System Interface Requirements IRIS Precursor

Document information	
Project Title	BAFO III Iris Precursor
Project Number	15.02.05
Project Manager	Airbus
Deliverable Name	System Interface Requirements IRIS Precursor
Deliverable ID	D04
Edition	00.01.02
Template Version	03.00.00
Task contributors	
Airbus, Honeywell	

Please complete the advanced properties of the document

Abstract

Iris is the European Space Agency's (ESA) program to develop a comprehensive satellite ATM system for SESAR based on a global communication standard.
As part of incrementally working towards the long-term Iris goals, the Iris Precursor service will provide air-ground communications for initial 4D flight path control by 2018.

This document describes an interface allowing the ATSU to transmit and receive ATN/OSI packets over a SATCOM INMARSAT system.

Authoring & Approval

Prepared By - *Authors of the document.*		
Name & Company	Position & Title	Date
[redacted] Airbus>	[redacted]	<25/07/2014>

Reviewed By - *Reviewers internal to the project.*		
Name & Company	Position & Title	Date
[redacted] Frequentis AG>	[redacted]	<01/08/2014>
[redacted] Indra>		<01/08/2014>
[redacted] Thales Alenia Space Italia>		<01/08/2014>
[redacted] Telespazio S.p.A>		<01/08/2014>
[redacted] Honeywell Aerospace>		<01/08/2014>

Reviewed By - *Other SESAR projects, Airspace Users, staff association, military, Industrial Support, other organisations.*		
Name & Company	Position & Title	Date
[redacted] INMARSAT>	[redacted]	<01/09/2014>

Approved for submission to the SJU By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
[redacted] Airbus>	[redacted]	<01/08/2014>
[redacted] Honeywell Aerospace>		<01/08/2014>

Rejected By - *Representatives of the company involved in the project.*		
Name & Company	Position & Title	Date
<Name / Company>	<Position / Title>	<DD/MM/YYYY>

Rational for rejection
None.

Document History

Edition	Date	Status	Author	Justification
00.00.01	14/02/2014	Draft	[redacted]	First draft for Airbus internal review
00.00.02	25/02/2014	Draft		Update after Airbus internal review
00.00.03	12/03/2014	Draft		Final update after Airbus internal review • Executive Summary completed • Validation Method added for each requirement • Verification Method added for each requirement • Project number is "15.02.05" • Validation method of requirement ATN_AGW-SID-0028 added in Open Points section
00.00.04	7/04/2014	Draft		• ATSU-SDU interface based on ARINC 429 Version 3 of the bit-oriented (Williamsburg) protocol (BOP), sections §1.6 and §3.1.1 updated accordingly, requirements ATN_AGW-SID-0002, ATN_AGW-SID-0007 and ATN_AGW-SID-0008 updated • Use of Label 271 for connectivity status introduced in section §3.1.2, requirements ATN_AGW-SID-0029 and ATN_AGW-SID-0030 added
00.00.05	26/05/2014	Draft		Update after SESAR project internal review • Figure 3 updated (§1.6) • Table 2 updated (§3.1.1.1) • ATN_AGW-SID-0005 updated (§3.1.1.3) • ATN_AGW-SID-0009 completed (§3.1.1.6) • ATN_AGW-SID-0027 updated (§3.1.2.2) • ATN_AGW-SID-0028 completed (§3.1.2.3) • ATN_AGW-SID-0032 added (§3.1.2.6) • ATN_AGW-SID-0030 updated (§3.1.2.8) • ATN_AGW-SID-0033 and ATN_AGW-SID-0034 added (§3.1.3.6) • Assumption on multilink aspects updated (§4) • Open point on GFI definition completed (§4.1) • Reference to SPR SC-214 / WG-78 added (§5.1)
00.00.06	7/07/2014	Draft		Update after SESAR project technical workshop held CW27 in Toulouse • ATN_AGW-SID-0004 updated (§3.1.1.2): remove reference to ICAO address and multicast/broadcast capability • ATN_AGW-SID-0005 updated (§3.1.1.3) • ATN_AGW-SID-0035 and ATN_AGW-SID-0036 added (§3.1.1.8) • Figure 6 added (§3.1.2.1) • Table 3 added (§3.1.2.8) • "Open points" section removed (§4.1) • Reference to SPR ED-228 and INTEROP ED-229 added (§5.1)

			[redacted]	Status changed to <Validated> for all validated requirements
00.01.00	25/7/2014	Release		Released version • Table 2 updated (§3.1.1.1) • ATN_AGW-SID-0004 validated (§3.1.1.2) • ATN_AGW-SID-0005 validated (§3.1.1.3) • ATN_AGW-SID-0007 clarification on option O8 added (§3.1.1.6) • ATN_AGW-SID-0035 and ATN_AGW-SID-0036 validated (§3.1.1.8) • ATN_AGW-SID-0030 reference to bit 29 and WB protocol removed (§3.1.2.8) • Table 3 updated and Figure 7 added (§3.1.2.8) • ATN_AGW-SID-0016 no label 377 transmitted by the SDU (§3.1.3.2), ATN_AGW-SID-0033 idem (§3.1.3.6) Ongoing action recorded in section §4.1, information on “Review of Design” verification method added in section §3.1
00.01.01	8/12/2014	Draft		Updated with INMARSAT comments and SJU feedback • Clarification added on interface definition sharing with ESA Iris project (§1.1) • Acronyms updated (§1.8) • ATN_AGW-SID-0005 Verification Method updated (§3.1.1.3) • Figures 5 & 6 updated (§3.1.2.1) • ATN_AGW-SID-0029 updated (§3.1.2.6), reference to ARINC741p2 updated (§5.1) • Table 4 added (§3.1.2.8) <ALLOCATED TO> attribute added for all requirements Honeywell added as approver and INMARSAT added as reviewer
00.01.02	26/1/2015	Final		Updated with and SJU feedback (round 2) • Clarification added on interface definition sharing with ESA Iris project (§1.1) <ALLOCATED TO> attribute linked to P09.49 functional block “Communication - A/G datalink”

Intellectual Property Rights (foreground)

This deliverable consists of SJU foreground.

Table of Contents

List of tables

List of figures

Executive summary

Iris is the European Space Agency's (ESA) program to develop a comprehensive satellite ATM system for SESAR based on a global communication standard.
As part of incrementally working towards the long-term Iris goals, the Iris Precursor service will provide air-ground communications for initial 4D flight path control by 2018.

This document describes an interface allowing the ATSU to transmit and receive ATN/OSI packets over a SATCOM INMARSAT system.

- The objective is to work on definition that minimizes the impacts on the both systems ATSU-SDU SATCOM and on the interface between the two systems. **The industry standard ARINC 429 physical interface will be used; such an interface already exists between the Air Traffic Services Unit (ATSU) and the Satellite Data Unit (SDU) and is currently used to support the transfer of ACARS format messages.**

- The purpose of the IRS is to specify interface requirements to be met by the participating functional blocks. It includes a synthetic description of the functional blocks, defines the message structure and protocols which govern the interchange of data, and identifies the communication paths along which the data is expected to flow.

1 Introduction

1.1 Purpose of the document

This document defines and allocates the set of requirements applicable to the Iris Precursor system for the ATSU-SDU interface aspects for implementations of data link services supporting ATS in continental or oceanic airspace.

Figure below illustrates, as a block diagram, how the Iris Precursor system is expected to be introduced into an ATN/OSI system, operating alongside the existing VDL Mode 2 service.

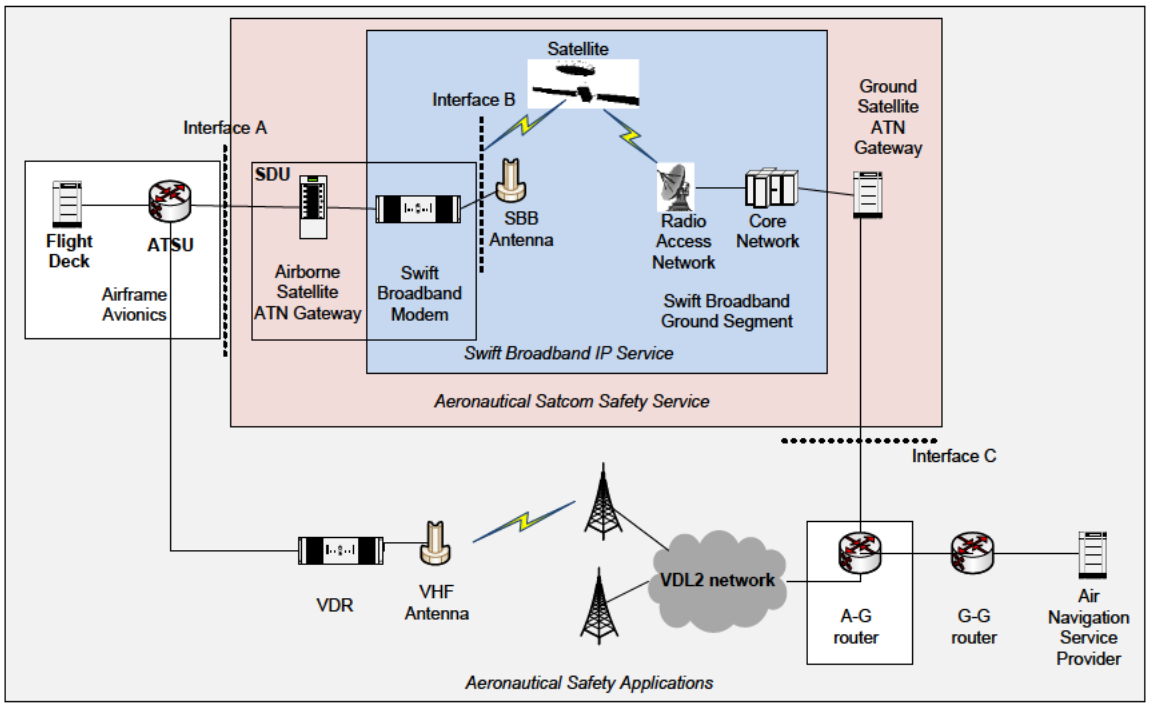

Figure 1: End-End System Architectural Concept

The Iris Precursor system will provide the Aeronautical SATCOM Safety Services, as per [SRD Iris Precursor system].

