

**Roadmap for the
implementation of data link
services in European Air Traffic
Management (ATM):
Phase 2: Public Consultation**

Date: 28 February 2003

Document information

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Document Control

The following table records the complete history of the successive editions of the present document.

EDITION	DATE	REASONS FOR CHANGE	SECTIONS AFFECTED
0.A	26 February 2003	Initial draft for comment	All
1.0	28 February 2003	FINAL VERSION	All

Executive Summary

This document has been produced during Phase 2 of a study for the European Commission to develop a roadmap for the implementation of data link services supporting air traffic management (ATM) applications in Europe. The work has been carried out under contract B2001/B2 – 7020B/S12.330694.

The following additional documents were produced during the study:

- “Executive Summary”, P167D017, version 1.0, 28th February 2003. This document contains an executive summary of the findings of the study.
- “Datalink Roadmap”, P167D2010, version 3.0, 28th February 2003. This document contains a full summary of the project including potential datalink roadmaps and community actions.
- “Application Assessment”, P167D1030 version 2.0, 30th October 2002. This document presents the results of Phase 1 which focussed on the identification, characterisation and selection of ATM applications. The document establishes initial timescales for each of the ATM applications and records stakeholder comments on the work carried out in Phase 1.
- “Non-ATS applications”, P167D1050 version 1.0, 28th February 2003. This document presents the results of a summary of requirements for non-ATS applications.
- “Technology Assessment”, P167D2020 version 5.0, 28th February 2003.. This document provides a detailed assessment of candidate datalink technologies. The document is subdivided as follows:
 - The main body of the report summarises the technology assessment, scenario analysis and technology selection.
 - The annexes of the report describe each of the technologies considered in the study as well as the overall network architecture and cost assessment.
- “References”, P167D3030 version 3.0, 28th February 2003. This sets out the references used in the study.

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1 Introduction

1.1 Purpose of this document

- 1.1.1 This document has been produced during Phase 2 of a study for the European Commission to develop a roadmap for the implementation of data link services supporting air traffic management (ATM) applications in Europe. The work has been carried out under contract B2001/B2 – 7020B/S12.330694.
- 1.1.2 This study is an independent assessment of different candidate data link technologies with the aim of proposing the most suitable data link(s) in support of the European decision-making process. To achieve this, Phase 1 of the study established a tentative list of ATM applications particularly suited for enhancing safety and capacity. These ATM applications are based on the definition of medium and long-term objectives in air traffic management.
- 1.1.3 The list of ATM applications identified during Phase 1 of the study was reviewed extensively by Stakeholders and agreement was reached as to the priority and timescales for each ATM application.
- 1.1.4 Phase 2 of the study has focussed on the assessment of candidate data link technologies taking account of factors such as the ability to meet the technical requirements of the ATM applications, maturity and cost. The results of the detailed technology assessment are contained in document P167D2020. These results were used to make a selection of suitable data link technologies to achieve the objectives of the ATM applications, to place the implementation of the technologies on a roadmap and to identify actions and Community measures necessary to support the successful implementation of the roadmap.
- 1.1.5 A public consultation process was held between December 2002 and February 2003, culminating in the second stakeholder workshop held on the 21st February 2003.
- 1.1.6 This document details proceedings of the second stakeholder workshop and the comments received during the public consultation process.

1.2 Contents of the document

- 1.2.1 The output of Phase 2 of the study was made available for public consultation on 16 December 2002. Comments were received during the period up to 21 February (the date of the second Stakeholder Workshop). The comments received were added to a database. Further comments were received after the second Stakeholder workshop. These were also added to the database. A copy of all comments received is contained in Annex A of this report¹. The Annex also contains the response of the study team to the comment. Note that comments up to comment number 506 were received before the workshop.

¹ Annex A is distributed as a separate excel file. Note also that red-line comments on an earlier version of P167D2010, provided by Airbus, are also provided as part of Annex A.

1.2.2 The second stakeholder workshop was held on 21 February. The main body of this report contains the notes of that meeting. The format used to guide the discussion was as follows:

- the study team presented “what the study said”;
- the study team then presented “comments from stakeholders” drawing on representative comments from the comments database;
- “topics for discussion” were then proposed by the study team;
- the discussion was then opened to the attendees of the workshop
- finally future actions were agreed.

1.2.3 The structure of this document follows the same format. There is one main section for each of the four agenda items:

- Link performance (Section 3)
- Co-site and spectrum issues (Section 4)
- Technology availability/maturity (Section 5)
- Future data link technologies (Section 6)

1.2.4 Within each of these sections, the sub-sections “what the study said”, “comments from stakeholders” and “topics for discussion” are verbatim copies of the presentation slides. The “comments made at workshop” represent the notes of the discussions, transcribing the statements of each attendee. The “actions” section is self-explanatory.

1.2.5 Two further sections have been added:

- section 2 to record initial comments made by attendees.
- section 7 to record final comments made by attendees.

1.3 Participants in the second public consultation and attendees at Second Stakeholder Workshop

1.3.1 The following table lists the attendees at the workshop.

	Name	E-Mail	Organisation	Position
1	Peter Potocki	Peter.POTOCKI@airbus.com	AIRBUS	Director, Air Traffic Systems
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1.3.2 The following table lists those who registered for the workshop but who were unfortunately unable to attend on the day.

	Name	E-Mail	Organisation	Position
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2 Introduction to Second Stakeholder Workshop

2.1 Study team

- The core team consisted of: Airbus, Helios Technology (lead), IATA, Integra and Sofreavia.
- Other partners: AENA, IAA, LFV/Swedavia, Mitre, NATS and University of Leiden.
- Eurocontrol provided review input and expert assistance.
- A Peer Review Group reviewed of deliverables and participated in stakeholder workshop.

2.2 Workshop objectives

- Validation of facts and conclusions related to technologies
 - expectation is that not all facts and conclusions will be verifiable at this stage
- Derivation of options for future action
 - aim is to determine how and when open issues can be resolved

2.3 Approach for workshop

- The workshop will review four key areas
 - Link performance
 - Co-site and spectrum issues
 - Technology availability/maturity
 - Future data link technologies
- Structure of discussions
 - what we said – what we concluded in the technical assessment and why
 - responses from stakeholders – what we have been told since presenting the documents
 - discussion – opportunity for stakeholders to give further details on their input
 - summary – we will attempt to summarise the consensus
 - way forward – working with the meeting participants, we will define the actions necessary to resolve the open issues

2.4 Agenda

- 10:00 Introduction
- 10:15 Link Performance
- 11:45 Co-site and onboard issues, and spectrum allocation
- 13:00 Lunch
- 14:00 Technology availability/maturity
- 15:30 Future data link technologies
- 16:45 Conclusions and next steps

2.5 Way ahead after workshop

- Workshop focuses on four key issue areas
 - other comments will be taken account of in revised study documentation
- Revise executive summary
 - incorporating key comments from stakeholders
 - where there is consensus – this will be indicated
 - where there is incomplete consensus – this will also be indicated
- Publish a collated set of comments on the whole documents set
 - Where points raised are of technical detail – we will incorporate the comments and re-issue documents
- Commission will use results of roadmap study to carry out an analysis for further action; this will be presented to the industry consultation process envisaged by the Single Sky legislation

2.6 Topics reminder

- Link performance
- Co-site and onboard issues, and spectrum allocation
- Technology availability/maturity
- Future data link technologies

3 Opening remarks from Workshop attendees

Who	Comment
Philippe Renaud (Eurocontrol)	<p>From Eurocontrol perspective – what is needed is first to provide stability of implementation from each step before moving forward to the next. Jumping from step to another should be dictated by aviation needs and not by needs of technology</p> <p>No system is perfect – every system has limitations</p> <p>It is important is to focus on an agreed first step. After that, continue to progress the issues identified for medium step (2010 – 2015).</p> <p>After that we need a new technology to provide high capacity after 2015</p> <p>Expectations 1) implement what has been decided 2) for medium term, progress issues, but do not take decisions until issues are clearly understood and resolved 3) undertake R&D for long term solution</p>
Ernst Hauf (IAOPA)	<p>Cannot leave these issue unreflected from user point of view. From study output, identified a lot of weaknesses and gaps and we should accept the issue that the data link issue is fundamental from the point of view of users, particularly GA. Note that the GA community consists of 400,000 aircraft ad 200 airports worldwide. Accepts that focus of study has been airlines and few airports.</p> <p>There are available technologies, spectrum and standards. These should be used as the basis for the next 10 years. Main objective is to support the right choice.</p>
Nicolas Zvegintzoff (IATA)	<p>Also puts high expectations on this study. The nightmare is to cope with the demand. Very nervous about 2012. The demand will bounce back, and we have to cope to enable the industry to grow. What after RVSM will increase capacity?</p> <p>We do not want to see a bad (early) decision made. We would like to know for each technology if it can cope with the applications with the number of aircraft. We need this commitment to make the investment.</p>
Peter Potocki (Airbus)	<p>Key issue is use of spectrum. Whatever brand of VDL is looked at, it will expire at about the same time as voice because of spectrum saturation by voice channels</p>
Johnny Nilsson (LFV)	<p>Issue is not a simple as portrayed by Philippe Renaud. Doing things step by step may prevent the best solutions. Believes that we should focus on the most spectrum efficient solutions.</p>
Harmut Uhr (Infosys)	<p>Thanked team for work carried out. Very wide scope.</p> <p>Need to avoid trying to decide on technology using today's procedures. There are many future options and there is the need for a lot of change on the ground. The clear vision of a paradigm change should not be lost. This could be slowed by too great a focus on step by step. GSM was not done so slowly/carefully.</p>
Ben van Houtte (EC)	<p>Agrees need to move forward to a different paradigm</p> <p>Wants to move forward step by step, but also needs to know where the Community is going. A clear vision is needed</p>
Philippe Renaud (Eurocontrol)	<p>At Eurocontrol we work a lot at the spectrum usage. It is difficult at this moment to talk about the capacity. There is uncertainty for each system. We need to take account of the spectrum needed. It is difficult to draw a conclusion</p>
Phil Platt (Qinetiq)	<p>Not 100% sure what Commission is going to do with the study. Is it going to be used as a source of information, OK. If it is going to be a source of data for recommending a mandate, then people will feel more passionate. Lots of lessons from previous experience in Mode S. There seems to be industry consensus that Mode S EHS and 1090 ES should be implemented. But this has taken a long time to achieve.</p>

