CEC TEN-T ATM Task UK/96/94

ACCESS

ATN Compliant Communications

European Strategy Study

Lifecycle Costs

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Draft 0.1	15/10/98	Initial version for consortium feedback.
Draft 0.2	02/11/98	First draft of section 4 added.
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Issue 1.0	14/12/98	Text in 2.4 amended to reflect EOLIA Project ongoing re-assessment of ATN avionics costs
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EXECUTIVE SUMMARY

The 'ATN Compliant Communications European Strategy Study' (ACCESS) project is being run under the European Commission's programme for financial aid in the field of Trans-European Transport Network (TEN-T), ATM Task UK/96/94. One of the objectives of the project is to estimate the ATN Life Cycle Costs, concentrating on the capital and running/ownership costs to the air traffic service organisations (ATSOs) but also considering the cost to airline operators of equipping and maintaining aircraft. The period of interest is 2000-2010 and the geographical area of interest comprises UK, Ireland, Belgium, Netherlands, Luxembourg, Germany, France, Italy, Spain and Portugal. It is anticipated that ATSOs will continue with national plans up to 2005 after which increasing coordination will lead to rapid expansion of ATN-based services.

This report explains how the various cost elements have been identified, drawing on other European Commission funded projects (COPICAT and EOLIA) and Eurocontrol output, and captured in a user friendly Microsoft Excel spreadsheet model. Of particular significance is the deployment of the ground infrastructure which is addressed on a per country basis in some detail. The ultimate objective is to identify where and when every main component needs to be deployed and the spreadsheet model supports this level of detail.

The air-ground subnetworks considered are VDL Mode 2, the Inmarsat based Aeronautical Mobile Satellite Service (AMSS) and Mode S, where the first two are considered to be supplied and administered by a third party. Thus usage charges (of the order of 1 EURO per kilobit) are incurred whereas for Mode S there is a high capital cost to the ATSOs but no communications charges are attributed.

Total (rather than by country) airline fleet sizes and growth rates are estimated together with a profile for equipping aircraft for ATN. The cost of adaptation and the subsequent maintenance costs are included.

Some analysis has been performed with the model by postulating, realistic and optimistic scenarios where the latter envisages that the full ATN infrastructure[1] is in place at 20 area control centres, 14 approach control centres and 27 airports in the ACCESS region by 2010.. It is recommended that further analysis be carried in order to obtain more accurate data, in particular for the costs of end systems, Mode S and Gatelink sub-networks and ATN avionics. Third party sub-network providers' charges need to be reviewed, while more accurate estimates of the data load for different types of flight are desirable.

The analysis demonstrates the potential impact of individual systems on the cost of ATN deployment based upon current understanding. It is expected that more accurate figures, both prices and system developments, will become available. These can be easily incorporated into the model to produce better cost estimates.

In conclusion, the model can play an important part in the investment analysis process by providing a convenient, flexible means of capturing and calculating approximate costs associated with ATN deployment and, should be of use to individual ATSOs in the planning of their transition strategies.

[1] An operational Mode S subnetwork is only considered in the optimistic scenario

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1. Introduction

1.1 Scope

This document is the ACCESS Work Package 226 Life Cycle Costs.

1.2 Purpose

The purpose of this document is to present a lifecycle cost model for the period 2000-2010 that is consistent with the deployment of the ATN in the considered ACCESS region envisaged in the Transition Plan [A240].

The information is captured in a user friendly multi-sheet Excel workbook. This document describes the tool and contains representative displays but is not meant to be either a user guide or a software design document.

Furthermore, it is important to note that the model is meant to facilitate exploration of the major cost drivers and does not contain low level details. The emphasis is on the costs to air traffic service organisations (ATSOs), not aircraft operators' costs.

Some analysis has been performed using the model and is described in this report. However, it must be emphasised that the cost of many items is still highly uncertain.

1.3 Approach

The ATN is the internationally agreed networking environment for the future aeronautical data communication and is the expected solution for overcoming the shortfalls of the present ATM system and for meeting the ambitious objectives set up by current forecasts of air traffic movements, changing user needs, and prevailing aviation and ATM related trends. However, the ATN consists only today in an ICAO standard, in pre-operational implementations of this standard and in experimental ATN networks that have been used to validate the ATN concepts.

The transition process, that will lead the aeronautical community from the current situation to an operational context where the ATN is widely deployed and used as the primary networking solution, will be driven by many factors. The main drivers are technical, economical, operational and political.

This document concentrates on the costs associated with ATN deployment. It draws on a variety of sources to estimate the cost of each item of equipment that will be installed on the ground and the number that will be deployed in each country in each year. A simpler approach is taken regarding the cost of fitting airborne equipment but the number of aircraft that will be equipped each year is estimated. Running costs in the form of spare equipment and communication charges for data link traffic are also considered.

The derived figures are used to populate an Excel spreadsheet to enable further analysis to be carried out.

1.4 Structure of the document

The document is structured as follows:

Chapter 2 first gives an overview of the cost model (structure, assumptions, limitations) and then explains the sources of data used to populate it.

Chapter 3 describes how the cost elements identified in Chapter 2 have been captured in the sheets of an Excel workbook and indicates the facilities available to the user to tailor the model.

Chapter 4 presents some results obtained with the model.

Chapter 5 contains conclusions and recommendations.

1.5 References

ACCESS Reference	Title
[A208]	ACCESS WP 208 – Proposed Network Architecture of the European ATN
[A240]	ACCESS WP 240 – Transition Planning and Future Evolution of the European ATN

Non-ACCESS Reference	Originator	Title
[1]	Eurocontrol (ATN Implementation Task Force)	ATN Scenario Definition DED6/ATN/ATN1-TF/DOC/25
[2]	EOLIA consortium	EOLIA Cost Benefits Report EOL/WP2/NATS/071/D23/P/1
[3]	COPICAT consortium	Technical Aspects
[4]	COPICAT consortium	Economic Assessment and Proposed ATN Organisation
[5]	STATFOR, Eurocontrol (June 1996)	Air Traffic Statistics and Forecast Number of Flights by Region 1974-2002, 2010
[6]	Airports Council International (ACI)	The World’s Airports in 1997 (see www.airports.org)
[7]	Eurocontrol/EMS.2	SkyLink issue 2 – June 1998 (see www. eurocontrol.be/dgs/publications/skylink)

2. Lifecycle Cost Model Discussion

2.1 Introduction

The ACCESS ATN lifecycle cost model has been developed with the objective of estimating the capital and operational costs for each of the 11 years in the period 2000-2010. Thus it is necessary to:

a) Identify the items of equipment to be deployed, how many and when;

b) Estimate the capital cost, annual operational cost and lifespan of each item of equipment;

c) Estimate the operating cost of using third party networks for the transmission of data.

Concerning (a) above, more structure has been provided by requiring line items to be associated with a particular location thereby enabling costs per country[2] to be calculated. Similarly, in (c) the volume of data is estimated separately for each country. Otherwise, the model makes use of work performed under the COPICAT and EOLIA projects.

