

MODE S IN THE LONDON

TERMINAL CONTROL CENTRE.

Bill Casey - NATS

Adrian Price - NATS

1. INTRODUCTION AND BACKGROUND

NATS provides Air Traffic Control (ATC) services to aircraft flying in UK airspace, and over the eastern part of the North Atlantic. The London Terminal Control Centre (LTCC) is based at West Drayton and is responsible for traffic below 24,500 feet arriving at, or departing from, the five main airports close to London. For a 30 Year period NATS, along with every other ATC service provider, relied on Secondary Surveillance Radar (SSR) to provide aircraft information. During that time, traffic levels have increased dramatically and it became vital to exploit new technology, which addressed the limitations of SSR. In December 2005 NATS introduced the next generation of SSR technology called Mode Select (Mode S) into the LTCC (References 1 and 2). The purpose of this article is to give a short insight into Mode S, its development, functions, and its operational introduction.

2. TRADITIONAL SSR

The previous Mode A/C SSR technology worked on a general 'broadcast and receive' principal that has recognised problems and limitations. The integrity of Mode A/C surveillance can be adversely affected by garbling of replies from aircraft close together (especially in stack airspace). In addition, Mode C replies have no encoded identity and rely on the association to the correct target by the ground system processing. These acknowledged limitations can affect the integrity of the information displayed to ATC.

3. MODE S TECHNOLOGY

There are two levels of Mode S, Elementary and Enhanced. Elementary allows selective interrogation of aircraft providing the potential to eliminate, amongst other things, the synchronous garbling of replies. Enhanced Mode S enables the selective interrogation of aircraft plus the facility to down-link specific airborne parameters from the cockpit, such as Indicated Airspeed and Selected Altitude.

4. BENEFITS OF MODE S TECHNOLOGY

Improved integrity of radar surveillance and the availability of Mode S Down-Linked Airborne Parameters (DAPs) have enabled NATS to develop controller support tools that have provided benefits to the safety and efficiency of ATC operations. A three year development programme has culminated in a system where the display of aircraft information is easily assimilated and understood. The Mode S tool-set consists of two main elements: the Vertical Stack List (VSL) and the display of DAPs in the Target Label.

5. SAFETY BENEFITS

For Enhanced Mode S aircraft the Selected Altitude entered by the crew into the Mode Control Panel (MCP) or Flight Control Unit (FCU), that feeds into the aircraft's auto pilot system, can now be down-linked and displayed to ATC. Mode S Selected Altitude is potentially one of the most useful pieces of data to prevent Level Busts as it provides the opportunity of alerting ATC if there has been any misinterpretation of the altitude/level clearance. Aircrew should be aware that a controller may challenge that reading if there is any doubt over the cleared level.

6. DISPLAY OF SELECTED ALTITUDE

Operational experience to date indicates that the facility to display Selected Altitude has helped controllers to intervene in situations, which might have otherwise led to the erosion of standard separation.

It is accepted that whilst the display of selected altitude is an obvious safety enhancement, aircraft label overlap and human workload limitation will affect the controllers' ability to check the Selected Altitude every time a vertical clearance is issued. Time delays incurred whilst information is input into the MCP/FCU reduce the controllers' ability even further. Therefore, the requirement for aircrew to read-back all clearances and for controllers to check the read-back will not be affected by introduction of Mode S and the display of Selected Altitude.

7. TARGET LABEL

Mode S information has been displayed in the aircraft Target Labels of suitably equipped aircraft, on all LTCC sectors since December 2005. Fig 1 shows the Target Label of BMA3XF. The Mode C readout and intention (or destination) code shown in line 2 is unchanged from the previous format. (LL represents a flight inbound to Heathrow.) As well as traditional information, the Mode S Target Label also displays aircraft DAPs.



Fig 1: Mode S information in the Target Label.

The MCP/FCU Selected Altitude is displayed in line two in the dark orange colour to distinguish it from the Actual Flight Level (Mode C). In Fig 1 BMA3XF has selected 15000 feet and is passing Flight Level 165.

Many pilots will select the missed approach altitude once the aircraft is established on final approach. The Selected Altitude is automatically removed from the target label before this occurs to avoid any confusion. If the system detects that the aircraft has broken off the approach and is climbing then the Selected Altitude will automatically be displayed again providing the controller with the aircraft's revised intention.

Down-linked Mode S parameters such as Ground Speed, Indicated Air Speed, and Magnetic Heading can also be displayed in line 3 of the Target Label either individually, or in combination using a 'quick-set display' facility. In Fig 1 Magnetic Heading has been selected showing 135 degrees (prefixed with an 'H' to denote Heading).

8. VERTICAL STACK LISTS

The most innovative function in the Mode S Tool Set is the VSL. It has been designed to compliment and support existing operations by providing controllers with enhanced vertical situational awareness in busy stack airspace.

