Data Link Roadmap

Second Stakeholder Workshop
21 February 2003

Study team

➢ Core team

- Airbus
- Helios Technology (lead)
- IATA
- Integra
- Sofreavia

➢ Other partners

- AENA
- IAA
- LFV/Swedavia
- Mitre
- NATS
- University of Leiden

➢ Eurocontrol

- review input
- expert assistance

➢ Peer Review Group

- review of deliverables
- participation in stakeholder workshop

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

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

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

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

Topics reminder

➢ Link performance

➢ Co-site and onboard issues, and spectrum allocation

➢ Technology availability/maturity

➢ Future data link technologies

Link Performance

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	✓				

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

What the study said

➢ 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

What the study said

➢ 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.

What the study said

➢ 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.

What the study said

- ➢ 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

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)

Comments from stakeholders

➢ VDL2

- 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)

Comments from stakeholders

- ➢ 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)

Comments from stakeholders

➢ 1090

- 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)

Comments from stakeholders

➢ 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)

➢ 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)

Comments from stakeholders

➢ Gatelink

- should not be a local implementation issue – it is more important than that as part of the CDM supply chain (EasyJet)

➢ General

- 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

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

Co-site and Spectrum Issues

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

What the study said

➤ 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.

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)

Comments from stakeholders

➢ 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

Comments from stakeholders

➢ More Eurocontrol comments

- 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)

Comments by stakeholders

➢ 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)

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

Technology availability/maturity

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

What the study said

➢ **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

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

Comments by stakeholders

➤ 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)

Comments by stakeholders

➢ VDL4

- 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)

Comments by stakeholders

- ➢ VDL4
  - 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)

Comments by stakeholders

➢ 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)

Comments by stakeholders

➢ 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)

➢ 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)

Comments by stakeholders

➢ 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)

Comments by stakeholders

➢ 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)

Comments by Stakeholders

➢ 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)

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

- 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)

Future technologies

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

What the study said

➢ 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

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)

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Comments by Stakeholders

- ➤ 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)

Discussion items

➢ General discussion on workshop participants views on future technology