HORVÁTH

Second Workshop

Interoperability of e-Conspicuity systems for GA

Ulrich Aldinger (Horváth)
Helge Mikuda (Droniq)

Cologne, 08.11.2023

Agenda

- **Introduction**
  - **Participants today**
  - Project scope and status
  - Objectives of workshop 2
- Recap and results of past workshops and target system combination
- Results of technical meetings (use of mobile network and different communication ways)
- Further inputs, programs and discussion (open points)
- Interoperability levels (needs - levels - requirements for implementation)
- Conclusion and further steps

We are happy to support EASA in this strategic project

Senior Manager	Consultant	Senior Aviation Manager	Senior Aviation Manager	Business Development & Sales Manager	Managing Director	Managing Director
						
Ulrich Aldinger	*Maximilian Barnes*	*Helge Mikuda*	*Alexander Tummes*	*Nicolas Koch*	*Jan-Eric Putze*	*Ralph Schepp*
Project Manager (Lead)	**Project Team**	**Technical Lead**	**Project Team**	**Project Team**	**SME[1]**	**SME[1]**
HORVÁTH	HORVÁTH	DRONIQ	DRONIQ	DRONIQ	DRONIQ	DRONIQ

[1]SME = Subject Matter Expert

EASA project members

Helder Mendes
Project lead / Flight data expert

Vladimir Foltin
PCM General aviation / ATM Expert

Alain Leroy
Chief engineer

Marco Capaccio
Section Manager - Small Aircraft, Balloons & Airships

Hette Hoekema
Chief Expert - Avionics & Electrical Systems

Dimitri Garbi
Avionics systems expert

Filippos Tymvios
Meteorological Expert (SME)

Who are you?

2 Minutes per Person

Introduce yourself: Name, Company/ Associations, expert for ?

What is your expectation for this workshop ?

Rules of today’s meeting

We would like to ask you to do the following things:

- Neutral, scientific work
- Fair share of speech
- Be open minded and fair

We ask you to not do the following things:

- Commercial-interest input
- Excessive presentation of own products (technical view allowed)

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Why are we sitting here ?

1. High numbers of mid-air collisions in GA

“

… the other to EASA, to ensure the complete interoperability of the electronic conspicuity systems that it promotes in the framework of the European Plan for Aviation Safety, with the aim of preventing mid-air collisions...

Recommendation from BEA, issued with an accident analysis 2020

”

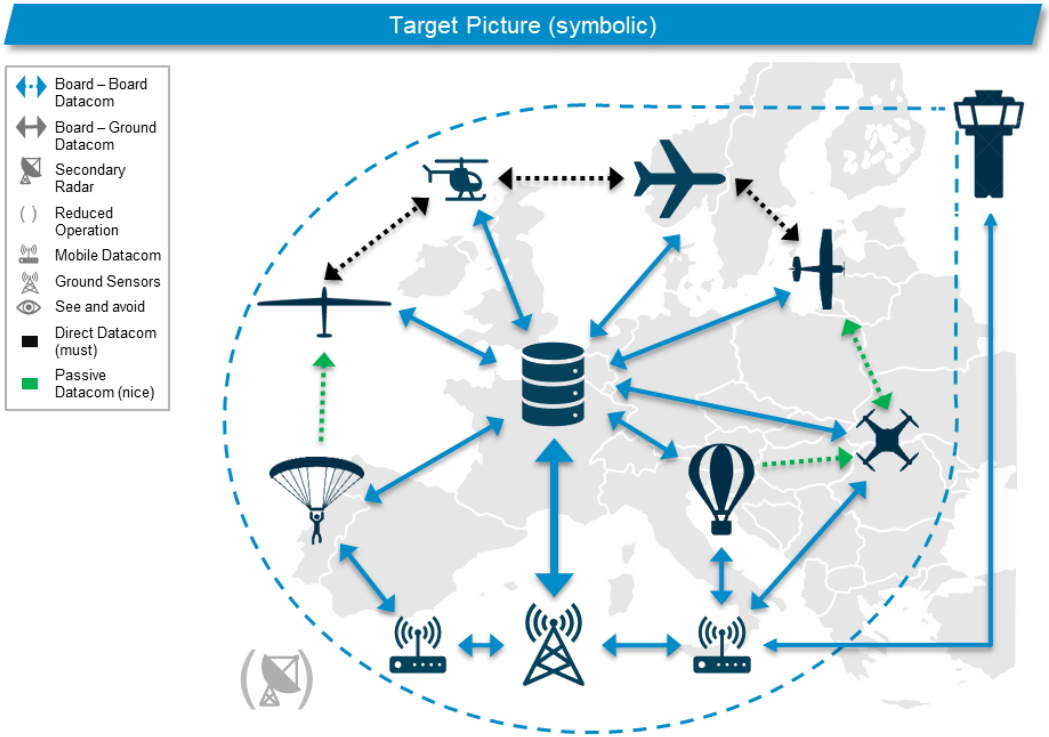
2. SERA 6005 C

“

Manned aircraft operating in airspace designated by the competent authority as a U-space airspace, and not provided with an air traffic control service by the ANSP, shall continuously make themselves electronically conspicuous to the U-space service providers.

”

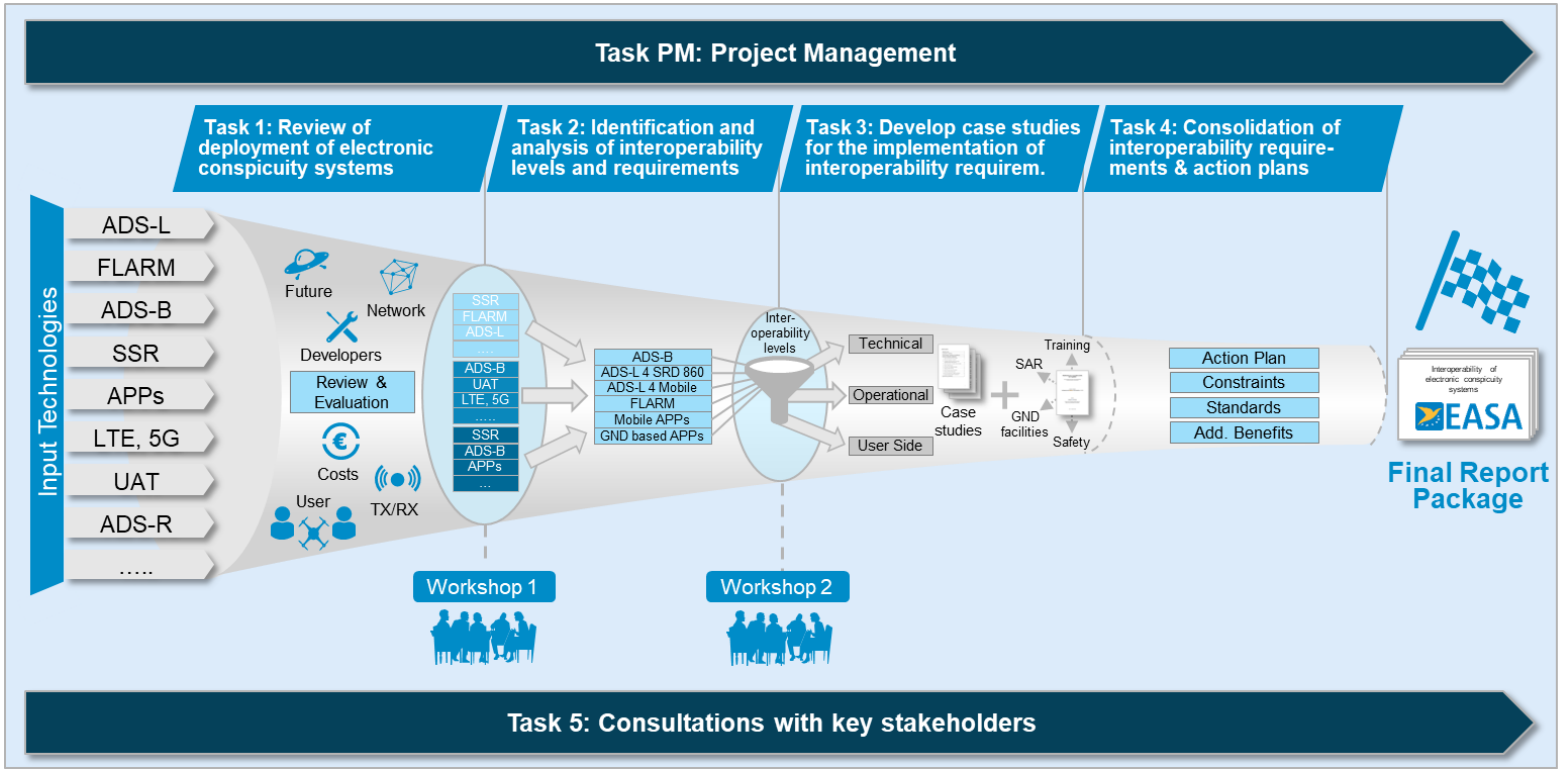
Objective of the project is to prepare a recommendation for an interoperable communication standard for aircraft



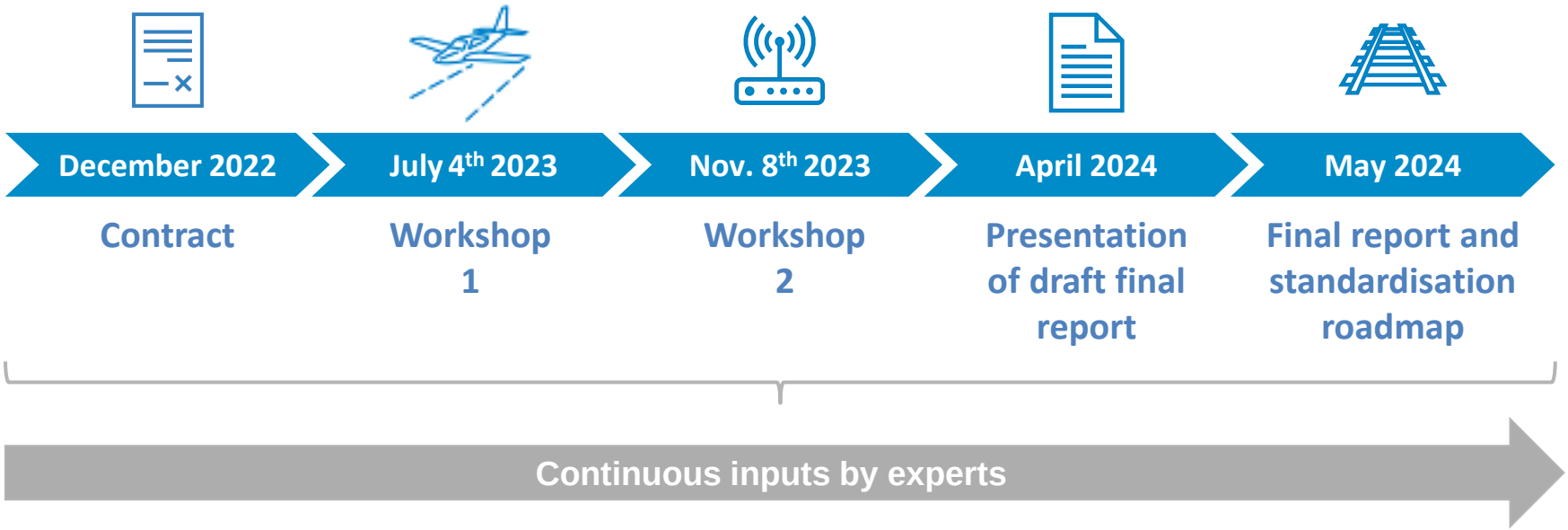
Comment

- Standardized data communication between aircraft and ground stations by interoperable systems
- Airborne collision avoidance for all participants in uncontrolled airspace
- Carriage of electronic conspicuity systems for General Aviation should be encouraged comprehensively

Project approach



Project timeline



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Workshop 2 guardrails

1. We are talking about electronic-conspicuity, not about air traffic control
2. Focus is the target system combination from WS 1
3. No evaluation of single systems
4. Concentrate on elaborating the needs and constraints for interoperability

Objectives of today’s meeting

- Collect and compile the main needs for interoperability
- Identify and specify the interoperability levels
- Derive the necessary requirements