Who	Comment
Ben van Houtte (EC)	<p>Not ready to move into direction of eg mandate at this stage. Feels there needs to be one further step which will be industry consultation. (expected timing, after summer).</p> <p>We may decide to go forward with a mandate but we need further work and reflection. The single Sky is project is about providing such input</p>
Larry Johnsson (LFV)	<p>Agrees with statements that study is important. It should be born in mind that a lot of work is being carried out on operational concepts. From the documents, it is very difficult to see what the future will look like. There is going to be a shift in paradigm.</p> <p>People have raised issue of spectrum efficiency. What balance will there be between voice communication and data. Expect this to be different from today's situation. Operational procedures not yet defined for future concepts</p> <p>Does not agree with statement that we should have a sequential process because this hampers development. Advice is to keep a parallel development going because that leads to more innovation.</p>
Bengt Moberg (Com4 solutions)	<p>Sees a lot of information in the report. One thing he does not see in the report is treatment of the voice communication strategy.</p> <p>Another thing is that there is concern for airlines that as soon as communication is installed, the technology is then taken away in 2008. The real decision for airlines is to do nothing.</p>
Pieter van der Kraan (Eurocontro)	<p>The ADS-B side, I have heard very little about the applications, ie Package 1, The important driver is the EATMP Roadmap Phase 3, 2008-2012, which has a number of applications and the data link roadmap should be linked to this. We have to go ahead. Requirements have not been mentioned, there is no real clear view on the requirements. We should not forget that we have to develop and validate these requirements, this will take 18 months, then is the time to decide what datalink supports them The MASPS, US only, is a first guess using bottom up. We are all waiting for everyone to say yes on the datalink decision.</p>
Ben van Houtte (EC)	<p>There is a necessity to align our work with the US, where they seem to be a bit ahead of us and we must contribute to the debate as an equal</p>
Alain Bourrez (Thales ATM)	<p>DFS raised a question about security requirements. Issue is, are we in a world which is secure. Security is a very important issue. What needs to be taken into account and how much to pay? We must look at this before deciding.</p>
Akhil Sharma (SITA)	<p>Helios has done a good job (as good as possible in the circumstances!)</p> <p>Gave some background on SITA business. SITA provides airline comms for 25 years, ACARS in early 80's now a global service. 700 stations deployed around the globe. In Western Europe, increased use of ACARS was leading to saturation.</p> <p>At that time, ICAO was looking at various links and trying to develop a protocol which could support AOC and ATS. Since then, SITA has made significant investment in VDL2: now over 25 stations in Europe and it is beginning to be used.</p> <p>For ACARS, it took 25 years to get 10000 aircraft equipped. Same thing will happen with Mode 2, particularly if there is the prospect of changing the technology in a few years time.</p> <p>Used by KLN, Quantas, etc, since January. VDL2 is being used, since January. There has to be a very strong reason to move to a new technology</p>

Who	Comment
Johnny Nilsson (LFV)	<p>Obvious that the introduction of data link for ATS will be incremental in the sense that, while you use it, you will learn how to benefit from it. Hence, Package 1 is the first step. But you cannot build a stair without first designing staircase. 1090 is a decision to not implement ADS-B. You cannot certify it. Certain technologies cannot deliver. Needs a different infrastructure to Mode S radar.</p> <p>With 1090 ES it will not be possible to certify it because of TCAS.</p> <p>SITA and ARINC's data link is AOC has about 50% in common with ADS-B. A lot of the messages sent by AOC are included in ADS messages, so you can reduce the burden on the AOC if you have ADS-B. Sita and ARINC have no interest in ATC, else they would chose another datalink.</p>
Nicolas Zvegintzoff (IATA)	<p>What is it that delivers the capacity. Link 2000+, which is more than broadly supported. For 75% equipage, how many aircraft is that, we know the applications. Can the technology support it? This should be the debate of today. We cant wait until 2012 for the first step. How can service providers implement as fast as possible to make it work.</p>

4 Link Performance

4.1 Links considered in the study

Group	Technology	Air-Ground Datalink	Air-Air Datalink	Air-Air Broadcast	Uplink Broadcast	Downlink Broadcast
Baseline Technologies	AVPAC	✓				
	HFDL	✓				
	AMSS	✓				
Significant Decisions	VDL2	✓			✓	
	1090 ES			✓	✓	✓
	Mode S ES				✓	✓
Emerging Technologies	VDL3	✓				
	VDL4	✓	✓	✓	✓	✓
	UAT			✓	✓	✓
	Gatelink	Airport Only				
Future Technologies	NGSS	✓				
	SDLS	✓				
	3G/UMTS	✓	✓	✓	✓	✓
	Boeing CS	✓				

4.2 What the study said

- HFDL
 - The existing HFDL is the only current system capable of covering north polar routes
 - HFDL is hindered by very low data rates, but does support basic FANS1/A type applications and ACARS (ARINC)
 - HFDL is retained in the roadmap for current use; but with long term replacement by future satcom possible
- AMSS
 - AMSS is an existing system capable of providing narrow band data (throughput approx equal to VHF but transfer delay is much longer)
 - Currently AMSS is used to support FANS1/A. AMSS is fitted to 1200+ mainly long haul aircraft. AMSS is hindered by high cost for avionics and communications charges.
 - Retained for current use; replacement by future satcom is likely. Consideration of ATS use for Inmarsat-4 services urgently required
- VDL2
 - The effective data rate for VDL2 is of order 3 kbps for en-route airspace (simulation)

- (dissent with this figure covered later)
- VDL2/ATN does not support long term goal of tactical datalinks
- VDL3
 - Within Europe, VDL3 could be deployed as a wide area data-link (3T) which has an effective data rate of 12.4 kbps
- VDL4
 - Point to point
 - The effective data rate for VDL4 is 14 kbps (calculations made within study)
 - Broadcast
 - VDL4 is the most flexible of the proposed systems providing variable reporting rates and a wide range of intent data
 - VDL4 has the best airport surface performance due to lower frequency of operation (it suffers fewer shielding problems)
 - Other
 - VDL4 is able to provide other services such as air/ground point-to-point communications and air-air point-to-point communications (it is the only link with air-air point to point data link) as well as broadcast services.
- Gatelink
 - A number of technologies have been proposed over the years for providing very high bandwidth communications for parked aircraft
 - The majority of the communications does not relate to ATC, although some clearances, including advanced slot management applications could be supported
 - Gatelink is seen as a local decision between Aircraft and Airport Operators
 - A European decision for a particular technology could support lower prices in the long term.
- 1090 ES
 - The air-air range limitations of 1090 ES make it unsuitable for long-range applications
 - Expected to be able to meet the early requirements although there is some doubt on range performance beyond 2010
 - simulation results indicate that it will saturate in core Europe between 2010 and 2015
 - Implementation of 1090 ES would benefit from, and may even require, a concerted rationalisation of the SSR ground infrastructure
- UAT

- Simulations show that UAT has the best range/capacity performance of the proposed systems with sufficient capacity for all applications including FIS-B and TIS-B

4.3 Comments from stakeholders

- VDL2
 - Throughput measured at 12-13 kbits/sec (SITA, ARINC)
 - ARINC simulation used in study for VDL2 results is invalid (ARINC)
 - VDL2 will provide 10 times the capacity of ACARS (SITA)
 - 6 channels will support forecast AOC and ATS data – capacity 140 million kilobits/month (SITA)
 - Difficult to definitively state number of VDL channels required (Eurocontrol)
 - only sources available based on theoretical calculation (ST15)
 - ST15 carried out several years ago – operational scenarios and systems have evolved since then – care needed when drawing conclusions from ST15
 - no simulation, although one currently being developed by Eurocontrol, taking account of separate channels for terminal and en-route
 - How can VDL2 be promoted as a solution when we don't know if it will cope under load? (EasyJet)
 - Simpler solution for step 4 (rather than VDL3/4) is to allocate more channels to VDL2 (SITA)
 - VDL2 not appropriate for step 4 and 5 because of non-deterministic QoS - new systems would have to be considered (Eurocontrol)
 - The requirements of time critical applications cannot be met using a non-predictive system like ACARS or VDL2 – there appears to be an unwillingness to adopt predictive systems such as VDL3/4(LFV)
 - How can we use a system that has no/limited Q of S or Priority control? (EasyJet)
- VDL4
 - rough agreement on throughput estimate (based on adaptation of ST15 – still needs to be validated) (Eurocontrol)
 - only technology proven to work on the ground – runway incursions one of the worst threats to air safety (CNS Systems)
 - due consideration must be made regarding potential consequences of using a technology such as VDL4 to support both ATS datalink communications and surveillance services (SITA)
 - A very positive feature of VDL4: ability to provide flexible solutions (EasyJet)