The end-end communications system architecture utilises for this prototype the SwiftBroadband system as the core satellite communications infrastructure for provision of SATCOM connectivity.

Figure below depicts the Iris Precursor system boundaries in accordance with [SDD Iris Precursor system].

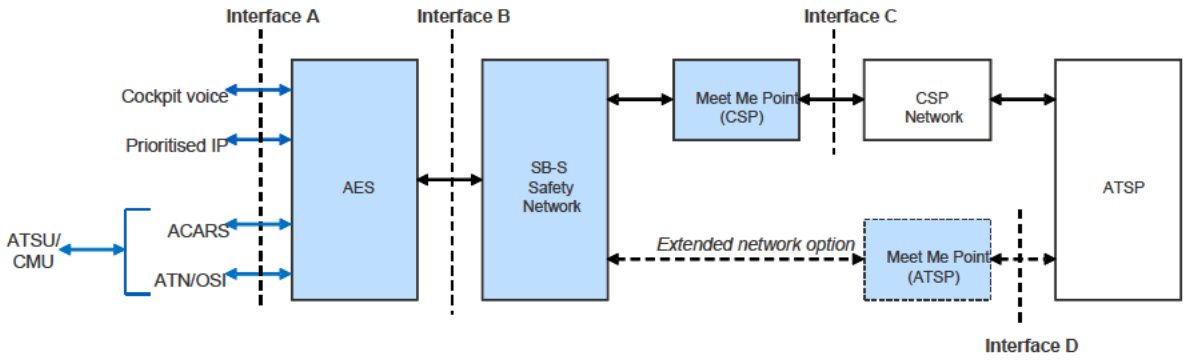

Figure 2: Iris Precursor system Delivery Boundaries

Four interfaces are defined:

- Interface 'A' to the ATSU. This marks the technical boundary for the SwiftBroadband system on the aircraft for ATN/OSI and ACARS data services, and the boundary to which practical measurements can be made regarding end-to-end transit delay performance of the SB-S Safety Service.

- Interface 'B' at the air interface to the AES antenna: This is the defined service boundary for air-to-ground communication service provision for both Link 2000+ and I4D services, and hence marks the contractual and safety service boundary for ISP provision on the air side. Specifically 'network availability' is defined at this point.

- Interface 'C' at the boundary to another CSP: This is the technical and service boundary for the SwiftBroadband system on the ground for the baseline service option. It marks the contractual and safety service boundary for ISP provision to CSPs.

- Interface 'D' at the boundary to an ATSP: This is an extension to the technical and service boundary for the SwiftBroadband system for service delivery direct to ATSPs.

➔ The scope of this document is Interface 'A' to the ATSU.

1. ***interfaces B & C are covered by SDD INMARSAT document [SDD Iris Precursor system] - INMARSAT confirmed that those interfaces will be verified as part of ESA Iris project***
2. ***the air-ground message format and how application message are encapsulated are described in the SDD INMARSAT [SDD Iris Precursor system]***

The objective is to work on definition that minimizes the impacts on the both systems ATSU-SDU SATCOM and on the interface between the two systems. The industry standard ARINC 429 physical interface will be used; such an interface already exists between the Air Traffic Services Unit (ATSU) and the Satellite Data Unit (SDU) and is currently used to support the transfer of ACARS format messages. It is intended that the ACARS messaging has to transit in same time on this interface.

The ATSU-SDU interface to support ACARS messaging is defined in ARINC 741 and has to be extended to include the exchange of CLNP packets and ISH PDU for ATN/OSI support.

1.2 Intended readership

The following readers should be interested in this document:

- Members of project developing functional requirements for the satellite/ground segment should verify that the airborne and satellite/ground segments are compatible.
- Developers of ATSU and SDU equipment should read and further elaborate the technical requirements captured in this document.

1.3 Inputs from other projects

N/A

1.4 Document Overview

The purpose of the IRS is to specify interface requirements to be met by the participating functional blocks. It includes a synthetic description of the functional blocks, defines the message structure and protocols which govern the interchange of data, and identifies the communication paths along which the data is expected to flow.

1.5 Requirements Definitions – General Guidance

This section introduces the general guidance on requirements used in the next sections.

In order to enable the import of SE Data in the SESAR SE Repository, the layout described in Templates and Toolbox User Manual [3] is used and illustrated below.

[REQ]

Identifier	< Each requirement is uniquely identified as it aids in requirements tracing>
Requirement	< This attribute contains the statement of the requirement>
Title	< This attribute contains the title of the requirement. This attribute is optional and was designed to help the projects identify different requirements via a short text rather than the identifier> **Not used for the purpose of this IRS**
Status	<In Progress> - if the requirement is applicable; <Deleted> - if it is no longer applicable and thus has been deleted; <Validated> - if the requirement has been validated within exercises.
Rationale	< The rationale should be a short text, a summary, of the reasoning behind the need of this requirement and could also point to any supporting analysis, trade study, modelling, simulation, or other substantive objective evidence>

Category	<Design> - Design requirements limit the options open to the designer of a solution by imposing immovable boundaries and limits (e.g., the system shall incorporate a legacy or provided system element, or certain data shall be maintained in an on-line repository). <Functional> - Functional requirements describe the system or system element functions or tasks to be performed. <Interface> - Interface requirements are the definition of how the system is required to interact with external systems (external interface), or how system elements within the system, including human elements, interact with each other (internal interface). <Interoperability> - Interoperability requirements define the ability of two or more systems or system components (including actors/operators) to exchange information and to use the information that has been exchanged. <Operational> - Operational requirements state operational attributes of a system needed for the effective and/or efficient provision/use of ATS to meet the operational objectives. <Performance> - Performance requirements define the extent or how well, and under what conditions, a function or task is to be performed. These are quantitative requirements of system performance and are verifiable individually. Note that there may be more than one performance requirement associated with a single function, functional requirement, or task.
Validation Method	<Live Trial> - Live trials involve the deployment of prototypes of operational tools and/or the use of proposed procedures in live operation. They have the advantage of exposing the proposed concept to reality but inevitably place high demands on rigorous safety assessment and understanding the effects (positive and negative) on impacted traffic. To gain maximum assessment benefit, a live trial should be run for an extended period of data collection. It must be understood that in experimental terms a live trial takes place in an uncontrolled situation, so experiments and data collections are often not easily repeatable or comparable with pre-trial operations. Live trials will generally be very expensive to set up and run, and hence they should only be carried out when justified by a high level of confidence in the proposed concept. <Expert Group (Judgement Analysis)> - Judgemental techniques involve having a team of subject matter experts participate in a structured review of a proposed concept. Well-known techniques exist, such as Delphi Methods. This technique should be used particularly to review immature concepts. A typical assessment would involve eliciting and recording the opinions from a representative group of experts – opinions will be recorded in accordance with the plans. The exercise could be in the form of a meeting, at which the validation team facilitates the discussions or it could be purely paper-based, circulating specific information and questionnaires e.g. by mail or e-mail to the experts.
Verification Method	<Review of Design> - A set of activities whose purpose is to evaluate the suitability, adequacy, effectiveness, and sometimes the efficiency of a set of specifications. Design review can be used to evaluate product, process, and system specifications. In this context, an effective set of specifications is one that has the potential to achieve planned results or realize planned activities. <Test> - An action by which the operability, supportability, or performance capability of an item is quantitatively verified when subjected to controlled conditions that are real or simulated. These verifications often use special test equipment or instrumentation to obtain very accurate quantitative data for analysis.

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance

Table 1: Requirements Layout

The "REQ Trace" table is composed of four columns, namely:

- **Relationship** – specifies the type of link (e.g. <SATISFIES>, <ALLOCATED_TO>). This column can have only one value.
- **Linked Element Type** – As the different type of links can connect different types of elements (SE and reference data), the element type needs to be specified. This column can have only one value for example <ATMS Requirement> for a requirement defined in the SESAR documents having templates (e.g. DOD, OSED, SPR, INTEROP, TS).

- **Identifier** – contains the identifier of the element (SE or reference data) to which the requirement is linked. This column should only contain one identifier.
- **Compliance** – the compliance cell, is included in any row that corresponds to a link, however it is only relevant for <SATISFIES> links.
  - For the <SATISFIES> link type, the compliance gives a rough estimate on how well this requirement meets the referenced requirement. It can have one of the following values:
    - <Full> when the requirement is 100% compliant with the linked requirement
    - <Partial> when the requirement is not 100% compliant with the linked requirement
    - <None> when the requirement is linked to but does not meet the linked requirement due to specific reasons (e.g. technology etc.).
  - For all other types of links, the compliance is N/A which indicates that it is not applicable.

1.6 Functional block Identification

Figure below identifies the functional blocks in both ATSU and SDU.

