colspan="3">Ec</td><td colspan="3">Es</td><td colspan="3">Env</td></tr>
<tr><td>Assignment</td><td>Graduation assignment</td><td></td><td colspan="3">-</td><td colspan="3">✓</td><td colspan="3">✓</td><td colspan="3">-</td></tr>
<tr><td>Project Plan</td><td>Proposal</td><td>ATM concept</td><td colspan="4">ATS</td><td colspan="4">ATFCM</td><td colspan="4">ASM</td></tr>
<tr><td>KDC Board Approval</td><td>Feb 2019</td><td></td><td colspan="4">✓</td><td colspan="4">-</td><td colspan="4">-</td></tr>
<tr><td>Project Lead</td><td>Alina Zelenevska (LVNL)</td><td>TRL</td><td colspan="12">3</td></tr>
<tr><td>Sponsor</td><td>Maartje van der Helm (LVNL)</td><td>Lifecycle phase</td><td colspan="12">Feasibility assessment</td></tr>
<tr><td>Financial Partner</td><td>DGB</td><td>Priority</td><td colspan="12">Normal</td></tr>
</table>

From November 2018 Arrival Management (AMAN) is live, which means that there will be more consistency in the whole approach process chain towards Schiphol airport.

AMAN is maintaining an arrival sequence for one or two main landing runways. Traffic is allocated to either one of these two runways by a separate function applying rules set by the Approach Planner (APLN) who is responsible for managing the Inbound Planning system. The rules for runway assignment can be configured by the APLN based on the traffic situation in the TMA. Typically, the APLN will assign traffic from each IAF to one of the main landing runways (if two are in use). Depending on actual runway loading, the APLN may decide to off-load for instance runway 18R by manually assigning some flights to 18C if traffic from the east is not heavy enough to fill that runway and runway 18R becomes overloaded. Or can adjust for sequence errors, fill gaps in the arrival sequence, to optimise the approach flow towards the airport.

Is there more uniformity in handling of the approach flow by the planners, area controllers? and has the AMAN system effectively been adopted in the operational air traffic control room? What are the measurable benefits of the AMAN implementation? More specifically did the accuracy and stability of the planning increase after the implementation? Which method can you create to measure this on a consequent basis, to provide insight into the influence of the new system?

The aviation sector at Schiphol requires research into; evaluation of the arrival efficiency to Schiphol airport after the implementation of AMAN.

6.8 Analysis of relationship between planning times and operational performance between the stakeholders to reduce planning inefficiencies

University	HvA	**Status**	Active				
Student	Femke Mollema	**Research Cluster**	Capacity Management				
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env	
Assignment	Graduation assignment		-	✓	✓	-	
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM		
KDC Board Approval	Feb 2019		-	-	✓		
Project Lead	Coen Vlasblom (KLM)	**TRL**	3				
Sponsor	KDC board	**Lifecycle phase**	Feasibility assessment				
Financial Partner	DGB	**Priority**	Normal				

Creating more capacity at Amsterdam Airport Schiphol by reducing planning inefficiencies amongst KLM, LVNL and AAS.

The stakeholders of the aviation sector in the Netherlands, create plans for their own operations, wherein different KPIs are relevant to measure performances or base decisions on for their operations. For instance, when an aircraft arrives at the Dutch airspace, when does this aircraft arrive at the FIR Boundary, IAF, runway and assigned gate position. For the individual stakeholders this is covered within their operational parameters, but when considering that slot times are used for the planning of the runway times at the LVNL and that also these are used a Schiphol airport for the gate times, and airlines manage for instance on flight schedule times and not slot times, it becomes difficult to match the plans across the whole system. There seems to be a difference in planning times between the stakeholders, if there is an actual difference than it is up to you to indicate and provide solutions what could be done to align.

In this complex aviation system, we are working together although we have different planning methods and planning KPIs between the stakeholders. Is the current way of working supporting the efficient use of the limited capacity at the airport and airspace? For instance, in the landing and take-off cycle are stakeholders planning on arrivals or departures? How is the whole system/ chain organised, what are the (inter)dependencies and which agreements are there surrounding the standardise performance monitoring/reporting systems.

The aviation sector at Schiphol requires research into; who plans on what and how are these related to each other?

What are the potential improvement benefits, where in the system can we find these? What actions are required to achieve alignment between the plans. Previous research performed within the KDC-CoE on planning deviations can provide a starting point.

6.9 Sector evaluation of implemented changes within D-1 project to establish an overview of stakeholder benefits

University	HvA	**Status**	Active			
Student	Flore Wassenberg	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Feb 2019		-	-	✓	
Project Lead	Evert Westerveld (LVNL)	**TRL**	3			
Sponsor	Maartje van der Helm (LVNL)	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	Normal			

The LVNL wants to provide information to all relevant stakeholders about the day of operation with regards to the capacity at Schiphol airport and surrounding airspace. Within the LVNL currently the project D-1 is being performed, the D-1 covers the planning horizon from a week before the day of operation to the day of operation (D-0). The departments Operations and Capacity Management Analysis gather information about the operating day to create an operational plan and include weather data to ensure a most stable execution of the plan. Besides weather data, also Network Manager, MIL and adjacent centre information is considered to match supply and demand. The operational plan is provided to the supervisor of that day, to inform on the events and capacity requirements of that day. The situation before the D-1 project, a supervisor would determine the possibilities of the operating day. After implementation of the D-1 process, the D-1 plan provides stakeholders with information about what they can expect in terms of capacity. The D-1 plan will be evaluated and implemented in the control room first to ensure plan stability before it will be widely shared with the stakeholders.

Furthermore, what benefits/opportunities are there for the stakeholders, when this information will be shared before the day of operation, currently they do not receive information on regular basis about what to expect from the LVNL's operation. Only during significant weather conditions, it is for the stakeholders clear what they can expect, a D-1 plan is prepared for consultation between the LVNL and its stakeholders. How is weather data considered in the capacity assessment of the airport, and when the weather impact is significant when can the airport provide 100% of its capacity again?

The aviation sector at Schiphol requires research into; an evaluation of the sector benefits considering the influence on the processes and predictability of the operations and changes of the implementation within the organization.

Does is it help to provide a more stable (execution matches with plan) operation? How does the D-1 plan influence (MIL, runway, delay and airport conditions) the processes of the stakeholders on the day of operations? Which stakeholders, airlines, ground handlers, airport, Network Manager perceive the benefits and how does it affect their operations? An evaluation of the D-0 will happen with a D+1 analysis.

