



International Civil Aviation Organization

**The Fourth Meeting of the Air Traffic Flow Management Task Force
(ATFM/TF/4) and BOBCAT Workshop**

Bangkok, Thailand, 7 to 11 November 2005

Agenda Item 6: Operational Trial Arrangements

BOBCAT DEVELOPMENT – WHEELS UP TIME (WUT) AND BUFFER

(Presented by Thailand)

SUMMARY

The purpose of this working paper is to finalize agreement on the methodology of calculating WUT including the use of a buffer time to take into account short delays to WUT or, in some cases, the possibility of earlier departures ahead of WUT.

1. INTRODUCTION

1.1 The request for or calculation of a time when an aircraft becomes airborne, is used by other major air traffic flow management systems which cover more than one country. As examples, EUROCONTROL ATFM uses a term, Calculated Take-off Time (CTOT) whereas the American FAA DOTS+ system has Wheels Up Time (WUT). The BOBCAT ATFM system has chosen to use WUT for its use.

1.2 The subject of WUT has been discussed at length during the course of all related ATFM meetings. Nevertheless notwithstanding numerous and lengthy discussions, it would appear that there is still further discussion required before unified agreement can be reached on the methodology of operation on this important item.

2. DISCUSSION

Wheels Up Time

2.1 The meeting would recall that, although the calculation of WUT is not an integral requirement of the system, the accuracy of this component is a major stepping stone and will have a major effect on the slot allocation time of each aircraft entering and leaving the Kabul FIR.

2.2 Notwithstanding para. 2.1 above, the meeting should note that with regard to the air traffic control responsibilities concerning ATFM, the use of WUT gives a picture to the ground and/or aerodrome controller regarding the departure sequence which allows proper management in sequencing aircraft to towards the runway threshold. It is considered that, without this information, errors in sequencing could occur to the point where aircraft may unnecessarily miss their requested slot time.

2.3 During the requested BOBCAT system Paper Trial held on 5 – 7 October 2005, flight plan data used for the trials was extracted from relevant ACC sources based on actual flights over the requested periods of 18 – 24 September 2005. There was agreement at the ATFM TF/3 meeting that, for consistency during this paper trial, a WUT of 20 minutes would be used.

2.4 It should be noted that, during the 19 October Paper Trial, the majority of the data used was submitted by airline dispatchers with other data being copied from the previous data used in the 5 – 7 October Paper Trial. With regard to WUT, some dispatchers used a standard 20 minutes from ETD to WUT for about half of the 41 flights that were involved in the trial. This did not include their 5 minutes buffer in cases where delays may occur. Other dispatchers varied their selection by giving aircraft as low as zero to 10 minutes WUT from ETD with others using more than 20 minutes from ETD to WUT.

Calculation of WUT

2.5 Taking the above into consideration, it would seem reasonable to assume that, at any particular airport using the same gate number, the time to push back and taxi to a particular runway should have little variance from one aircraft type to another. For this reason, the meeting is invited to discuss and agree on a simple calculation which would cover most occasions.

2.6 During previous ATFM related meetings, it has been pointed out that air traffic control would need to play an important role in assisting aircraft to make good their entry/exit time through the Kabul FIR. An inherent part of this assistance is making good their WUT.

2.7 It is considered that ATC would be in the best position to calculate how long it takes for an aircraft to taxi from any terminal gate or tarmac position to the nominated runway. Based on normal procedures to push back, un-hook aircraft and taxi to the nominated runway threshold, these figures could be calculated and given to all dispatchers for their use in submission of slot requests. This would then allow ATC to manage aircraft in an orderly manner to be in the correct departure sequence as well as assist aircraft as necessary during the taxi phase so as to make their WUT. It should be noted that the control tower will have information on all WUT's at their particular airport which have been calculated by BOBCAT.

2.8 In the case where there are major works on the airport which would have an affect on taxi time from the terminal gate position, ATC would calculate a new set of figures to cover this situation. They would also be in the best position to adjust taxi time as necessary for unforeseen occurrences which may occur.

Wheels Up Buffer Time (WUBT)

2.9 The meeting would recall that discussions of WUBT has also taken place in several ATFM meetings, including the Paper Trials. Nevertheless, further understanding may be necessary in the context of WUT buffer calculations.

