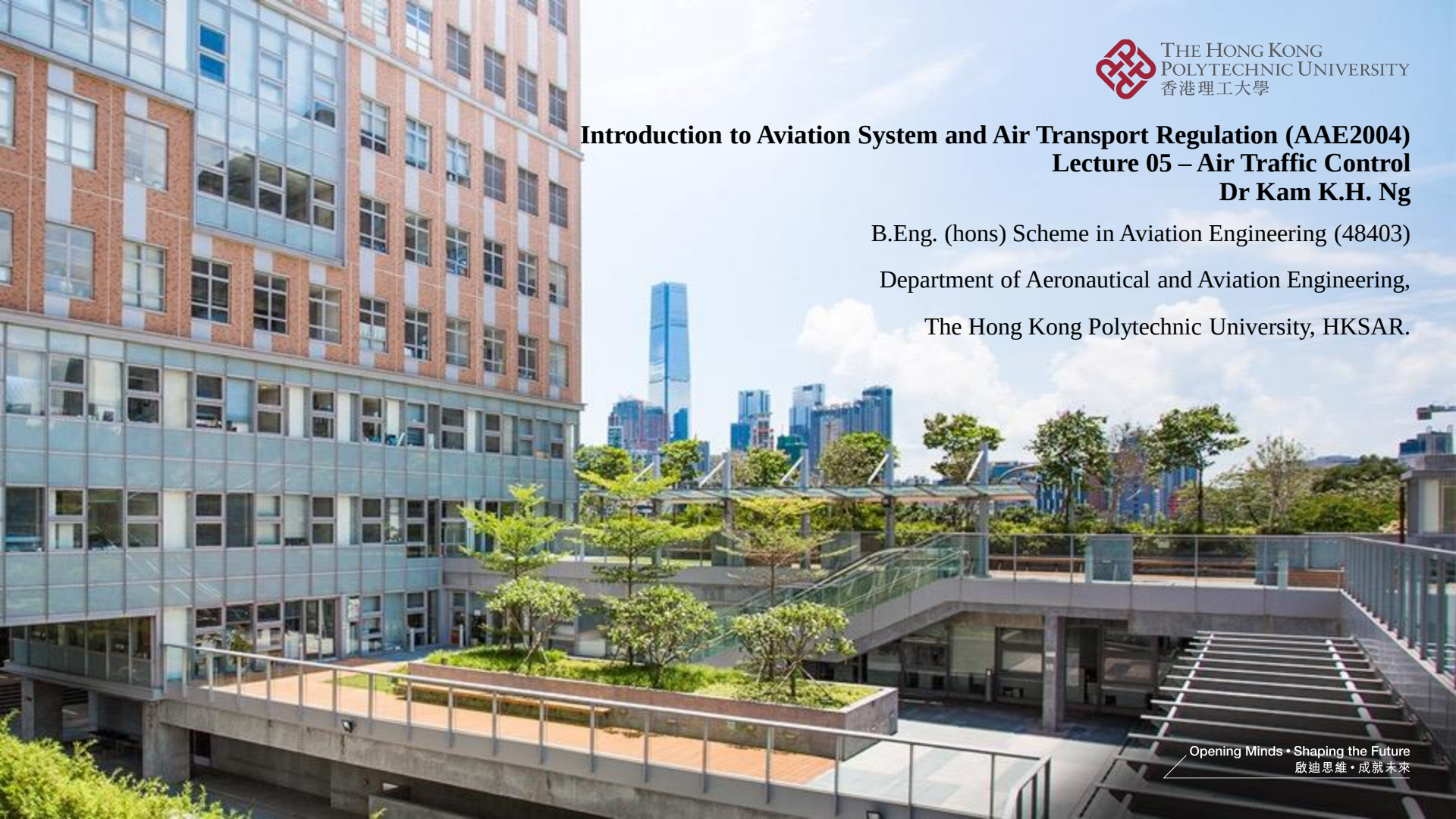

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Introduction to Aviation System and Air Transport Regulation (AAE2004)
Lecture 05 – Air Traffic Control

Dr Kam K.H. Ng

B.Eng. (hons) Scheme in Aviation Engineering (48403)

Department of Aeronautical and Aviation Engineering,

The Hong Kong Polytechnic University, HKSAR.

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Agenda

- History
- Air Traffic Control (ATC) Service
- Air Traffic Management (ATM)
- Air Traffic Controllers
- Technologies
- Procedures
- The Hong Kong ATC

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History

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History

- In 1920, Croydon Airport, London was the first airport in the world to introduce air traffic control.
- The first airport traffic control tower, regulating arrivals, departures and surface movement of aircraft at a specific airport, opened in Cleveland in 1930.
- The first air route traffic control centre (ARTCC), which directs the movement of aircraft between departure and destination, was opened in Newark in 1935, followed in 1936 by Chicago and Cleveland. Currently in the U.S., the Federal Aviation Administration (FAA) operates 22 ARTCCs.
- Approach/departure control facilities were created after adoption of radar in the 1950s to monitor and control the busy airspace around large airports.

