AN INVENTORY OF COST BENEFIT STUDIES IN THE FIELD OF ATC DATA COMMUNICATIONS

Prepared for the Directorate of EATCHIP Development

EUROCONTROL

Management in Confidence

Submitted by: GR Skinner

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EXECUTIVE SUMMARY

This Study was commissioned to conduct a survey of the Cost-Benefit literature relevant to data communications in ATM.

46 study reports were identified, of which 30 were analysed. Of these about two thirds described a methodology, two thirds provided cost data, one half gave benefit data and only about one third attempted cost-benefit calculations.

Of those which did provide data and cost-benefit calculations, about one third were looking at a narrow subset of the required scope.

In all, about 8 reports provide data and cost-benefit results which are likely to be useful and a further 5 provide potentially useful cost or benefit data but no cost-benefit results.

Much of the existing work has, however, been concerned with ADS and oceanic applications which are of limited relevance to core Europe. Few studies address all modes of digital datalink and/or the European context.

Where it is possible to discern a main message from the existing work, it is that digital datalink is deemed to have a good benefit to cost ratio. A caveat must be applied, however, in the sense that the way in which cost-benefit results have been calculated does not always measure up to best practice. In a number of instances, spot values have been calculated for a specific year rather than taking account of lifecycle costs and the cost to benefit time lag which occurs during implementation. The use of Net Present Value calculations is not consistent.

The survey draws a number of potentially important conclusions and provides some recommendations.

There is a need to verify and follow up on some of the data. A number of study reports which were identified by the survey could not be obtained within the study timeframe and could not be analysed. In addition, the most useful reports identified here may merit a deeper look when formulating follow-on studies.

The amount of information available is sufficient to warrant the use of a database to store and correlate key data.

There are ongoing studies identified which may well generate useful reports in future - these should be tracked.

It is suggested that any future CBA work in this domain should take account of a number of factors, not all of which feature in the existing literature. These include: the fact that some 90% of ECAC air movements are intra-European, not long haul or oceanic; all end-use applications of data link communications need to be considered; there are matters related to the views of stakeholders, market and commercial considerations and regulatory issues which are driving both the need for datalink communications and its practical implementation and take-up; different technology mixes need consideration and there are issues of COTS versus SARPS compliant applications and equipment.

Perhaps the most significant overall conclusion is that, whilst much good work has undoubtedly been done whether taken in aggregate or as individual studies, much remains to do before fully substantiated investment decisions can be taken for ECAC Europe.

CONTENTS

1. INTRODUCTION

1.1 SCOPE

The principal requirement of this inventory was to identify studies that have been made of the costs and benefits of end-system applications in relation to the ATM requirements. The emphasis was on Data Link Applications.

The secondary requirement was to identify studies that have been made of the costs and benefits of the use of different Systems/technologies for one application. Within this group, and for different applications, the following technologies were be represented:

Data Link:	VHF, Mode S, Satellite, Gatelink
Ground Data Communications:	ATN, all existing sub-networks.

The search was focused on Europe, US and ICAO. Other studies, e.g. those of Transport Canada, were reported if they arose.

1.2 TASKS

There were three main tasks.

1. Prepare a schedule of Cost-Benefit Analysis (CBA) work with dates and authors
2. Analyse each relevant CBA, at an appropriate level of detail to:
   - provide a one paragraph description of the scope of the CBA
   - state the context and purpose of the work
   - provide a brief description of the result of the CBA
3. Provide preliminary observations about the depth and coverage of the work done to date and possibly any gaps that can be seen.

1.3 THIS REPORT

This report documents the results of the three tasks.

Section 2 presents a list of the studies identified.

Section 3 sets out the framework for analysis of the studies explaining why various criteria have been selected.

Section 4 tabulates the coverage of the studies and the final three sections, identifies the most relevant studies and comments on the value of the whole set.

2. SCHEDULE OF REPORTS

2.1 LIST OF REPORTS

The following is a list of the reports identified.

No	Title
1	The Economic Case for On-Board Satellite Communications, by IATA Market and Economic Analysis Division on behalf of INMARSAT.
2	Cost Benefit Analysis Studies for Navigation Development. Initial Studies into RVSM and RLRS. Eurocontrol, Sept 1995
3	European Commission ATLAS Study, V2.5 Annex 4 Economic Assessment
4	Rentaux, J. and Schroter, H. "Fuel Savings in Air Transport - Possible Contributions of Air Traffic services in Europe" EUROCONTROL Doc 81 2007 February 1982
5	The Transition to Digital Communications "Urgent Needs, Practical Means", RTCA Task Force Report, December 1993
6	Automatic Dependent Surveillance Benefit And Cost Analysis, by GJ Couluris, IAT for FAA. Interim report November 1990, FAA-RD-90-34.
7	CNS/ATM Cost-Benefit Analysis Guide, by THA for Transport Canada, May 1993
8	A European Planning Strategy For Air Traffic To The Year 2010, by SRI for IATA, March 1990
9	A Study Of The Comparative Cost Of A Single European Air Traffic Control System, Phase 1 Report by General technology Systems Ltd for STOA of European Parliament, 1991
10	STOA, A Study of the Comparative Cost of a Single European Air Traffic Control System, Final Report July 1992
11	Free Flight Implementation, by RTCA Task Force 3, Final report October 1995
12	European En-Route Capacity Cost Study, by Eurocontrol Experimental Centre, Task AM01, June 1995
13	ICAO Special Committee On Future Air Navigation Systems (Phase II) Fourth Meeting, Montreal, October 1993
14	Benefit Analysis of a fully developed European ATN (including datalink costs), Phase 5, Draft Report, 30.03.1995, Alenia for DG VII - A - 4/C-3, Contract no. A4B93B2704
15	ICAO ATN Panel First Meeting: Cost Benefit Analysis of Aeronautical Telecommunications Network: Transition Issues Information Paper, June 1994
16	The Aeronautical Data Link System Operational Concept, by FAA, June 1994
17	Assessment of the potential of satellite navigation systems and the European dimension of their utilisation, by Deutsche Aerospace AG Notes on the Workshop in Brussels, May 1993

No	Title
18	IATA, Cost Benefit Analysis Methodology, by SH&E, October, 1993
19	FAA - Office of Aviation Policy and Plans, "Economic Values for Evaluation of Federal Aviation Investment and

	Regulatory Programs", Doc. No. FAA-APO-89-10, October 1989
20	ICAO, FANS: Cost-Benefit Analysis for the Establishment of the Future CNS Systems in Canada, Tenth Air Navigation Conference, Montreal, September 1991
21	Couluris, G.J. and S. Dorsky, September 1995, Advanced Air Transportation Technologies (AATT) Potential Benefits Analysis, Seagull Technology, Inc. Cupertino, CA. Also NASA-Ames Report AATT-95-001
22	Lacher, A.R., 15 August 1995, Putting Bounds on Free Flight's Benefits, Briefing, The MITRE Corporation, McLean, Virginia
23	Lawler, R., August 1995, Proposed Free Flight Cost Benefit Method, Boeing Commercial Airplane Group, Seattle, Washington
24	Cost -Benefit Analysis of Oceanic Automation, satellite Communications, navigation & surveillance, Draft Working Paper. Operations Research Service (AOR-100), FAA, October 1993
25	Muller, J. et al "The Crisis in Europe's Air Traffic Control System: An Assessment of its Economic Costs, (Background study to the report The Crisis of European Air Traffic Control: Cost and Solutions of the Planungsburo Luftraumnutzer 1989") July 1989, Section 2.6
26	ARINC Research Corporation, Cost-Benefit Analysis of Reduced Vertical Separation Minimum Implementation in North Atlantic Minimum Navigation Performance Specifications Airspace, 08351-01-91-SD-ANN-0059, Final Report August 1991
27	MITRE, The Advanced Automation System: A Benefit/Cost and Risk Analysis, volume 1 - Approach and Methodology, January 1988
28	A record of work undertaken to assess the benefits of delivering oceanic clearances by data link , by Boydell GB, CAA, 1992
29	ICAO, Economics of satellite based air navigation services: guidelines for cost/benefit analysis of communications, navigation & surveillance/air traffic management (CNS/ATM) systems, 1995. ICAO-CIRC-257
30	Information sources for use in cost benefit analyses, by Latif T, UK CAA, 1992, DORA-COMM-9201.
31	Current R/T communications and the potential for replacing them with datalink, by JE Sonander, UK CAA, 1994, OS-R-9457 -
32	An assessment of datalink technologies to support air traffic control applications in the North Atlantic, by IS Forsyth, NATS, 1996, RD-R-9612
33	An initial assessment of possible ATC datalink technologies and their relative costs, by Latif T, NATS, 1996, RD-R-9626

No	Title
34	Classic Radionav and GNSS in Europe: Part 1, Progress Report 2, Appendices and Final Report, 1994, for Eurocontrol by The European Aerospace Consultany
35	Summary of Arguments for and against Procuring a Low Cost ADS/AES, Eurocontrol, DED1, NJ Clark, 26 Jan 1994
36	Bringing FANS into Perspective: A Manufacturer's Viewpoint, presentation by DC Purdy, Honeywell at ATC '94
37	Outline Specification for a Cost/Benefit Study of ATC ADS in Europe, presented by Eurocontrol at SATCOM - ADS Sub-Group/Meeting No7/15-16.3.94/DP71
38	Summary of Eurocontrol Agency Activities in the Field of satellite Navigation, Satellite Navigation Applications Sub-Group, 26/4/1994, SNA/DP/007
39	Transport Canada, FANS Benefit Cost Analysis, July 19, 1991, prepared by THA
40	Transport Canada, Future Air Navigation System Cost-Benefit Analysis Guide, Oct 16, 1992, prepared by THA
41	[deleted, see #7]
42	SD-SCICON, Automatic Dependent Surveillance Cost Analysis, Final report, Issue 1.1, 15 April 1991, Harry Arrowsmith & John Hulet, Doc ref C27725.01.102
43	[deleted]
44	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Argentina, WP/45 FANS (II)/2, Montreal, 1991
45	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Canada, WP/52 ICAO 10 ANC, Montreal, 1991
46	User Benefits of Two-way Data Link ATC Communications: Aircraft Delay and Flight Efficiency in Congested En Route Airspace, data Link benefits study Team, February 1995, Final report, DOT/FAA/CT-95/4
47	FANS CBA for Australia, China, India, Germany & New Zealand
48	European Commission, AEGIS Study, Work Package 8

2.2 LIST OF ON-GOING STUDIES

The following is a list of on-going studies and known activities which may produce Cost Benefit reports of interest in the future.

S1	European AIS Database, Feasibility Study, CAP Debis, Sept 1993
S2	ADS Mediterranean trials
S3	Satellite Communications and ADS Studies and Applications (Eurocontrol STAR/SA2 1994)
S4	Satellite Communications and ADS (NATS Item 4.5 1994)
S5	VHF Data Links (NATS Item 4.6 1994)
S6	Mode S Surveillance (NATS Item 4.2 1994)
S7	European Union EURATN, APAS and ECARDA projects
S8	EATCHIP ECR SG for the development of operational concept and requirements for EATMS
S9	EATCHIP Communication Team (COMT) for short, medium term technical requirements - development of guidelines for intra-centre communications architecture within ATM systems
S10	EATCHIP Operational Requirements and Data Processing Team (ODT) for short, medium term operational requirements
S11	EATCHIP Future Concept Team (FCOT) for long term operational and technical requirements
S12	ICAO ATN & ADS panels; development of Operational Requirements for AIDC (ATS Interfacility Data Communications)

3. ANALYSIS OF REPORTS

3.1 REPORTS ANALYSED

The Study has assigned the various reports which were identified into categories:

Reports Analysed:

- relevant reports, within the scope of the Study, of which copies could be obtained.

Reports not Analysed due to one of the following:

- not possible to obtain a copy of the report to analyse. 5 reports are on back order with the EUROCONTROL Library and were not available to the Study.
- report not covering the scope of data link CBA
- report being of marginal relevance.

The analysis has concentrated on those studies likely to provide some valuable results.

3.2 REPORT ABSTRACTS

For those reports which are relevant and for which a copy has been obtained, a brief summary or abstract has been written. See relevant section of each analysis in Appendix B for the abstracts.

3.3 REPORT ANALYSIS STRUCTURE

3.3.1 Overview

Initial analysis indicated the wide variety of reports identified, which varied in terms of scope and coverage. The approaches taken to analysing Costs and Benefits were found to be highly variable.

In order to proceed, a working definition of a Cost-Benefit Study was developed:

Definition: The objectives of a Cost-Benefit Study are to: demonstrate the financial feasibility of the transition between two states; the parameters which have most effect; and the range of circumstances under which it is advantageous to proceed.