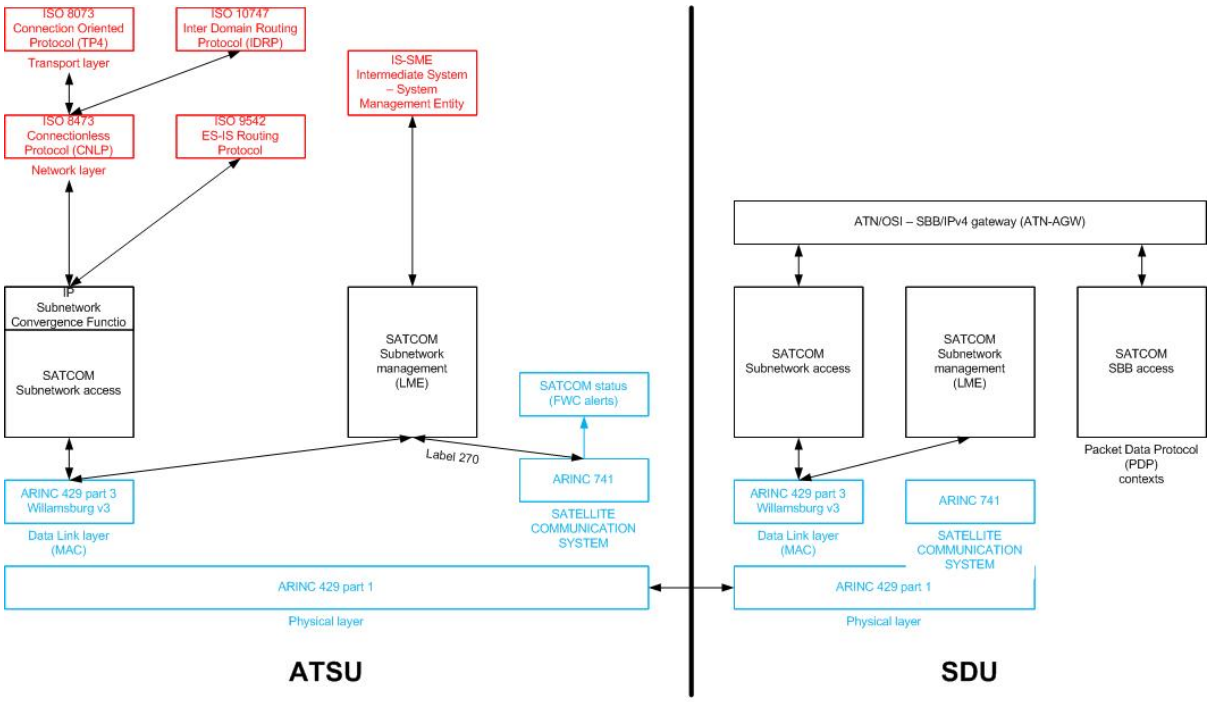

Figure 3: Iris Precursor system Functional block Identification for airborne subsystem

***Note**: the light blue boxes depict the functions already supported by ATSU and SDU, typically to support ACARS A/G communications. Red boxes refer to upper layers of communication stack in ATSU, while black boxes depict novelties or adaptations in both ATSU and SDU.*

The ATN Aircraft Gateway (ATN-AGW) (shown on figure 1 as 'Airborne ATN satellite Gateway') is implemented within the AES Satellite Data Unit and acts as a simple relay of ATN/OSI messages between the ARINC 429 bus and the subnetwork service supported over SwiftBroadband. Air-to-ground datagrams received from the Airborne Router within the ATSU are encapsulated in IP packets by the ATN-AGW and forwarded towards SB-S Safety Network; similarly ground-to-air datagrams

received encapsulated in IP packets are extracted and forwarded to the Airborne Router via the ARINC 429 bus.

The ATN-AGW therefore acts as the aircraft endpoint for the SB-S Mobile Sub-Network service for delivery of ATN/OSI traffic over the satellite link. It is implemented in the SDU to avoid significant changes to the Airborne Router functionality within the ATSU.

1.6.1 Functional block “SATCOM Subnetwork access”

The functional block “SATCOM Subnetwork access” is in charge of providing the SN-Service required for user data exchange, typically CLNP packets or ISH PDUs.

1.6.2 Functional block “SATCOM Subnetwork management”

The functional block “SATCOM Sub-network management” is in charge of providing connectivity information needed by the airborne router, typically “join” and “leave” events.

1.6.3 Functional block “SATCOM status”

The functional block “SATCOM status” is in charge of providing ARINC 741-defined information, typically those included in label 270. This functional block is identified to ensure compatibility with already implemented functions in ATSU, typically ACARS and alerts reporting to flight deck.

1.7 Glossary of terms

Aeronautical mobile-satellite (R) service (AMS(R)S)( ): An aeronautical mobile-satellite service reserved for communications relating to safety and regularity of flights, primarily along national or international civil air routes.

Unicast: the one-to-one transmission of data packets to one specified destination

Multicast: the one-to-many transmission of data packets to interested destinations

Broadcast: the one-to-all transmission of data packets to all possible destinations

Communication protocol: A set of rules defining how network entities interact with each other, including both syntactic and semantic definitions

Layered protocol: A class of communication protocols that is sub-divided into separate layers, each of which performs distinct functions.

Protocol stack: A specific instance of a layered protocol that defines the communication protocol.

> The satellite communication system developed within the Iris Programme supports several protocols in parallel, each with its own terminology. The ISO-OSI reference protocol stack terminology is used for describing these protocols.

Physical Layer: The physical layer defines the Satellite Communication System waveform, including modulation and coding.

Link Layer: The link layer defines the media access method (often referred to as MAC - Media access control) as well as framing, formatting and error control (often referred to as LLC - logical link control).

Network Layer: The network layer defines the format of en-to-end data packets, as well as routing of packets within the network

Transport layer: The transport layer defines end-to-end functionalities such as reliable/unreliable data transport, flow and congestion control.

> The transport layer operates end-to-end, and is implemented only in the end systems. Therefore, it has no direct impact on the Satellite Communication system. However, the mechanisms of the transport layer have to be carried, in the form of overhead on network layer packets and additional packets.

Ground Segment (GS): The collection of all entities in the System located on ground.

User Terminal (also called Airborne Earth Station - AES): The avionics onboard the aircraft that implements the communication protocol and provides the interface to other on-board elements via an on-board network.

Air Navigation Service Provider (ANSP): a body that manages flight traffic on behalf of a company, region or country.

Transaction: The basic unit of interaction between peer parties used for operational, safety and performance assessments. An interaction includes one or more operational messages that are transmitted using the same communication medium from one party to the other. It also includes related message activities, i.e. message identification, message composition, and message recognition.

Connection Establishment Delay: Connection establishment delay, as defined in ISO 8348, includes a component, attributable to the called subnetwork (SN) service user, which is the time between the SN-CONNECT indication and the SN-CONNECT response. This user component is due to actions outside the boundaries of the satellite subnetwork and is therefore excluded from the AMS(R)S specifications.

Data Transfer Delay requirements are set by the need to assure that data link messages are delivered through the communications system in a timely manner. The measured transfer delay characteristics of a subnetwork and its elements are normally characterized by data which, plotted as a histogram, appear as an probability distribution having a biased offset (latency) from the zero value. The DO270 expresses three different values of transfer delay the latency, the mean value (transit delay) and the 95th-percentile value. These values are the minimum necessary to combine properly the delay data of individual elements, systems and subnetworks for aggregated delay values (e.g., for "end-through-end" delays). (RTCA DO 270).

Data Transfer Latency of the AMS(R)S System is defined under conditions of no user traffic loading other than the test block itself; however, normal system management traffic and protocol overhead traffic are expected to be present, due to management entities internal to the subnetwork. Thus, latency is the minimum delay that can be expected within the system, and accounts for the relatively fixed delay components such as propagation delay, component transmission speeds, and latent buffering.[RTCA DO-270 Section 2.2.5.1.4].

Data Transit Delay: in packet data system, the elapsed time between a request to transmit an assembled data packet and an indication at the receiving end that the corresponding packet has been received and is ready to be used.

Validation: the process which demonstrates the conformance of the system to the user needs

> Note: The SATCOM system is only verified against the SRD requirements to transport messages from the aircraft antenna to the attachment point of the GES within the defined coverage and within the defined performance parameters. To validate that this SATCOM service is suitable to support operational application, additional activities are needed,

including the procedures and the HMI in the ATS Units and in the cockpit. Validation therefore requires the contribution of multiple actors. The end result of the validation is a safety assessment submitted respectively by the aircraft operator or by the ATSP to their competent authorities. The COM SP is not legally responsible for this latter process.

Verification: the process which demonstrates the conformance of the SATCOM system to applicable requirements.

PDP context: A Packet Data Protocol (PDP) context transfers information about data connections between the SwiftBroadband terminal and the Inmarsat Network. The PDP context defines connection aspects such as routing, QoS and security. The SwiftBroadband terminal opens a primary PDP context or a secondary PDP context, depending on the IP data connection type.

ORT: The Owner Requirements Table (ORT) is a table of configuration data that is used to customize the operation of the AES. The ORT is split in to two sub ORTs known as the "Secure ORT" and the "User ORT." The Secure ORT holds configuration data which if changed would affect the certification of the aircraft. The User ORT holds configuration data which if changed would not affect the certification of the aircraft. (Refer to ARINC 781)

ATSU (Air Traffic Services Unit) is the main component of Airbus ATIMS (Air Traffic and Information Management. System) – in this document the term ATSU refers to this airborne communication unit installed on Airbus aircraft family.