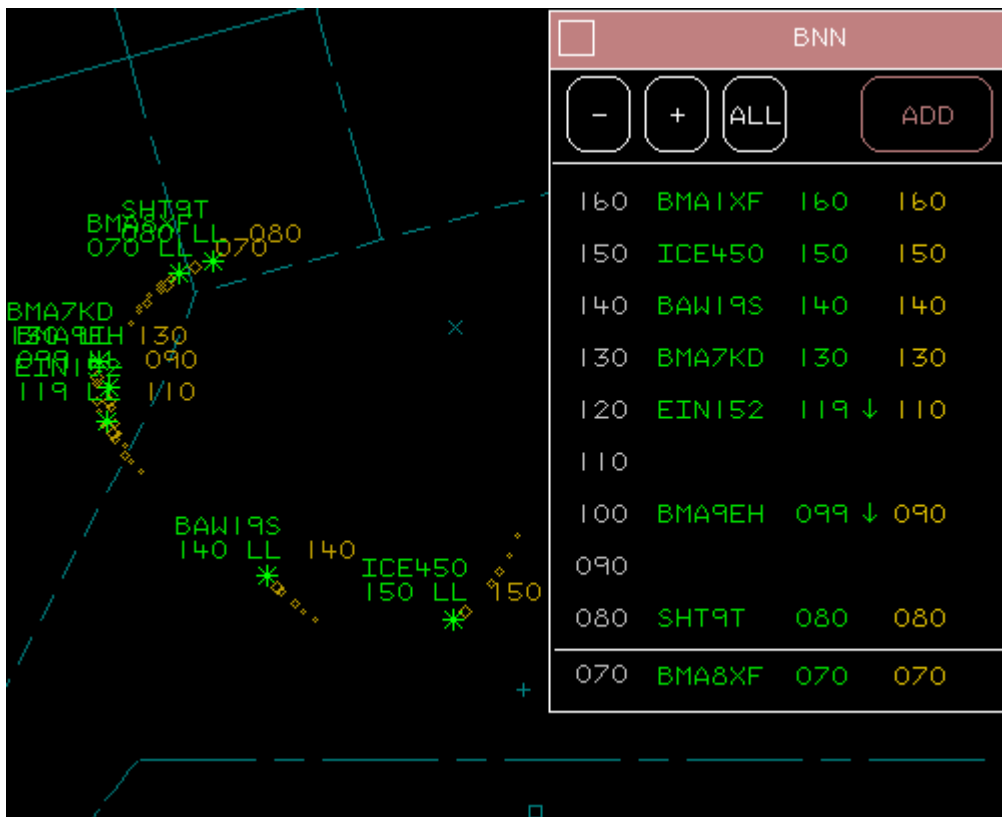


Fig 2: The Vertical Stack list

Fig. 2 shows a normal radar picture of the Bovingdon Hold on the left together with an enhanced view of the same hold as depicted in the Vertical Stack List on the controller's display. By utilising the integrity of Mode S derived altitude reports, the tool provides a vertical representation of aircraft in stack airspace. So, by monitoring the VSL, the controller can continuously see call-signs and occupied levels in the stack, even when SSR labels overlap on the radar display. In the VSL, the white numbers in the column on the left-hand side of the VSL are the Flight Levels that are selected for display by the controller. The call-sign and Mode C (height derived via Mode S) of the holding aircraft are shown in green in the middle two columns and the final column shows the aircraft's Selected Altitude.

The system tracks arrivals to each of the four Heathrow stacks. Population to and exit from the vertical Stack Lists is automatic with the aircraft descending in the VSL as the controller issues descent instructions. As the aircraft continues its descent, its progress is automatically updated in the list and the aircraft is removed when it meets defined criteria. The system applies standard ATC rules regarding level allocation and departure. Through the use of the VSL, controllers no longer need to confirm via RT that levels have been vacated. Thus, RT congestion is reduced and stack management is enhanced.

9. COCKPIT PROCEDURES

The cockpit procedures for setting the MCP/FCU are vital in realising the potential safety benefits of introducing Mode S. Fig 3 shows an example of a typical Mode Control Panel.



Fig 3: Mode Control Panel

The following cockpit techniques will enhance safety in the London Terminal Control airspace (Ref: 3):

- Upon receipt of an altitude clearance from ATC, immediately set the assigned/cleared altitude in the altitude select window (except when established on the ILS).
- Positively confirm the altitude clearance via R/T read-back.

Please note that many operators require the Selected Altitude to be cross-checked by both pilots; an action that is endorsed by the Flight Safety Foundation (Ref: 4). Adherence to the above procedure will maximise the controllers' opportunity to check the altitude selected in the cockpit. Controllers have been advised that there is no absolute guarantee that an aircraft will actually level off at or maintain the Selected Altitude. For example an aircraft may not adhere to the Selected Altitude when the autopilot is being used with an incorrect mode or has suffered a technical problem. An incorrect pressure setting on the altimeters' subscale will also invalidate the Selected Altitude.

10. CONCLUSION

The display of Selected Altitude to ATC along with R/T read-back will confirm the aircrew's interpretation of the assigned/cleared level. The ability of a controller to check the Selected Altitude in the target label and the VSL is dependant upon workload the elapsed time between the vertical clearance being issued and that value being displayed back to the controller and the aircraft label being clearly displayed. Aircrew can assist ATC by promptly entering the new altitude in the altitude select window every time a vertical clearance is issued. For Enhanced Mode S aircraft the display on the controllers' radar displays of Selected Altitude, together with VSLs, are potentially a great step forward in safety and the campaign to reduce level busts

11. REFERENCES

1. AIC105/2004 (Yellow 155) promulgated by the CAA 11 Nov 2004.
2. AIC49/2005 (Yellow 171) promulgated by the CAA 23 Jun 2005
3. AIC4/2006 (Yellow 187) promulgated by the CAA 5 Jan 2006
4. Briefing note 3.2 issued Year 2000 by the Flight Safety Foundation Approach and Landing Accident Reduction (ALAR), "Altitude Deviations".

For more information on the Mode S in the LTCC please contact:

Mr William Casey
Operational Support & Development
NATS
Porters Way
West Drayton
UB7 9AX,
United Kingdom

Telephone: +44 (0)1895 426356

eMail: william.casey@nats.co.uk Web: www.nats.co.uk

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