MASTER

Information management aspects of ATS route planning, now and in the future : a case study in Tanzania

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International Technological Development Sciences

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PREFACE

This thesis concludes the M.Sc. research performed at the Air Traffic Services department of the Directorate of Civil Aviation (DCA) in Tanzania. The field research period and the periods just before and after that period have been very dynamic in every way. Undoubtedly, another very interesting period in my life.

First let me start to offer my special thanks to the employees of the ATS department of DCA: Mr.M.R.Alloo, Mr.G.Makoroma, Mr.V.A.Mandepu, Mr.J.Minja. They have been supportive throughout the field period as much as was possible in every way. In addition I owe special thanks to Mr.L.Yomtonzi for his unconditional support in finding ICAO documents and reserve as much computer time as possible. Thanks to Mr.G.Mpili for his advice to visit the island of Mafia

Especially my heart goes out to the operational ATC site at Dar es Salaam International Airport.
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Many happy landings.

Eindhoven, October 1996 Pascal Hop

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SUMMARY

BACKGROUND, AIMS, RESEARCH QUESTIONS AND METHODOLOGIES APPLIED

BACKGROUND

The regulation, controlling, facilitation and management of air traffic in Tanzania is executed by the Directorate of Civil Aviation (DCA).

At the pre-stage of the research, DCA indicated to have problems with the operation of airspace and a first research proposal was written concentrating on operational Air Traffic Control (ATC) problems. The core of this research consisted of a comprehensive comparison of the Tanzanian and Dutch (benchmark) ATC organisations and their environments. On arrival in Tanzania, however, it appeared that the Tanzanian ATC technology complex was so fundamentally different from the Dutch one, that a comparison would be meaningless. In addition, DCA had identified a number of practical bottlenecks itself and made it clear that the research should focus on these bottlenecks.

AIM

The goal of the research was now placed in a wider framework: *provide DCA with information about their major technological bottlenecks in the air traffic control environment and to recommend on possible solutions.*

Since DCA is on the verge of reorganising its activities in order to let market forces become a major factor in its functioning, also future route planning related problems were taken into consideration.

RESEARCH QUESTIONS

To meet DCA's desires and still be able to maintain the overall goal, the research was divided into three parts. The first part focuses on the review of the Air Traffic Services (ATS) route network in Tanzania. Problems encountered in this part were the inputs for the second part. The second part focuses on backgrounds of ATS Planning at DCA. The final part focuses on the most appropriate organisational change for DCA to bring market forces into the ATS organisation and the effects such a change would have. Special attention was given to the problem areas that were determined in the second part of the research.

This resulted in the following main research questions:

1 *What are the differences between the status of the Air Traffic Services (ATS) route network of Tanzania and the operational air traffic characteristics and how should the ATS route network be adjusted to meet the present operational air traffic characteristics?*

2 *Why does a difference exist between the status of the ATS route network as implemented and the operational air traffic characteristics and how can this difference be rectified?*

3 *What impact would a change of DCA's organisation towards a more market orientated approach have on the ATS technology in general and on the presented technological bottleneck specifically?*

METHODOLOGY: IDENTIFICATION OF DIFFERENCES BETWEEN THE *STATUS* OF THE ATS ROUTE NETWORK AND THE *OPERATIONAL* AIR TRAFFIC CHARACTERISTICS

The Standard International ATC environment as described by the International Civil Aviation Organisation (ICAO)[1,2], in particular with reference to ATS Route Standards, was used as benchmark to analyse the ATC environment in Tanzania.

International Civil Aviation Organisations like the ICAO and Eurocontrol have described methods for the development and design of ATS routes. The Eurocontrol model[3] was chosen to be used in the research for its abstraction and completeness.

To identify the present usage of Tanzanian airspace, a selection of the raw data available the (Flight Progress Strips (FPSs) of a period of three months) was entered in a data-base. Selection of raw data was executed by determining a 'normal' week of air traffic. The 'normal' week was identified by selecting the least deviating 7 consecutive days from the mean daily air traffic demand. Of this week, the raw data were processed and converted into graphical presentations. Differences in status of the ATS Route Network and the operational ATS Route Network were identified by comparison.

METHODOLOGY: INFORMATION MANAGEMENT IN THE DCA/ATS ORGANISATION

ICAO literature[4], describing ATS organisations and ATS Planning, was used as theoretical framework. In addition, theoretical models with reference to information management were used. Initially, a model which justified the comparison of information management of other ATC organisations[5]. Later, more general models[6,7] on information management were used to analyse the information management problem at DCA. Focus on the information management within ATS was obtained by means of the model of Thiadens that describes the function of information in organisations. Data were collected by unstructured personal interviews and observations. Initially, interviews questioning the issue of information management problems directly. Later, more covered, indirect methods were used, such as un-announced interviews, in which interviewees were not aware of being interviewed, or, discussing issues that related strongly with information management.

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[1] ICAO, *The Air Traffic Services Planning Manual* (Doc 9426 AN/924 Montreal, 1984)

[2] ICAO, *Annex 11* (10th edition, Montreal)

[3] European Air Traffic Control Harmonisation and Integration Programme (EATCHIP), *Airspace Management Handbook for the Application of the Concept of the Flexible Use of Airspace* (Version 5.2, Eurocontrol, 19/05/1995)

[4] ICAO, *The Air Traffic Services Planning Manual* (Doc 9426 AN/924 Montreal, 1984)

[5] Starreveld, R.W., De Mare, H.B., de en Joëls, E.J.: *Bestuurlijke informatieverzorging* (Samsom, Alphen aan de Rijn, The Netherlands, 1981)

[6] Mintzberg, H., *The Structuring of Organisations* (Prentice Hall, Englewook Cliffs, 1979)

[7] Thiadens, T.: *Informatieverzorging in organisaties* (Academic Service, Schoonhoven, The Netherlands, 1995)

METHODOLOGY: COMMERCIALISATION OF ATS

The basic privatisation methods that the Worldbank (WB) identifies[8] were used to identify the most appropriate method of introducing market forces into the functioning of DCA. In addition, experiences of four other ATC organisations with reference to commercialisation were studied to determine relevant aspects that the introduction of market forces bring into a former, government-owned ATC organisation. These aspects were reflected on the organisation of DCA.

The relevant aspects that were identified were places within a framework the ICAO presented on autonomisation of ATS and airport departments.

With reference to upcoming technological changes in the ATC environment, especially referring to satellite navigation based systems, the possibility of DCA to join modern ATC technology was discussed. Articles about the future of the technology complex of ATC[9] were taken as a starting point.

CONCLUSIONS

IDENTIFIED DIFFERENCES BETWEEN THE *STATUS* OF THE ATS ROUTE NETWORK AND THE *OPERATIONAL* AIR TRAFFIC CHARACTERISTICS

The ATS staff at DCA Headquarters (DCA/HQ) believed that the current air route plan situation of the ATS Route Network was out of date. It had not been reviewed for a very long time, and, therefore, significant differences were supposed to exist, with respect to the wished situation

It appeared that processed data were not available to be used in the identification of the present usage of the airspace. To process the raw data available in order to complete a full review of the ATS route Network was not possible in the time span of the research. Instead, the analysis of the ATS route network was of preliminary character. The week of 11 to 18 July, 1995, was identified as a week with normal air traffic. It was found that the controlling of the air traffic on routes, between to specific airports, used more than 9 times in the month of July, 1995, accounted for more than 67% of total workload of the Air Traffic Controllers (ATCOs). The airport-pairs meeting the requirement of being used more than 9 times, were used to produce the graphical presentations for the operational ATS Route Network. Overall, from the database and the figures, it appeared that the route structure as implemented was quite suitable for the present operational situation. There were, however, some routes that differed from the operational situation.

It was possible to make a clear classification of route usage. Upper Airspace overflying traffic determines for the greater part the characteristics of the route-network in Tanzania, especially in the North-South direction from Kenya. For traffic having the destination or origin in Tanzania, traffic from and to neighbouring countries provided the major part of traffic along the Upper Airspace routes. Domestic Upper Airspace traffic and Lower Airspace traffic concluded the significance for the ATS Route Network.

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[8] Vuylsteke, C., *Techniques of Privatization of State-Owned Enterprises*, Volume I, Methods and Implemetation (World Bank Paper Number 88)

[9] *Aviation Week & Space Technology* (May, 16th, 1994, p. 36-53)

The availability of data was the major technological problem encountered. The identified ATS route network problem by ATS staff at DCA/HQ was afterall not a very big one, although staff identified this as the major problem in the DCA/ATS organisation. This already pointed towards communication and information problems.

INFORMATION MANAGEMENT IN THE DCA/ATS ORGANISATION

From the ICAO documents concerning the ATS Planning Organisation the following were derived: forecasting of future requirements; development of alternative ways of meeting requirements; devising of ways and means to meet objectives; feedback. In other words: ATS planning activities are facilitated by a sound information management system.

DCA/ATS experienced the biggest problems in the mutual interaction of the controlled system (the operational ATC) and the controlling organ (ATS staff at DCA/HQ). The lack of information initiated from a non-existing information management history and a non-transparent and non-communicative organisation and insufficient feedback from DCA/HQ to operational sites. Both staff at HQ and Dar es Salaam International Airport (DIA) were not sufficiently aware of each other's activities. People at DIA were frustrated about the HQ management and were unable to communicate efficiently with HQ. The motivation to develop an information management system was not present, not in the least because of a rigid hierarchical organisation. Information management presents DCA/ATS with a major technological bottleneck.

It appeared that especially improvements in the organisation would yield improvement of information management. DCA was labelled as a machine bureaucratic organisation, according to a model from Mintzberg[10]. This characterisation emphasised the importance of a sound information system. Moreover, it emphasised the importance of the relation between organisation and information. A model of Bemelmans[11] states that, for organisations that are not designed for control means and information systems, and that the information in the organisation is not adapted to control the situation, improvement of information, control means and organisation is necessary. DCA is such a case.
From the interviews and observations, especially personal characteristics, as demotivation, appeared to initiate information management problems.

COMMERCIALISATION OF ATS

For DCA the process of re-organisation into component parts is the most appropriate method of bringing market forces into the organisation. This way the ATC organisation will be separated from government control and the control and management will be transferred to an autonomous ATC organisation.

According to the ICAO, the most important effects of autonomisation on ATC organisations are in the field of:

- the efficiency of the organisation;

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[10] Mintzberg, H., *The Structuring of Organisations* (Prentice Hall, Englewook Cliffs, 1979)

[11] Bemelmans, prof.dr. T.M.A.: *Bestuurlijke informatiesystemen en automatisering* (Stenferd Kroese, 1987, Leiden)

- the financial situation of the organisation;
- productivity and motivation of personnel;
- the strategic position of the organisation in general;
- the strategic position of the organisation in financial, technological, and labour contract negotiation;
- ATC services fees.

Four cases of commercialisation experiences of ATC organisations in Holland, Germany, New Zealand and USA, showed 8 significant positive effects on the organisation and economic functioning of the organisations. These are:

- avoidance of government budget acquisition delays;
- change of salaries (+ incentives);
- the possibility to borrow of capital,
- the possibility and methods of system modernisation,
- the possibility of contractor selecting
- maintenance adjustments;
- monitoring the technology complex;
- the impact on GA..

Not all positive effects can be expected for the DCA, because of the typical developmental characteristics (mainly dependency on donors) in which the organisation is situated. This means that issues not effected by privatisation as in Western ATC organisations are:

- the possibility to borrow of capital,
- the possibility and methods of system modernisation,
- the possibility of contractor selecting
- maintenance adjustments;
- the impact on GA..

The financial position of Tanzania and DCA is weak. It is not likely that DCA has the possibility to borrow money.
Because of the donor dependency, DCA does not have the flexibility in system modernisation and contractor selecting. The different position maintenance of ATC systems is growing into as a result of package deals with the investments in modern ATC equipment is not a point of issue for DCA. The donor dependency immediately pushes DCA into a specific technological direction.
The impact on GA will be not effected by a commercialised ATC organisation due to low traffic demands. It is not in the economical interest of DCA to discourage GA.

For the other aspects privatisation probably make a significant difference. These aspects are:

- avoidance of government budget acquisition delays;
- change of salaries (+ incentives);
- monitoring the technology complex;

Government budget acquisition delays were considered by DCA staff as major aspect in the inefficient functioning of DCA. The availability of own revenues takes away this inefficient aspect.
Privatisation gives DCA the possibility to change salaries. In the experiences of the ATC organisations of Holland, Germany, New Zealand and USA, the salary level had a major influence on the efficient

functioning of the organisation. Interviews showed that a small increase in salary will not increase motivation.
The desire to monitor the technology system will increase. People tend to be more caring for things they control.. Especially these three issues will improve the functionality and efficiency of the DCA/ATS organisation, for in the previous chapter it was determined that a major bottleneck of DCA/ATS was the missing of a functional information system to be used by planners, amongst others caused by demotivation and rigid governmental bureaucratic methodologies.

The studied ATC organisations' relevant effects as a result of commercialisation, can be grouped into the ICAO list of effects as a result of autonomisation. As a result, in ICAO terms; not influenced aspects in the case of DCA are:

- the strategic position of the organisation in general;
- the strategic position of the organisation in financial, and technological contract negotiation;
- ATC's services fees.

Aspects that are majorly influenced by autonomisation for DCA:

- the efficiency of the ATC organisation,
- the financial situation of the ATC organisation,
- productivity and motivation of ATC personnel,
- the strategic position of the organisation in labour contract negotiation

Future ATC Technology
As far as technological development in the international environment is concerned, satellite navigation is about to be implemented. Already, aircraft are equipped with satellite navigation equipment and implementation has started in several western industrialised countries.
According the industrialised countries, the satellite navigation system should be globally implemented and should become the ATC standard. The industrialised world is pushing for the implementation of these systems because the ATC system is smothering.

RECOMMENDATIONS

ATS ROUTE NETWORK
Based on the information gained from the data processing of the data-base, there is no need for DCA to structurally alter the ATS Route Network in Tanzania. However, the routes on the maps that differ from the operational situation, or the routes in the operational situation that differ from the situation on the maps, should be studied for deletion or establishment

Route monitoring priority classification should be designed for the various route characteristics of air traffic. First, monitoring priority of routes should be on overflying air traffic in Upper Airspace, originating from the North, and especially Kenya. This traffic determines for the greatest part the characteristics of the ATS Route Network. Secondly, traffic to neighbouring countries should be monitored.

ATS Route data should be entered into a data-base and processed according to the methods described in the report to facilitate easy insight in the use of airspace. The selection criteria used to add aircraft flights to the data should be studied and possibly reviewed by DCA.

INFORMATION MANAGEMENT IN THE DCA/ATS ORGANISATION

DCA should focus on its information management system, since this is one of the most important facilitators for sound airspace management planning.
With reference to improvement of an information management system the DCA/ATS should improve organisation, control means and information.
People at DCA/ATS must be motivated to develop such an information management system. This will be best done by improving the transparency of the DCA/ATS organisation, especially to be improved by DCA/HQ. Additionally, the rigid structure of the organisation should be more flexible.

Statistics must be produced by planners and not by operators. Therefore, *(i) HQ should produce operational ATS statistics based on raw data from operational sites.*
Main problem is the additional workload for staff at DCA/HQ. The most logical person to carry out this task has already a too high a workload. *(ii) HQ must attract an extra staff member to develop and maintain an appropriate information system for both operational and planning sites.* With reference to the coming organisational changes of DCA, the need for a sound information system will become stronger. DCA must present its output in a transparent manner. This strengthens the need for a staff member for information system matters.

Little adjustments in control means could have a major impact on the improvement of information management. Logging of ATC data should be computerised. This would facilitate the easy processing of raw data into statistics to be used in the planning process.

- Data from the FPSs should be entered into a spreadsheet program instead of writing the data into a logbook;
- A desktop computer should be installed at the control room at DIA/ACC;
- The person now writing the FPS information in the logbooks should enter the data into a spreadsheet program and, therefore, should receive a computer course;
- The data from the spreadsheet should be submitted to DCA/HQ on a frequent basis, e.g. every week.
- Staff at DCA/ATS at DCA/HQ should process the data into appropriate statistics. They know best what statistics they need and, therefore,
- Staff at DCA/ATS should develop a computer program to automatically process raw data into appropriate statistics. Since the knowledge to develop such a program is currently not available at DCA,
- HQ should apply for a computer science student to study this problem as a subject for the student's final practical training.
- DCA/HQ should submit produced statistics on a reasonable frequent basis (every 3 months) to operational grounds to keep operations informed about their functioning and to build up an information institution within DCA.

COMMERCIALISATION ATS

The introduction of market forces into the operations of DCA is best done by separation from government control. Management is transferred to an autonomous ATC organisation.
The own responsibility for the ATC technology complex without intervention of the government will smoothen many processes in the DCA organisation.
Salaries will be influenced by the change into an autonomous organisation. Motivation could be improved with a significant amount. In order to improve motivation significantly, salaries should be increased significantly.
Motivation should be improved in order to make people monitor the technology complex.

Future ATC Technology

For countries like Tanzania it is not necessary to transfer to a system with enormous traffic handling capacity because traffic demand in Tanzania is not that high and is not growing to an unacceptable demand level for traditional ATC systems.
Still, the transfer to a satellite navigation based system for Tanzania is worth considering.
Reasons not to upgrade the conventional system, but to transfer to a satellite based systems are:

- satellite navigation is probably going to become an international standard for which Tanzania sooner or later has to choose;
- the satellite based system is much simpler than a traditional ATC would develop into;
- Tanzania would not discourage operators to overfly or to come to Tanzania.

DCA should, in detail, study the participation in satellite navigation

FURTHER RESEARCH

Further research is necessary for the design and implementation of an information system for operational ATS data at DCA.

GLOSSARY

Advisory airspace An airspace of defined dimensions, or designated route, within which air traffic advisory service is available.

Advisory Route A designated route along which air traffic advisory service is available.

Aerodrome A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome control service Air traffic control service for aerodrome traffic.

Aerodrome control tower A unit established to provide air traffic control service to aerodrome traffic.

Aeronautical fixed service (AFS) A telecommunication service between specified fixed points provided primarily for the safety of air navigation and for the regular, efficient and economical operation of air services.

Aeronautical Information Publication A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

Aeronautical Information Service (AIS) is a service provided for the collection and dissemination of information needed to ensure the safety, regularity and efficiency of air navigation.

Aeronautical telecommunication service A telecommunication service provided for any aeronautical purpose.

Aircraft Any machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth's surface.

Aircraft identification A group of letters, figures or a combination thereof which is either identical to, or the coded equivalent of, the aircraft call sign to be used in air-ground communications, and which is used to identify the aircraft in ground-ground air traffic services communications.

Aircraft type designator A group of alphanumeric characters used to identify, in an abbreviated form, a type of aircraft.

Air-filed flight plan (AFIL) A flight plan provided to an air traffic services unit by an aircraft during its flight.

Air-ground communication Two-way communication between aircraft and stations or locations on the surface of the earth.

Air route facilities Facilities provided to permit safe operation of aircraft along an air route, including visual and radio navigation aids for approach and landing at aerodromes, and communication services, meteorological services and air traffic services and facilities.

Airspace Management (ASM) is a generic term covering any management activity provided for the purpose of achieving the most efficient use of airspace based on actual needs and, where possible, avoiding permanent airspace segregation.

Airspace structure is a division of the airspace designed to accommodate the safe operation of aircraft during a specific phase of flight.

Air traffic All aircraft in flight or operating on the manoeuvring area of an aerodrome.

Air traffic advisory service A service provided within advisory airspace to ensure separation, in so far as practical, between aircraft which are operating on IFR flight plans.

Air traffic control clearance Authorisation for aircraft to proceed under conditions specified by an air traffic control unit.

Air traffic control service A service provided for the purpose of:

a) preventing collisions:
   1) between aircraft, and
   2) on the manoeuvring area between aircraft and obstructions; and

b) expediting and maintaining an orderly flow of air traffic.

Air traffic control unit A generic term meaning variously, area control centre, approach control office or aerodrome control tower.

Air Traffic Flow Management (ATFM) is a generic term covering any management activity provided for the purpose of ensuring an optimum flow of air traffic to or through areas during times when demand exceeds the available capacity of the ATC system.

Air Traffic Management (ATM) is a generic term covering both Air Traffic Services (ATS), Airspace Management (ASM) and Air Traffic Flow Management (ATFM).

Air traffic services A generic term meaning variously, flight information service, alerting service, air traffic advisory service, air traffic control service (area control service, approach control service or aerodrome control service).

Air traffic services unit A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office.

Airway A control area or portion thereof established in the form of a corridor equipped with radio navigation aids.

Altitude The vertical distance of a level, a point or an object considered as a point, measured from mean sea level.

Approach control service Air traffic control service for arriving or departing controlled flights.

Appropriate ATS authority The relevant authority designated by the State responsible for providing air traffic services in the airspace concerned.

Area control centre A unit established to provide air traffic control service to controlled flights in control areas under its jurisdiction.

Area control service Air traffic control service for controlled flights in control areas.

Area navigation (RNAV) A method of navigation which permits aircraft operation on any desired flight path within the coverage of station-referenced navigation aids or within the limits of the capability of self-contained aids, or a combination of these.

Area navigation route An ATS route established for the use of aircraft capable of employing area navigation.

ATC loop An ordered cycle of information or data flow, computation, co-ordination, decision making, control and monitoring, which constitutes the complete function of an air traffic control unit.

ATIS The symbol used to designate automatic terminal information service.

ATS route A specified route designed for channelling the flow of traffic as necessary for the provision of air traffic services.

Note: The term "ATS route" is used to mean variously, airway, advisory route, controlled or uncontrolled route, arrival or departure route, etc.

Automatic terminal information service The provision of current, routine information to arriving an departing aircraft by means of continuous and repetitive broadcasts throughout the day or a specified portion of the day.

Change over point The point at which an aircraft navigating on an ATS route segment defined by reference to very high frequency omnidirectional radio ranges is expected to transfer its primary navigational reference from the facility behind the aircraft to the next facility ahead of the aircraft.

Clearance function The formulation and transmission of a clearance by an air traffic control unit as well as the acknowledgement and acceptance of such clearance by the pilot.

Clearance limit The point to which an aircraft is granted an air traffic control clearance.

Conflict Predicted converging of aircraft in space and time which constitutes a violation of a given set of separation minima.

Control area A controlled airspace extending upwards from a specified limit above the earth.

Control assistant A person who assists in the provision of air traffic services but who is not authorised to make decisions regarding clearances, advice or information to be issued to aircraft.

Controlled aerodrome An aerodrome at which air traffic control service is provided to aerodrome traffic.

Controlled airspace An airspace of defined dimensions within which air traffic control service is provided to IFR flights and to VFR flights in accordance with the airspace classification.

Controlled flight Any flight which is subject to an air traffic control clearance.

Control zone A controlled airspace extending upwards from the surface of the earth to a specified upper limit.

Controller A person authorised to provide air traffic control services.

Cruising level A level maintained during a significant portion of a flight.

Data processing A systematic sequence of operations performed on data.

En-route clearance A clearance covering the flight path of an aircraft after take-off to the point at which an approach to land is expected to commence.

Entry fix The first reporting point, determined by reference to a navigation aid, over which an aircraft passes or is expected to pass upon entering a flight information region or a control area.

Estimated time of arrival For IFR flights, the time at which it is estimated that the aircraft will arrive over that designated point, defined by reference to navigation aids, from which it is intended that an instrument approach procedure will be commenced, or, if no navigation aid is associated with the aerodrome, the time at which the aircraft will arrive over the aerodrome. For VFR flights, the time at which it is estimated that the aircraft will arrive over the aerodrome.

Expected approach time The time at which ATC expects that an arriving aircraft, following a delay, will leave the holding point to complete its approach for a landing.

Exit fix The last reporting point, determined by reference to a navigation aid, over which an aircraft passes or is expected to pass before leaving a flight information region or a control area.

Flight information centre A unit established to provide flight information service and alerting service.

Flight information region An airspace of defined dimensions within which flight information service and alerting service are provided.

Flight information service A service provided for the purpose of giving advice and information useful for the safe and efficient conduct of flights.

Flight level A surface of constant atmospheric pressure which is related to a specific pressure datum, 1013,2 hectopascals (hPa), and is separated from other such surfaces by specific pressure intervals.

Flight Management System (FMS) is and integrated system, consisting of airborne sensor, receiver and computer with both navigation and aircraft performance data bases, which provides performance and RNAV guidance to a display and automatic flight control system.

Flight plan Specified information provided to air traffic services units, relative to an intended flight or portion of a flight of an aircraft.

Flight progress strip Strip used for the display of flight data on a flight progress board.

Flow control Measures designed to adjust the flow of traffic into a given airspace, along a given route, or bound for a given aerodrome, so as to ensure the most effective utilisation of the airspace.

Heading The direction in which the longitudinal axis of an aircraft is pointed, usually expressed in degrees form North (true, magnetic, compass or grid).

IFR The symbol used to designate the instrument flight rules.

IFR flight A flight conducted in accordance with the instrument flight rules.

IMC The symbol used to designate instrument meteorological conditions.

Instrument flight rules A set of rules governing the conduct of flight under instrument meteorological conditions.

Instrument meteorological conditions (IMC) Meteorological conditions expressed in terms of visibility, distance from cloud, and ceilings, less than the minima specified for visual meteorological conditions.

Lateral separation Separation between aircraft expressed on terms of distance or angular displacement between tracks.

Longitudinal separation Separation between aircraft expressed in units of time or distance along track. **Recommended Practice** Any specification for physical characteristics, configuration, materiel, performance, personnel or procedure, the uniform application of which is recognised as desirable in the interests of safety, regularity or efficiency of international air navigation, and t which Contracting States will endeavour to conform in accordance with the Convention (ICAO, Annex 11, 10th edition, p.vi).

Reporting point A specified geographical location in relation to which the position of an aircraft can be reported.

Required navigation performance (RNP) A statement of navigation performance accuracy necessary for operation within a defined airspace.

RNP type A containment value expressed as a distance nautical miles from the intended position within which flights would be for at least 95 per cent of the total flying time.

Runway A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Secondary radar A radar system wherein a radio signal transmitted from the radar station initiates the transmission of a radio signal from another station.

Secondary surveillance radar (SSR) A system of secondary radar using ground transmitters/receivers (interrogators) and airborne transponders conforming to specifications developed by ICAO.

Significant point A specified geographical location used in defining an ATS route or the flight path of an aircraft and for other navigation and ATS purposes.

Standard Any specification for physical characteristics, configuration, materiel, performance, personnel or procedure, the uniform application of which is recognised as necessary for the safety or regularity of international air navigation and to which Contracting States will conform in accordance with the Convention; in the event of impossibility of compliance, notification to the Council is compulsory under Article 38 (ICAO, Annex 11, 10th edition, p.vi).

Standard Arrival Route (STAR) are standard ATS routes identified in an approach procedure by which aircraft should proceed from the en-route phase to an initial approach fix.

Standard Instrument Departure Route (SID) are standard ATS routes identified in an instrument departure procedure by which aircraft should proceed form take-off phase to the en-route phase.

Terminal control area A control area normally established at the confluence of ATS routes in the vicinity of one or more major aerodromes.

Track The projection on the earth's surface of the path of an aircraft, the direction of which path at any point is usually expressed in degrees from North (true, magnetic or grid).

Traffic information Information issued by an air traffic services unit to alert a pilot to other known or observed air traffic which may be in proximity to the position or intended route of flight and to help the pilot avoid a collision.

Transfer of control point A defined point along the flight path of an aircraft, at which the responsibility for providing air traffic control service to the aircraft is transferred from one control unit or control position to the next.

Transferring unit Air traffic control unit in the process of transferring the responsibility for providing air traffic control service to an aircraft to the next air traffic control unit along the route of flight.

Transponder A receiver/transmitter which will generate a reply signal upon proper interrogation; the interrogation and reply being on different frequencies.

VFR The symbol used to designate the visual flight rules.

VFR flight A flight conducted in accordance with the visual flight rules.

Way-point A specified geographical location used to define an area navigation route or the flight path of an aircraft employing area navigation.

ABBREVIATIONS

ACC	area control centre or area control
ADF	automatic direction-finder
AERA	automated en route air traffic control
AFI	African-Indian Ocean Region
AFIS	aerodrome flight information service
AFTN	aeronautical fixed telecommunication network
AIP	aeronautical information publication
AIS	aeronautical information service
APP	approach control
ATC	air traffic control
ATCO	Air Traffic Controller
ATFM	air traffic flow management
ATIS	automatic terminal information service
ATM	air traffic management
ATS	air traffic services
ATSPM	Air Traffic Services Planning Manual
CNS	communication, navigation and surveillance
COM	communications
CTA	control area
DCA	directorate of civil aviation
DCA/ATS	ATS department of DCA
DCA/HQ	Headquarters of DCA
DF	direction finder
DFS	Deutsche Flugsicherung GmbH.
DIA	Dar es Salaam International Airport
DIA/ACC	ATC center of DIA
DME	distance measuring equipment
DVOR	Doppler VHF omni-directional range (VOR)
EDP	electronic data processing
ETA	estimated time of arrival
EUR	European Region
FAA	Federal Aviation Administration (US)
FANS	future air navigation systems
FIC	flight information centre
FIR	flight information region
FIS	flight information service
FL	flight level
FPL	filed flight plan
FPS	flight progress strip
FSS	flight surveillance system
GA	general aviation
GMT	Greenwich Mean Time
GNSS	Global Navigation Satellite System
GPS	global positioning satellite
HF	high frequency
HQ	headquarters
IATA	International Air Transport Association
ICAO	International Civil Aviation Organisation
IFR	instrument flight rules
ILS	instrument landing system
IMC	instrument meteorological conditions
IMF	International Monetary Fund
INS	inertial navigation system
LVB	Luchtverkeersbeveiliging (Air Traffic Control, Holland)
MET	meteorology
NDB	non-directional beacon
PANS-RAC	Procedures for Air Navigation Services - Rules of the Air and Air Traffic Services
RLD	Rijksluchtvaart Dienst (civil aviation authority, Holland)
RNAV	area navigation
SADC	Southern African Developing Countries
SAR	search and rescue
SARPs	Standards and Recommended Practices
SID	standard instrument departure
SOE	state owned enterprise
STAR	standard (instrument) arrival route
TAR	terminal and approach radar
TAS	true airspeed
TMA	terminal control area

TWR	aerodrome control tower or aerodrome control
USATS	US Air Traffic Services corporation
VFR	visual flight rules
VHF	very high frequency
VMC	visual meteorological conditions
VOR	VHF omni-directional radio range
WB	Worldbank

INTRODUCTION

The Directorate of Civil Aviation (DCA) is regulating, controlling, facilitating and managing air traffic in Tanzania. The specific controlling functions of air traffic, the Air Traffic Control (ATC), are operated by the Air Traffic Services (ATS) department within DCA.

In the first half of 1995, DCA and the University of Technology of Eindhoven, the Netherlands, agreed on the execution of a research within the ATS department of DCA, to be performed by a student from Eindhoven. This report is the result of the research.
DCA indicated to experience problems in the management of the airspace. The formulation of the research area was placed within a very broad framework. Accordingly, the goal of the research was placed within a very broad framework: *to provide DCA with information about their major technological bottlenecks in the air traffic control environment and to recommend on possible solutions.*
Already in the initial phase of the field research period (from September 1995 to March 1996), it was clear that DCA was interested in a review of the implemented ATS Route Network.
To combine the goal of the research with DCA's desires, the research was divided into three major parts. The first part focuses on the review of the ATS route network in Tanzania. Problems encountered in this part were the inputs for the second part. The second part focuses on backgrounds of ATS Planning at DCA. The final part focuses on the best organisational change for DCA to bring market forces into the ATS organisation, and the effects such a change would have. Special attention was given to the problem areas that were determined in the second part of the research.

This report finds that, based on the results of a pre-liminary airspace usage analysis, the structure of the ATS Route Network does not differ much from the operational situation. The analysis of the ATS route review process revealed more fundamental problems, that initiated practical problems, as ATS Planning problems. Directly initiating ATS Planning problems was the absence of a functional information management system for operational data. Organisational problems caused the absence of an information system. The final part of the report focuses on possible organisational changes of DCA. In the 1980s, the Tanzanian government adopted plans for government owned companies to introduce market forces into the organisation. An autonomisation of DCA from government control is expected to have a positive effect on the functioning of DCA, and on relevant aspects related to information management.

Chapter 1

RESEARCH FRAMEWORK

The Directorate of Civil Aviation (DCA) of the United Republic of Tanzania made clear that it had problems regarding the management and organisation of the Tanzanian airspace. In a collaboration program with the University of Technology of Eindhoven, the Netherlands, an investigation was conducted, focusing on the technological problems related to the management and organisation of Tanzanian airspace.

1.1 Problem setting

The problem definition prior to the execution of the field research was not very clear and accompanied by scanty information. DCA indicated to have problems concerning the operation of the airspace. A preliminary research proposal was written to concentrate on operational Air Traffic Control (ATC) problems. On arrival this proposal proved to be not appropriate for the field research. The initial idea was to compare two different Air Traffic Control environments: the Dutch and the Tanzanian. These environments were to be compared by productivity measurements classifying the relevant ATC variables according to the Technology, Human resources, Information and Organisation (THIO model). The Dutch ATC organisation would serve as a benchmark organisation. Differences between the two organisations would lead to an identification of technological bottlenecks in the Tanzanian ATC organisation.

Already in the beginning of the field research in Tanzania it became apparent that a sound scientific comparison of the Dutch and the Tanzanian ATC environment would be very difficult. Not in the sense that this would not be possible, but a technological productivity study of a technology complex as the Tanzanian ATC, using a fundamentally different technology complex compared to the Dutch ATC environment as a benchmark organisation, would not be a defensible scientific action.
The reason being that the Dutch ATC uses radar control to reach their goals, while the Tanzanian ATC uses procedure control. It is not a question of the two organisations having different goals, especially not technological ones. ATC goals are standardised by the International Civil Aviation Organisation (ICAO). Both the Tanzanian as the Dutch ATC organisation use these goals as standard.
Figure 1 presents the Dutch and Tanzanian ATC approaches graphically.

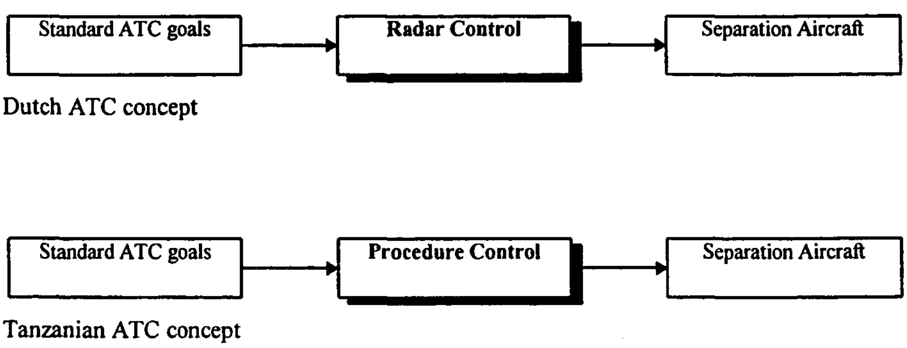


Figure 1: The Dutch and Tanzanian ATC concepts

Since the operational aspects of the technology complexes are basically different, a comparative technological productivity study, measuring performance or productivity, would be of little relevance. Using the Dutch organisation as a benchmark ATC organisation, this study would lead to the conclusion that the Tanzanian ATC organisation should use radar control to eliminate the technological bottlenecks identified. Especially since the study would be based on productivity measurements. Without any doubt, radar control is more productive, in terms of the air traffic controller's capacity of controlling aircraft safely, than procedure control.
Therefore, a different approach for the identification of technological bottlenecks in the technology complex was chosen.

The Directorate of Civil Aviation (DCA) itself identified some technological bottlenecks. These bottlenecks were of a practical nature and more of a technique than technology nature. However, the DCA preferred to see the research focused on these issues and this became a major factor in the choice of the new research approach.

The first part of the research focuses on the technical bottlenecks DCA had identified in a number of unstructured personnel (individual and group) interviews. From these interviews a major bottleneck was identified and the focus will be on this bottleneck in the first part of the technological section of the research report.
The problems encountered while concentrating on this major bottleneck, are the inputs for the second part of the technological section of the research. These inputs are the technological bottlenecks of the technology complex of the Tanzanian ATC organisation.
Finally, the coming change of DCA's organisation will be discussed specifically in relation to the major technological bottleneck identified.

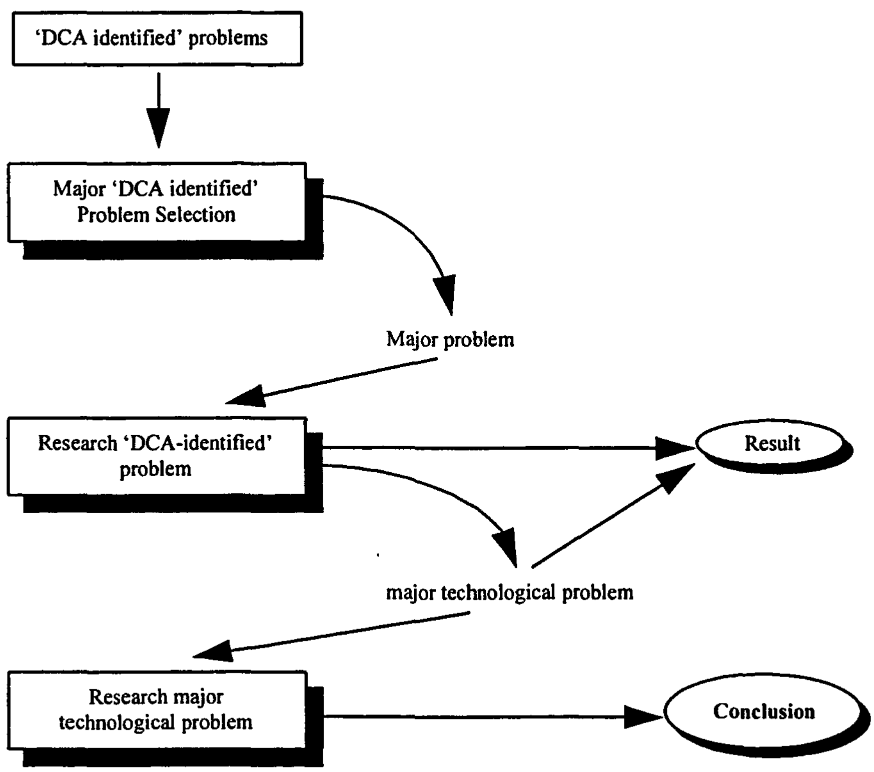


Figure 1: Basic research methodology

Imbalance in operational and implemented air traffic characteristics

From the interviews with DCA personnel it became clear that DCA experienced major problems in designing an appropriate airroute plan satisfying Tanzanian and international needs. This problem has been identified as the major 'DCA-identified' bottleneck to be studied in the initial stages of the research.

Backgrounds of imbalances in operational and implemented air traffic characteristics

Usually, in case of a number of technological bottlenecks, a classification technique is applied to identity the major one. Such classification techniques could be omitted, because one single technological bottleneck was identified.

The main problem in the initialy stages of the study was that hardly any data about the usage of the Tanzanian airspace were available. This lack of data made it impossible to design an air-route network that would serve national, international and user's (airliners) demands. At the same time, DCA employees seemed very knowledgable about the design of a route network, yet they claimed that operational and implemented use of Tanzanian airspace was diverging and should be reviewed. How is it possible that these differences exist between qualified employees of one organisation?

Methodologically, this lack of data, causing differences in operational and implemented situations, could be seen as a major technological bottleneck within DCA. Consequently, the second part of the technological section of the report is about the backgrounds of the differences in DCA's operational and implemented ATS route network situation.

DCA's changing organisation

July 1st, 1996, DCA is planned to become an autonomous government agency. This change is part of a Tanzanian government policy to autonomize government controlled organizations in order to have these organisations operate more efficiently and effective.

The backgrounds of the imbalance in the operational and implemented ATS route characteristics are related to operational characteristics of the DCA organisation. A change in DCA's organisation could also have effects on the technological bottleneck identified in the first section of this report. Other recent autonomised Air Traffic Services organisations already reported the impact the change of organisation had on the operational technological status.

The impact of a change of the DCA organisation is discussed in the final part of the report.

1.2 Research goals and questions

The original research goal was never abandonned. *This goal was to provide DCA with information about their major technological bottlenecks in the air traffic control environment and to recommend on possible solutions.*

All research questions have been formulated to finally reach this goal.

Basically, there is one major research question:

What is the major technological bottleneck of the Directorate of Civil Aviation (DCA) in Tanzania and how must DCA handle this bottleneck now and in the future?

1.2.1 Research sub-goals and sub-questions

The main question is divided into 3 parts, thus combining the original research goal with DCA desires. The first sub-question with a goal *to identify the major bottlenecks*, the second sub-question with the goal *to study the backgrounds of this major bottleneck* and the third sub-question *to view this major technological bottleneck in the light of future organisational changes.*

1.2.1.1 Sub-Research question 1

What are the differences between the status of the Air Traffic Services (ATS) route network of Tanzania and the operational air traffic characteristics and how should the ATS route network be adjusted to meet the present operational air traffic characteristics?