Thus each study should have a clear:

- purpose which is described by the transition between two states
- baseline situation or state described by a technical configuration and an operational context
- proposed end state described by a technical configuration and an expected operational context and timeframe
- scope defining the timeframe, geographic limits and population affected
- costs with assumptions
- benefits with assumptions
- cost-benefit calculation method with assumptions
- set of results.

The reports contain differing levels of detail and traceability according to how much of the work has been rigorously documented. There are also different representations of data e.g. cost saving may be represented as a benefit or as a negative cost.

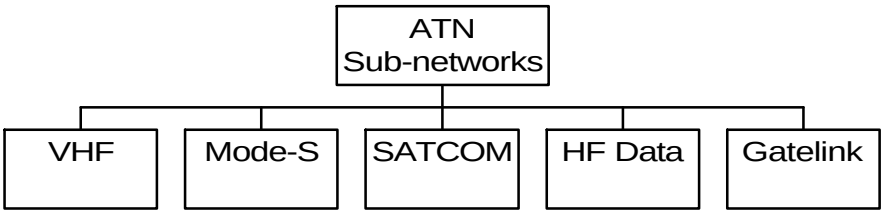
Whilst it may be difficult to compare the results of the studies, there is significant value in the cost and benefit data, provided that the base assumptions are stated i.e. the starting position or situation without data link is identifiable and is comparable with that of other CBAs.

More importantly, the results can be used to bound, size or position estimates for other studies so that there is an increased confidence in the data and results of future studies.

3.3.2 Purpose

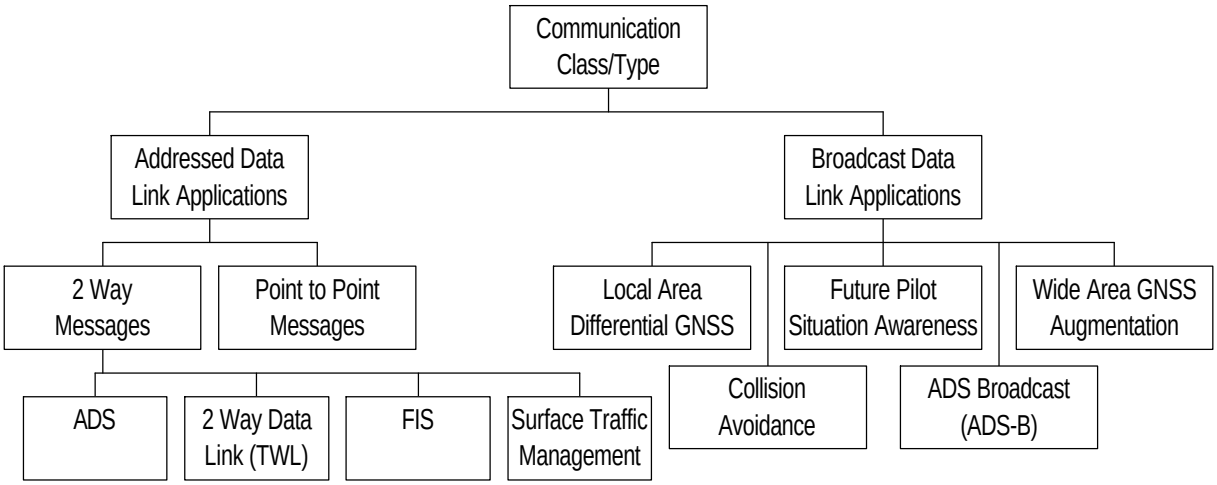
The purpose of the CBA should be described by the transition between two states. In this situation it is the introduction of data link communication technology. This may be provided by the ATN or the separate component technologies. See Appendix A for definition of the ATN.

Figure 1 Communication Technologies



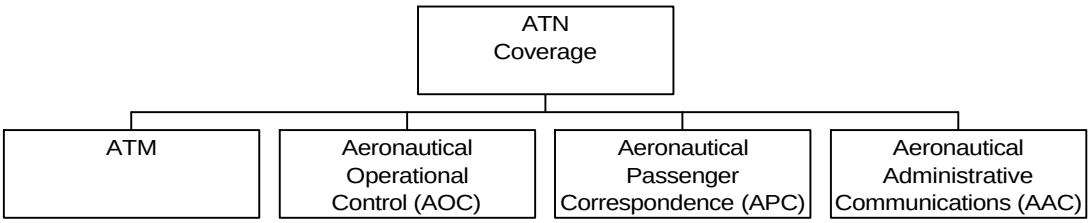
These communication technologies may support different types of communication protocol:

Figure 2 Communication Protocols



These communication technologies and protocols deliver different ATN services/applications (end systems).

Figure 3 ATN Services



Therefore it is necessary to consider CBA studies which either mention data link or any of the types of communication or ATN services/applications.

3.3.3 Base situation

The base situation or state should be described by a technical configuration and an operational context for the timeframe and scope being considered. In this instance it is what the ATM systems will be without data link and the resulting operational environment e.g. air traffic profiles.

3.3.4 Proposed end situation

The proposed end state again should be described by a technical configuration and an expected operational context. In this instance it is what the ATM systems will be with data link installed and the resulting operational environment. There may be more than one proposed end technical configuration and more than one possible resulting operational environment for each end technical configuration. Multiple situations help identify the parameters which have most effect and the range of circumstances under which it is advantageous to proceed.

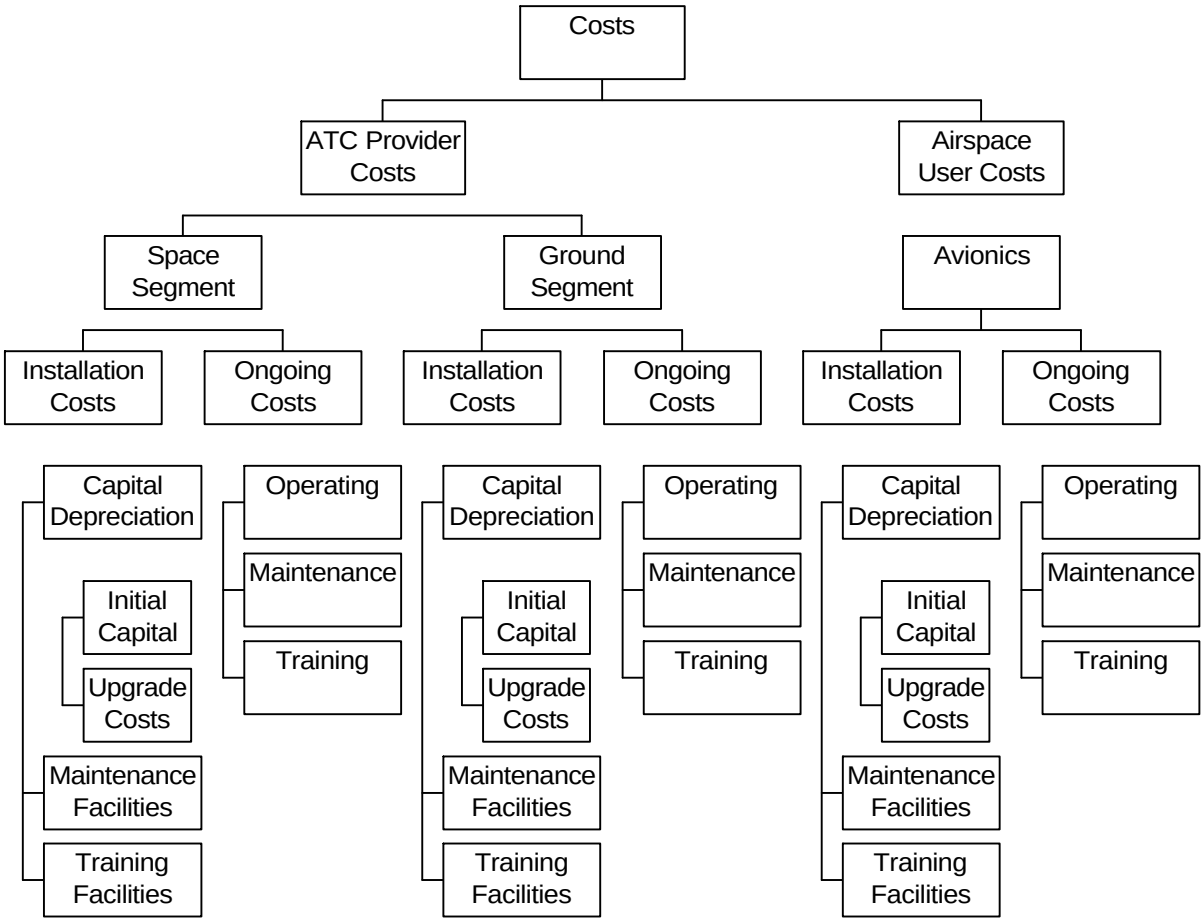
3.3.5 Scope

The scope defines the timeframe, geographic limits and any other constraints on the user population affected. In this report Europe and the USA are of prime interest.

3.3.6 Costs

The costs with assumptions must be clearly bounded and defined. The ATC Provider will incur extra costs above the base situation to implement and operate the proposed technical configuration. The Aircraft Operator may incur extra costs in installing and operating new avionics. However, costs transferred between the two parties i.e. increased ATC charges to pay for the new ATC technical configuration and its operation should be ignored. Any extra costs to third parties e.g. communication charges to satellite service providers, should be included.

Figure 4 Costs



Note: any cost can be substituted by a different cost e.g. the capital costs of a communication network can be avoided by renting facilities and bandwidth from a communications supplier.

3.3.7 Benefits

To be fully meaningful, the benefits with assumptions should be clearly bounded and defined.

The ATM service Provider may receive extra benefits above the base situation in implementing and operating the proposed technical configuration.

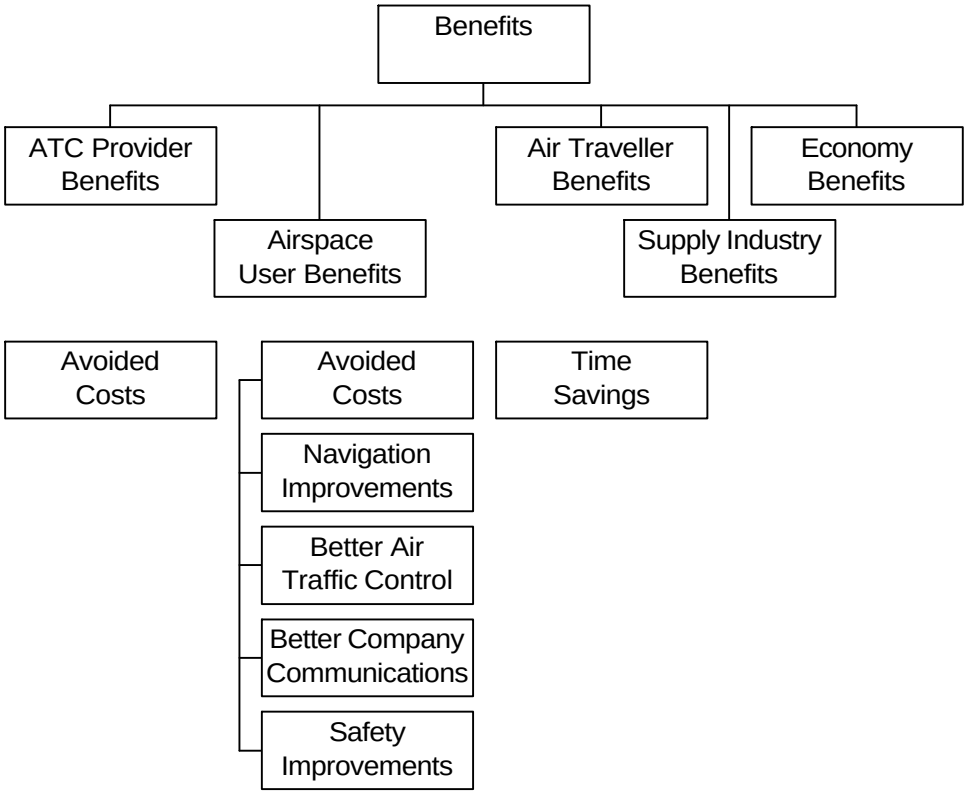
The Aircraft Operator should receive extra benefits from the changed situation provided by the new technical configuration and its operation.

The passenger may receive extra benefits from time savings, however, any possible reduction in airfares should be ignored as this is a transfer between the two parties i.e. a reduction in airfares which has been possible due to the reduction in operating costs will have already been accounted for and should be ignored.

Any extra marginal benefits to other third parties e.g. air transport supply community, the national economy, may be included.

Whilst the definition of costs is relatively straightforward i.e. the change is tangible, many of the benefits are difficult to quantify and are based on a belief that they can be realised. It is all too easy to say that a very small percentage improvement can be obtained and because of the scale of operation this improvement translates into significant value.

Figure 5 Benefits



The Airspace User Benefits are expanded further in Figure 6 overleaf.