- Step 1 - VDL2; six frequencies; this is the TOTAL required for VDL4 for all uses. (2 global, 2 regional, 2 local; possible benefit from another 2 though.) (EasyJet)
- 1090 ES
 - Performance on airport surface has been proven to be limited due to multipath and other propagation constraints (LFV)
 - For step 5, 1090 ES would not support the QoS required by the related applications – new systems would have to be considered (Eurocontrol)
 - TLAT did not take into account the lower interrogation rates that MSSRs and TCASs could use with 1090ES, extending traffic handling ability (Airbus)
 - Refer to DADI-2 Report. ADS-B shown to be a more effective mechanism for Downlinked Aircraft Parameters than Mode S. Any mandate should allow ADS-B ex including via Mode 4 (EasyJet)
 - Performance of 1090 as traffic grows is very significant; for operators taking significant deliveries of new aircraft, we will be throwing out 1090 before delivery stream is complete.... (EasyJet)
- UAT
 - In TLAT, UAT had best performance in terms of capacity/range but still did not meet all requirements (TCPs and range) – conclude dual link best/safest approach for ADS-B (Eurocontrol)
- Gatelink
 - should not be a local implementation issue – it is more important than that as part of the CDM supply chain (EasyJet)
- General
 - Has the study analysed the impact of security requirements (DFS)
 - Some applications in step 1 (eg D-RVR) are outside the scope of Link 2000+ and outside current ECIP and corresponding LCIPs (DFS)
 - Technical assessment shows that no single technology can meet the requirements of applications but that these requirements can be met by an appropriate combination of available technologies (LFV)
 - Mode S issues: high capital investment for outdated technology, expensive maintenance, line-of-sight and physical limitations, mechanical deficiencies, fruit, garble, processing delays etc. Mode S transponders do not deliver any safety enhancement over ordinary SSR Mode A/C transponders (IAOPA)
 - Cellular radio applications like VDL3/4 call on 10 years of GSM experience, 400 million tracked users – why are they classified as “emerging technologies” (IAOPA)
 - Mode S enhanced - How can this be mandated when the impact on other systems i.e. TCAS, Mode S Elementary and 1090/ADS-B/TIS-B are yet to be assessed? (EasyJet)

- TIS-B is conceptually attractive but there is no significant published documentation on research showing TIS-B performance or that it works (Airbus)

4.4 Discussion items

- Performance of point to point links
 - establish basis for comparison of links
 - discuss each link (VDL2/VDL3/VDL4)
 - throughput
 - quality of service
 - plans for simulations
 - scope/timescales
- Performance of broadcast links
 - limits to 1090 ES
 - merits of a dual link solution

4.5 Comments made at workshop

Who	Comment
Performance of VDL Mode 2	
Patrick Delhaise (Eurocontrol)	<p>Has carried out a lot of work on number of channels. Rules have been derived for protecting channels and agreed by ICAO. Frequency managers have found 4 channels. These four channels will deliver the same as 40 ACARS channels. ACARS is 2.4kbs but you get only 300bps. VDL2 is 10 times that.</p> <p>We need now to work on the optimum use of each channel. The old work, is wrong, There is now an ambitious capacity assessment programme with two different and independent simulators. These take account of propagation effects etc We should have results this year</p> <p>We take into account the bad effects of the propagation. we most also segregate traffic to minimise the interference between ground stations at airports, we separate the ground and air traffic, VDL 2 is based on CSMA, but the SARPS parameters are not the optimum, but we need to optimise to avoid collision and make best use of VDL mode 2. Eurocontrol believe output of work will be 8 – 12 kbps.</p>
Andy Hubbard (ARINC)	<p>Commented on ARINC study. Purpose of the study was to highlight the issues that were needed to be aware of in optimising the system.</p> <p>It was a worst case study and not a valid number for capacity.</p> <p>ARINC has done trials with a real aircraft and got 12kbps, one aircraft and sterile environment. ARINC are also depolying AOA and ATN network.</p> <p>We have 100 gs and can be upgraded to VDL Mode 2, it is a simple upgrade for us.</p>
Johnny Nilsson (LFV)	<p>Surprised that you dont get better performance since base data rate is 31.4kbps. You can always get best performance with a single aircraft</p> <p>The fundamental thing with VDL 2, is no air-air and poor CCI. The co-channel interference is 30db, VDL4 is 4 times better in channel reuse.</p> <p>VDL2 has nothing to do with air traffic management</p>

Who	Comment
Philippe Renaud (Eurocontrol)	The Link 2000 decision is to use VDL mode 2 for ATS.
Harmut Uhr (Infosys)	<p>Come back to issue that VHF spectrum is in short supply and now there is a commercial application that is eating up spectrum and also “clobbering” neighbouring channels.</p> <p>People with legitimate needs can not get a VHF allocation eg airports VDL 2 is not good, it is inefficient and clobbers the adjacent channels, why do we give away channels for AOC. Why not use the more efficient VDL Mode 4 for AOC. It would be more harmonic on the aircraft and save a lot of problems. Decision process seems to be “who comes first comes first” – not the best way to get the best system.</p>
Peter Potocki (Airbus)	<p>Lets base things on fact. The facts are: people are getting a certain amount of performance out of VDL2, people are using ACARS for ATS applications and are now starting to use VDL2.</p> <p>Should not be distracted by better performing links</p> <p>Opinions should be based on reality</p>
Philippe Renaud (Eurocontrol)	There is no system that resides within 25kHz and does not need guard band.
Patrick Delhaise (Eurocontrol)	Things are clear for VDL2 at the moment – one guard band is included. 4 channels will use 4 + 1 guard bands. There is an additional constraint for ground stations.
Ernst Hauf (IAOPA)	VDL Mode 2 – no interest at all, it would be a penalty if imposed on GA
Johnny Nilsson (LFV)	When VDL 3 is made a system, it will look very similar to VDL 4
Mode 4 performance	
Ernst Hauf (IAOPA)	Due to its air-air technologies and efficient use of spectrum and cost estimates provided by industry, VDL mode 4 is the preferred mode for GA.
Bengt Moberg (Com4 solutions)	<p>Fact is that VDL2 is being used with ACARS for PDC. Current ATS are not very safety critical.</p> <p>We look only at the aviation side. On the maritime we have AIS, which has 10 time stricter co-channel interference requirements. There are manufacturers of AIS which uses the same technology as Mode 4, AIS is a mature technology. Implemented in 70,000 ships</p> <p>Efficient way of using scarce channels, block 8 channels, only 4 useable Need guard band on each side of block but do not need guard bands between channels within block. Would need every other channel on an airport surface.</p>

Who	Comment
<p>Graeme Clark (EasyJet)</p>	<p>This is a very big and passionate subject, we represent different aspects of needs, builders, providers, airlines (old and new). The range of views, we get down to two or three key things. Technical facts are required, not opinions.</p> <p>Helios report has been valuable. Wants the facts and it is difficult these from the report. 268 document reference list. Wants to encourage the group to think about how to present the information. AEA did not make a submission – because there is too much information.</p> <p>Has spent a lot of time on the report.</p> <p>Easy jets sees datalink a strategic enabler.</p> <p>Report has not dealt with safety much – good thing to wave around when there are not any facts. Needs to be metricated more – need some European indicators of safety.</p> <p>A new system has to contribute to safety</p> <p>Other part of the report is about capacity – we have not used our free spectrum – we waste it (guard bands etc). Issues is design of voice radios which are impacting on data link (and constraining it)</p> <p>As an airline, looking for a system which is cost effective. If we had to pay for spectrum the issues would be very different. We should not be wasting spectrum. Need free access to spectrum. CNS systems say they can use 8 channels without guard bands.</p> <p>Once the enabler is there, applications will go on top.</p> <p>VDL 4 is the only one which has management of QoS, priority etc. We want a paradigm shift, a step change.</p> <p>Does not preclude those using systems until they run out of capacity</p> <p>EasyJet are a low cost airline – data link is a high cost input.</p> <p>Needs to be a tool which realises the safety aims that Eurocontrol has published</p> <p>Decisions should be based on technical facts</p> <p>If the 200Meurop on VDL 4 is waste, let it be exposed on a technical level.</p>
<p>Philippe Casisso (STNA)</p>	<p>Are we discussing VDL4 for broadcast first or also as a point to point. Aeroport de Paris are looking at trials with VDL4 – already needs 5 to 6 channels to perform applications and then may need to add in more.</p>
<p>Nicolas Fistas (Eurocontrol)</p>	<p>Eurocontrol is considering use of VDL4 for both point to point and broadcast. Believes that the study was a good reflection of the performance of the link.</p> <p>Capacity of VHF band is a serious issue – there is no answer available at the moment. Would like more information on why 6 channels are required in Paris.</p> <p>Eurocontrol is developing a simulator to make more accurate assessments of capacity.</p>
<p>Johnny Nilsson (LFV)</p>	<p>Note that 1090 and UAT exist in very large bandwidths. VDL4 is much more efficient.</p> <p>Surprised to hear about the 6 channels, our simulations for CDG we used 2 channels for 300 aircraft. We need 6 to 7 25Hz channels, for 2100 aircraft (Safe21), never more than 4 channels on the aircraft. For AOC we will be 10 to 15 times better</p>
<p>Philippe Casisso (STNA)</p>	<p>Studying both CdG and Orly and wants to cover all vehicles</p>

