



北京航空航天大学
BEIHANG UNIVERSITY

Avionics Technology

B31353551

— *Radio Navigation*

yunzhao@buaa.edu.cn

Spring Semester 2023 (4_May_T11)



VI. Radio Navigation



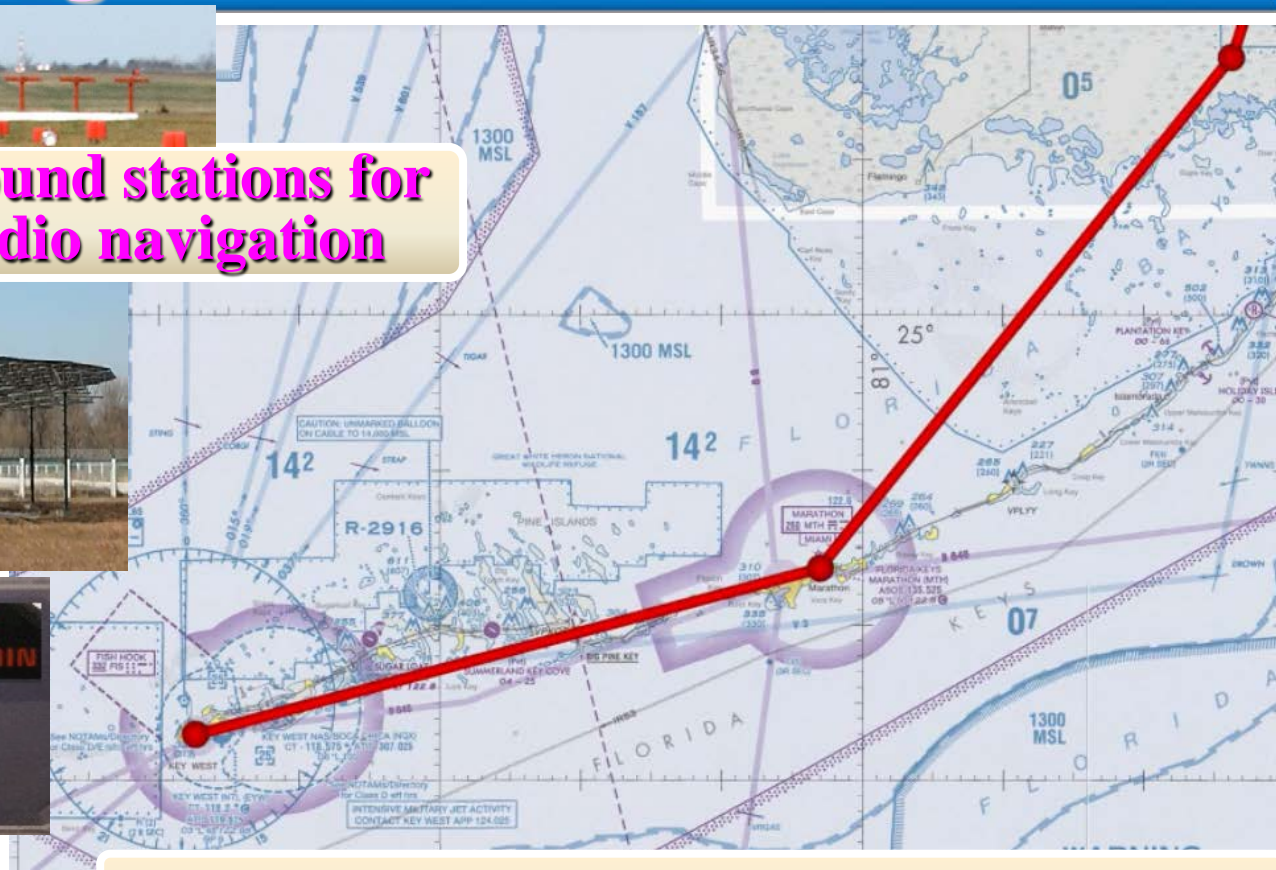
北京航空航天大学
BEIHANG UNIVERSITY



Ground stations for
radio navigation



Airborne radio
navigation equipment



Waypoints (radio stations) along air route

VI. Radio Navigation



北京航空航天大学
BEIHANG UNIVERSITY

References and further readings —

O. N. Skrypnik, Chapter 4: Radio-technical Landing Systems & Chapter 3: Rho-Theta Short-Range Radio-technical Navigation Systems, *Radio Navigation Systems for Airports and Airways*.



VI. Radio Navigation



北京航空航天大学
BEIHANG UNIVERSITY

- (1) Some concepts
- (2) Radio landing systems
- (3) Rho-theta navigation systems
- (4) Satellite navigation systems



(1) Some concepts



- *Navigation* is the act, science or art of directing the movement of a ship or an aircraft.
- Navigation thus involves both control of the path of movement and the guidance for arriving at destination.