In addition, an idea of aircraft fit costs is useful so a transition plan for European fleets has been assumed, resulting in equipage totals for each of the 11 years of interest.

The rest of this chapter explains how the various costs have been sourced and/or estimated and is structured as follows:

- Section 2.2 identifies and costs the different ground and subnetwork components of the ATN;
- Section 2.3 considers the deployment profile (i.e. per location per year);
- Section 2.4 discusses aircraft equipage costs and roll-out;
- Section 2.5 examines communication charges;
- Section 2.6 suggests how the calculation of data load per flight could be refined, particularly on a country-specific basis;
- Section 2.7 emphasises some limitations of the life cycle cost model.

Sections 2.2 – 2.5 should be read in conjunction with equivalent sections of Chapter 3 where the ACCESS spreadsheet model is explained. In addition the reader should be aware of the need to generate realistic and optimistic profiles for the deployment of ground infrastructure and aircraft equipage. these are discussed in more detail in section 4 but need to be identified at this stage.

2.2 Subnetworks and ATN Ground Infrastructure

The ATN consists of intermediate systems (routers) and end systems interconnected by a variety of ground-ground and air-ground data links. Non-ATN communication services can also be partially integrated via application gateways. The components ("line items") have been sourced and costed from COPICAT [3] and EOLIA [2], except were otherwise indicated.

There are significant differences between the two sources and their relative merits have not yet been fully assessed. However, [2] has been used to cost the installation and ownership of Mode S/VDL/Satcom subnetwork equipment and the other costs and all lifespans have been based on [3].

The ACCESS Network Architecture [A208] report discusses air-ground data link options and concludes that VDL Mode 2 will be the primary option but does not recommend a preferred secondary service although there are plans to offer an AMSS based oceanic service soon. The ATN Scenarios Definition [1] only ever envisages AMSS as a back-up option except in "remote" areas such as oceans. However, it is appreciated that new generations of LEO and MEO satellites may warrant reconsideration of the role of the satellite subnetwork sometime in the future.

Mode S is likely to be used for enhanced surveillance and ADS-B but a full data link service requiring aircraft to be fitted with level 4 transponders seems less probable. Although other options such as VDL Mode 3, VDL Mode 4 and HF data link continue to be developed and evaluated they are not

2 Or Eurocontrol.

currently considered to be potential ATN subnetworks in the shorter term. HF data link is seen as a potential back-up for AMSS in the North Atlantic and VDL Mode 4 is deemed suitable for ADS-B. Consequently, no “line items” have been provided here for HF and VDL Mode 4.

The rate of deployment of ATN-compliant ground networks is very uncertain with [7] propounding the most optimistic view, that EUR region-wide services will be available by the beginning of 2005. It is probable that new data link services will be provided via ATN-compliant air/ground sub-networks. Furthermore, it is certain that non-ATN services will continue for many years and therefore gateways between ATN-compliant networks and other, non-ATN networks can be anticipated. A gateway line item is included in the model as a reminder of the anticipated situation.

Figure 3-1 shows the list of line items considered to date. There are some line items listed in Figure 3-1 which appear to offer the same functionality but at different cost e.g. three types of router and three types of Network Management End System. For completeness a brief description of these line items is now provided to highlight the differences.

2.2.1 Routers

It is assumed that initial ATN routers will be workstation based i.e. software based routing and protocol handling, running on a standard mass produced workstation. (*Line Item: Operational Workstation Based Router*).

As ATN use increases, it is likely that these routers will not be sufficiently performant to handle the increasing volume of traffic and dedicated routers will be developed. As these products will have a more limited market, they will be more expensive. (*Line Item: Non Redundant ATN BIS*).

It is likely that at key points in the ATN, dual redundant routers will be required to provide an increased service availability; again it is expected that these will be more expensive again, as even fewer of these will be required. (*Line Item: Dual Redundant ATN BIS*).

2.2.2 Network Management End Systems (NM ES)

Whilst the Network Management (NM) for the ATN remains under definition, it could be assumed that the ATN would be managed in a similar way to other large multinational networks. Under these circumstances it could be assumed that many ‘local NM ES’ will exist, typically managing one site and/or one subnetwork. (*Line Item: NM End System - Local*)

Further, an organisation is likely to have a single ‘enterprise management system’ or ‘domain management system’ that enables all of its ‘local management systems’ to report alarms/performance etc to a single point within the organisation. (*Line Item: NM End System - Domain*)

Finally given the multiplicity of organisations involved in the deployment of the ATN Infrastructure, it is possible that a single regional management entity will be deployed to manage performance of the ATN Infrastructure over the whole Region. (*Line Item: NM End System - Regional*)

2.3 Equipment Deployment Profile

Previous ATN cost models have tended to look at the requirements for an overall region, albeit usually arrived at by accumulation based on some sort of distribution across the region. The ACCESS cost model provides the ability to build specifically from the bottom up, for example it is possible to capture the ATN equipment required at a specific airport. On the other hand, the mechanisms provided by the model are quite general so it could be used at the macro level if preferred. However, providing lower levels does encourage the more detailed consideration that is bound to be necessary eventually.

Figure 3-3 contains a hypothetical example of equipment deployment in a particular country, the countries and sites within them having been defined via Figure 3-2. The line item deployment data is based on the Eurocontrol ATN Scenario Definition [1] with additions (e.g. network management systems). It is hoped that further information will be included from the final version of the ACCESS Transition Plan [A240].

2.4 Aircraft Equipage Costs and Roll-out

The size and growth of the European aircraft fleets are estimated in Annex C.4 of [2] and in Appendix B of [1]. Those figures are different not least because [2] only considers aircraft that belong to airlines registered within the EOLIA area (a total of 1266 in 1996) while [1] considers the entire European population (a total of 14000 in 1996 of which only 4700 are commercial aircraft as opposed to business or private aircraft) plus aircraft registered outside Europe but operating inside (a total of 900 commercial aircraft in 1996). However, all sources ([1], [2] and [4]) have adopted the same growth rate.

For ACCESS purposes an estimate of the number of aircraft in 2000 is required and this was arrived at by scaling up the EOLIA figures to reflect the airlines of the extra countries (Spain, Italy, Portugal and Ireland but not Switzerland).

The percentage of aircraft equipped for ATN is suggested in Annex C.3.1 of [2] in the context of Oceanic traffic (long haul aircraft) and also in Appendix B.3 of [1]. Both envisage 5% by 2005 and 25% by 2010 although the latter quotes different figures for different sized aircraft, the take up being 18% and 60% respectively for the large passenger jets down to 0% and 5% for private aircraft. The ACCESS model allows the cumulative take up percentage to be entered for each year.

Some estimates concerning the cost of equipping an aircraft are detailed below:

- Reference [4] estimates 0.28 MEuro altogether,
- Reference [7] estimates that the implementation of the airborne ATN (excluding sub-networks) will be <0.03 MEuro.