3.3.8 Cost-Benefit Calculation

There are a variety of methods used, some of which are probably unsatisfactory. The objective is not only to establish the financial feasibility of the transition between two states, but also to identify the parameters which have most effect and the range of circumstances under which it is advantageous to proceed. It is also important to state any assumptions.

A good methodology has:

- an explicit context and working assumptions
- time phasing of costs and benefits
- costs and benefits expressed in values of the start date (Present Values with an assumed inflation/discount rate)
- Net Present Value (NPV) for the time series of costs and benefits
- sensitivity analysis on all parameters which have significant levels of uncertainty in the future:
  - discount rate

  - avionics costs
  - air traffic levels
  - distribution pattern of technology e.g. differing number of ATCCs
  - timing of costs and benefits
- order of magnitude checks against other studies.

3.3.9 Set of results

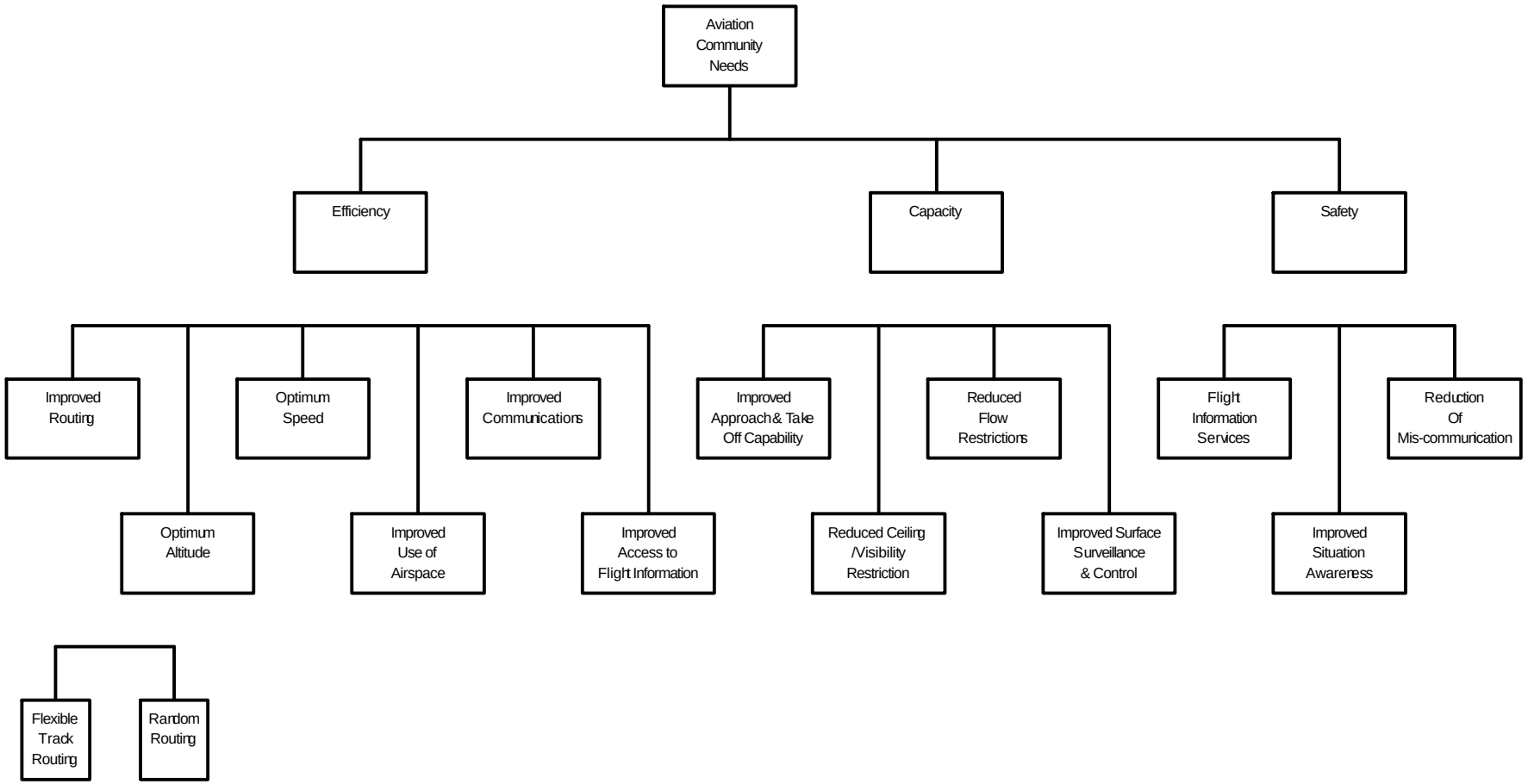
Ideally, this should be a time series of costs and benefits from which a Net Present Value (NPV) is calculated using a defined Discount Rate. NPVs on their own may be difficult to compare as the NPV of a series over the first 10 years is different to the NPV calculated over 12 years using the same series.

3.4 ANALYSIS OF EACH REPORT

A pro-forma has been prepared to document the attributes of each report. Those reports that are of little relevance have been filtered out.

The resulting pro-formas for the reports of interest are documented in Appendix B.

Figure 6 Aviation Community Needs



4. CBA SUBJECT COVERAGE

The nature of the Cost Benefit Work varies. Some papers provide method, some relevant reference data and a few results which partially cover the subject matter. A summary analysis is provided below. The key is:

Scope - this is scored in relation to coverage of datalink CBA:

- 'superset' (the scope of the report is wider and datalink is a subset);
- 'exact' (complete match with the technological, operational, airspace and application scope of this survey);
- 'subset' (not all aspects of datalink CBA are covered))
- 'marginal' (the report, although partly relevant is neither a superset nor a direct subset and is thus marginal to the scope of the survey)
- 'excluded' (the report was filtered out at an early stage on the basis of non-availability and/or limited relevance and was consequently not analysed).

Method - Y (method described)

Reference Data - Y (quantified data for costs and/or benefits provided)

Results - Y (CBA calculations performed)

No	Title	Scope	Method	Reference Data		Results
				Costs	Benefits	
1	The Economic Case for On-Board Satellite Communications, by IATA Market and Economic Analysis Division on behalf of INMARSAT.	Subset	Y	Y	Y	Y
2	Cost Benefit Analysis Studies for Navigation Development. Initial Studies into RVSM and RLRS. Eurocontrol, Sept 1995	Marginal	Y	Y	Y	
3	European Commission ATLAS Study, V2.5 Annex 4 Economic Assessment	Superset		Y	Y	
4	Rentaux, J. and Schroter, H. "Fuel Savings in Air Transport - Possible Contributions of Air Traffic services in Europe" EUROCONTROL Doc 81 2007 February 1982	Marginal		Y	Y	
5	The Transition to Digital Communications "Urgent Needs, Practical Means", RTCA Task Force Report, December 1993	Exact	Y	Y	Y	Y

No	Title	Scope	Method	Reference Data		Results
				Costs	Benefits	
6	Automatic Dependent Surveillance Benefit And Cost Analysis, by GJ Couluris, IAT for FAA. Interim report November 1990, FAA-RD-90-34.	Subset	Y	Y	Y	Y
7	CNS/ATM Cost-Benefit Analysis Guide, by THA for Transport Canada, May 1993	Superset	Y			
8	A European Planning Strategy For Air Traffic To The Year 2010, by SRI for IATA, March 1990	Superset	Y	Y	Y	
9	A Study Of The Comparative Cost Of A Single European Air Traffic Control System, Phase 1 Report by General technology Systems Ltd for STOA of European Parliament, 1991	Superset		Y		
10	STOA, European Parliament, A Study of the Comparative Cost of a Single European Air Traffic Control System, Final Report July 1992	Excluded	n/a	n/a	n/a	n/a
11	Free Flight Implementation, by RTCA Task Force 3, Final report October 1995	Subset	Y	Y	Y	Y
12	European En-Route Capacity Cost Study, by Eurocontrol Experimental Centre, Task AM01, June 1995	Marginal		Y		
13	ICAO Special Committee On Future Air Navigation Systems (Phase II) Fourth Meeting, Montreal, October 1993	Superset	Y			
14	Benefit Analysis of a fully developed European ATN (including datalink costs), Phase 5, Draft Report, 30.03.1995, Alenia for DG VII - A - 4/C-3, Contract no. A4B93B2704	Exact	Y		Y	
15	ICAO ATN Panel First Meeting: Cost Benefit Analysis of Aeronautical Telecommunications Network: Transition Issues Information Paper, June 1994	Excluded	n/a	n/a	n/n	n/a
16	The Aeronautical Data Link System Operational Concept, by FAA, June 1994	Exact	Y			
17	Assessment of the potential of satellite navigation systems and the European dimension of their utilisation, by Deutsche Aerospace AG Notes on the Workshop in Brussels, May 1993	Subset	Y			

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18	IATA, Cost Benefit Analysis Methodology, October 1993	Marginal	Y			
19	FAA - Office of Aviation Policy and Plans, "Economic Values for Evaluation of Federal Aviation Investment and Regulatory Programs", Doc. No. FAA-APO-89-10, October 1989	Excluded	n/a	n/a	n/a	n/a
20	ICAO, FANS: Cost-Benefit Analysis for the Establishment of the Future CNS Systems in Canada, Tenth Air Navigation Conference, Montreal, September 1991	Superset	Y	Y	Y	Y
21	Couluris, G.J. and S. Dorsky, September 1995, Advanced Air Transportation Technologies (AATT) Potential Benefits Analysis, Seagull Technology, Inc. Cupertino, CA. Also NASA-Ames Report AATT-95-001	Excluded	n/a	n/a	n/a	n/a
22	Lacher, A.R., 15 August 1995, Putting Bounds on Free Flight's Benefits, Briefing, The MITRE Corporation, McLean, Virginia	Excluded	n/a	n/a	n/a	n/a
23	Lawler, R., August 1995, Proposed Free Flight Cost Benefit Method, Boeing Commercial Airplane Group, Seattle, Washington	Superset	Y	Y	Y	Y
24	Cost -Benefit Analysis of Oceanic Automation, satellite Communications, navigation & surveillance, Draft Working Paper. Operations Research Service (AOR-100), FAA, October 1993	Excluded	n/a	n/a	n/a	n/a
25	Muller, J. et al "The Crisis in Europe's Air Traffic Control System: An Assessment of its Economic Costs, (Background study to the report The Crisis of European Air Traffic Control: Cost and Solutions of the Planungsbüro Luftraumnützer 1989") July 1989, Section 2.6	Excluded	n/a	n/a	n/a	n/a
26	ARINC Research Corporation, Cost-Benefit Analysis of Reduced Vertical Separation Minimum Implementation in North Atlantic Minimum Navigation Performance Specifications Airspace, 08351-01-91-SD-ANN-0059, Final Report August 1991	Excluded	n/a	n/a	n/a	n/a
27	MITRE, The Advanced Automation System: A Benefit/Cost and Risk Analysis, volume 1 - Approach and Methodology, January 1988	Excluded	n/a	n/a	n/a	n/a

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29	ICAO, Economics of satellite based air navigation services: guidelines for cost/benefit analysis of communications, navigation & surveillance/air traffic management (CNS/ATM) systems, 1995. ICAO-CIRC-257	Excluded	n/a	n/a	n/a	n/a
30	Information sources for use in cost benefit analyses, by Latif T, UK CAA, 1992, DORA-COMM-9201.	Excluded	n/a	n/a	n/a	n/a
31	Current R/T communications and the potential for replacing them with datalink, by JE Sonander, UK CAA, 1994, OS-R-9457 -	Exact			Y	
32	An assessment of datalink technologies to support air traffic control applications in the North Atlantic, by IS Forsyth, NATS, 1996, RD-R-9612	Exact		Y		
33	An initial assessment of possible ATC datalink technologies and their relative costs, by Latif T, NATS, 1996, RD-R-9626	Exact		Y		
34	Classic Radionav and GNSS in Europe: Part 1, Progress Report 2, Appendices and Final Report, 1994, for Eurocontrol by The European Aerospace Consultany	Subset		Y		
35	Summary of Arguments for and against Procuring a Low Cost ADS/AES, Eurocontrol, DED1, NJ Clark, 26 Jan 1994	Marginal		Y		
36	Bringing FANS into Perspective: A Manufacturer's Viewpoint, presentation by DC Purdy, Honeywell at ATC '94	Excluded	n/a	n/a	n/a	n/a
37	Outline Specification for a Cost/Benefit Study of ATC ADS in Europe, presented by Eurocontrol at SATCOM - ADS Sub-Group/Meeting No7/15-16.3.94/DP71	Marginal	Y			
38	Summary of Eurocontrol Agency Activities in the Field of satellite Navigation, Satellite Navigation Applications Sub-Group, 26/4/1994, SNA/DP/007	Excluded	n/a	n/a	n/a	n/a

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40	Transport Canada, Future Air Navigation System Cost-Benefit Analysis Guide, Oct 16, 1992, prepared by THA	Superset	Y			
41	[deleted, see #7]					
42	SD-SCICON, Automatic Dependent Surveillance Cost Analysis, Final report, Issue 1.1, 15 April 1991, Harry Arrowsmith & John Hulet, Doc ref C27725.01.102	Subset		Y		
43	[deleted]					
44	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Argentina, WP/45 FANS (II)/2, Montreal, 1991	Superset	Y	Y	Y	Y
45	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Canada, WP/52 ICAO 10 ANC, Montreal, 1991	Superset	Y	Y	Y	Y
46	User Benefits of Two-way Data Link ATC Communications: Aircraft Delay and Flight Efficiency in Congested En Route Airspace, data Link benefits study Team, February 1995, Final report, DOT/FAA/CT-95/4	Excluded	n/a	n/a	n/a	n/a
47	FANS CBA for Australia, China, India, Germany & New Zealand	Excluded	n/a	n/a	n/a	n/a
48	European Commission, AEGIS Study, Work Package 8	Subset	Y	Y	Y	Y

4.1 SUMMARY OF THE FINDINGS

Total number of CBA-relevant reports identified:		46	
Number of reports not analysed		16	
Number of reports analysed:			30
Of the 16 reports not analysed:			
Reports not obtained			5
Reports excluded/not relevant		11	
Of the 30 reports analysed:			
Methodology is described at some level by:	20	(66%)	
Cost data are provided by:		21	(70%)
Benefit data are provided by:	16	(53%)	
Cost-benefit calculations are given by:	10	(33%)	

Of the 10 reports which provide an attempt at cost-benefit calculations:

4 only address subsets of the scope

6 cover at least the full datalink scope.