1.8 Acronyms and Terminology

Acronym	Definition
ACARS	Aircraft Communications Addressing and Reporting System
ACD	Aircraft Control Domain
AES	Aeronautical Earth Station
AISD	Airline Information Services Domain
AMS(R)S	Aeronautical Mobile Satellite (Route) Service
ATC	Air Traffic Control
ATIMS	Air Traffic & Information Management System
ATM	Air Traffic Management
ATN	Aeronautical Telecommunication Network
ATS	Air Traffic Services
ATSP	Air Traffic Service Provider
ATSU	Air Traffic Services Unit
BGAN	Broadband Global Area Network
BOP	Bit Oriented Protocol

Acronym	Definition
CMU	Communication Management Unit
CSP	Communication Service Provider
E-ATMS	European Air Traffic Management System
EUROCAE	European Organisation for Civil Aviation Equipment
FANS	Future Air Navigation System
FDU	Frame Data Unit
FWC	Flight Warning Computer
GFI	General Format Identifier
I4D	Initial 4D (Trajectory Management)
ICD	Interface Control Document
IRS	Interface Requirement Specification
ORT	Owner Requirements Table
OSED	Operational Service and Environment Definition
OSI	Open System Interconnection
PDP	Packet Data Protocol
PDU	Protocol Data Unit
RTCA	Radio Technical Commission for Aeronautics
SAL	System Address Label
SBB	SwiftBroadband (aeronautical derivative of the BGAN service)
SDM	System Definition Manual
SDU	Satellite Data Unit
SE	System Engineering
SESAR	Single European Skies ATM Research
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU
SID	System Interface Document

Acronym	Definition
SJU	SESAR Joint Undertaking
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking
SPR	Safety and Performance Requirements
SRD	System Requirements Document
SSM	Sign/Status Matrix
TAD	Technical Architecture Description
TS	Technical Specification
UT	User Terminal
VDL	VHF DataLink

2 Functional block(s) and Interface(s) Overview

2.1 Functional block Overview

2.1.1 Functional block “SATCOM Subnetwork access” ATSU-SDU Interface Overview

The exchange of CLNP packets over the SBB IP Network is achieved via a suitable Subnetwork Dependent Convergence Function (SNDCF) which adapts the generic inter-layer interface presented from CLNP to the specific service interface presented by the subnetwork. The basis for the SNDCF for the SB-S network is using the model shown in Figure below.

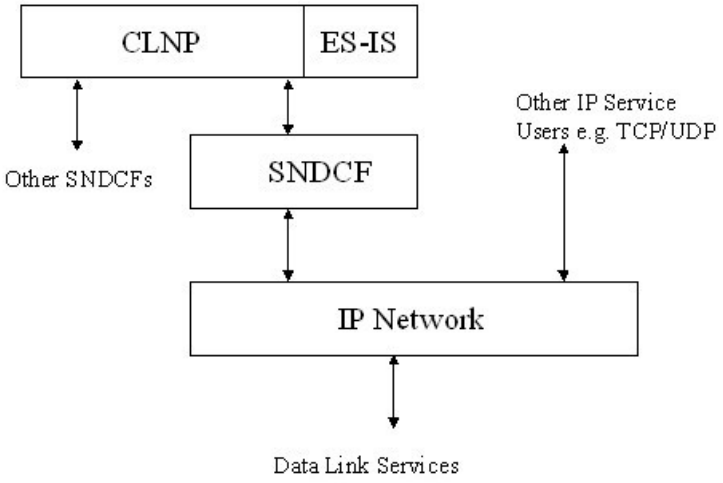

Figure 4: Basis for the SNDCF

SNDCF provides a relatively simple set of features to support SN-UNITDATA.Request and Indication primitives to/from the network layer, including presentation of user data to/from the subnetwork layer. CLNP packets become the payload of an IP packet with a protocol identifier of ISO-IP.

***Note**: provisions to support compression mechanisms will be defined (Local reference “LREF” compression as specified in 3.7.4 “SNDCF for ISO/IEC 8208 mobile subnetworks” – or others) but not foreseen to be activated in the scope of this project.*

2.1.2 Functional block “SATCOM Subnetwork management” ATSU-SDU Interface Overview

The ATN-AGW will establish a PDP Context for its own use and try to establish a connexion to the ground peer entity. Once successfully established, the ATN-AGW sends a JOIN event to the ATSU (Airborne Router IS-SME) via the ARINC 429 bus. It will also resolve the IP Address of the default Air/Ground ATN Router (ATN-GGW) using the DNS.

Then, the ATSU reacts to the Join Event by generating an ISH PDU and passing it to the ATN-AGW for downlink to the default ATN Air/Ground Router. ATN-AGW encapsulates the ISH PDU in an IP Packet and sends it to the ATN-GGW.

When the ISH is received by the ATN-GGW, the ATN-GGW reacts by generating its own ISH PDU and sending it back to the source IP Address. It will be routed back to the ATN-AGW in an IP Packet. The ATN-AGW will de-encapsulate the ISH PDU and forward it to the ATSU where it is used to generate an entry in the router's forwarding table i.e. an entry that indicating that any packet addressed to the ATN-GGW Network Address should be sent via the SATCOM link.

Route Termination is triggered when the ATN-AGW recognises that connectivity has been lost and issuing a LEAVE event to the respective IS-SME entity in the Airborne Router.

2.1.3 Functional block “SATCOM status” ATSU-SDU Interface Overview

This interface provides periodic ARINC labels already sent as per ARINC 741 – those labels are typically used to exchange status between ATSU and SDU:

- Label 377: Equipment ID
- Label 172: Subsystem Identifier
- Label 270: ATSU Status
- Label 270: SDU Status

3 Detailed Interface Requirements

3.1 General Requirements

***Note**: Verification Method for requirements in sections 3.1.3.1, 3.1.3.2 and 3.1.3.6 is set to <Review of Design> provided that the supplier will give to the Project the proper visibility of the test phase at sub-system level. Under this constraint, these requirements are not intended to be verified again by Airbus during ATSU-SDU integration phase.*

3.1.1 Interface "SATCOM Subnetwork access" ATSU-SDU Requirements

3.1.1.1 Operations

[REQ]

Identifier	ATN_AGW-SID-0001
Requirement	The Precursor System shall provide simultaneous ACARS and ATN/OSI network services to the ATS and AOC applications.
Title	
Status	<Validated>
Rationale	The Precursor System shall be compatible with and interface to the current ACARS network.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SRD Requirement>	PREC-CSY-0200	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0002
Requirement	The interface between ATSU and SDU shall be based on ARINC 429 Version 3 of the bit-oriented bit-oriented (Williamsburg) protocol (BOP) as specified in ARINC SPECIFICATION 429 PART 3
Title	
Status	<Validated>
Rationale	The Precursor System shall be compatible with and interfaced to the current ACARS network. The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU. See below
Category	<Design>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SRD Requirement>	PREC-CSY-0200	<Full>
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

It's assumed that ACARS and ATN/OSI have to be provided simultaneously, the table hereafter depicts the possible combinations between legacy ACARS over classic Aero, ACARS over SBB and ATN/OSI that can be used in same time over the ARINC 429 interface.

ACARS over Classic aero	ACARS over SBB (AGGW)	ATN over SBB	Possible cases	ARINC 429 interface	*Typical configuration*
No	No	No	**N/A**		
No	No	Yes	**Yes (ATN only)**	Williamsburg protocol V3	*Iris Presursor typical configuration with ATSU and SDU SBB*
No	Yes	No	**Yes (ACARS over SBB only)**	Williamsburg protocol V1 recommended – out of Iris Precursor scope	*SDU SBB connected to an ATSU legacy (not ATN/OSI over SATCOM capable)*
No	Yes	Yes	**Yes**	Williamsburg protocol V3	*Future configuration with ATSU and SDU SBB – extended with the support of ACARS*
Yes	No	No	**Yes (legacy ACARS only)**	Williamsburg protocol V1	*SDU Classic Aero connected to an ATSU legacy*
Yes	No	Yes	**Yes**	Williamsburg protocol V3	*Future configuration with ATSU and SDU SBB – extended with the support of ACARS*
Yes	Yes	No	**Yes (ACARS only)**	Williamsburg protocol V1 recommended – out of Iris Precursor scope	*SDU SBB connected to an ATSU legacy (not ATN/OSI over SATCOM capable)*
Yes	Yes	Yes	**Yes**	Williamsburg protocol V3	*Future configuration with ATSU and SDU SBB – extended with the support of ACARS*

Table 2: Services that can be used in same time

3.1.1.2 Functional Requirements

[REQ]

Identifier	ATN_AGW-SID-0003
Requirement	The ATSU shall forward air-to-ground datagrams encapsulated within data packets (e.g.: CLNP packets or ISH PDUs) to the SDU for transmission to a ground ATN router via SBB service.
Title	
Status	<Validated>
Rationale	The ATN Aircraft Gateway (ATN-AGW) shall be implemented as a relay between the ATSU/CMU and an ATN Air/ground or Ground/Ground ATN Router via SBB.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-ATNAGW-0010	<Full>

<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0031
Requirement	The SDU shall forward to the ATSU ground-to-air datagrams encapsulated within data packets (e.g.: CLNP packets or ISH PDUs) received from a ground ATN router via SBB service.
Title	
Status	<Validated>
Rationale	The ATN-AGW shall use the ATSU/CMU Interface function to pass packets to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-ATNAGW-0020	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0004
Requirement	The SDU shall deliver only valid data packets intended for the aircraft to ATSU.
Title	
Status	<Validated>
Rationale	The ATSU only expects messages intended for the aircraft.
Category	<Functional>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.1.3 Performance Requirements

[REQ]

Identifier	ATN_AGW-SID-0005
Requirement	The SDU (resp. ATSU) shall transfer data with the length up to 1024 bytes to the ATSU (resp. to the SDU) over ARINC 429 in less than 250ms. This time is evaluated starting from the transmission of Start of Frame (SOF) to the transmission of End of Frame (EOF) of the FDU, including the 16-bit Cyclic Redundancy Check (CRC).
Title	
Status	<Validated>
Rationale	The Precursor System shall support the Data Link services listed in EUROCAE ED-228 / RTCA DO-350, “Data Communications Safety and Performance Requirements” with the associated performance requirements. Max serialization time for a 1024-bytes buffer (worst case) on an ARINC 429 high-speed bus (100Kbps) is roughly 130ms, response time is evaluated to 100ms
Category	<Performance>
Validation Method	<Expert Group (Judgement Analysis)>

Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SRD Requirement>	PREC-CSY-0090	<Partial>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.1.4 Security and Integrity Requirements

N/A (refer to §4 "Assumptions").