- What are the International Standards and Recommendations of the ICAO regarding the airspace and route structuring?
- What is the present situation of the airspace and routes as implemented in Tanzania?
- What is the operational air traffic use of airways in Tanzania?
- What are the differences between the implemented situation and the actual operational situation?
- Which methods of route structuring can be identified?
- Which method(s) is (are) appropriate for the situation of Tanzania?
- What results do the application of the(se) method(s) have?
- What future development for the air traffic can be predicted?

1.2.1.2 Sub-Research question 2

Why does a difference exist between the status of the ATS route network as implemented and the operational air traffic characteristics and how can this difference be rectified?

- Which information is necessary to rationally review or monitor the ATS route network operational use?
- How should the information be processed in order to be able to adequately monitor the ATS route network operational use?
- How should communication between researchers and planners and operational staff members be managed in order to control monitoring of route usage?
- What is the present situation within DCA regarding the review of ATS network?
- Which differences exist between the present situation and the implemented situation?
- What origins do these differences have?

1.2.1.3 Sub-Research question 3

What impact would a change of DCA's organization towards a more market orientated approach have on the ATS technology in general and on the presented technological bottleneck specifically?

- What are the experiences of other ATS corporations on this subject?
- Which are the ways of privatizing?
- What are ICAO guidelines for commercialisation of ATS corporations?
- What is the DCA/ATS technology?
- How will this ATS technology develop?

- Which organisational factors are important for technology development?
- How are these organisational factors under the present situation (or under the situation of 5 years ago)?
- What is expected of these organisational factors in the new situation?

1.3 Methodology

1.3.1 Methodology 1

The methodology basically reflects the subquestions of the previous sections.

1. Study of relevant ICAO documents regarding ATS.
2. Study of airspace and route structure of Tanzania.
    - Data collection about usage of routes

    This will be done by first determining a statistical appropriate week by means of the information noted in the Area Control Centre (ACC) logbooks. Then, by means of Flight Progress Strips, the present operational routes will be determined.
3. Comparison of usage and present situation of route structure.
4. Identification of differences or identification of areas that need adjustment.
5. Identification of methods for airspace and route structuring, by means of ICAO documents.
6. Application of appropriate methods for the situation of Tanzania.
7. Recommendations for ATS Route Network.

1.3.2 Methodology 2

1. Study of ICAO literature about planning and organisation of ATS.
2. Study the data processing methods of the "LuchtVerkeers Beveiliging" in Holland.
3. Study literature about information management.
4. Identification of the availability of processed data within DCA and information management structures by means of unstructured personal interviews with the staff of ATS and Planning & Research Department.
5. Determination of imbalances causing the differences in implemented situation and the operating situation.

1.3.3 Methodology 3

1. Study, by means of a number of articles, the experiences of other ATS corporations.
   Additionally, the process of becoming autonomous of the ATS organisation in Holland will be studied by unstructured personal interviews.
2. The World Bank has submitted a report about privatising State Owned Enterprises (SOEs). This report will serve as a theoretical framework on privatization of SOEs.
3. Literature study of ICAO documents about guidelines for commercialising of ATS companies.
4. The DCA technology is already determined in the previous research.
5. The future development of DCA will be discussed with directors of DCA in unstructured personal interviews.
6. Based on the interviews and the literature study some focus point will be determined and studied.

7. Based on aquired knowledge from above mentioned studies and from sub-research question 2, a relation between discussed DCA-technology and future organisational status will be discussed.

Figure 3 provides a schematical lay-out of the research.

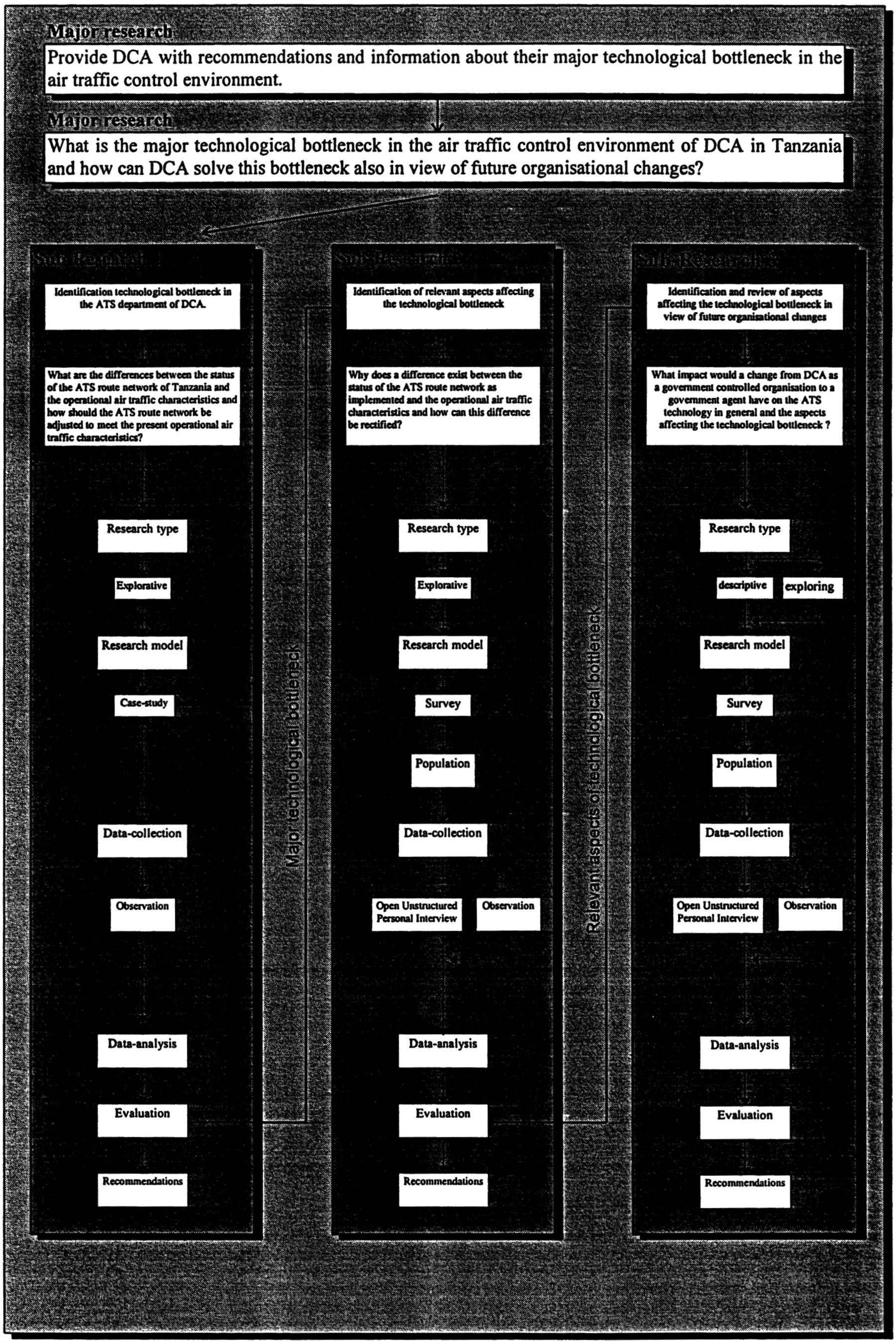


Figure 3: Lay-out of the research

1.4 Chapter contents

Chapter 2

Chapter 2 deals with the differences between status of ATS route network and operational air traffic characteristics in Tanzania.

Initially, an overview is given of the international standards and recommendations with respect to airspace organisation and ATC environment as presented by the ICAO. Next, these standards and recommendations are specified for ATS routes. After this, the Tanzanian operational air traffic characteristics and the implemented ATS environment are described as well as a major data-collection problem during the field research. Chapter 2 concludes with a planner's tool to collect and process route usage data to be able to more easily review route networks.

Chapter 3

The background of the difference between the implemented and the operational situation, specifically concerning the route network of airways in Tanzania, is analysis. Focus was on information management at DCA.

An overview is given of how a standard ATS planners' organisation operates, how information flows are situated in organisations and where possible improvements are necessary to develop an information system. Against this background, the Tanzanian ATS department situation is reflected, resulting in conclusions and recommendations to be used by DCA to improve its information capacity.

Chapter 4

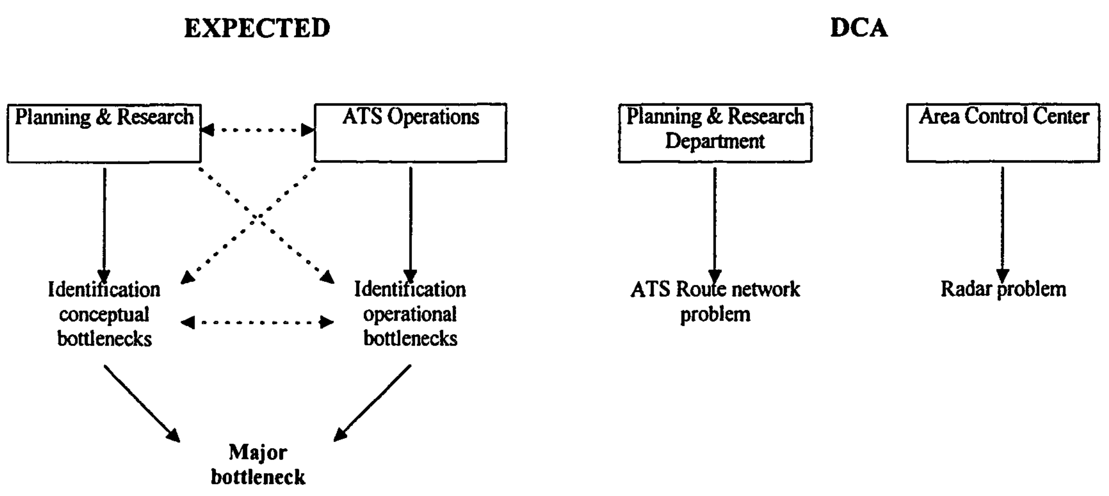
Organisational problems of DCA affecting the management of information, will be influenced by present organisational changes of DCA. The effects such organisational changes can have on the research & planning activity of DCA are discussed, based on literature on privatisation of the Worldbank, on ICAO literature about autonomisation of ATC and airport departments and on the commercialisation of four other ATC organisations.

Chapter 2

DIFFERENCES BETWEEN STATUS OF ATS ROUTE NETWORK AND OPERATIONAL AIR TRAFFIC CHARACTERISTICS IN TANZANIA.

2.1 Introduction

Identification of the major technical bottleneck in the ATS organisation was done by structural personal and group interviews with DCA/ATS staff attached to the Planning & Research Department and the ATS Department. Respondents were asked to identify the major technological bottleneck in their direct working environment and the one which they believed would be identified in the ATS environment. The outcomes showed that each respondent identified the same bottleneck for both personal and ATS working environment. The respondents at DCA Headquarters (DCA/HQ) all identified the same bottleneck, i.e. the difference in implemented and operational ATS route network characteristics. The respondents at Dar es Salaam International Airport (DIA) also identified one single bottleneck, i.e. the non-serviceable status of the terminal and approach radar (TAR).



Different from what could be expected, ATS staff at DCA/HQ and operations at DIA appeared to have no communication about ATS problems. Inside these two groups communication about ATS problems was lively. Both groups viewed problems on ATS from their own paradigm.

2.1.1 ATS Route Network problem

The people concerned with the research and planning of ATS, i.e. the Planning & Research staff and the ATS staff personnel at DCA/HQ, identified the status of the route network of airways in Tanzania

as a major technological problem. The existing route network has not been reviewed for many years and the routes presently used or requested by the users do not correspond to the network that aerial navigation maps suggest. Additionally, the size of the Terminal Area (TMA) of DIA does not meet the Recommendation as put forward by the ICAO. An international airport is recommended to provide approach control (APP) on ATS routes within 150 NM of the airport. APP-DIA does not meet this recommendation on some of the route segments. The ICAO has notified DCA on this shortcoming only recently during a regional meeting (African/Indian Ocean Regional Air Navigation Meeting) and DCA is expected to work on these problems. Appendix A presents the problems identified by the planning and research staff of DCA/ATS.
Continuation of these shortcomings could result in negative reports from ICAO about the ATS route network status in Tanzania, causing airliners to avoid Tanzania.

2.1.2 Non-Serviceable status of the Terminal and Approach Radar

For 2 years the Terminal Approach Radar (TAR) of DIA is not operative. The operational ATS unit at DIA identified the unserviceable status of the radar as the major technological problem of the organisation. Still, they controlled air traffic sufficiently with the limited means available. This is mainly possible because of low air traffic demand in Tanzania. In the follow-up unstructured personal interviews, controllers themselves admitted that they not necessarily need a radar at this moment but that it would help them in improving the quality of ATC to air traffic in Tanzania. Based on several observations during the busiest hours of air traffic, it can be said that quality of ATC during the field research was good.

2.1.3 Identification of major 'DCA-identified' problem

Based on this identification of problems, the research will concentrate on the major problem of the DCA/ATS department at this moment: the route network problem. The non-serviceable status of a radar could be a problem in the future when air traffic would increase, but is not a problem at present.

As every technology complex is under constant development, the ATS route network's operational use is also under constant development. Therefore, the ATS route network's operational use should be adequately monitored to be able to keep the implemented ATS route network up-to-date and prepared for future developments. An out-dated ATS route network could initiate unsafe situations. Operators might choose to avoid Tanzania, leaving Tanzania with a decline of an important economic activity.

2.2 The Standard International ATC Environment

The Civil Aviation industry is highly internationally orientated. In many cases aviation industry does not even start at national level (let alone at regional level) but immediately emerges from an international environment. As a result of the international character, policy makers felt the need for a standardisation of procedures, definitions, goals, means, etc. This would not only improve effectiveness and efficiency of necessary international co-operation but would above all improve safety of aviation operations.
Immediately after the second world war a Provisional International Civil Aviation Organisation (PICAO) was founded which by the Convention of Chicago of 1949 became the International Civil

Aviation Organisation (ICAO). This organisation, which contains almost all countries of the world as Contracting States, standardised much of the aviation activities either by means of International Standards or by Recommendations (see definitions). The following chapter gives an outline of how the ATC environment has been standardised and how the area in which ATC operates is defined and established. This information is mainly taken over from Annex 11, 10th edition of the ICAO and from the Air Traffic Services Planning Manual, first (Provisional) edition 1984, Doc 9426-AN/924 of the ICAO.

2.2.1 Objectives of the Air Traffic Services[1]

The objectives of the air traffic services shall be to:

a) prevent collisions between aircraft;

b) prevent collisions between aircraft on the manoeuvring area and obstructions on that area;

c) expedite and maintain an orderly flow of air traffic;

d) provide advice and information useful for the safe and efficient conduct of flights;

e) notify appropriate organisations regarding aircraft in need of search and rescue aid, and assist such organisations as required.

2.2.2 Division of the Air Traffic Services

The air traffic control services, to accomplish the objectives of ATS, are divided in three parts:

a) *Area control service*: the provision of air traffic control service for controlled flights, except for those parts of such flights as described in sub-parts b and c.

b) *Approach control service*: the provision of air traffic control service for those parts of controlled flights associated with arrival or departure.

c) *Aerodrome control service*: the provision of air traffic control service from aerodrome traffic, except for those parts of flight described in sub-parts a and b.

2.2.3 Structure of the Airspace

Ideally, the organisation of the airspace over a given area should be arranged so that it corresponds to operational and technical considerations only. This is a concept which, in view of the many divergent and sometimes contradicting demands made on its use can, however, never be achieved other than by approximation of a more or less satisfactory nature[2].

2.2.3.1 Designation of the portions of the airspace and controlled aerodromes where Air Traffic Services will be provided

When it has been determined that ATS will be provided in particular portions of the airspace or at particular aerodromes, then those portions of the airspace or those aerodromes shall be designated in relation to the ATS that are to be provided.

[1] ICAO, *Annex 11* (10^{th} edition, Montreal, p.6-7)

[2] ICAO, *Air Traffic Services Planning Manual* (Doc 9426 AN924, Montreal, 1984)

The designation of the particular portions of the airspace or the particular aerodromes shall be as follows:

Flight Information Regions.

Those portions of the airspace where it is determined that flight information service and alerting service will be provided shall be designated as flight information regions.

Control areas and control zones.

Those portions of the airspace where it is determined that air traffic control service will be provided to IFR flights shall be designated as control areas or control zones.

Controlled aerodromes.

Those aerodromes where it is determined that air traffic control service will be provided to aerodrome traffic shall be designated as controlled aerodromes.

2.2.3.2 Specification for flight information regions, control areas and control zones

The ICAO recommends that the delineation of airspace wherein ATS are to be provided, should be related to the nature of the route structure and the need for efficient service rather that to national boundaries. Flight information regions (FIRs) shall be delineated to cover the whole of the air route structure to be served by such regions. A FIR shall include all airspace within its lateral limits, except as limited by an upper flight information region. Control areas (CTAs) and control zones are those portions of the airspace where it is determined that ATC service will be provided to IFR flights[3]. Control areas including, inter alia, airways and terminal control areas, shall be delineated so as to encompass sufficient airspace to contain the flight paths of those IFR flights or portions thereof to which it is desired to provide the applicable parts of the ATC service, taking into account the capabilities of the navigation aids normally used in that area. The lower limit of a control area is established at a height above the ground or water of not less that 200m (700ft). It is desirable to have the lower limit of a control area established at a greater height to improve the freedom of action of VFR flights. When ATS is not provided above a specific height or when the control area is situated below an upper control area, an upper limit should be established.

The lateral limits of control zones must encompass at least those portions of the airspace, which are not within control areas, containing the paths of IFR flights arriving at and departing from aerodromes to be used under Instrument Meteorological Conditions (IMC). Additionally, the lateral limits of a control zone shall extend to at least 9.3 km (5 nm) from the centre if the aerodrome or aerodrome concerned in the directions from which approaches may be made. Within the lateral limits of a control area, a control zone shall extend upwards from the surface of the earth to at least the lower limit of the control area.

Controlled aerodrome lateral limits shall coincide with the physical limits of the aerodrome area. Traffic on the surface of the aerodrome is controlled. A control zone is entered as soon as aircraft lift off from the surface.

2.2.3.3 Airspace classes

The ICAO has classified airspace into 7 different classes. Basically, classes are identified by the VFR and/or IFR flights allowed and the ATS provided to them. The class A airspace is the most restricted airspace in which positive separation is applied by ATC. This means that only IFR flights are permitted, all flights are subject to ATC service and are separated from each other. The lowest class,

[3] ICAO, *Annex 11* (10^{th} edition, Montreal, p.7)

the class G airspace, permits IFR and VFR flights and aircraft receive flight information service if requested. Appendix B presents an overview of the different classes.

2.2.4 ATS Routes

2.2.4.1 Establishment and identification of ATS routes

Ideally, aircraft want to fly on the most direct route between their points of departure and their destination because the medium in which aircraft operate makes this possible, except when severe weather phenomena are encountered. However, because of the many conflicting demands made on the use of airspace by its many different users and because of environmental and security considerations, it is necessary to find a reasonable compromise between this desirable objective and reality.
In short, large amounts of air traffic are generally only manageable if they follow pre-established patterns which are arranged not only to facilitate the detection of possible conflicting intentions at an early stage, but which also lend themselves to resolution of such conflicts. At the same time, these pre-established patterns must also provide for the retention of the most direct routes for the majority of air traffic, if they are not to conflict with the need for economy and efficiency of flight operations. Experience gained in areas where large amounts of air traffic are handled has shown that the most satisfactory manner to meet the general considerations mentioned above is by way of an ATS route network[4].

The establishment of a detailed ATS route network can follow two distinct patterns depending on the composition of the air traffic it is intended to serve. In those cases where national operations constitute the bulk of the traffic which is to be accommodated, States should give priority to satisfying these needs. However, adequate arrangements should be made to meet the needs of international operations through appropriate trunk routes and development of these trunk routes must be co-ordinated on at least a regional basis. Where international operations constitute the majority of the traffic, establishment of an ATS route network needs to be undertaken from the outset on at least a regional basis.

2.2.4.2 ICAO methodology for establishment of an ATS route network[5]

The establishment of an actual ATS route network follows, in most cases, the approximate pattern outlined below:

a) operators identify their actual and anticipated requirements for routes between those aerodromes which they use;

b) the sometimes widely diverging demands of individual operators are then consolidated into a reasonably coherent pattern of route requirements;

c) these requirements are then measured against other demands made on the airspace traversed by these routes (military areas, avoidance of overflying sensitive installations on the ground, etc.) and alternative proposals for the exact alignment of individual routes are developed;

[4]ICAO, *ATS Planning Manual* (Doc9426 AN924, Montreal, 1984, p.I-2-4-1)

[5]ICAO, *ATS Planning Manual* (Doc9426 AN 924, Montreal, 1984, p.I-2-4-2)

d) these alternatives are then presented to and negotiated with the operators concerned until a reasonable compromise is achieved;

e) in the comparatively few cases where the offers which can be made to operators are found to be unacceptable, it should be agreed that the original requirement should be retained for further consideration by all parties concerned until such time as more favourable circumstances permit an alignment which comes reasonably close to that requested by operators.

Specifically, the detailed establishment or review of individual ATS routes, forming the ATS route network, should proceed along the following lines:

a) first establish or review the main trunk routes, serving the major traffic flow within a given area as well as those extending beyond that area;

b) establish or review those routes required to provide access to these trunk routes from and to locations not directly served by them;

c) establish or review those supplementary routes required to accommodate secondary traffic flows or which are required to alleviate the traffic load on the major trunk routes;

d) establish or review those routes of a more local nature which are required to satisfy either specific national needs or those of a specific user group (e.g. helicopter routes, VFR routes, military low-level routes, night flying. etc.) and determine if these local routes need to be integrated into the over-all route network.

Once the route network has been established or reviewed in accordance with the above, the detailed ATS route network should be reviewed as a whole to evaluate its coherence.

After the alignment and status of the ATS routes have been established or reviewed, it will be necessary to determine the use of flight levels on each of those routes which are to be established as controlled ATS routes. To this extend a series of flights levels are prescribed (normally "ODD" and "EVEN") which should be used in relation to the direction of flight on the route concerned. The principles governing such arrangements of flight levels include the following considerations:

a) the majority of air traffic operating along a controlled ATS route or portion thereof, should while in level flight, be permitted to remain at its assigned flight level without a need for changing levels simply because the orientation of the route in relation to compass direction changes;

b) at intersections of more than two controlled ATS routes, the likelihood that aircraft, operating on any of these routes and approaching the intersection, find themselves at the same level is kept to a minimum, thus avoiding the need for systematic control interventions in order to restore adequate separation between them.

2.2.4.3 Establishment of significant points

Significant points along ATS routes and/or terminal control areas (TMAs) are normally established at those geographical locations where an event in the conduct of a flight takes place which is either significant to the pilot or to ATS or to both, i.e. a change in the alignment of an ATS route or of a routing in a TMA, and intersection of the centre lines of two or more ATS routes, a transfer of control point, etc. In many cases such points are also marked by the site of a ground-based radio aid to navigation or with reference to navigational guidance derived from one or more such aids (intersection of two radials from different VORs or a point on a VOR radial determined by its distance from that VOR by means of the associated DME). In other cases, such points are established by reference to geographical co-ordinates only and navigation to and from these points will be made by reference to area coverage-type navigation aids (e.g. OMEGA) or by the use of self-contained navigation means (e.g. INS). In this case they are frequently referred to as "waypoints".

2.2.4.4 Alignment of ATS routes

The alignment of ATS routes and their integration into a coherent ATS route network is largely determined by the demands made on the use of airspace by its different users. However, national security, environmental and other considerations also play a part in determining the alignment of ATS routes. There is, therefore, a need to ensure that routes so established can be followed by aircraft under all conditions and that for this reason, suitable navigational guidance defining the centre lines of each of the established routes needs to be provided.

For areas over land and for comparatively short routes, such navigation guidance should be provided by ground-based, point source navigation aids. ICAO has established a policy that, wherever possible, the aid chosen should be a VOR, supplemented by a DME[6].

2.3 The Tanzanian ATS Environment

2.3.1 Introduction

Tanzania lies just south of the equator between the great lakes Victoria, Tanganyika, and Nyasa on one side and the Indian Ocean on the other (roughly between S002° and S011° latitude and E030° and E040° longitude). Tanzania has frontiers with the following countries: Kenya, Uganda, Rwanda, Burundi, Zaire, Malawi and Mozambique. Its area, including approximately 60,000 square kilometres of inland water, is about 945,000 square kilometres. This is about the same size as Nigeria and a little smaller than France and Spain combined. Except for a narrow belt along the 900 kilometres coast, most of its land lies above 200 m. altitude, and much of the country is higher than 1000 m. above sea level. In the north Mt. Kilimanjaro, with a permanent ice cap, rises to over 5,500 metres, with the highest peak Kibo reaching 5,895 metres (19,400 ft.)[7].

The United Republic of Tanzania is one of the Contracting States of the ICAO. This means that Tanzania organises its civil aviation activities according to the International Standards (IS) and recommendations of the ICAO.
The ATS environment in Tanzania is organised conform the IS and Recommendations of the ICAO. This means that, in principle, the information of the previous paragraphs regarding the International Standard ATS environment is applicable to the situation of ATS in Tanzania.

[6] ICAO, *Air Traffic Services Planning Manual* (Doc 9426 AN 924, Montreal, 1984, p.III-1-2-2)

[7] Bureau of Statistics, *Statistical abstract: 1993* (President's Office, Planning Commission, Dar-es-Salaam, February 1995)

2.3.2 Tanzanian Airspace Structure

The airspace of Tanzania, including adjacent international waters, comprises one Flight Information Region, the Dar es Salaam FIR (see Figure). This FIR is divided into a lower part from groundlevel up to 24,500 feet, or better, up to FL245, and an upper part above FL245. The upper airspace of Ruanda and Burundi, respectively in the Kigali FIR and the Bujumbura FIR, are also controlled by Tanzanian ATC. The lower parts of these FIRs are controlled by respectively Ruandanese and Burundi authorities.

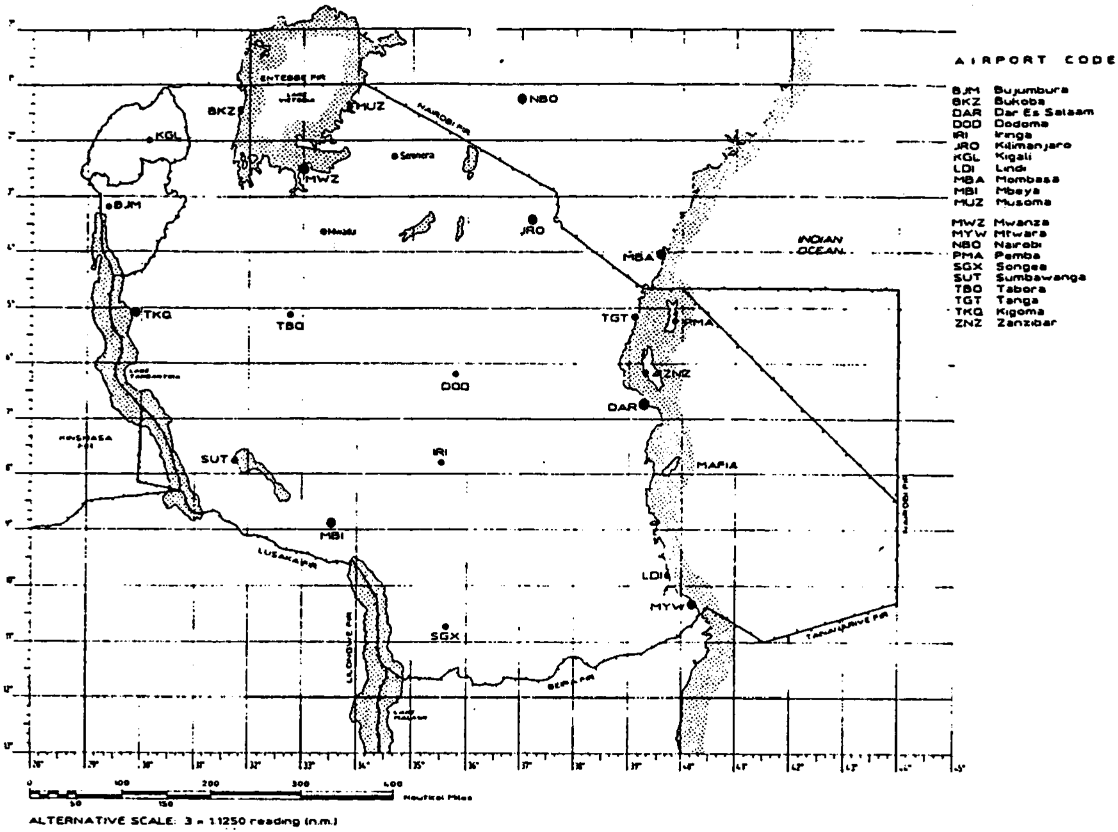


Figure 4: The Dar es Salaam FIR (Source: Civil Aviation Master Plan 1992)

2.3.3 Airspace Classification

The upper airspace of the Dar es Salaam FIR is class A airspace; every aircraft is positively separated from another by ATC. This means that VFR flights are not allowed to operate above FL245.

Below FL245, the lower airspace, is class G airspace in general and class D in control zones and TMAs (see app B). Class G airspace is uncontrolled airspace within which ATC separation services will not be provided to any aircraft, whether IFR or VFR. The regulations for flight in uncontrolled airspace are quite specific and place the burden of separation on the pilot[8].

In class D airspace IFR flights are separated from other IFR flights and VFR flights are permitted to operate in the airspace as long as the basic VFR weather minima, described in FAR part 91 of the ICAO, exist.

[8]Micheal S. Nolan, *Fundamentals of air traffic control* (Wadsworth Publishing Company, Belmont, California, 1994)

2.3.4 Air Traffic Control

Except for APP and aerodrome (tower) ATC at each airport, the whole of ATS is provided at the area control centre in the Dar es Salaam ATC building (DAR ACC) located near the eastern edge of the extensive FIR.

2.3.5 Airspace Use

The Civil Aviation Master Plan of 1992 gave the following overview of airspace use. All these quantities are estimations. It is not exactly clear how much aircraft flew the air routes.
The first figure gives the present air route structure of Tanzania. The second presents the estimated use of the routes.

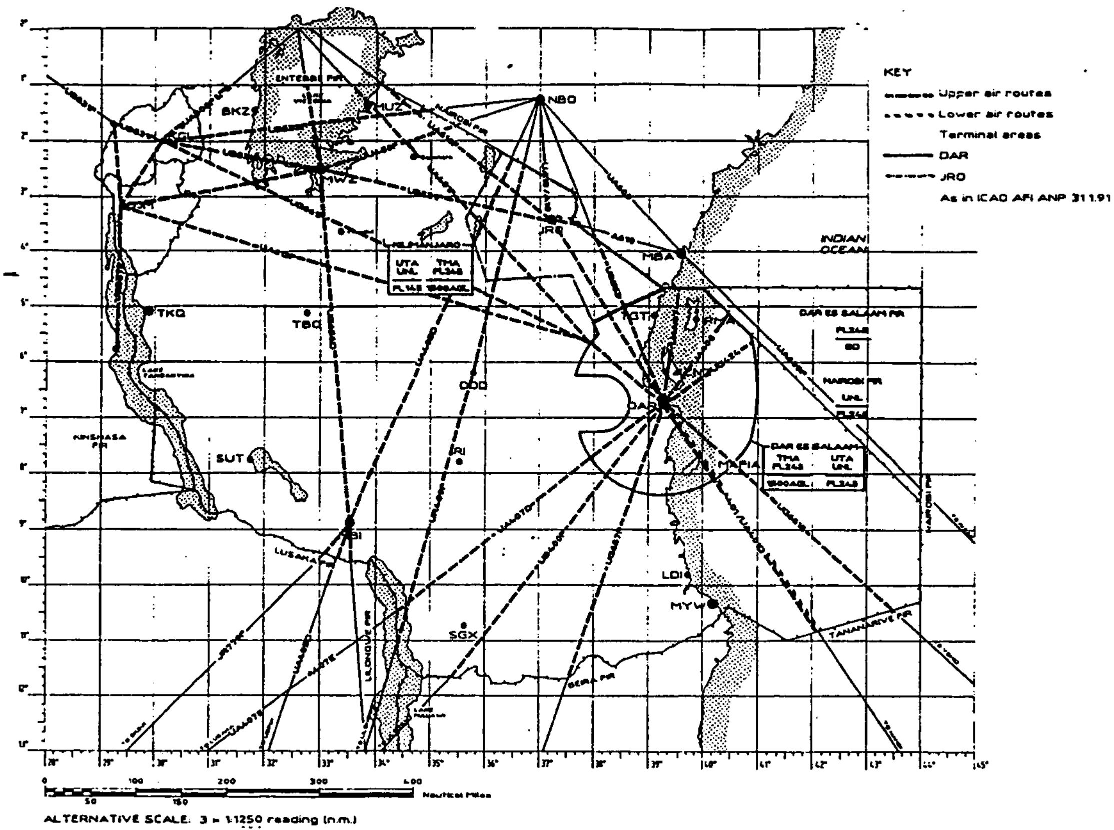


Figure 5: Upper and lower air routes in Dar es Salaam FIR (Source: Civil Aviation Master Plan)

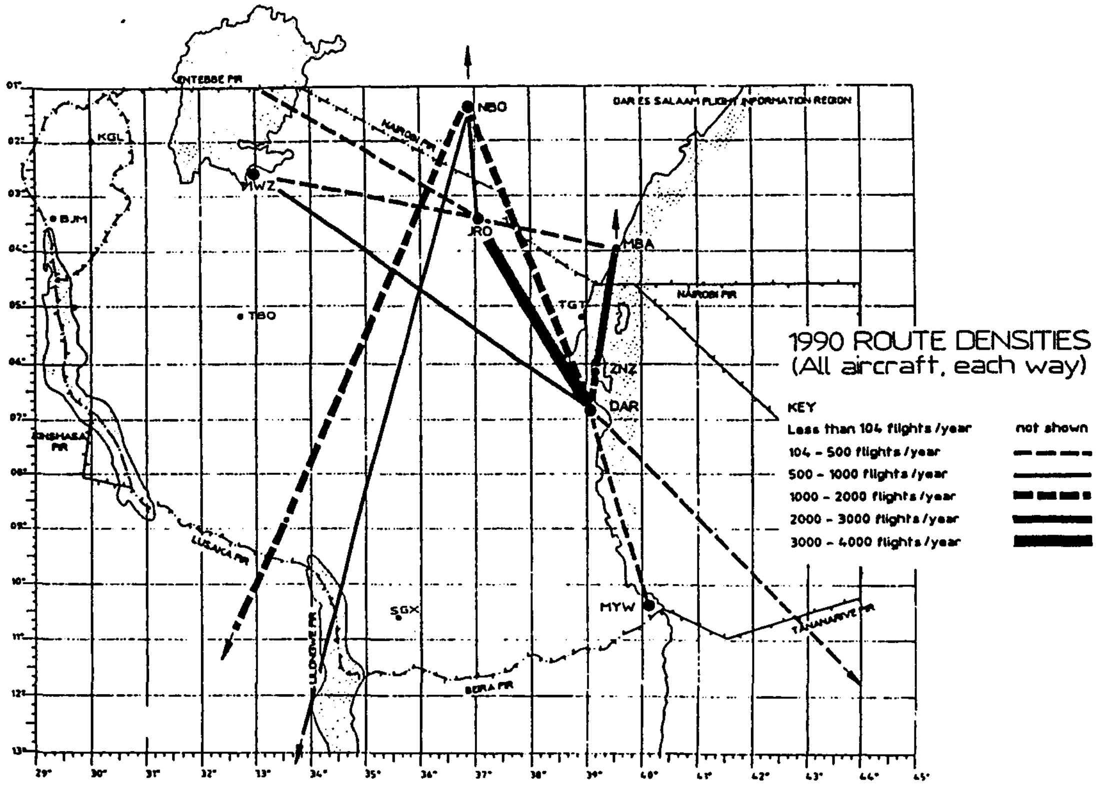


Figure 6: 1990 route densities, all aircraft, each way (Source: Civil Aviation Master Plan 1992)

2.3.6 ATS Routes

Basically, the ATS operational route network of airways of Tanzania does meet International Standards as set by the ICAO.

However, the ATS staff members at DCA/HQ are of opinion that the ATS route network status of Tanzania as implemented should be reviewed. Already for over 10 years the review of the route network has not been carried out.

In the international environment pressure is put on DCA by regional ICAO offices and by other civil aviation authorities to adjust or review the Tanzanian airspace structure to meet regional ICAO recommendations.

It is not only this pressure from the international environment exerted on DCA that moves DCA to the review of the airspace. Mainly the consciousness that a reviewance would lead to a greater transparency of the airspace structure and thus a more efficient control, moves DCA to review the Tanzanian airspace structure.

With reference to the establishment of a detailed route network in Tanzania it is noticed that traffic in Tanzania for a very large part (the majority) consists of international operations. This is especially the case for that traffic that flies under IFR rules in class A airspace. Therefore, Tanzania should make appropriate arrangements to meet the needs of the international operations through appropriate trunk routes. Establishment of an Tanzanian ATS route network needs to be undertaken from the outset on at least a regional basis.

2.4 ATS Route Reviewing

2.4.1 Methodology

As already mentioned, the ICAO presents a methodology for establishing or reviewing ATS routes. Airline operators identify their actual and anticipated requirements for routes between those aerodromes which they use. The Civil Aviation Authority, here DCA, then designs a route network as appropriate as possible for the airspace users and for Tanzanian airspace. This proposal will be presented to and negotiated with the operators concerned until a reasonable compromise is reached. Graphically, this methodology is:

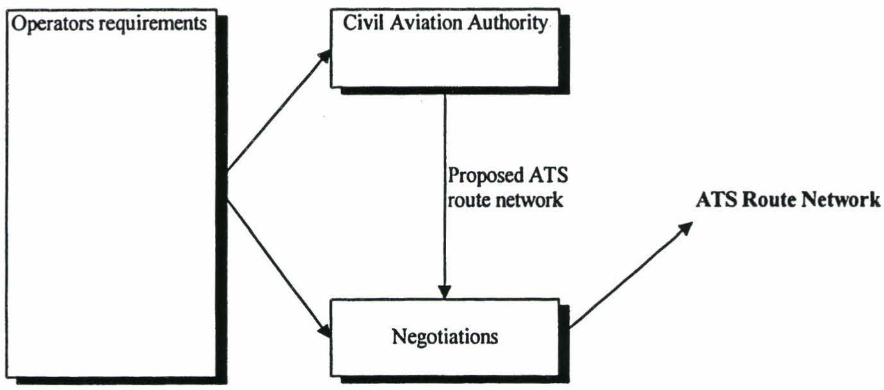


Figure 7: The ICAO methodology

The first point of the methodology is to identify the wishes of the operators. Within the timespan of this research it was not possible to visit all operators and collect data about their actual and anticipated requirements for routes.

Instead, since it was DCA who requested a route review, operators' requirements are assumed to be conform the operational situation to be studied. These data were obtained by consulting data already available at the ACC at DIA. The airports of departure and arrival used by operators are known to ACC-DIA and these data reflect the wishes of the operators, assuming operators wish to fly the most direct route between airports. In addition, ATCOs experiences anticipate and predict operators wishes very good.

Another methodology is the one from Eurocontrol in Beek, the Netherlands. Currently, Eurocontrol, which is controlling the upper airspace of a significant part of Europe, is studying the possibilities for a flexible use of airspace. In short, this means that through high-tech controlling systems, civil and military airspace can operate side by side without the rigid separation of civil and military airspace.

To study this concept the airspace use needs to be studied thoroughly, especially the use of ATS routes, like in the DCA ATS route review research.
Eurocontrol has presented a model for the ATS routes network planning & development process.