6.10 Evaluation of peak hour capacity at Schiphol and similar airports to determine common capacity management practices

University	HvA	**Status**	**Active**			
Student	Kyara Metz	**Research Cluster**	Capacity Management			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Sept 2018		-	✓	-	
Project Lead	Yoram Obbens (LVNL)	**TRL**	3			
Sponsor	Maartje van der Helm (LVNL)	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	Normal			

At Schiphol airport the mainport or hub function is a vital element of the airport, that involves providing capacity and an expeditious flow of traffic during peak hours and off-peak hours. At Schiphol this is determined by a vast number of factors e.g. available runways, runway-combinations, available airport infrastructure, navaids, noise restrictions and procedures, staffing or traffic mix characteristics. Furthermore, next to these operational factors, traffic planning (from airport slots, airline schedules to daily flight planning) is of vital importance to make the most use of available capacity. In addition, Schiphol airport is characterized by a variation of peak hour capacity due to the use of peak-periods. Research questions for a peak hour capacity benchmark study:

- What are the best practices considering peak hour capacity management at similar (hub) airports?
- Which techniques/concepts are used to increase peak hour capacity (e.g. final approach separation techniques, time-based separations, etc.) and which planning techniques are used?
- What is the effect of alternating peak hour capacity throughout the day? How do other airports deal with these planned variations?
- What measures are used to improve sustainability of peak hour capacity at other airports?

The aviation sector at Schiphol requires research into; evaluation of peak hour capacity at Schiphol and similar airports in the world to determine common capacity management practices.

The found practices must be assessed on feasibility within the Schiphol environment, this can be done together with the operations and capacity management and analytics departments of the LVNL. It is up to you to provide an overview (could be ranked) of which practices can beneficial to Schiphol and what these benefits specifically are on the short and long term. You research results will provide input for the LVNL, to support further developments on this topic. Previous research on the technical airport capacity can provide a starting point.

7 Airspace Design

7.1 Multi airport concept / TMA

Ref. Ext. Programme	Project Herindeling luchtruim	**Status**	**On hold**			
Project Number	-	**Research Cluster**	Airspace design			
Customer	KDC board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		✓	✓	✓	✓
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	-		✓	-	-	
Project Lead	t.b.d.	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasiblity assesment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Schiphol as well as regional airports grow. Traffic streams from different airports use the same airspace. Therefore it is needed that, parallel to a new airspace design, airports are jointly managed.

Background:
This concerns strategic, pre-tactical as well as tactical planning.

Assignment:
- Research how the management of traffic flows in Dutch airspace can be improved, taking in account the location and function of Dutch airports. Options under consideraion are: alignment of flight schedules, coordination of peak hours, refinement of flow measures, tactical complexity management measures.
- Develop a concept for the planning and management of traffic flows.

Involved parties:
LVNL, KLM, AAS, IenW

Source:
-

8 Airport Capacity

8.1 Business case - Optimising preferred use of Schiphol runways through flexible ILS maintenance

Ref. Ext. Programme	-	**Status**	**Active**			
Project Number	-	**Research Cluster**	Airport Capacity			
Customer	KDC board	**Performance Targets**	S	Ec	Es	Env
Assignment	Call for tender		-	-	✓	✓
Project Plan	NLR_AOAP_1609_14485_aangepast	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Sept 2017		✓	-	-	
Project Lead	Jacco Bos (LVNL)	**TRL**	3			
Sponsor	Marcel Bakker (LVNL)	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	Normal			

Goal / Expected benefit:
The goal for this activity is to assess the feasibility of additional permanent ILS signal quality monitoring, enabling a more flexible planning of ILS ground inspections at Mainport Schiphol Airport. If this study proves that additional ILS monitoring is technically feasible, this will allow the ground inspections deadlines to be loosened, and hence reducing the risk that ground inspections interfere with operational use of preferred runways.

These inspections are necessary to guarantee the required performance for ILS installations (per ICAO Annex 10). In current practice, they are done periodically using a special measurement vehicle on the runway for several hours and thereby blocking the runway for operational use. Most inspections are performed quarterly, within strict deadlines. With the increase of traffic this is increasingly conflicting with the preferred use of runways at the airport, especially with the use of the busy primary runways and night preferential runways 06 and 18R. At Mainport Schiphol these preferences are related to noise abatement and optimizing the airport capacity.
It is expected that this activity will demonstrate that additional ILS monitoring is technically feasible and will provide an improved status of the ILS signal quality, allowing the ground inspections deadlines to be loosened, and hence reducing the risk that ground inspections interfere with operational use of preferred runways.
In potential, and subject to follow-up studies, this additional way of ILS monitoring can be used diagnostically, as a trigger for a-periodic ground inspections. As the ILS installations are highly stable and ground inspections seldomly reveal any problems, a large reduction of ground inspections can be achieved.

Background:
The ILS is a safety critical system enabling aircraft to land in adverse weather conditions. In order to guarantee the extremely high ILS performance in terms of accuracy, integrity and continuity, an ILS is designed with multiple layers of performance monitoring, each covering different types of failure modes. As a final check, it is required to periodically measure the ILS Signals-in-Space in the EM far field (at a distances where aircraft receive the ILS signals). This is done by both flight inspections and ground inspections, requiring special measurement vehicles physically present at locations on the runway and in the ILS coverage area in the air.
The rationale for periodical inspections is that the confidence about the ILS signal quality is decreasing with time. Once an inspection is done this confidence is restored. Historically, the ILS inspection deadlines are such that the uncertainty is retained within limits acceptable to LVNL.
Alternatively, if ILS Signals-in-Space quality properties can be monitored in a permanent way, this will provide permanent additional insight in the ILS signal quality, which allows for a reconsideration of the inspections deadlines, leading to an increased sustainability of the Mainport Schiphol (reduced risk of conflicts between inspections and use of preferred runways).
This activity fits in the LVNL Roadmap for Navigation Maintenance Management.

Assignment:
- Perform a theoretical assessment of permanent ILS monitoring configurations, in terms of antenna types and positions as well as expected measurement quality.
- Provide a proof of concept for permanent ILS monitoring by building a test setup in a controlled environment, that is representative for ILS at Schiphol and perform tests that reveal measurement quality and stability.
- Determine the operational benefits: provide a rationale to what extent ground inspection deadlines can be reconsidered based on the permanent ILS monitoring data.