More recent work on the EOLIA project suggests costs of 1.0 MEuro for ATN avionics plus 0.43 MEuro for the subnetwork avionics (excluding Gatelink and HF), although these figures have not been confirmed.

On the basis of recency the EOLIA estimate has been used and a provision for annual maintenance costs has been included. Note that the 1.0 MEuro figure for ATN avionics is not explained but it is likely to be dominated by related FMS, cockpit and certification costs rather than the provision of ATN equipment (**NOTE**: The EOLIA Project is currently re-assessing these costs). Reference [7] probably reflects only the cost of an ATN router.

Most of the airborne sub-network costs are associated with providing Level 4 Mode S transponders. If the sub-network was used only for enhanced surveillance, not full data link, then Level 2 transponders would be sufficient and there would be no extra airborne cost associated with Mode S.

Figure 3-4 shows the self-contained spreadsheet for predicting the annual costs to airline operators in the ACCESS core region of installing and maintaining ATN and subnetwork equipment on their aircraft.

2.5 Communications Charges

The model of communications charges reflects how much data is expected to travel over the different subnetworks each year and the anticipated cost per megabyte. Annex C.2 of [2] provides a working assumption for the percentages of data carried by the Mode S, VHF and Satellite subnetworks (30%, 60%, 10%). The Mode S subnetwork is assumed to be owned by the ATSO and so no communications charges are incurred. The other two subnetworks are assumed here to be provided by a third party, although [2] also considers the possibility that an ATSO could own the VHF subnetwork. However, it is unlikely that Mode S will be deployed by 2010 in any realistic scenario. An alternative working assumption proposed by ACCESS is for the VHF and Satellite subnetworks to carry 80% and 20% of the data respectively. This assumes the subnetworks can handle this level of data traffic. The original assumption is also addressed in the following calculations for comparative purposes.

Annexes D.2.3 and D.2.4 of [2] estimate the unit charges for using the VHF and Satellite data link services with the former being about one third of the latter. COPICAT [3] estimated the charges to be much lower (30 times lower in the case of VHF!).

Average cost of data (ACCESS) = 80% * 0.4 + 20% * 1.1 = 0.54 Euro/kbit (Realistic)

Average cost of data (from [2]) = 30% * 0 + 60% * 0.4 + 10% * 1.1 = 0.35 Euro/kbit (Optimistic)

In Annex C.6 of [2] it is calculated that 117.2 kbit of data will be transmitted over air-ground data links in a typical 90 minute European flight that embraces 2 ACCs and 7 sectors, the data link being used for clearances (ACL), handover (ACM) and flight plan downlinking (FLIPCY). ADS periodic reporting is not included.

Average cost per en-route flight = 117.2 * 0.54 = 63.3 Euro[3] (Realistic)

Average cost per en-route flight = 117.2 * 0.35 = 41.0 Euro[4] (Optimistic)

It is assumed that on average a flight contains two movements and/or encompasses two countries (but see section 2.6 below), so the data/flight figure is halved when calculating the communications charges per country. (i.e. 60 kbits per movement is assumed). The total number of movements predicted for each country for each year has been obtained from Eurocontrol statistics [5], while the percentage of aircraft equipped for ATN is captured in the Aircraft Costs model (see section 2.4). Therefore, the volume and cost of data transmitted each year can be estimated, assuming that the ground infrastructure is in place. For example,

UK en-route traffic in 2005 = 2,270,000 flights (i.e. movements) ;

If ATN equipage = 5% that means 113,500 ATN flights => 3.7 MEuro of charges to the UK (Realistic)

If ATN equipage = 5% that means 113,500 ATN flights => 2.4 MEuro of charges to the UK (Optimistic)

By 2010, it is estimated that there will be nearly 6 times as many ATN flights as in 2005, due to a 16% growth in traffic and a five-fold increase (to 25%) in the proportion of aircraft equipped (Realistic).

Figure 3-5 shows the spreadsheet for estimating traffic volumes and for calculating the associated communications charges.

2.6 Data Load per Flight

The model allows a single figure to be entered to represent the average data load per flight. The derivation of that figure was discussed in section 2.5. The purpose of this section is to indicate how the figure could be tailored to an individual country.

Although most countries have both internal flights and overflights, the balance varies between countries and also it can be expected that overflights will be more relevant to ATN considerations. The following table, summarising the distribution of movement types by country, is deduced from [5].

	Internal	Short haul	Long haul	Overflights
UK	29%	51%	8%	12%
Ireland	9%	36%	3%	52%
France	23%	36%	4%	37%
Germany	26%	46%	5%	23%
Belgium/Lux	1%	39%	3%	57%
Netherlands	4%	53%	6%	37%
Benelux	2%	46%	4%	48%
Spain	28%	43%	3%	26%
Portugal	14%	33%	5%	48%

Figure 2-1: Approximate distribution of movement types by country

3 An alternative, lower VHF charge rate (0.14 Euro/kbit) is quoted in [2]) that would reduce the average cost of data communications per en-route flight to 38.9 Euro.

4 An alternative, lower VHF charge rate (0.14 Euro/kbit) is quoted in [2]) that would reduce the average cost of data communications per en-route flight to 22.7 Euro.

Note that there is no real difference between a short haul and a long haul flight for the current purpose of estimating the data load for the country of departure. The logical next step would be to use this table to attempt to deduce the average data load per flight for each country. In Table C.8 of [2] the data load for a flight is constructed from the following components:

(a)	TMA (departure)	14.46 kbits
(b)	En-route sector (10 mins)	11.22 kbits
(c)	ACC (1 FLIPCY)	1.18 kbits
(d)	Handover between ACCs	8.78 kbits
(e)	TMA (arrival)	13.08 kbits

Figure 2-2: Composition of data load for a typical European flight

Thus in the example used in section 2.5, the total data load for the flight is:

$$a + 7b + 2c + d + e = 117.2 \text{ kbits}$$

We have not pursued the suggested process to derive country-specific average data loads per flight. It is felt that further analysis is needed anyway in order to refine the estimates of the data load since, in the sources examined, most of it is due to header components where there is undoubtedly scope for further reductions e.g using compression techniques such as LRef and Deflate.

2.7 Limitations

In addition to the assumptions and limitations identified in the foregoing sections, the following should be noted.

- One effect of a transition to data link services is the initial division of the aircraft fleet into aircraft equipped for data link services (e.g. ATN and FANS-1/A) and those not equipped. This may require changes to the management of European airspace (e.g. airspace segregation for ATN equipped aircraft) and/or revised ATC procedures. The resulting costs incurred by ATSOs are not addressed in this document, nor are training costs associated with the introduction of data link services.
- Apart from an estimate of the cost of fitting and maintaining aircraft for ATN, aircraft operators' requirements are not directly considered in this study.
- The model assumes that the unit equipment costs are the same for all organisations, so if one is interested in the total cost to the ACCESS geographic area then representative average unit costs should be used. On the other hand, if one is interested in the cost to an individual country then the costs to other countries may not be of great interest, so one can use country-specific figures. This also applies to communication costs, where different countries might have different views on the Mode S/VHF/Satellite sub-network split and unit charges.
- All costs are based on year 2000 prices i.e. no cost inflation or deflation is included in the model.