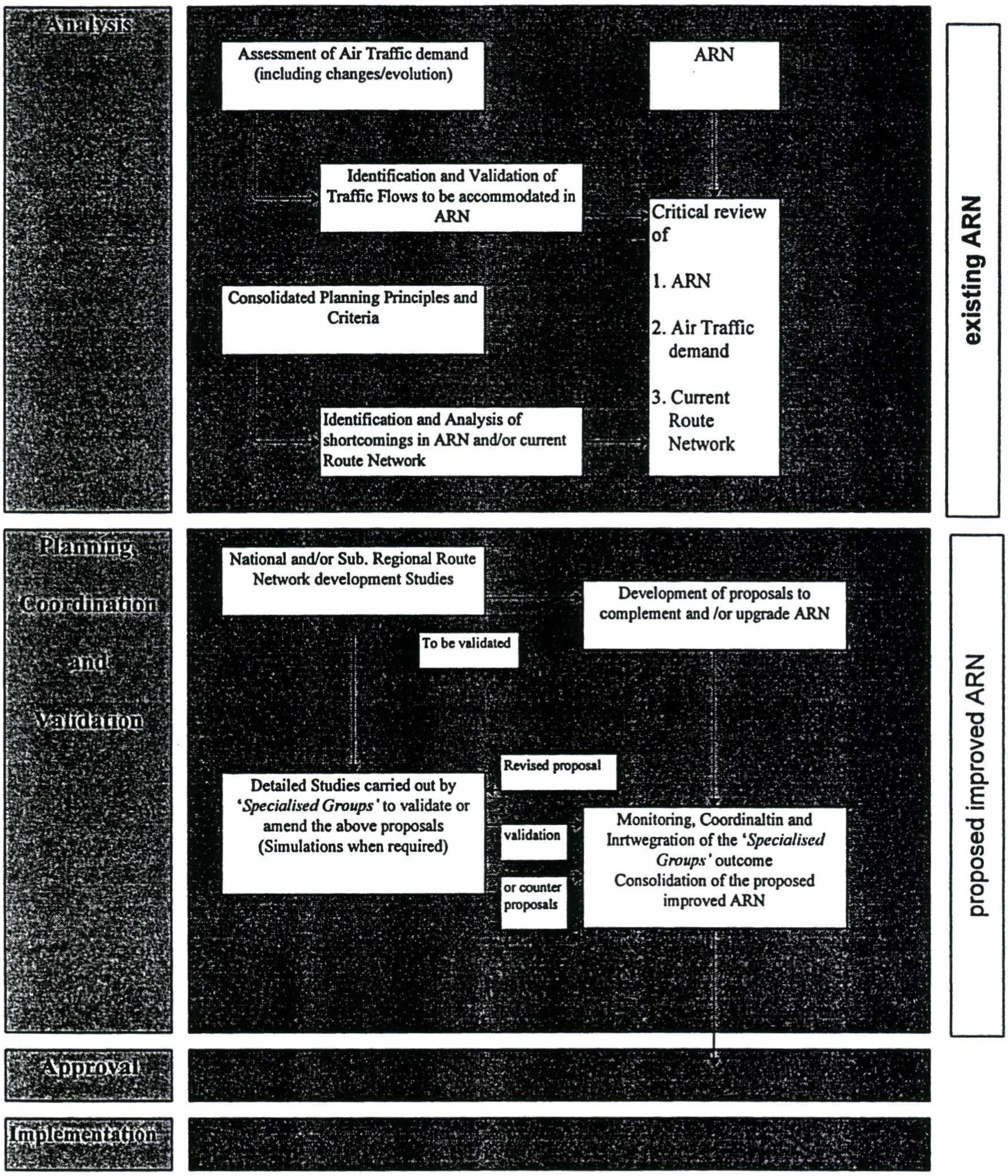


Figure 8: Eurocontrol ATS Route Planning development model

This model reflects very well the process of planning and development of a new to be designed ATS route network of Tanzania. The model emerges from an existing air route network clearly identifying stages of a general planning and development process, i.e. analysis, planning, co-ordination and validation, approval, and implementation. Compared to the ICAO model presented in figure 7, the Eurocontrol model gives a more complete model of planning and developing an ATS route network. Therefore, this model is used as practical model for the ATS route review study at DCA.

Only the first part of the model has been used in this research. This part is general and can be used for all ATS route planning and development studies. The last stages of the model of Eurocontrol are not appropriate for the DCA route network study since these stages deal specifically with the Eurocontrol study about the flexible use of airspace. It was intended to present DCA with proposals for a reviewed route network, so as far as the '*development of proposals to complement and/or upgrade ARN*', the model is appropriate and for the study at DCA.
The above 'Eurocontrol derived' model presents a process model. Equally important is a model that describes the involved actors in the process. The original Eurocontrol model (see app C) also presents the actor involvement in the model. However, these actors are not appropriate for this research. The actors in this research are DCA (especially the ATS department) and the airspace users.

2.4.2 Assessment of Air Traffic Demands (including changes/evolution)

Presently, the air traffic pattern over Tanzania is north/south for the long-haul aircraft. ATS routes in Tanzanian airspace are mainly in the north-south direction.
For Air Tanzania, the only national airliner licensed to offer scheduled flights on domestic and international routes, traffic on domestic routes declined dramatically since 1987 due to marked increases in fares. The effect of the fares was stronger on longer domestic sectors, such that passenger-km traffic declined more sharply. Domestic routes accounted for 61% of total passenger-kms in 1983; this share had declined to only 42% in 1990. Passenger traffic on Air Tanzania's international routes has grown by an average of only 1.2% over the period 1983 - 1992, or by 4% in terms of passenger-kms, implying higher growth on the longer sectors. The average number of daily departures over Air Tanzania's domestic network declined from 30 in 1987 to only 13 in 1990.
Foreign long-haul carriers all operate from the home base via an intermediate point (Nairobi being the most popular).
The Civil Aviation Master Plan 1992 forecasts a growth of aircraft movement from 24,112 in 1990 to 29,025 in 2001 according to an optimistic scenario.
Figure 9 presents the route usage forecast in the year 2001.

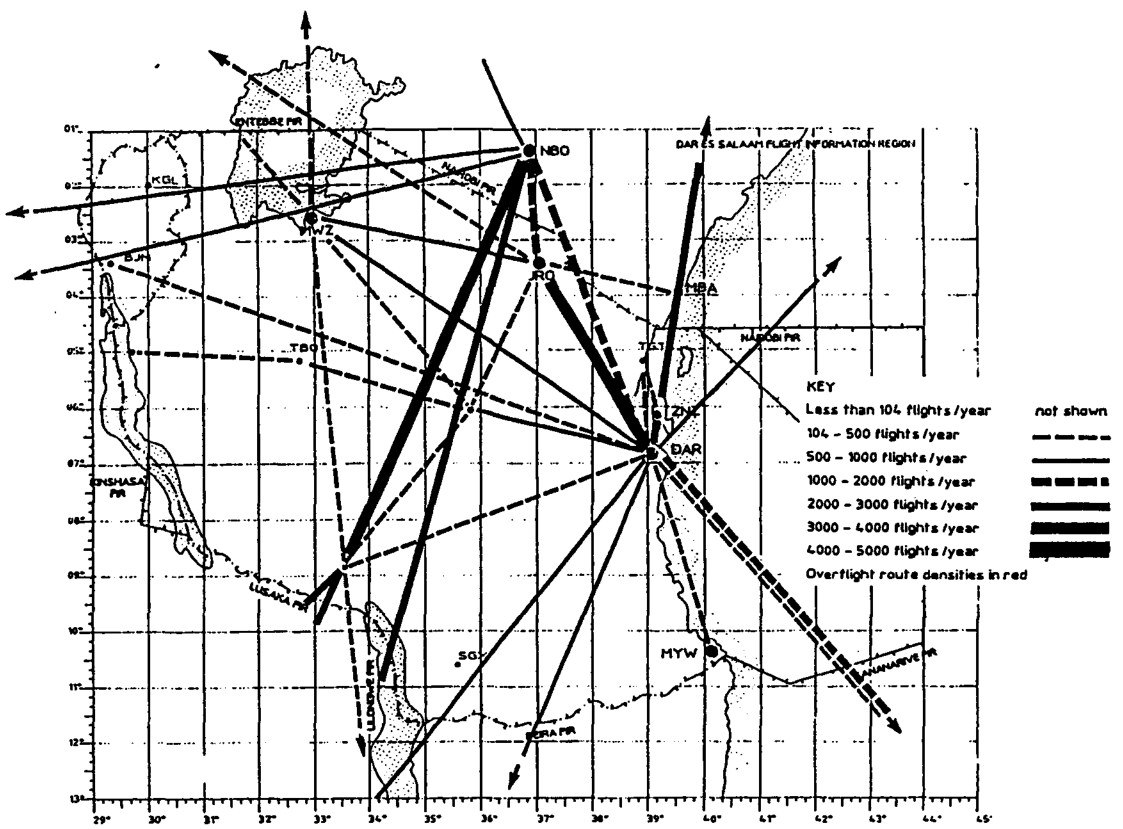


Figure 9: Route Usage Forecast 2001

2.4.3 Consolidated Planning Principles and Criteria

In the Air Traffic Services Planning Group Meeting of December, 1995, it was emphasised that the network of ATS routes should be established so as to enable aircraft along, or as near as practicable to, preferred flight paths, both the horizontal and vertical planes from the departure aerodrome to the destination aerodrome. These routes shall be a great circle between significant points whenever possible[9]. In order to develop an appropriate route network, an up-to-date basis must be provided for the progressive implementation of ATC service along the ATS routes except where the type and density of traffic clearly do not justify the provision of such service.

Other planning principles and criteria are taken from the Air Traffic Services Planning Manual. Deciding whether or not ATC should be provided, the following should be taken into account[10]:

- the desire of the operators of flights concerned to obtain that service;
- the types and density of air traffic at any moment or during specific periods and the resulting risk of possible collisions between flights;
- the prevailing meteorological conditions;
- other relevant factors of a local nature, i.e. the general topography, hospitality of the area overflown, etc.

[9]ICAO, *AFI Air Navigation Plan* (Doc 7474 Montreal)

[10]ICAO, *The Air Traffic Services Planning Manual,* Doc 9426 AN/924 (Montreal, Part 1, Chapter 3, paragraph 3.2.4)

2.4.4 Available Data

The available route data consisted of logbooks of ACC, APP and Tower. Flight Progress Strips are being kept for 3 months, after which the FPSs will be destroyed. Since the field research period started in September 1995, the FPSs of July 1995 and the following months were available.
The data in the ATS statistic file did not cover the last years and could not be used in the research.

2.4.5 Identification Present Usage

The parts from the Eurocontrol model *about Identification and Validation of Traffic Flows to be accommodated in ARN* and *Identification and Analysis of shortcomings in ARN and/or current Route Network* were included in this section about the identification of the present usage and in the following text. First of all, the routes as they are used should be identified. The research focused especially on the upper airspace. Lower airspace only has 3 ATS routes. It is hard to see lower airspace ATS routes as a network. DCA/ATS operational staff stated that it is customary to base a research concerning a route network on the routes flown or desired in three consecutive months.
Since this information would be too much to handle within a couple of months time, a different methodology was used to identify the usage of the route network.

For an identification of a route network we needed to know: aircraft type, airport of origin and destination and the path flown between these two airports, the time between significant waypoints and the altitude of aircraft. This information was only available on FPSs. To identify an appropriate period of time in which FPSs will be studied, we consulted ACC logbooks.

First, the busiest series of three consecutive months were determined. One month of these busiest months was selected to analyse.
Second, of this month an average week of traffic was determined by collecting route data from the available ACC logbooks. The most normal week is the average week.
An average week was chosen and not a maximum week, because the route network should be designed based upon appropriate needs. A maximum week would lead to many obsolete or hardly used routes and this would unnecessarely lead to unclear situations on air navigation maps and an unnecessarily high workload for ATCOs.
It is not a problem that routes that are hardly used are not on the maps. ATS will still be available (class A airspace).

The average week was thoroughly studied by collecting the information from the Flight Progress Strips and by entering this information in a spreadsheet program. The FPSs contain data about the actual use of the airspace and are the only data supplier for actual routes.

From interviews with ATCOs at the ACC at DIA it became apparent that the busiest months in air traffic were the months of July, August and September. Three Supervisor ATCOs and one ATCO were asked to mention the busiest consecutive three months. All respondents mentioned the same months.
Since July is a very common month to analyse (initiated by the ICAO), this month was chosen to identify the average week. In the international environment, the ICAO wishes to receive air traffic statistics of the last week of January and the last week of July from every member state every year. The Tanzanian air traffic statistics of the last years, sent to the ICAO, were not found.

Of every flight in the Tanzanian ACC area the flightnumber, the airport of origin and destination and the aircraft type are written in the ACC logbooks.

From the ACC logbooks a database was made containing traffic information of the month of July 1995 (app D). This database gives the frequency of flights between airports on a daily basis. The average week is determined by first calculating the mean number of daily flights between two airports and then for every day calculate the squared difference of the actual number of flights that day and the daily mean number of flights between those two airports. The sum of the squared differences for all the different paired airports will result in a daily total squared difference. Finally, it is calculated which consecutive 7 days will result in the smallest week total squared difference. This week will be the average week of air traffic.

Example:

	DAY	1	2	3	4	5		total	mean
DEPT - ARR									
a - z			1		3			4	0,8
b - y		1	2	1		4		8	1,6
c - x		1						1	0,2
d - w		3		6	1	5		15	3
e - v			2	2	2	1		7	1,4
f - u		1		1		1		3	0,6
total daily flights		6	5	10	6	11		38	7,6

The variables in the extreme left column present pairs of airports. The first variable gives the airport aircraft depart from, the second variable gives the airport aircraft arrive at. The values in the table are the number of flights using the paired departing/arriving airports. Over the period of 5 days aircraft have flown from airport a to airport z four times, one time at day 2 and three times at day 4. Resulting in a mean of 0.8 times a day.

To determine the weekly squared difference to finally determine the most representative week, we first determined the total squared difference of each day related to the individual paired dept/arr airport.

	DAY	1	2	3	4	5
DEPT - ARR						
a - z		0,64	0,04	0,64	4,84	0,64
b - y		0,36	0,16	0,36	2,56	5,76
c - x		0,64	0,04	0,04	0,04	0,04
d - w		0	9	9	4	4
e - v		1,96	0,36	0,36	0,36	0,16
f - u		0,16	0,36	0,16	0,36	0,16
total daily squared difference		3,76	9,96	10,56	12,16	10,76

For instance: at day 1, there were zero flights from airport a to airport z. The mean number of flights from a to z is *0.8* flights a day. This is a difference of *(0 - 0.8) = - 0.8*. Squared this is *0.64*. The same is done for every other pair of airports. This results in a total daily squared difference of *3.76* for day 1. Now we want to find the most representative period. In this example, we want to determine the most representative 3 days. This has been done by summing up the total daily squared differences of 3 consecutive days.

Day 1 - 3:	3,76 + 9,96 + 10, 56 = 24,28
Day 2 - 4:	9,96 + 10 56 + 12,16 = 32,68
Day 3 - 5:	10,56 + 12,16 + 10,76 = 33,48

Day 1 to 3 is the period of 3 consecutive days that differs the least from the mean situation.
In this example it is actually nonsense to speak about the most representative 3 days. The quantity of data is too limited to determine a reliable and useful representative period. The actual database, however, consists of about 20,000 entries. Then, statistically it is possible to determine a reliable representative week.

In formula form:
When the frequency of flights is the variable x, the daily difference for one airport pair is:

$$Diff_{day,a-z} = \left(x_{day,a-z} - \bar{x}_{a-z}\right)^2$$

Then the daily total squared difference is:

$$Diff_{day} = \sum_{n=a-z}^{f-u} \left(x_{day,n} - \bar{x}_n\right)^2$$

The representative (average) period is found by finding the minimum sum of the daily total squared differences of that period, i.e. the minimum weekly total squared difference:

$$Diff_{week} = \sum_{day}^{day+6} \sum_{n=a-z}^{f-u} \left(x_{day,n} - \bar{x}_n\right)^2$$

This process has been carried out for the data collected from the ACC logbooks. The result of this data processing is given in appendix E. The representative week in the month of July was determined as the week from the 11th until the 18th of July. This week was planned to analyse thoroughly.
Unfortunately, the Flight Progress Strips for the month of July 1995 had already been destroyed and, therefore, it was impossible to analyse the average week by means of the FPSs. Also, because of the time span of this research, it was not possible to insert data from the ACC logbooks for the month of August into a database and, therefore, we chose the first week of August to be the week to analyse by means of the FPSs. As can be seen from the determination of a average week in the month of July, there is not a significant difference in the various weeks. The random sample of the first week of August 1995 will, therefore, not lead to useless results. It should, however, be kept in mind that the calculated average week has not been used in the route review.

All data from the FPSs were entered into a spreadsheet. To be complete in the data collection and not to miss some data afterwards, we chose to insert all data from the FPSs. The data found on the FPS were: Flight number, Aircraft type, Airport of Departure, Airport of Arrival, Reporting Points used, Time at the reporting Points, Flight Level, and Type of Strip. A unicode has been given to every flight because flight numbers can be used more than one time and in order to not get data mixed during database processing between two flights having the same flight number, a unicode is introduced.

Now, there are two databases with raw data; one from the ACC logbooks containing flightdata between airports for one month, and detailed flightdata from FPSs for one week of traffic.

From the DCA company's point of view it is important to determine a criterion that can be used as a tool for establishment of ATS routes. For instance, it is not in the interest of ATCOs to have an ATS route that is only used a few times per month. This would give an unnecessary high workload for ATCOs and a less transparent ATS route system. DCA could set a criterion of at least 8 flights a month along a line to consider implementing an ATS route. Other less technical aspects could also influence the criterion setting (trading contacts, political reasons, etc.).

From the database of air traffic between airports for one month, a control load factor is determined. The control load factor represents the number of flights included using a specific criterion. For every route between an airport of departure and arrival the monthly number of times used is determined. Then the frequency is determined of routes between airports of departure and arrival having the same number of times used per month. The times used per month term and the frequency term are multiplied and result in a load factor.

For instance, in the month of July 1995, 14 aircraft used Nairobi Eastleigh Airport in Kenya (HKNA) as the departing airport and Kilimanjaro International Airport (HTKJ) as the arrival airport. Then 14 is the Times Used term. In the same period, 2 other airports of departure and related arrival were used 14 times, these were Tabora Airport (HTTB) as a departing airport and Arusha Airport (HTAR) as the arrival airport and Entebbe International Airport in Uganda (HUEN) as the departing airport and Kigali Airport in Ruanda (HRYR) as the arrival airport. The frequency of departing/arrival airports that were 14 times used is 3. This results in a load factor of 3*14 = 42.

This load factor will be used to set a criterion for the establishment of ATS routes.

A total control load factor can be determined by adding all load factors of routes between airports that are used more than a specific number of times.

For instance, when adding the load factors of routes between airports that are used more than 13 times, thus including the previously quoted example of 14 times used, the total control load factor will be 1661. Including all flights (the criterion is set at more than 0 flights), a grant total control load factor of 3071 is reached. With the criterion for establishment of an ATS route set at more than 13 flights per month between 2 airports, 54% of the total traffic is handled along established routes. Appendix F presents the control load factors for all possible criteria.

First let us elaborate on the criteria setting. For this, we used the data from the ACC logbooks. Basically, there are 2 methods of criterion setting.

1. Arrival/Departure based,
2. Route (Waypoint) based.

we have used the Arrival/Departure based method for this research to set a criterion. This means that we used data from the Departure/Arrival Airport database of the month of July 1995 to determine a criterion.

The route (waypoint) based method concentrates on the actual used route segments between the waypoints and for this it is a better method than the first method. But the data from the Departure/Arrival airports represent a 4 times larger sample and are, therefore, preferred above the second method for reasons of accuracy. In addition, since routes origin from the demands of the users, the airlines, and these demands are depending upon the airport of departure and arrival, the

Arrival/Departure based method comes closer to the demands of the users and is more at a grassroots level than the other method which is closer to the operational level because this method monitors the resulting use of the airspace.

For the further analysis of the route usage we have used the criterion of more than or equal to 10 flights per month between airports would make it worth to consider the establishment of a controlled route. By this, at least 63% of the total en-route IFR upper airspace traffic in Tanzania will be included in the analysis. This results in 75 pairs of airports on which will be focused. Appendix G presents the airport-pairs included. In this presentation, airports are called by their technical ICAO names. The numbers behind the airport-pair names give the total usage of the airport-pairs in the month of July 1995.
These airport-pairs are extracted from the database with flight information of one representative week, containing the detailed information of the FPSs (Appendix H).

2.4.6 Results from database

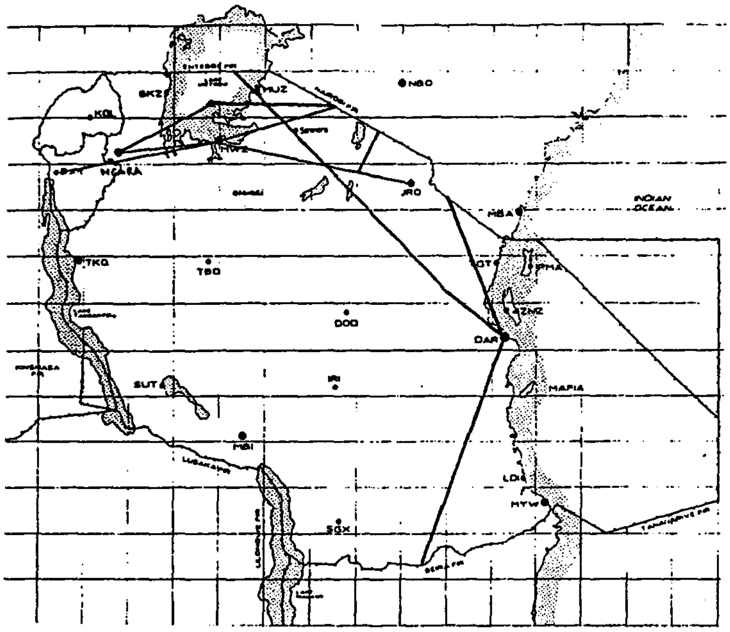
After the field research period at DAR ACC, with the appropriate means (a computer), we were able to graphically display the implemented versus the present situation based on the designed databases. To analyse differences and to obtain insight in the present situation, we produced 7 different graphical presentations which are given below.

The figures present the actual use of Upper Airspace in Tanzania. This airspace use can be simplified as follows:

- International arriving traffic;
- International departing traffic;
- Domestic arriving/departing traffic;
- Overflying traffic;
- Total airspace use.

First it is important to compare the implemented situation (see Figure 5) with the actual situation. When comparing, the following important observations can be made.A more detailed but older aerial map is given in appendix K. Appendix K is included to present the waypoints. Figure 5 presents the implemented ATS route situation.

International arriving traffic



International arriving traffic for the biggest part comes from northern situated areas. There is only one route, UG657F, from the south that is used significantly, according to the criterion set before. Kilimanjaro Int. Airport, Dar es Salaam Int. Airport, Mwanza, and Ngara receive the air traffic from abroad. A comparison with the implemented situation shows that all routes are present except the routes to Ngara.

Figure 10: International arriving traffic

International departing traffic

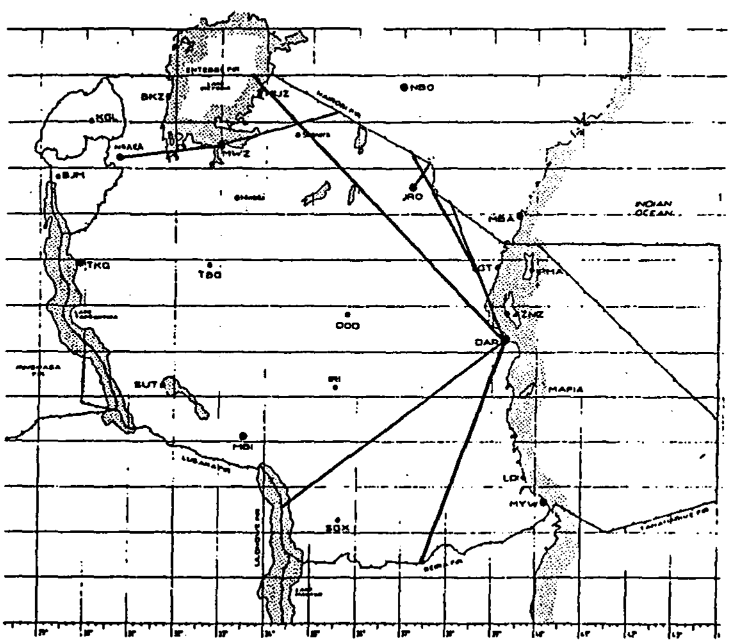
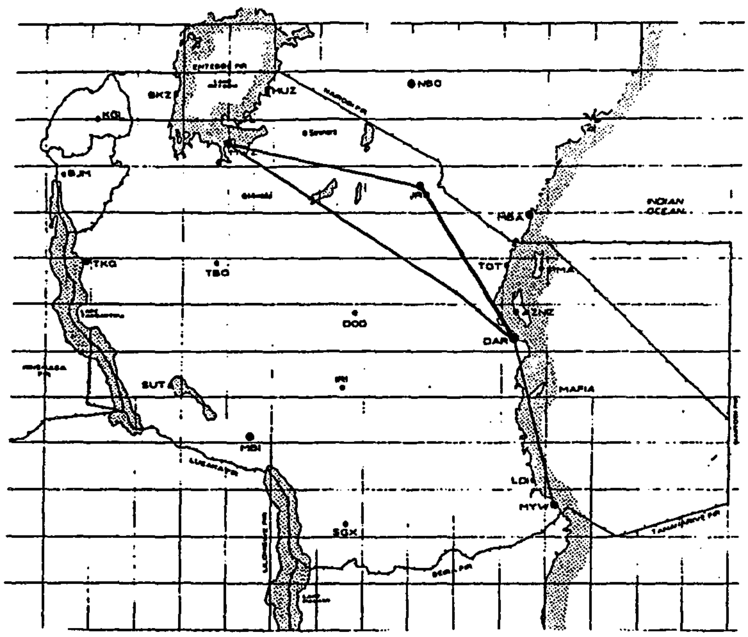


Figure 1: International departing traffic

Of the total routes, 62,5% of the routes (5 of 8 route-segments), used by departing traffic with destinations outside Tanzania, are present in the implemented situation. The following route segments differ from the implemented situation:

- The route from KIA to GEREN waypoint is not in the implemented route network,
- Traffic from DIA to Nairobi normally use route UB553, but a slightly deviating route from route UB533 is also frequently used. This deviating route is not an implemented route,
- The route from Ngara to Mwanza is not present in the implemented route network.

International departing traffic use KIA, DIA, and Ngara as airports.



Only 4 routes are used in case of domestic traffic. The route from DIA to Mtware is not present in the implemented route network. The route from DIA to KIA misses a designator (a route name).

Figure 12: Domestic traffic

Overflying traffic

For overflying traffic, it was convenient to categorise traffic as follows:

- traffic with southerly direction, sub-divided in:
  - originating from Nairobi (Kenya),
  - total,
- traffic with northerly direction,
- total overflying traffic.

A figure with only the total overflying traffic would be too complex to analyse.

Traffic with southerly direction originating from Nairobi (Kenya)

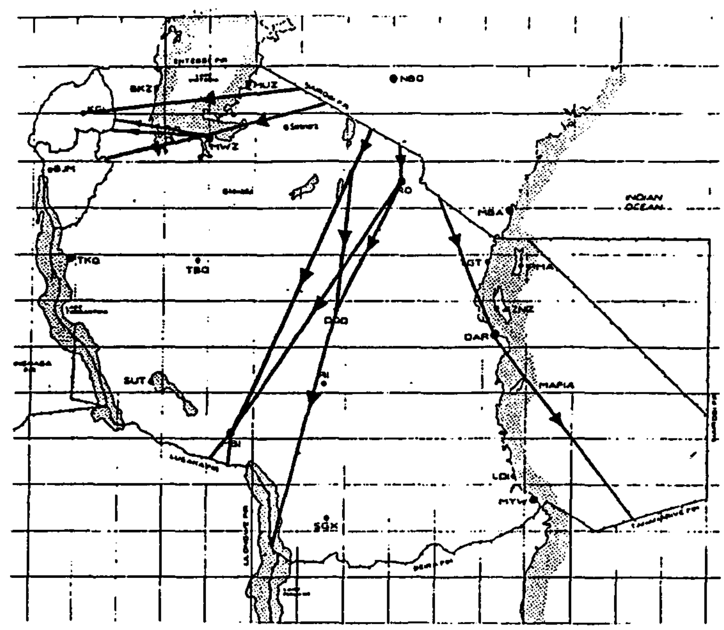


Figure 13: Traffic with southern direction originating from Nairobi (Kenya)

Traffic that follow implemented routes:

- traffic overflying Dar es Salaam,
- traffic in the direction Ruanda, Burundi.

For the traffic in the direction Ruanda overflying Mwanza, route UB531 is implemented. However, a slightly deviating route, which is not present in the implemented situation, is frequently used from Mwanza in the direction Kigali (Ruanda). Traffic from Nairobi to Zambia, Malawi, Zimbabwe, and South Africa use the centrally situated routes through Tanzanian airspace. Two routes are implemented but 4 different routes are used in present operational situation. Of one implemented route, route UR409F, the segment from Nairobi to Dodoma is not used significantly. Instead, traffic flies from Nairobi to Dodoma via waypoint LOSIN or KIA. These two segments (LOSIN-Dodoma and KIA-Dodoma) are not present in the implemented situation. The direct route between KIA and Mbeya is used frequently but not present in the implemented situation.

Traffic with southerly direction

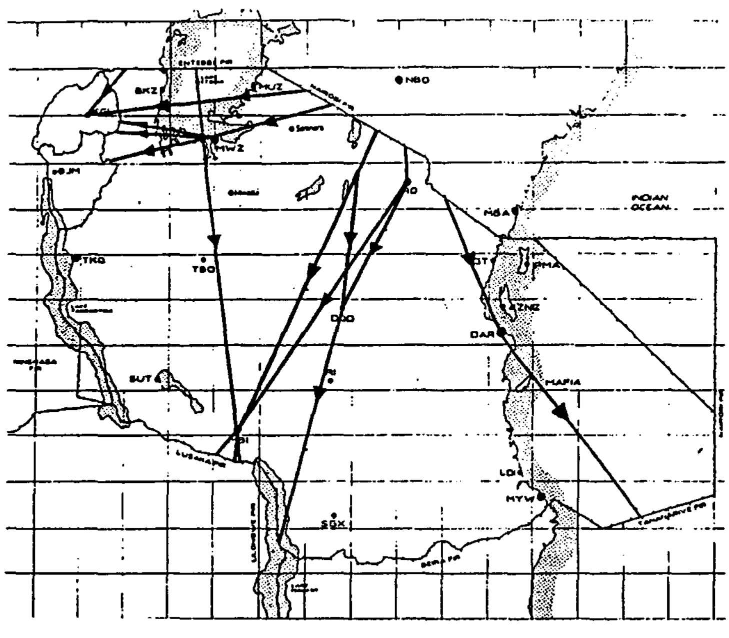


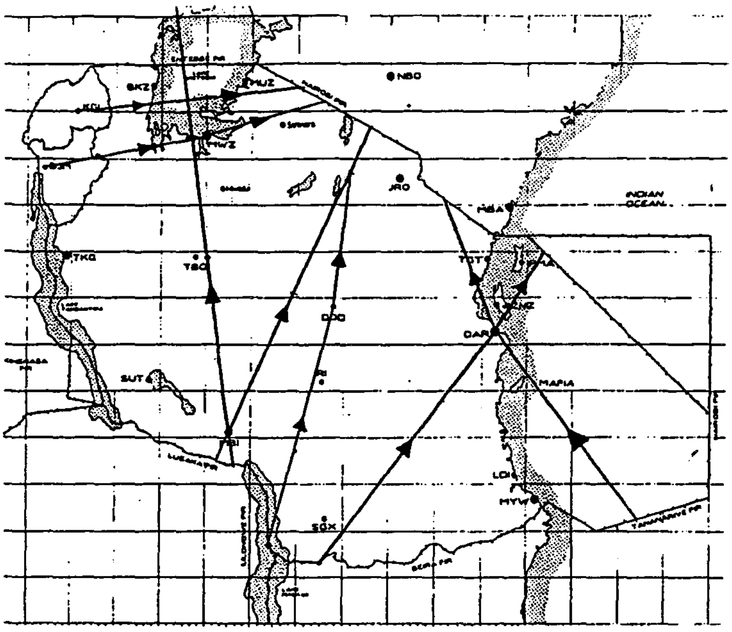
Figure 14: Traffic with southerly direction

Compared to the figure presenting the traffic with southerly direction originating from Nairobi (Kenya), only two routes are added:

- route UG656D from Entebbe FIR (Uganda) to Mbeya,
- route UA508F from Entebbe FIR (Uganda) to Kigali (Ruanda).

Both routes are present in the implemented situation.

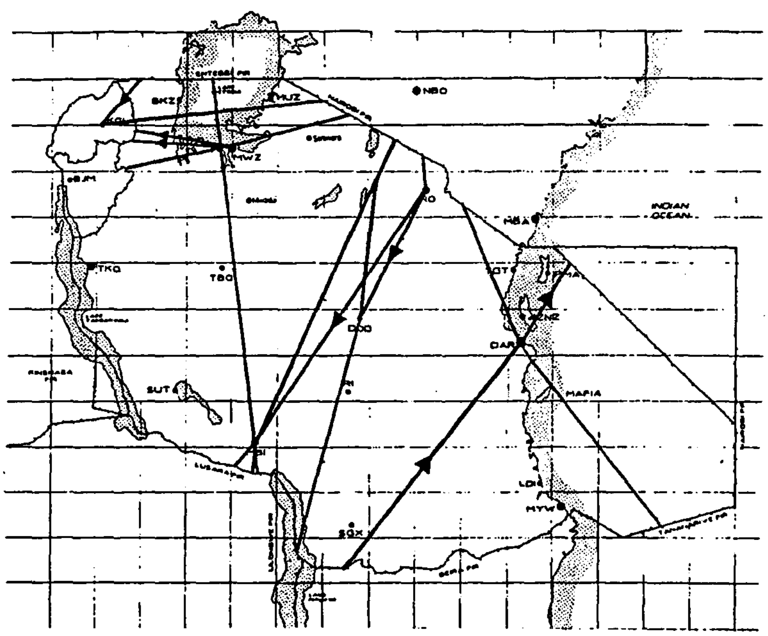
Traffic with northerly direction



Traffic follows implemented routes, except for traffic overflying Dodoma. Traffic to Dodoma follow route UR409F, all with destination Nairobi (Kenya). In the implemented situation route UR409F continues direct to Nairobi from Dodoma. In the present operational situation, traffic fly from Dodoma to Nairobi via waypoint LOSIN, thus creating a dog-leg. This route segment from Dodoma to LOSIN is not present in the implemented situation.

Figure 15: Traffic with northerly direction

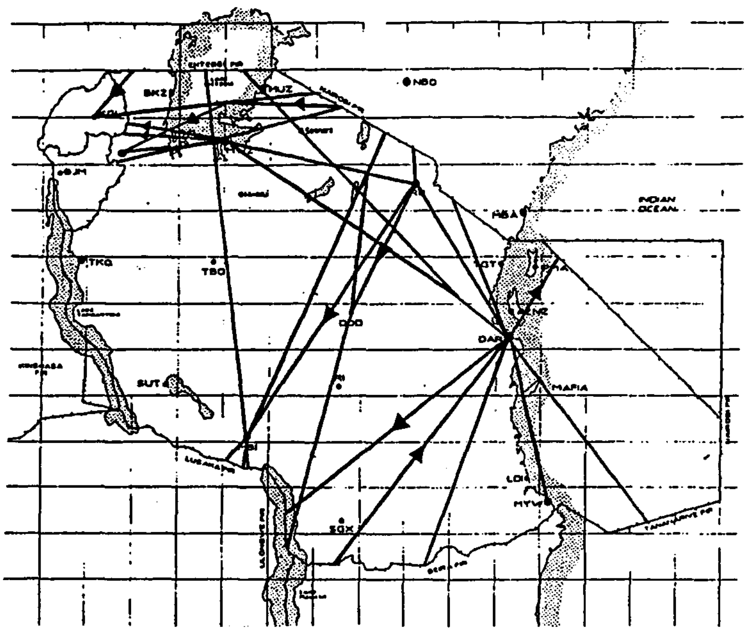
Total overflying traffic



The three previous sections combined discuss the total overflying traffic. It is interesting to add the direction usage of routes. The routes in the figure not having a direction indicator are used both directions. The routes with a direction indicator are only used in the direction the indicator shows.

Figure 16: Total overflying traffic

Total traffic



From the figure presenting the total traffic it is possible to identify obsolete routes. The following routes are used less than a significant number of times according to the criterion set before:

Figure 17: Total traffic

- UG661E, from Dar es Salaam to Kigali (Ruanda),
- UG661E, from Dar es Salaam with heading 131° (direction Seychelles),
- UA407, from Dar es Salaam to Mombassa (Kenya),
- UG424, from Dar es Salaam with heading 054° (direction Bombay, India),
- UA613F, from Dar es Salaam to Bujumbura (Burundi),
- UG661, from Dar es Salaam to Kigali (Ruanda),
- UA610F, from Kilimanjaro to Entebbe (Uganda),
- route-segment of route UR409F between Nairobi and Dodoma,
- UB531, from Kigali (Ruanda) to Goma (Zaire),
- UB527F, from Kigali (Ruanda) to Bujumbura (Burundi) and to Kalemie (Zaire)

The following routes are frequently used but are not present on the upper air routes chart of the Master Plan of Civil Aviation:

- route from Dar es Salaam to Mwanza,
- route from reporting point LOSIN to Dodoma,
- route from Kilimanjaro to Dodoma,
- route from Kilimanjaro to Mbeya,
- route from reporting point PARIN via reporting point ATUDO to Ngara,
- route from Ngara to Nairobi.

2.5 *Discussion about route network*

2.5.1 General

The routes mentioned above should be studied more thoroughly. This is very well possible with the database we developed. It takes only 1 or 2 minutes to extract specific waypoints from the database and have an immediate insight in who is using the route, what origin/destination, aircraft type, Flight Levels, etc. For example, UG424 is used by aircraft from Dar es Salaam to Bombay (India) and v.v. and aircraft from Lusaka (Zambia) to ZPPP (Beijing, China). In the month of July 1995, 9 aircraft flew from Bombay to Dar es Salaam and 8 from Dar es Salaam to Bombay. In the first week of August the route has been used 5 times. For the graphical presentation it meant that the route appeared not to be used, but in reality it was used. This route could be very important for trade treaty reasons and, therefore, must remain existing. In any case, it is efficient to analyse the usage of the route by consulting such a database.

From the database and the figures it appears that route UA613F from LUGAP to Bujumbura is not being used and could be deleted. It appeared that this route was already deleted but this was not adjusted on the aeronautical charts. Route UG661F from LUGAP to Kigali also has not been used and can be deleted. Area Control at DIA is very much aware of this situation and a recommendation will not help much. As stated before, the deletion of a route can only occur after presentation and discussion with the international aviation organisation and the users of the airspace.

With reference to the route usage to Kigali, it can be said that it is recommended to establish an ATS route from Nairobi to Ngara. Referring to the density of traffic, this is one of the busiest routes. However, no route has been established due to the believed temporary character of this route. The ICAO ATS Planning Manual states about non-permanent routes, which are defined as

a) when routes are required only for specific periods of the year (seasonal routes) in order to accommodate transit traffic during the holiday season; or

b) where specific routes can be made available only during weekends because they traverse areas which, during the week, are reserved for other activities; or

c) where routes whose use depends on special co-ordination procedures can only be effected on an ad hoc basis for the specific flights involved and depending on the circumstances as they prevail at that time.

Such non-permanent routes should also be included in the ATS route network However, with a clear indication of the limitations imposed on their use. Such an indication will then serve as a reminder that these routes should be reviewed at frequent intervals with a view to changing their status whenever the use made of them requires. Taking this in consideration, the establishment of a controlled ATS route from Nairobi to Ngara is recommended.

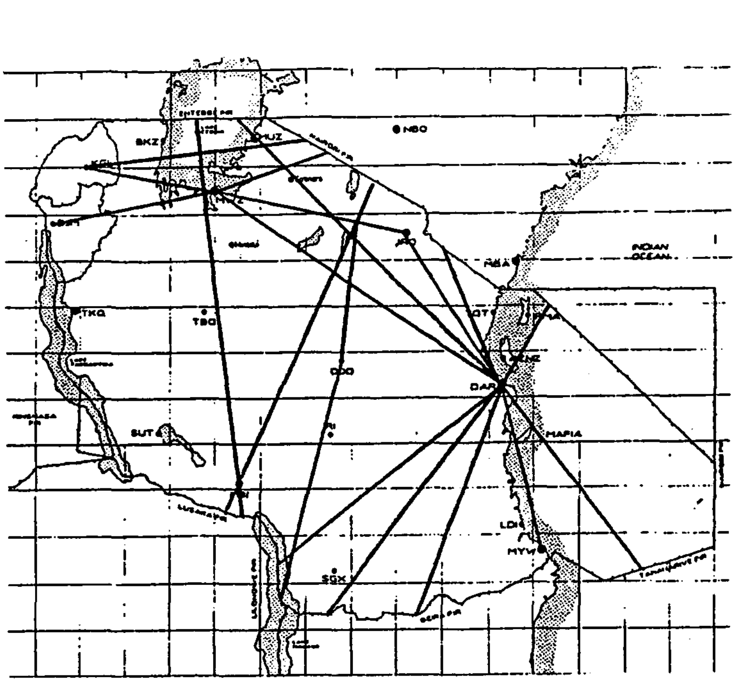


Figure 18: Pre-proposal ATS Route Network of Tanzania

For the routes to and from Ngara it is quite clear to recommend a route establishment. Of the other routes mentioned, we do not have additional background information. Therefore, it is not possible for us to recommend on the establishment of a route. For each of the mentioned routes DCA/ATS should consider the inclusion of the routes into the implemented situation for safety reasons. With the data we have processed so far, a preliminairy proposition of a reviewed ATS route network of Tanzania would be according to the figure aside. Again, we do not recommend this network.