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Air Traffic Control Service

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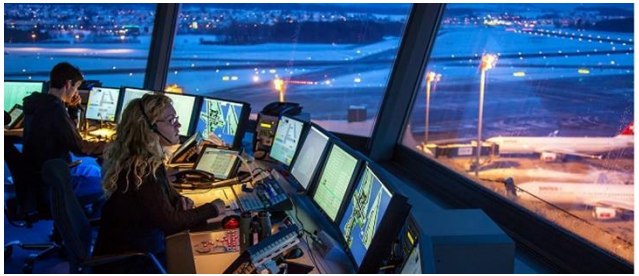
Air traffic control

1. Air Traffic Control
2. Air Traffic Control Facilities
3. Air Safety and Regulation Issues



Air traffic control (ATC)

A service provided by ground-based controllers who direct the aircraft on the ground and through controlled airspace;

Provide advisory services to aircraft in non-controlled airspace.

Functions of air traffic control

1. Prevent collisions and safeguard life and property;
2. Organise and expedite the flow of traffic;
3. Provide information and other support to pilots;
4. Security or defensive role or is operated by the military in some countries;
5. Enforce traffic separation rules, which ensure each aircraft maintains a minimum amount of empty space around it at all times to prevent collisions;
6. Modern aircrafts have a collision avoidance systems, which provide additional safety by warning pilots when other aircrafts get too close;
7. ATC is the nerve centre of an airport.

Need of air traffic control

Air transportation must ensure safe, convenient and economic movement of aircraft from one airport to another airport

→ Need to control the air space

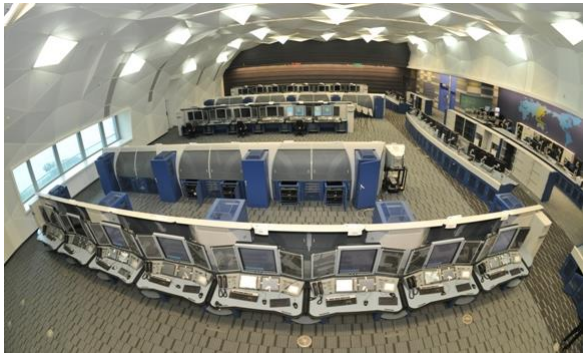
The aircraft flight from one airport to another airport is carried out in 4 phases:

1. The aircraft takes off from an airport
2. It maintains a proper altitude in air
3. It navigates from point to point safely
4. It lands at the desired airport

Air traffic control centre functions

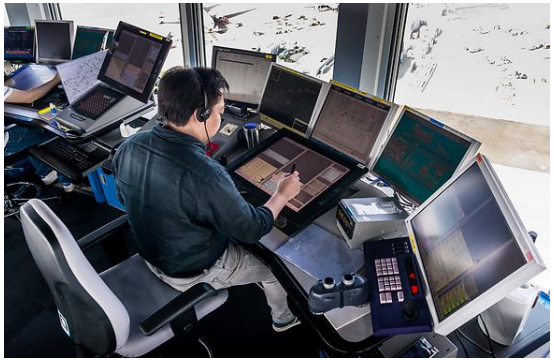
Functions of air traffic control centre

1. Airport traffic control
2. Airway traffic control
3. Airway communication
4. Non-airway traffic control (General)



Airport traffic control

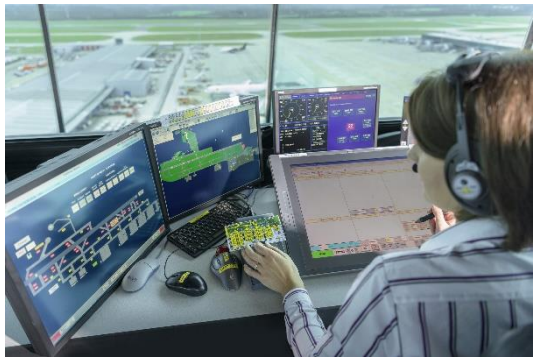
1. Guide the aircraft, desiring to land or take off
2. Control the taxiing of arriving and departing aircraft between apron and runway
3. It is taken care of by Airport Traffic Control Tower (ATCT)



Airway communication

Deals with conveying of airway and weather information to the pilot during the flight.;

Normally done by ARTC through Flight Service Stations (FSS) located at various locations along the airways.



General or non-airway traffic control

It’s a serious problem when personal flying is done by a large number of people;

In such cases, the movement of aircraft, not flying along the airway, must be regulated to prevent interference to main air traffic.