Of the 21 reports providing cost data:

10 do not address the full scope

11 cover at least the full datalink scope.

Of the 16 reports providing benefit data:

6 do not address the full scope

10 cover at least the full datalink scope.

Note: these statistics do not consider the quality of information provided, something which is unsatisfactory in a number of instances, see below.

5. OBSERVATIONS

Preliminary observations from the analysis of the CBAs provide a number of indications, although the story they present is far from comprehensive at this time.

5.1 THE STORY WHICH EMERGES

The following conclusions may be drawn from a review of the consistency of the published results:

- those studies which produce numeric cost-benefit indicate a result in favour of digital datalink
- there is insufficient evidence to say which technology is most cost-beneficial in any given context
- much of the existing work applies to North American and Oceanic regions, there is relatively little specifically for Core Europe or ECAC Europe
- ADS and FANS-1 have dominated the attention so far.

5.2 COVERAGE

In looking at the extent to which the available literature covers the full scope of this survey:

- there are a number of reports that provide either method or data of interest but not both
- relatively few provide assumptions, method, costs, benefit data and cost-benefit calculation
- only a few reports provide a CBA of data link
- the majority of full CBAs are overall studies, only a few examine a particular aspect in detail. We suspect that it is an order of magnitude more difficult to produce a CBA for a particular aspect, where it is necessary to assign benefits to items of enabling infrastructure which are dependent on other significant developments
- the studies tend to fall into one of three areas, FAA, ICAO and Europe
- the FAA predominates in data link studies
- the majority of data link studies are to support ADS in oceanic airspace
- very few studies detail the intended use of data link i.e. the end systems applications
- the possible role of airports in the use, costs and benefits of digital datalink is virtually ignored
- the possible medium to long term requirement for air to air datalink, in the context of Airborne Separation Assurance Systems (ASAS) under Free Flight and similar concept developments, is not explored.

5.3 METHODS

One of the things this survey was looking for was evidence of coherent and consistent methodologies being applied:

- there are many different approaches to producing a cost-benefit analysis. The differences include:
  - whether a snapshot comparison year is used or the more realistic life-cycle of costs and benefits

  - the presentation options i.e. NPV, discounted values, Benefit/Cost ratio and sensitivities. Some studies, such as the SRI International Study 'A European Planning Strategy For Air Traffic To The Year 2010' present the economic losses of inaction

- the latest ICAO methodology is becoming a standard. It now prescribes templates and formulae for the derivation of costs and benefits. It also sets out the use of life-cycle costs and benefits, discounted Benefit/Cost ratio, NPV and the use of sensitivities, such as different traffic levels

- the comparison of results between CBAs is very difficult as they use different sets of base assumptions. Not only do they use different geographic coverage, base years and currencies but often assume different base configurations throughout the period. An obvious example is that studies covering Europe will have different assumptions about what constitutes Europe or the ECAC region depending on when the study was conducted

- the majority of the actual cost benefit calculations are methodologically weak i.e. do not use NPV properly or perform sensitivity analysis. Of the studies which went as far as performing the cost benefit calculation only a few used NPV correctly with an adequate set of sensitivities

- in general, the documentation of the analyses is poor. Very few reports provide enough data and traceability so that the calculations can be reproduced. Of the 46 studies examined only about 5 documented their results to a level where the calculations could be checked. It is important that the CBAs used are documented well so that necessary adjustments to rationalise the data to a common base can be performed with confidence without introducing unknown errors.

5.4 THE USEFUL REPORTS

From the comprehensive list a short list of the most useful reports has been compiled. The following reports are useful for their results (see section 4 for key):

No	Title	Scope	Method	Reference Data		Results
				Costs	Benefits	
1	The Economic Case for On-Board Satellite Communications, by IATA Market and Economic Analysis Division on behalf of INMARSAT.	Subset	Y	Y	Y	Y
5	The Transition to Digital Communications "Urgent Needs, Practical Means", RTCA Task Force Report, December 1993	Exact	Y	Y	Y	Y
6	Automatic Dependent Surveillance Benefit And Cost Analysis, by GJ Couluris, IAT for FAA. Interim report November 1990, FAA-RD-90-34.	Subset	Y	Y	Y	Y
11	Free Flight Implementation, by RTCA Task Force 3, Final report October 1995	Subset	Y	Y	Y	Y
20	ICAO, FANS: Cost-Benefit Analysis for the Establishment of the Future CNS Systems in Canada, Tenth Air Navigation Conference, Montreal, September 1991	Superset	Y	Y	Y	Y
23	Lawler, R., August 1995, Proposed Free Flight Cost Benefit Method, Boeing Commercial Airplane Group, Seattle, Washington	Superset	Y	Y	Y	Y
44	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Argentina, WP/45 FANS (II)/2, Montreal, 1991	Superset	Y	Y	Y	Y
48	European Commission, AEGIS Study, Work Package 8	Subset	Y	Y	Y	Y

The following additional reports are useful for their data:

No	Title	Scope	Method	Reference Data		Results
				Costs	Benefits	
12	European En-Route Capacity Cost Study, by Eurocontrol Experimental Centre, Task AM01, June 1995	Marginal		Y		
31	Current R/T communications and the potential for replacing them with datalink, by JE Sonander, UK CAA, 1994, OS-R-9457 -	Exact			Y	
32	An assessment of datalink technologies to support air traffic control applications in the North Atlantic, by IS Forsyth, NATS, 1996, RD-R-9612	Exact		Y		
33	An initial assessment of possible ATC datalink technologies and their relative costs, by Latif T, NATS, 1996, RD-R-9626	Exact		Y		
42	SD-SCICON, Automatic Dependent Surveillance Cost Analysis, Final report, Issue 1.1, 15 April 1991, Harry Arrowsmith & John Hulet, Doc ref C27725.01.102	Subset		Y		

6. RECOMMENDATIONS

The emphasis has been on identifying a complete set of Cost Benefit Analyses. On the basis of the analysis carried out, some initial recommendations emerge.

6.1 VERIFICATION & DATA FOLLOW UP

The list of reports and studies gathered should be verified to confirm that all the major relevant reports have been identified and analysed.

In particular, if copies can be obtained of the missing reports whose existence was identified by the survey, they should be evaluated for relevance.

The FAA Report CT-95/4, FAA_46 in Appendix B which at the time of writing is on back order with the EUROCONTROL Library could be of particular interest.

It may also be that circulating the list of reports in section 2.1 to ECBAG would elicit some additional material.

The few relevant reports identified here may require further detailed analysis in the light of any intention to scope follow-up work on datalink CBA.

To assist the development and consistency of further cost benefit studies, information from the above reports should be extracted, converted to a consistent base and documented in a database.

The current on-going activities should be periodically checked to pick up any CBAs which are produced.

6.2 SUGGESTIONS IN RELATION TO FUTURE DATA COMMUNICATIONS CBA

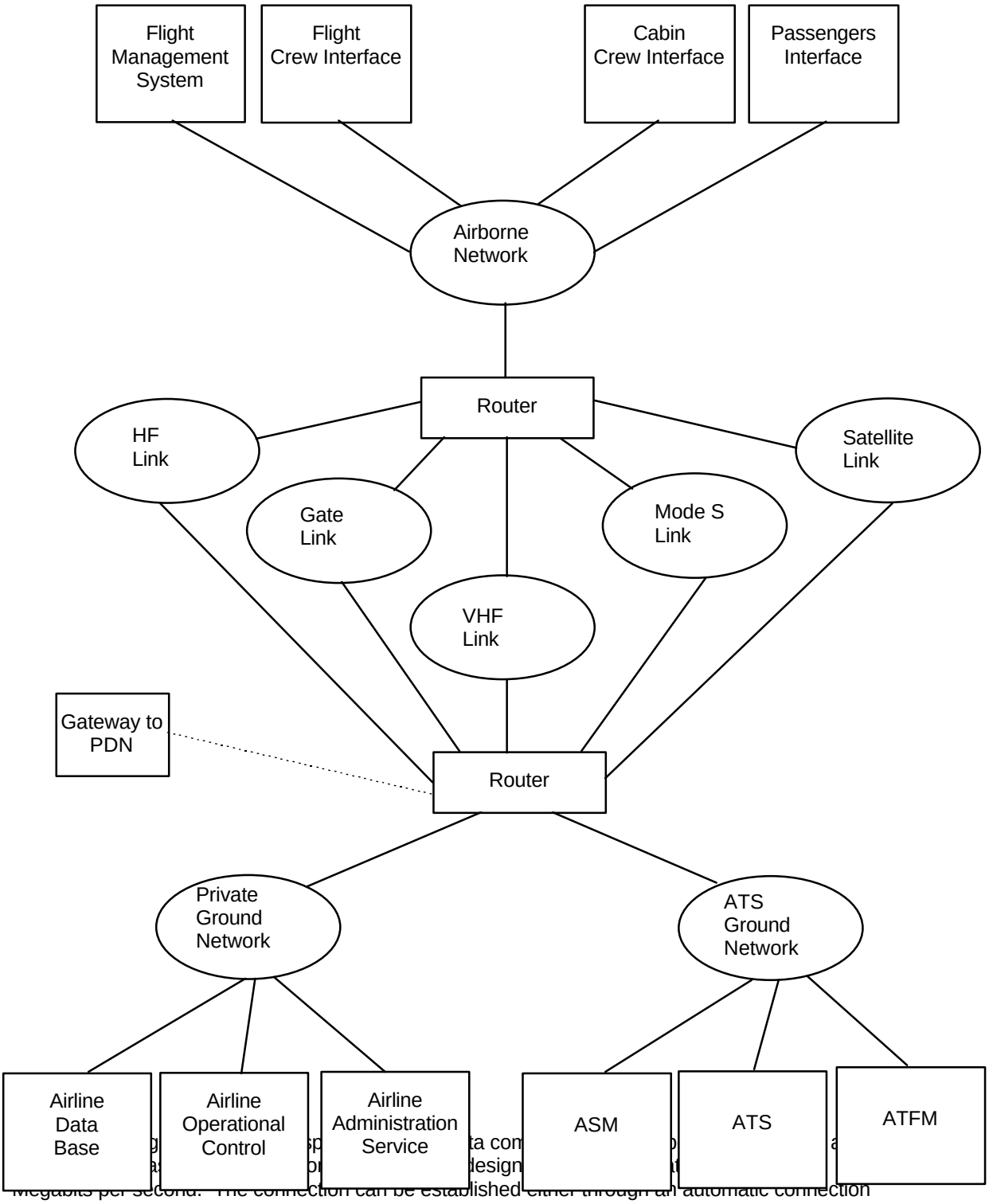
The picture for Europe is not yet clear enough to justify investment decisions in particular datalink services and technologies. What is needed is something which looks at:

- scenarios for high density traffic applications in Core Europe and lower density requirements in the wider ECAC Europe, bearing in mind that some 90% of ECAC air movements are flown entirely within ECAC airspace and are neither long haul nor flown over oceanic and remote regions
- all end-use applications of datalink including ATM, passenger correspondence and airline operational needs, including consideration of those which are likely to be subject to mandatory as opposed to voluntary carriage of airborne equipment
- the factors which are driving the implementation and take-up of datalink
- the involvement, needs, cost and benefits of all stakeholders including airports
- the overall cost-benefit of digital datalink in the context of the full suite of end system applications
- normalised life cycle costs and benefits, allowing for transition lead times and cost-to-benefit time lags
- comparative cost-benefit assessment of different technology mixes: single technology; dual and multiple system fits and their impact on service levels and resilience
- the implications of using COTS technologies as opposed to SARPS-compliant systems for non-safety critical applications and the effect this would have on the economic case for SARPS-based equipment.