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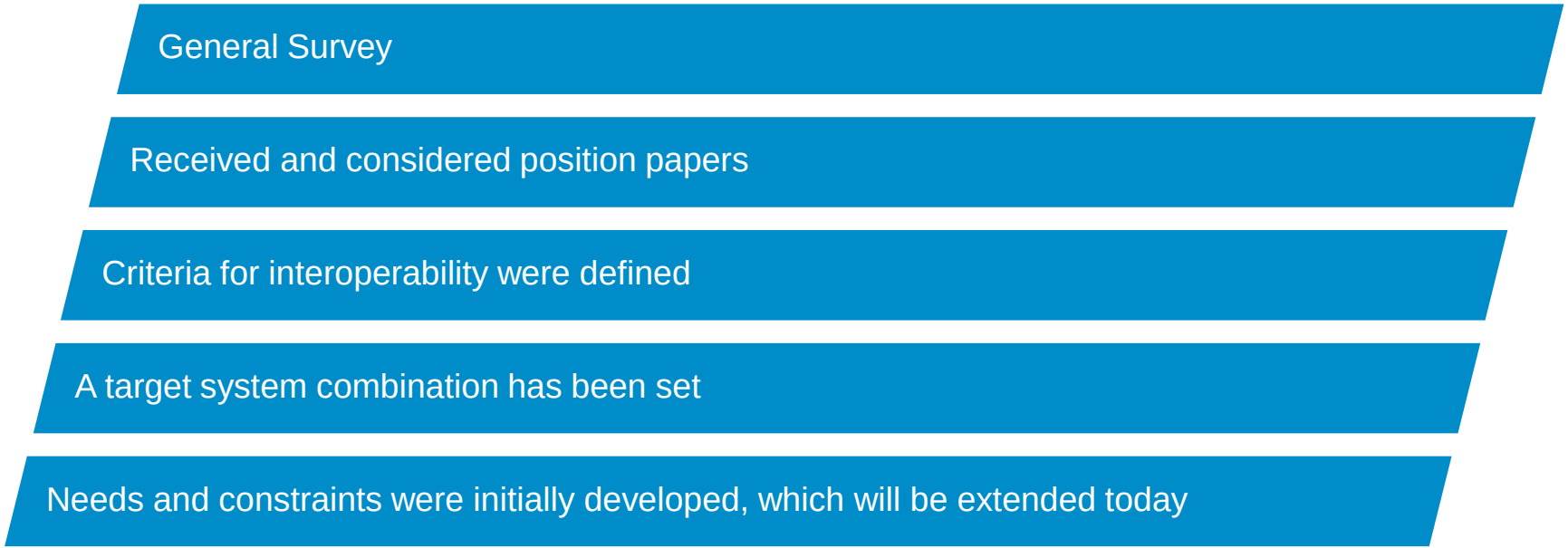
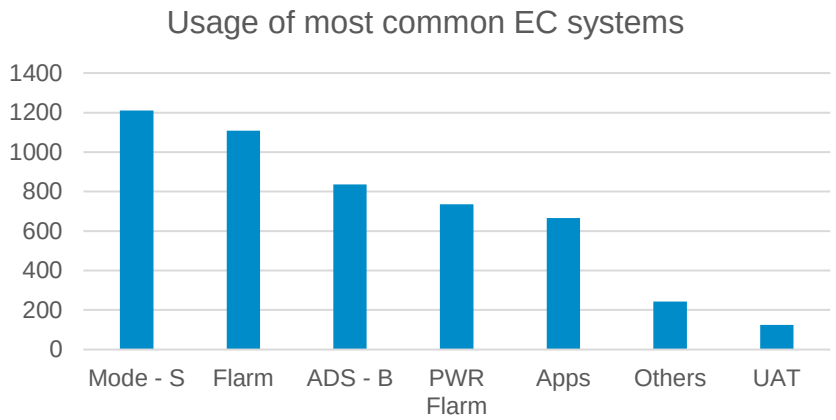
Recap project progress



Recap survey – Overview of results

- 2.133 Participants, 93% VFR (1.975), 7% IFR (158)
- 61% (1.300) answered in German, 39% (833) in English
- Most used aircrafts: Single Engine Piston, Glider, Motorglider, Ultralight
- 22% (463) do not use any e-conspicuity system



Recap – Target system combination

Target System Combination
ADS-B
ADS-L 4 SRD 860
ADS-L 4 Mobile
FLARM
Mobile APPs
GND based Apps

Systems still under investigation, but not in focus/scope
RADAR
Mode S
UAT
TCAS II
ACAS

Needs and constraints for interoperability from WS1

- Enabling of Air-Air Connection and network between different systems
- Enabling of network capabilities (via ground systems; ground infrastructure, network and antennas…)
- Frequency usage and congestion
- Certified and non-certified components regarding interchange data (e.g. SIL)
- Solution for position discrepancy (GPS and Radar, MLAT…)
- Interface for different (incompatible) transmission protocols
- Usage and legality of using mobile services in the air, service status in different altitudes
- Enabling security and anonymization of transmissions
- Enabling of cross-border flying and usage of the EC-systems in Non-EU countries

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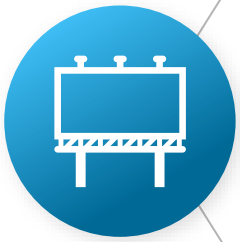
Summary TM1 aerial mobile network useage – Key takeaways

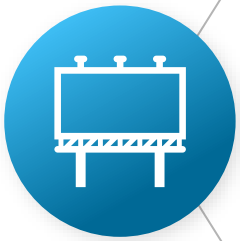
Participants: Thomas Neubauer (Dimetor), Mikael Timsater (Ericsson), Manuel Ruiz (Ericsson), Ralph Schepp (Droniq)



- **Actual available coverage** is up to 300 m altitude, correlated to ground coverage
- **Network connectivity:** between 300 m – 1000 m which is available in some areas, nevertheless the link quality is descending with rising altitude
- **Coverage:** in some countries like Sweden already a coverage up to 3000 m altitude is available due to uptilted antennas (Teracom, state owned company)
- **Requirements for coverage:** for a coverage up to 3000 m and more specific infrastructure is necessary
- **Usage:** no dedicated devices are needed, the usage of smartphones is possible
- **External and good antennas:** for better and unobstructed connectivity in the aircraft
- **Data volume:** e-conspicuity needs a very small amount of transmitted data

Summary TM1.2 aerial mobile network usage – Key takeaways

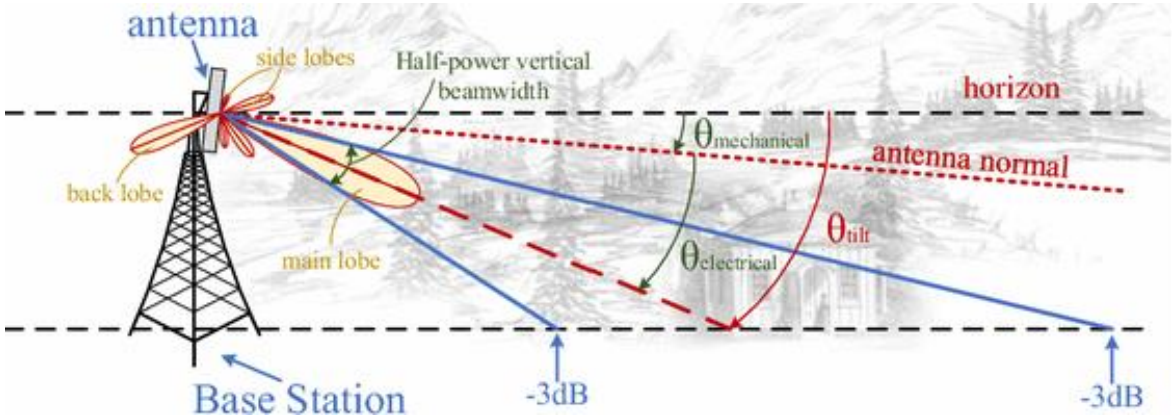
Participants: Thomas Pöggel (telecommunication expert)

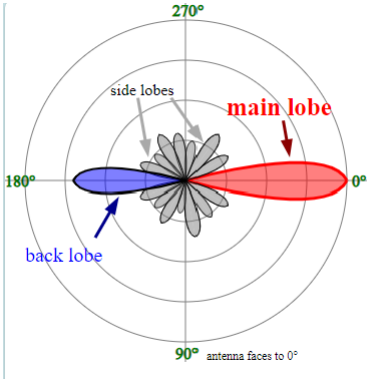


- **Best frequency** for aerial usage is below 1 GHz
- **Reception in aerial use** is varying because of the different frequencies
- **Why do we have coverage in the air?**
  - Through side lobes, interferences and reflections you also have some coverage in the air
  - Providers would like to eliminate this effect (>30-40 m altitude above the antenna is not intended for usage)
- **The lower the frequency** the higher the possibility of ground reflection
- **For aerial usage** a limitation to discrete frequencies is advantageous→ Bandlocking
- **Business Case view**: Influencing the ground network business case will not be accepted
- **Actual network** can be used to certain extend, but it has restrictions

Summary TM1.2 aerial mobile network usage – Key takeaways

Participants: Thomas Pöggel (telecommunication expert)

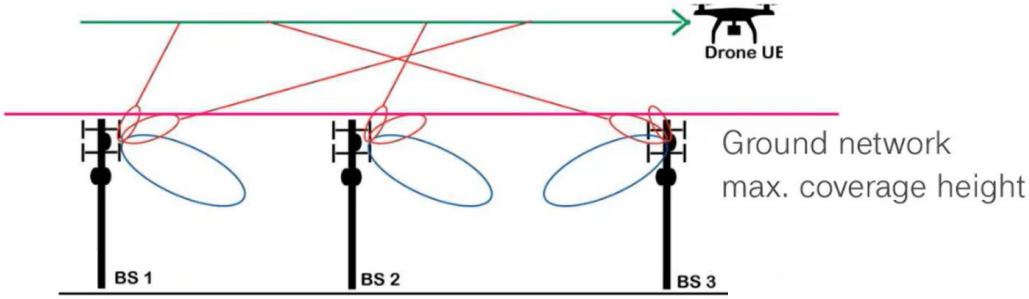


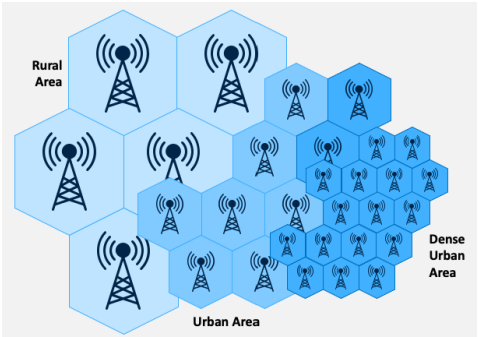


Summary TM1.2 aerial mobile network usage – Key takeaways

Participants: Thomas Pöggel (telecommunication expert)

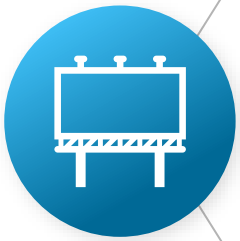
- Handovers between cells that are not network neighbors during a flight can pose a problem because the network is designed to hand over connections to its neighboring cells.
- To address this issue, you need to modify the network to handle handovers between cells that are not directly adjacent. However, this requires distinguishing between ground-based and aerial users, which the current network cannot do.
- Devices located above the antenna have a stronger signal than those on the ground.





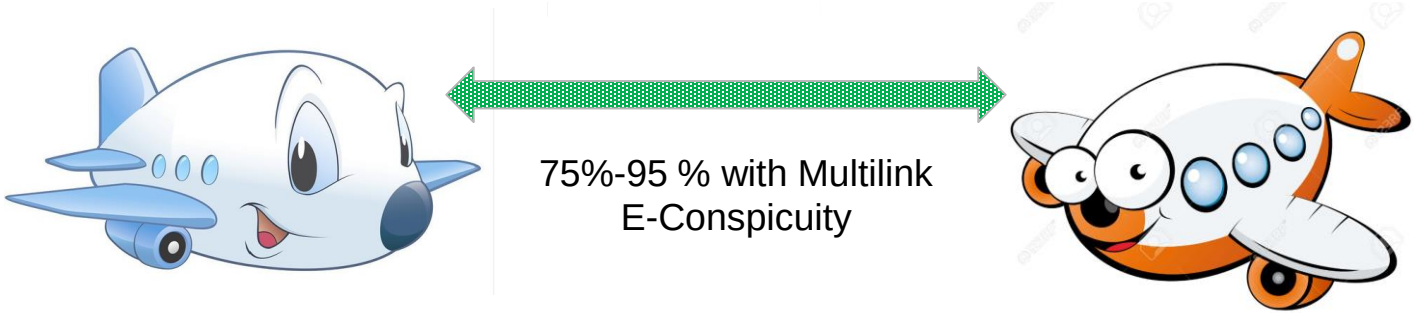
Summary TM2 Communication ways for e-conspicuity - Key takeaways

Participants: Junzi Sun (University Delft), Marc Förderer (Air Avionics), Urban Mäder (FLARM), Fynn Klaaßen (Droniq)

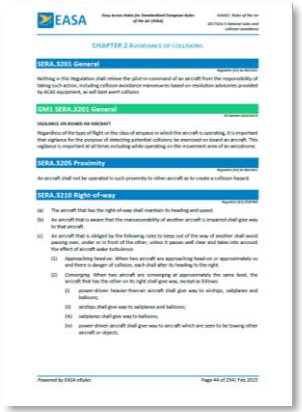


- Currently it is possible to transmit ADS-L, it's more difficult to build a receiver (SDR)
- No particular benefit (technically) on using ADS-L for collision avoidance
- The actual benefit is on entering U-Spaces
- Direct communication between ADS-L (SRD860) and ADS-B (1090 MHz) is not possible, even not on semantic level, because ADS-L does not have all information of ADS-B
- Affordable GPS devices can be installed on Mode-S with extended squitter and SIL0, will meet the requirements of SERA 6005C (U-Space)
- 75%-85% of Mode-S transponders can be equipped or adapted
- Every mobile device, which can be used at home and in the mobile network should also be usable for ADS-L 4 Mobile

