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RADIO NAVIGATION

CHAPTER 8 – MICROWAVE LANDING SYSTEM (MLS)

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CONTENTS .... PAGE

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INTRODUCTION

In 1978, ICAO adopted the Microwave Landing System as the international standard precision approach and landing guidance system to replace ILS. The need for a new system was recognized much earlier, in fact in the 1950's soon after ILS was installed. Problems with ILS such as frequency congestion had become apparent and plans were made to replace it by the mid 1960's. Since then, the transition plan has undergone many changes. Time referenced scanning beam MLS was chosen in preference to Doppler MLS in 1978 and the transition date was then to be 1985. By 1981, this had become 1995 and the timetable for the widespread introduction of MLS was further extended to 1998. Meanwhile advances in Global Navigation Satellite Systems (GNSS) led to the expectation in many countries that the life of ILS could be extended until GNSS would provide accurate approach guidance and that this was a more economical option than MLS. On the other hand, countries such as the UK and the Netherlands had experienced major problems with ILS and were not prepared to wait for the GNSS solution. These conflicting views led ICAO at a special Communications/Operations Divisional meeting held in Montreal in March 1995 to adopt a flexible policy to the introduction of MLS. The main outcomes of this meeting were as follows:

- ILS can be retained "as long as operationally acceptable and economically beneficial" but at least until the year 2010.
- At those international airports where ILS fails to meet these criteria, it can be replaced by MLS.
- It is projected that "augmented GNSS" would be able to meet Cat. 1 standards between 2005 and 2010, with Cat 2 / Cat 3 capability by 2015.

WHAT DOES MLS OFFER?

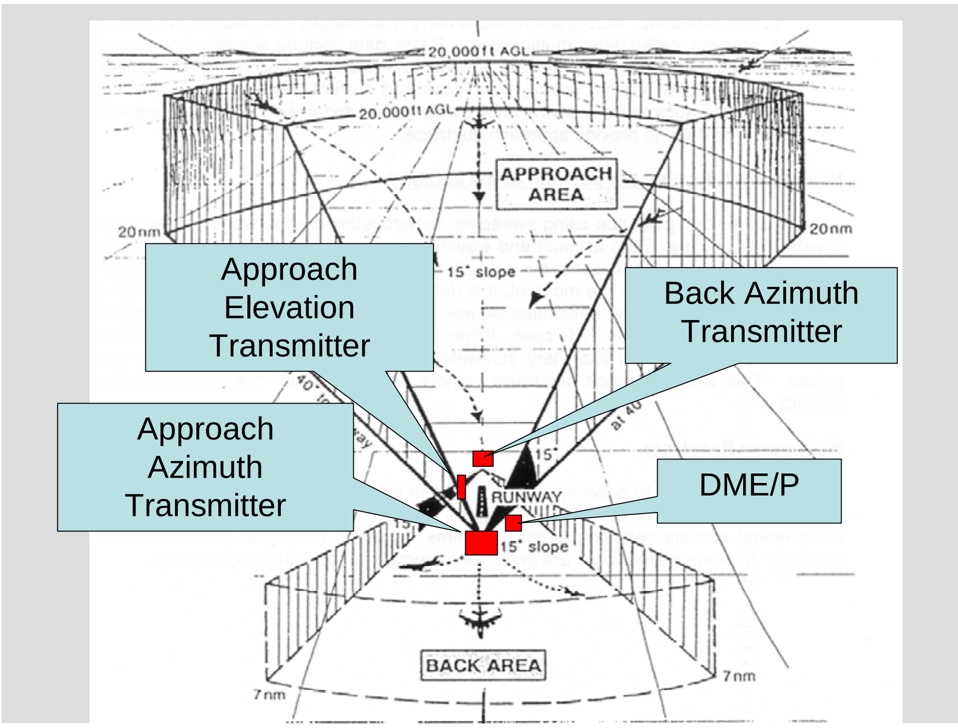
- Multiple approach paths to the same runway - horizontally and vertically.
- Large numbers of channels.
- Curved and zigzag as well as straight in approaches.
- Improved range information.
- Automatic data transfer (ground-to-air).