3. Lifecycle Cost Model Implementation

3.1 Introduction

The Microsoft Excel model consists of six main sections:

- Overview
- Country Overview
- Aircraft Costs
- Line Items
- Communications Charges
- Country Details

The first five are each contained on a single worksheet while the last section comprises one sheet per country and hence is extended as each new country is added (via the Country Overview sheet).

All operations are performed via macros associated with buttons provided on the worksheets. Cells where data needs to be entered are readily distinguishable and write access to all other cells is prevented.

The steps to create a model, which reflect the discussion in Chapter 2, are as follows:

1) Complete the Line Items sheet.
2) Complete the Country Overview sheet.
3) Complete the Country Details sheet for each country.
4) Complete the Aircraft Costs sheet.
5) Complete the Communication Charges sheet.
6) Select the Update button in the Overview sheet.

Sections 3.2 – 3.7 address the spreadsheet model in this order.

3.2 Line Items

Figure 3-1 contains a representative list of Line Items (ATN infrastructure components) corresponding to the discussion in section 2.2.

Line Items Add Item Remove Item

Item	Capital Cost (k ECU)	Annual Operational Cost (k ECU)	Lifespan (Years)
Non-Redundant ATN BIS	100	10	10
Dual-Redundant ATN BIS	150	15	10
Operational Workstation-Based Router	40	2	5
ACC End System	500	50	10
Airport End System	500	50	15
Network Management End System (Local)	100	10	15
Network Management End System (Domain)	400	40	15
Network Management End System (Regional)*	2,000	200	15
AMSS Subnetwork (Ground) - ATSO Equipment	128	89	10
VDL Mode 2 Subnetwork (Ground) - ATSO Equipment	141	109	10
Mode S Subnetwork (Ground) - ATSO Owned	9,747	989	10
Gateway to Non-ATN Network	100	10	10
Context Management Server	150	15	10
Gatelink Infrastructure	1,000	100	20
Gatelink Gate Equipage	50	5	10
ATIS Server	200	20	10

* - ACCESS Estimate

Figure 3-1: Cost and lifespan of ATN components

3.3 Country Overview

Figure 3.2 shows a representative Country Overview sheet. It can be seen that some structure has been provided, sites being instantiations of site types. However, a site type does not force a particular set of line items to be located at the site.

Approach ACC	**En-Route ACC**	**Approach ACC**	**Approach ACC**	**Approach ACC**	**En-Route ACC**	**Approach ACC**	**Approach ACC**
London ACC (TMA)	Dublin ACC	Paris-Orly APP	Berlin APP	Brussels APP	Maastricht UAC	Milan APP	Barcelona ACC (TMA)
Manchester ACC (TMA)	Shannon ACC	Paris-CDG APP	Dusseldorf APP	Amsterdam APP	**Misc**	Rome APP	Madrid ACC (TMA)
En-Route ACC	**Spares Site**	**En-Route ACC**	Frankfurt APP	**En-Route ACC**	Co-ordinating Entity	**En-Route ACC**	Palma APP
London ACC (En-Route)	Dublin Spares Store	Paris ACC	Munich APP	Brussels ACC		Brindisi ACC	**En-Route ACC**
Scottish ACC (En-Route)	**Major Airport**	Reims ACC	**En-Route ACC**	Amsterdam ACC		Milan ACC	Barcelona ACC (En-Route)
Major Airport	Dublin	Aix-Marseille ACC	Berlin UAC/ACC	**Major Airport**		Rome ACC	Canarias ACC
London-Heathrow		Bordeaux ACC	Bremen ACC	Brussels		Padua ACC	Madrid ACC (En-Route)
London-Gatwick		Brest ACC	Dusseldorf ACC	Amsterdam-Schipol		**Major Airport**	Seville ACC
Manchester		**Major Airport**	Frankfurt ACC	Rotterdam		Milan	**Major Airport**
Stansted		Paris-Orly	Karlsruhe UAC	**Spares Site**		Rome	Barcelona
Birmingham		Paris-CDG	Munich UAC/ACC	Brussels Spares Store		**Spares Site**	Madrid
Spares Site		Nice	**Major Airport**	**Large Airport**		Rome Spares Store	**Spares Site**
London Spares Store		Marseille	Frankfurt am Main	Maastricht			Barcelona Spares Store
Large Airport		Montpellier	Munich	Luxemburg			**Large Airport**
Aberdeen		Lyon	Dusseldorf				Gran Canaria
Edinburgh		**Spares Site**	Hamburg				Malalga
Glasgow		Paris Spares Store	Cologne				
Bournemouth		**Large Airport**	Stuttgart				
Liverpool		Tououse	Berlin				
		Pau	**Spares Site**				
		Nantes	Berlin Spares Store				
		Bordeaux	**Large Airport**				
			Hannover				
			Nuremberg				

Figure 3-2: ATN-relevant sites within ACCESS countries

The “spares” type is a flexible way of catering for the need to purchase specific spare line items.

Following the definition in [1], a Major Airport is one having >100,000 movements per year in 1997. All such airports in [6] have been captured plus the larger (>70,000 movements per year) Large[5] Airports.

3.4 Country Details

Figure 3-3 shows a representative Country Details sheet. The first two columns are automatically populated according to what has been entered via the Country Overview sheet

This is where the actual equipment deployment data is entered for each country and focuses attention on what line items need to be bought for each site in each year. Each item has to be selected from a menu that is automatically updated as Line Items are added or removed. The need for replacement when the lifespan of a line item is reached must be remembered.

It must be emphasised that at this stage, the data that has been entered is entirely speculative – no actual deployment plans are available.

5 [1] defines a Large Airport as one having >40,000 movements per year.