3.1.1.5 Physical requirements

[REQ]

Identifier	ATN_AGW-SID-0006
Requirement	The interface between ATSU and SDU shall use ARINC 429 high-speed bus as specified in ARINC SPECIFICATION 429 PART 1
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.1.6 Data Transfer

[REQ]

Identifier	ATN_AGW-SID-0007
Requirement	The interface between ATSU and SDU shall use ARINC 429 BOP options as follows:

OPTION	DESCRIPTION	DEFAULT
O1	Half or Full duplex	Full
O2	High or Low Speed Bus	High
O3	Automatic CTS When Ready	N/A
O4	Accept Automatic CTS	N/A
O5	SYS Priority to Resolve Conflict	N/A
O6	Reserved	
O7	Reserved	
O8	Use of SOLO Word	Yes
O9	Reserved	
O10	Destination Code Required	N/A
O11	Bit-Protocol Verification	Yes
O12	Use Subsystem SAL from ALO word	No
O13	Use of information or Command Frames	Command Frame
O14	Use of Pause Function	No
O15	Generate 32bit CRC for information frame	N/A

Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU. Option O8 is set to default value ('Yes') despite the fact that no SOLO Word is defined, this value is kept for compatibility with VDL interface.
Category	<Interface>

Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0008
Requirement	The interface between ATSU and SDU shall use ARINC 429 BOP timers defined in ARINC SPECIFICATION 429 PART 3 table 10-6.
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0009
Requirement	The interface between ATSU and SDU shall use ARINC 429 BOP as follows: - Destination code: ATSU=M, SDU=S - General Format Identifier (GFI): 5 (ATN SATCOM Format)
Title	
Status	<Validated>
Rationale	General Format Identifier (GFI) : already defined values (4=8208 packets and 14(0xE)=Data-2 Enveloped message) cannot be reused. Proposal to use value 5 ('Reserved') not yet defined in ARINC 429 Table 11-6A of Attachment 11. The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0010
Requirement	The SDU shall use the label 304 (ATSU SAL) during ARINC 429 Williamsburg exchanges with ATSU.
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0011
Requirement	The ATSU shall use the label 307 (SDU SAL) during ARINC 429 Williamsburg exchanges with SDU.
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.1.7 Transactions

N/A.

3.1.1.8 Service Interface Requirements

[REQ]

Identifier	ATN_AGW-SID-0035
Requirement	The ATSU and SDU shall encapsulate datagrams by adding a header within the ARINC 429 BOP frames.
Title	
Status	<Validated>
Rationale	This header is provisioned to support future flow-control, QoS, ... that may needed in the future. This header is added (resp. removed) by the SDU before transmission to the ATSU (resp. ground network).
Category	<Functional>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0036
Requirement	The header exchanged between ATSU and SDU shall be as follows: • One single byte ▪ 3 first MSB (most significant bits): Protocol Id, set to 5 ▪ 5 last LSB (least significant bits): Version, set to 0
Title	
Status	<Validated>
Rationale	Only a provisional header is defined in the scope of SESAR P15.2.5.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			

<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.2 Interface "SATCOM Subnetwork management" ATSU-SDU Requirements

3.1.2.1 Operations

The following "ATN join" sequence diagrams are presented below:

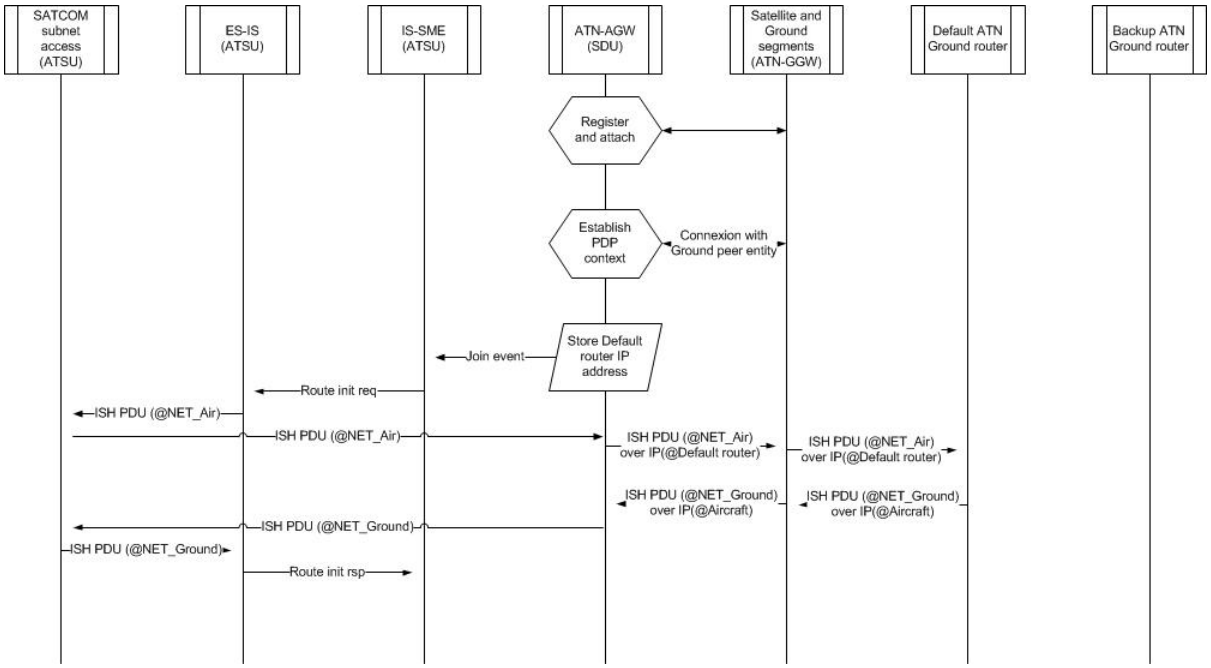

Figure 5: "ATN join" sequence diagram (with default AGR)

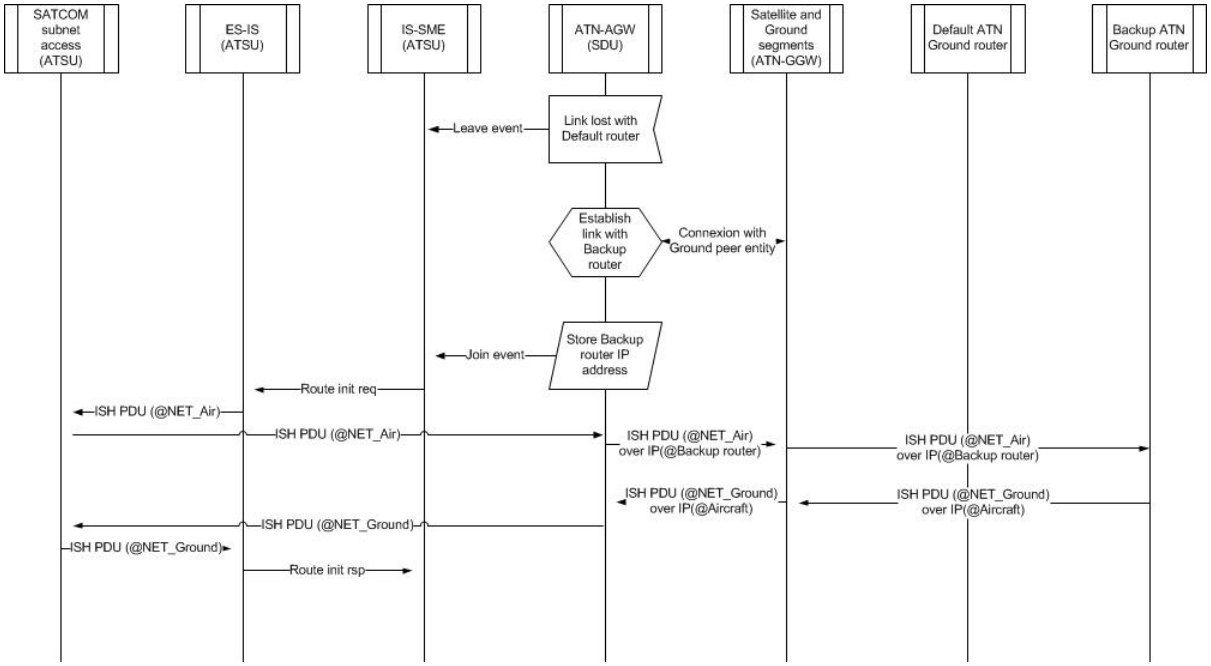

Figure 6: "ATN leave/join" sequence diagram (handover to backup AGR)