See and avoid improvement



Airspace classification – Rules of way


EASA

CHAPTER 2 AVOIDANCE OF COLLISIONS

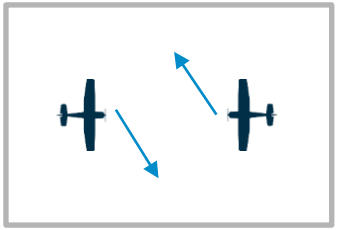
SERA.3201 General

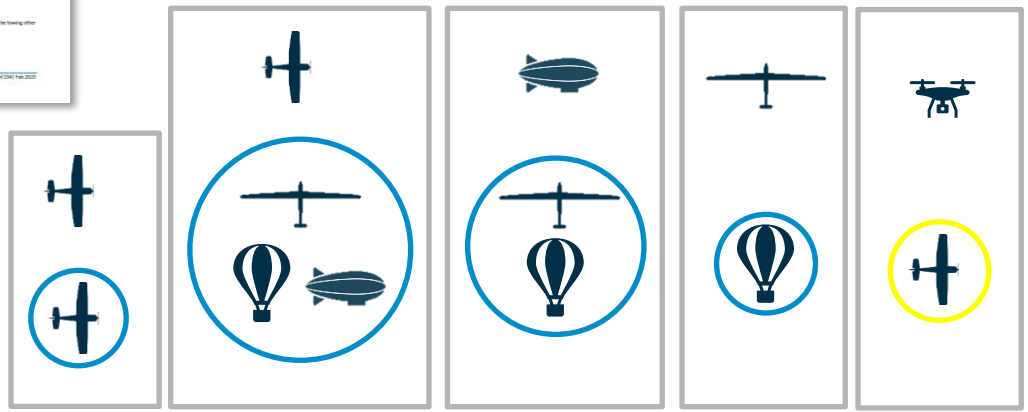
GM1 SERA.3201 General

SERA.3205 Proximity

SERA.3210 Right-of-way

- The aircraft that has the right-of-way shall maintain its heading and speed





Legend:

= Right of way

= tbc

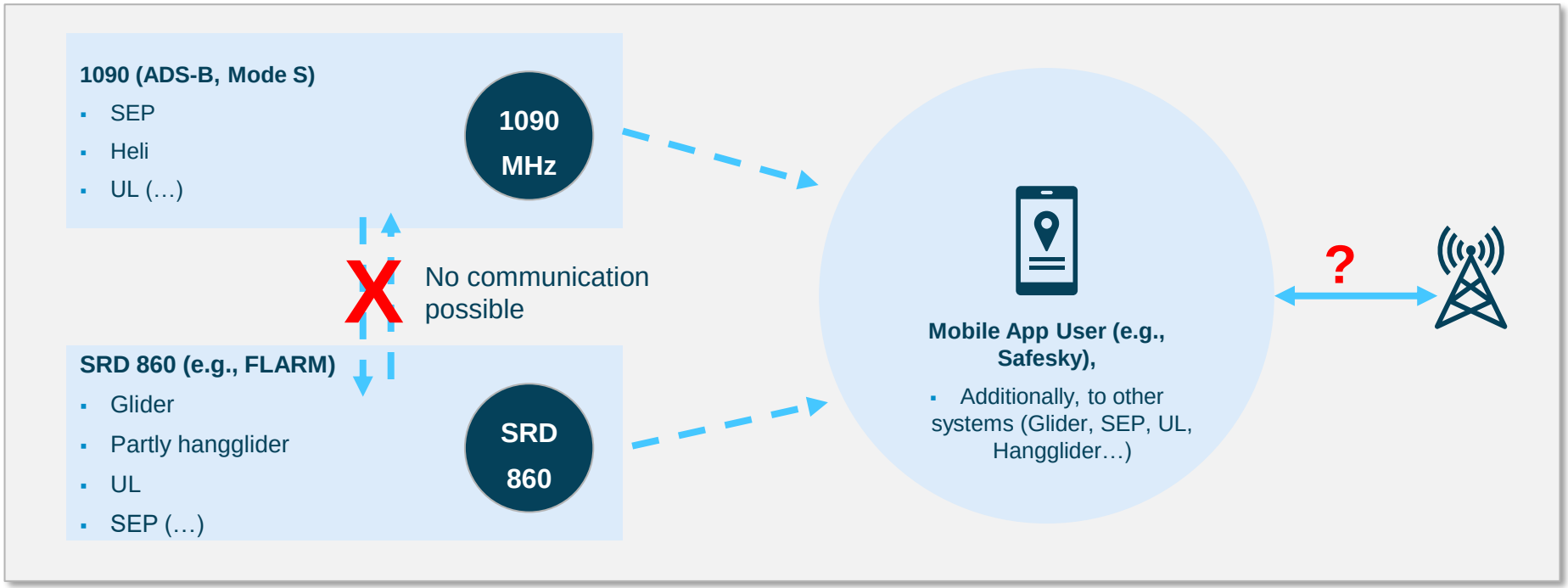
Airspace classification – Equipment requirements

- Airspace requirements for uncontrolled traffic:

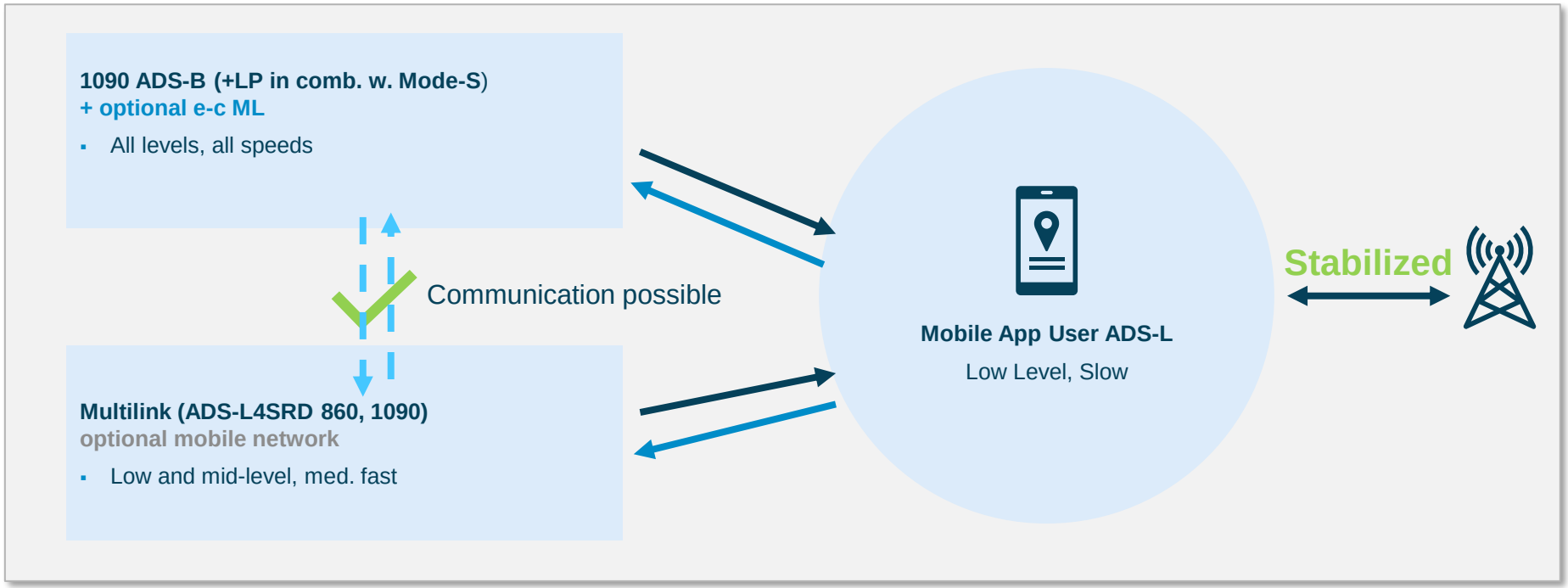
Transponder	E	G	TMZ	U-Space
SSR Mode S			X	X
ADS-B out	(X)	(X)	(X)	X
ADS-L4SRD860				X
ADS-L4Mobile				X

- (x) Note from EU 1207/2011: Aircrafts heavier (MTOW) than 5,7 t and/or faster than 250 kts are obliged to have an ADS-B transponder
- All installed SSR transponder have to be switched on

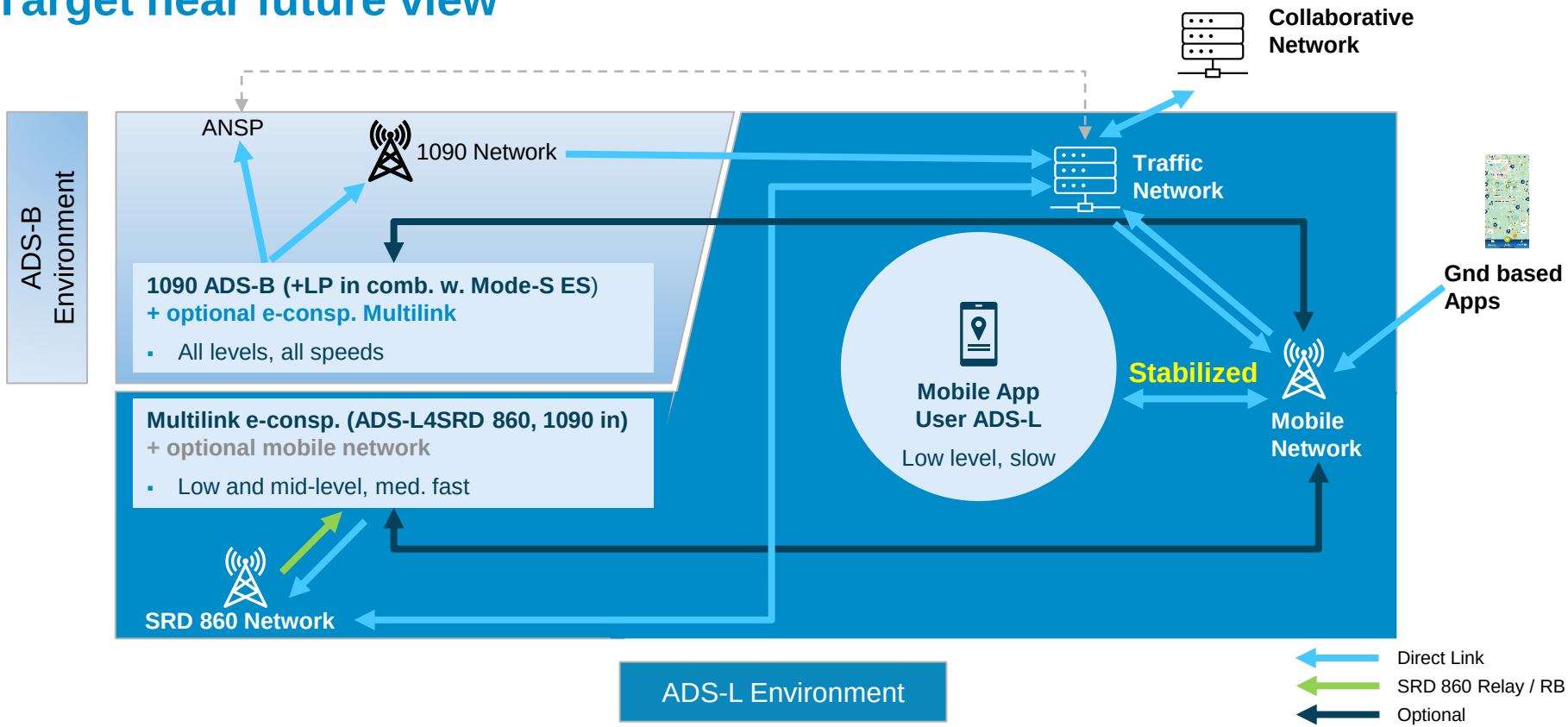
Cluster of airspace users



Target near future view

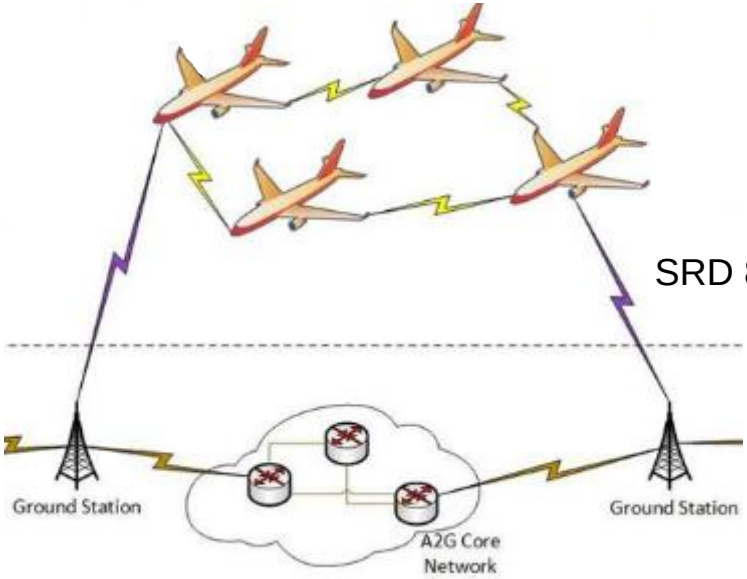


Target near future view



Target near future view

SRD 860 Relay (Air)



