

ADS-B-SITF/IP/10

International Civil Aviation Organization



Automatic Dependent Surveillance – Broadcast (ADS-B)

Study and Implementation Task Force

Brisbane, Australia, 24-26 March 2003

Agenda Item 2: Review of ADS-B activities

d) Review activities by Asia/Pacific States
in trials and demonstration of ADS-B

**ADS REAL TIME SIMULATION
MONGOLIAN AIRSPACE**

(Presented by Mongolia)

**ADS real time simulation
Mongolian airspace**

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Agenda

- Background
- Objectives of the Simulation
- Simulation organisation
- Conclusions
- Recommendations

Background

- The Real Time Simulation has been run through at the Swedish ATS Academy (SATSA) facilities in Sweden 18-22 November 2002.
- The roles of ADS in the ICAO CNS/ATM system were addressed from technical as well as operational aspects.
- In the upper airspace of Mongolia FIR Mongolian and Swedish controllers were responsible for the control from three Air Traffic Control positions.
- In the lower airspace of Mongolia FIR two systems were demonstrated, one with and one without ADS-B implemented.
- The simulator supports full-scale gate-to-gate operations including Apron, Tower, Approach and Area Control. All aircraft can be monitored on a Cockpit Display of Traffic Information (CDTI).

Objectives of the Simulation

Simulation High-Level Objectives

- H1 Perform an ATM real-time simulation using ADS-B based procedures at SATSA in Sweden as the basis for the operational validation of ADS-B implementation. Factors such as improved surveillance, navigation and communication for domestic traffic in the lower airspace shall be validated.
- H2 Give advices for improvements in ATC to overcome increasing traffic demands in the upper airspace of Mongolia. Different CNS techniques, such as ADS-B, radar, RNAV procedures based on ADS-C and flight plan tracking shall be validated.
- H3 Demonstrate approach procedures using GNSS.

Objectives of the Simulation(cont'd)

Simulation Low-Level Objectives

- L1 Assess the operational value of ADS-B for, a mix of ADS-B and non ADS-B equipped flights, in controlled airspace above 6150 MSTD
- L2 Assess the operational value of ADS-B for ADS-B equipped flights, in uncontrolled
- L3 Assess the operational value of ADS-B, for a mix of ADS-B and non ADS-B equipped flights to and from Ulaanbaatar, in TMA and CTR.
- L4 Assess the operational value of ADS-B, for provincial (Aimag) airports in Mongolia e.g. Khovd and Muren.
- L5 Assess the operational value of Radar for flights in controlled airspace above 6150 MSTD

Objectives of the Simulation(cont'd)

Simulation Low-Level Objectives(cont'd)

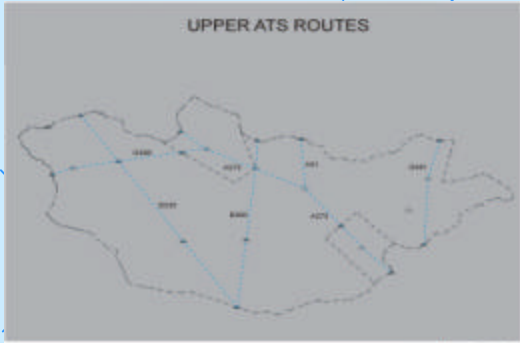
- L6 Assess the operational value of Radar for a mix of ADS-B and non ADS-B equipped flights, in Ulaanbaatar TMA and CTR.
- L7 Assess the operational value of Radar for ADS-B equipped flights in uncontrolled airspace below 6150 MSTD, outside Ulaanbaatar TMA and CTR.
- L8 Assess the operational value of RNAV separation based on ADS-C for, a mix of ADS-C and non ADS-C equipped flights, in controlled airspace above 6150 MSTD
- L9 Find out the present ATS situation in Mongolia.