SYSTEM COMPONENTS

MLS can be divided into five functions:

- Approach azimuth – from the approach azimuth antenna
- Back azimuth – from the back azimuth antenna
- Approach elevation – from the approach elevation antenna
- Range – by precision DME (DME/P)
- Data transfer – as apart of the approach azimuth transmission

All MLS signals, with the exception of DME, are transmitted on a single frequency through time sharing.



HOW DOES MLS COMPARE WITH ILS?

MLS can be viewed as an improved ILS but it has capabilities that ILS does not have and it operates by a different principle. The following are the major differences:-

1. **Multiple Approach Paths.** Whereas ILS is limited to a single localizer centre line, MLS can provide approach paths which vary 60° or more from the direction of the associated runway. This permits greater flexibility for ATC by allowing aircraft to make simultaneous approaches along different paths. Aircraft can approach in alternating fashion from either side of the extended runway centre line. It is possible for MLS to vector aircraft to multiple runways using a single MLS transmitter site.

2. **Multiple Glide Paths.** Each ILS installation has a single glide scope angle, typically 3°. MLS allows the selection of glide path from 0.1° to 15°. Each aircraft can choose the most appropriate glide path for its performance characteristics. For example, helicopters might approach at 15°, STOL aircraft at 10°, piston aircraft at 3.5° or 4° and jet aircraft at 2.5° or 3°.

3. **Continuous Range Information.** ILS installations include marker beacons which locate the aircraft in terms of range but only at 2 or 3 points on the approach. MLS incorporates precision DME, collocated and frequency paired so effectively providing accurate distance-to-go continuously during the approach.

4. **Lateral Coverage.** ILS provides lateral guidance, i.e. : right-left indications within 10° of the localizer centre line. MLS guidance is provided across the entire azimuth coverage area which is at least 40° either side of the extended centre line. An azimuth area of ± 90° is considered technically feasible.

5. **Vertical Coverage**. The vertical coverage of ILS is limited to 1.75 times the glide slope angle, e.g.: 5.25° for a 3° glide slope. MLS provides vertical guidance to 15° all the way to 20,000 feet.

6. **Number of Channels.** ILS has only 40 channels which has proved to be a limitation in some congested areas of the USA. MLS has 200 channels, numbered 500 to 699, using frequencies 5031 to 5091 MHz (SHF, C band). Both azimuth and elevation elements use the same frequency.

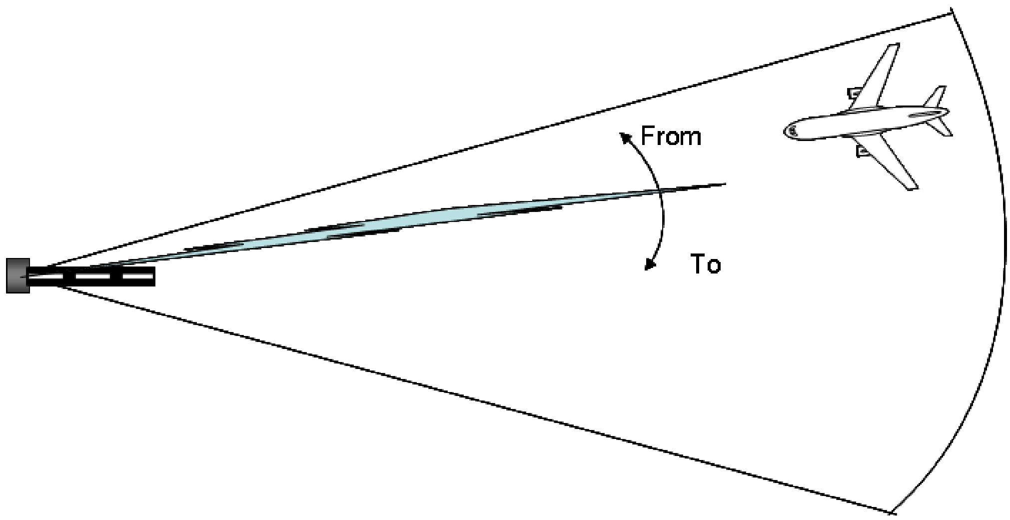
7. **Site/Weather Problems.** ILS is very sensitive to the levelling of the site and in some situations, the major cost of installation is earth work. ILS is also affected by weather induced errors, particularly by snow covered surfaces. If a vehicle passes in front of the localizer aerial, the ILS needle in the aircraft may deflect. MLS on the other hand is much simpler to install, is not critical in terms of terrain, is virtually immune to interference from vehicles on the ground, does not require a snow-free ground surface and is relatively free from other weather-induced errors. MLS does not suffer from false glide paths which affect ILS when lobes of energy are reflected from the ground.