SRD 860 Relay (GND)

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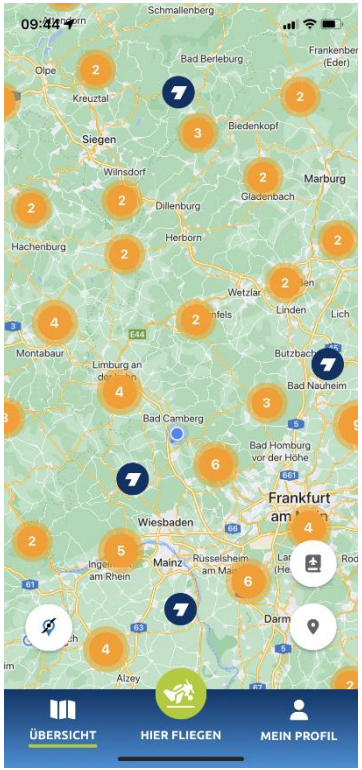
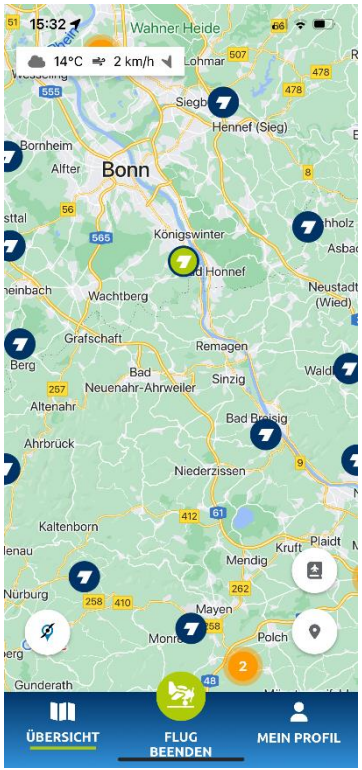
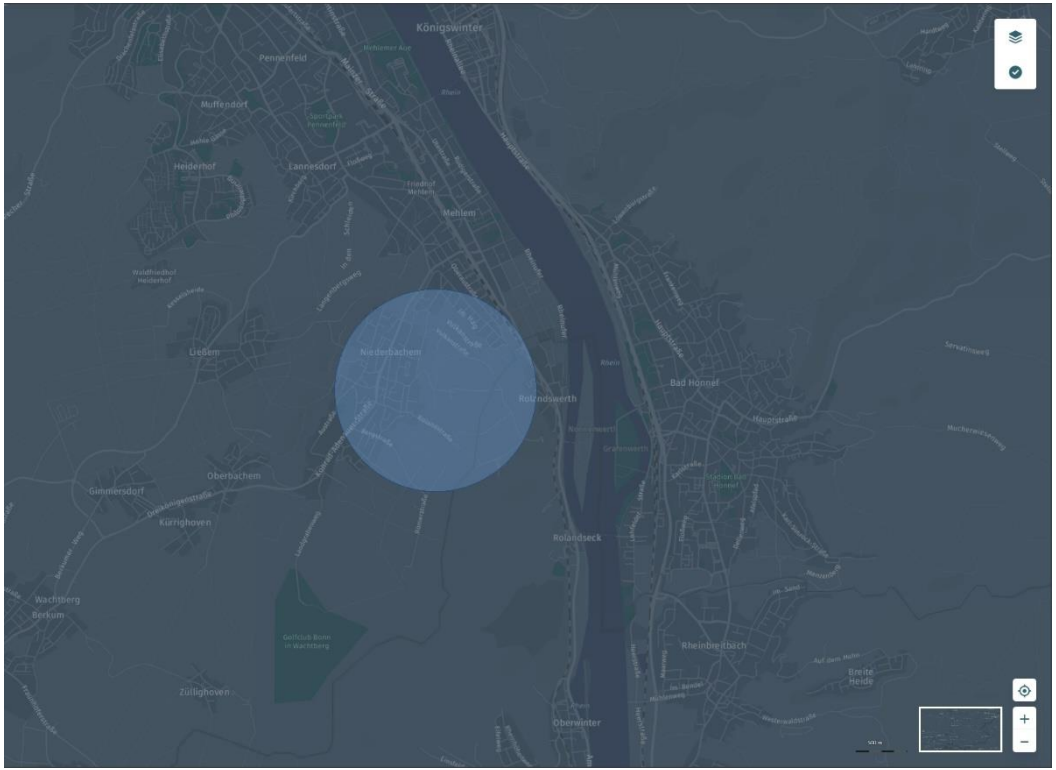
Further inputs and iniatives

- FlyDMFV App
- Safesky Project
- Starlink
- Space-based ADS-B
- Mode N

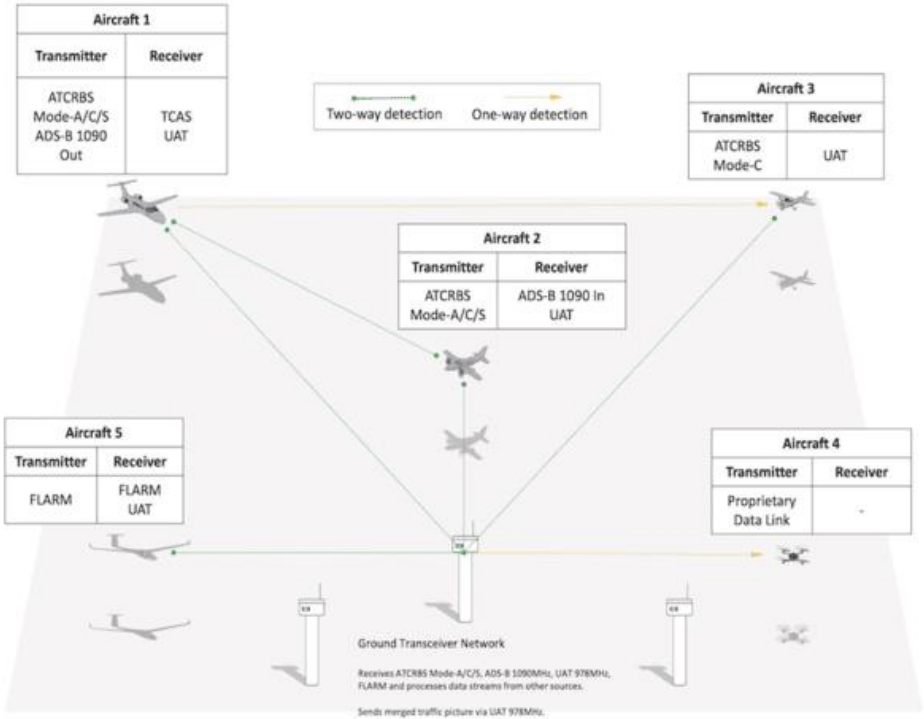
GND based Apps (FlyDMFV-App)







Further initiatives - SafeSky

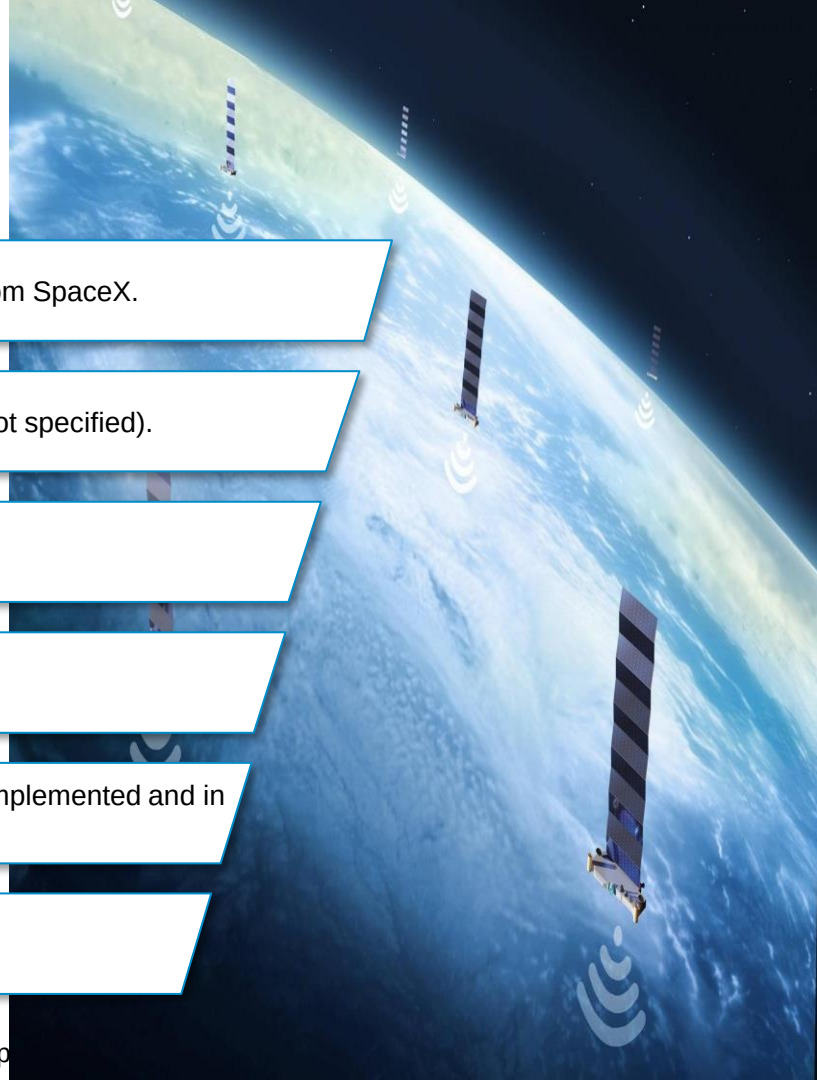


Comments

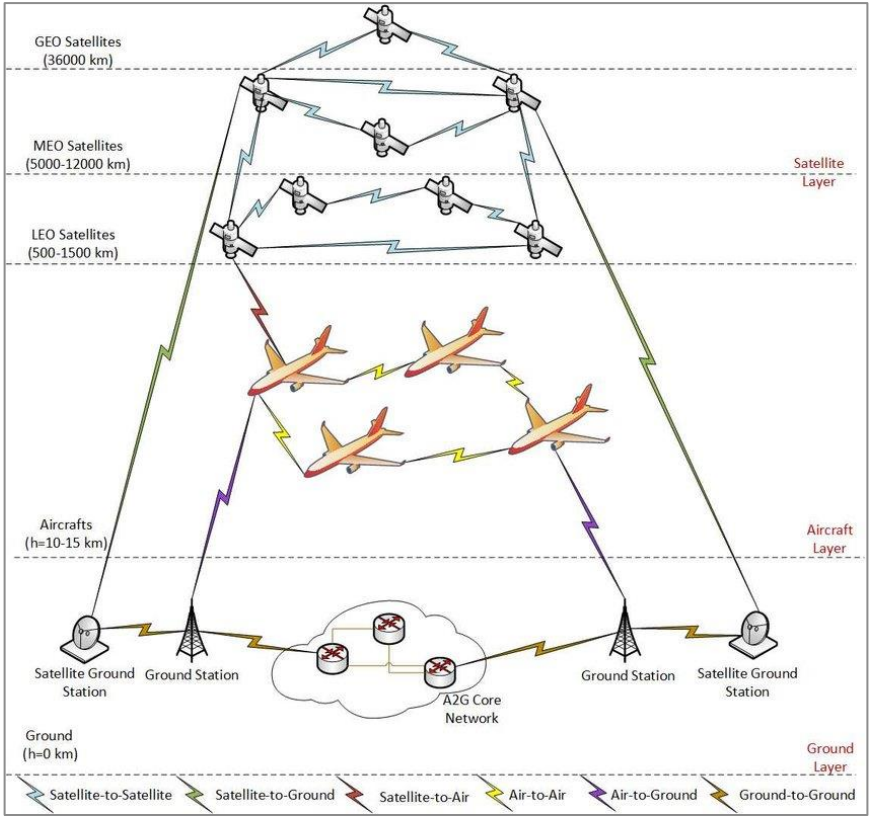
- Project of FH Aachen to build up a Ground Transceiver Network
- Receives ATCRBS, Mode-A/C/S, ADS-B, UAT, FLARM and processes data stream from other sources
- Sends merged traffic via UAT 978 MHz

Starlink (sat-com LTE)

- Satellite based network communication (4845 satellites in orbit stately growing) from SpaceX.
- A Starlink antenna is necessary and can speed up to 250 Mbit/s, but with delay (not specified).
- Possible to use in motion with the right antenna.
- Nearly whole Europe is covered.
- Starlink will be able to be used with smartphones. In 2024 text messages will be implemented and in 2025 phone calls and network connection with speed up to 15 Mbit/s are planned.
- Current iPhones can send emergency messages via sat-com.