UK ATN Requirements

Add Item Remove Item

Site	Type	Line Item	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
London ACC (TMA)	Approach ACC	Operational Workstation-Based Router	0	0	0	1	0	0	0	0	0	0	0	1
		Non-Redundant ATN BIS	0	0	0	0	0	1	0	0	0	0	0	1
		ACC End System	0	0	0	0	1	0	0	0	0	0	0	1
		Network Management End System (Local)	0	0	0	1	0	0	0	0	0	0	0	1
		Context Management Server	0	0	0	0	0	1	0	0	0	0	0	1
		ATIS Server	0	0	0	0	0	0	0	0	0	0	1	1
Manchester ACC (TMA)	Approach ACC	Operational Workstation-Based Router	0	0	0	0	0	0	1	0	0	0	0	1
		Non-Redundant ATN BIS	0	0	0	0	0	0	0	0	1	0	0	1
		ACC End System	0	0	0	0	0	0	0	1	0	0	0	1
		Network Management End System (Local)	0	0	0	0	0	0	0	1	0	0	0	1
		Context Management Server	0	0	0	0	0	0	0	0	1	0	0	1
London ACC (En-Route)	En-Route ACC	Operational Workstation-Based Router	0	0	0	1	0	0	0	0	0	0	0	1
		ACC End System	0	0	0	0	1	0	0	0	0	0	0	1
		Network Management End System (Local)	0	0	0	1	0	0	0	0	0	0	0	1
		Non-Redundant ATN BIS	0	0	0	0	0	1	0	0	0	0	0	1
		Gateway to Non-ATN Network	0	0	0	0	1	0	0	0	0	0	0	1
		Context Management Server	0	0	0	0	0	1	0	0	0	0	0	1
		VDL Mode 2 Subnetwork (Ground) - ATSO Equipment	0	0	1	0	0	0	0	0	0	0	0	1
Scottish ACC (En-Route)	En-Route ACC	Non-Redundant ATN BIS	0	0	0	0	0	0	1	0	0	0	0	1
		ACC End System	0	0	0	0	0	0	0	1	0	0	0	1
		Network Management End System (Local)	0	0	0	0	0	0	0	0	1	0	0	1
		Gateway to Non-ATN Network	0	0	0	0	0	0	0	0	0	0	0	0
		Context Management Server	0	0	0	0	0	0	1	0	0	0	0	1
		VDL Mode 2 Subnetwork (Ground) - ATSO Equipment	0	0	0	0	0	0	0	1	0	0	0	1
London-Heathrow	Major Airport	Operational Workstation-Based Router	0	0	1	0	0	0	0	0	0	0	0	1
		Airport End System	0	0	1	0	0	0	1	0	0	0	0	2
		Gatelink Gate Equipage	0	0	0	5	5	5	3	4	3	0	0	25
		Non-Redundant ATN BIS	0	0	0	0	0	1	0	1	0	0	0	2
		Network Management End System (Local)	0	0	0	1	0	0	0	0	0	0	0	1
		Gatelink Infrastructure	0	0	0	1	0	0	0	0	0	0	0	1
London-Gatwick	Major Airport	Operational Workstation-Based Router	0	0	0	0	0	0	1	0	0	0	0	1
		Airport End System	0	0	0	0	0	0	1	0	1	0	0	2
		Gatelink Gate Equipage	0	0	0	0	0	0	1	2	2	2	2	9
		Non-Redundant ATN BIS	0	0	0	0	0	0	0	1	0	0	0	1
		Network Management End System (Local)	0	0	0	0	0	0	1	0	0	0	0	1
		Gatelink Infrastructure	0	0	0	0	0	0	1	0	0	0	0	1
Manchester	Major Airport	Operational Workstation-Based Router	0	0	0	0	0	0	1	0	0	0	0	1
		Airport End System	0	0	0	0	0	0	1	0	0	1	0	2
		Gatelink Gate Equipage	0	0	0	0	0	0	0	0	0	0	5	5
		Non-Redundant ATN BIS	0	0	0	0	0	0	0	1	0	0	1	2
		Network Management End System (Local)	0	0	0	0	0	0	1	0	0	0	0	1
		Gatelink Infrastructure	0	0	0	0	0	0	0	0	0	0	1	1
Stansted	Major Airport		0	0	0	0	0	0	0	0	0	0	0	0
Birmingham	Major Airport		0	0	0	0	0	0	0	0	0	0	0	0
London Spares Store	Spares Site	Non-Redundant ATN BIS	0	0	1	0	0	0	0	0	0	0	0	1
		Operational Workstation-Based Router	0	0	1	0	0	0	0	0	0	0	0	1
		Gatelink Gate Equipage	0	0	0	2	1	1	0	0	0	0	0	4
		Airport End System	0	0	1	0	0	0	0	0	0	0	0	1
		ACC End System	0	0	1	0	0	0	0	0	0	0	0	1
Aberdeen	Large Airport		0	0	0	0	0	0	0	0	0	0	0	0
Edinburgh	Large Airport		0	0	0	0	0	0	0	0	0	0	0	0
Glasgow	Large Airport		0	0	0	0	0	0	0	0	0	0	0	0
Bournemouth	Large Airport		0	0	0	0	0	0	0	0	0	0	0	0
Liverpool	Large Airport		0	0	0	0	0	0	0	0	0	0	0	0

Figure 3-3: (Hypothetical) national deployment profile of ATN ground equipment

3.5 Aircraft Costs

Figure 3-4 shows a representative Aircraft Costs sheet. The size of the core area fleet in 2000 needs to be entered and the growth rates for each year. It is assumed that each element of the fleet grows at the same rate. The cumulative aircraft ATN equipage profile (columns 6-8) has to be input along with the installation cost per aircraft, which is assumed to be the same for all types. Subsequent ATN-specific maintenance is treated as a percentage of the installation cost, the normal assumption being that maintenance is carried out as part of routine servicing.

Column 9 gives the number of aircraft that become equipped in each year and column 11 reflects the increasing burden of maintenance costs.

Aircraft Costs

		Core Area Fleet Sizes			Aircraft Equipped (%)					
Year	Growth Rate %	Major	Regional	Cargo	Major	Regional	Cargo	Number of Aircraft Equipped	Capital Cost (k ECU)	Operating Costs (k ECU)
2000	-	1203	424	75	0%	0%	0%	0	0	0
2001	3%	1239	437	77	0%	0%	0%	0	0	0
2002	3%	1276	450	80	1%	1%	1%	18	25,200	1,770
2003	3%	1315	463	82	2%	2%	2%	19	26,600	3,645
2004	3%	1354	477	84	3%	3%	3%	20	28,000	5,632
2005	3%	1395	492	87	5%	5%	5%	42	58,800	9,668
2006	3%	1436	506	90	7%	7%	7%	43	60,200	13,941
2007	3%	1480	521	92	10%	10%	10%	67	93,800	20,514
2008	3%	1524	537	95	14%	14%	14%	93	130,200	29,581
2009	3%	1570	553	98	19%	19%	19%	120	168,000	41,350
2010	3%	1617	570	101	25%	25%	25%	150	210,000	56,040
								Total Cost:	800,800	182,141

Capital Cost per Aircraft (k ECU):	*1,400*
Operating Cost per Aircraft (k ECU):	*98*

Annual Operating Overhead:	*7%*

Figure 3-4: Aircraft ATN equipage profile and costs

3.6 Communication Charges

Figure 3-5 shows a representative Communication Charges sheet. The first column is automatically populated according to what has been entered via the Country Overview sheet The Mode S/VDL/Satcom subnetwork usage ratios and unit costs need to be entered. The rationale for only having a single set of these is given in section 2.7.