Who	Comment
Patrick Delhaise (Eurocontrol)	No basis for establishing capacity on the basis of bit rates. JN figures are just out of his mind
Johnny Nilsson (LFV)	Figures came from activities that were also supported by Eurocontrol. Would like to see a simulation of VDL2 to see how many channels are required. It is missing at the moment. For example: how many channel will we need for 400 airports in Europe.
P Delhaise (Eurocontrol)	Simulations we go full speed ahead. ACARS traffic to VDL2 in 2005 and some growth.
Graeme Clark (EasyJet)	150 ground stations needed for VDL2?
Andy Hubbard (ARINC)	Have 110 stations. SITA will need 150
Graeme Clark (EasyJet)	So 300 ground stations plus a VDL4 network with 150 ground stations. It is very late in the day to be talking about basic numbers
Mike Shorthose (Helios)	Asked if QoS issues with VDL2 preclude use of step 4
Philippe Renaud (Eurocontrol)	Believes that VDL2 will not be able to provide the required service in step 4 (expected date around 2012)- need simulations to finally bottom this out.
Andy Hubbard (ARINC)	Prefer to leave comments on throughput to Eurocontrol study
Nicolas Zvegintzoff (IATA)	When will simulation be ready. Is Eurocontrol be working on simulations of VDL4
Philippe Renaud (Eurocontrol)	Simulations complete in June 2003 for VDL 2, no date for VDL4
Nikolaos Fistas (Eurocontrol)	Work for simulator for VDL4 not yet started, broadcast simulator could be used.. 1998 study could be updated, NO DATE YET. We have some simulation data relating to all kinds of broadcast, we have not looked in simulations on point-to-point
Andrew Hill (Eurocontrol/ FDP)	FDP – two observations: technical facts – disputed, it is a moving target – throughput in 5 years time will be very different . QoS, VDL2 – you can not guarantee delivery due to collisions, FDP will be the end-system for some data, FDP also use Ethernet, is it neccessary for a predictable part for the end-ground part.
Broadcast Performance	

Who	Comment
Johnny Nilsson (LFV)	1090 and UAT are poorly performing on the surface. TCAS is turned off on the ground (below 9000ft) because it interferes
Peter Potoki (Airbus)	1090 performance on the ground – a number of airports are using multilateration applications on the ground and these applications are less demanding
Costas Tamvaclis (Eurocontrol)	Eurocontrol has been doing a lot of work. It is not true to say that UAT and 1090 do not work on the ground. VDL4 coverage is better and hence needs fewer ground stations
Johnny Nilsson (LFV)	Multilateration does not give a cockpit display
Mike Shorthose (Helios)	Asked if ARINC and SITA could provide references for measurements – AGREED

4.6 Agreed actions

No.	Action	Date
1	Complete Eurocontrol simulation on VDL2	mid 2003
2	Carry out simulations on other systems	
3	Provide references for quoted VDL2 performance	
4	Answer question: can technologies meet the requirements of applications at 75% equipage	

5 Co-site and Spectrum Issues

5.1 What the study said

- VDL2
 - VDL2/ATN is likely to be the first real continental ATC datalink, but will require 8 frequencies for Step 1.
- VDL3
 - Significant support in US where VDL3 is expected to be the next generation technology for both voice and data
 - No support in Europe where 8.33 kHz voice is being implemented to redress shortage of voice channels; Europe does not have a long term strategy for voice
- VDL4
 - Airborne VHF interference issues remain unresolved – they are still being addressed (eg the NUP programme, Eurocontrol study)
 - VDL2 may be adversely affected by the operation of VDL4 on the same airframe
 - Deployment of VDL4 will require a concerted effort to free sufficient bandwidth in the congested VHF bands
 - Work on a channel management plan, including identification of the number of VHF channels required, is critical and urgently required
- UAT
 - No suitable frequency for UAT before 2006 and even well after this date in Europe due to plans to extend DME network to support RNAV operations.

5.2 Comments from stakeholders

- It is voice requirements that lead to lack of availability of spectrum by 2010-2015 - the link efficiency of which variety of VDL you use is a second-order effect. (AIRBUS)
- To what extent has expansion of VDL channels made possible by 8.33kHz channelisation been taken account of in the study (SITA) – topic for future study?
- Use of a second link leads to additional costs and the need to solve additional technical problems eg integration of VDL2 and VDL4 on same airframe; solicit views of airline community on acceptability of migration from VDL2 to VDL4 (SITA)
- Study of VHF channel requirements of VDL3 and VDL4 should be made as well as that already recommended for VDL2 (SITA)
- Retain VDL2 in step 4 because capacity enhancements will reduce number of sectors and free up voice channels for more data (SITA)

- Continued Voice - if efficient use of datalink made then voice (reduced requirement) may well be adequately served (EasyJet)
- VDL3/4 requires 6MHz spacing from nearest voice, ACARS or VDL2 frequency to avoid interference (AIRBUS)
 - don't need this with ACARS or VDL2 because they transmit infrequently and sporadically (AIRBUS)
 - the problem with cyclic VHF transmissions such as VDL3&4 is that the co-site interference issues mean that you need 6 MHz guard bands each side, making them very spectrum-inefficient (AIRBUS)
 - need to discontinue the envisaged use of VDL3/4 on aircraft (AIRBUS)
- To compare spectrum efficiency of the VDLs need information on real channelisation (eg size of guard band) (Eurocontrol)
 - planning criteria available for VDL2
 - VDL3 – no information
 - VDL4 – early measurements were pessimistic – avionics manufacturers state that target figures can be achieved – no evidence as yet
- VDL4/voice/VDL2 co-site issues need to be solved
- VDL4 interference issues are being addressed by Eurocontrol and DFS (Eurocontrol)
- VDL4 frequency planning criteria need to be derived
- Simulations tools for planning VDL2 frequency deployment are under development and will be available mid-2003
- Availability of 2 additional channels for VDL4 (assumed to be in the NAV band) still being addressed (Eurocontrol)
- Introduction of VDL3 for voice in Europe is unlikely
 - consideration as a data link only raises questions in terms of eventual benefits
- Co-existence issues of VDL4/VDL2 is irrelevant since VDL4 is an alternative to VDL2 (LFV)
- roadmap analysis does not take account of other users like commuter, GA, military etc (LFV)
- Airborne VHF issues occur with ALL VHF datalinks; (the only difference is that VDL4, because of it's design can carry ADS-B and as such will enable regular transmissions.
- The Eurocontrol investigation being done by Honeywell is an essential companion document to this roadmap; both must be analysed to get full technical picture. (EasyJet)
- There is a repeating flavour running through the report, saying in effect 'because there are limited VHF channels, VDL4 is penalised' i.e. it is negative tends to imply that VDL4 is a 'guilty party'. (EasyJet)

- VDL2 - No Issues? Do not agree. Guard Bands is one for sure i.e bandwidth for one VDLm2 channel is in fact 37.5khz (assuming guard band shared with adjacent channel) (EasyJet)

5.3 Discussion items

- Co-site issues
 - reach consensus on issues to be addressed
 - discuss each link
- Spectrum Issues
 - availability of channels
 - current allocation plans
 - strategy for accommodating voice requirements

5.4 Comments made at workshop

Who	Comment
Clive Goodchild (BAE systems)	Is Airbus view to discontinue VDL3/4 also shared by Boeing
Peter Potocki (Airbus)	Has not asked Boeing
Graeme Clark (EasyJet)	Where are the technical documents supporting the requirement for the 6 MHz
Peter Potocki (Airbus)	Contained in ARINC 716. Based on effectiveness of first stage filtering in radio – leads to funny modulation effects. Airbus did have a problem with a non-compliant radio that did not meet the 6MHz requirement - lead to manufacturer fixing the radio.
Graeme Clark (EasyJet)	Has also read the Honeywell report (Eurocontrol study) – important to complete this work and put issue to bed. Believes that issue will not be born out in fact. Report also says it is a VDL DL issue, not a VDL4 issue. Question whether the very short transmissions of VDL4 for ADS-B will really be a problem. If it was a real issue, believes that existing data radios would have been taken out Why have the pilots of SAS/DLH with VDL2 equipped aircraft not complained?
Peter Potocki (Airbus)	Within 6MHz band, the interference may only occur on one of the 6 frequencies – so crew may not be affected
Graeme Clark (EasyJet)	Regardless of what is happening – we are talking about a data link which with ATS and AOC traffic will be operated a lot. So it is not true to say that VDL2 DL will only be sporadic. In the future this will increase greatly.

