

L-band Digital Aeronautical Communications System (LDACS)

draft-ietf-raw-ldacs-11

Nils Mäurer, Thomas Gräupl, Corinna Schmitt

Note Well

This is a reminder of IETF policies in effect on various topics such as patents or code of conduct. It is only meant to point you in the right direction. Exceptions may apply. The IETF's patent policy and the definition of an IETF "contribution" and "participation" are set forth in BCP 79; please read it carefully.

As a reminder:

- By participating in the IETF, you agree to follow IETF processes and policies.
- If you are aware that any IETF contribution is covered by patents or patent applications that are owned or controlled by you or your sponsor, you must disclose that fact, or not participate in the discussion.
- As a participant in or attendee to any IETF activity you acknowledge that written, audio, video, and photographic records of meetings may be made public.
- Personal information that you provide to IETF will be handled in accordance with the IETF Privacy Statement.
- As a participant or attendee, you agree to work respectfully with other participants; please contact the ombudsteam (<https://www.ietf.org/contact/ombudsteam/>) if you have questions or concerns about this.

Definitive information is in the documents listed below and other IETF BCPs. For advice, please talk to WG chairs or ADs:

[BCP 9](#) (Internet Standards Process)

[BCP 25](#) (Working Group processes)

[BCP 25](#) (Anti-Harassment Procedures)

[BCP 54](#) (Code of Conduct)

[BCP 78](#) (Copyright)

[BCP 79](#) (Patents, Participation)

<https://www.ietf.org/privacy-policy/> (Privacy Policy)



RAW	N. Mäurer, Ed.
Internet-Draft	T. Gräupl, Ed.
Intended status: Informational	German Aerospace Center (DLR)
Expires: 9 January 2023	C. Schmitt, Ed.
	Research Institute CODE, UniBwM
	8 July 2022

L-band Digital Aeronautical Communications System (LDACS)
draft-ietf-raw-ldacs-11

Abstract

This document gives an overview of the architecture of the L-band Digital Aeronautical Communications System (LDACS), which provides a secure, scalable and spectrum efficient terrestrial data link for civil aviation. LDACS is a scheduled, reliable multi-application cellular broadband system with support for IPv6. It is part of a larger shift of flight guidance communication moving to IP-based communication. High reliability and availability of IP connectivity over LDACS, as well as security, are therefore essential. The intent of this document is to introduce LDACS to the IETF community, raise awareness on related activities inside and outside of the IETF, and to seek expertise in shaping the shift of aeronautics to IP.

draft-ietf-raw-10 (IETF 113)

1. Introduction	3
2. Terminology	5
3. Motivation and Use Cases	6
3.1. Voice Communications Today	7
3.2. Data Communications Today	7
4. Provenance and Documents	8
5. Applicability	9
5.1. Advances Beyond the State-of-the-Art	9
5.1.1. Priorities	9
5.1.2. Security	10
5.1.3. High Data Rates	10
5.2. Application	10
5.2.1. Air/Ground Multilink	10
5.2.2. Air/Air Extension for LDACS	11
5.2.3. Flight Guidance	11
5.2.4. Business Communications of Airlines	12
5.2.5. LDACS-based Navigation	12
6. Requirements	13
7. Characteristics	14
7.1. LDACS Sub-Network	14
7.2. Topology	15
7.3. LDACS Protocol Stack	16
7.3.1. LDACS Physical Layer	17
7.3.2. LDACS Data Link Layer	18
7.3.3. LDACS Sub-Network Layer and Protocol Services	19
7.4. LDACS Mobility	20
8. Reliability and Availability	20
8.1. Below Layer 1	20
8.2. Layer 1 and 2	20
8.3. Beyond Layer 2	23
9. Security	23
9.1. Security in Wireless Digital Aeronautical Communications	24
9.2. LDACS Requirements	25
9.3. LDACS Security Objectives	25
9.4. LDACS Security Functions	26
9.5. LDACS Security Architecture	26
9.5.1. Entities	26
9.5.2. Entity Identification	27
9.5.3. Entity Authentication and Key Establishment	27
9.5.4. Message-in-transit Confidentiality, Integrity and Authenticity	28
10. IANA Considerations	28
11. Acknowledgements	28
12. Normative References	28
13. Informative References	28
Appendix A. Selected Information from DO-350A	34
Authors' Addresses	36