Air Traffic Control Service

Air traffic control service is a service provided fort he purpose of:

- Preventing collisions:
    - between aircraft, and
    - on the manoeuvring area between aircraft and obstructions; and
- Expediting and maintaining and orderly flow of air traffic. (ICAO Annex 11)

Air Traffic Control Service (cont'd)

ICAO adopted classification of airspace

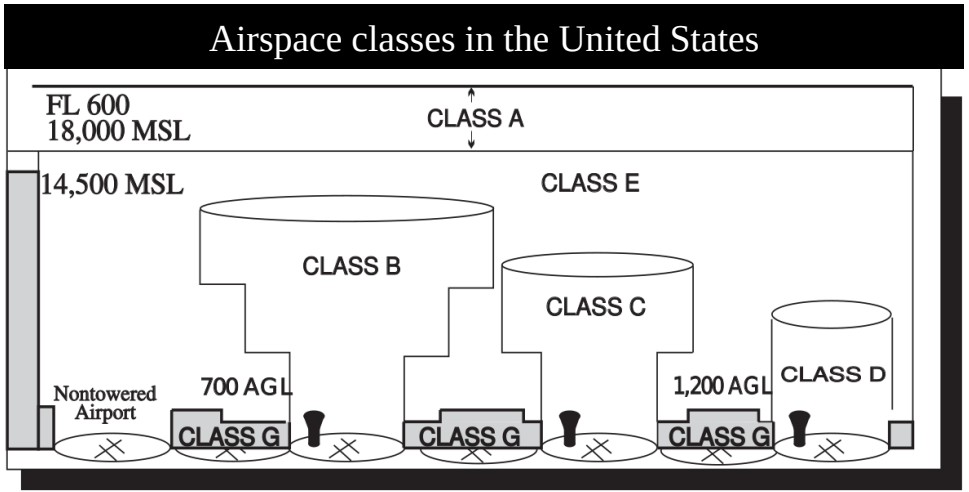
Class	Controlled	IFR	SVFR	VFR	ATC clearance	Separation	Traffic information
A	Controlled	Yes	No	No	Required	Provided for all flights	N/A
B	Controlled	Yes	Yes	Yes	Required	Provided for all flights	N/A
C	Controlled	Yes	Yes	Yes	Required	Provided for all IFR/SVFR to IFR/SVFR/VFR	Provided for all VFR
D	Controlled	Yes	Yes	Yes	Required	Provided for IFR/SVFR to other IFR/SVFR	Provided for all IFR and VFR
E	Controlled	Yes	Yes	Yes	Required for IFR and SVFR	Provided for IFR/SVFR to other IFR/SVFR	Provided for all IFR and VFR flights where possible
F	Uncontrolled	Yes	No	Yes	Advisory only	Provided for IFR/SVFR to other IFR/SVFR where possible	Provided where possible if requested
G	Uncontrolled	Yes	No	Yes	Not provided	Not provided	Provided where possible if requested

Air Traffic Control Service (cont'd)

Air traffic control service is provided:

- to all Instrument Flight Rules (IFR) flights in airspace Class A, B, C, D and E;
- to all Visual Flight Rules (VFR) flights in airspace Classes B, C and D;
- to all special VFR flights;
- to all aerodrome traffic at controlled aerodromes.

In Hong Kong, there are 3 classes of airspace present:
Class A, Class C and Class G.



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Air Traffic Management (ATM)

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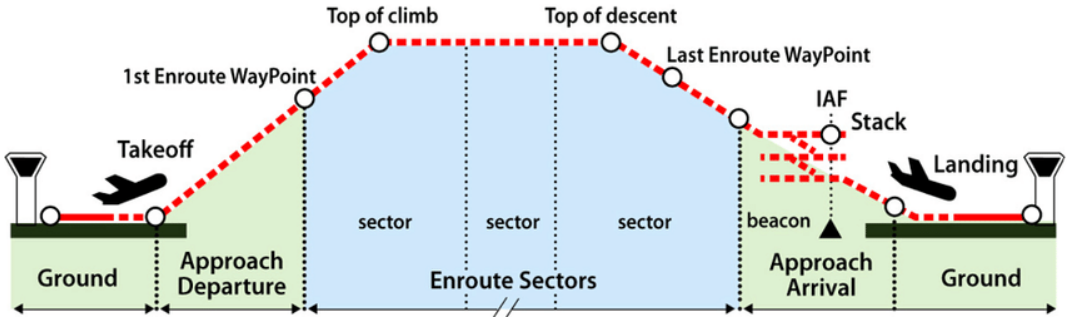
Air Traffic Service

- ATC
  - Aerodrome control service. This is focused on aircraft on the ground (the manoeuvring area of the aerodrome) or in the vicinity of the aerodrome
  - Approach control service. This service links the aerodrome control and the area control and is focused on the climb, descent and approach phases of the flight
  - Area control service. This service is focused on the cruising part of the flight



Air Traffic Management (cont'd)

Flight Information Service (FIS)

- Advice and information useful for safety and efficiency on flights:
  - Volcanic eruption
  - Radioactive or toxic chemicals
  - Serviceability of navigation aids
  - Weather conditions e.g. snow in apron
  - Unmanned free balloons
  - Etc …

Air Traffic Management (cont'd)

Alerting Service

- A service provided to notify appropriate organizations, regarding aircraft in need of search and rescue aid, and assist such organizations as required.
- To inform the search and rescue facilities of aircraft in distress.