Overall, from the database and the figures, it appears that the route structure as implemented is quite suitable for the present situation. Apart from those routes mentioned above, other routes are used as maps suggest. we feel no need to structurally alter the route network. In interviews with several controllers, who were asked to identify shortcomings of the route network, all replied not having problems with the route network. Also controllability of the air traffic gave no problems according to the ATCOs. During our field research in which we frequently monitored the ATC at various times during the week, we never saw a controller losing control. My personal impressions were that controllers could easily handle more traffic. Main problem that the controllers identified, after initially all identifying the non-serviceable status of the radar, were the frequent power cuts.

2.5.2 Route Monitoring Priorities

Discussing monitoring priorities a few aspects are important (in order of importance):

1. Flight Level used by air traffic,
2. Direction of traffic,
3. Destination and origin of traffic.

The order of importance here is based on the level of generalisation. The flight level used by air traffic is very general and is only used for the categorisation of Upper or Lower Airspace. The direction of traffic, i.e. north or south, gives a wide impression of the use of airspace. The destination or origin of traffic gives a more specific impression of the route usage in the airspace.

Already during the research, priority was given to the Upper Airspace routes (above FL245). The Tanzanian route network almost entirely has Upper Airspace routes. Only 3 Lower Airspace routes exist. Monitoring of the Upper Airspace routes should have priority.

The second aspect distinguishes traffic from or to the north and traffic to or from the south. It appears that traffic from or to the north determine the bulk of air traffic in Tanzania. Traffic from northern areas and traffic to northern areas should, therefore, receive priority attention.

Overflying traffic determines for the greater part the route-network in Tanzania, especially in the North-South direction. Traffic from Kenya, in particular from Nairobi, makes use of a lot of different routes in Tanzanian airspace.
For traffic having the destination or origin in Tanzania, it becomes clear that traffic from and to neighbouring countries provides the major part of traffic along the Upper Airspace routes. Therefore, special attention should be given to routes that facilitate traffic from and to neighbouring countries. Again, traffic from and to Kenya, Nairobi in particular, should be given priority attention.

In more practical terms, monitoring priority should be as follows:

- Overflying traffic:
    - Upper Airspace traffic from Nairobi,
    - Upper Airspace traffic Kenya,
    - Upper Airspace traffic from neighbouring countries other than Kenya,
    - Upper Airspace traffic from the North,
    - Upper Airspace traffic from the South,
- International traffic, other than overflying:
    - Upper Airspace traffic to and from Nairobi,
    - Upper Airspace traffic to and from Kenya,
    - Upper Airspace traffic to and from neighbouring countries other than Kenya,
    - Upper Airspace traffic to and from the North,
    - Upper Airspace traffic to and from the South,
- Domestic Upper Airspace traffic,
- Lower Airspace traffic.

2.5.3 The 150NM extension of the TMA

The extension to a DIA approach area of 150NM does not seem to be necessary. This measurement has been set in international environment. Western international airports have such a high approach and departure traffic demand that an APP area of 150NM is justified. The APP areas of Tanzanian international airports are large enough to safely control arriving and departing air traffic. This statements is based on interviews with controllers in which they were asked to describe the function and workload and encountered problems of their job. All respondents replied that the workload was not too high. The workload is defined as the number of aircraft to be controlled per hour and the number of times having radio-contact with approaching or departing aircraft. During the field research we also monitored the workload of the APP controllers. In busy times, they control 10 aircraft in one hour. Every flight needs about three or four messages from DIA Control. In comparison Amsterdam Airport APP controllers control about 100 aircraft in one hour. The number of messages from Amsterdam Control is also higher, about 6 or 7. Of course do they have advanced technical means to accomplish this task. All interviews with controllers were held while they were controlling.

The length of APP routes within DIA TMA is especially low in the southern area. All routes have a length of 99, 2 NM, while it should be the ICAO recommended 150NM for an international airport. Internationally, only two routes are used significantly in the southern area of Dar es Salaam, according to the criterion we have set at more than 10 flights between paired airports. These are the routes from Dar es Salaam to South Africa and to Lusaka (Zambia). Moreover, the 150 NM recommendation from the ICAO is meant for especially increasing the time span to control arriving air traffic on different arrival routes. Studying figure 15, that presents the international arriving air traffic route usage from the south (after filtering with our criterion), only the route BONAP, BOTEN, Dar es Salaam International Airport is used. Just for one single significant route in the southern area, controllers in DAR ACC do not need an extension to 150 NM. The northern area is somewhat denser for departing and arriving traffic demand. Three significant departure routes are used and two significant arriving routes. Arriving routes are from the TMA boundary points GEREN and LUGAP. The distance from DIA to these TMA boundary point is respectively 116.5 and 100.8 NM. Extension of the TMA does not seem to be necessary. When DCA will be still strongly recommended to adjust the TMA, the route to LUGAP should be extended first, since this is the shortest route that is used significantly by arriving traffic in the busier northern area of the DIA TMA.

2.5.4 Airspace classification

Above FL245 in the Dar es Salaam FIR, the airspace is classified as class A airspace. This means that positive separation is provided to all aircraft, which means that only IFR flights are allowed and that all IFR flights are separated. A continuous two-way communication is the radio requirement for this classification. The Area Control of the Dar es Salaam FIR does meet this requirement. The present chart does not reflect a class A airspace since it is suggested that only just over 5 airways exist which provide class A control. The actual situation is that in Upper Airspace the airspace is classified as class A. Therefore, this suggestion has to be removed.

The existence of an overall coverage of the airspace above FL245 as class A airspace actually removes the need for ATS routes in principle. The entire airspace is constantly under control and aircraft are positively separated everywhere. In Western ATC environments class A control is for a major part facilitated by the use of radar-equipment. However, the DIA-ACC uses procedural control to separate aircraft. Mainly, based on experience and the extensive use of the present routes, class A control is possible. More than in a radar-equipped ATC environments, with procedural control, it is not just possible to delete all ATS routes and consider the entire FIR as a controlled area. For safety and efficiency purposes for controllers and aircraft, it is very important to have a clear ATS route network, although the area is entirely class A controlled. The ATS route network facilitates anticipation and short-term prediction in the interaction of aircraft with obstacles (other traffic or geographical obstacles) for ATCO and pilot.

Therefore, it is recommended to omit of the airway marking (the white zones) to avoid the suggestion that only in those parts the airspace is classified as class A, and the omission of F-, E-, D-extensions for airway designators on the aeronautical maps.

2.5.5 ATS route widths

Since Upper Airspace is class A airspace, there does not seem to be a need for ATS route widths. Already the entire area is controlled in a sense that positive separation is applied and, therefore, the definition of widths of ATS routes does not seem appropriate or necessary. As long as normal separation standards are applied, aircraft are separated. Since this separation is continuously maintained, definition of ATS route width is not necessary and even superfluous.

2.5.6 Significant point (Waypoints)

Waypoints in Tanzania are not used as outlined in the ICAO documents. If aircraft do not have self-contained navigation means (e.g. inertial navigation (INS)), it is often not possible for the aircraft to determine the exact moment of crossing the waypoint. Due to non-operational navigational aids, this is the case for quite a number of reporting points. The ATCO will not know the exact time of waypoint crossing of the aircraft. It is the experience of the ATCO that enables the determination of the time of aircraft crossing a waypoint. This is not as accurate as the data navigational aids provide, but that is why separation standards for waypoints not supported by navigational aids are larger. ATCOs determine the waypoint crossing time based upon aircraft type (speed), windspeeds and direction. The reporting time information (the time aircraft cross the waypoint, according to the ATCO) will be passed on to the aircraft and the aircraft has to report at this time. Based on this information it is not possible to exactly determine the routes flown by aircraft. This devaluates the analysis of the route network significantly.

2.5 Evaluation

In this chapter, we have presented some variables to set criteria for the establishment of ATS routes, such as the total workload factor. The question is: is it acceptable to base the route structure on routes that at least 54% of the total of air traffic uses? Or should this percentage be higher?
This criterion can only be set by the planners of DCA after having the (indirect) approval for setting such a criterion by the ICAO. The ICAO will not disapprove the methodology of setting such criteria, but could, for example, reject the resulting route network. Unfortunately, we lack the experience in the airspace use of the Dar es Salaam FIR to judge the validity of the criteria. The HQ staff of DCA/ATS could not help us with the setting of such criteria because they had never dealt with data in this manner. Here we find the basic problem of the ATS route network research as desired by the DCA. A route network is not defined by a single research. It can merely serve as a tool to analyse a route network and enhance the monitoring capabilities of an organisation as the DCA. Route structure definition starts at the user level, i.e. the airliners. Suppose the KLM asks for a controlled route between Nairobi and Dar es Salaam, it is for the DCA to consider this route and study the implementation of the route. Then at regional level, i.e. African level in this respect, the Tanzanian authorities can make a recommendation for this route after which approval, the recommendation will be sent to the ICAO. After this, the path will be followed in the reversed way. Likewise, the deletion of a controlled air route is even more long-winded. For this, the users also have to approve the deletion of the route. The process of adjustment of the route network above Tanzania is quite a heavy process which can not be done without inclusion of a very large amount of international institutions. For that, this research can only serve indicative purposes and it should be directed to present more structural recommendations than recommendations for the direct adjustment of the route network. In case of the last, a rejection of the report in already the initial phase of recommendation would make the report useless. Structural recommendations are, from developmental point of view, more interesting, thus serving DCA with structural improvements instead of temporary ones.

In this chapter, we carried out the initial analysis of the present ATS route network in Tanzania. That research also facilitates the analysis of the present development of the ATS route network in Tanzania. Routes are determined based on communication, supported by statistical information, by planners which have great experience in the field of ATS. Routes are not determined by single researches. Route development has more the characteristics of a continuous communication and information exchange process. It is of utmost importance, from structural developmental point of view, that this research

focuses on the communication and information part of the route definition. Not only on the statistical data level, but also on the information and communication level between the persons that are involved in the route determination within DCA.
The statistical record of DCA is very poor and this presented the review of the ATS route network the biggest problem. Without statistics it is impossible to plan and develop an appropriate route network. This is the technological bottleneck of the ATS Dept. at DCA, the missing of a data processing system to process raw data into statistical data to be used by planners.
For ATS planning purposes, a great problem would already be solved when the data from the Flight Progress Strips are entered immediately in a spreadsheet program instead of writing the data in a logbook. This would not require organisational adjustments, as hiring new personnel to insert the data. The person now writing the data in a logbook only should have a spreadsheet computer course and a computer at his or her disposal. It is much easier for ATS staff at DCA/HQ to analyse data already in a database, than data written down in a logbook. An analysis of route usage is presently too time consuming to carry out.

The Transport Statistics of 1993 of the Bureau of Statistics comments: "Unfortunately in Tanzania, the available transport statistics are inadequate for planning, implementation and evaluation of transport projects. Information on volume, composition and direction of traffic is missing"[11]

The next chapter deals about this technological bottleneck in the ATS department of DCA.

[11]Bureau of Statistics, *Transport Statistics 1993* (President's Office, Planning Commission, Dar es Salaam, March 1995, p.5)

Chapter 3

INFORMATION MANAGEMENT IN THE DCA/ATS ORGANISATION

3.1 Introduction

In the previous chapter, it became clear that DCA/ATS' major bottleneck was not the difference in implemented and present ATS route network characteristics. The major bottleneck is found at a level beyond the practical ATS route network problem. How is it possible that there is a difference and what are the backgrounds of this problem? ATS planners at DCA/HQ lack data on which basis they are able to plan. This chapter deals about this major technological bottleneck within the DCA/ATS environment.

3.2 Development of ATS[1]

In planning ATS it must be ensured that early and timely provisions are made for development in traffic. This is because the lead times required for the initial implementation of an area control service, both as regards staffing and training of personnel and the provision of adequate means and facilities, especially communications, are significantly different from those required for the development and improvement of aerodrome control and APP. Aerodrome control and APP tend to progress along much more envisageable and thus predictable lines. It is for this reason that ICAO has recognised the progressive development of ATS in its provisions of air traffic advisory service as a temporary, intermediate stage in the progression from flight information to area control service in order to permit an orderly transition from a service which is primarily informative in nature to one which requires the assumption of increased responsibilities by controllers for the safety of flight operations.
At present, control areas are mainly formed by terminal control areas (TMAs) around major aerodromes connected with each other by air routes. Channelling of air traffic along routes has, however, the advantage that intersections of flight paths will be kept to manageable numbers and that their presentation to controllers on appropriate displays remains within normal limits of human perception.

Other, more liberal forms of organisation of the traffic flow, such as the provision of an area control service based on an area type control combined with the possibility of pilots planning their flights along the most direct flight path, have been found to be very difficult to accept by controllers. Such arrangements create an instant and continually changing ad hoc route system, determined by the individual intentions of pilots, require an inordinate amount of additional work by controllers in recording and updating flight progress strips, and also seem to render effective control much more difficult because possible conflicts between the intentions of individual flights cannot be projected on well-established geographical locations but have to be worked out for each case individually.

[1]ICAO, *ATS Planning Manual* (Doc.9426 AN 924, Montreal, 1984, p.I-2-1-5)

The development of ACC should, however, provide for the case that, while pilots may still be required to plan their flights along a published route structure, ACC will clear them to fly the most direct route between any two points whenever this is possible at the time the flight comes under the control of the ACC concerned. Such a method of control will have to depend to a large measure on the discretion of the controller concerned without the obligation on his part to apply it systematically on each and every occasion. In addition, it must also be ensured that the navigation guidance provided, or the monitoring of flight progress by radar, is adequate to permit pilots to fly such direct routes with the degree of accuracy upon which separation between aircraft is based.
Finally, the establishment of an ATS route network to support the provision of area control service also offers the possibility of accommodating the various, often diverging interests regarding the channelling of air traffic. It is, therefore, essential that, in its establishment, ample opportunity is offered to all airspace users as well as other interested parties (e.g. those on the ground) to participate in the development process and make their views known so that acceptable compromises can be found.

It is very important to base these discussions or negotiations upon a fairly sophisticated experience translated by records, databases etc. An organisation cannot discuss development without a very good picture of what is happening within the organisation.
For this, qualified and experienced management is vital to support the organisation.

3.3 Organisation of Air Traffic Services[2]

3.3.1 Introduction

The objectives of ATS and the functions of the service are set out in Annex 11 of the ICAO and chapter 2. However, neither the objectives nor the functions of ATS can be satisfactory accomplished unless there is an organisation to administer the service and methods established through which the objectives can be achieved. As the safety and security of civil aviation remains the ultimate aim, the management of the ATS must be developed with this in mind.
In one form or another, States generally divide the over-all administration of civil aviation into regulatory, engineering, planning and servicing divisions. It is the latter which is of most significance in the day-to-day conduct of civil and military flying and it is the individual air traffic controller who exercises the important function of preventing collisions and advising aircraft of known hazards. The procedures a controller uses, the equipment he operates, the building he occupies, the training he receives, are all intended to free him so that he can concentrate solely on this task.
It is generally accepted that in the organisation of the ATS there will be a section of the central or Headquarters administration responsible for the over-all policy, planning, personnel and budgetary management of ATS. This section should have a high enough ranking in the government hierarchy to assure that an equitable share of the total resources available are assigned to ATS (i.e. money and people) and that the importance of the role of ATS in the determination of the over-all priorities and policies of the administration is recognised.
A regional organisation may be a part of the ATS structure, although operating semi-independently in the provision of day-to-day service. Such a delegation of functional responsibility to the field by Headquarters allows individual ATS units to be grouped under a common regional management. These units may comprise area control centres (ACCs), approach control offices (APPs) and aerodrome

[2] ICAO, *ATS Planning Manual* (Doc 9426 AN924, Montreal, 1984, p.IV-1-1-1)

control towers, and their task is to provide ATS at the operational level and within a geographical region.

3.3.2 Functions and activities

A civil aviation administration is charged with the responsibility for promoting and supervising the development of civil aviation in the State concerned while, at the same time, fostering safety, achieving the efficient use of navigable airspace, and developing an operating a satisfactory air navigation system.

The director of civil aviation issues and enforces rules, regulations and minimum Standards relating to the operations of aircraft, the licensing and rating of personnel including the supervision and enforcement of medical standards, the operations specifications for commercial air operations, the surveillance of air operations, the operation of the air navigation system and the provision of ATS.

The safe and efficient utilisation of the airspace is the primary objective of ATS. To this extent, air traffic rules are developed and the use of the airspace is organised. ATS also develops the procedure necessary for a safe and efficient system of ATC and specifies the facilities, accommodation and equipment required to accomplish this. This included all types of communications equipment, including radar and other visual and elections aids to navigation.

Furthermore, ATS develops the training and physical standards for the employment of air traffic controllers, arranges training programmes and provides simulators and training devices unique to ATS. The licensing and rating of ATS personnel by examinations and the maintenance of satisfactory performance level is the task assigned to controllers trained in evaluation and teaching techniques. Headquarters determines the number of qualified personnel required to operate a unit. It negotiates terms and conditions of employment and concerns itself with the working environments.

Headquarters staff of ATS should include air traffic controllers with advanced experience in the performance of ATC and knowledge of actual field requirements.

Finally, ATS participates in other essential civil aviation activities such as the establishment of requirements for air navigation aids, and the development of aerodromes, particularly in respect to the design and layout of the movement area and the alignment of runways in relation to adjacent circuit traffic patterns. As computer technology is used more and more by ATS, selected controllers should be trained in the development of software programmes in order to ensure that equipment meets the controllers requirements.

The planning for and the execution of ATS is essentially a national responsibility unless agreements have been concluded amongst States to conduct this planning as a joint effort for a defined area covering more that one State, or for areas where no sovereign rights are exercised (e.g. the high seas). It is, therefore, of prime importance that both the planning and execution of ATS be done so that optimum uniformity is maintained to the largest possible extent. While this objective is normally pursued by ICAO through its effort in world-wide standardisation and in regional planning of air navigation services, it should, for the reasons given, be supplemented by bilateral or multilateral co-ordination among States. This bilateral or multilateral co-ordination should cover those generally more detailed aspects which have not been covered by the efforts make within the framework of ICAO.

3.4 The ICAO ATS Planning Organisation[3]

3.4.1 Introduction

In general, planning is understood as a dynamic process which involves seeking out facts, questioning established or newly proposed methods and searching for information. It is also a continuing process which, in the interpretation of available data and in the formulation of concepts, requires vision, imagination and the courage to support and justify one's convictions. Since ATS planning is an activity which cannot be disassociated from the overall development of civil aviation it must, therefore, be assumed that there is already a civil aviation infrastructure established and that the commencement or continuation of ATS planning by an administration is complementary to, and forms a part of, a national civil aviation plan. Also, ATS planning cannot be done in isolation with regard to other aspects of aviation but must take into account information concerning established commercial air route networks and existing or forecast traffic flows, the navigation aids programme, the airports development programme, the operators fleet composition and their future procurement programme and the over-all priorities of the many and varied civil aviation flying activities. It will also be necessary to give due regard to the sometimes conflicting demands of specialised military flying operations and airspace provisions for national security.

3.4.2 ICAO ATS planning objectives

The art of planning is to forecast future requirements as accurately as possible, to develop alternative ways of meeting these requirements and to devise the ways and means of implementing the agreed plan to meet the objectives.

In ATS planning, objectives will include:

a) planning the organisation and management of the airspace with all the ramifications and complexities which arise from the conflicting demands of the users;
b) investigating and recommending the best methods and technical equipment to operate the system;
c) planning for personnel and their appropriate qualifications;
d) functional planning and layout of the controllers' working environment and technical buildings.

Apart from specific project planning, ATS planning can form the basis for establishing many of the day-to-day requirements of the service. These include such important issues as:

a) determining the type of airspace required for the most effective system;
b) developing standardised working methods;
c) identifying existing shortcomings or potential problems;
d) developing new and improved facilities to best satisfy the ATS task;
e) determining future personnel requirements;
f) investigating and developing improved training techniques.

Sound planning will also provide policy guidance on many issues significant to the efficiency of the ATS system. Such matters include:

a) forecast of long-term budgets;

[3]ICAO, *Air Traffic Services Planning Manual* (Doc.9426 AN924, Montreal, 1984, p.I-1-1-1 ff.)

b) early warning of the need for negotiation and consultation between neighbouring States' airport authorities or other interests;

c) the determination in advance of likely environmental problems and methods of resolution;

d) providing expert advice to associated aviation disciplines such as airport engineering services; identifying the cost/benefit advantages of providing navigation aids specifically to facilitate traffic flows;

e) the need for improvements in taxiways, holding areas, security parking and other problems confronting controllers in the movement of aircraft on the ground.

All of these matters are pertinent to the work of planners and their role in establishing and maintaining an efficient ATS system. Finally, planners must arrange for a regular feedback on operating problems which are being encountered by ATS units so that these can be taken into account in their efforts to develop the plan along the most efficient channels.

3.4.3 Type of activity involved

Co-ordinated policy. This element covers the need for planning administrations to arrange for the establishment of data collection and evaluation methods, preparation work programmes, including schedules and target dates, the establishment of co-ordination procedures with associated disciplines, arrangements for staffing programmes and the establishment of an efficient monitoring system.

Physical planning. This element includes the study of such matters as personnel environment, accommodation and technical furnishings, facility location and essential supporting services.

Economic planning. This element involves the preparation of analyses of applicable ATS data concerning aerodrome, approach and en-route traffic, both actual and forecast. From these analyses planners can determine the limitations affecting the orderly flow of traffic, study alternative methods of resolving problems encountered including detailed cost-effectiveness calculations for each proposal, and prepare economic studies for use not only in determining preferred methods but also for the benefit of associated planners.

Financial planning. This element involves the preparation of estimates and proposals for budgeting after final agreement is reaches on a planning proposal.

3.4.4 Data recording and analysis

Recording of system data is required for various purposes. This includes data received by the computer, processed, displayed and transferred to other units as well as control actions entered by the controller. Analysis of these recorded data is a valuable aid for the correction of errors in software and hardware, and will meet the needs for the investigation of accidents. Additionally, further processing of recorded system data allows their use for planning and monitoring purposes, e.g. airport and airspace planning, system configuration and performance monitoring, as well as for user charges[4].

[4]ICAO, *Air Traffic Services Planning Manual* (Doc 9426 AN924 Montreal, 1984, p.II-3-3-11)

The collection of meaningful and relevant statistical data is basic to sound ATS planning. Such data can be used to determine short- or long term policy. They should include the volume and composition of traffic, split into arriving, departing and overflights, direction of flight, the levels used and types of aircraft. From the statistics thus produced, forecasts can be prepared concerning systems planning of services facilities and equipment (including navigation aids).
Statistics can be a very useful source in respect of among others the guidance to determine short- and long-term needs of the ATS system by:

1) documenting existing conditions;
2) identifying potential problem areas;
3) indicating facility requirements;
4) indicating personnel needs;
5) providing a data base for the determination of future demands;
6) providing information indicating an appropriate alternative to a plan.

For specified portions of an air route network which has to accommodate particularly heavy or otherwise critical traffic demands, planners should arrange, as a matter of routine, the regular collection and exchange of data and the publication of consequent analyses.

From the information ICAO gives about ATS Planning, it becomes clear that the basis of planning is the efficient control of ATS relevant information. The lack of sound statistical data is identified as the cause for a difference in implemented and present ATS route network use. **The availability of ATS related information is identified as the technological bottleneck of the ATS department of DCA.** The following part of this chapter focuses on this subject.

3.5 Research Practices

3.5.1 General

The execution of the route review was mainly done to identify major technological bottlenecks. From the practical work, i.e. the route review problem, it became apparent that a major technological problem was presented by the lack of data and specifically the lack of processed data or statistics. The lack of statistics was so serious that it was not possible to continue with the route review problem to identify additional technological bottlenecks. The lack of statistics for planners purposes is, therefore, identified as the major technological problem to be studied, or at least the major result of (technological) bottlenecks.
A first short survey with randomly chosen ATS employees at both the operational and HQ sites about the impact of this problem on DCA operations, showed that the reactions of all respondents justified the assumption that the lack of data and statistics was one of the largest problems of DCA.
To study the information management bottleneck, we have made use of a theoretical framework which is described later. The information we collected about information management at DCA/ATS has been projected on this theoretical framework.

3.5.2 Data-collection methods

By means of non-structural personal interviews, the causes for the poor information management were identified.

From the first impressions of the problem-area-identifying-interviews it was clear that causes would be in personal or group characteristics and not just in a shortage of technical capacity, although we initially expected the problems to be in technical limitations. Interviews about personal and group characteristics were considered to be very precarious and sensitive and, therefore, we chose to interview ATS people as inconspicuously as possible and to put as much effort as possible to relate the status of the interview to the emotional situation of the interviewee. For instance, interviews could occur everywhere, even during social times in a local bar, just because the time seemed to be right for interviewees to discuss the subject. In formal interviews respondents seldomly expressed their opinion; it was not their task to comment on the organisation.
In addition to the unstructured method of data collection, we also practiced a more structural approach for personal interviews. In these interviews, people were asked to elaborate on the organisational structure of DCA, specifically with reference to the ATS part. Consequently, relations between the employees inside the organisation could be discussed, as formal and actual information flows.

3.6 *Information management*

3.6.1 Control Paradigm

The place of information in an organisation is first discussed by means of the introduction of a control paradigm. Control-paradigms are used to identify, conceptually, the persons that are controlling, what is controlled, and what possibilities are present[5]. Clear definitions are necessary when discussing the support of organisations by information systems. Figure 19 presents the control-paradigm.

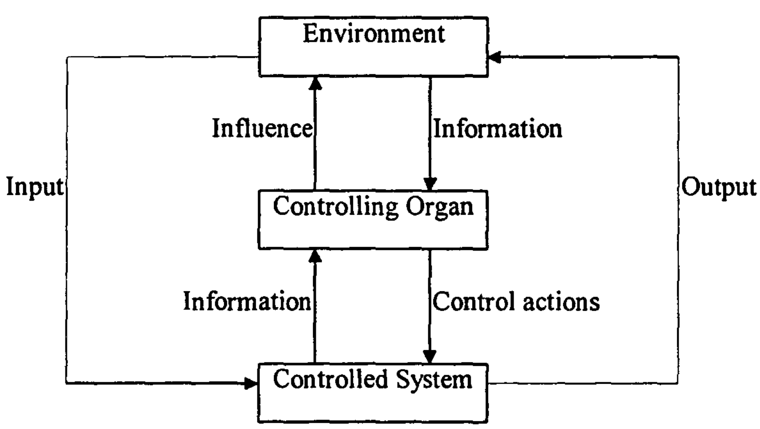


Figure 19: Control-paradigm

The environment in this research consists of:

- international and regional organisations under supervision of ICAO;
- the operators;
- neighbouring countries;
- Tanzania.

[5]Thiadens, Theo, *Informatieverzorging in organisaties: bestuurlijke informatieverzorging en administratieve organisatie* (Academic Service, Schoonhoven, the Netherlands, 1995, p.16 ff.)

The controlling organ can be divided into:

- Information system;
- Control system on planning, tactical, and operational level.

The controlled system is the ATS of Tanzania.

3.6.2 Interactions in the control paradigm

The interaction between the above mentioned aspects are

- environment - controlled system (input);
- environment - controlling organ (information);
- controlling organ - environment (influence);
- controlling organ - controlled system (control actions);
- controlled system - environment (output);
- controlled system - controlling organ (information).

Environment - controlling system (input)

Physical characteristics of Tanzania, operators that want to cross Tanzanian airspace, the international standards and recommendations of the ICAO, Tanzanian governmental demands on air traffic etc., are the inputs for the Tanzanian ATS system. The inputs are considered constant variables and not to be influenced by DCA. In any case, it is not in the interest of this research to study the influence DCA's output has on DCA's input, since the major bottleneck within DCA is studied, i.e. information management to facilitate proper output. Therefore, the input variables are considered constant.

Environment - Controlling organ (information)

For the research the focus was put on DCA and not on the activities within the environment to provide DCA with information. Only the resulting information that the environment provided was considered. It appeared that the environment provided DCA with all the required information to optimally operate the ATS system.

Special attention was given to the criticism of ICAO with reference to DCA. ICAO judged the airspace structure not to coincide with ICAO recommendations, in particular the 150NM TMA area around international airports. This information from the ICAO was taken very seriously by DCA and the major motivation to review the Tanzanian ATS route structure for DCA. From this, it can be seen that the environment has a very important role in influencing DCA's activities.

Controlling Organ - Environment (influence)

A functional ATS system will attract operators to use Tanzanian airspace. Aerial maps will change when DCA, through regional ICAO meetings, decides to change the ATS structure. DCA certainly influences the environment. In the framework of this research it is again not interesting to study this influence in detail, since the research deals about the backgrounds of differences in implemented and operational ATS route network originating from within the DCA organisation.

Controlling Organ - Controlled System (control actions)

Control actions can be divided in: control actions from and to operational sites, control actions from HQ to operational sites, control actions from and to HQ.

Control actions within HQ (e.g. from Director of ANS to the Chief of ATS) or operational sites (e.g. from Head of ATS at DIA to Senior Officer Operations) were not considered a problem. All respondents considered the interaction with direct colleagues very good.

Control actions from DCA/HQ to operational sites appeared to be very important in the research. From the interviews, it appeared that the frequency of control actions was very low, that sometimes control actions were missing, that control actions were not given when requested, and that control actions were often not explained. These imbalances resulted in an non-transparent organisation. The operational sites often have no idea of what is going on at DCA/HQ. These control-action problems were mainly taken from interviews with staff at the operational sites. The staff at HQ admitted that there were difficulties but that control actions were still appropriate, and issued when necessary. One respondent at HQ admitted that control actions from this respondent's side should be more frequent and explanatory.

Controlled System - Environment (output)

The provision of airspace and safety within the airspace is the output of the controlled system to the environment. Since this output is the result of the operation and design of the ATS system and not a input variable for the DCA/ATS planning process, it is considered to be a constant factor in this research, i.e. optimal safety and airspace use.

Controlled System - Controlling Organ (information)

This interaction between the controlled system and the controlling organ appeared to be very poor. Initially, we were to study the controlled system, but due to a lack of information it was not possible to completely study the system. From the interviews it appeared that DCA/HQ is aware of the lack of information for planning purposes. It has, however, never been a point of issue. Reasons for the lack of information can be divided into (resulting from the interviews):

- missing of historical background of data-processing;
- acquiescence in data-processing; "a data-processing system will develop someday";
- flight from the amount of work to be done;
- 'other persons should take pity on data-processing';
- manpower problem;
- financial problem.

Combinations of these points make it very hard for DCA to really solve the problem.

3.6.3 Discussing the controlling sytem-controlling organ and the controlling organ-controlled system interaction

The focus of the research was on the mutual interaction between the controlling organ and the controlled system. It appeared that the main problems were found in the information provision from the controlled system to the controlled organ and in the control actions given from the controlling organ to the controlled system.

Controlled system - controlling organ interaction

Based on the information from the interviews a clear separation should be made between the operational and the HQ staff.

Operational staff was unanimous worried about the feedback they received from HQ as well as the communication with HQ. Here we mean not the physical communication as such, but communication in general. As a result, operations do not feel the urge to inform or communicate with HQ in a structural manner. This lack of communication could emerge in extreme forms like for example, machinery being delivered at ACC site at DIA and nobody of the operational staff knows about the specific purpose of it. Operational staff felt that they were insufficiently informed about HQ issues like HQ's vision on operational performance and future plans. Contact with HQ was considered very poor. Moreover, operations considered HQ has lost touch with operations and that HQ's operational knowledge was not appropriate for planning purposed. According to operations, HQ should concentrate more on specific operational problems by contacting and visiting operational sites more often to keep informed about the functioning of operations.

Controlling organ - controlled system interaction

Surprisingly, HQ is aware of the communication problem. Moreover, they acknowledge that the lack of contact with operations causes problems like the unavailability of statistics.

The source of this communication problem has two reasons:

First, structural problems, like people at HQ are confronted with too much work so that they easily delay or avoid the extra work of communicating with operations.

Second, others identify this problem as typical cultural, especially the social distance between people that are not equal in rank. People at operations who get frustrated or delayed by the lack of control actions from HQ do not critise HQ-staff on this issue since HQ-staff is higher in rank. Consequently, the problem is not confronting them. One HQ staff member admitted that this communication problem was the most frustrating at former times when this person was stationed at the operational site. So actually, this person was very much aware of the presented problems to operational staff due to a poor communication and feedback with HQ. This person realised that now he was at a HQ's staff position, he did not communicate very much with the operational site, although he was aware of the problems this would present the operational site.

The problems described and discussed in the interaction between the controlled system and the controlling organ as well as the problems in the interaction between the controlling organ and the controlling system seem to initiate from HQ;

Concentrating on the controlling organ, this organ can be divided into two parts:

- the information system;
- the control system.

The information system collects data from the controlled system and processes this raw data into statistics to be used by the control system. Based on these statistics control actions are being submitted to the controlled system.

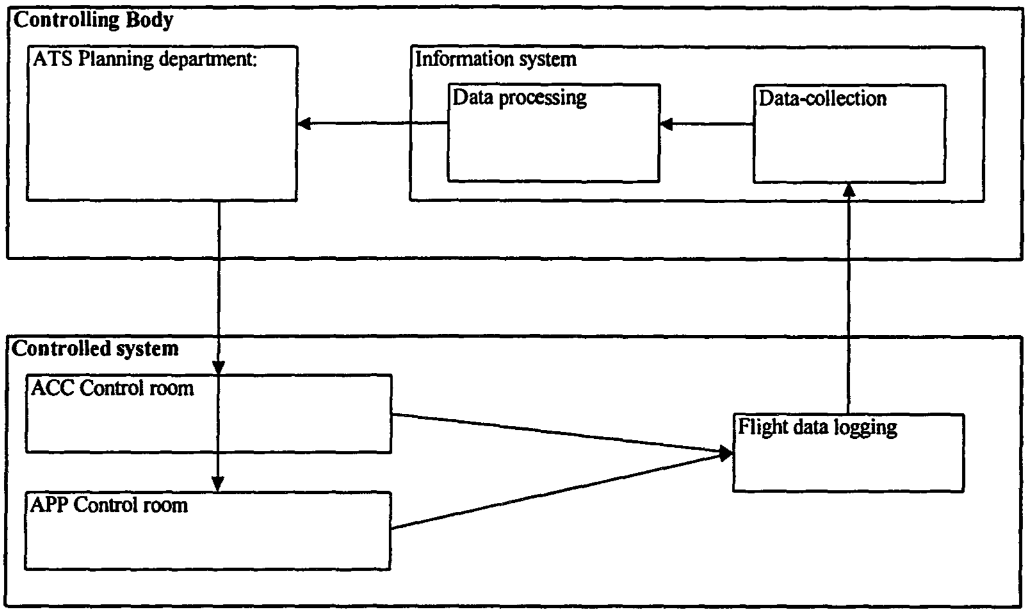


Figure 20: DCA/ATS information process model

An information system does not exist at DCA. The flight data are logged in the control rooms but are not submitted to a data-collection and data-processing department. Planners at DCA/HQ can only use the raw flight data from the logbooks in case they want to submit control actions based on the information available. As a result, control actions are submitted regardless the information available.
The reasons for this absence of an information system are already given as the problems in the controlled system - controlling organ interaction. The complete path from the data logging to the provision of statistics to the control system, we have considered to be the information system of an organisation.

3.7 Preliminary tackling of the problem

3.7.1 Introduction

Resuming, the main problem can be found in the information management from operational sites to the control system or the link from the logging of ATS data to the ATS Planning department of DCA/HQ. The control system, the ATS department at DCA/HQ, does not use statistics on which basis they issue control actions to operational sites. The complete process of ATS is untransparent, insufficiently controlled.

Bemelmans presented a model in which the relation between organisation, control and information provision were given and the plan of action for the different relations were given[6].

[6]Bemelmans, prof.dr. T.M.A., *Bestuurlijke informatiesystemen en automatisering* (Stenferd Kroese, 1987, Leiden)

Organisation designed for control means and information system	Control means adapted to control situation?			
	Yes		No	
	Information adapted to control situation?		Information adapted to control situation?	
	Yes	No	Yes	No
Yes	No action	Improve information	Improve control means	Improve control means and information
No	Improve organisation	Improve organisation and information	Improve control means and organisation	Improve information, control means and, organisation

During the field research an ATS information system appeared to be underdeveloped and not designed for control means and information systems. Consequently, in the table above, the ATS system of DCA ends up in the action to improve control means, organisation and information.
The three areas of improvement Bemelmans suggests, present different approaches to analyse an information management problem. The analysis of the organisation and the possible improvement of the organisation, is actually an actor-approach. The analysis of the control means and the possible improvement of control means is a process-approach. Finally, the analysis of the information and the possible improvement of information, we consider it to be an input/output approach. Since these three approaches differ structurally, it is very difficult to incorporate the interaction the three approaches have amongst each other without further research on this interaction. Initially, each approach is discussed separately, irrespective of the other areas. Finally, the interaction between the different areas is discussed, acknowledging the difficulties to incorporate the interaction between the three approaches.

3.7.2 Improvement of information with reference to information management (input/output approach)

3.7.2.1 General

The ICAO describes ATS Planning as a dynamic process which involves:

- seeking out facts;
- questioning established or newly proposed methods;
- searching for information.

All these points actually do refer to the information needed and the methods to gain this information to enable planning and not planning as such.

Associated with ATS Planning activity:

- overall development of civil aviation;
- established commercial air route networks;
- existing or forecast traffic flows;
- the navigation aids programme;

- the airports development programme;
- the operators fleet composition;
- future procurement programme;
- overall priorities of the many and varied civil aviation flying activities.

In the ATS department all data necessary to optimally start a planning process are available. Logically, since ATS actually does practice ATC, data are available. With these raw data it is perfectly possible to optimally plan the ATS process. Unfortunately, nothing is done with the raw data.
As already mentioned, not only direct ATS data are sufficient for planning ATS activities. The ICAO mentioned relevant activities associated with ATS Planning.

3.7.2.2 Recommendations

To improve the ATS information provision, an additional research is necessary. In this research, ATS planners at DCA should discuss in detail the information they need for the facilitation of the ATS planning. Raw data are already available, but not efficiently stored.
In the previous chapter, we have presented some methodologies to process raw data. These methodologies can serve as a basis for data processing development within the ATS department. Notice should be taken for this information to only relate directly to ATS and not containing all associated aspects of ATS as pointed out by ICAO.

3.7.3 Improvement of control means with reference to information management (process approach)

3.7.3.1 General

The analysis of information management by viewing control means is a process approach analysis, as is the analysis by means of the control paradigm. we consider the control means to be physical artefacts to facilitate the ATS information management process.
A simple process of data collection and processing in ATC is presented in figure 21. In this model, we initiated the model design from the core of ATC, i.e. the issuing of ATC information to aircraft to maintain flight safety in Tanzanian airspace (output in the control paradigm). Aircraft want to fly Tanzanian airspace and check in at DCA-ATC (input in the control paradigm). The operational data are logged and processed into statistics. Statistics are sent to DCA/HQ (Information in the control paradigm) and based on these statistics HQ gives feedback (Control actions in the control paradigm). Basically, the figure below presents the control paradigm. This strengthens the choice of taking the control paradigm as a starting point in analysing the information management problems at DCA/ATC. The environment aspect, except for the air traffic input, is not present in the figure. In this stage of the research, focus will be only on information management problems within the DCA/ATS organisation.

To analyse the control means, every block or interaction should be studied on control means used.

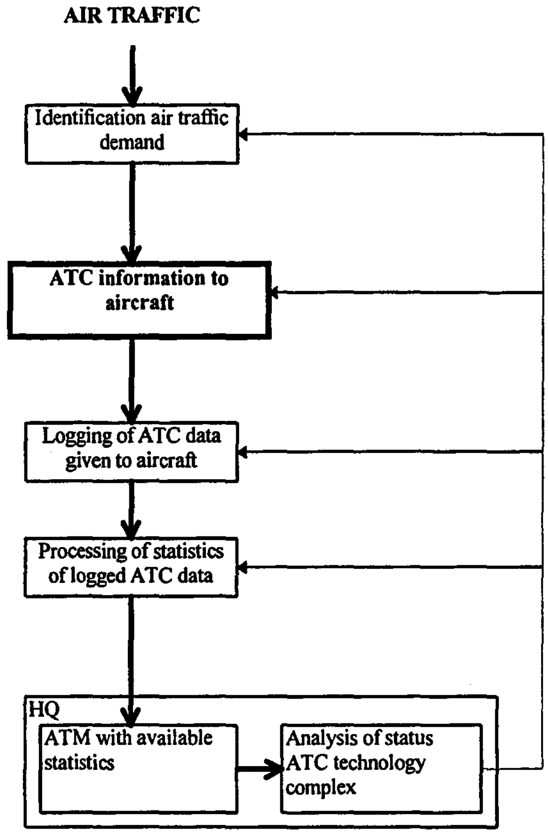


Figure 21: ATC data collection and processing

The first stages in this model, as far as data or information exchange is concerned, are automised at DCA/ATS. At DIA a computer receives all necessary data for expected flights. Via an automated telex-system, this information is sent to the correct place. ACC, for instance, will receive all necessary data about ACC flights and relevant other flights, straight into their control room, where this data are due for further processing on the Flight Progress Strips (FPSs). On the paper FPSs, ATCOs note the contact they had with controlled air traffic in ink. In Chapter 2, the data on the FPSs have been already mentioned. Then, after finishing controlling a flight, the FPS is submitted to an assistant ATCO, who logs the data of the FPS in the paper ACC logbook by pen. Of all data on the FPS, this person notes the flightnumber, the aircraft type, place of origin, and place of destination. The FPSs of one day are bundled and put into a closet and kept there for at least one month. The logbooks are filled until they are full. With a wild guess, we think a logbook contains about 6 months of even or odd days of controlled air traffic. There are two logbooks, one for even days and one for odd days. The full logbooks are submitted to the superiors at HQ if requested. Otherwise, they end up in a closet at DIA.