In many instances the costs of a particular data link service implementation will accrue to one set of stakeholders while the benefits accrue in a different way. Consideration of 'overall industry' costs or benefits, which is seen in some of the existing studies, is not meaningful unless this point is properly dealt with and mechanisms proposed which can make the economic case viable for each stakeholder.

Similarly there are institutional and market factors to be considered, which address the question of whether a particular datalink service is likely to be commercially viable, notwithstanding the raw cost-benefit numbers.

APPENDIX A THE AERONAUTICAL TELECOMMUNICATION NETWORK[1]



Megabits per second. The connection can be established either through an automatic connection using infrared beams across a free air gap or through a manual connection using a ground connector.

[1] Extract from IATA FANS MANUAL Overview and Benefits 1st Edition version 1.1 Effective May 1995

HF. High Frequency radio (voice) may need to be retained initially to provide communication over the polar regions where geostationary satellites currently have no coverage. Employment of modern technology enables the unpredictable HF wave propagation to be overcome to a large extent. HF Packet Communication data link is presently under development and is the subject of operational trials.

Satellite. Voice and data, using the Aeronautical Mobile Satellite Service (AMSS), will be the main new feature of future aeronautical communications systems. The use of communication satellites will provide global coverage and could support both high and low speed data links as well as high quality voice links between aircraft and ground.

SSR Mode S. In addition to its use for surveillance, the Mode S option of SSR also makes available an air-ground data link which could be used for ATS purposes in high density airspace.

VHF. Very High Frequency radio (voice) will remain in use in many continental and terminal areas. However, increasing use will be made of VHF data links with data eventually being used more than voice.

APPENDIX B ANALYSIS OF EACH REPORT

The following sheets provide a detailed analysis of each of the study reports identified.

CBA Identification	**IATA_1**
Name	The Economic Case For On-Board Satellite Communications
Document	The Economic Case For On-Board Satellite Communications
Date	January 1993
Author	IATA Market and Economic Analysis Division
Abstract	Cost-benefit appraisal of Aircraft Earth Station (AES) Satcoms, as seen from the airline viewpoint
CBA Description	Cost-benefit appraisal of Aircraft Earth Station (AES) Satcoms, as seen from the airline viewpoint
Catalyst Investigated	Aircraft Earth Station (AES) (on-board) Satcoms providing continuous real time contact capability between the aircraft and ground telecommunications facilities while over remote regions
End-System Application	Data Link & Ground Data Comms Two way, high quality voice and data connection between 3 types of mobile user (pax, cabin crew & cockpit/aircraft) & 3 types of contact (any point on the international phone/data network, ATC & the airline operator)
Safety Criticality/ATC Use	Yes
Technology	Satellite - Satcoms
Geographic Coverage	Link over remote regions
Time Period Covered	1992 to 2006
Cost Categories	
Organisation Incurring Cost	Aircraft Operator
Cost Location	Ground based systems (h/w & s/w required to operate system for airlines & ATC) Antenna, avionics, cabin
Cost Types	installation/approval costs system maintenance costs drag/penalty costs for satcoms equipment cost of space & ground segments for voice, data links achieved via satellite
Benefit Categories	
Organisation Receiving Benefit	Aircraft operator Passenger
Benefit Location	
Benefit Type	Improvements in normal aircraft performance: more optimal routing; reduction in flight times; reduction in fuel burned Dealing with unplanned events: maintenance needs; diversions options, requests & checks; weather conditions; security problems

	Passenger revenues: phone, fax, data, reservations, duty free purchases or office services HF elimination
CBA Context	
Scenarios	none used, although perhaps implicitly long haul operations
Results	
Methodology	2 types of aircraft (350 seat & 250 seat) Sensitivities used: • discount rate; • cost of avionics; • delay in benefits; • no HF elimination savings
CBA Purpose	
CBA Result	The question outstanding on AES Satcoms is no longer 'Whether or not?' but 'When'. The major source of benefits from Satcoms is from its application to produce more flexible long haul routing tied in with FANS developments.
CBA Numeric Results	
Overall Summary	

CBA Identification	**EUROCONTROL_2**
Document	Cost Benefit Analysis Studies for Navigation Development. Initial Studies into RVSM and RLRS
Date	Sept 1995
Author/Organisation	PA Consulting for Eurocontrol,
Abstract	Cost-benefit analysis study into the implementation of Reduced Vertical Separation Minima (RVSM) and into the use of P-RNAV for reduced Lateral route Spacing (RLRS) in the ECAC region.
CBA Description	
Catalyst Investigated	RVSM & RLRS (Navigation Development)
End-System Application	Neither Data Link nor Ground Data Comms required to implement RVSM & RLRS
Safety Criticality/ATC	Yes
Communication Technology	None used
Geographic Coverage	ECAC Region
Time Period Covered	1995 - 2015
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs
Cost Types	initial capital costs operating costs R&D costs
Benefit Categories	
Organisation Receiving Benefit	Aircraft Operator only as ATS Provider incremental costs are fully recovered via route charges
Benefit Location	
Benefit Type	Aircraft Operator - delay reduction; better profiles in upper airspace; improved access to upper airspace ATS Provider - increased capacity not exploited
CBA Context	
Scenarios	low and high cost low and high benefits
Methodology	use of scenarios; NPV; Benefit/Cost Ratio sensitivity analysis on:

	• the effects of the discount rate • ATS Cost recovery obtaining benefits earlier & the cost of avionics included in scenarios
CBA Purpose	
CBA Numeric Results	RVSM High Cost/High Benefit +ve year 2000 RVSM Low Cost/Low Benefit +ve year 2006 RLRS High Cost/High Benefit +ve year 2000 RLRS Low Cost/Low Benefit +ve year 1995
Overall Summary	RVSM & RLRS can be implemented independently of any data link technology. However, the study is a good example of a rigorous Cost Benefit Analysis and can bound the value of better flight profiles.

CBA Identification	**CEC_3**
Document	CEC ATLAS Study Volume 2.5, Interim Report, Feasibility of the Operational Requirement and Representative Operational Philosophies, Annex 4 - Economic Assessment.
Date	18 October 1993
Author/Organisation	PA Consulting Group, London on behalf of the European Commission
Abstract	An economic assessment of the ATLAS Operational Requirement and Representative Operational Philosophies (AAH and CTB).
CBA Description	
Catalyst Investigated	A single unified air traffic management system(SUATMS) for the Community which could meet the needs of the EC through the year 2020 and which is unconstrained by national boundaries within the EC
End-System Application	Data Link & Ground Data Comms assumed
Safety Criticality/ATC	Yes
Communication Technology	Technologies not specified in detail
Geographic Coverage	EC Airspace (which excludes airspace over international waters).
Time Period Covered	1998 -2020
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved)
CBA Context	
Scenarios	repressed growth; traffic increases by between 50% and 200% by 2020 compared to 1990

	sustained growth; 150% to 300% traffic growth; and reinforced growth; 250% to 500% traffic growth
Methodology	use of scenarios sensitivity analysis on: • the effect of growth on efficiency benefits • the cost of avionics • differing number of Area Monitoring Centres • obtaining benefits earlier • the effects of the discount rate order of magnitude checks against other studies
CBA Purpose	
CBA Numeric Results	
Overall Summary	The scope of the change is too large to be able to ascribe costs and benefits to any one technology. It is not a detailed Cost-Benefit Study.

CBA Identification	**EUROCONTROL_4**
Document	"Fuel Savings in Air Transport - Possible Contributions of Air Traffic services in Europe" EUROCONTROL Doc 81 2007
Date	February 1982
Author/Organisation	Rentaux, J. and Schroter EUROCONTROL
Abstract	The purpose of the study was to establish an inventory of actual and possible fuel saving measures**,** and to make recommendations for measures which could be implemented and yield benefits in the near future i.e. 1980/1990.
CBA Description	
Catalyst Investigated	Fuel Savings in Air Transport
End-System Application	Neither Data Link nor Ground Data Comms assumed
Safety Criticality/ATC	Yes
Communication Technology	No technology specified
Geographic Coverage	Western Europe
Time Period Covered	1980 - 1990
Cost Categories	
Organisation Incurring Cost	Costs not addressed
Cost Location	Costs not addressed
Cost Types	Costs not addressed
Benefit Categories	
Organisation Receiving Benefit	Aircraft Operator
Benefit Location	
Benefit Type	Route length Delays Profile restrictions
CBA Context	
Scenarios	No scenarios used
Methodology	Benefits only specified
CBA Purpose	
CBA Numeric Results	10.5 - 12.0% of fuel costs
Overall Summary	Useful for some base information and for bounding improvements in flight profiles

CBA Identification	**RTCA_5**
Document	The Transition to Digital Communications “Urgent Needs, Practical Means
Date	December 1993
Author/Organisation	RTCA Task Force 2
Abstract	The report is the result of the RTCA Task Force 2 which was set up to address the follow up to the report on the Global Navigation Satellite System transition and Implementation strategy. Because advanced data communications will be necessary to fully exploit GNSS capability, RTCA were requested to help develop industry consensus on the operational applications, technology choices, transition strategy, institutional issues, and future development in the area of data link communications.
CBA Description	
Catalyst Investigated	Digital Communications as a means for improved operational efficiency and capacity
End-System Application	Data Link & necessary Ground Data Comms
Safety Criticality/ATC	Yes
Communication Technology	VHF, Satellite, HF
Geographic Coverage	Oceanic (en-route, terminal area, surface studies not performed)
Time Period Covered	1995 - 1999
Cost Categories	
Organisation Incurring Cost	Aircraft Operator
Cost Location	Aircraft Operator communication costs (space segment costs)
Cost Types	initial capital costs not included digital message service costs
Benefit Categories	
Organisation Receiving Benefit	Aircraft Operator
Benefit Location	
Benefit Type	Efficiency - reduction in flight time from ATC; reduction in flight time from AOC; reduction in fuel burn Capacity Safety
CBA Context	
Scenarios	no scenarios used
Methodology	no sensitivity analysis
CBA Purpose	
CBA Numeric Results	

Overall Summary	

CBA Identification	**FAA_6**
Document	Automatic Dependent Surveillance Benefit And Cost Analysis, FAA-RD-90-34
Date	November 1990
Author/Organisation	GJ Couluris, IAT for FAA
Abstract	This study is a benefit and cost analysis of the economic and operational impacts of automatic dependent surveillance (ADS). The ADS function is currently under development and is designed to use satellite communications and advanced air traffic control (ATC) automation to improve air traffic services in oceanic and other airspace. ADS will provide direct communication between pilots and air traffic controllers and enhanced ATC flight monitoring and airspace management capabilities. The study identifies the operational benefits and implementation requirements of ADS and analyses their potential impacts on users and providers of air traffic services. Potential safety benefits are qualitatively assessed. Potential cost savings due to ADS operations are quantitatively estimated as are ADS system implementation costs. The expenditures considered in the analysis include user flight operating costs, air-ground communication user costs, aircraft ADS communication equipage costs, and ATC system enhancement costs. The study examines ADS implementation and potential operational impacts for the North Atlantic and Pacific oceanic areas. The resulting estimated cost savings due to ADS exceed the estimated implementation costs.
CBA Description	
Catalyst Investigated	Automatic Dependent Surveillance program of USA
End-System Application	ADS Data Link Ground Data Comms from satellite ground station to ATCC
Safety Criticality/ATC	Yes
Communication Technology	Satellite
Geographic Coverage	US North Atlantic & Pacific oceanic airspace areas
Time Period Covered	1990 - 2010
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs - ADS aircraft equipage space segment costs transition costs
Cost Types	initial capital costs - purchase operating costs - maintenance
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	

Benefit Type	reduced separation minima improved ATC flexibility
CBA Context	
Scenarios	ADS coverage constraints ATC service constraints
Methodology	use of scenarios & NPV sensitivity analysis on: • the cost of avionics • fuel price
CBA Purpose	
CBA Numeric Results	Net savings of $176.6 million with ADS starting in 1995 with 100% ADS fleet equipage
Overall Summary	

CBA Identification	**ICAO_7**
Document	CNS/ATM Cost-Benefit Analysis Guide
Date	May 1993
Author/Organisation	by THA for Transport Canada
Abstract	The future Air Navigation Systems (FANS) Cost-Benefit Analysis (CBA) Guide documents a method that individual states can follow in order to determine how they would be affected by the implementation of the ICAO CNS/ATM concept..
CBA Description	
Catalyst Investigated	CNS/ATM Cost-Benefit Analysis Guide for FANS Implementation
End-System Application	Data Link & Ground Data Comms implied
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite, gatelink, ATN, all existing sub-networks
Geographic Coverage	n/a
Time Period Covered	a single year 2010
Cost Categories	
Organisation Incurring Cost	ATC Service Provider Aircraft Operator (user)
Cost Location	ground-based costs avionics costs space segment costs intangible costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger Other Industries associated with air transport
Benefit Location	
Benefit Type	cost avoidance to ATC Service Provider cost avoidance to the Aviation Industry

	efficiency improvements to the Aviation Industry efficiency improvements to Passengers
CBA Context	
Scenarios	airspace definition equipment suite configurations equipment analysis demand assumptions & analysis
Methodology	use of scenarios defined above Benefit/Cost ratio for target year only sensitivity analysis on: • efficiency improvement levels • the cost of avionics • traffic forecasts • aircraft numbers
CBA Purpose	
CBA Numeric Results	n/a
Overall Summary	CBA methodology for full implementation does not take into account transition effects i.e. life-cycle analysis. It is a snapshot of costs and benefits for a specific year (2010). The costs and benefits are expressed as Uniform Annual Values without considering transition, indirect and training costs.