Multilink with satellites



Satellite-based ADS-B

Advanced form of ADS-B technology to ensure real-time surveillance of aircraft
(conventional ADS-B systems are acquired by ground stations)

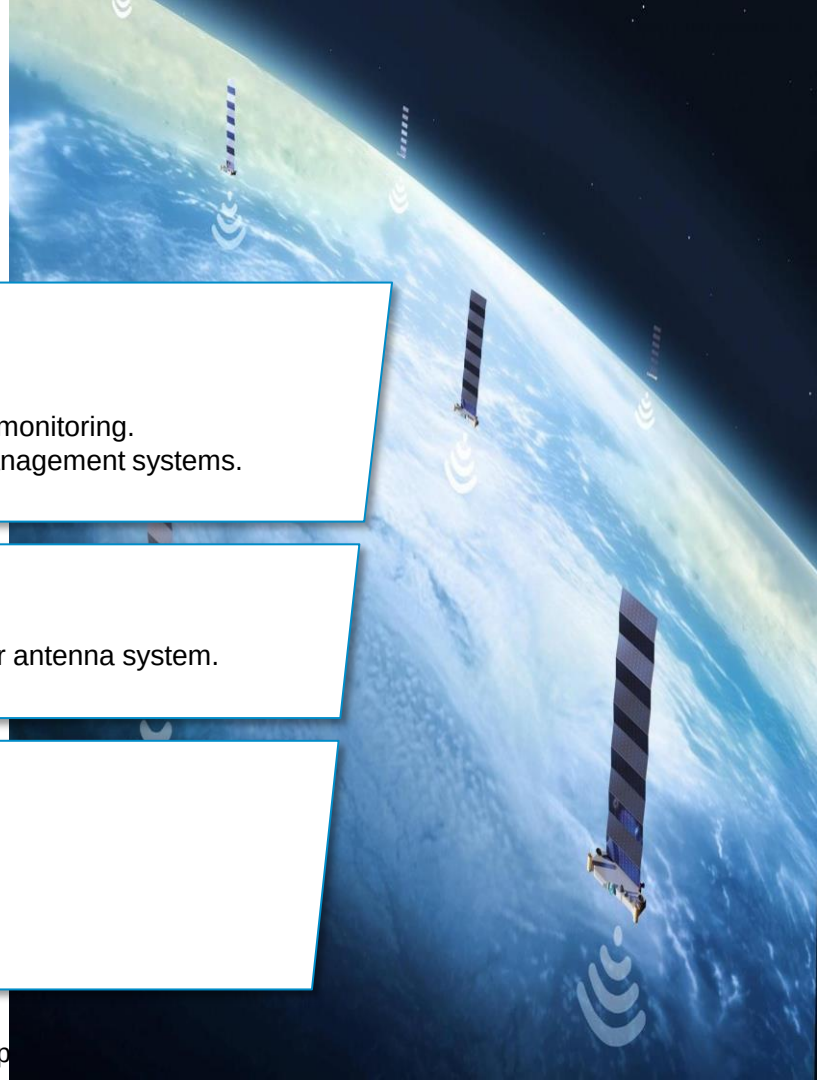
Space-Based ADS-B is based on satellite communication (low earth orbit) and monitoring.
The received data will be downlinked to ground stations for use in the traffic management systems.

It uses existing ADS-B Out equipment.

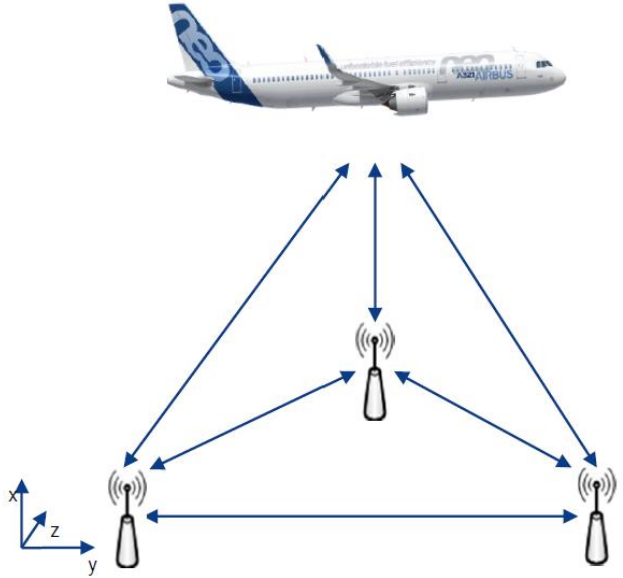
Specifically, it requires a Mode-S ADS-B transponder and an A1-class or higher antenna system.

Key Advantages over ground-based ADS-B:

- Real-time data
- Coverage in remote areas (also polar and oceanic areas)
- Improved safety, due to better and real time data
- Global deployment
- No limits trough line of sight



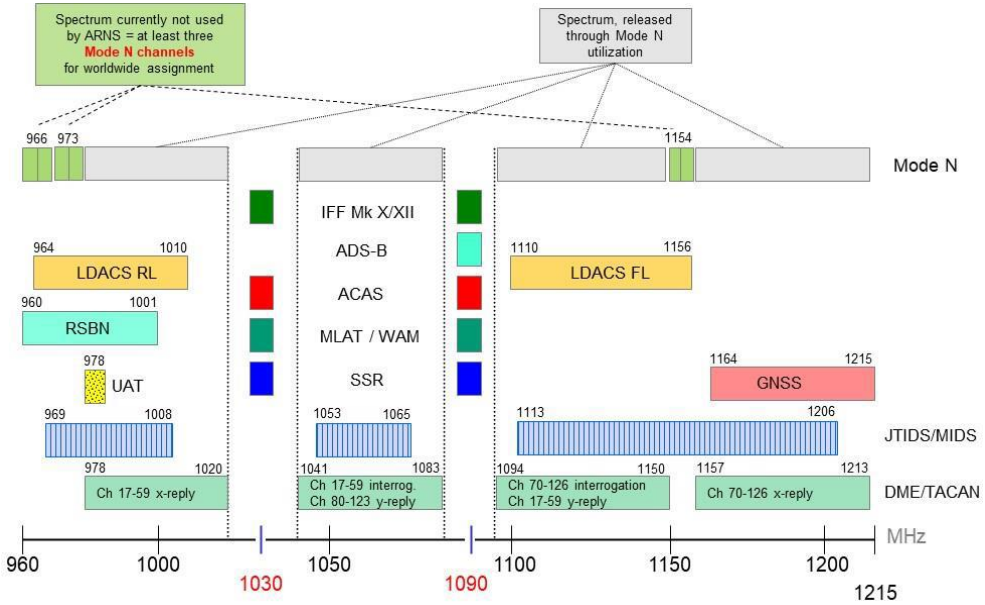
Mode N (navigation)



Comments

- DFS, Bundeswehr, EDA (Civil and military)
- Validated concept for ground-based navigation system
- Works in L-Band (960-1215 MHz, aeronautical L-Band)
- Terrestrial system, based on Mode S signal format (reduced standardization efforts)
- Alternative positioning and timing (A-PNT), backup for GNSS (-> PBN, RNAV…)
- Backwards compatible with legacy systems (DME, TACAN)

Mode N (navigation)



Comments

- Basis for broadband data exchange and integration in U-Space
- Needs only one frequency -> flexible transition
- Reduces Load 1030/1090
- Releases frequencies in L Band (-> UAT or similar systems)
- Validated position fata
- Use for e-conspicuity is in review
- Required hardware for GA will be affordable and small !

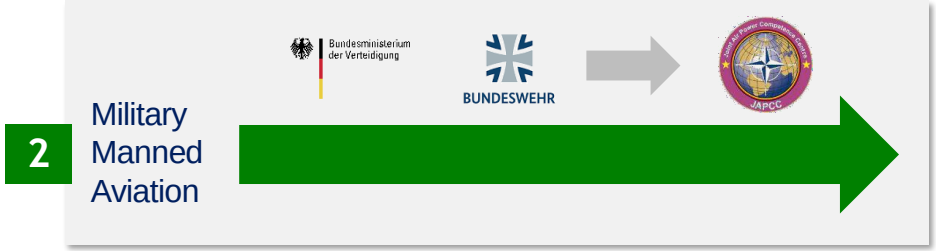
Mode N (navigation)

Ongoing activities

– Involvement in international CNS- and ATM-committees, Exchange with JURG

– Position BMVg/Bw in Dependence of Evaluation by NATO JAPCC (Joint Air Power Competence Centre)

Alignment and Time horizon open



Further development

Control by SG CNS&ATM systems

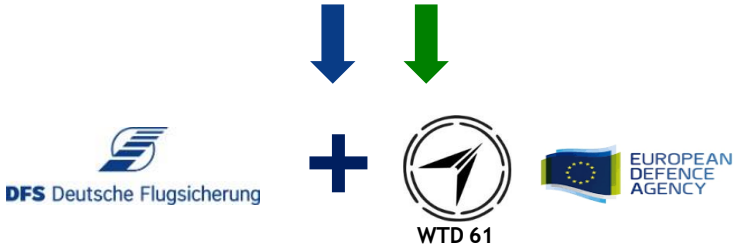
– 24/7 operation from four prototypical ground stations at airfield

– Validation of the operational range (< 125 km) by second station (Reiteralpe)

– Development and Expansion of a Mode N Ground infrastructure in Southern Germany

– If applicable. Use of DFS-locations

– Development On-board receiver in next phase (2023-26)



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- **Interoperability levels (needs - levels - requirements for implementation)**
  - **Definition of levels, needs and requirements**
  - Technical interoperability (transmission ways, protocols, ...)
  - Operational interoperability (legal/ practical rules and needs, interfaces to ANSPs, networks, ...)
  - User side interoperability (information and understanding, safety gain (HMI !), installation, support programs, ...)
- Conclusion and further steps

Interoperability – Needs – Levels – Requirements

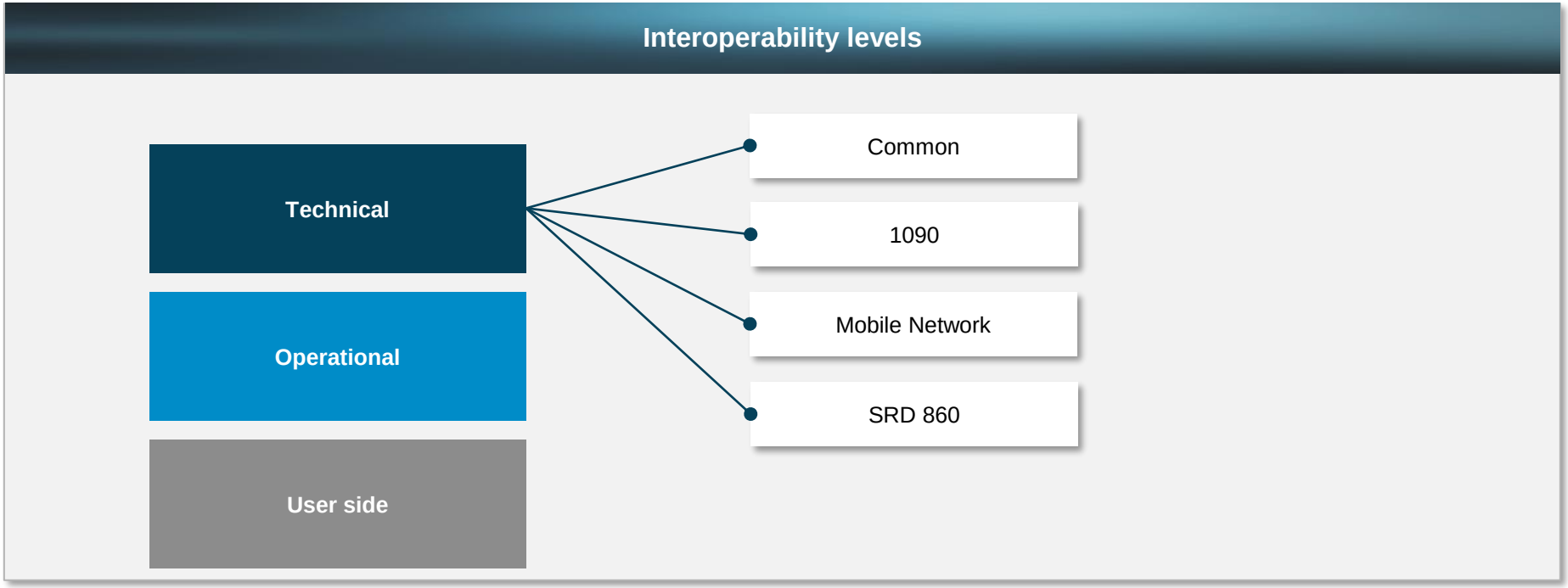
Needs for interoperability (identified in survey, technical meetings, workshop 1)

Derived interoperability levels (to be seen as categories)

