UNMANNED AIRCRAFT SYSTEMS STUDY GROUP (UASSG)

SECOND MEETING

Montréal, 2 to 5 December 2008

Agenda Item 6: Any other business

UAS FLIGHTS IN CIVIL AIRSPACE WITHIN EXISTING ICAO ARRANGEMENTS

(Presented by Edward Falkov)

1. INTRODUCTION

1.1 Initially Unmanned Aircraft Systems (UAS) were created to solve predominantly military tasks. The flights of these UAS are performed in segregated airspace and it is not the subject of ICAO consideration. A large number of military UAS in the world, necessity for them to flit from one segregated airspace to another one, a wish to use military UAS for civilian purposes and development of purely civil UAS raise the needs to provide UAS flights in civil airspace while not decreasing existing safety level and cost-efficiency of commercial aviation and general aviation as well. A lot of activity at EUROCAE, RTCA, Eurocontrol, FAA, CAA of many countries is going on but within this activity it is acknowledged that there is no solution yet. Section 1.5 of ICAO Circular on UAS says: “Development of the regulatory framework for unmanned aircraft systems will be a lengthy effort, lasting many years”.

1.2 Contrary to that this information paper based on Russia’s experience describes the technical solution that 1)is supported by existing ICAO provisions developed for ATM services; 2)does not need any new developments, new spectrum, new ICAO SARPs, etc; and 3)is verified by results of flight tests. The paper is based on the presentation delivered by the member from Russia during the second ICAO UASSG meeting.

2. ASSUMPTION

2.1 All UASs should be split into two groups. One where vehicle can carry about 5 kg load of ATM equipment that would allow the UAS to be part of the ATM environment in non-segregated airspace; and one that can not carry ATM equipment mentioned and will be limited to operate in segregated airspace.

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2.2 The UASs considered in this paper belong to the first group.

Note. Russia's industry is now developing ATM equipment of 2 kg weight that includes internal power supply for a few hours of flight. Use of such equipment could help to solve the most difficult case – flights in the airspace with non-cooperative surveillance (not considered in this paper); and after giving to each airspace user such a transponder it would be possible to try to transform this airspace into controlled airspace with cooperative surveillance and ATS.

3 UAS WITHIN ATM

3.1 From an ATM perspective, the UAS have to be handled as any other aircraft. In principle the controller should not care about if the vehicle under control is an UAS or a manned aircraft. It is envisaged that there will be a change within ATM that will imply that main mean for communication will be by data link, leaving traditional voice communications as a supplement that can be used for non-routine information exchange. This development fits well with the introduction of UAS, but still the UAS has to be able to handle voice communications.

3.2 Surveillance of UAS

3.2.1 Surveillance of UAS should be handled in line with cooperative surveillance principles, i.e. by using ADS-B. ICAO has standardised three technologies that support ADS-B. Therefore, no new technology is needed for UAS and the solution for UAS should ideally be technology independent. Within the aviation community there are three technologies that are standardised for ADS-B within ATM.

3.2.2 1090ES builds upon an extension of radar technology also used for ACAS that is a collision warning system, i.e. our last resort safety-net that enters into operation when normal separation precautions have failed. The 1090ES technology is being introduced as support to initial ADS-B based surveillance services including "ADS-B out" only, i.e. no support to ASAS based services. It is widely recognised by the community that something else is needed to support ASAS applications. Furthermore, it should be considered if it is wise to mix routine surveillance functions with a safety-net like ACAS within one technology operating in the same portion of spectrum.

3.2.3 UAT is another technology developed in the US as support to GA operations. The frequency used in the US is not available in other parts of the world, like Europe, which hampers the applicability globally.

3.2.4 VDL Mode 4 was developed as a general purpose data link, and broadcast services like ADS-B was the major design driver. The equipment that is used today supports full ADS-B, i.e. both "ADS-B out" and "ADS-B in".

