EASA
European Union Aviation Safety Agency

HORVÁTH

GA COLLISION RISK -

INTEROPERABILITY OF ELECTRONIC CONSPICUITY SYSTEMS

Case Studie: D-3.2

Version control

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1. Introduction and Outline

In D3.1 three case studies including the various transmission paths have been analyzed for feasibility, costs, and user matching. The observations and conclusions from D3.1 form the basis for the observations in this additional case study.

In Deliverable 3.2 the assessment of additional benefits for airspace and ground users through harmonized data exchanges, including the availability of additional (stored) traffic data for search and rescue operations, the investigation of safety related events and safety trends, as well as the reuse of stored traffic data for training purpose will be outlined (see Figure 1).

As an example, for SAR services, it would be a benefit to have access to callable real-time and historic data from aircraft involved in accidents, to be faster at the accident site. These could be possible through harmonized data exchange between different data storages and users.

This case study also includes the benefits for air traffic and air navigation services like FIS. However, these benefits might also result in a much higher workload for the air traffic controller, while they get access to traffic data which were not previously available and would have to deal with this for traffic advisory.

The storage of historical traffic data which can be used for training, safety analysis and investigations would also be a further benefit to the community and the "ground users" like flight schools.

Structured learning from own dangerous incidents and / or mistakes or from other pilots in a professional aviation safety culture, investments into education and ongoing training have a significant effect on overall safety.

This is why this case study dives deeper into the benefits and requirements of sharing real-time traffic data with the ATS/ANS world and looking into historic traffic data storage.

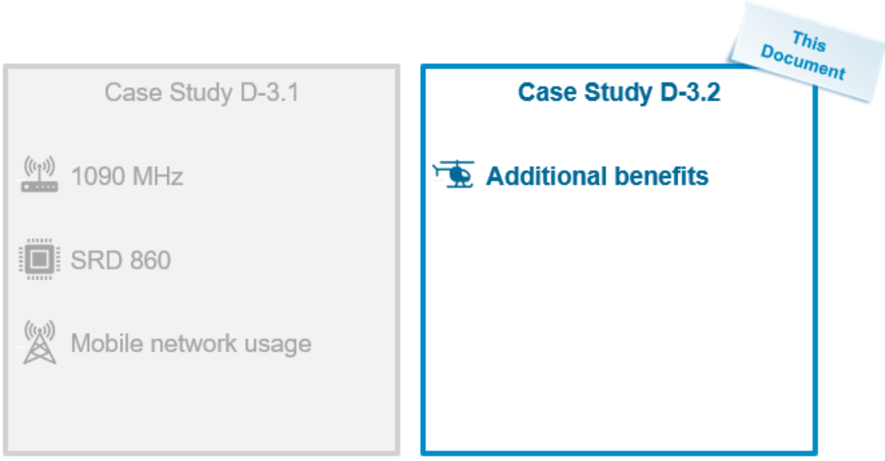

Figure 1: Overview deliverables

2. Assumptions

The considerations for the case studies have been prepared in conjunction with previous parts of this project and should not be published as a stand-alone document.

Generally speaking, most of the formulated additional benefits in the sections below are based on the general assumption of a “traffic data storage system” that can store large quantities of traffic data over an extended period of time (months/years).

It is also assumed that several traffic data systems can feed into such a traffic data storage system (analogous to the interoperability of the systems); these are in detail:

- ground receiver unit networks data like mentioned in 3.1. i.e., for ADS-B and SRD860
- Secondary radar systems
- MLAT receiver networks
- Mobile stations / airspace users transmitting their own position data via i.e., mobile network to an own server infrastructure as mentioned in case study three.

Keeping in mind that this might result in a doubling of information per target due to more than one feeding data system per target at the same time, it is also assumed to have an integrated “data consolidation functionality” to consolidate feeding data from more than one system to one target if needed. Raw data should be stored in parallel for detailed analysis, i.e., if one feeding system is producing corrupt data.

3. Case Study - Additional Benefits

3.1. Use of large Data sets for general aviation

The interoperability of the various systems and transmission paths considered in Deliverable 3.1 not only opens the possibility of a more complete real-time traffic situation picture but can also offer benefits for many additional users by storing this data.