Changes

draft-ietf-raw-11 (IETF 114)

1. Introduction	3
2. Acronyms	5
3. Motivation and Use Cases	7
3.1. Voice Communications Today	7
3.2. Data Communications Today	8
4. Provenance and Documents	8
5. Applicability	9
5.1. Advances Beyond the State-of-the-Art	10
5.1.1. Priorities	10
5.1.2. Security	10
5.1.3. High Data Rates	10
5.2. Application	10
5.2.1. Air/Ground Multilink	11
5.2.2. Air/Air Extension for LDACS	11
5.2.3. Flight Guidance	12
5.2.4. Business Communications of Airlines	12
5.2.5. LDACS-based Navigation	13
6. Requirements	13
7. Characteristics	15
7.1. LDACS Access Network	15
7.2. Topology	16
7.3. LDACS Protocol Stack	16
7.3.1. LDACS Physical Layer	18
7.3.2. LDACS Data Link Layer	18
7.3.3. LDACS Sub-Network Layer and Protocol Services	20
7.4. LDACS Mobility	20
7.5. LDACS Management - Interfaces and Protocols	21
8. Reliability and Availability	21
8.1. Below Layer 1	21
8.2. Layer 1 and 2	21
8.3. Beyond Layer 2	24
9. Security	25
9.1. Security in Wireless Digital Aeronautical Communications	25
9.2. Security in Depth	26
9.3. LDACS Security Requirements	26
9.4. LDACS Security Objectives	27
9.5. LDACS Security Functions	28
9.6. LDACS Security Architecture	28
9.6.1. Entities	28
9.6.2. Entity Identification	29
9.6.3. Entity Authentication and Key Establishment	29
9.6.4. Message-in-transit Confidentiality, Integrity and Authenticity	30
9.7. Considerations on LDACS Security Impact on IPv6 Operational Security	30
10. IANA Considerations	30
11. Acknowledgements	30
12. Normative References	31
13. Informative References	31
Appendix A. Selected Information from DO-350A	38
Authors' Addresses	40

Overall changes

- Addressed feedback from IESG
 - Gen-ART:
 - How is LDACS interacting with IPv6?
 - Please provide more details on frame structure and protocol.
 - INT:
 - Please provide more information how IPv6 over LDACS is handled.
 - Please provide more information on handover and FCI multilink interactions.
 - RTG:
 - What is the purpose of the draft and can it pass consensus bar set by RFC 8789?
 - Is it intended that LDACS is standardized within IETF?
 - SEC:
 - How are IPv6 and LDACS security considerations intertwined?
- Overall issue in aeronautical communications:
 - Many standards behind paywall

Addressing main issues

1. LDACS is an aeronautical datalink (layer two) that is standardized at the International Civil Aviation Organization (ICAO).

The intent of this draft is to introduce that IP supporting datalink to the IETF community.

2. LDACS is intended to be exchanging Aeronautical Traffic Network (ATN)/Internet Protocol Suite (IPS) data between aircraft and ground.

This means that air traffic management shall be done via IPv6 in the future.

Addressing main issues (con't)

3. LDACS defines 1536 B user-data packets, in which IPv6 (via UDP) traffic is encapsulated.
4. LDACS handovers between ground stations are seamless and transparent to the IP layer. This has been demonstrated during flight trials in July 2022.
5. LDACS is part of the Future Communications Infrastructure (FCI). The term refers to a family of different layer two technologies such as other terrestrial or satellite datalinks. Its purpose is to deliver aeronautical traffic safely and timely to the aircraft by situationally switching between datalinks.