CBA Identification	**IATA_8**
Document	A European Planning Strategy For Air Traffic To The Year 2010
Date	March 1990
Author/Organisation	by SRI for IATA
Abstract	The emphasis is on the ECAC region of Western Europe, although key parts encompass the region from Moscow to Iceland to Mediterranean Europe. It identifies plausible alternative demand forecasts and in doing so incorporates an entire range of social and airline issues. It includes airports as well as airway/airspace issues. It recognises the achievements and benefits of the current institutional structure, as well as its failings. It identifies the costs of the initiatives required to meet demand - as well as selected costs of not meeting demand. Finally, it develops an action plan identifying the responsible agencies, the actions required, and the timetable. In the process of achieving the above, this study delivers to IATA a passenger and aircraft movement demand forecasting model and an airway capacity model that IATA can use in subsequent analyses
CBA Description	
Catalyst Investigated	A European Planning Strategy For Air Traffic
End-System Application	Data Link & Ground Data Comms not mentioned
Safety Criticality/ATC	Yes
Communication Technology	Mode S is the only communications technology expressly mentioned
Geographic Coverage	Europe
Time Period Covered	1990 - 2010
Cost Categories	
Organisation Incurring Cost	no differentiation
Cost Location	no differentiation
Cost Types	infrastructure & investments
Benefit Categories	
Organisation Receiving Benefit	no differentiation
Benefit Location	
Benefit Type	losses to the aviation community due to inactivity i.e. potential benefit direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved) indirect benefits (benefits to wider industries associated with air transport) induced benefits (including market growth)
CBA Context	
Scenarios	none specified
Methodology	simple calculation only

	no scenarios no sensitivity analysis
CBA Purpose	
CBA Numeric Results	
Overall Summary	Whilst not a cost benefit study, it provides some useful data and a context for other more detailed studies.

CBA Identification	**CEC_9 & 10**
Document	A Study Of The Comparative Cost Of A Single European Air Traffic Control System, Phase 1 Report
Date	1991 & July 1992
Author/Organisation	by General Technology Systems Ltd for STOA of European Parliament
Abstract	A comparison is made between the present situation and the situation that would exist with an alternative single integrated system of the same capacity. The alternative system is hypothetical and is based on current technology and the operating concepts of the present systems. Potential savings in resources required to implement the single integrated system are shown.
CBA Description	
Catalyst Investigated	Provision of a Single European ATC system
End-System Application	not defined
Safety Criticality/ATC	
Communication Technology	not defined
Geographic Coverage	Europe
Time Period Covered	
Cost Categories	
Organisation Incurring Cost	ATC Provider
Cost Location	ground-based costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	not defined
Benefit Location	
Benefit Type	not defined
CBA Context	
Scenarios	not defined
Methodology	n/a
CBA Purpose	
CBA Numeric Results	
Overall Summary	Only value is in the cost data which is available in the Final Report

CBA Identification	**RTCA_11**
Document	Free Flight Implementation, Final Report
Date	October 1995
Author/Organisation	by RTCA Task Force 3
Abstract	On April 20, 1995 FAA Administrator David R. Hinson asked RTCA to "…form a new task force, led by an appropriate representative from the civilian aviation community, to develop consensus regarding free flight implementation." This report defines the implementation of a concept to move from today's rather rigid and largely procedural, analogue, and ground-based system comprising HF/VHF-voice communications, terrestrial-based navigation systems, radar surveillance, and limited air traffic decision support to that of the future flexible collaborative system by applying today's technologies. These largely space-based technologies are fully embraced by a visionary FAA, and some notable examples have already been incorporated in several aviation applications, forming a precursor to a system virtually space-based, and a new form of Air Traffic Control and Flow Management that will increasingly seamless and truly global,
CBA Description	
Catalyst Investigated	Implementation of Free Flight Concept
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	not defined
Geographic Coverage	not defined
Time Period Covered	1995 - 2001 & beyond
Cost Categories	
Organisation Incurring Cost	not defined
Cost Location	not defined
Cost Types	not defined
Benefit Categories	
Organisation Receiving Benefit	not defined
Benefit Location	
Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved) indirect benefits (benefits to wider industries associated with air transport) induced benefits (including market growth)
CBA Context	
Scenarios	not defined
Methodology	not performed
CBA Purpose	

CBA Numeric Results	
Overall Summary	The report builds on the previous report which does contain some figures. This report concentrates on implementation issues rather than providing a cost-benefit. The concept places data link at the centre of the new system.

CBA Identification	**EUROCONTROL_12**
Document	European En-Route Capacity Cost Study, Task AM01
Date	June 1995
Author/Organisation	by Eurocontrol Experimental Centre
Abstract	The efficiency of en-route Air Traffic Control is generally judged on the basis of sector capacity (flights per hour). Average workload required per flight varies from sector to sector as each en-route sector has its own individual problems. Hence, sector capacity figures represent; the control complexity (depending on traffic pattern, route structure, etc.); the control efficiency (depending on procedures, equipment, motivation etc.). This paper introduces a methodology for comparing en-route sectors in terms of their capacities, capacity favoring and constraining factors and the associated costs.
CBA Description	
Catalyst Investigated	Sector capacity constraints, drivers & costs
End-System Application	n/a
Safety Criticality/ATC	Yes
Communication Technology	n/a
Geographic Coverage	European en-route sectors
Time Period Covered	
Cost Categories	
Organisation Incurring Cost	ATC Provider
Cost Location	ground-based costs
Cost Types	initial capital costs as depreciation operating costs
Benefit Categories	
Organisation Receiving Benefit	not specified
Benefit Location	
Benefit Type	not specified
CBA Context	
Scenarios	not specified
Methodology	not provided
CBA Purpose	
CBA Numeric Results	
Overall Summary	This is not a cost-benefit. However, it provides useful costs and parameters for ATC operations.

CBA Identification	**ICAO_13**
Document	ICAO Special Committee On Future Air Navigation Systems (Phase II) Fourth Meeting, Montreal
Date	October 1993
Author/Organisation	ICAO Special Committee On Future Air Navigation Systems
Abstract	The Tenth Air Navigation Conference and the 29th Session of the Assembly recommended that States undertake cost/benefit analyses in conjunction with implementation of the ICAO CNS/ATM systems and that ICAO provide assistance to States in carrying out these analyses in the form of cost/benefit analysis guidance material. This report contains a CNS/ATM Cost/Benefit Guide which has been updated in response to comments received from the FANS Committee members and further developed in co-operation with the ICAO Secretariat. The guide is based on the methodology contained in the report of FANS/4, where a global cost/benefit analysis for the implementation of satellite-based communication, navigation, and surveillance systems was presented. The guide includes, in its appendices, a set of default values.
CBA Description	
Catalyst Investigated	FANS Cost Benefit Methodology
End-System Application	Data Link Ground Data Comms
Safety Criticality/ATC	
Communication Technology	VHF, Mode S, Satellite, gatelink ATN, all existing sub-networks
Geographic Coverage	
Time Period Covered	
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger

	Other Industries associated with air transport
Benefit Location	
Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved) indirect benefits (benefits to wider industries associated with air transport) induced benefits (including market growth)
CBA Context	
Scenarios	
Methodology	use of scenarios sensitivity analysis on: • the effect of growth on efficiency benefits • the cost of avionics • differing number of Area Monitoring Centres • obtaining benefits earlier • the effects of the discount rate order of magnitude checks against other studies
CBA Purpose	
CBA Numeric Results	
Overall Summary	This methodology is the same as the Guide with Life Cycle Analysis added

CBA Identification	**CEC_14**
Document	Benefit Analysis of a fully developed European ATN (including datalink costs), Phase 5, Draft Report, Contract no. A4B93B2704
Date	30.03.1995
Author/Organisation	Alenia for DG VII - A - 4/C-3
Abstract	
CBA Description	
Catalyst Investigated	A fully developed European ATN
End-System Application	Data Link & Ground Data Comms
Safety Criticality/ATC	Yes
Communication Technology	ATN, all existing sub-networks (VHF, Mode S, Satellite, gatelink)
Geographic Coverage	Europe
Time Period Covered	Snapshot of year unknown
Cost Categories	Note: no values provided
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs - no values provided operating costs (including maintenance) - no values provided ongoing capital costs - no values provided
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved)
CBA Context	
Scenarios	Three scenarios used: • Oceanic (high & low density)

	• Continental & Terminal Areas - high density • Continental - low density
Methodology	use of scenarios no sensitivity analysis performed as no cost data available
CBA Purpose	
CBA Numeric Results	
Overall Summary	This material is noticeably incomplete, in particular the lack of cost data limits value of the study.

CBA Identification	**ICAO_15**
Document	ICAO ATN Panel First Meeting: Cost Benefit Analysis of Aeronautical Telecommunications Network: Transition Issues Information Paper
Date	June 1994
Author/Organisation	ICAO ATN Panel
Abstract	
CBA Description	
Catalyst Investigated	
End-System Application	Data Link Ground Data Comms
Safety Criticality/ATC	
Communication Technology	VHF, Mode S, Satellite, gatelink ATN, all existing sub-networks
Geographic Coverage	
Time Period Covered	
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger Other Industries associated with air transport
Benefit Location	

Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved) indirect benefits (benefits to wider industries associated with air transport) induced benefits (including market growth)
CBA Context	
Scenarios	repressed growth; traffic increases by between 50% and 200% by 2020 compared to 1990 sustained growth; 150% to 300% traffic growth; and reinforced growth; 250% to 500% traffic growth
Methodology	use of scenarios sensitivity analysis on: the effect of growth on efficiency benefits the cost of avionics differing number of Area Monitoring Centres obtaining benefits earlier the effects of the discount rate order of magnitude checks against other studies
CBA Purpose	
CBA Numeric Results	
Overall Summary	

CBA Identification	**FAA_16**
Document	The Aeronautical Data Link System Operational Concept
Date	June 1994
Author/Organisation	by FAA
Abstract	This paper presents an operational concept for the Aeronautical Data Link System (ADLS). Its purpose is to describe the philosophy and goals for use of the system, the services to be provided, and the user capabilities needed to manage the exchange of information. A key focus is on explaining and examining benefits that can be achieved when the ADLS is placed in the service of the evolving National Airspace System (NAS) operational capabilities.
CBA Description	
Catalyst Investigated	Aeronautical Data Link
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite, gatelink ATN, all existing sub-networks
Geographic Coverage	USA (FAA domain) Airport, Terminal, En-route, Oceanic/Remote
Time Period Covered	1994 - 2000 & beyond
Cost Categories	
Organisation Incurring Cost	not addressed
Cost Location	not addressed
Cost Types	not addressed
Benefit Categories	
Organisation Receiving Benefit	ATC Provider - controller Aircraft Operator - pilot & flight planner
Benefit Location	
Benefit Type	technical benefits only
CBA Context	
Scenarios	not defined other than for different types of airspace
Methodology	no cost benefit performed
CBA Purpose	
CBA Numeric Results	
Overall Summary	Describes a transition plan and all the benefits but ignores all quantification of costs and benefits. It concentrates on the technical benefits available in the different types of airspace and at different transition

	periods.