3.1.2.2 Functional Requirements

[REQ]

Identifier	ATN_AGW-SID-0012
Requirement	The SDU shall issue a "join event" to the ATSU to indicate the availability of a communication path over SATCOM.
Title	
Status	<Validated>
Rationale	When the ATN-AGW is notified by the PDP Context Management function that it has established a PDP Context for ATS use, it shall a) perform a DNS lookup to determine the IP Address(es) of the ATN-GGW by looking up the Domain Name: atn.iris.inmarsat.com b) and then send an ATN Service Join Event to the ATSU/CMU. The ATSU/CMU shall use the IRISP-ACI-0020 Join Event (ATN) and the IRISP-ACI-0020 Leave Event (ATN) to determine when to start the ATN Route Initiation Procedure over SATCOM and when the SATCOM link is no longer available, respectively.
Category	<Functional>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-ATNAGW-0060	<Full>
<SATISFIES>	<SDD Requirement>	IRISP-CMU-0070	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0013
Requirement	The SDU shall issue a "leave event" to the ATSU to indicate that a previously available communication path over SATCOM is no longer available.

Title	
Status	<Validated>
Rationale	When the ATN-AGW is notified that the current PDP Context has been irretrievably lost, it shall send an ATN Service Leave Event to the ATSU/CMU. The ATSU/CMU shall use the IRISP-ACI-0020 Join Event (ATN) and the IRISP-ACI-0020 Leave Event (ATN) to determine when to start the ATN Route Initiation Procedure over SATCOM and when the SATCOM link is no longer available, respectively.
Category	<Functional>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-ATNAGW-0100	<Full>
<SATISFIES>	<SDD Requirement>	IRISP-CMU-0070	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0027
Requirement	The SDU shall manage transparently all satellite/GES handovers or potential RAN/Core Network failovers without the need to issue a “handoff event” to the ATSU. **Note**: a change of Air-Ground Router (AGR) is covered by a LEAVE/JOIN sequence as defined above.
Title	
Status	<Validated>
Rationale	Handoff is implemented by some ISO/IEC 8208 subnetworks, for example, the VHF digital link (VDL), when an aircraft moves out of the coverage of a ground station it is currently using and into the coverage of another – typically operated by the same service provider. When the change of ground station also requires a change of ATN air-ground router then the subnetwork may simply generate a join event for the new air-ground router, followed by a leave event for the old air-ground router. In that case, reconnection of ATN upper layers is necessary. But, when the air-ground router accessed through the old ground station is also accessible through the new ground station then a different procedure is required if the full overhead of route initiation is to be avoided.
Category	<Functional>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.2.3 Performance Requirements

[REQ]

Identifier	ATN AGW-SID-0028
Requirement	The SDU shall filter overly-frequent “join/leave events” and report a change in the availability of a communication path over SATCOM not more frequent than 10 seconds.
Title	
Status	<In Progress>
Rationale	To prevent highly dynamic changes to router state, timers are implemented in subnetwork itself to suppress overly-frequent JOIN/LEAVE events. Spotbeam handover is about 1sec, by analogy with VDL2 filtering implemented in ATSU the value of 10sec is proposed. Spotbeam handovers will not cause a change in Join/Leave status (unless it fails, as data is preserved across the handover).
Category	<Performance>
Validation Method	<Live Trial>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

***Note**: Potential need for a customisation parameter in the SDU ORT to define this threshold will be discussed in SDU system requirements document*

3.1.2.4 Security and Integrity Requirements

N/A (refer to §4 "Assumptions").

3.1.2.5 Physical requirements

Refer to 3.1.1.5 "Physical requirements"

3.1.2.6 Data Transfer

[REQ]

<table>
<tr><td>Identifier</td><td>ATN_AGW-SID-0029</td></tr>
<tr><td>Requirement</td><td>The SDU shall transmit ARINC 429 Label 271: Join/Leave Message as follows:
<table>
<tr><th>BIT</th><th>DEFINITION</th><th>COMMENTS</th></tr>
<tr><td>1-8</td><td>Label 271</td><td></td></tr>
<tr><td>9-16</td><td>GES ID</td><td></td></tr>
<tr><td>17-22</td><td>Satellite ID</td><td></td></tr>
<tr><td>23-25</td><td>Aero service type</td><td>Aero service type currently being provided :
000: Aero-L
001: Aero-I
010: Aero-H
011: Aero-H+
100: SwiftBroadband (regardless of Class/antenna type)
101-111: Reserved for future use</td></tr>
<tr><td>26-28</td><td>Connectivity status</td><td>Not defined yet in ARINC 741</td></tr>
<tr><td>29</td><td>Data Link via MU/CMU Not Available (identical to Label 270 Bit 11)</td><td></td></tr>
<tr><td>30-31</td><td>Sign Status Matrix</td><td>Normal 00_h</td></tr>
<tr><td>32</td><td>Parity (odd)</td><td></td></tr>
</table></td></tr>
<tr><td>Title</td><td></td></tr>
<tr><td>Status</td><td><Validated></td></tr>
<tr><td>Rationale</td><td>Label 271 is defined in ARINC 741 as "SDU to ACARS MU/CMU Join/Leave Message". This label can be used also for ATN Join/Leave, bits 26-28 currently defined as spares can provide connectivity status based on SDU capability and subnetwork availability.</td></tr>
<tr><td>Category</td><td><Interface></td></tr>
<tr><td>Validation Method</td><td><Expert Group (Judgement Analysis)></td></tr>
<tr><td>Verification Method</td><td><Review of Design></td></tr>
</table>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0032
Requirement	The SDU shall transmit ARINC 429 Label 271 once per second.
Title	
Status	<Validated>
Rationale	As per ARINC 741 §4.7.3 Link Layer – Broadcast: "The SDU and the ACARS MU/CMU should monitor each other's status by exchanging Label 27x status words (as defined in the subsection which follow) once per second".
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance

<SATISFIES>			
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.2.7 Transactions

N/A.

3.1.2.8 Service Interface Requirements

[REQ]

Identifier	ATN_AGW-SID-0030
Requirement	The SDU shall transmit ARINC 429 Label 271 as follows: • bit 26: set to 1 when ACARS legacy (Aero-H+ or equivalent) is AVAILABLE • bit 27: set to 1 when ACARS SB-S (SBB or equivalent) is AVAILABLE • bit 28: set to 1 when ATN/OSI SB-S (SBB or equivalent) is AVAILABLE
Title	
Status	<Validated>
Rationale	To support configurations identified in table 2 the ATSU needs to know if ACARS or ATN/OSI are available. See below.
Category	<Interoperability>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

Considering the possible cases identified in table 2 the potential SDU configurations are evaluated, detailed requirements will be provided in both ATSU and SDU system requirements documents:

Configuration #1: SDU only capable of ACARS over Classic aero

This configuration is related to the legacy SATCOM systems already installed.

- The SDU provides a Williamsburg protocol V1 interface compliant with the ARINC 741 legacy definition,
- The ATSU doesn't make use of Label 271.

Configuration #2: SDU capable of ACARS over Classic aero and over SBB (AGGW)

This configuration is related to future SATCOM systems that provide only ACARS services, use of Williamsburg protocol V1 interface is recommended to ensure upward compatibility.

- The SDU provides a Williamsburg protocol V1 interface, use of label 271 is optional but the SDU can only set bit 26 or 27 depending on connectivity status (bit 28 must be set to 0),
- Potential need for a customisation parameter in the SDU ORT to define priority between ACARS over Classic aero and over SBB will be discussed in SDU system requirements document.

Configuration #3: SDU with full capability

This configuration is related to future SATCOM systems that provide full ACARS and ATN/OSI services.

- The SDU provides a Williamsburg protocol V3 interface, use of label 271 is mandatory, the SDU sets bit 26 to 28 depending on connectivity status, the ATSU selects the subnetwork to be used based on its own capability and routing policy (ATN in a FANS B environment, ...), use of those bits will be discussed in ATSU system requirements document,
- As the SDU provides only connectivity status to the ATSU, all bits 26 to 28 in label 271 can be set at a given time, see table below. When the SDU is failed it will reset the corresponding bits in label 271, this will be discussed in SDU system requirements document.

ACARS over Classic aero (bit 26)	ACARS over SBB (AGGW) (bit 27)	ATN over SBB (bit 28)	Connectivity status	*Typical configuration/case*
0	0	0	**No service**	*SATCOM not logged-on*
0	0	1	**ATN only**	*Iris Presursor typical configuration with ATSU and SDU SBB*
0	1	0	**ACARS over SBB only**	*SATCOM connected to SBB only, no ATN available on ground, no Classic Aero available*
0	1	1	**ATN and ACARS over SBB**	*SATCOM connected to SBB only, no Classic Aero available*
1	0	0	**Legacy ACARS only**	*SATCOM connected to Classic Aero (e.g. I-3 satellite) – legacy configuration*
1	0	1	**ATN and Legacy ACARS**	*SATCOM connected to SBB, no ACARS available on ground, Classic Aero available Fallback when ACARS over SBB is unavailable*
1	1	0	**ACARS only (over SBB and Legacy)**	*SATCOM connected to SBB, no ATN available on ground, Classic Aero available ACARS datalink messages will be exchanged using the SDU preferred subnetwork*
1	1	1	**ATN and ACARS (over SBB and Legacy)**	*Full service ACARS datalink messages will be exchanged using the SDU preferred subnetwork*

Table 3: Label 271 bit 26 to 28 (connectivity status)

Configuration #4: SDU capable of ATN over SBB (ATN-AGW)

This configuration is related to the P15.2.5 Iris Precursor SATCOM system.