- Consult LVNL on the practical implementation of permanent ILS monitoring at Mainport Schiphol, in terms of optimal antenna types and positions, data distribution and software processing.

Involved parties:
LVNL

Source:
-

8.2 TTOT_TARGET vs TTOT_OPTIMAL

Ref. Ext. Programme	BE/CDM	**Status**	**Initiative**			
Student	-	**Research Cluster**	Airport capacity			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation university		-	✓	✓	-
Project Plan	BE/CDM	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	2018		✓	✓	-	
Project Lead	David Zwaaf (LVNL)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Minimal delay for the mix of regulated and non-regulated departure traffic

Introduction:
Airport Collaborative Decision Making (CDM) is an important process at Amsterdam Schiphol Airport to facilitate a smooth operation at the Airport. An important component of this process is the departure planning functionality. The Pre-Departure Sequencer (PDS) in use at Schiphol TWR takes planning information from the airlines, indicating when their aircraft are ready to depart and builds a departure planning utilizing the available take-off capacity as much as possible. In this process, the constraints from the NMOC (Network Manager Operational Centre) in Brussels are taken into account. All this information is highly dynamic in nature and many dependencies and interactions exist. The complexity of these relationships has increased when in May 2018, the A-CDM information, including the PDS output, is shared with the NMOC in Brussel.

When the European Network Capacity is temporarily fully or partially saturated, ETFMS could regulate a flight with a Calculated Take-Off Time (CTOT). The CTOT restricts the flight not to be airborne before this time. Without such a regulation, the Target-Take-Off-Time (TTOT) based on the airline information is taken. Based on this TTOT, the time is calculated when the aircraft may start its engines and leave the gate (TSAT = Target-Startup-Approval-Time). This will regulate the flow of the traffic at the airport.

Apart from the dynamics in the outbound process, the PDS has to address the distribution of delay between regulated and non-regulated flight. The current delay distribution and communication rules with the NMOC causes non-regulated traffic to sometimes become regulated due to excessive ATC-delay, whilst the interaction rules for non-regulated traffic with NMOC limit their possibility of receiving slot improvements from NMOC.

Due to the current design of the PDS, the dynamics in the operational process of the turn-around process translate directly into a volatile pre-departure planning. This is often experienced by the ground handling process as a constantly moving target. The delay distribution problem outlined above compounds the difficulties for the ground handling process to adhere to the departure planning at Schiphol.

Assignment:
The assignment is to:
- Develop a method for the assignment of ATC-delay between regulated and non-regulated traffic considering the applicable constraints.
- Define a modified scheme for the interaction with NMOC concerning the delay assigned by the PDS. This may include the development of a simple validation model of the NMOC behavior.
- Develop a prototype to demonstrate the effects the proposed changes.

Short term objective:
Midterm/Long term objective:

Involved parties:
KLM, AAS, LVNL, Min. I&M

Source: -

8.3 De-icing concept for the new sequencer						
Ref. Ext. Programme	BE/CDM	**Status**	Active			
Project Number	-	**Research Cluster**	Airport Capacity			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		-	✓	✓	-
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓	-	-	
Project Lead	David Zwaaf (LVNL)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
The goal is a more efficient deicing process for the new outbound planning sequencer.

The expected benefits are:
- Reduction of the workload for deicing companies / ground handlers and outbound planner of ATC
- Reducing delay and better runway utilization

Introduction:
Current deicing concept based on turnaround times does not function adequately. These times are set manually by deicing coordinators (DeCo). The DeCo sets an Extra Deicing Time (EDIT) as the duration of deicing when the pilot applies for deicing. When the deicing capacity is insufficient, the DeCo sets a Deicing Waiting Time (DIWT), an extra delay until deicing capacity is available for the flight.

The manual setting of EDIT and DIWT gives a high workload. Certainly when the number deicing requests increases with different wishes of pilots, DeCos have difficulty keeping up with the times. This results in a lot of miscommunication between DeCo and Oubound Planner (OPL). This leads to an increase in workload for both functions.

In addition, the deicing plan is now invested with the deicing companies and not centrally with the sequencer. The deicing companies optimize on the basis of their own deicing capacity. However, the sequencer must optimize on the runway capacity. The sequence on the runway that follows is therefore usually not the most optimal with the least delay.

The local process does not match the deicing process as Eurocontrol has described in their A-CDM documentation. In the past, CDM @ AMS's CDM program has already been analysed by system architects. They concluded that a deicing planning based on a prediction of start and end times of deicing works better than on the basis of EDIT and DIWT.

With the arrival of the new sequencer, to be realized in the Outbound Planning project, the opportunity arises to have the new sequencer make deicing planning. Then the complete outbound planning including deicing can be determined at one central point.

Assignment:
Investigate the benefits and possible risks of a deicing concept based on start and end times instead of lead times. What is the impact on the current process with the consequences for the relevant actors and systems? Work out a deicing concept with which the workload and delay can be reduced to a minimum. The concept must be coordinated with the sector parties. In any case need to be involved:
- Service owner deicing (AAS)
- PL Outbound Planning (LVNL)
- Winter performance working group (Sector) (name TBC)
- A-CDM Experts (Sector)

In connection with the development of the new sequencer, it is important to have the new concept quickly clear.

Short term objective:
Concept ready end Q1 2019

Midterm/Long term objective:

Involved parties:
KLM, AAS, LVNL, Min. I&M

Source:
-

9 Schiphol Airport Meteo Development

9.1 Improved weather forecasting for airlines

Ref. Ext. Programme	-	**Status**	**Initiative**			
Project Number	-	**Research Cluster**	Schiphol Airport Meteo Development			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		✓	✓	✓	-
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓	✓	✓	
Project Lead	T.b.d.	**TRL**	6			
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Pre-industrial development & integration			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Operational efficiency, Reduction of operational cost

Introduction:
Accurate weather prediction is increasingly important for airlines. In the first place customers demand upfront information on possible delays. Secondly the impact of weather increases in a congesting airspace with high utilisation rates. Significant weather has a tremendous impact on the efficiency of an airline and its operation. For KLM a disrupted day equals a loss of more than 1 million euros spent on passenger claims, operational- and hotelcost. Furthermore KLM loses valuable customers. Early information (>24h in advance) on the impact of significant weather in terms of capacity and runway usage helps airlines anticipate for example by cancelling specific flights. This reduces the operational loss significantly. Furthermore it helps to reduce the number of dissatisfied customers.