Simulation organisation

Exercises

- 1) No ADS B, C or radar. Flight plan tracking, manual input of ATO/ETO. Longitudinal time and DME separations.
- 2) 12 ADS-B ground stations. MIAT domestic, A310 and B738 are ADS-B equipped. Apply 10 km separation between ADS-B equipped aircraft.
- 3) 3 radar, 12 ADS-B ground stations. ADS-B as above. 10 km radar and ADS-B separation. No minima for one ADS-B and one radar position symbol.
- 4) No radar, 12 ADS-B, 4 ADS-C. ADS-B as above, ADS-C for separation of some international flights. ADS-C separation 93 km.
- 5) 12 ADS-B, no radar or ADS-C. ADS-B for some international flights. The same international flights have ADS-B in this exercise that had ADS-C in exercise 4.
- 6) New Upper ATS RNAV routes. (RAMS).

Simulation organisation(cont'd)



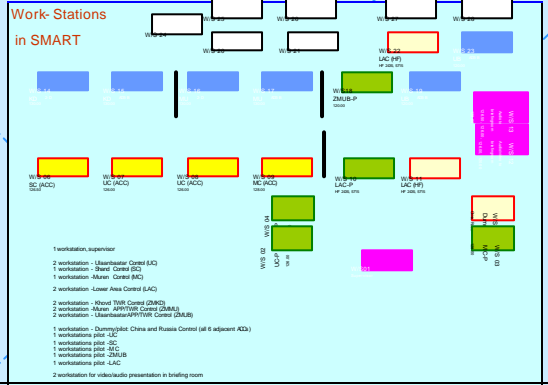
Simulation organisation(cont'd)



Simulation organisation(cont'd)



Simulation organisation(cont'd)



Simulation organisation(cont'd), Procedures

Flight Plan Tracking, FPT

- ICAO Doc 4444
- 10 minutes longitudinal separation
- Lateral separation using same Nav-aids, 15°, 30 km
- VOR/DME using on track reports to/from UDA
VOR/DME. 37 km (20NM) or 19 (10 NM) km.
- The flight plan tracking position symbol is a plus-sign.



Simulation organisation(cont'd), Procedures

ADS – B

- No ICAO procedure, radar like, 10. km separation
- Automatic accurate position transmission every 4th second below and every 8th second above 6150 MSTD
- All navigation points are compulsory reporting points but the controller can ask the pilot to "OMIT POSITION REPORTS UNTIL", "RESUME POSITION REPORTING". The observed passing time is enough for separation.
- The ADS-B position symbol is a filled triangle.
- In exercise 2-5 the ADS-B equipped traffic is presented with ADS-B position symbols.



Simulation organisation(cont'd), Procedures

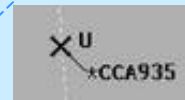
ADS – C

- Simplified ADS-C procedures in the simulator.
- During the validation the controller should not establish ADS Contract, it is assumed that this already has been done.
- Periodic reporting interval is every 20 minutes.
- The simulator is set to give position reports when the aircraft enters the ADS-C area, over the FIR boundary and after that every 20 minutes and compulsory reporting points. The last report will be when leaving the FIR.
- New procedures, 2002-11-28, for ADS-C included in ICAO ANNEX 11 and Doc 4444 are used in the simulation.

Simulation organisation(cont'd), Procedures

ADS – C(cont'd)

- ICAO procedures for area navigation where Required Navigation Performance, RNP is specified. RNP has not been established for Mongolia but there are works in progress in the region. During this simulation MCAA and Swedavia has decided that it shall be RNP 10.
- The minimum longitudinal separation is 93 km independent of whether the tracks are same or reciprocal. For aircraft on reciprocal tracks the separation shall only be applied after the aircraft involved have passed each other.
- The ADS-C position symbol is a cross.



Simulation organisation(cont'd), Procedures

Radar

- The minimum radar separation shall be 10 km.
- A hierarchic system is used where only the position with the best accuracy is shown in the order ADS-B, radar, ADS-C and last FPT.
- It is not possible to separate one with from one without ADS-B. If this situation occurs we suggest that the ADS-B broadcast is stopped and radar separation applied. Phraseology "STOP TRANSMITTING ADS-B".
- The radar position symbol is a square with a cross.