This exposition reflects the situation for flight data processes at DCA/ATS as it is.
Control means used:

- computer to receive air traffic to be controlled and other relevant flight information;
- telex-net to distribute the computer received messages and to submit messages;
- conventional (paper) Flight Progress Strips;
- conventional (paper) logbooks.

Not much is done with the logbooks in HQ. It appeared that no control means are structurally being used to submit control actions. More or less, control means are very 'soft'; the person at HQ 'feels' that a specific control action is justified. Without monitoring the functioning of the ATC system or the effect a control action has on the functioning of the ATC system, it is quite easy to loose contact with the operational ground. Subsequently, control actions could increasingly deviate from ATC's actual needs.

3.7.3.2 Recommendations

Improvement of control means seems obvious. The biggest problem is that to process the raw data from the logbooks into usable statistical data for the planners at DCA/HQ takes too much time.

- *(i) The data from the FPSs should be entered into a spreadsheet program instead of writing data into a logbook.* In this manner, it becomes easier to process the raw data into appropriate statistics.
- To accomplish this, *(ii) a desktop computer should be installed at the control room at DIA/ACC.*
- The person, now writing the FPS information in the logbooks should insert the data into a spreadsheet program and, therefore, should receive *(iii) a computer course.*
- *(iv) The data from the spreadsheet have to be submitted to DCA/HQ on a frequent basis, e.g. every week.*
- *(v) Staff at DCA/ATS at DCA/HQ should process the data into appropriate statistics.* They know best what statistics they need.
- Therefore, *(vi) staff at DCA/ATS should develop a computer program to automatically process raw data into appropriate statistics.*
- Since the knowledge to develop such a program is currently not available at DCA, we recommend *(vii) that HQ applies for a computer science student to study this problem as a subject for the student's final practical training.*
- Finally, we recommend *(viii) that DCA/HQ submits produced statistics on a reasonable frequent basis (every 3 months) to operational grounds to keep operations informed about their functioning and to build up an information institution within DCA.*

3.7.4 Improvement organisation with reference to information management (actor approach)

3.7.4.1 The DCA ATS (Planning) Organisation

The structural set-up of the DCA organisation does identify with the organisation the ICAO recommends in the ATS Planners handbook. Figure 22 presents the DCA/ATS organisation. An elaboration of the organisation follows the figure.

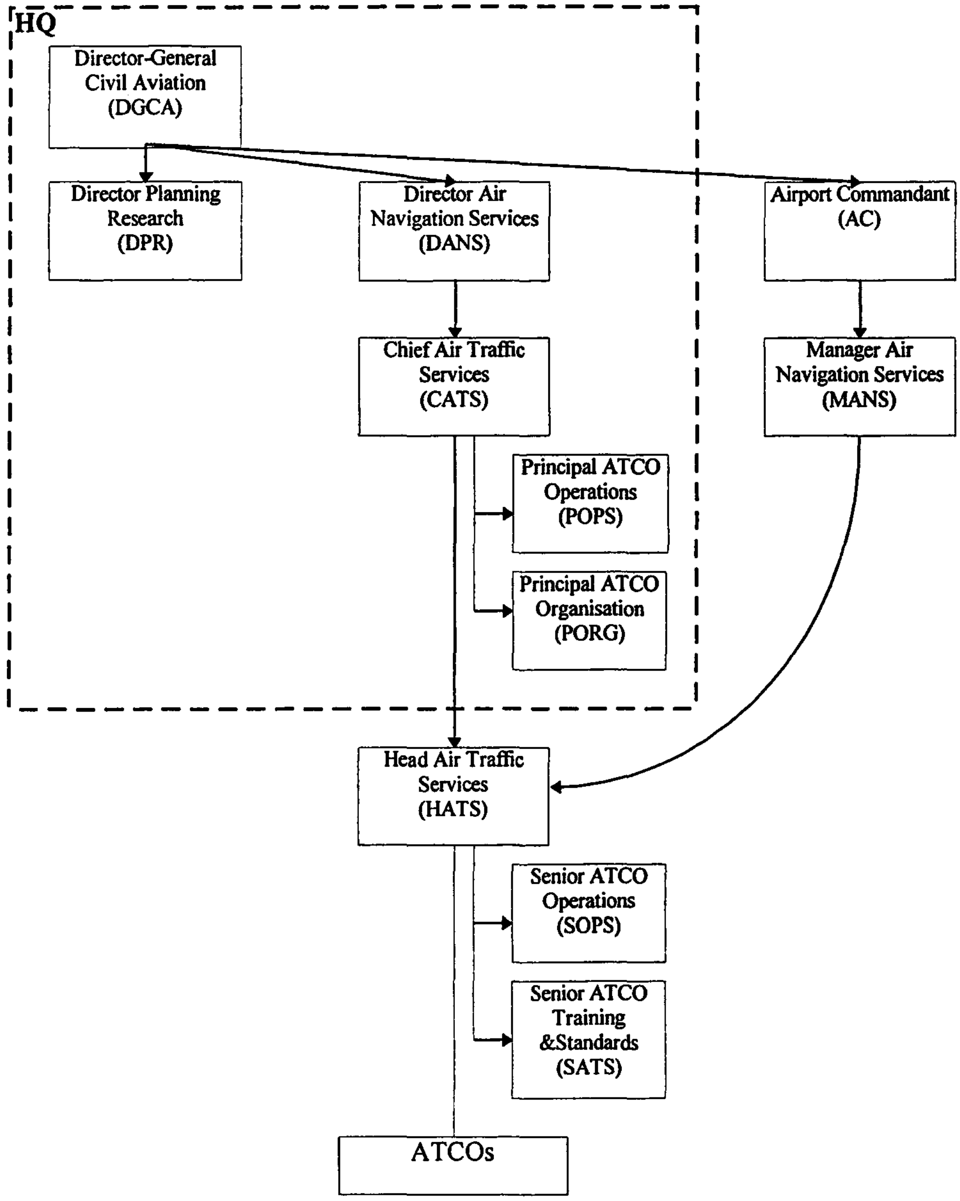


Figure 22: The DCA/ATS organisation

The figure does not present the entire DCA organisation but only the ATS organisation as seen from a bottom-up approach. First, the ATCOs, who actually operate ATS, until the Director-General of Civil Aviation (DGCA), who is responsible for civil aviation activities in Tanzania.

ATCOs are responsible to the Head of Air Traffic Services (HATS), who is also stationed at the airport. The HATS is responsible to the Chief of Air Traffic Services (CATS) with as main task: the supervising of ATS operations to ensure that all units operate in accordance with approved policies, standards, and procedures. To accomplish this task, HATS is assisted by a Senior ATCO Operations (SOPS) and a Senior ATCO Training & Standards (SATS). The supervisor officer of HATS is CATS, who is stationed at DCA/HQ. The CATS is responsible to the Director of Air Navigation Services (DANS) for mainly:

- evolvement and implementation of ATS policy in Tanzania;
- management, monitoring and quality control of ATS in Tanzania.

Appendix I presents the complete terms of reference of the CATS.

To accomplish his/her task, CATS is assisted by a Principal ATCO of ATS Operations (POPS) and a Principal ATCO of ATS Standards and Training or PATCO of Organisation (PORG). As the HATS, the POPS is responsible to the CATS for supervising ATS operations to ensure that all units operate in accordance with approved policies, standards and procedures. POPS is senior to HATS. Also, POPS has to advise on operation organisation of ATS being provided and has to participate in the ATS planning functions of the ATS Division. Appendix I presents the complete terms of reference of POPS.

PORG is responsible to the CATS for amongst others: the arrangements for medical examinations, ATC Licensing and rating boards, the preparation of the ATS establishment and manpower utilisation, the analysis of ATS training requirements co-ordination with CATS for preparation of training programs. Also, PORG has to participate in the ATS Planning function. Appendix I presents the complete terms of reference of PORG.

CATS is direct responsible to the Director of Air Navigation Services (DANS). DANS is responsible for about 250 officers within ANS. DANS is responsible to the Director-General of Civil Aviation for, amongst others,:

- the overall management and direction of the ANS department which consists of 4 departments: Engineering, Communications, Air Traffic Services, and Aeronautical Information Services (AIS);
- policy advisory to DGCA concerning ANS,
- implementation ANP for AFI region and ICAO recommendations;
- present DGCA at international meetings;
- preparation ANS budget;
- permits co-ordinating.

DGCA: Director-General of Civil Aviation

DPR: Director of Planning and Research

DANS: Director of Air Navigation Services

AC: Airport Commandant

MANS: Manager Air Navigation Services

CATS: Chief ATS

POPS: Principle ATCO Operations

PORG: Principle ATCO Organisation

HATS: Head ATS

SOPS: Senior ATCO Operations

SATS: Senior ATCO Training & Standards

The functions described above handle the operational ATS. To facilitate ATS an operational site at DIA is operated. Airports fall under another department than ANS, i.e. airport department. The Airport Commandant (AC) is responsible to the DGCA for the overall management of the airport. Thus, one main task of AC is to integrate ATS tasks and airport tasks as well as possible. The AC is assisted in this task by the Manager of Air Navigation Services (MANS), who is managing the Air Navigation Services in the ACC at DIA. The MANS is the senior officer at DIA/ACC, Thus senior to HATS in management aspects, not in ATS operational aspects.

3.7.4.2 DCA/ATS organisation characterisation

It is quite difficult to characterise an organisation. However, we characterise the DCA/ATS organisation as a service company that places airspace at operators' disposal according to the classification that Starreveld produced[7]. With this classification DCA could check other service companies' that place space at one's disposal for their information management organisational methodologies, as we did with the Dutch ATC, the LuchtVerkeersBeveiliging (LVB). Unfortunately, the ATC companies all over the world are not developed as much as today's technology permits as far as information management in operational ATC is concerned. The first serious steps are already taken by some Western ATC companies, but it is still far from establishment. The LVB does also not have an information management system for ATS route data. ICAO documents stress the importance for an efficient information system but that is all the ICAO does.

[7]Starreveld, R.W., De Mare, H.B., de en Joëls, E.J.: *Bestuurlijke informatieverzorging* (Samsom, Alphen aan de Rijn, The Netherlands, 1981)

Another organisational characterisation is from Mintzberg[8]. Mintzberg classifies organisations according to their structure. The DCA/ATS organisation can be classified in the machine bureaucratically structure. In these organisations emphasis is put on standards and a lot of decisions are submitted by experts. The advice of an expert has the main role in the decision making process. For the information provision this means that in bigger organisations as normally machine bureaucracies are, planners usually control at a distance. This means:

- that there is a need for reports , on time and easy to read;
- there are longer procedures to reach a decision about bigger investments;
- there exists a difference in addressing, detail and transparency of information on different levels in the organisation. For machine bureaucracies this means that information is different for various levels in the organisation and strongly focused on efficient functioning[9].

With these characteristics, the DCA/ATS organisation is caught in a theoretical framework. To elaborate on information management within DCA/ATS within this framework, first an actor model with reference to information management should be presented.

3.7.4.3 Actor model with respect to ATS information

Below, a model is presented of the present information management structure within the ATS department of DCA. The control paradigm and the ATS personnel are integrated in this model.

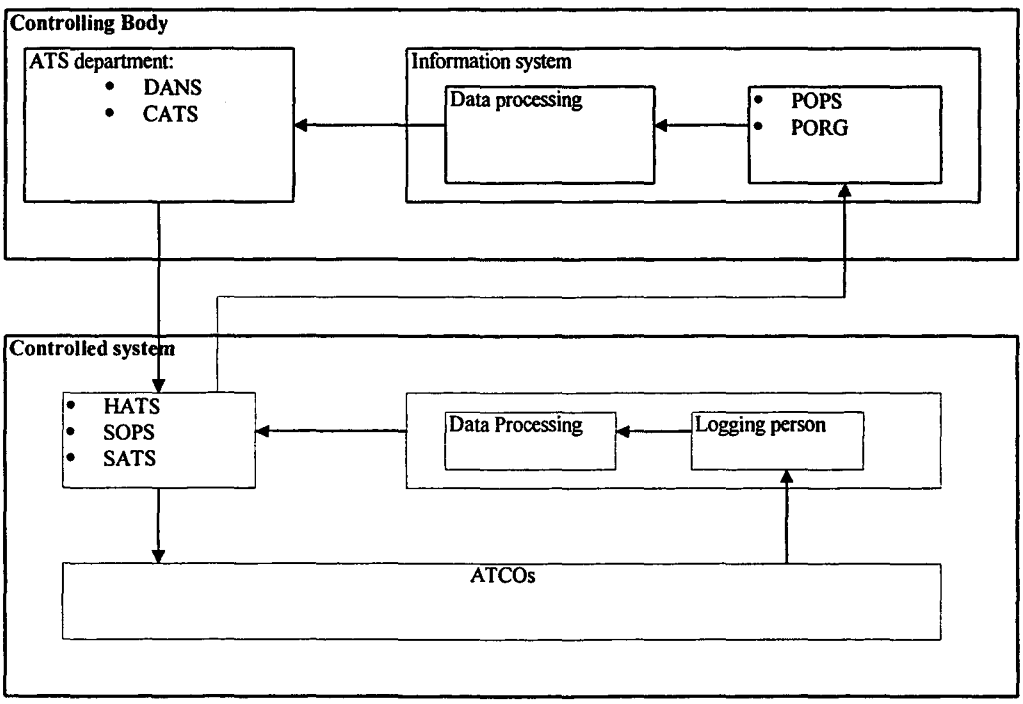


Figure 23: DCA/ATS actor model

[8]Mintzberg, H., *The Structuring of Organisations* (Prentice Hall, Englewook Cliffs, 1979)

[9]Thiadens, T.: *Informatieverzorging in organisaties* (Academic Service, Schoonhoven, The Netherlands, 1995)

Within the operational organisation, the controlled system, a similar structure can be seen as in the controlled system - controlling organ interaction of the control paradigm. This approach is necessary to enable the presentation of an actor model. In both the controlled system and the controlling body, the data processing functions are vacant.

For the controlled system it is not clear if the data from the logbooks should already be processed before submitting the data to the supervising officers at DIA. Probably, the statistics that HATS, SOPS, and SATS need are equal to the data planners at DCA/HQ need. Therefore, the data processing step at the operational site can be skipped. Information should be strongly focused on efficient functioning, as the characterisation of Mintzberg stated.

3.7.4.4 Recommendations

Statistics must be produced by planners and not by operations. Planners must work extensively with these data and know best the format in which they are able to efficiently work with statistics. In the interviews, staff at HQ wanted statistics to be produced at operational sites. Operational sites believed statistics should be produced at planners' sites. we agree with the latter; *(i) HQ should produce operational ATS statistics based on raw data from operational sites.*
Main problem is the additional workload for staff at DCA/HQ. POPS is the most logical person to carry out this task, but already POPS' workload is very high. *(ii) HQ must attract an extra staff member to develop and maintain an appropriate information system for both operational and planning sites.* With reference to the coming organisational changes of DCA becoming a government agent, the need for a sound information system will become bigger. DCA must present its output in a transparent manner. This strengthens the need for a staff member on information system matters.

3.7.5 Interaction in organisation, control means, and information changes/improvements

The previous section discussed the improvement of organisation, control means, and information with reference to information management without including possible interactions in these three areas. The influence of, for example, organisational changes in information management was discussed. Since organisation, information and control means are linked, a change in one of these areas is likely to initiate a change in another area. This section discusses these interactions.

Information changes

With information changes, DCA personnel will be confronted with the advantages better information has in the ATS planning process. This could initiate the desire to improve control means and organisation with reference to information management. However, an improved information system is not to be expected from the DCA organisation, since the organisation does not have an information system. Initiatives have to come from outside the information, like ICAO, or from these words. It would be better to initiate an information culture from the DCA organisation itself. Adjustments in the DCA/ATS organisation with reference to information are necessary to develop an information system from within DCA/ATS.

Control means changes

Control means changes will have a motivating influence on the production of information. It will, however, not have a significant influence on the organisation and, therefore, not a maximum influence on the change of type of information since this change has to be initiated from the planning organisation. With improved control means, people are motivated to search for more ways to use information, but this will be in a rather unstructured way, thus not very efficient. Control means must be seen as facilitator to produce information, not as facilitator to set up an information culture in the DCA organisation.

Organisational changes

DCA's organisational structure leaves little space for the improvement in information management. As discussed before, it seems that problems in information management are highly influenced by the organisational structure. The rigid hierarchical structure makes it very hard to initiate an information-based organisation. As a result, DCA staff lack the motivation to set up an information-based planning organisation. A change in organisation could strengthen the motivation to initiate a sound information system and could ease the acquisition of appropriate control means.

From the sections above it appears that the improvement of information management of the DCA/ATS organisation must be carried out in the information, control means, and organisation area. Especially, changes in the organisation of ATS would have the biggest influence on improvement of the information system. Chapter 4 discusses the change of the DCA organisation into a government agent instead of the current government owned structure.

3.8 Evaluation

From the previous chapter it became apparent that a main bottleneck was found in the management of ATS data. In this chapter, we have first of all described the organisational aspects of ATS and ATS planning as it is seen from the international aerospace environment embodied by the ICAO. From this information it became apparent that the sound management of information plays a very important role in ATS planning. Especially for activities as co-ordinated policy, described in this chapter, and economic planning, not described in this chapter, the importance of efficient information use was indicated. From the theoretical part submitted by ICAO and described above concerning the ATS Planning Organisation, the following keywords came forward discussing ATS Planning: forecasting of future requirements, development alternative ways of meeting requirements, devise ways and means to meet objectives, feedback. In other words; ATS planning activities are facilitated by a sound information management system.

Focus on the information management within ATS was put by means of the control paradigm. The DCA/ATS organisation has been described based on this model. Problems were found by means of interviews with ATS staff and operational staff and by means of observations. It appeared that DCA/ATS had the biggest problems in the interaction of the controlled system (the operational ATC) and the controlling organ (ATS staff at DCA/HQ). The lack of information initiated from a non-existing information management history, a very non-transparency and non-communication in the organisation. Both staff at HQ and DIA were not sufficiently aware of each other's activities. People at DIA were very frustrated about the management from HQ, and were unable to communicate efficiently

with HQ. The motivation to develop an information management system was not present, not in the last place because of a rigid hierarchical organisation.
According to a model from Bemelmans, the DCA/ATS organisation should improve control means, information and organisation to set-up a information management system. The research was focused on these three areas in the remainder of the chapter. It appeared that especially improvements in the organisation would yield improvement of information management. DCA was indicated as a machine bureaucratic organisation, according to a model from Mintzberg. This characterisation emphasised the importance of a sound information system. Moreover, it emphasised the importance of the relation between organisation and information. It can be said that an improvement of information management is especially to be searched for in the organisational structure of the DCA/ATS organisation. From the interviews and observations, especially personal or human imbalances appeared to initiate information management problems. Even when discussing the possible improvement of only control means or information with reference to information management, organisational changes do come forward. Therefore, organisational improvement would have the biggest impact on the development of a sound information system.

The next chapter discusses what influence a change of organisation into a more private organisation would have on information management.

3.9 Conclusions

Information management presents DCA/ATS with a major technological bottleneck. With reference to. the comment about the information management, we have to say that the people at DCA are very much aware of the information problem. They even know (some of them even use it as a credo); information is power! So remarks about that DCA should do more about information management are justified and initiate a little push towards real improvement of information management, but the real solution for the problem is not the reduction of the lack of awareness for the poor information management. The real problem is in the poor motivation people have, and the rigid organisational structure of DCA.
It became clear that a non-transparent organisation, insufficient communication between operational sites and DCA/HQ, insufficient feedback from DCA/HQ to operational sites, a rigid bureaucratic organisation, absence of an information based organisation initiate the lack of motivation to develop a sound information system. Adjustments in the organisational sphere would give the biggest impact on information management improvements. People at DCA/ATS must be motivated to develop such a information management system. This will be best done by improving the transparency of the DCA/ATS organisation, especially to be improved by DCA/HQ. Feedback from HQ to operational sites is insufficient. People at operational sites get frustrated about working practices; they feel 'abandoned' by HQ. Additionally, the rigid structure of the organisation should be more flexible. People shrink from the effort to be done to take initiatives in a believed positive development. The rigid organisational structure makes it very hard for people to obtain information or to go for changes in the existing structure and on top of that the motivation lacks to do all this effort of making DCA a more effective company. DCA's organisational structure should really be more flexible and open for their employees. This alone would already incentive motivation.

Positive development is also to be expected in the information sphere and in the control means sphere. Little adjustments in control means could have major impact in the improvement of information management. Logging of ATC data should be computerised. This would facilitate the easy processing of raw data into statistics to be used in the planning process. Information improvements are already discussed in chapter 2.

Chapter 4

COMMERCIALISATION: FUTURE CONSEQUENCES FOR DCA'S TECHNOLOGICAL COMPLEX

4.1 Introduction

The political climate in Tanzania has recently been characterised by efforts to liberalise State Owned Enterprises (SOEs). This has been mainly the result of great balance of payment problems during the 1980s. The IMF and the government of Tanzania decided to adopt a more market oriented economy in which, among others, privatisation of SOEs is planned. The government of Tanzania now has listed 17 companies which should become autonomous government agents in the second part of the 90s. DCA is one of the first SOEs which is becoming an autonomous government agent.

In this chapter, the problems identified previously are viewed against a changing DCA organisation. Several autonomisation experiences of government owned and controlled ATC organisations that became autonomous government organisations, showed that the problems identified in the previous chapter were influenced by the changing organisation[1].

The last part of chapter 3 revealed that a change of organisation would have the biggest impact on the information management bottleneck. The causes for the technological bottleneck were fundamental: motivation problems, untransparant organisation, hierarchical structure which causes changes to be implemented to be very slow. These problems must be solved at the very basic of the ATC technology complex. we reckon this would be the manner in which to work with this technology complex, i.e. the organisation of ATS.

4.2 PRIVATISATION METHODS

4.2.1 The World Bank Methodology

Vuylsteke gives the following definition of privatisation: *privatisation is the transfer of commercially orientated State Owned Enterprises (SOEs), activities or productive assets of the government to total, majority or minority private ownership or to private control*[2].

The choice of privatisation techniques is generally a function of the government's objectives, the SOE condition and its sector of activity and the country characteristics. Obviously, the profitability of an SOE is one of the determinants of how easy or how difficult its sale will be (Vuylsteke, World Bank technical paper 88, p.4). Each case must be examined on its own merits. Probably, the method of privatisation is different for each case. Still, the World Bank identifies 7 basic methods of privatisation which will be discussed and summarized below.

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[1] *Aviation Week & Space Technology* (May 16th 1994, p.36-54)

[2] Vuylsteke, C., *Techniques of Privatisation of State-Owned Enterprises*, Volume I, Methods and Implementation (World Bank Paper Number 88)

Basic Privatisation Methods

The most common used methods of privatisation are:

Method	Characteristics	Preferred Applications / Special Features
Public offering of shares	The state sells to the general public all or large blocks of stock it holds in a wholly or partly owned SOE.	Public offering requires that: (i) the enterprise be a sizeable going concern with a reasonable earning record or potential, or that it can be readied to become so; (ii) a full body of financial, management and other information is available or can be prepared for disclosure to the investing market; (iii) there is a discernible liquidity in the local market; and (iv) either the equity markets are developed or there is some structured mechanism (including a regulatory body) that can be made to function to reach, inform and attract (as well as protect) the general investing public. It meets the government's objective to encourage widespread share ownership.
Private sale of shares	The state sells all or part of its shareholding in a wholly or partly owned SOE to a pre-identified single purchaser or group of purchasers.	Because of their flexibility, private sales are the preferred method with weak performing SOEs or SOEs in need of stronger owners with relevant industrial, financial, commercial and other experience and a high financial stake in the success of the firm. It may also be the only feasible alternative in the absence of developed equity markets, where no mechanisms can be developed for reaching the general investing public, and where the size of the enterprise may not justify a public offering.
New private investment in an SOE	A government may wish to add more capital to an SOE (mostly for rehabilitation and for expansion) and achieve this by a capital increase opening equity ownership to the private sector. The main characteristic of such a privatisation method is that the state is not disposing of any of its existing equity in the SOE. Rather, it increases the equity and causes a dilution to the government's equity position. The resulting situation will be joint private/government ownership of the enterprise (often referred to as joint venture).	This method is the preferred one for dealing with funding problems of under-capitalised enterprises. A new issue may be combined with an offering of existing government shares. In addition, it should be considered where the sudden sales of government holdings in several SOEs may be politically difficult to authorise and carry through, in that the transformation of an enterprise into a joint stock corporation with very limited private participation may be popular (e.g., investors provide equity financing to a debt-ridden public enterprise). Governments are likely to favour joint ventures with foreign companies so as to gain management and other expertise in addition to capital. Once the transformation has taken place, further privatisation through a gradual transfer of government owned shares can take place more easily. In some circumstances, this privatisation method may be applied to strengthen SOEs which the government intends to keep in the state portfolio. In summary, this will be the preferred method if a government's objective is both to reduce its proportionate shareholding or change the state/private mix in the SOE and if the enterprise is in need of capital.

Sale of government of SOE assets	The transaction consists basically of the sale of assets, rather than shares in a going concern.	By definition, a sale of assets involves a known party and in that sense it may have the same advantages as a direct sale of shares. In addition, it offers additional flexibility in that it may be more feasible to sell individual assets than the whole SOE or it may permit the sale of an SOE that might be extremely difficult to sell as a going concern. This approach may result in residual liabilities for the government. In many cases of SOEs that are not saleable as going concerns, the sale of assets is the preferred method.
Reorganisation (or break-up) into component parts	This method involves the breaking-up or reorganisation of an SOE into several separate entities or into a holding company and several subsidiaries. This technique can be regarded simply as a form of restructuring prior to privatisation. However, since it is found to be a distinct action with many applications in developing countries, it is dealt with as a separate form of privatisation.	This method permits piecemeal privatisation. It further permits different methods of privatisation to be applied to different component parts, thereby possibly maximising the overall process. If an SOE incorporates too many activities, that in the aggregate, are not attractive to potential investors, whereas individual units would be, fragmentation is a possible alternative. Sometimes, the government wishes to sell only certain components of the SOE, while retaining others. Or sometimes it is found that certain activities are better handled by the private sector, whereas global operation might not be. **This could make sense for the ATC case.** The regulatory and controlling part could never be privatised since enterprises might pursue lower safety standards to reduce costs. Another reason for fragmenting an SOE may be that it is a monopoly and that the government would like to fragment it into separate enterprises to create competition.
Management/ employee buyout	The term management buy-out (MBO) generally refers to the acquisition of a controlling shareholding in a company by a small group of managers. The special characteristics of the financing arrangements for management buy-outs is that the financiers provide the bulk of the funds but take a disproportionately small part of equity; on the other hand, the buy-out team obtains a large share of the equity but provides a small proportion of the funding	Management/employee buy-outs are a relevant means of transferring ownership to management and employees with little wealth or knowledge of share ownership and may be a solution for SOEs not otherwise saleable. They also constitute an enormous incentive to productivity. Management/employee buy-outs require the presence of competent and skilled management and a committed and stable work force. A strong cash-flow is usually a precondition for obtaining credit for a buy-out.

Lease and management contract	Both leases and management contracts are arrangements whereby private sector management, technology and/or skills are provided under contract to an SOE or in respect of state-owned assets for an agreed period and compensation. While there is normally no transfer of ownership and therefore no divestiture of state assets, these arrangements can be used to "privatise" management and operations and thereby possibly increase the efficiency and effective use of state assets. Leases and management contracts are more often used as temporary measures.	Leases and management contracts are the principal method of privatisation of an activity in situations where privatisation of the ownership of the assets or SOE is not appropriate. The lease may also be used as an intermediate solution aimed at making a subsequent sale possible. Similarly, the management contract may also be an intermediate solution in turning an enterprise around for subsequent privatisation of ownership. Leases and management contracts may be particularly attractive in situations in which the state may not be able or willing to divest itself of the ownership of an SOE or certain productive facilities but still wishes to see the activity taken over or managed by the private sector. Leases and management contracts are tailored to meet specific circumstances. The choice of a lease as opposed to a management contract depends on the government's objectives and the state of the enterprise in question. If the enterprise is run-down and unlikely to respond to external management expertise, it may choose to lease certain assets or facilities that generate revenues. The lease is also an important alternative if all operations of the SOE had ceased. On the other hand, if the enterprise is merely in need of a short-term injection of management or other skills to restore it to profitability, a management contract might be appropriate. Beside being a good intermediate solution, the lease can be the preferred method because of a variety of other reasons such as tax advantages to the lessee, overcoming constraints to land title, as well as overall flexibility. It permits the introduction of timid investors to a venture to be privatised and it helps overcome financing constraints.

4.2.2 ICAO comments on autonomisation

The ICAO comments on autonomisation in the Airport Economic Manual[3]. In this manual the ICAO addresses various aspects of the organisational structures of airports in which the operation of route facilities and services is included.

Autonomisation of ATC organisations would positively effect:

- the efficiency of the ATC organisation;
- the financial situation of the ATC organisation;
- productivity and motivation of ATC personnel;
- the strategic position of the organisation in general;
- the strategic position of the organisation in financial, technological, and labour contract negotiation;
- ATC's services fees.

[3] ICAO, *Airport Economics Manual* (Montreal)

The ICAO states that the main objective to establish an autonomous organisation is to improve the efficiency and finances of the organisation concerned. However, profitable operation may not be possible for reasons beyond the control of the authority or Sate concerned, such as low traffic volumes. Still, autonomisation experiences indicate that where airports (as route facilities) have been operated by autonomous authorities their overall financial situation tended to improve. Consequently, ICAO generally recommends that States consider the desirability of establishing authorities to manage airports, route facilities, or both, where improved efficiency and financial results would be achieved.

ICAO emphasises that many significant financial advantages may be achieved by vesting an airport authority with the necessary financial autonomy, including control over the use of airport generated revenues. Notably, it permits and encourages airport management to exercise closer control over revenues and costs. It also offers the possibility of negotiating loans best suited to meeting the airport's needs. Moreover, it places the airport in a stronger position regarding other financial matters such as in the negotiation of concession contracts, and in industrial relations, for example when negotiation labour contracts or establishing the remuneration of staff.

With regard to personnel, an autonomous authority is not required to use the civil service charter and the salary structure applied by the Government for civil servants, but could offer more advantageous terms to personnel and thereby increase motivation and productivity.

4.2.3 Privatisation experiences in ATC organisations

4.2.3.1 General

During the research, we have studied the privatisation experiences of other ATC organisations than the Tanzanian. ATC organisations are standardised and can be compared. In chapter 3, this was already attempted with the methodology of Starreveld[4].

Most of the information on privatisation experiences, we obtained from articles in the magazine *Aviation Week & Space Technology*[5]. For a major part, these articles focus on organisational developments within the ATC environment of the United States of America. Additionally, we have interviewed people from the Dutch ATC, who in the beginning of the 1990s, experienced some form of privatisation.

In nearly all cases, the government remains in charge of the regulatory safety function, while management of operations is given over to a government-owned corporation. In case the ownership of the ATC remains in government hands, it is not justified to speak in privatisation terms, but in commercialisation terms instead. Both the privatisation and commercialisation process are used to bring market forces into the organisation. In the research, focus was on the process of organisational change to bring market forces into the organisation.

The creation of a private air traffic control corporation would shift responsibility from the government to the private sector. A major policy change to foster system modernisation and increase efficiency without sacrificing safety.

[4] Starreveld, R.W., De Mare, H.B., de en Joëls, E.J.: *Bestuurlijke informatieverzorging* (Samsom, Alphen aan de Rijn, The Netherlands, 1981)

[5] *Aviation Week & Space Technology*, May 16th 1994, p.36-54.

4.2.3.2 US Air Traffic Services Corporation

The ATC organisation would be a financially independent, autonomous organisation, funded primarily by user fees.

Impact on efficiency and financial situation

The organisation would be able to borrow form the private sector as well as from the government treasury. This is a crucial policy change for an ATC organisation. Currently, the FAA must submit its budget to Congress, where it is subjected to the annual appropriations process. Proponents of USATS (the private ATS corporation) say that this requirement is largely responsible for the agency's inability to modernise the ATC network.

Proponents of the privatisation of ATC services all agree -even the opponents agree on this point- that privatisation of ATC services will improve the efficiency of the autonomous organisation, especially when modernisation is concerned. This would be mainly the result of the possibility to avoid the bureaucracy of governments. ATC organisations should be able to work more flexible.

Impact on strategic position (general)

Another key development is in the dual responsibilities of operating the ATC system and ensuring compliance with safety regulations designed to make the system safe. Board of Directors will also include users of the system. They would have a direct role in making policy and taking financial decisions affecting ATC services and fees.

Impact on strategic position (technological)

The new organisation would adopt a system of preselecting contractors and suppliers based upon demonstrated performance not on "best value" or past performance. The competition in Contracting Act requires the FAA to solicit bids from all potential vendors, regardless of their qualifications or expertise in the area in question. The act compounds its slowing effects by requiring competition at each stage in the life of a program. The result may be changes in vendors at mid-stream, which creates further delays and loss of continuity as a new vendor gets up to speed. Among the relieves the study recommends is creating simplified acquisition guidelines for the proposed US Air Traffic Services Corporation (USATS). Additionally, contractors for a technology should be selected from a list of those who have proven past performance and demonstrated technical competence. Furthermore, the corporation should have the freedom to use a contractor across the life of a program without additional competition, if the supplier's performance had been superior and staying with the contractor if that were a good business decision. Potentially more controversial is the recommendation that "USATS be permitted to negotiate a sole source contract if good business reasons (cost, timeliness, continuity, efficiency, etc.) justify such practices."

System users also would participate in the early stages of the acquisition process to help ensure that programs and equipment will meet operational and performance demands.

Impact on strategic position (labour)

In addition, the corporation would adopt policies to attract and retain qualified employees -an ongoing problem of FAA- because of the plethora of rules and regulations governing personnel. It also would expand employee involvement in the operation of the organisation; create a more flexible requiting, hiring and placement system, and develop a new compensation schedule.

Impact on ATC's services fees

Impact of a change is not just limited to the civil aviation organisation alone. All users of this organisation are about to feel the impact this change will have. Commercial airliners, general aviation, charter airliners etc.

The Transportation Department's Executive Oversight Committee (EOC) in the USA on the future of the ATC system has recommended that direct user fees be assessed only in those cases that would not discourage the use of ATC services. As a consequence, only commercial operators will be responsible for paying user fees.

General aviation is an integral part of the nation's air transportation system, and its use for business transportation by companies as well as entrepreneurs is essential to the economic growth of the country.

Air traffic control privatisation issues have yet to be resolved in the US, but the experiences of some nations show positive results. Some opponents argue that the privatisation and the research of how to improve the organisation into a corporation will cost too much. The money would have been better spent by using their talent and expertise to create a more efficient system, not a new corporation.

4.2.3.3 The Deutsche Flugsicherung GmbH. (DFS)

The arguments for privatising or corporatising air traffic services are generally the same from country to country. Dieter Kaden, the chief executive of the Deutsche Flugsicherung GmbH. (DFS), listed the most significant weaknesses of the old system as: hierarchical civil service structure, personnel recruitment policies, and the rigid procurement system within the German government budget. Privatisation or corporazation of DFS would, consequently, have a major impact on the efficiency of DFS, the financial situation of DFS, and the strategic position of DFS with reference to labour.

4.2.3.4 Airways Corporation of New Zealand

The *Airways Corporation* of New Zealand showed the benefits of ATC privatisation[6]. New Zealand's Airways Corp. earns high marks for lowering operating costs and improving the nation's air traffic control services as the world's first fully commercial national air traffic control organisation.

Created in 1987, Airways is a government-owned monopoly. But it pays taxes, raises its revenue through user fees and is expected to pay dividends to its shareholder, the government.

Impact on efficiency

The system is now handling 1.1 - 1.2 million movements a year -in a nation of just 3.1 million persons. In the last 7 years, Airways has reduced staffing from the 1,055 handling air traffic control for the old Air Transport Div. to 655, the majority of those lost as "layers and layers" of management.

Impact on financial situation

Within the first year of its founding, Airways Corp. reversed operating losses of the Air Transport Div. of about NZ$10 million a year and turned a NZ$4.2 million profit. Valued at NZ$51 million when purchased, the company was worth NZ$164 million at the end of its last fiscal year, June 30th 1993.

Profits have been consistent. In the last fiscal year, Airways reported a NZ$11 million net profit.

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[6]Mecham, Michael, *Aviation Week & Space Technology*, Airways Corp. leads way in ATC commercialisation, May 16th, 1994.

Impact on strategic position (general)

Still concern about the safety of ATC in New Zealand exists, mainly caused by the aggressive business-like policy of ATC. Some regional airports are on the verge of being excluded from ATC coverage because of bad economic performance of these airports. One of the critics, an Airways official commended: "We are not running a public service, we are running a business" (Aviation Week & Space Technology, May 16th, 1994, p.45).

Impact on ATC's services fees

Since the profit exceeded expectations, instrument flight rule fees were cut by 10%. The discount reflects a government policy of recognising that Airways is a monopoly so profits that exceed targets should be returned to users.

The greater efficiency they have reached resulted in lower service charges. For instance, the flight fee for a Boeing 737 from Auckland to Wellington, a distance of 258 naut. mi., had dropped from NZ$2,187 in 1987 (about US$1,300 in 1994 dollars) to NZ$653 (about US$386) at the end of 1993.

4.2.3.5 ATC Holland

Background of commercialisation

In Holland, the Minister of Transport and the Minister of Defence are responsible for the safety of the air. Under the jurisdiction of the Minister of Transport is the Rijksluchtvaartdienst (RLD), the Dutch administration of civil aviation, with at the top the Director-General. The Luchtverkeersbeveiliging (LVB), the ATC organisation in Holland, has been a part of the RLD for many years as one of the directorates. Since the beginning of the 1990s the LVB has transformed into an autonomous organisation. A board of Directors takes care of the contacts between the LVB and the RLD and the Ministers and the companies outside the LVB-organisation.

The change of statutionary organisation into an autonomous organisation is best comparable with the World Bank privatisation method of the reorganisation in components parts or fragmentation of the organisation.

The direct incentive of the LVB to privatise has been a loan conflict between the RLD and the LVB-group of the RLD. The Dutch Upper Airspace had just been taken over by Eurocontrol in Maastricht and these controllers received more money for their control jobs than the LVB controllers. The RLD did not respond to the demands of the LVB controllers to raise their salaries. As a result, the LVB organisation believed that they were quite obstructed by the overall organisation of the RLD with its extensive government participation. Therefore, the LVB proposed the change into an autonomous organisation. A major policy reform designed to foster system modernisation and increase efficiency without sacrificing safety. In the early 90s the Dutch government approved the plans.

Impact on efficiency

The acquisition processes delayed modernisation very much, sometimes even resulting in investments of already out-of-date material. The impact of such delays on ATC systems is greater than in other areas of government because of the rapidly changing technology (Privatisation may speed ATC Systems Acquisitions, *Aviation Week & Space Technology*, May 16th, 1994).

Impact on financial situation

The LVB is now an autonomous organisation that is financially independent and funded by user fees. A crucial policy change for the LVB corporation is its ability to borrow capital from the private sector and the treasury. The LVB used to submit its budget to the government, where is was subjected to the annual appropriations process. This method of acquiring capital is held responsible for the inability to modernise the ATC systems efficiently.

Impact on productivity and motivation

An interview with the Head of Operational matters revealed that the motivation to control the ATC system efficiently and functionally had increased amongst personnel at the LVB. This resulted in a more caring monitoring of the ATC activities.

Impact on strategic position (general)

The LVB is now governed by a Board of Directors in which main users of the ATC system are vested. They have a direct role in making policy and financial decisions affecting ATC services and fees. They still have to stay within the practical framework the Dutch Transportation Ministry has determined. For instance, the LVB is not allowed to make profits. The LVB is seen as a facilitator of aerial transport, thus as a facilitator for the economy. By this policy, the government minimalises the possibility of discouragement of ATC services.

As far as safety is concerned, the most important item, the autonomous organisation solves one of the biggest problems. When the LVB was incorporated in the RLD, it actually implied that the LVB was controlled by its own organisation. For safety reasons this does not make sense. Presently, the RLD operates as a virtual external organisation to control safety aspects of the LVB. Since the fragmentation, the LVB has maintained the safety rules as used before the fragmentation.

Impact on strategic position (technological)

The method of selecting contractors and suppliers could be changed into a more efficient one. Contractors and suppliers used to be selected based not only on demonstrated value but also based on strategic value for the government. The LVB could only advise the government about the best contractor or best supplier. Now suppliers and contractors are selected based upon demonstrated value only, resulting in to-the-point technology choices. In addition to the contractor selection, the maintenance of equipment is also affected by the privatisation. LVB is now allowed to not only purchase equipment but also to contract the suppliers for the maintenance of equipment. Thus the Technical Service crew of the LVB is becoming redundant since suppliers are made responsible for the maintenance of equipment. This is not only the result of the fragmentation but also the result of the state of the technology used. More and more, electronic equipment is used in ATC equipment which is experiencing a high-speed development. It is not possible for Technical Services to keep up the pace of new ATC developments. Therefore, contracts with suppliers include more and more, the maintenance of the equipment.