CBA Identification	**DEUTSCHE AEROSPACE_17**
Document	Assessment of the potential of satellite navigation systems and the European dimension of their utilisation, Notes on the Workshop in Brussels
Date	May 1993
Author/Organisation	by Deutsche Aerospace AG
Abstract	The study work on the "Assessment of the potential of satellite navigation systems and the European dimension of their utilisation" commenced in January 1993. The first phase of the study was very much centred around the collection of data and opinions from experts in various areas. This interim report summarises the findings in the first phase and gives an outlook to the further work and intended contents of the final report.
CBA Description	
Catalyst Investigated	Assessing the situation with regards to SATNAV applications in Europe.
End-System Application	Data Link & Ground Data Comms
Safety Criticality/ATC	Yes
Communication Technology	Satellite (SATNAV)
Geographic Coverage	Europe
Time Period Covered	1993-
Cost Categories	
Organisation Incurring Cost	Aircraft Operator
Cost Location	avionics costs space segment costs
Cost Types	initial capital costs
Benefit Categories	
Organisation Receiving Benefit	Aircraft Operator Other Industries associated with air transport
Benefit Location	
Benefit Type	not quantified
CBA Context	
Scenarios	not applicable
Methodology	not applicable
CBA Purpose	
CBA Numeric Results	
Overall Summary	Although this document touches on the economic value of SATNAV this is superficial as its purpose is to describe the general situation with regards to SATNAV in Europe for all forms of transport.

CBA Identification	**IATA_18**
Document	IATA, Cost Benefit Analysis Methodology
Date	October, 1993
Author/Organisation	by SH&E
Abstract	
Overall Summary	***considered peripheral, not acquired****

CBA Identification	**FAA_19**
Document	"Economic Values for Evaluation of Federal Aviation Investment and Regulatory Programs", Doc. No. FAA-APO-89-10
Date	October 1989
Author/Organisation	FAA - Office of Aviation Policy and Plans
Abstract	
Overall Summary	***considered peripheral, not acquired****

CBA Identification	**ICAO_20**
Document	FANS: Cost-Benefit Analysis for the Establishment of the Future CNS Systems in Canada, ICAO Tenth Air Navigation Conference, Montreal
Date	September 1991
Author/Organisation	prepared by THA for Transport Canada
Abstract	The purpose of this document is to conduct an overview of the costs and benefits of implementing the FANS concept in Canada for presentation to the Air Navigation Conference in Montreal in September, 1991. The figures presented should be taken to be order of magnitude approximations.
CBA Description	
Catalyst Investigated	Implementation of FANS concept in Canada
End-System Application	Data Link Ground Data Comms
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite, HF
Geographic Coverage	Canadian airspace (Polar, Northern, Southern & Oceanic)
Time Period Covered	2010
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ATC Provider ground-based costs (CNS) Aircraft Operator avionics costs (CNS) ATC Provider space segment costs (CNS)
Cost Types	capital costs operating costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger
Benefit Location	
Benefit Type	ATC Provider avoided costs (capital & operating costs, C, N, S) Aircraft Operator avoided costs (capital & operating costs, C, N, S) Aircraft Operator efficiency improvements (Communications improvements for company operations, Navigation improvements, Passenger time savings)

	Aircraft Operator safety improvements	
CBA Context		
Scenarios		
Methodology	single year comparison (i.e. 2010) costs & benefits expressed as incremental uniform annual values (UAV) sensitivity analysis on: • the effect of growth on efficiency benefits • the cost of avionics • aircraft numbers • GES service provider leases	
CBA Purpose		
CBA Numeric Results	Costs: (millions of 1991 US $) Transport Canada Industry Total: Benefits: Transport Canada Industry Passengers Total	 130.04 98.67 228.71 99.70 363.71 61.99 525.47
Overall Summary	This is an early FANS CBA. It produces a single benefit cost ratio for 2010. It does not used discounted life cycle values.	

CBA Identification	**FAA_21**
Document	Advanced Air Transportation Technologies (AATT) Potential Benefits Analysis. Also NASA-Ames Report AATT-95-001
Date	September 1995
Author/Organisation	Couluris, G.J. and S. Dorsky, Seagull Technology, Inc. Cupertino, CA
Abstract	
Overall Summary	******* awaiting library **********

CBA Identification	**MITRE_22**
Document	Putting Bounds on Free Flight's Benefits, Briefing
Date	15 August 1995
Author/Organisation	Lacher, A.R., The MITRE Corporation, McLean, Virginia
Abstract	** value regarded peripheral - not pursued at present time ***

CBA Identification	**BOEING_23**
Document	Proposed Free Flight Cost Benefit Method
Date	August 1995
Author/Organisation	Lawler, R., Boeing Commercial Airplane Group, Seattle, Washington
Abstract	The RTCA Task Force 3 on Free Flight Implementation stressed that economic benefits must drive the transition to free flight. Economic analysis is expected to guide the choice of the specific changes that produce the greatest value. It provides a common basis to dispassionately assess what produces tangible value and what doesn't. This is a preliminary definition of a Free Flight Economic Model.
CBA Description	
Catalyst Investigated	Implementation of Free Flight
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	not defined
Geographic Coverage	Domestic United States (coverage is not clear)
Time Period Covered	1995 - 2001 & beyond
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger
Benefit Location	
Benefit Type	perfect free flight time & fuel savings converted to value of: • block time (passenger value of time) • utilisation

	• range • payload • schedule surplus value of equipment & property					
CBA Context						
Scenarios	3 scenarios are used - each of the 65 input parameters has a low, nominal and high estimate that represent the 0.1, 0.5 & 0.9 probability points respectively.					
Methodology	use of scenarios					
CBA Purpose						
CBA Numeric Results	Free Flight Development Phase Near Term Mid Term Long Term	Nominal Annual Value $0.2 billion $0.8 billion $3.3 billion	Expected Net Present Value $2.0 billion $7.3 billion $18.4 billion	Low Value (10% NPV probability) $0.2 billion $2.4 billion $4.8 billion	High Value (90% NPV probability) $3.9 billion $12.0 billion $30.0 billion	Nominal Return on Investment 42.4 15.2 11.1
Overall Summary	The overall model was not completed, however, preliminary results look promising. Unfortunately the model is not fully documented.					

CBA Identification	**FAA_24**
Document	Cost -Benefit Analysis of Oceanic Automation, Satellite Communications, Navigation & Surveillance, Draft Working Paper.
Date	October 1993
Author/Organisation	Operations Research Service (AOR-100), FAA
Abstract	
Overall Summary	*** awaiting EUROCONTROL Library to acquire ****

CBA Identification	**PLANUNGSBURO_25**
Document	"The Crisis in Europe's Air Traffic Control System: An Assessment of its Economic Costs, (Background study to the report The Crisis of European Air Traffic Control: Cost and Solutions of the Planungsbüro Luftraumnützer 1989)"
Date	July 1989
Author/Organisation	Muller, J. et al of the Planungsbüro Luftraumnützer
Abstract	
Overall Summary	*** regarded as peripheral - not pursued **********

CBA Identification	**ARINC_26**
Document	Cost-Benefit Analysis of Reduced Vertical Separation Minimum Implementation in North Atlantic Minimum Navigation Performance Specifications Airspace, 08351-01-91-SD-ANN-0059, Final Report
Date	August 1991
Author/Organisation	ARINC Research Corporation
Abstract	
Overall Summary	** awaiting EUROCONTROL Library to acquire ****

CBA Identification	**MITRE_27**
Document	The Advanced Automation System: A Benefit/Cost and Risk Analysis, volume 1 - Approach and Methodology
Date	January 1988
Author/Organisation	MITRE
Abstract	
Overall Summary	*** regarded as peripheral/out of date - not pursued **********

CBA Identification	**CAA_28**
Document	A record of work undertaken to assess the benefits of delivering oceanic clearances by data link
Date	1992
Author/Organisation	by Boydell GB, CAA
Abstract	
Overall Summary	*** not pursued at present ***

CBA Identification	**ICAO_29**
Document	Economics of satellite based air navigation services: guidelines for cost/benefit analysis of communications, navigation & surveillance/air traffic management (CNS/ATM) systems. ICAO-CIRC-257
Date	1995
Author/Organisation	ICAO
Abstract	
Overall Summary	*** to be acquired ****

CBA Identification	**CAA_30**
Document	Information sources for use in cost benefit analyses, DORA-COMM-9201.
Date	1992
Author/Organisation	by Latif T, UK CAA
Abstract	Provides details of the main information sources available to Chief Scientist Division for use in carrying out cost benefit analyses. Contents A, DORA reports relating to cost benefit analyses; B, CAA publications available in the Central Library; C, External publications available in the Central Library - UK Statistical Publications, International Statistical Publications, US Statistical Publications, FAA Air Traffic Activity; D, Database sources - D Plans En-route oceanic statistics, Airport Statistics, UK airline statistics, passenger allocation model, route charging model, cost database.
Overall Summary	*** not pursued at the present *****

CBA Identification	**CAA_31 (RESTRICTED - MANAGEMENT)**
Document	Current R/T communications and the potential for replacing them with datalink, OS-R-9457 -
Date	1994
Author/Organisation	by JE Sonander, UK CAA
Abstract	This document gives an overview of current UK ATC Radio Telephony (R/T) communications. It collates information from a number of sources providing details on the work performed by controllers and assistants at each CAA Air Traffic Control (ATC) Centre as well as estimates of workload at future centres such as NERC. The potential benefits of replacing a number of existing R/T communications with datalink are considered and possible methods for estimating these benefits are discussed.
CBA Description	
Catalyst Investigated	The potential benefits to Controller's workload of replacing a number of existing R/T communications with datalink.
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	Datalink technology not defined.
Geographic Coverage	UK (ground movement, TMA, en-route & oceanic)
Time Period Covered	1992
Cost Categories	
Organisation Incurring Cost	ATC Provider
Cost Location	ground-based costs - specifically Controller workload
Cost Types	operating costs - specifically Controller workload
Benefit Categories	
Organisation Receiving Benefit	ATC Provider
Benefit Location	
Benefit Type	direct benefits to controllers of reduced R/T communications
CBA Context	
Scenarios	not appropriate
Methodology	not a CBA study
CBA Purpose	not appropriate
CBA Numeric Results	not appropriate
Overall Summary	The study provides useful quantified figures for the R/T communications workload. It analyses this workload to define those messages most appropriate to datalink.

CBA Identification	**CAA_32 (RESTRICTED - MANAGEMENT)**
Document	An assessment of datalink technologies to support air traffic control applications in the North Atlantic, RD-R-9612
Date	1996
Author/Organisation	by IS Forsyth, NATS
Abstract	The development of air traffic control services in the North Atlantic will require provision of data links via satellite to support position reporting and communications between pilots and controllers. The report reviews the requirements for datalinks and undertakes a technical and cost assessment of FANS-1 and ATN, the two technologies proposed to support datalink services.
CBA Description	
Catalyst Investigated	Datalink support to ATC in North Atlantic
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	FANS - 1 & FANS - A (adaptation of ACARS, ATN (OSI)
Geographic Coverage	North Atlantic
Time Period Covered	
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	benefits described in the requirements for aircraft datalink communications, however, these are not quantified
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	increase in the chance of aircraft getting an optimal clearance through reductions in separation minima improvements in efficiency and safety of air traffic management reduction in voice radio channel congestion

CBA Context	
Scenarios	not provided
Methodology	not provided
CBA Purpose	not provided
CBA Numeric Results	not provided
Overall Summary	The study recommends that a cost model should be created. FANS-1 displays significant weaknesses when compared with the ATN. However, the ATN is due for implementation later. A strategy is required using the model as a basis for aiding the economic decision making.

CBA Identification	**CAA_33 (RESTRICTED - MANAGEMENT)**
Document	An initial assessment of possible ATC datalink technologies and their relative costs, RD-R-9626
Date	1996
Author/Organisation	by Latif T, NATS
Abstract	A status report on the use of datalinks for Air Traffic Management (ATM) in the UK: the need for domestic applications such as Mode S, VHF and satellite communications are discussed. NATS development of datalink services are reviewed and recommendations for future actions are made.
CBA Description	
Catalyst Investigated	ATC Datalink technologies
End-System Application	Data Link
Safety Criticality/ATC	Yes (pre-departure clearances, STAR & Oceanic clearance messages only)
Communication Technology	VHF, Mode S, Satellite, HF datalink
Geographic Coverage	Aircraft using Heathrow, Gatwick, Stansted & Shanwick
Time Period Covered	2000 - 2009
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs
Benefit Categories	Mentioned but not quantified
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	direct benefits to operators and passengers (including benefits arising from increased utilisation and operational efficiency and passenger time saved)
CBA Context	
Scenarios	not performed
Methodology	not performed

CBA Purpose	
CBA Numeric Results	not performed
Overall Summary	This is not a CBA. The costs are examined in detail and well documented. The benefits need to be assessed and a proper economic analysis performed.