Air Traffic Flow Management

- is intended to arrange traffic flows in such a way as to avoid congestion and reduce the risk of controller overload.

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Air Traffic Controllers

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Air Traffic Controllers

Types

- Tower controller
- Approach controller
- Area controller

Other similar positions

- FIS Officer
- Assistant

Air Traffic Controllers (cont'd)

Before a person starts to provide ATC service, they must be properly trained and qualified.

- Controller training
  - Initial training – basic training/ rating training
  - Operational training – transition training/ Pre-OJT training/ OJT training
- Controller refresher training
  - Procedures/ abnormal and emergency/ human factors
- Minimum hours in position
- English proficiency

Air Traffic Controllers (cont'd)

ICAO English proficiency levels (cont'd)

Level	Pronunciation Structure Assumes a dialect and/or accent intelligible to the aeronautical community.	Structure Relevant grammatical structures and sentence patterns are determined by language functions appropriate to the task.	Vocabulary	Fluency	Comprehension	Interactions
Expert 6	Pronunciation, stress, rhythm, and intonation, though possibly influenced by the first language or regional variation, almost never interfere with ease of understanding.	Both basic and complex grammatical structures and sentence patterns are consistently well controlled.	Vocabulary range and accuracy are sufficient to communicate effectively on a wide variety of familiar and unfamiliar topics. Vocabulary is idiomatic, nuanced, and sensitive to register.	Able to speak at length with a natural, effortless flow. Varies speech flow for stylistic effect, e.g. to emphasize a point. Uses appropriate discourse markers and connectors spontaneously.	Comprehension is consistently accurate in nearly all contexts and includes comprehension of linguistic and cultural subtleties.	Interacts with ease in nearly all situations. Is sensitive to verbal and non-verbal cues, and responds to them appropriately.
Extended 5	Pronunciation, stress, rhythm, and intonation, though influenced by the first language or regional variation, rarely interfere with ease of understanding.	Basic grammatical structures and sentence patterns are consistently well controlled. Complex structures are attempted but with errors which sometimes interfere with meaning.	Vocabulary range and accuracy are sufficient to communicate effectively on common, concrete, and work-related topics. Paraphrases consistently and sucessfully. Vocabulary is sometimes idiomatic.	Able to speak at length with relative ease on familiar topics, but may not vary speech flow as a stylistic device. Can make use of appropriate discourse markers or connectors.	Comprehension is accurate on common, concrete, and work-related topics and mostly accurate when the speaker is confronted with a linguistic or situational complication or an unexpected turn of events. Is able to comprehend a range of speech varieties (dialect and/or accent) or registers.	Responses are immediate, appropriate, and informative. Manages the speaker/listener relationship effectively.
Operational 4	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation but only sometimes interfere with ease of understanding.	Basic grammatical structures and sentence patterns are used creatively and are usually well controlled. Errors may occur, particularly in unusual or unexpected circumstances, but rarely interfere with meaning.	Vocabulary range and accuracy are usually sufficient to communicate effectively on common, concrete, and work related topics. Can often paraphrase successfully when lacking vocabulary in unusual or unexpected circumstances.	Produces stretches of language at an appropriate tempo. There may be occasional loss of fluency on transition from rehearsed or formulaic speech to spontaneous interaction, but this does not prevent effective communication. Can make limited use of discourse markers or connectors. Fillers are not distracting.	Comprehension is mostly accurate on common, concrete, and work-related topics when the accent or variety used is sufficiently intelligible for an international community of users. When the speaker is confronted with a linguistic or situational complication or an unexpected turn of events, comprehension may be slower or require clarification strategies.	Responses are usually immediate, appropriate, and informative. Initiates and maintains exchanges even when dealing with an unexpected turn of events. Deals adequately with apparent misunderstandings by checking, confirming, or clarifying.
Pre-Operational 3	Pronunciation, stress, rhythm, and intonation are influenced by the first language or regional variation and frequently interfere with ease of understanding.	Basic grammatical structures and sentence patterns associated with predictable situations are not always well controlled. Errors frequently interfere with meaning.	Vocabulary range and accuracy are often sufficient to communicate on common, concrete, or work-related topics but range is limited and the word choice often inappropriate. Is often unable to paraphrase successfully when lacking vocabulary.	Produces stretches of language, but phrasing and pausing are often inappropriate. Hesitations or slowness in language processing may prevent effective communication. Fillers are sometimes distracting.	Comprehension is often accurate on common, concrete, and work related topics when the accent or variety used is sufficiently intelligible for an international community of users. May fail to understand a linguistic or situational turn of events.	Responses are sometimes immediate, appropriate, and informative. Can initiate and maintain exchanges with reasonable ease on familiar topics and in predictable situations. Generally inadequate when dealing with an unexpected turn of events.
Elementary 2	Pronunciation, stress, rhythm, and intonation are heavily influenced by the first language or regional variation and usually interfere with ease of understanding.	Shows only limited control of a few simple memorized grammatical structures and sentence patterns.	Limited vocabulary range consisting only of isolated words and memorized phrases.	Can produce very short, isolated, memorized utterances with frequent pausing and a distracting use of fillers to search for expressions and to articulate less familiar words.	Comprehension is limited to isolated, memorized phrases when they are carefully and slowly articulated.	Response time is slow, and often inappropriate. Interaction is limited to simple routine exchanges.
Pre-Elementary 1	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.	Performs at a level below the Elementary level.