3.3 Data link for Command & Control (C2)

3.3.1. Typically C2 data link is the core part of UAS. It provides safe and secure UAS operating and usually is “know how” of UAS designer. In the course of controller – pilot-in-command (PiC) ATC interaction it serves as “hands” of a pilot of remotely operated aircraft and is not a subject of ICAO consideration till UAS performs all controller indications. But when this specific DL fails it is suggested that controller & PiC should get access to transparent to ATC and adopted by ICAO controller-pilot data link communications (CPDLC) with help of which it would be possible to solve the case and complete the UAS flight. CPDLC here serves as a reserved data link for C2 in point-to-point mode.

3.3.2 Assuming that a specific secure non-ICAO system will be developed for the C2 function, it should be recognised that the already existing data link systems and CPDLC services within ATM could be used in cases where the C2 data link fails. There are several technologies available that supports CPDLC, i.e. SATCOM based on satellites, HF DL and VHF DL (VDL). Of these, the VDL alternative is the only realistic alternative first of all due to delays in SATCOM and HF DL.

3.3.3 Two VDL technologies under implementation are available today. Initial CPDLC services based on ATN/OSI and VDL Mode 2 is being implemented European wide. As a complement, similar and more advanced CPDLC services are being implemented in Sweden based on ATN/IPS (i.e. taking advantage of the well known IP protocols) and VDL Mode 4. ICAO has also standardised VDL Mode 3, but no implementation plans are known.

3.3.4 It should be noted that the VDL Mode 2 data link is not able to support time critical communications because of the non deterministic link access methodology used. This limitation makes the technology less useful for C2 as command & control is a typical real time activity with high criticality with respect to latency.

3.3.5 VDL Mode 4 was designed to support time critical communications that includes point-to-point as well as broadcast services in both air-to-ground and air-to-air modes. VDL Mode 4 is the only technology standardised for ATM services that supports communication and surveillance services. Furthermore, provisions exist that supports navigation services over VDL Mode 4 as well.

3.3.6 The VDL Mode 4 data link is being operated in the VHF spectrum, and it is often argued that this portion is so congested that there are no room for VDL Mode 4 based services. However, it should be recognised that the role of traditional voice communication in aviation is going to change, which will affect the utilisation of the VHF spectrum. At the World Radio Conference 2007 aviation got an allocation for communication services (AM(R)S) in the band 112-117.975 MHz and it is assumed (e.g. stated in the European Navigation Strategy) that VORs will be decommissioned in the near future. This leaves room for new services in the VHF band. VDL Mode 4 was, as stated in the standards, designed to operate from 108-137 MHz, with recommended limitation to 112-137 MHz which now is fully in line with the ITU Radio Regulation. ICAO ACP and ICAO NSP are working on defining frequency planning parameters for VDL Mode 4 operations below 118 MHz. It is expected that this work will be finalised during 2009 and after that implementations of operational services can begin.

4. RUSSIAN ACTIVITY

4.1 Russia's industry has developed equipment and carried out flight tests of UAS with take-off weight of 350 kg, 1 turbojet, speed of 700 km/h, height of 9 km). Surveillance based on ADS-B and control/command based on CPDLC were carried out with the help of VHF Mode 4 data link transponders performed in accordance with ICAO SARPs and Manual, EUROCAE ED108A and ETSI European Norms EN 301.842 and 302.842. The equipment is under certification by both Air Force and Interstate Aviation Committee (civil aviation).

4.2 Ground Control Station (GCS) includes two control working position for two Pilot-in-Command (PiC) and controls up to four UAS. From each UAS PiC gets: ID, position, intentions in broadcast mode and telemetry information concerning status of all onboard systems in CPDLC mode. Also PiC gets information about positions and intentions of all airspace users in surrounding airspace on the map as background directly through ADS-B from equipped aircraft or through TIS-B from non-equipped aircraft. All information is updating every second. Range of interaction with each UAS is within line of sight. Using CPDLC PiC from GCS transmits to each AT fixed commands from set of 24 and gets receipts after that. The core element of GCS - CNS ground station is certified by Interstate Aviation Committee and recommended by Russian CAA to be used in ATM system. Every pilot of manned or unmanned aircraft could see (on CDTI) all traffic and know where everybody is going to. Collision avoidance: it doesn't matter whether manned or unmanned aircraft. ATC controller surveys manned and unmanned aircraft using PSR, SSR and ADS-B and provides TIS-B service to PiC and other equipped airspace users. Onboard UAS ATM unit includes radio receivers/transmitters, GPS/GLONASS receiver and controller. It mated with UAS automatic pilot unit & telemetry system, and interfaced with diagnostic & control unit & "Intactness" signal (full registered data for last 24 hours are stored). The results of flight tests are given in Fig. 1-2.