Simulation organisation(cont'd)

Separation table

	ADS-B	Radar	ADS-C	Non
ADS-B	10 km	Stop ADS-B	93 km	See below
Radar	Stop ADS-B	10 km	93 km	See below
ADS-C	93 km	93 km	93 km	See below
Non	Longitudinal time (10, 5, 3 min) Longitudinal time using Mach number technique (10, 9, 8, 7, 6, 5 min) Longitudinal DME (37, 19 km)			

Simulation organisation(cont'd)

Traffic to and from ZMUB, ZMKD and ZMMN

- The traffic is visualised in a 2-D tower simulator.
- In exercise 2-5 the ADS-B equipped traffic is presented with ADS-B position symbols.
- There are no lateral geographical separation minima approved by MCAA. The only separation minima except vertical, radar or ADS-B are longitudinal or lateral separation for aircraft using the same navigation aid or method.

Simulation organisation(cont'd)

FMS/RNAV SIDs and STARs

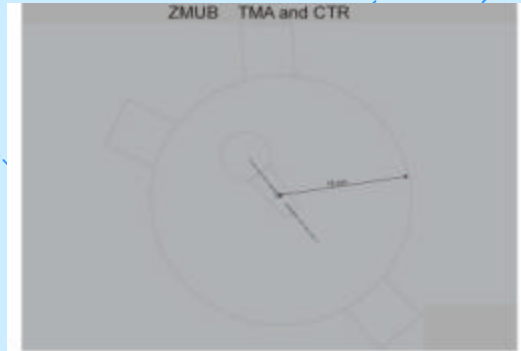
- Since no procedures using GNSS exist the procedures are exclusively for this simulation and don't take into consideration any ground obstacles.
- The SIDs/STARs are based on FMS/RNAV and the pilot shall fly-over or fly-by designated waypoints. The names of the points follows a naming convention based on the two last letters in the ICAO Location Indicator code, UB for Ulaanbaatar, followed by 3 digits numbered from 001 to 999.

Simulation organisation(cont'd)

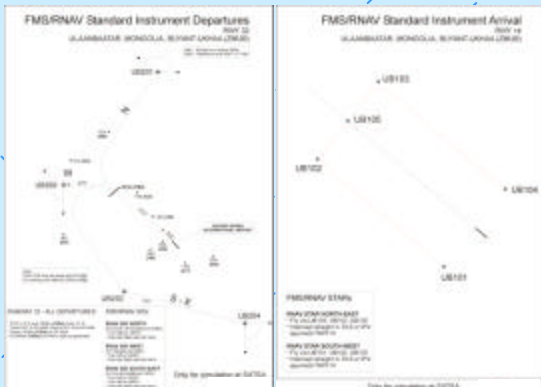
Approach procedures

- Arrival to ZMUB will make ILS approach.
- Arrival to Khovd and Muren shall follow STARs and make straight in instrument approach using GNSS. The simulated method is an IPV approach, which is an Instrument Approach with Vertical Guidance. IPV is formally a non-precision approach but the improved accuracy and use of vertical guidance from Ground-based Regional Augmentation System (GRAS) enables for lower minima than for non-precision approach when IPV is certified.
- After landing the aircraft will taxi to its gate on the apron.