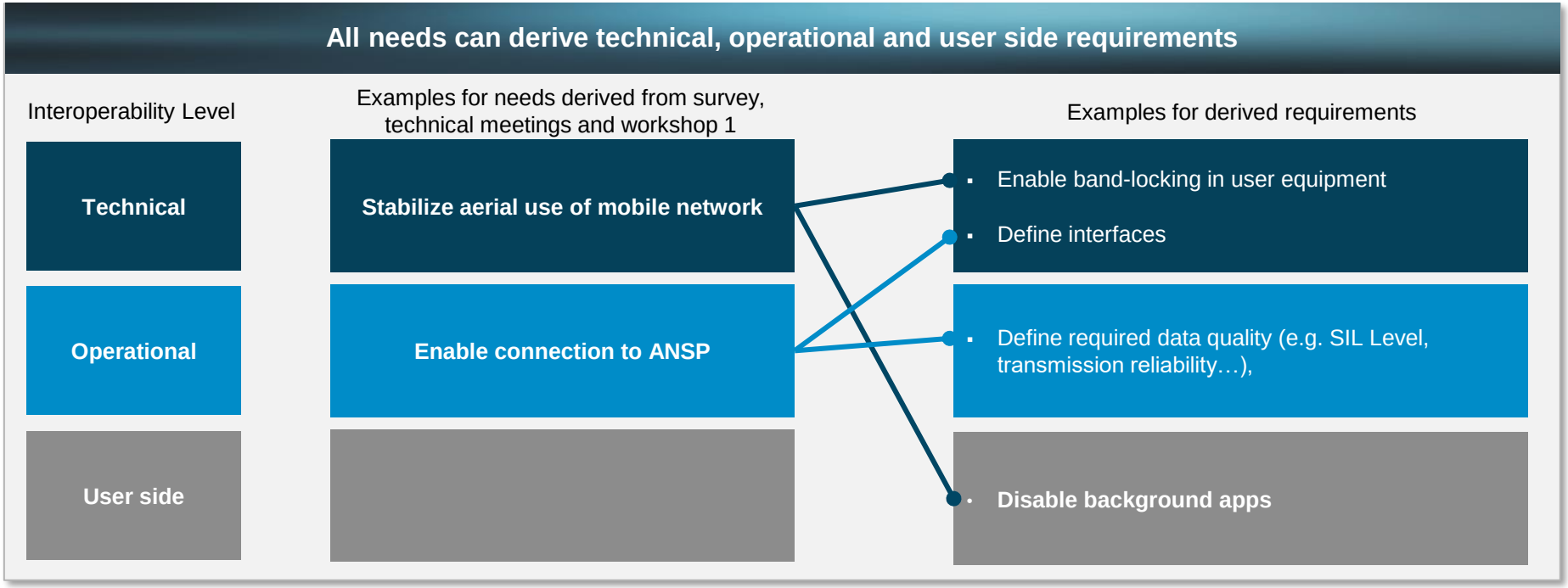
Requirements derived from interoperability levels to achieve the solution (→ steps on roadmap)

In this procedure we will have (limited) time to review and consider the backgrounds to the specific areas !

Identified interoperability levels



Interoperability (examples from need to requirement)



Agenda

- Introduction
- Recap and results of past workshops and target system combination
- Results of technical meetings (use of mobile network and different communication ways)
- Further inputs, programs and discussion (open points)
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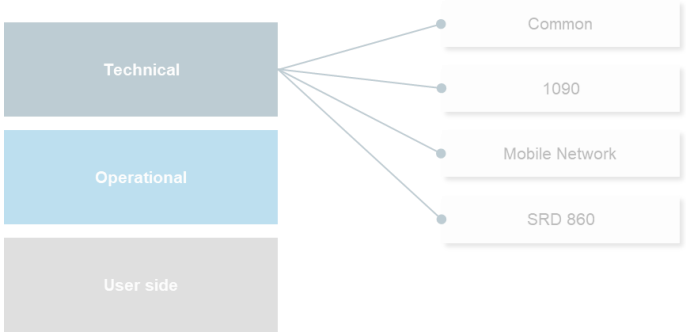
  - Definition of levels, needs and requirements
  - **Technical interoperability (transmission ways, protocols, ...)**
  - Operational interoperability (legal/ practical rules and needs, interfaces to ANSPs, networks, ...)
  - User side interoperability (information and understanding, safety gain (HMI !), installation, support programs, ...)
- Conclusion and further steps

Explanation

- The subsequent slides have been prepared after facilitation of Workshop 2.
- The slides incorporate the feedback that has been provided to the project team after Workshop 2, e.g. with regards to needs and requirements.
- Furthermore, four conclusion slides have been prepared.
- The slides as presented in the workshop are in the backup at the end of the presentation.



Technical needs – Common (1/2)

- Use of current installed hardware
- Open protocols, no fees or charges
- Determine the limits of e-conspicuity (e.g. aerobatics, high climb/descend rates…)
- Minimize obscuration in all transmission ways
- Future proof (interfaces for future features and transmission ways, e.g. Sat-Com)

Technical needs – Common (2/2)

- Open up new capabilities to display threats and traffic (e.g. model flying)
- Transmission and display of active radio frequency for reception
- System redundancy
- Setup supporting ground network

Derived requirements from Technical Needs Common (1/2)

Requirements

Technical

- Enable ADS-L
- Evaluate max possible reception measures (e.g. ext. antennas)
- Develop multilink devices, which include existing hardware
- Enable connection to peripheral equipment (radio, altimeter, etc.) to integrate this information into transmission (e.g. actual used frequency to reach the pilot)

Operational

- Setup update/upgrade programs for existing hardware
- Mandate free updates
- Initiate an evaluation group for setting up ground network (interfaces, locations, costs…)

User Side

- Setup communication program about e-conspicuity, limits, techniques for all user groups

Derived requirements from Technical Needs Common (2/2)

Requirements

Technical

- Put ground-based apps (e.g. FlyDMFV) into operation with connection to traffic network
- Setup interfaces to certified equipment (e.g. ACAS)

Operational

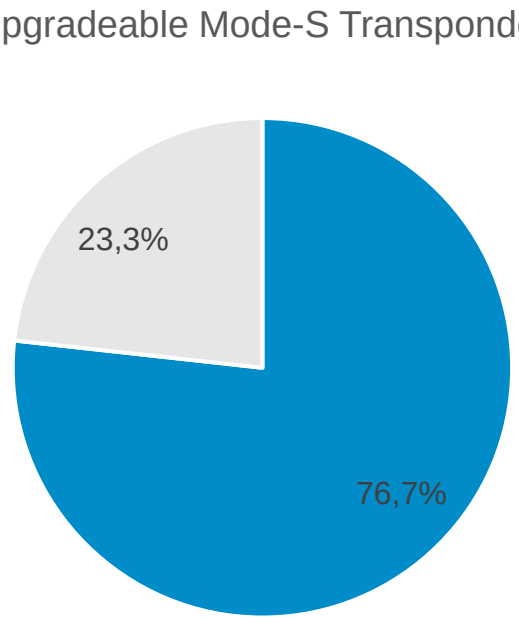
- Permanently watch out and enable integration of uprising technologies (e.g. Mode N, UAT-Frequencies, Satellite usage…)

User Side

Technical Needs 1090 User

- Enable visibility and positioning of Mode-S Users for e-conspicuity
- Avoid (excessive) additional load on 1090, do not disturb TCAS/ACAS Systems
- Enable traffic information about SRD 860 and Mobile Network User

Mode-S upgrade to ADS-B out



Comments

- Feedback from 3 Companies
- Includes 26.230 Mode-S Transponders
- 2 Companies provides Mode-S Transponder which are nearly 100% upgrade able
- Agrees with the statement from TM2 that approx. 75% of all transponders are upgrade capable.
- Update to a no certified ADS-B out transponder wit SIL 1

ADS-B out regulatory

1. ETSO Approval necessary (protected frequency, compliance to ICAO standard)
2. Installation must be certified (EASA or NAA approved)
3. Radio communication authority approval
4. LPAT do not meet ETSO standards -> no use of 1090 possible, except:
   - Allowance of NAA in their airspace
   - Notification of ICAO (differences to standards)

Load on 1090 MHz

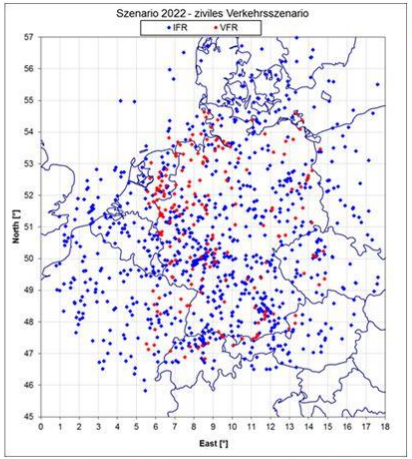
1. All transponders fitted in have to be switched on
2. Depending on the airspace a Mode-S transponder responds to several hundreds of request per second
3. Most of the requests are “All Calls” from SSR and TCAS
4. Within the newest MOPS an ADS-B-Transponder transmits around 6.5 transmissions per second
5. A Mode S transponder is able to respond to up to 1250 requests per second (not prioritized)

Load on 1090 MHz

Zivil / militärisches Luftverkehrsszenario

- Beruht auf Radardatenaufzeichnungen von DFS und EinsFüDst des größten Verkehrsaufkommens in 2015
- Hochrechnung auf 2022 mit EUROCONTROL Forecast

System	Anzahl
IFR Luftfahrzeuge	**863**
Mode S Transponder	100%
ACAS	100%
ADS-B Out	99%
VFR Luftfahrzeuge	**201**
Mode S Transponder	100%
ACAS	0%
ADS-B Out	15%
Militärische Luftfahrzeuge	**108**
Mode S Transponder	100%
ACAS	16%
ADS-B Out	6%

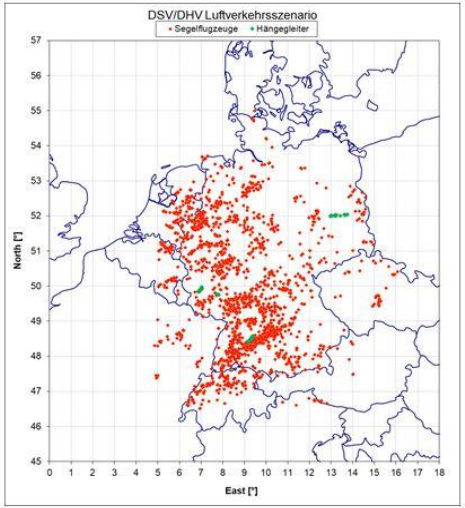


Basisszenario – ziviles Luftverkehrsszenario

DSV/DHV Luftverkehrsszenario

- Beruht auf Datenaufzeichnungen von DSV und DHV
  DSV: 21.05.2017
  DHV: 02.08.2017 (BER), 28.04.2017 (MOS), 21.05.2017 (SAL)
- größtes Verkehrsaufkommen in 2017

System	Anzahl
Segelflugzeuge	**2256**
Mode S Transponder	100%
ACAS	0%
1090 MHz Extended Squitter	100%
Hängegleiter	**95**
Mode S Transponder	100%
ACAS	0%
1090 MHz Extended Squitter	100%



Differences to the study 2015:

- The actual SRD 860 users will not change to 1090 out
- Only upgrades from existing Mode-S to ADS-B are in scope

Derived requirements from Technical Needs 1090 User

Requirements

Technical

- Enable upgrade of existing Mode-S Transponders to ADS-B (connection with certified and non-certified positioning source)
- Develop affordable GNSS sources for upgrades (preferably as e-conspicuity Multilink device with GNSS interface)
- Setup service to collect and verify identifiers and deal with amount of identifiers

Operational

- Encourage an exemption permit for those with older, not upgradeable Mode-S transponders in EASA member states for usage of an additional low power device
- Recheck TABS Usage
- Setup technical evaluation group to investigate the additional 1090-load
- Ensure clarity that it is a “situation awareness support”
- Analyse effect and effort to deal with non-certified transponders

User Side

- Supplement equipment to e-conspicuity functionality

Technical Needs - Mobile Network

- Stabilize the network availability and reliability in the air, optimize usage of the mobile network in the current stage of expansion
- Minimize interferences and disturbances of ground network
- Clarify the usable altitude and speed ranges
- Optimize the reception in aircraft and for utilization without airframes
- Check user and provider contracts for aerial usage with e-conspicuity

Derived requirements from Technical Needs Mobile Network (1/2)

Requirements

Technical

- Define recommendations and specifications for mobile devices in terms of e-conspicuity
- Check UE (User Equipment/ modem) based features for more stable aerial use of mobile network (i.e. „band locking“ to most suitable frequency bands to prevent UE from trying to hop across frequencies)
- Design external devices (like 5G/LTE WLAN Router) with specific external antennas for usage in aircrafts
- Initialize studies and tests for stable aerial usage together with European network providers (Script with realistic data streams)
- Setup Standardization for ADS-L4Mobile
- Define a minimum standard for the aerial usage

Operational

- Clarify responsibility for implementation of U-Space (not focus of this project)
- Ensure contracts with providers to foresee aerial use
- Define cost/budget for setting up network and operate it

User Side

- Stop background apps on mobile devices
- Analyse impact of additional App for pilot

Derived requirements from Technical Needs Mobile Network (2/2)

Requirements

Technical

- Define communication volume (bytes/sec) upstream/downstream (also for ADS-L uplink)
- Address cross-border traffic (roaming)
- Ensure availability of the network
- Scan existing IoT solutions
- Define minimum requirements towards apps
- Define technical infrastructure (e.g. owner of servers)