Who	Comment
Larry Johnsson (LFV)	<p>Gets upset when co-site issue is portrayed as a VDL4 problems. In ICAO, after VDL2 standardisation, it was found that spectrum mask was not sufficient and hence it was modified. At the same time, it was indicated that there was a co-site issue for all DLs including ACARS. It was concluded that solving the problem was an implementation issue. Of course, industry was alarmed by this and a special AEEC working group was set up with broad help from industry, ARINC, Eurocontrol, FAA. They worked on the issue between 1999 – 2000. Results were reported to ACMP8. The key results were: all VDL transmissions would be the most serious source of interference to DSB-AM. Two sources a) breaking the squelch and b) straying into adjacent channels. Concluded how problem could be solved by adaptive squelch and sensitivity. Without these techniques it is highly likely that VDLs including ACARS would not be acceptable. Degradation below levels in Annex 10 would not be acceptable and hence it is likely that the solutions are not affecting DSB-AM performance. Conclude that there is a way of resolving the issue.</p> <p>Hence Co-site problems have been resolved for ACARS and VDL2 and will be resolved for VDL4.</p>
Nokolaos Fistas (Eurocontrol)	<p>Information on Honeywell study. Comments have been received. Does not see why VDL4 will be any different from any other system. For ADS-B there are other issues to resolve.</p>
Sami Zinad (CNS Systems)	<p>Has also read the Honeywell report. The main problem is interference between VDL and voice + not using VDL2 and VDL4 on same aircraft. Report has a lot of strange numbers which are not justified. CNS transponders have better figures than are quoted in the report. It is not very hard to make a better VHF radio that is more resilient to interference. The maritime system (AIS) has much more severe interference requirements – why not build a better radio for an aircraft.</p> <p>Why should we allow the old voice radios that are 30 years old to waste the spectrum. Why not transfer some of the voice communications over to data link.</p> <p>We only need 200-300 khz for VDL4. The Honeywell have used the worst case parameters. You must use operational values as well.</p>
Ben van Houtte (EC)	<p>Can some way be found of clarifying the claim that alternative figures should be used</p>
Sami Zinad (CNS Systems)	<p>Concentrates on the worst case all the time.</p>
Nikos Fistas (Eurocontrol)	<p>Aim is to provide technical figures. It is important that the current DRAFT report is not over-emphasised. It is still in the consultation process. Providing there is reference to an alternative number, these will be used. Need to expand work to eg do more realistic simulations including statistical usage of channels. It is a valid comment that the report is looking at worst cases. Expect interference analysis to be completed by end March.</p> <p>We hear about the AIS standard, which is interesting, but we need to start with the VDL Mode 4, the recommendation from the study could be to improve the mask, This is the first step towards the integration of VDL4 on the aircraft.</p> <p>Next stage will be to look at integration of VDL4 on three types of aircraft including GA. Also three types of VDL4 user will be assumed: ptp only, bcast only, and both</p>

Who	Comment
Philippe Renaud (Eurocontrol)	Needs to add something with Eurocontrol hat on. Difficult to use information that is draft and provided by Eurocontrol. There is still a gap and conclusions should not be drawn yet. The work also needs to be put in the context of the applications. Note that the worst cases will have to be taken account of by the airframe manufacturer to achieve certification. Every concept that he knows of at the moment still requires voice channel at least as the final back up. So it is difficult to see how requirement for voice channels could be reduced.
Graeme Clark (EasyJet)	Would like this meeting to ensure that the work from Eurocontrol is hardwired to the data link roadmap. There is too much fragmentation of information. Can the appropriate body look at the use of DSB voice and see if it can be improved. It needs a long term view. If the voice area is lacking then it should be ramped up and solved. Need to minimise issues at technical level
Peter Potocki (Airbus)	There is more connection between the studies because it was the data link roadmap people who informed Airbus about the study. Airbus view is that worst case should be used. Regarding comment needing a guard band with respect to other maritime systems. Airbus provides guard bands to protect other services. Hence 6MHz Airbus believes community should pause to look at guard bands before committing any more funds to development of VDL4. Airbus has currently paused its own development.
Johnny Nilsson (LFV)	Have studies been carried out on VDL2 co-site issues. Can the material be made available LFV has carried out compatibility tests. yes you get some clicking in the background on the next channel but otherwise no big problems detected. Work also done at DFS and University of Ohio Reality and the numbers quoted by Airbus do not match very well
Bengt Moberg (Com4 solutions)	Interesting to see that Airbus stopped work on the basis of the guard band. Yet the issues are the same for any VDL, as confirmed by ICAO. Why does this not disqualify the use of VDL2?
Nicolas Zvegintzoff (IATA)	When will radio experts come back with answers. Is the problem different for VDL2 and VDL3/4? Ie is it the applications that might be different.
Nikos Fistas (Eurocontrol)	Have to distinguish use of VDL4 according to applications. There is a difference for ADS-B but not for point to point
Patrick Delhaise (Eurocontrol)	Thinks that we do have problem with VDLs. Solution is to have only one use of VHF band. VDL2 have shorter messages than ACARS and hence an improvement When going to the more ambitious data link, need to check
Bengt Moberg (Com4 solutions)	Hears that we must use worst case. Then hears that for VDL2 it is not a problem because it is sporadic. Cant say both.
Sami Zinad (CNS Systems)	From design point of view for the radio – if someone could decide a subband for the radio – it would be easily be possible to provide a very good filter to reduce the interference. Rest of the problem is the DSB-AM radio – easy to solve by use of simple filter. Thinks Eurocontrol should consider this.

Who	Comment
Johnny Nilsson (LFV)	LFV waiting for frequency assignments – 1999 a request was made. No response yet.
Peter Potocki (Airbus)	Wants to comment on CNS systems input: feels that they are well intentioned but do not take into account the realities of the airframe
Sami Zinad (CNS Systems)	Input was not based on feeling, based on general design practice when you design radio links
Larry Johnsson (LFV)	Important to undertake an activity to improve radios and also look at use of voice strategy
Philippe Renaud (Eurocontrol)	Each month considering frequency allocations. Each time, not meeting demand. It is difficult to create a subband On the proposal to create new frequency space, each month we progress requirements for VHF, we now find this hard, it requires frequency swapping etc, it would need to be a political decision. Very difficult to create a subband.
Mike Shorthose (Helios)	Conclusions Eurocontrol architecture study is an important study that needs to direct research on the possible issues arising from We need to look at the issues of improving voice radios. We need to determine a strategy for voice and sub-bands , We need to look how frequencies are assigned.
Combination of voice and data	
Johnny Nilsson (LFV)	We tested voice over VDL4 but dropped it for two reasons. Did not understand how transition could be managed from analogue to digital voice.
Ernst Hauf (IAOPA)	ATIS is the way of having voice and data on one channel
Johnny Nilsson (LFV)	Digital ATIS is in VDL4
Marco Porzi, (Marconi Sekenia)	A point about interference between data and voice – all the avionics equipment has been updated with a filter because of the FM immunity issue – so it can be done for other reasons
Harmut Uhr (Infosys)	When there is data – there will not be much talking. Why not multiplex the voice channels.
Mike Shorthose (Helios)	Not considered in the study. But multiplexing is a good idea – how do you do it – analogue methods eg Climax system? trunking of digital voice?
Philippe Renaud (Eurocontrol)	We are indeed looking at 3G and new satellite systems, for getting back some VHF spectrum – but this is longer term

5.5 Agreed actions

No	Actions	Date
1	Complete Eurocontrol architecture study	
2	Use results to direct R&D on possible solutions	
3	Investigate if voice radios can be improved	
4	Determine voice strategy, subbands etc	

6 Technology availability/maturity

6.1 What the study said

- VDL2
 - Significant deployment plans for VDL2/AOA
 - Could be in widespread use by 2005/6
- VDL4
 - VDL4 has only just been standardised for point-to-point communications, but the maturity of avionics and ground stations is supported by the maturity of products for broadcast services
 - Subject to frequency availability and channel management plan – which are serious constraints
 - VDL4 could be in widespread use by 2006
- 1090 ES
 - Most mature of the proposed technologies with the earliest potential implementation date and possible widespread use by 2006
 - An ‘ADS-out’ solution, whilst the cheapest way to get ADS-B capability of all the data links, does not include the traffic display required for air-air applications
- UAT
 - UAT requires SARPs standardisation work which can be a very slow process
 - To avoid significant delays, SARPs standards should have minimum deviation from the existing MOPS published by RTCA
 - UAT could not be considered for operational use in Europe before 2006, and it may be longer since it depends on several factors being resolved quickly: SARPs completion, frequency availability and equipment availability

6.2 Comments by stakeholders

- VDL2
 - Highly questionable that even by 2008 75% of Eur fleet will be ATN/VDL2 equipped – 15% more realistic (SITA)
 - aware of a number of airlines that will retrofit with VDL2 – including 40 pioneer aircraft LH and SAS (SITA)
 - All ARINC ground stations are AOA and ATN capable and used operationally in US and Europe (ARINC)
 - FAA have stated that VDL3 will be voice and ATS data only, AOC data will remain on VDL2 – therefore VDL2 will remain and not disappear (ARINC)

- ATS over ATN has been operational since Oct 2002 in Miami (ARINC)
- Apart from CPDLC at Maastricht UACC, there are no committed plans for ATS providers to implement the technology (SITA)
- This means that VDL2 is not yet available. Do both SITA and ARINC propose 150 ground stations providing the same service, each requiring separate channels; where is the spectrum? (EasyJet)
- VDL2 is of no use; i.e. either operators have V2 & V4 (assuming 1090 costs and short operating life discount it), or they use V4 ONLY
- VDL3
 - expected to be deployed for high altitude voice in US in 2009 timeframe. No plans for data until 2012 (SITA)
- VDL4
 - not aware of any serious commercial service provider. How will infrastructure be provided? Who will pay for it? Which airlines will equip? need more information on validation of VDL4 in ATN context, availability of relevant avionics etc (SITA)
 - can 75% of ACCs and aircraft in Europe really be equipped with VDL4 by 2006? (SITA)
 - Com 4 solutions has a great demand from potential customers for AOC purposes. This market not included in roadmap summary (CNS systems)
 - most expensive of proposed systems to install on an airliner (AIRBUS)
 - has been rejected by the US and is not a worldwide standard (AIRBUS)
 - DLS not yet officially standardised although AMCP8 accepted DLS subject to flight trials (Eurocontrol + Helios)
 - SITA understands that there are no Eurocontrol plans to implement VDL4 for comm (SITA)
 - In diagram showing step 4 as “VDL M3 or VDL M4 (regional decision)” VDL M3 should not be in (Eurocontrol)
 - Maturity of ground components for broadcast services not taken into account – first two phases of ADS-B validation in Eurocontrol will be performed over VDL4 (LFV)
 - Implementation plans for ADS-B in Sweden and Russia must be taken into account (LFV)
 - Affordable air-air data link applications based on unambiguous public standards offer immediate safety benefits in managed and unmanaged airspace. VDL4 appears to be the most promising standard for GA/AW and ATM applications in Europe and Russia. Its implementation should be given precedence over mandatory carriage of Mode S ELS and EHS. An implementation delay in Europe of 8 years is considered a serious penalty for GA/AW users and an obstacle to voluntary global application (IAOPA)