The better the quality of the traffic data and the more complete the set of aircraft position data, the easier it is to initiate and coordinate rescue measures for a lost aircraft, for example, if these data are stored. However, large data sets also make it possible to improve the accuracy of predictions and forecasts, e.g., to predict hotspots (e.g., airspace edges or popular gliding routes), to equalize processes and to mitigate the approach of aircraft as early as the flight planning phase.

A distinction must be made regarding the type of data for the individual areas under consideration. On the one hand, services such as ANS, ATS and, in some cases, SAR require validated, “real-time” data that can be appropriately integrated and used in their existing systems. On the other hand, the areas of safety analysis, investigation of safety trends and training only have a benefit if the data is stored and made available over a longer period.

In this context, real-time data means that the data was either received and made available directly or provided via a server-based system with an acceptable latency as shown in D3.1. The quality and quantity as well as the validity and acceptable latency still need to be defined here.

The advantages of distributing live data and storing the traffic data are demonstrated in this case study using various additional user groups, apart from the flying participants. The prerequisite for utilizing these benefits is the establishment and operation of the traffic networks for interoperability of e-conspicuity systems mentioned in D3.1. These must have interfaces to connect them with the storage networks that are also yet to be set up. The main task here is therefore to develop the necessary network and network storage structure.

Interfaces means data exchange with the systems for traffic data, best case all in the same format (e.g., ADS-L format) transmitted via the discussed transmission paths: 1090 MHz, SRD 860, and mobile networks. The most feasible way to achieve this is to build software interfaces to existing receiver networks such as OGN for FLARM, ADS-B receiver networks and others.

In the case of mobile networks there is an assumption (see D-3.1/3.4. for details) that there is already a server infrastructure of the receiving/re-broadcasting client/server system, that enables to send traffic data to the connected aircraft/clients for enhanced situational awareness.

This infrastructure does not necessarily store historic data or not for a long time. But it could be synchronized with the data lake for safety analysis investigation.

As a last prerequisite for benefit derivation the access to the storage system data needs to be looked at:

a. Data Visualization of historical data:
   e.g., simple GUI type access for all user groups

b. Data Interfaces to other stakeholders:
   e.g., ADS-L/ FLARM layer for FIS air traffic controllers

3.2. Air Navigation Services

Air Navigation Services (ANS) according to EASA are mainly Air Traffic Management (ATM) services, Communication, Navigation and Surveillance services (CNS) and Search and Rescue Services. Meteorological services for air navigation and aeronautical information services are also included. (Article 2(4) of Regulation (EC) No 549/2004), see Figure 2.

ANS are predominantly provided in airspaces, which need an air traffic control clearance. ANS allow safe and efficient use of the airspace structure. Today's minimum equipment for most services is a Mode S transponder with altitude encoding. The services are usually provided by an Air Navigation Service Provider (ANSP). For uncontrolled airspaces there is no need for Air Navigation Services.

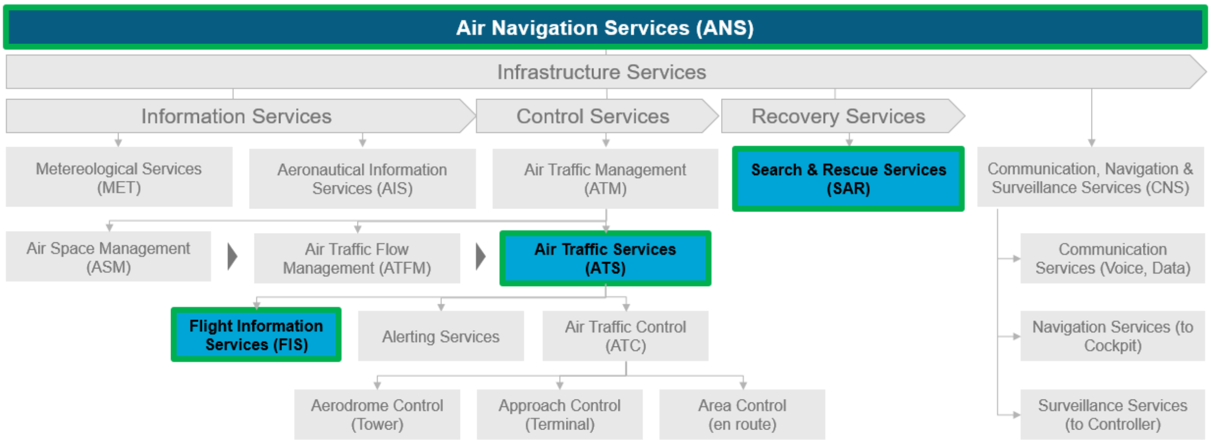

Figure 2: Air navigation services

In between the uncontrolled airspaces there are controlled airspaces, that do not need a clearance, for example airspace E. Usually there is a growing demand for air navigation services to the IFR traffic, because it can of course happen, that VFR traffic encounters IFR traffic.