CBA Identification	**EUROCONTROL_34**
Document	Classic Radionav and GNSS in Europe: Part 1, Progress Report 2, Appendices and Final Report
Date	1994
Author/Organisation	for EUROCONTROL by The European Aerospace Consultancy
Abstract	The aim of this study is to examine the costs of implementing a GNSS in Europe. All candidate technologies to augment the existing GPS/GLONASS will be considered. The cost implications of moving directly to a GNSS II, with Europe taking the initiative to launch a number of additional geostationary satellites will be examined.
CBA Description	
Catalyst Investigated	GNSS in Europe
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite
Geographic Coverage	Europe (all ECAC countries)
Time Period Covered	1996 - 2006
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	not addressed
Benefit Location	
Benefit Type	not addressed
CBA Context	
Scenarios	Four scenarios considered: • Total GNSS1 system, as envisaged by EUROCONTROL, the European Commission & ESA

	• Wide Area Differential excluded from system • Gradual move to GNS II • Maintain classic en-route system and install MLS for precision approach
Methodology	use of scenarios
CBA Purpose	
CBA Numeric Results	
Overall Summary	The results are not documented in the copies of the progress reports reviewed.

CBA Identification	**EUROCONTROL_35**
Document	Summary of Arguments for and against Procuring a Low Cost ADS/AES
Date	26 Jan 1994
Author/Organisation	NJ Clark, EUROCONTROL, DED1
Abstract	This paper re-states EUROCONTROL's objectives for the Low Cost ADS Study and reviews the arguments and points raised at the 6th meeting of the SAT/ADS working group in November. It reviews the advantages to be gained from the Study and summarises the known limitations. It concludes that the Study is a necessary preliminary to evaluating Satcom-ADS field trials.
CBA Description	
Catalyst Investigated	Low cost ADS/AES
End-System Application	Data Link
Safety Criticality/ATC	Yes - ADS
Communication Technology	Satellite
Geographic Coverage	not defined
Time Period Covered	not defined
Cost Categories	
Organisation Incurring Cost	Aircraft Operator
Cost Location	avionics costs
Cost Types	initial capital costs
Benefit Categories	not quantified
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	
CBA Context	
Scenarios	
Methodology	
CBA Purpose	
CBA Numeric Results	
Overall Summary	This is feasibility study and does not quantify the benefits of a low cost ADS/AES. Information of limited value to a full datalink CBA.

CBA Identification	**HONEYWELL_36**
Document	Bringing FANS into Perspective: A Manufacturer's Viewpoint
Date	presentation at ATC '94
Author/Organisation	by DC Purdy, Honeywell
Abstract	
Overall Summary	*** considered peripheral, not acquired ******

CBA Identification	**EUROCONTROL_37**
Document	Outline Specification for a Cost/Benefit Study of ATC ADS in Europe
Date	at SATCOM - ADS Sub-Group/Meeting No7/15-16.3.94/DP71
Author/Organisation	by EUROCONTROL
Abstract	This paper outlines those issues that need to be considered when undertaking a cost benefit assessment of an ADS-Based ATC service for Europe.
CBA Description	
Catalyst Investigated	Outline Specification for a Cost/Benefit Study of ATC ADS in Europe
End-System Application	Data Link
Safety Criticality/ATC	Yes
Communication Technology	Satellite
Geographic Coverage	Europe - precise definition to be given later
Time Period Covered	1997 - 2012
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	use IATA categories
CBA Context	
Scenarios	Airspace classes: • high/low density traffic

	• continental, oceanic • en-route, TMA Technical scenarios: • baseline - CMU plus 2 Mode S transponders • option1a - baseline but low cost ADS system replacing 1 Mode S transponder, plus ATN • option 1b: - baseline plus low cost ADS plus ATN • option 2 - baseline plus full specification Satcom system, GPS & ATN
Methodology	use of scenarios sensitivity analysis on many factors
CBA Purpose	
CBA Numeric Results	
Overall Summary	This outline specification is useful in defining the issues that need to be considered when undertaking a cost benefit analysis.

CBA Identification	**EUROCONTROL_38**
Document	Summary of Eurocontrol Agency Activities in the Field of Satellite Navigation, SNA/DP/007
Date	26/4/1994
Author/Organisation	Satellite Navigation Applications Sub-Group
Abstract	
Overall Summary	*** not reviewed ****

CBA Identification	**CANADA_39**
Document	FANS Benefit Cost Analysis
Date	July 19, 1991
Author/Organisation	prepared by THA for Transport Canada
Abstract	
Overall Summary	See ICAO_20

CBA Identification	**CANADA_40**
Document	Future Air Navigation System Cost-Benefit Analysis Guide
Date	Oct 16, 1992
Author/Organisation	prepared by THA for Transport Canada
Abstract	The Future Air Navigation Systems (FANS) Cost-Benefit Analysis (CBA) Guide documents a method that individual states can follow in order to determine how they would be affected by the implementation of the International Civil Aviation Organisation (ICAO) FANS concept.
CBA Description	
Catalyst Investigated	Implementation of FANS concept
End-System Application	Data Link Ground Data Comms
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite, HF
Geographic Coverage	to be defined
Time Period Covered	2010
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ATC Provider ground-based costs (CNS) Aircraft Operator avionics costs (CNS) ATC Provider space segment costs (CNS)
Cost Types	capital costs operating costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator Passenger
Benefit Location	
Benefit Type	ATC Provider avoided costs (capital & operating costs, C, N, S) Aircraft Operator avoided costs (capital & operating costs, C, N, S) Aircraft Operator efficiency improvements (Communications improvements for company operations, Navigation improvements, Passenger time savings)

	Aircraft Operator safety improvements
CBA Context	
Scenarios	
Methodology	single year comparison (i.e. 2010) costs & benefits expressed as incremental uniform annual values (UAV) sensitivity analysis on: • the effect of growth on efficiency benefits • the cost of avionics • aircraft numbers • GES service provider leases
CBA Purpose	
CBA Numeric Results	to be defined
Overall Summary	This is an early FANS CBA Guide. It produces a single benefit cost ratio for 2010. It does not used discounted life cycle values.

CBA Identification	**UKCAA_42**
Document	Automatic Dependent Surveillance Cost Analysis, Final report, Issue 1.1, Doc ref C27725.01.102
Date	15 April 1991
Author/Organisation	by SD-SCICON for UKCAA
Abstract	This report presents an analysis of the costs of the ADS system. The various ground, satellite and aircraft components are described to form a basis for the assessment of costs.
CBA Description	
Catalyst Investigated	Cost of ADS
End-System Application	Data Link & Ground Data Comms, voice links remain for non ADS communications
Safety Criticality/ATC	ADS only
Communication Technology	SATCOM
Geographic Coverage	North Atlantic (NAT) Oceanic Routes (Minimum Navigation Performance Specification airspace only)
Time Period Covered	1991 - 2010
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs (NAT ADS Provider Costs) avionics costs space segment costs (air-ground communication charges) transition costs included - HF continues
Cost Types	initial capital costs (R&D, capital equipment investment) operating costs (operations, maintenance) ongoing capital costs
Benefit Categories	No benefits (efficiency, etc) are assessed
Organisation Receiving Benefit	ATC Provider - some cost avoidance
Benefit Location	
Benefit Type	Cost avoidance only
CBA Context	
Scenarios	Three traffic scenarios used: • baseline • high traffic

<table>
<tr><td></td><td>
low traffic
Two equipment fit scenarios used:
low cost ADS implementation
high cost ADS implementation
</td></tr>
<tr><td>Methodology</td><td>
use of scenarios above
Costs discounted to current day @ 8%
sensitivity analysis on:
air-ground communications user charges
traffic forecast growth
the cost of avionics
equipage rate
implementation schedule
the effects of the discount rate
continuation of existing HF services
</td></tr>
<tr><td>CBA Purpose</td><td></td></tr>
<tr><td>CBA Numeric Results in 1991 $million</td><td>
<table>
<tr><td>Scenario</td><td>NAT ATC</td><td>Avionics</td><td>A/G Comms</td><td>Total PV</td></tr>
<tr><td>Low</td><td>-37.96</td><td>519.20</td><td>-121.60</td><td>359.64</td></tr>
<tr><td>Baseline</td><td>-14.04</td><td>734.20</td><td>-108.40</td><td>611.76</td></tr>
<tr><td>High</td><td>43.53</td><td>892.80</td><td>-72.70</td><td>863.63</td></tr>
</table>
</td></tr>
<tr><td>Overall Summary</td><td>The study is a cost analysis only and does not address benefits other than cost avoidance. The cost of the ATN Air Router is not included, however, this equipment is only necessary for the ADS implementation. The costs are clearly defined.</td></tr>
</table>

CBA Identification	**IACO_44**
Document	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Argentina
Date	1991
Author/Organisation	WP/45 FANS (II)/2, Montreal
Abstract	The paper presents a cost/benefit analysis for the installation in Argentina of the CNS systems in accordance with the FANS concept. Certain parameters are identified as requiring more refined study since they carry the most weight in the final balance. Guidelines are provided concerning the issues which the service provider must consider most carefully in order to obtain the best possible cost/benefit ratio when the transition is concluded.
CBA Description	
Catalyst Investigated	FANS concept implementation in Argentina
End-System Application	Data Link assumed but not stated
Safety Criticality/ATC	Yes
Communication Technology	Satellite, other technologies not stated
Geographic Coverage	Argentina
Time Period Covered	2010
Cost Categories	
Organisation Incurring Cost	ATC Provider Aircraft Operator
Cost Location	ground-based costs avionics costs space segment costs transition costs
Cost Types	initial capital costs operating costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider Aircraft Operator
Benefit Location	
Benefit Type	avoided costs efficiency improvements safety improvements
CBA Context	

Scenarios		
Methodology	no use of scenarios sensitivity analysis not performed	
CBA Purpose		
CBA Numeric Results	Costs: (millions of 1991 US $) per year CAA Industry Total: Benefits: CAA Industry Total	 12.40 20.37 32.77 4.00 72.90 76.90
Overall Summary	This is an early FANS CBA. It produces a single benefit cost ratio for 2010. It does not used discounted life cycle values.	

CBA Identification	**ICAO_45**
Document	Cost/Benefit Analysis for the establishment of the Future CNS Systems in Canada
Date	1991
Author/Organisation	WP/52 ICAO 10 ANC, Montreal
Abstract	
Overall Summary	See ICAO_20

CBA Identification	**FAA_46**
Document	User Benefits of Two-way Data Link ATC Communications: Aircraft Delay and Flight Efficiency in Congested En Route Airspace, Data Link Benefits Study Team, Final report, DOT/FAA/CT-95/4
Date	February 1995
Author/Organisation	DOT/FAA
Abstract	
Overall Summary	**** awaiting EUROCONTROL Library to acquire report *****

CBA Identification	**ICAO-47**
Document	FANS CBA for Australia, China, India, Germany & New Zealand
Date	
Author/Organisation	
Abstract	
Overall Summary	*** reports not pursued at present ***

CBA Identification	**AEGIS_48**
Document	AEGIS Work Package 8 Results (Cost benefit Analysis)
Date	October 1994
Author/Organisation	
Abstract	
CBA Description	
Catalyst Investigated	Economic feasibility of the GIANTS scenario
End-System Application	Data Link & Ground Data Comms assumed
Safety Criticality/ATC	Yes
Communication Technology	VHF, Mode S, Satellite, gatelink, ATN, all existing sub-networks not specifically specified
Geographic Coverage	Europe region
Time Period Covered	2000 -2014
Cost Categories	
Organisation Incurring Cost	Aircraft Operator only (assumed that ATM costs will be borne by airlines)
Cost Location	ground-based costs expressed as a differential ATM service cost to airlines (includes R&D costs) avionics costs including initial spare parts, modification of maintenance facilities & crew training facilities, and modification of aircraft wiring space segment costs (datalink) transition costs
Cost Types	initial capital costs (non-recurring) differential operating costs (personnel, fuel, aircraft amortisation & aircraft maintenance) ongoing capital costs
Benefit Categories	
Organisation Receiving Benefit	ATC Provider through productivity Aircraft Operator Passenger Other Industries associated with air transport
Benefit Location	
Benefit Type	differential income to airlines generated by implementation of GIANTS scenario
CBA Context	
Scenarios	

Methodology	use of NPV sensitivity analysis on: • average traffic demand • capacity increase brought about by GIANTS • the cost of avionics • differing number of operational staff persons per controller working position • delay in the GIANTS transition time scale
CBA Purpose	
CBA Numeric Results	NPV + -19,885 MECU
Overall Summary	It is a useful attempt at an overall CBA of the GIANTS scenario. The figures are credible for bounding other studies. The NPV is a little crude (it is not evident whether the figures are discounted and time periods seem to be split into 3 i.e. up to 2005, 2005 -2010, and beyond 2010.