- GGS manufacture VDL4 airborne and ground stations. One GGS delivered system is certified in Peru (GGS)
- Universal Enabler - Very significant characteristics summary; obvious point of note is only 2 technologies can deliver to all Groups i.e. VDL4 and 3G/UMTS. However, assuming announced roll-out of VDL4 network (COM 4 Solutions by end 2004), then ADS-B moves into 'significant decisions'.....NOTE: VDL2 network is only starting implementation (EasyJet)
- Move VDL4 from emerging to significant. This table in the report shows that it is the only technology that gives delivers functionality and produces a good ROI; add point to point to ICAO VDL4 SARP (2003) and case is even stronger (EasyJet)
- VDL2 is more mature.... relative; VDL4 has over 100,000 hours of operational experience. VDL2 is not yet in full operation. (EasyJet)
- UAT
 - UAT has been selected by the US and is a worldwide standard (AIRBUS)
 - UAT - Realistically, we must ignore UAT for the short to medium term... even so, because it was designed for a limited range of services it is yet another silo solution to aeronautical enabler needs. (EasyJet)
- 1090 ES
 - two way full ADS-B not available today. Evaluation work on large commercial aircraft is very limited. Mode S elementary/enhanced surveillance and ADS-B are different things (LFV)
 - all large airlines (>100 seats) are being equipped with updated Mode S transponders starting in 2003 with retrofit complete by 2005 – these transponders perform 1090 ES ADS-B. An ADS-out solution will extend the life of Mode S by reducing the need for frequent interrogations by ACASs and MSSRs (Airbus)
 - 1090 ADS-B is not mature. Very few trials have been performed (CNS systems)Based on the achievement of gaining community consensus for 1090 ES and Mode S EHS, would like to highlight the window of opportunity for an early and economic introduction of initial ADS-B capabilities (DFS)
- General
 - Data link is only one of the cornerstones for increased capacity – overall roadmap results must be put into overall ATM2000+ strategy and Strategic Performance Framework (DFS)
 - Present situation with two main data link service providers, having de facto monopoly on a-g data link using VDL2 might risk liberalisation of telecommunications promoted by EC (LFV)
 - Support for direct incentives from ANSPs for voluntary equipage for air-air and air-ground data links (IAOPA)

- Support for accelerated European infrastructure harmonisation and coordination of spectrum allocations allowing GA/AW and airline operations to grow on an equal footing (IAOPA)
- Work over-emphasises ANSPs and airline user requirements (IAOPA)
- absence of explicit GA/AW and military user requirements for IFR a serious weakness (IAOPA)
- support for early implementation of lower cost safety enhancements (IAOPA)
- available spaced-based nav systems and cellular radio techniques already offer a solid base for implementation planning, thus avoiding nugatory investments in outdated technologies (IAOPA)
- concern that GA/AW users will be driven out of large parts of European airspace (IAOPA)
- Roadmap supports continuation of monopoly market for comm. Mode 4 exists and has interested customers. VDL2 has test sites with digital ACARS, but these are the same to VDL2 as NEAN/STDMA is to VDL4. No airline has invested on a commercial basis in VDL2 (CNS systems)
- Future public funding for data link technology should be allocated to those technologies that are feasible, proven and, for which, there is general industry consensus to proceed (SITA)
- Consideration of VDL4 by military for costs reasons is an unlikely development (Eurocontrol)
- Step 1 assumes 75% equipage by 2006 – extremely optimistic as by 2006 there will likely be only 2, maybe 3, ACCs equipped to support ATS datalink and at most 100-200 aircraft. Step 1 cannot be realistically assumed complete until 2011/12 – hence subsequent steps need to be delayed. (SITA)
- Timescales indicated in the work are optimistic – do not underestimate the effort and time for certification and validation (DFS)
- Airbus roadmap seems to be more realistic also for ANSPs than the original Phase 1 roadmap (DFS)
- further detailed comments provided by DFS on timescales
- Dates are over-optimistic (ARINC)

6.3 Discussion items

- Verify technology availability
- Verify current implementation plans
 - investments already made or planned by stakeholders to equip for data link
 - airline equipage plans
 - ANSP equipage plans

- Many comments received on timescales (see table below)
 - ANSPs and aircraft equipage not able to meet ATM application roadmap timescales
 - Note that ATM application timescales based on perceived needs of ATM business and reviewed during first workshop
 - possible conclusion is that there will be problems meeting future demand
 - for discussion – can anything be done to speed things up?

Timescales to achieve widespread use (75% equipage)		
ATM application step	Phase 1 timescales (“operational need”)	Stakeholder comments (“availability of technology and infrastructure”)
Step 1: early air/ground ATM applications	2006	2011/2012 (SITA)
Step 2: ATM applications related to downlink of air-derived data	2008	2006 (Airbus)
Step 3: introduction of spacing	2010	EVA – 2007 (Airbus) Final approach spacing – 2008 (Airbus) Other spacing – 2012 (Airbus)
Step 4: extension of air/ground ATM applications	2009/2010	
Step 5a: introduction of separation and self-separation	2013+	Oceanic and remote –2012 (Airbus) Terminal an en-route – 2018 (Airbus) Sole means surveillance –2017 – 2019 (Airbus)
Step 5b: conflict free trajectory negotiation.	2013+	2011 (Airbus)

6.4 Comments made at workshop

Who	Comment
Andy Hubbard (ARINC)	Arinc AOA delivered operational since 2000. Both SAS and DLH have committed 20 aircraft to VDL2/ATN, for VDL2/AOA is for all fleet
Johnny Nilsson (LFV)	<p>Commitment from LH is that they have accepted money from Eurocontrol for equipage. Eurocontrol are paying 20k Euro per tail</p> <p>Suspicious of timescales. Airbus is building a brand new airplane in 6 years time. Seems to mean we have to wait an unreasonable time to obtain equipage</p> <p>Anything that goes beyond 5 years is not worth mentioning – you can do it, it is just having the will</p> <p>There are no ADS-B standards – how can 1090 be implemented by 2003</p> <p>DO260B is supposed to be completed in 2006 and that will provide the starting point for 1090</p> <p>UAT has been declared a worldwide standard in the US only!!</p>
Bengt Moberg (Com4 solutions)	<p>Also employed by SAS. SAS decided to accept the generous funding of the VDL2 equipage.</p> <p>Comment by ARINC that SAS will equip is not true. They will equip only 20 aircraft</p>
Harmut Uhr (Infosys)	If you want to talk to timescales for equipage – dont go to manufacturers – go to airlines. So forget Airbus values
Philippe Renaud (Eurocontrol)	Eurocontrol is sponsoring 20k for 20aircraft and the upgrade is for AOA to ATN.
Patrick Delhaise (Eurocontrol)	SAS confirmed the migration of the fleet to AOA, but continuing to look at ADS-B
Andy Hubbard (ARINC)	Happy to confirm what people has said – did not mean to represent SAS
Graeme Clark (EasyJet)	<p>Easyjet CEO just talks in terms of 6 months – the timescales quoted are just too slow</p> <p>We need faster equipage in order to enable the EC transport program. We need to get the enabling technology going faster. We need to do much better and we are heading off on the wrong track.</p>
Ben van Houtte (EC)	Sympathy with this point of view

Who	Comment
Nicolas Zvegintzoff (IATA)	<p>Cannot afford to be optimistic these days. There are many delays already – cannot afford to add to this. This is why it is so important to assess maturity. What, apart from RVSM, are we going to implement. Nothing.</p> <p>Decisions actually add delay because of politics– we need a clear roadmap. The idea that leaving the market to decide is probably not the best way because people have short horizons. What the industry must do is commit and commit early</p> <p>This can be backed up by the teeth of the EC.</p> <p>What IATA expects is information on what is really available now so that aircraft can be retrofitted. The decision time horizon is three months not 3 years. This is the year for decisions</p>
Peter Potocki (Airbus)	<p>Action can be taken very quickly to respond to a safety problem. The fix is fast but expensive.</p> <p>Dates for ADS-B-in are beyond date of introduction of A380. Reason is that test pilots have had difficulty flying spacing and need more time to sort it out. The Airbus pilots are saying that to do station keeping on a routine basis we need an appropriate display (ie not the TCAS display).</p> <p>Airbus is certifying ADS-B out – a version that is prior to the standards that are currently being revised.</p>
Philippe Caisso (STNA)	<p>The last versions of MOPS in January, deals with ADS-B, next version in 2005'6 will take account of the safety implications from the ACAS package 1, the same update will be needed by all the links.</p>
Peter Heldt (Flight Management Consultant)	<p>Retired chief technical pilot for LH. Participated in eg CATMAP (cooperative ATM). He would agree that it is difficult for manufacturer to make decisions</p> <p>Problem is elsewhere – we need political decisions to be made to bring all parties together and pushing for the same thing</p> <p>Stop talking, start working together</p> <p>Some meetings have eg airport representatives but no airlines. This meeting has insufficient airlines.</p> <p>Now we do not need more studies – we just need decisions</p>
Ben van Houtte (EC)	<p>Agreed that we need a sense of urgency but we need to provide information to assist the decision making process</p>
Graeme Clark (EasyJet)	<p>It is very sad that there are aircraft that are RNAV equipped but ground infrastructure is not in place, or the regulations, to use it</p>
Clive Goodchild	<p>Comment on timescales – could start introducing spacing in low density airspace in 2007 if there is the will. Not in core. Separation could be introduced earlier than 2012 but there needs to be the will</p>
Andy Hubbard (ARINC)	<p>DL Mode operational in Nov 2000, primarily in US, 24/7 service, we have the ground stations in place. We will not deploy until we have the business case, ie we need to see equipage, we fit in with the community decisions re 8.33 and Mode s, Arinc is an airline owned company</p>
Akhil Sharma (SITA)	<p>We, like ARINC, have deployed a VDL2 service in Europe – 25 stations operating 24 hours per day. Agreement with Spain to deploy across whole of the region. Will expand as customers or ANSPs require. Business decision.</p> <p>Has missed from decision the roles of the ANSPs. Would expect a huge mismatch between phase 1 workshop timescales and the plans of ANSPs. Recommends that next phase of the study is to canvas the views of service providers</p>