Impact on operational aspects and workload

An interview with the Chef Controller of the LVB in Beek showed that basically nothing has changed in the execution and workload for the controllers. Only the staff experienced a higher workload due to the budget work and the cost-control work they have to do in the autonomous organisation. Presently, the staff has to control the cost and expenditures related to the investmentplan. In the early days, staff did not pay attention to these controls. Currently, the staff is now rationally financially concerned with the continuity of the corporation which results in an increase in effectiveness.

2.4.3.6 Comparison of privatization experiences of ATC organisations.

All discussed ATC organisations have brought market-forces into their organisation. This was done by separating ATC from government control. This action is best comparable to *the 'autonomisation or breaking up into component parts'* method, described by the WB.

A comparison of the 4 discussed privatisation or commercialisation experiences of ATC organisations shows that all organisations experienced major impacts on:

- efficiency of the organisation;
- financial situation;
- strategic position.

The efficiency is especially related to the avoidance of the government budget procurement system. In the new organisation it is easier to use money. In addition, it is easier to control money, resulting in a better financial situation, also from a strategic point of view.
All ATC organisations are confronted with a different situation with reference to the dual responsibility of controlling and regulating air traffic. In the new situation, the autonomous ATC organisations must ensure compliance with safety regulations, which are, in the new situation, not designed by the ATC organisation. The ATC organisations will now view safety regulations from a more economical point of view; more safety regulations will cost more.

Other impacts are on:

- ATC service fees;
- strategic position with reference to technology;
- strategic position with reference to labour;
- productivity and motivation

Not every aspect is mentioned by the different ATC organisations, but we believe that all ATC organisations experience major impacts on every aspect mentioned.
Mainly as a result of the improved efficiency and financial situation, ATC user fees were decreased. This development has a major effect on the operation of air traffic. Lower user fees will result in more air traffic.
The improved strategic position in system modernisation contract negotiations is considered one of the best reasons for commercialisation, regarding the amount of writing about this aspect. Also, the improved strategic position with reference to labour contracts is very important. An improvement of the labour contract even initiated the commercialisation of the LVB in Holland.
The LVB in Holland was the only ATC organisation that mentioned an improved productivity and motivation among the personnel. It should be noted that only in this organisation more detailed interviews about the commercialisation subject were held.

4.3 Data -collection

Data have been collected by means of personal unstructured interviews with staff at HQ, who were concerned with organisational changes and data-collection by means of impressions, observations, and conversations.

Important direct data about DCA's changing organisation were not obtained. A staff-member with the key to relevant data about organisational adjustments was not willing to discuss the matter. Therefore, the following text is purely indicative from our point of view. Very disappointing in this respect is that the WB was assisting DCA in its reorganisation programs. It would be very interesting to reflect WB's propositions against the experiences of other privatised ATC organisations and the comments of ICAO on autonomisation matters. Unfortunately, information about the co-operation of the WB for DCA was not obtained.

4.4 Theoretical framework reflected on DCA

4.4.1 World Bank privatisation methods

Public offering of shares

Equity markets do not exist in Tanzania. A prerequisite for equity markets are liberalised banks. Since there are not any, equity markets can not exist. This immediately excludes privatisation methods that require a mechanism of reaching, informing, and attracting the general investing public, like the public offering of shares.

Private sale of shares

The private sale of shares method is a possibility for the Tanzanian ATC organisation. Indeed, DCA would be very much helped with strong owners with relevant industrial, financial, commercial, and other experience and a high financial stake in the success of the firm. However, the ATC organisation can not offer attractive assets or future developments to persuade possible investors to participate in the organisation.

New private investment in a SOE

New private investment would be a better option for DCA than the private sale of shares, but still a profitable future must be offered to potential investors. Current developments in air traffic and DCA operations make this method of privatisation unattractive.

Sale of government of SOE assets

The same comments that go against the public offering of shares, are applicable for the sale of government of SOE assets.

Re-organisation (or break-up) into component parts

The re-organisation (or break-up) of DCA into component parts could be a successful privatisation method. To bring market forces into the ATC organisation would be a very feasible action. Moreover, the separation of ATC from the overall DCA organisation could improve efficiency and turn the autonomised ATC organisation into a profitable one.

As can be seen later, this method of privatisation (or actually commercialisation) is applied to other ATC organisation in the world with success.

Management/employee buy-out

As a strong cash-flow is a precondition for obtaining credit for a buy-out, this method appears to be unsuitable for DCA.

Lease and management contract

Initially, the lease and management contract options seems to be a good temporary measure to possibly increase the efficiency and effective use of state assets. But still, potential lease holders have to be found to take over certain activities for a certain amount of time that can generate profit. Profit generating activities are very much desired by DCA or the government and will, therefore, not be leased.

DCA does not think that short-term injection of management or other skills to restore it to profitability is needed. Competent managers are already available. The possibility of a management contract would be very difficult to discuss. Still, it would be an option to inject DCA with management or other skills to restore efficiency or profitability. The funds to realise a management contract will remain a problem.

4.4.2 Experience of other ATC organisations

To compare the Tanzanian ATC organisation with Western ATC organisations, as we intended, brings me, however, to some problems. The technology level of Western organisations is much higher, technology development in Western ATC organisations is more continuous already from the 1930's, whereas the Tanzanian ATC organisation is caught more in a constant technology complex. Very important here is, that the environment in Western countries is more dynamic. ATC must continuously search for better methods, better means and better organisations to be able to continue controlling the increasing amount of air traffic. The Tanzanian situation is more static. The need for change is less, air traffic is not yet complex. Still, it is useful to compare organisations, since characteristics of Western organisational development can be basically the same as DCA's organisational developments, only at a different level.

In the previous text, a number of areas were identified in which positive effects as a result of privatisation could be expected. These areas are, again, given below. In addition, more practical keypoints are given that were found in the theoretical framework text

Privatisation of ATC organisations would positively effect:

- the efficiency of the ATC organisation:
  - increase efficiency by avoiding government bureaucracy;
  - the possibility to borrow capital;
  - the avoidance of government budget acquisition delays;
- the financial situation of the ATC organisation:
  - the possibility to borrow capital;
  - the avoidance of government budget acquisition delays;
- productivity and motivation of ATC personnel:
  - the flexibility of salaries (+ incentives);
  - the monitoring the technology complex;
- the strategic position of the organisation in general:
  - negotiations with reference to safety aspects;
  - impact on General Aviation;

- the strategic position of the organisation in financial, labour, and technological contract negotiation:
  - the flexibility of salaries (+ incentives);
  - the possibility of system modernisation;
  - the possibility of selecting contractors;
  - the possibility of maintenance adjustments;
- ATC's services fees.

These point will be discussed separately for the situation of DCA and with reference to the technological bottleneck aspects identified in the previous chapter.

Efficiency of the ATC organisation

Increase efficiency
In the Western ATC organisations, the increase in efficiency because of less burdensome government procurement regulations, financial constraints (time and availability) is considered as the most vocal critic to privatise ATC. ICAO also stated that autonomisation is mainly an instrument to improve efficiency. Already staff members of DCA/ATS could experience improvement in efficiency from the separation of DCA from government procurement regulations. The increase in efficiency was especially marked as time-savings.

Borrowing of capital
The possibility to borrow capital is identified as a major improvement for Western ATC organisations, especially with regard to the efficient functioning of the financial ATC organisation and to an optimal system modernisation.
It is not clear to us if DCA has the possibility to borrow capital. It seems, however, unlikely.

Government budget acquisition delays
Already, DCA could notice the advantages an autonomous organisation has above a government controlled one. Before, DCA was to submit all revenues directly to the government. Since July 1995, DCA can spend the revenues itself. For DCA this roughly means an improvement of 2.5 - 3 times the old budget. For ANS this means an improvement of twice the old budget. Time was considered as another problem. The slow governmental procedures seriously delayed funding. This could even take extreme forms. For example, it occurred regularly that other, later, government projects that had gained priority status, were given the funding that was already assigned to DCA. The funds had not reached DCA yet because of slow processing.

The financial situation of the ATC organisation

Borrowing of capital and Government budget acquisition delays have effects on the financial situation of the ATC organisation. An elaboration is given above.

Productivity and motivation of ATC personnel

Salaries

A huge displeasure about the height of salaries exists amongst DCA/ATC personnel. From July 1996, DCA is expected to account for the salary-administration herself. Salaries must be increased, only to keep motivation at the same level as now. People expect an increase in salary because of the separation from the government. Salary works as a major incentive for motivation. Therefore, it is of utmost importance for DCA to first consider the increase of salaries. Interviews showed that a small increase in salary will not increase motivation.

Monitoring the technology complex

With reference to the previous chapter, this is a major point of issue. Privatisation causes changes in the monitoring of the technology complex. The people working the technology complex must present their output to the environment, especially to the government that still owns the technology complex. From interviews with the Dutch ATC, employees at ATC were also more concerned with the well-being of the ATC apparatus and were therefore more motivated to monitor the technology complex.
Interviews with HQ - personnel showed an increased interest in the financial functioning of DCA due to DCA's autonomous control of the revenues since July 1995.

The strategic position of the organisation in general

Safety aspects

Civil aviation authorities can have a duo-role in the operational field. They, on one hand, have to secure the safety in the airspace and on the ground, on the other hand, they must run a company efficiently. These two fields are actually in contradiction. To ensure optimal safety, huge costs have to be made. In the previous part, this problem was already brought forward. ATC companies with such a duo-role must see to it that safety does not become of secondary priority. However, the danger exists, as described in the experiences of other privatised ATC organisations.
The plans of DCA after autonomisation have not been revealed to me, thus we can not elaborate on this issue for the case of Tanzania. It should, however, be noted that safety should have top priority.

Impact on General Aviation

The impact on General Aviation (GA) is not such a hot item for Tanzania as it is for the Western countries. In Western countries, GA is about to be considered as a restrictor for the efficient control in busy areas, especially around international airports. Therefore, the fear exists that GA will be banned from busy areas by means of financial discouragement. In Tanzanian airspace plenty of space is left for GA.

The strategic position of the organisation in financial, labour, and technological contract negotiation

Salary

Comments on salaries are given earlier.

System modernisation

System modernisation is mentioned as a last point. Near future ATC system development discussions are a hot item and highly relevant for the technology direction of DCA/ATC and will be discussed extensively in the next part of this chapter.

In Western ATC organisations, system modernisation is considered to improve extensively because of the autonomous control of the ATC organisation. ATC organisations are not any more restricted by governmental approvement and procurement regulations.

For now, this is still not the case for DCA. DCA remains dependable on donors, especially for the main ATC installations like VOR, ILS, HF-stations, etc.

Selecting contractors

The possibility of selecting contractors based upon demonstrated performance instead of best value or past performance is considered as one of the major advantages of becoming autonomous. However, DCA is not in a position to select contractors. Also in the government controlled period, DCA was dependable on donor countries to provide DCA with ATC equipment. A Dutch donor would deliver Dutch equipment, a French donor would deliver French equipment. DCA or Tanzania is not in a position to select, it is more in a position to take whatever can be taken.

Under the 'old' system, the government has always relied on DCA to take decisions about ATC equipment. The government has never restricted DCA. The developing position of Tanzania in the world does account for this. The Tanzanian government nor DCA had have the choice to select, because of financial shortage. For larger investments (main ATS equipment) DCA is completely dependent on donor help and must accept everything that is offerered. Normally, second-hand equipment from Western countries is donated.

Maintenance adjustments

Related to the selecting contractors part above, is the maintenance development of equipment. In Western government controlled ATC organisations, maintenance is done by the ATC organisation itself. It seems to be more efficient to contract the manufacturer of the equipment to maintain the equipment.

DCA has always been dependable on donor help for the maintenance of the equipment. For instance the TAR radar at DIA. This radar, donated by the French, is not operative for already a few years. DCA has not the knowledge, nor the spare parts, nor the financial means to buy the required spare parts to fix the installation. DCA 'waits' for French spare parts and maintenance to fix the radar system.

In the technology complex of today, DCA remains in this position, also in the new autonomous structure.

4.5 Future developments

4.5.1 Introduction

Developments in ATC systems are becoming more internationally orientated. A satellite based system that, more or less, integrates all ATC systems is about to be implemented. This would also have a major impact on the development of the ATC system of Tanzania. Conventional ATC systems may become redundant and maybe attention should be on satellite based systems instead.

4.5.2 International technological system trends

Especially, in western countries, air traffic control operations are characterised as high-level stress work for the controllers. In terminal areas (TMAs) traffic congestion seems to become the standard instead of a continuous flow of aircraft due to operational capacity constraints. ATCOs need more and more tools to be able to handle the traffic demand.

The 'traditional' tools for ATCOs soon will reach their operational capacity to control air traffic. These traditional tools, i.e. primary radar, SSR, ILS, and ground based navigation aids, have been improved over and over since the second world war. The last decades mainly by improving the information provision to the controllers using electronic and computer technologies.

Every FIR has built up a technology complex using 'traditional' controlling aids, operating as an autonomous system. Co-ordination with other autonomous ATS systems is facilitated by communication means such as direct telephone lines.

Now, there is a need for a completely new concept, a global automated air traffic control technology complex. If ATS continues to separate traffic as it does now. a significant number of new controllers will need to be hired and trained. In theory, this growing demand might be met by hiring additional controllers and managers, but this approach would be prohibitively expensive and would not improve the system's overall efficiency. As the ATC system operates now, every controller is responsible for separating aircraft within a certain block of airspace. Using current technology and procedures, each controller can separate a finite number of aircraft. Employing additional controllers might permit the FAA to reduce the size of every sector, thereby reducing the load on each controller, but system capacity would be only marginally increased, and the amount of co-ordination to operate the system would increase monumentally. Whereas the ATC system of the 1950s was drowning in paperwork, the ATC system of the 1990s would smother in co-ordination.

The FAA's proposed solution is to increase every controller's productivity, thereby increasing the number of aircraft that can be separated. The FAA believes that by using sophisticated computer hardware and software, every controller can become less involved in the mechanics of separating aircraft and can become more of a traffic manager or monitor. The computer system envisioned by the FAA would help the controller determine whether potential aircraft conflicts exist and would even be able to automatically propose alternative resolutions to the controller[7].

4.5.3 Automation of ATC systems

Automation of ATC systems originally started off with the plans for an advanced system called the Automated En Route Air Traffic Control (AERA).

With the introduction of AERA, the routine use of procedural separation will be reduced significantly, thereby permitting pilots to determine the most efficient route and altitude that should be flown. The pilot will still be responsible for flight planning, but an automated FSS system should make it easier to obtain the required weather and flight plan information and transmit the data for flight data processing. The initial flight planning process will probably remain the same. But as advanced data link equipment is installed on aircraft and at ATC facilities, real-time flight information will be transmitted from the aircraft to the controller and control instructions from the controller directly to the aircraft. This information will include climb and descent rates, speed schedules, optimal performance characteristics, navaid failures, weather information, and ATC clearances. Using this information, the AERA computer system will be able to predict potential traffic conflicts and to determine optimal resolutions to those conflicts.

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[7] Nolan, Micheal S., *Fundamentals of air traffic control* (Wadsworth Publishing Company, Belmont, California, 1994, p463-464)

The controller will still be responsible for the separation of each aircraft and the adjustment of aircraft routes and altitudes to form an orderly and expeditious flow of traffic. But as system users update their equipment and transmit flight information to the controllers on a real-time basis, the ATC system will be able to apply these data in a manner that will reduce the need for many routinely applied procedural restrictions. As the AERA system becomes more sophisticated, the area of airspace allocated to each aircraft can be safely reduced, thereby increasing the capacity of the air traffic control system.

These systems emerge from a principle to integrate conventional ATC systems extensively by means of automated information management between the installations. There is also a development to emerge from a 'new' principle, reorganising the complete technology complex of international ATC, the satellite-based systems.

4.5.4 Global Navigation Satellite System[8]

The newest and most accurate form of en route navigation has been accepted by the ICAO as the navigation system for the 21st century. This space-based system, using satellites owned and operated by the US government and possibly Russian satellites, will be known as the Global Navigation Satellite System (GNSS).

The GNSS (known in the US as the Global Positioning Satellite (GPS), and in Russia as GLOSNASS) will provide world-wide navigation service using a system of at least 21 (probably 24) operational satellites in orbit. Aircraft equipped with relatively low-cost receivers will be able to pinpoint their location and their altitude using GNSS. The satellites operate in circular orbits arranged so that a minimum of five satellites are in view at any one time to users world-wide.

The GPS concept is predicated upon accurate and continuous knowledge of the spatial position of each satellite in the system and the exact distance from each satellite to the user. Each satellite transmits unique data periodically updated by a master control station based upon information obtained from five widely dispersed monitor stations. The GPS receiver on board the aircraft makes time-of-arrival measurements of the satellite signals to obtain the distance between the aircraft and each satellite. These distance calculations produce the aircraft's three-dimensional position and velocity with respect to the satellite system. A time co-ordination factor then calculates the aircraft's exact location.

Since the GPS system will be operated by the US Department of Defence, security interest will limit the civilian accuracy of the system. When GPS is declared operational, the Department of Defence plans to provide to civilian users, horizontal positioning accuracy of between 100 and 300 meters with 99,99 percent probability. Military and selected civilian users will be provided with accuracy of about 22 meters. It is highly likely that GPS navigation systems will become the world-wide en route navigation standard and will be able to provide non-precision approach navigational capability.

GNSS operates similarly to OMEGA/VLF, LORAN, and other hyperbolic navigation systems. The only difference is that the transmitters are located on orbiting satellites instead of fixed ground locations. GNSS also operates at much higher frequencies, which permits lateral positional accuracy of plus or minus 30 metres anywhere in the world.

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[8]Nolan, Michael, *Fundamentals of Air Traffic Control* (Wadsworth Publishing Company, Belmont, California, 1994, p.78 ff.)

4.5.6 New ATC technology implementation[9]

The technologies for air traffic communication, navigation, surveillance and management are advancing at an unprecedented rate, which eventually should enhance air safety, cut delays and reduce operating costs. Technology is no longer the stumbling block. What slows progress is the necessary but time-consuming process of building international consensus on the standards and procedures that pilots and controllers will follow in using each of the new technologies.

The ICAO has directed significant effort toward that problem since it established a special committee on Future Air Navigation Systems (FANS) in November, 1983.
H.Brian O'Keefe of the Australian Civil Aviation Authority chaired the special committee for the monitoring and co-ordination of development and transition planning (FANS Phase 2). He reported the Phase 2 progress to ICAO in December 1993, with a global plan that includes milestones and cost-benefit models for world-wide implementation of communication navigation surveillance and air traffic management (CNS/ATM).
Key to the future of air traffic management will be the two-way transmission of data. Ultimately, aircraft will communicate with controllers on the ground world-wide using digital data transmissions via satellites and the aeronautical telecommunication network (ATN) architecture. The design uses international standards for open systems interconnections so digital information can flow between dissimilar networks. Although the new satellite technology is global in nature, it will be implemented at different times around the world. A big challenge for those envisioning the new high-technology systems has been to develop a plan that will allow consistent air traffic services with smooth transitions between airspace of neighbouring countries, no matter what state of development.
From the aircraft operator's perspective, global navigation satellite systems (GNSS) will allow navigation anywhere using a single set of navigation avionics. Countries that now have ground-based navigation aids will realise cost savings when the equipment is phased out, while satellite navigation will bring the benefits of high-integrity, high-accuracy navigation systems for en route, terminal and non-precision approaches to countries that now lack navaids.
A by-product of the new communications navigation and surveillance (CNS) system will be the capability for closer interaction between controllers on the ground and aircraft. Air Traffic Management (ATM) in the future will benefit from increasing automation. Flow management personnel will use improved aircraft position information, large data bases and sophisticated models to better predict congestion and suggest strategies for coping in real time. When a controller or pilot wants to amend a flight plan, data link communication between the aircraft's flight management system and ATC will improve the speed and accuracy of the process. ICAO expects that integration of the en route and terminal ATM functions will smooth traffic flow between the areas. The result should be higher traffic throughput and fewer delays.
While the changes will automate many ATC functions that are now performed manually, both pilots and controllers will need training to understand all the implications, including back-up procedures if the system malfunctions.
Training is generally the responsibility of each country, but ICAO recognises that guidance and assistance may be necessary, especially for less-developed countries.

HF voice, VOR and TACAN are expected to disappear when satellite-based systems are in operation. Except in high-density airspace, primary surveillance radar will also be eliminated. Savings and cost avoidance for countries that now operate the ground systems should be significant.

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[9] *Aviation Week & Space Technology*, Standards main hurdle to new ATC technologies, May 16th 1994.

The FANS Phase 2 committee finished its work with a global plan, which it gave to ICAO in December 1993. O'Keefe, the committee's chairman, said the need now is for a new task force to help implement FANS. The developed countries will know what they need to do from the report -they can plan, fund and implement- and only need a forum to get together from time to time. But the level of understanding is much lower in underdeveloped countries. One representative asked O'Keefe, "How does my little country get the money to launch the 24 satellites for navigation?"

4.5.7 Tanzanian future outlook

(from 9th ATS Planning Group Meeting, Dar es Salaam, December 1995, Agenda item 8: Status of GNSS Standardisation)

On 30 November 1993, the Air Navigation Commission, at the 18th meeting of its 134th Session, agreed to the establishment of the Global Navigation Satellite System Panel (GNSSP) and approved its terms of reference and work programme.

First of all, referring to the comment O'Keefe submitted about developing countries having absolutely none knowledge about satellite based systems; officials at DCA/HQ in the ANS departments are very up-to-date with satellite-based navigation systems. Only problem may be that just a select group is up-to-date.

The GNSSP held its first meeting from 17 to 25 October 1994. Among other outcomes of this meeting was the establishment of working arrangements and work plan. The meeting initiated the material to assist States in realising early benefits from existing satellite-based navigation systems. The panel also began developing Standards and Recommended Practices (SARPs) and guidance material for GNSS.

(See Appendix J)

From these plans it appears that Tanzanian authorities plan to start with satellite navigation based ATC systems already within 5 years. Initially, this seems to be a quite big leap. The present technology complex of the Tanzanian ATC system is comparable with the ATC technology complex of the industrialised countries of the 1950s. Yet, the industrialised countries are also planning to implement satellite based navigation systems, but only after having experienced an extensive technological development during the last 40 years.

Now, is it possible for Tanzania to get involved into this new technological development without the experience of the technological development of the last 40 years?

Initially, it seems quite inappropriate for Tanzania to frog-leap into the ATC technology for the 21st century. The present technological system fulfils requirements.

Based on the past experiences, high-tech satellite based navigation systems do not seem very appropriate. The present technology complex lags behind satellite navigation technology quite much and Tanzania has not a good record of maintaining the system. For instance, the radar equipment that was implemented in the 1980s, is already unserviceable for a very long time and it is likely that this radar will not become operational ever. The Kilimanjaro Airport ILS equipment is present but has not been operational since the 1980s. The DIA ILS system has great technical difficulties with the glideslope part.

So it is justified to question if it is appropriate to provide Tanzania with such a sophisticated technology as satellite technology. Moreover, they should re-organise the complete technical organisation. People should be educated in industrialised countries which is about 20 times as expensive as a local training, ATS organisation will be completely integrated and controlled at regional level (SADC-level) instead of national level control and additional co-ordination with neighbouring FIRs.

One reason for the lagging behind is the dependency DCA has on donors. To participate in a world-wide navigation system, this dependency will not change. But to maintain the world-wide navigation system, industrialised countries are also dependent on the co-operation of Tanzania. In addition, satellite navigational systems will be maintained by a group of countries. Hands will be put together to maintain the system. Probably a more favourable position for Tanzania.

4.6 Evaluation

Privatisation method

The privatisation of ATC organisations does have the characteristics of the becoming of an autonomous organisation instead of a government-controlled organisation. In the Worldbank methodology this is best comparable with the reorganisation (or break up) into component parts of the government. The term privatisation is not right. In most cases the government remains owner of the technology complex. The main purpose for the re-organisation is to use the advantages that the introduction of market forces have. It is better to speak in terms of commercialisation instead.

For DCA the process of re-organisation into component parts is the most appropriate method of bringing market forces into the organisation. The ATC organisation will be separated from government control. The control and management will be transferred to an autonomous ATC organisation.

Effect of Re-organisation

According to ICAO, autonomisation of ATC organisations would positively effect:

- the efficiency of the ATC organisation
- the financial situation of the ATC organisation;
- productivity and motivation of ATC personnel;
- the strategic position of the organisation in general;
- the strategic position of the organisation in financial, technological, and labour contract negotiation;
- ATC's services fees.

In more practical terms, the effects will be on:

- increase efficiency (by avoiding government bureaucracy);
- borrow capital;
- Government budget acquisition delays;
- salaries (+ incentives);
- monitoring the technology complex;
- safety aspects;
- impact on General Aviation;
- system modernisation;
- selecting contractors;
- maintenance adjustments;
- ATC's services fees.

All of which aspects do have a positive effect on the efficient functioning of the ATC technology complex.

Not affected in the case of DCA

Not all positive effects are valid for the DCA because of typical developmental characteristics of the environment in which the organisation is situated. This means that issues not effected by privatisation as in Western ATC organisations are:

- borrowing of capital;
- system modernisation;
- contractor selecting;
- maintenance adjustments, and impact on GA.

Probably, these issues are not affected at all by means of autonomisation because of the dependency of donor help in these issues (except the impact on GA). The Western countries are not dependable on donors in these issues. The impact on GA will be not effected by a commercialised ATC organisation due to low traffic demands. It is not in the economical interest of DCA to discourage GA.

Affected aspects in the case of DCA

For the other aspects privatisation probably makes a significant difference. These aspects are:

- government budget acquisition delays;
- salaries (+ incentives);
- monitoring the technology complex;

The own responsibility for the ATC technology complex without intervention of the government will smoothen many processes in the DCA organisation. Salaries will be influenced by the change into an autonomous organisation. Motivation could be improved to a significant degree. Interviews showed that a small increase in salary will not increase motivation. The desire to monitor the technology system will increase. People tend to be more caring for things they control. Especially these three issues will improve the functionality and efficiency of the DCA/ATS organisation, for in the previous chapter it was determined that a major bottleneck of DCA/ATS was the missing of a functional information system to be used by planners, amongst others caused by demotivation and rigid governmental bureaucratic methodologies.

In more abstract ICAO terms, autonomisation of the DCA/ATC organisations would positively effect:

- the efficiency of the ATC organisation;
- the financial situation of the ATC organisation;
- productivity and motivation of ATC personnel;
- the strategic position of the organisation in labour contract negotiation.

These expected improvements in the organisation with reference to the identified bottlenecks in the previous chapter, make it justified to advocate the change of the DCA organisation to an autonomous one.

Future developments

As far as technological development in the international environment is concerned, satellite navigation is about to be implemented. Already, aircraft are equipped with satellite navigation equipment and implementation has started in several western industrialised countries.

The satellite navigation system should be globally implemented according the industrialised countries for it is designed to function globally, and should become the ATC standard. The industrialised world is pushing for the implementation of these systems because the ATC system is smothering. For countries like Tanzania it is not necessary to transfer to a system with enormous traffic handling

capacity because traffic demand in Tanzania is not that high and is not growing to unacceptable demand level for traditional ATC systems.
Still, the transfer to a satellite navigation based system for Tanzania is very much worth considering. Presently, Tanzania must consider to replace or to upgrade old systems. This would mean that Tanzania would have to make big investments. Are these investments in an old technology appropriate if within a few years new technology investments will be made globally and for which Tanzania only has to join hands with regional countries? Moreover, Tanzania is dependent on western donors for major ATC investments.
Reasons to not upgrade the conventional system but to pass to satellite based systems are:

- satellite navigation is probably going to become an international standard for which Tanzania sooner or later has to choose;
- the satellite based system is much simpler than a traditional ATC would develop into;
- Tanzania would not discourage operators to overfly or to come to Tanzania.

For DCA it is not interesting to spend significant amounts of money on ground based systems if traffic stays low, if it is even possible to spend significant amounts of money. With the present technology, traffic is under control. DCA better waits for the world wide satellite navigation implementation which is about to take off. HF voice, VOR and TACAN are expected to disappear when satellite-based systems are in operation. Except in high-density airspace, primary surveillance radar will also be eliminated. Savings and cost avoidance for countries that now operate the ground systems should be significant.
Because of the global character of satellite-based systems, it is also in the interest of Western countries that developing countries participate in the satellite-based ATC systems. The success of the global system makes the Western countries dependent on participation of developing countries. This development could be an improvement (strategically) for Tanzania.

4.7 Conclusions

The introduction of market forces into the operations of DCA is best done by separation from government control. Management is transferred to an autonomous ATC organisation. This method reflects *the 're-organisation (or break-up) into component part'* method of the basic privatisation methods of the ICAO. Other ATC organisations in western countries have also become autonomous ATC organisations.

The advantages that the western ATS organisations seem to have from privatisation are not the same for the case of DCA. Factors that are majorly influenced by autonomisation for DCA:

- the efficiency of the ATC organisation;
- the financial situation of the ATC organisation;
- productivity and motivation of ATC personnel;
- the strategic position of the organisation in labour contract negotiation.

The reason for the other factors not to be influenced is because DCA depends heavily on donors as far as major investments are concerned. The strategic position of DCA is very weak and will remain weak because of donor dependency. The main reason for this is the financial weak situation of the Tanzanian ATS organisation. The flexibility that western companies have for their technology choices is not available for DCA. The donor dependency immediately pushes DCA into a specific technological direction.

Still, autonomisation of DCA would be a positive development since the technological bottlenecks identified are positively effected by the organisational change.

In future developments in ATC technologies, positive effects can be expected for DCA. This is mainly the result of the desire of Western countries to implement a global navigation system based on satellite navigation. The success of implementation is, amongst others, dependable on the participation of all ICAO members. DCA should, in detail, study the participation in satellite navigation.

Recommendations ?

Priorities ?

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APPENDICES

Appendix A

PROBLEM IDENTIFICATION BY DCA PLANNING AND RESEARCH STAFF

1. ATS Route Network

The present route network is out-of-date and should be reviewed. Therefore there is a need for:

a) identification of additional route requirements;
b) identification of route segments requiring realignment;
c) identification of routes which can be deleted from the AIP;
d) consideration ATS interface routes with other Regions;
e) identification of unimplemented routes.

2. Area Control Service

The various ICAO requirements and Basic Operational Requirement and Planning Criteria in the AFI Region that Area Control Service should be provided on a 24 hours basis for flight along all ATS routes and provision of Area Control Service on:

a) all route segments within 150 NM of international airports;
b) all ATS routes in the Upper Airspace;
c) all other ATS routes.

3. Status of Navigational Aids in Tanzania

The status of the navigational aids is unsufficiently known. Therefore there is a need for:

a) identification of the status of navigation aids in Tanzania;
b) identification of additional navigation aids requirements;
c) identification of navigation aids which can be replaced.

4. Search and Rescue (SAR) Services

SARPS and other AFI regional meetings identified the need for a review of the status of umplementations or the requirements in the SAR field in Tanzania.

5. Future developments

What new technologies should Air Traffic Services in Tanzania adopt to meet future developments?

Appendix B

ATS AIRSPACE CLASSIFICATIONS

Class	Type of flight	Separation provided	Service provided	VMC visibility and distance from cloud minima*	Speed limitation*	Radio Communication Requirement	Subject to an ATC clearance
A	IFR Only	All aircraft	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
B	IFR	All aircraft	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
	VFR	All aircraft	Air traffic control service	8 km at and above 3050m (10 000 ft) AMSL 5 km below 3050m (10000 ft) AMSL Clear of clouds	Not applicable	Continuous two-way	Yes
C	IFR	IFR from IFR IFR from VFR	Air traffic control service	Not applicable	Not applicable	Continuous two-way	Yes
	VFR	VFR from IFR	1)Air traffic control service for separation from IFR;* 2)VFR/VFR traffic information about VFR flights (and traffic avoidance advice on request)	8 km at and above 3050m (10000 ft) AMSL 5 km below 3050m (10000 ft) AMSL 1500m horizontal; 300m vertical distance from clouds	250 kt IAS below 3050m (10000 ft) AMSL	Continuous two-way	Yes
D	IFR	IFR from IFR	Air traffic control service including traffic information about VFR flights (and traffic avoidance advice on request)	Not applicable	250 kt IAS below 3 050 m (10 000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information between VFR and IFR flight (and traffic avoidance advice on request)	8 km at and above 3050m (10000 ft) AMSL 5 km below 3050m (10000 ft) AMSL 1500m horizontal; 300m vertical distance from clouds	250 kt IAS below 3050m (10000 ft) AMSL	Continuous two-way	Yes
E	IFR	IFR from IFR	Air traffic control service and traffic information about VFR flights as far as practical	Not applicable	250 kt IAS below 3050m (10000 ft) AMSL	Continuous two-way	Yes
	VFR	Nil	Traffic information as far as practical	8 km at and above 3050m (10000 ft) AMSL 5 km below 3050m (10000 ft) AMSL 1500m horizontal; 300m vertical distance from clouds	250 kt IAS below 3050m (10000 ft) AMSL	No	No

F	IFR	IFR from IFR as far as practical	Air traffic advisory service; flight information service	Not applicable	250 kt IAS below 3050m (10000 ft) AMSL	Continuous two-way	
	VFR	Nil	Flight information service	8 km at and above 3050m (10000 ft) AMSL 5 km below 3050m (10000 ft) AMSL 1500m horizontal; 300m vertical distance from cloud At and below 900m AMSL or 300m above terrain whichever is higher - 5 km** clear of cloud and in sight of ground or water	250 kt IAS below 3050m (10000 ft) AMSL	No	No
G	IFR	Nil	Flight information service	Not applicable	250 kt IAS below 3050m (10000 ft) AMSL	Continuous two-way	No
	VFR	Nil	Flight information service	8 km at and above 3050m (10000 ft) AMSL 5 km below 3050m (10000 ft) AMSL 1500m horizontal; 300m vertical distance from clouds At and below 900 m AMSL or 300 m above terrain whichever is higher - 5 km** clear of cloud and in sight of ground or water	250 kt IAS below 3050m (10000 ft) AMSL	No	No

* When the height of the transition altitude is lower than 3050 m (10000 ft) AMSL, FL 100 should be used in lieu of 10000 ft.

** When so prescribed by the appropriate ATS authority:

a) lower flight visibilities to 1500 m may be permitted for flights operating:

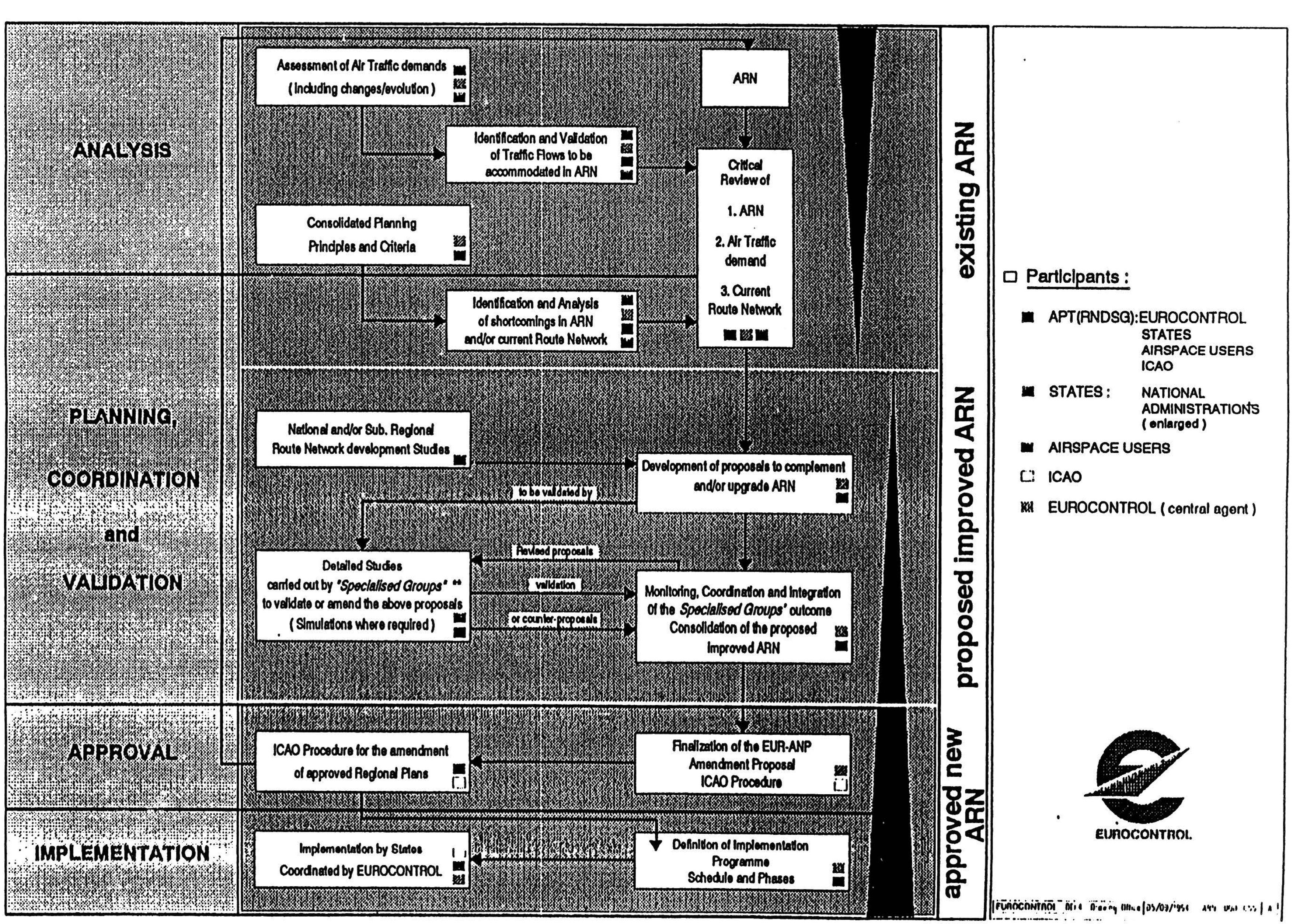
1) at speeds that will give adequate opportunity to observe other traffic or any obstacles in time to avoid

or

2) in circumstances in which the probability of encounters with other traffic would normally be low, e.g. in areas of low traffic volume and for aerial work at low levels;

b) helicopters may be permitted to operate in less than 1500 m flight visibility, if manoeuvred at a speed that will give adequate opportunity to observe other traffic or any obstacle in time to avoid collision.