In the past few years improvement on weather models have been realised and accuracy margins have increased. However a number of situations were experienced where airlines were confronted with significant weather (eg. fog) which was not forecasted. Also a number of times significant weather occurred in a different time interval, not according forecast.

Assignment:
A study has to be carried out how weather forecasting can be improved to better serve airlines in anticipating on significant weather:
1. Which weather phenomena and parameters have the highest impact on airline cost and passenger dissatisfaction (and relevant restrictions taken by LVNL and AAS)
2. Which meteorological improvements are currently foreseen to improve prediction of those phenomena and parameters.
3. What is the implementation timeframe for candidate improvements

Mid term objective (two – three years) :
1. Implement candidate improvements and carry out evaluations

Long term objective (> three years) :
-

Involved parties:
KLM, AAS, LVNL, KNMI, KDC partners

Source:
-

9.2 De-icing planner - phase 4

Ref. Ext. Programme	-	**Status**	**Active**			
Project Number	-	**Research Cluster**	Schiphol Airport Meteo Development			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Call for tender		-	✓	✓	-
Project Plan	De-icing planner phase 4 final2018	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	2018		+	+	0	
Project Lead	Coen Vlasblom (KLM)	**TRL**	6			
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Pre-industrial development & integration			
Financial Partner	DGB	**Priority**	Normal			

Goal / Expected Benefit:
Improvement of operational efficiency.

Introduction:
The KLM De-Icing department has supporting meteo tools available to predict De-Icing capacity required 12h/24h hours before operations. Based on those predictions required resources are determined. Adequate De-Icing resources ensure a smooth and predictable De-Icing flow for all stakeholders (LVNL, AAS) with minimal effects on airport capacity.

In earlier phases of the De-icing project a wing forecasting tool has been developed (C47: De-icing Planner, phase 3). Based on evaluation and recommendations, this tool could be further improved.

Assignment:
Resolve limitations of the tool, based on the evaluation of the tool and previous studies. To further enhance the tool the effects of the following limitations should be studied and modelled:
- Location of the planes;
- Amount and type of ice on the wing;
- Flight schedule.

Short term objective (first year):
Build an improved tool

Midterm objective (two - three years):
Better prediction of frost build-up on aircraft wings.

Long term objective:
-

Involved parties:
LVNL, KLM, AAS, KDC partners

Source:
-

9.3 Lightning strike prediction

Ref. Ext. Programme	-	**Status**	**Initiative**			
Project Number	-	**Research Cluster**	Schiphol Airport Meteo Development			
Customer	KDC board	**Key Performance Areas**	**EFF**	**ENV**	**CAP**	**CST**
Assignment	Call for tender		**PRD**	~~INT~~	**SAF**	
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	2018		+	0	+	
Project Lead	Coen Vlasblom (KLM)	**TRL**	6			
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Pre-industrial development & integration			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit:
Increased safety level for airspace users. Reduction of disruptions in the Schiphol operation caused by outbound traffic returning to Schiphol after being struck by a lightning strike.

Introduction:
Recently, thunderstorms in the Schiphol vicinity caused lightning to strike several aircraft. Those incidents caused unplanned returns to Schiphol creating delays for those particular flights while increasing the work for air traffic controllers to accommodate unplanned returns in. Nowadays, no systems exist to accurately predict lightning strikes to warn operational units (ATC, OCC) effectively and take measures to reduce the chance to encounter a lightning strike.

Assignment:
- Inventarise completed research / market to identify tools and systems which would support prediction of lightning strikes.
- Determine potential research to be carried out to enhance the accuracy to predict lightning strikes
- Propose a concept of operations of a system that predicts lightning strikes
- Determine needs of operational units to effectively use output of a system described above

Midterm objective (two – three years) :
- Create a prototype lightning strike predictor
- Carry out trials with prototype

Long term objective (> three years) :
-

Involved parties:
LVNL, KLM, AAS, KDC partner

Source:
-

9.4 Effects of wind & uncertainty in strategic 4D ATC Decision Support Interface

University	TU Delft	**Status**	**Active**			
Student	Matthijs Ottenhof	**Research Cluster**	Schiphol Airport Meteo			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Graduation assignment, Max Mulder		-	✓	✓	-
Project Plan	Proposal	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	Dec 2018		-	✓	-	
Project Lead	Ferdinand Dijkstra (KDC)	**TRL**	3			
Sponsor	KDC Board	**Lifecycle phase**	Feasibility assessment			
Financial Partner	LVNL	**Priority**	Normal			

What are the effects of implementing wind & trajectory uncertainty information in an existing strategic 4D ATC decision support interface, assuming that all aircraft have a digital datalink?

10 AMAN Cluster including iCAS development

10.1 XMAN trial Reims-Amsterdam, CONOPS

Ref. Ext. Programme	Airspace programma van LVNL	**Status**	**Active**			
Project Number	-	**Research Cluster**	AMAN cluster			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Call for tender		-	✓	✓	✓
Project Plan	Offerte 18.282.03 CONOPS XMAN Trials Reims-Amsterdam	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	July 2018		✓	-	-	
Project Lead	Alina Zelenevska (LVNL)	**TRL**	6			
Sponsor	Michiel van Dorst (LVNL)	**Lifecycle phase**	Pre-industrial development & integration			
Financial Partner	DGB	**Priority**	Normal			

Introduction:
Reims has offered LVNL to put the inbound Schiphol traffic in Reims on the required speed. LVNL is interested in this offer as a potential means to de-bunch traffic in sector 3. The Reims-Amsterdam XMAN concept is new since four centers should work together to manage the speed from TOD until the touch down. Before this new concept can be implemented, the concept and the expected benefits should be validated. LVNL wants to do it based on life trials. During the trial, Reims would put aircraft on the speed requested by LVNL ACC in order to absorb all or a part of the delay in the descend mode. This should result in less vectoring in the Dutch FIR, an efficient flight profile for the airlines and a lower workload for the controllers.

Goal / Expected benefit:
To be able to perform the trial, many things need to be done. The goal for this activity is to describe the new concept of operations in the preparation of the XMAN trial with Reims, MUAC and Belgocontrol in Sector 3.
The goal of the trial itself is to assess whether the influence of the traffic just before the TOD leads to the decrease of workload of the ATCOs and efficiency of the flight profiles.