The current solution attempt for mixed IFR/VFR traffic zones are TMZ/RMZ airspaces to make all VFR traffic visible to the ANSP and being able to contact the VFR traffic via two-way radio communication. This segregation limits the airspace use to users equipped with transponders.

To improve IFR/VFR mixed traffic situations, the electronic conspicuity of the VFR airspace users without transponders to the ANSP could be facilitated by real time data availability from a ground based electronic conspicuity receiver system data center. This will include ADS-L messages over other communication paths towards the data center and could make the transponder as minimum equipment unnecessary.

3.3. Air Traffic Services

Air Traffic Services (ATS) encompass a range of services, which are primarily aimed at ensuring the safe, orderly, and expeditious flow of air traffic within controlled airspace.

The most relevant air traffic service for general aviation operating under visual flight rules (VFR) is the flight information service (FIS). For the time being the core element of FIS is traffic advisory. It is advisory in nature and helps pilots maintain awareness of surrounding air traffic but does not include instructions or clearances from air traffic control but helps. Since this service is currently based on primary and secondary radar surveillance data, aircraft without transponders can usually not receive the service.

However, this also means that the FIS controller sees less electronically conspicuous traffic than a pilot using an interoperable e-conspicuity system. On the other hand, the controller sees the traffic using Mode S very precisely due to the secondary radar, which the pilot may not see. The entire traffic spectrum that transmits traffic messages on SRD860 or mobile network systems remains hidden from him. The only exceptions to this are aircraft that are large enough to be targeted on a primary radar.

Including traffic data of currently not yet supported e-conspicuity systems like SRD860 systems and others into the surveillance systems would result in a great improvement of the traffic advisory. It cannot be ruled out, that non-transponder equipped aircraft / airspace users could also receive the service, but including e-conspicuity data would result in much better traffic advisory. Probably it would also create much more workload for the FIS specialists, especially in high density traffic areas, i.e., areas where glider aircraft find good thermal updrafts. On the other hand, it could also be that participants no longer need or want to use the FIS if they have a fully interoperable e-conspicuity system on board.

For Air Traffic Services the question will arise, how to deal with the quantity of traffic advisories to FIS users, since the service is currently based on one-to-one VHF radio communication.

Making the most relevant electronic conspicuity system data / ADS-L message content available to a centralized ground-based network data center can also change the future way of long-distance flight planning and FIS interaction with general aviation users under visual flight rules due to long distance planning data information availability.

3.4. Search and Rescue Services

Search And Rescue (SAR) operations follow international standards. A systematic approach has been e.g., issued by the U.S. Coast Guard. In this approach there are five SAR stages for an incident:

Awareness,
Initial Actions,
Planning,
Operations and
Conclusions.

Any system or data analysis that can help to reduce the uncertainties of location during the awareness stage will help to make the SAR planning and operation far more efficient and successful.

Data from any on board e-conspicuity data systems of the missing aircraft itself, stored and made available in a reasonable timeframe during an SAR operation planning stage have a massive impact on the process of seeking amplifying information before activating, mobilizing, and tasking SAR resources.

Collection and storage of e-conspicuity system data via ground-based receiver networks can become very important. This assumption is based on the experience of SAR incident controllers, that i.e., primary radar data analysis of the search object has been very helpful in several SAR incidents to reduce uncertainties of location.

A quick access to historical data will help to minimize the search area and further harm and operational cost. Access to historical e-conspicuity / traffic data also might help in the conclusion phase with the aspect to learn from further investigated data for future incidents.