Who	Comment
Harmut Uhr (Infosys)	Of course, ATS services could just be implemented via Mode 4 and run from ANSPs without the input of ARINC or SITA
Johnny Nilsson (LFV)	Had heard that FAA had refused to sanction further deployment of VDL2 other than at Miami Should separate VDL2 from AOA
Ben van Houtte (EC)	Try to avoid getting into anecdotes
Philippe Renaud (Eurocontrol)	Can also talk about maturity of decisions. For examples, states of Core Europe have committed to Link 2000+
Heribert Lafferton (DFS)	Has not spoken much today – he is lost in that kind of discussion. It is going on and on and nothing new has been discussed today. As an ANSP, this is not the issue that they are interested in. It is one of the things they have to take into account. DFS issues is how to improve operations. Main comments is on timescales. Does not believe the current timescales in Phase 1 could be achieved. But agree with the strategy. Need to keep the delta between aspiration and reality as small as possible DFS is committed to Link 2000+ programme. in respect of political decisions, the EATMP sets clear goals for implementation of the first step of data link. Hoped that the roadmap will help
Andy Hubbard (ARINC)	VDL2 is being deployed by ARINC in the US (not by the FAA) – not sure what the issue raised by J Nilsson meant
Peter Potocki (Airbus)	Wanted to pick up that we need a political decision in order to proceed. Notes that there has been a decision to implement 1090 and VDL2.
Johnny Nilsson (LFV)	FAA need to be involved if you are to provide ATS over VDL2.

6.5 Agreed actions

No	Actions	Date
1	Get confirmation from SAS and LH of implementation plans	
2	Canvas views on ATM application roadmap from ANSPs	

7 Future technologies

7.1 What the study said

- NGSS
 - A number of potential NGSS, including Iridium, ICO and Globalstar, have been proposed over the years
 - These systems have their roots in mass personal communications. Only Iridium is still hopeful of providing an aeronautical service and is currently used for voice services by General Aviation in the US
 - The continued operational and financial difficulties of NGSS operators make them unattractive for commercial aviation
 - Not retained for inclusion in the roadmap.
- SDLS
 - SDLS is a research project sponsored by ESA and to some extent Eurocontrol
 - The design brief is to replicate VHF communications (voice and data) using a geo-stationary satellite
 - In its first guise, it would reuse existing Inmarsat infrastructure but use CDMA to improve services
- Boeing CS
 - Broadband system capable of live TV to aircraft but has not been proposed for safety services
 - Not retained for inclusion in the roadmap
- 3G
 - The aeronautical application of 3G is being researched by Eurocontrol, and the potential to offer significant advantages over VHF communications
 - Retained for use in Step 5.
 - Significant research should be conducted into the best way of using 3G for aviation. This research should include security concerns of the use of a single channel to support all aircraft communications needs

7.2 Comments by Stakeholders

- General
 - likely to be a lot of value in the VDL4 protocol were it to be applied where the interference issue is different, such as L-band, as used by UAT (AIRBUS)
 - Eurocontrol and AMCP WG-C proposed roadmaps include 2 alternatives for new systems operating outside the VHF band: 3G-based and NGSS based (Eurocontrol)

- Solution for moving from VDL2/8.33kHz directly to broadband appears very attractive and could be supported by DFS if proved feasible (DFS)
- SDLS
 - Eurocontrol is not sponsoring SDLS – Eurocontrol is progressing an NGSS definition re-using some concepts identified by SDLS (Eurocontrol)
 - there is not a lot in the study about SDLS: it seems merely to be seen as an R&D exercise that does not significantly contribute to an increase of ATC capacity (Astrium)
- NGSS
 - overall perception of NGSS seems rather negative, although the document clearly states that there are advantages that must not be ruled out (Astrium)
 - NGSS covers Iridium, ICO and Globalstar but potentially includes any new entrant. Note that AMSS is provided by Inmarsat but may be provided by others (eg Japanese MTSAT) (Astrium)
 - Inmarsat and Inmarsat 4 seem to be used synonymously. In the timeframe under consideration, Inmarsat 5 becomes potentially interesting and aviation needs could influence its definition (Astrium)
 - NGSS could be delivered by dedicated GEOs at lower costs (Astrium)
 - Question of whether there is sufficient bandwidth at L-band is not really addressed – some doubts about availability of spectrum in this band for a mature aeronautical system (Astrium)

7.3 Discussion items

- General discussion on workshop participants views on future technology

7.4 Comments made at workshop

Who	Comment
Philippe Renaud (Eurocontrol)	<p>Giving some words on programmes at Eurocontrol. Believe that should look at complementing current technologies by looking outside VHF band</p> <p>Firstly looking at re-using international products on 3G/broadband. Some experimentation has been carried out – just at the beginning of this work</p> <p>Looking at developing NGSS working with ESA/SDLS.</p> <p>Open to any ideas for new technology particularly satellites that can provide a global service and serve the needs of Europe</p> <p>All activities are carried out with liaison with FAA. AMCP 8 agreed to restart the satellite work</p>

Who	Comment
Johnny Nilsson (LFV)	<p>Satellites will never provide air to air communications. Good as a complement to long distance air to ground.</p> <p>There was a suggestion to use VDL4 at UAT frequencies. If that were the case – we would subdivide the band (driven by guard range etc). If you go up in band, then get problems with poor performance on the ground. So there are many questions that need to be addressed</p> <p>3G: dont know what is in mind – but 3G is a ground based cell based system. GSM is forbidden on aircraft. 3G would also be forbidden. If you are going to talk about broadband – scrup out 3G</p>
Richard Peckham (Astrium)	<p>Sees satellite as a complement to terrestrial systems</p> <p>People write off satellite because it is expensive. That is because it is one service provider. Prices can come down.</p> <p>One advantageous service is broadcast to many</p> <p>Should take account of Galileo – it has the capability to put in comm package. May be Galileo has enough problems at the moment – but the opportunity should not be forgotten</p> <p>Costs for ground infrastructure for satcom should not be exclusively assigned to aviation – it will serve many clients</p>
Peter Potocki (Airbus)	<p>Believes we have solutions that will carry for the next few years. The problem with the VHF spectrum is that it will be used up in the next 10 years. Anything new in VHF will have no space. So do not do a new system in VHF.</p> <p>Anything new has to include voice and data – it is voice that is taking up the VHF spectrum</p> <p>Transfer services to new band and then put in place an efficient bearer for VHF services</p>
Pieter van der Kraan (Eurocontrol)	<p>A study has just been launched looking at a military data link for ADS-B. May complicate the issue but is still worth looking at. JTIDS/MIDS (the mode is Mode 4 – a different Mode 4). What they are going to study is feasibility and cost impact. The thing is serious because very often there is a problem for military users to equip with civil data links</p> <p>Eurocontrol believe a dual link will be required to meet future ADS-B requirements</p>
Graeme Clark (EasyJet)	<p>Report does a wide scan of all possible areas. Broadband is of no interest because it is about in-flight entertainment. EasyJet passengers will have no interest in this (ie they will not pay a premium)</p> <p>For future work, some technologies should be eliminated in order to get a clearer focus on the issues associated with genuine candidates</p> <p>Very keen to get a solution that can be applied to GA. The two communities share the same airspace and safety issues need to be improved. Division of airspace is not a solution because there are level busts</p> <p>With the technologies available today – it is not expensive to provide the technology. He believes that an 8.33 + VDL4 radio is being developed</p>
Johnny Nilsson (LFV)	<p>It is very interesting to hear about all the various studies.</p> <p>Conclusions from ATLAS study have not changed in the 7 years since the study was carried out</p>
Ben van Houtte (EC)	<p>Asked DFS to comment on sequence of technologies</p>

Who	Comment
Heribert Lafferton (DFS)	Had liked the possible solution to go from VDL2 to broadband Did not look very realistic to have short replacement times for technologies Hence it seems attractive to complete 8.33/VDL2, use for as long as possible, and then move to broadband Acknowledges that the feasibility needs to be assessed
Nicolas Zvegintzoff (IATA)	Not sure if we wrote that there is a 5 year change of technology in the report we need to know how to move from step to step Step 5 is a major capacity enabler. We need to know how to move ahead to that step, so the roadmap should be based on decisions to implement a set of applications and the R&D needed to support the implementation of those applications (Ie now is the time to look at the future technologies.)
Johnny Nilsson (LFV)	Need to include ground vehicles Link 16 was very costly for surface operations, we must also include ground vehicles, Link 16 MIDS cost 560,000 dollars per unit. How can GA equip with this? A lot of this is an excuse for doing nothing.
Peter Heldt (Flight Management Consultant)	Should invite the airports next time – they are a key partner in future. They need to realise this and start to participate.
Ben van Houtte (EC)	Agree that it is important
Philippe Renaud (Eurocontrol)	We also need to look at gatelink and reconsider those decisions.
Pieter van der Kraan (Eurocontrol)	Re airports – agree that it is important. There is an airport programme within Eurocontrol. There are two important airport applications in Package 1. Projects are underway. Eurocontrol is planning to set up an implementation oriented programme for the Package 1 applications Aim to get benefits by 2012. Need a number of decisions to support this. The data link issue needs to be made. There does not seem to be an ideal system on the table. We need to decide on something to start to work on. From some of the reactions that have been heard today – we could go on for ever without any real decisions. It is no different to discussions held a long time ago. Things like D-FIS are very important. These are in the EATMP roadmap – which is an agreed document
Johnny Nilsson (LFV)	Operate 19 airports in Sweden. There was a plan to certify ground systems – but some of the standards were blocked
Larry Johnsson (LFV)	Agrees that decisions have to be taken. Unfortunately, the decisions that are emerging are limiting us for the future. Probably we will have to stick with the systems – and these will not necessarily do the job. It is important that decisions made should allow people to keep working on a solution that can meet all needs.