Assignment CONOPS of the XMAN trial:
The agreed CONOPS is an enabler for holding the trial. Development of the CONOPS should be performed in several steps to include input of all stakeholders. The first draft should be ready on the 1st of September to be able to use it during the meeting on September 13th. The writer of the CONOPS should be able to attend the meeting at LVNL on the 13th of September to get the feedback from all involved ANSPs. During the meeting the next steps will become clear. The expectation is that two or three follow-up meetings will be necessary to finalize the CONOPS. The meetings will probably take place at Belgocontrol, Reims and MUAC. The dates are not known yet.

This trial will be a first example of an XMAN trajectory based concept. The Heathrow XMAN concept, which has already been implemented, is a flow management concept in which the whole flow of traffic gets delayed in order to reduce the delay in the holding. The demand and supply balance at Schiphol airport is of high quality, therefore there is no need for LVNL to influence the whole inbound stream. To improve flight efficiency and to decrease workload, LVNL needs to spread bunches of traffic.

In order to agree on the operational concept with the involved ANSPs, LVNL has to prepare a first draft of the operational concept document, based on the high level description provided below and other available FABEC XMAN documentation such as XMAN Advanced Step CONOPS. The operational concept document will be a trial concept, and will serve as input to an update of the more general XMAN Advanced Step CONOPS after the trial.

Concept of Operations (first high level sketch):

- LVNL freezes the planning horizon at 18 min from the IAF;
- Based on the delay value, LVNL ATCO takes a decision to ask MUAC and Reims to influence a certain aircraft or not:
    - If the delay is less than X minutes, the delay will be absorbed in the Dutch FIR;

  - If the delay is more than X but less than Y minutes, ATCO will ask MUAC and Reims to put the concerned aircraft on a fixed Mach speed and descend speed. Reims, MUAC and Belgocontrol will keep the aircraft on the requested speed when possible (best effort, not mandatory).
    An option can be to add one more step: if the delay is more than X but less than Y', ATCO will provide the speed request to MUAC; if the delay is more than Y' but less than Y, ATCO will provide the requested speed to Reims and MUAC.
  - If the delay is more than Y minutes, LVNL will use holding in the Dutch FIR to absorb the delay.
- The trial will be a "single shot" concept. If a speed has been requested, no new requests will come to adjust the speed;
- The speed is individual for the individual aircraft, but it is possible to agree on several standard speed values that can be requested;
- If Reims and MUAC were not able to put the aircraft on the requested speed, Belgocontrol will not do it either because of the proximity of the Dutch FIR and the short time aircraft is under the control of Belgocontrol (3 minutes);
- If possible, the adjacent centres will let the aircraft fly CDA
- The AMAN system of LVNL looks at the traffic in Reims, MUAC and Belgocontrol airspace and presents ATCO an inbound planning. ATCO does not see the traffic of adjacent centres on the radar, only the planning.

10.2 XMAN trial Reims-Amsterdam, KPIs

Ref. Ext. Programme	Airspace programma van LVNL	**Status**	**Active**				
Project Number	-	**Research Cluster**	AMAN Cluster				
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env	
Assignment	Call for tender		-	✓	✓	✓	
Project Plan	NLR proposal 15262_ XMAN KPI's	**ATM concept**	ATS	ATFCM	ASM		
KDC Board Approval	July 2018		✓	-	-		
Project Lead	Alina Zelenevska (LVNL)	**TRL**	6				
Sponsor	Michiel van Dorst (LVNL)	**Lifecycle phase**	Pre-industrial development & integration				
Financial Partner	DGB	**Priority**	Normal				

Introduction:
Reims has offered LVNL to put the inbound Schiphol traffic in Reims on the required speed. LVNL is interested in this offer as a potential means to de-bunch traffic in sector 3. The Reims-Amsterdam XMAN concept is new since four centers should work together to manage the speed from TOD until the touch down. Before this new concept can be implemented, the concept and the expected benefits should be validated. LVNL wants to do it based on life trials. During the trial, Reims would put aircraft on the speed requested by LVNL ACC in order to absorb all or a part of the delay in the descend mode. This should result in less vectoring in the Dutch FIR, an efficient flight profile for the airlines and a lower workload for the controllers.

Goal / Expected benefit:
To be able to perform the trial, many things need to be done. The goal for this activity is to describe the new concept of operations in the preparation of the XMAN trial with Reims, MUAC and Belgocontrol in Sector 3.
The goal of the trial itself is to assess whether the influence of the traffic just before the TOD leads to the decrease of workload of the ATCOs and efficiency of the flight profiles.

Assignment XMAN trial KPIs:
An agreed set of KPIs is an enabler for holding the trial. The right KPIs will provide the evidence of the benefits. Development of the KPIs should be performed in several steps to include the input of all stakeholders. The first draft should be ready on the 1st of September to be able to use it during the meeting on September 13th. The writer of the KPIs should be able to attend the meeting at LVNL on the 13th of September to get the feedback from all involved ANSPs. During the meeting it will become clearer whether more steps will be required. The expectation is that one or two more meetings will be necessary to finalize the KPIs. The meetings will probably take place at Belgocontrol, Reims and/or MUAC. The dates are not known yet.

This trial will be a first example of an XMAN trajectory based concept. The Heathrow XMAN concept, which has already been implemented, is a flow management concept in which the whole flow of traffic gets delayed in order to reduce the delay in the holding. The demand and supply balance at Schiphol airport is of high quality, therefore there is no need for LVNL to influence the whole inbound stream. To improve flight efficiency and to decrease workload, LVNL needs to spread bunches of traffic.

The expectation is that XMAN will provide benefits for the airlines and for the ANSPs. To implement the XMAN concept after the trial, evidence is required that shows the impact of the new concept on all parties involved. Therefore LVNL needs a good set of KPIs, which have been agreed with those parties involved. Each KPI should be accompanied by a use case that will explain what kind of benefits we expect and how these benefits can be achieved during the trial (use examples from FABEC use cases). Once the KPIs have been defined, a baseline measurement will need to be performed.

Ideas named during the kick off meeting:

- Overall vectoring time;
- # track miles/delay;

In order to define the best suitable moment for the trial, LVNL needs the answers to the following questions:

1. What is the timeframe when the majority of the delay in Sector 3 occurs?
2. What is the estimated percentage of flights that will be affected during the trial? This is necessary for the

involved ANSPs in order to assess the workload impact on their side.