Another valid information source is the IGC logs of FLARM equipped aircraft, that will store encounters with the missing aircraft (if also FLARM equipped) automatically, if they were close to it. To access this information the data of the FLARM receivers need to be copied to an SD card and analyzed accordingly.

The planned relay function between the interoperable e-conspicuity systems (see D3.1) can forward traffic data from all processed sources from the aircraft via the ground network and store it processed in a storage network. In this case, data would also be available if the aircraft in distress no longer has reception from ground stations but is in contact with other aircraft.

3.5. Safety Analysis / Use of data for incident investigation and safety trends

Aviation safety is significantly enhanced through thorough incident investigation, which analyzes contributing factors to prevent future incidents and promote improvements. The investigation of safety related incidents, e.g., air proximity hazards, is much easier, if reliable traffic data from as many as data sources as possible help to reconstruct a dangerous situation in detail. Historic e-conspicuity data represent a great opportunity to achieve this.

In commercial aviation, especially with large airlines, a safety management system is established and required, which has the task of processing accidents and incidents and taking measures to prevent them in the future. The recording of flight data is also used to better reconstruct incidents. This has enabled the airlines to achieve and maintain a very high safety standard over decades. The knowledge gained is implemented in countermeasures and in pilot training.

In general aviation, such evaluations are often not fully possible due to a lack of data. Furthermore, neither the professionally trained personnel nor the financial resources are available. However, an enhancement in the data situation and the simple and easily accessible use of e-conspicuity data would lead to a significant improvement and simplification of safety analyses and the corresponding countermeasures.

For example, the APEG (Aircraft Proximity Evaluation Group) is established in Germany and consists of a large group of aviation experts (often controllers and pilots). The purpose and task of APEG is to analyze reports of aircraft approaches in the airspace of the Federal Republic of Germany. Precise analyses are often not possible due to a lack of data. This clarification of cases could be significantly improved with the measures mentioned.

Therefore, the demands are similar as for SAR operation (3.4):

- Interfaces to all relevant e-conspicuity receiver station systems / networks as feeding systems to data storage. Interfaces means data exchange with the existing systems for traffic data, best case all in the same protocol (e.g., ADS-L)
- Traffic data storage server infrastructure as storage place
- User interface to access / visualize data for analysis.
- Export functionality to existing professional incident analysis tools.

The easier data can be accessed and evaluated without expert knowledge, the more it will be used, especially for the reflection of everyday situations where you wouldn't have expected to use it beforehand.

The benefits of rapid investigations are directly linked to the ease of use! The safety culture among general aviation pilots could improve significantly.

3.6. Re-Use of Data for Training

Training related data analysis primarily helps to create useful training scenarios, that feed from real life situations observed. If contain a high-risk potential or flight incident/accident-related moments like air proximity events.

For general aviation in contrast to commercial aviation in general flight simulators are not available. But learning how to deal with critical situations in a training environment theoretically helps flight students and pilot certificate holders. Keep in mind that a big part of general aviation training and continuing education takes place in voluntary environment like flying clubs and that trainers mostly work there on a voluntary basis.

To get access to real life traffic data situations from a data lake (see 3.5) could become a sustainable part of our future error culture in general aviation training environment.

4. Conclusion

Any additional benefits for air and ground users through e-conspicuity data sharing rely on the successful implementation of:

- Common interfaces and protocols (ADS-L) to bring as many different e-conspicuity systems together in one central data sink as possible
- Traffic data storage systems that can store substantial amounts of air traffic data
- Easy access and visualization tools to historical data
- “Real-time” data interfaces to existing systems for ATM/ANS

At least SAR operation will become faster and far more efficient with easy access to the data storage. Services to general aviation as FIS will clearly benefit from it because they are able to see more airspace participants.

Safety analysis becomes much easier and more accurate with the ability to access a large data set of e-conspicuity data. This means that safety mechanisms can also be established in general aviation in the same way as in commercial aviation.

The advantages for downstream investigations and learnings achievements for initial and continuing education of pilots are clearly obvious.

Side Note for NAA / ANSP

A crucial criterion for successfully establishing the use of electronic conspicuity traffic data in general aviation is the introduction of a declaration for NAAs and ANSPs. This declaration is intended to stipulate that a rule violation committed without intent or purpose and made visible through i-conspicuity either immediately or subsequently will not be penalized.

5. Table of illustrations