Operational

User Side

Technical Needs - SRD 860

- Implementation of ADS-L in SRD 860 equipment
- Enable direct communication (Air-Air) with ADS-L
- Use and upgrade of existing equipment for target system combination
- Optimized reception and enlarged range

Derived requirements from Technical Needs SRD 860

Requirements

Technical

- Finish ADS-L specification, define integration and payload
- Enable Relay communication on O-Band (air-air and ground-air)
- Encourage hardware manufacturers (integration of ADS-L, upgrades, exchanges…)
- Integrate optional Mobile connection

Operational

- Incorporate model flying, ground vehicles, starting and landing sites and airborne hazards

User Side

- Install and use external antennas
- Enable participants to use devices (training material)

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  - User side interoperability (information and understanding, safety gain (HMI !), installation, support programs, ...)
- Conclusion and further steps

Needs - Operational

- Enable connection to ANSP and the usage of e-conspicuity data also for airspace utilization (e.g. SIL Handling)
- Enforce “just culture” principles, no chasing of pilots by being conspicuous
- Avoid spoofing (of) signals
- Minimum standard of e-conspicuity data and transfer way
- Put Ground Based Apps (like FlyDMFV) into operation

Derived requirements from Operational Needs

Requirements

Technical

- Enable encryption
- Setup interface for e-conspicuity data for ANSP
- Authentication
- Flexibility of protocol to evolve is required
- Integration of model flying site (“geo zone”) → hazard areas

Operational

- Mandate data fusion and sharing
- Enable usage of e-conspicuity data by ANSP (Airspace and FIS)
- No punishment by being conspicuous and making small individual mistakes (just culture)
  Encourage NAAs to join → get “Acceptance Declaration”
- Define minimum requirements for data quality (all transfer ways, latency…)
- Avoid duplicate identifications
- Enable conformity management; pilots to be obliged to have their devices up-to-date
- Interconnection and prioritisation of systems (Best system broadcasts on ground & air)

User Side

- Use Ground Based Apps iso paper-logs (e.g. model flying)
- Always switch on transponder / ADS-B (as prescribed)
- Inform about U-Space
- Integrate ADS-L in training (commit manufacturers to provide right training material)
- Ensure TCAS information is not interfered or made less important.

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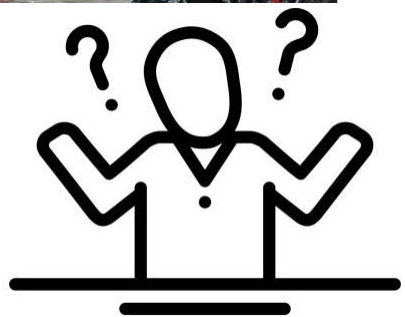
  - **User side interoperability (information and understanding, safety gain (HMI !), installation, support programs, ...)**
- Conclusion and further steps

Needs - User side

- All user groups need clear information and backgrounds
- Affordable solutions with free updates and no yearly fees
- Support programs, hardware swapping programs
- A positive safety gain is indispensable (Human Machine Interfaces)
- Anonymization

Human machine interfaces (Safety Gain)



Derived requirements from user needs

Requirements

Technical

- Enable anonymization in protocols
- Define recommendations for usage (HMI, warnings, utilization without airframes (e.g. Hang gliders…)
- Differentiate interfaces between “reliable” TCAS and other systems

Operational

- Enable support programs (exchange of hardware, supported new devices)
- Setup training programs and material for users

User Side

- Inform about e-conspicuity and it´s limits
- Be open for changes, new features, installation changes (e.g. outside antennas…)
- Train system usage for interfaces/systems after installation
- Stay close to existing standards for indications (use of colours – avoid red)
- Transparency which mode is currently used
- Prioritization of information
- Be compatible with existing cockpit solutions e.g. audio
- Simple to use, simple to understand, enabling fast decisions → reduce complexity (e.g. “Connected” indication regardless of link)
- Make clear that see and avoid is still important

Agenda

- Introduction
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- Interoperability levels (needs - levels - requirements for implementation)
- **Conclusion and further steps**

Summary and conclusion 1/4

- Interoperability needs and constraints for deployed e-conspicuity systems have been analysed by means of the results of the General Survey, Workshop 1 and several technical meetings
- As key technologies **ADS-B, ADS-L, FLARM, Mobile** and **Ground Based Apps** are designated
- The interoperability levels “Technical”, “Operational” and “User Side” were identified
- The associated needs have been collected and in discussion with participants of Workshop 2 the corresponding requirements for interoperability and implementation were determined
- The main scenario was set in dependence of these inputs. This scenario will require the usage of **multilink devices** (different transmission ways), as single solutions will not lead to a noticeable improvement
- In this scenario the introduction of **ADS-L as open protocol** and without charges will have a key role
- To achieve the relay functionality (air-gnd-air) a **supporting ground network must be set up. The air-air relay function** with ADS-L should be setup for **O-Band frequencies.**

Summary and conclusion 2/4

- One major common requirement is the spread of **simplified**, but **comprehensive information** for all user groups about e-conspicuity including goal (See and Avoid - support), limits and requirements
- **Support programs** for new/exchange hardware must be **initiated** and maximize the use of existing installations (devices and equipment, e.g. audio). Upgrades of single solutions to multilink devices should be encouraged
- For the technical interoperability level, a division into four parts **(common, 1090 (MHz), SRD 860 and Mobile)** was made
- In all transmission ways obscuration must be minimized with **external antennas** and **external devices** (as far as practical for user)
- Suppliers should be encouraged to develop multilink devices and **hardware upgrades** for existing hardware, also including the ADS-L protocol
- Therefore, the specification of the **ADS-L protocol** has to be finished for **SRD 860** and **mobile usage**. The protocol must be kept flexible for evolving and payload

Summary and conclusion 3/4

- All existing Mode-S transponders should be upgraded to **ADS-B** out with certified or non-certified GNSS sources. The additional load to the 1090 MHz frequency band is negligible
- The use of low power ADS-B out devices in addition to existing Mode-S transponders, which cannot be modified, should be considered (e.g. by exemption permits). In this context the usage of **TABS** and **TABS-modes** should be investigated
- The meaningful usage of **mobile network** in the current stage is **limited** to low and slow users, but it can act as complementary transmission way for all users under certain conditions (multilink)
- To **stabilize** the transmission quality, external antennas and devices (e.g. 5G/4G router) should be used. The frequency range may be limited by **bandlocking feature**. This feature will reduce the impact to the ground network, but more extensive testing and a Pan-European coordination with the providers is required. The satellite-based transmission way has to be observed for further usage, as it will also reduce the influence on the ground network.
- Transmitted **data volume must be kept as small as possible** (e.g. no further apps running)
- Further development of the **aerial mobile usage** must be based on clear specifications of transferred data and necessary quality, agreement with **mobile providers** and definition of technical infrastructure (e.g. owner of servers)

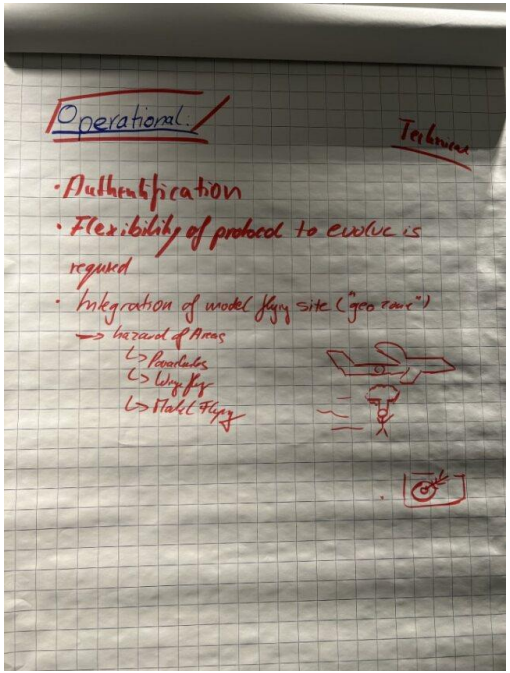
Summary and conclusion 4/4

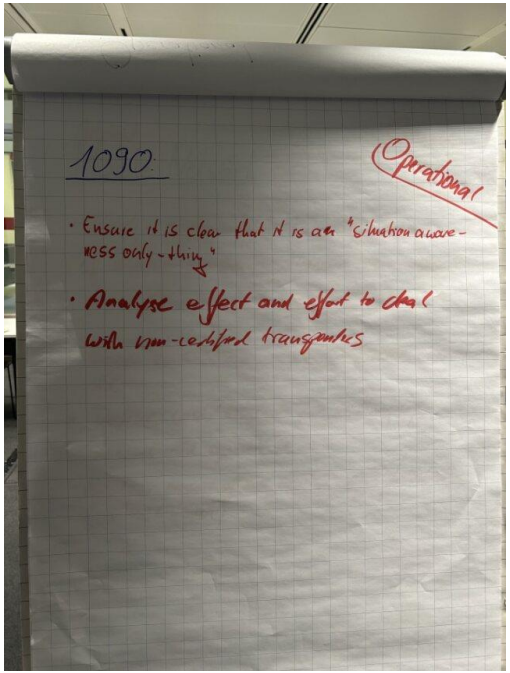
- **Model flying** (on model airfields or outside), **hang gliding starting** and **landing sites**, **parachute areas** and similar hazards must be **integrated** in the traffic network (e.g. by FlyDMFV App) to allow strategic avoidance
- The **safety gain** must be kept **positive**, therefore **training** and information material must be provided and disturbance of the users from flying tasks must be avoided (e.g. optimize human machine interface, stay close to existing standards)
- **Authentication, anonymization** and **encryption** must be integrated in the devices and protocols
- **ANSPs** should **use** the **e-conspicuity data** for releasing FIS service and frequencies, the interfaces for this have to be defined
- **Punishment** of pilots **must not happen** due to making small individual mistakes and being conspicuous (just culture). The NAAs must be encouraged to set an acceptance declaration
- Users must keep their devices autonomously **up to date**

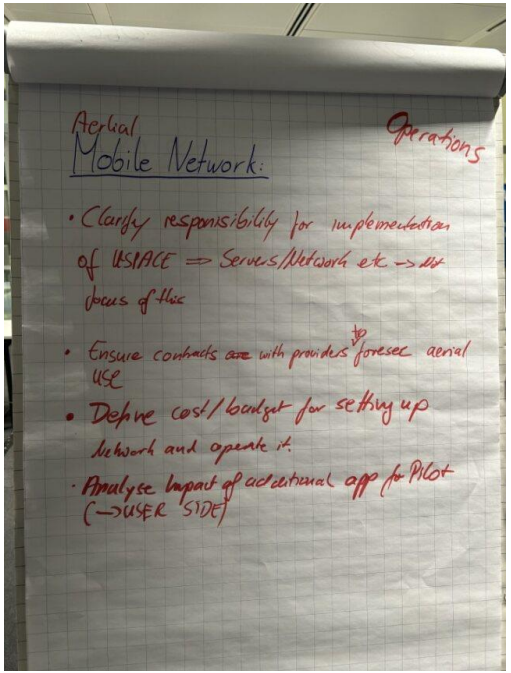
Conclusion and next steps

Nº	Description	Responsibility	Start CW	Due CW
1	Compile all the information that was gathered in this workshop	Horváth/ Droniq		
2	Think about potential further requirements	All participants		
3	Distribute updated presentation to the workshop participants	Horváth/ Droniq		

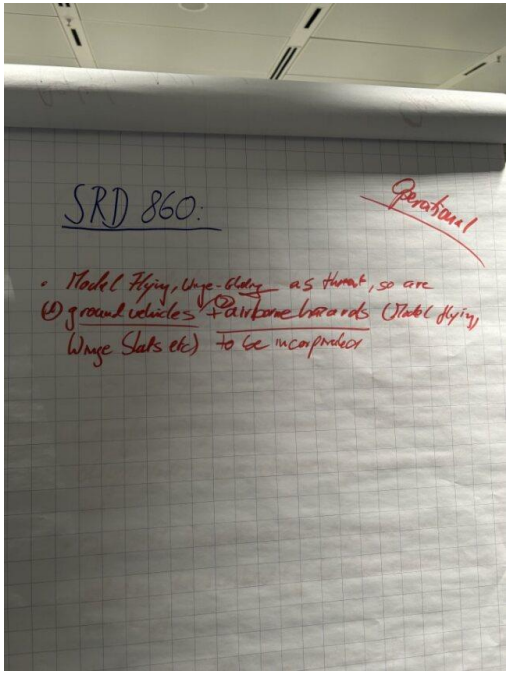
Workshop documentation (1/4)