8. **Curved and Segmented Approaches**. Unlike ILS, MLS allows aircraft to make curved and/or segmented approaches. Flexibility of approach paths aids noise abatement procedures and allows aircraft to avoid restricted and prohibited areas. Segmented approaches are especially useful in mountainous regions where high ground prevents aircraft from making straight -in approaches.

9. **Data Transfer.** ILS localizer transmissions routinely carry morse identification and can carry voice transmissions, either voice ident, or ground-air communications. MLS transmissions carry much larger quantities of data using a process called time multiplexing. Basic data include identification, exact transmitter location, performance level and status. Auxiliary data include waypoint coordinates, runway conditions and current weather. The data are accepted automatically by the onboard computer and are processed, along with position data, to provide approach guidance.

HOW DOES MLS LOCATE THE POSITION OF THE AIRCRAFT?

The MLS provides guidance using sweeping, reciprocating beams whose timed cycle is extremely precise. Both azimuth and elevation transmitters use the same principle and the elevation part is similar to the azimuth but laid on its side. After an initial pulse, the TO sweep begins. At the moment, it is detected at the aircraft aerial, the receiver begins a timing cycle. The transmitter pauses at the end of the TO scan, then begins the return sweep called the FRO scan. When the aircraft receiver detects the passing FRO scan, it turns off its imaginary stopwatch and notes the time between the two pulses. This time difference determines where on the azimuth scan the aircraft is located.



Time referenced scanning in Azimuth

Note that the approach azimuth, back azimuth and elevation beams operate on the same frequency but their transmitters are at different locations.

MULTI-MODE RECEIVERS

The period from 1995 to possibly 2015 is a time of transition when approaches may be made by ILS, MLS and GNSS. The flexible solution adopted by ICAO will result in international carriers requiring avionic systems capable of using any of the three systems. Multi-mode receivers are under development to meet this requirement.

WORKSHEET - MLS

1. Compared with ILS, MLS has the following characteristics:

    (i) Approaches are possible from anywhere within its horizontal and vertical fan-shaped coverage area
    (ii) Back beams are not available
    (iii) It is insensitive to geographical site

    (a) All the above statements are true
    (b) Only statement (i) is true
    (c) Only statements (i) and (iii) are true
    (d) Only statements (ii) and (iii) are true.

2. MLS operates in the _________ frequency band on 200 channels. The azimuth and elevation elements operate on ________.

    (a) UHF different frequencies
    (b) SHF the same frequency
    (c) EHF different frequencies
    (d) EHF the same frequency.

3. Which of the following statements are true with reference to MLS?

    (i) Marker beacons are not required
    (ii) Ground-to-air data is automatically transferred by the beam.
    (iii) A typical azimuth coverage area is 40^0 either side of the extended centre line.

    (a) All the statements are true
    (b) Only statements (i) and (ii) are true
    (c) Only statements (ii) and (iii) are true
    (d) Only statements (i) and (iii) are true

4. MLS transmissions consist of:

    (a) A single beam which alternately scans in azimuth and elevation plus DME/P.
    (b) Separate azimuth and elevation beams which are frequency paired to reduce flight-deck work load.
    (c) Marker beacons or DME/P frequency paired with a single frequency of about 5 GHz used by both azimuth and elevation elements.
    (d) Azimuth and elevation beams on a common frequency which is paired with a DME/P facility.

5. Compared with ILS, MLS ground facilities are:

(i) much simpler to install.
(ii) not critical in terms of terrain.
(iii) virtually immune to interference from vehicles on the ground.

(a) All the statements are true
(b) Only statements (ii) and (iii) are true
(c) Only statements (i) and (iii) are true
(d) Only statements (i) and (ii) are true.

6. Which of the following statements is true with reference to MLS?

(a) Special EFIS displays are required to show azimuth and elevation guidance.
(b) Azimuth and elevation angle selections can only be made by ATC
(c) Transmitting aerials on the aircraft allow the equipment to interrogate the MLS azimuth and elevation transponders.
(d) The approach area extends to at least 20nm.