3. Are there any other parameters that help to define a suitable time for the trial?

10.3 Sensitivity study high-res meteo for ATM

Ref. Ext. Programme	AMAN-roadmap	**Status**	**Active**			
Project Number	-	**Research Cluster**	AMAN Cluster including ICAS			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		-	✓	✓	-
Project Plan	Ferway offerte hi-res resolutie studie 2018_v0.1	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	December 2018		✓	-	-	
Project Lead	Ilse Megens (LVNL)	**TRL**	3			
Sponsor	Maartje van der Helm (LVNL)	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	Normal			

Introduction:
In order to handle traffic conform schedule, the sector is working on improving arrival management. A new arrival management system has been operational at LVNL since November 13, 2018. With this, steps have been taken to make new developments possible, for example cross border arrival management (XMAN). A new step in further development is the implementation of Hi-res meteo.

Hi-res meteo provides more accurate weather information, which increases the predictability of the operation. The benefits of hi-res meteo have been described earlier as part of the KDC study "Demonstration of arrival trajectory prediction for optimizing the Schiphol night-time arrival process".

Goal / Expected benefit:
Before introducing hi-res meteo into the ATM system, choices must be made for the sake of accuracy. The proposed research "Sensitivity study high-res meteo for ATM" highlights the impact of different options. This research therefore provides decision information for arrival management system choices.

Assignment:
Perform a sensitivity study and write a report.

Involved parties:
KLM, AAS, LVNL, Min. IenW, KNMI

Source:
-

10.4 Schiphol Target Time of Arrival (TTA) Concept

Ref. Ext. Programme	-	**Status**	**Active**			
Project Number	-	**Research Cluster**	Airline Operational Efficiency			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	Call for tender		-	✓	✓	-
Project Plan	Feasibility study of TTO/TTA concept for Amsterdam Airport Schiphol to improve capacity and reduce ATFM delay	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	7-12-2018		✓	✓	-	
Project Lead	Coen Vlasblom (KLM)	**TRL**	3			
Sponsor	Maartje van der Helm (LVNL)	**Lifecycle phase**	Feasibility assessment			
Financial Partner	DGB	**Priority**	High			

Goal / Expected benefit:
More effective EHFIRAM regulations, less Airport ATFM delay and (in longer term) increased capacity

Introduction:
In 2017 traffic numbers for LVNL peaked at their highest on record. More than 600,000 flights were handled by Amsterdam ACC and almost 500,000 commercial flights (without general aviation) arrived and departed at Schiphol Airport. These record traffic numbers resulted in a significant increase in delay as well. To counter these delays and looking to improve its performance.

In current operations LVNL is facing traffic demand well above the declared capacity on daily basis. Regulations are put into place to counter these Schiphol inbound traffic peaks. As such safety and orderly handling of traffic are ensured. With the increase in traffic, the delay caused by these regulations has increased as well. In 2017 Amsterdam Airport generated 13.8% of all European airport arrival ATFM delay (ATFM stands for Air Traffic Flow Management). According to the Network Manager, Schiphol Airport is one of the most congested airports in Europe and its generated delay has the largest impact on the network.1 ATFM delays are a problem for the aviation business mainly for the airline operators. Delays increase airline operating costs (cost of ATFM delay is around €80-€100 per minute2) and it disrupts airline operations (including reactionary delay). Furthermore delays can disrupt airport operations (need for use of less environmentally preferable runways, gate planning, planning of ground handling, etc.). Finally the use of ATFCM-measures (regulations) decreases the planning flexibility of the European Network (due to the increased issuing of CTOT's).

To counter these delays, LVNL is seeking to increase capacity and to balance capacity & traffic demand in more efficient ways. One of the potential improvements is the use of "less stringent" regulations (potentially using higher rates and/or smaller regulation periods) by increasing the effectiveness of these regulations. In current operations, LVNLs experience is that regulations, used to reduce traffic peaks / bunches, do not always results in a sufficient safeguard for traffic overloads. Often traffic peaks reoccur because airlines try to recover any endured delay by flying faster and/or using shorter routings. Furthermore ATC in enroute sectors can issue directs to aircraft, resulting in further deviations. Therefore regulations (and capacity) are managed with some conservatism to overcome these effects.

KDCs is interested in the concept of TTO/TTA as a measure to increase effectiveness of regulations by preventions of bunching. TTO stands for Target Time Over (TTA Target Time Arrival) and represents the target time for a flight to enter an (regulated) airspace according to the flight profiling done by Network Manager. When pilots are able to operate more according to these times, risk of traffic bunches occurring may decrease.

In Europe some ANSP's have conducted trials for TTO/TTA (Target Time Arrival). TTO/TTA is incorporated in SESAR as one of the future operational concepts. Therefore it is expected that understanding of this concept can be acquired by a short study of already available information and trial experiences.

Assignment:
KDC requires a short study addressing the following topics

What is the TTO/TTA concept, how does it work?
- SESAR concept
- Trials at ANSP's
- Collaboration between Network Manager, ANSP's and Airlines

Which performance benefits can TTO/TTA deliver
- Effectiveness of ATFCM measures (regulations)
- Performance effects on capacity and ATFM-delay
- Effects on runway usage

Feasibility of TTO/TTA use at Amsterdam Airport Schiphol / Amsterdam ACC
- Incorporation of TTO/TTA in current and/or future operations
- Possibilities to conduct trials in current operations
- Effectiveness for non-regulated flights (e.g. intercontinental traffic)
- Relations with current and future developments (like AMAN 2.0 and XMAN-trials)

Short term objective:
Delivery of a report addressing the benefits and feasibility of TTO/TTA at Amsterdam Airport Schiphol and Amsterdam ACC

Midterm/Long term objective:
Depending on the feasibility study:
Midterm objective is the conducting of one or multiple trials at Amsterdam Aiport Schiphol and Amsterdam ACC

Depending on trial results:
Long term objective is to introduce TTO/TTA at Amsterdam Airport Schiphol and Amsterdam ACC

Involved parties:
KLM, AAS, LVNL, Min. IenW

Source:
-

1 Source: PPR2017, Performance Review Report 2017,
https://www.eurocontrol.int/sites/default/files/publication/files/prr-2017.pdf
2 Source: European airline delay cost reference values Final Report (Version 3.2),
https://www.eurocontrol.int/sites/default/files/publication/files/european-airline-delay-cost-reference-values-final-report-v3.2.pdf
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10.5 ASAS Interval Management, Implementation Business Case

Ext. Programme	-	**Status**	Initiative				
Project Number	-	**Research Cluster**	AMAN Cluster				
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env	
Assignment	-		✓	✓	✓	✓	
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM		
KDC Board Approval	31-1-2019		✓	-	-		
Project Lead	T.b.d.	**TRL**	3				
Sponsor	Maarten Oort (KLM)	**Lifecycle phase**	Feasibility assessment				
Financial Partner		**Priority**	Normal				

Goal / Expected Benefit:
Fixed arrival routes and low altitude CDA's with high capacity. Stable, safe and environmental friendly TMA operations with high capacity.