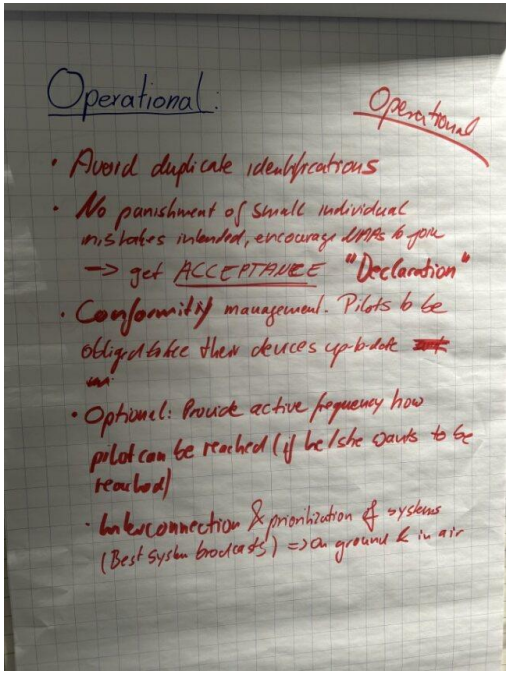


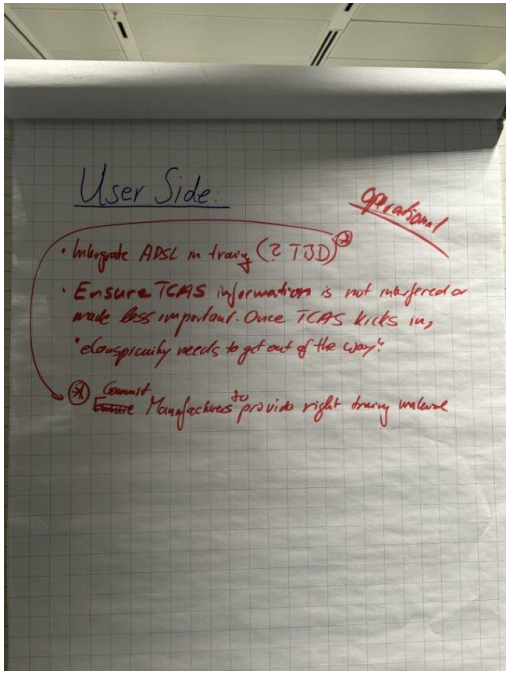




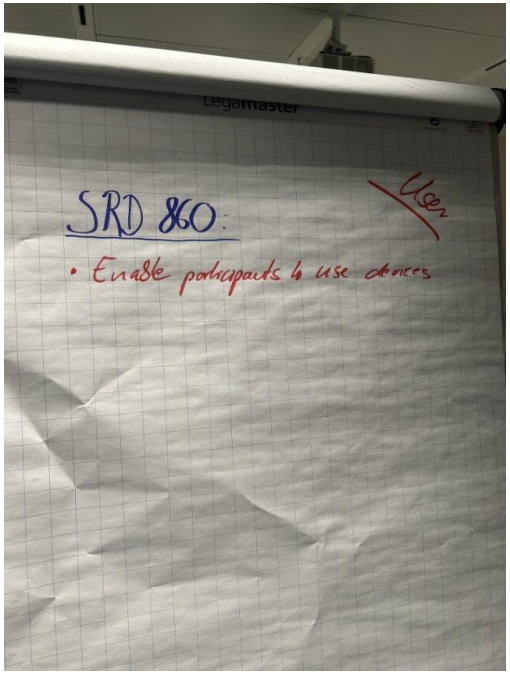
Workshop documentation (2/4)

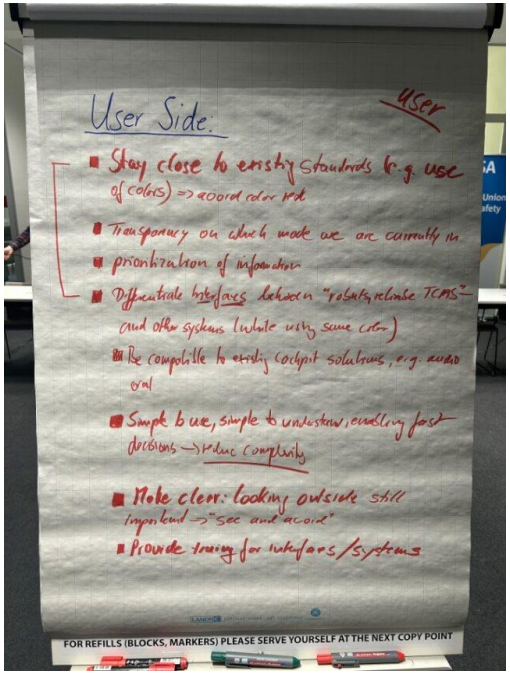


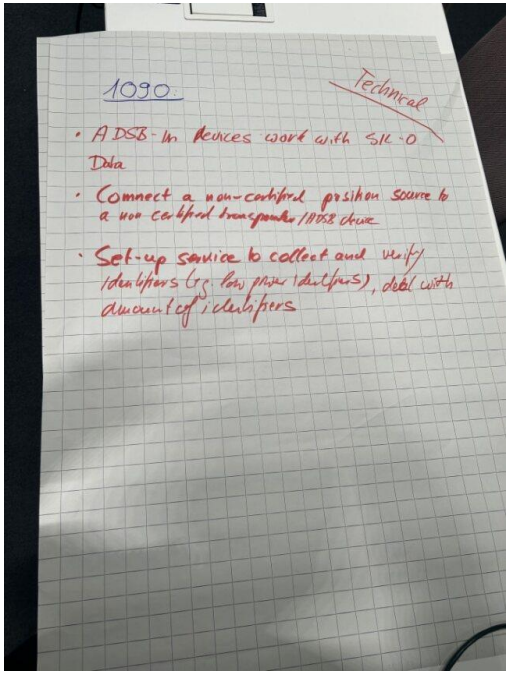




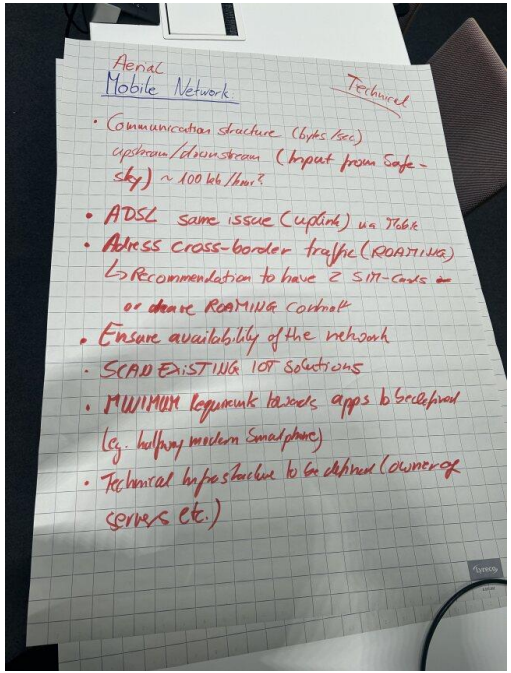
Workshop documentation (3/4)







Workshop documentation (4/4)




HORVÁTH

Technical needs - Common

- Use of current installed hardware
- Open protocols
- Define and communicate the limits of e-conspicuity (e.g. aerobatics, high climb/descend rates…)
- Minimize obscuration in all transmission ways
- System redundancy
- Setup traffic ground network
- Permanently watch out and enable integration of new or uprising technologies (e.g. Mode N, UAT-Frequencies, Satellite usage…)

Derived requirements from technical needs common

Hypothesis: To be verified and completed

Requirements

Technical

- Enable ADS-L
- Evaluate max possible reception measures (e.g. external antennas, on all transmission ways)
- Develop multilink solutions
- *Evaluation group for setting up ground network (interfaces, locations, costs…)*

Operational

- Setup update/upgrade programs for legacy hardware
- Mandate free updates

User Side

- Setup communication program about e-conspicuity, limits, techniques for all user groups
- *Evaluation group for setting up ground network (interfaces, locations, costs…)*

Technical needs 1090 User

- Enable visibility and positioning of Mode-S Users for e-conspicuity
- Avoid (excessive) additional load on 1090, do not disturb TCAS/ACAS Systems
- Enable traffic information about SRD 860 and Mobile Network User
- …

Derived requirements from technical needs 1090-User

Hypothesis: To be verified and completed

Requirements

Technical

- Enable upgrade of existing Mode-S Transponders to ADS-B
- Develop affordable GNSS sources for upgrades (preferably as e-conspicuity ML device with GNSS interface)
- Connect a non-certified position source to a non-certified transponder/ADS-B device
- Setup service to collect and verify identifiers and deal with amount of identifiers

Operational

- Exemption permit for those with older, not upgradeable Mode-S Transponders in EASA member states for usage of an additional low power device
- Recheck TABS Usage in this manner
- Setup technical evaluation group to investigate the additional 1090-load in this case
- Ensure clarity that it is a “situation awareness only-thing”
- Analyse effect and effort to deal with non-certified transponders

User Side

- Supplement equipment to e-conspicuity functionality

Technical needs - Aerial mobile network usage

- Stabilize the network availability and reliability in the air
- Minimize interferences and disturbances of ground network
- Clarify the usable altitude and speed ranges
- Optimize the reception in Aircraft
- Check user and provider contracts for aerial usage with e-conspicuity

Derived requirements from needs aerial mobile network usage (1/2)

Hypothesis: To be verified and completed

Requirements

Technical

- Define recommendations and specifications for mobile devices in terms of e-conspicuity
- Check UE (User Equipment/ modem) based features for more stable aerial use of mobile network (i.e. „band locking“ to most suitable frequency bands to prevent UE from trying to hop across frequencies)
- Design external devices (like 5G/LTE WLAN Router) with specific external antennas for usage in aircrafts
- Initialize studies and tests for stable aerial usage together with European network providers (Script with realistic data streams)
- Setup Standardization for ADS-L4Mobile
- Define a minimum standard for the aerial usage

Operational

- Clarify responsibility for implementation of U-Space (not focus of this project)
- Ensure contracts with providers to foresee aerial use
- Define cost/budget for setting up network and operate it

User Side

- Stop background apps on mobile devices
- Analyse impact of additional App for pilot

Derived requirements from needs aerial mobile network usage (2/2)

Hypothesis: To be verified and completed

Requirements

Technical

- Communication structure (bytes/sec) upstream/downstream
- ADS-L same issue (uplink) via Mobile
- Address cross-border traffic (roaming)
- Ensure availability of the network
- Scan existing IoT solutions
- Minimum requirements towards apps to be defined
- Technical infrastructure needs to be defined (e.g. owner of servers)

Operational

User Side

Technical needs SRD 860

- Implementation of ADS-L in SRD 860 equipment
- Enable direct communication (Air-Air) with ADS-L
- Use and upgrade of existing equipment for target system combination
- Optimized Reception and enlarge range

Derived requirements from technical needs SRD 860

Hypothesis: To be verified and completed

Requirements

Technical

- Finish ADS-L specification, define integration and payload
- Encourage hardware manufacturers (integration of ADS-L, upgrades, exchanges…)
- Integrate optional Mobile connection

Operational

- Model flying, ground vehicles and airborne hazards to be incorporated as threat

User Side

- Install and use external antennas
- Enable participants to use devices

Needs – Operational

- Enable connection to ANSP and the usage of e-conspicuity data also for airspace utilization (e.g. SIL Handling)
- Avoid spoofing (of) signals
- Minimum standard of e-conspicuity data and transfer way
- Put Ground Based Apps (like FlyDMFV) into operation

Derived requirements from operational needs

Hypothesis: To be verified and completed

Requirements

Technical

- Enable encryption
- Setup interface for e-conspicuity data for ANSP
- Authentication
- Flexibility of protocol to evolve is required
- Integration of model flying site (“geo zone”) → hazard areas

Operational

- Mandate data fusion and sharing
- Enable usage of e-conspicuity data by ANSP (Airspace and FIS)
- Define minimum requirements for data quality (all transfer ways, latency…)
- Avoid duplicate identifications
- No punishment of small individual mistakes intended, encourage NAAs to join → get “Acceptance Declaration”
- Conformity management. Pilots to be obliged to have their devices up-to-date
- Interconnection and prioritisation of systems (Best system broadcasts on ground & air)
- Provide active frequency how pilot can be reached (optional)

User Side

- Use Ground Based Apps iso Paper Logs (Modelflying)
- Always switch on transponder / ADS-B
- Information about U-Space
- Integrate ADS-L in training (commit manufacturers to provide right training material)
- Ensure TICAS information is not interfered or made less important. “Once TICAS kicks in, e-conspicuity needs to get out of the way”

Needs – User

- All user groups need clear information and backgrounds!
- Affordable solutions with free updates and no yearly fees
- Support programs, hardware swapping programs
- A positive safety gain is indispensable (Human Machine Interfaces)
- Anonymization

Derived requirements from user needs

Hypothesis: To be verified and completed

Requirements

Technical

- Enable anonymization in protocols
- Define recommendations for usage (HMI, warnings, utilization without airframes (e.g. Hang gliders…)
- *Setup training programs and material for users*

Operational

- Enable support programs (exchange of hardware, supported new devices)
- *Setup training programs and material for users*

User Side

- Inform about e-conspicuity
- Be open for changes, new features, installation changes (e.g. outside antennas…)
- Train system usage for interfaces/systems after installation
- Stay close to existing standards (use of colours – avoid red)
- Transparency on which mode we are currently in
- Prioritization of information
- Differentiate interfaces between “reliable” TICAS and other systems
- Be compatible with existing cockpit solutions e.g. audio
- Simple to use, simple to understand, enabling fast decisions → reduce complexity
- Make clear that see and avoid is still important