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Technologies

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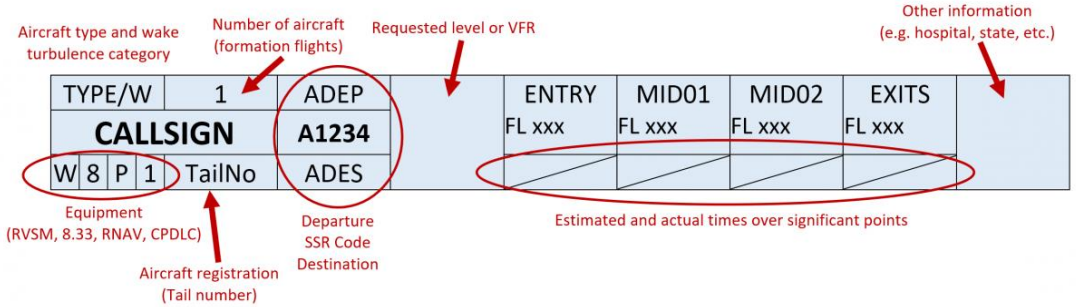
Technologies

Most common technologies at the moment:

- Radar
  - Using radio waves to detect objects
- Two-way radio communication
  - Bidirectional person-to-person voice communications
- Flight progress strips



Technologies (cont'd)

Some tools are available in different domains to help the controller further, few examples:

- Flight data processing systems
    - It processes all the information related to the flight and distribute to relevant stakeholders
- Short-term conflict alert
    - Checks conflict situations in a time horizon, say 2 or 3 minutes and alerts the controller before loss of separation
- Minimum safe altitude warning
    - To warn the controller if an aircraft is flying too close to terrain
- Area penetration warning (APW)
    - To inform a controller that a flight will penetrate a restricted area.

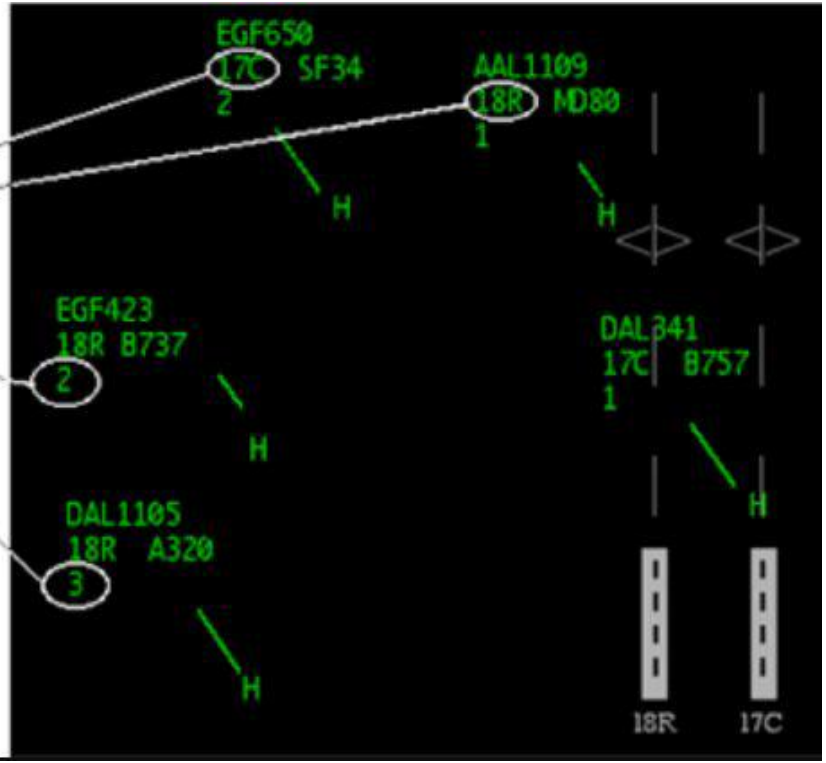
Technologies (cont'd)

Passive final approach spacing tool (pFAST)