2.10 WUBT was designed in an attempt to take into account deviations from expected aircraft push-back time to runway entry, whether this was caused by technical conditions at an airport, missing passenger, or any other causes. WUBT allows such deviations by simply spacing aircraft further apart, resulting in trade-off between efficiency of aircraft movement planned and smooth air traffic operations.

2.11 It is important to note that WUBT configuration and interpretation needs to be uniform during BOBCAT operations, as aircraft can enter into BOBCAT airspace from any waypoint.

Consistency of WUBT Interpretation

2.12 In order to understand the rationale of consistent interpretation of a WUBT throughout the entire airspace planned by BOBCAT, consider two simple two-aircraft traffic scenarios.

2.13 For simplicity, the two aircraft are assumed to have the following common characteristics:

- a) Same aircraft type;
- b) Same aircraft speed;

2.14 For this particular scenario, the WUBT is configured to be 5 minutes. Within the context of BOBCAT, aircraft are planned 15 minutes apart at the same flight level, to allow for 10 minutes spacing and 5 minutes WUBT. This usage is configured as follows:

- a) Scenario 1: WUBT is configured so that aircraft will be able to take off 5 minutes after his allocated time (+5).
- b) Scenario 2: WUBT is configured so that aircraft will be able to take off 2 minutes before and 3 minutes after his allocated time (-2, +3).

2.15 Let aircraft 1 (AC1) be an aircraft departing from Singapore with the following slot allocation from BOBCAT:

Waypoint	Flight Level	Allocated ETO
IKULA	320	17:41
DI	310	21:45

2.16 Let aircraft 2 (AC2) be an aircraft departing from Bangkok with the following slot allocation from BOBCAT:

Waypoint	Flight Level	Allocated ETO
LIMLA	320	18:15
DI	310	22:00

Scenario 1: (+5 minutes WUBT)

2.17 Given that this BOBCAT configuration allows 5 minutes WUBT after the allocated time, the interpretation of AC1's slot allocation is as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO
IKULA	320	17:41	17:41	17:46
DI	310	21:45	21:45	21:50

2.18 Similarly AC2's slot allocation can be interpreted as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO
LIMLA	320	18:15	18:15	18:20
DI	310	22:00	22:00	22:05

2.19 The meeting is invited to note that if AC1 takes his entire WUBT and depart 5 minutes after his allocated WUT, he will consequentially arrive at BOBCAT waypoints as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
IKULA	320	17:41	17:41	17:46	17:46
DI	310	21:45	21:45	21:50	21:50

2.20 On the other hand, if AC2 departs on time, he will arrive at BOBCAT waypoints as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
LIMLA	320	18:15	18:15	18:20	18:15
DI	310	22:00	22:00	22:05	22:00

2.21 Aircraft spacing at waypoint DI in this scenario is as follows:

Waypoint	Flight Level	Actual ETO	Callsign
DI	310	21:50	AC1
DI	310	22:00	AC2

2.22 From the depicted scenario, the meeting is invited to note that spacing between aircraft at DI is exactly 10 minutes.

2.23 Alternatively, if AC1 departs on time, he will arrive at BOBCAT waypoints as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
IKULA	320	17:41	17:41	17:46	17:41
DI	310	21:45	21:45	21:50	21:45

2.24 If AC2 departs 5 minutes after his allocated time, he will arrive at BOBCAT waypoints as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
LIMLA	320	18:15	18:15	18:20	18:20
DI	310	22:00	22:00	22:05	22:05

2.25 Aircraft spacing at waypoint DI in this scenario is as follows:

Waypoint	Flight Level	Actual ETO	Callsign
DI	310	21:45	AC1
DI	310	22:05	AC2

2.26 From the depicted scenario, the meeting is invited to note that spacing between aircraft at DI is exactly 20 minutes.

2.27 It should be noted that best case actual aircraft spacing of 10 minutes will take place if the front aircraft takes his entire 5 minutes WUBT and the back aircraft departs on time. Whereas if the front aircraft departs on time but the back aircraft departs 5 minutes late, actual aircraft spacing would become 20 minutes.