ATS ROUTE NETWORK PLANNING/DEVELOPMENT PROCESS



Appendix D

DIALY FREQUENCY OF FLIGHTS BETWEEN AIRPORTS

Airport of Departure	Airport of Arrival	Date 07/01	07/02	07/03	07/04	07/05	07/06	...	07/26	07/27	07/28	07/29	07/30	07/31	TOTAL
HTDA	HELX						1	...							1
HTDA	HILI							...							1
HTDA	HKNA	3	3	1	4	3	2	...	2	3	2	3	3	1	79
HTDA	HKNW							...							1
HTDA	HRYR							...							3
HTDA	HTDO	1				1		...	3			2			29
HTDA	HTIR		1					...							1
HTDA	HTKA							...							1
HTDA	HTKJ	2	2	1	1	2	1	...	1	1	1	2	1	1	43
HTDA	HTKT							...							0
HTDA	HTLI	1			1			...				1			11
HTDA	HTLM							...							1
HTDA	HTMB					1	1	...						1	7
HTDA	HTMD						1	...		1		1	1		7
HTDA	HTMI		1			1	1	...	1						5
HTDA	HTMO	1						...							1
HTDA	HTMR		1	1				...			1				9
HTDA	HTMT			3	1	2		...			2	1		1	18
HTDA	HTMU					1		...							3
HTDA	HTMW	1	1	3	1	3	1	...	4	2	2	1	1	2	55
HTDA	HTNA							...							2
HTDA	HTNJ						1	...							4
HTDA	HTSD							...							1
HTDA	HTSN			1				...							1
HTDA	HTSO							...				1			2
HTDA	HTTB			1			2	...	2		1			1	23
HTDA	HTTU		1			1		...	1	3		1		1	11
HTDA	HTZA							...							0
HTDA	HUEN	2	2				1	...	1	1		1	2		21
HTDA	IFAKARA				1			...				1			7
HTDA	ILONGA							...							0

Appendix E

Determination representative week

DAY	DIFF	(DIFF-MEAN)^2	X=DIFF SUM(X..(X+6))
1	98,52	28,81	597,82
2	88,85	18,58	586,95
3	80,55	158,77	599,20
4	68,97	584,72	636,53
5	104,88	137,41	628,75
6	87,65	30,29	613,88
7	68,39	613,14	612,91
8	87,65	30,29	642,79
9	101,10	63,17	636,62
10	117,88	611,18	623,79
11	61,20	1021,14	583,14
12	90,01	9,92	592,95
13	86,68	41,88	596,88
14	98,26	26,10	590,14
15	81,49	136,07	624,91
16	88,26	23,92	632,27
17	77,23	253,54	674,50
18	71,01	490,57	693,72
19	93,94	0,62	769,85
20	79,94	174,59	797,85
21	133,04	1590,69	793,33
22	88,85	18,58	743,79
23	130,49	1393,91	753,01
24	96,46	10,91	707,59
25	147,14	2913,87	706,50
26	121,94	828,67	
27	75,43	314,33	
28	83,49	93,41	
29	98,07	24,16	
30	85,07	65,36	
31	95,36	4,87	
MEAN	93,16		

Appendix F

Determination Control Load Factor

GRANT TOTAL 3071

IMES USED	FREQ	TIMES USED * FREQ
0	0	0
1	171	171
2	59	118
3	39	117
4	30	120
5	28	140
6	29	174
7	17	119
8	9	72
9	12	108
10	7	70
11	5	55
12	10	120
13	2	26
14	3	42
15	6	90
16	3	48
17	5	85
18	3	54
19	0	0
20	2	40
21	1	21
22	0	0
23	3	69
24	0	0
25	2	50
26	2	52
27	0	0
28	1	28
29	1	29
30	1	30
31	1	31
32	1	32
33	1	33
34	0	0
35	0	0
36	0	0
37	0	0
38	0	0
39	1	39
40	0	0
41	0	0
42	0	0
43	1	43
44	0	0
45	0	0
46	0	0
47	0	0
48	0	0
49	0	0
50	2	100
51	0	0
52	0	0
53	0	0
54	0	0
55	1	55
56	0	0
57	0	0
58	1	58
59	1	59
60	0	0
61	1	61
62	0	0
63	0	0
64	0	0
65	2	130
66	0	0
67	0	0
68	0	0
69	0	0
70	0	0
71	0	0
72	2	144
73	0	0
74	0	0
75	0	0
76	0	0
77	0	0
78	1	78
79	1	79
80	0	0
81	1	81

LOAD TOTAL (>#)	CONTROL LOAD FACTOR	PERC
0	3071	. 100%
1	2900	94%
2	2782	91%
3	2665	87%
4	2545	83%
5	2405	78%
6	2231	73%
7	2112	69%
8	2040	66%
9	1932	63%
10	1862	61%
11	1807	59%
12	1687	55%
13	1661	54%
14	1619	53%
15	1529	50%
16	1481	48%
17	1396	45%
18	1342	44%
19	1342	44%
20	1302	42%
21	1281	42%
22	1281	42%
23	1212	39%
24	1212	39%
25	1162	38%
26	1110	36%
27	1110	36%
28	1082	35%
29	1053	34%
30	1023	33%
31	992	32%
32	960	31%
33	927	30%
34	927	30%
35	927	30%
36	927	30%
37	927	30%
38	927	30%
39	888	29%
40	888	29%
41	888	29%
42	888	29%
43	845	28%
44	845	28%
45	845	28%
46	845	28%
47	845	28%
48	845	28%
49	845	28%
50	745	24%
51	745	24%
52	745	24%
53	745	24%
54	745	24%
55	690	22%
56	690	22%
57	690	22%
58	632	21%
59	573	19%
60	573	19%
61	512	17%
62	512	17%
63	512	17%
64	512	17%
65	382	12%
66	382	12%
67	382	12%
68	382	12%
69	382	12%
70	382	12%
71	382	12%
72	238	8%
73	238	8%
74	238	8%
75	238	8%
76	238	8%
77	238	8%
78	160	5%
79	81	3%
80	81	3%
81	0	0%

Appendix
G

DEPARTURE	ARRIVAL	total
FAJS	HECA	18
FAJS	HKNA	59
FAJS	OMAA	10
FDMS	HTDA	10
FLLS	HKNA	23
FMCH	HKNA	10
FMMI	HKNA	25
FVHA	HECA	12
FVHA	HKNA	26
FWKI	HKNA	15
FZAA	HKNA	17
FZMA	HKNW	15
FZNA	HKNW	15
HBBA	HKNA	33
HBBA	HKNW	12
HBBA	HTKJ	10
HECA	FAJS	26
HECA	FVHA	15
HKNA	FAJS	58
HKNA	FMMI	20
HKNA	FVHA	31
HKNA	FWKI	20
HKNA	FZNA	12
HKNA	HBBA	32
HKNA	HRYR	61

HKNA	HTDA	61
HKNA	HTKJ	14
HKNW	FZMA	12
HKNW	FZNA	28
HKNW	HBBA	17
HKNW	HRYR	25
HKNW	HTDO	13
HKNW	HTMW	72
HKNW	NGARA	17
HRYR	HKNA	65
HRYR	HKNW	39
HTAR	HTDO	10
HTAR	HTMW	13
HTAR	HTSN	16
HTDA	FADN	10
HTDA	FLLS	12
HTDA	HKNA	79
HTDA	HTDO	29
HTDA	HTKJ	43
HTDA	HTLI	11
HTDA	HTMT	18
HTDA	HTMW	55
HTDA	HTTB	23
HTDA	HTTU	11
HTDA	HUEN	21

DEPARTURE	ARRIVAL	total
HTDA	NGARA	12
HTDO	HTAR	16
HTDO	HTDA	30
HTDO	HTZA	12
HTKA	HTTB	12
HTKJ	HKNA	15
HTKJ	HTDA	50
HTKJ	HTMW	16
HTLI	HTDA	10
HTMT	HTDA	17
HTMW	HKNW	72
HTMW	HTAR	15
HTMW	HTDA	65
HTMW	HTKJ	11
HTMW	NGARA	78
HTTB	HTAR	14
HTTB	HTDA	23
HTTB	HTKA	11
HTZA	HTDA	12
HTZA	HTDO	11
HUEN	HBBA	12
HUEN	HRYR	14
HUEN	HTDA	18
NGARA	HKNW	17
NGARA	HTMW	50

Appendix H

Detailed data-base of representative week

Date	Unique nr	Flight number	Type	Depart	Arrival	TRAJECTORY point1	point2	point3	point4	point5	time1	time2	time3	time4	time5	FL1	FL2	FL3	FL4	FL5
01-09-1998	1	9H TOP	F50	FMCV	HTDA	KINAN	KOBEL	RIDIR			13:01	14:13	14:41			240	240	240		
	2	ETH 837	B767	HAAB	FADN	UVURO	DV	BOTEN	BONAP		10:37	15:47	10:10	10:30		390	390	380	390	
	3	ETH 823	B737	HAAB	FWLI	LOGIN	DO	UVUKAT	UTINA		11:09	11:33	11:50	12:04		390	370	380	350	
	4	ATC 721	B737	HTDA	FLLS	ODBAT	RAPOR	ORLIM			11:21	11:00	11:08			310	310	310		
	5	B 5002	DC8	FLLS	HUEN	MB	ITOBO	UTEGI	APNAD		12:09	12:33	12:51	12:01		390	350	390	390	
	6	SAA 183	EA31	HKNA	FAJS	KV	BEBOH	DO	UTINA	UVUKAT	12:45	12:57	13:15	13:42	13:54	390	350	390	390	390
	7	SAA 270	B747	FAJS	HECA	MB	ITOBO	UTEGI	APNAD		12:11	12:41	13:01	13:11		330	390	380	390	
	8	KQA 411	EA30	HTDA	HKNA	GEREN	GABOO				13:51	14:03				390	350			
	9	VR CUB	D1	HKNA	FALA	LOGIN	DO	UVKAT	UTINA		13:22	13:45	14:09	14:23		430	430	430	430	
	10	KLM 569	B747	HTDA	EHAM	GEREN	GABOO				21:17	21:36				235	310			
	11	AFR 477	B747	FMMI	HKNA	KINAN	KOBEL	RIDIR	GEREN	GABOO	16:49	17:01	17:13	17:27	17:50	390	350	350	390	350
	12	QAL 183	EA30	HKNA	FAJS	LOGIN	DINGI	MB			03:44	04:09	04:32			310	310	390		
	13	ELY 511	B767	HKNA	FAJS	LOGIN	DINGI	MB			02:45	03:09	03:30			390	390	350		
	14	DDR 402	B707	HFFF	FLLS	LOGIN	DINGI	MB			04:07	04:23	05:02			390	390	360		
	15	QWR 293	MD11	HTDA	HKNA	GEREN	GABOO				08:34	09:13				350	350			
	16	B 5002	DC8	HKNA	FLLS	LOGIN	DINGI	MB			06:43	07:06	07:29			310	350	310		
	17	AFR 485	B747	HTDA	HKNA	GEREN	GABOO				19:46	10:03				390	390			
	18	KLM 563	MD11	HKNA	FWKI	LOGIN	DO	UVKAT	UTINA		07:36	07:57	08:29	08:34		390	390	390	390	
	19	RCM 303	FK100	HTDA	HKNA	GEREN	GABOO				13:31	13:40				235	350			
	20	GFA 711	B767	OMAA	HTZA	UVUFO					10:26					390	250			
	21	5Y MHM		HKNW	HRYR	APLOG	ATUDO	BOSAD			07:41	09:18	09:51	10:03		120				
	22	SAA 187	B747	HTDA	FAJS	KADIM	ROVUM				09:42	10:11				310	390			
	23	ETH 825	B7	HAAB	HRYR	ALTIN	ALSAR				10:53	11:00	11:12			390	390			
	24	AZR 071	FK27	HKNA	FZNA	APLOG	ATUDO	BOSAD			12:27	13:03	13:30			190	190	190		
	25	ATC 524	B737	HTDA	HTMW	LUGAP	XUA406	TOD	MZ		03:55	04:10	04:29	04:40		310	310	310	0	
	26	UNK 96	BE20	HKNW	HRYR	APLOG	ATUDO	BOSAD			05:44	09:18		09:51		390	290	290		
	27	AZW 303	B737	HTDA	FWLI	KADIM	ROVUM				12:51	17:20				310	310			
	28	FED 01	BE20	HKNW	NGARA	PARIN	ATUDO				06:04	06:30	07:10			240	240			
	29	UN 071	L382	HKNA	HRYR	APLOG	ATUDO	BOSAD			07:50	08:14	08:37	08:46		190	190	190		
	30	KQA 470	B737	HKNA	HBBA	PARIN	MZ	GETAB			10:57	11:16	11:33	11:51		390	250	250		
	31	UAP 511	C130	HTKJ	LOLICHOGO	TMA					14:37	14:07				100				
	32	ATC 420	FK27	HTLI	HTDA	TMA					13:31	13:58				140				
	33	9H ELC	C402	HTMR	NGARA	TMA					07:42	08:30				120				
	34	GFA 715	B767	OMAA	FADN	UVURO	DV	BOTEN	BONAP		17:09	14:08	14:28	14:44		390	380	380	390	
	35	ATC 530	B737	HTDA	HTKJ	MUMTU					08:06	08:23				290				
	36	9H ELC	C402	HTDO	HTAR	TMA	RS				06:11	06:33	06:43			110	110			
	37	ATC 721	B737	HTKJ	HTDA	MUMTU					09:24	09:40				270				
	38	AFJ 001	B747	HUEN	HTDA	LABAT	NEDOG	UVKIR	LUGAP		06:53	07:22	07:40	07:51		290	290	290	290	
	39	ATC 525	B737	HTMW	HTDA	XUA406	LUGAP				05:50	06:23				330	330			
	40	KLM 566	B747	HTKJ	HTDA	MUMTU					18:53					260				
	41	KLM 566	B747	EHAM	HTKJ	EVATO					16:48	17:01				290				
	42	NWC 202	B727	HTMW	HTDA	XUA406	TOD	LUGAP			15:09	16:23	16:33	16:49		330	330	170		
	43	UYC 800	B737	FZAA	HKNA	BJA	GETAB	MZ	PARIN		17:00	17:14	17:33	17:55		330	330	330	330	
	44	AZW 300	B737	FWKI	HTDA	ROVUM	KARIM				18:31	19:04				330	330	70		
	45	UN 071	L382	HRYR	HKNA	BOSAD	ATUDO	APLOG			09:42	10:07	10:40			190	190	190		
	46	FED 01	BE20	NGARA	HKNW	MZ	PARIN				12:01	12:37				290	290			
	47	ATC 421	FK27	HTDA	HTLI	TOD					12:15	12:36				190				
	48	RCM 302	FK100	FQMB	HTDA	BONAD	BOTEN				11:38	12:01				330	260			
	49	9H COL	C414	HTMW	HTDA	DO	LUGAP					13:12				130	130			
	50	ETH 821	B767	HTKJ	HTDA	TOD	MUMTU					14:02				330	250			
	51	UNK 96	BE20	FZNA	HKNW	ATUDO	APLOG				11:25	11:57								
	52	NWC 211	B727	FZNA	HTMW	TOD					12:06					270				
	53	5Y MYM		HRYR	HKNW	ATUDO	APLOG				13:10	17:14				130	130			
	54	ETH 821	B767	HUEN	HTKJ	NEDAL	HIMLAR				13:11	13:34				370	370			
	55	KQA 471	B737	HBBA	HKNA	GETAB	MZ	PARIN			12:16	13:30	13:50			330	370	330		
	56	AFM 03	DC8	FVHA	HECA	MB	DINGI	LOGIN			04:16	04:48	05:00			330	330	330		
	57	AFR 476	B747	HKNA	FMMI	GABOO	GEREN	RIDIR	KOBEL	KINAN	08:04	08:22	08:47	08:50	09:14	330	330	330	330	330
	58	MOR 870	EA10	HECA	FVHA	APNAD	UTEGI	ITOBO	MB		08:24	08:38	09:01	09:20		330	330	330	390	
	59	9H TOP	F50	HTDA	FMCH	RIDIR	KOBEL	KINAN			06:48	07:13	07:27			210	210	210		
	60	AFR 4638	B737	HKNA	FMCH	GABOO	GEREN	RIDIR	KOBEL	KINAN	06:09	07:18	07:40	08:03	08:13	330	330	330	330	370
	61	QWR 892	MD11	HKNA	HTDA	GABOO	GEREN				03:36	03:54				330	250			
	62	KLM 564	MD11	FWKI	HKNA	UTINA	UVKAT	DO	LOGIN		16:23	16:38	17:02	17:26		410	410	410	410	
	63	DDR 403	B707	FLLS	HKNA	MB	DINGI	LOGIN			19:46	20:10	20:37			370	370	370		
	64	MAA 182	DC8	FAJS	HKNA	UTINA	UVKAT	DO	LOGIN		16:14	16:35	16:53	17:10		370	370	370	240	
	65	QAL 184	EA31	FAJS	HKNA	MB	DINGI	LOGIN			11:20	11:54	12:14			330	330	330		
	66	SAA 182	EA31	FAJS	HKNA	UTINA	UVKAT	DO	LOGIN		09:20	09:41	10:07	10:30		370	370	370	370	
	67	ELY 612	B767	FAJS	HKNA	MB	DINGI	LOGIN			11:55	12:21	12:42			370	370	370		
	68	KQA 410	EA31	HKNA	HTDA	GABOO	GEREN				11:30	11:54				370	290	80		
	69	GFA 712	B767	HTDA	OOMS	UVUFO					14:22					330				
	70																			

02-08-1995	71	MSR 860	EA30	FVHA	HECA	MB	ITOBO	UTEGI	APNAD		00:07	00:36	00:56	01:07		330	330	350	350	
	72	SAA 271	B767	HECA	FAJS	APNAD	UTEGI	ITOBO	MB		01:45	01:56	02:16	02:46		370	370	370	390	
	73	KQA 420	B737	HKNA	FWKI	LOSIN	DO	UVKAT	UTINA		08:36	09:02	09:28	09:39		310	310	310	310	
	74	ATC 732	B737	HTDA	HKNA	GEREN	GABSO				13:01	13:21				310	310			
	75	AEL 505	B767	HTKJ	LIMC	GABSO					13:24					280				
	76	UGA 530	B737	HUEN	FAJS	APNAD	UTEGI	ITOBO	MB		06:14	06:26	06:46	06:23		330	330	330	350	
	77	AIC 213	EA31	VABB	HTDA	AVIGO					05:00					300	50			
	78	BAW 066	B747	HTDA	HKNA	GEREN	GABSO				05:12	05:29				280	280			
	79	UAF 311	C130	HTKJ	OMDB															
	80	DUBA 001	B747	OMDB	HTKJ	UTATA					11:14					390	290			
	81	UGA 531	B737	FVHA	HUEN	MB	ITOBO	UTEGI	APNAD		13:58	14:29	14:46	15:04		330	350	350	350	
	82	AFR 460		HKNA	HTKJ						09:07					280				
	83	AFM 05	DC8	FVHA	HECA	MB	ITOBO	UTEGI	APNAD		19:41	20:12	20:33	20:42		290	310	350	350	
	84	AFR 465	B747	HTKJ	HKNA	GABSO					17:24					250	310			
	85	KQA 440	B737	HKNA	FVHA	LOSIN	SINGI	MB			11:05	11:30	11:59			340	350	350		
	86	AFR 461	B747	FMCH	HTKJ	KINAN	KOBEL	KISIR			15:33	15:46	16:00			310	390	390		
	87	DSR 402	B707	HTDA	HKNA	GEREN	GABSO				14:57	15:17				310	310			
	88	AFR 460	B747	HTKJ	FMCH	KISIR	KOBEL	KINAN			11:54	12:07	12:17			370	370	370		
	89	RSN 303	FK100	HKNA	HTDA	GABSO	GEREN				07:30	07:59				310	330			
	90	ATC 733	B737	HKNA	HTDA	GABSO	GEREN				14:40	15:00				330	330	250	70	
	91	ETH 832	B757	FWLI	HAAB	UTINA	UVKAT	DO	LOSIN		05:40	05:55	06:20	06:44		370	370	370	370	
	92	IND 8540	B727	HKNA	HTDA	GABSO	GEREN				05:00	05:21				290	290	50		
	93	MDG 051	B747	HKNA	FMMI	GABSO	GEREN	KISIR	KOBEL	KINAN	21:40	21:56	22:24	22:38	22:48	250	330	330	330	330
	94	BAW 069	B747	HKNA	HTDA	GABSO	GEREN				01:42	02:00				330	250	50		
	95	ETH 828	B767	FAJS	HAAB	UTINA	UVKAT	DO	LOSIN		01:17	01:31	01:56	02:20		370	370	370	370	
	96	ATC 730	B737	FLLS	HTDA	ORLIM	RABOR	ODKAT			10:49	10:59	11:28			330	330	330	70	
	97	KQA 441	B737	FVHA	HKNA	MB	SINGI	LOSIN			16:00	16:30	16:55			330	330	330		
	98	KQA 421	B737	FLLS	HKNA	MB	SINGI	LOSIN			14:43	15:09	15:33			330	330	330		
	99	AEL 504	B767	LIMC	HTZA	GABSO	GEREN				08:24	08:43				370	70			
	100	ATC 734	B737	HTZA	OYAA	UVUKO					17:16					330				
	101	AIC 214	EA31	HTDA	VABB	AVIGO					19:48					330				
	102	QFA 716	B767	FAJS	OMAA	ROVUM	KASIM	DV	ELAVA		00:11	00:44	00:57	01:14		370	370	370	330	
	103	ATC 735	B737	HTMW	HTDA	XUA405	LUGAP				10:56	11:20				330	160			
	104	AFR 460	B747	HTKJ	FMCH	MUMTU	DV				11:27	11:42				280	270	325		
	105	IND 8541	B727	HBBA	HKNW	GETAB	MZ	PARIN			08:46	09:08	09:24			230	310	370		
	106	MAF 200	BE20	HTMW	HKNW	PARIN					11:04					250				
	107	DSR 402	B707	HUEN	HTDA	LABAT	NESOS	LUGAP			12:17	12:41	13:08			370	350	170		
	108	ETH 834	B757	HRYR	HAAB	ALSAR	ALTIN				06:40	06:48				370	370			
	109	5H NAB	C208	HTTB	HTKJ		TMA				16:00	16:45				110	110			
	110	5H NAA	C208	IYANSI	HTKJ	TB	TMA	KB			15:49	17:01	17:20			150	130	110		
	111	ATC 537	B737	HTKJ	HTDA	MUMTU					14:48					290	50			
	112	KHO 319	AN12	FNLU	HKNA	BJA	GETAB	MZ	PARIN		04:22	04:43	05:14	05:48		250	250	250	250	
	113	UN 279		FZNA	HKNA	BOSAD	ATUDO	APLOG			10:40	11:15	11:46			250	250	250		
	114	RED 435		HRYR	HKNW	BOSAD					09:55					290	270			
	115	ATC 214	EA31	FAJS	HTDA	ROVUM	KASIM				16:57	17:30				370	370			
	116	ZS BEN	BE91	FLND	HTMW	FIB	TB	TOD			13:45	15.02	15:29			150	150	150		
	117	5H MAF	C402	HTDO	HTDA	TMA					15:22					110				
	118	ATC 230		HTDA	HTMU	TMA	UVKIR	NESOS	TOD		06:06	06:26	07:00	07:20		160	160	160	160	
	119	IND 8540	B727	HTDA	HBBA	LUGAP	DO	TB	TOD		06:48	07:03	07:27	07:43		250	350	350	350	
	120	AIC 213	EA31	HTDA	FADN	BOTEN	BONAP				06:53	07:19				350	350			
	121	AEL 504	B767	HTZA	HTKJ	MUMTU					11:05					280	280			
	122	NWC 3766	B727	HTMW	FZNA	DATAN	KNM				09:28	09:42				280	280			
	123	UYC 601	B737	HKNA	HBBA	PARIN	MZ	GETAB	TOD		08:40	09:01	09:16	09:17		310	310	310	310	
	124	IND 8543	B727	HKNA	HRYR	PARIN	MZ	DATAN			10:54	11:14	11:29			310	310	310		
	125	NWC 311	B727	HTDA	HTMW	LUGAP	XUA405	TOD			07:03	07:23	07:36			310	310	310		
	126	RSN 303	FK100	HTDA	FDMS	BOTEN	BONAP				09:18	09:45				350	350	350		
	127	SAB 569		HUEN	HBBA	EGREK					05:45					280				
	128	5H ELC		HTMS	HTDO	TMA	TOD				11:00	11:23				120	120			
	129	5H JRD	PA32	HTMT	HTDA	TMA					13:40					85				
	130	ATC 730	B737	HTDA	HTKJ	MUMTU					13:15					260				
	131	AFR 461	B747	FMCH	HTKJ	DV	MUMTU				16:11	16:25				250	250			
	132	ATC 736	B737	HTDA	HTMW	LUGAP	XUA405	TOD			05:56	06:18	06:30			310	310	310		
	133	ETH 830	B767	HTDA	HUEN	IMLAK	NESAL				04:42	05:02				350				
	134	MAF 200	BE20	HKNW	HTMW	PARIN					05:59					240				
	135	UN 279	BE20	HKNA	HRYR	APLOG	ATUDO	BOSAD			05:37	06:00	06:28			260	260	260		
	136	MAF 200		HTMW	NGARA										07:32	160				
	137	MAF 200		HTMW	NGARA										09:10	190				
	138	ATC 252	FK27	HTDA	HTTB	AVITA	DO	TOD			13.49	14:15	14:53			160	160	160		
	139	RED 455	BE20	HKNA	HRYR	APLOG	ATUDO	BOSAD			07:45	08:14	08:42			260	260	260		
	140	ETH 850	B767	HTDA	HTKJ	MUMTU	TOD				03:21	03:27				310	310			

03-08-1995	141	KQA 462	EA31	HKNA	FAJS	LOSIN	SINGI	MB			06:55	07:17	07:43			350	350	350		
	142	UGA 545	B737	FVHA	HUEN	MB	ITOBO	UTEGI	APNAD		13:52	14:25	14:48	15:01		350	350	350	350	
	143	AZW 755	B767	HKNA	FVHA	LOSIN	SINGI	MB			13:19	13:41	14:08			390	390	390		
	144	MSR 876	EA30	FAJS	HECA	MB	ITOBO	UTEGI	APNAD		22:33	23:03	23:23	23:34		290	310	310	310	
	145	LAZ 516		FAJS	LBSF	MB	ITOBO	UTEGI	APNAD		20:16	20:45	21:0[illegible]	21:17		330	350	350	350	
	146	AFR 6501	B747	FMMI	HKNA	KINAN	KOBEL	KISIR	GEREN	GABSO	19:31	19:42	19:54	20:22	20:42	390	390	390	390	390
	147	ETH 847	B767	HTKJ	FWLI	DEBON	DO	UVKAT	UTINA		14:58	15:12	15:37	15:53		350	390	390	390	
	148	SAA 151	B767	OMDB	FAJS	ELAVA	DV	ROVUM			23:56	00:16	00:55			390	390	390		
	149	ATC 741	B737	OYAA	HTZA	UVUKO					08:00					310	80			
	150	KLM 563	MD11	HKNA	FWLI	LOSIN	DO	UVKAT	UTINA		07:31	07:54	08:18	08:32		390	390	390	390	
	151	UGA 544	B737	HUEN	FVHA	APNAD	UTEGI	ITOBO	MB		07:23	07:36	07:57	08:29		370	370	370	350	
	152	MDG 050	B747	FMMI	HKNA	KINAN	KOBEL	KISIR	GEREN	GABSO	05:03	05:16	05:28	05:54	06.13	350	350	350	350	350
	153	SWR 293	MD11	HTDA	HKNA	GEREN	GABSO				08:28	08:48				310	310			
	154	M 131 MF	C141	HFFF	FVHA	LOSIN	DO	UVKAT	UTINA		03:23	03:46	04:13	04:28		350	350	350	350	
	155	QFA 713	B767	HKNA	HTKJ	LOSIN					05:35					350	250			
	156	MSR 877	EA30	HECA	FAJS	APNAD	UTEGI	ITOBO	MB		01:40	01:51	02:11	02:40		330	330	330	350	
	157	LAZ 517	B767	LBSF	FAJS	APNAD	UTEGI	ITOBO	MB		03:08	03:19	03:39	04:09		370	370	370	390	
	158	QFA 711	B767	OOMS	HTZA	UVUKO										310				
	159	KQA 463	B737	HTDA	HKNA	GEREN	GABSO				09:55	10:15				350	350			
	160	ATC 743	B737	HTDA	HKNA	GEREN	GABSO				13:23	13:41				310	310			
	161	AZW 754	B767	FVHA	HKNA	MB	SINGI	LOSIN			10:37	11:05	11:25			410	410	410		
	162	KLM 564	MD11	FWLI	HKNA	UTINA	UVKAT	DO	LOSIN		16:23	16:39	17:04	17:27		410	410	410	410	
	163	AML 162	B737	FWLI	HKNA	UTINA	UVKAT	DO	LOSIN		17:51	18:08	18:36	19:02		370	370	370	370	
	164	KQA 462	B737	HKNA	HTDA	GABSO	GEREN				07:41	08:00				330	330			
	165	SWR 292	MD11	HKNA	HTDA	GABSO	GEREN				03:34	03:51				330	330	70		
	166	ATC 742	B747	HKNA	HTDA	GABSO	GEREN				15:15	15:33				330	330			
	167	QFA 714	B767	HTKJ	HKNA	EVATO					08:35					330				
	168	KQA 463	EA31	FAJS	HKNA	MB	SINGI	LOSIN			14:19	14:45	15:09			370	370	370		
	169	QFA 712	B767	HTDA	OOMS	ELAVA					14:14					370				
	170	ETH 847	B767	HUEN	HTKJ	NESAL	TOD	IMLAK			13:27	13:44	13:50			370	370			
	171	MAF 1	BE99	FZNA	HKNW	BOSAD	ATUDO	APLOG			12:02	12:44	13:10			130	130	130		
	172	5H AZM		LUKULA	HTDA											70				
	173	AFB 068	C130	HRYR	HKNA	BOSAD	ATUDO	APLOG			16:02	16:26	16:53			230	230	230		
	174	SAA 186	B747	FAJS	HTDA	ROVUM	KASIM				15:31	16:05				410	410	410		
	175	UN 072		HRYR	HKNA	ATUDO	APLOG				14:56	15:27				230	230			
	176	ATC 2233	FK27	HTTB	HTDA	DO	AVITA				06:15	06:46				170	170			
	177	ETH 930	B767	FZAA	HKNA	BOSAD	ATUDO	APLOG			03:45	04:02	04:18			410	410	410		
	178	PBU 902	BE20	HBBA	HKNA	GETAB	MZ	PARIN			10:11	10:48	11:22			210	210	210		
	179	ETH 8653	B707	HRYR	HKNA	BOSAD	ATUDO	APLOG			10:36	10:54	11:10			330	330	330		
	180	ATC 547	B737	HTKJ	HTDA	NUMTU					11:52					250				
	181	GAF 5453	C130	FLLS	HKNA	MB	SINGI	LOSIN			09:17	10:07	10:49			210	210	210		
	182	UN 071		HRYR	HKNA	BOSAD	ATUDO	APLOG			08:22	08:51	09:20			230	230	230		
	183	ATC 541	B747	HTMW	HTDA	XUA405	LUGAP				08:29	08:54				290	290			
	184	5Y MKM	C406	HRYR	HKNW	BOSAD	ATUDO	APLOG			12:46	13:18	13:56			130	130	130		
	185	SAA 150	B767	FAJS	OMDB	ROVUM	KASIM	DV	UVUKO		11:01	11:31	11:43	11:58		330	330	330	330	
	186	UN 272	BE20	HKNA	HRYR	ATUDO	TOD	BOSAD			12:54	13:17	13.24			260	260	250		
	187	MAF 1	BE99	HKNW	FZNA	PARIN	MZ	ELOBO	KNM		06:31	07:17	07:52	08:00		120	120	120	120	
	188	MSR 3001		HECA	HRYR	EGREK					04:33					390	290			
	189	MAF 200	BE20	HKNW	HTMW	PARIN					05:22					240				
	190	ATC 540	B737	HTDA	HTMW	LUGAP	XUA405	TOD			06:17	06:34	06:44			280	280	280		
	191	UAF 312	C130	HTKJ	LOLIONDO	TMA					08:45					160				
	192	5Y MKM	C406	HKNW	HRYR	APLOG	ATUDO	BOSAD			08:37	09:12	09:47			120	120	120		
	193	UN 071	L382	HKNA	HRYR	APLOG	ATUDO	BOSAD			06:33	07:00	07:30			220	220	220		
	194	ZS BEN	BE20	HTMW	FLND	TB	FIB				08:50	09:10				180				
	195	AFJ 002	B747	HTDA	HUEN	LUGAP	UVKIR	NESOS	GAGNA		18:17	18:30	18:42	19:00		390	390	390	390	
	196	PBU 903	BE20	HKNA	HBBA	PARIN	MZ	GETAB			13:19	13:54	14:30			200	200	200		
04-08-1995	197	AFM 06	DC8	HECA	FVHA	APNAD	UTEGI	ITOBO	MB		07:05	07:16	07:38	08.07		330	330	330	350	

04-09-1996	197	APM 06	DC9	HECA	FVHA	APHAD	UTEGI	ITOBO	MB		07:06	07:16	07:38	08:01		330	330	330	350	
	198	ATC 750	B737	HTDA	HKNA	GEREN	GABDO				14:28	14:47				310	310			
	199	DAA 182	EA30	HKNA	FAJS	LOGIN	DO	UVKAT	UTINA		12:40	13:04	13:28	13:40		310	310	310	310	
	200	AZW 759	B767	HKNA	FVHA	LOGIN	SINGI	MB			13:33	13:57	14:22			390	390	390		
	201	OAL 106	EA30	HKNA	FAJS	KV	MB				11:55	12:45				310	310			
	202	AML 181	B737	HKNA	FWLI	LOGIN	DO	UVKAT	UTINA		07:38	08:01	08:24	08:45		310	310	310	310	
	203	ELY 611	B747	LLBG	FAJS	LOGIN	SINGI	MB			01:04	01:25	01:51			390	390	350		
	204	ETH 856	B767	FWLI	HUEN	MB	ITOBO	UTEGI	APHAD		04:45	05:14	05:35	05:45		370	390	350	390	
	205	KLM 568	MD11	HTDA	HKNA	GEREN	GABDO				17:00	17:24				390	390			
	206	AFR 478	B747	FMMI	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABDO	16:57	17:10	17:22	17:40	18:00	390	390	350	390	390
	207	AZW 732	B767	FVHA	LCLK	MB	ITOBO	UTEGI	APHAD		19:10	19:40	20:08	20:20		370	390	390	390	
	208	AFR 8492	B737	FMCZ	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABDO	14:53	15:00	15:01	15:51	16:11	350	390	350	390	350
	209	OPA 718		OMAA	FAJS	LOGIN	SINGI	MB			12:38	12:40	13:13			350	390	390		
	210	DLH 8288	B747	HKNA	FAJS	LOGIN	DO	UVKAT	UTINA		06:52	07:14	07:30	07:51		350	390	350	350	
	211	ATQ 8003	TU54	HFFF	FYWH	LOGIN	SINGI	MB			07:31	07:50	08:10			390	390	390		
	212	INL 201	B727	FLND	HUEN	MB	ITOBO	UTEGI	APHAD		11:53	12:20	12:43	12:58		330	390	350	330	
	213	INL 202	B727	HUEN	FLND	APHAD	UTEGI	ITOBO	MB		14:48	15:00	15:20	15:00		330	330	330	350	
	214	5H AZN	PA31	HTDA	LUNDA	TMA	TOO				10:30	10:50				120	120			
	215	UN 279	BE20	HKMW	HBBA	PARIN	MZ	GETAB			07:40	07:56	08:00			240	240	240		
	216	5H TZA	C130	HTMG	HTDO											90				
	217	5H ELG	BE55	HTDA	HTDO											100				
	218	TRU 702	B707	HECA	HBBA	EDREK					07:00					350				
	219	5H COG	C414	HTDA	IFAKARA	TMA					06:01					120				
	220	ATC 560	B737	HTKJ	HTMW											240				
	221	ATC 566	B737	HTDA	HTMW	LUGAP	XUA405	TOO			06:34	07:00				310	310	310		
	222	UGA 552	B737	HUEN	HRYR	ALTIN	ALBAR				07:07					290	290			
	223	KQA 470	B737	HKNA	HBBA	PARIN	MZ	GETAB	TOO		12:28	12:45	12:57	13:00		310	310	310	290	
	224	ETH 861	B767	HKNA	FZAA	PARIN	MZ	GETAB	BJA		10:21	10:40	10:57	11:00		390	390	350	350	
	225	ATC 562		HTMT	HTDA	NAGON					13:00					200				
	226	FED 02		HKMW	FZMA	APLOG	ATUDO	BODAD	KNM		06:40	06:15	06:40	06:50		240	240	240	240	
	227	FED 01		HKMW	NGARA	PARIN	MZ	TOO			06:41	06:15	06:35			240	240	240		
	228	UNK 96		HKNA	FZMA	APLOG	ATUDO	BODAD	KNM		06:15	06:50	07:10	07:20		290	290	290	290	
	229	JW 8030		HTDA	HTDV											120				
	230	5H JET		HTDA	HTTU	TMA	ON	TOO			06:32	07:00				90				
	231	5Y BKN	C404	HKMW	HTMW	PARIN					10:00					140				
	232	5H TZA	C310	HTDO	HTTB	OPH					06:30					90				
	233	FED 01	BE20	HTMW	NGARA											190				
	234	UN 071	L382	HKNA	HRYR	APLOG	ATUDO	BODAD			03:30	03:56	04:21			220	220	220		
	235	RED 436	BE200	HKMW	HRYR	APLOG	ATUDO	BODAD			06:59	06:29	07:00			290	290	290		
	236	VH NJE	B737	HRMO	HRYR	MODAM	MZ	DATAN			05.15	05.38	05:56			350	350	350		
	237	5H RAZ	C402	HTAR	INYONGA	TMA	ON	TOO			11:12	12:16	12:16			120	120	120		
	238	5H TGF	FK50	HTDA	HTDO	TMA	ON				10:41	11:15				220				
	239	FED 01	BE20	HTDA	HTMW	LUGAP	ON	ON	TOO		12:01	12:30	13:00	13:12		240	240	240	240	
	240	KLM 567	MD11	HKNA	HTDA	GABDO	GEREN				07:25	07:43				370	370	100		
	241	APM 07	DC9	FVHA	HECA	MB	SINGI	LOGIN			20.10	20:37	21:00			330	330	330		
	242	CCA 099	B743	FLLS	ZPPP	GRLIM	RABOR	ODGAT	AVIGO		17:20	17:37	18:00	18:20		330	330	370	330	
	243	OAL 100	EA30	FAJS	HKNA	MB	SINGI	LOGIN			10:21	10:40	20:11			330	330	370		
	244	ATC 751	B737	HKNA	HTDA	GABDO	GEREN				16:24	16:44				330	330	100		
	245	SOT 262	BA46	FLLS	HKNA	MB	SINGI	LOGIN			13:50	14:20	14:52			290	290	290		
	246	AZW 759	B767	FVHA	HKNA	MB	SINGI	LOGIN			10:27	10:56	11:10			410	410	410		
	247	DAA 183	EA30	FAJS	HKNA	UTINA	UVKAT	DO	LOGIN		06:31	06:46	10:06	10:21		330	330	330	370	
	248	AFR 479	B747	HKNA	FMMI	GABDO	GEREN	KIDIR	KOBEL	RINAN	07.52	08:12	08:30	08:52	09:08	330	330	370	330	330
	249	DLH 8294	B747	FAJS	HKNA	MB	SINGI	LOGIN			16:18	16:44	10:06			370	370	370		
	250	UN 279	BE20	HRYR	HKMW	BODAD	ATUDO	APLOG			13:05	13:30	14:12			230	230	230		
	251	5H NAA		MAKWAZA	HTAR	TMA					08:43					115				
	252	FED 01		NGARA	HTMW											190				
	253	5H TZA	C310	HTMG	HTDA	TMA					18:34					70				
	254	ATC 567	B737	HTKJ	HTDA	MUMTU	TOO				10:07					270				
	255	ATC 553	B737	HTDA	HTMT	TMA					11:40					240				
	256	ATC 557	B737	HTMW	HTKJ	MODAM					08:40					290				
	257	UGA 553		HRYR	HUEN	ALTIN					08:26					270				
	258	ATC 559	B737	HTKJ	HTDA	MUMTU					16:00					290				
	259	FED 01	BE200	HTMW	HTDA	XUA405	LUGAP				08:50	10:21				250				
	260	ATC 551	B737	HTMW	HTDA	XUA405	LUGAP				10:44	11:00				290				
	261	5H ELG	BE55	HTDO	HTDA	IMDAT					10:23					110				
	262	FED 01	BE20	NGARA	HKMW	MZ	PARIN				16:42	18.22				230	230			
	263	5H ZAL	C402	HTMW	HTDA	ON	ON	TMA			14:47	15:24	15:51			110	110	110		
	264	UN 017	L382	HRYR	HKNA	BODAD	ATUDO	APLOG			13:50	14:20	14:48			230	230	230		
	265	UNK 96	BE20	HRYR	HKMW	BODAD	ATUDO	APLOG			11:50	12:32	13:05			250	250	250		
	266	MDR 7006	B707	FLMD	HRYR	BJA	TOO				16:00	17:52				290	330			
	267	ATC 320	B737	FWCL	HTDA	ROVUS	KARIM				18.20	19:05				330	330			
	268	KQA 471	B737	HRBA	HKNA	GETAB	TOO	MZ	PARIN		14:10	14:20	14:37	14:50		330	330	330	330	
	269	VH NJE	B737	HRYR	FBGB	MZ	KV	MERKU			08:29	08:00	09:16			370	370	370		
	270	FED 02	BE20	FZMA	HKMW	BODAD	APLOG				08:20	10.34				270	270			
	271	5H COG	C402	IFAKARA	HTDA											130				
	272	RED 436	BE20	NGARA	HKMW	MZ	PARIN				08:00	08:20				250	290			
	273	5Y BKN		HTMW	HKMW	PARIN					11:53					130				
	274	5H RAZ	C402	INYONGA	HTAR											130				
	275	5H TGF	FK50	HTDO	HTDA											210				