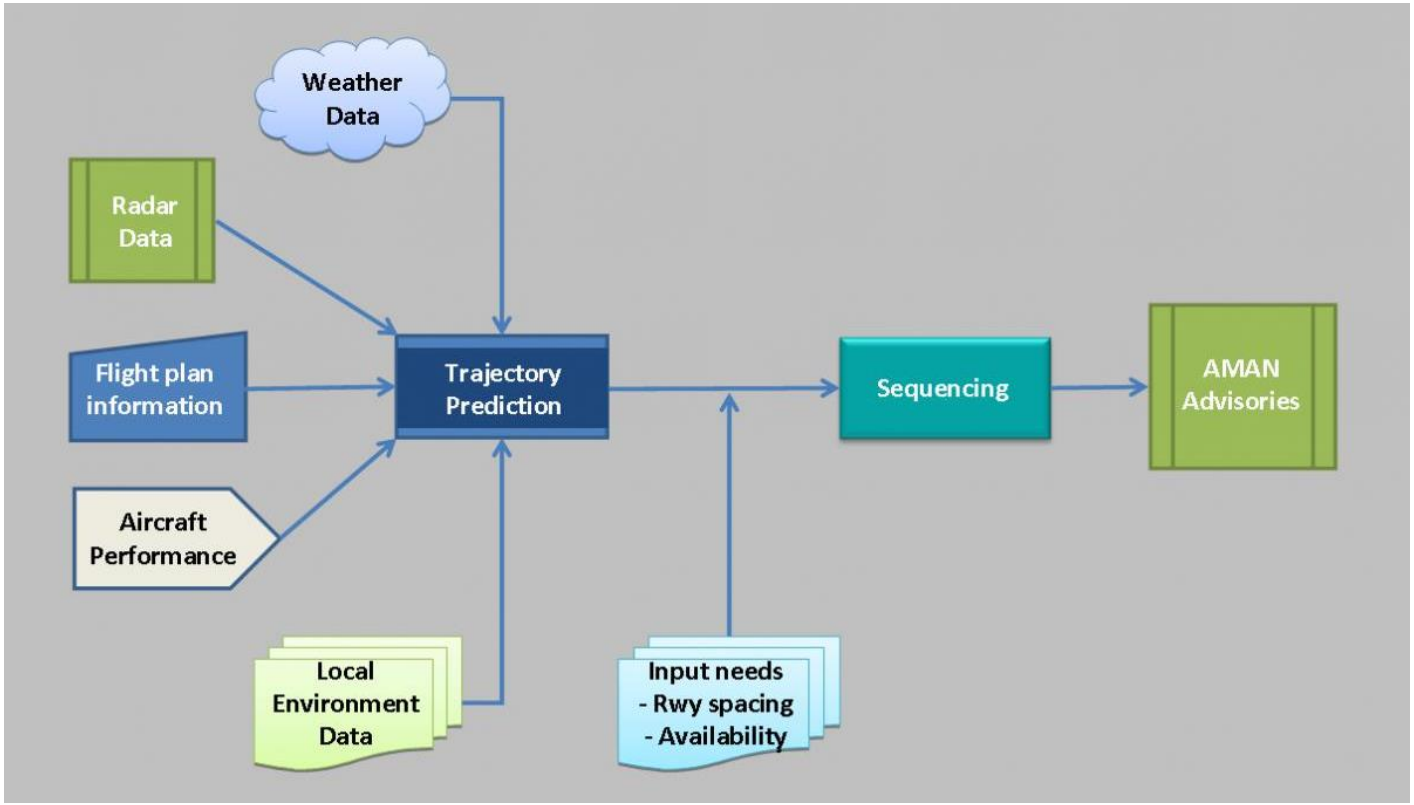
Passive FAST provides terminal area controllers with

- runway assignments
- landing sequences

to increase airport throughput and balance controller workload



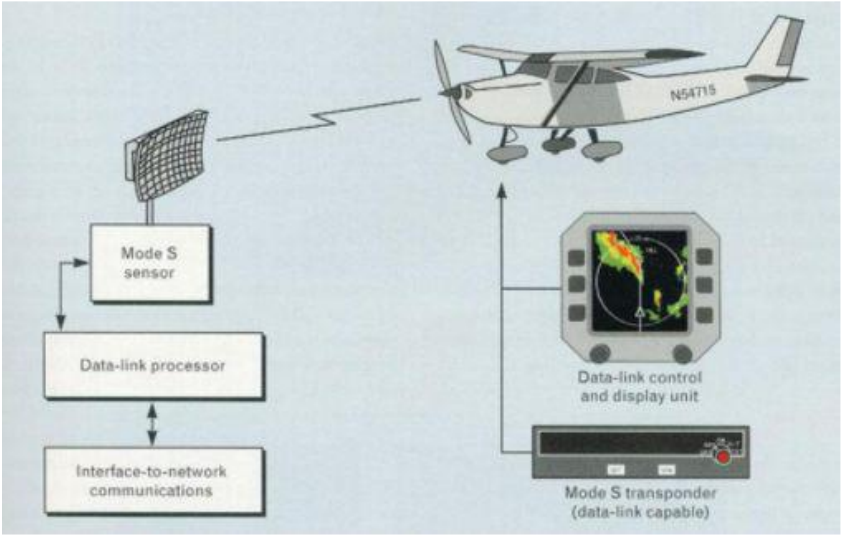
The Arrival Manager (AMAN)