Scenario 2: (– 2 and +3 minutes WUBT)

2.28 Given that BOBCAT configuration with 5 minutes WUBT and aircraft being able to depart between 2 minutes earlier than allocated time and 3 minutes after allocated time, the interpretation of AC1's slot allocation from para. 2.14 is as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO
IKULA	320	17:41	17:39	17:44
DI	310	21:45	21:43	21:48

2.29 Similarly AC2's slot allocation from para. 2.15 can be interpreted as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO
LIMLA	320	18:15	18:13	18:18
DI	310	22:00	21:58	22:03

2.30 The meeting is invited to note that given this particular WUBT configuration, aircraft can still be able to depart earlier than his allocated time, as well as later than the allocated time.

2.31 Similar to what is depicted in Scenario 1, the meeting is invited to note that best case 10-minute aircraft spacing at LLK, DI and LEMOD would be achieved when AC1 takes 3 minutes delay and AC2 departs 2 minutes early. Furthermore, if AC1 takes off 2 minutes early and AC2 takes 3 minutes delay, spacing between the two aircraft at LLK, DI and LEMOD would become 20 minutes.

2.32 In this case, the meeting is invited to note the importance of consistent interpretation of slot allocation as the same slot allocation shown in para 2.14 and para 2.15 can also be interpreted as ETO times in para 2.16 – para 2.17 for the case of system configured for aircraft to be able to depart 5 minutes after his allocated time, in addition to ETO times in para 2.31 – para 2.32 where BOBCAT is configured so that aircraft can depart either between 2 minutes early and 3 minutes late.

2.33 The meeting is advised that if interpretation of slot allocation differs from aircraft to aircraft, planned spacing within BOBCAT system could also fail. Consider BOBCAT configuration in Scenario 2. However, aircraft AC1 interprets his allocated time as in Scenario 1. In this case, AC1 departed 5 minutes after his allocated time, so that his time at BOBCAT waypoint is as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
IKULA	320	17:41	17:39	17:44	17:46
DI	310	21:45	21:43	21:48	21:50

2.34 In the meantime, AC2 interprets his allocated slot time as in Scenario 2 and departs 2 minutes early. His BOBCAT waypoint time is as follows:

Waypoint	Flight Level	Allocated ETO	Earliest ETO	Latest ETO	Actual ETO
LLK	320	18:15	18:13	18:18	18:13
DI	310	22:00	21:58	22:03	21:58

2.35 Aircraft spacing at waypoint DI in this scenario is as follows:

Waypoint	Flight Level	Actual ETO	Callsign
DI	310	21:50	AC1
DI	310	21:58	AC2

2.36 From situation in para 2.38 – 2.40, the meeting should note that spacing between AC1 and AC2 at DI has become 8 minutes which is less than the 10 minutes spacing criteria.

2.37 In summary, the meeting is invited to note the importance of uniform interpretation of BOBCAT slot allocation in context of a WUBT setting.

Trade-off Between Efficiency and Flexibility from WUBT

2.38 In addition to interpretation of WUBT, the meeting is invited to note the trade-off between “efficiency” and system flexibility. It should be noted that if all waypoint in BOBCAT airspace requires 10 minutes spacing and WUBT is configured to be 5 minutes, aircraft will be planned 15 minutes apart by BOBCAT at any waypoint. However, if WUBT is configured to be 2 minutes, aircraft will be planned 12 minutes apart by BOBCAT.

Large WUBT and Airspace Utilization

2.39 The consequence of large WUBT on airspace utilization can be illustrated in this example. If WUBT is configured to be 10 minutes apart, aircraft within the system will be planned 20 minutes apart. This implies that 3 aircraft can be planned to traverse a waypoint in an hour.

2.40 However, if WUBT is configured to be 2 minutes apart, aircraft within the system will be planned 12 minutes apart. This implies that 5 aircraft can be planned to traverse a waypoint in an hour.

2.41 It should be noted that situation in para 2.43 can accompany 40% less aircraft than the situation from para 2.44.

Small WUBT and Departure Flexibility

2.42 The consequence of small WUBT on flexibility of the system also should not be overlooked. If WUBT is configured to be two minutes apart and an aircraft departs 5 minutes late, the late departure could cause insufficient spacing in the system.