05-08-1999	276	KQA 465	B737	HTDA	HKNA	GEREN	GABSO				20:51	21:10				310	310			
	277	RBN 306	F100	HTDA	HKNA	GEREN	GABSO				18:11	18:31				310	350			
	278	KLM 569	B747	HTDA	EHAM	GEREN	GABSO				21:43	22:00				310	310			
	279	ETH 863	B767	HTKJ	FVHA	DO	MB				13:00	13:28				390	390			
	280	AFR 465	B747	HTKJ	HKNA	GABSO					17:33					280				
	281	ETH 867	B757	HAAB	FADN	UVUKO	DV	BOTEN	BONAP		16:39	16:57	17:10	17:37		390	390	390	390	
	282	BOT 251	BA46	HKNA	FVHA	LOSIN	SINGI	MB			08:15	08:45	09:17			310	310	310		
	283	ZS NUS	BA11	HFFF	HTDA	UVUKO					10:35					310				
	284	KLM 569	B747	EHAM	HTKJ	EVATO	LOSIN				17:27	17:32				350	250	170		
	285	ATC 787	B737	HTKJ	FAJS	DEBON	DO	UVKAT	UTINA		06:21	06:37	07:03	07:18		310	310	310	310	
	286	MSR 877	B767	HECA	FAJS	APNAD	UTEGI	ITOBO	MB		05:55	06:06	06:26	06:56		410	410	390	390	
	287	ATC 783	B737	HTDA	FLLS	ODGAT	RABOR	ORLIM			05:51	06:16	06:29			310	310	310		
	288	QFA 711	B767	OOMS	HTZA	UVUKO					09:58					390				
	289	BAW 066	B747	HTDA	HKNA	GEREN	GABSO				05:21	05:39				310	310			
	290	MSR 2877	B767	HECA	FAJS	APNAD	UTEGI	ITOBO	MB		04:05	04:19	04:37	05:08		330	330	330	390	
	291	ELY 512	B747	FAJS	HKNA	MB	SINGI	LOSIN			21:21	21:45	22:07			330	330	330		
	292	ATG 9004	TU54	FYWH	HFFF	MB	SINGI	LOSIN			19:20	19:50	20:11			370	370	370		
	293	ATC 786	B737	FAJS	HTKJ	UTINA	UVKAT	DO	DEBON			13:35	14:01	14:15		330	330	330	250	90
	294	KQA 423	EA31	FLLS	HKNA	MB	SINGI	LOSIN			16:04	16:31	16:53			410	410	410		
	295	KQA 464	B737	HKNA	HTDA	GABSO	GEREN				18:33	18:51				330	330	50		
	296	AFR 8493	B737	HKNA	FMCZ	GABSO	GEREN	KISIR	KOBEL	KINAN	08:02	08:24	08:54	08:58	09:22	370	370	370	370	370
	297	BUD 324	EA30	HKNA	FMCH	GABSO	GEREN	KISIR	KOBEL	KINAN	10:20	10:40	11:07	11:21	11:31	330	330	330	330	330
	298	HR AMD	H825	FALA	HKNA	UTINA	UVKAT	DO	LOSIN				01:29	01:50		330	330	330	330	
	299	KQA 422	EA30	FLLS	HKNA	LOSIN	SINGI	MB			11:29	11:54	12:17			390	390	390		
	300	BAW 069	B747	HKNA	HTDA	GABSO	LOSIN				02:30	02:48				370	370			
	301	QFA 712	B767	HTDA	OMAA	ELAVA					14:16					330				
	302	MSR 3007	B707	FLND	HKNA	MB	SINGI	LOSIN			22:15	22:40	23:03			370	370	370		
	303	ATC 768	B737	HTZA	HFFF	UVUKO					14:31					330				
	304	RBN 306	F100	FDMS	HTDA	BONAP	BOTEN				14:23	14.51				330	330			
	305	ATC 563	B737	HTKJ	HTZA	UTA					15:30					250				
	306	ATC 2251	FK27	HTMW	HTDA	DO	LUGAP				13:20	13:49				190	190			
	307	ATC 763	B737	FVHA	HTDA	ROVUM	KASIM				11:25	12.00				330	330			
	308	ATC 561	B737	HTMW	HTDA	XUA405	LUGAP				11:40	12:05				290	290			
	309	CS TMF	DA50	HTKJ	HKMO											270				
	310	AFR 465	B747	HBBA	HTKJ	FIR					14:30					370				
	311	ETH 864		HBBA	HAAB	ALSAR	ALTIN				13.47	13:46				410	410			
	312	QAF 412		FLLS	HTDA	ORLIM	RABOR	ODGAT				13:12	14:05			170	170	170		
	313	KQA 465	B737	FAJS	HKMO	ROVUM	KASIR	DV	UVUKO		19:06	19.44	19:54	20.15		330	330	330	330	
	314	ETH 861	B767	HUEN	HTDA	LABAT	NESOS	LUGAP			11:45	12:11	12:35			410	370	250		
	315	PBU 906		HBBA	HKNA	GETAB	MZ	PARIN			11:00	11:30	12:06			210	210	210		
	316	A 2A15	C404	FVHA	HKNW	UTINA	UVKAT	DO	?		08:30	09:12	10:22	11:00		110	110	110	110	
	317	AUA 532	EA34	FAJS	LOWW	KMI	TALAL	BJA			20:35	20:49	20:53			330	330	330		
	318	CFC 6722	C130	HRYR	HKNA	BOSAD	ATUDO	APLOG			08:10	08:39	09:06			210	210	210		
	319	QFA 716	B767	FAJS	OMAA	ROVUM	KASIR	DV	ELAVA		23:20	23:45	23:58	00:15		330	330	330	330	
	320	AJF 001		HUEN	HTDA	GAGNA	NESOS	UVKIR	LUGAP		07:33	07:52	08:05	08:16		410	410	410	410	
	321	5H MOF	BE55	HTMD	HTDA	DO	TMA				05:46	06:26				110	110			
	322	CS TMF	DA50	DRRN	HTKJ	NESAL	IMLAK				09:27	09:50				410	410			
	323	MSR 621	EA30	HUEN	HTDA	LABAT	GAGNA	NESOS	UVKIR	LUGAP	09:06	09:15	09:35	09:49	10:02	330	330	330	330	330
	324	LTU 671	B767	FADN	HKMO	BONAP	BOTEN	DV	UVUKO		16:09	16:34	16:48	17:05		310	310	310	310	
	325	SAB 563	DC10	HRYR	HKNA	BOSAD	ATUDO	APLOG			04:59	05:16	05:31			330	330	330		
	326	ATC 2251	FK27	HTKA	HTMW											170				
	327	ETH 950	B757	FZAA	HKNA	BJA	GETAB	MZ	PARIN		03:57	04:09	04:26	04:47		370	370	370	370	
	328	UYC 802	B737	FZAA	HKNA	BJA	GETAB	MZ	PARIN		19:14	19:25	19:46	20:08		330	330	330	330	
	329	KLM 569	B747	HTKJ	HTDA	UTA					19:18					250				
	330	ATC 786	B737	HTKJ	HTDA	MUMTU					15:55					330				
	331	ATC 562	B737	HTDA	HTKJ	MUMTU					13:52					280				
	332	KQA 464	B7.	HKMO	FAJS	DV	KASIM	ROVUM			12:18	12:29	13:07			310	310	310		
	333	ATC 321	B737	HTDA	FWLI	KASIM	ROVUM				17:41	18:14				350	350			
	334	AFR 464	B767	HTKJ	HBBA	TMA					10:46					390				
	335	ATC 2250	FK27	HTMW	HTKA	TOC	TOD				08:16	08:24				90	90			
	336	ETH 981	B767	HKNA	FCBB	APLOG	ATUDO	BOSAD	KNM		10:27	10:45	11:00	11:03		350	350	350	350	
	337	AFR 464	B747	HKNA	HTKJ	LOSIN					08:42					280				
	338	ETH 865	B767	HAAB	HRYR	ALTIN					10:33					330				
	339	CFC 6721	C130	HKNA	HRYR	APLOG	ATUDO	BOSAD			05:07	05:33	05:56			180	180	180		
	340	ATC 2250	FK27	HTDA	HTMW	LUGAP	?	ON	TOD		05:21	05:50	06:38	06:38		180	180	180	180	
	341	ATC 787	B737	HTDA	HTKJ	MUMTU					04:53					310				
	342	PBU 907	BE20	HKNA	HBBA	PARIN	MZ	GETAB			13:51	14:27	15:03			220	220	220		
	343	UN 071	L382	HKNA	HRYR	APLOG	ATUDO	BOSAD			03:24	03:50	04:15			200	200	200		
	344	ZS NUS	BA11	HTDA	FALA	KASIM	ROVUM				12:25	13:01				310	310			
	345	ATC 580	B737	HTDA	HTMW	LUGAP	XUA405	TOD			09:16	09:35				280	280	280		

06-08-1996	346	GAA 193	EA30	HKNA	FAJS	LOGIN	DO	UVKAT	UTINA		12:37	13:00	13:20	13:40		310	310	310	310	
	347	BAW 3677	DC9	HKNA	FAJS	LOGIN	DINGI	MB			10:29	10:51	11:17			390	360	350		
	348	DLH 8206	B747	HKNA	FAJS	LOGIN	DO	UVKAT	UTINA		06:36	06:08	07:23	07:38		390	360	390	390	
	349	DWR 203	MD11	HTDA	HKNA	GEREN	UTATA				08:34	08:54				290	290			
	350	ATC 771	B737	HPPP	HTZA	UVUKO					06:02					310				
	351	AFM 10	DC96	HECA	FVHA	APNAD	UTEGI	ITOBO	MB		04:08	04:10	04:30	05:12		330	330	330	380	
	352	KLM 967	B747	HKNA	FAJS	LOGIN	DINGI	MB			06:09	06:20	06:47			390	360	390		
	353	KQA 440	B737	HKNA	FVHA	LOGIN	DINGI	MB			07:54	08:18	08:40			360	390	350		
	354	AIC 217	EA31	VABB	HTDA	AVIGO					04:42					390				
	355	LAZ 616	B767	LBSF	FAJS	APNAD	UTEGI	ITOBO	MB		03:07	03:17	03:37	04:07		370	370	370	390	
	356	MDR 2076	B767	FAJS	HECA	MB	ITOBO	UTEGI	APNAD		22:47	23:18	23:38	23:49		370	360	390	390	
	357	GUD 326	EA31	FMCH	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABOO	00:13	00:27	00:38	01:00	01:20	390	360	350	380	390
	358	QFA 716	B767	OMAA	FAJS	LOGIN	DINGI	MB			06:20	06:43	03:00			390	360	350		
	359	UN 071	L382	HRYR	FWLI	1	ITOBO	MB	OVANA		01:11	01:30	02:26	08:30		290	260	200	260	
	360	AZW 733	B767	LCLK	FVHA	APNAD	UTEGI	ITOBO	MB		01:38	01:48	02:02	02:33		370	370	370	390	
	361	AFM 008	DC9	HECA	FVHA	APNAD	UTEGI	ITOBO	MB		02:49	03:00	03:18	07:50		330	330	330	390	
	362	LAZ 616	B767	FAJS	LBSF	MB	ITOBO	UTEGI	APNAD		20:11	20:40	21:00	21:11		390	350	350	390	
	363	MDR 576	B767	FAJS	HECA	MB	ITOBO	UTEGI	APNAD		22:20	23:06	00:16	00:29		370	390	390	390	
	364	GAA 270	B767	FAJS	HECA	MB	ITOBO	UTEGI	APNAD		12:29	12:57	13:17	13:28		370	390	390	390	
	365	KQA 441	B737	FVHA	HKNA	MB	DINGI	LOGIN			12:31	12:09	13:23			330	330	330		
	366	KQA 481	EA31	HTDA	HKNA	GEREN	GABOO				14:24	14:40				390	300			
	367	UGA 574	B737	HUEN	FVHA	APNAD	UTEGI	ITOBO	MB		13:19	13:31	13:53	14:24		370	370	350	390	
	368	AFR 456	B747	HTDA	HKNA	GEREN	GABOO				17:33	17:52				390	390			
	369	MDG 062	B747	FMMI	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABOO	18:58	19:11	19:24	19:40	20:06	390	390	350	360	370
	370	AFR 456	B747	FMCH	HTDA	KINAN	KOBEL	KIDIR			14:47	15:00	15:13			390	390	390		
	371	QFA 718	B767	FADN	OMAA	ELAVA					13:05					370				
	372	GAA 192	EA30	FAJS	HKNA	UTINA	UVKAT	DO	LOGIN		09:31	09:47	10:12	10:30		330	330	330	330	
	373	AFR 458	B747	HTDA	FMCH	KIDIR	KOBEL	KINAN			10:08	10:21	10:34			370	370	370		
	374	AFR 480	B747	HKNA	HTDA	GABOO	GEREN				07:41	07:56				330	330			
	375	ETH 872	B767	FVHA	HAAB	MB	DINGI	LOGIN			06:26	06:53	06:12			370	370	370		
	376	RDN 306	FK100	HKNA	HTDA	GABOO	GEREN				05:40	06:00				330	330			
	377	ETH 808	B767	FAJS	HTKJ	UTINA	UVKAT	DO	DEBON			02:01	02:27	02:49		370	390	250		
	378	MDG 063	B747	HKNA	FMMI	GABOO	GEREN	KIDIR	KOBEL	KINAN	03:51	04:10	04:30	04:48	05:00	330	330	330	330	370
	379	DWR 202	MD11	HKNA	HTDA	GABOO	GEREN				03:34	03:51				330	330			
	380	AML 184	B767	FWKI	HKNA	UTINA	UVKAT	DO	LOGIN		17:43	17:58	18:26	18:60		370	370	370	370	
	381	AFM 01	DC9	FVHA	HECA	MB	DINGI	LOGIN			19:53	20:10	20:41			330	330	330		
	382	AFR 0563	B747	FAJS	HKNA	MB	DINGI	LOGIN			13:41	14:06	14:32			370	370	370		
	383	KQA 480	EA31	HKNA	HTDA	GABOO	GEREN				12:24	12:42				370	370			
	384	BAW 3676	DC9	FAJS	HKNA	MB	DINGI	LOGIN			17:44	18:11	18:32			370	330	330		
	385	KLM 968	B747	FAJS	HKNA	MB	DINGI	LOGIN			16:41	17:07	07:31			410	410	410		
	386	DLH 8207	B747	FAJS	HKNA	UTINA	UVKAT	DO	LOGIN		14:40	14:54	15:20	15:42		370	370	370	370	
	387	AIC 216	EA31	HTDA	VABB	AVIGO					20:00					330				
	388	ATC 772	B737	HUEN	HBBA	ALTIN	ALDAR	KNM	TOO		11:54	11:60	12:06	12:06		290	290	290		
	389	ATC 270	FK27	HTKJ	HTMU	TMA	TOO				07:30	07:35				100				
	390	5H TGF	FK50	HTDA	HTBU	LUGAP	DO	WMA	MZ		12:10	12:43	13:26	13:44		220	220	220	220	
	391	PPI 906	BE02	HKNA	HBBA	PARIN	MZ	GETAB			10:23	11:01	11:31			220	220	220		
	392	ATC 773	B737	HTDA	HUEN	LUGAP	UVKIR	NEGOG	LABAT		09:48	10:01	10:18	10:46		310	310	310	310	
	393	UYC 803	B737	HKNA	HRYR	APLOG	ATUDO	TOO	BOGAD		08:00	08:20	08:28	08:36		310	310	310	340	
	394	RDN 306	F100	HTDA	FDMS	BOTEN	BONAP				07:40	08:00				310	310			
	395	DTA 805	AN12	HUEN	FLLS	OH	OH	MB			06:46	06:16	06:10			200	200	200		
	396	5H B12	MU2	HKNW	FWLI	TMA	DO	UVKAT	UTINA		06:21	06:40	06:30	07:04		200	200	200	200	
	397	5H TGF	F50	HTDA	HTBU	LUGAP	DO	WM	MZ		02:50	04:20	04:58	05:14		220	220	220	220	
	398	5H MOF	BE90	HTDA	HTMD	TMA	DO	OH	TOO		06:31	06:06	06:36	06:56		120	120	120	120	
	399	ATC 679	B737	HTDA	HTMW	LUGAP	XUA408	TOO			06:30	06:02	06:11			310	310	310		
	400	AIC 217	EA31	HTDA	FADN	BOTEN	BONAP				06:49	07:14				390	360			
	401	UN 071	L482	FWLI	HRYR	MB	ITOBO	OH	ELOBO		07:03	07:60	08:20	08:32		220	220	180	220	
	402	5H APR		HTMW	NGARA											140				
	403	ATC 672	B737	HTDA	HTKJ	MUMTU					05:30					300				
	404	ETH 870	B767	HTDA	HUEN	LUGAP	UVKIR	NEGOG	LABAT		04:08	04:20	04:33	04:58		360	360	350	350	
	405	5Y BKN	C406	HKNW	HTMW	PARIN					09:30					140				
	406	MDR 822	EA30	HTDA	HUEN	LUGAP	UVKIR	NEGOG	LABAT		00:34	00:40	01:02	01:24		310	310	310	310	
	407	5H COG	C404	HTDA	TARIME	TMA	UVKIR	NEGOG	TOO		12:53	13:26	14:00	14:30		100	100	100	100	
	408	UYC 803	B737	HKNA	FZAA	PARIN	MZ	GETAB	BJA		12:13	12:34	12:53	13:08		310	310	310	310	
	409	AFJ 002	B747	HTDA	EGLL	LUGAP	UVKIR	NEGOG	LABAT		21:01	21:13	21:29	21:52		390	390	390	390	
	410	ATC 2460	FK27	HTLI	HTDA	TOC	TMA				14:59	16:00				140	140	140		
	411	5Y B12	MU2	FWLI	HKNW	UTINA	UVKAT	DO	TMA		10:27	10:08	11:43	12:06		230	230	230	230	
	412	ATC 772	B737	HBBA	HTKJ	FIB	MZ	UTA			13:47	14:08	14:30			330	330	330		
	413	ATC 2481	FK27	HTDA	HTLI	TMA	TOO				12:38	12:06				100	160			
	414	ATC 671	B737	HTMW	HTDA	XUA408	LUGAP				10:51	11:12				330	330			
	415	UYC 803	B737	HRYR	HKNA	BOGAD	ATUDO	APLOG			09:40	10:10	10:20			330	330	330		
	416	5H RKM		HTMW	HKNW											130				
	417	PBU 904	BE02	HBBA	HKNA	GETAB	MZ	PARIN			07:39	08:07	08:56			210	210	210		
	418	5H TGF	FK50	HTMD	HTDA	TOC	DO	LUGAP			06:40	06:06	06:36			210	210	210		
	419	5H TGF		HTMW	HTMD											90				
	420	ATC 271	FK27	HTMU	HTKJ	MODAM					10:06					170				
	421	UN 071	L382	FWLI	HRYR	MB	ITOBO				07:03	07:40				210	210			
	422	DTA 805	AN26	HUEN	FLLS	APNAD	OH	OH	OH	MB	04:04	04:48	06:15	05:48	06:16	200	200	200	200	200
	423	ATC 673	B737	HTKJ	HTDA	MUMTU					06:40					110				
	424	ETH 900	B767	FCBB	HKNA	KNM	BOGAD	ATUDO	APLOG		03:57	04:02	04:10	04:33		370	370	370	370	
	425	GAB 573	DC10	HBBA	HUEN											330				
	426	QFA 719	B767	FADN	OMAA	BONAP	BOTEN	DV	ELAVA		12:10	12:35	12:48	13:06		370	370	370	370	
	427	UN 071	L382	HRYR	FWLI	ELOBO	ITOBO	MB	OVANA		10:13	11:04	11:55	12:03		210	210	210	210	
	428	AIC 216	EA31	FADN	HTDA	ROVUM	RADIM				17:03	17:36				370	340			
	429	5H TGF	FF50	HTBU	HTDA	MZ	WM	DO	LUGAP		16:40	16:06	16:47	17:13		290	290	290	290	
	430	ATC 772	B737	HTKJ	HTDA	MUMTU					15:30					270				

07-06-1995	431	BAW 068	B747	HTDA	HKNA	GEREN	GABGO				10:41	10:59				350	350			
	432	AZZ 903	B707	HBOJ	FVHA	APNAD	UTEGI	ITOBO	MB		07:40	07:51	08:11	08:41		370	370	390	390	
	433	UGA 613	B737	FVHA	HUEN	MB	ITOBO	UTEGI	APNAD		10:42	11:10	11:39	11:40		330	330	390	390	
	434	SAA 271	B767	HECA	FAJS	APNAD	UTEGI	ITOBO	MB		01:44	02:25	02:45	03:14		370	370	370	390	
	435	ATC 716	B737	HKNA	HTZA	GABGO	GEREN				10:09	10:30				330	330	340		
	436	KQA 482	EA31	HKNA	FVHA	LODIN	DINGI	MB			07:44	08:19	08:34			390	390	390		
	437	ATC 714	B737	HTZA	HKNA	GEREN	GABGO				14:18	14:34				310	310			
	438	AML 163	B737	HKNA	FWKI	LODIN	DO	UVKAT	UTINA		10:47	11:13	11:30	11:58		390	390	390	390	
	439	MDG 730	B737	FMMI	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABGO	08:30	08:46	08:59	09:29	09:48	310	310	310	310	310
	440	APR 4634	B747	FMCH	HKNA	KINAN	KOBEL	KIDIR	GEREN	GABGO	10:47	11:04	11:14	11:48	12:05	390	390	390	310	310
	441	AZW 767	B767	HKNA	FVHA	LODIN	DINGI	MB			09:51	10:14	10:40			390	390	390		
	442	KQA 483	EA31	FAJS	HKNA	MB	DINGI	LODIN			14:47	15:15	15:38			370	370	370		
	443	UN 071	L382	FWLL	HRYR	MB	ITOBO	ELOBO			13:31	14:19	15:06			270	290	290		
	444	AZW 766	B767	FVHA	HKNA	MB	DINGI	LODIN			07:01	07:28	07:53			410	410	410		
	445	MDG 731	B737	HKNA	FMMI	GABGO	GEREN	KIDIR	KOBEL	KINAN	11:40	12:09	12:40	12:52	13:07	330	330	330	330	330
	446	BAW 069	B747	HKNA	HTDA	GABGO	GEREN				07:58	08:13				330	330			
	447	GEC 8643	DC8	FLLD	HKNA	MB	DINGI	LODIN			16:59	17:25	17:47			370	370	370		
	448	ATC 617	B737	HTMW	HTKJ	MODAM					09:11					290				
	449	ATC 617	B737	HTKJ	HTDA	MUMTU					10:21					270				
	450	9H AZH	PA31	RUNGWA	ZIWANDU											130				
	451	ATC 611	B737	HTMW	HTDA	XUA405	LUGAP				14:50	15:10				290	290			
	452	5Y BIZ	MU2	FZNA	HKNA	BODAD	ATUDO	APLOG			15:34	16:06	16:30			180	180	180		
	453	ATC 613	B737	HTDA	HTMT	NAGON					15:58					250				
	454	UN 071	L382	HRYR	FWLI	ELOBO	ITOBO	MB			08:15	09:03	09:51			210	210	210		
	455	9H TZA	C310	HTDO	HTDA	IMBAT					09:40					110				
	456	9H TZA	C310	HTTV	HTMG											90				
	457	FED 01	BE20	NGARA	HKNW	MZ	PARIN				10:54	10:12				250	290			
	458	DUB 001	B747	HTKJ	OMDB	MERKU					09:03					370				
	459	ATC 211	FK27	HTKA	HTTB											150				
	460	ATC 211	FK27	HTTB	HTDA	DO	AVITA				12:08	12:44				170	170			
	461	FED 01	BE20	NGARA	HTMW											160				
	462	FED 01	BE20	HTMW	HTDA	LUGAP					10:20					230				
	463	MAF 1	BE90	FZMA	HTMW	ELOBO					12:04					110				
	464	MAF1	BE90	HTMW	HKNW	PARIN					14:00					110				
	465	MAF 200	BE20	HTMW	HKNW	PARIN					08:30					290				
	466	GEC 8642		HBBA	FLLD											330				
	467	IND 8641		HRYR	HKNA	BODAD	ATUDO	APLOG			07:18	07:33	07:52			330				
	468	UN 279	BE20	FZNA	HKNW	ATUDO	APLOG				11:35	11:54				265	290			
	469	UNK 98	BE20	NGARA	IDAKA											180				
	470	UNK99	BE20	IDAKA	NGARA	XUA405	IMBAT	GERUS			13:02	13:30	13:45			270	230	230		
	471	9H COG	C414	HTDO	HTAR											180				
	472	UN 01		HTKA	HTMW											110				
	473	9H TCP	FK50	HTKA	HTTB											180				
	474	9H TCP	FK50	HTTB	HTDA	DO	AVITA				10:19	10:51				230	230			
	475	9H COG	C414	KAHAMA	HTDO											150				
	476	RED 476	BE20	HRYR	HKNA	BODAD	ATUDO	APLOG			07:51	08:26	08:55			290	290	290		
	477	SAA 152	B767	FAJS	OOOB	ROVUM	KADIM	DV	ELAVA		11:23	11:53	12:00	12:23		410	410	410	410	
	478	PBU 900	BE02	HBBA	HKNA	GETAB	MZ	PARIN				07:22	07:59			210	210	210		
	479	9H NAA		HTTB	HKNW											130				
	480	C9 TAH		FOPA	HTMT											130				
	481	DAS 5??	DC10	HRYR	HKNA	BODAD	ATUDO	APLOG			10:03	10:10	10:33			370	370	370		
	482	CMB 740	B707	FZNA	HKNA	KNM	BODAD	ATUDO	APLOG		11:41	11:47	12:02	12:18		370	370	370	370	
	483	9H AZH	PA31	HTDA	HTMR											180				
	484	UN 071	L382	FWLI	HRYR	MB	ITOBO	ELOBO			08:18	09:06	09:44			240	240	240		
	485	ATC 610	B737	HTDA	HTKJ	MUMTU					11:58					280				
	486	FED 01	BE20	HTDA	HTMW	LUGAP	DO				12:04	12:20				290	290			
	487	FED 01	BE02	HTMW	NGARA											180				
	488	FED 01	BE20	HKNW	NGARA	PARIN	MZ				08:40	09:20				220	230			
	489	5Y BIZ	BE20	HKNW	FZNA	APLOG	ATUDO	BODAD	KNM		10:27	10:50	10:24	10:34		220	220	220	220	
	490	DUB 001	B747	OMDB	HTKJ	UTATA					08:41					390				
	491	ATC 210	FK27	HTDA	HTTB	AVITA	DO				09:04	09:30				100	100			
	492	ATC 210	FK27	HTTB	HTKA											100				
	493	9H TZA	C130	HTMG	HTTB	DO					08:30					90				
	494	9H TZA	C310	HTDA	HTTU	TMA					11:29					120				
	495	UAF 312	L382	HTKJ	LOLIONDO											100				
	496	UAF 312	C130	HTKJ	LOLIONDO	TMA					10:00					100				
	497	ATC 610	B737	HTDA	HTMW	LUGAP	XUA405				07:10	07:30				250	290			
	498	ATC 612	B737	HTMT	HTDA	NAGON					12:27					240				
	499	UNK 099	BE20	HKNW	HRYR	APLOG	ATUDO	BODAD			06:14	06:44	07:13			290	290	290		
	500	ATC 610	B737	HTKJ	HTMW	MODAM					13:10					290				
	501	MAF 1		HKNW	FZMA	APLOG	ATUDO	BODAD			06:19	06:54	07:35			120	120	120		
	502	MAF 200	BE20	HKNW	HTMW	PARIN					05:55					220				
	503	IND 8640	B737	HKNA	HRYR	PARIN	MZ	DATAN			05:33	05:53	06:06			310	310	310		
	504	IND 8642	B737	HKNA	HBBA	PARIN	MZ	GETAB			09:29	09:45	10:04			290	290	290		
	505	UN 279	BE20	HKNW	FZMA	PARIN	MZ	GETAB			06:17	06:55	07:20			220	270	220		
	506	9H COG	C404	HTMW	KAHAMA											110				
	507	RED 476	BE20	HKNW	HRYR	APLOG	ATUDO	BODAD			06:52	08:23	08:53			270	270	270		
	508	9H TCP	FK50	HTDA	HTKA	LUGAP	DO	TB			04:22	04:45	05:32			220				
	509	9H COG	C402	TARIME	HTMW											100				
	510	DAA 6216	EA30	HKMO	FAJS	UVUFO	DV	KADIM	ROVUM		07:08	07:17	07:29	08:02		310	310	310	310	
	511	XA DJE	DA90	LIRP	HTKJ	UTATA					07:04					310				
	512	PRU 901	BE02	HKNA	HBBA	PARIN	MZ	GETAB			10:00	10:30	11:00			220	220	220		

Appendix
I

AIR TRAFFIC SERVICES

TERMS OF REFERENCE 1.6.95

I. CHIEF OF AIR TRAFFIC SERVICES

Responsible to the Director of Air Navigational Services for:

1. Evolvement and implementation of ATS policy in Tanzania
2. Management, monitoring and quality control of Air Traffic Services in Tanzania
3. Evolvement of ATS procedures at all ATS units
4. Implementation of new ATS Procedures as determined by ICAO and approved by DCA
5. Evolvement of ATS Division organisational structure that meets the country's requirement for ATS
6. Assessment of station manpower requirements and meeting these requirements as necessary
7. Assessment of training requirements; evolvement of implementation and monitoring of training programs of the division including OJT
8. Licensing and Rating of Air Traffic Controllers
9. Liaison with national, regional and international institutions on ATS matters
10. Co-ordination with neighbouring states on ATS
11. Liaison with operating companies on ATS
12. Organisation and management of Search and Rescue
13. Servicing of Civil Military Co-ordination Committee
14. Participation in the planning functions of the Directorate
15. Any other duties as allocated by Director, ANS

II. HEAD OF ATS OPERATIONS - (PATCO OPERATIONS)

Responsible to the Chief of Air Traffic Services for:

1. Supervising ATS operations to ensure that all units operate in accordance with approved policies, standards and procedures
2. Advise on operation organisation of ATS being provided

3. Assisting in investigation of complaints, incidents, accidents and breaches of air navigation regulations

4. Implementation and supervision of the SAR Plan

5. Checking of SSIs and USOIs and making appropriate recommendations

6. Monitoring of flight surveillance of ATS procedures, Navigational Aids and adequacy of air ground communications

7. Participation in the ATS planning functions of the Division

8. Arrangement of Civil/Military Co-ordination Committee as secretary of the committee

9. Perform any other duties as delegated to him by CATS or DANS

III. HEAD OF ATS STANDARDS AND TRAINING (PRINCIPAL ATCO ORGANISATION)

Responsible to the Chief of Air Traffic Services for:

1. Arrangements for medical Examinations, ATC Licensing and rating boards

2. Preparation of the ATS establishment and manpower utilisation

3. Preparation and maintenance of staff inventory and statistics

4. Co-ordination with manpower division of DCA on transfers, resignations, retirements, recruitments and staff complaints

5. Processing and evaluation of school and field training reports

6. Analysis of ATS training requirement co-ordination with CATS for preparation of training programs

7. Preparation of ATS staff development programs and recommendations on promotions

8. Participation in the ATS Planning function

9. Preparation and secretary to the ATS Planning Group Meeting and ATS Division Meetings

10. Perform any other duties as delegated to him by CATS or DANS

Appendix J

Future Programs

AFI CNS/ATM IMPLEMENTATION PLAN
PROGRAMME OF ACTIVITIES

Activity Reference	2. Domain	3. Sub-Domain	4. Coordinator
EUR AFI East AR-3	ATM	Separation longitudinal	

Title	Reduction of longitudinal separation minima
Description	Present longitudinal separation minima of 20 minutes will be reduced to 10 minutes.
Shortcoming or Problem Addressed	Present longitudinal separation minima lead to unavailability of economic flight trajectories during peak periods
Expected benefits	Increased airspace capacity and reduced delays
Requirements	
Airborne	Nil
Ground	Availability of ATS DS circuits between ATS units, extended VHF coverage

Cost benefit assessment: High

Area of applicability	13. States concerned
Selected volume of airspace in FIRs: Addis Ababa, Antananarivo, Cairo, Dar es Salaam, Entebbe, Khartoum, Mauritius, Mogadishu, Nairobi, Seychelles and Tripoli	Egypt, Ethiopia, Kenya, Libya, Madagascar, Mauritius, Seychelles, Somalia, Sudan, Tanzania and Uganda.
Phases	15. Target dates
ATS DS circuits Extended VHF coverage Application	1996 1996 1996

Related Activities *(all other mutually related Activities)*

Amendment proposal to Doc.7030, First quarter 1996

Prerequisites *(requisites without which the intended benefit would not materialise)*

Common application date by NOTAM
Work of others

Activity Reference	2. Domain	3. Sub-Domain	4. Coordinator
SP EUR/AFI-East AR-3	ATM	RNAV - Fixed RNP 5/12.6	

[illegible]	Fixed RNAV routes
[illegible]	Present system of RNAV routes have dog-legs
Shortcoming or objective addressed	Elimination of dog-legs leading to more direct routings
[illegible]	Reduce fuel costs
[illegible]	
[illegible]	CPDLC
Ground	ATS/DS circuits CPDLC

. Cost benefit assessment: Expected high

Area of applicability	13. States concerned
[illegible] airspace within FIRs: Addis Abeba, [illegible], Cairo, Dar es Salaam, Entebbe, [illegible], Mauritius Mogadishu, Nairobi, [illegible] and Tripoli	Egypt, Ethiopia, Kenya, Libya, Madagascar, Mauritius, Seychelles, Somalia, Sudan, Tanzania and Uganda

[illegible]	15. Target dates
[illegible]P 12.6 [illegible]P 5 [illegible]P 5	1998: Antananarivo, Khartoum, Mogadishu, Mauritius, Seychelles FIRs 1998: Other FIRs 2000: Khartoum and Mogadishu FIRs

Related Activities *(all other mutually related Activities)*

[illegible] *(requisites without which the intended benefit would not materialise)*

DLC

AFI CNS/ATM IMPLEMENTATION PLAN
PROGRAMME OF ACTIVITIES

Activity Reference	2. Domain	3. Sub-Domain	4. Coordinator
(ADV/S) EUR/AFI-East AR-3	Communications	Data link	

Task	Controller-Pilot data link communications (CPDLC) via VHF/satellite along the EUR to Eastern AFI and Indian Ocean routes.
Description	This capability allows aircraft operating along the EUR to Eastern AFI and Indian Ocean routes to exchange ATS messages with ATS units using data link.
Shortcoming or Objective addressed	Present exchanges of ATS messages via HF are inherently unreliable resulting in need for increased longitudinal separation minima and reduced freedom of flight.
Expected benefits	RNP along specific itineraries as a result of improved communications, reduced longitudinal separation minima. Initial step toward Automatic Dependent Surveillance (ADS).
Required elements	
Airborne	Satellite and VHF air/ground data communications capability.
Ground	Satellite and VHF air/ground data communications capability through a service provider. Flight data processing system (FDPS).

Cost benefit assessment:
Benefits expected from improved communications. To be quantified.

Area of applicability	13. States concerned
ACCs: Addis Ababa, Antananarivo, Cairo, Dar es Salaam, Entebbe, Khartoum, Mauritius, Mogadishu, Nairobi, Seychelles and Tripoli	Egypt, Ethiopia, Kenya, Libya, Madagascar, Mauritius, Seychelles, Somalia, Sudan, Tanzania and Uganda.

Phases	15. Target dates
Trial Demonstrations	1998 - 1999
Operational service	2000

Related Activities (all other mutually related Activities)

Coordination with service providers
Coordination with adjacent EUR and MID States.

Dependencies (requisites without which the intended benefit would not materialise)

Standardized message formats and contents

D:\WP51\DOC\EURINO.DVS

AFI CNS/ATM IMPLEMENTATION PLAN
PROGRAMME OF ACTIVITIES

. Activity Reference	2. Domain	3. Sub-Domain	4. Coordinator
-ADS EUR/AFI-East AR-3	Surveillance	Dependent	

. Title	Automatic Dependent Surveillance EUR/AFI-East routes
Description	To establish a capability in which aircraft automatically provide, via a data link, data derived from on-board navigation and position-fixing systems, including aircraft identification, four-dimensional position, and additional data as appropriate to ATS units.
Shortcoming or Objective Addressed	Present imprecise displays at ATS units of air traffic situation outside radar coverage lead to increased separation minima and constrained freedom of flight, both of which impact negatively on airspace users.
. Expected benefits	Better accommodation of user preferred trajectories, resulting in more economic flight profiles.

quired elements

irborne	ADS avionics capability. Air-to-ground data communications capability.
. Ground	<u>Hardware:</u> *For trials-* Single computer platform - RAM in 64MB range; Hard disk in the 2GB range; dual graphics high resolution displays; suitable input-output devices; data logging and archiving. *For operational application:* dual processor; <u>Software:</u> Capability to process and display ADS messages and eventually Current Flight Plan derived flight profiles.

. **Cost benefit assessment:** Estimated to be high. To be quantified.

. Area of applicability	13. States concerned
Rs: Addis Ababa, Antananarivo, iro, Dar es Salaam, Entebbe, artoum, Mauritius, Mogadishu, irobi, Seychelles and Tripoli.	Egypt, Ethiopia, Kenya, Libya, Madagascar, Mauritius, Seychelles, Somalia, Sudan, Tanzania and Uganda.

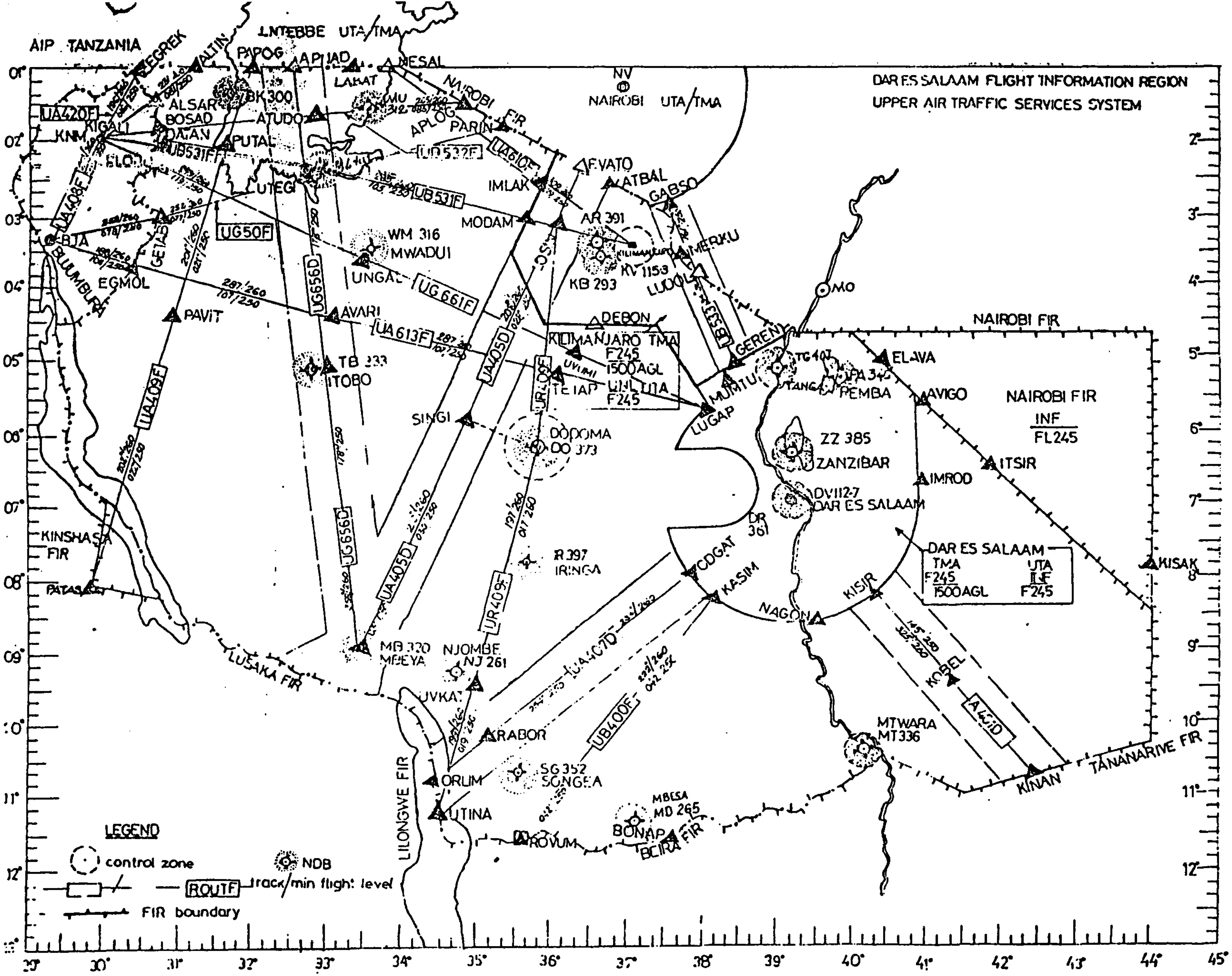
. Phases	15. Target dates
ials and demonstrations	1997
mited functionality (APR)	1998
ll functionality	2000

elated Activities (all other mutually related Activities)

(V/S) EUR/AFI-East (CPDLC)
ordination with adjacent NAT and SAM States.

. **Dependencies** (requisites without which the intended benefit would not materialise)

r-ground data communications capability (CPDLC).


DAR ES SALAAM FLIGHT INFORMATION REGION
UPPER AIR TRAFFIC SERVICES SYSTEM
ENTEBBE UTA/TMA
NAIROBI UTA/TMA
NAIROBI FIR
KILIMANJARO TMA F245 1500AGL UNL UTA F245
DAR ES SALAAM TMA F245 1500AGL UTA UNL F245
NAIROBI FIR INF FL245
KINSHASA FIR
LUSAKA FIR
LILONGWE FIR
BEIRA FIR
TANANARIVE FIR
DODOMA DO 373
ZANZIBAR ZZ 385
DAR ES SALAAM
MTWARA MT336
MWADUI WM 316
KIGALI
IRINGA
SONGEA SG 352
MBEYA MB 320
NJOMBE NJ 261
TB 233 ITOBO
LEGEND
control zone
NDB
ROUTE track/min flight level
FIR boundary