Who	Comment
Peter Heldt (Flight Management Consultant)	<p>Airlines like to use the same equipment worldwide. They want the same radios and display equipment: en-route and on the ground.</p> <p>He had reviewed some study elements carried out in Germany. They were looking at ideas that were not synchronised with the needs of the airline industry.</p> <p>With the current digital technology it is very easy to create a standard hardware – this has to serve both ground and airborne environments</p> <p>Also need to serve remote areas like Africa and India. The first step of ADS-B would give us an opportunity to protect LH aircraft.</p>
Ben van Houtte (EC)	We have to organise in Europe to make things happen – this has to be coordinated but we must first get our own house in order
Ernst Hauf (IAOPA)	<p>Global obligation to defend the interests of the GA community. UAT: not happy in Europe. Therefore adopt a divergent position in Europe. Would like the only system that is standardised, that uses available spectrum – IAOPA would reluctantly suggest that Europe takes the lead. Civil aviation has not succeeded to take on board technology. Expects that the analysis of the recent mid-air will demonstrate all the sins of the current system.</p> <p>Clear the way for implementation on a voluntary basis for VDL4 – lets states like Russia benefit from that</p>
Heribert Lafferton (DFS)	At the end of the workshop, I would like to come back to a comment we provided, the question to what extent did the study take security issues into consideration. We face future security requirements being put on ourselves, IFALPA ICAO datalink requirements paper, pointed out security and privacy issues, these are new requirements , when trying to asses the capabilities of future technologies we need to consider them.
Ben van Houtte (EC)	Agrees that we must take account of security issues
Johnny Nilsson (LFV)	Security features already exist in maritime area. Possibility is there for VDL4. Requires a 2 way datalink

7.5 Agreed actions

No	Actions	Date
1	Continue current and initiate new research programmes	
2	Initiate activity to set design guidelines for future systems	

8 Closing remarks

Who	Comment
<p>Mike Shorthose (Helios)</p>	<p>Link Performance</p> <ul style="list-style-type: none"> • Eurocontrol should simulate VDL2 • Simulations should also be done on other systems • Refs from ARINC/SITA on vdl2 performance • Performance of technology to meet applications requirements at 75% equipage • Community to continue to address 1090 post 2010 <p>Co-site</p> <ul style="list-style-type: none"> • EHQ complete architecture study, • Results used to direct work on possible solutions • Investigate voice radio improvements • Look at more efficient use of the VHF spectrum and start planning for spectrum use <p>Maturity</p> <ul style="list-style-type: none"> • Disconnect between the application roadmap timescales and the ability to equip. • Rate of equipage is set by the need expressed by AO and ANSP • Political decision would allow people to sign up • SAS/DLH statements on equipage to be verified • ANSP to be canvassed on ability to meet roadmap <p>Future</p> <ul style="list-style-type: none"> • Some guiding principles and work in progress • Increase work in progress to take account of GA, military, airports, bring on the surface enhancements and security requirements • Action: view need on future requirements, do we know what we are designing the technology for.
<p>Larry Johnsson (LFV)</p>	<p>Need to plan for ANC/11. Point to point has an impact on security. Aviation could adopt protocols that are already available in other commercial fields (ie banking).</p> <p>Can combine a lot of current systems to provide a safe system. ie ADS-B data can help in security</p> <p>It is also possible to get an independent verification of range/position</p> <p>If there is automatic reporting of intent data – it might be useful as a security mechanism</p>
<p>Philippe Renaud (Eurocontrol)</p>	<p>Eurocontrol has gained a lot of actions. Will be happy to provide this information.</p> <p>Simulations will be Mode 2 and available mid-year. Mode 4 comes later</p> <p>Also co-site is VHF wide not just VDL</p> <p>Need to refer to decisions already taken</p>

Who	Comment
Clive Goodchild (BAE Systems)	Rate of equipage is set by ability to retrofit
Graeme Clark (EasyJet)	<p>Some conclusions of his own:</p> <p>We are behind time.</p> <p>Need generic solutions that can work across the fleet (ie Easyjet have Boeings and Airbus) – “all aircraft to all places at all times”</p> <p>VHF co-existence. We need digital voice radios – may help with encryption and security</p> <p>Spectrum – ITU allocation criteria must be respected – allocate to most efficient user</p> <p>Data link is just one enabler of their business</p> <p>It is unfortunate that aviation invents a new system for each problem</p> <p>There are only a few bits of information to exchange: position, time, intent. Unfortunate that mandatory Mode S is put up as the only way to go forward.</p> <p>Thinks that global interoperability is a myth. If so, Europe must consider Mode 3</p> <p>Should support different regional solutions</p> <p>Great interest in CDM</p> <p>Airports are critical</p> <p>Holistic data link important</p> <p>Decisions should not be biased by previous decisions that may not work.</p> <p>Need to focus on measuring safety – could use data link to help measure safety criteria – to be complemented with safety reporting system</p> <p>p92 of report – tick in every box for VDL4. Has not heard any technical issues that are not being researched and could be solved</p> <p>Low cost airlines will drive the shape of aviation in Europe, their views are important and they require services based on elegant solutions and cost effective use of technologies.</p> <p>Need to get industry, airlines, airports, service providers to work together</p> <p>Very strong support for VDL Mode 4</p> <p>EU should provide a very strong lead,</p> <p>People with existing investment should be allowed to run that investment.</p>
Harmut Uhr (Infosys)	Was disturbed to see a statement that VDL3/4 should not be incorporated on an aircraft. Solutions had been proposed. Suggest that Airbus should remove comment. Not substantiated
Peter Potocki (Airbus)	Until co-site issue is resolved he stands by it

Who	Comment
Ben van Houtte (EC)	<p>Thanks to Helios, partners and people who came to meeting</p> <p>It has been a good discussion</p> <p>Need to complete the study – Helios will have to finalise this.</p> <p>Helios will provide an accessible summary of the study</p> <p>There is not a lot of new information in this area. The current mechanisms are not delivering results. Eurocontrol has said that decisions have already been made. We need additional drive to the process, that is acceptable, and enforceable. The latter is where the Commission could step in as part of the interoperability regulation as part of the Single Sky Package.</p> <p>Whether there is any need for any mandate on this needs further consideration.</p> <p>To be dealt with in priority study on implementing rules. (Sofreavia)</p> <p>Need to discuss together with Eurocontrol and operational conclusions which is one which can be put to the industry consultation process</p> <p>This study will provide the input for the step. Whether there will be voluntary or mandatory measures is still to be decided.</p> <p>If there is a need for a regulatory solution, then this could be followed.</p>
Johnny Nilsson (LFV)	References have been made to decisions. Revisit these decisions because there is not an homogeneous agreement
Philippe Renaud (Eurocontrol)	Need to have a step to review comments
Ben van Houtte (EC)	Problem is that there is no time left to carry out such a review
Philippe Renaud (Eurocontrol)	Talk about mandating systems working with Eurocontrol. Eurocontrol welcomes that but must also keep in mind the ICAO relationship.
Akhil Sharma (SITA)	Will roadmap be issued for comment
Ben van Houtte (EC)	One further opportunity for comment then finalised
Nicolas Zvegintzoff (IATA)	<p>IATA sees from the applications roadmap the way ahead</p> <p>See output as being very important for future discussions as a working document</p> <p>Document includes a short, mid and long term solution and is supported by IATA</p> <p>IATA happy and pleased with this important study: it was useful in bringing together all the available information, It was important in developing an application roadmap.</p> <p>The datalink roadmap will be a working document for the ongoing dialogue with the manufacturers, airlines and ANSPS, as we move towards the needed decisions. IATA are serious about mandates, both on Airlines and ANSPS to ensure that the dreams come true.</p> <p>It is one of the few documents which encompasses so much information on datalinks.</p>

Who	Comment
Patrick Delhaise (Eurocontrol)	Real progress has been made since 7 years ago – we now have the Link 2000+ programme. Decisions must not jeopardise the progress that has been made.
Johnny Nilsson (LFV)	If decisions had been taken earlier we could have saved airline money.
Ben van Houtte (EC)	Concluded meeting

A Comments database

A.1 See separate Excel file which accompanies this document.