4.3 Conclusions that could be made after UAS flight tests: 1)standardised, adopted by ICAO data link is used to control UAS flights in a manner when civil ATC staff could survey UASs independently of pilots-in-command and interact with them; 2)one (adopted by ICAO) data link is used by PiC for surveillance and command & control.

5 EQUIPMENT DEVELOPMENTS OTHER THAN RUSSIAN

Certified and fully operational implemented in Sweden's ATM equipment can be used to provide VDL-4 based services:

5.1 Any from set of Rockwell-Collins (France) VHF multimode radio (VMMR) or CNSS (Sweden) or RTX (Denmark) VDL-4 transponders as airborne units.

5.2 Thales ATM (France) VDL Mode 4 ADS-B Ground Station or similar ground stations from LFV (Sweden) operational VDL-4 ATM Network as ground ATM facility.

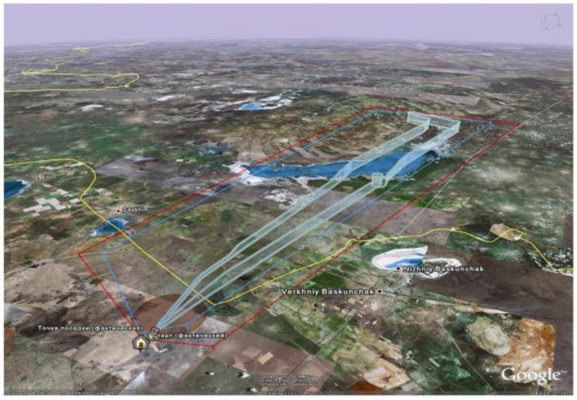

Fig. 1

Fig. 2

6 SUMMARY

6.1 Standardised ATM technologies exist today that can be used to support surveillance of UAS and "Command & Control" functions. The necessary services could either be supported by a set of different technologies or by one technology that can support both surveillance and communication. From a UAS perspective, where weight is an important issue, the second alternative is the most attractive one. Taking advantage of existing technical developments would allow for a timely introduction of UAS in non-segregated airspace.

6.2 Activities in Russia clearly demonstrate the potential that VDL Mode 4 as a standardised ATM technology offers to support surveillance of UAS and as a role of backup to a dedicated "Command & Control" link. It should be considered if VDL Mode 4 could be the main link to handle CPDLC-like instructions after including some small encoding “box” providing security functions.

6.3 This approach should avoid the need for lengthy development of new technologies and also reduce the risk of limitations in spectrum availability.

7 RECOMMENDATION

It is recommended that:

a) VDL Mode 4 based ADS-B should be used for surveillance of UAS; and

b) CPDLC like services should be used for control & command of UAS using the VDL Mode 4 data link as a complement and/or backup to a dedicated command & control link.

8 THE CORE QUESTION: WHAT TO DO IF VDL-4 IS NOT ACCEPTED IN SOME AIRSPACE YET OR FOREVER

The following alternatives could be suggested:

8.1 To continue to not accept VDL-4 and to look for other capabilities. It would be interesting to discuss these approaches "C2 failure" including. It would also be interesting to estimate how long does it take to get corresponding ICAO SARPs.

8.2 To implement VDL-4 ground and airborne parts for managing only UAS flights in civil airspace mentioned; coupling of existing airspace facility and VDL-4 ground unit could be done very easily.

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