Technologies (cont'd)

Mode S

- Aircraft must be equipped with a transponder
- Secondary surveillance radar receives:
  - The aircraft ID
  - Indicated airspace
  - Altitude



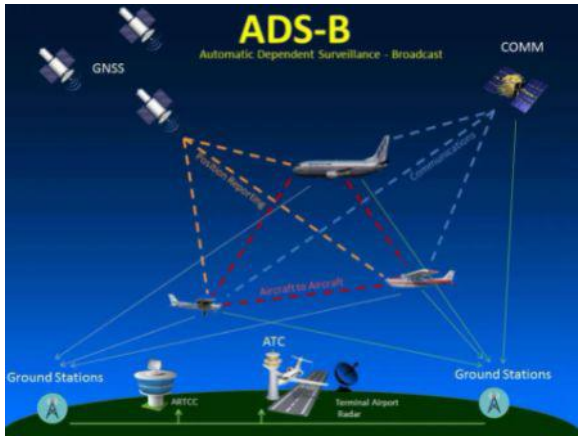
Technologies (cont'd)

Controller-pilot Data Link Communications (CPDLC)

- Digital message between ATC and pilots via VHF or satellite
- To replace HF
- Cover oceanic areas mostly

Automatic Dependent Surveillance Broadcast (ADS-B)

- Aircraft determines its position then transmit periodically
- To replace SSR
- To cover areas where SSR difficult to install



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Procedures

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ATC Clearances

- Definition – Authorization for an aircraft to proceed under conditions specified by an air traffic control unit
- Purposes
  - Solely for safety
  - Not to violate regulations
  - Does not relief pilot-in-command’s responsibility
  - Crew may object
- Applicability
  - Controlled flights only
  - Depends on the flight rules and airspace class
    - IFR in class A, B, C, D and E airspace
    - VFR in class B, C and D (not permitted in class A and are not controlled in class E airspace)

Procedures (cont'd)

- Contents
  - Aircraft identification
  - Clearance limit
    - Generally the designation airport
  - Route of flight
  - Altitudes
    - Initial and expected altitude
  - Frequency and transponder code information

Departure clearance examples

IFR flight Cathay 123, cleared to destination Taipei via Ocean 1A Departure, FPR, climb 9,000', SQ2467. When airbourne contact Departure 123.8

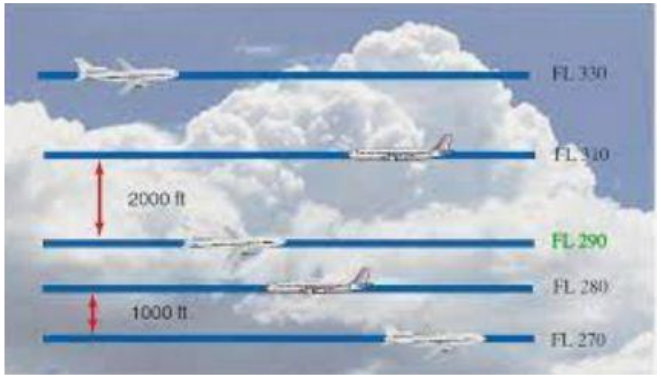
VFR flight BHOM Cleared for takeoff RWY21, wind 300 degrees 15 knots, caution flock of birds is possible on RWY Heading

Procedures (cont’d)

- Readback
  - ATC route clearance
  - Clearance or instruction to enter, land on, takeoff from, hold short of, cross, taxi on any runway
  - Runway in use, altimeter settings, SSR codes, level instructions, heading and speed instructions

Procedures (cont'd)

- **Separation**
  - Vertical Separation
    - Common altimeter setting
    - ICAO: minimum vertical separation as 1,000' below FL290 and 2,000' above FL290, except in RVSM
  - Lateral Separation
    - By reference to different geographic locations. Fig. 1
    - By reference to the same navigation aid. Fig. 2



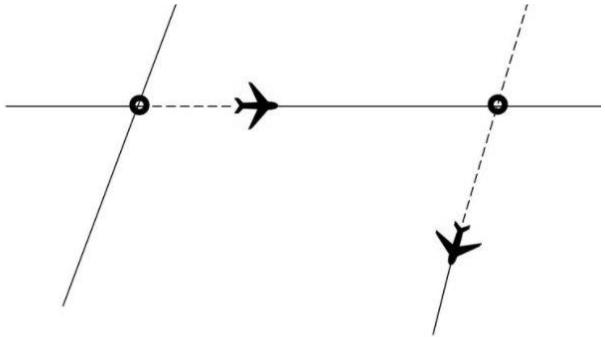


Fig. 1—Lateral separation achieved by reference to different geographic locations