The total number of aircraft movements needs to be entered per year for each country. Using the average data load per flight and the aircraft ATN equipage profile from the Aircraft Costs sheet (see section 3.5), the total data load is calculated and thus the annual cost

Communications Charges

Subnetwork	Cost per Mbyte (Ecu)	Usage Ratio
Mode S	0	0%
VDL	3,277	80%
Satcom	9,011	20%

Average Kilobits Used Per Flight	60

State		Usage (Mbytes) 2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total
UK	Flights	1,958,020	2,016,761	2,077,263	2,139,581	2,203,769	2,269,882	2,337,978	2,408,118	2,480,361	2,554,772	2,631,415	25,077,920
	Usage (Mbytes)	0	0	152	312	480	834	1,196	1,761	2,545	3,556	4,820	15,655
	Cost (k ECU)	0	0	671	1,379	2,125	3,690	5,293	7,790	11,257	15,730	21,321	69,255
Ireland	Flights	375,000	386,250	397,838	409,773	422,066	434,728	447,770	461,203	475,039	489,290	503,969	4,802,923
	Usage (Mbytes)	0	0	29	60	92	160	229	337	487	681	923	2,998
	Cost (k ECU)	0	0	128	264	407	707	1,014	1,492	2,156	3,013	4,083	13,264
France	Flights	2,438,055	2,511,197	2,586,533	2,664,129	2,744,052	2,826,374	2,911,165	2,998,500	3,088,455	3,181,109	3,276,542	31,226,110
	Usage (Mbytes)	0	0	189	388	598	1,039	1,490	2,193	3,168	4,427	6,001	19,494
	Cost (k ECU)	0	0	835	1,717	2,645	4,595	6,590	9,700	14,016	19,586	26,548	86,233
Germany	Flights	2,576,545	2,653,841	2,733,457	2,815,460	2,899,924	2,986,922	3,076,529	3,168,825	3,263,890	3,361,807	3,462,661	32,999,862
	Usage (Mbytes)	0	0	200	410	632	1,098	1,574	2,317	3,348	4,679	6,342	20,601
	Cost (k ECU)	0	0	883	1,815	2,796	4,856	6,965	10,251	14,813	20,698	28,056	91,132
Benelux	Flights	1,707,000	1,758,210	1,810,956	1,865,285	1,921,244	1,978,881	2,038,247	2,099,395	2,162,377	2,227,248	2,294,065	21,862,907
	Usage (Mbytes)	0	0	132	272	419	727	1,043	1,535	2,218	3,100	4,202	13,648
	Cost (k ECU)	0	0	585	1,202	1,852	3,217	4,614	6,791	9,814	13,713	18,587	60,376
Eurocontrol	Flights	100,000	103,000	106,090	109,273	112,551	115,927	119,405	122,987	126,677	130,477	134,392	1,280,780
	Usage (Mbytes)	0	0	8	16	25	43	61	90	130	182	246	800
	Cost (k ECU)	0	0	34	70	109	188	270	398	575	803	1,089	3,537
Italy	Flights	1,155,000	1,189,650	1,225,340	1,262,100	1,299,963	1,338,962	1,379,130	1,420,504	1,463,119	1,507,013	1,552,223	14,793,004
	Usage (Mbytes)	0	0	89	184	283	492	706	1,039	1,501	2,097	2,843	9,235
	Cost (k ECU)	0	0	396	814	1,253	2,177	3,122	4,595	6,640	9,279	12,577	40,852
Spain	Flights	1,127,000	1,160,810	1,195,634	1,231,503	1,268,448	1,306,502	1,345,697	1,386,068	1,427,650	1,470,479	1,514,594	14,434,386
	Usage (Mbytes)	0	0	87	179	276	480	689	1,014	1,465	2,047	2,774	9,011
	Cost (k ECU)	0	0	386	794	1,223	2,124	3,046	4,484	6,479	9,054	12,272	39,862
Portugal	Flights	374,000	385,220	396,777	408,680	420,940	433,569	446,576	459,973	473,772	487,985	502,625	4,790,116
	Usage (Mbytes)	0	0	29	60	92	159	229	336	486	679	921	2,990
	Cost (k ECU)	0	0	128	263	406	705	1,011	1,488	2,150	3,004	4,072	13,228

Figure 3-5: Communications charges by country

3.7 Overview

Figure 3-6 shows a representative Overview sheet. The Aircraft Costs summary is automatically updated when that sheet is amended but the rest of the Overview sheet is only re-calculated when the Update button is selected, the Status box displaying the progress of the update. A separate check box allows communications charges to be included in or excluded from the operating costs (OPEX) as desired.

Update

ACCESS Project Cost Life-Cycle Analysis

Note:- All costs are in thousands of Euros

☒ Include communications charges

		2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	TOTAL COSTS
UK	CAPEX	0	0	3,310	1,541	550	450	2,180	1,141	2,040	1,200	1,900	14,312
	OPEX	0	0	994	1,951	2,752	4,362	6,179	8,877	12,546	17,139	22,920	77,719
Ireland	CAPEX	280	641	128	0	0	350	0	0	0	0	0	1,399
	OPEX	24	183	400	536	679	1,010	1,317	1,795	2,459	3,316	4,376	16,095
France	CAPEX	3,301	940	1,400	1,050	450	1,750	2,711	1,490	3,318	750	3,500	20,660
	OPEX	417	509	1,484	2,471	3,444	5,561	7,914	11,171	15,893	21,538	28,671	99,074
Germany	CAPEX	2,960	1,141	1,500	1,040	1,382	1,700	2,530	1,040	1,600	2,050	3,950	20,893
	OPEX	288	497	1,530	2,564	3,873	6,095	8,453	11,841	16,561	22,651	30,354	104,706
Benelux	CAPEX	2,820	1,000	150	150	250	491	1,500	240	890	1,850	1,291	10,632
	OPEX	276	376	976	1,608	2,283	3,786	5,333	7,532	10,642	14,726	19,774	67,313
Eurocontrol	CAPEX	150	0	0	0	0	0	891	0	100	0	150	1,291
	OPEX	15	15	49	85	124	203	469	597	784	1,012	1,298	4,652
Italy	CAPEX	2,461	950	440	150	750	1,150	350	890	391	100	1,100	8,732
	OPEX	335	430	868	1,301	1,815	2,848	3,828	5,386	7,565	10,214	13,463	48,052
Spain	CAPEX	2,601	1,000	391	1,150	500	400	900	1,480	1,640	978	1,650	12,690
	OPEX	347	447	967	1,490	1,969	2,902	3,914	5,496	7,653	10,402	13,626	49,213
Portugal	CAPEX	540	0	381	500	0	350	1,850	250	350	250	850	5,321
	OPEX	52	52	311	496	639	971	1,462	1,962	2,659	3,538	4,641	16,784
Total Core Area	*CAPEX*	15,113	5,672	7,700	5,581	3,882	6,641	12,912	6,531	10,329	7,178	14,391	95,930
	OPEX	1,754	2,509	7,580	12,503	17,577	27,737	38,870	54,658	76,761	104,535	139,122	483,607

AIRCRAFT COSTS	Number of Aircraft	0	0	18	19	20	42	43	67	93	120	150	
	Capex	0	0	25,200	26,600	28,000	58,800	60,200	93,800	130,200	168,000	210,000	800,800
	Opex	0	0	1,770	3,645	5,632	9,668	13,941	20,514	29,581	41,350	56,040	182,141
												Total including aircraft costs	***1,562,478***

Status

Version 1.5

Figure 3-6: Summary of ATS and aircraft installation capital and operating costs

4. Analysis of Lifecycle Costs

4.1 Introduction

The model described in Sections 2 and 3 facilitates the exploration of alternative scenarios covering the 2000 – 2010 timescale. Two scenarios have been generated and identified as:

- Scenario R (= Realistic i.e. considered to be most likely); and
- Scenario O (= Optimistic i.e. rapid ATN deployment).