Starting point

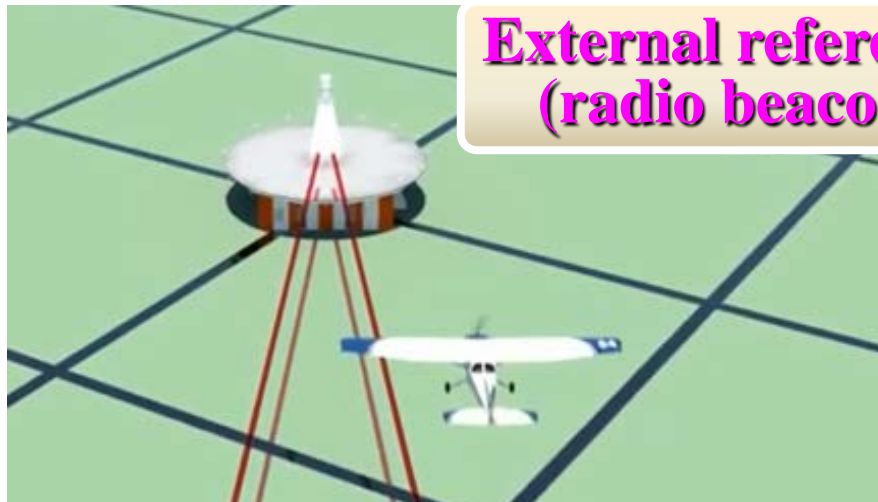
Process of directing the movement

Destination point

(1) Some concepts



- There are two basic methods of navigation: **dead reckoning (DR) navigation**, *position fixing navigation*. Both types are required in the aircraft.

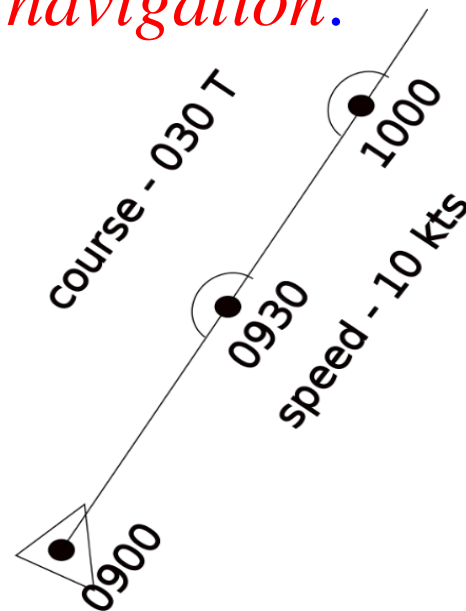


**External references
(radio beacons)**

Position fixing depends on external references to derive the position

**Without
external aids**

DR is the process of continually computing a vehicle's position



(1) Some concepts



- Position fixing navigation systems derive the aircraft's position from the radio signals transmitted from the external references (aids), i.e. radio transmitters on ground stations or in orbiting navigation satellites, whose positions are precisely known. Unlike DR systems, their errors are not time dependent.

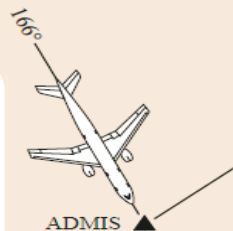


(1) Some concepts



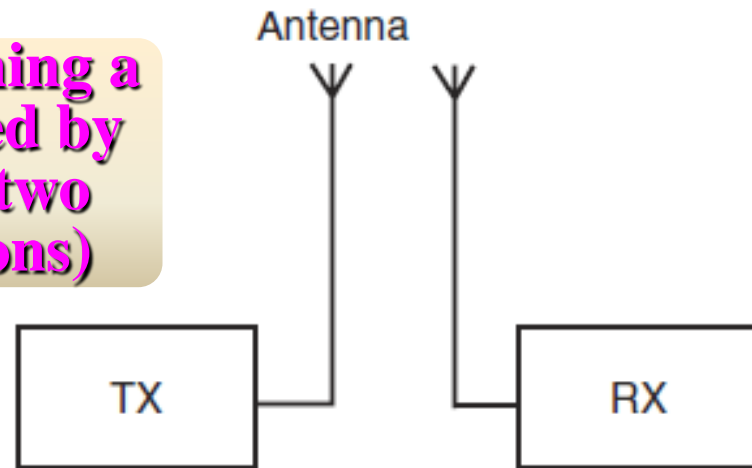
- The use of **radio waves** for measuring and obtaining **position estimates**, also known as **position fixes**, is nearly as old as that for aero communication.