Addressing main issues (con't)

6. LDACS offers integrity and authenticity protection of its user- and control data. Rate-limiting, adapted to the capacity of the current connection, is performed prior to user data actually reaching the LDACS radios. Certain traffic is filtered out by the Access Router (AC-R).
7. We can provide any aeronautical standard behind paywalls for internal review only.

Abstract and Chapter 1 – Introduction

- Clarified purpose of LDACS at IETF:
 1. Raise awareness for aeronautical communications going digital and via IP(v6)
 2. Raise awareness for new datalinks (layer two technologies) transporting IP traffic

Chapter 2 – Acronyms

- Renamed chapter „Terminology“ → „Acronyms“
- Streamlined acronyms

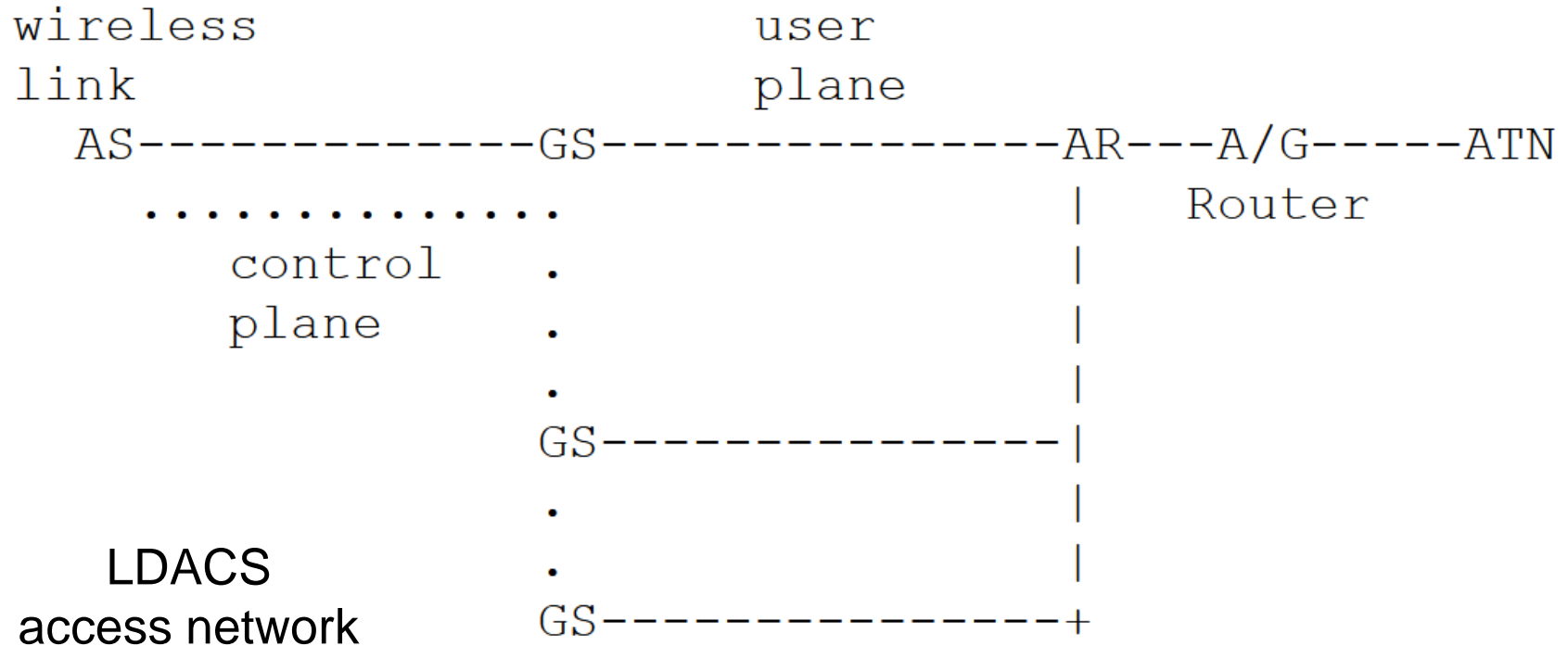
Chapter 4 – Provenance and Documents

- Pointed out sources to IPv6 over LDACS (where applicable) and to the FCI and its datalinks