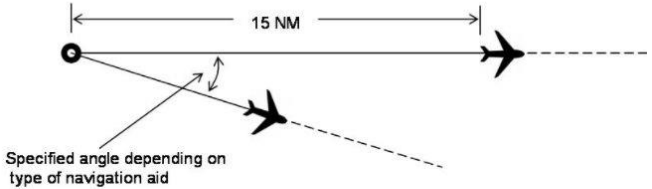


Fig. 2—Lateral separation achieved by reference to the same navigation aid

Procedures (cont'd)

Separation

- Longitudinal Separation
  - Based on position report and speed of the two aircraft
  - Same of diverging track
  - Eg, 15 mins in Fig. 3

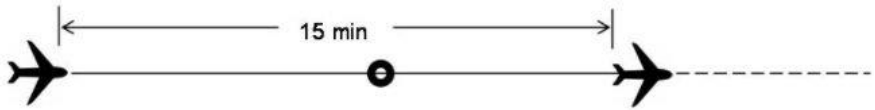


Fig. 3—Longitudinal separation for aircraft on the same track achieved by requiring them to pass over a specified point with separation of at least 15 minutes.

- Separation minima based on ATS surveillance systems
  - When surveillance systems are used (radar or ADS-B), the minimum ICAO separation by ICAO is 5 nm.
  - Lower separation is possible depending on the capabilities of the surveillance system and the national regulation
- Emergency Separation
  - In case of emergency, a 1000 ft vertical separation minimum may be reduced to 500 ft and 2000 ft vertical separation minimum may be reduced to 1000 ft. All flight crews concerned must be advised if emergency separation is used.

Procedures (cont'd)

Basic Control Techniques

- Identification
  - By use of a transponder
  - By comparing the reported position
  - By observing the response of the aircraft on a requested maneouvre
  - By transfer of identification by other ATC
- Radar Vectoring
  - Guide aircraft by a specific heading, under an ATS surveillance system
  - For smooth and expeditious flow of traffic
- Speed control
  - To achieved desired separation

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ATC in Hong Kong

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Hong Kong ATC

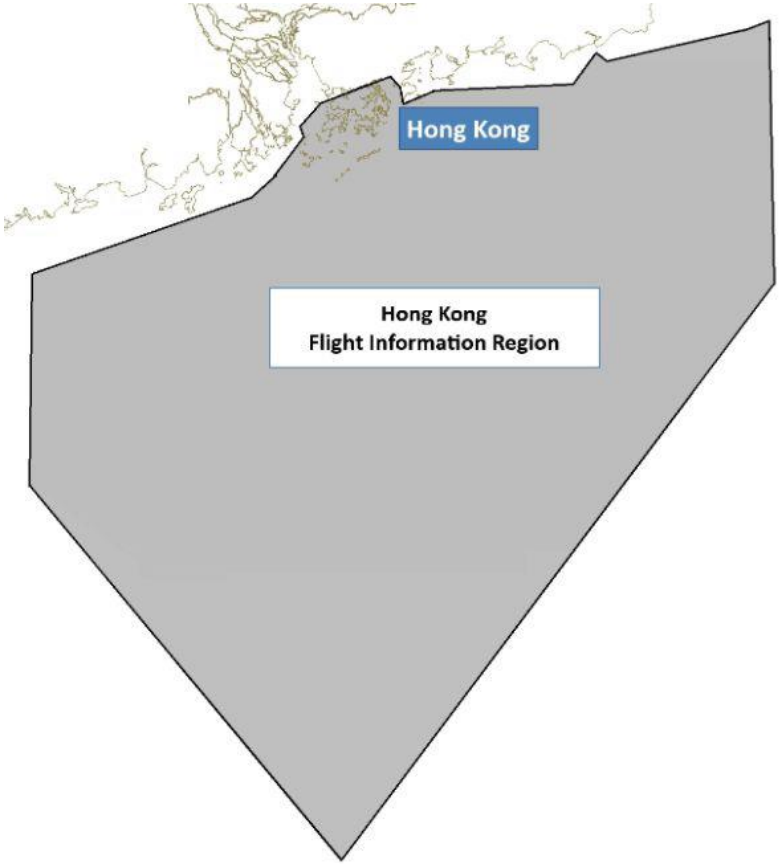
The ATC in Hong Kong

Hong Kong ATC (cont'd)

Airspace

Flight Information Region (FIRs) – All airspace around the world is divided into FIRs. Each FIR managed by a controlling authority that has responsibility for ensuring that air traffic services are provided to the aircraft flying within it.

The HK FIR covers a total area of 276,000 square kilometres extending over the South China Sea



Hong Kong ATC (cont'd)

Responsibility

- Provision of air navigation services
  - Air traffic services
  - Communication
  - Navigation and surveillance
  - Search and rescue
- Reliable and sustainable air navigation services; efficient and orderly in air traffic flow within the HK FIR
- Training
- Aeronautical Communication Services
- Design of ATC procedures

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