These scenarios consider different rates of deployment of both ground and airborne equipment.

The other main parameters that could be varied, but have been held constant in this study, are:

- line item costs (see sections 2.2 and 3.1);
- communications charges (both cost/Mbyte and Kbits/flight (see sections 2.5 and 3.6));
- growth rates of aircraft fleets (see sections 2.4 and 3.5); and
- total numbers of flights per year per country (see sections 2.5 and 3.6).

4.2 The Realistic/Optimistic Scenarios

The starting point for the R/O scenarios was [1]. The realistic and optimistic scenarios have been derived by scaling back from [1]. The main characteristics of the scenarios are summarised in Figures 4-1 to 4-2.

Year	***% of aircraft equipped***
2000	0
2001	0
2002	1
2003	2
2004	3
2005	5
2006	7
2007	10
2008	14
2009	19
2010	25

	2005	***2010***
ATSO equipage profile	50% of ACCs are equipped for ATN 1 ATN BIS, 1 ATN ESs and 1 local NMS per ACC 20% of ATN-equipped ACCs have gateways to non-ATN networks	80% of ACCs are equipped for ATN 1 ATN BIS, 1 ATN ESs and 1 local NMS per ACC 1 CM server per ACC 50% of ATN-equipped ACCs have gateways to non-ATN networks 50% of the countries have 1 ATIS server.
Percentage of ACCESS airports equipped with Gatelink	20%	50%
Number of Gatelink equipped gates per equipped airport	15	25
% of ACCESS airports equipped with ATN facilities	10%	50%
Number of ATN routers per ATN-equipped ACCESS airport	1-2	2-3
Number of ATN ESs per ATN-equipped ACCESS airport	1	2

Figure 4-1: Deployment characteristics of the Realistic scenario

Year	***% of aircraft equipped***
2000	0
2001	1
2002	2
2003	3
2004	4
2005	5
2006	10
2007	16
2008	22
2009	29
2010	37

	2005	***2010***
ATSO equipage profile	80% of ACCs are equipped for ATN 1 ATN BIS, 1 ATN ESs and 1 local NMS per ACC 20% of ACCs operate gateways to non-ATN networks	100% of ACCs are equipped for ATN 1 ATN BIS, 1-2 ATN ESs and 1 local NMS per ACC 1 CM server per ACC 50% of ACCs operate gateways to non-ATN networks 80% of the countries have 1 ATIS server.
Percentage of ACCESS airports equipped with Gatelink	50%	80%
Number of Gatelink equipped gates per equipped airport	20	30
% of ACCESS airports equipped with ATN facilities	25%	75%
Number of ATN routers per ATN-equipped ACCESS airport	1-2	2-3
Number of ATN ESs per ATN-equipped ACCESS airport	1	2

Figure 4-2: Deployment characteristics of the Optimistic scenario

4.3 Summary of ACC and Airport Transition

The following table summarises the assumed implementation of ATN infrastructure over the 28 en-route ACCs, 15 Approach Control centres and 42 most significant airports in the ACCESS region.

	REALISTIC		*OPTIMISTIC*	
	2005	2010	2005	2010
Approach control centres ATN equipped	8	11	11	15
En-route ACCs ATN equipped	14	23	23	27
Mode S	0	0	0	10
VDL Mode 2	10	16	10	17
AMSS	2	3	2	4
Airports ATN equipped	4	18	9	27
Gatelink	8	18	18	29

Figure 4-3: Summary of ATN and sub-network deployment at ACCs and airports

4.4 Costs in the RO scenarios

4.4.1 Total costs (2000 - 2010)

	REALISTIC (MEuro)	*OPTIMISTIC (MEuro)*
ACCESS Area CAPEX	95.93	237.69
ACCESS Area OPEX	65.87	118.86
ACCESS Area Comms Costs	417.74	395.35
Aircraft Capital Costs	800.80	1184.40
Aircraft Operating Costs	182.14	265.99

Figure 4-4: Summary of estimated costs in the R/O scenarios (2000 – 2010)

Note that the costs are expressed in millions of Euros (MEuro) and that the OPerational EXpenses do not include the Comms Costs. The following sections contain some explanation of the basis of these costs.

4.4.2 Capital Expenses (CAPEX)

Capital expenses are the costs of the ground infrastructure and arise as follows:

Line Item	*Unit Cost (MEuro)*	*Number of units installed in the period 2000 - 2010*	
		R	*O*
Non-Redundant ATN BIS	0.1	67	83
Dual-Redundant ATN BIS	0.15	2	2
Operational Workstation-Based Router	0.04	46	53
ACC End System	0.5	41	63
Airport End System	0.5	40	51
ATIS Server (National)	0.2	4	7
Network Management End System (Local)	0.1	51	61
Network Management End System (Domain)	0.4	0	0
Network Management End System (Regional)	2.0	1	1
AMSS Subnetwork (Ground) - ATSO Equipment	0.128	3	4
VDL Mode 2 Subnetwork (Ground) - ATSO Equipment	0.141	16	17
Mode S Subnetwork (Ground) - ATSO Owned	9.747	0	10
Gateway to Non-ATN Network	0.1	7	7
Context Management Server	0.15	34	42
Gatelink Infrastructure	1.0	17	28
Gatelink Gate Equipage	0.05	305	509

Figure 4-5: Number of line items deployed in the R/O scenarios

The main costs are the end systems, Gatelink and Mode S sub-networks, as summarised in the following table.

Line Item[6]	*Distribution of capital costs 2000 - 2010*	
	R	*O*
End Systems	49.6%	27.4%
Mode S sub-networks	0%	41.0%
Gatelink	33.6%	22.5%
Other	16.8%	9.1%

Figure 4-6: Capital cost drivers

[6] The deployment of Mode S and Gatelink is still the subject of much debate, however, they have been included in the costs (the former only in the optimistic (O) scenario) to demonstrate the impact upon the capital cost.

It would seem reasonable to anticipate a reduction in the cost of end systems given the number that are envisaged. The high Gatelink costs are also due to the large number of units and it could be that the costs (and of the sub-network) have been over-estimated. Half of the Mode S sub-network costs are attributable to testing and integration, which may also be an overestimate.