- The SDU provides a Williamsburg protocol V3 interface, use of label 271 is mandatory, the SDU sets bit 28 depending on connectivity status (JOIN/LEAVE event),
- Label 271 bit 26 to 27 will remain set to 0 if no ACARS connectivity is offered.

The figure below illustrates typical Williamsburg protocol session establishment between ATSU and SDU:

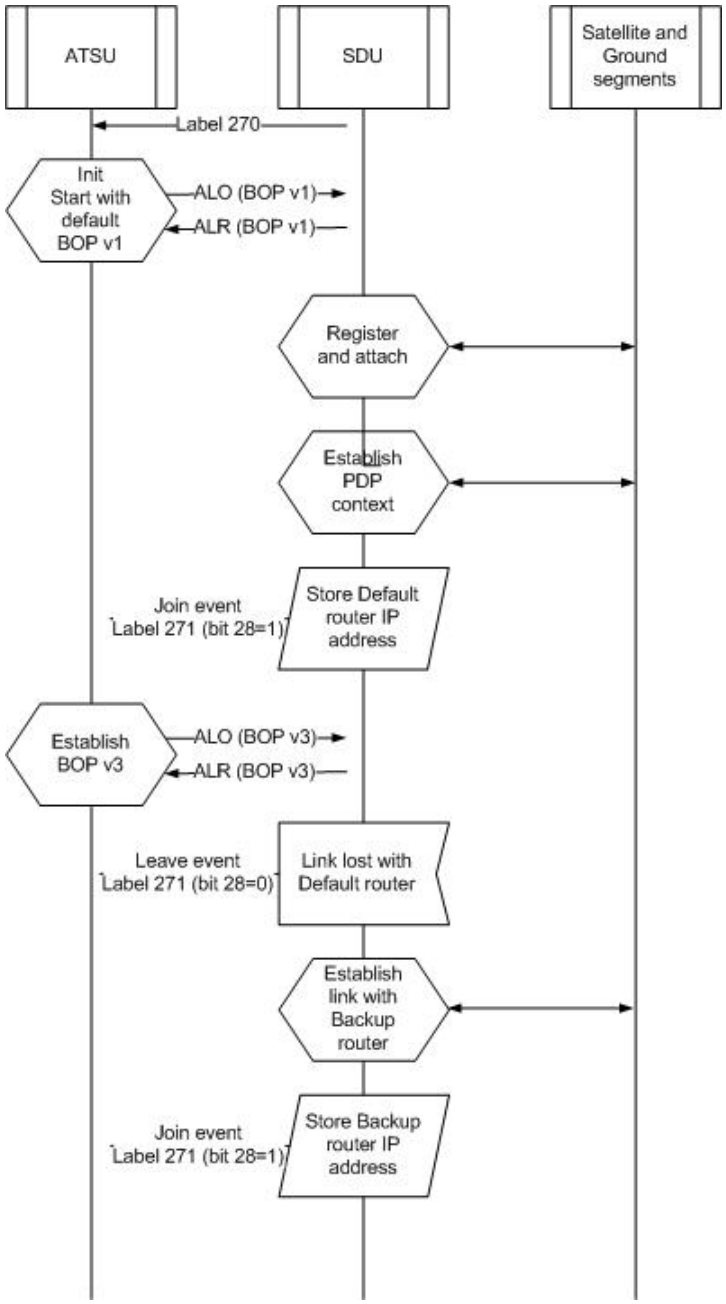

Figure 7: Typical "P15.2.5 Iris Precursor" sequence diagram (Williamsburg protocol)

3.1.3 Interface “SATCOM status” ATSU-SDU Requirements

3.1.3.1 Operations

[REQ]

Identifier	ATN_AGW-SID-0014
Requirement	The ATSU shall monitor cyclically ARINC 429 “Label 270: Status” transmitted by the SDU.
Title	
Status	<Validated>
Rationale	The ATSU monitors the SDU bus in order to determine if the transmission between the SDU and the ATSU is working or not. This monitoring consists in checking the update of a periodically transmitted ARINC 429 label. As per ARINC 741 (4.7.3 Link Layer - Broadcast) Label 27x status words exchanged once per second.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0015
Requirement	The SDU shall monitor cyclically ARINC 429 “Label 270: Status” transmitted by the ATSU.
Title	
Status	<Validated>
Rationale	The SDU monitors the ATSU bus in order to determine if the transmission between the ATSU and the SDU is working or not. This monitoring consists in checking the update of a periodically transmitted ARINC 429 label. As per ARINC 741 (4.7.3 Link Layer - Broadcast) Label 27x status words exchanged once per second.
Category	<Operational>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.3.2 Functional Requirements

[REQ]

Identifier	ATN_AGW-SID-0016
Requirement	ATSU shall transmit ARINC 429 “Label 377: Equipment ID”.
Title	
Status	<Validated>
Rationale	The ATSU shall provide an ARINC 429 compliant interface to the SDU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0017
Requirement	Both ATSU and SDU shall transmit ARINC 429 “Label 172: Subsystem Identifier”.
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU. As per ARINC 741 Part 1 Attachment 2 label 172 is transmitted at a nominal rate of 1 Hz.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0018
Requirement	Both ATSU and SDU shall transmit ARINC 429 “Label 270: Status”.
Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU. As per ARINC 741 (4.7.3 Link Layer - Broadcast) Label 27x status words exchanged once per second.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.3.3 Performance Requirements

N/A.

3.1.3.4 Security and Integrity Requirements

N/A (refer to §4 "Assumptions").

3.1.3.5 Physical requirements

Refer to 3.1.1.5 "Physical requirements"

3.1.3.6 Data Transfer

[REQ]

<table>
<tr><td>Identifier</td><td>ATN_AGW-SID-0019</td></tr>
<tr><td>Requirement</td><td>The SDU shall transmit ARINC 429 Label 270: SDU Status as follows:
<table>
<tr><th>BIT</th><th>DEFINITION</th><th>COMMENTS</th></tr>
<tr><td>1-8</td><td>Label 270 (octal)</td><td></td></tr>
<tr><td>9-10</td><td>SDI</td><td>SDU1 = 01</td></tr>
<tr><td>11</td><td>Data Link via ATSU Not Available</td><td>1 = Not available; 0 = Available</td></tr>
<tr><td>12</td><td>ATSU #1 Inactive</td><td>1 = Inactive</td></tr>
<tr><td>13</td><td>SATCOM Voice Unavailable</td><td>1= unavailable</td></tr>
<tr><td>14</td><td>SELCAL</td><td></td></tr>
<tr><td>15</td><td>Message Alert with Chime</td><td>1 = Alert</td></tr>
<tr><td>16</td><td>Message Alert without Chime</td><td>1 = Alert</td></tr>
<tr><td>17</td><td>SATCOM Not Logged-On</td><td>1 = Not Logged On</td></tr>
<tr><td>18</td><td>SATCOM Master/Slave</td><td>0 = Master</td></tr>
<tr><td>19</td><td>ATSU #2 Inactive</td><td>1 = Inactive</td></tr>
<tr><td>20</td><td>SATCOM Cockpit Fault</td><td>1 = no cockpit voice and no data com transmissions are possible</td></tr>
<tr><td>21</td><td>SATCOM Cockpit Voice Fault</td><td></td></tr>
<tr><td>22</td><td>SATCOM Voice Call 1</td><td></td></tr>
<tr><td>23</td><td>SATCOM Voice Call 2</td><td></td></tr>
<tr><td>24</td><td>SATCOM Voice Alert 1</td><td></td></tr>
<tr><td>25</td><td>SATCOM Voice Alert 2</td><td></td></tr>
<tr><td>26</td><td>SATCOM Cockpit Voice Communication 1</td><td></td></tr>
<tr><td>27</td><td>SATCOM Cockpit Voice Communication 2</td><td></td></tr>
<tr><td>28</td><td>SATCOM LGA Subsystem Failure</td><td></td></tr>
<tr><td>29</td><td>SATCOM Data</td><td></td></tr>
<tr><td>30-31</td><td>SSM</td><td></td></tr>
<tr><td>32</td><td>Parity (odd)</td><td></td></tr>
</table></td></tr>
<tr><td>Title</td><td></td></tr>
<tr><td>Status</td><td><Validated></td></tr>
<tr><td>Rationale</td><td>The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Standard Label 270 definition is provided in ARINC 741 Part 2 (4.7.3.1 SDU to ACARS MU/CMU Status Word).</td></tr>
<tr><td>Category</td><td><Interface></td></tr>
<tr><td>Validation Method</td><td><Expert Group (Judgement Analysis)></td></tr>
<tr><td>Verification Method</td><td><Test></td></tr>
</table>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0020
Requirement	The ATSU shall transmit ARINC 429 Label 270: ATSU Status as follows: On LR aircraft:

BIT	DEFINITION	COMMENTS
1-8	Label 270 (octal)	
9-10	SDI	ATSU1 = 01
11	Spare	
12	ATSU No comm	1 = All ACARS (VHF, HF and SATCOM) Links unavailable
13	VDR3 Voice	1 = Voice mode
14	VDR3 data mode failed	1 = No data comm with VDR3
15	Spare	
16	ATSU1 failed	1 = Failed
17	SAT and HF ACARS Data link status	1 = Satcom and HF ACARS Links unavailable
18	VDR3 ACARS Data link status	1 = Link unavailable
19	Mode S	1 = Link unavailable - Always set to 1
20	ATSU Active/Standby	1 = Active (shall be set to 1)
21	SATCOM Data failed	1 = Failed
22-23	Not used	
24	HFDL link available	1 = Available
25	Datalink init fault	1 = Fault
26	CMC BITE data report program bit	1 = Active (default value)
27	CMC/CFDIU ECAM Warning report program bit	0 = Not Active (default value)
28	CMC/CFDIU Failure report program bit	0 = Not Active (default value)
29	CMC/CFDIU Post Flight report program bit	1 = Active (default value)
30-31	SSM	
32	Parity (odd)	

Title	
Status	<Validated>
Rationale	The ATSU shall provide an ARINC 429 compliant interface to the SDU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0021
Requirement	The ATSU shall transmit ARINC 429 Label 377: Equipment ID as follows:

BIT	DEFINITION	COMMENTS
1-8	Label 377	
9-10	SDI 01	
11-22	Equipment Code	200_h
23-29	Pad	Zero
30-31	Sign Status Matrix	Normal 00_h
32	Parity (odd)	

Title	
Status	<Validated>
Rationale	The ATSU shall provide an ARINC 429 compliant interface to the SDU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	

[REQ]

Identifier	ATN_AGW-SID-0022
Requirement	The ATSU and the SDU shall both transmit ARINC 429 Label 172: Subsystem identifier as follows:

	ATSU	SDU
BIT	DEFINITION	DEFINITION
1-8	Label 172	Label 172
9-16	ATSU SAL (304)	SDU SAL (307)
17-29	Spare	Spare
30-31	Sign Status Matrix	Sign Status Matrix
32	Parity (odd)	Parity (odd)

Title	
Status	<Validated>
Rationale	The SDU shall provide an ARINC 429 compliant interface to the ATSU/CMU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0033
Requirement	The SDU shall transmit ARINC 429 Labels 270 and 172 once per second.
Title	
Status	<Validated>
Rationale	As per ARINC 741 §4.7.3 Link Layer – Broadcast: “The SDU and the ACARS MU/CMU should monitor each other’s status by exchanging Label 27x status words (as defined in the subsection which follow) once per second”. Label 377 doesn’t need to be transmitted by the SDU as not used by ATSU.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0034
Requirement	The ATSU shall transmit ARINC 429 Label 270, 172 and 377 with the following update rate: • Label 270: 600ms, • Label 172: 1sec, • Label 377: 500ms.
Title	
Status	<Validated>
Rationale	As per ATSU-SDU legacy interface defined for ACARS services.
Category	<Interface>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Review of Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

3.1.3.7 Transactions

N/A.

3.1.3.8 Service Interface Requirements

[REQ]

Identifier	ATN_AGW-SID-0023
Requirement	The SDU shall transmit ARINC 429 Label 270 as follows: • bit 20 SATCOM Cockpit Fault set to 1 when SATCOM is INOP • bit 11 Data link via ATSU set to 1 when NOT AVAILABLE • bit 17 SDU is not logged-on set to 1 when NOT LOGGED-ON • bit 18 SDU master/slave set to 0 when SATCOM is MASTER
Title	
Status	<Validated>
Rationale	Bit 20 is used by FWC for alert COM SATCOM FAULT Bits 11, 17 & 18 are used by ATSU
Category	<Interoperability>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>		<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0024
Requirement	The ATSU shall transmit ARINC 429 Label 270 as follows: • bit 16 ATSU1 failed set to 1 when FAILED • bit 20 ATSU Active/Standby set to 1 when ACTIVE
Title	
Status	<Validated>
Rationale	Use of other bits by SDU in ARINC 429 Label 270 transmitted by ATSU has to be agreed through this IRS
Category	<Interoperability>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>	<SDD Requirement>	IRISP-SDU-0030	<Full>
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0025
Requirement	The ATSU shall transmit data packets (downlink) to the SDU only when datalink is reported as available by the SDU (ARINC 429 Label 270).
Title	
Status	<Validated>
Rationale	Blocks sent to the SDU when the datalink is not available will cause the SDU to transmit a BUSY response.
Category	<Interoperability>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

[REQ]

Identifier	ATN_AGW-SID-0026
Requirement	The SDU shall deliver data packets (uplink) to the ATSU only when ATSU is reported as active (ARINC 429 Label 270).
Title	
Status	<Validated>
Rationale	Blocks sent to the ATSU when not ready will cause the ATSU to either reject them or not answer.
Category	<Interoperability>
Validation Method	<Expert Group (Judgement Analysis)>
Verification Method	<Test>

[REQ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<SATISFIES>			
<ALLOCATED_TO>	<Functional block>	Communication - A/G datalink	N/A

The following table provides the relationship between label 270 and label 271 transmitted by the SDU:

Label 270 Data link via ATSU (bit 11)	Label 270 SDU is not logged-on (bit 17)	Label 270 SATCOM Cockpit Fault (bit 20)	Label 271 ACARS over Classic aero (bit 26)	Label 271 ACARS over SBB (AGGW) (bit 27)	Label 271 ATN over SBB (bit 28)	
1 (NOT AVAILABLE)	1 (NOT LOGGED-ON)	1 (SATCOM is INOP)	0	0	0	*SATCOM is failed*
1 (NOT AVAILABLE)	1 (NOT LOGGED-ON)	0 (SATCOM is operational)	0	0	0	*SATCOM not logged-on*
1 (NOT AVAILABLE)	0 (LOGGED-ON)	0 (SATCOM is operational)	0	0	0	*SATCOM logged-on but no service available*
0 (AVAILABLE)	0 (LOGGED-ON)	0 (SATCOM is operational)	X	X	X	*SATCOM logged-on with at least one service available, label 271 provides connectivity status*

Table 4: Relationship between label 270 and label 271 transmitted by the SDU

4 Assumptions

The following assumptions have been made for this IRS:

- The Iris Precursor system should support concurrently ATN/OSI and ACARS protocols, typically the FANS-B CPDLC, ADS-C and legacy ACARS AOC.

- The air-ground security aspects have not been considered, however it's assumed that they will be managed by the SDU without impact on the ATSU – SDU interface. **Note**: the Iris Precursor system is assumed to be connected only with ACD ("Aircraft Control Domain") systems, e.g ATSU, FWC, ..., and as such those interfaces are considered as "trusted". No interface with AISD ("Airline Information Services Domain") or passengers domain is foreseen for the purpose of this project.

- The air-ground multilink aspects have been considered, it's assumed that they will be managed by the ATSU based on the information provided by the SDU and defined in this SID.

4.1 Ongoing actions

- During the SID comments review held end of June an action has been raised to assess the suitability of the baseline protocol architecture to manage CoS/QoS (Class/Quality of Service) required for P15.2.5. The result of this action will be included in next release of this document.

5 References

5.1 International Standards

[RD 1]. EUROCAE ED-228 / RTCA DO-350, “Safety and Performance Standard for Baseline 2 ATS Data Communications (Baseline 2 SPR Standard)”, March 2014

[RD 2]. ICAO Doc. 9880, 1st Edition, “Manual On Detailed Technical Specifications For The Aeronautical Telecommunication Network (ATN) Using ISO/OSI Standards And Protocols”.

[RD 3]. ARINC 429 Mark 33 Digital Information Transfer System (DITS)

[RD 4]. ARINC 758 Communications Management Unit (CMU)

[RD 5]. ARINC 781 Mark 3 Aviation Satellite Communication System

[RD 6]. ARINC 741p2-11 Aircraft Satellite Communication System

[RD 7]. ISO 8473 Information processing systems -- Data communications -- Protocol for providing the connectionless-mode network service

[RD 8]. DO3xx Minimum Aviation System Performance Standard for Data and Voice Communications via Inmarsat Swift Broadband (SBB) Supporting Required Communications Performance (RCP) – draft 1 30 Sept 2010

[RD 9] EUROCAE ED-229 / RTCA DO-351, “Interoperability Requirements Standard for Baseline 2 ATS Data Communications (Baseline 2 Interop Standard)”, March 2014

5.2 Iris Precursor Project Documents

[SRD Iris Precursor system] THAUMAS - D1.1-1 – Precursor System Requirement Document (SRD), Ref : THA.RP.AST.0031, Edition : Iss 2.4

[SDD Iris Precursor system] INMARSAT - Iris Precursor - System Design Document (SDD), Doc Ref: IrisPre-C-OS-Inm-SDD-0001, Issue draft 5

5.3 SESAR Documentation

[1] Template Toolbox 03.00.00
https://extranet.sesarju.eu/Programme%20Library/SESAR%20Template%20Toolbox.dot

[2] Requirements and V&V Guidelines 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Requirements%20and%20VV%20Guidelines.doc

[3] Templates and Toolbox User Manual 03.00.00
https://extranet.sesarju.eu/Programme%20Library/Templates%20and%20Toolbox%20User%20Manual.doc

[4] EUROCONTROL ATM Lexicon
https://extranet.eurocontrol.int/http://atmlexicon.eurocontrol.int/en/index.php/SESAR

-END OF DOCUMENT-