Introduction:
The airspace vision for the Netherlands (2012) has adopted a concept for the Schiphol TMA, the area around Schiphol with a 50 km radius, which is based on fixed arrival routes and low altitude continuous descent approaches. The concept is founded on accurate delivery of traffic to the TMA, typically within 30 seconds of the planned TMA entry time. However, there is a concern that fixed arrival routes negatively affect arrival capacity, compared to the current arrival capacity which is based on vectoring traffic to the runway.

It is expected that the airspace redesign project that takes place in the 2019 – 2023 timeframe will be based on the principles layed-out in the airspace vision. Note: The implementation of fixed arrival routes is also demanded by the European PCP regulation (716-2014). Thus the future relationship with the surrounding communities in the greater Schiphol area is based on (carefully designed) fixed arrival routes and (the already existing) standard instrument departure routes (SIDs). This will enable better planning of areas that are affected by (some level of) noise annoyance and areas that are not affected.

Besides the planning of noise affected areas in the greater Schiphol area, the Schiphol operation is bound by rules and regulations for use of the runways. These regulations ensure that the noise preferred runways (the Kaag runway 06/24 and Polder runway 18R/36L) are used as much as possible to protect communities close to Schiphol. Furthermore, how these runways are used follows the pattern of arrival and departure peaks as much as possible, in essence the 2 + 1 runway concept. In addition, the use of a fourth runway in the overlap of arrival and departure peaks is limited.

The key point is: The demand for air travel keeps growing, also at Schiphol airport. If Schiphol is to accommodate greater volumes of air traffic, runway capacity needs to be increased to operate within 2 + 1 runway concept, and within the boundaries of the runway use regulations. However, to meet environmental requirements of the greater Schiphol area, and to comply with European regulations, fixed arrival routes need to be implemented which tends to drive down the arrival capacity. Thus the future of Schiphol airport is defined by two requirements which are difficult to reconcile.

Interval Management (IM) is a technology that can increase safety and capacity of fixed arrival route operations. IM requires technology on board of the aircraft which supports the time/distance achieving and keeping functions. This technology has been developed but airline equipage levels are currently zero. However, American Airlines decided in 2018 to equip some 200 A321 aircraft with ADSB-IN technology in order to fly IM procedures into Phoenix, Arizona, becoming the first early adopter of the IM concept

In the 2009 – 2016 timeframe an NLR led consortium has looked into the potential of IM for Schiphol, through fast-time and real-time simulations. The technology looks promising in terms of capacity benefits, but a business case has not been made yet. It is apparent that the dominance of KLM in the arrival peaks poses a business opportunity for IM deployment. It may turn out that, similar to the Phoenix situation, equipage of only KLM aircraft is sufficient to carry the business case.

Assignment
Build a business case which supports the aviation sector, and KLM in particular, to move forward with the

implementation of Interval Management.

The business case must address the following aspects:

- Business problem or opportunity,
- Capacity benefits on fixed arrival routes with various levels of airline equipage
- Associated risks,
- Expected costs for KLM of equipage, including certification costs
- Deployment timeframes,
- Impact on operations, and
- Organisational capability to deliver the project outcomes.

Make use, where possible, of the decision making process that took place at American Airlines.

The business case is needed in order to be able to take next steps in the validation process. Foreseen steps that are needed are largescale demonstrations of the concept and technology.

Involved parties:
NLR (project lead), KLM, LVNL, Schiphol Group, TU Delft
Possibly expanded with partners like Rockwell Collins, EUROCONTROL, Boeing and Airbus.

Source:
-

10.6 Holding support for area control

Ref. Ext. Programme	-	**Status**	Initiative			
Project Number	-	**Research Cluster**	AMAN Cluster including ICAS			
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env
Assignment	-		-	✓	✓	✓
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM	
KDC Board Approval	31-1-2019		✓	✓	-	
Project Lead	T.b.d.	**TRL**	3			
Sponsor	KDC board	**Lifecycle phase**	Feasibility assessment			
Financial Partner		**Priority**	Normal			

Goal / Expected benefit
Holding patterns are mainly flown in non-nominal situations in order to deal with adverse weather, wind, emergencies or delays. Flying holding patterns have significant environmental, cost impact and plan stability. Optimizing the holding operation could lead to a better flow of traffic, less fuel use and improves accurate delivery for approach Schiphol.

Introduction:
Holding procedures keep aircrafts within a specified airspace by proscribing speed, hold entry procedures, timing and rate of turn. AMAN tools for area control do not offer any decision support for flying a holding pattern. Area controllers use only their expertise for an efficient holding. Awaiting further clearance from ATC, aircrafts can safely and orderly be sequenced to the runway.

Assignment:
- Research possibilities to provide area controllers decision support while holding (speed, timing and rate of turn while holding, taking in account separation minima). Also, take in account the available vertical view tool.
- Assess the performance of relevant options.

Short term objective:
Creating an overview of the available options to provide ATCOs with decision support during holdings.

Midterm/Long term objective:
Provide ATCOs with more convenient procedures or decision support tooling in flying holding patterns

Involved parties:
KLM, AAS, LVNL, Min. IenW, KNMI

Source:
-

11 Fixed Arrival Routes and CDA's

11.1 3D systemization of Schiphol routes

Ref. Ext. Programme		**Status**	**Initiative**					
Project Number	-	**Research Cluster**	Airspace design					
Customer	KDC Board	**Performance Targets**	S	Ec		Es	Env	
Assignment	-		-	✓		-	✓	
Project Plan	-	**ATM concept**	ATS		ATFCM		ASM	
KDC Board Approval	31-1-2019		✓		-		✓	
Project Lead	Bart Banning (LVNL)	**TRL**	3					
Sponsor	KDC board	**Lifecycle phase**	Feasibility assessment					
Financial Partner		**Priority**	Normal					

Goal / Expected benefit:
Develop a method to design three dimensionally separated arrival and departure routes. This will allow for more efficient use of the airspace, with higher capacity as well as lower environmental impact as results.