Figure 3-3 indicates the kind of equipage that might be anticipated at ACCs and airports. The resulting costs for a typical en-route ACC and major airport are summarised in Figure 4-8 using the item costs given in Figure 4-5. The cost of spare or replacement items has not been included.

En-route ACC costs	*Realistic (MEuro)*	*Optimistic (MEuro)*
ATN Infrastructure	0.35	0.35
End systems (2)[7]	0.65	0.65
Mode S sub-network	0	9.75
VDL Mode 2 interface equipment	0.15	0.15
Total	1.15	10.9
Airport costs	*Realistic (MEuro)*	*Optimistic (MEuro)*
ATN infrastructure	0.35	0.35
End systems (3[8])	1.15	1.15
Gatelink (25 gates equipped)	2.25	2.25
Total	3.75	3.75

Figure 4-7: Estimated costs of equipping an ACC and a major airport

4.4.3 Operational Expenses (OPEX)

The typical cost of maintaining the capital items has been set at 10% per year, except for the third party owned items (VDL and AMSS sub-networks) where the initial cost is relatively low so the annual maintenance is relatively very high, mainly because of the anticipated power costs (see Annex D of [2]).

Over the life of an item, the maintenance costs are likely to exceed the initial installation cost. There is expected to be a lot of equipment in service by 2010 and it can be seen from Figure 4-4 that the cost of maintenance will have become very large, particularly of course in the optimistic scenario where more equipment is deployed sooner.

4.4.4 Communications Costs

The communications costs are based on the cost per equipped flight calculated in section 2.5. The number of ATN flights in each year is obtained from the suitably grown year 2000 total number of flights (same for all three scenarios) multiplied by the appropriate equipage percentage from Figures 4-1 and 4-2.

4.4.5 Aircraft Capital Costs

The costs reflect the different percentages of aircraft equipped (Figures 4-1 and 4-2). The total fleet sizes are the same in each scenario. The actual number of aircraft based in the ACCESS area that are estimated to become equipped each year is given in Figure 4-8.

[7] This is one ACC End System and one Network Management End System (Local).

[8] This is two Airport End Systems and one Network Management End System (Local).

Year	*REALISTIC*	*OPTIMISTIC*
2000	0	0
2001	0	0
2002	18	18
2003	19	19
2004	20	20
2005	42	42
2006	43	104
2007	67	132
2008	93	139
2009	120	170
2010	150	202
Totals	572	846

Figure 4-9: Number of ATN equipped aircraft in the R/O scenarios

4.4.6 Aircraft Operating Costs

The annual cost of maintaining the ATN equipment on an aircraft is calculated as a fixed percentage (same in all scenarios) of the installation cost.

5. Conclusions

5.1 The Life Cycle Costs Model

This report captures the work performed under WP226 of the ACCESS project. The ATN Life Cycle Costs have been estimated, concentrating on the capital and running/ownership costs to the air traffic service organisations (ATSOs) but also considering the cost to aircraft operators of equipping and maintaining aircraft. The period of interest is 2000-2010 and the geographical area of interest comprises UK, Ireland, Benelux, Germany, France, Italy, Spain and Portugal.

The report explains how the various cost elements have been identified, drawing on other European Commission funded projects (COPICAT and EOLIA) and Eurocontrol output, and captured in a user friendly Microsoft Excel spreadsheet model. Of particular significance is the deployment of the ground infrastructure which is addressed on a per country basis in some detail. The ultimate objective is to identify where and when every main component needs to be deployed and the spreadsheet model supports this level of detail, although real data from national CAAs has not been forthcoming.

The air-ground subnetworks considered are VDL Mode 2, the Inmarsat based Aeronautical Mobile Satellite Service (AMSS) and Mode S, where the first two are considered to be supplied and administered by a third party. Thus usage charges (of the order of 1 EURO per kilobit) are incurred whereas for Mode S there is a high capital cost to the ATSOs but no communications charges are attributed.

Total (rather than by country) airline fleet sizes and growth rates are estimated together with a profile for equipping aircraft for ATN. The cost of such adaptation and the subsequent maintenance costs are included.

Although the numbers used to populate the model are becoming more reliable, there is still some uncertainty in all areas and considerable uncertainty in some areas. However, the model can be used to identify the main cost drivers and to give ATSOs and aircraft operators a reasonable idea of the costs that will be incurred to help them to plan their strategies.

5.2 Analysis Performed with the Model

Some analysis has been performed with the model by postulating realistic and optimistic scenarios where the latter envisages that the full ATN infrastructure is in place at all 27 area control centres[9] and at 27 of the 42 largest airports in the ACCESS region by 2010. The rate of equipage of aircraft fleets belonging to airlines in the region also varies between the two scenarios but not dramatically, even the optimistic scenario only expects 37% of aircraft to be ATN-compliant by 2010.

The analysis identifies the following main capital cost drivers:

- Airport and ACC end systems;
- Mode S sub-networks (which are associated with ACCs);
- Gatelink sub-networks at airports.

In the first two cases there would seem to be scope for significant cost reductions. The number of end systems that could be deployed in ACCs and airports ought to bring down the unit cost from the currently assumed level of 500KEuro. The high cost of a Mode S data link is dominated by the perceived cost to ATSOs of testing and integration. This component may have been over-estimated and/or it may be decided to confine Mode S usage to the accepted role of enhanced surveillance (for which there would be no extra costs) rather than making use of its full capability, which would also necessitate expensive airborne transponder upgrades. However, the anticipated data communication would then have to be shared entirely between VDL and Satcom sub-networks, resulting in perhaps 54% higher total communications charges (realistic scenario), assuming that those sub-networks were not ATSO-owned.

There may also be scope for reduction of Gatelink costs but the available information on cost build-up was minimal for this sub-network.

9 But note that this does not imply that every ACC supports all types of air-ground sub-network.

Regarding operating costs, it was generally assumed that maintenance costs of 10% of capital cost per annum was reasonable, although much higher percentages are appropriate for VDL and AMSS sub-networks since the capital costs are relatively low, due to the assumption that these sub-networks are provided by third parties.

Data communications charges are high for third party sub-networks, even with relatively low aircraft equipage, resulting in total operating costs being similar to total capital costs by 2010 in all scenarios. However, it is felt that:

- unit charges should be much lower than the figures used, particularly for VDL; and
- a more accurate analysis of the data transmitted during a flight is desirable. Most of the bits are in headers so there is scope for taking advantage of addressing commonalities to achieve significant reductions (e.g. the use of the mobile SNDCF compression algorithms LREF and Deflate)

The cost of equipping aircraft is dominated by the cost, installation and certification of ATN avionics and Level 4 Mode S transponders. There is scope for significant reductions here, indeed the Mode S component of the cost could be removed altogether if the strategy of using Mode S only for enhanced surveillance rather than for full data link, were widely adopted.