2.43 In order to illustrate such consequence, consider the following two-aircraft scenario (Scenario 3) similar to that in scenario 1. In this case, BOBCAT WUBT is set to 0 minute, so that aircraft will be planned 10 minutes apart.

Scenario 3: (No WUBT)

2.44 In this scenario, AC1 departing from Singapore or Kuala Lumpur has the following slot allocation:

Waypoint	Flight Level	Allocated ETO
IKULA	320	17:41
DI	310	21:45

2.45 AC2 departing from Bangkok has the following slot allocation:

Waypoint	Flight Level	Allocated ETO
LIMLA	320	18:10
DI	310	21:55

2.46 If AC1 departs 3 minutes late, his actual time at BOBCAT waypoints are as follows:

Waypoint	Flight Level	Allocated ETO	Actual ETO
IKULA	320	17:41	17:44
DI	310	21:45	21:48

2.47 In the meantime, AC2 departs on time, so that his actual time at BOBCAT waypoints are exactly as planned. In this scenario, aircraft spacing at DI is as follows:

Waypoint	Flight Level	Actual ETO	Callsign
DI	310	21:48	AC1
DI	310	21:55	AC2

2.48 It is important to note that aircraft spacing at DI is 7 minutes, well below the 10 minutes required spacing.

2.49 Given an understanding that if an aircraft departs late, he could vary his cruise speed by 0.01 mach, whereas mach number technique in the range of 1200 nm – 1800 nm is in use at several FIRs for aircraft transiting Bay of Bengal from the eastern coast of the Bay of Bengal to western coast of Bay of Bengal, it may be possible that aircraft could depart up to 3 minutes late in excess of system-wide WUBT and still be able to speed up and make his waypoint time on the other side of Bay of Bengal.

2.50 It must be understood that an earlier departure ahead of allocated WUT may cause a spacing issue with another aircraft. Consider another situation where aircraft AC2 was ready to depart 2 minutes early and was allowed to depart 2 minutes early, while AC1 departs on time. AC1's waypoint times are as follows:

Waypoint	Flight Level	Allocated ETO	Actual ETO
IKULA	320	17:41	17:41
DI	310	21:45	21:45

2.51 Since Aircraft AC2 was allowed to depart 2 minutes early, AC2's waypoint times are as shown below:

Waypoint	Flight Level	Allocated ETO	Actual ETO
LIMLA	320	18:10	18:08
DI	310	21:55	21:53

2.52 Aircraft spacing at DI is as follows:

Waypoint	Flight Level	Actual ETO	Callsign
DI	310	21:45	AC1
DI	310	21:53	AC2

It is important to note that aircraft spacing at DI is 8 minutes, which is below the 10 minutes required spacing at this waypoint.

2.53 In summary, the meeting is invited to note that a small WUBT could have an adverse affect on flexibility of aircraft departures within BOBCAT. The smaller the WUBT is, the more likely that BOBCAT-planned aircraft spacing will break down, like what is shown in Scenario 3. However, too large a WUBT could also decrease airspace utilization.

2.54 In summary, it is considered that the use of a buffer time is important from a flexibility point of view. However this buffer, no matter what additional time is being used or how it is calculated, needs to be consistent in application with all aircraft during the period of BOBCAT operations.

3. ACTION BY THE MEETING

3.1 In order to arrive at final decisions on the use of WUT, the meeting is invited to:

- a) Understand the important role that ATC is required to play in the management of ATFM aircraft from terminal gateway to the runway holding point;
- b) Concur on the importance a departure time has with respect to the entry/exit time through the Kabul FIR;
- c) Understand trade-off between higher airspace utilization implied by smaller WUBT and higher system flexibility implied by larger WUBT;
- d) Realize the importance of a uniform methodology of WUBT within BOBCAT airspace;
- e) Recognize the possibility of using WUBT in allowing aircraft to depart earlier than the allocated WUT time; and,
- f) Decide on a uniform methodology to be used by airlines in using WUT and the necessary agreed buffer in their slot allocation requests.

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