**Radial =
specific
direction
in this case**



**Aircraft is approaching a
fix (the point defined by
the intersection of two
radials from beacons)**

**Beacon with a
directional antenna**



**Transmitter, antenna, air
propagation and receiver**

(1) Some concepts



北京航空航天大学
BEIHANG UNIVERSITY

- Radio navigation in aviation evolved from simple radio direction finding (NDB): a radio transmitter radiates a single frequency omnidirectional signal, and the receiver antenna was manually adjusted to find the signal bearing (direction), in which the maximum amplitude attains.



Tracking radio
tagged objects

(1) Some concepts



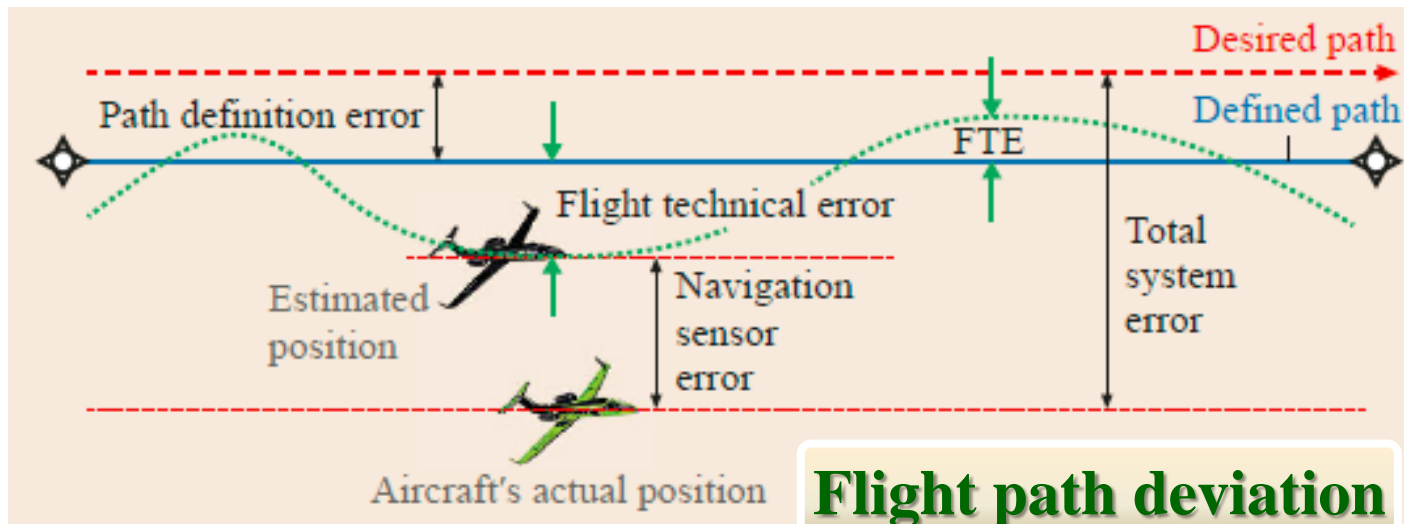
- The whole aircraft's **radio navigation process** is divided into separate sequential phases: takeoff and climbing, entering the waypoint, **the waypoint transition with controlling and correction of deviation from desired path**, descending and approach, landing on runway.



(1) Some concepts



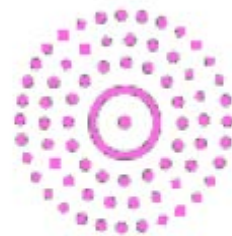
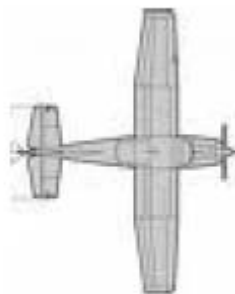
- Radio navigation systems consist of airborne and ground- or satellite-based navigation aids, including range- and direction-measuring radio navigation systems, radio-technical landing systems, short- and long-range systems, and satellite navigation systems.



(1) Some concepts



- Airborne equipment usually provides the radio navigation signal detection and its processing, and the ground- or satellite-based radio beacons — the forming of the radio signals of required structure and its emission. These aids based on radio waves conditions are exposed to radio interference and are not autonomous in most cases.



Airborne equipment: radio receiver

**Radio beacon:
radio transmitter**

(1) Some concepts



- **NDB (Non Directional Beacon)** is simply just a ground-based **AM radio transmitter** that transmits radio waves in all directions. In the aircraft, the receiving antenna was originally manually **adjusted** to find the signal bearing but very quickly became **automated** and is today called **Automatic Direction Finding (ADF)**. This allows to identify the relative bearing to the beacon.



(1) Some concepts



- If radio waves hit the receiving antenna loop in any direction other than directly perpendicular, a voltage will be induced over the antenna, and the ADF can deduce down to possible bearings.