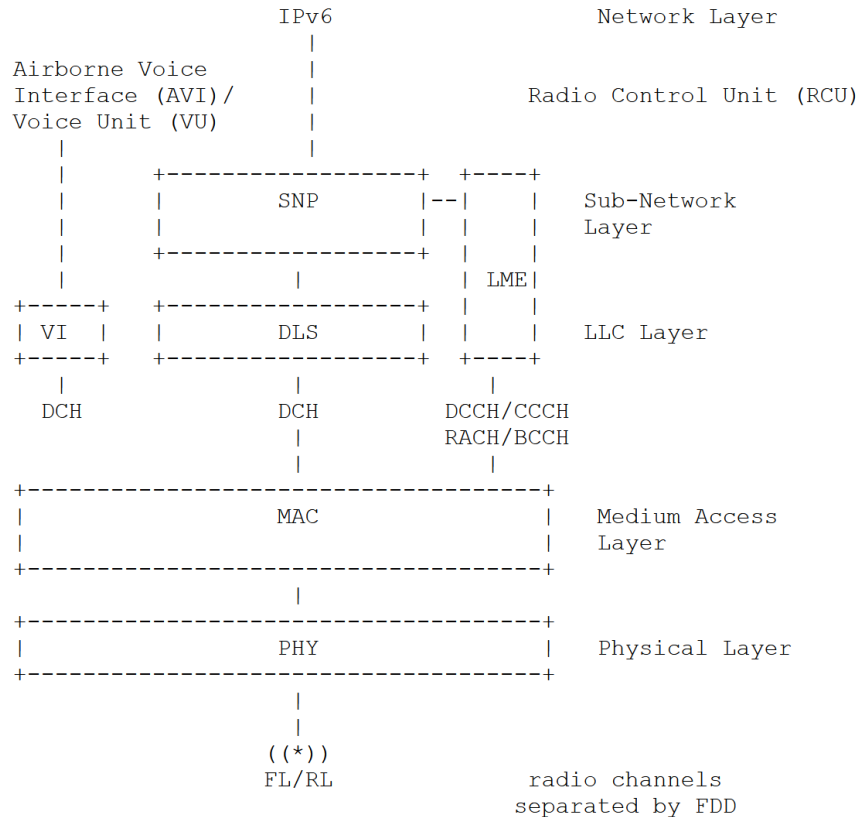
Chapter 5 – Applicability

- Within LDACS access network, local mobility solution will be PMIPv6
- Within FCI, global mobility solution will be implemented on top of LISP
- LDACS Alternative Positioning Navigation and Timing (APNT):
 - Performed via (1) receiving multiple ground stations signals and via (2) knowing the exact positions of these and (3) having a good channel estimation
 - Measuring signal propagation times from and to each GS
 - 171m accuracy demonstrated with 4 GS at flight trials 2019

Chapter 7 – Characteristics



Chapter 7 – Characteristics



LDACS protocol stack

- BCCH/CCCH control channels ground → aircraft
- RACH/DCCH control channels aircraft → ground
- DCH bidirectional (user) data channel

Chapter 8 – Reliability and Availability

- Priorities managed via DiffServ classes
 - CS01 – lowest priority
 - CS07 – highest priority
- Multiple LDACS ground stations visible to aircraft at same time

Chapter 9 – Security

- LDACS security requirements in a nutshell:

[Provide] „a secure channel between the airborne radio systems and the peer radio access endpoints on the ground [...] to ensure authentication and integrity of air-ground message exchanges“
[ARINC 858, 2021]

- LDACS control message protection helps ensuring e.g., IPv6 Neighbor Discovery Protocol (NDP) works as intended

Next Steps

- `draft-ietf-raw-ldacs11`
 - Addressed feedback by IESG
- We can provide necessary aeronautical standards for necessary review of draft version 11!

→ What are next steps now?

Thanks