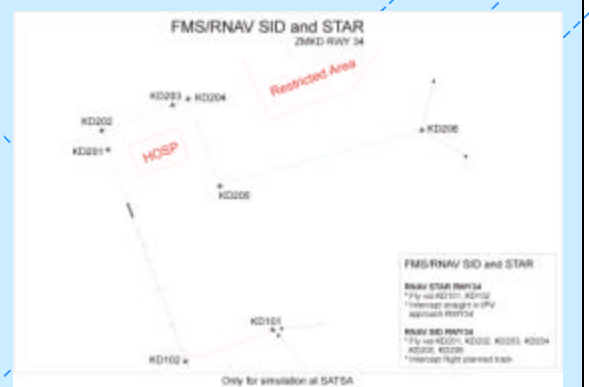
Simulation organisation(cont'd)



Simulation organisation(cont'd)



Simulation organisation(cont'd)



Simulation organisation(cont'd)



Conclusions

ADS-B in the upper airspace

- The value of ADS-B is high in the upper airspace. Most flights will have requested levels, easy to apply separation, shorter tracks and the safety benefit is huge.
- The ADS-B equipped flights are not a problem; it's the mix and the not equipped flights that are a disadvantage. The share of equipped flights must be high, 70 % seemed to be too little. The mix was experienced to be a risk because of e.g. different separation minima and the need to focus on both strips and screen.
- The fact that Mongolia can't demand the air companies to equip the aircraft is negative. The time when enough aircraft is equipped is uncertain and this is a disadvantage to radar.
- New technique will come and meanwhile a first step could be to implement for the traffic in the lower airspace and to use the extra value in the upper.

Conclusions(cont'd)

ADS-B in the lower airspace

- To implement ADS-B in the lower airspace is good. It gives surveillance possibilities and thus better service in form of FIS and SAR and could also, if needed, be good for separation.
- It will have other positive influences such as improved navigation, communication and overall safety.
- The mix of ADS-B equipped and not equipped flights are a disadvantage but since almost all aircraft is Mongolian certified this problem is limited, close to zero.
- The lower airspace should be served from the same place/room as the upper. If moving, the workload in the upper area control sectors should be taken into consideration, since it's already experienced to be high enough today.

Conclusions(cont'd)

ADS-B in ZMUB TMA/CTR

- The Tower controller will be able to see most flights on the ADS display and that will make ATC much more effective. Only few aircraft in TMA will be procedurally controlled.
- The mix of ADS-B equipped and not equipped flights are a disadvantage but since only very few aircraft is Mongolian certified this is much less than in the upper airspace where almost all are foreign aircraft.
- Aircraft not equipped with VOR/DME receivers will be able to use GNSS for navigation.
- The region or the State must establish separation minima between ADS-B equipped flights.
- Geographical lateral separation minima must be established between not ADS-B equipped flights and between one ADS-B equipped and one not equipped flight.

Conclusions(cont'd)

ADS-B at Aimag airports

- Ground stations supporting both ADS-B and GNSS approaches would be of benefit for Aimag airports.

Recommendation

ADS-B implementation

- Implement ADS-B ground stations to get coverage for surveillance of domestic traffic in the lower airspace.
 - Equip the unit responsible for surveillance of the lower airspace, Ulaanbaatar Tower and x number of Aerodrome Towers with ADS-B displays.
 - Modify the presentation displays for the Upper Area Control with technique to support presentation of ADS-B data.
 - Mandate Air Companies operating Mongolian registered aircraft in Mongolia to install ADS-B equipment in all aircraft.
 - Collaborate with ICAO and States concerned to reach a regional air navigation agreement on ADS-B.
- Collaborate with concerned Air Companies, especially those operating on Buyant-Ukhaa, Ulaanbaatar, on ADS-B solutions.

Recommendation(cont'd)

GNSS for navigation

- Implement ground stations to support GNSS navigation including approach procedures. VDL Mode 4 Ground stations supporting ADS-B also include a GNSS augmentation function.

Navigation and communication

- Collaborate with ICAO and States concerned to reach a regional air navigation agreement on CPDLC, RNP, RNAV routes and RVSM.

Note. The benefits of ADS-C and CPDLC are dependent on RNP specification.

Recommendation

Procedures

- Apply DME separations on UDA VOR/DME.
- The service could be improved if local operation procedures of lateral geographical separations determined by MCAA were established.

Radar

- If the above recommendations were implemented, then the benefits of radar would be limited. However in the short run radar could be of value but the implementation should be in collaboration with adjacent States.

Thank you