Introduction:
The PCP and PBN Regulation require to implement RNAV routes in the Schiphol TMA with defined lateral navigation standards. If we can constrain the vertical profile then we can create 'tubes'. A single 'tube' can be designed from one airport exit point to one FRA entry point with acceptable environmental and capacity performance. This gives us more efficient use of the airspace and the controllers.
SIDs at EHAM are already designed to RNAV1 standards. We can introduce a minimum 6% fixed climb profile for all types on routing. The SIDs will be vertically and horizontally constrained with PBN design criteria, separated from all other routes.
Arrival streams will be managed by XMAN before descent from FRA exit points. Descents will be separated from other routes to the airport gateways (IAFs). From gateways a fixed RNAV approach route to the runway will be available. Initially this may be replaced by linear holding followed by a vector to instrument approach.
Inbound 3D systemization is already used in some states (DFS, FAA). Outbound 3D systemization has still a few fundamental issues. Combination of the two should give overall benefits in terms of safety, capacity and environmental metrics.
Use can be made of existing software tools (e.g. OPERA) to develop potential designs of the tubes network. This will allow to develop a route design that can be used for fast time simulation. The software input requires the position of the airport, the FRA connection points and the aircraft type information. The algorithm then optimizes the network to minimize interactions and enhance environmental performance.
UK NATS has proposed this approach for the London airspace modernization program. They have also proposed to work collaboratively with neighboring countries to make the entire network better.

Assignment:
Conduct a short market survey to identify possible software candidates for the route network design. Use the preferred software tool to develop an initial design of 3D systemization for Schiphol inbound and outbound routes. This may be restricted to the top four preferential runway combinations at EHAM. Make a quantitative assessment of the performance of such a network, preferably using fast time simulations.

Short term objective:
Feasibility of the concept as a major building block in airspace restructuring for the 2023 deployment timeframe.

Midterm/Long term objective:
Finalize the design by performing real time simulations and subsequent development of procedural and technical changes to the ATM system. The 3D systemization may further evolve into the ICAO 4D trajectories paradigm.

Involved parties:
KLM, AAS, LVNL, Min. I&M

Source:
LVNL PRO architecture assessment; NATS LAMP2 ANSP slides.

11.2 Advanced RNAV approaches at night

Ref. Ext. Programme		**Status**	Initiative				
Project Number	-	**Research Cluster**	Airspace design				
Customer	KDC Board	**Performance Targets**	S	Ec	Es	Env	
Assignment	-		-	-	✓	✓	
Project Plan	-	**ATM concept**	ATS	ATFCM	ASM		
KDC Board Approval	31-1-2019		✓	-	-		
Project Lead	T.b.d.	**TRL**	3				
Sponsor	Maartje van der Helm (LVNL)	**Lifecycle phase**	Feasibility assessment				
Financial Partner		**Priority**	Normal				

Goal / Expected benefit:
Currently many aircrafts fly unnecessarily low when approaching Schiphol at night. Deployment of RNAV approaches at night, will result in:

- Reduction of noise nuisance during nights
- Improved efficiency for airlines
- Make it possible to avoid certain populated areas
- Reduction of workload for controllers

Introduction:
By deploying advanced RNAV approaches at night, more optimal routes are flown. Currently RNAV night-approaches are in place for runway 06 and 18R. ATC now lacks advanced RNAV procedures for approaching other runways at Schiphol and lacks adequate system support tools. RNAV-procedures for more runways could help to achieve a high accuracy of arriving aircraft and supports controllers in achieving safe operations.

Assignment:

- Form and design different alternatives for RNAV procedures for Schiphol night operations which specifically focus on:
  - noise nuisance reduction
  - efficiency
- Simulate these procedures
- Measure the benefits and drawbacks of the different alternatives.

Short term objective:
Study the feasibility of advanced RNAV approaches during night operations

Midterm/Long term objective:
Design and implement operational support by support tools or straightforward procedures. Implement advanced RNAV approaches during night operations. Alternatively, operations can be supported by a tool during approaches at night.

Involved parties:
KLM, AAS, LVNL, Min. I&M

Source:

12 List of Acronyms

AADT	Advanced Arrival and Departure Techniques
AAS	Amsterdam Airport Schiphol
ANSP	Air Navigation Service Provider
ASAS	Airborne Separation Assurance System
ASM	Airspace Management
A-SMGCS	Advanced Surface Movement Guidance and Control System
ATCFM	Air Traffic Capacity and Flow Management
ATM	Air Traffic Management
ATS	Air Traffic Service
CONOPS	Concept of Operations
CDA	Continuous Descent Approaches
CDM	Collaborative Decision Making
CDTI	Cockpit Display Traffic Information
CROS	Commissie Regionaal Overleg Schiphol
DCMS	Dynamic Capacity Management Schiphol
DGB	Directoraat Generaal Transport en Luchtvaart
DME	Distance Measuring Equipment
E_C	Efficiency related to capacity
E_S	Efficiency related to sustainability
ETA	Estimated Time of Arrival
FMS	Flight Management System
GBAS	Ground Based Augmentation System
GNSS	Global Navigation Satellite System
HvA	Hogeschool van Amsterdam
ILS	Instrument Landing System
KBN	Klimaat Bestendig Nederland
KDC	Knowledge and Development Centre
KLM	Koninklijke Nederlandse Luchtvaartmaatschappij
KNMI	Koninklijk Nederlands Meteorologisch Instituut
KPI	Key Performance Indicator
LVNL	Luchtverkeersleiding Nederland
LVP	Low Visibility Procedure
MLS	Microwave Landing System
MT	Management Team
NLR	Nationaal Lucht- en Ruimtevaart Laboratorium
NM	Nautical Miles
NOC	No Connection
P-RNAV	Precision Area Navigation
R&D	Research & Development
RNAV	Area Navigation
ROT	Runway Occupancy Time
SBAS	Satellite Based Augmentation System
SESAR	Single European Sky ATM Research
STAR	Standard Arrival Route

TBD	To be determined
TRL	Technology Readiness Level
ToD	Top of Descent
TU	Technische Universiteit/ University of Technology
VEMER	Veiligheid, Efficiency en Milieu Effect Rapportage
WG	Werkgroep